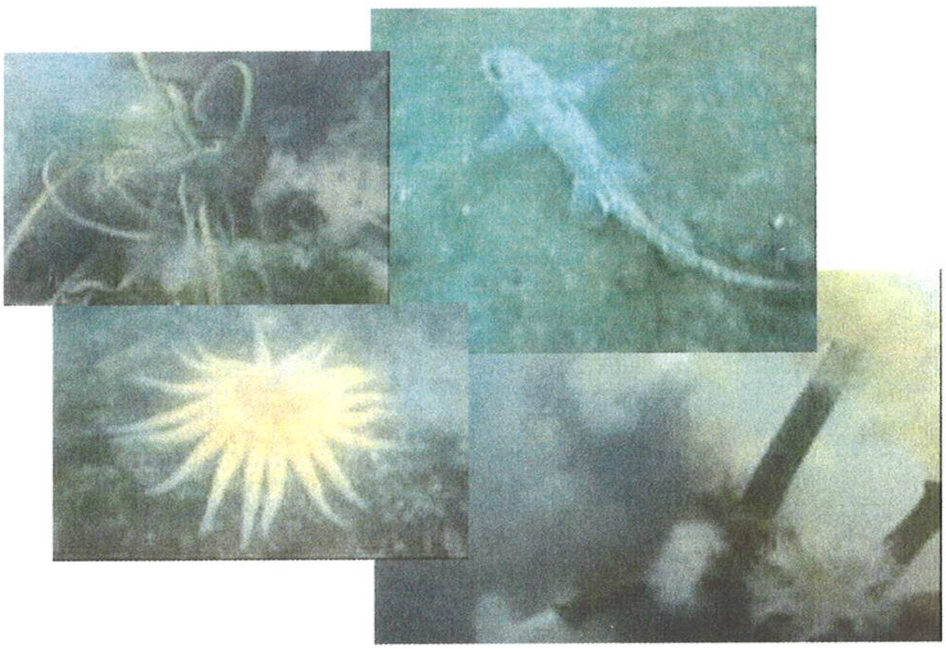
A SUBTIDAL SURVEY OF THE PHYSICAL AND BIOLOGICAL FEATURES OF VICTORIA HARBOUR



ARCHIPELAGO
MARINE RESEARCH LTD

2ND FLOOR, 525 HEAD STREET
VICTORIA, B.C. V9A 5S1
TEL: (250) 383-4535 FAX: (250) 383-0103
EMAIL: AMR@ARCHIPELAGO.BC.CA

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Prepared for: Transport Canada
Programs Group - Environmental Services
620 – 800 Burrard St.
Vancouver, BC
V6Z 2J8

Prepared by: Brian Emmett and Pamela Thuringer
Archipelago Marine Research Ltd.

John Harper
Coastal and Oceans Resources Inc.

Dale McCullough
Seaconsult Marine Research Ltd.

#200 – 525 HEAD STREET
VICTORIA, BC V9A 5S1
TEL: (250) 383-4535 FAX: (250) 383-0103
EMAIL: AMR@ARCHIPELAGO.BC.CA

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1.0 INTRODUCTION

1.1 BACKGROUND

The 1924 Six Harbours Treaty between Canada and the Province of British Columbia confirmed the federal government's ownership of all areas below the high water mark, including filled areas. This includes the marine foreshore and subtidal area of Victoria Harbour from a line between Odgen Point and McLoughlin Point to the Selkirk Water trestle bridge. The land surrounding the harbour is held by a variety of private, municipal, provincial and federal interests. In 1996, under the National Marine Policy, Victoria Harbour was identified as one of a number of Transport Canada's harbours and ports in Canada to be divested to local interest.

Victoria Harbour is also undergoing a transition from the historic industrial base (sawmills, shipbuilding, log storage, and manufacturing (see Drinnan and Couch 1994, City of Victoria 1998 for details) to a mixed use of residential, transportation, tourism, retail and industrial activities. Planning for these changes requires knowledge of physical and biological features, environmentally valued and sensitive areas as well as sites which may have been degraded by historic uses.

For these reasons an important component of the divestiture process is the documentation of environmental conditions and features of the harbour, including recognition of valued fish habitat and areas which have been historically degraded. To complete this requirement, Transport Canada has undertaken a number of inventory and assessment projects in Victoria Harbour including:

1. Environmental baseline studies, including facility audits and contaminated site investigations of all facilities and properties,
2. Sediment contamination sampling,
3. Characterization of bottom sediments and sediment transport processes,
4. Intertidal habitat inventory (in conjunction with VEHEAP).

To further address the inventory requirements and prepare for anticipated upland and harbour seabed risk assessment and management, an inventory of the subtidal physical and biological features of Victoria Harbour was required.

Although the primary purpose of this work is to achieve Transport Canada objectives related to the divestiture process, it is Transport Canada's desire that this data, as with all other Transport Canada data, be used in support of various environmental projects. For example, the Victoria and Esquimalt Harbours Environmental Action Program (VEHEAP) is a multi-agency initiative to improve and protect the environmental quality of Victoria and Esquimalt Harbours. VEHEAP has undertaken detailed assessment of the environmental status of the Upper Harbour and Selkirk Waters areas of the harbour (Emmett *et al.* 1996). More recently VEHEAP, with direct financial support from Transport Canadam, has completed a Harbour Ecological Inventory and Rating (HEIR) of backshore and intertidal areas within Victoria and Esquimalt Harbours (Westland Resource Group 1998). The recent draft Victoria Harbour Plan (City of Victoria 1998) incorporates a number of these features into its planning process. Phase 2 of the VEHEAP HEIR project intends to extend the rating process to subtidal areas of the harbour. The results of the

Transport Canada subtidal inventory project could be used in this rating exercise and other environmental projects related to Victoria Harbour.

1.2 OBJECTIVES

The subtidal physical and biological survey was designed to address the following objectives for Victoria Harbour:

1. Complete a comprehensive inventory and mapping of subtidal, physical and biological features.
2. Identify valued/sensitive habitat such as eelgrass beds, areas of dense or diverse algal vegetation, and important invertebrate resources.
3. Describe important subtidal community features.
4. Identify physically degraded habitats including areas with extensive man-made debris, log and bark accumulations, and sediment deposition.
5. Use geographical positioning methods (GPS) to produce a digital mapping product.
6. Produce a digital map compatible with the existing HEIR intertidal and other Transport Canada mapping for Victoria Harbour.

1.3 SURVEY AREA

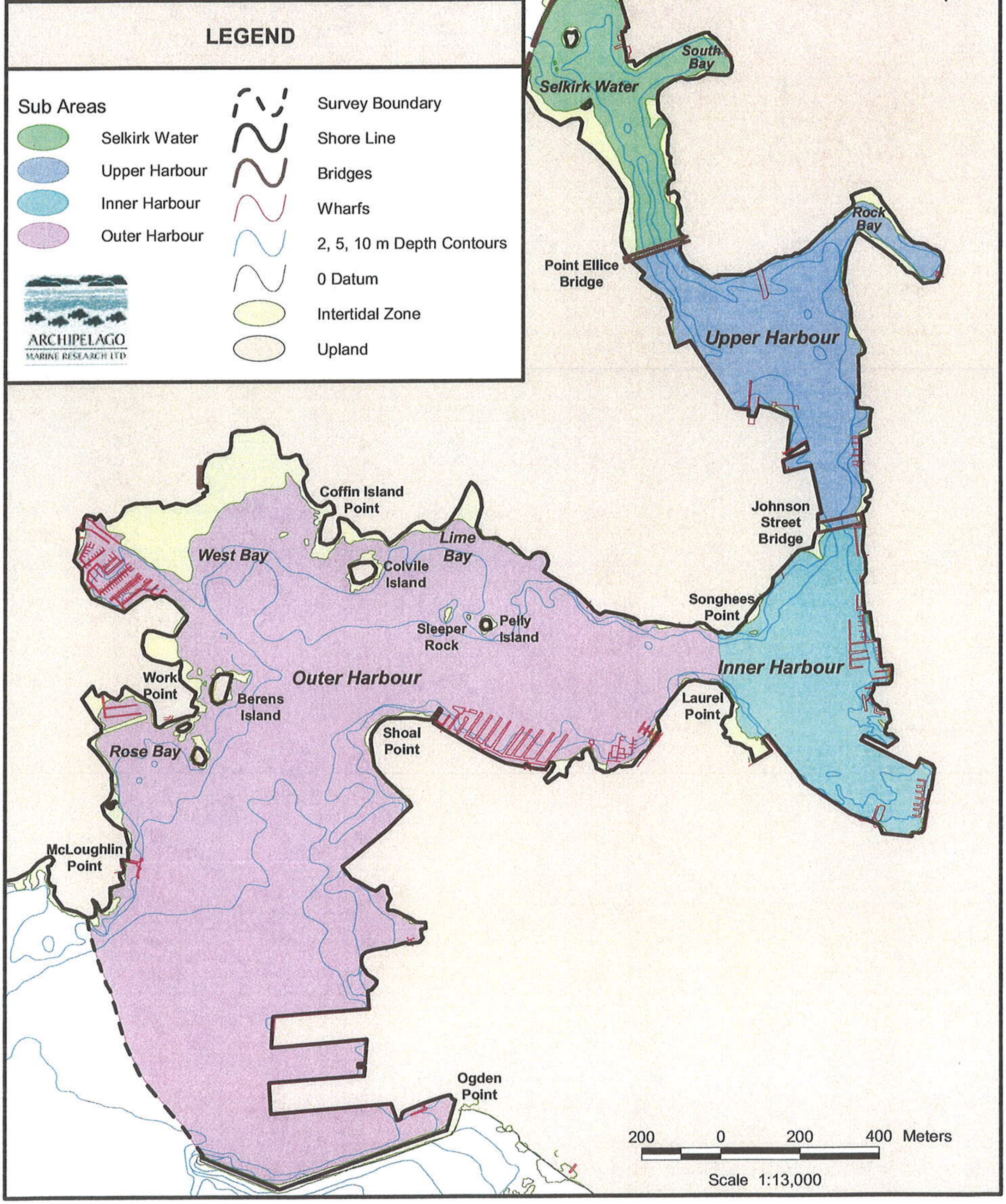
Initially a pilot phase was carried out in the Upper Harbour (Pt. Ellice Bridge to the Johnson St. Bridge) to test the feasibility of using the proposed video mapping technology in the harbour. Upon successful completion of this pilot phase, the survey area was extended to include all subtidal waters of Victoria Harbour from the Galloping Goose Trestle Bridge to a line between the end of the Ogden Point breakwater and McLoughlin Point (Figure 1). This encompasses 190 hectares of subtidal area and 18.5 km of shoreline.

The bottom of the harbour is relatively shallow (less that 15m depth relative to chart datum), flat and formed primarily of sand or silt material. There are also several rock islets and shallow rocky reefs. For descriptive and analytical purposes, the survey area was divided into four sub-areas as follows (see Figure 1):

(A) **Selkirk Waters** - Galloping Goose Trestle Bridge to Pt. Ellice Bridge (including South Bay),
(B) **Upper Harbour** - Pt. Ellice Bridge to Johnson St Bridge (including Rock Bay),
(C) **Inner Harbour** - Johnson St Bridge to Laurel Point,
(D) **Outer Harbour** - Laurel Point to Ogden Point.

These sub-areas approximately correspond to a number of the sediment transport environments established in a recent sediment trend analysis (STA) of Victoria Harbour (GeoSea 1999) as well as to planning areas designated in the recent draft Victoria Harbour Plan (City of Victoria 1998).

Figure 1
Victoria Harbour Subtidal Survey Area



2.0 METHODS

The survey plan called for use of a towed, underwater video system (Seabed Imaging and Mapping System, or SIMS) to obtain extensive, geo-positioned imagery of the seabed. Following preliminary classification and mapping of this video imagery, SCUBA dive methods were used to ground truth the imagery and obtain more detailed information on the biotic community of specific seabed features.

2.1 SIMS SURVEY

The Seabed Imaging and Mapping System (SIMS) involves the use of a precisely positioned, towed video camera that collects imagery of the seabed (see Harper *et al.* 1998a&b; Harper *et al.* 1999). Because the system is towed and intentionally kept simple, the maximum practical towing depth is approximately 20m. Towing speed varies between 1 –2 knots. Each image (defined as one second of video imagery) is geo-referenced to differential global positioning system (DGPS) standards, so its position is known within ±10m, and can be mapped by digital mapping software such as ArcView or ArcInfo. Time (GMT) is also recorded for each image, and depth is recorded at approximately 10 second intervals.

The SIMS survey of Victoria Harbour took place over six days, April 22-23, 1999 being the test period in the Upper Harbour and May 4-7, 1999 for the remainder of the harbour. Visibility over the seabed ranged from 0.5 to 2.0m, degrading slightly over the survey period. In some areas of the harbour (e.g. Rock Bay) the visibility was not suitable for subsequent video classification. In general, the video survey used a 100m trackline grid, however finer resolution (5-10m spacing) was used in nearshore areas anticipated to contain important physical or biological features. The towing speed was approximately 1.5 knots. The survey tracklines are shown in Figure 2. The survey was limited to depths below 0m relative to chart datum. Approximately 100,000 images (27.8 hours of video imagery, 79km of tracklines representing about 120,000 m^2 of seabed), were collected.

2.2 CLASSIFICATION AND MAPPING

The video imagery was reviewed by a geologist and a biologist using a classification system initially developed for the provincial Land Use Coordination Office (Harper *et al.* 1998b). Substrate and biota classes are provided for each image, resulting in a data record for each second of video imagery. The geology database includes nine seabed substrate data fields including substrate type, sediment class and gravel content (Table 1). Man-made features are also classified as part of the geological inventory. The biological database captures detail on seabed biota within two general categories, vegetation and fauna and contains a total of 13 data fields (Table 2). Primary, secondary and tertiary vegetation types are characterised for each image and also evaluated for percent cover. Each classified faunal type is also assigned a distribution code. Comprehensive detail of the geology and biology databases (including data dictionaries) used to classify the video imagery is given in Appendix A.

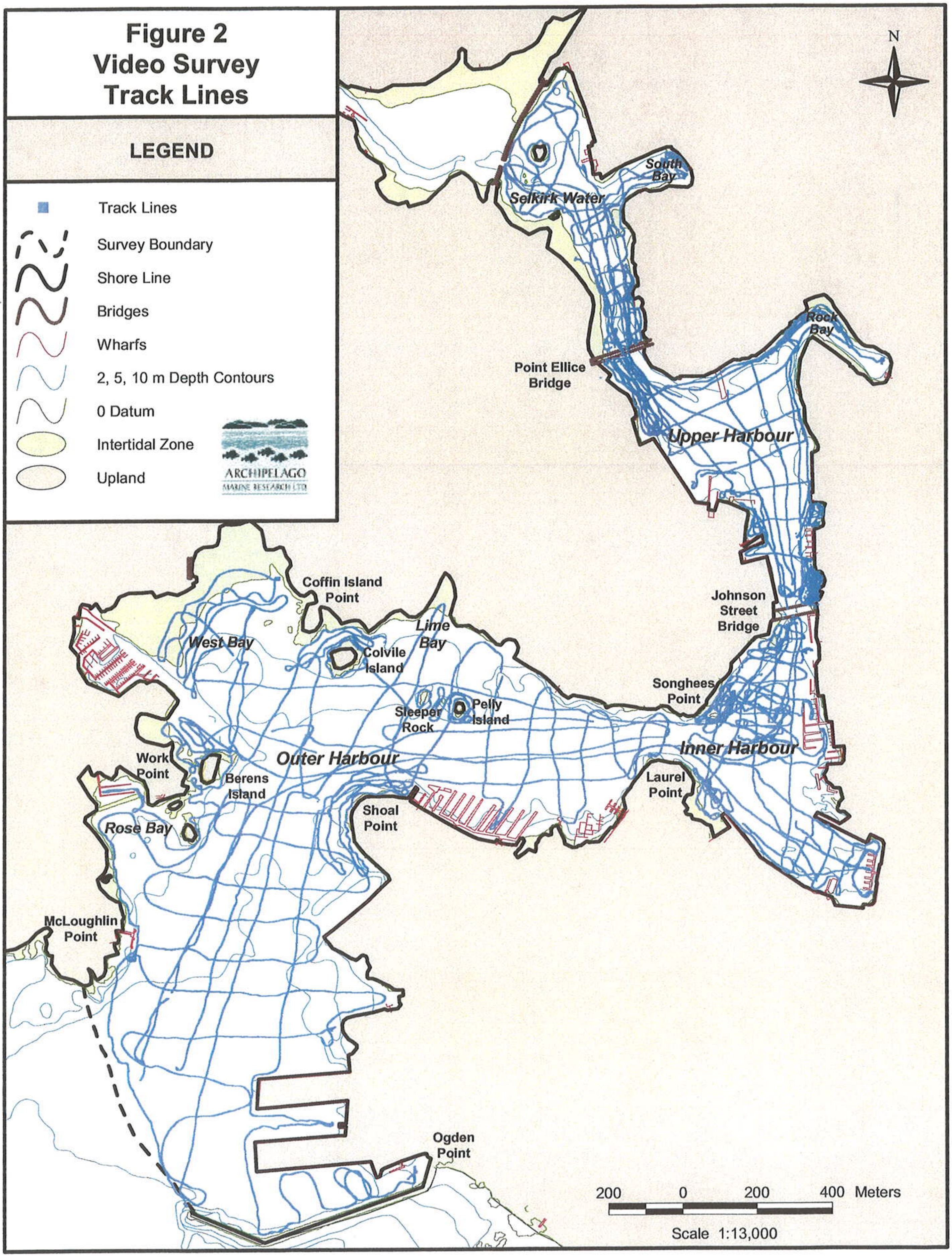


Figure 2
Video Survey Track Lines

Table 1. Geology Data Fields

FIELD	DESCRIPTION
INDEX	unique point identification number
DATE	month/day/year
TIME(UTC)	UTC time of frame (hr:min:sec)
SUBSTRATE	the general substrate of the seabed (rock, veneer, clastics, biogenic)
SED_CLASS	11 classes of clastic sediment
BOULDER	% pebbles on the seabed by class
COBBLE	% cobbles on the seabed by class
PEBBLE	% boulders on the seabed by class
GRAVEL	% gravel; sum of pebbles, cobbles and boulders by class
ORGANICS	% of visible wood or organic debris on the seabed by class
SHELL	% of coarse shell on the seabed by class
MORPH	primary secondary and tertiary morphologic features of the seabed
MAN_MADE	man-made objects seen on the seabed
GEOMAPPER	last name of individual responsible for the mapping interpretation
COMMENT	field for recording non-standard information

Table 2. Biology Data Fields

FIELD	DESCRIPTION
INDEX	unique point identification number
DATE	month/day/year
TIME(UTC)	UTC time of frame (hr:min:sec)
DEPTH	water depth measured from the sound and NOT corrected for tidal amplitude
VEGMAP	code for vegetation map types
VEG1	primary vegetation assemblage on the seabed
COV1	coverage of the VEG1 vegetation (1,2,3 or 4)
VEG2	secondary vegetation assemblage on the seabed
COV2	coverage of the VEG2 vegetation (1,2,3 or 4)
VEG3	tertiary vegetation assemblage on the seabed
COV3	coverage of the VEG3 vegetation (1,2,3 or 4)
TOT_COV	total coverage of vegetation on the seabed
FAUN1	primary faunal type
DIST1	distribution of the FAUNA1 type
FAUN2	secondary faunal type
DIST2	distribution of the FAUNA2 type
FAUN3	tertiary faunal type
DIST3	distribution of the FAUNA3 type
BIOMAPPER	last name of the biology mapper
COMMENT	field for non-standard data comments

Of the 100,000 video images, 92,359 (92%) were classified for substrate and 89,606 (90%) were classified for biota. The remainder of the imagery (8-10%) could not be classified due to high turbidity (e.g. upper Rock Bay) or poor visibility. Since the position of each image is known, plots of the various substrate and biota classes are generated and provide the basis for characterising the habitat. Polygon maps of the survey data were then created by manually contouring the point data.

Original database files are in MDB format (Microsoft Access 97). Information was then extracted from these databases and exported in DBF format to an ArcView geographic information system (GIS).

A number of representative video images were captured to digital image files (either as still images or video files) to illustrate seabed types and biota. Selected video images from the dive survey were also used. These image captures are geo-referenced to the biophysical maps on an interactive CD-ROM, which has been produced as a separate HTML data product of the project. The video images will assist the reader in understanding both the application of the classification system and the mapped harbour features.

2.3 DIVE SURVEYS

After completing the image classification and a preliminary review of the mapped results, SCUBA dive observations were conducted on July 7, 8, and 22, 1999 at sites selected from a review of the video imagery. The objectives of the dive observations were to:

1. Ground truth the position and extent of highly valued features such as eelgrass beds,
2. Compile a detailed community description for selected subtidal features such as vegetated rocky areas, and
3. Collect additional video imagery at the dive sites.

Observations were made at 15 dive sites (Figure 3, Table 3). The position (DGPS) of each site was recorded. A summary of the habitat observations for each of these sites including position, depth, substrate, algal species (with estimated percent cover), invertebrates (with estimated abundance) and fish species is given in Appendix B.

Table 3. Dive Sites

SITE #	LOCATION	HABITAT TYPE
1	West Bay	Mud/Sand Substrate
2	Inner Harbour	Bedrock Outcrop
3	Johnson St Bridge	Eelgrass
4	Songhees Point	Eelgrass
5	Songhees Point	Vegetated Bedrock
6	Point Ellice	Vegetated Bedrock
7	Off Shoal Point	Gravely Channel
8	Johnson St. Bridge	Gravely Channel
9	Shoal Point	Eelgrass Beds
10	McLoughlin Pt.	Vegetated Bedrock
11	James Bay Angler's	Eelgrass Bed
12	Berens Rock	Eelgrass Bed
13	Berens Rock	Eelgrass Bed
14	Berens Rock	Vegetated Bedrock
15	Sleeper Rock	Vegetated Bedrock

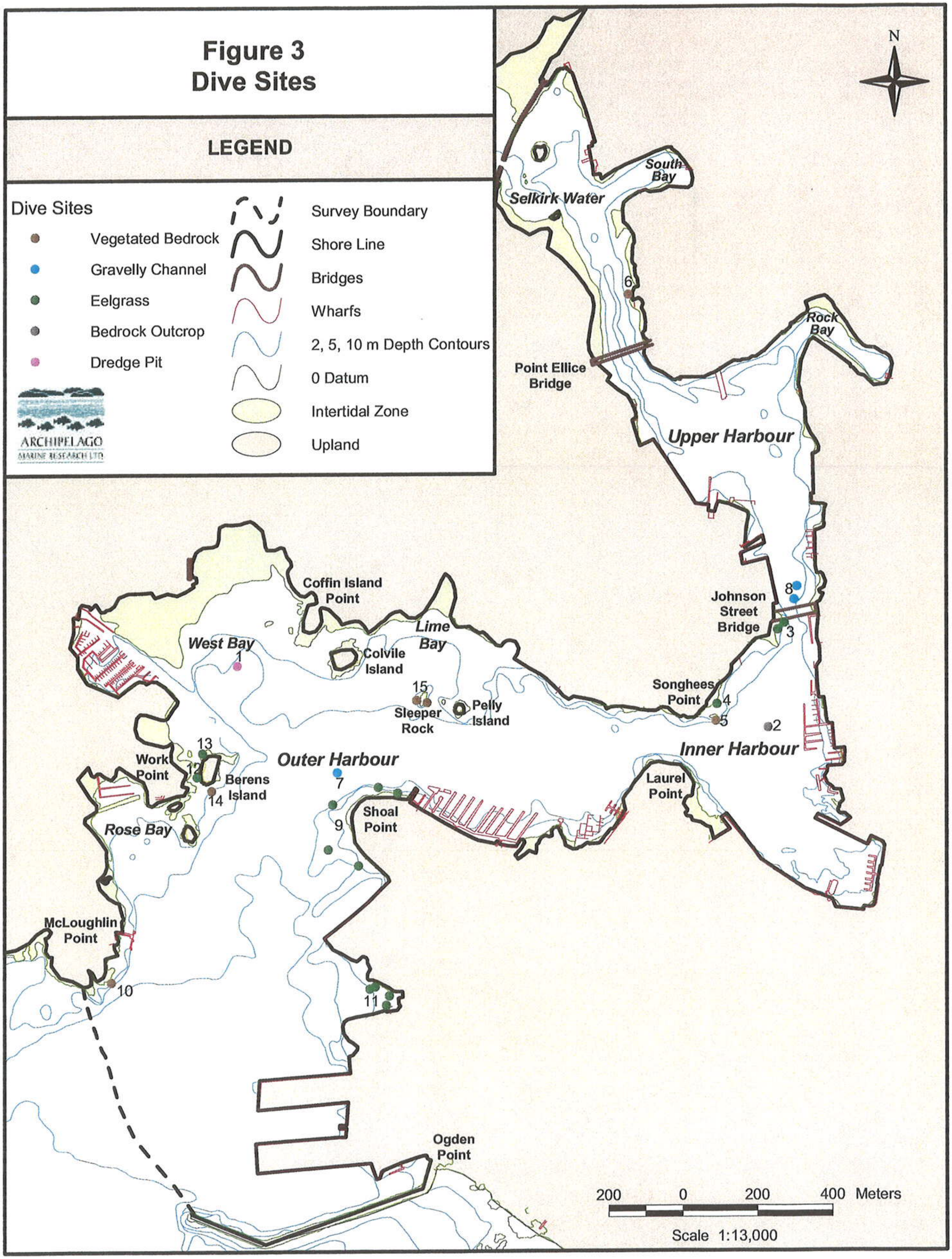


Figure 3
Dive Sites

3.0 RESULTS

This section summarises selected physical and biological features from the classification of the video imagery, and provides a description of subtidal community features from the SCUBA dive observations. Tabulated summaries of the video imagery classification are provided within the text of the following subsections. These tables summarise features classified along the survey tracklines (approximately 90,000 images or 110,000m^2 of seafloor), which amounts to direct observations of approximately 5% of the harbour seafloor. The mapped physical and biological features (Figures 4 to 16) are provided in Section 6.0, the report Map Folio.

