Report on

Flood Protection and Beach Retention Boundary Bay Village Area Delta, B.C.

Fraser River Flood Control Program

February 1987

Hay and Co. Consultants Inc.

ASSOCIATED ENGINEERING

ASSOCIATED
ENGINEERING (B.C.) LTD.

4940 Canada Way
Burnaby, B.C.
V5G 4M5
Tel: (604) 293-1411
Telex: 04-354757

February 18, 1987
File: VW11

Ministry of Environment and Parks
Water Management Branch
Rivers Section
737 Courtney Street
VICTORIA, B.C.
V8V 1X5

Attention: Mr. R. Cameron, P.Eng.
Project Manager

Dear Sirs:

Re: Boundary Bay Village Report on
Flood Protection and Beach Retention

We are pleased to present 20 copies of the final report on the Boundary Bay Village area. This report was prepared jointly by Associated Engineering (B.C.) Ltd. and Hay and Co. Consultants Inc.

The recommended design of the flood protection and beach retention facilities is the combination of a reinforced concrete wall and a system of filled groynes to meet the project requirements. A number of other designs were investigated and set aside. The costs range from a low of $1,980,000 to $2,708,000, giving the two possible extremes for a groyne-wall installation.

Procedures are recommended for implementation for the proposed works, which include review by the Municipality and local residents, as well as affected governmental authorities.

Yours truly,

Associated Engineering (B.C.) Ltd.

Hay and Co. Consultants Inc.

c.c. J. Leong - Environment Canada (2 copies)

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BOUNDARY BAY VILLAGE REPORT
DECEMBER 8, 1986

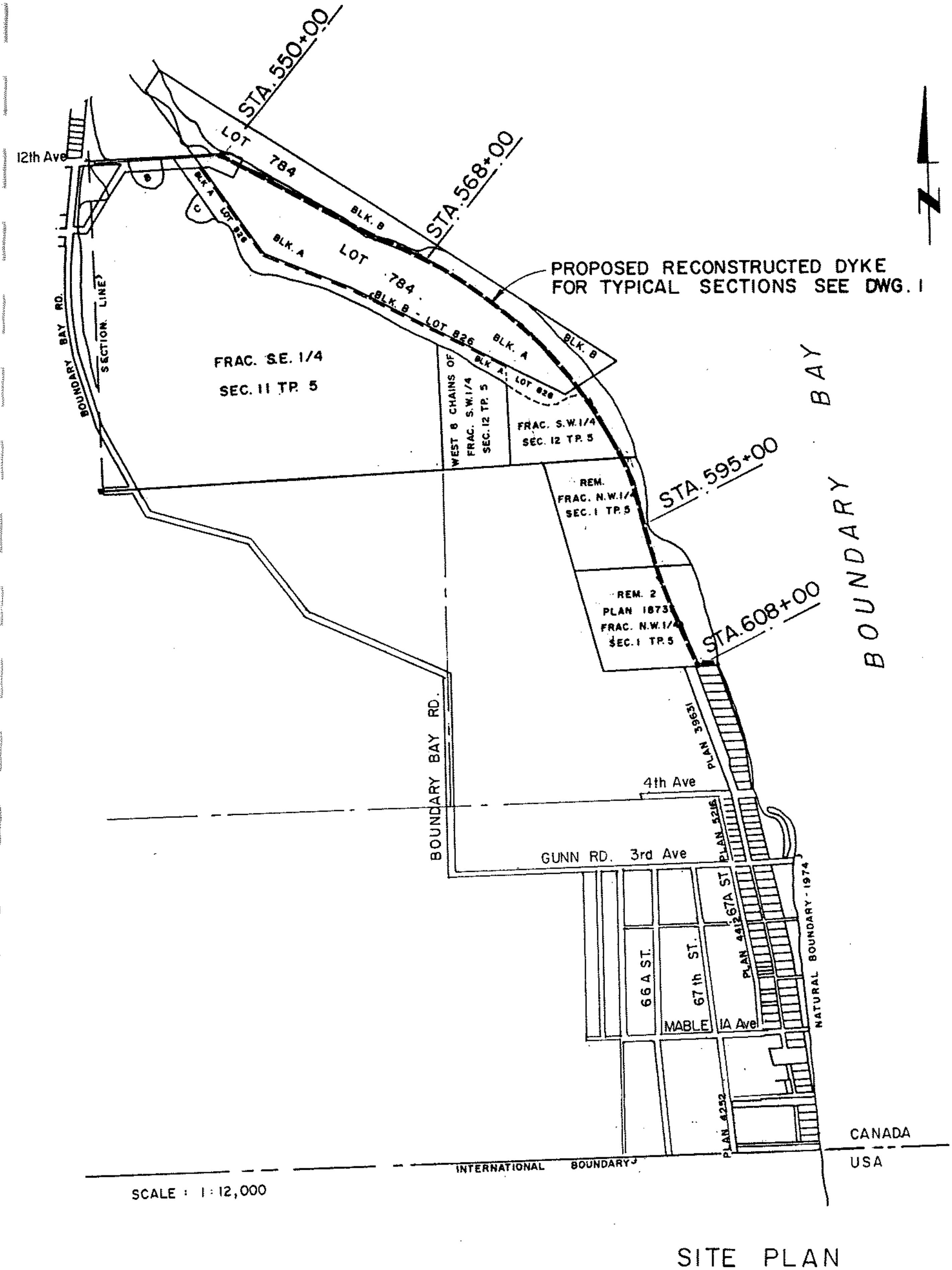
FLOOD PROTECTION AND BEACH RETENTION

CHAPTER 1 - INTRODUCTION

Upgrading of flood protection for the Municipality of Delta under the Fraser River Flood Control Program (FRFCP) commenced in 1973. To date, all waterfront areas have been improved to the Program's 200 year flood protection level, with the exception of the western shore of Boundary Bay from 12th Avenue, south to the United States border. This is the area covered by this report. (See Site Plan following page.)

The objective of the FRFCP is the provision of flood protection for the lands and development areas behind the dyking system to a standard which will substantially reduce the threat of flooding. An additional objective for the Boundary Bay Village area is to incorporate in the flood protection works, beach retention measures to ensure the preservation of the valuable beach areas for public use and enjoyment.

This assignment requires the provision of the approved level of flood protection in this area to the Program standard and, at the same time, to endeavour to minimize any detrimental environmental or social impact on the beach area. To attempt to accomplish this, the design team of Associated - Hay, met with the Boundary Bay Seawall Committee during the course of the study. These meetings were effective in securing local input on a number of matters relating to resident and public use and enjoyment of the beach area. There remains, however, the unresolved question of acceptance of the design concept by the Committee and this is dealt with in the sections on design concepts and procedures for implementation.



STA.550+00
STA.568+00
LOT 784
12th Ave
BLK. B
BLK. A
LOT 826
LOT 784
BLK. B - LOT 826
BLK. A
BLK. B
PROPOSED RECONSTRUCTED DYKE
FOR TYPICAL SECTIONS SEE DWG. I
BOUNDARY BAY RD.
SECTION LINE
FRAC. S.E. 1/4
SEC. 11 TP. 5
WEST 8 CHAINS OF FRAC. S.W.1/4 SEC. 12 TP. 5
FRAC. S.W.1/4
SEC. 12 TP. 5
REM. FRAC. N.W.1/4 SEC. I TP.5
STA.595+00
BOUNDARY BAY
REM. 2 PLAN 18731 FRAC. N.W.1/4 SEC. I TP.5
STA.608+00
PLAN 39631
BOUNDARY BAY RD.
4th Ave
GUNN RD. 3rd Ave
PLAN 5216
PLAN 4412
67A ST
66 A ST.
67 th ST.
MABLE
IA Ave
NATURAL BOUNDARY - 1974
PLAN 4252
CANADA
USA
INTERNATIONAL BOUNDARY
SCALE : 1:12,000

SITE PLAN

CHAPTER 2 - BACKGROUND

There have been a number of reports dealing with various aspects of the area under study and the most relevant of these was prepared by Associated Engineering for the Fraser River Flood Control Program in February of 1975.

The 1975 report covered the flood protection alternatives for the shoreline extending from the north limit of Beach Grove (17A Avenue), southward to the United States border. In 1977 construction of flood protection works was carried out in the Beach Grove area joining on to the previously constructed Boundary Bay dykes at 17A Avenue and extending southward to 12th Avenue. The work consisted of upgrading the existing seawalls to the Program standards for approximately 3,900 feet of waterfront in this built-up area north of 12th Avenue.

The preliminary design from 12th Avenue to the United States border was also studied in the 1975 report. The northernmost 3,000 feet of dyke follows the shoreline southward from 12th Avenue and is to be a standard FRFCP dyke with 12 foot wide roadway and stabilized landside and waterside slopes. The remaining 4,000 feet to the south side of Centennial Beach area, was to be grass slopes with a 12 foot wide gravelled travelling surface. As the dyke section was to be set back from the shoreline, with a wide sand foreshore, the waterside and landside treatments were to be medium slopes covered with native grass.

The remainder of the works extending from the south side of Centennial Beach through Boundary Bay Village to the U.S. Border, presented a special problem. In 1975, various alternative treatments were examined including flat beach slopes 40 horizontal to 1 vertical and a number of modifications to the Standard dyke with roadway and rock protected face. None of the suggested alternatives met the requirements of all affected parties and accordingly work on the southern section of the area was postponed.

In December of 1982, a storm combining the effects of the all-time high tide of 8.8 feet geodetic with prolonged southeasterly winds resulted in widespread damage to many areas in the Gulf of Georgia. In the Boundary Bay Village area, flooding of some shorefront buildings and of buildings and roadways in the adjacent streets took place. Emergency barriers of sand and logs were constructed by Delta, on the beach, to minimize flooding.

This storm renewed interest in flood control measures and has resulted in this study. The recommended flood protection concepts and beach retention measures are set out in Chapter 5, and represent the engineering approach to achieve a relatively self-sustaining installation and, at the same time, to minimize the impact upon the desirable beach facility.

During the course of this study, meetings have been held with the Boundary Bay Seawall Committee, set up by the Municipality to provide input on local viewpoints in respect of flood protection and beach retention measures. The Committee recognizes the potential threat of flooding, but have a number of concerns regarding any works on the beach area which may affect the use and enjoyment of the beach by residents of the area and by the public. The Committee concerns focus on the areas outlined in Appendix A.

There should be further discussion on the proposals set out herein and it is suggested these be discussed at public meetings, where every affected resident can present his/her concerns and receive information on the intended program.

CHAPTER 3 - GEOMORPHOLOGY

At the close of the last glaciation, the piedmont glacier which covered the Fraser Lowland downwasted and receded towards the north and east. As lowland areas were freed of their ice cover, they were invaded by the sea but subsequently rebounded restricting marine waters to relatively narrow arms in the low valleys now occupied by the Fraser River and its tributaries.

About 11,000 to 11,300 years ago, glacier ice had disappeared from the eastern Fraser Lowland and the valley between Mission and Pitt Meadows, which formerly carried meltwater from the piedmont glacier, was now occupied by the Fraser River.

By about 10,500 years ago, the Fraser River flood plain was continuous east of Pitt Meadows. All of the glacially eroded basins on the floor of the Fraser River valley east of Pitt Meadows were completely filled with sediment, and the Fraser River emptied into a fjord extending northeast to present Pitt Lake.

Point Roberts Peninsula was an island at this time having emerged after the glacial retreat, and the sea was in direct contact with the Surrey and Burrard uplands in the vicinity of New Westminster. A narrow gap in the uplands connected the Pitt fjord with the Strait of Georgia. The prograding Fraser delta subsequently closed Pitt fjord isolating Pitt Lake from the sea, Figure 1. Shortly thereafter, the Fraser River extended its floodplain westward to New Westminster and began to empty into the Strait of Georgia.

While these events were occurring, the level of the sea continued to fall relative to the land until about 8000 years ago when the sea was at its lowest position, a level of 12 m or more below the present sea level. The Fraser River floodplain stabilized and the delta continued to grow westwards.

This period of low sea levels was followed by a marine transgression which commenced about 7000 to 7500 years ago and continued until about 5000 to 5500 years before present (BP). Rising seas triggered aggradation of the Fraser River flood plain and an intradelta platform extending at least 15 km south and west of New Westminster was formed. The seaward edge of this platform, about 5000 years ago was west of Burn's Bog and Lulu Island, and most or all of the southern delta found at Boundary Bay was in existence.

The Fraser River did not enter the eastern half of Boundary Bay across the delta after this period, however, a distributory may have passed west of Burn's Bog entering westernmost Boundary Bay some time after 500 years BP.

Westward progradation of the Fraser Delta during the last 5000 years has been accompanied by comparatively stable sea levels. Development of the delta during this time saw the southern boundary connect with Point Roberts Island forming Boundary Bay. Channel instabilities were confined to the prograding mouth of the delta to the north of Point Roberts as inner channels remained relatively fixed in position.

Coastal processes including tidal currents and wave action have assisted in shaping the Fraser River delta and adjacent shorelines. Erosion of the Point Roberts and White Rock uplands has supplied sediments to the littoral zone or shoreline for transport by longshore currents resulting from wave action. Once Boundary Bay had stabilized littoral sediments were carried northwards and deposited over the Fraser River delta silts and sands.

