APPENDIX

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CAPE LAZO OUTFALL ASSESSMENT

COMOX VALLEY WATER POLLUTION CONTROL CENTRE - CAPE LAZO MARINE OUTFALL

Overview Assessment For Potential Upgrades

Technical Memo

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1 Introduction

The Comox Valley Regional District is preparing to upgrade their wastewater treatment system at the Comox Valley Water Pollution Control Centre (CVWPCC) to accommodate capacity for future population growth, and improve effluent quality.

This report is intended to review the state of the current outfall, incorporate updated flow projections and consider present regulatory requirements related to upgrades.

1.1 Scope of Work

The scope of work for this report includes:

- Review the outfall hydraulic performance under future flows from the current service area.
- High level gravity option and cost estimate for upgrading the marine outfall
- Update dilution modelling using future flows for the current service area, and current outfall configuration.
- Provide an opinion on Environmental Impact Study information gaps/requirements to satisfy a *Municipal Wastewater Regulation* Registration.

2 Background

The existing outfall was constructed in 1982. Capacity exceedances under gravity flow conditions have resulted in reliance on overflow basins and pumping on a more frequent basis. Several studies, summarized in ISL 2016, have been completed over the past decade to assess the condition of the outfall and to provide options for upgrading the marine outfall capacity. The work described in this document references and relies on the infrastructure descriptions from the previous studies.

3 Effluent Flows

Effluent flow projections for the CVWPCC from 2020 to 2060 were updated and provided by WSP (pers.com 2019), and are provided in Table 1.

**Table 1	Effluent Flow Projections, 2020-2060**

	2020	2030	2040	2050	2060
Population Projection	45,259	53,018	60,448	68,940	78,645
Flow Projections					
Average Dry Weather Flow (ADWF) (m3/d)	12,885	15,094	17,210	19,627	22,390
Average Day Flow (ADF) (m3/d)	15,542	18,206	20,758	23,674	27,007
Average Wet Weather Flow (AWWF) (m3/d)	21,887	25,640	29,233	33,339	38,033
Max Day Flow (MDF) (m3/d)	37,547	43,984	50,148	57,193	65,244
Peak Hour Flow(1) (PHF) (m3/d)	46,626	54,619	62,274	71,022	81,020
Maximum Instantaneous(2) (m3/d)	49,734	58,260	66,425	75,757	86,421
Maximum Instantaneous (L/s)	576	674	769	877	1,000

(1) Peaking Factor of 3.0 was adapted from the ISL CVWPCC Capacity Assessment (2016).
(2) Peaking Factor of 3.2 was adapted from the ISL CVWPCC Capacity Assessment (2016)

4 Outfall Hydraulics – Existing Infrastructure and Future Flows

The capacity assessment described in ISL 2016 included:

a) Review of outfall condition assessments from 1998 to 2014;
b) Review of a 2006 outfall hydraulic capacity assessment;
c) Development of a hydraulic model of the existing outfall and discharge equalization and pump system; and
d) Development of outfall remediation and/or replacement options and associated costs.

Results of the ISL hydraulic model concluded that:

a) A gravity discharge would be capable of discharging between 370 to 440 L/s depending on the internal pipe friction factors used;
b) The existing pumped discharge is capable of discharging 646 to 728 L/s; and,
c) Replacement of the pumps may increase the discharge to 846 L/s, with a design head loss of 19.1 m.

An updated water level summary for determining the available head room is provided in Table 2.

Table 2 Water Level and Elevation Summary

Description	Elevation (m, Geodetic)
Historical Higher High Water Level	2.1
Net Sea Level Rise (Little River @ 7 mm/year from 2000); 2040/2060	0.28/0.42
Storm Surge Allowance (above historical)	0.3
Total Water Level	**2.68/2.82**
Elevation of Overflow Weir	**8.4**
Head Room	**5.72/5.58**

The head losses for the current outfall infrastructure at year 2040 and year 2060 flows were estimated using GreatPacific's outfall system calculator. Friction losses were determined using the Darcy-Weisbach equation. The results are summarized in Table 3 and Table 4.

Table 3 Head Loss Estimate Summary at 2040 Instantaneous Flows – Existing Infrastructure

Head Loss Component	HW C factor (end of life)	Length (m)	ID (mm)	Velocity (m/s)	Head Loss (m)
Fluid density difference					1.6
Pre-stressed concrete lined pipe (PCCP): Outfall Chamber to Shore	120	2,827	882	1.3	5.0
Steel Pipe – Offshore	90	2,825	845	1.4	10.4
Diffuser (Approximated using 20 m solid pipe)	90	175	591	2.8	0.4
Form Losses Allowance					0.5
Total					**17.9**

Table 4 Head loss Estimate Summary at 2060 Instantaneous Flows – Existing Infrastructure

Head Loss Component	HW C factor (end of life)	Length (m)	ID (mm)	Velocity (m/s)	Head Loss (m)
Fluid density difference					1.6
Pre-stressed concrete lined pipe (PCCP): Outfall Chamber to Shore	120	2,827	882	1.6	8.1
Steel Pipe – Offshore	90	2,825	845	1.8	16.9
Diffuser (Approximated using 20 m solid pipe)	90	175	591	3.6	0.7
Form Losses Allowance					0.5
Total					**27.8**

The following items that have potential of affecting the future outfall system performance were not described in previous studies, but should be addressed as part of future engineering phases:

1. Accommodation of sea level rise
2. Effects of air entrainment (if any) as velocities in the outfall increase.
3. Competence of PCCP pipe to accommodate higher service pressures and risk of rupture/leaks.
4. Insufficient condition assessment data of the offshore steel pipe to adequately estimate a remaining service life.

