VILLAGE OF CUMBERLAND

LIQUID WASTE MANAGEMENT PLAN

SUPPLEMENTAL REPORT
VERSION 2

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1rst DRAFT

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TABLE OF CONTENTS

1. Introduction

The Village of Cumberland began formulation of a Liquid Waste Management Plan (LWMP) in 1998 issuing the Stage 1 Report February 2001 and the Stage 2 Report January 2003.

The Village of Cumberland's current Official Community Plan (OCP) was adopted in 2004 and the growth strategies presented in that document departed significantly from those presented in the 1998 OCP. The LWMP Stage 1 and Stage 2 reports were based on the 1998 OCP. One of the major objectives of this Supplemental Report is to reassess the direction of the Liquid Waste Management Plan (LWMP) given the new OCP and associated changes in the size of the serviced population and the volumes of treated wastewater being discharged to Maple Lake Creek. The Supplementary Report is also to address issues that the Ministry of Environment (MOE) in April 2003 highlighted for review during Stage 3 of the LWMP process[1]. MOE highlighted these issues using the following headings; 1) Reclaimed Water Standards, 2) Draft Operational Certificate, 3) Design Issues, 4) Phosphorus Removal, 5) Stormwater Management, 6) Construction Costs and Schedule, 7) Waste Management Plan, 8) Consultation and 9) Infrastructure Funding.

This report addresses each of the items that MOE highlighted in the April 2003 letter, but within a structure that at MOE's request, mirrors the Stage 1 and Stage 2 reports. The subject matter on that basis is presented in the following sequence:

- Section 2 - Local and Regional Planning;
- Section 3 - Sewage Flow and Strength Characteristics;
- Section 4 - Environment;
- Section 5 - Alternative Treatment and Disposal Options;
- Section 6 -Proposed Treatment and Disposal Systems;
- Section 7 – Biosolids Management;
- Section 8 – Sewer Separation Program;
- Section 9 – Stormwater Management Plan;
- Section 10 – Sewer Bylaws;
- Section 11 – Public and First Nations Consultation
- Section 12 – Implementation Plan
- Section 13 – Conclusion and Recommendations

[1] Ministry of Water, Land and Air Protection; File: 76780-3/CUMB; April 11, 2003 – Letter to the Village of Cumberland from B. W. Medlar, Assistant Regional Waste Manager, Environmental Protection Division
[2] Bylaw 842 Schedule "C" Village of Cumberland Official Community Plan Amendment Bylaw, 2006

2. Local & Regional Planning

2.1 Cumberland OCP 2004

The 1998 and 2004 OCPs depict significantly different community boundaries in terms of the size of the area they encompass and in the land-use allocations. The planning objectives reflected in the two OCPs shifted from restrictive development within the Village Core in 1998 to managed growth within an expanded land base in 2004. The 2004 OCP community boundaries encompass an area of 30.23 km^2 compared to 7.42 km^2 in the 1998 OCP. The following table summarizes designated areas of different land-use types.

	Units	2004 OCP	1998 OCP
Residential	ha	305	125
Commercial	ha	125	5.48
Industrial	ha	401	42.3
Institutional	ha	20.1	14.2
Recreational/ Residential	ha	192	59.6

In the context of the wastewater management, land-use areas fall into two service categories; on-site and centrally-serviced areas. Recreational and industrial lots typically use on-site treatment and disposal systems. Areas encompassed by the 1998 community boundary and newly designated[2] development areas east of the highway will continue to use central, treatment and disposal facilities. The centrally serviced areas are predominantly residential and commercial areas. This serviced area and the centralized wastewater collection and treatment systems are the primary focus of this report.

2.2 Regional Growth Strategy & Related Studies

The Comox Valley Regional Growth Strategy (RGS) is a partnership arrangement between the CVRD, the Village of Cumberland, the City of Courtenay and the Town of Comox. The purposes of the RGS are to:

- Build consensus among local governments on future policies regarding land use activities and development over the next 20 years, as legislated by Part 25 of the Local Government Act; and
- Inform the provincial government of local priorities and objectives in order to allow for them to align their program delivery in support of these local priorities.

The RGS as required by Provincial legislation consists of three key elements:

1. a vision statement on the future of the region over a 20 year time frame;
2. population and employment projections for the region; and,
3. actions to be taken in relation to specific issues: housing; ecosystems, natural areas, and parks; local economic development, transportation, infrastructure, food systems, public health and safety, and climate change

Part 3 of Comox Valley Regional District Regional Growth Strategy Bylaw No. 120 – 2010 outlines the goals, with supporting policies and explanatory text. Goal 5 is most directly relevant to Cumberland's LWMP.

***"Goal 5-Infrastructure:** Provide affordable, effective and efficient services and infrastructure that conserves land, water and energy resources. "*

Each goal contains six elements; issue overview, current situation, objectives, targets, measures and supporting policies. RGS Bylaw No 120- 2010 contains the following text with respect to infrastructure and more specifically to sewage systems

Two key considerations with respect to infrastructure:

- Avoiding urban and rural sprawl, and ensuring that development takes place where adequate facilities exist or can be provided in a timely, economic and efficient manner; and
- Infrastructure extensions should be guided by an understanding of where and how growth should occur, considering natural capacity, environmental impact, costs and efficiency, and to resolve health risk implications from failing onsite systems.

Current Situation:

> "There are presently three communal sewer systems in operation in the Comox Valley. The CVRD owns and operates two systems – one for the participating jurisdictions of Courtenay and Comox and the other for the participating Jackson Drive local service area, while the Village of Cumberland operates the third system. In the Comox Valley, sewer servicing takes the form of communal sewer service and septic systems. There are signs of needed sewage infrastructure investment such as failing septic systems that continue to threaten the waters of Baynes Sound and create Public Health concerns. The CVRD is in the process of completing a Sewerage Master Plan."

***"Objective 5-D:** Encourage sewage management approaches and technologies that respond to public health needs and maximize existing infrastructure."*

"The CVRD *Sewerage Master Plan* will set out a long-term strategy for sewer expansion that is aligned with other regional strategies, including this RGS." The RGS is one of four regional strategies created to help guide future growth. The others are the *Regional Water Supply Strategy*, the *Regional Sewer Strategy* and the *Sustainability Strategy* and they provided input to the RGS.

Measures and targets applicable to the sanitary sewer system were identified as:

MEASURES	Baseline (2010)	TARGETS Short-term (2015)	Medium-term (2020)	Long-term (2030)	Data sources
Percentage of new growth serviced by sanitary sewer	n/a	90%	90%	90%	CVRD

Supporting policies

5D-1	The majority of growth should be focused in *Core Settlement Areas* where appropriate sewer servicing already exists.
5D-2	New development will replace and/or upgrade aging sewer infrastructure or provide cash-in-lieu contributions for such upgrades through Development Cost Charges or similar financial contributions.
5D-3	Promote eco-industrial development that turns wastes into resources.
5D-4	For existing developments outside of *Core Settlement Areas*, where there are demonstrated onsite health related issues, publically owned sanitary sewer services may be provided.
5D-5	Prepare an Implementation Agreement for sewer services once the RGS is finalized.

The CVRD in 2008 as part of the *Regional Sewer Strategy* expanded the scope of work of the Comox Valley Sanitary Sewer Master Plan (CVSSMP) study to include Cumberland in the evaluation of servicing options for the Royston/Union Bay area. The draft CVSSMP study completed in June of 2009 recommended construction of a South Regional Sewage System to service these areas.

The CVRD has since commissioned the South Regional Sewage System Collection, Treatment and Discharge Study to investigate and to recommend the direction for sewage collection, treatment and disposal services for these areas to proceed. The study focus is on Royston and Union Bay areas having the option of Cumberland connecting to the system. The Terms of Reference for the study state *"The direction must be based on the most favorable treatment and discharge options which optimize social, environmental and economic benefits. Direction must also incorporate opportunities for integrated resource recovery (IRR). The study shall present two distinct options for moving forward, one which includes connecting the Village of Cumberland to the south regional system and one which does not."*

2.3 Population Projections

Estimated population growth for Cumberland is based on recent projections published in the draft CVSSMP study report dated June 2009. The population projections in that document included potential growth from the proposed developments in West Egremont[2] and Cumberland Interchange Lands[3]. Private servicing with respect to water and wastewater has been an integral part of planning the Bevan West (Cumberland Green) Development to date and, on that basis these lands are not included in the projected service population. The population projections in the final CVSSMP may be tempered by the results of RGS, however, for purposes of assessing centralized wastewater treatment and disposal options, the current CVSSMP population growth projections have been adopted and presented in Figure 2-3. Refer to Appendix B for projected population details.

The RGS projects that over the next 20 years population growth in the region will be approximately 24,000 persons. It also recognizes that 16,783 new housing units potentially will be available over the same period. The estimated number of potential new units includes 5,100 units for Cumberland. That number represents more than 30% of the total for the region and is the highest of the three *municipal areas*. These figures suggest that housing availability over the period may exceed demand.

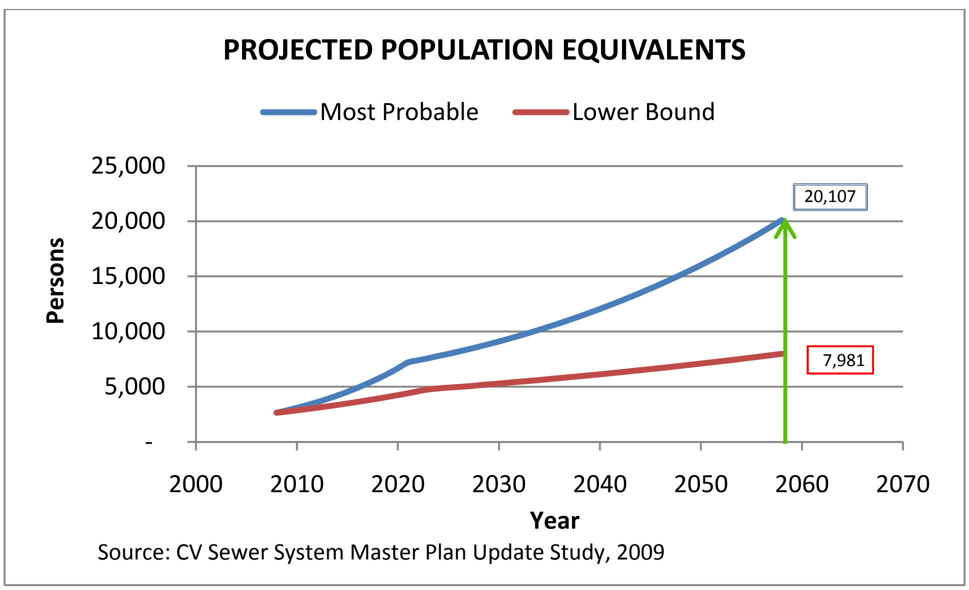


Figure 2-1: Serviced Population Projections

[2] Coal Valley Estates Phase 4 and 5; 46 ha of residential land-use with a projected population equivalent of 2,030 persons.
[3] Trilogy Group; 340 ha of mixed land-use with a projected population equivalent of 4,380 persons

3. Sewage Strength & Flow Characteristics

3.1 Existing Permit and Historical Records

Discharges from the Cumberland Lagoon are authorized under the provisions of the Waste Management Act and permit PE-00197 as issued to the Village of Cumberland on August 25, 1967 and as last amended December 3, 1997. Permit conditions presently in affect include:

Parameter	Limit
Maximum annual average flow	910 m^3/d
Maximum rate of discharge, currently after September 1, 2015	7,600 m^3/d 2,710 m^3/d
5-Day Biochemical Oxygen Demand (BOD_5)	30 mg/L
Total Suspended Solids (TSS)	30 mg/L
Faecal Coliform bacteria (FC)	200 MPN/100 mL
Total Phosphorus (P_T)	1.0 mg/L

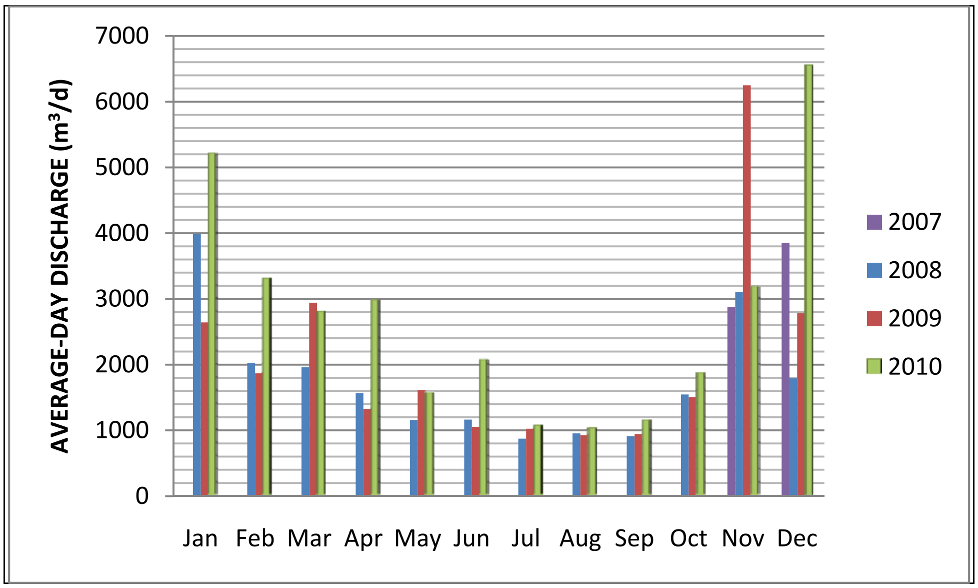
Other provisions of Permit PE-00197 include:

1. Sampling requirements for monitoring the quality of the lagoon discharges and the receiving waters (Four sites along Maple Lake Creek and the Trent River) (Section 3)
2. Requirement to erect signs along the alignment of Maple Lake Creek at all recognized access points, to the Creek and at all road crossings and at the confluence with the Trent River. (2.5)
3. Authorized works after May 1, 1999 included disinfection and nutrient removal facilities or alternate disposal methods. (1.1.4)
4. Operators be trained and to qualify under the Environmental Operators Certification Program Society. (2.12)
5. Cumberland's authorized discharge would to be subject to the provisions of a Regional District's Liquid Waste Management Plan if that plan incorporated the Cumberland area, and was developed and approved by the Minister by December 31, 1999. Otherwise Cumberland was to undertake the following activities:
   Source Control Program
   Stormwater Management Plan
   Sludge Wasting and Screening Disposal and Biosolids Management Plan
   Inflow and Infiltration Control Program
   Sanitary and Storm Sewer Separation Plan (2.14)

Historical discharge volumes since 1997 consistently exceeded the 910 m^3/d permit limit for annual average flow with a trend that continues to rise (Figure 1). Peak annual flows typically exceed the stipulated maximum flow of 7,600 m^3/d

two to five days per annum. Peak flows are expected to decrease over time with the sewer separation program that Cumberland has adopted. That program is designed to eliminate combined sewers and to reduce extraneous flow entry, primarily inflow and infiltration, to the sanitary sewage collection and treatment system.

