Final Report

Forcemain Re-alignment Study (2005)

December 2005

submitted to

REGIONAL DISTRICT
Comox-Strathcona

submitted by

CH2MHILL
Responsible Solutions for a Sustainable Future®

W102005003VBC

CH2M HILL
Metrotower II – Suite 2100
4720 Kingsway
Burnaby, BC V5H 4N2
Canada
Tel: 604.684.3282
Fax: 604.684.3292
www.ch2mhillcanada.com

CH2MHILL
Responsible Solutions for a Sustainable Future®

December 2, 2005

332069/W102005003VBC

Mr. Graeme Faris
Regional District of Comox-Strathcona
600 Comox Road
Courtenay, BC V9N 3P6

Subject: Forcemain Re-alignment Study – Final Report

Dear Mr. Faris,

CH2M HILL is pleased to submit three copies of the Final Forcemain Re-alignment Study (2005) and a CD containing a PDF version for your review.

Please feel free to contact myself at 604-439-2362 if you have any questions or comments.

Sincerely,

CH2M HILL

Trevor Jones, P.Eng.
Project Manager

Contents

List of Exhibits

Executive Summary

The Regional District of Comox-Strathcona (Regional District) owns and operates a major pump station and forcemain system that services the communities of Comox and Courtenay (See Exhibit 1–1). The system was constructed in the early 1980s and has performed well. The final section of the forcemain runs along the beachfront below the Willemar Bluffs between Goose Spit and a location on Curtis Road. At Curtis Road, the forcemain turns inland and ends at the Comox Valley Water Pollution Control Centre (CVWPCC).

In 2002, the Regional District discovered that changes to erosion and deposition patterns along the beach had exposed sections of the forcemain and had removed protective cover material along a significant section of the forcemain route. The Regional District has taken steps to protect the forcemain, but has concluded that it cannot continue to use the existing section of forcemain due to the risk to the environment and to public health and safety.

In June 2005, the Regional District retained CH2M HILL to conduct a concept-level study of replacement options for the forcemain section along Willemar Bluff. The objective of the study is to provide recommendations for an alignment for the forcemain relocation. The study scope included reviewing alternate forcemain alignments, and determining the infrastructure necessary to replace this section of the existing forcemain.

This report contains the results of the study.

Recommended Force Main Alignment

CH2M HILL has evaluated four alignment alternatives and recommends a forcemain alignment that intercepts the existing force main on the beach at the south end of Croteau Road, follows Croteau Road north, Lazo Road east, Moreland Road north to Noel Avenue. At this point it turns east, crossing Lazo Marsh to Brent Road east and to the Pollution Control Centre. This alignment follows public road right-of-ways in its entire length of approximately 3,330 m, except the approximately 100 m long wetland crossing. (See Exhibit 3-5)

The alignment includes the construction of a new pumping station along Croteau Road, the extension of the existing force main to the new pump station (380 m), a new force main from the pump station to a high point along Lazo Road (880 m) and a gravity pipe from the high point to the Pollution Control Centre (2,070 m) and various structures along the alignment. The gravity section of the pipe includes an inverted siphon at the wetland crossing (930 m) (See Exhibit 3-6). A potential variation of this alignment alternative is a direct connection between a point approximately 250 m south of Noel Avenue in Moreland Road and the Pollution Control Centre, if right of way could be acquired through private land. This variation would reduce the length of the siphon by approximately 550 m.

Wastewater Flows and Projections

Design flow rates for the purposes of this project are based on the following assumptions:

- The current daily average wastewater generation will remain approximately the same for the study period of 50 years
- The rate of population growth observed in the past five years will remain the same throughout the study period of 50 years
- Wet weather infiltration and inflow rates will not significantly increase over the currently observed rates due to improved design and construction practices.

The assessment of flow and population data revealed that the average wastewater flow rate is approximately 355 liter/capita/day in the communities of Comox and Courtenay, which includes dry weather groundwater infiltration into the system.

The populations of Comox and Courtenay have grown at approximately 3 percent and 3.5 percent annually, respectively. While long term growth rates may not be sustainable at this level, but the values were adopted to allow CH2M HILL to estimate the average wastewater flow rates in 50-year time when the new infrastructure is expected to reach its design capacity.

Wet weather infiltration and inflow rates are estimated to be 9,300 m^3/day for the Courtenay and 7,600 m^3/day for the Comox pump station.

The Regional District only records total day flows at the two pump stations. CH2M HILL estimated peak hourly flow rates using the empirical Harman formula.

Design flow rates for the system, based on the above set of criteria, and is estimated as follows:

RDCS Wastewater Force Main Realignment		2005	2055
Population:			
	Courtenay	12,400	124,300
	Comox	22,300	54,200
	TOTAL	**34,700**	**178,500**
Average Daily Wastewater Generation (Liter/capita/day)		355 L/c/d	355 L/c/d
Average Wastewater Flow (m^3/day)			
	Courtenay	7,800 m^3/day	44,200 m^3/day
	Comox	4,500 m^3/day	19,200 m^3/day
	TOTAL	**12,300 m^3/day**	**63,400 m^3/day**
Average Total Wastewater Flow (l/s)		142 l/s	733 l/s
Peaking Factor (Harman formula)		2.42	1.81
Peak Hourly Dry Weather Flow Rate (l/s)		**344 l/s**	**1,325 l/s**

Wet Weather Infiltration and Inflow (m^3/day)			
	Courtenay	9,300 m^3/day	9,300 m^3/day
	Comox	7,600 m^3/day	7,600 m^3/day
	TOTAL	**16,900 m^3/day**	**16,900 m^3/day**
Total Wet Weather Infiltration and Inflow (l/s)		**196 l/s**	**196 l/s**
Design Wastewater Flow Rate (Peak Hourly Dry Weather Flow Rate + Wet Weather I/I)		**540 l/s**	**1,520 l/s**

The design flow rate for the force main realignment project is 1,520 l/s, which is estimated to be reached by the year of 2055.

The scope of services for this assignment did not include the evaluation of the wastewater collection and conveyance system in the tributary areas of Comox and Courtenay. The wastewater collection strategy developed in the early 1980's remains as the basis for operations. However, with actual development now in place and more up to date plans for development within the two communities and surrounding areas, the Regional District should consider performing an update of this collection system master plan. An updated plan could lead to re-routing wastewater flows and potentially reducing operating costs, reducing the capital cost of the infrastructure discussed in this report, and extending the service life of the existing pumps, and changing the design criteria for this force main realignment project.