In consideration of potential options of partial replacement of the outfall, either by replacing only the onshore PCCP pipe, or only the offshore steel pipe in isolation will not eliminate the need for pumping, as leaving either section in service will result in a system head loss that exceeds the available head room of approximately 5.6 m under gravity flow conditions. If pumping, a head of approximately 22.2 m (=27.8-5.6) would be required for the 2060 flows.

GreatPacific's outfall system calculator was used to estimate the pipe diameter for a new HDPE outfall system (replaced along the existing route) that would convey the year 2060 flows by gravity without exceeding the available head room. The results are summarized in Table 5 which identifies that a 54 inch nominal diameter HDPE pipe would be required.

Table 5 Head loss Estimate Summary at 2060 Instantaneous Flows – New Infrastructure

Head Loss Component	HW C factor (end of life)	Length (m)	ID (mm)	Velocity (m/s)	Head Loss (m)
Fluid density difference					1.6
54 inch HDPE: Onshore	130	2,827	1,233	0.84	1.4
54 inch HDPE: Offshore	130	2,825	1,233	0.84	1.4
54 inch HDPE Multiport Diffuser	130	100	1,233	0.84	0.9
Form Losses Allowance					0.2
Total					**5.5**

4.1 Outfall Upgrade Options

Several options for upgrading the outfall in combination with or without pumping were discussed in prior studies. Generally, the options included:

1. Twinning the existing outfall
2. Replace the outfall to accommodate gravity conveyance only
3. Replace the outfall to accommodate forcemain conveyance (several options are possible based on the frequency of pumping)

Twinning the outfall was not a recommended option for the following reasons; and therefore, a cost estimate was not prepared for this option:

1. The remaining service life of the existing outfall is not well defined or understood.
2. There is significant disturbance and related costs associated with the scale of marine excavation works, so it would be inefficient to incur those costs without achieving a renewed outfall conveyance system with capacity adequate to accommodate the full level of service.

Estimating the costs of options involving pumping were also excluded from this assignment.

4.2 Capital Cost Estimates

An estimate (Class D level) of the probable capital construction costs for a new outfall pipeline (2019 CAD) are provided in the table below. Engineering and permitting were not included. The costs are for an all gravity discharge option at 2060 flows.

Table 6 Estimated Construction Costs

Outfall Component	Length (m)	Volume (m^3)	Unit Cost	Cost
Onshore (54” HDPE DR21)	2,827		$2,955	$8,354,000
Onshore Excavation	2,827	15,266	$60	$916,000
Offshore (54” HDPE DR21)	2,825		$4,827	$13,635,000
Multiport Diffuser (54” HDPE DR21)	100			$350,000
Marine Dredging	1,700	29,750	$60	$1,785,000
Total				**$25,040,000**

5 Dilution Modelling Assessment

Preliminary dilution modelling analysis was conducted for the existing diffuser configuration to predict the concentration of wastewater constituents within the effluent plume as it travels away from the outfall terminus. Modelling was conducted using the U.S. Environmental Protection Agency (USEPA) computer modelling package Visual Plumes, which is a recommended dilution model noted in the Ministry of Environment’s EIS guideline document (MELP, 2000).

The Visual Plumes model predicts the dilution of the effluent plume during the initial dilution and the subsequent dispersion. The initial dilution of the effluent plume was modeled using the UM3 model within Visual Plumes which is based on the model UM (Baumgartner, *et al.*, 2001). The subsequent dispersion (Farfield dilution) of the effluent plume uses algorithms developed by N. Brooks (Fisher, *et al.*, 1979).

The initial dilution of the effluent plume occurs as a result of the dissipation of momentum and energy immediately after discharge and the entrainment associated with the buoyant rise of the effluent plume. Initial dilution of the effluent plume continues until it reaches its trapping depth. The effluent plume was modeled to estimate the minimum dilution and the shallowest trapping depth, which are considered two types of “worst case scenarios” for marine discharges.

Dilution modelling was previously conducted during the 2010 Stage II EIS. The modelling performed herein was completed using similar methodology, and input receiving environment characteristics (temperature and salinity profiles and currents speeds). The diffuser configuration was based on the input configuration used in the Stage II EIS. Effluent flow characteristics were updated with the most recent predictions.

5.1 Model Inputs

Dilutions were modelled for the four flow regimes described in Table 7.