Erosion of the bluffs at the southeast tip of Point Roberts, Photo 1 provides a source of material for development of the shoreline between Boundary Bay Village and Beach Grove. The predominant southeasterly waves create a northerly littoral drift or longshore sediment transport. Figure 5, which diminishes in magnitude to the north, as the waves traverse a greater portion of the tidal flats. Transport of the bluff material after the stabilization of Boundary Bay has resulted in a progressive development of the shoreline with a convex platform, Figure 2. The littoral sediments migrate along the coast as longshore bars and are deposited over the tidal flats formed by the Fraser River. Evidence of the transport and deposition process can be seen in the longshore bar currently approaching 12th Avenue and in the strata exposed in several test pits excavated across the foreshore. The test pit logs, Figure 3, show a layer of black silty sand at an elevation similar to the tidal flats. The locations of the test pits are shown on Figure 2.

The upper foreshore sediments, above mean high water are also transported shorewards by wind action building a frontal dune and leaving the area behind at a lower elevation. Several relic frontal dunes are shown in Figure 2. The current frontal dune is typically breached during severe storms with subsequent flooding of the low area behind. The Boundary Bay Village properties abutting the shoreline have been constructed on the frontal dune whereas the remainder of the village is situated on the adjacent low area and is subject to flooding during severe storms.

The foreshore zone or beach is characterized by a sandy upper portion with a cobble covered or armoured lower section leading to the tidal flats. Typical beach profiles are shown in Figure 4 and the characteristic segments of the foreshore are shown in Photo 2. The upper foreshore slopes at around 1V:10H extending from the crest of the frontal dune to around elevation 3.3 ft geodetic (GSC). The lower foreshore flattens to a slope of 1V:20H and is armoured with 1 inch to 3 inch cobble. The tidal flats lie at around elevation 0 ft GSC and are composed of a fine uniform sand. Test pits tp2 and tp4 indicate the cobble armour layer of the lower foreshore to be derived from the underlying matrix of sand, gravel and cobble, the fines having been transported onshore and alongshore by wave action.

The section at line 1 Figure 4, Photo 3, is an exception to the typical foreshore profile. The upper foreshore is essentially nonexistent having been replaced by a wall and the armoured lower foreshore extends into a shallow trench scoured into the tidal flats along the front of the wall. the scour along this section of the foreshore adjacent to the Canada - USA border is caused through reflection southeasterly waves approaching the shoreline obliquely. Where the reflected wave crosses the incident wave, Photo 4, the wave height is almost doubled with a subsequent increase in sediment transport capability.

The effect of structures on sediment transport patterns can also be seen at the 3rd Avenue outfall. A concrete box culvert extends a short distance seawards of the property lines and has trapped the longshore sediment transport on the upcoast or south side widening the backshore area, Figure 2, Photo. 5

CHAPTER 4 - WAVE AND TIDE CONDITIONS

The predominant waves at the site and those which have developed the shoreline from Boundary Bay Village to Beach Grove are generated by southeast winds. These prevailing southeast winds are developed as Pacific frontal systems cross the coast during the winter (Dec - Feb) and set up a pressure gradient along the Strait of Georgia. Wind speeds range from 30 knots for typical winter storms to 50 knots during extreme events.

A fetch of open water extends from 40 km to the southeast of the site. Waves generated over this fetch are modified on approaching the coast as they refract and shoal across the tidal flats. A typical refraction pattern, Figure 5, shows lines of wave rays or orthogonals which are normal to the wave crests. Converging rays indicate a concentration of wave energy whereas diverging rays indicate a reduction in wave height. The eroding bluffs at the southeast corner of the Point Roberts peninusla lie at an area of concentrated wave energy.

To the north of the point, southeast waves approach the foreshore obliquely generating a northerly littoral drift. The rate of sediment transport along the foreshore diminishes with distance to the north as the tidal flats widen. The increasing length of travel across the tidal flats reduces the wave energy through the effects of shoaling and bottom friction.

Extreme tides in the Strait of Georgia occur during the winter months when astronomical tides are their greatest and low pressure meteorological events create a storm surge raising the tide level. The extreme high tide level with a probability of occurring once in 200 years has been estimated at 9.1 ft GSC. The value was derived from an analysis of storm surge data recorded at the Point Atkinson tide gauge from 1914 to 1984.

Meteorological conditions for the two highest recorded tides (1967 12 05 and 1982 12 16) together with the conditions for a typical event are shown in Table 1 below.

The typical storm event (1984 12 14) was observed and recorded photographically. The deep water wave climates for the observed storm and the two highest recorded events were hindcast using a 40 km fetch and the results are included in Table 1. Further calculations were made to determine the wave heights along the shoreline and to estimate the likely run up at the wall adjacent to the Canada - USA border (Line 1, Figure 4). The results of the run up analysis are also included in Table. 1

TABLE I - STORM EVENT CHARACTERISTICS

Item	1967 12 05	1982 12 16	1984 12 14
Meteorological Conditions			
Low pressure	986.4 mbar	986.4 mbar	996.6 mbar
1 hour wind	31 knots	22 knots	15 knots
Direction	South	SSE	SSE
Equiv. 3 hr wind	28 knots	18 knots	12 knots
Max. Tide	8.6 ft	8.8 ft	6.2 ft
Deep Water Wave Climate			
Ho significant	6.3 ft	3.4 ft	2.2 ft
Period	5.4 s	4.4 s	3.8 s
Shoreline Waves			
Refraction coeff.	0.6	0.8	0.8
H toe of beach	3.8 ft	2.7 ft	1.8 ft
H against wall	6.0 ft	4.4 ft	2.9 ft
Run up el at wall	11.6 ft GSC	11.0 ft GSC	7.7 ft GSC

Notes: refraction coefficient derived from figure 4, H = wave height, run up based on beach/wall profile on line 1.

The wave period for the 1984 event was observed to be between 3 and 4 seconds and as Photo 4 shows the waves overtopped some of the lower walls. The 1984 event can be classed as a typical winter storm resulting from a Pacific low pressure system crossing the coast. The high water level was slightly less than that of a large tide and the winds were moderate, whereas the 1982 and 1967 storms were more extreme events. Figure 6 indicates the high water level recorded for the extreme events to have a probability of occurring once in 50 years. The wind speeds recorded during the extreme tides although stronger than the 1984 storm are not severe and occur frequently each winter.

The high water level with a probability of occurring once in 10 years is only slightly lower than the highest recorded level, Figure 6, and if coupled with a sever winter storm could have a greater potential for flooding and damage than the 1982 and 1967 events.

5.0 FLOOD PROTECTION CONCEPTS

Flood protection for Boundary Bay Village forms the last link in providing complete flood protection for the Municipality of Delta. The protection works in Delta have been provided under the Fraser River Flood Control Program and designed accordingly. The primary objective of the Program is to provide flood protection against an event with a probability of occurring once in 200 years.

The main parameter to be considered in the design of flood protection works is the high water level achieved during the design flood event. Several other factors apart from height also need considering in any concepts for shoreline flood protection. Such factors are: access to the foreshore, view from any houses along the shoreline, stability of the foreshore, retention of a recreational beach, outflanking at the extremities of any structure, and stability of the structure itself.

Options addressing the technical needs for providing flood protection for Boundary Bay Village have been examined. The concepts include a seawall or impervious barrier, a beach with a backshore berm supported by cobble armour or groynes, and headlands supporting a stable shoreline planform. The headland scheme was abandoned on the basis of visual impact and the other three options were studied in greater detail.

The criteria for determining the required height of protection works along the shoreline are tides, storm surge, and freeboard allowance to provide for wave runup. The meteorological event creating a large storm surge will also develop high winds with subsequently large wave heights. The one in 200 year design flood level can be taken as equal to the one in 200 year high tide and storm surge level of 9.1 ft GSC. The maximum wind speed and wave height likely to occur concurrently with the one in 200 year storm surge has not been determined, however a typical winter storm with wind speeds of 30 knots could easily be expected.

Flood protection for the village could be achieved by means of the upgrading and interconnecting of the existing privately owned seawalls. Although such an approach may be easily implemented, there are several drawbacks where the upper foreshore is narrow or could become narrow as a result of increased sediment transport. high wall with deep foundations and a rip-rapped toe would be required to avoid overtopping by waves and undermining of the base.

The determination of a freeboard for seawalls is tied to the likely wave run up. Using the cross-section at line 1, Figures 4 as a design basis, a water depth of 5.5 ft would exist at the wall during the 1 in 200 year high tide. The maximum wave height is limited by the depth of water and a wave with a height of 4.6 ft and as 5 second period would be just breaking at the wall. Reflection of the incident wavew from the wall would result in a standing wave with a run up of 3.9 ft above the still water or high tide level.

Protection against flooding during a 1 in 200 year high tide and typical winter storms could be provided by a seawall with a top elevation of 13.1 ft GSC and founded with suitable toe protection, Figure 7.

The use of a wall alone as flood protection for Boundary Bay Village has several disadvantages. The necessary height of the wall will impose a visual barrier to views from the ground floor of houses along the foreshore and access to the beach will be restricted. More importantly from a technical viewpoint will be the effect of the wall on the beach. During high tides, incident waves will be reflected back across the foreshore leading to increased longshore sediment transport rates and subsequent lowering of the beach face.

The disadvantages of the seawall could be overcome if the majority of wave energy approaching the shoreline could be dissipated before reaching the wall. The incorporation of a stabilized beach as an integral part of the flood protection would achieve this aim. The components of a combined beach/seawall scheme would include: a beach face to dissipate most of the wave energy through breaking in a surf zone, a backshore berm to provide some insurance against the erosive effects of severe storms and a wall backing the foreshore to formalize the protection and act as a barrier against extreme tides.

The characteristics of the proposed beach and backshore berm concept have already developed naturally, south of the 3rd Avenue outfall (Figure 2, line 2, Figure 4 and Photo 5).

The issues to be addressed in the beach/wall concept are the stabilization of the beach, the width and elevation of the backshore berm and the elevation for the top of the wall.

The foreshore facing Boundary Bay Village is highly mobile and stabilization measures will be required to support the beach as part of the flood protection scheme. Two options for stabilizing the beach were considered: a perched beach and a groyne field. Both schemes include a backshore berm with a suggested width of 50 ft to 75 ft set at an elevation around the annual high water mark of 8 ft GSC. The berm, which would be grassed to stabilize the sand surface, is backed by a wall along property boundaries and faced with a beach leading to the tidal flats. The top elevation of the wall, as set by the Fraser River Flood Control Program guidelines would be 2 ft above the one in 200 year flood level or 11.1 ft GSC and the beach would be sloped at approximately 1V:12H. The two schemes differ in the approach taken to stabilize the beach.

The perched beach is stabilized by a layer of cobble of sufficient size to remain in place during severe wave attack. A typical plan and cross-section of the perched beach concept is shown in Figure 8. The foreshore would be filled out with sand as necessary to meet the required profile then protected with a layer of cobble armour. The armour size becomes coarser near the top of the beach and is capped with a row of boulders along the crest to prevent erosion during extreme tides. A short groyne would be required at the Canada-USA border to establish the profile.

The basic groyne concept as shown in Figure 9 involves the use of structures normal to the wall and spaced apart approximately four times the width of the berm at the structure. The groynes act as hard points stabilizing the foreshore alignment against erosion by wave action. Continual supply of sediment from upcoast would maintain the berm adjacent to the wall. Cessation of the sediment supply would result in a loss of a portion of the berm between adjacent groynes, however, the integrity of the shoreline would be maintained and the wall's foundation would not be threatened.

The groynes would not need to be massive structures and could be buried across the berm. The beach would be generally flush with the sloping portion of the groyne along the updrift (south) side while a portion of the structure would be visible on the downdrift side. The structures could be composed of posts or piles with walings from timber, concrete, steel or a combination of materials. The berm and beach would need to be filled initially to a stable alignment to avoid starving the downdrift foreshore from a supply of sediment. The existing characteristics of the foreshore should be maintained, that is a sand/gravel berm and upper foreshore with a cobble armoured lower foreshore.

A continual supply of sediment is required to maximize the factor of safety associated with stability of the foreshore strip and maintain a dynamic equilibrium. The supply currently arrives as littoral drift from the eroding bluffs of Point Roberts. Should the relevant US agencies alter their current policy and the bluffs be stabilized or the supply otherwise be trapped, a means of maintaining the sand within the groyne field would be desirable. Carting sand by truck annually or bi-annually from Centennial Beach to the border would be a suitable means of maintaining a full beach. Failure to maintain the beach fill would allow the static equilibrium profile to develop with a loss of the berm and exposure of the wall over a portion of the beach between adjacent groynes. The flood protection scheme would not be in jeopardy, however a small amount of overtopping of the wall may occur at the exposed portions during an extreme event. Maintenance would otherwise be associated with upkeep of the structures.

The number of groynes needed to stabilize the shoreline requires further discussion and study. The two possible extremes; numerous short structures closely spaced and few long structures are shown in Figures 10 and 11 respectively. A suggested approach to finalizing the groyne concept would be to select a length, spacing and location using the layouts in the above figures as limits. The 3rd Avenue outfall has been incorporated into one of the groynes in both layouts. The outfall would need to be extended to the high-water line of the new shoreline if not incorporated into one of the groynes.

