Stantec

# Memo

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| To: | Core Area Wastewater Treatment Project Board | From: | David Lycon<br>Bob Dawson<br>Stantec Surrey |
| File: | 111700431 | Date: | August 10, 2016 |

**Reference: CRD Core Area Wastewater Treatment – Flows and Loads**

The purpose of this technical memorandum is to provide a summary of the current and proposed flows and organic loads from the CRD's Core Area. Recent flow data from Clover and Macaulay suggests a decline in average dry weather flow over the past 6 years. Analysis of this data is required to confirm primary and secondary treatment sizing.

## METHOD OF DETERMINING DESIGN FLOW AND LOAD

In order to determine the future flows and loads that will be used as a basis of design for a secondary wastewater treatment facility, an analysis of historic flow and load data is first undertaken. Flows are examined first based on average dry weather flow (ADWF). This is the sum of the base sanitary flow plus the flows attributed to groundwater infiltration during the summer months. The summer months are normally defined as the period from June 1st to August 31st. Once an ADWF is determined, the various peaking factors associated with maximum month, maximum day and peak hourly flows can likewise be determined. Each peaking factor relates to the sizing of a given piece of process equipment within the wastewater treatment facility. However, when dealing solely with the design of the secondary treatment processes load is the governing sizing criteria along with the regulatory requirement to provide, two times the ADWF capacity. The determining organic loading conditions used for secondary treatment facility design will be discussed in a subsequent section.

Once the ADWF for a given year is determined, it is coupled with that year's equivalent population to derive a per capita flow (expressed in L/cap/d). The equivalent population is the combined domestic sewered population plus an equivalent population value that is attributed to the industrial, commercial and institutional (ICI) sectors. The next step in this analysis is to determine what the design year's population will be based on accepted population projections. This derived design population is then coupled with the accepted per capita flow to arrive at a design ADWF.

Using this approach, the basis of design for sizing a secondary treatment facility is determined in the following manner. For the sewered area of the CRD the equivalent population predicted for 2030 is expected to be 436,000 persons. This is coupled with a design per capita flow of 246 L/cap/d to arrive at the design ADWF of 107,500 $m^3$/day (~108 ML/day). The 246 L/cap/d consists of 196 L/cap/d of sanitary sewage and 50 L/cap/d of ground water infiltration.

Since the development of the aforementioned design per capita flows and projected equivalent populations, there is a noted concern that the per capita flows may actually be dropping below the assumed value of 246 L/cap/d. The next section examines historical flow data to determine if this concern is valid.

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Design loads are determined in a similar fashion to design flows. Data for organic and solids loads are determined by combining concentration data and ADWF data. The concentration data is derived from the CRD's sampling program and is presented in mg/L quantities. When these daily average concentration values are multiplied by the daily average flow, a resulting mass load is determined (*i.e.* kg/d). These load values can then be divided by the equivalent population to arrive at per capita loading values (expressed in g/cap/d).

For BOD the typical range of per capita generation is 60 to 80 g/cap/d. Using the lower BOD generation rate of approximately 65 g/cap/d together with the design population, an ADWF organic load of 28,080 kg/d results. Similarly the per capita solids loads vary between 50 and 70 g/cap/d. Like BOD, the solids will continue to increase as population increases regardless of the per capita sewage flow. Using the low range of per capita solids loading results in an ADWF load of 20,960 kg/d for a population of 436,000 persons in CRD at the design year 2030.

## FLOW ANALYSIS

The data that has been reviewed encompasses the past five complete reporting years (2011 to 2015). Table 1 summarizes the average daily total flows for the period from June 1st to August 31st (ADWF), along with a comparison to the 2008/2009 basis of design data. This data is taken from the daily totalized flow values recorded at each of the two outfalls by their respective magnetic flow meters.

### Table 1. ADWF ($m^3/d$)

| Catchment | 2008/2009 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|
| Macaulay | 39,171 | 37,448 | 36,815 | 35,397 | 35,601 | 35,659 | 36,453 |
| Clover | 45,000[1] | 40,466 | 39,213 | 37,553 | 35,760 | 34,504 | 35,701 |
| **TOTAL** | **84,171** | **77,914** | **76,029** | **72,951** | **71,361** | **70,163** | **72,154** |

Over the past five years, the ADWF has been dropping by 2.6% per year on average (1.2% for Macaulay and 3.9% for Clover). Flows appear to have bottomed out in 2015 and 2016 saw an increase in flow of 2 MLD in comparison to 2015 flows for the average dry weather period from June 1 to August 31.

