MEMORANDUM

URBAN systems

Date:	July 6, 2012
To:	Jenni Chancey, District of Squamish
Cc:	Peter Gigliotti; Catherine Simpson, Urban Systems Ltd.
From:	Ehren Lee, Urban Systems Ltd.
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Subject:	Technical Memo #1 – Collection

This technical memo describes collection system issues and priorities as it relates to the District of Squamish's Liquid Waste Management Plan (LWMP).

Eight information sources were consulted to create this document:

I. 2011 and 2012 Wastewater Treatment Plant (WWTP) Flow Records
II. Public Works Asset Management Plan (2011)
III. Downtown Sanitary Servicing Options Study (2011)
IV. Mamquam WWTP Capacity and Risk Assessment
V. Water Loss Management Program (2011)
VI. Environment Canada Historical Weather Data (N Vancouver Wharves)
VII. Growth Management Strategy (2005)
VIII. Interviews with District of Squamish Operations Team

The aim of this document is to summarize issues and priorities for the collection system through review and evaluation of existing information. Sections of the memorandum will be further discussed during Stage 1 committee meetings scheduled for summer 2012.

1. COLLECTION SYSTEM OVERVIEW

The sanitary collection system is made up of 105km of mains, over 1,400 manholes, 25 lift stations and over 7,000 service connections. The estimated replacement value of the sanitary collection system is $92,000,000 not including the Mamquam WWTP.

The service area is generally defined as North and South Squamish. Most (75%) of the projected growth in the next 20 years is planned for South Squamish.

There are roughly 50 developed properties in the municipal boundary that are not connected to community sewer (Mamquam WWTP Capacity and Risk Assessment). This represents a relatively low percentage of unserviced properties, or only 0.7%. Expanding the sewer system to connect these properties is not expected to be a key issue for the LWMP.

Map 1, enclosed, illustrates the existing sanitary system.

2. WASTEWATER QUALITY AND QUANTITY

2.1 Wastewater Quantity

All sanitary flows are conveyed to the Mamquam Wastewater Treatment Plant. Flows generally consist of domestic and commercial/industrial sanitary flows in addition to inflow and infiltration (I&I). The average, maximum, and minimum influent flow rates encountered at the plant in 2011 are listed below:

- Average 7,654 m^3/day
- Maximum 14,088 m^3/day
- Minimum 5,612 m^3/day

Further analysis on plant inflows and wastewater flow characterization is provided below.

Characterizing Indoor Demands and Wastewater Flows

In the Mamquam Wastewater Treatment Plant Capacity and Risk Assessment, average daily flows (dry weather) were estimated based on theoretical per capita demands, population equivalents, and groundwater infiltration rates, as listed below.

I. Per capita demand 250 l/person/day
II. Groundwater infiltration 3,500 l/ha/day
III. Population Equivalents 24,702

The results of the estimates for 2011 and 2031 are provided in Table 1. These are based on a population equivalent of 24,702 (residential population of 17,759) in 2011, and 45,789 in 2031 (almost double existing).

Table 1 WWTP Inflow Estimates for 2011 and 2031

Flow Parameter	2011 Flow m^3/day	2031 Flow m^3/day
ADWF	8,646	16,026
MDF	22,134	36,860
PWWF	34,584	64,104

However, the actual recorded ADWF is 7,654 m^3/day (2011) which is approximately 13% less than the estimated inflow (8,646 m^3/day). Therefore, based on a 2011 population equivalent of 24,702, the per person sanitary loading for dry weather flows is 309.4 l/person/day. The additional 59.4 l/person/day on top of estimated indoor demands would likely be made up of groundwater infiltration. However, this requires further consideration. Approximately 70% of the urban areas in Squamish are located within of sanitary catchments. This equates to an area of 1,350 ha. At 3,500 l/ha/day, the total daily volume is estimated at 4,725 m^3, or 191.3 l/person/day (more than 3x greater than 59.4 l/person/day). The 3,500

l/ha/day figure appears to overestimate groundwater infiltration on an average basis. It is likely more accurate for peak rainfall events.

