# DISCUSSION PAPER

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

**Clover Point Wet Weather Facility**

**Discussion Paper – Conceptual Alternatives for Clover Point Wet Weather Facility 035-DP-2**

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| ***Prepared by:*** | Michelle Maynard |
| ***Issued:*** | November 4, 2008 |
| ***Previous Issue:*** | None |

# 1 Introduction

The objectives of this Discussion Paper are to develop the conceptual alternatives for Clover Point Wet Weather Facility. First, the paper will define the design parameters for the facility such as design flows and wastewater characteristics. This will assist in developing the conceptual plans for the facility.

The second objective will be to develop conceptual level plans of the three technology approaches.

The third objective will evaluate the operational impacts, risk and comparative costs of the three options to give an insight into the relative desirability of the alternatives.

# 2 Design Parameters

## 2.1 Expected Wet Weather Wastewater Characteristics

The Clover Point catchment is almost completely separate sewers. However Clover Point has high Inflow and Infiltration rates. During wet weather events, the estimated peaking factor between the dry weather flow and a wet weather event has been as high as 10 due to these high levels of inflow and infiltration. The CRD has started a wet weather and dry weather sampling program at the Clover Point facility to characterize the wastewater quality. Based on the data collected to date, it has not been possible to determine the wet weather wastewater characteristics of the Clover Point facility, due to insufficient flow at the time of sampling.

Metcalf and Eddy (2003) give the following characteristics for municipal wastewater and combined wastewater.

| | Combined Wastewater | Municipal Wastewater |
|---|---|---|
| Total Suspended Solids, TSS | 270 – 550 mg/L | 120 – 370 mg/L |
| Biological Oxygen Demand, BOD | 60 – 220 mg/L | 12 – 380 mg/L |

Discussion Paper 035 DP-1 Table 2 summarizes a review of recent WEFTEC conference papers on pilot testing for wet weather flow treatment plants. The table showed that influent used to represent wet weather events during pilot testing was generally in the range of 50 to 150 mg/L for TSS and BOD.

An increase in TSS is often seen for combined sewer systems during wet weather flows due to a phenomenon known as ‘first flush”. The first flush has been observed following the initial phase of a rainfall event during which much of the accumulated surface containments are washed into the combined system. In addition in combined sewers, the increased flow may be capable of re-suspending material previously deposited during low-flow periods. While the Clover Point catchment is almost completely separate sewers, it has high peaking factors between the dry weather flow and wet weather flow. Therefore Clover Point may experience the first flush effect for the first rainfall event after an extended dry period where the increased flow re-suspends material previously deposited during low flow periods. Scruggs et al (2001) reports first flush TSS concentrations during a storm event of 270 to 300 mg/L while pilot testing ballasted flocculation for a wet weather flow treatment facility.

For the purposes of this discussion paper, and to provide sludge production estimates, it was assumed that TSS for a typical storm is 150 mg/L and for a storm with a first flush effect the TSS is 200 mg/L. See **Appendix A** for sludge production estimates for the high rate enhanced primary treatment (HREPT) ballasted flocculation process.

## 2.2 Expected Flows to Clover Point Wet Weather Treatment Facility

The Average Dry Weather Flows (ADWF) and Peak Wet Weather Flow (PWWF) to Clover Point Pump Station in Discussion Paper 033-DP2 are given in Table 1. These flows are not reduced by any capacity issues in the upstream system.

**Table 1**
**Average Dry Weather Flow and Peak Wet Weather Flows**

| | 2005 | 2015 | 2030 | 2045 | 2065 |
|---|---|---|---|---|---|
| ADWF L/s | 607 | 643 | 678 | 724 | 735 |
| 5 year storm event PWWF L/s | 5127 | 5182 | 5234 | 5302 | 5314 |
| 25 year storm event PWWF L/s | 6321 | 6375 | 6427 | 6495 | 6511 |
| 100 year storm event PWWF L/s | 7307 | 7361 | 7413 | 7481 | 7497 |

Currently flow to Clover Point is limited by the capacity of the existing Northeast Trunk/East Coast Interceptor (NET/ECI) conveyance system to convey flow to Clover Point. The limitations are the current confirmed pump capacity of Currie Pump Station and the Northeast Trunk capacity. In addition, Trent Street Pump Station and force main are not included as functional. Therefore, the above reported flows will not reach Clover Point in the short term.

For the purposes of this discussion paper, it is assumed that by 2015 all upstream conveyance upgrades on the NET/ECI system will be completed. This includes Trent Pump Station and force main functioning and the force main extended to Clover Point; Currie Pump Station upgraded to 1500 L/s and twinning and extension of the Currie Pump Station force main to Clover Point. In addition, the Currie Pump Station overflow (McMicking Overflow) will be operational for flow greater than the pump station capacity. After 2015 is also assumed East Saanich WWTP is operational.

The following tables indicate the flows that will be conveyed to Clover Point before and after upgrades to NET/ECI system for 5, 25 and 100 year storm return periods and the average dry weather flow. Both assume Saanich East WWTP is functional.

**Table 2**
**Estimated ADWF at Clover Point in 2015, Prior to Any Further Upgrades on the NET/ECI System**

| | ADWF |
|---|---|
| Design Flow at Clover Point from Discussion Paper 033-DP2 | 643 L/s |
| Estimated Flow to reach Clover Point | 643 L/s |

**Table 3**
**Estimated ADWF at Clover Point in 2015, After Conveyance Upgrades on the NET/ECI System**

| | ADWF |
|---|---|
| Design Flow at Clover Point from Discussion Paper 033-DP2 | 643 L/s |
| Less flow from Saanich East WWTP | 143 L/s |
| Estimated Flow to reach Clover Point | 500 L/s |

**Table 4**
**Estimated ADWF at Clover Point in 2065, After Conveyance Upgrades on the NET/ECI System**

| | ADWF |
|---|---|
| Design Flow at Clover Point from Discussion Paper 033-DP2 | 735 L/s |
| Less flow from Saanich East WWTP | 197 L/s |
| Estimated Flow to reach Clover Point | 538 L/s |

**Table 5**
**Estimated PWWF at Clover Point in 2015, Prior to Any Further Upgrades on the NET/ECI System**

| | 5 Year | 25 Year | 100 Year | | 5 Year | 25 Year | 100 Year |
|---|---|---|---|---|---|---|---|
| Design flow at Clover Point from Discussion Paper 033-DP2 | 5182 L/s | 6375 L/s | 7361 L/s | Design Flow for Arbutus/Penrhyn | 595 L/s | 705 L/s | 795 L/s |
| Less flow from Arbutus/Penrhyn dosing valve closed | 595 L/s | 705 L/s | 795 L/s | Design Flow for Trent Street Pump Station | 870 L/s[1] | 1096 L/s | 1283 L/s |
| Less Excess flow that can't go through Trent Street or Currie Pump Stations | 1136 L/s[1] | 1652 L/s | 2079 L/s | Design Flow for Currie Pump Station | 1266 L/s[1] | 1556 L/s | 1796 L/s |
| Estimated flow to reach Clover Point | 3451 L/s | 4018 L/s | 4487 L/s | | | | |

Note: Until trunk upgrades, the combined Trent Street and Currie Pump Station flows cannot exceed 1000 L/s.