Figure 3-1 - Cumberland Lagoon
Monthly Average-day Discharges



Average dry weather flow (ADWF)
To quote from Section 1 of the provincial Municipal Sewage Regulation (MSR)

> *"average dry weather flow" or ADWF means the daily municipal sewage flow to a sewage facility that occurs after an extended period of dry weather such that the inflow and infiltration has been minimized to the greatest extent practicable and is calculated by dividing the total flow to the sewage facility during the dry weather period by the number of days in that period."*

ADWF for purposes of this assessment equates to the lowest monthly average-day flow, and accordingly the value is currently in the order of 1,000 m^3/d. ADWF was 872 m^3/d in July 2008, 927 m^3/d in August 2009 (a 6% increase), and 1,026 m^3/d in August 2010 (a 10.7% increase).

Figure 3-1 shows on the high side that average daily flows for at least one month during the October through April period will exceed three and a half times ADWF to as much as six and a half times ADWF. Rainfall and snowmelt dominate recorded flows during this time of the year. In the transition to drier weather, monthly average-day flows in April and October can be as low as one and a half times ADWF.

Cumberland collects water samples of the lagoon discharge and the receiving waters monthly and the quality data records extend back to 1992. Effluent BOD_5 and TSS concentrations typically meet the permit limits but concentrations are trending higher (Figures 3.2 and 3.3).

Figure 3.2 - Cumberland Lagoon Effluent
Monthly BOD_5 Concentrations

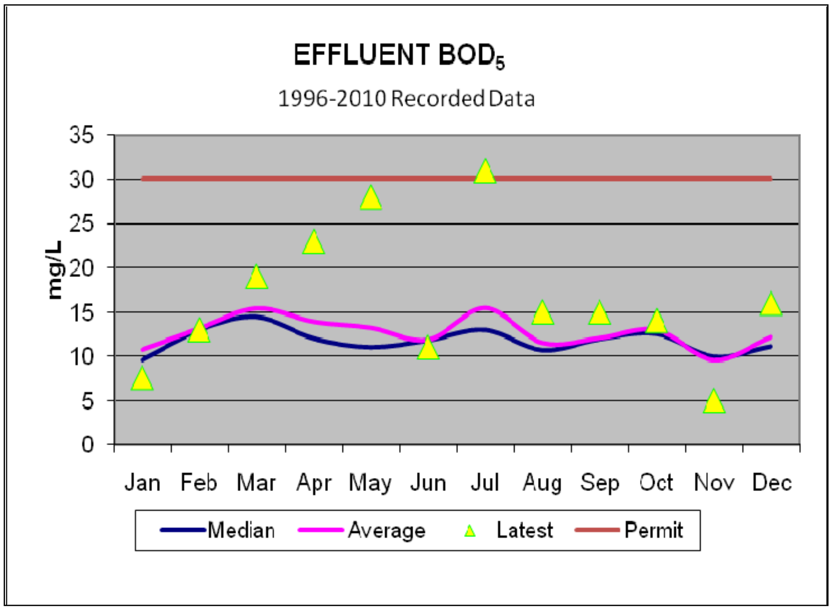
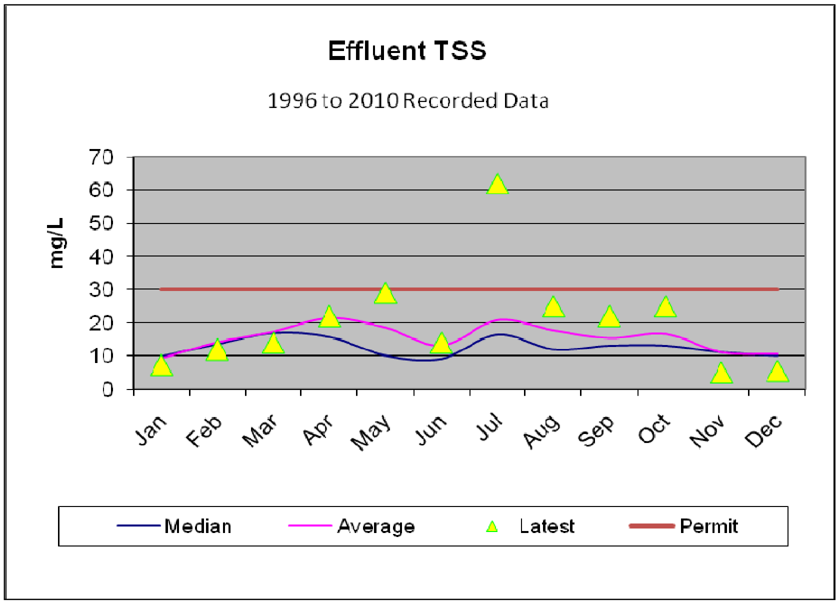


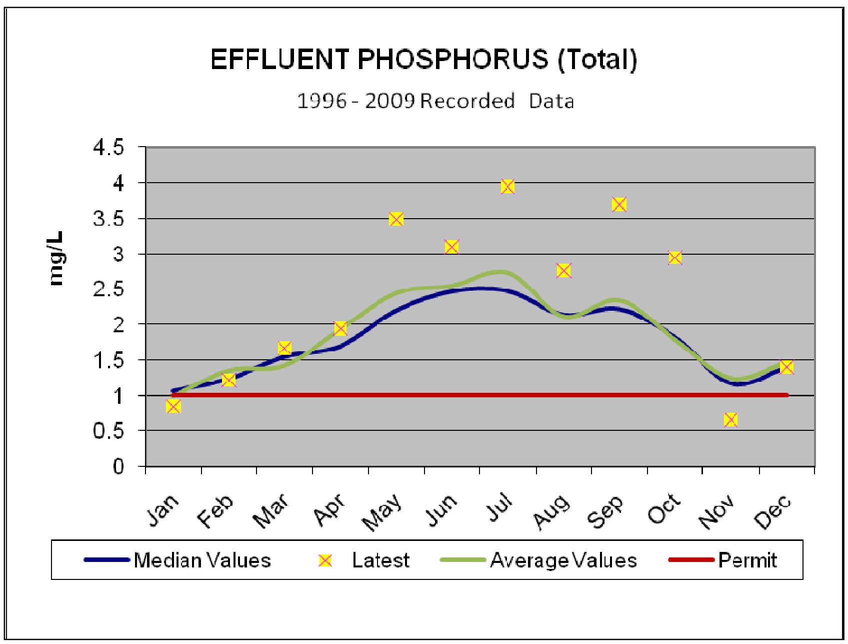
Figure 3.3 - Cumberland Lagoon Effluent
Monthly TSS Concentrations



Faecal Coliform counts typically exceed the permit density limit of 200 MPN/100 mL, and levels are trending higher. Earlier Stage 2 LWMP designs included disinfection facilities in the treatment process train anticipating that Maple Lake Creek would continue to receive the effluent discharge. Installation of any disinfection works at this stage however, is contingent upon completion of Stage 2 and Stage 3 assessments and approval of the associated recommendations.

Total phosphorous concentrations similarly, are only rarely below the permit limit of 1.0 mg/L (Figure 4), and earlier investigations within Stage 2 of the Cumberland LWMP investigated the addition of phosphorus removal facilities to the treatment process train. As noted above, those investigations had anticipated Maple Lake Creek continuing to be the receive waters. The Stage 2 assessments were not completed and no action other than conducting a source control study[4] was taken to reduce phosphorus concentrations.

Figure 3.4 - Cumberland Lagoon Effluent
Monthly Phosphorus Concentrations



The recently completed Village of Cumberland Stormwater Drainage Master Plan and Sanitary Sewer Master Plan meet permit stipulations regarding stormwater management, sewer separation, and inflow and infiltration (I&I) control programs.

Permit stipulations regarding Sludge Wasting and Screening Disposal and a Biosolids Management Plan have limited application to the existing lagoon. The first biosolids (lagoon solids) removal, however, occurred September 2009 and the dewatered solids were applied to agricultural lands under the Provincial Organic Matter Recycling Regulation

[4] McElhanney Consulting Services Ltd., February 2005; Village of Cumberland Liquid Waste Management Plan Stage 3 - Phosphorus Source Control Study Report

(OMRR). Design of new treatment works is still in the planning stages and consequently, it is too early to develop management plans for screenings and waste activate sludge (WAS).

3.2 Community Initiatives That Impact Sewage

3.2.1 Water Conservation Programs

Water consumption levels have direct impacts on the volumes of wastewater to be treated and discharged to the receiving environment. The impacts of consumption levels on water system expansion in terms of scheduling, sizing and costs are more obvious. Cumberland recognizes that demand management opportunities exist to alter water consumption levels and loading conditions on sewerage and water systems with potential financial and environmental benefits to the community. The Village has implemented a combination of soft and hard conservation measures as elements of their demand management program.

Soft conservation methods have included voluntary restrictions, educational and information sharing initiatives, and planning tools. They have targeted residential, commercial/industrial and school audiences.

Cumberland, Courtenay, Comox, Campbell River and the Regional District formed a regional partnership in 2006, to raise water conservation awareness in the greater areas of Campbell River and Comox Valley. This partnership has since implemented media campaigns, community presentations, and door-to-door watershed education canvassing. Key messages have been that water demand is high and the public can make a difference through conservation reducing costs and taxes.

Hard conservation options are based on more demanding and restrictive approaches that include legal, economic, financial, and operational tools. Cumberland has chosen to implement universal water metering and leak detection programs.

Universal water metering means that meters are required of all water users - residential, industrial, and commercial - such that 100% of the consumption can be tracked by the meters. Installation of these meters in combination with a suitable charging rate encourages water users to reduce consumption to avoid higher billing costs.

Cumberland's water supply system currently serves a community of approximately 5,300 people consisting of the Village of Cumberland and Royston. Cumberland has a flat-rate yearly water usage fee of $78 for single family residences, plus a parcel charge. The Village, however, applied and received provincial funding under the **Towns for Tomorrow Program** to implement a metered water system. That system is to be in place by March 31, 2011. Royston implemented a metered water system in 1997.

Royston's consumption before 1997 was quite similar to Cumberland's. The impact of water metering was as shown in Table 3.1, to reduce Royston's consumption by approximately 50%.

Table 3.1 Water Consumption 1997- 2006

	Cumberland (l /c/d)	Royston (l/c/d)
Average Annual	830	425
Average Summer	1,100	575
Peak Day (Summer)	1,600	825

The impact of metered water on sewage flows could not be established because Royston does not have a central wastewater treatment facility. The impact of metered water should be apparent in the discharge volumes from Cumberland lagoon. Reductions in lagoon discharges would be smaller than the reductions on the water consumption side because metered water is particularly effective in reducing outdoor water-use. Outside use typically is not reflected in sewage flows.

3.2.2 Sewer Separation

Cumberland's combined sewers date back to the late 1800s and consist of vitrified clay and asbestos cement sewer pipes generally in a state of disrepair. Cracks, holes and displaced joints along these sewers are common and the amount of extraneous flow entering the pipes through infiltration nearly doubles sewage flows during seasonal periods of high groundwater levels.

Cumberland in 2005, embarked on a plan to replace combined sewers with separate sanitary sewers and storm drainage systems. Sewer separation work to date has been limited to replacement of trunk and collector sewers in the Ravine District and collector sewers in the Second Street district. The remaining combined sewers service an area of 31.6 ha which represent 15% of the full serviced area of 213 ha.

The Capital Improvement Program[5] includes replacement of the combined sewers with separate sanitary sewer and storm drainage systems. An implementation period of 15 years applies to the current strategy of replacing combined sewers at the rate of two blocks per year in conjunction with the upgrading of other services and works.

A decrease in extraneous flow volumes conveyed to the Cumberland lagoon is projected to occur over the 15 year period that the sewer separation program is being implemented. Sewer separation is expected to reduce the large inflow and infiltration (I&I) flow components associated with the existing combined sewers. As the I&I component is progressively reduced, the range of the seasonal sewage flows will also shrink.

[5] McElhanney Consulting Services Ltd. July 13, 2010; Village of Cumberland Liquid Waste Management Plan Stage 2 - Sanitary Sewer Master Plan

3.3 Updated Design Criteria and Flow Projections

Overview

Growth in the community has resulted in a 20% increase in sewage dry-weather flows to the lagoon over the last three years. Additional growth is anticipated in the serviced population and in the volume of sewage to be treated and disposed. Anticipated growth is both within and beyond the existing boundaries of the Village Core area. Cumberland's Sanitary Sewer Master Plan (SSMP) dated July 2010 identifies the new development areas as the Interchange Lands and West Egremont.