Table 7 Effluent Scenarios Modelling Scenarios

Scenario	Year	Flow Regime	Flow (m^3/d)
1	2040	Average Dry Weather Flow (ADWF)	17,210
2	2040	Max Day Flow (MDF) (m3/d)	50,148
3	2060	Average Dry Weather Flow (ADWF)	22,390
4	2060	Max Day Flow (MDF) (m3/d)	65,244

5.1.1 Discharge Characteristics

The model input characteristics of the outfall diffuser configuration are described below in Table 8.

Table 8 Dilution Modelling Parameters

Parameter	Value	Unit
Port Diameters	50	mm
Terminus Elevation above Seafloor	0.8	m
Port Depth	60	m
Port Vertical Angle [3]	90	degrees
Number of Ports[4]	119	
Ports Spacing	0.68	m
Effluent Salinity	0	psu
Effluent Temperature	15	°C
Diffuser angle relative to current direction	90	degrees
Fairfield Dispersion Coefficient	0.000452	$m^{2/3}/s$
Aspiration Coefficient	0.1	
Diffuser Port Contraction Coefficient	0.6	

[3] In actuality, the ports discharge from alternating sides of the pipe. The model assumes all of the ports discharge vertically.

[4] It was assumed there are no breaks in the diffuser, as were reported in previous condition assessments.

5.2 Receiving Environment Characteristics

Dilution modelling was conducted using ambient water properties described in the 2010 EIS.

Water column profiles were used that represent the two extreme seasons:

- a typical summer stratification which was the most stratified water column profile (i.e. lowest salinity, and highest temperature) measured on September 4th, 2008; and,
- a typical winter water column profile which was the least stratified, (highest salinity, and lowest temperature), measured on February 11, 2008.

A range of receiving environment tidal current speeds were modeled, taken from a 2008 current meter deployment.

Previous modelling efforts predicted that the effluent plume would remain trapped below a water depth of 45m during the summer therefore only the deepest available current measurements (40 m water depth) were considered. For winter conditions the trapping depth was predicted to be below 12 m 90% of the time. For modelling purposes, a mid water column (25 m) current speed was considered for the initial dilution and 10 m current speed was consider for the far field.

Five receiving environment flow regimes were modelled (Table 9).

Table 9 Receiving Environment Current Speeds

Scenario	Flow Regime	Winter Farfield (m/s)	Winter Nearfield (m/s)	Summer Farfield (m/s)
		10 m depth	25 m depth	40 m depth
A	99th Percentile	0.96	0.73	0.53
B	90th Percentile	0.58	0.46	0.32
C	50th Percentile	0.17	0.15	0.09
D	10th Percentile	0.06	0.04	0.02
E	1st Percentile	0.02	0.01	0.01

5.3 Modelling Results

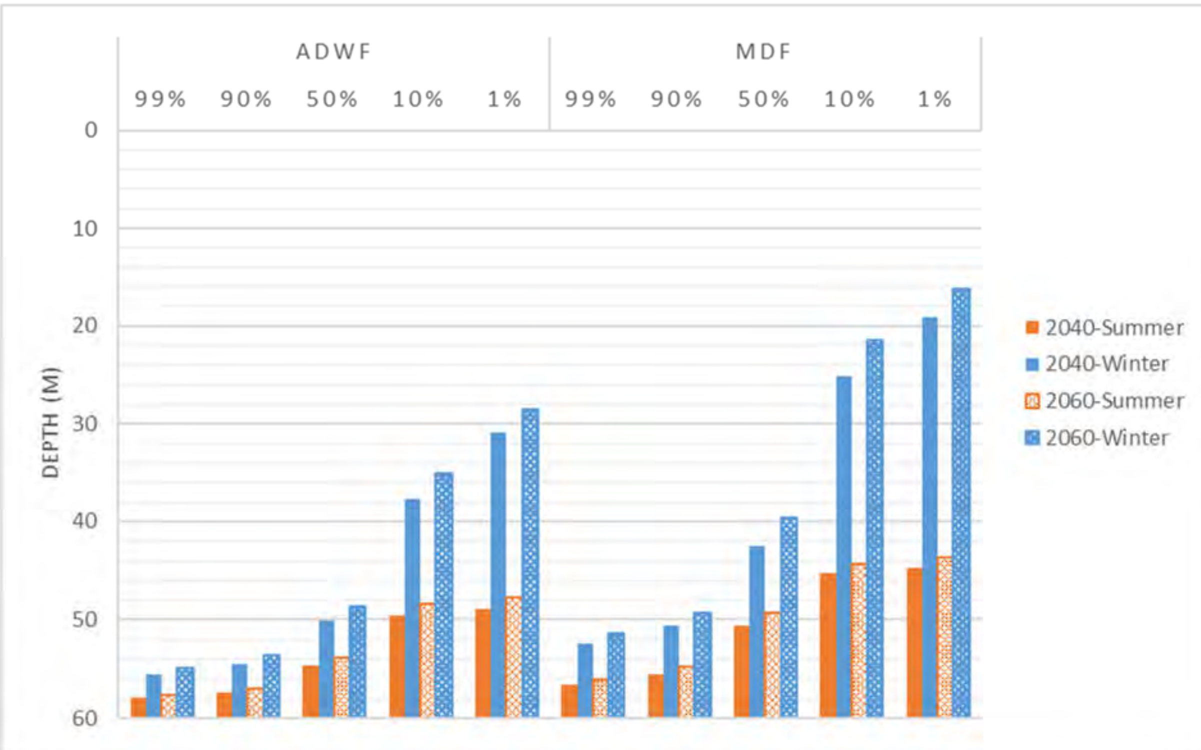
5.3.1 Trapping Depth

The predicted effluent plume trapping depths for each of summer and winter water column stratification profiles are shown in Figure 1.