1. Flow = 870 + 1266 – 1000 = 1136 L/s.

## Table 6
## Estimated PWWF at Clover Point in 2015, After Conveyance Upgrades on the NET/ECI System

| | 5 Year | 25 Year | 100 Year | | 5 Year | 25 Year | 100 Year |
|---|---|---|---|---|---|---|---|
| Design flow at Clover Point from Discussion Paper 033-DP2 | 5182 L/s | 6375 L/s | 7361 L/s | Design Flow for Arbutus/Penrhyn | 595 L/s | 705 L/s | 795 L/s |
| Less flow from Saanich East WWTP | 595 L/s | 705 L/s | 795 L/s | Design Flow for Trent Street Pump Station | 870 L/s | 1096 L/s | 1283 L/s |
| Less excess flow that can't go through Trent Street Pump Station | 0 L/s | 0 L/s | 0 L/s | Design Flow for Currie Pump Station | 1266 L/s | 1556 L/s | 1796 L/s |
| Less excess flow that can't go through Currie Pump Station | 0 L/s | 56 L/s | 296 L/s | | | | |
| **Estimated flow to reach Clover Point** | **4587 L/s** | **5614 L/s** | **6270 L/s** | | | | |

Note: Trent Street Pump Station was designed to convey 100 year flows and Currie Pump Station will be upgraded to 1500 L/s in current footprint.

## Table 7
## Estimated PWWF at Clover Point in 2065, After Conveyance Upgrades on the NET/ECI System

| | 5 Year | 25 Year | 100 Year | | 5 Year | 25 Year | 100 Year |
|---|---|---|---|---|---|---|---|
| Design Flow at Clover Point from Discussion Paper 033-DP2 | 5318 L/s | 6512 L/s | 7497L/s | Design Flow for Arbutus/Penrhyn | 670 L/s | 780 L/s | 870 L/s |
| Less flow from Saanich East WWTP | 670 L/s | 780 L/s | 870 L/s | Design Flow for Arbutus/Penrhyn | 887 L/s | 1114 L/s | 1301 L/s |
| Less Excess flow that can't go through Trent St Pump Station | 0 L/s | 0 L/s | 0 L/s | Design Flow for Currie Pump Station | 1264 L/s | 1553 L/s | 1793 L/s |
| Less Excess flow that can't go through Currie Pump Station | 0 L/s | 53 L/s | 293 L/s | | | | |
| **Estimated Flow to reach Clover Point** | **4648 L/s** | **5679 L/s** | **6334 L/s** | | | | |

Note: Trent Street Pump Station was designed to convey 100 year flows and Currie Pump Station will be upgraded to 1500 L/s in current footprint.

For the purposes of this discussion paper, it is assumed that the average dry weather flow for Clover Point Wet Weather Treatment Plant will be based on the year 2065 AWDF, where the reported flow is not reduced by any capacity issues in the upstream system or any upstream wastewater treatment plants. Therefore, the ADWF is 735 L/s. In reality, with the improvements to the NET/ECI system and with Saanich East WWTP in place, the ADWF to Clover Point will reduce over time and, by 2065, will be 538 L/s as indicated in Tables 2 to 4.

### 2.3 Wet Weather Event Frequency and Duration

Currently Discussion Paper 033-DP3, which estimates the frequency, duration and volume of sanitary sewer overflows, has not yet been completed. This will provide information on the duration, frequency, and flows of storm events arriving at Clover Point during wet weather events. As an interim, flow data for Clover Point from March 2004 to December 2007 was assessed to gain an understanding of the duration, frequency, and flows of storm events arriving at Clover Point that were greater than two times ADWF in the past four years. Note that flow to Clover Point is limited by the capacity of the upstream components of the NET/ECI. The return period of the storms that created these events was not determined. Tables 8 and 9 summarize the number of events per year, total duration of storm events greater than 2 ADWF, peak and average flow rates greater than 2 ADWF. Figure 1 shows the distribution of the length of storms for flows greater than 2 ADWF.

**Figure 1**
**Distribution of Length of Storms for Flows Greater than 2 ADWF**

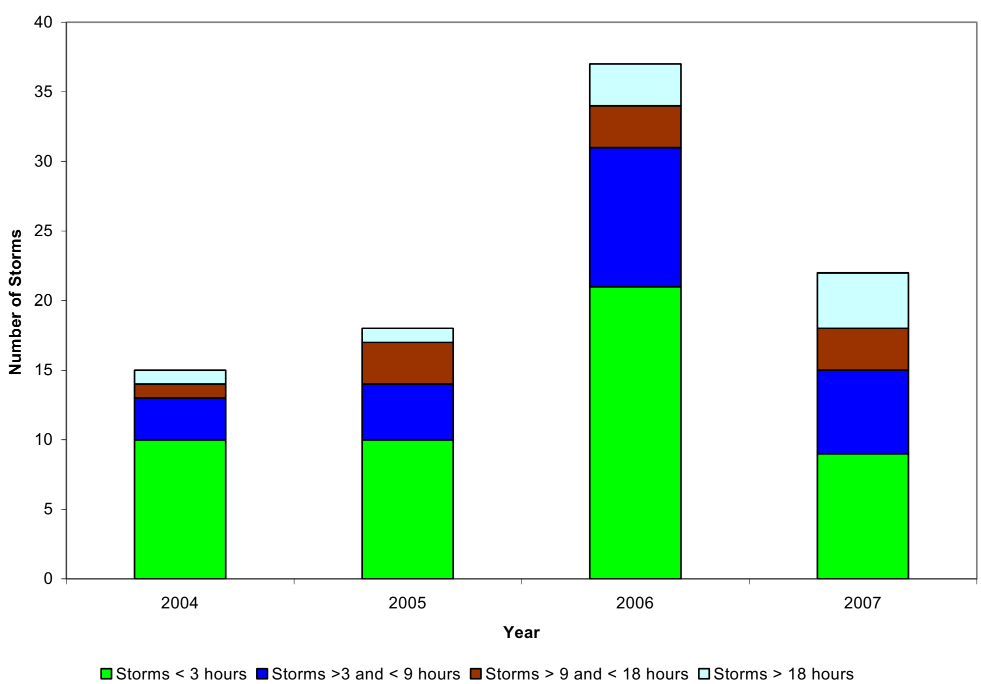


**Table 8**
**Number of Storms and Durations of Storms with Flow Greater than 2 ADWF**

| Year | Number of Storms | Total Duration of Storms with Flow Greater than 2 ADWF |
|---|---|---|
| 2004 | 15 | 72 hours |
| 2005 | 18 | 119 hours |
| 2006 | 38 | 193 hours |
| 2007 | 22 | 172 hours |

Note: 2004 data is from March to December.