3.1 SUBSTRATE TYPE

Substrate type provides a general description of bottom type; 1) sediment (or clastics), 2) biogenic (primarily densely vegetated areas), 3) bedrock, and 4) bedrock with a veneer of sediment. The substrate types are summarised in Table 4 and the distribution of these substrates in the harbour is mapped in Figures 4a and 4b.

Table 4. Substrate Type

SUBSTRATE TYPE	SUBTIDAL AREA		IMAGE POINTS	
	HA	%	#	% OF TOTAL
Biogenic	4.6	2.4	5,737	6.2
Sediment	163.4	85.8	72,037	78.0
Rock	1.4	0.7	2,496	2.7
Rock with Sediment Veneer	9.8	5.2	12,089	13.1
TOTAL	**179.2**	**94.1**	**92,359**	**100**

Most of the substrate in Victoria Harbour is clastic sediment (mud, sand, gravel), which forms approximately 85% of the harbour seafloor. Most rocky areas in the harbour are bedrock outcrops. Archival charts of the Victoria Harbour (Victoria Archives 1929) show the presence of a rock outcrop in the middle of the Inner Harbour. This rock has been blasted, and both SIMS imagery and diver video shows angular blast rock in the vicinity of the remaining bedrock outcrop. Most biogenic substrates are densely vegetated areas where the underlying substrate is not visible.

3.2 SEDIMENT SIZE CLASS

Sediment size classes are assigned to the *sediment* and *sediment veneer over bedrock* substrate types. Sediment size class is summarised in Table 5 and the distribution of these classes shown in Figures 5a and 5b.

Table 5. Sediment Size Class

SEDIMENT CLASS	SUBTIDAL AREA		IMAGE POINTS	
	Ha	**%**	**#**	**% of Total**
Gravel	5.2	2.7	4,750	5.6
Sand	1.1	0.6	905	1.1
Mud	0.5	0.3	32,468	38.6
Mud/Sand	167.4	87.9	46,003	54.7
TOTAL	**174.2**	**91.5**	**84,126**	**100**

Most of the harbour sediments are mapped as sand/mud, with a single mud polygon behind the breakwater in Rose Bay and several areas of sand along the north shore of the Outer Harbour (Figures 5a and b). Table 5 shows that a considerable number of the video images (38.6%) were classified as mud. These images were located throughout the harbour area and generally co-occurred with images classified as mud/sand. As it is difficult to visually distinguish mud substrates from mixtures of sand and mud, most of the mud image points were pooled with mud/sand images when the polygon areas were interpreted. As such, a large portion of the Victoria Harbour seabed is classified as "mud/sand", however the subsequent dive observations show that, within the sand/mud sediment class, there is a gradation to coarser substrates from the Inner Harbour to the seaward extent of the Outer Harbour.

The gravel components (pebble, cobble, boulder) are readily distinguished on the video imagery. Figures 5a and b show areas with greater that 30% gravel content. These include the blast rock around the perimeter of the bedrock outcrop in the Inner Harbour, the riprap along the inside of the Ogden Point breakwater, and a number of areas with smaller sized gravel associated with narrow, higher current areas of the Harbour. Further detail on gravel content is given in Section 3.3.

Within the Inner Harbour, one of the major influences on sediment transport appears to be the movement of the M/V Coho. Several plumes of sediment were observed on the SIMS video imagery in this area when the M/V Coho was moving into and out of the docking area.

3.3 GRAVEL

The gravel content (the percent composition of boulders + cobbles + pebbles) is summarised in Table 6. Percent gravel categories are determined by standard geological size ranges (Appendix A; Table A4). The distribution of gravel in Figures 6a and 6b has been mapped as contours, and areas with greater than 30% gravel content are shown as polygons in Figures 5a and b. The gravel content provides a good index of energy in that the higher the gravel content, the higher the assumed energy generated by waves or tidal currents. Most of the harbour contains no gravel or only a trace of gravel, indicative of low energy environments. Areas of higher gravel composition occur within the harbour narrows such as the Bay Street Bridge, the Johnson Street Bridge, Laurel Point and the area between Shoal Point and Work Point. The area shown as gravel in the Inner Harbour is primarily blast rock (boulder and large cobble), described in Section 3.1.

The gravel in nearshore areas, particularly at the Ogden Point breakwater, is also formed primarily of boulder and cobble.

Table 6. Gravel Classes

GRAVEL CONTENT	IMAGE POINTS	
	#	% OF TOTAL
0%	52,181	62.0
T-5%	18,525	22.0
5-30%	7,952	9.5
30-50%	3,002	3.6
50-80%	1,783	2.1
>80%	683	0.8
Total	**84,126**	**100.0**

3.4 MAN-MADE OBJECTS

A variety of man-made objects were identified from the imagery and classified in the database. These objects are summarised in Table 7 and the distribution mapped in Figures 7a and 7b. Man-made debris in the harbour is widespread, with much of the debris, such as bottles and cans, being relatively innocuous. The most common man made object found in the harbour are bottles or aggregations of bottles, which make up 40% of the objects. Aggregations of man-made debris are generally associated with docks, wharves and bridges and are shown in Figures 7a and b by delineating polygons with a high concentration of man made material. No large aggregations of potentially hazardous or contaminant material (e.g. paint, oil cans) were observed, however these materials are likely to be present in the larger debris aggregations around the docks and pilings. Cable and wire could potentially be hazardous to equipment and anchors dragged across the harbour bottom. A shipwreck in the bay just south of Capital Iron was observed; the position of this wreck is noted on CHS Chart 3415 for Victoria Harbour. In addition a small, sunken rowboat was noted in West Bay.

Table 7. Man-made Objects

MAN-MADE OBJECT		IMAGE POINTS	
		#	% OF TOTAL
Aggregations of Bottles	BB	2,638	40.7
Bottles	B	812	12.5
Other	O	811	12.5
Garbage	G	695	10.7
Metal Objects	M	531	8.2
Cable/Wire/Rope	C	287	4.5
Pipe	P	224	3.5
Cans	CN	223	3.4
Logs	L	200	3.1
Wood Debris	WD	45	0.7
Tire	T	16	0.2
Total		**6,482**	**100**

3.5 ORGANIC MATERIAL

The distribution of organic material, as estimated from the video images, is shown in Figures 8a and 8b. The category "wood debris" is limited to recognisable man-made wood, usually rotted planks, while the category "logs" are defined as either partial or whole logs. "Organic cover" is comprised of small, coffee ground material, dead plant material and bark debris. Organic cover generally was observed to be greater than trace levels throughout the harbour. Figures 8a and b show areas with greater than 30% organic cover. These areas contain mainly wood and bark debris, and generally reflect historic wood storage areas (Drinnan and Couch 1994).

3.6 VEGETATION COVER

Vegetation cover is the estimate of percent cover for all vegetation observed in each image (Appendix A, Table A8). Table 8 summarises the vegetated area in Victoria Harbour by sub-area and percent cover categories (sparse = <5% cover; low = 5-25% cover; moderate = 25-75% cover; dense = >75% cover). The distribution of subtidal vegetation in the harbour is shown in Figures 9a and 9b.

Almost 50% of the Outer Harbour is vegetated compared to 22% of the Inner Harbour. The vegetation is densest in the Outer Harbour, with about 12% of the area being moderate to dense (25%-100%) cover in contrast to less that 3% of the Inner Harbour area and no moderate to dense vegetation in the Upper Harbour and Selkirk Waters. Most of the vegetation in the Inner Harbour is associated with rocky outcrops, particularly around Songhees Point and the rock pile in the middle of the harbour. About 50% of the subtidal area of Selkirk Waters is sparsely vegetated by foliose green algae and foliose green/bladed kelp. Less than 10% of the Upper Harbour is vegetated, primarily with sparse (<5%) to low (5-25%) cover of *Ulva* and bladed kelps.

Table 8. Vegetation Cover

HARBOUR SUB-AREA	SUBTIDAL AREA				
	TOTAL AREA (HA)	VEGETATED AREA		MOD. – DENSE COVER	
		HA	%	HA	%
Selkirk Waters	13.4	6.9	51.5	0	0
Upper Harbour	22.7	2.2	9.7	0	0
Inner Harbour	22.2	4.8	21.6	0.5	2.3
Outer Harbour	132.3	64.0	48.4	15.3	11.6
Total	**190.6**	**77.9**	**40.9**	**15.8**	**8.3**

3.7 VEGETATION TYPE

Fifteen marine vegetation types are identified in the SIMS classification table (see Appendix A, Table A-9). Some vegetation types are single species or genus groupings such as eelgrass (*Zostera*) and *Agarum*. Other types are broader taxonomic groupings such as filamentous red algae (FIL1 and FIL2) and soft brown kelps (BKS). Species in these vegetative types are grouped by similar morphologies (which aids recognition in the video imagery) and by habitat association (see definition of FIL1 And FIL2, Appendix A, Table A-9). The fifteen vegetation types provide a reasonably comprehensive description of the nearshore (<20m depth) vegetation of coastal British Columbia. The classification system permits a primary (most common) vegetation type, secondary (next most common) and tertiary (third most common) vegetation type to be identified for each image point.

A total of 11 of the 15 vegetation types were identified in Victoria Harbour. The most common primary vegetation types are foliose green algae, bladed kelps, and filamentous red algae (Table 9). The majority of filamentous red algae were the FIR2 type, a mix of species often including *Neoagardhiella* and *Gracilaria*, which grow on coarse sand and gravely substrates. The most common foliose green algae species is *Ulva* sp., while the most common bladed kelps are *Laminaria saccharina* and *Desmerestia sp.*. Approximately 60% of the video images contained no vegetation.

Table 9. Primary Vegetation Type

CODE	TYPE	IMAGE POINTS	
		#	%
NOV	No Observed Vegetation	55,458	62
FOG	Foliose Greens	12,059	13
BKS	Bladed Kelps	11,104	12
FIR2	Filamentous Reds 2	5,421	6
AGR	*Agarum*	1,775	2
FOR	Foliose Reds	1,701	2
ZOS	*Zostera*	994	1
SAR	*Sargassum*	512	1
FIR1	Filamentous Reds 1	473	1
BKD	Dark Brown Kelps	93	0
FUC	*Fucus*	13	0
NER	*Nereocystis*	3	0
	Total	**89,606**	**100**

Table 10 shows the twenty most common combinations of primary and secondary vegetation types in Victoria Harbour. These 20 combinations account for 97% of all biotic classified imagery. As it would be difficult to map all these combinations, they were grouped into 6 major vegetation classes as shown in Table 11. Table 12 summarises the total area (ha) for these vegetation classes (excluding the no vegetation class) by sub-area. The distribution of the 5 major vegetation classes is shown in Figures 10a and 10b.

Table 10. Twenty Most Common Primary and Secondary Vegetation Type Groupings

RANK	VEG1	VEG2	# IMAGE POINTS	%	CUM %
1	NOV		55,458	62	62
2	FOG		6,338	7	69
3	BKS		5,805	6	75
4	FOG	BKS	4,847	5	81
5	FIR2		3,342	4	85
6	BKS	FOG	3,171	4	88
7	FIR2	BKS	1,055	1	89
8	AGR		922	1	90
9	FOR		868	1	91
10	BKS	FIR2	785	1	92
11	FOG	FIR2	595	1	93
12	AGR	FOR	579	1	93
13	ZOS	BKS	570	1	94
14	BKS	FOR	560	1	95
15	FIR2	AGR	466	1	95
16	FOR	BKS	454	1	96
17	BKS	FIR1	385	0	96
18	FIR2	FOG	369	0	97
19	ZOS	FIR2	316	0	97
20	BKS	SAR	293	0	97

Table 11. Mapped Vegetation Classes

RANK	VEGETATION CLASS	VEGETATION TYPE COMBINATIONS
1	No observed vegetation	NOV
2	Bladed kelps	BKS, BKS/FIR, BKS/FOR, BKS/FIR1
3	Filamentous reds	FIR2, FIR2/BKS, FIR2/AGR, FIR2/FOG
4	Foliose greens	FOG, FOG/FIR2
5	Foliose greens/bladed kelps	FOG/BKS, BKS/FOG
6	Other	All other combinations

Table 12. Major Vegetation Classes

HARBOUR SUB-AREA	VEGETATED AREA (HA)					
	BLADED KELP	FILAMENTOUS REDS	FOLIOSE GREENS	FOLIOSE GREENS/ BLADED KELP	OTHER	TOTAL
Selkirk Waters	0.27	0	4.24	2.23	0	**6.74**
Upper Harbour	0.02	0	1.72	0.77	0.40	**2.91**
Inner Harbour	3.63	0.08	0 00	0.62	1.27	**5.60**
Outer Harbour	6.79	17.85	2.01	21.27	9.69	**57.61**
Total	**10.71**	**17.93**	**7.97**	**24.89**	**11.36**	**72.86**

3.8 FOLIOSE GREEN ALGAE

Table 13 summarises foliose green algae cover in Victoria Harbour by sub-area. Distribution and density of foliose green algae is mapped in Figures 11a and 11b. This summary includes all image points in which foliose green algae was identified as a primary, secondary or tertiary vegetation types. *Ulva* is the most common foliose green algae species in the harbour and often co-occurs with bladed kelp, primarily *Laminaria* (see Table 10 and Figures 10a and b). *Ulva* is an annual plant, growing seasonally from March to October. *Ulva* is usually associated with sand/mud substrates and does not usually grow in the more exposed areas (Figures 11a and 11b). *Ulva* also grows abundantly on both intertidal rocky substrate and drying sand/mudflats and, although vegetation cover in intertidal areas is not shown, many intertidal mud/sand flats (especially in West Bay) have a substantial amount of *Ulva* growing during the summer months.

Table 13. Foliose Green Algae Cover

HARBOUR SUB-AREA	SUBTIDAL AREA				
	TOTAL AREA (ha)	VEGETATED AREA		MOD. – DENSE COVER	
		HA	%	HA	%
Selkirk Waters	13.4	8.02	59.9	0.01	0.1
Upper Harbour	22.7	2.83	12.5	0.08	0.4
Inner Harbour	22.2	2.42	10.9	0.22	1.0
Outer Harbour	132.3	25.89	19.6	7.69	5.8
Total	**190.6**	**39.16**	**20.5**	**8.0**	**4.2**

3.9 KELPS

Kelps are a group of brown algae generally characterised by a holdfast, stalk and blade. The holdfast anchors the plant to the substrate. Figures 12a and 12b show the distribution of kelp in Victoria Harbour. The mapped kelp distribution includes three vegetation types, soft brown kelps (primarily *Laminaria* and *Desmerestia*), *Agarum*, and dark brown stalked kelps (primarily *Pterygophra*) and include all images in which these vegetation types are identified as either primary, secondary or tertiary vegetation. Appendix B, Subtidal Dive Observations, lists the invertebrates, fish and other algal species associated with kelp habitats as documented from the spot dives.

There is relatively more kelp in the Inner and Outer Harbour compared to Selkirk Waters and the Upper Harbour (Table 14). Areas in the Outer and Inner Harbour with a moderate to dense (>25% cover) kelp are associated with rocky substrate, such as Tuzo Rock (Songhees Point), Pelly Island, Sleeper Rock, Bergens Island and McLoughlin Point. There is no areas of moderate to dense kelp cover in the Upper Harbour or Selkirk Waters, and only 4% of the Upper Harbour contains sparse to low (trace to 25%) cover. In contrast, about 15% of the Selkirk Waters area is vegetated with a sparse to low kelp cover.

Table 14. Kelp Cover

HARBOUR SUB-AREA	SUBTIDAL AREA				
	TOTAL AREA (HA)	VEGETATED AREA		MOD. – DENSE COVER	
		HA	%	HA	%
Selkirk Waters	13.4	2.18	16.3	0	0
Upper Harbour	22.7	0.87	3.8	0	0
Inner Harbour	22.2	6.14	27.7	0.39	1.8
Outer Harbour	132.3	32.43	24.5	3.42	2.6
Total	**190.6**	**41.62**	**21.8**	**3.81**	**2.0**

Figure 13 shows the distribution of specific kelp species *(Agarum, Pterygophora* and *Nereocystis)* identified during the video classification *Agarum* is more commonly found in the deeper water of the harbour, associated with sand/mud substrates. Both the stalked kelp, *Pterygophora californica*, and bull kelp, *Nereocystis luetkeana,* grow in the more exposed areas of the outer harbour. A single bull kelp plant was noted on the east harbour shoreline just north of the Johnson Street Bridge.

3.10 EELGRASS

Figure 14 shows the location of eelgrass beds in Victoria Harbour. Table 15 summarises the area of these eelgrass beds. Within the survey area, eelgrass is confined to the Inner and Outer Harbour, although substantial beds occur outside the survey area, above the Trestle Bridge in the Gorge. The largest eelgrass bed (1.6 – 2.1ha) in Victoria Harbour is at Shoal Point.

Table 15. Eelgrass Beds

HARBOUR SUB-AREA	BED (SITE #)	AREA (m^2)	
		SIMS SURVEY	DIVE SURVEY
Inner Harbour	Johnson St. Bridge (1)	230	90
	Songhees Point North (2)	300	50
	Songhees Point South (3)	360	N/A
Outer Harbour	Inside Berens Island (4)	1,300	1,710
	Shoal Point (5)	15,920	21,000
	James Bay Anglers (6)	1,750	1,040

Spot dives were made in five of the six eelgrass beds (Figure 3), with the objectives of verifying the bed area and documenting the associated plant and invertebrate communities. For the larger beds, the area estimated by the dive and video surveys were within ±30% (Table 15). For the SIMS survey, the bed area was estimated from the interpolation of the trackline data to form an eelgrass area polygon. A more accurate area would be obtained with a higher density of tracklines, with the specific objective of delineating the bed area. The present survey effort has provided an accurate location and approximate size for the eelgrass beds in the survey area.

In most beds, the eelgrass occurred at a depth of +0.4 to –2.5m relative to chart datum (CD). The deepest eelgrass was found at Shoal Point at a depth of –3.5m CD.

Other algal species associated with the eelgrass beds include *Laminaria*, the filamentous red algae *Neoagardhiella sp.*, *Ulva* and the epiphytic red algae, *Smithora naiadum*. Most of the eelgrass blades were covered with diatoms. Common invertebrates within the beds include crabs (Red Rock, *Cancer productus*; Dungeness, *Cancer magister;* Graceful Kelp, *Pugettia gracilis*; Helmet, *Telmessus cheiragonus*), the chink shell, *Lacuna crassicornis* (found on eelgrass blades), the aeolid nudibranch, *Hermissenda*, and the sunflower star, *Pycnopodia helianthoides*. Schools of striped perch (*Embiotoca lateralis*), pile perch (*Rhacochilus vacca*), stickleback (*Gasterosteus aculeatus*) and tubesnouts (*Aulorhynchus flavidus*) were common throughout many of the beds. Other invertebrate and fish species are noted in Appendix B.

3.11 FAUNAL TYPES

Twenty two faunal types are included in the SIMS classification table (see Appendix A, Table A-10 for a complete description of the faunal classification). Some types are single species or genus groupings such as the anemone *Metridium*. Others are broader taxonomic groupings such as brittle stars and bryozoan complexes. Unlike the vegetation types, the twenty two faunal types do not provide a comprehensive description of the nearshore (<20m depth) macrofauna, but rather were developed to document larger, aggregating macrofauna. The classification system permits a primary (most common) faunal type, secondary (next most common) and tertiary (third most common) faunal type to be identified for each image point. A distribution code (Appendix A, Table A-12) is used to describe both abundance and the pattern of distribution within the image point.

Faunal types was identified in about 20% of the 90,000 classified images. Ten of the 22 possible faunal types were identified in Victoria Harbour (Table 16). Two of the ten faunal types refer to holes found in the unconsolidated substrate and account for 60% of the classified faunal data points. Aggregations of the plumose anemone (*Metridium senile)* was found throughout the harbour on hard substrates including rock, boulder, cobble, wood and other man made debris such as metal, concrete and bottles. Another anemone (*Tealia* sp.) was not as common as *Metridium*, and was observed both in the SIMS imagery and by divers.

Table 16. Faunal Types

CODE	TYPE	# OF IMAGE POINTS
HLF	Unmounded holes	10,262
ANM	*Metridium*	5,195
PCL	Piddock Clams	1,378
HLM	Mounded holes	621
TUBP	Parchment Tubeworms	333
SCA	Swimming Scallops	273
BRY	Bryozoans	160
RSU	Red sea urchins	19
HCL	Horse Clams	14
CUC	Sea cucumber-*Cucumaria*	7
Total		**18,262**

Piddock clam (*Ziphaea pilsbryi*) distribution is shown in Figure 16. Piddock clams live in clay substrate and are able to move their distinctive split siphon through a veneer of angular cobble. These clams are common throughout Victoria Harbour with areas of high densities found in South Bay, Rock Bay, the blasted rock in the Inner Harbour, Pelly Island, and off the cruise ship dock at Ogden Point.

Swimming scallops (*Chlamys hastata*) were identified from the SIMS imagery (Table 16) on the rip rap of the Ogden Point breakwater. Rock scallops (*Crassadoma gigantea*), up to eight inches in diameter, were common on the rock pile in the Inner Harbour. Rock scallops were also observed during spot dives at Shoal Point and on rock at the northern end of the eelgrass bed near the Johnson Street Bridge.

3.12 DESCRIPTION OF SUBTIDAL COMMUNITY FEATURES

A total of 15 spot dives were conducted in Victoria Harbour. (Figure 3, Table 3). The biophysical information collected in these dives was used to describe community features for specific habitats and/or locations. A summary of invertebrate, algal and fish species collected for each dive is included in Appendix B. Five dives were made within the eelgrass beds noted in Section 3.9, and the community description for eelgrass habitat is included in that Section. A description of the community features for the other habitats and locations follows:

3.12.1 Vegetated Bedrock

Moderate to dense algal cover and diverse invertebrate communities were observed at all vegetated bedrock locations in the Inner and Outer Harbour. Fish were also observed at each of the spot dives made in vegetated bedrock habitat (Appendix B). The coonstripe shrimp (*Pandalus danae)* was also noted at all vegetated bedrock areas.

At McLoughlin Point (Site #10), one of the most exposed spot dive locations, large blades of dense kelps (*Laminaria* and *Agarum*, >2m in length) were present under a canopy of stalked kelp (*Pterygophora*). A rich complex of foliose red algae (including *Opuntiella californica*) and filamentous red algae (including *Plocamium*) were present at shallow subtidal depths, while a cover of encrusting and foliose coralline reds was present on bedrock from -2.1m to –5m CD. Both a foliose and filamentous form of *Desmerestia* (*D. herbacea* and *D intermedia* respectively) was also noted. Bryozoans, sponges and ascidians (sea squirts) were common features on the bedrock. Patches of tiny parchment tube worms and anemones (*Tealia* sp.) were also common.

At the north and south ends of Berens Island (Sites #12 and #13), the red algal complex included different species from those noted at Site 10, such as the foliose reds *Gigartina exasperatus, Cryptopleura* sp. and *Polyneura latissima* and the filamentous red *Odonthalia sp.*. Four species of crab; red rock (*Cancer productus*), Dungeness (*Cancer magister*), helmet (*Telmessus cheiragonus*) and the kelp crab (*Pugettia gracilis*) were found in both sites, along with sponges, bryozoans and ascidians.

