A STATUS REPORT OF SEVERN SOUND SEWAGE TREATMENT PLANTS ACHIEVING AND MAINTAINING REMEDIAL ACTION PLAN EFFLUENT OBJECTIVES

APRIL 1998

Prepared for

THE SEVERN SOUND REMEDIAL ACTION PLAN AND ENVIRONMENT CANADA

Prepared by

WATER TECHNOLOGY INTERNATIONAL CORPORATION
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Chief, Great Lakes 2000 Cleanup Fund
Environment Canada
P.O. Box 5050, Burlington, Ontario, L7R 4A6
Tel: (905) 336-6276 Fax: (905) 336-6272

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EXECUTIVE SUMMARY

The 8 municipal sewage treatment plants which discharge into Severn Sound are attempting to meet stringent effluent total phosphorus concentrations to restore water quality in the Sound. A 1991 report reviewed the historical performance of these plants and estimated that the total effluent TP loading from all plants was 6,207 kg/y in 1989/90, more than twice the RAP TP loading target of 2,788 kg/yr. The average effluent TP concentration for all of the plants was 0.90 mg/L (arithmetic average). Two of the plants did not practice chemical addition for phosphorus removal in 1989/90 and thus did not meet the RAP target. At three additional plants, chemical addition for phosphorus removal was practiced but the level of performance did not achieve RAP TP targets. The report provided cost estimates to upgrade plants to achieve RAP TP targets.

The purpose of this report was to document activities from 1991 to present to achieve RAP TP targets, compare the 1989/90 results to those currently available, and provide both plant-specific and area-wide recommendations to sustain or enhance plant performance. On-site reviews were conducted for each plant and discussions held with operators and management to document the current status and issues. These results are summarized in plant-specific reports consisting of:

- Background information,
- Current performance (plots of average monthly flows, TSS, BOD5, and TSS),
- Data checks (sludge accountability analysis, per capita flows and loads, etc.)
- Performance Potential Graph (a graphical display of the rated capacity of each unit process).

In addition, summary tables of results from all plants were prepared to facilitate comparisons between plants, estimate total RAP flows and loads and establish overall reductions from 1989/90 to 1997.

Four plants (Midland, Main St., Fox St. and Elmvale) have undergone major upgrades since 1991. In addition, on-site technical assistance was applied employing the Composite Correction Program to upgrade operational skills at two plants (MHC and Coldwater). A Core Team of Severn Sound operators and managers was formed to develop common operational procedures and provide a support system to address operational issues.

A review of results for the most recent calendar year, 1997, indicated a significant reduction in TP loading from 1989/90. Total effluent TP loading from all plants in 1997 was 1,022 kg/y or 37% of the total RAP target. The average effluent TP concentration for all of the plants was 0.15 mg/L (arithmetic average). All plants practiced chemical addition for phosphorus removal, with alum dosing rates falling roughly in the range of 160-180 mg/L. All plants reported achieving RAP effluent TP targets.

A review of plant design capability indicated that current hydraulic loadings, with the exception of Port McNicoll, are less than the nominal design capacities. The major unit processes at Port McNicoll, as well as those at Elmvale may be capable of treating flows beyond nominal design. Common issues related to plant design included the potential to preserve plant capacity by reducing infiltration/inflow at a number of plants and the need to better define existing plant loadings by improving influent monitoring and analyses. Midland's aeration system and Coldwater's aerobic digester may require upgrading or expansion.

The Coldwater STP was optimized without major capital upgrading to achieve the RAP effluent TP target, resulting in an estimated capital cost saving of $466,000 in comparison to 1989/90 estimates. The accuracy, reliability, and completeness of monitoring data has been improved through the efforts of the Core Team and the use of performance checks implemented to verify monitoring results. Information on the program was transferred to the public and to other STP owners and operators. Based on information collected by the Core Team, sludge production information was assembled, reviewed, and summarized to support planning efforts to develop area-wide sludge management.

Between 1989/90 and 1997, the Severn Sound Remedial Action Plan has established STP effluent objectives for all Severn Sound STPs and supported activities to achieve these objectives. The following are some key activities, where Severn Sound RAP has provided leadership:

- Established the effluent quality targets for all Severn Sound STPs;

  - 5 of the 8 STP's Certificate of Approvals reflect RAP effluent objectives (Elmvale, Midland, Main St., Fox St., Coldwater)

- Increased public awareness of the impact of STP effluent on the receiving waters;

- Established the communication and coordination mechanisms between the municipalities, STP operators, consultants and regulatory authorities to ensure RAP effluent objectives were incorporated into STP construction, upgrades and optimization activities;

- Supported procurement of funding for STP upgrades and optimization activities;

- Supported development of an area-wide optimization Core Team to focus and provide solutions to plant specific and area-wide STP needs to achieve and sustain RAP effluent objectives.

Issues to be addressed in sustaining effluent TP performance at each plant were identified and presented in each of the plant-specific reports. Common area-wide issues were also identified to provide a focus for follow-up. The following recommendations were provided to address these issues:

- Because influent and effluent monitoring practices were inconsistent from plant to plant, a uniform monitoring and sampling program should be considered involving the use of composite samples for both influent and effluent and a minimum monitoring frequency (i.e. weekly sampling). Data, which are not truly representative of plant loading or performance, introduce uncertainty and may lead to poor decision-making.

- An annual review should be conducted of the reported data and performance checks performed to establish status with respect to RAP targets. The annual review should also include a review of plant capability using the Performance Potential Graphs contained in this report. Such a review would help to flag unit processes requiring upgrading or expansion.

- The Core Team, with support from the RAP Coordinator, should continue to develop operational skills in areas of common interest, serve as a resource for one another, and communicate the importance of impeccable operation in sustaining RAP targets.

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1.0 INTRODUCTION

Severn Sound is one of 17 Canadian Areas of Concern (AOC) identified by the Great Lakes Water Quality Board. To restore water quality in the Severn Sound, the 8 municipal sewage treatment plants (STP) in the AOC are required to achieve and maintain low effluent total phosphorus (TP) concentrations. The STPs at Midland, Port McNicoll, Coldwater and Penetanguishene Mental Health Centre (MHC) have target effluent TP concentrations of 0.30 mg/L. The objective for Victoria Harbour is 0.15 mg/L. To prevent eutrophication in Pentanguishene Bay, the Penetanguishene Main St. and Fox St. and Elmvale STPs have a TP objective of 0.10 mg/L.

In September 1991, XCG Consultants reviewed the historical performance of the Severn Sound STPs with respect to the RAP effluent targets[1]. Reported effluent concentrations were reviewed for the period January 1989 to December 1990. The XCG report provided cost estimates and upgrade requirements for the eight Severn Sound WPCPs to achieve a higher level of phosphorus removal. Proven and innovative technologies were reviewed to determine maximum phosphorus removal achievable on a consistent basis from the plants.

Since 1991, considerable work has been carried out at the municipal STPs to improve the ability of the plants and operating staff to achieve the Severn Sound RAP effluent objectives. The purpose of this report is to document the approach and progress in achieving RAP effluent objectives.

2.0 OBJECTIVES AND SCOPE

The main objectives of this report are as follows:

- To document activities from 1991 to present to improve the ability of the Severn Sound STPs to achieve RAP effluent targets.
- To review current plant performance (January to December 1997) and compare it to January 1989 to December 1990 performance with respect to RAP effluent phosphorus objectives.
- To determine current plant capability to achieve and maintain RAP phosphorus objectives.
- To identify plant specific and area-wide issues impacting plants in achieving the effluent objectives.
- To recommend follow-up activities to sustain or enhance plant performance.

In section 3.0 of this report, a brief overview is provided of upgrading activities which were conducted from 1991 to present to improve Severn Sound STP performance.

Sections 4.0 to 11.0 are specific plant reports for each of the eight municipal STPs in the Severn Sound Area of Concern. Each section reviews current plant performance, performance checks, major unit process capability and issues requiring follow-up. In section 12.0 an overall summary and area-wide recommendations are presented.

3.0 OVERVIEW OF UPGRADING AND OPTIMIZATION ACTIVITIES

Since the XCG report in 1991, considerable effort has been made to improve the performance of the Severn Sound STPs. These efforts have included major plant upgrades and skills transfer to plant operators. An overview is provided in the following sections.

3.1 Major Plant Upgrades

Since 1991, 4 of the 8 Severn Sound STPs with provincial and federal financial support, were upgraded to improve their ability to achieve and maintain the RAP effluent objectives. The plants upgraded were Elmvale, Main St. Penetanguishene, Fox St. Penetanguishene and Midland. The Elmvale lagoon system was replaced with an extended aeration plant with tertiary treatment. Main St. contact stabilization plants were replaced with a modified conventional activated sludge plant with tertiary treatment and Fox St. contact stabilization plant was upgraded with tertiary treatment. In 1996/97, the Midland conventional activated sludge plant was upgraded with a flow equalization tank, primary clarifier, primary digester and upgrades of the existing digesters for secondary digestion.

3.2 Skills Transfer

In April 1994, Environment Canada, Ontario Ministry of the Environment (MOE) and the Wastewater Technology Centre (WTC) initiated a program to systematically transfer skills to the owners, operators and regulators of the Severn Sound STPs to achieve and sustain RAP effluent objectives. The skills transfer employed the following four key phases:

(1) Awareness and partnership development
(2) Plant prioritization
(3) Evaluation and technical assistance
(4) Program maintenance

Skills transfer activities were focussed on a Core Team of STP operators and managers representing all eight Severn Sound STPs.

The basis for area-wide optimization in Severn Sound was the two-step Composite Correction Program (CCP). The CCP was developed by the U.S. Environmental Protection Agency and has been applied in Ontario since 1991. The first step of the CCP, the Comprehensive Performance Evaluation (CPE) evaluates a plant's operation, design, maintenance and administration to determine the combination of factors limiting performance. Providing that a plant does not have major design limitations the second step, Comprehensive Technical Assistance (CTA) is applied to systematically resolve the performance limiting factors identified during the evaluation. CTA facilitators support process control activities and transfer of skills to operators and managers to sustain improved plant performance. Appendix 1 provides additional background information on the Composite Correction Program.

From 1994 to 1997, the Core Team with facilitation support from MOE and WTC identified two plants as candidates for on-site optimization. The Mental Health Centre and Coldwater STPs were selected for the CCP activities because they were not, achieving RAP effluent phosphorus objectives and the main factors limiting performance were operational and administrative. Technical assistance focussed on transfer of skills to plant operators, managers and owners to address the factors limiting performance and achieve and sustain the RAP effluent objectives with the existing facilities. The operators with support from managers and owners successfully achieved this goal[2,3]. MHC staff achieved and sustained the RAP phosphorus objective of 0.3 mg/L with no capital upgrades and reduced the operational and maintenance costs through improved control of chemical addition for phosphorus removal. The optimization efforts at the Coldwater STP have supported lifting a development freeze on the town by the MOE and deferred major plant expansion. The capital cost savings were approximately $466,000 based on the difference estimated in the 1991 report and the optimization efforts in 1995/96. An application for provincial funding has also been submitted to upgrade the lift station and force main for the Coldwater plant.

Also from 1994 to 1997, the optimization Core Team participated in strategic planning meetings, implementation training workshops and optimization partnership meetings. The activities supported the Team in planning, prioritization and learning from other's experiences to improve operation and performance. Key activities included a workshop on on/off aeration control hosted by the Elmvale staff and a Severn Sound open-house display. To complete the program, an on-site review and detailed data analysis were conducted. Through discussions with operators and management and data collection, review, and analysis, the current status of the plants was documented. To provide feedback on the status of the plants and bring closure to the formal, optimization program development phase, an exit meeting was held with the Core Team. Plant specific reports, presented in the following sections, summarize the current findings.

4.0 COLDWATER STP

The Coldwater STP is an extended aeration plant with a nominal design flow of 546 m3/d servicing an estimated population of 900 people. The plant is required under MOE Policy 08-01 to achieve an annual average effluent qaulity of 25 mg/L BOD_5 and TSS and 1.0 mg/L TP. The plant C of A is currently being amended to 0.3 mg/L for TP based on demonstrated optimized performance. The RAP effluent phosphorus objectives are 0.30 mg/L with a loading to the receiver of 110 kg/y at a forecast design flow of 1,000 m^3/d. Table 1 summarizes key information for the Coldwater plant.

Table 1 Key Information for Coldwater STP

Background Information:	
Plant Name: Coldwater	Contact name: Wayne White
Plant Owner: Severn Township	Contact number: 705-534-3866
Plant Operator(s): Gary Watson & Jim Bernas, OCWA	Fax number: 705-534-4591
Population serviced: approx. 900 people	
Nominal plant design flow: 0.546 1000 m^3/d	
RAP Effluent Phosphorus Objectives:	
Concentration = 0.3 mg/L	
Loading = 110 kg/y at design flow	
Type of Plant:	
Extended aeration	
Aeration Basin:	
Aeration volume = 444 m^3	
Blower or aerator horsepower = 3 blowers @ 7.5 hp each = 22.5 hp	
Type of aeration: Coarse bubble diffusers	
Operational flexibility: None	
Secondary Clarifier:	
Surface area = 44 m^2	
Depth = 2.4 m	
Digestion:	
See aerated sludge storage below	
Aerated Sludge Storage:	
Volume = 33 m^3	
Means of disposal = contract haulage to land	
Disinfection:	
Chlorine contact chamber volume = 11.3 m^3	
Effluent Sampling:	
Influent/Effluent: non- refrigerated composite samplers, some samples submitted are grab	
Frequency: daily for TSS, SP, weekly outside lab analysis for TP, TBOD, TKN	
Comments :	
Plant has bypass capability to chorine contact tank.	
Application submitted for upgrades to lift station and force main to plant	

4.1 Key Activities

A September 1991 report by XCG Consultants provided analysis and upgrade requirements for the eight Severn Sound STPs to achieve a higher level of phosphorus removal and a review of proven and innovative technologies to determine maximum phosphorus removal achievable on a consistent basis from the plants. To achieve the RAP phosphorus objective of 0.3 mg/L the report recommended effluent filtration with dual media filters in conjunction with simultaneous chemical precipitation of phosphorus for the Coldwater STP. The estimated capital cost was $500,000.

A CPE was carried out in February 1995 by a joint MOE, WTC and Severn Sound Core Team, to comprehensively evaluate the plant and determine factors preventing the plant from achieving RAP effluent objectives. The major factors limiting performance were:

(1) No capability to add chemical for phosphorus removal (design)
(2) Inadequate plant coverage (administration)
(3) Performance monitoring (operation)
(4) Application of concepts and testing to process control (operation)

A CTA was recommended, provided the owner and operator first install chemical addition capability for phosphorus removal. The evaluation Team determined that with chemical addition, the plant was potentially capable of achieving the RAP phosphorus objectives.

A CTA was carried out by a joint MOE, WTC Team from August 1995 to July 1996. Through installation of temporary chemical addition equipment and skills transfer to OCWA operators and managers, the Coldwater STP achieved and sustained the RAP phosphorus of objective of 0.3 mg/L from November 1995 to July 1996. The cost of the CTA, which included facilitation support by MOE and WTC, chemical and equipment, increased plant monitoring and operator coverage was approximately $33,300. Upon completion of the CTA, recommendations were made to sustain the effluent quality achieved during the CTA. Severn Township and OCWA committed to support plant needs and maintain phosphorus removal to meet RAP objectives.

During the CTA, it was observed that under high flow conditions the lift station and force main were limited in their ability to handle collection system flows to the plant. This resulted in direct discharging of untreated wastewater from the lift station to the receiving water. A briefing report was completed by WTI in February 1998 to support an application made to the MOE, by OCWA Engineering, to upgrade the lift station and force main of the Coldwater STP[4]. The report assessed the performance and follow up activities for the plant from August 1996 to January 1998. The reported data showed that the operators had maintained the RAP phosphorus objective of 0.3 mg/L. Also, the MOE lifted a development freeze on the Town of Coldwater and allowed the construction of 50 housing units. The deferred capital cost savings for the Township to upgrade the STP was approximately $466,000 when compared to the estimated costs to achieve and sustain the 0.3 mg/L in the 1991 XCG report.

From 1994 to 1998, operators and managers participated in a Severn Sound area-wide optimization program. The program focussed on achieving and sustaining RAP effluent objectives with existing treatment plants through the transfer of skills to the owners and operators. The transfer of skills involved on-site, hands-on training, workshops and presentations.

4.2 Current Performance

Figure 1 is a summary of 1997 reported performance (on a monthly average basis) for the Coldwater STP. The following comments are applicable:

The average monthly plant flows for 1997 were below the nominal design flow of 546 m^3/d. The average daily flow of 327 m^3/d is 60% of the nominal design flow and is 150 m^3/d less than the 1990 average daily flow of 477 m^3/d. The decrease in flow may be a result of Township efforts to address inflow/infiltration problems in the collection system. To assess the impact of 50 new housing units in Coldwater the following calculations were carried out. Assuming four persons per household contributing 450 L/d would produce a flow of 90 m^3/d to the plant. The current reported flow is 327 m^3/d and with the projected flow increase of 90 m^3/d the projected plant flow would be 417 m^3/d which is 76% of the nominal design flow of 546 m^3/d. It is estimated based on past operational information that this increased flow can be treated to achieve RAP objectives with existing plant capability.

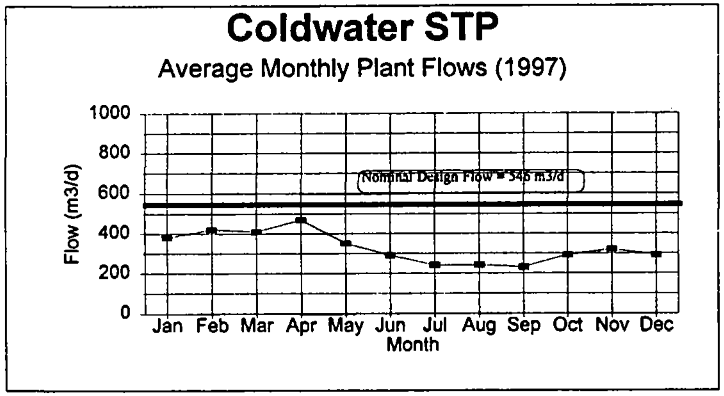
BOD_5 and TSS reported monthly average concentrations were below 10 mg/L in 1997 except for TSS which was 11.6 mg/L in February. During the CTA program, a key focus for operators was to control sludge mass in the process to achieve less than 10 mg/L TSS in the final effluent to ensure 0.3 mg/L TP could be achieved with chemical addition. This target is especially important for plants without tertiary treatment.

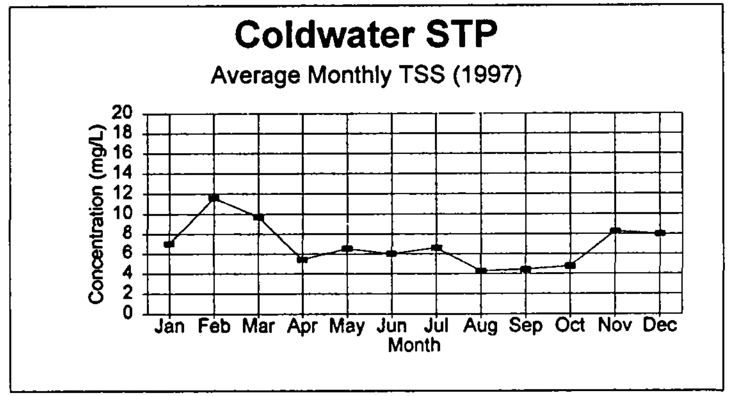
The reported monthly average phosphorus concentrations reported for 1997 achieved the RAP phosphorus objective of 0.3 mg/L in all months. The annual phosphorus loading of 22 kg/y is well below the 110 kg/y RAP objective and the 1989/90 reported loading of 526 kg/y. The TP objective assumes a nominal design flow of 1,000 m^3/d and a effluent concentration of 0.3 mg/L.

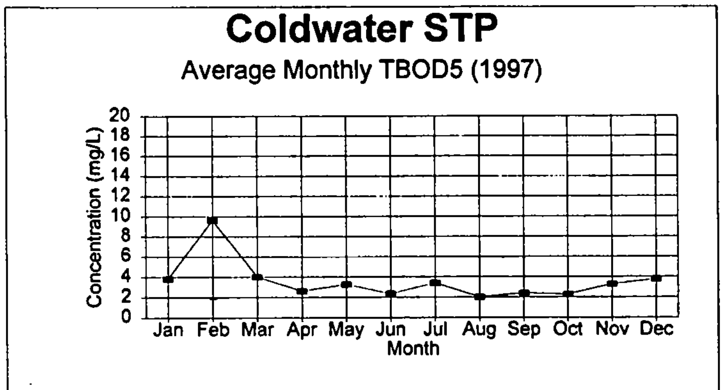
4.3 Data Checks

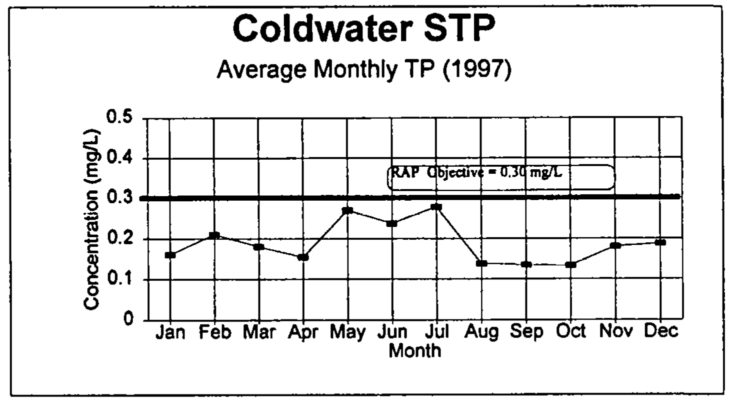
Data verification checks were carried out on-site with operational staff to verify reported plant data. The data checks included reported versus projected flows, BOD_5 loading, chemical dosing for phosphorus removal and a sludge accountability analysis. The detailed calculations are presented in Appendix 1.

Figure 1: Coldwater STP Monthly Average Performance for 1997

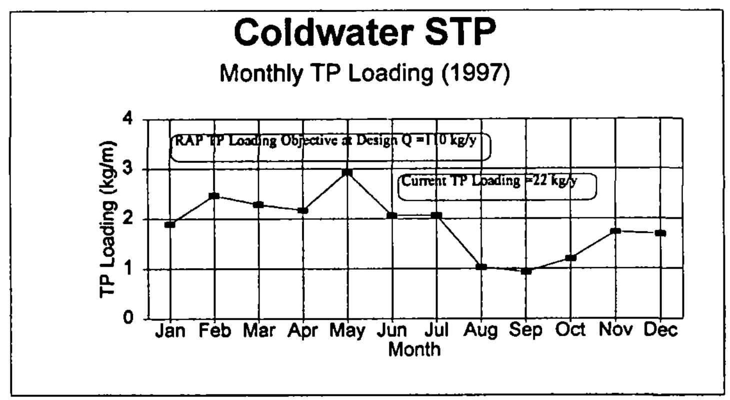








Month	Avg. Flow	TBOD5	TSS	TP	TP load
1997	m3/d	mg/L	mg/L	mg/L	kg/m
Jan	380	3.8	7.0	0.16	2
Feb	420	9.6	11.6	0.21	2
Mar	410	4.0	9.7	0.18	2
Apr	470	2.6	5.4	0.15	2
May	350	3.3	6.5	0.27	3
Jun	290	2.3	6.0	0.24	2
Jul	240	3.4	6.6	0.28	2
Aug	240	2.0	4.3	0.14	1
Sep	230	2.4	4.4	0.13	1
Oct	290	2.3	4.8	0.13	1
Nov	320	3.3	8.3	0.18	2
Dec	290	3.8	8.0	0.19	2
Avg.	328	3.6	6.9	0.19	22



As a result of the on-site data checks, the following conclusions were reached:

- The sludge accountability analysis of –19% was not within the expected +/- 15% therefore some of the reported data may not reflect true plant operation.

- Influent BOD appears to be low (i.e. reported = 115 mg/L, projected = 220 mg/L). Influent sampler may not be taking a representative sample because of the on/off cycles of the lift station.

- Hauled sludge volumes may be inaccurate. Reported sludge mass wasted appears to be higher than expected.

- Reported chemical dosing is significantly higher than projected to remove the reported phosphorus loading.

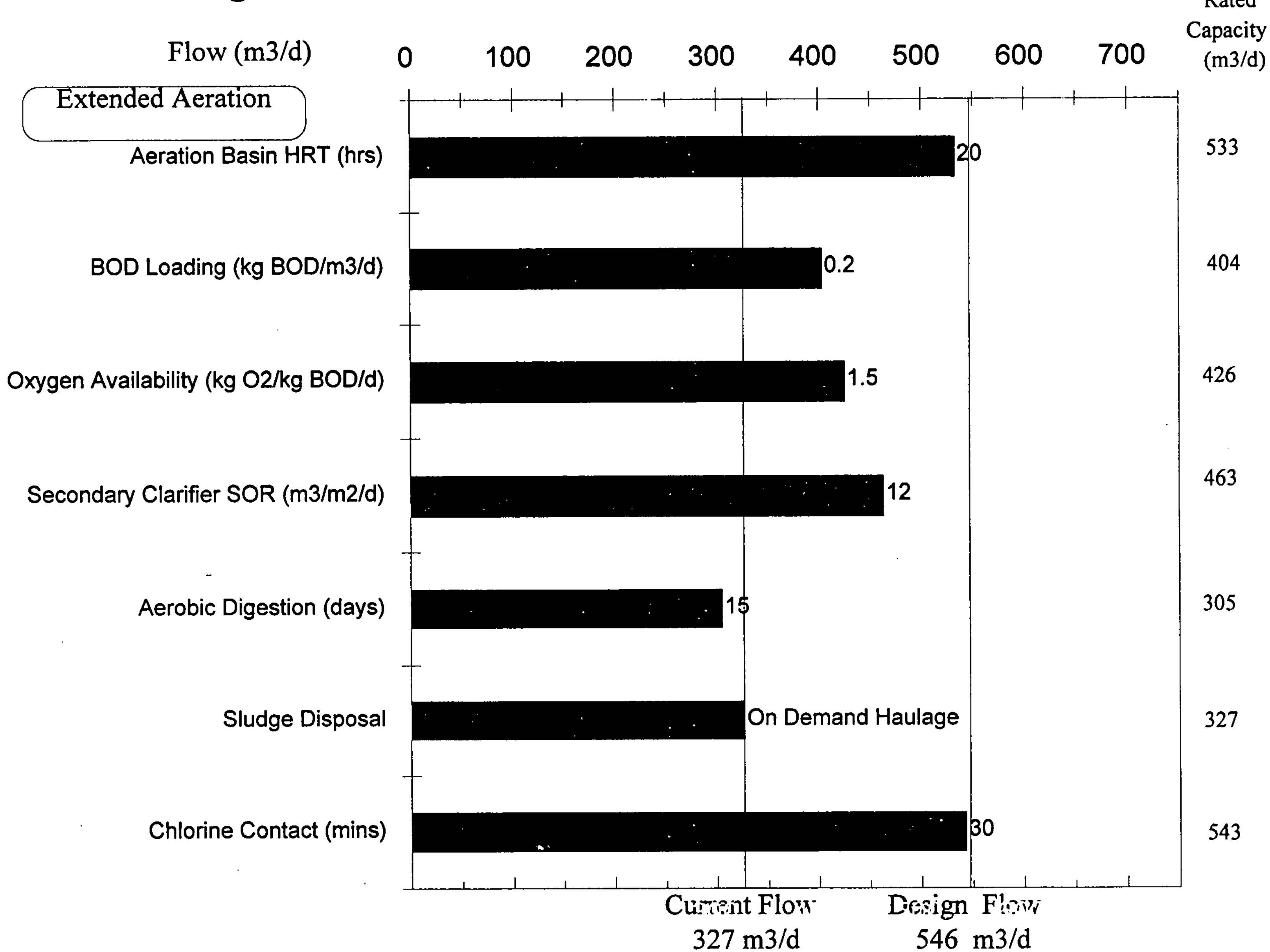
4.4 Design Capability

The capability of the existing plant to treat current flows and achieve the RAP effluent objectives was evaluated using a Performance Potential Graph (PPG). The graph evaluates the capability of the existing major unit processes to meet the RAP effluent objectives. The evaluation is based on a review of plant drawings, equipment information, performance data as well as operation and maintenance practices.

Figure 2 is the Coldwater Performance Potential Graph. The major unit processes included in the evaluation are shown in the left-hand column. Unit processes are rated based on experience against a combination of design and operational parameters. The horizontal bars in the Performance Potential Graph represent the estimated capacity for the parameters associated with each major unit process. Vertical lines indicate the current and nominal design flows for comparison relative to the estimated capacity. A projected influent BOD_5 concentration was used to calculate BOD loading and oxygen availability capability of the Coldwater plant.

The Coldwater PPG shows that under current loading the most limiting unit process is the aerobic digester. To effectively stabilize sludge for safe land application the sludge should be aerobically stabilized for 15 days with adequate air supply and mixing to ensure volatile solids destruction. The current loading and sludge generation indicates that the digester is marginal. Operators need to monitor sludge into and from the digester for TSS and VSS to determine digestion efficiency. Any future upgrades to the plant should consider the need for increasing digester capability. There is a need to confirm true influent BOD_5 loading for BOD loading and oxygen availability capability.

Figure 2: Coldwater STP Performance Potential Graph



4.5 Summary

OCWA operators and management with support from Severn Township achieved and maintained the RAP phosphorus objectives with minimal capital expenditure to the existing facilities. The 1991 estimated cost to achieve the 0.3mg/L effluent phosphorus concentration was $500K. The actual costs to achieve the phosphorus objective, was $33,300. The enhanced level of process control and plant performance has led to a greater awareness of plant needs and capability which allowed the Township and OCWA to approach the MOE to remove the development freeze on the Town. The MOE approved construction of 50 new residences based on reported improvements in effluent quality.

