Winnipeg Sewage Treatment Program

NEWPCC Fecal and E-Coli Compliance Investigation Report 2014

November 2014

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1 Introduction

Since the ultraviolet (UV) disinfection facility was commissioned in mid-2006, the North End Water Pollution Control Centre (NEWPCC) has experienced difficulties in meeting its license requirements for both fecal coliform and Escherichia coli (E-coli) (most probable number (MPN) less than 200/100 mL on monthly geometric mean).

This report summarizes the work done to document the investigation into this issue and the recommendations for actions.

2 Methodology

The following activities have been carried out to investigate the Fecal and E-coli compliance issues at the NEWPCC:

1. Review of data and historical actions
    a. A review of drawings and operational practices was conducted to identify potential sources of contamination
    b. A review of previous actions by the City to investigate the issues was conducted
    c. Analysis of sampling data for Fecal and E-Coli was carried out to provide information of sources of contamination
2. Condition assessment planning study
    a. A planning study to examine the practicalities of carrying out a physical condition assessment was made
3. Assessment of most likely cause of contamination
    a. A review of existing data was completed by an external consultant and an analysis was undertaken to determine the most likely source of contamination from the list of possible sources.
    b. The consultant proposed options to address the most likely sources of contamination
    c. A risk workshop was held with operations and the external consultant to examine the operational issues related to each of the recommended options
    d. Further hydraulic modelling was carried out to analyze the options

3 Review of Data and Historical Actions

3.1 Potential sources of contamination

A review of historical actions by the City to investigate the Fecal and E-coli issues at the NEWPCC was conducted and Fecal and E-coli sampling data was analyzed. A summary of the review is included in Appendix 1.

The study of drawings of the conduit arrangements identified seven potential sources of contamination of the disinfected effluent. Figures 1 to 4 were provided by AECOM in Appendix 3 and are reproduced here for reference.

The numbers on figures 1 to 4 relate to the potential sources of contamination.

1. Continuous leakage from gate YG12B (normally closed), which isolates the south secondary effluent conduit at the junction chamber located near the west end of the grit building (Figure 1 and Figure 2).
2. Stagnated (trapped) flow in the UV, secondary and raw sewage (RS) bypass channels from previous permitted bypass operations washing out and contaminating treated UV effluent (Figure 4).
3. Flow from UV effluent discharge flowing backwards along the UV, secondary and raw sewage bypass channels, stagnating and allowing regrowth of fecal coliform and E.coli which eventually washes out and contaminates the treated UV effluent at low flows (Figure 4).
4. Continuous leakage between the North and South secondary effluent conduits (Figure 1, Figure 2, and Figure 4).
5. Occasional unintended primary effluent overflow at the junction chamber when a raw sewage pump starts (Figure 1 and Figure 2).
6. Occasional unintended raw sewage bypass or leakage at the raw sewage discharge well (Figure 1 and Figure 3).
7. Continuous leakage from gate YG11A and YG11B (both normally closed), which can provide secondary treatment bypass if required

A visual inspection was made of sluice gates YG11A and YG11B by removing the chamber covers. With the covers removed and normal flow on one side of the gates, it could readily be observed that there was no leakage from these gates. Consequently this source of contamination was ruled out.

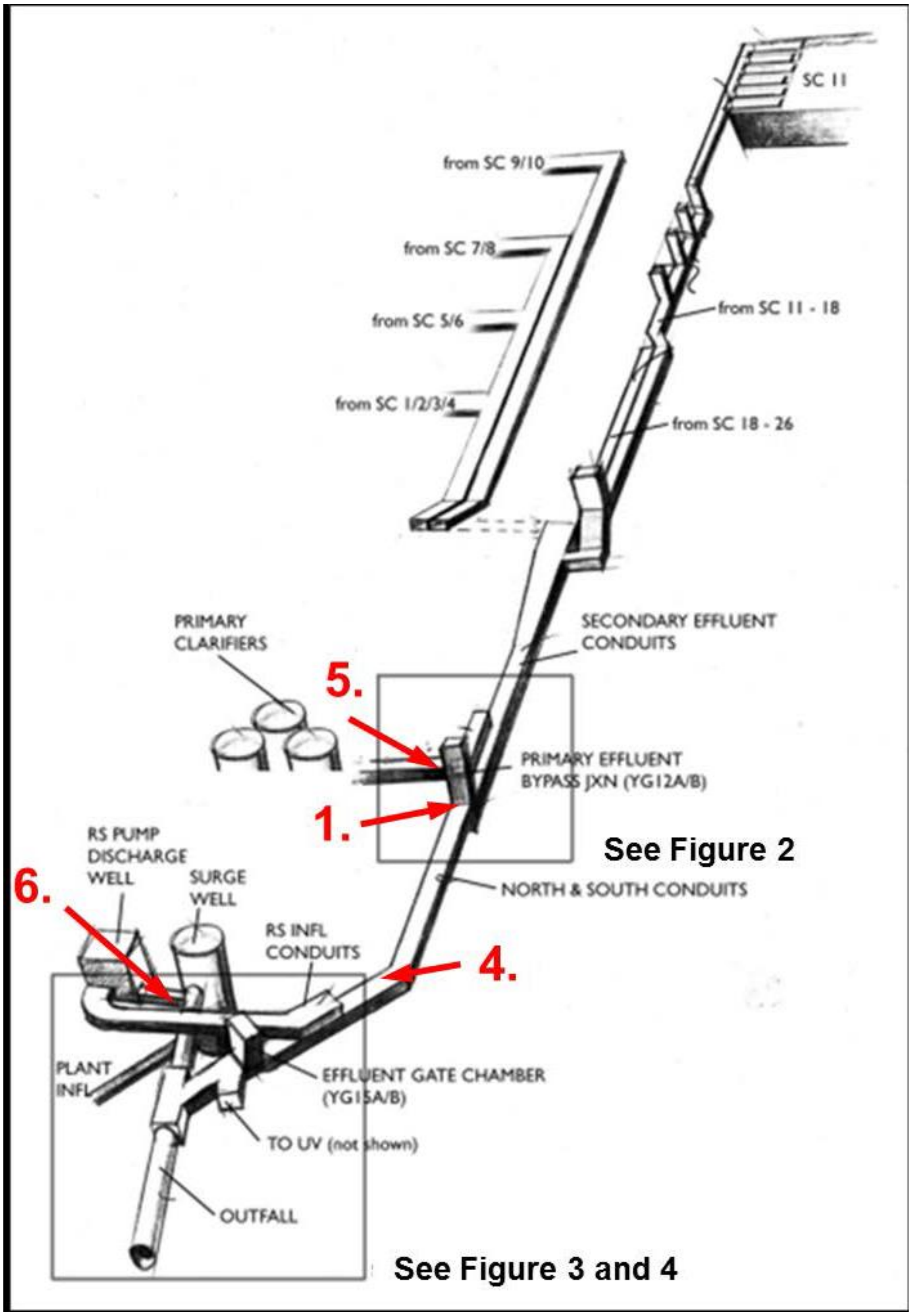


Figure 1 - NEWPCC Effluent Conduit System Overflow

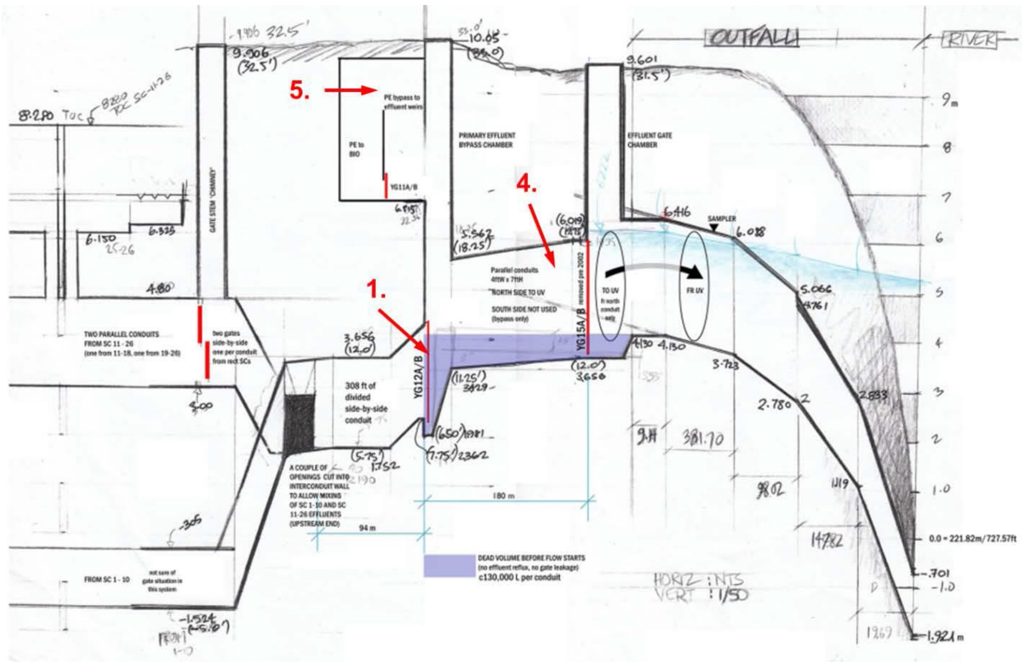


Figure 2 - Profile through the Secondary Effluent and Outfall Conduits

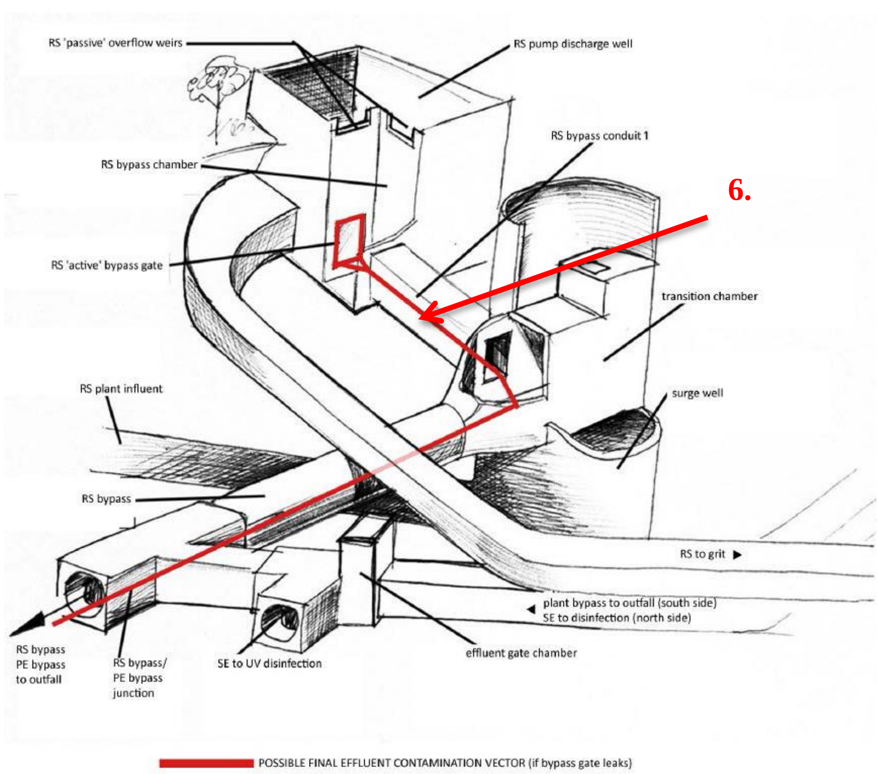


Figure 3 - NEWPCC Influent (Raw Sewage) Bypass

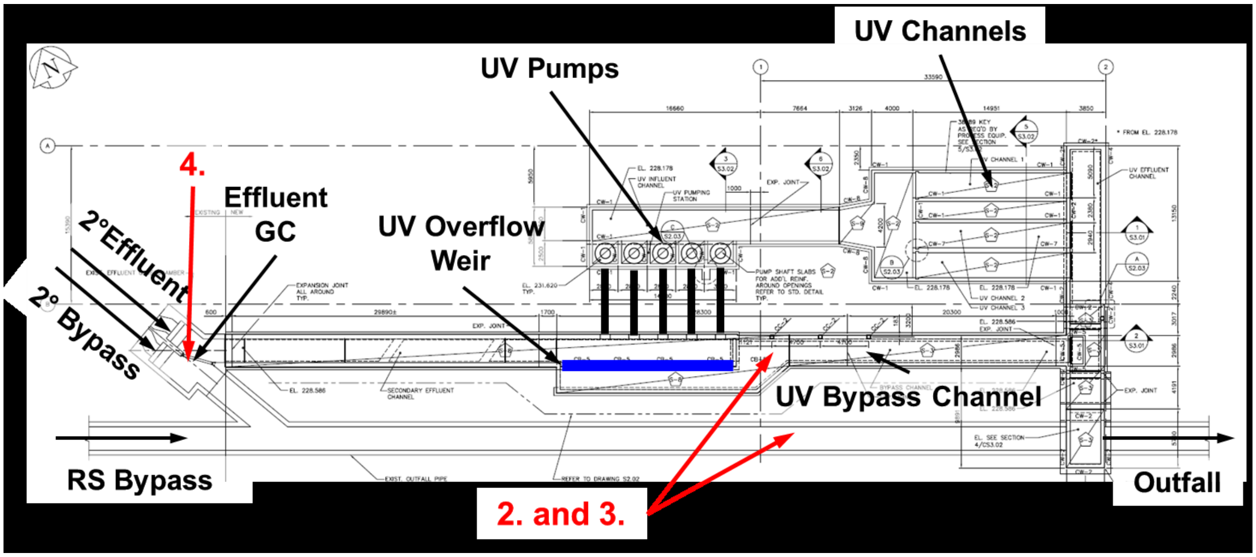


Figure 4 - Effluent Gate Chamber, UV and Outfall Interface

3.2 Analysis of Available Data

Due to the location of the assets below ground, understanding their condition and contribution to the causes of contamination is difficult to achieve by direct observation. To begin the investigation a desktop study of available data was carried out by the Program Team.

The analysis of Fecal and E-coli sampling data indicated that the UV plant was performing correctly and producing an effluent with low levels of Fecal and E-coli. It was concluded that the contamination of the final effluent was not associated with the UV plant performance. Further, the analysis concluded that the contamination was associated with low wastewater flow conditions.

4 Condition Assessment Planning Study

A desktop analysis of available data has limitations when investigating the condition of buried assets. The possible root causes of problems may not be revealed by indirect data analysis, or the contribution of identified root causes may not be fully revealed through the data available.

To address this limitation it was proposed to carry out a direct condition assessment of the assets. This was planned as a two stage investigation, first through the use of advanced remote inspection technology followed by man entry to visually inspect the assets. The assets in question are in continual use and can only be taken out of service for limited periods with a high degree of planning for safety work execution.

An external consultant proposal was received to conduct the direct condition assessment of the assets described above. The cost of the proposal was assessed to be over $300,000. Although the condition assessment would have produced useful data, it would not solve the problem and it was decided that a more practical approach would be of better value to the City of Winnipeg. Consequently, the condition assessment was not taken forward, however details of the proposal are provided in Appendix 2.

5 Assessment of Most Likely Cause of Contamination

An external consultant with knowledge of the NEWPCC effluent conduit configuration and expertise in hydraulic analysis was engaged to validate the possible sources of contamination and assess the most likely sources. The results are documented in Appendix 3 – TM1.

5.1 Most likely sources of contamination

The consultant reviewed the Summary of Historical Work (Appendix 1) and validated the possible sources of contamination. After conducting an analysis of the behavior of the South effluent conduit during normal dry weather flow conditions, the consultant identified the most likely contamination scenario as hydraulically trapped effluent in the by-pass channel (either secondary effluent or backflow from the UV plant) followed washout of this stagnated flow during low flow conditions, Table 1.

Ref	Description	Analysis Summary Likelihood of root cause
1	Continuous leakage from gate YG12B	Possible
2	Stagnated flow in bypass channel	Most likely
3	Backflow and washout	Most likely
4	Continuous leakage between N and S conduits	Possible
5	Primary effluent overflow	Unlikely
7	Raw sewage by-pass	Unlikely
7	Leakage from gates YG11A and B	Ruled out by inspection

Table 1 - Summary of most likely causes of Fecal and E-coli contamination

5.2 Options to address most likely source of contamination

Remedial options were identified to address the most likely sources of contamination are shown on Table 2.

Option	Description
1	Improve water tightness of stop log septum in Effluent Gate Chamber and install new gate YG15
2	Add gate at UV outlet-outfall junction chamber
3	Pumping out the South conduit

Table 2 - Solution options

Option 1 – Improve water tightness of stop log septum in Effluent Gate Chamber and install new gate YG15

This option would address the risk that the wall (constructed of stop logs) separating the North and South effluent conduits within the Effluent Gate Chamber is leaking. The option would also take physical action to block potentially contaminated flow draining from the South conduit at low flow.

The stop log barrier would either be enhanced with a secondary barrier (e.g. membrane and concrete wall) or replaced with a solid barrier. The option would install a new effluent control gate in the location of the abandoned gate YG15B. The installation of the control gate would create operational risk by the addition of an additional barrier to wet weather flows. The control gate would be required to be linked into the plant control system to ensure it was operated at the correct time to coincide with high flows. In addition the option may also require actions to pump out the isolated South conduit.

The option has limitations in that potentially contaminating flows from the raw sewage conduit would not be addressed.

Option 2 – Add gate at UV outlet-outfall junction chamber

This option addresses the limitation of option 1 by fully isolating all sources of contamination upstream of the UV plant discharge. The option would install a control gate in the junction chamber on the UV outlet-outfall. Installation of this gate would require a major excavation and possible alterations to the chamber. Similarly to Option 1, the option would add a physical barrier to wet weather flows, require to be connected to the plant control system and require regular pumping out of the isolated South conduit.

Option 3 – Pumping out the South conduit

This option recognizes that there is a constant minimum level in the South conduit which is continually replenished by backflow of disinfected effluent from the UV plant and normal leakage from sluice gates. The option would allow the regular pumping out of the South conduit to keep the contents “fresh”. Pumping options include the use of the existing flushing water pumps and system, use of the existing flushing water pumps into a modified line to by-pass the flushing water pipework or use of a new drainage pump and pipework drawing from the flushing water suction line.

It was recognized that there could be higher Fecal and E-coli levels present in the South Conduit than is the North Conduit due to the trapped flows and possible regrowth. Staff should be reminded to follow the existing protocol for the safe handling of flushing water if the flushing water pumps are used to dewater the South Conduit. The risk would be reduced once the contaminated water was replaced with disinfected UV effluent. The risk could be further mitigated by additional pipework and pumps to direct flow to the primary tanks without using the flushing water pipe work.

This option would be required to be implemented with Options 1 and 2 if they were chosen.

5.3 Analysis of options

The consultant led a risk workshop with operations staff to examine the operational issues related to each of the recommended options, minutes of the risk workshop are provided in Appendix 4. Hydraulic and water quality analysis was completed to review the effectiveness of the options. The results of the analysis were combined with a planning level assessment of cost and operational complexity and feedback from the risk workshop. The results are shown in Table 3 and Figure 5.

Option 1 was split into two sub options of a) improving water tightness of the stop logs in the Effluent Control Chamber and b) installing a new gate in the location of YG15B. A fourth option which combined 1a and 3 was later added.

Option	Description	Predicted 24hr Geometric Ave of Coliforms / 100ml in Final Effluent	Impact High = 10 Low =0	Ease of Implementation Easy = 10 Difficult =0
	Existing	290		
1a	Improve water tightness of stop log septum in Effluent Gate Chamber	120	6	6
1b	Install new gate at YG15	280	2	3
2	Add gate at UV outlet-outfall junction chamber	Not modelled	10	1
3	Pumping out the South conduit	130	6	10
4	Combined option of sealing stop logs and recycling flows (1a + 3)	100	9	6

Table 3 - Solution options

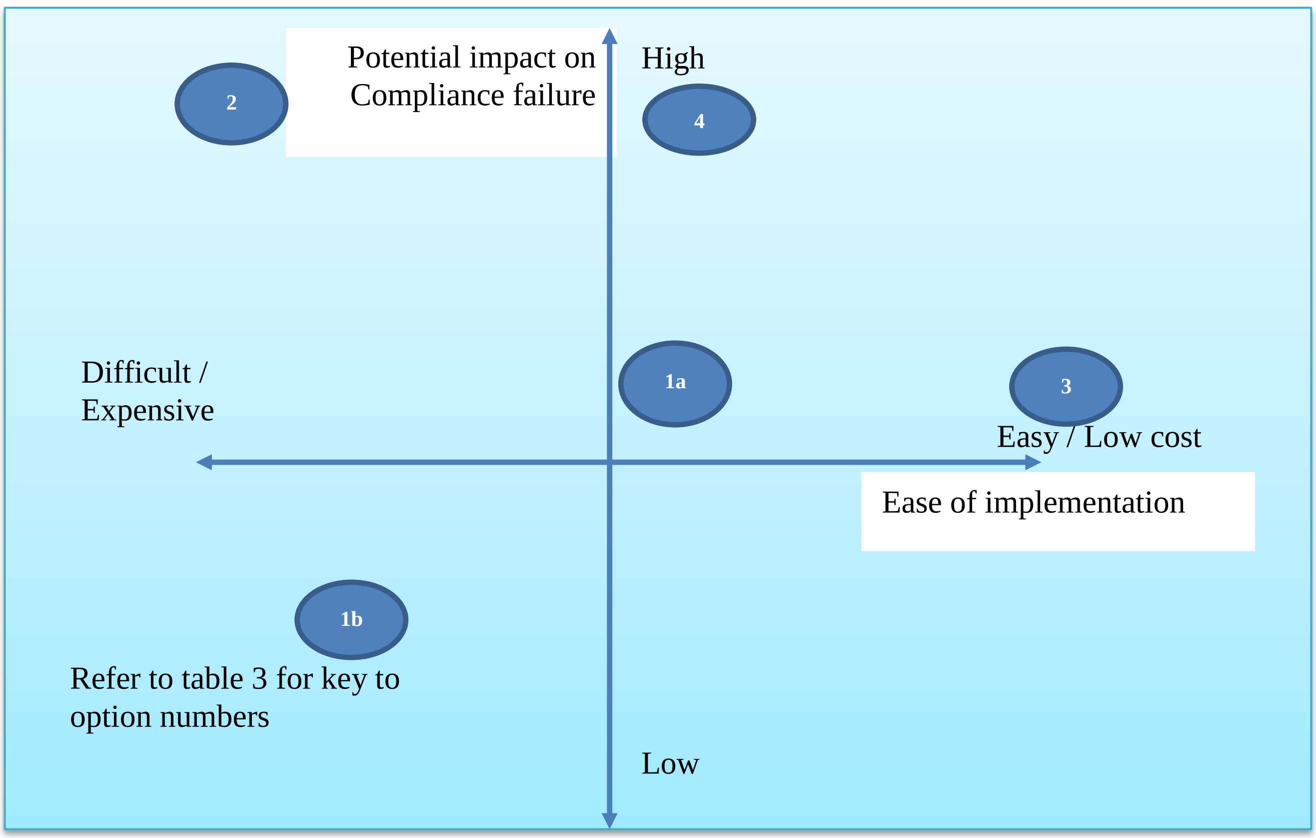


Figure 5 - Option Analysis

New Gate YG15B (Option 1b)
The results of the analysis indicated that Option 1b alone, installation of new gate YG15B, would likely provide only marginal benefit in terms of improved quality of the final effluent in reducing the geometric mean of coliform counts from 290 to 280 per 100mL. This is due to the assumed continuous leakage through the stop logs downstream of the gate position. It should be noted that actual leakage levels through the stop logs are unknown. Installation of the gate would have a medium installation cost (approximately $200,000). This option would have significant operational consequences in terms of managing the control of the gate in conjunction with wet weather flow.

Seal Stop Logs (Option 1a)
The results of the analysis indicated that sealing the stop logs could significantly reduce contamination of the final effluent to a level slightly above the regulated level. Logistically this is technically feasible by a repair such as pouring a watertight wall over the face of the stop logs. This would require one or more temporary shutdowns of the treatment plant to adequately isolate the area of work in the effluent gate chamber from outfall backwater. Sealing the stop logs would have a low to moderate cost, depending on the level of sealing required (estimated at under $100,000).

Pumping Out the South Conduit (Option 3)
The results of the analysis indicate that dewatering (recycling flows) could be very effective at reducing contamination of the final effluent. However, as was the case for sealing stop logs, this approach would not necessarily eliminate the potential for contamination of the final effluent.
Option 3 was assessed as being able to be implemented immediately using the existing wash water pumps.

If it were deemed necessary by operations that a dedicated pump and discharge line was required to reduce the operational inconvenience of using the wash water pumps, it was assessed that this could be done with a minimal cost compared to the other options (estimated at less than $50,000).

It was recognized that this option would not address the root cause if it were due to leaking gates or cross contamination from the North to South conduit, however the action would most likely -treat the consequences at minimal cost.

Combination of Sealing Stop Logs and Recycling Flows (Option 4)
The combination of pumping out the South conduit and sealing stop logs was examined in the hydraulic model. The modelling suggested that this effectively prevented contamination of the final effluent. These findings are based on the assumption that the stop log barrier are leaking and contribute significantly to the issue, that they can be completely sealed and that there are no other significant sources of contamination downstream of the effluent gate chamber.

New Gate at UV Outfall (Option 2)
This was the most expensive (estimated at over $700,000) however it would have a certain impact on addressing the contamination and would have the same operational disadvantages as Option 1b relating to control.

6 Recommendations

Analysis of the mitigation options using the external consultants' hydraulic model suggests that:

- The installation of a new gate YG15B would likely not significantly improve the quality of the final effluent;
- Sealing of the stop logs in the Effluent Gate Chamber or dewatering of the south conduit would both be potentially effective at improving quality but by themselves would likely not eliminate potential contamination of the final effluent;
- The combination of dewatering of the south conduit and sealing of the stop logs in the Effluent Gate Chamber has the potential to reduce contamination of the final effluent to a negligible amount.

Detailed analysis is provided in the external consultants final report, Appendix 5.

6.1 Recommendation 1

Dewatering of the South conduit using the flushing water offtake is recommended as the first approach to be implemented. This approach has the lowest cost, introduces little operational complexity or risk and is anticipated to provide significant improvement in effluent quality. If the existing flushing water piping and pumps can be used for dewatering, this option requires no capital costs to implement and relatively insignificant operational costs. If piping modifications and/or separate pumps are required as part of a more permanent solution, these would incur relatively low capital and operational costs.

It is recommended that the effectiveness of dewatering be evaluated by routinely monitoring the quality of the water drawn from the South conduit as well as continuing to measure quality in both the UV and final effluents. This would determine whether additional measures are required or whether the dewatering process needs to be modified to improve its effectiveness (continuous vs intermittent dewatering, rate and/or frequency of dewatering, etc…).

6.2 Recommendation 2

Sealing of the stop logs in the Effluent Gate Chamber appears to be an equally effective means of improving the quality of the final effluent. However, this would involve more significant capital costs than dewatering of the South conduit and would require one or more temporary shutdowns of the treatment plant to adequately isolate the work area in the Effluent Gate Chamber from the outfall backwater.

This option should be investigated after the results of monitoring of the effectiveness of the de-watering have been evaluated. If further reduction in contamination of the final effluent is required beyond that which dewatering can provide, then sealing of the stop logs should be investigated as a supplementary measure. In the event that it is considered necessary to proceed with this recommendation resources will be requested through Task Group 6.

As planning for Recommendation 2, in conjunction with monitoring the effectiveness of the effluent quality under Recommendation 1, consideration should be given to develop a protocol to reasonably estimate of the rate of leakage into the South conduit.

7 Action Plan

The following action plan is proposed.

Action	Description	Action By and timescale
1	Periodically pump out the South conduit.	
1-1	**Temporary Immediate Action**	
	Initially operate the existing flushing water pumps to draw contaminated effluent from the South conduit and discharge it through the flushing water distribution system to a point upstream of secondary treatment. This action will allow the water to be replaced with freshly disinfected final effluent from the UV plant. <u>Safety issues</u> The flushing water system uses secondary effluent which contains Fecal and E-coli. Operations indicated at the risk workshop that water in the South effluent conduit had at some point been sampled and showed very high bacterial levels (counts as high as 10^5 or 10^6 were reported). When initially run these high levels will be passed into the flushing water system. As contaminated flow is removed, the contents of the South conduit will be progressively replaced with disinfected effluent from the UV plant. The flushing water pumps should be run for an extended period to allow any contamination of the flushing water system to be cleared. Staff should be reminded of the existing protocol for the safe handling of flushing water.	**Operations Immediate**
1-2	**Permanent Pumping Arrangement**	
	If deemed necessary by operations, depending on the results of dewatering using flushing water pumps, an additional pump to draw from the South conduit could be installed together with a separate discharge line from this pump to the primary tanks. Some design work will be required to correctly size the pump and pipework. Implementation can be carried out by Operations staff.	**Operations / Engineering 2015** **Estimated cost $50,000**

2 **Monitoring**

Monitoring of final effluent for Fecal and E-coli is carried out on a daily basis for compliance reporting. At the end of the low flow season results will be analyzed to assess the success of recommendation 1-1.	**Operations Immediate and ongoing**

If further failures are observed, they should be reviewed to determine if there was an identifiable event associated with them or if they are likely to be a continuation of current issues.

3 **Capital Program Recommendations (Asset Refurbishment and Replacement Program)**

The actions to implement a recirculation of the South effluent conduit will mitigate the most likely source of contamination. A residual risk remains that the source of contamination will not be addressed by this mitigation plan.	**Engineering Q1 2015**

It is recommended to include Option 1a and 1b (enhancement or replacement of the stop logs in the Effluent Gate Chamber and installation of a control gate in place of abandoned gate YG15B) within the Asset Refurbishment and Replacement capital program with an estimated project start date in 2016 and a cost of $0.3m to address the residual risk.

4 **Compliance Management Plan**

The NEWPCC Compliance Management Plan is to be updated with these actions.	**Operations Q4 2014**

8 Appendices

8.1 Appendix 1 – Summary of historical work

8.2 Appendix 2 - Condition assessment proposal

8.3 Appendix 3 – AECOM TM – October 21

8.4 Appendix 4 – Risk workshop minutes and presentation

8.5 Appendix 5 – AECOM TM – November 14

Appendix 1
Summary of Historical Work

- Appendix 1-1 - Comparison lab result between UV effluent and Final effluent
- Appendix 1-2 – Patch condition assessment report (November 15, 2006)
- Appendix 1-3 – Memo on dye test at gate YG12B (July 23, 2008)

NEWPCC
Fecal & E-coli Non-Compliance Plan

Summary of Historical Work

Rev	Prepared by	Reviewed by	Date	Approved by	Date
6/6/14	N Abercrombie	R Song	6/6/14		

Contents

Issue

Since the UV disinfection facility was commissioned in mid 2006, the NEWPCC has experienced difficulties in meeting its license requirement for both Fecal and E-Coli (MPN index < 200/100ml on monthly Geometric mean).

This report summarizes previous investigation work carried out into the issue and identifies possible further steps.

Previous investigations and discussion

Three separate investigations have been carried out since 2006 to investigate the causes of the Fecal and E-coli excursions. These were

1. Apr 2012 to - Nov 2013 - Comparative Sampling of Final Effluent and UV
2. July 23, 2008 - Dye Test at Gate YG12B
3. November 15, 2006 - Patch condition assessment

Comparative Sampling of Final Effluent and UV (Apr 2012 to Nov 2013)

In 2012 and 2013 sampling was carried out to compare results of regulatory samples of final effluent against effluent from the UV facility, Appendix 1. Results indicate the UV facility performs well with the UV effluent having a much lower MPN index than the final effluent, and that high E-coli levels at the final effluent sampler correspond with low flows.

