Report #EWW 10-96

REPORT TO CORE AREA LIQUID WASTE MANAGEMENT COMMITTEE
MEETING OF WEDNESDAY 27 OCTOBER 2010

SUBJECT **ATTENUATION TANK IN SAANICH EAST–NORTH OAK BAY – CORE AREA WASTEWATER TREATMENT PROGRAM**

ISSUE

To report on the need for the attenuation tank, its proposed size, optimal location along the East Coast Interceptor (ECI) and options to address Oak Bay's combined sewers.

BACKGROUND

The Capital Regional District (CRD) has been analyzing the requirements for the ECI since the early 1980s. The 1986 ECI Design Memorandum by Kerr Wood Leidal (KWL) identifies the infrastructure upgrade requirements for the ECI to reduce the overflows to 1% of the total annual flow. The report predicted that at ultimate development, on average, there would be approximately 18 overflows per year at McMicking Point based on the infrastructure upgrades outlined in the report. The CRD continues to experience overflows every year at McMicking Point since the completion of the infrastructure upgrades.

When the Ministry of Environment (MOE) approved the Core Area Liquid Waste Management Plan (LWMP) in 2003, the design criteria for the ECI was changed to allow no overflows for a one-in-five year storm event. LWMP Amendment No. 4 (approved October 2005) included the provision for 18,000 cubic metres of storage (6,000 cubic metres initially) to be built in three phases, pending inflow and infiltration (I&I) growth. MOE also included a requirement for Oak Bay to separate the combined sewer systems for the Humber and Rutland catchment areas. The requirement for Oak Bay to separate the Humber and Rutland catchment areas has been confirmed by MOE a number of times.

The analysis to establish the infrastructure upgrading requirements to meet the new overflow criteria outlined above used flow data gathered from strategic locations throughout the ECI catchment area. Over the years, the CRD has continued to gather data to calibrate the sewage flow model and confirm the accuracy of the various flow meters.

CRD staff has previously identified two options to reduce the overflows along the ECI to a one-in-five year storm event: build larger infrastructure (i.e., pipes and pump stations) to convey the flows to Clover Point or build storage to attenuate the peak I&I flows. The analysis indicates that attenuating the peak I&I flows would be the most cost-effective solution and this was included in LWMP Amendment No. 4.

As part of the CRD on-going calibration program, a velocity profiling technology was recently used to measure the sewage flow in the ECI for the Saanich East catchment area. The results indicated that the Arbutus flume, as CRD staff suspected, was reading low. The velocity profiling technology recently measured the average dry weather flow (ADWF) at 10.3 million litres per day (ML/day), higher than previously measured ADWF of 8.8 ML/day and much closer to the engineer's theoretical flow calculations of 10.9 ML/day.

With the continued refinement of the sewage flow estimates, the hydraulic model has been calibrated with real data and has predicted outcomes of several storms with good accuracy. The attached report by KWL from 21 October 2010, *Core Area Wastewater Management Program – Determination of Storage Volumes along the East Coast Interceptor*, in Appendix A indicates that a 5,000 cubic metre attenuation tank is required to eliminate the ECI overflows to a one-in-five year event, assuming Oak Bay separates its combined sewers in the Rutland and Humber catchment areas. An additional 5,000 cubic metres will be required at ultimate build-out if I&I increases as experienced in other areas.

At its meeting of 13 October 2010, the Core Area Liquid Waste Management Committee requested staff to investigate the infrastructure requirements to eliminate sewer overflows to a one-in-five year event for the ECI, assuming that Oak Bay does not separate the Humber and Rutland catchment areas. The technical memorandum by KWL from 20 October 2010, *Core Area Wastewater Management - ECI Storage and Flows – Uplands Sewers Not Separated, Estimation of Wet Weather Flows and Detention Requirements* in Appendix B provides the results of that investigation. The options to comply with the MOE requirement to eliminate the one-in-five year overflows along the ECI and to address the Oak Bay combined sewer issue are as follows:

Option 1

A 5,000 cubic metre attenuation tank would be required upstream of the Penrhyn pump station and Oak Bay separates the combined sewer system in the Humber and Rutland catchment areas.