The data checks carried out on-site with plant operators focussed on issues to improve process and performance monitoring to ensure reported information reflects true plant operation and performance. The performance checks failed to confirm the reported data. As identified in the following section some follow-up activities are required to improve process and performance monitoring.

The plant capability to treat current flows was evaluated using the Performance Potential Graph, which evaluates the major unit processes to achieve the RAP effluent objectives. The most limiting major unit process is the digester, which may be marginal for effectively stabilizing the sludge for safe land application.

4.6 Recommendations

The following recommendations are based on the findings of the on-site data review with plant operators and a review of design capability based on current plant loading:

- Set-up the influent composite sampler to sample only during the on-cycles of the lift station pumps.

- Carry out influent TSS analysis and compare against BOD values from the lab. Typical influent TSS/BOD ratio should be between 0.8 – 1.2.

- Obtain accurate population for Town of Coldwater and recalculate projected BOD and hydraulic loading for STP.

- Currently total suspended solids results are calculated based on microwave drying. It is suggested that a special study be carried out to establish the correct length of time to ensure a dry sample.

- Document hauled sludge volumes based on depth of sludge removed from the holding tank. Record on same sheet as sludge haulage contractor.

- Initiate regular TSS/VSS analysis on hauled sludge to determine digester efficiency of the aerated sludge storage tank.

- Check waste sludge volumes and concentrations for 1997.

- Chemical dosing calculations should be checked, discussed and a strategy developed to determine whether a more effective chemical dosing strategy is required to reduce chemical consumption.

- Any future plant upgrades should consider increasing digester capability. Also, if upgrades are made to the lift station and force main, consideration should be given to upgrading the preliminary treatment and aeration basin flexibility (ie. step feed) to allow operators to effectively treat and control the extra loading to the plant.

5.0 MHC STP

The MHC STP is a conventional activated sludge plant with a nominal design flow of 568 m^3/d servicing an estimated population of 1,200 people. The plant is required under MOE Policy 08-01 to achieve an annual average effluent quality of 25 mg/L for BOD_5 and TSS and 1.0 mg/L TP. The RAP effluent phosphorus objectives are 0.30 mg/L and a loading to the receiver of 39 kg/y at nominal design flow. Table 2 summarizes key information for the MHC plant.

Table 2 Key Information for MHC Penetanguishene STP

Plant Information:	
Plant Name: MHC WPCP	Contact name: Andy Zurawski
Plant Owner: Ministry of Health	Contact number: 705-549-3181
Plant Operator: Andy Zurawski	Fax number: 705-549-5628
Population serviced: 1,200	
Nominal plant design flow: 0.568 1000 m^3/d	
RAP Effluent Phosphorus Objectives:	
Concentration = 0.3 mg/L	
Loading = 39 kg/y at design flow	
Type of Plant:	
Conventional Activated Sludge	
Primary Clarifier:	
Surface area = 25.7 m^2	
Depth = 3.0 m	
Aeration Basin:	
Aeration volume = 258 m^3	
Blower or aerator horsepower = 20 hp	
Type of aeration: coarse bubble diffusers, wide band pattern	
Operational flexibility: two aeration tanks allows maintenance flexibility	
Secondary Clarifier:	
Surface area = 38.2 m^2	
Depth at weirs = 4.3 m	
Digestion:	
Type of digestion = aerobic	
Volume = 265 m^3	
Sludge Storage:	
Volume = 265 m^3	
Means of disposal = drying beds, contract haulage, land disposal	
Disinfection:	
Chlorine Gas	
chamber volume = 11.2 m^3	
Effluent Sampling:	
Influent grab sample, effluent continuous sampling, refrigerated	
Frequency: daily effluent TSS, monthly outside lab analysis	
Comments:	
Consideration is being given to treat sewage from new jail with the existing STP. This would increase flows significantly.	

5.1 Key Activities

A September 1991 report by XCG Consultants provided analysis and upgrade requirements for the eight Severn Sound STPs to achieve a higher level of phosphorus removal and a review of proven and innovative technologies to determine maximum phosphorus removal achievable on a consistent basis from the plants. The plant reported a total phosphorus of 0.15 mg/L in 1990 at an average day flow of 259 m^3/d. Effluent data was based on weekly grab samples submitted to MOE for analysis. There was very little process information available during the study period to quantify sludge production or unit process performance. Since the MHC STP was achieving the RAP effluent phosphorus objective of 0.3 mg/L and no major flow increases were projected for the plant, no upgrades were suggested for the plant to maintain the RAP phosphorus objective of 0.3 mg/L.

A CPE was carried out in January 1995 by a joint MOE, WTC and Severn Sound Core Team to comprehensively evaluate the plant to determine factors limiting the plant from consistently achieving RAP effluent objectives. The major performance limiting factors identified were:

(1) Performance monitoring (operation)
(2) Lack of familiarity of plant needs (administration)
(3) Plant operational coverage (operation)
(4) Process controllability (design)

A CTA was recommended conditional that the Ministry of Health personnel support addressing the performance limiting factors identified, to consistently achieve the RAP effluent objectives[4].

A CTA was carried out from May 1995 to January 1996 by a MOE/WTC Team. Through implementation of a comprehensive process monitoring and control program the MHC operators with support from management consistently achieved and maintained the RAP phosphorus of objective of 0.3 mg/L during the CTA. Upon completion of the CTA, recommendations were made to sustain the effluent quality achieved during the CTA[5].

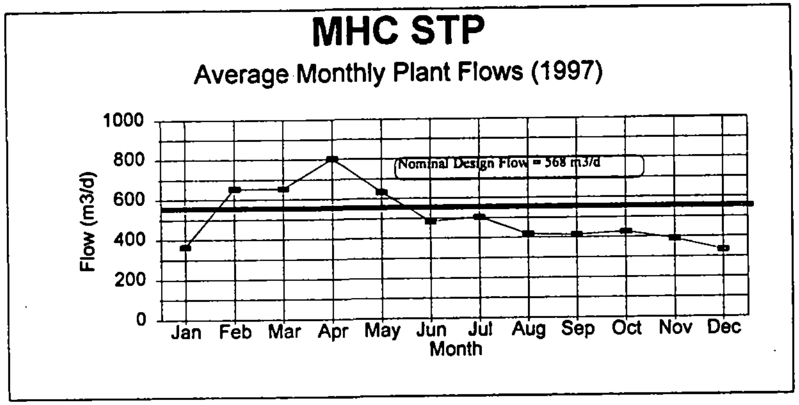
After the CTA, the operator maintained active involvement in the Severn Sound area wide optimization program Core Team, participating in hands-on activities, workshops and communicating performance achievements and issues addressed to maintain the RAP effluent objectives.

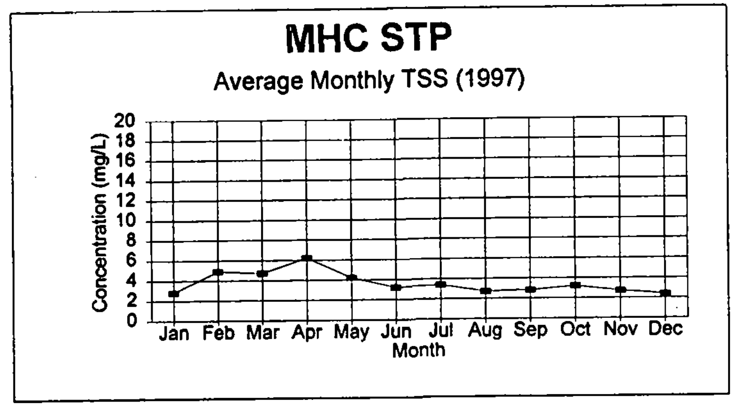
5.2 Current Performance

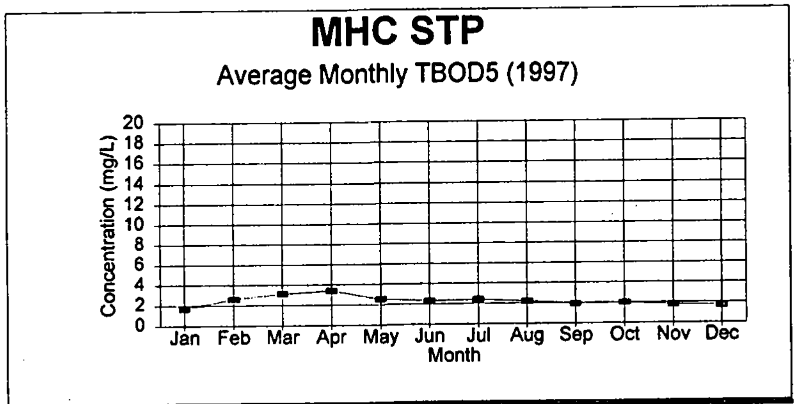
Figure 3 is a 1997 summary of reported performance (on a monthly average basis) for the MHC STP. The following comments are applicable:

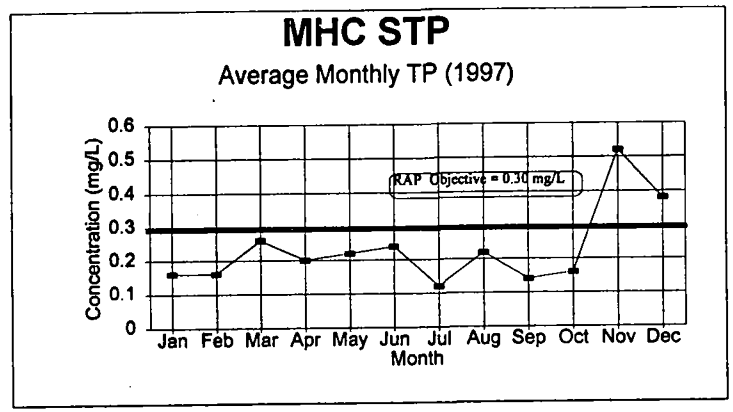
Four of the reported average monthly plant flows for 1997 were above the nominal design flow of 568 m^3/d. The average daily flow of 506 m^3/d is 89% of nominal design flow and

Figure 3: MHC Monthly Average Performance for 1997

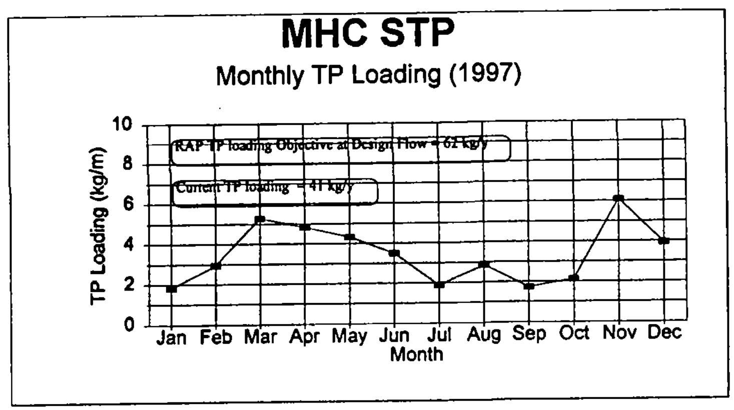








Month	Avg. Flow	TBOD5	TSS	TP	TP load
1997	m3/d	mg/L	mg/L	mg/L	kg/m
Jan	363	1.7	2.8	0.16	2
Feb	654	2.6	4.9	0.16	3
Mar	653	3.1	4.7	0.26	5
Apr	803	3.4	6.2	0.20	5
May	633	2.5	4.2	0.22	4
Jun	484	2.3	3.2	0.24	3
Jul	504	2.4	3.4	0.12	2
Aug	417	2.2	2.7	0.22	3
Sep	412	1.9	2.8	0.14	2
Oct	425	2.0	3.2	0.16	2
Nov	390	1.8	2.7	0.52	6
Dec	333	1.7	2.4	0.38	4
Avg.	506	2.3	3.6	0.23	41



is 249 m^3/d greater than the 1990 average daily flow of 259 m^3/d. Reported flows for 1997 may not reflect true plant hydraulic loading. A calibration of the flow measurement device late in 1997 showed that the existing 60 degree, V-notch weir was not an accurate primary measuring device and was replaced with a 90 degree, V-notch weir. Improved flow monitoring indicated that actual flows were significantly lower than previously reported.

BOD_5 and TSS reported monthly average concentrations were below 10 mg/L in 1997. During the CTA program, a key focus for operators was to control sludge mass in the process to achieve less than10 mg/L TSS in the final effluent to ensure 0.3 mg/L TP could be achieved with chemical addition. This target is especially important for plants without tertiary treatment.

The reported monthly average phosphorus concentrations reported for 1997 achieved the RAP phosphorus objective of 0.3 mg/L in all months except November and December when the concentrations were 0.52 and 0.38 respectively. The reported reason for exceeding the RAP objective was a power failure, which perpetuated equipment failure and process upset. The annual phosphorus loading of 41 kg/y is below the 62 kg/y RAP objective and 27 kg/y more than the 1989/90 reported loading of 14 kg/y.

5.3 Data Checks

Data verification checks were carried out on-site with operational staff to verify reported plant data. The data checks included reported versus projected flows, BOD_5 loading, chemical dosing for phosphorus removal and a sludge accountability analysis. The detailed calculations are presented in Appendix 2.

As a result of the on-site data checks, the following conclusions were reached:

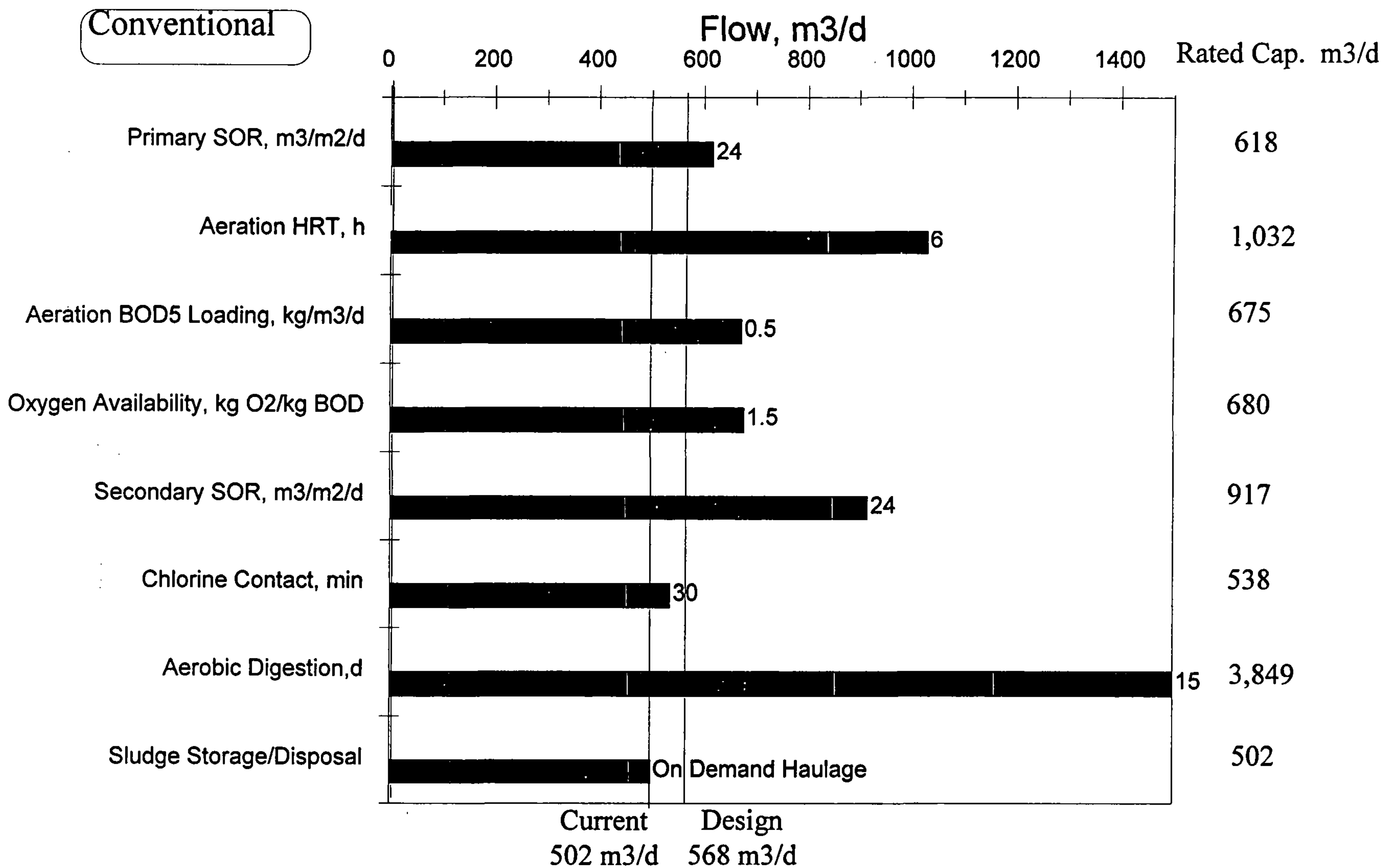
- The sludge accountability analysis, which compares the reported against the projected sludge produced, was within the expected +/- 15%. Therefore, the reported data probably reflects true plant performance. Assumptions had to be made on influent and primary effluent quality and concentration of the sludge to the digester to close the analysis. Also, the sludge accountability was based on corrected flows for 1997.

- Reported data for sludge mass from the digester was 80% higher than projected.

5.4 Design Capability

The capability of the existing plant to treat current flows and achieve the RAP effluent objectives was evaluated using a Performance Potential Graph (PPG). The graph evaluates the capability of the existing major unit processes to meet the RAP effluent

Figure 4: MHC STP Performance Potential Graph



objectives. The evaluation is based on a review of plant drawings, equipment information, performance data as well as operation and maintenance practices.

Figure 4 is the MHC Performance Potential Graph. The major unit processes included in the evaluation are shown in the left-hand column. Unit processes are rated based on experience against a combination of design and operational parameters. The horizontal bars in the Performance Potential Graph represent the estimated capacity for the parameters associated with each major unit process. Vertical lines indicate the current and nominal design flows for comparison relative to the estimated capacity. A projected influent and primary BOD_5 concentration was used to calculate BOD loading and oxygen availability capability of the MHC plant.

The MHC PPG shows that under current reported loading, the plant is capable of achieving the RAP effluent objectives. There is a need to confirm true influent and primary effluent BOD_5 loading for BOD loading and oxygen availability capability. A projected BOD loading was used to determine unit process capability.

5.5 Summary

MHC operators have achieved and maintained the RAP phosphorus objective of 0.3 mg/L in all but two months in 1997. The reported cause was a plant power failure and subsequent equipment failure. The reported phosphorus loading of 41 kg/y is less than the RAP phosphorus load objective of 62 kg/y but has increased by 27 kg/y from 1990 reported loading. The enhanced level of process control and plant performance has led to a greater awareness by MHC staff of plant needs and capability.

The data checks carried out on-site with plant operators focussed on issues to improve process and performance monitoring to ensure reported information reflects true plant operation and performance. The sludge accountability analysis indicated that the reported data probably reflects true plant performance but projected influent, primary and waste sludge values and projected flows were used to close the analysis. As identified in the following section, some follow-up activities are required to improve process monitoring.

The plant capability to treat current flows was evaluated using the Performance Potential Graph, which evaluates the major unit processes to achieve the RAP effluent objectives. The plant is capable of achieving and maintaining the RAP objectives under current loading.

5.6 Recommendations

The following recommendations are based on the findings of the on-site data review with plant operators and a review of design capability based on current plant loading:

- Initiate composite sampling on the influent and primary effluent to determine true plant loading and unit process performance.

- Initiate regular TSS and VSS analysis on sludge transferred to and from digester to accurately quantify sludge produced and solids reduction across digester.

- Maintain an accurate record of sludge volume wasted and transferred to and from digester.

- Verify plant flows through regular spot checks.

6.0 MIDLAND STP

The Midland STP is a conventional activated sludge plant with a nominal design flow of 15,665 m^3/d servicing an estimated population of 16,430 people. The plant Certificate of Approval (C of A) requires the plant achieve an annual average effluent quality of 10 mg/L for BOD_5 and TSS, 0.3 mg/L TP, 10 mg/L NH_3 (June 1 to August 31) and 15 mg/L (September 1 to May 31). The RAP effluent phosphorus objectives are 0.30 mg/L and a loading to the receiver of 1,992 kg/y at a forecast design flow of 18,180 m^3/d. Table 3 summarizes key information for the Midland STP.

Table 3 Key Information for Midland STP

Plant Information:	
Plant Name: Midland WPCP	Contact name: Tim Toole
Plant Owner: Town of Midland	Contact number: 705-526-4268
Plant Operator: Pat J LeClair	Fax number: 705-528-6072
Population serviced: 16,430	
Nominal plant design flow: 15.665 m^3/d 1000 m^3/d	
RAP Effluent Phosphorus Objectives:	
Concentration: 0.30 mg/L	
Loading: 1,992 kg/y at design flow	
Type of Plant:	
Conventional activated sludge	
Primary Clarifiers (3):	
Surface area = 2 @ 173.8 m^2, 1 @ 181 m^2	
Depth = 2 @ 2.4 m, 1 @ 3.4 m	
Aeration Basins (6 cells):	
Aeration volume = 2868 m^3	
Blower Horsepower = 60 hp	
Type of aeration: fixed mechanical aerators, 6 separate cells	
Operational flexibility: plug flow, step feed capable, multiple point RAS return	
Secondary Clarifiers (2):	
Surface area = 1,006 m^2	
Depth = 3.7 m	
Digestion (3):	
Type of digestion = anaerobic	
Volume = 1,908 m^3	
2 secondary digesters at 454 m^3 each, 1 at 1000 m^3	
Sludge storage:	
Means of disposal = contract haulage, land disposal	
Disinfection:	
Chlorine = seasonal requirement, sodium hypochlorite	
Volume of contact tank = 427m3	
Effluent Sampling:	
Influent/Effluent: 24 hr composite, refrigerated samplers	
Frequency: daily TSS, TP	
Comments (Recent upgrades, unit process limitations etc.):	
Plant upgrade, expansion in 1997. Flow equalization tank, one primary, one primary egg digester and upgrade 2 existing digesters for secondary digestion. A SCADA monitoring and control system was also installed. There has been recent work completed to assess aerator capability.	

6.1 Key Activities

A September 1991 report by XCG Consultants provided analysis and upgrade requirements for the eight Severn Sound STPs to achieve a higher level of phosphorus removal and a review of proven and innovative technologies to determine maximum phosphorus removal achievable on a consistent basis from the plants. The plant reported a total phosphorus of 0.72 mg/L in 1989/90 at an average day flow of 11,550 m^3/d. To achieve and sustain the RAP phosphorus objective of 0.3 mg/L the report recommended effluent polishing by filtration in conjunction with the current simultaneous chemical precipitation of phosphorus for the Midland STP. The estimated capital cost was $2,300,000.

A design process audit was carried out in 1993 by Enviromega to determine the limitations of existing unit processes to achieve RAP objectives. The study also evaluated dual point chemical addition to achieve the RAP phosphorus objective of 0.3 mg/L.

The plant was expanded, upgraded and commissioned in 1996/97 with a flow equalization tank, primary clarifier, primary anaerobic egg shaped digester, upgrading of the two existing digesters for secondary digestion and a SCADA monitoring and control system.

A study on aerator oxygen transfer capability was carried out in 1997 by XCG Consultants.

From 1994 to 1998, the operator and manager participated in a Severn Sound area-wide optimization program. The program focussed on achieving and sustaining RAP effluent objectives with existing, treatment plants through the transfer of skills to the owners and operators. The transfer of skills involved on-site, hands-on training, workshops and presentations.

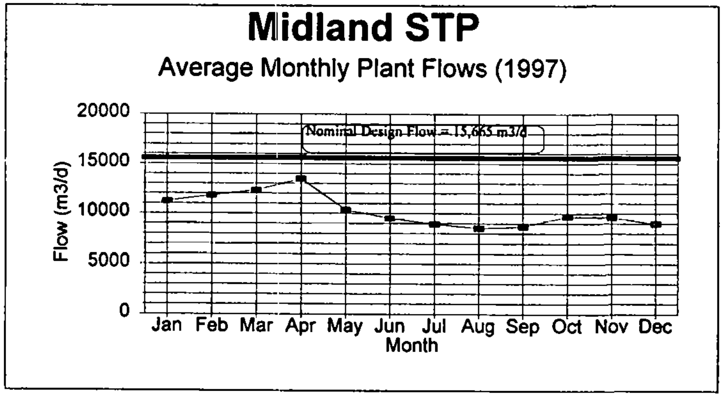
6.2 Current Performance

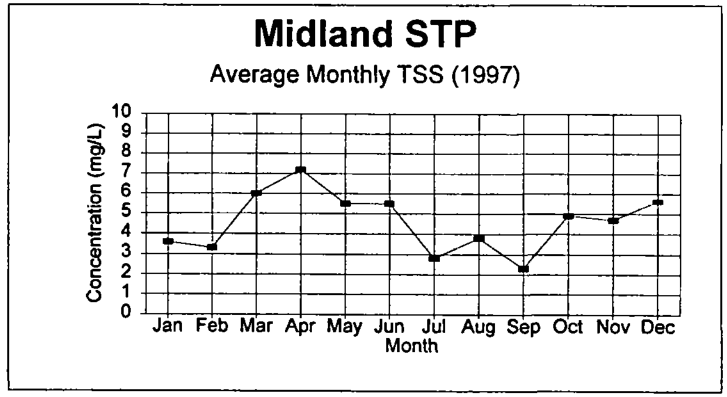
Figure 5 is a 1997 summary of reported performance (on a monthly average basis) for the Midland STP. The following comments are applicable:

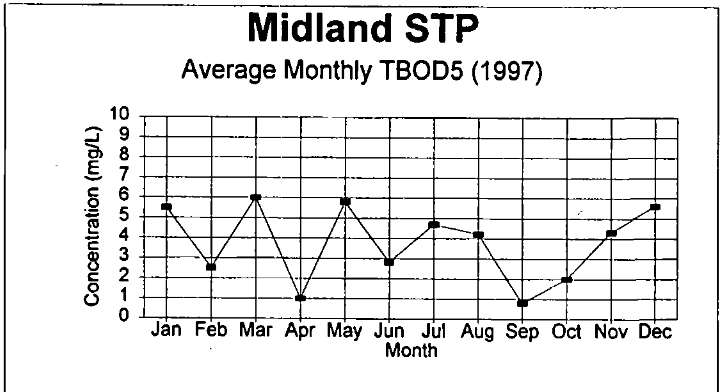
Average monthly plant flows for 1997 were below the nominal design flow of 15,665 m^3/d. The average daily flow of 10,240 m^3/d is 56% of nominal design flow and is 1,310 m^3/d less than the 1990 average daily flow of 11,550 m^3/d

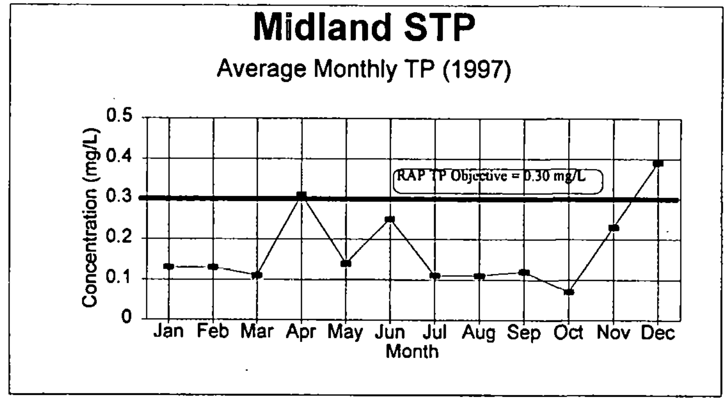
BOD_5 and TSS reported monthly average concentrations were below 10 mg/L in 1997. A key focus for operators to achieve and sustain a 0.3 mg/L phosphorus objective is to control sludge mass in the process to achieve less than10 mg/L TSS in the final effluent. This target is especially important for plants without tertiary treatment.

Figure 5: Midland STP Monthly Average Performance for 1997

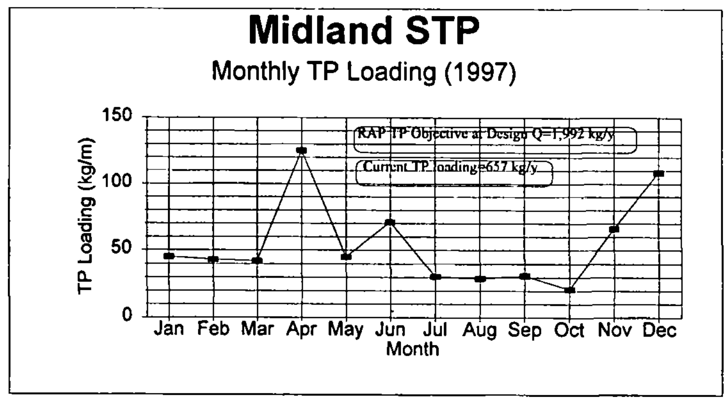








Month	Avg. Flow	TBOD5	TSS	TP	TP load
1997	m3/d	mg/L	mg/L	mg/L	kg/m
Jan	11207	5.5	3.6	0.13	45
Feb	11784	2.5	3.3	0.13	43
Mar	12284	6.0	6.0	0.11	42
Apr	13464	1.0	7.2	0.31	125
May	10328	5.8	5.5	0.14	45
Jun	9475	2.8	5.5	0.25	71
Jul	8920	4.7	2.8	0.11	30
Aug	8525	4.2	3.8	0.11	29
Sep	8679	0.8	2.3	0.12	31
Oct	9660	2.0	4.9	0.07	21
Nov	9587	4.3	4.7	0.23	66
Dec	8971	5.6	5.6	0.39	108
Avg.	10240	3.8	4.6	0.18	657



The reported monthly average phosphorus concentrations reported for 1997 achieved the RAP phosphorus objective of 0.3 mg/L in all months except April and December when the concentrations were 0.31 and 0.39 respectively. The annual phosphorus loading of 657 kg/y is below the 1,992 kg/y RAP objective and 2,387 kg/y less than the 1989/90 reported loading of 3,044 kg/y. Plant upgrades and commissioning of new unit processes made it very difficult for operators to maintain a consistent process control program in 1997.