The conclusion from this analysis is that high E-coli levels in the final effluent are coming from the UV by-pass culvert which is causing contamination of UV effluent. The source of the contamination cannot be deduced from the data.

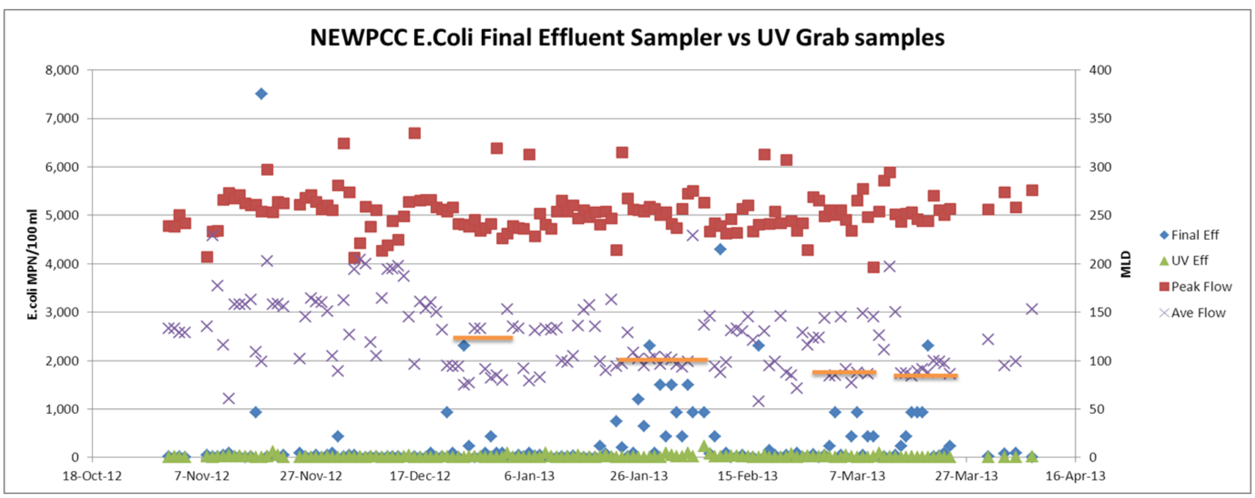


Figure 1 - Correlation of flow and effluent quality

Dye Test at Gate YG12B (July 23, 2008)

In 2008, right after the commissioning of UV facility, two investigations were carried out to investigate the condition of gate YG12B, Appendix 3. The intent of the test was to investigate whether Gate YG12B leaks or not. The conclusion made by Terry Holding was that the Gate YG12B does not leak, however from the recorded information it is hard to understand the methodologies behind the dye test. More information or study is needed to understand whether the conclusion made by Terry Holding is valid or not.

Patch condition assessment (November 15, 2006)

Patch on the wall of the conduit some 3 meters West of the old sampling building
From the condition assessment report of 2006, the patch should be located at south east of the Effluent Gate Chamber, i.e, in the old out fall channel.

Though the planned work was originally to assess the condition of the previously installed patch, it was not successfully carried out because of an unsafe shutdown practice. At the end, the investigation was abandoned. However, what was recorded for the event (Appendix 2) did confirm that a backwater effect from the UV effluent into the outfall pipe.

The abandoned investigation left the condition of the patch as unknown. It is not known why the water level slowly dropped down and caused the ultrasonic level sensor went out of calibrated range, and eventually led to the restart of UV pumps and observed backwater effect?

The following diagram shows flow conditions through the secondary effluent conduits and location of flow control structures.

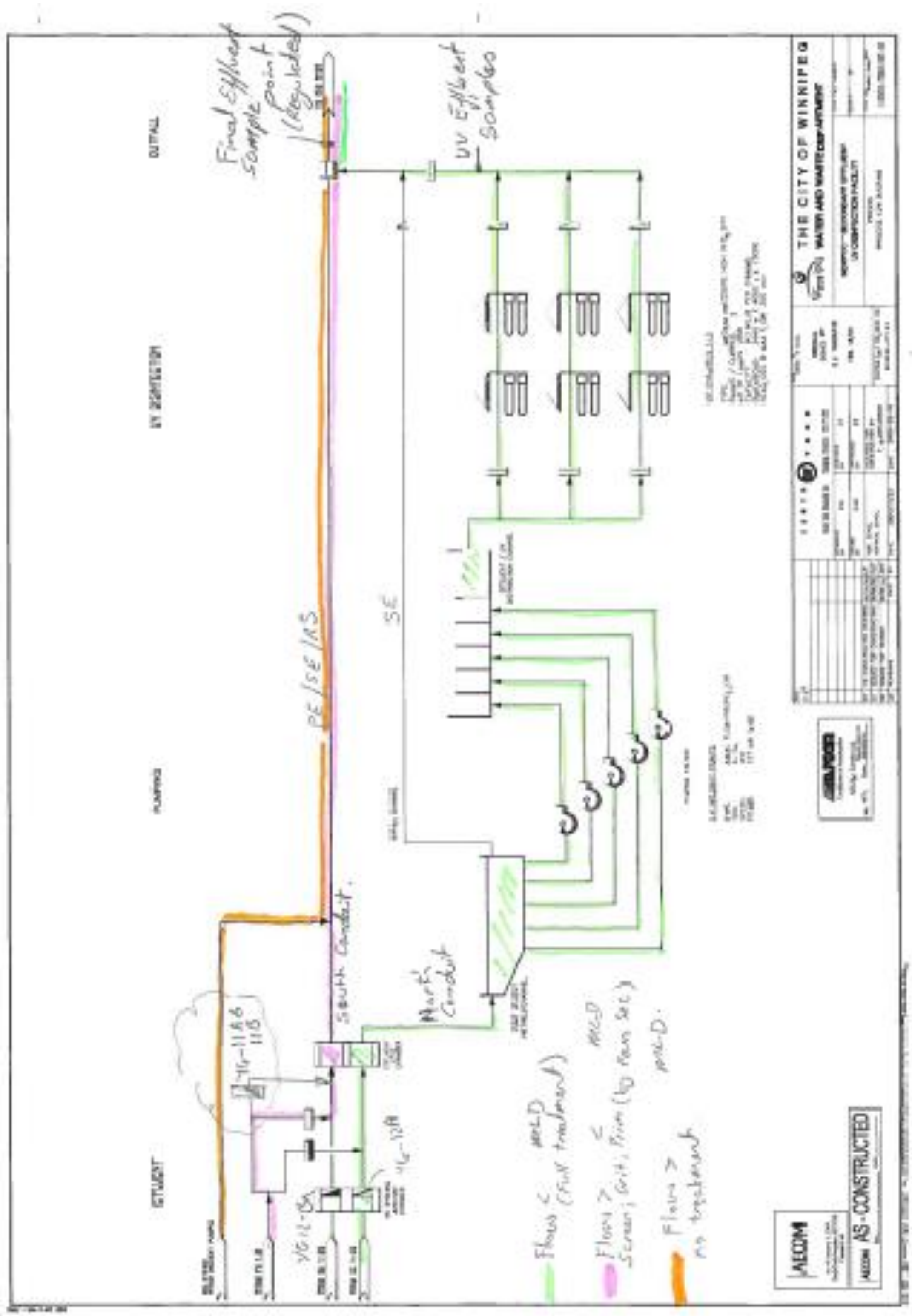


Figure 2 - Flow diagram

Potential causes of high MPN index at Final effluent into following

Demonstration of the performance of the UV facility between April 2012 and November 2013 indicate that high E-coli levels in the final effluent are coming from the UV by-pass culvert which is causing contamination of UV effluent.

The potential sources of the contamination could be

1) Continuous leakage from gate YG12B (Normally closed), which isolates the south secondary effluent conduit at the junction chamber located near west end of grit building
2) Continuous leakage from gate YG11A and YG11B (both normally closed), which can provide secondary treatment bypass if required
3) Continuous leakage between the North and South secondary effluent conduits
4) Occasional unintended primary effluent overflow at the junction chamber when a raw sewage pumps starts
5) Occasional unintended raw sewage bypass at raw sewage discharge well
6) Stagnated (trapped) flow in the UV by-pass channel from previous permitted by-pass operations washing out and contaminating treated UV effluent
7) Flow from UV effluent discharge flowing backwards along the UV by-pass channel, stagnating and resulting in a regrowth of Fecal and E-coli which washes out and contaminates the treated UV effluent at low flows

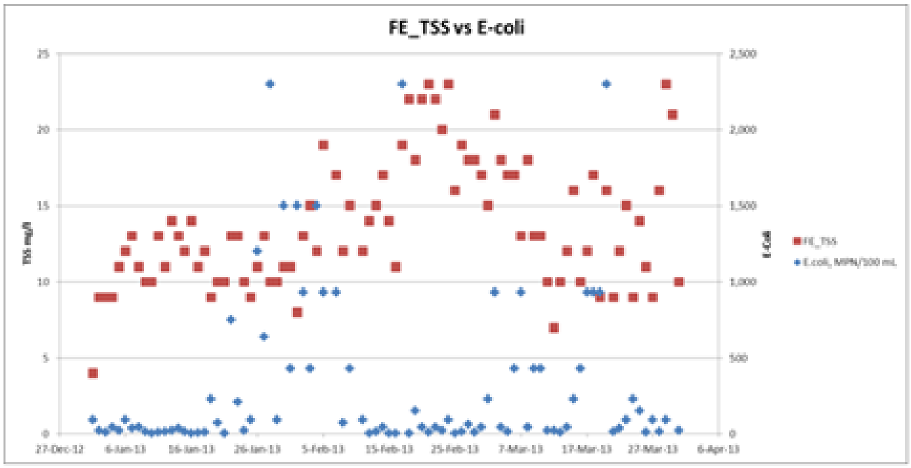
Correlation with River Level and TSS

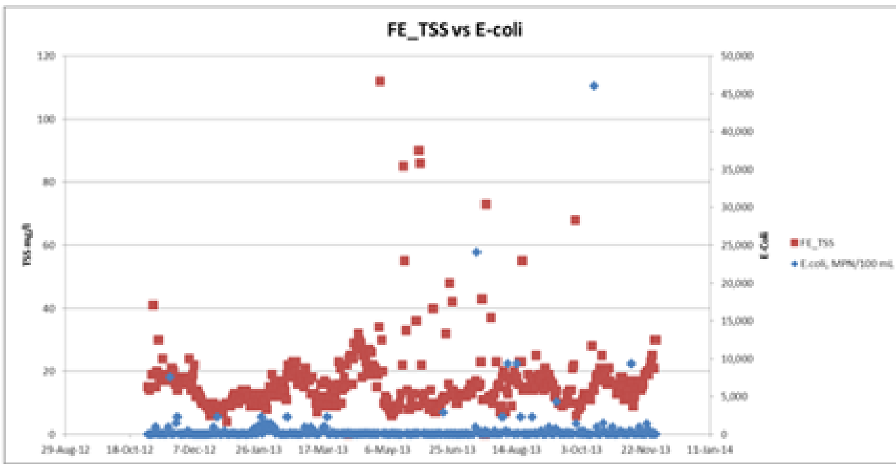
River Level data from Kildonan bridge and the Final Effluent TSS were compared against the final effluent Grab sample E-Coli results to look for possible correlation. Daily minimum and daily maximum and average levels were examined with respect to river levels.

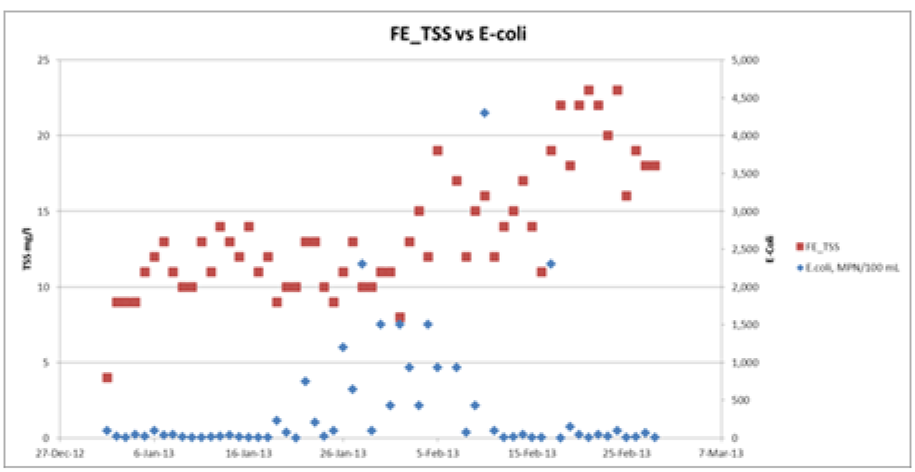
Correlation values of final effluent E-Coli against river level and TSS were all found to be below 0.1 with the exception of daily minimum river level between the dates of 4/25/12 and 6/8/12 which was around 0.2. A coefficient below 0.2 is very low.

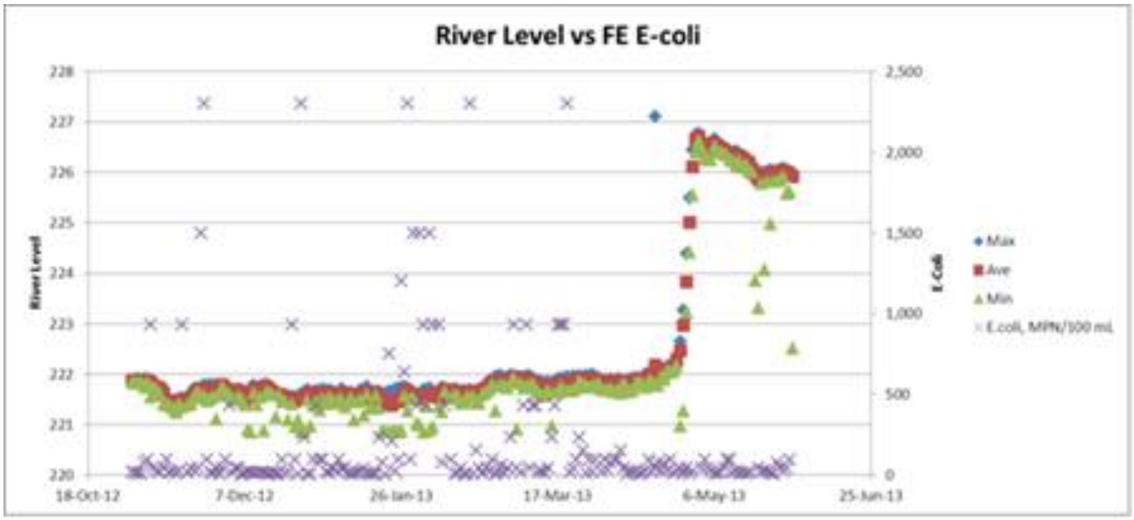
The biggest cluster of E-coli failures were between Jan to Mar in 2012, at this time the max River level was below 222m. A reliable figure for the invert level of the effluent conduit at the final effluent sampler was not available. The invert level of the South conduit where the UV discharges into it is marked as 225.478m on drwg 1-0101U-P0002--001-02".

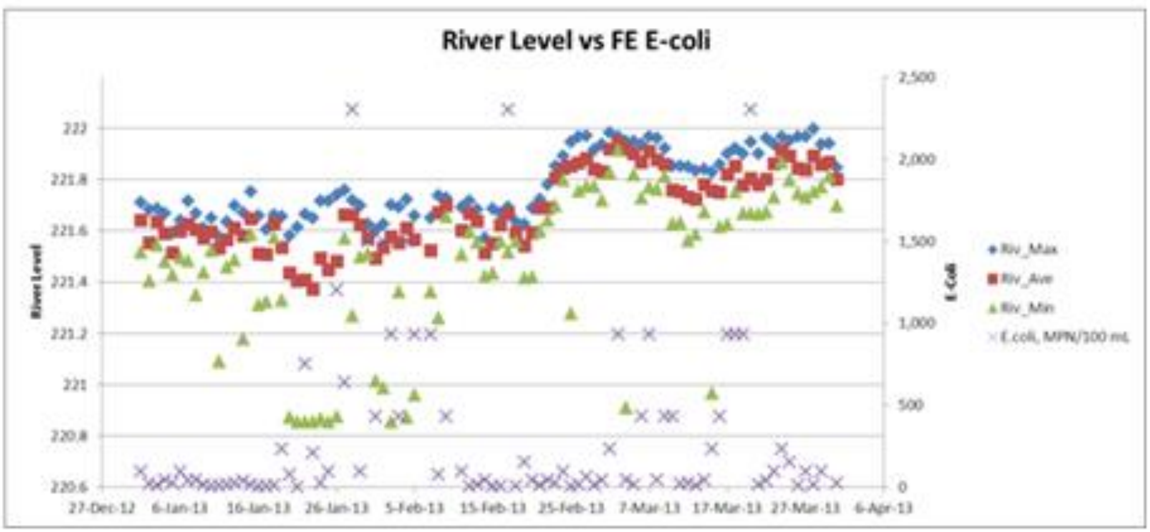
From this analysis it is unlikely that the E-coli failures which occur at low flow are associated with river level or TSS.


FE_TSS vs E-coli
TSS mg/l
E-Coli
FE_TSS
E.coli, MPN/100 mL


FE_TSS vs E-coli
TSS mg/l
E-Coli
FE_TSS
E.coli, MPN/100 mL


FE_TSS vs E-coli
TSS mg/l
E-Coli
FE_TSS
E.coli, MPN/100 mL


River Level vs FE E-coli
River Level
E-Coli
Max
Ave
Min
E.coli, MPN/100 mL
18-Oct-12
7-Dec-12
26-Jan-13
17-Mar-13
6-May-13
25-Jun-13


River Level vs FE E-coli
River Level
E-Coli
Riv_Max
Riv_Ave
Riv_Min
E.coli, MPN/100 mL

Next steps for investigation

The following possible next steps can be considered to identify the root cause, in order of complexity:

Condition Assessments

1. Gate condition assessment planning
   To facilitate planning of an entry to inspect control gates as much information as possible should be gathered from the above ground prior to entry to the conduits.

   Once snow cover has receded, all covers from above the junction chamber should be removed and a top down inspection performed to verify as much information as possible.

The following actions will require partial or full plant shut downs and entry into confined spaces, entries require to be planned safely and timed to coincide with low flows.

2. Gate YG12B condition assessment
   Records of the methodology of the dye test carried out in 2008 do not allow certainty that gate YG12B does not leak. A safe condition assessment methodology could be developed.

   [Is it possible to perform a plant shutdown and set up a temporary sandbag dame/inflatable dame east of Gate YG12B? So, a sump pump can be used to dewater the section between the damn and Gate YG12B. A detailed inspection can be carried out on the Gate YG12B]

3. Secondary effluent south conduit condition assessment (UV By-pass)
   A plant shutdown and safe condition assessment would be required to inspect the condition of the secondary effluent conduits. The inspection would look for evidence of leakage between north conduit and south conduit.

   [possible synergies for condition data gathering related to the upgrade project]

4. Gate YG11A, YG11B and stop log weir condition assessment
   Gate YG11A and YG11B can be used to bypass the secondary treatment if needed. Possible leakage of these two gates would lead contamination of secondary effluent south conduit east of Gate. A safe condition assessment methodology could be developed.

   An inspection of the primary effluent overflow weir could be carried out at the same time.

Effluent conduit profile

5. Secondary effluent conduit profile
   Review as constructed drawings to confirm the levels and gradient of the Secondary effluent conduit.

Level monitoring

The following actions will require installation of additional level measuring equipment, monitoring of levels over a variety of flows and correlation of the results with flow and final effluent sampling results

6. Primary effluent overflow monitoring
   Installing a new level sensor at primary effluent overflow will provide data on the time of overflow events. Correlating this measurement against flow can indicate if unintended primary effluent overflow is occurring.

7. Raw sewage discharge level monitoring
   Installing a new level sensor at the raw sewage discharge well will provide data on the time of overflow events to the UV by-pass channel. Correlating this measurement against flow can indicate if unintended raw sewage overflow is occurring.

Possible solutions

Prior to the results of any further investigations, the following solution options may be considered.

South secondary effluent conduit disinfection procedure

A procedure for periodic disinfection of the South secondary effluent conduit could be established. Options for disinfection could range from operationally implemented measures such as chlorination with [tablets – what are they called] to permanently engineered chlorination equipment. In either case issues with chlorinated effluent entering the river would need to be assessed may involve consultation with the regulator.

Disinfection could be considered as either a temporary mitigation measure or a long term solution.

South secondary effluent conduit backflow control

Install an actuated gate, or other backflow control structure, at the end of South secondary effluent conduit where it joins UV effluent channel. The purpose would be to isolate the South conduit and eliminate contamination of disinfected effluent from this channel.

Appendix 1 - Comparison lab result between UV effluent and Final effluent

Test Methodology

A test program carried out to determine why final effluent Fecal and E-coli results often exceeded the regulated limit at the NEWPCC.

Between April 2012 and November 2013 additional grab samples of UV effluent were taken at the discharge end of the UV Building at the same time as the normal final effluent grab samples (those reported to the Regulator) taken at the regulatory sample point. The sampling was carried out over three separate periods:

Apr 25 2012 to Jun 8 2012
Nov 1 2012 to May 9 2013
Aug 26 2013 to Nov 30 2013

The results were analyzed for Fecal and E-coli at the NEWPCC laboratory.

Although both Fecal Coliform and E-coli results are reported to the Regulator, comparative samples were only analyzed for E-coli. It was assumed that if E-coli exceeded the 200 MPN/100 mL regulated limit then so will Fecal Coliform results.

Analysis

On days with peak flows greater than 380 MLD, flow will by-pass secondary treatment and tertiary treatment. At higher flows, pre-treatment and primary treatment are also by-passed. On days with flows above 380 MLD, although final effluent Fecal and E-coli samples are taken and reported to the Regulator, they are not included in the calculation of the monthly geometric mean.

The days where peak flows exceeded 380 MLD are highlighted, also highlight those days in which E-coli results exceed 200 MPN/100 mL and those days in which the filtered UVt appeared to be unusually low.

As peak flows over 380 MLD bypass UV disinfection they are excluded from the analysis. Specific outliers were excluded from the data. Figures ## to ## show the results of the sampling program.

Figure ## shows four periods between Dec 17 2012 and March 27 2013 where final effluent E-coli was high while the E-coli levels coming from the UV plant were consistently low. This data corresponds to periods of low average flow to treatment. The conclusion from this set of data is that the high E-coli level in the final effluent is coming from contamination of treated UV effluent from the UV by-pass culvert. The source of the contamination can not be deduced from the data.

Figures 3 to 5 show that the UV facility is producing a good quality tertiary treated effluent and it is unlikely that the Fecal and E-coli violations are related to the UV facility performance.

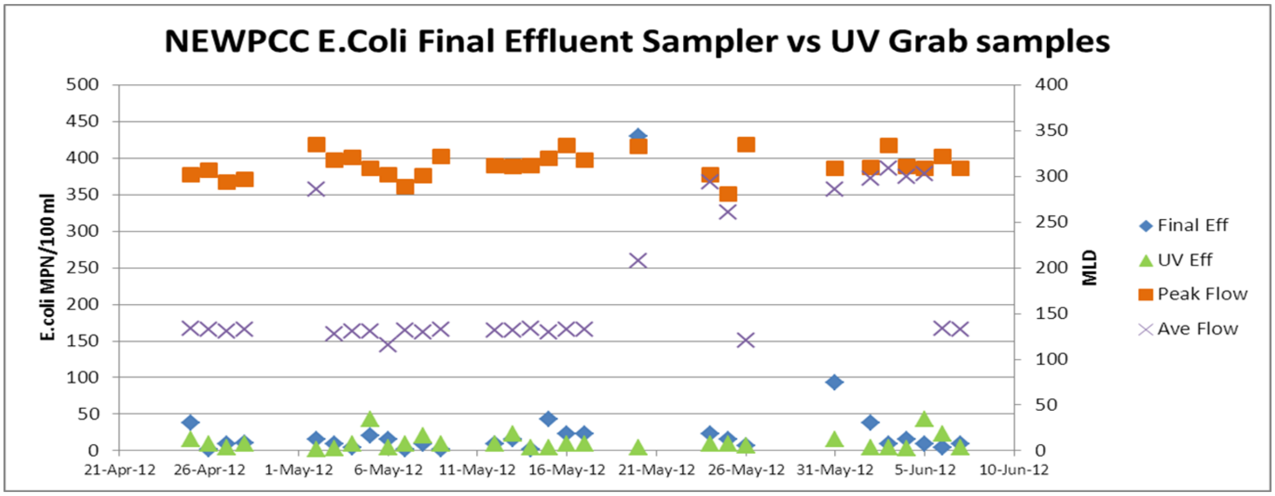


Figure 3

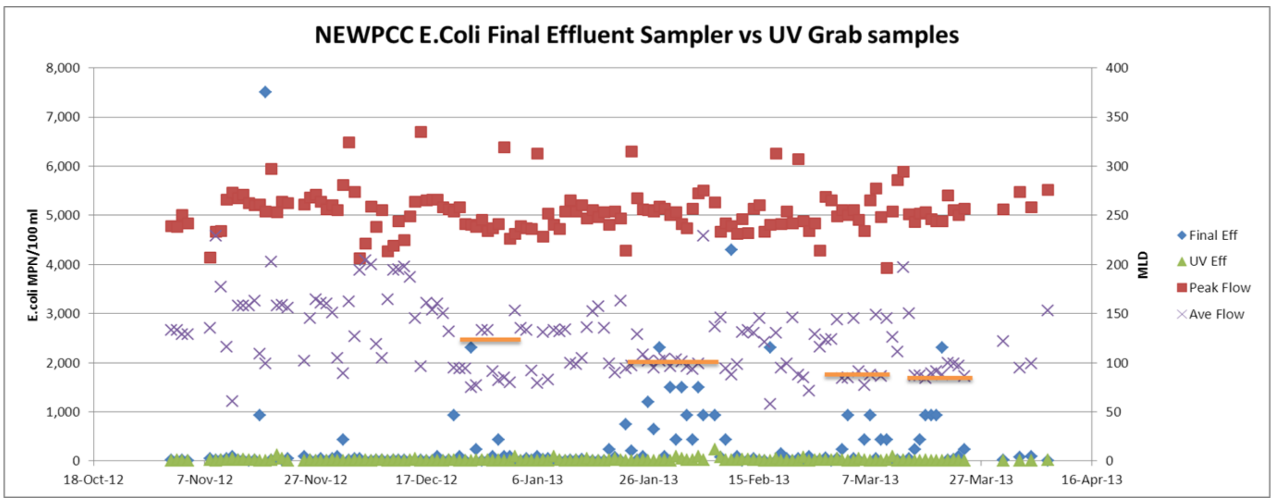
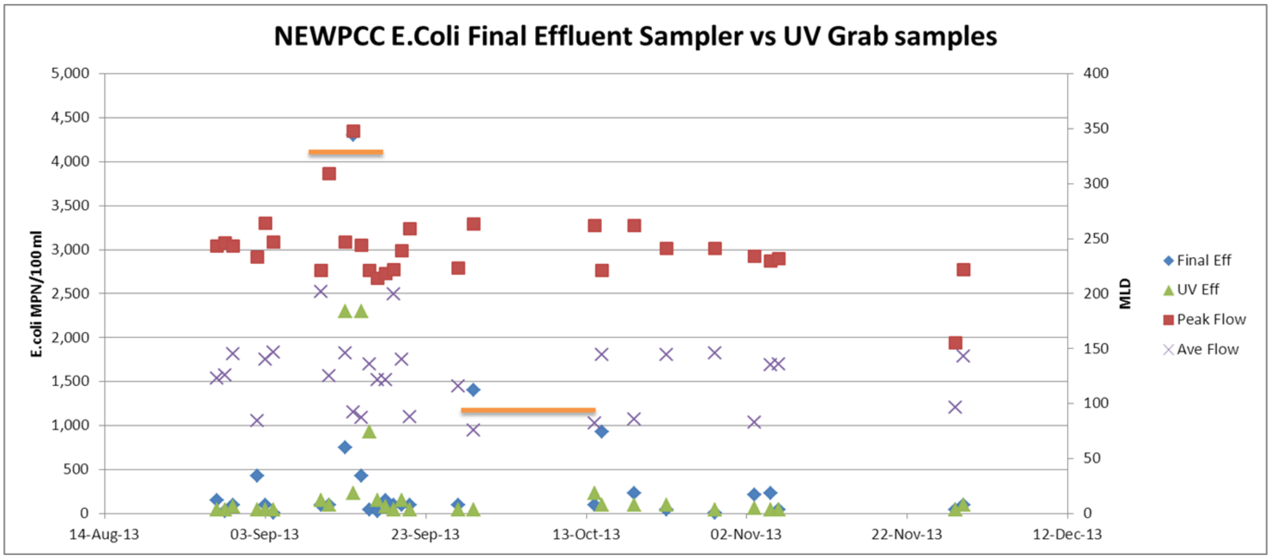


Figure 4



NEWPCC E.Coli Final Effluent Sampler vs UV Grab samples
E.coli MPN/100 ml
MLD
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
400
350
300
250
200
150
100
50
0
14-Aug-13
03-Sep-13
23-Sep-13
13-Oct-13
02-Nov-13
22-Nov-13
12-Dec-13
Final Eff
UV Eff
Peak Flow
Ave Flow

Figure 5

Appendix 2 – Patch condition assessment report (November 15, 2006)

Appendix 3 – Memo on dye test at gate YG12B (July 23, 2008)

15 November 2006

NEWPCC Disinfection – Effluent conduit shutdown

Purpose: Shut down of effluent pipe to review the previously installed patch to ascertain condition and future patching requirements.

Notes from the observations of Terry Holding – 986-4643

Civil Maintenance (Paul Boucher and crew) on site to inspect previously installed patch on the wall of the conduit some 3 metres Wets of the old sampling building for 5.00 am preparing for entry to the conduit.

During the entry preparation Bob Romance asked me to check the UV lamp status with him as the lights were on full but no flow was recorded. As we walked to the UV building I asked Bob if the pumps were off and he said that they were off. We entered the UV building and checked the UV lights. The two channels that were in service had one UV unit in each channel operating and with no flow visible (channel 2 out of service with broken drive unit on the gate mechanism). We tried to shut down the UV units via the HMI without success and agreed to shut the units down via the hand-off-comp switches. All units were switched off in this fashion. We left the building and a civil maintenance crew member called me to the valve chamber.

Paul Boucher and his crew had entered the North Channel and asked me if they were in the right channel. They had entered the newly constructed north section of the conduit which was incorrect. Looking into the start of the North Channel it was evident that the new channel was empty as the concrete surface was visible through the small amount of liquid on the floor.

All staff came to the surface and then prepared to enter the south conduit to check the patch location. After approx. 15 minutes the staff were in the south conduit and Paul Boucher stated from the invert of the channel that he could hear water running. I suggested that this would likely be the residual water trickling over the weir gates at the UV discharge. Within 30 seconds of the last man entering the south conduit, staff ran to the ladder as backwater flow from the UV pumps had caused the level in the south conduit to rise approx 18 inches in a few seconds with water flowing back up the conduit to the west. Within approx 20 seconds all staff were on the ladder and climbing out and it was noted that the water level mark on Paul Boucher's waders was 100 mm above his knee. Backwater flow was coming from the UV pumps.

