Report prepared for:

DISTRICT OF SQUAMISH
File No. 5225-04

SQUAMISH SEA DYKE UPGRADE ASSESSMENT

March 1999

Bland Engineering Ltd.
Consulting Hydrotechnical Engineers
West Vancouver, B.C.

SQUAMISH SEA DYKE UPGRADE ASSESSMENT

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1.0 SUMMARY

The District of Squamish's previous study titled "Flood Hazard Management Plan - 1994" contained recommendations on the sea dyke. The recommended alignment was the existing alignment along Loggers Lane or alternatively along Highway 99; then Highway 99 to Pemberton Avenue; a shoreline walkway along the Mamquam Blind Channel; and Third Avenue to the BC Rail embankment. The BC Rail embankment would form the remainder of the sea dyke until the natural ground rises to above sea level.

This sea dyke upgrade assessment report reviews and develops the recommendations of the Flood Hazard Management Plan. Bland Engineering Ltd. generally concurs with the previous recommendations including the dyke crest elevation of 3.3m. The dyke freeboard can be reduced where a road surface forms the dyke.

The Loggers Lane alternative was chosen due to Ministry of Highways and Transportation's concerns regarding the use of Highway 99 as the dyke. A gap in the dyke at the tie-in to high ground requires fill and a new floodbox. The Loggers Lane pavement needs to be raised by up to 0.6m over a 200m length.

Highway 99 from Loggers Lane to Pemberton Avenue is high ground well above dyke level.

The Mamquam Blind Channel shore line has already been partly developed with an elevation 3.3m walkway forming the dyke. It is recommended that this concept be continued. The placement of temporary fill to the 200-year high water level (without freeboard) of 2.7m geodetic datum is recommended while the shoreline is being developed.

The railway at Vancouver Street is at elevation 2.6m. It is recommended that concrete blocks be stockpiled so that they can be placed across the railway when needed.

Third Avenue is about 0.2m low. The placement of fill to elevation 3.3m on the west side of the road is recommended.

The BC Rail embankment has acted as the sea dyke since 1985 and can continue to do so subject to a geotechnical assessment.

The sea dyke project could be implemented over a 5-year period. Assuming that the Blind Channel walkway and slope protection will be provided by the developers, the estimated costs are:

Studies, investigations and preliminary	$ 90,000
Temporary protection	$ 20,000
Permanent protection	$501,000
Contingency for BC Rail embankment upgrade	$100,000
TOTAL (excluding GST)	$711,000

2.0 INTRODUCTION

2.1 Background

A study titled "Flood Hazard Management Plan - 1994" (1), (2) prepared by the consulting engineering firm Klohn Leonoff Ltd. in association with Graham Farstad Associates Ltd. contains recommendations dealing with management of floods in the District of Squamish. Specific recommendations concerning upgrading of the sea dykes can be summarized as:

- The sea dyke crest elevation should be 3.3m geodetic datum,
- The existing alignment along Loggers Lane could be adopted, or an alternative alignment along Highway 99 would form the north east end of the dyke,
- Highway 99 would continue to form the dyke from Loggers Lane to the Mamquam Blind Channel,
- A shoreline walkway along the Mamquam Blind Channel would form the dyke to Vancouver Street,
- There is an existing dyke from Vancouver Street to Third Avenue along Cattermole Slough,
- Third Avenue would form the dyke to the B C Rail embankment,
- The BC Rail embankment would form the remainder of the sea dyke until the natural ground rises to above sea level.
- The old dyke along Cattermole Slough is not needed as part of the sea dyke. — check ?

The Flood Hazard Management Plan included cost estimates of work required of $478,000 or $510,000 depending on the alternative chosen.

2.2 Authorization and Terms of Reference

By letter dated 5 January 1999, Bland Engineering Ltd. was authorized to carry out an upgrade assessment of the Squamish sea dyke in accordance with the terms of reference of the District's proposal call dated 25 November 1998. Nelson Environmental Services was included in the consultant team to carry out the environmental portion of the work. The terms of reference are summarized as:

- Review the recommendations in Klohn Leonoff report and confirm the validity of the rationale used in determining the required improvements;
- Prepare an updated list of the required improvements;
- Prepare preliminary designs and cost estimates for each recommended improvement;
- Determine the environmental aspects of alterations to the Highway 99 culverts and the best alternative for flood protection on the Blind Channel;
- Prepare and recommend an implementation strategy including the funding requirements and scheduling of works for inclusion in the District's 5 to 10 year Capital Budget;
- Review and document land ownership of the dykes and identify related issues that need to be addressed.

In addition, the contract included the preparation of an operation and maintenance manual.

2.3 District of Squamish's Flood Hazard Management Plan

Bland Engineering Ltd. generally concurs with the proposals of the Flood Hazard Management Plan. The current update study develops the proposals and prepares preliminary designs of the recommended improvements.

3.0 DYKE DESIGN

3.1 Crest elevation

(All elevations are to geodetic datum unless stated otherwise.)

The 200-year high water level at the Point Atkinson was estimated based on en extreme value analysis. This value was transferred to Squamish using data provided by the Canadian Hydrographic Service. The 200-year high water level at Squamish for still water was calculated as 2.7m GSC. An allowance for waves must be added to the still water level. Since the highest levels include a storm surge component, an intense storm should be assumed to occur during the 200-year high water event. Although major storm events with south east winds in the Lower Mainland generally have little wind effect at the head of Howe Sound, it is recommended that allowance be made for waves due to 20 knot winds blowing up Howe Sound. Calculations of the local wind waves against the BC Rail embankment and the dyke in the Mamquam Blind Channel result in waves up to 0.25 m in height trough to crest. An allowance of 0.3m above the still water level is recommended to include for wave run up.

Current expert opinion on sea level rise is that the expected net rise is in the range -1 to +2 mm/year. It is recommended that the designs include a contingency allowance of 0.3m for sea level rise.

The recommended dike crest elevation is

200-year high water level		2.7m GSC
Freeboard		
wave effects	0.3m	
contingency for sea level rise	0.3m	
Total freeboard		0.6m
Total crest elevation		3.3m GSC

It is recommended that temporary protection while shoreline developments are in progress should be provided to at least El. 2.7m. Until the permanent protection has been completed the District will need to be especially vigilant during extreme high tides, and be prepared to dump emergency fill or sandbag critical locations.

Permanent protection where the surface is a black topped road on the Mamquam Blind Channel can have a reduced freeboard, at 3.0m geodetic datum, since overtopping due to wave action will be minimal with a wide road surface.

The 3.3m GSC value is the same as the value in the Klohn Leonoff 1994 reports. Details of the high water analysis are given in Appendix B.

3.2 Erosion protection

The 200-year one-hour peak wind velocity was obtained from the B.C. Building Code as 34m/s. The calculated wave heights for various reaches of the Mamquam Blind Channel, Cattermole Slough and the B.C. Rail embankment are in the range 0.40 to 0.65m. Details of the wind and wave analysis are given in Appendix B.

The Mamquam Blind Channel and Cattermole Slough shorelines are subject to waves from boat traffic. Although tugs at full power can develop large waves of 1.0m or more, boat traffic was observed to move at slow speed. A 0.6m boat wave is recommended for riprap design.

Preliminary design of riprap erosion protection for a 1V:2H slope results in an angular rock riprap cover layer of 0.4 to 0.6m thickness, with an additional 0.2m thick filter layer where required by the nature of the underlying material. A construction tolerance should be added to the minimum layer thickness. Typical erosion protection design is shown on figure 7.

The BC Rail embankment has a vegetated slope and shows no signs of erosion. It is considered that the wave climate is such that riprap is not necessary.

3.3 Minimum cross section

The Ministry of Environment Lands and Parks minimum dike template comprises a gravel or black top surfaced crest of 3.7m minimum width, and side slopes of 1V:2H or flatter. New dikes are constructed of compacted granular fill. Old uncompacted dikes require assessment by a geotechnical engineer to develop a satisfactory design. A special problem in the Mamquam Blind Channel and Cattermole Slough areas is the likelihood of old timber piles, timber bulkheads and the like embedded in the dike. The final design stage of the sea dikes should include a search of historical information and old aerial photographs to identify problem areas.

3.4 Shoreline walkway

Figure 7 illustrates typical designs for the shoreline walkway. Designs will be site specific. Constructed marsh areas will likely be required by the environmental agencies to compensate for habitat loss.

4.0 DYKE ALIGNMENT AND IMPROVEMENTS

The plan and profile of the sea dyke are shown on figures 3-5. Cross sections are shown on figure 6.

4.1 Alternative dyke alignments at north east end

The Flood Hazard Management Plan (1) proposed as one alternative, that the sea dyke be relocated from Loggers Lane to Highway 99, by fitting flap gates on the existing culverts. The culverts were inspected and found to be partly or severely corroded. In addition, the culverts would not have seepage collars or the special compaction necessary for a floodbox. New culverts would be necessary if this alternative were adopted.

The Ministry of Transportation and Highways (MOTH) was contacted regarding this alternative, and its reply is included in Appendix C. This option is not feasible since MOTH intends to double-lane the highway and bridge over the Blind Channel. A solution might be for the new north bound lane to be designed to incorporate a dyking function and incorporate a new floodbox. Access to the floodbox could be from Loggers Lane. This concept has not been discussed with MOTH and would need its approval.

It should be noted that the Central Squamish Drainage Study (3) saw the need for a pump station on the Blind Channel at Loggers Lane. It can be concluded that the Highway 99 dyke alternative alignment would worsen flooding the Loggers Lane-Robin Drive area.

The environmental study is included in Appendix D. The floodboxes on Loggers Lane can be operated to allow a small flow into the slough during rising tides. Coho salmon spawn and rear in the slough upstream of the floodboxes. Relocating the sea dyke alignment to Highway 99 would ease fish passage throughout the tidal cycle and enhance the fish utilization of the slough and tributaries between Loggers Lane and Highway 99.

The existing dyke alignment along Loggers Lane is the best alternative for flood protection, and is retained for the preliminary design. The road elevation is above 2.7m, which is satisfactory for temporary protection. In view of the existing general road elevation of 3.3m, the preliminary design includes for raising the low spot to the same elevation over about a 200m length.

The dyke would tie in to the hillside along an old road on unsurveyed Crown land. A gap in the dyke where a culvert appears to have been removed needs to be filled including a new floodbox.

4.2 Highway 99 (Loggers Lane to Pemberton Avenue)

Highway 99 is a substantial fill well above the 3.3m elevation. There is not a dyke right of way. It is recommended that the highway be treated as high ground which does not require a dyke.

4.3 Mamquam Blind Channel

4.3.1 Pemberton Avenue

The Pemberton Avenue pavement elevation is generally El. 2.9-3.1m, rising to El. 5.3m at the BC Rail crossing, which is satisfactory for temporary protection. A portion of the shoreline has a covenant for a dyke. It is recommended that an elevation 3.3m shoreline walkway including riprap slope protection, or other acceptable dyke be required at the time of development. An acceptable alternative would be to raise the road pavement by 0.1m to El. 3.0m so that Pemberton Avenue forms the permanent protection. In this case, any development between the road and the shoreline would have to incorporate its own protection.

4.3.2 Pemberton Avenue to Marina Estates

The ground elevation is 2.8m GSC along the shoreline which is acceptable as temporary protection. It is recommended that an elevation 3.3m shoreline walkway including riprap slope protection, or other acceptable dyke be required at the time of development.

4.3.3 Marina Estates

The shoreline has been developed as an El. 3.3m walkway with riprap slope protection. No further work is required.

4.3.4 Marina Estates to Winnipeg Street

The lots are privately owned, and only one has a covenant for a dyke. The ground is above El. 2.7m so temporary protection is not necessary. It is recommended that an elevation 3.3m shoreline walkway including riprap slope protection, or other acceptable dyke be required at the time of development.

