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CAW 13-14

REPORT TO CORE AREA WASTEWATER TREATMENT PROGRAM COMMISSION
MEETING OF THURSDAY, MAY 30, 2013

SUBJECT **CORE AREA WASTEWATER TREATMENT PROGRAM COMMISSION REQUESTS FOR INFORMATION**

ISSUE

The Core Area Wastewater Treatment Program Commission has requested additional information on a number of matters related to assumptions and criteria used to develop the current Core Area Liquid Waste Management Plan.

BACKGROUND

The Commission requested staff to provide more detailed information on a number of topics. Four of the topics are attached to this report as memos:

1) Projected Design Flows
2) The Relationship Between Unit Cost And Capacity For Wastewater Treatment Plants
3) Cost Implications for a Combined Liquids and Biosolids Treatment at Hartland Landfill
4) McLoughlin Wastewater Treatment Plant Capacity

Additional topics will be brought to the next Commission meeting.

RECOMMENDATION

That the Core Area Wastewater Treatment Program Commission receive the attached memoranda for information and forward them to the Core Area Liquid Waste Management Committee for information.

Tony Brcic, P.Eng
Deputy Program Director
Core Area Wastewater Treatment Program

J. A. (Jack) Hull, P.Eng, MBA
Interim Program Director
Core Area Wastewater Treatment Program
Concurrence

TB:hr

Attachments: 4

Memo

CRD

TO: Core Area Wastewater Treatment Program Commission

FROM: J. A. (Jack) Hull, P.Eng, MBA

Interim Program Director, Core Area Wastewater Treatment Program.

DATE: May 30, 2013 **FILE:** 0360-20

SUBJECT: **Projected Design Flows**

BACKGROUND

Projected Design Flows

The projected flows were developed based on the following approaches assuming that the Capital Regional District (CRD) continues to implement its wide ranging water demand management programs. The CRD implemented a demand management program as early as 1995, significantly expanded the program in the late 1990's. As a result of these programs and the introduction of water efficient fixtures and appliances over the last 10 years total water demand has continued to decline despite the increase in population. Total water demand has dropped 15% since 1995 despite a 15% increase in serviced population.

Average Dry Weather Flow (ADWF):

ADWF consists of two main components: Dry Weather Base Sanitary Flow (BSF) and Ground Water Infiltration $(GWI)_{summer.}$

- BSF: The per capita equivalent BSF in the projected areas is currently averages 206 L/d/capita. With ongoing demand management and the normal replacement of inefficient fixtures , the per capita equivalent value could be reduced to 195 L/d/capita in year 2030 and to 184 L/d/capita in year 2065.

- GWI: It represents leakage of ground water into the sewer system through cracked pipe or pipe joints. Older sewer systems typically have higher GWI rates than newer sewer systems. GWI_{summer} represents ground water that infiltrates into the collection system during the driest months of the year.

Typically, GWI increases with time as a sewer system deteriorates due to age. A considerable investment would be required for the CRD to reduce the GWI as the core system is getting older. The summer groundwater infiltration is estimated as 70% of the sewage flow at 4:00 AM. Using this approach, the following groundwater infiltration rates have been estimated:

- Clover Point catchment area, which includes Saanich East: 3,900 L/ha/day. This has been apportioned into a lower rate of 2,100 L/ha/day for Saanich East and a higher 3,946 L/ha/day for the balance of the Clover Point area.

- Macaulay Point catchment area, which includes the West Shore: 1,900 L/ha.day.