Proposed Pipeline Sizing

The proposed force main includes both gravity and pressure pipe sections with variable design criteria for each section:

- Force main from the new pump station to the high point in Lazo Road. The size of the pipe is defined based on the optimum life time cost of the pipe, which include the cost of construction of the pipe and the cost of pumping through the pipe. The estimated life time cost is virtually identical for pipe from 750 mm to 1,000 mm in internal diameter. However, an escalation in energy cost is anticipated in the future which makes the selection of the larger pipe a prudent investment. The recommended pipe therefore is 1,000 mm (40 in) HDPE. The force main extension between the point of diversion to the pump station should be of the same size.
- Gravity pipe from the high point on Lazo Road to the inlet of the inverted siphon. The objective in this section is to maintain an open channel flow for odor control. The recommended conduit is 1,050 mm (42 in) Weholite gravity pipe.

The objective for the inverted siphon at the wetland crossing is minimum hydraulic losses through the structure. The recommended pipe is 1,200 mm (48 in) HDPE, that withstands the low pressures encountered in this section.

Croteau Road Pump Station

The Regional District will need to construct a major wastewater pump station along Croteau Road. The proposed plan includes constructing the pump station in a location approximately 17 metres above sea level (i.e. near the intersection of Croteau and Ducliddle roads) in order to maintain the existing operating conditions at the Courtenay and Comox pump stations and to maximize the capabilities of the existing pumps. This approach also reduces the size and power requirements for the new pumps when compared to building a pump station at sea level.

The proposed pump station consists of a below grade wet well and superstructure that includes an electrical room, janitorial area and washroom.

The Regional District would install three, 475 hp, submersible pumps (two duty, one standby) initially. The pump station will include a spare space for the installation of one more pump for future flows. Each pump has a capacity of 500 L/s.

The location of the new pump station could enable the Regional District and the Town of Comox to divert a portion of flows from the Comox pump station thereby reducing flows to the existing pump station and deferring the replacement of the pumps. A very cursory investigation indicates that the Regional District could divert five percent of current flows. However, a more detailed assessment may show that a significantly larger proportion of flow could be diverted.

The Regional District needs to install an odour control system to treat the air from the pump station. The location and odour control philosophy must be developed further during the next phase of the project.

There do not appear to be significant geotechnical, environmental impact, or contaminated site issues at the proposed site although complete investigations must be performed in the next phase of project development.

The impact of the new pumping station on the BC Hydro electrical system was not evaluated at this stage of the project. However, CH2M HILL suspects that a relatively major upgrade to their system will be required. The Regional District should address this issue during the next phase of project development.

Cost Estimates

The total estimated capital cost for this project is $8.25 million

Operating and maintenance costs are estimated at $250,000 per year

The cost estimate does not include the costs related to BC Hydro system upgrades.

Constructability Issues

CH2M HILL anticipates few difficult construction related issues on this project. However, key areas that need attention during design include the tie-in location to the existing forcemain and the connection to the CVWPCC inlet works.

1. Introduction

The Regional District of Comox-Strathcona (Regional District) owns, operates and manages on behalf of the City of Courtenay and Town of Comox a major pump station and forcemain system that services the communities of Comox and Courtenay (See Exhibit 1–1). The system was constructed in the early 1980s and has performed well. The final section of the forcemain runs along the beachfront below the Willemar Bluffs between Goose Spit and a location on Curtis Road. At Curtis Road, the forcemain turns inland and ends at the Comox Valley Water Pollution Control Centre (CVWPCC).

In 2002, the Regional District discovered that changes to erosion and deposition patterns along the beach had exposed sections of the forcemain and had removed protective cover material along a significant section of the forcemain route. The Regional District has taken steps to protect the forcemain, but has concluded that it cannot continue to use the existing section of forcemain due to the risk to the environment and to public health and safety.

In June 2005, the Regional District retained CH2M HILL to conduct a concept-level study of replacement options for the forcemain section along Willemar Bluff. The objective of the study is to provide recommendations for an alignment for the forcemain relocation. The study scope included reviewing alternate forcemain alignments, and determining the infrastructure necessary to replace this section of the existing forcemain.

The study included an assessment of population growth and the development of flow projections to 2055 and also recommended an alignment, developed conceptual capital cost estimates, and produced concept-level drawings of the proposed new system.

This report summarizes CH2M HILL's work.

The following data has been provided by the Regional District and used to prepare this report:

- Dayton and Knight Report regarding pump station capacities
- Asbuilts Drawings for the existing forcemain
- 2004 Populations and growth projections for Comox and Courtenay
- Daily Flow Volumes (March 1999 to summer 2005)
- 2 m contours for Comox and Courtenay (GIS format)
- Orthophotos for Comox and Courtenay
- Road right-of-way data (GIS format)