Algal diversity decreased at the more protected sites in the harbour. A dense cover of *Laminaria* was the dominant vegetation at Sleeper Rock. Red algal species included *Odenthalia* and *Gigartina*. The Japanese weed, *Sargassum muticum* was also present at this site and at the more protected sites in the Inner Harbour and Selkirk Waters (including Ellice Point). Patches of tiny parchment tube worms and shrimp (*P. danae*) were the most common invertebrates. Invertebrate diversity was similar at Tuzo Rock (Songhees Point) (see Appendix B) but only three species of algae, a dense cover of large bladed *Laminaria*, moderate cover of *S. muticum* and low cover of *D. herbacea* was observed. Algal cover at Ellice Point in Selkirk Waters was low, with 10-20% cover of *Laminaria* and a 5% cover of *S. muticum, D. herbacea* and filamentous red algae.

3.12.2 Gravelly Channels

Off Shoal Point (Site #7), the substrate was comprised of cobble and boulder over sand as well as mud with patches of exposed clay and pieces of whole shell. Piddock clams were common as well as parchment tube worms (*Mesochaetopterus taylori*), bryozoans and horse clams (*Tresus* sp.). A low to moderate cover of *Agarum* (10-30%) on rock was noted along with a low cover of filamentous and foliose reds, including *Neoagardhiella*. Filamentous red algae are associated with the gravelly areas in the harbour as shown in Figure 15.

Just north of the Johnson Street Bridge (Site #8) the two most notable features are the high degree of shell debris and abundance of shrimp. Substrate was comprised of cobble and whole shells, with the shoal of shells including macoma, littleneck, horse clam, butter clam and the native oyster. Algae was absent with the exception of encrusting coralline reds. The spiral hydroid, *Bugula californica* was abundant on cobbles. Coonstriped shrimp, *Pandalus danae*, were abundant with aggregations of shrimp forming a carpet on the seabed floor.

3.12.3 Subtidal Bedrock Outcrop

Substrate at Site #2 was mixed, with areas of cobble, pebble and boulder (angular blast rock) over sand and mud. Whole and fragmented shells, pockets of exposed clay, and a large bedrock outcrop are also important substrate features. A fine layer of sediment covered the substrate. Algal cover on the hard substrate was sparse (trace to 5%) and included *Agarum, Laminaria, D. herbacea* and filamentous and foliose red algae. Encrusting coralline red algae was present on all rock. Observed invertebrate species are listed in Appendix B, with piddock clams, bryozoans, hydroids, sea stars (*Pycnopodia, Pisaster brevispinus*) and *Metridium* being most common.

3.12.4 West Bay Dredge Pit

This site (#1) in West Bay was identified in the SIMS imagery as large depression, approximately two to three meters below the surrounding substrate at a depth of 4 to 6m. The substrate is fine silt and mud. The most striking feature of this site is the presence of the chemosynthetic blue green algae, *Beggiatoa* sp., which is generally associated with anoxic or reducing conditions. The *Beggiatoa* is white in colour and forms a veneer over the soupy mud substrate. This area is mostly devoid of vegetation and invertebrates, although a large neried worm (*Nereis* sp.) was found during the spot dive. This area does not appear to be a natural feature, but rather may have been formed by dredging or propeller scour ing.

4.0 DISCUSSION

4.1 GENERAL

The survey of Victoria Harbour is the largest subtidal area surveyed to date with the SIMS system. This survey method, coupled with the use of SCUBA for ground truthing and detailed community description purposes, has provided an inventory and atlas of subtidal biophysical features in the harbour area. This information can be used for further evaluation of valued and sensitive habitat features as well as areas of the harbour which have been historically degraded. In Victoria Harbour, this survey method has worked well due to the flat, shallow nature of the harbour bottom. The survey grid design, approximately 100m spacing with greater trackline density in selected nearshore areas, provides the ability to map major physical and biological features of the harbour.

There are a number of advantages of this survey method over more conventional dive survey methods.

1. **Efficiency and Diver Safety**
   A total of 72 kilometres of survey tracklines were conducted over the six day field period. A similar length of survey transects using a SCUBA dive team approach would require 20-25 days of field work. As the field day cost of the SIMS survey is only 20-30% higher than a three person dive survey team, there a considerable time and cost savings associated with the underwater video system. In addition, many areas in the harbour are not suitable for safe dive survey operations due to the high degree of vessel and float plane traffic. These areas could be safely surveyed using the SIMS method.

2. **Accurate Positional Data for all Observations**
   The SIMS survey method provides accurate (±10m) positional data for each second of video imagery. Conventional dive surveys provide accurate positional information for the beginning and end of the transect line; bearing and transect line distance are used to position features along the transect line. The SIMS positions readily adapt to database and GIS mapping software, facilitating data analysis and map production.

3. **Structured Data Analysis**
   The SIMS survey method uses a standard geological and biological classification system, and the data for each image (1 second of video time) is input to database software. This provides greater options for data analysis than conventional dive survey observations which rely on quadrat and/or transect observations.

Despite these advantages it is important to also recognise the value of direct dive observations in both verifying the video imagery and assembling detailed plant and invertebrate community information which usually cannot be resolved from the video imagery. In addition, while the SIMS system has proven to be an effective method of mapping subtidal features in Victoria Harbour, several constraints must be recognised.

1. **Seasonally of vegetation type and cover.** Many algal species are annuals, with seasonal growth patterns. These species will in die back in winter and grow vigorously in spring and summer. The SIMS survey was conducted in late April when most seasonal algae have initiated spring growth. The distribution and cover of green algae and certain species of kelp will be significantly different (less abundant) in late fall and winter (October to early March). Certain mobile invertebrate species also show seasonal distribution. For example, very few shrimp (*P. danae*) were observed during the SIMS survey in late April. However shrimp were abundant in many areas of the harbour in July, when the SCUBA surveys were undertaken.

2. **Survey Resolution.** Most of the harbour was surveyed using a 100 by 100 m trackline grid. Survey tracklines were denser (to 10 by 10m) in selected nearshore areas and around rock outcrops (see Figure 2). In the 100 by 100m grid areas, the mapped polygons have a resolution of $\pm$10s of metres, as these polygons are interpolated from the classified image trackline. There may be small vegetated areas or fine scale physical features which may not have been detected in the 100m survey grid area. The survey resolution is finer in the more intensely surveyed nearshore areas.

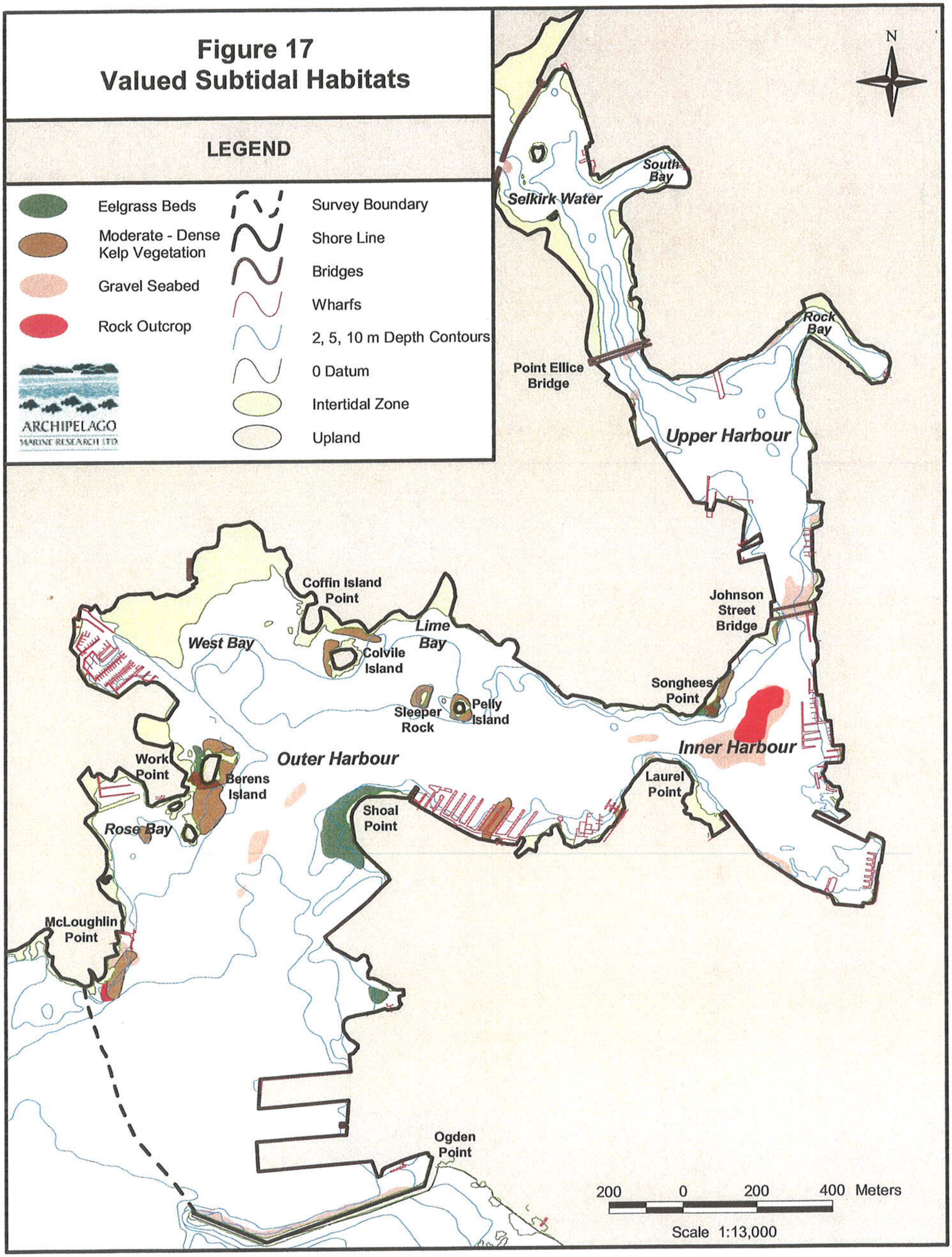
   As a finer survey grid was used in many rocky nearshore areas and rock outcrops, there are relatively large numbers of image data points in the biogenic, rock and veneer over rock substrate types as well as the associated vegetative and fauna categories (e.g. bladed kelps). For this reason the relative percent of image data points for these categories tends to be higher than the relative percent of polygon area for these features (see Table 4).

Although these constraints should be recognised, the SIMS survey has provided a comprehensive summary of the physical and biological features of Victoria Harbour and has documented a number of previously unrecognised subtidal features, including the bedrock outcrop in the Inner Harbour and the location and extent of eelgrass beds. The follow-up dive surveys have proven to be an effective way of addressing some of the SIMS survey constraints, particularly documentation of biotic community features.

4.2 VALUED SUBTIDAL HABITATS

Transport Canada's divestiture process requires the identification of valued habitat features of the harbour, as well as areas which may have been historically degraded by human use. As stated in Section 1.1, VEHEAP with financial support of Transport Canada, has undertaken detailed assessments of the environmental status of the Upper and Selkirk Waters (Emmett *et al.* 1996) and, more recently, a ecological inventory and rating (HEIR) of intertidal areas within Victoria and Esquimalt Harbours (Westland 1999). In both projects, valued intertidal habitat features were identified for possible protection and/or remediation based on ecological criteria. The current SIMS inventory Victoria Harbour can form the basis for a similar identification of valued and/or sensitive subtidal features. Several examples shown in Figure 17 follow:

Figure 17
Valued Subtidal Habitats



1. **Eelgrass Beds**: Six eelgrass beds were mapped within Victoria Harbour, the largest at Shoal Point (1.6 ha). The dive survey observations show a relatively high diversity of algal and invertebrate species (Appendix B) within the beds. Fish use of eelgrass areas (schools of shiner perch, stickleback, and tubesnouts as well as rock sole, kelp greenling and buffalo sculpin), was evident in 5 of the 6 beds. Eelgrass is generally recognised as important rearing habitat for juvenile fish and invertebrates, and is highly sensitive to impacts from foreshore development. Compensation for the loss of eelgrass areas cannot readily be provided. For these reasons the identified eelgrass areas should be considered sensitive habitat areas and management efforts should be implemented to conserve these areas.

2. **Densely Vegetated Kelp Areas**: Areas of predominantly rocky substrate in the outer harbour support a diverse algal community and rich bryozoan, ascidian, sponge and tube worm complexes. These structural elements provide habitat for species of sea star, crab and anemone. The vertical layering of the kelp affords protective foraging and rearing opportunities for many species. This habitat is common in more exposed nearshore areas outside the harbour, however its importance within the harbour area should also be recognised. These areas should be considered valued due to their contribution to nearshore productivity and diversity. However, they are less sensitive than eelgrass beds to physical impacts from infilling in that, if suitable areas exist, they can be readily compensated for by the construction of other rocky substrate features such as artificial reefs. In addition, due to the more exposed nature of these habitats, they are less susceptible to sedimentation impacts.

3. **Rock and Gravel Areas**: Most of the harbour bottom is formed of a sediment layer (silt and fine sands) overlying marine clay. Rock and gravel areas are less common and contribute to the diversity of substrate within the harbour. In particular, the area of blasted rock and bedrock in the middle of the Inner Harbour provides hard substrate for a variety of invertebrates not found in the surrounding soft bottom substrate including rock scallops, sponges, and ascidians. The gravel areas provide substrate for a variety of filamentous and foliose red algae, and appear support the highest densities of coonstripe (or dock) shrimp, *Pandalus danae*.

4.3 Degraded Areas

Most areas of the harbour bottom exhibit some degree of human influence or disturbance, as man-made objects are common throughout the survey area. The Upper Harbour is particularly notable in that macroalgae, particularly bladed kelps such as *Agarum*, are notably sparse and are more abundant, although at low cover, in the more "upstream" Selkirk Waters. This may be a natural situation or could be related to anthropogenic influences such as contaminants, increased sedimentation or nutrient input, particularly as this area of the harbour receives storm water discharges from several large urban and residential areas. The recent sediment transport study undertaken by GeoSea (1999) for Transport Canada indicates that mud sediments in the Upper Harbour are more extensive then other areas of the harbour.

Areas with the highest degree of disturbance, where habitat degradation is clearly evident, include (see Figure 18):

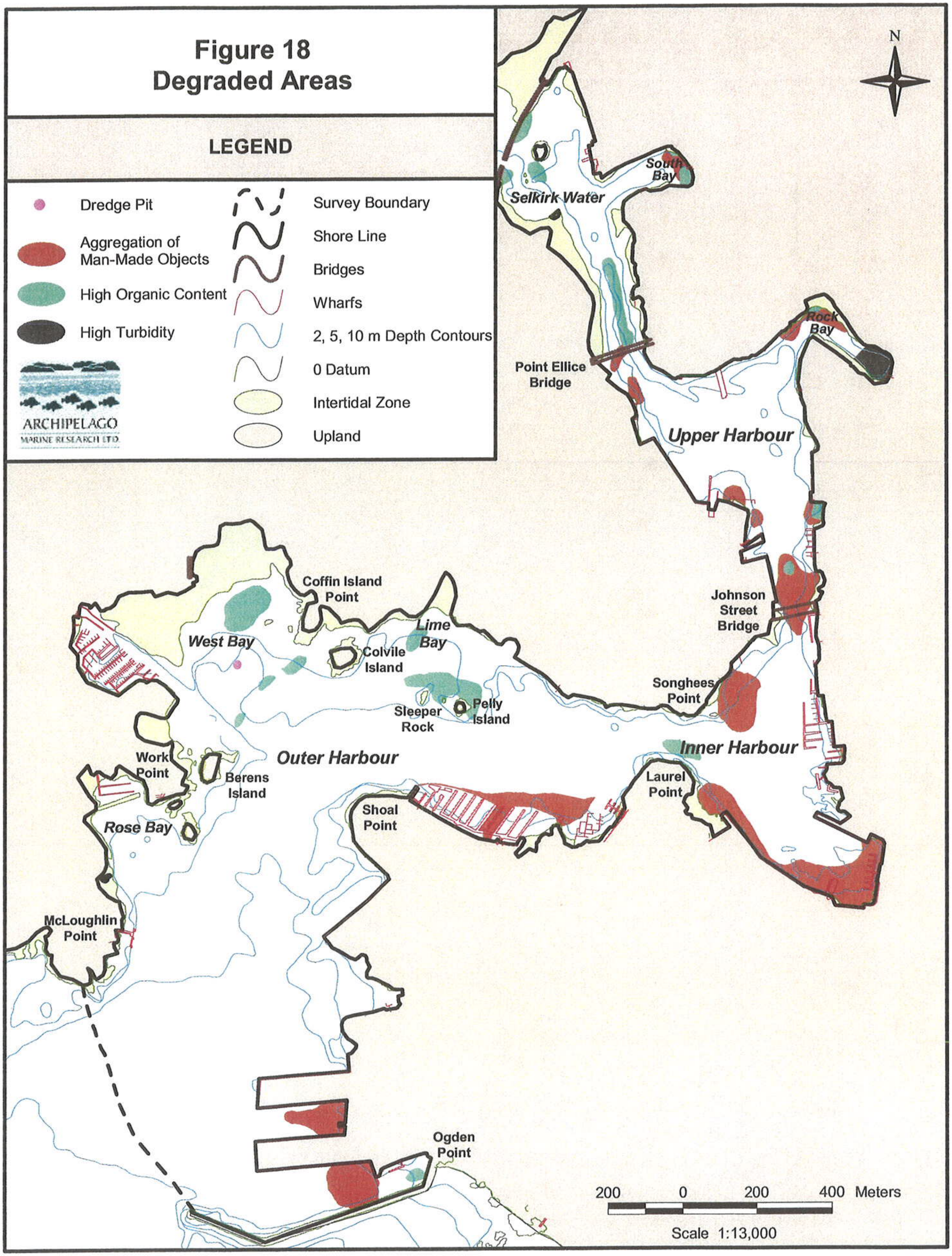


Figure 18
Degraded Areas
LEGEND
Dredge Pit
Aggregation of Man-Made Objects
High Organic Content
High Turbidity
Survey Boundary
Shore Line
Bridges
Wharfs
2, 5, 10 m Depth Contours
0 Datum
Intertidal Zone
Upland
ARCHIPELAGO
MARINE RESEARCH LTD.
N
Selkirk Water
South Bay
Rock Bay
Point Ellice Bridge
Upper Harbour
Johnson Street Bridge
Songhees Point
Inner Harbour
Laurel Point
Coffin Island Point
West Bay
Lime Bay
Colvile Island
Sleeper Rock
Pelly Island
Outer Harbour
Work Point
Berens Island
Rose Bay
Shoal Point
McLoughlin Point
Ogden Point
200 0 200 400 Meters
Scale 1:13,000

1. **Rock Bay**: At the time of the survey the inner (eastern) third of Rock Bay had such a high degree of turbidity that video observations were not possible. The reduced visibility extends throughout the bay, particularly just above the seabed. This was observed at the time of the SIMS video survey (late April 1999), during the dive survey (July 1999) and during previous surveys of the area (Archipelago Marine Research Ltd. 1998). Sediment input is most likely from the two large storm drains at the head of the bay as well as adjacent industrial areas. Epifauna and infauna within this area of Rock Bay appear to be sparse and there are areas of *Beggiatoa* type mats, indicative of anaerobic conditions in the surface sediments (Archipelago Marine Research Ltd. 1998).

2. **Areas of Bark/Wood Debris:** Many intertidal and subtidal areas in Victoria Harbour have been used historically for log storage. Areas in the harbour (Figures 8a and b) identified during the SIMS survey as having a high degree of organic material on the surface (>30% cover) include:
   - East of the Trestle Bridge and around Halkett Island,
   - Mid Channel north of the Point Ellice Bridge,
   - Laurel Point,
   - Sleeper/Pelly Rock and Lime Bay,
   - West Bay.

   Most of these areas coincide with historic log storage areas. The area north of the Point Ellice Bridge may reflect "downstream" movement and accumulation of bark and log debris from the old BCFP sawmill and the adjacent Bayside Land log storage areas.

3 **West Bay Dredge Pit:** The dive site at West Bay (Site 1, Figure 3) is a notable depression in the muddy bottom substrate which exhibitsw anoxic or reducing conditions in the seabed substrate, as evidenced by chemosynthetic bacteria or blue green algae mats, (e.g. *Beggiatoa* sp., see Section 3.12.5). This depression does not appear to be a natural feature and may be the result of historic dredging activity or some other means of substrate removal.

4 **Large Aggregations of Man-Made Debris:** The most prominent aggregations of man made debris within the harbour are under current or historic docks and wharves as well as under the Johnson and Point Ellice Bridges (Figures 7a and 7b). Much of the debris is relatively benign with respect to impacts to habitat value (e.g. bottles and cans), however these areas may also be indicative of potential contaminant sources, particularly where the debris aggregations occur adjacent to historic industrial sites.

4.4 NOTABLE BIOTA

1. **Piddock Clams:** The rough piddock *(Ziphaea pilsbry)* is common throughout Victoria Harbour, and occurs in clay and/or gravely substrates, particularly in areas where the overlying silt/sand sediment is thin or absent. Marine clays are common substrates along the Victoria waterfront and Saanich Peninsula, and the occurrence of piddocks is not unexpected, rather should be considered characteristic. Piddocks are of limited commercial or recreational value due to the difficulty of harvesting them from the clay or rocky substrate.

2. **Rock scallops:** Rock scallops (*Crassadoma gigantea*) are a large, long-lived species which adheres to rocky substrate by its thick shell valve. Rock scallops are harvested recreationally by divers and populations are often severely depleted in areas with a high degree of recreational diving. Rock scallops appear to be relatively common in both Victoria and Esquimalt Harbours, perhaps because these populations are not subject to harvesting due to contamination concerns.

3. **Coonstripe (Dock) Shrimp:** Coonstripe (dock) shrimp (*Pandalus danae*) were observed in the harbour, particularly in gravel substrate areas, during the July 1999 dive survey. Similar aggregations of shrimp were observed during harbour trials of the SIMS video system one year earlier, July 1998. Shrimp were not noted as abundant in the harbour during the April 1999 SIMS survey, indicating that their use of the harbour area may be seasonal. Coonstripe shrimp are fished recreationally in winter from docks and floats, and there is a small commercial winter trap fishery in Sooke Harbour.

4. **Dungeness and Red Rock Crab:** Both Dungeness (*Cancer magister*) and red rock (*C. productus*) crab are common throughout the harbour. At present, the recreational harvest of crab is permitted in Victoria Harbour, but there is no commercial fishery. As with rock scallops, public concern over potential contamination levels may limit the harvest of crab in the harbour areas.

5. **Bivalve Shell Accumulations:** In certain areas of the harbour, most notably near the Johnson St Bridge and in the Upper Harbour, clam and oyster shells are common on the silt/sand substrate. As summarised in Section 3.12.4, these shells include macoma, littleneck, horse clam, butter clam and the native oyster (*Ostrea lurida*). All species are found in the harbour and Gorge areas (Emmett *et al.* 1996, Westland 1999), however the abundance of native oyster shell on the bottom of the harbour is notable. Native oysters are reported to have been historically abundant in Portage Inlet and the Gorge (Qualye 1988), but now appear to be relatively rare (Lambert 1967, Emmett *et al.* 1996). It is not known whether the observed shell debris represents historic accumulation or more recent deposition.

