

Notice of Meeting # 6 of the  
**LIQUID WASTE MANAGEMENT PLAN**  
**JOINT TECHNICAL AND PUBLIC ADVISORY COMMITTEES (TACPAC)**

Friday, March 22, 2019  
CVRD Boardroom, 600 Comox Road  
9:00 am - 3:00 pm

| ITEM, TIME                | DESCRIPTION   | OWNER                          |
|---------------------------|---|--------------------------------|
| 6.1<br>9:00               | Call to Order   | Allison Habkirk                |
| 6.2<br>9:00-9:10          | Review of Minutes of Meeting #5   | Allison Habkirk                |
| 6.3<br>9:10-9:20          | <ul style="list-style-type: none"> <li>Report to committee the Comox Valley Sewage Commission decision for long listed options.</li> <li>Update the committee on the decision and rationale to separate conveyance from treatment and resource recovery components of the LWMP.</li> <li>Update the committee on consultation with K'ómoks First Nation Chief &amp; Council and their feedback on the long listed options.</li> <li>Next steps in regards to consultation with the K'ómoks First Nation.</li> </ul> | Kris La Rose                   |
| 6.4<br>9:30 –10:30        | <p>Long List Options – Conveyance</p> <ul style="list-style-type: none"> <li>Review of conceptual studies of conveyance options.</li> <li>Explanation of technical and financial modelling</li> </ul>   | WSP                            |
| Break                     |   |                                |
| 6.5<br>10:40 – 11:30      | <ul style="list-style-type: none"> <li>Review of technical consultants scoring on technical criteria.</li> <li>Review of TAC scoring of technical criteria.</li> <li>Review of affordability scoring.</li> </ul>  | WSP/<br>Paul Nash              |
| 6.6<br>11:30-12:30        | <p>TACPAC Evaluation of the Long List Options – Conveyance</p> <ul style="list-style-type: none"> <li>Staff summary of option attributes for economic, environmental and social categories</li> <li>Example evaluation for one option (4B)</li> <li>Begin evaluation process for remaining options</li> </ul>   | Allison Habkirk<br>& Paul Nash |
| Lunch Break<br>12:30-1:00 |   |                                |

| ITEM, TIME                      | DESCRIPTION  | OWNER                       |
|---------------------------------|--|-----------------------------|
| 6.6<br>(continued)<br>1:00-2:45 | Evaluating the Long List Options – Conveyance <ul style="list-style-type: none"> <li>• Continue TACPAC scoring for remaining options.</li> <li>• Discussion.</li> <li>• Finalize list for detailed study.</li> </ul> <p><b><i>Make a recommendation to the Comox Valley Sewage Commission on the short list of conveyance options for detailed study</i></b></p> | Allison Habkirk & Paul Nash |
| 6.7<br>2:45-2:50                | LWMP Schedule Update <ul style="list-style-type: none"> <li>• Completing the shortlisting and selection of conveyance options before treatment and resource recovery.</li> <li>• Revised Dates.</li> </ul>   | Paul Nash                   |
| 6.8<br>2:50-3:00                | Preview of TACPAC #7, Thursday, May 30, 2019. <ul style="list-style-type: none"> <li>• Review of detailed studies of short list conveyance options.</li> <li>• Preliminary evaluation.</li> <li>• Preliminary determination of preferred conveyance option for public consultation.</li> </ul>   | Paul Nash                   |
| 6.9<br>3:00                     | Adjournment  | Allison Habkirk             |

**Attachments:**

1. Minutes of TACPAC Meeting #5, February 8, 2019
2. Conceptual Studies of Conveyance Options

Minutes of the meeting of the Liquid Waste Management Plan (LWMP) Joint Technical and Public Advisory Committees (TACPAC) Meeting #5 held on Friday, February 8, 2019 at the Comox Valley Regional District (CVRD) Boardroom, commencing at 9:00am.

**PRESENT:**

|   |         |
|---|---------|
| A. Habkirk, Chair and Facilitator                       |         |
| P. Nash, LWMP Project Coordinator                       |         |
| K. La Rose, Senior Manager of Water/Wastewater          | CVRD    |
| M. Imrie, Manager of Wastewater Services                | CVRD    |
| J. Boguski, Branch Assistant – Engineering Services     | CVRD    |
| A. Idris, Engineering Analyst                           | CVRD    |
| W. Bayless  | WSP     |
| M. Swift, Town of Comox Councillor                      | PAC     |
| W. Cole-Hamilton, City of Courtenay Councillor          | PAC     |
| C. McColl, K'ómoks First Nation                         | PAC/TAC |
| T. Ennis, Comox Valley Conservation Partnership         | PAC     |
| D. Winterburn, BC Shellfish Growers Association         | PAC     |
| S. Wood, Comox Business Improvement Association         | PAC     |
| A. Gower, Comox Valley Chamber of Commerce              | PAC     |
| S. Carey, Courtenay Resident Representative             | PAC     |
| T. Serviz, Courtenay Resident Representative            | PAC     |
| K. Niemi, Courtenay Resident Representative             | PAC     |
| K. vanVelzen, Comox Resident Representative             | PAC     |
| D. Jacquest, Comox Resident Representative              | PAC     |
| M. Holm, Area B Resident Representative                 | PAC     |
| M. Lang, Area B Resident Representative                 | PAC     |
| R. O'Grady, City of Courtenay Engineering               | TAC     |
| S. Ashfield, Town of Comox Engineering                  | TAC     |
| G. Bonekamp, Department of National Defence Engineering | TAC     |
| L. Aitken, Area B Representative Alternate (Observer)   |         |

| ITEM | DESCRIPTION  | OWNER              |
|------|--|--------------------|
| 5.1  | Call to Order<br>Allison called the meeting to order at 9:10am   | Allison<br>Habkirk |
| 5.2  | Review of Minutes of Meeting #4 <ul style="list-style-type: none"> <li>A disconnect with the agenda and report item 4.3. – K. vanVelzen</li> <li>A typo in the description of Treatment Option No. 2. – K. van Velzen               <ul style="list-style-type: none"> <li>The disinfection criteria reads “fecal coliforms not to exceed 200FC/1900mL”, and should be corrected to read 200FC/100mL.</li> </ul> </li> </ul> <p>MOTION: That the minutes of meeting #4 be adopted – A. Hamir<br/>           SECONDED: M. Lang<br/>           CARRIED</p> | Allison<br>Habkirk |
| 5.3  | LWMP Process from Here<br>Paul gave a quick overview of the remaining process for the evaluation to short list and preferred options and the LWMP report itself.   | Paul<br>Nash       |

| ITEM | DESCRIPTION  | OWNER        |
|------|--|--------------|
| 5.3  | The meeting schedule was presented, noting that some future meeting dates may change.  | Paul Nash    |
| 5.4  | <p>Reclaimed Water</p> <p>Paul gave a quick presentation about the need to identify potential uses of reclaimed water as part of the resource recovery study. This is of equal importance as the technical study of producing the water.</p> <p>A brainstorming exercise was conducted to identify potential users, uses and locations for reclaimed water use. This will be incorporated with the reclaimed water options study.</p>  | Paul Nash    |
| 5.5  | <p>Public Feedback on Long List Options</p> <p>Kris provided an overview of the feedback sessions about the long list options.</p>   | Kris La Rose |
| 5.6  | <p>Deciding the Long List –Conveyance Options</p> <ul style="list-style-type: none"> <li>Is the proposal from Electoral Area A being considered? – M. Swift <ul style="list-style-type: none"> <li>WSP is undertaking separate work to analyze the impacts of including sewer from the south region to the infrastructure as was mandated by the Comox Valley Sewage Commission. - K. La Rose</li> </ul> </li> <li>Are other service areas (adjacent to sewer infrastructure) being considered? – A. Gower <ul style="list-style-type: none"> <li>No, sewer system plan area is not part of the LWMP scope. – K. La Rose</li> </ul> </li> <li>More clarification should be provided to the public on what stage in the process they are providing feedback on (inform, consult, and involve stages). – M. Lang</li> </ul> <p>MOTION: That in-series pump station Options 1C and 2B be removed due to high risk – M. Lang</p> <p>SECONDED: A. Gower/A. Hamir</p> <ul style="list-style-type: none"> <li>What are the costs and benefits of the options proposed to be removed? What is the actual risk and is it worth removing these options now? Can redundancies be implemented to mitigate the risks? – K. vanVelzen <ul style="list-style-type: none"> <li>It would be premature to eliminate options containing Comox No. 2 Pump Station, the decision to eliminate them would open the process to criticism that not all options were considered. – K. La Rose</li> </ul> </li> <li>How common are in-series pump stations implemented? – W. Cole-Hamilton <ul style="list-style-type: none"> <li>The in-series option is avoided wherever possible. – W. Bayless</li> </ul> </li> </ul> <p>MOTION DEFEATED</p> <p>MOTION: In recognizing the technical consultant’s opinion as “not technically feasible”, that conveyance Option 6 be removed. – A. Gower</p> <p>SECONDED: K. Niemi</p> <p>CARRIED</p> <p>MOTION: That conveyance Options 1A, B and C be removed. – T. Ennis</p> <p>SECONDED: M. Lang/C. McColl</p> <ul style="list-style-type: none"> <li>Discussion took place as to whether these options should be removed at this stage in the planning process.</li> </ul> |              |

| ITEM | DESCRIPTION   | OWNER |
|------|---|-------|
| 5.6  | <ul style="list-style-type: none"> <li>• Mitigation to the risks of Options 1A, B and C are possible but can also increase the maintenance costs and issues. – W. Bayliss</li> <li>• Digging along the Dyke Road raises concerns as this is an archaeological site. There are also greater spill risks and concern with the sensitive work area with regard to tides and ecosystems.</li> <li>• These options should be carried through the evaluation process and explored further, they could be more cost effective. – S. Ashfield</li> <li>• All options should be explored to build a case on decisions made to create the short list. – D. Winterburn               <ul style="list-style-type: none"> <li>◦ We are only looking to remove technically non-feasible options at this point. – K. La Rose</li> </ul> </li> </ul> <p>MOTION DEFEATED</p> <ul style="list-style-type: none"> <li>• A modification to Option 4 to convey through McDonnald Road to Idiens/Hudson should be looked at. This option had previously been supported by the public. – S. Ashfield.</li> </ul> <p>Approval by consensus to revise Option 4 to create 4A and 4B to conveyance options.</p> <p>MOTION: That Options 1 through 5, including all their variants, be forwarded to the Comox Valley Sewage Commission - A. Gower</p> <p>SECONDED: M. Lang</p> <p>CARRIED</p> |       |
| 5.7  | <p>Deciding the Long List – Treatment Options</p> <p>MOTION: That all options for treatment be forwarded to the Comox Valley Sewage Commission. – M. Lang</p> <p>SECONDED: W. Cole-Hamilton</p> <ul style="list-style-type: none"> <li>• When considering treatment options, studies should be more based on future projections of the requirements rather than historical. (Example: future temperatures and tides). – T. Enns</li> </ul> <p>CARRIED</p>   |       |
| 5.8  | <p>Deciding the Long List - Resource Recovery</p> <ul style="list-style-type: none"> <li>• The term “fertilizer pellets” should be changed to “Enhanced Nutrient Recovery” to be a more broad term. Also it should be noted that nutrient recovery is in addition to bio-solids removal to produce SkyRocket.</li> </ul> <p>MOTION: To remove hydroelectric turbine option. – D. Jacquest</p> <p>SECONDED: R. O’Grady</p> <ul style="list-style-type: none"> <li>• All options should be brought forward for consideration and removed later in the process if found necessary. – T. Serviz, W. Cole-Hamilton</li> </ul> <p>MOTION DEFEATED</p> <p>MOTION: That all options for resource recovery be forwarded to the Comox Valley Sewage Commission.</p> <p>SECONDED: D. Jacquest</p> <p>CARRIED</p>   |       |

| ITEM | DESCRIPTION   | OWNER             |
|------|---|-------------------|
| 5.9  | <p>Technical Update #4, Costing, Conveyance Hydraulics</p> <p>Walt provided an overview of the terminology and formulation of classes of cost estimates. For the long list options, estimates will be Class D – conceptual and for the short list will be Class C – indicative.</p> <p>A brief explanation of conveyance hydraulics was given, with an explanation of terminology and the meaning of a key term -“Hydraulic Grade Line”</p> <ul style="list-style-type: none"> <li>• Market volume and volatility impact costing greatly and must be considered. – A. Gower</li> <li>• At what point are lifecycle costs considered? – M. Lang                             <ul style="list-style-type: none"> <li>○ They are considered in parallel with project costs. – W. Bayliss</li> </ul> </li> </ul> | Walt Bayless, WSP |
| 5.10 | <p>Future meeting structure was considered. The Technical Advisory Committee will meet separately prior to TACPAC meeting No. 6, to facilitate in-depth technical discussions on the options. The summary of these discussions will be provided to the TACPAC.</p> <p>Meeting No. 6 will be extended to adjourn at 3:00pm to not rush the process.</p>  | Paul Nash         |
| 5.11 | The meeting adjourned at 12:05pm  |                   |

COMOX VALLEY REGIONAL DISTRICT

# LIQUID WASTE MANAGEMENT PLAN STAGE 1 – CONVEYANCE LONG LIST STUDY

MARCH 15, 2019





# LIQUID WASTE MANAGEMENT PLAN STAGE 1 CONVEYANCE LONG LIST STUDY

COMOX VALLEY REGIONAL DISTRICT

REV 1

PROJECT NO.: 18P-00276-00  
DATE: MARCH 15, 2019

WSP  
210 – 889 HARBOURSIDE DRIVE  
NORTH VANCOUVER, BC  
V7P 3S1

T: +1 604-990-4800  
WSP.COM



# 10 CONVEYANCE OPTIONS

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## 10.1 OVERVIEW

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### 10.1.1 EXISTING INFRASTRUCTURE CAPACITY AND CONDITION

The existing large diameter sanitary system on the south side of the Comox Valley Sewerage System (CVSS) consists of three pump stations, namely Courtenay, Jane Place Pump Stations (PS) and K'omox First Nation Pump Station. Courtenay PS (CPS) is located on Comox Road, near the Highway 19A bridge that crosses the Puntledge River and services Courtenay. Jane Place PS (JPS) is located in Jane Place, near the Comox Valley Marina, and it services the south area of Comox. The K'omox FN pump station is relatively small and connects directly into the forcemain. A combined gravity and pressurized system serves the north sections of the CVSS. This system consists of various gravity trunks including the Hudson and Greenwood trunks, and the Canadian Forces Base (CFB) pump station and the associated alignment to convey the sewage to the treatment plant. Figure 10-1 presents the existing CVSS infrastructure.

Currently, sewage is conveyed from the Courtenay PS in a 750 mm ø reinforced concrete pipe (Hyperscon) eastward along Comox Road and Bayside Road before routing into the foreshore, where sewage from JPS ties directly into and the diameter increases to 860 mm ø. The force main makes a turn northward at Goose Pit by crossing Hawkins Road and continues in the foreshore along Willmar Bluffs to the Comox Valley Water Pollution Control Centre (CVWPCC).

In 2002, the Comox Valley Regional District (CVRD) discovered significant sections of the forcemain in the foreshore were exposed without the protective cover material due to changes in soil deposition patterns and erosion. This was confirmed by Northwest Hydraulic Consultants Ltd. (NHC) in 2003, which was again reaffirmed in a 2016 study, *Risk Analysis of CVRD Force main on Balmoral Beach*, NHC, 2016. A risk analysis of the forcemain along the Bluffs was prepared by NHC in 2016. It was concluded that risk of forcemain failure exists along the beach and estimated a minimum 24-hour response time is required to fix any major failures to the forcemain. The study recommended that the affected portion of the forcemain to be relocated off-the-beach. The existing forcemain has an estimated 12 years remaining in the design life. A forcemain re-alignment study was performed in 2005 to assess various options for re-routing the forcemain, allowing the section along Willemar Bluffs to be decommissioned. This LWMP process is intended to further develop and select a preferred alignment.



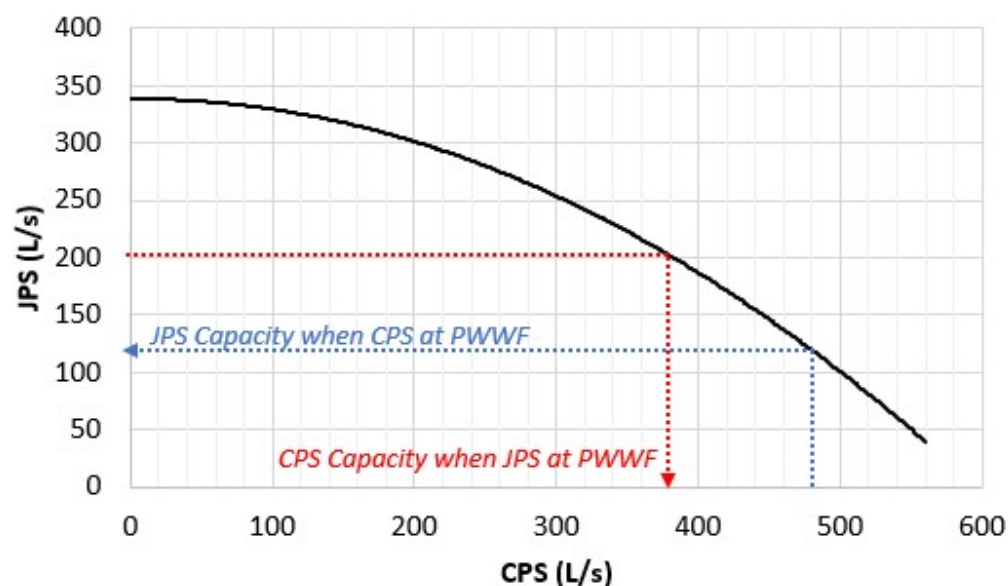
**Figure 10-1: Existing Force Main Alignment**

Courtenay PS has a wet well and dry well configuration with 3 service and 1 standby 200 HP pumps. The lead-lag-pumps-off elevation in the wet well is -4.25 m. Jane PS has a wet well configuration with 2 service and 1 standby 77 HP pumps. The lead-lag-pump off elevation in the wet well is -3.25 m. Both pump stations are currently pumping sewage to the CVWPCC that has an inlet invert elevation at 8 m. Currently, sewage is conveyed at 0 m elevation as the force main travels along the foreshore. The hydraulics of the existing systems are presented in Table 10-1.

**Table 10-1: Hydraulics of Existing System**

| Parameter                 | Courtenay PS | Jane Place PS |
|---------------------------|--------------|---------------|
| Static Head to CVWPCC (m) | 17           | 15            |
| Line Losses (m)           | 12           | 7             |
| Total Head (m)            | 29           | 22            |

The achievable pumping capacities at either of the pump stations declines with the flowrate of the other pump station. Such that Courtenay PS is only able to achieve 380 L/s when JPS is operating at Peak Wet Weather Flow (PWWF), and JPS is only able to achieve 120 L/s when Courtenay PS is operating at PWWF. Figure 10-2 was derived from the 2013 AECOM report, demonstrating the operating rate range between the two pump stations.



**Figure 10-2: Existing System Performance**

Given the current flow restrictions at either pump stations, upgrades to both pump stations are imminent in the near future to ensure management of the sanitary flows.

### 10.1.2 OPTIONS BOUNDARIES AND LIMITING FACTORS

The LWMP Stage 1 and Stage 2 studies are limited to the existing sewage conveyance systems between Courtenay, Comox and the CVWPCC. Consideration for future sewage from Area A's South Sewer project is not in this report but is addressed elsewhere. Furthermore, the current and future sewage that flows into the CFB Pump station via the Hudson and Greenwood trunk mains is not directly included in this evaluation. It is indirectly addressed through population growth off-sets where future loads to the foreshore system are adjusted to address sewage loads directed to through the CFB pump station.

