CANADA-NEWFOUNDLAND
FLOOD DAMAGE REDUCTION PROGRAM

ENVIRONMENT CANADA DEPARTMENT OF ENVIRONMENT AND LANDS

REPORT ON REASSESSMENT OF ECONOMIC ANALYSIS FOR FLOOD CONTROL MEASURES IN PLACENTIA

Prepared by:

SHAWMONT NEWFOUNDLAND LIMITED

SMR-23-88 October, 1988

ShawMont Newfoundland Limited

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Dr. Wasi Ullah
Director
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Dept. of Environment and Lands
Government of Newfoundland and Labrador
4th Floor Annex
Confederation Building
St. John's, Newfoundland
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Dear Dr. Ullah:

We are pleased to submit our final "Report on Reassessment of Economic Analysis for Flood Control Measures in Placentia". This final report incorporates the Technical Committee's comments on the draft report.

We appreciate the opportunity to have worked on this reassessment for you and gratefully acknowledge the assistance provided by your staff.

Yours very truly,

D.H. Brown, P. Eng.
Vice-President
Engineering

DHB/gar

REPORT ON REASSESSMENT OF ECONOMIC ANALYSIS FOR FLOOD CONTROL MEASURES IN PLACENTIA

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1.0 INTRODUCTION

This report was authorized by the Department of Environment and Lands on behalf of the Canada-Newfoundland Flood Damage Reduction Program on 1988-09-27, based on the Department's request for proposal of 1988-09-15, ShawMont's letter proposal dated 1988-09-20, and a subsequent update letter dated 1988-09-22.

The scope of the study was to:

1. Review the economic analysis presented in the Placentia Hydrotechnical Study* and determine the benefit-cost ratio for:

   a) construction of the wave wall and the raising of Riverside Drive a maximum of 0.6 m, and

   b) construction of the wave wall only.

2. Provide ten (10) copies of the report, including:

   a) a description of the methodology used,

   b) discussion of assumptions made, and

   c) a comparison of the results with those of the original study.

For this analysis, the stage-damage relationships established in the original study were to be assumed to be still valid and all costs were to be estimated in the same year dollars (December, 1984) as the original study.

2.0 BACKGROUND INFORMATION

The Placentia Hydrotechnical Study assessed the flooding problem in the Placentia area, determined the 1 in 20 year and 1 in 100 year flood contours and recommended alternative flood control measures to minimize future flood damage in four geographical regions, the following table summarizes the structural alternatives that were considered in detail for flood control, together with the results of the benefit-cost analysis for both the 1 in 20 year and 1 in 100 year flood events.

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* ShawMont Martec Limited, April 1985. Hydrotechnical Study of the Placentia Area Flood Plain.

1 in 20 Year Event

Region	Alternative	Description	Benefit-Cost Ratio
1	1	Raise Riverside Drive and 5 Buildings	3.1
2 & 3	2	Raise 4 Buildings in Regions 2 and 3	0.3
1,2,3&4	3	Alternative 1 and 2 combined	3.0

1 in 100 Year Event

Region	Alternative	Description	Benefit-Cost Ratio
1	1	Raise Riverside Drive, 5 Buildings and Construct Wave Wall	2.2
2 & 3	2	Raise Selected Buildings in Regions 2 and 3	0.2
1,2,3&4	3	Alternative 1 and 2 combined	2.1

2.1 Flooding Problem

The Placentia Hydrotechnical Study concluded that the flooding in the Placentia area occurred from two sources:

i) high water levels in the Arms (Northeast, Swan and Southeast), and

ii) waves overtopping the beach to the west.

These sources result in flooding of one or more of the geographical regions denoted in the above table, defined as follows.

Region 1

This region encompasses the older section of the Town of Placentia and borders on Swan Arm, Northeast Arm and the Narrows. The area is the most important in

2.1 Flood Problem (Cont'd)

Region 1 (Cont'd)

terms of the flooding situation in Placentia, in that, it is the region most effected by recurring flood waters which primarily result from high tides in Swan Arm and the Narrows. Most of the Town's services such as schools, churches and the hospital are found in this region.

Region 2

This is the portion of Jerseyside immediately adjacent to the lift bridge. This area is bordered by Placentia Road to the west and Northeast Arm to the east. Flooding results from overtopping of the beach on Placentia Road and high tidal water in Northeast Arm. Since conditions resulting in significant flooding are infrequent in this area the associated damages are low.

Region 3

This region is the area bordering on Southeast Arm. Housing density is much lower than in Region 1. Flood levels resulting in flood damage are infrequent in this area.

Region 4

This region is that part of the Town of Placentia adjacent to Placentia Road. This is a more recently developed area of Placentia which has been affected by waves overtopping the beach to the west. Flooding in this region, like Regions 2 and 3 is rare and therefore associated damages, in the long term, are low.

2.2 Flood Control Measures

The only structural flood control measure with a benefit-cost ratio greater than 1.0 was Alternative 1, and this ratio was greater than 1.0 for both the 1 in 20 year and 1 in 100 year flood events, as shown in the foregoing table.

Alternative 1, for the 1 in 20 year event, comprised the raising of Riverside Drive to elevation 2.17 metres (above geodetic datum) and the raising of five buildings adjacent to the road. For the 1 in 100 year event, Alternative 1 comprised the raising of Riverside Drive to elevation 2.34

2.2 Flood Control Measures (Cont'd)

metres (above geodetic datum), the raising of the five buildings and the construction of a 300 m extension to an existing wave wall along Placentia beach, to the west of the Town.

2.3 Review of Flood Control Measures

The raising of Riverside Drive to elevation 2.34 m, as recommended in the Hydrotechnical Study, to prevent the flooding of Region 1 during the 1 in 100 year flood event, was not looked upon favorably by the Town Council of Placentia. It was felt that the raising of Riverside Drive as much as 1.3 m was undesirable from aesthetic and practical points of view. The Council were concerned about the height of the road above the adjacent properties and the boardwalk along the Narrows, as well as the possible loss of the boardwalk. The Council expressed a preference for a lower level for Riverside Drive, even if this resulted in some flooding of Region 1.

The Town Council expressed concern about potential flooding as a result of waves overtopping the beach to the west of the Town. High winds on one occasion late in December of 1987 caused waves to overtop the beach. During this event there was some flood damage to properties in the area, and traffic on the Beach Road was interrupted as rocks were washed onto the road. Heavy equipment was required during the event to clear the road and to maintain a barrier of rocks on the beach crest to reduce the wave wash-through.