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Subtidal Survey of Physical and Biological Features of Victoria Harbour

SECTION 6.0 MAP FOLIO

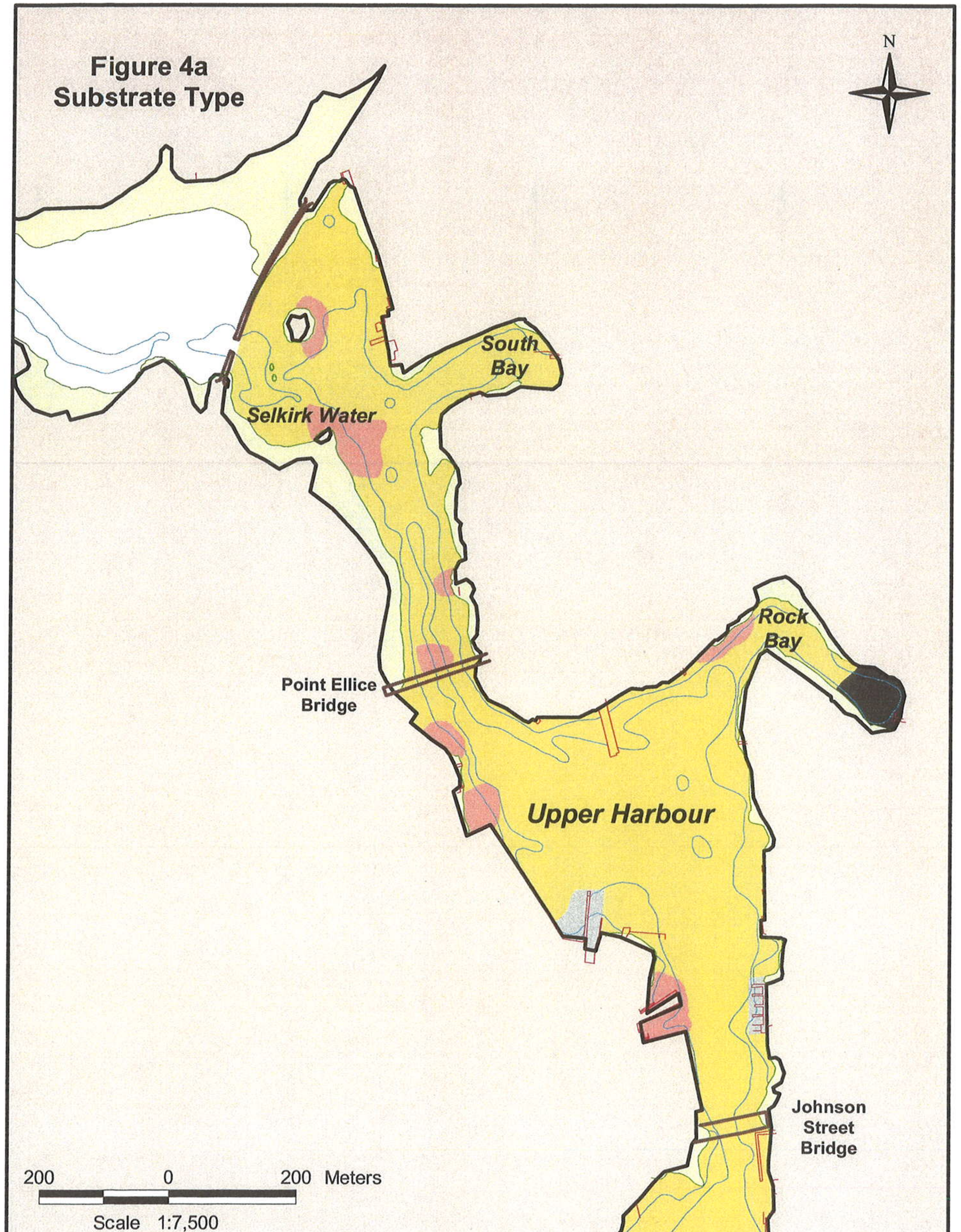


Figure 4a
Substrate Type
N
South Bay
Selkirk Water
Rock Bay
Point Ellice Bridge
Upper Harbour
Johnson Street Bridge
200 0 200 Meters
Scale 1:7,500

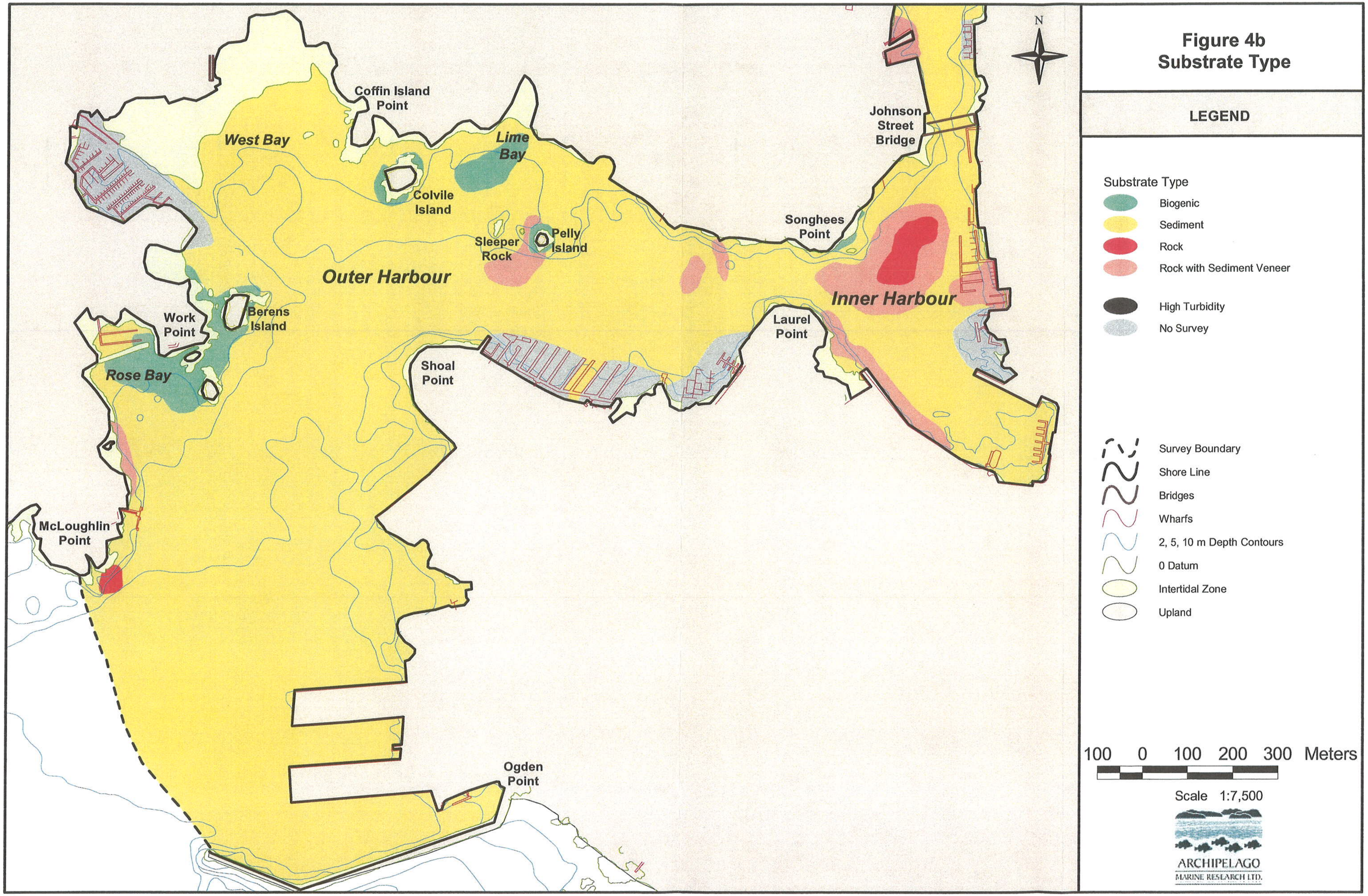


Figure 4b
Substrate Type
LEGEND
Substrate Type
Biogenic
Sediment
Rock
Rock with Sediment Veneer
High Turbidity
No Survey
Survey Boundary
Shore Line
Bridges
Wharfs
2, 5, 10 m Depth Contours
0 Datum
Intertidal Zone
Upland
100 0 100 200 300 Meters
Scale 1:7,500
ARCHIPELAGO
MARINE RESEARCH LTD.
N
Coffin Island Point
West Bay
Lime Bay
Colvile Island
Sleeper Rock
Pelly Island
Outer Harbour
Work Point
Berens Island
Rose Bay
Shoal Point
McLoughlin Point
Ogden Point
Johnson Street Bridge
Songhees Point
Laurel Point
Inner Harbour

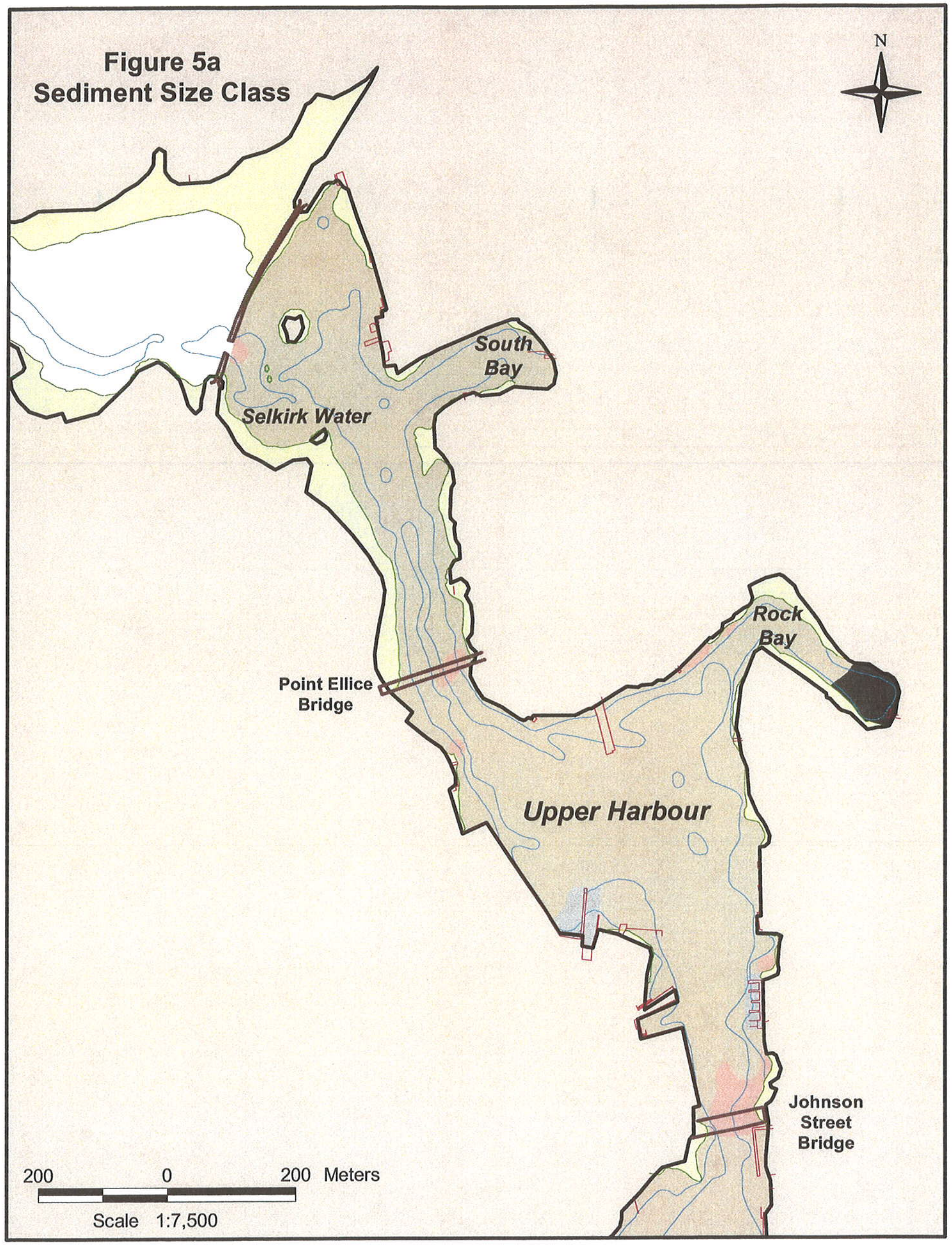


Figure 5a
Sediment Size Class
N
South Bay
Selkirk Water
Rock Bay
Point Ellice Bridge
Upper Harbour
Johnson Street Bridge
200 0 200 Meters
Scale 1:7,500

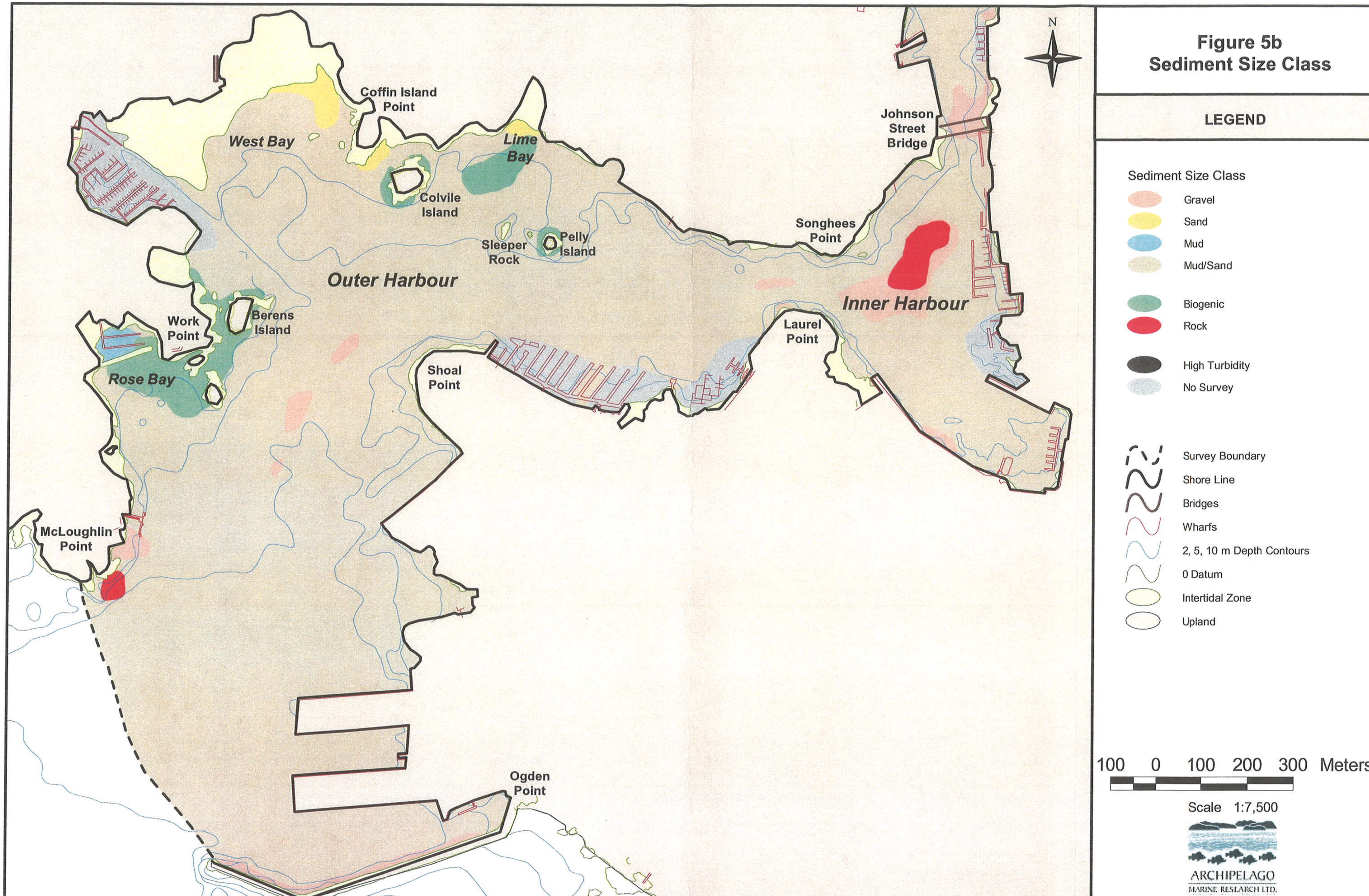


Figure 5b
Sediment Size Class
LEGEND
Sediment Size Class
Gravel
Sand
Mud
Mud/Sand
Biogenic
Rock
High Turbidity
No Survey
Survey Boundary
Shore Line
Bridges
Wharfs
2, 5, 10 m Depth Contours
0 Datum
Intertidal Zone
Upland
100 0 100 200 300 Meters
Scale 1:7,500
ARCHIPELAGO
MARINE RESEARCH LTD.
N
Coffin Island Point
West Bay
Lime Bay
Colvile Island
Sleeper Rock
Pelly Island
Outer Harbour
Johnson Street Bridge
Songhees Point
Inner Harbour
Laurel Point
Work Point
Berens Island
Rose Bay
Shoal Point
McLoughlin Point
Ogden Point

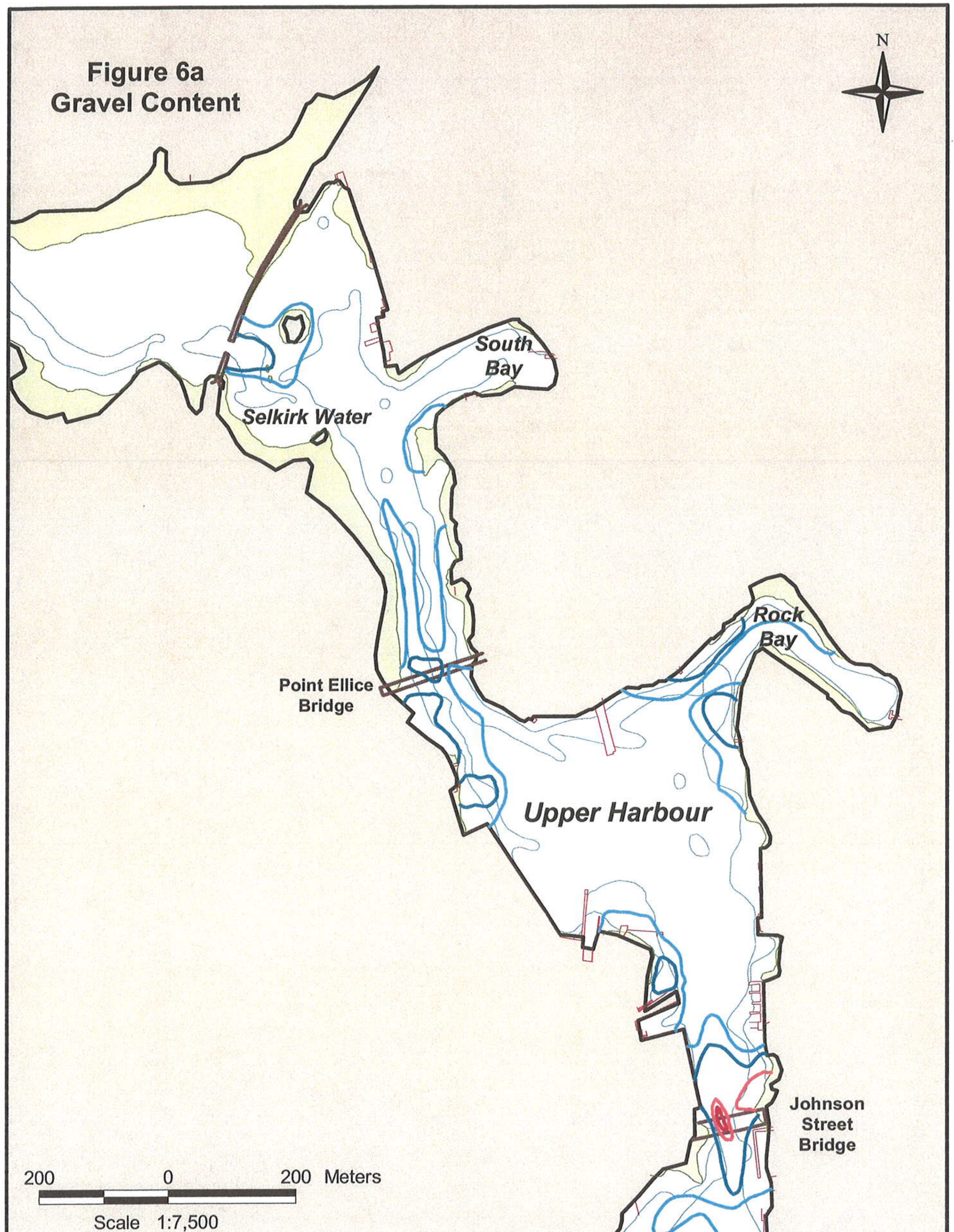


Figure 6a
Gravel Content
N
South Bay
Selkirk Water
Rock Bay
Point Ellice Bridge
Upper Harbour
Johnson Street Bridge
200 0 200 Meters
Scale 1:7,500

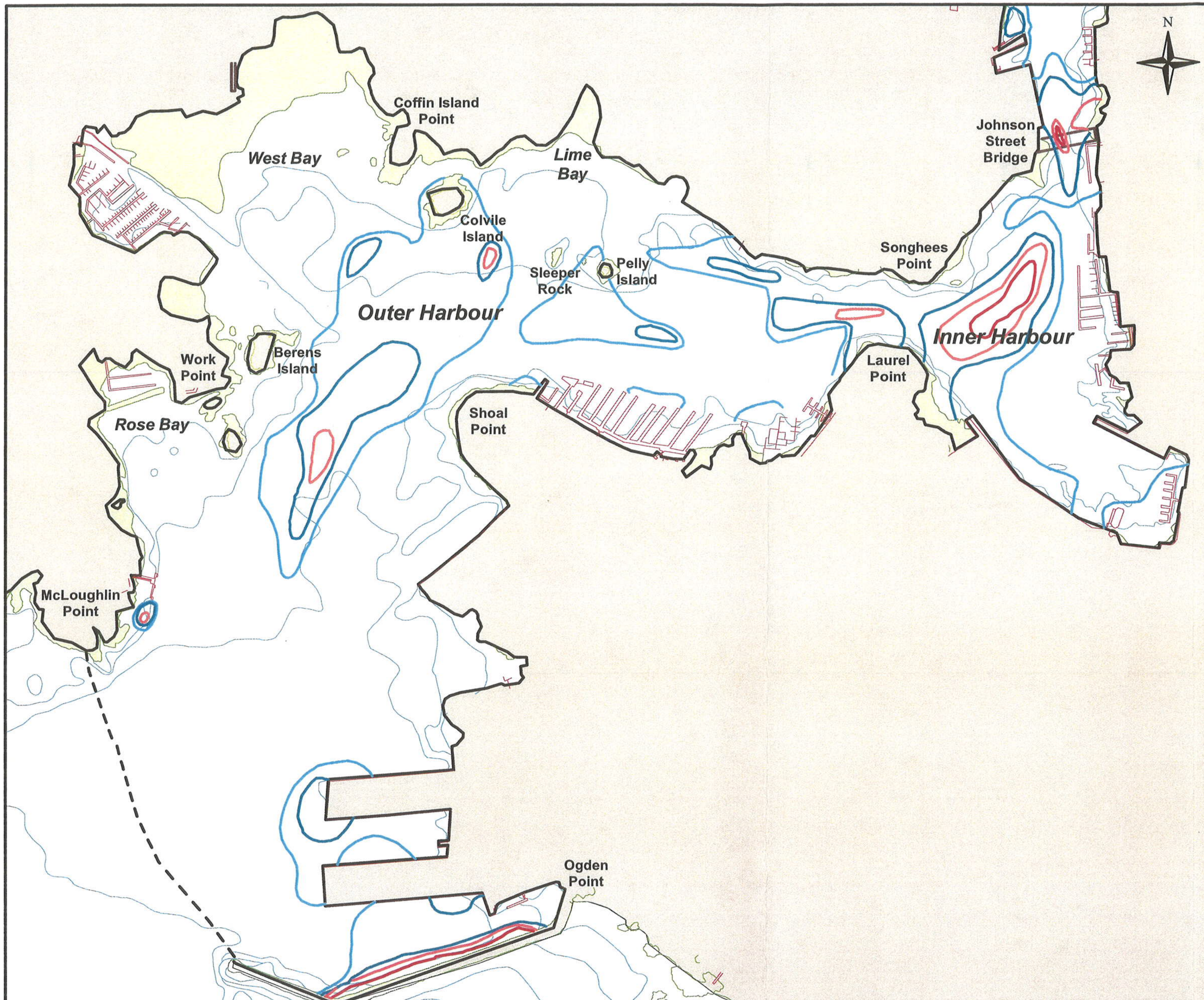


Figure 6b
Gravel Content

LEGEND

Gravel Content
- Trace-5%
- 5-30%
- 30-50%
- 50-80%

- Survey Boundary
- Shore Line
- Bridges
- Wharfs
- 2, 5, 10 m Depth Contours
- 0 Datum
- Intertidal Zone
- Upland

100 0 100 200 300 Meters

Scale 1:7,500

ARCHIPELAGO MARINE RESEARCH LTD.