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## 10.2 STAGE 1 LWMP CONVEYANCE OPTIONS

The work team developed a preliminary long-list of options which could feasibly be used to convey sewerage from Courtenay, K'ómoks First Nation, and Comox to the CVWPCC. Options which were considered technically viable were carried forward to the Technical and Public Advisory Committees (TAC and PAC, respectively) for review and consideration. The option of a deep water marine alignment between the Courtenay PS and the CVWPCC was eliminated from further study by the team due to unacceptable fundamental technical and environmental issues. The remaining options were categorized as conveyance alignments and concepts and are described below:

1. Estuary Alignments – These alignments all include a section of forcemain in the estuary, specifically the inter-tidal zone. The objective of these options is to only eliminate the section of forcemain along Willmar Bluffs while minimizing impact of construction in the heavily populated and built-out sections of the CVRD.
2. Overland Alignments – These alignments are entirely overland and would generally follow existing road right-of-ways and be installed using traditional cut and cover trenching methods. These options minimize the need for construction in the estuary and allow for more conventional proven overland construction methods.
3. Tunnel Alignments – As a variation to overland options these alignments would incorporate a significant tunnelled section of pipe to off-set the hydraulic pressures necessary to overcome the natural topography between the CPS, JPS, and the CVWPCC.
4. North Side Concept – This option is a broad consideration for a conveyance system that includes an alignment which follows roads North of Comox Road between the CPS pump station and the CVWPCC, and a separate alignment conveying sanitary sewer directly from JPS to the CVWPCC.
5. Decentralized Treatment Concept – This option is a broad consideration which explores the idea that a portion of the sewage could be treated at a location at a wastewater treatment plant other than the CVWPCC rather than pumping the sewage to a common location. The effluent from this new wastewater treatment plant would then need to be conveyed to the location of the existing outfall at the CVWPCC.

The level of detail noted below is intended to broadly outline the above alignment and conveyance concepts. As such, detailed routings and facility locations are not included or discussed. Critical factors noted in the reviews include:

- General location and size of critical infrastructure such as pipes, pump stations, and treatment facilities;
- Technical challenges such as hydraulics, servicing capacity, and risks of construction and installation;
- Environmental considerations such as habitat impact, ecosystem impacts and proximity to known sensitive habitat;
- Archaeological considerations such as proximity to known sites;
- Operations and maintenance considerations including ability to isolate the system, shutdown operations, undertake repairs, flexibility, and complete spill management activities;
- Marine construction costs are carried at approximately double the terrestrial construction. This is based on historic comparison pricing along with the basis that working times are governed by tides which impact efficiency. Furthermore, excavation in the tidal zone is inefficient as the trench side slopes must be flatter due to sloughing of the saturated sands/mud soils;
- Land acquisition is not included in any price;
- Potential to expand the system to address future capacity; and
- Relative capital and operational costs.

With respect to cost estimates, the following is the basis of costing. Cost estimates are Class 'D' which can be defined as follows:

*“A preliminary estimate which, due to little or no site information, indicates the approximate magnitude of cost of the proposed project, based on the client's broad requirements. This overall cost estimate may be derived from lump sum or unit costs for a similar project. It may be used in developing long term capital plans and for preliminary discussion of proposed capital projects.” - EGBC Cost Estimate Definitions.*

Furthermore, the following assumptions and criteria are incorporated into the cost estimates.

- Capital costs are based on the following:
  - Similar infrastructure installed in other communities, where available; and
  - Cost curves and project holistic unit rates.
- Operating costs are based on:
  - Estimated annual average power consumption for major equipment only;
  - Estimated relative labour effort between options; and
  - Asset renewal requirements.

The costs presented in this report do not include GST. These costs are only for the purpose of options comparison and discussion and are not suitable for budgeting. Detailed industry quotes, building sizing, layouts and such are not included or considered for this level of costing.

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## 10.2.1 ESTUARY ALIGNMENTS

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### OPTION 1A – ESTUARY WITH LAZO HILL TUNNEL

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|                               |  |
|-------------------------------|--|
| Description:                  | The forcemain from CPS would continue directly to the CVWPCC along the estuary and across the peninsula, such that there is no in-line pump station; however, a tunnel through the Lazo Road hill would be used to reduce the required pressures in the system. Pending the tunnel elevation, a new pump station may be required in the general vicinity of the existing JPS. Detailed financial modelling of the tunnel length verses the pumping costs would need to be undertaken to optimize this option. In order to evaluate this option a tunnel elevation which does not result in a major pump station upgrade at CPS or JPS has been assumed. The existing JPS would be repurposed as a small subdivision pump station.  |
| Advantages                    | <ul style="list-style-type: none"><li>» Subject to tunnel elevation, there may be potentially limited changes to existing pump stations hydraulics.</li><li>» Maximizes useful life of estuary foreshore forcemain</li><li>» Avoids construction of a forcemain through Comox.</li><li>» Avoids the construction of additional large pump stations.</li></ul>  |
| Disadvantages                 | <ul style="list-style-type: none"><li>» Involves work along and in the estuary, including environmentally and archaeologically sensitive areas.</li><li>» Elevated maintenance and risk management needs due to proximity to marine environment.</li><li>» Elevated construction and operational risk associated with a tunnel.</li></ul>  |
| Technical Consideration       | <p>The system would be installed and operated very similar to the existing CVRD forcemain configuration. Required pumping head and pressure to convey sewage would be provided by separate pumping stations which would function nearly independently of each other. Any operational issues at any one station would be isolated in that collection zone. The hydraulic pressures can be reduced by tunnelling through the Lazo Road hill. The estimated system hydraulic operating pressure would be in the order of 40 to 50 meters.</p> <p>A significant technical challenge of this project is the inherent nature of the risks involved in tunnelling. As a result, a higher front-end effort may be required to map the geotechnical conditions along and around the proposed tunnelled alignment. Due to the uncertainty and risks surrounding tunnelling, a higher contingency would need to be accounted for during construction.</p> |
| Environmental Considerations  | Marsh habitat within the estuary area is recognized as major habitat for numerous water bird species. The estuary constitutes large intact salt marsh communities which have been noted as significant due to the increasing rarity on the east coast of Vancouver Island.   |
| Archaeological Considerations | Significant sections of the pipe alignment would follow through existing archaeological sites, such as DkSf-4 and DkSf-44, however any estuary alignments should be assumed to encounter archeological sites.  |
| Operational Considerations    | Maintenance and repair of any inter-tidal section of pipe would be limited by tidal conditions. Furthermore, the ability to detect and control any leakage or sewage spilled due to a line break would be significantly limited and potentially improbable. As such the design of the system would have to recognize the risks associated with a failure and a higher material strength would have to be used to off-set this risk. Present day material standards for this application would utilize a continuously fused HDPE pipe retained below the seabed using concrete weights. As HDPE is susceptible to punctures due to boat anchors, additional concrete armouring would likely be required to protect the pipe from external damage. This configuration would add  |



significant costs to the project due to the relatively large diameter (~1,000 mm) and the resulting weight and size of a concrete collars. Furthermore, this protective armour would further limit any access to allow repair work to be completed in the future.

Subject to the methods used to install the tunnel section, repairs to any damaged section of pipe would not be possible as the system cannot be shut down or excavated to undertake repair work. A critical consideration during the tunnel design would be the choice of material used and if a carrier pipe arrangement is to be employed. The more cost-effective solution would utilize the same pipe to line the micro-tunnel as the fluid carrying pipe. However, this arrangement would not provide any indication of leakage or opportunity to repair the carrier pipe. An alternative arrangement is to utilize a separate casing and carrier pipe. This would result in a casing pipe with a diameter approximately 200 mm larger than the carrier pipe. This arrangement would provide containment should the carrier pipe leak and would permit replacement of the carrier pipe should alternative methods be available to temporarily convey the sewage around the tunnel during repairs.

Operational flexibility is provided by the independence of each of the pump stations. Future twinning of the alignment would be at elevated risks in the estuary as work would be completed in intertidal zones, similar to the initial construction. Future twinning of the tunnelled section would be at elevated risks as it would be installed parallel to the first tunnel section.

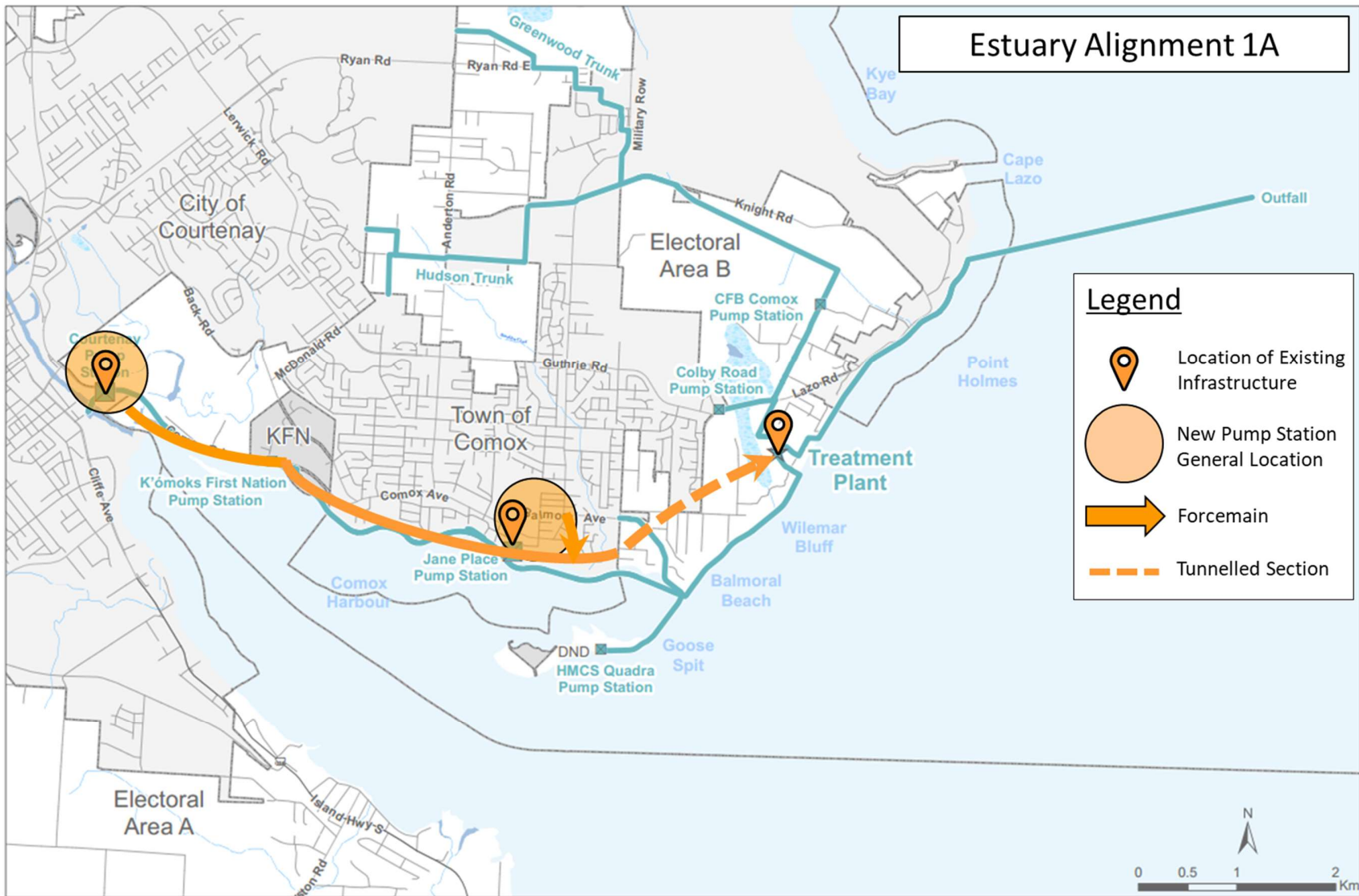
#### Infrastructure Elements

| Description                                | Capital Cost | Investment Year | Renewal Frequency | Renewal % | Total Power (kW) | Labour hrs/day |
|--|--------------|-----------------|-------------------|-----------|------------------|----------------|
| New Courtenay - Moderate Pressure Increase | \$10,500,000 | 2020            | 25                | 40%       | 625              | 3              |
| Downgrade Jane                             | \$2,362,500  | 2020            | 25                | 40%       | 25               | 0              |
| New Jane - Moderate Pressure Increase      | \$3,850,000  | 2020            | 25                | 40%       | 250              | 3              |
| Forcemain Tunnel through Lazo hill         | \$23,587,200 | 2020            | 60                | 100%      | 0                | 0              |
| Estuary Courtenay to Lazo Hill             | \$38,133,480 | 2030            | 60                | 100%      | 0                | 0              |
| Jane to forcemain                          | \$1,108,800  | 2030            | 60                | 100%      | 0                | 0              |
| Total Capital Cost                         | \$79,541,980 |                 |                   |           |                  |                |

**Cost Considerations** This option has an initial capital expenditure of around \$80M which can be spread over a 10 year period as all components are not required simultaneously. , the majority of which accounts for the cost of the linear conveyance infrastructure between the CPS and the CVWPCC, particularly as construction must be partially completed in the foreshore conditions, leading to significantly higher construction costs.

Power requirements are low as the forcemain is maintained at a lower elevation. There are advantages based on operating cost for this option as it sustains a relatively low elevation throughout the length of the alignment.

**Figures** Alignment is provided on Figure 10-3. Profile is provided on Figure 10-6.



**Figure 10-3: Estuary Alignment 1A**



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**OPTION 1B – ESTUARY WITH LAZO HILL OVERLAND ROUTE**

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|                               |  |
|-------------------------------|--|
| Description:                  | The forcemain from CPS would continue directly to the CVWPCC in the estuary such that there is no in-line pump station. In order to overcome the Lazo Road hill, the CPS would be upgraded to provide sufficient forcemain pressure to overcome the height of land. As a result, the existing JPS would not be able to cope with this higher hydraulic requirement and therefore a new high head pump station would be required in the general vicinity of the existing JPS. This new facility would convey raw sewage into the forcemain between CPS and the CVWPCC. The existing JPS would be repurposed as a small subdivision pump station to convey sewage from the small catchments remaining outside of the service area of the new pump station.   |
| Advantages                    | <ul style="list-style-type: none"><li>» Minimizes construction of a forcemain through Comox.</li><li>» Only involves 2 large pump stations (JPS repurposed as local facility only).</li></ul>  |
| Disadvantages                 | <ul style="list-style-type: none"><li>» Involves work along and in the estuary, including environmentally and archaeologically sensitive areas.</li><li>» Elevated maintenance and risk management needed due to proximity to the marine environment.</li></ul>  |
| Technical Consideration       | <p>The system would be installed and operated very similar to the existing CVRD forcemain configuration. Required pumping head and pressure to move sewage would be provided by separate pumping stations which would function nearly independently of each other. Any operational issues at any one station would be isolated in that collection zone. The required discharge pressures from the CPS would be in the order of 60 to 70 meters and be in excess of typical sanitary pumps. This would limit the available options for pumps or require a high pressure sanitary pump station configuration, specifically using two lower head pumps in direct series to achieve the necessary discharge pressures.</p> <p>The existing Jane Place property would not be large enough to accommodate a new pump station and as such a new property would be required to facilitate this new station. The existing JPS would still be required, albeit for a lower pumping capacity as it would only service the properties which would not gravity drain to the new pump station.</p> |
| Environmental Considerations  | Marsh habitat within the estuary area is recognized as major habitat for numerous water bird species. The estuary constitutes large intact salt marsh communities which have been noted as significant due to the increasing rarity on the east coast of Vancouver Island.   |
| Archaeological Considerations | Significant sections of the pipe alignment would follow through existing archaeological sites, such as DkSf-4 and DkSf-44, however any estuary alignments should be assumed to encounter archeological sites.  |
| Operational Considerations    | Maintenance and repair of any inter-tidal section of pipe would be limited by tidal conditions. Furthermore, the ability to detect and control any leakage or sewage spilled due to a line break would be significantly limited and potentially improbable. As such the design of the system would have to recognize the risks associated with a failure and a higher material strength would have to be used to off-set this risk. Present day material standards for this application would utilize a continuously fused HDPE pipe retained below the seabed using concrete weights. As HDPE is susceptible to punctures due to boat anchors, additional concrete armouring would likely be required to protect the pipe from external damage. This configuration would add significant costs to the project due to the relatively large diameter (~1,000 mm) and the resulting weight and size of a concrete collars. Furthermore, this protective armour would further limit any access to allow repair work to be completed in the future.                                      |

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The selection of a new property for the JPS provides an opportunity to consider future sea-level changes and increased resilience of this station to climate change.

Operational flexibility is provided by the independence of each of the pump stations. Future twinning of the alignment would be at elevated risks in the estuary as work would be completed in intertidal zones, similar to the initial construction. Excavation and installation of a twinned section of pipe in the overland portion would not be a significant challenge.

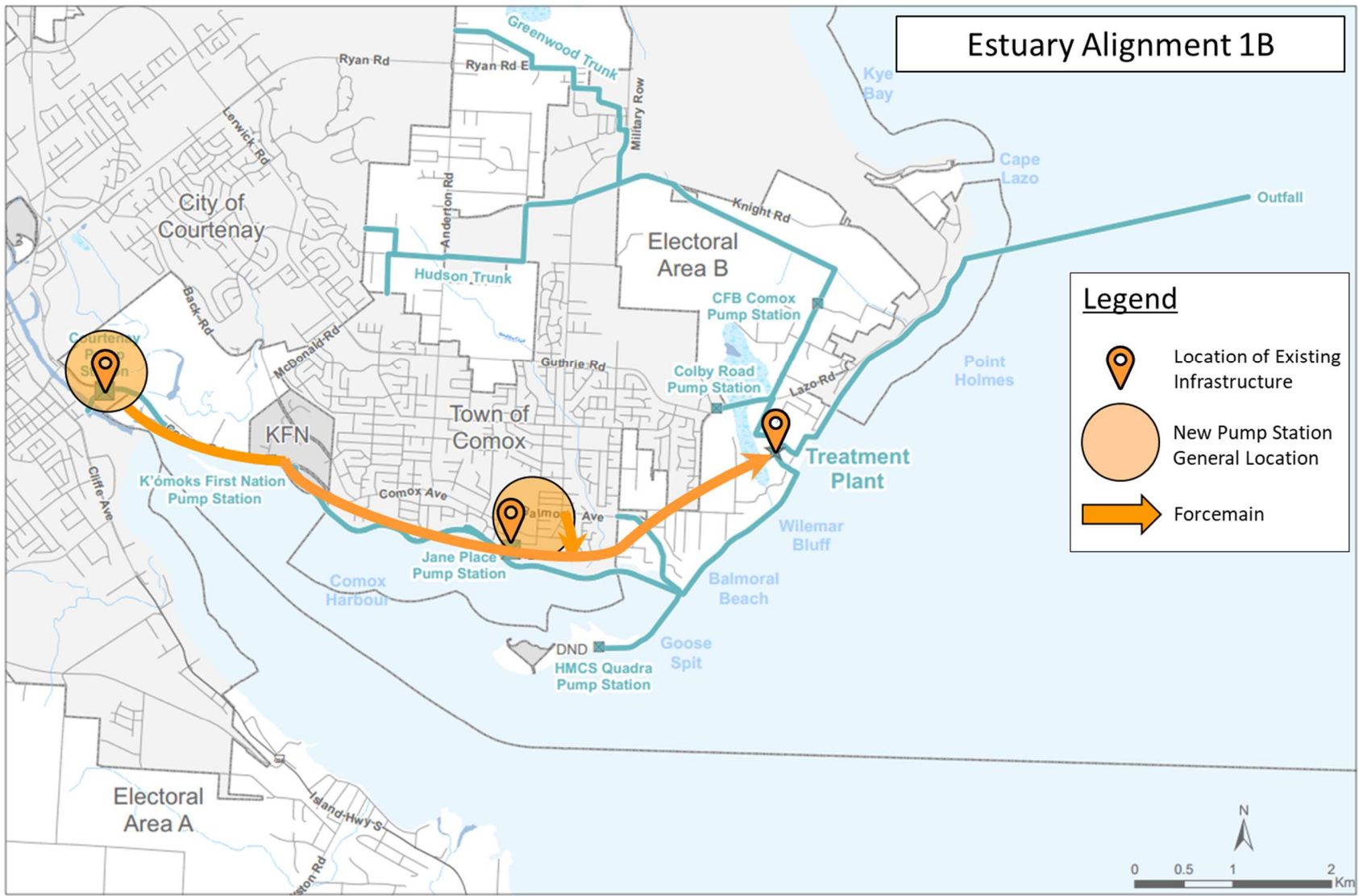
#### Infrastructure Elements

| Description                                | Capital Cost        | Investment Year | Renewal Frequency | Renewal % | Total Power (kW) | Labour hrs/day |
|--|---------------------|-----------------|-------------------|-----------|------------------|----------------|
| New Courtenay - Moderate Pressure Increase | \$10,500,000        | 2020            | 25                | 40%       | 1125             | 3              |
| Downgrade Jane                             | \$2,362,500         | 2020            | 25                | 40%       | 25               | 0              |
| New Jane - Moderate Pressure Increase      | \$3,850,000         | 2020            | 25                | 40%       | 425              | 3              |
| Overland Lazo Hill to CVWPCC               | \$5,913,600         | 2020            | 60                | 100%      | 0                | 0              |
| Estuary Courtenay to Jane                  | \$32,728,080        | 2020            | 60                | 100%      | 0                | 0              |
| Jane to forcemain                          | \$1,108,800         | 2020            | 60                | 100%      | 0                | 0              |
| Old Jane to New Jane                       | \$51,744            | 2020            | 60                | 100%      | 0                | 0              |
| <b>Total Capital Cost</b>                  | <b>\$56,514,724</b> |                 |                   |           |                  |                |

**Cost Considerations** This option has a capital cost of around \$57M, a significant part of which accounts for the cost of the linear conveyance infrastructure between the CPS and the CVWPCC, particularly as construction must be partially completed in the foreshore conditions, leading to higher construction costs. There is also a need for the construction of a new moderate-pressure CPS and a new moderate-pressure JPS. This option requires the downgrading of the JPS and continued asset maintenance for a total of three pump stations, however the downgraded JPS will require minimal maintenance efforts.