**Table 9**
**Average and Maximum Storm Duration and Flow Data**

| | 2004 – 2007 Clover Point Flow |
|---|---|
| Average Storm Duration | 6 hours |
| Maximum Storm Duration | 33 hours |
| Average Flow Less 2 ADWF range | 0 - 640 L/s (Average 216 L/s) |
| Average Peak Flow Less 2 ADWF | 333 L/s |
| Maximum Peak Flow Less 2 ADWF | 943 L/s |

Note:
1. Duration is the length of time when the flow to Clover Point is greater than 2 ADWF.
2. Average flow is the average of the flow to Clover Point, which greater than 2 ADWF, for each storm.
3. Peak flow is the peak flow for each storm.

## 2.4 Summary of Design Parameters

The selected design flow parameters for the Clover Point Wet Weather Treatment Facility are summarized as follows:

- Average Dry Weather Flow is 735 L/s.
- Pass forward flow to a downstream treatment facility is 2 ADWF, 1470 L/s.

- Maximum flow to the wet weather treatment facility, 4 ADWF, 2940 L/s.
- Screens will be sized based on 1-in-25 year storm event, for the 2065 design horizon, less 2 ADWF, 4209 L/s. Note that there is only a small increase in flow a 1-in-25 year storm in 2015 (4144 L/s) and the same event in 2065. Therefore, the year 2065 was chosen as the design horizon for the screens.
- Where required screened flow greater than the wet weather treatment facility, 2940 L/s, will bypass the wet weather treatment facility and will blend with the treated effluent from the wet weather treatment facility before being discharged through the existing long outfall.
- Any flow greater than the 2065, 1-in-25 year storm event will bypass the screens and discharge via the existing short outfall.

# 3 Conceptual Plans

## 3.1 Overview

Discussion Paper 035-1 discussed three treatment options for the Clover Point Wet Weather Treatment Facility. These were:

- Continue to use 6 mm screens
- Implement microscreens
- Implement HREPT

The following three process flow schematics show the different flow scenarios for the three treatment options and are based on the flow data in Table 7 for 2065 for a 1 –100 year return period storm.