ADWF

Section 3 of the SSMP discusses design criteria and flow projections for each of the eight existing sanitary sewer districts at length. This report primarily addresses a centralized community sewage treatment and disposal system and the population projections in Section 2.3 reflect the full serviced area and include commercial, industrial, and institutional land-use areas using population equivalents based on a per capita sewage generation rate of 300 L/d. This adopted rate is equivalent to the recommended Master Municipal Construction Documents (MMCD) per capita flow generation guideline for sewer design.

Different land-use segments of the community generate wastewater at varying rates and Table 3-2 shows historical rates applicable to Cumberland as derived from past dry-weather flow measurements and discussed in detail in the SSMP.

TABLE 3-2: SANITARY SEWAGE FLOW COMPONENTS 2009		
Serviced Area Source	**Unit Rate**	**Component Flow (m^3/d)**
Residential (2,750 persons)	260 L/d/c	712
Commercial (2.9 ha)	19.7 m^3/ha/d	57
Institutional (Hospital Laundry)	157 m^3/d	157
Industrial (9 ha)	0.45 m^3/ha/d	4
Total Sanitary Sewage Flow		930

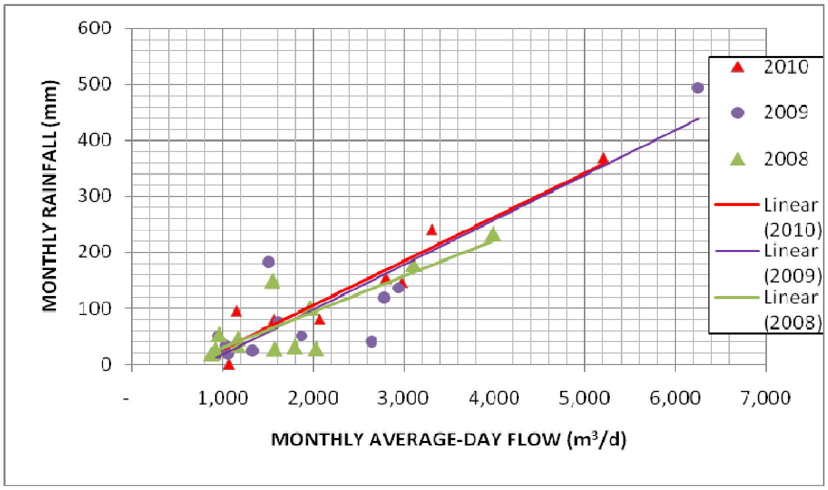
Projected future flows and population equivalent values for the new development areas are based on the current development zoning, plans and supporting documentation. Based on these data, population equivalents for the Interchange Lands and West Egremont area are 4,170 and 2,674 persons respectively[6]. ADWFs based on projected population growth is anticipated to double in 10 years and triple in 15 years.

[6] SSMP July 2010; Tables 3-4 and 3-5.

I&I Flow Contributions

I&I components of the total wet-weather flow will decrease over time as the sewer separation program proceeds, and the associated trends are evident in Figure 3-5.

Figure 3.5 Relationships between Cumberland Rainfall and Sewage Flows



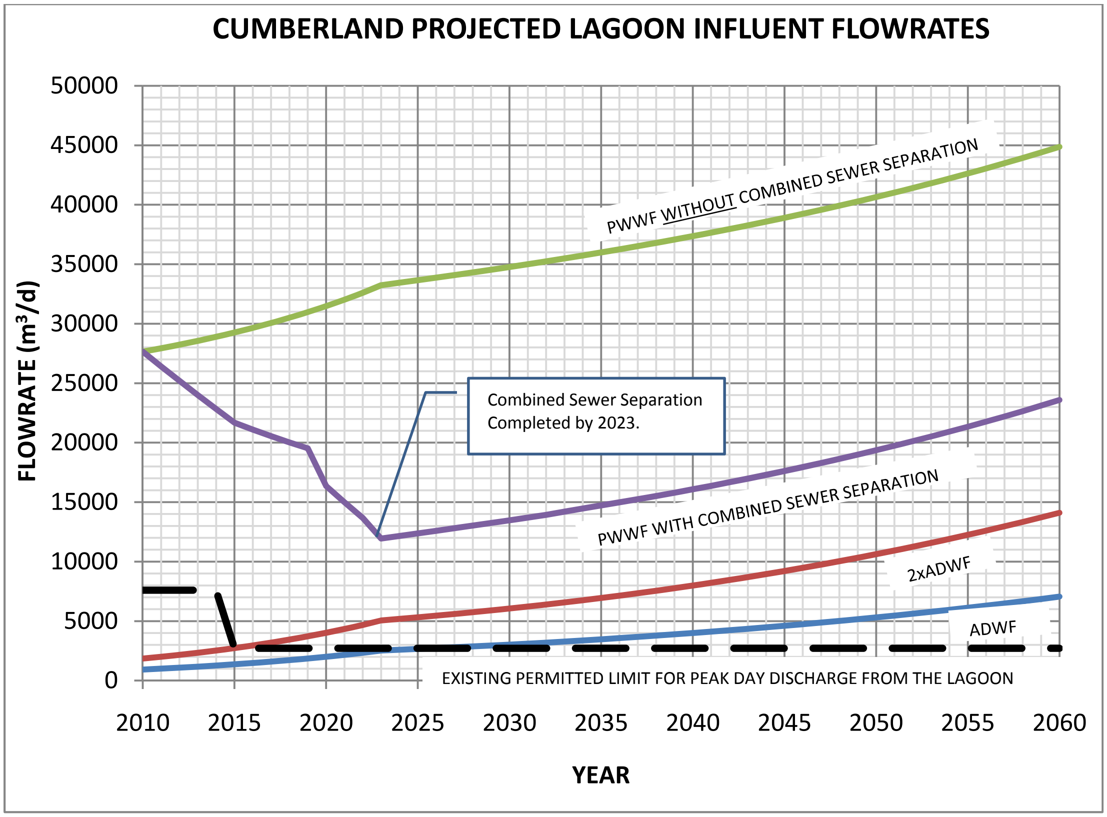
The impacts of the sewer separation program and the associated smaller I&I flow contributions are hardly evident at this stage because of the high degree of variability in rainfall events. Plotting rainfall against lagoon discharges, the evidence is in the higher slopes of the annual graphs and in progressively increasing correlation coefficients (r= 0.84 in 2008, 0.90 in 2009 and 0.94 in 2010).

Cumberland funding provisions for the sewer separation program in the absence of senior government funding, are integrated with other required infrastructure improvements being implemented on a block-by block basis. The target is two blocks of street and service restoration each year. Advantages of this approach over a separate sewer installation project are: higher construction efficiencies, and greater opportunities to minimize service disruptions and to protect ground surface restoration works. Implementation at this rate, however, extends completion of the sewer separation program to 2023.

Figure 3.6 is from the SSMP report and it shows dry-weather and wet-weather projected flows to the year 2060. The figure clearly shows anticipated impacts of the 15-year sewer separation program on wet-weather flows.

Storm events having a return period of five years are used to estimate I&I flow components of the projected peak wet weather flows (PWWFs). A peaking factor of 30 on ADWF roughly approximates current PWWF with this storm frequency. When the sewer separation program is complete, that peaking factor is expected to be 3 to 4.

Figure 3.6



Wet-Weather Flows

Wet-weather flows when defined as the annual maximum day discharge from the lagoon, has ranged from 10 to 18 times ADWF over the last three years.

3.4 The Need to Review Earlier LWMP Findings

Projections used in earlier Stage 2 reports saw population and sewage flows doubling over 25 years. Current projections are that the population will double within 5 to 10 years based on the revised growth patterns and rates Cumberland adopted with the 2004 OCP and on development plans be currently being processed. Higher growth rates have implications on sizing and selecting the type of treatment facilities. The higher discharge rates and volumes of treated wastewaters potentially have impacts on the receiving environment greater than previously estimated.

4. Environment

4.1 Introduction

Environmental topics of particular relevance relate to placement of treatment facilities and center primarily on potential impacts to the receiving environment into which the treated effluents are discharged. Earlier investigations and reports in the LWMP process identified the most likely location of future treatment works to be the existing lagoon site and areas immediately adjacent. These earlier investigations focused almost exclusively on the Maple Lake Creek/Trent River system as the effluent receiving environment. The following section is a summary of earlier findings and it expands the assessment of options based on more recent developments.

4.2 Potential Receiving Waters

The earliest studies considered three general receiving water options, namely, Maple Lake Creek/Trent River, Perseverance Creek/Comox Lake and an ocean outfall. The following is a point-form summary of findings and conclusions at each stage of investigation deemed relevant to the selection of receiving waters.

<u>Maple Lake Creek & Trent River</u>

- Stage 1 Report, February 2001, Section 3.15:
    - In 1989, concerns were raised that water quality in Maple Lake Creek was seriously affecting fish habitat in the Trent River below the confluence.
    - The Province conducted several extensive studies 1995 to1997 to assess the assimilative capacities of Maple Lake Creek and Trent River. The latest revisions to Cumberland's Sewage Discharge Permit PE-00197, issued December 1997 were formulated using the essential information gathered through these investigations as baseline data.
    - Continuing deterioration of water quality in Maple Lake Creek and Trent River was noted.
    - Highlighted references in earlier studies that suggested treated effluent augmenting low summer flows had potential benefits for habitat preservation.
- Stage 1 Report, February 2001, Section 5 –
    - Recommended Course of Action for Stage 2:
        - Complete Environmental Impact Assessment for discharge to Maple Lake Creek receiving waters for the range of treatment options under consideration.
        - Identify requirements for summer low-flow augmentation, assess related options and prepare cost estimates.

- Stage 2 Report, January 2003,:
  - Mimulus Biological Consultants, November 2001 Report – Environmental Assessment for the Proposed Cumberland Treatment Wetlands and Sewage Discharge
    - Compiled water quality records (1996 to 2001) and compared observed values with the recommended concentrations limits presented in the BC water quality guidelines (Section 6.3), and
    - Recommended effluent quality levels deemed applicable to Maple Lake Creek (Table 7.1).
  - Algae growth in the Trent River downstream of the confluence –
    - Compiled Chlorophyll a measurements 1997 – 2002 upstream and downstream of the confluence and compared them to BC Approved Water Quality Guidelines (Recreation ≤50 mg/m^2; Aquatic Life ≤ 100 mg/m^2);
    - Identified concentration profiles of orthophosphate and total phosphorus between the lagoon discharge point and the trestle approximately three km downstream of the confluence.
  - Recognized that for these receiving waters treated effluent must meet the Municipal Sewerage Regulation (MSR) quality standards for reclaimed water. The amount of available dilution is less than 10:1 during the summer months.
  - In addition the standard applicable for reclaimed water with unrestricted public access, effluent quality target orthophosphate concentrations ≤ 100 µg/L (0.1 mg/L) for the May 1^{rst} to September 30th period.
- March 23, 2010 Project Meeting Minutes
  - The Ministry was on record as adopting a 5 µg/L as the in-stream limit for phosphorus on Vancouver Island during the critical May to September period.
  - Difficulty of establishing the corresponding upstream or effluent discharge limit was acknowledged given phosphorus take-up by algae is almost instantaneous. Effective control requires that mass discharge limits be applied to jurisdictions with a growing population such as Cumberland.
- Current status:
  - Monthly sampling and analysis of receiving waters and lagoon discharges quality continue, and
  - Stream flows are difficult to monitor and field data are limited. The Trent River Pulsed Discharge Study[7], included dye testing in early summer 2006. The conclusion was that travel time in Maple Lake Creek was greater than five days during that monitoring period. The researchers attributed low dye recovery rates to hyporheic exchange which in part would explain the variability in both nutrient concentrations and

[7] Ministry of Environment, Environmental Quality, January 2007 Draft – Trent River Pulsed Discharge Study

flow rates downstream of the lagoon outfall. Earlier Provincial studies report effluent dilution ratios ranging from 5:1 to 1:1 with calculated and observed summer flows in the Trent River.

- Sage Hills plans and potential approvals will increase development pressures along the Trent River downstream of the confluence.

<u>Perseverance Creek/Comox Lake</u>

- Stage 1 Report, February 2001, Section 3.15:
  - Large transfer costs to pump effluent a distance of 3.9 km, and
  - Any potential cost savings on treatment were conditional upon findings of additional environmental studies and dilution calculations.
  - This option was to be presented to the PAG and the public for review.
- Stage 2 Report, January 2003, Section 9.2 e):
  - Identified uses as the drinking water source for the Regional District; the water source for the Puntledge River Hatchery; public use and recreation, and the water supply for BC Hydro generation facility.
  - Noted treatment would be required to meet phosphorus limits set by the BC Approved Water Quality Guidelines for lakes (1.0 mg/L total phosphorus, 0.5 mg/L ortho-phosphate).
  - Emphasized that use of this system as receiving waters would require extensive environmental impact assessments and public consultation.
  - Noted that Vancouver Island Health Authority was not in favour of using Comox Lake as receiving waters.
- Regional Water Supply Strategy – Phase 4 – Regional Water Supply Options, November 2009:
  - Comox Lake will remain the primary water supply source for the region and the size of the serviced area will increase.

<u>Ocean Discharge</u>

- Stage 1 Report, February 2001, Section 3.15:
  - Scope identified as including a connection to the regional trunk sewer system, processing at the Comox treatment plant and discharge through the existing ocean outfall.
  - Construction of a new separate outfall discharging into Baynes Sound noted as not feasible for environmental and economic reasons.
- Stage 2 Report, January 2003, Section 9.2 d):
  - An ocean outfall alternative has been under consideration since the KPA Engineering Ltd report November 1990, <u>Feasibility Study for Sewage and Wastewater Disposal</u>.

  - NovaTec Consultants Inc. May 1992 report Impact of Connecting Cumberland and Royston to the Comox-Strathcona Regional Collection System and Wastewater Treatment Plant confirmed adequate hydraulic capacity in the existing forcemain and pumping stations, and that the treatment plant would have sufficient capacity following scheduled expansion plans.

