Appendix 1 Stage I Environmental Impact Study

March 27, 2009

CAPITAL REGIONAL DISTRICT WASTEWATER TREATMENT PLANT DISCHARGE

Stage 1 Environmental Impact Study

Submitted to:
Associated Engineering
Suite 300 - 4940 Canada Way
Burnaby BC V5G 4M5
Attention: Mr. Rick Corbett

REPORT

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Executive Summary

Background

Golder Associates Ltd. (Golder) was retained by Associated Engineering (BC) Ltd. on behalf of the Capital Regional District (CRD) to prepare a Stage 1 Environmental Impact Study (EIS) for the effluent discharge from two proposed new waste water treatment plants (WWTP) being constructed by the CRD. One of the plants is expected to be in the Finnerty Cove area (referred to here as the Saanich East WWTP) while the other is planned for the Albert Head area (referred to here as the West Shore WWTP) near Victoria, BC. However, neither of these locations has been finalized and the exact location of the WWTP or the outfall terminus is presently unknown. The level of treatment has also not been decided; however, it will not be less than conventional secondary treatment and the assessment carried out was done under an assumption that the effluent quality would be similar to that for conventional secondary treatment.

In discussions with the CRD and the Ministry of Environment (MoE), the CRD agreed with the MoE that the EIS framework provides an appropriate approach to pre-discharge evaluation. This report represents a Stage 1 EIS with the specific scope being based on the applicable guidance document and as modified in (similar to pre-application) discussions with the MoE.

Approach

The approach to assessing the impact of the proposed secondary effluent involved computer simulation modeling of the dilution that would result from discharging the proposed effluent into the ocean from an effluent diffuser located at Finnerty Cove and one located near Albert Head. A number of effluent flow scenarios based on a series of conservative assumptions were modeled by Dr. Donald Hodgins. As the proposed effluent does not yet exist, the anticipated effluent quality was derived by Associated Engineering based on the composition of the Macaulay Point effluent, adjusted on the basis of literature-derived relative removal efficiencies for a conventional secondary treatment WWTP. The concentration in the ocean of treated effluent constituents were calculated based on the effluent concentration, the amount of dilution that is reached at the edge of the initial dilution zone (IDZ) and the background concentration of that constituent in the ocean water. The IDZ is the three-dimensional zone around the point of discharge where mixing of the effluent and the receiving water occurs. For a large waterbody such as would apply with the proposed outfall locations, the IDZ is commonly defined as a cylindrical body of water around the outfall with a lateral radius of 100 m from the outfall and extending upwards to the surface of the water column.

At a Stage 1 EIS level, existing data are used in the evaluation; in a Stage 2 EIS, pre-discharge baseline environmental quality and oceanographic data are collected to provide a detailed level of receiving environment characterization and a refined impact assessment based on that characterization. A search for existing ocean chemistry data in the areas of Finnerty Cove and Albert Head was carried out by Golder as part of this Stage 1 EIS. There were few data available in the immediate area of estimated outfall locations and the search was expanded to a broader geographical area. The data set was limited though reasonable for the purpose of a Stage 1 EIS and the present level of detail in facility planning. The baseline data are not adequate for a Stage 2 EIS level of detail and a baseline characterization program is necessary.

The assessment of impact from the discharge was based on characterizing uses in the receiving environment by ecological resources and by recreational users and identifying if these uses would be impaired as a result of the effluent. The identification of such uses was broad; the specific location of the outfalls is presently unknown and detailed studies of habitat use at those locations will need to be carried out as part of permitting stages. Areas of receiving environment use identified by the report include:

- First Nations uses;
- Fisheries and aquaculture;
- Parks;
- Recreational activities; and,
- Ecological uses, including protected areas, marine plants, birds, mammals, fish, invertebrates and the potential presence of rare or endangered species.

The background information compiled in the report provides a suitable characterization from which to base discussions of potential impact in the context of a Stage 1 EIS; however, specific and more narrowly focused studies (*e.g.,* biophysical surveys) will be needed to confirm the suitability of final outfall locations.

Predicted concentrations of effluent constituents were obtained from the plume dilution modeling and compared to WQG. WQG represent a conservative environmental quality benchmark with built-in safety factors and therefore represent a concentration at which a designated use (*e.g.,* use by marine aquatic life) will not be adversely affected. Screening Quotients (SQ) were calculated by dividing the model-predicted water concentration at the edge of the IDZ by the WQG. A SQ < 1 would mean that the concentration is less than the WQG; conversely, a SQ > 1 would indicate the factor by which the parameter concentration exceeds the WQG. Where a SQ is < 1, harmful impacts are not predicted.

Impact Assessment

The predicted dilution of the plume at the IDZ for dry and wet weather periods are predicted to be >100:1 at the edge of the IDZ for all seasonal flow conditions modeled. At the West Shore WWTP, plume dilution ratios at the IDZ ranged from 1,570:1 during summer low flow to 660:1 under the winter high flow conditions. At the Saanich East WWTP, predicted dilution ratios ranged from 3,100:1 during summer low flow to 820:1 during the winter high flows. The plumes are also predicted to be trapped (*i.e.,* they are physically constrained from surfacing by water density barriers) at depths of about 30 m in most of the cases modeled.

For the Saanich East WWTP, the running 5-d mean concentration of fecal coliforms was < 200 CFU/100 mL (the WQG for primary contact such as swimming). For the West Shore WWTP, the 5-day running mean coliform concentrations were predicted to exceed 200 CFU/100 mL twice during a high-flow event lasting > 48 h (the maximum calculated means were in the order of 228 CFU/100 mL). However, these coliform level predictions are based on conservative assumptions that were used at the Stage 1 level and are subject to uncertainty. The effect of uncertainty in this case is such that the assumptions used would overpredict coliform levels.

The concentrations of other substances at the edge of the IDZ were calculated on the basis of the plume dilution, the concentration of the substance in the effluent and the background concentration as follows:

$$Concentration_{IDZ} = \left(\frac{Concentration_{Effluent}}{Dilution_{IDZ}}\right) + Concentration_{Background}$$

Where:

- $Concentration_{IDZ}$ = The predicted concentration of the parameter at the edge of the IDZ
- $Concentration_{Effluent}$ = The predicted concentration of the parameter in the effluent
- $Dilution_{IDZ}$ = The predicted dilution of the plume at the edge of the IDZ
- $Concentration_{Background}$ = The assumed concentration of the parameter in the receiving environment.

The results for all parameters modeled are provided in detail in the report. However, SQ values were less than one (*i.e.*, concentrations were predicted to be below WQG) for all parameters except for fecal coliforms (discussed above) and benzo(a)pyrene for which background data were above the WQG. However, the increase in benzo(a)pyrene concentration as a result of the effluent was small, being less than the limits of analytical precision. This was also the case for those substances for which WQG were not available.

Uncertainty Assessment

At present the effluents are conceptual and there is no discharge from which to collect direct measurements. The assessment of impacts is necessarily a predictive exercise and there is uncertainty associated with such efforts. Although EIS guidance does not require an uncertainty assessment, it is appropriate for the impact assessor to acknowledge where uncertainty exists and to evaluate the extent to which that uncertainty influences impact predictions. The main areas of uncertainty in this assessment are:

1) Expected environmental concentrations, which are influenced by:

   a) The plume dilution model and expected flows;

   b) Background concentrations; and,

   c) Effluent concentrations.

2) Identification of species assemblage, habitat use, and ecological interactions; and,

3) Interactions of a contaminant mixture.

A summary of the influence of these uncertainties on impact predictions are summarized in Table ES1.

Table ES1: Evaluation of Uncertainty

Assumption	Uncertainty	Under/over Estimate of Impact	Rationale
Plume dilution is as predicted by the model	Low	Neutral	The plume dilution predictions are based on a model that is recommended by MoE and carried out by an experienced modeller. The oceanographic inputs to the model were based on calibrated models for the area and background conditions were based on data sets used for near-by areas. The model predicts a high level of dilution, even if reasonable uncertainty is factored in.
Background concentrations are as identified in the existing data set	Moderate	Neutral	The background concentrations selected were from the local area and/or were within those published for general marine conditions. A sensitivity analysis indicated that increasing background concentrations in the model to ambient WQG resulted in predicted concentrations at the edge of the IDZ that would be indistinguishable from the surrounding receiving environment outside the IDZ. It should be noted that in reality, not all parameters would be expected to be at the WQG concentration. In reality, most should be well below the WQG and some may be naturally above the WQG.
Effluent flow estimated represents the flows under operation	Moderate	Neutral	The plume dilution model incorporated an assessment of different flows by season, which varied up to an order of magnitude. While dilution was predicted to also vary an order of magnitude between summer low flows and winter peak wet weather flows, dilution in all the scenarios modeled was high (i.e., >100:1) and exceedances of WQG at the edge of the IDZ were not predicted in any case. The exceedance of the WQG for benzo(a)pyrene was the result of the background concentrations (which are subject to uncertainty as noted in the report) being higher than the WQG. Fecal coliforms may also exceed WQG under certain, limited circumstances that will be re-evaluated in the Stage 2 assessment.
Effluent concentrations under operation will be similar to those predicted using existing data and relative removal estimates	Low	Neutral	The assessment was based on effluent concentrations measured at the Macaulay WWTP in 2005 and 2006 with literature-based relative removal estimates for conventional secondary treatment. It is anticipated that the eventual treatment process will achieve a secondary level of treatment or better.
Nutrient loadings will be as calculated	Moderate	Over	The calculation of nutrient loadings was based on highly conservative assumptions of flow rates and durations during wet weather flows and therefore likely overestimates what the loadings will be by a factor of two.
Identification of habitat and use is as described	Moderate	Neutral	The selection of sites for the treatment plants and associated infrastructure has not been completed. Prior to completion of the Stage 2 assessment, detailed site-specific receiving environment use studies will need to be conducted. Information from these studies will be used to guide the eventual siting of the physical outfall structure.
Interaction of contaminant mixtures will not result in effects greater than estimated through the use of WQG.	Low	Neutral	While substances of concern were assessed individually, the expected dilution ratios will be high. Screening quotients were low and multiple criteria exceedances were not predicted, indicating a low likelihood for contaminant interactions by virtue of low concentrations. Biological testing will be carried out on the (undiluted) effluent to determine potential for adverse interactions.

CONCLUSIONS AND RECOMMENDATIONS

The predicted concentrations of select parameters in municipal sewage treated to conventional secondary levels were modeled for the Saanich East WWTP (discharge to Finnerty Cove area) and the West Shore WWTP (discharge to Albert Head area) on the basis of existing information for several effluent flow scenarios to predict concentration in the receiving environment. The specific locations of the treatment plants and the outfall pipes are assumed at the present time, the WWTP and the outfall locations have not been finalized.

The predicted concentrations were compared to applicable WQGs and modeled parameter concentrations were less than the applicable WQG in all cases except for benzo(a)pyrene and fecal coliforms. The exceedance of the WQG for benzo(a)pyrene was the result of the background concentrations being higher than the WQG. The prediction of fecal coliform concentrations at the IDZ was based on a series of conservative assumptions and therefore is likely to overestimate of fecal coliform concentrations. This conservative assessment indicated that fecal coliforms may exceed WQG for recreational contact under certain limited circumstances (*e.g.*, during a winter high flow event that lasted > 48 h). Under such conditions and the predicted plume trapping it is unlikely that there will be substantial recreational contact with the plume; however, the predictions here are subject to uncertainty (*i.e.*, they may overestimate the potential for exceeding WQG). Therefore, based on this Stage 1 EIS, it would be premature to conclude that effluent disinfection is needed. Further assessments of the need for disinfection will be made as part of the Stage 2 EIS and as site selection and treatment processes are decided upon.

Overall, the Stage 1 assessment, which was based on conservative assumptions, did not predict that the proposed treated effluent discharge will result in harm to the receiving environment. Indeed, conventional secondary treatment removes a significant proportion of substances of concern such as nitrogen, phosphorus, TSS, BOD, and selected metals and organic compounds.

Table ES2 summarizes a series of recommendations intended to address the uncertainties identified in the Stage 1 assessment, as well as data requests made by MoE during pre-EIS consultation, MoE guidance for conducting Stage 2 EIS's and other government guidance received during the collection of receiving environment information. The detailed scope of work for the recommended site-specific studies will require consultation with MoE and will benefit from an increased level of detail regarding potential outfall locations and oceanographic conditions.

Table ES2: Summary of Recommendations for Stage 2 EIS

Uncertainty	Recommendation	Rationale
Plume dilution model	• Collect site-specific baseline oceanographic information (*e.g.*, current/flow studies, conductivity/temperature/depth [CTD] measurements) for inclusion in a refinement of the plume dilution model. A pre-requisite to these studies is the selection of the physical outfall location. • Conduct sedimentation analysis.	• Identified as an uncertainty • MoE guidance
Effluent flow	• Incorporate updated flow rates into plume dilution model once WWTP design finalized. • Model additional scenarios including daily peaks and seasonal fluctuations in flows.	• Identified as an uncertainty • MoE guidance
Background concentrations	• Conduct site-specific water quality monitoring program following MoE guidance. • Conduct site-specific sediment quality monitoring program. • Include assessment of *Entercocci* as an additional microbiological indicator.	• Identified as an uncertainty • MoE guidance Anticipated future microbiological indicator
Effluent concentrations	• Incorporate updated effluent concentrations into plume dilution model once WWTP design/specifications are finalized. • Develop contingency plan and design WWTPs for possible future disinfection in the event that microbial indicators are found to exceed WQG. • Conduct a more detailed assessment of potential for impacts from nutrient loading once baseline water quality studies have been conducted and the WWTP design/specifications are finalized.	• Identified as an uncertainty • MoE guidance
Identification of habitat and use	• Conduct site-specific habitat and use studies to assist in locating the physical outfall structures. • Conduct abalone assessment per DFO protocol.	• Identified as an uncertainty • Existing information indicates potential presence of important habitat features • MoE guidance • DFO guidance
Interaction of contaminant mixtures	• Conduct toxicity testing	• Identified as an uncertainty • Anticipated effluent monitoring requirement in the future

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LIST OF ACRONYMS

ADWF	Average dry weather flow
BOD	Biochemical oxygen demand
CCME	Canadian Council of Ministers of the Environment
CDC	Conservation Data Centre
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CRD	Capital Regional District
CRIS	Coastal Resources Information System
CTD	Conductivity, temperature, depth
DFO	Fisheries and Oceans Canada
EDC	Endocrine disrupting compound
EIS	Environmental impact study
FN	Fishery Notice
IDZ	Initial dilution zone
ILMB	Integrated Land Management Bureau
IOS	Institute of Ocean Sciences
LWMP	Liquid Waste Management Plan
MAL	Ministry of Agriculture and Lands
MoE	Ministry of Environment
MSR	Municipal Sewage Regulation
NA	Not available
NR	None recommended
PBT	Persistent, bioaccumulative toxic
PPCP	Pharmaceutical and personal care product
PSAMP	Puget Sound Ambient Monitoring Program
PWWF	Peak wet weather flow
RPD	Relative percent difference
RRE	Relative removal efficiency
SARA	*Species at Risk Act*
SCUBA	Self-contained underwater breathing apparatus
SPTP	Saanich Peninsula Treatment Plant
SQ	Screening quotient
TAN	Total ammonia nitrogen
TIE	Toxicity identification evaluation
TSS	Total suspended solid
UCLM	Upper confidence limit of the mean
USEPA	United States Environmental Protection Agency
VEC	Valued ecosystem component
VIHA	Vancouver Island Health Authority
WQC	Water quality criteria
WQG	Water quality guideline
WQS	Water quality standard
WWTP	Waste water treatment plant

LIST OF UNITS

°	Degrees
°C	Degrees Celsius
CFU/100 mL	Colony forming units per 100 mL
cm	Centimetre
h	Hour
kg/yr	Kilogram per year
m	Metre
m^3/s	Cubic metre per second
mg/L	Milligrams per litre
µg/L	Microgram per litre
mL	Millilitre
µM	Micromolar
ppm	Parts per million
ppt	Parts per thousand
s	Second

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was retained by Associated Engineering (BC) Ltd. (Associated) on behalf of the Capital Regional District (CRD) to prepare a Stage 1 Environmental Impact Study (EIS) for the effluent discharge from two proposed new waste water treatment plants (WWTP) being constructed by the CRD near Victoria, BC (Figure 1). One of the plants is expected to be in the Finnerty Cove area (the "Saanich East" WWTP; Figure 2) while the other is planned for the Albert Head (the "West Shore" WWTP; Figure 3). However, neither of these locations has been finalized and the exact locations of the outfalls are presently unknown. For the purpose of this assessment, conventional secondary effluent treatment has been assumed. While the level of treatment has not been decided, it will not be less than conventional secondary treatment and an assessment carried out under this assumption will therefore represent a conservative evaluation.

In discussions with the CRD and the Ministry of Environment, the CRD agreed with the MoE that the EIS framework provides an appropriate approach to pre-discharge evaluation. This report represents a Stage 1 EIS with the specific scope being based on the applicable guidance document and as modified in (similar to pre-application) discussions with the MoE.

1.1 Objectives of the Stage 1 EIS

The terms of reference for this study were to provide an assessment of potential impacts of the effluent discharge from the treatment facilities to the marine environment in the vicinity of Finnerty Cove and Albert Head. A Stage I EIS is prepared as a preliminary evaluation at the planning stage to check on the acceptability of a proposed treated sewage discharge before detailed studies and designs are undertaken and to assist in focusing those detailed investigations. At a Stage 1 EIS level, existing data are used in the evaluation; in a Stage 2 EIS, pre-discharge environmental quality and oceanographic data are collected to provide a detailed level of receiving environment characterization. Guidance for conducting a Stage 1 EIS (BCMoE 2000) suggests the following tasks, which were undertaken subject to the extent to which the treatment systems have been developed as well as consultation with MoE (Section 1.2)[1]:

- Identify the effluent characteristics, including flows and quality, as well as the outfall characteristics, including depth (Sections 4.2 and 4.3);
- Inventory receiving water uses and environmental resources and select appropriate water quality guidelines (WQG) to protect these uses (Section 2.0);
- Determine the initial dilution of the effluent plume (*e.g.*, via modeling) and estimate the concentration of parameters of concern at the edge of the initial dilution zone (IDZ; for a discharge of the size of CRD's proposed WWTP this includes parameters listed in Schedule 3 of the MSR as well as metals and "other parameters of concern") (Section 4.0). The IDZ is the three-dimensional zone around the point of discharge where mixing of the effluent and the receiving water occurs. For a large waterbody such as would apply with the proposed outfall locations, the IDZ is commonly defined as a cylindrical body of water around the outfall with a lateral radius of 100 m from the outfall and extending upwards to the surface of the water column;

1 The treatment plant sites have not yet been finalized; therefore, an assessment of terrestrial impacts, including an archaeological overview assessment, were not included in this report. Westland Resource Group has been retained to conduct these studies.

- Evaluate the potential for harmful effects to the receiving environment on the basis of comparisons to applicable WQG[2] (Section 4.0);
- Make recommendations for additional studies such as pre-discharge environmental monitoring and for planning the level of treatment and outfall locations (based on consultation with MoE – Section 1.2 – the pre-discharge monitoring program will be documented separately); and,
- Make recommendations for the scope of the Stage 2 EIS (Section 6.0).

1.2 Consultation with Ministry of Environment

Golder prepared a proposed scope of work for the Stage 1 EIS (dated April 1, 2008) based on Section 5.2.1 of MoE (2000) guidance for preparing EIS documents, as well as preliminary input provided by MoE technical specialists[3]. The work plan highlighted a number of points to be confirmed by MoE so that the final report would meet their expectations and was submitted to MoE on April 3, 2008. MoE provided comments on the proposed scope of works, and the following scope of work for the EIS was agreed to[4]:

- Use of conservative assumptions, including an assessment based on assumed secondary treatment without disinfection;
- The evaluation of effluent parameters should include conventional parameters (*i.e.*, those included in Schedule 3 of the MSR), as well as other substances for which environmental quality benchmarks are available, based on the following hierarchy:
  - Approved BC marine water quality guidelines (WQG);
  - Working BC marine WQG;
  - Canadian Council of Ministers of the Environment (CCME) marine WQG;
  - Washington State marine water quality standards (WQS); and,
  - US Environmental Protection Agency (USEPA) national recommended marine water quality criteria (WQC).
- Evaluation of seasonal variability in the concentrations of parameters of concern.
- Use of fecal coliforms as the main microbiological indicator.
- Use of existing water quality data from outside the immediate area of the proposed outfalls to characterize background conditions for the Stage 1 assessment, with an understanding that pre-discharge monitoring will be included as part of the Stage 2 assessment.

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2 As noted in Section 4.1, the expectations of the Municipal Sewage Regulation and other applicable environmental legislation (*e.g.*, *Environmental Management Act*, *Fisheries Act*) extend beyond the comparisons to WQG recommended in MoE (2000). Therefore, additional assessments will be conducted as appropriate.

3 E-mail from J. Deniseger (MoE) to L. Taylor (CRD) dated March 3, 2008.

4 Letter from J. Deniseger (MoE) to C. Lowe (CRD) dated June 19, 2008.

- Existing sediment chemistry data will be assessed as part of Stage 1 only if such data are available from the immediate area[5].
- Characterization of receiving environment uses on the basis of existing information such as may be available from applicable federal and provincial resource agencies and other appropriate sources.
- Assessment of potential impacts on the basis of comparison of predicted effluent concentrations at the edge of the IDZ to established BC WQGs (or others as necessary) to provide a conservative assessment.
- Deferral of a sedimentation analysis to the Stage 2 assessment.
- The Stage 1 assessment will identify areas of uncertainty and potential data gaps that can be used in the design of baseline studies for the Stage 2 assessment.

The consultation noted here was of a technical, regulatory nature and was therefore narrow in its focus. However, CRD has been engaged in consultation with First Nations and CRD citizens on broader issues relating to upgrades in sewage treatment infrastructure.

5 Use of data from outside the immediate zone of expected influence as surrogates was not considered suitable for assessing potential impacts to sediment.

2.0 RECEIVING ENVIRONMENT

The final location of the marine discharges will be determined as part of a detailed permitting process and on the basis of detailed engineering, planning, and other necessary studies. For the purposes of the present Stage 1 EIS the general locations of the outfalls are expected to be adjacent to Finnerty Cove (approximately as shown in Figure 2) and in the vicinity of Albert Head (approximately as shown in Figure 3). This section provides a summary of available information used for the purposes of the Stage 1 impact assessment. Details regarding site-specific physical oceanography, habitat presence and use, and water quality will be collected for inclusion in the Stage 2 impact assessment and/or the permitting phase. The scope of site-specific data collection will be informed in part by the findings of this Stage 1 assessment.

2.1 Water Quality

A search of existing marine water chemistry data was conducted to enable the preliminary characterization of the receiving environment to provide a baseline for which the Stage 1 impact assessment could be conducted. The search and review of existing water chemistry data applicable to the areas of Albert Head and Finnerty Cove included accessing the following potential sources:

- Government agency websites;
- CRD data summaries and archived reports;
- Environment Canada and Fisheries and Oceans Canada (including the Institute of Ocean Sciences) - Search of relevant data produced from their ongoing regulatory and scientific research programs;
- Ministry of Environment - Search of environmental quality data from various initiatives.
- Vancouver Island Health Authority (VIHA) - Search for data on receiving environment quality, particularly for microbiological indicators and human use patterns.
- Local universities - for pertinent information on studies in the general area of either of the proposed outfall locations; and,
- Available scientific literature and selected reference databases as well as a general search of the internet.

An initial literature and internet search produced a number of information sources that were reviewed for potential marine water quality data sources. Primary sources of information for marine waters of interest were obtained via communications with key contacts and were retained and reviewed in detail for relevant water chemistry data. A list of key contacts is presented in Table 1. A summary of the data compiled is presented in Appendix I. List of Agencies Contacted for Water Quality Information

Table 1: List of Agencies Contacted for Water Quality Information

Contact	Title	Agency	Date Contacted	Result
Deanna Lee	Program Scientist	Environment Canada – Vancouver	22 May 2008	No data available
Margaret Wright	Water Quality Biologist	Fisheries and Oceans - Nanaimo	23 May 2008	No data available
Donald Hodgins	President	Seaconsult Marine Research Ltd.	23 May 2008	CTD (conductivity, temperature, depth) data available through CRD

Contact	Title	Agency	Date Contacted	Result
Robin Brown	Manager, Ocean Sciences	Institute of Ocean Sciences	23 May 2008	No data available
Dario Stucchi	Physical Oceanographer	Institute of Ocean Sciences	23 May 2008	No data available
John Deniseger	*Section Head, Environmental Quality*	Ministry of Environment - Nanaimo	29 May 2008	No data available
Terry Curran		Institute of Ocean Sciences	30 May 2008	No data available
Gary Gibson		Vancouver Island Health Authority	10 June 2008	No data available
Terry Sowden	*Data Manager*	Institute of Ocean Sciences	11 July 2008	Sediment and biota information only
Peter Chandler	*Physical Oceanographer*	Institute of Ocean Sciences	11 July 2008	Access to data contained in Water Profile Data Inventory
Chris Lowe	*Marine Programs Supervisor*	Capital Regional District	18 July 2008	Access to data from CRD outfall monitoring programs and CTD data.

The search strategy was refined by using a combination of search terms such as area/location names and key words (marine water chemistry). A number of potential information sources were identified; however, upon review it was determined that most of the marine water chemistry data were outside the areas of interest.

Background water quality characteristics in the areas of the proposed outfalls were estimated based on information compiled from the following sources:

The Department of Fisheries and Oceans (DFO) Institute of Ocean Sciences (IOS) water profile data inventory - The IOS data archive contains ocean data collected by a variety of government agencies from present and historical sampling events in BC coastal waters and inlets. The data search of the archive was refined to the area of interest defined by the following coordinates: Latitude - (N) 48°36.0' - (S) 48°17.0' and Longitude - (W) 123°32.0' - (E) 123°05.6'. Data collected from coastal waters within this boundary were considered to be applicable, at the level of a Stage 1 report, to the receiving environment in the area of the proposed outfalls. Parameters available from the data archive included salinity, ammonium, nitrate, nitrite, dissolved oxygen, temperature, phosphate, and silicate.

CRD's pre- and post-monitoring programs and ongoing monitoring program for Saanich Peninsula treatment plant - CRD has conducted numerous environmental monitoring programs in relation to existing waste water discharges in coastal waters off Vancouver Island (Clover Point, Macaulay Point, and Saanich Peninsula). Historical data from the CRD monitoring programs collected in the area of the proposed outfalls was compiled and reviewed. This data set was further refined by the removal of data that was collected in close proximity to the existing outfalls due to the potential for influence on water chemistry from the existing effluent discharge, because the objective was to characterize background conditions. General parameters compiled for the characterization of the receiving environment included temperature, depth, salinity, ammonia, nitrate, nitrite, phosphate and coliforms.

Monitoring programs in the Lower Mainland of British Columbia and in Washington State - The above data sources did not include parameters such as metals and organics. Therefore, the search for water quality data was later broadened to include historic monitoring by MoE in the Strait of Georgia[6] as well as contemporary monitoring in Puget Sound in Washington State. Additional data (nutrients) were available from the Puget Sound Ambient Monitoring Program (PSAMP; WDOE 2008), Puget Sound Research Conference proceedings (metals; Crecelius and Cullinan 1998), and a marine water quality monitoring program conducted by King County (metals and organics; King County 2001).

Data compiled from the above sources provides an estimate of the ambient water quality in the area of the proposed outfall locations in the context of this preliminary assessment (Table 2) although it was necessary to look farther afield for some parameters.

Table 2: Summary of Background Values (and Their Sources) Selected for Use in the Impact Assessment

Parameter	Units	Background Concentration	Data Source
MSR Schedule 3 Parameters			
Total ammonia nitrogen	mg/L	0.024	CRD SPTP Monitoring Program Data 2002 - 2007
Total phosphorus	mg/L	0.075	CRD SPTP Monitoring Program Data 2002 - 2007
BOD	mg/L	1	No data available, value assumed.
TSS	mg/L	4	MoE Strait of Georgia Monitoring (1977-1980)
Other Nutrients			
Nitrate nitrogen	mg/L	0.194	CRD SPTP Monitoring Program Data 2002 - 2007
Total Kjeldahl nitrogen	mg/L	0.132	CRD SPTP Monitoring Program Data 2002 - 2007
Total Metals			
Arsenic	µg/L	0.475	Crecelius and Cullinan (1998); Cherry Point
Barium	µg/L	NA	No data available.
Cadmium	µg/L	0.046	Crecelius and Cullinan (1998); Cherry Point station
Chromium (not speciated)	µg/L	0.1435	Crecelius and Cullinan (1998); Cherry Point station
Chromium VI	µg/L	NA	No data for speciated chromium.
Copper	µg/L	0.62	Crecelius and Cullinan (1998); Cherry Point station
Iron	µg/L	60	MoE Strait of Georgia Monitoring (1977-1980)
Lead	µg/L	0.01537	Crecelius and Cullinan (1998); Cherry Point station
Manganese	µg/L	3	MoE Strait of Georgia Monitoring (1977-1980)
Mercury	µg/L	0.000491	Crecelius and Cullinan (1998); Cherry Point station
Nickel	µg/L	0.41	Crecelius and Cullinan (1998); Cherry Point station
Selenium	µg/L	0.00178	Crecelius and Cullinan (1998); Cherry Point station

6 MoE has made available scanned copies of data outputs from water sampling conducted in the 1970s in the Strait of Georgia at http://www.env.gov.bc.ca/epd/regions/lower_mainland/water_quality/wq_data/georgia_str/index.htm. While a broad range of parameters were analyzed for several sampling events, other more recent data sources were used where available as analytical methods have changed.

Parameter	Units	Background Concentration	Data Source
Silver	µg/L	0.01	Crecelius and Cullinan (1998); Cherry Point station
Zinc	µg/L	1.13	Crecelius and Cullinan (1998); Cherry Point station
Organic Constituents			
Benzo(a)pyrene	µg/L	0.017	King County (2001), offshore waters
Fluorene	µg/L	0.0067	King County (2001), nearshore waters
Phenanthrene	µg/L	0.0055	King County (2001), offshore waters
Pyrene	µg/L	0.0053	King County (2001), offshore waters
Ethylbenzene	µg/L	NA	No data available.
Toluene	µg/L	NA	No data available.
Butylbenzyl phthalate	µg/L	0.048	King County (2001), offshore waters
DDT (2,4)	µg/L	NA	No data available.

Notes: BOD – Biological oxygen demand; TSS – Total suspended solids; CRD – Capital Regional District; SPTP – Saanich Peninsula Treatment Plant; MoE – Ministry of Environment; NA – No data available

The nature (locations, sampling frequency, and age) of available water chemistry data is a source of uncertainty and, in our opinion is not adequate for a more detailed assessment such as would occur in a Stage 2 EIS or as a baseline characterization. However, the values used in the present assessment for select metals are within the range of values for seawater as noted below:

- Background concentrations of total arsenic in the ocean are typically in the order of < 10 µg/L (Eisler 1988).
- Typical background concentrations of cadmium in coastal seawaters are around 0.05 µg/L (Eisler 1985).
- Total copper concentrations in ocean water range from 0.06 to 6.7 µg/L, while contaminated estuaries have concentrations ranging from 3 to 176 µg/L (Eisler 1998).
- Ambient lead concentrations in seawater are ~0.005 µg/L (ATSDR 1999).
- Mercury concentrations in the open ocean are < 0.01 µg/L, while in coastal seawaters they are < 0.02 µg/L (Eisler 1987).

During the Stage 2 assessment, site-specific water chemistry will be collected to provide a reliable characterization of baseline conditions for detailed impact predictions and, subsequently, as a characterization of baseline conditions from which future data comparisons can be made.

2.2 Receiving Environment Uses

A desktop review of available resources was conducted to determine the types of ecological and human uses of the marine environment in the general vicinity of the two proposed outfall locations and the surrounding areas.

Rare and endangered species were identified, as well as Valued Ecosystem Components (VECs)[7]. Sources of information included online databases, websites, publications, DFO personnel, marine mammal specialists, and Parks Canada. A record of resource reviews and correspondence is provided in Appendix II. Maps obtained from these sources, with the exception of those from Parks Canada which were draft maps, are available in Appendix III.

The receiving environment uses as identified here are for a general area very broadly situated around the proposed outfall locations. It is important to appreciate that the following overview is intended to be inclusive and is based on broad database searches. However, the uses noted are not based on data from actual surveys. It is also important to note that where there is reference to potential or confirmed organism presence in the "area of the outfall", it does not mean that their habitat is centralized near the proposed outfall locations.

At such time as outfall locations are being finalized it is anticipated that a detailed evaluation of marine habitat in each outfall location and their interaction with the physical structure and the effluent will be required to enable permitting.

2.2.1 First Nations

Information regarding the traditional use of marine resources, and other cultural uses, by the Songhees (Table 3) and Beecher Bay (Table 4) First Nations in the area of the proposed WWTPs to be constructed by the CRD was collected by Westland Resource Group Inc. (Westland) for the purposes of an assessment of potential terrestrial impacts related to infrastructure upgrades. The specific information on First Nation resource use collected by Westland is confidential at this time; therefore, Westland (2008) provided Golder with a summary of general information for use in this EIS[8].

In addition to traditional harvest of marine resources, there are also unidentified cultural uses associated with Albert Head (south and east shores), Oak Bay and Cadboro Bay. Traditional transportation routes used by the Songhees First Nation are along the south shore of Vancouver Island, from Albert Head to Gordon Head. Traditional transportation routes used by the Beecher Bay First Nation are along the south shore of Vancouver Island, from Albert Head to Cadboro Bay.

Table 3: Songhees First Nation Traditional Uses

Geographic Area	Resource Use
Albert Head (south shore)	Saltwater fish species harvest
Albert Head (east shore)	Anadromous fish species harvest
Albert Head Lagoon	Shellfish harvest
Esquimalt Lagoon	Shellfish harvest
Macaulay Point	Shellfish harvest, anadromous fish species harvest
Clover Point	Saltwater fish species harvest
Oak Bay	No information
Cadboro Bay	No information
Finnerty Cove	Anadromous fish species harvest

7 VECs are ecosystem components that are generally considered important during the Environment Assessment process such as may be required under the *Canadian Environmental Assessment Act*, in the event that a federal trigger (*e.g.*, a *Fisheries Act* Authorization or permit under the *Navigable Waters Protection Act*) exists.

8 Pers. comm., e-mail from D. Harper of Westland to L. Nikl of Golder, dated July 8, 2008.

Table 4: Beecher Bay First Nation Traditional Uses

Geographic Area	Resource Use
Albert Head (south shore)	Anadromous fish species harvest
Albert Head (east shore)	Shellfish harvest
Albert Head (north shore)	Shellfish harvest
Esquimalt Lagoon	Shellfish harvest
Macaulay Point	No information
Clover Point	Shellfish harvest
Oak Bay	Saltwater fish species harvest
Cadboro Bay	No information
Finnerty Cove	No information

2.2.2 Fisheries and Aquaculture

Management of the fisheries industry in BC is divided between the Ministry of Agriculture and Lands (MAL) and DFO. MAL is responsible for licensing of all fish processing plants, fish buying stations, fish brokers and fish vendors; all aquaculture operations; and harvesting of wild oysters and/or marine plants (MAL 2007). DFO is responsible for managing the commercial, subsistence, and recreational fisheries in BC, as well as habitat for those species. While this arrangement is likely to change in the future (Morton V. British Columbia [2009]), the existing provincial regulatory scheme for aquaculture remains in place by judicial order until at least February 9, 2010.

The outfall areas are within DFO Fisheries Management Area 19. Albert Head is in DFO Sub Area 19-3 and Finnerty Cove is in DFO Sub Area 19-5 (DFO 2008a).

The Coastal Resources Information System (CRIS) and Mapster were searched for commercial and recreational fisheries in the general vicinity the two outfall areas. Various DFO personnel were also contacted to provide additional information on fisheries resources. The data obtained from these sources is outlined in Table 5.

Table 5: Commercial and Recreational Fisheries Near the Outfall Areas

Type of Fishery	Commercial Fisheries	Recreational Fisheries
Albert Head Area		
Shellfish and other invertebrates	Crab, prawn, octopus, red sea urchin, shrimp and squid	Crab and prawn
Groundfish	Rockfish, lingcod, dogfish	Undetermined species
Finfish	No fishery identified	Coho and Chinook Salmon
Finnerty Cove Area		
Shellfish and other invertebrates	Crab, prawn and shrimp	Crab and prawn
Groundfish	Undetermined species	No fishery identified
Finfish	No fishery identified	Coho and Chinook Salmon

Sources: ILMB 2007; DFO 2006; Gary Logan of DFO pers. comm. April 25, 2008; Erin Wylie of DFO pers. comm.. April 15, 2008; DFO 2008d.

The predominant fishery between William Head and Victoria is recreational but commercial fisheries also exist (pers. comm., Gary Logan, DFO, April 25, 2008). The commercial groundfish fisheries in this area include hook and line, mid-water and bottom trawl. Constance Bank, east of the Albert Head outfall area, is a popular recreational fishing location (pers. comm., Bill Shaw, DFO, April 3, 2008; IWL Fishing Charters 2005).

Miscellaneous fisheries information (not specific to outfall locations) contained in CRIS includes the distribution of clam beds in coastal areas, herring spawning grounds, as well as salmon and herring holding areas. Herring spawning grounds were identified in the general vicinity of the Albert Head outfall area.

Although no clam beds were found through CRIS in either outfall area, clam beds were identified near Esquimalt Lagoon through Mapster. According to DFO, there is a permanent year-round shellfish sanitary closure from Albert Head to Cordova Bay which encompasses the Albert Head outfall area and the shore along Finnerty Cove (Sanitary Closure 19.1; DFO 2008b). Environment Canada (2008a) also confirmed that these areas are currently not approved for bivalve shellfish harvesting. According to Fishery Notice (FN) 0623, August 22, 2008, there are also extensive bivalve shellfish closures for biotoxins (Paralytic Shellfish Poisoning or "red tide") in Area 19 (DFO 2008c).

No marine finfish aquaculture farms, shellfish aquaculture farms, or shellfish hatchery tenures/facilities were identified near either outfall area. The closest tenures/facilities are in Sooke Basin and Saltspring Island (ILMB 2007).

2.2.3 Parks

Various coastal and marine parks were identified in the vicinity of the outfall areas using the CRD's Natural Areas Atlas. Parks identified within a 5-km radius of the approximate centre of the outfall areas are outlined in Table 6. Additional parks that have not been identified in this list exist beyond the 5-km radius. Provincial ecoreserves are discussed in Section 2.3.1.

Table 6: Parks within 5 km of the Albert Head and Finnerty Cove Areas

Park Name	Type	Approximate Distance from Estimated Centre of Outfall Area (km)[1]
Albert Head Area		
Albert Head Lagoon Regional Park	Regional Park	1.5
Royal Roads Park	City of Colwood Municipal Park	2
Esquimalt Lagoon Park	City of Colwood Municipal Park	2.5
Witty's Lagoon Regional Park	Regional Park	3
Hatley Park National Historic Site	Federal Park	3.5
Fort Rodd Hill National Historic Site	Federal Park	4
Saxe Point Park	Township of Esquimalt Municipal Park	5
Macaulay Point Park	Township of Esquimalt Municipal Park	5

Park Name	Type	Approximate Distance from Estimated Centre of Outfall Area (km)[1]
Finnerty Cove Area		
Holleydene Park	District of Saanich Municipal Park	0.5
Arbutus Cove Park	District of Saanich Municipal Park	0.5
Gordon Head East Park	District of Saanich Municipal Park	0.5
Unnamed Park	District of Saanich Municipal Park	0.5
Gordon Head North Park	District of Saanich Municipal Park	1
Glencoe Cove - Kwatsech Park	District of Saanich Municipal Park	1
Cranford Park	District of Saanich Municipal Park	1.5
Phyllis Park	District of Saanich Municipal Park	2.5
Mount Douglas Park	District of Saanich Municipal Park	3.5

[1]Distances are indicative only as the outfall location has not been established.

2.2.4 Recreational Activities

In addition to recreational fishing, the marine waters around Victoria are used for SCUBA diving, wind surfing, kiteboarding, sailing, kayaking and wildlife viewing.

Several shore dive sites exist near the two outfall areas. The closest to the Albert Head area includes Albert Head Lagoon, Esquimalt Lagoon, Fisgard Island and Saxe Point Park. More sites exist along the Esquimalt and Victoria waterfront and south near Race Rocks. South of the Finnerty Cove area there are shore dive sites at Cranford Place, Telegraph Bay, Spring Bay, Ten Mile Point as well as boat dive sites near Chatham Islands (Parks Canada 2008; Pratt Johnson 1988; ShoreDiving.Com 2008).

Maps obtained from Parks Canada indicate that there are also ship wrecks near the Albert Head area including one to the north and two to the east all about 3 km away. There are also several wrecks near Discovery Island south of Finnerty Cove. Parks Canada has identified these as archaeological sites.

There are windsurfing sites near the Albert Head area including Esquimalt Lagoon and Taylor Beach. The closest windsurfing sites to the Finnerty Cove area are Willows Bay Beach, Cattle Point, Cadboro Bay Beach, and Agate Beach in Cordova Bay (BigWaveDave.Ca 2007; Shangaan Webservices Inc. 2008; Waterose Environmental 2008).

2.3 Ecological Resources

2.3.1 Protected Areas

Several Provincial ecological reserves were identified near the outfall areas (CRD 2008a) and are outlined in **Table 7** (coastal parks are discussed in Section 2.2.3). Provincial ecological reserves are designated under the *Ecological Reserve Act*, the purpose of which is to reserve Crown land for "ecological purposes" such as scientific research and education, protection of representative or rare ecosystems or species, or protection of unique "botanical, zoological or geological phenomena".

Table 7: Ecological Reserves in the Vicinity of the Outfall Areas

Park Name	Area	Approximate Distance from Area (km)[1]
Race Rocks Ecological Reserve	Albert Head	11
Ten Mile Point Ecological Reserve	Finnerty Cove	4
Oak Bay Islands Ecological Reserve (multiple areas)	Finnerty Cove	4.5, 6.5, 7

[1]Distances are indicative only as the outfall location has not been established.

Currently there are no Federal reserves near the proposed outfall areas; however, Parks Canada is conducting a feasibility study to identify if the southern Georgia Straight is a suitable area to include in the system of national marine conservation area reserves (Parks Canada 2008). No boundary has been established for the potential reserve.

2.3.2 Aquatic Macrophytes

Kelp beds were identified in the vicinity of both the Albert Head and Finnerty Cove areas and eelgrass beds were identified in Esquimalt and Witty's Lagoon near the Albert Head outfall area (ILMB 2007).

2.3.3 Birds

According to the CRIS database, the following bird species are found in the vicinity of Albert Head and Finnerty Cove: alcids (*e.g.*, murres, murrelets, auklets, guillemots), bald eagles (*Haliaeetus leucocephalus*), black oystercatchers (*Haematopus bachmani*), blue heron (*Ardea herodias*), cormorants (*Phalacrocorax* spp.), dabbling ducks, diving ducks, geese, swans, gulls, loons, grebes, and shorebirds (ILMB 2007). Fulmars (*Fulmarus glacialis*), shearwaters (*Puffinus creatopus*) and petrels (*Oceanodroma* spp.) were also identified south of the Albert Head area (ILMB 2007). MoE's Conservation Data Centre (CDC) Internet Mapping Service showed that there are also surf scoters (*Melanitta perspicillata*) in Esquimalt Lagoon and purple martins (*Progne subis*) in Esquimalt and Victoria Harbours (MoE 2007a).

There are two Federal Migratory Bird Sanctuaries to the north of Albert Head; one covers Esquimalt Lagoon and one is located throughout Victoria Harbour (CRD 2008a, Government of Canada 2008).

Two migratory birds areas of interest were identified near the Albert Head outfall area on maps obtained from Parks Canada (Parks Canada 2008). They include areas at Witty's Lagoon and Esquimalt Lagoon. The areas identified represent Canadian Wildlife Service knowledge on important migratory bird areas as of 1994; however, it does not mean that other areas have no value.

Several of the bird species identified are of special conservation status (Section 2.3.7).

2.3.4 Marine Mammals

The CRIS database showed that gray whales, harbour porpoises, and killer whales may travel through both the Albert Head and Finnerty Cove areas. Golder marine mammal specialist, Phil Rouget (pers. comm. March 27, 2008), confirmed that these species as well as the following ones frequent the waters around Albert Head and Finnerty Cove:

- California Sea Lion (*Zalophus californianus*);
- Steller Sea Lion (*Eumetopias jubatus*);
- Harbour Seal (*Phoca vitulina*);
- Killer Whale (*Orcinus orca*; Transient Population);
- Killer Whale (*O. orca*; Southern Resident Population);
- Humpback Whale (*Megaptera novaeangliae*);
- Minke Whale (*Balaenoptera acutorostrata*);
- Harbour Porpoise (*Phocoena phocoena*);
- Dall's Porpoise (*Phocoenoides dalli*); and,
- Gray Whale (*Eschrichtius robustus*).

The presence of these species along the South Coast of BC was confirmed by Reeves *et al.* (2002).

Harbour seal haul outs were identified near both Albert Head and Finnerty Cove from maps provided by Parks Canada (2008). There are haul outs at Albert Head, Haystock Island (just south of Albert Head) as well as several others along the Esquimalt and Victoria waterfront and near William Head. Near Finnerty Cove, haul outs have been identified at Finnerty Cove Reef, Gordon Rock near Gordon Head, and at Cadboro Point near Ten Mile Point.

Several of the marine mammal species identified are of special conservation status (Section 2.3.7).

2.3.5 Fish (Anadromous and Marine)

DFO's Mapster application (DFO 2006) contains information on herring holding and spawning areas which is based on DFO local knowledge. Herring spawning sites were identified along Esquimalt and Victoria waterfronts. The area around Albert Head was identified as a herring holding area.

Mapster also showed that salmon migrate through the general area around the Albert Head area to streams that flow into Esquimalt Harbour and Victoria Harbour. Information from CRIS indicates that there are also groundfish and finfish near Albert Head (ILMB 2007).

Maps obtained from Parks Canada indicate that there is potential rockfish habitat in the vicinity of both Albert Head and Finnerty Cove (2008).

Fish Wizard (Freshwater Fisheries Society of BC 2005) and the Fisheries Inventory Data Queries (MoE 2007b) were used to identify streams that flow into the ocean near the proposed outfall areas and that contain anadromous fish (Appendix IV). In the Albert Head area, Colwood Creek, Mill Stream, Craigflower Creek, and Colquitz Creek support two species of Pacific salmon (chum [*Oncorhynchus keta*] and coho [*O. kisutch*]), anadromous cutthroat trout (*O. clarkii clarkii*) and steelhead trout (*O. mykiss*). In the Finnerty Cove area Douglas Creek supports cutthroat trout; however, it is unknown if these trout are anadromous. Other streams exist in the vicinity of the outfall areas but did not have a record of anadromous fish.

Coastal cutthroat trout is of special conservation status (Section 2.3.7).

2.3.6 Invertebrates

The CRIS and Mapster were searched to determine the types of invertebrates that inhabit the marine environment around Albert Head and Finnerty Cove. From the fisheries information in these two databases and from communication with DFO personnel (pers. comm. Erin Wylie April 15, 2008; pers. comm. Garry Logan April 25, 2008) it was found that various species of crab, prawn, octopus, shrimp, squid, and the red sea urchin (*Strongylocentrotus franciscanus*) are located in the general vicinity of Albert Head. Various crab, prawn, and shrimp species are located in the general vicinity of Finnerty Cove. No clam beds were identified in either proposed outfall area; however, clams beds were identified in Esquimalt Lagoon, north of Albert Head.

Northern abalone (*Haliotis kamtschatkana*) has been reported in the vicinity of Albert Head and to the south of Finnerty Cove (pers. comm. Bruce Adkins April 22, 2008). In 1982, 1985 and 1986, surveys for Northern abalone were conducted by DFO in the South Coast of BC (Adkins 1996). A survey was conducted at Albert Head as well as at sites to the north and south, and Northern abalone was found. The closest survey to the Finnerty Cove area was conducted at Cadboro Point and Northern abalone were observed at this site as well. As abalone are identified as a threatened species (Section 2.3.7), DFO has indicated that an abalone assessment would need to be carried out before final outfall sites are selected (pers. comm. Joanne Lessard April 29, 2008). A protocol for assessing potential impacts on abalone and their habitat, and for siting project works to avoid abalone habitat, has been developed by DFO (Lessard 2007).

2.3.7 Listed Rare and Endangered Species

Numerous species have been listed by the Federal and Provincial governments as being of special conservation status. The Provincial government assigns a rank or listing of 'red' or 'blue' to a species based on its status within BC. The rankings or Provincial listing categories described below highlight species as well as natural plant communities that require special attention (MoE 2007c):

- **Red** - any indigenous species, subspecies or plant community that is extirpated, endangered, or threatened in BC.
- **Blue** - any indigenous species, subspecies or community considered to be vulnerable (special concern) in BC.

Federally, species ranking is conducted by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), established under S.14 of the *Species at Risk Act* (SARA). COSEWIC is a committee of experts that assesses and designates, under S.15 to S.21 of SARA, which wild species of animal, plant or other organisms are in danger of disappearing from Canada (Government of Canada 2007). Below is a listing of the status categories used by COSEWIC to rank or list a species:

- **Extinct** - a species that no longer exists;
- **Extirpated** - a species no longer existing in the wild in Canada, but occurring elsewhere;
- **Endangered** - a species facing imminent extirpation or extinction;
- **Threatened** - a species likely to become endangered if limiting factors are not reversed;
- **Special concern** - a species that is particularly sensitive to human activities or natural events, but is not an endangered or threatened species;
- **Data deficient** - a species for which there is inadequate information to make a direct, or indirect, assessment of its risk of extinction; and,

- **Not at risk** - a species that has been evaluated and found to be not at risk.

COSEWIC rankings are regarded as recommendations to the Federal government; the government makes the final decision on whether species will be listed under SARA. Schedule 1 of SARA provides the official list of wildlife species at risk in Canada, including species that are extirpated (extinct in Canada), endangered, threatened, and of special concern. Species listed on Schedules 2 and 3 are not yet officially protected under SARA.

A general prohibition under SARA is that "No person shall kill, harm, harass, capture or take an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species" (S.32). SARA also prohibits the damage or destruction of the habitat ("residence") used by listed species (S.33) unless authorized or permitted (S.73).

The CDC has a searchable database called *BC Species and Ecosystem Explorer* that contains information on rare and endangered species and ecosystems in BC. Species can be searched by Forest District, Regional District, MoE Region, biogeoclimatic zone, and habitat type. Faunal species occurring in the marine and estuary environment of the Coastal Douglas Fir Biogeoclimatic Zone, the zone in which Albert Head and Finnerty Cove are located, were searched. This area-based (*e.g.*, biogeoclimatic zone) search provides a broad list of species that could potentially occur in the areas. Twenty-two Red and Blue-listed species were reported by the CDC (Appendix V).

To determine if these species have been recorded by the CDC in the areas of interest, the CDC's internet mapping service was searched. Only marine-related species (including birds, bivalves, gastropods, lampreys, mammals, and ray-finned fishes) were searched. This search indicated one known occurrence of surf scoter in the Esquimalt Lagoon and several occurrences of purple martin in Victoria Harbour and Esquimalt Harbour. The CDC was also contacted to determine if there were any further known occurrences of marine species within the study areas; however, no other relevant information on marine species was available from the CDC.

The species believed to occur in the vicinity of Albert Head and Finnerty Cove as confirmed by local knowledge (*e.g.*, government scientists) and other databases, was determined to include six mammalian species, two birds, one fish and one invertebrate (Table 8). Other species identified through the BC Species and Ecosystem Explorer may be present in the vicinity of the outfall areas but have not been validated.