**Figure 2**
**Process Flow Schematic for 6 mm Screens**

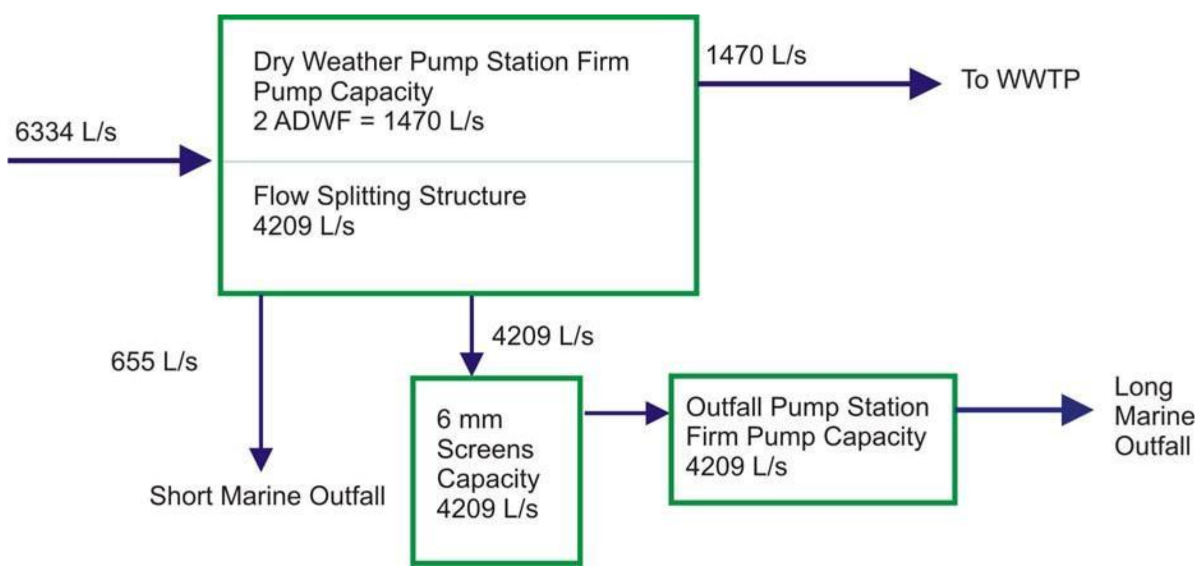


**Figure 3**
**Process Flow Schematic for Microscreens**

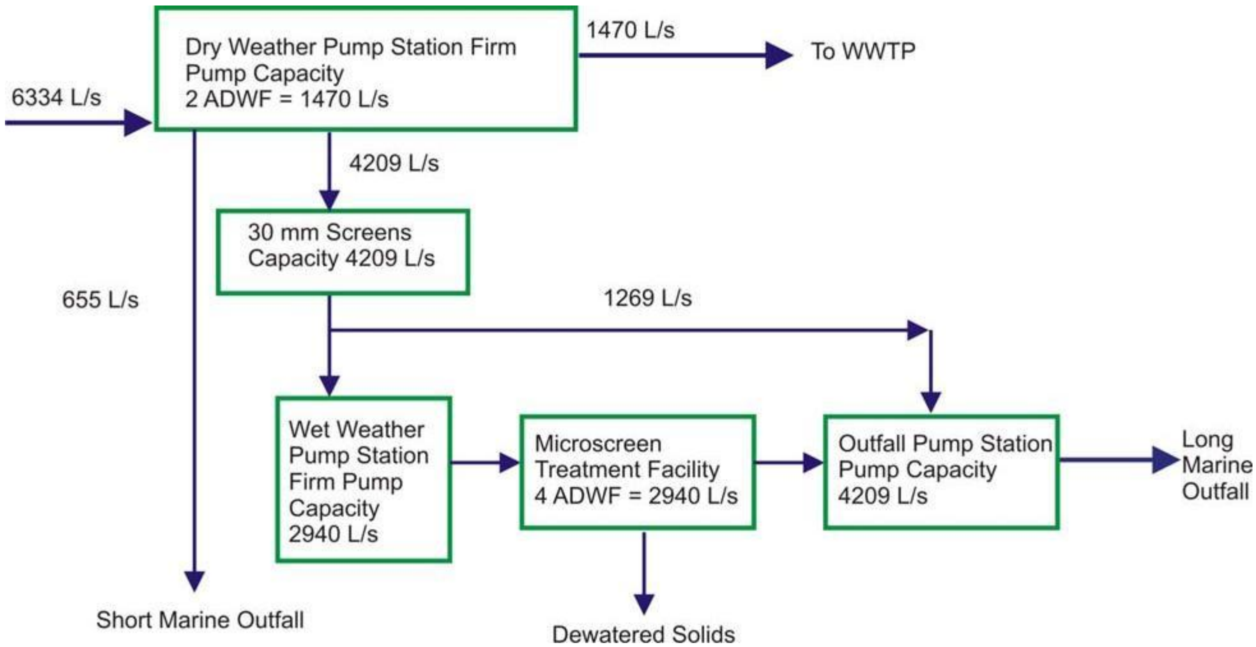
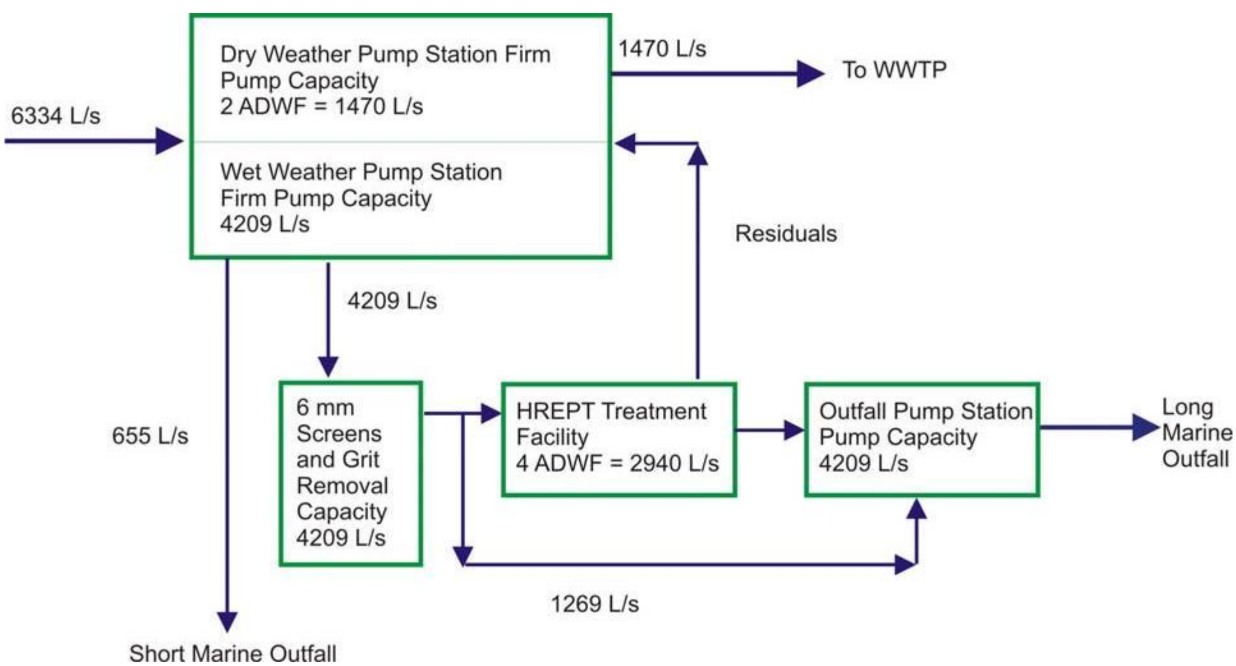



**Figure 4**
**Process Flow Schematic for HREPT**



### 3.2 6 mm Screen Option

This treatment option will consist of the following components:

- Dry weather pump station
- Wet weather flow splitting structure
- 6 mm fine screens
- Screening washing, compaction and storage
- Outfall pump station
- Chemical odour control
- Instrumentation/control and SCADA
- Electrical including standby power

It is envisaged the facility will function as follows.

**Dry Weather Pump Station** – Four equally sized dry pit submersible wastewater pumps each rated at a capacity of 490 L/s are proposed for the pump station to pump to the proposed downstream wastewater treatment facility. The firm pumping capacity of these pumps will be 1470 L/s. The pumps will be controlled by variable frequency drives. An electromagnetic flowmeter will be installed on the discharge header to measure and record the flow pumped to the downstream wastewater treatment facility.

**Wet Weather Flow Splitting Structure** – When the flow to the dry weather pump station exceeds the firm capacity of the dry weather pump station (1470 L/s), the water level in the channel feeding the dry weather pump station wet well will increase as the flow into the facility increases, when the water level reaches a specified level the water will pass over a weir and into the channel that feeds the fine screens. A separate weir will also divert flow greater than the combined capacity of the screens and dry weather pump station to the short sea outfall. A Parshall flume will be installed in the overflow channel to record flows.

**Fine Screens** – Three mechanically cleaned 6 mm perforated plate screens (two duty, one standby) will screen out the floatables and the solids greater than 6 mm. The captured screenings will be dewatered, and stored in bin for disposal. Manually-operated slide gates are provided to allow for isolations of the screens when required. An emergency overflow weir and channel will be provided in the event the screens become blinded.

**Outfall Pump Station** - The pump station will consist of a combination of six pumps of two different sizes. There will be three large pumps at 1403 L/s to handle large storms and three small pumps at 468 L/s for small storms. The firm capacity of the pump station will be 4209 L/s. The arrangement will be dry pit submersible wastewater pumps. The outfall pumps will discharge the screened effluent through the outfall system. The pumps will be controlled by variable frequency drives. This combined with the different pump sizes will provide control of the pump discharge rate for the different storm events. An electromagnetic flowmeter will be installed on the discharge header to measure and record the flow pumped to the outfall.

### Operational Considerations

Given the intermittent operation of a wet weather plant, the following should be considered in relation to fine screens, Keller (2005):

- *Test Runs* – During non active periods both the fine screen and the transport system should be operated to ensure their operation during wet weather events.
- *Screen Cleaning* – Effective screen cleaning mechanism to ensure the screen is appropriately cleaned after each operation, in preparation for the next wet weather event.
- *Screenings Disposal* – Consideration should be given to the removal of the washed and compacted screenings from the washer/compactor equipment to ensure the screenings do not dry and cake up in the discharge chute. A short disposal chute should be considered.
- *Grit Deposition* – For an intermittent operation of a fine screen without a grit removal process upstream it is important to clean out screening approach channel out after each use. If grit is present within the channel and flow enters, the grit can be re-suspended and may lodge in the fine screen components. This could cause failure. Mud valves should be provided within the channel floor with a water system at the operating floor for drainage and washing down of the screen channels.

## 3.3 Microscreen Option

This treatment option will consist of the following components:

- Dry weather pump station
- 30 mm fine screens
- Screening washing, compaction and storage
- Wet weather pumping station
- Bypass weir
- 250 micron microscreens and ancillary equipment
- Dewatered solids storage
- Chemical odour control
- Instrumentation/control and SCADA
- Electrical including standby power

It is envisaged the facility will function as follows.

**Dry Weather Pump Station** – Four equally sized dry pit submersible wastewater pumps each rated at a capacity of 490 L/s are proposed for the pump station to pump to the proposed downstream wastewater treatment facility. The firm pumping capacity of these pumps will be 1470 L/s. The pumps will be controlled by variable frequency drives. An electromagnetic flowmeter will be installed on the discharge header to measure and record the flow pumped to the downstream wastewater treatment facility.

Two motorized slides gates will separate the dry weather wet well from the channel that feeds 30 mm screens, these gates will remain closed until the flowmeter on the discharge side of the dry weather pumps reaches maximum flow for a period of them and the water level in the wet well continues to rise. When this condition is reached then the slide gates will open and allow flow to the screen channels.