Table 1. McLoughlin Point WWTP Design Flows

Item	2030		2065	
	Flow (ML/d)	Action	Flow (ML/d)	Action
Design ADWF	107.8	On-site secondary	107.8	On-site secondary
Total design flow of 2 x ADWF	215.6	On-site secondary	215.6	On-site secondary
2 x ADWF – 3 x ADWF (from Clover)	51.9	On-site primary only	51.9	On-site primary only
2 x ADWF – 4 x ADWF (from Macaulay)	111.7	On-site primary only	111.7	On-site primary only
Wet Weather Flow (Total)	163.6	On-site primary only	163.6	On-site primary only
>4 x ADWF(tributary)	≅20 (1)	Screening to outfall	≅0 (1)	Screening to outfall
Filtration for Reuse	6		6	
Biosolids		Pump to digesters at Hartland		Pump to digesters at Hartland

Notes on Table 1: Based on effective I&I reduction program.

Based upon the above the design flow for the primary plant at McLoughlin Point will be 376 ML/day.

Peak Wet Weather Flow (PWWF)

PWWF is estimated as Peak Dry Weather Flow (PDWF) plus inflow and infiltration (I&I).

PDWF is the product of ADWF and peaking factor using the Harmon equation (an empirical equation based on population). Usually, 80% of the calculated value from the Harmon equation is applied. The exception is that 100% of the Harmon equation value was used for peak flow estimate along the East Coast Interceptor and has been confirmed by flow monitoring results.

I&I for wet weather flows is the sum of rainfall dependent inflow and infiltration (RDI&I) and GWI_{winter} where GWI_{winter} is the ground water that infiltrates into the collection system during the wettest months of the year.

Wet weather flows are typically based on storm events. The magnitude of storm events varies based on the frequency of their return periods. The methodology used in the Discussion Paper 033-DP-2 is termed as the “I&I Envelope”, which uses a series of flow monitored storm events, including 2, 5, 10, 25, 50 and 100 years, to develop a correlation between the amount of rainfall that occurs and the magnitude of I&I that shows up at a given site. A return period of 5-year and a 6-hour rainfall duration were selected for best correlation of return period. The projected flows (ADWF) for the catchments as shown in the Appendices of Discussion Paper 033-DP-2 are summarized and tabulated above for comparison with the design flows used in the cost estimate. The 5 year return period is a regulatory requirement under the Municipal Sewage Regulation.

TB:hr

Memo

TO:	Core Area Wastewater Treatment Program Commission
FROM:	J.A. (Jack) Hull, P.Eng, MBA Interim Program Director, Core Area Wastewater Treatment Program
DATE:	May 30, 2013 **FILE:** 0360-20
SUBJECT:	**The Relationship Between Unit Cost and Capacity for Wastewater Treatment Plants**

BACKGROUND

The evaluation to develop a cost curve for unit costs versus capacity is not as simple as it may seem. This is largely a result of developing an "apples to apples" analysis in terms of what is included in the scope. The reported costs for wastewater treatment projects have varying degrees of scope that may include sewage conveyance, sludge treatment and other infrastructure upgrades. This analysis considers the unit cost of liquid treatment only.

This analysis was developed from a review of projects completed and cost curves developed in the past. These past projects were adjusted to present cost using the Engineering News Record index. The graph in Appendix A provides a cost curve based on this information.

This cost curve was then compared to the extensive analysis of wastewater treatment configurations for the Core Area Wastewater Treatment Program (CAWTP) where various size wastewater treatment plants ranging in capacity from 7 million litres per day up to 130 million litres per day were analyzed. There was a reasonable correlation between the indexed cost curve and the estimating completed for the CAWTP.

CONCLUSION

It is difficult to develop an accurate cost curve for wastewater treatment plants because the reported costs for projects have varying scope. The graph provided in Appendix A clearly indicates that the unit costs increase as the wastewater treatment plant gets smaller in capacity, as expected, with the economies of scale.

The capacity of the McLoughlin wastewater treatment plant is on the cost/capacity curve at a point which demonstrates the economies of scale.