The stabilized beach and wall concept has some disadvantages. Although the view from the residences will be improved over the seawall concept, the high-water line will be further seaward. A portion of the tidal flats will be covered and mitigation may be required for loss of habitat. Occasional maintenance of the berm may be required to remove excessive debris. The perched beach has the further disadvantage of presenting a somewhat unsuitable access to the tidal flats.

6.0 RECOMMENDED FLOOD PROTECTION CONCEPT

A groyne field supporting a backshore berm and beach together with an impervious wall is the recommended option for flood protection along the Boundary Bay Village shoreline. The scheme would consist of the following components:

- a concrete or other impervious wall set along property boundaries and founded to an elevation of 0 ft to 2 ft GSC.
- a field of groynes set normal to the wall.
- each groyne having a horizontal section abutting the wall at an elevation of 7.5 ft GSC, extending out a distance to suit the spacing followed by a 125 ft long section sloping to the tidal flats at a gradient of 1V:12H.
- incorporation of the 3rd Avenue stormwater outfall into one of the groynes.
- pre-filling of the foreshore to the top of the groynes with sand.
- armouring of the lower portion of the beach face from elevation 3 ft GSC to the toe with 1 inch to 3 inch round natural gravel-cobble.

A specific groyne field layout has not been recommended as the choice should suit the desires of the District, Committee and local residents. Limits for high and low densities of technically feasible groyne fields have been presented as a guideline for selecting an acceptable layout.

Further items will need addressing prior to and during the detailed design of the protection scheme:

- the length of the groynes once a spacing and layout has been selected.
- a means to avoid outflanking of the groyne field and erosion at the downcoast end adjacent to Centennial Park.
- top elevation of the wall.
- the width of the berm desired.
- the stable fill alignment between adjacent groynes, and
- the effects on habitat of the tidal flats.

CHAPTER 7 - ESTIMATED COSTS

7.1 CONSTRUCTION COSTS

Cost estimates have been prepared to indicate the construction costs of the basic alternatives which have been evaluated in this report. Also shown are the relative costs of maintenance for each alternative which would be borne by the Corporation of Delta.

Item 1

Section I (12th Avenue to Centennial Park - 5,800 feet)

DYKE		
Upgrading of dyke to crest elevation of 11.1 ft, with 12-ft wide roadway and stabilized grass slopes	-	$ 468,600

Item 2

Section II (Centennial Park to U.S. Border - 4,200 ft)

IMPERVIOUS CONCRETE WALL		
Concrete seawall barrier	-	336,600

Item 3

Groynes (Groynes - Centennial Park to U.S. Border)

ALTERNATIVE 3A - Groyne beach stabilization (13 groynes)	-	1,174,800
ALTERNATIVE 3B - Groyne beach stabilization (3 groynes)	-	1,903,000
TOTAL COST (13 groyne system) (Item 1 + Item 2 + Item 3A)		$1,980,000
TOTAL COST (3 groyne system) (Item 1 + Item 2 + Item 3B)	=	$2,708,200

NOTES:

1) These estimates are based upon current construction unit prices and include a contingency allowance of 10%.

2) No allowance has been made for engineering, site supervision or escalation.

7.2 MAINTENANCE COSTS

The maintenance of the completed flood protection and beach retention works will be handed over to the Municipality upon completion and acceptance of the project.

Projected maintenance costs are set out herein to indicate the probable magnitude of those costs. The report emphasizes the importance of a continuing supply of sediment from the feeder source up-coast, in projecting maintenance costs. The Corps of Engineers offices in Seattle have indicated that they know of no plans to interrupt the natural erosion of the Point Roberts Bluffs. Any such plan would have to be reviewed by that Agency to assess the possible effect on the beach south of Boundary Bay Village on the American side, and the Canadian beaches also would be of concern to them. The costs indicated herein are prepared on the assumption of continuation of the long-term sediment supply by natural means.

Projected Maintenance Costs

Projected normal annual maintenance	-	$ 6,500
Projected major storm maintenance (once in 10-year period)	-	$25,000

CHAPTER 8 - PROCEDURES FOR IMPLEMENTATION

It is recognized that there may be a need for further discussion upon the proposals outlined herein. The hope is that these can be examined through public discussion and input, and eventually resolved to permit the final "closing of the protective ring" of flood protection for the Municipality of Delta, to be put in place.

Meetings have been held with the Boundary Bay Seawall Committee and a number of comments have been received on the groyne concepts. The comments have been helpful in identifying areas of concern about the groyne proposal itself, and also many aspects of use of the beach (See Appendix A).

The following steps are set out to indicate a sequential pattern of events leading to public review and comment and to decisions as to future action.

The suggested procedures are as follows:

1. Review of this report by the Fraser River Flood Control program.

2. If approved, distribution of copies of the report to the Boundary Bay Seawall Committee and to the Corporation of Delta.

3. Public meeetings to present the proposed program to the residents of the area concerned. These could be small gatherings to permit face-to-face discussions with the designers to ensure that all affected property owners and residents are clear as to the proposed construction and that they have the opportunity to express their opinions and concerns.

4. Hopefully from the above would emerge an acceptance of the design, or amendments, if appropriate, which would have public support and understanding, and which will preserve the beach and still meet the flood control requirements set out by the FRFCP. If this step can be accomplished, a detailed design should be prepared and submitted for review and comments to the review agencies having jurisdiction.

5. The current extension to the Fraser River Flood Control Program is to the year 1994, with a limit on annual expenditures in the program. It is important that this closing link in the flood protection for Delta be recognized as a necessary project for this area, and that measures to preserve the quality of the beach be included.

APPENDIX A

BOUNDARY BAY SEAWALL COMMITTEE CONCERNS

QUESTION 1 : Would the concrete wall to elevation 11.0 be adequate flood protection on its own, without some beach improvement?

ANSWER : No, without the beach protection it would be topped and flooding would occur. Either the wall should be raised to 13 ft, or the beach protection should be provided.

QUESTION 2 : Cost of proposed works and maintenance costs?

ANSWER : See Chapter (7)

QUESTION 3 : Will the sand levels in the upstream (south) side of groynes, and in the downstream (north) side of groynes be maintained?

ANSWER : Yes, during normal annual tidal cycles, within 1% of beach materials costs. Following peak storm and tide conditions - some refilling would likely be required, i.e. 4% of cost of beach materials (once every 10 years).

QUESTION 4 : How would additional maintenance costs be covered?

ANSWER : The Municipality of Delta would be required to maintain the filled groynes.

QUESTION 5 : Types of groynes (See Drawing No. 2)

QUESTION 6 : Will groynes be a hazard to users of beach?

ANSWER : The modified design calls for wooden plank interlocking piles driven or jetted and capped by a concrete cap with a smooth curbed upper section (See Drawing Nos. 2 and 3). The top of the cap would be buried in the flat 75-ft beach berm outside the wall. On the sloped section of the beach, the cap would be exposed with possibly some of the vertical plank piles under the cap visible from the north exposure and buried on the south side. All exposed surfaces would be smooth and not be as much hazard as stranded logs on the beach.

QUESTION 7 : What would be the type of sand used and would the sand be costly?

ANSWER : The sand would be similar material and size to the natural material deposited by littoral drift. It is estimated to run about $7.50 per yd in place for imported sand. If the sand can be obtained from the area north and west of Centennial Beach, the cost would be lower.

QUESTION 8 : Does the berm have to be 50 ft in width?

ANSWER : The width of the berm at the groyne vries with the groyne spacing, however, a minimum of 50 ft is desirable midway between groynes, to ensure the beach integrity.

QUESTION 9 : Will the waterfront homes lose their privacy?

ANSWER : The site line drawing shows to actual scale the situation with regard to a number of waterfront homes. The drawing indicates very little change in the existing situations on these homes.

QUESTION 10: Will the proposed method of groyning affect the aesthetics of the beach?

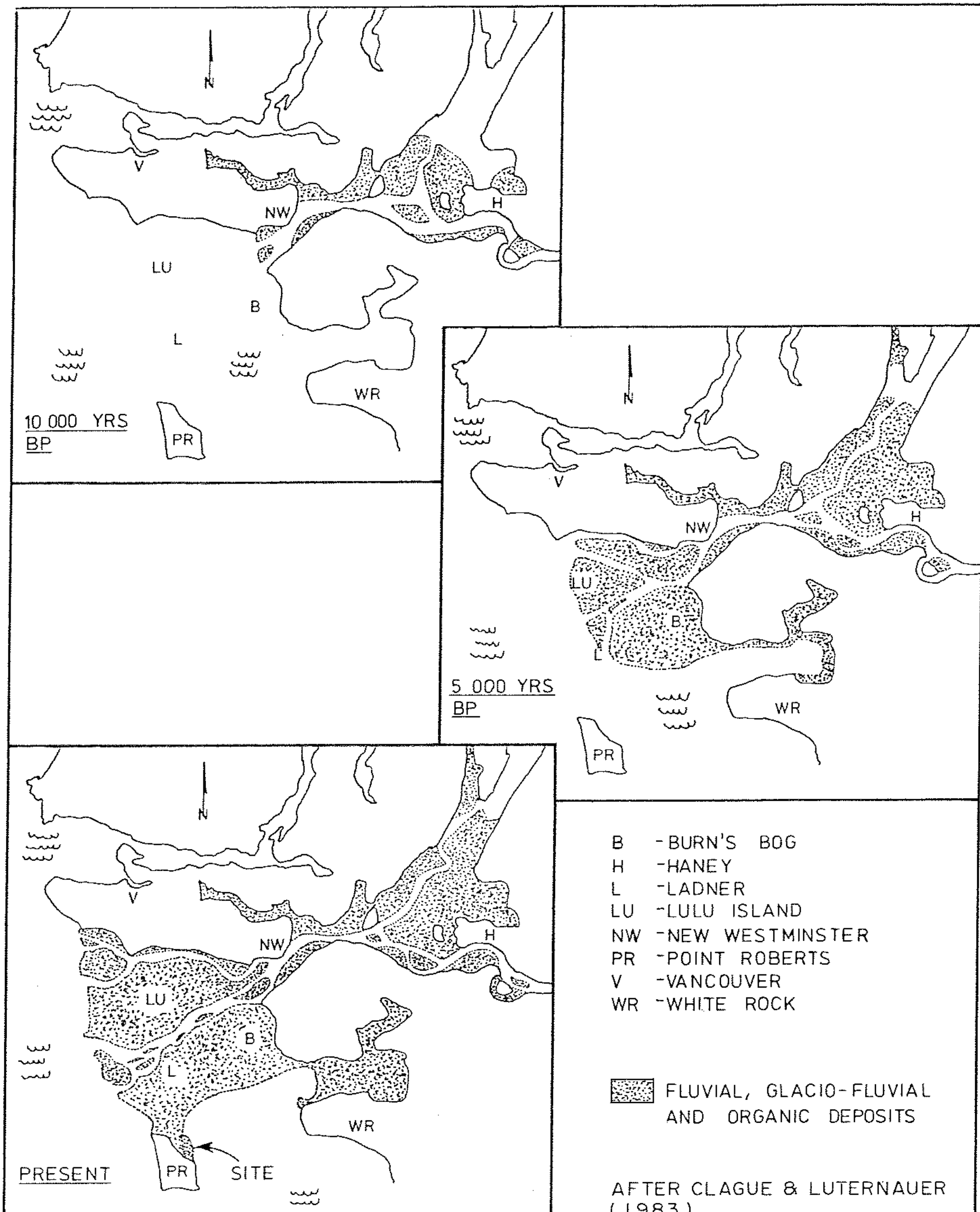
ANSWER : Yes, undoubtedly, to some extent. The upper level groyne extending horizontally from the concrete wall will be unseen, as the groynes will be buried there and covered with approximately 6 in. of sand. They will only act as protection in extreme storm conditions.

Proceeding waterside, down the sloping face of the beach, the top section of groyne will usually be exposed. The top concrete cap will be a smooth curved surface and should not present any hazard, but may be regarded as an interruption of the line of the beach. The surface would look somewhat like the perspective Drawing No. 3 attached.

QUESTION 11: Will Fisheries and Oceans approve of the proposed groynes?

ANSWER : This method of beach stabilization has been widely applied and is adapted to the specific needs of the Boundary Bay Village area. When completed the design will produce a reasonably stable environment for sea life comparable to the present situations.

Once an acceptable design is selected, the details of the design and the sequence of construction would be reviewed with the appropriate authorities.