When all staff were safely above grade the north conduit access hatch was then opened and it was noted that the water level was just below the chamber offset, with the water depth estimated by me to be at least 2.0 metres higher that the last time the hatch was open. Backwater flow in the South conduit was noted to be slowing considerably from the initial surge with the level of liquid appearing to decline.

I went to the main control room to find out if the UV pumps were in fact running and the operator confirmed that 4 of 5 of the pumps were running at 99%. I asked the operator to call Bob Romance so that he could witness the flow in the North Channel. Bob Romance accompanied me to the valve chamber and witnessed the level of the liquid in the north channel which had now commenced to recede and was estimated by me to 50% lower that the last observation approximately 5 minutes earlier.

Following the observation of the liquid levels the man hoist was dismantled and staff removed their waders as this part of the operation was deemed by all to be at an end and the valve chamber access hatches were closed and locked. I discussed the next step with Paul Boucher and it was agreed that Paul would review the photographs previously sent to Steve Kussy and contact me with his opinion regarding permanent sealing of the patch.

On returning to the control room it was determined that four UV pumps were still running at 99%. I proceeded to the UV building to check the flow meter in the UV room which indicated 0.61 ML/d for a total flow of 1.83 ML/d. I then raised the hatch on two of the submersible pumps and noted that the pumps were in fact only pumping bubbles (spinning without producing flow). I returned to the main control room and informed Bob of the situation. Bob Romance, Charles Wright and I then proceeded to the UV building to turn off all the VFD's to disable the UV pumps until the main pumps were returned to service.

Following VFD shut down Bob, Charles and I convened in the main control and discussed possibilities for where the slug of liquid had originated from down the north conduit that had started the UV pumps. Bob Romance and Charles Wright checked for flow at gate YG12B and reported that no flow was visible. The above information was relayed and discussed with senior operators and I offered to provide the preceding notes.

Compiled by Terry Holding
16 November 2006

RE: Day # 2 Dye Test Results (Leak Testing of South Effluent Conduit Gate).

Song, Richard
Sent: Saturday, January 25, 2014 8:50 PM
To: Zaleski, Allan

Hi, Al

I am confused by Terry's conculsion.

1. What was the intention of closing YG12A? At the time, did we open/close YG12B? Since YG12A could not been closed, what the N-1 & N-2 results meant??
2. What was the YG12B gate position between S-0 and S9? What was the purpose have 15% and 25% YG12B gate position there?
3. Would you be able to provide more detailed setup infor for this test?

Regards,
Richard

From: Holding, Terry
Sent: Friday, July 25, 2008 9:13 AM
To: Lagasse, Paul; Smyrski, Ken; Amos, John; Barnard, John; Maxwell, Dave
Cc: Gibson, Dwight; Zaleski, Allan
Subject: FW: Day # 2 Dye Test Results (Leak Testing of South Effluent Conduit Gate).

All

Please find below the recorded details of the dye testing that took place on Wednesday 23 July 2008 at Junction Chamber gate YG12B.

Results S-0 to S-11 are for the South conduit during the injection of the dye and are timed at one minute intervals. The N-1& 2 are random samples from the North conduit downstream of gate YG12A following closure of the gate to check on levels of dye being in that conduit.

The results S+0 to S+1500hrs indicate no evidence of dye on the downstream side of the gate (YG12B) and therefore the assumption is that gate YG12B under the current operating condition does not leak.

During the dye testing YG12A (north conduit) was closed to direct flow and dye to the south conduit. It was noted that gate YG12A would not fully close and sufficient flow was passing the YG12A gate in the closed position to maintain pumps operating in the UV building. This information is provided for maintenance information only as this gate would not close completely.

I would also like to take this opportunity to thank all Operations staff who made this testing process simple by their valued assistance.

Thanks

Terry Holding

T.D.Holding C.E.T
Project Coordinator

City of Winnipeg
Water and Waste Department
110-1199 Pacific Avenue
Winnipeg, Mb.
R3E 3S8
Telephone 204-986-4447
Cell: 204-795-8549
tholding@winnipeg.ca

From: Zaleski, Allan
Sent: Thursday, July 24, 2008 1:38 PM
To: Holding, Terry
Subject: Day # 2 Dye Test Results (Leak Testing of South Effluent Conduit Gate).

The following is a summary of dye test results carried out at the NEWPCC on Wednesday, July 23, 2008. 350 mL of 20 % Rhodamine Dye was diluted to 12 litres to produce a theoretical dye concentration of 62 ppb based on a flow of 222 MLD at the time of testing. Dye was added at the former Secondary Effluent sampling site located next to Final Clarifier # 26. Dye was added at a constant rate over a period of six minutes. Samples collected at the Gate Chambers were analyzed at the laboratory located at the NEWPCC using a Field Fluorometer. Results are reported in ppb for the samples identified as S for South Conduit and N for North Conduit.

Sample Identification	Test Result	Comments
S- 0	0.487	Background
S- 1	0.560	
S- 2	0.601	
S- 3	0.537	
S- 4	0.618	
S- 5	22.13	
S- 6	30.07	
S- 7	21.58	
S- 8	16.23	
S- 9	10.88	
S- 10	24.86	Gate 15 % Open
S- 11	9.90	Gate 25 % Open
N-1	25.06	
N- 2	18.82	
S + 0	3.19	Background
S + 12:00 hrs	3.24	

S + 13:00 hrs	**3.06**
S + 14:00 hrs	**2.47**
S + 15:00 hrs	**2.53**

Appendix 2
Condition Assessment Proposal

- 140611 – Fecal and E-coli issues - condition assessment scope
- ~~Proposal for Engineering Services for the NEWPCC Fecal & Ecoli Non-Compliance Investigation (AECOM)~~
- ~~Schedule~~

Winnipeg Sewage Treatment Program

NEWPCC
Fecal & E-coli Non-Compliance
Condition Assessment Scope

Rev	Prepared by	Reviewed by	Date	Approved by	Date
05/04/14	N Abercrombie	R Song			
06/11/14	N Abercrombie				

Contents

1 Purpose

The purpose of this document is to plan for a condition assessment of the NEWPCC junction chamber and North and South effluent conduits.

2 Objectives

Understand the condition of underground assets and how their condition relates to the Fecal and E-Coli violations at the NEWPCC.

Make recommendations for next steps to address Fecal and E-Coli compliance issues based on information gathered.

3 Deliverables

- Resource Plan (Operations)
- An operational shut down plan (Operations)
- SWPs (Operations)
- Condition assessment plan (Consultant)
- Condition assessment template (Consultant)
- Post shut down report (Consultant)

4 Condition Assessment Scope

4.1 Phasing of work

The condition assessment will be carried out in three phases:

1. **Survey from top** - An assessment from above ground through all available covers and manholes for the purpose of gathering as much information for planning purposes as possible. This inspection is to be facilitated by operations and can take place under normal flow conditions
2. **Remote inspection** of the gates and conduits using CCTV and similar technologies. May be combined with stage 1
3. **Shut down** of the NEWPCC treatment plant and an entry into the South and North effluent conduits and junction chamber to carry out a condition assessment.

Specialists with skills in the condition assessment of large flow control gates (Penstocks) and large diameter conduits are required for the condition assessment. The specialists are required to be available to take part in the inspection from the top to assist in planning the condition inspection. Resourcing of the specialist skills is to be confirmed, if non-city resources are required an order will need to be raised, alternatively the resources can be procured through a

Veolia Work Pack. Resources carrying out the condition assessment will comply with the City confined space entry procedures and training requirements.

Assets to be inspected are detailed in Table 1.

Table 1 –Assets requiring condition assessment	
Asset	**Inspection Scope**
Gates YG11A and YG11B	Normally closed, inspection of mechanical and civil integrity of the gate and installation. Inspect for signs of leakage of primary effluent Produce inspection record Complete condition assessment sheet Gate size: 24" x 36", installed 1963
Gate YG12B	Normally closed, inspection of mechanical and civil integrity of the gate and installation. Inspect for signs of leakage of secondary effluent Produce inspection record Complete condition assessment sheet Gate size: 48" x 84", installed 1963
Primary Effluent overflow weirs	Inspection of primary effluent overflow weir Produce inspection record
South effluent conduit	Inspection of civil structure, provide a condition grading. Look for signs of leakage between the North and South effluent conduits. Assess potential for stagnation of flows in the South conduit upstream of the final effluent. Produce inspection record Conduit size: height at YG12B 7'; width 4'6".
North Effluent conduit	Inspection of civil structure, provide a condition grading. Look for signs of leakage between the North and South effluent conduits. Produce inspection record

4.2 Operations Scope

During phase 1 and 2, survey from top and remote inspection, Wastewater Treatment (WWT) Operations will:

- Facilitate and guide an assessment of assets from above ground through all available covers and manholes under normal flow conditions.
- Facilitate others to use remotely inspect the gates and effluent conduits – plan to be developed with specialists in remote inspection techniques

For phase 3, shut down, WWT Operations will prepare a Safe Work Procedure for a controlled shut down of the NEWPCC to facilitate a confined space entry to NEWPCC South and North effluent conduits and junction chamber. The SWP will include all resources, operational actions, lockout / tag out requirements, and all required permits and authorizations.

The following issues are to be addressed in the shut down plan:

Gate YG12B Inspection Issues

Gate YG12B, normally closed, sits at the bottom of a 1.68m (5.5') deep 30^{o} (approx.) incline. The base of the gate is approx. 7.8m (25.25') below grade. The volume (5m^3 approx. when gate closed) between the gate and the incline will require to be de-watered in order to inspect the gate.

It is not known when this gate was last operated.

There will be an, as yet, unknown volume of secondary effluent behind Gate YG12B when it is in its closed position. To assess its condition gate YG12B should be inspected in its closed and open positions. The volume of secondary effluent behind Gate YG12B needs to be determined during the planning for the shut down and a SWP created for operation of the gate during the condition assessment.

Gate YG11A and YG11B Inspection Issues

It should be possible to check for leakage from gates YG11A and YG11B from the above ground inspection through available covers under dry weather flow conditions. Assuming the weir primary effluent weir is not overflowing.

For a full condition assessment of gates YG11A and B and entry into the primary effluent overflow channel is required with operation of the gates. It is to be confirmed if primary effluent will be present in the PE channel at shut down which would be drained to the effluent conduits if the gates are to be operated.

WWT Operations execute the shutdown according to SWP, coordinate activities and supervise entry to confined spaces.

<u>**Operations Deliverables**</u>**:**

Resource Plan - A plan for resourcing relevant condition assessment skills and pre-inspection preparation including any relevant procurement documents or work packs if required

An operational shut down plan – detailed work plan to prepare for, carryout and complete plant shut down. This is the overall coordination plan for the shutdown and condition assessment. The plan will explain the work required to provide safe access by engineers to carry out a condition assessment of the assets, including all relevant notifications and permits.

Sequencing of the activities in the Consultants condition assessment plan have to be taken into consideration in the shutdown plan.

Any SWPs required – Risk assessment, review and update relevant existing SWPs or creation of new SWPs as required

4.3 Consultants (or Contractor) Responsibilities

The Consultant will produce a safety plan for their activities.

The Consultant will prepare an asset inspection plan for each type of asset in table 1. The inspection plan is to take account of the limited time available (assume maximum of ## hours for the inspection).

- Scope and goal of each inspection
- Skills required
- Resources
- Safety requirements
- Check list of items to be inspected

To facilitate planning of an entry to inspect the control gates as much information as possible should be gathered from the above ground prior to entry to the conduits. The contractor / consultant will perform an inspection, as far as possible, of assets in table 1 from above ground through all available covers and manholes for the purpose of planning for a confined space entry.

The Consultant will use the results of the above ground inspection to update their safety plan and prepare a detailed condition assessment plan for use during the controlled plant shut down.

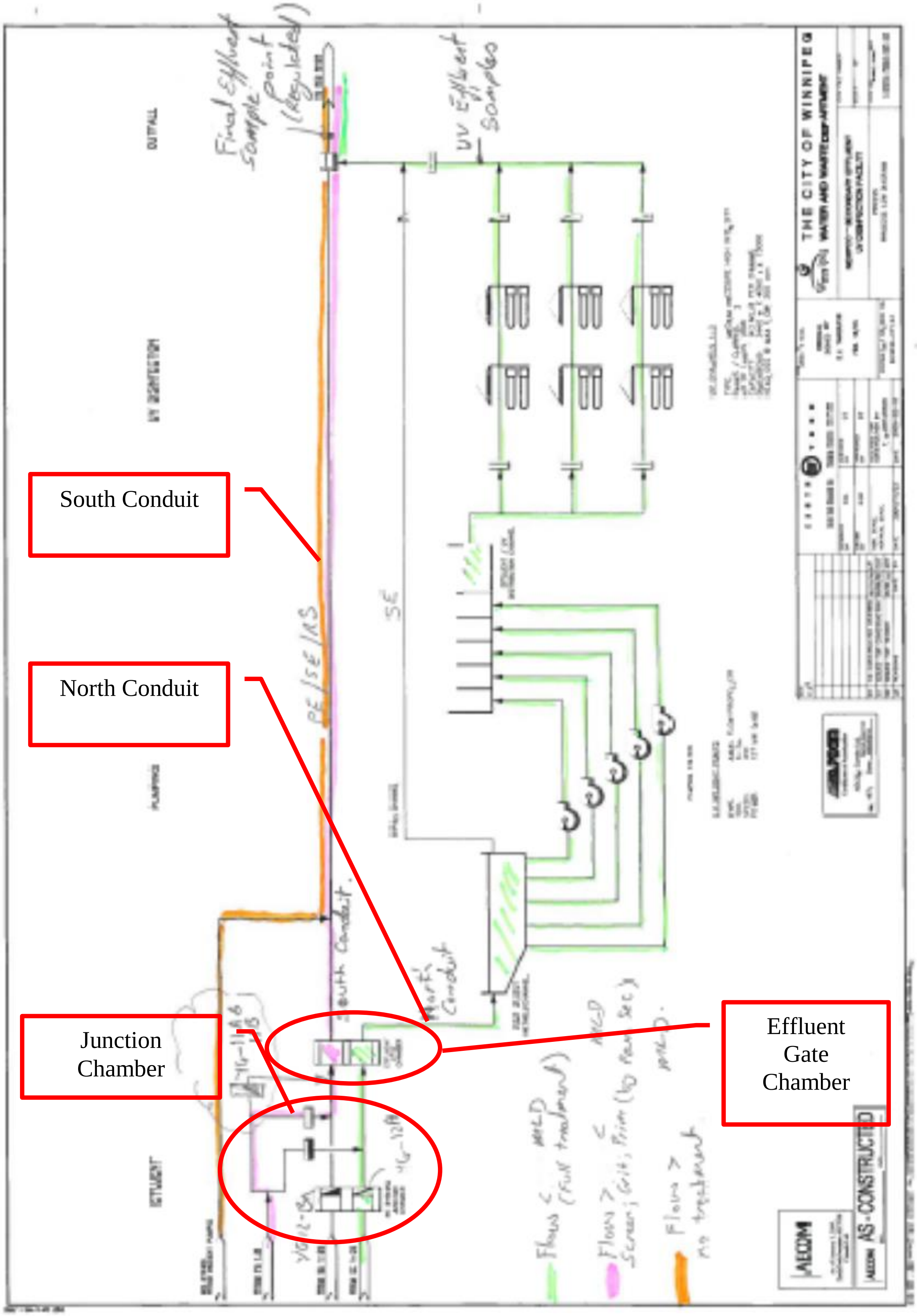
The Consultant will perform a condition assessment of assets in table 1 during a specifically planned plant shut down.

Consultant Deliverables:

Condition assessment plan, Plan for resourcing, safety, equipment, and all activities together with their sequencing to carry out the condition assessment.

Condition assessment template - A schedule of information required to be gathered during the shutdown. Produce as a checklist to complete during an entry.

Post shut down report – A report describing the condition of the assets as they relate to the Fecal and E-coli violations and provide recommendations for corrective and preventative maintenance.


South Conduit
North Conduit
Junction Chamber
Effluent Gate Chamber
THE CITY OF WINNIPEG
AECOM
AS-CONSTRUCTED

5 Drawing and Data List

Table 2 – Data and Drawing References			
Description	**Purpose**	**Received**	**Reference File**
Compliance data for years: 2008 to 2013		✓	13EQualSum.xls
As constructed drawings for junction chamber	Planning condition assessment	✓ ✓	NEP 172 – Structural layout, galleries 1,4,6,8 and related conduits NEP 173 – NEP 176 – Plans of Junction Chamber NEP 177 – Junction Chamber section 8 details, sheet 1 NEP 315 Misc plant flow diag & hydraulic profile NEP 181 – Structural raw sewage discharge conduits, sheet I NEP 182 – Structural raw sewage discharge conduits, sheet II
Junction chamber		✓	Isometric drawing of junction chamber from Plant Manual
As constructed drawings for South and North Conduits and UV plant	Planning condition assessment	✓ ✓ ✓	1-0101U-S0010-001-03 Effluent gate chamber and outfall tie in plan, sections and details 1-0101U-E0005-001-03 Electrical UV Facility Site Plan NEP 1368 NEWPCC site plan and hydraulic profile 1-0101U-S0003-001-03 1-0101U- S0004-001-03 1-0101U- S0007-002-03 1-0101U- P0002-001-02
Secondary clarifier and RAS gallery	Levels		NEP 1413 – RAS pipe gallery plan NEP 1412 – Secondary clarifier sections NEP 1415 – RAS pipe gallery sections
All relevant P&IDs and flow diagrams		✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓	1-0101U-P0010-001 1-0101U-P0006-001 1-0101U-P0004-001 1-0101U-P0003-001 1-0101U-P0002-001 1-0101M-A0003-001 1-0101M-A0011-001
Location of automatic samplers and position of grab samples		✓	Marked on 1-0101M-A0003-001
Results of previous investigations and planning	Avoid repeating previous investigations	✓ ✓ ✓	RE_ Day # 2 Dye Test Results (Leak Testing of South Effluent Conduit Gate).pdf Backflow_1_151106.pdf NEWPCC Fecal.doc

Table 2 – Data and Drawing References			
Description	**Purpose**	**Received**	**Reference File**

Appendix 3
AECOM TM – October 21

AECOM
99 Commerce Drive
Winnipeg, MB, Canada R3P 0Y7
www.aecom.com

204 477 5381 tel
204 284 2040 fax

Technical Memorandum

To	Neil Abercrombie, Veolia	Page	1
CC			
Subject	Review of Historical Data – NEWPCC Fecal and E.coli Non-Compliance Investigation		
From	Eymond Toupin, Chris Lipscombe, Chris Macey		
Date	December 19, 2014	Project Number	60333011 (500)

1. Background

Since the ultraviolet (UV) disinfection facility was commissioned in mid-2006, the North End Water Pollution Control Centre (NEWPCC) has experienced difficulties in meeting its license requirements for both fecal coliform and Escherichia coli (E.coli) (most probable number (MPN) <200/100 mL on monthly geometric mean).

Based on investigations carried out to date, the following potential sources of contamination have been identified:

1. Continuous leakage from gate YG12B (normally closed), which isolates the south secondary effluent conduit at the junction chamber located near the west end of the grit building (Figure 1 and Figure 2).
2. Stagnated (trapped) flow in the UV, secondary and raw sewage (RS) bypass channels from previous permitted bypass operations washing out and contaminating treated UV effluent (Figure 4).
3. Flow from UV effluent discharge flowing backwards along the UV, secondary and raw sewage bypass channels, stagnating and allowing regrowth of fecal coliform and E.coli which eventually washes out and contaminates the treated UV effluent at low flows (Figure 4).
4. Continuous leakage between the North and South secondary effluent conduits (Figure 1, Figure 2, and Figure 4).
5. Occasional unintended primary effluent overflow at the junction chamber at the junction chamber when a raw sewage pump starts (Figure 1 and Figure 2).
6. Occasional unintended raw sewage bypass or leakage at the raw sewage discharge well (Figure 1 and Figure 3).

This memorandum documents the review of the investigations and data collected to date related to the potential sources of contamination as well as the possible solutions for the isolation of these sources to prevent future contamination of the final effluent.

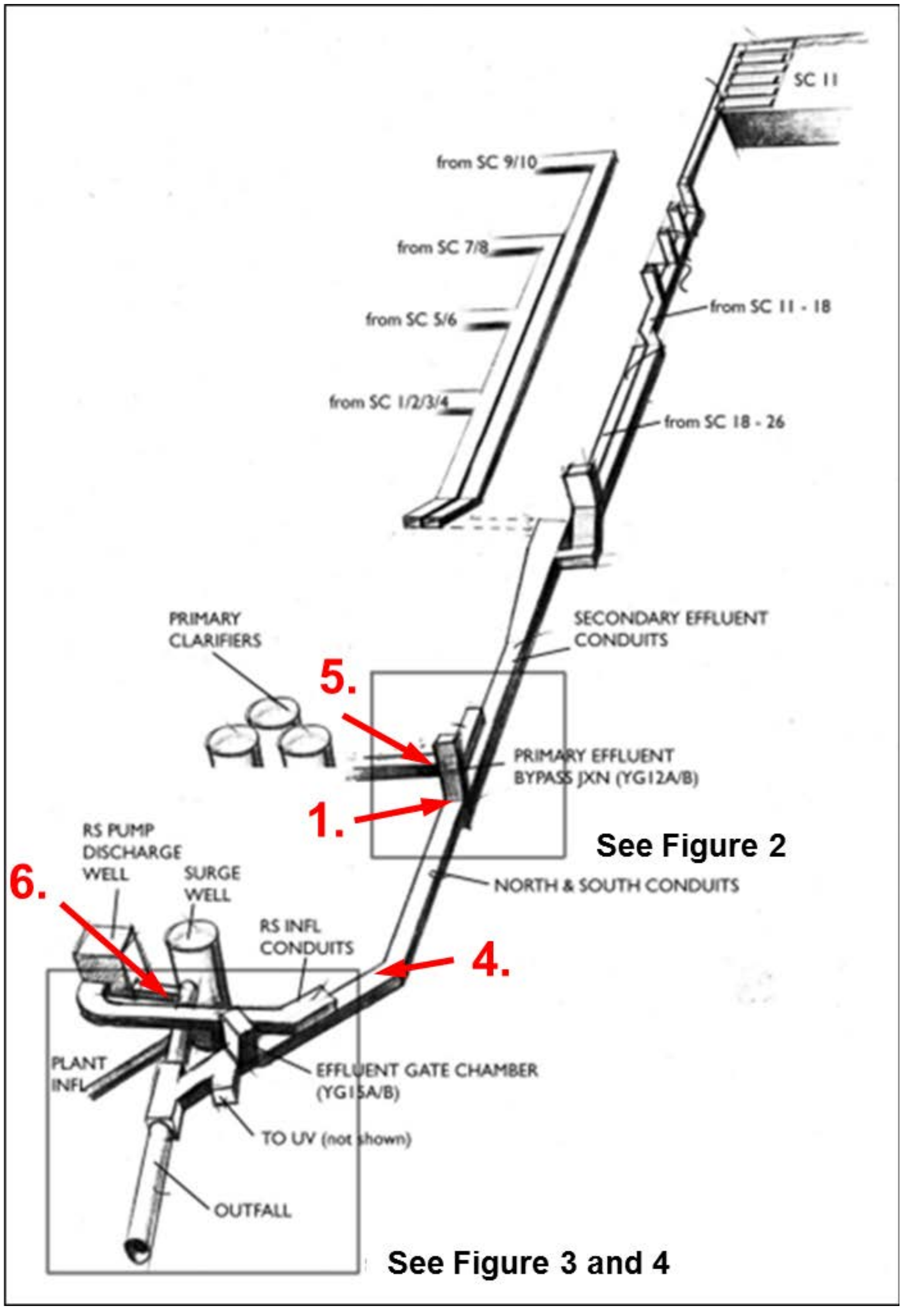


Figure 1 - NEWPCC Effluent Conduit System Overview

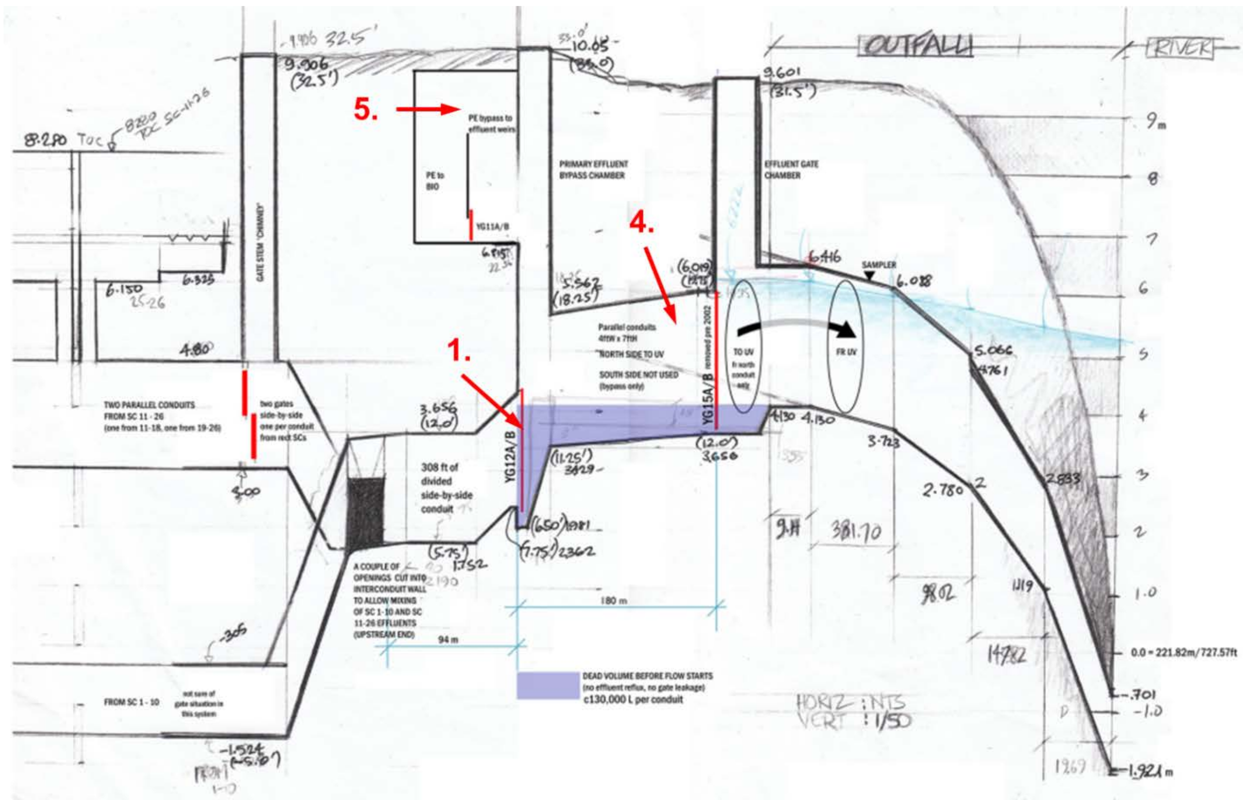


Figure 2 - Profile through the Secondary Effluent and Outfall Conduits

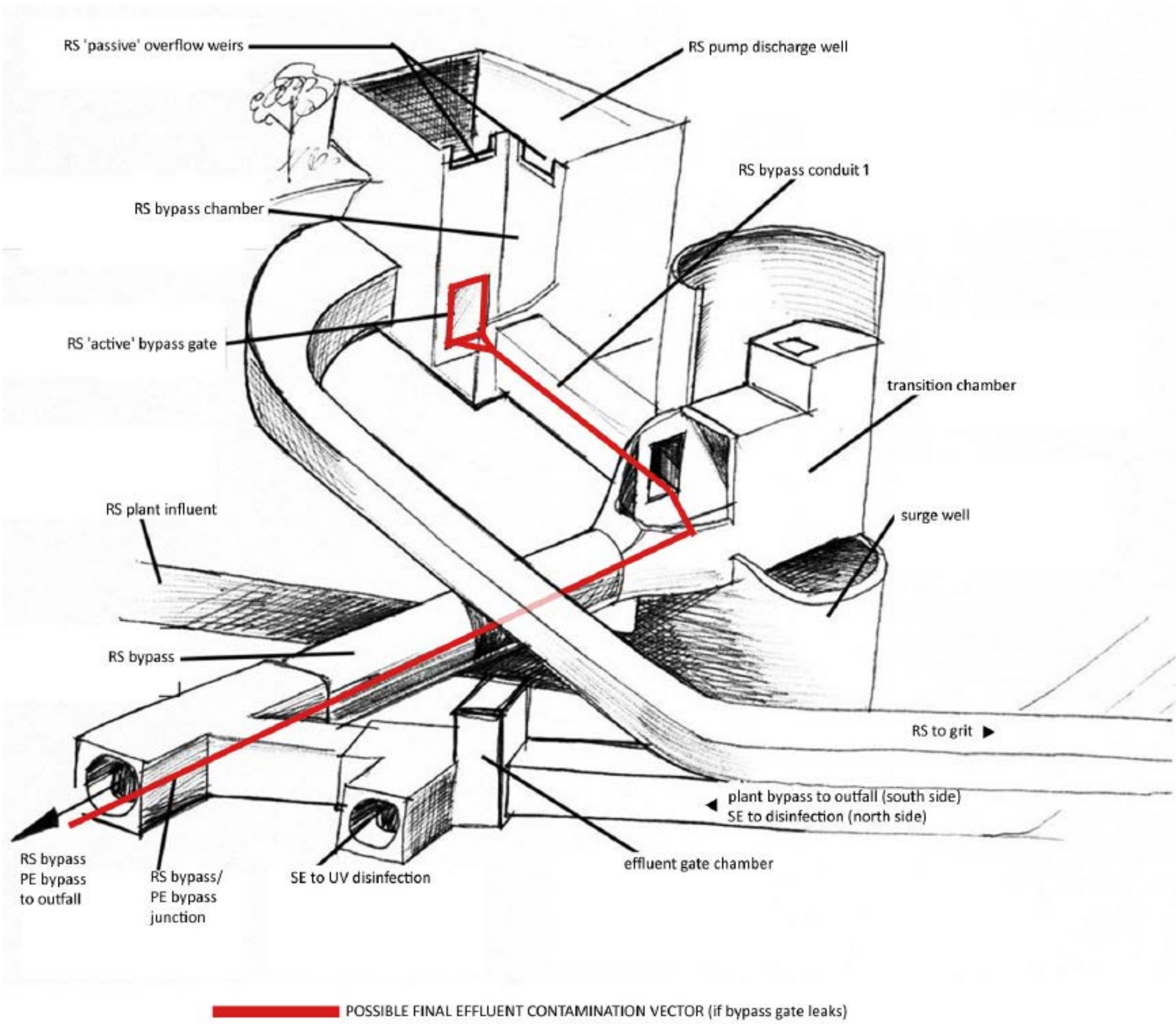


Figure 3 - NEWPCC Influent (Raw Sewage) Bypass

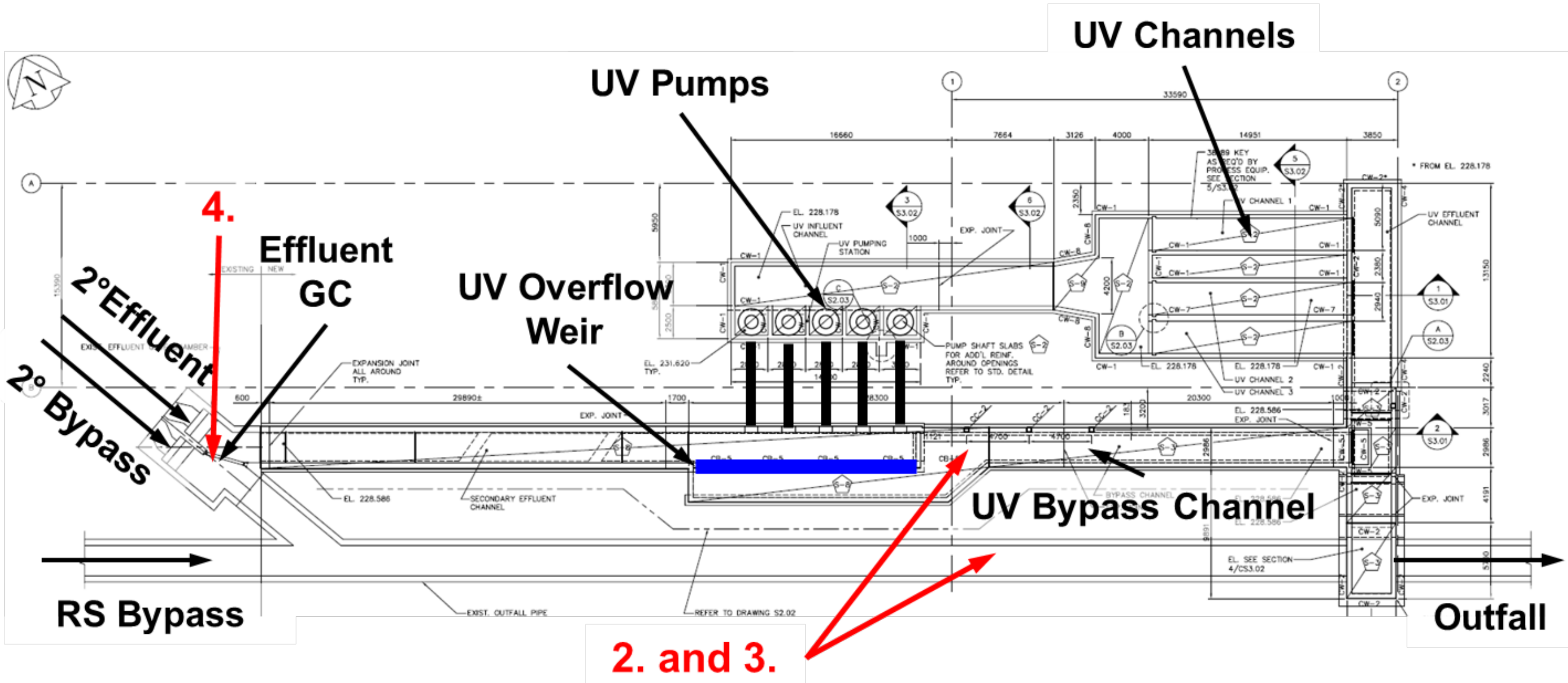


Figure 4 - Effluent Gate Chamber, UV and Outfall Interface

2. Review of Historical Data

2.1 Fecal Coliform and E.coli in Grab Samples

Effluent sampling data for fecal coliform and E.coli were provided for the period of November 1, 2013 to August 31, 2014 for effluent collected at two locations downstream of the UV disinfection facility. The 'final effluent' samples are collected in the sampling chamber which was installed on the outfall piping as part of the construction of the UV facility in 2006. These are the samples used for regulatory reporting. UV effluent was collected as 'grab samples' within the UV facility, i.e. upstream of the UV bypass and outfall channels, and were used to compare against the final effluent (Figure 5).