6.3 Data Checks

Data verification checks were carried out on-site with operational staff to verify reported plant data. The data checks included reported versus projected flows, BOD_5 loading, chemical dosing for phosphorus removal and a sludge accountability analysis. The detailed calculations are presented in Appendix 3.

As a result of the on-site data checks, the following conclusions were made:

- The sludge accountability analysis, which compares the reported against the projected sludge produced, was within +/- 15% therefore, the reported data probably reflects true plant performance. To close the sludge accountability analysis a projected influent BOD_5 concentration was used. The reported BOD_5 did not compare to typical values.

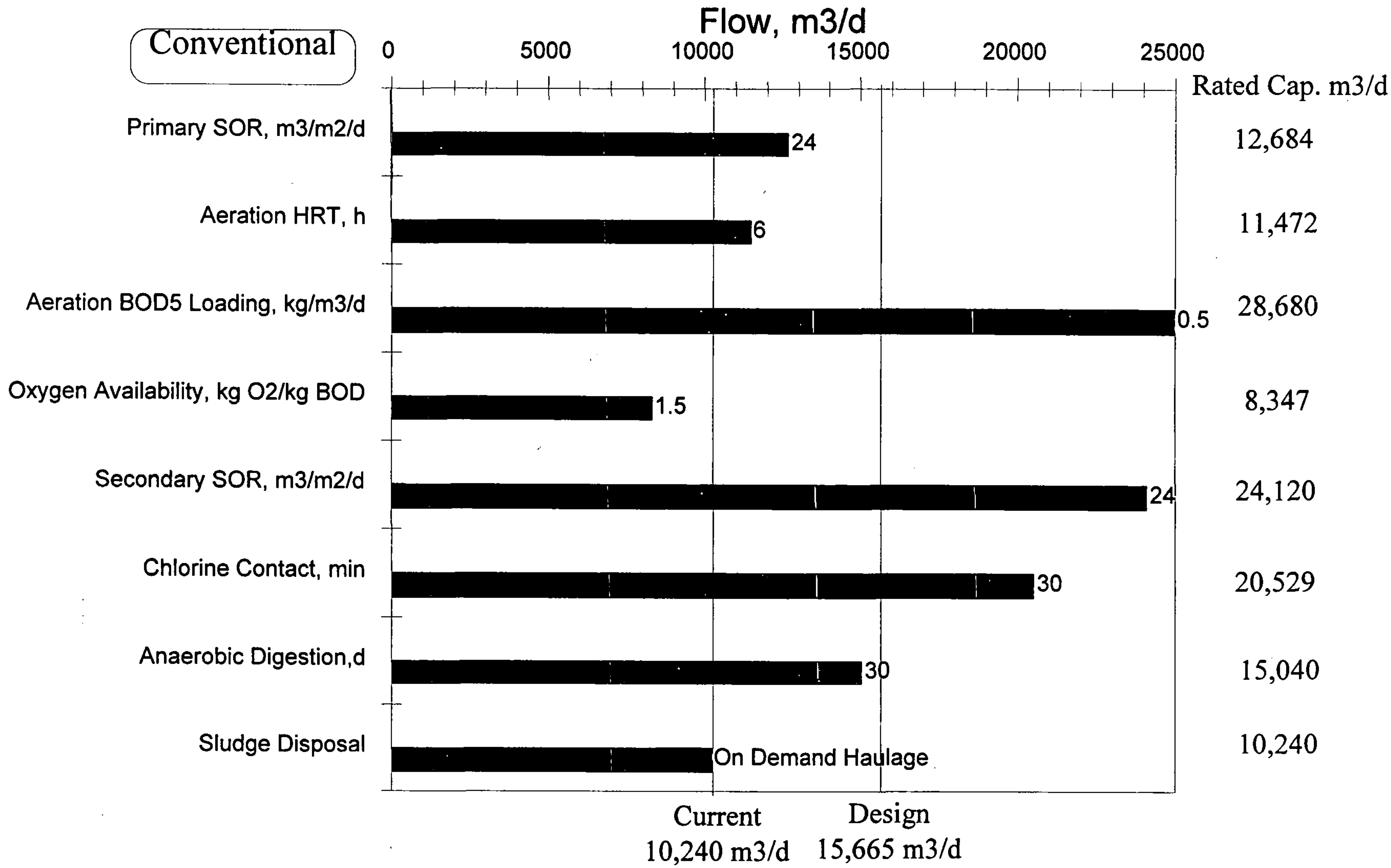
- Reported flows are significantly higher than projected based on population served. The Town has combined sewers which probably accounts for the higher than expected flows.

6.4 Design Capability

The capability of the existing plant to treat current flows and achieve the RAP effluent objectives was evaluated using a Performance Potential Graph (PPG). The graph evaluates the capability of the existing major unit processes to meet the RAP effluent objectives. The evaluation is based on a review of plant drawings, equipment information, performance data as well as operation and maintenance practices.

The major unit processes included in the evaluation are shown in the left-hand column. Unit processes are rated based on experience against a combination of design and operational parameters. The horizontal bars in the Performance Potential Graph represent the estimated capacity for the parameters associated with each major unit process. Vertical lines indicate the current and nominal design flows for comparison relative to the estimated capacity. A projected influent and primary BOD_5 concentration was used to calculate BOD loading and oxygen availability capability of the Midland plant.

Figure 6: Midland STP Performance Potential Graph



The Midland PPG shows that under current reported loading, the oxygen availability to remove projected BOD_5 loading is marginal. Plant staff have completed comprehensive testing to determine current capability and are planning to upgrade the mechanical aerator capability over the next six years. All other major unit processes are capable of achieving the RAP effluent objectives under current loading conditions. There is a need to confirm true influent and primary effluent BOD_5 loading for BOD loading and oxygen availability capability.

6.5 Summary

Midland operators have achieved and maintained the RAP phosphorus objective of 0.3 mg/L in all but two months in 1997. Plant upgrades and commissioning of new unit processes and control impacted the operator's ability to maintain a consistent process control program. The reported phosphorus loading of 637 kg/y is less than the RAP phosphorus load objective of 1992 kg/y. This represents a major phosphorus loading reduction from 1989/90 when the reported loading was 3,044 kg/y.

The data checks carried out on-site with the plant operator focussed on issues to improve process and performance monitoring to ensure reported information reflects true plant operation and performance. The sludge accountability analysis indicated that the reported data probably reflects true plant performance. To close the data, a projected influent and primary effluent BOD was used. In the following section, follow-up activities are suggested to improve process monitoring and enhance awareness of plant needs.

The plant capability to treat current flows was evaluated using the Performance Potential Graph, which evaluates the major unit processes to achieve the RAP effluent objectives. The aerator capability to provide oxygen to treat the reported BOD5 loading is marginal but staff, are planning to upgrade the aerator capability over the next six years. The other major unit processes are capable of achieving and maintaining the RAP objectives under current loading.

6.6 Recommendations

The following recommendations are based on the findings of the on-site data review with plant operators and a review of design capability based on current plant loading:

- Implement aerator upgrades as a priority activity.

- A review of current sampling and analysis practices should be carried out for the influent and primary effluent BOD to determine if they reflect true plant loading and unit process removal.

- Continue to check ratio of influent TSS:BOD_5. The current ratio is higher (2.1) than typical (0.8 – 1.2).

- Continue to monitor the difference between reported and projected flows (currently reported is 38% greater than expected). Develop a strategy to systematically reduce combined sewers and inflow/infiltration to preserve plant capacity.

- Obtain water consumption rates from the Town to check population serviced and projected hydraulic plant loading (i.e. 70 – 90% of daily water consumed should reach the plant). Determine magnitude of combined sewer problem.

- Check the population of the Town and recalculate the data checks for anticipated loading if the population number is different from what was used.

- Check plant flows for 1997. The flow used on site for data checks was 11,400 m^3/d and follow-up data reported the average day flow as 10,240 m^3/d.

- Review the sludge accountability analysis, data checks and discuss with operators and manager.

7.0 MAIN ST. PENETANGUISHENE STP

The Main St. STP is a modified conventional activated sludge, tertiary filtration plant with a nominal design flow of 4,545 m^3/d servicing an estimated population of 5,831 people. The plant C of A requires the plant achieve a monthly average effluent quality of 15 mg/L for BOD_5 and TSS and 0.2 mg/L TP. The RAP effluent phosphorus objectives are 0.10 mg/L and a loading to the receiver of 166 kg/y at nominal design flow. Table 4 summarizes key information for the Main St. plant.

Table 4 Key Information for Main St. Penetanguishene STP

Plant Information	
Plant Name: Main St.WPCP	Contact name: John Boucher
Plant Owner: Town of Penetanguishene	Contact number: 705-549-8784
Plant Operator: Mark Charlebois, Scott Hook	Fax number: 705-549-3743
Population serviced: 5,831	
Nominal plant design flow: 4.545 1000 m^3/d	
RAP Effluent Phosphorus Objectives:	
Concentration: 0.10 mg/L	
Loading: 166 kg/y at design flow	
Type of Plant:	
Modified Conventional Activated Sludge	
Aeration Basin:	
Aeration volume = 1,160 m^3	
Blower or aerator horsepower = 60 hp	
Type of aeration: fine bubble diffusers, total floor coverage	
Operational flexibility: selector tank	
Secondary Clarifier:	
Surface area = 402 m^2	
Depth = 3.6 m	
Tertiary Treatment:	
Upflow sand filters (10 units)	
Flow capability: 13,651 m^3/d	
Digestion:	
Type of digestion = 2 aerobic	
Combined Volume = 2824 m^3	
Sludge Storage:	
Volume = 2824 m^3	
Means of disposal = contract haulage, land disposal (agricultural)	
Disinfection:	
Sodium Hypochlorite	
Contact chamber = 120 m^3	
Effluent Sampling:	
Influent/Effluent: 24 hr composite, refrigerated samplers	
Frequency: daily TSS, TP, weekly outside lab effluent anlysis, biweekly influent analysis	
Comments:	
Plant expansion in 1993.	
Dual point chemical addition (alum, polymer)	
Automated control through SCADA system	

7.1 Key Activities

A September 1991 report by XCG Consultants provided analysis and upgrade requirements for the eight Severn Sound STPs to achieve a higher level of phosphorus removal and a review of proven and innovative technologies to determine maximum phosphorus removal achievable on a consistent basis from the plants. During the study, the plant consisted of two contact stabilization plants designed to treat an average daily flow of 3000 m^3/d. An environmental study had been completed which proposed that the existing plant be converted to a modified conventional activated sludge plant. The plant reported a total phosphorus of 0.58 mg/L at an average day flow of 2,574 m^3/d in 1990. To achieve and sustain the RAP phosphorus objective of 0.1 mg/L, the report recommended effluent polishing by filtration, dual point chemical precipitation of phosphorus, a solids contact clarifier and anionic polymer addition upstream of the filters for the Main St. STP. The estimated capital cost was $2,270,000.

A two-phase sampling study was carried out in March and April 1991 by Rupke and Associates. The study indicated that the effluent actual BOD_5, TSS and TP were significantly higher than were being reported over the same period. Combined effluent data from the plant and lift station bypass flow was used to determine loading to the receiver and it was projected that the phosphorus loading could be twice the reported loading to the receiver.

A modified conventional activated sludge plant was built and commissioned in 1993/94 with two aeration tanks, two secondary clarifiers, solids contact clarifier, ten up-flow sand filters, chemical addition facilities, modifications of the two existing plants to aerobic sludge digesters and a SCADA monitoring and control system.

7.2 Current Performance

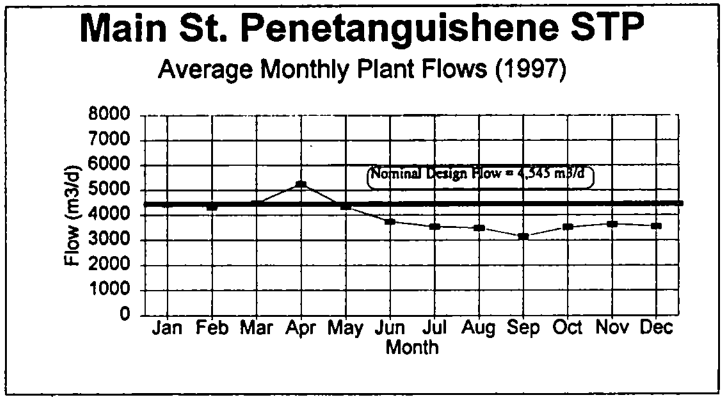
Figure 7 is a summary of 1997 reported performance (on a monthly average basis) for the Main St. STP.

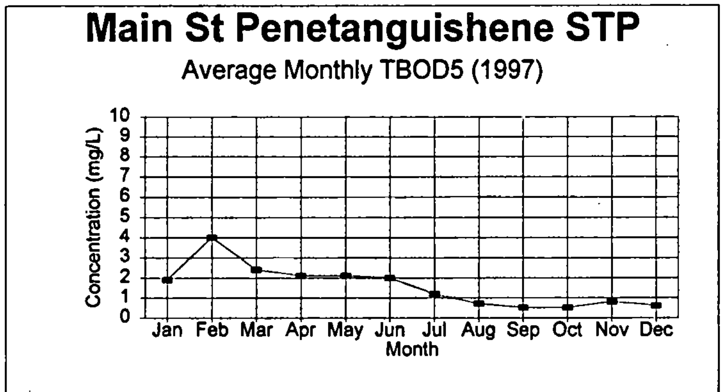
Average monthly plant flows for 1997 were below the nominal design flow of 4,545 m^3/d in all months except April when the reported average flow was 5,240 m^3/d. The average daily flow of 3,939 m^3/d is 87% of nominal design flow and is 1,365 m^3/d greater than the 1990 average daily flow of 2,574 m^3/d.

BOD5 and TSS reported monthly average concentrations were below 5 mg/L in 1997.

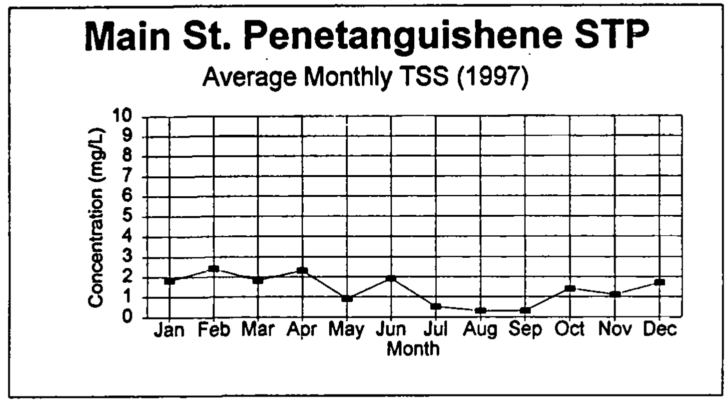
The reported monthly average phosphorus concentrations reported for 1997 achieved the RAP phosphorus objective of 0.1 mg/L in all months except December when the concentration was 0.12. The annual phosphorus loading of 78 kg/y is below the 166 kg/y RAP objective and 522 kg/y less than the 1989/90 estimated loading of 600 kg/y.

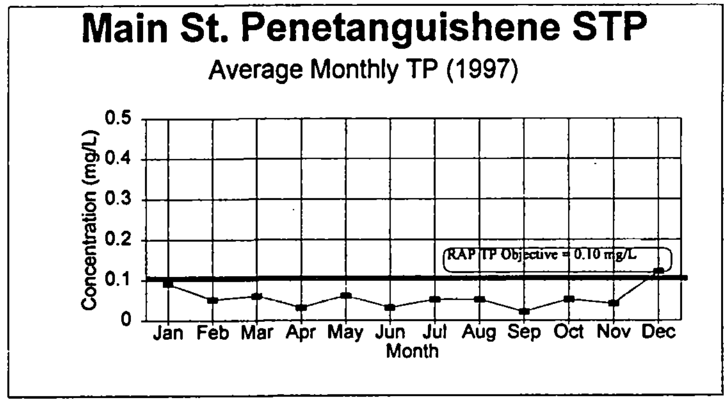
Figure 7: Main St. STP Monthly Average Performance for 1997

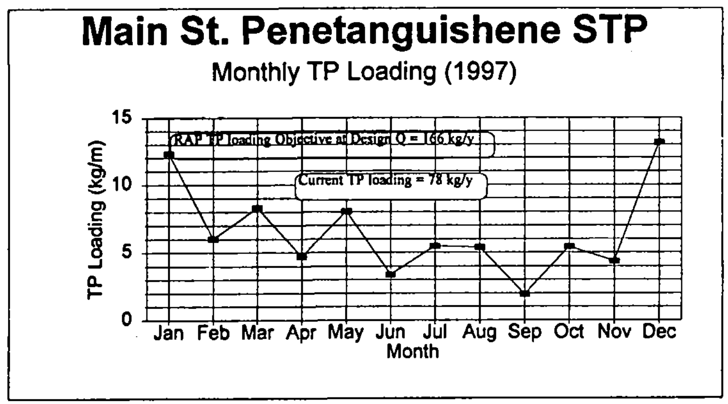




Month	Avg. Flow	TBOD5	TSS	TP	TP load
1997	m3/d	mg/L	mg/L	mg/L	kg/m
Jan	4417	1.9	1.8	0.09	12
Feb	4307	4.0	2.4	0.05	6
Mar	4467	2.4	1.8	0.06	8
Apr	5240	2.1	2.3	0.03	5
May	4318	2.1	0.9	0.06	8
Jun	3725	2.0	1.9	0.03	3
Jul	3527	1.2	0.5	0.05	5
Aug	3470	0.7	0.3	0.05	5
Sep	3141	0.5	0.3	0.02	2
Oct	3501	0.5	1.4	0.05	5
Nov	3621	0.8	1.1	0.04	4
Dec	3535	0.6	1.7	0.12	13
Avg.	3939	1.6	1.4	0.05	78







7.3 Data Checks

Data verification checks were carried out on-site with operational staff to verify reported plant data. The data checks included reported versus projected flows, BOD5 loading, chemical dosing for phosphorus removal and a sludge accountability analysis. The detailed calculations are presented in Appendix 4.

As a result of the on-site data checks, the following conclusions were made:

- The sludge accountability analysis, which compares the reported against the projected sludge produced, was within +/- 15%. Therefore, the reported data probably reflects true plant performance. To close the sludge accountability analysis a projected influent BOD_5 concentration was used.

- The BOD5 loading to the plant is lower than expected. The influent TSS to BOD ratio of 1.6 is higher than the typical of 0.8 to 1.2.

- The difference between reported and projected flow is 1,269 m3/d. Combined sewers are likely the main cause for the high hydraulic loading. Systematically reducing the inflow/infiltration will improve plant capability.

- Currently there is very little data for secondary effluent to monitor and control system performance.

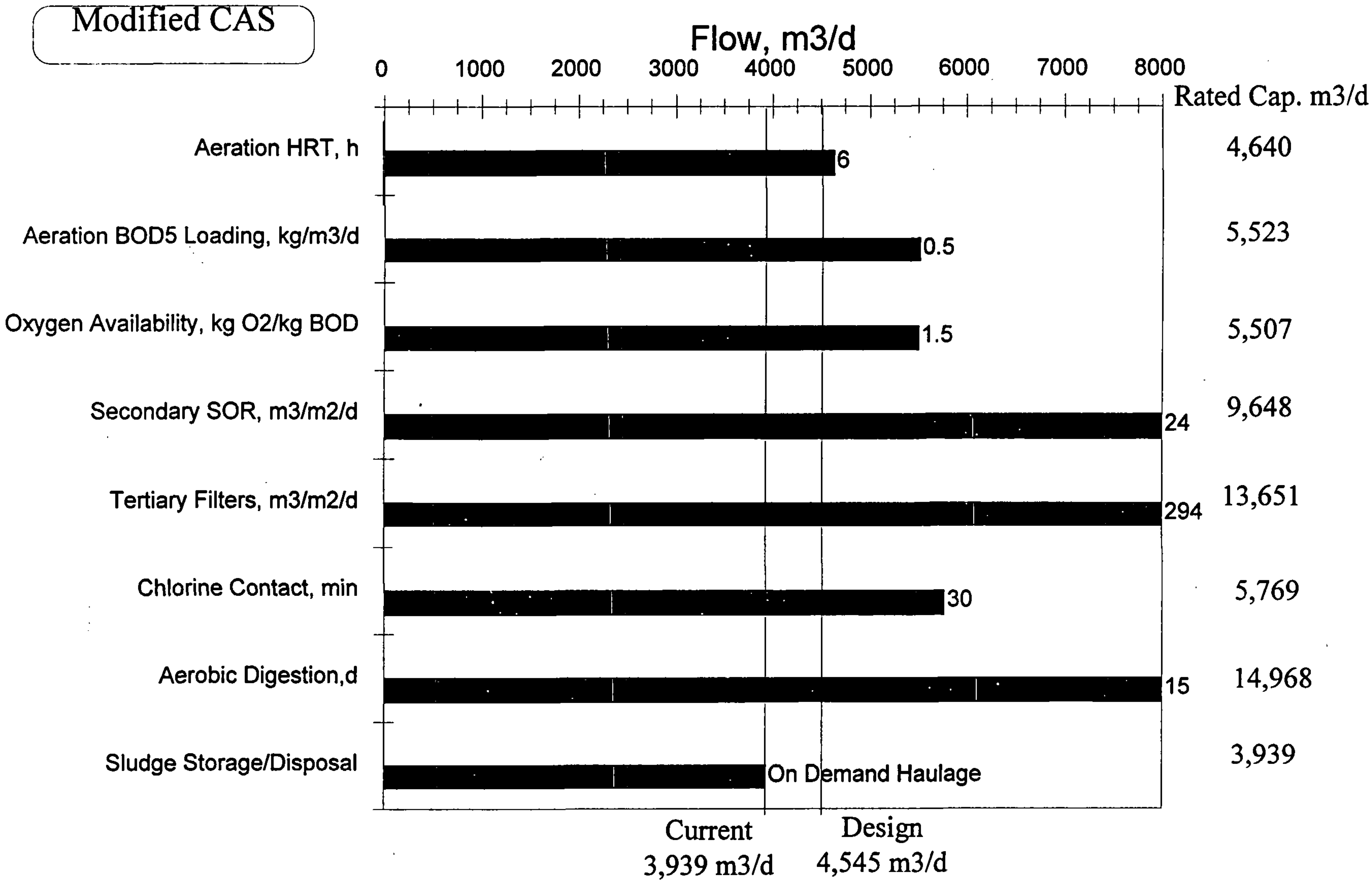
- The current chemical addition for phosphorus removal is higher than projected.

7.4 Design Capability

The capability of the existing plant to treat current flows and achieve the RAP effluent objectives was evaluated using a Performance Potential Graph (PPG). The graph evaluates the capability of the existing major unit processes to meet the RAP effluent objectives. The evaluation is based on a review of plant drawings, equipment information, performance data as well as operation and maintenance practices.

Figure 8 is the Main St. Performance Potential Graph. The major unit processes included in the evaluation are shown in the left-hand column. Unit processes are rated based on experience against a combination of design and operational parameters. The horizontal bars in the Performance Potential Graph represent the estimated capacity for the parameters associated with each major unit process. Vertical lines indicate the current and nominal design flows for comparison relative to the estimated capacity. A projected influent BOD_5 concentration was used to calculate BOD loading and oxygen availability capability of the Main St. plant.

Figure 8: Main Street STP Performance Potential Graph



The Main St. PPG shows that under current reported loading, the major unit processes are capable of achieving the RAP effluent objectives. There is a need to confirm true influent BOD_5 concentration for BOD loading and oxygen availability capability.

7.5 Summary

Main St. operators have achieved and maintained the RAP phosphorus objective of 0.1 mg/L in all but one month in 1997. The plant has had major upgrades since 1990, which supported operators in achieving the stringent RAP objectives. The reported phosphorus loading of 78 kg/y is less than the RAP phosphorus load objective of 166 kg/y. This represents a major phosphorus loading reduction from 1989/90 when the estimated loading was 600 kg/y.

The data checks carried out on-site with the plant operator focussed on issues to improve process and performance monitoring to ensure reported information reflects true plant operation and performance. The sludge accountability analysis indicated that the reported data probably reflects true plant performance. Projected influent BOD concentrations were used to close the sludge accountability analysis.

The plant capability to treat current flows was evaluated using the Performance Potential Graph, which evaluates the major unit processes to achieve the RAP effluent objectives. The major unit processes of the Main St. STP are capable of achieving and maintaining the RAP objectives under current loading conditions.

7.6 Recommendations

The following recommendations are based on the findings of the on-site data review with plant operators and a review of design capability based on current plant loading:

- Continue to check the TSS to BOD ratio for the influent and discuss with outside lab if the ratio is not within typical ranges.

- Continue monitoring and reporting flows against expected flow values. This will become more important as the town develops and loading to the plant increases. Activity should be initiated, to systematically separate the storm water and sanitary sewers and reduce the infiltration/ inflow.

- Increase the sampling of the secondary clarifier for TSS, BOD and TP. Use the information as a focus for process control decisions.

8.0 FOX ST. PENETANGUISHENE STP

The Fox St. STP is a contact stabilization, tertiary filtration plant with a nominal design flow of 1,515 m³/d servicing an estimated population of 1,169 people. The plant C of A requires the plant achieve a monthly average effluent quality of 15 mg/L for BOD_5 and TSS and 0.2 mg/L TP. The RAP effluent phosphorus objectives are 0.10 mg/L and a loading to the receiver of 55 kg/y at nominal design flow. Table 5 summarizes key information for the Fox St. plant.

Table 5 Key Information for Fox St. Penetanguishene STP

Plant Information:	
Plant Name: Fox St. WPCP	Contact name: John Boucher
Plant Owner: Town of Penetanguishene	Contact number: 705-549-8784
Plant Operator(s): Scott Hook, Mark Charlebois	Fax number: 705-549-3743
Population serviced: 1,169	
Nominal plant design flow: 1.5 1000 m³/d	
RAP Effluent Phosphorus Objectives:	
Concentration = 0.1 mg/L	
Loading = 55 kg/y at design flow	
Type of Plant:	
Contact stabilization	
Aeration Basin:	
Aeration volume = 562 m³	
Type of aeration: Coarse bubble diffusers wide band pattern	
Operational flexibility: None	
Secondary Clarifier:	
Surface area = 65 m²	
Depth = 4.0 m	
Tertiary Treatment:	
Membrane Drum Filters (2 units)	
Flow capability = 6000 m³/d	
Digestion:	
Type of digestion = aerobic, 2 tanks	
Volume = 376 m³	
Sludge Storage:	
Same as Digestion Volume	
Means of disposal = contract haulage, land disposal (agricultural)	
Disinfection:	
Sodium Hypochorite	
Chamber volume = 44.45 m³	
Effluent Sampling:	
Influent/Effluent: 24 hr composite, refrigerated samplers	
Frequency = daily TSS, TP, outside lab biweekly influent, weekly effluent	
Comments:	
Tertiary treatment upgrade in 1994.	
Dual point chemical addition for phosphorus removal (alum, polymer).	
Some automation with SCADA system.	

8.1 Key Activities

A September 1991 report by XCG Consultants provided analysis and upgrade requirements for the eight Severn Sound STPs to achieve a higher level of phosphorus removal and a review of proven and innovative technologies to determine maximum phosphorus removal achievable on a consistent basis from the plants. In 1989/90, the plant reported a total phosphorus of 0.47mg/L at an average day flow of 1,213 m^3/d with an annual phosphorus loading to the receiver of 160 kg/y in 1990. To achieve and sustain the RAP phosphorus objective of 0.1 mg/L the report recommended effluent polishing by filtration, dual point chemical precipitation of phosphorus, a solids contact clarifier and anionic polymer addition upstream of the filters for the Fox St. STP. The estimated capital cost was $1,680,000.

A tertiary treatment upgrade was added to the plant in 1994, which included a solids contact clarifier, two membrane filter systems, chemical addition facilities and a SCADA monitoring and control system.

8.2 Current Performance

Figure 9 is a summary of reported performance (on a monthly average basis) for the Fox St. plant. The following comments are applicable:

Average monthly plant flows for 1997 were below the nominal design flow of 1,500 m^3/d in all months. The average daily flow of 790 m^3/d is 53% of nominal design flow and is 423 m^3/d less than the 1989/90 average daily flow of 1,213 m^3/d. More flow has been transferred to the Main St. plant because of the major upgrades.

BOD_5 and TSS reported monthly average concentrations were below 5 mg/L in 1997.

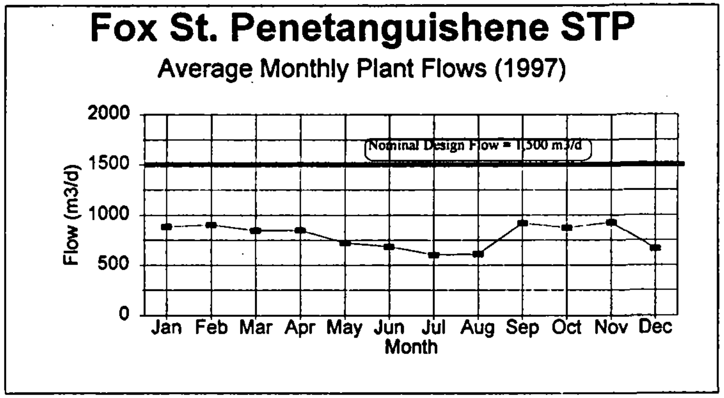
The reported monthly average phosphorus concentrations reported for 1997 achieved the RAP phosphorus objective of 0.1 mg/L in all months. The annual phosphorus loading of 15 kg/y is well below the 55 kg/y RAP objective and 145 kg/y less than the 1990 reported loading of 160 kg/y.