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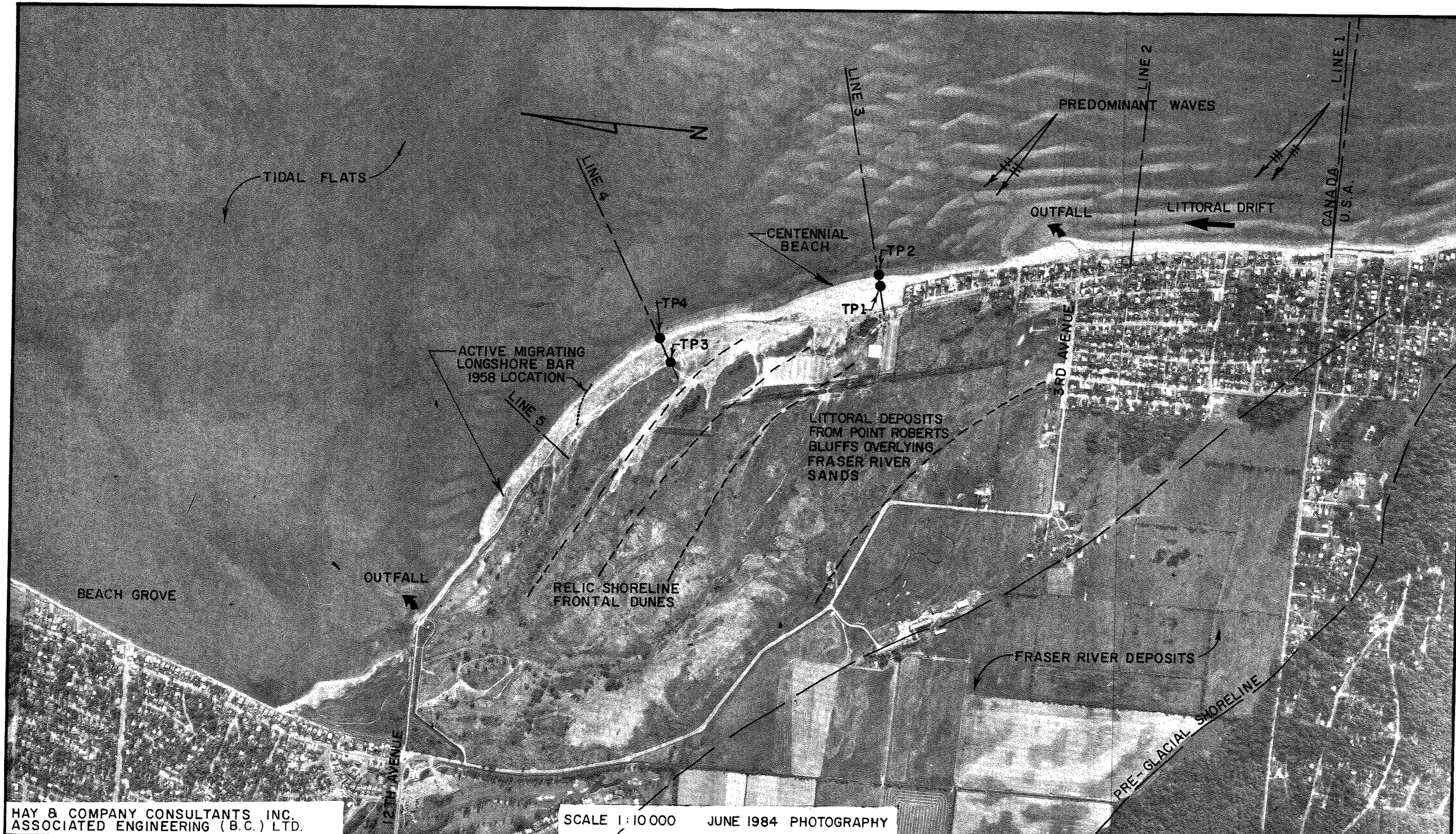
BOUNDARY BAY VILLAGE
FLOOD PROTECTION

FRASER RIVER DELTA
DEVELOPMENT

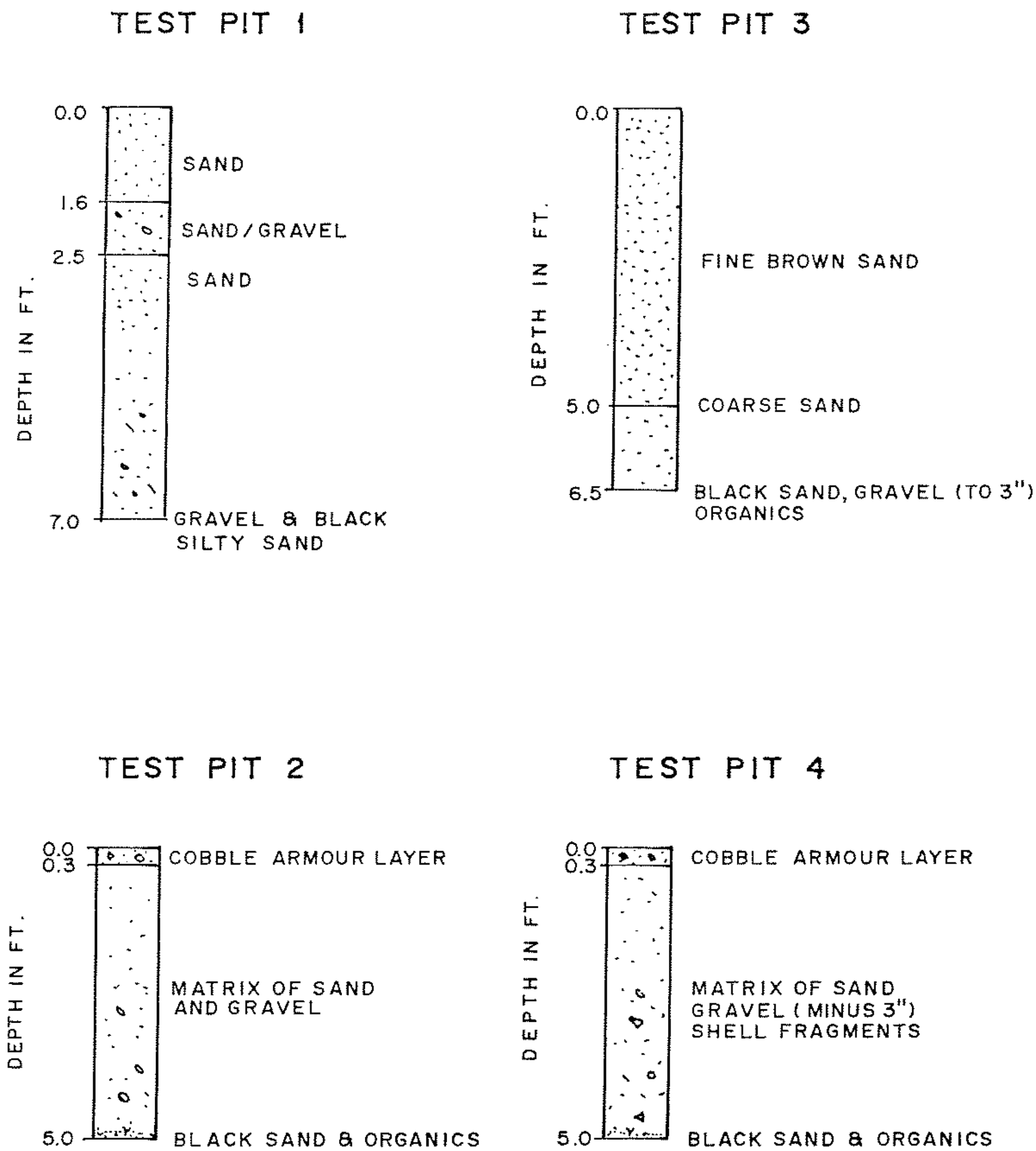
FIG. 1



BOUNDARY BAY VILLAGE
FLOOD PROTECTION

SITE PLAN

FIGURE 2



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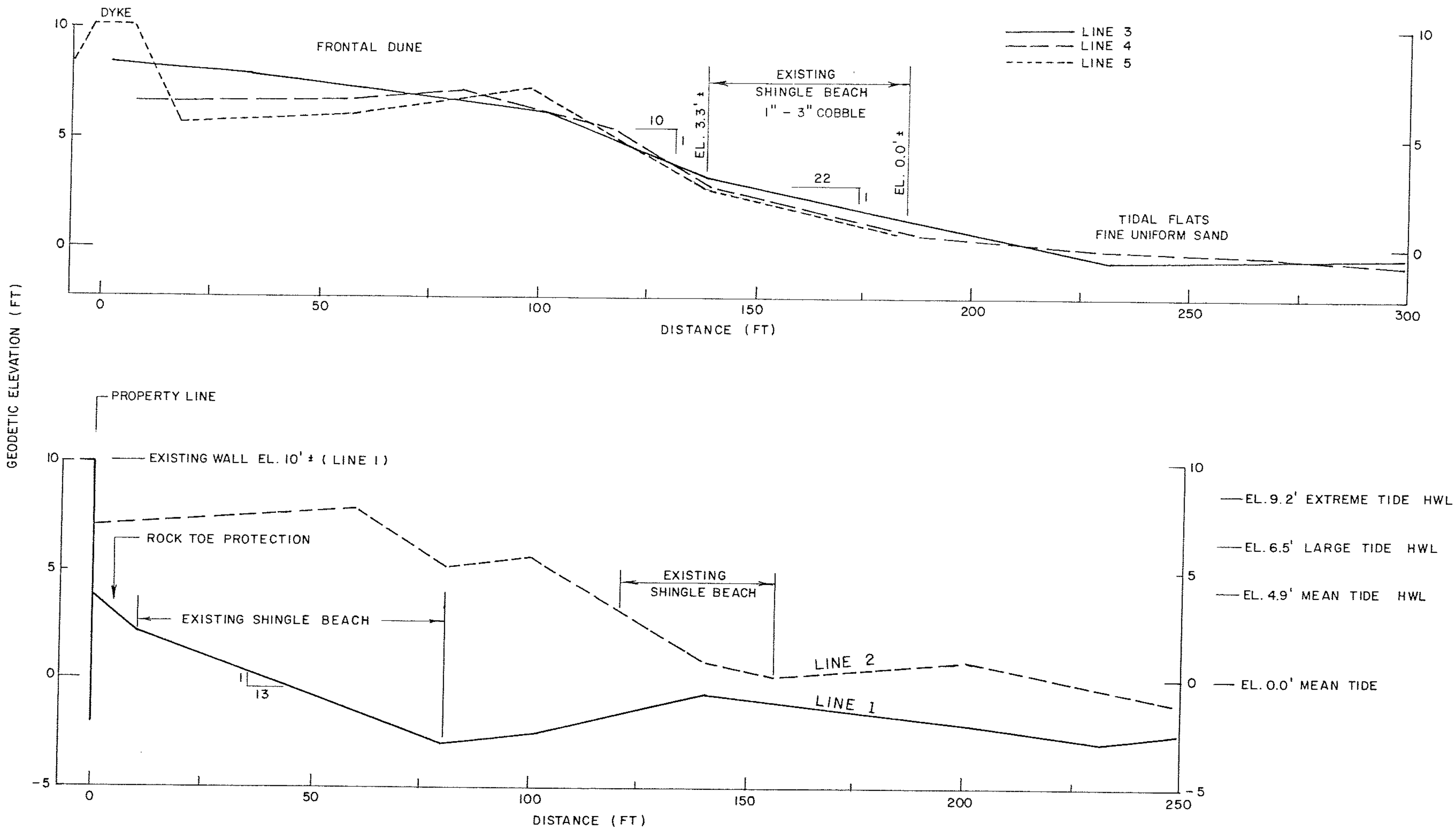
BOUNDARY BAY VILLAGE
FLOOD PROTECTION

TEST PIT LOGS

FIG. 3



NOTE : SEE FIG. 2 FOR LOCATION OF LINES.