There are three observations to be made from the analysis above, assuming that the population equivalents are accurate:

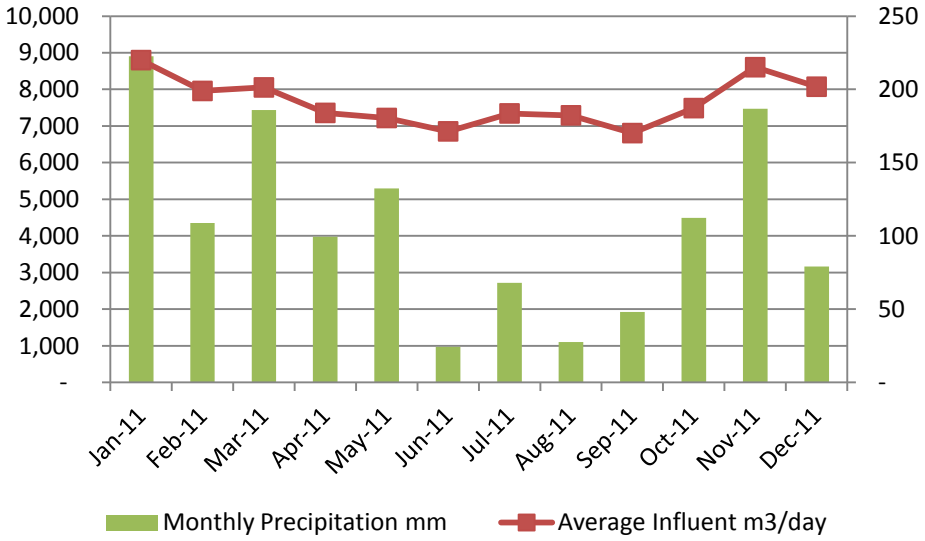
- That because groundwater infiltration occurs (see discussion in Section 3.5), that indoor water use is likely in the range of 200 to 300 l/person/day.
- That groundwater infiltration is significant, yet likely much less than 3,500 l/ha/day for dry weather flow.
- The difference (13%) between actual ADWF and estimated ADWF likely relates to estimates for groundwater infiltration.

Also, this information points to the potential for reductions in both indoor water use and groundwater infiltration.

Wastewater Inflow and Precipitation

Fiugre 1 illustrates the monthly variability of influent flows throughout 2011, and shows a correlation to precipitation.