Option 2

A 700 cubic metre storage tank would be required at the Humber pump station, a 700 cubic metre storage tank at the Rutland pump station, an additional 6,000 cubic metres (total of 11,000 cubic metres) of storage at the Saanich East attenuation tank location, new forcemains and pump station upgrades for Humber and Rutland, and additional upgrades to the Currie pump station along with additional upgrades to the downstream forcemain and gravity sewer system.

Option 3

A 700 cubic metre storage tank would be required at the Humber pump station, a 700 cubic metre storage tank at the Rutland pump station, an additional 13,000 cubic metres (total of 18,000 cubic metres) of storage at the Saanich East attenuation tank and new forcemains and pump station upgrades for Humber and Rutland.

CRD has not completed a detailed evaluation to site an attenuation tank in the vicinity of the Humber and Rutland pump stations.

FINANCIAL IMPLICATIONS

The overall capital cost estimate of the Core Area Wastewater Treatment Program (CAWTP) for Option 1 will be reduced to $784 million from $791.2 million with the reduction in storage from 12,000 cubic metres to 5,000 cubic metres.

Option 2 will increase the capital cost estimate of the CAWTP by $23.5 million and includes two – 700 cubic metre attenuation tanks at $2.2 million each, an additional 6,000 cubic metres of storage at Saanich East at $6.6 million and conveyance upgrades at $12.5 million.

Option 3 will increase the capital cost estimate of the CAWTP by $25.2 million and includes two – 700 cubic metre attenuation tanks at $2.2 million each, an additional 13,000 cubic metres of storage at Saanich East at $13.5 million and conveyance upgrades at $7.3 million.

CRD staff believes that the additional $23.5 to 25 million to implement interim infrastructure for Oak Bay will not be cost shareable with senior levels of government. Oak Bay will still be required to develop a plan to separate the combined sewers in the two catchment areas of Humber and Rutland.
A public consultation program would need to be developed for each option and CRD staff would continue to work with Oak Bay and MOE to reach an acceptable short and long-term plan to separate the combined sewers in Oak Bay.

CONCLUSION

Based on the recent analysis by KWL, a 5,000 cubic metre attenuation tank is required to eliminate the ECI overflows to a one-in-five year storm event, assuming Oak Bay separates its combined sewers. The preferred location for the attenuation tank is near the ECI upstream of the Penrhyn pump station.

The 5,000 cubic metre tank currently proposed for the program at Saanich East will need to be increased to 11,000 or 18,000 cubic metres if Oak Bay does not separate the combined sewer systems in the Humber and Rutland catchment areas. In addition, other storage and conveyance upgrades will need to be implemented to meet the requirement to have no overflows along the ECI for a one-in-five year storm event.

The capital costs to address Oak Bay's combined sewer system with additional storage and conveyance upgrades will increase the CAWTP by at approximately $25 million. These additional costs will likely not be shareable with senior levels of government. Also, Oak Bay will still be required to develop a plan for separating the combined sewers in the Humber and Rutland sewer catchment areas.

RECOMMENDATION

That the Core Area Liquid Waste Management Committee receive this report for information.

Tony Brcic, PEng, Project Manager, Core Area Wastewater Treatment	J.A. (Jack) Hull, MBA, PEng General Manager, Integrated Water Services Concurrence

TB:hr
Attachments: 2

APPENDIX A

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Technical Memorandum

DATE: October 21, 2010

TO: Tony Brcic, P.Eng.

FROM: Jeff Howard, P.Eng.
Chris Johnston, P.Eng.

RE: **CORE AREA WASTEWATER MANAGEMENT PROGRAM** *DRAFT*
Determination of Storage Volumes along the East Coast Interceptor
Our File 283.315

Introduction

The purpose of this document is twofold:

- determine the storage volume required to optimize the conveyance of design flows along the East Coast Interceptor (ECI) and Northeast Trunk – Clover (NET-Clover)
- determine the optimal location of such a facility.

The analysis will build on the earlier analysis performed in 2003 as part of the *Northeast Trunk Sewer and East Coast Interceptor Sewer Upgrade Options Study, CRD, September 2004.* The previous study recommended that a 6,000 cubic metre tank be constructed in 2011-2012 then expanded to a 12,000 cubic metre facility in 2025.