Review of the data yielded in following observations and conclusions:

1. The fecal coliform and E.coli samples were similar to each other in terms of the overall trend and magnitude over the sampling period.
2. In terms of the geometric mean, the fecal coliform and E.coli counts were consistently higher in the final effluent than in the UV effluent. The only exception over the sampling period was the month of May, 2014 where they were roughly equal. This is consistent with the hypothesis that effluent may be getting contaminated at some point downstream of the UV facility.
3. The highest values for the both final and UV effluents were recorded in January and February.
4. The only month in which the geometric mean for fecal coliform exceeded the 200/100mL limit for the UV effluent was February. However, there were five months where the final effluent did not meet the requirement. Similarly for E.coli, there was one month where the UV effluent was only slightly higher than the limit but two where the final effluent did not meet the requirement.

The data also appeared to suggest a higher frequency of elevated fecal coliform and E.coli levels in the final effluent during periods of low flows through the NEWPCC. In order to further examine this hypothesis, final effluent fecal coliform and E.coli data were plotted against daily flow at the NEWPCC (Figure 6). The data suggests that the overwhelming majority of instances where fecal coliform and E.coli exceeded the license limit in the final effluent were during periods of dry weather flow (DWF), i.e. when flows were a maximum of approximately 150 ML/d.

The ratio of final to UV effluent for fecal coliform and E.coli were calculated and plotted against daily flow (Figure 7). This presentation of the data suggests that the largest discrepancies between final and UV effluent (i.e. the largest ratios) were observed during periods of low flow. In other words, that recontamination of final effluent may be more likely under DWF.

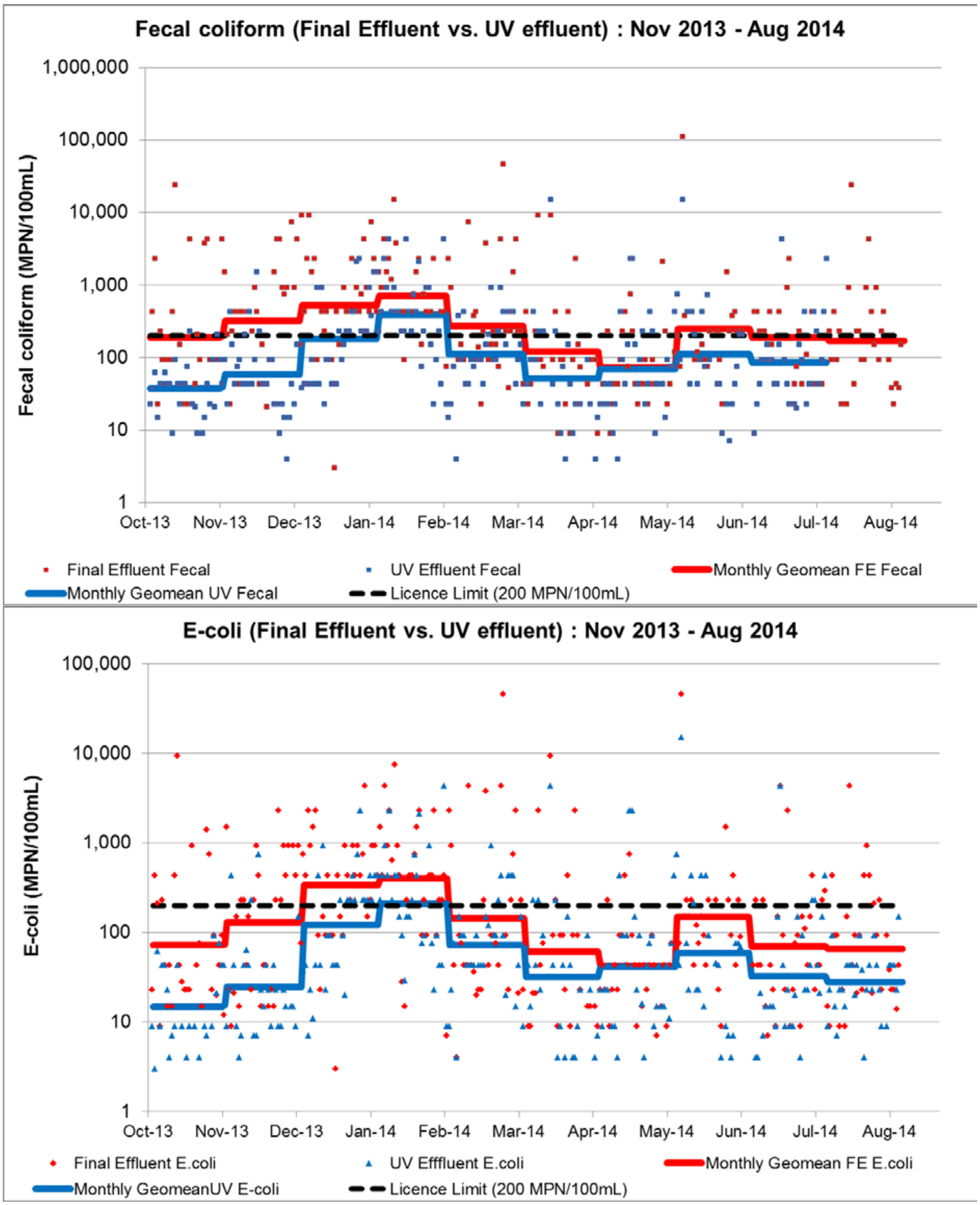


Figure 5 - Fecal Coliform and E.coli in UV and Final Effluent (November 2013 to August 2014)

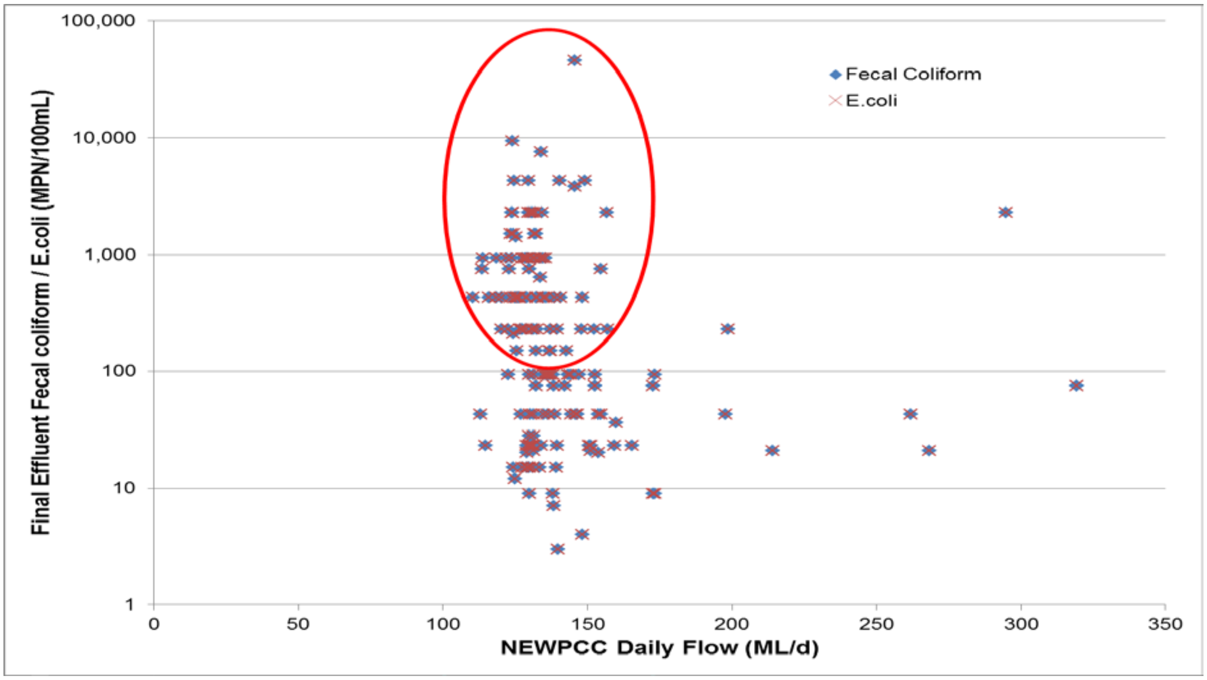


Figure 6 - Final Effluent Fecal Coliform and E.coli vs Plant Daily Flow

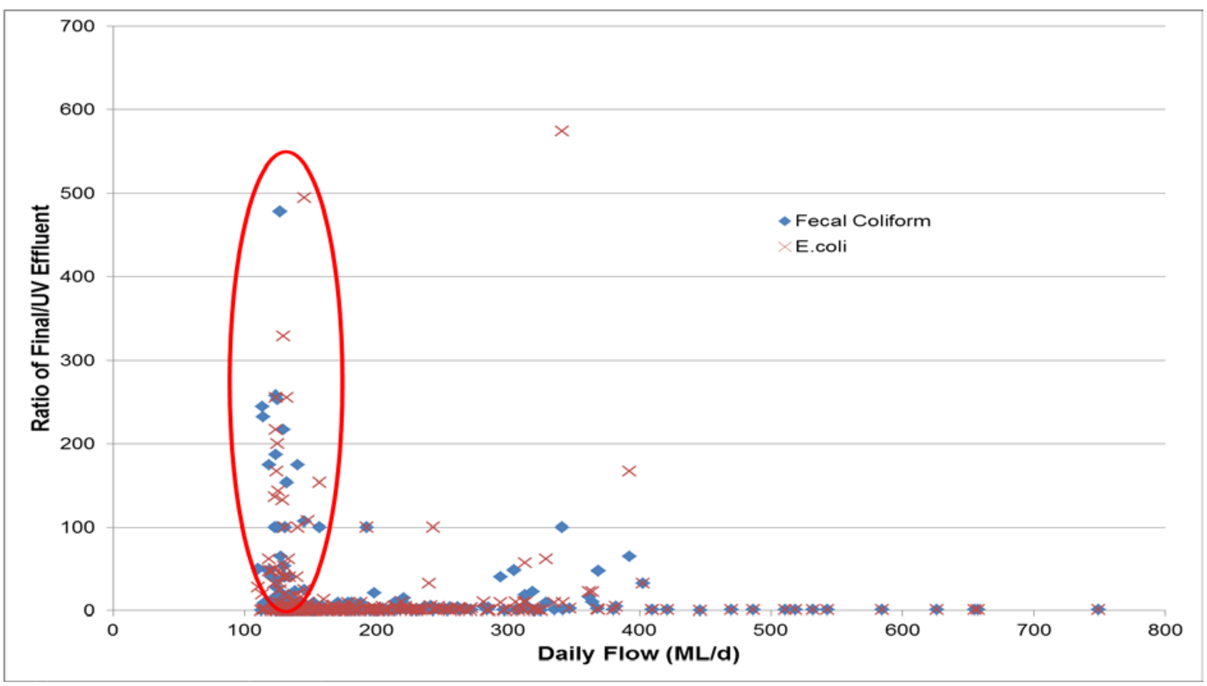


Figure 7 - Final/UV Effluent Fecal Coliform and E.coli vs Plant Daily Flow

2.2 Effluent Conduit Shutdown in November, 2006 (Observation of Backflow)

In November, 2006, an inspection of the effluent conduit took place and was documented by Terry Holding. Civil Maintenance was to inspect a previously installed patch in the effluent conduit at a location 3 metres west of the old sampling building (Figure 8). Based on this description, the patch would appear to be located in the original outfall pipe, i.e. not in the parallel secondary effluent and secondary bypass conduits upstream of the effluent gate chamber.

Flow through the treatment plant was interrupted to allow the man entry inspection to take place which also included shutting down the UV facility and its pumps. However, it appears that while the crew was preparing to complete the inspection that the UV pumps accidentally restarted. This resulted in a rapid backflow up the bypass piping and south (secondary bypass) channel towards the effluent gate chamber. During the initial surge of the backflow event, the level rose to a maximum level of approximately 2 metres. The pumps were subsequently shutdown and the inspection abandoned.

These observations confirm backflow into the UV, secondary and raw sewage bypasses can occur when the rate of discharge from the UV facility increases.

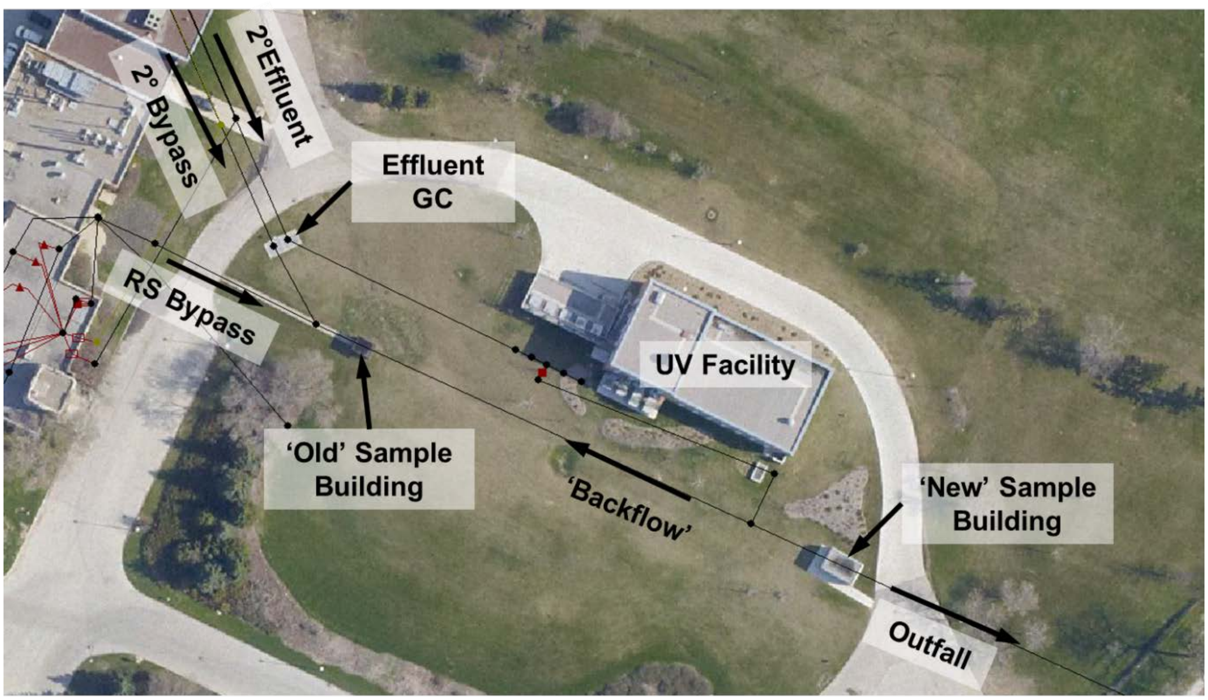


Figure 8 - Site Plan of Effluent Conduit Inspection

2.3 Hydraulic Analysis

At normal river levels, the depth of backwater in the South Channel (i.e. secondary bypass) is simply a function of the rate of flow in the outfall. As shown in Figure 9, even under conditions of no flow, water is remains trapped in the South Channel as dead storage between the effluent gate chamber and YG-12B. The depth of water stored in the channel increases up to approximately 1 metre at a flow of between 200 and 250 ML/d.

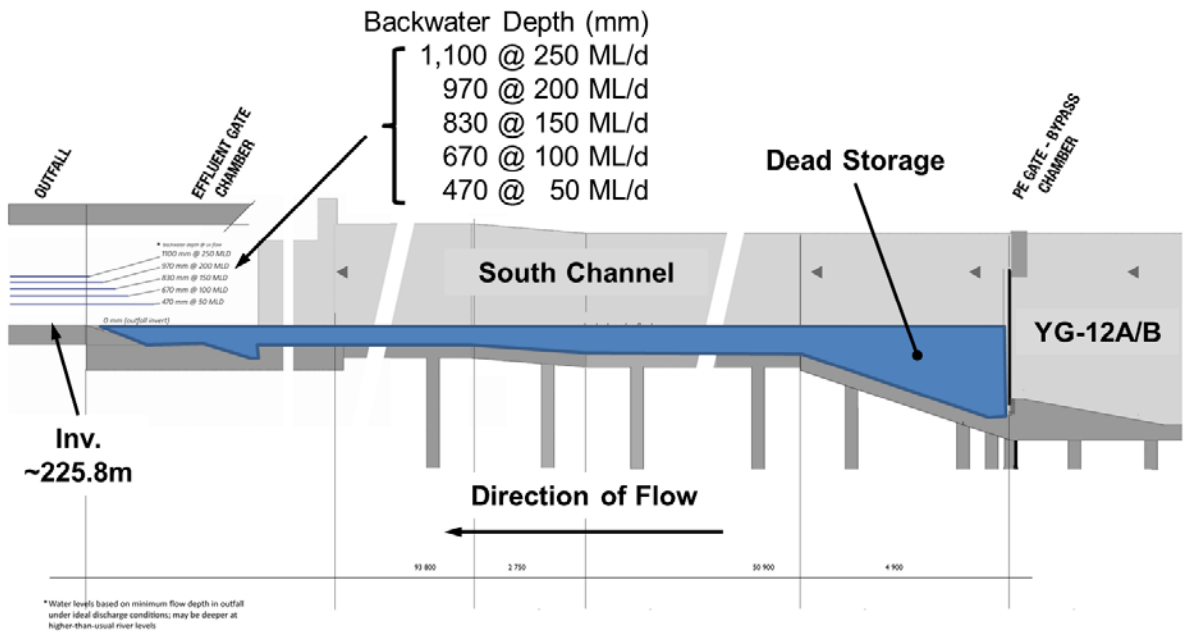


Figure 9 - Profile of the South Channel and Backwater from Outfall

A hydraulic model of the outfall conduits was created in InfoWorks CS to more closely examine the flow conditions in the UV, secondary and raw sewage bypass conduits as shown in Figure 10. A typical diurnal inflow pattern (data from March 2011) was applied to the model and the response in the outfall examined.

The model indicates that over the course of a typical day, levels in the outfall, and consequently in the bypass conduits, will fluctuate as a result of the diurnal variation in flow (Figure 11). When flow decreases, there would be outflow from the conduits bypassing the UV facility, potentially contaminating effluent flow. Conversely, when flow increases, there is backflow into the 'dead storage' of the bypass conduits. The ebb and flow in the bypass conduits is likely to be more significant during periods of low flow which coincides with the observed elevated levels of fecal coliform and E.coli.

This analysis also suggests that the timing of the collection of the final effluent grab samples could affect the results. Based on the diurnal pattern shown in Figure 11, collecting the samples at roughly 7:00AM could yield the worst results in terms of the bacteriological analysis if contamination from the bypass channel is in fact occurring. Conversely, collecting the samples at peak flow, which appears to occur at roughly 11:30AM, could yield lower fecal coliform and E.coli counts in the final effluent.

Sampling at a point where the outflow is relatively stable and approximately equivalent to ADWF would likely yield the most representative results. Based on the diurnal pattern shown in Figure 11, this would correspond to a time in the late afternoon (i.e. between 16:00 and 18:00).

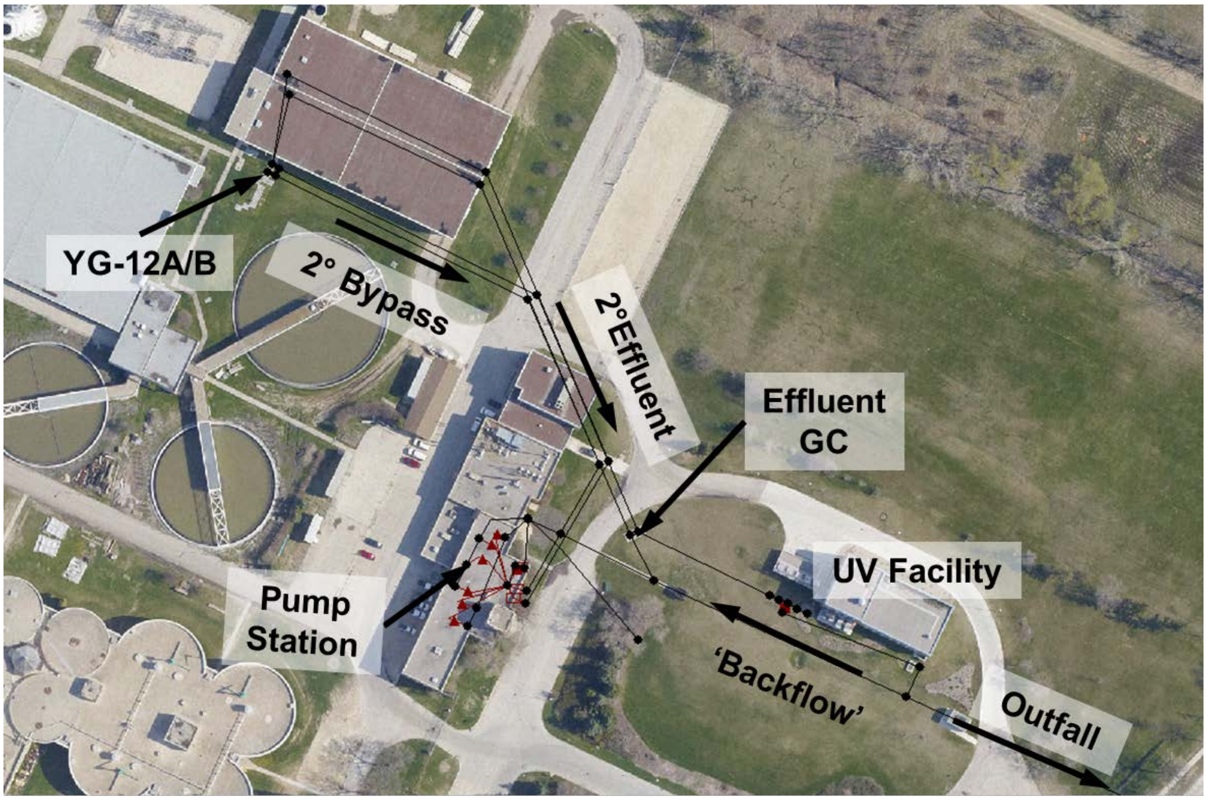


Figure 10 - InfoWorks CS Model of NEWPCC Outfall and Bypass Conduits

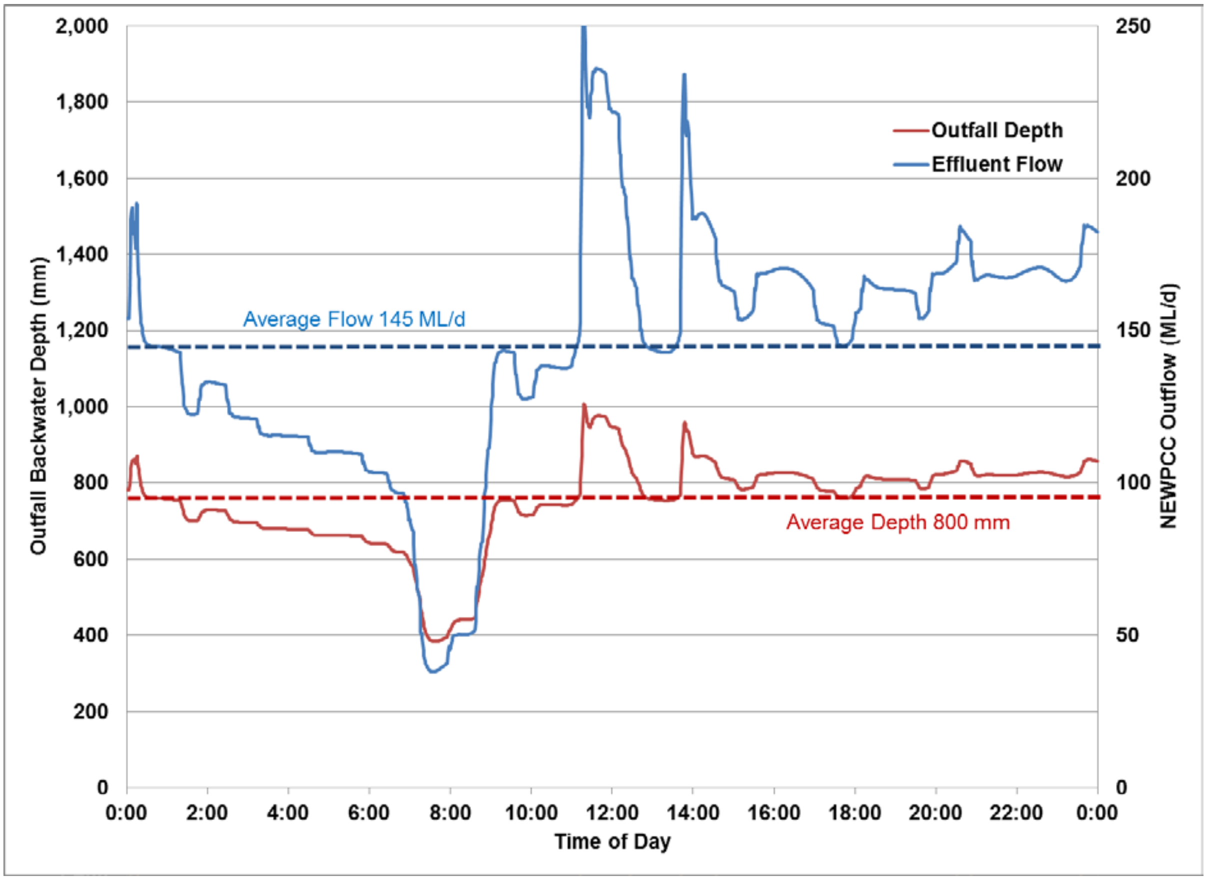


Figure 11 - Diurnal Fluctuation in Outflow and Outfall Backwater Depth

3. Remedial Alternatives

3.1 Improve Watertightness of Stop Log Septum in Effluent Gate Chamber and Install New YG15

The north duty conduit and the south bypass conduit are presently separated by a wall in the EGC which is comprised of 200 x 200 wooden stop logs (Figure 12). Although every effort was made to seal the gaps during construction, it is suspected that undisinfected secondary effluent may be passing through the south side and contaminating the final effluent in the outfall.

This wall was designed as such to facilitate construction; the plant could not be shut down long enough to construct a solid watertight membrane. However, with the south conduit now nominally isolated by this baffle and YG12A, it may be possible to dewater and isolate the south side for a sufficient time to allow placement of a concrete or other solid material wall without the need for a full plant shutdown. This would also require temporarily isolating the EGC from the outfall backwater with a sufficiently high dam or weir.

Rendering this septum wall watertight will allow the placement of a new gate in place of the long-removed YG15. This would serve to isolate the south conduit and prevent or significantly reduce the ability of the 130,000 L of potentially contaminated dead storage to mix with the final effluent. Without the improved baffle wall, such a gate would need to be installed at the outlet of the EGC to achieve the same effect. This would require extensive structural modifications and even longer shutdowns than anticipated to simply seal the stop logs.

The existing septum was made with stop logs simply for ease of construction - they could be placed in the least time. They were never intended for removal under any normal or expected abnormal condition, therefore making them watertight (and therefore immovable) should not adversely affect plant operation.

The new gate YG15 would need to be integrated into the control system to open and close in concert with YG12A. The present basic bypass operating protocol would therefore not be required to change significantly (open or close 2 gates instead of only 1, but under the same conditions). The introduction of a second active element, however, does increase the risk of failure (two gates need to be in working order, not just one). On the other hand, it does provide a some level of redundancy - one gate could fail and the other one could operate and the result would not be appreciably worse (or better) than the existing; there is still one gate keeping the south conduit closed at one end or the other.

The advantages of this solution are that the gate infrastructure (mounting face, access hatches) is already in place; the working area is nominally isolated and it may therefore be less difficult to upgrade the baffle wall (longer shutdown period available, easier to keep dewatered).