Table 8: Listed Species Identified as Occurring in the Vicinity of Albert Head and Finnerty Cove

Scientific Name	Common Name	Species Group	Provincial Listing	COSEWIC Ranking	SARA Designation
Eumetopias jubatus	Steller Sea Lion	Mammal	Blue	Special Concern	Schedule 1
Orcinus orca	Killer Whale (Transient Population)	Mammal	Red	Threatened	Schedule 1
Orcinus orca	Killer Whale (Southern Resident Population)	Mammal	Red	Endangered	Schedule 1
Megaptera novaeangliae	Humpback Whale	Mammal	Blue	Threatened	Schedule 1
Phocoena phocoena	Harbour Porpoise	Mammal	Blue	Special Concern	Schedule 1
Eschrichtius robustus	Gray Whale	Mammal	Blue	Special Concern	Schedule 1
Melanitta perspicillata	Surf Scoter	Bird	Blue	No Ranking	No Designation
Progne subis	Purple Martin	Bird	Blue	No Ranking	No Designation

Scientific Name	Common Name	Species Group	Provincial Listing	COSEWIC Ranking	SARA Designation
Oncorhynchus clarkii clarkii	Cutthroat Trout, *clarkii* subspecies	Ray-finned fish	Blue	No Ranking	No Designation
Haliotis kamtschatkana	Northern Abalone	Gastropod	Red	Threatened (May 2000)	Schedule 1

3.0 CONSTITUENTS OF SEWAGE AND POTENTIAL EFFECTS

This section provides a general overview of sewage and the potential environmental effects of sewage discharges to the receiving waters. Whether or not these potential impacts occur will depend on the specific characteristics of the effluent and on the specific characteristics of the receiving environment. That evaluation is carried out in Section 4.0 of this report.

Domestic wastes originate from toilets, sinks, dishwashers, laundry machines, and bathtubs/showers and are collected into the sanitary sewer where it is conveyed to a sewage treatment facility. In the CRD, municipal effluents also include minor industrial and commercial inputs. At the treatment facility, the liquids and solids are treated prior to being discharged as treated effluent. Sewage is therefore comprised of feces, urine, food wastes, clothing soils and surfactants (detergents) and water, as well as any other waste that may be discharged into the system. With respect to the environmental significance of sewage, it contains oxygen-depleting substances, ammonia and other nutrients, solids, pathogenic microorganisms and surfactants. Hydrogen sulphide may be present as an outcome of bacterial processes.

Although sewage is a complex effluent, there are certain substances and properties of sewage that have been associated with known adverse effects or conditions in aquatic environments, particularly those that are poorly flushed. Some of the key substances found in sewage are discussed in more detail below.

3.1 Oxygen-Depleting Substances

Sewage contains many substances that give rise to the potential depletion of oxygen from surrounding water. Various types of microorganisms that utilize the organic wastes as a food material degrade the constituents of sewage. These organic wastes in the water are consumed by the microorganisms and converted into energy that can be used for various life processes. The biochemical process of conversion of that food into energy requires (or "demands") oxygen (O_2), which is taken up from the surrounding environment, thereby leading to reductions in oxygen available for aquatic organisms such as fish. Oxygen is also removed from the surrounding environment by direct chemical reaction of the oxygen molecule with substances in the waste. This reaction with oxygen (known as oxidation) consumes dissolved oxygen in the process.

The oxygen-depleting potency of an effluent is measured as the biochemical oxygen demand (BOD) which is measured in a laboratory over a 5 day period. The extent to which oxygen is removed from the receiving waters depends on the dynamics of this process in relation to dispersion and oxygenation of the receiving waters. Waters that are confined and stagnant are more prone to oxygen reduction than waters that are unconfined and well flushed. In the case of the proposed discharges, the areas are well flushed and dilution is predicted to be high (refer to Section 4.3.3)

Dissolved oxygen concentrations should be close to the saturation value. Levels of dissolved oxygen should not be less than 5 mg/L and should only occur at this concentration for brief periods of time. For long-term exposure, dissolved oxygen should not be less than 8 mg/L (MoE 2006).

3.2 Ammonia

Ammonia is a naturally occurring substance. However, its concentration in unpolluted waters is low and not of toxicological concern. Ammonia is a waste product that is produced by fish such as salmon to dispose of their nitrogenous wastes and is excreted (disposed of) by way of their gills. Such wastes originate from their normal breakdown of food. These nitrogenous wastes are also produced by humans or animals but are excreted in the form of urea by way of the urine. Ammonia can result from the breakdown of urea as well as from the amine portion of amino acids, which make up proteins. While ammonia is a natural substance, it can be introduced into the environment in concentrated amounts from a variety of sources and cause toxic or other effects. The specific characteristics of the effluent and of the receiving environment will influence the extent of effects.

Ammonia dissolved in water exists in two forms or "species". Which species it is in will, in large part, influence its toxicity. These two forms are un-ionized ammonia (NH_3) and ionized ammonia (NH_4^+, also known as the ammonium ion). When a chemistry laboratory measures the ammonia concentration of a sample of water, the ammonia is measured as total ammonia nitrogen (sometimes abbreviated as TAN), which includes the combined total nitrogen concentration of the NH_3 and the NH_4^+ forms.

The two forms of ammonia exist in a balance (equilibrium) in the water and the ammonia can readily change between the two species. That equilibrium is influenced by the pH, temperature, and in marine waters, the salinity of the water (Trussell 1972; Bower and Bidwell 1978). As the pH becomes more basic, the amount of the more toxic (un-ionized) form will increase. As the pH becomes more acidic, the amount of the un-ionized form will decrease. An increased water temperature will favour an increased amount of the un-ionized form (NH_3) while higher salinities favour the ionized form of ammonia. Water quality guidelines (marine) are set on the basis of pH, temperature and salinity because of the influence of these environmental factors on the potential toxicity of ammonia.

The form in which ammonia exists is relevant to predicting the toxicity of ammonia. Each of the two forms of ammonia has differing chemical properties, which influence their toxicity. The chemical properties of the ionized form of ammonia (NH_4^+) are such that it does not pass across the gills of the fish and into the blood very well. The un-ionized form (NH_3) is able to readily pass across the gill surface and enter into the bloodstream of the fish. Since ammonia toxicity results from entrance of ammonia into the fish (Person Le Ruyet *et al.* 1995; Hillaby and Randall 1979), NH_3 is, therefore, the more toxic species. Once inside the fish, both the NH_3 and the NH_4^+ are responsible for the toxic effects (Hillaby and Randall 1979). In the majority of aquatic species most of the ammonia toxicity is accounted for in the un-ionized form. However, it should be noted that some exceptions to this exist. For species such as the freshwater amphipod (*Hyalella azteca*), important contributions to toxicity do occur from the ionized form of ammonia (Borgman 1994; Ankley *et al.* 1995). Also, as pH becomes acidic, the un-ionized form of ammonia also begins to play an apparently greater role in freshwater ammonia toxicity to fish (Thurston and Russo 1981). Acutely lethal (*i.e.*, mortality occurs over a short exposure duration) levels of ammonia for marine fish range from 0.59 ppm un-ionized ammonia (NH_3-N) for winter flounder (*Pseudopleuronectes americanus*) to 3.59 ppm NH_3-N for turbot (*Scophthalmus maximus*) (Environment Canada and Health Canada 2001).

Some of the environmental factors that a fish may encounter can alter their sensitivity to toxic substances. Ammonia toxicity to Atlantic salmon in fresh water was found to increase when the fish were exposed to additional environmental stressors. When the dissolved oxygen concentration was reduced, it took less ammonia (*i.e.*, its toxicity was more severe) to kill the Atlantic salmon than when dissolved oxygen levels were high. Atlantic salmon in fresh water had a 24-h LC50 of 0.145 ppm (as un-ionized ammonia nitrogen) when the dissolved oxygen concentration was near the saturation value (9.6 mg/L). However, when the dissolved oxygen concentration was reduced to 3.5 mg/L, the 24-h LC50 decreased (*i.e.*, became more toxic) to 0.086 ppm, nearly twice as toxic (Alabaster *et al.* 1979). The same pattern has been observed in toxicity tests with sea bream (*Sparus auratae*), in which the LC_{50} value decreased from 2.34 ppm (NH_3-N) at 93% oxygen saturation to 0.49 ppm at 26% oxygen saturation (Environment Canada and Health Canada 2001). The influence of combining these two stressors resulted in their combined effect having a greater toxic severity than the individual substances tested separately (*i.e.*, the combination resulted in synergistic, or more-than-additive effects).

3.3 Nutrient Enrichment

Nitrogen, in the form of nitrate (NO_3^-) and phosphorus have relatively low toxicity to aquatic organisms and the effects of these nutrients are usually indirect (Nordin and Pommen 1986). Some nutrient enrichment can improve the fish productivity of a waterbody (*i.e.*, by increasing the availability of food); however, beyond a certain point, the assimilative capacity, excess nutrient input can lead to a process called eutrophication (Nordin 1985).

Biological processes are controlled by the resource in short supply (the limiting factor). Phytoplankton take up mineral elements such as nitrogen, phosphorus, silicate, iron and trace metals which they use to convert light energy into organic material via the process of photosynthesis. Any one of these elements, if in short supply, could potentially limit phytoplankton biomass. Conversely, an enrichment of nutrients that are limiting could result in increased phytoplankton production. In coastal marine waters of British Columbia most cases of limited phytoplankton growth are attributed to nitrate and ammonia concentrations (Anita *et al.* 1963). Studies of phytoplankton in Indian Arm (Burrard Inlet area) showed that nitrate limitation and zooplankton grazing were the major factors limiting phytoplankton production (Stockner and Cliff 1979).

In the water column, nutrient enrichment can result in a phenomenon known as an "algal bloom" either in the water column or on shallow substrates depending on the nature of the water body. It is not possible with information typically available to reliably predict when an algal bloom may occur; however, certain conditions are more favourable to algal growth. For example, in the Strait of Georgia, one of the factors affecting the development of the spring algal bloom is the strength of stratification that occurs with increasing freshwater outflow from the Fraser River (Yin et al. 1996). Strong winds or other factors that disrupt the development of stratification will cause phytoplankton to mix to deeper layers rather than staying at the surface and resulting in a bloom.

The typical background concentrations of nutrients will also control when and if a bloom will occur. In an assessment of the potential for eutrophication to occur in the Juan de Fuca Strait, the Strait of Georgia and Puget Sound estuarine system, Mackas and Harrison (1997) assumed that nitrogen inputs (either natural or anthropogenic) would not affect local productivity if ambient nitrogen concentrations (ammonium and nitrate combined) were >5 µM. The Strait of Georgia can experience nitrogen concentrations in the order or 1-5 µM (moderate nitrogen-limiting conditions) during the summer, depending on zooplankton grazing, tides, winds and freshwater influx from the Fraser River. In comparison, nitrogen concentrations in Juan de Fuca Strait remain relatively high throughout the year (minimums of 12 µM, which are not considered limiting) and therefore Mackas and Harrison (1997) concluded that the Juan de Fuca Strait and the tidally-mixed passages linking it to the Strait of Georgia (*e.g.*, Haro Strait) are the least sensitive to nutrient inputs. Factors influencing ambient nutrient concentrations in Juan de Fuca Strait include strong tides and upwelling from deeper off-shore currents.

3.4 Hydrogen Sulphide

Hydrogen sulphide is formed under anaerobic conditions (*i.e.*, conditions lacking oxygen) when bacteria convert the sulphate ion into toxic hydrogen sulphide (H_2S) gas. This gas is highly soluble in water, is toxic to fish (Adelman and Smith 1970) and produces an objectionable odour, similar to rotten eggs. This dissolved gas may be present naturally in areas of geothermal activity and its odour is usually noticeable near mudflats at low tide. Hydrogen sulphide may also have corrosive actions on sewage infrastructure and thus sewerage authorities seek to create conditions that do not favour the formation of hydrogen sulphide. As it is expected that the discharge will not result in concentrations of sulphides that are of concern, it has not been evaluated here. Should future plant monitoring results indicate that sulphide is present at unacceptable concentrations, it will be addressed through plant operation.

3.5 Surfactants

Surfactants are a group of substances more commonly referred to as detergents. However, the composition of detergents such as those used for domestic laundry will also contain detergent builders and bleaches as well as surfactants (Hennes-Morgan and De Oude 1994). These substances enter sewage through the domestic and other use of commercial detergent products in bathrooms, kitchens, and laundry rooms.

Surfactants have been identified as important toxicants in sewage effluent, particularly where that effluent has received inadequate treatment (Ankley and Burkhard 1992). The damage caused by surfactants appears to be principally directed at the fish gill where the surfactant, presumably through effects on the lipid and/or protein component of the cell membrane, disrupts the cell envelope such that it can no longer maintain its internal balance (Abel 1976).

3.6 Pathogens

Contact with raw sewage has long been recognized as a potential source of infectious disease-causing organisms (Dadswell 1990) such as bacteria, viruses and protozoans. There are many different kinds of disease that can be transmitted through contact with sewage. Not every disease-causing organism lends itself well to being identified in a sample of sewage or an area that is affected by sewage. However, a group of bacteria known as fecal coliforms are abundant in sewage and this group of bacteria are used as an indicator of the presence of sewage contamination and the associated risk of sewage-borne pathogens. More recently, there is increasing interest in using *Enterococci* bacteria as an indicator of potential sewage contamination because they survive longer. However, fecal coliforms remain the most common indicator.

The release of untreated sewage into a water body where there are shellfish resources such as clams can result in risks to potential consumers. Bivalve shellfish are filter feeders and become contaminated when they concentrate bacteria and other microbes (*e.g.*, viruses) by filtering them from the surrounding water.

Free-swimming finfish differ from bivalve shellfish with respect to becoming contaminated by sewage-borne pathogens. Exposure of finfish to coliform bacteria does not result in accumulation of the bacteria in the edible flesh, although some risk does occur if the fish were improperly cleaned. The composition of the microbial community in the human intestine is relatively stable and, in healthy individuals, aids in digestion. In contrast, the microbial community of fish tends to reflect the microbial composition of the water in which they reside (Fattal *et al.* 1992). Accordingly, the fish intestine may harbour sewage-borne pathogens and could cause contamination of edible fish flesh during cleaning. While fishery closures are invoked for shellfish beds contaminated by sewage (and for other reasons), the risk of finfish contamination is not considered to be sufficiently great to warrant fishery closures.

Risk from pathogens requires that there be contact with the source of pathogens and humans or harvestable shellfish resources. As noted in Section 2.2.2, the outfall areas are not located adjacent to harvestable shellfish resources and, due to plume trapping, the likelihood for significant contact between the plume and human users is low (Section 4.3.3).

3.7 Metals

All metals occur naturally in the environment, as geochemical components of sediments, soils and rocks. Weathering processes mobilize these compounds and transport them into streams, rivers and eventually the ocean. However, greater loads of metals generally enter the aquatic environment through sources such as fossil fuel combustion, industrial emissions, the discharge of municipal waste waters and via stormwater runoff from paved surfaces.

The chemistry and behaviour of metals in water can be complex and are dependent on a number of factors. Metals in the aquatic environment can exist in dissolved form, adhered to particulates, as part of organic and/or inorganic complexes, and in various oxidation states. In the marine environment, most metals will partition into sediments. Key factors influencing the chemistry, partitioning and bioavailability (and therefore toxicity) of metals include reduction-oxidation (redox or Eh) conditions, pH, hardness, and the presence of organic carbon and other compounds with which metals will complex or bind.

Certain metals are essential for maintaining good health because of their importance as components of enzymes or other biologically important proteins (*e.g.*, iron in haemoglobin) and a shortage of those metals can result in adverse effects, yet at excess concentration, toxic effects can result. The toxicity of metals to aquatic organisms ranges widely from slight reductions in growth rates to mortality and may be acute (*i.e.*, after a short term exposure) or chronic (over a longer term). The expression of toxic effects is dependent on several factors including:

- Exposure route, duration and concentration;
- The form of the metal at the time of exposure (*e.g.*, inorganic arsenic is more toxic than the organic form, while methylmercury is more toxic than inorganic mercury), which can be affected by site-specific physical and chemical conditions (*e.g.*, pH, redox);
- External and internal synergistic, additive or antagonistic interactions of co-occurring contaminants (*e.g.*, cadmium has been observed to reduce the teratogenic[9] effects of methylmercury on fish);
- Sensitivity of a given organism (*e.g.*, mollusks are generally less sensitive to metals than other aquatic phyla);
- Physiological ability to detoxify and/or excrete the metal (*e.g.*, some vertebrates produce a protein, metallothionein, which can sequester metals like copper);
- Life stage (*e.g.*, embryonic and larval stages of benthic organisms are generally more sensitive than adult stages); and,
- The condition of the exposed organism (*e.g.*, a fish that is stressed by elevated water temperatures or low oxygen levels is potentially more sensitive to toxicant exposure).

The impact assessment conducted in the present report was based on a comparison to generic WQG. These guidelines do not generally take into account toxicity-modifying factors, with some limited exceptions. For this reason, comparison to WQG provides a conservative assessment of potential impact and exceeding generic WQG does not mean that "pollution" has been caused, within the meaning of the *Environmental Management Act*. However, they provide an appropriate, albeit conservative, evaluation of the potential impacts at a Stage 1 level of assessment where various other uncertainties exist (Section 5.0). If impact assessment indicates that exceeding WQG at the edge of the IDZ is unlikely, then more detailed examination of the toxicity-modifying factors would not be warranted. However; should impact predictions indicate that WQG will be exceeded at the IDZ, further detailed analysis of toxicity-modifying factors can be pursued.

3.8 Organics

Organic compounds range from the simple methane molecule to long-chained, multi-ringed, halogenated structures that vary in persistence in the environment and effects on aquatic organisms. The fate and transport of organic compounds in environmental systems is controlled by the partitioning of the compound between sediment, suspended particulates, pore water, surface water and biota. The observed partitioning of non-ionic organic chemicals is due to sorption to organic phases, including dissolved organic matter in pore water and sedimentary organic matter. The extent to which chemicals are associated with organic matter relative to their dissolved aqueous concentrations is related to a number of factors including molecular weight, and number and position of chlorine atoms in the case of chlorinated compounds.

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9 Causing an alteration in the developing cells, tissues or organs at the embryonic stage of development.

Organic compounds have a wide range of effects on aquatic organisms, from reproductive impairment such as reduced fecundity and viability of offspring, developmental impairment such as brain and skeletal deformations and reduced growth, to acute mortality of both adults and juveniles. Of particular concern are the persistent, bioaccumulative and toxic compounds (or PBTs). Because many organics are lipophilic, they tend to accumulate in fatty tissues unless the organism has a mechanism for metabolizing and excreting the compound. The contaminants can then be biomagnified up the food chain, resulting in exponentially higher concentrations in higher trophic level organisms such as carnivorous marine mammals. The manifestation of toxic effects related to organic contaminants is dependent on similar factors as summarized in Section 3.7.

The identity and concentration of organic substances in CRD effluent based on high-resolution analysis initiated in 2004 is summarized in Golder (2006), along with an assessment of the ecological relevance of the concentrations of detected parameters. As noted in Section 1.2, the assessment of organic substances included those substances for which environmental quality criteria are available and source concentrations of the substances were based on relative removal efficiencies (RREs) provided by Associated Engineering (Section 4.2).

3.9 Endocrine Disrupting Compounds

Municipal sewage also contains substances known or suspected to be endocrine disrupting compounds (EDCs), which include metals (*e.g.,* cadmium), surfactants, plasticizers, and pharmaceutical and personal care products (PPCP) (Environment Canada 2007; Anderson 2005). EDCs interfere with the endocrine (hormonal) system of animals and may cause reproductive abnormalities such as the feminization of male individuals. For example, male fish have been observed to contain vitellogenin – a yolk-like substance deposited into fish eggs and normally present only in female fish (Harries *et al.* 1996).

The presence and ecological significance of EDCs are an area of emerging international science. Anderson (2005) provides an overview of the state of knowledge regarding the fate and behaviour of EDCs in the environment as well as the effectiveness of various wastewater treatment methods. In Canada the need for research and policy directions regarding EDCs such as PPCPs has been recognized and priorities in the areas of effects research and risk management for PPCPs have been discussed and include the following (Environment Canada 2007):

- Effects of PPCP mixtures at the population and ecosystem levels;
- Standardization of effects research, including prioritizing substances to monitor;
- Quantification of loadings and concentrations of PPCPs;
- Development of source control and life cycle management programs to reduce the need for treatment at end-of-pipe; and,
- Validation and comparison of analytical methods.

Research by Environment Canada under the *Canadian Environmental Protection Act* (CEPA) includes the development of analytical methods, as well assessment of the efficiency of treatment of various EDCs and the presence and effects of EDCs in the aquatic environment (Environment Canada 2008b).

EDCs are an international issue being faced by all WWTPs and science, policy, practices, and treatment methods are evolving. The issue of EDCs may need to be revisited by CRD as science and resulting policies are developed.

4.0 ASSESSMENT OF IMPACTS OF THE EFFLUENT TO THE RECEIVING ENVIRONMENT

4.1 Approach

4.1.1 Information Used in the Assessment

This assessment of potential effects took into account the following information sources:

- The treatment will be secondary treatment without disinfection. It is anticipated that the eventual treatment processes will achieve a secondary level of treatment or better.
- The known potential effects of sewage on the receiving environment (Section 0);
- An assumption that background conditions of the marine receiving environment are represented by water quality data from nearby CRD and DFO monitoring programs as well as from the Strait of Georgia and Puget Sound (Sections 2.1);
- Dilution ratios as determined through computer modeling (Section 4.3.3); and,
- The Approved and Working Water Quality Guidelines for the protection of aquatic life and recreational uses (MoE 2006).
- The common expectations under the MSR, which are two-fold:
  - Lethal conditions should not exist within the IDZ. The treated effluent itself is expected to be non-acutely lethal; therefore, conditions within the IDZ would likewise be non-acutely lethal. Samples are not available to test for toxicity at this time; such testing would be part of an operational monitoring program.
  - Chronic sublethal effects should not occur outside of the IDZ. A lack of chronic sublethal effects are predicted when the parameter of concern has a concentration lower than the ambient WQG.

It is appropriate at a Stage 1 level of assessment to use conservative assumptions, which are described further in the following text. In this report, the term "conservative" is used to describe assumptions and conditions that would result in an assessment that is more likely to over-predict adverse effects than to under-predict them.

Potential environmental impact was identified in the present study by predicting the concentration of treated sewage constituents in the receiving environment (Section 4.4). The concentrations predicted at the IDZ were then compared to WQG for the protection of marine aquatic life and recreational uses. Where the concentration of a substance was predicted to be less than its applicable WQG, impact was not predicted. This approach provides a conservative estimate of potential effects because the process of deriving WQG results in a conservative (*i.e.*, more protective) approximation of the "safe level". The WQG for marine aquatic life are more conservative for parameters relevant to sewage contamination than guidelines for other uses (Table 9). Accordingly, assessment against the marine aquatic life WQG will also inherently protect those other uses. The exception to this assumption is for fecal coliforms, for which a WQG for the protection of aquatic life has not been recommended by MoE. The most stringent, and therefore most applicable, WQG for the evaluation of fecal coliform concentrations is the recreational WQG for primary contact.

Water quality guidelines are intended to provide generic protection of aquatic life, and thus it is not necessary for the purpose and scope of the present assessment to know the exact details of the species using a given habitat. If the concentrations of substances of interest are lower than WQG, then it is expected that aquatic life will not be harmed.

Table 9: Summary of Applicable Water Quality Guidelines

Parameter*	Water Quality Guideline			
	Aquatic Life (Marine)	Source	Recreation	Source
MSR Schedule 3 Parameters				
Total ammonia nitrogen	8.7 mg N/L (30-day average)**	A	No guideline	-
Total phosphorus	No guideline	-	No guideline	-
BOD	No guideline	-	No guideline	-
Total suspended solids	5 mg/L above background (when less than or equal to 25 mg/L)	A	No guideline	-
Fecal coliforms	No guideline	-	< 200 CFU/100 mL (primary contact)***	A
Other Nutrients				
Nitrate	3.6 mg N/L (interim)	C	10 mg N/L (maximum)	A
Total Kjeldahl nitrogen	No guideline	-	No guideline	-
Total Metals				
Arsenic	12.5 µg/L (interim)	A	No guideline	-
Barium	200 µg/L (under review)	B	No guideline	-
Cadmium	0.12 µg/L (maximum)	B	No guideline	-
Chromium III	56 µg/L (interim maximum)	B	No guideline	-
Chromium VI	1.5 µg/L (maximum)	B	No guideline	-
Copper	2 µg/L (30-day average)	A	1,000 µg/L (maximum)	A
Iron	No guideline	-	No guideline	-
Lead	2 µg/L (30-day average)	A	50 µg/L (maximum)	A
Manganese	No guideline	-	No guideline	-
Mercury	0.02 µg/L (30-day average when MeHg = 0.5% of THg	A	1.0 µg/L (maximum)	A
Nickel	8.3 µg/L (4-d average)	B	No guideline	-
Selenium	2 µg/L (30-day average)	A	No guideline	-
Silver	1.5 µg/L (30-d average)	A	No guideline	-
Zinc	10 µg/L (maximum)	A	5,000 µg/L (maximum)	A

Parameter*	Water Quality Guideline			
	Aquatic Life (Marine)	Source	Recreation	Source
Selected Organics				
Benzo(a)pyrene	0.01 µg/L (maximum)	A	No guideline	-
Fluorene	12 µg/L (maximum)	A	No guideline	-
Phenanthrene	No guideline	-	No guideline	-
Pyrene	No guideline	-	No guideline	-
Ethylbenzene	0.25 mg/L (interim maximum)	A	No guideline	-
Toluene	0.33 mg/L (maximum)	A	No guideline	-
Butylbenzyl phthalate	No guideline	-	No guideline	-
DDT (2,4)	0.001 µg/L (4,4 DDT; chronic)	D	No guideline	-

Notes:
*This table summarizes the parameters for which removal efficiency information could be located in the literature (Table 10 provides a summary of effluent quality and removal efficiency expected to be achieved by the proposed WWTPs)

** Assumes that salinity = 30 ppt, temperature = 10°C, and pH = 7.4.

*** The fecal coliform recreation criteria is evaluated based on the geometric mean of 5 samples collected over a 30d period.

BOD – Biological oxygen demand; CFU – colony forming unit

Sources: A – Approved BC WQG; B – Working BC WQG; C – CCME WQG; D – Washington State water quality standards (WQS); E – USEPA water quality criteria; '-' – benchmark not available from any of the sources.

4.2 Anticipated Effluent Quality

The effluent quality used in the assessment of potential for environmental impacts was estimated for selected parameters by Associated Engineering based on application of RREs available from the literature to raw influent quality from the Macaulay Point WWTP. Table 10 summarizes the existing influent and predicted effluent quality (assuming secondary treatment) for which RREs were available in the literature.

Table 10: Summary of predicted effluent quality used in the impact assessment

Parameter	Units	Raw Wastewater* (*i.e.*, influent)	RRE*	Predicted Secondary Effluent Quality*
MSR Schedule 3 Parameters				
Total ammonia nitrogen	mg/L	28.2	57%	12.1
Total Phosphorus as P	mg/L	5.5	44%	3.1
BOD	mg/L	175	90%	17
Fecal coliform	CFU/100 mL	5,995,093	98%	119,902
Total Suspended Solids	mg/L	199	95%	9.9

Parameter	Units	Raw Wastewater* (*i.e.*, influent)	RRE*	Predicted Secondary Effluent Quality*
Other Nutrients				
Total Kjeldahl nitrogen	mg/L	39	56%	17
Nitrate nitrogen	µg/L	69.9	0%	70
Total Metals				
Arsenic	µg/L	0.645	22%	0.503
Barium	µg/L	34.1	35%	22.2
Cadmium	µg/L	0.419	17%	0.348
Chromium	µg/L	3.29	32%	2.24
Chromium VI	µg/L	5.09	62%	1.93
Copper	µg/L	109	62%	41
Iron	µg/L	1,004	70%	301
Manganese	µg/L	117	41%	69
Mercury	µg/L	0.130	66%	0.044
Nickel	µg/L	5.22	33%	3.50
Selenium	µg/L	0.50	16%	0.42
Silver	µg/L	1.38	75%	0.35
Zinc	µg/L	79.6	70%	23.9
Selected Organic Substances of Interest				
Benzo(a)pyrene	µg/L	0.092	85%	0.014
Fluorene	µg/L	0.075	95%	0.004
Phenanthrene	µg/L	0.172	95%	0.009
pyrene	µg/L	0.103	95%	0.005
Ethylbenzene	µg/L	0.308	95%	0.015
Toluene	µg/L	2.70	95%	0.14
Phenol	µg/L	13.5	95%	0.68
Butylbenzyl phthalate	µg/L	10.7	80%	2.1
DDT (2,4)	µg/L	0.003	95%	0.00015

Source: Associated Engineering (2008)
*Based on 2005-2006 mean raw effluent quality for the Macaulay Point WWTP.
RRE – relative removal efficiency; BOD – Biological oxygen demand; CFU – colony forming unit

4.3 Plume Modelling

Plume dilution modeling was conducted by Dr. Don Hodgins (Hodgins 2008). The report detailing the derivation of dilution estimates is provided in its entirety in Appendix VI , and is summarized here. In addition to determining the level of dilution at the IDZ, Dr. Hodgins was also specifically requested by the CRD to assess the level of fecal coliforms expected at the edge of the IDZ (the assessment of other conventional parameters and substances of interest was done by Golder and is provided in Section 4.4).

4.3.1 Dilution Model

Hodgins (2008) used the United States Environmental Protection Agency (USEPA) model "UM" (Baumgartner *et al.* 1993), in conjunction with ocean current and stratification data from previously existing databases. Currents were predicted using the C3 model database developed by Hodgins and Hodgins (2002) as part of a sediment transport investigation in the Victoria area. Conductivity, temperature and depth (CTD) data collected in 1993 and 1994 near Clover and Macaulay Points (Chandler 1998a,b) were used to determine density stratification of the water column, and therefore potential trapping depths for the modeled plumes. Finally, Hodgins (2008) selected currents based on maximum current speed and slack water, as previous studies at the Clover Point outfall have suggested that this is when minimum dilution at the edge of the IDZ would occur, therefore presenting a conservative ("worst case") scenario.

4.3.2 Model Inputs

Effluent discharge rates were taken from estimates prepared by Associated Engineering for two seasons, the summer low flow period (average dry weather flow or ADWF[10]) and the winter high flow period (peak wet weather flow or PWWF[11]), and three future time periods (2013, 2023, and 2038[12]) based on projected population growth. Plume dilution modeling was conducted for both seasons, and for the projected population growth as of the year 2038 as this is considered the "worst case" scenario for the present set of scenarios and therefore provides a conservative basis upon which to assess the potential for effects. The modeling assumed the outfall configurations for both the Albert Head (hereafter referred to as the 'West Shore' WWTP) and Finnerty Cove (the 'Saanich East' WWTP) areas were as summarized in Table 11 (except where noted). The number of ports was selected to optimize dilution for each outfall for a combination of dry and wet-weather periods.

Table 11: Summary of outfall configuration parameters used in modeling the plumes

Parameter	Input Value
Diffuser depth	51 m
Port height above bottom	1 m
Port diameter	15 cm
Port orientation (relative to horizontal)	90°
Distance between ports	7.5 m
Number of ports	26 (West Shore) 14 (Saanich East)

10 ADWF = the average influent flow rate in a 24-h period during dry weather.

11 PWWF = the peak wet weather inflow rate occurring in a 24-h period during winter. This value was estimated from 30-d synthetic wet weather flow time-series.

12 These dates are five, 15 and 30 years from present.

4.3.3 Results of the Plume Dilution Modeling

4.3.3.1 Dilution of the Plume

The predicted dilution of the plume at the IDZ for dry and wet weather periods is summarized in Table 12 for the proposed West Shore WWTP and in Table 13 for the proposed Saanich East WWTP. The dilution ratio of the plumes for both WWTP locations is predicted to be > 100:1 at the edge of the IDZ for all seasonal flow conditions modeled.[13] The plumes are also predicted to be trapped (*i.e.*, they will not surface due to water density) at depths of about 30 m with one exception. During the highest wet weather flow modeled for the Saanich East WWTP, the trapping depth is predicted to be 15 m.

Table 12: Summary of Plume Dilution Modeling Results for the Proposed West Shore WWTP

Flow (m^3/s)	Dilution ratio at IDZ (x:1)	Trapping Depth (m)
Summer Low Flow Period		
0.35	1,570	30-35
Winter High Flow Period		
0.42	1,360	35
0.54	1,130	34
0.66	960	33
0.77	853	32
1.03	660	30

Table 13: Summary of Plume Dilution Modeling Results for the Proposed Saanich East WWTP

Flow (m^3/s)	Dilution ratio at IDZ (x:1)	Trapping Depth (m)
Summer Low Flow Period		
0.17	3,100	25-30
Winter High Flow Period		
0.20	2,310	38
0.26	2,100	38
0.36	1,680	32
0.39	1,600	32
0.49	1,350	30
0.75	820	15

13 Appendix 1 to Schedule 3 of the MSR indicates that if the expected dilution ratio is <100:1, the EIS must assess whether or not the Standards for Discharges to Water in Schedule 3 are adequately low to protect the receiving environment. In this case, as the dilution is expected to be >100:1, the Schedule 3 Standards for Discharge are applicable.

4.3.3.2 Fecal Coliform Concentrations

Hodgins (2008) plotted a time series of flows and effluent concentrations using a series of conservative assumptions and calculated 5-d geometric means[14] to determine what the fecal coliform concentrations would be at the IDZ. In that analysis, the background coliform concentration was assumed to be zero. For the Saanich East WWTP, the running 5-d means were all < 200 CFU/100 mL (the WQG for recreation, assuming primary contact such as swimming). For the West Shore WWTP, fecal coliform concentrations were predicted to exceed 200 CFU/100 mL twice during a high-flow event lasting > 48 h (the maximum calculated means were in the order of 228 CFU/100 mL).

Conditions under which fecal coliforms were predicted to exceed WQG for recreational contact were extended high flow conditions during winter for the West Shore WWTP. Under such conditions and the predicted plume trapping it is unlikely that there will be substantial recreational contact with the plume; however, the predictions here are subject to uncertainty (*i.e.*, they may overestimate the potential for exceeding WQG). Therefore, based on this Stage 1 EIS, it would be premature to conclude that effluent disinfection is needed. Further assessments of the need for disinfection will be made as part of the Stage 2 EIS and as site selection and treatment processes are decided upon.

4.4 Assessment of Environmental Impact

The predicted dilution ratios (Section 4.3.3.1), the anticipated secondary effluent quality (Section 4.2) and the compiled background receiving environment concentrations (Section 2.1) were used in the following equation to determine the predicted concentration of the selected parameters at the edge of the IDZ:

$$Concentration_{IDZ} = \left(\frac{Concentration_{Effluent}}{Dilution_{IDZ}} \right) + Concentration_{Background}$$

Where:

- $Concentration_{IDZ}$ = The predicted concentration of the parameter at the edge of the IDZ
- $Concentration_{Effluent}$ = The predicted concentration of the parameter in the effluent
- $Dilution_{IDZ}$ = The predicted dilution of the plume at the edge of the IDZ
- $Concentration_{Background}$ = The assumed concentration of the parameter in the receiving environment.

The predicted concentrations of MSR Schedule 3 parameters, other conventional parameters, metals and selected substances of concern for the West Shore WWTP are summarized in Table 14 and screening quotients (SQs) are provided in Table 15 for aquatic life WQG and in Table 16 for recreational WQG. SQs were derived by dividing the predicted concentration at the IDZ with available WQGs (Table 9). SQs < 1 indicate that the predicted parameter concentration is expected to be less than the WQG at the edge of the IDZ and therefore no potential for impact is predicted. SQs > 1 indicate that the WQG is exceeded and that chronic impacts may

14 The WQG for fecal coliforms is based on the geometric mean of five samples collected during 30 consecutive days (MoE 2006 – approved WQG).

occur.[15] The numeric deviation from a SQ = 1 provides a factor by which the predicted concentration is above or below the WQG. The calculation of a SQ normalizes the different predicted parameter concentration in relation to the WQG and provides an at-a-glance reference to the WQG. Predicted concentrations of the same parameters for the Saanich East WWTP are summarized Table 17, while SQs for aquatic life WQGs are in Table 18 and SQs for recreation WQGs are in Table 19.

Where WQG were not available and SQs could therefore not be derived, the relative percent difference (RPD)[16] between the background concentration and the predicted concentration at the edge of the IDZ was calculated. Where the RPD was < 20%, concern is not indicated because this means that the predicted concentration is within the limits of precision that analytical laboratories are able to produce.[17]

Table 14: Predicted Concentrations of Selected Parameters at the Edge of the IDZ for the West Shore WWTP

Parameter	Units	Concentration							
				Predicted at IDZ					
		Effluent*	Background	Summer Low Flow (m^3/s)	Winter High Flow (m^3/s)***				
				0.35	0.42	0.54	0.66	0.77	1.03
Dilution ratio **	(x:1)	-	-	1570	1360	1130	960	853	660
MSR Schedule 3 Parameters									
Total ammonia nitrogen	mg/L	12.14	0.024	0.032	0.033	0.035	0.037	0.038	0.042
Total phosphorus	mg/L	3.086	0.075	0.0770	0.0773	0.0777	0.0782	0.0786	0.0797
BOD	mg/L	17.6	1	1.01	1.01	1.02	1.02	1.02	1.03
TSS	mg/L	9.97	4	4.01	4.01	4.01	4.01	4.01	4.02
Other Nutrients									
Nitrate nitrogen	mg/L	0.070	0.194	0.19	0.19	0.19	0.19	0.19	0.19
Total Kjeldahl nitrogen	mg/L	17.2	0.132	0.14	0.14	0.15	0.15	0.15	0.16
Total Metals									
Arsenic	µg/L	0.5027	0.475	0.4753	0.4754	0.4754	0.4755	0.4756	0.4758
Barium	µg/L	22	NA	-	-	-	-	-	-
Cadmium	µg/L	0.348	0.046	0.0462	0.0463	0.0463	0.0464	0.0464	0.0465

15 The interpretation of potential for adverse effects when WQG are exceeded is complex. WQGs represent a conservative benchmark and have been used for screening purposes. These ambient guidelines are developed for general and broad application at a provincial level. Accordingly, to be protective in all cases, WQG protect the most sensitive species and typically under the least favourable conditions of background water chemistry, which has a considerable influence on how an organism will respond when exposed to a parameter of concern (*e.g.*, metals – Section 4.4.6.1).

16 RPD = relative percent difference, calculated as the absolute value of the following: $RPD = \left(\frac{Value1 - Value2}{\left(Value1 + Value2 \right) / 2} \right) \times 100$.

17 BCMWLAP (2003) indicates that two samples that have an RPD of <20% are not notably different.

Parameter	Units	Concentration							
		Effluent*	Background	Predicted at IDZ					
				Summer Low Flow (m^3/s)	Winter High Flow (m^3/s)***				
				0.35	0.42	0.54	0.66	0.77	1.03
Chromium	µg/L	2.2	0.1435	0.1449	0.1451	0.1455	0.1458	0.1461	0.1469
Chromium VI	µg/L	1.9	NA	-	-	-	-	-	-
Copper	µg/L	41.4	0.62	0.64	0.65	0.65	0.66	0.66	0.68
Iron	µg/L	301	60	60.2	60.2	60.3	60.3	60.4	60.5
Lead	µg/L	5.74	0.01537	0.0190	0.0196	0.0204	0.0213	0.0221	0.0241
Manganese	µg/L	69	3	3.04	3.05	3.06	3.07	3.08	3.10
Mercury	µg/L	0.044	0.000491	0.00052	0.00052	0.00053	0.00054	0.00054	0.00056
Nickel	µg/L	3.50	0.41	0.412	0.413	0.413	0.414	0.414	0.415
Selenium	µg/L	0.4202	0.00178	0.0020	0.0021	0.0022	0.0022	0.0023	0.0024
Silver	µg/L	0.3457	0.01	0.0102	0.0103	0.0103	0.0104	0.0104	0.0105
Zinc	µg/L	24	1.13	1.15	1.15	1.15	1.16	1.16	1.17
Organic Constituents									
Benzo(a)pyrene	µg/L	0.0138	0.017	0.017	0.017	0.017	0.017	0.017	0.017
Fluorene	µg/L	0.0038	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067
Phenanthrene	µg/L	0.0086	0.0055	0.006	0.006	0.006	0.006	0.006	0.006
Pyrene	µg/L	0.0051	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
Ethylbenzene	µg/L	0.0154	NA	-	-	-	-	-	-
Toluene	µg/L	0.1350	NA	-	-	-	-	-	-
Butylbenzyl phthalate	µg/L	2.1330	0.048	0.0494	0.0496	0.0499	0.0502	0.0505	0.0512
DDT (2,4)	µg/L	0.00015	NA	-	-	-	-	-	-

Notes:
* from Associated (2008)
** from Hodgins (2008)
*** the flows represent 6 scenarios, ranging from predicted "base" flow to maximum predicted PWWF.
IDZ – initial dilution zone; BOD – biological oxygen demand; TSS – total suspended solids; NA – background information not available for the parameter
'-' – concentration at IDZ not predicted because background data were not available.

Table 15: Screening Quotients for Predicted Concentrations of Selected Parameters at the Edge of the IDZ Compared to WQG for the Protection of Marine Aquatic Life (West Shore WWTP)

Parameter	WQG Aquatic Life (Marine)	Units	Screening Quotient of Predicted Concentration at IDZ: Summer Low Flow (m^3/s)	Winter High Flow (m^3/s)				
			0.35	0.42	0.54	0.66	0.77	1.03
MSR Schedule 3 Parameters								
Total ammonia nitrogen	8.7	mg/L	0.004	0.004	0.004	0.004	0.004	0.005
Total phosphorus	NR	mg/L	-	-	-	-	-	-
BOD	NR	mg/L	-	-	-	-	-	-
TSS	10	mg/L	0.4	0.4	0.4	0.4	0.4	0.4
Other Nutrients								
Nitrate nitrogen	3.6	mg/L	0.05	0.05	0.05	0.05	0.05	0.05
Total Kjeldahl nitrogen	NR	mg/L	-	-	-	-	-	-
Total Metals								
Arsenic	12	µg/L	0.040	0.040	0.040	0.040	0.040	0.040
Barium	200	µg/L	-	-	-	-	-	-
Cadmium	0.12	µg/L	0.385	0.385	0.386	0.386	0.387	0.388
Chromium	1.5**	µg/L	0.097	0.097	0.097	0.097	0.097	0.098
Chromium VI	1.5	µg/L	-	-	-	-	-	-
Copper	2	µg/L	0.321	0.323	0.326	0.330	0.332	0.339
Iron	NR	µg/L	-	-	-	-	-	-
Lead	2	µg/L	0.010	0.010	0.010	0.011	0.011	0.012
Manganese	NR	µg/L	-	-	-	-	-	-
Mercury	0.02	µg/L	0.026	0.026	0.026	0.027	0.027	0.028
Nickel	8.3	µg/L	0.050	0.050	0.050	0.050	0.050	0.050
Selenium	2	µg/L	0.001	0.001	0.001	0.001	0.001	0.001
Silver	1.5	µg/L	0.007	0.007	0.007	0.007	0.007	0.007
Zinc	10	µg/L	0.115	0.115	0.115	0.116	0.116	0.117
Organic Constituents								
Benzo(a)pyrene	0.01	µg/L	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**
Fluorene	12	µg/L	0.001	0.001	0.001	0.001	0.001	0.001
Phenanthrene	NR	µg/L	-	-	-	-	-	-
Pyrene	NR	µg/L	-	-	-	-	-	-
Ethylbenzene	250	µg/L	-	-	-	-	-	-

Parameter	WQG		Screening Quotient of Predicted Concentration at IDZ					
	Aquatic Life (Marine)	Units	Summer Low Flow (m^3/s)	Winter High Flow (m^3/s)				
			0.35	0.42	0.54	0.66	0.77	1.03
Toluene	330	µg/L	-	-	-	-	-	-
Butylbenzyl phthalate	NR	µg/L	-	-	-	-	-	-
DDT (2,4)	0.001	µg/L	-	-	-	-	-	-

Notes:
WQG – water quality guideline; IDZ – initial dilution zone; NR = none recommended; BOD – biological oxygen demand; TSS - total suspended solids
'-' = not calculable either because background data or an applicable WQG were not available
Bold values have a Screening Quotient of >1
**The chromium value was not speciated. For the purposes of this assessment the chromium was conservatively assumed to be hexavalent.

Table 16: Screening Quotients for Predicted Concentrations of Selected Parameters at the Edge of the IDZ Compared to WQG for Protection of Recreational Uses (West Shore WWTP)

Parameter	WQG		Screening Quotient of Predicted Concentration at IDZ					
	Recre-ational Use	Units	Summer Low Flow (m^3/s)	Winter High Flow (m^3/s)				
			0.35	0.42	0.54	0.66	0.77	1.03
MSR Schedule 3 Parameters								
Total ammonia nitrogen	NR	mg/L	-	-	-	-	-	-
Total phosphorus	NR	mg/L	-	-	-	-	-	-
BOD	NR	mg/L	-	-	-	-	-	-
TSS	NR	mg/L	-	-	-	-	-	-
Other Nutrients								
Nitrate nitrogen	10	mg/L	0.019	0.019	0.019	0.019	0.019	0.019
Total Kjeldahl nitrogen	NR	mg/L	-	-	-	-	-	-
Total Metals								
Arsenic	NR	µg/L	-	-	-	-	-	-
Barium	NR	µg/L	-	-	-	-	-	-
Cadmium	NR	µg/L	-	-	-	-	-	-
Chromium	NR	µg/L	-	-	-	-	-	-
Chromium VI	NR	µg/L	-	-	-	-	-	-
Copper	1000	µg/L	0.001	0.001	0.001	0.001	0.001	0.001
Iron	NR	µg/L	-	-	-	-	-	-
Lead	50	µg/L	0.0004	0.0004	0.0004	0.0004	0.0004	0.0005

Parameter	WQG		Screening Quotient of Predicted Concentration at IDZ					
	Recre-ational Use	Units	Summer Low Flow (m^3/s)	Winter High Flow (m^3/s)				
			0.35	0.42	0.54	0.66	0.77	1.03
Manganese	NR	µg/L	-	-	-	-	-	-
Mercury	1	µg/L	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	NR	µg/L	-	-	-	-	-	-
Selenium	NR	µg/L	-	-	-	-	-	-
Silver	NR	µg/L	-	-	-	-	-	-
Zinc	5000	µg/L	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Organic Constituents								
Benzo(a)pyrene	NR	µg/L	-	-	-	-	-	-
Fluorene	NR	µg/L	-	-	-	-	-	-
Phenanthrene	NR	µg/L	-	-	-	-	-	-
Pyrene	NR	µg/L	-	-	-	-	-	-
Ethylbenzene	NR	µg/L	-	-	-	-	-	-
Toluene	NR	µg/L	-	-	-	-	-	-
Butylbenzyl phthalate	NR	µg/L	-	-	-	-	-	-
DDT (2,4)	NR	µg/L	-	-	-	-	-	-

Notes:
WQG – water quality guideline; IDZ – initial dilution zone; NR = none recommended; BOD – biological oxygen demand; TSS - total suspended solids
'-' = not calculable either because background data or an applicable WQG were not available
Bold values have a Screening Quotient of >1
**The chromium value was not speciated. For the purposes of this assessment the chromium was conservatively assumed to be hexavalent.

Table 17: Predicted Concentrations of Selected Parameters at the Edge of the IDZ for the Saanich East WWTP

Parameter	Units	Concentration								
		Effluent*	Back-ground	Predicted at IDZ						
				Summer Low Flow (m^3/s)	Winter High Flow (m^3/s)***					
				0.17	0.2	0.26	0.36	0.39	0.49	0.75
Dilution ratio **	(x:1)	-	-	3100	2310	2100	1680	1600	1350	820
MSR Schedule 3 Parameters										
Total ammonia nitrogen	mg/L	12.14	0.024	0.028	0.029	0.030	0.031	0.032	0.033	0.039
Total phosphorus	mg/L	3.086	0.075	0.0760	0.0763	0.0765	0.0768	0.0769	0.0773	0.0788
BOD	mg/L	17.6	1	1.01	1.01	1.01	1.01	1.01	1.01	1.02
TSS	mg/L	9.97	4	4.00	4.00	4.00	4.01	4.01	4.01	4.01
Other Nutrients										
Nitrate nitrogen	mg/L	0.070	0.194	0.19	0.19	0.19	0.19	0.19	0.19	0.19
Total Kjeldahl nitrogen	mg/L	17.2	0.132	0.14	0.14	0.14	0.14	0.14	0.14	0.15
Total Metals										
Arsenic	µg/L	0.5027	0.475	0.4752	0.4752	0.4752	0.4753	0.4753	0.4754	0.4756
Barium	µg/L	22	NA	-	-	-	-	-	-	-
Cadmium	µg/L	0.348	0.046	0.0461	0.0462	0.0462	0.0462	0.0462	0.0463	0.0464
Chromium (not speciated)	µg/L	2.2	0.1435	0.1442	0.1445	0.1446	0.1448	0.1449	0.1452	0.1462
Chromium VI	µg/L	1.9	NA	-	-	-	-	-	-	-
Copper	µg/L	41.4	0.62	0.63	0.63	0.64	0.64	0.64	0.65	0.67
Iron	µg/L	301	60	60.1	60.1	60.1	60.2	60.2	60.2	60.4
Lead	µg/L	5.74	0.01537	0.0172	0.0179	0.0181	0.0188	0.0190	0.0196	0.0224
Manganese	µg/L	69	3	3.02	3.03	3.03	3.04	3.04	3.05	3.08
Mercury	µg/L	0.044	0.000491	0.00051	0.00051	0.00051	0.00052	0.00052	0.00052	0.00054
Nickel	µg/L	3.50	0.41	0.411	0.412	0.412	0.412	0.412	0.413	0.414
Selenium	µg/L	0.4202	0.00178	0.0019	0.0020	0.0020	0.0020	0.0020	0.0021	0.0023
Silver	µg/L	0.3457	0.01	0.0101	0.0101	0.0102	0.0102	0.0102	0.0103	0.0104
Zinc	µg/L	24	1.13	1.14	1.14	1.15	1.15	1.15	1.15	1.16

Parameter	Units	Concentration								
		Effluent*	Back-ground	Predicted at IDZ						
				Summer Low Flow (m^3/s)	Winter High Flow (m^3/s)***					
				0.17	0.2	0.26	0.36	0.39	0.49	0.75
Organic Constituents										
Benzo(a)pyrene	µg/L	0.0138	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
Fluorene	µg/L	0.0038	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067
Phenanthrene	µg/L	0.0086	0.0055	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Pyrene	µg/L	0.0051	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053
Ethylbenzene	µg/L	0.0154	NA	-	-	-	-	-	-	-
Toluene	µg/L	0.135	NA	-	-	-	-	-	-	-
Butylbenzyl phthalate	µg/L	2.133	0.048	0.0487	0.0489	0.0490	0.0493	0.0493	0.0496	0.0506
DDT (2,4)	µg/L	0.00015	NA	-	-	-	-	-	-	-

Notes:
* from Associated (2008)
** from Hodgins (2008)
*** the flows represent 6 scenarios, ranging from predicted "base" flow to maximum predicted PWWF.
IDZ – initial dilution zone; BOD – biological oxygen demand; TSS – total suspended solids; NA – background information not available for the parameter
'-' – concentration at IDZ not predicted because background data were not available.