Figure 1 Monthly Inflow and Precipitation 2011

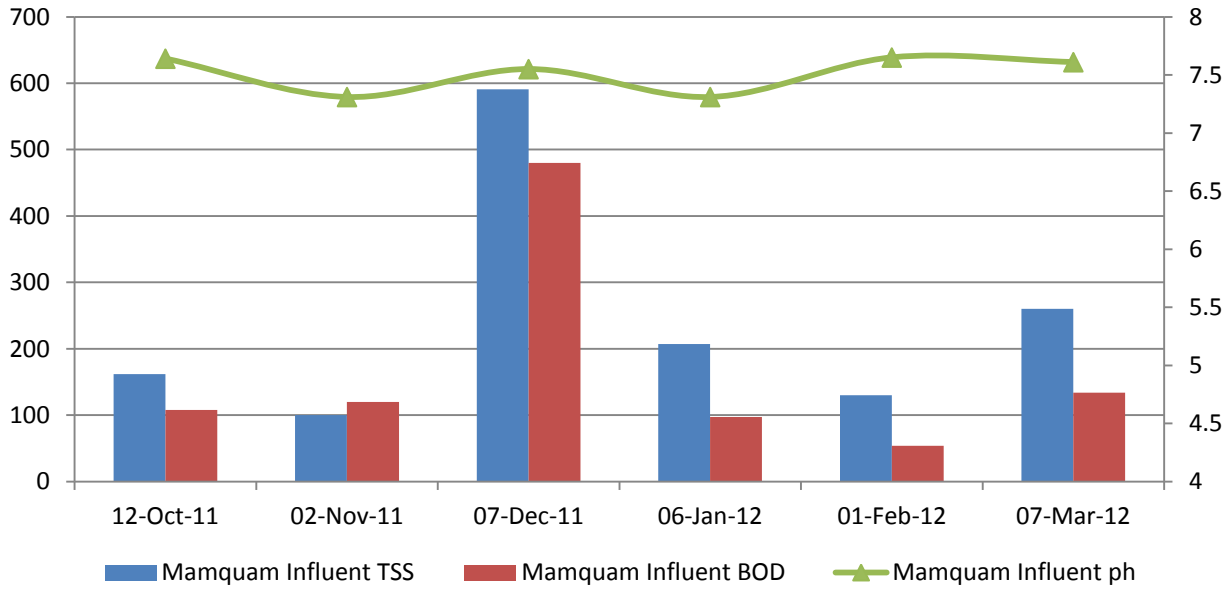


The monthly sanitary flow average is noticeably lower from April to September, than it is during the fall and winter months when precipitation and groundwater levels are higher. The difference between the average inflow for wet months and dry months is roughly 11%. Both groundwater infiltration and rainfall dependent inflow and infiltration are major contributors to the difference. Additional discussion on I&I issues is provided in Section 3.4.

2.2 Wastewater Quality

Wastewater quality is measured by three parameters at the Mamquam Wastewater Treatment Plant, including total suspended solids, BOD_5, and pH. Figure 2 outlines the influent once-per-month testing results from October 2011 to March 2012.

Figure 2 Summary Influent Wastewater Quality (mg/L)



The average for TSS, BOD and are pH are 241.7 mg/L, 165.5 mg/L, and 7.5, respectively. There are three observations that can be made from the influent wastewater quality information:

- That BOD_5 averages are quite low compared to typical community levels (250 – 270mg/L). This reflects the lack of high-strength industry in Squamish and also the likelihood of constant groundwater infiltration which dilutes BOD_5.
- That there are occasional spikes in total suspended solids and BOD_5; the source of the spikes should be investigated.
- That pH and BOD_5/TSS levels are not directly connected.

2.3 Industrial, Commercial and Institutional

Occasionally, municipal sanitary collection systems deal with issues that are unique to industrial and heavy commercial businesses. High strength wastewater and irregular flows are typically the focus. There are no known high-strength waste water flows, with only one exception. The District landfill is updating its leachate management system and will begin discharging liquid wastes in 2012. The quality of flows is poor and various contaminants within the flows will impact conditions in the collection system and the

plant. The schedule for releasing leachate and the need to identify pre-treatment requirements will be a LWMP issue.

3. COLLECTION SYSTEM PERFORMANCE REVIEW

3.1 Pipe Performance Failure

There are two primary categories of pipe failure: condition and capacity.

A sanitary hydraulic model was created in 2006 to investigate capacity issues. That model was likely used to create a list of capital projects stated in the Growth Management Strategy. Table 2 outlines these capital projects which are considered to be existing performance issues.

Table 2 Existing Capacity Issues and Priority Capital Projects

Project ID	Description	Timeline	Cost
S1	Mamquam Rd. Gravity Sewer Upgrade	2011	$1,000,000
S2	Government Rd. Gravity Sewer Upgrade	2011	$1,500,000
S3	Garibaldi Way/Cheakamus Way Gravity Sewer	2011	$550,000
S4	Mamquam Rd. Trunk, Easy of Highlands Hwy.	2011	$650,000
S5	Loggers Lane Gravity Sewers, Lift Station and Forcemain	2011	$1,500,000
S6	Downtown Trunk Main east end of Pemberton	2011	$1,800,000
		Total	**$7,000,000**

Growth and Future Capacity

Of the additional 17,000 people expected in the next 20 years, approximately 75% of the growth will be located in South Squamish. The Growth Management Strategy and OCP lay out a sequential approach to development which supports linear expansion of the system. The risk of leapfrogging (and the corresponding operational and financial challenges) have been largely reduced.

Future capacity constraints are also described in the Downtown Sanitary Servicing Options Study which looked at the areas of significant growth in South Squamish, and proposed options for accommodating new flows. The recommended servicing option is Option A, which includes adding capacity to pump stations, twinning forcemains, and increasing diameters in gravity trunk sewers. The Class D cost estimate for the works is $7.9MM, not including optional items.