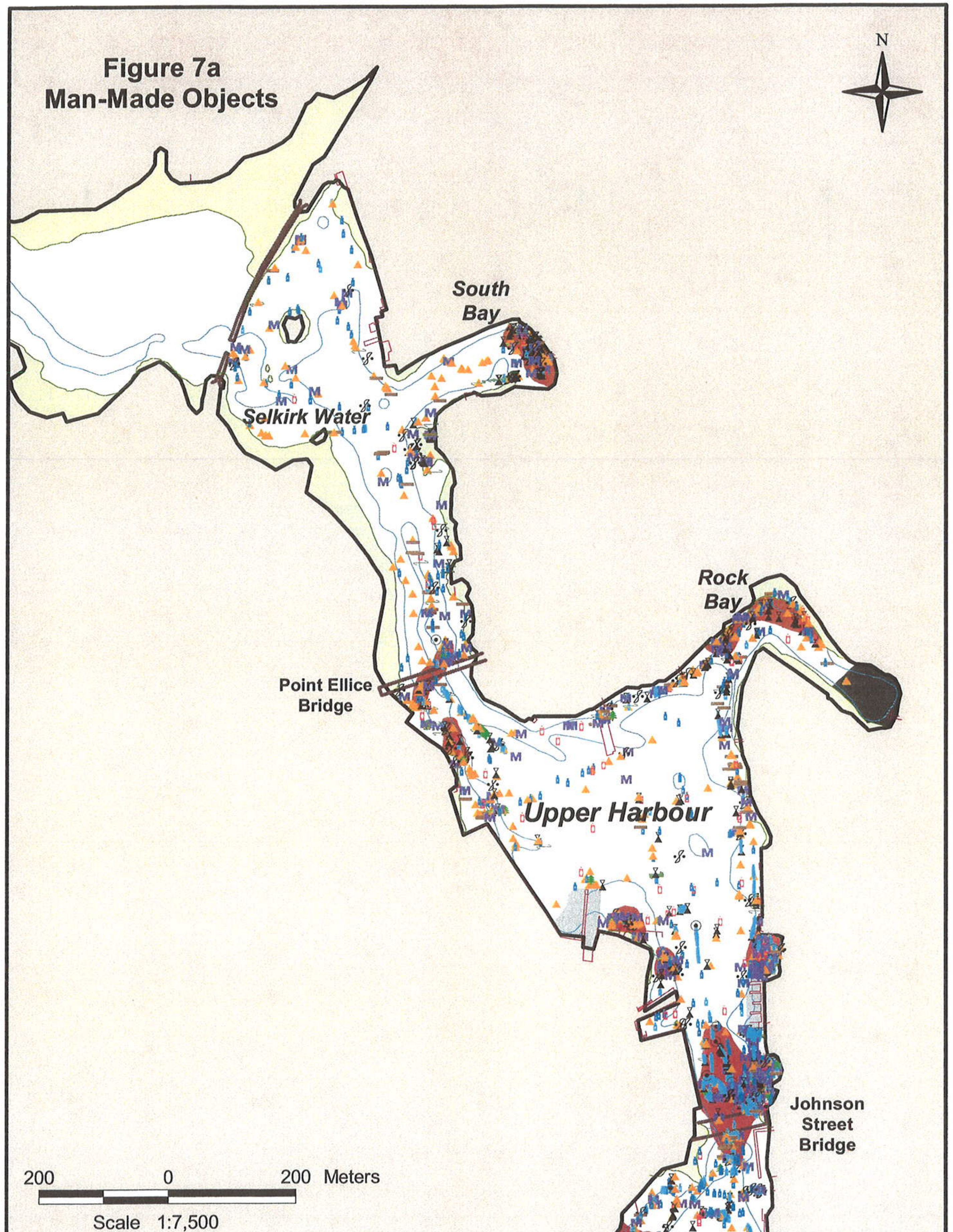


Figure 7a
Man-Made Objects
N
South Bay
Selkirk Water
Rock Bay
Point Ellice Bridge
Upper Harbour
Johnson Street Bridge
200 0 200 Meters
Scale 1:7,500

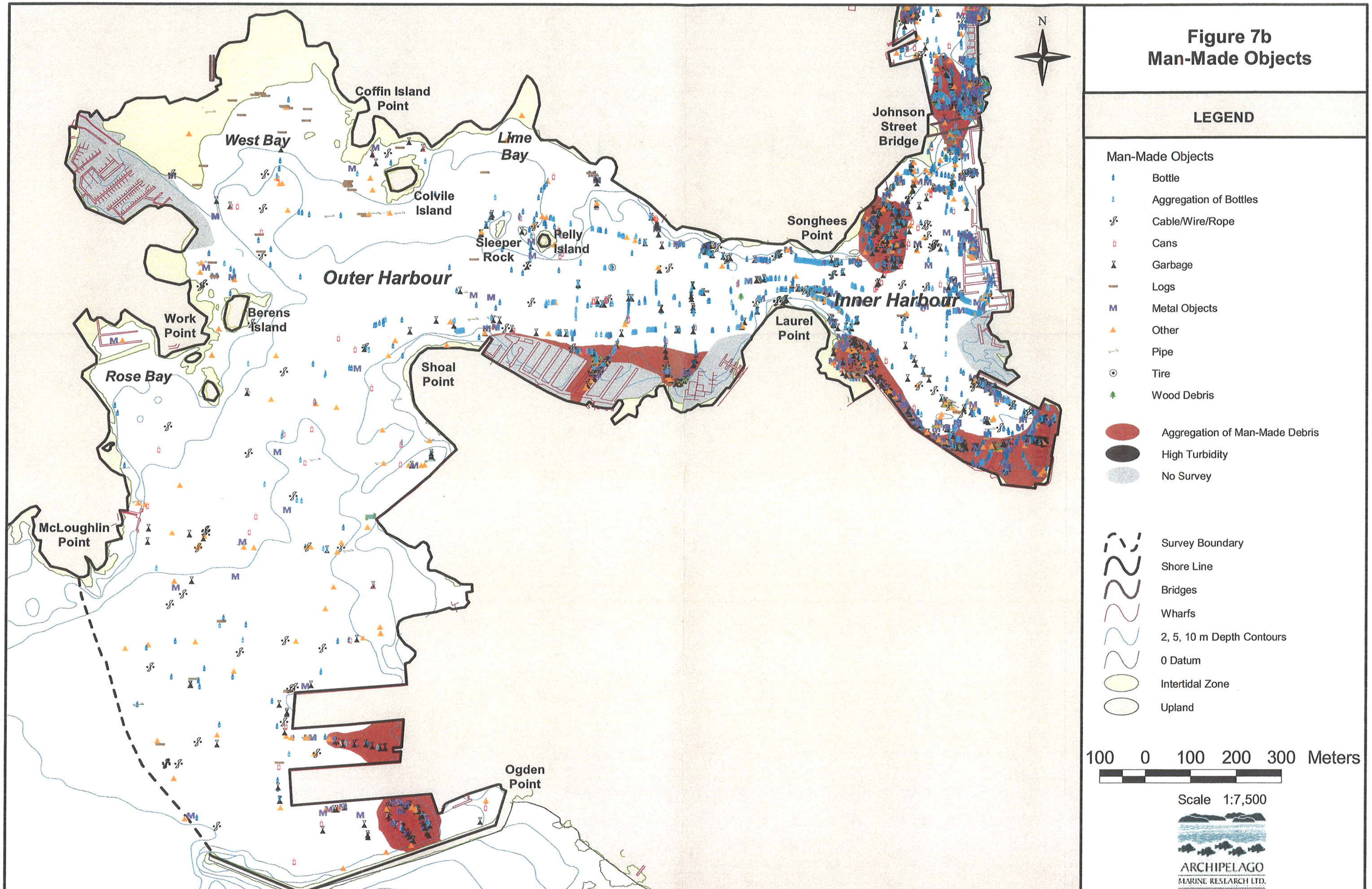


Figure 7b
Man-Made Objects
LEGEND
Man-Made Objects
Bottle
Aggregation of Bottles
Cable/Wire/Rope
Cans
Garbage
Logs
Metal Objects
Other
Pipe
Tire
Wood Debris
Aggregation of Man-Made Debris
High Turbidity
No Survey
Survey Boundary
Shore Line
Bridges
Wharfs
2, 5, 10 m Depth Contours
0 Datum
Intertidal Zone
Upland
100 0 100 200 300 Meters
Scale 1:7,500
ARCHIPELAGO MARINE RESEARCH LTD.
N
West Bay
Coffin Island Point
Colvile Island
Lime Bay
Sleeper Rock
Relly Island
Outer Harbour
Work Point
Berens Island
Rose Bay
Shoal Point
Johnson Street Bridge
Songhees Point
Inner Harbour
Laurel Point
McLoughlin Point
Ogden Point

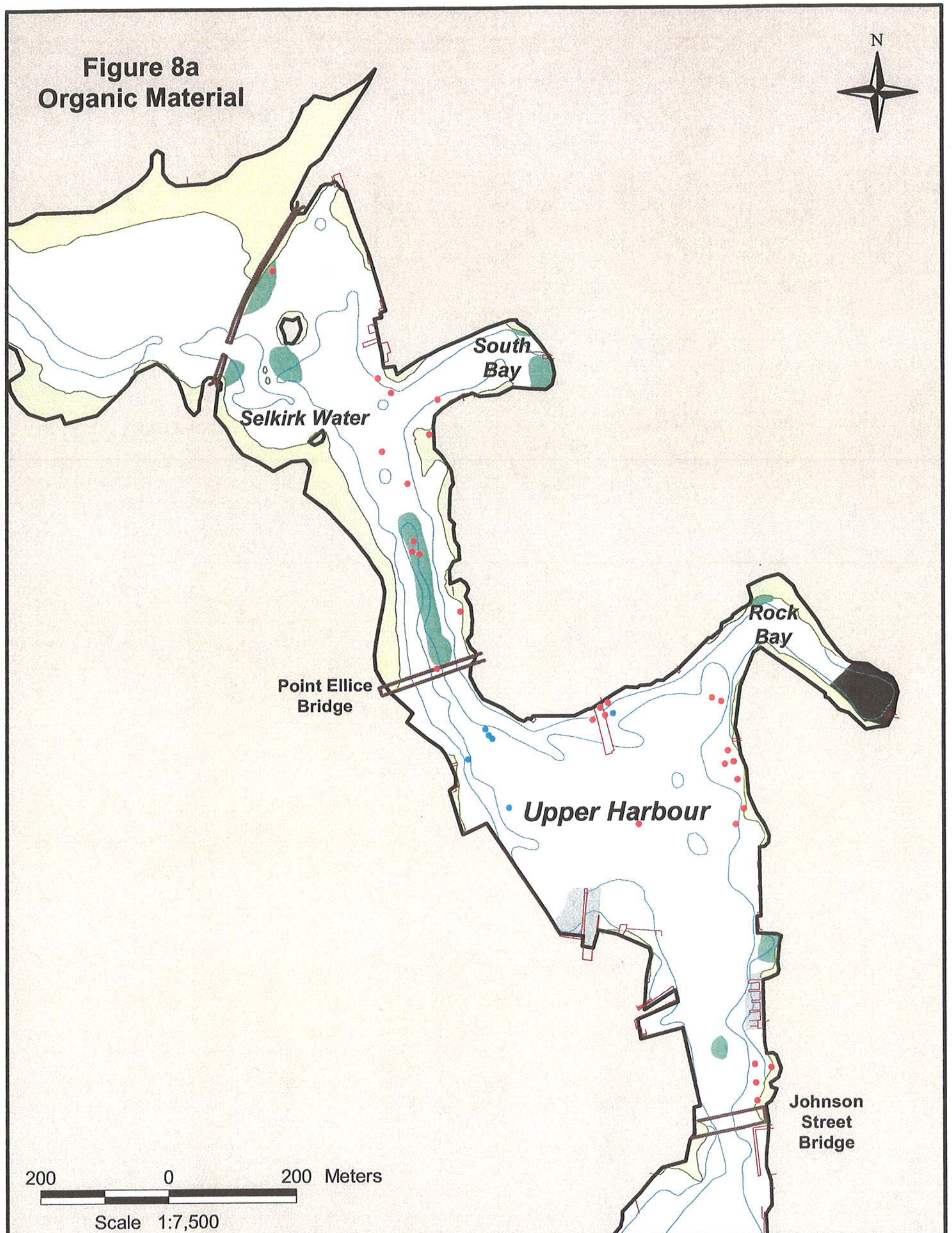


Figure 8a
Organic Material
N
South Bay
Selkirk Water
Rock Bay
Point Ellice Bridge
Upper Harbour
Johnson Street Bridge
200 0 200 Meters
Scale 1:7,500

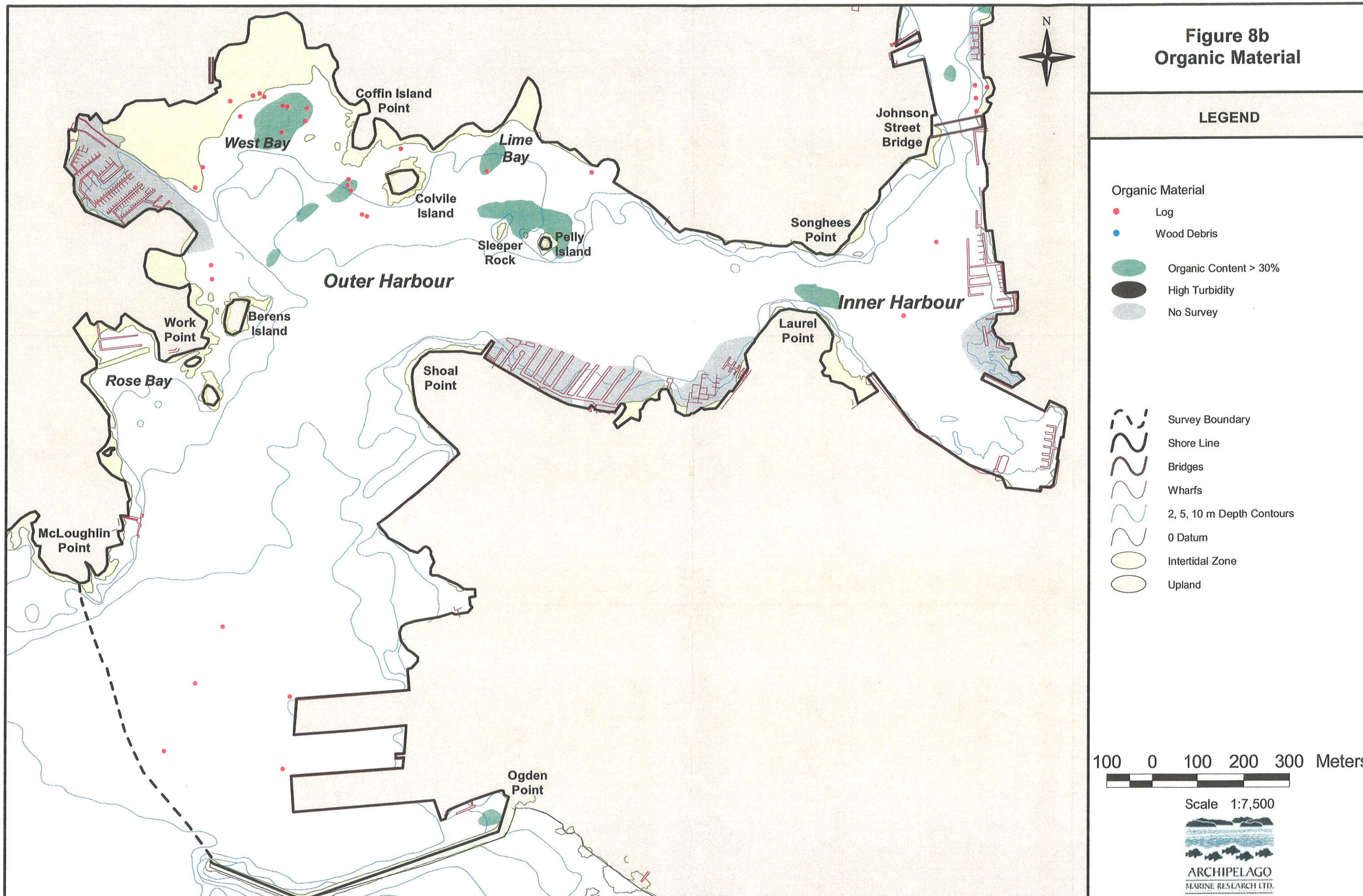


Figure 8b
Organic Material
LEGEND
Organic Material
Log
Wood Debris
Organic Content > 30%
High Turbidity
No Survey
Survey Boundary
Shore Line
Bridges
Wharfs
2, 5, 10 m Depth Contours
0 Datum
Intertidal Zone
Upland
100 0 100 200 300 Meters
Scale 1:7,500
ARCHIPELAGO
MARINE RESEARCH LTD.
N
Coffin Island Point
West Bay
Lime Bay
Colvile Island
Sleeper Rock
Pelly Island
Outer Harbour
Work Point
Berens Island
Rose Bay
Shoal Point
McLoughlin Point
Johnson Street Bridge
Songhees Point
Inner Harbour
Laurel Point
Ogden Point

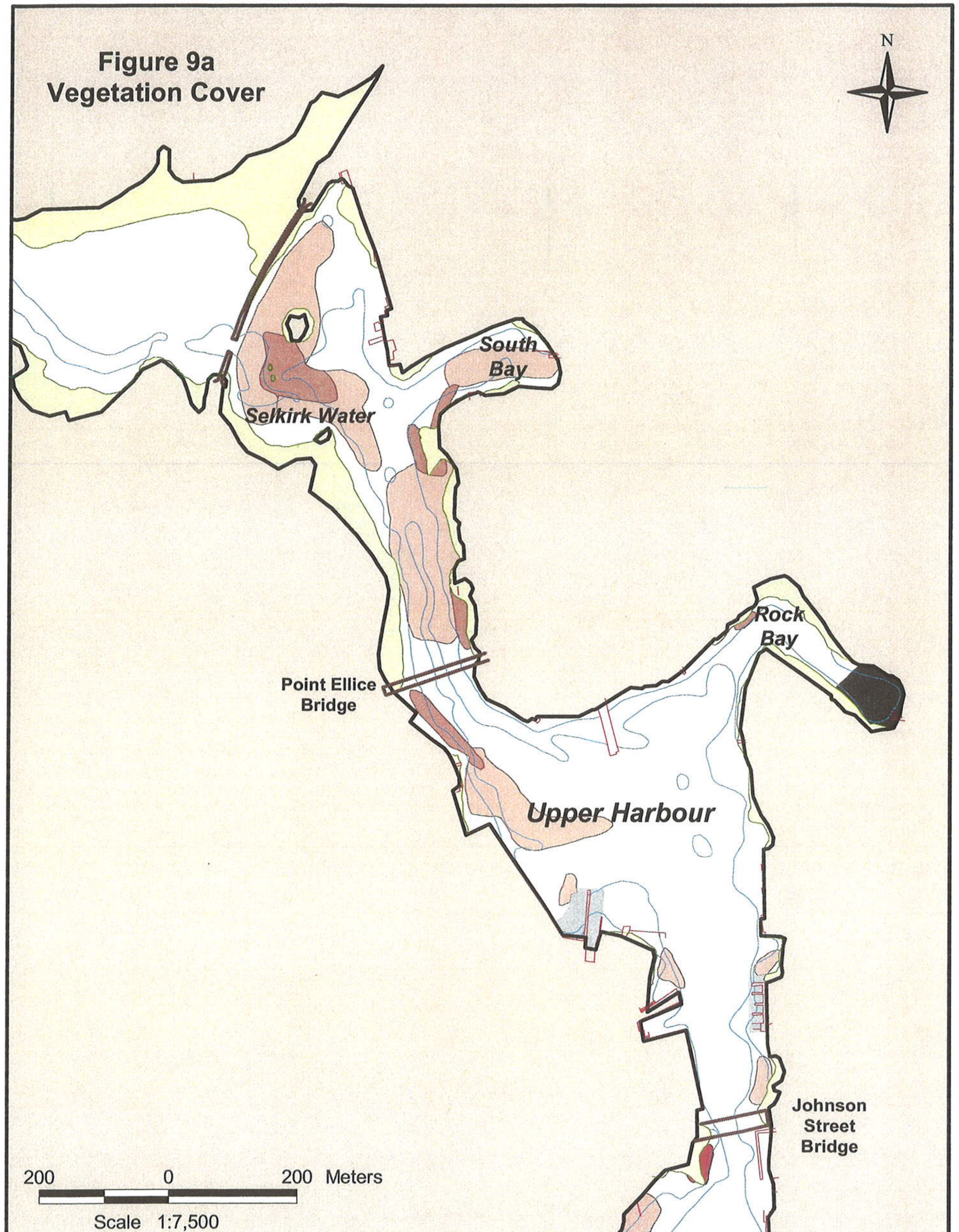


Figure 9a
Vegetation Cover
N
South Bay
Selkirk Water
Rock Bay
Point Ellice Bridge
Upper Harbour
Johnson Street Bridge
200 0 200 Meters
Scale 1:7,500

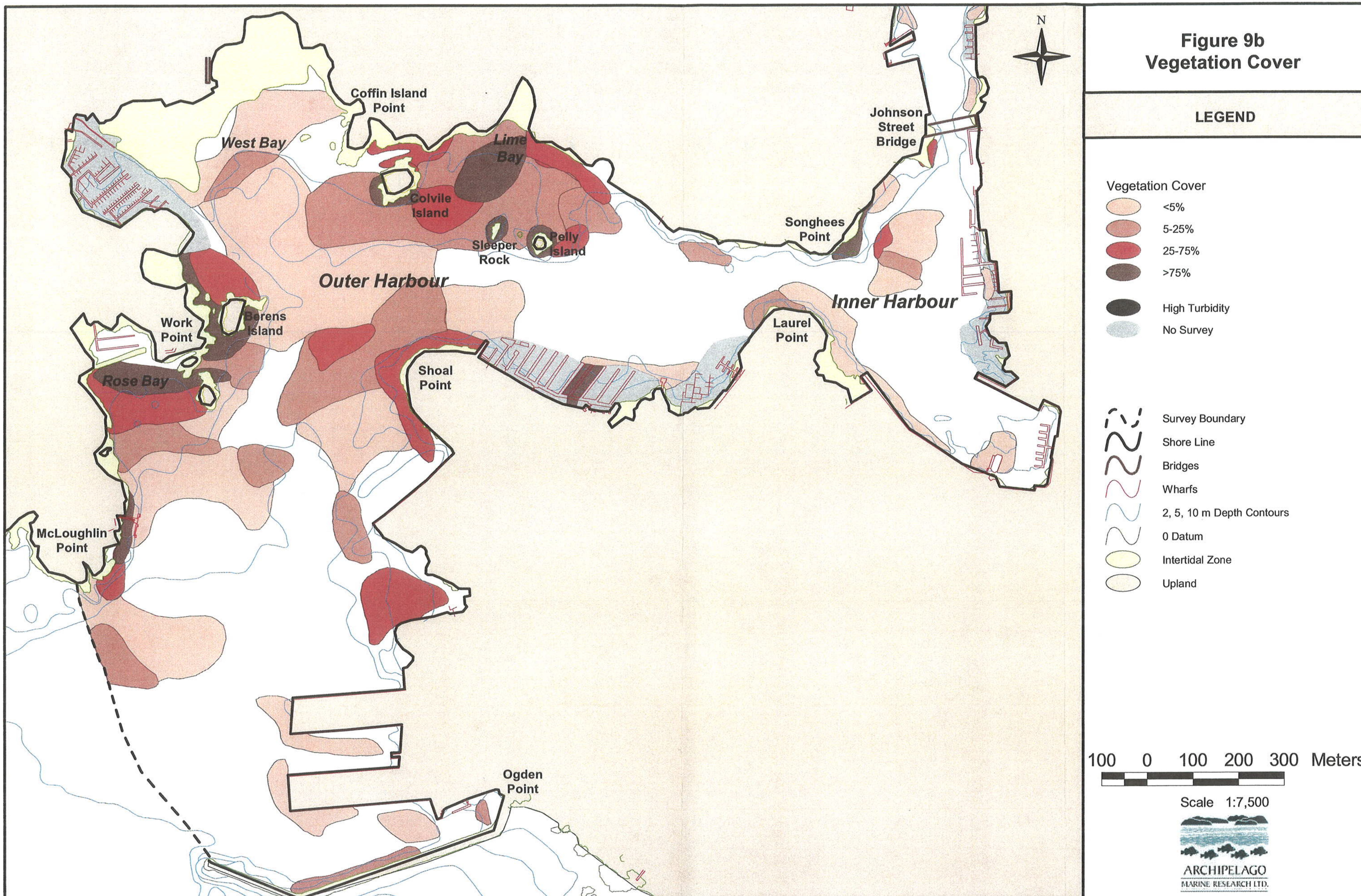


Figure 9b
Vegetation Cover
LEGEND
Vegetation Cover
<5%
5-25%
25-75%
>75%
High Turbidity
No Survey
Survey Boundary
Shore Line
Bridges
Wharfs
2, 5, 10 m Depth Contours
0 Datum
Intertidal Zone
Upland
100 0 100 200 300 Meters
Scale 1:7,500
ARCHIPELAGO
MARINE RESEARCH LTD.
N
Coffin Island Point
West Bay
Lime Bay
Colvile Island
Sleeper Rock
Pelly Island
Johnson Street Bridge
Songhees Point
Outer Harbour
Inner Harbour
Work Point
Berens Island
Laurel Point
Shoal Point
Rose Bay
McLoughlin Point
Ogden Point