The Council noted that the conditions on the beach appear to be worsening and the residents of the area are concerned about the potential for a major wash-out of the beach crest and consequent flooding of the Town from Placentia Road. For this reason, the Council felt that the wave wall recommended in the Placentia Hydrotechnical Study should be given higher priority than the raising of Riverside Drive, and be constructed immediately.

3.0 REVIEW OF ECONOMIC ANALYSIS

Considering the Town's concern about the raising of Riverside Drive and the possible loss of the boardwalk, two other options, which were previously considered during the Hydrotechnical Study, were briefly reviewed. These options would help to reduce the impact of the construction on adjacent properties and connecting side roads. These options are described in the following.

3.0 REVIEW OF ECONOMIC ANALYSIS (Cont'd)

Rock/Earth Dyke

This option would comprise removal of the timber boardwalk and brestwork, and construction of a rock/earth fill dyke adjacent to, but outside of and above, the existing road. This dyke would result in additional infilling of the Narrows than what presently exists and could adversely affect the hydraulics of area. Also, this option would eliminate the existing wharfage which is a favorite berthing for small fishing craft of the area. Although not estimated in detail, approximate calculations indicated that this would be a much more costly option.

Raise Timber Brestwork

This option comprised the raising of the timber brestwork and boardwalk to the new level of the road and locating the new paved road surface as close as possible to the boardwalk, as it presently is in many areas. This option would generally provide extra space between existing properties and the new road surface and reduce, to a small degree, the impact of grade differentials on these properties and the connecting side roads. This option would be considerably more costly than the original approach of raising the road, due to the timber cribwork involved. This option also assumes that the existing cribwork is structurally sound and would be structurally stable with the increased height. Based on observed conditions, these assumptions would be risky for the purpose of this review.

Based on the above review of options, it appears that the original recommendation of raising Riverside Drive would be the least costly method of providing flood protection, even though it has some inherent disadvantages. To again consider the Town's concern about the asthetics of raising Riverside Drive, the resulting benefits and costs of raising the road to levels below that recommended in the Hydrotechnical Study were reviewed.

Based on the conclusions of the Hydrotechnical Study, it is confirmed that the barrier to high water level in the Narrows, provided by raising Riverside Drive, must have a horizontal (level) crest. Therefore, considering the Town's request to raise Riverside Drive to levels lower than previously recommended, three additional levels of 1.44 metres, 1.60 metres and 1.80 metres above geodetic datum were considered.

3.0 REVIEW OF ECONOMIC ANALYSIS (Cont'd)

To assess the effects of:

i) construction of Riverside Drive to a lower level than recommended in the Hydrotechnical Study and construction of the wave wall on Placentia beach, and

ii) construction of the wave wall only (excluding the raising of Riverside Drive),

on the benefit-cost analysis of the Hydrotechnical Study, the benefit-cost analysis was repeated for the new scenarios, using economic data from the Hydrotechnical Study.

The following sections describe the significance of the new levels for Riverside Drive, the methodology used and the results obtained in a review of cost estimates and benefit-cost analysis.

3.1 Cost Estimates

To provide cost data for a review of the benefit-cost analysis of raising Riverside Drive to a lower level than previously recommended, cost estimates were prepared for three (3) new levels. These were: 1.44 metres, 1.60 metres and 1.80 metres. Detailed cost estimates for each level are provided in Appendix I and these are based on the same year's dollars as for the Hydrotechnical Study (December, 1984).

For the new cost estimates, the latest available mapping* of the Town of Placentia was obtained from the Department of Environment and Lands. Based on the available mapping and a reconnaissance site visit, a profile and typical cross-sections were developed for Riverside Drive, as shown on Drawing B1-84979-1 in Appendix II. These were based on spot elevations and contours from the mapping, supplemented by field observations and basic measurements (no field geometric survey data was available).

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* Flood risk map of the Placentia area, prepared in 1984 from aerial photographs flown in June, 1984, to scale of 1:2500 with one and two metre contours.

3.1 Cost Estimate (Cont'd)

The profile of the existing road indicates a low section between chainages 6+000 and 1+250**. Raising the road to elevation 1.44 metres would essentially fill in this low area. The profile also indicates that Riverside Drive generally rises from Swan Arm towards Northeast Arm and is at elevation 1.60 metres at Northeast Arm. Raising the road to elevation 1.60 metres would provide a horizontal road throughout, with no increase in elevation in the area of Northeast Arm. Raising Riverside Drive to elevation 1.80 metres was considered as an intermediate level between the lower levels noted above and the higher levels recommended in the Hydrotechnical Study.

3.2 Level of Flood Protection

Based on the findings of the Hydrotechnical Study, flooding of Region 1 from Swan Arm, the Narrows and Northeast Arm occurs when high water levels in these areas overtops Riverside Drive and Swan Road. Part 6 of the Hydrotechnical Study described how the frequency of water levels was determined and Figure 6.4.1 of the Study graphically illustrated the resulting water level frequency. From Figure 6.4.1 the water levels of 1.87 m and 2.04 m are seen to have return periods of 1 in 20 years and 1 in 100 years, respectively. Based on these water levels, the elevation of Riverside Drive for both flood events was determined by adding 0.3 metre extra height for freeboard. The resulting elevations of Riverside Drive were therefore determined to be 2.17 m and 2.34 m for the 1 in 20 year and 1 in 100 year flood events, respectively. Similarly, the return period for water levels corresponding to the new levels being considered for Riverside Drive can be determined from Figure 6.4.1 of the Hydrotechnical Study. Assuming the same freeboard requirement, the water levels and associated return periods corresponding to the Riverside Drive levels of 1.44 m, 1.60 m and 1.80 m are summarized in the following table.

** The findings of the Hydrotechnical Study indicated that it is in this area that flooding of the Town always begins, as high water in Swan Arm overtops Riverside Drive and Swan Road.

3.2 Level of Flood Protection (Cont'd)

Elevation of Riverside Drive*	Flood Water Level	Flood Return Period
2.34 m **	2.04 m	1:100 years
2.17 m **	1.87 m	1:20 years
1.80 m	1.50 m	1:2.6 years
1.60 m	1.30 m	1:2 years
1.44 m	1.14 m	1:1.05 years

* Elevations include a freeboard of 0.3 metre above flood water levels.
** These levels are from the Hydrotechnical Study.