4.3.5 Winnipeg Street to Vancouver Street

The land owners are BC Rail, Interfor, and the District's street ends. It is understood that a joint development proposal incorporating an El. 3.3m shoreline walkway has been presented to Council. BC Rail advised that the proposal has not yet been formalized. The fill on the property is at El. 2.2 to 3.3m. It is recommended that temporary fill be placed along the shoreline north of Vancouver Street to raise the elevation to above 2.7m.

4.4 BCR and Loggers Lane crossing

The existing elevation at the BC Rail track is 2.6-2.7m GSC. Since this location is well back from the shoreline, significant waves cannot propagate through the shallow sheet of water which would form at 200-year high water. The alternatives are to raise the BCR track and Loggers Lane pavement by 0.3-0.4m to El. 3.0m, or to provide a mechanism of

temporary closure such as a line of concrete blocks. The preliminary design included the latter alternative. The black top of Vancouver Street and Loggers Lane would be locally raised to 3.0m elevation. The preliminary design for the closure is shown on figure 7.

4.5 Southwood Holdings

An application for development has been made, and drawings have been submitted to the Ministry of Environment Lands and Parks (MELP). It is understood that discussions with MELP are in progress, regarding an elevation 3.3m walkway including riprap slope protection as the sea dyke.

4.6 Southwood Holdings to Third Avenue

This section is owned by BC Rail. The land has been filled to general elevation 2.4 to 3.4m. It is recommended that temporary fill be placed to El. 3.0m on the low spots. It is recommended that an elevation 3.3m shoreline walkway, or other acceptable dyke be required at the time of development.

4.7 Third Avenue

Third Avenue is owned by the District. The cross section more than meets provincial dyke template standards apart from the top elevation which is 0.1-0.2m below El. 3.3m. The preliminary design includes for placing fill to El. 3.3m on the land side of the existing pavement, and for upgrading the existing river side riprap adjacent to the Cattermole Creek gate structure.

4.8 B.C. Rail embankment

The BC Rail embankment was not constructed in a 1968 air photo and appears to be newly constructed in a 1973 photo. It did not function as a sea dyke until the culverts through the rail embankment were sealed and the control gate structure was constructed on Cattermole Creek in 1984 or 1985. Since that time the railway embankment has acted as part of the sea dyke protection for downtown Squamish against high sea water levels.

MELP was contacted regarding precedent or comment on the use of the rail embankment as a dyke, and advised that it could be accepted.

BC Rail was contacted regarding the use of the embankment as part of the sea dyke, and its reply is included in Appendix C.

The embankment does not meet provincial dyke standards for the following reasons:

a) The embankment was apparently not designed as a dyke.
b) The owner, BC Rail does not accept any responsibility for flood protection.
c) There is not an agreement regarding maintenance or a right of way in favour of the District.

d) There is not a physical dyke crest along much of the embankment which can be used for dyke maintenance purposes.

BC Rail has not ruled out the embankment as forming part of the sea dyke. For the preliminary design it was assumed that the embankment can form part of the sea dyke subject to a geotechnical investigation and review. The review should include site investigations at the culverts reported as 'sealed'. It is assumed that any upgrading or maintenance work for dyke purposes can be done with equipment suitable for operation on the rail track. Agreement should be reached with BC Rail on ownership of the embankment should BC Rail no longer require it. These concepts have not been discussed with BC Rail and would need its approval.

4.9 The old dyke

The old dyke alignment is shown on Figure 2. It runs from Third Avenue towards Main Street, and then follows the sewage outfall to the rail embankment. Two culverts with slide and flap gates control the internal drainage by providing stormwater detention during high tide periods. The dyke crest elevations vary from 2.7 to 3.4m GSC. It is used as part of the trail system.

The Cattermole Slough gate structure has 5 slide/flap gates (hydraulically operated, electrically powered, manually controlled). The District closes the gates during high forecast tides; they are left open at other times. Under this scenario, the old dyke forms a necessary part of sea dyke.

It would be possible to leave the gates in the closed position, which would improve the drainage of the downtown area by increasing the detention pond storage volume. Then the old dyke would not be needed as part of the sea dyke.

4.10 Floodboxes

The following floodboxes are located along the sea dike alignment.

REF NO.	DISTANCE ON DYKE, km	SIZE AND TYPE	COMMENTS
a.	1.00	(none)	Gap in dyke (floodbox removed?)
b.	1.12	0.9m CSP, flap gate	Under Loggers Lane
c.	1.12	0.9m CSP, slide & flap gates	Under Loggers Lane
d.	1.21	1.2m CSP, flap gate	Under Loggers Lane
e.	1.21	1.2m CSP, slide/flap gate	Under Loggers Lane
f.	1.88	0.45m CSP, flap gate	Under Pemberton Ave. S of H-99
g.	2.01	0.45m CSP, flap gate	Under Pemberton Ave. S of BCR
h.	2.01	0.60m CSP, flap gate	Under Pemberton Ave. S of BCR
i.	2.39	0.60m conc, flap gate	Winnipeg St outfall
j.	3.62	conc structure, sluice gates	Cattermole Creek gate structure

A new culvert with flap gate should be installed at floodbox 'a'. The preliminary design allows for a 1.2m dia. concrete pipe with flap gate. This floodbox would serve the Loggers Lane east side drainage ditch

The corrugated steel pipe (CSP) culverts can be expected to have a limited life since the salt water action first removes the zinc then corrodes the underlying steel. Culverts 'b', 'c', 'd' and 'e' have lost the zinc and corrosion of the steel is well advanced. A new concrete floodbox is recommended as part of the permanent protection. The other CSPs should be replaced by concrete pipes as part of the shoreline developments.

5.0 COST ESTIMATES

The construction cost estimates are based on construction by force account using hired equipment and purchased materials. Equipment rental rates are based on the Province of BC 1998-99 guide. Allowance is included for design, construction management and contingency. GST is not included.

			$	
a)	studies, investigations and preliminary			
	i.	BCR embankment geotechnical investigation	60,000	
	ii.	Loggers Lane floodboxe geotechnical investigation and preliminary design	30,000	
	Total a)			90,000
b)	construct temporary works Place temporary fills to El 2.7m at 2.84-3.05km and to El 3.0m at 3.34-3.45km			20,000
c)	construct permanent works			
	i.	Install new floodbox at 1.00km	44,000	
	ii.	Raise Loggers Lane tie-in to El. 3.3m	10,000	
	iii.	Raise Loggers Lane to El. 3.3m	167,000	
	iv.	Blind Channel - Loggers Lane, new floodboxes	200,000	
	v.	BC Rail crossing at Vancouver St	20,000	
	vi.	3rd Ave. dyke fill and riprap upgrade	60,000	
	vii.	Contingency for BCR embankment upgrades	100,000	
	Total c)			601,000
TOTAL (GST extra)				711,000

add note re. shoreline costs in development areas assumed by developer.

6.0 IMPLEMENTATION STRATEGY

The implementation strategy includes construction of the recommended temporary protection in the first year.

An agreement with BC Rail on the use of the embankment as the dyke should be reached as soon as possible. The geotechnical investigation of the embankment can then be carried out.

The Loggers Lane floodboxes probably have several useful years life remaining. The geotechnical investigation for their replacement has been included in year 4 with construction of the floodboxes and raised pavement in year 5.

ITEM	YEAR 1	YEAR 2	YEAR 3
Install floodbox at 1.00km	44,000		
Temporary fills	20,000		
BC Rail crossing at Vancouver St		20,000	
BCR embankment geotech. investigation		60,000	
Contingency for BCR embankment upgrades			100,000
3rd Ave. dyke fill and riprap upgrade			60,000
TOTALS	64,000	80,000	160,000

ITEM	YEAR 4	YEAR 5
Loggers Lane floodboxes prelim. design	30,000	
Raise Loggers Lane tie-in to El. 3.3m	10,000	
Loggers Lane, new floodboxes		200,000
Raise Loggers Lane to El. 3.3m		167,000
TOTALS	40,000	367,000

7.0 LAND OWNERSHIP

Details of the land ownership along the sea dyke are included in Appendix E.

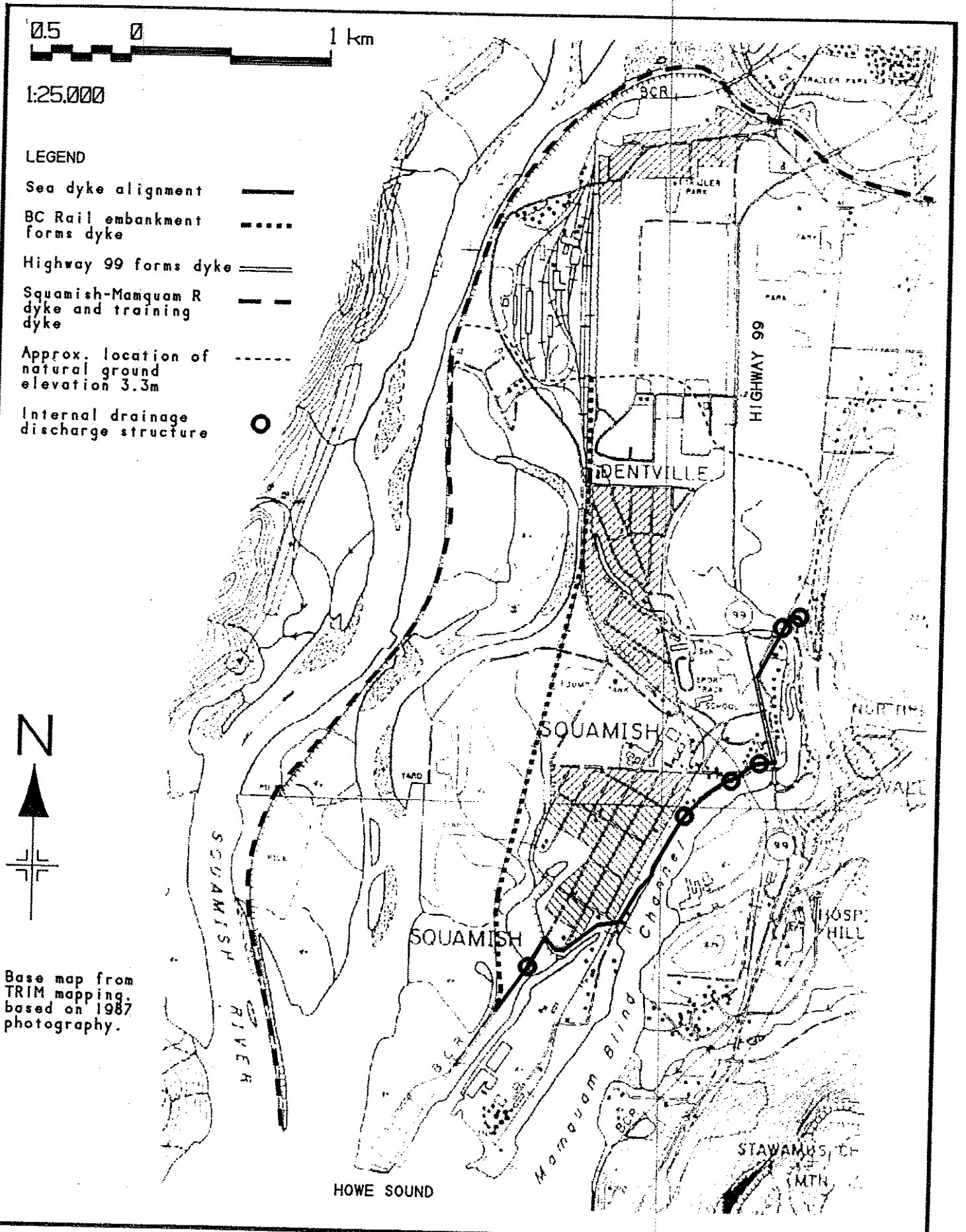
The following recommendations are made:

- The District should acquire the unsurveyed Crown land for the Loggers Lane dyke tie-in.
- The District should continue to acquire the Blind Channel and Cattermole Slough shorelines as developments take place, including all the waterside slope, the 3.7m wide crest, and 2.0m on the landside of the crest as shown on figure 7.