**30 mm Screens** – Two mechanically cleaned 30 mm bar screens (one duty, one standby) will screen out the floatables and the solids greater than 30 mm. The screened effluent will discharge directly into the wet weather wet well. The captured screenings will be dewatered, and stored in bins for disposal. Manually operated slide gates are provided to allow for isolations of the screens when required. An emergency overflow weir and channel will be provided in the event the screens become blinded. The vendor of microscreens used for this discussion paper recommended 30 mm screen upstream of the microscreens.

**Wet Weather Pump Station** – The pump station will consist of a combination of six pumps of two different sizes. There will be three large pumps at 980 L/s to handle large storms and three small pumps at 327 L/s for small storms. The firm capacity of the pump station will be 2940 L/s. The arrangement will be dry pit submersible wastewater pumps. The wet weather pumps will discharge the screened effluent to the microscreens. The pumps will be controlled by variable frequency drives. This combined with the different pump sizes will provide control of the pump discharge rate for the different storm events. An electromagnetic flowmeter will be installed on the discharge header to measure and record the flow pumped to the microscreens.

When the screened effluent flow exceeds the capacity of the wet weather treatment facility a bypass weir will allow the excess flow to continue to the outfall pump station via a channel with a Parshall flume to record bypass flows.

**250 Micron Microscreens** – For this conceptual design a fine mesh wire cloth sieve mechanical screen was used. Based on the largest microscreen of this type currently available a total of 32 microscreens are required. The microscreens can be paired together. An arrangement of two banks of eight pairs was chosen. To control flow to the screens a motorized isolation valve is provided. The number of screens operating at anyone time will be based on the flow measurement from the flow meter on the wet weather discharge header. Each of these screens requires a dedicated blower for cleaning. The microscreen effluent will discharge to the outfall pump station wet well.

**Dewatered Solids Storage** – This type of microscreen will produce solids residuals at 25 to 35% dry solids. At this dry solids percentage the solids can be discharge directly to storage bins for disposal.

**Outfall Pump Station** - The pump station will consist of a combination of six pumps of two different sizes. There will be three large pumps at 1403 L/s to handle large storms and three small pumps at 468 L/s for small storms. The firm capacity of the pump station will be 4209 L/s. The arrangement will be dry pit submersible wastewater pumps. The outfall pumps will discharge the treated effluent through the outfall system. The pumps will be controlled by variable frequency drives. This combined with the different pump sizes will provide control of the pump discharge rate for the different storm events. An electromagnetic flowmeter will be installed on the discharge header to measure and record the flow pumped to the outfall.

### Operational Considerations

For wet weather applications where operations of the plant will be intermittent in addition to the operation considerations for the fine screens, the fine mesh wire cloth sieve mechanical screen will need an automatic clean after being dormant for a period of time to ensure it is ready for use during the next wet weather event. It is ready for screening the instant flow arrives at the screen.

## 3.4 HREPT Ballasted Flocculation Option

This treatment option will consist of the following components:

- Dry weather pump station
- 6 mm fine screens
- Screening washing, compaction and storage
- Grit removal
- Grit washing and storage
- Wet weather pumping station
- Bypass weir
- Ballasted Flocculation and ancillary equipment including chemicals and sludge pumps
- Residual Management
- Chemical based odour control
- Instrumentation/control and SCADA
- Electrical including standby power

It is envisaged the facility will function as follows.

**Dry Weather Pump Station** – Four equally sized dry pit submersible wastewater pumps each rated at a capacity of 490 L/s are proposed for the pump station to pump to the proposed downstream wastewater treatment facility. The firm pumping capacity of these pumps will be 1470 L/s. The pumps will be controlled by variable frequency drives. An electromagnetic flowmeter will be installed on the discharge header to measure and record the flow pumped to the downstream wastewater treatment facility.

Two motorized slides gates will separate the dry weather wet well from the channel that feeds wet weather pump station wet well, these gates will remain closed until the flowmeter on the discharge side of the dry weather pumps reaches maximum flow for a period of time and the water level in the wet well continues to rise. When this condition is reached then the slide gates will open and allow flow to the channel. In addition as the ballasted flocculation facility has a minimum flow to treatment, the dry weather pump station will reduce its output by this amount to ensure the minimum flow requirements for the ballasted flocculation facility is met. This is for those wet weather events where the flow into the facility is less than the minimum flow to treatment but greater than the dry weather pump station capacity. However, when the flow from the wet weather pump station reaches two times the minimum flow requirements, the dry weather pump capacity returns to 1470 L/s.

**Wet Weather Pump Station** – The pump station will consist of a combination of six pumps of two different sizes. There will be three large pumps at 1403 L/s to handle large storms and three small pumps at 468 L/s for small storms. The firm capacity of the pump station will be 4209 L/s. The arrangement will be dry pit submersible wastewater pumps. The wet weather pumps will discharge the wet weather flow to the 6 mm screens. The pumps will be controlled by variable frequency drives. This combined with the different pump sizes will provide control of the pump discharge rate for the different storm events. An electromagnetic flowmeter will be installed on the discharge header to measure and record the flow pumped to the screens.

When the flows exceed the combined firm capacity of the wet weather pump station and dry weather pump station, 5679 L/s, the excess flow will be discharge via an overflow weir in the wet well to the short sea outfall. A Parshall flume will be installed in the overflow channel to record flows.

**Fine Screens** – Three mechanically cleaned 6 mm perforated plate screens (two duty, one standby) will screen out the floatables and the solids greater than 6 mm. The captured screenings will be dewatered, bagged and stored in bin for disposal. Manually operated slide gates are provided to allow for isolations of the screens when required. An emergency overflow weir and channel will be provided in the event the screens become blinded.

**Grit Removal** – A grit removal system to remove particles greater than 300 microns, upstream of the ballasted flocculation facility was indicated as preferable by the vendor, if grit was present in the system, to prevent sand accumulation in the coagulation tank and any interference with the ballasted flocculation process. The vendor also commented that grit removal was not critical and as an alternative they recommend that a means of blowing off excess solids was installed, such a bypass line on the hydrocyclones or at the sludge pumps. It should also be noted that with the intermittent operation of the facility, grit accumulation in the process might not occur. As a conservative approach and to determine the maximum plan area required for the facility a grit removal system was included; a vortex system was used for the conceptual design.

When the water level in the channel between the 6 mm screens and grit removal, and the ballasted flocculation facility reaches a specific level water will pass over a bypass weir. The bypass channel will then allow the flow to continue onto the outfall pump station. A Parshall flume will be installed in the bypass channel to record any bypass flows.

**Ballasted Flocculation Facility** – The treatment capacity of the ballasted flocculation facility is 2940 L/s and will consist of two trains. Each train will be made of a coagulation basin, injection basin, maturation basin and a lamella clarifier. Initially the facility will operate one train, if the flows continue to increase, when the capacity of the first train is met the second train is brought online and flow equalizes between the two trains. If the flow then drops, the second train is dropped when the total flow is less than two times the minimum flow to treatment. When the dry weather pump station pumped flow begins to decrease over a specified time period then the flow to the first train is stopped. That is the wet weather pump station stops pumping and the dry weather pump station pumps returns to its full capacity of 1470 L/s, if it had previously been operating at a reduced capacity.