Compared to alignment 1A, there are no advantages based on operating cost for this option as it has a higher pumping head requirement since the conveyance system needs to overcome the height of land at Lazo hill.

**Figures** Alignment is provided on Figure 10-4. Profile is provided on Figure 10-6.



**Figure 10-4: Estuary Alignment 1B**

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## OPTION 1C – ESTUARY WITH A NEW IN-LINE PUMP STATION

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|                               |   |
|-------------------------------|---|
| Description:                  | This option includes the construction of a new pump station facility located between Comox and the Lazo Road hill, at the Beech Street property. This would be an inline facility which receives raw sewage from the CPS/JPS discharge forcemain. The new pump station would pump the sewage over the Lazo Road hill and the sewage would flow to the CVWPCC. The JPS would tie-in to the CPS discharge forcemain at a location upstream of the new pump station. The elevation of the new pump station would have to be low enough to permit the JPS to pressures at the forcemain connection.   |
| Advantages                    | <ul style="list-style-type: none"><li>» Minimize hydraulic changes to existing CPS and JPS.</li><li>» Maximize useful life of existing foreshore forcemain.</li><li>» Avoids construction of a forcemain through Comox.</li></ul>   |
| Disadvantages                 | <ul style="list-style-type: none"><li>» Pump stations in series and single point of complete failure of sewage conveyance system.</li><li>» Involves operation and maintenance of 3 large pump station.</li><li>» Involves work along and potentially in the estuary, including environmentally and archaeologically sensitive areas.</li><li>» Elevated maintenance and risk management needs due to proximity to marine environment.</li></ul>  |
| Technical Consideration       | <p>Unlike the existing CVRD pump station configuration, this station would be in-line with existing pump stations and all sewage would pass through this facility. Total capacity of this station would be the combined flow from CPS and JPS. To address the operational risks with this single point of operation, a very high level of system redundancy and operational flexibility would be required. This could include balancing storage or double redundancy on major systems such as power supply and piping systems.</p> <p>This arrangement limits the need to change the existing system pressure as the new station would be located to accommodate the existing CPS and JPS hydraulic operations. The discharge pressure required from this station would need to overcome the Lazo road hill of approximately 50m.</p> |
| Environmental Considerations  | Marsh habitat within the estuary area is recognized as major habitat for numerous water bird species. The estuary constitutes large intact salt marsh communities which has been noted as significant due to the increasing rarity on the east coast of Vancouver Island.   |
| Archaeological Considerations | Significant section of the pipe alignment would follow through existing archaeological sites, such as DkSf-4 and DkSf-44.   |
| Operational Considerations    | <p>Maintenance and repair of any inter-tidal section of pipe would be limited to tidal conditions. Furthermore, isolation and collection of leaking sewage would not be possible in intertidal zones.</p> <p>Repair and restoration of any damaged sections of pipe in the overland portions would be completed following common practices and could be completed quickly, with limited long-term impacts and completed using readily available local resources.</p> <p>Operation of the entire CVRD sewage system would be contingent on the operation of this new pump station. Overflows at this location would not be permitted and the provision of balancing storage would be strongly encouraged to provide an opportunity for maintenance activities or emergency responses to any faults.</p>                                |

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## Infrastructure Elements

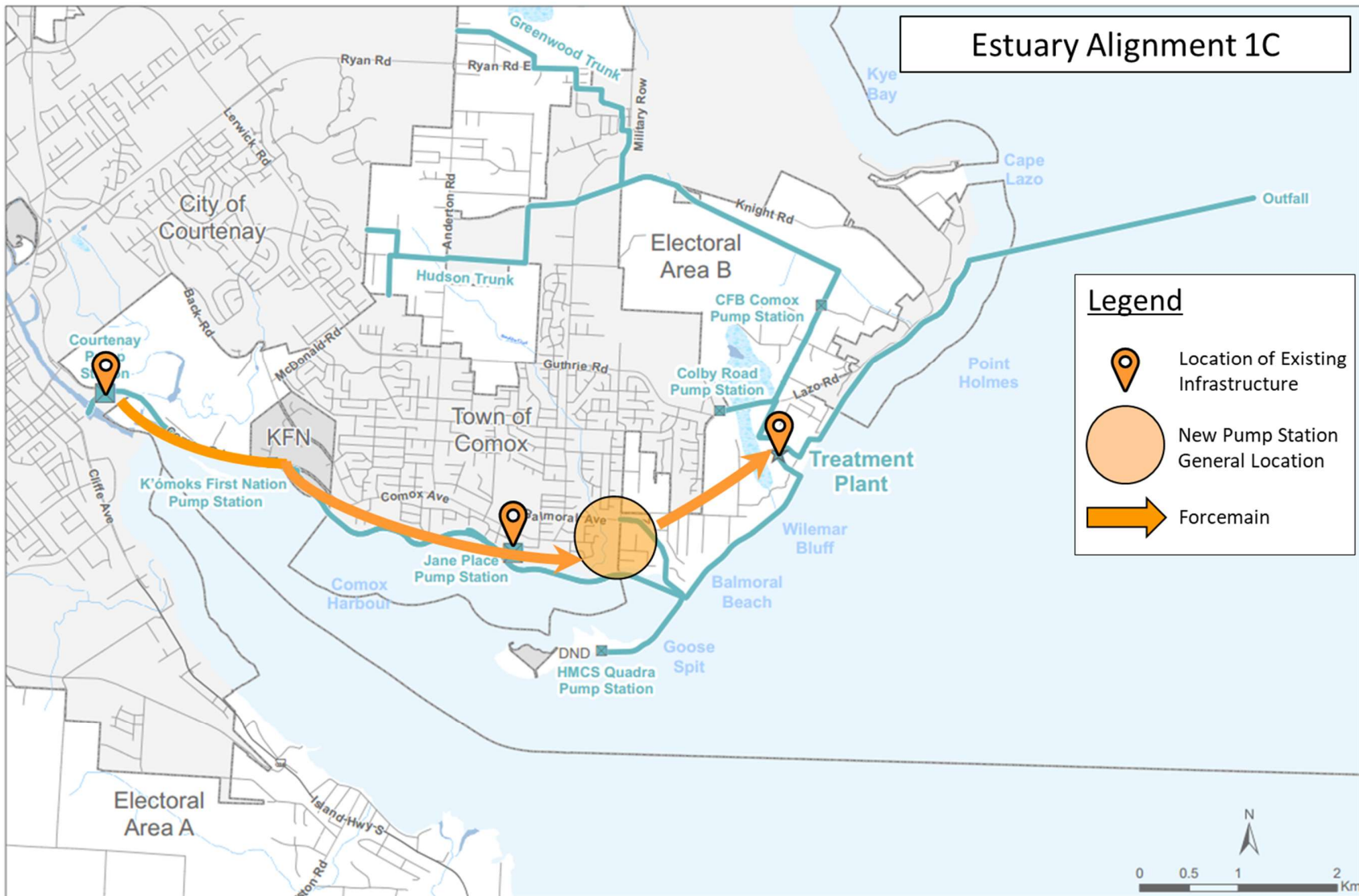
| Description                                | Capital Cost | Investment Year | Renewal Frequency | Renewal % | Total Power (kW) | Labour hrs/day |
|--|--------------|-----------------|-------------------|-----------|------------------|----------------|
| Upgrade Courtenay (Capacity and AM driven) | \$4,200,000  | 2020            | 25                | 40%       | 375              | 3              |
| Upgrade Jane (Capacity and AM driven)      | \$3,150,000  | 2020            | 25                | 40%       | 150              | 3              |
| New In-line Pump Station                   | \$12,040,000 | 2020            | 25                | 40%       | 1075             | 3              |
| Overland Lazo Hill to CVWPCC               | \$5,913,600  | 2020            | 60                | 100%      | 0                | 0              |
| Estuary Courtenay to Lazo Hill             | \$38,133,480 | 2030            | 60                | 100%      | 0                | 0              |
| Jane to forcemain                          | \$1,108,800  | 2030            | 60                | 100%      | 0                | 0              |
| Total Capital Cost                         | \$64,545,880 |                 |                   |           |                  |                |

**Cost Considerations** This option has a moderate initial capital expenditure of around \$65M, a significant part of which accounts for the cost of the linear conveyance infrastructure between the CPS and the CVWPCC, particularly as construction must partially be completed in the foreshore conditions, leading to significantly higher construction costs. There is also a need for the construction of a new in-line pump station west of the Lazo Road hill with sufficient capacity to convey all of Courtenay and Comox's sewage. This option requires the continued asset maintenance for a total of three pump stations.

Similar to option 1B, and compared to alignment 1A, there are no advantages based on operating cost for this option as it has a higher pumping head requirement since the conveyance system needs to overcome the height of land at Lazo Road hill.

**Figures** Alignment is provided on Figure 10-5. Profile is provided on Figure 10-6.

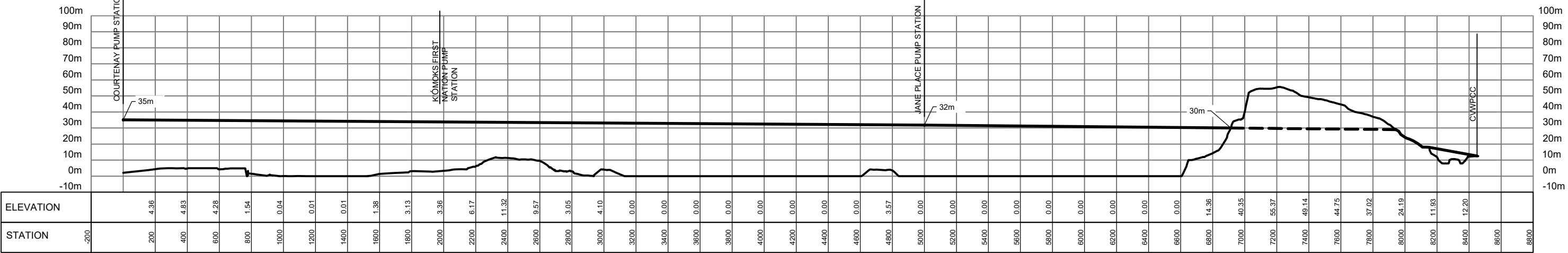
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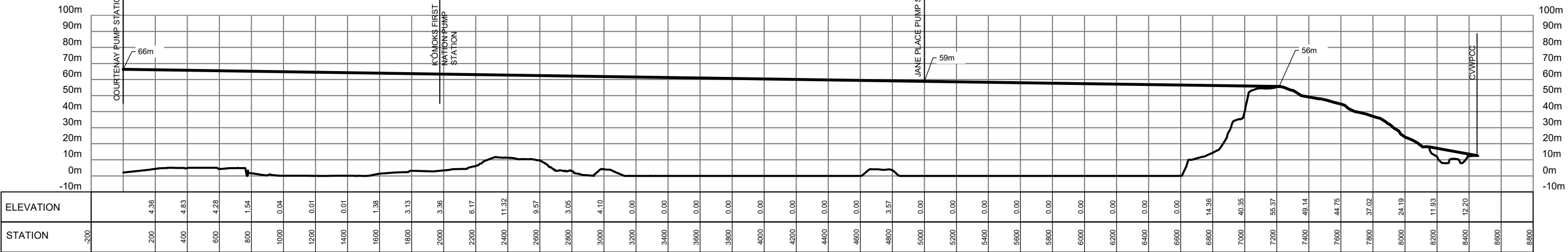
**Figure 10-5: Estuary Alignment 1C**



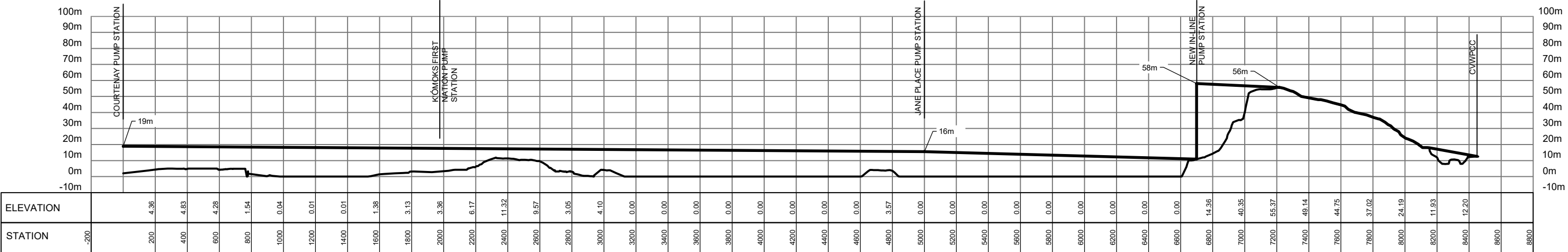
Option 1A



Option 1B



Option 1C



OPTION 1  
PROFILE BETWEEN CH: -200.00 AND 8800.00  
1:12500(H) 1:1250(V) AT A1

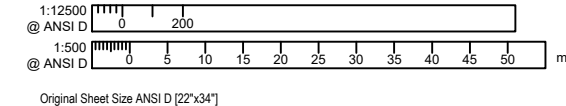


Figure 10-6: Option 1 Hydraulic Profiles

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## 10.2.2 OVERLAND ALIGNMENTS

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### OPTION 2A – OVERLAND FORCEMAIN

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|                               |  |
|-------------------------------|--|
| Description:                  | <p>This alignment would involve installation of a new forcemain overland from the CPS towards the CVWPCC. This forcemain would pass over the Comox Road hill. Due to the change in discharge pressure, a significant upgrade or rebuild would be required at the CPS. The forcemain from CPS would continue directly to the CVWPCC such that there is no in-line pump station. In order to overcome both the Comox Road hill and the Lazo Road hill, the CPS would be upgraded to meet the necessary hydraulic pressure. As a result, the existing JPS would not be able to cope with this higher hydraulic requirement and therefore a new higher head pump station would be required in the general vicinity of the existing JPS. This new facility would convey raw sewage into the forcemain between CPS and the CVWPCC. The existing JPS would be repurposed as a small subdivision pump station to convey sewage from the small catchments remaining outside of the service area of the new pump station.</p>  |
| Advantages                    | <ul style="list-style-type: none"><li>» No pipe in the estuary mitigating environmental and archaeological risks.</li><li>» All pipe and structures would be on-land to maximize maintenance accessibility.</li><li>» Only involves 2 large pump stations (JPS repurposed as local facility only).</li></ul>   |
| Disadvantages                 | <ul style="list-style-type: none"><li>» Significant hydraulic changes to the CPS and JPS.</li><li>» Construction of new conveyance system through an area with significant existing infrastructure and high traffic.</li></ul>   |
| Technical Consideration       | <p>The system would operate similar to the existing CVRD sewage system where a single forcemain conveys sewage directly to the CVWPCC. The two pump stations would operate independently of each other. The most significant variation from the existing system is that the forcemain would follow the natural topography of the land and therefore the pump station would need to be relatively high pressure in order to overcome the existing hills.</p> <p>As the flow rate through these stations is reasonably high, there are options available to provide the necessary discharge pressures, however the selection of options becomes reduced at these pressures, which are estimated to be in the order of 60 to 70 m of pressure.</p> <p>The overland forcemain would be installed using standard cut-and-cover installation methods with the general intention of following existing roadways. This approach is very common and as such, reasonably well established. Additional complexities would involve relocating existing utilities and restoration of surface roadways, sidewalks, and similar features. Due to the nature of sanitary systems, the depth of excavation would be set to be below the existing water systems.</p> |
| Environmental Considerations  | <p>Overland portions routed along existing roadways would have limited environmental impacts. Areas with significant adjacent trees could be potentially damaged due to root damage.</p>   |
| Archaeological Considerations | <p>The intention would be to remain within existing areas of disturbance, so no unique archaeological impacts are likely.</p>  |