- The District should reach an agreement with BC Rail on the use of its embankment as the dyke.

Prepared by:
BLAND ENGINEERING LTD.

C. Robert Bland, P.Eng.



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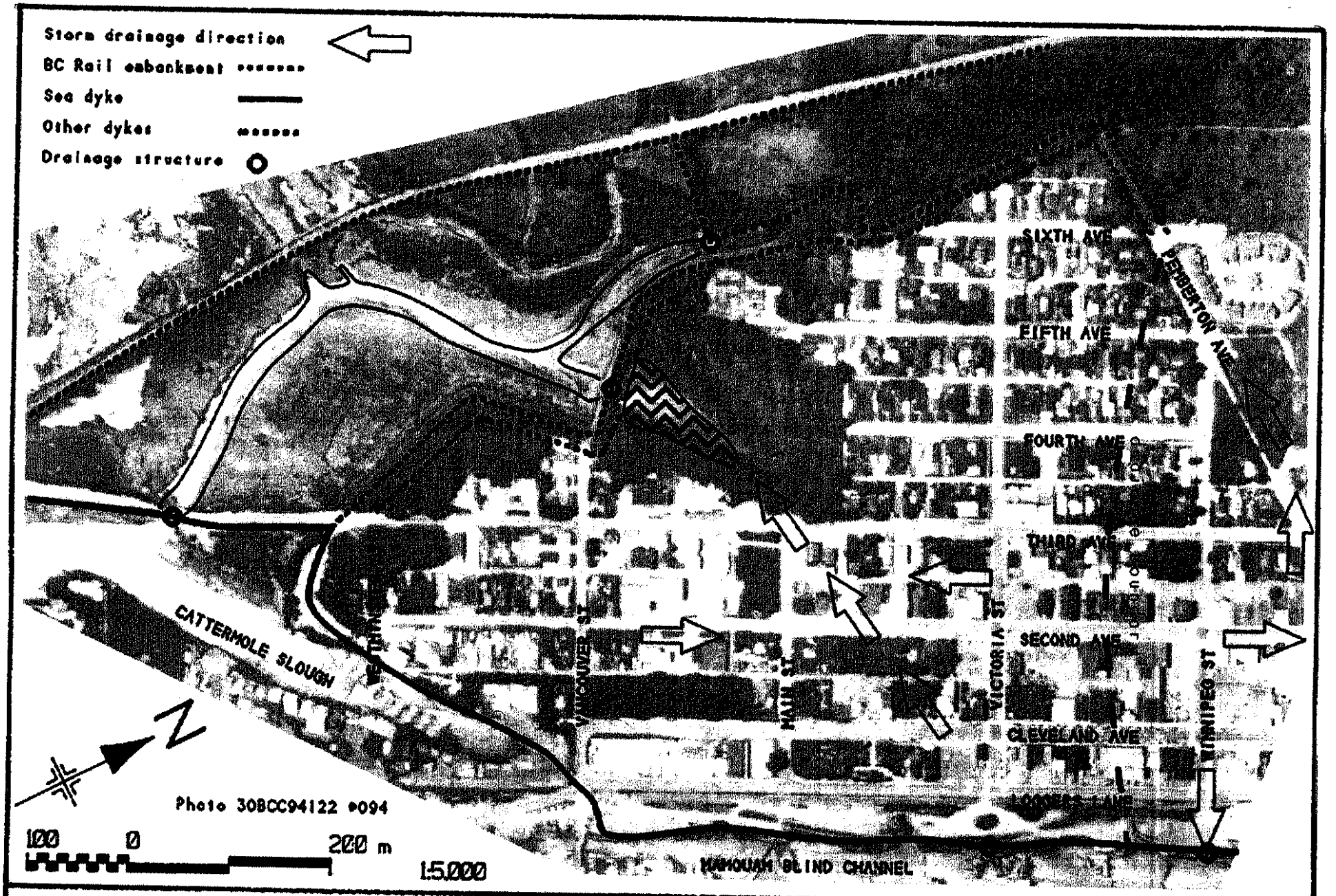
SQUAMISH SEA DYKE LOCATION PLAN

FIG. 1



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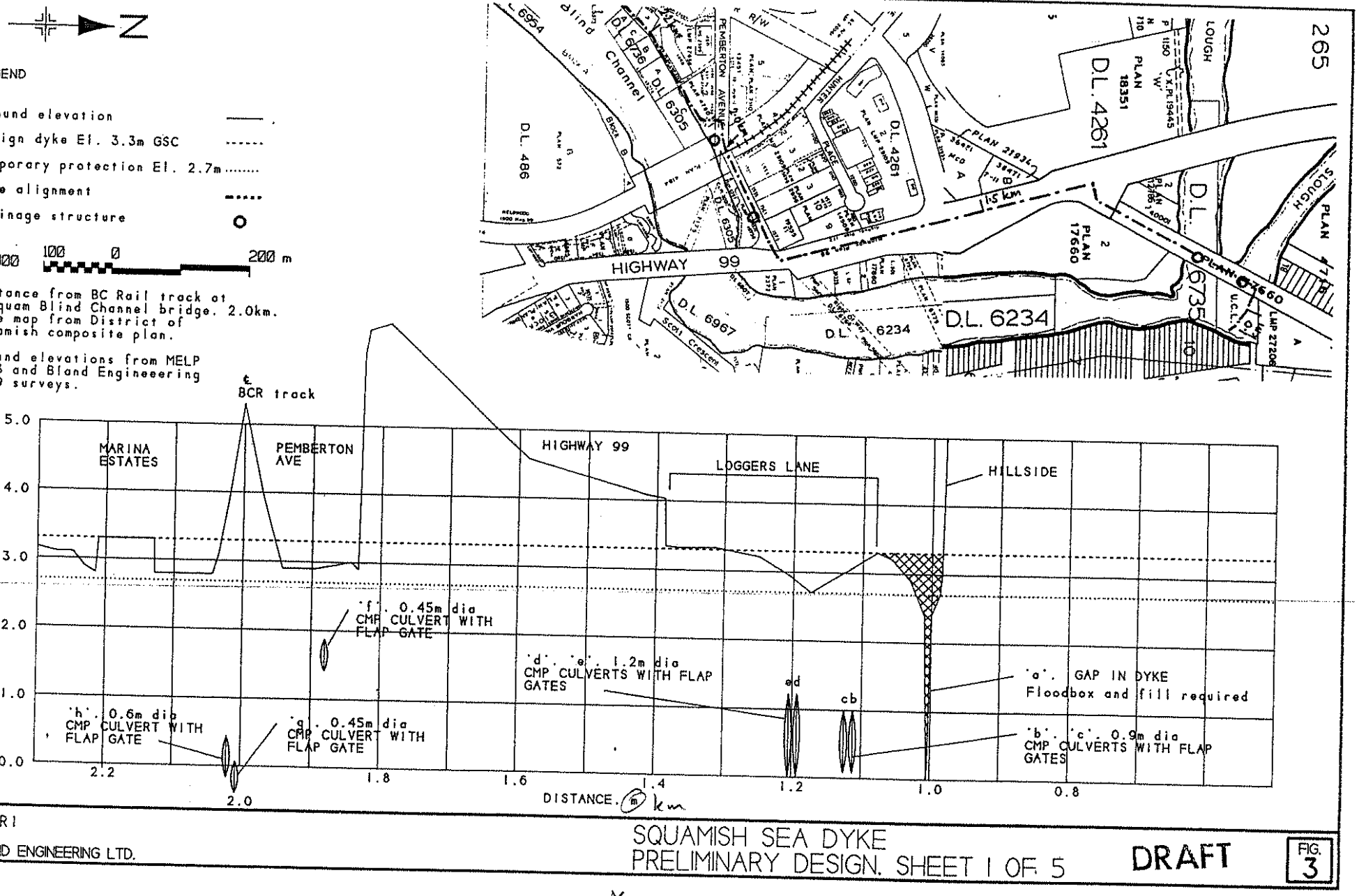
CATTERMOLE SLOUGH INTERNAL DRAINAGE

FIG. 2



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SQUAMISH SEA DYKE
PRELIMINARY DESIGN. SHEET 1 OF 5

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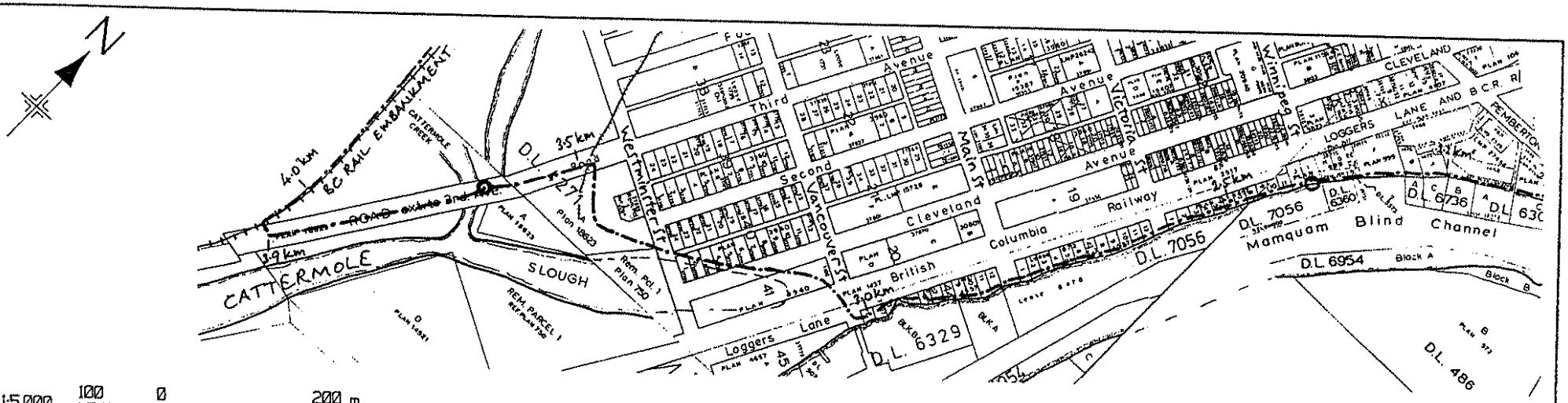
FIG. 3



Distance from BC Rail track at Mamquam Blind Channel bridge, 2.000km.
Base map from District of Squamish composite plan.
Ground level from MELP 1993 survey.