3.3 Benefit-Cost Analysis

The benefit-cost analysis previously completed for the Hydrotechnical Study was reviewed and the same principles and methodologies used in that study were used for this reassessment. Benefit-cost analyses were completed for two scenarios as noted in the scope of work. These were:

i) for the raising of Riverside Drive and the construction of the wave wall along Placentia beach, and

ii) for the construction of the wave wall only.

In the first scenario, benefit-cost ratios were determined for each of the levels considered for Riverside Drive.

3.3.1 Average Annual Damage Assessment

For this analysis, the water level/damage summaries for Regions 1 and 4, as given in the Hydrotechnical Study, were assumed to be still valid (reference Tables 7.1.2 and 7.1.5 for Regions 1 and 4, respectively, in the Hydrotechnical Study). Also, the expected average annual damages for Region 1, as given in Table 10.3.1 of the Study for various water levels, and the expected average annual damage for Region 4, as given in Table 10.3.4 of the Study, were assumed to be still valid.

Based on the expected average annual damages for particular water levels in Region 1 as given in Table 10.3.1 of the Hydrotechnical Study, average annual damages

3.3.1 Average Annual Damage Assessment (Cont'd)

for the new water levels associated with the lower elevations for Riverside Drive were calculated by straight pro-ration. These are included in Table 3.1, herein, together with values from Table 10.3.1 of the Hydrotechnical Study, for a complete Stage - Damage Summary for Region 1.

3.3.2 Present Value

The present value of costs and benefits were determined (following the same procedure used in the Hydrotechnical Study) by multiplying the cost or benefit for a particular scenario by the following discount factor:

$$\frac{1}{(1 + i)^j}$$

where: j is the index of the year concerned
i is the social discount rate (taken as 10% for this reassessment).

The discounted values of all costs or benefits for a particular scenario are summed to give the total present value of the costs or benefits. The net present value for the scenario is then found by subtracting its present value of costs from its present value of benefits. The benefit-cost ratio of the scenario is calculated by dividing its present value of benefits by its present value of costs.

3.3.3 Benefit-Cost for Riverside Drive and Wave Wall

Table 3.2 provides a summary of the benefits and costs for the alternative elevations of Riverside Drive (from the table in Section 3.2) and the construction of the wave wall along Placentia beach.

Figure 3.1 provides a graphical plot of the present value of benefits and costs of raising Riverside Drive and the construction of the wave wall, versus the elevation of Riverside Drive (from the table in Section 3.2). From this graph it can be determined that a benefit-cost ratio equal to one would occur with an elevation on Riverside Drive of approximately 2.0 m.

3.3.4 Benefit-Cost for the Wave Wall Only

The alternative for flood protection in Region 4 was described as Alternative 4B in Section 7.5 of the Hydrotechnical Study. The present values of benefits and costs,

3.3.4 Benefit-Cost for the Wave Wall Only (Cont'd)

and the benefit-cost ratio for the wave wall, alone; were given in Table 8.3.1 of the Hydrotechnical Study. The benefit-cost ratio from Table 8.3.1 was less than 0.01.

The Town Council recently expressed concern about an apparent worsening condition at the beach. The concern is that the beach is eroding, and overtopping seems to be more common.

A review of changed conditions, new oceanographic data, reassessment of damages resulting from flooding of new construction in Region 4, etcetera, was not within the scope of this reassessment. However, simple calculations would illustrate that unless either the probability of recurrence of flooding from this source, or the expected average annual damages in Region 4, increase substantially, the benefit-cost of the wave wall alone will not change significantly. To illustrate, the probability of recurrence was changed to determine new benefit-cost ratios. The following table summarizes the results and compares them with the original figures from the Hydrotechnical Study.

Probability of Recurrence	Avg Ann Damages	PV Benefits ($1000)	PV Costs ($1000)	Net PV ($1000)	B/C Ratio
1:100 yrs	$ 635	3	530	-527	<.01
1: 50 yrs	1,270	12	530	-518	.02
1: 2 yrs	31,750	299	530	-231	0.56
1:1.12 yrs	56,500	530	530	0	1.00
1: 1 yr	63,500	599	530	69	1.13

From this table it can be seen that for the wave wall alone to have a benefit-cost ratio greater than unity, flooding from this source would have to occur annually. However, this is not known to happen at the present time.

4.0 CONCLUSIONS

Based on the reassessment of the economic analysis for the raising of Riverside Drive and the construction of the wave wall along Placentia beach, the following conclusions are made:

1. Raising Riverside Drive is the most cost effective method of protecting against flooding of Region 1 resulting from high water levels in the Arms and the Narrows.

4.0 CONCLUSIONS (Cont'd)

2. The benefit-cost ratios of constructing the wave wall along Placentia beach and raising Riverside Drive to elevations 1.44 m, 1.60 m, 1.80 m, 2.17 m and 2.34 m (above Geodetic datum) are 0.04, 0.25, 0.65, 1.75 and 2.2, respectively.

3. The level to which Riverside Drive must be raised, in conjunction with construction of the wave wall, to attain a benefit-cost ratio equal to or greater than unity is elevation 2.0 m.

4. The benefit-cost ratio of constructing the wave wall, only, is less than 0.01.

5. For the benefit-cost ratio of constructing the wave wall, only, to be equal to or greater than unity, flooding due to waves overtopping the beach would have to occur annually. Alternatively, the value of damages resulting from a flooding event from this source (with a 1 in 100 year return period) would have to be in the order of 80 times larger than that which was reported as a result of the January, 1982 flooding.

TABLE 3.1

STAGE - DAMAGE SUMMARY - REGION 1

Stage * (m)	Expected Average Annual Flood Damage
0.9	0
1.14	3,366**
1.2	4,208
1.3	28,143**
1.5	76,012
1.8	225,911
2.0	293,212

* Stage means water level expressed in metres above Geodetic datum.

** Values for expected Average Annual Flood Damage were obtained by pro-rating values in Table 10.3.1 of the Hydrotechnical Study.