Using the flow data in Table 1 and a combination of census-based population numbers and accepted CRD population projections based on accepted growth rates, per capita flow have also been derived (Table 2).

[1] This is an estimate as the data for this outfall was not available.

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### Table 2. Per Capita Flow

| | 2008/2009 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| Total Flow ($m^3/d$) | 84,171 | 77,914 | 76,029 | 72,951 | 71,361 | 70,163 |
| Population (1.3% growth rate) | 341,093 | 350,507 | 354,185 | 358,789 | 363,453 | 366,014 |
| **Per Capita Flow (L/cap/d)** | **247** | **222** | **215** | **203** | **196** | **192** |

If the projected populations are considered to be reasonable estimates of the actual populations, the per capita flows have been dropping by 3.2% per year on average. This drop is consistent with water conservation measures that have been implemented in the CRD over the past number of years. The question remains as to how much further the per capita flows could potentially drop. These values are already considered to be low, relative to other South Coast communities, where average dry weather flows of 250 to 300 L/cap/d are the norm. Analysis of flow data indicates that the flow reduction has flattened in the last several years with only a 4 L/cap/d reduction from 2014 to 2015.

Population projections play a significant role in the development of the design flows to be used as a basis for liquid stream treatment. The CRD is currently using population projections that average approximately 1.08% per year, and previous planning work undertaken as part of this project used a low growth rate of 1.3% and a high growth rate of 2.1%. Projecting flows from 2015 forward to a design flow rate108 MLD will yield varying design horizons, depending on which of these annual populations projections is utilized. The design horizons will vary from 2036 to 2055, depending on which approach for population projection is used. Figure 1 presents the flow projection for the 1.08% growth rate.

Confirmation of the flow estimates was completed by placing a secondary insertion meter at each of the Clover and Macaulay flow measurement sites and good correlation was obtained between the flow meters. In addition bulk system flows are within 3% of the measured flows at Macaulay Point and Clover Point. Similar flow reduction has been observed at the Saanich Peninsula wastewater treatment plant.

## LOAD ANALYSIS

While it has been noted that per capita flows appear to be dropping on an annual basis, it is anticipated that the organic and solids loading has remained constant, or has increased with

population growth in the Core Area. Tables 3 and 4 summarize the average organic and solids, respectively for the period from June 1st to August 31st (ADWF). This data is derived from the daily totalized flow values recorded at each of the two outfalls by their respective magnetic flow meters, and from the concentration data derived from 24-hour composite samples obtained at each of the outfalls.

### Table 3. BOD (kg/d)

| Catchment | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|
| Macaulay | 9,250 | 9,179 | 10,395 | 12,589 | 10,177 |
| Clover | 8,498 | 9,328 | 10,085 | 9,778 | 8,793 |
| **TOTAL** | **17,747** | **18,508** | **20,480** | **22,366** | **18,971** |

### Table 4. TSS (kg/d)

| Catchment | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|
| Macaulay | 9,202 | 9,179 | 10,076 | 11,091 | 9,799 |
| Clover | 8,595 | 9,032 | 9,946 | 10,303 | 9,502 |
| **TOTAL** | **17,796** | **18,211** | **20,021** | **21,394** | **19,301** |

Using the population numbers in Table 2 and the loading values presented in Tables 3 and 4, the per capita loading values can also be determined (Table 5).

### Table 5. Per Capita Loading (g/cap/d)

| Parameter | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|
| BOD | 51 | 52 | 57 | 62 | 52 |
| TSS | 51 | 51 | 56 | 59 | 53 |

The per capita loads presented in Table 5. are relatively low, where typical per capita values are 70 g/cap/d for both BOD and TSS. This is due to the large population equivalent that is assigned to the ICI sector (on average, 28% of the total population). If this equivalent population is backed out of