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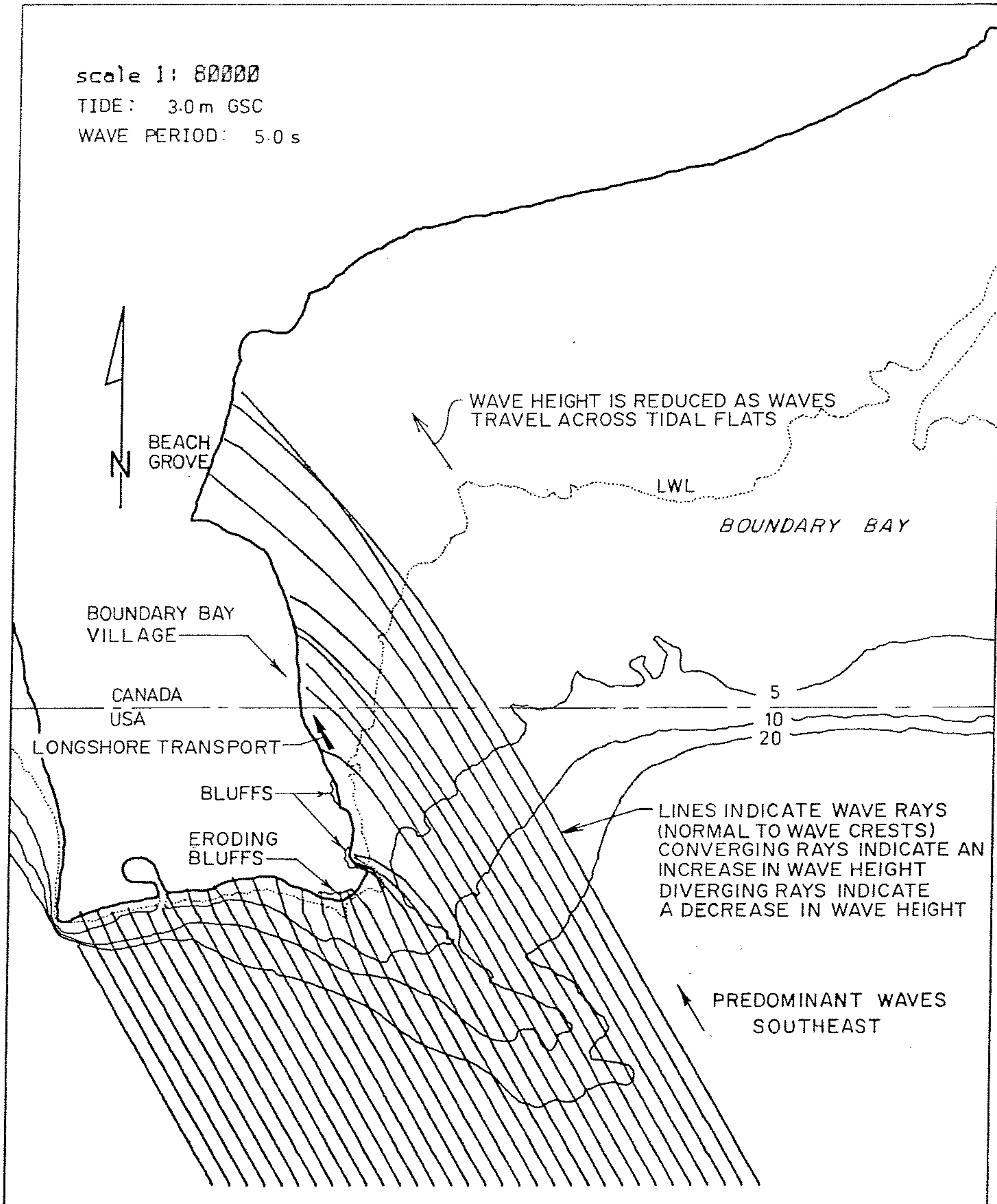
BOUNDARY BAY VILLAGE
FLOOD PROTECTION

BEACH PROFILES

FIGURE 4



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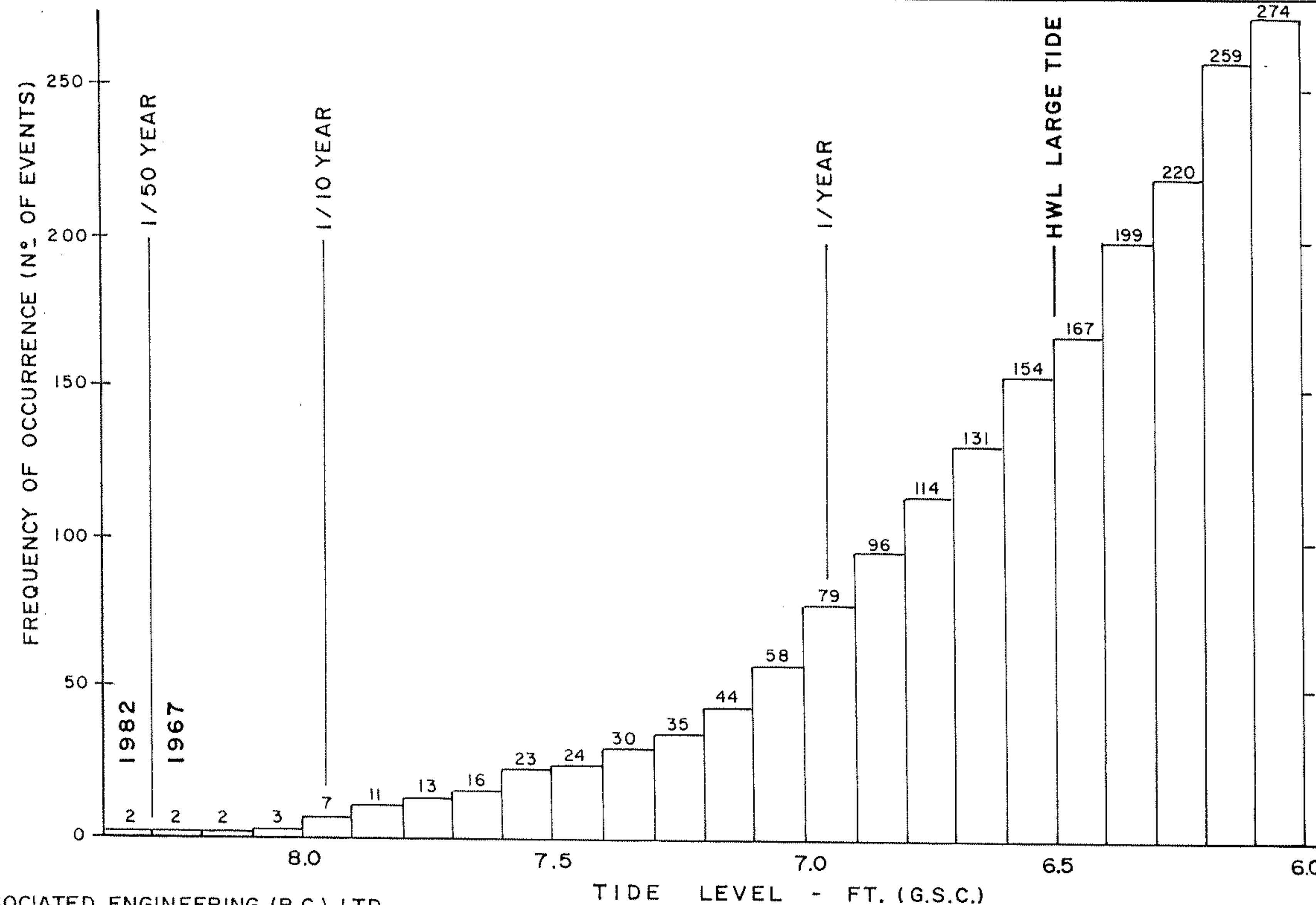
BOUNDARY BAY VILLAGE
FLOOD PROTECTION

WAVE
REFRACTION

FIG.
5



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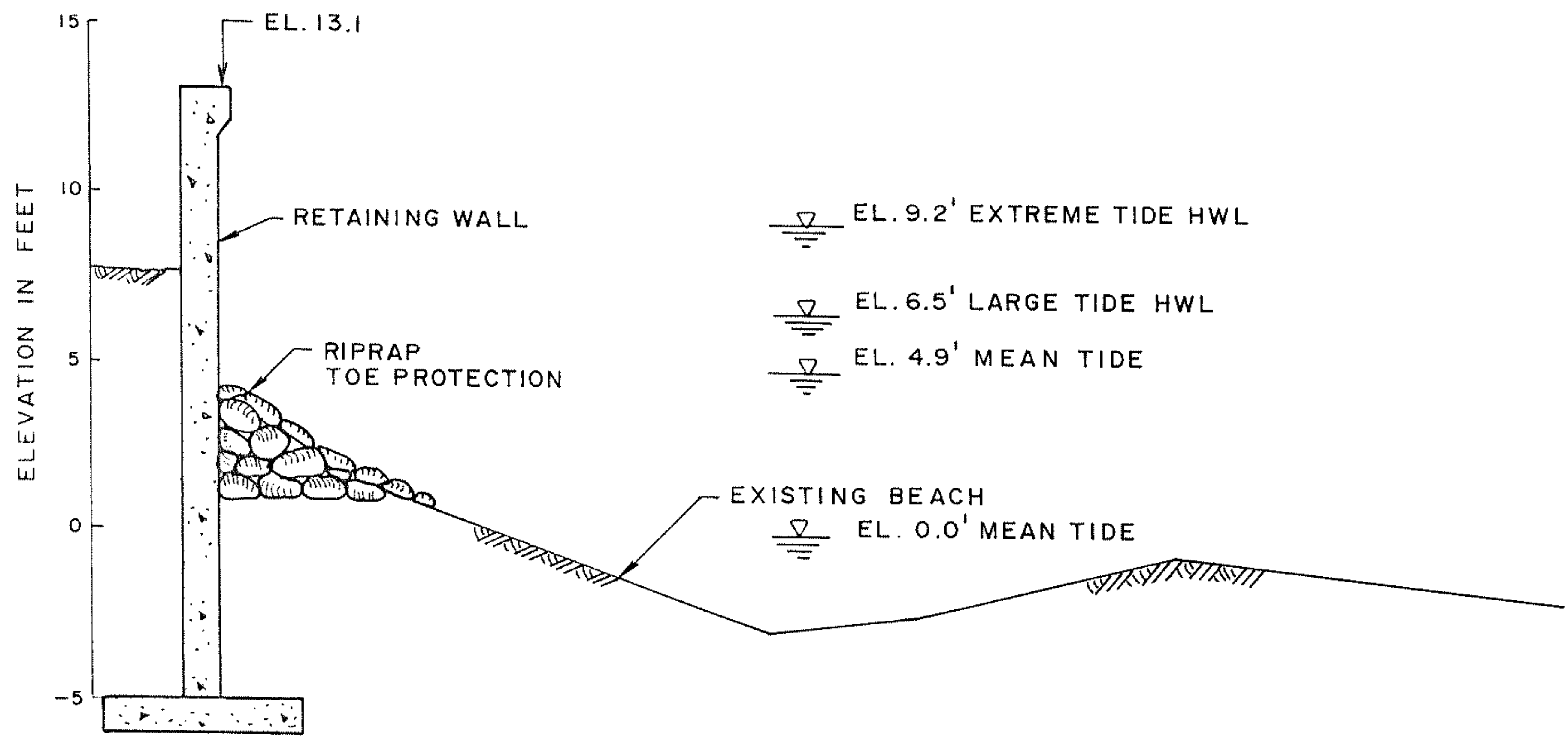
BOUNDARY BAY VILLAGE
FLOOD PROTECTION

MONTHLY EXTREME TIDE LEVELS AT
POINT ATKINSON 1914 TO 1984

FIG.
6



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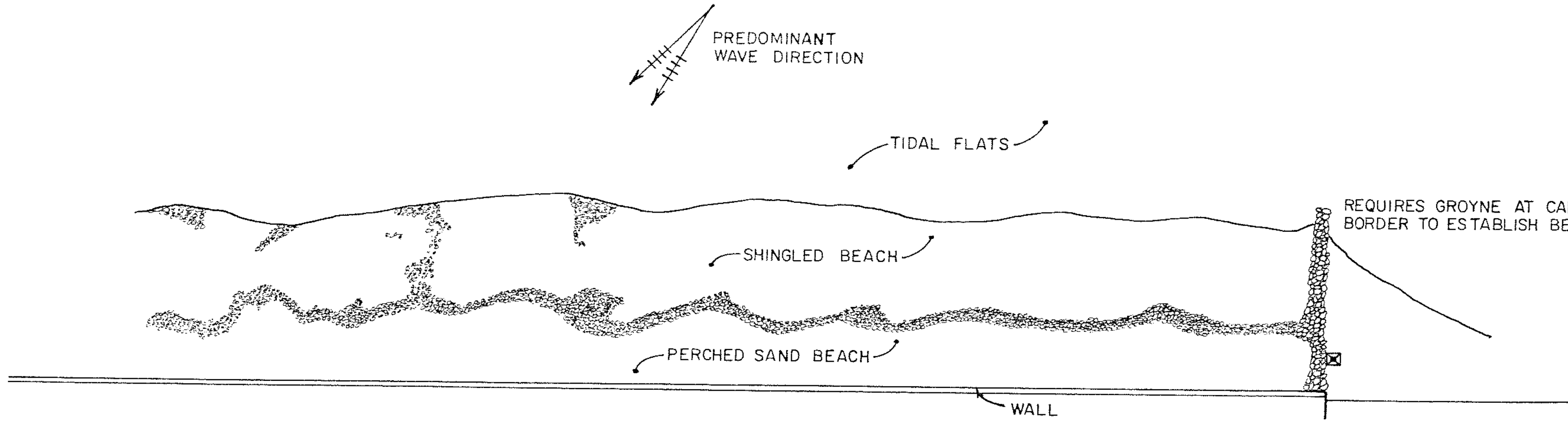
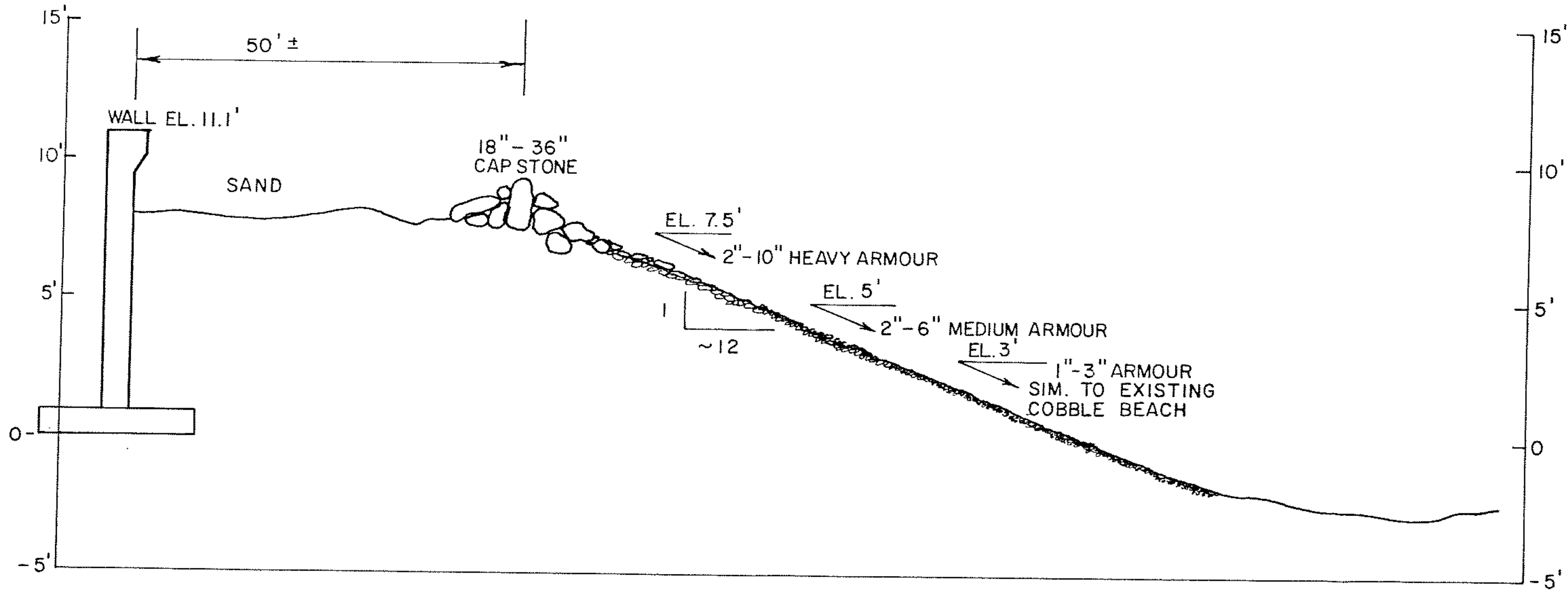
BOUNDARY BAY VILLAGE
FLOOD PROTECTION

