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CAPITAL REGIONAL DISTRICT

CRD Core Area Wastewater Treatment Program

Stage 2 Environmental Impact Study

307071-00020 – MAR-REP-002

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PROJECT 307071-00020 - CRD CORE AREA WASTEWATER TREATMENT PROGRAM							
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EXECUTIVE SUMMARY

Background

WorleyParsons was retained by the Capital Regional District (CRD) to complete the pre-discharge monitoring studies and marine component of a Stage 2 Environmental Impact Study (EIS) under the BC Municipal Wastewater Regulation (MWR) for the CRD Core Area Wastewater Treatment Program (CAWTP). The CAWTP will result in the cessation of screened wastewater effluent discharge from the Macaulay Point and Clover Point outfalls and the commencement of the discharge of secondary treated domestic wastewater from a new McLoughlin Point outfall. The proposed outfall will terminate approximately 150 m east of the existing Macaulay Point outfall diffuser. An EIS associated with the McLoughlin Point-Hartland facilities terrestrial environment was conducted separately from this report by Westland Resources Group in 2010.

In 2006 the British Columbia Ministry of the Environment (MOE) mandated that the CRD implement secondary wastewater treatment to comply with present day legislation and minimum standards for wastewater treatment. Since that time, the CRD outlined the proposed wastewater treatment program in the Core Area Liquid Waste Management Plan (LWMP). Their proposed program includes three main capital projects: a secondary treatment facility at McLoughlin Point, a biosolids and energy facility and a marine outfall. The capital projects are expected to be in operation by 2018.

To advance the CAWTP, the CRD commissioned a two-stage EIS for the proposed discharge. Stage 1 of the EIS was completed in 2009 by Golder Associates. Stage 1 described the receiving environment including water quality, receiving environment uses and ecological resources. The effluent was characterized including the proposed flow and quality and points of discharge. The effluent plume was modelled in the receiving environment and anticipated environmental impact was assessed.

This Stage 2 EIS refines the results of the Stage 1 study by using site specific receiving environment data and updated wastewater system design characteristics. The scope was based on the requirements of an expanded scope EIS for discharges to marine waters with maximum daily effluent flow greater than 10,000 m^3/d as outlined in the *Environmental Impact Study Guideline*.

The proposed CAWTP will implement secondary treatment for wastewater flows up to two times the average dry weather flow (ADWF) of 215.6 ML/day. Flows between 2 x ADWF and 3 x ADWF from the Clover Point catchment area and between 2 x ADWF and 4 x ADWF from the Macaulay Point catchment area will receive primary treatment from the new WWTP prior to discharge through the new McLoughlin Point outfall. Flows above 3 x ADWF from the Clover Point catchment area will be screened and discharged through the Clover Point outfall. Flows above 4 x ADWF from the Macaulay Point catchment area will be screened and discharged from the Macaulay Point outfall.

Receiving Water

The receiving water off southern Victoria is used for recreation and has important marine fisheries resources. The Juan de Fuca Strait supports a number of ecologically, economically and culturally important invertebrates. Crab, shrimp, prawn, octopus, squid, red sea urchin and shellfish (swimming scallops, geoduck, cockles, mussels, and oysters) are documented in the marine project area. Some of the significant fish species known to occur in the McLoughlin Point discharge area include all five Pacific salmon species (Coho, chum, Chinook, sockeye and pink), cutthroat and steelhead trout, Pacific herring, lingcod, dogfish, flatfish (sole and halibut), rockfish and Pollock. Potential rockfish habitat has been documented in the vicinity of Albert Head. Marine mammal presence in the area includes harbour seal, California sea lion and steller sea lion, Dall's porpoise, harbour porpoise and killer whale. Migratory gray whale, humpback whale and minke whale may also be present in the summer.

A variety of recreational activities occur in the marine waters near the proposed McLoughlin Point outfall. Primary contact activities tend to be conducted along the shore and near shore areas. Activities such as swimming, wading, diving, skim boarding and paddle boarding are conducted near shore, while kayaking, outrigger canoeing, kite surfing, and wind surfing may occur further offshore.

Pre-Discharge / Baseline Sampling

An inventory of baseline sediment chemistry, sediment toxicity, sediment benthic community and seasonal water quality and water column profiles was collected as part of this EIS. The results of the field investigations provide a foundation for dilution modelling of the proposed discharge, the environmental impact assessment and post-discharge receiving environment monitoring program.

Water Quality

Quarterly water quality and water column profile data was collected under the pre-discharge monitoring program (PDMP) from July 2010 to June 2012. This program included the collection of the following site specific microbiological, chemical and physical characteristics: water quality, water column profiles and current profiles. Pre-discharge monitoring was conducted off Albert Head, McLoughlin Point and one reference location, Finnerty Cove. Water column profiles measured temperature, salinity, pH, dissolved oxygen (DO) and turbidity. Temperature and salinity profiles provide ambient density characteristics used in the dilution modelling of the effluent plume. The measured turbidity of the receiving environment was low (clear water) during all sampling events.

Oxygen concentrations did not meet either of the BC water quality guidelines for DO (30-day means of 8 mg/L and instantaneous minimum of 5 mg/L) at all stations including the reference station FC-7. For cases where natural DO concentrations do not meet water quality guidelines, a statistically significant reduction below natural levels is not permitted.

Given that wastewater discharges occur within the vicinity of the baseline monitoring program, with the exception of the reference station (FC-7), where low DO concentrations were also measured, the low DO conditions could be natural or result from anthropogenic influences. However, given that low DO concentrations (< 5 mg/L) at depth were observed, DO concentrations in the receiving environment should continue to be monitored.

Water quality sampling was conducted for a wide range of parameters including microbiological indicators, conventional properties (physical, nutrients, anions), metals, organics and hormones and sterols. The analysis of microbiological indicators (fecal coliforms and *Enterococci*) found levels above either or both of the shellfish harvesting and recreational guidelines occurred at all stations except the reference station (FC-7). Concentrations of both indicators were within guidelines at the reference station FC-7.

Median and 90th percentile microbiological shellfish harvesting guideline exceedances were measured at every station, except for the reference (FC-7). Mean primary contact recreational guidelines exceedances were measured at MP-4 and MP-5, while maximum primary contact recreational guideline exceedances were measured at AH-2, MP-4 and MP-5. Mean secondary contact recreational guideline exceedances were measured at MP-4.

Conventional parameters were within applicable guidelines with the exception of fluoride which was measured at the guideline limit on several occasions. Trace metal concentrations were analyzed at three stations during all sampling events. When compared against BC and CCME water quality guidelines the measured concentrations were below applicable guidelines for the protection of marine aquatic life, with the following exceptions:

- Copper: a single exceedance of maximum allowable concentration was measured at AH-2 mid water sample during the winter 2012; and,
- Zinc: the maximum allowable concentration was exceeded in the AH-2 mid water sample during the winter 2012 sampling event and in the reference station FC-7 surface sample in the fall 2010.

The source of the copper and zinc exceedances is unknown. These infrequent elevated concentrations may be natural anomalies or potentially introduced through field sampling (e.g. the exterior of the sampling equipment is equipped with some brass (alloy of zinc and copper) components.

Organic constituents (Group 1 and 2) and analysis of hormones and sterols were measured in bottom samples at three stations, during the winter and summer sampling event. The vast majority of the results were below the method detection limit and all were below the applicable water quality guidelines.

Sediment Quality

Pre-discharge sediment samples were collected in the vicinity of Albert Head in 2010. In 2011, sediment samples were collected off of Macaulay and McLoughlin Points, with reference stations at Parry Bay and Finnerty Cove. The sediment component of the PDMP included collection of the following site specific biological, chemical and physical characteristics: sediment chemistry, benthic toxicity and benthic bioaccumulation.

Results were compared to applicable provincial contaminated sites criteria and national CCME marine sediment quality guidelines where available. Marine sediment guidelines and/or criteria exist for total metals, PAHs, organochlorinated pesticides, a pentachlorophenol and PCBs. The remaining analytes have no relevant provincial sediment quality criteria or federal sediment quality guidelines.

Four total metals and 14 PAHs exceeded sediment quality guidelines and/or criteria at stations east of the existing Macaulay Point outfall. There were no sediment quality guideline and criteria exceedances measured at the reference stations at Finnerty Cove and Parry Bay. Total metal concentrations of chromium, lead and zinc were within sediment quality provincial criteria and federal guidelines. Total metal criteria and guidelines were exceeded for arsenic, cadmium, copper and mercury. Cadmium concentrations exceeded the BC MOE contaminated sites criteria (sensitive) at two stations in the vicinity of the proposed outfall and the CCME PEL guideline at a single station in the vicinity of the proposed outfall. Concentrations of arsenic, copper and mercury were measured above the CCME ISQG, but below the less stringent CCME PEL and both the BC MOE contaminated sites criteria.

PAH criteria and guideline exceedances were measured at all of the stations within the vicinity of the proposed outfall. Measured PCBs with sediment quality criteria and/or guidelines (aroclor 1254 and total PCBs) were less than their detection limits and within the sediment quality limits at all stations. Organochlorinated pesticides were measured below sediment quality criteria and/or guidelines or below the method detection limits. Pentachlorophenol concentrations were within sediment quality criteria.

Toxicity and bioaccumulation tests were completed on samples collected from eight sampling stations. Results found a statistically significant decrease in mean survival for the *Eohaustorius estuaries* 10-day survival test as compared to the laboratory control, in sediment samples from the three stations within 800 m of the Macaulay point outfall. No statistically significant difference in mean survival between the test sediments and the laboratory controls were observed in a *Neanthes arenaceodentata* 20-day growth and survival test. However, statistically significant decreases in individual dry weights and mean growth rates were measured between the laboratory control test sediments from five stations within the vicinity of the proposed outfall.

The bioaccumulation test determines the bioaccumulation potential of contaminants in polychaete *Nereis virens*. Concentrations of arsenic and copper (in the polychaetes) were lower than the T=0 concentrations at all stations. Concentrations of cadmium were higher at stations M1E and the reference station PB1 in comparison to T=0, while all other cadmium concentrations were either lower or showed no statistical difference between the T=0 and the 28 day result. Mercury concentrations were below the detection limit of the analysis for all REM stations, and no statistical differences in the Mercury concentrations were measured as compared to T=0. Concentrations of cadmium were slightly higher in the M1E, M2E, M8E and the reference station PB1 test results in comparison to the T=0 results.

Benthic Infauna

Benthic infaunal samples were collected and analyzed for all of the sediment sample locations. Summary biotic factors calculated for the 2010 Albert Head and 2011 stations included abundance of all size groups, abundance of major taxonomic groups, number of taxa, organic biomass, production and mean organism size, sampling precision, the Shannon-Weiner (H'), Simpson's (1-D) and the Swartz Dominance Index (SDI). In addition, comparisons were made of summary abundance; biomass and taxa number overall for the 2010 Albert Head data, 2011 pre-discharge data and historical Macaulay Point monitoring stations (M1E, M2E, M8E and PB1). Production/biomass estimates for each sample location were calculated and compared with predicted ranges for similar habitats, as well as 95th percentile values for 30-90 m depth the Strait of Georgia/Juan de Fuca background database were compared with values for the 2010 and the 2011 stations. Cluster analyses using Bray-Curtis similarity, along with significance and power testing of cluster groups were applied to total abundance composition, total organic biomass composition, proportional trophic composition and proportional size class composition for all samples, as well as for abundance composition of the 4 historical Macaulay Point monitoring stations from 2003-2011.

Comparison of the Albert Head 2010 and Macaulay/McLoughlin Point 2011 data showed that fauna were not significantly distinct between stations within each survey area, but were clearly distinct between the two survey areas. In addition, based on the existing sampling methodologies, it could be concluded that faunal composition has not changed significantly in the four historical CRD stations since 2003. The 2011 faunal composition, abundance, biomass, taxa number, and contribution from the smallest and largest fauna were different from that of the Albert Head 2010 samples. As a result, most of the 2011 samples were below 95th percentile thresholds for biomass and production. These differences are likely due to variations in sampling methodology between the two studies rather than solely attributable to the outfall discharge.

The benthic faunal patterns and composition were not predictable by either natural habitat conditions, or by sediment metals. Most of the stations had metal contaminant levels within expected background ranges, except for the two 2011 stations closest to the Macaulay Point outfall (M1E and M2E). Results suggest that other than potential biotic effects related to deposition from the Macaulay outfall, infaunal structure in the overall region appear to be relatively homogeneous, given consistent sampling methodology.

Proposed McLoughlin Point Outfall Configuration

The proposed McLoughlin Point outfall will extend offshore approximately 2 km with a 200 m long multi-port diffuser in approximately 61 m water depth. The diffuser concept consists of 33 vertical 200 mm diameter ports.

Dilution Modelling and Impact Assessment

Dilution modelling of the proposed discharge was completed for summer and winter conditions under WWTP normal operation and failure scenarios. The summer condition considers an ADWF and storm event, which is within 2 x ADWF. The winter condition considers a wet weather flow and storm event, which is above 2 x ADWF.

Key results from the dilution modelling exercise determined:

- the effluent will be discharged to a well flushed marine environment which is not considered embayed as defined by the MWR;
- the minimum dilution at the edge of the Initial Dilution Zone (IDZ) (throughout the water column) to be 108:1, which would occur under summer conditions; and,
- the minimum dilution at the surface is predicted to be 292:1, which would occur under winter conditions;

Modelling of microbiological indicators predicts that recreational water quality guidelines will be achieved throughout influenced recreational waters. Occasional, short duration, low magnitude exceedances are predicted primarily at offshore areas near the outfall diffuser where primary contact would not be expected to occur.

The recreational water quality guideline of 200 cfu/100 mL would be exceeded under summer conditions at the surface within about 300 m of the outfall diffuser approximately 2% of the time. Under winter conditions, fecal coliform concentrations above 200 cfu/100 mL (up to 1,400 cfu /100 mL) at the surface were predicted to occur within approximately 500 m of the McLoughlin outfall diffuser up to 10 % of the time. In addition, concentrations around 200 cfu / 100 mL at the surface were predicted occasionally near Trial Island and east toward Chatham and Discovery Island under winter conditions.

A “slight episodic” risk of shellfish contamination at Chatham and Discovery Islands was predicted for both summer and winter conditions. The maximum concentration on the west shore of Discovery Island in Plumper Passage was predicted to be approximately 40 cfu /100 mL. This exceeds the median water quality guideline of 14 cfu /100 mL but not the 90th percentile guideline of 43 cfu /100 mL. Fecal coliform concentrations greater than 14 cfu /100 mL were predicted following a storm event and a potential overflow from the Macaulay Point and Clover Point outfalls. For this reason, it is recommended that receiving environment monitoring include water quality monitoring stations at Chatham and Discovery Islands.

The proposed system design is expected to provide adequate protection of human health and shellfish resources. Disinfection should not be required, but may need to be implemented in the future based on receiving environment monitoring results if it is determined that water quality guidelines are not being achieved at receptor sites (e.g. commonly used recreational waters and harvestable shellfish areas).

The project will reduce overall nutrient inputs as compared to existing conditions. Primary production is light-limited in Juan de Fuca Strait, therefore nutrient loading is not predicted to stimulate algal production. Advanced treatment for nutrient removal is not expected to be required to achieve acceptable water quality.

There will be adequate protection of aquatic marine resources as relevant water quality guidelines for the protection of aquatic life will be achieved at the boundary of the IDZ. Potential cumulative effects of discharging CRD Core Area wastewater to the marine environment will be mitigated by a significant reduction in contaminant loadings to the receiving environment. For the predicted 2030 ADWF, the proposed treatment program is anticipated to reduce the net loadings of contaminants by the following amounts, in comparison to screened effluent:

- biochemical oxygen demand by 6,217 tonnes/year;
- total suspended solids by 7,441 tonnes/year;
- copper by 2,676 kg/year;
- mercury by 3 kg/year;
- benzo(a)pyrene by 3 kg/year;
- pyrene by 4 kg/year; and,
- phenol by 529 kg/year.

The proposed discharge of secondary treated wastewater from a new McLoughlin Point marine outfall is not predicted to result in significant adverse effects to human health or the receiving environment.

Recommendations

A receiving environment monitoring program was recently developed jointly between the MOE and the CRD for the existing Macaulay and Clover Point outfalls. It is recommended that the monitoring program for the existing Macaulay Point discharge be adopted for the proposed McLoughlin Point outfall with some modifications.

Water quality monitoring stations should be re-aligned to be centered over the as-constructed terminus of the proposed outfall. Additional water quality monitoring stations should be added near Trial Island and Chatham and Discovery Islands, where the potential to exceed recreational and/or shellfish guidelines was predicted.

- recommended modifications to the proposed benthic infaunal surveys include:
- refinement of schedule and timing;
- sediment sampling stations should primarily include existing Macaulay Point outfall sampling stations with the addition of some pre-discharge monitoring stations;
- stable carbon and nitrogen isotope analyses should be conducted;
- bivalve *Axinopsida serricata* with and without a rusty deposit on their shells recorded;
- detailed field sampling and laboratory methods should be compiled in a written manual; and,
- additional benthic invertebrate community data endpoints should be incorporated into program.

It is recommended that one additional year of the finalized sediment portion of the post- discharge receiving environment monitoring program should be executed prior to commissioning the discharge. The pre-discharge water quality data should be supplemented with one year of water quality monitoring at potential receptor locations at Trial, Chatham and Discovery Islands.

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LIST OF ACRONYMS

5-IN-30	FIVE SAMPLES IN A 30-DAY PERIOD
ADCP	ACOUSTIC DOPPLER CURRENT PROFILER
ADWF	AVERAGE DRY WEATHER FLOW
AH	ALBERT HEAD
BC	BRITISH COLUMBIA
BOD_5	5-dAY CARBONACEOUS BIOCHEMICAL OXYGEN DEMAND
CAWTP	CORE AREA WASTEWATER TREATMENT PROGRAM
CCME	CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT
CCTV	CLOSED-CIRCUIT TELEVISION
CFIA	CANADIAN FOOD INSPECTION AGENCY
CFU	COLONY FORMING UNIT
CMP	CONDITIONAL MANAGEMENT PLAN
COD	CHEMICAL OXYGEN DEMAND
COSEWIC	COMMITTEE ON THE STATUSOF ENDANGERED WILDLIFE IN CANADA
CRD	CAPITAL REGIONIAL DISTRICT
CSSP	CANADIAN SHELLFISH SANITATION PROGRAM
CTD	CONDUCTIVITY-TEMPERATURE-DEPTH
DFO	FISHERIES AND OCEANS CANADA
DND	DEPARTMENT OF NATIONAL DEFENCE
EBSA	ECOLOGICALLY AND BIOLOGICALLY SIGNIFICANT AREA
EC	ENVIRONMENT CANADA
EIS	ENVIRONMENTAL IMPACT STUDY
EMA	ENVIRONMENTAL MANAGEMENT ACT
FC	FINNERTY COVE
IDZ	INITIAL DILUTION ZONE
I & I	INFLOW AND INFILTRATION
LWMP	LIQUID WASTE MANAGEMENT PLAN

MMAG	MARINE MONITORING ADVISORY GROUP
MOE	MINISTRY OF ENVIRONMENT
MOH	MINISTRY OF HEALTH
MP	MCLOUGHLIN POINT
MSR	MUNICIPAL SEWAGE REGULATION
MWR	MUNICIPAL WASTEWATER REGULATION
OC	OPERATIONAL CERTIFICATE
PDMP	PRE-DISCHARGE MONITORING PROGRAM
PNCIMA	PACIFIC NORTH COAST INTEGRATED MANAGEMENT AREA
REM	RECEIVING ENVIRONMENT PROGRAM
NH_3-N	AMMONIA-NITROGEN
SARA	SPECIES AT RISK ACT
SETAC	SOCIETY OF ENVIRONMENTAL TOXICOLOGY AND CHEMISTRY
SMMWE	CANADA-WIDE STRATEGY FOR THE MANAGEMENT OF MUNICIPAL WASTEWATER EFFLUENTS
SPSO	SEWAGE OVERFLOW CAPACITY
SS	SUSPENDED SOLIDS
SSR	SEWERAGE SYSTEM REGULATIONS
TSS	TOTAL SUSPENDED SOLIDS
USEPA	UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WMEP	WASTEWATER AND MARINE ENVIRONMENT PROGRAM
WSER	WASTEWATER SYSTEMS EFFLUENT REGULATION
WWTP	WASTEWATER TREATMENT PLANT

1. INTRODUCTION

WorleyParsons was retained by the Capital Regional District (CRD) to complete the pre-discharge monitoring studies and marine component of a Stage 2 Environmental Impact Study (EIS) for the CRD Core Area Wastewater Treatment Program (CAWTP), near Victoria, BC (Figure 1). The CAWTP will result in the cessation of screened wastewater discharges from the Macaulay Point and Clover Point outfalls and the commencement of discharge of treated domestic wastewater from a new McLoughlin Point outfall (Figures 2 and 3). An EIS associated with the McLoughlin Point-Hartland facilities terrestrial environment was conducted separately from this report (Westland 2010).

In 2006 the British Columbia Ministry of the Environment (MOE) mandated that the CRD implement secondary wastewater treatment to comply with present day legislation and minimum standards for wastewater treatment. Since that time, the CRD has outlined their proposed wastewater treatment program in their Core Area Liquid Waste Management Plan (LWMP). Their proposed program includes three main capital projects: a secondary treatment facility and marine outfall at McLoughlin Point , upgrades to the conveyance system, and a biosolids and energy facility. The capital projects are expected to be in operation by 2018.

To advance the CAWTP, the CRD commissioned a two-stage EIS for the proposed discharge. Stage 1 of the EIS was completed in 2009 by Golder Associates (Golder 2009) and is included in Appendix 1 of this study. The focus of Stage 1 was a preliminary evaluation of the proposed discharge using available data. Stage 1 described the receiving environment including water quality, receiving environment uses and ecological resources. The effluent was characterized including the proposed flow and quality and points of discharge. The effluent plume was modelled in the receiving environment and anticipated environmental impact was assessed. The results from the Stage 1 EIS were used to provide recommendations for a pre-discharge monitoring program (PDMP) and additional studies to be completed as part of Stage 2.

During the preparation of the Stage 1 EIS, the CRD pursued constructing two wastewater treatment facilities; one in Saanich East that would discharge effluent via a new outfall offshore of Finnerty Cove, and a second treatment facility in Colwood that would discharge effluent via a new outfall offshore of Albert Head.

In the summer of 2010 the CRD adopted a revised system configuration with a centralized facility located at McLoughlin Point. The focus of this Stage 2 EIS is on applying site specific receiving environment data and updated wastewater system design characteristics to refine the results of Stage 1 EIS. This Stage 2 EIS report is based on the discharge of secondary quality effluent from a new outfall terminating approximately 150 m east of the existing Macaulay Point outfall diffuser (Figure 3).

2. STAGE 2 EIS OBJECTIVES

The scope of this Stage 2 report will be based on the requirements of an expanded scope EIS for discharges to marine waters with maximum daily effluent flow greater than 10,000 m^3/d as outlined in the *Environmental Impact Study Guideline* (MELP 2000). The scope of the EIS report includes:

1) identification of maximum daily and average annual effluent flow, including possible seasonal-only discharge;
2) identification of influent and effluent sewage quality: 5-day Carbonaceous Biochemical Oxygen Demand (BOD_5), Total Suspended Solids (TSS), total phosphorus (P), ammonia (NH_3), fecal coliforms, and other parameters of concern identified in the Stage 1 EIS;
3) identification of source control measures;
4) identification of any existing or proposed nearby discharges, including their quantity and quality;
5) an inventory of receiving water uses, fisheries resources, commercial and shellfish leases, recreational uses, and other uses. These will be illustrated on the marine chart or topographical map;
6) identification of applicable water quality guideline at areas of concern;
7) the physical meteorological and physical oceanographic setting as it relates to the discharge and dispersion of the effluent plume. This will include;
    a) accessing and summarizing meteorological data available from Environment Canada (EC);
    b) a historical review of applicable oceanographic data collected in the area of the proposed discharges;
    c) summary of current meter readings and an assessment of the calibration of the dilution/current model used in relation to the measured currents;
    d) summary of CTD profiles measured (including temperature, salinity, turbidity, pH, and dissolved oxygen(DO)) and their relation to the dispersion of the effluent plume;
8) baseline water quality data collected during the PDMP summarized and compared to applicable guidelines;
9) baseline sediment quality data collected during the PDMP summarized and compared to applicable guidelines;
10) baseline benthic invertebrate community structure data collected during the PDMP will be summarized;
11) the outfall depth/distance requirement in the MWR will be determined by modelling the discharge;
12) based on the physical and biological oceanographic setting an outfall terminus location will be recommended**;**

13) utilizing computer models estimates of the behaviour of the plume, including the initial dilution and subsequent "far field" dilution, diffusion and dispersion that will occur from the outfall diffuser during “worst case” conditions;

14) based on modelling results, estimates of receiving water quality at the edge of the initial dilution zone (IDZ) and at any areas of concern (shellfish areas, beaches, spawning and rearing habitat areas, etc.) for the two times average dry weather flow secondary treatment requirement set out in Schedule 3 of the MSR. The predicted water quality will be compared with the applicable water quality guidelines;

15) based on study results, a determination if secondary treatment requirements will adequately protect human health and the environment, otherwise, additional treatment or measures will be recommended; and,

16) recommendations for post-discharge effluent and environmental monitoring programs.

Ultimately, the Stage 2 EIS will determine if the proposed treated wastewater discharge will achieve environmental objectives and regulatory criteria.

3. REGULATORY FRAMEWORK

The discharge of municipal wastewater is regulated provincially through the Municipal Wastewater Regulation (MWR) under the British Columbia *Environmental Management Act* (EMA) and federally through the Wastewater Systems Effluent Regulations (WSER) under the *Fisheries Act*.

3.1 Municipal Wastewater Regulation

In April 2012 the EMA Municipal Sewage Regulation (MSR) was replaced with the MWR. The MWR applies to all discharges of domestic sewage except those regulated under the Sewerage System Regulation (SSR) (British Columbia 2004). The SSR applies to domestic sewerage systems with those discharges to water from individual single-family or duplex dwellings.

The MWR sets out the requirements that are to be met by wastewater discharges for the protection of public health and the environment. The MWR includes specific requirements for:

- environmental impact studies;
- operating plans;
- security and assurance plans;
- general design and construction requirements;
- general operating requirements; including:
  - municipal effluent requirements;
  - monitoring requirements; and,
  - administrative requirements
- specific requirements for discharge to water; and,
- reclaimed water requirements.

The MOE and EC are currently in negotiations on an equivalency agreement that would harmonize the MWR with the federal Wastewater Systems Effluent Regulations described in Section 3.2 (MOE 2013).

Liquid Waste Management Plan

The EMA allows a Liquid Waste Management Plan (LWMP) to be developed by local governments and submitted for approval to the Minister of Environment. The approved LWMP, in conjunction with Operational Certificates, authorizes local governments to proceed with strategies in the LWMP to accommodate existing or future development (MOE 2011).

Public and stakeholder consultation is required for the collection and consideration of multiple interests and to garner support from the public. A projected implementation schedule is usually included with the

LWMP. The LWMP establishes a schedule for upgrading facilities when the MWR standards are not being met (MOE 2011).