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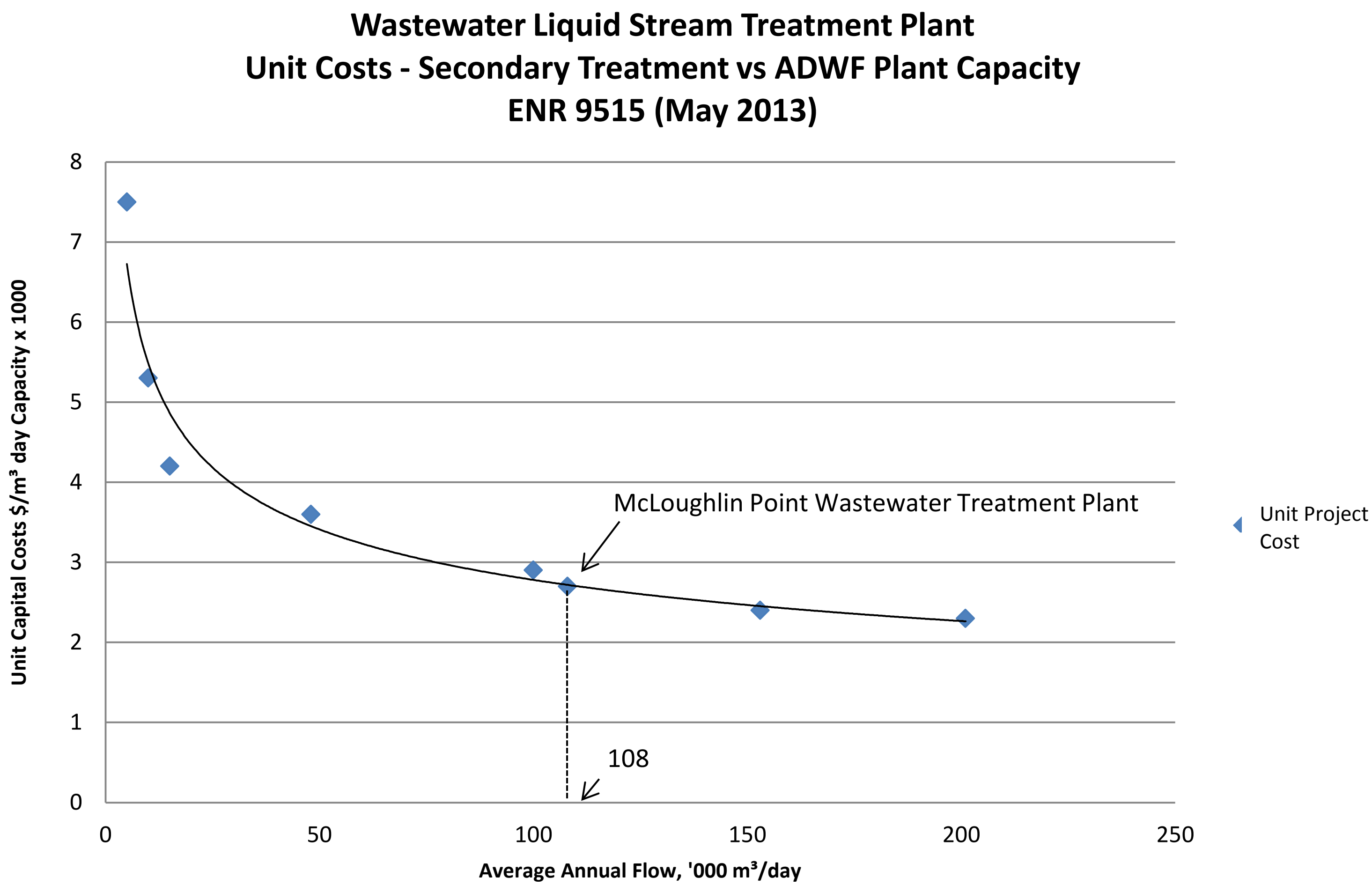
Attachment: 1