Since 2003, considerable data has been collected on the performance of the ECI/NET system, and the impact of water efficiency programs such as low-flow fixtures. The purpose of this study is to utilize this data to refine the previous analysis and confirm the sizing of the proposed storage facility.

Regulatory Requirements

The current Liquid Waste Management Plan (LWMP) submitted to the Province by the CRD commits the CRD to intercept and convey all flows up to the 5-year storm through to the Clover Point Pumping Facility for marine locations along the East Coast of Greater Victoria. The combined sewer areas of the Uplands are excluded from this commitment as an additional commitment has been made to separate the sewers. All flows in excess of the 5-year storm will be permitted to discharge through approved overflow facilities at Finnerty Cove and McMicking Point. Previous overflow locations both inland or discharging to sensitive marine receiving waters will be upgraded to a 100-year return period level.

Approach to Analysis

The following data was received from the CRD to complete this analysis:

- Arbutus Flume Flow Data (August 1999 to May 2010);
- Level Data at Arbutus Overflow Chamber (August 1999 to February 2010), and;
- As-constructed drawings of the Arbutus Overflow Chamber (used in combination with the level data to calculate overflows).

The Arbutus Flume and Overflow Chamber are located at the upstream end of the ECI pressure siphon. This pressure siphon was analyzed in the *Assessment of ECI Pressure Siphon Capacity*[1]. A hydraulic model was created to analyze the upper sections of the ECI. This model examined the available capacity in the pressure siphon for the year 2045, 5-year storm event.

As part of the *Northeast Trunk Sewer and East Coast Interceptor Sewer Upgrade Options Study, CRD, September 2004,* a larger XP-SWMM model was created for the entire NET/ECI system. This 2004 XP-SWMM model was updated as part of the current analysis to reflect completion of Phase 1 of the study recommendations including the construction of the Trent Street Pump Station, Bowker Relief sewer, and Currie Twin sewer, and the Phase 2 improvements including the Trent siphon, Currie twin sewer, and Currie Road Pump Station to 1509 L/s.

The approach adopted for this study is to run the flows for the entire period of record through the upgraded model under both existing and future populations to determine the size of storage facility required to meet the regulatory requirements. Several scenarios will be developed and compared in order to determine the sensitivities over various assumptions.

Existing Operational Control of the NET/ECI

The NET/ECI system is controlled through a set of logic commands administered through the operations centre at Macaulay Point. Should rainfall events overwhelm the capacity of trunk sewer system, a series of commands are issued to protect residents from sewer backups and direct excess flows through controlled overflow locations in a priority sequence. This is done through a sequence of commands that reduce pumping capacity and close valves based on sewer levels obtained in the collection system.

[1] Kerr Wood Leidal Associates, Assessment of ECI Pressure Siphon Capacity, February 2004.

Currently, the main capacity-deficiency is in the NET-Clover section of the trunk sewer downstream of the Currie Road Pump Station. When trunk sewer levels reach critical levels, the Currie Pump Station is told to reduce its pumping rate. The pump stations in the combined sewer areas of Humber and Rutland (the "Uplands") then reduce their pumping rates accordingly. If the storm is significant, the Penrhyn siphon dosing valve closes, and all flow from the Arbutus, Haro, and Penryhn sewer catchments is diverted through the Finnerty Cove overflow.

Table 1 shows a summary of the current number of overflows along the NET/ECI for the period of 2000 to 2007 upstream of the Clover pump station (reference: *Sanitary Sewer Overflow Management Plan*, CRD, June 2008).

Table 1 – Recorded Overflows Upstream of Clover Point: 2000 - 2007

Overflow Name	2000	2001	2002	2003	2004	2005	2006	2007	Total
Finnerty Cove	1	3	3	6	2	3	4	7	**29**
Currie PS/McMicking Point	1	6	2	7	3	7	8	9	**43**
Humber PS	4	3	1	5	3	6	8	5	**34**
Rutland PS	4	6	2	8	8	10	8	7	**53**

Future Operational Control of the ECI/NET System

Once all of the capacity upgrades are completed, the model predicts that control of the NET/ECI system will shift from the NET-Clover section to the Penryhn siphon. This means that larger storm events will first overwhelm the Penrhyn siphon before other downstream sections. However, it should be noted that based on the current modelling, there is only 60L/s excess capacity remaining at both the proposed upgraded Currie Road Pumping Station and the upgraded NET-Clover Sewer. Therefore, although control of the NET/ECI shifts to the siphon section, it is only by a small margin and is highly dependent on future inflow and infiltration levels and the status of combined sewer separation programs in the Uplands area of Oak Bay.