Predicted trapping depths were determined for different near seabed current velocities during discharge. The minimum (shallowest) trapping depths were predicted to occur during winter conditions with slow current speeds. The mean (50% percentile currents) trapping depth was 40 m or deeper, while a trapping depth less than 20 m was only predicted during max day effluent flows at the minimum (1 percentile) current speed.

Summer trapping depths were predicted to be deeper than 44 m under all conditions modelled.

Figure 1 Predicted Trapping Depth vs Percentile Current Speed



5.3.2 Predicted Dilution

Predicted summer and winter dilutions of the effluent plume at a distance of 100 m away from the diffuser are shown in Figure 2 and at a distance of 400 m away from the diffuser in Figure 3. The results are plotted at each distance in relation to effluent flow rate and modelled current speed.

A distance of 100 m is at the boundary of the initial dilution zone (IDZ). A distance of 400 m is the minimum allowable distance of the point of discharge from harvestable bivalve shellfish.

Note that summer dilutions at 400 m, with a 1 percentile current speed, are not reported as the width of the effluent plume was estimated to exceed the distance from the terminus to shallow water (~500 m) and therefore the predictions provided by the model would be an overestimate of the level of dilution that could actually be achieved in the receiving environment.

Figure 2 Predicted Dilution at 100 m (IDZ) vs Percentile Current Speed

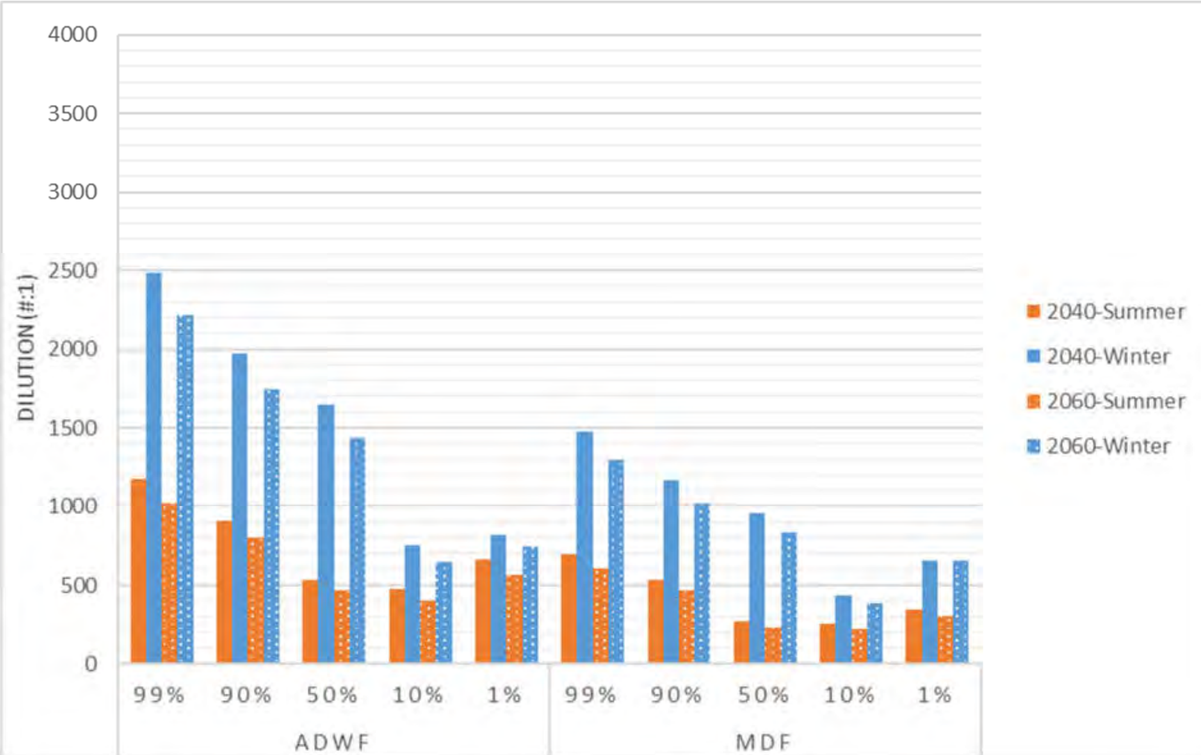
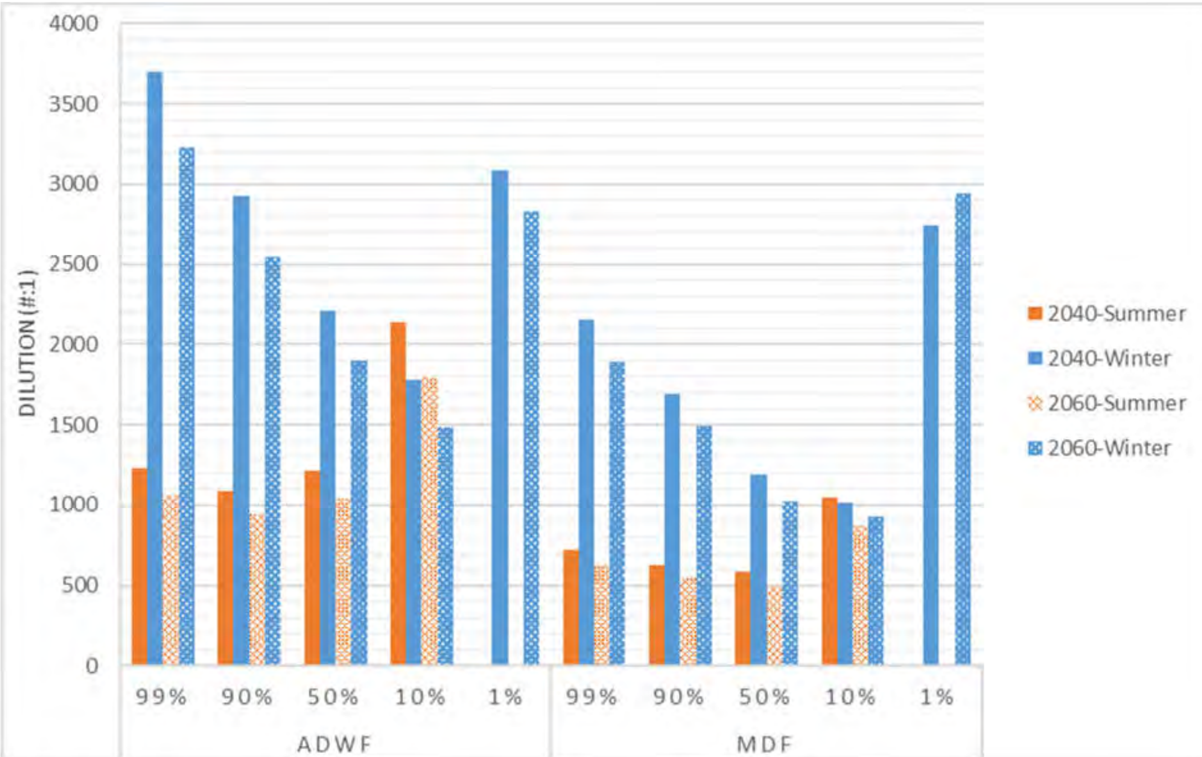