If development proceeds as laid out in the OCP and follow the Growth Management Strategy, then future infrastructure upgrades required to accommodate a large percentage of the growth is understood. The scope of improvements would be reduced if sanitary flows are reduced through water conservation and I&I reduction programs.

Condition Failure

Pipe failure due to condition issues is briefly discussed in the Public Works Asset Management report. In summary, the remaining service life of the sanitary collection system is approximately 35 years. Certain assets, such as mechanical facilities and the WWTP have shorter remaining lives. Also, it is noted that asbestos cement (AC) mains have a remaining service life of 12 to 15 years. Approximately 70% of the sanitary system is made up of AC mains. The risk to environment from condition failure can be reduced significantly by carrying through with asset renewal commitments and by targeting high priority mains (such as asbestos cement) for closed circuit video inspection.

3.2 Fats, Oil and Grease

There are many sources of fats, oil, and grease (FOG) in the District's collection system. Three common sources of FOG are restaurants, residences, as well as car and service repair shops. FOG issues can arise in lift stations and sanitary mains downstream of restaurant areas, even though many restaurants are required to install grease interceptors. Automotive repair shops are required to install similar devices to reduce FOG in the collection system.

There are two primary issues with FOG in the wastewater system:

1. ***Capacity.*** Build-up of fats, oil and grease reduces capacity of the collection system including pipe and pump station capacity. Screens located throughout the system can also clog and bind reducing throughput.

   When flows are constricted, the likelihood of backups and odours increases. Also, treatment performance can be compromised leading to lower quality effluent in the receiving environment.

2. ***Cost.*** High levels of FOG requires more energy to treat and convey wastewater throughout the plant and collection system. System blockages and overflows require urgent repairs and occasionally liabilities, which both result in high costs as well.

The annual FOG loading for the collection system is estimated at 70 tonnes per year. This figure is based on averages encountered in other communities (25mg/L). Ultimately, a reduction in FOG concentrations and loadings will reduce the risk of blockages or overflows, reduce energy costs, and extend system capacity.

Source control programs typically target two audiences for FOG management: residences and businesses. The District will be implementing a source control program in 2012. Determining the success of the source control program can be done by monitoring the concentrations and mass loadings of FOG in the system and at the plant.

3.3 Facility Overflows and Cross Connections

Based on operator comments, there are no known overflow issues in the collection system. However, there are reported pump failures, at a rate of 1.9 per year.

The District's Asset Management Plan includes financial strategies to complete a short-term renewal program for most of the existing sanitary lift stations. The program intends to reduce pump failure risk by renewing assets which have exceeded their anticipated service life.

A more thorough evaluation of the lift stations, including mechanical reliability and detailed condition reviews would yield a prioritized approach to lift station renewal. A non-prioritized capital program, or departure from the funding plan for renewal, would increase the likelihood of lift station overflows.

There are no known cross connections in the District. However, closed circuit television programs for sewer condition inspections can help identify unknown connections.

3.4 Inflow and Infiltration

In absence of inflow and infiltration monitoring programs, flow records from the WWTP were reviewed along with precipitation levels at a nearby weather station to characterize the current I&I issues. Data comparisons for September 2010 and September 2011 are provided below (Figure 3 and Figure 4). These two months were selected because they represent a similar service population however with different weather conditions. Rainfall in September 2010 was 3x greater than rainfall in September 2011. The impact of high rainfall on average influent flows can be noticed at the plant however the impact is noticed roughly 3+ days afterward.