MWR Effluent Quality

The MWR specifies minimum effluent quality requirements based on specific characteristics of the receiving environment. The proposed discharge will be “open marine water” as defined by the MWR and therefore, the MWR (Part 6 Division 1) requires that secondary treatment be provided for all flows up to two times ADWF. Additional minimum effluent quality criteria are outlined in

Table A (Section 3.5).

Flows above 2 x ADWF require primary treatment. Under the proposed design, flows greater than 2 x ADWF and up to 3 x ADWF from the Clover Point catchment area and up to 4 x ADWF from the Macaulay Point catchment area will receive primary treatment. Until improvements to reduce inflow and infiltration can be made to the system, flows above this will receive screening and grit removal only.

3.1.1 Core Area Liquid Waste Management Plan

The essential elements of the Core Area Wastewater Treatment Program (CAWTP) are outlined in the latest LWMP developed by the CRD (CRD 2011). LWMP Amendment No. 8 was approved in August 2010. A draft Operational Certificate for the McLoughlin Point outfall is also included in the latest LWMP amendment.

The LWMP outlines the CRD’s plan to achieve compliance with the MWR through the implementation of secondary treatment for Core Area wastewater. In relation to the environmental impact of existing discharges and the proposed discharge, the LWMP specifies:

- receiving environment monitoring;
- pre-discharge monitoring activities; and,
- the completion of this EIS.

Existing Discharges

The CRD presently operates two major sewerage systems within the CRD Core Area that terminate at screened outfalls at Macaulay Point and Clover Point. The Macaulay Point and Clover Point outfalls operate under the CRD Core Area Liquid Waste Management Plan (LWMP) that was approved by the BC Minister of Environment in 2003, and waste discharge permits ME-00270 and ME-01877 respectively. These permits were issued by the BC MOE under the MSR and the EMA. These two outfalls currently contribute to the marine water quality within the region of interest.

The Macaulay Point sewage outfall was initially installed in 1915 and discharged at the low tide level (CRD 2006). To reduce shoreline pollution, the outfall was extended offshore in 1971 approximately 1,800 m into Juan de Fuca Strait, terminating at a depth of 60 m (CRD 2006). This outfall is approximately 0.9 m in diameter, terminating in a 135 m long 28 port diffuser. The current average daily flow for this outfall is 44,000 m^3/day [2008 average] (CRD 2011), which is screened to 6 mm prior to discharge.

The discharge of sewage from Clover Point began in 1894 and discharged wastewater to the shoreline until 1981 (CRD 2006). In 1981 the outfall was extended offshore to approximately 1,160 m into Juan de Fuca Strait to an approximate depth of 65 m. This outfall is approximately 1.1 m in diameter, terminating in a 196 m long 37 port diffuser. The current average daily flow for this outfall is 50,000 m^3/day [2008 average] (CRD 2011), which is also screened to 6 mm prior to discharge.

CRD Monitoring Programs for Existing Discharges

Operational Certificates (OC) under the Core Area LWMP for the Macaulay Point and Clover Point outfalls (CRD 2011) were drafted, but are not currently included in the LWMP. Instead, the operation of the Clover and Macaulay Point outfalls are governed under their respective waste discharge permits (described in the previous section). Regardless, both the draft OC's and the waste discharge permits specify that the CRD is responsible for wastewater and marine receiving environment monitoring (REM) (CRD 2011). The monitoring programs are used to determine regulatory compliance and to assess impacts on the marine receiving environment from the outfalls. In addition, the monitoring results are used to identify potential impacts to human health and the environment that may be related to the effluent discharges (CRD 2011).

The CRD conducts REM in the marine environment which includes monitoring the surface waters and benthic environment in the vicinity of the Macaulay Point and Clover Point outfalls. REM has been conducted by the Wastewater and Marine Environment Program (WMEP) on a regular basis since the late 1980s (CRD 2010).

In the interest of protecting the public from exposure to wastewater in the marine environment, marine surface water is collected and its quality assessed. Fecal coliform concentrations within the receiving environment around the Macaulay Point and Clover Point outfalls have been monitored monthly since the early 1980s. Sampling stations have changed over time, with the elimination of shoreline sampling stations in 2000 and the addition of more stations around the vicinity of the outfalls.

The Society of Environmental Toxicology and Chemistry (SETAC) recommended a review of the REM program for the Macaulay Point and Clover Point outfalls, which included a review of the monitoring frequency and station locations, as well as including testing for *Enterococci* near the outfalls (CRD 2010). In 2011, the CRD and MOE revised the surface water sampling program with the objective of determining whether regulatory requirements were being met and water quality guidelines were not being exceeded at the edge of the IDZ (CRD 2012a).

Under the new monitoring program monthly surface water sampling was replaced with quarterly surface water sampling that collected five samples in a 30 day period (CRD 2012a). Water column samples were also added to the program for stations around the IDZ of both Macaulay Point and Clover Point outfalls. Parameters sampled included nutrients, conventional parameters, metals and bacteriological indicators. Surface water samples at all stations are collected at 1 m depth. IDZ stations are sampled with a Seabird conductivity-temperature-depth (CTD) instrument and an automated rosette sampler. Water column profiles collected with the Seabird, and water samples collected with the rosette were taken at the top

(5 m depth), middle (in the predicted plume trapping depth) and bottom (5 m above seabed) locations in the water column at each IDZ station (CRD 2012a).

In October 2012, the CRD proposed a revised WMEP for the Macaulay Point and Clover Point outfalls. This revised WMEP is based on a five-year rotational cycle with brief annual reports that summarize the monitoring activities and results for the respective year and then a more comprehensive report at the end of the five-year cycle (CRD 2012b). This WMEP was developed in collaboration with the CRD and MOE.

Pre-Discharge Monitoring Program for McLoughlin Point Outfall

As committed to in the LWMP, a PDMP was initiated to characterize the background environmental conditions prior to discharge and assess the potential for recreational and ecological impacts (CRD 2011). Golder recommended a PDMP based on the information collected in the Stage 1 EIS, the identified data gaps and the requirements of the Stage 2 EIS (CRD 2011). The Minister of Environment and the Marine Monitoring Advisory Group (MMAG) reviewed the PDMP and provided comments that were then incorporated into the program design.

Water column profiles, water chemistry, current meter, sediment chemistry, and biological community assessments were identified in the LWMP to be included in the PDMP. In spring 2009, Golder conducted the first two water column assessments for the then proposed outfall discharges, Finnerty Cove and Albert Head. In winter 2009, WorleyParsons continued the PDMP. The PDMP was adjusted in 2010 when both the proposed Finnerty Cove and Albert Head wastewater treatment plants and outfall locations were eliminated in favour of a single treatment plant and discharge. The monitoring effort shifted to accommodate a new wastewater treatment plant and outfall off of McLoughlin Point with the McLoughlin Point outfall terminus co-located with the Macaulay Point outfall terminus. Pre-discharge monitoring for the McLoughlin Point outfall was a two year program that included the same assessments identified in the LWMP as the original program.

3.2 Fisheries Act

3.2.1 CCME Canada-wide Strategy

The *Canada-wide Strategy for the Management of Municipal Wastewater Effluent* (SMMWE) was endorsed by the Canadian Council of Ministers of the Environment (CCME) in 2009. The strategy sets out a harmonized framework to manage municipal discharges to provide wastewater facility owners with regulatory clarity in managing municipal wastewater effluent and protecting human health and the environment. The SMMWE establishes minimum standards, and jurisdictions may establish more strict requirements.

The strategy requires that all facilities achieve a minimum National Performance Standard, as well as develop and manage site-specific Effluent Discharge Objectives (CCME 2009). These standards are the minimum performance requirements for effluent quality from municipal, community and government facilities that discharge to surface waters (CCME 2009).

Effluent discharge objectives are a site-specific concentration of a substance that should be met in the effluent discharge to adequately protect human health and the receiving environment (CCME 2009). An effluent discharge objective is to be established if an effluent has been identified to not be protective of human health or the receiving environment (CCME 2009), and should be based on site specific environmental risk assessments.

The CCME based National Performance Standards and the Effluent Discharge Objectives in the Strategy are the basis for the federal Wastewater Systems Effluent Regulations (WSER).

Wastewater Systems Effluent Regulations

The Wastewater Systems Effluent Regulations (WSER, Canada 2012a) were published in July 2012 and developed under the *Fisheries Act* (Canada 2012b). The Regulations include mandatory minimum effluent quality standards that can be achieved through secondary wastewater treatment or equivalent. The Regulations fulfill a federal commitment under the CCME Strategy of 2009. The objective of the proposed regulations is to reduce the risks to human health, fisheries resources and ecosystem health by decreasing the level of harmful substance deposited to Canadian surface water from wastewater effluent. In addition, the Regulations specify the conditions to be met in order to deposit effluent containing deleterious substances (CBOD, suspended solids (SS), total residual chlorine, un-ionized ammonia), specifically concerning toxicity, effluent monitoring, receiving environment monitoring and reporting.

3.3 Species at Risk Act

The *Species at Risk Act* (SARA) enacted in 2002 is federal legislation intended to prevent indigenous wildlife species (as well as subspecies and distinct populations) from becoming extirpated or extinct, aid in the recovery of species that are endangered, extirpated or threatened and assist in preventing other species from becoming at risk.

The SARA established the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). COSEWIC is an independent body of experts that assesses and identifies at risk species and existing and potential threats to the species.

Previous reports have identified the following species that fall under SARA which are found near the proposed outfall location: stellar sea lions, killer whales, humpback whales, harbour porpoises, gray whales and northern abalone, all of which are designated under Section 1 of the SARA (Westland 2012).

3.4 Canadian Shellfish Sanitation Program

The Canadian Shellfish Sanitation Program (CSSP) is a federal food safety program administered jointly by the DFO, EC and the Canadian Food Inspection Agency (CFIA). The *Fisheries Act,* the *Management of Contaminated Fisheries Regulations,* the *Fish Inspection Act* and the *Fish Inspection Regulations* are the legal authority for the CSSP (CSSP 2011). The goal of the CSSP is to protect Canadians from the health risks associated with consuming contaminated bivalve molluscan shellfish (CSSP 2011). The program classifies harvesting areas and controls the commercial and recreational harvest of molluscs, as well as the processing of the product for consumers (CSSP 2011).

The protection of bivalve shellfish is an important consideration when discharging wastewater into the marine environment. Intertidal and subtidal bivalves have been identified and predicted to occur in Juan de Fuca Strait within the potential influence of the effluent plume. These shellfish resources represent a valuable recreational, aboriginal and commercial fisheries resource.

Conditional Management Plans (CMPs) are developed to allow shellfish harvesting in areas that may be periodically at risk of poor water quality, such as the presence of wastewater discharges. The plans identify the circumstances that may trigger a temporary shellfish harvesting closure in that area. There are four CMPs in BC, the first three cover harvest areas near wastewater treatment plants of Ladysmith, Chemainus and Crofton. The fourth CMP covers harvesting areas within Baynes Sound. The CRD has identified that they will consider preparing a CMP to minimize the risk of the release of effluent that may affect shellfish resources (Westland 2010). A CMP would need to be approved by the CRD, CFIA, DFO, EC and BC MOE.

3.5 Summary of Regulatory Effluent Criteria

Table A summarizes the minimum effluent discharge requirements based on the provincial MWR and the federal WSER.

Table A Minimum Effluent Requirements – Municipal Wastewater Regulation, (Open Marine Water) and Wastewater Systems Effluent Regulation

	Criteria	
Parameter	**MWR – Open Marine Waters**	**WSER**
Toxicity[1]	Effluent is not acutely lethal	Effluent is not acutely lethal
CBOD[2]	≤ 45 mg/L (maximum)[3]	< 25 mg/L (average)
TSS	≤ 45 mg/L (maximum)	< 25 mg/L (average)
pH	6.0 - 9.0	---
Total phosphorus (P)	n/a	---
Ortho-phosphate as (P)	n/a	---
Ammonia Nitrogen[4]	Based on receiving water characteristics	---
Un-Ionized Ammonia (as Nitrogen)	---	1.25 mg/L (maximum at 15˚C ± 1˚C)
Fecal Coliforms[5]	Based on receiving water usage	---
Total Residual Chlorine	<0.02 mg/L (maximum)	<0.02 mg/L (average)

1. The discharger must monitor the toxicity of the effluent in accordance with the 96 hour LC50 bioassay test as defined by Environment Canada's Biological Test Method: *Reference Method for Determining Acute Lethality of Effluents to Rainbow Trout, (Reference Method*, EPS 1/RM/13), and if applicable Environment Canada's *Procedure for pH Stabilization During the Testing of Acute Lethality of Wastewater Effluent to Rainbow Trout (Reference Method EPS 1/RM/50)*
2. CBOD: Carbonaceous biochemical oxygen demand
3. The MWR defines BOD5 as the carbonaceous 5-day biochemical oxygen demand
4. Effluent standards for ammonia nitrogen are based on the predicted dilution within the effluent plume at the boundary of the Initial Dilution Zone (IDZ). The IDZ is defined in the MWR as a cylindrical volume of water centered on the terminus of the outfall with a radius that is the lesser of 100 m or 25% of the width of the body of water; the cylinder extends from the seafloor to the surface of the water. For discharges from an outfall diffuser, the radius must be measured from the first and last diffuser ports. The allowable ammonia nitrogen concentration is based on back calculations of water quality guidelines and the predicted dilution of the effluent plume at the boundary of the IDZ.

5. The allowable effluent fecal coliform concentration is back calculated from the predicted dilution at the boundary of the IDZ and any sensitive areas, and is based on the allowable fecal coliform concentration for these areas. The allowable fecal coliform concentration is dependent on the water based activities in the area of the discharge.

   For discharges to recreational use waters, the applicable water quality standard states that the number of fecal coliform organisms outside the IDZ must be less than 200 cfu /100 mL. Recreational usage is considered as *"…any activity involving the intentional immersion (e.g., swimming) or incidental immersion (e.g., waterskiing) of the body, including the head, in natural waters"* (Health and Welfare Canada 1992).

   For discharges to shellfish bearing waters the applicable water quality standard is median or geometric mean of less than 14 cfu/100 mL at the edge of the IDZ (Canadian Food Inspection Agency 2008). For the purpose of this regulation, shellfish water means water bodies "*capable of supporting shellfish in quantities that permit aboriginal, commercial or recreational shellfish harvesting*" (MOE 2012a). Shellfish are defined as: "*all edible species of oysters, clams, mussels and scallops either shucked, in the shell, fresh or fresh frozen or whole or in part. For the purposes of marine biotoxin control, predatory gastropod molluscs shall also be included*" (Canadian Food Inspection Agency 2008).

The MWR also specifies a number of engineering requirements specific to outfalls. Applicable requirements relating to the proposed outfall include:

- the IDZ must not extend closer to shore than the mean low water mark;
- the IDZ must be located at least 300 m away from sensitive areas such as; recreational areas, aboriginal, commercial or recreational shellfish areas, domestic water intakes, agricultural water intakes, or any other sensitive area requiring protection as identified by a director;
- the outfall diffuser must be designed and located at a sufficient depth to maximize the frequency that trapping of the effluent occurs;
- the outfall diffuser is located to intercept the predominant current and avoid small currents that tend to move towards shore;
- depth and distance of the terminus are to be determined by an EIS and computer modelling of the discharge;
- a minimum 10:1 initial dilution must be attained at the boundary of the IDZ through the use of a diffuser;
- outside the IDZ, the discharge does not cause water quality parameters to exceed water quality guidelines; and,
- the outfall is located such that they are protected from wave, boat and marine activity.

4. PROPOSED WASTEWATER FACILITIES

The CAWTP will include a wastewater treatment plant (WWTP) that can treat up to two times the average dry weather flow to a secondary level. The CAWTP will also include a biosolids handling facility and a new marine outfall. In addition to the capital projects there will also be improvements to the existing sewer collection system and inflow and infiltration reduction through a remediation program. The details of the proposed treatment system are outlined in the latest LWMP amendment, from May 2011 (CRD 2011).

4.1 Collection System Upgrades

The existing facilities at Macaulay Point and Clover Point will be upgraded to include grit removal prior to pumping of the sewage to the new McLoughlin Point facility. The Macaulay facility will be expanded to include a generator. Clover Point will be retrofitted with new pumps, grit removal and possibly new screens. New attenuation tanks will be built in Saanich East to allow a more even flow to be pumped to Clover Point. A new pump station will be constructed in the vicinity of the existing Craigflower Pump Station. The new pump station building will include a wet well and pump room which will pump a maximum of 172 ML/day to the Macaulay Point pump station (Westland 2010).

4.2 McLoughlin Point Wastewater Treatment Plant

Table B summarizes the level of treatment that is predicted to be achieved under the different treatment scenarios. Flows between 2 x ADWF and 3 x ADWF from the Clover Point catchment area and between 2 x ADWF and 4 x ADWF from the Macaulay Point catchment area will receive primary treatment from the new WWTP prior to discharge through the new McLoughlin Point outfall. Flows above 3 x ADWF from the Clover Point catchment area will be screened and discharged through the Clover Point outfall. Flows above 4 x ADWF from the Macaulay Point catchment area will be screened and discharged from the Macaulay Point outfall. The amount of flow that will receive only screening and grit removal is expected to be on average 20 ML/day, during high rain events. The I&I reduction programs are expected to reduce these high flow events (see Section 4.4).

Table B Wastewater Treatment Plant Design Hydraulic Flows (ML/day)

	From Clover	From Macaulay	Total	Treatment	Discharge
Plant Design (ADWF)			107.8	Secondary	McLoughlin Point Outfall
Total Design Flow (2 x ADWF)			215.6	Secondary	McLoughlin Point Outfall
2x ADWF to 3x ADWF	51.9	55.8	107.7	Primary	McLoughlin Point Outfall
3x ADWF to 4x ADWF		55.8	55.8	Primary	McLoughlin Point Outfall
	Total Wet Weather Flow		379.2		
>3x ADWF Clover, >4x ADWF Macaulay	Unknown	Unknown	≈20[1]	Screening & Grit Removal	Clover and Macaulay Point Outfalls

[1.] Screened flow to be reduced to 0 by year 2030 with I&I reduction programs

The preferred treatment technology is Biological Aerated Filtration which was recommended due to its level of treatment, low footprint requirements and its proven track record in similar communities (Stantec 2011).

4.2.1 Influent and Effluent Quality

Table C outlines the expected influent and effluent quality at the WWTP. Influent quality data was gathered for the Stage 1 EIS completed in 2009 (Golder 2009). Expected effluent quality was determined using published values on removal efficiencies of secondary wastewater treatment plants (Associated Engineering 2008). A more extensive list of effluent parameters can be found in Section 10.3.

Table C Expected Influent and Effluent Concentrations at WWTP

Parameter	Unit	Influent Concentration	Removal Efficiency	Effluent Concentration
Total Suspended Solids (TSS)	mg/L	199	95%	9.97
5 day Biochemical Oxygen Demand (BOD_5)	mg/L	175.7	90%	17.6
Carbonaceous BOD	mg/L	151.9	93%	10.6
Chemical Oxygen Demand (COD)	mg/L	392.8	80%	78.6
Total Alkalinity	mg/L	184.7	50%	92.3
Total Ammonia	mg/L	28.2	57%	12.1
Un-Ionized Ammonia	mg/L	-	-	0.07[1]
Nitrate	mg/L	0.07	0%	0.07
Total Kjedahl Nitrogen (TKN)	mg/L	39.1	56%	17.2
Oil and Grease (TOG)	mg/L	37.95	50%	19.0
pH	-	7.21	-	6.0 - 8.6[2]
Cadmium	µg/L	0.419	17%	0.348
Copper	µg/L	109	62%	41.4
Lead	µg/L	5.74	0%	5.74
Mercury	µg/L	0.13	66%	0.044
Zinc	µg/L	79.6	70%	24

1 The concentration of un-ionized ammonia was calculated based on the formula specified in the WSER (Canada, 2012): total ammonia × 1 ÷ (1 +109.56 – pH), assuming a pH of 7.3 and total ammonia concentration of 12.1 mg/L.

2 Assuming a total ammonia concentration of 12.1 mg/L, the effluent pH will need to remain below 8.6 for the concentration of un-ionized ammonia to remain below the WSER criteria of 1.25 mg/L.

4.2.2 Wastewater Treatment Plant Operating Requirements

A draft operational certificate has been included in the latest LWMP (CRD 2011). The permit outlines the flow rates and level of treatment required with the CAWTP.

Maximum authorized rate of discharge = 379,100 m^3/day

Maximum ADWF (in year 2030) = 107,800 m^3/day

- Up to 2 x ADWF must be treated to the following degree: $CBOD_5$ and TSS : 45 mg/L and pH: 6-9
- Flows above 2 x ADWF treated to the following degree: $CBOD_5$ and TSS: 130 mg/L and pH: 6-9
- Flows above 4 x ADWF: Equivalent or better than typical screened sewage (disallowed after Dec 31, 2030)

Sampling locations:

- One location that represents the portion up to 2x ADWF
- One location that represents the portion above 2X ADWF but below 4 X ADWF
- One location after the flows are combined

Sampling of the following parameters:

- $CBOD_5$ and TSS: 5 days a week, 24-hr composite sample
- NH_3-N: 2 times per month, 24-hr composite
- Other parameters as directed

4.3 Solids Handling Facility

Solids from the WWTP will be pumped through a conveyance pipeline up to the proposed biosolids handling facility at Hartland North. The CRD has plans to apply thermophilic anaerobic digestion and capture the methane generated by the digestion. The digested solids will then be dewatered to 25-30% solids and the struvite (phosphorous) will be recovered for reuse. The wastewater from dewatering will be returned to the McLoughlin Point wastewater treatment plant. The dewatered biosolids will then be dried to achieve a solids content of 95%. Dried sludge will be sent to waste-to-energy facilities on Vancouver Island or the lower mainland (Westland 2010).

4.4 Inflow and Infiltration

As part of the LWMP, the CRD has designed an I&I program to reduce wet weather flows to less than four times the ADWF. The I&I program will define priority areas for remediation and options to minimize I&I. The program will include regular inspection of sewers using closed-circuit television (CCTV) and the rehabilitation of sewer mains to improve capture and conveyance. SCADA system upgrades are also included in the I&I program in order to obtain real-time flow information from the existing pump stations. Further information on the proposed I&I program can be found in the LWMP (CRD 2011a and Stantec 2010).

5. RECEIVING ENVIRONMENT CHARACTERISTICS

5.1 Physical Oceanographic Characteristics

Effluent from the proposed wastewater treatment plant will be discharged approximately 2 km south of Victoria Harbour, to Juan de Fuca Strait. Juan de Fuca Strait is a long narrow body of water that runs approximately 150 km from the Pacific Ocean at its western end to the San Juan Islands at the eastern end. From its entrance at the Pacific Ocean to Race Rocks the Strait is approximately 22 – 28 km wide. The narrowest point is located between Race Rocks and Angeles Point, USA. The strait is considerably wider at Victoria, measuring approximately 30 km from Victoria Harbour to Port Angeles, USA. For purposes of this report, the study area is defined as the waters and coastline from Race Rocks east to Ten Mile Point, and including the waters and coastline around Chatham and Discovery Islands (Figure 2).

5.1.1 Bathymetry and Seabed Composition

Bathymetric contours (water depths) in the vicinity of the proposed discharge are shown on Figures 2 and 3. The proposed terminus of the outfall will be located at a depth of approximately 60 m.

To the west and north (shoreward) of the outfall water depths are shallow. To the south, water depths generally deepen, reaching depths greater than 120 m near Race Rocks. To the east, between the proposed discharge and Trial Island depth contours follow the general profile of the shoreline, reaching maximum depths of over 100 m approximately 3 km offshore. Water depths are shallow (minimum 15 m) at Constance Bank, 6 km south of Clover Point. Constance Bank forms part of the Victoria sill that runs from Victoria to Port Angeles.

The seabed along the alignment of the outfall was visually surveyed using a remotely operated vehicle (ROV) (WorleyParsons 2013c). Along the alignment of the outfall, the seabed is primarily composed of sand and mud from a water depth of 10 m to the proposed terminus. At depths shallower than 10 m, pebble, cobble and exposed bedrock were observed to the high water mark.

5.1.2 Wind and Waves

Wind patterns within Juan de Fuca Strait are strongly influenced by the local topography. Prevailing oceanic wind patterns are funnelled along Juan de Fuca Strait by upland topographic features. Easterly winds prevail during winter months (October through March) and westerly winds prevail in the summer (Thompson 1981).

Generally, the winter wind pattern is dominated by cyclonic storms which move through the region, with infrequent periods of high pressure. The summer weather pattern is dominated by the North Pacific high which results in north-westerly winds along the Pacific coast. The northwesterly winds are funnelled into Juan de Fuca Strait, enhanced by a sea-breeze that develops during the day. Predominant summer wind speeds at Victoria are 7.5 m/s from the southeast generally reaching a maximum in the late afternoon (Thompson 1981).

Wind patterns can significantly affect the fate of an effluent plume as the wind can generate waves and modify near surface circulation. Wind generated waves within Juan de Fuca Strait in the vicinity of the proposed outfall will be fetch limited. Peak wave heights of around 4 m are expected in the vicinity of the proposed outfall (*Pers. comm*. Chowdhury 2012). Wind conditions should be included in effluent plume dilution and dispersion modelling. Protection of the outfall from wave forces and associated shoreline flotsam (i.e.driftwood) will be an important design consideration. The existing Macaulay Point outfall has similar exposure and is protected using rock embedded in concrete. The protection has proven to be durable since its installation (WorleyParsons 2012).

5.1.3 Tides

The range of tide elevations is important for the design and dilution modelling of the proposed discharge. The proposed outfall design will need to accommodate high water conditions. Tides are also the dominant force behind currents within Juan de Fuca Strait and the Georgia Basin.

Tides at Victoria are described as “mixed, mainly semi diurnal” (DFO 2008). This is to say that there are two complete tidal oscillations each day. These oscillations will vary daily in both height and the time when highs and lows are reached. The tide ranges of Victoria are given in Table D (DFO 2008).

Table D Tides at Clover Point, Victoria BC

Tide Cycle		Tide Elevation (m) above chart datum
Higher High Water	Recorded Extreme	3.7
	Large Tide	3.4
	Mean Tide	2.5
Mean Water Level		1.9
Lower Low Water	Mean Tide	0.7
	Large Tide	0.0
	Recorded Extreme	-0.5

A large tide is defined as the average of the highest high waters or lowest low waters one from each of 19 years of predictions. Mean tide is defined as the average from all the higher high or lower low water waters from 19 years of predictions.

Sea Level Rise

The projected sea level rise due to global warming has been predicted for locations along the BC coast (Thomson *et.al.* 2008). The predicted sea level rise at Victoria is provided in Table E.

Table E Predicted Relative Sea Level Rise at Victoria (cm)

Relative Sea Level Rise 2100 (Mean Scenario)			Relative Sea Level Rise 2100 (High Scenario)		
Mean	Low	High	Mean	Low	High
25	9	41	65	58	119

The mean scenario is based on the on the International Panel on Climate Change (AR4) mean predicted sea level rise of 30 ± 12 cm by the year 2100. The high scenario is based on the International Panel on Climate Change (AR4) high predicted sea level rise of 100 ± 12 cm by the year 2100.