Based on the above, it can be concluded that a proposed storage facility should be controlled using information from the Penryhn siphon, and any excess flows should be stored, and released after a storm event has passed. Storms up to a 5-year return period will be targeted for capture. Larger events will be stored up to the capacity of the facility.

Data Analysis

Design flows were calculated as part of the *Wastewater Flow Management Strategy Discussion Paper*[2]. This document summarizes that for the "Fixture Reduction Rates Scenario", the sanitary flow will be equal to 196 L/cap/day for the year 2030 and the total population equivalent of

[2] CH2M Hill, Associated Engineering and Kerr Wood Leidal Associates, Capital Regional Disctrict Core Area Wastewater management Program, Wastewater Flow management Strategy Discussion Paper – Design Flow Tables, 033-Dp-2, January 2009.

Arbutus, Haro and Penrhyn will increase from 45,859 in 2005 to 53,919 in 2030. Using a population equivalent of 45,859, a review of the current data indicates that the sanitary flow is approximately 195 L/cap/day.

The Arbutus Flume is immediately upstream of the Arbutus Overflow Weir. The overflows at the Arbutus Overflow Chamber were calculated using a weir formula taking into consideration the overflow chamber hydraulics, and the level data provided. This flow data was then shifted using standard methods to the year 2030 based on the population equivalent data above.

The model was then run to determine both the existing and future (including proposed upgrades) overflow volume amounts. Under existing operational control conditions with the current facilities in place, the model predicted a similar number of overflow events as shown in Table 1. Under the future condition, although several storm events came close to triggering an overflow event, only the December 15, 1999 event produced an overflow upstream of the Clover Point Pump Station (excluding the combined sewer areas tributary to the Humber and Rutland pump stations). However, it should be noted that the major storm event on October 20, 2003 would have likely produced an overflow, had it not been preceded by an extended dry period (the soil was able to absorb a significant portion of the event).

The return period of the December 15, 1999 event is estimated to be close to 5 years at the critical 12 to 24 hour duration based on a comparison of rainfall recorded at the Penryhn rain Gauge to the historical Intensity-Duration-Frequency curves for the area. Therefore, the storage facility should be sized to capture this event.

Tabular Results

The results of this analysis for various scenarios domestic flow, I&I and Upland's inflow scenarios are summarized on the attached Table 2. Twelve storage scenarios were developed reflecting the different combinations and permutations of the following three main assumptions:

- **Domestic Flow and Annual Change:** The current domestic flow recorded in the Saanich East catchment is 195 L/capita/day. This value has been recently updated as a result of a meter verification program. Unit rates in other areas of Greater Victoria range from slightly below this rate to greater than 225 L/capita/day. The current design rate is 225 L/capita/day and is forecasted to reduce to 196 L/capita/day in 2030 for all areas due to wide spread adoption of low flow fixtures.
- **Inflow and Infiltration (I&I) Rates in the East Saanich Catchments:** The current I&I rate for the East Saanich Catchments is 18,175 Litres/hectare/day for a 5-year storm event. Research in other areas of the CRD has shown that I&I rates will increase unless aggressive I&I reduction programs are implemented. However, the East Saanich catchments are relatively young, and the current I&I rate is reasonable. It may be difficult to justify expenditures in these catchments as priority will likely be given to older catchments. I&I rates may increase as a result.

- **Humber and Rutland Combined Sewer Areas (the "Uplands"):** Although the current LWMP commitments include the separation of the combined sewer in the Uplands area of Oak Bay, it may take some time to accomplish that program. If the uplands area is assumed to be separated immediately, but in reality may take many years, the frequency of overflows from the Humber and Rutland pump stations will actually increase as flow will be limited below current conditions. This assumption shows the sensitivity of continuing with a 1 pump operating condition at Humber and Rutland in order to not increase the frequency of overflows until the basin is separated.