Table 18: Screening Quotients for Predicted Concentrations of Selected Parameters at the Edge of the IDZ Compared to WQG for Protection of Marine Aquatic Life (Saanich East WWTP)

Parameter	WQG		Screening Quotient of Predicted Concentration at IDZ						
	Aquatic Life (Marine)	Units	Summer Low Flow (m^3/s)	Winter High Flow (m^3/s)					
			0.17	**0.2**	**0.26**	**0.36**	**0.39**	**0.49**	**0.75**
MSR Schedule 3 Parameters									
Total ammonia nitrogen	8.7	mg/L	0.003	0.003	0.003	0.004	0.004	0.004	0.004
Total phosphorus	NR	mg/L	-	-	-	-	-	-	-
BOD	NR	mg/L	-	-	-	-	-	-	-
TSS	10	mg/L	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Other Nutrients									
Nitrate nitrogen	3.6	mg/L	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Total Kjeldahl nitrogen	NR	mg/L	-	-	-	-	-	-	-
Total Metals									
Arsenic	12	µg/L	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Barium	200	µg/L	-	-	-	-	-	-	-
Cadmium	0.12	µg/L	0.38	0.385	0.385	0.385	0.385	0.385	0.387
Chromium (not speciated)	1.5**	µg/L	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Chromium VI	1.5	µg/L	-	-	-	-	-	-	-
Copper	2	µg/L	0.315	0.317	0.318	0.320	0.321	0.323	0.333
Iron	NR	µg/L	-	-	-	-	-	-	-
Lead	2	µg/L	0.009	0.009	0.009	0.009	0.009	0.010	0.011
Manganese	NR	µg/L	-	-	-	-	-	-	-
Mercury	0.02	µg/L	0.025	0.026	0.026	0.026	0.026	0.026	0.027
Nickel	8.3	µg/L	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Selenium	2	µg/L	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Silver	1.5	µg/L	0.007	0.007	0.007	0.007	0.007	0.007	0.007
Zinc	10	µg/L	0.114	0.114	0.115	0.115	0.115	0.115	0.116
Organic Constituents									
Benzo(a)pyrene	0.01	µg/L	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**
Fluorene	12	µg/L	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Phenanthrene	NR	µg/L	-	-	-	-	-	-	-
Pyrene	NR	µg/L	-	-	-	-	-	-	-
Ethylbenzene	250	µg/L	-	-	-	-	-	-	-

Parameter	WQG Aquatic Life (Marine)	Units	Screening Quotient of Predicted Concentration at IDZ Summer Low Flow (m^3/s)	Winter High Flow (m^3/s)					
			0.17	0.2	0.26	0.36	0.39	0.49	0.75
Toluene	330	µg/L	-	-	-	-	-	-	-
Butylbenzyl phthalate	NR	µg/L	-	-	-	-	-	-	-
DDT (2,4)	0.001	µg/L	-	-	-	-	-	-	-

Notes:
WQG – water quality guideline; IDZ – initial dilution zone; NR = none recommended; BOD – biological oxygen demand; TSS - total suspended solids
'-' = not calculable either because background data or an applicable WQG were not available
Bold values have a Screening Quotient of >1
**The chromium value was not speciated. For the purposes of this assessment the chromium was conservatively assumed to be hexavalent.

Table 19: Screening Quotients for Predicted Concentrations of Selected Parameters at the Edge of the IDZ Compared to WQG for Protection of Recreational Uses (Saanich East WWTP)

Parameter	WQG Recre-ational Use	Units	Screening Quotient of Predicted Concentration at IDZ Summer Low Flow (m^3/s)	Winter High Flow (m^3/s)					
			0.17	0.2	0.26	0.36	0.39	0.49	0.75
MSR Schedule 3 Parameters									
Total ammonia nitrogen	NR	mg/L	-	-	-	-	-	-	-
Total phosphorus	NR	mg/L	-	-	-	-	-	-	-
BOD	NR	mg/L	-	-	-	-	-	-	-
TSS	NR	mg/L	-	-	-	-	-	-	-
Other Nutrients									
Nitrate nitrogen	10	mg/L	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Total Kjeldahl nitrogen	NR	mg/L	-	-	-	-	-	-	-
Total Metals									
Arsenic	NR	µg/L	-	-	-	-	-	-	-
Barium	NR	µg/L	-	-	-	-	-	-	-
Cadmium	NR	µg/L	-	-	-	-	-	-	-
Chromium	NR	µg/L	-	-	-	-	-	-	-
Chromium VI	NR	µg/L	-	-	-	-	-	-	-
Copper	1000	µg/L	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Iron	NR	µg/L	-	-	-	-	-	-	-
Lead	50	µg/L	0.0003	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004

Parameter	WQG		Screening Quotient of Predicted Concentration at IDZ						
	Recreational Use	Units	Summer Low Flow (m^3/s)	Winter High Flow (m^3/s)					
			0.17	0.2	0.26	0.36	0.39	0.49	0.75
Manganese	NR	µg/L	-	-	-	-	-	-	-
Mercury	1	µg/L	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	NR	µg/L	-	-	-	-	-	-	-
Selenium	NR	µg/L	-	-	-	-	-	-	-
Silver	NR	µg/L	-	-	-	-	-	-	-
Zinc	5000	µg/L	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Organic Constituents									
Benzo(a)pyrene	NR	µg/L	-	-	-	-	-	-	-
Fluorene	NR	µg/L	-	-	-	-	-	-	-
Phenanthrene	NR	µg/L	-	-	-	-	-	-	-
Pyrene	NR	µg/L	-	-	-	-	-	-	-
Ethylbenzene	NR	µg/L	-	-	-	-	-	-	-
Toluene	NR	µg/L	-	-	-	-	-	-	-
Butylbenzyl phthalate	NR	µg/L	-	-	-	-	-	-	-
DDT (2,4)	NR	µg/L	-	-	-	-	-	-	-

Notes:
WQG – water quality guideline; IDZ – initial dilution zone; NR = none recommended; BOD – biological oxygen demand; TSS - total suspended solids
'-' = not calculable either because background data or an applicable WQG were not available
Bold values have a Screening Quotient of >1
**The chromium value was not speciated. For the purposes of this assessment the chromium was conservatively assumed to be hexavalent.

4.4.1 Ammonia Nitrogen

4.4.1.1 West Shore WWTP

TAN is predicted to be 0.032 mg/L at the IDZ during summer low flows and 0.03 – 0.04 mg/L during winter high flows, resulting in SQs of 0.004 – 0.005 when compared to WQGs for protection of marine aquatic life. A WQG for recreational uses does not exist, but the predicted concentrations of TAN are not expected to be harmful to those engaging in primary or secondary contact activities.

Acutely lethal concentrations of ammonia in seawater are in the range of 0.59 to 3.59 mg/L, expressed as NH_3-N (Section 3.2). Based on an assumed effluent pH of 7.5 (rel. units), maximum summer water temperature[18] at the depth of the outfall (12°C; reported in the Aquametrix dataset for 30 m, the trapping depth for most of the scenarios modeled by Hodgins [2008]), and a salinity of 31‰, Bower and Bidwell (1978) predict that 0.558% of the TAN will be in the un-ionized form. Therefore, at an effluent concentration of 12 mg/L TAN, the predicted un-ionized concentration of ammonia, under the conditions of the receiving environment, in the effluent is calculated to be 0.067 mg/L. At this effluent concentration, lethal effects from ammonia are not expected at either the end of the pipe or within the IDZ where the modeled concentration of un-ionized ammonia would be 0.00018 mg/L during the summer and 0.00018 – 0.00023 mg/L during the winter.

The CRD will likely be required to conduct toxicity testing of the proposed effluents. The test used for assessing potential for acute lethality is the 96h LC_{50} rainbow trout toxicity test, and the temperature at which the test is conducted is 15°C as per standard protocols (*e.g.,* Environment Canada 2000). As ammonia toxicity in freshwater is governed by temperature and pH (Section 3.2), laboratory tests can over-estimate the potential for acute effects from ammonia if the laboratory temperature is higher than those measured in the receiving environment, which is the case for CRD's proposed discharges based on the available background temperature (*i.e.,* 15°C in the lab versus 12°C in the receiving environment). Based on the laboratory temperature of 15°C and an assumed effluent pH of 7.5, the equations of Emerson *et al.* (1975) predict that the un-ionized concentration of ammonia-N would be 0.085 mg/L. This concentration is higher than those predicted in the receiving environment, highlighting the difficulty in extrapolating toxicity results between laboratory conditions and the receiving environment. However, in this case ammonia toxicity in the lab is not predicted as acutely lethal levels of ammonia for rainbow trout in freshwater are between 0.16 ppm and 1.1 ppm NH_3-N (Thurston and Russo 1983).

An additional concern related to nutrient inputs is the potential for indirect effects associated with algal blooms (Section 3.3). Mackas and Harrison (1997) assessed the potential for eutrophication in the Juan de Fuca Strait/Strait of Georgia/Puget Sound complex and concluded that the Juan de Fuca Strait and the tidally-mixed passages linking it to the Strait of Georgia (*e.g.,* Haro Strait) are the least sensitive to nutrient inputs. Given that secondary treatment reduces nutrients (the RRE for TAN is 57%), it is not expected that the proposed WWTP will result in unacceptable algal blooms as there will be a net reduction in nutrient loadings as a result of changes to sewage treatment.

4.4.1.2 Saanich East WWTP

TAN is predicted to be in the order of 0.028 mg/L at the IDZ during summer low flows and 0.029 – 0.039 mg/L during winter high flows, resulting in SQs of 0.003 – 0.004 when compared to WQG for the protection of marine aquatic life (1.0 mg/L). A WQG for recreational uses does not exist, but the predicted concentrations of TAN are not expected to be harmful to those engaging in primary or secondary contact activities.

18 Ammonia toxicity increases at higher temperatures. Therefore, using the maximum temperature to calculate the concentration of un-ionized ammonia provides a conservative measure of the potential for ammonia toxicity.

As discussed in Section 4.4.1.1, at this effluent concentration, lethal effects from ammonia are not expected at either the end of the pipe or within the IDZ where the modeled concentration of un-ionized ammonia would be 0.00016 mg/L during the summer and 0.00016 – 0.00022 mg/L during the winter.

4.4.2 Phosphorus

4.4.2.1 West Shore WWTP

Predicted phosphorus concentrations at the edge of the IDZ during summer low flows (0.077 mg/L) and during winter high flows (0.077-0.08 mg/L) were marginally (<6% as RPD) above the background concentration used in this assessment. This change in concentrations at the IDZ would not be analytically distinguishable. There are no phosphorous WQG for either protection of marine aquatic life or recreational uses. However, it is not expected that the slight increase in phosphorus in the receiving environment from the West Shore will result in harmful water quality. The RRE for phosphorus in conventional secondary treatment is about 44%; therefore, phosphorus loading from the proposed WWTP is not expected to adversely alter existing phosphorus conditions.

4.4.2.2 Saanich East WWTP

Predicted phosphorus concentrations at the edge of the IDZ (0.076 – 0.079 mg/L) were marginally (< 5% as RPD) above the background concentration used in the assessment. As discussed in Section 4.4.2.1, these slight increases in phosphorus are not expected to have a harmful effect on the receiving environment.

4.4.3 Biochemical Oxygen Demand

Biochemical oxygen demand was originally developed as a standardized means of monitoring the efficacy of the sewage treatment process. It is a measure of the aggregate ability of a liquid to consume ("demand") oxygen and is not a measurement of a specific substance. The interpretation of BOD concentrations, as it relates to aquatic life, therefore differs from that of specific chemical substances. For example, for substances such as ammonia, the potential for harm to an organism is interpreted, and ambient WQG are developed, on the basis of known scientific data where a relationship has been established between the concentration of the substance and the effect on an organism exposed to that substance at a given concentration. In comparison, there is no relationship between a fixed amount of BOD and its effect on an aquatic organism, and thus there are no ambient WQG for BOD.

BOD data for the Strait of Georgia and Haro Strait were not available at the time of the modelling exercise therefore an assumed concentration of 1 mg/L was used. The effluent from the proposed WWTPs is expected to have a BOD of 17.6 mg/L. The MSR Schedule 3 Standards for Discharge to Water for the size and location of the proposed discharges allow for a BOD of 45 mg/L. For the purposes of providing a conservative assessment, both values were assessed here.

4.4.3.1 West Shore WWTP

At an effluent concentration of 17.6 mg/L, the predicted BOD at the edge of the IDZ during summer low flows will be 1.01 mg/L and during winter high flows will be 1.01 – 1.03 mg/L, which is marginally (< 2.6% RPD) above background. Changing the effluent concentration to 45 mg/L resulted in predicted concentrations of 1.03 mg/L during the summer and 1.03 – 1.07 mg/L during the winter. These changes in concentrations at the IDZ would not be analytically detectable.

The RRE for BOD via conventional secondary treatment is ~90% (Section 4.2). Therefore, BOD loading from the proposed WWTPs is not expected to adversely alter existing conditions in the receiving environment than may presently exist.

4.4.3.2 Saanich East WWTP

At an effluent concentration of 17.6 mg/L, the predicted BOD at the edge of the IDZ during summer low flows will be 1.01 mg/L and during winter high flows will be 1.01 – 1.02 mg/L. Changing the effluent concentration to 45 mg/L resulted in predicted concentrations of 1.01 mg/L during the summer and 1.01 – 1.05 mg/L during the winter. As discussed in Section 4.4.3.1, the incremental increase in BOD above background is not likely to result in worse conditions in the receiving environment than may presently exist.

4.4.4 Total Suspended Solids

The effluent from the proposed WWTPs is expected to have a TSS of 9.97 mg/L. The MSR Schedule 3 Standards for Discharge to Water for the size and location of the proposed discharges allow for a TSS of 45 mg/L. Both values were assessed here.

4.4.4.1 West Shore WWTP

TSS is predicted to be 4.01 mg/L at the edge of the IDZ during summer and 4.01 – 4.02 mg/L during winter based on an effluent concentration of 10 mg/L. These values are < 0.5% (as RPD) higher than background (4.0 mg/L was used here) and result in an SQ of 0.4 when compared to the WQG for protection of aquatic life. If an effluent TSS concentration based on the maximum Schedule 3 Standard were assumed (*i.e.,* 45 mg/L), the predicted TSS at the edge of the IDZ will be 4.03 mg/L during the summer and 4.03 – 4.07 during the winter. These values also result in SQs of 0.4 and are < 1.7% (as RPD) higher than background.

There are no WQG for the protection of recreational uses; however, this marginal increase in TSS is not expected to affect clarity of the water and therefore will not affect recreational uses.

4.4.4.2 Saanich East WWTP

TSS is predicted to be 4.0 mg/L at the edge of the IDZ during summer and 4.0 – 4.01 mg/L during winter. These values are < 0.3% (as RPD) higher than background and result in an SQ of 0.4 when compared to the WQG for protection of aquatic life. an effluent TSS concentration based on the maximum Schedule 3 Standard were assumed (*i.e.,* 45 mg/L), the predicted TSS at the edge of the IDZ will be 4.01 mg/L during the summer and 4.02 – 4.05 during the winter. These values also result in SQs of 0.4 and are < 1.4% (as RPD) higher than background.

There are no WQG for the protection of recreational uses; however, this marginal increase in TSS is not expected to affect clarity of the water and therefore will not affect recreational uses.

4.4.5 Fecal Coliforms

The prediction of fecal coliform concentrations at the edge of the IDZ was conducted by Hodgins (2008) and is detailed in Section 4.3.3.2. A summary is also provided here for convenience.

4.4.5.1 West Shore WWTP

For the West Shore WWTP, the 5-day running mean coliform concentrations were predicted to exceed 200 CFU/100 mL twice during a high-flow event lasting > 48 h (the maximum calculated means were in the order of 228 CFU/100 mL. Based on this Stage 1 EIS, it is premature to determine whether effluent disinfection is needed. Further assessments of the need for disinfection will be made as part of the Stage 2 EIS and as site selection and treatment processes are decided upon.

4.4.5.2 Saanich East WWTP

For the Saanich East WWTP, the running 5-d means were all predicted to be < 200 CFU/100 mL; therefore impacts to the receiving environment are not expected.

4.4.6 Other Parameters

The EIS for a small municipal sewage discharge from a localized, residential area typically is concerned with the parameters listed in Schedule 3 of the MSR (MoE 2000). However, as the proposed WWTPs at Finnerty Cove and Albert Head will serve a relatively large population of residences as well as some commercial and industrial facilities, it is appropriate to address other substances of interest here. Specifically, a select suite of total metals and organic parameters (*i.e.*, those for which predicted effluent concentrations and environmental quality criteria were available, and which are often considered "priority pollutants") are assessed in brief here.

4.4.6.1 Metals

The speciation of metals affects their toxicity. As a conservative means of assessing the potential for sublethal effects outside the IDZ was based on a comparison of total metals concentrations expected in the effluent to WQG, which are also expressed in total concentrations. For both WWTP locations, the calculated SQs were all < 1, suggesting that individually the subset of metals assessed would not be expected to result in sublethal effects outside the IDZ.

4.4.6.2 Organic Parameters

The CRD conducts extensive characterization of effluent quality at the Macaulay Point and Clover Point WWTPs. However, as the RRE is only known for a subset of organic parameters and WQG are available for a smaller subset yet, only a limited assessment of the potential for effects from organic substances of interest can be addressed in this Stage 1 EIS. Concentrations at the edge of the IDZ were predicted for four polycyclic aromatic hydrocarbons (PAHs; benzo(a)pyrene, fluorene, phenanthrene, and pyrene), two volatiles (ethylbenzene, toluene), one phthalate ester (butylbenzyl phthalate) and one pesticide (2,4-DDT).

SQs were calculated for only two of these parameters as they were the only ones for which background concentrations and WQG were both available: benzo(a)pyrene (1.7) and fluorene (0.001). The SQ for benzo(a)pyrene was > 1 because the background concentration used (0.017 µg/L) exceeded the WQG of 0.01 µg/L. Where the background concentration exceeds the WQG, a common practice followed by the MoE is to identify if the predicted post-discharge scenario will elevate the environmental concentration by more than a RPD of 20%. A 20% RPD is the limit of precision that is commonly offered by analytical laboratories. The RPD between the background concentration and the predicted concentrations of benzo(a)pyrene were < 1%, which given the precision commonly available in analytical methods would likely not be detectable in a monitoring program.

4.5 Nutrient Loadings

The EIS guidelines recommend the calculation of nutrient loading to the receiving environment (MoE 2000).[19] The loading was calculated as follows (with appropriate conversions to account for necessary changes in units):

$$Load = Flow \times Concentration_{Effluent}$$

The inputs to this equation were based on the following values and assumptions:

- The estimated effluent concentrations for TAN and total phosphorus (Table 10);
- The maximum effluent flows estimated for the year 2038 (Table 12 – West Shore WWTP; Table 13 – Saanich East WWTP);
- It was assumed that the summer low flows occur for six months of the year and that the peak winter flows occur for the remaining six months of the year.

As the design and specifications of the treatment facilities have not yet been finalized, the calculation of nutrient loadings here is based on a highly conservative scenario. Specifically, the highest PWWF values for each WWTP has been used in the calculations. In reality, these values represent a 25-year return period flow with a maximum duration of one hour, and are thus higher than what "typical" wet weather flows would be. Therefore, the following calculation of loading is likely an over estimate by a factor of about two (R. Corbett, Associated Engineering, pers. comm.).

Using these conservative assumptions, annual loadings from the West Shore WWTP by the year 2038 are estimated to be ~67,000 kg/yr phosphorus and ~263,000 kg/yr nitrogen (as TAN; Table 20). The loading from the Saanich East WWTP is estimated to less, at ~45,000 kg/yr phosphorus and ~176,000 kg/yr nitrogen (as TAN).

Table 20: Summary of Anticipated Annual Nutrient Loading from the Proposed WWTPs With Secondary Treatment

Proposed WWTP	Effluent Concentration (mg/L)		Effluent Flow at Year 2038 Capacity (m^3/s)		Loading (kg/yr)	
	P	N (as TAN)	Summer	Winter	P	N (as TAN)
West Shore	3.086	12.1	0.35	1.03	67,151	263,294
Saanich East	3.086	12.1	0.17	0.75	44,767	175,529
Totals					**11,918**	**438,832**

Notes:
P – phosphorus; N – nitrogen; TAN – total ammonia nitrogen

19 The EIS guidelines recommend that the calculation of nutrient loading include "all relevant nitrogen and phosphorus species" (MoE 2000). For the present assessment, total ammonia nitrogen and total phosphorus were selected as they comprise the largest fraction of these two nutrients in the proposed WWTP effluents. Nitrate-N is an important form of nitrogen from the perspective of relatively high uptake efficiency by plants; however, nitrogen is not expected to occur in significant concentrations as nitrate-N, and is therefore not included in the nutrient loading assessment.

A detailed assessment of potential for effects on the assimilative capacity of the receiving water, including the cumulative impact of other nearby discharges, is beyond the scope of an EIS at Stage 1. For a qualitative comparison, the present loadings from the Macaulay and Clover Point WWTPs as calculated by the CRD (2008b) are provided in Table 21. The assessment of nutrient loadings is an area of uncertainty (due to the conservative assumptions used in the calculations) in the EIS that should be addressed further in the Stage 2 assessment.

Table 21: Summary Annual Nutrient Loading from the Macaulay Point and Clover Point WWTPs in 2007

Wastewater Treatment Plant	Effluent Concentration (mg/L)		Loading (kg/yr)	
	P	N (as TAN)	P	N (as TAN)
Macaulay Point	5.75	31.44	93,307	518,811
Clover Point	5.01	20.97	105,459	442,629
Total			**198,766**	**961,440**

5.0 ASSESSMENT OF UNCERTAINTIES

The Stage 1 EIS conducted here was necessarily a predictive exercise with the objective of forecasting whether or not the proposed effluent will result in adverse effects to the receiving environment. Accordingly, it is not possible to make direct environmental measurements in the receiving environment and assess impact directly. Moreover, assessing impact pre-discharge requires the use of various predictive tools such as effluent dispersion modeling. While these tools are useful and provide a reasonable prediction of likely circumstances, it is important to identify the major uncertainties associated with a predictive EIS and to consider the implications of these uncertainties on predictions made, particularly for an ecologically significant waterbody such as the Juan de Fuca/Haro Strait/Strait of Georgia complex. Finally, if the findings of the EIS and the analysis of uncertainties provide confidence that the discharge can proceed, the identification of uncertainties will assist in focusing a receiving environment monitoring program once effluent discharge commences. The key uncertainties are as follows:

1) Expected environmental concentrations, which are influenced by:
   a) The plume dilution model and expected flows;
   b) Background concentrations; and,
   c) Effluent concentrations.
2) Identification of species assemblage, habitat use, and ecological interactions; and,
3) Interactions of a contaminant mixture.

5.1 Expected Environmental Concentrations

The prediction of environmental concentrations at the edge of the IDZ (the assessment point in this EIS) was based on predictive modeling as well as a series of existing data sources, each of which may introduce uncertainty into the assessment as follows.

5.1.1 Plume Dilution Model and Effluent Flow

Computer models such as the plume dilution model presented in Hodgins (2008) are a useful environmental management tool as they enable timely prediction of potential environmental effects or lack thereof before any effluent is discharged. However, because the discharge does not yet exist it was necessary to make assumptions about the condition of the discharge.

The plume dilution modeling provided some information about the influence of changing effluent flows on expected receiving environment concentrations. Effluent discharge rates were taken from estimates prepared by Associated Engineering for two seasons, the summer low flow period and the winter high flow period and three future time periods (2013, 2023, and 2038) based on projected population growth. Plume dilution modeling was conducted for both seasons and for the projected population growth as of the year 2038 as this is considered the "worst case". While effluent flows used in the plume dispersion modeling for the West Shore WWTP ranged from 0.35 m^3/s during summer low flows to 1.03 m^3/s during peak winter flows (a 98% RPD), the predicted concentrations of parameters of interest generally varied < 5% (as RPD).[20] The parameters with the highest RPD values were those for which the effluent concentration was significantly greater than the background concentration. For example, predicted TAN concentrations at the IDZ for the West Shore WWTP ranged from

20 RPD <20% indicate that two values are not considered notably different in the context of the ability to detect differences given analytical variability.

0.032 to 0.042 mg/L, which results in an RPD of 28% between minimum and maximum values. However, an RPD > 20% for TAN is not significant as predicted TAN values for both flow conditions are below WQG. This indicates that predicted receiving environment concentrations are relatively insensitive to changes in effluent flow.

An additional uncertainty associated with the plume dilution model was associated with the oceanographic data used (Section 4.3.1). The currents and density stratification information were from studies done in nearby areas, and were suitable for conducting a Stage 1 assessment. For Stage 2 assessments, the EIS guidelines indicate that site-specific current and flow studies should be conducted to establish oceanographic conditions and help select the optimum outfall location, at which CTD profiles should be measured to confirm stratification levels (MoE 2000). The selection of an outfall location is a pre-requisite to undertaking current meter studies at the outfall (diffuser) location.

5.1.2 Background Concentrations

The background concentrations used in conjunction with the plume dilution modeling to predict receiving environment concentrations at the edge of the IDZ were based on a series of data sources ranging from relatively local measurements of nutrients to concentrations of metals and organic substances of concern from farther afield. The selected background concentrations were considered acceptable for the purposes of a Stage 1 EIS, though the lack of site-specificity and dated nature of the data set is a clear uncertainty. Site-specific baseline water quality characterization will be undertaken in advance of the Stage 2 EIS and, given the uncertainty in the existing data set, is a necessity.

A means of assessing the uncertainty (or sensitivity) in the expected environmental concentrations predicted in this component of the EIS is to (artificially within the modeling) vary the background concentrations used in predicting effluent concentrations at the edge of the IDZ. To do this, background concentrations were assumed to be equivalent to WQG values where available (done only for aquatic life as there are few WQG for recreational uses). The presence of substances at or above the WQG value is not uncommon and therefore a plausible value to use for the purpose of uncertainty assessment, in a conservative context. Assuming a background concentration of zero was not done because this would result in a less conservative prediction (see equation in Section 4.4).

The resulting predicted receiving environment concentrations and RPDs between the new predictions and WQG/background are provided in Table 22 and Table 23 for the West Shore WWTP and Table 24 and Table 25 for the Saanich East WWTP. When calculated assuming that background concentrations are equivalent to WQG, all predicted concentrations exceed the WQG, as expected since the background concentration alone would produce a SQ of 1. The RPD between the predicted receiving environment concentrations and WQG/background were all < 5%. Accordingly, the plume at the edge of the IDZ would not be analytically distinguishable from the surrounding receiving environment outside the IDZ. It should be noted that not all parameters would be expected to be at the WQG concentration. In reality, most should be well below the WQG and some may be naturally above the WQG.

Table 22: Predicted Concentrations of Selected Parameters at the Edge of the IDZ for the West Shore WWTP Assuming that Background Concentrations are Equivalent to WQG (West Shore WWTP)

Parameter	Units	Concentration							
		Effluent	Back-Ground (= WQG)	Predicted at IDZ					
				Summer Low Flow (m^3/s)	Winter High Flow (m^3/s)				
				0.35	**0.42**	**0.54**	**0.66**	**0.77**	**1.03**
Dilution ratio **	(x:1)	-	-	1570	1360	1130	960	853	660
MSR Schedule 3 Parameters									
Total ammonia nitrogen	mg/L	12.14	8.7	8.71	8.71	8.71	8.71	8.71	8.72
Total phosphorus	mg/L	3.086	NR	-	-	-	-	-	-
BOD	mg/L	17.6	NR	-	-	-	-	-	-
TSS	mg/L	9.97	10	10.01	10.01	10.01	10.01	10.01	10.02
Other Nutrients									
Nitrate nitrogen	mg/L	0.070	3.6	-	-	-	-	-	-
Total Kjeldahl nitrogen	mg/L	17.2	NR	-	-	-	-	-	-
Total Metals									
Arsenic	µg/L	0.5027	12	12.0003	12.0004	12.0004	12.0005	12.0006	12.0008
Barium	µg/L	22	200	200	200	200	200	200	200
Cadmium	µg/L	0.348	0.12	0.1202	0.1203	0.1203	0.1204	0.1204	0.1205
Chromium	µg/L	2.2	1.5	-	-	-	-	-	-
Chromium VI	µg/L	1.9	1.5	1.50	1.50	1.50	1.50	1.50	1.50
Copper	µg/L	41.4	2	2.03	2.03	2.04	2.04	2.05	2.06
Iron	µg/L	301	NR	-	-	-	-	-	-
Lead	µg/L	5.74	2	2.0037	2.0042	2.0051	2.0060	2.0067	2.0087
Manganese	µg/L	69	NR	-	-	-	-	-	-
Mercury	µg/L	0.044	0.02	0.02003	0.02003	0.02004	0.02005	0.02005	0.02007
Nickel	µg/L	3.50	8.3	8.302	8.303	8.303	8.304	8.304	8.305
Selenium	µg/L	0.4202	2	2.0003	2.0003	2.0004	2.0004	2.0005	2.0006
Silver	µg/L	0.3457	1.5	1.5002	1.5003	1.5003	1.5004	1.5004	1.5005
Zinc	µg/L	24	10	10.02	10.02	10.02	10.02	10.03	10.04
Organic Constituents									
Benzo(a)pyrene	µg/L	0.0138	0.01	0.010	0.010	0.010	0.010	0.010	0.010
Fluorene	µg/L	0.0038	12	12.0	12.0	12.0	12.0	12.0	12.0
Phenanthrene	µg/L	0.0086	NR	-	-	-	-	-	-
Pyrene	µg/L	0.0051	NR	-	-	-	-	-	-
Ethylbenzene	µg/L	0.0154	250	250	250	250	250	250	250
Toluene	µg/L	0.1350	330	330	330	330	330	330	330
Butylbenzyl phthalate	µg/L	2.1330	NR	-	-	-	-	-	-
DDT (2,4)	µg/L	0.00015	0.001	-	-	-	-	-	-

Notes:
IDZ – Initial dilution zone
NR – None recommended
'-' – not predicted because either a background concentration or WQG was not available.

Table 23: Relative Percent Difference Between Predicted Receiving Environment Concentrations Based on Two Different Background Concentrations (West Shore WWTP)

Parameter	RPD Between Predicted Concentrations at IDZ					
	Summer Low low (m^3/s)	Winter High Flow (m^3/s)				
	0.35	0.42	0.54	0.66	0.77	1.03
MSR Schedule 3 Parameters						
Total ammonia nitrogen	0.09	0.10	0.12	0.15	0.16	0.21
Total phosphorus	-	-	-	-	-	-
BOD	-	-	-	-	-	-
TSS	0.06	0.07	0.09	0.10	0.12	0.15
Other Nutrients						
Nitrate nitrogen	-	-	-	-	-	-
Total Kjeldahl nitrogen	-	-	-	-	-	-
Total Metals						
Arsenic	0.003	0.003	0.004	0.004	0.005	0.006
Barium	0.007	0.008	0.010	0.012	0.013	0.017
Cadmium	0.18	0.21	0.26	0.30	0.34	0.44
Chromium	-	-	-	-	-	-
Chromium VI	0.08	0.09	0.11	0.13	0.15	0.20
Copper	1.31	1.51	1.81	2.13	2.39	3.08
Iron	-	-	-	-	-	-
Lead	0.18	0.21	0.25	0.30	0.34	0.43
Manganese	-	-	-	-	-	-
Mercury	0.14	0.16	0.19	0.23	0.26	0.33
Nickel	0.03	0.03	0.04	0.04	0.05	0.06
Selenium	0.01	0.02	0.02	0.02	0.02	0.03
Silver	0.01	0.02	0.02	0.02	0.03	0.03
Zinc	0.15	0.18	0.21	0.25	0.28	0.36
Organic Constituents						
Benzo(a)pyrene	0.09	0.10	0.12	0.14	0.16	0.21
Fluorene	0.00002	0.00002	0.00003	0.00003	0.00004	0.00005
Phenanthrene	-	-	-	-	-	-
Pyrene	-	-	-	-	-	-
Ethylbenzene	0.000004	0.000005	0.000005	0.000006	0.000007	0.000009
Toluene	0.000026	0.000030	0.000036	0.000043	0.000048	0.000062
Butylbenzyl phthalate	-	-	-	-	-	-
DDT (2,4)	-	-	-	-	-	-

Notes:

RPD – Relative percent difference (calculated using original predicted values in Table 14 and those in Table 22 which assumed that background concentrations were equivalent to WQG.

'-' – RPD not calculated because a WQG was not available

Table 24: Predicted Concentrations of Selected Parameters at the Edge of the IDZ for the West Shore WWTP Assuming that Background Concentrations are Equivalent to WQG (Saanich East WWTP)

Parameter	Units	Effluent	Background (= WQG)	Concentration						
				Predicted at IDZ						
				Summer Low Flow (m^3/s)	Winter High Flow (m^3/s)					
				0.17	0.2	0.26	0.36	0.39	0.49	0.75
MSR Schedule 3 Parameters										
Total ammonia nitrogen	mg/L	12.14	8.7	8.70	8.71	8.71	8.71	8.71	8.71	8.71
Total phosphorus	mg/L	3.086	NR	-	-	-	-	-	-	-
BOD	mg/L	17.6	NR	-	-	-	-	-	-	-
TSS	mg/L	9.97	10	10.00	10.00	10.00	10.01	10.01	10.01	10.01
Other Nutrients										
Nitrate nitrogen	mg/L	0.070	3.6	-	-	-	-	-	-	-
Total Kjeldahl nitrogen	mg/L	17.2	NR	-	-	-	-	-	-	-
Total Metals										
Arsenic	µg/L	0.5027	12	12.0002	12.0002	12.0002	12.0003	12.0003	12.0004	12.0006
Barium	µg/L	22	200	200	200	200	200	200	200	200
Cadmium	µg/L	0.348	0.12	0.1201	0.1202	0.1202	0.1202	0.1202	0.1203	0.1204
Chromium	µg/L	2.2	1.5	-	-	-	-	-	-	-
Chromium VI	µg/L	1.9	1.5	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Copper	µg/L	41.4	2	2.01	2.02	2.02	2.02	2.03	2.03	2.05
Iron	µg/L	301	NR	-	-	-	-	-	-	-
Lead	µg/L	5.74	2	2.0019	2.0025	2.0027	2.0034	2.0036	2.0043	2.0070
Manganese	µg/L	69	NR	-	-	-	-	-	-	-
Mercury	µg/L	0.044	0.02	0.02001	0.02002	0.02002	0.02003	0.02003	0.02003	0.02005
Nickel	µg/L	3.50	8.3	8.301	8.302	8.302	8.302	8.302	8.303	8.304
Selenium	µg/L	0.4202	2	2.0001	2.0002	2.0002	2.0003	2.0003	2.0003	2.0005
Silver	µg/L	0.3457	1.5	1.5001	1.5001	1.5002	1.5002	1.5002	1.5003	1.5004
Zinc	µg/L	24	10	10.01	10.01	10.01	10.01	10.01	10.02	10.03
Organic Constituents										
Benzo(a)pyrene	µg/L	0.0138	0.01	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Fluorene	µg/L	0.0038	12	12.0	12.0	12.0	12.0	12.0	12.0	12.0
Phenanthrene	µg/L	0.0086	NR	-	-	-	-	-	-	-
Pyrene	µg/L	0.0051	NR	-	-	-	-	-	-	-
Ethylbenzene	µg/L	0.0154	250	250	250	250	250	250	250	250
Toluene	µg/L	0.1350	330	330	330	330	330	330	330	330
Butylbenzyl phthalate	µg/L	2.1330	NR	-	-	-	-	-	-	-
DDT (2,4)	µg/L	0.00015	0.001	-	-	-	-	-	-	-

Notes:

IDZ – Initial dilution zone

NR – None recommended

'-' – not predicted because either a background concentration or WQG was not available.

Table 25: Relative Percent Difference Between Predicted Receiving Environment Concentrations Based on Two Different Background Concentrations (Saanich East WWTP)

Parameter	RPD Between Predicted Concentrations at IDZ						
	Summer Low Flow (m^3/s)	Winter High Flow (m^3/s)					
	0.17	0.2	0.26	0.36	0.39	0.49	0.75
MSR Schedule 3 Parameters							
Total ammonia nitrogen	0.04	0.06	0.07	0.08	0.09	0.10	0.17
Total phosphorus	-	-	-	-	-	-	-
BOD	-	-	-	-	-	-	-
TSS	0.03	0.04	0.05	0.06	0.06	0.07	0.12
Other Nutrients							
Nitrate nitrogen	-	-	-	-	-	-	-
Total Kjeldahl nitrogen	-	-	-	-	-	-	-
Total Metals							
Arsenic	0.001	0.002	0.002	0.002	0.003	0.003	0.005
Barium	0.004	0.005	0.005	0.007	0.007	0.008	0.014
Cadmium	0.09	0.13	0.14	0.17	0.18	0.21	0.35
Chromium	-	-	-	-	-	-	-
Chromium VI	0.04	0.06	0.06	0.08	0.08	0.10	0.16
Copper	0.66	0.89	0.98	1.22	1.28	1.52	2.49
Iron	-	-	-	-	-	-	-
Lead	0.09	0.12	0.14	0.17	0.18	0.21	0.35
Manganese	-	-	-	-	-	-	-
Mercury	0.07	0.10	0.10	0.13	0.14	0.16	0.27
Nickel	0.01	0.02	0.02	0.03	0.03	0.03	0.05
Selenium	0.01	0.01	0.01	0.01	0.01	0.02	0.03
Silver	0.01	0.01	0.01	0.01	0.01	0.02	0.03
Zinc	0.08	0.10	0.11	0.14	0.15	0.18	0.29
Organic Constituents							
Benzo(a)pyrene	0.04	0.06	0.07	0.08	0.09	0.10	0.17
Fluorene	0.00001	0.00001	0.00001	0.00002	0.00002	0.00002	0.00004
Phenanthrene	-	-	-	-	-	-	-
Pyrene	-	-	-	-	-	-	-
Ethylbenzene	0.000002	0.000003	0.000003	0.000004	0.000004	0.000005	0.000008
Toluene	0.00001	0.00002	0.00002	0.00002	0.00003	0.00003	0.00005
Butylbenzyl phthalate	-	-	-	-	-	-	-
DDT (2,4)	-	-	-	-	-	-	-

RPD – Relative percent difference (calculated using original predicted values in Table 17 and those in Table 24 which assumed that background concentrations were equivalent to WQG.

'-' – RPD not calculated because a WQG was not available

5.1.3 Effluent Concentrations

The effluent concentration used in the impact assessment was based on mean values measured at the Macaulay WWTP for 2005 and 2006 with assumed relative removal efficiency values for conventional secondary treatment applied (Section 4.2). The level of treatment has not yet been decided and the effluent concentrations used in the modeling are therefore uncertain. However, the level of treatment will not be less than conventional secondary treatment and an assessment carried out under this assumption is therefore believed to represent a conservative evaluation.

To provide an additional assessment of the potential uncertainty (or sensitivity) associated with this data source, the 95% upper confidence limit of the mean (UCLM) was calculated (based on the same dataset from which mean effluent concentrations were derived [Table 10]) for a subset of parameters for which the largest SQs were observed in the preliminary assessment (Section 4.4). The concentration of these parameters at the edge of the IDZ was then recalculated for the highest winter flow scenario (the "worst case"), as were SQs (Table 26). Increasing the predicted effluent concentration from mean values to the 95% UCLM did not result in increasing SQs by more than about 0.05 (and none exceeded a value of 1), indicating that the predicted receiving environment concentrations are relatively insensitive to changes in the predicted effluent concentrations used in the evaluation, because the expected dilution will be high.

Table 26: Summary of Variability in Predicted Receiving Environment Concentrations When the Effluent Concentration is Changed.

Selected Parameter	Units	Concentration				SQ
		Effluent		Background	Predicted at IDZ, Winter High Flow (m^3/s) 1.03	
Total ammonia nitrogen	mg/L	Mean	12.14	0.024	0.042	0.0049
		95% UCLM	13.05	0.024	0.044	0.0050
TSS	mg/L	Mean	9.97	4	4.02	0.4015
		95% UCLM	11.30	4	4.02	0.4017
Copper	µg/L	Mean	41.4	0.62	0.68	0.3394
		95% UCLM	45.6	0.62	0.69	0.3426
Zinc	µg/L	Mean	24	1.13	1.170	0.1170
		95% UCLM	25.7	1.13	1.173	0.1173
Benzo(a)pyrene	µg/L	Mean	0.0138	0.017	0.01702	1.7020
		95% UCLM	0.0166	0.017	0.01703	1.7025

5.2 Identification of Species Assemblage, Habitat Use, and Ecological Interactions

The level of knowledge presented in the report is sufficient for the purposes of this assessment as conservative values were used for modeling receiving environment concentrations of parameters of interest and generic protection levels for aquatic life (WQG) were used as data screening benchmarks. WQG are intended to be conservative and therefore considered to be protective of a wide assemblage of aquatic organisms.

An essential aspect of site-specific studies as part of Stage 2 will be to identify important habitat features and usage to guide the eventual siting of the physical outfall structure. For example, herring spawning grounds have been identified in the Albert Head area (Section 2.2.2) as has rockfish habitat (Section 2.3.5) and potentially Northern abalone (a red-listed species) habitat (Section 2.3.6). The specific interactions with potentially "critical" habitat could not be evaluated at the Stage 1 level because the precise location of the outfall is not known. The evaluation conducted here has been carried out on the basis of dilution at the edge of the IDZ. However, as the project design advances, it will be necessary to avoid[21] critical habitat areas or to conduct a more detailed evaluation of exposure conditions in such areas, even within the IDZ.

5.3 Interaction of a Contaminant Mixture

The assessment and conclusions herein are based on individual substances of interest. However, aquatic biota in the marine receiving environment will be exposed to a mixture of substances in which contaminants can interact (*e.g.*, Section 3.7). The ability to predict the toxicity of chemical mixtures is not well developed and this is a potential source of uncertainty. However, the findings of this assessment have identified no exceedances of WQG except for benzo(a)pyrene (which exceeds WQG due to the background concentration used) and thus the significance of this uncertainty is thought to be low. The potential for adverse interactions would likely be greater if there were multiple parameter exceedances of WQG. The known interaction of reduced oxygen with ammonia toxicity is unlikely to be an issue because predicted ammonia concentrations are well below WQG and dissolved oxygen reductions are expected to be small.

The issue of mixture toxicity will be addressed through toxicity testing carried out as part of a subsequent effluent monitoring program. Toxicity identification evaluation (TIE) can be carried out if necessary to ascertain causal agents.

5.4 Summary

Identified uncertainties and the estimated impact of these uncertainties on the prediction of effects is summarized in Table 27.

Table 27: Evaluation of Uncertainty

Assumption	Uncer-tainty	Under/over Estimate of Impact	Rationale
Plume dilution is as predicted by the model	Low	Neutral	The plume dilution predictions are based on a model that is recommended by MoE and carried out by an experienced modeler. The oceanographic inputs to the model were based on calibrated models for the area and background conditions were based on data sets used for near-by areas. The model predicts a high level of dilution, even if reasonable uncertainty is factored in.

21 Fish habitat management policy in Canada indicates a policy preference for avoidance of such impacts at the outset, through project design, rather than assessment/mitigation. It is recommended that detailed habitat surveys be carried out to support siting of the outfall structure. As well, the MSR specifies that the edge of the IDZ must be 300 m away from sensitive areas such as recreational areas and shellfish beds (S.5[6]).

Assumption	Uncer-tainty	Under/over Estimate of Impact	Rationale
Background concentrations are as identified in the existing data set	Moderate	Neutral	The background concentrations selected were from the local area and/or were within those published for general marine conditions. A sensitivity analysis indicated that increasing background concentrations in the model to ambient WQG resulted in predicted concentrations at the edge of the IDZ that would be indistinguishable from the surrounding receiving environment outside the IDZ. It should be noted that in reality, not all parameters would be expected to be at the WQG concentration. In reality, most should be well below the WQG and some may be naturally above the WQG.
Effluent flow estimated represents the flows under operation	Moderate	Neutral	The plume dilution model incorporated an assessment of different flows by season, which varied up to an order of magnitude. While dilution was predicted to also vary an order of magnitude between summer low flows and winter peak wet weather flows, dilution in all the scenarios modeled was high (*i.e.*, >100:1) and exceedances of WQG at the edge of the IDZ were not predicted in any case except for benzo(a)pyrene and fecal coliforms. The exceedance of the WQG for benzo(a)pyrene was the result of the background concentrations being higher than the WQG. Fecal coliforms may also exceed WQG under certain, limited circumstances that will be re-evaluated in the Stage 2 assessment.
Effluent concentrations under operation will be similar to those predicted using existing data and relative removal estimates	Low	Neutral	The assessment was based on effluent concentrations measured at the Macaulay WWTP in 2005 and 2006 with literature-based relative removal estimates for conventional secondary treatment. It is anticipated that the eventual treatment process will achieve a secondary level of treatment or better.
Nutrient loadings will be as calculated	Moderate	Over	The calculation of nutrient loadings was based on highly conservative assumptions of flow rates and durations during wet weather flows and therefore likely overestimates what the loadings will be by a factor of two.
Identification of habitat and use is as described	Moderate	Neutral	The selection of sites for the treatment plants and associated infrastructure has not been completed. Prior to completion of the Stage 2 assessment, detailed site-specific receiving environment use studies will need to be conducted. Information from these studies will be used to guide the eventual siting of the physical outfall structure.
Interaction of contaminant mixtures will not result in effects greater than estimated through the use of WQG.	Low	Neutral	While substances of concern were assessed individually, the expected dilution ratios will be high. Screening quotients were low and multiple criteria exceedances were not predicted, indicating a low likelihood for contaminant interactions by virtue of low concentrations. Biological testing will be carried out on the (undiluted) effluent to determine the potential for adverse interactions.

6.0 CONCLUSIONS AND RECOMMENDATIONS

To identify the potential environmental impact of effluent from the proposed WWTPs in the vicinity of Albert Head and Finnerty Cove, a Stage 1 EIS was conducted. The anticipated concentrations of select parameters in municipal sewage treated to conventional secondary levels were modeled on the basis of existing information for several effluent flow scenarios to predict concentrations in the receiving environment. These predicted concentrations were compared to applicable WQGs, which took into account the ecological resources in the area of the proposed discharges as well as the human and ecological uses of the receiving water. The predicted concentrations of the select parameters were less than the applicable WQG in all cases except for benzo(a)pyrene and fecal coliforms. The exceedance of the WQG for benzo(a)pyrene was the result of the background concentrations being higher than the WQG. Fecal coliforms may also exceed WQG under certain circumstances (*e.g.*, during a high flow event that lasted > 48 h). Conditions under which fecal coliforms were predicted to exceed WQG for recreational contact were extended high flow conditions during winter at the West Shore WWTP. Under such conditions and the predicted plume trapping it is unlikely that there will be substantial recreational contact with the plume; however, the predictions here are subject to uncertainty (*e.g.*, due to conservative assumptions used, they may overestimate what will occur in the receiving environment). Therefore, based on this Stage 1 EIS, it would be premature to conclude that effluent disinfection is needed. Further assessments of the need for disinfection will be made as part of the Stage 2 EIS and as site selection and treatment processes are decided upon.

Overall, the Stage 1 assessment, which was based on conservative assumptions, did not predict that the proposed treated effluent discharge will result in harm to the receiving environment (*i.e.*, impacts are not expected to be significant). Indeed, conventional secondary treatment removes a significant proportion of substances of concern such as nitrogen, phosphorus, TSS, BOD, and selected metals and organic compounds.

Computer models are a useful environmental management tool as they enable the timely prediction of potential environmental effects or lack thereof before any effluent is discharged. As the discharge does not yet exist, it was necessary to make assumptions about the conditions of discharge. Uncertainties associated with those assumptions were assessed and were found to be low or moderate and the potential under or over estimate of impacts related to these uncertainties was found to be neutral as a Stage 2 assessment is expected to be completed. Finalization of the treatment plant designs and specifications as well as collection of site-specific baseline data will provide additional information to place the physical outfall structure in the optimal location and thus help mitigate these potential uncertainties. Table 28 summarizes a series of recommendations intended to address the uncertainties identified in the present report, as well as data requests made by MoE during pre-EIS consultation, MoE guidance for conducting Stage 2 EIS's (MoE 2000) and other government guidance received during the collection of receiving environment information. The detailed scope of work for the recommended site-specific studies will require consultation with MoE and will benefit from an increased level of detail regarding potential outfall locations and oceanographic conditions.

Table 28: Summary of Recommendations

Uncertainty	Recommendation	Rationale
Plume dilution model	• Collect site-specific baseline oceanographic information (current/flow studies, CTD measurements) for inclusion in a refinement of the plume dilution model. These studies are done once the physical outfall structure siting is finalized • Conduct sedimentation analysis.	• Identified as an uncertainty • MoE guidance
Effluent flow	• Incorporate updated flow rates into plume dilution model once WWTP design finalized. • Model additional scenarios including daily peaks and seasonal fluctuations in flows.	• Identified as an uncertainty • MoE guidance
Background concentrations	• Conduct site-specific water quality monitoring program following MoE guidance. • Conduct site-specific sediment quality monitoring program. • Include assessment of *Entercocci* as an additional microbiological indicator.	• Identified as an uncertainty • MoE guidance • Anticipated future microbiological indicator
Effluent concentrations	• Incorporate updated effluent concentrations into plume dilution model once WWTP design/specifications are finalized. • Develop contingency plan and design WWTPs for possible future disinfection in the event that microbial indicators are found to exceed WQG. • Conduct a more detailed assessment of potential for impacts from nutrient loading once baseline water quality studies have been conducted and the WWTP design/specifications are finalized.	• Identified as an uncertainty • MoE guidance
Identification of habitat and use	• Conduct site-specific habitat and use studies to assist in locating the physical outfall structures. • Conduct abalone assessment per DFO protocol.	• Identified as an uncertainty • Existing information indicates potential presence of important habitat features • MoE guidance • DFO guidance
Interaction of contaminant mixtures	• Conduct toxicity testing	• Identified as an uncertainty • Anticipated effluent monitoring requirement in the future

7.0 CLOSURE

We trust this report meets your needs at this time. Should you have any questions or concerns, please do not hesitate to contact the undersigned at 604-296-4200.

GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED

ORIGINAL SIGNED

Lee Nikl, M.Sc., R.P.Bio.
Associate/Senior Environmental Scientist

Barbara Wernick, M.Sc., R.P.Bio.
Associate/Senior Environmental Scientist

LHN/BGW/nlb

Attachments

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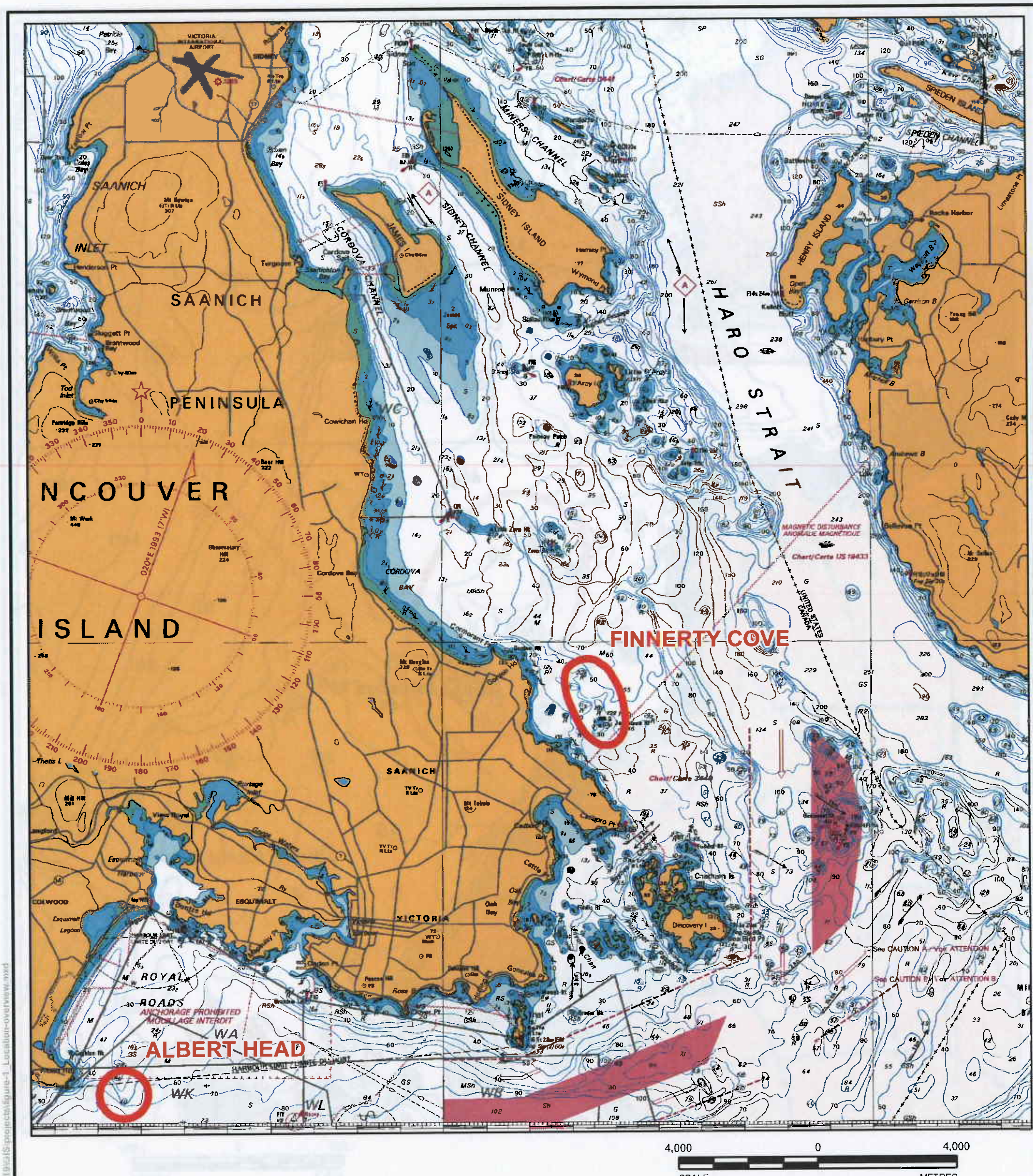


CLIENT

CAPITAL REGIONAL DISTRICT
STAGE 1 ENVIRONMENTAL IMPACT STUDY
VANCOUVER ISLAND, B.C.