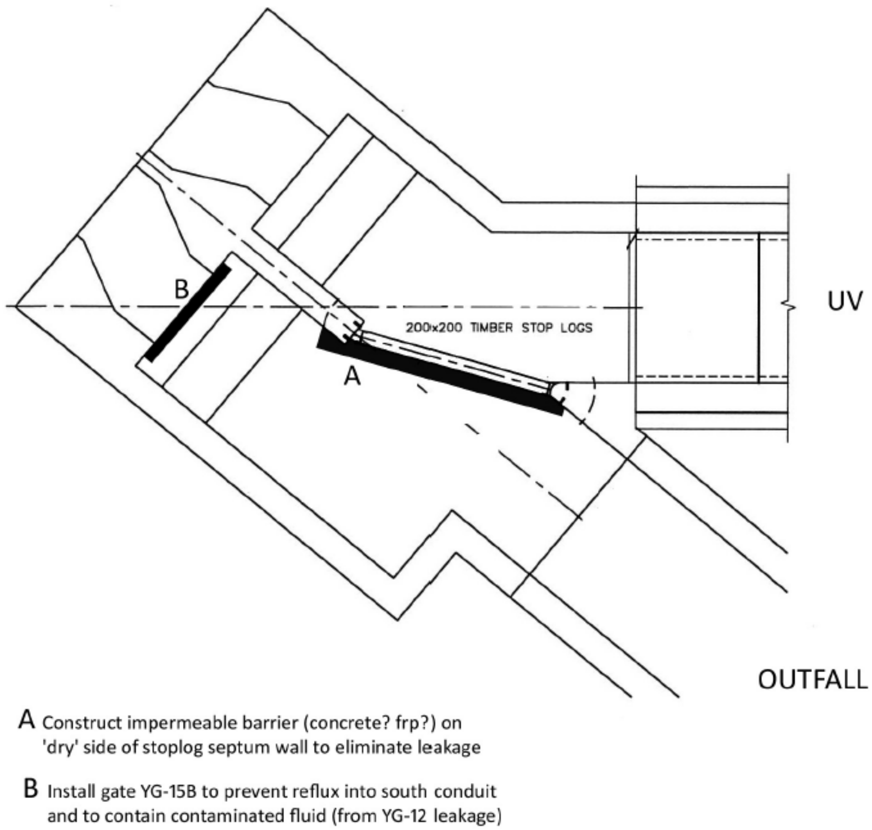


Figure 12 - Effluent Gate Chamber Proposed Modification (Plan)

3.2 Add Gate at UV Outlet-Outfall Junction Chamber

This junction (Figure 13) presently has no barriers to prevent reflux into the unused upstream conduits. Unfortunately, all or most of the upstream structures are lower than the outfall, meaning that if the outfall has even a minimal depth in it (as it would as long as the plant is discharging), treated effluent can mix with any contaminants that have entered the out of service bypass and conduits through any leaking gates. While ostensibly isolated by the EGC septum wall, gate YG12-A, and the raw sewage bypass gate, if any one of these leaks, the disinfected effluent may be contaminated.

This new gate would provide another barrier to isolate any contaminated fluid that may leak into the south conduit or raw sewage bypass lines. However, the raw sewage bypass is presently passive - once it is initiated (either by overflowing the raw sewage well weirs, surge well weirs, or passing through the gate into the bypass chamber), its path to the outfall and out to the river is unimpeded. Installing this new gate would introduce a barrier than would need to be automatically opened when a

RS bypass begins (either intentionally or in an emergency). As this gate would also prevent secondary bypass from leaving the south conduit, it would also need to be integrated into the control of YG12A.

The UV effluent-outfall junction structure appears to have a flat face that may be suitable to mount such a gate, but the chamber is covered by at least 2 m of earth and there is no access hatch. The structure would need major excavation and modification, as well as a watertight baffle to isolate the UV effluent during the construction and installation. In order to more easily and effectively isolate the construction area and minimize disruption to plant operations, it may in fact be necessary to construct a new chamber upstream of the existing UV-outfall junction chamber to house the proposed gate.

The primary advantage is that this approach would completely isolate the treated and untreated streams. However, this would significantly complicate the RS bypass system relying on gate opening when required and increase overall operational risk, significantly. This would also require either extensive modifications to the existing chamber or the construction of a new gate chamber.

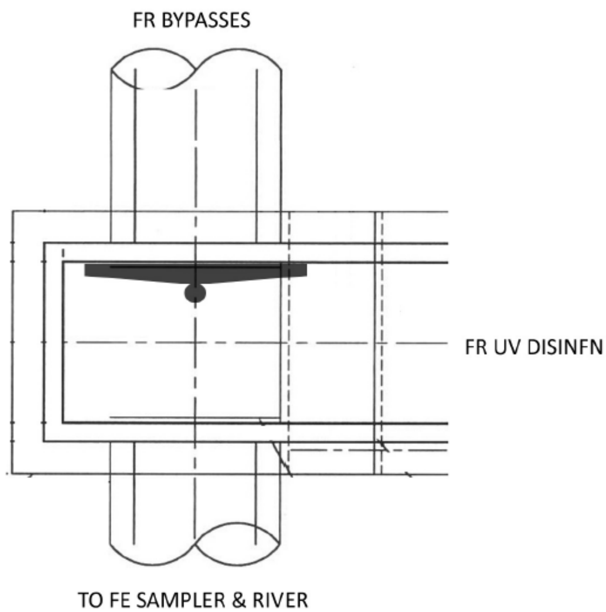
3.3 Pumping Out the South Conduit

Although the south conduit appears to be continuously replenished by reflux from the outfall, it may be effective to dewater it either continuously or at regular intervals. By removing sufficient volume to ensure that the contaminants introduced at either of both ends (via leaks through YG12A and the stop log septum in the EGC), i.e. the stagnant bottom layer, are removed or reduced to low enough concentrations that they have minimal effect on the final effluent. Intermittent sampling of the material removed would be recommended as it would provide an indication of the water quality in the dead storage.

The material from the south conduit could be pumped into the neighbouring north conduit and conveyed to the UV facility for disinfection. The conduit just downstream of gate YG12 is the lowest point of the system, and therefore a dedicated sump would not need to be provided; a portable pump could simply be lowered into place. If proven to be effective, a more permanent system could be installed (guide rails, hard piping) and the installation of gates as described above may not be necessary.

Most of the disinfected effluent will flow to the river, so the pump rate will not need to be anywhere near the actual treatment flow. A temporary option could involve the use of portable dewatering pumps, such as those which are used by the WWD to dewater storm relief sewers during floods (e.g. Flygt BIBO pump shown in Figure 14). One of these could provide dewatering rates in the order of 100 L/s (8.6 ML/d) which would be more than adequate to help refresh the estimated 150,000 L of dead storage in the south conduit. Continuously pumping at this flow rate, it would take roughly 30 minutes to turn over the dead storage volume once. Conversely, a small 5 or 6 L/s (0.4 ML/d) pump could remove this same volume in about 8 hours.

The advantage of this approach is that is the least complex and easiest to implement. This could be a first step before deciding whether the more intrusive proposals (additional gates, enhanced control systems) are required.



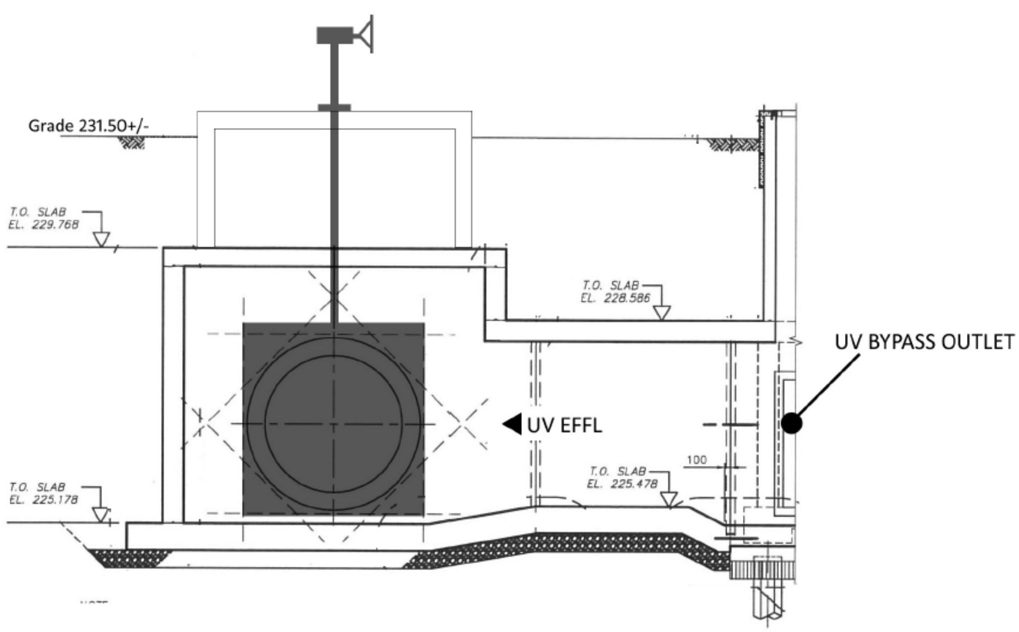
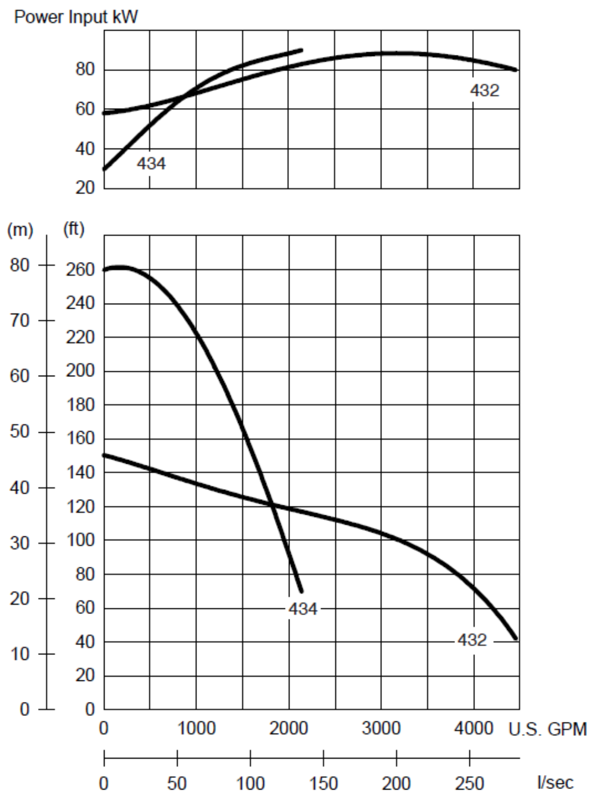
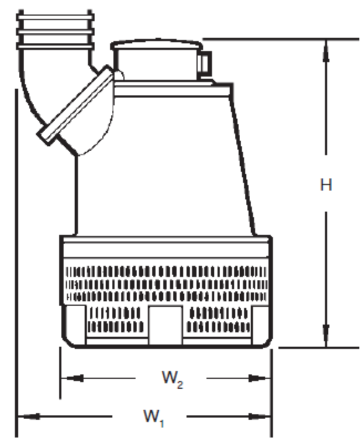


Figure 13 - Proposed Isolation Gate at UV-Outfall Junction Gate Chamber

BIBO BS-2290.010

Power Input and Performance Data





Dimensions

Discharge conn.	W_1 inches	W_1 mm	W_2 inches	W_2 mm	H inches	H mm	Weight lbs.	Weight kg	Tandem conn.*
6" High Head									
6" NPT (female)	33 3/8	848	30 3/8	771	45	1143	1190	540	6" Hose conn.
6" Hose conn.*	33 3/4	832	30 3/8	771	45	1143	1190	540	6" Hose conn.
8" Standard									
8" NPT (female)	35 1/2	902	30 3/8	771	45	1143	1190	540	-----
8" Hose conn.*	34 3/4	883	30 3/8	771	45	1143	1190	540	-----
10" Standard									
10" NPT (male)	36 7/8	937	30 3/8	771	45	1143	1190	540	10" Hose conn.
10" Hose conn.*	36	915	30 3/8	771	45	1143	1190	540	10" Hose conn.

*Optional

VERSION	IMP. CODE	HP	PHASE	VOLTS	FLA	STARTING CURRENT	CABLE SIZE AWG
High Head HT 6"	434	110	3	460 600	127 99	810 650	1/3-2-1-GC
Standard MT 8" or 10"	432	110	3	460 600	127 99	810 650	1/3-2-1-GC

Figure 14 - Example Portable Dewatering Pump (Flygt BIBO)

4. Summary

A number of potential sources of contamination of the final effluent from the NEWPCC which have resulted in difficulties in meeting license requirements for both fecal coliform and E.coli were previously identified. Review of the data, including record drawings, historical water quality data (grab samples), and hydraulic analysis, suggests that:

- Fecal coliform and E.coli counts have consistently been higher in the final effluent than in the UV effluent;
- The largest deviations between final and UV effluent appear to have occurred during periods of DWF, i.e. that recontamination of final effluent may be more likely under DWF;
- Backflow into the conduits bypassing the UV facility has been physically observed (November, 2006 Effluent Conduit Shutdown); and
- Hydraulic analysis confirms flow in and out of the 'dead storage' in the bypass conduits likely occurs one or more times a day as a result of typical diurnal fluctuation in flow.

Three remedial alternatives to minimize potential recontamination of UV effluent were described and are summarized in Table 1 including their order of magnitude cost, operational complexity risk, and anticipated effectiveness. Cost estimates for the alternatives will be developed and provided at the upcoming workshop on October 28, 2014.

Table 1 - Summary of Remedial Alternatives to Minimize Recontamination of UV Effluent

Alternative	Relative Cost	Operational Complexity/Risk	Other Factors
1 - Improve Watertightness of Stop Logs and Install New YG15 EGC	$$$	Medium	Moderate risk profile and high probability of success. May require supplemental dewatering as per #3.
2 - Add Gate at UV Outlet-Outfall Junction Chamber	$$$$$	High	Greatest isolation of potential contamination sources.
3 - Pumping Out the South Conduit	$	Low	Lowest level of isolation from contamination sources but very low cost and may ultimately be required in conjunction with other measures.

Eymond Toupin, P. Eng.
Municipal Engineer
Community Infrastructure
EDJT/CGL/CCM/pab

PROVINCE OF MANITOBA
Dec 19, 2014
E.D.J.
TOUPIN
Member
23484
REGISTERED PROFESSIONAL ENGINEER

Appendix 4
Risk Workshop Minutes and Presentation

AECOM
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204 284 2040 fax

Minutes of Meeting

Date of Meeting	October 28, 2014	Start Time	1:00PM	Project Number	60333011 (300)
Project Name	NEWPCC - Fecal and E.coli Non-Compliance Investigation				
Location	NEWPCC Boardroom				
Regarding	Risk Workshop - Review of Historical Investigations, Most Probable Cause, Alternatives and Risk Management Review				
Attendees	Neil Abercrombie, Veolia John Amos, WWD Wastewater Operations John Barnard, WWD Wastewater Operations Shane Westover, WWD Wastewater Operations Mike Hargreaves, WWD Wastewater Operations Glen Greenaway, WWD Wastewater Operations Marc Goovaerts, WWD Wastewater Operations Dave Maxwell, WWD Wastewater Operations Richard Song, WWD Wastewater Planning Jong Hwang, WWD Wastewater Planning Chris Macey, AECOM Chris Lipscombe, AECOM Eymond Toupin, AECOM				neil.abercrombie@veolia.com jamos@winnipeg.ca jbarnard@winnipeg.ca swestover@winnipeg.ca mhargreaves@winnipeg.ca ggreenway@winnipeg.ca mgoovaerts@winnipeg.ca dmaxwell@winnipeg.ca rsong@winnipeg.ca jhwang@winnipeg.ca chris.macey@aecom.com chris.lipscombe@aecom.com eymond.toupin@aeocom.com
Distribution	All Present				
Minutes Prepared By	Eymond Toupin, P. Eng.				

PLEASE NOTE: If this report does not agree with your records of the meeting, or if there are any omissions, please advise, otherwise we will assume the contents to be correct.

Slides presented at the meeting are attached to these minutes.

Agenda for the meeting was as follows:

1. Introductions and Overview
2. Review of Historical Studies and Assessment of Most Probable Cause
3. Alternatives Review
4. Facilitated Discussion of Options, Operational Risk and Implementation Logistics
5. Summary and Next Steps

AECOM presented findings as summarized in the attached slides. Discussion and comments were exchanged between the attendees over the course of the meeting, the nature of which are summarized in the following:

- WWD operators generally concurred with the review of historical data and assessment of most probable cause which suggested that the source of contamination was the stagnant flow trapped in the bypass conduits (i.e. south secondary effluent conduit).
- WWD operators indicated water in south secondary effluent had at some point been sampled and showed very high bacterial levels (counts as high as 10^5 to 10^6).
- WWD operators indicated grab samples are collected approximately 10AM and that this precedes the diurnal peak into the plant which occurs closer to noon.
- WWD operators indicated that the chamber immediately downstream of the raw sewage overflow gate is accessible and confirmed that no leakage from that gate is evident (the floor of the chamber is 'dry'). This suggests that this gate is not a likely source of contamination.
- WWD operators inquired as to the volume of water stored in the unused south bypass conduit.
  - AECOM indicated a minimum dead storage volume (constantly present) of approximately 150,000L, with additional volume entering and leaving as a result of backflow from the UV discharge.
- AECOM presented the options considered to mitigate contamination of the final effluent.
  - With respect to the option of replacing previously removed gate YG15 in the effluent gate chamber, WWD operators inquired as to the impact on the volume of backwater in the bypass channels, AECOM to review and comment on in final technical memo.
  - WWD operators inquired about the possibility of replacing gate YG15 at some point downstream of the stop logs in the effluent gate chamber.
  - AECOM indicated this would require significant modifications to the effluent piping and likely a new chamber to accommodate the gate.
  - AECOM to review potential benefit/impact of the installation of gate at YG15 in reducing the volume of backwater exchanged with UV effluent in the outfall.
  - Option of only sealing stop logs in effluent gate chamber (and not replacing YG15) was discussed as a variant of Option 1.
  - Appeared to be general consensus that the installation of a new gate at or near the UV/outfall gate chamber would be difficult to construct, costly, and would introduce fairly significant operational risk.
  - Discussion focused on 3rd mitigative option involving pump from the south secondary effluent conduit to improve the quality of the water in this conduit.

- WWD wastewater planning inquired about the possibility of chlorinating to disinfect the south secondary effluent conduit.
    - WWD operators indicated it would be difficult to properly dose chlorine and that dechlorination would be required at some point downstream to ensure chlorinated water is not discharged to the environment.
- WWD operators indicated infrastructure already in place to allow water to be drawn from south secondary effluent conduit.
- Secondary effluent from the north secondary effluent conduit is used as wash water within the plant; effluent can also be drawn from the south conduit.
- Appeared to be general consensus that pumping from the south secondary effluent conduit was feasible option which could be implemented in the short term.
- AECOM suggested that grab samples intermittently be collected from the water pumped from the south secondary effluent conduit to verify its quality over time.
- WWD wastewater planning inquired about the operational costs of pumping from the south secondary effluent conduit.
- AECOM indicated pumping requirement will likely be small (in order of 5 to 10L/s) as such power consumption costs would be relatively insignificant, will review and comment on such in final TM.
- Veolia to provide available drawings of conduits connecting secondary effluent conduits to wash water pumps in grit building.
- AECOM to review the location and elevation of the offtake from the south secondary effluent conduit and to assess its effectiveness in refreshing/removing contaminated water from the conduit.
- Following the meeting, WWD operators provided AECOM a tour of the wash water pumps in the lower level of the grit facility.

Eymond Toupin, P. Eng.
Senior Engineer
Community Infrastructure
ET/pab

NEWPCC Fecal and E.coli Non-Compliance Investigation

Historical Review, Mitigation and Risk Workshop

October 28, 2014

Agenda

- Introductions
- Review of Historical Data and Assessment of Most Probable Cause
- Alternatives Review
- Facilitated Discussion of Options, Operational Risk, and Implementation Logistics
- Summary, Next Steps and Closure

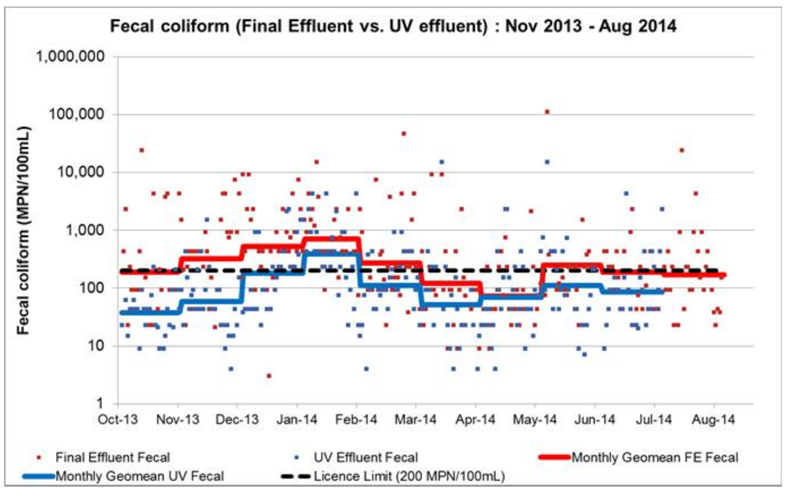
Review of Historical Data and Assessment of Most Probable Cause

Review of Historical Data and Assessment of Most Probable Cause

- Background
  - NEWPCC UV disinfection facility commissioned in mid-2006
  - Final effluent not meeting the 200/100mL license requirement for fecal coliform and E.coli

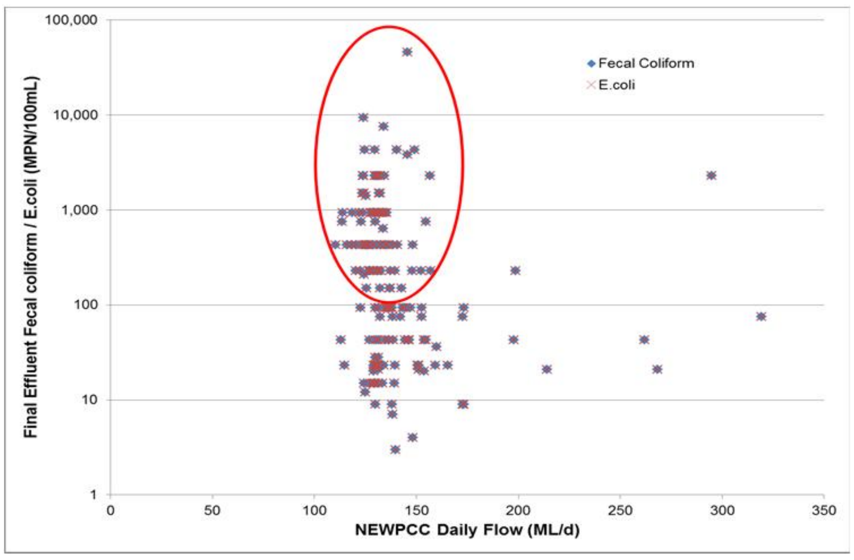
Review of Historical Data and Assessment of Most Probable Cause

- Highest values during periods of dry weather (Nov – Feb)
- Fecal and E.coli generally higher in final vs UV effluent



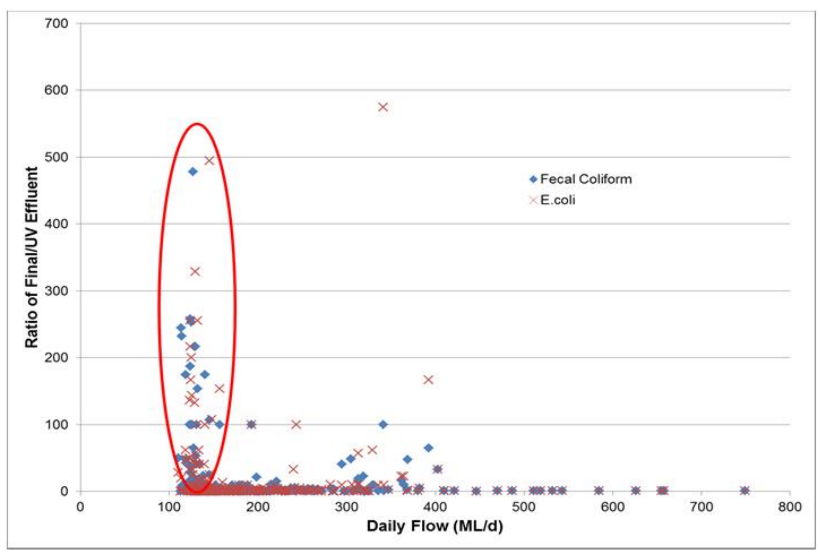
Review of Historical Data and Assessment of Most Probable Cause

- Largest fecal and E.coli counts in final effluent at low flows (<150ML/d)



Review of Historical Data and Assessment of Most Probable Cause

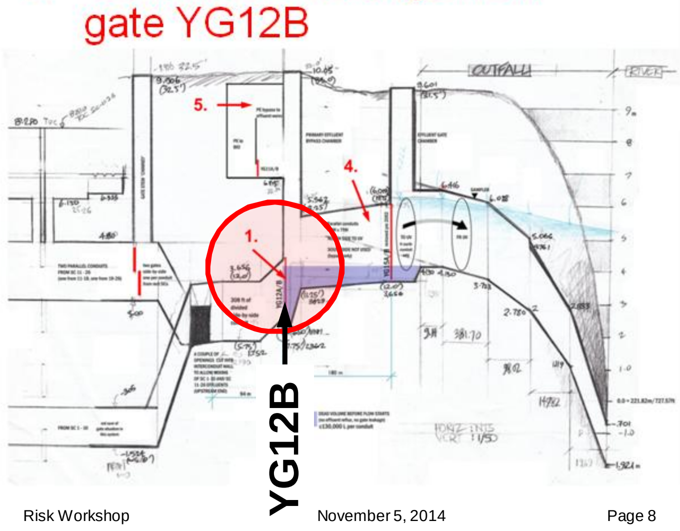
- Largest ratio of final to UV effluent also at low flows (<150ML/d)