LEGEND

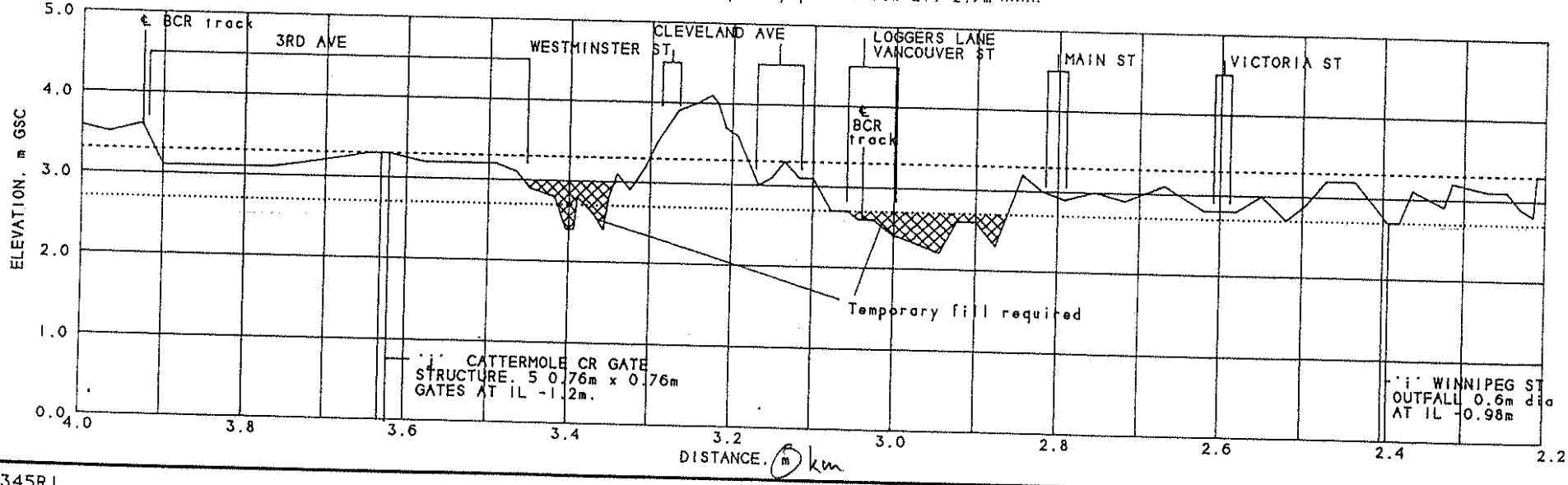
Ground elevation ——

Design dyke El. 3.3m GSC ------

Temporary protection El. 2.7m .....

Dyke alignment

Drainage structure



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SQUAMISH SEA DYKE
PRELIMINARY DESIGN. SHEET 2 OF 5

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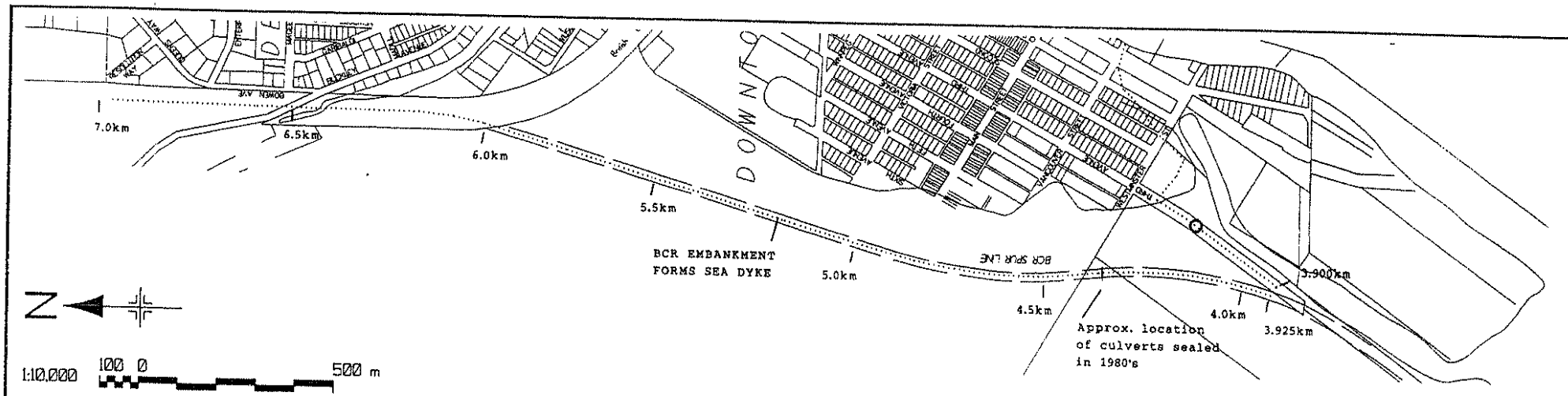
FIG. 4



Distance from BC Rail track at Mamquam Blind Channel bridge. 2.000km.
Base map from composite plan by Insite Planning Services.
Surveys by MELP 1993. and Bland Engineering 1999.

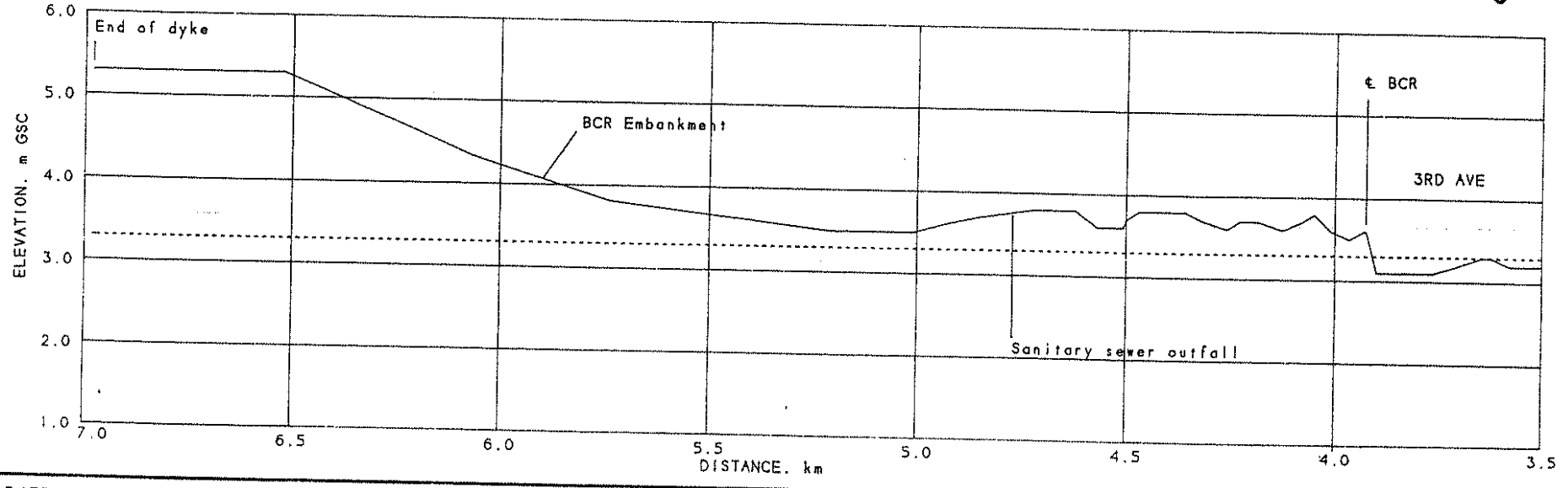
LEGEND

Ground elevation

Design dyke El. 3.3m GSC

Dyke alignment

Drainage structure



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SQUAMISH SEA DYKE
PRELIMINARY DESIGN. SHEET 3 OF 5

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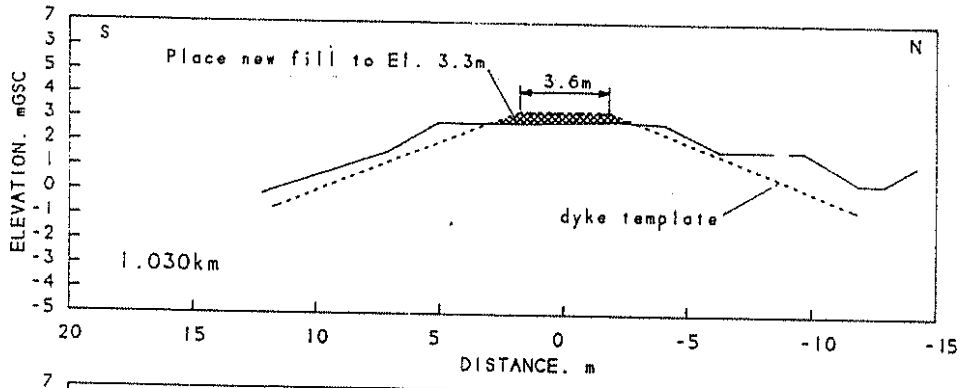
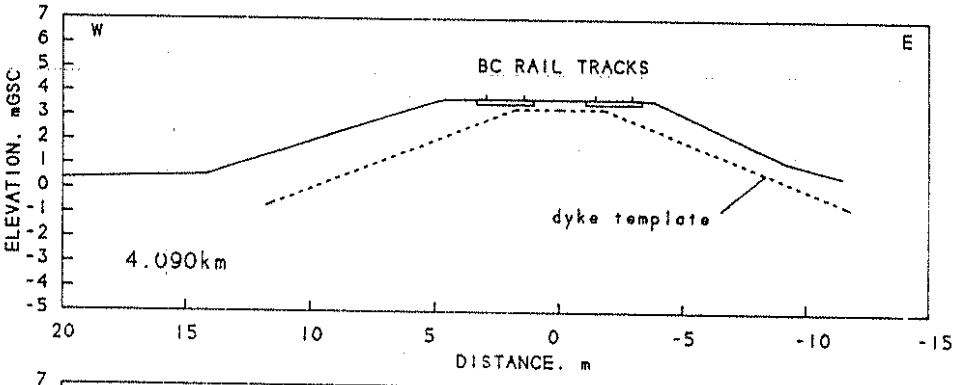
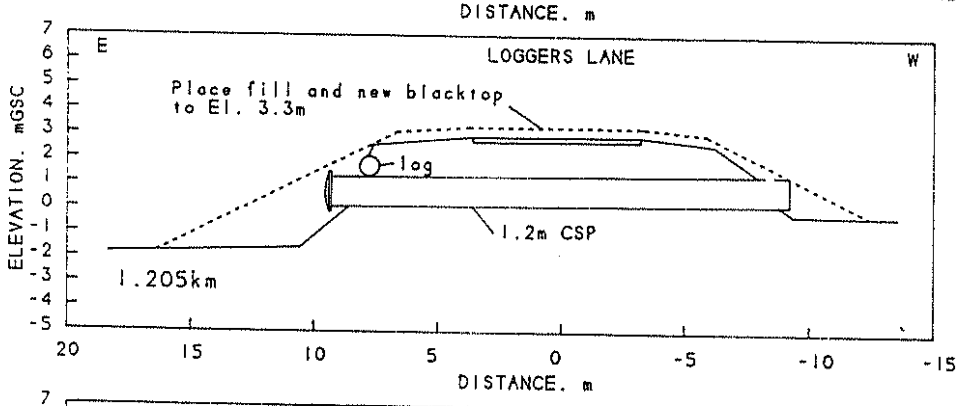
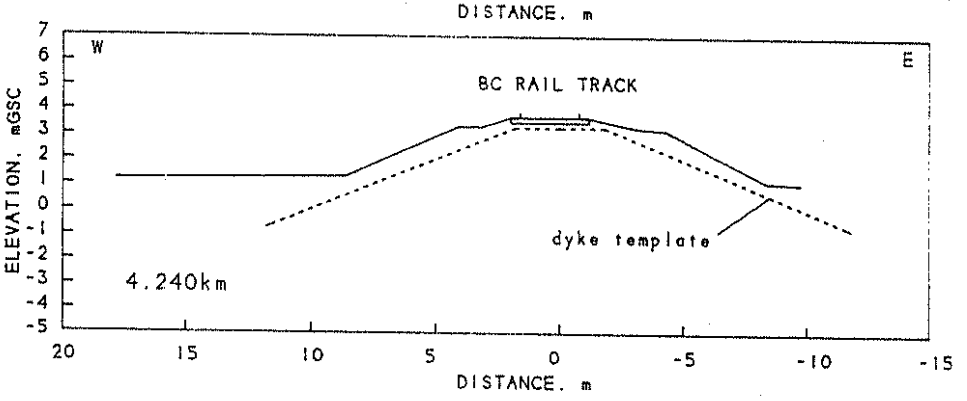
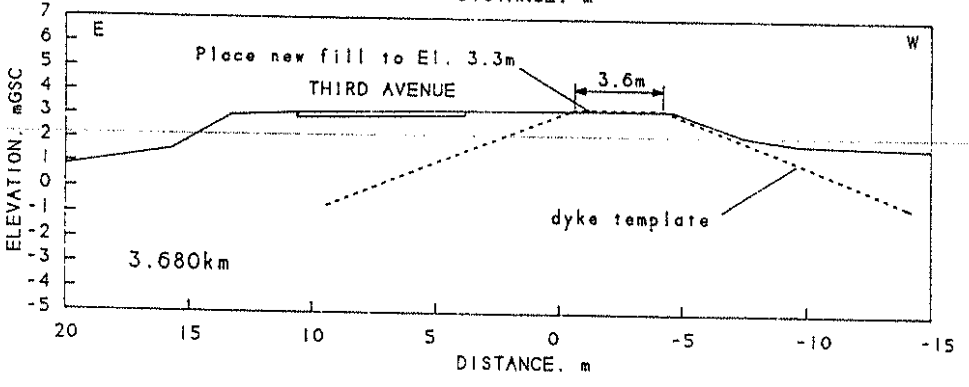
FIG. 5