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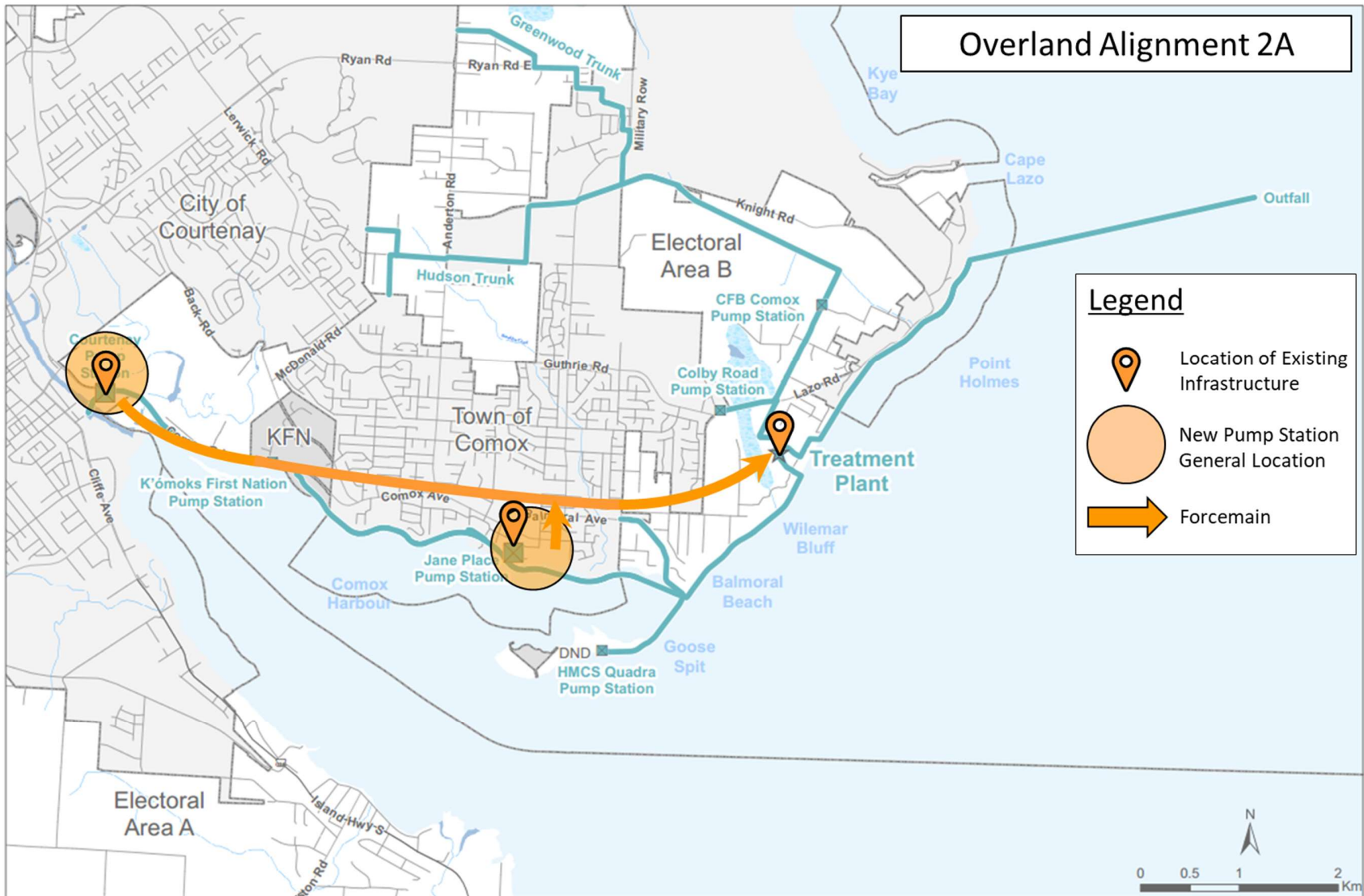
|                            |  |
|----------------------------|--|
| Operational Considerations | Maintenance of the higher head pump station would be similar to that of the existing facilities, however there is a reduced selection of pump options. In addition, a typical higher head sewage pump operates at reduced efficiency compared to lower head pumps. Maintenance and repair on the overland forcemain would be completed using well established repair methods based on open excavation. Should a pipe failure occur, standard methods of isolation and pumping off-site using a vacuum truck would be employed. |
|----------------------------|--|

#### Infrastructure Elements

| Description                                  | Capital Cost | Investment Year | Renewal Frequency | Renewal % | Total Power (kW) | Labour hrs/day |
|--|--------------|-----------------|-------------------|-----------|------------------|----------------|
| New Courtenay - Moderate Pressure Increase   | \$10,500,000 | 2020            | 25                | 40%       | 1050             | 3              |
| Downgrade Jane                               | \$2,362,500  | 2020            | 25                | 40%       | 25               | 0              |
| New Jane - Moderate Pressure Increase        | \$3,850,000  | 2020            | 25                | 40%       | 425              | 3              |
| Overland Courtenay to Jane (New or Existing) | \$16,493,400 | 2020            | 60                | 100%      | 0                | 0              |
| Overland Jane to Lazo Hill                   | \$4,851,000  | 2020            | 60                | 100%      | 0                | 0              |
| Overland Lazo Hill to CVWPCC                 | \$5,913,600  | 2020            | 60                | 100%      | 0                | 0              |
| Jane to forcemain                            | \$1,108,800  | 2020            | 60                | 100%      | 0                | 0              |
| Total Capital Cost                           | \$45,079,300 |                 |                   |           |                  |                |

|                     |  |
|---------------------|--|
| Cost Considerations | <p>This option has a relatively low initial capital expenditure at \$45M, as construction of the linear conveyance infrastructure is mostly completed overland in already-disturbed areas, leading to lower construction costs. There is need for the construction or re-construction of two new pump stations. This option requires the continued asset maintenance for a total of three pump stations, however the downgraded JPS will require minimal maintenance efforts.</p> <p>There is no operating cost advantage to this option as it requires pumping of the raw sewage over the heights of land at both Comox Road and Lazo Road hills, resulting in significant financial operating costs.</p> |
|---------------------|--|

|         |   |
|---------|---|
| Figures | Alignment is provided on Figure 10-7. Profile is provided on Figure 10-9. |
|---------|---|



**Figure 10-7: Overland Alignment 2A**

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**OPTION 2B – OVERLAND FORCEMAIN WITH IN-LINE PUMP STATION**

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|                               |  |
|-------------------------------|--|
| Description:                  | <p>This alignment would involve installation of a new forcemain overland from CPS towards a new in-line pump station. The forcemain from CPS would convey raw sewage over the Comox Road hill and down into a new pump station, connected in series, between the JPS and Lazo Road heights of land, at the Beech Street property. The elevation of the new pump station would need to be at an elevation to suit the existing discharge pressures from the JPS. From the new pump station, the raw sewage would be conveyed over the Lazo Road hill to the CVWPCC.</p>   |
| Advantages                    | <ul style="list-style-type: none"><li>» No pipe in the estuary mitigating environmental and archaeological risks.</li><li>» All pipe and structures would be on-land to maximize maintenance accessibility.</li><li>» Minimize hydraulic changes to existing JPS.</li></ul>  |
| Disadvantages                 | <ul style="list-style-type: none"><li>» Pump in series and single point of complete failure of sewage conveyance system.</li><li>» Involves operation and maintenance of 3 large pump station, one of high criticality.</li><li>» Significant hydraulic changes to the CPS.</li><li>» Construction of new conveyance system through an area with significant existing infrastructure and high traffic.</li></ul>   |
| Technical Consideration       | <p>Unlike the existing CVRD pump station configuration this new system would include an in-line pump station where all sewage would pass. Total capacity of this station would be the combined flow from CPS and JPS. To address the operational risks with this single point of operation a very high level of system redundancy and operational flexibility would be required. This could include balancing storage or double redundancy on major systems such as power supply and piping systems.</p> <p>This arrangement limits the need to change the existing JPS pressure as the new station would be located to accommodate the existing JPS hydraulic operations. The discharge pressure required from this station would need to overcome the Lazo road hill.</p> <p>The overland forcemain would be installed using standard cut-and-cover installation methods with the general intention of following existing roadways. This approach is very common and as such, reasonably well established. Additional complexities would involve relocating existing utilities and restoration of surface roadways, sidewalks and similar features. Due to the nature of sanitary systems the depth of excavation would be set to be below the existing water systems.</p> |
| Environmental Considerations  | <p>Overland portions routed along existing roadways would have limited environmental impacts. Areas with significant adjacent trees could be potentially damaged due to root damage.</p>   |
| Archaeological Considerations | <p>The intention would be to remain with existing areas of disturbance, so no unique archaeological impacts are likely.</p>  |
| Operational Considerations    | <p>Maintenance of the higher head pump station would be similar to that of the existing facilities, however there is a reduced selection of pump options. In addition, a typical higher head sewage pump operates at reduced efficiency compared to lower head pumps.</p> <p>Operation of the entire CVRD sewage system would be contingent on the operation of this new pump station. Overflows at this location would not be permitted and the provision of balancing storage would be strongly encouraged to provide an opportunity for maintenance activities or emergency responses to any faults.</p>  |

Maintenance and repair on the overland forcemain would be completed using well established repair methods based on open excavation. Should a pipe failure occur standard methods of isolation and pumping off-site using a vacuum truck would be employed.

#### Infrastructure Elements

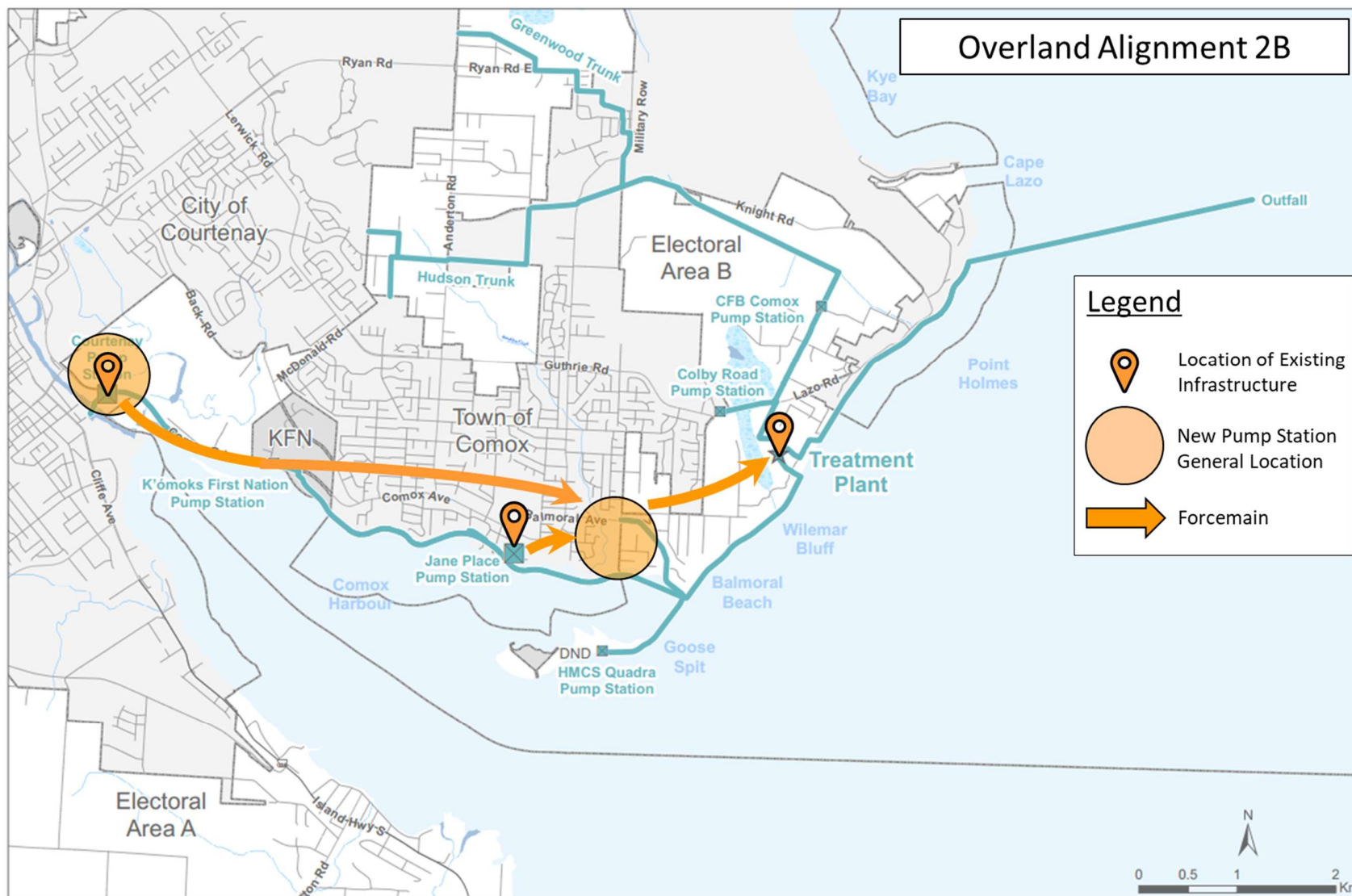
| Description                                | Capital Cost        | Investment Year | Renewal Frequency | Renewal % | Total Power (kW) | Labour hrs/day |
|--|---------------------|-----------------|-------------------|-----------|------------------|----------------|
| New Courtenay - Moderate Pressure Increase | \$10,500,000        | 2025            | 25                | 40%       | 750              | 3              |
| Upgrade Jane (Capacity and AM driven)      | \$3,150,000         | 2020            | 25                | 40%       | 300              | 3              |
| New In-line Pump Station                   | \$12,040,000        | 2020            | 25                | 40%       | 1075             | 3              |
| Overland Courtenay to Lazo Hill            | \$26,999,280        | 2030            | 60                | 100%      | 0                | 0              |
| Overland Lazo Hill to CVWPCC               | \$5,913,600         | 2020            | 60                | 100%      | 0                | 0              |
| <b>Total Capital Cost</b>                  | <b>\$58,602,880</b> |                 |                   |           |                  |                |

**Cost Considerations**

This option has moderate initial capital expenditure of \$59M, as construction of the linear conveyance infrastructure is mostly completed overland in already-disturbed areas, leading to lower construction costs. There is need for the construction of a new CPS and a new in-line pump station west of the Lazo Road hill. This option requires the continued asset maintenance for a total of three pump stations.

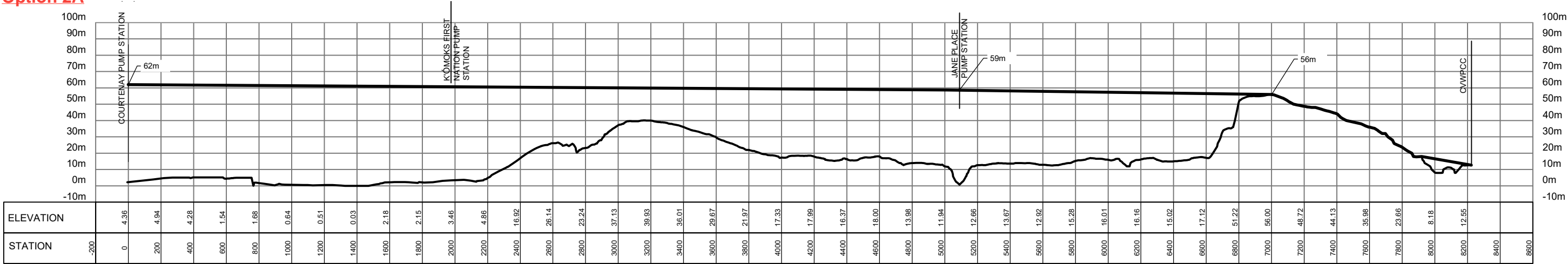
There are operating cost disadvantages to this option as it requires pumping of the raw sewage over the height of land at Comox Road hill, breaking head at the location of the new in-line pump station, and again pumping over the height of land at the Lazo Road hill, resulting in significant financial operating costs.

**Figures** Alignment is provided on Figure 10-8. Profile is provided on Figure 10-9.

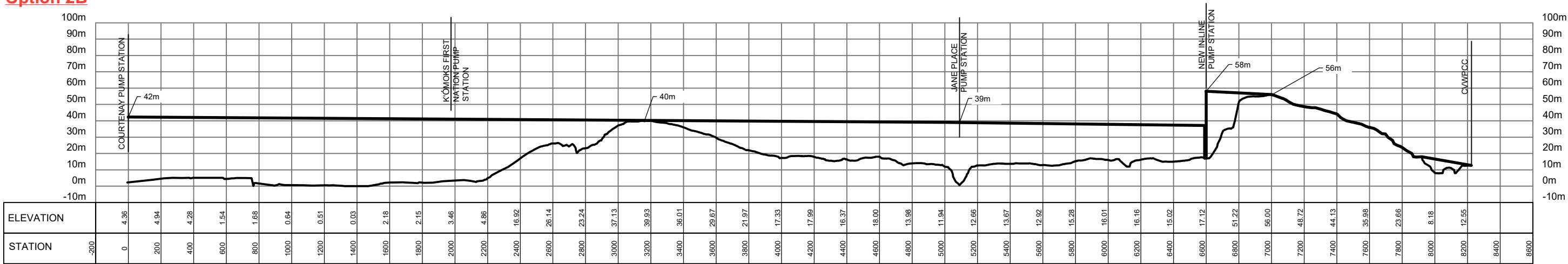


**Figure 10-8: Overland Alignment 2B**

Option 2A



Option 2B



OPTION 2  
PROFILE BETWEEN CH: -200.00 AND 8600.00  
1:12500(H) 1:1250(V) AT A1

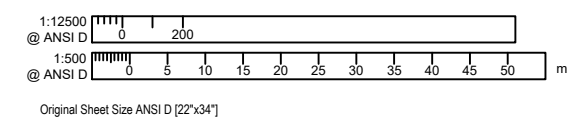


Figure 10-9: Option 2 Hydraulic Profiles



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### 10.2.3 TUNNELLING ALIGNMENTS

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#### OPTION 3A – TUNNEL THROUGH COMOX RD HILL AND LAZO RD HILL

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|                         |   |
|-------------------------|---|
| Description:            | <p>This alignment would involve installation of a combination of new forcemains installed using open cut methods and micro-tunnel methods in order to minimize pumping requirements. The primary areas where tunnelling would be appropriate are under the Comox Rd. and Lazo Rd hills. Sewage would be pumped from the CPS to an elevation where a tunnel would be constructed through the Comox Road hill. The forcemain would transition to an open cut installation through Comox and back to a tunnel to pass under the Lazo Road hill and down to the CVWPCC. The JPS could connect to the forcemain. To avoid major modifications to the JPS the tunnel elevations would have to be selected to suit the existing hydraulics of the JPS.</p> <p>The tunnel through the Comox Road hill would be around a 30-meter elevation and be in the 800 to 1,000 m length. To pass through the Lazo Road hill, while maintain an elevation suitable to limit upgrades at the JPS it is likely that 1,200 to 1,500 m tunnel would be required. This would necessitate an intermediate shaft and add cost and complexity to the project as this has the potential to penetrate the groundwater in the area. Following construction this shaft would be removed. Alternative routing would need to be explored to evaluate options to avoid this shaft.</p> <p>The overland forcemain would be installed using standard cut-and-cover installation methods with the general intention of following existing roadways. This approach is very common and as such, reasonably well established. Additional complexities would involve relocating existing utilities and restoration of surface roadways, sidewalks, and similar features. Due to the nature of sanitary systems the depth of excavation would be set to be below the existing water systems.</p> |
| Advantages              | <ul style="list-style-type: none"><li>» No pipe in the estuary mitigating environmental and archaeological risks.</li><li>» All overland pipes and structures will maximize maintenance accessibility.</li><li>» Alleviates some of the high head requirements as compared to other overland options.</li></ul>   |
| Disadvantages           | <ul style="list-style-type: none"><li>» Construction of new conveyance system through an area with significant existing infrastructure.</li><li>» High risk tunnel installation and a potential construction shaft located along the Lazo Road hill section.</li><li>» Limited maintenance accessibility for the tunnelled sections of alignment.</li></ul>   |
| Technical Consideration | <p>This system would operate similar to the existing configuration where a single forcemain connects the CPS with the CVWPCC and the JPS connects into the forcemain. To avoid significant changes to the existing pump stations a micro-tunnel would be used to pass through the two heights of land. The length of the micro-tunnel would be limited to 800 to 1,000 m between access shafts.</p> <p>Tunnel sections would need to be reviewed for the financial benefit of installing a twinned system during initial construction. Risks to future expansion and tunnelling adjacent a critical forcemain would need to be factored into the decision making during preliminary design.</p> <p>The design of the tunnel forcemain would likely utilize materials not commonly used in Western Canada for sewage infrastructure as the pipe would have to be designed for the installation conditions and the exposure to sewage.</p>  |

|                               |  |
|-------------------------------|--|
| Environmental Considerations  | <p>Overland portions routed along existing roadways would have limited environmental impacts. Areas where there are significant adjacent trees could be potentially damaged due to root damage.</p> <p>The deeper tunnel options would likely involve dewatering during installation and construction which may temporarily impact local groundwater wells.</p>  |
| Archaeological Considerations | <p>The intention would be to remain with existing areas of disturbance so no unique archaeological impacts are likely.</p>   |
| Operational Considerations    | <p>Maintenance of the pump stations would be similar to that of the existing facilities.</p> <p>Maintenance and repair on the overland forcemain would be completed using well established repair methods based on open excavation. Should a pipe failure occur standard methods of isolation and pumping off-site using a vacuum truck would be employed.</p> <p>There would be no opportunity to undertake maintenance on the tunnel section of pipe and any damage would require a cured-in-place repair technology. This repair cannot be completed while the system is in operation and therefore would necessitate a significant by-pass design to permit the tunnel to be taken off-line.</p> |