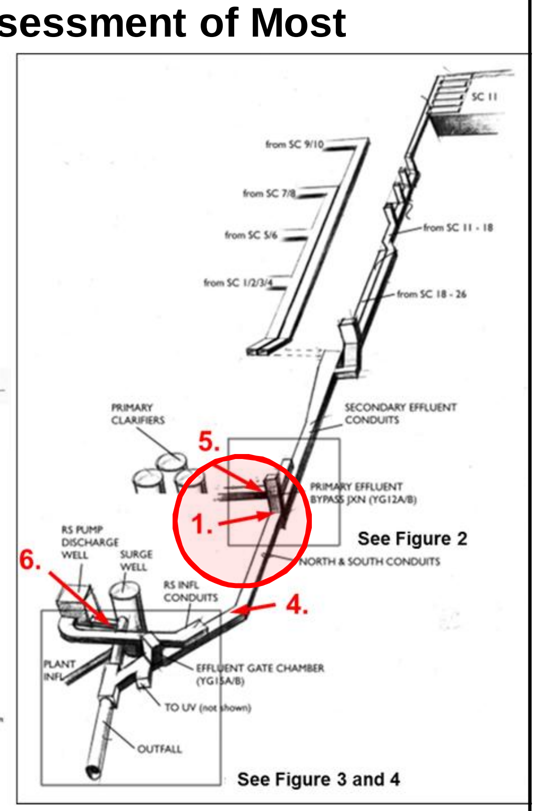


Review of Historical Data and Assessment of Most Probable Cause

- Potential Sources of Contamination

1. Continuous leakage from gate YG12B

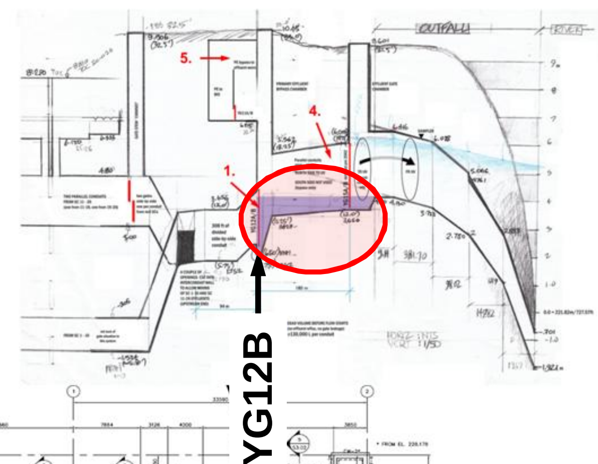


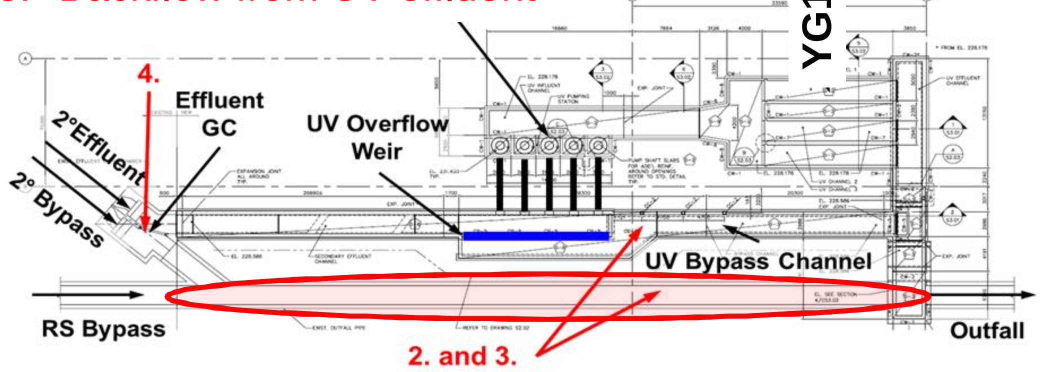


Review of Historical Data and Assessment of Most Probable Cause

- Potential Sources of Contamination

2. Stagnated flow trapped in bypass conduits
3. Backflow from UV effluent

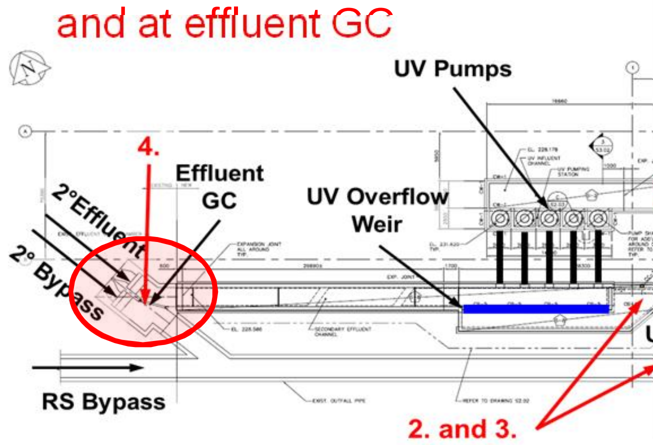


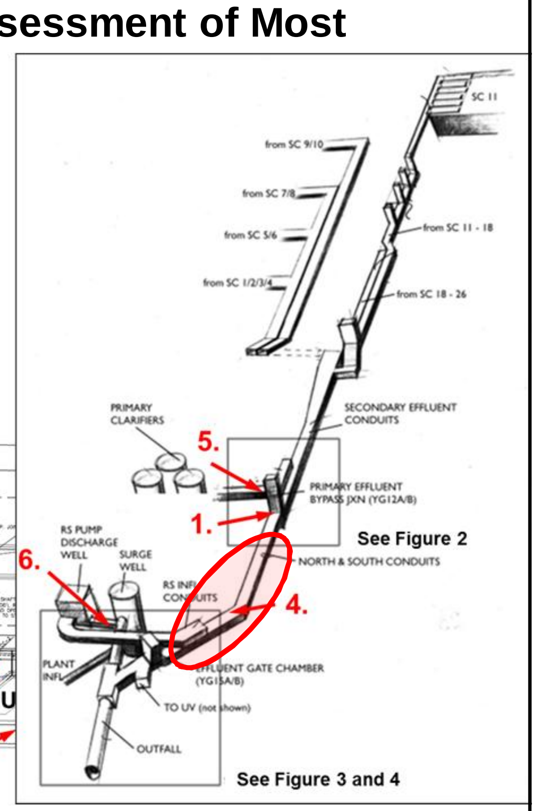


Review of Historical Data and Assessment of Most Probable Cause

- Potential Sources of Contamination

4. Continuous leakage between 2° effluent conduits and at effluent GC

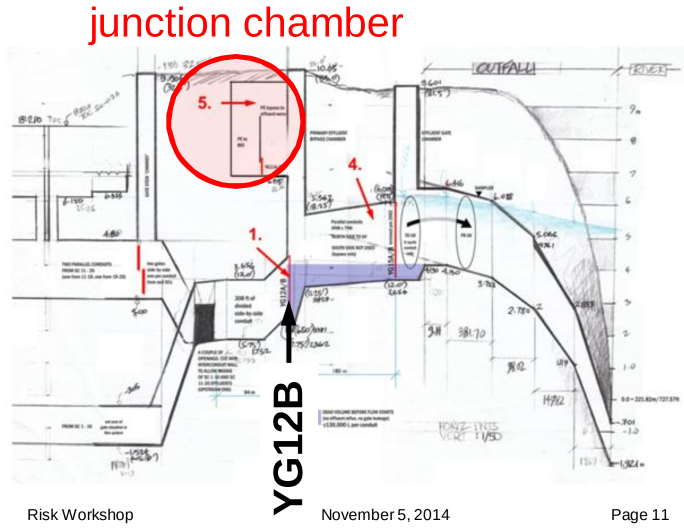


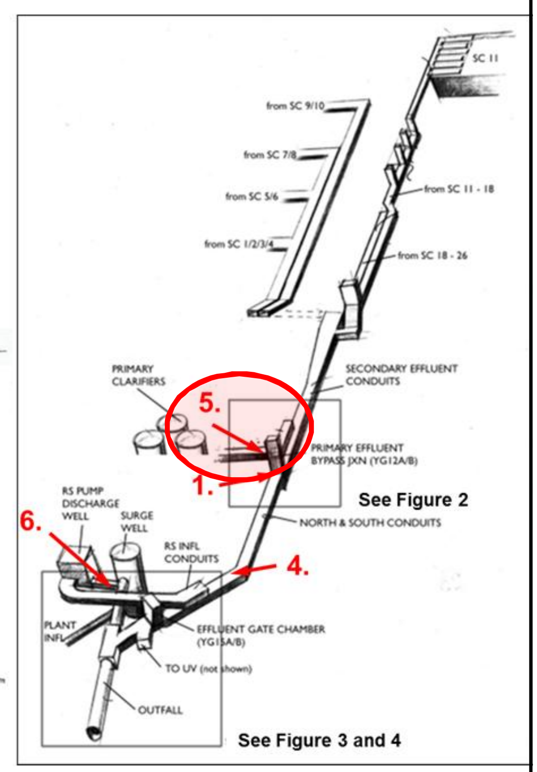


Review of Historical Data and Assessment of Most Probable Cause

- Potential Sources of Contamination

5. 1° effluent overflow at junction chamber

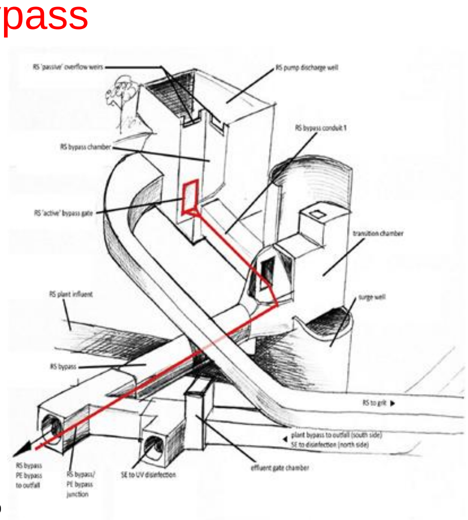


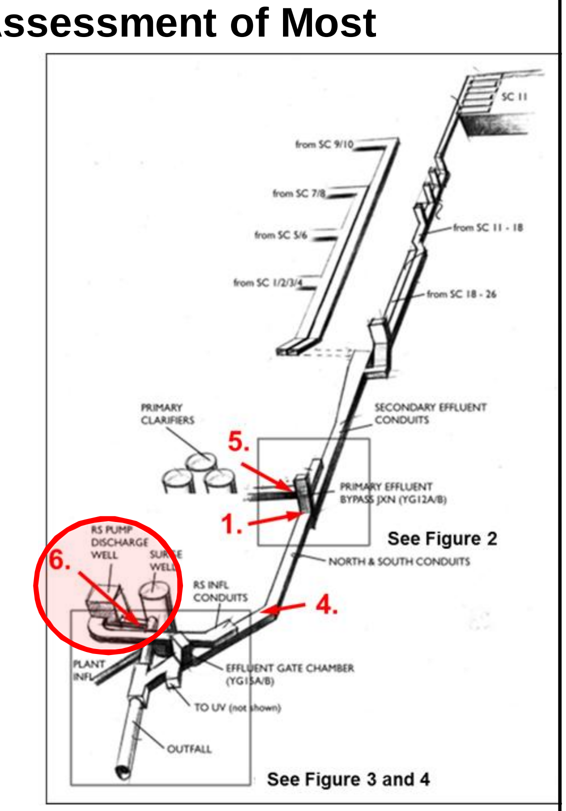


Review of Historical Data and Assessment of Most Probable Cause

- Potential Sources of Contamination

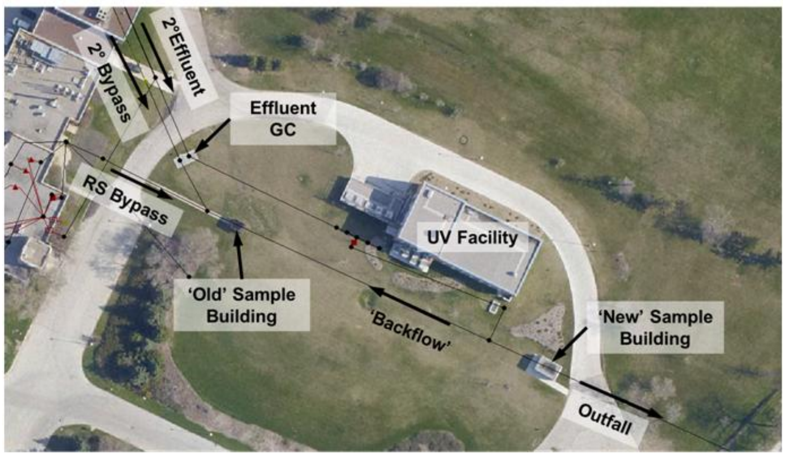
6. Occasional raw sewage bypass





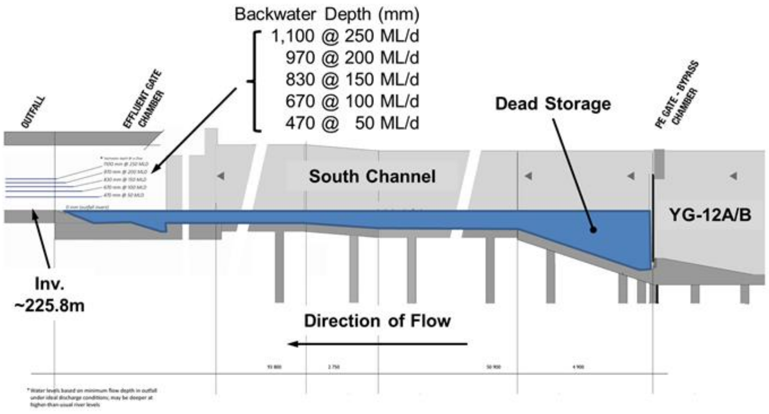
Review of Historical Data and Assessment of Most Probable Cause

- Observation of Backflow (November, 2006)
  - During inspection of effluent conduit by Civil Maintenance
  - UV pumps accidentally restarted, rapid backflow up bypass conduits
  - Physical observation of backflow confirmed



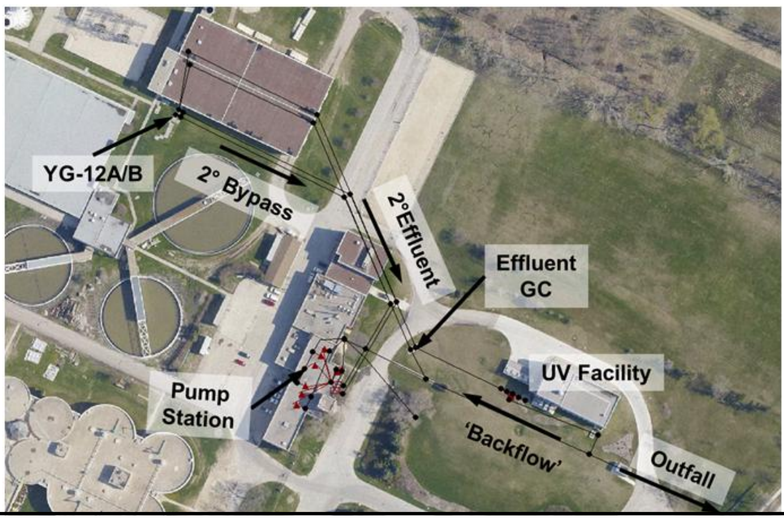
Review of Historical Data and Assessment of Most Probable Cause

- Hydraulic Analysis
  - Depth of backwater in South Channel a function of flow rate in outfall
  - Even under no flow, effluent trapped as dead storage in South Channel between YG12B and Effluent GC



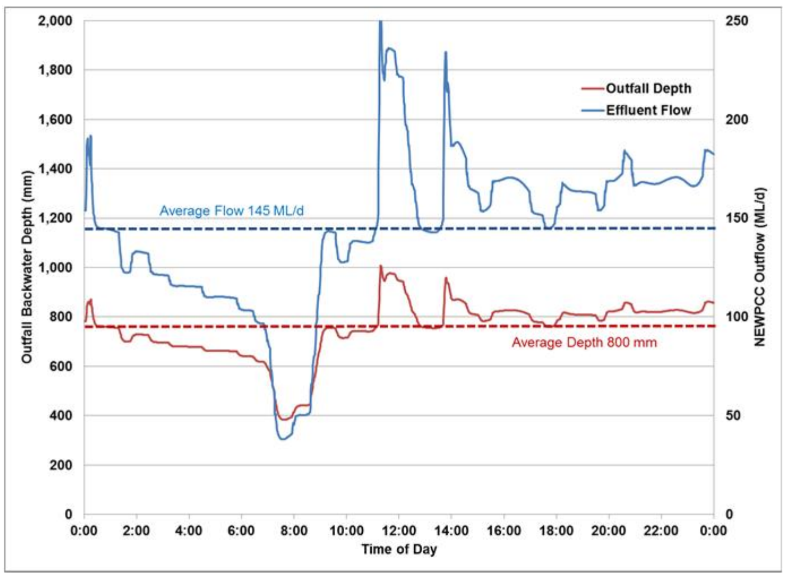
Review of Historical Data and Assessment of Most Probable Cause

- Hydraulic Analysis
  - Hydraulic model of effluent conduits and outfall created to analyze conditions during DWF
  - Applied typical NEWPCC DWF data (March 2011)



Review of Historical Data and Assessment of Most Probable Cause

- Hydraulic Analysis
  - Over course of typical day, level in outfall and bypass conduits fluctuate in response to changing flows



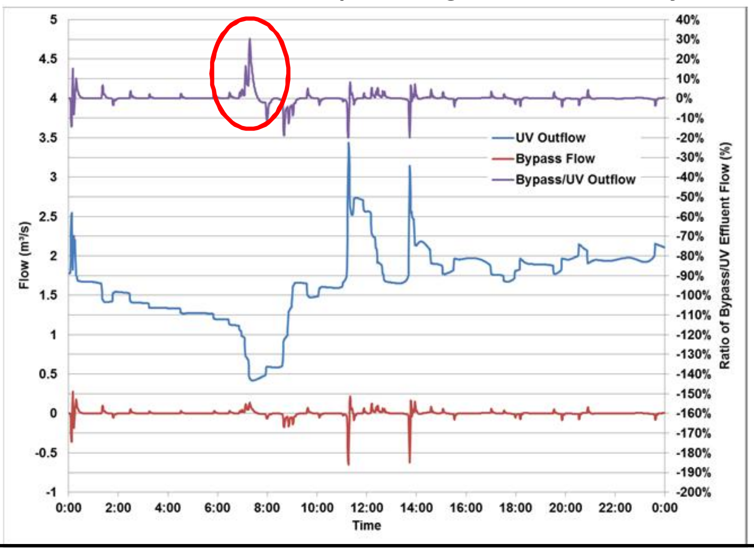
Review of Historical Data and Assessment of Most Probable Cause

- Hydraulic Analysis
  - Ebb and flow in and out of bypass conduit -0.6 (in) to 0.2 m³/s (out)

Risk Workshop

Review of Historical Data and Assessment of Most Probable Cause

- Hydraulic Analysis
  - Ratio of 'bypass flow' to UV flow potentially as high as 30% at ~7:30AM
  - Potential for contamination depending on time of day sample is taken



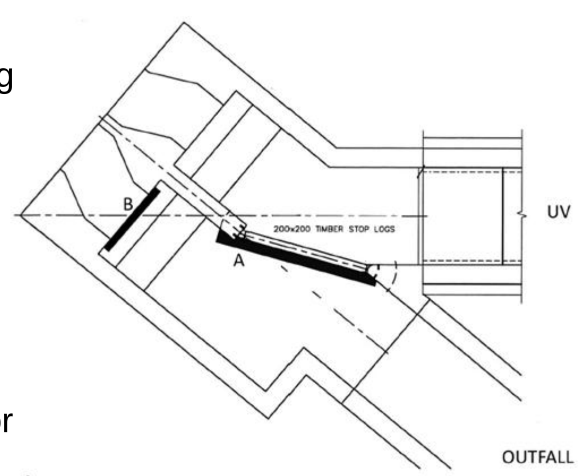
Risk Workshop

Alternatives Review

Alternatives Review

1. Improve Watertightness of Stop Log Septum in Effluent Gate Chamber and Install New YG15

- North and South conduits separated by wooden stop logs
- All that could be constructed during short shut down, some leakage of 2° effluent (likely in order of a few L/s)
- Replace removed YG15 to isolate 'dead storage' in South conduit
- Some of the gate infrastructure already in place
- Would add second gate to open for 2° bypass



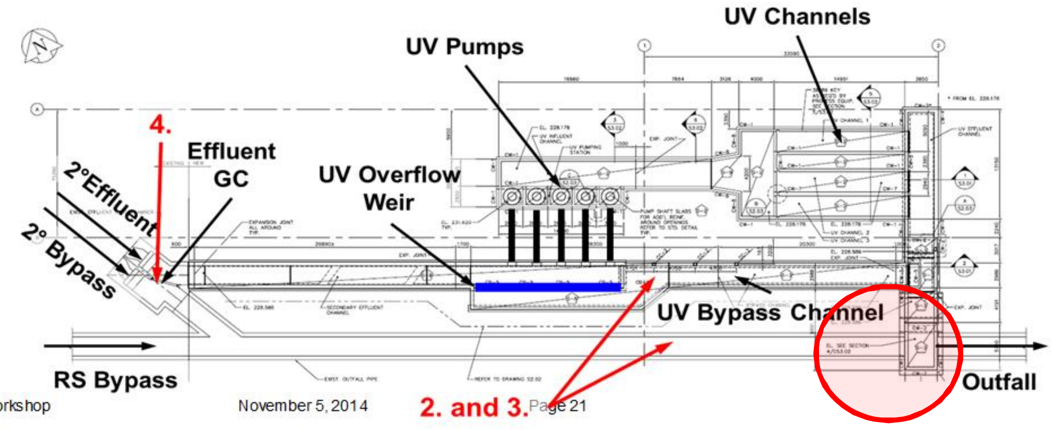
A Construct impermeable barrier (concrete? frp?) on 'dry' side of stoplog septum wall to eliminate leakage

B Install gate YG-15B to prevent reflux into south conduit and to contain contaminated fluid (from YG-12 leakage)

Alternatives Review

2. Add Gate at/near UV Outlet
   Outfall Gate Chamber

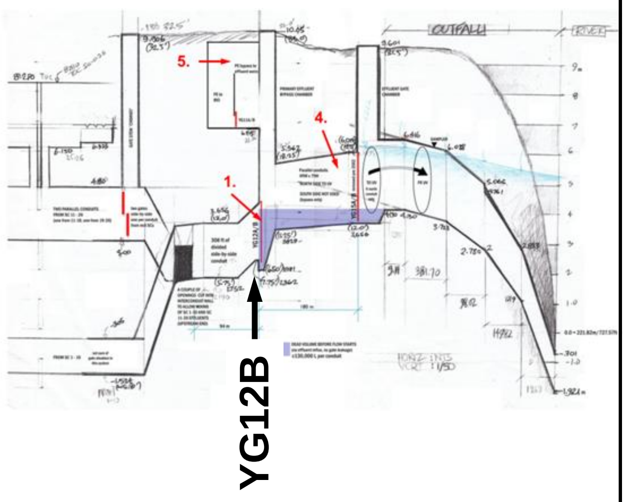
- Junction provides no barrier to reflux in/out of bypass conduits
- Gate provides barrier to contaminated fluid possibly leaking into bypass conduits
- Would be significant change to existing system – raw sewage bypass can currently occur passively, i.e. without gate opening required



Alternatives Review

3. Pumping Out South Conduit

- Dewatering South Conduit at YG12B
- Would remove stagnant bottom layer to reduce concentration of contaminants
- Pump into adjacent North Conduit for disinfection
- 5 to 6L/s would likely be sufficient to turn over water in ‘dead storage’ in about 8 hours



Alternatives Review

- Cost and Operational Risk of Alternatives

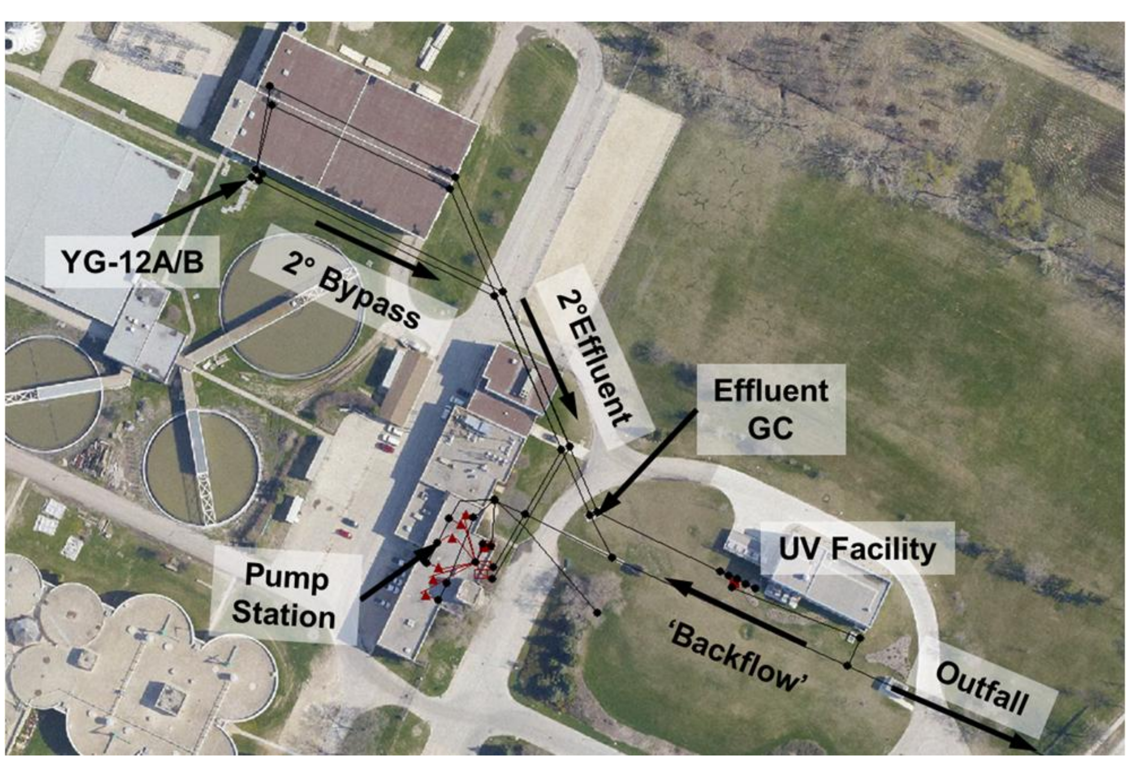
Alternative	Relative Cost	Operational Complexity/Risk	Other Factors
1 - Improve Watertightness of Stop Logs and Install New YG15 EGC	$150,000++	Medium	Moderate risk profile and high probability of success. May require supplemental dewatering as per #3.
2 - Add Gate at UV Outlet-Outfall Junction Chamber	$700,000++	High	Greatest isolation of potential contamination sources.
3 - Pumping Out the South Conduit	$40,000+ for temporary installation $70,000++ for permanent installation with controls/monitoring	Low	Lowest level of isolation from contamination sources but very low cost and may ultimately be required in conjunction with other measures.

Facilitated Discussion of Options, Operational Risk, and Implementation Logistics

Facilitated Discussion of Options, Operational Risk, and Implementation Logistics

Alternative	Relative Cost	Operational Complexity/Risk	Other Factors
1 - Improve Watertightness of Stop Logs and Install New YG15 EGC	$150,000++	Medium	Moderate risk profile and high probability of success. May require supplemental dewatering as per #3.
2 - Add Gate at UV Outlet-Outfall Junction Chamber	$700,000++	High	Greatest isolation of potential contamination sources.
3 - Pumping Out the South Conduit	$40,000+ for temporary installation $70,000++ for permanent installation with controls/monitoring	Low	Lowest level of isolation from contamination sources but very low cost and may ultimately be required in conjunction with other measures.

Facilitated Discussion of Options, Operational Risk, and Implementation Logistics



Summary

Summary, Next Steps and Closure

- Consistently higher fecal and E.coli counts in final vs UV effluent
  - particularly during DWF
- Potential sources of contamination of final effluent have been identified
  - Gates, stop logs, backflow of UV effluent, stagnant dead storage
- Hydraulic analysis and physical observation confirm ebb and flow in bypass conduits likely occurring as result of diurnal variation in flow
- Sampling time may affect effluent quality measured

Summary, Next Steps and Closure

- Remedial Alternatives

Alternative	Relative Cost	Operational Complexity/Risk	Other Factors
1 - Improve Watertightness of Stop Logs and Install New YG15 EGC	$150,000++	Medium	Moderate risk profile and high probability of success. May require supplemental dewatering as per #3.
2 - Add Gate at UV Outlet-Outfall Junction Chamber	$700,000++	High	Greatest isolation of potential contamination sources.
3 - Pumping Out the South Conduit	$40,000+ for temporary installation $70,000++ for permanent installation with controls/monitoring	Low	Lowest level of isolation from contamination sources but very low cost and may ultimately be required in conjunction with other measures.

Thank You

Appendix 5
AECOM TM – November 14

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204 477 5381 tel
204 284 2040 fax

Technical Memorandum

To	Neil Abercrombie, Veolia	Page	1
CC	File		
Subject	Recommendation for Mitigative Alternatives		
From	Eymond Toupin, Chris Lipscombe and Chris Macey, AECOM		
Date	December 19, 2014	Project Number	60333011 (500)

1. Risk Workshop

A Risk Workshop to review mitigative alternatives was completed on October 28, 2014. The minutes of the workshop are attached to this document.

2. Review of Alternatives

As a result of the risk workshop, three alternatives were selected for more detailed review:

1) Installation of new gate YG15 in the effluent gate chamber (EGC).
2) Improving watertightness of the stop logs in the EGC.
3) Refreshing water stored in the unused south conduit by dewatering with the flushing water pumps in the grit building.

In order to evaluate the potential effectiveness of these options, the InfoWorks CS hydraulic model of the outfall conduits (Figure 2.1) was utilized. The water quality modelling feature available in InfoWorks CS was used to assess the potential effectiveness of the alternatives on the coliform levels in the final effluent. The following assumptions were made in the analysis:

a) Water quality of 100 coliform/100 mL in UV effluent (i.e. half of the license requirement of 200 MPN /100 ml)
b) Average dry weather flow of 130 ML/d (1.5 m^3/s) was applied with a typical diurnal inflow pattern to NEWPCC
c) Continuous leakage of 1 L/s from gate YG12B (roughly based on allowable leakage from sluice gate according to AWWA C560 for Cast-Iron Slide Gates)
d) Continuous leakage of 5 L/s from stop log septum in EGC (roughly based on the total length of sealing surfaces between the stop logs and a potential leakage rate per unit length of wetted perimeter)
e) Water quality of leakage from gate YG12B and stop logs of 100,000 coliform/100 mL

The results of the hydraulic analysis are intended to illustrate the potential diurnal variation in the effluent water quality. The 24-hour geometric mean shown in Figure 2.2, Figure 2.3, Figure 2.4, Figure 2.6, and Figure 2.7 represent the geometric mean of the coliform counts predicted by the hydraulic model at approximately 1 minute intervals over the course of a typical day (i.e. at average dry weather flow (ADWF)). The effluent quality predicted by the model would not necessarily accurately represent the results obtained by grab sample at any particular time or day. Actual effluent water quality will vary and be a function of influent water quality and flow and of the operation and performance of the influent pumps and overall plant processes.

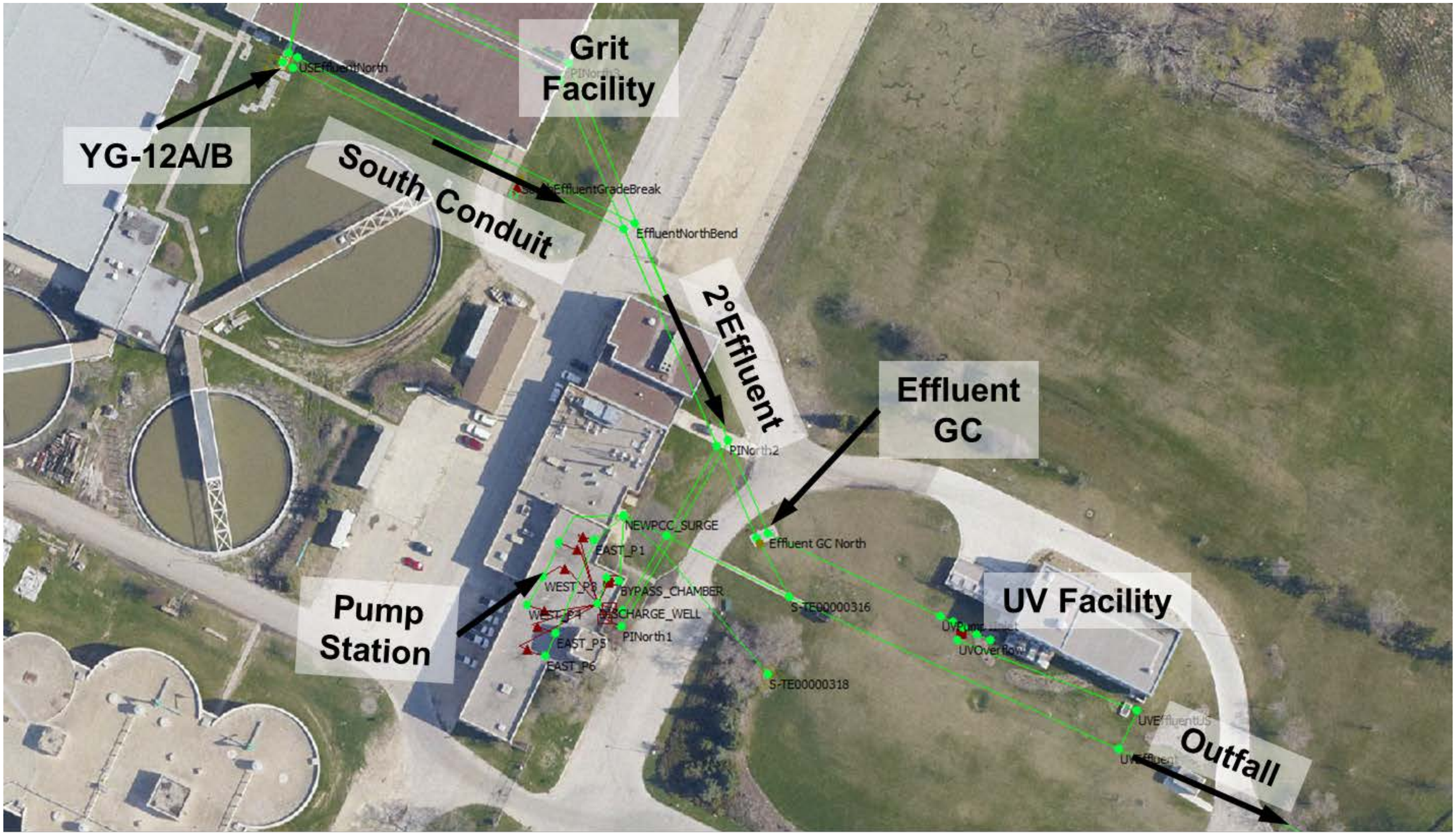

Figure 2.1 – InfoWorks CS Model of NEWPCC Outfall and Bypass Conduits

2.1 Existing Conditions

The hydraulic model representative of existing conditions was run to assess baseline conditions in terms of final effluent water quality.

The results of the analysis, illustrated in Figure 2.2, indicate water quality would vary over the course of the day as a result of the ebb and flow of water from the unused south conduit contaminating the final effluent. Under existing conditions, the geometric mean of the coliform counts predicted by the model over the course of the 24 hour modelling period is 290 / 100mL.

On average, this represents an additional 190 counts per 100 mL over the assumed quality of the UV effluent. Coincidentally, this is roughly consistent with the average difference measured between final and UV effluent grab samples collected over the last year by the WWD.