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SQUAMISH SEA DYKE
PRELIMINARY DESIGN. SHEET 4 OF 5

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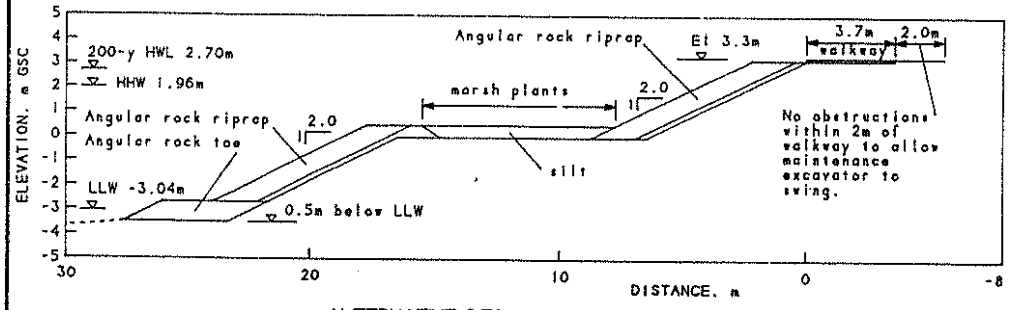
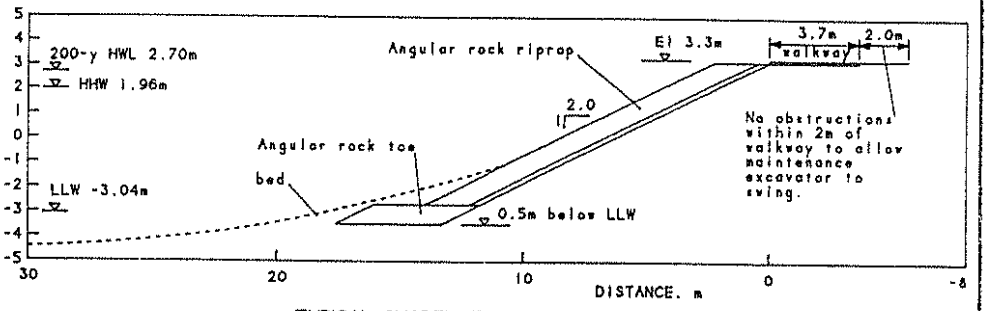
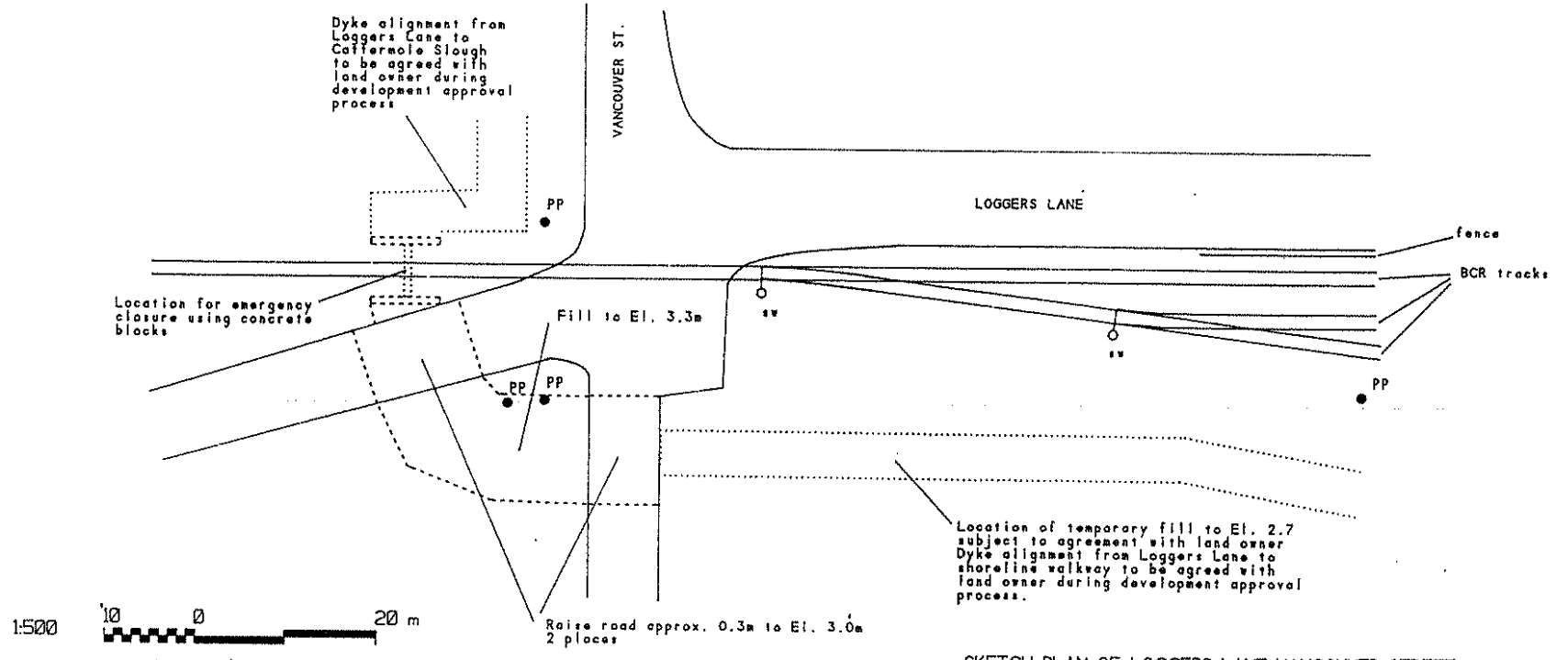
FIG. 6



ALTERNATIVE DESIGN INCORPORATING MARSH



TYPICAL SHORELINE WALKWAY DESIGN



SKETCH PLAN OF LOGGERS LANE-VANCOUVER STREET

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SQUAMISH SEA DYKE
PRELIMINARY DESIGN. SHEET 5 OF 5

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FIG. 7

APPENDIX A

REFERENCES

(1) District of Squamish's Flood Hazard Management Plan dated 11 May 1994 and

(2) Background Report dated 18 February 1994, both by Klohn Leonoff Ltd. in association with Graham Farstad Associates Ltd.

(3) Central Squamish Drainage Study, Steffan, Robertson and Kirsten (Canada) Inc. in association with R.F.Binnie & Associates Ltd. and Nelson Environmental Services, 23 February 1995.

APPENDIX B

TIDES AND WAVES FOR PRELIMINARY DYKE DESIGN

APPENDIX B
TIDES AND WAVES FOR PRELIMINARY DYKE DESIGN

B1.0 High sea water level

The highest sea water levels due to the gravitational effects of the sun and moon occur during December and January. Other factors which affect the highest tides are the winds along the west coast which generally increase sea levels by about 0.1 to 0.2m in winter; the El Nino effect in El Nino years; and storm surge due to severe depressions. For example, the highest recorded Point Atkinson sea level on 16 December 1982 was 0.9m above the normal high tide, of which 0.2m was attributed to El Nino effects and 0.7m due to an intense storm (2).

The highest Point Atkinson sea levels are plotted on figure B-1 (maximum annual series, Gumbel extreme value analysis). From this plot, the 200-year high water level is estimated as 2.7m GSC. This level was transferred to Squamish using the chart datum of -3.04m GSC at Point Atkinson, and the Hydrographic Service's adjustment of +0.09m for Squamish. The chart datum at Squamish is 5.305m below monument 1274J, which has an elevation of 2.175m GSC (1993). Therefore, chart datum at Squamish is -3.13m GSC.

The estimated 200-year high water level at Squamish is 2.70m GSC in accordance with the following table:

	POINT ATKINSON chart datum		DIFFERENCE	SQUAMISH chart datum		SQUAMISH GSC datum
	ft	m	ft	ft	m	m
200-y HWL	18.8	5.74		19.1	5.83	2.70
Extreme HWL	18.4	5.61		18.7	5.69	2.56
HHW large tides	16.4	5.00	+0.3	16.7	5.09	1.96
HHW mean tides	14.4	4.39	+0.3	14.7	4.48	1.35
MWL	10.1	3.08		10.3	3.14	0.01
LLW mean tides	3.7	1.13	+0.1	3.8	1.16	-1.97
LLW large tides	0.2	0.06	+0.1	0.3	0.09	-3.04
Extreme LWL	-1.3	-0.40		-1.2	-0.37	-3.50

B2.0 Winds

The fleet captain of the Squamish Yacht Club (1) kindly provided information on winds at the head of Howe Sound:

- Major storms with wind from the south east in the Vancouver area have little effect on wind at the head of Howe Sound. If the wind veers to the south west in the Strait of Georgia, the wind picks up a little at the head of the sound.

- Summer afternoon thermal inflow winds associated with fine weather often blow 20-25 knots (10-13m/s) at the head of the sound, increasing to 25-30 knots (13-15m/s) near the end of the Squamish River training dyke.
- Winter outflow winds associated with high pressure systems can reach 60 knots (31m/s) in the Mamquam Blind Channel.

Principal directions and speeds of inflow winds are shown on figure B-2.

The maximum wind speeds for Squamish from the B.C. Building Code (1998) are:

Return period, y	10	30	100	200
Maximum hourly wind speed at 10m height, m/s	24.2	27.8	31.7	33.9

B3.0 Waves

B3.1 Waves in conjunction with 200-Year high water

An allowance for waves must be added to the 200-year still water level of 2.7m GSC. Since the highest levels include a storm surge component, an intense storm should be assumed to occur during the 200-year event. Although major south east storm events generally have little effect at the head of Howe Sound, it is recommended that allowance be made for waves due to 20 knot winds blowing up Howe Sound. Adjacent to the Squamish estuary, the winds have a fetch of 5km. A 20 knot (10m/s) wind over 5km fetch would generate 0.5m waves (measured from trough to crest). However, these waves will have substantially diminished by the time they reach the dyke, which is partly protected by the Squamish River training dyke and the ship terminal. According to local knowledge, swell from waves in the sound quickly dies out up the Mamquam Blind Channel and does not affect the sea dyke. Calculations of the local wind waves against the BC Rail embankment and the dykes in Cattermole Slough and the Mamquam Blind Channel result in waves up to 0.25 m in height trough to crest.

A 0.30m freeboard allowance above the still water level is recommended for wave effects in conjunction with the 200-year high water level; total elevation 3.0m GSC.