The solids from the ballasted flocculation process are extracted from the bottom of the clarifier and pumped to the hydrocyclones to separate the microsand from the solids. The solids are returned to the dry weather pump station wet well. Here the solids will mix with the incoming flow and be pumped to the proposed downstream treatment facility. The solids flow rate is dependant on the storm duration and intensity and characteristics. However, based on the sludge production estimate, see Appendix A, the solids flow rate could be between 92 L/s for 24 hour storm, TSS/BOD 150 mg/L, for a flow rate of 3 ADWF to 155 L/s for 6 hour storm, TSS/BOD 200 mg/L, for a flow rate of 4 ADWF. By returning the dry weather pump station to full capacity once the flow to treatment exceeds two times the minimum flow requirement for the facility ensures the solids is pumped to downstream to the treatment facility. It is not envisage that additional pumping capacity is required for the solids flow.

**Outfall Pump Station** – The pump station will consist of a combination of six pumps of two different sizes. There will be three large pumps at 1403 L/s to handle large storms and three small pumps at 468 L/s for small storms. The firm capacity of the pump station will be 4209 L/s. The arrangement will be dry pit submersible wastewater pumps. The outfall pumps will discharge the treated effluent through the outfall system. The pumps will be controlled by variable frequency drives. This combined with the different pump sizes will provide control of the pump discharge rate for the different storm events. An electromagnetic flowmeter will be installed on the discharge header to measure and record the flow pumped to the outfall.

### Operational Considerations

To operate the ballasted flocculation as a wet weather plant there are a number of considerations. There are:

- *Winter Months Startup or Standby Conditions* – The facility can use a completely wet startup method where all associated basins are kept full with influent and effluent between wet weather events. Or all tanks can be drained down between wet weather events for a completely dry event. A combination of the dry and wet startup methods could be used where only the clarifier is drained down and the coagulation, injection and maturation basins are full with influent.
- *Summer Months Shutdown Conditions* – The facility could be left completely dry or wet. The City of Bremerton CSO Actiflo® facility is filled with potable water during the summer months, with a very low circulation of water through the system. See **Appendix B** for a summary of the site visit to the City of Bremerton CSO facility.
- *Microsand Storage* – Sand can be stored in the injection or coagulation basin. At the end of a wet weather event, the microsand can be returned to the injection basin by removing the sludge in the bottom of the clarifier and the hydrocyclone used to separate the sand from the sludge. When the basin is started up, the microsand will be re-suspended. This method of storage means only a small volume of sand will need to be kept on site to replenish the microsand when needed.
- *Test Runs* – During not active periods both mixers and clarifier scrappers should be operated to ensure their operation during wet weather events.

### 3.5 Area Requirements

The area requirements for each of the options are shown in Tables 10 to 12.

**Table 10**
**Estimated Plan Areas for Screens**

| Fine Screens | Length/m | Width/m | Area/m$^2$ |
|---|---|---|---|
| Dry weather pump station including flow splitting structure | 22 | 25 | 550 |
| 6 mm fine screens | 10 | 10 | 100 |
| Screening washing, compaction and storage | 20 | 10 | 200 |
| Outfall pump station | 20 | 23 | 460 |
| Chemical odour control | 20 | 10 | 200 |
| MCC and controls | 4 | 23 | 92 |
| Genset | 6 | 23 | 138 |
| **Total** | | | **1740** |

**Table 11**
**Estimated Plan Areas for Microscreens**

| Microscreens | Length/m | Width/m | Area/m$^2$ |
|---|---|---|---|
| Dry weather pump station | 14 | 23 | 322 |
| 30 mm fine screens | 17 | 7 | 119 |
| Wet weather pump station includes area for screening washing, compaction and storage | 17 | 32 | 544 |
| Microscreens includes area for solids storage | 22 | 75 | 1650 |
| Blowers | 6 | 63 | 378 |
| Mechanical room | 7 | 15 | 105 |
| Outfall pump station | 20 | 32 | 640 |
| Chemical odour control | 11 | 16 | 176 |
| MCC and controls | 7 | 48 | 336 |
| Genset | 11 | 7 | 77 |
| **Total** | | | **4347** |

**Table 12**
**Estimated Plan Areas for HREPT Ballasted Flocculation**

| HREPT Ballasted Flocculation | Length /m | Width/m | Area/m$^2$ |
|---|---|---|---|
| Dry weather pump station | 14 | 23 | 322 |
| Wet weather pump station | 17 | 32 | 544 |
| 6 mm fine screens, grit removal and residual handling | 23 | 24 | 552 |
| Ballasted flocculation facility | 17 | 26 | 442 |
| Sludge Pumps | 9 | 15 | 135 |
| Chemical and sand storage | 10 | 18 | 180 |
| Outfall pump station | 20 | 31 | 620 |
| Chemical odour control | 10 | 13 | 130 |
| MCC and controls | 10 | 31 | 310 |
| Genset – located in existing building | 11 | 7 | 77 |
| **Total** | | | **3312** |

As can be seen above, the screen option requires the least amount of land, while the microscreens requires the most land with HREPT ballasted flocculation in the middle. The smaller the land requirement, the easier it will be to incorporate the facility within the surroundings and minimize the impact on the function of the park.

### 3.6 Overall Operational Considerations

As the facility will only be operation during wet weather events all options will reduce vehicle traffic to the site and reduce landfill material from Clover Point. However the microscreen option will have to solids truck away from the site. The volume of solids and therefore the number of truck trips is dependant on the size wet weather event. The HREPT ballasted flocculation is the only option of the three options that will require additional chemicals to those required for the chemical odour control. There will be limited chemical deliveries to the site for this option, dependant on the frequency and intensity of the wet weather events.

All options should be able to minimize odours from the site but the microscreen options will have an increased chance of odour complaints due to the transportation of solids from the site.

## 4 Project Related Risks

Four main risks have been identified that might help give insight into the relative desirability of alternatives:

- *Public Acceptance:* Any new wastewater or solid waste project is likely to result in opposition. The risk of adverse public perception, including political risks, is evaluated in the context of whether an activity is likely to run counter to public expectations. If the opposition is strong enough, experience has shown that the project might fail to be implemented as planned.
- *Technical and Financial:* The risk exists that a new process or technology will not work as planned, thus resulting in unbudgeted costs and political embarrassment to correct the deficiencies. Such unanticipated changes in costs have the potential to trigger unplanned rates increases or decreases.
- *Changes in Regulatory Requirements:* The risk exists that current applicable regulations become more stringent in the future, resulting in changes to the facility to meet the effluent qualities. Depending on the technology approach chosen, additional processes may be required to meet more stringent effluent qualities.
- *Climate Change:* The risk exists that climate change will result in unanticipated sea level rise and/or a substantial increase in the volatility of weather patterns and extreme events. These changes would result in increased use of the wet weather facility. Operational costs would likely increase. As Clover Point is located on the coast, the site may be more susceptible to increased sea level and resultant flooding of the site. For the outfall pump station, increases in sea level will result in increased total dynamic head for the pumps and therefore reduced capacity and increased energy costs.