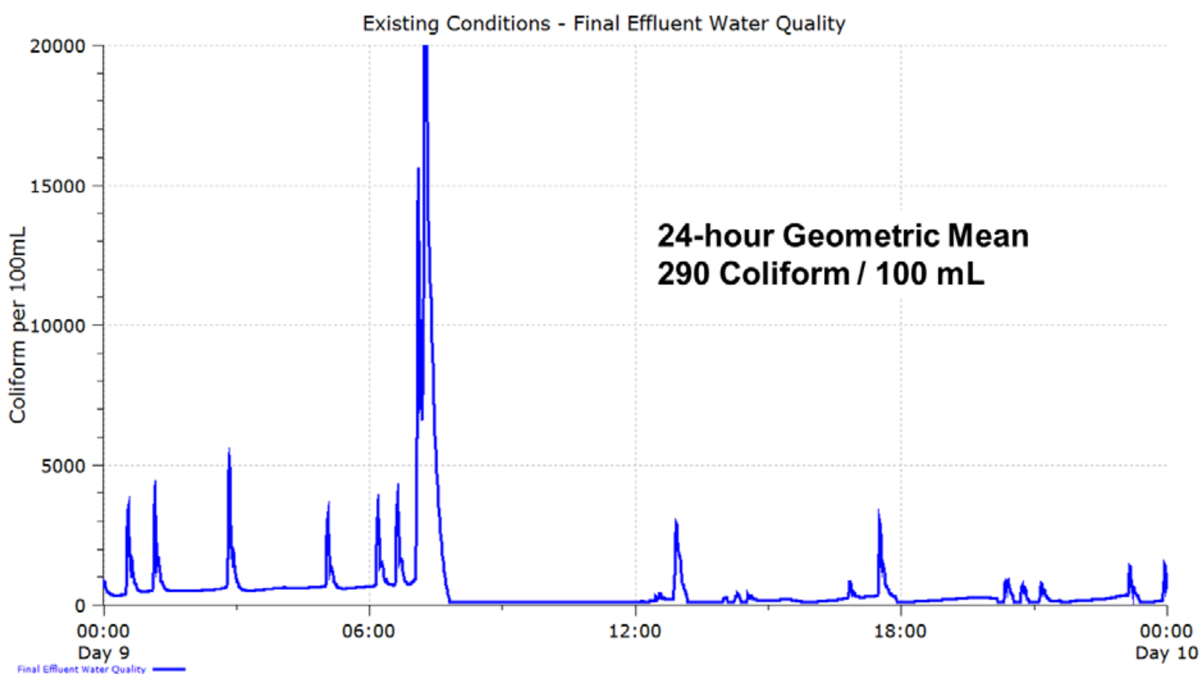

Figure 2.2 – 24 Hour Diurnal of Final Effluent Water Quality Predicted by the InfoWorks CS Hydraulic Model – Existing Conditions

2.2 New Gate YG15 in Effluent Gate Chamber

The benefit of the installation of a new gate YG15 in the EGC was assessed by assuming that the new gate would completely isolate any potential leakage from existing gate YG12B (estimated at 1 L/s). However, the proposed gate would have no impact on potential leakage from the stop log septum in the effluent gate chamber as its most practical and easily constructible location would be upstream of the stop logs. The gate would, however, effectively isolate the 'dead storage' volume in the south conduit upstream of the effluent gate chamber.

The results of the hydraulic analysis, illustrated in Figure 2.3, indicate that the proposed gate alone would likely provide only a marginal benefit in terms of improved quality of the final effluent in reducing the geometric mean of coliform counts from 290 to 280 per 100 mL. This is due to the continued leakage of the estimated 5 L/s from the stop logs in the EGC downstream of the proposed gate.

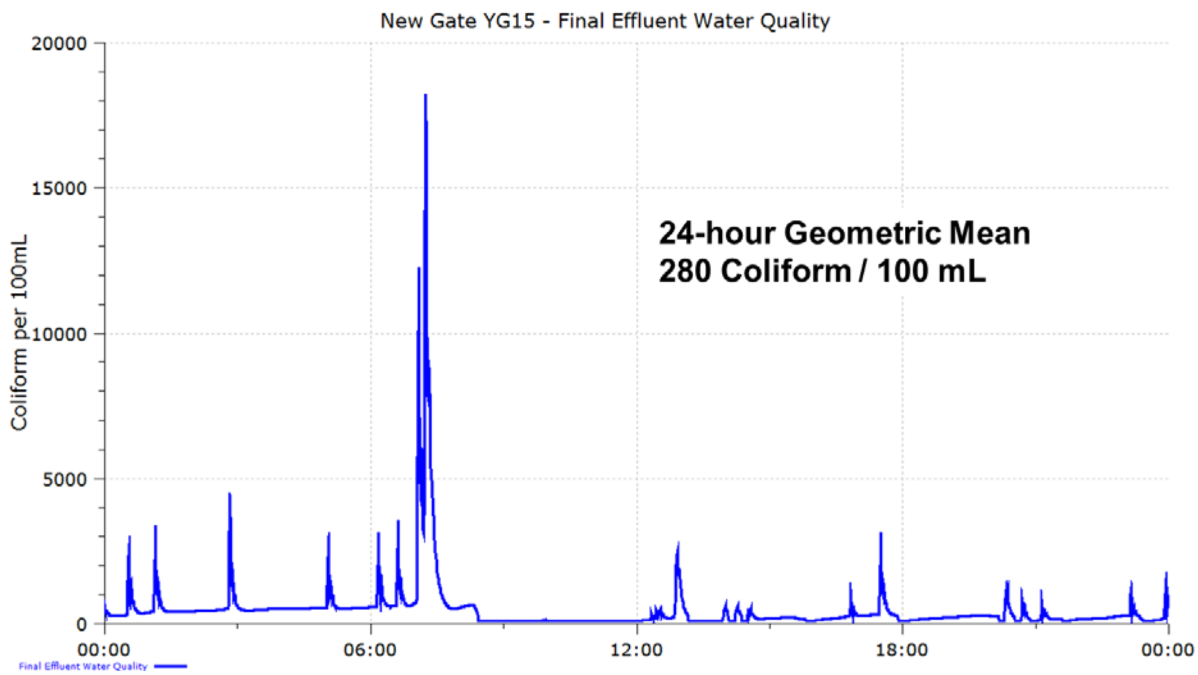

Figure 2.3 – 24 Hour Diurnal Final Effluent Water Quality Predicted by the InfoWorks CS Hydraulic Model – New Gate YG15

2.3 Seal Stop Log Septum in Effluent Gate Chamber

The benefit of sealing the stop logs in the effluent gate chamber was assessed assuming that this would prevent all leakage from the stop logs (currently estimated at 5 L/s). Logistically we believe this is technically feasible by a repair such as pouring a watertight wall over the face of the gates. This would require one or more temporary shutdowns of the treatment plant to adequately isolate the work area in the EGC from the outfall backwater but should be technically feasible.

The results of the analysis, illustrated in Figure 2.4, indicate that sealing of the stop logs could significantly reduce contamination of the final effluent to only 20 coliform counts above the estimated 100 per 100 mL in the UV effluent. However, it appears that this approach would not be sufficient to completely eliminate the potential for contamination of the final effluent, particularly at the diurnal low (at approximately 7:30 a.m.) when water from the unused south conduit mixes with UV effluent.

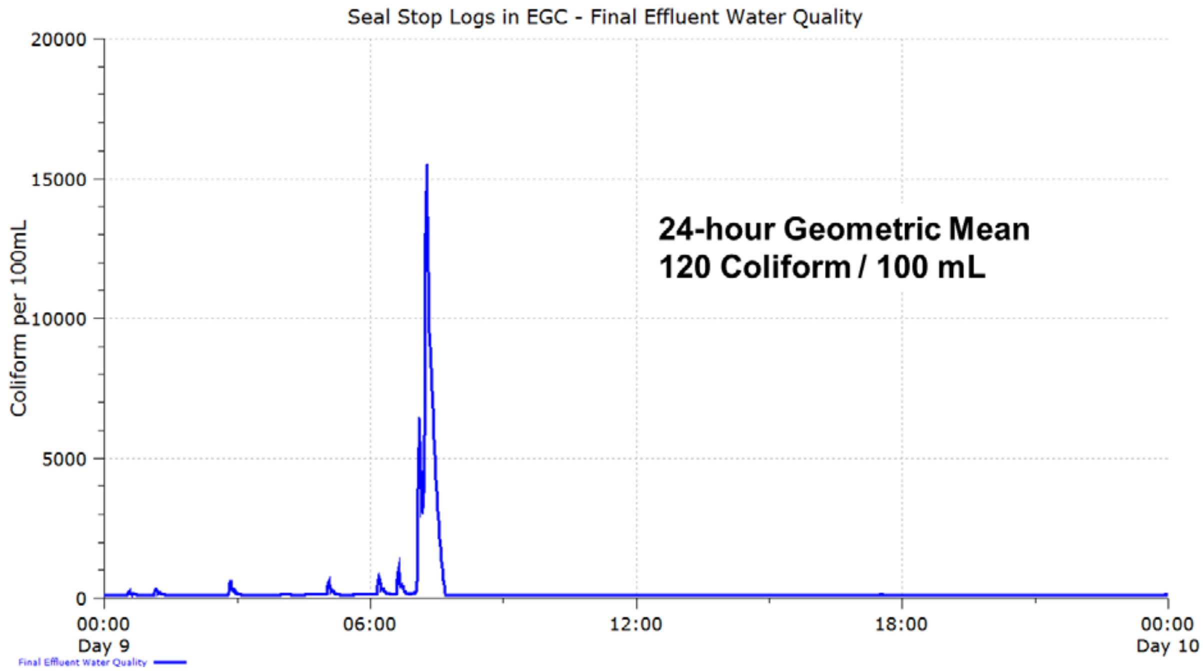

Figure 2.4 – 24 Hour Diurnal Final Effluent Water Quality Predicted by the InfoWorks CS Hydraulic Model – Seal Stop Logs

2.4 Dewater Unused South Conduit

To simulate this alternative, a small pump was added to the model which would draw from the south conduit at the same point as the flushing water pumps in the Grit Facility as shown in Figure 2.5. A constant dewatering rate of 6 L/s (equivalent to the estimated combined leakage from gate YG12B and from the stop logs in the EGC) was assumed for the analysis.

The results (Figure 2.6) indicate that dewatering could also be very effective at reducing contamination of the final effluent. However, as was the case for sealing of the stop logs, this approach would not necessarily eliminate potential contamination of the final effluent. This is also based on the dewatering rate being approximately equal to the total rate of leakage into the south conduit, a value which has been estimated herein but needs to be verified through measurements in a controlled test after dewatering.

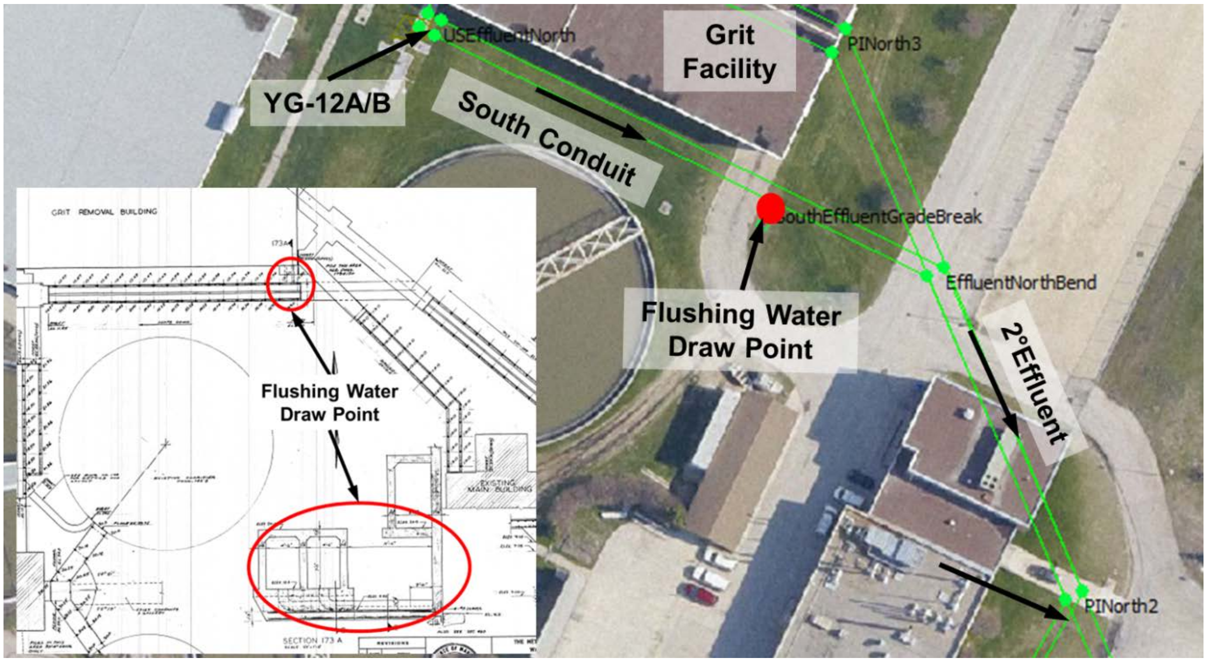

Figure 2.5 – Dewater South Effluent Conduit via Flushing Water Offtake

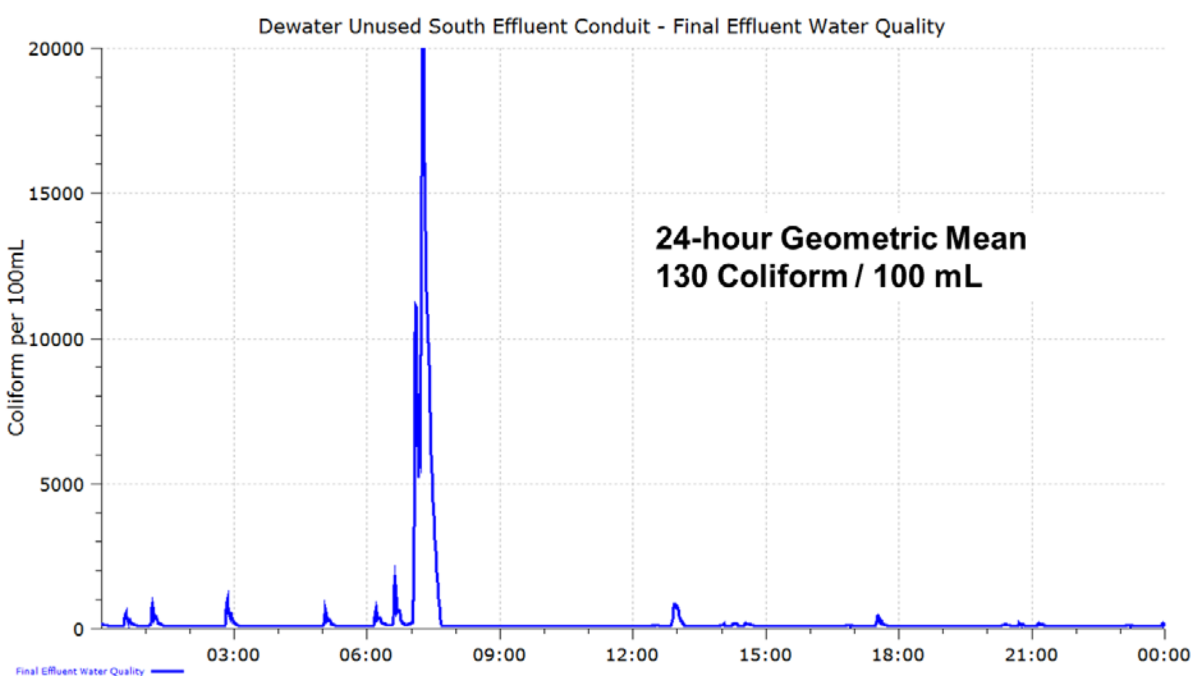

Figure 2.6 – 24 Hour Diurnal Final Effluent Water Quality Predicted by the InfoWorks CS Hydraulic Model – Dewater South Effluent Conduit

2.5 Dewater South Conduit and Seal Stop Log Septum in Effluent Gate Chamber

The combination of dewatering of the south conduit (at a constant rate of 6L/s) and sealing the stop logs in the effluent gate chamber was examined in the model. The modelling suggests this could effectively prevent contamination of the final effluent (Figure 2.7).

These findings are based on the assumption that the stop log septum can be completely sealed and that there are no other sources of contamination downstream of the effluent gate chamber. The analysis also does not take into account any other sources of recontamination which may exist from previous bypasses and overflows such as debris within the pipe or bacterial film on pipe walls in the unused conduits. However, dewatering via the flushing water offtake would continuously refresh the water in the unused south conduits with UV effluent which would help prevent future recontamination of the final effluent. From this perspective, the provision of a new gate YG15 in the effluent gate chamber could be somewhat detrimental as it would inhibit the ability to refresh the water in the south conduit.

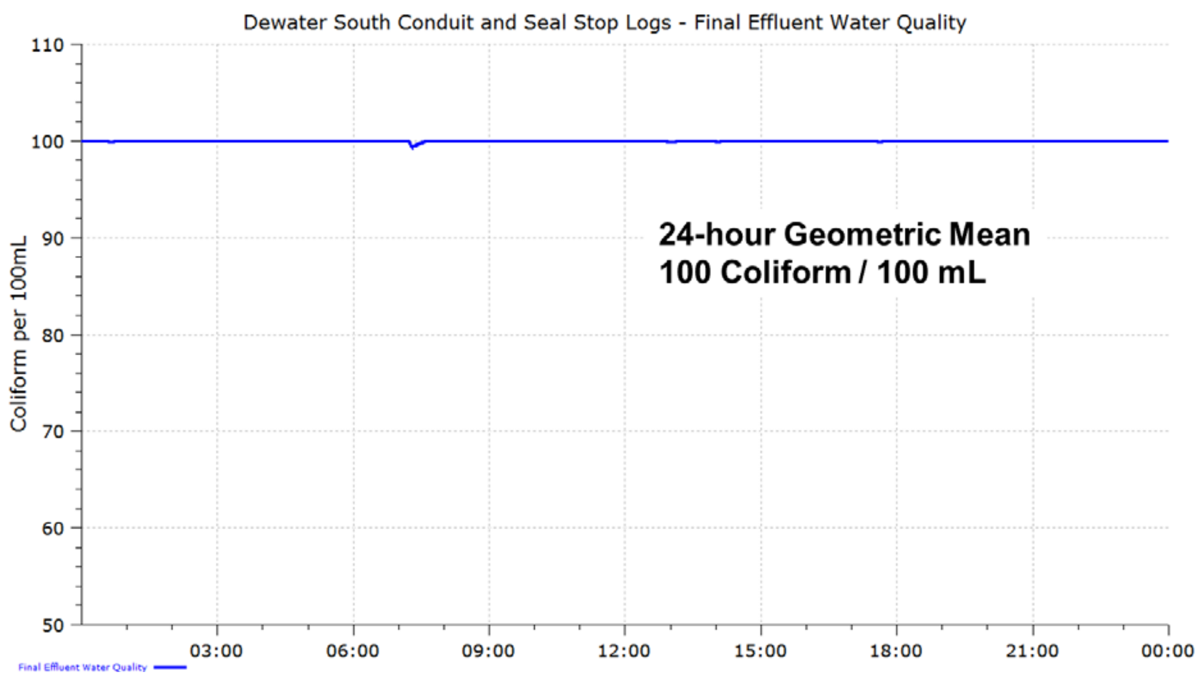

Figure 2.7 – 24 Hour Diurnal Final Effluent Water Quality Predicted by the InfoWorks CS Hydraulic Model – Dewater South Effluent Conduit and Seal Stop Logs in EGC

2.6 Summary

The assessment of the mitigative alternatives using the hydraulic model is summarized in Table 2.1. The analysis suggests that:

- the installation of a new gate YG15 would likely not significantly improve the quality of the final effluent;
- sealing of the stop logs in the EGC or dewatering of the south conduit would both be potentially effective at improving quality but by themselves would likely not eliminate potential contamination of the final effluent;
- the combination of dewatering of the south conduit and sealing of the stop logs in the EGC have the potential to reduce contamination of the final effluent to a negligible amount.

Table 2.1 – Potential Impact of Mitigative Alternatives of Final Effluent Water Quality

Alternative	Modelled 24-Hour Geometric Average of Coliforms per 100 mL in Final Effluent
Existing Conditions	290
Install Gate YG15 in EGC	280
Seal Stop Logs in EGC	120
Dewater South Conduit	130
Dewater South Conduit and Seal Stop Logs in EGC	100

3. Conclusions and Recommendations

A number of potential measures were identified to mitigate bacterial contamination of the NEWPCC final effluent were previously identified and reviewed at the Risk Workshop of October 28, 2014. As a result of the workshop three alternatives were targeted for further review:

1) Installation of new gate YG15 in the EGC
2) Improving watertightness of stop logs in the EGC
3) Refreshing water stored in the unused south conduit by dewatering with the flushing water pumps in the grit building.

Hydraulic and water quality analysis was completed to review the effectiveness of these alternatives with the following findings:

- Installation of a new gate YG15 would likely not significantly improve the quality of the final effluent;
- Sealing of the stop logs in the EGC or dewatering of the south conduit would both be potentially effective at improving quality but by themselves would likely not eliminate potential contamination of the final effluent;
- Combined dewatering of the south conduit and sealing of the stop logs in the EGC have the potential to reduce contamination of the final effluent to a negligible amount.

The results of the analysis were combined with the previous assessments of costs and operational complexity and risk (table) to identify the recommended phased approach to mitigate bacterial contamination of the final effluent from the NEWPCC.

1) Dewatering of the south conduit using the flushing water offtake is recommended as the first approach to be implemented.

    a. This approach has the lowest cost, introduces little operational complexity or risk and is anticipated to provide significant improvement in effluent quality.

    b. If the existing flushing water piping and pumps can be used for dewatering, this option requires no capital costs to implement and relatively insignificant operational costs. If piping modifications and/or separate pumps are required as part of a more permanent solution, these would incur relatively low capital and operational costs.

    c. Assuming power consumption represents the bulk of the operating costs, it is estimated dewatering of the south conduit would represent an annual operating cost of roughly $1,000 (based on continuous dewatering at 6 L/s).

    d. It is further recommended that the effectiveness of dewatering be evaluated by routinely monitoring the quality of the water drawn from the south conduit as well as continuing to measure quality in both the UV and final effluents. This would determine whether additional measures are required or whether the dewatering process needs to be modified to improve its effectiveness (continuous vs intermittent dewatering, rate and/or frequency of dewatering, etc…). As indicated previously, the analysis was completed assuming continuous dewatering.

    e. In conjunction with monitoring the effectiveness of the effluent quality consideration should be given to develop a protocol to reasonably estimate the rate of leakage into the south conduit.

2) Sealing of the stop logs in the EGC also appears to be an equally effective means of improving the quality of the final effluent.

    a. However, this would involve more significant capital costs than dewatering of the south conduit and would require one or more temporary shutdowns of the treatment plant to adequately isolate the work area in the EGC from the outfall.

    b. It is therefore, recommended that this option be further investigated only after the effectiveness of dewatering the south conduit has been evaluated and optimized. If further reduction in contamination of the final effluent is required beyond that which dewatering can provide, then sealing of the stop logs should be investigated and implemented as a supplementary measure.

3) The analysis suggests that the installation of new gate YG15 in the EGC would not by itself significantly reduce contamination of the final effluent.

    a. This measure would also involve significant capital costs for the supply and installation of the gate.

    b. Similar to the sealing of the stop logs, this would require one or more temporary plant shutdowns to isolate the work area from the outfall.

c. This alternative introduces operational complexity and risk in that an additional gate needs to be operated when south conduit is activated by a bypass or overflow.

d. Also, the installation of the gate would impede the ability to dewater the south conduit using the flushing water system which may be a more effective means of preventing contamination of the final effluent.

e. It is recommended that the gate not be installed unless the other means recommended above prove to be ineffective at improving the quality of the final effluent.

Table 3.1 - Summary of Remedial Alternatives to Minimize Recontamination of UV Effluent

Alternative	Approximate Capital Cost	Operational Complexity/Risk	Potential Effectiveness
1 - Dewatering the South Conduit via Flushing Water System	<$50,000	Low	Could significantly reduce contamination of final effluent.
2 - Improve Watertightness of Stop Logs in EGC	<$100,000	Low – Would require temporary shutdown(s) for implementation but would have no long term impact on plant operation.	Could significantly reduce contamination of final effluent
3 - Install New YG15 in EGC	$200,000	Medium – Introduces additional gate to operate.	Limited benefit by itself, not recommended until alternatives 1 and 2 have been implemented and evaluated.

PROVINCE OF MANITOBA
Dec 22, 2014
E.D.J.
TOUPIN
Member
23484
REGISTERED PROFESSIONAL ENGINEER

Eymond Toupin, P. Eng.
Municipal Engineer
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Minutes of Meeting

Date of Meeting	October 28, 2014	Start Time	1:00PM	Project Number	60333011 (300)
Project Name	NEWPCC - Fecal and E.coli Non-Compliance Investigation				
Location	NEWPCC Boardroom				
Regarding	Risk Workshop - Review of Historical Investigations, Most Probable Cause, Alternatives and Risk Management Review				
Attendees	Neil Abercrombie, Veolia	neil.abercrombie@veolia.com			
	John Amos, WWD Wastewater Operations	jamos@winnipeg.ca			
	John Barnard, WWD Wastewater Operations	jbarnard@winnipeg.ca			
	Shane Westover, WWD Wastewater Operations	swestover@winnipeg.ca			
	Mike Hargreaves, WWD Wastewater Operations	mhargreaves@winnipeg.ca			
	Glen Greenaway, WWD Wastewater Operations	ggreenway@winnipeg.ca			
	Marc Goovaerts, WWD Wastewater Operations	mgoovaerts@winnipeg.ca			
	Dave Maxwell, WWD Wastewater Operations	dmaxwell@winnipeg.ca			
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	Chris Macey, AECOM	chris.macey@aecom.com			
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	Eymond Toupin, AECOM	eymond.toupin@aeocom.com			
Distribution	All Present				
Minutes Prepared By	Eymond Toupin, P. Eng.				

PLEASE NOTE: If this report does not agree with your records of the meeting, or if there are any omissions, please advise, otherwise we will assume the contents to be correct.

Slides presented at the meeting are attached to these minutes.

Agenda for the meeting was as follows:

1. Introductions and Overview
2. Review of Historical Studies and Assessment of Most Probable Cause
3. Alternatives Review
4. Facilitated Discussion of Options, Operational Risk and Implementation Logistics
5. Summary and Next Steps

AECOM presented findings as summarized in the attached slides. Discussion and comments were exchanged between the attendees over the course of the meeting, the nature of which are summarized in the following:

- WWD operators generally concurred with the review of historical data and assessment of most probable cause which suggested that the source of contamination was the stagnant flow trapped in the bypass conduits (i.e. south secondary effluent conduit).
- WWD operators indicated water in south secondary effluent had at some point been sampled and showed very high bacterial levels (counts as high as 10^5 to 10^6).
- WWD operators indicated grab samples are collected approximately 10AM and that this precedes the diurnal peak into the plant which occurs closer to noon.
- WWD operators indicated that the chamber immediately downstream of the raw sewage overflow gate is accessible and confirmed that no leakage from that gate is evident (the floor of the chamber is 'dry'). This suggests that this gate is not a likely source of contamination.
- WWD operators inquired as to the volume of water stored in the unused south bypass conduit.
    - AECOM indicated a minimum dead storage volume (constantly present) of approximately 150,000L, with additional volume entering and leaving as a result of backflow from the UV discharge.
- AECOM presented the options considered to mitigate contamination of the final effluent.
    - With respect to the option of replacing previously removed gate YG15 in the effluent gate chamber, WWD operators inquired as to the impact on the volume of backwater in the bypass channels, AECOM to review and comment on in final technical memo.
    - WWD operators inquired about the possibility of replacing gate YG15 at some point downstream of the stop logs in the effluent gate chamber.
    - AECOM indicated this would require significant modifications to the effluent piping and likely a new chamber to accommodate the gate.
    - AECOM to review potential benefit/impact of the installation of gate at YG15 in reducing the volume of backwater exchanged with UV effluent in the outfall.
    - Option of only sealing stop logs in effluent gate chamber (and not replacing YG15) was discussed as a variant of Option 1.
    - Appeared to be general consensus that the installation of a new gate at or near the UV/outfall gate chamber would be difficult to construct, costly, and would introduce fairly significant operational risk.
    - Discussion focused on 3rd mitigative option involving pump from the south secondary effluent conduit to improve the quality of the water in this conduit.

- WWD wastewater planning inquired about the possibility of chlorinating to disinfect the south secondary effluent conduit.
    - WWD operators indicated it would be difficult to properly dose chlorine and that dechlorination would be required at some point downstream to ensure chlorinated water is not discharged to the environment.
- WWD operators indicated infrastructure already in place to allow water to be drawn from south secondary effluent conduit.
- Secondary effluent from the north secondary effluent conduit is used as wash water within the plant; effluent can also be drawn from the south conduit.
- Appeared to be general consensus that pumping from the south secondary effluent conduit was feasible option which could be implemented in the short term.
- AECOM suggested that grab samples intermittently be collected from the water pumped from the south secondary effluent conduit to verify its quality over time.
- WWD wastewater planning inquired about the operational costs of pumping from the south secondary effluent conduit.
- AECOM indicated pumping requirement will likely be small (in order of 5 to 10L/s) as such power consumption costs would be relatively insignificant, will review and comment on such in final TM.
- Veolia to provide available drawings of conduits connecting secondary effluent conduits to wash water pumps in grit building.
- AECOM to review the location and elevation of the offtake from the south secondary effluent conduit and to assess its effectiveness in refreshing/removing contaminated water from the conduit.
- Following the meeting, WWD operators provided AECOM a tour of the wash water pumps in the lower level of the grit facility.