Figure 3 WWTP Inflow and Daily Precipitation September 2010

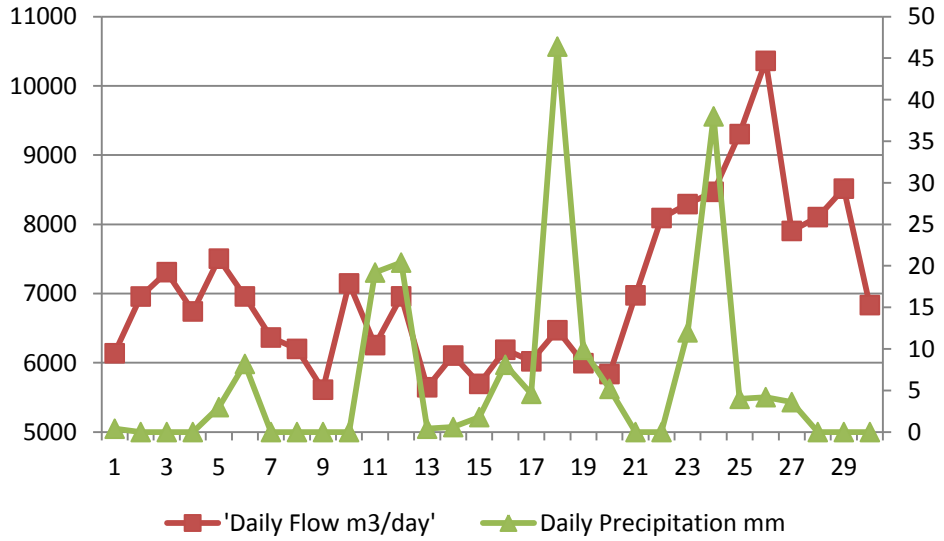
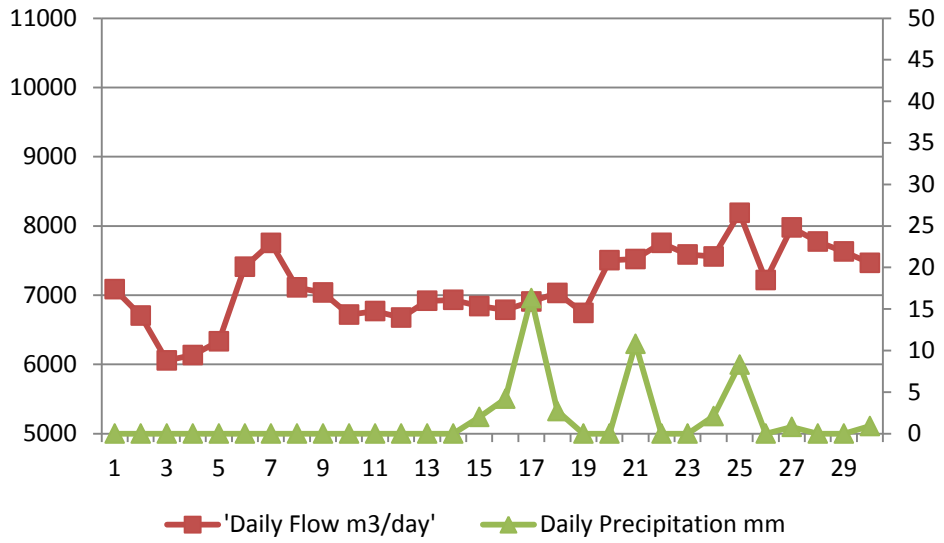


Figure 4 WWTP Inflow and Daily Precipitation September 2011



These two figures help to illustrate that the collection system is indeed susceptible to inflow and infiltration, and, that groundwater infiltration is a noteworthy contributor of flows (albeit delayed). This is further supported by very low BOD_5 levels in the 2011/12 influent water quality sampling data.

The change in plant inflows between wet and dry months further attests that inflow and infiltration is a significant contribution to plant inflows. The difference between average monthly inflow from wet months to dry months is about 11%.

Inflow and Infiltration Design Rates

Where inflow and infiltration rates are not well known, local design standards can provide an indication of the severity of I&I in the collection system. There are various I&I design rates for the District collection system, including:

- The District's Subdivision and Servicing Standards include design flows for inflow and infiltration. For new developments, where the collection system is considered less susceptible to ground water infiltration, the design rate is 13,000 l/ha/day. For existing neighborhoods, where the system is older and less robust, the design rate is 39,000 l/ha/day.
- The 2011 Asset Management plan refers to an I&I monitoring study which estimated inflow and infiltration flows 50,000 l/ha/day. Some justification for this high level comes from the total annual rainfall received in Squamish.
- The Wastewater Treatment Plant Capacity and Risk Assessment (2011) relied upon 3,500 l/ha/day for groundwater infiltration during dry weather flows.