Sea level rise should be considered in the design of the proposed outfall to promote longevity of the proposed discharge and to limit possible overflow events that may result from high water levels.

5.1.4 Currents

Current patterns in Juan de Fuca Strait are dominated by tidal flow, with estuarine circulation and wind driven current superimposed on the tidal currents. The general surface tidal flow at the eastern end of Juan de Fuca Strait is plotted in Figures 7 and 8 (DFO 2008). The current plots show modelled current velocities during a typical large (spring) tide. At the beginning of the ebb tide, (chart 52), the flow south of Victoria parallels the shoreline near trial island and is then directed to the south as it approaches Royal Roads and Albert Head. As the ebb tide progresses an eddy may develop south of Discovery and Chatham Islands. This eddy can result in currents that draw the effluent in towards the shoreline and then to the east.

Flood tide surface current patterns are depicted in Figure 8. Early in the flood, currents generally flow parallel to the shoreline between Race Rocks and Royal Roads. As the flow approaches Victoria it is deflected to the east and accelerates as it flows around Trial, Discovery and Chatham Islands into Haro Strait. During the latter part of the flood, an eddy develops between Race Rocks and Victoria Harbour (Chart 63).

Detailed current measurements within the study area were collected as part of the PDMP. Current measurements were used in the calibration of the hydrodynamic model of the receiving environment for dilution modelling of the effluent plume (See Section 9).

A total of four Acoustic Doppler Current Meters (ADCP`s) were deployed for a period of 30 days. The ADCP's were deployed at Albert Head and Finnerty Cove. The ADCP deployment locations are shown in Figures 5 and 6.

Details of the ADCP deployment methods, instrument specification and data quality assurance and quality control are included Appendix 2. The ADCP's were moored near the seabed facing up and were configured to measure currents in two metre depth intervals (bins) between the instrument and the water surface. The frequencies of measured current velocities for three depth intervals (near surface, mid water and near bottom) are shown in Appendix 3. The full measured tidal current data set was provided for use in the calibration of the hydrodynamic model.

Drogue and wind studies recommended in the *Environmental Impact Study Guideline* (MELP 2000) were not completed as part of this EIS. These studies are intended to help predict the far field trajectory of the effluent plume, which for the proposed discharge was predicted using the calibrated hydrodynamic model. The recommended drogue studies added little additional value beyond the results of the hydrodynamic model.

5.2 Water Quality

The CRD has monitored the impacts of wastewater discharges on surface water quality in the vicinity of the Macaulay Point and Clover Point outfalls on a regular basis since the late 1980s (CRD 2010). A brief summary of the 2011 water quality component of the Macaulay Point and Clover Point REM program is described below in Section 5.2.1. A summary of the water quality component of the PDMP is included in Section 5.2.2, with a more detailed report provided in Appendix 4 (WorleyParsons 2013a).

5.2.1 Macaulay and Clover Point Receiving Environment Monitoring

In 2011, the CRD conducted quarterly surface water monitoring in the marine environment in the vicinity of both the Macaulay and Clover Point outfalls. Each quarterly sampling program consisted of five sampling events over a 30-day period (5-in-30). Water quality samples were collected at the surface at 13 fixed stations and two variable stations and at three depths at four dynamic stations at the edge of the IDZ.

Surface water samples were collected at a depth of 1 m and analyzed for fecal coliforms and *Enterococci.* Results were compared to relevant BC MOE water quality guidelines. One variable station was established at the end point of a drogue released at the onset of each sampling event and allowed to travel during the entire sample collection process. At the end of the sample collection process, the location of the drogue was marked and a surface sample was collected at that station. A second variable station was selected at the location of any visual evidence of the discharge (if any).

During each sampling event four stations were selected for water sampling along the IDZ. These four stations varied between each event. Three sampling depths were monitored at the four IDZ stations (surface, middle and bottom). Each sampling day the predicted current direction and the trapping depth of the effluent plume were determined using the CRD hydrodynamic C3 model. The four stations along the IDZ and the middle sampling depth were selected based on the models predicted plume direction of travel and trapping depth. Bacteriological samples were collected for each depth at every sample event in the 5-in-30 (five samples in a 30-day period). Metal analysis, conventional parameters and nutrients were only sampled at one event per 5-in-30. Bacteriological concentrations were compared BC MOE and Health Canada guidelines for the protection of human health. Metals were compared to water quality guidelines for aquatic life.

The surface fecal coliform and *Enterococci* results indicate that the outfall plumes were predominantly trapped below the ocean surface. The geometric mean for fecal coliform and *Enterococci* were below guideline limits used to assess potential human health risks for all surface samples. The IDZ water column sampling indicated that fecal and *Enterococci* results were above applicable water quality guidelines at depth indicating that regulatory limits were exceeded outside the IDZ. The results also indicated that the sewage plume was trapped below the surface for the majority of the year. Exceedances of the zinc water quality guideline were occasionally observed at depth in three single day samples. Note that the zinc exceedance is based on single samples and not 5-in-30 sample as per the guideline and therefore the exceedance should be interpreted with caution.

5.2.2 McLoughlin Point Pre-Discharge Water Quality Sampling

Quarterly water quality and water column profile data were collected under the PDMP from July 2010 to June 2012. This program included the collection of the following site specific microbiological, chemical and physical characteristics: water quality, water column profiles and current profiles. Pre-discharge monitoring was conducted off Albert Head, McLoughlin Point and Finnerty Cove (Figure 9).

Pre-discharge water column profiles and water quality samples were collected at five stations, with the goal of providing a comprehensive baseline characterization of the receiving environment conditions prior to discharge. Two water quality stations were located near the proposed point of discharge (MP-4 and MP-5), one (AH-2) was located 4 km to the south west near Albert Head, one (MP-6) was located 7 km to the south west in deep water and the fifth (reference station FC-7) was located in Haro Strait.

Water column profiles measured temperature, salinity, pH, DO and turbidity. Temperature and salinity profiles provide ambient density characteristics used in the dilution modelling of the effluent plume. The toxicity of ammonia is influenced by the temperature, salinity, and pH of the receiving environment. *In situ* measurements were therefore used to determine the appropriate ammonia water quality guideline.

Oxygen concentrations did not meet either of the BC water quality guidelines for DO (30-day mean of 8 mg/L and instantaneous minimum of 5 mg/L) at all stations including the reference station FC-7. For cases where natural DO concentrations do not meet criteria no statistically significant reduction below natural levels are permitted (WorleyParsons 2013a; Appendix 4).

Given that wastewater discharges occur within the vicinity of the baseline monitoring program, with the exception of the reference station (FC-7), where low concentrations were also measured, it is difficult to conclude if the low DO conditions measured are natural or result from anthropogenic influences. However, given that low oxygen concentrations (< 5 mg/L), specifically at depth, were observed oxygen concentrations in the receiving environment should continue to be monitored.

The measured turbidity of the receiving environment was low (clear water) during all sampling events.

Water quality sampling was conducted for a wide range of parameters including microbiological indicators, conventional properties (physical, nutrients, anions), metals, organics and hormones and sterols. Results from the analysis of microbiological indicators (fecal coliforms and *Enterococci*) found levels above either or both of the shellfish harvesting and recreational guidelines at four of the five baseline water sampling stations (AH-2, MP-4, MP-5 and MP-6) (WorleyParsons 2013a; in Appendix 4). Concentrations of both indicators were within guidelines at reference station FC-7 (WorleyParsons 2013a; in Appendix 4).

Conventional parameters were within all applicable guidelines with the exception of fluoride, which was measured at the guideline of 1.5 mg/L limit on several occasions. Natural levels of fluoride in the marine environment are reported to range from 0.86 to 1.4 mg/L (MOE 1995, Dyson 1977), and therefore these represent a minor deviation from expected concentrations.

Trace metal concentrations were analyzed at three stations during all sampling events. When compared against BC and CCME water quality guidelines the measured concentrations were below applicable guidelines for the protection of marine aquatic life, with the following exceptions (WorleyParsons 2013a; in Appendix 4):

- Copper: a single exceedance of maximum allowable concentration was measured at AH-2 mid water sample during the winter 2012.
- Zinc: the maximum allowable concentration was exceeded in the AH-2 mid water sample during the winter 2012 sampling event and in the reference station FC-7 surface sample in the fall 2010

Organic constituents (Group 1 and 2) and analysis of hormones and sterols were measured in bottom samples at three stations, during the winter and summer sampling event. The vast majority of the results were below the method detection limit and all were below the applicable water quality guidelines.

5.3 Sediment Quality

Sediment quality in the vicinity of the Macaulay Point outfall and reference locations has been assessed through the CRD REM program since the late 1980s. A brief summary of the most recent (2010) published sediment quality component of the Macaulay Point and Clover Point REM program is described below in Section 5.3.1.

In 2010, WorleyParsons collected pre-discharge sediment samples at 13 stations (1-13) in the vicinity of Albert Head (Figures 10 and 13). In 2011, the CRD collected sediment samples in accordance with their REM program for the Macaulay Point outfall (Figures 10 and 11). Specifically, the CRD collected sediment samples at three Macaulay Point outfall stations (M1E, M2E, M8E) and one Parry Bay reference station (PB1) (Figures 11 and 13). In 2011, WorleyParsons also collected sediment samples at six stations in the vicinity of the proposed McLoughlin Point outfall (M500SE, M800NE, M1300E, M1400ESE, M1600SE, M2300ESE) and at two reference stations (FC3500NE, FC4000ENE) near Finnerty Cove (Figures 11 and 12). Stations M1E, M2E and M8E are historically used by the CRD as part of their REM program; however for the purposes of this report, the 2011 data was analyzed as part of the PDMP for the McLoughlin Point outfall due to its proximity to the proposed McLoughlin Point discharge location.

The sediment component of the pre-discharge monitoring included collection of sediment samples for sediment chemistry analysis, bioaccumulation and toxicity, and benthic infaunal community analyses.

A summary of the sediment quality component of the PDMP is included in Section 5.3.2, with a detailed report provided in Appendix 5 (WorleyParsons 2013b). A summary of the benthic infaunal analyses is included in Section 5.3.3 with a detailed report provided in Appendix 5 (WorleyParsons 2013b).

5.3.1 Macaulay and Clover Point Receiving Environment Monitoring

CRD monitors the effects of the wastewater discharges on the seafloor by analyzing sediments near the Macaulay Point and Clover Point outfalls. The sediment is analyzed for a series of chemical substances, as well as benthic organism community structure at the Macaulay Point outfall, and for deep-sea mussel chemical, morphological, reproductive and community structure at the Clover Point outfall.

Different biological indicator analyses (horse mussels vs. benthic organisms) are conducted at each outfall because the substrate within the vicinity of these outfalls differs from one another. The substrate at the Macaulay Point outfall is composed of soft sediments (mud and sand) and the substrate at the Clover Point outfall is composed of coarser material (pebbles, rock, boulders, coarse sand). A Van Veen sediment grab is used to collect sediment and marine organisms from the seabed near the outfalls and reference stations. Sediment chemistry samples are analyzed for metals, PAHs and phenolic compounds and compared with relevant sediment quality guidelines (CRD 2010). Annually, sediment is collected at the Macaulay Point outfall and Parry Bay reference stations.

The sediment monitoring results in the most recent published monitoring program document (the 2010 Annual Report) were reviewed and summarized (CRD 2011b). The majority of chemical constituents were found at levels similar to previous years, with few exceeding sediment quality guidelines (CRD 2011b). Sediment samples with concentrations exceeding guidelines were at stations within 200 m of the Macaulay Point outfall diffusers. These exceedances included copper, mercury and the following PAHs: acenaphthene, anthracene, benz(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, indeno (1,2,3-c,d)pyrene, phenanthrene, pyrene, 1,4-dichlorobenzene, 1,2,4-trichlorobenzene, and phenol. Four chemical constituents (copper, mercury, acenaphthene and bis(2-ethylhexyl) phthalate) exceeded sediment quality guidelines at the Clover Point outfall terminus station.

5.3.2 McLoughlin Point Sediment Chemistry

The CRD commissioned a PDMP to provide site specific data for the Stage 2 EIS which is intended to be used for comparison with future monitoring surveys conducted after construction and commissioning of a new deep-sea outfall at McLoughlin Point (WorleyParsons 2013a, 2013b; in Appendices 4 and 5 respectively).

The sediment component of the PDMP included collection of the following site specific biological, chemical and physical characteristics: sediment chemistry, benthic toxicity and benthic bioaccumulation (WorleyParsons 2013b in Appendix 5).

Sediment samples were analyzed for a comprehensive suite of analytes including:

- Fecal Coliform;
- Acid Volatile Sulphide and Simultaneous Extractable Metals
- Total Organic Carbon;
- Total Carbon;

- Moisture;
- Total Phosphorus;
- Total Trace Metal Suite;
- Polycyclic Aromatic Hydrocarbons;
- Organochlorinated Pesticides;
- Chlorinated Phenolics;
- Volatile Organic Compounds (VOCs including BTEX);
- Phthalates;
- Polybrominated Diphenyl Ethers;
- Polychlorinated Biphenyls;
- Nonylphenol and its Ethoxylates;
- Pharmaceutical and Personal Care Products;
- Marine Amphipod Sediment Toxicity;
- Marine Polychaete Sediment Toxicity; and,
- Marine Polychaete Sediment Bioaccumulation

Results were compared to applicable provincial contaminated sites criteria and national CCME marine sediment quality guidelines where available. Marine sediment guidelines and/or criteria exist for: total metals, PAHs, organochlorinated pesticides, pentachlorophenol and PCBs. The remaining analytes have no relevant provincial sediment quality criteria or federal sediment quality guidelines.

Four total metals (arsenic, cadmium, copper and mercury) exceeded sediment quality provincial criteria and/or federal guidelines at several stations east of the existing Macaulay Point outfall. The remaining total metals results were within the BC contaminated sites criteria and the federal CCME guidelines. Cadmium concentrations exceeded the BC MOE contaminated sites criteria (sensitive) at station M500SE and M2300SE and the CCME PEL guideline at station M500SE. Concentrations of arsenic, copper and mercury were measured above the CCME ISQG, but below the less stringent CCME PEL and both the BC MOE contaminated sites criteria.

PAH guideline and criteria exceedances were measured at all of the stations within the vicinity of the existing discharges (M1400ESE, M1600SE, M2300ESE, M800NE, M2E and M8E). In total, there were 43 PAH sediment quality guideline and/or criteria exceedances measured within the six stations with exceedances. Of the 43 exceedances, 16 of them were within five times the detection limit (5xDL), and therefore should only be considered “possible exceedances” due to the reduced precision on analytical results near the detection limit of the analysis (WorleyParsons 2013b; Appendix 5).

Highest concentrations and the largest number of the possible exceedances were measured at M1600SE and M2E. The PAH concentrations at M1600SE were higher than other stations in the vicinity and may have been the result of a confounding factor (Section 5.3.4). The detection limit exceeded sediment quality guidelines and/or criteria for seven of the 14 PAHs (WorleyParsons 2013b; Appendix 5).

Measured PCBs with sediment quality criteria and/or guidelines (aroclor 1254 and total PCBs) were less than their detection limits and within the sediment quality limits at all stations. Organochlorinated pesticides were measured below sediment quality criteria and/or guidelines or below the method detection limits. Pentachlorophenol concentrations were within sediment quality criteria (WorleyParsons 2013b; Appendix 5).

Toxicity and bioaccumulation tests were completed on samples collected from eight sampling stations. Results found a statistically significant decrease in mean survival for the *Eohaustorius estuaries* 10-day survival test as compared to the laboratory control, in sediment samples from the three stations within 800 m of the Macaulay point outfall. No statistically significant difference in mean survival between the test sediments and the laboratory controls were observed in a *Neanthes arenaceodentata* 20-day growth and survival test. However, statistically significant decreases in individual dry weights and mean growth rates were measured between the laboratory control test sediments from five stations within the vicinity of the proposed outfall (WorleyParsons 2013b; Appendix 5).

The bioaccumulation test determines the bioaccumulation potential of contaminants in polychaete *Nereis virens*. Concentrations of arsenic and copper (in the polychaetes) were lower than the T=0 concentrations at all stations. Concentrations of cadmium were higher at stations M1E and the reference station PB1 in comparison to T=0, while all other cadmium concentrations were either lower or showed no statistical difference between the T=0 and the 28 day result (WorleyParsons 2013b; Appendix 5). Mercury concentrations were below the detection limit of the analysis for all REM stations, and no statistical differences in the mercury concentrations were measured as compared to T=0. Concentrations of cadmium were slightly higher in the M1E, M2E, M8E and the reference station PB1 test results in comparison to the T=0 results (WorleyParsons 2013b; Appendix 5).

5.3.3 Benthic Infaunal Community

Benthic infauna composition and community analysis was completed as part of the CRD PDMP (WorleyParsons 2013b, Appendix 5). Summary biotic factors calculated for the 2010 Albert Head and 2011 stations included abundance of all size groups, abundance of major taxonomic groups, number of taxa, organic biomass, production and mean organism size, sampling precision, the Shannon-Weiner (H'), Simpson's (1-D) and the Swartz Dominance Index (SDI). In addition, comparisons were made of summary abundance; biomass and taxa number overall for the 2010 Albert Head data, 2011 pre-discharge data and historical Macaulay Point monitoring stations (M1E, M2E, M8E and PB1). Production/biomass estimates for each sample location were calculated and compared with predicted ranges for similar habitats, as well as 95^{th} percentile values for 30-90 m depth from the Strait of Georgia/Juan de Fuca background database. The 95th percentile thresholds for most summary biotic factors were calculated for samples from a depth range of 30-90 m from the British Columbia coastal background database (Burd et al. 2009; Burd et al. 2012), and compared with values for all Albert Head 2010 and 2011 stations. Cluster analyses using

Bray-Curtis similarity (Bray and Curtis 1957), along with significance and power testing of cluster groups (Nemec and Brinkhurst 1988; Nemec 2000) were applied to total abundance composition, total organic biomass composition, proportional trophic composition (as per Macdonald et al. 2012a) and size class composition (Macdonald et al. 2012b) for all samples, as well as for abundance composition of the four historical Macaulay Point monitoring stations from 2003-2011 (WorleyParsons 2013b; Appendix 5).

Comparison of the Albert Head 2010 and Macaulay/McLoughlin Point 2011 data showed that fauna were not significantly distinct between stations within each survey area, but were clearly distinct between the two survey areas. In addition, based on the existing sampling methodologies, it could be concluded that faunal composition has not changed significantly in the four historical CRD stations since 2003. The 2011 faunal composition, abundance, biomass, taxa number, and contribution from the smallest and largest fauna were different from that of the Albert Head 2010 samples. As a result, most of the 2011 samples were below 95th percentile thresholds for biomass and production. These differences are likely due to variations in sampling and taxonomic methodology between the two studies (WorleyParsons 2013b; Appendix 5).

The benthic faunal patterns and composition were not predictable by either natural habitat conditions, or by sediment metals. Most of the stations had metal contaminant levels within expected background ranges, except for the two 2011 stations closest to the Macaulay Point outfall (M1E and M2E). Results suggest that other than potential biotic effects related to deposition from the Macaulay Point outfall, infaunal structure in the overall region appear to be relatively homogeneous, given consistent sampling methodology

5.3.4 Other Factors Affecting Sediment Quality

Multiple sediment samples (both benthic and chemistry) collected as part of the PDMP included visible anthropogenic waste such as glass at M800NE and M1300E, a shoe at M500SE (sample was not used) and plastic at M2300ESE. Given the visible waste observed in these samples it is anticipated there is also waste buried within the samples which was not observed. Therefore, exceedances of the sediment quality criteria and guidelines may not be solely attributed to the current wastewater discharges.

The waters in the vicinity of the proposed McLoughlin Point outfall discharge have a long history of industrial use. For 50 years (1908-1958) garbage was deposited into the marine environment off Ogden Point (Ringuette 2005). Victoria Harbour has had a number of industrial activities conducted in and adjacent to it, including a coal gasification facility, a propane tank farm, concrete batch plant, asphalt plant, saw milling and log booming, machine manufacturing, tannery and ship building and repair (CRD 2013). The coal gasification facility resulted in the contamination of soil, groundwater and sediment on the site, on the neighboring properties and within the seabed of Rock Bay. Remediation is proposed for this contaminated site, which includes remediation of soil, groundwater and seabed sediments (CEAA 2013). Storm water from the core area is discharged into the marine environment of Portage Inlet, Gorge Waterway and Victoria Harbour and subsequently discharged into the Juan de Fuca Strait. The historic use of the waters near Ogden Point by the Department of National Defence (DND) has not been characterized.

The Victoria ocean disposal site has been in use since 1970 when it was designated for use by the provincial Ministry of Transport in British Columbia (Environment Canada 2012). The approximate total volume of dredged and excavated material disposed of at the Victoria ocean disposal site is approximately 296 544 m^3 (Environment Canada 2012). The center of the ocean disposal site is located approximately 2.5 km south of Albert Head, at a water depth of approximately 90 m. The disposal site has a diameter of approximately 1.85 km and al surface area of approximately 2.69 km^2 (Environment Canada 2012; DFO 2010a). Material disposed of at the site is mainly from maintenance dredging at marinas and commercial properties near Victoria (Environment Canada 2012).

An analysis of PAH distributions from Macaulay Point and Clover Point receiving environment monitoring sediment samples (Yunker et al. 2012) suggest that PAHs likely originate from numerous sources including:

- coal from the SS San Pedro collier which sunk off Brochie Ledge in 1891;
- dreged sediments containing pyrolised coal waste from a former coal gas plant in Victoria Harbour; and,
- combustion PAHs introduced by a combination of atmospheric deposition and delivery via stormwater and the outfalls.

6. RECEIVING WATER USES

The Stage 1 EIS provided a summary of information on the receiving water uses in the vicinity of the previously proposed Finnerty Cove and Albert Head outfalls. Receiving water uses such as the presence of biological resources (invertebrates, fish, seabirds, marine mammals, and aquatic vegetation), rare and endangered species, fisheries (recreational, commercial), aquaculture, recreational activities, ecological reserves and parks were summarized. Much of the information supplied by the Stage 1 EIS applies to the receiving waters of the McLoughlin Point outfall and is therefore relevant to the proposed discharge. Receiving water uses in relation to the proposed McLoughlin Point outfall discharge area are summarized in the following sub-sections.

6.1 Fisheries and Biological Resources

The presence of fisheries and biological resources is an important consideration when discharging wastewater into marine waters. The proposed project area provides habitat for a number of invertebrates, fish, seabirds and marine mammals and is identified as being an ecologically and biologically significant area (EBSA). The EBSA is a preliminary identification process for the Pacific North Coast Integrated Management Area (PNCIMA) initiative (DFO 2012a). The proposed project area has been identified as being an EBSA for green sea urchin, dungeness crab, herring, salmon, steller sea lions, harbour seals, harbour porpoises and southern resident killer whales (DFO 2012a).

6.1.1 Invertebrates

Juan de Fuca Strait supports a number of ecologically, economically and culturally important invertebrates. Crab, shrimp, prawn, octopus, squid, red sea urchin and shellfish (swimming scallops, geoduck, cockles, mussels, and oysters) are documented in the marine project area (ILMB 2012; DFO 2012a; Golder 2009).

Commercial harvesting of prawn, shrimp, dungeness crab, red rock crab, octopus and red sea urchin in addition to recreational of harvesting crab and prawn have been identified in the area (DFO 2012a; Golder 2009). The point of discharge is greater than 400 m from known harvestable shellfish beds. Intertidal bivalves are reported or predicted to occur near Parker Bay, Witty's Lagoon, Albert Head, Esquimalt Lagoon, Macaulay Point, Chain Islets, and Chatham and Discovery Islands (DFO 2012a; Golder 2009; Figure 14). During a seabed video survey, subtidal geoduck and rough necked piddock clams were observed to occur along the proposed McLoughlin Point outfall alignment at depths ranging from 22 to 44 m (relative to chart datum, WorleyParsons 2012; Figure 14). The shellfish harvesting industry generally considers subtidal clam harvesting viable to a maximum depth of 20 m due to diving limits (*Pers. comm.* Dovey 2009). The 20 m contour, which is located approximately 1.2 km from the proposed diffuser, is therefore the closest potential location of harvestable shellfish (assuming no sanitary closure). Other bivalves, such as scallops, that could be harvested in deeper waters with trawl gear have not been reported to occur near the outfall location.

Northern abalone are reported to occur in the vicinity of Albert Head (Golder 2009) and near Macaulay Point (*Pers. comm.* Clarke 2012). Abalone occur in a variety of habitats, ranging from sheltered bays to exposed coastlines. Abalone are typically found on hard substrates, such as boulders and bedrock in the intertidal and shallow subtidal waters up to 15 m depth (COSEWIC 2009; Harbo 2010) where kelp are prevalent, as it is a major food source (COSEWIC 2009). The point of discharge is approximately 1.5 km offshore from the nearest potential northern abalone habitat at Macaulay Point. The path of the plume is not predicted to travel to this location. The fishery for northern abalone is currently closed for conservation purposes (COSEWIC 2009).

The waters and intertidal foreshore in the Victoria Harbour area, from Albert Head to Cordova Bay and Quarantine Cove near William Head are closed year round to shellfish harvesting due to a sanitary shellfish closure, Closures 19.1 and 19.8 respectively (DFO 2012b;Figure 14) and PSP closures (DFO 2012b).

No shellfish aquaculture or shellfish hatchery facilities or tenures were identified in the vicinity of the McLoughlin Point outfall discharge. The closest shellfish aquaculture tenures and facilities are located in Sooke Harbour and Sooke Basin (DFO 2012a; ILMB 2012).

Some marine invertebrates that occur near the McLoughlin Point outfall discharge are classified as Species at Risk (Section 6.2).

6.1.2 Fish

Numerous fish species occur or were assumed to be near the project area based on background information of the site and life history and habitat ranges of fish species. Some of the fish species known to occur in the McLoughlin Point discharge area include all five Pacific salmon species (coho, chum, Chinook, sockeye and pink), cutthroat and steelhead trout, Pacific herring, lingcod, dogfish, flatfish (sole and halibut), rockfish and pollock. Potential rockfish habitat has been documented in the vicinity of Albert Head (Golder 2009).

Fish such as salmonids and Pacific herring are of significant ecological, economic and social/cultural importance. Nearshore areas are important nursery and rearing habitat for fish such as juvenile salmonids and Pacific herring. Juan de Fuca Strait and associated waters such as Esquimalt Harbour and Victoria Harbour are migratory corridors for anadromous salmon populations, as salmon bearing rivers are located at the head of each of the waterways (ILMB 2012; DFO 2012a). Colquitz Creek, Craigflower Creek, Millstream River, Colwood Creek and Bee Creek are urban salmon bearing drainages in the CRD (FISS 2012; CMN 2012). Outmigrating juvenile salmonids from the CRD area and surrounding areas in the Strait of Georgia likely travel by the proposed discharge area en route to the open Pacific Ocean. Adult spawners will swim by the discharge area to return to their natal stream to spawn and complete their lifecycle.