TITLE

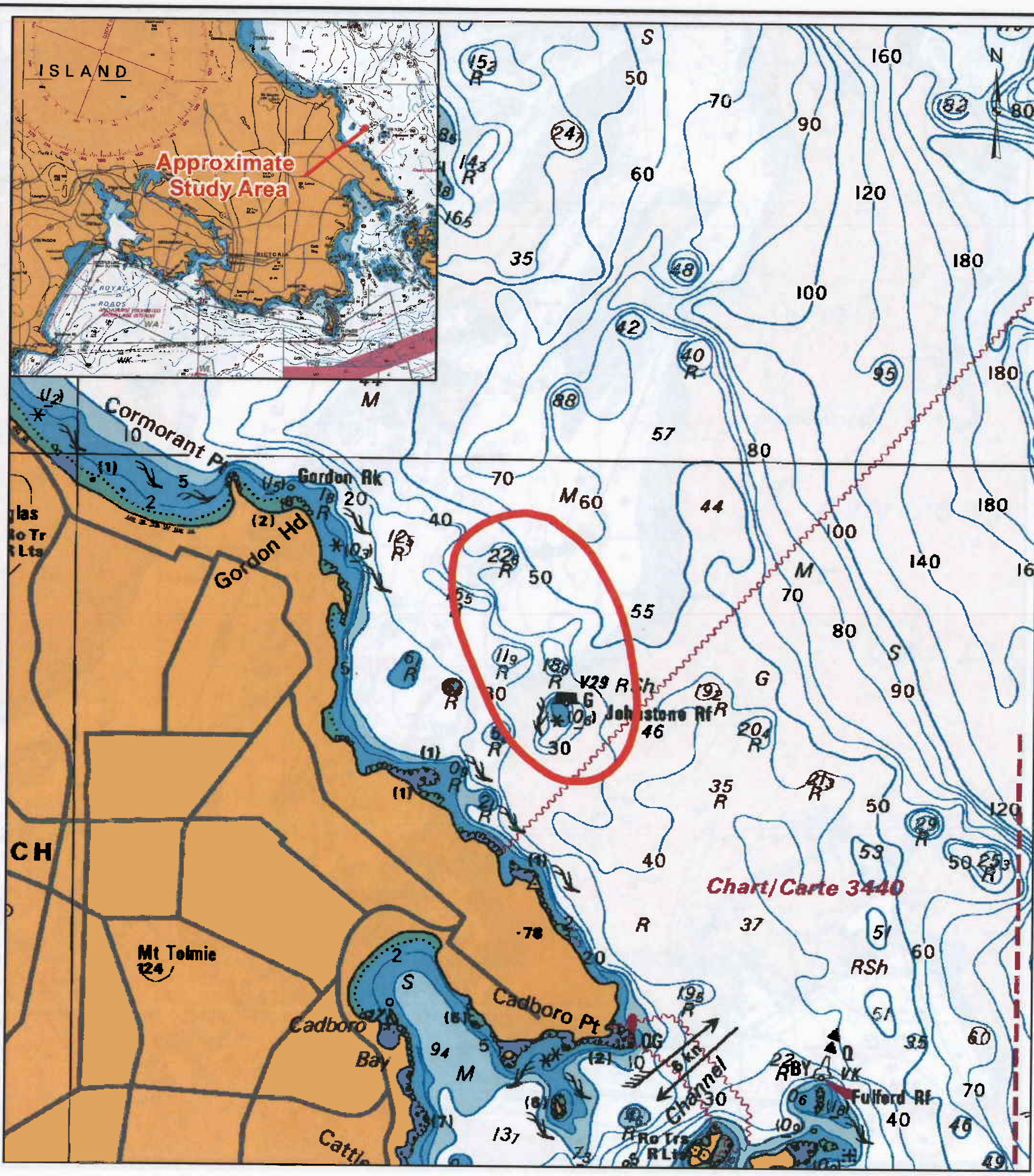
LOCATION OF PROPOSED WWTP OUTFALLS NEAR VICTORIA, B.C.

PROJECT No. 08-1421-0019			PHASE No. 5000
DESIGN	SA	23DEC08	SCALE AS SHOWN REV. 0
GIS	AL	23DEC08	
CHECK			**FIGURE: 1**
REVIEW			

Golder Associates
Greater Vancouver Office, B.C.

REFERENCE

CHART 346201 PROVIDED BY NAUTICAL DATA INTERNATIONAL.
PROJECTION: UTM ZONE 10 DATUM: NAD 83



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CLIENT
CAPITAL REGIONAL DISTRICT
STAGE 1 ENVIRONMENTAL IMPACT STUDY
VANCOUVER ISLAND, B.C.

TITLE
LOCATION OF PROPOSED OUTFALL IN THE VICINITY OF FINNERTY COVE

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No. 08-1421-0019			PHASE No.	5000
DESIGN	SA	23DEC08	SCALE AS SHOWN	REV. 0
GIS	AL	23DEC08		
CHECK			**FIGURE: 2**	
REVIEW				

REFERENCE
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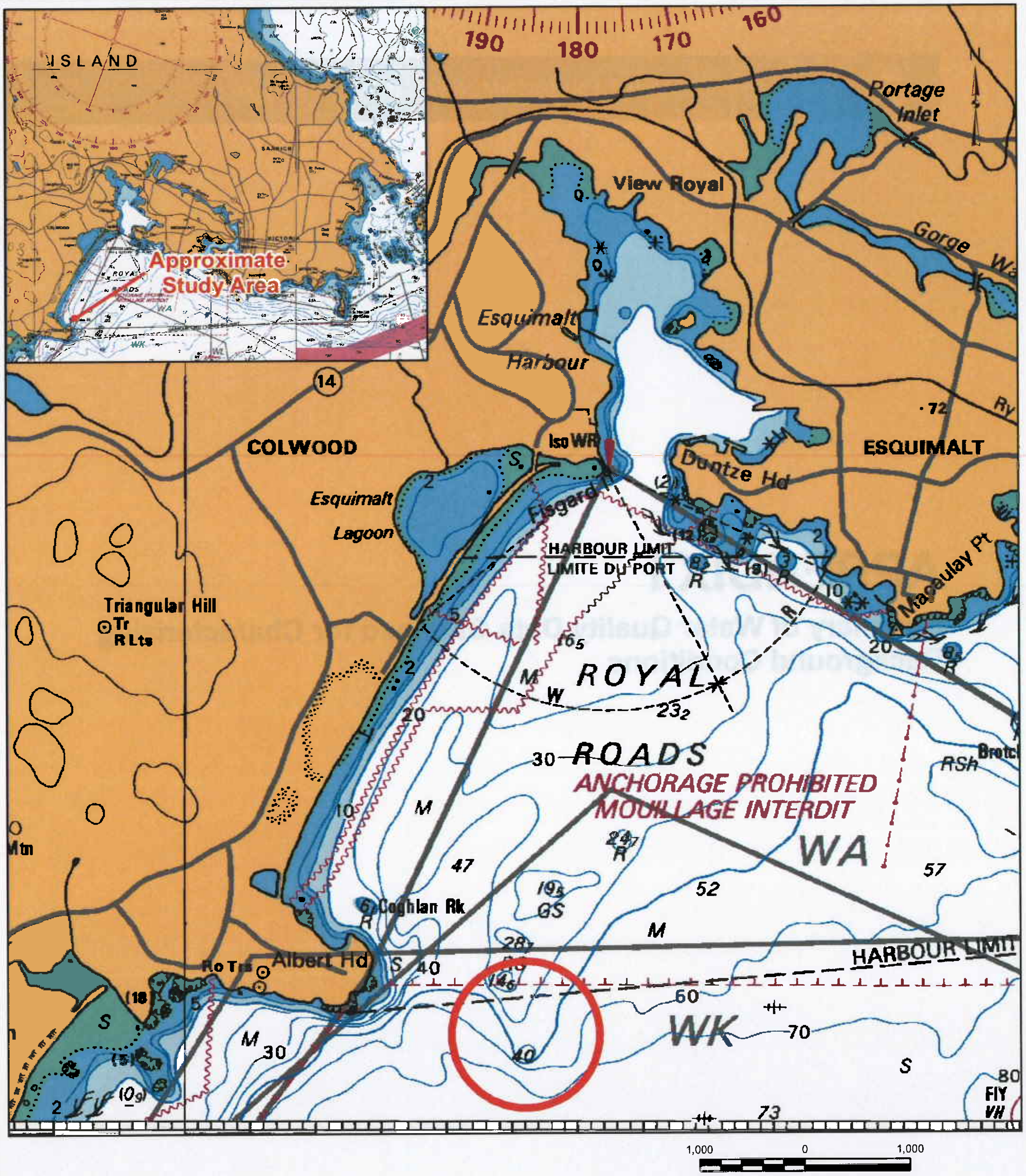

CLIENT	
	CAPITAL REGIONAL DISTRICT STAGE 1 ENVIRONMENTAL IMPACT STUDY VANCOUVER ISLAND, B.C.

TITLE

LOCATION OF PROPOSED OUTFALL IN THE VICINITY OF ALBERT HEAD

PROJECT No. 08-1421-0019			PHASE No.	5000
DESIGN	SA	23DEC08	SCALE AS SHOWN	REV. 0
GIS	AL	23DEC08		
CHECK			FIGURE: 3	
REVIEW				

Golder Associates
Greater Vancouver Office, B.C.

REFERENCE

CHART 346201 PROVIDED BY NAUTICAL DATA INTERNATIONAL.
PROJECTION: UTM ZONE 10 DATUM: NAD 83

APPENDIX I

Summary of Water Quality Data Obtained for Characterizing Background Conditions

March 27, 2009
Report No. 08-1421-0019

Table 1: Pre- and Post-Discharge Data for the Saanich Peninsula Treatment Plant (1998 – 1999)

Parameter	Units	Pre-Discharge				Post-Discharge			
		N	Min.	Max.	Mean	N	Min.	Max.	Mean
Ammonia	mg/L	381	0.00038	0.0287	0.0079	360	0.00038	0.0644	0.0194
Nitrate	mg/L	381	0.087	0.41	0.24	360	0.057	0.46	0.25
Nitrite	mg/L	381	0.00045	0.0057	0.0035	360	0.00045	0.00577	0.0039
Coliforms	per 100mL	1,062	0	304	6.1	1,482	0	122	1.78

Table 2: Saanich Peninsula Treatment Plant Monitoring Program (2002 – 2007)

Parameter	Units	N	Min.	Max.	Mean
Total Nitrogen	mg/L N	4	0.183	0.272	0.233
Total Nitrogen Ammonia	mg/L N	63	0.002	0.5	0.024
Total Nitrogen Nitrate	mg/L N	66	0.059	0.373	0.194
Total Nitrogen Nitrite	mg/L	53	0.002	0.006	0.004
Total Kjeldahl Nitrogen	mg/L N	62	0.002	1	0.132
Total Phosphate	mg/L P	66	0.038	0.15	0.075
Total Dissolved Phosphate	mg/L P	66	0.022	0.087	0.062
Total Organic Carbon	mg/L	18	1.1	7.6	1.783
Conductivity	µS/cm	12	42400	45900	44058

Table 3: DFO Ocean Chemistry Data 2003 - 2005

Parameter	Units	N	Min.	Max.	Mean
Salinity	PSS-78	28	30.64	32.98	31.49
Ammonium	mg/L	11	0.00036	0.00108	0.00054
Nitrate-Nitrite	mg/L	28	1.2	1.8	1.53
Dissolved Oxygen	mL/L	28	3.06	5.57	4.63
Temperature	°C	28	8.12	10.76	9.19
Phosphate	mg/L	28	0.17	0.22	0.2
Silicate	mg/L	28	3.27	4.43	3.98

Table 4: Summary of Seasonal CTD data (1994)

Parameter	Value	Winter	Spring	Summer	Fall
Depth (m)	Min	0.0	0.4	2.0	2.0
	Max	60	64	64	64.5
	Average	24.8	26.9	27.3	28.2
Temperature (°C)	Min	7.5	8.4	10.1	8.8
	Max	8.0	9.6	12.1	9.9
	Average	7.9	8.8	11.4	9.4
Salinity	Min	17.5	30.8	29.7	23.9
	Max	31.5	31.6	31.1	25.1
	Average	31.1	30.97	30.2	24.4

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APPENDIX II

List of Contacts, Resource Reviews and Correspondence for Receiving Environment Information

Record of Resource Reviews and Consultation

Info Source	Web Address	Description	Type of Info	Date of Access/ Correspondence	Info Searched	Results
Coastal Resource Information System	http://maps3.gov.bc.ca/imf406/imf.jsp?site=dss_coastal	Eelgrass Bed Mapping Atlas, Pacific Coastal Resources Atlas for British Columbia, Southern Gulf Island Atlas, plus more.	Ecological and Human Uses	26/03/2008	1a. Aquaculture - Tenures and Facilities - Marine Finfish Aquaculture Farms, Shellfish Aquaculture Farms, Shellfish Hatcheries.	1a. No Marine Finfish Aquaculture Farms, Shellfish Aquaculture Farms, or Shellfish Hatcheries within study areas (map saved). The closest tenures/facilities are in Sooke Basin and Saltspring Island.
					1b. Aquaculture - Capabilities - Japanese Scallop (Deepwater Culture Rating), Manila Clam (Beach Culture Rating), Pacific Oyster (Beach Culture Rating), Pacific Oyster (Deepwater Culture Rating), Salmon Suitability Rating.	1b. Aquaculture - Capabilities - No ratings within study areas (no map saved).
					2a. Biological - Birds - Bird Colonies, Alcids, Bald Eagles, Black Oystercatchers, Blue Heron, Cormorants, Dabbling Ducks, Diving Ducks, Fulmars Shearwaters and Petrels, Geese and Swans, Gulls, Loons and Grebes, Marbled Murrelet, Pelagic birds - unspecified, Shorebirds, Waterfowl.	2a. Biological - Birds - Bird Colonies (one unidentified bird colony near Finnerty Cove - map saved); Alcids, Bald Eagles, Black Oystercatchers, Blue Heron, Cormorants, Dabbling Ducks, Diving Ducks, Geese and Swans, Gulls, Loons and Grebes, and Shorebirds identified in both study areas (no map saved).
					2b. Biological - Mammals - Dall's Porpoise, Gray Whale, Harbour Porpoise, Killer Whale, Harbour Seal, Humpback Whale, Northern Fur Seal, Pacific White Sided Dolphin, Sea Otter, Sealion - California, Sealion - Stellar, Sealion - Haulout (point), Sealion - Haulout (polygon), Sealion - Rafting Area.	2b. Biological - Mammals - Gray Whale, Harbour Porpoise, and Killer Whale identified in both study areas (maps of each ID'd mammal saved).
					2c. Biological - Marine Plants - Eelgrass, Kelp beds	2c. Biological - Marine Plants - Eelgrass located near Albert Head study area, Kelp beds located near both study areas (map saved).
					3a. Fisheries - Commercial - Anchovy, Crab, Geoduck, Gooseneck Barnacle, Groundfish, Herring, Herring Roe, Octopus, Prawn, Salmon - net, Salmon - troll, Scallop, Seacucumber, Shrimp, Squid, Urchin.	3a. Fisheries - Commercial - Crab, Groundfish, Octopus, and Squid within Albert Head study area (map of each saved). Seacucumber was close to Finnerty Cove but not in study area (map saved).
					3b. Fisheries - Misc. - Clam beds, Herring spawning grounds, Salmon and Herring holding areas.	3b. Fisheries - Misc. - Herring spawning grounds near Albert Head study area (map of all three misc. saved)
					3c. Fisheries - Recreational - Crab, Finfish, Groundfish, Prawn, Scallop, Squid.	3c. Fisheries - Recreational - Crab and Finfish near Albert Head Study Area (map of each saved).
					4a. Offshore Oil and Gas - Sponge Reefs	4a. Offshore Oil and Gas - Sponge Reefs not in study areas.
					5a. Shoreline Biophysical Classification	Not relevant.

Info Source	Web Address	Description	Type of Info	Date of Access/ Correspondence	Info Searched	Results
Phil Rouget - Marine Mammal Specialist (Golder Employee)				27/03/2008	Marine Mammals	Marine Mammals that frequent the waters around Albert Head and Finnerty Cove:
						California Sea Lion - Aug - May
						Northern Sea Lion (Steller Sea Lion) - Listed Species - Aug - May
						Harbour Seal - Year Round
						Transient Killer Whale - Threatened
						Resident Killer Whale - Endangered
						Humpback Whale - May - Nov - Endangered
						Minke Whale - year round
						Fin Whale - rare occurrence in area - year round - endangered
						Harbour Porpoise - Year round - Listed
						Dall's Porpoise - Year round
						Grey Whale - May to Nov
Community Mapping Network	http://www.shim.bc.ca/	Eelgrass Bed Mapping Atlas, Pacific Coastal Resources Atlas for British Columbia, Southern Gulf Island Atlas, plus more.	Ecological and Human Uses	26/03/2008	Searching for relevant info in the various mapping applications	Appears to be same info as in CRIS and Mapster
Fisheries Information Summary System	http://a100.gov.bc.ca/pub/fidq/main.do;jsessionid=8e248a8d30d7ce74af0bda9040ceaefcd849d6311f0d.e3uMah8KbhmLe34Ob3uQbNaPaNr0n6jAmljGr5XDqQLvpAe	Fish distribution in lakes and streams	Ecological Uses	26/03/2008	Searched Colwood Creek and Douglas Creek	Same fish species information as Fish Wizard
Fish Wizard	http://maps.gov.bc.ca/imf50/imf.jsp?site=libc_awiz	Location of lakes and streams with info on types of fish that inhabit them	Ecological Uses	3/26/2008 3/28/2008 4/14/2008	Lakes, Rivers and Streams	See Fisheries Worksheet for streams and fish.

Info Source	Web Address	Description	Type of Info	Date of Access/ Correspondence	Info Searched	Results
CRD Natural Areas Atlas	http://www.crd.bc.ca/maps/natural/atlas.htm	Contains Harbour Atlas, as well as natural areas and parks/protected areas	Ecological Uses	26/03/2008	1a. Harbour Atlas - Subtidal Survey - Marine Flora - Agarum Kelp (Agarum sp.), Bacterial Mats (Beggiotoa sp.), Bladed Kelps (Laminaria sp.), Bull Kelp (Nereocystis sp.), Eelgrass (Zostera spp.), Filamentous Red Algae (Gastroctonium, Prionitis sp.), Foliose Green Algae, Foliose Red Algae (Gigartina, Iridaea), Japanese weed (Sargassum), Stalked Kelps (Pterygophora californica), Widgeon Grass (Ruppia maritima), Total Vegetation Cover	1a. Harbour Atlas - Subtidal Survey - Marine Flora - Survey covers Victoria and Esquimalt Harbour, Gorge and Portage Inlet and Esquimalt Lagoon. These areas are north of the Albert Head Study Area - see map for species present.
					1b. Harbour Atlas - Subtidal Survey - Marine Fauna - Bryozon Complex (bryozoans, sponges, ascidians), Burrowing Sea Cucumbers (Cucumaria miniata), Native Oysters (Ostrea lurida), Painted Anemones (Tealia sp.), Piddock Clams, Plumose Anemones (Metridium sp.), Red Sea Urchins (Strongylocentrotus franciscanus).	1b. Harbour Atlas - Subtidal Survey - Marine Fauna - Survey covers Victoria and Esquimalt Harbour, Gorge and Portage Inlet and Esquimalt Lagoon. These areas are north of the Albert Head Study Area - see map for species present.
					2a. Natural Areas - Ecosystems - Sensitive Ecosystems	2a. Natural Areas - Ecosystems - Sensitive Ecosystems - see map for sensitive ecosystem categories - only includes terrestrial areas.
					3a. Parks and Protected Spaces - Migratory Bird Sanctuaries (Federal)	3a. Parks and Protected Spaces - Migratory Bird Sanctuaries (Federal) - north of Albert Head Study Area (map saved).
				3/26/2008 3/27/2008 4/21/2008	3b. Parks and Protected Spaces - Parks	3b. Parks and Protected Spaces - Coastal and Marine Parks - Albert Head: Royal Roads Park, Esquimalt Lagoon Park, Hatley Park National Historic Site, Witty's Lagoon Regional Park, Albert Head Lagoon Regional Park, Devonian Regional Park, Race Rocks Ecological Reserve. Finnerty Cove: Glencoe Cove-Kwatsech Park, Gordon Head North Park, Gordon Head East Park, Arbutus Cove Park, Holleydene Park, Cranford Park, Phyllis Park, Ten Mile Point Ecological Reserve, Oak Bay Islands Ecological Reserve, Mount Douglas Park, Discovery Island Marine Park.
				27/03/2008	4a.Water Features - Detailed Stream Survey Themes - Spawning Habitat	4a.Water Features - Detailed Stream Survey Themes - Spawning Habitat - Some streams in the Albert Head Study Area have been surveyed. Colwood Creek which feeds into Esquimalt Lagoon has anadromous and resident spawning habitat (see map). None in the Finnerty Cove Study Area have been surveyed.

Info Source	Web Address	Description	Type of Info	Date of Access/ Correspondence	Info Searched	Results
Department of Justice: Migratory Bird Sanctuary Act	http://laws.justice.gc.ca/en/ShowTdm/cr/C.R.C.-c.1036///en		Ecological Uses	27/03/2008	1a. Schedule (List of Sanctuaries)	"Esquimalt Lagoon Bird Sanctuary: All and singular, that certain parcel or tract of land, and lands covered by water, situated in Esquimalt District, Province of British Columbia, which lands may be more particularly described as follows: Salt Lagoon, known locally as Esquimalt Lagoon, Cobourg Peninsula, known locally as the Lagoon Sand Spit, also a strip of land 300 feet in width extending inland from high-water mark of the said Lagoon, all as shown on the map of Esquimalt Harbour, Vancouver Island, Province of British Columbia, issued in A.D. 1918-1919, under the orders of the Minister of the Naval Service of Canada (now Department of National Defence)."
						"Victoria Harbour Bird Sanctuary: COMMENCING at high-water mark on Cadboro Point (commonly called Ten-mile Point), near the City of Victoria, British Columbia; THENCE, in a southwesterly direction to the most southerly point of Trial Island; THENCE, westerly to Brotchie Ledge; THENCE, to high-water mark on Macauley Point; THENCE, along high-water mark on the shores of Vancouver Island to point of commencement; including all areas below high-water mark in Victoria Harbour, Selkirk Water, Victoria Arm and Portage Inlet."
BC CDC Mapping Service	http://maps.gov.bc.ca/imf50/imf.jsp?site=cdc	Mapped known locations of species and ecological communities at risk	Ecological Uses	27/03/2008	1a. Non-sensitive Occurrences - Taxonomic Class - birds, bivalves, gastropods, lampreys, mammals, ray-finned fishes (ie. potentially marine related).	1a. Non-sensitive Occurrences - Taxonomic Class - several non-sensitive bird occurrences near Albert Head Study Area (see map). They included one occurrence of surf scoter at Esquimalt Lagoon, and several occurrences of purple martin in Victoria Harbour and Esquimalt Harbour. Closest mammal is the Steller Seal Lion at Race Rocks.
					1b. Masked Occurrences	1b. Masked Occurrences - There are several masked occurrences near both study areas - will need to contact CDC to determine if there is anything marine related.
CDC BC Species and Ecosystem Explorer	http://a100.gov.bc.ca/pub/eswp/		Ecological Uses	02/04/2008	1a. Searched for plants and animals in a marine habitat in the Coastal Douglas Fir Biogeoclimatic Zone.	See results on CDC Search Worksheet.
				03/04/2008	2a. Searched for rankings of other known species	See results on Ranking of Known Species Worksheet.

Info Source	Web Address	Description	Type of Info	Date of Access/ Correspondence	Info Searched	Results
BC CDC			Ecological Use	24/04/2008	1a. Requested custom data search and information on masked occurrences that are relevant to coastal/marine environment.	Sent request to BC CDC
				28/04/2008		Received information from Erin Prescott from BC CDC. "The Conservation Data Centre does not actively track marine plants and animals, with the exception of marine birds. There was, however one old algae record in our database, and I have attached a shapefile and report for the record. The report also contains a contact name where you may be able to obtain more information regarding algae in the area. In addition BC Species and Ecosystems Explorer does not list marine fish, mammals or plants by BGC." Two of the sensitive occurrences are for "big trees" and therefore not relevant. One record is for a terrestrial animal species and the remaining records are for a plant located near the shoreline and bird occurrences. The release of specific location and species information pertaining to sensitive occurrences is at the discretion of the Regional Biologists in the Ministry of Environment and is subject to the Confidentiality and Non-Reproduction Agreement (attached), signed by yourself and the Regional Biologist. The sensitive information is provided on the condition that the data not be released to the public.
Internet Search using Google	www.google.com	Searched for "dives sites victoria bc"	Human Uses	27/03/2008	1a. "dive sites victoria bc" - http://www.diveliquidheaven.com/victoria-bc-diving.html	**1a. "dive sites victoria bc" - http://www.diveliquidheaven.com/victoria-bc-diving.html**
						GB Church - within the Princess Margaret Marine Park off Portland Island near Sidney
						Mackenzie DDE 261 - miles (6.4 metres) east of Sidney, about 150 yards north of Gooch Island
						Clover Point - jut of land on the west side of Ross Bay in Victoria BC
						Ogden Point
						Race Rocks - off the southern tip of Vancouver Island in the Strait of Juan de Fuca
						Spindrift - Entry is at the end of Cranford Place off of Queenswood Drive.
						SaxePoint - A small memorial park in southern Esquimalt
						Spring Bay - Visible from Ten Mile Point,
						Telegraph Bay - near Cadboro Bay
					1b. "dive sites victoria bc" - http://www.vancouverisland.com/recreation/?id=161	1b. "dive sites victoria bc" - http://www.vancouverisland.com/recreation/?id=161 - Ogden Point, **Ten Mile Point**, Race Rocks, Barnard Castle, G.B. Church, HMCS MacKenzie, North Cod Reef, South Bedford Island, Octopus Island, Swordfish Island, Graham's Wall, Strongtide Island and Saxe Point.

Info Source	Web Address	Description	Type of Info	Date of Access/ Correspondence	Info Searched	Results
Internet Search using Google	www.google.com	Searched for "dive sites albert head bc"	Human Uses	27/03/2008	1a. "dive sites albert head bc" - http://www.shorediving.com/Earth/Canada/Vancouver_Island/	1a. "dive sites albert head bc" - http://www.shorediving.com/Earth/Canada/Vancouver_Island/ - **1.Telegraph Bay, 1.Spring Bay, 3.Ten Mile Point,** 4.Cattle Point Park, 5.McMicking Point, 6.McNeill Point, 7.Ross Charles Park, 8.Clover Point, 9.Ogden Breakwater, 10.Saxe Point Park, 11.**Esquimalt Lagoon, 12.Albert Head Lagoon. One shore dive at Albert Head Lagoon, several others in area. Several close to Finnerty Cove (see map).**
Internet Search using Google	www.google.com	Searched for "windsurfing victoria bc"	Human Uses	27/03/2008	1.a "windsurfing victoria bc" - http://www.bigwavedave.ca/	1a. http://www.bigwavedave.ca/wiki/index.php/Sailing_Guide: **Taylor Beach, Metchosin; Esquimalt Lagoon, Esquimalt;** Clover Point, Victoria; Ross Bay, Victoria; Cook Street, Victoria; **Willow's Beach, Oak Bay; Cattle Point, Victoria; Agate Beach, Cordova Bay**; Island View Beach, Saanichton.
		Searched for "popular windsurfing sites around victoria bc"	Human Uses	01/04/2008	2a. http://www.vancouverisland.com/recreation/?id=174	2a. "Try **Cadboro Bay Beach**, a prime location for intermediate shortboarders, or **Willows Beach in Oak Bay** if you enjoy the ocean breeze - a couple of hard upwind tacks will bring you **to Cattle Point.** Expert wave sailors can launch at the bottom of **Cook Street** near downtown Victoria - hazards here include strong winds, tidal currents and floating logs. From **Dallas Road**, a walkway drops down to an open cobble beach with many driftwood logs everywhere - a popular site for sailboarding. **Esquimalt Lagoon** offers good sailing for beginners, and Elk Lake, located about twenty minutes north of Victoria on Highway 17, is also a popular windsurfing destination for beginners."
					2b. http://www.geocities.com/rainforest/vines/4301/island.html#Cook	2b. Cook Street, **Esquimalt Lagoon, Willows Beach, Island View Beach**
		Searched for "Albert Head recreational fishing"	Human Uses	28/03/2008	3a. "Albert Head recreational fishing" - http://www.pac.dfo-mpo.gc.ca/recfish/Tidal/area19_e.htm and http://www.pac.dfo-mpo.gc.ca/ops/fm/shellfish/biotoxins/closures/area19/area_19_e.htm	**3a. Shellfish Contamination Albert Head to Cordova Bay**; Curteis Point to Cordova Bay; Hatch Point to Bamberton; Thompson Cove; Brentwood Bay; Coles Bay; Finlayson Arm; Quarantine Cove; Cordova Split to James Island to Island View Beach; Mosses Point to north of Dogwood Road access; Squally Reach; Bazan Bay; and North Yarrow Point.
		Searched for "Constance Bank Victoria"	Human Uses	21/04/2008	4a. "Constance Bank Victoria" - http://www.iwlfishingcharters.com/locations.htm	4a. Oak Bay Flats, Discovery Island, Trial Island and Constance Bank: all good halibut spots, and, during the winter, good Chinook salmon spots. Becher Bay , Beechey Head, and Church Rock: salmon spots. Salmon fishing at Secretary (Donaldson) Island , Otter Point and Sheringham Point.

Info Source	Web Address	Description	Type of Info	Date of Access/ Correspondence	Info Searched	Results
CRD	www.crd.bc.ca		Ecological Uses	28/03/2008	1a. Searched under "Marine Science and Research "	1a. "About 30 scientists and technical staff work for the CRD's Scientific Program. They include five staff in Marine Programs with a range of field and research experience. These scientists study the effects of discharges from CRD sewer systems to ensure the ocean environment and public health are safe today and into the future." From http://www.crd.bc.ca/wastewater/marine/documents/2006summarybrochure.pdf
University of Victoria	www.uvic.ca	Research	Ecological Uses	28/03/2008	1a. Searched under "Research - Oceans and Climate"	From a brief review, I could not find any relevant research
					1b. Searched under "Faculty and Programs - Science - Biology - Research	Too much information to search through - will search through journal databases instead
Fisheries and Oceans Canada - Pacific Region	http://www.pac.dfo-mpo.gc.ca		Human Uses	28/03/2008	1a. Fisheries Management - http://www.pac.dfo-mpo.gc.ca/ops/fm/fishmgmt_e.htm	1a. Both areas in Fisheries Management Area 19. Albert Head in Sub Area 19-3 and Finnerty Cove in 19-5.
Ministry of Agriculture and Lands - Fisheries and Aquaculture	http://www.al.gov.bc.ca/fisheries/index.htm		Human Uses	28/03/2008	1a. http://www.al.gov.bc.ca/fisheries/commercial/commercial_main.htm	The basis of the mandate lies within the context of the *Fisheries Act* (R.S.B.C. 1996 Chapter 149) and *Fish Inspection Act* (R.S.B.C. 1996 Chapter 148), and accompanying regulations. Through these pieces of legislation and several Memorandum of Understandings (MOU) with other agencies, the Ministry of Agriculture and Lands licenses: all fish processing plants, fish buying stations, fish brokers and fish vendors; all aquaculture operations; and harvesters of wild oysters and/or marine plants.
Fisheries and Oceans Canada - Mapster	http://www-heb.pac.dfo-mpo.gc.ca/maps/maps-data_e.htm		Ecological and Human Uses	31/03/2008	1a. Marine Resources - Local Knowledge - South and North Coast 2004 Fisheries Inventory - Searched all layers.	1a. Marine Resources - Local Knowledge - South and North Coast 2004 Fisheries Inventory: Clam (Bed Distribution) - near Esquimalt Lagoon, Crab (Crab Fishery Distribution) - near both areas, Herring Spawn - along Esquimalt and Victoria waterfronts, Herring (Herring Fishery Distribution) - Victoria Harbour/Gorge, Herring Holding Area - Albert Head, Octopus (Octopus Fishery Distribution) - Victoria Waterfront, Prawn (Prawn by Trap Fishery Distribution) - both areas, Salmon Migration - Albert Head, Sea Cucumber (Seacucumber Fishery Distribution) - not close (near Rose Bay), Shrimp (Shrimp by Trawl Fishery Distribution) - Finnerty Cove, Sport Fish (Co, Ch) - both areas.
					1b. Marine Resources - Scientific	1b. Marine Resources - Scientific: Sponge Reef - none, DFO Clam Atlas (Clam Beaches) - Esquimalt Lagoon, Kelp Dist. - none, Rockfish Conc. Areas - somewhat close to both areas, Shellfish Closures - both areas.
					1c. Marine Resources - Commercial - Aggregated Catch - Searched all layers.	1c. Marine Resources - Commercial - Aggregated Catch: Groundfish ZN Catch 1993-2004 - near Finnerty Cove, Prawn - both areas, Shrimp Trawl - Finnerty Cove, Crab - Albert Head, near Ten Mile Point south of Finnerty Cove.

Info Source	Web Address	Description	Type of Info	Date of Access/ Correspondence	Info Searched	Results
Parks Canada (Southern Strait of Georgia National Marine Conservation Area Reserve Feasibility Study) - Feasibility Study for the Proposed Southern Strait of Georgia National Marine Conservation Area Reserve - Public Values	http://www.pc.gc.ca/progs/amnc-nmca/cnamnc-cnnmca/dgs-ssg/itm5-/map_report_E.asp		Ecological and Human Uses	31/03/2008	1a. Viewed all 9 maps - all maps saved	1a. Coastal and Marine Use - Pollution notes near Albert Head, Other Recreational Activities - Fishing near Albert Head - Diving near Victoria and Esquimalt Harbour, Fish and Bird - Bird area at Finnerty Cove, Marine Mammals and Sharks - Sea Lions and Whales near Albert Head, Invertebrates - Crab somewhat close to both areas - Invertebrates in Victoria Harbour.
				01/04/2008	2a. emailed 'straitofgeorgianmca@pc.gc.ca' to see if we could obtain marine resource maps of their study area.	2a. emailed 'straitofgeorgianmca@pc.gc.ca'
				07/04/2008		2a. Doug Hrynyk emailed back asking for a list of maps and for GIS layers of potential outfall areas. James was going to ask Lee Nikl if we could provide the GIS layers.
				22/04/2008		2a. Emailed Doug PDF's of potential outfall areas and asked for relevant maps.
				28/04/2008		2a. Doug provided us with 32 pdf maps. **Maps not to be released to public.**
						Areas of High Conservation Value - **CWS Migratory Birds Areas of Interest south of Albert Head around Witty's Lagoon and north of Albert Head around Esquimalt Lagoon.** Other information includes: The Nature Conservancy: Priority Conservation Areas, CPAWS: Proposed NMCA Core Areas June 2004, People for Puget Sound: Biodiversity Hotspots in Orca Pass, Bird Studies Canada: Important Bird Areas.
						BC Federation of Fly Fishers - not near outfall areas - outfall areas might not have been included in study
						Bottom Quality - both outfall areas included on this map - info not relevant to this study
						Bottom Trawl Fishery Catch - not near study areas - outfall areas might not have been included in study
						Bottom Trawl Fishery Effort - not near outfall areas - outfall areas might not have been included in study
						Cetacean Sightings - **~ 7 km radius from outfall areas. Finnerty Cove - Harbour Porpoise, Grey Whale Minke Whale, Dall's Porpoise. Albert Head - Humpback Whale, Grey Whale, Dall's Porpoise, Minke Whale**
						Crab Trap Fishery Catch - somewhat close to Finnerty Cove - info on Albert Head might not have been included - will use other data source for Crab Fishery
						Crab Trap Fishery Effort - somewhat close to Finnerty Cove - info on Albert Head might not have been included - will use other data source for Crab Fishery

Info Source	Web Address	Description	Type of Info	Date of Access/ Correspondence	Info Searched	Results
						Dive Sites and Wrecks - **Numerous shore and boat dive sites north of Albert Head along Victoria and Esquimalt shoreline. Three wrecks identified by Underwater Archaeological Society of BC near Albert Head - Royal Bay Barge outside of Esquimalt Lagoon, two other wrecks ~3 km east of Albert Head. Several shore dives south of Finnerty Cove and several boat dives around Discovery Island. Two wrecks on east side of Discovery Island - farther away from Finnerty Cove**
						Dogfish Hook and Line Fishery - Could not open map
						Estuarine Habitat - Pacific Estuary Conservation Program Identified Estuaries - Identified estuaries represent those that meet certain criteria but do not necessarily represent all of the most important estuaries in BC. Biltson Creek/Witty's Lagoon south of Albert Head identified as one of these Estuaries. Will not use this data as others may be important as well.
						Herring Fishery - Same info as in CRIS and Mapster
						Important Bird Areas and Migratory Bird Sanctuaries - Same info as CRD's natural areas atlas and map of Areas of High Conservation Value
						Inter and Subtidal Benthic Community Sampling Points - No data in outfall areas
						Kayaking - map legend does not appear to be complete - sea kayaking south of Finnerty Cove around Discovery Island Marine Park - not sure if Albert Head area included in study.
						Killer Whales - **southern resident and transient sighted around both outfall areas.**
						Marine Ecosystem Classification - Benthic - broad scale - substrate, exposure, current, etc. - not relevant to this study
						Marine Ecosystem Classification - Pelagic - data on salinity and stratigraphy - not really relevant to this study
						Marine Habitat - Eelgrass and Kelp - **Info appears to be consistent with info from CRIS - kelp near both outfall areas and eel grass in Esquimalt Lagoon.**
						Marine Wildlife Viewing - areas of importance for marine wildlife viewing identified by members of the Whale Watch Operators Association NW - **Around both outfall areas.**
						Midwater Trawl Fishery Catch - no data in outfall areas
						Midwater Trawl Fishery Effort - no data in outfall areas
						Pinnipeds - **Harbour Seal Haulout at Albert Head and Finnerty Cove Reef.**

Info Source	Web Address	Description	Type of Info	Date of Access/ Correspondence	Info Searched	Results
						Prawn Trap Fishery Catch - near Finnerty Cove, but Albert Head might not have been included in study - will use Mapster info.
						Prawn Trap Fishery Effort - near Finnerty Cove, but Albert Head might not have been included in study - will use Mapster info.
						Rockfish Conservation Areas and Habitat Model - **potential rockfish habitat at both outfall areas.**
						Sanitary Shellfish Closures - same info as DFO website.
						Schedule II Fishery Catch - no data in outfall areas
						Schedule II Fishery Effort - no data in outfall areas
						Shrimp Trawl Fishery Catch - appears to be same info as Mapster
						Shrimp Trawl Fishery Effort - appears to be same as Mapster
						Sport Fishery - at Albert Head and Finnerty Cove outfall areas.

Info Source	Web Address	Description	Type of Info	Date of Access/ Correspondence	Info Searched	Results
Fisheries and Oceans Canada - Fisheries Management Contacts	http://www.pac.dfo-mpo.gc.ca/ops/fm/toppages/contacts_e.htm#Shellfish		Human Uses	31/03/2008	1a. **Recreational** Fisheries Coastal B.C. South Coordinator - Bill Shaw - shawb@pac.dfo-mpo.gc.ca - 250-723-1290	Emailed Bill Shaw
				01/04/2008		Called Bill, but his number was not correct. I emailed him to find out his correct number.
				03/04/2008		Bill called and forwarded my request onto Chris Bos by email. Bill said that **Constance Bank is a popular recreational fishing spot.**
				04/04/2008		Chris Bos emailed back asking for more info. James emailed Chris and asking Chris to call him to discuss the project.
				31/03/2008	1b. Regional Resource Manager - **Groundfish** - Gary Logan 604-666-9033 - LoganG@pac.dfo-mpo.gc.ca	Emailed Gary. Gary emailed back to let me know that he will be away until the next week but that he may have info. "I am familiar with the areas that you are talking about and yes there are **commercial and recreational fisheries in both the areas**. I am surprised they would propose an outfall on the inside rather than the outside waters. There are **active shrimp, crab, prawn, and groundfish fisheries** in the proposed areas from my recollection."
				01/04/2008		Emailed Gary to let him know I would call him in a few weeks and to let him know he could email me info.
				22/04/2008		Called Gary and he said he could look into catch data for the areas we are interested in. Emailed him the maps of the two areas and informed him that they are general locations and the actual locations have not been decided on.
				25/04/2008		Gary emailed and said "There are as I stated earlier several fisheries located within the water between William Head and Victoria. The predominant fishery is recreational. Heavy usage for salmon, groundfish, prawn and crab. From a commercial perspective, the hook and line fleet operates for rockfish, lingcod, dogfish. There is also some minor mid-water and bottom trawl activity in the area. Lastly small amounts of commercial crab, prawn and shrimp."
				31/03/2008	1c. South Coast Area Chief - Resource Management - Gordon McEachen - 250-756-7288 - McEachenG@pac.dfo-mpo.gc.ca - emailed about Salmon, but he is also a resource manager for pelagics.	Emailed Gordon.
				01/04/2008		Called Gordon, but no answer. Left a message.
				01/04/2008	1d. Shellfish Biologist, Areas 11 to 27 - Rick Harbo - 250-756-7268 - HarboR@pac.dfo-mpo.gc.ca	Emailed Rick Harbo.
				07/04/2008		Emailed Rick again and he responded and asked Erin Wylie to respond.
				15/04/2008		Erin Wylie emailed back and said " It seems you have most things covered. The only resource I can see that your missing is Red Sea Urchins. Red Sea Urchins have been harvested in the vicinity of Albert Head. Also I would be surprised if there wasn't recreational catch of crab in and around Finnerty Cove."

Info Source	Web Address	Description	Type of Info	Date of Access/ Correspondence	Info Searched	Results
				21/04/2008		Erin confirmed that the red sea urchin is commercial.
				07/04/2008	1e. Marine Mammal Coordinator - Marilyn Joyce - 604-666-9965 - marilyn.joyce@dfo-mpo.gc.ca	Emailed Marilyn to see if she could confirm Phil Rouget's list of marine mammals in the outfall areas.
						Marilyn emailed back and said she will forward the request onto Dr. John Ford who heads the Cetacean Research Program and Mr. Peter Olesiuk who is responsible for the Pinniped Program. She also asked who the DFO contact for the project was. I phoned back and left a message saying that this is just a preliminary overview assessment and a DFO contact has not been assigned.
				22/04/2008	1f. Bruce Adkins, Area Chief of OHEB with DFO	Lee Nikl contacted Bruce to inform him of the project. Bruce indicated that he had seen abalone at Albert Head while diving.
				23/04/2008	1g. Laurie Convey and Joanne Lessard of DFO	James contacted both to see if they had any more information on abalone in the Albert Head area.
				25/04/2008		Laurie wrote back and said Joanne would be able to answer the question.
				29/04/2008		Joanne wrote back and said "We don't release site-specific information on abalone anymore. Bruce Adkins authored a report in 1996 describing 2-3 surveys that took place in fishery areas 18 and 19 in the 80's (reference below). We repeated some of these sites in 2005, but only 3 abalone were measured in 3 days of survey (not published; some info included in the CSAS document, see below). Whatever information we have is very site specific and does not account for abalone that could present just a few meters away. Regardless, any site proposed will have to have an assessment done prior to that site being selected. The protocol to assess the possible impact of works and development on abalone and their habitat is attached. If you want to avoid places where abalone may be present, abalone habitat is described within that document. The protocol was part of a larger document that assessed the recovery potential of northern abalone and the potential human-induced mortality/harm that could be sustained by the species without impairing recovery: http://www.dfo-mpo.gc.ca/csas/Csas/Publications/ResDocs-DocRech/2007/2007_061_e.htm
Food and Aquaculture Organization of the United Nations	http://www.fao.org/fishery/asfa		Ecological/Human Uses	14/04/2008	1a. Searched "British Columbia" and "Victoria" under publications	1a. Three results, none relevant
					1b. Searched "Sewage" and "British Columbia" and "Victoria" under publications	1b. No results
					1c. Searched "Juan de Fuca" under publications	1c. No results
					1d. Searched 'Straight of Georgia" under publications	1d. No results

Info Source	Web Address	Description	Type of Info	Date of Access/ Correspondence	Info Searched	Results
Environment Canada	http://www.pyr.ec.gc.ca/EN/index.shtml http://waterquality.ec.gc.ca/EN/home.htm http://www.pyr.ec.gc.ca/EN/Shellfish/index.shtml		Ecological/Human Uses	22/04/2008	1a. Searched for relevant information	1a. No relevant information found.
Integrated Land Management Bureau	http://ilmbwww.gov.bc.ca/cis/coastal/mris/sog_mpa.htm		Ecological/Human Uses	23/04/2008	1a. Southern Gulf Islands Marine Protected Areas Workshop: Resource Maps	1a. Red and Green Sea Urchin and Sea Cucumber commercial fishery near Finnerty Cove. Squid and Crab near Albert Head. Data is from 1995, 1998. Data from CRIS and Mapster appear to be more up to date, so this information will not be used.
141 Dives in the protected water of Washington and British Columbia		Book by Betty Pratt-Johnson	Human Uses	28/04/2008	1a. Dive sites	Ten Mile Point and Fisgard Island
DFO		Abalone report	Ecological Uses	26/08/2008	Abalone Surveys in South Coast Areas during 1982, 1985, and 1986 by B.E. Adkins	

CRD FILE: 5400-20.01

REÇU / RECEIVED
10 -11- 2008

Fisheries and Oceans
Pêches et Océans

Pacific Region
Shellfish Data Unit
Pacific Biological Station
3190 Hammond Bay Road
Nanaimo, BC V9T 6N7

November 4, 2008

Mr. Glenn Harris PhD, RPBio
Senior Manager, Scientific Programs
CRD Environmental Services
625 Fisgard Street
PO Box 1000
Victoria, BC V8W 2S6

Dear Mr. Harris:

Subject: Capital Regional District's request for information on shellfish resources in the vicinity of two proposed outfalls and the Macaulay and Clover Point outfalls.

Your request for information on shellfish resources was received by the Shellfish Data Unit, Marine Ecosystem and Aquaculture Division of Fisheries & Oceans Canada, on October 22, 2008. Regarding the three questions relating to the proposed outfalls at the Albert Head and Finnerty Cove locations:

1. Please be advised that no directed studies of shellfish resources have been undertaken at the locations depicted on the photocopied map provided with the request. The species present, locations and quantities are unknown.
2. Similarly, as no directed studies have been undertaken, the presence of commercially harvestable shellfish resources in the vicinity of the proposed outfalls is unknown. There is however, evidence of harvesting of prawns by trap, red sea urchins by dive and octopus by dive in the vicinity of the Albert Head location. This information comes from fishery-dependent commercial harvest log records. Note that a lack of commercial harvest log records for other species should not be interpreted to mean that the species are not present.
3. The commercial value of any harvestable shellfish resources in the vicinity of the proposed outfalls is unknown.

Regarding the follow up question to the 2006 information request from the CRD, no new information has become available regarding shellfish resources around the Macaulay and Clover Point outfalls since this issue was last addressed by this office on January 26, 2006.

If you have further questions regarding these topics please contact me at (250) 756-7306.

Sincerely yours,

Leslie Barton

Environment Canada | Environnement Canada

November 12, 2008

File:7616-56/C6

Dr. Glenn Harris
Senior Manager, Scientific Programs
625 Fisgard Street, PO Box 1000
Victoria, BC V8W 2S6

CRD F.6 5400-20.01

Dear Dr. Harris:

RE: Capital Regional District Information Request on Shellfish Closures in the Vicinity of Two Proposed Outfalls and Macaulay and Clover Point Outfalls

Thank you for your letter of October 20, 2008 to Lisa Walls, A/ Manager Environmental Assessment and Marine Programs, requesting information about the size of the sanitary closures which could be expected around two existing CRD sewage outfalls and two new proposed outfalls discharging into Juan de Fuca and Haro Straits. Your letter was forwarded to me just recently so I apologize for the delay in responding.

The Federal Canadian Shellfish Sanitation Program (CSSP) is implementing enhanced measures for bivalve molluscan shellfish harvest areas adjacent to waste water treatment plants (WWTPs). These enhancements are designed to strengthen food safety measures by preventing any potentially contaminated bivalve shellfish, including all species of clams, scallops, mussels and oysters, from reaching consumers, and to help maintain Canada's reputation as a source of safe, high quality shellfish.

As recognized in your correspondence, the size of shellfish closure safety zones near WWTP outfalls depends on numerous factors including the WWTP and outfall design, characteristics of the effluent, the receiving environment, the area's hydrography, etc. These are just some of the factors which need to be considered when estimating the impact area around all sewage outfalls.

To address your questions on specific impacts, currently a minimum 300m Prohibited zone (no harvest for any purposes) is established around municipal sewage outfalls. The Canadian Food Inspection Agency (CFIA) is working with Health Canada to determine if this zone offers adequate protection from potential contamination from viruses as other jurisdictions such as the United States, use more conservative boundaries. The CSSP is regularly audited by the United States Food and Drug Administration in accordance with the 1948 Canada-USA Bilateral Agreement on Shellfish Sanitation.

Shellfish harvesting outside Prohibited area may be permitted provided the area meets the specific criteria outlined in the Canadian Shellfish Sanitation Program Manual of Operations. Briefly the following must be met for:

Restricted classification areas : harvesting for depuration may be permitted under special license from DFO provided the median of the water samples does not exceed 88 FC/100 ML MPN and not more than 10% of the samples exceed 260 FC/ 100ml MPN based on a five tube decimal dilution test.

Approved classification areas: harvesting for direct consumption may be permitted provided the median of the water samples does not exceed 14 FC/ 100ml/ MPN and not more than 10% of the samples exceed 43 FC/ 100 ml MPN based on a five tube decimal dilution test.

Classification of the areas adjacent to WWTP outfalls (i.e. beyond the Prohibited area) are currently delineated based on conditions expected in growing waters during normal WWTP operation. In general, the size of the sewage impact area (or the Restricted zone) is currently inversely related to the level of effluent treatment. Approved areas are established where the criteria outlined above is confirmed with empirical data.

Under the new enhanced CSSP protection measures, WWTP failures or other emergency conditions at the WWTP must be fully accounted for when delineating the Restricted and Approved classification boundaries. Expected Restricted and Approved classification boundaries around outfalls will be determined by computer modeling, assuming WWTP failure and peak flows, to determine the location where water quality is expected to achieve 88 FC/100 ml and 14 FC/100ml, respectively.

The CSSP partners, comprised of CFIA, Department of Fisheries and Oceans (DFO) and Environment Canada, also recognize that there may be unique situations where shellfish harvesting could be permitted within a portion of the "modeled" Restricted area when the WWTP is operating normally (i.e there are no failures, sewage overflows etc). Such cases require implementation of strict protocols which must ensure that only wholesome shellfish reaches markets. The protocol must include:

1. Area-specific 'management plans' which outline the respective responsibilities of the WWTP, municipalities, and CSSP partners to ensure timely WWTP failure detection, notification, and response; and
2. New Hazard Analysis Critical Control Point controls by fish processors to restrict the distribution of product affected by an operational failure at a waste water treatment plant.

It is important to note that none of the areas outlined in the map you provided are currently classified as Approved for bivalve shellfish harvesting. The area south of Cordova Bay and seaward of the Restricted (or closed) areas shown in your map, are considered Unclassified. There is no monitoring under the CSSP for either fecal coliform bacteria (by EC) or for Paralytic Shellfish Poisoning (by CFIA) south of Cordova Bay because shellfish resources have not been identified outside the Restricted zones. Information you requested from DFO regarding any new data on the location and importance of any species of bivalve shellfish in the vicinity of the proposed and existing CRD outfalls will be very useful for your impact analysis.