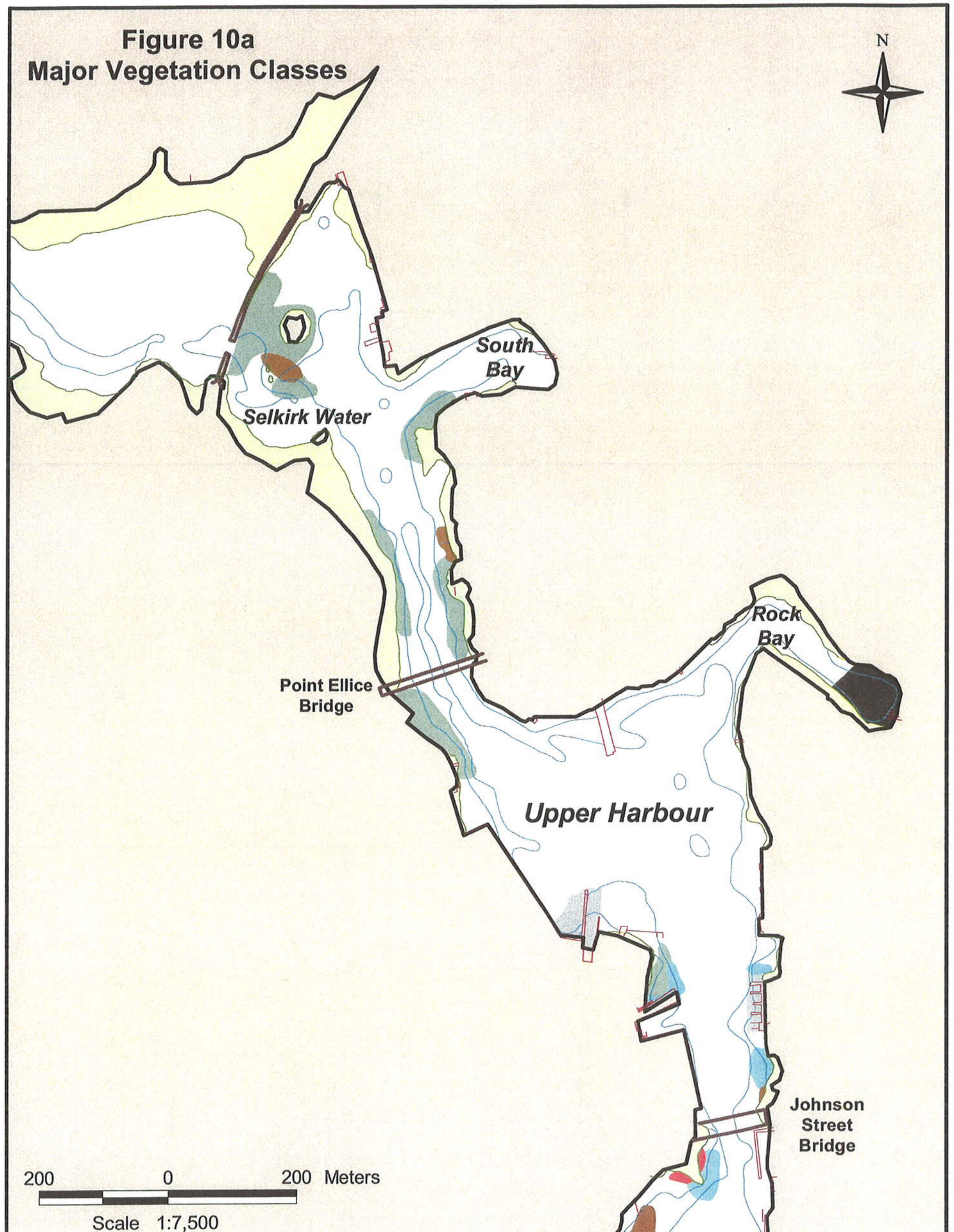


Figure 10a
Major Vegetation Classes
N
South Bay
Selkirk Water
Rock Bay
Point Ellice Bridge
Upper Harbour
Johnson Street Bridge
200 0 200 Meters
Scale 1:7,500

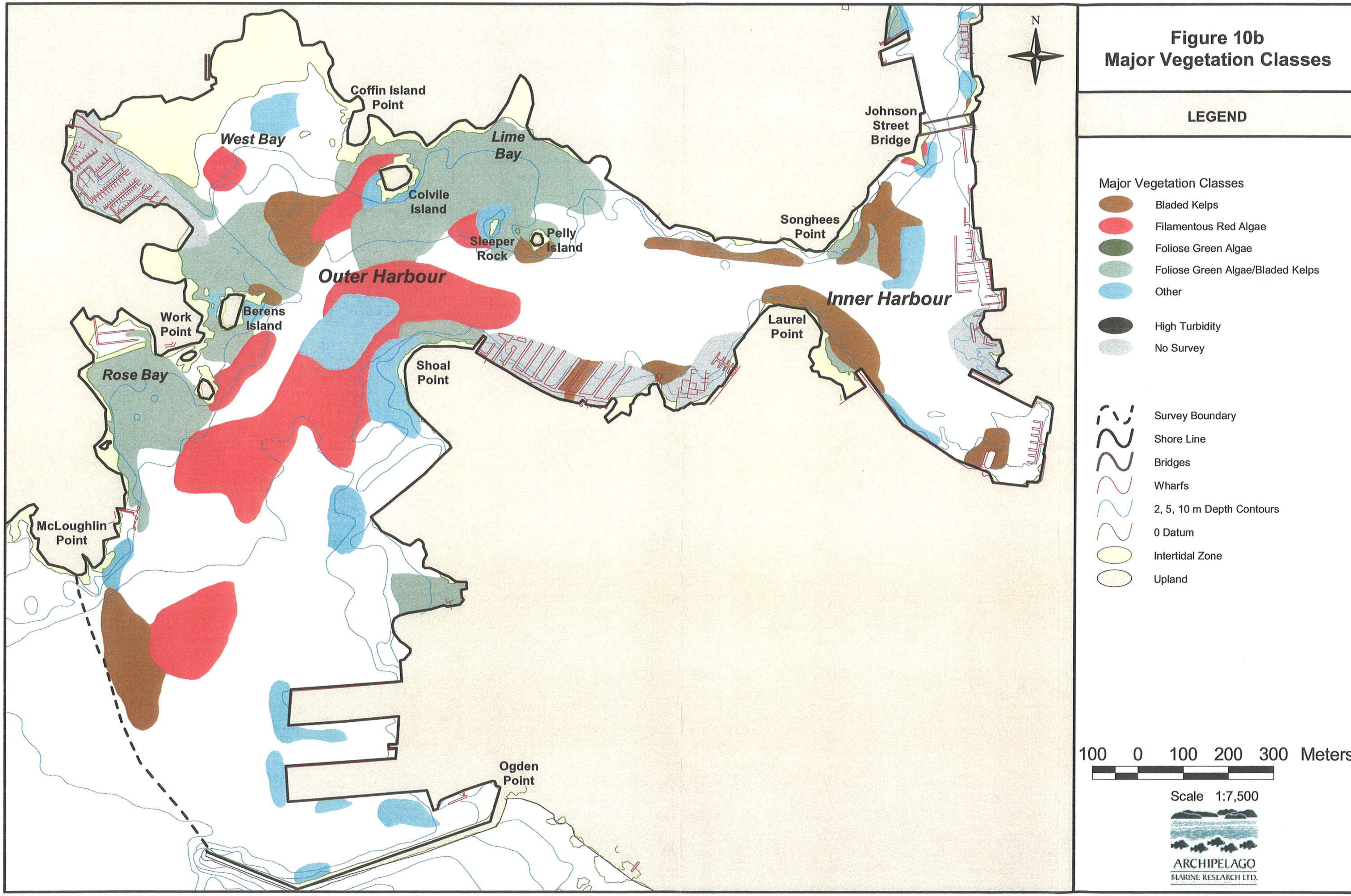


Figure 10b
Major Vegetation Classes

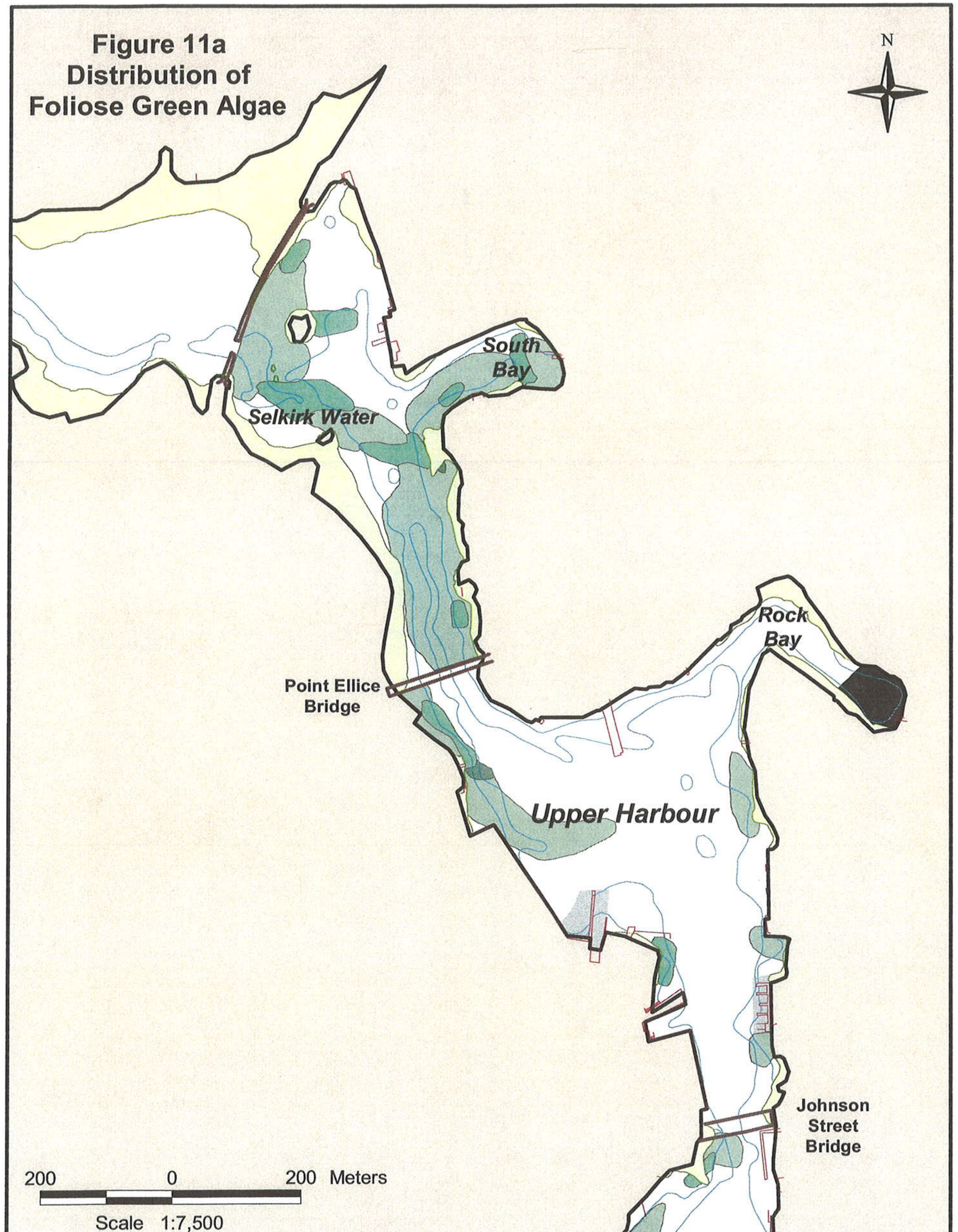


Figure 11a
Distribution of
Foliose Green Algae
N
Selkirk Water
South
Bay
Rock
Bay
Point Ellice
Bridge
Upper Harbour
Johnson
Street
Bridge
200
0
200 Meters
Scale 1:7,500

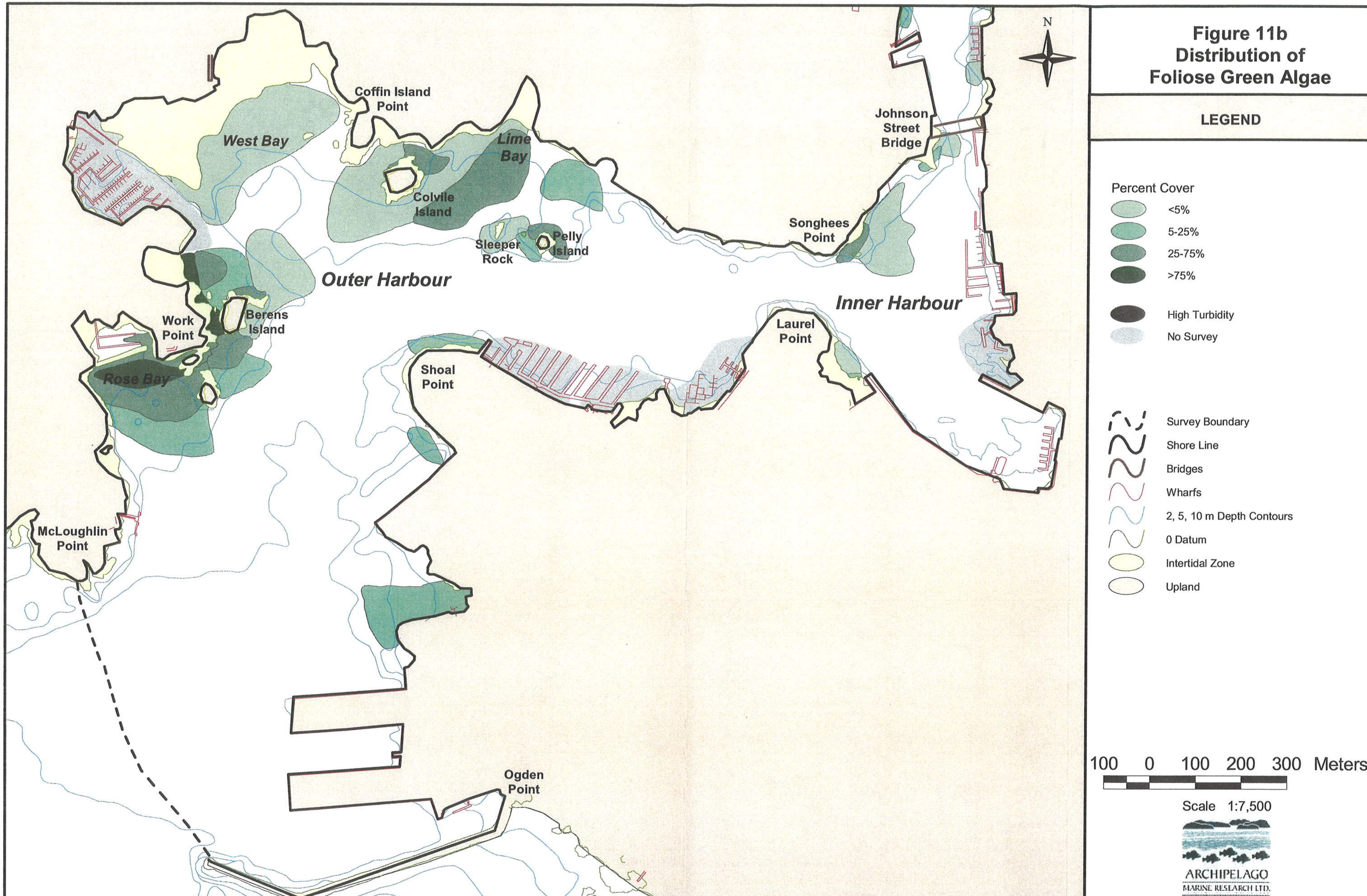


Figure 11b
Distribution of
Foliose Green Algae

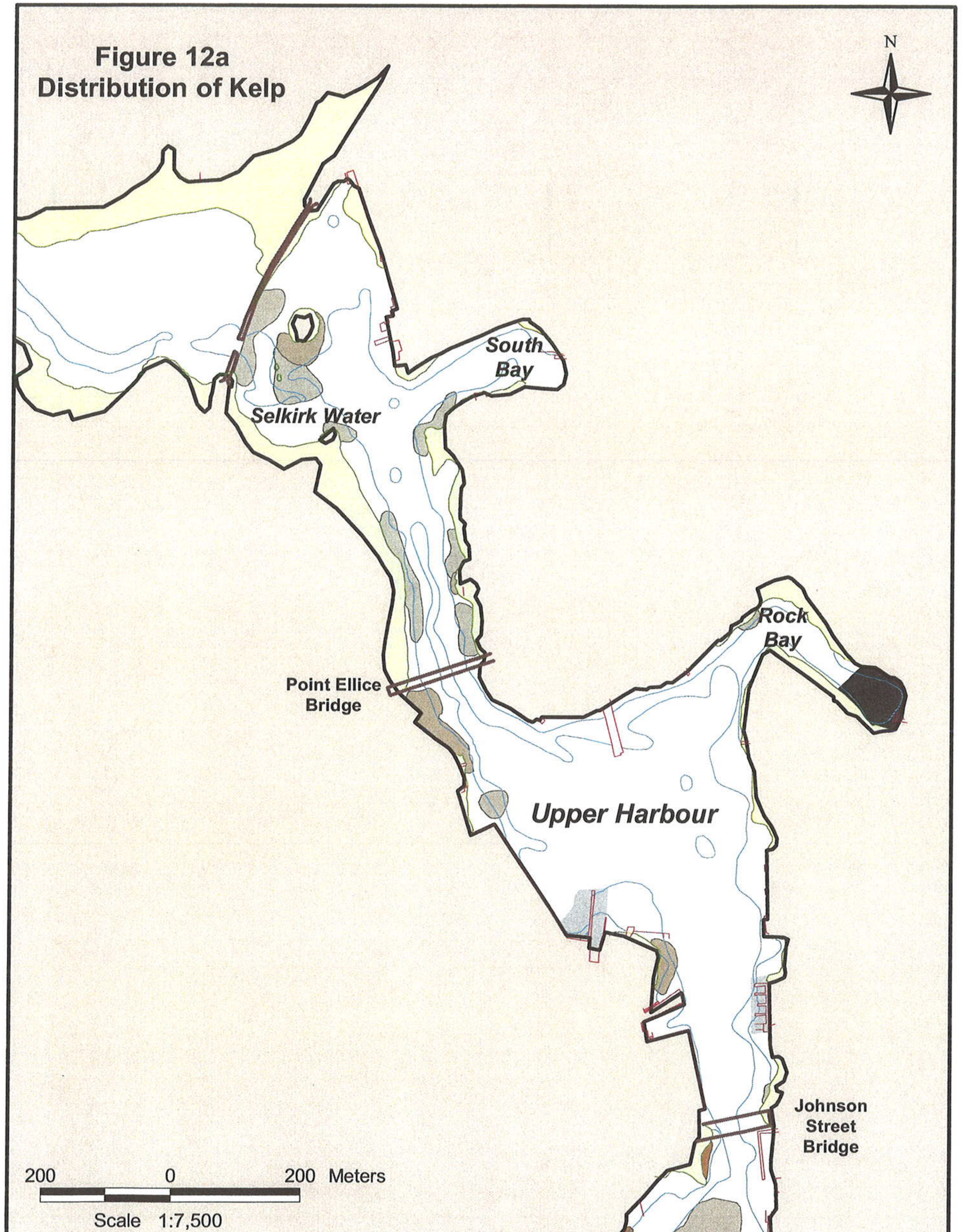


Figure 12a
Distribution of Kelp
N
South Bay
Selkirk Water
Rock Bay
Point Ellice Bridge
Upper Harbour
Johnson Street Bridge
200 0 200 Meters
Scale 1:7,500

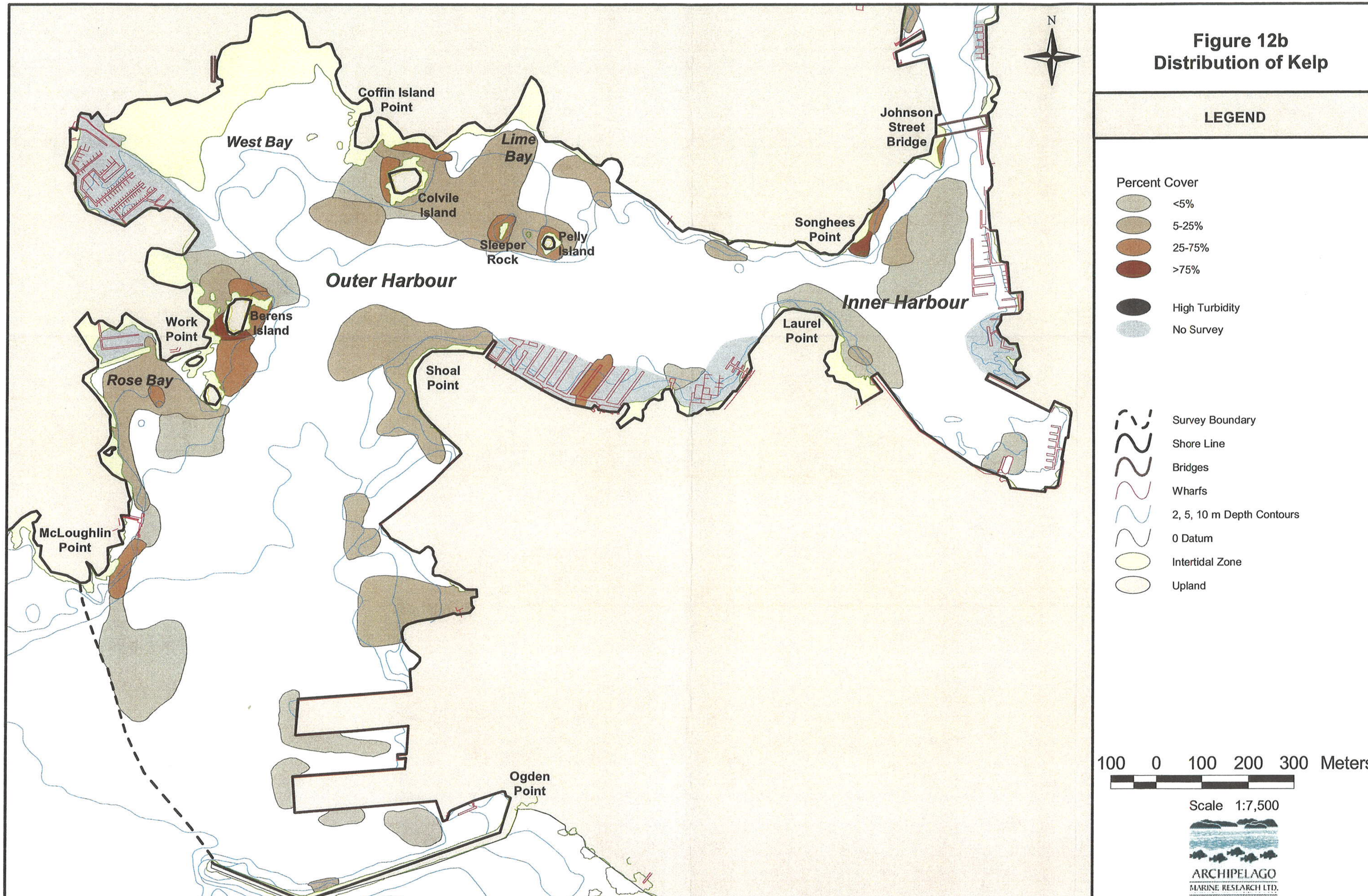


Figure 12b
Distribution of Kelp

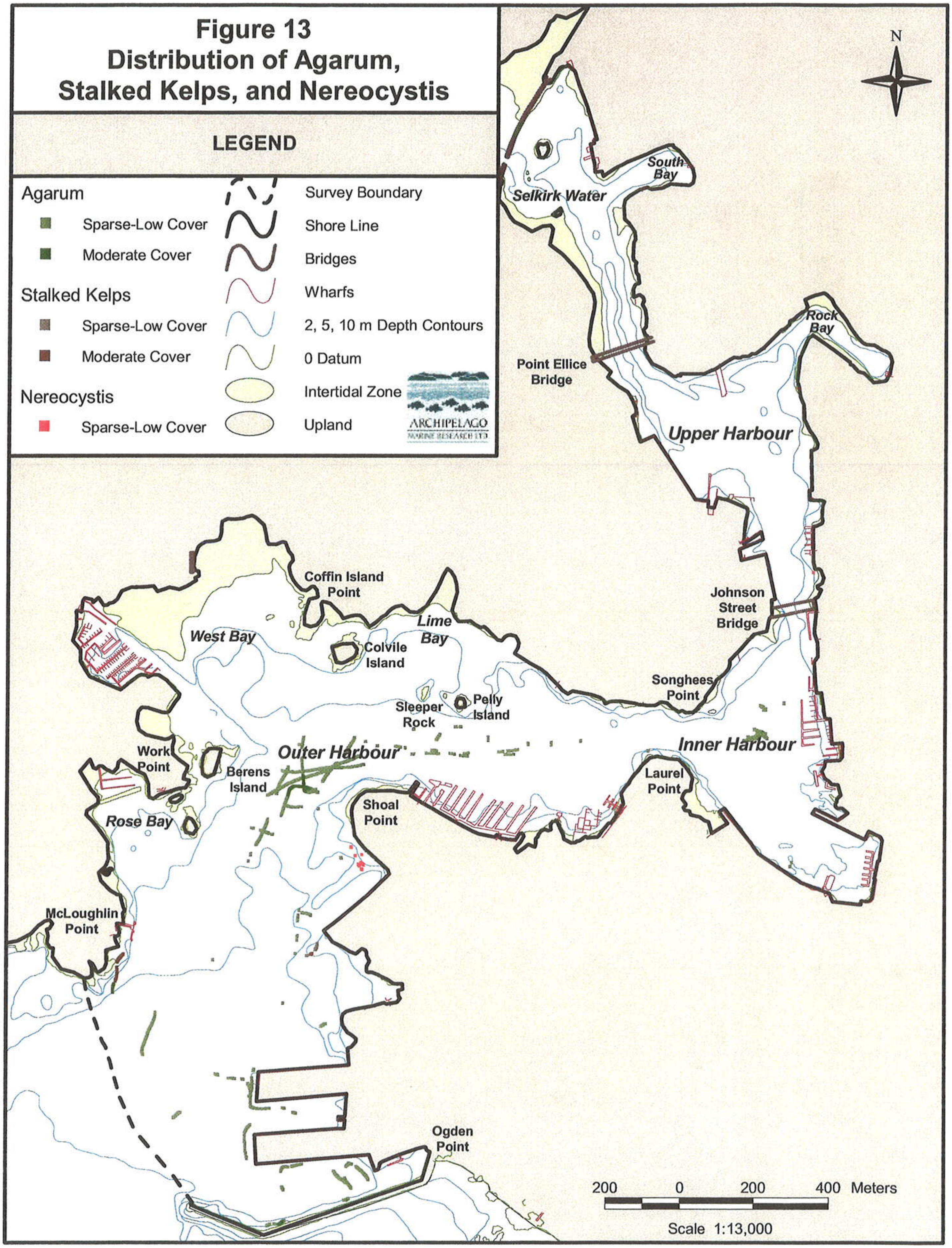


Figure 13
Distribution of Agarum, Stalked Kelps, and Nereocystis
LEGEND
Agarum
Sparse-Low Cover
Moderate Cover
Stalked Kelps
Sparse-Low Cover
Moderate Cover
Nereocystis
Sparse-Low Cover
Survey Boundary
Shore Line
Bridges
Wharfs
2, 5, 10 m Depth Contours
0 Datum
Intertidal Zone
Upland
ARCHIPELAGO
N
South Bay
Selkirk Water
Rock Bay
Point Ellice Bridge
Upper Harbour
Coffin Island Point
Johnson Street Bridge
Lime Bay
West Bay
Colvile Island
Songhees Point
Sleeper Rock
Pelly Island
Inner Harbour
Work Point
Outer Harbour
Berens Island
Laurel Point
Shoal Point
Rose Bay
McLoughlin Point
Ogden Point
200 0 200 400 Meters
Scale 1:13,000