KWL previously estimated the required storage volume for the year 2030 to be 8000 m^3. This value was calculated assuming a domestic flow rate of 225 L/cap/day, I&I growth, and separated sewers in Uplands. This is comparable with Scenario 6 in Table 2, which shows a required storage volume of 10,500 m^3. Considering the previous analysis was based on a synthetic I&I pattern the results are somewhat similar.

Selection of Preferred Storage Volume

Although significant care has been taken in confirming the accuracy of the flow data used in this analysis, it is important to note that there are some significant data resolution factors associated with predicting future overflow volumes from storm events using the 4 metre long sharp crested weir at the Arbutus flow monitoring Station. For this reason, a sensitivity analysis was performed to derive appropriate factors of safety to add to any particular scenario. The sensitivity analysis includes analyzing the historical storm events using a 1 to 2 cm drift in the measurement equipment over an average storm duration. The appropriate factor of safety is calculated to be 2,000 cu.m.

Three preferred options have been developed based on the scenarios presented in Table 2. Table 3 summarizes the options and explains the rationale used.

Table 3 – Preferred Options for Tank Sizing

No.	Option	Description	Storage Volume (cu.m)
1	Base Case Scenario	Scenario 3 with 2,000 c.m. factor of safety, and 25% provision for operational control.	5,000
2	Provision for I&I Increase	50% of the volume of Scenario 5 with provision for the future. No factor of safety.	4,750
3	Maintaining Upland Overflow Frequencies	Scenario 9. No factor of safety	6,000
Average			**5,250**

The provision for operational control is based on the fact that storage facilities will not operate exactly as the theoretical model used in this study. This is due to the fact that the SCADA system will have inherent issues such as time lags, hydraulic constraints, sensor resolution, or other equipment limitations. Depending where the tank is actually situated, the operational control could be up to 25% of the total storage volume.

Preferred Location of Storage Tank

As mentioned previously, the future capacity-bottleneck is predicted to be the siphon section of the ECI followed shortly by the entire ECI collection system. The siphon must convey all flows from the Arbutus, Haro, Penryhn, Humber and Rutland areas. Several options were reviewed during the 2005 Options study, and the preferred option was to construct a storage facility upstream of the siphon near the existing Arbutus Flume. The storage facility would store flows in excess of siphon capacity, and limit the degree of upgrades required at the Currie Road pump station. As part of this report, this decision was reviewed.

Based on the preceding sections, the long term analysis of 10 years of flow data has solidified the conclusions reached in the 2005 Options Study. A storage facility is required to prevent the upgrading of significant sections of the ECI sewage collection system. The preferred location of the facility would either be immediately upstream of the siphon or along the alignment of the siphon. Since hydraulic control of sewage storage facilities can be complicated, it is recommended that the preferred location be upstream of the siphon near the Arbutus Flume and Finnerty Overflow Weir as shown in the original 2005 Options Study. This upstream location would provide the simplest control scheme. Other benefits would include the ability of the tank to settle solids during extreme events prior to overflowing to the Finnerty Outfall, and providing a facility that could be used to recover sewage heat for sale to the University of Victoria District Energy System and surrounding area.

Summary

In summary, Table 2 provides an estimate of the flows and storage volumes at Arbutus for the 2030 design horizon for various scenarios. The predicted volumes range from 150 cu.m. to 18,000 cu.m.. This analysis summarizes the required storage volume at Arbutus in order to eliminate overflows in the ECI down to the Clover Pump Station up to and including a 5-year storm event.

Based on the Table 3 analysis, the recommendation is to construct a 5,000 cubic metre storage facility along the Penryhn siphon preferably at the top end of the siphon next to the existing Arbutus Flume and Finnerty Cove Overflow facility. It is also recommended that space be reserved to double the size of the facility at some time in the future should I&I increase above current levels.