Wastewater Liquid Stream Treatment Plant
Unit Costs - Secondary Treatment vs ADWF Plant Capacity
ENR 9515 (May 2013)
Unit Capital Costs $/m³ day Capacity x 1000
8
7
6
5
4
3
2
1
0
0
50
100
150
200
250
Average Annual Flow, '000 m³/day
McLoughlin Point Wastewater Treatment Plant
108
Unit Project Cost

Memo

TO:	Core Area Wastewater Treatment Program Commission	
FROM:	J. A. (Jack) Hull, P.Eng, MBA Interim Program Director, Core Area Wastewater Treatment Program.	
DATE:	May 30, 2013	**FILE:** 0360-20
SUBJECT:	**Cost Implications for Combined Liquids and Biosolids Treatment at Hartland Landfill**	

BACKGROUND

The current plan for the Core Area Wastewater Treatment Program involves construction of a liquid train wastewater treatment plant at McLoughlin Point and biosolids treatment facility at Hartland landfill. The estimated cost for the facilities is $ 782.7 million.

Under this plan the wastewater flows are collected at the existing outfall locations at Clover Point and Macaulay Point and pumped to the McLoughlin site. The transmission of the raw sewage flows to the McLoughlin site is relatively straight forward and can be completed for the most part within existing road right of ways. A horizontal directional drill beneath Victoria Harbour is required to bring Clover Point flows to the McLoughlin site.

The biosolids treatment facility is located 17 km from the McLoughlin site and requires pumping of sludge through a small diameter forcemain to Hartland landfill.

The current plan takes advantage of using existing conveyance infrastructure upstream of the Clover and Macaulay Point pump stations. The McLoughlin site is at approximate elevation 5 metres geodetic and thus the pumping heads to convey sewage to the McLoughlin site are not significant. Sludge pumping does require a significant pump of approximately 180 metres but the volume is approximately 1% of the liquid stream.

A combined liquid and sludge treatment at Hartland landfill would require significant infrastructure to convey the peak flow to Hartland. CRD staff recently completed an analysis to combine these facilities on Agricultural Land Reserve property on Burnside Road approximately half the distance to Hartland and at elevation about 160 metres lower. While a detailed cost analysis has not been undertaken, the recent cost estimate for a combined wastewater treatment and biosolids facility at a property on Burnside Road is used as a basis to illustrate the significant additional costs to locate at Hartland.

The following facilities were identified is being required to convey sewage to the Burnside Road site:

- A large 376 Ml/d raw sewage pumping station at Macaulay Point. Additional land will be required from Department of National Defence to build the facility. The pump station has to be sized to pump 4 times average dry weather flow to the plant for primary treatment.
- A 9,500 metre, 1,800 mm diameter forcemain to bring raw sewage to the Burnside Road site from Macaulay Rd. pump station.

- A 9,500 metre, 1,800 mm forcemain to bring treated effluent back to the Macaulay outfall. Note because of the high point in Esquimalt, the effluent will have to be pumped back to the Macaulay outfall.
- A large 376 Ml/d treated effluent pump station at the Burnside Road site.

The capital cost of the Burnside Road option is estimated at $180 million higher than the current plan. The large diameter pipelines to and from the site will require separate trench excavations and likely will require major utility relocations which would result in significant utility relocation costs.

Considering the distance and elevation difference between McLoughlin Point and Hartland landfill, the capital and operating costs for this option will be much higher than the Burnside Road option. The increased friction losses from the long distance and additional static head will require multiple pump stations and larger pipes than the Burnside Road option, likely making a tunnel a more cost effective conveyance system for this option.

The 15 kilometre tunnel recently completed by Metro Vancouver for the Seymour Filtration Water Treatment Plant project was approximately $300 million. A 17 kilometre tunnel with pump stations would likely cost at least $500 million more than the current plan.