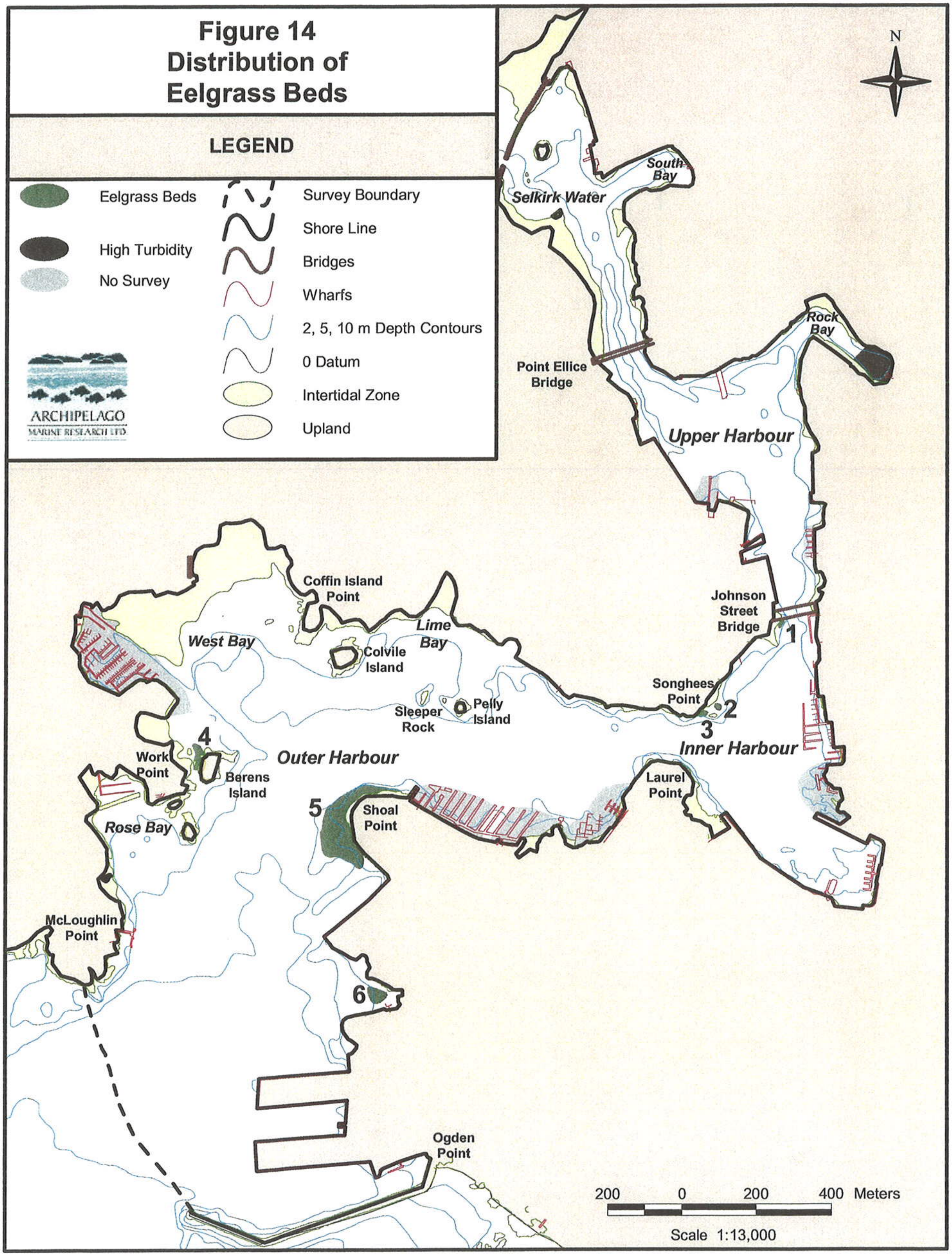


Figure 14
Distribution of Eelgrass Beds
LEGEND
Eelgrass Beds
High Turbidity
No Survey
Survey Boundary
Shore Line
Bridges
Wharfs
2, 5, 10 m Depth Contours
0 Datum
Intertidal Zone
Upland
ARCHIPELAGO
MARINE RESEARCH LTD
N
Selkirk Water
South Bay
Rock Bay
Point Ellice Bridge
Upper Harbour
Johnson Street Bridge
1
Songhees Point
2
3
Inner Harbour
Laurel Point
Coffin Island Point
West Bay
Lime Bay
Colvile Island
Sleeper Rock
Pelly Island
4
Work Point
Berens Island
Outer Harbour
5
Shoal Point
Rose Bay
McLoughlin Point
6
Ogden Point
200 0 200 400 Meters
Scale 1:13,000

Figure 15
Distribution of Filamentous Red Algae

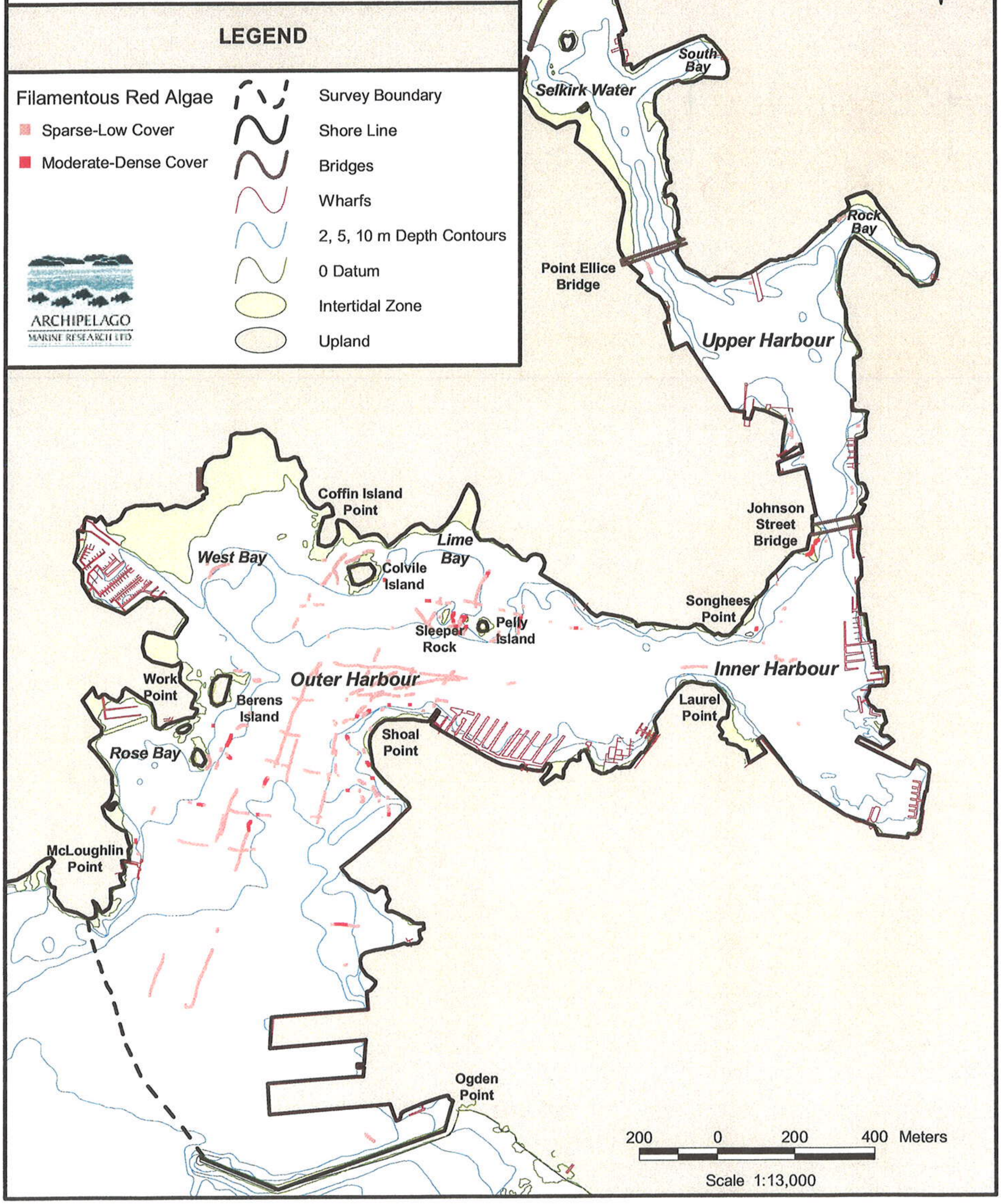
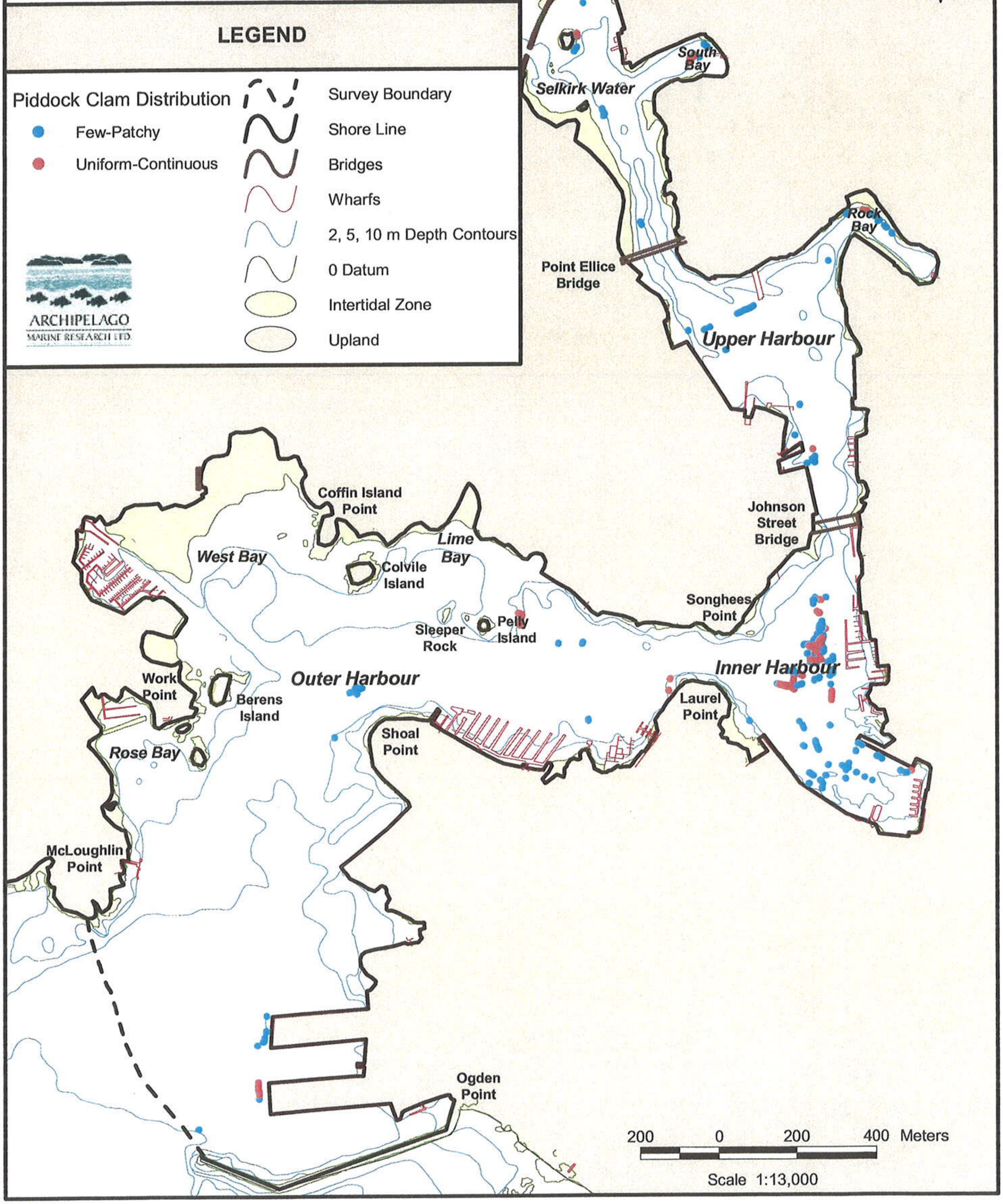


Figure 16 Distribution of Piddock Clams



APPENDIX A

SIMS CLASSIFICATION DATA DICTIONARY

The UVI database is in ACCESS97. There are three separate tables or databases included:

- **Navigation (NavData)** – includes all navigation data for the survey, including both geographic and UTM locational fixes and uncorrected depth data.
- **Geology (GeoData)** – information of seabed substrate and on seabed geomorphology.
- **Biology (BioData)**– information on epiflora and epifauna classifications.

The UVI Seabed Database is summarized in Tables A-1, A-2 and A-8. The associated data dictionary and field descriptions are outlined to provide users with a defined procedure for professionally classifying video imagery. The data are from the data logging system (date, time, latitude, longitude) or professional classifications.

A.1 Navigation Database (NavData)

A summary of the data fields contained in the navigation database is provided in Table A-1 and detailed explanation of each field follows.

INDEX

A unique identification number identifying the record and linking the navigation, geology and biology data records.

ID2

Temporary index number

DATE

The date is entered in a "month-day-year" format. The date information is provided by the DGPS data string and automatically entered into the database.

TIME(UTC)

The UTC time (GMT) in a combined "hour:minute:second" format. The UTC time is provided in the DGPS data string and automatically entered into the database.

TAPE_NO

The videotape number associated with the fix point.

Table A-1 Summary of Navigation Data Fields

Field	Description
INDEX	unique point identification number
ID2	temporary index number indicating sequence on each GPS data file
DATE	month/day/year
TIME	UTC time of frame (hr:min:sec)
TAPE_NO	videotape number
LAT_DEG	whole degree component of latitude
LAT_MIN	whole minutes component of latitude
LAT_SEC	seconds component of latitude
LAT_DIR	direction of latitude (N or S)
LON_MIN	whole degree component of longitude
LON_MIN	whole minute component of longitude
LON_SEC	seconds component of longitude
LON_DIR	direction of longitude (E or W)
ELEVATION	the altitude of the GPS antenna relative to a geode
PDOP	a 1 to 10 index of fix quality; 1=good and 10=poor
DEPTH	uncorrected water depth at the time of the fix
LAT_DDEG	latitude in decimal degrees (used in ArcView)
LONG_DDEG	longitude in decimal degrees (used in ArcView; W-values expressed as negative)
UTM_N	UTM northing position
UTM_E	UTM easting position

LAT_DEG

The latitude of the data point in whole degrees. The latitude is based on real-time DGPS data, is provided in the GPS data string and is also burned onto the video imagery.

LAT_MIN

The minutes component of the latitude in whole minutes, provided by the GPS data string.

LAT_SEC

The minutes component of the latitude provided by the GPS data string.

LAT_DIR

The hemisphere of the latitude, either north (N) or south (S).

LON_DEG

The longitude of the data point in whole degrees. The latitude is based on real-time DGPS data, is provided in the GPS data string and is also burned onto the video imagery.

LON_MIN

The minutes component of the longitude in whole minutes, provided by the GPS data string.

LON_SEC

The minutes component of the longitude provided by the GPS data string.

LON_DIR

The hemisphere of the longitude, either east (E) or west (W).

ELEVATION

The elevation of the GPS antenna relative to a selected geode. The elevation is usually negative when running in DGPS mode.

PDOP

An index of the quality of the GPS satellite fix; the index is 1 to 10 with 1 is good and 10 is poor. Fixes <6 are considered acceptable.

DEPTH

The measured depth from the sounder. This depth is NOT corrected for the tidal amplitude

LAT_DDEG

The latitude in decimal degrees; required for use in ArcView plotting.

LON_DDEG

The longitude in decimal degrees; required for use in ArcView plotting. Western hemisphere longitude is expressed as a negative number.

UTM_N

The UTM northing, computed from the DGPS geographic positional data using batch program "Convert", developed by CHS and incorporating project and GEOD considerations. Required for use in ArcView with UTM base maps (e.g., NDI/DXF charts).

UTM_E

The UTM easting, computed from the DGPS geographic positional data using batch program "Convert", developed by CHS and incorporating projection and GEOD considerations. Required for use in ArcView with UTM base maps (e.g., NDI/DXF).

IMAGE

A text field indicating if an image capture exists.

A.2 Geology Database (GeoData)

The geology database (Table A-2) provides a comprehensive summary of seabed characteristics including substrate size, percentages of coarser seabed materials and seabed morphology.

INDEX

A unique identification number identifying the record and linking the navigation, geology and biology data records.

DATE

The date is entered in a "month-day-year" format. The date information is provided by the GPS data string and automatically entered into the database.

TIME(UTC)

The UTC time (GMT) in a combined "hour:minute:second" format. The UTC time is provided in the GPS data string and automatically entered into the database.

SUBSTRATE

The general classification schema follows other provincial mapping guides in terms of substrate classes. Four general classes of substrate provide a very general index of substrate composition:

rock (R) – bedrock outcrop; may be partially covered with a veneer of sediment

veneer over bedrock (vR) – intermittently visible bedrock covered with a thin veneer of clastic sediments.

clastic (C) – seabed comprised of mineral grains of gravel, sand or mud sized material.

biogenic (B) – surface of seabed comprised of material of biogenic origin such as vegetation.

wood (W) – wood debris or bark completely covering the mineral grains.

SED_CLASS

Seabed sediment characteristics are based on visual estimates of clast sizes (Table A-3) on the seabed and percentage occurrence. Each clast category will be estimated in terms of *projected area surface cover*. The *projected area surface cover* is defined as the total projected area in a horizontal plane of each sediment category, estimated to the nearest 10%.

Table A-2 Summary of Geology Data Fields

Field	Description
INDEX	unique point identification number
DATE	month/day/year
TIME(UTC)	UTC time of frame (hr:min:sec)
SUBSTRATE	the general substrate of the seabed (rock, veneer, clastics, biogenic)
SED_CLASS	11 classes of clastic sediment
BOULDER	% pebbles on the seabed by class
COBBLE	% cobbles on the seabed by class
PEBBLE	% boulders on the seabed by class
GRAVEL	% gravel; sum of pebbles, cobbles and boulders by class
ORGANICS	% of visible wood or organic debris on the seabed by class
SHELL	% of coarse shell on the seabed by class
MORPH	primary secondary and tertiary morphologic features of the seabed
MAN_MADE	man-made objects seen on the seabed
GEOMAPPER	last name of individual responsible for the mapping interpretation
COMMENT	field for recording non-standard information

Table A-3 Sediment Categories Used in the UVI Classification

Sediment Category	Size (intermediate axis)	General Category
boulder	>25.6cm	GRAVEL
cobble	6.4 to 25.6cm	
pebble	4mm to 6.4cm	
granules	2-4mm	
sand	0.062 to 2mm	SAND
mud	<0.62mm	MUD
shell (coarse)	>2mm	ORGANICS
organic debris	n/a	
wood debris	n/a	

A description of 11 sediment classes based on a systematic application of percentage of gravel and the sand: mud ratio estimates. The classification system is summarized in Table A-4.

Table A-4 Sediment Class Code

Gravel Content	>90% Mud	Mud/Sand Mixture	>90%Sand
>80%	gravel: **G**		
30-80%	-	muddy-sandy gravel: **msG**	sandy gravel: **sG**
5-30%	-	gravelly mud/sand: **gMS**	gravelly and: **gS**
T-5%	slightly gravelly mud: **(g)M**	slightly gravelly mud/sand: **(g)MS**	slightly gravelly sand: **(g)S**
0%	mud: **M**	mud/sand: **MS**	sand: **S**

ORGANICS

An estimate of the percent of organics or wood debris covering the surface of the seabed (Table A-5).

SHELL

An estimate of the percent coarse shell (>2mm) covering the surface of the seabed (Table A-5).

BOULDER

An estimate of the percent boulders (>25.6cm) covering the surface of the seabed (Table A-5)

Table A-5 Gravel, Shell and Organic Cover Classes

Class Code	% Clast or Cover
1	none
2	T-5%
3	5-30%
4	30-50%
5	50-80%
6	>80%

COBBLE

An estimate of the percent cobbles (6.4cm to 25.6cm) covering the surface of the seabed (Table A-5).

PEBBLE

An estimate of the percent pebbles (2mm to 6.4cm) covering the surface of the seabed in one of 6 classes (Table A-5).

GRAVEL

The total estimate by class (Table A-5) of pebbles, cobbles and boulders. The percent gravel estimate should be consistent with the categories in the SED_CLASS field.

MORPH

The MORPHOLOGY field provides a qualitative indication of features on the seabed. The classification is provisional. Classes are summarized in Table A-6.

Table A-6 Morphology Classes

Class	Code	Description
Anthro-pogenic	**A**	features of man-made origin such as trawl marks, anchor drag marks, cable drag marks.
Bedforms	**B**	large scale bedform features with wave lengths greater than 30cm or with a non-repetitive pattern.
Current Rippled	**C**	asymmetric current ripples evident; ripples arbitrarily defined as less than 30cm wave length
Hummocky	**H**	hummocky seabed with pits created by macro-fauna such as starfish or crabs ("bio-cratered")
Other	**O**	seabed features that can not be classified in the above-defined categories.
Planar	**P**	no obvious bedform features.
Wave Rippled	**W**	symmetrical, oscillation ripples evident; ripples arbitrarily defined as less than 30cm wave length

MAN_MADE

A code for man-made objects that are visible on the seabed (Table A-7).

GEOMAPPER

The last name of the individual responsible for the interpretation of the GeoData fields.

COMMENT

A data field for recording information that may not be captured by the standard data fields.