Implementation of the new CSSP requirements will be carried out nationally using a phased approach over the next several years. The first phase of the initiative in British Columbia is being conducted near the outfalls at Ladysmith, Crofton and Chemainus.

If you require any further specific information on the implementation of the enhanced CSSP measures or about the management of the bivalve shellfish fishery near WWTP's, please contact my colleagues at the CFIA or the DFO as follows:

Mr. Lyle Reid
A/Manger, Fish, Seafood and Production Division- West
Canadian Food Inspection Agency
4321 Still Creek Drive. 4th Floor
Burnaby, B.C. V5C 6S7

Kerry Marcus
Aquaculture, CSSP Coordinator
Fisheries and Oceans Canada
60 Front Street
Nanaimo, B.C. V9R 5H7

I trust that this information answers. Please do not hesitate to contact me if you require any further clarification.

Sincerely,

Walter Hajen
Head, Marine Water Quality Monitoring- Pacific Region
401- 201 Burrard Street
Vancouver, B.C.
V6C 3C5
Fax : (604) 666-2947

Cc: Lyle Reid, A/Manager, Fish Seafood and Production Division, CFIA
Kerry Marcus, Aquaculture CSSP Coordinator, DFO
Blake Medlar, Section Head, Government & Compliance, MOE
Randy Alexander, Manager, Environmental Protection, MOE

CRD
Making a difference...together

Environmental Services
625 Fisgard Street, PO Box 1000
Victoria, BC, Canada V8W 2S6

T: 250.360.3078
F: 250.360.3079
www.crd.bc.ca

October 20, 2008

File: 5400-20.01

Ms Leslie Barton
Pacific Biological Station
3190 Hammond Bay Road
Nanaimo BC V9T 6N7

Dear Ms Barton:

RE: CAPITAL REGIONAL DISTRICT INFORMATION REQUEST ON SHELLFISH RESOURCES IN THE VICINITY OF TWO PROPOSED OUTFALLS AND THE MACAULAY AND CLOVER POINT OUTFALLS

The Capital Regional District (CRD) is planning for new municipal wastewater treatment facilities. As part of this process, the BC Ministry of Environment (MOE) suggested that we contact you to request information on shellfish resources in two locations where marine outfalls are proposed: 1) adjacent to Albert Head and 2) off Finnerty Cove. A section of the chart showing our areas of interest is enclosed.

I would also appreciate an update on the shellfish resource knowledge with respect to the existing CRD outfalls at Macaulay and Clover points. In early 2006, you provided my processor, Laura Taylor, with information and on October 16, 2008, you had a brief telephone discussion about these requests with Chris Lowe, Supervisor, Marine Programs.

The information you provide will be used in the environmental impact studies currently being undertaken to meet requirements of the BC Municipal Sewage Regulation and any federal regulatory requirements regarding outfall siting. Note that we have also contacted Environment Canada to determine the potential implications of the proposed outfalls on shellfish closure areas in the vicinity of the proposed and existing CRD outfalls.

With respect to the two proposed outfall locations, our request is presented in three questions. These are:

1. What shellfish resources are present in the vicinity of the two proposed outfall locations; i.e., what species are present, where are they located and in what quantities?

2. Are there commercially harvestable shellfish resources in the vicinity of the two proposed outfall locations?

3. What is the commercial value of any harvestable shellfish resources in the vicinity of the two proposed outfall locations?

With respect to the existing Macaulay and Clover point outfalls, a January 26, 2006 letter from yourself to Laura Taylor, based on the above three questions, advised that: "*no directed studies of bivalves have been undertaken in the vicinity of the two outfalls. The species present, locations and quantities are unknown. The presence of commercially harvestable shellfish resources in the vicinity of the two outfalls is unknown. The value of harvestable shellfish resources in the vicinity of the two outfalls is unknown.*"

We have one follow up question based on this previous letter:

1. Has any new information become available regarding shellfish resources around the Macaulay and Clover point outfalls since your January 26, 2006 letter?

Thank you for your consideration of our request. If you require any clarification, please contact Chris Lowe at 250-360-3296 or clowe@crd.bc.ca.

Sincerely

Glenn Harris, PhD, RPBio
Senior Manager, Scientific Programs

Enclosure: 1

cc: Randy Alexander, Manager, Environmental Protection, MOE
Blake Medlar, Section Head, Government & Compliance, MOE
Dwayne Kalynchuk, General Manager, Environmental Services, CRD
Tony Brcic, Project Manager, Core Area Wastewater Treatment Project, CRD
Seamus McDonnell, Senior Manager, Engineering Services, CRD
Chris Lowe, Supervisor, Marine Programs, CRD

CRD
Making a difference...together

Environmental Services
625 Fisgard Street, PO Box 1000
Victoria, BC, Canada V8W 2S6

T: 250.360.3078
F: 250.360.3079
www.crd.bc.ca

October 20, 2008

File: 5400-20.01

Ms Lisa Walls
Acting Manager, Pollution Prevention and Assessment
Environment Canada
201-401 Burrard Street
Vancouver, BC V6C 3S5

Dear Ms Walls:

RE: **CAPITAL REGIONAL DISTRICT INFORMATION REQUEST ON SHELLFISH CLOSURES IN THE VICINITY OF TWO PROPOSED OUTFALLS AND THE MACAULAY AND CLOVER POINT OUTFALLS**

The Capital Regional District (CRD) is planning for new municipal wastewater treatment facilities. As part of this process, the BC Ministry of Environment (MOE) suggested that we contact you to request further information on shellfish resources and closure areas around the two proposed marine outfalls locations as follows: 1) adjacent to Albert Head and 2) off Finnerty Cove. A section of the chart showing our areas of interest is enclosed.

Note that we have also contacted Fisheries and Oceans Canada to determine the specific location, quantity and commercial value of any species of shellfish in the vicinity of the proposed and existing CRD outfalls.

Our questions build on correspondence you had with my predecessor, Laura Taylor, in 2005 and relate to how these proposed outfalls may influence shellfish closures in their vicinity. As context, effluent quality from the two proposed outfalls is anticipated to be equivalent to secondary or better. It should be noted that, as part of the move to treatment, the Macaulay and Clover point outfalls will also have treatment installed. These existing outfalls are within the same shellfish closure areas as the proposed new outfalls. It is anticipated that Macaulay Point will handle the vast majority of the existing wastewater flow and will be treated equivalent to secondary or better. Clover Point will likely become a wet weather flow outfall and will be treated equivalent to primary or better.

Our request is presented as four primary questions. These are:

1. Would the installation of these two proposed outfalls affect the size of the existing shellfish closure area along the Albert Head to Cordova Bay shoreline and around the Macaulay and Clover point outfalls or would new closure areas be created? (refer to Closure 19.1 - http://www.pac.dfo-mpo.gc.ca/ops/fm/shellfish/Biotoxins/closures/area19/19.1_e.htm).

2. a) What factors will dictate the size of future or existing shellfish closures?

   In a November 22, 2005 letter from yourself to Laura Taylor, you advised that "*the precise closure boundary delineation would be dependent on factors such as effluent quality, reliability and consistency of treatment, and evaluation of other pollution sources in the vicinity. At a minimum, a 300 meter shellfish harvesting prohibition radius would be maintained around each outfall terminus.*"

   b) Are these statements still applicable?

   c) Are there any additional factors?

3. a) What are the implications of the Canadian Shellfish Sanitation Program (CSSP) enhanced measures for the management of shellfish harvest areas adjacent to waste water treatment plants on the potential closures surrounding the two proposed outfall locations and the existing Closure 19.1 mentioned above? (http://www.inspection.gc.ca/english/fssa/concen/specif/wateaue.shtml)

   b) Are these enhanced measures going to result in more stringent CSSP water quality criteria for fecal coliforms?

   c) Will they result in the need for the CRD to plan for higher levels of treatment (e.g., effluent disinfection) than what would be anticipated under current regulatory requirements?

4. What other factors should the CRD consider with respect to these two proposed outfall locations, any potential new shellfish closure areas, upgrades to Macaulay and Clover point outfall effluent quality, and the current Closure 19.1 mentioned above?

We understand that it may be premature for you to definitively answer some of these questions as we are, as of yet, unable to provide you with detailed information about future effluent quality, treatment reliability and consistency, etc., however; general or preliminary responses would still be useful to us.

Thank you for your consideration of this request. If you require any clarification, please contact Chris Lowe, Supervisor, Marine Programs at 250-360-3296 or clowe@crd.bc.ca.

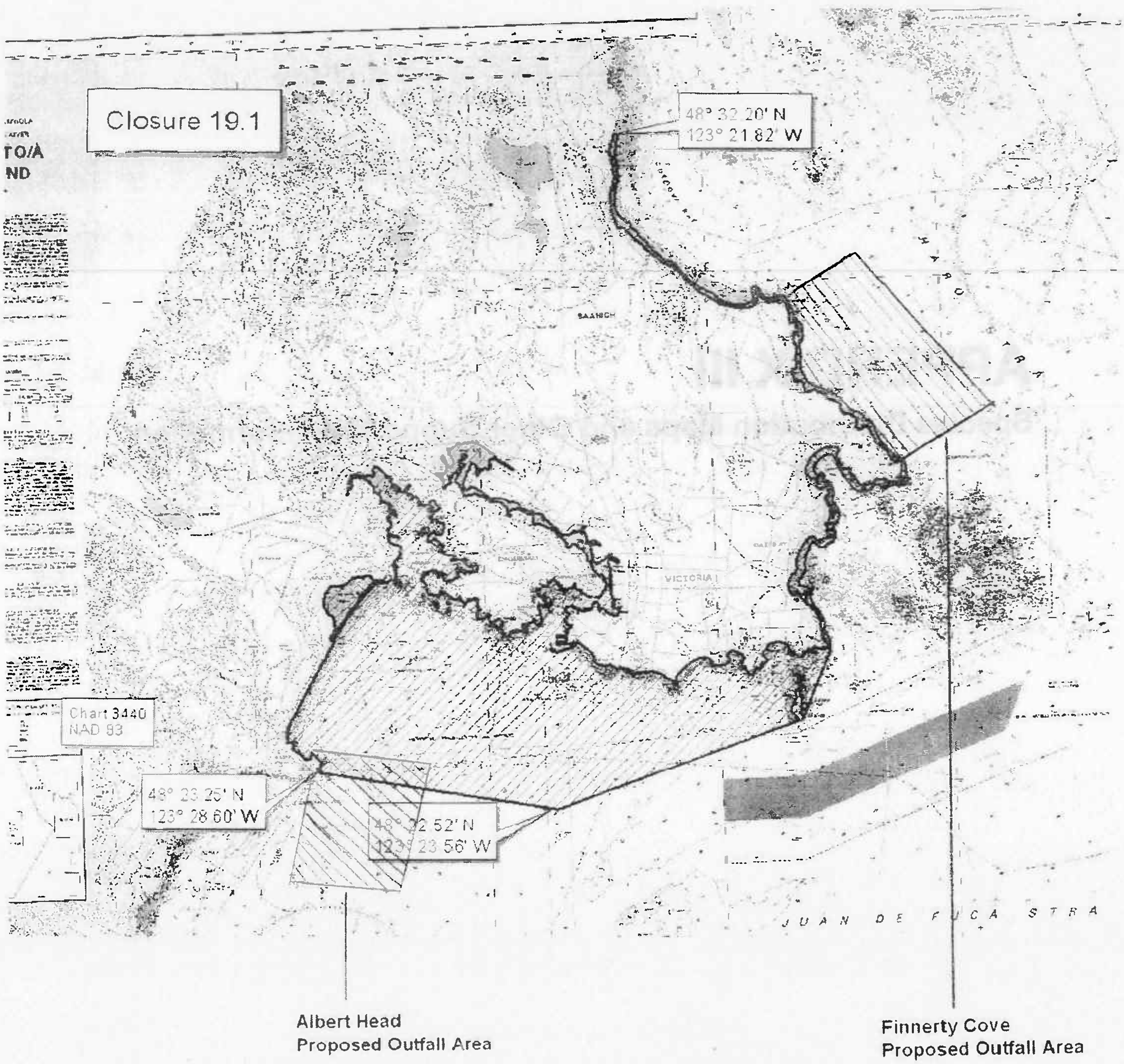
Sincerely,

Glenn Harris, PhD, RPBio
Senior Manager, Scientific Programs

Enclosure: 1

cc: Randy Alexander, Manager, Environmental Protection, MOE
Blake Medlar, Section Head, Government & Compliance, MOE
Dwayne Kalynchuk, General Manager, Environmental Services, CRD
Tony Brcic, Project Manager, Core Area Wastewater Treatment Project, CRD
Seamus McDonnell, Senior Manager, Engineering Services, CRD
Chris Lowe, Supervisor, Marine Programs, CRD

HDM#263102\v1


Closure 19.1
48° 32.20' N
123° 21.82' W
SAANICH
VICTORIA
Chart 3440
NAD 83
48° 23.25' N
123° 28.60' W
JUAN DE FUCA STRA
Albert Head
Proposed Outfall Area
Finnerty Cove
Proposed Outfall Area

STAGE 1 ENVIRONMENTAL IMPACT STUDY

APPENDIX III

Species Distribution Maps and Other Supporting Information

March 27, 2009

Report No. 08-1421-0019

Golder Associates

CRD
Making a difference...together

Parks and Protected Spaces - Parks - Parks in Vicinity of Finnerty Cove Outfall Area

Legend

- Municipal Boundaries
- Highways
- Major Roads
- Parks
- Federal Park
- Provincial Park
- Provincial Ecoreserve
- Regional Park
- Future Regional Park
- Municipal and Community Parks
- Protected Area
- Major Lakes
- Lakes and Rivers
- CRD Boundary

0 600 1200 1800 2400 m.

This map is a visitor generated static output from the Capital Regional District's Internet mapping site and is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION. For more information please visit http://www.crd.bc.ca/maps.

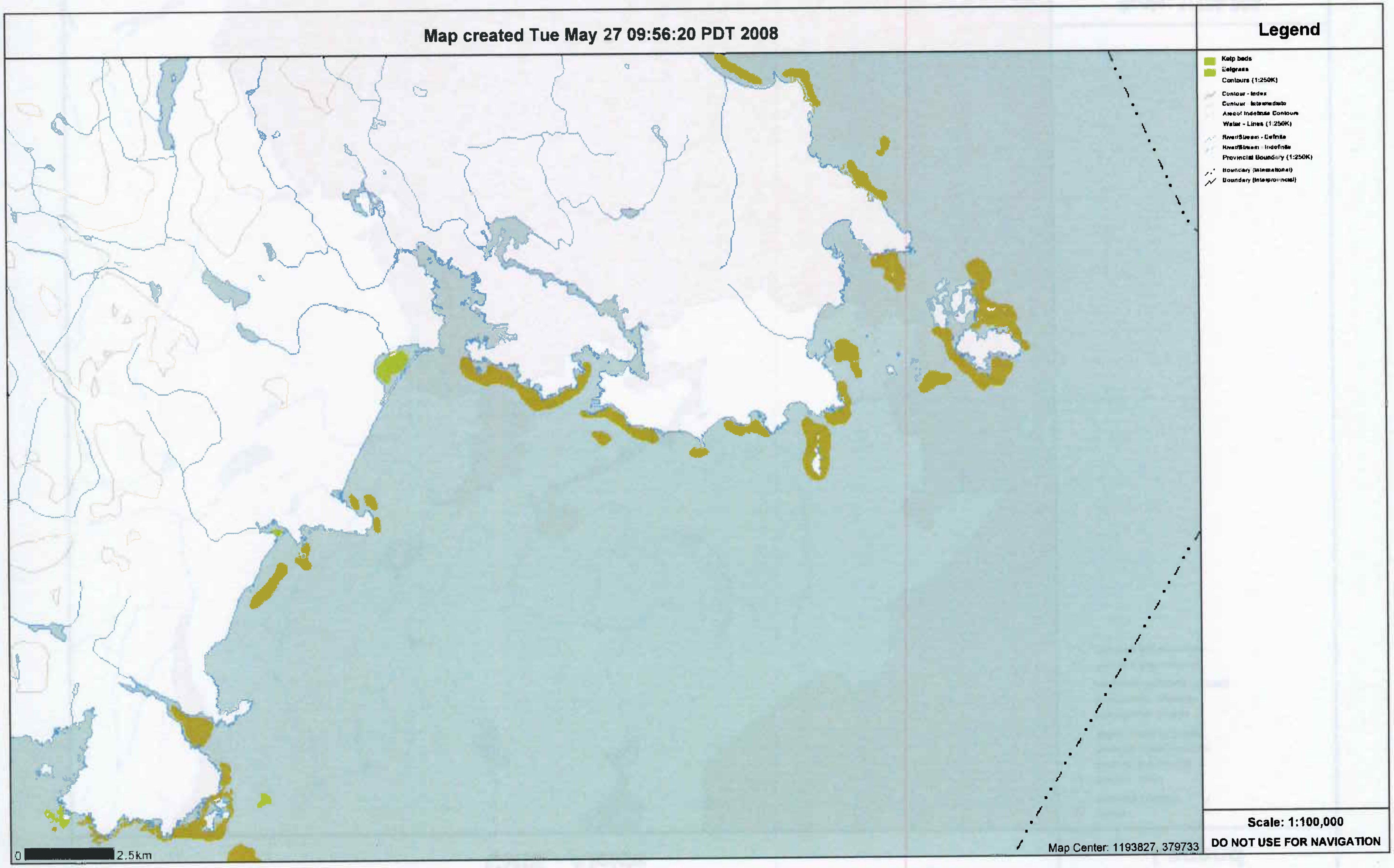
Scale: 1:53,475
Created: April 21, 2008

CRD
Making a difference...together

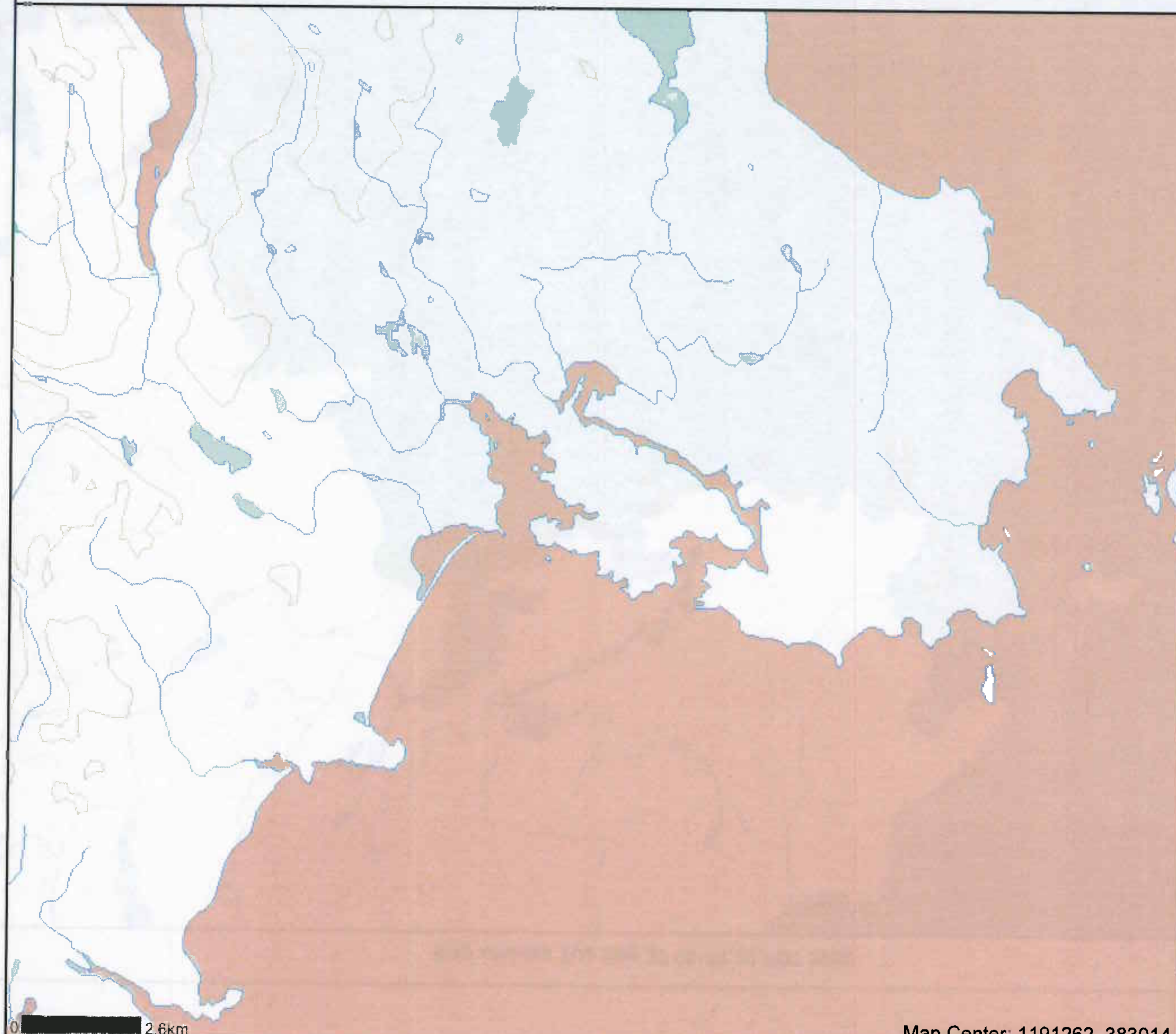
Parks and Protected Spaces - Parks - Parks near Albert Head Outfall Area

This map is a visitor generated static output from the Capital Regional District's Internet mapping site and is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION. For more information please visit http://www.crd.bc.ca/maps.

Scale: 1:90,634
Created: April 21, 2008


Map created Tue May 27 09:56:20 PDT 2008
Legend
Kelp beds
Eelgrass
Contours (1:250K)
Contour - Index
Contour - Intermediate
Area of Indefinite Contours
Water - Lines (1:250K)
River/Stream - Definite
River/Stream - Indefinite
Provincial Boundary (1:250K)
Boundary (International)
Boundary (Interprovincial)
0
2.5km
Map Center: 1193827, 379733
Scale: 1:100,000
DO NOT USE FOR NAVIGATION

CRIS - Alcids



Legend

- Alcids
- Contours (1:250K)
  - Contour - Index
  - Contour - Intermediate
  - Areaof Indefinite Contours
- Water - Lines (1:250K)
  - River/Stream - Definite
  - River/Stream - Indefinite
- Provincial Boundary (1:250K)
  - Boundary (International)
  - Boundary (Interprovincial)

Scale: 1:135,985

DO NOT USE FOR NAVIGATION

CRIS - Bald Eagle

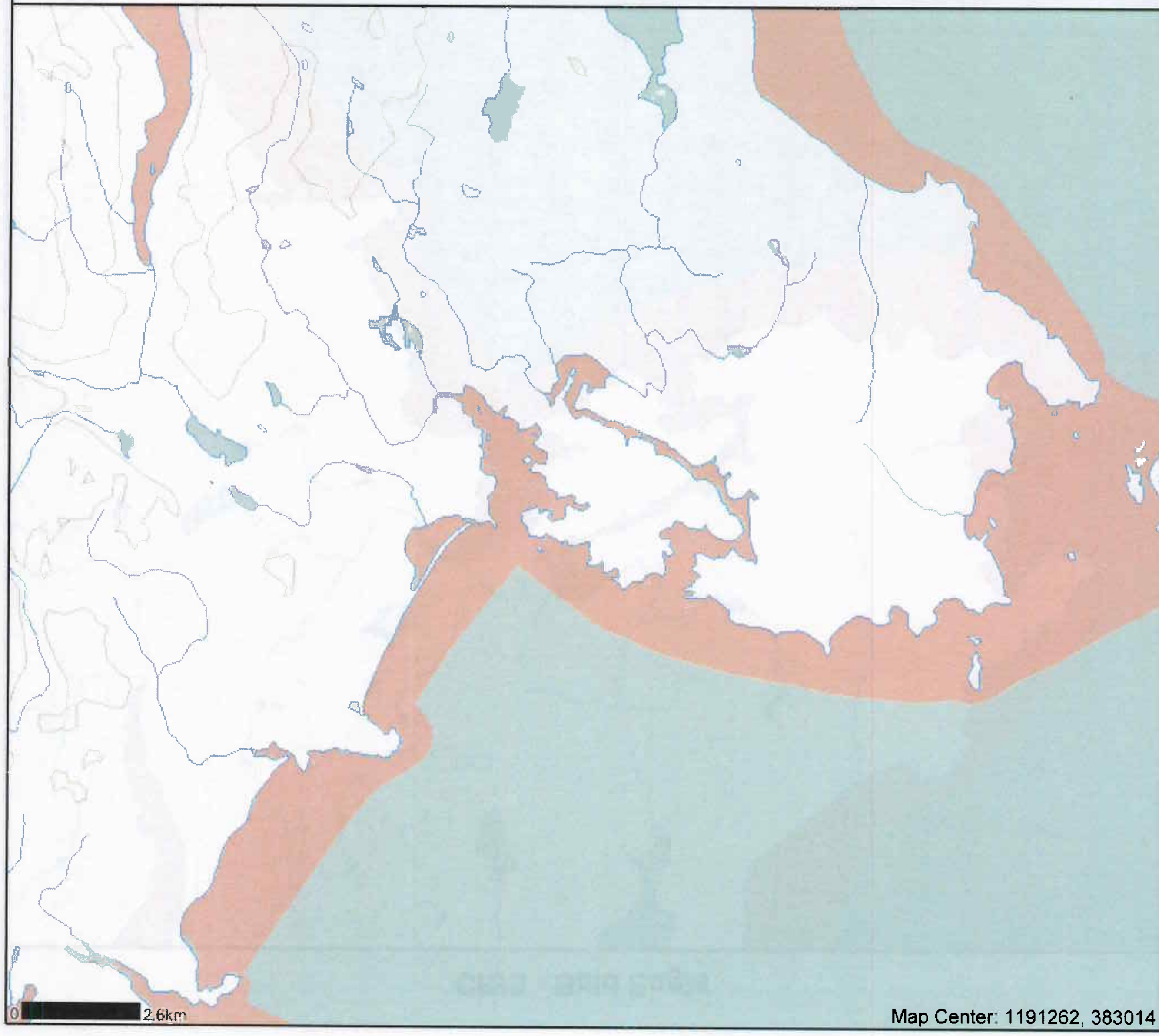
Legend

Bald Eagles
Contours (1:250K)
Contour - Index
Contour - Intermediate
Areaof Indefinite Contours
Water - Lines (1:250K)
River/Stream - Definite
River/Stream - Indefinite
Provincial Boundary (1:250K)
Boundary (International)
Boundary (Interprovincial)

Scale: 1:135,985

DO NOT USE FOR NAVIGATION

CRIS - Black Oystercatcher



Legend

- Black Oystercatcher
- Contours (1:250K)
  - Contour - Index
  - Contour - Intermediate
  - Areaof Indefinite Contours
- Water - Lines (1:250K)
  - River/Stream - Definite
  - River/Stream - Indefinite
- Provincial Boundary (1:250K)
  - Boundary (International)
  - Boundary (Interprovincial)

Scale: 1:135,985

DO NOT USE FOR NAVIGATION

CRIS - Great Blue Heron

Legend

Blue Heron

Contours (1:250K)

- Contour - Index
- Contour - Intermediate
- Area of Indefinite Contours

Water - Lines (1:250K)

- River/Stream - Definite
- River/Stream - Indefinite

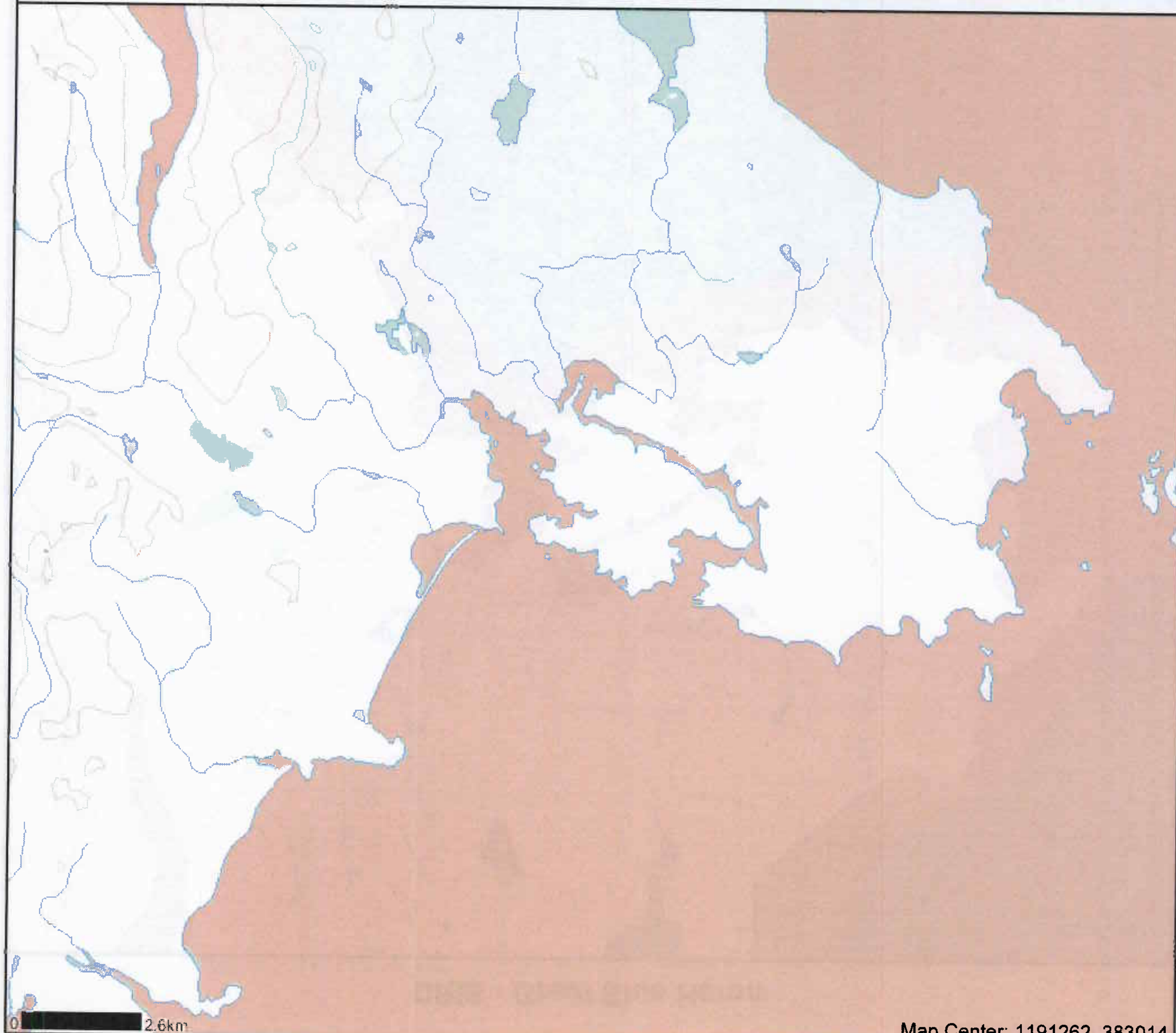
Provincial Boundary (1:250K)

- Boundary (International)
- Boundary (Interprovincial)

Scale: 1:135,985

DO NOT USE FOR NAVIGATION

CRIS - Cormorants



Legend

Cormorants
Contours (1:250K)
Contour - Index
Contour - Intermediate
Areaof Indefinite Contours
Water - Lines (1:250K)
River/Stream - Definite
River/Stream - Indefinite
Provincial Boundary (1:250K)
Boundary (International)
Boundary (Interprovincial)

Scale: 1:135,985

DO NOT USE FOR NAVIGATION

CRIS - Dabbling Ducks

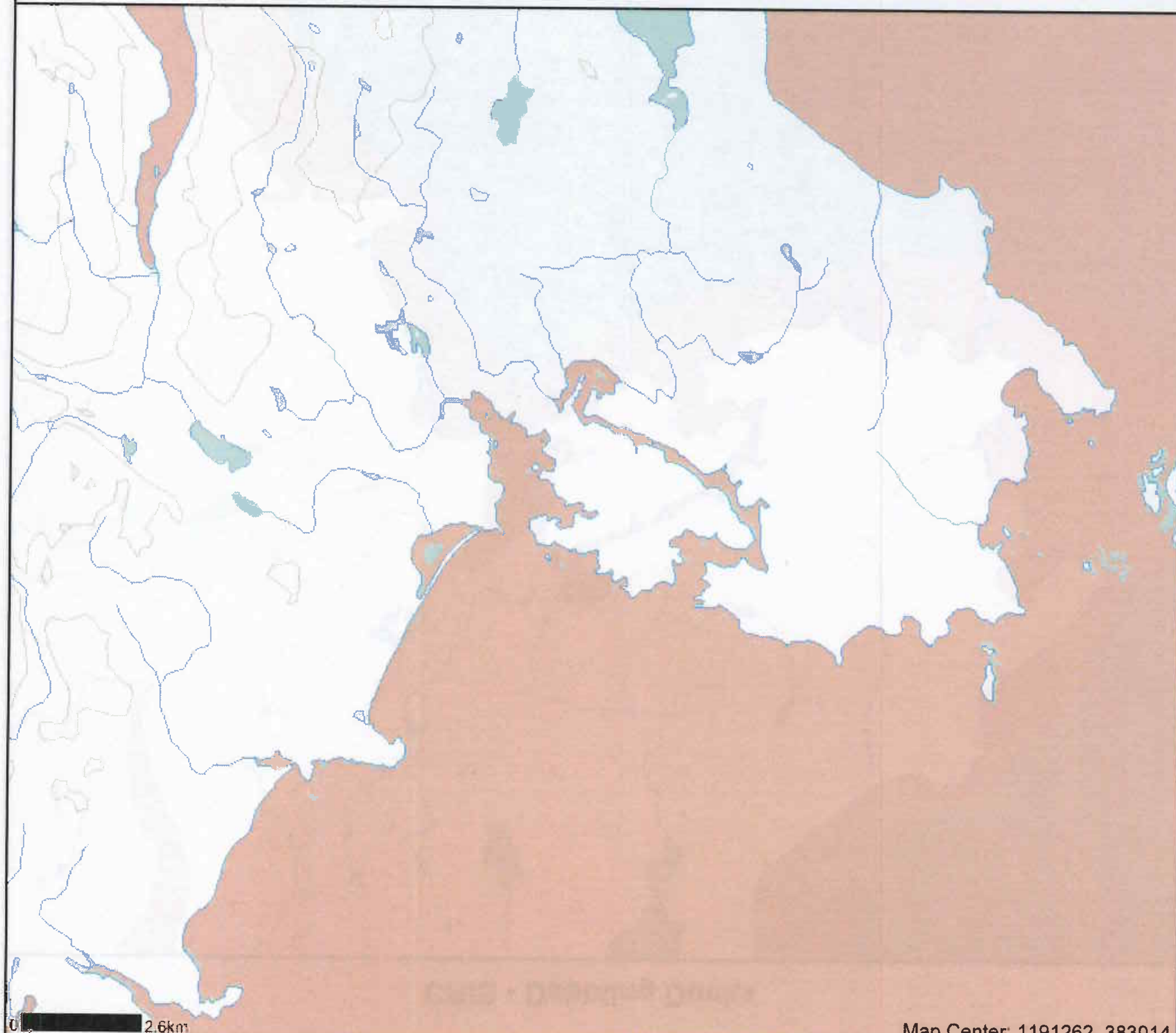
Legend

- Dabbling Ducks
- Contours (1:250K)
  - Contour - Index
  - Contour - Intermediate
  - Areas of Indefinite Contours
- Water - Lines (1:250K)
  - River/Stream - Definite
  - River/Stream - Indefinite
- Provincial Boundary (1:250K)
  - Boundary (International)
  - Boundary (Interprovincial)

Scale: 1:135,985

DO NOT USE FOR NAVIGATION

CRIS - Diving Ducks



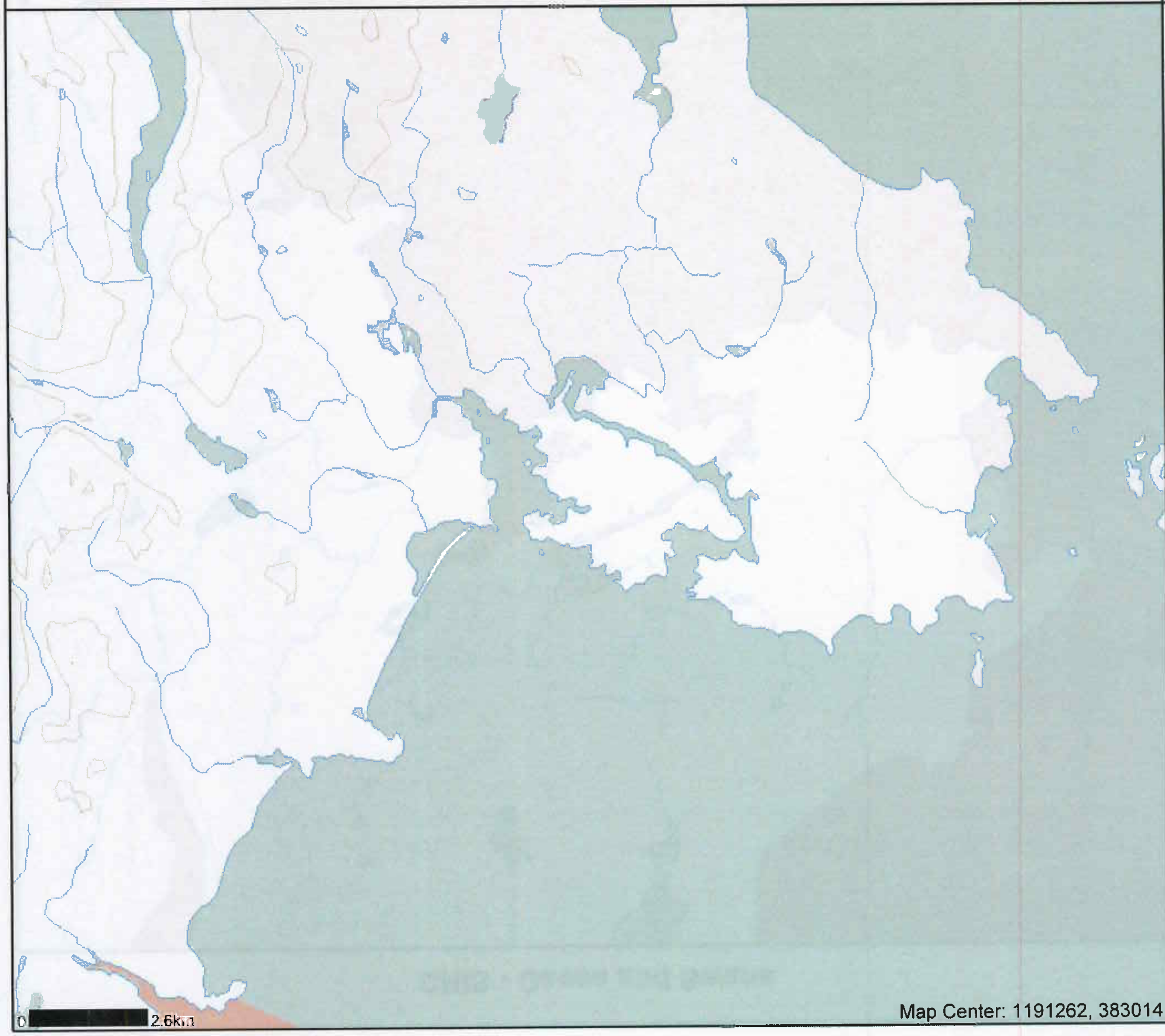
Legend

- Diving Ducks
- Contours (1:250K)
- Contour - Index
- Contour - Intermediate
- Areaof Indefinite Contours
- Water - Lines (1:250K)
- River/Stream - Definite
- River/Stream - Indefinite
- Provincial Boundary (1:250K)
- Boundary (International)
- Boundary (Interprovincial)

Scale: 1:135,985

DO NOT USE FOR NAVIGATION

CRIS - Fulmars Shearwaters and Petrels



Legend

Fulmars Shearwaters and Petrels

Contours (1:250K)

- Contour - Index
- Contour - Intermediate
- Area of Indefinite Contours

Water - Lines (1:250K)

- River/Stream - Definite
- River/Stream - Indefinite

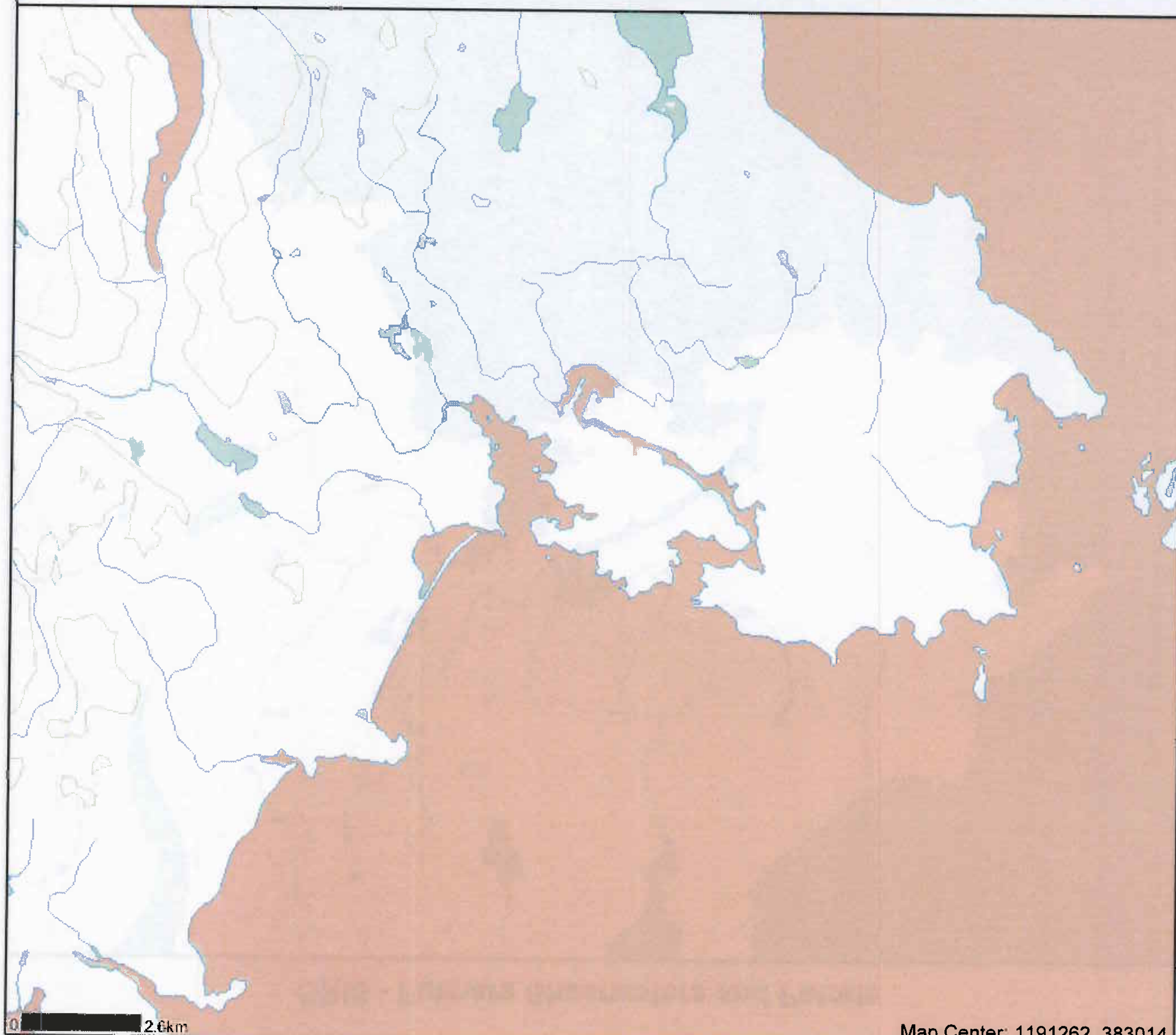
Provincial Boundary (1:250K)

- Boundary (International)
- Boundary (Interprovincial)

Scale: 1:135,985

DO NOT USE FOR NAVIGATION

CRIS - Geese and Swans



Legend

Geese and Swans

Contours (1:250K)

Contour - Index

Contour - Intermediate

Areaof Indefinite Contours

Water - Lines (1:250K)

River/Stream - Definite

River/Stream - Indefinite

Provincial Boundary (1:250K)

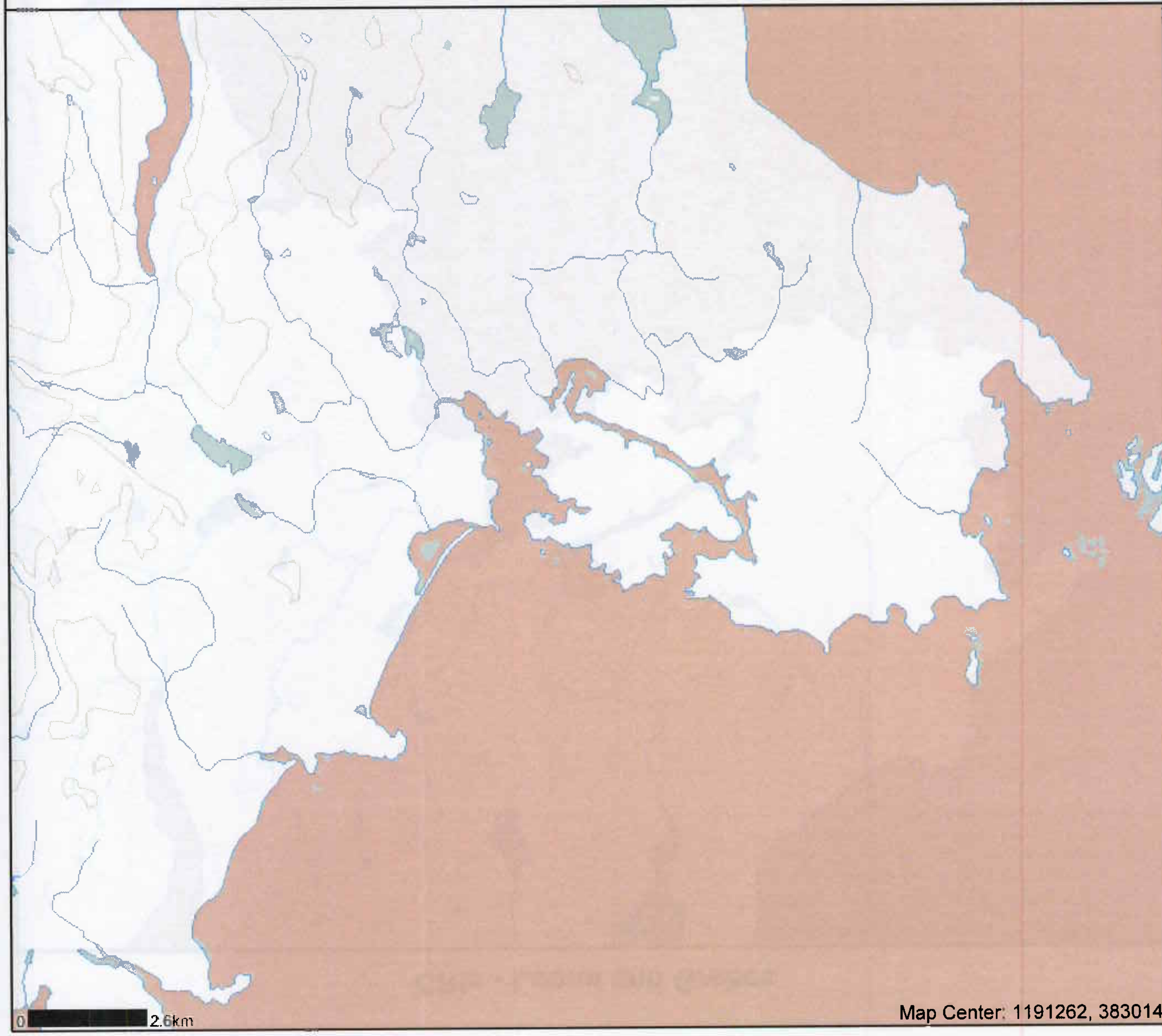
Boundary (International)

Boundary (Interprovincial)

Scale: 1:137,999

DO NOT USE FOR NAVIGATION

CRIS - Gulls



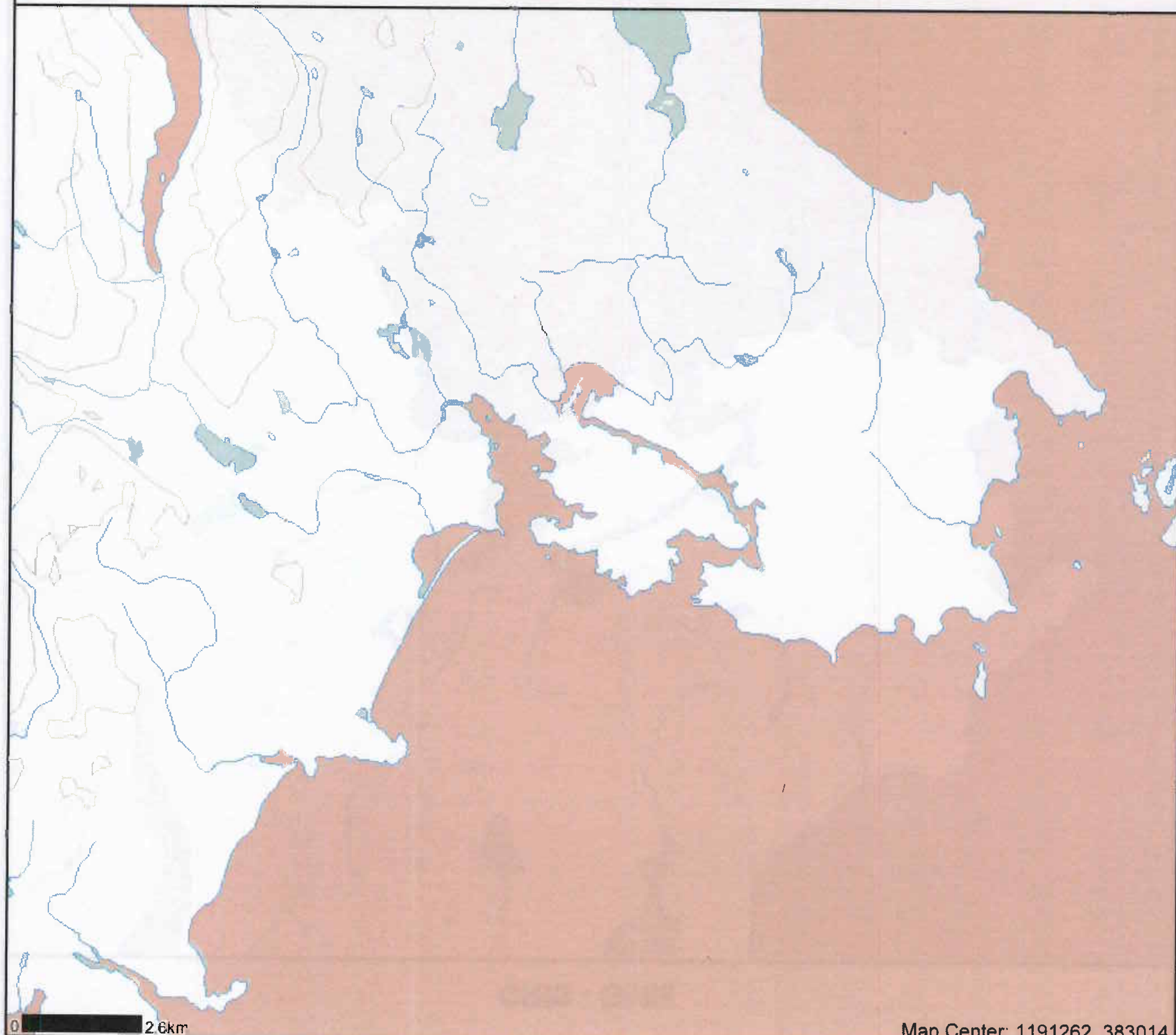
Legend

Gulls
Contours (1:250K)
Contour - Index
Contour - Intermediate
Area of Indefinite Contours
Water - Lines (1:250K)
River/Stream - Definite
River/Stream - Indefinite
Provincial Boundary (1:250K)
Boundary (International)
Boundary (Interprovincial)

