# DISCUSSION PAPER

**Capital Regional District**
**Core Area Wastewater Management Program**

**Integrated Resource Management Strategy**

**Discussion Paper – Wet Weather Management Strategies for Clover Point Wet Weather Facility – 035 DP-1**

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## 1 Introduction

The objectives of this Discussion Paper are three fold to determine the wet weather management strategies for Clover Point Wet Weather Facility. First, the paper will discuss the wet weather management goals for Clover Point from a regulatory and policy perspective. This will assist in determining the effluent quality for the facility and therefore guide the type of treatment options available for this wet weather treatment facility.

The second objective will be to provide overview of the appropriate technology for treating wet weather events to meet the Capital Regional District (CRD) and Ministry of Environment (MoE) goals and policies on wet weather flow management.

The third objective will present a decision-making framework for determining which technology should be implemented at the Clover Point Wet Weather Facility.

## 2 Clover Point Wet Weather Facility – General Overview

Under the proposed wastewater management program, the function of the Clover Point site will change but the appearance will remain the same.

The Clover Point facility will be a wet weather facility only. The dry weather flows, up to two times the average dry weather flow (ADWF), arriving at the site through the existing wastewater conveyance system, will be pumped to a wastewater treatment facility, tentatively located at Macaulay Point/McLoughlin Point via a new pump station and force main. For the vast majority of the time, there will be no flow out the Clover Point outfall. During wet weather events, where the flow exceeds the pumping capacity to the wastewater treatment facility, the surplus wastewater flow, up to four times ADWF, will receive treatment and be discharged out the Clover Point outfall. Flows above this amount would go through fine screening only and be blended with the treated effluent.

Depending on the treatment process chosen, any residuals from the treatment process would be returned to the dry weather pump station for transport to the Macaulay Point facility.

The new dry weather pump station and the wet weather treatment facility can be located underground in a similar manner to the existing works. Some disruption of public access will be required during the construction period, as it will be necessary to employ a “cut and cover” construction process. Once in operation, the site would appear essentially as it currently looks. Truck traffic to the site will be minimal, as the wet weather facility will only operate during limited periods.

The Clover Point site is currently owned by the City of Victoria and a legal covenant exists, defining portions of the site as park use. The proposed strategy will keep the final appearance and use of the existing park area as is.

# 3 Regulatory and Policy Perspectives

Wet weather flow management is one of the four key elements of the Core Area Wastewater Management Strategy. The majority of the CRD wastewater collection system is composed of a separated sanitary system and stormwater system. Rainwater inflow and groundwater infiltration enters the sanitary sewer system through unauthorized connections or cracks in the pipes or manholes. During wet weather events, this water overwhelms the wastewater collection system resulting in sanitary sewer overflows (SSOs) at various points in the collection system.

The policy of the Provincial Government is to ultimately eliminate SSOs and combined sewer overflows (CSOs). It is recognized that this is a significant undertaking and that will take decades to achieve. The CRD has previously committed to this goal through a combination of sewer separation, inflow and infiltration (I&I) reduction and increased wastewater conveyance capacity.

The focus of the Core Area Wastewater Management Strategy is managing the surplus wet weather flows on a more local basis. This will be done in conjunction with the distributed treatment approach, where wet weather flows from the upper reaches of the wastewater collection system will be treated and reused or discharged at a decentralised water reclamation facility.

The Municipal Sewage Regulations (MSR) requires CSO and SSO prevention and treatment in addition to sewer separation and I&I reduction. If primary and secondary treatment are available, the discharger must do the following:

- Provide at least primary treatment for the flow greater than two times the ADWF.
- Utilize the full secondary capacity of the treatment plant.
- Combine the primary and secondary effluent prior to discharge.
- Maintain a minimum receiving environment to discharge dilution ratio of 40:1.
- If disinfection is required, provide adequate excess disinfection capacity to ensure disinfection of the entire discharge flow.

The Clover Point catchment is almost completely separated sewers. Of the total 3,829 ha catchment area contributing to Clover Point, only the two catchments, Humber and Rutland (total area of 134.6 ha), are combined and these two catchments are limited to 90 L/s each during major storm events by their pump stations. Upstream of Clover Point wet weather facility, a decentralized water reclamation facility is proposed for the District of Saanich. This facility would provide secondary treatment capacity for up to two times the ADWF. Primary treatment would be provided for flows above the two times ADWF. Effluent not required for reuse would be discharged out the existing outfall. By having this facility upstream of Clover Point, the wastewater load at Clover Point is reduced.