2. Evaluation of Existing System

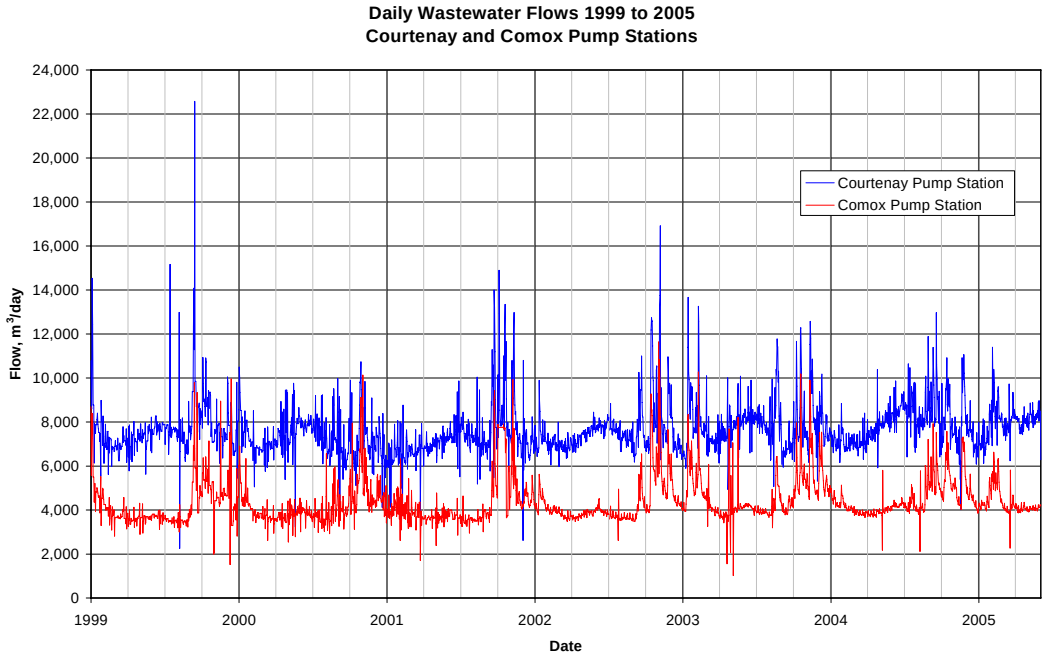
2.1 Population Served

The existing system services the municipalities of Courtenay and Comox, the Comox First Nation Band located between the two municipalities, and the HMCS Quadra training base on Goose Spit. In 2004, the system served populations of approximately 21,500 in Courtenay and 12,000 in Comox, totaling 33,500 between the two municipalities. The 2005 populations for Courtenay and Comox, respectively, are estimated to be 22,300 and 12,400, totaling 34,700 for the service area. The wastewater flows from the Comox First Nation Band and HMCS Quadra are minimal compared to the flows from the two municipalities; therefore this study does not evaluate them any further. It is assumed that the capacity requirements identified for Courtenay and Comox include flows from the First Nation Band and HMCS Quadra throughout the study period.

2.2 Existing Wastewater Flows

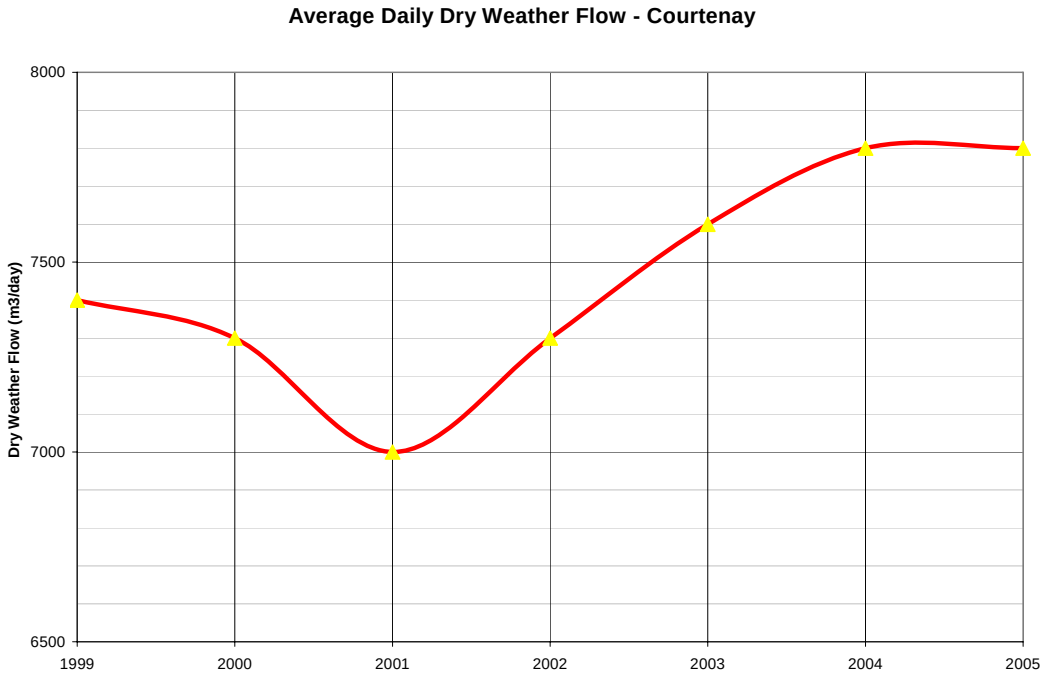
The Regional District has provided daily flow measurement for the pump stations from 1999 to 2005, which this study has used for flow analysis. Exhibit 2-1 shows the observed flows at the Courtenay and Comox pump stations.

EXHIBIT 2-1
Observed Daily Flows at the Courtenay and Comox Pump Stations



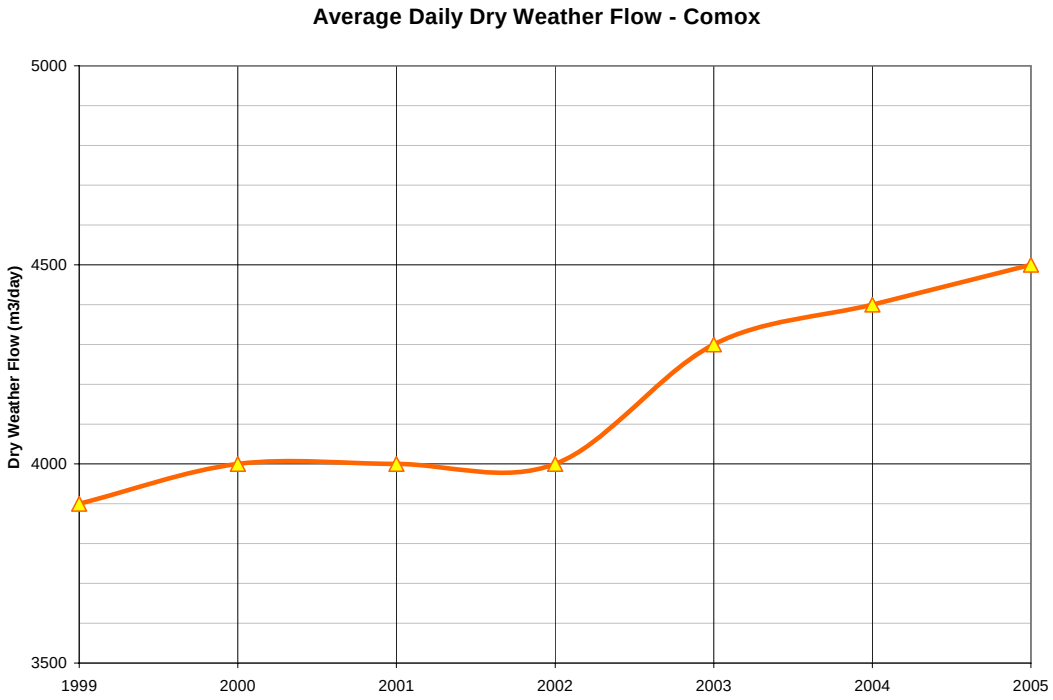
The flow records indicate some seasonal variation of the wastewater flows with several high flow events that have resulted from wet weather infiltration and inflow (I/I). For future population-based wastewater flow projections, the wet and dry weather flows must be separated and an Average Dry Weather Flow (ADWF) must be defined for each of the pump stations. The yearly ADWF for the Courtenay pump station has varied greatly since 1999. That year, it averaged 7,400 m^3/day, whereas it dropped to 7,000 m^3/day in 2001, and then gradually increased to 7,800 m^3/day in 2004 and 2005. The average yearly increase in ADWF from 2001 to 2005 is approximately 3 percent. Exhibit 2-2 shows the variation of the dry weather flow rates for the Courtenay pump station throughout the observation period.