Scale: 1:137,999

DO NOT USE FOR NAVIGATION

CRIs - Loons and Grebes



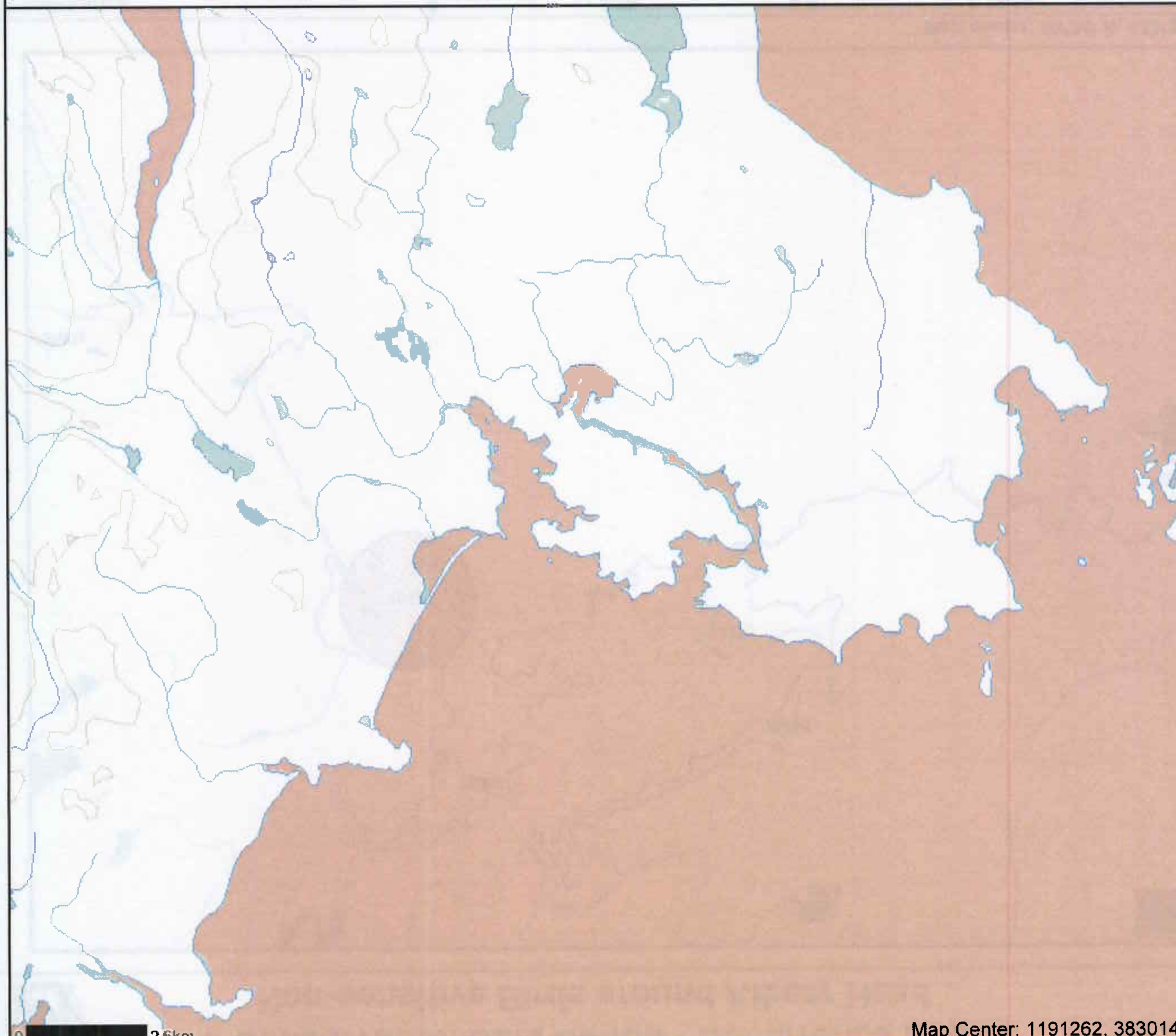
Legend

- Loons and Grebes
- Contours (1:250K)
  - Contour - Index
  - Contour - Intermediate
  - Areaof Indefinite Contours
- Water - Lines (1:250K)
  - River/Stream - Definite
  - River/Stream - Indefinite
- Provincial Boundary (1:250K)
  - Boundary (International)
  - Boundary (Interprovincial)

Scale: 1:137,999

DO NOT USE FOR NAVIGATION

CRIS - Shorebirds



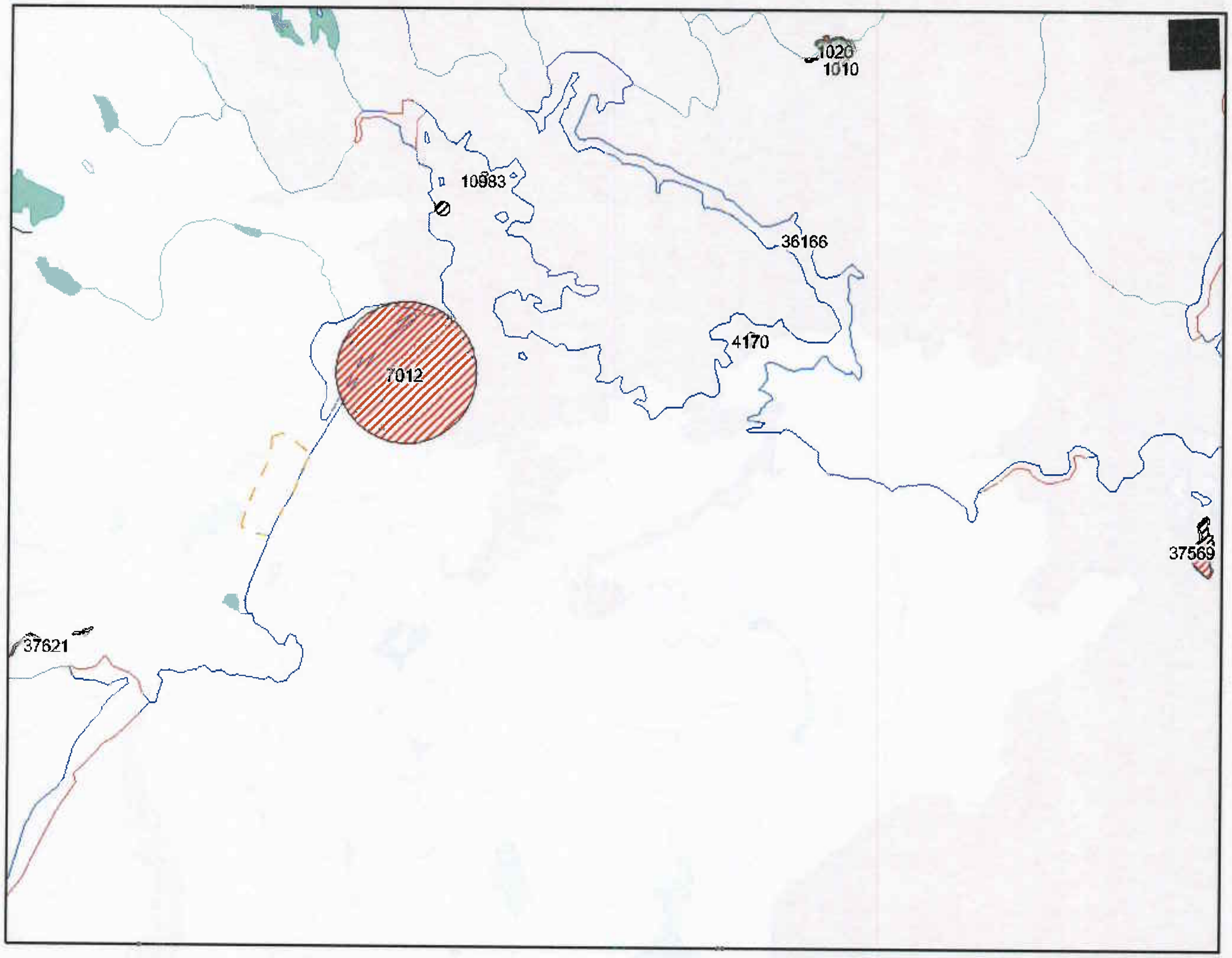
Legend

Shorebirds
Contours (1:250K)
Contour - Index
Contour - Intermediate
Areaof Indefinite Contours
Water - Lines (1:250K)
River/Stream - Definite
River/Stream - Indefinite
Provincial Boundary (1:250K)
Boundary (International)
Boundary (Interprovincial)

Scale: 1:137,999

DO NOT USE FOR NAVIGATION

BC Conservation Data Centre - Occurrence Report
Non-sensitive Birds around Albery Head



Legend

Non-sensitive Occurrences
- Animal - Vertebrate
- Animal - Invertebrate
- Plant - Vascular
- Plant - Non-vascular
- Ecological Community

Masked Sensitive Occurrences

Big Trees

Occurrence data is updated frequently. This map should be considered out of date 6 months after
March 27, 2008

For more information about the BC CDC visit: http://www.env.gov.bc.ca/cdc/

Index Map

Map center: 48°24' N, 123°25' W

MAP COMPILATION
Projection: Albers Equal Area Conic
Datum: NAD 83

0 2.75 5.5 8.25 km.

Scale: 1:92,681

Province of British Columbia
Ministry of Environment

Map Created **March 27, 2008**

BC Conservation Data Centre: Occurrence Report (10983)

August 25, 2008

Progne subis
Purple Martin

Field definition document available at **http://www.env.gov.bc.ca/atrisk/ims.htm**

This is a summary report. For a complete record contact the CDC (cdcdata@gov.bc.ca).

Identifiers

Occurrence ID:	148	**Status:**	
Shape ID:	10983	Global:	G5
Type:	Vertebrate Animal	Provinicial:	S2S3B
		COSEWIC:	
		BC List:	Blue
Taxonomic Class:	birds	SARA Schedule	
Data Sensitive:	N		

Locators

Survey Site: ESQUIMALT HARBOUR

Directions: At the Canadian Forces Base Esquimalt Diving Units, Esquimalt Harbour. Enter via Wilfert Road. Diving units are on T-shaped dock.

Survey Information

First Obs. Date: 1985 **Last Obs. Date:** 2004-SU

Occurrence Data: Purple Martins have nested around the harbour and in the "Chaudiere", a decommissioned ship, from about 1985 to present (2004). The numbers have risen from 6 pairs to approximately 30.

2004: 41 of 51 nest boxes (80%) had active Purple Martin nests and 34 of these (83%) were successful and produced 154 young (B. Cousens, pers. comm. 2004).

In 1991, the holes in the Chaudiere were sealed and more nest boxes provided, which the birds occupied. 1987: 6 pairs nested in portholes of ship; 1990: 2 pairs nested in portholes, 1 pair in a box, and another in a PVC pipe nest cylinder (Siddle *et al.* 1991). 1991: 6 pairs nested at diving units; 5 were apparently successful (large young seen looking out holes in early August (Palmateer 1991). Another pair nested in a box on a piling about 400 m WNW of plywood plant (adults seen entering in May). Martins feed over conifers on DND property and on Mill Hill to NW (Palmateer, pers. comm. 1991).

Occurrence Rank and Occurrence Rank Factors

Rank:	AB Excellent or good estimated viability	**Rank Date:**	2004-SU
Rank Comments:	Numbers of pairs increasing, nesting area stable.		
Condition of Occurrence	Nesting in and around the harbour in nest boxes and in the "Chaudiere", a decommissioned ship.		
Size of Occurrence:	Nesting known from about 1985 to present (2004). The numbers have risen from 6 pairs to approximately 30.		
Landscape Context:	The harbour is largely naval/industrial shipyards or lumberyards, but also contains a large mudflat at north end. The surrounding vegetation is dry *Pseudotsuga menziesii* with *Arbutus menziesii* and *Quercus garryana*. The shoreline is rocky (Siddle *et al.* 1991).		

Description

General Description:	The harbour is largely naval/industrial shipyards or lumberyards, but also contains a large mudflat at north end. The surrounding vegetation is dry *Pseudotsuga menziesii* with *Arbutus menziesii* and *Quercus garryana*. The shoreline is rocky (Siddle *et al.* 1991).
Vegetation Zone:	
Habitat:	TERRESTRIAL: Nestboxes

Documentation

References:	Copley, D., Personal communication. Cousens, B. Personal communication. Georgia Basin Ecological Assessment and Restoration Society Finlay, C. Personal communication. Palmateer, C. Personal communication. Siddle, C., E.L. Walters, and D.R. Copely. 1991. A status report on the Purple Martin (Progne subis) in British Columbia, 1990. Unpubl. rep., B.C. Environ., Wildl. Branch, Victoria. 85pp.

Version

Version Date:	31-MAY-07

Mapping Information

Estimated Representation Accuracy:	Very High
Confidence Extent:	Y

August 25, 2008

BC Conservation Data Centre: Occurrence Report (7012)

August 25, 2008

Melanitta perspicillata
Surf Scoter

Field definition document available at http://www.env.gov.bc.ca/atrisk/ims.htm

This is a summary report. For a complete record contact the CDC (cdcdata@gov.bc.ca).

Identifiers

Occurrence ID: 382
Shape ID: 7012
Type: Vertebrate Animal
Taxonomic Class: birds
Data Sensitive: N

Status:
Global: G5
Provinicial: S3B,S4N
COSEWIC:
BC List: Blue
SARA Schedule

Locators

Survey Site: ROYAL ROADS UNIVERSITY

Directions:

Survey Information

First Obs. Date: 1980-09-24

Last Obs. Date: 1993-03-06

Occurrence Data: 1989: 16,000 heading south, 3000 feeding approx. 0.5 km off shore of Coburg Peninsula. 1991-03-04: 2300 just offshore. 1993-03-06: 900 R. Satterfield (B.C. Vertebrate Record File 2001).

Occurrence Rank and Occurrence Rank Factors

Rank:

Rank Date:

Rank Comments:

Condition of Occurrence

Size of Occurrence:

Landscape Context:

Description

General Description:

Vegetation Zone:

Habitat: MARINE; NEARSHORE

Documentation

References: British Columbia Vertebrate Record File. 2001. Royal B.C. Mus., Victoria, BC. V8V 1X4.

Version

Version Date: 29-AUG-93

Mapping Information

Estimated Representation Accuracy:

Confidence Extent:

August 25, 2008

BC Conservation Data Centre: Occurrence Report (4170)

August 25, 2008

Progne subis
Purple Martin

Field definition document available at http://www.env.gov.bc.ca/atrisk/ims.htm

This is a summary report. For a complete record contact the CDC (cdcdata@gov.bc.ca).

Identifiers

Occurrence ID:	1072	**Status:**	
Shape ID:	4170	Global:	G5
Type:	Vertebrate Animal	Provincial:	S2S3B
		COSEWIC:	
Taxonomic Class:	birds	BC List:	Blue
		SARA Schedule	
Data Sensitive:	N		

Locators

Survey Site: VICTORIA HARBOUR

Directions: Nest box on second piling in row between West Bay marina and Work Island, north of Work Point. Access is through RV park near marina.

Survey Information

First Obs. Date: 1991

Last Obs. Date: 2003

Occurrence Data: Numbers have gone from a single pair in 1991 to 10 to 12 pairs in 2003.

Occurrence Rank and Occurrence Rank Factors

Rank: E Verified extant (viability not assessed)

Rank Date: 2003

Rank Comments:

Condition of Occurrence Nest boxes on dolphins.

Size of Occurrence: Numbers have gone from a single pair in 1991 to 10 to 12 pairs in 2003.

Landscape Context: On piling in entrance to Victoria's Inner Harbour, a busy marine port.

Description

General Description: On piling in entrance to Victoria's Inner Harbour, a busy marine port.

Vegetation Zone:

Habitat: TERRESTRIAL: Nestbox

Documentation

References:

Copley, D., Personal communication.
Cousens, B. Personal communication. Georgia Basin Ecological Assessment and Restoration Society
Palmateer, C. Personal communication.

Version

Version Date: 31-MAY-07

Mapping Information

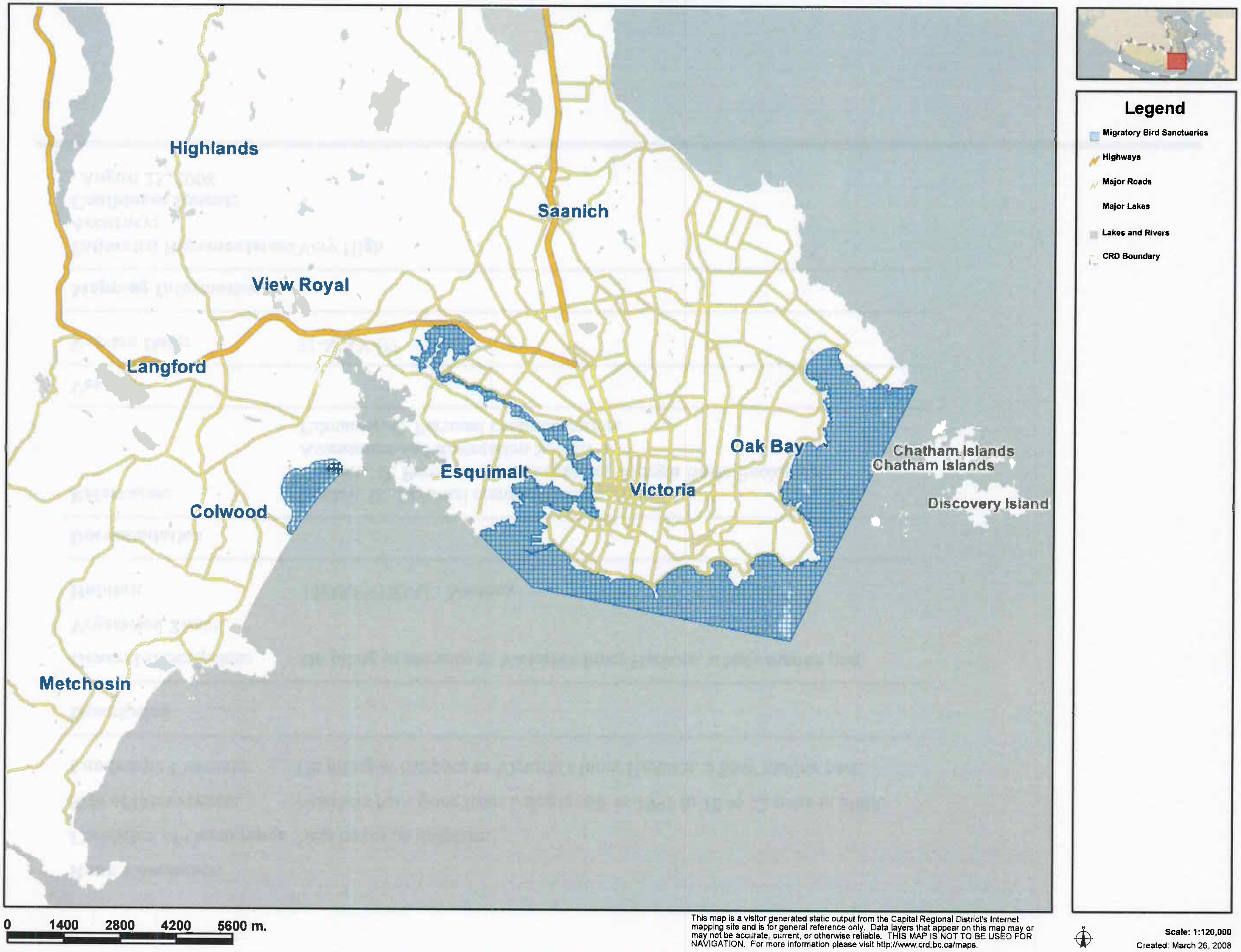
Estimated Representation Accuracy: Very High

Confidence Extent: Y

August 25, 2008

CRD
Making a difference...together

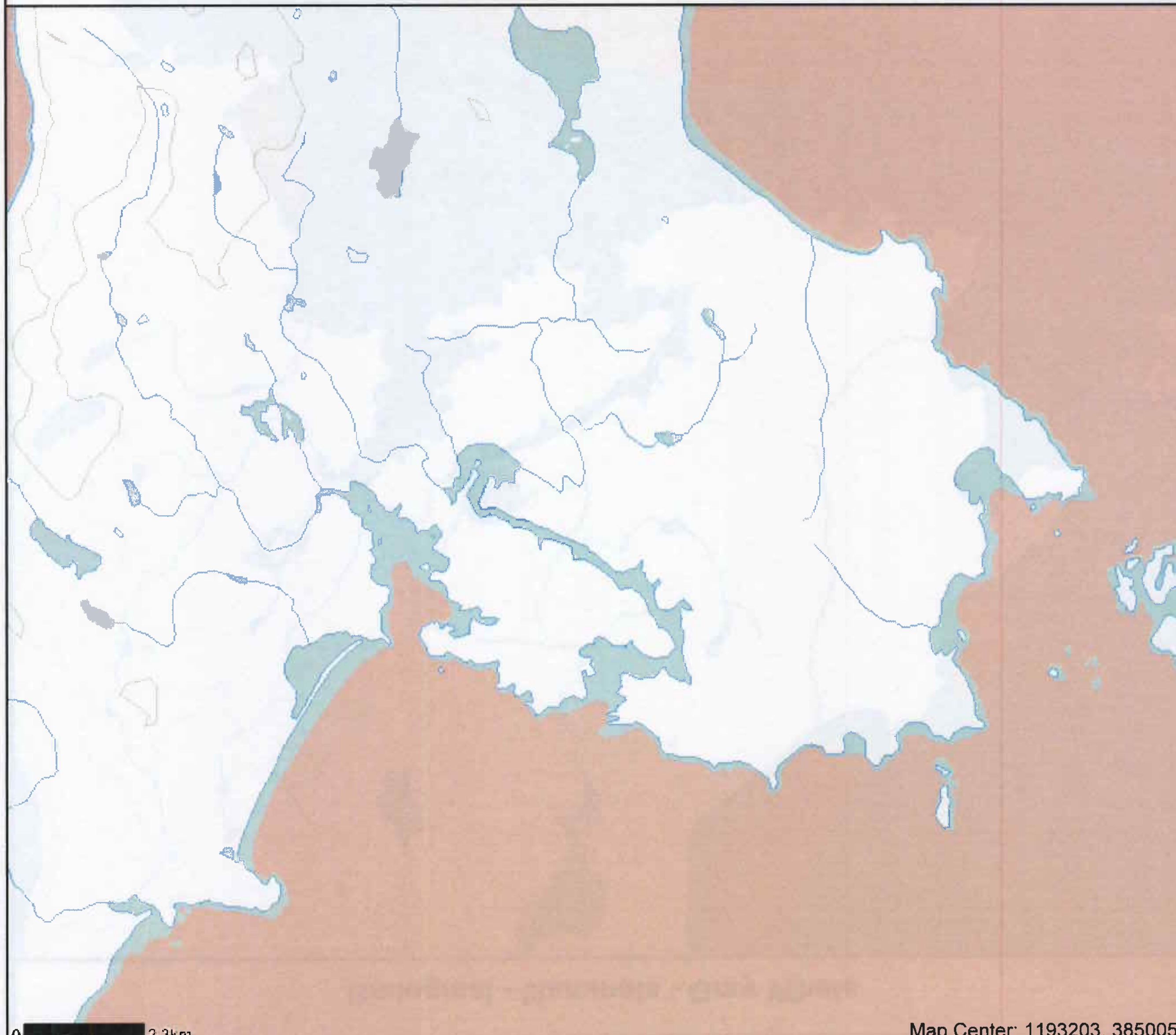
Parks and Protected Spaces - Migratory Bird Sanctuaries



This map is a visitor generated static output from the Capital Regional District's Internet mapping site and is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION. For more information please visit http://www.crd.bc.ca/maps.

Scale: 1:120,000
Created: March 26, 2008

Biological - Mammals - Killer Whale



Legend

- Killer Whale
- Waterfowl

Contours (1:250K)

- Contour - Index
- Contour - Intermediate
- Area of indefinite Contours

Water - Lines (1:250K)

- River/Stream - Definite
- River/Stream - Indefinite

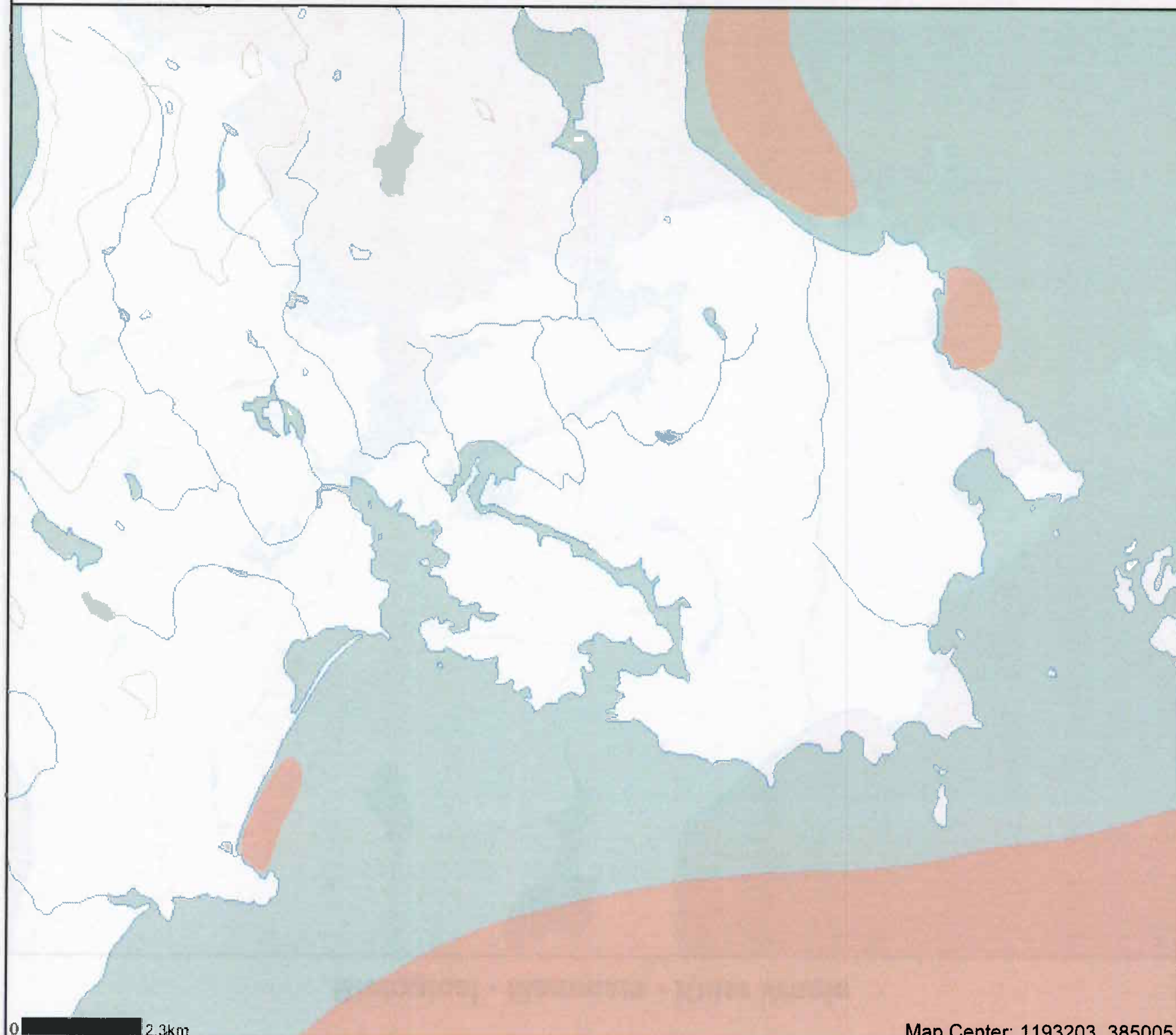
Provincial Boundary (1:250K)

- Boundary (International)
- Boundary (Interprovincial)

Scale: 1:120,000

DO NOT USE FOR NAVIGATION

Biological - Mammals - Gray Whale



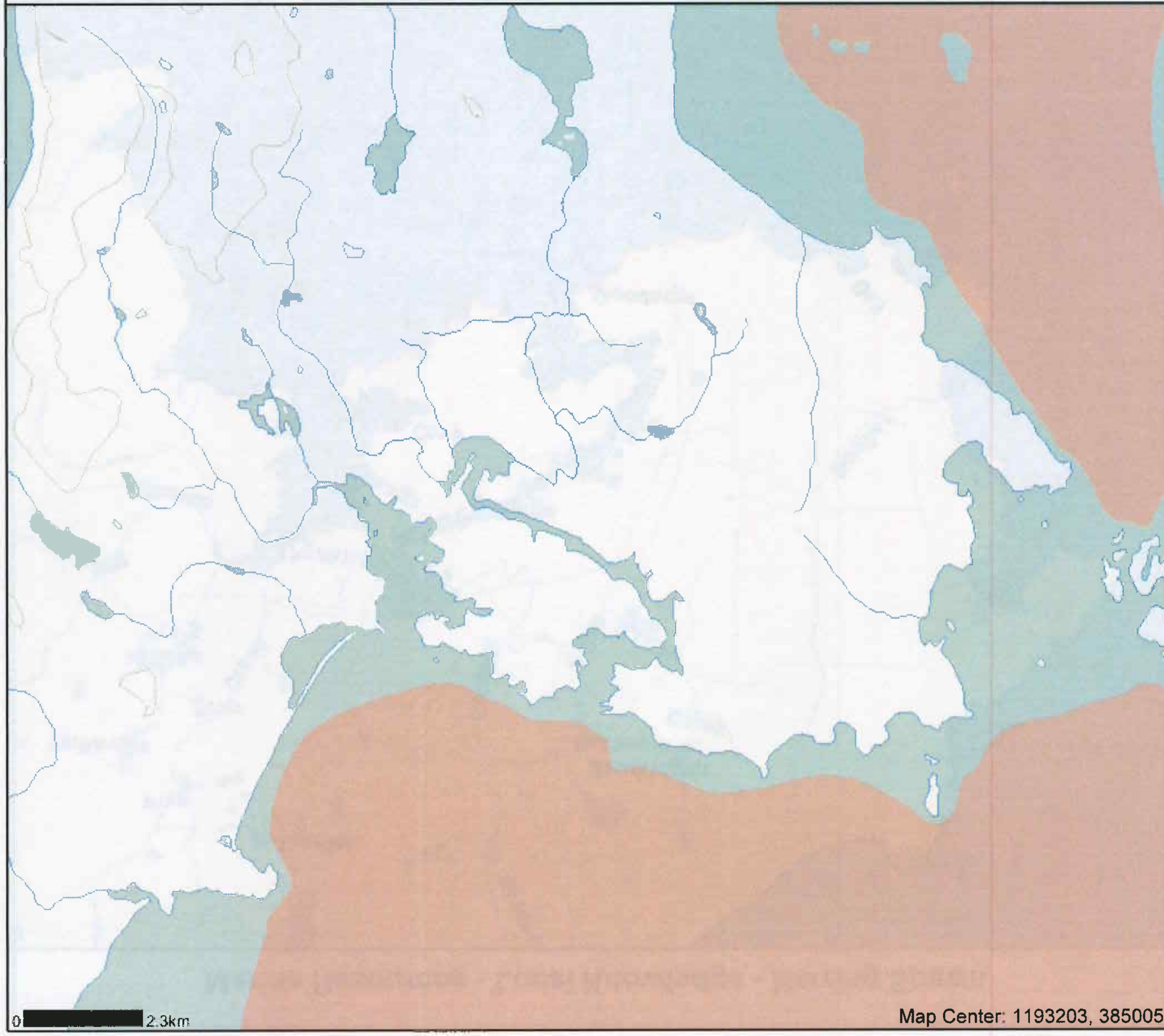
Legend

- Gray Whale
- Waterfowl
- Contours (1:250K)
- Contour - Index
- Contour - Intermediate
- Areaof Indefinite Contours
- Water - Lines (1:250K)
- River/Stream - Definite
- River/Stream - Indefinite
- Provincial Boundary (1:250K)
- Boundary (International)
- Boundary (interprovincial)

Scale: 1:120,000

DO NOT USE FOR NAVIGATION

Biological - Mammals - Harbour Porpoise



Legend

- Harbour Porpoise
- Waterfowl

Contours (1:250K)
- Contour - Index
- Contour - Intermediate
- Areaof Indefinite Contours

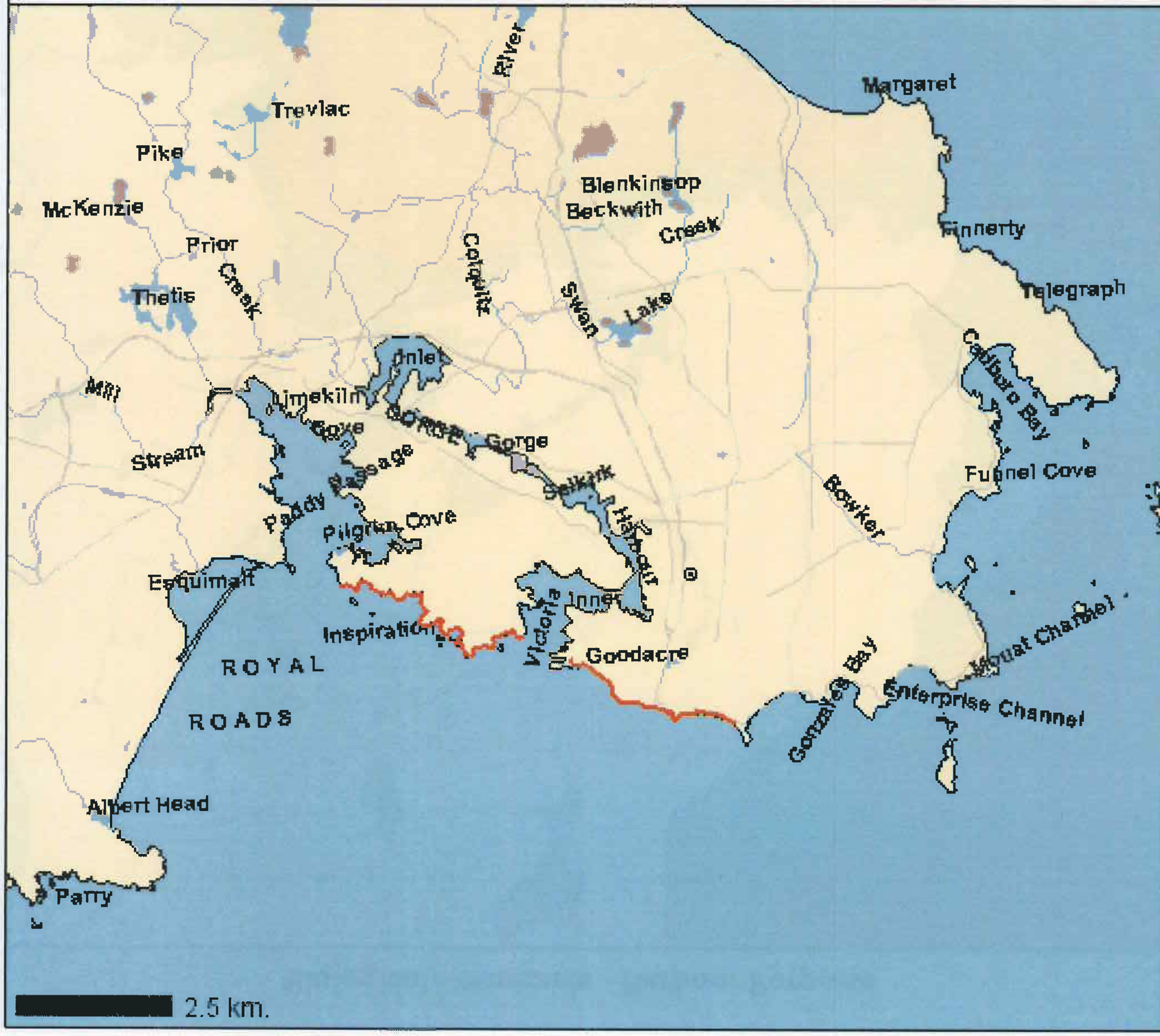
Water - Lines (1:250K)
- River/Stream - Definite
- River/Stream - Indefinite

Provincial Boundary (1:250K)
- Boundary (International)
- Boundary (interprovincial)

Scale: 1:120,000

DO NOT USE FOR NAVIGATION

Marine Resources - Local Knowledge - Herring Spawn



Legend

Borders

Streams (1:50k)

- Stream
- Canal

Lakes (1:50k)

- Lake/River
- Wetland
- Marsh

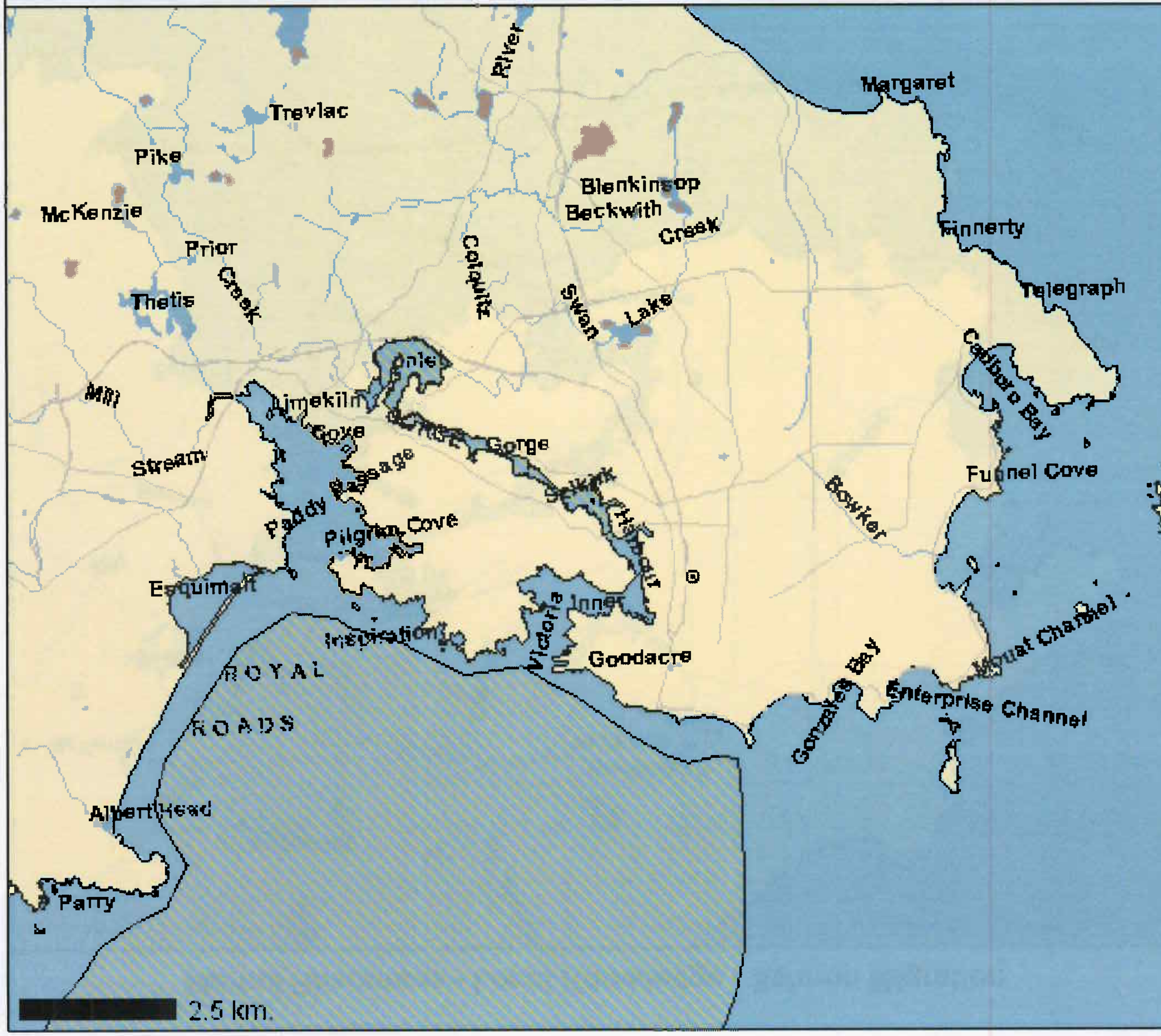
Settlements

SC Herring Spawn

Scale: 1:100,000

DO NOT USE FOR NAVIGATION

Marine Resources - Local Knowledge - Herrring Holding Area



Legend

Borders

Streams (1:50k)
- Stream
- Canal

Lakes (1:50k)
- Lake/River
- Wetland
- Marsh

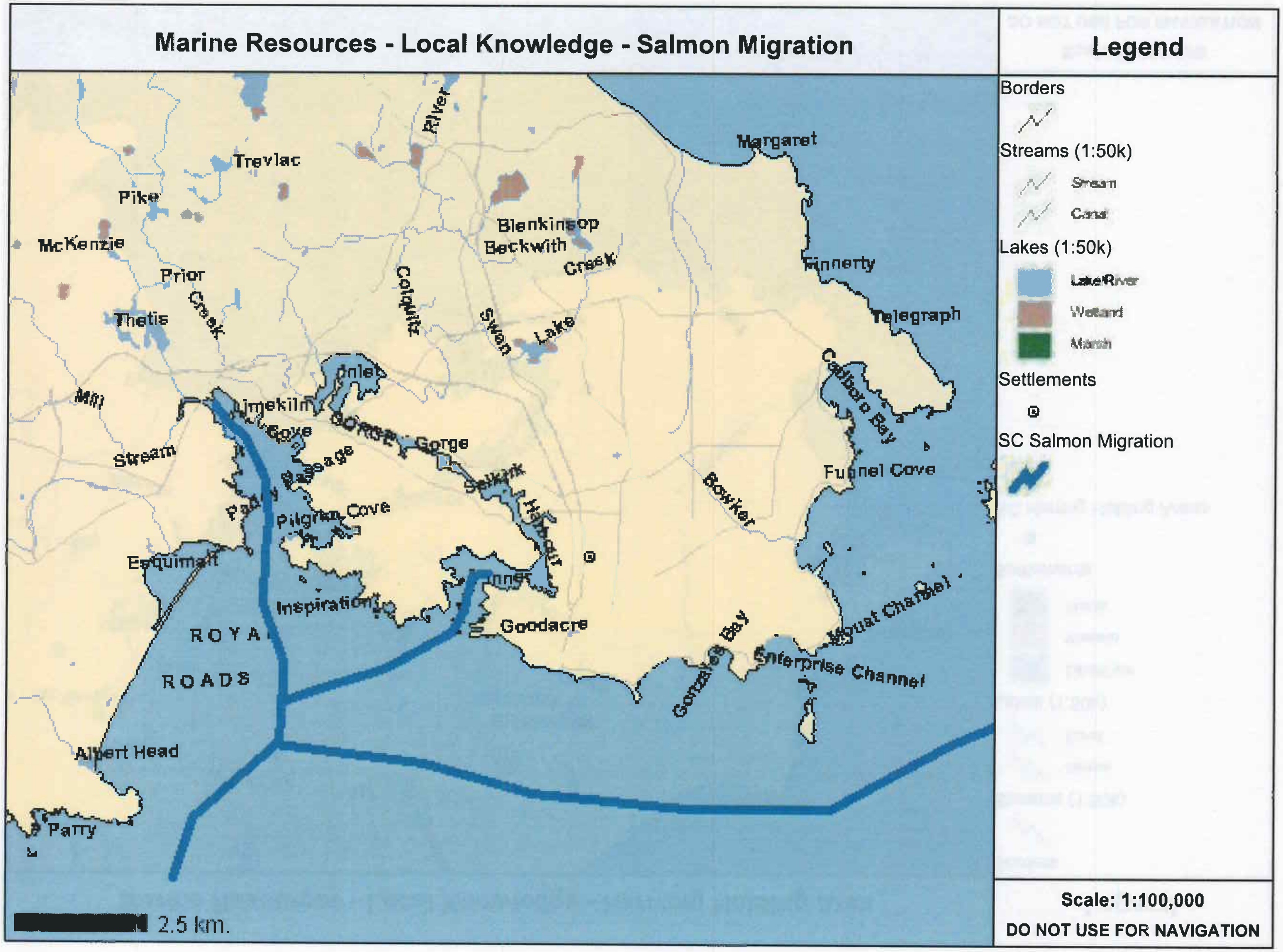
Settlements

SC Herring Holding Areas

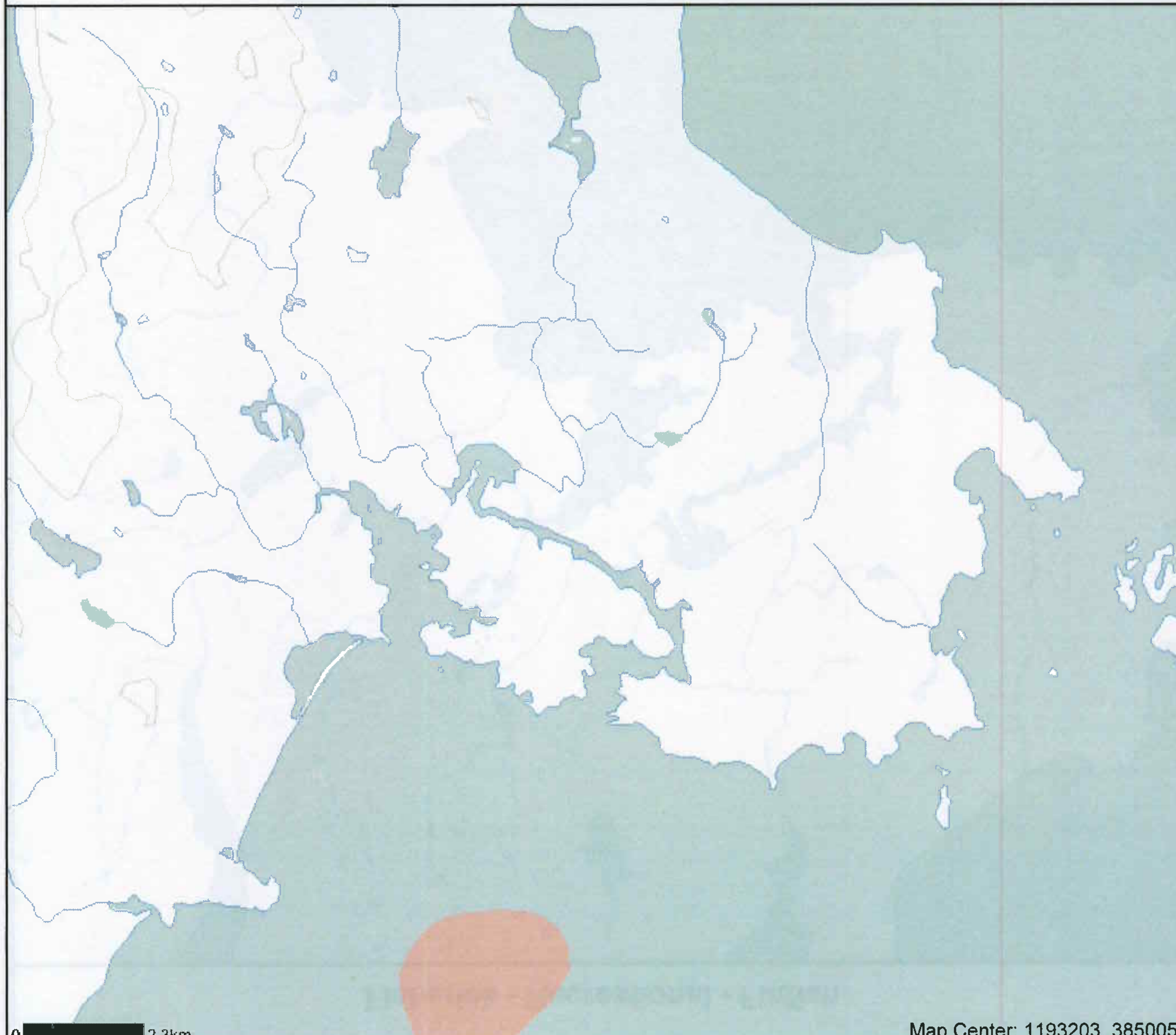
Scale: 1:100,000

DO NOT USE FOR NAVIGATION

Marine Resources - Local Knowledge - Salmon Migration



Fisheries - Commerical - Groundfish



Legend

Groundfish

Contours (1:250K)

Contour - index

Contour - intermediate

Areaof Indefinite Contours

Water - Lines (1:250K)

River/Stream - Definite

River/Stream - Indefinite

Provincial Boundary (1:250K)

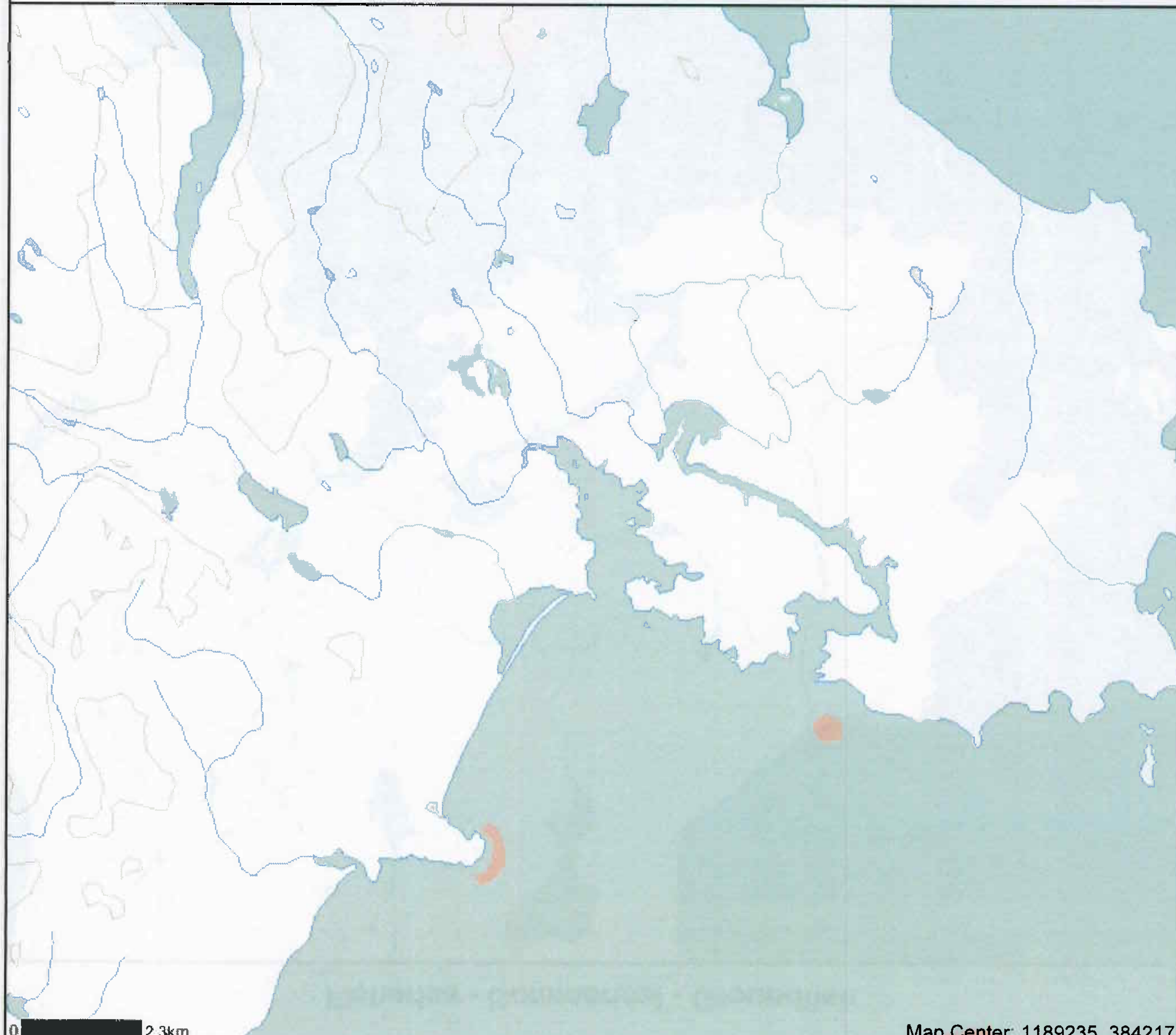
Boundary (International)