- Royston/Union Bay Sewage Collection Treatment and Discharge Study – 2005 Study and the November 2009 Update:
  - Recognizes the possibility of a south regional sewerage system based on the findings and recommendations of the regional sewer study and acknowledges Cumberland's potential involvement in that system.
  - Makes references only to ocean outfall Option C previously identified as one of three options in the 2005 report:
    - North end of Baynes Sound (Option A)
    - Strait of Georgia northeast of Sandy Island (Option B)
    - The existing Cape Lazo Outfall near Goose Spit into which the Comox Valley Water Pollution Control Centre (CVWPCC) currently discharges treated effluent (Option C).
  - Identified Option C as the most feasible from the standpoint of minimizing impacts to the marine environment through consultation with local regulatory agencies and shellfish growers.
  - Recommended:
    - Increased stakeholder consultation that includes First Nations; and
    - Detailed oceanographic study and receiving environment monitoring of the selected marine disposal area.

4.2.1. Fisheries Resources

Fisheries resources are a primary environmental concern associated with any existing or proposed discharge of treated effluent to the potential receiving water noted above. Each water body has been subject of a number of associated assessments and studies.

Maple Lake Creek/Trent River System:

Related studies with respect to this system include:

- Ministry of Environment, Lands and Parks, Nile Creek to Trent River – Water allocation Plan, January 1995.
  - Trent River near Royston (08HB044, data 1971-1976) – Mean Annual Discharge of 4.282 m^3/s; Mean 7-day average low flow of 0.022 m^3/s (1980 m^3/d).
  - Flows are naturally limiting to fish habitat and survival.
- Ministry of Environment, Lands and Parks, Technical Report and Addenda on Cumberland Sewage Treatment Plant, October 1995; November 1995 and October 1997.
  - Trent River noted as having high recreational fishery value, and
  - Coho smolts being released into the Trent River as part of a salmonoid enhancement project.
- John Deniseger, R.P.Bio., Report on Cumberland Sewage Treatment Plant and Impacts on the Trent River, December 1998.
  - Trent River survey findings (one day per month during July August and September 1998);
  - Flow ratios found to range from 5:1 to 1:1;
  - Ammonia levels higher than the provincial criteria for aquatic life were found in MLC but not the Trent River.
  - Algal biomass measured as chlorophyll a in the Trent 400 m downstream of the confluence was as much as two times the provincial criteria for protection of aquatic life and four times the criteria set to protect recreational use.
- Mimulus Biological Consultants, Environmental Assessment for the Proposed Cumberland Treatment Wetlands and Sewage Discharge, November 2001.
  - The downstream reaches of MLC are accessible to fish from the Trent River, and
  - "The physical aspects of fisheries habitat in the lower portions of MLC should be considered good".
- R Wong & Associates, Stream Classification within Maple Creek Tributary to Trent River, Cumberland B.C.; June 30, 2008.
  - A low probability of MLC being able to support resident salmonids upstream of the anadromous barrier due to the combination of marginal habitat and potentially lethal D.O. levels.
  - MLC's role in conveying food, nutrients and flow to downstream fish-bearing reaches of the Trent River is important.

<u>Perseverance Creek/Comox Lake</u>

Perseverance Creek Streamkeepers are local volunteers who routinely conduct stewardship activities such as fry salvage, and flow testing on Perseverance Creek. Based on their observations, lack of summer flow in the lower reaches is considered to be the primary limiting factor to fish productivity in Perseverance Creek. An estimated 50,000 fry die in the creek each year when it dries up[8].

Cumberland water supply reservoirs are located at the headwaters of Perseverance Creek and one of its tributaries, Cumberland Creek. Cumberland has committed in the next stage of expansion at the reservoirs to increase the summer water release for fisheries.

In exploring the widest range of wastewater management options, Cumberland identified augmenting Perseverance Creek summer flows with treated effluent as an Integrated Resource Recovery (IRR) opportunity. Ministry of Environment rejected this option for public health reasons[9] i.e. due to current sensitivity regarding Comox Lake as a current and future source of drinking water.

<u>Ocean Discharge:</u>

- Royston/Union Bay Sewage Collection, Treatment and Discharge Study; September 2005; Section 4 -
  - Baynes Sound:
    - One of the most productive marine ecosystems on the east coast of Vancouver Island;
    - Supports various fisheries including groundfish, salmon, bivalves, Geoducks and sea urchins.
    - Over one hundred shellfish farms and numerous indigenous clam beds.
- RGS
  - Support and enhance the agricultural and aquaculture sectors and increase local food security (Goal 6: Food Systems);
  - Protect shoreline areas for existing and future aquaculture and associated activities (Objective 6-B);
  - Existing tenures and farms should be protected to ensure no net-loss of farming activity.

4.2.2. Water Quality

<u>Maple Lake Creek/Trent River</u>

Water quality monitoring records are extensive and Cumberland since the beginning of 2003 conducts monthly sampling and analyses at four locations. Routine sampling on a less frequent basis extends back to 1996. The permit defines the parameters to be monitored and these are summarized in the following table.

[8] Comox Valley Project Watershed Society; Perseverance Creek Mapping and Inventory Project; Sensitive Habitat Inventory and Mapping (SHIM) Survey; December 2003
[9] Project Progress Meeting minutes, June 18, 2010

Table 4.1 – Water Quality Sampling Program

Site		Parameters
Designation	**Location**	
EMS E100753	Lagoon Discharge	Monthly BOD_5, TSS, F.C., P_{Total}, NH_3, NO_3, and $NO_{2;}$ Once annually: full scan and toxicity (Rainbow Trout Bioassay).
EMS 0140124	Maple Lake Creek (MLC) just upstream of Trent River	Monthly BOD_5, TSS, F.C., P_{Total}, NH_3, NO_3, NO_2, and temperature; Five months (March, May, July, September and November) add conductivity, D.O., P_{Ortho}, and pH.; Three months (May, July, September) add Chlorophyll-A.
EMS 0127582	Trent River 100 m downstream of MLC	
EMS 0127581	Trent River 100 m upstream of MLC	
EMS E227350	Trent River 400 m downstream of MLC	

Section 3 discusses how effluent quality for the Cumberland lagoon discharges has changed.

In contrast to the increase in loading from the lagoon, recorded ortho-phosphate and total phosphorous concentrations in Maple Lake Creek and the Trent River have change little over the last 15 years. Rising chlorophyll “a” concentrations, however, are evident in MLC and the Trent River, both upstream and downstream of the confluence.

Perseverance Creek/Comox Lake

- Extensively monitored as a water supply source.

Ocean Discharge

- Royston/Union Bay Sewage Collection, Treatment and Discharge Study; September 2005; Section 4
    - High, measured, fecal coliform concentrations in the North end of Baynes Sound have resulted in extended periods of shellfish closures since 1994.
    - Significant amounts of microbiological contaminants are attributed to failing septic systems, agricultural runoff stormwater drains, and boater wastes.
    - Environment Canada assessments that included baseline and post discharge monitoring programs 1981 through 1986 concluded that installation and operation of the Cape Lazo Outfall had no significant impact on water quality.

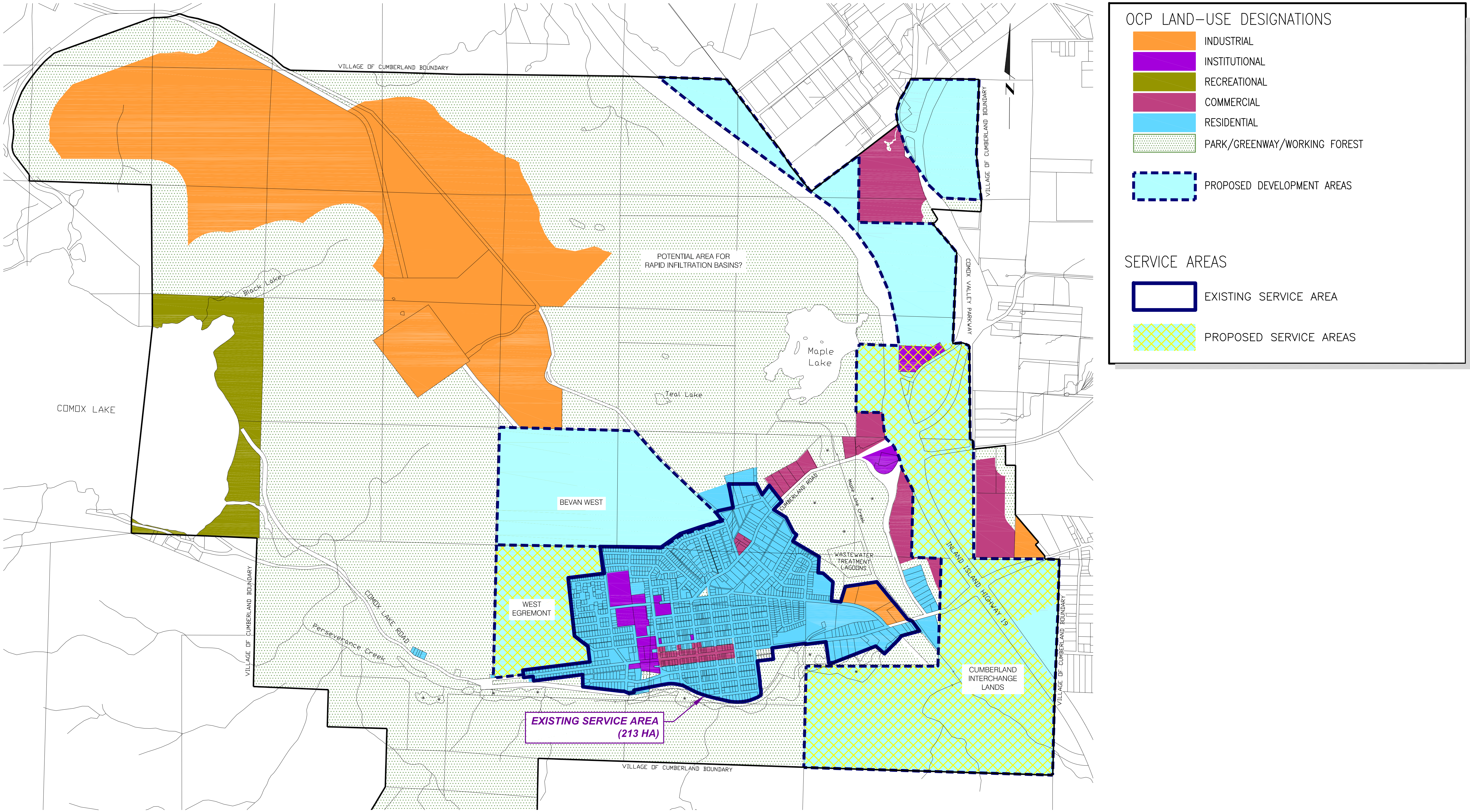
4.3 Potential Ground Application Areas

Earlier investigations into potential ground application areas for effluent disposal were confined to the areas within the Village of Cumberland boundaries. This report provides a summary of earlier findings and expands the assessments based on the new boundaries of the community. The following is a point-form summary of findings and conclusions at each stage of investigation deemed relevant to the selection of potential ground application sites.

- Stage 1 Report, February 2001, Section 3.15
    - The 1990 KPA assessment was reaffirmed. Any land application option would be located on private lands and given that areas with 1.3 m of soil above the water table, rock or till were very limited and performance of existing septic systems were generally poor, the concept of centralized land application was rejected.
- Stage 2 Report, January 2003, Section 9
    - 9.4 b) Irrigation to eliminate summer discharges to Maple Lake Creek was the land application option under consideration. The option was not recommended on the basis of high comparative costs and uncertainty as to whether it would "meet the goals of the MSR for standard of discharge throughout the year."
    - 9.2 c) Identifies in excess of 40 ha as the land area required if irrigation was used to eliminate summer discharge to Maple Lake Creek for a serviced population of 5000. Expressed concerns with respect to the irrigation option included: land ownership; proximity of springs and well water systems; shallow bedrock or till, and indications from the Vancouver Island Health Authority that they were not in favour of this alternative.
- Current Status
    - Cumberland's boundaries expanded northward in 2002 beyond the Residential Growth Boundary of the Historic Village to an industrial park area that now warrants assessment as potential land application areas for treated effluent.
    - The 2004 OCP land-use designations for these newly encompassed lands include working forest, industrial and greenway areas. (Figure 4.1). At the time, Comox Timber Ltd. owned the majority of designated Working Forest lands within the Village.

4.3.1. Compatible Land-use

Given these new areas are within the Village boundaries, land application in the form of rapid infiltration basin (RIB) may be an option and forest irrigation a potential integrated resource Recovery (IRR) opportunity. Joint participation in an effluent disposal facility may also be a possibility, given the designated industrial lands include the Pigeon Lake Landfill which is operated by the Regional District.



No.	Date	Revision	Dr.
0	JUL13/10	FINAL SUBMISSION	DT

McElhanney

McElhanney Consulting Services Ltd.

SUITE #1, 1351 ESTEVAN RD, NANAIMO, BC V9S 3Y3 PH (250) 716-3336 FAX (250) 716-3339

Designed: – Checked: DH Date: JAN 27/11

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THE VILLAGE OF CUMBERLAND

CUMBERLAND, BC

LWMP Supplementary Report

SANITARY SERVICE AREAS AND OCP LAND-USE DESIGNATIONS

Client Project No

Client Drawing No

MCSL Project No. 2231-21246-1

Drawing No. Figure 4.1 Rev. 0

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The size of the area suggests there would be no difficulty in establishing an appropriate buffer area between a land application facility and residential properties. Several water-related factors, however, suggest that caution would be needed in siting and operating a land application facility in this area.

- Aquifer 417 underlies the general area;
- Community and private wells and springs within the aquifer area are water supply sources; and
- Adjacent greenway lands are dotted with surface water ponds and springs.