By installing a dry weather pump station at Clover Point, which conveys up to two times ADWF downstream for treatment, the overall amount of untreated wastewater discharged to the ocean is reduced. That is to say, for the vast majority of the time, there will be no flow out the Clover Point outfall. It is only when the wet weather event exceeds the pump capacity of the dry weather pump station that surplus wastewater will be treated and discharged out the Clover Point outfall. The question is what level of effluent quality should the wet weather treatment facility achieve? A point for consideration is that with surplus wet weather flows being dealt with on a more local basis in conjunction with the planned distributed treatment approach, a greater percentage of total flow in the Core Area catchment is treated before discharge to the ocean and therefore reducing the level of pollutants entering the environment.

The MSR designates an effluent quality for daily flow greater than two times average dry weather flow, for a receiving water, with a dilution rate of equal to or greater than forty to one of 130 mg/L biological oxygen demand (BOD) and total suspended solids (TSS), when the maximum daily flows are equal to or greater than 50 $m^3$/day and primary treatment is applied.

The CRD, in consultation with the MoE, will need to determine the effluent quality for the Clover Point facility and this will therefore determine the type of treatment implemented for this wet weather treatment facility.

# 4 Treatment Overview

There are a number of treatment options for the Clover Point Wet Weather Treatment Facility. For flows greater than two times ADWF and up to flow equal to four times ADWF these are:

- Continue to use 6 mm screen
- Implement microscreens
- Implement high rate enhanced primary treatment (HREPT)

Each of these will result in different effluent quality, with 6 mm screens maintaining the current level of treatment and high rate enhanced primary treatment achieving effluent qualities better than the MSR effluent quality of 130 mg/L BOD and TSS.

These treatment options are discussed in the following sections.

## 4.1 Screening

Screening is the first unit process in a conventional wastewater treatment facility and is used to protect downstream process components, and to remove trash and rags. For combined sewer overflows or sanitary sewer overflows, screens reduce or eliminate solids and floatable materials to avoid discharging visible objectionable material.

Screen openings vary greatly, but generally can be classified as:

- Trash Racks: > 25 mm
- Coarse: 25 – 9 mm
- Fine: 9 – 1 mm
- Microscreen: < 1 mm

Coarse screens are often used to protect equipment and remove larger objects from the wastewater. Fine screens will remove smaller material and may remove an amount of organic material. Very fine screens or microscreens remove even smaller material and can be used to replace grit removal and primary treatment.

Assessment of Technologies for Screening, Floatable Control and Screenings Handling (WERF, 2002) reports that many CSO locations are considering fine to micro size openings of less than 6 mm, to as low as 50 microns to provide visible and overall loading reductions prior to discharge during wet weather events. Increasing solids removal efficiencies for screens are attributed to the straining that occurs from a mat or film accumulating on the screen and through filtering smaller particles. Fine screens and microscreens are surface filtration devices used to remove a portion of suspended solids from all types of wastewater. However, there is little reported data on the expected level of BOD or TSS removal with fine screens or microscreens.

CSO applications are particularly difficult for screening due to the varying nature of the screening material, large changes in hydraulic loading, and characteristics of the screening. The movement to using finer screens makes design considerations such as hydraulic throughput and the amount of screenings removal more critical. Finer screening requires greater washing and compaction to mitigate odours and ensure acceptance for final disposal. The smaller the material to be removed, the finer the screen and the larger the unit needs to be to reduce the headloss through the process.

Generally, screens to date in CSO or SSO applications are provided to contain and capture floatables and not to provide any reduction in BOD or TSS concentrations.

### Pilot Testing of Microscreens

Stantec Consulting Ltd. was retained by the CRD to pilot test screen technologies. The initial objective of the pilot testing was to establish if there were one or more technologies available that could meet the requirement of 50% solids removal in a small footprint. This objective was amended to meet the MSR, which prescribes a concentration limit of 130 mg/L for TSS and does not require a percentage removal. Pilot testing was eventually carried out the following three vendor technologies:

- Salsnes Filters
- Hydrotech Drumfilter
- Waste-Tech Roto-Sieve Filter.