B3.2 Waves in conjunction with HHW and for riprap design

The dyke crest elevation should satisfy another criterion in addition to the 200-year HWL condition. The crest should be higher than the 200-year wind waves in conjunction with HHW of 1.96m GSC. The 200-year wind velocity of 34m/s is recommended to be applied to outflow winds. The calculated wave heights for various reaches are in the range 0.40 to 0.65m. The estimated wave run up is 0.4 to 0.7m above the still water level, total elevation 2.7m GSC. The recommended 200-year water elevation of 3.0m GSC from section B3.1 is the most critical condition.

B4.0 Sea level rise

A rising sea level due to global warming has been widely predicted. The actual rise in sea level relative to the ground surface is the sum of several processes such as thermal expansion of the oceans, glacier melt, uplift due to deep seated earth movements, and uplift due to rebound from the pressure of the last ice age. Current expert opinion (3) is that the south B.C. inner coast will experience a net change of -1 to +2 mm/y. Of relevance to the Squamish sea dyke is the possibility of land subsidence due to consolidation of alluvial sediments.

It is recommended that the design of the sea dyke includes a contingency allowance of at least 0.3m for net sea level rise.

B5.0 Recommended dyke crest elevation

The recommended dyke crest elevation is 3.30m GSC calculated as follows:

200-year high water level		2.70m GSC
Freeboard		
wave effects	0.30m	
contingency for sea level rise	0.30m	
total freeboard		0.60m
Total		3.30m GSC

Figures in Appendix B

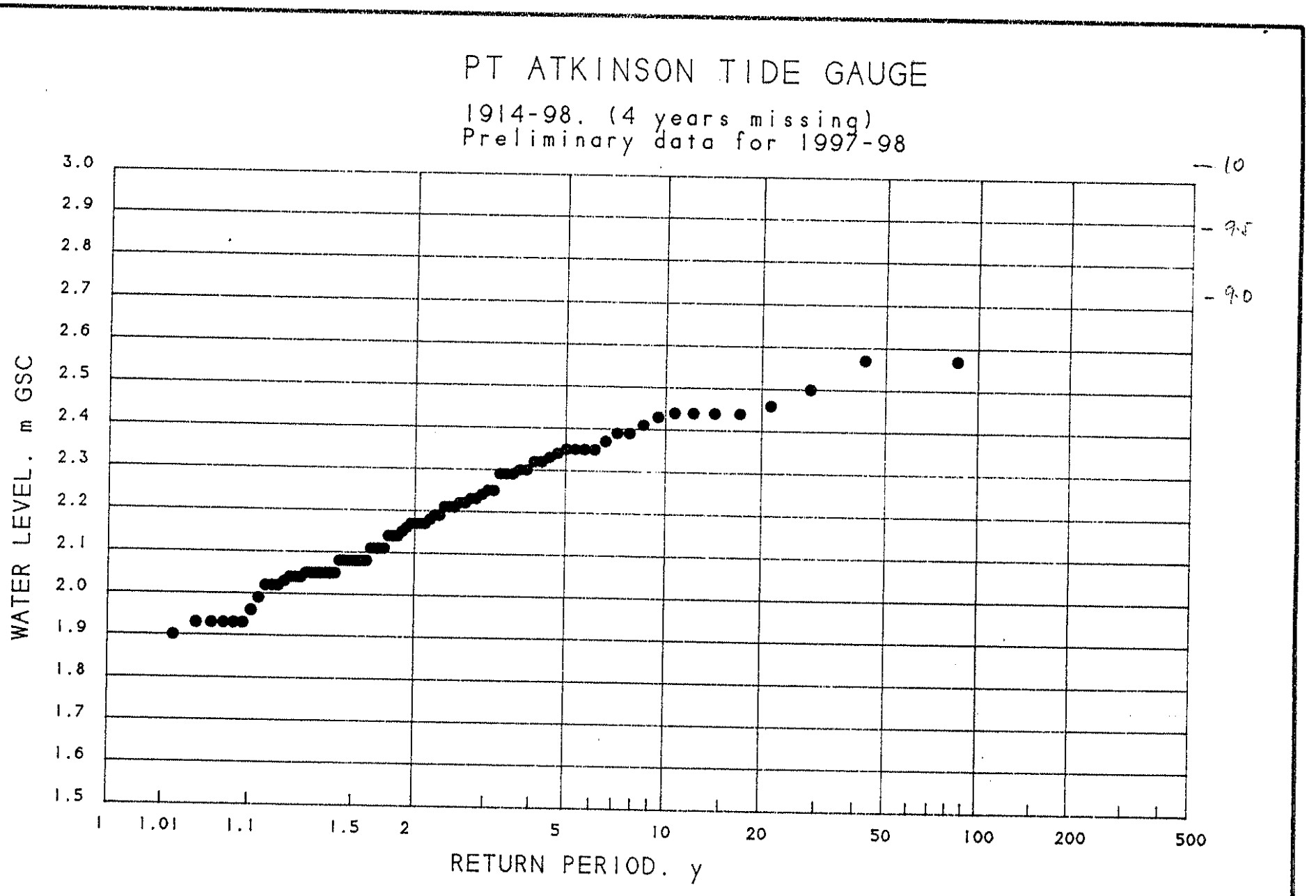
Figure B-1 Point Atkinson Tide Gauge
Figure B-2 Thermal inflow winds

Principal references for Appendix B

(1) Personal communication from John Gugins, 1998 fleet captain Squamish Yacht Club, January 1999.

(2) Impact of El Nino in British Columbia, Bill Crawford and Bodo de Lange Boom, CHS Pacific, 3 April 1998.

(3) Processes affecting sea level change along the coasts of British Columbia and Yukon, R. Thomson and W. Crawford, in Responding to climate change in B.C. and Yukon, workshop at SFU, Vancouver, B.C., 27-28 February 1997.



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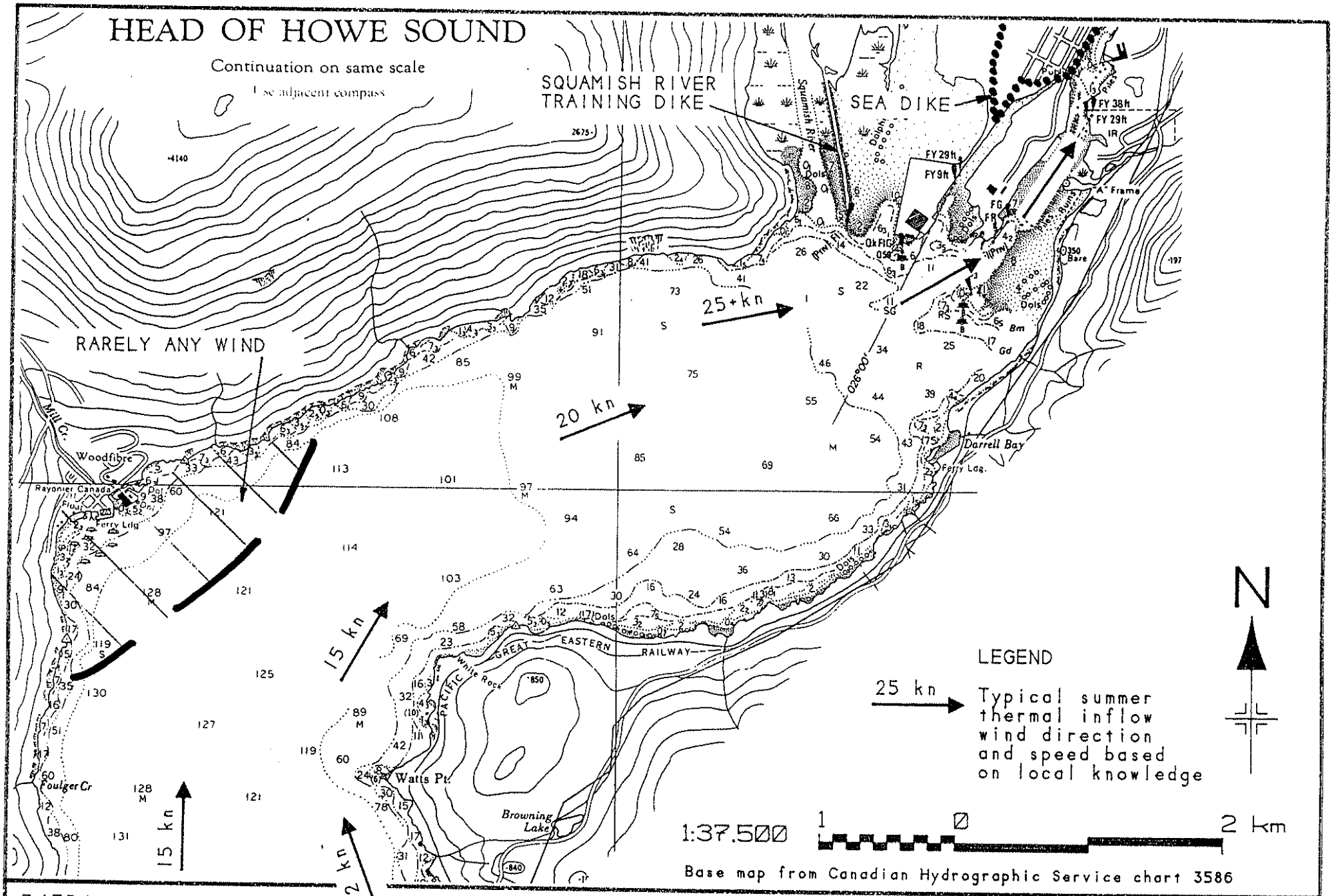
POINT ATKINSON TIDE GAUGE MAXIMUM ANNUAL WATER LEVEL

FIG. B-1



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HOWE SOUND AT SQUAMISH
THERMAL INFLOW WINDS

FIG. B-2

APPENDIX C

LETTERS FROM BC RAIL AND MINISTRY OF TRANSPORTATION AND HIGHWAYS

BCR
PROPERTIES

January 25, 1999

Direct Dial: 984-5458

Your File: 345L1

Our File: DL 486, NWD

Bland Engineering Ltd.
4013 Bayridge Crescent
West Vancouver, B.C.
V7V 3K5

Attention: Robert Bland, P.Eng.

Dear Sir:

Re: Squamish Dikes

Further to your letter of January 7, 1999, this office has the completed a review of the above noted subject.

At the rail crossings at Pemberton Avenue and Loggers Lane near Vancouver Street, there would be no problem at these two locations as long as the rail elevations remain the same.

Section D on your plan is the BC Rail grade to Squamish Terminals of which BC Rail will retain ownership as rail right of way. Please be advised that this grade was not built as a dike and would not meet diking standards. BC Rail would not want to be subject to any costs associated with upgrading same to dike standards.

The two proposed crossings and Section D would be covered by our standard crossing/encroachment agreements permitting construction and access approved by BC Rail Ltd. These agreements have a one time documentation fee and annual rental fees that are reviewed every two years. The Applicant would have all the responsibility, maintenance and liability for use of the railway grade as a dike and the crossings.

For the area of foreshore along the Mamquam Blind Channel between Winnipeg and Vancouver Streets, BCR Properties is hesitant at present to grant a right of way as it impacts future development of this site. Any diking work at this location would be temporary and subject to BCR Properties approval. Any diking work would be covered by our encroachment agreement until such time as the right of way can be formalized through the development application process.

/.....2

Suite 506 - 221 West Esplanade, North Vancouver, B.C. V7M 3J3 Telephone: (604) 984-5211 Fax: 984-5200

Our Engineering Department does not have any recent information related to the elevations of the top of rail for the subject areas.

Yours truly,

BCR PROPERTIES LTD.

C.R. Dawson

C.R. Dawson
Supervisor of Legal Surveys

/crd

cc: G. Silvera, BCRP Development
D. Carabetta, BC Rail Engineering

BRITISH COLUMBIA

File: 11050-40/SQU
11-20-99(C)

February 2, 1999

Bland Engineering
4013 Bayride Crescent
West Vancouver, B.C. V7V 3K5

Attention: Mr. C. Robert Bland, P.Eng.