4.3.2. Groundwater Quality Protection

Past study reports conducted on behalf of the following agencies and organizations describe groundwater conditions and uses in the area.

- Regional District:
  - Pigeon Lake Regional Landfill Hydrogeological Investigations extending back to 1995;
  - Aquifer Classification Mapping Project Report, May 2000,
- Comox Economic Development Society:
  - Environmental and Geotechnical Site Assessment, Bevan Road Value-Added Forestry Industrial Village, Cumberland, BC.
- Comox Valley Project Watershed Society:
  - Morrison Creek Headwaters – Sensitive Habitat Inventory & Mapping Report 2003
- Trilogy Properties Corporation:
  - Levelton Consultants Ltd. August 17, 2009; Results of Groundwater Exploration Program, Trilogy Properties, Cumberland ,BC
  - Installation and capacity testing of Exploration Well W09-1 on Lot 11, Minto Road, April 2009.
- Coal Valley Estates Joint Ventures:
  - EBA Engineering Consultants Ltd. August 25, 2010; Installation and Capacity Testing of Water Supply Well 19349, Bevan Road, Cumberland, BC; August 2010.

Generally the area is underlain with an unconfined aquifer with variable depths of unsaturated soil. The data suggests that there are extensive areas with unsaturated depths greater than 3 m. Wells and springs in the area are used as water sources and under these conditions Schedule 4 of the MSR requires ground application sites with setbacks of 300 m or more.

Detailed consideration and costing of land application options if warranted will require identification of candidate areas through site screening and field assessments.

4.4 Areas Adjacent to Existing Treatment Works

Areas adjacent to the existing treatment works have been extensively studied to assess the environment impacts of constructing and operating a constructed treatment wetland (CTW) on the site. CTWs were identified in the Stage 1 as a treatment option and identified as the recommended treatment method in the January 2003 Stage 2 Report. The supporting environmental assessments include:

- Canadian Wildlife Service, Ron Buechert, Ground-truthing, Delineation and Conservation Evaluation of Part Sensitive Ecosystem Polygon #65003, Cumberland, July 2001.
- Mimulus Biological Consultants (MBC), Environmental Assessment of the Proposed Cumberland Constructed Treatment Wetlands and Sewage Discharge, November 2001.

MBC and McElhanney conducted additional environmental site investigations further to the Stage 2 Report recommendations related to the proposed CTW.

- McElhanney Consulting Services Ltd.; Design of Treatment System Improvements Including a Constructed Treatment Wetland, Preliminary Engineering Report, October 31, 2006
- Mimulus Biological Consultants, Rare Species Assessment of the Proposed Cumberland Constructed Treatment Wetland, September 25, 2008.

4.4.1. Plants and Wildlife

The plant communities were identified and mapped. No rare or threatened plant species were located during the survey. Fourteen plant community types were identified and five of the classified site series were considered rare or threatened based on the Conservation Data Center information. Much of the area was found to be heavily impacted by earlier agricultural uses including market gardens and hay fields and these areas were assessed as having little or no value for preservation.

The rare species assessment confirmed that:

- Four amphibian species are present on the site (Red-legged frogs (Blue listed), Pacific Treefrogs, Rough-skinned Newts and Northwester Salamanders).
- The Vancouver Island water shrew (*Sorex palustris brooksi*) and the Keen's myotis (*Myotis keenii*) are provincially Red-listed species in BC and are potential residents of the Cumberland Wastewater Treatment Wetlands area; and
- The area is a highly productive site for breeding birds (especially songbirds), but is not a critical site for Red or Blue-listed bird species.

4.4.2. Sensitive Ecosystem

The fen/bog area west of Maple Lake Creek was identified as the area with the highest sensitivity and environmental value. As noted earlier, five of the classified site series were considered rare or threatened. These plant communities are based on a wet fen regime and the assessments highlighted the importance of avoiding groundwater disturbances in these areas. Preliminary Engineering investigations identified the groundwater and soil conditions within and adjacent to this fen/bog area.

4.5 General Summary

Three candidate receiving environments are identified on the basis of the above review of potential options:

- Maple Lake Creek/Trent River system either on:
    - A full-year discharge basis where during the May1 to September period, the major challenge will be treatment that reliably limits phosphorus levels receiving waters to less than 5 µg/L, and otherwise meets the provincial quality standards for reclaimed water with unrestricted access; or
    - A seasonal basis where discharge to Maple Lake Creek would be limited to the October 1 to April 30 period and an alternate discharge site would be required for the summer period.
- An unidentified ground application site in designated industrial/working forest land-use areas north of the Residential Growth Boundary of the Historic Village; and
- One of three possible ocean discharges that preliminary studies conducted on behalf of the regional district located and identified as North end of Baynes Sound, Strait of Georgia northeast of Sandy Island, and the existing Cape Lazo Outfall.

Completion of environmental assessments of the area immediately adjacent to Cumberland's existing treatment works and the associated findings suggest that construction and operation of a CTW as previously proposed could be accommodated on this site.

*4.6 **Recommendations –** Remains blank until after MOE review of 1rst Draft*

4.6.1. Receiving Environment

4.6.2. Construction Area

5. Alternative Treatment and Disposal Options

5.1 Introduction

The intent of environmental assessments is to define effluent quality requirements specific to a receiving environment, and these requirements essentially dictate the level of treatment. In the context of option assessments, effluent quality and disposal options consequently, are linked and not amenable to separate consideration. A number of treatment options may be able to meet required effluent quality standards and selection of a preferred option is a level of refinement beyond this initial screening.

Through earlier assessments and public consultations back to 2001, the community identified a preferred treatment and disposal system. That preferred system consisted of a proposed 10 ha CTW, the existing lagoon system and a physical/chemical plant for supplemental phosphorus removal. The system would continue to be discharged to Maple Lake Creek on a year-round basis and produce effluent of reclaimed water quality through the May 1^{rst} to September 30th period. Design received funding under the Canada/British Columbia Infrastructure Program (CBCIP Project No. 7762) and advanced to the functional design stage. Construction received funding allocation under the British Columbia Water Improvement Program (BCCWIP Project 4055).

This earlier system was based on a serviced population of 5000, which as previously noted represented a design horizon of 25 years at the time. Actual and projected population growth increased after the 2004 OCP to levels where MOE required re-assessment of the plan. McElhanney prepared a Supplemental Report (Version 1) in 2007-2008 that presented revised population growth and design flow projections. The report assessed the relative merits and costs of two options: one with the CTW and supplemental mechanical treatment, and the other was a larger, high-rate mechanical treatment system sized to process all wastewater flows. That report was unable to address Regional options adequately because of the lack of available information at the time. Regional studies were being planned, and given MOE concern that the Supplementary report had not fully explored this option, design of the CTW-based system was halted and BCCWIP funds were re-allocated to sewer separation program and CTW pilot studies.

Several regional studies now completed enable re-assessment of treatment and disposal options. This re-assessment includes the following considerations among others.

- The serviced population equivalent (most-probable projection) for a design horizon of 25 years is now 12,000 persons as opposed to the 5,000 previously used for design.
- Effluent quality for discharges to the Maple Lake Creek/Trent River system are now more stringent, particularly in relation to phosphorus concentrations;
- The expanded Village development boundaries encompass some new areas where potential sites may be available and appropriate for ground application of treated effluent; and

- The CVRD Sanitary Sewer Master Plan Update Study identified a South Regional Wastewater Treatment Plant within a preferred management strategy and the Regional District is encouraging Cumberland to participate in this option.

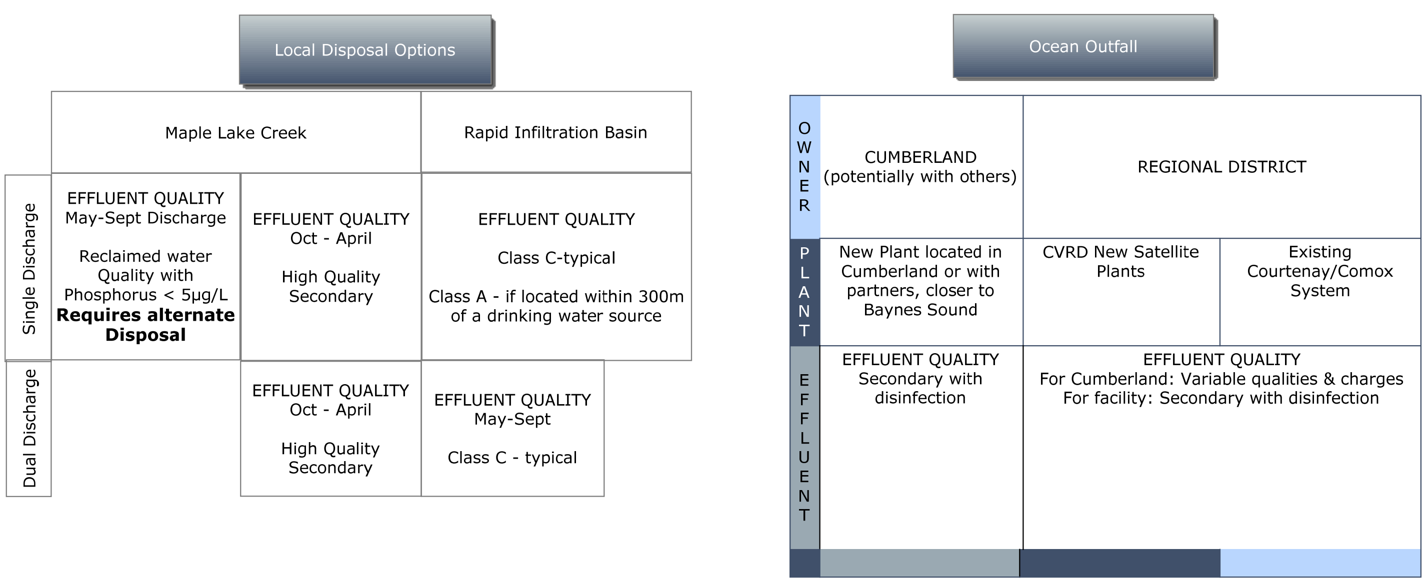
5.2 Broad Categories of the Alternatives

Alternatives can be divided into two broad categories; Local Disposal Options, where treated effluent discharges would be to receiving environments located within the boundaries of Cumberland, and with Perseverance/Comox Lake no longer considered potential receiving waters, any other option would have an ocean outfall.

Maple Lake Creek and unspecified ground application sites are potential receiving environments for local disposal options. McElhanney uses rapid infiltrations basins (RIBs) to represent ground application in the balance of the option screening discussions. RIBs are a cost-effective ground application option that the Municipal Sewerage Regulation recognizes as an appropriate disposal method for suitable sites. Although a conceptual layout of a simple RIB system is used for costing comparisons, forest irrigation and other uses of treated effluent are potential IRR enhancements with this type of system.

Options within the Ocean Outfall category with appropriate partnerships potentially could be attractive. Figure 5.1 illustrates through a matrix the next level of system options available given the above list of receiving environments and the required levels of treatment associated with each. The restrictions on discharges.to Maple lake Creek could vary seasonally creating the possibility of dual discharge arrangements; one discharge used during the summer months and another during the October to April period.

Figure 5.1 Matrix of System Options



The receiving environment dictates required treatment levels and the matrix shows those requirements relative to other potential options. Discharging to the Maple Lake Creek/Trent River (MLC) system during the summer months would require the highest levels of treatment. Lower levels of treatment during the winter months are possible based on higher dilution ratios and discharges of lower quality effluent to MLC. The same treatment facility under the MSR must have the capability of diverting summer discharges from MLC to either a ground application (RIB) site or to an Ocean Outfall.

Options outlined in the Ocean Outfall matrix show a number of possibilities for Cumberland with respect to leadership or participation. Some form of partnership would be essential for Cumberland to seriously consider an ocean outfall option. Wastewater treatment and disposal facilities currently being considered in the CVRD South Regional Sewage System Collection, Treatment and Discharge Study are considered appropriate for comparison purposes. Cumberland participates in the study on two levels. At the Stakeholder level it provides input of Cumberland's issues and concerns to the study and reviews the findings, conclusions and recommendations. Cumberland on another level is exchanging information with the study team to facilitate early completion of both the regional study and this portion of the LWMP.

5.3 First–Level Listing of Wastewater Treatment & Disposal Options

The broad-category options identified in Figure 5.1 provide a basis for the initial listing of potential wastewater treatment and disposal systems. The following discussion uses the same framework to identify and describe the Local Disposal and Ocean Outfall options.

5.3.1. Local Disposal Options

Placement of the treatment facilities within the boundaries of the Village applies to all "local" options. Discharge Locations for treated effluent could vary, being to Maple Lake Creek, an unspecified RIB site, an ocean outfall through connection to a regional facility, or based on seasonal discharge options some combination of these three potential discharge sites. Treatment levels are linked to the receiving environment, but another set of options is generated when treatment methods are taken into consideration. In the context of treatment methods, CTW options are of particular importance given earlier interest and support that the community expressed for this type of facility. Sequencing batch reactors (SBR) were selected for discussion and costing purposes as a more generic biological process with relatively high nutrient removal capabilities. Phosphorus removal required for discharges to Maple Lake Creek, however, is greater than any biological process typically can achieve so active filtration, a physical/chemical process, was adopted for costing purposes.

MLC Discharge Options

Certain conditions apply for MLC discharges based on the findings of earlier environmental impact assessments and Provincial standards set by the Municipal Sewage Regulation (MSR).

Year-round discharges – Lack of dilution during the summer months defines the effluent quality and treatment requirements. Summer discharges must meet reclaimed water quality (Class A) applicable to unrestricted access, and the treatment process must include supplemental phosphorus removal.