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STATEMENT OF LIMITATIONS

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Table 2: Arbutus, Haro and Penryhn Storage Analysis Results

Scenario	Domestic Flow (L/c/day)				I&I Rate (L/ha/day)				Humber & Rutland Discharge (L/s)				Results	
	2005	Annual Change	2030	*Note Ref.*	2005	Annual Change	2030	*Note Ref.*	2005	Change	2030	*Note Ref.*	**1999 adjusted to 2030 - 15-min Peak Flow (L/s)**	**1999 adjusted to 2030 - Required Storage Volume (m^3)**
1	195.1	none	195.1	*1*	18,175	-1%	13,631	*a*	180	Separated	52	*Δ*	**609**	**150**
2	225	design value	225	*2*	18,175	-1%	13,631	*a*	180	Separated	52	*Δ*	**644**	**300**
3	195.1	none	195.1	*1*	18,175	none	18,175	*b*	180	Separated	52	*Δ*	**736**	**2,000**
4	225	design value	225	*2*	18,175	none	18,175	*b*	180	Separated	52	*Δ*	**771**	**2,500**
5	195.1	none	195.1	*1*	18,175	+2.1%	33,751	*c*	180	Separated	52	*Δ*	**1000**	**9,500**
6	225	design value	225	*2*	18,175	+2.1%	33,751	*c*	180	Separated	52	*Δ*	**1032**	**10,500**
7	195.1	none	195.1	*1*	18,175	-1%	13,631	*a*	180	none	180	*δ*	**609**	**2,500**
8	225	design value	225	*2*	18,175	-1%	13,631	*a*	180	none	180	*δ*	**644**	**3,000**
9	195.1	none	195.1	*1*	18,175	none	18,175	*b*	180	none	180	*δ*	**736**	**6,000**
10	225	design value	225	*2*	18,175	none	18,175	*b*	180	none	180	*δ*	**771**	**7,000**
11	195.1	none	195.1	*1*	18,175	+2.1%	33,751	*c*	180	none	180	*δ*	**1000**	**16,500**
12	225	design value	225	*2*	18,175	+2.1%	33,751	*c*	180	none	180	*δ*	**1032**	**18,000**
Notes:	*1. no change from the current 195 liters/capita/day recorded.* *2. the design value of 225 liters/capita/day.*				*a. 1% I&I reduction from current values.* *b. no change from the current I&I values.* *a. 2.1% annual I&I increase from current values as per Decay Strategy 3.*				*Δ. Uplands sewers separated and an I&I rate of 25,000 L/ha/day.* *δ. Uplands sewers unchanged, Humber and Rutland Pump Stations limited to 1 pump operation each (90 L/s).*					

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Technical Memorandum

DATE: October 20, 2010

TO: Tony Brcic, P.Eng.

FROM: Jeff Howard, P.Eng.
Chris Johnston, P.Eng.

RE: **CORE AREA WASTEWATER MANAGEMENT**
ECI Storage and Flows – Uplands Sewers Not Separated *DRAFT*
Estimation of Wet Weather Flows and Detention Requirements
Our File 283.323

Introduction

Kerr Wood Leidal Associates Ltd. (KWL) has previously assessed flows in the CRD's East Coast Interceptor (ECI) and determined the storage volumes required to eliminate overflows from storms up to the 5-year return period. The analyses included various scenarios, all based on the assumption that the sewers in the Uplands area of Oak Bay will be separated, or allowed to overflow in the interim until the catchments are separated.

This memorandum addresses further scenarios wherein the Uplands sewers would remain combined for the foreseeable future, resulting in the need for additional storage and upgrades now to prevent overflows up to the 5-year return period.

In this context 'combined' sewers convey both domestic wastewater and stormwater together in a single conduit (the existing situation), in contrast to 'separated' sewers.

Background

The Humber and Rutland Lift Stations collect domestic wastewater and stormwater from the Uplands areas, and then pump this combined sewage into the siphon portion of the ECI. If separation of the combined sewers were delayed for the foreseeable future, but overflows up to a 5-year return period must be eliminated in the near future (as agreed to in the CRD's Liquid Waste Management Plan), then additional pumping and/or storage would be required at the lift stations. Additional storage would also be required in Saanich East (Arbutus).

The amount of additional storage that could be provided at the stations is limited by site constraints. At the same time, the amount that the pumping rates could be increased is limited by the capacity of the siphon, particularly because such flow increases would decrease the capacity available for the Saanich East catchment areas. As a result, more storage would be required in Saanich East.