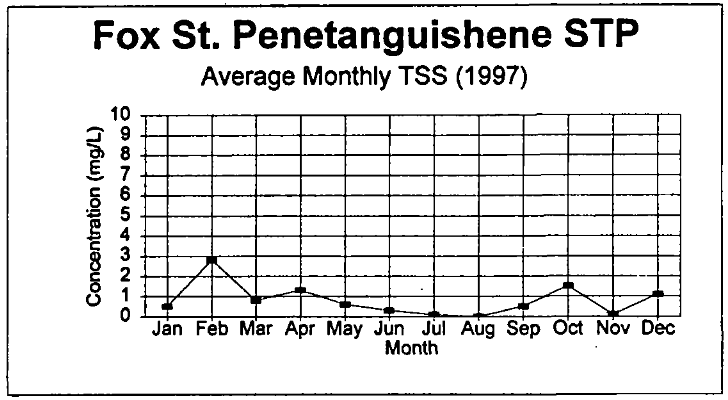
8.3 Data Checks

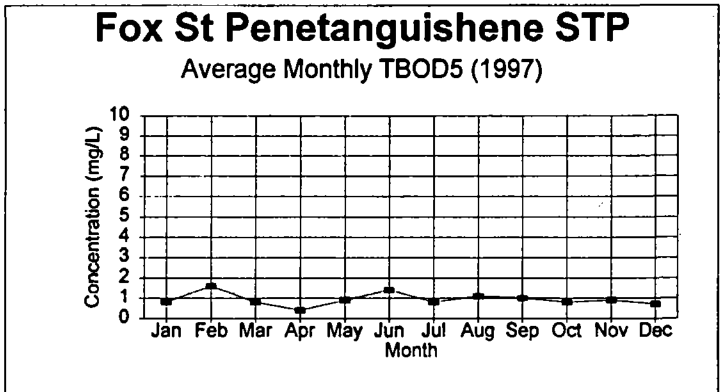
Data verification checks were carried out on-site with operational staff to verify reported plant data. The data checks included reported versus projected flows, BOD_5 loading, chemical dosing for phosphorus removal and a sludge accountability analysis. The detailed calculations are presented in Appendix 5.

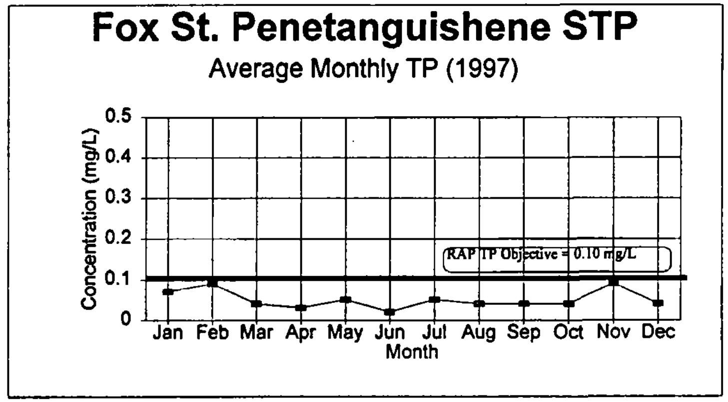
As a result of the on-site data checks, the following conclusions were reached:

Figure 9: Fox St. STP Monthly Average Performance for 1997

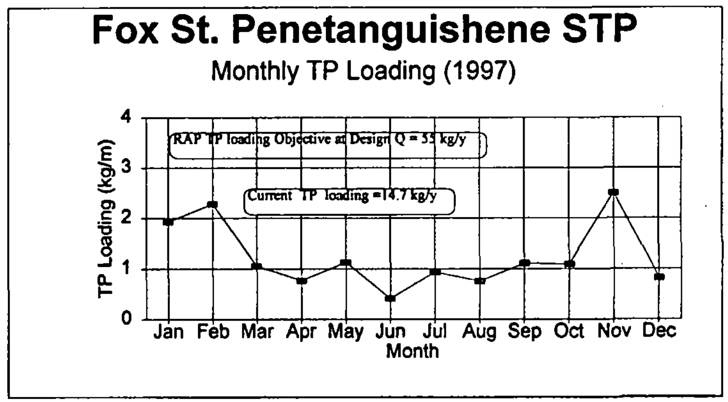








Month	Avg. Flow	TBOD5	TSS	TP	TP load
1997	m3/d	mg/L	mg/L	mg/L	kg/m
Jan	885	0.8	0.5	0.07	1.9
Feb	903	1.6	2.8	0.09	2.3
Mar	846	0.8	0.8	0.04	1.0
Apr	849	0.4	1.3	0.03	0.8
May	722	0.9	0.6	0.05	1.1
Jun	684	1.4	0.3	0.02	0.4
Jul	601	0.8	0.1	0.05	0.9
Aug	609	1.1	0.0	0.04	0.8
Sep	920	1.0	0.5	0.04	1.1
Oct	873	0.8	1.5	0.04	1.1
Nov	925	0.9	0.1	0.09	2.5
Dec	664	0.7	1.1	0.04	0.8
Avg.	790	0.9	0.8	0.05	14.7



- The sludge accountability analysis, which compares the reported against the projected sludge produced, was within +/- 15% therefore, the reported data probably reflects true plant performance. To close the sludge accountability analysis a projected influent BOD_5 and waste sludge concentration were used.

- Reported flows are much higher than projected for population serviced which appears to be a result of combined sewer loading. Currently the plant appears to be capable of handling these flows but in the future as the load increases this may reduce treatment capability.

- Reported chemical dosing was greater than projected to achieve RAP phosphorus objectives. Also, greater than dosage at Main St. for same sewage and similar treated. Therefore, there may be an opportunity to reduce alum consumption.

8.4 Design Capability

The capability of the existing plant to treat current flows and achieve the RAP effluent objectives was evaluated using a Performance Potential Graph (PPG). The graph evaluates the capability of the existing major unit processes to meet the RAP effluent objectives. The evaluation is based on a review of plant drawings, equipment information, performance data as well as operation and maintenance practices.

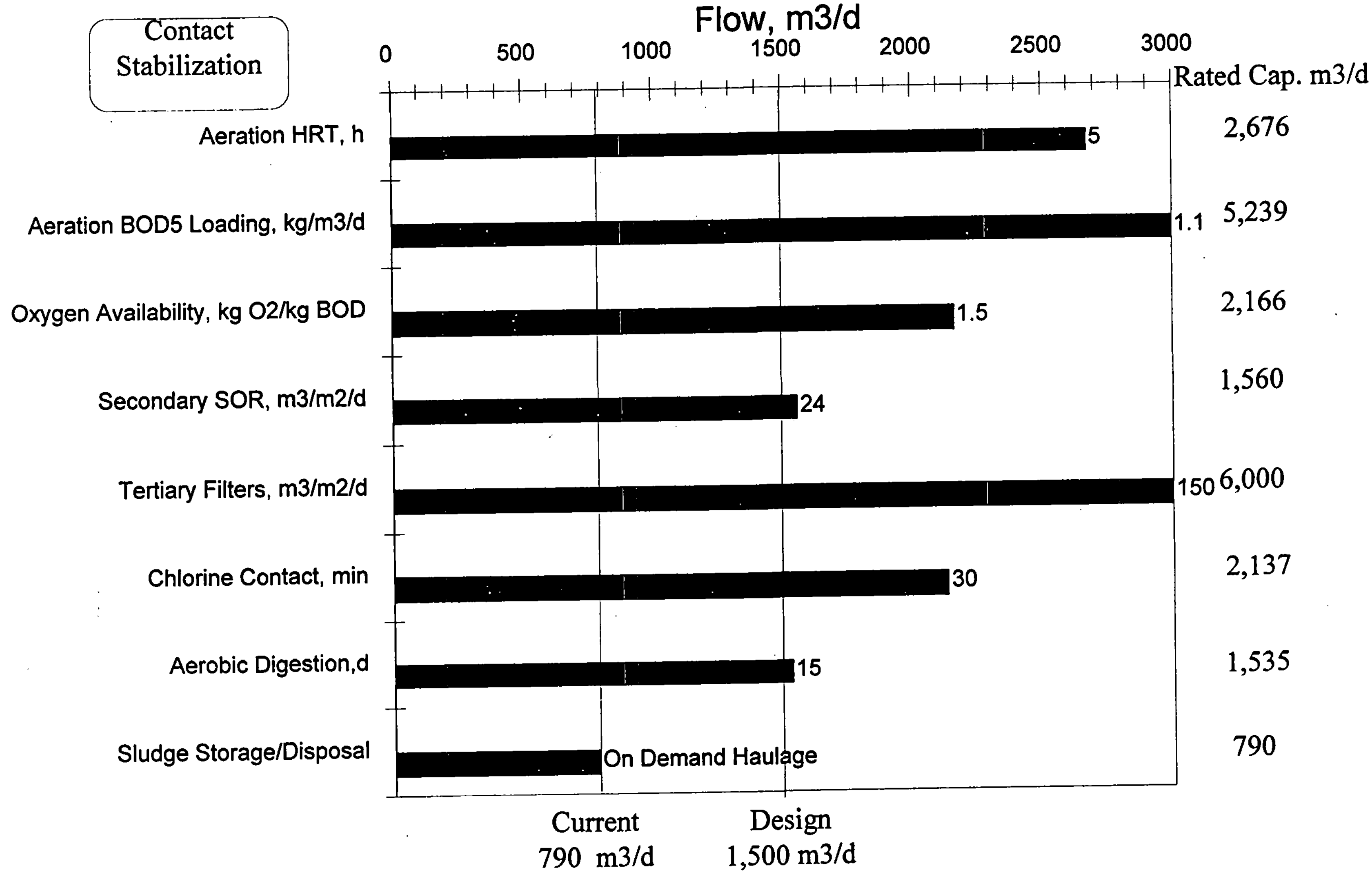
Figure 10 is the Fox St. Performance Potential Graph. The major unit processes included in the evaluation are shown in the left-hand column. Unit processes are rated based on experience against a combination of design and operational parameters. The horizontal bars in the Performance Potential Graph represent the estimated capacity for the parameters associated with each major unit process. Vertical lines indicate the current and nominal design flows for comparison relative to the estimated capacity. A projected influent BOD_5 concentration was used to calculate BOD loading and oxygen availability capability of the Fox St. plant.

The Fox St. PPG shows that under current reported loading, the major unit processes are capable of achieving the RAP effluent objectives. There is a need to confirm true influent BOD_5 concentrations for BOD loading and oxygen availability capability.

8.5 Summary

Fox St. operators have achieved and maintained the RAP phosphorus objective of 0.1 mg/L in all months of 1997. The plant has had major upgrades since 1990, which supported operators in achieving the stringent RAP objectives. The reported phosphorus loading of 14 kg/y is less than the RAP phosphorus load objective of 55 kg/y. This represents a major phosphorus loading reduction from 1989/90 when the estimated loading was 160 kg/y.

Figure 10: Fox Street STP Performance Potential Graph



The data checks carried out on-site with the plant operator focussed on issues to improve process and performance monitoring to ensure reported information reflects true plant operation and performance. The sludge accountability analysis indicated that the reported data probably reflects true plant performance. Projected influent BOD and waste sludge concentrations were used to close the sludge accountability analysis. In the following section, some follow-up activities are suggested to improve process monitoring.

The plant capability to treat current flows was evaluated using the Performance Potential Graph, which evaluates the major unit processes to achieve the RAP effluent objectives. The major unit processes of the Fox St. STP are capable of achieving and maintaining the RAP objectives under current loading conditions.

8.6 Recommendations

The following recommendations are based on the findings of the on-site data review with plant operators and a review of design capability based on current plant loading:

- A review of current influent sampling procedure and analysis is suggested to determine true plant loading.

- Reported plant flows should be checked against typical per capita loading on an annual basis by operators and reported to management. There is a need to systematically separate the combined and sanitary sewer system and reduce infiltration/inflow to preserve plant capability.

- Solids analysis should be carried out on wasted sludge to avoid estimating concentrations.

- A review and discussion by operators and management of chemical dosing requirements for phosphorus removal to determine if current dosing is higher than necessary to achieve RAP objectives.

9.0 ELMVALE STP

The Elmvale STP is a extended aeration, tertiary filtration plant with a nominal design flow of 1,512 m^3/d servicing an estimated population of 1,700 people. The plant C of A requires the plant achieve an annual average effluent quality of 10 mg/L BOD_5. 5 mg/L TSS and 0.15 mg/L TP. The RAP effluent phosphorus objectives are 0.10 mg/L and a loading to the receiver of 55 kg/y at nominal design flow. Table 6 summarizes key information for the Elmvale plant.

Table 6 Key Information for Elmvale STP

Plant Information:	
Plant Name: Elmvale WPCP	Contact name: Wayne White, OCWA
Plant Owner: Town of Elmvale	Contact number: 705-534-3866
Plant Operator: Ed O'Donnell, OCWA	Fax number: 705-534-4591
Population serviced: approx. 1700	
Nominal plant design flow: 1.512 1000 m^3/d	
RAP Effluent Phosphorus Objectives:	
Concentration: 0.10 mg/L	
Loading: 55 kg/y at design flow	
Type of Plant:	
Extended Aeration	
Aeration Basin:	
Aeration volume = 2,040 m^3/d	
Blower or aerator horsepower = 40 hp	
Type of aeration: jet aerators, fine bubble	
Operational flexibility: two aeration tanks in parallel, selector tank in each	
Secondary Clarifier:	
Surface area = 377 m^2	
Depth = 3.6 m	
Tertiary Treatment:	
4 upflow sand filters	
Flow Capability: 4,773 m^3/d	
Digestion:	
Type of digestion = aerobic	
Volume = 242.5 m^3	
Sludge Storage:	
Volume = 2,016 m^3	
Means of disposal : contract haulage, land disposal	
Disinfection:	
UV disinfection	
Effluent Sampling:	
Influent/Effluent: 24 hr composite, refrigerated samplers, influent is sampled after preliminary treatment	
Frequency: daily TSS,SP and once per month outside lab analysis	
Comments:	
Plant upgraded from lagoon system to an extended aeration, tertiary treatment plant in 1994	
On/Off aeration control has been successfully implemented to achieve energy savings.	

9.1 Key Activities

A September 1991 report by XCG Consultants provided analysis and upgrade requirements for the eight Severn Sound STPs to achieve a higher level of phosphorus removal and a review of proven and innovative technologies to determine maximum phosphorus removal achievable on a consistent basis from the plants. In 1989/90, the Elmvale lagoon reported a daily average effluent phosphorus of 3.50mg/L at a average day flow of 1,379 m^3/d (185% of design flow of 750 m^3/d) with an annual phosphorus loading to the receiver of 1,748 kg/y. The loading did not include lift station bypass flows. Phosphorus removal was not practiced in 1989/90 at the Elmvale lagoon. To achieve and sustain the RAP phosphorus objective of 0.1 mg/L at Elmvale, the report suggested follow-through on a Class EA to construct a new mechanical plant, effluent polishing by filtration, dual point chemical precipitation of phosphorus, a solids contact clarifier and anionic polymer addition upstream of the filters. The estimated capital cost, not including the cost of the new mechanical plant was $1,940,000.

A new 1,512 m^3/d extended aeration plant was built and commissioned in 1993/94 with a solids contact clarifier, 4 up-flow sand filters, chemical addition facilities and a SCADA monitoring and control system.

9.2 Current Performance

Figure 11 is a summary of reported performance (on a monthly average basis) for the Elmvale plant. The following comments are applicable:

Average monthly plant flows for 1997 were close to or below the nominal design flow of 1,500 m^3/d in all months. The average daily flow of 1,102 m^3/d is 73% of nominal design flow and is 277 m^3/d less than the 1989/90 average daily flow of 1,379 m^3/d.

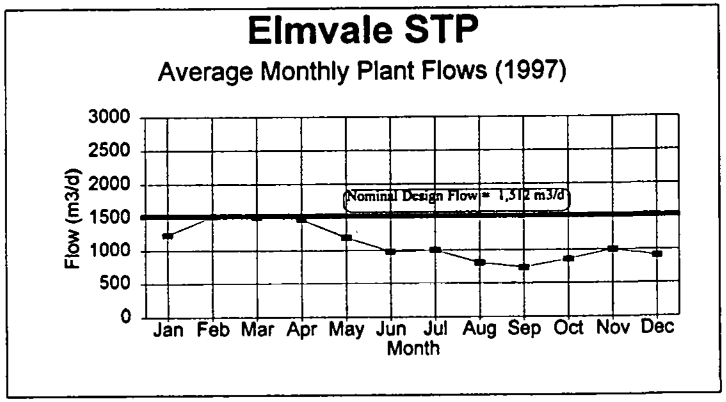
BOD_5 and TSS reported monthly average concentrations were at or below 5 mg/L in 1997.

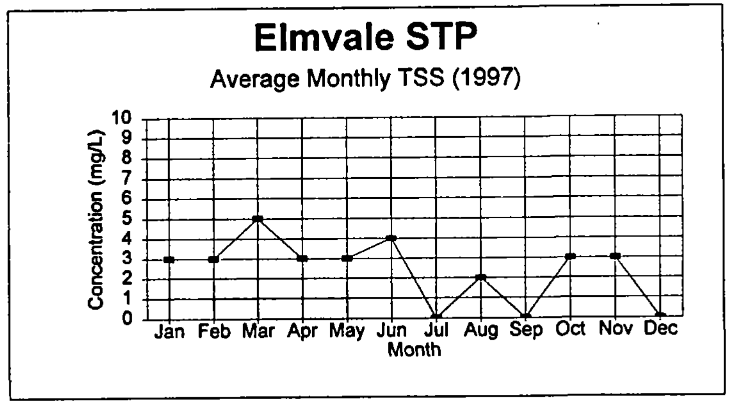
The reported monthly average phosphorus concentrations reported for 1997 achieved the RAP phosphorus objective of 0.1 mg/L in 8 of the 12 months. The annual phosphorus loading of 35 kg/y is below the 55 kg/y RAP objective and 1,713 kg/y less than the 1990 reported loading of 1,748 kg/y.

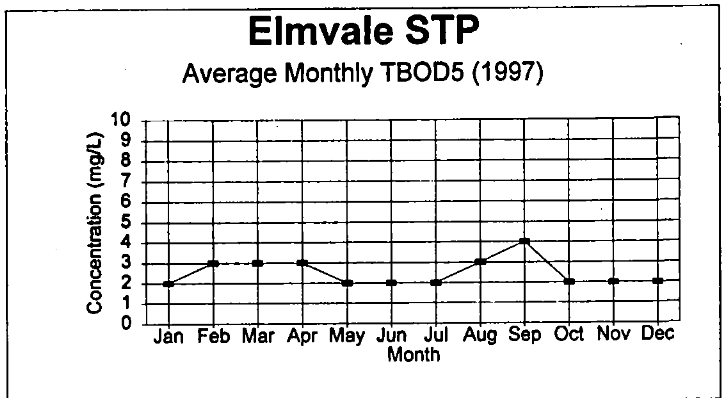
9.3 Data Checks

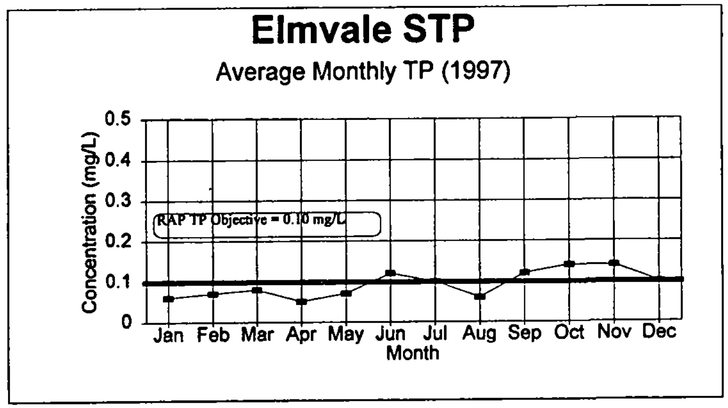
Data verification checks were carried out on-site with operational staff to verify reported plant data. The data checks included reported versus projected flows, BOD_5 loading, chemical dosing for phosphorus removal and a sludge accountability analysis. The detailed calculations are presented in Appendix 6.

Figure 11: Elmvale STP Monthly Average Performance for 1997

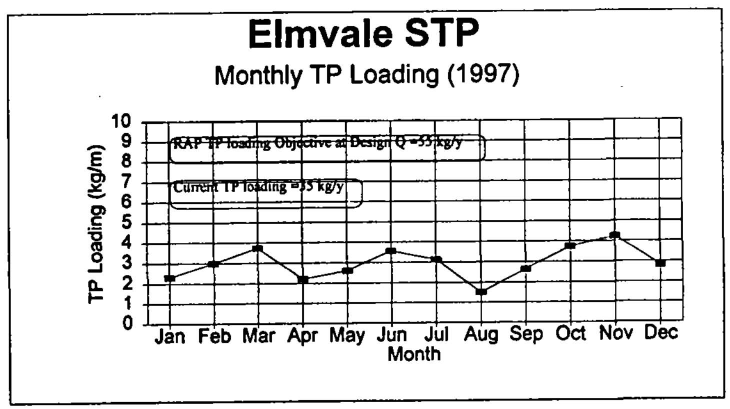








Month	Avg. Flow	TBOD5	TSS	TP	TP load
1997	m3/d	mg/L	mg/L	mg/L	kg/m
Jan	1237	2.0	3.0	0.06	2
Feb	1514	3.0	3.0	0.07	3
Mar	1502	3.0	5.0	0.08	4
Apr	1470	3.0	3.0	0.05	2
May	1199	2.0	3.0	0.07	3
Jun	985	2.0	4.0	0.12	4
Jul	1004	2.0	0.0	0.10	3
Aug	806	3.0	2.0	0.06	1
Sep	731	4.0	0.0	0.12	3
Oct	860	2.0	3.0	0.14	4
Nov	1005	2.0	3.0	0.14	4
Dec	908	2.0	0.0	0.10	3
Avg.	1102	2.5	2.4	0.09	35



As a result of the on-site data checks, the following conclusions were reached:

- The sludge accountability analysis, which compares the reported against the projected sludge produced, was within +/- 15% therefore, the reported data probably reflects true plant performance. The reported BOD loading to the plant sampled after the preliminary treatment was very low (50 mg/L).

- Reported flows (1,102 m^3/d) are higher than projected (765 m^3/d) for population serviced, which appears to be a result of combined sewer loading. Currently the plant appears to be capable of handling these flows but in the future as the load increases this may reduce treatment capability.

- The phosphorus objective of 0.1 mg/L was not achieved in 4 of 12 months in 1997.

9.4 Design Capability

The capability of the existing plant to treat current flows and achieve the RAP effluent objectives was evaluated using a Performance Potential Graph (PPG). The graph evaluates the capability of the existing major unit processes to meet the RAP effluent objectives. The evaluation is based on a review of plant drawings, equipment information, performance data as well as operation and maintenance practices.

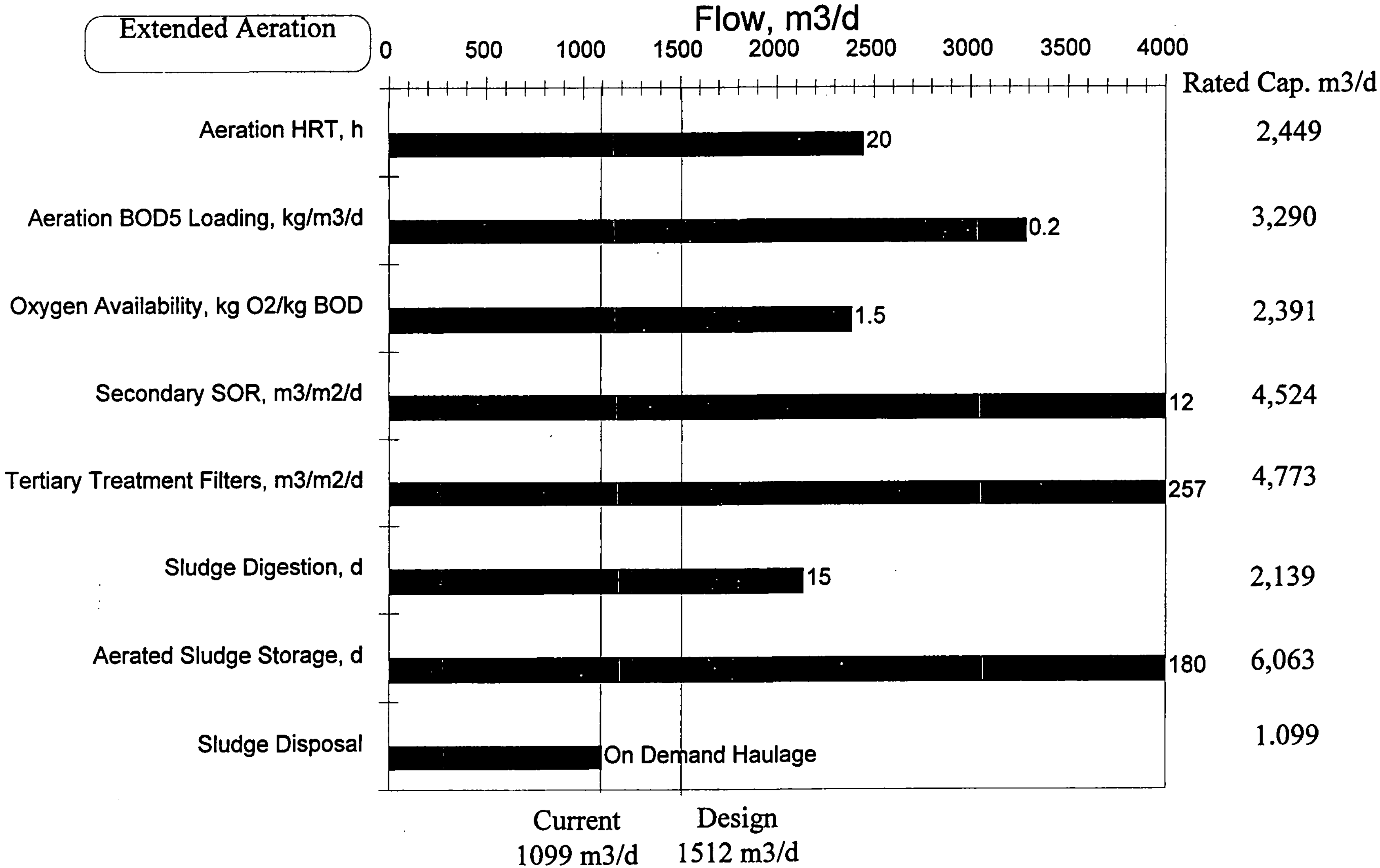
Figure 12 is the Elmvale Performance Potential Graph. The major unit processes included in the evaluation are shown in the left-hand column. Unit processes are rated based on experience against a combination of design and operational parameters. The horizontal bars in the Performance Potential Graph represent the estimated capacity for the parameters associated with each major unit process. Vertical lines indicate the current and nominal design flows for comparison relative to the estimated capacity.

The Elmvale PPG shows that under current reported loading, the major unit processes are capable of achieving the RAP effluent objectives. There is a need to confirm true influent BOD_5 concentrations for BOD loading and oxygen availability capability.

9.5 Summary

Elmvale operators have achieved and maintained the RAP phosphorus objective of 0.10 mg/L in 8 of 12 months of 1997. The plant has had major upgrades since 1990, which supported operators in achieving the stringent RAP objectives. The reported phosphorus loading of 35 kg/y is less than the RAP phosphorus load objective of 55 kg/y. This represents a major phosphorus loading reduction from 1989/90 when the estimated loading was 1,748 kg/y.

Figure 12: Elmvale STP Performance Potential Graph



The data checks carried out on-site with the plant operator focussed on issues to improve process and performance monitoring to ensure reported information reflects true plant operation and performance. The sludge accountability analysis indicated that the reported data probably reflects true plant performance. In the following section, some follow-up activities are suggested to verify process monitoring.

The plant capability to treat current flows was evaluated using the Performance Potential Graph, which evaluates the major unit processes to achieve the RAP effluent objectives. The major unit processes of the Elmvale STP are capable of achieving and maintaining the RAP objectives under current loading conditions.

9.6 Recommendations

The following recommendations are based on the findings of the on-site data review with plant operators and a review of design capability based on current plant loading:

- Sample influent before and after preliminary treatment to determine BOD, TSS reduction and verify true plant loading.

- Operators should monitor and document reported versus projected flows on annual basis and report to management. If plant loading warrants, pursue reducing combined sewer, infiltration/inflow issues and reassess nominal design flow capability.

- Review current chemical dosing requirements and implement a strategy to consistently achieve the monthly RAP effluent phosphorus objective of 0.1 mg/L.

10.0 VICTORIA HARBOUR STP

The Victoria Harbour STP is an extended aeration, tertiary filtration plant with a nominal design flow of 2,364 m^3/d servicing an estimated population of 3,245 people. The plant C of A requires the plant achieve an annual average effluent quality of 10 mg/L BOD_5 and TSS and 0.5 mg/L TP. The RAP effluent phosphorus objectives are 0.15 mg/L and a loading to the receiver of 129 kg/y at nominal design flow. Table 7 summarizes key information for the Victoria Harbour plant.