Table 13 presents the associated risks for each of the treatment options.

**Table 13**
**Associated Risk for Each Treatment Option**

| Risk | Fine Screens | Microscreens | HREPT Ballasted Flocculation |
|---|---|---|---|
| There is no public acceptance of the project | Moderate risk - *all options will generate some level of public opposition* | | |
| Process does not work as planned resulting in unbudgeted costs | Low Risk *Established technology* | Moderate Risk *Untested technology at this flow rate* | Low Risk *Established technology* |
| Current applicable regulations become more stringent resulting in changes to the facility to meet effluent quality and additional construction | High Risk *Additional processes and construction required* | Moderate Risk *Additional processes and construction likely to be required* | Low Risk *Process capable of producing high quality effluent* |
| Climate change resulting in more wet weather events and increased operational costs | Moderate risk – *Climate change will result in increased operational costs for all options* | | |

## 5 Comparative Process Costs

Table 14 shows the comparative costs for the different options. These costs are limited to the main process equipments costs only and do not include any structural, civil, electrical, instrumentation and other process mechanical costs.

**Table 14**
**Comparative Costs**

| | Equipment | Cost |
|---|---|---|
| Fine Screens | Three screens (two duty, one standby arrangement) with screenings washer/compactor with bagging attachment.<br><br>Peak flow per screen 2190 L/s. | $1.3 Million |
| Microscreens | 32 - 250 micron microscreens and ancillary equipment (28 duty, four standby).<br><br>Peak flow per screen 105 L/s. | $6.4 Million |
| HREPT – Ballasted Flocculation | Three screens (Two duty, one standby arrangement) with screenings washer/compactor.<br><br>Peak flow per screen 2190 L/s.<br><br>Grit Removal - Peak flow 4209 L/s.<br><br>Two HREPT trains – mixers, scrappers, sludge pumps, hydrocyclones.<br><br>Peak flow per train – 1470 L/s.<br><br>Coagulant dosing skid, polymer preparation and dosing skid, automatic sand dosage system | $4 Million |

Note:

1. Equipment direct costs only.

# 6 Summary

Microscreens will produce an effluent quality comparable to primary effluent. However, microscreens are primarily used for small communities and have not been used for treating wastewater at the flow rates required for Clover Point Wet Weather Facility. The end result is a large number of units are required for the facility. Due to the high number of units, the area required for this type of facility is the largest for the three options. The comparative cost for microscreens is also the highest for the three options. The cost is more than the ballasted flocculation cost, which will produce a higher quality effluent than the primary treatment effluent. It should be noted that with technology development, the maximum capacity per unit will increase, which should result in a smaller footprint and reduced costs. At this stage, microscreens are eliminated as a viable option for the Clover Point Wet Weather Treatment Facility due to the reasons given above.

# 7 Next Steps

Discussion Paper 3 will continue to develop the options of fine screening only or HREPT ballasted flocculation with fine screens for the Clover Point Wet Weather Treatment Facility.

# References

Keller, John. 2005. Actiflo®: A Year's Worth of Operation Experience from the Largest SSO System in the US. WEFTEC 2005 Conference Proceedings.

Metcalf and Eddy. 2003. Wastewater Engineering Treatment and Reuse.

Scruggs, Caroline, Wallis-Lage, Cindy. 2001. Ballasted Flocculation: A Wet-Weather Treatment Solution?. WEFTEC 2001 Conference Proceedings.

# APPENDIX A - HREPT Sludge Production Estimates

Capital Regional District - Core Area Wastewater Management Strategy: Program Development Phase
Clover Point Wet-Weather Treatment Facility

| | | | |
|---|---|---|---|
| **File:** | 20062935.04.E.03.05 | **Subject:** | Sludge Production Estimates |
| **Last Revision:** | September 11, 2008 | | Scenario: Preliminary Calculation |
| **Prepared:** | M. Maynard / D. Shiskowski | | |
| **Checked:** | | | |

**Yellow-shaded cell denotes assumed/input values**

**Scenario Description:**
Maximum design flow to Actiflo facility = 4 x ADWF = 3116 L/s

Historical flow data from 2004 to 2008 show Clover Pt has experienced events where the flow is over 2 x ADWF (1558 l/s) from 1 hour up to 33 hours. Note currently the maximum capacity of the existing pumps is 2500 L/s. The conveyance system that brings flow to Clover Point is under capacity and restricts the amount of flow to the plant. Upgrades are planned for the system by the year 2015 which will increase the flows to Clover Pt. However the Actiflo plant will treat a maximum of 4 x ADWF regardless of how much flow arrives at Clover Pt. Flows greater than 4 DWF will be screen and bypass the Actiflo plant. Therefore the worst case scenario for sludge production will be when the plant is at maximum capacity, 4 x ADWF, 3116 L/s.

Assumptions were made on the duration of the storm event and the BOD and TSS. The parameter concentrations were based on data for other facilities, with consideration given to very limited CRD data currently available.

**Scenario 1.** 24 hour duration storm with BOD/TSS at 150 mg/l. Mean flow rate for entire duration assumed to be 3 x ADWF.
**Scenario 2.** 6 hour duration storm with first flush conditions BOD/TSS at 200 mg/l. Mean flow rate for entire duration assumed to be 4 x ADWF, which is the capacity of the ActiFlo system.

**Scenario 1**

**Wastewater:**

| | | |
|---|---|---|
| Event duration [1]= | 24 | hr |
| Mean flow rate [1] = | 2337 | L/s |
| Mean TSS conc [2] = | 150 | mg/L |
| Mean BOD conc [2] = | 150 | mg/L |
| TSS loading = | 1262 | kg/hr |
| BOD loading = | 1262 | kg/hr |
| TSS mass = | 30288 | kg/event |
| BOD mass = | 30288 | kg/event |

**Chemicals / sand:**

| | | |
|---|---|---|
| Alum dose concentration [3]= | 110 | mg/L |
| Chemical precipitate mass [4] = | 0.23 | g/g alum |
| Sand dosing rate [5] | 4 | kg/m3 treated flow |

(not used in calculation)

**ActiFlo System**

**System performance:**

| | | |
|---|---|---|
| TSS removal eff [6]= | 85 | % |
| BOD removal eff [6]= | 70 | % |
| Sludge conc [7]= | 4,000 | mg/l |
| Sand loss [8] = | 4 | g/m3 |