EXHIBIT 2-2
Average Daily Dry Weather Flow - Courtenay



The yearly ADWF for the Comox pump station has also varied. In 1999, it averaged 3,900 m^3/day, and has gradually increased to 4,500 m^3/day in 2005. The average yearly increase in ADWF from 2001 to 2005 is approximately 3 percent. Exhibit 2-3 shows the variation of the dry weather flow rates for the Comox pump station throughout the observation period.

EXHIBIT 2-3
Average Daily Dry Weather Flow - Comox



Based on the 2005 population and ADWF, the daily per capita wastewater flow contribution is 355L for both communities, including the dry weather base infiltration.

There is no continuous digital flow monitoring at either of the pump stations or the wastewater treatment plant; therefore, the hourly peak flow rates need to be estimated using an empirical peaking factor (Harman) formula. The estimated hourly wastewater peak flow rates in 2005 are 146 L/s for Comox, 240 L/s for Courtenay, and the combined total is 346 L/s, as Exhibit 2-4 shows. These values were used to evaluate the performance of the existing system and as a basis for projecting future wastewater flows.

EXHIBIT 2-4
Estimated Hourly Wastewater Peak Flow Rates - 2005

	Comox	Courtenay	Total
Population 2005	12,400	22,300	34,700
Average Daily Dry Weather Flow	4,500 m^3/day	7,800 m^3/day	12,300 m^3/day
Unit Wastewater Flow	355 L/c/d	355 L/c/d	355 L/c/d
Average Wastewater Flow	51 L/s	92 L/s	143 L/s
Peaking Factor	2.86	2.61	2.42
Peak Hourly Wastewater Flow	**146 L/s**	**240 L/s**	**346 L/s**

Appendix D contains a detailed discussion of the provision of data collection and pump station control through the use of a SCADA (computer) system. (To be provided later)

2.3 Wet Weather Infiltration and Inflows

The 1999 to 2005 flow records indicate numerous wet weather high flow events. The wet weather flows (WWF) have been defined as a difference of the observed flow rate for the day and the ADWF. During the approximately five-year observation period, there were 114 events at the Courtenay pump station and 282 events at the Comox pump station when the daily flow exceeded the ADWF by more than 30 percent. Exhibit 2-5 shows the twenty-five largest wet weather events for the two pump stations.

Of the 30 largest events, the ratio of the WWF and the ADWF varied between 1.61 and 2.23 for the Courtenay pump station for 29 of the events, and there was one extreme event on November 12, 1999 when the ratio was 3.05. That extreme event led to the implementation of several I/I reduction improvements. Therefore, the next largest event on January 4, 2003, with 2.23 ratio and 9,315 m^3/day wet weather I/I, was selected as the maximum wet weather I/I for the Courtenay pump station.

Of the 30 largest events for Comox, the ratio of the WWF and the ADWF varied between 1.94 and 2.91. The largest event with 2.91 ratio 7,635 m^3/day wet weather I/I occurred on December 31, 2002 and was selected as the maximum wet weather I/I for the Comox pump station.

The Regional District has indicated that both the Courtenay and Comox collections systems have significant I/I issues that impact design flows for the system. While both communities have invested in I/I reduction over the last few years, high wet weather flows will likely continue and must be considered in the development of the pumping station. New development should, however, follow current construction standards for pipes (e.g. pressure testing) to minimize infiltration, and design principles (e.g. connecting roof drains to storm drains rather than to sanitary sewers) to minimize inflows. For this study, it was therefore assumed that future I/I would not significantly increase over the current maximum I/I rates (9,300 m^3/day [108 L/s] for Courtenay and 7,600 m^3/day [88 L/s] for Comox).

2.4 Consideration of the Basis for Evaluation

The wastewater conveyance philosophy currently followed by the Comox, Courtenay and the Regional District forms the basis for this evaluation. All wastewater from Comox and Courtenay flows to the respective pump stations and then gets pumped to the CVWPCC.

CH2M HILL has reviewed the recently prepared "Long Range Development Plan" for the two communities. This plan shows significant future development potential to the north and east of the existing communities. The recommended new forcemain alignment requires the Regional District to pump wastewater over the top of a large ridge that lies between the pump stations and the CVWPCC. Several of the future development areas appear to lie on the CVWPCC side of the ridge and it may be more cost effective to transfer the wastewater generated in these areas to the plant by a more direct route.

The Regional District has not performed a formal evaluation of regional wastewater conveyance approaches since the early 1980's when Comox and Courtenay were much smaller communities. The growth patterns of the communities and future development plans indicate that the conveyance strategy originally developed may no longer be valid and the Regional District, Comox, and Courtenay could benefit from an update to their sewerage master plan. Potential benefits of reviewing the existing master plan include:

Extended service life of the existing pumps at the Comox and Courtenay pump stations by reducing flows to the pump stations.

Reduced operating costs by reducing the amount of wastewater that needs to be pumped over the ridge.

Reduced or deferred capital costs related to the new pump station by reducing the infrastructure that the Regional District needs to construct now to handle future growth demands.

Reduced capital cost related to the forcemain as the result of reducing the long term maximum flow criteria through the pipe. This could lead to the installation of a smaller pipe and the resulting reduction in capital cost.

CH2M HILL recommends that the Regional District consider completing a more comprehensive sewerage master planning study prior to committing to the design as developed as part of this current assignment.