Table 7 Key Information for Victoria Harbour STP

Plant Information:	
Plant Name: Victoria Harbour	Contact name: Wayne White
Plant Owner: Town of Victoria Harbour	Contact number: 705-534-3866
Plant Operator: Richard Jolliffe, OCWA	Fax number: 705-534-4591
Population serviced: 3,245	
Nominal plant design flow: 2.364 1000 m^3/d	
RAP Effluent Phosphorus Objectives:	
Concentration = 0.15 mg/L	
Loading = 129 kg/y at design flow	
Type of Plant:	
Extended aeration, tertiary treatment	
Aeration Basins (3):	
Aeration volume = 1,675 m^3	
Blower Horsepower = 80 hp	
Type of aeration: fine bubble diffusers, total floor coverage	
Operational flexibility: plug flow, step feed capable	
Secondary Clarifiers (1):	
Surface area = 200 m^2	
Depth = 4 m	
Tertiary Treatment:	
Sand Filter = 46 m^2	
Design Flow = 6,600 m^3/d	
Digestion (2):	
Type of digestion = aerobic	
Volume = 410 m^3	
Sludge Storage:	
Volume = 104 m^3	
Means of disposal = contract haulage, land disposal	
Disinfection:	
Chlorine = sodium hypochlorite	
Volume of contact tank = 183 m^3	
Effluent Sampling:	
Grab sample influent (sampler on-site, not being used), non-refrigerated composite sampler on effluent	
Frequency: daily TSS and SP once per month for outside lab analysis for BOD, TP, TKN	
Comments:	

10.1 Key Activities

A September 1991 report by XCG Consultants provided analysis and upgrade requirements for the eight Severn Sound STPs to achieve a higher level of phosphorus removal and a review of proven and innovative technologies to determine maximum phosphorus removal achievable on a consistent basis from the plants. In 1989/90, the Victoria Harbour plant reported a daily, average effluent phosphorus of 0.12 mg/L at a average day flow of 646 m^3/d with an annual phosphorus loading to the receiver of 27 kg/y. To sustain the RAP phosphorus objective of 0.15 mg/L at Victoria Harbour, the report suggested dual point chemical addition for phosphorus removal. The estimated capital cost was $11,000.

10.2 Current Performance

Figure 13 is a summary of reported performance (on a monthly average basis) for the Victoria Harbour plant. The following comments are applicable:

Average monthly plant flows for 1997 were below the nominal design flow of 2,364 m^3/d in all months. The average daily flow of 1,339 m^3/d is 57% of nominal design flow and is 693 m^3/d greater than the 1989/90 average daily flow of 646 m^3/d.

BOD_5 and TSS reported monthly average concentrations were at or below 5 mg/L in 1997.

The reported monthly average phosphorus concentrations reported for 1997 achieved the RAP phosphorus objective of 0.15 mg/L in 7 of the 12 months. The annual phosphorus loading of 74 kg/y is below the 129 kg/y RAP objective and 46 kg/y greater than the 1990 reported loading of 27 kg/y.

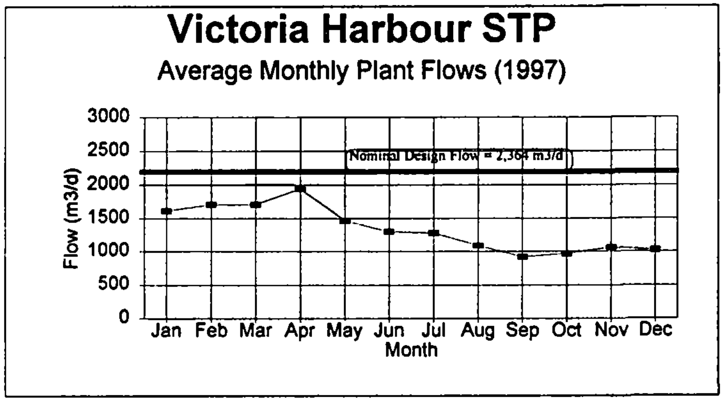
10.3 Data Checks

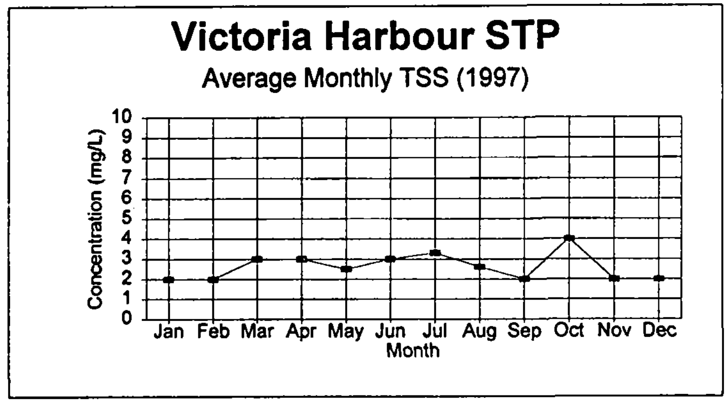
Data verification checks were carried out on-site with operational staff to verify reported plant data. The data checks included reported versus projected flows, BOD_5 loading, chemical dosing for phosphorus removal and a sludge accountability analysis. The detailed calculations are presented in Appendix 7.

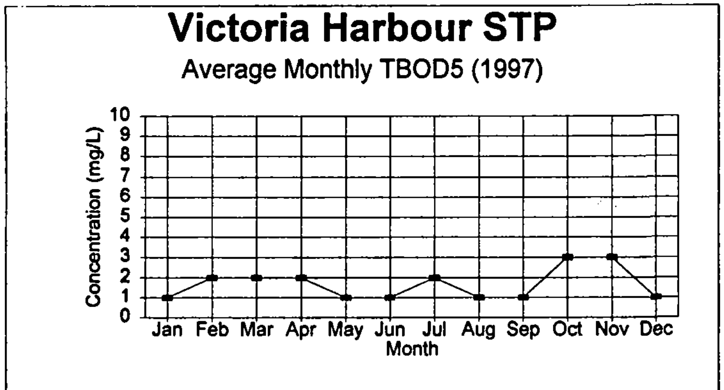
As a result of the on-site data checks, the following list of issues were identified:

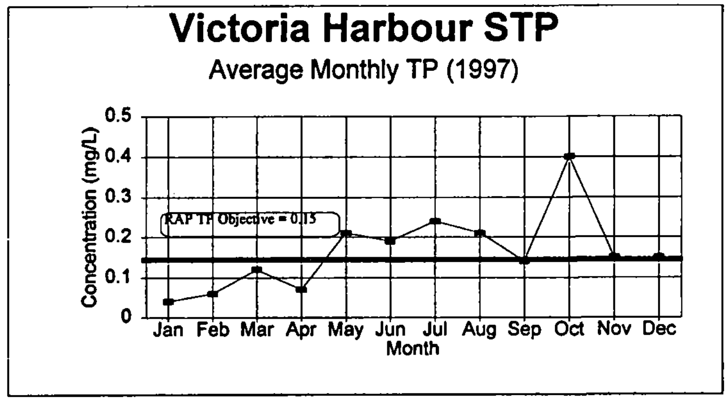
- The sludge accountability analysis, which compares the reported against the projected sludge produced was within +/- 15%. Therefore, the reported data probably reflects true plant performance. Projected influent BOD and waste sludge concentrations were used to close the analysis.

Figure 13: Victoria Harbour STP Monthly Average Performance for 1997

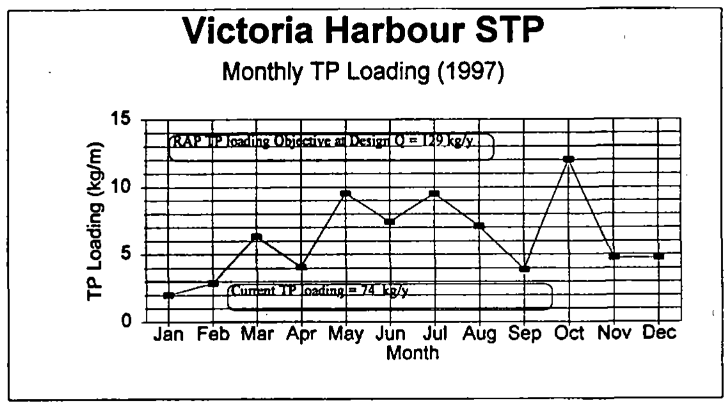








Month	Avg. Flow	TBOD5	TSS	TP	TP load
1997	m3/d	mg/L	mg/L	mg/L	kg/m
Jan	1610	1.0	2.0	0.04	2
Feb	1708	2.0	2.0	0.06	3
Mar	1708	2.0	3.0	0.12	6
Apr	1942	2.0	3.0	0.07	4
May	1464	1.0	2.5	0.21	10
Jun	1300	1.0	3.0	0.19	7
Jul	1279	2.0	3.3	0.24	10
Aug	1089	1.0	2.6	0.21	7
Sep	922	1.0	2.0	0.14	4
Oct	969	3.0	4.0	0.40	12
Nov	1059	3.0	2.0	0.15	5
Dec	1023	1.0	2.0	0.15	5
Avg.	1339	1.7	2.6	0.17	74



- Influent data is based on grab sampling once per month.
- Effluent data is based on composite sampling once per month.
- Reported chemical dosing is less than projected to achieve and sustain RAP phosphorus objectives. The plant did not achieve the phosphorus objective for 5 of 12 months in 1997.

10.4 Design Capability

The capability of the existing plant to treat current flows and achieve the RAP effluent objectives was evaluated using a Performance Potential Graph (PPG). The graph evaluates the capability of the existing major unit processes to meet the RAP effluent objectives. The evaluation is based on a review of plant drawings, equipment information, performance data as well as operation and maintenance practices.

Figure 14 is the Victoria Harbour Performance Potential Graph. The major unit processes included in the evaluation are shown in the left-hand column. Unit processes are rated based on experience against a combination of design and operational parameters. The horizontal bars in the Performance Potential Graph represent the estimated capacity for the parameters associated with each major unit process. Vertical lines indicate the current and nominal design flows for comparison relative to the estimated capacity. A projected influent BOD_5 concentration was used to calculate BOD loading and oxygen availability capability of the Victoria Harbour plant.

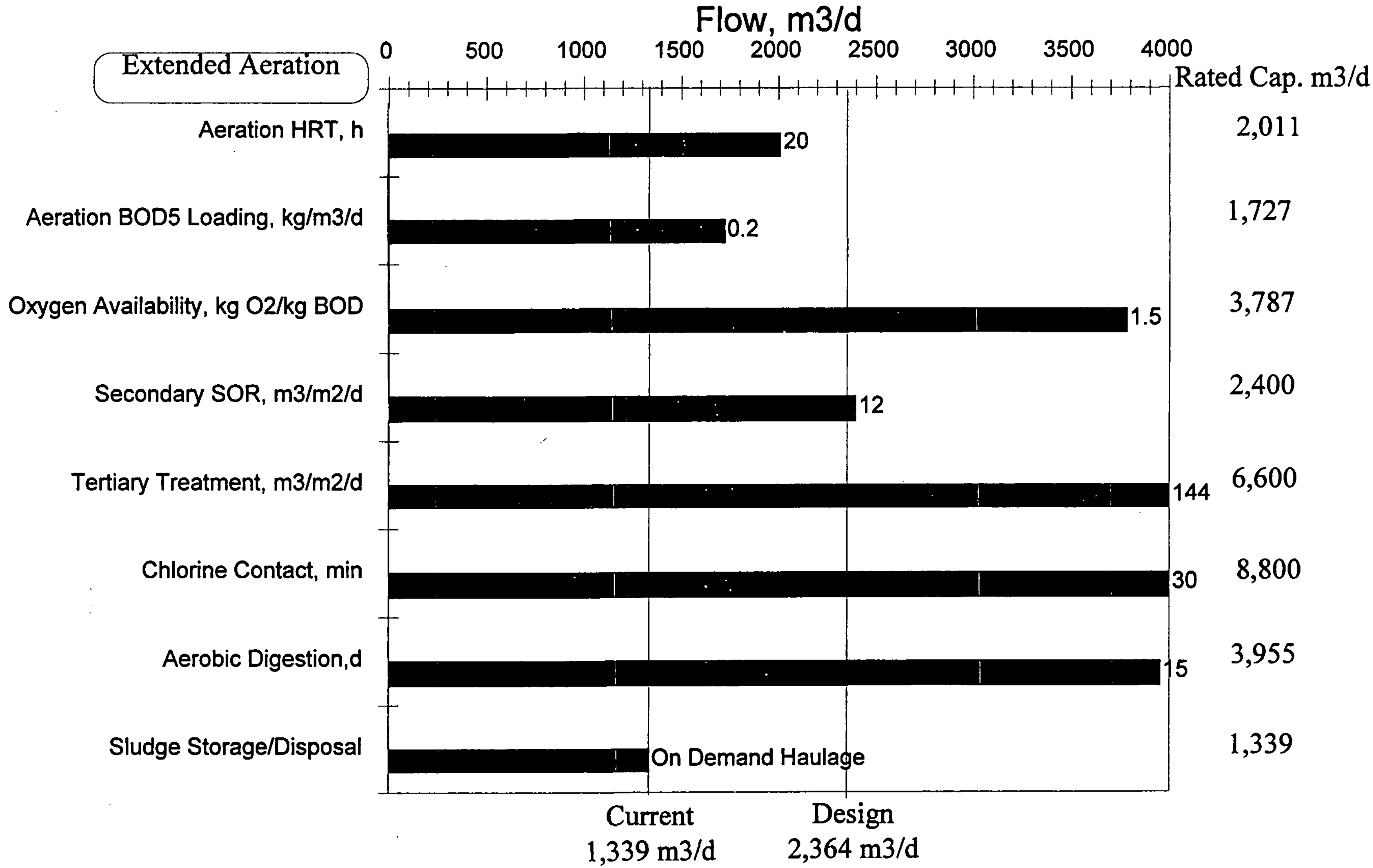
The Victoria Harbour PPG shows that under current reported loading, the major unit processes are capable of achieving the RAP effluent objectives. There is a need to confirm true influent BOD_5 concentrations for BOD loading and oxygen availability capability.

10.5 Summary

Victoria Harbour operators have achieved and maintained the RAP phosphorus objective of 0.15 mg/L in 7 of 12 months of 1997. The reported phosphorus loading of 74 kg/y is less than the RAP phosphorus load objective of 129 kg/y but an increase in phosphorus loading from 1989/90 when the reported loading was 27 kg/y.

The data checks carried out on-site with the plant operator focussed on issues to improve process and performance monitoring to ensure reported information reflects true plant operation and performance. The sludge accountability analysis indicated that the reported data probably reflects true plant performance. In the following section, some follow-up activities are suggested to verify process monitoring and performance.

Figure 14: Victoria Harbour STP Performance Potential Graph



The plant capability to treat current flows was evaluated using the Performance Potential Graph, which evaluates the major unit processes to achieve the RAP effluent objectives. The major unit processes of the Victoria Harbour STP are capable of achieving and maintaining the RAP objectives under current loading conditions.

10.6 Recommendations

The following recommendations are based on the findings of the on-site data review with plant operators and a review of design capability based on current plant loading:

- Initiate composite sampling of influent to determine true plant loading.
- Increase frequency of influent and effluent composite samples for BOD, TSS and TP analysis to an outside lab.
- Verify population serviced and confirm plant flows
- Initiate TSS, VSS analysis and measure volume of waste sludge to digester to quantify sludge produced by the plant.
- Review, discuss and implement a chemical dosing strategy to consistently achieve the monthly RAP effluent phosphorus objective of 0.15 mg/L (jar testing to determine dosing requirements).

11.0 PORT MCNICOLL STP

The Port McNicoll STP is a contact stabilization, extended aeration plant with a nominal design flow of 1,050 m^3/d servicing an estimated population of 2,125 people. The plant is required under MOE Policy 08-01 to achieve an annual average effluent quality of 25 mg/L BOD_5 and TSS and 1.0 mg/L TP. The RAP effluent phosphorus objectives are 0.30 mg/L and a loading to the receiver of 219 kg/y at a forecast nominal design flow of 2000 m^3/d. Table 8 summarizes key information for the Port McNicoll plant.

Table 8 Key Information for Port McNicoll STP

Plant Information:	
Plant Name: Port McNicoll	Contact name: Wayne White
Plant Owner: Town of Port McNicoll	Contact number: 705-534-3866
Plant Operator: Richard Jolliffe, OCWA	Fax number: 705-534-4591
Population serviced: 2,125	
Nominal plant design flow: 1.050 1000 m^3/d	
RAP Effluent Phosphorus Objectives:	
Concentration: 0.30 mg/L	
Loading: 219 kg/y at design flow	
Type of Plant:	
Extended aeration, contact stabilization	
Aeration Basin:	
Aeration volume = 399 m^3	
Blower Horsepower = 50 hp	
Type of aeration: coarse bubble diffusers, wide band	
Operational flexibility: extended aeration, contact stabilization	
Secondary Clarifiers:	
Surface area = 60.8 m^2	
Depth = 3.7 m	
Digestion (2):	
Type of digestion = aerobic	
Volume = 195.5 m^3	
Sludge Storage:	
Volume = 40.9 m^3	
Means of disposal = contract haulage, land disposal	
Disinfection:	
Chlorine = sodium hypochlorite	
Volume of contact tank = 30.7 m^3	
Effluent Sampling:	
Influent/Effluent: grab sampling on both influent and effluent	
Frequency: daily TSS and SP, once per month analysis by outside lab for BOD, TP, TKN	
Comments:	
A Class EA to determine plant needs in 1993/94	
An funding application has been made to the MOE to upgrade the plant to handle increased loading.	

11.1 Key Activities

A September 1991 report by XCG Consultants provided analysis and upgrade requirements for the eight Severn Sound STPs to achieve a higher level of phosphorus removal and a review of proven and innovative technologies to determine maximum phosphorus removal achievable on a consistent basis from the plants. In 1989/90, the Port McNicoll plant reported a daily, average effluent phosphorus of 0.32 mg/L at a average day flow of 891 m^3/d with an annual phosphorus loading to the receiver of 88 kg/y. To sustain the RAP phosphorus objective of 0.30 mg/L at Port McNicoll as flows increase to the nominal design capacity, the report recommended effluent filtration . The estimated capital cost was $600,000.

A Class Environmental Assessment was carried out at the plant in 1993/94. An application was made to the provincial Municipal Assistance Program to fund a plant expansion. To date, there has been no provincial financial commitment to support plant expansion.

11.2 Current Performance

Figure 15 is a summary of reported performance (on a monthly average basis) for the Port McNicoll plant. The following comments are applicable:

Average monthly plant flows for 1997 were below the nominal design flow of 1,050 m^3/d in 7of 12 months. The average daily flow of 1,074 m^3/d is 102% of nominal design flow and is 183 m^3/d greater than the 1989/90 average daily flow of 891 m^3/d.

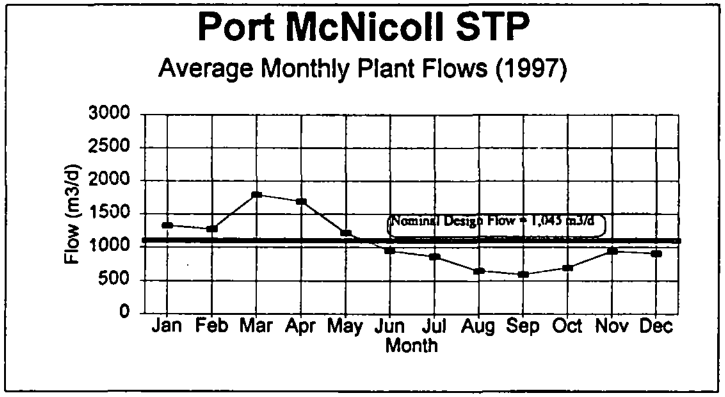
BOD_5 and TSS reported monthly average concentrations were 10 mg/L or less for 11 of 12 months for BOD_5 and 9 of 12 months for TSS in 1997. A key focus for operators to achieve and sustain a 0.3 mg/L phosphorus objective is to control sludge mass in the process to achieve <10 mg/L TSS in the final effluent. This target is especially important for plants without tertiary treatment.

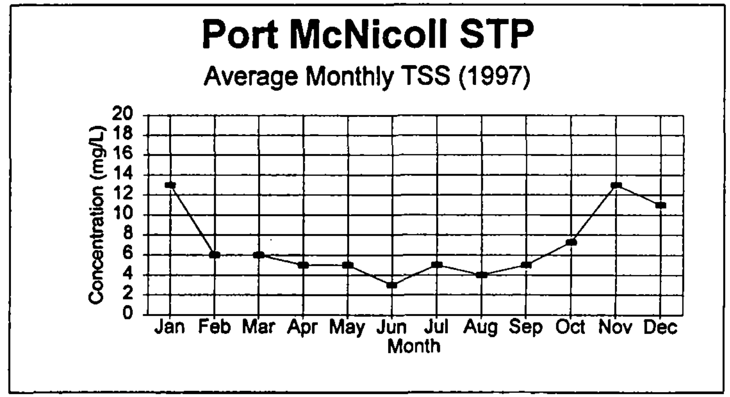
The reported monthly average phosphorus concentrations reported for 1997 achieved the RAP phosphorus objective of 0.30 mg/L in 8 of 12 months. The annual phosphorus loading of 100 kg/y is below the 219 kg/y RAP objective and 12 kg/y greater than the 1990 reported loading of 88 kg/y.

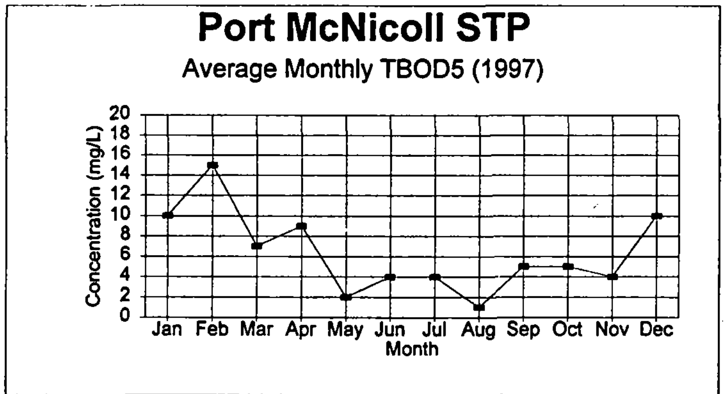
11.3 Data Checks

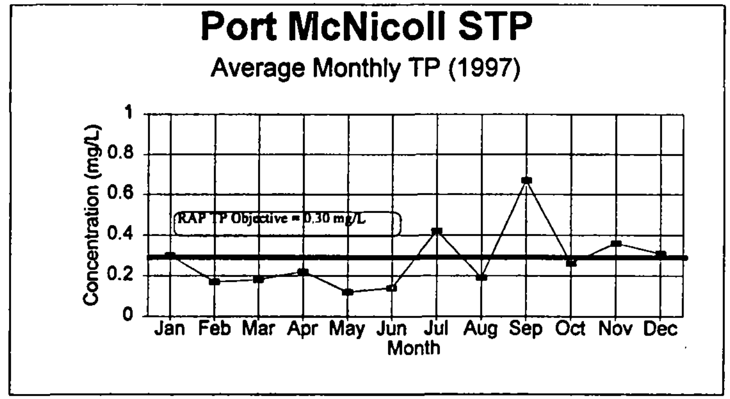
Data verification checks were carried out on-site with operational staff to verify reported plant data. The data checks included reported versus projected flows, BOD_5 loading, chemical dosing for phosphorus removal and a sludge accountability analysis. The detailed calculations are presented in Appendix 8.

Figure 15: Port McNicoll STP Monthly Average Performance for 1997

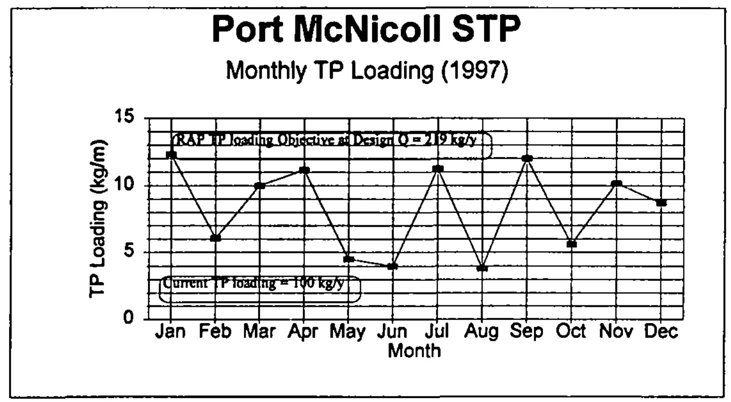








Month	Avg. Flow	TBOD5	TSS	TP	TP load
1997	m3/d	mg/L	mg/L	mg/L	kg/m
Jan	1325	10.0	13.0	0.30	12
Feb	1272	15.0	6.0	0.17	6
Mar	1790	7.0	6.0	0.18	10
Apr	1690	9.0	5.0	0.22	11
May	1215	2.0	5.0	0.12	5
Jun	950	4.0	3.0	0.14	4
Jul	864	4.0	5.0	0.42	11
Aug	645	1.0	4.0	0.19	4
Sep	597	5.0	5.0	0.67	12
Oct	694	5.0	7.3	0.26	6
Nov	940	4.0	13.0	0.36	10
Dec	907	10.0	11.0	0.31	9
Avg.	1074	6.3	6.9	0.28	100



As a result of the on-site data checks, the following conclusions were reached:

- The sludge accountability analysis, which compares the reported against the projected sludge mass produced, was not within +/- 15%. Therefore, the reported data may not reflect true plant performance.

- Influent and effluent data is based on grab sampling once per month.

- Reported influent BOD was lower than projected for population serviced.

- The plant was over the nominal design flow in 5 of the 12 months in 1997. The projected flow of 956 m^3/d was not significantly higher than the reported flow of 1,074 m^3/d.

- Information was not available to calculate sludge mass transferred to the digester.

- The plant did not achieve the phosphorus objective for 5 of 12 months in 1997.

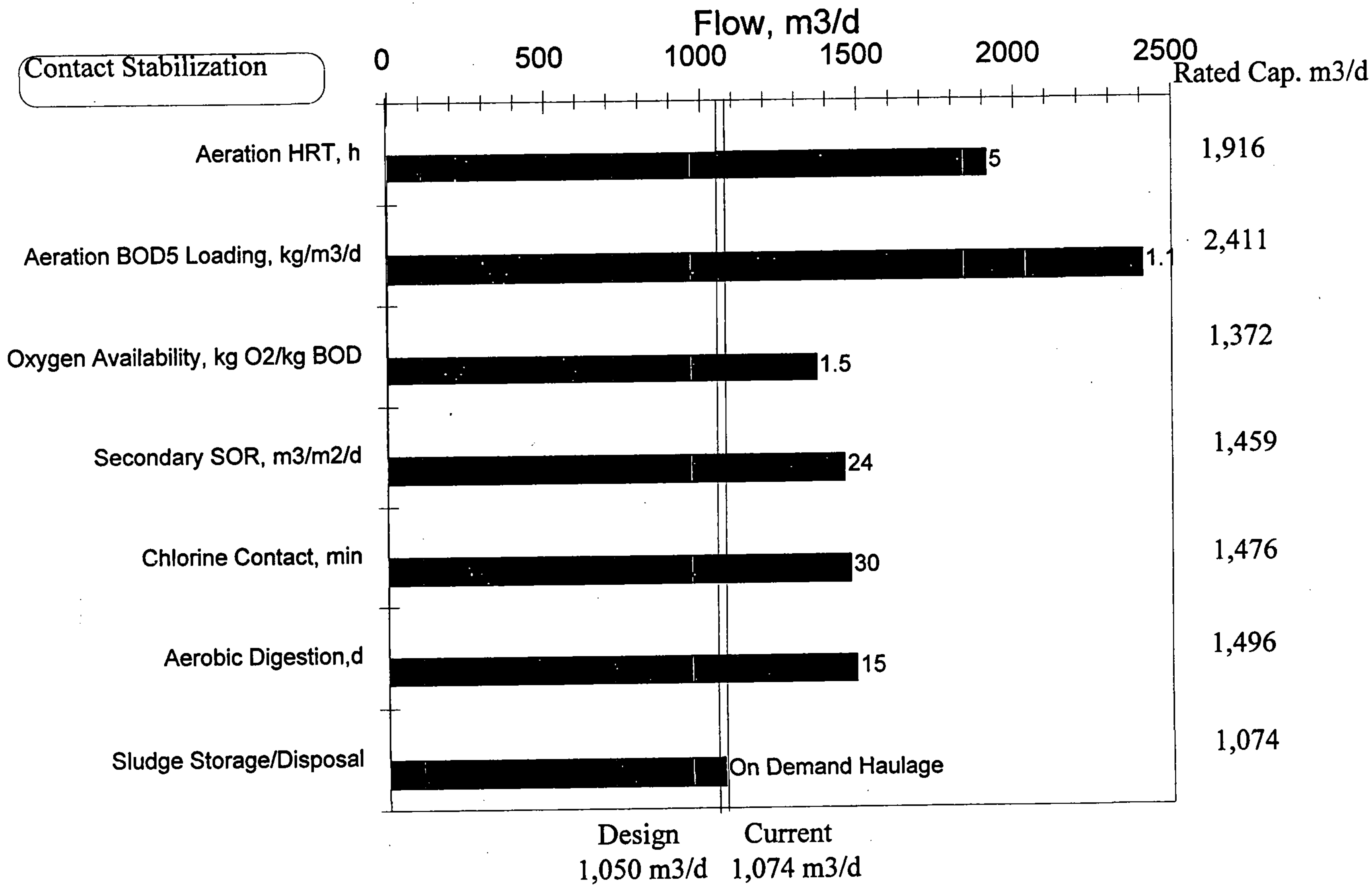
11.4 Design Capability

The capability of the existing plant to treat current flows and achieve the RAP effluent objectives was evaluated using a Performance Potential Graph (PPG). The graph evaluates the capability of the existing major unit processes to meet the RAP effluent objectives. The evaluation is based on a review of plant drawings, equipment information, performance data as well as operation and maintenance practices.