TABLE 3.2

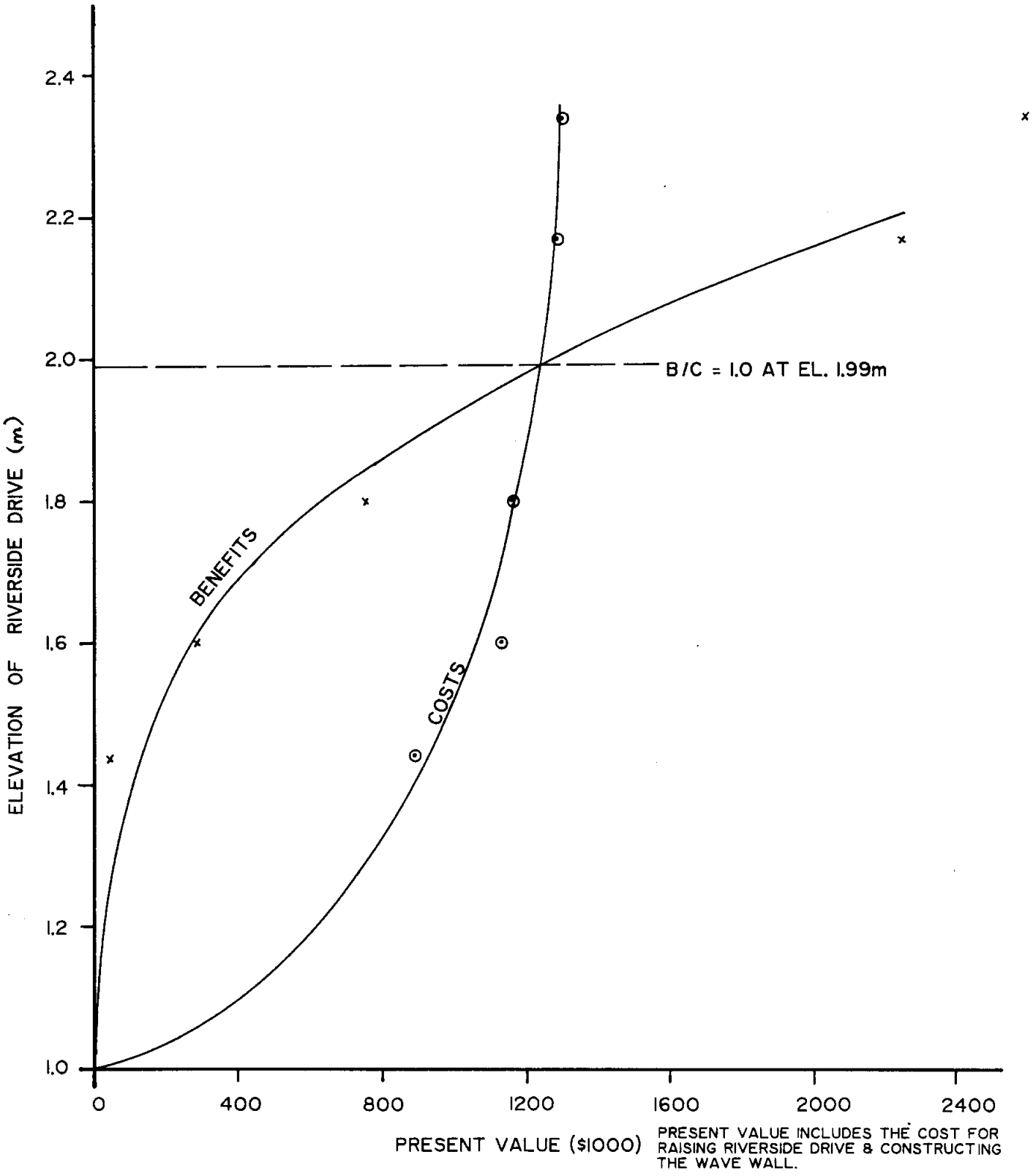
SUMMARY OF BENEFITS AND COSTS FOR

RAISING RIVERSIDE DRIVE & CONSTRUCTING WAVE WALL

ALTERNATIVE	(1) WATER LEVEL (m)	FLOOD EVENT PROTECTION	PV BENEFITS ($1000)	PV COSTS ($1000)	NET PV ($1000)	B/C RATIO
Raise Riverside Drive To El. 2.34 m + Wave Wall (3)	2.04	1:100 yr (2)	2,913	1,307	1,606	2.2
Raise Riverside Drive To El. 2.17 m (No Wave Wall) (3)	1.87	1:20 yr (2)	2,240	725	1,515	3.1
Raise Riverside Drive To El. 2.17 m + Wave Wall	1.87	1:20 yr (2)	2,246	1,287	959	1.75
Raise Riverside Drive To El. 1.80 m + Wave Wall	1.50	1:2.6 yr	754	1,161	-407	0.65
Raise Riverside Drive To El. 1.60 m + Wave Wall	1.30	1:2 yr	279	1,131	-852	0.25
Raise Riverside Drive To El. 1.44 m + Wave Wall	1.14	1:05 yr	33	891	-858	0.04

Notes:
(1) Water level is expressed in metres above Geodetic datum.
(2) Estimated flood recurrence from Table 6.4.1 of the Hydrotechnical Study.
(3) Present values for these alternatives are from Table 10.6.1 of the Hydrotechnical Study.
PV = Present Value
B/C Ratio = Benefit-Cost Ratio

FIGURE 3 . 1



ELEVATION OF RIVERSIDE DRIVE
VS.
PRESENT VALUE BENEFITS & COSTS

APPENDIX I

COST ESTIMATES

APPENDIX I - COST ESTIMATES

ALTERNATIVE I (1 in 100 Year Event)*

(Raise Riverside Drive and 5 Buildings and Construct Wave Wall):

Contractor Mobilization and Demobilization	Provisional		$ 20,000
Demolition of Existing Pavement	7700 m^2	@ $6/$m^2$	46,000
Excavation of Cut Off Trench	1600 m^3	@ $10/$m^3$	16,000
Mass Fill	16,000 m^3	@ $8/$m^3$	128,000
Pavement	7700 m^2	@ $22/$m^2$	170,000
Raising Properties	Provisional		50,000
Ramping	Provisional		25,000
Guard Rail	1280 m	@ $60/m	77,000
Wave Wall	300 m	@ $1450/m	435,000
Drainage Culvert with Flap Gate	Lump Sum		15,000
Sub-Total			982,000
15% Contingency Factor			147,000
Total Construction			$1,129,000
Engineering including pre-design services (site survey, sub-surface investigations), design services, administration and inspection services during construction.			$ 120,000
Total Estimated Cost			$1,249,000

Notes:

- $5,000 maintenance to guard rail every 2 years.
- 100% reduction in flood damage for 1 in 20 and 1 in 100 year events.
- 50 year economic life on Riverside Drive and 30 years economic life on wave wall.