The three units were operated in parallel over a six-month period, from June 2004 to November 2004, at Macaulay Point. The wastewater for pilot testing was obtained downstream of the existing 6 mm perforated screens. Additional testing with chemical coagulants added to the wastewater was carried out. The purpose of adding chemical was to determine if enhanced removals could be achieved. The chemicals used were ferric chloride and polymer.

*Salsnes Filter* – This unit consists of a mesh screen on an inclined belt. The wastewater passes through the screen and the solids are carried upward on the inclined belt. The solids then fall in a separate compartment where they are dewatered with a screw press, producing a cake with solids contents of 27%. Mesh screen size of 250 and 350 micron were tested. The unit was tested at a range of flows from 15 to 22 L/s. Flow in excess of 20 L/s increased the frequency of overflows.

*Hydrotech DrumFilter* – A rotating stainless steel drum screen covered with removable filter panels filters the wastewater. Wastewater flows through the filter from the inside of the drum to the outside. The solids are carried upward by the drum rotation and removed from the screen by spraying clean water. The solids are mixed with the backwash water, producing a liquid sludge content of 0.4%. Drumfilter sizes of 200 and 250 micron were tested. The unit was tested at a range of flows from 6 to 12 L/s. Flows in excess of 8 L/s increased the frequency of overflows.

*Waste-Tech Roto Filter* – The screen unit consist of a rotating perforated drum with an internally mounted transport screw to convey the separated solids out of the drum. Wastewater flows through the filter from inside of the drum to the outside. Perforated drum size of 600 to 1000 micron were tested. The unit was tested at a range of flows from 6 to 12 L/s.

The results from the pilot testing without chemicals are summarized in Table 1 (Stantec Consulting Ltd, 2005). The 200 and 250 micron filter sizes were effective at achieving an average TSS concentration of less than 130 mg/L. With 250 micron screen, the Salsnes filter removed 51% of the TSS, producing filtered wastewater with an average concentration of 102 mg/L. With a 200 micron screen, the Hydrotech Drumfilter also achieved a 51% TSS removal, with an average concentration of 109 mg/L. With the 250 micron screen, the Hydrotech Drumfilter achieved a 47% TSS removal with an average concentration of 113 mg/L.

**Table 1**
**Summary of TSS and BOD Results of Pilot Testing**
**without Chemical Coagulants**

| | **Salsnes Filter** | | **Hydrotech Drumfilter** | | **Waste-Tech RotoSieve** | |
|---|---|---|---|---|---|---|
| Screen Size (micron) | 250 | 350 | 200 | 250 | 600 | 1000 |
| Average Effluent TSS concentration (mg/L) | 102 | 180 | 109 | 113 | 185 | 217 |
| Range of Effluent TSS Concentration (mg/L) | 67-142 | 70-359 | 68-168 | 68-212 | 152-258 | 98-430 |
| # of TSS test results above 130 mg/L | 2 (3%) | 34 (85%) | 10 (18%) | 13 (15%) | 49 (98%) | 105 (94%) |
| % TSS Removal | 51% | 27% | 51% | 47% | 12% | 12% |
| % BOD Removal | 30% | 7% | 20% | 27% | 4% | 10% |

The addition of ferric chloride with polymer did not increase TSS removal and the limited date indicates that TSS removal actually decreased, presumably due to loss of iron based precipitate.

The solids or sludge that would be produced by a full-scale facility would need to be either hauled or pumped from the site to downstream treatment or a biosolids facility. The 27% solids cake produced by the Salsnes filter is suitable for hauling. The liquid sludge produced by the Hydrotech Drumfilter could be returned to the beginning of the process stream and conveyed downstream to the wastewater treatment facility.

### Expected Level of Treatment from Screening Options

Providing 6 mm screens will contain and capture floatables, and will unlikely provide any reduction in BOD or TSS concentrations. While this could be seen as maintaining the status quo, it is still an improvement to the existing treatment facility, as less volume of flow and therefore fewer pollutants are being discharged to the ocean, as screens will only be used when the flow exceeds the capacity of the dry weather pump station.