Figure 16 is the Port McNicoll Performance Potential Graph. The major unit processes included in the evaluation are shown in the left-hand column. Unit processes are rated based on experience against a combination of design and operational parameters. The horizontal bars in the Performance Potential Graph represent the estimated capacity for the parameters associated with each major unit process. Vertical lines indicate the current and nominal design flows for comparison relative to the estimated capacity. A projected influent BOD_5 concentration was used to calculate BOD loading and oxygen availability capability of the Port McNicoll plant.

The Port McNicoll PPG shows that under current reported loading and operating as a contact stabilization plant, the major unit processes are capable of achieving the RAP effluent objectives. There is a need to confirm true influent BOD_5 concentrations for BOD loading and oxygen availability capability.

Figure 16: Port McNicoll Performance Potential Graph



11.5 Summary

Port McNicoll operators have achieved and maintained the RAP phosphorus objective of 0.30 mg/L in 8 of 12 months of 1997. The reported phosphorus loading of 100 kg/y is less than the RAP phosphorus load objective of 219 kg/y but an increase in phosphorus loading from 1989/90 when the reported loading was 88 kg/y.

The data checks carried out on-site with the plant operator focussed on issues to improve process and performance monitoring to ensure reported information reflects true plant operation and performance. The sludge accountability analysis indicated that the reported data may not reflect true plant performance. In the following section, some follow-up activities are suggested.

The plant capability to treat current flows was evaluated using the Performance Potential Graph, which evaluates the major unit processes to achieve the RAP effluent objectives. Operating as a contact stabilization plant the major unit processes of the Port McNicoll STP are capable of achieving and maintaining the RAP objectives under current loading conditions.

11.6 Recommendations

The following recommendations are based on the findings of the on-site data review with plant operators and a review of design capability based on current plant loading:

- Initiate composite sampling of influent and effluent to determine true plant loading and performance.

- Increase frequency of influent and effluent composite samples for BOD, TSS and TP analysis to an outside lab.

- Initiate TSS, VSS analysis and measure volume of waste sludge to digester to quantify sludge produced by the plant.

- Implement the Composite Correction Program (CCP) at the Port McNicoll STP to support the owner and operator in optimizing the plant until financial resources can be procured to upgrade the facility. Implement a more comprehensive sludge mass control program to consistently achieve an effluent TSS of <10 mg/L.

12.0 OVERVIEW OF RESULTS

The previous sections document current performance, status, issues and recommendations for each plant on an individual basis. Summary tables of results from all Severn Sound plants were also prepared to facilitate comparisons between plants, estimate total RAP flows and loads and establish overall reductions from 1989/90 to 1997. The following sections present and discuss the summary results.

12.1 Hydraulic Loading

Table 9 summarizes and compares 1989/90 and 1997 hydraulic flows for the 8 Severn Sound plants. The plants are ordered roughly accordingly to size with the largest plant (Midland) at the top and the smallest plant (Coldwater) at the bottom in this and subsequent tables. An exception to the ordering is the Fox St. plant which is placed following the Main St. plant, since both plants treat sewage from the Town of Penetanguishene. The shaded cells indicate which plants reported a flow increase from 1989/90 to 1997.

The 8 plants in the Severn Sound Area of Concern treated a total flow of 19,367 m^3/d in 1997 and provided service to an estimated total population of approximately 32,600. The 1997 total flow represents 70% of the total nominal design flow (27,750 m^3/d) for all plants. (Additional information and comments on current hydraulic loadings are presented in Section 12.5 on plant design capability.)

A comparison of reported flows from 1989/90 to those in 1997 indicates a modest increase of +2%. Plants reporting flow increases included Victoria Harbour (+107%), MHC (+95%), Main St. (+53%) and Port McNicoll (+21%). Plant staff confirm that community growth has occurred between 1989/90 and 1997 for Victoria Harbour. As discussed in Section 5, the reported increase in flow for MHC may be more a function of the flow metering than growth at the facility. Further work is required to better define flow changes. The increase in flow reported at the Main St. plant is partly a function of flow splitting with Fox St. Considering the two Penetanguishene plants together, flows increased by +20% from 1989/90 to 1997.

12.2 TP Loading and Concentrations

Table 10 presents information on effluent TP concentrations, loadings, and targets. In the second column (89/90 concentration) the shaded cells indicate which plants did not practice chemical addition for phosphorus removal. In the third column (1989/90 loads), the shaded cells indicate which plants failed to achieve the RAP effluent TP loading target (listed in the first column).

Table 9: Summary of STP Flows						
Plant	**Nominal Design Flow** (m³/d)	**Population**	**89/90 Flow** (m³/d)	**97 Flow** (m³/d)	**% Change 89/90 - 97**	**% Total (97 Flow)**
Midland	15,665	16,430	11,500	10,240	-11	53
Main St.*	4,545	5,831	2,574	3,939	+53	20
Fox. St.*	1,500	1,169	1,213	790	-35	4
Victoria Hrb	2,364	3,245	646	1,339	+107	7
Elmvale	1,512	1,700	1,379	1,102	-20	6
Port McNicoll	1,050	2,215	891	1,074	+21	6
MHC	568	1,200	259	506	+95	3
Coldwater	546	900	477	327	-31	2
Overall	**27,750**	**32,600**	**18,898**	**19,367**	**+2**	**101**

Notes:
* the combined flows for Main St. and Fox St. were: 3,287 m3/d 89/90 and 4,729 m3/d, representing a change of +20%;

Table 10: Summary of Effluent TP Loads and Concentrations								
Plant	**RAP TP Target (kg/y)**	**89/90 Conc. (mg/L)**	**89/90 Load (kg/y)**	**97 Conc. (mg/L)**	**97 Load (kg/y)**	**% Change Load 89/90 - 97**	**% RAP Target 97 Load**	**% Total] 97 Load**
Midland	1,992	0.72	3,044	0.18	657	-78	33	64
Main St.*	166	0.64	600	0.05	78	-87	47	8
Fox. St.*	55	0.36	160	0.05	15	-91	27	1
Victoria Hb	129	0.11	27	0.15	74	+174	57	7
Elmvale	55	3.47	1,748	0.09	35	-98	64	3
Pt McNicoll	219	0.23	88	0.26	100	+14	46	10
MHC	62	0.15	14	0.22	41	+193	66	4
Coldwater	110	3.02	526	0.18	22	-96	20	2
Overall	**2,788**	**0.90**	**6,207**	**0.15**	**1,022**	**-84**	**37**	**99**
Notes:								

In 1989/90, the total effluent TP loading from all Severn Sound plants was estimated to be 6,207 kg/yr, more that twice the RAP TP loading target of 2,788 kg/yr. The average effluent TP concentration for all of the plants in 1989/90 was 0.90 mg/L (arithmetic average). Two of the plants, Coldwater and Elmvale, did not practice chemical addition for phosphorus removal in 1989/90 and thus did not meet the RAP target. At three additional plants (Midland, Main St., Fox St.) chemical addition for phosphorus removal was practiced but the level of performance did not achieve RAP TP targets. Three plants (Elmvale, Port McNicoll, and MHC) reported achieving RAP TP targets in 1989/90.

By 1997, the total effluent TP loading from the Severn Sound plants had been reduced to 1,022 kg/y, representing 37% of the total RAP effluent loading target. The average effluent TP concentration for all of the plants was 0.15 mg/L (arithmetic average). All plants practiced chemical addition for phosphorus removal and reported achieving RAP effluent TP targets. Three plants (Victoria Harbour, Port McNicoll and MHC) reported an increase in effluent TP loading. In all three cases, the reported data indicated a modest increase in effluent TP concentrations (columns 2 & 4) combined with flow increases (Table 9, columns 2 & 3) from 1989/90 to 1997. In terms of 1997 total TP loading, the three largest sources were Midland (64%), Port McNicoll (10%) and Main St. (8%).

In summary, the results summarized in Table 10 indicate a significant reduction in TP loading from 1989/90 to roughly one-third of the total RAP target, with all plants reporting achieving RAP loading targets.

12.3 Sampling, and Monitoring

Two tables were prepared to document current monitoring practices and check the adequacy of influent loading results. High quality information on the effluent, established by rigorous sampling and analysis, is key to determining how well a wastewater treatment process is performing and accurately estimating loads to the receiver. High quality information on influent helps to accurately evaluate the current design capability of an existing facility and treatment efficiency. Poor quality data introduces uncertainty and leads to poor decision-making.

Table 11 summarizes current monitoring practices in terms of type of samples and frequency of sampling to characterize influent and effluent concentrations. In the first and third columns the shaded cells highlight plants which conduct grab sampling. One plant (Port McNicoll) practises effluent grab sampling and three plants (Victoria Harbour, Port McNicoll, and MHC) practise influent grab sampling. In the second and fourth columns, the shaded cells highlight plants which sample less frequently than 4 times per month (i.e. weekly). Three plants (Victoria Harbour, Elmvale, and Port McNicoll) sample the influent and effluent once per month. Midland samples the influent twice per month.

Table 11: Summary of Sampling & Analysis for External Lab for TSS, BOD5, TP				
Plant	Influent Type*	Influent Frequency (per month)	Effluent Type	Effluent Frequency (per month)
Midland	C	2	C	4
Main St.*	C	4	C	4
Fox. St.*	C	4	C	4
Victoria Hrb	G	1	C	1
Elmvale	C**	1	C	1
Port McNicoll	G	1	G	1
MHC	G	4	C	4
Coldwater	C#	4	C	4#

Notes:
* C = composite sampling; G= grab sampling;
** for Elmvale, the influent sampling is conducted following preliminary treatment;
# for Coldwater, there have been freezing problems with composite samplers; as well, issues related to timing of influent sampling with on/off lift stations cycle;

Table 12: Summary of Plant Loading Checks					
Plant	Population	TSS/TBOD5[1]	Per Cap Flow[2] (L/d)	Per Cap BOD5[3] Load (g/d)	Per Cap TSS Load[4] (g/d)
(Typical)		0.8-1.2[5]	450	70 - 90[6]	80 - 110[5]
Midland	16,430	2.2	623	53	115
Main St.*	5,831	1.6	676	71	116
Fox. St.*	1,169	1.7	676	52	89
Victoria Hrb	3,245	1.2	413	40	46
Elmvale	1,700	1.3	648	31*	40*
Port McNicoll	2,125	1.0	505	65	66
MHC	1,200	0.9	422	52	49
Coldwater	900	1.2	363	42	50

Notes:

1. the ratio of average annual influent TSS concentration to the average annual influent BOD5 concentration
2. the reported average annual flow rate divided by the estimated population (Column 1)
3. the reported average daily BOD5 loading divided by the estimated population
4. the reported average daily TSS loading divided by the estimated population
5. from: U.S. EPA, *Manual: Nitrogen Control*, EPA/625/5-93/010, Sep. 1993: Table 2-2, p. 26
6. from: U.S. EPA,. *Handbook: Retrofitting POTWs*, EPA/625/6-89/010, July 1989, p. 30

* for Elmvale, the influent sampling is conducted following preliminary treatment;

Table 12 is summary of results from performing some basic checks of plant loading. These checks help determine the adequacy of influent monitoring practices. Values or ranges designated as "typical" are expected at plants, which are not subject to infiltration/inflow or industrial loading. Cells are shaded where estimated values derived from monitoring results are outside of the expected values. The main comments, which apply, are as follows:

- For 4 plants (Midland, Main St., Fox St., and Elmvale), the percent capita flow rates exceeded the expected rate of 450 L/d. These plants receive sewage from combined sewer systems (treating both sanitary and storm wastes).

- For 3 plants (Midland, Main St., Fox St.) the TSS/BOD5 ratio was greater than expected suggesting that BOD5 influent concentrations were lower than expected. Sample preservation and/or lab analysis procedures may be the cause.

- For Victoria Harbour and MHC, the per capita flow was close to expected but both the BOD5 and TSS per capita loads were low. Current influent sampling procedures may not be adequate. As discussed previously, both plants employ influent grab sampling.

- For Elmvale, influent samples are collected following preliminary treatment. Per capita BOD5 and TSS loads are therefore much lower than expected for raw wastewater.

- For Coldwater, reported per capita flows and loadings (for both BOD5 and TSS) were lower than expected. The reported population (900) may be higher than actual and should be verified.

In general, therefore, there is a need for plants within the Severn Sound Area of Concern to verify and improve influent characterization.

12.4 Chemical Dosing Rates

Table 13 provides a summary of alum practices for phosphorus removal. The purpose of this summary is twofold: to summarize alum dosing rates for use by facilities in other RAP areas and to conduct a rough check on dosing rates. Dosing rates, which appear to be significantly higher or lower than other plants have been indicated by shading of cells. In general alum dosing rates for Severn Sound plants fall roughly in the range of 160-180 mg/L.

For Fox St. and Coldwater, the reported dosing rates appear to be higher than other Severn Sound plants and higher than projected dosage. For Victoria Harbour, the dosing rate seems lower than other plants and projected.

Table 13: Chemical Dosing for TP Removal				
Plant	Dosing Type Type[1]	Dosing Rate Alum (mg/L)	Dosing Rate (Al^{3+}/TPrem)[2]	Proj, Dosing Rate[3] (Al^{3+}/TPrem)
Midland	DP	170	1.6	2.1
Main St.*	DP	182	2.7	2.1
Fox. St.*	DP	224	3.8	2.1
Victoria Hrb	SP	63	1.1	1.9
Elmvale	DP	133	3.0	2.0
Port McNicoll	SP	173	2.4	1.9
MHC	SP	164	2.1	1.9
Coldwater	SP	364	3.9	2.0

<u>Notes:</u>

1 for Dosing Type: DP = dual point chemical addition; SP = single point chemical addition;

2. ratio of aluminum ion added (in kg) to total phosphorous removed (in kg)

3. interpolation from: U.S. EPA, Process Design Manual for Phosphorus Removal, EPA 625/1-76-001a, April 1976, p. 3-3.

Table 14: Summary Design Review Comments				
Plant	**Nominal Design (m^3/d)**	**Current Flow %Design**	**Major Upgrade Since 89/90?***	**PPG Review Comments**
Midland	15,665	65	Y	• Marginal O2 availability currently; • Aeration/secondary clarifier imbalance? • reduce hydraulic loading through I/I control?
Main St.*	4,545	87	Y	• potential to split flows with Fox St.; • reduce hydraulic loading through I/I control?
Fox. St.*	1,500	53	Y	• potential to split flows with Main St.; • reduce hydraulic loading through I/I control?
Victoria Hrb	2,364	57	N	• confirm PPG by improving influent monitoring;
Elmvale	1,512	73	Y	• reduce hydraulic loading through I/I control? • plant capable beyond nominal design flow to >2000 m^3/d?
Port McNicoll	1,050	102	N	• plant capable beyond nominal design flow to > 1500 m^3/d?
MHC	568	89	N	• primaries may limit as hydraulic load increases? • Establish primary removal efficiencies; • confirm PPG by improving influent monitoring;
Coldwater	546	60	N	• digester may be marginal? confirm performance • secondary clarifiers may be limit if hydraulic load increases? consider step feed modification; • confirm PPG by improving influent monitoring;
Notes: * Major Upgrade Since 89/90: Y = Yes; N = No.				

12.5 Plant Capability

Table 14 is a summary of the design capability of Severn Sound plants. In general, current hydraulic loading is less than the nominal design. An exception is Port McNicoll; reported flows have currently reached the plant's nominal design flow. However, examination of the Port McNicoll PPG indicates that the major unit processes may be capable beyond the nominal design flow of 1500 m^3/d. Further work would be required to verify the potential additional capacity. Similarly, the PPG at Elmvale suggests that this plant may also be capable beyond nominal design capacity.

Common issues related to design within the Severn Sound AOC are the potential to preserve plant capacity, by reducing infiltration/inflow (at four plants) and the need to verify the PPG by improving influent monitoring (MHC, Coldwater and others). Notable design concerns requiring follow-up are marginal aeration capacity at Midland and marginal digester capacity at Coldwater.

12.6 Severn Sound RAP Impact on STP Performance

Between 1989/90 and 1997, the Severn Sound Remedial Action Plan has established STP effluent objectives for all Severn Sound STPs and supported activities to achieve these objectives. The following are some key activities, where Severn Sound RAP has provided leadership:

- Established the effluent quality targets for all Severn Sound STPs;

  - 5 of the 8 STP's Certificate of Approvals reflect RAP effluent objectives (Elmvale, Midland, Main St., Fox St., Coldwater)

- Increased public awareness of the impact of STP effluent on the receiving waters;

- Established the communication and coordination mechanisms between the municipalities, STP operators, consultants and regulatory authorities to ensure RAP effluent objectives were incorporated into STP construction, upgrades and optimization activities;

- Supported procurement of funding for STP upgrades and optimization activities;

- Supported development of an area-wide optimization Core Team to focus and provide solutions to plant specific and area-wide STP needs to achieve and sustain RAP effluent objectives.

13.0 SUMMARY OF ACHIEVEMENTS

As a result of a review of the upgrading and optimization activities supported by the Severn Sound RAP and a comparison of 1989/90 and 1997 results, the following achievements were identified:

- Since 1991, 4 of the 8 Severn Sound STPs were upgraded to improve their ability to achieve and maintain the RAP effluent objectives. The plants upgraded were Elmvale, Main St. Penetanguishene, Fox St. Penetanguishene and Midland. The Elmvale lagoon system was replaced with an extended aeration plant with tertiary treatment. Main St. contact stabilization plants were replaced with a modified conventional activated sludge plant with tertiary treatment and Fox St. contact stabilization plant was upgraded with tertiary treatment. In 1996/97, the Midland conventional activated sludge plant was upgraded with a flow equalization tank, primary clarifier, primary digester and upgrades of the existing digesters for secondary digestion.

- Between 1989/90 and 1997, the performance of the Severn Sound plants significantly improved. By 1997, all 8 Severn Sound treatment plants had attained RAP effluent TP loading targets. Total plant loading in 1997 was 1,022 kg/y, 37% of the total RAP effluent loading target of 2,788 kg. The average effluent TP concentration for all of the plants was 0.15 mg/L (arithmetic average). In contrast to 1989/90, 5 of the 8 plants did not achieve the RAP target and the total plant loading was more than twice the RAP target at 6,207 kg/yr. The average effluent TP concentration for all of the plants in 1989/90 was 0.90 mg/L (arithmetic average).

- On-site technical assistance employing the Composite Correction Program was completed at Coldwater and MHC to transfer skills to owners and operators to improve and sustain process performance. Consequently, the Coldwater STP was optimized to achieve the RAP effluent TP target, resulting in an estimated capital cost saving of $466,000 in comparison to 1991 estimates. Based on documented plant performance, the Ontario Ministry of Environment lifted a development freeze (allowing for future construction of 50 houses) and an application made for funding to upgrade the plant's lift station and force main. Some O&M costs were also realized. Coldwater sludge haulage costs, despite the implementation of chemical addition for phosphorus removal, did not increase. MHC reduced chemical addition by approximately $10,000 per year.

- An area-wide optimization program has been developed and implemented in Severn Sound. A Core Team of Severn Sound operators and managers was formed to develop common operational procedures and a support system to address operational issues. The accuracy, reliability, and completeness of monitoring data has been improved through the efforts of the Core Team and the use of performance checks implemented to verify monitoring results. Information on the program was transferred to the public during the March 1998 Severn Sound Open House and to other owners and operators at Optimization Partnership Meetings (March, June, October 1997) and a meeting of managers of the Ontario Clean Water Agency (June 1997). Based on information collected by the Core Team, sludge production data was assembled, reviewed, and summarized to support planning efforts to develop area-wide sludge management.

- The current status, performance and issues were identified and documented on a site-specific and area-wide basis. The results were reviewed with the Core Team and RAP Coordinator.

14.0 AREA-WIDE ISSUES AND RECOMMENDATIONS

Common area-wide issues were identified to provide a focus for follow-up after the completion of the formal program development. Recommendations were then developed to assist the Core Team in sustaining the RAP effluent objectives into the future. The following sections identify these common issues and follow-up recommendations.

14.1 Issues

The following are area-wide issues:

- Inconsistent monitoring, analysis and control from plant to plant makes it difficult for the Core Team and Severn Sound RAP to compare performance, plant loading and operational information to identify issues and follow-up activity.

- As municipalities grow and loading to the Severn Sound STPs increase, sustainability of current performance will become more difficult. Awareness of plant needs by owners and operators, will be key to ensuring effluent performance sustainability. As hydraulic and organic loading increases to the plant, operational staff will have to clearly identify and communicate unit process limitations and the impact on plant performance to the managers and administrators so that proactive measures can be taken to maintain plant treatment capability.

- Sustainability of the Core Team will impact on STP performance sustainability. The Core Team (mainly STP operational staff) are responsible on a day to day basis for the effluent quality and identifying plant limitations and needs. The ability to continue to function as a Team to share operational knowledge, develop new skills and effectively communicate issues is key to performance sustainability of the Severn Sound STPs.

14.2 Recommendations

The following recommendations are provided, to ensure sustainability of the STP effluent achievements:

- RAP Coordinator and Core Team develop and implement an area-wide sampling and monitoring strategy (ie. TBOD5, TSS and TP analysis on composite influent, primary and final effluents once per week).

- Annual review of reported data and performance checks should be, jointly conducted by RAP Coordinator and Core Team to verify reported data integrity and determine site specific and area-wide issues requiring follow-up.

- Annual review of plant capability using Performance Potential Graph by RAP Coordinator and Core team to determine any unit process limitations and a follow-up strategy to address.

- The Core Team should continue to pursue operational skill's development in areas of common interest. Specific areas include:

Chemical addition for TP removal (ie. jar tests, chemical dosing calculations for phosphorus removal).

Performance checks (ie. per capita loading, sludge accountability).

Flow meter spot checks (ie. on-site flow checks with different flow measurement devices).

Continue to pursue process control uniformity for all plants (ie. develop site specific and area-wide process control manuals).

- Core Team members should assume responsibility for sustainability of Core Team by scheduling regular, task-oriented meetings.

- Core Team should seek management support to ensure continuity of Core Team (ie. utilize training budgets to support Core Team training activities). Core Team must develop track record of successes to ensure long-term management support (ie. goal oriented activities that benefit the operators, managers and administrators).

- The RAP Coordinator should provide incentive, coordination and support for the Core Team.

REFERENCES

1. XCG Consultants Limited, "A Review of the Performance and Upgrading Alternatives for Water Pollution Control Plant Discharging to Severn Sound", Prepared for the Severn Sound Remedial Action Committee and Wastewater Technology Centre, September 30, 1991.

2. Water Technology International Corporation, "Results of the Comprehensive Technical Assistance Program at the Coldwater Sewage Treatment Plant", Severn Sound Remedial Action Plan, Environment Canada, Ontario Clean Water Agency, August 1996.

3. Joint MOE/WTC Facilitation Team, "Results of the Comprehensive Technical Assistance at the Mental Health Centre STP Penetanguishene, Ontario",Severn Sound Remedial Action Plan, Environment Canada, February 1996.

4. Water Technology International Corporation, "Briefing Notes for Upgrading the Town of Coldwater Lift Station and Force Main", Severn Sound Remedial Action Plan, Environment Canada and Ontario Clean Water Agency, February 1998.

Appendix 1

Composite Correction Program

Composite Correction Program Description:

Developed by the U. S. Environmental Protection Agency, the Composite Correction Program is a two-step approach to improve the performance of existing municipal STPs[2]. As shown in Figure 1, the approach identifies and addresses the unique combination of design, operational, maintenance, and administrative factors contributing to discharge violations.

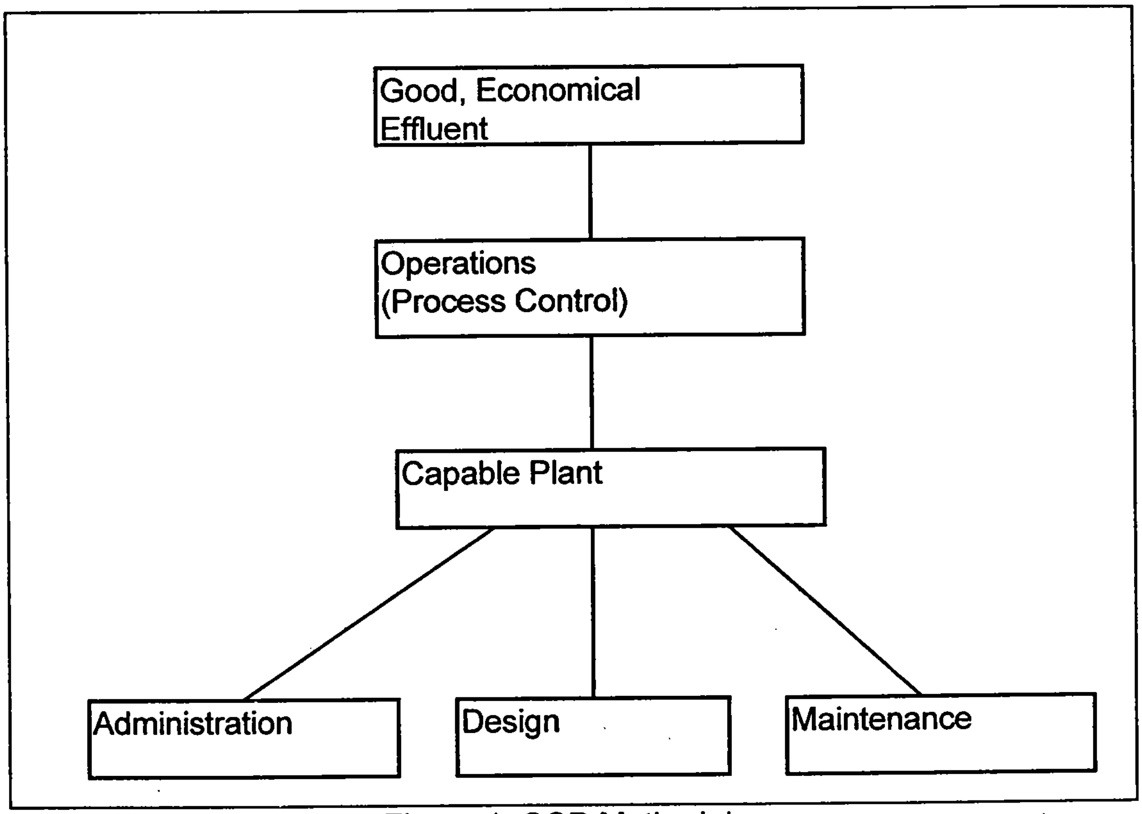


Figure 1. CCP Methodology

The first step of the CCP, the Comprehensive Performance Evaluation (CPE), evaluates the operation, design, maintenance and administration of the STP to determine which combination of factors limit performance. The CPE includes: a review of plant performance and verification checks; identification and prioritization of factors limiting performance (see Appendix A); determination of the need for follow-up technical assistance; and reporting of the results of the evaluation. An evaluation of the major unit processes determines the capability of each unit process to achieve the levels required by the facility's Certificate of Approval. Based on the results from the major unit process evaluation, the facility is classified as capable (Type 1), marginal (Type 2), or not capable (Type 3), in terms of its ability to achieve the required effluent quality with existing unit processes at current flows. Staff responsible for operating, maintaining, and managing the facility are interviewed to determine other factors causing poor performance, such as inability to apply wastewater treatment knowledge or poor staffing practices.

If the CPE determines that the facility is Type 1 (capable) or Type 2 (marginal), a Comprehensive Technical Assistance (CTA) resolves the factors preventing the achievement of a good, economical effluent. Minor modifications may be implemented at Type 1 or 2 facility as part of a CTA. If the STP is a Type 3 facility with significant unit process limitations, then a CTA is not appropriate until major design factors are resolved, (i.e., conduct a design evaluation to identify cost effective facility improvements).

The objective of a CTA is to improve the performance of an existing STP by systematically addressing the performance limiting factors identified during the CPE. A CTA facilitation team supports process control activities and transfers skills to the staff and administrators responsible for the facility and assists management to upgrade policies (such as those relating to "chain of command", workload distribution, plant coverage, etc.).

A period of 12 to 18 months is typically required to complete the CTA. This length of time is required to progressively transfer new skills and develop staff confidence in new methods to implement new policies, to address a variety of operating conditions (i.e., wet weather flows during the spring), to allow biological systems to respond to changes, and to allow physical modifications and procedural changes to be completed.

Since a CTA seeks skills transfer and empowerment, staff must assume responsibility for learning and applying new techniques. The support of administrators and managers is therefore crucial to achieving "buy-in" from plant staff. As appropriate, a CTA also develops or upgrades management skills.