* This estimate is from the Hydrotechnical Study

APPENDIX I - COST ESTIMATES

ALTERNATIVE I (1 in 20 Year Event)*

(Raise Riverside Drive and 5 Buildings):

Contractor Mobilization and Demobilization	Provisional		$ 20,000
Demolition of Existing Pavement	7700 m^2	@ $6/$m^2$	46,000
Excavation of Cut Off Trench	1600 m^3	@ $10/$m^3$	16,000
Mass Fill	13,400 m^3	@ $8/$m^3$	107,000
Pavement	7700 m^2	@ $22/$m^2$	170,000
Raising Properties	Provisional		50,000
Ramping	Provisional		25,000
Guard Rail	1280 m	@ $60/m	77,000
Drainage Culvert with Flap Gate	Lump Sum		15,000
Sub-Total			526,000
15% Contingency Factor			79,000
Total Construction			$ 605,000
Engineering including pre-design services (site survey, sub-surface investigations), design services, administration and inspection services during construction.			$ 90,000
Total Estimated Cost			$ 695,000

Notes:

- $5,000 maintenance to guard rail every 2 years.
- 100% reduction in flood damage for 1 in 20 year event.
- 50 year economic life on Riverside Drive.

* This estimate is from the Hydrotechnical Study.

APPENDIX I - COST ESTIMATES

ALTERNATIVE Ia

(Raise Riverside Drive to El. 1.44 m and Construct Wave Wall):

Contractor Mobilization and Demobilization	Provisional		$ 20,000
Demolition of Existing Pavement	2400 m^2	@ \$6/m^2	14,000
Excavation of Cut Off Trench	645 m^3	@ \$10/m^3	6,500
Mass Fill	3460 m^3	@ \$8/m^3	27,700
Pavement	2970 m^2	@ \$22/m^2	65,300
Raising Properties	Provisional		-
Ramping	Provisional		25,000
Guard Rail	610 m	@ \$60/m	36,600
Wave Wall	300 m	@ \$1450/m	435,000
Drainage Culvert with Flap Gate	Lump Sum		15,000
Sub-Total			645,500
15% Contingency Factor			96,800
Total Construction			$ 742,300
Engineering including pre-design services (site survey, sub-surface investigations), design services, administration and inspection services during construction.			$ 90,000
Total Estimated Cost			$ 832,300

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Notes:

- \$5,000 maintenance to guard rail every 2 years.
- 50 year economic life on Riverside Drive and 30 years economic life on wave wall.

APPENDIX I - COST ESTIMATES

ALTERNATIVE Ib

(Raise Riverside Drive to El. 1.60 m and Construct Wave Wall):

Contractor Mobilization and Demobilization	Provisional		$ 20,000
Demolition of Existing Pavement	7700 m^2	@ \$6/m^2	46,200
Excavation of Cut Off Trench	645 m^3	@ \$10/m^3	6,500
Mass Fill	5890 m^3	@ \$8/m^3	47,100
Pavement	7240 m^2	@ \$22/m^2	169,400
Raising Properties	Provisional		-
Ramping	Provisional		25,000
Guard Rail	1170 m	@ \$60/m	70,200
Wave Wall	300 m	@ \$1450/m	435,000
Drainage Culvert with Flap Gate	Lump Sum		15,000
Sub-Total			834,400
15% Contingency Factor			125,200
Total Construction			$ 959,600
Engineering including pre-design services (site survey, sub-surface investigations), design services, administration and inspection services during construction.			$ 110,000
Total Estimated Cost			$1,069,600

Notes:

- $5,000 maintenance to guard rail every 2 years.
- 50 year economic life on Riverside Drive and 30 years economic life on wave wall.

APPENDIX I - COST ESTIMATES

ALTERNATIVE Ic

(Raise Riverside Drive to El. 1.80 m and Construct Wave Wall):

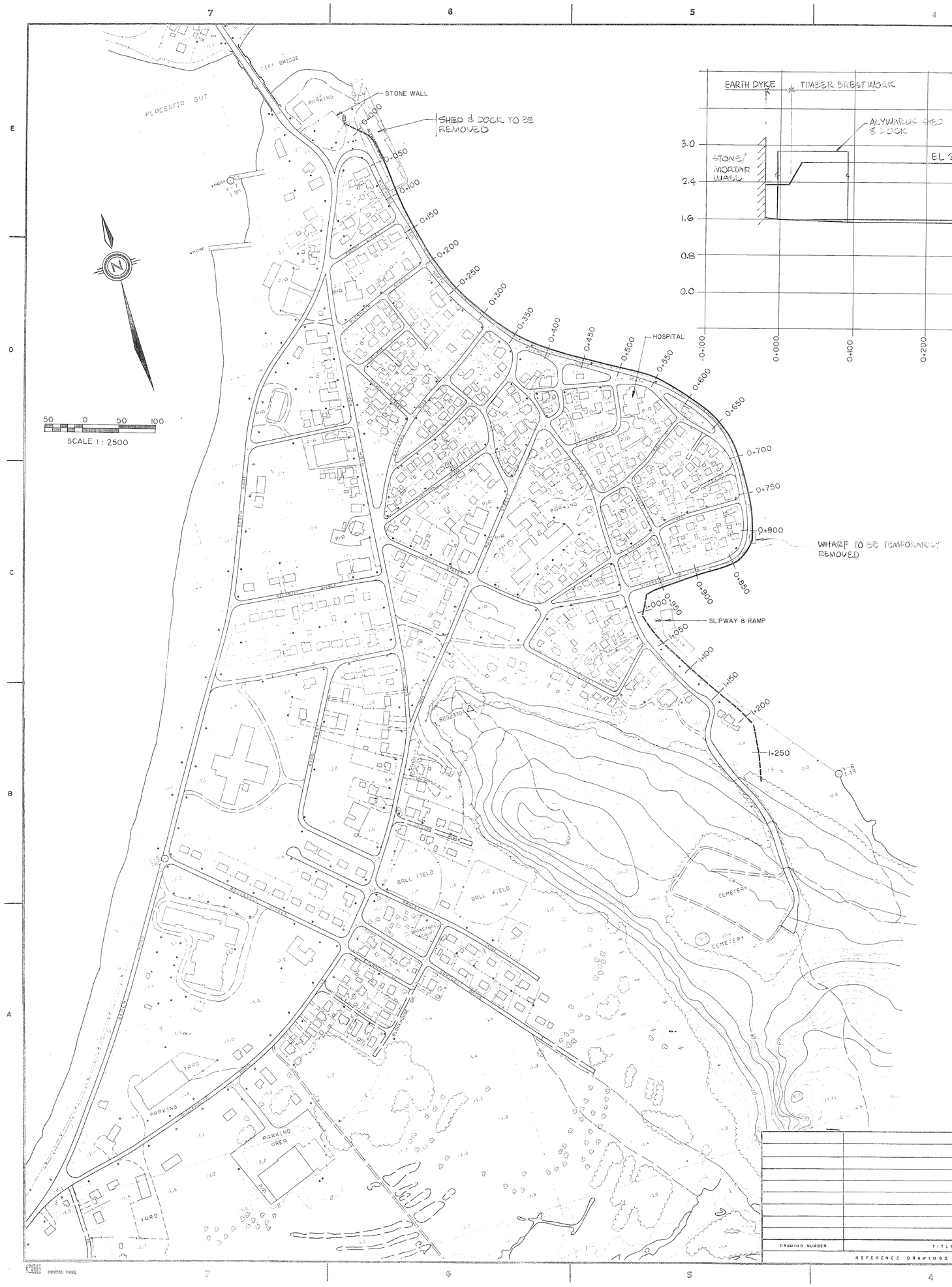
Contractor Mobilization and Demobilization	Provisional		$ 20,000
Demolition of Existing Pavement	7700 m^2	@ $6/$m^2$	46,200
Excavation of Cut Off Trench	645 m^3	@ $10/$m^3$	6,500
Mass Fill	9180 m^3	@ $8/$m^3$	73,400
Pavement	7700 m^2	@ $22/$m^2$	109,400
Raising Properties	Provisional		-
Ramping	Provisional		25,000
Guard Rail	1170 m	@ $60/m	70,200
Wave Wall	300 m	@ $1450/m	435,000
Drainage Culvert with Flap Gate	Lump Sum		15,000
Sub-Total			860,700
15% Contingency Factor			129,100
Total Construction			$ 989,800
Engineering including pre-design services (site survey, sub-surface investigations), design services, administration and inspection services during construction.			$ 110,000
Total Estimated Cost			$1,099,800