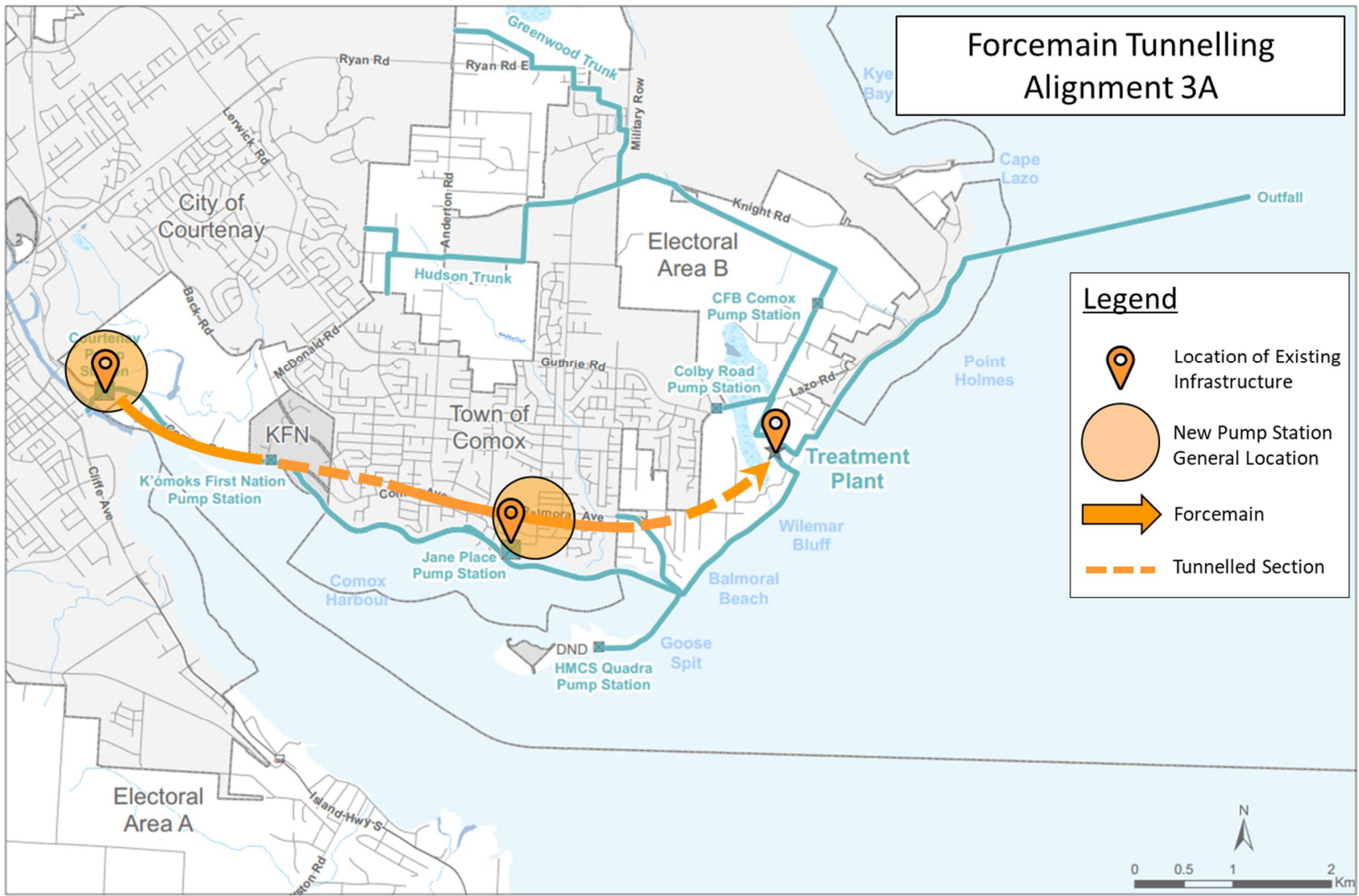
#### Infrastructure Elements

| Description  | Capital Cost | Investment Year | Renewal Frequency | Renewal % | Total Power (kW) | Labour hrs/day |
|--|--------------|-----------------|-------------------|-----------|------------------|----------------|
| New Courtenay - Moderate Pressure Increase           | \$10,500,000 | 2020            | 25                | 40%       | 625              | 3              |
| Downgrade Jane                                       | \$2,362,500  | 2020            | 25                | 40%       | 25               | 0              |
| New Jane - Moderate Pressure Increase                | \$3,850,000  | 2020            | 25                | 40%       | 250              | 3              |
| Forcemain Tunnel through Lazo hill                   | \$23,587,200 | 2020            | 60                | 100%      | 0                | 0              |
| Forcemain Tunnel through Comox hill                  | \$11,734,800 | 2020            | 60                | 100%      | 0                | 0              |
| Overland from Comox hill to Lazo hill                | \$10,977,120 | 2020            | 60                | 100%      | 0                | 0              |
| Jane to forcemain                                    | \$1,108,800  | 2020            | 60                | 100%      | 0                | 0              |
| Overland Courtenay to CVWPCC (Excl. Tunnel Sections) | \$15,846,600 | 2020            | 60                | 100%      | 0                | 0              |
| Total Capital Cost                                   | \$79,967,020 |                 |                   |           |                  |                |

|                     |  |
|---------------------|--|
| Cost Considerations | <p>This option has moderate initial capital expenditure of \$80M, as construction of tunnelled sections carries additional cost compared to open-cut installation of linear infrastructure. However, the remainder of the alignment construction is mostly completed overland in already-disturbed areas. This option requires the continued asset maintenance for a total of the two existing CPS and JPS.</p> <p>There are significant advantages based on operating cost for this option as it sustains a relatively low elevation by tunnelling through the heights of land at the Comox Road and Lazo Road hills.</p> |
|---------------------|--|

|         |   |
|---------|---|
| Figures | Alignment is provided on Figure 10-10. Profile is provided on Figure 10-13. |
|---------|---|





**Figure 10-10: Forcemain Tunnelling Alignment 3A**

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### OPTION 3B – TUNNEL THROUGH LAZO RD HILL

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|                               |   |
|-------------------------------|---|
| Description:                  | <p>A new open cut forcemain would be installed from CPS and would continue directly to the CVWPCC with a tunnel through the Lazo Road Hill. The existing JPS would likely not be able to cope with this higher hydraulic requirement and therefore a new high head pump station would be required in the general vicinity of the existing JPS. This new facility would convey raw sewage into the forcemain between CPS and the CVWPCC. The existing JPS would be repurposed as a small subdivision pump station. If the tunnel elevation is sufficiently low, the existing JPS would be suitable.</p> <p>Assuming a new JPS the tunnel through Lazo Road hill would be approximately 800 to 1,000 m long.</p> <p>The overland forcemain would be installed using standard cut-and-cover installation methods with the general intention of following existing roadways. This approach is very common and as such, reasonably well established. Additional complexities would involve relocating existing utilities and restoration of surface roadways, sidewalks and similar features. Due to the nature of sanitary systems the depth of excavation would be set to be below the existing water systems.</p> |
| Advantages                    | <ul style="list-style-type: none"><li>» No pipe in the estuary mitigating environmental and archaeological risks.</li><li>» All pipe and structures on-land to maximize maintenance accessibility.</li><li>» Alleviates some of the high head requirements as compared to other overland options.</li></ul>   |
| Disadvantages                 | <ul style="list-style-type: none"><li>» Construction of new conveyance system through an area with significant existing infrastructure.</li><li>» Higher upgrade requirements at the CPS and JPS.</li></ul>   |
| Technical Consideration       | <p>This system would operate similar to the existing configuration where a single forcemain connects the CPS with the CVWPCC and the JPS connects into the forcemain. As the flow rate through these stations is reasonably high there are options available to provide the necessary discharge pressures, however the selection of options becomes reduced at these pressures, which are estimated to be in the order of 50 to 60 m of pressure.</p> <p>Tunnel sections would need to be reviewed for the financial benefit of installing a twinned system during construction. Risks to future expansion and tunnelling adjacent a critical forcemain would need to be factored into the decision making at the project on-site.</p> <p>The design of the tunnel forcemain would likely utilize materials not commonly used in Western Canada for sewage infrastructure as the pipe would have to be designed for the installation conditions and the exposure to sewage.</p>   |
| Environmental Considerations  | <p>Overland portions routed along existing roadways would have limited environmental impacts. Areas where there are significant adjacent trees could be potentially damaged due to root damage.</p> <p>The deeper tunnel options would likely involve dewatering during installation/construction which may temporarily impact local groundwater wells.</p>   |
| Archaeological Considerations | <p>The intention would be to remain with existing areas of disturbance so no unique archaeological impacts are likely.</p>  |

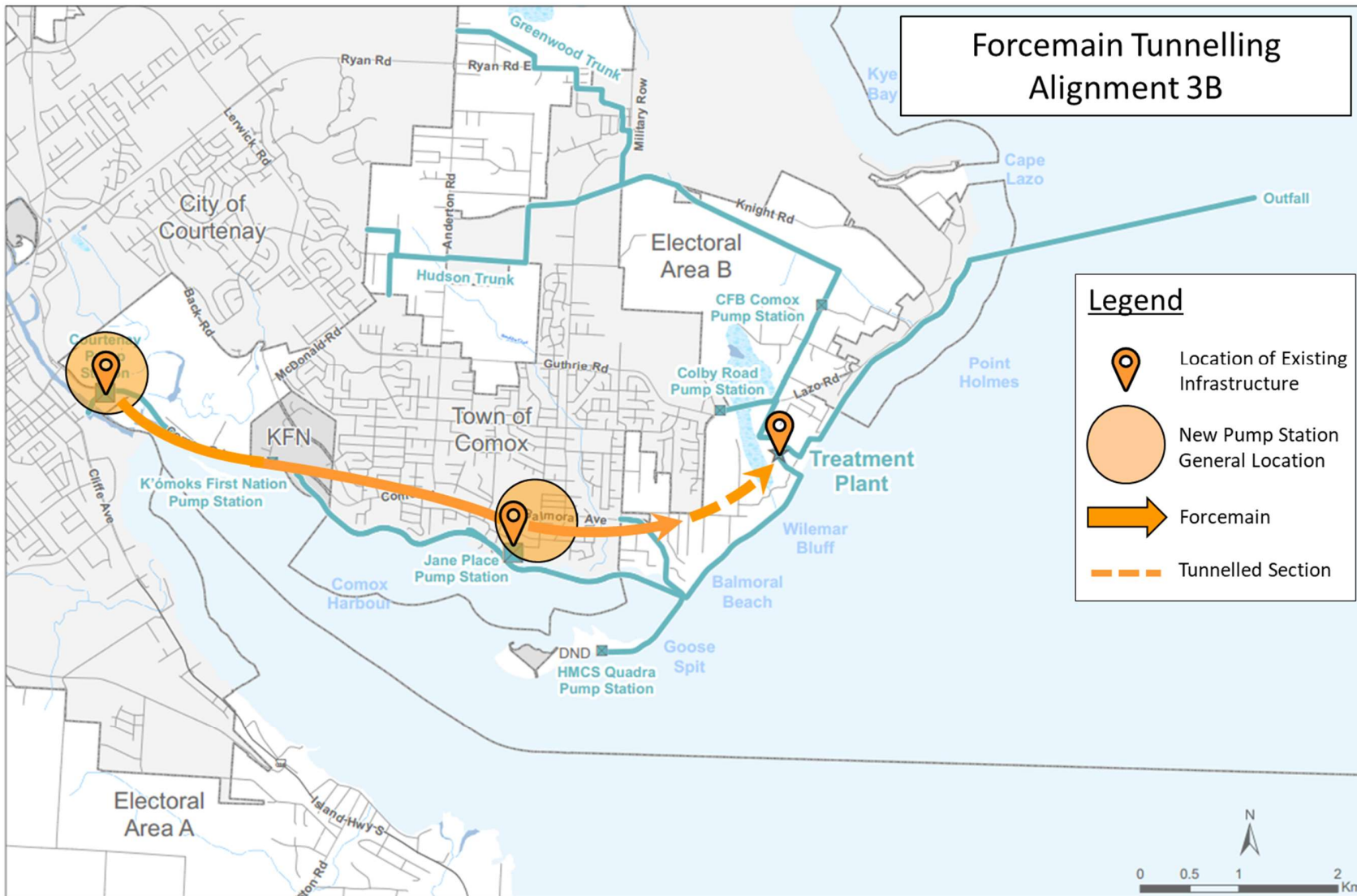
|                            |  |
|----------------------------|--|
| Operational Considerations | <p>Maintenance of the higher head pump station would be similar to that of the existing facilities, however there is a reduced selection of pump options. In addition, a typical higher head sewage pump operates at reduced efficiency compared to lower head pumps. Maintenance and repair on the overland forcemain would be completed using well established repair methods based on open excavation. Should a pipe failure occur standard methods of isolation and pumping off-site using a vacuum truck would be employed.</p> <p>There would be no opportunity to undertake maintenance on the tunnel section of pipe and any damage would require a cured-in-place repair technology. This repair cannot be completed while the system is in operation and therefore would necessitate a significant by-pass design to permit the tunnel to be taken off-line.</p> |
|----------------------------|--|

#### Infrastructure Elements

| Description                                | Capital Cost | Investment Year | Renewal Frequency | Renewal % | Total Power (kW) | Labour hrs/day |
|--|--------------|-----------------|-------------------|-----------|------------------|----------------|
| New Courtenay - Moderate Pressure Increase | \$10,500,000 | 2020            | 25                | 40%       | 750              | 3              |
| Downgrade Jane                             | \$2,362,500  | 2020            | 25                | 40%       | 25               | 0              |
| New Jane - Moderate Pressure Increase      | \$3,850,000  | 2020            | 25                | 40%       | 275              | 3              |
| Forcemain Tunnel through Lazo hill         | \$23,587,200 | 2020            | 60                | 100%      | 0                | 0              |
| Overland Courtenay to Lazo Hill            | \$26,999,280 | 2020            | 60                | 100%      | 0                | 0              |
| Old Jane to New Jane                       | \$51,744     | 2020            | 60                | 100%      | 0                | 0              |
| Overland Lazo Tunnel to CVWPCC             | \$1,617,000  | 2020            | 60                | 100%      | 0                | 0              |
| Total Capital Cost                         | \$68,967,724 |                 |                   |           |                  |                |

|                     |  |
|---------------------|--|
| Cost Considerations | <p>This option has moderate initial capital expenditure of \$69M, as construction of tunnelled sections carries additional cost as compared to open-cut installation of linear infrastructure. However, the remainder of the alignment construction is mostly completed overland in already-disturbed areas. This option requires the downgrading of the JPS and continued asset maintenance for a total of three pump stations, however the downgraded JPS will require minimal maintenance efforts.</p> <p>There are advantages based on operating cost for this option compared to overland options as it sustains a lower elevation by tunnelling through the height of land at the Lazo Road hills.</p> |
|---------------------|--|

|         |  |
|---------|--|
| Figures | Alignment is provided on Figure 11. Profile is provided on Figure 10-13. |
|---------|--|



**Figure 10-11: Forcemain Tunnelling Alignment 3B**

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### OPTION 3C – GRAVITY TUNNEL FROM COMOX TO THE CVWPCC

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|                         |  |
|-------------------------|--|
| Description:            | <p>A new open cut forcemain would be installed from CPS and would continue directly to the CVWPCC such that there is no in-line pump station. To reduce pressures a gravity sewer main tunnel would be used to pass through the Lazo Road height of land. Depending on the tunnel elevation the existing JPS may not require replacement to a high head pump station. The alignment options for the gravity sewer main would be restricted to those which accommodate the required slope. The JPS would connect to the gravity sewer main through a new forcemain. The tie-in location would be governed by the gravity sewer main alignment.</p> <p>In order to maintain the existing JPS hydraulic conditions a tunnel length of around 2,300 m would be required. It is likely that this would necessitate 2 access shafts during construction. Each shaft would be in the order of 15 m and 25 m deep. Detailed analysis during preliminary design would be required to determine the benefit of a minor hydraulic upgrade at the JPS as compared to a tunnel of around 1,500 m with only one access shaft.</p> <p>The overland forcemain would be installed using standard cut-and-cover installation methods with the general intention of following existing roadways. This approach is very common and as such, reasonably well established. Additional complexities would involve relocating existing utilities and restoration of surface roadways, sidewalks and similar features. Due to the nature of sanitary systems the depth of excavation would be set to be below the existing water systems.</p> |
| Advantages              | <ul style="list-style-type: none"><li>» No pipe in the estuary mitigating environmental and archaeological risks.</li><li>» All pipe and structures on-land to maximize maintenance accessibility.</li><li>» Alleviates some of the high head requirements for the CPS and most of the high head requirements for the JPS as compared to other overland options.</li><li>» Part of the JPS catchment and the HMCS Quadra outlet could potentially be tied directly into the gravity tunnel.</li></ul>  |
| Disadvantages           | <ul style="list-style-type: none"><li>» Construction of new conveyance system through an area with significant existing infrastructure.</li><li>» Gravity sewer main alignment must follow a specific slope which is dependent on the topography.</li><li>» Gravity sewer mains are nominally larger diameter as compared to forcemains for the same flow.</li></ul>   |
| Technical Consideration | <p>This system would operate similar to the existing configuration where a single forcemain connects the CPS with the CVWPCC and the JPS connects into the forcemain. Significant upgrades to the CPS would be required to overcome the hydraulic pressure of the Comox Road Hill. Between Comox and the Lazo Road Hill the forcemain would transition to a gravity sewer which would connect to the CVWPCC.</p> <p>Design of the gravity sewer would require a minimum slope which can be relatively low due to the large diameter of the pipe, potentially as low as 0.5%. The elevation of the CVWPCC is approximately 12 meters and therefore a 2,300-m gravity sewer would require a tunnel elevation of around 24 meters. Subject to pump selection review, it is possible that the JPS could be upgraded to meet this new discharge pressure within the existing site.</p> <p>The design of the tunnel gravity sewer would likely utilize materials not commonly used in Western Canada for sewage infrastructure as the pipe would have to be designed for the installation conditions and the exposure to sewage.</p>   |