Appendix 2

Data Checks for Coldwater STP

Coldwater STP

Typical Wastewater Values:

Domestic BOD5 load = range 0.07- 0.09 kg BOD5/cap
Wastewater production = 450 L/cap day
Ratio of wastewater to water consumed = range 70 – 90 %
Influent TSS/BOD5 ratio = 0.8 – 1.2

Sludge Production Ratio:

Extended aeration = 0.65 kg TSS/kg BOD5 rem

Chemical sludge production ratio

Alum = 4.79 kg TSS/kg Al+3 added

Reported Data for Coldwater STP (1997)

Avg. daily flow	327 m3/d
Avg. influent BOD	115 mg/L = 0.115 kg/m3
Avg. final effluent BOD	3.6 mg/L = 0.0036 kg/m3
Avg. influent TSS	138 mg/L = .138 kg/m3
Avg. final effluent TSS	6.9 mg/L = 0.0069 kg/m3
Avg. influent TP	4.2 mg/L = .0042 kg/m3
Avg. effluent TP	0.19 mg/L = .00019 kg/m3
Total mass sludge wasted	44,712 kg/y
Hauled sludge vol.	891 m3/y
Avg. hauled sludge conc.	33,584 mg/L = 33.584 kg/m3
Volume of Alum added	32.714 m3
% Al in Aluminum Sulphate	4.3 %
Density of Aluminum Sulphate	1,330 kg/m3

Data Checks

Projected flow to plant based on reported population and typical per capita loading
= reported population x typical per cap. loading
= 900 people x .450 m^3/cap.d = 405 m^3/d (higher than reported of 327 m^3/d)

Reported BOD5 load to plant
= avg. day flow (m^3/d) x Avg. influent BOD_5 (kg/m^3)
=327 m^3/d x 0.115 kg/m^3 = 37.6 kg BOD_5/d

Typical per capita BOD_5 loading (kg BOD_5/cap.d)
= population serviced (people) x typical BOD5 loading (kg BOD_5/cap)
= 900 people x 0.08 (kg BOD_5/cap) = 72 kg BOD_5/d

Projected BOD5 concentration(mg/L)
= BOD_5 load / Avg. daily flow
= 72 kg / 327 m3 = 0.220 kg/m3 = 220 mg/L (medium strength loading, Metcalf & Eddy)

Population verification based on BOD5 load
= reported BOD5 load / Typical BOD5 load

= 37.6 kg BOD5/d / 0.08 kg BOD5/d = 470 people (This is very low?)

Based on data checks, it appears that the influent BOD5 is approximately 50% of what would be expected. Therefore, for the sludge accountability analysis, the projected BOD5 concentration of 220 mg/L was used to project sludge mass produced.

Chemical Dosing Projection – single point addition

$$\text{Alum dosing} = \frac{(\text{mg } Al^{+3} / \text{mg/L } P_{rem}) \times \text{TP removed (raw TP – eff TP) (mg/L)}}{\% \ Al^{+3}}$$

$$= \frac{1.3 \times (4.2 \text{ mg/L} - 0.19 \text{ mg/L})}{0.043}$$

= 121.2 mg Alum /mg TPrem

therefore,

$$= \frac{0.121 \text{ kg/m3} \times 327 \text{ m3/d}}{1330 \text{ kg/m3}}$$

= 0.0298 m3/d = 29.8 L/d = 10.9 m3/y

Reported dosing of 32.7 m3/y is approximately 3x greater than the projected dosing of 10.9 m3/y.

<u>Sludge Accountability Analysis</u>

1. Reported Sludge Mass Produced

Reported wasted sludge mass
= Sludge vol. wasted (m3) x Sludge vol. concentration (kg/m3)
=m3 x kg/m3 = 44,712 kg/y

Reported sludge mass hauled (kg/y)
= Sludge vol. hauled (m3/yr) x Avg. waste sludge conc. (kg/m3)
=891 m3 x 33.584 kg/m3 = 29,923 kg/y

Unintentional sludge mass wasted (kg/y)
=Avg. daily flow (m3) x Avg. final effluent TSS (kg/m3) x 365 d/yr
=327 m3/d x 0.0069 kg/m3 x 365 d/yr = 823.5 kg/yr

1i. Total reported waste sludge mass (kg/y)
=Intentional sludge wasted kg/yr + Unintentional sludge wasted kg/yr
=44,712 kg/y + 823.5 kg/yr = 45,536 kg/y (This value looks too high?)

1ii. Total reported hauled sludge mass (kg/y)
= Reported sludge mass hauled + Unintentional sludge wasted
=29,923 kg/y + 823.5 kg/yr = 30,747 kg/y

<u>2. Projected Biological Sludge Mass Produced</u>

=Avg. daily flow (m3/d) x BOD removed (kg/m3) x Sludge production ratio (kg TSS prod./kg BOD5 rem.) x 365 d/yr
=327 m3/d x (.220 - .0036 kg/m3) x 0.65 kg TSS/kg BOD5 rem x 365 d/yr = 16,789 kg/yr

3. Projected Chemical Sludge Mass Produced

=Alum added (m3/yr) x Density of the metal (kg/m3) x % Metal (%) x Chemical sludge production ratio (kg TSS/kg BOD5 rem)
=32.714 m3/yr x 1330 kg/m3 x 4.3 % x 4.79 kg TSS/kg BOD5 rem = 8,962 kg/yr

4. Total Projected Sludge Mass Produced

=Biological sludge mass produced (kg/yr) + Chemical sludge mass produced (kg/yr)
=16,789 (kg/yr) + 8,962 (kg/yr) = 25,751 kg/yr

5. Sludge Accountability Analysis

$$\% \text{ difference} = \frac{\text{Projected sludge mass (kg/yr)} - \text{Reported sludge mass (kg/yr)}}{\text{Projected sludge mass (kg/yr)}} \times 100$$

$$= \frac{25{,}751 \text{ (kg/yr)} - 30{,}747 \text{ (kg/yr)}}{25{,}751 \text{ (kg/yr)}} \times 100$$

$$= -19\ \%$$

Assumed minimal solids reduction in aerated sludge storage tank given sludge is hauled every other week. The sludge accountabilty analysis indicates that approximately 19% more sludge is being produced than would be expected. This is not within the target of +/- 15%. There may be problems with sampling and analysis.

Suggested Follow-up:

- Influent BOD appears to be low (i.e. reported = 115 mg/L, projected = 220 mg/L). Carry out influent TSS analysis and compare against BOD values from the lab. Typical influent TSS/BOD ratio should be between 0.8 – 1.2. Add the TSS values and SRT to worksheet for references.
- Obtain accurate population for Town of Coldwater and recalculate projected BOD and hydraulic loadings for STP.
- Protocol for microwaving solids needs to be refined. Perform a QC check on drying time. For example, dry duplicate samples for 4, 8, 12 minutes. Also, try a duplicate sample in the oven at Victoria Harbour. Obtain a dessicator or fabricate using a sealed container with dessicant inside.
- Hauled sludge volumes may be inaccurate. Document hauled sludge volumes based on feet removed from the holding tank. Record on same sheet as hauler.
- Influent sampling may not reflect true plant loading. Discuss with Martin flow proportioning the composite sampler to the on-cycles of the lift station pumps.
- Regular TSS/VSS analysis on hauled sludge to determine whether there is any solids reduction across aerated sludge storage tank.
- Check waste sludge volumes and concentrations for 1997. Reported mass wasted appears to be higher than expected?
- Chemical dosing calculations should be checked, discussed and a strategy developed to determine a more effective chemical dosing strategy to reduce chemical consumption (ie. flow proportion chemical pump?)

Appendix 3

Data Checks for MHC STP

MHC Pentanguishene STP

Typical Wastewater Values:

Domestic BOD5 load = range 0.07- 0.09 kg BOD5/cap
Wastewater production = 450 L/cap day
Ratio of wastewater to water consumed = range 70 – 90 %
Influent TSS/BOD5 ratio = 0.8 – 1.2

Sludge Production Ratio:

CAS with primary = 0.70 kg TSS/kg BOD5 rem

Chemical Sludge Production Ratio:

Alum = 4.79 kg TSS/kg Al^{+3} added

Reported Data for MHC STP (1997):

Avg. daily flow	502.1	m3/d		
Avg. raw influent BOD	123.7	mg/L	= 0.1237 kg/m3	
Avg. final effluent BOD	7.3	mg/L	= 0.0073 kg/m3	
Avg. raw influent TSS	117.4	mg/L	= 0.1174	kg/m3
Avg. final effluent TSS	3.5	mg/L	= 0.0035 kg/m3	
Avg. raw influent TP	3.6	mg/L	= 0.0036 kg/m3	
Avg. final effluent TP	0.23	mg/L	= 0.00023 kg/m3	
Avg. waste sludge conc.	24,000	mg/L	= 24 kg/m3	
Hauled sludge vol.	374.3	m3		
Sludge mass transferred to drying beds	24	kg/m3		
Sludge volume transferred to drying beds	1,086	m3/yr		
Volume of Alum added	22.6	m3		
% Al in Aluminum Sulphate	4.3	%		
Density of Aluminum Sulphate	1,330	kg/m3		

Data Checks:

Projected flow to plant based on population and typical per capita loading
= reported population x typical per capita loading
= 1200 people x .450 L/cap.d = 540 m3/d (close to reported flow of 502 m3/d)

Population verification based on BOD5 load = Reported BOD5 load (kg/m3) / Typical BOD5 load (kg BOD/cap d)
= 62.1 (kg/m3) / 0.08 kg BOD/cap d = 776 people (low compared to rep. 1200 people)

Reported BOD5 load to plant = Avg. daily flow (m3) x Avg. influent BOD5 (kg/m3) = kg BOD5/d
= 502.1 m3 x 0.1237 kg/m3 = 62.1 kg BOD5/d

Typical per capita BOD5 loading = Population serviced (people) x Typical BOD5 loading (kg BOD5/cap) = kg BOD5/d
= 1,200 people x 0.08 kg BOD5/cap) = 96 kg BOD5/d

Projected BOD5 concentration = BOD5 load (kg BOD5/d) / Avg. daily flow (m3) = kg/m3
= 96 kg BOD5/d / 502.1 m3/d = 0.191 kg/m3 = 191 mg/L (reported 124 mg/L)

Projected Chemical Dosing:

Alum dosing $= \dfrac{(\text{mg } Al^{+3} / \text{mg/L } P_{rem}) \times \text{TP removed (raw TP – eff TP) (mg/L)}}{\% \, Al^{+3}}$

$= \dfrac{1.3 \times (3.6 \text{ mg/L} - 0.23 \text{ mg/L})}{0.043}$

$= 101.9 \text{ mg } Al^{+3} / \text{mg/L } P_{rem}$

therefore, $= \dfrac{0.102 \text{ kg/m3} \times 502.1 \text{ m3/d}}{1330 \text{ kg/m3}}$

= 0.038 m3/d = 38 L/d = 13.9 m3/y (reported = 22.6 m3/y)

Sludge Accountability Analysis

1. Reported Sludge Mass Produced

Reported sludge mass transferred to digester = vol. transferred (m3/y) x estimated conc. (kg/m3)
627 m3/yr x 50 kg/m3 = 31,350 kg/yr

Reported sludge mass hauled = Sludge vol. hauled (m3/yr) x Avg. waste sludge conc. (kg/m3) = kg/yr
374.3 m3/yr x 24 kg/m3 = 8,983 kg/yr

Reported sludge mass to drying beds = Sludge volume transferred (m3/yr) x Sludge concentration (kg/m3) = kg/yr
1086 m3/yr x 24 kg/m3 = 26,064 kg/yr

Unintentional sludge mass wasted = Avg. daily flow (m3) x Avg. final effluent TSS (kg/m3) x 365 d/yr = kg/yr
502.1 m3 x 0.0035 kg/m3 x 365 d/yr = 641 kg/yr

1i. Total reported sludge mass (to digester) = sludge mass to digester (kg/y) + unintent. mass in eff. (kg/y)
31,350 kg/y + 641 kg/y = 31,991 kg/y

1ii. Total reported sludge mass (from digester) = hauled sludge mass (kg/yr)+ reported sludge mass to drying beds (kg/yr) + Unintentional sludge wasted (kg/yr) = kg/yr
8,983 kg/yr + 26,064 kg/yr + 641 kg/yr = 35,689 kg/yr

2. Projected Primary Sludge Mass Produced

= Avg. daily flow (m3) x TSS removal across primary ($TSS_{in} - TSS_{out}$) (kg/m3) x 365 d/yr = kg/yr
(assume 50% TSS reduction across primary since TSS value for primary effluent is missing)
= 502.1 m3/d x (0.1174 kg/m3 x 0.5) x 365 d/yr
= 502.1 m3/d x 0.0587 kg/m3 x 365 d/yr = 10,758 kg/yr

3. Projected Secondary Sludge Mass Produced

= Avg. daily flow (m3) x BOD5 removal across secondary system (= $BOD_{in} - BOD5_{out}$) (kg/m3) x sludge production ratio (kg TSS/kg BOD5 rem x 365 d/yr
= 502.1 m3 x ((0.191 x 0.7) - 0.0073) x 0.70 x 365 = 16,215 kg/yr

4. Projected Chemical Sludge Mass Produced

= Alum added (m3) x Density of the metal (kg/m3) x % metal x Chemical sludge production ratio
= 22.6 m3 x 1,330 kg/m3 x 4.3% x 4.79 kg TSS/kg Al^{+3} = 6,191 kg/yr

5. Total Projected Sludge Mass (to digester)

= Biological sludge mass produced (kg/yr) + primary sludge mass (kg/yr) + secondary sludge mass (kg/yr) + chemical sludge mass (kg/y)
= 10,758 (kg/y) + 16,215 (kg/yr) + 6,191 (kg/yr) + 10172 = 33,164 kg/yr

6. Projected Digester Sludge Mass

Assume a 40% reduction in solids across digester
= total projected mass (kg/y) x 0.60 (% solids remaining after digestion)
= 33,164 x .6 = 19,898 kg/y

7. Sludge Accountability (sludge mass to digester)

$$\% \text{ difference} = \frac{\text{Projected sludge mass - Reported sludge mass}}{\text{Projected sludge mass}} \times 100$$

$$= \frac{33,164 - 35,689}{33,164} \times 100$$

$$= -7.6\ \%$$

Reported sludge mass is within +/- 15% of what was projected therefore, the reported data probably reflects true plant performance.

8. Sludge Accountability Analysis (sludge mass from digester)

$$\% \text{ difference} = \frac{\text{Projected sludge mass - Reported sludge mass}}{\text{Projected sludge mass}} \times 100$$

$$= \frac{19,898 \text{ kg/y} - 35869 \text{kg/y}}{19,898 \text{ kg/y}} \times 100$$

$$= -80\ \%$$

Reported sludge mass is 80% greater than projected. This indicates that the reported volumes or concentrations wasted from the digester may not reflect true sludge mass produced.

Suggested Follow-up:

- Initiate composite sampling of influent to determine true plant loading.
- Measure TSS and VSS on sludge to and from digester on a consistent basis.
- Take composite samples of primary effluent for outside lab analysis to quantify primary removal efficiency.

- Sample filtrate from drying beds for BOD5, TSS, TP and NH_3 to quantify loading back to plant.
- Calculate population and per cap BOD5 loading (1-2 times/yr) based on average daily water consumption and STP flows.
- Review and discuss projected chemical dosing requirements with management and determine feasibility of flow proportioning the chemical feed pump.

Appendix 4

Data Checks for Midland STP

Town of Midland STP

Typical Wastewater Values

Domestic BOD5 load = range 0.07- 0.09 kg BOD5/cap
Wastewater production = 450 L/cap day
Ratio of wastewater to water consumed = range 70 – 90 %
Influent TSS/BOD5 ratio = 0.8 – 1.2

Sludge Production Ratio

CAS with primary = 0.70 kg TSS/kg BOD5 rem

Chemical sludge Production Ratio

Alum = 4.79 kg TSS/kg Al+3 added

Reported Data for Midland STP

Avg. daily flow	10,240 m3/d
Avg. raw influent BOD	85 mg/L = 0.085 kg/m3
Avg. final effluent BOD	5.0 mg/L = 0.0050 kg/m3
Avg. raw influent TSS	185 mg/L = 0.185 kg/m3
Avg. final effluent TSS	4.6 mg/L = 0.0046 kg/m3
Avg. raw influent TP	4.6 mg/L = 0.0046
Avg. final effluent TP	0.15 mg/l = 0.00015 kg/m3
Avg. primary effluent TSS	67 mg/L = 0.067 kg/m3
Avg. primary effluent BOD	50 mg/L = 0.050 kg/m3
Waste sludge (to digesters) volume	16,920 m3/yr
Avg. waste sludge conc.	50,710 mg/L = 50.71 kg/m3
Hauled sludge vol.	15,065 m3/yr
Concentration of hauled sludge	37.6 kg/m3
Volume of Alum added	1.458 m3/d = 532.17 m3/yr
% Al in Aluminum Sulphate	4.3 %
Density of Aluminum Sulphate	1,330 kg/m3
Population serviced	16,430 people

Data Checks

Population check based on Avg. day plant flow = Avg. daily flow (m3/d) / Typical wastewater production (m3/cap d)
= 10,240 m3/d / 0.450 m3/cap d = 22,756 (high, I/I, combined sewerage?)

Anticipated plant flow = Population (people) x Typical wastewater production (m3/cap d)
= 16,430 people x 0.450 m3/cap d = 7,394 m3/d

Difference between projected plant flow and actual plant flow = Actual flow (m3) – Projected flow (m3)
= 10,240 m3/d - 7, 394 m3/d = 2,846 m3/d

Influent TSS / Influent BOD ratio (Typical range 0.8 – 1.2)
= 185 / 85 = 2.1 (high ratio, industry, low BOD5?)

Reported BOD_5 load to plant = Avg. daily flow (m3/d) x Avg. influent BOD_5 (kg/m3) = kg BOD_5/d
= 10,240 m3/d x 0.085 kg/m3 = 870 kg BOD_5/d

Population verification based on BOD_5 load = Reported BOD_5 load / Typical BOD_5 load
= 870 kg BOD_5/d / 0.08 kg BOD_5/d = 10,875 people (lower than reported 16,430, reported BOD5?)

Typical per capita BOD_5 loading
= Population serviced (people) x Typical BOD_5 loading (kg BOD_5/cap)
= 16,430 people x 0.08 (kg BOD_5/cap) = 1,314 kg BOD_5/d

Projected BOD_5 concentration = BOD_5 load (kg BOD_5/d) / Avg. daily flow (m3/d)
= 1,314 kg BOD_5/d / 10,240 m3/d = 0.128 kg/m3 = 128 mg/L

Projected Chemical Dosing – dual point

Alum dosing $= \dfrac{(\text{mg } Al^{+3} / \text{mg/L } P_{rem}) \times \text{TP removed (raw TP – eff TP) (mg/L)}}{\% Al^{+3}}$

$= \dfrac{1.1 \times (4.6 \text{ mg/L} - 0.15 \text{ mg/L})}{0.043}$

$= 113.8 \text{ mg } Al^{+3} / \text{mg/L } P_{rem}$

therefore, $= \dfrac{0.1138 \text{ kg/m3} \times 11{,}400 \text{ m3/d}}{1330 \text{ kg/m3}}$

= 0.975 m3/d = 975 L/d = 356 m3/y (reported = 532 m3/y)

Sludge Accountability Analysis

1. Reported Sludge Mass Produced

Reported sludge mass to digester = Sludge vol. wasted (m3) x Sludge vol. concentration (kg/m3)
= 16,920 m3 x 50.71 kg/m3 = 858,013 kg/yr

Reported sludge mass hauled = Sludge vol. hauled (m3/yr) x Avg. waste sludge conc. (kg/m3)
= 15,065 m3/yr x 37.6 kg/m3 = 566,444 kg/yr

Reported reduction in solids across digester = Reported sludge mass produced – Reported sludge mass hauled x 100%

$= \dfrac{858{,}013 - 566{,}444}{858{,}013} \times 100\%$

= 34%

Unintentional sludge mass wasted = Avg. daily flow (m3) x Avg. final effluent TSS (kg/m3) x 365 d/yr
= 10,240 m3 x 0.0046 kg/m3 x 365 d/yr = 17,193 kg/yr

1i. Total reported sludge mass to digester
= Sludge mass to digester (kg/yr) + Unintentional sludge wasted (kg/yr)
= 858,013 kg/yr + 17,193 kg/yr = 875,206 kg/yr

1ii. Total reported sludge mass hauled

= Reported sludge mass hauled (kg/yr) + Unintentional sludge wasted (kg/yr)

= 566,444 kg/yr + 17,193kg/yr = 583,637 kg/yr

2. Projected Primary Sludge Mass Produced

= Avg. daily flow (m3) x TSS removed (kg/m3) x Sludge production ratio (kg TSS/kg BOD5 rem) x 365 d/yr

= 10,240 m3 x (0.185 kg/m3 – 0.067 kg/m3) x 365 d/yr = 441,037 kg/yr

3. Projected Secondary Sludge Mass Produced

Assume 128 mg/L influent BOD5 is reduced by 40% across primary (reduction based on reported) = 77 mg/L = .077 kg/m3

= Avg. daily flow (m3) x BOD removed (kg/m3) x Sludge production ratio (kg TSS/kg BOD5 rem) x 365 d/yr

= 10,240 m3 x (0.077 kg/m3 - .0005 kg/m3) x 0.70 kg TSS/kg BOD5 rem x 365 d/yr = 200,148 kg/yr

4. Projected Chemical Sludge Mass Produced

= Alum added (m3) x Density of the metal (kg/m3) x % Metal (%) x Chemical sludge production ratio (kg TSS/kg BOD5 rem)

= 532.2 m3/yr x 1,330 kg/m3 x 4.3 % x 4.79 kg TSS/kg BOD5 rem = 145,791 kg/yr

5. Total Projected Sludge Mass Produced

= Primary sludge mass produced (kg/yr) + Secondary sludge mass produced + Chemical sludge mass produced (kg/yr)

= 441,037 (kg/yr) + 200,148 (kg/yr) + 145,791 (kg/yr) = 770,693 kg/yr

6. Sludge Accountability Analysis (sludge to digester)

$$\% \text{ difference} = \frac{\text{Projected sludge mass (kg/yr)} - \text{Reported sludge mass (kg/yr)}}{\text{Projected sludge mass (kg/yr)}} \times 100$$

$$= \frac{770{,}693 \text{ (kg/yr)} - 875{,}637 \text{ (kg/yr)}}{770{,}693 \text{ (kg/yr)}} \times 100$$

$$= -14\ \%$$

7. Sludge Accountability Analysis (sludge from digester)

Assume 30% reduction in projected mass across digester

30% reduction in TSS = 770,693kg/y (into digester) x 0.7 (% solids remaining)

= 539,485 kg TSS out of digester

$$\% \text{ difference} = \frac{\text{Projected sludge mass (kg/yr)} - \text{Reported sludge mass (kg/yr)}}{\text{Projected sludge mass (kg/yr)}} \times 100$$

$$= \frac{539{,}485 \text{ (kg/yr)} - 583{,}637 \text{ (kg/yr)}}{539{,}485 \text{ (kg/yr)}} \times 100$$

= -8 %

Reported sludge produced is within +/- 15% of projected sludge mass therefore, the reported data probably reflects the true plant performance.

Suggested Follow-up:

- Continue to monitor the difference between reported and projected flows (currently reported is 35% greater than expected). This may become important information if major development is scheduled in the future increasing the hydraulic loading to the plant.
- Continue to check ratio of influent TSS : BOD5. Ratio is higher (2.1) than the typical ratio (0.8 – 1.2). Influent BOD5 may not relect true plant loading?
- Influent BOD5 may be higher than is currently being reported. The projected BOD5 concentration of 128 mg/L based on population served was used to project secondary sludge produced. The sludge accountability analysis did not close using reported BOD5 concentrations. Check sampling and analysis procedures.
- Review sludge accountability analysis, data checks and discuss with operators and manager
- Obtain water consumption rates from PUC to check population serviced and projected hydraulic plant loading (i.e. 70 – 90% of water consumed should reach the plant). Determine magnitude of I/I.
- Discuss strategy for operating one instead of two secondary clarifiers to improve sludge distribution control between the aeration basins and secondary clarifiers. Clarifier Sludge Residence Time (CSRT) should be less than 1 hour.

Appendix 5

Data Checks for Main St. Penetanguishene STP

Main St. Penetanguishene

Typical Wastewater Values

Domestic BOD5 load = range 0.07- 0.09 kg BOD5/cap
Wastewater production = 450 L/cap day
Ratio of wastewater to water consumed = range 70 – 90 %
Influent TSS/BOD5 ratio = 0.8 – 1.2

Sludge Production Ratio:

Conventional Activated Sludge without primary = 0.85 kg TSS/kg BOD5 rem

Chemical Sludge Production Ratio:

Alum = 4.79 kg TSS/kg Al+3 added

Reported Data for Coldwater STP (1997)

Avg. daily flow	3,939 m3/d
Avg. raw influent BOD	105 mg/L = 0.105 kg/m3
Avg. final effluent BOD	1.57 mg/L = 0.00157 kg/m3
Avg. raw influent TSS	172 mg/L = 0.172 kg/m3
Avg. final effluent TSS	1.37 mg/L = 0.00137 kg/m3
Avg. raw influent TP	3.0 mg/L = 0.003 kg/m3
Avg. final effluent TP	0.05 mg/L = 0.0005 kg/m3
Hauled sludge conc.	22,700 mg/L = 22.7 kg/m3
Hauled sludge vol.	6,107 m3
Waste sludge vol.	22,597 m3
Waste sludge conc.	9,543 mg/L = 9.543 kg/m3
Volume of Alum added	196.45 m3/yr
% Al in Aluminum Sulphate	4.3 %
Density of Aluminum Sulphate	1,330 kg/m3
Population serviced	5,831 people (based on 83% flow split to Fox St. plant)
Avg. daily water consumption	4,021 m3/d or based on flow split to Fox St. plant = 3,337 m3/d

Data Checks

Projected plant flow based on population and typical per capita loading
= population x .450 m3/cap.d
= 5,831 people x .450 m3/cap.d = 2,624 m3/d (reported flow of 3,939 m3/d is 50% greater than projected flow)

Population check based on STP flow
= Avg. daily flow (m3/d) / Typical wastewater production (m3/cap.d)
= 3,939 m3/d / 0.450 m3/cap d = 8,753 people (high)

Projected wastewater flow based on daily water consumption
= Avg. water consumption (m3/d) x Ratio of wastewater consumed
= 3,337 m3/d x 80% = 2,669.6 m3/d (compares with projected STP flow of 2,624 m3/d)

Difference in measured and projected daily flow
= Measured flow (m3/d) - Projected flow (m3/d)

= 3,939 m3/d - 2669.6 m3/d = 1269.4 m3/d (combined sewers, some I/I)

Influent TSS/BOD5 ratio = Measured influent TSS (mg/L) / Measured influent BOD5 (mg/L)
172 mg/L / 105 mg/L = 1.64 (higher than typical of 0.8 to 1.2)

Reported BOD5 load to plant
= avg. daily flow (m3/d) x avg. influent BOD5 (kg/m3)
= 3,939 m3/d x 0.105 kg/m3 = 414 kg BOD5/d

Typical per capita BOD5 loading
= Population serviced (people) x Typical BOD5 loading (kg BOD5/cap)
= 5,831 people x 0.08 (kg BOD5/cap) = 466 kg BOD5/d (close to reported)

Projected BOD5 concentration
= BOD5 load / Avg. daily flow
= 466 kg / 3,939 m3 = 0.118 kg/m3 = 118 mg/L vs reported 105 mg/L

Chemical Dosing Projection – dual point addition

Alum dosing $= \dfrac{(\text{mg } Al^{+3} / \text{mg/L } P_{rem}) \times \text{TP removed (raw TP – eff TP) (mg/L)}}{\% Al^{+3}}$

$= \dfrac{1.1 \times (3.0 \text{ mg/L} - 0.05 \text{ mg/L})}{0.043}$

$= 75.5 \text{ mg } Al^{+3} / \text{mg/L } P_{rem}$

therefore, $= \dfrac{0.0755 \text{ kg/m3} \times 3939 \text{ m3/d}}{1330 \text{ kg/m3}}$

= 0.224 m3/d = 224 L/d = 82 m3/yr (less than half reported, 196 m3)

<u>Sludge Accountability Analysis</u>

1. Reported Sludge Mass Produced

Reported sludge mass wasted = Sludge vol. wasted (m3/yr) x Sludge vol. concentration (kg/m3) = kg/yr
22,597 m3/yr x 9.543 kg/m3 = 215,643 kg/yr

Reported sludge mass hauled = Sludge vol. hauled (m3/yr) x Hauled waste sludge conc. (kg/m3) = kg/yr
6,107 m3/d x 22.7 kg/m3 = 138,629 kg/yr

Unintentional sludge
mass wasted = Avg. daily flow (m3) x Avg. final effluent TSS (kg/m3) x 365 d/yr = kg/yr
3,939 m3 x 0.00137 kg/m3 x 365 d/yr = 1,970 kg/yr

1i. Total reported wasted
sludge mass = Intentional sludge wasted kg/yr + Unintentional sludge wasted kg/yr = kg/yr
215,643 kg/yr + 1,970 kg/yr = 217,613 kg/yr

1ii. Total reported hauled sludge mass = Reported sludge mass hauled + Unintentional sludge wasted = kg/yr
138,629 kg/yr + 1,970 kg/yr = 140,599 kg/yr

2. Projected Biological Sludge Mass Produced

= Avg. daily flow (m3) x BOD removed (kg/m3) x Sludge production ratio (kg TSS/kg BOD_5 rem) x 365 d/yr
= 3,939 m3 x (.118 - .00157 kg/m3) x 0.85 kg TSS/kg BOD_5 rem x 365 d/yr = 142,286 kg/yr

3. Projected Chemical Sludge Mass Produced

= Alum added (m3) x Density of the metal (kg/m3) x % Metal (%) x Chemical sludge production ratio (kg TSS/kg BOD_5 rem)
= 196.45 m3 x 1,330 kg/m3 x 4.3 % x 4.79 kg TSS/kg BOD_5 rem = 53,816 kg/yr

4. Total Projected Sludge Mass Produced

= Biological sludge mass produced (kg/yr) + Chemical sludge mass produced (kg/yr) = kg/yr
142,286 (kg/yr) + 53,816 (kg/yr) = 196,102 kg/yr

5. Sludge Accountability Analysis (wasted sludge mass)

$$\% \text{ difference} = \frac{\text{Projected sludge mass (kg/yr)- Reported sludge mass (kg/yr)}}{\text{Projected sludge mass (kg/yr)}} \times 100$$

$$= \frac{196{,}102 \text{ kg/yr} - 215{,}643 \text{ kg/yr}}{196{,}102 \text{ kg/yr}} \times 100$$

$$= -10\ \%$$

6. Projected Sludge Reduction Across Digester

Assuming a 35% reduction of solids across the digester =
196,102 kg/yr x 0.60 = 127,466 kg/yr

7. Sludge Accountability Analysis (hauled sludge mass)

Assuming a 35% reduction in solids across the digester;

$$\% \text{ difference} = \frac{\text{Projected sludge mass (kg/yr)- Reported sludge mass (kg/yr)}}{\text{Projected sludge mass (kg/yr)}} \times 100$$

$$= \frac{127{,}466 \text{ kg/yr} - 140{,}599 \text{ kg/yr}}{127{,}466 \text{ kg/yr}} \times 100$$

$$= -10.3\ \%$$

Both the reported and hauled sludge mass are within +/-15% of projected sludge mass therefore, the reported data probably reflects the true plant performance.