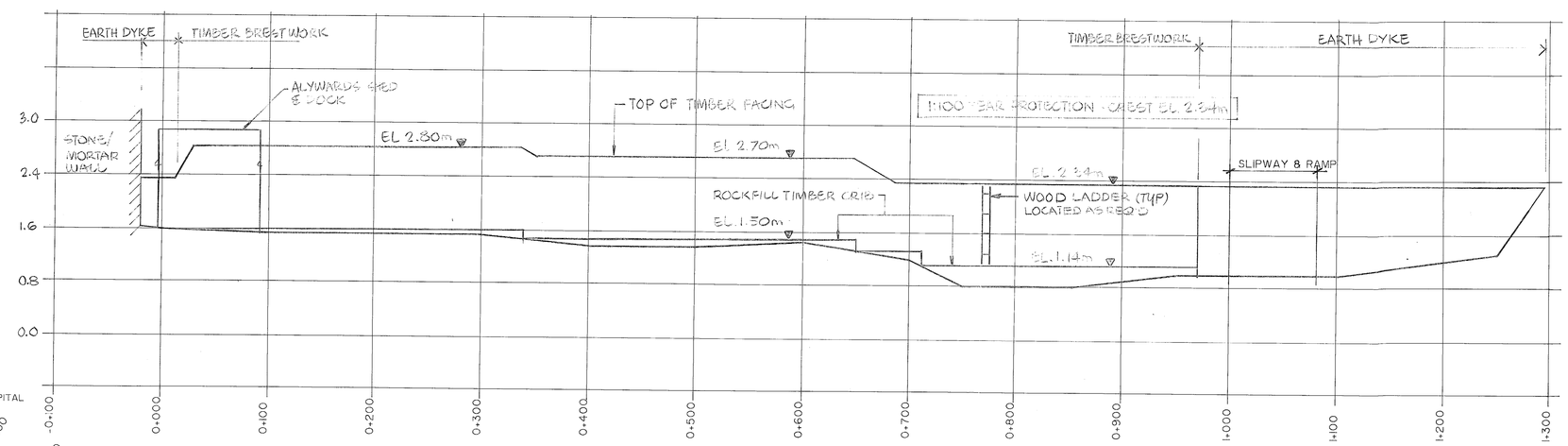
Notes:

- $5,000 maintenance to guard rail every 2 years.
- 50 year economic life on Riverside Drive and 30 years economic life on wave wall.

APPENDIX II

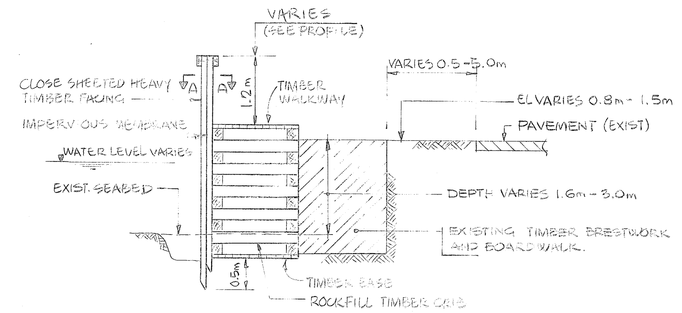
DRAWING



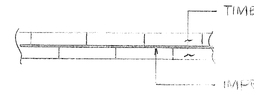


PROFILE

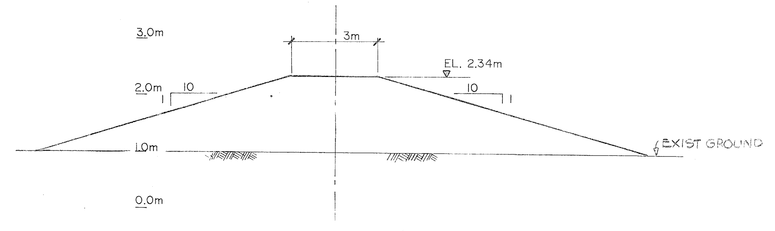
SCALE- 1 : 2500 (HORZ.)
1 :40 (VERT.)