Figure 3 Predicted Dilution at 400 m



There is a general trend of increasing dilution with increasing current speed at a distance of 100 m, with minimum dilutions predicted with the 10th percentile current speeds (i.e. 90% of the time dilutions are predicted to be better).

Minimum dilutions at a distance of 400 m vary depending on the season and current speeds. Summer minimum dilutions are precited with 50th or 90th percentile currents, and minimum dilutions in the winter are predicted with the 10th percentile currents.

The minimum dilutions predicted at 100 m and 400 m distances from the diffuser are provided below in Table 10.

Table 10 Predicted Minimum Dilutions

Year	Effluent Flow Regime	Dilution @ 100 m (#:1)	Dilution @ 400 m (#:1)
2040	ADWF	472	1,083
	MDF	255	588
2060	ADWF	406	947
	MDF	220	487

5.3.3 Bacteria

This report is not intended to evaluate the range of effluent constituents with respect to acceptable levels for the receiving environment, as that analysis should be completed as part of an Environmental Impact Study.

Of particular interest with respect to municipal wastewater effluents is the concentration and potential effects of pathogens in the effluent. This section applies the dilution model results to provide an indication of effluent quality for pathogens. Since it is impractical to test for the presence of every potential pathogen, it is widely accepted that fecal coliform bacteria are used as an indicator species.

The concentration of bacterial constituents (i.e., fecal coliforms and *enterococci*) decreases in the effluent plume at a faster rate than conservative constituents due to additional decay by predation, flocculation, sedimentation and breakdown due to ultraviolet light. However, due to the relatively short time scales for the effluent plume to reach a distance of 400 m (~0.5 hrs at mean current speed) decay has not been considered for this report.

Guidelines for fecal coliform and enterococci are provided as allowable median and 90th percentile concentrations for recreational and shellfish harvesting waters. The stage 2 EIS (WorleyParsons 2010) identified potential geoduck harvesting 400 m inshore of the point of discharge. Also, tidal currents flow toward Comox Bar at the entrance to Baynes Sound; therefore, the receiving environment would be considered bivalve shellfish bearing waters.