Herring spawn in shallow vegetated areas such as kelp and eelgrass beds in nearshore areas. Herring spawning sites have been recorded to occur along the shoreline in Esquimalt Lagoon, the entrance to Esquimalt Harbour and Victoria Harbour, Portage Inlet and the shoreline from Ogden Point to Ross Bay (Hay *et al.* 1989, revised 2009). The spawning events range from minor to medium (DFO 2012a; Hay *et* *al.* 1989, revised 2009). Offshore herring holding areas are documented to occur near the project area (DFO 2012a).

A commercial salmon fishery is present in the marine waters of Juan de Fuca Strait using gillnet, seine and troll catch methods (DFO 2012a). Recreational fishing for salmon and flatfish occur in the proposed point of discharge area.

No marine finfish aquaculture farms were identified in the vicinity of the McLoughlin Point outfall discharge. The closest marine finfish tenure is located at Goodridge Island in the Sooke Basin (DFO 2012a; ILMB 2012).

Some finfish species near the proposed discharge are identified as being at risk (Section 6.2).

6.1.3 Marine Mammals

A variety of marine mammals have been documented to migrate through the proposed point of discharge area. Marine mammal presence in the Albert Head and Finnerty Cove areas was reported in 2008 by Golder (2009). Common marine mammals that occur in the project area include harbour seal, California sea lion and steller sea lion (ILMB 2012). Dall's porpoise, harbour porpoise and killer whale are also present (ILMB 2012; Golder 2009). In the summer, gray whale, humpback whale and minke whale may also be present (Golder 2009).

Marine mammals are highly mobile species that are not likely to continuously inhabit a relatively small geographic area around the discharge. Harbour seals and steller sea lions are generally non-migratory species that tend to move locally for breeding and feeding (Harbo 1999). Harbour seal haul outs are identified near William Head, Albert Head, Haystock Island, Esquimalt and Victoria coastline (Golder 2009).

Some marine mammal species near the proposed discharge are identified as at risk (Section 6.2)

6.2 Species at Risk

The Stage 1 EIS identified a number of species that are listed by the federal and provincial governments as being at risk in the vicinity of Albert Head and Finnerty Cove (Canada 2008a; Golder 2009; Appendix 1). The description of the provincial and federal species conservation rankings are detailed in the Stage 1 EIS (Appendix 1).

A summary of at risk species (invertebrates, fish, birds, mammals) that inhabit the marine environment in the vicinity of the McLoughlin Point discharge area are listed in Table F. There are five provincially red listed species/populations that potentially occur in the project area, four killer whale populations and northern abalone. One species, the southern resident killer whale population, is classified federally as endangered.

Table F At Risk Species Identified to Occur in the Marine Environment Near McLoughlin Point

Common Name	Scientific Name	BC/COSEWIC
Marbled Murrelet	*Brachyramphus marmoratus*	Blue/T (2012)
Surf Scoter	*Melanitta perspicillata*	Blue/No ranking
Purple Martin	*Progne subis*	Blue/No ranking
Peregrine Falcon, *pealei* subspecies	*Falco peregrinus pealei*	Blue/SC (2007)
Cutthroat Trout, *clarkii* subspecies	*Oncorhynchus clarkii clarkii*	Blue/No ranking
Gray Whale	*Eschrichtius robustus*	Blue/SC (2004)
Steller Sea Lion	*Eumetopias jubatus*	Blue/SC (2003)
Northern Abalone	*Haliotis kamtschatkana*	Red/T (2000)
Killer Whale – Southern	*Orcinus orca*	Red/E (2008)
Killer Whale – Northern	*Orcinus orca*	Red/T (2008)
Killer Whale – Offshore	*Orcinus orca*	Red/T (2008)
Killer Whale – West Coast	*Orcinus orca*	Red/T (2008)
Olympia Oyster	*Ostrea conchaphila*	Blue/SC (2011)
Humpback Whale	*Megaptera novaeangliae*	Blue/SC (2011)
Harbour Porpoise	*Phocoena phocoena*	Blue/SC (2003)

6.3 Recreational Activities

Health Canada has guidelines for Canadian recreational water quality which consider the human health risks associated with recreational activities, classified according to primary contact and secondary contact activities. Primary contact is defined as an activity in "*which the whole body or the face and trunk are frequently immersed or the face is frequently wetted by spray, and where it is likely that some water will be swallowed (e.g., swimming, surfing, waterskiing, whitewater canoeing/rafting/kayaking, windsurfing, subsurface diving)"* (Health Canada 2012). Secondary contact is defined as an activity in "*which only the limbs are regularly wetted and in which greater contact (including swallowing water) is unusual (e.g., rowing, sailing, canoe touring, fishing)"* (Health Canada 2012). Some activities may fall into both categories depending on the skills of the participant and conditions of the waterbody.

The BC MOE and Health Canada have established primary and secondary contact recreation guidelines for the protection of human health. These guidelines are identified in Table G.

Table G Microbiological Indicator Guidelines

Water Use		*Enterococci*	Fecal Coliforms
Recreation Secondary Contact	MOE 2001a.	≤ 100 cfu/100 mL (geometric mean)	None
	Health Canada 2012	None	None
Recreation Primary Contact	MOE 2001a.	≤ 20 cfu/100 mL (geometric mean)	≤ 200 cfu/100 mL (geometric mean)
	Health Canada 2012	≤ 35 cfu/100 mL (geometric mean)	≤ 200 cfu/100 mL (geometric mean)
		≤ 70 cfu/100 mL (Single Sample Maximum)	≤ 400 cfu/100 mL (Single Sample Maximum)

A variety of recreational activities occur in the marine waters near the proposed McLoughlin Point outfall. Victoria Harbour and the near shore waters of Juan de Fuca Strait are popular recreational use areas. The populated shoreline provides numerous access points to the marine environment through both public and private docks, boat launches and beach access. Golder and Archipelago Marine Research Ltd. (Archipelago) conducted a study in 2002 that characterized public use activities in the vicinity of Macaulay Point and Clover Point outfalls and assessed the health risks of the activities with the outfall discharges (Golder and Archipelago 2002). The location and level of use for each activity was characterized for both wet and dry weather seasons.

Primary contact activities tend to be conducted along the shore and near shore areas. Activities such as swimming, wading, diving, skim boarding and paddle boarding are conducted close to shore, while kayaking, outrigger canoeing, kite surfing, and wind surfing are further offshore (Golder and Archipelago 2002). Primary contact recreational activity areas were documented to occur within the project area as far south as the Clover Point outfall discharge (over 1 km offshore) and Trial Islands. Kayaking is a relatively near shore activity with routes extending from Albert Head to Trial Islands. Outrigger canoe areas were identified to extend from Esquimalt Harbour to Trial Islands. Wind and kite surfing was reported to occur primarily from Ogden Point to Clover Point, with some documented activity east of Clover Point to approximately Trial Islands. The coastal waters directly east of Esquimalt Lagoon are also documented wind and kite surfing areas. Wind and kite surfing areas were documented to extend as far south as the Clover Point outfall discharge (Golder and Archipelago 2002). Recreational diving is identified to occur near the shore at McLoughlin Point, the Ogden Point breakwater, Brotchie Ledge and Saxe Point (Golder and Archipelago 2002; ILMB 2012)

Secondary contact recreational activities such as fishing, boating and whale watching often occupy a wider area of use, from the shoreline to the open ocean. Many recreational activities occur over a wide area in the marine environment (boating, fishing), while others are more site specific (swimming, wading, diving). In addition, activities often coincide to a time of year, with most recreational activities occurring more frequently in the drier/warmer months and less frequently in the wetter/cooler months. Kayaking and outrigger canoeing are considered primary contact recreation activities as the participants are likely to have their faces sprayed or the whole body immersed in the waters of Juan de Fuca Strait if a boat capsizes. There is no definitive boundary between primary and secondary contact recreational waters.

In general recreational activities such as swimming and wading are more popular in the dry season with a higher frequency of participants. However, many recreational activities occur year round with participant intensity fairly uniform throughout the year, such as outrigger canoeing and diving.

Surface water samples were collected by the CRD from 1995 to 1999 at 19 stations in the vicinity of Macaulay Point outfall and 21 stations in the vicinity of the Clover Point outfall. Fecal coliform concentrations in the surface waters were generally < 100 cfu/100 mL in both the dry and wet season. There were more occurrences of fecal coliform concentrations above the primary contact recreational water quality guideline (>200 cfu/100 mL) in the wet season (Golder and Archipelago 2002). The frequencies of elevated fecal coliform concentrations were higher at offshore water sampling stations than nearshore stations during the wet season (Golder and Archipelago 2002). In the dry season both the nearshore and offshore stations had low frequencies (3%) of elevated fecal coliform concentrations. The nearshore water stations with elevated fecal coliform concentrations were located near Ross Bay and were attributed to the stormwater discharges and not the CRD sewage outfalls. Moderate health risks were associated with swimming, beach walking and wind and kite surfing at Ross Bay in the dry season. In the wet season, moderate health risks were associated with swimming, wading and beach walking at Ross Bay, wind and kite surfing from Finlayson Point to Clover Point and diving at Clover Point (Golder and Archipelago 2002).

More recently, the 2000 to 2010 surface water sample data from the Macaulay Point outfall and Clover Point outfall areas were analyzed for special trends (Hatfield 2012). Clear spatial patterns in fecal coliform concentrations were evident. Fecal coliform concentrations were highest in winter and have increased from 2000 to 2010.

6.4 Protected Areas

6.4.1 Ecological Reserves

The provincial *Ecological Reserve Act* allows for the designation of Crown land into reserves for scientific research and education, preservation of representative or rare ecosystems or protection of rare species or unique botanical, zoological or geological phenomena in British Columbia. Four ecological reserves are identified in the study area and are shown on Figure 15:

1) Race Rocks
2) Trial Islands
3) Ten Mile Point
4) Oak Bay Islands

6.4.2 Migratory Bird Sanctuaries

EC maintains seven federal Migratory Bird Sanctuaries in British Columbia, two of which are designated in the vicinity of the McLoughlin Point outfall: 1) Esquimalt Lagoon and 2)Victoria Harbour and associated waters (Selkirk Waterway, Gorge Waterway, Portage Inlet) (CRD 2012; Canada 2008a).

6.4.3 Critical Habitat

Critical habitat is defined under the *Species at Risk Act* (SARA) as "*the habitat that is necessary for the survival or recovery of a listed wildlife species that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species"* (SARA s.2(1)).

Juan de Fuca Strait has been identified as critical habitat for southern resident killer whales (Figure 15). This is adjacent to an area that Washington State has designated as critical habitat under the *Endangered Species Act* (COSEWIC 2008). The proposed McLoughlin Point outfall will extend over 700 m into the southern resident killer whale critical habitat, as defined by the Government of Canada (Canada 2009). The Macaulay Point outfall presently extends over 500 m into this critical habitat, while the Clover Point outfall is located entirely in the southern resident killer whale habitat.

6.4.4 Marine Protected Areas

Fisheries and Oceans Canada under the *Oceans Act* designated a number of marine protected areas and areas of interest. These areas are important ecologically and are designated to protect and conserve important marine mammal and fish habitat, endangered species, as well as areas of high biodiversity and biological productivity.

Race Rocks was identified as an area of interest to be considered a marine protected area as it was recognized as an area with an ecosystem with high biodiversity and biological productivity (DFO 2010b). Race Rocks is an important nursery and recruitment area for northern abalone (DFO 2010b) and provides habitat for a number of invertebrates, fish, seabirds, mammals and plants (DFO 2010b). This area is also designated provincially as an ecological reserve.

6.5 Parks

There are a number of coastal and marine federal, provincial, regional and municipal parks situated in the Capital Regional District. These parks are extensively used by the public. The Stage I EIS identified a number of coastal and marine parks in the vicinity of the formerly proposed Albert Head and Finnerty Cove outfalls. Many of these parks are within the McLoughlin Point outfall study area. Parks identified from Race Rocks to Ten Mile Point are listed in Table H and are shown on Figure 15.

Table H Parks within the Study Area

Jurisdiction	Park Name	Approximate Distance From Outfall Terminus
Regional	Albert Head Lagoon Regional Park	6.0 km
	Witty's Lagoon Regional Park	7.5 km
	Devonian Regional Park	10.0 km
Municipal	Esquimalt Lagoon Park	4.5 km
	Saxe Point Park	2.5 km
	Macaulay Point Park	2.0 km
	Dallas Road - Beacon Hill Park	3.0 km
Federal	Hatley Park Reserve	5.5 km
	Fort Rodd Hill National Historic Site	4.5 km
	Clover Point Park	4.5 km

6.6 First Nations and Traditional Use

The Stage 1 EIS identified traditional and cultural use of marine resources by the Songhees and Becher Bay First Nations based on the formerly proposed locations (Albert Head and Finnerty Cove) of the wastewater treatment plants. The specific information on these uses, such as location and species were confidential; however, information on the general uses by these First Nations was provided. Traditional transportation routes and marine resource harvesting were also summarized. Marine resources traditionally harvested by Songhees and Becher Bay First Nation were listed according to geographic area. The closest geographic area to the proposed McLoughlin Point discharge where harvests were identified is Macaulay Point. Shellfish and anadromous fish species harvest were identified to occur in this area.

Traditional uses by the Tsawout and Esquimalt First Nations were not identified in the Stage 1 EIS. The CRD consulted First Nation communities, including Tsawout, Esquimalt, Songhees and Becher Bay. The marine resource use by these communities is being reviewed and accommodated for by the CRD but the specific information on these uses was intentionally not provided in this report (CRD 2011).

7. OUTFALL CONFIGURATION

The recommended outfall alignment is presented in the *McLoughlin Point Outfall Siting Study* (WorleyParsons 2013c) provided in Appendix 6. The preferred discharge of effluent through the outfall is by gravity. Since the treatment plant is near sea level, there is very limited elevation to accommodate head losses associated with the discharge and allowances for sea level rise, and potentially, storm surge. A concept design for the outfall and diffuser has estimated an outfall diameter to be approximately 1,800 mm in diameter (Van Bastelaere 2010).

7.1 Proposed Outfall Alignment and Distance

The proposed outfall alignment and terminus location is provided in Figure 3 (WorleyParsons 2012; Appendix 6). A terminus location approximately 2 km from shore and approximately 150 m east the existing Macaulay Point Outfall terminus was selected based on an effluent plume modelling assessment (Hodgins and Tinis 2011). The benefit of a co-located diffuser is that historic seabed monitoring data at the Macaulay Point outfall can be utilized for future receiving environment monitoring that will be required for the McLoughlin Point outfall. Also, it is logical that the potentially compromised seabed area around the Macaulay Point outfall terminus be re-utilized for the McLoughlin Point outfall.

7.2 Diffuser Configuration and Depth

Effluent will be discharged from the proposed outfall via a 33 port, 200 m long diffuser. The conceptual design for the diffuser includes 33 vertical ports with a diameter of 200 mm with an average spacing of 6.15 m (Van Bastelaere 2010). The diffuser will be located on a nearly flat seabed at a water depth of approximately 60 m below chart datum. The diffuser has been conceived on the basis of providing a combination of adequate dilution characteristics and the hydraulic requirement of full flow by gravity at higher high water large tide with an assumed allowance for 1 m for potential sea level rise and 1 m storm surge.

7.3 Embayment

Under the *Municipal Wastewater Regulation* (MWR), embayed waters are defined as:

Located within a bay from which the access to the sea, by any route, has a maximum width of less than 1.5 km

Located, if a line less than 6 km long is drawn between any 2 points on a continuous coastline, on the shore side of the line, or

In which flushing action is identified in a notice given by a director to be inadequate. (MOE 2012a)

The McLoughlin Point outfall discharge is proposed to be located outside of embayed waters and modelling of the effluent plume (Hodgins and Tinis 2011) demonstrates the plume to be located away from areas with poor flushing. Therefore, the proposed discharge is not within embayed waters according to the MWR definition.

8. EXISTING AND NEARBY DISCHARGES

The proposed core area wastewater treatment plant will discharge secondary treated effluent to the marine environment. The water quality of the receiving environment may be adversely impacted by the cumulative effects of other nearby discharges acting in combination with the proposed McLoughlin Point discharge. These may include industrial discharges, nearby domestic wastewater discharges and storm water discharges.

The storm water and sewerage network for the core area (CRD 2011) of the CRD comprises seven municipalities, two First Nations, DND land, and federal, provincial, regional and municipal parkland. The jurisdictions involved are City of Colwood, Township of Esquimalt, City of Langford, District of Oak Bay, District of Saanich, City of Victoria, Town of View Royal, Esquimalt First Nation, Songhees First Nation and DND. These jurisdictions are bounded by varying quantities of coastline, and discharge both storm water and screened sewage through several types of infrastructure. The combination of these discharge sources has a combined effect on the marine receiving environment.

The Core Area of the CRD-managed storm water network comprises approximately 511 numbered discharges (*Pers.comm*. Ruljancich 2012). Appendix 7 provides a tabular summary of these discharges, which are plotted on the marine chart within the study area shown in Figure 4 (CRD 2007). Of these discharges, it is estimated that 439 of the discharges may have an adverse effect on the water quality in the region of study where the new McLoughlin Point outfall is proposed. The region considered to be included in this current study area extends from Ten Mile Point in Saanich (CRD 2007) at the eastern extent of the region, to Race Rocks at the western extent (CHS 3440, 2009).

Of the estimated 439 discharges, 59 of these have the additional capability of operating as sewage network overflows (denoted as “SPSO” in the “Additional Functionality” column of Appendix 7, shown also in Figure 4). The volume and frequency of the storm water discharges combined with sewage is unknown. The major combined stormwater and sewage overflows operated by the CRD are listed as follows (CRD 2011a):

- Macaulay Point- exists in conjunction with current marine outfall
- Clover Point - exists in conjunction with current marine outfall
- Finnerty Cove
- Humber Point
- Rutland Point
- McMicking Point
- Harling Point
- Broom Road

There exist several privately permitted marine outfalls within the study area that actively discharge effluent into the receiving environment. These outfalls are considered to contribute less than 1,200 m^3/day, and would have an insignificant effect upon the water quality within the region, in comparison to the McLoughlin Point discharge and multitude of stormwater discharges. These outfalls are listed as follows:

- Pedder Bay Marina, Pedder Bay, 175 m^3/day (CHS Marine Chart # 3440)
- Lester B Pearson College, Pedder Bay, 109 m^3/day (CHS Marine Chart # 3440)
- William Head Prison, William Head, 450 m^3/day (CHS Marine Chart for the region does not show outfall location)
- Dockside Green, Victoria Harbour, 380 m^3/day (CHS Marine Chart for the region does not show outfall location)

9. DILUTION AND DISPERSION MODELLING

The resulting water quality in the receiving environment was predicted by hydrodynamic models of the receiving environment and the proposed discharge. Modelling was completed for effluent flow up to two times average dry weather flows for which secondary treatment is required. The results were used to estimate the water quality at the edge of the IDZ in comparison to applicable water quality guidelines and areas of concern. A summary is provided below with a more detailed assessment in Appendix 8.

9.1 Model Description

Dilution models predict the dilution or ratio of ambient water to effluent within the effluent plume as it travels away from the outfall diffuser. The predicted dilution can then be used to calculate the anticipated concentration of effluent constituents in the receiving environment. Modelling was carried out using the 3 dimensional water quality model C3-UM custom built and periodically upgraded for the CRD over the past 20 years. The C3-UM model incorporates thee individual model elements described in Hodgins et al., 1998, Li and Hodgins (2004) and Hodgins (2009). They include:

a) 3D hydrodynamic model and 3D scalar properties model for salinity, temperature and density;

b) 3D non-conservative substance model; and

c) UM, buoyant plume model.

The 3D hydrodynamic model and 3D scalar model simulate the physical process in the ocean using data on tides, ocean properties, freshwater discharges from rivers and wind. The 3D non-conservative substances model calculates the far field dilution and dispersion by currents and turbulence (Hodgins 2006).

The UM component was developed by the USEPA specifically to predict the initial dilution of the effluent plume (Baumgrater, Frick, and Roberts 1994). The model is specified in the *Environmental Impact Study Guideline (*Ministry of Environment, Lands and Parks 2000) as a suitable model for estimating the initial dilution of the effluent plume.

Initial dilution occurs immediately following the discharge of the effluent into the receiving environment. It is proposed that the effluent will be discharged from a multi-port diffuser, where each diffuser port will result in a jet of effluent entering the receiving environment. Photo A provides an example of one type of diffuser port that could be used.

Photo A Effluent Jet Discharged from Clover Point Outfall Diffuser Port

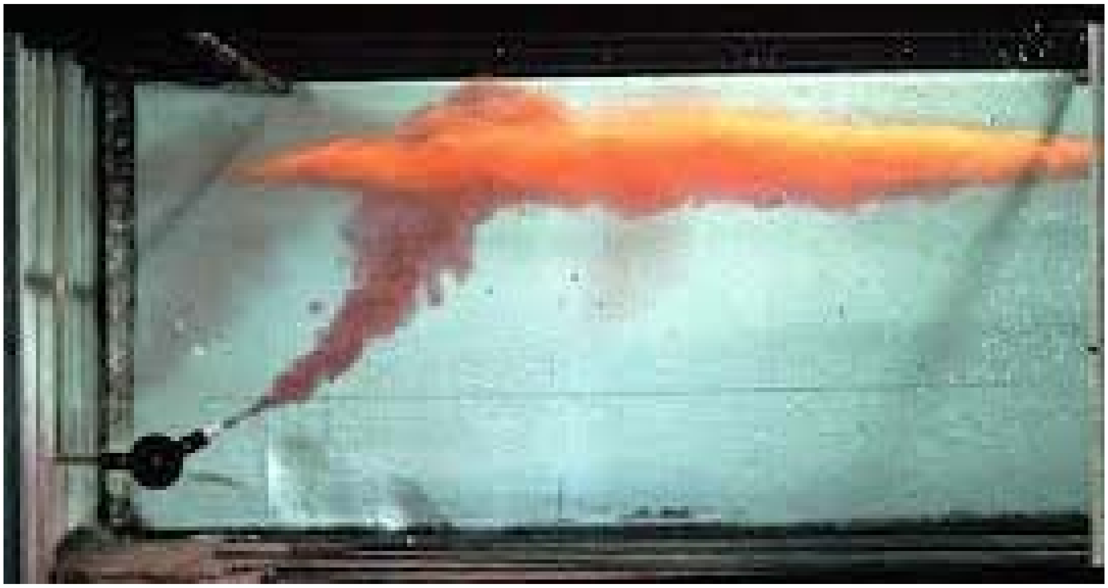
Source: WorleyParsons 2012

The UM model predicts the path and the dilution of the jet of effluent, modelling several processes including:

- the conservation of mass, momenta, and energy,
- entrainment of ambient water with the effluent plume; and,
- merging of adjacent effluent plumes.

When effluent is discharged into the receiving environment, the jet of effluent has an initial velocity based on the flow rate and the shape and diameter of the diffuser port. Much of the initial momentum of the effluent plume is dissipated rapidly through turbulent mixing with the ambient water. In addition, the effluent plume which will have a density close to that of fresh water will be buoyant in a salt water (marine) receiving environment. The buoyancy of the effluent forces the effluent plume towards the water surface, increasing the turbulent mixing of the plume. As the effluent plume rises and mixes with the receiving water the density of the effluent plume approaches that of the density of the ambient seawater. When the density of the effluent reaches that of the receiving water the effluent plume is no longer buoyant and ceases to rise. The depth where this occurs is generally referred to as the trapping depth. The vertical momentum of the effluent plume may cause it to overshoot the trapping depth, however once the momentum has dissipated the effluent will sink back to the trapping depth as shown in the Photo B.

Photo B Trapping Depth



Source: http://www.ifh.uni-karlsruhe.de/science/envflu/research/ww-discharges/default.htm

The trapping depth is strongly influenced by the stratification in the water column of the receiving environment and speed of water current. If there is strong stratification (i.e. a significant change in density with depth) and sufficient mixing of the effluent plume then the density of the plume and the receiving environment will converge deeper than a weakly stratified receiving environment. In the case of weak stratification, greater mixing of the effluent plume will occur resulting in a shallower trapping depth. If there is insufficient mixing, limited stratification, and/or shallow water depth, then the effluent plume may rise until it reaches the surface.

Ambient current velocities also play a large role in the trapping depth and dilution of the effluent plume. High currents will tend to depress the effluent plume and result in deeper trapping depths. The effluent plume will also reach the boundary of the IDZ faster and therefore lower dilution may be expected at the boundary of the IDZ.

In low current conditions, the effluent plume will tend to rise to shallower depths. In the case of the proposed outfall, currents are primarily driven by the tides which, as discussed in Section 5.1.3, are semi-diurnal. Minimum trapping depths are therefore expected during high and low slack tide conditions (high slack occurs when the tidal flow changes direction from flood tide to ebb tide and low slack occurs during the change from ebb tide to flood tide). Also, the lack of stratification in the winter leads to more surfacing.

In addition to the diurnal variation in tidal velocities, the range of tide heights vary daily over a two week cycle closely linked to the phases of the moon.

9.2 Modelled Ambient Conditions

Dilution modelling was conducted for two seasons, summer and winter. The summer model represents stratified water column conditions, i.e. there is a strong gradient in temperature and salinity with depth as observed in the pre-discharge monitoring water column profiles. The winter model represents un-stratified conditions, i.e. little variation in temperature and salinity with depth (Appendix 8).

Both summer and winter models were run for a minimum of 14 days to capture one complete tidal cycle.

9.3 Modelled Discharge Configurations

The effluent plume was modelled for a number of anticipated effluent flow conditions these included:

1) proposed normal conditions with a discharge through the new McLoughlin outfall terminating either at M8E or co-located with Macaulay Point;
2) anticipated failure conditions; and,
3) existing conditions (screened, effluent discharged at Macaulay and Clover Point).

9.3.1 Normal Operation

The first scenario considers "normal" operating conditions with treated effluent discharged through a new outfall terminating at either M8E (MP-5) or co-located with the existing Macaulay Point outfall. These two outfall options consisted of identical 33 port diffuser configurations previously discussed in Section 7.2. Modelling was initially conducted for both proposed terminus locations to help determine if significant improvement in dilution would be achieved at either location such that a preferred terminus location could be selected.

A co-located terminus was selected prior to this study based in part on the modelling results which concluded that there would likely be no significant difference in risk of shellfish contamination between the two discharge locations (although ME8 offered slightly better dilution results). The benefit of a co-located diffuser is that historic seabed monitoring data at the Macaulay Point outfall can be utilized for future receiving environment monitoring that will be required for the McLoughlin Point outfall. Also, it is logical that the potentially compromised seabed area around the Macaulay Point outfall terminus be utilized for the McLoughlin Point outfall.

Results from the dilution modelling of the outfall presented in this section apply specifically to the co-located diffuser.

A 14-day hydrograph of the predicted Average Dry Weather Flow (ADWF) was used to model the effluent plume for the summer discharge scenario. The hydrograph is presented in Appendix 8 and includes a storm event during which higher than normal flows are experienced and discharge occurs through the McLoughlin Point outfall. During the summer scenario, the full flow including the storm event receives secondary treatment and is discharged through the new outfall.