Suggested Follow-up:

- The difference between measured flow and projected flow is high (1269 m3/d). Appears to be an I/I or combined sewer issue. Continue to monitor and report to municipality. This will become more important in the future as the town develops and plant hydraulic loading increases.

- The BOD_5 plant loading appears to be lower than expected. TSS to BOD ratio should be between 0.8 – 1.2. The ratio for Main St. is high (1.6). Watch for large variations in raw BOD5 from the new lab and correlate with influent TSS.

- Regular sampling of secondary clarifier effluent for BOD5, TSS, and TP. This will allow a more accurate assessment of plant performance and provide a focal point for process control.

- Discuss strategy with management for operating 1 versus 2 secondary clarifiers to minimize clarifier solids retention time (CSRT). CSRT should be less than 1 hr.

- Record actual hauled sludge volumes and concentrations (i.e. truck weight full, draw down tests of digester, magmeter readings for loading trucks.

- The current reported chemical addition (538 L/d) is much higher than the projected chemical addition (224 L/d). Re-evaluate value of dual point chemical addition to achieve TP objective (i.e. perform a special study with single point addition). Reduce chemical and monitor TP closely to determine minimal dosing requirements.

- Chemical addition (alum) should be used to control phosphorus and not turbidity. Turbidity is primarily controlled through sludge mass control and sludge characteristics.

Appendix 6

Data Checks for Fox St. Penetanguishene STP

Fox St. Penetanguishene STP

Typical Wastewater Values

Domestic BOD5 load = range 0.07- 0.09 kg BOD5/cap
Wastewater production = 450 L/cap day
Ratio of wastewater to water consumed = range 70 – 90 %
Influent TSS/BOD5 ratio = 0.8 – 1.2

Sludge Production Ratio:

Contact Stabilization = 1.0 kg TSS/kg BOD5 rem

Chemical Sludge Production Ratio:

Alum = 4.79 kg TSS/kg Al+3 added

Reported Data for Fox St. STP:

Avg. daily flow	790 m3/d
Avg. raw influent BOD	76.7 mg/L = 0.0767 kg/m3
Avg. final effluent BOD	0.91 mg/L = 0.00091 kg/m3
Avg. raw influent TSS	130.9 mg/L = 0.1309 kg/m3
Avg. final effluent TSS	0.79 mg/L = 0.00079 kg/m3
Avg. raw influent TP	2.61 mg/L = 0.00261kg/m3
Avg. final effluent TP	0.05 mg/L = 0.0009 kg/m3
Hauled sludge conc.	2.35% = 23.5 kg/m3
Hauled sludge vol.	1373.6 m3/yr
Waste sludge vol.	4,013 m3/yr
Waste sludge conc.	10,000 mg/L = 10.0 kg/m3 (estimated value)
Volume of Alum added	48.66 m3/yr
% Al in Aluminum Sulphate	4.3 %
Density of Aluminum Sulphate	1,330 kg/m3
Avg. water consumption	671.5 m3/d

Data Checks:

Projected flow based on reported population and typical per capita loading
= reported population x .450 m3/cap.d
1,169 people x .450 m3/d = 526 m3/d (reported flow of 790 m3/d is 50% greater than projected)

Population based on water consumption
= avg. daily water consumed/typical per capita water consumed
= 4,021 m3/d x .167/.418 m3/cap.d
= 1,606 people
The population projected is 30% greater than the estimated population of 1,169 people.

Projected wastwater flow based water consumed
= avg. daily water consumed x .167 (% water to fox St.) x .80 (typical wastewater:water ratio)
= 4,021 m3/d x .167 x .80 = 537 m3/d
Reported plant flow of 790 m3/d is approx. 32% greater than projected. I/I, combined sewers?

Projected BOD5 loading to the plant
= population x typical BOD5 produced daily per capita

= 1,169 people x .08 kg/cap. d
= 93.5 kg/d

Projected concentration in raw sewage
= projected BOD5 load/Avg. day flow
= 93.5 kg/d/790 m3/d
= .118 kg/m3 = 118 mg/L

Chemical Dosing Projection – single point addition

Alum dosing $= \frac{(\text{mg } Al^{+3} / \text{mg/L } P_{rem}) \times \text{TP removed (raw TP – eff TP) (mg/L)}}{\% Al^{+3}}$

$= \frac{1.1 \times (2.61 \text{ mg/L} - 0.05 \text{ mg/L})}{0.043}$

= 65.5 mg/L Alum /mg TPrem

therefore, $= \frac{0.065 \text{ kg/m3} \times 790 \text{ m3/d}}{1330 \text{ kg/m3}}$

= 0.039 m3/d = 39 L/d = 14.2 m3/y

Reported dosing of 48.66 m3/y is approximately 3x greater than the projected dosing of 14.2 m3/y.

<u>**Sludge Accountability Analysis**</u>

1. Reported Sludge Mass Produced:

Reported sludge mass wasted
= sludge vol. wasted (m3/yr) x sludge concentration (kg/m3)
= 4,013 m3/yr x 10.0 kg/m3 = 40,130 kg/yr

Reported sludge mass hauled
= sludge vol. hauled (m3/yr) x hauled waste sludge conc. (kg/m3)
= 1373.6 m3/yr x 23.5 kg/m3 = 32,280 kg/yr

Unintentional sludge mass wasted
= avg. daily flow (m3) x avg. final effluent TSS (kg/m3) x 365 d/yr
= 790 m3/d x 0.00079 kg/m3 x 365 d/yr = 228 kg/yr

1i. Total reported waste sludge mass
= intentional sludge wasted kg/yr + unintentional sludge wasted kg/yr
= 40,130 kg/yr + 228 kg/yr = 40,358 kg/yr

1ii. Total reported hauled sludge mass
= reported sludge mass hauled + unintentional sludge wasted
= 32,280 kg/yr + 228 kg/yr = 32,508 kg/yr

2. Projected Biological Sludge Mass Produced

= avg. daily flow (m3) x BOD5 removed (kg/m3) x sludge production ratio (kg TSS/kg BOD5 rem) x 365 d/yr
= 790 m3/d x (.118 - .00091 kg/m3) x 1.0 kg TSS/kg BOD5 rem x 365 d/yr = 33,763 kg/yr

3. Projected Chemical Sludge Mass Produced

= alum added (m3/yr) x density of alum (kg/m3) x % Al in alum x chemical sludge production ratio (kg TSS/kg BOD5 rem)
= 48.66 m3/yr x 1,330 kg/m3 x 4.3 % x 4.79 kg TSS/kg BOD5 rem = 13,330 kg/yr

4. Total Projected Sludge Mass Produced

= biological sludge mass produced (kg/yr) + chemical sludge mass produced (kg/yr)
= 33,763 kg/yr + 13,330 kg/yr = 47,093 kg/yr

Assume 35% reduction solids across digester (> 20 days HDT)
= 47,093 x .65 (solids remaining) = 30,611 kg/y

5. Sludge Accountability Analysis (for wasted sludge)

$$\%\ \text{difference} = \frac{\text{Projected sludge mass (kg/yr)} - \text{Reported sludge mass (kg/yr)}}{\text{Projected sludge mass (kg/yr)}} \times 100$$

$$= \frac{47{,}093\ \text{kg/yr} - 40{,}358\ \text{kg/yr}}{47{,}093\ \text{kg/yr}} \times 100$$

$$= +14.3\ \%$$

6. Sludge Accountability Analysis (for hauled sludge)

$$\%\ \text{difference} = \frac{\text{Projected sludge mass (kg/yr)} - \text{Reported sludge mass (kg/yr)}}{\text{Projected sludge mass (kg/yr)}} \times 100$$

$$= \frac{30{,}611\ \text{kg/yr} - 32{,}508\ \text{kg/yr}}{30{,}611\ \text{kg/m3}} \times 100$$

$$= 6.2\%$$

Reported sludge masses produced are within +/- 15% of projected sludge mass produced. Therefore, the reported data probably reflects true plant performance.

Suggested Follow-up:

- Solids analysis should be be carried out on wasted sludge to avoid estimating concentrations.
- Influent BOD5 data appears to be lower than expected. Review of sampling procedures and analysis should be carried out.
- Reported flows are much higher than projected for population serviced. This may be caused by I/I or combined sewer loading. Currently the plant appears to be capable of handling these flows but in the future as the load increases this may reduce treatment capability. This issue should be regularily monitored and reported by plant operators and reported to the Town.
- Review and discussion by operators and management of chemical dosing requirements for phosphorus removal to determine if current dosing is higher than necessary.

Appendix 7

Data Checks for Elmvale STP

Elmvale STP

Typical Wastewater Values:

Domestic BOD5 load = range 0.07- 0.09 kg BOD5/cap
Wastewater production = 450 L/cap day
Ratio of wastewater to water consumed = range 70 – 90 %
Influent TSS/BOD5 ratio = 0.8 – 1.2

Sludge Production Ratio:

Extended aeration = 0.65 kg TSS/kg BOD5 rem

Chemical Sludge Production Ratio:

Alum = 4.79 kg TSS/kg Al+3 added

Reported Data for Elmvale STP (1997):

Avg. daily flow = 1,099 m3/d
Avg. raw influent BOD (sampled after preliminary treatment) = 48 mg/L = 0.048 kg/m3
Avg. final effluent BOD = 3.0 mg/L = 0.003 kg/m3
Avg. raw influent TSS = 62 mg/L = 0.062 kg/m3
Avg. final effluent TSS = 2.0 mg/L = 0.0020 kg/m3
Avg. raw influent TP = 2.0 mg/L = 0.0020kg/m3
Avg. final effluent TP = 0.09 mg/L = 0.0009 kg/m3
Hauled sludge conc. = NA (assumed 2% or 20 kg/m3)
Hauled sludge vol. = 287 m3/y
Waste sludge vol. = 5291.2 m3/yr
Waste sludge conc. = 3,830 mg/L = 3.83 kg/m3
Volume of Alum added = 40.04 m3/yr
% Al in Aluminum Sulphate = 4.3 %
Density of Aluminum Sulphate = 1,330 kg/m3
Population serviced = approx. 1700 people
Avg. water consumption = NA

Data Checks:

Projected plant flow based on population
= population x typical per capita flow
= 1,700 people x .450 m3/cap.d = 765 m3/d
Does not compare to reported flow of 1,099 m3/d. I/I problems? Combined sewers? Population inaccurate?

Population check based on avg. day flow to plant
= avg. day flow/typical per capita flow
= 1,099 m3/d/ .450 m3/cap.d = 2,442 people
Projected population significantly greater than reported population of 1,700. Projected population appears to be too high. I/I or combined sewerage a problem?

Projected BOD5 loading to plant using reported population
= population x typical per capita BOD5 loading
= 1700 people x 0.08 kg BOD5/ Cap.d = 136 kg BOD5/d

Projected BOD5 concentration to plant
= projected BOD5 loading/ avg. day plant flow
= 136 kg/d/1,099 m3/d = .124 kg/m3 = 124 mg/L
124 mg/L does not compare with reported raw BOD5 of 48 mg/L. Samples are taken bya refrigerated composite sampler after pretreatment (hydrasieve, vortex seperator. Is the pretreatment reducing the raw BOD5?

Projected Chemical Dosing

Alum dosing $= \frac{(\text{mg } Al^{+3} / \text{mg/L } P_{rem}) \times \text{TP removed (raw TP} - \text{eff TP) (mg/L)}}{\% Al^{+3}}$

$= \frac{1.1 \times (3.0 \text{ mg/L} - 0.05 \text{ mg/L})}{0.043}$

$= 75.5 \text{ mg } Al^{+3} / \text{mg/L } P_{rem}$

therefore, $= \frac{0.0755 \text{ kg/m3} \times 3939 \text{ m3/d}}{1330 \text{ kg/m3}}$

$= 0.224 \text{ m3/d} = 224 \text{ L/d}$

Sludge Accountability Analysis

1. Reported Sludge Mass Produced

Reported sludge mass wasted
= Sludge vol. wasted (m3/yr) x Sludge vol. concentration (kg/m3)
= 5,291.2 m3/yr x 3.83 kg/m3 = 20,265 kg/yr

Reported sludge mass hauled
= Sludge vol. hauled (m3/yr) x Hauled waste sludge conc. (kg/m3)
= 287 m3 x (assumed 2% or 20 kg/m3) = 5,740 kg/yr

Unintentional sludge mass wasted
= Avg. daily flow (m3/d) x Avg. final effluent TSS (kg/m3) x 365 d/yr
= 1,099 m3/d x 0.0020 kg/m3 x 365 d/yr = 802 kg/yr

1i. Total reported waste sludge mass
= Intentional sludge wasted kg/yr + Unintentional sludge wasted kg/yr
= 20,265 kg/yr + 802 kg/yr = 21,067 kg/yr

1ii. Total reported hauled sludge mass
= Reported sludge mass hauled + Unintentional sludge wasted
= 5,740 kg/yr + 870 kg/yr = 6,610 kg/yr

Hauled sludge mass is low due to large on-site storage capability. Hauled sludge does not reflect sludge mass produced over the year. Therefore, the reported sludge mass wasted will be used for the sludge accountability analysis.

2. Projected Biological Sludge Mass Produced

= Avg. daily flow (m3/d) x BOD removed (kg/m3) x Sludge production ratio (kg TSS/kg BOD5 rem) x 365 d/yr
= 1,099 m3/d x (.048 - .003 kg/m3) x 0.65 kg TSS/kg BOD5 rem x 365 d/yr = 11,733 kg/yr

3. Projected Chemical Sludge Mass Produced

= Alum added (m3/yr) x Density of the metal (kg/m3) x % Metal (%) x Chemical sludge production ratio (kg TSS/kg BOD5 rem)
= 40.04 m3/yr x 1,330 kg/m3 x 4.3 % x 4.79 kg TSS/kg BOD5 rem = 10,969 kg/yr

4. Total Projected Sludge Mass Produced

= Biological sludge mass produced (kg/yr) + Chemical sludge mass produced (kg/yr)
= 11,733 kg/yr + 10,969 kg/yr = 22,702 kg/yr

5. Sludge Accountability Analysis

$$\% \text{ difference} = \frac{\text{Projected sludge mass (kg/yr)} - \text{Reported sludge mass (kg/yr)}}{\text{Projected sludge mass (kg/yr)}} \times 100$$

$$= \frac{22{,}702 \text{ kg/yr} - 21{,}067 \text{ kg/yr}}{22{,}702 \text{ kg/yr}} \times 100$$

$$= +4.8\ \%$$

The projected sludge mass is within +/- 15% of the reported sludge mass therefore, the reported data probably reflects the true performance of the plant.

Suggested Follow-up:

- The projected average daily flow is lower than the reported average daily flow for the plant (i.e. projected = 765 m3/d reported = 1099 m3/d, a difference of 143%). Acquire accurate population numbers and recalculate data checks.
- Appears to be a significant BOD5 reduction across the headworks when compared to projected raw BOD5 loading. Sample raw sewage prior to headworks to determine BOD5, TSS, reduction across headworks.
- TSS/VSS analysis on hauled sludge.
- Review data checks and chemical dosing calculations with management.

Appendix 8

Data Checks for Victoria Harbour STP

Victoria Harbour STP

Typical Wastewater Values

Domestic BOD5 load = range 0.07- 0.09 kg BOD5/cap
Wastewater production = 450 L/cap day
Ratio of wastewater to water consumed = range 70 – 90 %
Influent TSS/BOD5 ratio = 0.8 – 1.2

Sludge Production Ratio

Extended Aeration = 0.65 kg TSS/kg BOD5 rem

Chemical sludge Production Ratio

Alum = 4.79 kg TSS/kg Al^{+3} added

Reported Data for Victoria Harbour STP (1997)

Avg. daily flow	1,339 m3/d
Avg. raw influent BOD	95.7 mg/L = 0.0957 kg/m3
Avg. final effluent BOD	1.67 mg/L = 0.00167 kg/m3
Avg. raw influent TSS	112 mg/L = 0.112 kg/m3
Avg. final effluent TSS	2.62 mg/L = 0.00262 kg/m3
Avg. raw influent TP	2.6 mg/L = 0.0026
Avg. final effluent TP	0.17 mg/l = 0.00017 kg/m3
Waste sludge to digesters	9,473 m3/yr
Avg. waste sludge conc.	no data
Hauled sludge vol.	1,242 m3/yr
Concentration of hauled sludge	36.4 kg/m3
Volume of Alum added	23.17 m3/yr
% Al in Aluminum Sulphate	4.3 %
Density of Aluminum Sulphate	1,330 kg/m3
Population serviced	3,245 people

Data Checks

Projected plant flow using reported population and typical per capita loading
= population x typical per capita loading
= 3,245 cap. x .450 m3/cap.d = 1,460 m3/d (compares to reported flow of 1,339 m3/d)

Projected population using reported average day flows
= avg. day flow / typical per capita loading
= 1,339 m3/d / .450 m3/cap.d = 2,976 people (compares to reported pop. of 3,245)

Projected population using average daily water consumption
= avg. daily water produced / estimated per capita consumption x 0.6 (% water distributed to Vic. Harb.)
= 1,240 m3/d / .230 m3/cap.d x 0.6 = 3,235 people (compares to reported population of 3,245)

Projected BOD5 loading to plant
= population x typical per capita BOD5 loading
= 3,245 people x 0.08 kg BOD5/cap.d = 260 kg BOD5/d

Projected BOD5 concentration in raw sewage
= BOD5 loading / avg. daily plant flow
= 260 kg/d / 1,339 m3/d = .194 kg/m3 = 194 mg/L

194 mg/L is much higher than reported 95.7 mg/L. Use 194 mg/L for sludge accountability analysis.

Chemical Dosing Projection – single point addition

Alum dosing $= \frac{(\text{mg } Al^{+3} / \text{mg/L } P_{rem}) \times \text{TP removed (raw TP – eff TP) (mg/L)}}{\% Al^{+3}}$

$= \frac{1.3 \times (2.6 \text{ mg/L} - 0.17 \text{ mg/L})}{0.043}$

= 73.5 mg Alum /mg TPrem

therefore, $= \frac{0.0735 \text{ kg/m3} \times 1{,}339 \text{ m3/d}}{1{,}330 \text{ kg/m3}}$

= 0.074 m3/d = 74 L/d = 27 m3/y

Reported dosing of 23 m3/y is comparable to the projected dosing of 27 m3/y. Victoria Harbour has flow proportioned chemical feed pumps.

Sludge Accountability Analysis

1. Reported Sludge Mass Produced

Reported sludge mass to digester = Sludge vol. wasted (m3) x assumed concentration (kg/m3) = kg/yr
9,473 m3/y x 7.5 kg/m3 = 71,048 kg/y

Reported sludge mass hauled = Sludge vol. hauled (m3/yr) x Avg. waste sludge conc. (kg/m3) = kg/yr
1,242 m3/yr x 36.4 kg/m3 = 45,209 kg/yr

Unintentional sludge
mass wasted = Avg. daily flow (m3) x Avg. final effluent TSS (kg/m3) x 365 d/yr = kg/yr
1339 m3/d x 0.00262 kg/m3 x 365 d/yr = 1,280 kg/yr

1i. Total reported sludge mass to digester
= Sludge mass to digester (kg/yr) + Unintentional sludge wasted (kg/yr)
= 71,048 kg/yr + 1,280 kg/yr = 72,328 kg/yr

1ii. Total reported sludge mass hauled
= Reported sludge mass hauled (kg/yr) + Unintentional sludge wasted (kg/yr)
= 45,209 kg/yr + 1,280 kg/yr = 46,489 kg/yr

2. Projected Secondary Sludge Mass Produced

= Avg. daily flow (m3) x BOD removed (kg/m3) x Sludge production ratio (kg TSS/kg BOD5 rem) x 365 d/yr
= 1,339 m3/d x (0.194 kg/m3 - .00167 kg/m3) x 0.65 kg TSS/kg BOD5 rem x 365 d/yr = 61,099 kg/yr

3. Projected Chemical Sludge Mass Produced

= Alum added (m3) x Density of Alum (kg/m3) x % Al in Alum x Chemical sludge production ratio (kg TSS/kg BOD5 rem)
= 23.169 m3/yr x 1,330 kg/m3 x 4.3 % x 4.79 kg TSS/kg BOD5 rem = 6,347 kg/yr

4. Total Projected Sludge Mass Produced

= Secondary sludge mass produced + Chemical sludge mass produced (kg/yr)
= 61,099 (kg/yr) + 6,347 (kg/yr) = 67,446 kg/yr

5. Sludge Accountability Analysis (sludge to digester)

$$\% \text{ difference} = \frac{\text{Projected sludge mass (kg/yr)} - \text{Reported sludge mass (kg/yr)}}{\text{Projected sludge mass (kg/yr)}} \times 100$$

$$= \frac{67{,}446 \text{ (kg/yr)} - 72{,}328 \text{ (kg/yr)}}{67{,}446 \text{ (kg/yr)}} \times 100$$

$$= -7\,\%$$

6. Sludge Accountability Analysis (sludge from digester)

Assume 35% reduction in projected mass across digester
35% reduction in TSS = 67,446 kg/y (into digester) x 0.65 (% solids remaining)
= 43,840 kg/y (out of digester)

$$\% \text{ difference} = \frac{\text{Projected sludge mass (kg/yr)} - \text{Reported sludge mass (kg/yr)}}{\text{Projected sludge mass (kg/yr)}} \times 100$$

$$= \frac{43{,}840 \text{ (kg/yr)} - 46{,}489 \text{ (kg/yr)}}{43{,}840 \text{ (kg/yr)}} \times 100$$

$$= -6.0\,\%$$

Reported sludge produced is within +/- 15% of projected sludge mass therefore, the reported data probably reflects the true plant performance.

Suggested Follow-up:

- Initiate composite sampling of raw sewage to determine true plant loading.
- Suggest more frequent sampling (currently one day per month) of influent and effluent to determine true plant loading and performance.
- Carry out TSS, VSS analysis on wasted sludge whenever wasting to digester.
- Review calculations and discuss follow up strategy with manager and other operators.

Appendix 9

Data Checks for Port McNicoll STP

Port McNicoll STP

Typical Wastewater Values

Domestic BOD5 load = range 0.07- 0.09 kg BOD5/cap
Wastewater production = 450 L/cap day
Ratio of wastewater to water consumed = range 70 – 90 %
Influent TSS/BOD5 ratio = 0.8 – 1.2

Sludge Production Ratio

Extended Aeration = 0.65 kg TSS/kg BOD5 removed
Contact Stabilization = 1.0 kg TSS/kg BOD5 removed

Chemical sludge Production Ratio

Alum = 4.79 kg TSS/kg Al+3 added

Reported Data for Port McNicoll STP (1997)

Avg. daily flow	1,074 m3/d
Avg. raw influent BOD	128 mg/L = 0.128 kg/m3
Avg. final effluent BOD	6.3 mg/L = 0.0063 kg/m3
Avg. raw influent TSS	131 mg/L = 0.131 kg/m3
Avg. final effluent TSS	6.9 mg/L = 0.0069 kg/m3
Avg. raw influent TP	3.4 mg/L = 0.0034
Avg. final effluent TP	0.28 mg/l = 0.00028 kg/m3
Waste sludge to digesters	1,552 m3/yr
Avg. waste sludge conc.	no data
Hauled sludge vol.	1,033 m3/yr
Concentration of hauled sludge	40.2 kg/m3
Volume of Alum added	50.9 m3/yr
% Al in Aluminum Sulphate	4.3 %
Density of Aluminum Sulphate	1,330 kg/m3
Population serviced	2,125 people

Data Checks

Projected plant flow using reported population and typical per capita loading
= population x typical per capita loading
= 2,125 cap. x .450 m3/cap.d = 956 m3/d (reported flow of 1,074 m3/d is 12% greater than projected)

Projected population using reported average day flows
= avg. day flow / typical per capita loading
= 1,074 m3/d / .450 m3/cap.d = 2,387 people (compares to reported pop. of 2,452)

Projected population using average daily water consumption
= avg. daily water produced / estimated per capita consumption x 0.6 (% water distributed to Vic. Harb.)
= 596 m3/d / .230 m3/cap.d x 0.6 = 2,207 people (compares to reported population of 2,452)

Projected BOD5 loading to plant
= population x typical per capita BOD5 loading
= 2,452 people x 0.08 kg BOD5/cap.d = 196 kg BOD5/d

Projected BOD5 concentration in raw sewage
= BOD5 loading / avg. daily plant flow
= 196 kg/d / 1,074 m3/d = .182 kg/m3 = 182 mg/L

Projected BOD5 of 182 mg/L is higher than the reported BOD5 of 128 mg/L. Use 182 mg/L for sludge accountability analysis.

Chemical Dosing Projection – single point addition

$$\text{Alum dosing} = \frac{(\text{mg } Al^{+3} / \text{mg/L } P_{rem}) \times \text{TP removed (raw TP – eff TP) (mg/L)}}{\% \ Al^{+3}}$$

$$= \frac{1.3 \times (3.4 \text{ mg/L} - 0.28 \text{ mg/L})}{0.043}$$

= 94 mg Alum /mg TPrem

therefore,

$$= \frac{0.094 \text{ kg/m3} \times 1{,}074 \text{ m3/d}}{1330 \text{ kg/m3}}$$

= 0.076 m3/d = 76.0 L/d = 27.8 m3/y

Reported dosing of 50.9 m3/y is approximately 2x greater than the projected dosing of 27.8 m3/y.

<u>Sludge Accountability Analysis</u>

1. Reported Sludge Mass Produced

Reported sludge mass to digester = Sludge vol. wasted (m3) x RAS concentration (kg/m3) = kg/yr
9,356 m3/y x 6.03 kg/m3 = 9,356 kg/y

Reported sludge mass hauled = Sludge vol. hauled (m3/yr) x Avg. waste sludge conc. (kg/m3) = kg/yr
1,033 m3/yr x 40.22 kg/m3 = 41,524 kg/y

Unintentional sludge
mass wasted = Avg. daily flow (m3) x Avg. final effluent TSS (kg/m3) x 365 d/yr = kg/yr
1,074 m3/d x 0.00694 kg/m3 x 365 d/yr = 2,721 kg/yr

1i. Total reported sludge mass to digester
= Sludge mass to digester (kg/yr) + Unintentional sludge wasted (kg/yr)
= 9,356 kg/yr + 2,721 kg/yr = 12,077 kg/yr (too low, use hauled sludge data for sludge account.)

1ii. Total reported sludge mass hauled
= Reported sludge mass hauled (kg/yr) + Unintentional sludge wasted (kg/yr)
= 41,524 kg/yr + 2,721 kg/yr = 44,245 kg/yr

2. Projected Secondary Sludge Mass Produced

= Avg. daily flow (m3) x BOD removed (kg/m3) x Sludge production ratio (kg TSS/kg BOD5 rem) x 365 d/yr
= 1,074 m3/d x (0.182 kg/m3 - .0063 kg/m3) x 1.0 kg TSS/kg BOD5 rem x 365 d/yr = 68,876 kg/yr

3. Projected Chemical Sludge Mass Produced

= Alum added (m3) x Density of Alum (kg/m3) x % Al in Alum x Chemical sludge production ratio (kg TSS/kg BOD5 rem)
= 50.859 m3/yr x 1,330 kg/m3 x 4.3 % x 4.79 kg TSS/kg BOD5 rem = 13,932 kg/yr

4. Total Projected Sludge Mass Produced

= Secondary sludge mass produced + Chemical sludge mass produced (kg/yr)
= 68,876 kg/yr + 13,932 kg/yr = 82,808 kg/yr

5. Sludge Accountability Analysis (sludge from digester)

Assume 35% reduction in projected mass across digester
35% reduction in TSS = 82,808 kg/y (into digester) x 0.65 (% solids remaining)
= 53,825 kg/y (out of digester)

$$\% \text{ difference} = \frac{\text{Projected sludge mass (kg/yr)} - \text{Reported sludge mass (kg/yr)}}{\text{Projected sludge mass (kg/yr)}} \times 100$$

$$= \frac{53{,}825 \text{ (kg/yr)} - 44{,}245 \text{ (kg/yr)}}{53{,}825 \text{ (kg/yr)}} \times 100$$

$$= +18\ \%$$

Reported sludge produced is not within +/- 15% of projected sludge mass therefore, the reported data may not reflect true plant performance.

Suggested Follow-up:

- Initiate composite sampling of raw sewage and final effluent to determine true plant loading and performance.
- Measure volume and carry out TSS, VSS analysis on wasted sludge whenever wasting to digester.
- Develop RAS control strategy with other operators (ie. on/off timer control).
- Measure sludge blanket depth in clarifier daily.
- Discuss using sludge mass control strategy previously implemented at plant with manager.
- Review, discuss and develop strategy for more effective chemical dosing with a focus on maintaining the RAP TP objective.
- Review calculations and discuss follow up strategy with manager and other operators.