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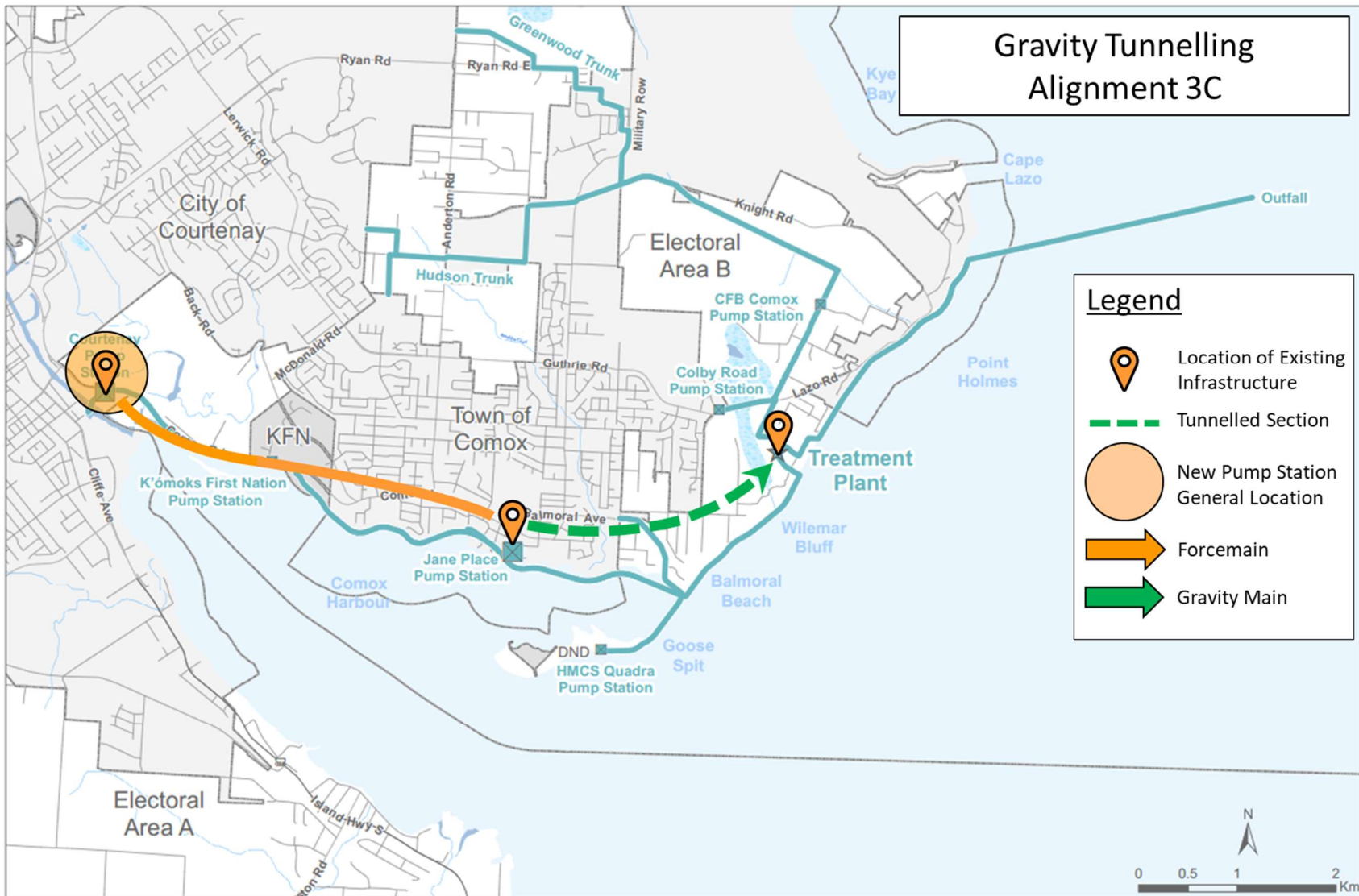
|                               |  |
|-------------------------------|--|
| Environmental Considerations  | <p>Overland portions routed along existing roadways would have limited environmental impacts. Areas where there are significant adjacent trees could be potentially damaged due to root damage.</p> <p>The deeper tunnel options would likely involve dewatering during installation/construction which may temporarily impact local groundwater wells.</p>  |
| Archaeological Considerations | <p>The intention would be to remain with existing areas of disturbance, so no unique archaeological impacts are likely.</p>  |
| Operational Considerations    | <p>Maintenance of the higher head pump station would be similar to that of the existing facilities, however there is a reduced selection of pump options. In addition, a typical higher head sewage pump operates at reduced efficiency compared to lower head pumps. Maintenance and repair on the overland forcemain would be completed using well established repair methods based on open excavation. Should a pipe failure occur standard methods of isolation and pumping off-site using a vacuum truck would be employed.</p> <p>The gravity tunnel pipe could potentially be repaired using cured-in-place technologies which would utilize robotic tooling to inspect and prepare repair patches. As the gravity pipe has storage capacity very short-term shutdowns could be accommodated in low flow seasons.</p> |

#### Infrastructure Elements

| Description                                  | Capital Cost | Investment Year | Renewal Frequency | Renewal % | Total Power (kW) | Labour hrs/day |
|--|--------------|-----------------|-------------------|-----------|------------------|----------------|
| New Courtenay - Moderate Pressure Increase   | \$10,500,000 | 2020            | 25                | 40%       | 750              | 3              |
| Upgrade Jane (Capacity and AM driven)        | \$3,150,000  | 2020            | 25                | 40%       | 275              | 3              |
| Gravity Tunnel through Lazo hill             | \$27,800,640 | 2020            | 60                | 100%      | 0                | 0              |
| Overland Courtenay to Jane (New or Existing) | \$16,493,400 | 2020            | 60                | 100%      | 0                | 0              |
| Overland Jane to Lazo Hill                   | \$4,851,000  | 2020            | 60                | 100%      | 0                | 0              |
| Jane to forcemain                            | \$1,108,800  | 2020            | 60                | 100%      | 0                | 0              |
| Overland Lazo Tunnel to CVWPCC               | \$1,617,000  | 2020            | 60                | 100%      | 0                | 0              |
| Total Capital Cost                           | \$65,520,840 |                 |                   |           |                  |                |

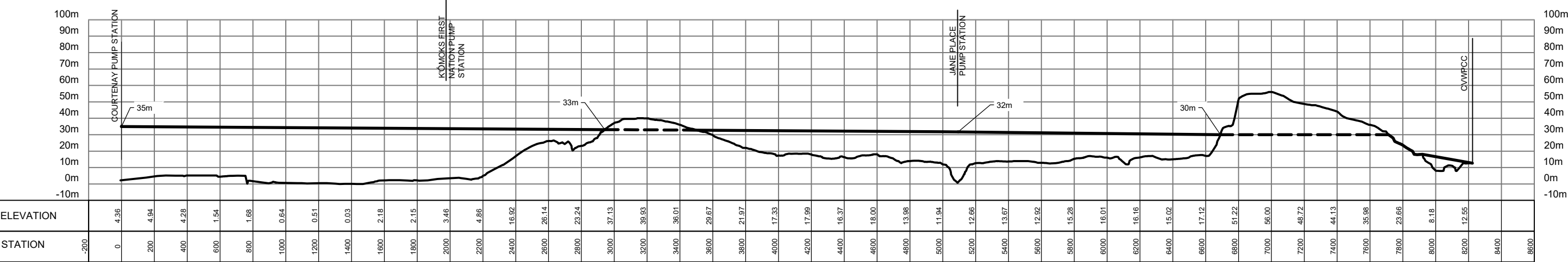
|                     |   |
|---------------------|---|
| Cost Considerations | <p>This option has moderate initial capital expenditure of \$66M, as construction of tunnelled sections carries additional cost compared to open-cut installation of linear infrastructure. However, the remainder of the alignment construction is mostly completed overland in already-disturbed areas. This option requires the continued asset maintenance for the two existing CPS and JPS.</p> <p>There are advantages based on operating cost for this option as it sustains a relatively low elevation by tunnelling through the height of land at the Lazo Road hills.</p> |
|---------------------|---|

|         |  |
|---------|--|
| Figures | Alignment is provided on Figure 12. Profile is provided on Figure 10-13. |
|---------|--|

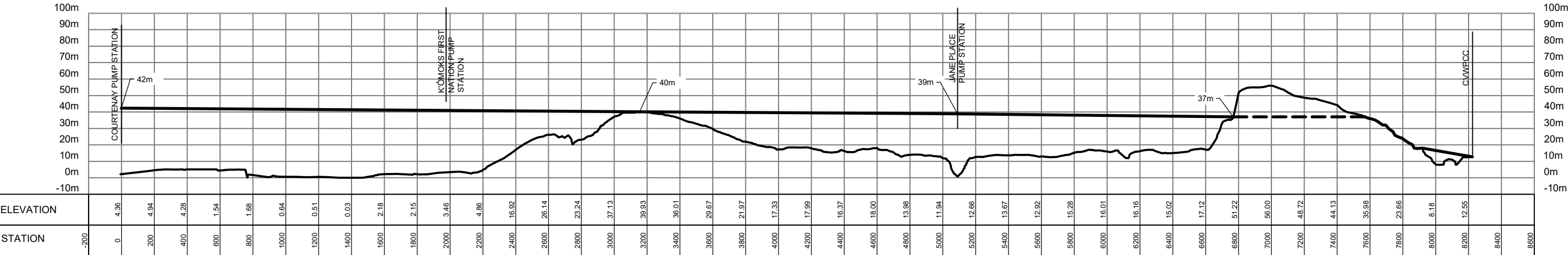


**Figure 10-12: Gravity Tunnelling Alignment 3C**

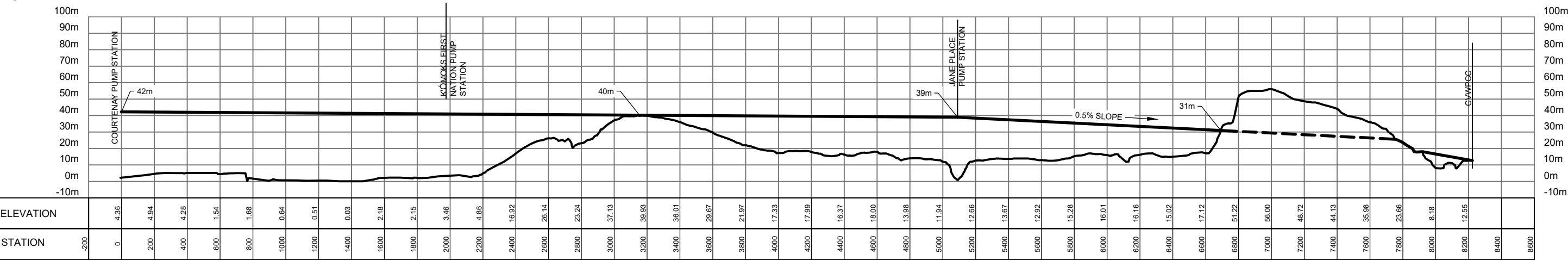
Option 3A



Option 3B



Option 3C



OPTION 3  
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1:12500(H) 1:1250(V) AT A1

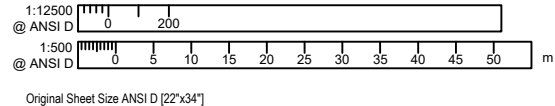


Figure 10-13: Option 3 Hydraulic Profiles



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## 10.2.4 NORTH SIDE CONCEPTS

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### OPTION 4A – NORTH SIDE FORCEMAIN CONCEPT

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|                         |   |
|-------------------------|---|
| Description:            | <p>In this concept, raw sewage would be pumped from the location of the existing CPS along the north side of the Comox to the CVWPCC. Sewage from the JPS would be conveyed to this north side forcemain at a location west of the Lazo Road hill. A joint forcemain would convey the combined flows from the CPS and JPS to the CVWPCC.</p> <p>CPS would potentially be required to pump sewage to the CVWPCC over the highest elevation of Glacier View Drive hill (El. 73 m) in a forcemain. JPS would be required to pump sewage to the new forcemain between Courtenay and the CVWPCC which would have a hydraulic grade of around 50 to 60 m. The combined forcemain would continue to the CVWPCC along existing roadways or right-of-ways. This option would trigger a high head upgrade at both the CPS and JPS, leading to the requirement for a rebuild of both pump stations.</p> <p>The overland forcemain would be installed using standard cut-and-cover installation methods with the general intention of following existing roadways. This approach is very common and as such, reasonably well established. Additional complexities would involve relocating existing utilities and restoration of surface roadways, sidewalks and similar features. Due to the nature of sanitary systems the depth of excavation would be set to be below the existing water systems.</p> |
| Advantages              | <ul style="list-style-type: none"><li>» Only involves 2 large pump stations (JPS repurposed as local facility only)</li><li>» Pump Stations operating in parallels as opposed to in series, minimizing need for a sophisticated control system.</li><li>» Avoids construction in the downtown core area, limiting construction impact to areas with less infrastructure development as compared to the downtown core.</li><li>» No pipe in the estuary mitigating environmental and archaeological risks.</li><li>» All pipe and structures on-land to maximize maintenance accessibility.</li></ul>  |
| Disadvantages           | <ul style="list-style-type: none"><li>» Construction for the linear assets required along two separate alignments within the CVSS, increasing construction disturbance.</li><li>» Operating two partially separate high pressure forcemain networks.</li><li>» The North Side of Glacier View Drive is at a significant higher elevation than that of the South Side (73 m vs 39 m).</li></ul>  |
| Technical Consideration | <p>The system would operate as two independent systems. The Courtenay pump station would be a high head pump station, in the order of 80 to 100 m pressure, and would likely require a two stage pump configuration which utilizes two standard sewage pumps configured immediately in-line with each other. This approach to sewage conveyance is relatively unique in this market, but not unheard-of. A new right-of-way would be required through the ALR and up to existing roadways. It is unlikely that this system could transition to a gravity system as there is a high point at near the crossing of Prichard Rd.</p> <p>The forcemain from the JPS could be routed up Prithcard Rd to intersect with the Courtenay forcemain or be routed directly to the CVWPCC, with the short alignment likely a connection to the forcemain from Courtenay. Either way the JPS would require a significant upgrade to increase the discharge pressure to around 50 to 60 m hydraulic pressure.</p>   |

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|                               |   |
|-------------------------------|---|
| Environmental Considerations  | Overland portions routed along existing roadways would have limited environmental impacts. Areas where there are significant adjacent trees could be potentially damaged due to root damage.  |
| Archaeological Considerations | The intention would be to remain with existing areas of disturbance, so no unique archaeological impacts are likely.  |
| Operational Considerations    | <p>Maintenance of the higher head pump station would be similar to that of the existing facilities, however there is a reduced selection of pump options. In addition, a typical higher head sewage pump operates at reduced efficiency compared to lower head pumps. Although there would only be 2 pump stations in the system, the Courtenay facility would effectively be two stations in one. Pumps and electrical equipment would be provided in duplicate as two pumps would be operating in-series to meet the operational pressures. As such, the number of pumps and associated equipment in the system would increase from the existing.</p> <p>Maintenance and repair on the overland forcemain would be completed using well established repair methods based on open excavation. Should a pipe failure occur standard methods of isolation and pumping off-site using a vacuum truck would be employed.</p> <p>A benefit of this arrangement is the opportunity to route the new infrastructure along roadways which are not as constrained by traffic and existing infrastructure as would be expected within the higher density areas of Comox.</p> |

#### Infrastructure Elements

| Description   | Capital Cost | Investment Year | Renewal Frequency | Renewal % | Total Power (kW) | Labour hrs/day |
|---|--------------|-----------------|-------------------|-----------|------------------|----------------|
| New Courtenay - High Pressure Increase                  | \$29,400,000 | 2020            | 25                | 40%       | 1250             | 3              |
| Downgrade Jane  | \$2,362,500  | 2020            | 25                | 40%       | 25               | 0              |
| New Jane - Moderate Pressure Increase                   | \$3,850,000  | 2020            | 25                | 40%       | 425              | 3              |
| Overland Jane to connect to FM (Long Distance to North) | \$4,804,800  | 2020            | 60                | 100%      | 0                | 0              |
| Overland Forcemain North from Courtenay to CVWPCC       | \$27,489,000 | 2020            | 60                | 100%      | 0                | 0              |
| Old Jane to New Jane                                    | \$51,744     | 2020            | 60                | 100%      | 0                | 0              |
| KFN Pump Station and FM to Courtenay                    | \$616,000    | 2020            | 60                | 100%      | 0                | 0              |
| Total Capital Cost                                      | \$68,574,044 |                 |                   |           |                  |                |

|                     |   |
|---------------------|---|
| Cost Considerations | <p>This option has a moderate initial capital expenditure of \$69M as it includes an overall alignment from the CPS to the CVPWCC on the north side, and another alignment from the JPS to the above forcemain. There is also a need for the construction of a new high-pressure CPS and a new moderate-pressure JPS. This option requires the downgrading of the JPS and continued asset maintenance for a total of three pump stations, however the downgraded JPS will require minimal maintenance efforts.</p> <p>There is no operating cost advantage to this option as it requires pumping a significant portion of the Courtenay sewage over the height of land, resulting in significant financial operating costs.</p> |
|---------------------|---|

|         |  |
|---------|--|
| Figures | Concept alignment is provided on Figure 14. Profile is provided on Figure 10-15. |
|---------|--|

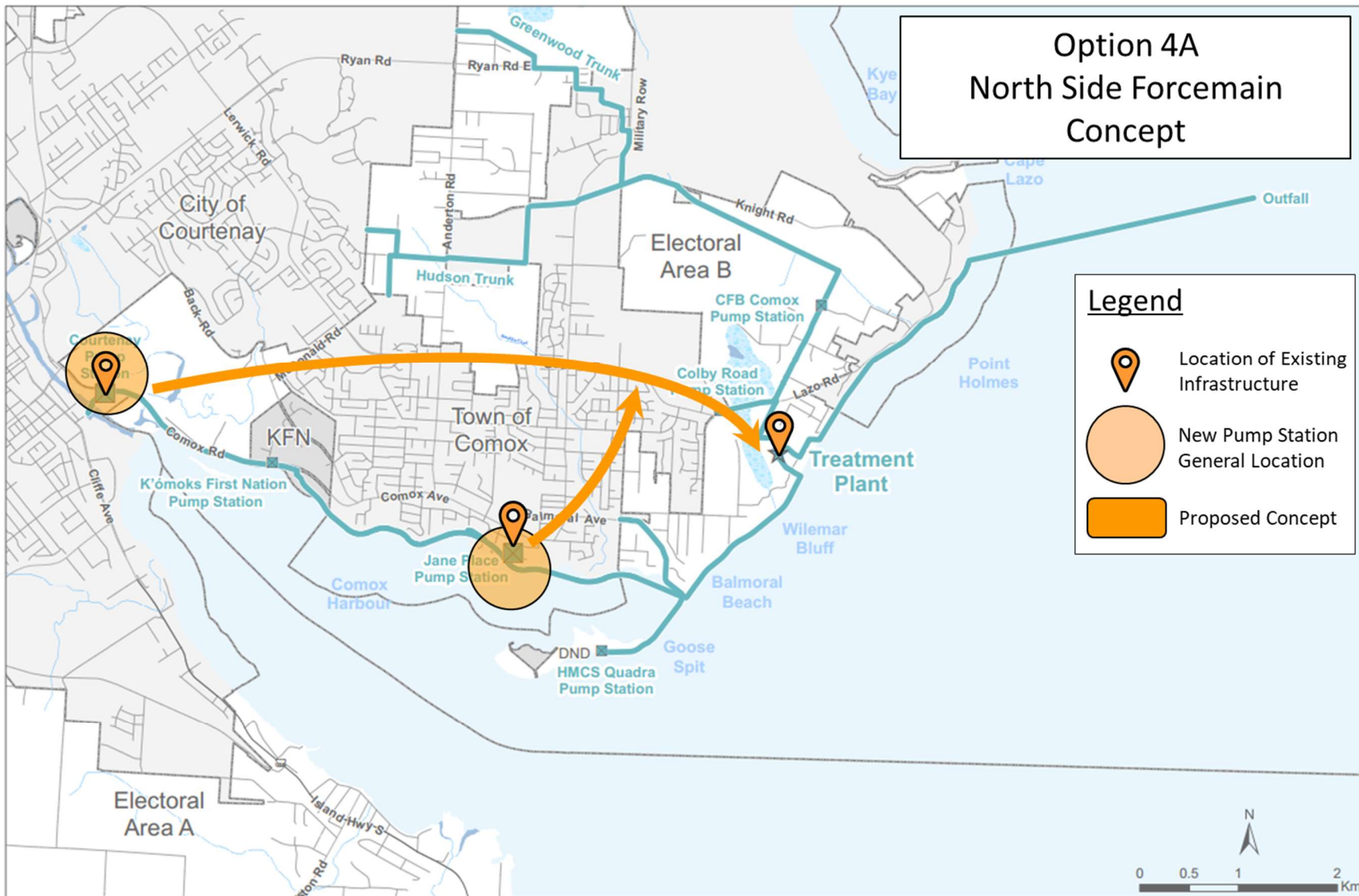
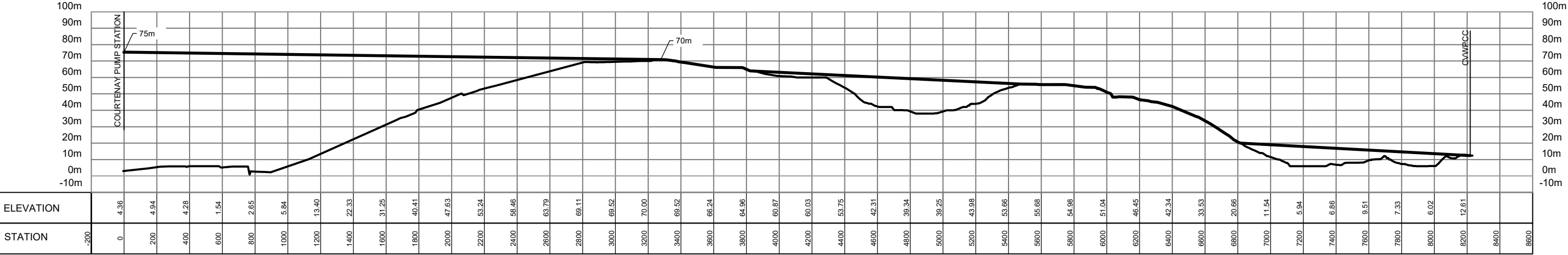
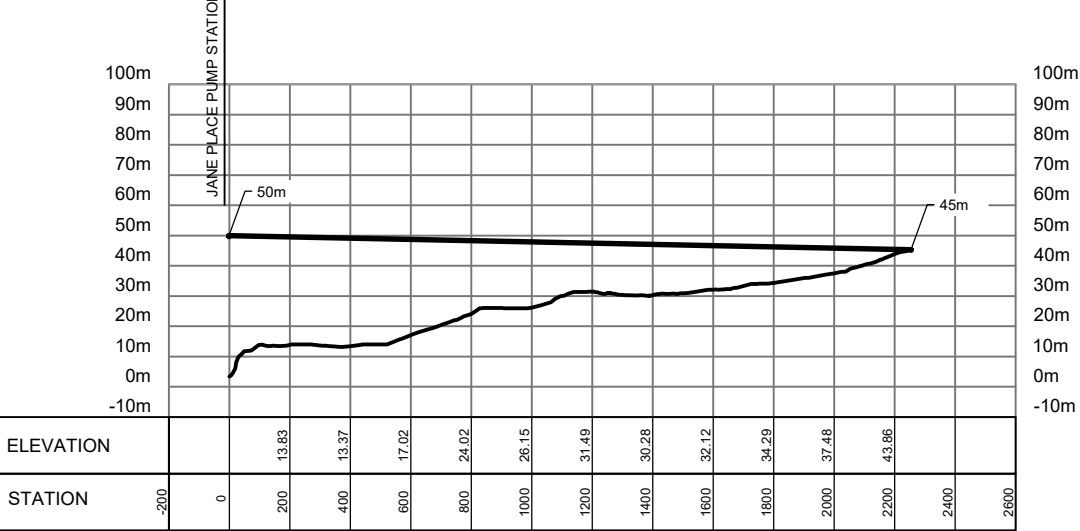