Alternate disposal provisions are required under the MSR for treatment systems designed to achieve effluent of reclaimed water quality. Alternate systems for a MLC summer discharge potentially could include a CTW (Subject to confirmation in the current MSR review process), ground application (RIB) at some as yet unspecified location, or to an ocean outfall through connection to a currently undefined regional sewage collection and treatment system. Table 5.1 summarizes the effluent quality and management requirements associated with each of these alternate disposal options.

Winter discharges to MLC would apply in all three cases with no distinction made on the basis of the option selected for management of summer flows. Given higher available dilution ratios and less stringent phosphorus limits, lower treatment costs and a lower standard of effluent would be anticipated for these winter discharges.

Table 5.1 Alternate Disposal Options
With Summer Discharges to Maple Lake Creek

A) CTW	Relies on the ability of the CTW to boost effluent quality to the Class A standard and/or provide adequate storage capacity. Storage capacity requirements vary with the treatment provisions (e.g. firm capacity and filtration)
B) RIB (to ground)	RIB typically will require Class C – 45/45 unless near well then Class A – 10/10; disinfection; turbidity and nitrogen monitoring are required. The main treatment system would almost with certainty be able to achieve this lower effluent standard when alternate disposal was required.
C) Regional (Ocean Outfall)	Effluent quality is likely to be 45/45 with disinfection

Ground Application Options

2 -A Year-round RIB discharges:

This option requires transfer and disposal facilities but avoids the additional costs and treatment redundancy associated with summer discharges to MLC. Treatment of the effluent to reclaimed water quality would not normally apply to ground application systems.

2 -B Combined MLC and RIB discharges that exclude MLC summer discharges.

As for 2-A, but a smaller RIB system given design based on lower summer flows. Operating costs would be lower given elimination of the sewage transfer costs during the October to April period.

Ocean Outfall Options

Figure 5.1 shows three treatment plant options. A new satellite plant sized for local service areas is the most likely scenario. Ownership as a consideration has potential significance only in terms of timing and protection of one's interests. Physically there would be very little difference between a Cumberland plant designed on the basis of new partnerships and a new Regional District satellite plant. Uncertainty with respect to the timing of a regional option was a concern in the earlier stages of the LWMP process. Timing associated with this option is clearer. The Regional District identified a new South Regional plant as the preferred option to expanding the existing central treatment facility (Memo #3). Implementation advantages were primary reasons for giving the satellite plant a higher ranking as an option. Further, the Regional District is currently conducting the required pre-design studies and reports for a new South Regional plant. The Regional District is seeking Cumberland's participation in these investigations as a potential Stakeholder. If as a result of the study findings, the Regional District makes funding applications to senior governments for new treatment and disposal facilities, then they would seek Cumberland commitments to participate in funding the construction and operation of those facilities.

Section 4.2 highlighted earlier studies where three different outfall arrangements were considered. Environmental concerns and applicable effluent quality standards were not fully defined for the two new outfall locations. The other discharge option was to connect to the existing Cape Lazo Outfall which the Comox Valley Water Pollution Control Centre (CVWPCC) currently uses for effluent discharges. Monitoring of the discharge area in 1986 confirmed no significant environmental impacts since the beginning of operations.

5.3.2. Summary List of Options

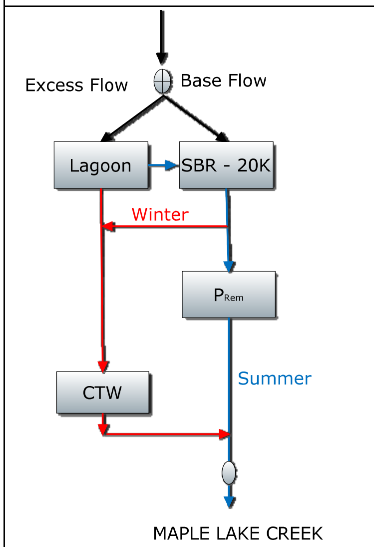
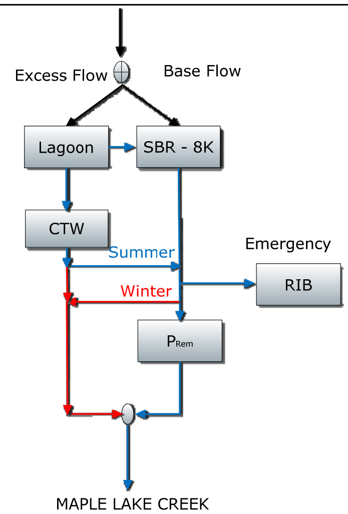
Table 5.2 summarizes these six options for treatment and disposal and Figure 5.2 graphically illustrates the same options.

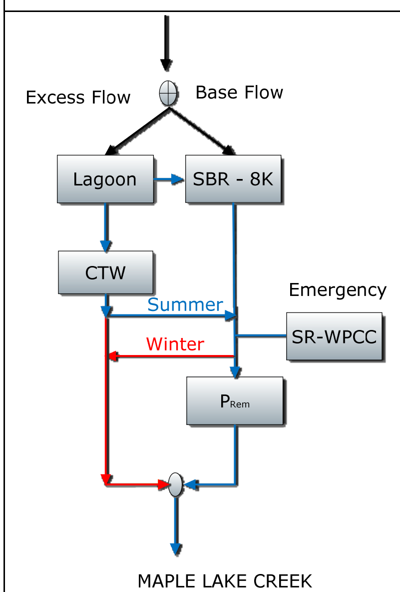
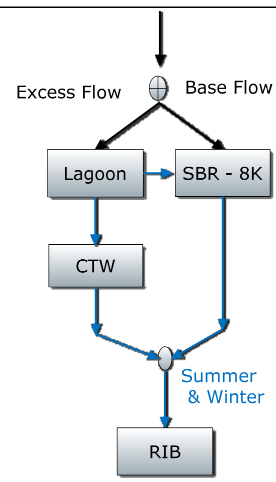
These descriptions are the first-level definition of options. Refinements occur later in the assessment process and they include consideration of wet weather flows (WWFs), choice of treatment processes with their potential opportunities for Integrated Resource Recovery (IRR) strategies, and possibly further revisions to the projected serviced populations.

Table 5.2 Descriptions of the First-Level Options

Designation	Discharge Arrangements	Major System Elements
1 -A	Summer flow discharges to MLC and Alternate Disposal is a CTW.	New - Lift station, SBR, active filtration (P-removal), PH adjustment, and UV disinfection. Lagoon – flow balancing and primary treatment of excess flows CTW – new, limited use as a backup treatment facility.
1 –B	Summer flow discharges to MLC and Alternate Disposal is a RIB.	New - Lift station, SBR or SBR/CTW combination, active filtration (P-removal), PH adjustment, and UV disinfection. Lagoon – flow balancing, primary treatment of excess flows New RIB Alternate – pumping station, forcemain and ground application site; all sized for projected summer flows.
1 -C	Summer flow discharges to MLC and Alternate Disposal is an Ocean Outfall.	New - Lift station, SBR or SBR/CTW combination, active filtration (P-removal), PH adjustment, and UV disinfection. Lagoon – flow balancing and primary treatment of excess flows New Ocean Outfall Alternate – pumping station, forcemain, gravity sewer; access to ocean outfall; all sized for projected summer flows.
2 -A	Year-round discharges to a RIB	New – Low-lift pumping station, SBR or SBR/CTW combination, high-lift pumping station, forcemain, and ground application site; all sized for projected buffered wet weather flows. Lagoon – flow balancing and primary treatment of excess flows.
2 -B	Summer flow discharges to RIB and winter discharge to MCL.	New – Low-lift pumping station, SBR or SBR/CTW combination, high-lift pumping station, forcemain, and ground application site; all sized for projected summer flows. Lagoon – flow balancing and primary treatment of excess flows.
3	Year-round discharge to South Regional STP	New – Low-lift pumping station, forcemain, and gravity sewer; all sized for projected buffered wet weather flows. Lagoon – flow balancing and primary treatment of excess flows. Joint facilities – new treatment plant, pumping station and forcemain connection to the Cape Lazo Outfall at the CVWPCC.

Figure 5.2 - System Schematics & Major Elements

OPTION 1 -A		OPTION 1 -B	
	Major Components • Low- lift Station • SBR (20^K) • P_{rem} (Active Filtration) • Lagoon • CTW (10 ha) • UV Disinfection		Major Components • Low Lift Station • SBR (8K) • CTW (10 ha) • Prem (Active Filtration) • Lagoon • UV Disinfection • RIB o Pumping Station o Forcemain (3.5 km) o Land Application Site (12 ha)

		OPTION 2 -A	
	Major Components • Low- lift Station • SBR (8^K) • CTW (10 ha) • P_{rem} (Active Filtration) • Lagoon • UV Disinfection • SR-WPCC o Pumping Station o Forcemain (1.1 km) o Gravity Sewer (4.8 km) o Treatment Plant (48.6^K) o Ocean Outfall		Major Components • Low Lift Station • SBR (8^K) • Lagoon • CTW (10 ha) • RIB o Pumping Station o Forcemain (3.5 km) o Land Application Site (20 ha)

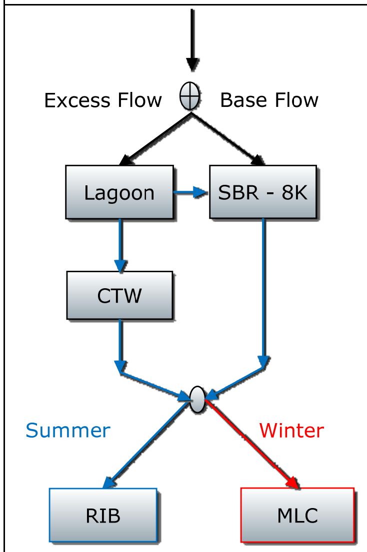
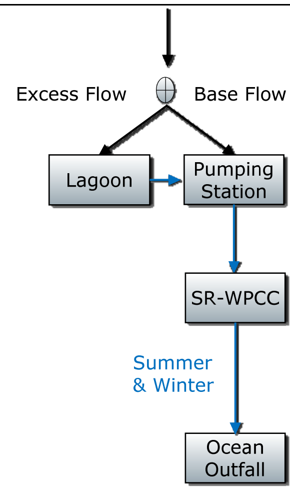
OPTION 2 -B		OPTION 3	
	Major Components • Low Lift Station • SBR (8K) • Lagoon • CTW (10 ha) • RIB o Pumping Station o Forcemain (3.5 km) o Land Application Site (12 ha)		Major Components • Pumping Station • Lagoon • Forcemain (1.1 km) • Gravity Sewer (4.75 km) • SR-WPCC o SBR (48.6K) o Effluent Pumping Station • Ocean Outfall

Figure 5.2 cont'd

5.4 Discharge Implications

Assessment of the first-level options begins with indentifying the implications associated with treated effluent discharges to each of the potential receiving environments discussed earlier. Table 5.3 groups options on the basis of their receiving environments and identifies specific advantages and disadvantages related to the sensitivity of that environment. The assessment then extends to the advantages and disadvantages of treatment processes and implementation planning issues associated with the system options for each receiving environment.

Table 5.3 - First-Level Options - Advantages and Disadvantages

	Pros	Cons
MLC Summer Discharges (Options 1 –A, 1 –B and 1 –C)	No/low effluent transfer costs	Highly sensitive receiving environment
	Relatively short lag time to design (a matter of months)	Other users of the receiving waters
	Effluent quality provides numerous IRR opportunities e.g. low summer flow, augmentation, irrigation etc.	High treatment levels with associated greater process complexity, higher level operator and facility certifications; greater monitoring and
		The need to construct and maintain an alternate disposal system
MLC Winter Discharges (Option 2 –B)	Low effluent transfer costs	Other users of the receiving waters
	Moderate treatment levels and costs using conventional processes	Requires access to a second discharge/disposal site
CTW (Option 1 –A)	An amenity with strong community support	Long phase-in period to achieve acceptable treatment levels
	High buffering treatment and hydraulic capacity	Significant level of uncertainty with respect to construction and O&M
	Low operating and maintenance skill levels and costs	Capacity limited by the available space consequently, not a stand-alone solution
RIB (Option 2 –A)	Receiving environment is not overly susceptible to damage	Undefined location (assumptions needed)
	Moderate treatment levels and costs using conventional processes	Lag time of a year or more to detailed design
	Potential opportunity for a joint facility with the Regional Landfill	
South Regional WPCC (Option 3)	Greater economies of Scale	Requires additional partners
	Availability of Operators	Lag time of three years or more
	Minimizes dedicated lands	Subject to outside influences

5.5 Initial Cost Comparisons

Costs are an important consideration in assessing and screening options. At this stage in the assessment, systems are coarsely defined and are sized based upon projected serviced populations and treatment levels; consequently costing is indicative (Class D Estimates) and for comparison purposes only. The costs are based on earlier estimates of similar facilities and on generalized cost curves. Referenced costing data are time-adjusted using the Engineering News Record (ENR) Construction Cost Index (CCI) to approximate current costs.

Cost projections are based on the Regional SSMP design year of 2058 for comparisons purposes. Comparisons of total cost include capital costs and net present values (NPV) of projected operation and maintenance costs for the treatment and conveyance systems of each option. NPV calculations include a 5% per annum discount rate.

Treatment & Disposal

Four treatment scenarios were assessed as Local Discharge Options. All four include SBRs and a CTW.

Option 1 –A assumes that a single SBR facility provides full secondary treatment and the CTW serves solely as the alternate backup system.

Options 1 –B, and 1 –C have the same effluent quality standards as 1 –A, and the secondary treatment processes is a single SBR facility identical to option 1 –A, or a combination CTW/SBR facility.

Options 2 –A, 2 –B and 3 have lower effluent quality standards than 1 –A, the secondary treatment processes similar to the options immediately above, is either a single SBR facility, or a combined CTW/SBR facility.