EXHIBIT 2-5
Wet Weather Flow Rates 1999 to 2005

Courtenay Pump Station				Comox Pump Station			
Date	Observed Flow m^3/day	Wet Weather I/I m^3/day	WWF/ADWF Ratio	Date	Observed Flow m^3/day	Wet Weather I/I m^3/day	WWF/ADWF Ratio
11/12/1999	22,571	15,171	3.05	12/31/2002	11,635	7,635	2.91
01/04/2003	16,915	9,315	2.23	12/31/2000	10,129	6,129	2.53
12/02/2001	14,892	7,892	2.13	01/02/2003	10,839	6,539	2.52
09/12/1999	15,164	7,764	2.05	11/11/1999	9,792	5,892	2.51
11/20/2001	13,994	6,994	2.00	02/10/2000	9,953	5,953	2.49
03/04/1999	14,531	7,131	1.96	01/05/2002	9,919	5,919	2.48
12/17/2001	13,348	6,348	1.91	11/18/1999	9,336	5,436	2.39
11/10/1999	14,075	6,675	1.90	04/08/2003	10,267	5,967	2.39
11/21/2001	13,188	6,188	1.88	12/17/2003	10,179	5,879	2.37
12/03/2001	12,916	5,916	1.85	11/21/2001	9,428	5,428	2.36
01/03/2003	13,743	6,143	1.81	12/12/2002	9,274	5,274	2.32
03/14/2003	13,662	6,062	1.80	12/26/2000	9,119	5,119	2.28
01/08/2002	12,975	5,675	1.78	12/16/2003	9,777	5,477	2.27
12/16/2001	12,284	5,284	1.75	01/08/2004	9,895	5,495	2.25
10/05/1999	12,984	5,584	1.75	01/15/2000	8,950	4,950	2.24
01/02/2003	13,266	5,666	1.75	11/20/2001	8,935	4,935	2.23
12/13/2002	12,732	5,432	1.74	03/01/1999	8,687	4,787	2.23
04/08/2003	13,254	5,654	1.74	01/03/2003	9,516	5,216	2.21
12/15/2002	12,593	5,293	1.73	03/04/1999	8,394	4,494	2.15
12/14/2002	12,592	5,292	1.72	03/05/1999	8,367	4,467	2.15
03/05/1999	12,441	5,041	1.68	12/14/2002	8,556	4,556	2.14
12/12/2002	12,185	4,885	1.67	01/09/2004	9,336	4,936	2.12
11/09/1999	12,346	4,946	1.67	12/13/2002	8,443	4,443	2.11
12/19/2001	11,655	4,655	1.67	12/15/2002	8,281	4,281	2.07
11/15/2004	12,965	5,165	1.66	04/09/2003	8,608	4,308	2.00

Exhibit 2–6 shows the ground surface and the pipe profile for the existing forcemain. The profile also shows the hydraulic grade line (HGL) based on the peak wet weather flows for 2005.

3. Proposed Forcemain Relocation

3.1 General

Mr. Gabor Vasarhelyi and Mr. Trevor Jones from CH2M HILL, and Ms. Lara Fletcher from our geo-technical subconsultant (EBA Engineering Ltd.), visited the Comox area on July 21st. They met with Mr. Graeme Faris and Mr. Jim Elliott from the Regional District, and separately with Mr. Glenn Westendorp (Town of Comox), and inspected potential alignment routes.

The team concluded that the Croteau Road beach access represents the most feasible point of access to the forcemain and to bring the forcemain off the foreshore to an inland route. The key factor for this conclusion was that this location is the only place with public access between the road network and the existing forcemain on the beach that may be considered for forcemain construction.

During the site visit, CH2M HILL and the Regional District identified four potential alignment options. The horizontal alignments are shown in Exhibit 3–1, and the ground surface profiles are shown in Exhibits 3–2.

3.2 Population Projections

Planning staff from Courtenay and Comox recently reviewed population growth rates and concluded that their communities will experience annual growth rates of 3.5 % and 3.0 %, respectively. CH2M HILL has used these estimates as the basis for planning.

Exhibit 3–3 summarizes population estimates at ten year increments for Comox and Courtenay.

EXHIBIT 3-3
Population Projections

Year	Courtenay	Comox	Total
2004	21,500	12,000	33,500
2005	22,300	12,400	34,700
2015	31,400	16,600	48,000
2025	44,300	22,300	66,600
2035	62,500	30,000	92,500
2045	88,100	40,300	128,400
2055	124,300	54,200	178,500

Note: 2004 Populations provided by the Regional District

3.3 Future Wastewater Flows

Future wastewater flows were estimated based on the following assumptions:

- The 2005 populations of Courtenay and Comox, respectively, are 22,300 and 12,400, totaling 34,700 for the service area
- The yearly population growth is 3.5% for Courtenay and 3% for Comox for the next 50 years
- Wastewater generation is based on 355 L/capita/day for the entire service area and for the duration of the study period (50 years)
- Peak flows are computed by the Harman formula, based on the individual populations for the Courtenay and Comox pump stations, and based on the combined population for the proposed forcemain and pump station
- The existing maximum wet weather I/I is 9,300 m^3/day (108 L/s) for Courtenay and 7,600 m^3/day (88 L/s) for Comox, assuming it will not significantly increase in the future
- Peak design flow rates for each element of the system are computed as the sum of the peak hourly flow rate and the maximum wet weather I/I.

Exhibit 3-4 summarizes the estimated peak design flow rates for the study period of 2005 to 2055.

EXHIBIT 3-4
Summary of Estimated Peak Flow Rates

Year	Peak Sewage and I&I Flow		
	Comox	Courtenay	Total
	L/s	*L/s*	*L/s*
2005	237	343	540
2010	253	383	589
2015	275	425	645
2020	299	473	710
2025	327	529	784
2030	358	593	869
2035	393	666	966
2040	433	751	1,077
2045	478	848	1,205
2050	528	961	1,352
2055	**585**	**1,090**	**1,520**

3.4 Potential Alignments

Four potential alignment alternatives have been identified in this study, namely:

1. The **Noel Road route** follows Croteau Road from the beach up to Noel Road. At that point the alignment turns east and follows Noel Road to the marsh, crosses the marsh, and then follows Brent Road into the CVWPCC.

   The Noel Road route was originally selected because of the simple alignment with minimum number of bends. After a site visit and review of ortho photos and property information, however, this alignment was eliminated early in the evaluation process as it would cross through a new development, creating numerous property and utility conflicts.

2. The **Lazo Road North route** follows Croteau Road from the beach up to Lazo Road. From there, the alignment turns east and follows Lazo Road up to Brent Road. The alignment then turns southwest and follows Brent Road to the CVWPCC.

   This route was originally selected because it follows existing road alignment in its entire length and eliminates the need for construction in sensitive wetland areas. This alignment was eliminated early in the evaluation process, however, because the length of this alignment is approximately 900 m, or 30 percent, longer than any of the other

evaluated alternatives. There are also potential utility conflicts due to recent development activities north of Noel Avenue.