The winter scenario was modelled assuming wet weather conditions where some overflow of screened effluent is discharged for a short period of time through the Clover Point and Macaulay Point outfalls during peak flow conditions. This is considered a "worst case scenario" where effluent flows exceed two times the ADWF as a result of inflow and infiltration. Within the LWMP, the CRD committed to reducing I&I by 2030 (CRD 2011) so as to eliminate discharges from the Clover and Macaulay Point outfalls. The winter hydrograph is provided in Appendix 8.

9.3.2 Failure Conditions

The effluent plume was modelled for two possible mechanical failure scenarios. These failure scenarios were modelled at the request of EC specifically to delineate predicted fecal coliform concentrations in relation to shellfish harvesting areas. These failure scenarios are anticipated to be considered outside of the normal operation of the wastewater system.

Two possible failure scenarios were modelled; the first scenario is failure of the diversion from Clover Point to the McLoughlin Point treatment plant. The modelled failure scenario assumes that immediately following the failure, screened wastewater is discharged from both Clover and McLoughlin outfalls for a period of one hour. After the first hour screened effluent is only discharged from the Clover Point outfall for a period of seven days, while secondary treated effluent is discharged through the McLoughlin Point outfall.

The second scenario is a failure of the influent pump from the Macaulay Point outfall for a period of two days. During the second failure scenario, untreated effluent is discharged from the Macaulay Point outfall for two days, in combination with secondary treated effluent discharged from the McLoughlin Point outfall.

Additional details and hydrographs of the failure scenario are provided in Appendix 8.

9.3.3 Existing Conditions

The existing discharge condition with screened wastewater being discharged through the existing Macaulay and Clover Point outfalls was modelled. This scenario was modelled to provide validation of the model results and serves as a far field baseline with which to compare the proposed McLoughlin WWTP discharge.

9.4 Effluent Plume Modelling Results

Results from the effluent plume modelling are presented for constituents of concern and microbiological indicators separately. Constituents of concern are to meet applicable water quality guidelines at the boundary of the IDZ, and for the purpose of this study, are considered conservative in that they do not undergo any decay or transformations with the short time period between times of discharge to arrival at the IDZ boundary.

Microbiological indicators will decay with time and concentrations are not necessarily expected to meet water quality guidelines at the IDZ. The fate of these indicators has therefore been modelled in the far field beyond the IDZ.

9.4.1 Trapping Depth

The predicted trapping depth of the effluent plume was assessed for both summer and winter considering normal operating conditions. For the summer scenario the effluent plume is predicted to remain trapped below the water surface at depths greater than 15 m over 98% of the time. When the effluent plume is predicted to surface, it is only predicted for a brief amount of time, as little as a few minutes. Approximately, 80 % of the time the effluent plume is predicted to be trapped between a depth of 35 and 50 m.

For the winter scenario with predicted wet weather flows and un-stratified ambient conditions, the effluent plume is predicted to surface approximately 10% of the time, and in contrast to the summer conditions, the effluent plume is predicted to trap at depths below 35 m approximately 46 % of the time.

In relation to the trapping depth, the winter scenario should be considered the worst case because the effluent plume will more frequently reach the surface in winter, increasing the risk that the effluent plume will reach receptors such as intertidal shellfish and recreational waters. During the summer the increased trapping depth provides a measure of mitigation for shallow water receptors.

9.4.2 Dilution at the Initial Dilution Zone

The results of dilution modelling for the proposed normal operating conditions are summarized in Table I. The table shows the predicted minimum, median, and maximum dilution of the effluent plume at the boundary of the IDZ and at the water surface. The predicted dilutions are represented as ratios of receiving water to effluent within the effluent plume.

Table I Summary of Dilution Statistics for a Co-located Diffuser with the Existing Macaulay Outfall

Season		**Summer**	**Winter**
Effluent Flow		**ADWF+storm**	**WW+storm**
IDZ	Minimum	108:1	182:1
	Median	430:1	604:1
	Maximum	2280:1	1:5500
Surface	Minimum	509:1	292:1
	Mean	566:1	1250:1
	Maximum	622:1	5000:1

As discussed in Section 3.5, the IDZ is a cylindrical volume of water from the seabed to the water surface with a radius of 100 m that extends from each diffuser port. Applicable water quality guidelines must be met at the boundary of the IDZ. For those pollutants within the effluent that do not achieve applicable water quality guidelines at the end of pipe (before dilution), the water quality guidelines can be achieved through dilution of the effluent within the IDZ. Concentrations of constituents within the effluent plume are calculated using the following equation.

$$C = \frac{V_a C_a + V_e C_e}{V_a + V_e}$$

Where:

C *is the concentration in the effluent plume*
V_a *is the volume of ambient water*
C_a *is background ambient concentration*
V_e *is the volume of effluent*
C_e *is effluent concentration*

9.4.3 Effluent Plume Screening

The suitability of the proposed treatment system and the resulting effluent quality was assessed by back calculating the maximum allowable concentration of effluent constituents from applicable water quality guidelines and the predicted dilution of the effluent plume at the boundary of the IDZ. The predicted concentration of the effluent parameters were then compared to calculated maximum allowable effluent concentrations.

Constituents of Concern

A review of the constituents of concern within the influent and effluent was completed as part of the Stage 1 EIS (Golder 2009). Identified constituents were:

- **Oxygen Depleting Substances (ODS):** ODSs are measured in the effluent as biochemical oxygen demand (BOD). Within the receiving environment BOD can result in the depletion of DO.
- **Ammonia:** This constituent can be toxic to marine life. It is typically measured as total ammonia as nitrogen. The MWR specifies that allowable effluent ammonia nitrogen concentrations are to be back calculated from the applicable water quality guideline and the predicted dilution of the effluent plume at the IDZ.
- **Nitrate:** This parameter has a relatively low toxicity to aquatic organism, however can lead to increased primary production in the receiving environment and potential eutrophication.
- **Surfactants (detergents):** These have been identified as toxic in sewage effluent.
- **Pathogens:** These can result in the transfer of infectious disease to water users. Fecal coliforms and *Enterococci* are used as indicator species for the pathogens in the effluent and receiving environment (See Section 9.4.4).
- **Metals:** Concentrations in excess of natural concentrations may lead to toxic effects in aquatic organisms.

- **Organic Compounds:** Numerous organic compounds including PAHs, organochlorinated pesticides, phenols and volatile organic compounds have been measured in the effluent. Organic compounds can have a wide range of effects on aquatic organisms.

The analysis of allowable effluent concentrations was completed only for parameters where applicable water quality guidelines exist and background water quality data was available (Table J). The allowable concentrations were compared to anticipated effluent or influent concentrations where available. Predicted influent concentrations were compiled based on measured effluent concentrations for the Macaulay Point outfall; while effluent concentrations were predicted based on the typical removal rates of the selected parameters by secondary treatment technology (Associated Engineering 2008). Where influent and effluent concentrations were not predicted only maximum allowable effluent concentrations were calculated.

Receiving water quality guidelines are based on the BC MOE approved water quality guidelines (MOE 2012b), and the CCME water quality guidelines (CCME 1999). Where multiple guidelines exist the more conservative guideline was used. In addition, multiple water quality guidelines (ammonia, TSS, copper, lead and endosulfan) have allowable mean (chronic) guidelines along with maximum (acute) guidelines. The mean guidelines were used to calculate maximum allowable effluent concentration using the predicted mean dilution of the effluent plume, while maximum guidelines were used to calculate the maximum allowable effluent concentration using the minimum predicted dilution of the effluent plume.

The lowest of the calculated maximum allowable effluent concentrations were then compared with predicted effluent concentrations.

Table J Maximum Allowable Effluent Concentrations Compared to Predicted Influent and Effluent Concentrations

Parameter	Unit	Water Quality Guideline [1,2] Mean	Water Quality Guideline [1,2] Maximum	Ambient Concentration Mean	Maximum Allowable Effluent Concentration: Required to Meet Mean Guideline Dilution (430:1)	Required to Meet Mean Guideline Dilution (108:1)	Required to Meet Maximum Guidelines Dilution (108:1)	Minimum	Influent: Measured Concentration	Influent: Percent of Maximum Allowable Concentration	Effluent: Predicted Concentration	Effluent: Percent of Maximum Allowable Concentration
Conventional												
Ammonia	mg/L	1[3]	6.7[3]	0.24	328	83	704	83	28	34 %	12.1	15 %
Nitrate	mg/L	3.7	N/A	0.44	1,406	356	N/A	356	0.07	<1 %	0.07	<1%
Fluoride	mg/L	N/A	1.5	1.2	N/A	N/A	34	34	-	-	-	-
TSS	mg/L	18[4]	38[4]	13	2,168	558	2,738	558	199	36 %	9.97	2 %
Total Metals												
Cadmium	µg/L	0.12	N/A	0.09	13	3	N/A	3	0.419	12 %	0.348	10 %
Copper	µg/L	2	3	1	432	110	219	110	109	99 %	41.4	38 %
Lead	µg/L	2	140	0.07	832	210	15,252	210	5.74	3 %	5.74	3 %
Mercury	µg/L	0.016	N/A	0.01	3	1	N/A	1	0.13	20 %	0.044	7 %
Zinc	µg/L	10	N/A	3	3,020	766	N/A	766	79.6	12 %	24	3 %
PAHs												
Naphthalene	µg/L	N/A	1	<0.05	N/A	N/A	104	104	0.7	<1 %		
Methylated naphthalene	µg/L	N/A	1	<0.05	N/A	N/A	104	104	-	-		
Acenaphthene	µg/L	N/A	6	<0.05	N/A	N/A	649	649	0.086	<1 %		
Fluorene	µg/L	N/A	12	<0.05	N/A	N/A	1,303	1,303	0.075	<1 %	0.004	<1 %
Chrysene	µg/L	N/A	0.1	<0.05	N/A	N/A	6	6	-	-		
Benzo[a]pyrene	µg/L	N/A	0.01	<0.02[5]	N/A	N/A	-	-	0.092	-	0.014[5]	-
Organochlorinated Pesticides									-	-		
Endosulfan	µg/L	0.002	0.09	<0.005	1.3	0.3	9.3	0.3	-	-		
VOC												
1,2-Dichlorobenzene	µg/L	N/A	42	<0.5	N/A	N/A	4,567	4,567	0.250	<1%		

[1] Ministry of Environment Water Quality Guidelines for the Protection of Aquatic Life
[2] CCME Water Quality Guideline for the Protection of Aquatic Life
[3] Based on a receiving environment salinity of 20 ppt, temperature of 15°C and pH of 8.2
[4] Assumes an average change of 5 mg/L from background and a maximum change of 25 mg/L from background
[5] The method detection limit of Benzo[a]pyrene in the results of pre-discharge monitoring exceeds the applicable water quality guideline and therefore maximum allowable effluent concentration could not be calculated. The predicted concentration at the IDZ with a dilution of 108:1 and assuming a background concentration of zero would be 0.00013 µg/L, well below the water quality guideline.

Parameter	Unit	Water Quality Guideline Water Quality Guideline		Ambient Concentration	Maximum Allowable Effluent Concentration				Influent		Effluent	
					Required to Meet Mean Guideline		Required to Meet Maximum Guidelines					
		Mean	Maximum	Mean	Mean Dilution (430:1)	Minimum Dilution (108:1)	Minimum Dilution (108:1)	Minimum	Measured Concentration	Percent of Maximum Allowable Concentration	Predicted Concentration	Percent of Maximum Allowable Concentration
Phenols									-	-		
2,3,4,5-Tetrachlorophenol	µg/L	N/A	2.8	<0.1	N/A	N/A	294	294	-	-		
2,3,4,6-Tetrachlorophenol	µg/L	N/A	8.0	<0.1	N/A	N/A	861	861	-	-		
2,3,4-Trichlorophenol	µg/L	N/A	3.6	<0.1	N/A	N/A	382	382	-	-		
2,3,5,6-Tetrachlorophenol	µg/L	N/A	3.6	<0.1	N/A	N/A	382	382	-	-		
2,3,5-Trichlorophenol	µg/L	N/A	3.7	<0.1	N/A	N/A	393	393	-	-		
2,3,6-Trichlorophenol	µg/L	N/A	12	<0.1	N/A	N/A	1,297	1,297	-	-		
2,3-Dichlorophenol	µg/L	N/A	8.3	<0.1	N/A	N/A	894	894	-	-		
2,4 & 2,5-Dichlorophenol	µg/L	N/A	3.7	<0.1	N/A	N/A	393	393	0.19	<1%		
2,4,5-Trichlorophenol	µg/L	N/A	3.3	<0.1	N/A	N/A	349	349				
2,4,6-Trichlorophenol	µg/L	N/A	8.8	<0.1	N/A	N/A	948	948	0.095	<1%		
2,6-Dichlorophenol	µg/L	N/A	15	<0.1	N/A	N/A	1,624	1,624				
3&4-Methylphenol	µg/L	N/A	13	<0.5	N/A	N/A	1,363	1,363				
3,4,5-Trichlorophenol	µg/L	N/A	3.3	<0.1	N/A	N/A	349	349				
3,4-Dichlorophenol	µg/L	N/A	4.3	<0.1	N/A	N/A	458	458				
3,5-Dichlorophenol	µg/L	N/A	3.4	<0.1	N/A	N/A	360	360				

[1] Ministry of Environment Water Quality Guidelines for the Protection of Aquatic Life
[2] Based on a receiving environment salinity of 20 ppt, temperature of 15°C and pH of 8.2
[3] CCME Water Quality Guideline for the Protection of Aquatic Life
[4] NK - Not Known
[5] Assumes an average change of 5 mg/L from background and a maximum change of 25 mg/L from background

The predicted effluent concentrations (where available) and influent concentrations (where predicted removal rates are known) of the various constituents found within Table J are all below the calculated maximum allowable concentrations. Ammonia and copper concentrations are the only constituents where the predicted effluent concentration is greater than 10% of the allowable effluent concentration. Ammonia is predicted to be 15% of the maximum allowable concentration and copper is predicted to be 38% of the maximum allowable concentration.

Provided that removal rates of the proposed wastewater treatment facility are within the typical range of secondary treatment facilities the effluent is predicted to achieve available water quality guidelines at the boundary of the initial dilution zone at all times. In fact, for most parameters there is a reasonable safety factor to achieve water quality guidelines. For example, constituent concentrations in the effluent could be roughly 10 times higher than predicted before approaching water quality guidelines.

9.4.4 Microbiological Indicators

A separate analysis of microbiological indictors was completed by Hodgins and Tinis (2011). Water quality guidelines for microbiological indicators are intended to protect human health and are discussed in further detail in Section 10.2. The guidelines are not intended to protect the health of aquatic life as most human pathogens are not infective to the aquatic flora and fauna (MOE 1988); however, aquatic organisms (eg. bivalve shellfish) may act as carriers or concentrators of pathogens that may subsequently be ingested by humans.

Water quality guidelines for microbiological indicators are specific to recreational water use and shellfish harvesting. Recreational activities may result in the direct (primary contact) or indirect (secondary contact) interaction with the effluent plume. As previously discussed, primary contact activities mostly occur near the shoreline within the study area while secondary contact activities such as fishing occur over the entire region.

Fecal coliform concentrations were modelled for both the summer and winter conditions, and results are presented graphically in Appendix 8. For the summer condition an effluent fecal coliform concentration of 400,000 cfu/100 mL was modelled (Hodgins and Tinis 2011). For the winter scenario an effluent concentration of 400,000 cfu/100 mL was modelled for the portion of the flow that received secondary treatment. A concentration of 14,000,000 cfu/100 ml was used for the portion of the flow receiving only primary and screened treatment (Hodgins and Tinis 2011).

Recreational Water Quality Assessment

In the summer, the maximum fecal coliform concentration at the water surface (0-5 m) is predicted to be 786 cfu /100 mL based on a minimum dilution at the surface of 509:1 and an effluent fecal coliform concentration of 400,000 cfu /100 mL. This exceeds the maximum allowable primary contact guideline of a geometric mean of 200 cfu /100 mL. However, concentrations higher than 200 cfu/100 mL are predicted within approximately 300 m of the outfall terminus, only when the effluent plume was predicted to surface (less than 2% of the time). Beyond the immediate vicinity of the outfall, maximum fecal coliform concentrations were predicted to be less than 100 cfu /100 mL at the surface, and the effluent plume was not predicted to reach the shoreline except for at Trial Island. Therefore the proposed discharge was not anticipated to result in summer recreational water quality guideline exceedances where the vast majority of primary recreational activities occur.

Maximum concentrations of fecal coliforms in the winter at the water surface are predicted to be higher, and extend further from the point of discharge than during the summer. Fecal coliform concentrations above 200 cfu/100 mL (up to 1,400 cfu /100 mL) at the surface were predicted to occur within approximately 500 m of the McLoughlin outfall diffuser up to 10% of the time, while concentrations above about 200 cfu /100 mL at the surface were predicted to occur occasionally near Trial Island and east toward Chatham and Discovery Island. The concentrations near Trial Island were predicted in part to result from potential overflows from the Macaulay Point and Clover Point outfalls when flows exceed two times the average dry weather flow.

Given that the results were derived from predicted effluent characteristics and modelled oceanographic conditions some level of uncertainty is inherent in the results. Therefore, the recreational water quality guidelines may be exceeded as a result of the proposed discharge in the vicinity of Trial Island. It is recommended that post discharge monitoring include stations in the vicinity of Trial Island to assess fecal coliform concentrations relative to recreational guidelines.

Bivalve Shellfish Water Quality Assessment

Bivalve shellfish harvesting guidelines are of specific concern as coliforms in bivalve shellfish may concentrate up to 100 times ambient levels and various related enteric bacteria and viruses can be transmitted to shellfish consumers (MOE 1988). As previously discussed, shellfish harvesting areas are not well defined within the study area and therefore the nearest potential actively harvested intertidal shellfish areas are considered to be Chatham and Discovery Islands to the east of the proposed discharge and Haystock Islets and Witty’s Lagoon to the south of the proposed discharge. The waters and intertidal foreshore in the Victoria Harbour area, from Albert Head to Cordova Bay and Quarantine Cove near William Head are closed year round to shellfish harvesting due to a sanitary shellfish closure, Closures 19.1 and 19.8 respectively (DFO 2012b;Figure 14) and PSP closures (DFO 2012b).

Model results suggested there would be negligible risk of shellfish contamination at Haystock Islets in either summer or winter conditions. A “slight episodic” risk of shellfish contamination at Chatham and Discovery Islands was predicted for both summer and winter conditions. The maximum concentration in the top 5 m of the water column on the west shore of Discovery Island in Plumper Passage was predicted to be approximately 40 cfu /100 mL. This exceeds the median water quality guideline of 14 cfu / 100 mL but not the 90th percentile guideline of 43 cfu /100 mL. The time series of fecal coliforms at Chatham Island is provided in Appendix 8. Fecal coliform concentrations greater than 14 cfu /100 mL were predicted following a storm event and a potential overflow from the Macaulay Point and Clover Point outfalls. It is recommended that post discharge monitoring include stations in the vicinity of Chatham and Discovery Island to monitor if fecal coliform concentrations meet shellfish harvest guidelines.

The effluent plume is predicted to reach the shoreline between Victoria Harbour and Oak Bay. In addition, a large number of stormwater discharges including several emergency sewage overflows (described in Section 8) discharge directly to the water surface along this shoreline. Water quality between Victoria Harbour and Oak Bay will continue to be significantly influenced by stormwater discharges and despite a predicted improved water quality as a result of the new discharge it is likely the shoreline will remain closed to shellfish harvesting.

Failure Conditions

In addition to the predicted normal operating conditions, EC requested that fecal coliform concentrations should be assessed for possible failure conditions. The failure conditions considered the most likely significant failures in the system, outside the normal operation of the system, and are described in Section 9.3.2.

Both failure scenarios were modelled for the winter ambient conditions at a time when the effluent plume was predicted to more frequently surface thereby presenting a higher risk to intertidal shellfish. Results of the modelling are provided in Appendix 8. Fecal coliforms in the surface layer during the first failure scenario were predicted to result in maximum fecal coliform concentrations between 250 and 300 cfu /100 mL on the west side of Chatham Island (the nearest potential shellfish harvesting location). The elevated concentrations were predicted to be sustained for the duration of the failure, and to be quickly diluted and flushed from the area following the restoration of normal operating conditions.

The second failure scenario is predicted to result in fecal coliform concentrations below shellfish harvesting guidelines at Chatham Island; however, there is an increased risk to shellfish at Haystock Islets near Albert Head. A single peak concentration of approximately 90 cfu /100 mL is predicted at the Islets. Fecal coliform concentrations at Haystocks Islets were predicted to quickly decline following the reinstatement of normal operating conditions.

The waters and intertidal foreshore in the Victoria Harbour area, from Albert Head to Cordova Bay and Quarantine Cove near William Head are closed year round to shellfish harvesting due to a sanitary shellfish closure, Closures 19.1 and 19.8 respectively (DFO 2012b;Figure 14) and PSP closures (DFO 2012b).

Existing Conditions

The existing discharge conditions were modelled for the winter ambient properties and hydrographs derived from measured daily flows during the winter of 2008 and 2009. The modelled conditions and results are provided in Appendix 8. The purpose of the model was to provide a far-field baseline with which to compare the predicted McLoughlin Point discharge. The model results were also compared with measured fecal coliform concentrations measured as part of the PDMP activities.

Results from modelling the existing conditions predicted maximum fecal coliform concentrations of 80 to 100 cfu /100 mL on the west side of Discovery and Chatham Island in Plumper Passage with reoccurring periods with concentrations greater than 14 cfu /100 mL. The modelled concentrations at Haystock Islets, at Albert Head, were all below 14 cfu /100 mL at the water surface, however at depths between 5 and 15 m concentrations up to 41 cfu /100 mL were predicted.

The present day discharge is predicted to pose a risk of intertidal shellfish contamination at Discovery and Chatham Islets during the winter. At Haystock Islets there is presently some risk to subtidal shellfish in winter, however surface water quality is modelled to meet shellfish water quality guidelines of < 14 cfu/100 mL.

Measurements of fecal coliform concentration from the PDMP can be used to validate the model predictions. The maximum measured fecal coliform concentration in the surface samples (AH-2, MP-4, MP-6 and reference station FC-7) were compared against the predicted maximum surface concentrations from modelling results (existing conditions; Table K).

Table K Maximum Fecal Coliform Concentrations Measured versus Predicted (cfu/100 mL)

Station	AH-2	FC-7	MP-4	MP-6
Measured	77	2	3500	32
Predicted	30 to 100	<1	>8000	15 to 30

The maximum measured and predicted fecal coliform concentrations in surface samples corresponded well with the modelled concentrations. The comparison suggests the C3 model should accurately predict the dilution and dispersion of discharge conditions.

10. IMPACT ASSESSMENT

10.1 Water Quality (Aquatic Life)

The proposed discharge has the potential to impact marine aquatic life if water quality is degraded as a result of the discharge of effluent. For the purposes of this assessment, the receiving environment is considered to have degraded water quality if marine water quality guidelines are exceeded outside of the IDZ.

Based on dilution and dispersion modelling of the effluent plume, all parameters with known or predicted effluent concentrations and an applicable ambient water quality guideline were predicted to achieve the water quality guideline for the protection of marine aquatic life at the boundary of the IDZ. Therefore, the proposed discharge is not likely to result in significant impacts to marine aquatic life.

Within the IDZ, some water quality guidelines may be exceeded, however this is permitted under the MWR. The terminus of the proposed outfall and the resulting IDZ is located approximately 2 km from the shoreline in a water depth of approximately 61 m. A number of marine invertebrates, fish, marine mammals, birds and species at risk may enter the waters within the IDZ. Species at risk include killer whales, steller sea lions, gray whales and harbour porpoises and marine birds such as marbled murrelets and surf scoters. These species are mobile and therefore exposure to waters within the IDZ would be limited and brief.

10.2 Water Quality (Human Health)

The proposed discharge may pose a risk to human health through contamination of recreational water and/or shellfish that are harvested and consumed. Under normal operating conditions the proposed discharge is predicted to pose occasional low risk to human health. The occasional risk would occur east of Clover Point as a result of potential overflows during winter wet weather conditions. Recreational water quality guidelines may be exceeded near Trial Island and shellfish harvesting water quality guidelines may be exceeded at Chatham and Discovery Islands. During summer (dry weather) months the effluent plume is not predicted to reach recreational and/or shellfish harvesting areas in concentrations that would pose a threat to human health.

The predicted receiving environment water quality does not account for combined effects resulting from other sources such as stormwater discharges along the Victoria waterfront. Stormwater discharges have the potential to discharge water containing pathogens which also presents risk to human health.

The water quality that could potentially result from the combined wastewater and stormwater discharges is difficult to predict as it would require specific knowledge of the flow rates and quality of the stormwater discharges but it is assumed that storm water effects would be predominantly along the shoreline. The REM for the proposed discharge should address the water quality of recreational areas such as Trial Island.

10.3 Contaminant Loading and Cumulative Effects

In addition to the application of relevant water quality guidelines at the boundary of the IDZ the discharge of effluent constituents could result in other impacts, such as eutrophication, accumulation in sediments and bioaccumulation of effluent contaminants.

Nutrient Enrichment and Eutrophication

The addition of nutrients (primarily nitrate or phosphorous) from the discharge has the potential to increase primary production in the receiving environment. In some cases the increased primary production can lead to eutrophication of the receiving environment. This occurs when oxygen in the water column is consumed during the decay of the additional biomass.

Natural primary production in marine water is described by the seminal Sverdrup model (1953). Deep convective mixing during winter months elevates nutrient levels and stimulates phytoplankton growth. This results in a spring bloom in phytoplankton biomass which is limited by declining nutrient concentrations and/or zooplankton grazing.

In the Juan de Fuca Strait, the nutrient input is from two primary sources (Thomson 1981). A surface layer flows seaward carrying riverine water from freshwater sources while a subsurface layer flows landward from the Pacific Ocean. Circulation and mixing patterns are modulated by factors such as winds, tidal currents and bathymetry.

The input of additional wastewater derived nutrients to the Juan de Fuca Strait is not predicted to result in adverse effects caused by eutrophication. The resultant estuarine circulation (Mackas and Harrison 1997) enables a strong transfer of nutrients to phytoplankton as deep water inflow from the Pacific Ocean is upwelled to the surface layer in Haro Strait then exported to the Juan de Fuca Strait by estuarine outflow. High nutrient concentrations are present throughout the year in the Juan de Fuca Strait but a spring phytoplankton bloom, as found in the Strait of Georgia, is not evident (Mackas and Harrison 1997). Further investigation of factors affecting the seasonal variability of phytoplankton (Li et al. 2000) indicate that light levels limit phytoplankton productivity in the Juan de Fuca Strait.

Contaminant Loading

Sediment quality monitoring in the vicinity of the existing Macaulay Point outfall found exceedances of several sediment quality guidelines including copper, mercury, some PAHs (acenaphthene, anthracene, benz(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, indeno(1,2,3-c,d) pyrene, phenanthrene, pyrene), 1,4-dichlorobenzene, 1,2,4-trichlorobenzene, and phenol (CRD 2010). The CRD concluded that these exceedances indicated a "*demonstrable impact of the outfall on sediment chemistry*" (CRD 2010) and a "*potential for biological communities to be affected*".