The CTW size is limited by site boundaries to approximately 10 ha of total cell surface area. The CTW in Option 1 –A if acceptable to MOE would provide as the Alternate System, a combination of treatment and storage. For all other options where the CTW is used, its capacity corresponds to a serviced population equivalent of approximately 12,000 people based on achieving effluent BOD_5/TSS quality of 30/30 mg/L. The capital cost of the CTW is estimated at $5.8 M (in 2010 dollars) based on McElhanney's 2006 functional design, subsequent findings of the CTW pilot project, and costing escalations derived from the ENR CCI

The design year, 2058, corresponds to a 20,100-person population equivalent for the serviced area based on the Section 2.3 "most-probable" projection. If the CTW capacity was fully utilized in a combined CTW/SBR facility, the SBR must have the capacity to service a population equivalent of 8,100 persons. The two different sized SBRs have estimated capital costs of $10.3 M and $16.7 M as derived with the CCME, August 2006, Wastewater Treatment and Collection System Costing Templates, and applicable ENR CCI costing escalations. The difference in capital costs between the CTW/SBR combination ($5.8+$10.3 = $16.1 M) and the single SBR is less than 5%. These two secondary treatment options have essentially the same capital costs. These assessments are based on comparative costs only; the CCME costing templates do not include all costs. For example, inlet pumping stations, biosolids handling and treatment facilities, site access and land purchase are excluded costs.

Local disposal options would incur additional treatment costs.

- Tertiary treatment for phosphorus removal applies to all MLC summer discharge options (1 –A, -B, and –C). Basing the size and costing on the active filtration system from Blue Water Technologies, this process has an estimated capital cost of $2.6 M installed.
- Land application sites and facilities for Options1 –B and 2 -B are identical with a design based on summer flows and an estimated capital cost of $1.7 M. Average annual flows (AAF) are the basis for sizing the Option 2 –A facilities, and the corresponding estimate for capital cost is $2.2 M.
- Yardworks, lagoon modifications, an Operations Building, electrical upgrades including standby power, disinfection and flow metering are base items applicable to all local treatment facilities with an estimated capital cost of $3.9 M.

The Regional or Ocean Outfall Option (Option 3) would be sized on a serviced population equivalent of 48,600 persons using the same design horizon and CVSSMP projections. Treatment capacity to produce effluent of secondary quality (45/45) is required for costing purposes and the discharge is assumed to be connected to the Cape Lazo Outfall. Estimated costs are $31.2 M for the plant and $2.3 M for the outfall connection. This estimate for the plant is derived from the CCME costing template with an allowance of $5 M for base items. The outfall connection estimate is derived from the earlier estimate of $1.82 M[10] and application of ENR CCI index values. The Cumberland proportion of the South Regional treatment plant and outfall if based on serviced population would be in the order of $13.8 M. In addition, some modifications to the lagoon site would be required and an allowance of $1.0 M is made for that purpose.

Costs noted above are comparative capital costs and total cost comparisons include NPV estimates of treatment plant operating and maintenance (O&M) costs. Most NPV estimates in this assessment are derived from annual O&M figures the CCME costing template generates. Separate estimates were derived for the CTW, phosphorus removal facilities and RIBs from the technical literature and supplier information.

Table 5.4. First-Level Options - Estimated Treatment Costs

		Capital Cost ($M)	O&M Costs NPV ($M)	Total Costs ($M)
1 -A	Summer flow discharges to MLC and Alternate Disposal is a CTW.	29.0	18.9	47.9
1 –B	Summer flow discharges to MLC and Alternate Disposal is a RIB.	24.3	15.3	39.6

[10] 2005 Royston/Union Bay Sewage Collection Treatment & Discharge Study

		Capital Cost ($M)	O&M Costs NPV ($M)	Total Costs ($M)
1 -C	Summer flow discharges to MLC and Alternate Disposal is an Ocean Outfall.	22.6	13.7	36.3
2 -A	Year-round discharges to a RIB	22.2	11.4	33.6
2 -B	Summer flow discharges to RIB and winter discharge to MCL.	21.7	10.9	32.6
3	Year-round discharge to South Regional STP	14.9	8.1	23.0

Conveyance

All options with the exception of 1 –A, have significant conveyance as well as treatment costs. Conveyance is either to a Land Application site (Options 1 –B; 2 –A and 2 –B) or to the proposed South Regional Treatment Plant (Options 1 –C and 3). Both conveyance systems require pumping stations and forcemains and for this stage of the assessment, design flows would be the same (1.5 times ADWF).

Table 5.5 - First-Level Options - Estimated Conveyance Costs

		Capital Cost ($M)	O&M Costs NPV ($M)	Total Costs ($M)
1 -A	Summer flow discharges to MLC and Alternate Disposal is a CTW.	-	-	-
1 –B	Summer flow discharges to MLC and Alternate Disposal is a RIB.	3.0	1.2	4.2
1 -C	Summer flow discharges to MLC and Alternate Disposal is an Ocean Outfall.	4.5	0.9	5.4
2 -A	Year-round discharges to a RIB	3.0	1.4	4.4
2 -B	Summer flow discharges to RIB and winter discharge to MCL.	3.0	1.2	4.2
3	Year-round discharge to South Regional STP	4.5	1.2	5.7

Table 5.6 - First-Level Options – Comparative Total Costs

		Capital Cost ($M)	O&M Costs NPV ($M)	Total Costs ($M)
1 -A	Summer flow discharges to MLC and Alternate Disposal is a CTW.	29.0	18.9	47.9
1 –B	Summer flow discharges to MLC and Alternate Disposal is a RIB.	27.3	16.5	43.8
1 -C	Summer flow discharges to MLC and Alternate Disposal is an Ocean Outfall.	27.1	14.6	41.7
2 -A	Year-round discharges to a RIB	25.2	12.8	38.0
2 -B	Summer flow discharges to RIB and winter discharge to MCL.	24.7	12.1	36.8
3	Year-round discharge to South Regional STP	19.4	9.3	28.7

5.6 Discussion of First-Level Options

<u>CTW – Based Options</u>

The role the CTW as an integral part of the community greenway area would be best served through Option 1 -A where it would provide the emergency storage requirements outlined in Section 10 of the MSR and potentially meets new provisions for alternate disposal under pending revisions to that regulation.

The CTW as a primary element of the treatment process (Options 1 –B –C 2 –A and 2 –B) would:

- Provide large buffering capacity for variations in sewage flow and strength.
- Reduce biosolid volumes through in-cell digestion with corresponding savings in capital and O&M costs of stabilizing, dewatering and disposal systems.
- Provide secondary-level treatment capacity for roughly half the sewage generation projected for the design period.
- Have access restrictions inconsistent with typical public green spaces due to health-related concerns.

Implementing CTW-based options has:

- Timing issues related to summer construction and growth of the aquatic plants to be fully-functional;
- Uncertainties with respect to some costs of construction. The number of potential contactors with required peat construction experience is small and the potential for mishaps during construction is relatively high.
- Uncertainties with respect to maintenance time and costs during the first few years of operation to address settlement. Settlement is to be expected as the underlying peat consolidates under the weights of the new berms and the contents of the cells.

Any CTW-based option also requires at least one mechanical plant; initially for supplemental phosphorus removal if summer discharges are to Maple Lake Creek. All options require treatment capacity in addition to the CTW to meet projected sewage flows for the design period. This mechanical treatment plant capacity potentially could be added as second phase of construction.

Mechanical plants have some advantages over CTWs and they include: shorter implementation periods; and greater operator control which could be considered an advantage or disadvantage depending upon the range of influent conditions, type of plant, and the level of operator training and competence.

<u>RIB – Based Options</u>

Potentially RIB options could be more cost-effective than any option that relies on summer discharges to MLC. Other positive features include:

- Potential use of a CTW as an element in the treatment process; and
- Potential opportunities for:
  - A joint arrangement with the Regional Landfill to construct and operated the RIB; and
  - Forestland irrigation.

Uncertainties exist in relation to implementing a RIB-based option.

- Length and size of the sewage/treated effluent conveyance system to the land application site. A 3.5 km, 300 mm diameter forcemain was assumed for initial costing purposes. This sizing assumes flow-balancing at the existing lagoon site to restrict wet-weather flows to 9,000 m^3/d;
- Locations of any specific sites that are available and any associated environmental issues related to their use for this purpose;
- Given the site location issues, timing of design and construction are uncertain; and
- Details of any potential partnership arrangements.

Regional or Ocean Outfall Options

Regional options are potentially the most cost-effective and the current study and funding application address previous concerns with respect to timing.

Implementing a regional-based option has uncertainties related to:

- Details of any partnership arrangements in relation to funding structures,
  - Connections;
  - Flows; and
- Cost implications for owners and residents of Cumberland's existing and future properties.

5.7 *Wet Weather Flow Implications*

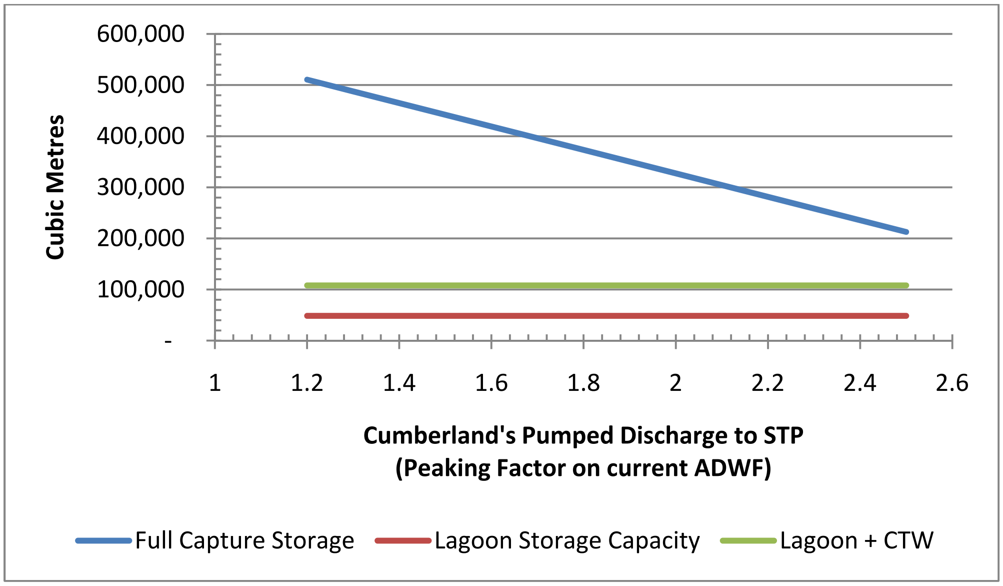
Conventional per capita flow allowances were the basis of the comparisons outlined above. Cumberland has a very large infiltration and inflow (I&I) flow component. Analysis of the wet-weather flow data indicates that if all discharge had to be routed through a treatment plant and a single outfall, either the required volumes of balancing storage would be massive or treatment and disposal facilities would be oversized by a large amount.

Excess wet-weather flow volume for the period October 1, 2009 to May 31, 2010 totaled 550,000 m^3. Excess wet-weather flow for purposes of this calculation is defined as any flow above ADWF (1,000 m^3/d). The volume of balancing storage required would depend on influent flow limits applied for the specific treatment plant. These influent flow limits are frequently defined applying a peaking factor to the ADWF. Figure 5.3 shows flow balancing volumes required for typical peaking factors used in the design of sewage treatment processes and plants.

Ignoring volumes lost in the capture of site runoff and in base level operations, the holding capacity of the existing lagoon being 48,600 m^3 is approximately 10% that required balancing storage volume for a treatment plant with a design flow 1.5 times current ADWF. Adding the CTW presented in McElhanney's 2006 functional design report would provide less than 25% of the required volume. The ability to accommodate on the existing site flow balancing facilities of larger capacity than the lagoon and CTW is very limited.

Further reference to Figure 5.3 shows that required balancing storage volumes decrease as treatment withdrawal rates increase. The graph suggests that at a withdrawal rate of 2.5 times ADWF the combined volumes of the lagoon and CTW would represent approximately half the balancing storage capacity required. Allowing for rainfall capture on site, the lagoon and CTW would provide less than half the required storage volume.

Figure 5.3 – Storage Required for Full Capture Of Excess Wet-Weather Flows



Reducing balancing storage capacity requires higher withdrawal rates. If balancing storage capacity was restricted to the existing lagoon, analysis indicates that a withdrawal rate of 4.5 times ADWF would be required. This estimate is based on wet-weather flows experienced December 23-27, 2010. If these flow relations were to persist, the hydraulic capacities of the treatment and conveyance systems would need to be increase by a factor of three over flow estimates used in comparison of the first level options.

The graph on Figure 3.6 shows in peak flow conditions will change with growth of the serviced population and with elimination of the combined sewers. The figure also suggests that if flow-balancing provisions are not made, the sewage conveyance system and downstream treatment and disposal facilities would have to accommodate flows up to 30 times Cumberland's current ADWF. This estimate applies to storm events with a return frequency of once in five years and to Cumberland's current level of sewer separation. Given these high peak flow multiples of ADWF, any reliable, cost-effective system will include flow-balancing facilities. Excluding flow balancing would raise a number of concerns.

- Wet-weather flows being highly variable, pose operational difficulties with processes in the downstream treatment plant,
- Installing large capacity systems to accommodate high, relatively short-duration, and infrequent flows:
    - Poses serious problems for operation of the conveyance system during dry-weather periods; and
    - Requires standby facilities of similar or larger size because peak flows being largely the result of uncontrollable rainfall events can exceed the design flow provisions.

Wet-weather flow options which include balancing storage for the reasons outlined above, fall within two broadly defined categories. Both categories incorporate Cumberland's existing lagoon system for flow-balancing and treatment. Treated effluent from the lagoon is conveyed then to either:

- A new treatment facility for further treatment and ultimate discharge to the associated receiving environment (MLC, RIB site or Ocean Outfall), or
- A new CTW for further treatment and ultimate discharge to MLC.