If the water body at the point of discharge is interpreted to be shellfish bearing waters, Section 96 of the MWR requires that shellfish harvesting criteria (median or geometric mean MPN of fecal coliform organisms less than 14/100 mL, with not more than 10% of the samples exceeding 43/100 mL) is also to be achieved at the boundary of the IDZ (100 m).

For the purpose of this assignment, median dilution was assumed to be the minimum dilution at ADWF, and the 10th percentile dilution was assumed be the minimum dilution at maximum day flow.

The calculated maximum effluent fecal coliform concentrations to achieve water quality guidelines at 100 m and 400 m are provided in Table 11. The maximum enterococci concentrations are provided in Table 12.

Table 11 Dilution and Maximum Effluent Fecal Coliform Concentrations

Year	Scenario	Water Quality Guideline	Dilution @ 100 m	Effluent Concentration Required to Meet Guideline
2040	MDF	≤ 14 /100 mL (median)	255:1	<3,570 /100 mL
2060	MDF	≤ 14 /100 mL (median)	220:1	<3,080 /100 mL

Table 12 Dilution and Maximum Effluent *Enterococci* Concentrations

Year	Scenario	Water Quality Guideline	Dilution @ 100 m	Effluent Concentration Required to Meet Guideline
2040	MDF	≤ 4 /100 mL (90^{th} percentile)	255:1	<1,020 /100 mL
2060	MDF	≤ 4 /100 mL (90^{th} percentile)	220:1	<880 /100 mL

As described in the Stage 2 EIS, there are several assumptions and approximations integrated into this analysis that could elevate the factor of safety regarding the results. The UM3 model assumes a flat seabed. In the area of the discharge this is not the case and nearby geoduck beds are located at depths less than 20 m. Based on the preliminary modelling, the predicted trapping depth of the effluent plume was deeper than 20 m and therefore much of the effluent is unlikely to reach the shallower shellfish beds. Though, some upwelling south of the outfall was indicated in the Stage 2 EIS.

Despite the requirements contained in the MWR, Environment Canada (EC) will complete their own analysis using three dimensional hydrodynamic modelling to determine water quality effects and associated bivalve shellfish area closures, and may provide advice to MECCS. As part of their analysis, EC will assess virus reduction capability of the wastewater system (treatment combined with dilution). Typically, EC will be interested in the boundaries where 1000:1 dilution is achieved, related to protection of shellfish areas against viruses. The modelling predictions (year 2060; existing outfall infrastructure) in Table 10 showed that a dilution of 1000:1 would not likely be achieved within 400 m of the diffuser location, which could result in modified shellfish harvesting closure areas. If a new outfall were designed, it would be prudent to complete three dimensional hydrodynamic modelling to provide confidence in the assessment of potential effects to nearby shellfish areas.

6 Gap Assessment for Stage 2 EIS

6.1 Outfall Location

A cursory review of the geography, bathymetry and oceanography was conducted to attempt to identify potential alternative outfall locations that would either offer lower construction costs or a high degree of environmental protection. Assuming the treatment plant location would not change, no obvious alternative outfall locations were identified. Any options to the south are faced with challenging bathymetry and closer proximity to Baynes Sound, which is an important shellfish growing area. An offshore area that would be worthy of consideration as an alternative discharge location would be in the vicinity of Little River, as there is proximity from shore to deep water; however, a significant, and likely cost prohibitive overland conveyance distance would be required to reach that area from the existing treatment plant location.

6.2 MWR

Guidance for the Registration of a wastewater treatment system under the MWR, is provided by the Ministry of Environment and Climate Change Strategy (MECCS) at the following website: www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/guidance-forms-and-fees.

During the application phase, MECCS will provide the applicant with an Information Requirements Table (IRT), that outlines the technical submission requirements with respect to the MWR

The existing Stage 2 EIS completed in 2010 was compared against the general IRT table for MWR Registrations. Relevant requirement items are provided in the table below with data gaps identified. Significant future work items are highlighted in yellow.

In general, the EIS is approximately 10-years-old and the associated pre-discharge monitoring data is over 10 years old, which, in our experience would not likely be accepted by MECSS. The site-specific physical oceanography data collected remains relevant and should be included in the registration package, however, it is anticipated that additional, up-to-date baseline monitoring will be necessary.

It is also recommended that First Nations and other stakeholders (e.g. Environment Canada, bivalve shellfish fisheries) be consulted early during the scoping of any additional baseline monitoring work and provided an opportunity to comment on the scope of the EIS.