Detailed analysis of the benthic community concluded that the benthic community within 200 m of the Macaulay Point outfall diffuser was "moderately degraded" in comparison to far field stations (greater than 400 m) where "net-neutral or positive" impacts were measured (CRD 2010).

The implementation of secondary treatment will significantly reduce the net loading of many of the constituents of concern in comparison to the current discharge of screened wastewater. The annual loading of effluent constituents for which removal efficiencies (RE) were available from literature were calculated for the predicted 2065 average dry weather flow of 107.8 ML/d for both the raw effluent and proposed secondary treated effluent. The anticipated REs, raw wastewater and predicted effluent concentrations are presented in Table 10 of the Stage 1 EIS (Appendix 1; Golder 2009).

Those parameters for which sediment quality guideline exceedances were measured and anticipated removal rates were predicted are indicated in red in Table L. Assuming the discharge of ADWF conditions, 2.7 tonnes of copper, 3.4 kg of mercury per year, and 85 to 95% of the organic compounds in Table L are anticipated to be removed from the effluent.

Table L Predicted Loadings of Effluent Contaminants

Parameter	Total Loading			
	Raw Wastewater	RE	Secondary Treated Effluent	Predicted Reduction
MWR Legislated Parameters (Tonnes/Year)				
Total ammonia nitrogen	991	57%	476	633
Total Phosphorus as P	216	44%	122	94
BOD	6,885	90%	668	6,217
CBOD	5,977	93%	417	5,560
Total Suspended Solids	7,830	95%	389	7,441
Other Nutrients (Tonnes/Year)				
Total Kjeldahl nitrogen	1,535	56%	668	866
Nitrate nitrogen	2,750	0%	2,750	0
Total Metals (Kg/Year)				
Arsenic	25.4	22%	19.8	6
Barium	1,340	35%	873	468
Cadmium	5.9	17%	13.7	3
Chromium	130	32%	88.1	41
Chromium VI	200	62%	75.9	124
Copper [1]	4,290	62%	1,610	2,676
Iron	39,500	70%	11,800	27,661
Manganese	4,600	41%	2,715	1889
Mercury	5.1	66%	1.7	3
Nickel	205	33%	138	68
Selenium	19.7	16%	1.7	18
Silver	54.3	75%	13.8	41
Zinc	3,130	70%	940	2,192

Parameter	Total Loading			
	Raw Wastewater	RE	Secondary Treated Effluent	Predicted Reduction
Select Organic Substances (Kg/Year)				
Benzo(a)pyrene	3.6	85%	0.6	3
Fluorene	3.0	95%	0.2	3
Phenanthrene	6.8	95%	0.0	7
pyrene	4.1	95%	0.2	4
Ethylbenxene	12.1	95%	0.6	12
Toluene	106	95%	0.6	106
Phenol	531	95%	2.7	529
Bytylbenzyl phthalate	421	80%	82.6	338
DDT (2,4)	0.1	95%	0.0	0

[1]Those parameters for which sediment quality guideline exceedances were measured and anticipated removal rates were predicted are indicated in red.

As presented in Table L, the implementation of secondary treatment will result in a significant reduction in the input of contaminants to the Juan de Fuca Strait and reduce potential cumulative impacts to the receiving environment from existing conditions.

11. MONITORING RECOMMENDATIONS

11.1 Additional Pre-discharge Monitoring

Due to project schedule timelines, only 1 year of sediment monitoring was conducted at six stations in the vicinity of the proposed McLoughlin Point outfall (M500SE, M800NE, M1300E, M1400ESE, M1600SE, M2300ESE) and at two reference stations (FC3500NE, FC4000ENE) near Finnerty Cove. For the scale of the discharge proposed, a data set of one year at these stations provides limited opportunity to verify the pre-discharge conditions at these stations. It is recommended that a second year of pre-discharge sediment monitoring be conducted sometime prior to outfall commissioning. This would provide a robust data set for future post-discharge monitoring analysis and would provide the opportunity to confirm the quality of the existing data collected. Once the final location of the outfall terminus is known with more certainty, and the future Receiving Environment Monitoring program is finalized (see Section 11.2.2), the protocol of the Receiving Environment Monitoring program should be executed for 1 year prior to outfall commissioning.

Also, 1 year of pre-discharge water quality monitoring should be executed at the recommended water stations (Section 11.2.1) adopted in the finalized Receiving Environment Monitoring program.

11.2 Post Discharge Monitoring

The Receiving Environment Monitoring program for the existing Macaulay Point and Clover Point discharges was recently re-developed by the CRD in conjunction with the MOE. The monitoring program is included in Appendix 9.

The new monitoring program developed for the Macaulay Point outfall is applicable to the proposed McLoughlin Point outfall. The Macaulay Point outfall monitoring program includes:

- effluent chemistry and toxicity analysis;
- surface water quality monitoring;
- initial dilution zone water quality samples;
- sediment chemistry, toxicity and bioaccumulation; and,
- benthic invertebrate sampling; and,
- fish tissue chemistry.

The following subsections provide recommended amendments to the monitoring program for improved effectiveness and applicability to the McLoughlin Point outfall.

11.2.1 Water Component Amendments

Sample Stations

As discussed in previous sections, it is recommended that water sampling occur at shellfish areas and recreational areas where the diluted effluent plume is predicted to occasionally approach or exceed water quality guidelines for microbiological parameters. Additional surface water sampling stations should be located at:

1) Trial Island
2) Chatham and Discovery Islands

11.2.2 Sediment Component Amendments

The following subsections provide recommended amendments primarily related to benthic community sampling, although the recommended sampling stations should apply to all sediment sub-components.

Schedule and Timing

To balance costs from increased effort in other components of the monitoring program, the proposed sampling frequency was reduced from annually to every second year and the number of benthic invertebrate sampling stations was reduced from 23 stations to 16 stations. The benthic invertebrate monitoring component should be conducted every second year. Benthos samples should be collected concurrent with sediment chemistry, and if possible, toxicity, bioaccumulation and pore water assessments, which is the current strategy by the CRD. If this presents budget challenges there may be other options for reducing the sampling effort.

A core grouping of long-term monitoring stations should be maintained (identified in consultation with CRD) to check that temporal patterns related to the outfall are not missed because of changing background conditions (climate patterns). Typically, if certain thresholds are reached in benthos conditions, rapid changes may occur thereafter. In order to identify cause, a reasonable frequency of sampling is required.

Sample Stations

The recommended sampling stations include primarily existing Macaulay Point monitoring stations, but additionally several stations which were sampled in 2011 as part of the Stage 2 EIS. The addition of these stations to the sampling grid provides a clear gradient along the direction of prevailing sediment transport away from the outfall, and will thus help to determine spatial extent and subtle effects (assuming revised sampling protocols) related to the outfall discharge and confounding background (climate-related) effects.

The recommended near-field, far-field and reference sediment stations include:

- M0
- M100W
- M100SW
- M100S
- M100SE
- M100E
- M200NW
- M200NE
- M200SE
- M400E
- M400SE
- M800E
- M1300E (2011 pre-discharge)
- M2300ESE (2011 pre-discharge)
- Parry Bay Reference Station #1
- Parry Bay Reference Station #5

Sample Analyses

Recommended additional sample analyses include:

Stable carbon and nitrogen isotope analyses for each benthic invertebrate location should be added to the list of analytes. These samples can typically be analyzed by the UBC mass spec lab in CEOS in conjunction with sediment %TOC and %TN. The isotopes are excellent tracers of outfall deposition for untreated, primary or secondary treated municipal wastewater.

The numbers and categorization (0-3) of the bivalve *Axinopsida serricata,* with and without a rusty deposit on their shells, should also be recorded (see Burd et al., 2008) as this is an excellent indicator of 3-4 year integrated organic enrichment patterns in the upper 4 cm of sediments in the habitats of these organisms.

Field Sampling and Laboratory Processing

The methodologies and experience level of personnel conducting the field work and laboratory processing are extremely important for data quality and subsequent data analysis and interpretation. The taxonomy of many of the organisms are challenging and many small specimens can be concealed in debris (eg. wood, shell), and have delicate tissues easily damaged. It is recommended that the details of field sampling and laboratory methods be reviewed, updated and compiled in a written manual such that the procedures could be audited against for optimum quality control. Some of the important topic areas include:

- Field washing methodology
- Debris processing and QA
- Personnel training and supervision
- Sorting procedures and QA

- Taxa and life stage identification procedures
- Reference collections and external taxonomic verifications
- Sample handling, preservation, transport and storage
- Data management and photographic records

Data Endpoints

Minimum data endpoints should consist of measured biotic factors including adult, intermediate and juvenile abundance, taxonomic richness and biomass-converted abundance. These will provide historical endpoints, as described in past CRD monitoring programs, and additional recommended endpoints including;

- Total wet weight and organic carbon biomass (kj) per taxon and sample (see Burd et al. 2012a,b)
- Production per taxon and sample (Burd et al. 2012a,b)
- Trophic and size class frequency distributions (Macdonald et al. 2012a,b)
- 95th percentile thresholds analyses for relevant indicators based on the BC background database (Burd et al. 2009, 2012a). This allows determination of extraordinary faunal impoverishment relative to the outfall (baseline criteria)
- Additional multivariate community analyses as deemed appropriate to understand spatial and temporal patterns (typically based on abundance, organic biomass, production, trophic structure and size structure), including comparisons of biotic and sediment multivariate patterns

11.3 Outfall Inspection

The outfall should be inspected at least once every five years.

12. CONCLUSIONS

The proposed Core Area Wastewater Treatment Program will implement secondary treatment for wastewater flows up to 2 x the ADWF (215.6 ML/ day).. Effluent will be discharged to the Juan de Fuca Strait through a new outfall. The outfall discharge location is approximately 2 km offshore from the proposed McLoughlin Point wastewater treatment plant and at a depth of approximately 61 m. The recommended diffuser configuration is 200 m in length with 33 vertical 200 mm diameter ports.

The existing Macaulay and Clover Point outfalls will cease to operate as the primary points of discharge and will only operate for flows above 3 x ADWF from Clover Point and above 4 x ADWF from Macaulay Point. The amount of flow that will receive only screening and grit removal is expected to be on average 20 ML/day until such time that I&I reduction programs can eliminate the excess flow (anticipated by 2030).

Receiving water uses near the proposed discharges include fisheries resources, fish habitat and recreational use. The Juan de Fuca Strait supports a number of ecologically, economically and culturally important invertebrates. Crab, shrimp, prawn, octopus, squid, red sea urchin and shellfish (swimming scallops, geoduck, cockles, mussels, oysters) are documented in the marine project area. Some of the significant fish species known to occur in the McLoughlin Point discharge area include all five Pacific salmon species (Coho, chum, Chinook, sockeye and pink), cutthroat and steelhead trout, Pacific herring, lingcod, dogfish, flatfish (sole and halibut), rockfish and Pollock. Potential rockfish habitat has been documented in the vicinity of Albert Head (Golder 2009). Marine mammal presence in the area includes harbour seal, California sea lion and steller sea lion, Dall's porpoise, harbour porpoise and killer whale. Migratory gray whale, humpback whale and minke whale may also be present in the summer.

A variety of recreational activities occur in the marine waters near the proposed McLoughlin Point outfall. Primary contact activities tend to be conducted along the shore and near shore areas. Activities such as swimming, wading, diving, skim boarding and paddle boarding are conducted close to shore, while kayaking, outrigger canoeing, kite surfing, and wind surfing occur further offshore

An inventory of baseline sediment chemistry, sediment toxicity, sediment benthic community and seasonal water quality and water column profiles was collected as part of this EIS. The results of the field investigations provide a foundation for dilution modelling of the proposed discharge, the environmental impact assessment and post-discharge receiving environment monitoring program.

Dilution modelling of the proposed discharge was completed for summer and winter scenarios. The summer condition considers an ADWF and storm event, which is within 2 x ADWF. The winter condition considers a wet weather flow and storm event, which is above 2 x ADWF.

Key results from the dilution modelling exercise include:

- the effluent will be discharged to a well flushed marine environment which is not considered embayed as defined by the MWR;
- the minimum dilution at the edge of the IDZ (throughout the water column) predicted to be 108:1, which would occur under summer conditions; and,

- the minimum dilution at the surface is predicted to be 292:1, which would occur under winter conditions;

Modelling of microbiological indicators predict that recreational water quality guidelines will be achieved at recreational waters. Occasional, short duration, low magnitude exceedances are predicted primarily at offshore areas near the outfall diffuser where primary contact would not be expected to occur. The recreational water quality guideline of 200 cfu/100 mL would be exceeded under summer conditions at the surface within about 300 m of the outfall diffuser approximately 2% of the time. Under winter conditions, fecal coliform concentrations above 200 cfu/100 mL (up to 1,400 cfu /100 mL) at the surface were predicted to occur within approximately 500 m of the McLoughlin outfall diffuser up to 10% of the time. In addition, concentrations around 200 cfu /100 mL at the surface were predicted occasionally near Trial Island and east toward Chatham and Discovery Island under winter conditions.

A “slight episodic” risk of shellfish contamination at Chatham and Discovery Islands was predicted for both summer and winter conditions. The maximum concentration on the west shore of Discovery Island in Plumper Passage was predicted to be approximately 40 cfu /100 mL. This exceeds the median water quality guideline of 14 cfu /100 mL but not the 90th percentile guideline of 43 cfu /100 mL. Fecal coliform concentrations greater than 14 cfu /100 mL were predicted following a storm event and a potential overflow from the Macaulay Point and Clover Point outfalls. For this reason, it is recommended that future receiving environment monitoring include water quality monitoring stations at Chatham and Discovery Islands.

Effluent quality is anticipated to achieve the minimum effluent quality standards for; toxicity, BOD_5, CBOD, TSS, pH and un-ionized ammonia (N) outlined in the Municipal Wastewater Regulation and Wastewater Systems Effluent Regulation. Applicable water quality guidelines for these parameters are predicted to be achieved at the boundary of the IDZ. The proposed system design is expected to provide adequate protection of human health and shellfish resources. Disinfection is not expected to be required, but may need to be implemented in the future based on receiving environment monitoring results if it is determined that water quality guidelines are not being achieved at receptor sites (e.g. commonly used recreational waters and harvestable shellfish areas).

The project will reduce overall nutrient inputs relative to existing conditions. Primary production is light limited in Juan de Fuca Strait, therefore nutrient loading is not predicted to stimulate algal production. Advanced treatment for nutrient removal should not be required.

There will be adequate protection of aquatic marine resources as relevant water quality guidelines for the protection of aquatic life will be achieved at the boundary of the IDZ. Potential cumulative effects of discharging CRD Core Area wastewater to the marine environment will be reduced by the significant reduction in contaminant loadings attributed to the new wastewater treatment plant. For the predicted 2030 ADWF, the proposed treatment program is anticipated to result in the net reduction of:

- BOD by 6,217 tonnes/year;
- CBOD by 5,560 tonnes/year;
- TSS by 7,441 tonnes/year;

- copper by 2,676 kg/year;
- mercury by 3 kg/year;
- benzo(a)pyrene by 3 kg/year;
- pyrene by 4 kg/year; and.
- phenol by 529 kg/year.

A receiving environment monitoring program was recently developed jointly between the MOE and the CRD for the existing Macaulay and Clover Point outfalls. It is recommended that the monitoring program for the existing Macaulay Point discharge be adopted for the proposed McLoughlin Point outfall with some modifications.

Water quality monitoring stations should be re-aligned to be centered over the as-constructed terminus of the proposed outfall. Additional water quality monitoring stations should be added near Trial Island and Chatham and Discovery Islands, where the potential to exceed recreational and/or shellfish guidelines was predicted.

Recommended modifications to the proposed benthic infaunal surveys include:

- refinement of schedule and timing;
- sediment sampling stations should primarily include existing Macaulay Point outfall sampling stations with the addition of some pre-discharge monitoring stations;
- stable carbon and nitrogen isotope analyses should be conducted;
- bivalve *Axinopsida serricata* with and without the presence of a rusty deposit on their shells should be recorded;
- update of detailed field sampling and laboratory methods should be compiled in a written manual; and,
- additional benthic community data endpoints should be incorporated into program.

It is recommended that one additional year of the finalized sediment portion of the post- discharge receiving environment monitoring program should be executed prior to commissioning the discharge. The pre-discharge water quality data should be supplemented with one year of water quality monitoring at potential receptor locations at Trial, Chatham and Discovery Islands.

13. CLOSURE

We trust that this report satisfies your current requirements and provides suitable documentation for your records. If you have any questions or require further details, please contact the undersigned at any time.

Report Prepared by

Original signed on file February 18, 2013.

Boone Barber, BIT, B.Sc. Aquatic Biologist	Peter Howland B.Sc. Physical Oceanographer	Jason Clarke EIT Manager - Aquatic and Marine Sciences

Senior Review by

Original signed and sealed on file February 18, 2013.

Brenda Burd, RPBio Benthic Ecologist	David Jackson, MSc. Eng., MA(Econ), P. Eng. Technical Director, Senior Environmental Engineer

Water Business Unit
Infrastructure & Environment
WorleyParsons Canada Services Ltd.

14. ACKNOWLEDGEMENTS

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Benthic Services Group, LLC.

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Capital Regional District

Donald Hodgins

Kuroshio Charters

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Ruljancich, Shane, GIS Technologist II, Environmental Sustainability Group, CRD, 2012

Figures

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CRD Core Area Wastewater Treatment Program
Stage 2 Environmental Impact Study
Regional Map

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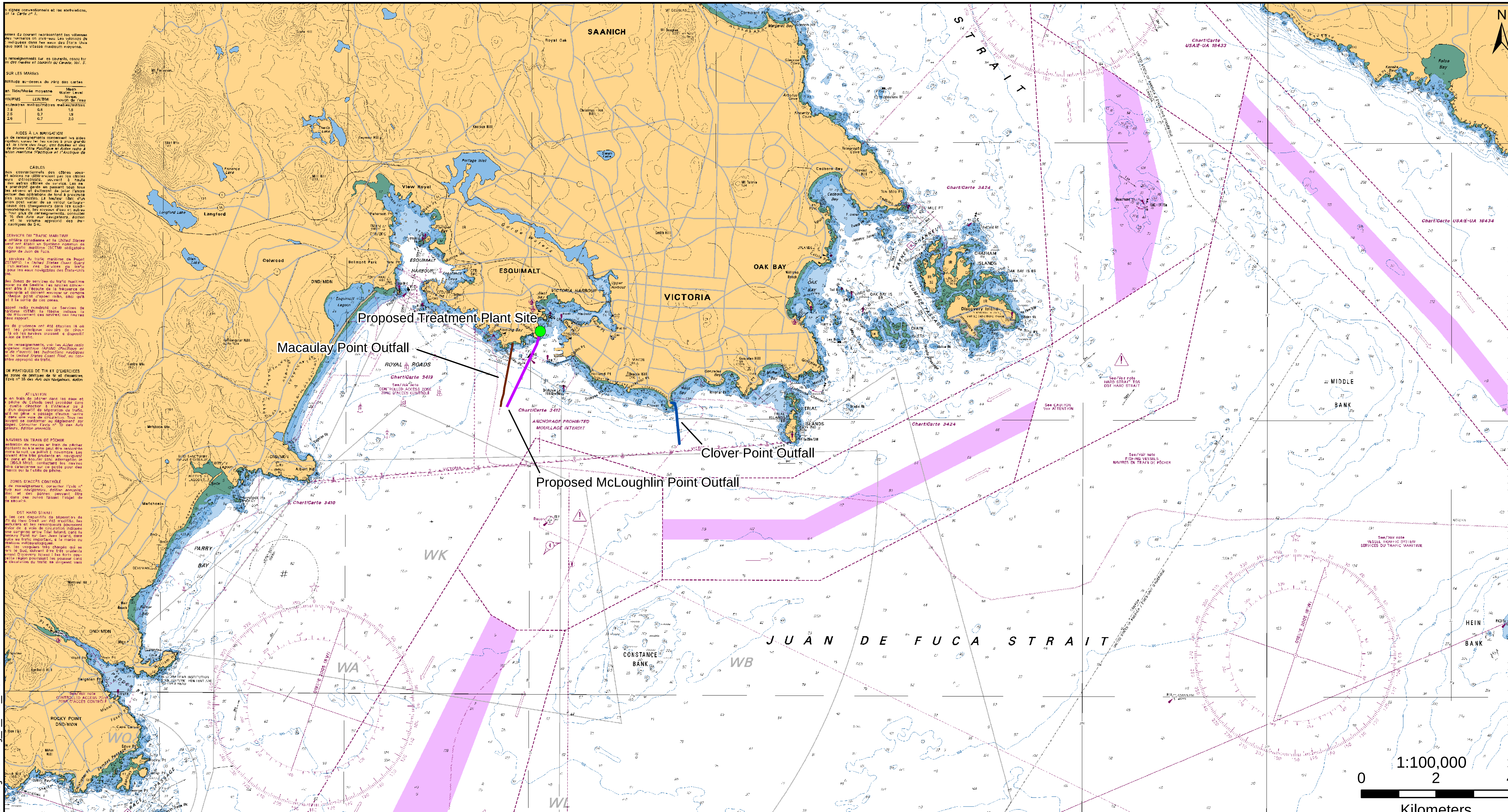

Legend

- Proposed Treatment Plant Site
- Macaulay Point Outfall
- Clover Point Outfall
- Proposed McLoughlin Point Outfall

Sources: Canadian Hydrographic Survey. 2009. Race Rocks to D'arcy Island. Marine Chart # 3440

B SHEET	SCALE: SHOWN
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Stage 2 Environmental Impact Study
Site Plan

WORLEYPARSONS PROJECT No.	FIG No.	REV
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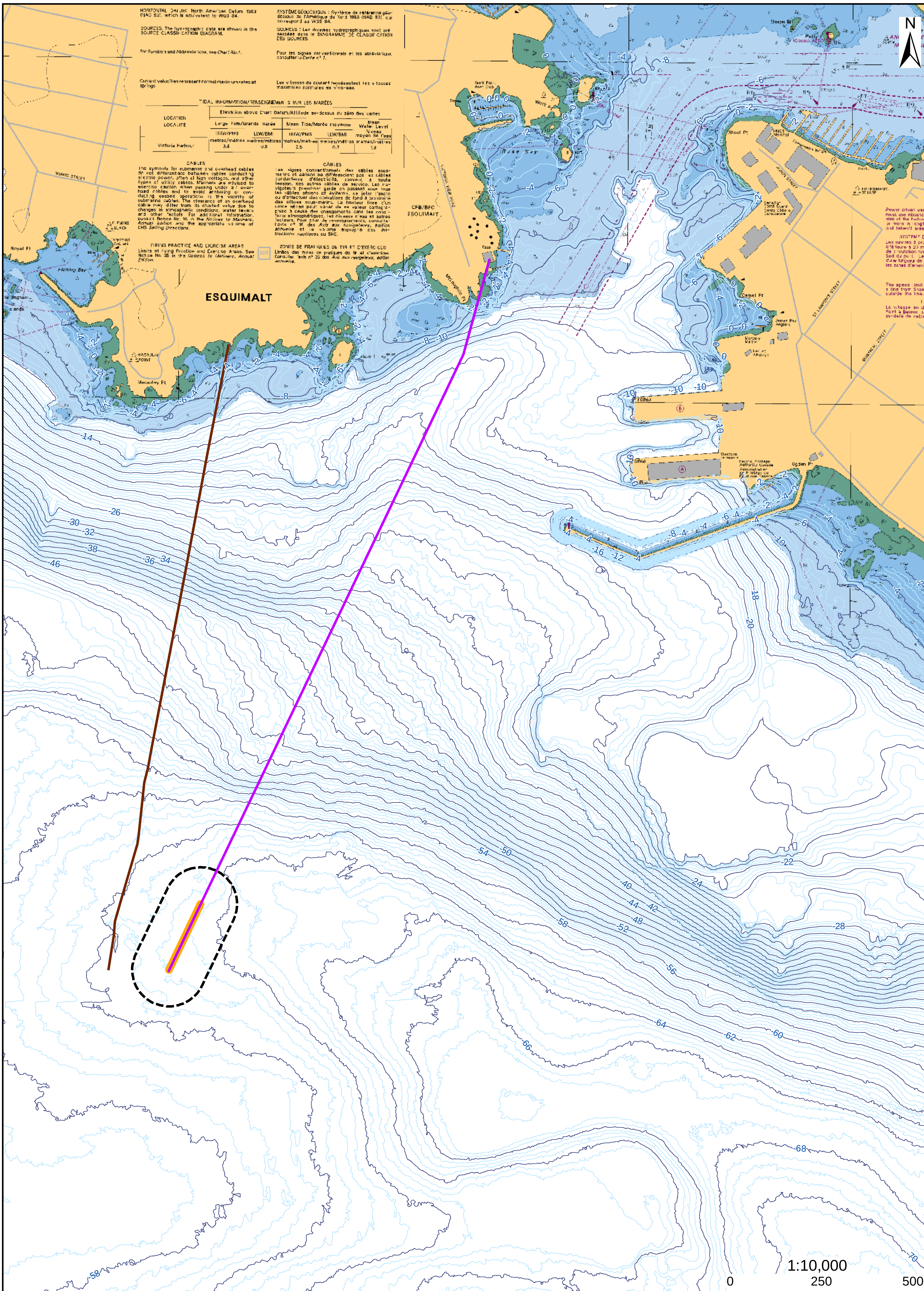

Sources: Canadian Hydrographic Survey. 2009. Marine Chart # 3412

Legend

- Macaulay Point Outfall
- Proposed McLoughlin Point Outfall
- Major Bathymetry (2m)
- Minor Bathymetry (0.5m)
- Diffuser
- Initial Dilution Zone

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CRD Core Area Wastewater Treatment Program
Stage 2 Environmental Impact Study
Proposed McLoughlin Point Outfall Location