The following discussion superimposes these wet-weather flow considerations on the previously defined first-level options.

Option 1 –A

This option already uses the CTW as the alternate disposal for a reclaimed water system discharging to MLC during the May 1^rst^ to Sept 30^th^ period. Treatment of excess wet-weather flow is a reasonable role for the CTW during the October 1^rst^ to April 30^th^ period. Reasonable expectations with this type of system operating under wet-weather flow conditions are that:

- The system would reliably meet applicable MSR regulations and effluent quality objectives,
- The seasonal shift in the role of the CTW would have minimal additional costs.
- Conveyance costs to discharge to MLC would be minimal.

Excess wet-weather flows are projected to decrease over the next 15 years with implementation of the sewer separation. Option 1 –A as is provides an effective means of addressing these interim excess wet-weather flows. CTW physical and biological processes are well suited to treat these excess flows. As the sewer separation advances, the winter role of the CTW potentially could change to treatment of storm runoff.

Option 1 –B

The same wet-weather management capabilities and effluent quality possible with Option 1 –A are also achievable with this option by replacing the 8^K^SBR with the 20^K^SBR. Applying the assumptions that were used in the earlier comparative costing, this increase in plant size would raise the NPV costs approximately $11.6 M.

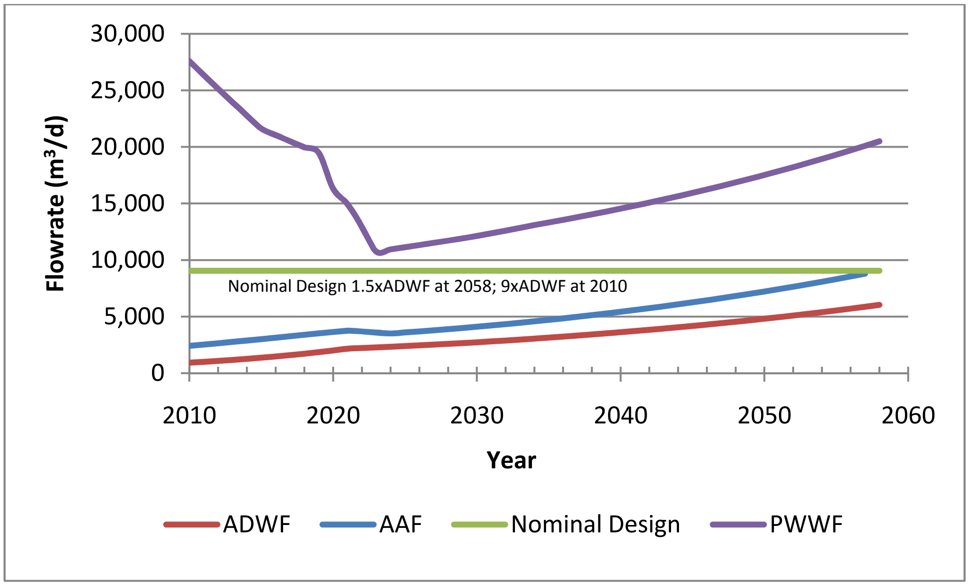
Similarly for Option 1 –C and Option 2 –B, this same SBR replacement achieves the same management capabilities and quality of discharges to MLC as Options 1 –A and 1 -B. Additional costs would be identical to Option 1 –B.

Option 2 –A

This option has a discharge to a land application site rather than MLC. Replacement of the 8^K^SBR with the 20^K^SBR is assumed to provide treatment capacity comparable to the 1 – B and 1 –C options. Conveyance capacity needs to be adjusted to wet weather flow conditions and the first step in estimating the increase is to determine the withdrawal rate consistent with the lagoon and CTW being used for flow balancing. Under present WWF conditions and no discharge to MLC, a withdrawal rate three times ADWF would be required based on an analysis similar to that shown in Figure 5.3. With flow-balancing provisions, the hydraulic capacity of the conveyance system included in the earlier 2 –B conceptual design could accommodate this higher flow during the early years of operation (Figure 5.4). The system capacity is based on 1.5 times the projected 2058 ADWF. If Cumberland failed to reduce the excess WWF volumes below present levels, increasing the pumping period and rate would be possible without increasing the size of the forcemain.

Estimated additional costs are $11.6 M for treatment, and increased conveyance costs would be in the cost of operation. Increased pumping costs are estimated to have a NPV of $0.25M.

Figure 5.4 - Capacity Versus Projected Flows



<u>Option 3</u>

A regional option of this nature typically provides treatment and disposal capacity up to 2 times ADWF, but un-buffered WWFs can be factors of 10 higher as previously noted. One option is to treat and discharge excess wet-weather flows to MLC. This is relatively easy to achieve at the existing lagoon site. A MLC discharge eliminates any need for additional conveyance capacity, and minimizes the flow-balancing and special piping configurations that would be required to manage wet-weather flows at the regional treatment plant.

If MLC was no longer available as receiving waters for treated WWFs, Cumberland's discharge to a regional plant while fully utilizing the flow-balancing capacity of the existing lagoon would be 4.5 times ADWF under present conditions. As Cumberland proceeds with its sewer separation programs a decrease in this multiple can be anticipated.

Options without MLC discharge would convey one of two types of wastewaters to the regional treatment plant: either

- A combination of treated and raw sewage in single or dual forcemains, or possibly
- Fully treated CTW effluent.

The two options outlined below encompass these possibilities.

Option 3 –A – *All wastewater conveyed to a Regional Plant*

Earlier assumptions for the regional plant cost allocations were based on Cumberland's proportion (41%) of the full population the facility serviced (48,600 persons by the year 2058). If all excess wet-weather flows were treated in the regional plant, Cumberland's portion of total plant flow would currently be in excess of 60%. Allocation of operating costs would be based on these annual flows. With implementation of the sewer separation program Cumberland's portion will gradually decline to the 41% level more representative of its serviced population.

Plant system design based on typical projected flows to 2058 would have adequate treatment capacity to process Cumberland's excess WWFs during the earlier years of plant operation. Capital costs attributed to WWF on this basis would be minor but could include additional flow balancing facilities at the plant.

Under a worst case scenario, Cumberland's current excess WWFs would continue and require plant expansion prior to 2058. The marginal cost to add 3,500 m^3/day of treatment capacity is in the order of $4.4 M. If this increase was attributed to the WWF, then Cumberland's first-level assessment estimate of $14.9M capital cost would increase to $19.3M. The more likely scenario is that Cumberland continues to reduce peak WWFs avoiding the need for an early expansion of capacity. Given the currently high WWFs Cumberland would pay a higher portion of the operating and maintenance costs during the initial years of plant operation.

Similarly a conveyance system designed for growth projected to 2058 could accommodate current WWFs for a period of time. Cumberland's continued sewer separation program and associated reductions in WWFs would avoid the need for additional hydraulic capacity within this design period. Pumping of WWFs would result in conveyance costs higher than the first –level assessment identified.

Estimated average annual cost to treat 550,000 m^3/year of excess WWF is $70,000. The associated NPV is $1.35M assuming that the WWFs are not reduced over the design period. Increased costs to convey WWFs between the Cumberland lagoon site and the regional plant are estimated to have a NPV of $0.2M.

Option 3 –B – *Flows up to 1.5 times ADWF to a Regional Plant and Excess WWF to MLC*

If separate treatment of excess wet-weather flows and winter discharges to MLC is permitted, the existing lagoon and the CTW previously proposed for the site could be used. Compared to first-level Option 3, the additional treatment cost would be the CTW and the conveyance costs would not change significantly.

Summary Tables

Table 5.7 – Wet-Weather Flow Management Implications On Treatment Processes & Comparative Costs

Option	Treatment Change	Capital Costs	O&M NPV Costs	Combined Costs
1 -A	None	None	None	None
1 -B	8^{K} SBR → 20^{K} SBR	$6.4 M	$5.2 M	$11.6 M
1 -C	8^{K} SBR → 20^{K} SBR	$6.4 M	$5.2 M	$11.6 M
2 -A	8^{K} SBR → 20^{K} SBR	$6.4 M	$5.2 M	$11.6 M
2 -B	8^{K} SBR → 20^{K} SBR	$6.4 M	$5.2 M	$11.6 M
3 -A	48.6^{K} SBR → 56.4^{K} SBR	$4.4 M	$1.4 M	$5.8 M
3 -B	+ CTW	$5.8 M	$1.0 M	$6.8 M

Table 5.8 – Wet-Weather Flow Management Implications On Conveyance Systems & Comparative Costs

Option	Conveyance Change	Capital Costs	O&M NPV Costs	Combined Costs
1 -A	None	None	None	None
1 -B	None	None	None	None
1 -C	None	None	None	None
2 -A	Extended pumping hours	None	$0.25 M	$0.25 M
2 -B	None	None	None	None
3 -A	Extended pumping hours	None	$0.20 M	$0.20 M
3 -B	None	None	None	None

Table 5.9 – Wet-Weather Flow Management Implications
On Total Comparative Costs

Option	Base System	WWF Addition	Combined Cost	Ranking Lowest to Highest Cost
1 -A	$47.9 M	None	$47.9 M	3
1 -B	$43.8 M	$11.6 M	$55.4 M	7
1 -C	$41.7 M	$11.6 M	$53.3 M	6
2 -A	$38.0 M	$11.9 M	$49.9 M	5
2 -B	$36.8 M	$11.6 M	$48.4 M	4
3 -A	$28.7 M	$6.0 M*	$34.7 M*	1
3 -B	$28.7 M	$6.8 M	$35.5 M	2

**Worst-case scenario where Cumberland does not reduce WWFs over time.*

The regional options (3 –A and 3 –B) have a comparative cost advantage in the order of $12M based on this analysis. The number of serviced lots in 2058 is projected to be approximately 7,800 and on that basis the cost advantage of regional solutions is in the order of $1,550 per lot.

5.1 Recommendations – *blank until after MOE review the First Draft and input from the TAC and PAC consultation process*

6. Proposed Treatment and Disposal System(s)

6.1 Design Criteria and Assessments

6.2 Projected Effluent Quality and Quantities

6.3 Draft Certification Certificate

6.3.1 Operational Standards

6.3.2 Monitoring and Reporting

6.4 Functional Design

6.5 Cost Estimates

7. Biosolids Management – *Only complete with MOE review of the Second Draft and input from the TAC and PAC consultation process*

ABBREVIATIONS

ADWF	Average Dry Weather Flow
AAF	Annual Average Flow
BOD_5	Biochemical Oxygen Demand
CIP	Capital Improvement Program
Cumberland	Village of Cumberland
CVRD	Comox Valley Regional District
CVRSSMP	Comox Valley Regional Sewer System Master Plan
d	day
DCC	Development Cost Charges
ha	hectares (1 ha = 10,000 m^2 = 2.47 acres)
I&I	Infiltration and Inflow
IRR	Integrated Resource Recovery
L	litres
LWMP	Liquid Waste Management Plan
m	metres
m/s	metres per second
m^2	square metres
m^3/d	cubic metres per day
McElhanney	McElhanney Consulting Services Ltd.
mm	millimetres
MMCD	Master Municipal Construction Documents
MOE	Ministry of Environment
MSR	Municipal Sewage Regulation, Environmental Management Act, British Columbia.
NH_3	Ammonia
NO_2	Nitrite
NO_3	Nitrate
OCP	Official Community Plan
PWWF	Peak Wet Weather Flow
Q	Flowrate
RIB	Rapid Infiltration Basin
RGS	Regional Growth Strategy
SSMP	Sanitary Sewer Master Plan
TSS	Total Suspended Solids
WWF	Wet-Weather flows

DEFINITIONS

Combined Sewers	Sewers that collect and transport a combination of municipal sewage and stormwater in a single system.
Cross-Connection	The inadvertent connection of a sewer service or private drainage system to the incorrect public sewer system. For example, a storm sewer service from a house that discharges to the sanitary sewer in the street rather than the storm sewer.
Dry Weather Flow	The flows in a sewer during dry weather.
Discharge	Flow from a sewer to another sewer, trunk, interceptor or lagoon.
Diurnal flow pattern	Typical hourly variation in flow throughout the day
Drainage	Interception and removal of groundwater or surface water by artificial or natural means.
Effluent	Outflow or discharge from a chamber or wastewater treatment facility.
Groundwater Table	The level at which the groundwater pressure is equal to atmospheric pressure; the 'surface' of the groundwater in a given vicinity.
Infiltration	Water entering a sewer system from the ground through such means as defective sewers, sewer joints, connections, or manhole walls.
Inflow	The entry of extraneous rainwater into a sanitary sewer system from sources other than infiltration, such as basement drains, roof leaders, manhole openings and storm drains. Inflow does not include and is distinguished from infiltration.
Influent	Inflow to a chamber or wastewater treatment facility.
Municipal Sewage	Domestic sewage, wastewater originating primarily from residences, but may include commercial, institutional and industrial sources and may include infiltration and inflow.
Overflow	The excess water that flows above the limits of the sewer, manhole, or containment structure and may result in flooding (see definition above).
Precipitation	Process by which water in liquid or solid state (rain, sleet, snow) is discharged out of the atmosphere to a land or water surface.
Population Equivalent	Equates sewage generation rates on land-use areas such as commercial, industrial etc to the per capita rates used in estimating sewage flows from residential.
Return Storm	A return storm defines a period that is an estimate of the interval of time between storm events of a certain intensity or size. It is a statistical measurement denoting the average recurrence interval over an extended period of time.
Runoff	That part of precipitation carried off from the area on which it falls.
Surcharge	When sewer flow exceeds the carrying capacity of the sewer line but does not necessarily flood above ground level.
Sewer Separation	Separating domestic sewage from other wastewaters and replacing the combined sewer in which they were discharged with a new sanitary sewer that discharges to the sewage collection system and lagoon, and a new connection to the storm drainage system.
Village Core	Areas west of the Island Highway that are currently developed within the Village of Cumberland.