TYPICAL SECTION THRU' BRESTWORK (SCALE 1:50)



SECTION A-A



TYPICAL SECTION THRU' EARTH DYKE
SCALE HORIZ 1:100
VERT 1:50

LEGEND

TIMBER OR B RESTWORK
EARTH DYKE

NOTES:

1. MAPPING IS BASED ON FLOOD RISK MAP FOR PLACENTIA, NEWFOUNDLAND, PRODUCED IN 1984 FROM AERIAL PHOTOGRAPHY FLOWN IN JUNE, 1984.
2. SCALES ON PROFILE & SECTIONS ARE EXAGERATED.

DRAWING NUMBER	TITLE	NO	DATE	LOCATION	DESCRIPTION	MADE BY	APPR'D	CONSTR	MECH.	ELECT'L	CIVIL
REFERENCE DRAWINGS		REVISIONS						PASSED			

DESIGNED
DRAWN RKeid
CHECKED
RECOMMENDED

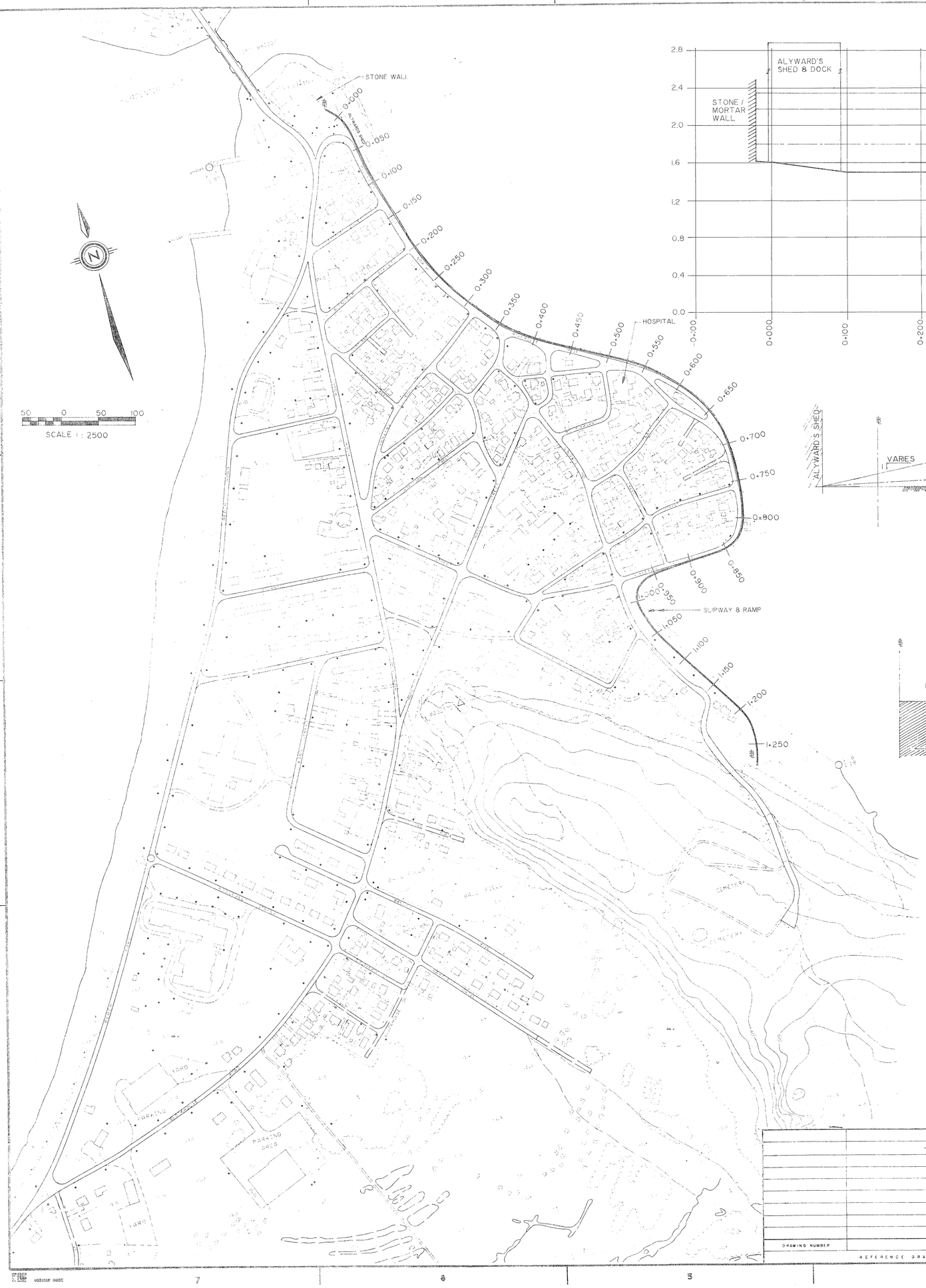
GOVERNMENT OF NEWFOUNDLAND & LABRADOR
DEPARTMENT OF ENVIRONMENT & LANDS

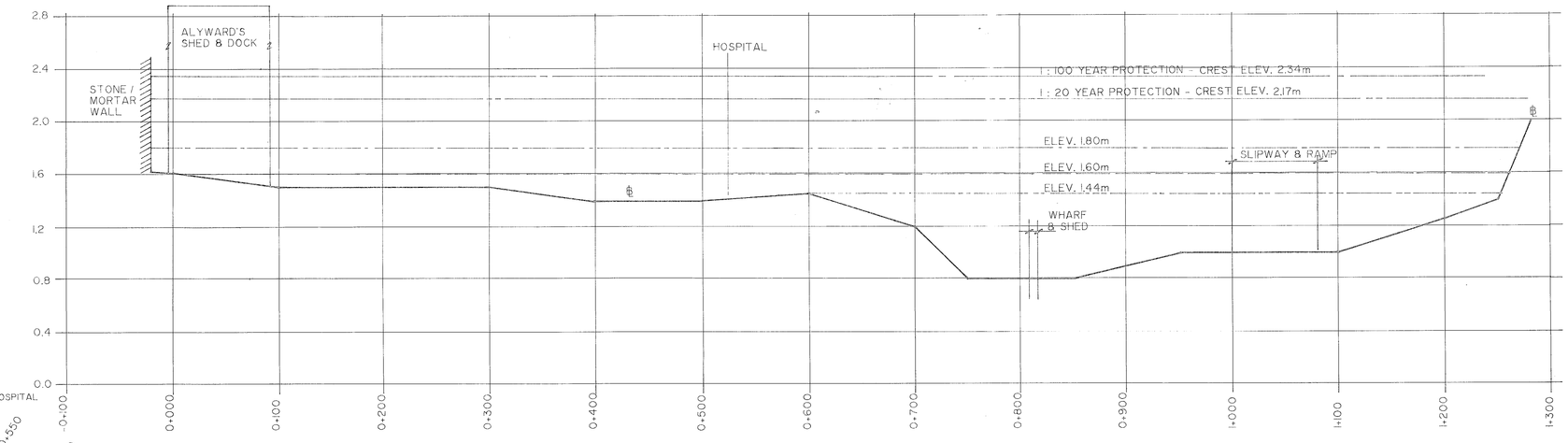
RAISING OF BRESTWORK
ALONG RIVERSIDE DRIVE-PLACENTIA

SHAWMONT NEWFOUNDLAND LIMITED
ST. JOHN'S, NEWFOUNDLAND

BRESTWORK ALTERNATIVE-RIVERSIDE DRIVE
PLAN, PROFILE & CROSS-SECTIONS

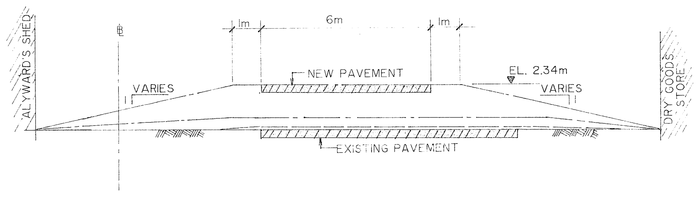
FILE NO.	SCALE	DATE	DWG. NO.	REV.
	AS NOTED	88-12-21	81-84979-2	0





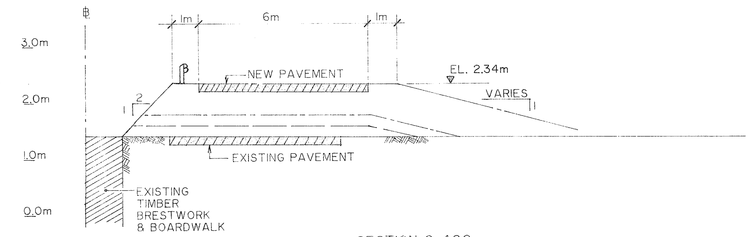
PROFILE

SCALE - 1 : 2500 (HORZ.)
1 : 20 (VERT.)



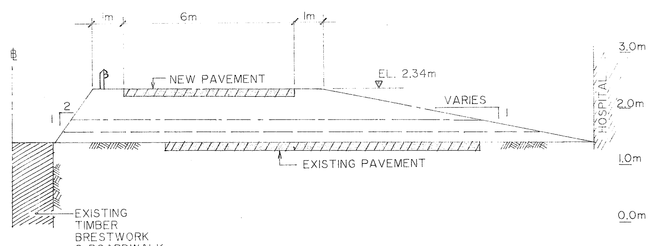
SECTION 0+050