SEAWALL CONCEPT

FIG. 7



TYPICAL PLAN



TYPICAL PERCHED BEACH X-SECTION

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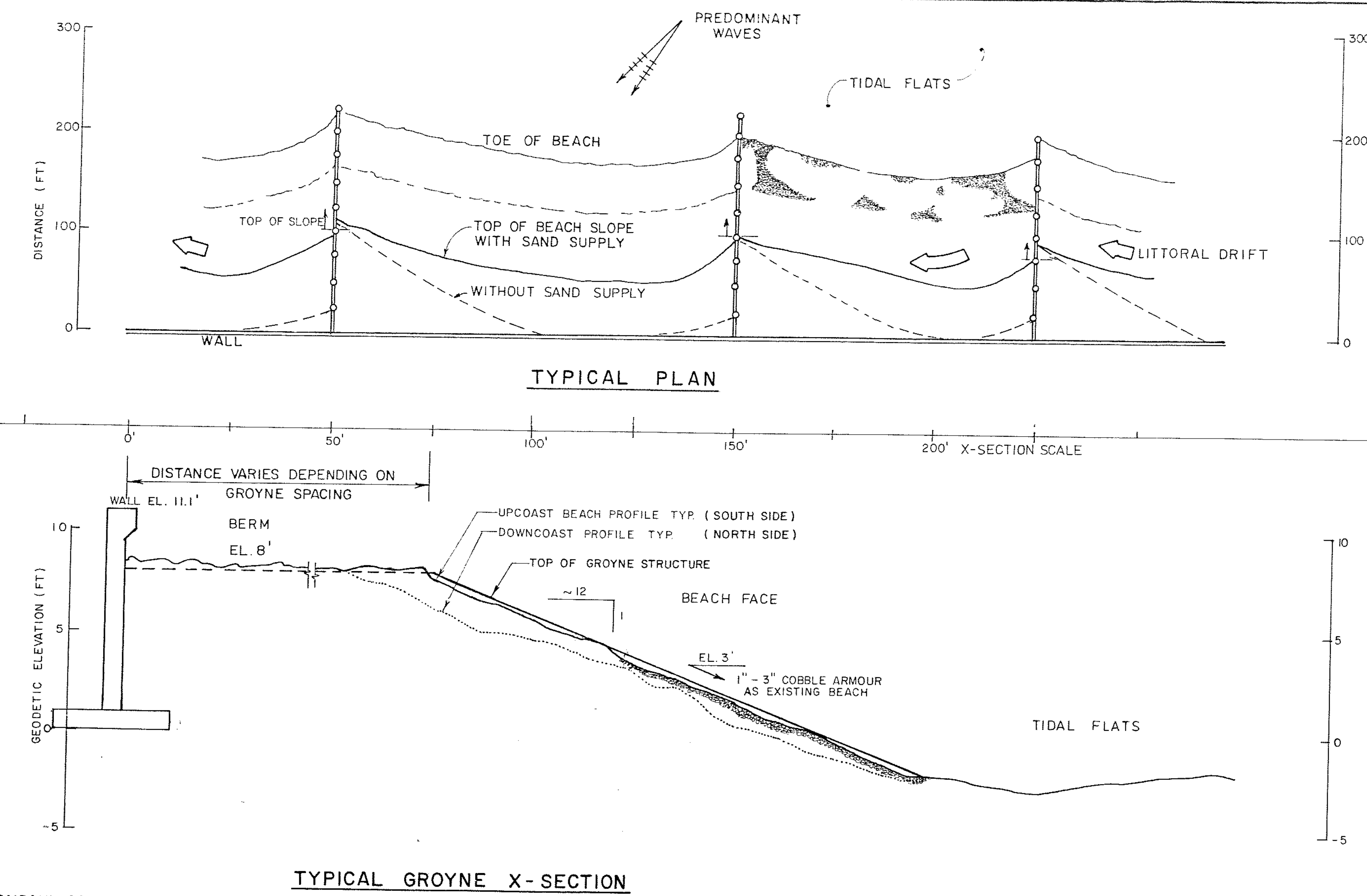
BOUNDARY BAY VILLAGE
FLOOD PROTECTION

PERCHED BEACH CONCEPT

FIGURE 8



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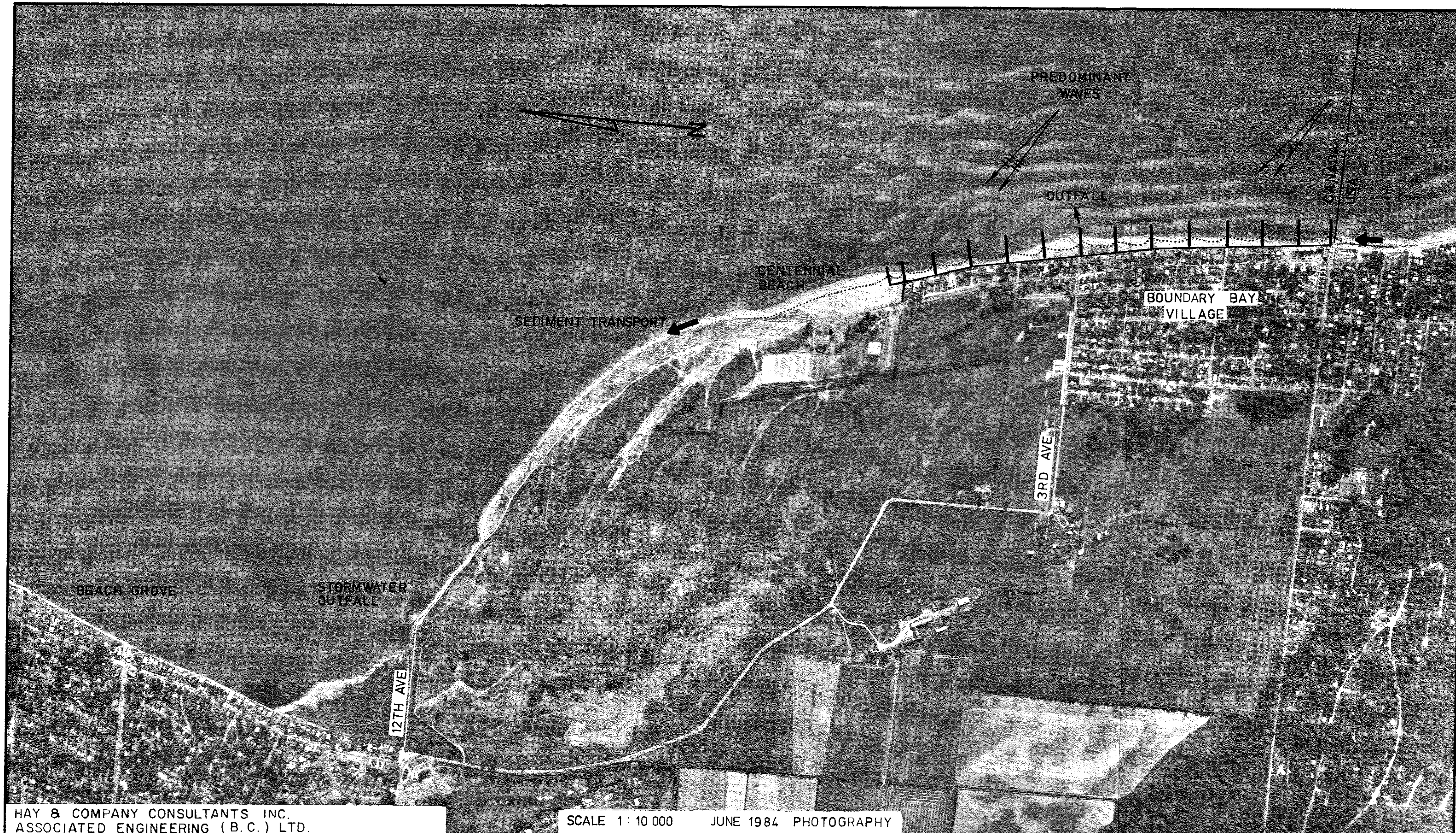
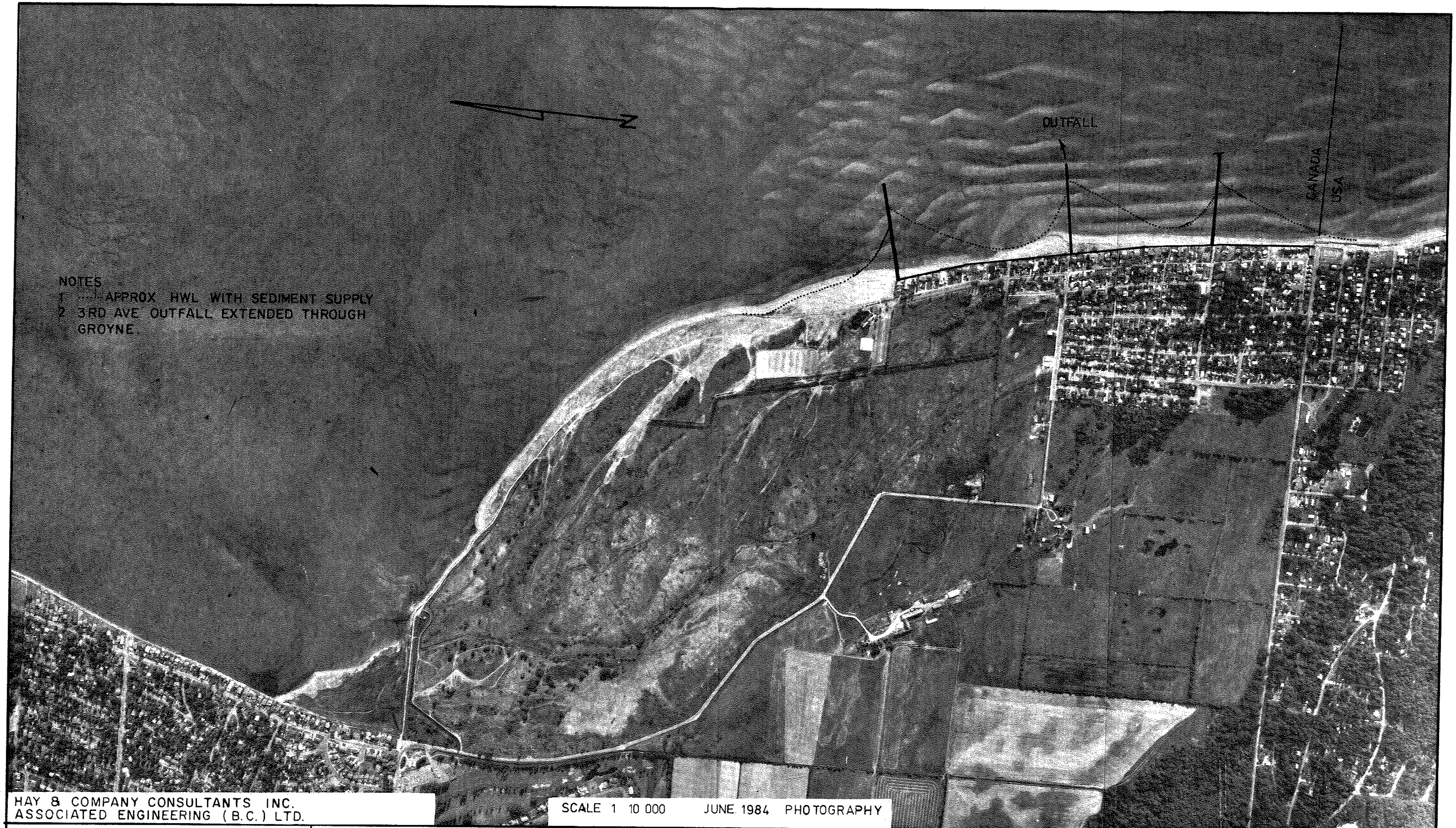
BOUNDARY BAY VILLAGE
FLOOD PROTECTION