These rates are used to establish peak wet weather flow, and therefore to size sanitary pump stations and treatment process. The accuracy of inflow and infiltration rates is critical to determining the scope of projects and ultimately for establishing utility investments.

Inflow and Infiltration Summary

Based on the above, the severity of I&I is described as follows:

- The delay time between rainfall and response at the WWTP is more than a few days, suggesting that groundwater infiltration is a majority contributor to I&I (i.e. direct connections in inflows typically result in increased flows within the first 24 to 48 hours). Low concentrations BOD_5 throughout the year of corroborate the incidence of groundwater infiltration.
- There is a significant range of I&I flow estimates such as 13,000 l/ha/day for new developments (Subdivision and Servicing Standards) up to 50,000 l/ha/day for 5 year return period (Public Works Asset Management Plan). The InfrasGuide Best Practices target for I&I throughout the collection system is 11,000 l/ha/day. The impact of the range of estimates likely results in oversizing infrastructure, specifically when overly-conservative I&I factors are used.

A more detailed characterization of I&I can be done by monitoring select neighborhoods before and after high rainfall events.

3.5 Indoor Water Demands and Conservation Potential

Almost all wastewater comes from indoor water demands from residential, commercial, industrial and institutional land uses. Inflow and infiltration is the other contributor to wastewater flows. Any reductions in these contributors can result in operational savings for sanitary facilities and defer pre-emptive upsizing.

Indoor water demands are estimated at between 200 and 300 l/person/day.

Current Conservation Program

The District's conservation program centers on watering restrictions. The restrictions are in effect during the outdoor watering season and are likely designed to reduce peaks in the summer. Reducing indoor demands may be done using other techniques.

Also, the District has completed a water loss management study to prioritize efforts to reduce losses and leaks throughout the system. Leakage that ends up in the sanitary system is difficult to estimate. Also, this report does not readily lend itself to characterizing the potential for water conservation that would impact sanitary flows.

With respect to targets, the Living Water Smart framework (for improved water management in BC) suggests that 50% of all new demands will be accommodated through conservation. For a community set to double in population in 20 years, this would be a significant undertaking. A more reasonable water

demand reduction target should be established, and it should be effective encouraging residents and business to aggressively target indoor demand reductions. Also, Squamish is interested in exploring grey water reuse opportunities, which should be factored into indoor water reduction targets.

4. PRELIMINARY PRIORITIES

This memorandum culminates into a list of collection system issues. Each issue will be explored in further detail with the Committees to improve upon the descriptions and to add in any issues that have not yet been identified.

4.1 Issue Definitions

a) More investigation into the source and severity of inflow and infiltration will improve flow estimates. Over-sized infrastructure, loss of system capacity, and unnecessary energy costs due to pumping all lead to additional costs that can be reduced with an accurate understanding of inflow and infiltration rates. Groundwater infiltration rates appear significant and may correlate the risk of condition failure in the collection system i.e. low integrity of the mains increases the likelihood of infiltration.

b) Indoor water demands can be reduced in order to accommodate new growth through conservation programs. Targets for reductions will assist in collection system capacity modelling and reduce operations costs.

c) Squamish is projected to grow in population by almost 100% in the next 20 years. Additional sanitary mains and pumping station capacity is required to accommodate the growth. Accurate project scoping based on actual waste water flows is necessary so that the District selects the most cost-effective and low-risk approach to growth.

d) Most of the mechanical and structural facilities in the collection system are approaching the end of their service lives. Pump failures occur occasionally, at a rate of 1.9 per year. Integration between asset management and renewal funding levels is necessary to reduce the risk of discharge of raw wastewater to the environment.

e) Energy efficiency is an issue, particularly as it relates to growth. There is a need to evaluate energy opportunities (e.g. heat recovery) in the short term so that new growth is designed accordingly. Key topics for energy sustainability include transporting large flows from new growth in South Squamish and from operating 25 lift stations (existing.

f) The District landfill will begin periodic leachate releases into the collection system. The scheduling of leachate release and the need to pre-treat liquid wastes from the landfill (to reduce the impacts to collection system and treatment plant performance) is an LWMP issue.

g) Fats, oil, and grease reduce capacity of the system by creating risk of blockages. FOG also increases energy costs for pumping and treatment.