Dear Mr. Bland:

Re: Squamish Dykes - Sea to Sky Highway #99

Thank you for your letter of January 7, 1999 regarding the above noted. I am writing to clarify this Ministry's position on using the Sea to Sky Highway #99 as part of the proposed sea dyke.

As you may know, Highway #99 is the only route that provides a link between the Lower Mainland and the Howe-Sound/Whistler Communities. It is critical that the integrity of this road system not be compromised by using the road base as a dyking mechanism.

The Ministry of Transportation & Highways is currently reviewing the future planning options for this section of Highway #99. It is anticipated that any future widening of the highway will take place to the east of the current highway alignment. This future widening will most likely incorporate the widening of the existing Mamquam Blind Channel Bridge; improvement of the existing Highway #99 pavement structure; and this additional lane construction. Therefore, the placement of unsuitable material and drainage appurtenances along this proposed section of Highway #99, is not acceptable to the Ministry. Further, the Ministry would not be prepared to have any ownership or maintenance responsibilities for this type of flood protection.

Should you have any questions or concerns, please contact this office at (604)981-0042.

Yours truly,

Maria Szalay

Maria Szalay, P.Eng.
District Highways Manager

BS/tr

Ministry of Transportation and Highways

South Coast Region

Mailing Address:
1690 Main Street
North Vancouver BC V7J 1E3

Telephone: 981-0042
Facsimile: 981-0064

APPENDIX D

ENVIRONMENTAL ASSESSMENT OF ALTERNATIVE DYKE ALIGNMENTS AT MAMQUAM BLIND CHANNEL

CASCADE ENVIRONMENTAL RESOURCE GROUP

MEMORANDUM

DATE: March 22, 1999

TO: Robert Bland, Bland Engineering Ltd.

CC: Mohammed Afsar, District of Squamish

FROM: Mike Nelson, R.P. Bio.

RE: Squamish Sea Dyke, Environmental Considerations

FILE #: 064-01-01

Task 4, determine the environmental aspects of alterations to Highway 99 culverts and the best alternatives for flood protection of the Blind Channel

1.0 Baseline Conditions

The Squamish Estuary Management Plan, Habitat Work Group Final Report (1981) describes the northern portion of the Mamquam Blind Channel as providing shallow water estuarine/marine habitat. Water depths are between the low tide mark and a depth of 10 metres. The waters are generally brackish. The northern portion of the Mamquam Blind Channel is bordered by disturbed/developed commercial/industrial lands and to a lesser extent by mixed deciduous/coniferous forest and residential property. The District of Squamish is actively pursuing developing a park in this area, as the last of the residents and industrial tenants vacate the area.

Predominant trees within the deciduous forests are red alder (*Alnus rubra*) and northern black cottonwood (*Populus trichocarpa*). Tree species found within the mixed forest stands include the above two species, bigleaf maple (*Acer macrophyllum*), Sitka spruce (*Picea sitchensis*), western red cedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*). The tidal portions of the channel generally have a silty organic mud substrate, and are fringed with marsh. Vegetation within the marshes is dependent on its tidal zonation. Lower and mid intertidal marshes are dominated by Lyngbye's sedge (*Carex lyngbyei*), while the upper intertidal marshes are dominated by grasses, predominantly reed canarygrass (*Phalaris arundinaceae*), meadow barley (*Hordeum bracyantheum*) and creeping bentgrass (*Agrostis alba*).

Fish species found in the Mamquam Blind Channel are likely to be similar to those found in the central delta of the Squamish Estuary by Levy and Levings (1978) (see Table 1). Goodman and Vroom (1972), however, noted that densities of salmonids were greater in the central basin than in other areas of the Squamish Estuary.

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Loggers Lane Creek (Watershed Code 9000-919)

Loggers Lane Creek's source are springs or water piping through the local gravels from the Mamquam River, located under the powerlines east of the Squamish Forestry office. The creek flows through a logged area and then becomes a ditch beside Loggers Lane Creek. Riparian vegetation is present to some degree along most of the creek's length, although the extent of the vegetation is limited adjacent to the road. The creek flows through culverts under Raven, Finch and Robin Drive and under Loggers Lane south of Raven Drive, none of which pose a barrier to fish migration. Loggers Lane Creek discharges into the Mamquam Blind channel through two culverts under Loggers lane. Flap gates have been installed on the downstream end of the culverts. These culverts prevent fish movements through the culverts during rising tides when the head on the discharge side is greater than in the creek. The gates also create a velocity barrier to fish migration during low tides and low flows in the creek, when there is insufficient water pressure to open the gates beyond a crack. The creek can also flow into the tidal slough between Loggers Lane and Highway 99 (a.k.a. McKay Slough), and again, discharge through two flap gate controlled culverts to the Mamquam Blind Channel.

The creek has several tributaries that flow through the subdivision between Robin and Raven Drive, collectively known as "Finch Creek". During winter months, these drainages appeared to have ample flow to provide fisheries habitat, although it is noted that they run dry in summer (Sam Gidora, pers. com.). The water quality in these drainages is also suspect, as they flow through areas draining domestic animal

Table 1 Fish Species found in the Central Delta of the Squamish Estuary

Common Name	Specific Name	Period of Peak Abundance
Permanent Residents		
Staghorn sculpin	*Leptocottus armatus*	June to September
Starry flounder	*Platichthys stellatus*	
Surf smelt	*Hypomesus pretiosus*	
Cutthroat trout	*Salmo clarki clarki*	
Dolly Varden Char	*Salvelinus malma*	
Temporary Residents		
Herring	*Clupea Harengus*	
Chum salmon	*Oncorhynchus keta*	Fry peak in late April & early June
Coho salmon	*O. kisutch*	Smolts peak in early June & early July
Chinook Salmon	*O. tshawytscha*	Fry peak in early July
Spiny dogfish	*Squalus acanthias*	
Snake prickleback	*Lumpenus sagitta*	
Prickly sculpin	*Cottus asper*	Various Times
Shiner perch	*Cymatgaster aggregatta*	September & October
Threespine stickleback	*Gasterosteus aculeatus*	
Pink salmon	*O. gorbuscha*	
Eulachon	*Thaleichthys pacificus*	
Sand lace	*Ammodytes hexapterus*	

Modified from Levy and Levings (1978), in B.C. Ministry of Environment (1981).

paddocks, which have been cleared of vegetation, in some places right up to the drainage channel. The creek also flows through a wood waste disposal area near Robin Drive and Loggers Lane. There are blockages caused by beavers on the tributaries of Loggers Lane Creek and in the main stem itself.

Coho salmon are known to spawn and rear in Loggers Lane Creek (DFO, 1992; ECL, 1995 & FISS, 1997). Escapement records in the Stream Information Summary (1992) show a mean of 37 fish returning to spawn in Loggers lane Creek from 1979 to 1985, with a peak of 150 fish. The Stream Information Summary also indicates that migration to spawning areas typically occur from mid October through November, with spawning usually from mid November through January. Anadromus cutthroat trout have also been recorded (Sam Gidora, Pers. Com.; ECL, 1995 & FISS, 1997), and the Squamish Estuary Management Plan, Habitat Work Group Final Report indicates a historical presence of steelhead (*Oncorhynchus mykiss*), although none were found in more recent surveys in October 1993 and March 1994 by the Salmonid Enhancement Program or by ECL in 1995. Cutthroat trout are generally spring spawners, while steelhead spawning can be quite variable. Lamprey and threespine stickleback have also been noted in Loggers Lane Creek (NES, 1995; ECL, 1995 & FISS, 1997).

Several enhancement projects have been conducted on Loggers Lane Creek to improve salmonid production. A Salmonid Enhancement Program (SEP) project pre 1982 involved placing gravel at the headwaters of the creek to improve spawning conditions. A more recent SEP project in 1994 involved local residents helping to clean up debris in the creek and enumerate fish populations (Sam Gidora & Piere Friele, pers. com.). A report commissioned by a land developer in the area identifies potential habitat enhancement opportunities (ECL, 1995). These include riparian planting, installation of a culvert near the creek's headwaters, and the addition of suitable substrates for salmonid spawning. The District of Squamish have recently applied for federal Salmon Enhancement Project funding to conduct rehabilitation works and studies on Loggers Lane Creek. These works include enhancement efforts, trail development, as well as the potential for relocating the creek channel away from Loggers Lane.

Tidal Slough between Highway 99 and Loggers Lane (McKay Slough)

This slough is a brackish, tidal drainage where access to the Mamquam Blind Channel has been restricted by Loggers Lane and associated culverts (as described above). The slough receives fresh water from Loggers Lane Creek, and runoff from adjacent lands through a complex of sloughs upstream (west) of Highway 99. Aquatic vegetation is dominated by widgeon grass (*Ruppia maritima*) while emergent vegetation along the water fringes is primarily cat-tail (*Typha latifolia*), sedges (*Carex spp.*) and various grasses (BC Environment et al., 1981).

The Squamish Estuary Management Plan, Habitat Work Group Final Report states that coho salmon and steelhead are "suspected to spawn in the slough located near the high school". The author has found no other records to support the claim of steelhead being present in these areas, although coho salmon and cutthroat trout presence were noted by Bob Reynolds (pers. Comm.) in the past. In addition, one long time Squamish resident (Bill Manson, Per. Com.) reported that "flathead" were once caught in the

slough behind Wilson Crescent which connects to this slough. More recent limited sampling recorded only threespine stickleback for this area (NES, 1995).

SEP has been approached in the past about the possibility of reconnecting the Squamish River to the slough adjacent to Wilson Crescent. The purpose was to improve water quality and perhaps the local fisheries. The problems concerning dyking, flooding and water levels were never elucidated, and the project was not pursued. The District of Squamish, however, is revisiting this possibility, although there are no firm plans to date.

2.0 Alterations At Highway 99 Culverts

One alternative that was being investigated was to dismantle the flap gates at both the outlet of Loggers Lane Creek and at the outlet of "McKay Slough" (under Loggers Lane), and install flap gates on the 1800 and 600 mm diameter culverts under Highway 99 (which drain the tidal sloughs upstream of Highway 99). In addition, the culverts under Loggers Lane are nearing the end of their life span. They could thus be replaced with a structure that does not need an outlet control. This scenario would have eased fish passage into both Loggers Lane Creek and into "McKay Slough", which is presently a concern. In addition, the round existing culverts could be replaced with larger culverts (or other structure) which would further improve fish passage in these areas.

Discussions with the Ministry of Transportation and Highways (MoTH) have indicated that they have plans to double-lane Highway 99 in this area, and therefore, installation of flap gates on the existing culverts under highway 99 is not feasible. A solution might be to incorporate a dyking function, including a new floodbox, into the design of the new north bound lane. While this concept has not been discussed with MoTH, it would allow for better fish access into Loggers Lane Creek and "McKay Slough".

The above options will also have implications for re-watering Wilson Slough (if that project proceeds beyond the concept stage), as a re-watering scenario will increase the flow of water through the floodbox and related structures downstream. The use of a floodbox, flap gate, or other control structure, will also influence the species of fish which could utilize a re-watered Wilson Slough, and possibly limit its ecological value. It is likely that such a scheme would improve the water quality in the area, however, to what extent the water quality and ecological values would be "improved" is beyond the scope of this letter-report.

3.0 Water Quality Issues

The ditch on east side of Loggers Lane presently drains directly to Mamquam Blind Channel. This ditch bisects a wood waste disposal area, and receives runoff and seepage that may have elevated levels of tannins, lignins, and other chemicals as well as an altered pH level. Water quality, therefore, is dubious.