SCALE - 1 : 100 (HORZ.)
1 : 50 (VERT.)



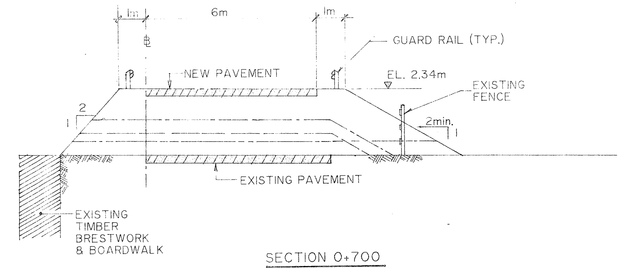
SECTION 0+400

SCALE - 1 : 100 (HORZ.)
1 : 50 (VERT.)



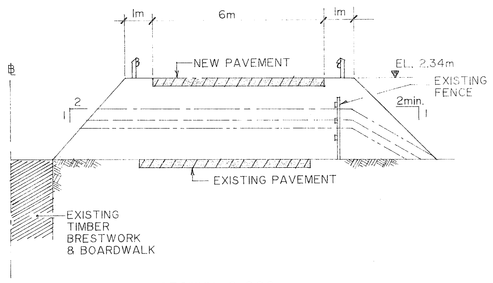
SECTION 0+525

SCALE - 1 : 100 (HORZ.)
1 : 50 (VERT.)



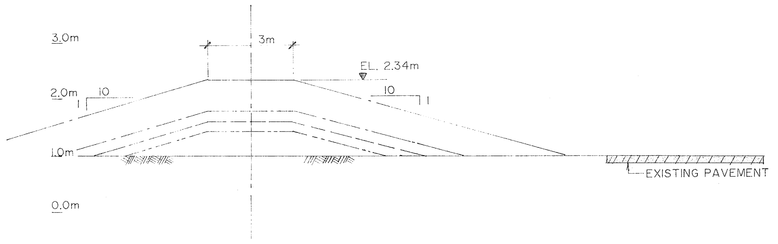
SECTION 0+700

SCALE - 1 : 100 (HORZ.)
1 : 50 (VERT.)



SECTION 0+900

SCALE - 1 : 100 (HORZ.)
1 : 50 (VERT.)



SECTION 1+000

SCALE - 1 : 100 (HORZ.)
1 : 50 (VERT.)

NOTES:

1. MAPPING IS BASED ON FLOOD RISK MAP FOR PLACENTIA, NEWFOUNDLAND, PRODUCED IN 1984 FROM AERIAL PHOTOGRAPHY FLOWN IN JUNE, 1984.
2. SCALES ON PROFILE & SECTIONS ARE EXAGERATED.

DRAWING NUMBER	TITLE

REFERENCE DRAWINGS

NO	DATE	LOCATION	DESCRIPTION	MADE BY	APPR'D

REVISIONS

CONST'N	MECH.	ELECT'L	CIVIL

PASSED

DESIGNED

DRAWN: W.E. LEAMAN

CHECKED

RECOMMENDED

FILE NO.

GOVERNMENT OF NEWFOUNDLAND & LABRADOR
DEPARTMENT OF ENVIRONMENT & LANDS

REASSESSMENT OF ECONOMIC ANALYSIS
PLACENTIA HYDROTECHNICAL STUDY

SHAWMONT NEWFOUNDLAND LIMITED
ST. JOHN'S, NEWFOUNDLAND

RIVERSIDE DRIVE
PLAN, PROFILE & CROSS-SECTIONS

SCALE	DATE	DWG. NO.	REV.
AS NOTED	88-10-14	81-84979-1	0