Table A-7 Codes for Man-Made Objects

Code	Object
B	bottle or can
BB	aggregation of bottles or cans
C	cable/wire/rope
CN	cans
G	Garbage such as undistinguishable trash
L	log/logs
M	metal object
O	other; specific object listed in comment field
P	pipe
T	tire
WD	wood debris

A.3 Biology Database (BioData)

The biology database provides an overview of the seabed biota and is subdivided into both an *Epiflora* or vegetation section and a *Fauna* or animal section (Table A-8). The data is derived entirely from interpretation of the imagery; no measurements are made as part of the interpretation.

INDEX

A unique identification number identifying the record and linking the navigation, geology and biology data records.

DATE

The date is entered in a "month-day-year" format. The date information is provided by the GPS data string and automatically entered into the database.

TIME(UTC)

The UTC time (GMT) in a combined "hour:minute:second" format. The UTC time is provided in the GPS data string and automatically entered into the database.

DEPTH

The uncorrected depth field is the depth measured by the sounder.

VEGMAP

Temporary code for vegetation map types.

VEG1

The VEG1 field indicates the primary vegetation type. Marine plant assemblages which are categorised in coastal waters to 20m are summarised in Table A-9; all surveyed areas should be assignable to one of these categories

COV1

The coverage (Table A-10) of the VEG1 type.

VEG2

The VEG2 field indicates the secondary vegetation type (Table A-9).

COV2

The coverage (Table A-10) of the VEG2 type.

Table A-8 Summary of Biology Data Fields

Field	Description
INDEX	unique point identification number
DATE	month/day/year
TIME(UTC)	UTC time of frame (hr:min:sec)
DEPTH	water depth measured from the sound and NOT corrected for tidal amplitude
VEGMAP	code for vegetation map types
VEG1	primary vegetation assemblage on the seabed
COV1	coverage of the VEG1 vegetation (1,2,3 or 4)
VEG2	secondary vegetation assemblage on the seabed
COV2	coverage of the VEG2 vegetation (1,2,3 or 4)
VEG3	tertiary vegetation assemblage on the seabed
COV3	coverage of the VEG3 vegetation (1,2,3 or 4)
TOT_COV	total coverage of vegetation on the seabed
FAUN1	primary faunal type
DIST1	distribution of the FAUNA1 type
FAUN2	secondary faunal type
DIST2	distribution of the FAUNA2 type
FAUN3	tertiary faunal type
DIST3	distribution of the FAUNA3 type
BIOMAPPER	last name of the biology mapper
COMMENT	field for non-standard data comments

VEG3

The VEG3 field indicates the tertiary vegetation type (Table A-9)

COV3

The coverage (Table A-10) of the VEG3 type.

TOT_COV

The total coverage of vegetation on the seabed following Table A-10. This is an independent estimate and not necessarily the sum of the COV1, COV2 and COV3 fields.

Table A-10 Vegetation Coverage Codes

Code	Class	Abundance
0	None	no visible vegetation
1	Sparse	less than 5% cover
2	Low	5 to 25% cover
3	Moderate	26 to 75% cover
4	Dense	>75% cover

Table A-9 Vegetation Classification

ALGAL GROUP	SUBGROUP	CODE	DESCRIPTION
Green Algae	Foliose Greens	FOG	Primarily *Ulva*, but also include *Enteromorpha* and *Monostroma.*
	Filamentous Greens	FIG	The various filamentous green/red assemblages (*Spongomorpha/Cladophora* types).
Brown Algae	Fucus	FUC	*Fucus* and *Pelvetiopsis* species groups.
	Sargassum	SAR	*Sargassum* is the dominant and primary algal species.
	Soft Brown Kelps	BKS	Large laminarian bladed kelps, including *L. saccharina* and *groenlandica*, *Costaria costata, Cymathere triplicata.*
	Dark Brown Kelps	BKD	The LUCO chocolate brown group,. *L. setchelli, Pterygophora, Lessoniopis. Alaria* and *Egregia* may also be present. Generally more exposed than soft browns.
	Agarum	AGR	*Agarum* is the dominant species but other laminarians may also occur. Generally found deeper than the other Laminarian subgroup.
	Macrocystis	MAC	beds of canopy forming giant kelp.
	Nereocystis	NER	beds of canopy forming bull kelp.
Red Algae	Foliose Reds	FOR	A diverse species mix of foliose red algae (*Gigartina, Iridea, Rhodymenia, Constantinia*) which may be found from the lower intertidal to depths of 10m primarily on rocky substrate.
	Filamentous Reds	FIR1	A diverse species mix of filamentous red algae (including *Gastroclonium, Odonthalia, Prionitis*) which may be found from the lower intertidal to depths of 10m, often co-occuring with the foliose red group described above.
	Filamentous Reds	FIR2	A mix of red algae (primarily *Neoagardhiella* and *Gracilaria*) which grow on shallow, sub-tidal cobble and pebble in fine sand and silt bottoms.
	Coralline Reds	COR	rocky areas with growths of encrusting and foliose forms of coralline algae.
Seagrasses	Eelgrass	ZOS	eelgrass beds.
	Surfgrass	PHY	Areas of surfgrasses (*Phyllospadix*), which may co-occur with subgroup BKS or BKD above.
Unknown		UNK	vegetation present by cannot be identified.
No Vegetation		NOV	
Cannot Classify		X	Imagery is not clear, classification not possible.

FAUNA1

FAUNA1 is the primary faunal type noted on the seabed (Table A-11). The faunal classification focuses on sessile, aggregating species or species groups. They are not all epifauna - we have included tube worms, bivalves, burrowing anemones which, although strictly speaking are infauna, are important, visible elements of soft bottom communities. Species have been grouped by feeding habit as this can help to relate faunal composition to the physical environment.

This not a comprehensive faunal classification system; one maps all fauna in all areas. Blank areas do not mean no animals, simply no animal groups which fit easily in the groupings given below.

DIST1

An estimate of the *distribution* of individuals of the FAUNA1 type based on Table A-12.

FAUNA2

FAUNA2 is the secondary faunal type (Table A-11).

DIST2

An estimate of the *distribution* of individuals of the FAUNA2 type based on Table A-12.

FAUNA3

FAUNA3 is the secondary faunal type (Table A-11).

DIST3

An estimate of the *distribution* of individuals of the FAUNA3 type based on Table A-12.

BIOMAPPER

The last name of the individual providing the professional interpretation and classification of biological features visible in the imagery.

COMMENT

Field for recording non-standard information on the seabed biology.

Table A-11. Faunal Classification with Emphasis on Sessile, Aggregating Species or Species Groups

SPECIES OR SPECIES COMPLEX	CODE	DESCRIPTION
Bryozoan Complex	BRY	Bryozoans, Ascidians, sponges - generally on rock substrate.
Tunicates	TUN	Aggregations of tunicates primarily *Ciona* and colonial forms.
Anemone	ANS	Anemones aggregates - strawberry type, generally in high current areas on rock substrates.
	ANM	Aggregations of *Metridium* and other "predator" species.
	ANP	Burrowing anemone (*Pachycerianthes*) on unconsolidated substrates.
Corals	CUP	cup coral (*Balanophyllia elegans*)
	SPN	sea pens and sea whips
Tube worms	TUB	Aggregations of parchment tube dwelling polychaete worms such as *Mesochaetopterus* found in sand and silty substrates.
	TUC	Calcarious tube dwellers such as *Serpula*.
Subtidal Clams	GCL	Geoduck clams.
	HCL	Horseclams.
	PCL	Piddock Clams
	OCL	Other clam species.
Brittle Stars	BRT	Aggregations on sand and silt bottoms, may co-occur with burrowing worms.
Sand Dollars	SDD	Aggregations of sand dollars.
Sea Urchins	RSU	Red sea urchin.
	GSU	Green sea urchins.
	PSU	Purple sea urchin.
Sea Cucumber	CUC	Sea cucumber (*Cucumaria*)
In fauna "holes"	HLM	Mounded worm, clam or crustacean holes but species or species group cannot be distinguished.
	HLF	Unmounded (flat) worm or clam holes but species or species group cannot be distinguished.
Unknown	UNK	macro fauna visible but cannot be identified
No Fauna	NOF	no fauna observed

Table A-12 Faunal Distribution Classes

Code	Descriptor	Distribution
1	few	a rare (single) or a few sporadic individuals
2	patchy	a single patch, several individuals or a few patches
3	uniform	continuous uniform occurrence
4	continuous	continuous occurrence with a few gaps
5	dense	continuous dense occurrence

APPENDIX B

SUBTIDAL DIVE OBSERVATIONS

Appendix Table B1. Habitat Observations for Subtidal Dives in Victoria Harbour.

Location	Date Time	Vertical Elevation (relative to chart datum (m)	Substrate	Vegetation Scientific Name	% cover	Invertebrates Scientific Name	Common Name	Abund.*	Fish
Dive Site 1	July 7/99	-11.2	soupy mud	Beggiatoa (blue-green algae)	90%	*Nereis* sp.	neried worm	P	
Sink Hole	10:45		visibility=1 ft						
West Bay									
Dive Site 2			cobble(some angular)/pebble/boulder on	Filamentous and foliose red algae	5%	*Zirphaea pilsbryi*	Piddock clam	C	Buffalo sculpin (*Enophrys bison*)
Blasted	11:45		sand/mud with whole shell	*Laminaria saccharina*	<5%	*Cancer productus*	Red rock crab	P	Blackeye goby (*Coryphopterus nicholsi*)
Bedrock			pockets of exposed clay	*Agarum* sp.	<5%	*Cancer gracilis*	Graceful crab	P	Female kelp greening (*Hexagrammos decagrammus*)
Inner Harbour			substrate covered with fine layer of sand	*Desmerestia herbacea*	5%	*Oregonia gracilis*	Decorator crab	P	
				Encrusting coralline red algae		*Telmessus cheiragonus*	Helmet crab	P	
						Pugettia gracilis	Graceful kelp crab	P	
		top of bedrock @	bedrock			*Bugula sp.*	Spiral bryozoan	C	
		-6.4m depth				*Crassadoma gigantea*	Rock scallop	P	
						Halichondria spp.	Bread crumb sponge	P	
						Pisaster brevispinus	Short spined sea star	C	
						Pycnopodia helianthoides	Sunflower star	C	
						Parastichopus californicus	California sea cucumber	P	
						Cucumaria pallida	Pale sea cucumber	P	
						Cucumaria miniata	Orange sea cucumber	P	
						Anisodoris nobilis	Sea Lemon	P	
						Metridium	Plumose Anemone	C	
						Tubularia	Athecate hydroid	C	
						Abietinaria sp.	Sea fir (hydroid)	C	
						Sea squirt (ascidian)		P	
						Membranipora membrancea	encrusting bryozoan	P	
Dive Site 3		+0.4 to -1.2m	Sand	*Zostera marina* (eelgrass)	60-70%	*Cancer productus*	Red rock crab	P	Stickleback (*Gasterosteus aculeatus*)
Johnson St.	13:30			*Laminaria saccharina*	drift	*Cancer magister*	Dungeness crab	P	Pile Perch (*Rhacochilus vacca*)
Bridge				*Neoagardhiella* (filamentous red)	10%	*Cancer gracilis*	Graceful crab	P	
				Diatom cover		*Hermissenda crassicornis*	Aeolid nudibranch	P	
Eelgrass Bed						*Pandalus danae*	Dock shrimp	P	
						Tresus sp.	Horse clam	P	
			boulder (at north end)	*Laminaria saccharina*		*Crassadoma gigantea*	Rock scallop	P	
						Lacuna variegata	chink shell	C	
Dive Site 4	15:35	+0.0m to -0.5m	Sand with some shell	*Zostera marina* (eelgrass)	50%	*Cancer gracilis*	Graceful crab	P	
Ocean Point				*Neoagardhiella* (filamentous red)	30-40%	*Hermissenda crassicornis*	Aeolid nudibranch	P	
Resort				*Laminaria saccharina*	drift	*Lacuna variegata*	chink shell	C	Striped perch (*Embiotoca lateralis*)
Eelgrass bed									
Dive Site 5	16:00	base of rock at	Bedrock	*Sargassum muticum* (+0.0m)	30%	*Metridium*	Plumose Anemone	C	Stickleback (*Gasterosteus aculeatus*)
Tuzo Rock		-3.4m		*Laminaria saccharina* (large blades)	80-90%	*Cancer productus*	Red rock crab	P	Buffalo sculpin (*Enophyrus bison*)
				Desmerestia herbacea	10-20%	*Parastichopus californicus*	California sea cucumber	P	Tubesnouts (*Aulorhynchus flavidus*)
				Encrusting coralline red algae		*Diaulula sandiegensis*	Leopard (dorid) nudibranch	P	
							Orange sponge/bryozoan	P	
							Compound ascidian	P	
						Bugula sp.	Spiral bryozoan	C	
							Stalked Ascidian	P	
							Sea squirt	P	
						Pandalus danae	Coon striped shrimp	P	
						Membranipora membrancea	encrusting bryozoan	P	
							Chitons	P	
						Tubularia	Athecate hydroid	P	

Vertical height/depth given in metres relative to chart datum.
Invertebrates: A = Abundant, C = Common, P = Present.
Vegetation: % cover estimated for dominant vegetation.

Appendix Table B1. Habitat Observations for Subtidal Dives in Victoria Harbour.

Location	Date Time	Vertical Elevation (relative to chart datum (m)	Substrate	Vegetation Scientific Name	Vegetation % cover	Invertebrates Scientific Name	Invertebrates Common Name	Abund.*	Fish
Dive Site 6	16:45		Bedrock	*Sargassum muticum*	5%		Tubeworms (red/orange)	P	Striped perch (*Embiotoca lateralis*)
Ellice Point				*Laminaria* (top at +0.1m)	10-20%	*Myxicolla infundibulum*	Sabellid tube worms	P	Kelp greening (*Hexagrammos decagrammus*)
				Desmerestia herbacea	5%	*Pododesmus macrochisma*	Jingle shells/rock scallop	P	
Bedrock				*Filamentous red algae*	5%	*Hermissenda crassicornis*	Aeolid nudibranch	P	
						Cancer gracilis	Graceful crab	P	
						Pandalus danae	Coon striped shrimp	A	
							Encrusting purple/orange bryozoan	P	
						Metridium	Plumose Anemone	C	
Dive Site 7	July 8/99	-6.3m	sand/clay	*Neoagardhiella* (filamentous red)	10%	*Zirphaea pilsbryi*	Piddock clam	C	Female kelp greening (*Hexagrammos decagrammus*)
Coast Guard	9:25		cobble/boulder	Foliose and filamentous reds	10%	*Cancer gracilis*	Graceful crab	P	Quillback rockfish (*Sebastes maliger*)
Shoal Point			whole shell	Encrusting foliose red algae		*Cancer productus*	Red rock crab	P	Tubesnouts (*Aulorhynchus flavidus*)
channel			bottles	*Agarum* sp.	10-30%	*Cancer magister*	Dungeness crab	P	Blackeye goby (*Coryphopterus nicholsi*)
				Laminaria saccharina	<5%	*Tresus* sp.	Horse clams	C	
						Crassadoma gigantea	Rock scallop	P	
						Pandalus danae	dock shrimp	P	
							Bryozoans	C	
						Oregonia gracilis	Decorator crab	P	
						Mesochaetopterus taylori	Parchment tube worms	C	
							Yellow vase sponge	P	
						Pisaster brevispinus	Short Spined Sea Star	P	
Dive Site 8	12:45	-6.2m	sand/mud	Encrusting coralline red algae		*Cancer gracilis*	Graceful crab	C	
Johnson St			cobble/whole shell			*Tealia (Urticina)* spp.	Anemone	P	
bridge						*Metridium*	Plumose Anemone	C	
			shoal of shells include:macoma,littleneck,			*Pandalus danae*	dock shrimp	A	
cobble/shell			native oyster,horse clam, butter clam			*Mesochaetopterus taylori*	Parchment tube worms	A (patches)	
						Cancer productus	Red rock crab	P	
						Cancer magister	Dungeness crab	P	
						Diaulula sandiegensis	Leopard (dorid) nudibranch	P	
						Tresus sp. (in sand)	Horse clams	P	
						Bugula californica	Spiral bryozoan	A	
						Calliostoma	Snails	P	
						Pisaster brevispinus	Short Spined Sea Star	P	
Dive Site 9	13:40		Sand with shell	*Zostera marina* (eelgrass) with diatom	10%-80%	*Telmessus cheiragonus*	Helmet crab	P	Shiner perch (*Cymatogaster aggregata*)
Shoal Point				cover - eelgrass 1 to 1.5m tall		*Cancer magister*	Dungeness crab	P	Stickleback (*Gasterosteus aculeatus*)
				Smithora naiadum (Foliose red algae)		*Pycnopodia helianthoides*	Sunflower star	P	Kelp greenling (*Hexagrammos decagrammus*)
Eelgrass Bed				-epiphytic on eelgrass blades		*Pisaster brevispinus*	Short spinned sea star	P	Buffalo sculpin (*Enophyrus bison*)
				Neoagardhiella (filamentous red)	10%-40%	*Mesochaetopterus taylori*	Parchment tube worms	C (patches)	Tubesnouts (*Aulorhynchus flavidus*)
				Laminaria saccharina	drift		Tube worms with shell	C	Rock sole (*Lepidopsetta bilineata*)
				Ulva (foliose green algae)	10-20%		Unidentified tube worm	C	
						Pycnopodia helianthoides	Sunflower star	P	
			Bedrock outcrops	*Laminaria saccharina* (large blades)	60 - 80%	*Pododesmus macrochisma*	Jingle shell	P	
				Desmerestia herbacea	20-40%	*Tonicella sp.*	chiton	P	
				Filamentous and foliose red algae	20-30%				
				Encrusting coralline red algae		*Telmessus cheiragonus*	Helmet crab	P	

Vertical height/depth given in metres relative to chart datum.
Invertebrates: A = Abundant, C = Common, P = Present.
Vegetation: % cover estimated for dominant vegetation.

Appendix Table B1. Habitat Observations for Subtidal Dives in Victoria Harbour.

Location	Date Time	Vertical Elevation (relative to chart datum (m))	Substrate	Vegetation Scientific Name	Vegetation % cover	Invertebrates Scientific Name	Invertebrates Common Name	Abund.*	Fish
Dive Site 10	July 22/99	to -5.1m	Bedrock	*Pterygophora californica* (stalked kelp)	50-70%	*Pugettia producta*	Northern kelp crab	P	Male Kelp greenling (*Hexagrammos decagrammus*)
McLoughlin	9:25			*Agarum* sp. (deeper)	50%	*Telmessus cheiragonus*	Helmet crab	P	Quillback rockfish (*Sebastes maliger*)
Point				*Laminaria saccharina* (large blades)	70-90%	*Cancer productus*	Red rock crab	P	Striped perch (*Embiotoca lateralis*)
				Encrusting coralline red algae			Sea squirt	P	Pile Perch (*Rhacochilus vacca*)
Stalked kelp				*Plocamium* (filamentous red)	10%	*Cucumaria miniata*	Orange sea cucumber	P	
Bladed kelp				*Opuntiella californica (blade red)*	10%	*Cryptochiton stelleri*	Giant chiton	P	
				Corallina spp. (foliose coralline reds)	20-30%		bryozoans	P	
				Desmerestia intermedia	10-20%	*Tealia (Urticina)* spp.	Anemone	C	
				Desmerestia herbacea	20-30%		yellow sponge	P	
				Egregia menziesii	10%	*Pandalus danae*	Coon striped shrimp	P	
						Membranipora membrancea	encrusting bryozoan	P	
							tiny tube worms	C (patches)	
						Pycnopodia helianthoides	Sunflower star	P	
Dive Site 11	10:30	-0.4 to -2.4m	Sand	*Zostera marina* (eelgrass)	50-70%	*Hermissenda crassicornis*	Aeolid nudibranch	P	Stickleback (*Gasterosteus aculeatus*)
James Bay			Whole shell	-approx 1m tall, covered with diatoms		*Telmessus cheiragonus*	Helmet crab	C	
Anglers				*Neoagardhiella* (filamentous red)	10%	*Cancer productus*	Red rock crab	P	
				Ulva (foliose green)	10-20%	*Cancer magister*	Dungeness crab	P	
Eelgrass				*Laminaria saccharina*	10-20%	*Gonionemus vertens*	Clinging jellyfish	P	
							Tube worms with shells	P	
Dive Site 12	12:15	+0.2 to -0.1m	Sand/mud	*Zostera marina* (eelgrass)- diatom cover	50-75%	*Cancer productus*	Red rock crab	P	
Berens Island				*Ulva* (foliose green)	50%		Terebellid worm	P	
				Laminaria saccharina	20-30%	*Lacuna variegata*	chink shell	C	
Eelgrass				*Neoagardhiella* (filamentous red)	10%	*Telmessus cheiragonus*	Helmet crab	P	
Dive Site 13	12:30		Bedrock	*Ulva* (foliose green)	30%	*Tealia (Urticina) spp.*	Anemone	P	
Berens Island			Large holes in sand/shell at base of rock	*Odenthalia* (filamentous red)	10%	*Metridium*	Plumose anemone	C	
Inside to				*Polyneura latissima* (foliose red)	10%	*Pisaster ochraceus*	Ochre Star	C	
north end				*Laminaria saccharina*	40-60%	*Cucumaria miniata*	Orange sea cucumber	P	
				Desmerestia herbacea	10-20%	*Ophiopholis*	Brittle Star	P	
Bedrock				*Gigartina exasperatus* with bladelets	10-20%	*Cancer productus*	Red rock crab	P	
				Encrusting coralline red algae		*Cancer magister*	Dungeness crab	P	
				Halosaccion glandiforme	5%	*Pugettia gracilis*	Graceful kelp crab	P	
				Sargassum muticum	10%		Orange nudibranch	P	
							Bryozoans	C	
							White/orange sponge	P	
							Encrusting purple/orange sponge	P	
						Pandalus danae	Coon striped shrimp	P	

Vertical height/depth given in metres relative to chart datum.
Invertebrates: A = Abundant, C = Common, P = Present.
Vegetation: % cover estimated for dominant vegetation.

Appendix Table B1. Habitat Observations for Subtidal Dives in Victoria Harbour.

Location	Date Time	Vertical Elevation (relative to chart datum (m))	Substrate	Vegetation Scientific Name	% cover	Invertebrates Scientific Name	Common Name	Abund.*	Fish
Dive Site 14	14:15	-0.3 to -2.2m	Bedrock	*Ulva* (foliose green)	20-30%				
Berens Island			sand/shell at -2.2m depth at south end	*Halosacchion glandiforme*	5%	*Pycnopodia helianthoides*	Sunflower star	P	Striped perch (*Embiotoca lateralis*)
south end				*Gigartina exasperatus* with bladelets	30%	*Pugettia gracilis*	Graceful kelp crab	C	
	jh			Encrusting coralline red algae		*Cancer productus*	Red rock crab	P	
Bedrock				*Laminaria saccharina* (large blades)	40-70%	*Cancer magister*	Dungeness crab	P	
				Desmerestia herbacea	10-20%	*Telmessus cheiragonus*	Helmet crab	P	
				Desmerestia intermedia	5%	*Metridium*	Plumose anemone	C	
				Cryptopleura (foliose red)	5%	*Tealia (Urticina) spp.*	Anemone	P	
				Neoagardhiella (filamentous red)	5%	*Tonicella*	Chiton	P	
				Porphyra			Orange nudibranch	P	
							Small tube worms	C (patches)	
							White sponge	P	
							Bryozoans (sample)	P	
							Sea squirt	P	
						Pododesmus macrochisma	Jingle shell	P	
							Yellow bryozoan	P	
Dive Site 15	13:10	-1.0 to -3.6m	Bedrock	*Sargassum muticum*	10-20%	*Telmessus cheiragonus*	Helmet crab	P	Tubesnouts (*Aulorhynchus flavidus*)
Sleeper Rock			Large holes in sand at base of bedrock	*Odonthalia*	10-30%	*Cancer productus*	Red rock crab	P	Pile Perch (*Rhacochilus vacca*)
				Ulva (green foliose)	20-30%	*Pugettia gracilis*	Graceful kelp crab	P	
Bedrock				*Prionitis*	10-20%	*Pododesmus macrochisma*	Jingle shell	P	
				Gigartina exasperatus	20-30%		Yellow sponge	P	
				Laminaria saccharina	80-100%		tiny tube worms	A (west side of island)	
				Encrusting coralline reds			encrusting pink sponge	P	
						Hermissenda crassicornis	Aeolid nudibranch	P	
							shrimp (on sand and *Laminaria*)	C	
							Orange sponge	P	
						Tresus sp.	horse clam (in sand)	P	

Vertical height/depth given in metres relative to chart datum.
Invertebrates: A = Abundant, C = Common, P = Present.
Vegetation: % cover estimated for dominant vegetation.