**Effluent:**

| | | |
|---|---|---|
| TSS conc = | 23 | mg/L |
| BOD conc = | 45 | mg/L |

**Sludge:**

| | | | | |
|---|---|---|---|---|
| TSS total mass (WW solids only) = | 1073 | kg/hr | 25,744 | kg/event |
| Chemical Sludge mass = | 217 | kg/hr | 5,203 | kg/event |
| Sand = | 34 | kg/hr | 808 | kg/event |
| **Total sludge mass =** | **1,323** | **kg/hr** | **31,755** | **kg/event** |
| **Mean flow rate =** | **331** | **m3/hr** | **7,939** | **m3/event** |
| Sludge removal rate from clarifier | 4% | of total flow | | |
| TSS conc ( all solids) = | 4,000 | mg/L | | |
| | | | | |
| BOD total mass (WW solids only) = | 883 | kg/hr | | |
| BOD conc = | 2,671 | mg/L | | |

**Scenario 2**

**Wastewater:**

| | | |
|---|---|---|
| Event duration [1]= | 6 | hr |
| Mean flow rate [1] = | 3116 | L/s |
| Mean TSS conc [2] = | 200 | mg/L |
| Mean BOD conc [2] = | 200 | mg/L |
| TSS loading = | 2244 | kg/hr |
| BOD loading = | 2244 | kg/hr |
| TSS mass = | 13461 | kg/event |
| BOD mass = | 13461 | kg/event |

**Chemicals / sand:**

| | | |
|---|---|---|
| Alum dose concentration [3]= | 110 | mg/L |
| Chemical precipitate mass [4] = | 0.23 | g/g alum |
| Sand dosing rate [5] | 4 | kg/m3 treated flow |

(not used in calculation)

**ActiFlo System**

**System performance:**

| | | |
|---|---|---|
| TSS removal eff [6]= | 85 | % |
| BOD removal eff [6]= | 70 | % |
| Sludge conc [7]= | 4,000 | mg/l |
| Sand loss [8] = | 4 | g/m3 |

**Effluent:**

| | | |
|---|---|---|
| TSS conc = | 30 | mg/L |
| BOD conc = | 60 | mg/L |

**Sludge:**

| | | | | |
|---|---|---|---|---|
| TSS total mass (WW solids only) = | 1,907 | kg/hr | 11,442 | kg/event |
| Chemical Sludge mass = | 289 | kg/hr | 1,734 | kg/event |
| Sand = | 45 | kg/hr | 269 | kg/event |
| **Total sludge mass =** | **2,241** | **kg/hr** | **13,445** | **kg/event** |
| **Mean flow rate =** | **560** | **m3/hr** | **3,361** | **m3/event** |
| Sludge removal rate from clarifier | 5% | of total flow | | |
| TSS conc ( all solids) = | 4,000 | mg/L | | |
| | | | | |
| BOD total mass (WW solids only) = | 1,570 | kg/hr | | |
| BOD conc = | 2,803 | mg/L | | |

**Notes and References:**
See Reference Tab

# APPENDIX B - Actiflo® Plant Site Visits

Associated Engineering | GLOBAL PERSPECTIVE. LOCAL FOCUS.

# MEMO

**Date:** October 29, 2008 **File:** 20062935

**To:** File

**From:** Michelle Maynard

**Project:** CRD Core Area Wastewater Management Plan

**Subject:** Site Visits to Tacoma and Bremerton, Wet Weather Actiflo® Facilities

## 1 INTRODUCTION

The site visit to the Cities of Tacoma and Bremerton, WA wet weather Actiflo® facilities provided an interesting insight into the Actiflo process and the small footprint required to treat the comparatively large peak flows.

## 2 CITY OF TACOMA SITE VISIT

The City of Tacoma wet weather facility is part of their existing Central Wastewater Treatment Plant. Here the secondary treatment capacity of the existing plant is 3505 L/s. To provide additional treatment during wet weather flow, up to 3066 L/s, two 1533 L/s Actiflo® process streams were installed. This expansion is in the final stages of commissioning and handover to the City of Tacoma on this design build project.

Observations from site visit:

- There is no grit removal upstream of the Actiflo® process. Flow is diverted to the two Actiflo® process stream upstream of the aerated grit tanks, via two large diameter pipes with isolation valves.
- The minimum flow to treatment is 526 L/s.
- The coagulation, injection and maturation basins are kept full of influent to provide a wet start during a wet weather event.
- The process included an additional recirculation pumped system to ensure that effluent did not exit the Actiflo® process until the discharge requirements were met.
- The overall process start up time is around 30 minutes, as this is the time it take to get the chlorination system up and running to the Actiflo® process for final effluent disinfection.
- Chemicals used are ferric chloride and polymer. The chemical system is ready within 30 minutes.
- Storage for sand was limited.
- Maintenance plan not determined yet as the plant is still in the process of being handed over to the City of Tacoma.
- There is two year performance contract on the Actiflo® plant; the Design-Build team and Kruger will be responsible for the plant's performance.

## 3 CITY OF BREMERTON SITE VISIT

The City of Bremerton combined sewer overflow treatment facility is a remote plant. This 876 L/s facility has been in operation since 2001. The plant operates 10 to 12 times during the winter months and is always process-ready to treat any wet weather event. The facility consists of a 379 $m^3$ upstream storage tank, horizontal screen, Actiflo® process, UV disinfection and biosolids storage tank.

Observations from site visit:

- There is no grit removal upstream of the Actiflo® process. However the storage tank most likely provides an environment in which grit and some solids will settle out as the storage tank fills and then overflows through the screen into Actiflo® plant. At the end of a wet weather event, the storage tank is drained and cleaned for the next wet weather event.
- During the winter months the Actiflo® plant is kept full with influent/effluent in ready state for a wet weather event. At the end of the wet weather season the plant is drained, cleaned and filled with potable water. The small flow of potable water is circulated through the Actiflo® plant.
- The chemicals used are aluminium chlorohydrate and polymer; the dosage rates are 5 mg/L and 2.3 mg/L, respectively. The chemical system is kept in a ready state. Made up polymer is wasted to sewer using a small pump, on a weekly basis. The aluminium chlorohydrate was chosen due to the downstream the UV disinfection system and its long shelf life.
- The sludge for the Actiflo® process is collected in a separate tank and returned to the sewer at the end of the wet weather event.
- For every 3785 $m^3$ of treated effluent, 3.6 kg of sand is lost.
- There is a weekly maintenance program for the Actiflo® plant.
- Storage for sand was limited.

Michelle C. Maynard, M.Sc., C.Eng., MICE
Project Engineer

MM/lp

City of Bremerton


Storage Tank, Actiflo Building and Chemical Building


Standby Generator and Electrical Building


Inside Actiflo Building


Desludge Pumps


Trojan UV Disinfection


Trojan UV Disinfection

City of Bremerton

Polymer Systems


Polymer Pumps


Aluminum Chlorohydrate Tank


ACH Pumps

City of Tacoma


Hydrocyclones


Hydrocyclones


Maturation Tank


Clarifier


Clarifier


Clarifier

Lamella Plates

Effluent Channel

Polymer System

Polymer Pumps

Ferric Chloride Pumps

Chemical Delivery Point


Hoist for Sand Storage


Desludge Pumps


Desludge Pumps