3. The **Lazo Road South route** starts at the south end of Croteau Road and proceeds north to Lazo Road, where the alignment turns east. The alignment continues east along Lazo Road, then turns north on Lazo Road to Noel Road, where it turns east onto the Noel Road right-of-way. This section of Noel Road has not yet been developed, and access will need to be constructed for this section of the alignment. At the east end of Noel Road the alignment crosses the marsh before reaching Brent Road and the CVWPCC.

   This alignment was considered as a feasible alternative and selected for further evaluation.

4. The **Morland Road route** starts at the south end of Croteau Road and proceeds north to Lazo Road, where the alignment turns east. The alignment continues south along Lazo Road and onto Balmoral Road, and then turns north on Morland Road. At the north end of Morland Road the alignment turns east and crosses the marsh before reaching Brent Road and the CVWPCC.

   This alignment is similar to option three, the Lazo Route South, and was selected for further evaluation. The difference between the Lazo Road South and Morland routes is that the latter follows the less traveled Morland Road rather than Lazo Road, and therefore creates fewer disturbances to residents and disruption to traffic. The Morland Road route is described further in detail in section 3.6.

3.5 Geotechnical

CH2M HILL retained EBA Engineering Consultants Ltd. to carry out a desktop geotechnical study and to provide input in the alignment selection process.

The geotechnical report, included in Appendix B, indicates that the soils along each of the alignments are relatively similar and consist primarily of sand and gravel mixtures. Little information is available for the marsh section. The available information does not indicate a preferred alignment from a geotechnical perspective at this stage.

Construction would likely require an open cut, with side slopes of 1:1 or flatter in less stable areas. As the 1000 mm (40”) diameter forcemain would require 1.2 m of cover, the top trench width would be about 6 m.

3.6 Morland Road Alignment

3.6.1 Horizontal Alignment

The alignment for this option, shown in Exhibit 3–5, starts at the south end of Croteau Road and proceeds north to a new pump station. From the pump station the alignment continues north to Lazo Road, where the alignment turns east. The alignment continues east along Lazo Road to a discharge chamber at the high point of the road, where it changes from a forcemain to a gravity pipe. The alignment continues east onto Balmoral Road, and then

turns north on Morland Road. At the north end of Morland Road the alignment turns east and crosses the marsh before reaching Brent Road and the CVWPCC.

The alignment for this option, which is predominantly outside of the Town of Comox's boundaries, benefits from a more rural setting than any of the other evaluated options. As a result, this option is likely to result in a lower level of inconvenience than the other potential alignments. In particular, the Morland Road option is likely to have a lower level of community impact than the Lazo Road South option because Morland Road is a dead end street and accommodates fewer residents.

The roadways along this alignment appear to have 20 m right-of-ways. This should leave adequate room on either side of the road for a 6 m wide open cut, and should provide space for stockpiling pipe and excavated material and permit one-way traffic.

3.6.2 Vertical Profile

The vertical profile for this alignment is shown in Exhibit 3-6.The forcemain will discharge into a collection chamber and be drained by a gravity sewer. The collection chamber will be near the intersection of Lazo and Butchers Road. This method of conveying flow will reduce the total pumping distance from 3200 m to 880 m and lead to lower pumping costs as a result of the reduction in operating headloss.

A section of the alignment, from the north end of Morland Road to the treatment plant, will have to be operated under pressure. Flows through this section will be conveyed by an inverted siphon and will not require pumping.

The following are the elements of the new forcemain section:

- Forcemain extension from the diversion point on the existing forcemain on the beach to a new pump station at Croteau Road (380 m)
- A new pump station at Croteau Road
- Forcemain from the new pump station to a high point in Lazo Road (880 m)
- Gravity pipe from the high point to the treatment plant (2100 m), which includes a 940 m inverted siphon under the marsh.

The use of a forcemain collection chamber with a rising profile up to the high point will eliminate the need for air-vacuum release equipment. This equipment is needed to release air while the pipe is filling up, as well as to prevent collapse of the pipe while draining the forcemain, and in case of pipe failure. This equipment is maintenance-intensive on sewage forcemains because suspended grease in the sewage tends to collect at high points when the pumps are not operating. This would lead to regular maintenance requirements to prevent the air-vacuum equipment from clogging.

A second highpoint is located west of Stafford Street on Lazo Road. The need for air-vacuum equipment at this location can be eliminated by installing the pipe at a greater depth to provide a continuously rising grade. Open cut excavation would likely not be feasible for this 160 m section. The installation for this section may, however, be feasible using trenchless methods such as pipe jacking or horizontal directional drilling.

3.6.3 Utility Conflicts

Residents living east of the proposed alignment routes have their own drinking water wells and septic systems. There are not expected to be any sewer, storm or water lines crossing the alignments. It is expected that utilities such as telephone, cable and power would be located on local utility poles; therefore, potential utility conflicts are likely limited to gas lines, if such service is provided in this area.

A number of utility conflicts are anticipated within the CVWPCC due to site utilities.

3.6.4 Environmental Issues

There are two areas where further study will be required to assess any potential environmental or archeological impact. These areas are the tie-in to the existing forcemain along the foreshore and the marsh crossing.

These issues will need to be addressed at the preliminary or detail design stage.

3.6.5 Constructability

This particular alignment and its components consist of typical municipal infrastructure and can be constructed with typical construction methods.

At this stage it is expected that the entire alignment, apart from a 160 m trenchless section, will be constructed using traditional cut and cover methods. Once more detailed geotechnical information is obtained, these assumptions will be re-assessed.

The only anticipated challenges to the project are the connection to the existing forcemain and to the CVWPCC headworks.

A preliminary review of the existing forcemain configuration and the proposed connection location indicate that a more detailed study will be necessary to determine a feasible connection method and the associated costs.

3.7 Option 2 – Lazo Road South

This option is very similar to the Morland Road option. The following are the key differences between the Lazo Road South and Morland Road options:

- The Lazo Road South option is nearly 100 m shorter,
- The Lazo Road South option requires a shorter inverted siphon,
- The pumping cost for both alignments will be the same,
- The Morland Road section is more rural,
- The Morland Road option is likely to cause less inconvenience to the community,
- The Lazo Road South option is likely to result in more utility conflicts.

The horizontal alignment is shown in Exhibit 3–7 and the vertical profile is shown in Exhibit 3–8.