It is also possible that during wet weather events that the concentrations of TSS and BOD are already reduced or diluted to equivalent to primary effluent, 130 mg/L TSS and BOD. A review of recent WEFTEC conference papers on pilot testing of ballasted flocculation (e.g. HREPT) for wet weather flow treatment facilities, summarized in Table 2, showed that influent used to represent wet weather events during the pilot testing were generally in the range of 50 to 150 mg/L for TSS and BOD.

**Table 2**
**Reported Wet Weather Wastewater Characteristics**

| | | Wet Weather Wastewater Characteristics |
|---|---|---|
| Independence Facility, Missouri | Scruggs et al (2001) | • 151 ML/day facility with a peak storm flow rate of 1135 ML/day.<br>• Simulated wet weather flow TSS concentration range 115 to 135 mg/L.<br>• First flush TSS concentrations during an actual storm event were 270 to 300 mg/L. |
| New York City | Kurtz (2003) | • Primary effluent was used as it represented the New York City CSO adequately.<br>• Solids to the pilot facility ranged from 20 to 150 mg/L. |
| Lawrence WWTP | Keller (2003) | 95 ML/day facility with a peak storm flow rate of 227 ML/day, the anticipated wastewater characteristics to Actiflo facility were:<br>• TSS: 25 – 140 mg/L<br>• BOD: 60 – 100 mg/L |
| City of Salem | Matson (2002) | • Pilot testing for a 606 ML/day SSO facility.<br>• WWTP Influent during high flows and five SSO events were analyzed:<br>  • Dilute WWTP influent BOD/TSS: 40 – 100 mg/L<br>  • Union St. SSO BOD/TSS 55 – 200 mg/L<br>  • N. River Rd. SSO BOD/TSS 40 – 145 mg/L |
| City of Toledo | Nitz et al (2004) | Pilot testing for a 757 ML/day wet weather facility. Reported wet weather influent characteristics from three events were:<br>• CBOD: 44 to 147 mg/L<br>• TSS: 57 to 151 mg/L |
| Baton Rouge | Kirby et al (2005) | Pilot testing as part of the sanitary sewer overflow corrective action plan. Reported wet weather influent characteristics from two events were:<br>• BOD: 212 to 226 mg/L<br>• TSS: 86 to 127 mg/L |
| Lawrence WWTP | Keller et al (2005) | 151 ML/day Actiflo SSO facility. Recorded storm event influent characteristics:<br>• CBOD: 150 to 600 mg/L<br>• TSS: 140 to 360 mg/L |

The CRD has started a wet weather and dry weather sampling program at the Clover Point facility to characterize the outfall effluent. Unfortunately, there was insufficient flow at the time of sampling to determine the wet weather wastewater characteristics of the Clover Point facility. When this sampling regime is continued it will provide useful insight as to what the expected wet weather wastewater characteristics of the Clover Point facility could be and whether during wet weather events the concentrations of TSS and BOD are already reduced or diluted to equivalent to primary effluent, 130 mg/L.

The pilot testing of the microscreens demonstrated that it is possible for microscreens to produce an effluent that will meet the MSR, 130 mg/L TSS concentration. Microscreens have, in the past, been used previously as a final effluent polishing step. Recently, the use of microscreens has been implemented in small communities to replace the need for primary treatment. As technology development has been focussed on small applications; screening units are limited in capacity. The use of microscreens for Clover Point will then require a large number of screens to accommodate the wet weather design flows.

### 4.2 High Rate Enhanced Primary Treatment

High-rate clarification is a physical/chemical treatment with special flocculation and sedimentation systems to achieve rapid settling. The essential elements of high-rate clarification are enhanced particle settling and the use of inclined plate or tube settlers.

Ballasted flocculation with lamella plate clarification is used in this discussion paper as a representative process for high rate clarification. It employs a proprietary process in which a flocculation aid and a ballasting agent (typically a silica microsand) are used to form dense microfloc particles. The resulting floc particles are thus “ballasted” and settle rapidly. The treatment system consists of three compartments: a mixing zone, maturation zone and a settling zone. Typically, screened wastewater is introduced to the ballasted flocculation reactor where chemical coagulant, usually an iron salt, is injected to destabilize the solids. The wastewater then enters a mixing zone where the microsand and polymer are injected to maximize the efficiency of flocculation and enhance settling of suspended solids. In the mixing zone, the polymer acts as a bonding agent for adhering the destabilized solids to the microsand. The maturation zone follows and is used to keep the solids in suspension while floc particles continue to develop and grow. Once developed, the ballasted floc particles settle rapidly in the bottom of the clarifier. Sand and floc particles removed from the clarifier water are pumped to a cyclone separator for the separation of the sand. The separated sand is returned to the injection tank and the solids from the cyclone are sent to the bio-solids processing facilities.