Boundary (Interprovincial)

Scale: 1:120,000

DO NOT USE FOR NAVIGATION

Fisheries - Recreational - Finfish

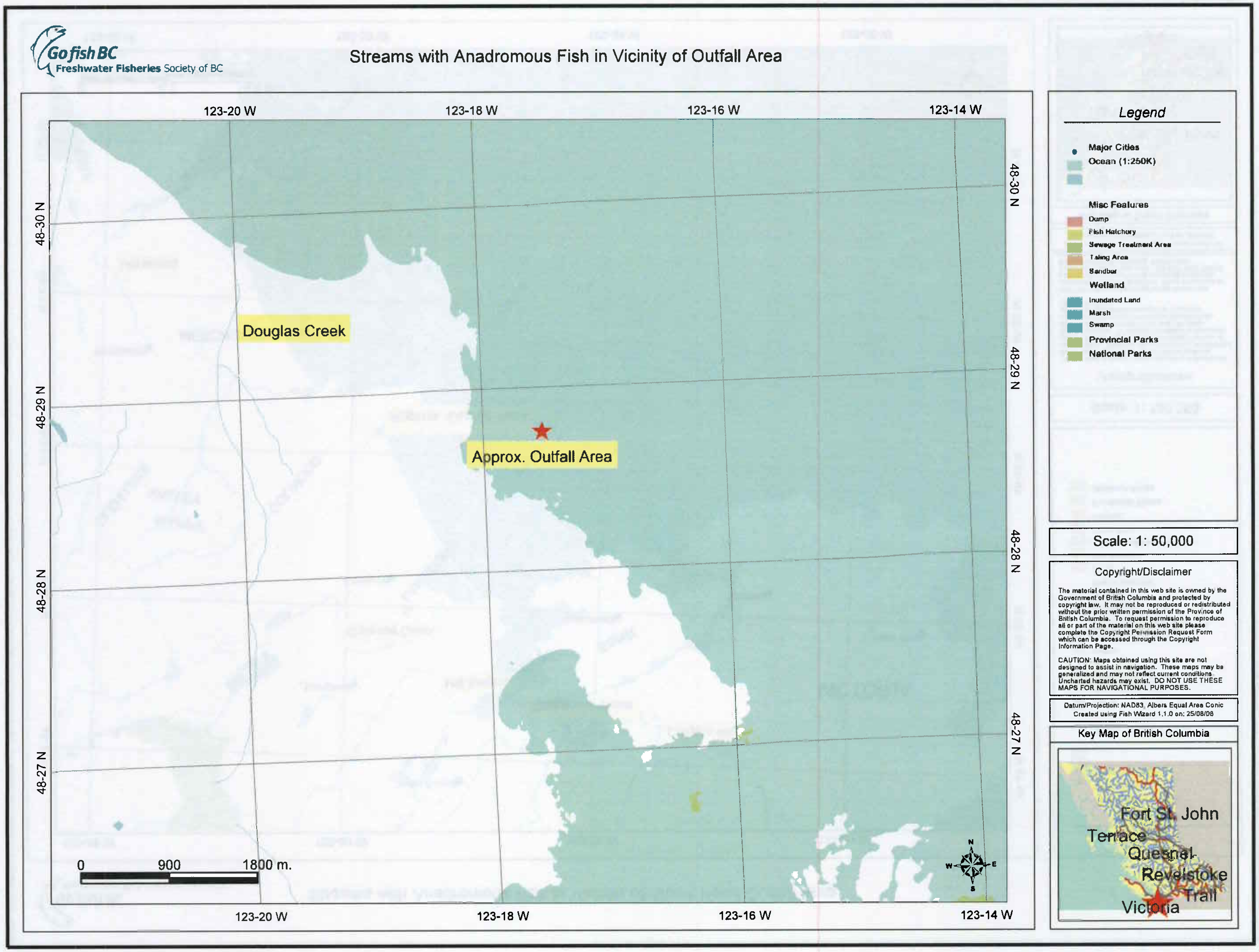


Legend

- Recreational Finfish
- Contours (1:250K)
- Contour - Index
- Contour - Intermediate
- Areaof Indefinite Contours
- Water - Lines (1:250K)
- River/Stream - Definite
- River/Stream - Indefinite
- Provincial Boundary (1:250K)
- Boundary (International)
- Boundary (Interprovincial)

Scale: 1:120,000

DO NOT USE FOR NAVIGATION



Go fish BC
Freshwater Fisheries Society of BC
Streams with Anadromous Fish in Vicinity of Outfall Area
123-20 W
123-18 W
123-16 W
123-14 W
48-30 N
48-29 N
48-28 N
48-27 N
Douglas Creek
Approx. Outfall Area
0
900
1800 m.
N
W
E
S
Legend
Major Cities
Ocean (1:250K)
Misc Features
Dump
Fish Hatchery
Sewage Treatment Area
Tailing Area
Sandbar
Wetland
Inundated Land
Marsh
Swamp
Provincial Parks
National Parks
Scale: 1: 50,000
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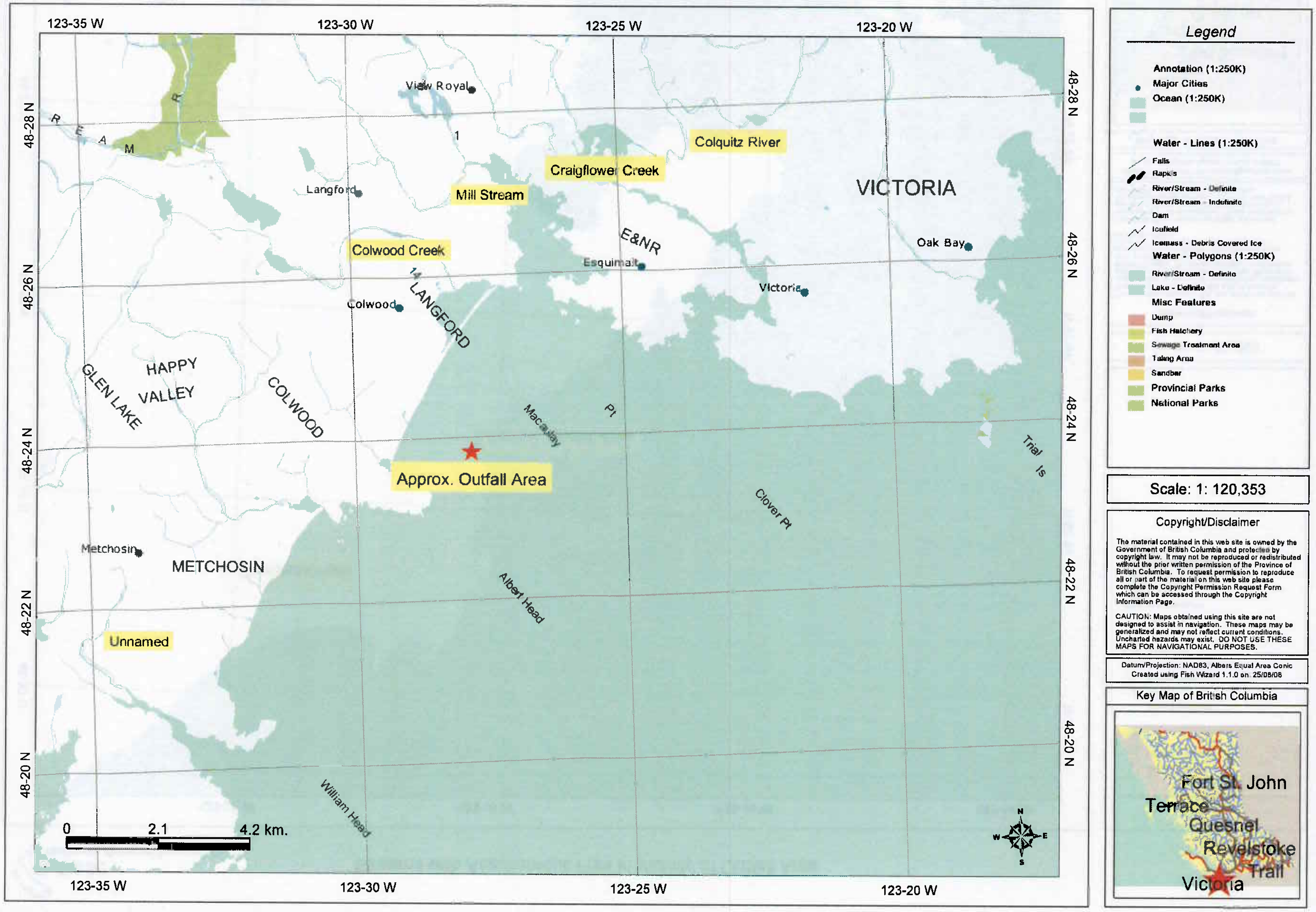
CAUTION: Maps obtained using this site are not designed to assist in navigation. These maps may be generalized and may not reflect current conditions. Uncharted hazards may exist. DO NOT USE THESE MAPS FOR NAVIGATIONAL PURPOSES.
Datum/Projection: NAD83, Albers Equal Area Conic
Created using Fish Wizard 1.1.0 on: 25/08/08
Key Map of British Columbia
Fort St. John
Terrace
Quesnel
Revelstoke
Trail
Victoria

Gofish BC
Freshwater Fisheries Society of BC

Streams with Anadromous Fish in Vicinity of Albert Head Outfall Area



Datum/Projection: NAD83, Albers Equal Area Conic
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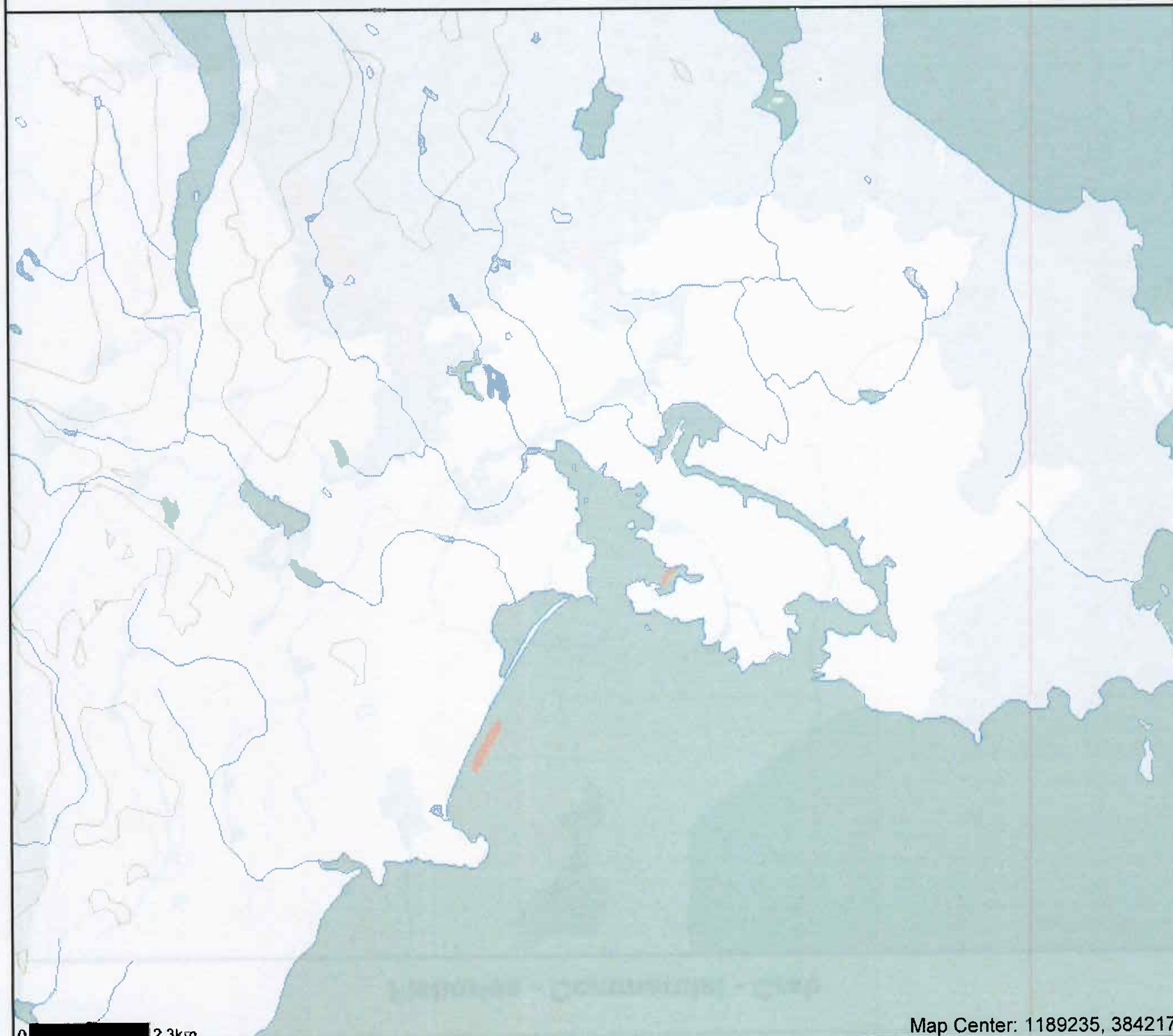
Fisheries - Commercial - Squid



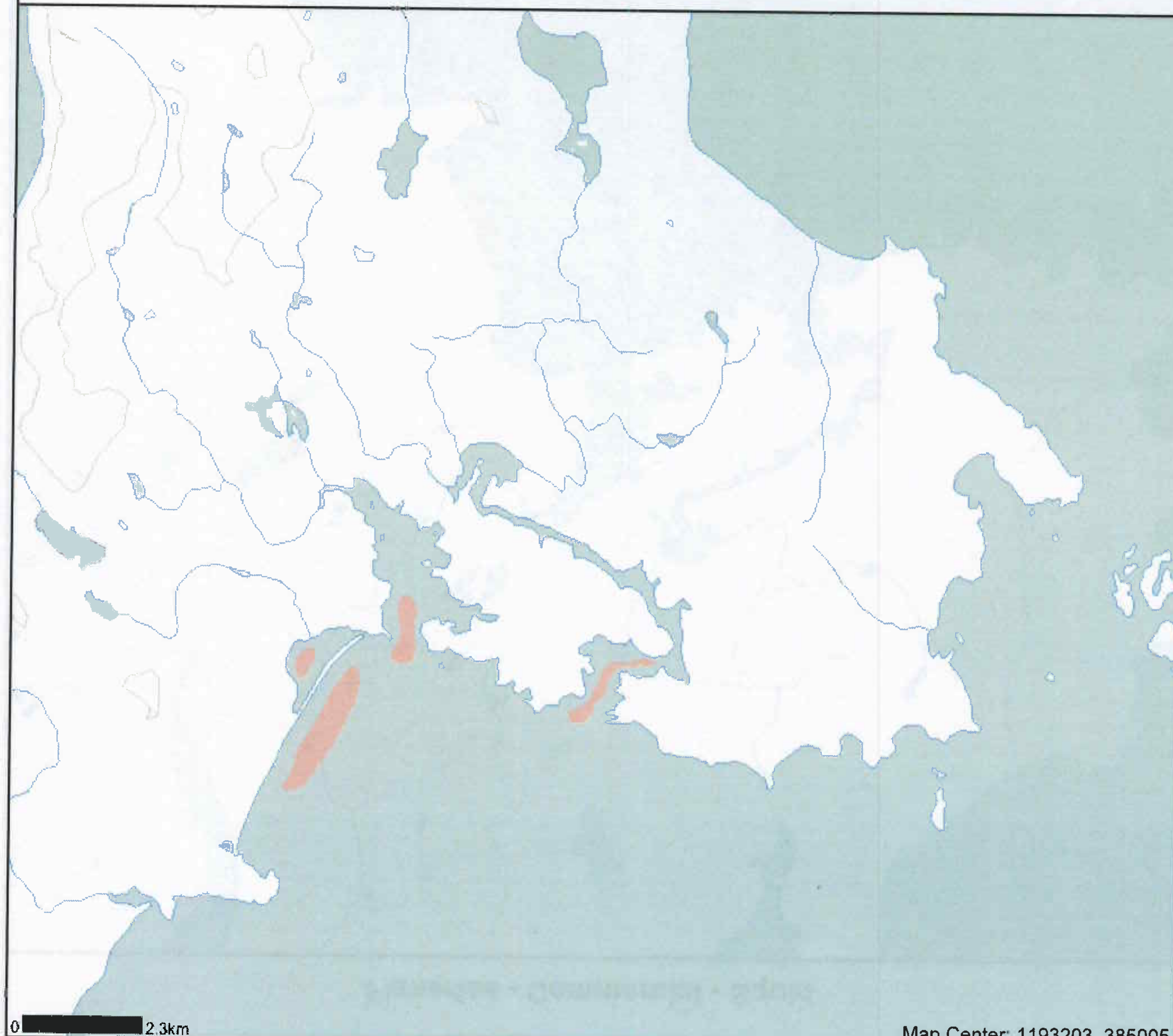
Legend

- Squid
- Contours (1:250K)
  - Contour - Index
  - Contour - Intermediate
  - Area of Indefinite Contours
- Water - Lines (1:250K)
  - River/Stream - Definite
  - River/Stream - Indefinite
- Provincial Boundary (1:250K)
  - Boundary (International)
  - Boundary (Interprovincial)

Scale: 1:120,000

DO NOT USE FOR NAVIGATION

Fisheries - Commercial - Crab



Legend

Crab
Contours (1:250K)
Contour - Index
Contour - Intermediate
Area of Indefinite Contours
Water - Lines (1:250K)
River/Stream - Definite
River/Stream - Indefinite
Provincial Boundary (1:250K)
Boundary (International)
Boundary (Interprovincial)

Scale: 1:120,000

DO NOT USE FOR NAVIGATION

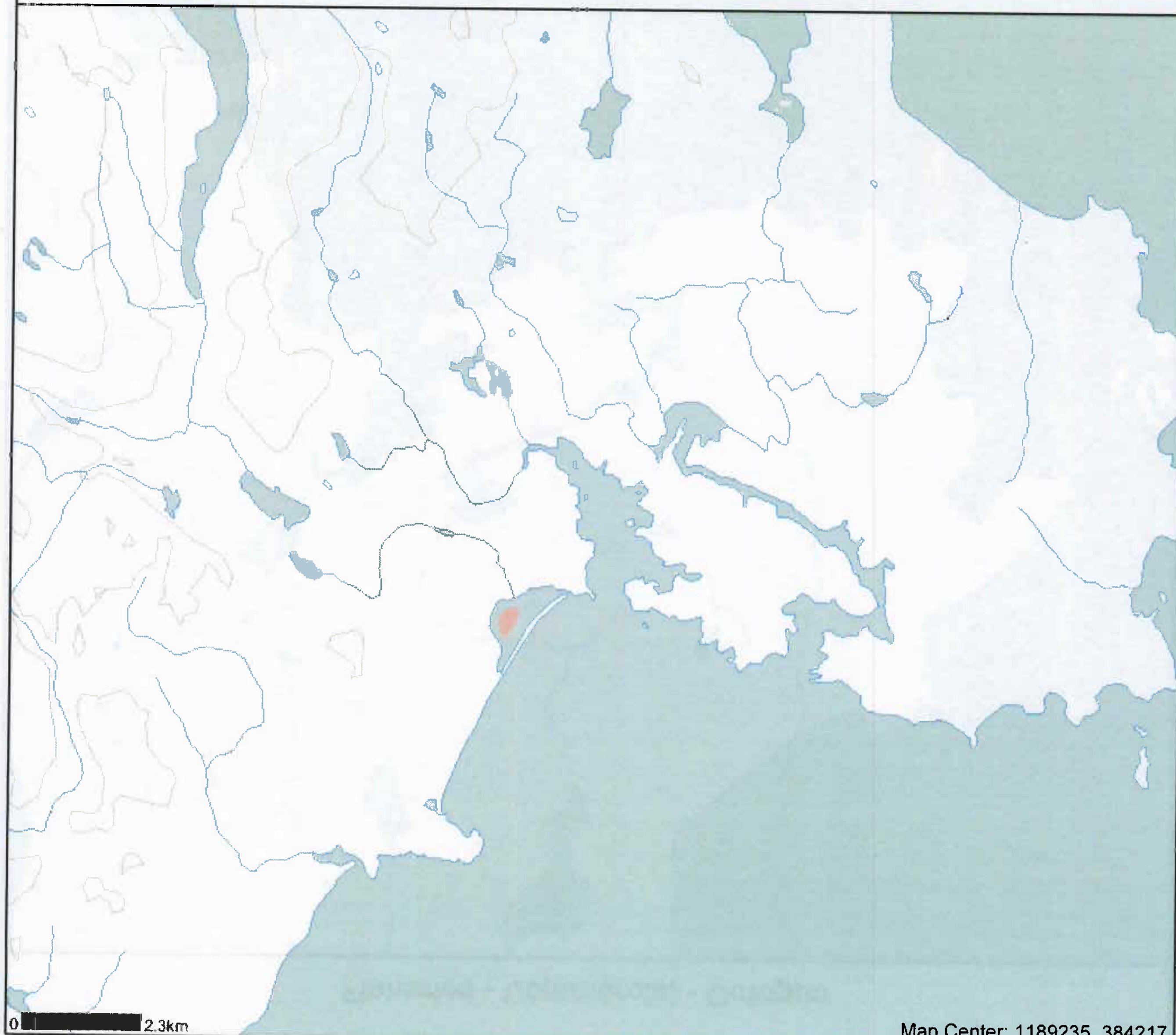
Fisheries - Commercial - Octopus

Legend

Scale: 1:120,000

DO NOT USE FOR NAVIGATION

Fisheries - Recreational - Crab



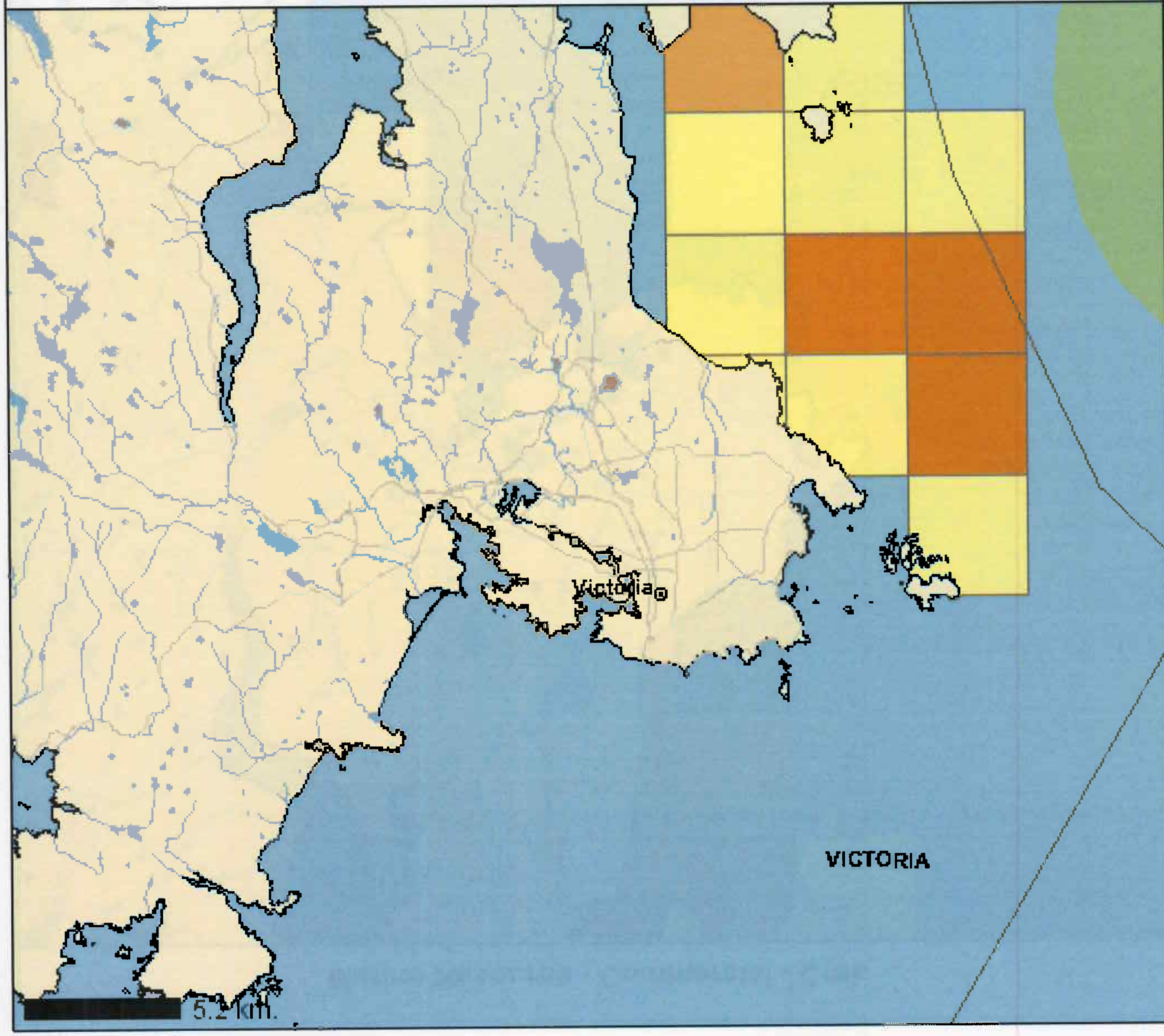
Legend

- Recreational Crab
- Contours (1:250K)
- Contour - Index
- Contour - Intermediate
- Area of Indefinite Contours
- Water - Lines (1:250K)
- River/Stream - Definite
- River/Stream - Indefinite
- Provincial Boundary (1:250K)
- Boundary (International)
- Boundary (Interprovincial)

Scale: 1:120,000

DO NOT USE FOR NAVIGATION

Marine Resources - Commercial - Shrimp



Legend

Shrimp Trawl Catch 1996-2004

CATCH (LB)

- 0 - 50000
- 50001 - 100000
- 100001 - 200000
- 200001 - 400000
- 400001 - 1853608

Borders

Streams (1:50k)

- Stream
- Canal

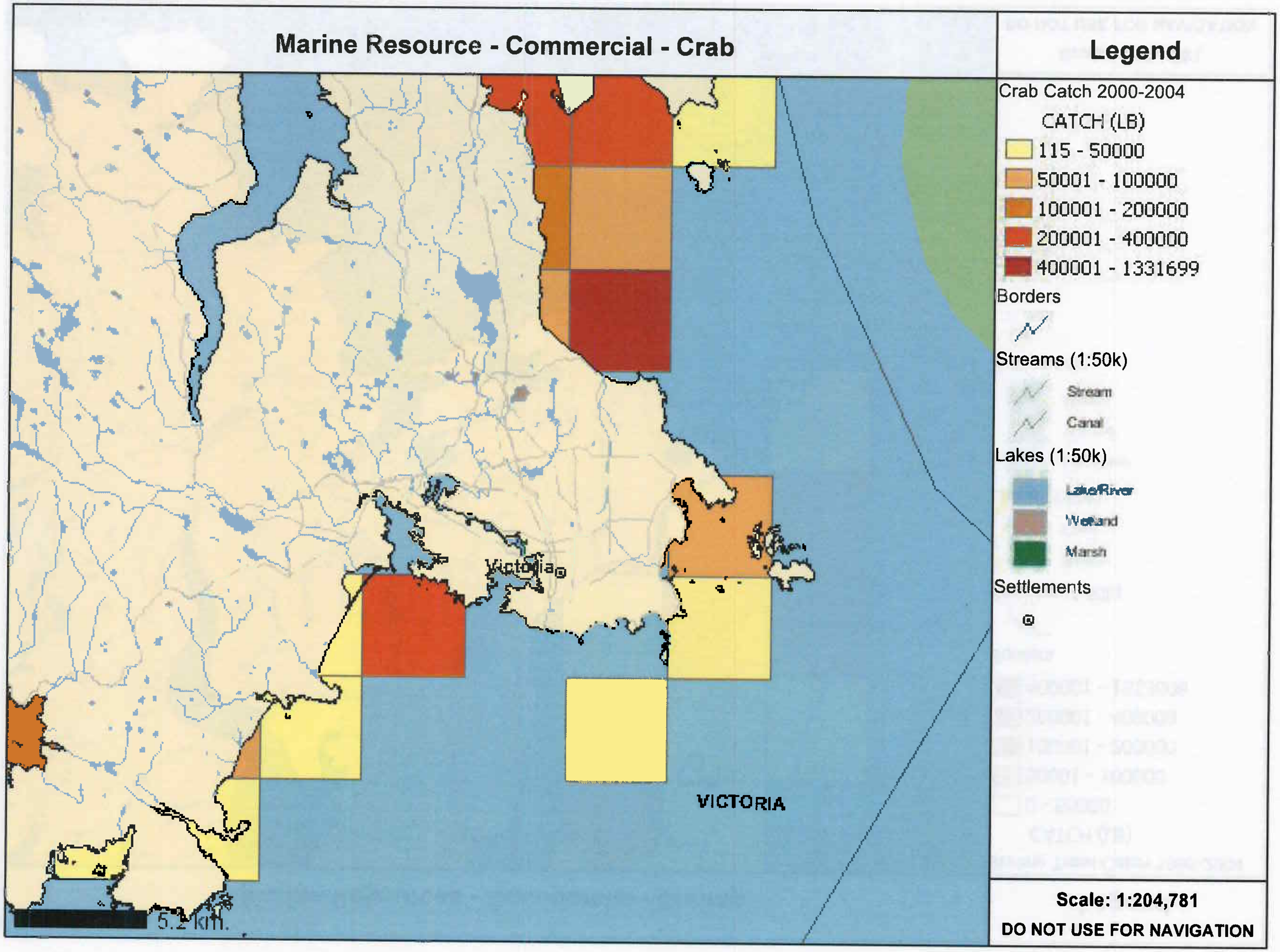
Lakes (1:50k)

- Lake/River
- Wetland
- Marsh

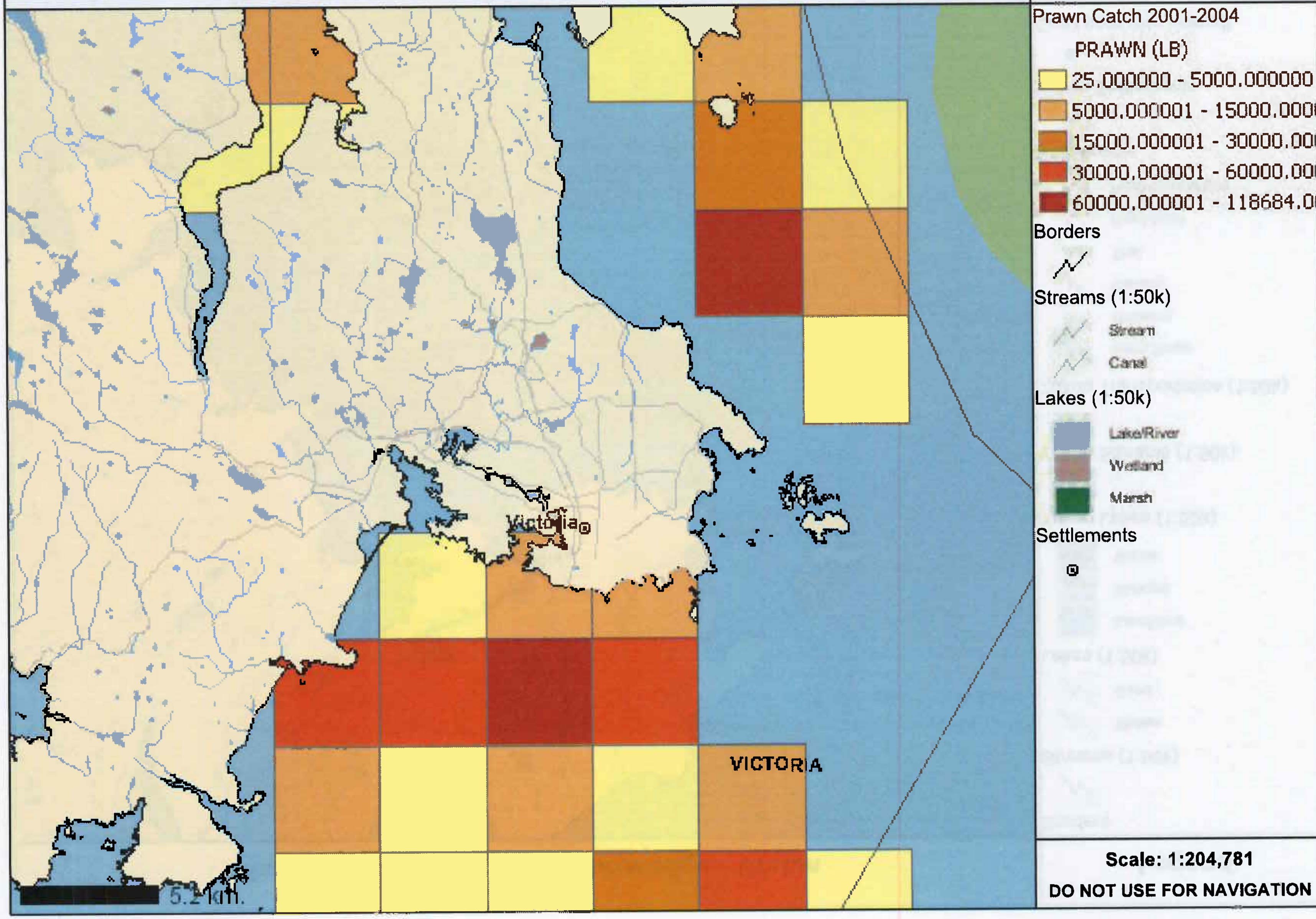
Settlements

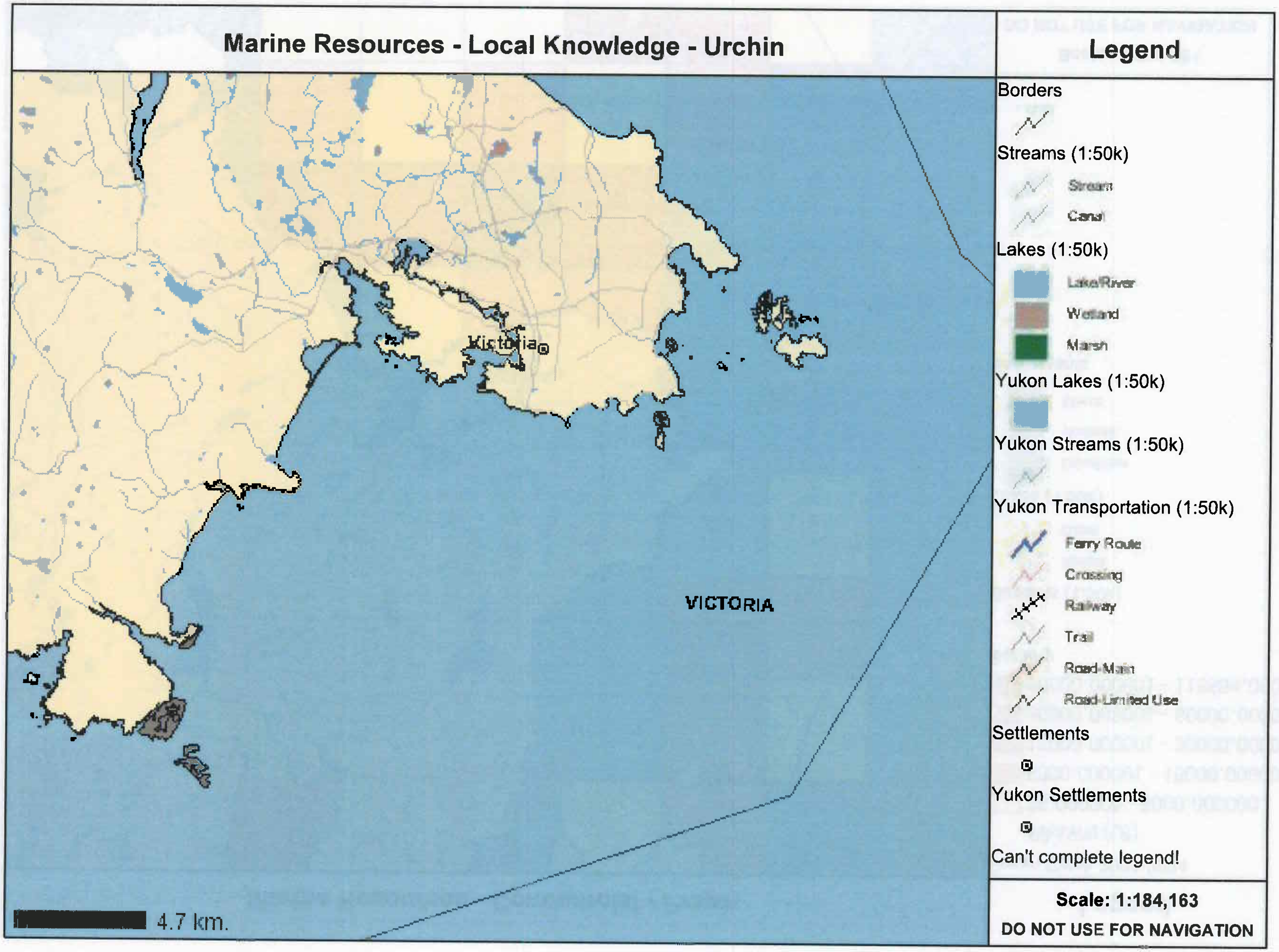
Scale: 1:204,781

DO NOT USE FOR NAVIGATION

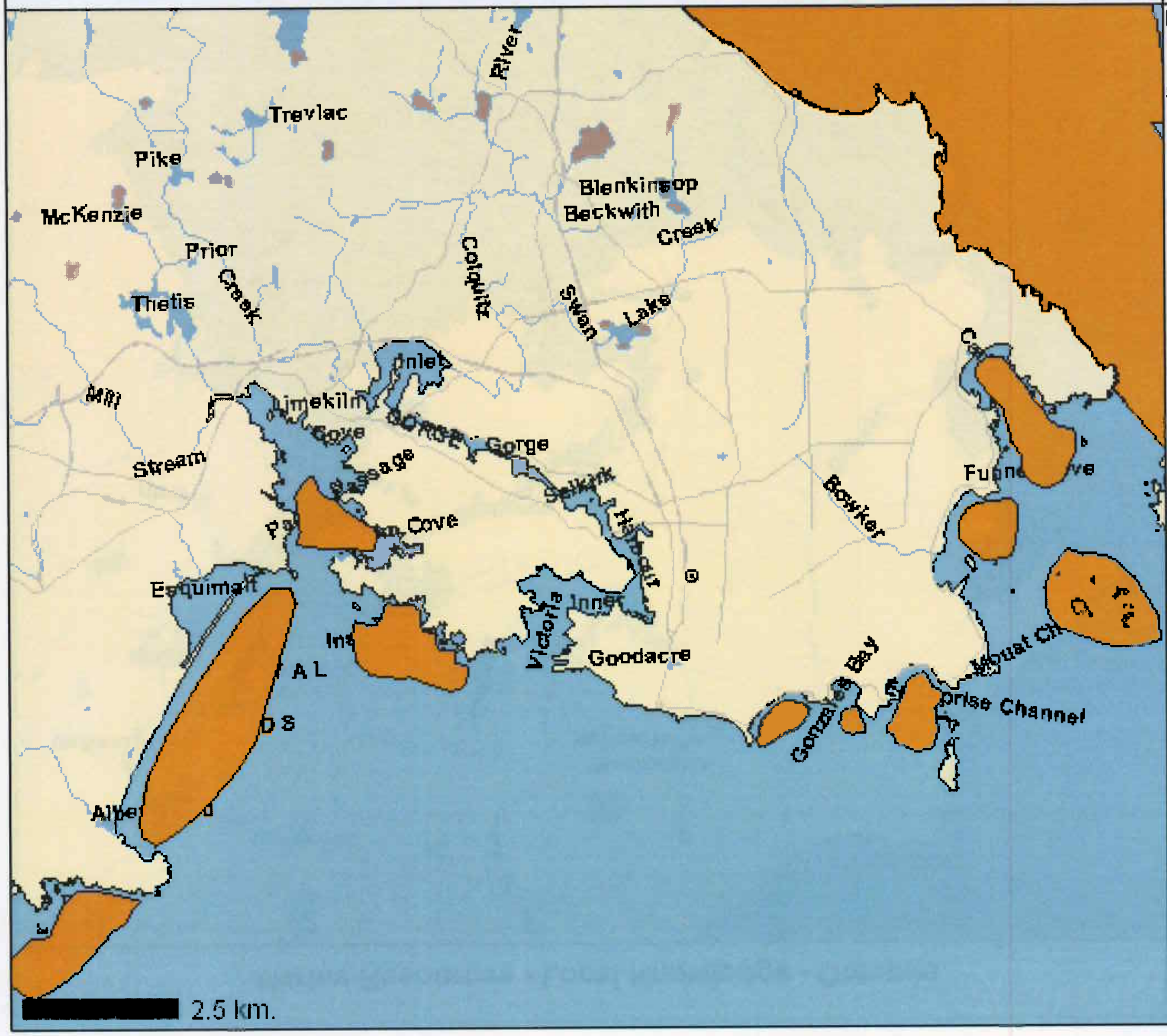

Marine Resource - Commercial - Crab
Legend
Crab Catch 2000-2004
CATCH (LB)
115 - 50000
50001 - 100000
100001 - 200000
200001 - 400000
400001 - 1331699
Borders
Streams (1:50k)
Stream
Canal
Lakes (1:50k)
Lake/River
Wetland
Marsh
Settlements
Victoria
VICTORIA
5.2 km
Scale: 1:204,781
DO NOT USE FOR NAVIGATION

Marine Resources - Commercial - Prawn




Marine Resources - Local Knowledge - Urchin
Victoria
VICTORIA
4.7 km.
Legend
Borders
Streams (1:50k)
Stream
Canal
Lakes (1:50k)
Lake/River
Wetland
Marsh
Yukon Lakes (1:50k)
Yukon Streams (1:50k)
Yukon Transportation (1:50k)
Ferry Route
Crossing
Railway
Trail
Road-Main
Road-Limited Use
Settlements
Yukon Settlements
Can't complete legend!
Scale: 1:184,163
DO NOT USE FOR NAVIGATION

Marine Resources - Local Knowledge - Crab



Legend

Borders

Streams (1:50k)

- Stream
- Canal

Lakes (1:50k)

- Lake/River
- Wetland
- Marsh

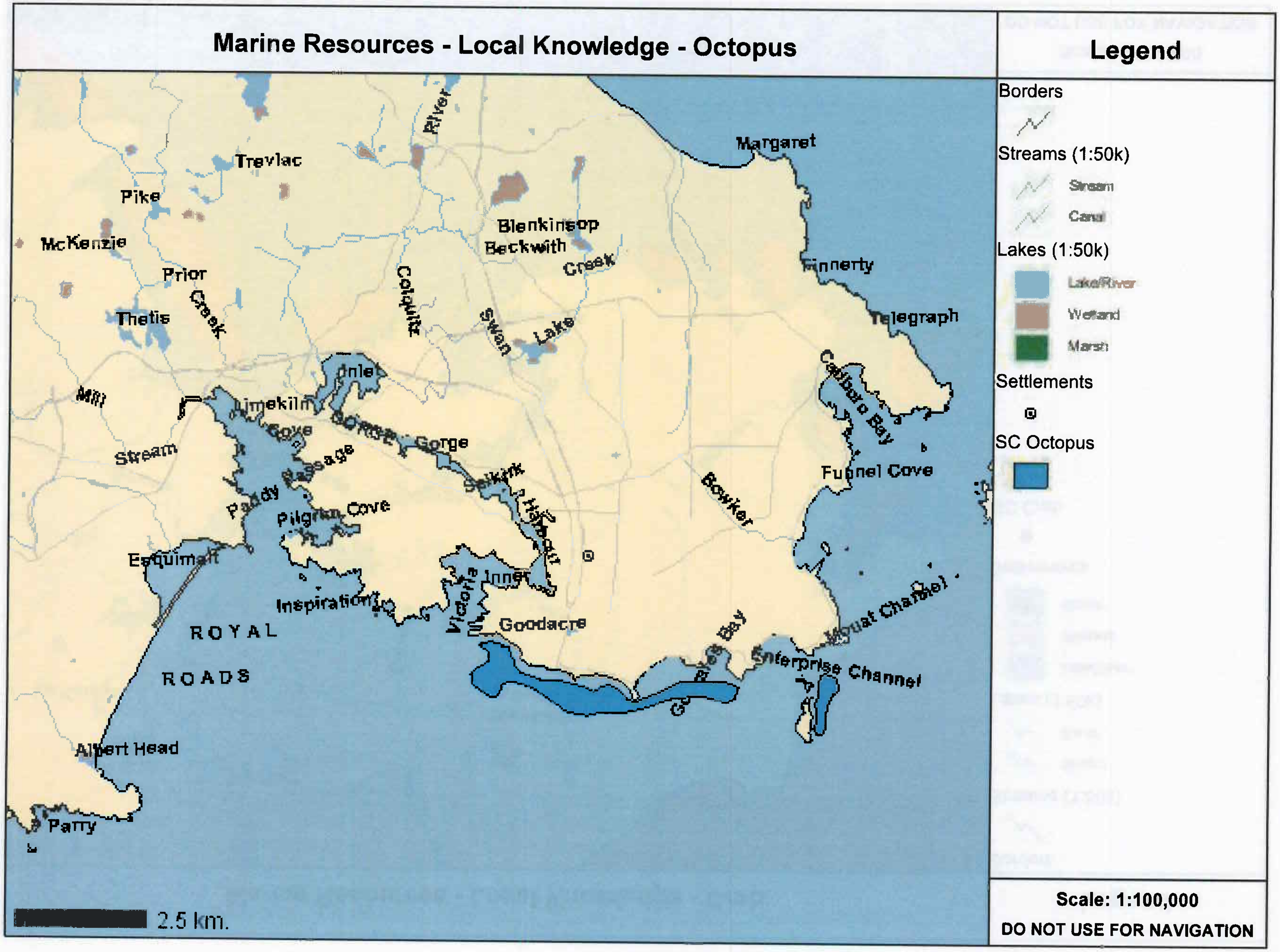
Settlements

SC Crab

Scale: 1:100,000

DO NOT USE FOR NAVIGATION

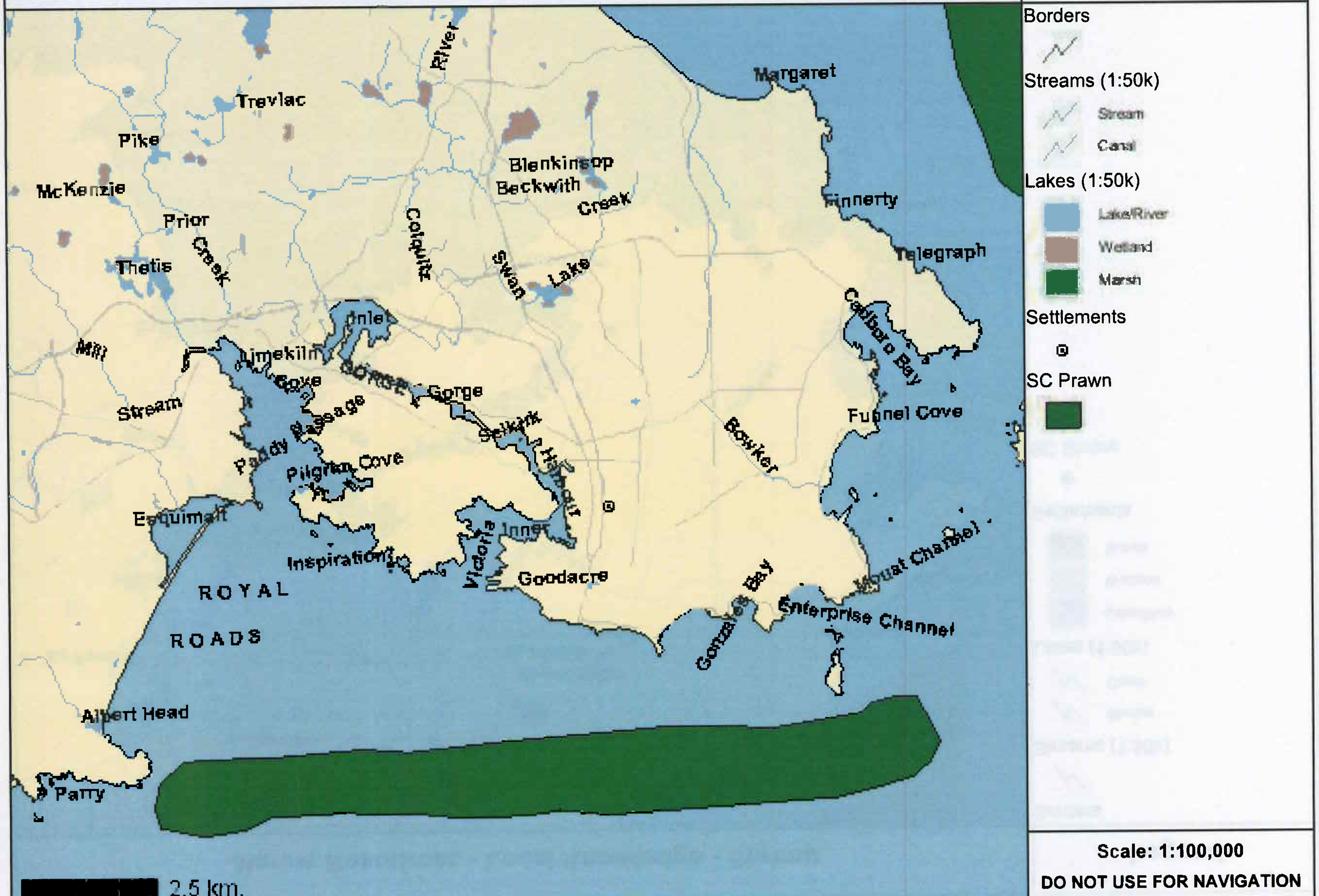
Marine Resources - Local Knowledge - Octopus