Eymond Toupin, P. Eng.
Senior Engineer
Community Infrastructure
ET/pab

NEWPCC Fecal and E.coli Non-Compliance Investigation

Historical Review, Mitigation and Risk Workshop

October 28, 2014

Agenda

- Introductions
- Review of Historical Data and Assessment of Most Probable Cause
- Alternatives Review
- Facilitated Discussion of Options, Operational Risk, and Implementation Logistics
- Summary, Next Steps and Closure

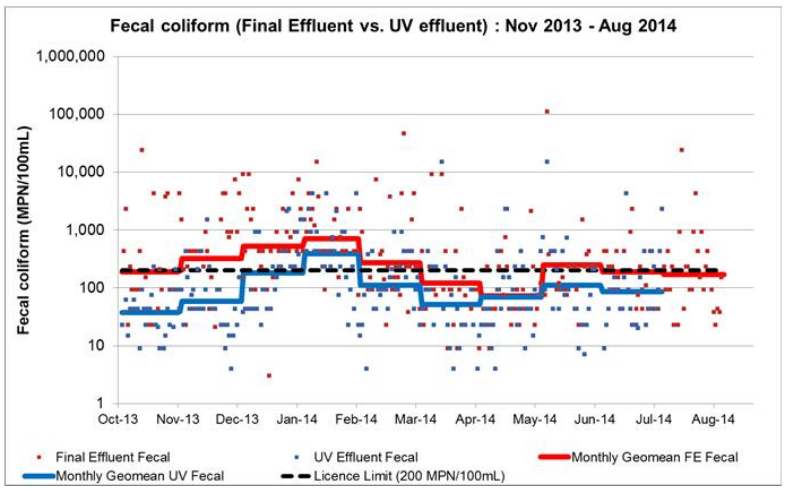
Review of Historical Data and Assessment of Most Probable Cause

Review of Historical Data and Assessment of Most Probable Cause

- Background
  - NEWPCC UV disinfection facility commissioned in mid-2006
  - Final effluent not meeting the 200/100mL license requirement for fecal coliform and E.coli

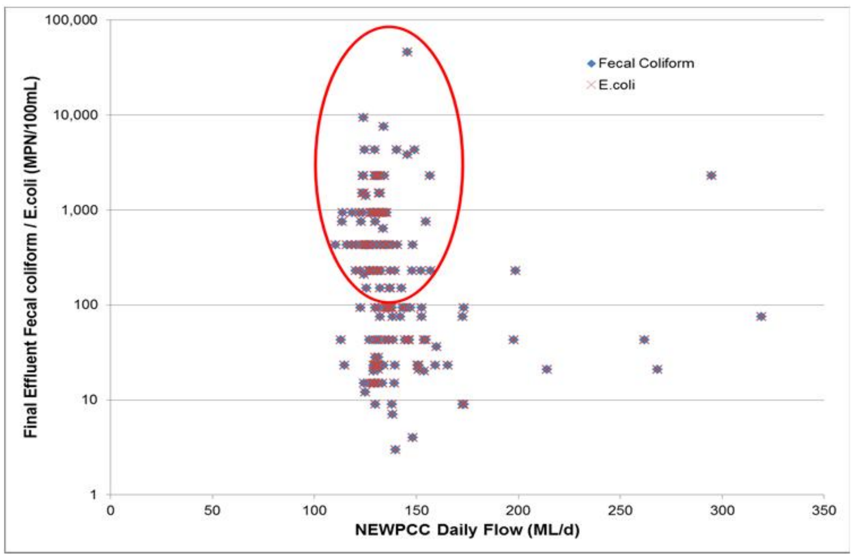
Review of Historical Data and Assessment of Most Probable Cause

- Highest values during periods of dry weather (Nov – Feb)
- Fecal and E.coli generally higher in final vs UV effluent



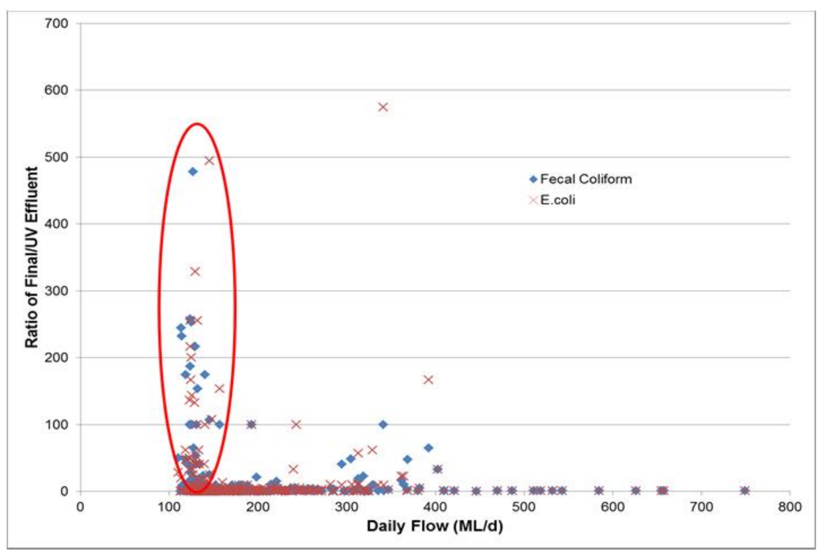
Review of Historical Data and Assessment of Most Probable Cause

- Largest fecal and E.coli counts in final effluent at low flows (<150ML/d)



Review of Historical Data and Assessment of Most Probable Cause

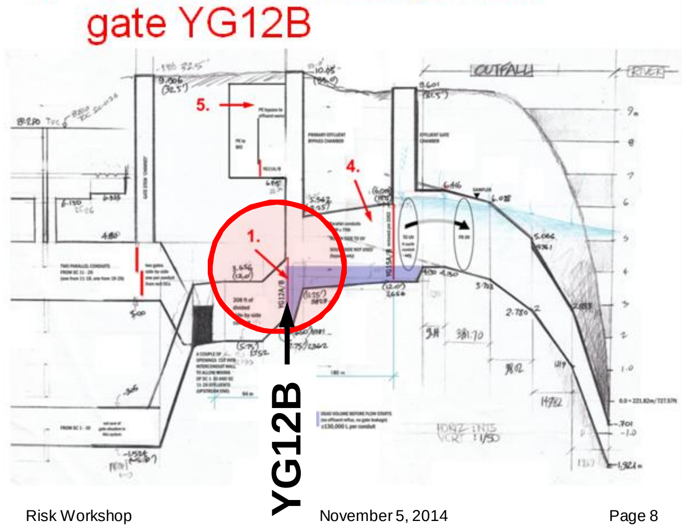
- Largest ratio of final to UV effluent also at low flows (<150ML/d)

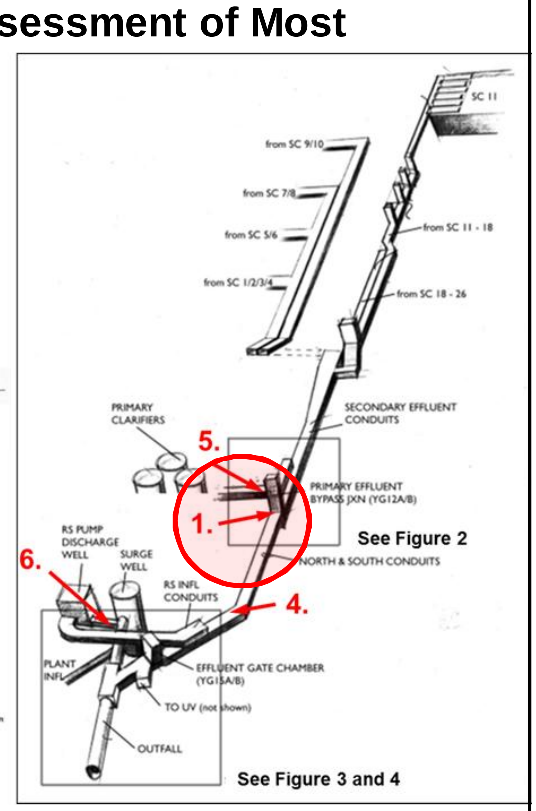


Review of Historical Data and Assessment of Most Probable Cause

- Potential Sources of Contamination

1. Continuous leakage from gate YG12B

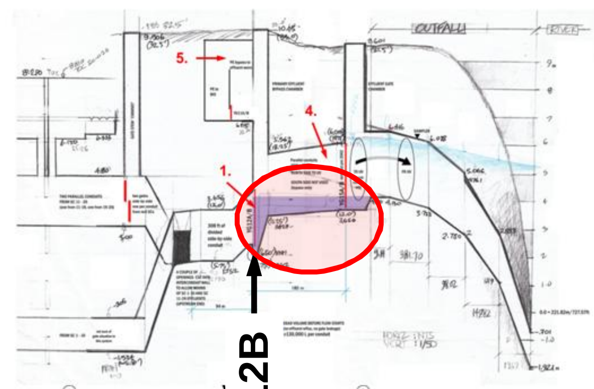


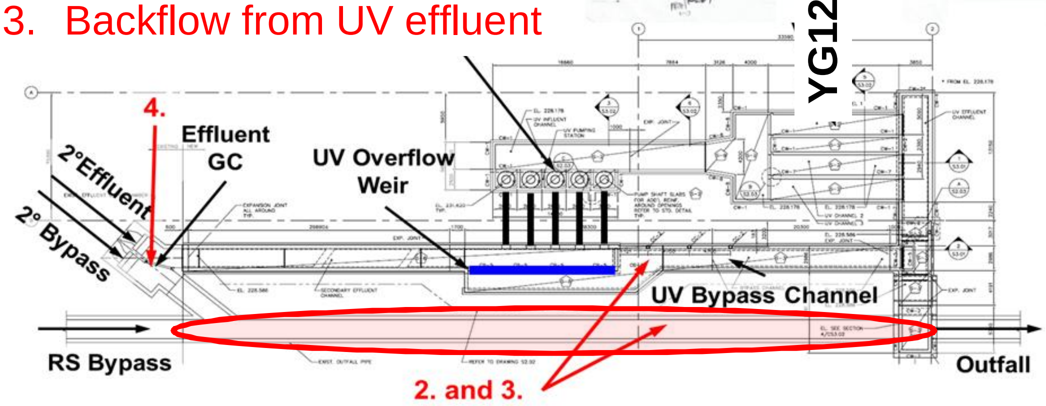


Review of Historical Data and Assessment of Most Probable Cause

- Potential Sources of Contamination

2. Stagnated flow trapped in bypass conduits
3. Backflow from UV effluent

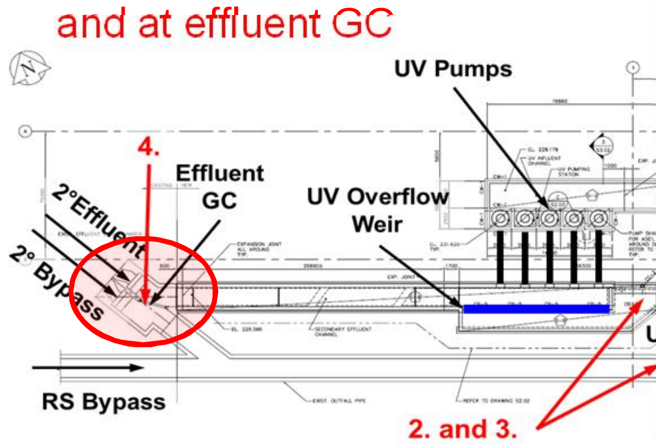


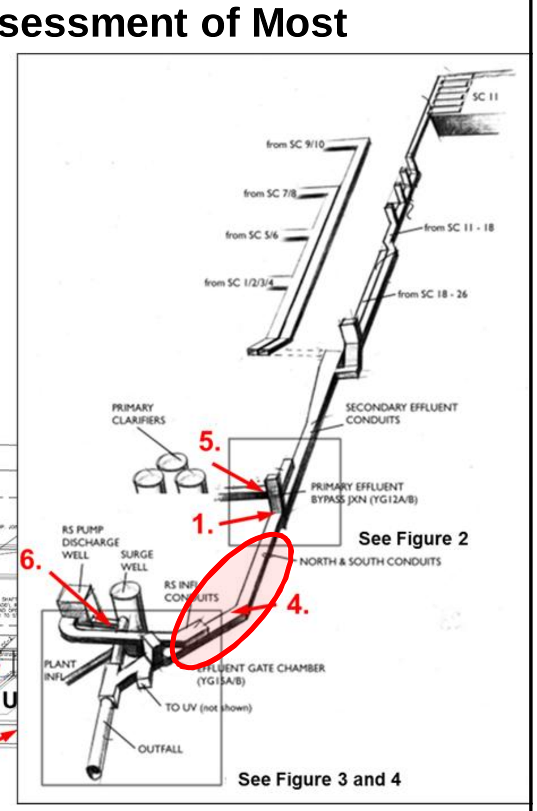


Review of Historical Data and Assessment of Most Probable Cause

- Potential Sources of Contamination

4. Continuous leakage between 2° effluent conduits and at effluent GC

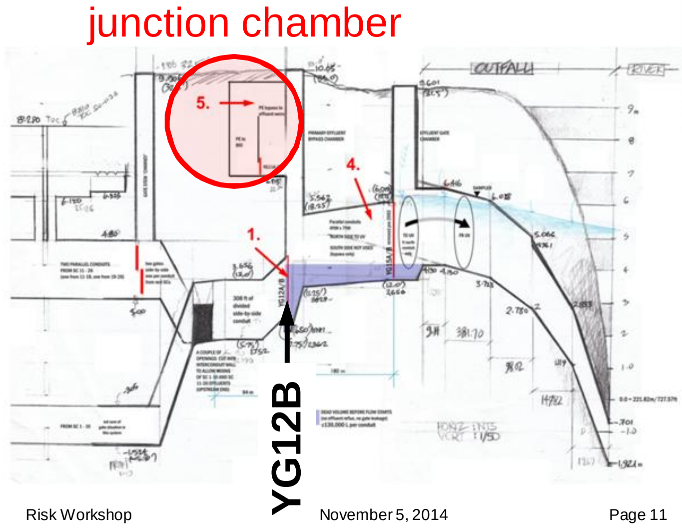


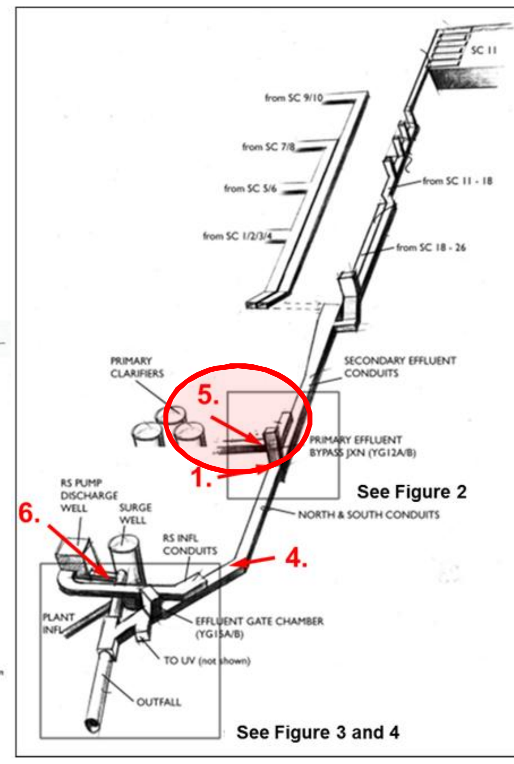


Review of Historical Data and Assessment of Most Probable Cause

- Potential Sources of Contamination

5. 1° effluent overflow at junction chamber

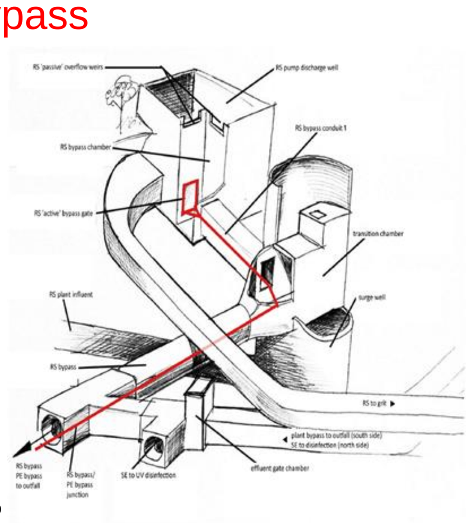


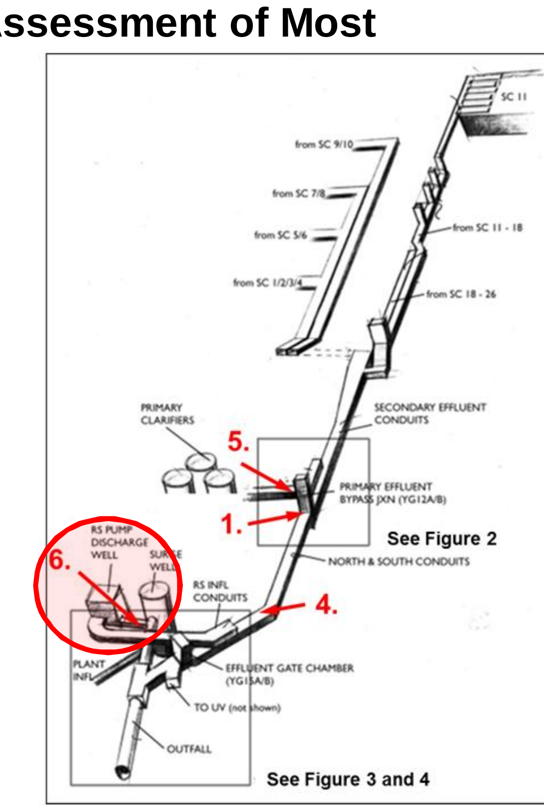


Review of Historical Data and Assessment of Most Probable Cause

- Potential Sources of Contamination

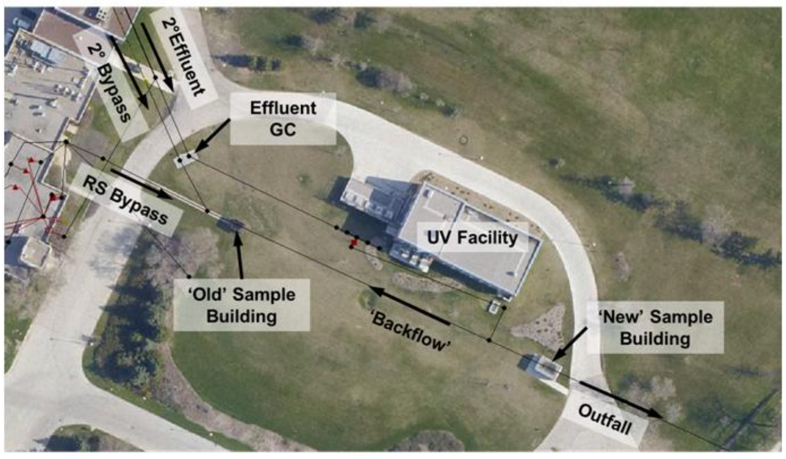
6. Occasional raw sewage bypass





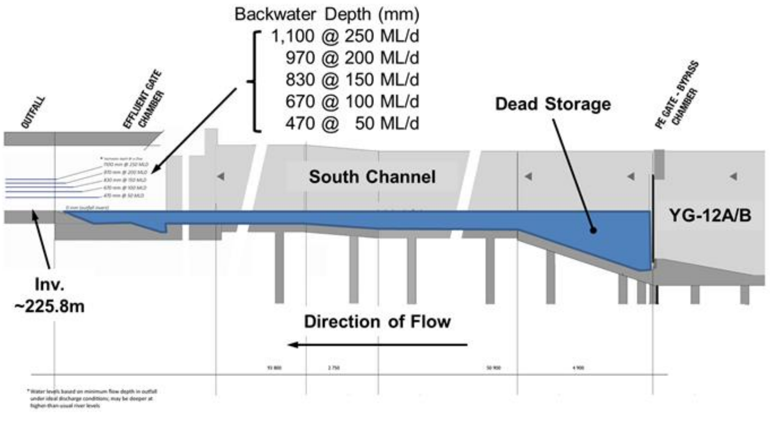
Review of Historical Data and Assessment of Most Probable Cause

- Observation of Backflow (November, 2006)
  - During inspection of effluent conduit by Civil Maintenance
  - UV pumps accidentally restarted, rapid backflow up bypass conduits
  - Physical observation of backflow confirmed



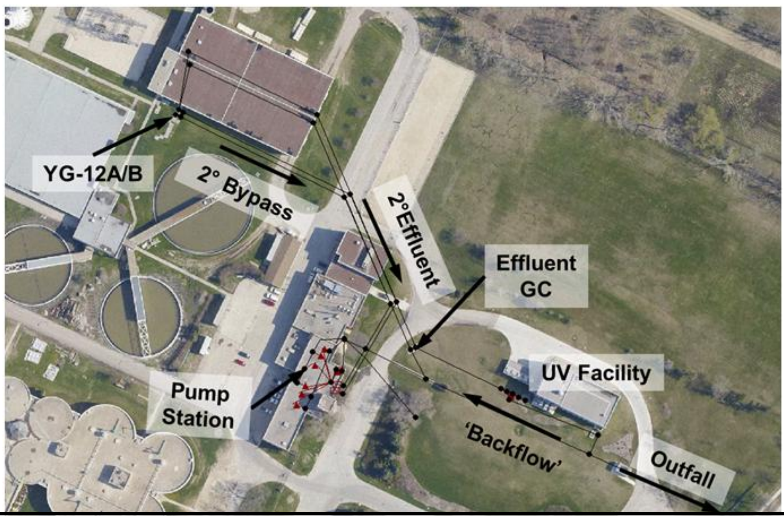
Review of Historical Data and Assessment of Most Probable Cause

- Hydraulic Analysis
  - Depth of backwater in South Channel a function of flow rate in outfall
  - Even under no flow, effluent trapped as dead storage in South Channel between YG12B and Effluent GC



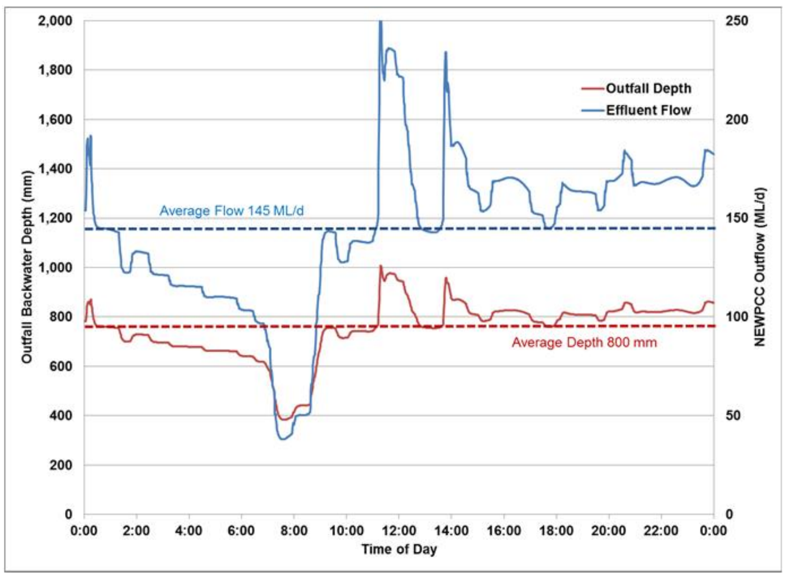
Review of Historical Data and Assessment of Most Probable Cause

- Hydraulic Analysis
  - Hydraulic model of effluent conduits and outfall created to analyze conditions during DWF
  - Applied typical NEWPCC DWF data (March 2011)



Review of Historical Data and Assessment of Most Probable Cause

- Hydraulic Analysis
  - Over course of typical day, level in outfall and bypass conduits fluctuate in response to changing flows



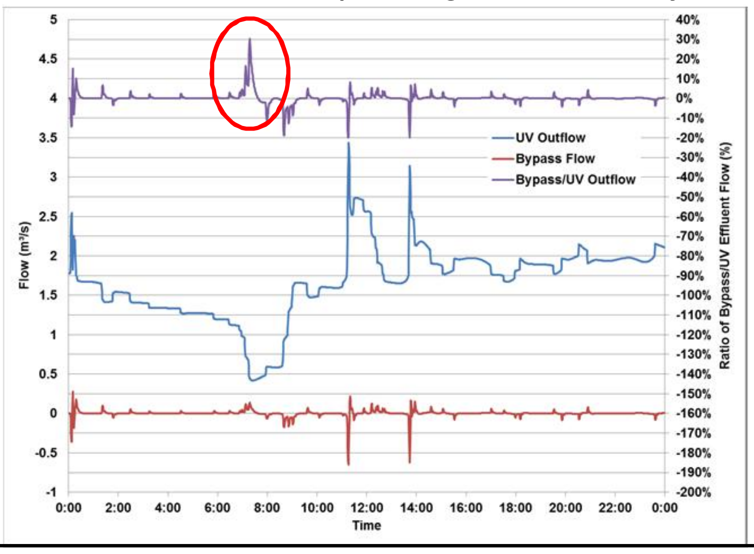
Review of Historical Data and Assessment of Most Probable Cause

- Hydraulic Analysis
  - Ebb and flow in and out of bypass conduit -0.6 (in) to 0.2 m³/s (out)

Risk Workshop

Review of Historical Data and Assessment of Most Probable Cause

- Hydraulic Analysis
  - Ratio of 'bypass flow' to UV flow potentially as high as 30% at ~7:30AM
  - Potential for contamination depending on time of day sample is taken



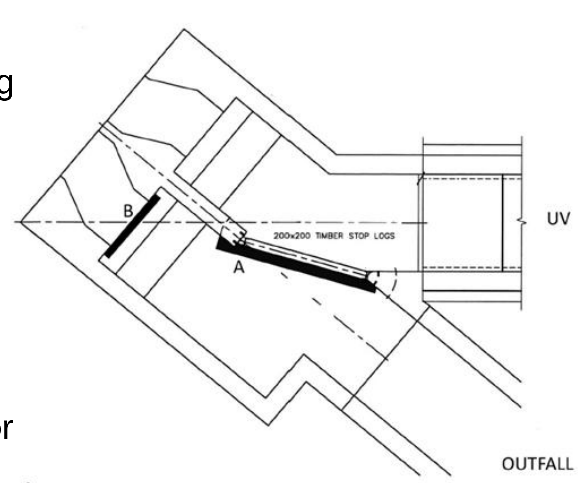
Risk Workshop

Alternatives Review

Alternatives Review

1. Improve Watertightness of Stop Log Septum in Effluent Gate Chamber and Install New YG15

- North and South conduits separated by wooden stop logs
- All that could be constructed during short shut down, some leakage of 2° effluent (likely in order of a few L/s)
- Replace removed YG15 to isolate 'dead storage' in South conduit
- Some of the gate infrastructure already in place
- Would add second gate to open for 2° bypass



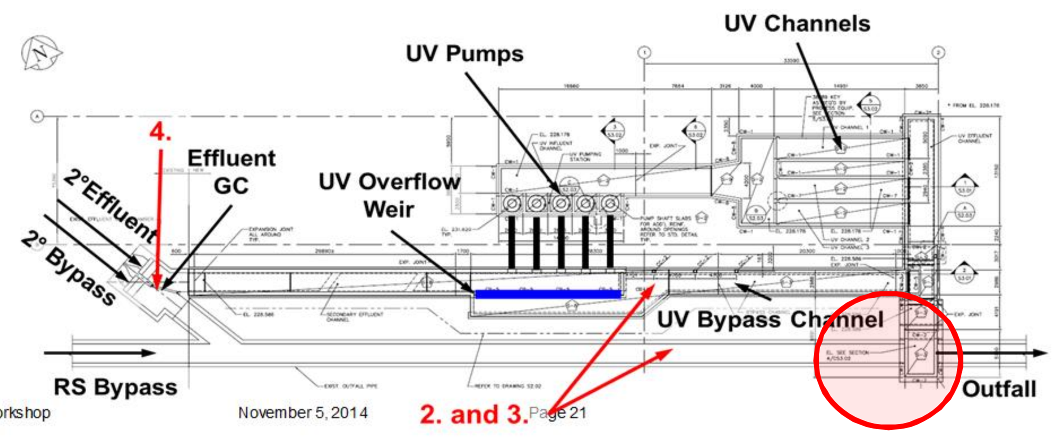
A Construct impermeable barrier (concrete? frp?) on 'dry' side of stoplog septum wall to eliminate leakage

B Install gate YG-15B to prevent reflux into south conduit and to contain contaminated fluid (from YG-12 leakage)

Alternatives Review

2. Add Gate at/near UV Outlet
   Outfall Gate Chamber

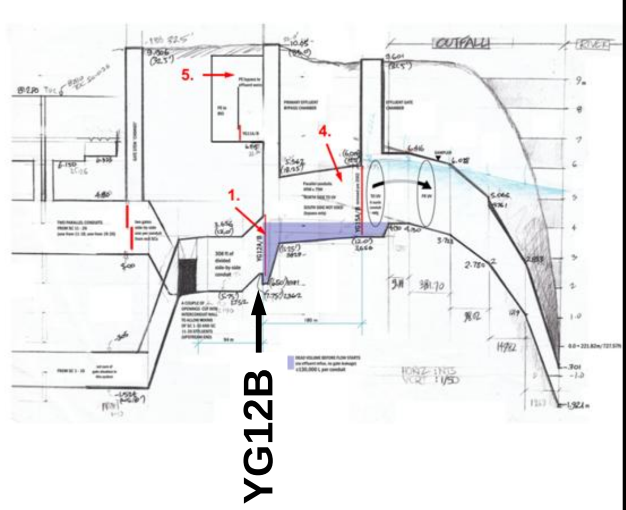
- Junction provides no barrier to reflux in/out of bypass conduits
- Gate provides barrier to contaminated fluid possibly leaking into bypass conduits
- Would be significant change to existing system – raw sewage bypass can currently occur passively, i.e. without gate opening required



Alternatives Review

3. Pumping Out South Conduit

- Dewatering South Conduit at YG12B
- Would remove stagnant bottom layer to reduce concentration of contaminants
- Pump into adjacent North Conduit for disinfection
- 5 to 6L/s would likely be sufficient to turn over water in 'dead storage' in about 8 hours



Alternatives Review

- Cost and Operational Risk of Alternatives

Alternative	Relative Cost	Operational Complexity/Risk	Other Factors
1 - Improve Watertightness of Stop Logs and Install New YG15 EGC	$150,000++	Medium	Moderate risk profile and high probability of success. May require supplemental dewatering as per #3.
2 - Add Gate at UV Outlet-Outfall Junction Chamber	$700,000++	High	Greatest isolation of potential contamination sources.
3 - Pumping Out the South Conduit	$40,000+ for temporary installation $70,000++ for permanent installation with controls/monitoring	Low	Lowest level of isolation from contamination sources but very low cost and may ultimately be required in conjunction with other measures.

Facilitated Discussion of Options, Operational Risk, and Implementation Logistics

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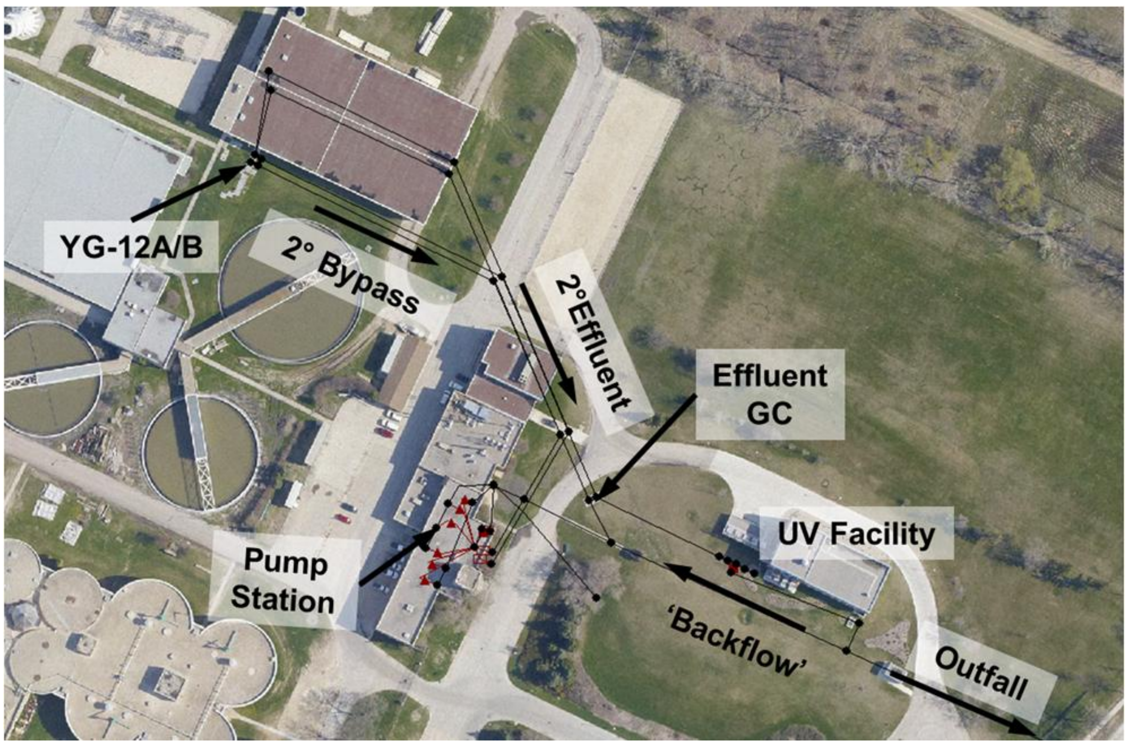
Facilitated Discussion of Options, Operational Risk, and Implementation Logistics



Summary

Summary, Next Steps and Closure

- Consistently higher fecal and E.coli counts in final vs UV effluent
  - particularly during DWF
- Potential sources of contamination of final effluent have been identified
  - Gates, stop logs, backflow of UV effluent, stagnant dead storage
- Hydraulic analysis and physical observation confirm ebb and flow in bypass conduits likely occurring as result of diurnal variation in flow
- Sampling time may affect effluent quality measured

Summary, Next Steps and Closure

- Remedial Alternatives

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Thank You