Figure 10-14: North Side Forcemain Concept 4A

Option 4A - North Section



Option 4A - South Section



OPTION 4A  
PROFILE BETWEEN CH: -200.00 AND 8600.00  
PROFILE BETWEEN CH: -200.00 AND 2600.00  
1:12500(H) 1:1250(V) AT A1

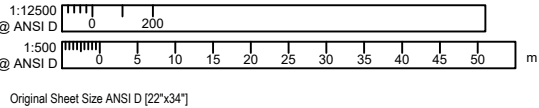


Figure 10-15: Option 4A Hydraulic Profiles

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## OPTION 4B – NORTH SIDE GRAVITY CONCEPT

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|                         |   |
|-------------------------|---|
| Description:            | <p>In this concept, raw sewage would be pumped from the location of the existing CPS along the north side of the Comox to an alignment parallel with the Hudson Gravity Sewer System. Sewage would gravity flow along this route to the existing CFB pump station. As the CFB pump station does not have adequate capacity to accommodate the CPS flows a new significantly larger facility would be required at this location. From the CFB pump station the sewage would be conveyed to the CVWPCC.</p> <p>CPS would be required to pump sewage to the CVWPCC over the highest elevation of Glacier View Dr hill (El. 73 m) to reach the height of land where it can gravity flow to the CFB pump station. JPS would be required to pump sewage directly to the CVWPCC over Lazo Hill which would have a hydraulic grade of around 50 to 60 m. This option would trigger a high head upgrade at both the CPS and a moderate head upgrade at the JPS, leading to the requirement for a rebuild of both pump stations.</p> <p>The overland forcemain would be installed using standard cut-and-cover installation methods with the general intention of following existing roadways. This approach is very common and as such, reasonable well established. Additional complexities would involve relocating existing utilities and restoration of surface roadways, sidewalks and similar features. Due to the nature of sanitary systems the depth of excavation would be set to be below the existing water systems.</p> |
| Advantages              | <ul style="list-style-type: none"><li>» Pump Stations operating independently from each other.</li><li>» Avoids construction in the downtown core area, limiting construction impact to areas with less infrastructure development as compared to the downtown core.</li><li>» No pipe in the estuary mitigating environmental and archaeological risks.</li><li>» All pipe and structures on-land to maximize maintenance accessibility.</li></ul>   |
| Disadvantages           | <ul style="list-style-type: none"><li>» Construction for the linear assets required along two separate alignments within the CVSS, increasing construction disturbance.</li><li>» Operating two partially separate high pressure forcemain networks.</li><li>» The North Side of Glacier View Drive is at a significant higher elevation than that of the South Side (73 m vs 39 m).</li><li>» A very long conveyance upgrade is required.</li><li>» Requires a significant upgrade to the CFB pump station and results in 3 large pump stations in the conveyance. CFB is in-line with CPS pump station and would be a significant point of failure.</li></ul>   |
| Technical Consideration | <p>The CPS and JPS system would operate as two independent systems. The Courtenay pump station would be a high head pump station, in the order of 80 to 100 m pressure, and would likely require a two stage pump configuration which utilizes two standard sewage pumps configured immediately in-line with each other. This approach to sewage conveyance is relatively unique in this market, but not unheard-of. A new right-of-way would be required through the ALR and up to existing roadways. It is unlikely that this system could transition to a gravity system as there is a high point at near the crossing of Prichard Rd. The CPS would pump to the CFB pump station which would be in-series and as such would be a risk should the CFB pump station be off-line as it would restrict flow from CPS and the existing Hudson/Greenwood gravity collection system.</p> <p>The forcemain from the JPS could be routed directly to the CVWPCC over Lazo Hill The JPS would require a significant upgrade to increase the discharge pressure to around 50 to 60 m hydraulic pressure.</p>   |

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|                               |   |
|-------------------------------|---|
| Environmental Considerations  | Overland portions routed along existing roadways would have limited environmental impacts. Areas where there are significant adjacent trees could be potentially damaged due to root damage.  |
| Archaeological Considerations | The intention would be to remain with existing areas of disturbance, so no unique archaeological impacts are likely.  |
| Operational Considerations    | <p>Maintenance of the higher head pump station would be similar to that of the existing facilities, however there is a reduced selection of pump options. In addition, a typical higher head sewage pump operates at reduced efficiency compared to lower head pumps. Although there would only be 2 pump stations in the system, the Courtenay facility would effectively be two stations in one. Pumps and electrical equipment would be provided in duplicate as two pumps would be operating in-series to meet the operational pressures. As such, the number of pumps and associated equipment in the system would increase from the existing.</p> <p>Maintenance and repair on the overland forcemain would be completed using well established repair methods based on open excavation. Should a pipe failure occur standard methods of isolation and pumping off-site using a vacuum truck would be employed.</p> <p>A benefit of this arrangement is the opportunity to route the new infrastructure along roadways which are not as constrained by traffic and existing infrastructure as would be expected within the higher density areas of Comox.</p> |

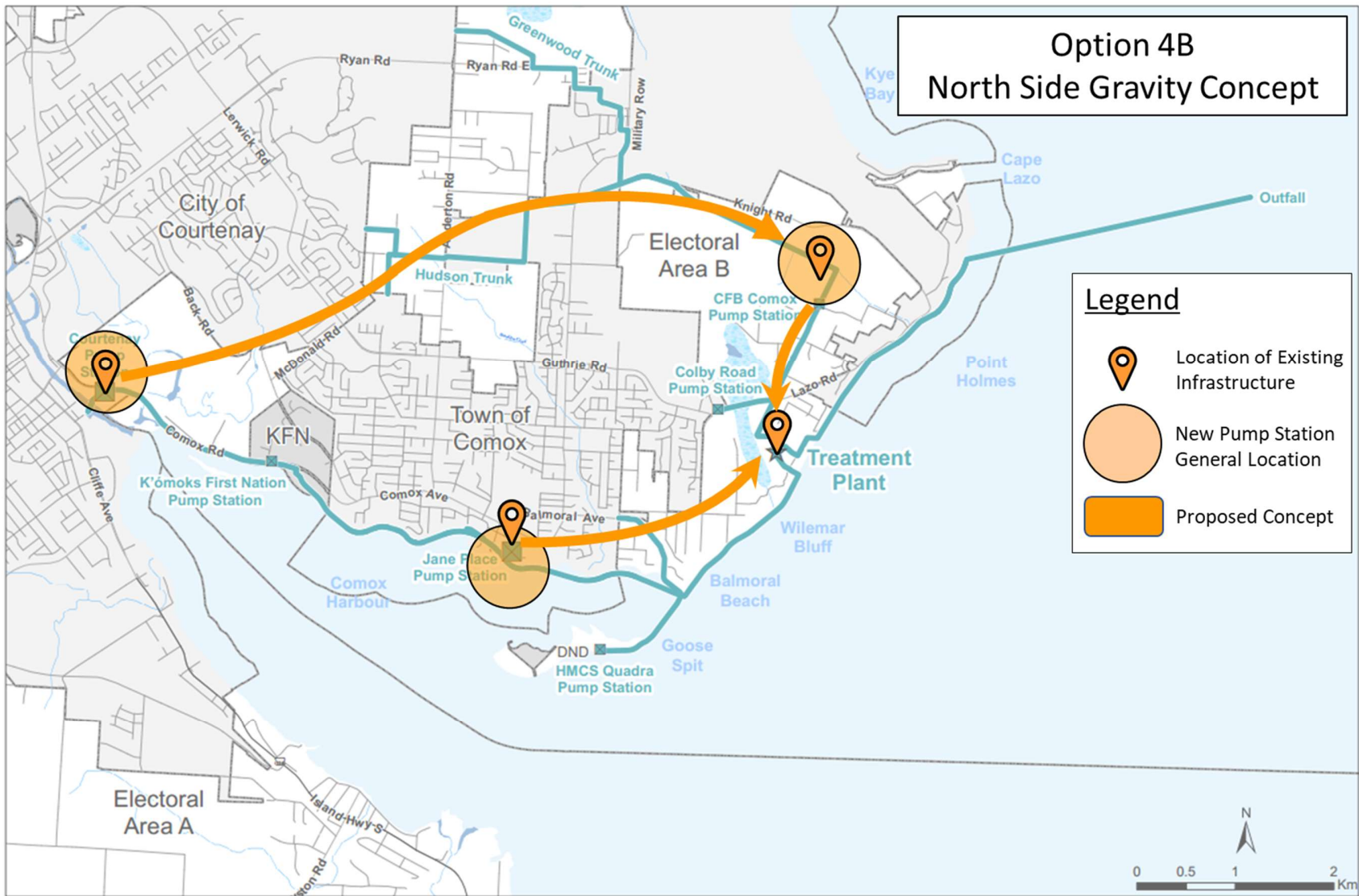
#### Infrastructure Elements

| Description   | Capital Cost | Investment Year | Renewal Frequency | Renewal % | Total Power (kW) | Labour hrs/day |
|---|--------------|-----------------|-------------------|-----------|------------------|----------------|
| New Courtenay - High Pressure Increase                  | \$29,400,000 | 2020            | 25                | 40%       | 1250             | 3              |
| Downgrade Jane  | \$2,362,500  | 2020            | 25                | 40%       | 25               | 0              |
| New Jane - Moderate Pressure Increase                   | \$3,850,000  | 2020            | 25                | 40%       | 425              | 3              |
| Overland Jane to connect to FM (Long Distance to North) | \$4,804,800  | 2020            | 60                | 100%      | 0                | 0              |
| Overland Gravity North from Courtenay to CVWPCC         | \$38,962,000 | 2020            | 60                | 100%      | 0                | 0              |
| Old Jane to New Jane                                    | \$51,744     | 2020            | 60                | 100%      | 0                | 0              |
| KFN Pump Station and FM to Courtenay                    | \$616,000    | 2020            | 25                | 40%       | 25               | 0              |
| New CFB Pump Station                                    | \$3,920,000  | 2020            | 25                | 40%       | 225              | 2              |
| Total Capital Cost                                      | \$83,967,044 |                 |                   |           |                  |                |

|                     |   |
|---------------------|---|
| Cost Considerations | <p>This option has a significant initial capital expenditure of \$84M as it follows the longest conveyance route between the CPS and the CVWPCC. In addition, it requires the CFB Pump station to be upgraded to pass the CPS flows, resulting in a 3rd large pump station. The Hudson and Greenwood collection system is not sized to accommodate all the Courtenay flows and therefore would need to be twinned.</p> <p>There is no operating cost advantage to this option as it requires pumping a significant portion of the Courtenay sewage over the height of land, resulting in significant financial operating costs. Furthermore, all the CPS flows are re-pumped at the CFB pump station.</p> |
|---------------------|---|

|         |  |
|---------|--|
| Figures | Concept alignment is provided on Figure 16. Profile is provided on Figure 10-17. |
|---------|--|

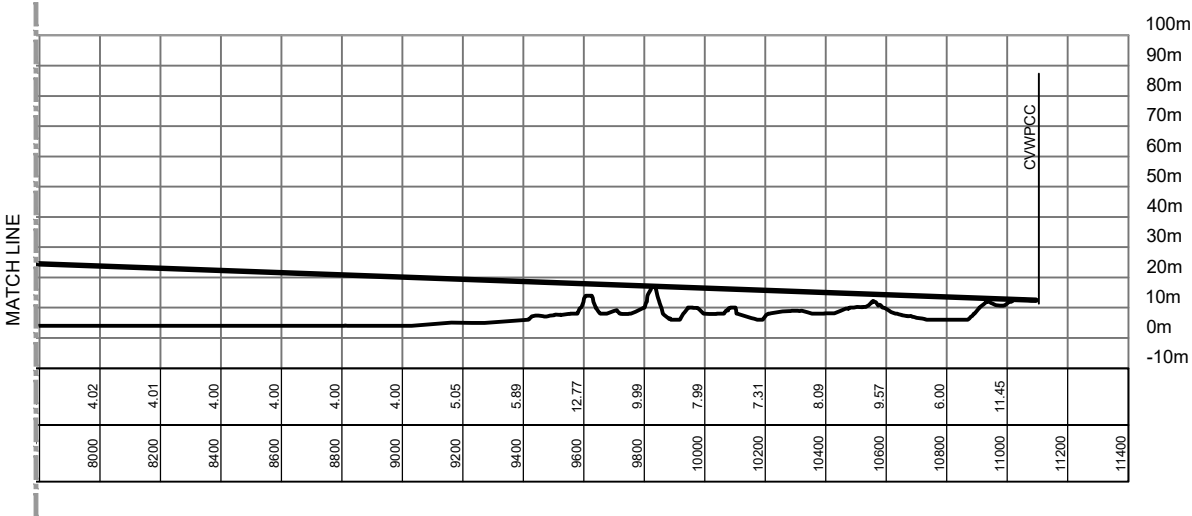
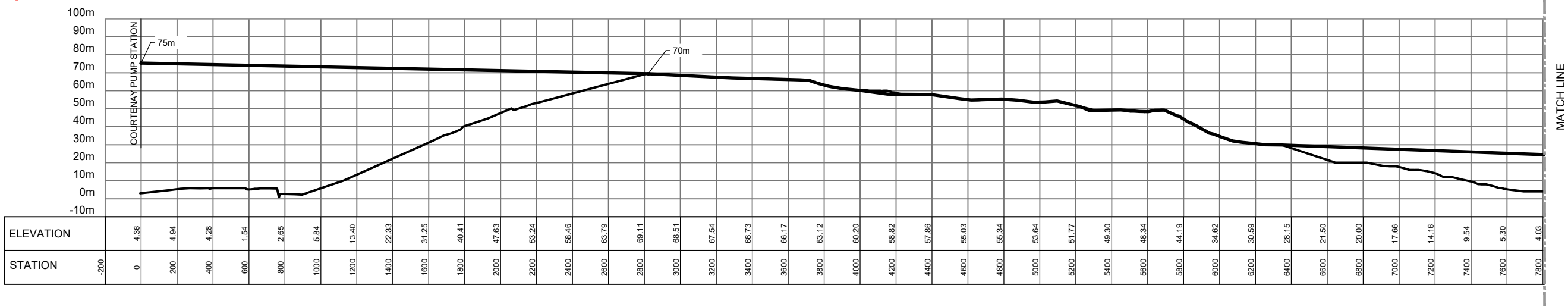




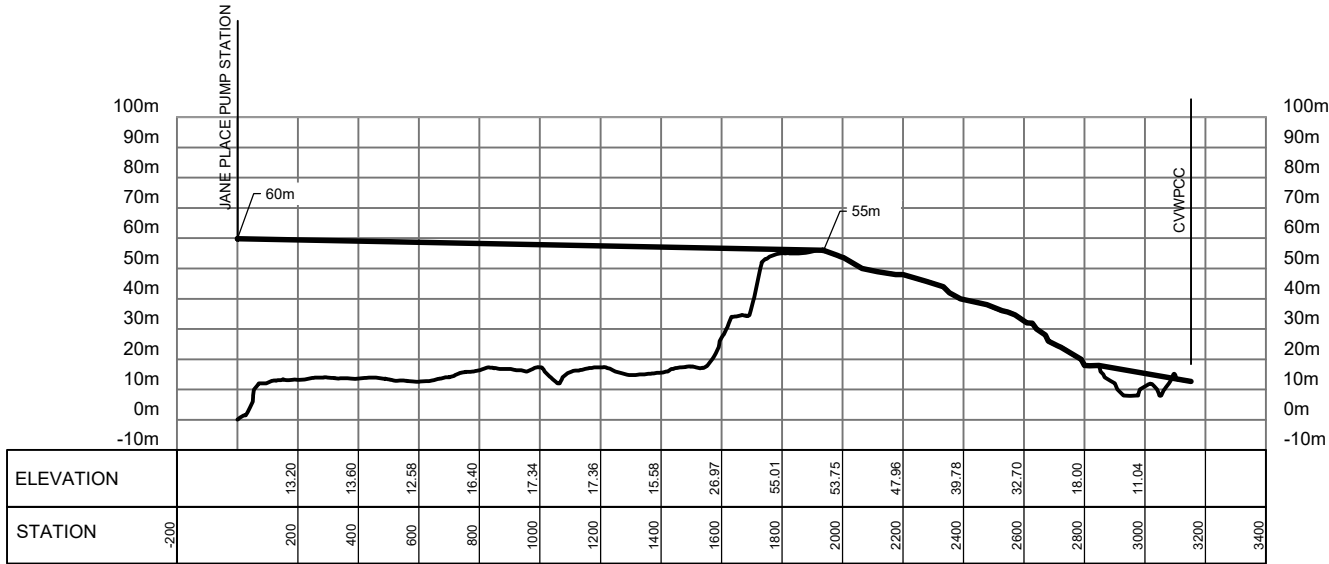
**Figure 10-16: North Side Gravity Concept 4B**