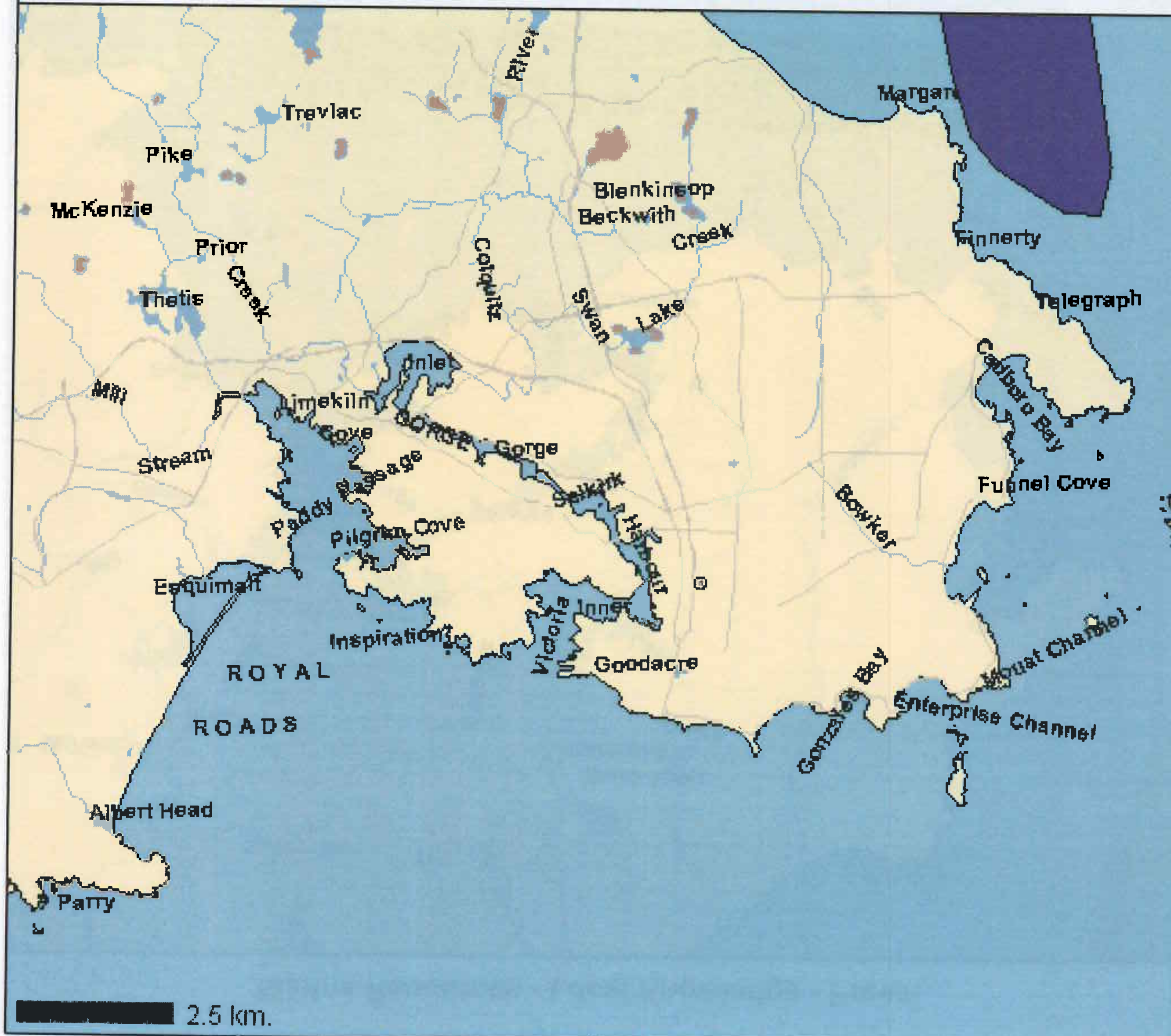
Scale: 1:100,000

DO NOT USE FOR NAVIGATION

Marine Resources - Local Knowledge - Prawn



Marine Resources - Local Knowledge - Shrimp



Legend

Borders

Streams (1:50k)
- Stream
- Canal

Lakes (1:50k)
- Lake/River
- Wetland
- Marsh

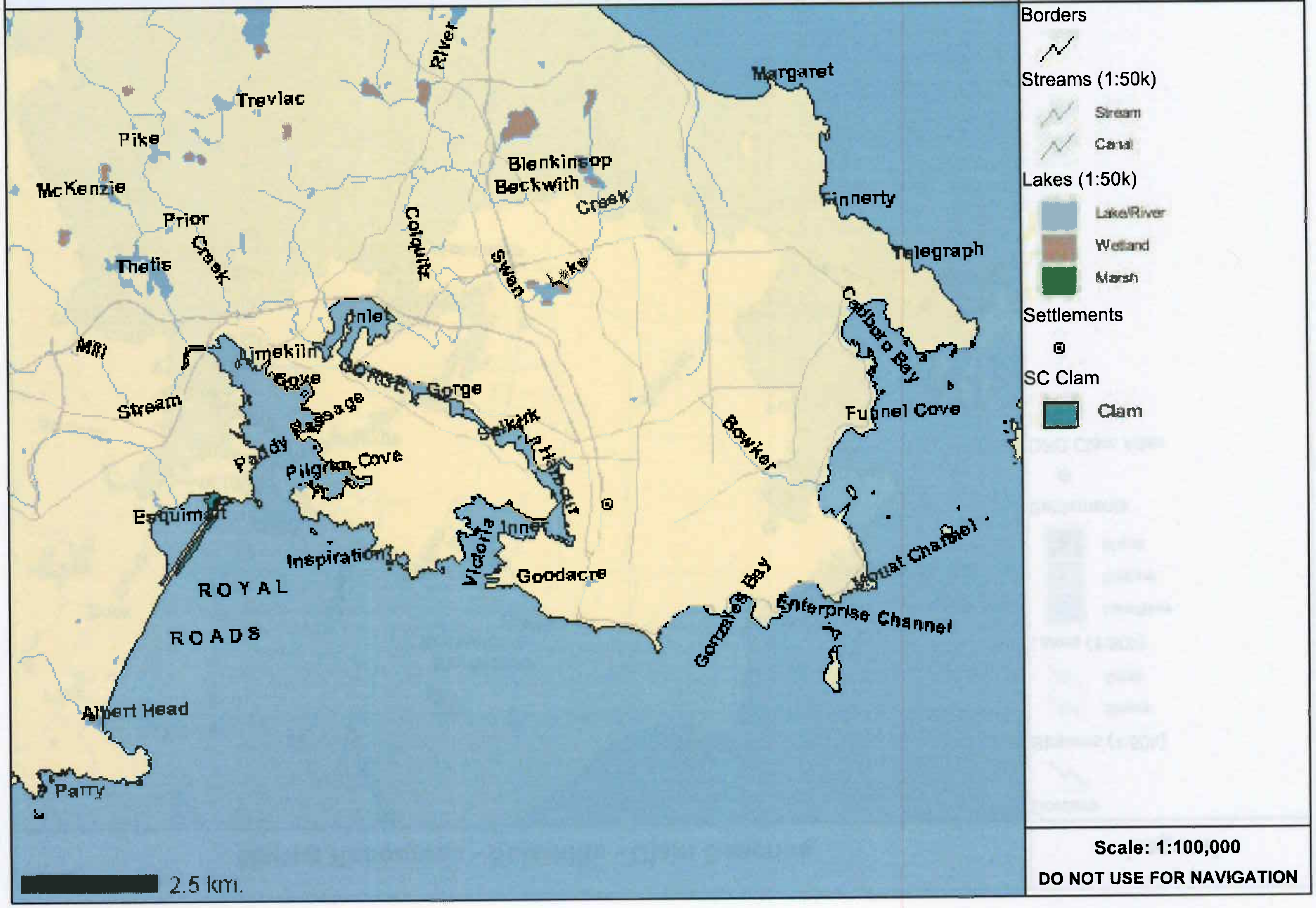
Settlements

SC Shrimp

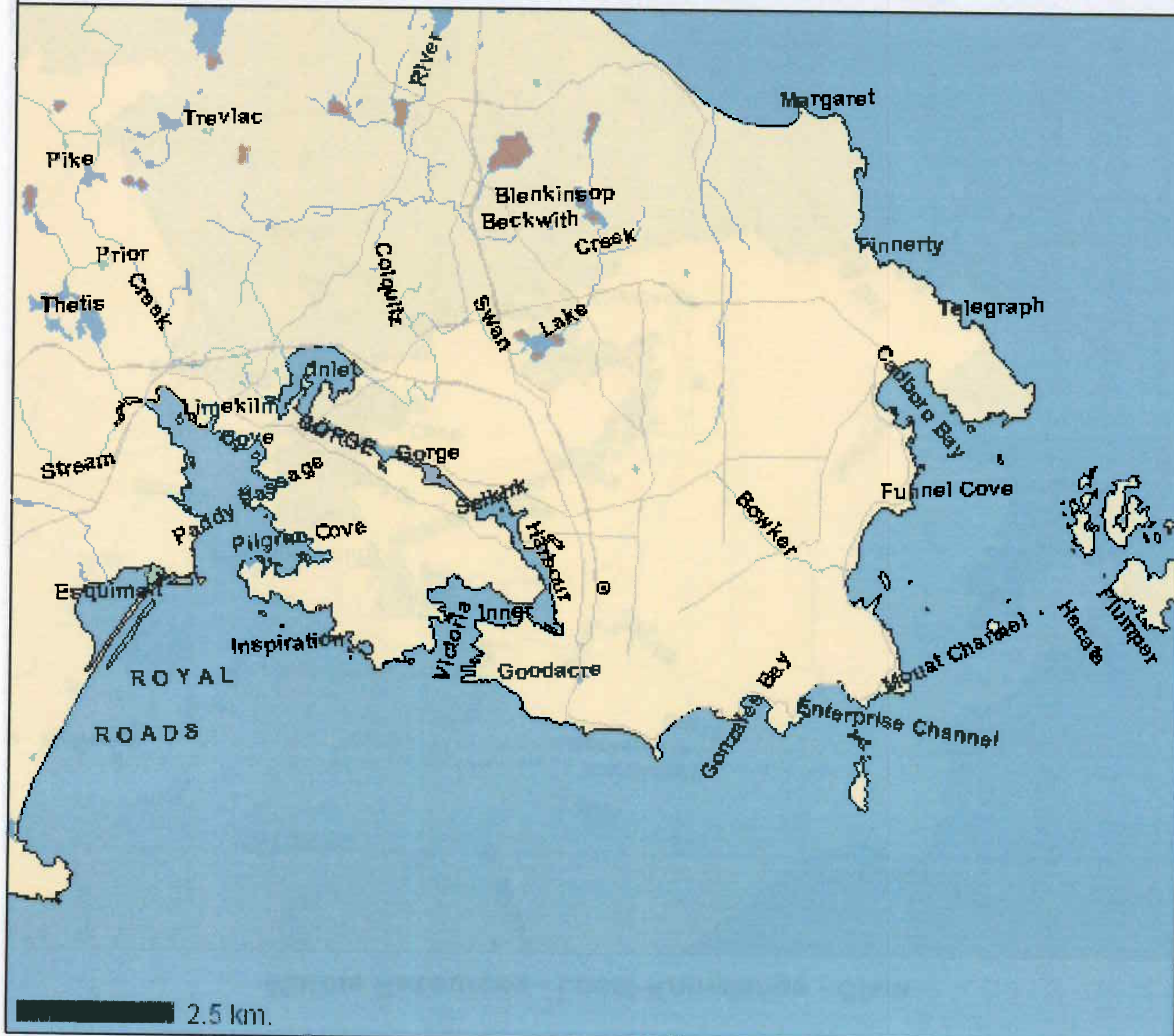
Scale: 1:100,000

DO NOT USE FOR NAVIGATION

Marine Resources - Local Knowledge - Clam



Marine Resources - Scientific - Clam Beaches



Legend

Borders

Streams (1:50k)

- Stream
- Canal

Lakes (1:50k)

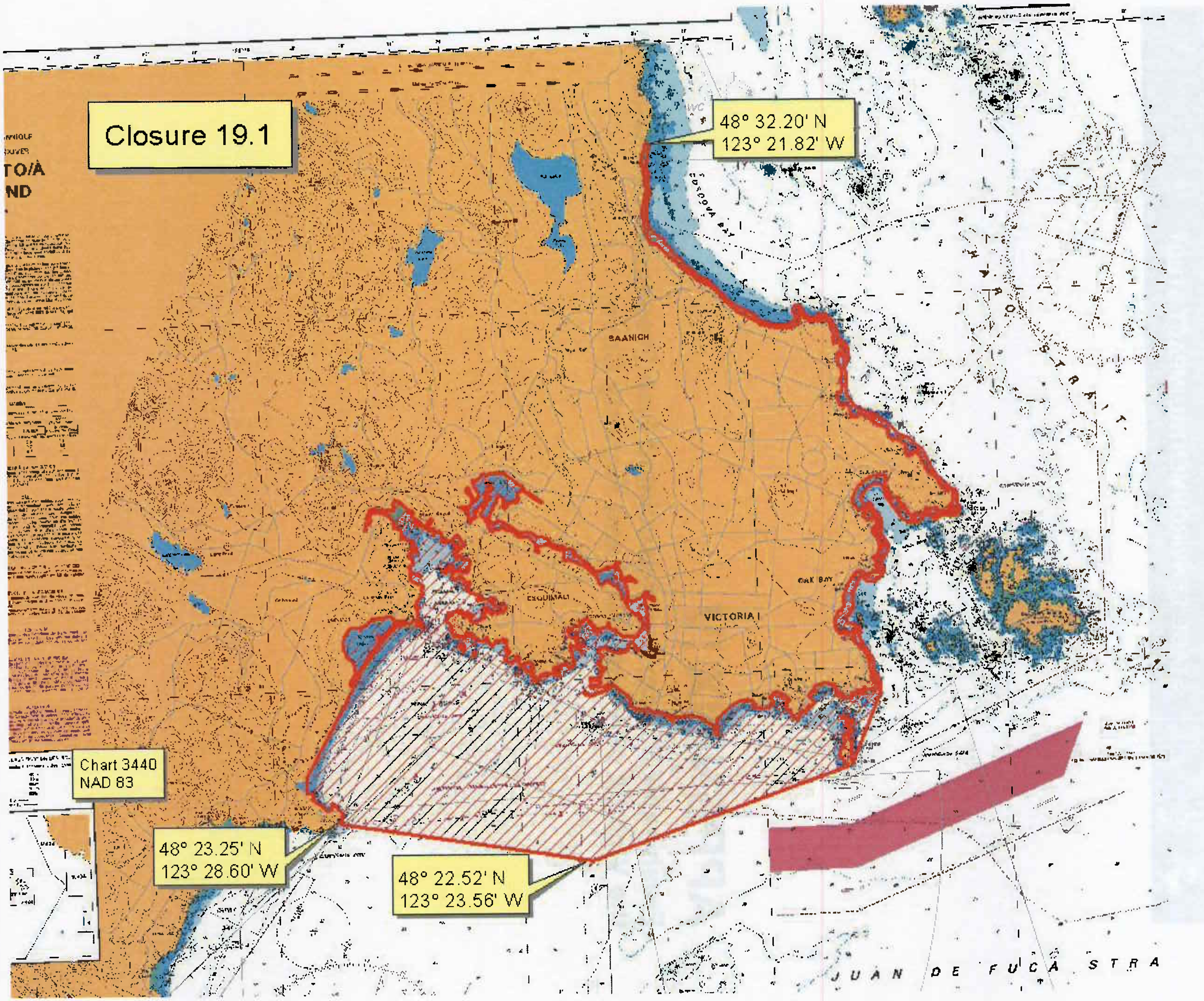
- Lake/River
- Wetland
- Marsh

Settlements

DFO Clam Atlas

Scale: 1:100,000

DO NOT USE FOR NAVIGATION


Closure 19.1
48° 32.20' N
123° 21.82' W
SAANICH
ESQUIMALT
VICTORIA
OAK BAY
Chart 3440
NAD 83
48° 23.25' N
123° 28.60' W
48° 22.52' N
123° 23.56' W
JUAN DE FUCA STRA

STAGE 1 ENVIRONMENTAL IMPACT STUDY

APPENDIX IV

Freshwater Stream and Associated Fish Presence Information in the Vicinity of Albert Head and Finnerty Cove

Golder Associates

Appendix IV: Freshwater Stream and Associated Fish Presence Information in the Vicinity of Albert Head and Finnerty Cove.

Name	Watershed Code	Waterbody Identifier	Stream Length	Location Description	Fish Presence
Albert Head Area					
Unnamed	920-012200	00000VICT	3.44 km	South of Albert Head	Chum salmon (*Oncorhynchus keta*), cutthroat trout (*O. clarkii clarkii*; life history not specified)
Colwood Creek	920-040500	00000VICT	5.38 km	Esquimalt Lagoon	Brown catfish (formerly brown bullhead; *Ameiurus nebulosus*), coho salmon (*O. kisutch*), cutthroat trout (anadromous), prickly sculpin (*Cottus asper*), pumpkinseed (*Lipomus gibbosus*), rainbow trout (*O. mykiss*), smallmouth bass (*Micropterus dolomieu*), threespine stickleback (*Gasterosteus aculeatus*)
Mill Stream	920-047500	00000VICT	13.29 km	Esquimalt Harbour	Brown catfish, coho salmon, cutthroat trout (fluvial and anadromous), prickly sculpin, pumpkinseed, rainbow trout, smallmouth bass, steelhead trout (*O. mykiss*), threespine stickleback
Craigflower Creek	920-077200	00000VICT	10.05 km	Victoria Harbour	Brown catfish, coho salmon, cutthroat trout (fluvial and anadromous), pumpkinseed, rainbow trout, sculpin (general), smallmouth bass, steelhead trout
Colquitz River	920-079700	00000VICT	9.64 km	Victoria Harbour	Bass/sunfish (general), brown catfish, chum salmon, coho salmon, cutthroat trout (fluvial and anadromous), prickly sculpin, pumpkinseed, rainbow trout, sculpin (general), smallmouth bass, threespine stickleback
Finnerty Cove Area					
Douglas Creek	920-125200	00000VICT	5.8 km	North of Finnerty Cove	Cutthroat trout (life history not specified)

APPENDIX V

Listed Species Potentially Occurring in the Vicinity of the Outfall Areas

Appendix V: Species Potentially Occurring in the Vicinity of Albert Head and Finnerty Cove.

Scientific Name	English Name	COSEWIC	BC Status	SARA	Class (English)	Habitat and Distribution[2]
			Potential to Occur in Vicinity of Albert Head and Finnerty Cove			
Oncorhynchus clarkii clarkii	Cutthroat Trout, *clarkii* subspecies		Blue		ray-finned fishes	Requires small, low gradient coastal streams and estuarine habitats; well-shaded streams with water temperatures below 18 C are optimal. Some may spend entire life in freshwater (many of these live in lakes), but most are anadromous (summer in saltwater). Found along the entire BC Coast including most coastal islands (McPhail 2007).
Salvelinus malma	Dolly Varden		Blue		ray-finned fishes	Anadromous individuals occur in coastal seas (2-3 years) and in deep runs and pools of creeks and small to large rivers. Some landlocked populations inhabit lakes and tributary streams. It is primarily a coastal species. It regularly enters the sea and occurs on most coastal islands that contain lakes or permanent streams (McPhail 2007).
Eschrichtius robustus	Gray Whale	SC (May 2004) (NE Pacific Population)	Blue	1	mammals	Mostly in coastal and shallow shelf waters. Coastal waters of the North Pacific. Mostly in Bering and Chukchi seas in summer (some occur then off northern Alaska, the Siberian coast, and southward along the coast to British Columbia and northern California). In winter, occurs in coastal waters off Baja California, Sonora, and Sinaloa.
Eumetopias jubatus	Steller Sea Lion	SC (Nov 2003)	Blue	1	mammals	Marine habitats include coastal waters near shore and over the continental slope; sometimes rivers are ascended in pursuit of prey. When not on land, the sea lions may congregate at nearshore traditional rafting sites, or move out to the edge of the continental shelf. Occurs in the coastal waters of the North Pacific.

Scientific Name	English Name	COSEWIC	BC Status	SARA	Class (English)	Habitat and Distribution[2]
Haliotis kamtschatkana	Northern Abalone	T (May 2000)	Red	1	gastropods	At its northern range limit, the Northern Abalone occurs from the lower intertidal zone to at least 100 m depth. In British Columbia, it is mostly subtidal; adults are usually found at <10 m depth. The abalone prefer a firm substrate, usually rock, and are generally found in areas of moderate water exchange, such as occurs on exposed or semi-exposed coasts. They are patchily distributed within this habitat. Loss of sea weed (marine macroalgae) along the British Columbian coast may have increased the visibility of the molluscs to predators.
Ardea herodias fannini	Great Blue Heron, *fannini* subspecies	SC (Mar 2008)	Blue	3	birds	Nests colonially in tall Sitka spruce, western red cedar, western hemlock, pine, red alder and black cottonwood (Campbell et al. 1990). Isolation from disturbance appears to be an important factor in nest site selection. Foraging habitat includes aquatic areas generally less than 0.5 m deep, such as: marine intertidal areas, estuaries, riparian areas, wetlands, freshwater lakes, and muskegs. These areas are generally within 5 km of the nest site, although some areas have been identified up to 33 km
Brachyramphus marmoratus	Marbled Murrelet	T (Nov 2000)	Red	1	birds	Coastal areas, mainly in salt water within 2 km of shore, including bays and sounds; not uncommon up to 5 km offshore; occasionally also on rivers and lakes usually within 20 km of ocean (but up to 75 km), especially during breeding season. Nests often are in mature/old growth coniferous forest near the coast: on large mossy horizontal branch, mistletoe infection, witches broom, or other structure providing a platform high in mature conifer (e.g., Douglas-fir, mountain hemlock). Most nesting occurs in large stands of old growth.

Scientific Name	English Name	COSEWIC	BC Statu s	SARA	Class (English)	Habitat and Distribution[2]
Falco peregrinus anatum	Peregrine Falcon, *anatum* subspecies	SC (Apr 2007)	Red	1	birds	Anatum Peregrine Falcons typically nest on rock cliffs above lakes or river valleys where abundant prey is nearby. Interior populations are typically associated with wetland habitats that support a sufficient prey base. In the Gulf Islands, nests are found on seaside cliffs. Concentrated populations of shorebirds, waterfowl, pigeons and songbirds are important prey; other prey may include bats, rodents and insects.
Falco peregrinus pealei	Peregrine Falcon, *pealei* subspecies	SC (Apr 2007)	Blue	1	birds	Coastal beaches, tidal flats, reefs, islands, marshes, estuaries and lagoons. Typically nests on ledges of rocky island cliffs, usually near seabird colonies. Occasionally, nests occur on mainland headland cliffs. A few nests occurred on grassy ledges on rock bluffs. Within British Columbia, it is found from northern Vancouver Island to Alaska; the centre of the provincial population is on the Queen Charlotte Islands.
Fratercula cirrhata	Tufted Puffin		Blue		birds	Nonbreeding: primarily pelagic. Can be found well out to sea all year; summer observations probably immature nonbreeders. Immatures more likely than adults to winter in bays. Probably the most pelagic of alcids. Nests on offshore islands or along the coast. Nests on slopes in ground burrows, sometimes under boulders and piles of rocks, occasionally under dense vegetation.

Scientific Name	English Name	COSEWIC	BC Status	SARA	Class (English)	Habitat and Distribution[2]
Hydroprogne caspia	Caspian Tern	NAR (May 1999)	Blue		birds	Seacoasts, bays, estuaries, lakes, marshes, and rivers. Nests on sandy or gravelly beaches and shell banks along coasts or large inland lakes; sometimes with other water birds. Pacific coast populations formerly nested mainly in inland marshes, now mainly on human-created habitats (e.g., salt pond dikes and levees) along coast. Known to breed on the Fraser River delta, and at Fraser and Shuswap lakes. Nonbreeding birds occur along the entire coast and in the southern interior.
Phalacrocorax auritus	Double-crested Cormorant	NAR (May 1978)	Blue		birds	Lakes, ponds, rivers, lagoons, swamps, coastal bays, marine islands, and seacoasts; usually within sight of land. Nests on the ground or in trees in freshwater situations, and on coastal cliffs.
Phalacrocorax pelagicus pelagicus	Pelagic Cormorant, *pelagicus* subspecies		Red		birds	Breeding is restricted to the Queen Charlotte Islands and northern mainland coast. Precise southern boundary with smaller race P. p. resplendens is unknown. Winters in the breeding range and south to Vancouver Island.
Phalacrocorax penicillatus	Brandt's Cormorant		Red		birds	Mainly inshore coastal zone, especially in areas having kelp beds; also around some offshore islands; less commonly, inshore on brackish bays; in winter, mostly around sheltered inlets and other quiet waters. BREEDING: coastally along Pacific coast from southern Alaska (very local, Prince William Sound and Hazy Island near Coronation Island) and Vancouver Island. NON-BREEDING: mostly near nesting areas. Common to very abundant as a non-breeder in southern British Columbia.

Scientific Name	English Name	COSEWIC	BC Status	SARA	Class (English)	Habitat and Distribution[2]
Progne subis	Purple Martin		Blue		birds	Nest in natural cavities and woodpecker holes in trees and snags, and in holes in buildings. In recent years they have been almost entirely restricted to nest boxes and artificial holes in pilings in estuaries, bays, and harbours. Now restricted to six sites on southeast Vancouver Island (Victoria Harbour, Esquimalt Harbour, Cowichan River Estuary, Nanaimo River Estuary, Newcastle Island, and Ladysmith Harbour).
Potential to Occur in Vicinity of Albert Head and Finnerty Cover but Unlikely						
Acipenser medirostris	Green Sturgeon	SC (May 1987)	Red	1	ray-finned fishes	Most often in marine waters; estuaries, lower reaches of large rivers, salt or brackish water off river mouths. Has been reported 140 miles inland in the Columbia River. Ascends rivers to spawn, but specific spawning and rearing habitats are poorly know. Majority of recent BC records are either from the sea off the west coast of Vancouver Island or from northern estuaries (e.g. Skeena, Nass, and Taku estuaries) (McPhail 2007).
Acipenser transmontanus pop. 4	White Sturgeon (Lower Fraser River population)	E (Nov 2003)	Red	3	ray-finned fishes	Occur in the Sacramento, Columbia, and Fraser River Systems. Within these drainage systems, they are found in river mainstems, large tributaries, reservoirs, and large lakes. They often occur in estuaries and sometimes spend protracted periods in the marine environment. Occasionally turn up in rivers on both the west and east coasts of Vancouver Islands (McPhail 2007).
Asio flammeus	Short-eared Owl	SC (Mar 2008)	Blue	3	birds	BREEDING: Broad expanses of open land with low vegetation for nesting and foraging are required. Habitat types frequently mentioned as suitable include fresh and saltwater marshes, bogs, dunes, prairies, grassy plains, old fields, tundra, moorlands, river valleys, meadows, savanna, open woodland, and heathland

Scientific Name	English Name	COSEWIC	BC Status	SARA	Class (English)	Habitat and Distribution[2]
Botaurus lentiginosus	American Bittern		Blue		birds	Nests primarily in inland freshwater wetlands, sometimes in tidal marshes or in sparsely vegetated wetlands or dry grassy uplands. Breeding occurs primarily in wetlands with tall emergent vegetation. Sparsely vegetated wetlands and dry grassy uplands are sometimes used, as are tidal marshes in some areas
Coccyzus americanus	Yellow-billed cuckoo		Red		birds	BREEDING: Open woodland (especially where undergrowth is thick), parks, deciduous riparian woodland; in the West, nests in tall cottonwood and willow riparian woodland.
Butorides virescens	Green Heron		Blue		birds	Swamps, mangroves, marshes, and margins of ponds, rivers, lakes, and lagoons. Eggs are laid in platform nest in tree, thicket, or bush over water or sometimes in dry woodland or orchard; nests in both freshwater and brackish situations.
Hirundo rustica	Barn Swallow		Blue		birds	Open situations, less frequently in partly open habitats, frequently near water. Nests in barns or other buildings, under bridges, in caves or cliff crevices, usually on vertical surface close to ceiling.

2. Habitat and Distribution information from MOE 2007a unless otherwise noted.

APPENDIX VI

Hodgins, D. 2008. Technical Memorandum – Conceptual Diffuser Design and Dilution Estimates for the Proposed Saanich East WWTP and West Shore WWTP

TECHNICAL MEMORANDUM

To:	Chris Lowe, Capital Regional District
From:	Donald Hodgins, PhD, P.Eng. Seaconsult
Subject:	Conceptual diffuser design and dilution estimates for the proposed Saanich East WWTP and West Shore WWTP
Date:	November 6, 2008
Copies:	Dean Shiskowski, Associated Engineering; Lee Nikl, Golder Associates

1.0 Purpose

Based on preliminary design parameters for the proposed treatment plants, and conceptual designs for outfall diffusers, calculations have been made for effluent dilution at the edge of the initial dilution zone (IDZ). These results have been used, in turn, for determining potential environment impacts associated with the discharge of wastewater. The purpose of this memorandum is to describe and discuss the basic input data and assumptions used in these dilution calculations, and to present the results.

This memorandum does not consider potential environmental impacts. Such assessments are reported elsewhere.

2.0 Basic Input Data for the Treatment Plant Effluent

In order to calculate effluent dilution, it is necessary to have estimates of total effluent flow, effluent salinity and temperature, and the concentration of potential contaminants of concern. In the following analyses, fecal coliform bacteria are considered as one potential contaminant of concern. Accordingly the following discussion provides an outline of how both effluent flow rates, and coliform concentrations, were determined for the proposed plants.

These parameters were derived for two seasons: (i) the summer low flow period, and (ii) the winter high flow period. During summer, inflow to the treatment plants is expected to be relatively steady based on CRD experience at the Macaulay plant, and is conventionally expressed in terms of the ADWF[1]. Estimates of the ADWFs for Saanich East and West Shore were derived for three future times (2013, 2023 and 2038) based on catchment area and projected population (Table 2.1[2]). During summer no heat recovery from the effluent stream is proposed, and the temperature at discharge is expected to be about 23° C. The effluent salinity is expected to be nil in comparison with seawater.

Using fecal coliform data from Macaulay, and treatment efficiencies in coliform removal, coliform concentrations during dry weather are not expected to exceed 110,000 cfu/100 mL. This value has been used as a representative worst-case condition for the following analyses.

---

[1] ADWF is the average influent flow rate in a 24-h period during dry weather.

[2] Data provided by Associated Engineering, October 2008.

Table 2.1: Effluent parameters for Saanich East WWTP and West Shore WWTP (source: Associated Engineering, October 2008)

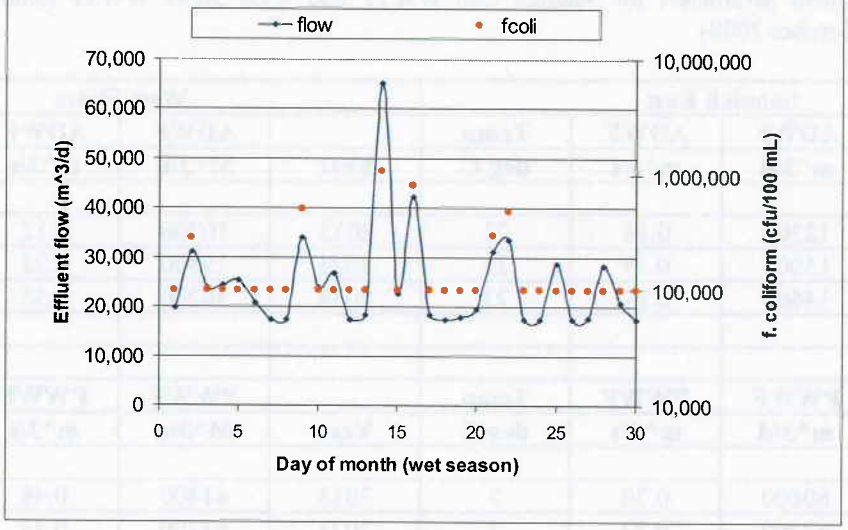
	Saanich East				West Shore		
	ADWF	**ADWF**	**Temp**		**ADWF**	**ADWF**	**Temp**
Year	**m^3/d**	**m^3/s**	**deg C**	**Year**	**M^3/d**	**m^3/s**	**deg C**
2013	12300	0.14	23	2013	10700	0.12	23
2023	13000	0.15	23	2023	19300	0.22	23
2038	14600	0.17	23	2038	30200	0.35	23
	PWWF	**PWWF**	**Temp**		**PWWF**	**PWWF**	**Temp**
Year	**m^3/d**	**m^3/s**	**deg C**	**Year**	**M^3/d**	**m^3/s**	**deg C**
2013	60800	0.70	7	2013	41400	0.48	7
2023	62200	0.72	7	2023	63700	0.74	7
2038	65200	0.75	7	2038	89400	1.03	7

Characterization of wet weather flows is more difficult because of the variability in flow rates caused by inflow and infiltration in the sewer collection system. The approach adopted here was to calculate a 30-d synthetic wet weather flow time-series based on the ADWF rates in Table 2.1, and known peaking factors expressing the ratio between the PWWF[3] and the ADWF. The PWWFs were derived by randomly sampling the peaking factor distribution, scaling up the ADWF and adjusting the values such that all PWWF values were greater than the ADWF (i.e. at least 1.2 x ADWF), and the greatest PWWF agreed with the single largest flow projection shown in Table 2.1. The effluent flow time-series are shown in Fig. 2.1, and are representative of a 30-d period in winter (December to February).

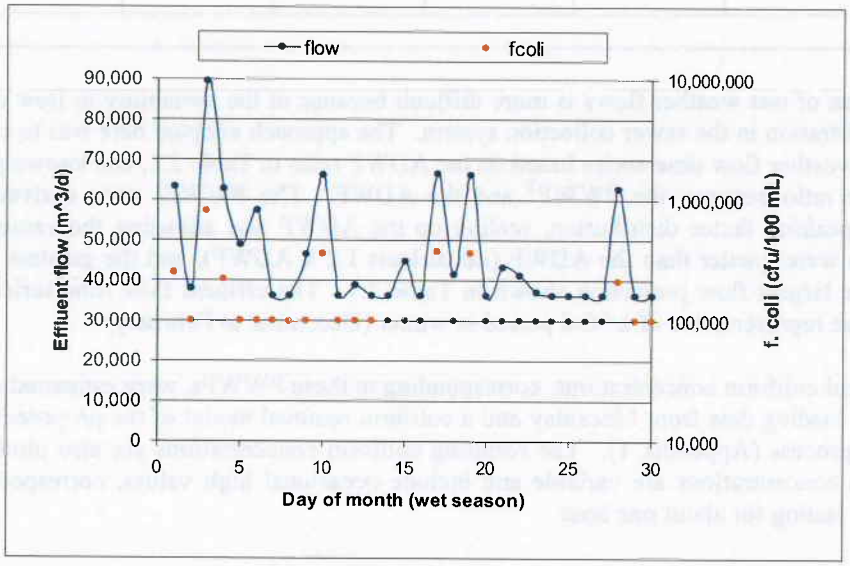
Worst-case fecal coliform concentrations, corresponding to these PWWFs, were estimated using historical fecal coliform loading data from Macaulay and a coliform removal model of the proposed split treatment and blending process (Appendix 1). The resulting coliform concentrations are also plotted in Fig. 2.1, and show that concentrations are variable and include occasional high values, corresponding with rare rainfall events lasting for about one hour.

At this time, heat removal during winter is proposed. As a result the effluent temperature was taken as 7° C. In the absence of heat removal temperatures will increase to about 16° C, and dilutions will increase slightly due to the higher buoyancy flux in the plume.

[3] PWWF is the peak wet weather inflow rate occurring in a 24-h period during winter. The duration of this flow rate is significantly less than 24 h.



(a)



(b)

Figure 2.1 Projected effluent flow and fecal coliform concentration during wet weather at the Saanich East WWTP (a) and the West Shore WWTP (b).

3.0 Oceanographic Data

The dilution calculations require reasonably site-specific information on prevailing currents, at various stages of the tide, and on the seasonal variations in density stratification. Suitable measurements at the two possible outfall locations are not available. Accordingly, information on currents was derived from the C3 model database that formed part of the investigation into sedimentation and sediment transport carried out for the CRD by Seaconsult (Hodgins and Hodgins, 2002). This database contains information on currents distributed on a 200-m regular grid, over 8 depths, covering the south coast off Victoria and a portion of Haro Strait. This information is stored in the form of harmonic constants, and is suitable for prediction of flows at any required time resolution. As a result, the tidal influence can be fully resolved. This is important for determining current conditions at times of peak flow (maximum speed) and at times of slack water when the potential for surfacing is greatest. Both conditions can lead to minimum dilution at the edge of the IDZ.

The most comprehensive seasonal data describing density stratification was collected by Aquametrix over the period November 1993 to September 1994. These data were obtained in the vicinity of the Macaulay Point and Clover Point outfalls. The Macaulay data are expected to be representative of conditions for the West Shore outfall because of its proximity and the absence of factors that would modify the stratification in that area. Extrapolating the Clover data into Haro Strait is slightly more approximate since the intensity of tidal mixing differs, and the proximity to Gulf Island passes yields a different circulation regime than off the south coast of Victoria. However, these differences are mitigated in winter by the fact that both areas are quite weakly stratified, and it is this condition that gives rise to minimum dilution.

During summer there may be slight differences in stratification, but these are not expected to be large and are not expected to change the fact that the plumes will tend to trap below surface at all stages of the tide.

4.0 Conceptual Diffuser Locations and Design Parameters

For this analysis, the following assumptions have been made about outfall locations:

1. The outfall for the Saanich East WWTP will follow the alignment of the existing Finnerty Cove outfall, extended outward to water depths of 45 to 50 m.

2. The outfall for the Westshore WWTP will extend southeastward from the shoreline in Royal Roads, approximately 400 – 800 m north of Albert Head, terminating in about 50 m water depth.

The diffuser parameters for the conceptual designs are as follows:

Diffuser depth	51 m
Port height above bottom	1 m
Port diameter	15 cm
Port orientation wrt horizontal	90 degrees
Port spacing	7.5 m

All dilution analyses have been carried out for 2038 effluent characteristics (worst case). The principal variable for each outfall is the number of active ports; this number has been selected to optimize dilution for a combination of the ADWF and the PWWFs.

5.0 Dilution Model

The diffuser dilution calculations were carried out using the US Environmental Protection model 'UM', described in Baumgartner et al. (1993). This model is applicable to multi-port diffusers discharging into vertically varying velocity and stratification regimes.

Past studies of the Clover Point diffuser, for example, have shown that minimum dilutions at the edge of the IDZ tend to occur at one of two stages of the tide:

- During slack water (minimum current speeds) as the buoyant plumes trap above the diffuser, and
- At times of maximum current speed when the buoyant plumes are deflected laterally and intersect the edge of the IDZ, sometimes before reaching their trapping depth.

In the present study, monthly current time-series were predicted using the C3 model database at the expected trapping depth over each diffuser. Times of maximum current speed and slack water were then extracted from these time-series, and profiles of current were derived from the C3 database. This process was carried out for August, typical of dry weather conditions, and for January for winter conditions.

Stratification profiles were obtained from the Aquametrix database, corresponding to moderately stratified summer conditions and to weakly stratified winter conditions.

These current and stratification profile data were input to UM, and dilutions were calculated for each condition that potentially gives rise to minimum dilutions for a range of diffuser port options.

6.0 Results

6.1 Saanich East WWTP

A diffuser with 14 ports was used for the final assessment of the Saanich East outfall. During the summer dry season, this configuration provides a trapping depth of between 25 and 30 m, with a minimum dilution of approximately 3100:1 at the edge of the IDZ. As a result, fecal coliform concentrations are expected to be less than 50 cfu/100 mL. These conditions obtain during slack water, which provides lower dilutions than at times of strongest current flow.

To examine conditions during winter, dilution calculations were carried out for six scenarios with effluent flow rates ranging from a base flow of 0.20 m^3/s to a maximum of 0.75 m^3/s. Of these scenarios, four correspond to the peak flows, and coliform concentrations, shown in Fig. 2.1 (a). The results (Table 6.1 and Fig. 6.1) provide the following predictive equation for minimum dilutions at the edge of the IDZ:

$$D = 674\ \text{PWWF}^{(-0.8107)} \text{ with an } R^2 = 0.96$$

Application of this equation to the flows and coliform data shown in Fig. 2.1(a) yields the time-series plotted in Fig. 6.2. The 5-d geometric mean of this time-series is also plotted in Fig. 6.2 and shows that all mean values are less than the recreational water quality criterion of 200 cfu/100 mL.

This approach recognizes that compliance with water quality criteria for fecal coliform bacteria is based on the geometric mean of 5 samples during a 30-d period. It is conservative in that a running mean provides higher averages than a random sample, and it is combined with estimates of minimum achievable dilution during the tidal cycle.

Table 6.1: Results for trapping depth and minimum dilution for a conceptual diffuser design with 14 ports for the Saanich East WWTP.

PWWF	Trapping depth	Dilution at 100 m	Effluent coliform	Receiving water concentration
m^3/s	m		cfu/100 mL	cfu/100 mL
0.2	38	2310	100,000	43
0.26	38	2100	100,000	48
0.36	32	1680	290,000	173
0.39	32	1600	490,000	300
0.49	30	1350	815,000	604
0.75	15	820	1,100,000	1340

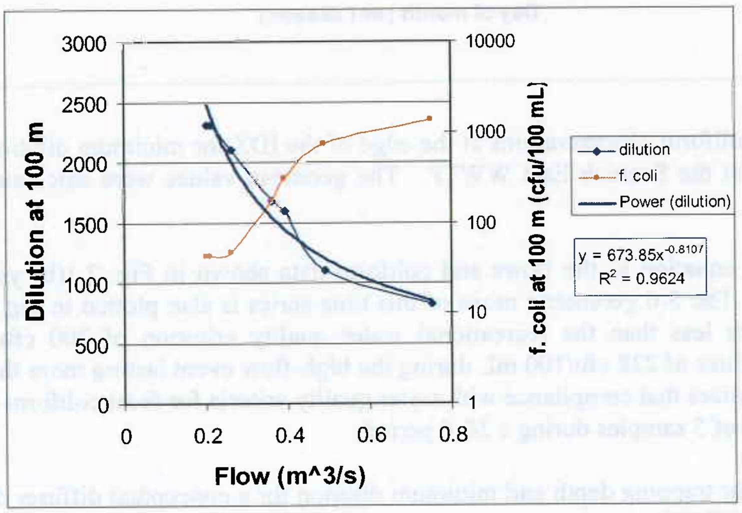


Figure 6.1 Diffuser dilution curve for 14 ports, and corresponding fecal coliform concentrations at the edge of the IDZ for minimum dilution conditions, for the Saanich East WWTP.

6.2 West Shore WWTP

For this case, a diffuser with 26 ports was used for the final assessment of dilution and fecal coliform concentrations. During the summer dry season, this configuration provides a trapping depth of between 30 and 35 m, with a minimum dilution of approximately 1570:1 at the edge of the initial dilution zone (IDZ). As a result, fecal coliform concentrations are expected to be less than 70 cfu/100 mL at times of slack water, which provides lower dilutions than at times of stronger current flow.

To examine conditions during winter, dilution calculations were carried out for five scenarios with effluent flow rates ranging from a base flow of 0.42 m^3/s to a maximum of 1.03 m^3/s (Fig. 2.1b). The results (Table 6.2, Fig. 6.3) provide the following predictive equation for minimum dilutions at the edge of the IDZ:

$$D = 684\ PWWF^{(-0.8048)} \text{ with an } R^2 = 0.99.$$

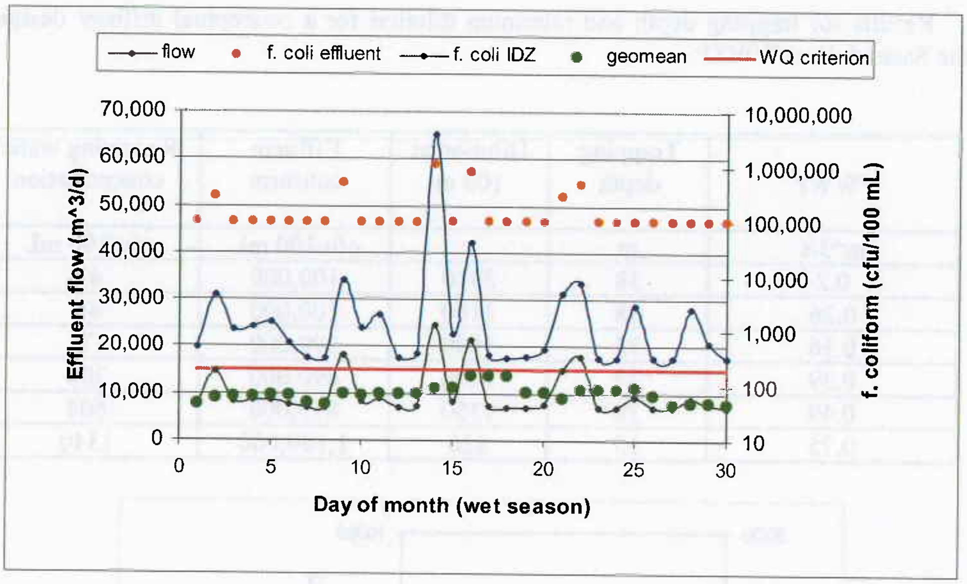


Figure 6.2 Fecal coliform concentrations at the edge of the IDZ for minimum dilution conditions during winter at the Saanich East WWTP. The geomean values were calculated as a 5-d running mean.

Application of this equation to the flows and coliform data shown in Fig. 2.1(b) yields the time-series plotted in Fig. 6.4. The 5-d geometric mean of this time-series is also plotted in Fig. 6.4 and shows that all mean values are less than the recreational water quality criterion of 200 cfu/100 mL, with the exception of two values of 228 cfu/100 mL during the high-flow event lasting more than 48 h. As before, this approach recognizes that compliance with water quality criteria for fecal coliform bacteria is based on the geometric mean of 5 samples during a 30-d period.

Table 6.2: Results for trapping depth and minimum dilution for a conceptual diffuser design with 26 ports for the West Shore WWTP.

PWWF	Trapping depth	Dilution at 100 m	Effluent coliform	Receiving water concentration
m^3/s	m		cfu/100 mL	cfu/100 mL
0.42	38	1360	100,000	74
0.54	38	1130	100,000	88
0.66	15	960	100,000	104
0.77	38	853	365,000	428
1.03	30	660	825,000	1250

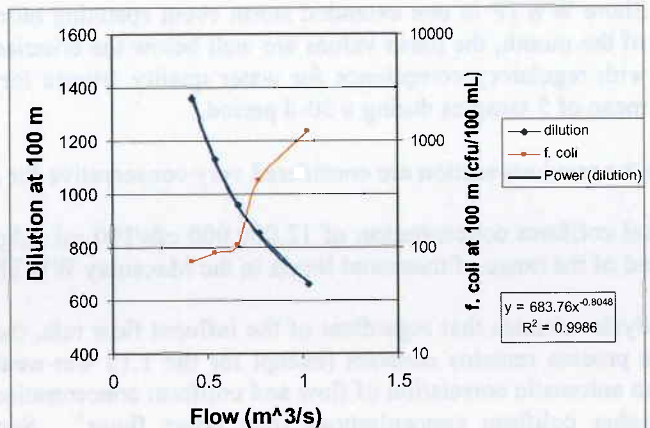


Figure 6.3 Diffuser dilution curve for 26 ports, and corresponding fecal coliform concentrations at the edge of the IDZ for minimum dilution conditions, for the West Shore WWTP.

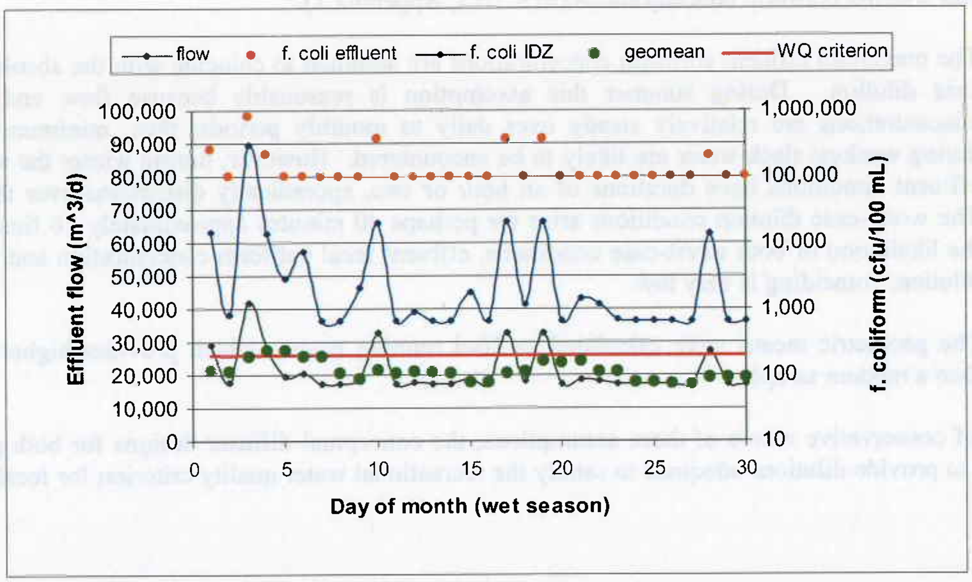


Figure 6.4 Fecal coliform concentrations at the edge of the IDZ for minimum dilution conditions during winter at the West Shore WWTP. The geomean values were calculated as a 5-d running mean.

7.0 Discussion

The previous analysis shows that for both proposed treatment plants, the conceptual diffuser designs provide adequate dilutions at the edge of the IDZ to meet the recreational water quality criterion (200 cfu/100 mL) at all times during the summer dry weather period.

During wet weather, the same conceptual designs provide sufficient dilution to meet this criterion based on a geometric mean of 5 samples over a 30-d period for the Saanich East outfall. The criterion is slightly exceeded for the West Shore WWTP in one extended storm event spanning more than 2 days (by about 14%). For the balance of the month, the mean values are well below the criterion. As noted earlier, this approach is consistent with regulatory compliance for water quality criteria for fecal coliform bacteria based on the geometric mean of 5 samples during a 30-d period.

The results presented in the previous section are considered very conservative for a number of reasons:

1. The ADWF fecal coliform concentration of 12,000,000 cfu/100 mL (Appendix 1) was selected from the high end of the range of measured levels in the Macaulay WWTP influent stream;

2. The present analysis assumes that regardless of the influent flow rate, the coliform mass loading to the treatment process remains constant (except for the 1.15 wet-weather adjustment). As a result, there is an automatic correlation of flow and coliform concentration such that higher flows always have higher coliform concentrations than lower flows[4]. Such a correlation is not supported by data from actual plant operations. For example, the Saanich WWTP data shows that high winter flows are often accompanied by low coliform concentrations. A similar regime is expected for both proposed plants once they become operational.

3. A conservative run-off factor was included in the generation of the 30-d synthetic time-series for wet weather coliform concentrations (ro = 1.15, Appendix 1).

4. The maximum effluent coliform concentrations are assumed to coincide with the absolute worst-case dilution. During summer this assumption is reasonable because flow and coliform concentrations are relatively steady over daily to monthly periods; thus, minimum dilutions during weakest slack water are likely to be encountered. However, during winter the worst-case effluent conditions have durations of an hour or two, sporadically distributed over the month. The worst-case dilution conditions arise for perhaps 40 minutes approximately 10 times. Thus, the likelihood of both worst-case conditions, effluent fecal coliform concentration and minimum dilution, coinciding is very low.

5. The geometric means were calculated as 30-d running means, which provides higher averages than a random sample.

In view of conservative nature of these assumptions, the conceptual diffuser designs for both plants are expected to provide dilutions adequate to satisfy the recreational water quality criterion for fecal coliform bacteria.

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[4] Higher influent flows induce higher effluent coliform concentrations only in the situation where primary effluent is split around the secondary treatment system.

Given the preliminary nature of the dilution calculations presented here, and the assumptions described previously, additional modelling should be conducted once the treatment facility and outfall locations are better defined, and better specification of the treatment technologies is available.

References

Baumgartner, D.J., W.E. Frick and P.J.W. Roberts, 1993. Dilution Models for Effluent Discharges 2nd Ed., Report EPA/600/R-93/193, US Environmental Protection Agency.

Hodgins, D.O. and S.L.M. Hodgins, 2002. Predicted Sedimentation Patterns for Effluent Solids Discharged from the Clover Point and Macaulay Point Outfalls. Technical Memorandum prepared for the Capital Regional District by Seaconsult Marine Research Ltd.

APPENDIX 1 – Split Treatment and Blending Process Model for Fecal Coliform Removal

The treatment process is comprised of primary treatment and secondary treatment, with a bypass at each stage for flows in excess of the treatment stage capacity. The following model provides an estimate of the fecal coliform concentration in the final effluent based on the influent PWWF and coliform concentration. The following definition of terms is used:

Description	Symbol	Assumed value	Units
ADWF	Qd	Table 1	m^3/d
Peaking factor	f	variable	
Primary treatment capacity	C1	4	m^3/d
Secondary treatment capacity	C2	2	m^3/d
Coliforms after primary stage	R1	50%	
Coliforms after secondary stage	R2	7%	
Fecal coliform scaling factor for runoff	ro	1.15	
ADWF coliform concentration	FC	12×10^6	cfu/100 mL
Fecal coliform effluent concentration	FC_{eff}	Output	cfu/100 mL

The model has the final forms:

$$FC_{eff} = [(C2 \cdot R1 \cdot R2) + (C1 - C2)R1 + (f - C1)] \cdot (ro \cdot FC)/f^2 \quad \text{if } C1 \le f, \qquad (1)$$

$$FC_{eff} = [(C2 \cdot R1 \cdot R2) + (f - C2)R1] \cdot (ro \cdot FC)/f^2 \quad \text{if } f > C1 \qquad (2)$$

With the assumed values, and f = 4.47 for the maximum wet weather flow at Saanich East, equation (1) yields:

$$FC_{eff} = 1.06 \times 10^6 \text{ cfu/100 mL}$$

Similarly, with f = 2.96 for the maximum wet weather flow at West Shore, equation (2) yields:

$$FC_{eff} = 8.03 \times 10^5 \text{ cfu/100 mL}$$

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solutions@golder.com
www.golder.com

Golder Associates Ltd.
500 - 4260 Still Creek Drive
Burnaby, British Columbia, V5C 6C6
Canada
T: +1 (604) 296 4200
F: [+1] (604) 298 5253

Golder Associates