WORLEYPARSONS PROJECT No.	FIG No.	REV
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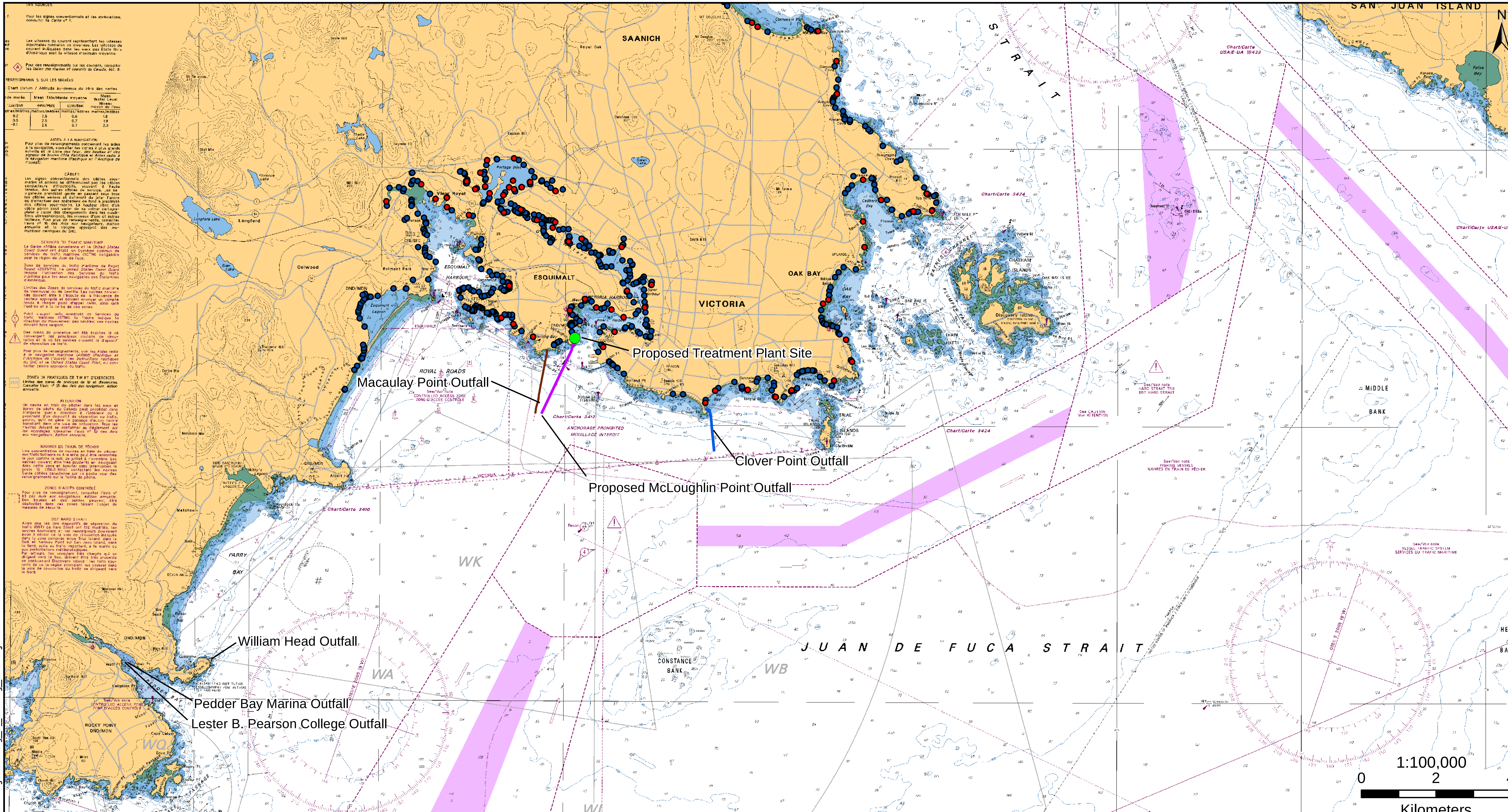

Legend

- Proposed Treatment Plant Site
- Stormwater Discharge
- Stormwater Discharge with Capacity for Sewage Overflow
- Clover Point Outfall
- Macaulay Point Outfall
- Proposed McLoughlin Point Outfall

Sources:
- Canadian Hydrographic Survey. 2009. Race Rocks to D'arcy Island. Marine Chart # 3440
- Pers.comm: Ruljancich, S, 2012

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Stage 2 Environmental Impact Study
Existing Discharges

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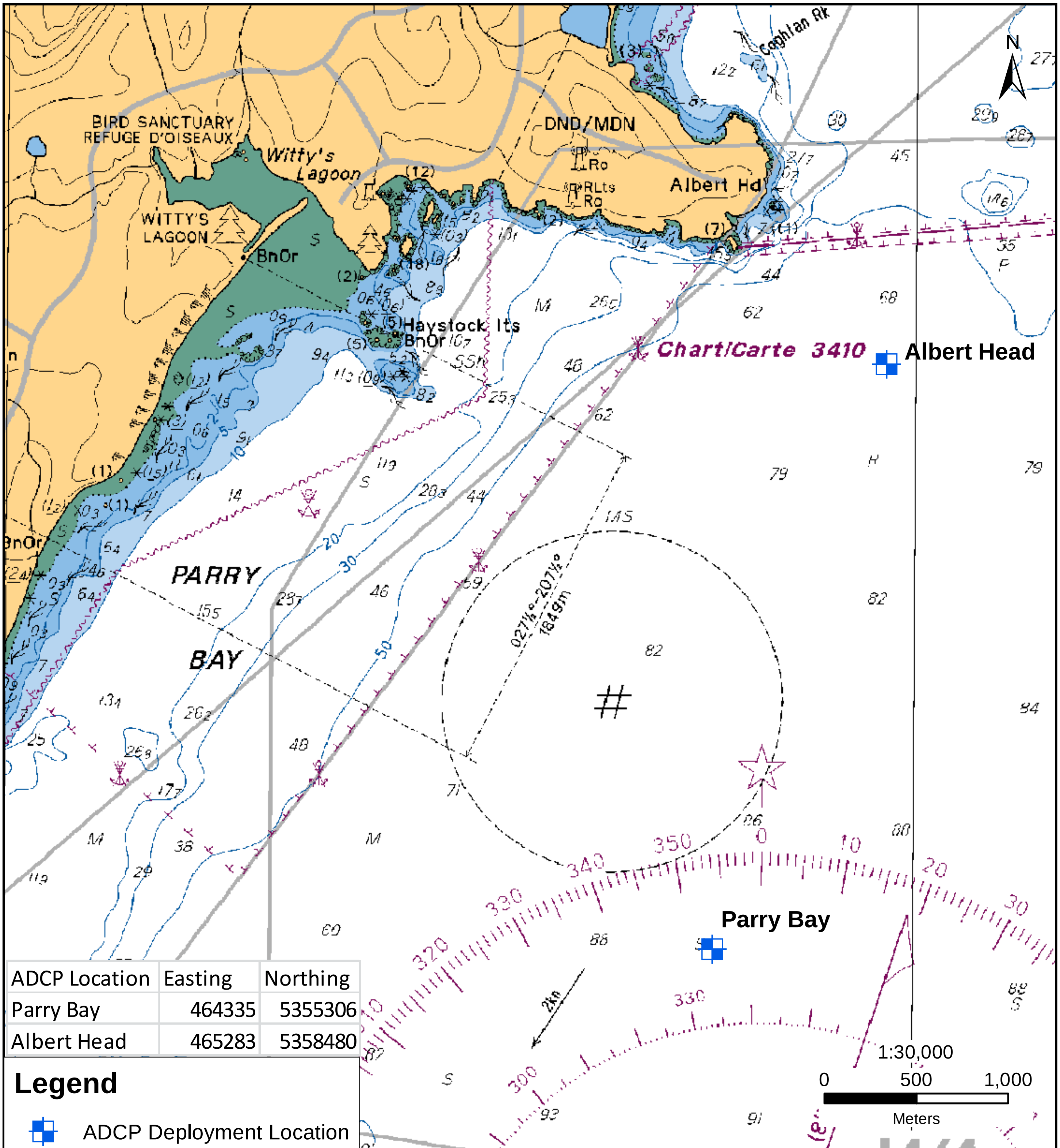

ADCP Location	Easting	Northing
Parry Bay	464335	5355306
Albert Head	465283	5358480

Legend

ADCP Deployment Location

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CRD Core Area Wastewater Treatment Program
Stage 2 Environmental Impact Study
ADCP Deployment Locations - Albert Head

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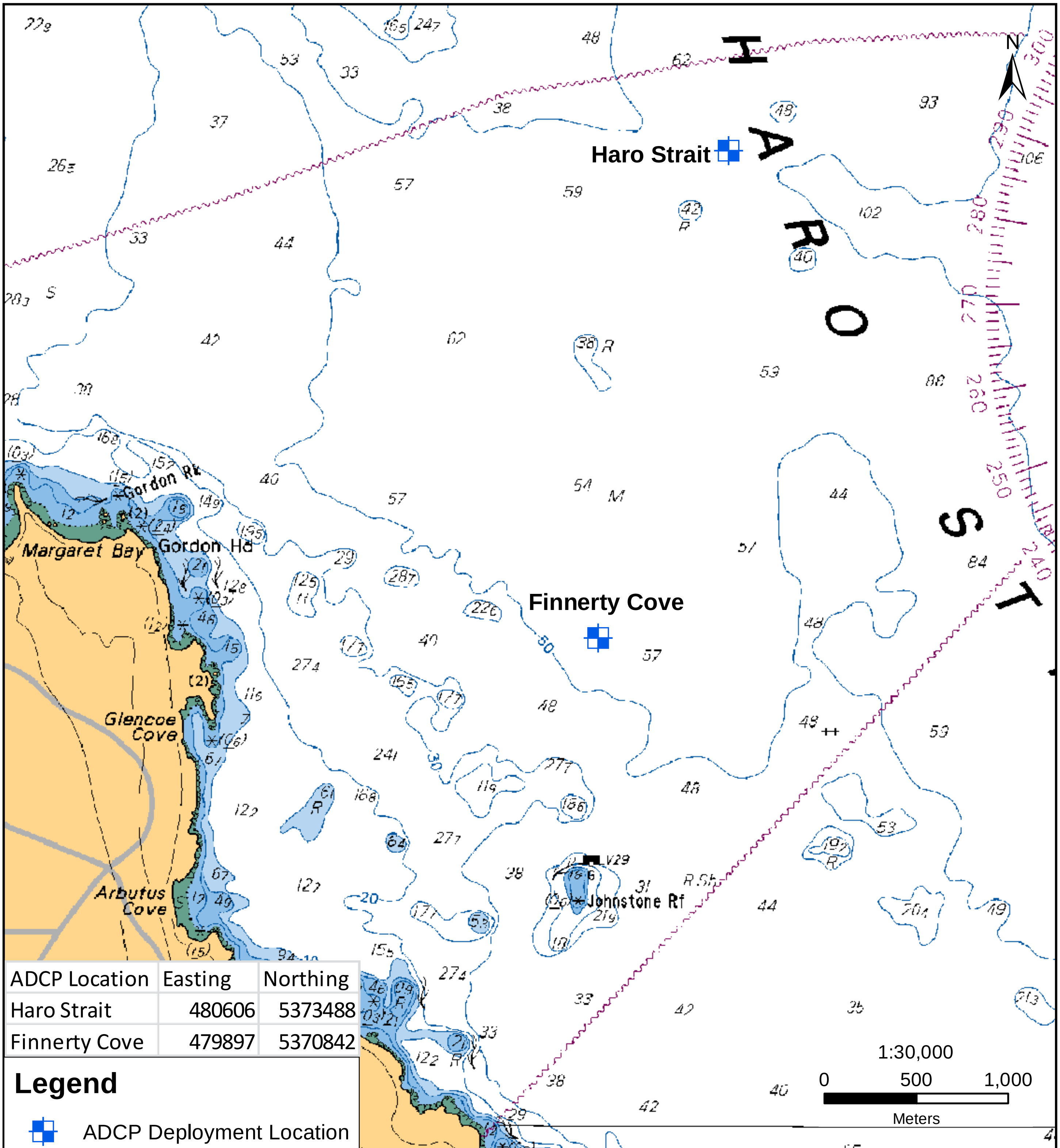

ADCP Location	Easting	Northing
Haro Strait	480606	5373488
Finnerty Cove	479897	5370842

Legend

ADCP Deployment Location

A SHEET	SCALE: SHOWN
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CRD Core Area Wastewater Treatment Program
Stage 2 Environmental Impact Study
ADCP Deployment Locations - Finnerty Cove

WORLEYPARSONS PROJECT No.	FIG No.	REV
307071-00020	6	0

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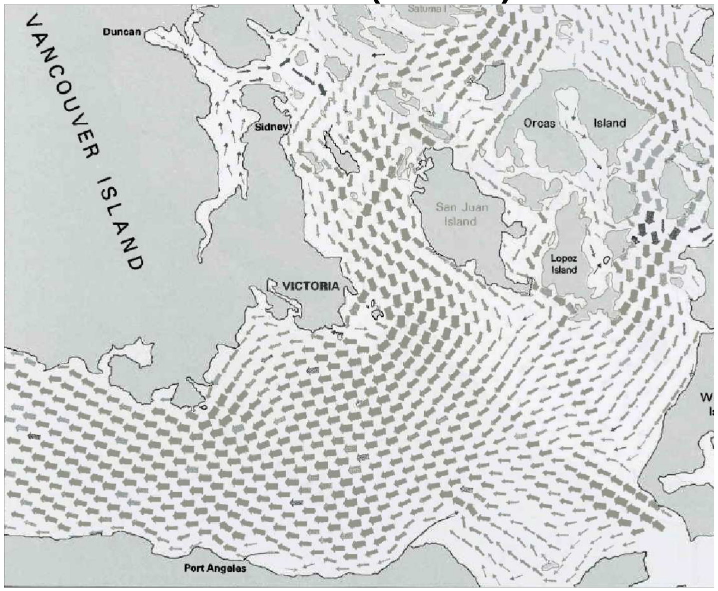
CHART 52 (HOUR 9)



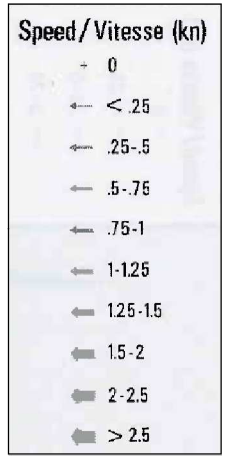
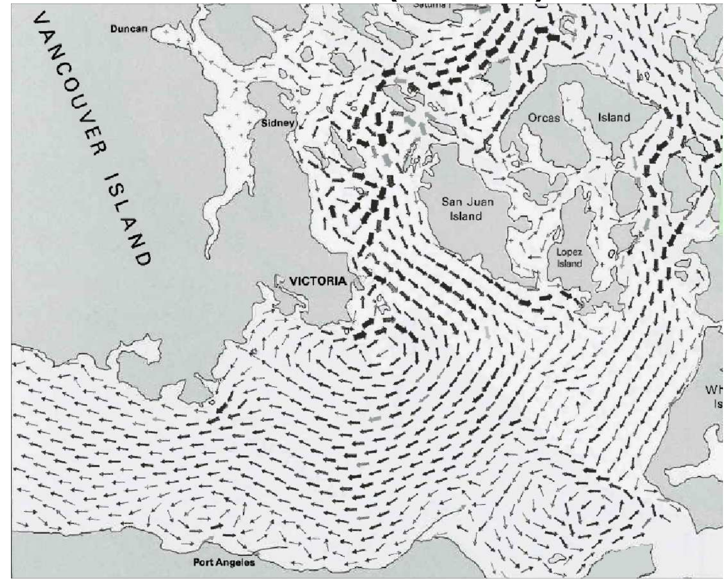
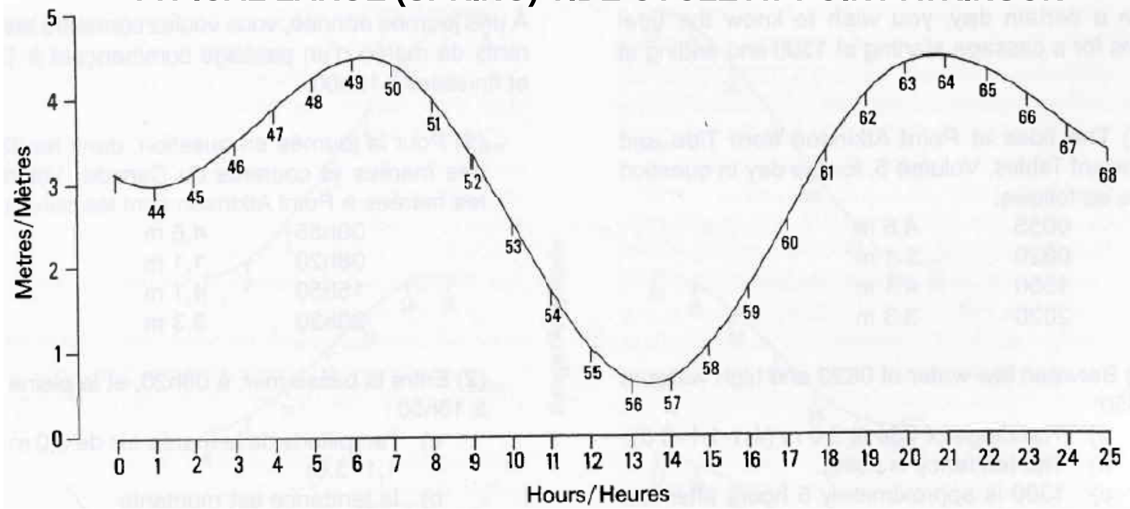


CHART 56 (HOUR 13)



TYPICAL LARGE (SPRING) TIDE CYCLE AT POINT ATKINSON



Note:

The chart number shown at hourly intervals along the tidal curves above show the tidal streams for that stage of the tide.

Sources: Fisheries and Oceans Canada, 2008

A SHEET SCALE: N/A

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CRD Core Area Wastewater Treatment Program
Stage 2 Environmental Impact Study
Tidal Current Pattern - Ebb

WORLEYPARSONS PROJECT No.	FIG No.	REV
307071-00020	7	0

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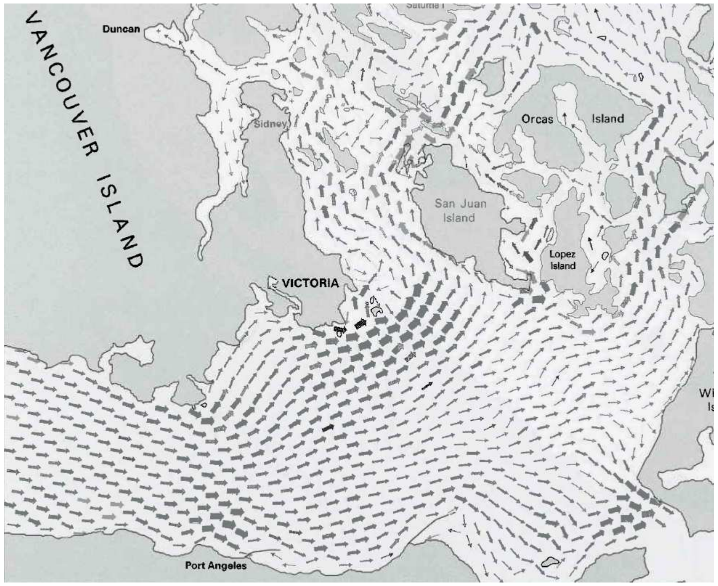
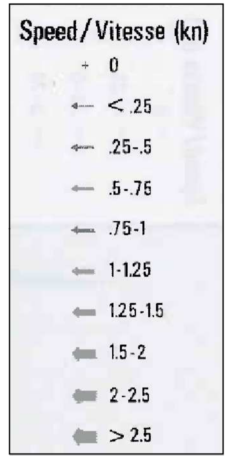
CHART 58 (HOUR 15)





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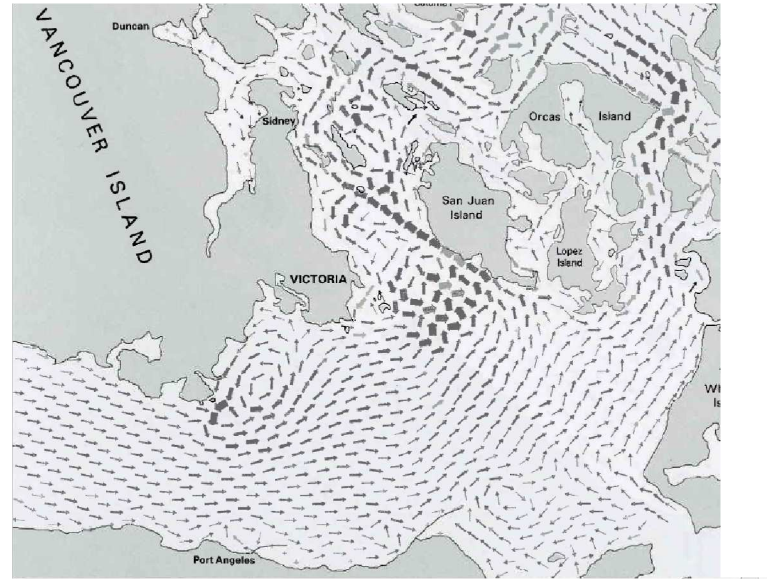
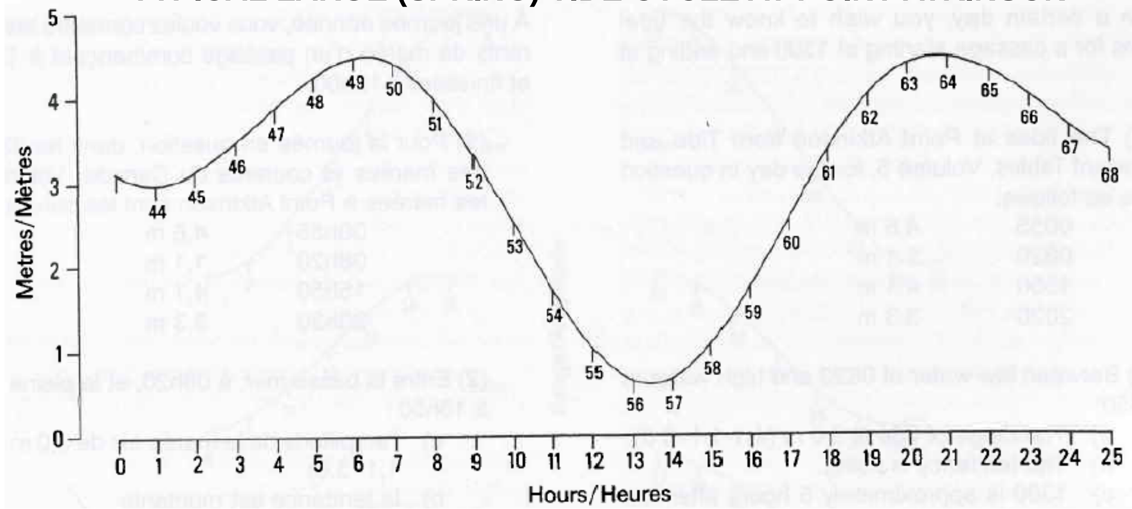


TYPICAL LARGE (SPRING) TIDE CYCLE AT POINT ATKINSON



Note:

The chart number shown at hourly intervals along the tidal curves above show the tidal streams for that stage of the tide.

Sources: Fisheries and Oceans Canada, 2008

A SHEET	SCALE:	N/A
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CRD Core Area Wastewater Treatment Program
Stage 2 Environmental Impact Study
Tidal Current Pattern - Flood

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WORLEYPARSONS PROJECT No.	FIG No.	REV
307071-00020	8	0

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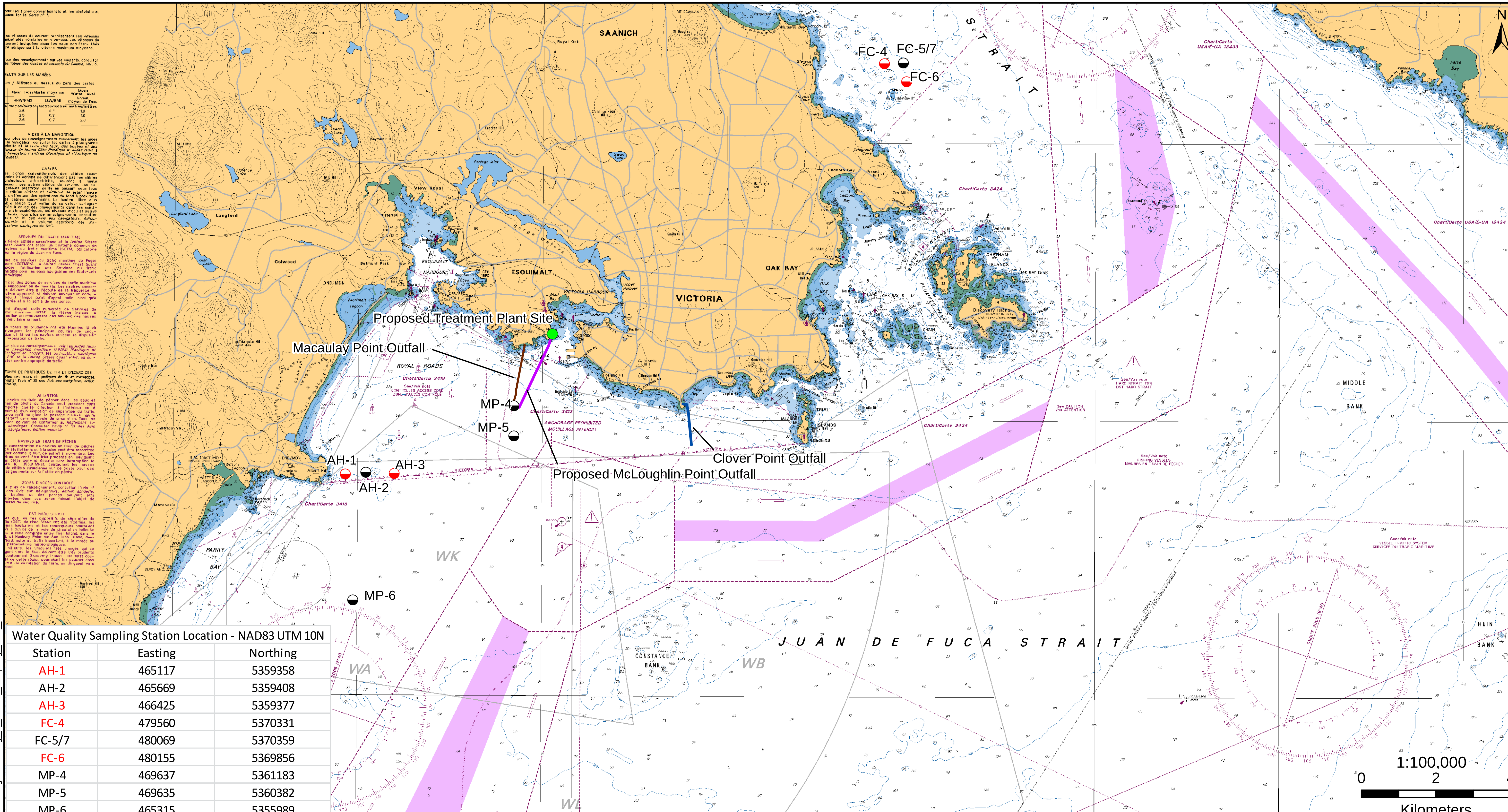

Water Quality Sampling Station Location - NAD83 UTM 10N

Station	Easting	Northing
AH-1	465117	5359358
AH-2	465669	5359408
AH-3	466425	5359377
FC-4	479560	5370331
FC-5/7	480069	5370359
FC-6	480155	5369856
MP-4	469637	5361183
MP-5	469635	5360382
MP-6	465315	5355989

Legend

- Proposed Treatment Plant Site
- Water Quality Sampling Station
- Abandoned Sampling Station
- Macaulay Point Outfall
- Clover Point Outfall
- Proposed McLoughlin Point Outfall

Sources: Canadian Hydrographic Survey. 2009. Race Rocks to D'arcy Island. Marine Chart # 3440

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Stage 2 Environmental Impact Study
Water Sampling Site Plan