Option 4B - North Section



Option 4B - South Section



OPTION 4B  
PROFILE BETWEEN CH: -200.00 AND 11400.00  
PROFILE BETWEEN CH: -200.00 AND 3400.00  
1:12500(H) 1:1250(V) AT A1

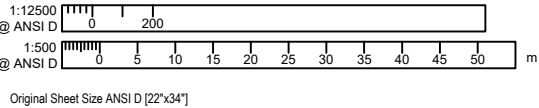


Figure 10-17: Option 4B Hydraulic Profiles

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## 10.2.5 DECENTRALIZED TREATMENT CONCEPT

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### OPTION 5 – DECENTRALIZED TREATMENT

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|                         |  |
|-------------------------|--|
| Description:            | <p>In this option, an additional wastewater treatment plant would be constructed in close proximity to the location of the existing Courtenay PS to treat the sewage collected and currently conveyed by the Courtenay PS.</p> <p>Due to the location of the outfall, the effluent of a decentralized wastewater treatment plant would have to be conveyed to the location of the existing outfall for discharge. Alignments for the conveyance of the effluent discharge are similar to those discussed within Options 1, 2, 3 and 4, and include estuary, overland, tunnelled, and north side alignments.</p> <p>The sewage collected at the JPS will be conveyed to the existing CVWPCC for treatment using an overland or tunnelled option. Overland options would still require a new pump station for the JPS, and subject to the length and depth of the tunnelled option a new pump station in Comox maybe required.</p>   |
| Advantages              | <ul style="list-style-type: none"><li>» Eliminates the need for conveyance of Courtenay's raw sewage through the CVSS to the CVWPCC</li><li>» Alleviate capacity-driven upgrade requirements at the CVWPCC.</li></ul>  |
| Disadvantages           | <ul style="list-style-type: none"><li>» Requires the need for conveyance of the decentralized Wastewater Treatment Plant (WWTP) effluent to the outfall using a new pumping and conveyance system.</li><li>» Significant operational burden with two wastewater treatment plants.</li><li>» Significant cost associated with the construction of a new wastewater treatment plant, and maintenance and operation of two plants.</li><li>» Still requires conveyance of raw sewage overland from Comox.</li></ul>   |
| Technical Consideration | <p>Even following treatment of the sewage, the effluent would need to be discharged to the existing outfall as it is not an option to discharge treated effluent within the embayed waters around Comox. As a result, an effluent pipe would have to be routed from the CPS to the CVWPCC. This effluent would be a unique fluid (i.e.: not potable water, storm water or sewage) and as such could not be integrated with any existing system in the Comox area. Once the effluent is at the CVWPCC site it would by-pass the treatment plant and combine with the CVWPCC effluent.</p> <p>By removing a major portion of the sewage from the existing CVWPCC the existing plant would likely be rendered oversized and could result in a reduction in treatment efficiency and performance.</p> <p>Locating a new treatment plant in the general area of the CPS would be a significant challenge as this would have a very large footprint and need to be designed to address all future sewage flows in the catchment area. Once the effluent has been treated a high pressure effluent pump station would be required to convey the effluent.</p> <p>The ground elevation at a potential WWTP site would potentially be exposed to sea-level rise and storm surges.</p> |

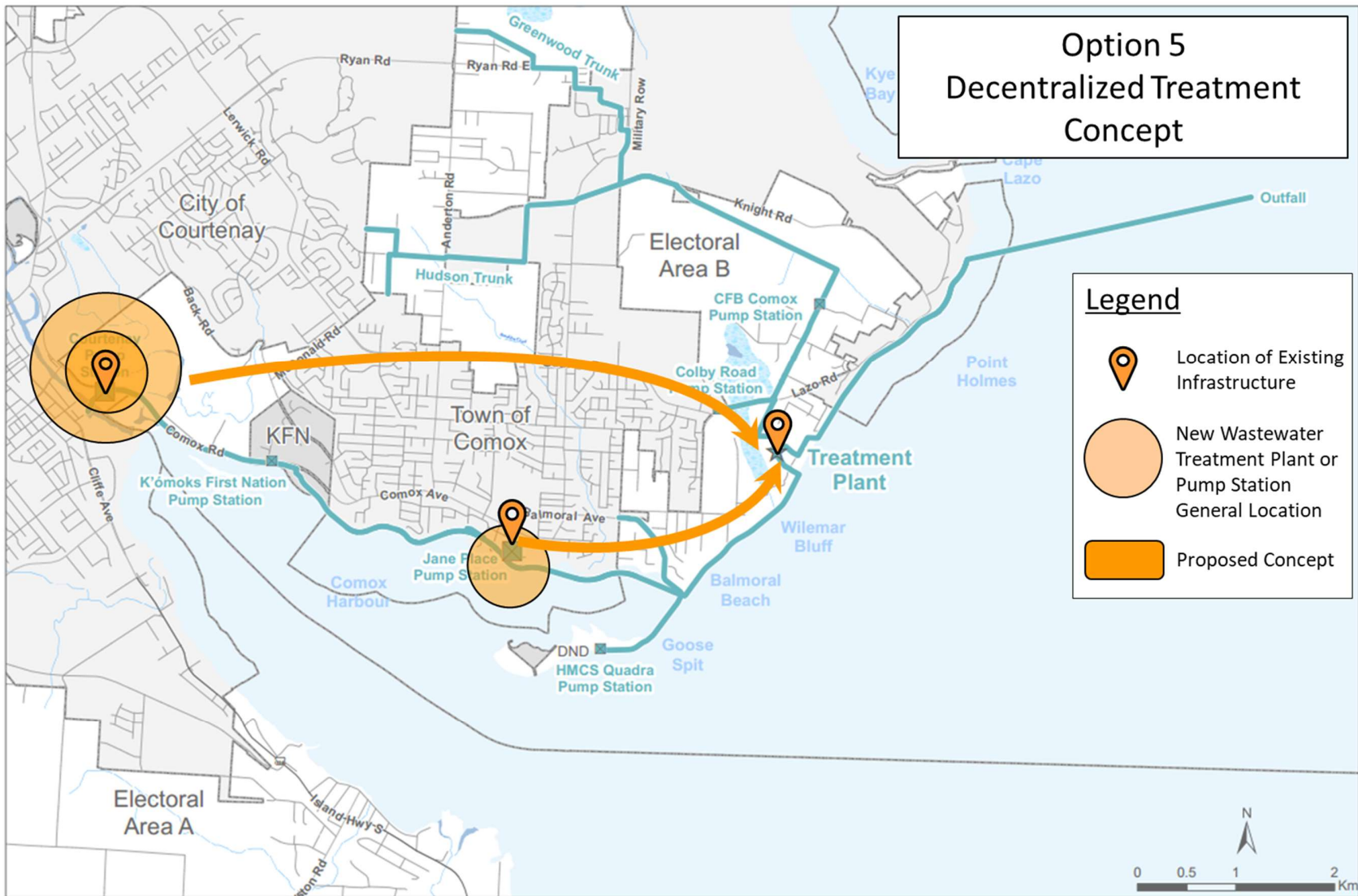
|                               |  |
|-------------------------------|--|
| Environmental Considerations  | <p>Overland portions routed along existing roadways would have limited environmental impacts. Areas where there are significant adjacent trees could be potentially damaged due to root damage.</p> <p>Depending on the exact location, new WWTP would result in a loss of land around the ALR and the associated habitat in the area.</p>   |
| Archaeological Considerations | <p>Depending on the exact location of the new WWTP, and the alignment associated with the effluent conveyance, there can moderate to high potential of encountering known or unknown archeological sites in this general area. Construction of new infrastructure along existing areas of disturbance will minimize risk of archaeological impacts.</p>  |
| Operational Considerations    | <p>Operation of a second CVWPCC would be required and would not be suitable for overlap of many operational resources. Staff would be required at both sites and treatment systems would be duplicated, resulting a loss of efficiency associated with system maintenance.</p> <p>Solids handling and disposal would have to occur at two locations, rather than at one centralized site.</p> <p>There would be limited reduction in overall power requirements as a pump station is still required to convey treated effluent to the CVWPCC. A minor increase in pump efficiency would be achieved as a pump suitable for treated effluent will be more efficient than a raw sewage pump.</p> |

#### Infrastructure Elements

| Description   | Capital Cost  | Investment Year | Renewal Frequency | Renewal % | Total Power (kW) | Labour hrs/day |
|---|---------------|-----------------|-------------------|-----------|------------------|----------------|
| New Courtenay - High Pressure Increase                  | \$29,400,000  | 2020            | 25                | 40%       | 900              | 3              |
| Downgrade Jane  | \$2,362,500   | 2020            | 25                | 40%       | 25               | 0              |
| New Jane - Moderate Pressure Increase                   | \$3,850,000   | 2020            | 25                | 40%       | 425              | 3              |
| Overland Jane to connect to FM (Long Distance to North) | \$4,804,800   | 2020            | 60                | 100%      | 0                | 0              |
| Overland Forcemain North from Courtenay to CVWPCC       | \$27,489,000  | 2020            | 60                | 100%      | 0                | 0              |
| New Courtenay WWTP                                      | \$105,000,000 | 2020            | 100               | 100%      | 2000             | 24             |
| Old Jane to New Jane                                    | \$51,744      | 2020            | 60                | 100%      | 0                | 0              |
| KFN Pump Station and FM to Courtenay                    | \$616,000     | 2020            | 60                | 100%      | 0                | 0              |
| Total Capital Cost                                      |               | \$173,574,044   |                   |           |                  |                |

Note that Total Power for the New Courtenay WWTP is not necessarily representative of the expected total power required for the facility. The value of 2000 kW has been used such that it accounts for a number of various Operations and Maintenance cost categories that are not built into the cost model and are difficult to individually account for.

|                     |  |
|---------------------|--|
| Cost Considerations | <p>This option has a significant initial capital expenditure of \$174M, approximately double the average capital cost for all other options considered. This cost is driven by the need for construction of an additional WWTP in Courtenay.</p> <p>There is no operating cost advantage to this option as it requires the operation of an additional WWTP, including additional power requirements and labor. Also, depending on the alignment for the effluent conveyance (assumed a North side alignment similar to 4A in this case), the high pumping head requirement for conveyance of effluent can result in significant financial operating costs.</p> |
| Figures             | <p>Concept alignment is provided on Figure 18. Profiles are not provided as the alignment will follow a combination of the alignments presented under one of options 1, 2, 3, or 4.</p>  |



**Figure 10-18: Decentralized Treatment Concept 5**

## 10.2.6 OPTIONS FINANCIAL SUMMARY

Table 10-2 shows the summary of the infrastructure components that are applicable to each of the alignment and concept options presented in this section, as well as the approximate capital cost associated with each item. The costs presented in this report do not include GST. These costs are only for the purpose of options comparison and discussion and are not suitable for budgeting.

**Table 10-2: Infrastructure Components' Capital Cost**

| Description   | Class 'D' Cost<br>2019\$ | Alignments and Conveyance Concepts |    |    |    |    |    |    |    |    |    |    |   |
|---|--------------------------|------------------------------------|----|----|----|----|----|----|----|----|----|----|---|
|   |                          | 40% Contingency                    | 1A | 1B | 1C | 2A | 2B | 3A | 3B | 3C | 4A | 4B | 5 |
| Upgrade Courtenay (Capacity and AM driven)              | \$ 4,200,000             |                                    |    |    | •  |    |    |    |    |    |    |    |   |
| New Courtenay - Moderate Pressure Increase              | \$ 10,500,000            |                                    | •  |    |    | •  | •  | •  | •  |    |    |    |   |
| New Courtenay - High Pressure Increase                  | \$ 29,400,000            |                                    |    |    |    |    |    |    |    |    | •  | •  | • |
| Upgrade Jane (Capacity and AM driven)                   | \$ 3,150,000             |                                    |    |    | •  |    | •  |    | •  |    |    |    |   |
| New Jane - Moderate Pressure Increase                   | \$ 3,850,000             |                                    | •  | •  |    | •  |    | •  | •  |    | •  | •  | • |
| Downgrade Jane  | \$ 2,363,000             |                                    | •  | •  |    | •  |    | •  | •  |    | •  | •  | • |
| New In-line Pump Station                                | \$ 12,040,000            |                                    |    |    | •  |    | •  |    |    |    |    |    |   |
| Forcemain Tunnel through Lazo hill                      | \$ 23,587,000            |                                    | •  |    |    |    |    | •  | •  |    |    |    |   |
| Forcemain Tunnel through Comox hill                     | \$ 11,735,000            |                                    |    |    |    |    |    | •  |    |    |    |    |   |
| Gravity Tunnel through Lazo hill                        | \$ 27,801,000            |                                    |    |    |    |    |    |    |    | •  |    |    |   |
| Overland from Comox hill to Lazo hill                   | \$ 10,977,000            |                                    |    |    |    |    |    | •  |    |    |    |    |   |
| Overland Courtenay to Lazo Hill                         | \$ 26,999,000            |                                    |    |    |    |    | •  |    | •  |    |    |    |   |
| Overland Courtenay to Jane (New or Existing)            | \$ 16,493,000            |                                    |    |    |    | •  |    |    |    | •  |    |    |   |
| Overland Jane to Lazo Hill                              | \$ 4,851,000             |                                    |    |    |    | •  |    |    |    | •  |    |    |   |
| Overland Jane to connect to FM (Long Distance to North) | \$ 4,805,000             |                                    |    |    |    |    |    |    |    |    | •  | •  | • |
| Overland Lazo Hill to CVWPCC                            | \$ 5,914,000             |                                    |    | •  | •  | •  | •  |    |    |    |    |    |   |
| Overland Forcemain North from Courtenay to CVWPCC       | \$ 27,489,000            |                                    |    |    |    |    |    |    |    |    | •  |    | • |
| Overland Gravity North from Courtenay to CVWPCC         | \$ 38,962,000            |                                    |    |    |    |    |    |    |    |    |    | •  |   |
| Estuary Courtenay to Jane                               | \$ 32,728,000            |                                    |    | •  |    |    |    |    |    |    |    |    |   |
| Estuary Courtenay to Lazo Hill                          | \$ 38,133,000            |                                    | •  |    | •  |    |    |    |    |    |    |    |   |
| New Courtenay WWTP                                      | \$ 105,000,000           |                                    |    |    |    |    |    |    |    |    |    |    | • |
| Jane to forcemain                                       | \$ 1,109,000             |                                    | •  | •  | •  | •  |    | •  |    | •  |    |    |   |
| Old Jane to New Jane                                    | \$ 52,000                |                                    |    | •  |    |    |    |    | •  |    | •  | •  | • |
| Overland Courtenay to CVWPCC (Excl. Tunnel Sections)    | \$ 15,847,000            |                                    |    |    |    |    |    | •  |    |    |    |    |   |
| Overland Lazo Tunnel to CVWPCC                          | \$ 1,617,000             |                                    |    |    |    |    |    |    | •  | •  |    |    |   |
| KFN Pump Station and FM to Courtenay                    | \$ 616,000               |                                    |    |    |    |    |    |    |    |    | •  | •  | • |
| New CFB Pump Station                                    | \$ 3,920,000             |                                    |    |    |    |    |    |    |    |    |    | •  |   |

Table 10-4 on the following page shows the 30, 50, and 100-year Net Present value (NPV) for all alignments options and conveyance concepts discussed in this report. The NPV is representative of the capital cost, asset management cost, and operations and maintenance costs (inclusive of power and labour). The parameters used in calculating the NPV are shown in Table 10-3.

**Table 10-3: NPV Calculations Parameters**

| Parameter  | Value   | Unit     |
|--|---------|----------|
| 15-yr Municipal Finance Authority (MFA) Long-Term Lending Rate | 3.05    | %        |
| 15-yr Engineering News-Record (ENR) Construction Index         | 3.02    | %        |
| Starting Power Cost  | 11.21   | \$/kW-hr |
| Power Rate Increase  | 5       | %        |
| Operating hrs/day  | 12      | hr       |
| Variable Rate  | 0.055   | \$/kW-hr |
| Labour Rate  | 100,000 | \$/yr    |
| Labour Inflation   | 3       | %        |

**Table 10-4: Options Net Present Value**

| Option ID | Options Description                          | Initial<br>Capital Cost | 30-Year  |         |          | 50-Year  |          |          | 100-Year |          |          |
|-----------|--|-------------------------|----------|---------|----------|----------|----------|----------|----------|----------|----------|
|           |  |                         | Capital  | O&M     | Total    | Capital  | O&M      | Total    | Capital  | O&M      | Total    |
| 1A        | Estuary With Lazo Hill Tunnel                | \$ 79.5                 | \$ 86.1  | \$ 14.9 | \$ 100.9 | \$ 92.7  | \$ 29.4  | \$ 122.1 | \$ 167.4 | \$ 97.4  | \$ 264.8 |
| 1B        | Estuary with Lazo Hill Overland Route        | \$ 56.5                 | \$ 63.2  | \$ 24.3 | \$ 87.5  | \$ 69.8  | \$ 48.5  | \$ 118.3 | \$ 121.9 | \$ 164.9 | \$ 286.8 |
| 1C        | Estuary with a New In-Line Pump Station      | \$ 64.5                 | \$ 72.1  | \$ 25.8 | \$ 97.9  | \$ 79.8  | \$ 51.1  | \$ 130.9 | \$ 139.2 | \$ 171.1 | \$ 310.3 |
| 2A        | Overland Forcemain                           | \$ 45.1                 | \$ 51.7  | \$ 23.3 | \$ 75.0  | \$ 58.4  | \$ 46.4  | \$ 104.8 | \$ 99.3  | \$ 157.4 | \$ 256.7 |
| 2B        | Overland Forcemain with In-Line Pump Station | \$ 58.6                 | \$ 68.7  | \$ 33.1 | \$ 101.8 | \$ 74.7  | \$ 66.0  | \$ 140.7 | \$ 127.1 | \$ 223.5 | \$ 350.6 |
| 3A        | Tunnel Through Comox Hill and Lazo Hill      | \$ 80.0                 | \$ 86.6  | \$ 14.9 | \$ 101.5 | \$ 93.2  | \$ 29.4  | \$ 122.6 | \$ 168.4 | \$ 97.4  | \$ 265.8 |
| 3B        | Tunnel Through Lazo Hill                     | \$ 69.0                 | \$ 75.6  | \$ 17.0 | \$ 92.6  | \$ 82.2  | \$ 33.6  | \$ 115.8 | \$ 146.6 | \$ 112.4 | \$ 259.0 |
| 3C        | Gravity Tunnel From Comox to the CVWPCC      | \$ 65.5                 | \$ 70.9  | \$ 16.6 | \$ 87.6  | \$ 76.4  | \$ 32.9  | \$ 109.3 | \$ 138.0 | \$ 109.9 | \$ 247.9 |
| 4A        | North Side Forcemain Concept                 | \$ 68.6                 | \$ 82.7  | \$ 26.0 | \$ 108.8 | \$ 96.8  | \$ 52.1  | \$ 148.9 | \$ 157.0 | \$ 177.4 | \$ 334.4 |
| 4B        | North Side Gravity Concept                   | \$ 84.0                 | \$ 99.9  | \$ 30.3 | \$ 130.2 | \$ 115.8 | \$ 60.4  | \$ 176.2 | \$ 190.2 | \$ 204.8 | \$ 395.0 |
| 5         | Decentralized Treatment Concept              | \$ 173.6                | \$ 187.7 | \$ 58.3 | \$ 246.0 | \$ 201.8 | \$ 114.0 | \$ 315.8 | \$ 364.0 | \$ 371.9 | \$ 735.9 |

For ease of comparison, the following colour gradient has been used in Table 10-4. The highest cost in each column is shown in red (right of the color gradient), and the lowest cost in each column is shown in green (left of the colour gradient), with the in-between values shown in the respective colour along the gradient.