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Memo

TO: Core Area Wastewater Treatment Program Commission

FROM: J. A. (Jack) Hull, P.Eng, MBA,
Interim Program Director, Core Area Wastewater Treatment Program

DATE: May 30, 2013 **FILE**: 0360-20

SUBJECT: **McLoughlin Wastewater Treatment Plant Capacity**

BACKGROUND

The capacity of a sewage treatment plant is based on the average dry weather flow (ADWF) and the organic and inorganic load that requires treatment. The flow is measured in million litres per day (ML/d) and the load is measured in terms of kilograms per day comprised of organic and inorganic loads.

The provincial regulations require that 4 X ADWF receive primary treatment and 2 X ADWF receive secondary treatment. The current ADWF that arrives at Clover Point is approximately 52 million litres per day (Ml/d) and Macaulay Point is approximately 56 Ml/d, for a total of approximately 82 Ml/d. The ADWF design criteria used to size the McLoughlin Point wastewater treatment plant (McLoughlin) is 108 Ml/d. Since the Capital Regional District's (CRD) Liquid Waste Management Plan allows for pumping the reduced amount of 3 X ADWF from Clover Point to McLoughlin, the total primary treatment capacity provided at McLoughlin is 376 Ml/d (ie 3 X ADWF from Clover and 4 X ADWF from Macaulay). The secondary treatment capacity provided at McLoughlin is 216 Ml/d.

The inorganic solids in the sewage are measured by the amount of total suspended solids (TSS) in a litre of sewage – milligrams per litre (mg/l). The TSS determines the size of the primary treatment process. Primary treatment is a physical process where gravity is used to settle suspended solids. The TSS in the sewage that arrives at Clover Point and Macaulay Point is 260 mg/l. The TSS design criteria used to size the primary treatment process at McLoughlin is 325 mg/l, a 25% safety factor to account for variations between ADWF and maximum month loading conditions.

The organic solids in the sewage are a measure of the oxygen that the sewage will consume in a litre of water – milligrams per litre (mg/l). This measure is referred to as biochemical oxygen demand (BOD). The BOD in sewage determines the size of the secondary treatment process. Secondary treatment is a biological process where aerobic microorganisms (principally bacteria) break down the organic matter producing more microorganisms and inorganic end products (principally carbon dioxide, ammonia and water). The BOD for the sewage that arrives at Clover Point and Macaulay Point is 240 mg/l. The BOD design criteria used to size the secondary treatment process at McLoughlin Point is 300 mg/l, a 25% safety factor to account for variations between ADWF and maximum month loading conditions.

McLoughlin is predicted to reach capacity around 2030 if no capacity redundancies or safety factors are utilized and if the sewerage collection network is expanded to unserviced areas in the Westshore by 2030. However, utilizing the current extra flow capacity of 26 Ml/d and the safety factors in design criteria for TSS and BOD noted above, McLoughlin will be able to provide capacity beyond this date, especially since it is very unlikely that the Westshore sewage collection network will be expanded to all unserviced areas by 2030. Colwood, which has only 14% of its population connected to sewers, has no plans to expand the sewage collection network by 2030. As well, in the future, chemical coagulants and other technologies could be implemented to enhance removal efficiencies within the footprint and increase the treatment capacity at McLoughlin.

The current plan anticipates that capacity will be required in the future, and that that capacity will be provided on the Westshore where most of the growth is occurring. This may be required after 2040, and when built, it will free up capacity at McLoughlin for growth in the core municipalities. The current plan maximizes use of existing infrastructure and includes flexibility for future decentralized treatment to serve new development in growth areas. The design life for the equipment and concrete structures at McLoughlin is 25 years and 75 years, respectively.

CONCLUSION

McLoughlin represents the first building block in developing a long term sewage treatment strategy for the core area. This strategy ensures that current treatment needs are being met and provides flexibility to incorporate alternative strategies for future developments, such as a decentralized treatment model.

The current design capacity for the McLoughlin Wastewater Treatment Plant is based on conservative loading assumptions and serviced population and will provide capacity beyond 2030 and is in accordance with normal design criteria for wastewater treatment plants.

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