WORLEYPARSONS PROJECT No. 307071-00020

FIG No. 9

REV 0

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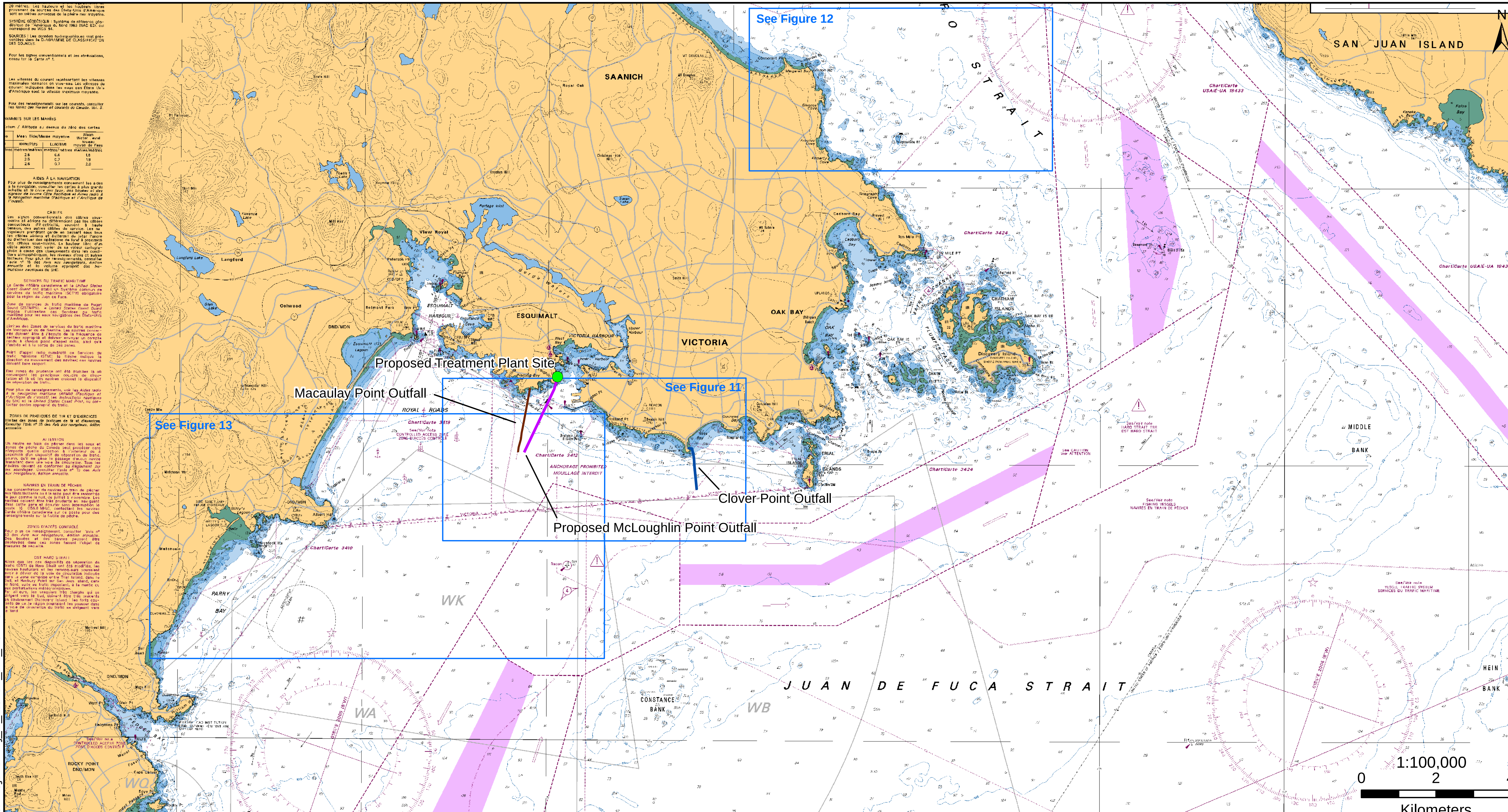

Legend

- Proposed Treatment Plant Site
- Macaulay Point Outfall
- Clover Point Outfall
- Proposed McLoughlin Point Outfall

Sources: Canadian Hydrographic Survey. 2009. Race Rocks to D'arcy Island. Marine Chart # 3440

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WORLEYPARSONS PROJECT No.	FIG No.	REV
307071-00020	10	0

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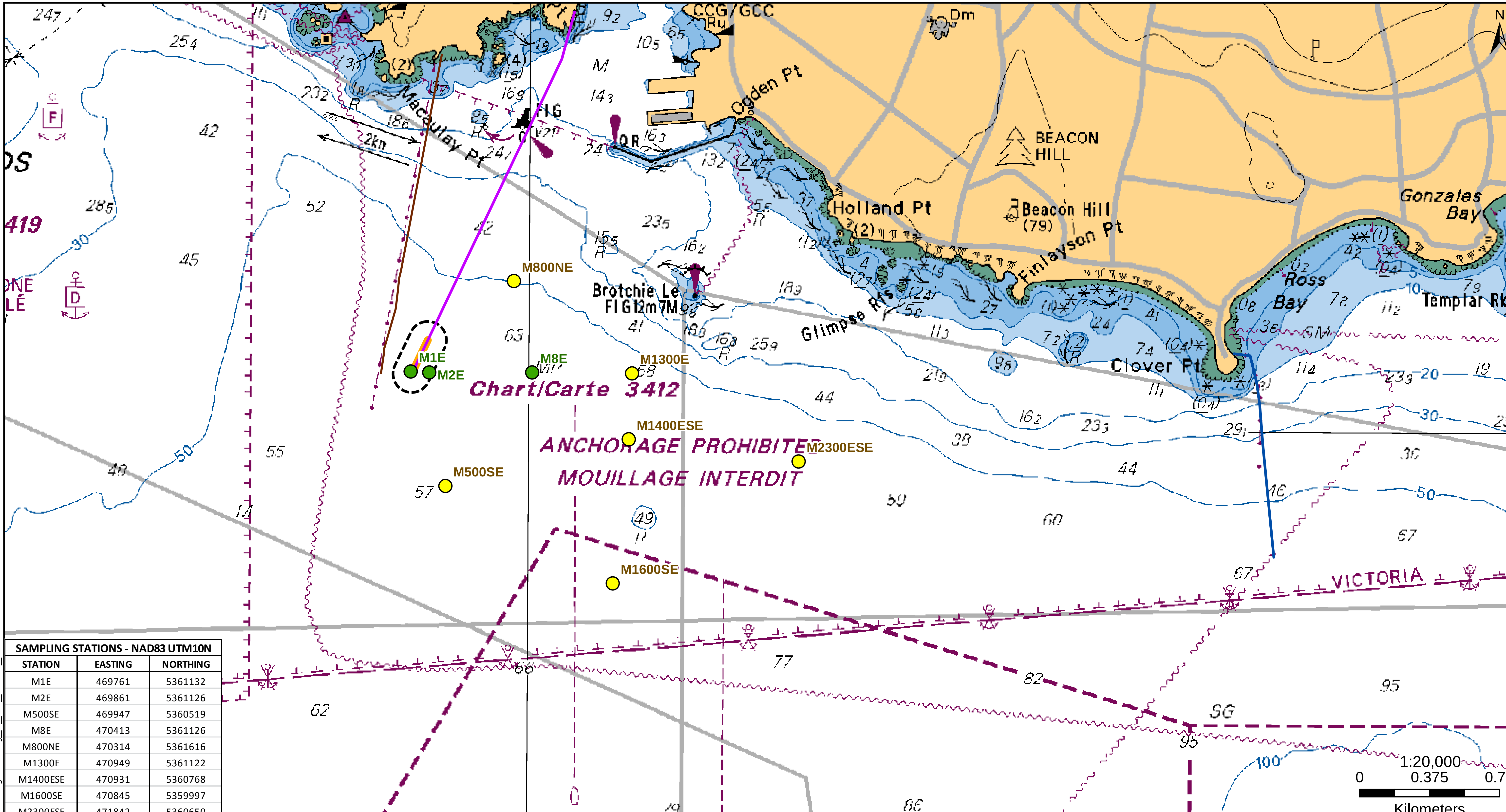

SAMPLING STATIONS - NAD83 UTM10N		
STATION	EASTING	NORTHING
M1E	469761	5361132
M2E	469861	5361126
M500SE	469947	5360519
M8E	470413	5361126
M800NE	470314	5361616
M1300E	470949	5361122
M1400ESE	470931	5360768
M1600SE	470845	5359997
M2300ESE	471842	5360650

Legend

Sediment Sampling Stations

- McLoughlin Point - Pre-Discharge Monitoring Station
- Macaulay Point - Receiving Environment Monitoring Station
- Macaulay Point Outfall
- Clover Point Outfall
- Proposed McLoughlin Point Outfall
- Diffuser
- Initial Dilution Zone

Sources: Canadian Hydrographic Survey. 2009. Race Rocks to D'arcy Island. Marine Chart # 3440

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Sediment Sampling Stations – McLoughlin Point

WORLEYPARSONS PROJECT No. 307071-00020

FIG No. 11

REV 0

FILE LOCATION: Y:\Yao.Mo\307071-00020\mxds\Stage II EIS\Fig_11_Sed_Station_2011.mxd

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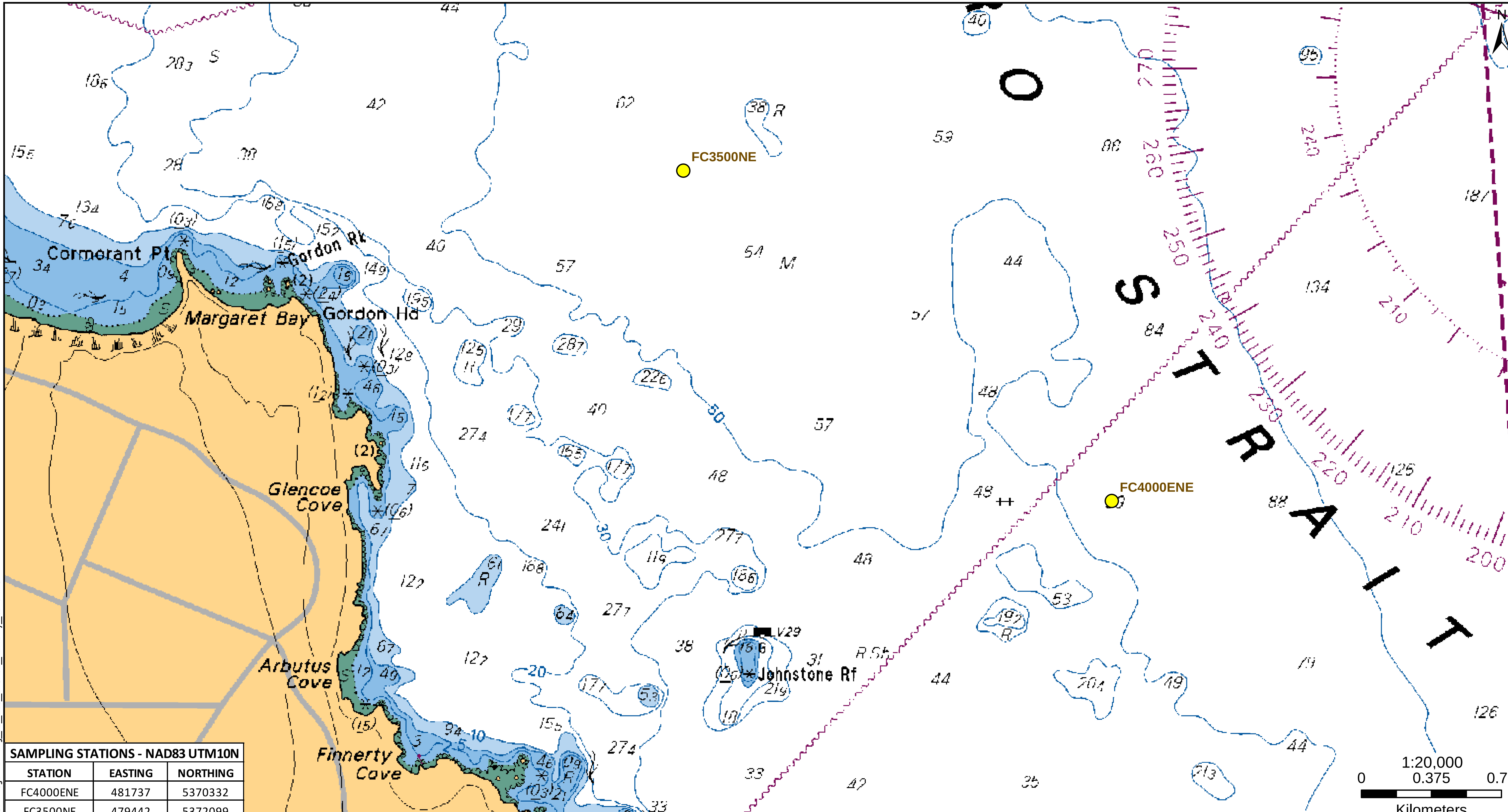

SAMPLING STATIONS - NAD83 UTM10N		
STATION	EASTING	NORTHING
FC4000ENE	481737	5370332
FC3500NE	479442	5372099

Legend

Sediment Sampling Stations

- Finnerty Cove – Pre-Discharge Monitoring Station

Sources: Canadian Hydrographic Survey. 2009. Race Rocks to D'arcy Island. Marine Chart # 3440

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Sediment Sampling Stations Finnerty Cove

WORLEYPARSONS PROJECT No.	FIG No.	REV
307071-00020	12	0

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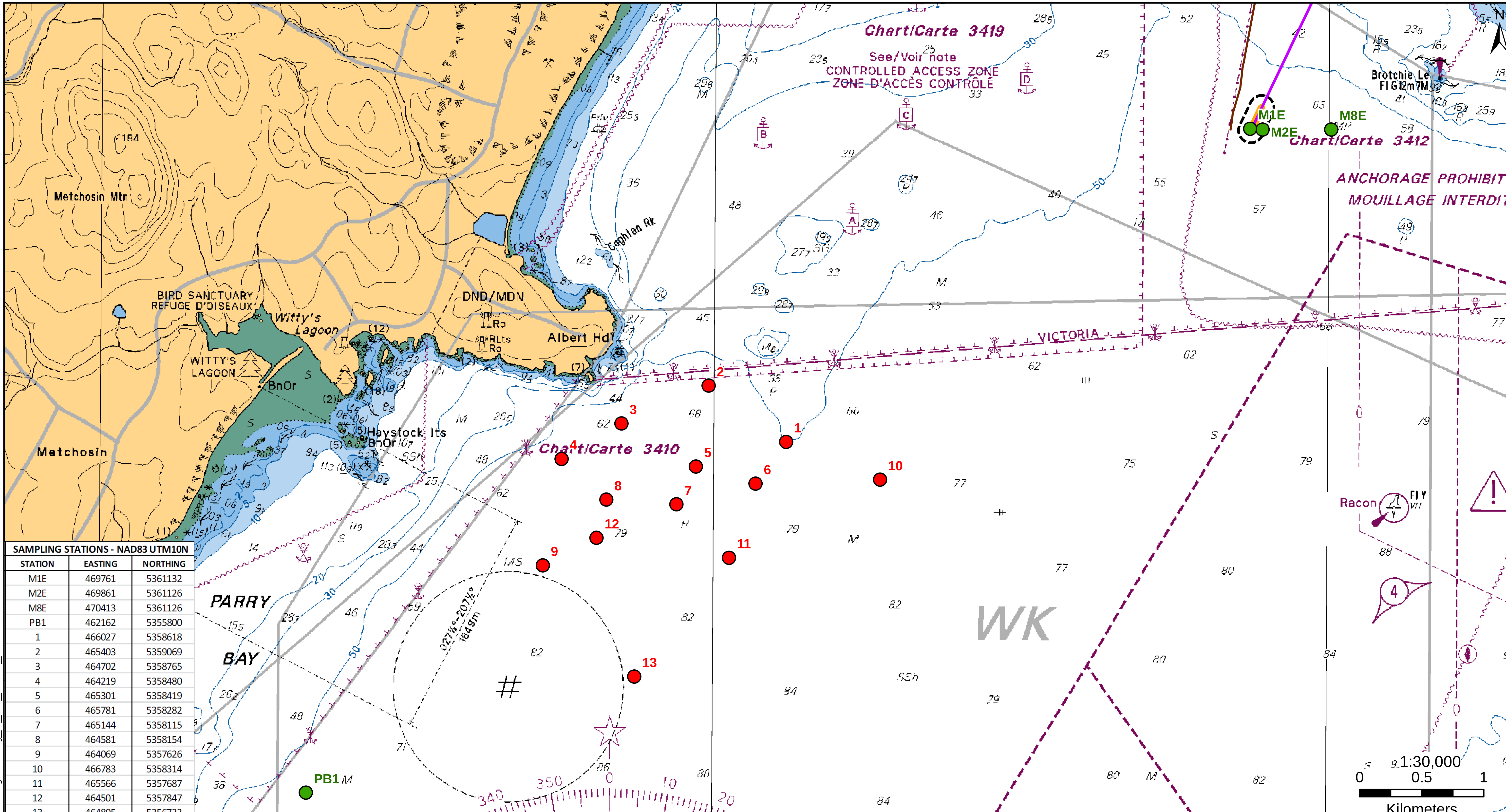

SAMPLING STATIONS - NAD83 UTM10N		
STATION	EASTING	NORTHING
M1E	469761	5361132
M2E	469861	5361126
M8E	470413	5361126
PB1	462162	5355800
1	466027	5358618
2	465403	5359069
3	464702	5358765
4	464219	5358480
5	465301	5358419
6	465781	5358282
7	465144	5358115
8	464581	5358154
9	464069	5357626
10	466783	5358314
11	465566	5357687
12	464501	5357847
13	464805	5356733

Legend

Sediment Sampling Stations

- Albert Head – Pre-Discharge Monitoring Station
- Macaulay Point/Parry Bay Receiving Environment Monitoring Station
- Macaulay Point Outfall
- Proposed McLoughlin Point Outfall
- Diffuser
- Initial Dilution Zone

Sources: Canadian Hydrographic Survey. 2009. Race Rocks to D'arcy Island. Marine Chart # 3440

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Sediment Sampling Stations Albert Head

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FIG No. 13

REV 0

FILE LOCATION: Y:\Yao.Mo\307071-00020\mxds\Stage II EIS\Fig_13_Sed_Station_2010.mxd

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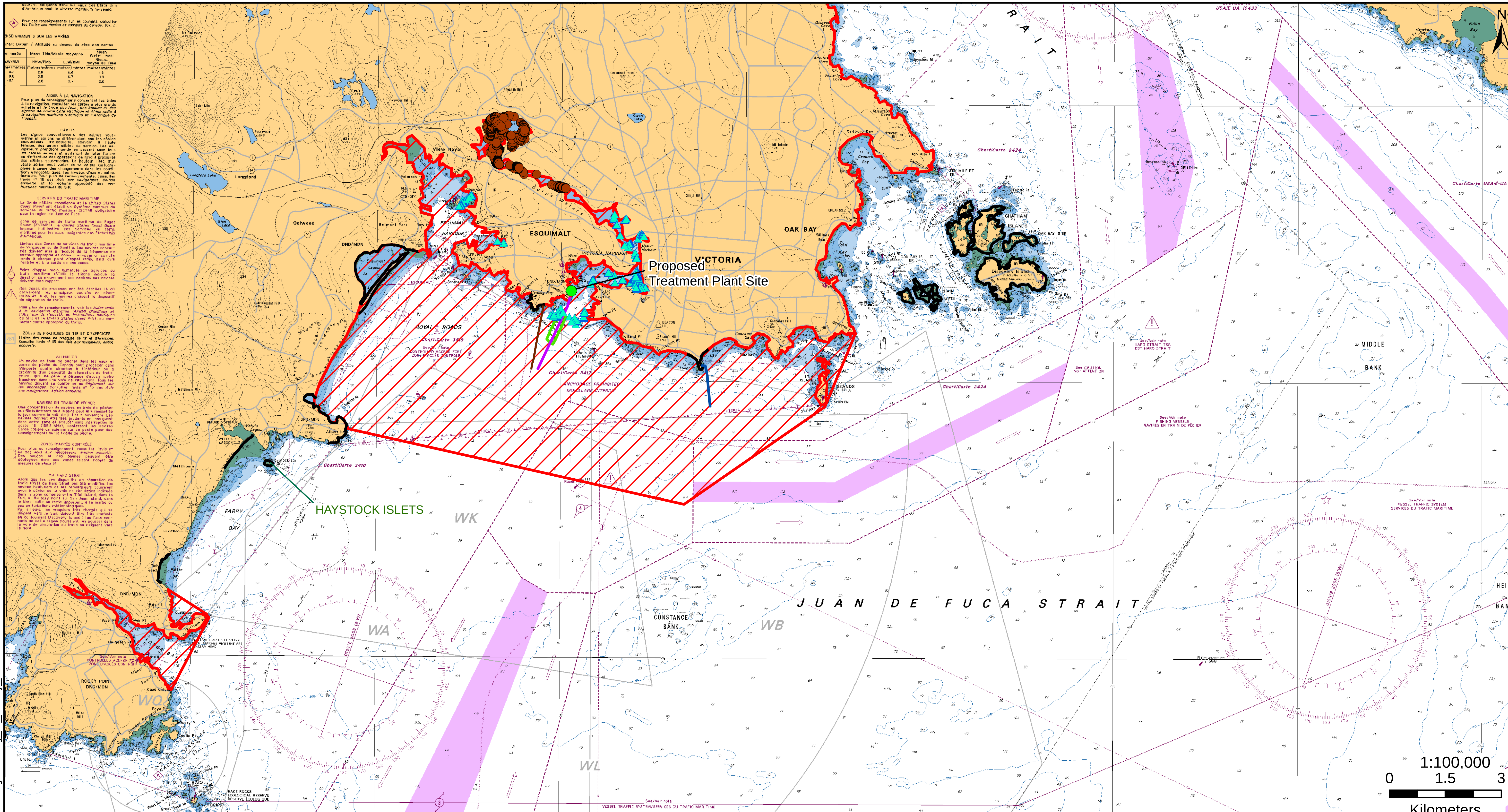

Legend

- Piddock Clams
- Native Oysters
- Bivalve Shellfish Sanitary Closure
- Observed Subtidal Bivalves
- Reported or Predicted Intertidal Bivalves
- Proposed Treatment Plant Site
- Macaulay Point Outfall
- Clover Point Outfall
- Proposed McLoughlin Point Outfall

Sources:
- *Canadian Hydrographic Survey. 2009. Race Rocks to D'arcy Island. Marine Chart # 3440*
- *Fisheries and Oceans Canada, 2009*
- *Capital Regional District, 2012*

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Stage 2 Environmental Impact Study
Shellfish Resources

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307071-00020	14	0

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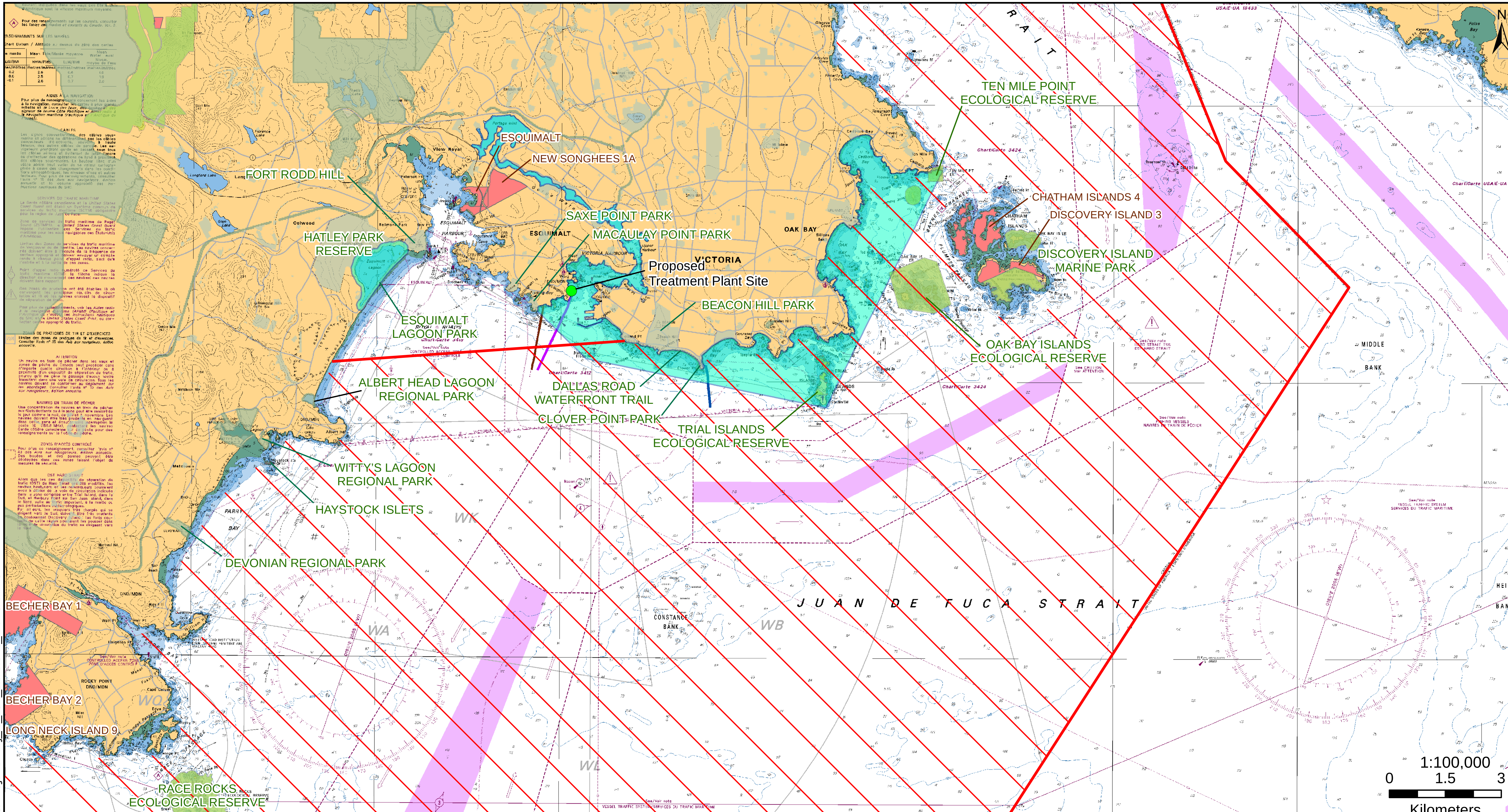

Legend

- Regional Parks
- Provincial Park and Ecological Reserve
- Other Parks
- First Nation Reserve
- Bird Sanctuary
- Southern Resident Killer Whale Critical Habitat (SARA)
- Proposed Treatment Plant Site
- Macaulay Point Outfall
- Clover Point Outfall
- Proposed McLoughlin Point Outfall

Sources:
- Canadian Hydrographic Survey. 2009. Race Rocks to D'arcy Island. Marine Chart # 3440
- Capital Regional District, 2012

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Stage 2 Environmental Impact Study
Parks, Ecological Reserves and First Nation Reserves

WORLEYPARSONS PROJECT No.	FIG No.	REV
307071-00020	15	0

FILE LOCATION: Y:\Yao.Mo\307071-00020\mxds\Stage II EIS\Fig_15_Park_EcoReserve_FirstNation.mxd

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