Table 13 IRT Environmental Impact Study Requirements

IRT Section	Information Required	Data Gap
1.7	**Discharge to Water:**	
1.7.1	Provide a site plan to scale showing the discharge location, the IDZ, other discharges and their IDZ, recreational areas, shellfish harvesting areas, domestic or agricultural water intakes and any other sensitive areas identified in the EIS.	To be reviewed and updated as necessary
1.7.2	Provide the dilution ratio calculation and identify any additional requirements resulting from this.	To be reviewed and updated as necessary
1.7.3	Describe the IDZ and demonstrate how the IDZ meets applicable MWR requirements.	To be reviewed and updated as necessary
1.7.4	Describe the design of the outfall and describe how it meets the requirements of the MWR.	To be reviewed and updated as necessary
1.7.5	Provide critical flow calculation for discharges under 5,000 m^3/d.	n/a
1.7.5	Identify whether the MWR requires advanced treatment (nutrient removal) for the proposed receiving environment.	To be reviewed and updated as necessary
1.7.6	Identify whether the MWR requires an enhanced EIS for the proposed receiving environment. If so, Terms of Reference for the EIS need approval by ENV.	n/a
2	**ENVIRONMENTAL IMPACT STUDIES**	
2.1	Construction	n/a
2.2	Overflow	n/a
2.3	Discharge to Ground	n/a
2.4	**Discharge to Surface Water**	
2.4.1	**Characterize the Receiving Environment**	
2.4.1.1	Provide a figure at an appropriate scale that shows the location of the outfall terminus, the IDZ and the locations of any sensitive receptors (e.g. recreational areas, water intakes, shellfish beds, protected areas, ecosystems at risk etc.). The figure should include topology (contour	Included in 2010 EIS To be reviewed and updated as necessary

IRT Section	Information Required	Data Gap
	lines, bathymetry), dominant current vectors and standard map features (north arrow, scale).	
2.4.1.2	Provide a summary of the seasonal hydrological conditions including tides, currents, flow rates, flushing rates.	Included in 2010 EIS To be reviewed and updated as necessary
2.4.1.3	Provide a summary of the seasonal temperatures, precipitation, wind speeds and direction.	Included in 2010 EIS To be reviewed and updated as necessary
2.4.1.4	Provide a summary of the current and future receiving environment water uses and locations of any public areas, private residences, commercial or recreational fisheries, water intakes or traditional food harvesting areas in relation to the discharge location.	Included in 2010 EIS To be reviewed and updated as necessary
2.4.2	**Characterize the pre-discharge environmental baseline conditions:**	
2.4.2.1	Describe pre-discharge monitoring locations, sampling parameters and frequencies including rational for their selection.	Included in 2010 EIS To be reviewed and updated as necessary
2.4.2.2	Provide a summary of all existing water quality and sediment quality data compared to applicable water and sediment quality guidelines.	Baseline data is now over 10 years old. New baseline data will likely be required. Additional sampling parameters may include metals, hydrocarbons, and emerging contaminants (e.g. personal care product, microplastics)
2.4.2.3	Summarize existing benthic community data including species and abundance.	Baseline data is now over 10 years old and should be updated. Marine tissue analysis (e.g. shellfish, crab, shrimp or prawn) has been identified by First Nations in similar projects.
2.4.2.4	Provide an assessment of seasonal current speed and direction through approved methods such as current meter and drogue study.	Existing data is expected to be sufficient.
2.4.2.5	Assess seasonal water column stratification and ambient conditions through approved methods such as depth	Existing data is expected to be sufficient, but should be

IRT Section	Information Required	Data Gap
	profiles of temperature, dissolved oxygen, conductivity, pH and salinity.	included with any updated baseline water quality monitoring.
2.4.2.6	Do a hydrodynamic analysis of minimum available dilution and mixing in the receiving environment using approved methods.	Analysis update required if new outfall is going to be installed, or higher flow capacity is required.
2.4.2.7	Assess flushing rates or lack thereof and determination of any known back eddies. For proposed discharges into lakes assessment of limnology including stratification and overturn, average yearly lake outflow, theoretical detention time.	Included in 2010 EIS To be reviewed and updated as necessary
2.4.2.8	If daily flow is more than or equal to 50 m3/day then the ammonia discharge limit must be back calculated from the edge of the IDZ. Provide the ammonia back calculation and provide rational for assumptions used in the calculation.	Minor update with final design flow projections used.
2.4.3	**Impact Assessment**	
2.4.3.1	Identify spatial and temporal boundaries for the effects prediction for each phase of the project.	Included in 2010 EIS To be reviewed and updated as necessary
2.4.3.2	Provide an interaction table that identifies potential interactions between the various project phases and activities and the identified receptors. Describe how the phase or activity has the potential to interact with the receptors.	Required
2.4.3.3	Identify human and biological receptors that have potential to interact with the discharge. It is recommended that a Conceptual Site Model (CSM) is used as a framework to describe the environmental conditions, contaminant pathways and linkages between water, groundwater, and sediment, human and ecological receptors.	Required
2.4.3.1	Evaluate and describe each contaminant in the discharge, its pathway through the receiving environment food web including linkages between environmental media types (e.g. water, sediment, groundwater), human and ecological receptors and potential for trophic transfer of	Required