4. Optimum Pipe Size Selection

4.1 Forcemain Section

Wastewater forcemains are typically most economical when the selected pipe diameter yields a velocity of approximately 2 m/s for the design flow, which would result in a diameter of 54" being selected. The proposed forcemain alignment is, however, somewhat different from typical forcemain design because of the high static lift of 38 m. As a result, the construction and operating costs for a number of available HDPE pipe diameters were examined to determine the most cost-effective solution.

The construction cost estimates for the various pipe diameters account for variation in excavation volumes, surface restoration work, and pipe material costs.

The operating cost estimates are based on the estimated annual sewage volume and the average distance that the wastewater must be raised: 38 m static lift plus headloss. The operating headloss was calculated for each evaluated pipe diameter. An average pumping cost of $0.06/kWh and a pump efficiency of 75% were used in this analysis. Appendix C contains detailed calculations. Exhibit 4 – 1 shows the estimated construction and operating costs for the Morland Road alignment.

EXHIBIT 4-1
Pipe Size Optimization

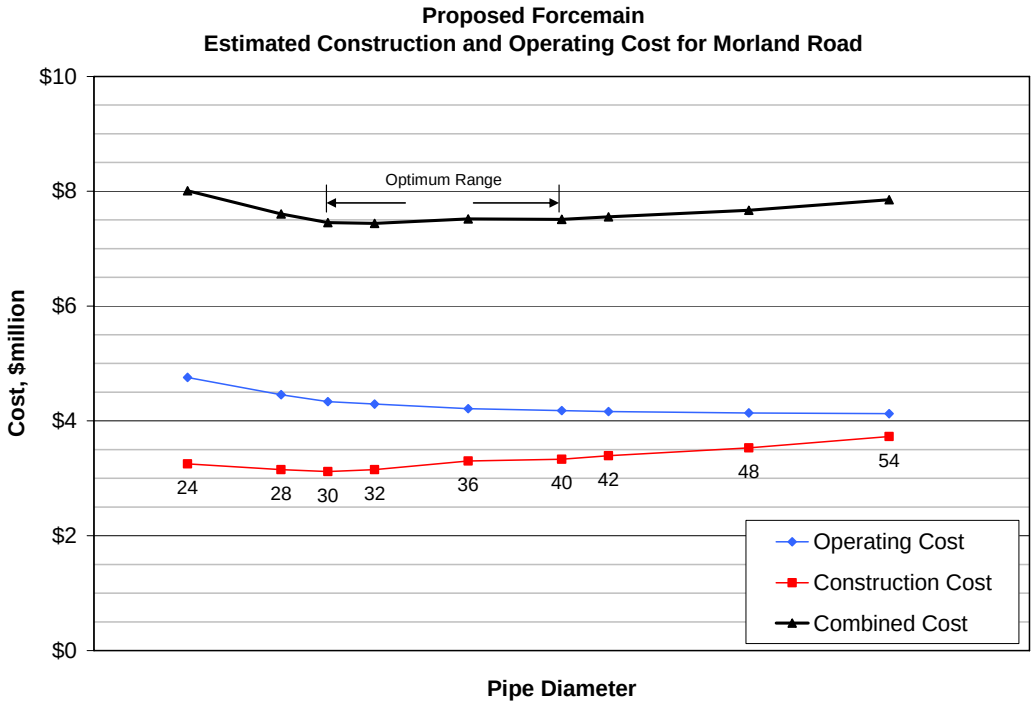


Exhibit 4–1 shows that the combined cost for pipes between 30" and 40" are quite similar at $7.5 million. Selecting a larger pipe size would be a prudent investment due to escalating energy prices.

4.2 Gravity Sewer Section

The odour control concept requires that the gravity sewer section flows partially full. This will allow all of the manholes upstream of the inverted siphon to draw in fresh air with the help of a low vacuum fan, which will be located at the inlet to the inverted siphon. The proposed concept will only require odor control at the (downstream) inverted siphon location. It would be prudent to allocate space at the forcemain discharge chamber, though, in case future conditions require odour control at this location.

The odour control equipment will require potable water and power supply.

Based on this assessment, the gravity sewer section has been sized at 1050 mm (42") HDPE. The proposed material for this section is Weholite, which is a low pressure, hollow wall, HDPE pipe.

The connection between the forcemain and the gravity main is expected to be made with a large HDPE lined concrete chamber since the forcemain discharge will release a significant amount of hydrogen sulphide (H_2S) gas. H_2S corrodes concrete, which the Regional District has experienced at the CVWPCC. Dynamic simulations will be necessary to determine the required forcemain outlet configuration, as well as the inlet for the gravity section.

Exhibit 4-2 shows a concept-level configuration for this connection.

4.3 Inverted Siphon Section

The inverted siphon section should be designed so that this section of pipe is completely full during periods of zero flow, as any air exiting the pipe while it is being filled will result in reduced capacity. This condition requires that the crown of the pipe at the entrance to the inverted siphon be located at an elevation of 12.1 m; the operating water level of the headworks at the CVWPCC. The depth of the manhole at the upstream end of the inverted siphon is then determined by summing the siphon pipe diameter, the headloss through the siphon, the gravity sewer pipe diameter, and the ground cover of 1.2 m. The inverted siphon pipe size is then selected to minimize the headloss and provide an adequate velocity to resuspend material. On this basis the inverted siphon section has been sized at 1200 mm (48") HDPE. This results in a headloss of 2.6 m and velocities of 1.5 m/s.

The gravity sewer and the inverted section will likely be connected with a large-diameter manhole or chamber; however, the exact dimensions and elevations will need to be determined at the detail design phase.

Exhibit 4–3 shows a concept-level configuration for this connection.

5. Pump Station

5.1 General

The pump curves for the existing pump stations and the condition of the existing forcemain both indicate that a new pump station will be required to traverse any of the proposed inland routes. This is primarily because the peak elevation along the proposed routes is 50 m, whereas the existing pumps are designed for operating pressures of 20 – 25 m.

Locating the pump station along Croteau Road will permit the existing sanitary sewer along Croteau Road to be connected directly to the proposed wetwell. The catchment area for this sewer line, shown in Exhibit 5 – 1, is estimated to represent 5% of the flows for the Town of Comox. Implementing this change would reduce flows to the Comox Pump Station thereby extending the service life of the pumps at both the Comox and Courtenay pump stations.

5.2 Pump Station Location

The following are two potential locations for the new pump station:

- The south end of Croteau Road (~ 0 m elevation), and
- North of the intersection of Croteau Road and Ducliddle (17 m elevation).