Two alternatives have been proposed to deal with the waters within this ditch. One is to direct the waters into Loggers lane Creek, and the other is to continue to direct the waters directly into the Mamquam Blind Channel. The latter alternative is the preferred option with respect to water quality, as their will likely be more dilution within the

Mamquam Blind Channel as compared to Loggers lane Creek. Potential detrimental affects due to poor water quality would therefore be reduced.

The water quality within Finch Creek has also been the source of some debate, as it flows through animal paddocks and along the fringe of the above noted wood waste disposal area. There have been some preliminary discussions between the local DFO office and the District of Squamish on the merits of diverting the creek. The plans however, are very much in the early discussion stages, and require additional study. Note that despite these water quality concerns, Finch Creek is known to support coho and threespine stickleback (NES, 1998).

4.0 Mamquam Blind Channel

The District of Squamish are in the process of establishing a park (Rose Park) adjacent to the Mamquam Blind Channel between the Highway 99 bridge and the "McKay Slough". Conditions with the park will not be altered from the current conditions with either proposed dyking option at Loggers Lane Creek (i.e. using flood control measures at Highway 99 upstream of "McKay Slough", or the current location at Loggers Lane). The same volumes of water will flow into the channel, and the existing aquatic and terrestrial habitat won't be affected by the choosing of one flood protection scheme over the other.

Downstream of Highway 99 bridge, the construction of sea dykes will likely involve the use of riprap along the shores of the Mamquam Blind Channel. There would be a corresponding loss of riparian vegetation, for which DFO will require compensation. Provisions for planting along the dyke, therefore will have to be made, and should include planting shelves for semi-aquatic species, as well as areas for terrestrial plants.

References

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Harcombe, A. 1994. Terms of Endangerment. in Biodiversity in British Columbia: Our Changing Environment. ed. L.E. Harding and E. McCullum. Canadian Wildlife Service, Environment Canada. Ottawa, Ont.

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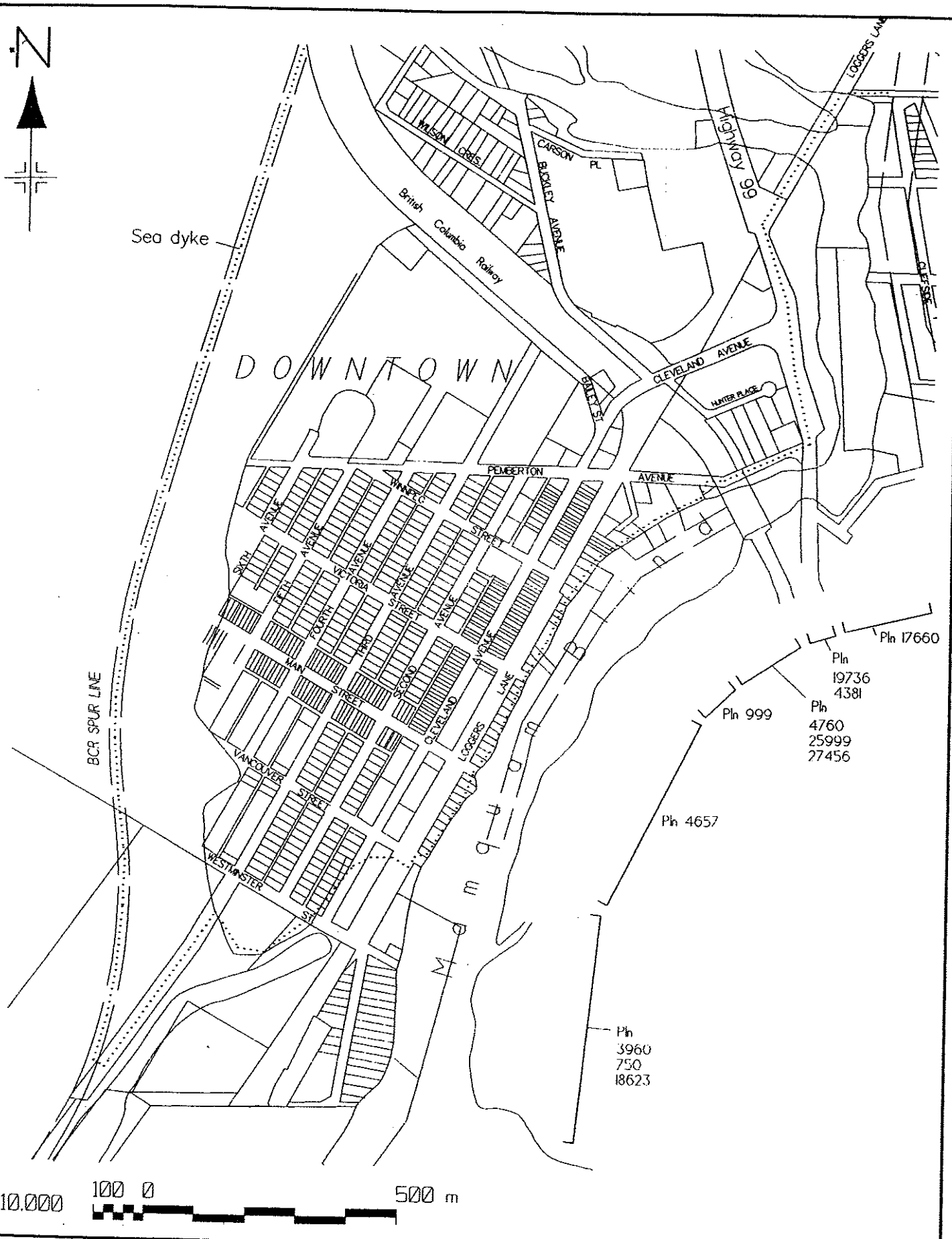
APPENDIX E

LAND OWNERSHIP

LAND OWNERSHIP

Land ownership data were obtained through the BC Online system and from the Land Titles office during the period January-March 1999.

Figure E1 shown the sea dyke alignment and the general locations of property plan numbers. Table E1 lists the properties along the sea dyke alignment in order of increasing distance from the north east corner.



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SQUAMISH SEA DYKE LAND OWNERSHIP

FIG. E-1

TABLE E1 LAND OWNERSHIP

PLAN AND LOT	PARCEL ID	OWNER	CHARGES FOR DYKE	OWNER OF CHARGE
Pln 19736	006-965-440	Amiable Industries Inc. (282660 BC Ltd.)	r/w EP20213 - 3.071m wide along shoreline	District of Squamish
Pln 4381, Blk O	015-858-022	Drenka, John		
Pln 4760 Lot 1	011-321-962	Barr, Norman & Drenka, John		
Pln 4760, Lot 2	011-321-997	Woods, Georgette	r/w LMP27666 - 3.006m wide along shoreline	District of Squamish
Pln 2599 Lot P(common)		328354BC Ltd. (Marina Estates)	r/w LMP27458, approx 3.0-5.6m along shoreline	District of Squamish
Pln 27456 Lot 7	023-370-386	Saindon, Michael		
Pln 27456 Lot 8	023-370-394	Saindon, Michael		
Pln 999 Lot F	015-040-135	Shell Oil Co. of Canada Ltd.		
Pln 999 Lot EE	015-052-702	Saindon, Michael		
Pln 999 Lot G	006-650-406	International Forest Products Ltd.		
Pln 999 Lot H	006-650-597	International Forest Products Ltd.		
Pln 999 Lot I	006-650-813	International Forest Products Ltd.		
Pln 999 Lot J	015-041-514	BCR Properties Ltd.		
Pln 4657 Blk 42 Lot 11	011-442-638	BCR Properties Ltd.		
Pln 4657 Blk 42 Lot 10	011-442-751	BCR Properties Ltd.		
Pln 4657 Blk 42 Lot 9	011-442-735	BCR Properties Ltd.		
Pln 4657 Blk 42 Lot 8	011-442-727	BCR Properties Ltd.		
Pln 4657 Blk 42 Lot 7	011-442-719	BCR Properties Ltd.		
Pln 4657 Blk 42 Lot 6	011-442-701	BCR Properties Ltd.		
Pln 4657 Blk 42 Lot 5	011-442-697	BCR Properties Ltd.		
Pln 4657 Blk 42 Lot 4	011-442-689	BCR Properties Ltd.		
Pln 4657 Blk 42 Lot 3	011-442-671	BCR Properties Ltd.		
Pln 4657 Blk 42 Lot 2	011-442-662	BCR Properties Ltd.		
Pln 4657 Blk 42 Lot 1	011-442-654	BCR Properties Ltd.		
Pln 4657 Blk 43 Lot 12	011-442-620	BCR Properties Ltd.		
Pln 4657 Blk 43 Lot 11	011-442-611	BCR Properties Ltd.		
Pln 4657 Blk 43 Lot 10	011-442-590	BCR Properties Ltd.		
Pln 4657 Blk 43 Lot 9	011-442-581	BCR Properties Ltd.		
Pln 4657 Blk 43 Lot 8	011-442-573	BCR Properties Ltd.		
Pln 4657 Blk 43 Lot 7	011-442-565	BCR Properties Ltd.		
Pln 4657 Blk 43 Lot 6	011-442-557	BCR Properties Ltd.		
Pln 4657 Blk 43 Lot 5	011-442-549	BCR Properties Ltd.		
Pln 4657 Blk 43 Lot 4	011-442-531	BCR Properties Ltd.		
Pln 4657 Blk 43 Lot 3	011-442-522	BCR Properties Ltd.		
Pln 4657 Blk 43 Lot 2	011-442-484	BCR Properties Ltd.		
Pln 4657 Blk 43 Lot 1	011-442-476	BCR Properties Ltd.		
Pln 4657 Blk 44 Lot 12	006-641-938	International Forest Products Ltd.		
Pln 4657 Blk 44 Lot 11	006-641-890	International Forest Products Ltd.		
Pln 4657 Blk 44 Lot 10	006-635-911	International Forest Products Ltd.		
Pln 4657 Blk 44 Lot 9	006-635-881	International Forest Products Ltd.		
Pln 4657 Blk 44 Lot 8	006-635-873	International Forest Products Ltd.		
Pln 4657 Blk 44 Lot 7	006-635-865	International Forest Products Ltd.		
Pln 4657 Blk 44 Lot 6	006-635-831	International Forest Products Ltd.		
Pln 4657 Blk 44 Lot 5	006-635-636	International Forest Products Ltd.		
Pln 4657 Blk 44 Lot 4	006-635-377	International Forest Products Ltd.		
Pln 4657 Blk 44 Lot 3	006-635-334	International Forest Products Ltd.		
Pln 4657 Blk 44 Lot 2	006-635-300	International Forest Products Ltd.		
Pln 4657 Blk 44 Lot 1	006-635-172	International Forest Products Ltd.		
Pln 3960 Blk 41	011-991-275	McKay & Callum Logs Ltd.		
Pln 3960 Blk 40 Lot 10	011-993-022	Tanburn, Christopher		
Pln 3960 Blk 40 Lot 9	011-992-999	Southwood Holdings Ltd.		
Pln 3960 Blk 40 Lot 8	011-992-981	Southwood Holdings Ltd.		
Pln 3960 Blk 40 Lot 7	011-992-051	Firman Holdings Inc.		
Pln 3960 Blk 40 Lot 6	011-992-085	Firman Holdings Inc.		
Pln 3960 Blk 40 Lot 5	011-992-034	SBO Distributors Ltd.		
Pln 3960 Blk 40 Lot 4	011-992-000	Southwood Holdings Ltd.		
Pln 3960 Blk 40 Lot 3	011-991-984	Southwood Holdings Ltd.		
Pln 3960 Blk 40 Lot 2	011-991-950	Southwood Holdings Ltd.		
Pln 3960 Blk 40 Lot 1	011-991-291	Southwood Holdings Ltd.		
Pln 750 Rem 1	013-337-661	BCR Properties Ltd.		
Pln 18623 Lot A	007-152-108	BCR Properties Ltd.		

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