IRT Section	Information Required	Data Gap
	contaminants (e.g. bioconcentration and/or bioaccumulation).	
2.4.3.2	Provide predicted concentrations of effluent parameters at the edge of the IDZ based on dilution and plume dynamics modelling under various effluent discharge scenarios (e.g. minimum, average and maximum flow) and receiving environment conditions (e.g. seasonal variations, average and storm conditions, tide cycles etc.).	Analysis update required if new outfall is going to be installed, or higher flow capacity is required.
2.4.3.3	Compare predicted concentrations to applicable WQG (e.g. provincial or federal) and other relevant scientific studies of sensitivity estimates of biological effects. Include a comparison to Fecal Coliform limits from MWR s.96.	Analysis update required if new outfall is going to be installed, or higher flow capacity is required.
2.4.3.4	Provide a detailed discussion of predicted incremental increases in relevant ambient parameters and assess the residual impacts on identified receptors including but not limited to: assessment of acute and chronic toxicity, oxygen depletion, microbiological loading, nutrient loading, thermal effects, biodiversity effects, and bioconcentration or bioaccumulation effects.	Required
2.4.3.5	Establish applicable effluent and receiving environment water quality requirements and demonstrate that the proposed treatment works and discharges from these will not adversely affect public health or the receiving environment and, if necessary, establish additional municipal effluent quality requirements to ensure protection of public health and the environment.	Required
2.4.4	**Cumulative Effects**	
2.4.4.1	Identify current and future point and non-point sources of the discharge on the receiving environment.	Included in 2010 EIS To be reviewed and updated as necessary
2.4.4.2	Assess the impact of combined discharges on identified receptors including incremental changes in receiving environment water and sediment quality and the implication these impacts may have on identified receptors.	Included in 2010 EIS To be reviewed and updated as necessary

IRT Section	Information Required	Data Gap
2.4.4.3	Based on the EIS, determine which reliability category applies to the proposed wastewater facility.	Included in 2010 EIS To be reviewed and updated as necessary
3	**RECEIVING ENVIRONMENT MONITORING**	
3.2	**Discharge to Surface Water**	
3.2.1	Provide a figure showing the location of the outfall, the IDZ, and all monitoring stations for water, sediment and biota including a reference (control) station.	Included in 2010 EIS To be reviewed and updated as necessary
3.2.2	Locate at least one control sampling station upstream, upgradient or outside the influence of the IDZ.	Included in 2010 EIS To be reviewed and updated as necessary
3.2.3	Provide a table that summarizes monitoring station ID, coordinates, water depth, monitoring parameters and frequencies. Include rational for the selection of sites, parameters and frequencies.	Included in 2010 EIS To be reviewed and updated as necessary
3.2.4	Describe sampling equipment, sampling methods, field and laboratory QA/QC methods and criteria, methods of data analysis including comparison to applicable water and sediment quality guidelines, reference sites and/or other established receiving environment benchmarks, data interpretation and reporting cycle.	Included in 2010 EIS To be reviewed and updated as necessary
3.2.5	Follow ENV approved methods for sample collection and analysis of the environmental media type (e.g. water, sediment) and the specific parameters (e.g. 5 samples collected in 30 day period for microbiological and nutrient analysis).	Included in 2010 EIS To be reviewed and updated as necessary
3.2.6	Provide monitoring results in tabular form and compare them to applicable benchmarks and reference sites.	Included in 2010 EIS To be reviewed and updated as necessary

Source: www2.gov.bc.ca/assets/gov/environment/waste-management/waste-discharge-authorization/guides/irt/irt-mwr-01_irt_for_municipal_wastewater.pdf

7 Conclusions/ Recommendations

Based on the work completed for this assignment, the following conclusions and recommendations are offered:

1. The limited head room for an all-gravity discharge will necessitate a larger than economically efficient pipe diameter, operating at lower flow velocities. It will likely more economical to combine a new outfall pipe (larger diameter than what currently exists) with pump assistance and/or temporary storage to address the uppermost conveyance capacity requirements.
2. Although the dilution modelling was completed for the existing diffuser configuration (as this is what would likely need to be approved in the immediate future), a new diffuser design, with much fewer ports, is recommended for any new outfall that is constructed to realize improvements in hydraulic efficiency and dilution performance.
3. Effluent plume dilution and dispersion analysis should be conducted for any new outfall/diffuser upgrade that is designed. As identified in Section 5.3.3, three dimensional hydrodynamic modelling should be considered. This analysis could likely be issued as an addendum to the EIS that assesses water quality effects to verify that public health and the environment will be adequately protected.
4. Based on the dilution modelling analysis, the recommended maximum fecal coliform and *Enterococci* concentrations in the effluent would suggest disinfection of the effluent should be implemented.
5. Further work is recommended to update the 2010 Stage II EIS as outlined in Section 6.2.

8 References

Baumgartner, L.R., et al. 1979. Dilution Models for Effluent Discharges. 4th ed. Washington DC: USEPA

Fisher, H.B., E.L. List, R.C.Y. Koh, J. Imberger, and N.H. Brooks. 1979. Mixing in inland and coastal waters. Academic Press. Orlando.

ISL Engineering. 2016. Cape Lazo Outfall Capacity Assessment. Report to Comox Valley Regional District.

Ministry of Environment Land and Parks (MELP). 2000. Environmental Impact Study Guideline – A Companion Document to the Municipal Sewage Regulation.

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