#### Expected Level of Treatment

Reported BOD removal and TSS removals for ballasted flocculation in Metcalf and Eddie 2003 are given in Table 3.

**Table 3**
**BOD and TSS Removals adapted from Metcalf and Eddie, 2003**

| | Percentage Removal, % | Percentage Removal, % |
|---|---|---|
| | BOD removals | TSS removals |
| At low overflow rates | 35 - 50 | 70 - 90 |
| At medium overflow rates | 40 - 60 | 40 - 80 |
| At high overflow rates | 30 - 60 | 30 - 80 |

A review of recent WEFTEC conference papers on pilot testing of ballasted flocculation for wet weather flow treatment facilities gave the following percentage removals for TSS and BOD.

**Table 4**
**Percentage Removals for TSS and BOD**

| Location | | Effluent Quality Requirements | Report Effluent TSS and BOD | Report TSS and BOD Removal Efficiency Rates |
|---|---|---|---|---|
| City of San Francisco | Jolis et al (2001) | No data given | TSS: <45 mg/L | TSS: 75 - 90%<br>BOD: 60 – 75% |
| Independence Facility, Missouri | Scruggs et al (2001) | Target TSS: 45 mg/L | TSS: <45 mg/L | TSS: 75 – 90%<br>BOD: 60 – 80% |
| New York City | Kurtz et al (2003) | No data given | TSS: 16 mg/L<br>BOD: 51 mg/L | TSS: 84%<br>BOD: 54% |
| City of Salem | Matson (2002) | To achieve secondary equivalent treatment | No data given | TSS: 85 - 90%<br>BOD: 50 – 70% |

| Location | | Effluent Quality Requirements | Report Effluent TSS and BOD | Report TSS and BOD Removal Efficiency Rates |
|---|---|---|---|---|
| City of Toledo | Nitz et al (2004) | No data given | No data given | Ferric Chloride<br>TSS: 82 – 94%<br>Alum<br>TSS: 66 – 92%<br>ACH<br>TSS: 23 – 91%<br>PACl<br>TSS: 0 – 88% |
| Baton Rouge | Kirby et al (2005) | Treatment goal:<br>BOD: 45 mg/L<br>TSS: 45 mg/L | BOD: < 30 mg/L<br>TSS: < 30 mg/L | TSS: > 85%<br>BOD: > 80% |
| Lawrence WWTP | Keller et all (2005) | BOD: 45 mg/L<br>TSS: 45 mg/L | Wet weather effluent TSS less than 45 mg/l, after 10 hours runtime less than 20 mg/L | Reported TSS removal efficiency after 18 months of operation is 88% |

It is expected that ballasted flocculation will produce an effluent that exceeds the MSR requirements of 130 mg/L TSS and BOD concentration and would most likely produce an effluent that is close to or less than 45 mg/L TSS concentration. If it is expected in the future that the effluent quality requirements will become more stringent, say 45 mg/L BOD and TSS, ballasted flocculation provides the flexibility to adapt to potential changes regulations and effluent quality.

## 5 Decision-Making Framework

The overall decision-making framework, and its various elements that will be applied to the Clover Point Facility, was described previously in Discussion Paper 031-DP-1: A Decision-Making Framework for the wastewater Biosolids Management Program (April 14, 2008). In general terms, the Sustainability Assessment Framework (SAF) consists of three main elements: multi-objective alternative analysis, risk identification and analysis and a decision process.

Through these elements the SAF provides a defensible method of developing and evaluating alternatives that address multiple, and potentially conflicting, objectives while identifying and mitigating key risks.

# 6 Next Steps

The consultant team will conduct a more detailed analysis of the treatment alternatives and develop the SAF elements, which form the basis of the SAF analysis.

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