Data Analysis

The Humber and Rutland Lift Stations are currently limited to one pump operation at each station during storm events, due to limited downstream capacity. The pumping rate for one pump operation at each of these stations is approximately 90 L/s.

For the year 2030, the peak flows to the Humber and Rutland Lift Stations for the 5-year I&I event are estimated to be 402 L/s and 276 L/s, respectively. Four potential scenarios have been developed to prevent overflows during this event, as summarized in Table 1.

Scenarios A and B require significant storage volumes in the vicinity of each of the Humber and Rutland Lift Stations. Construction of storage volumes of these sizes is not practical within the road allowances.

Scenarios C and D require upgrades to the Humber and Rutland Lift Stations in order to reduce the storage volumes to practical limits. Scenarios C and D assume the practical limit for detention within Humber and Rutland roadways east of Beach Drive is 700 m^3 each based on previous site investigations undertaken by the District of Oak Bay.

Scenario C uses the maximum pumping rate possible to limit upgrades to the Currie Road Wastewater Pump Station to the current recommended upgrade of 1509 L/s. In this scenario the Humber and Rutland Lift Stations will continue to pump into the siphon portion of the ECI. Flow from Saanich East will be significantly restricted during the peak of the storm event and will have to be stored.

Scenario D has the same storage at Humber and Rutland as Scenario C, but assumes that a new forcemain from the Humber and Rutland Lift Stations can be constructed to the gravity portion of the ECI. This increases the allowable flows from Saanich East, thereby lowering the storage requirement. Scenario D will also require the Currie Road Pump Station to be further upgraded to 1800 L/s (compared with 1509 L/s for all other scenarios).

Considering the pumping rates and storage volumes, Scenarios C and D warrant further consideration, assuming Uplands is not separated.

Summary

The attached Table 1 provides an estimate of the required storage volumes for the 5-year return period event for four scenarios assuming the Uplands area of Oak Bay is not separated. Scenarios C and D warrant further consideration based on the practicality of siting the storage facilities.

KERR WOOD LEIDAL ASSOCIATES LTD.

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STATEMENT OF LIMITATIONS

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Table 1: Arbutus, Humber and Rutland Analysis Results - Upalnds not Separated

Scenario	East Saanich Domestic Flow (L/c/day)				East Saanich I&I Rate (L/ha/day)				Humber & Rutland Combined Discharge (L/s)				**Required Storage Volume (m3)**		
	2005	Annual Change	2030	*Note Ref.*	2005	Annual Change	2030	*Note Ref.*	2005	Change	2030	*Note Ref.*	**Arbutus**	**Humber**	**Rutland**
A	195.1	none	195.1	*1*	18,175	none	18,175	*a*	180	none	**180**	*Δ*	7,000	9,500	5,000
B	195.1	none	195.1	*1*	18,175	none	18,175	*a*	180	none	**300**	*δ*	14,000	6,500	2,500
C	195.1	none	195.1	*1*	18,175	none	18,175	*a*	180	none	**538**	Φ	18,000	700	700
D	195.1	none	195.1	*1*	18,175	none	18,175	*a*	180	none	**538**	£	11,000	700	700
<u>*Notes:*</u>	*1. no change from the current 195 liters/capita/day for area upstream of Uplands. Downstream of Uplands 250 l/c/day was used.*				*a. no change from the current I&I value of 18,175 upstream of Uplands. No change in I&I rates for Uplands and downstream to Currie Lift Station*				*Δ. 1 Pump operation at each Humber and Rutland. Assumes Currie LS upgraded to 1509 L/s.* *δ. 2 Pump operation at each Humber and Rutland. Assumes Currie LS upgraded to 1509 L/s.* *Φ Upgraded Humber and Rutland Lift Stations for pumping rates of 326 L/s and 212 L/s. Assumes Currie LS upgraded to 1509 L/s.* *£ Upgraded Humber and Rutland Lift Stations, dedicated forcemain beyond siphon, assuming Currie LS upgraded to 1800 L/s (siphon throttled to 340 L/s).*				*Required storage volumes for no overflow during 5-year I&I event*		