CH2M HILL recommends the Croteau Road location for the following reasons:

- The cost for building the pump station would be somewhat lower due to the reduced requirements for dewatering.
- Locating the pump station at the south end of Croteau Road would reduce the observed operating pressures at the Comox and Courtenay pump stations by about 17 m. The pumps would need to be replaced or have new impellers installed to meet the new duty point. This lower elevation location would also result in the need to install about 230 m of high pressure pipe to handle the higher pressures due to the additional pumping head. The higher pressure pipe is considerably more expensive than the pipe that would be needed to extend the existing forcemain to Ducliddle Road.
- Constructing the new pump station north of Ducliddle and Croteau Road would not require the immediate upgrade or replacement of the existing pumps and would also reduce the pipe costs as discussed previously. The proposed pipe for the extension of the existing forcemain is 1050 mm (42") HDPE.

Choosing the higher elevation location would increase the pressure requirements for the proposed pump station at HMCS Quadra. However, CH2M HILL considers the impacts relatively minor compared to the benefits of locating the pump station at the high elevation.

5.3 Pumping Station Concept

The proposed pump station would handle the combined flows from Courtenay and Comox. Currently, the Courtenay pump station capacity ranges from 480 L/s to 560 L/s, and the Comox pump station capacity is 245 L/s. (Dayton and Knight report)

At this stage, it is expected that the proposed pump station should have a capacity exceeding the possible maximum flow from the existing pump stations. As the Comox pump station is near maximum capacity, and as the Dayton and Knight report indicated that the new pump station capacity should be 365 L/s, the required capacity has been estimated at 1000 L/s (560 L/s+ 365 L/s = 925 ~ 1000 L/s).

The proposed pump station would have three 475 hp submersible VFD controlled pumps with space for a fourth to be added in the future. Each pump would have a capacity of 500 L/s thereby meeting the Municipal Sewage Regulation's redundancy requirements by providing 50% redundancy through a standby pump.

The fourth pump would be added at the same time as the upgrades to the existing pumps at the Comox and Courtenay Pump Stations.

Exhibit 5–4 shows the hydraulic grade line for the forcemain and the inverted siphon along the proposed Morland Road alignment.

The pump station building would consist of a wetwell, some office space, a washroom, a janitor room, an electrical control room, and space for an emergency generator and fuel storage. Exhibit 5–5 shows concept-level plan and profile sections for the proposed pump station.

Odour control will also be necessary at the proposed pump station. This will require a potable water supply and a power supply.

5.4 Cost Estimates

5.4.1 Capital Cost Estimate

The capital cost estimate for the Croteau Road Pump Station is based on a database of historical costs for pump station. Exhibit 5-2 contains a summary of the capital costs for the Croteau Road and Ducliddle site.

The capital cost estimate does not include a large allowance for the provision of power to the site. The size of the pumps may necessitate a significant upgrade to the Hydro system in this area. An investigation of the Hydro requirements related to this project should be completed early in the next stage of planning to identify significant cost items that the Regional District has to include in the project budget.

Construction costs have increased dramatically over the last two years due to increases in labour costs and the cost of raw materials. Recent experience shows that wastewater infrastructure costs have increase by approximately 30 to 40 percent over this period. The cost estimate presented in Exhibit 5-3 reflects this cost increase.

5.4.2 Operating Cost Estimate

Operation costs for the pump station are primarily related to the cost of power supplied to the pumps. The Exhibit 5-3 contains a summary of the average annual operating costs for the facility. We have not included any cost for major pump overhauls.

EXHIBIT 5-3
Capital Cost Estimate

Description	Cost, $CDN
General Requirements	$520,000
Site / Civil	$260,000
Structural	$920,000
Major Process Equipment and Installation	
Pumps (3 required)	$655,000
General Process Mechanical Supply and Installation	$312,000
Electrical and Instrumentation	$478,000
Subtotal	**$3,145,000**
Design Contingency (15%)	$472,000
Materials and Labour Contingency (15%)	$472,000
Engineering and Administration @ 20%	$629,000
G.S.T. at 3%	$94,000
Project Total	**$4,812,000**

EXHIBIT 5-4
Operations and Maintenance Cost Estimate (Year 2030)

Description	Cost, $CDN/year
Power Costs @ $0.06/kWh	$75,000
Daily Inspections ($200/day)	$75,000
Maintenance Labour	$50,000
Maintenance Parts	$50,000
Total Annual O&M Cost	**$250,000**

6. Conclusions and Recommendations

CH2M HILL has visited the Comox area, met with key Regional District and Town of Comox staff, and completed an assessment of options for the future conveyance of wastewater to the Comox Valley Water Pollution Control Centre (CVWPCC). As a result of this work, CH2M HILL concludes that:

- The Courtenay Pump Station appears to have enough capacity for a further ten years before a pump upgrade becomes necessary. Further I/I reduction efforts will extend this service horizon.
- The Comox Pump Station appears near to capacity and the pumps need to be replaced.
- Continued use of the existing forcemain along the beachfront section presents an unacceptable risk to the Regional District with regards to pipe failure due to loss of cover over the pipe.
- No other low-level alignment option exists.
- Existing infrastructure within Comox, Courtenay and the Regional District jurisdictions mandate the continued use of the existing forcemain alignment prior to the beachfront section.
- Alternate inland alignments all involve pumping wastewater over a high ridge that runs in a north/south alignment between Comox and Courtenay, and the CVWPCC.
- The extra elevation gain means that a new pump station is required. CH2M HILL recommends the construction of a 1,000 L/s pump station with the capability of expansion to 1,500 L/s to accommodate future growth.
- The most appropriate place for a new pump station is near the intersection of Croteau and Ducliddle Roads.
- The most cost effective and least disruptive alignment option involves a route along Lazo Road and Moreland.
- The recommended alignment crosses a wetland and requires work in the tidal area inside Goose Spit. An environmental assessment is needed.
- Soil conditions along the route are considered good although a more detailed evaluation is needed.
- The pump station may require a significant increase in the BC Hydro power supply in the Croteau Road area. Further investigation is needed.

Exhibit 6-1 contains a summary of costs related to the recommended pump station and alignment.

EXHIBIT 6-1
Cost Summary

Cost Item	Cost
Pipeline Construction	$3,440,000
Pump Station Construction	$4,810,000
Annual Operation and Maintenance (2005 Dollars)	$250,000
Net Present Value of Operations and Maintenance Cost	$4,790,000
50 year Life Cycle Cost (NPV)	**$13,040,000**

Trevor Jones, P.Eng
Project Manager

Gabor Vasarhelyi, P.Eng