GROYNE FIELD CONCEPT

FIGURE 9



BOUNDARY BAY VILLAGE FLOOD PROTECTION	CLOSE SPACED GROYNE FIELD LAYOUT	FIGURE 10



BOUNDARY BAY VILLAGE
FLOOD PROTECTION

MINIMUM GROYNE FIELD LAYOUT

FIGURE 11

Eroding sand bluffs, south of Canada - USA border. Major supply of littoral sediments to western shore of Boundary Bay.
1986 09 19

Typical foreshore profile north of Centennial Beach 1984 09 24

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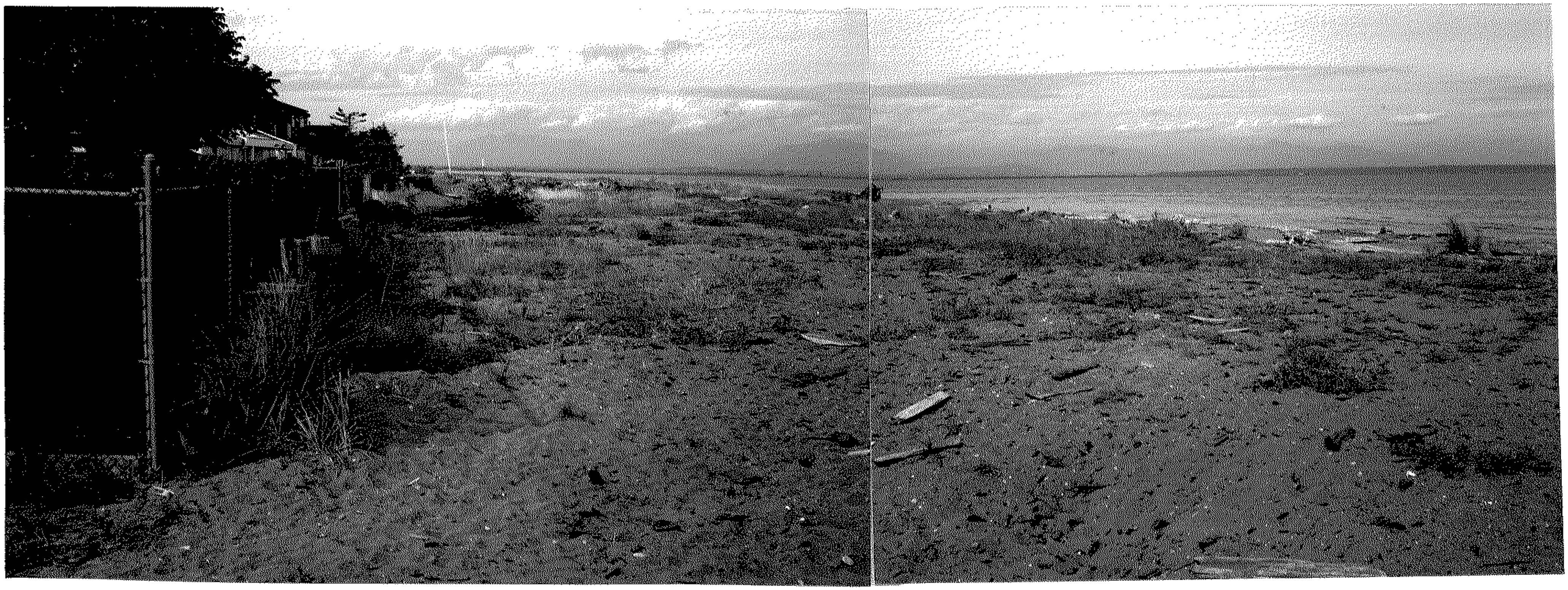
BOUNDARY BAY VILLAGE - FLOOD PROTECTION

PHOTO 2

Looking north from Canada - USA border - note riprap at toe of wall. 1984 12 13

Interaction of incident and reflected waves at wall.
1986 12 14



Backshore berm near line 2.

1984 09 24

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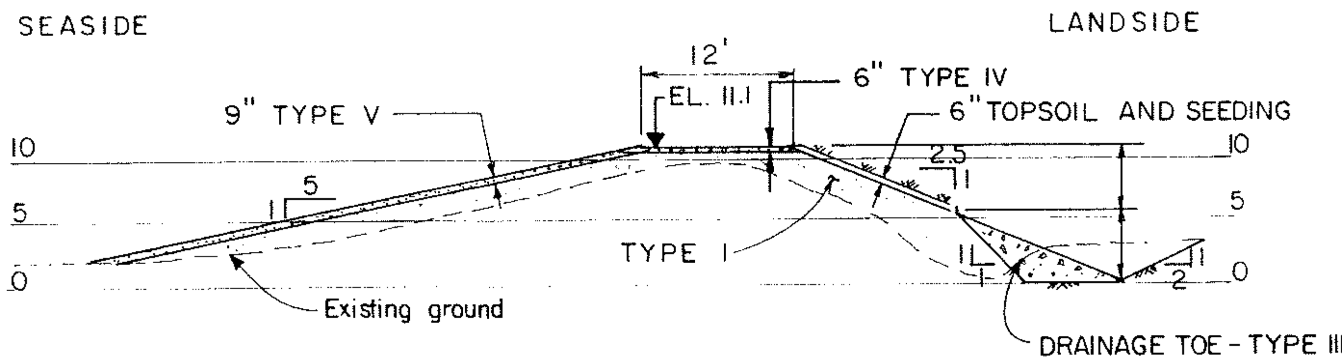
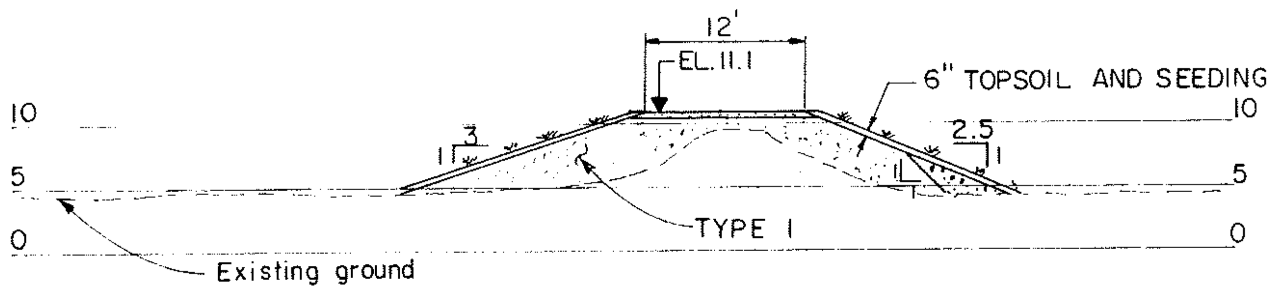
BOUNDARY BAY VILLAGE - FLOOD PROTECTION

PHOTO 5



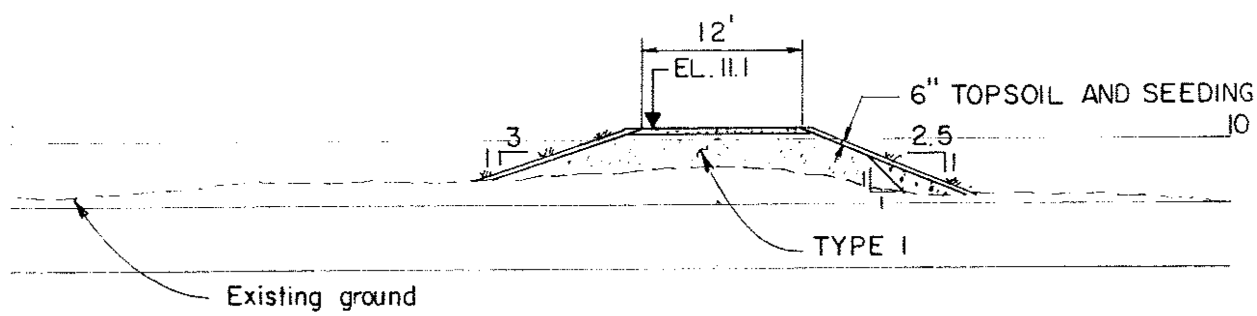
TYPICAL DYKE SECTION BETWEEN STA. 550+00 AND 568+00

N.T.S.



TYPICAL DYKE SECTION BETWEEN STA. 568+00 AND 595+00

N.T.S.

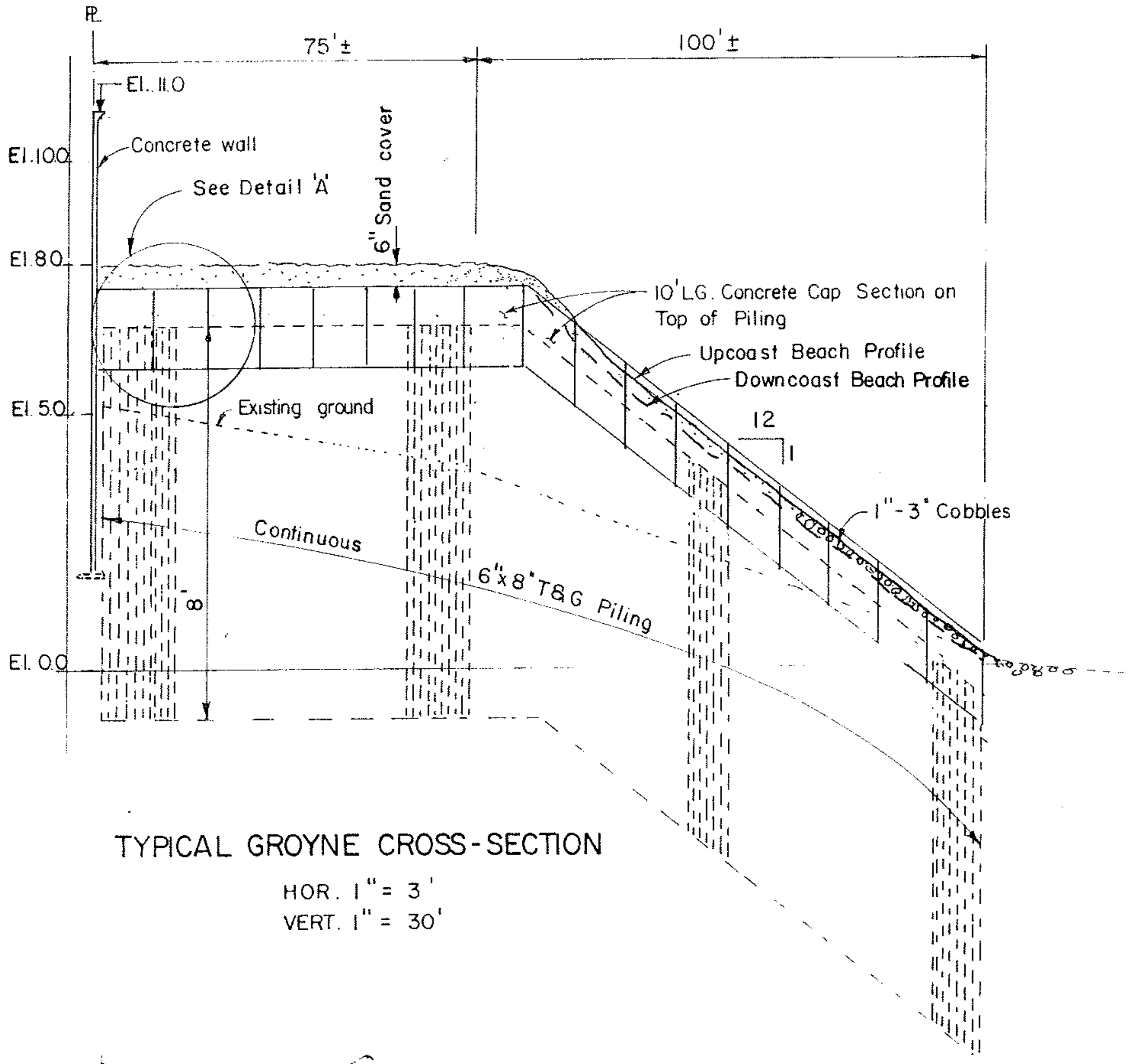


TYPICAL DYKE SECTION BETWEEN STA. 595+00 AND 608+00

N.T.S.