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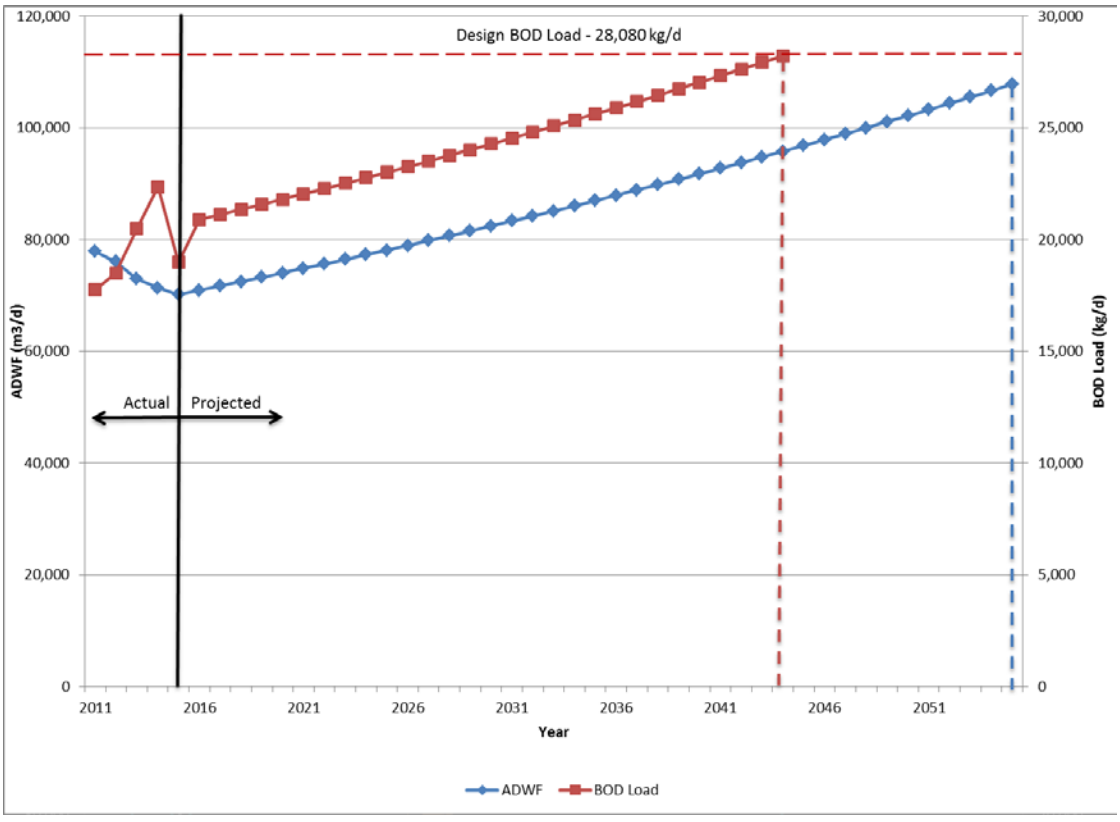
the overall population values, the per capita numbers will then range between 70 and 85 g/cap/d. This per capita load is consistent with the per capita load observed in similar communities.

Over the past five years, the BOD loading has been increasing by 2.2% per year on average (8.1% per year if the anomalous 2015 data is excluded), and the TSS loading has been increasing by 2.3% per year on average (6.4% per year if the anomalous 2015 data is excluded). This is to be expected if the per capita flows have been decreasing over this same five year period As secondary treatment facilities are primarily sized based on the incoming organic load, it is anticipated that the current basis of design for secondary treatment remains valid. Based on the population growth rates outlined in the previous section, BOD load projections have also been developed. Projecting BOD loads from 2015 forward to a design load of 28,080 kg/d will yield varying design horizons, depending on which of these annual populations projections is utilized. The design horizons will vary from 2026 to 2044, depending on which approach for population projection is used. Figure 1 presents the load projection for the 1.08% growth rate.

**Figure 1. ADWF and BOD Load Projections (1.08% Annual Growth Rate)**



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## SUMMARY AND CONCLUSION

Results of flow data indicate a dropping average dry weather flow which appears to have flattened. The load has continued to increase as the population grows and the flows drop. Since secondary treatment sizing is based on load, the observed loads are consistent with values selected for the design of the secondary treatment facility.

For wet weather flow sizing which is based on a multiple of the average dry weather flow, it would theoretically be possible to slightly reduce the size of these facilities however there is an inherent risk with doing this given the age of the CRD sanitary sewer systems and the fact that sub – catchments within the Macaulay and Clover catchments experience significant I&I above the multiples approved in the LWMP. Furthermore, wet weather flows are subject to winter rainstorms which are highly unpredictable.

Given the above considerations, we recommend the CRD continue to size the plant for an average dry weather flow of 108 MLD and an influent BOD load of 28,080 kg/d.