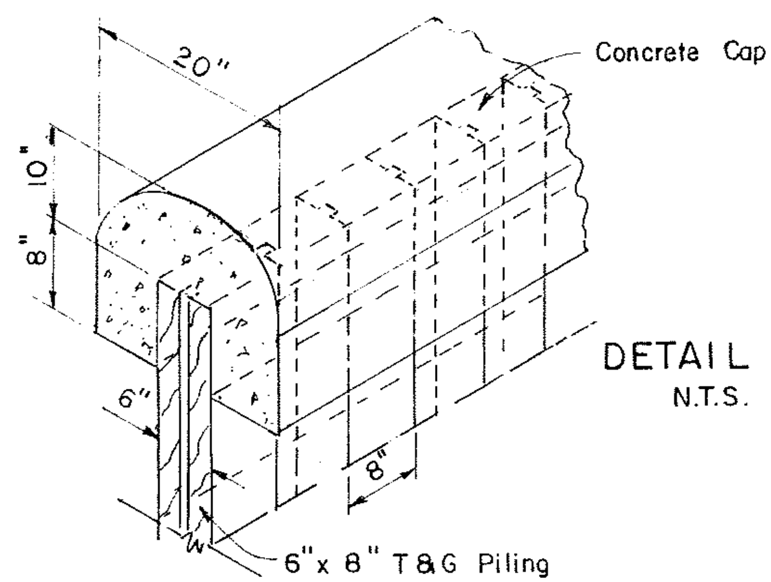
DYKE SECTIONS — 12th AVE. TO CENTENNIAL PARK

DWG. NO. 1



TYPICAL GROYNE CROSS-SECTION

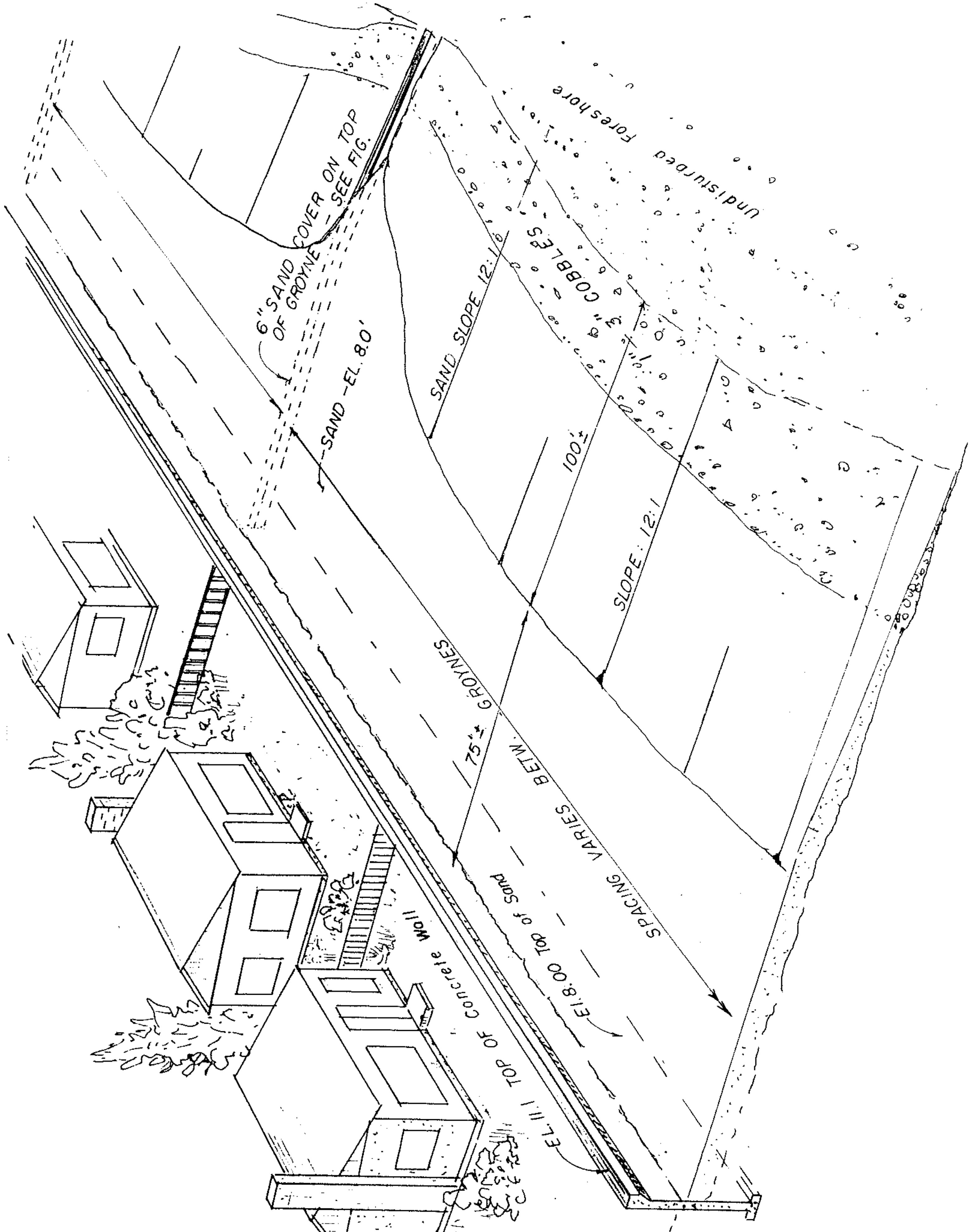
HOR. 1" = 3'
VERT. 1" = 30'



DETAIL 'A'
N.T.S.

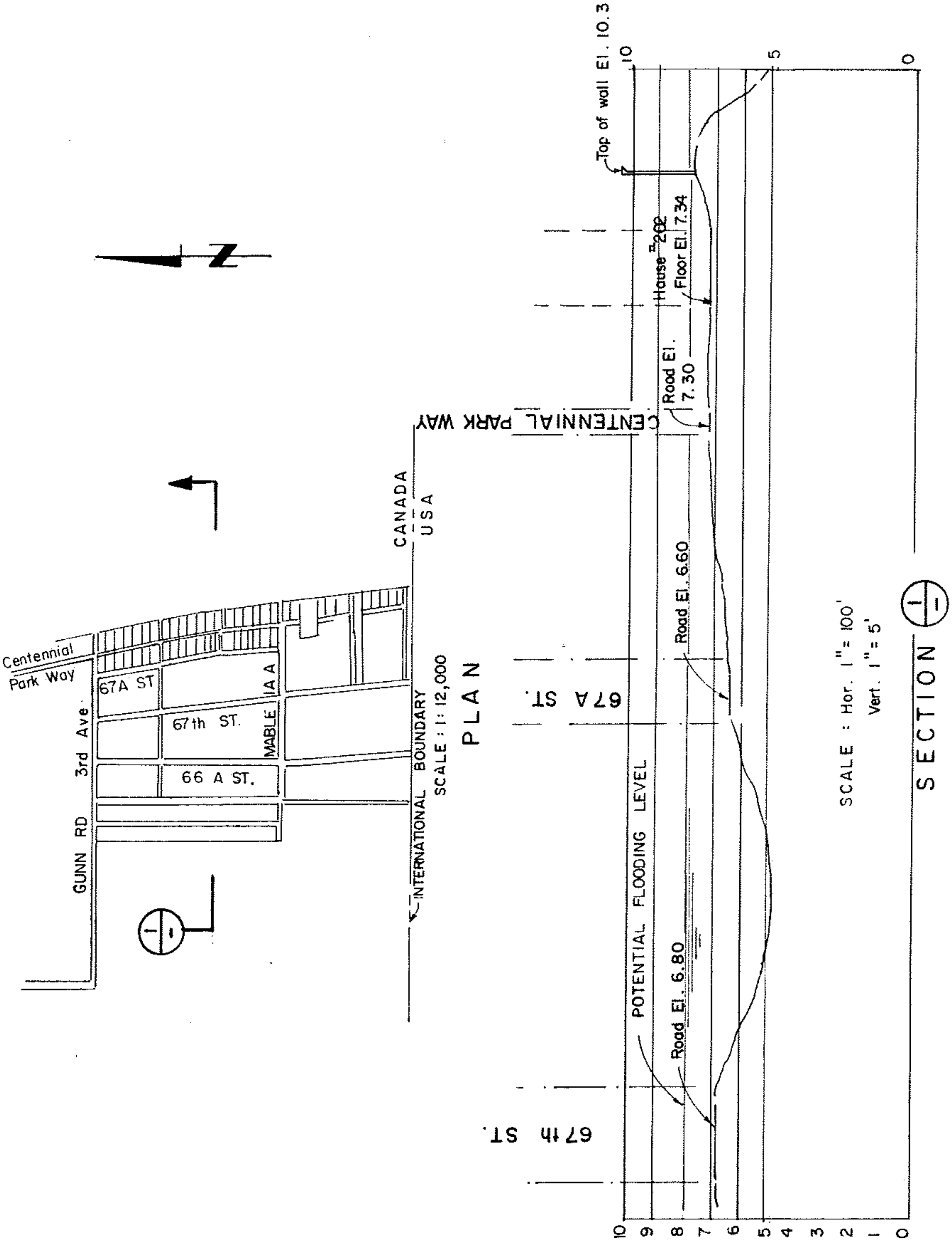
GROYNE CONSTRUCTION - CENTENNIAL PARK TO U.S.A. BORDER

DWG. NO. 2



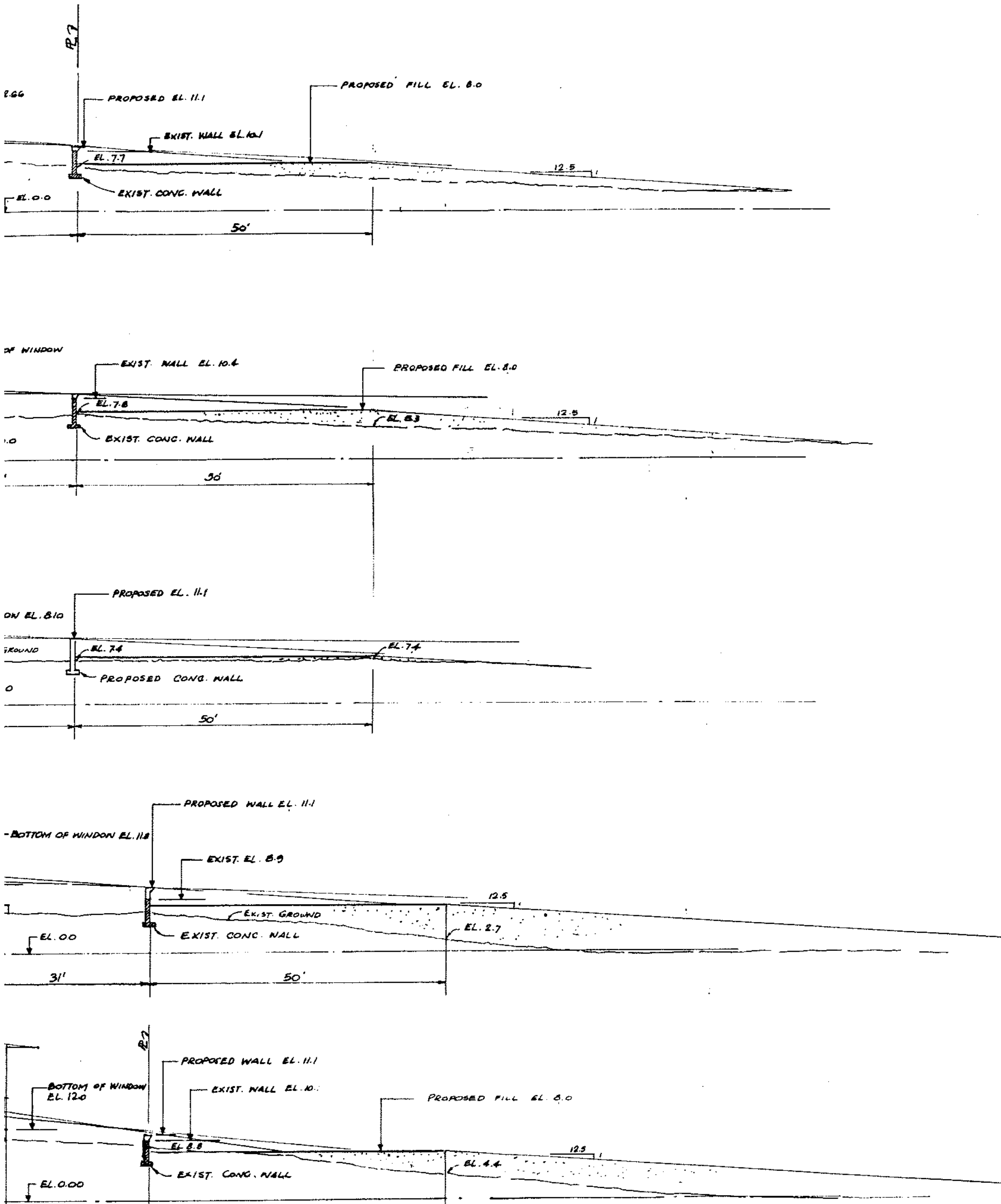
PERSPECTIVE VIEW OF GROYNE INSTALLATION

DWG. NO. 3



X-SECTION EXTENDING TO 67th STREET

DWG. NO.4



TYPICAL X- SECTIONS TO CENTENNIAL PARKWAY

DWG. NO. 5