Expert Advice Panel (EAP): Preliminary comments

on the Winnipeg Sewage Treatment Program (WSTP) Process Selection Report (PSR) for the South End Water Pollution Control Center (SEWPCC), prepared by Veolia Water (VW)

JA Oleszkiewicz (University of Manitoba)
JB Neethling (HDR Folsom, CA)
F Rogalla (Aqualia in Madrid, Spain)
JA Husband (Malcolm Pirnie, White Plains, NY)
JH Hwang (University of Manitoba)
Q Yuan (University of Manitoba)

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1. Introduction

The PSR (Process Selection Report) report, sent on the afternoon of Friday August 27th 2010, was presented by VW during the Workshop held in the Greenwood Inn-Winnipeg between 31st August and 3rd September 2010 (later on called "Workshop"). Four Options were presented and the following contains brief comments on these Options based on the Workshop. The final EAP assessment will be made up to 14 days after the total operating and capital costs and total life cycle costs are presented and environmental footprint/impact is assessed.

Nutrient removal in Winnipeg plants has been mandated by the Minister of Conservation, acting on the advice from the MB Clean Environment Commission (CEC). Besides recommending the effluent nutrient concentrations and ratios the CEC stated (March 2009) in its recommendations that "….biological nutrient removal represents the most environmentally sustainable and responsible approach to phosphorus, nitrogen and ammonia management. Removal processes that create increased sludge and render nutrients less available for use as fertilizer do not meet the test of sustainability."

In 2008 Stantec has conducted an evaluation of a number of wastewater treatment options for the SEWPCC and with the advice of the Independent Review Team (IRT) selected "Option G" comprising Modified Johannesburg (MJHB) process with IFAS configuration in the aerobic zone.

The four Options proposed by VW have used influent conditions that were different from those used by Stantec. The VW 2010 flow and load were based on data collected between 2005 and 2010, when the raw wastewater samplers were deemed reliable, as opposed to the less reliable raw wastewater characterization data preceding 2005 available to Stantec. VW calculated the 2031 design parameters based on the 2005-2010 data plus the population increase multiplied by the per capita numbers published by Ontario MOE; and included a 10% safety factor. Stantec used as their design flow 88 MLD and checked the design for 125 MLD and 175 MLD Spring maximum flows. VW used 125 MLD as their design flow.

The land for expansion is available all around the SEWPCC site. The availability of the hydraulic head still has to be checked in Options that do not feature intermediate pumping.

The Wet Weather flow (WWF) above 125 MLD is proposed to be treated in the side stream and VW proposed Actiflo (micro-sand enhanced high rate chemical treatment and lamella settling) common to all evaluated options.

As per VW presentation the Actiflo has a cyclone to separate the micro-sand from the captured raw wastewater solid. This cyclone requires protection from large objects since the cyclone utilizes a small orifice to control flow. Therefore, raw wastewater screens with a maximum size of 6 mm (standard maximum size in new Actiflo plants in the world) must be incorporated into the plant design. This can either be done by modifying the influent raw screens or a second set of screens downstream of the larger (12 mm) raw screens, only on the bypass. In costs analysis this has to be weighed against CEPT in clarifiers (replacing Actiflo) and the no change of the 12 mm screens.

EAP's comments to the options are based on the PSRv.3 which is at the very preliminary level of detail, essentially presenting the concept proposed and early estimates of sizes and number of units required. The Minutes of the Proceedings of the August 31- September 3 Workshop (called "Minutes" and enclosed with this Report) have documented the comments made by the City of Winnipeg (CoW) and the EAP as well as provisional answers or promises of further refinement, clarification, optimization made by the VW design team. There is also a need to specify clearly the redundancy and safety philosophy assumed for the design, as well as redefining the design horizon.

As the design horizon is 2031 and the construction completion is anticipated in 2012 it is necessary to provide the assessment of staging and phasing-in of the proposed treatment units. The design should define the modularity of the proposed options and besides the high flows should address individual option's performance under low flow conditions.

1.1. Design Influent Flows and Loads

The flows and loads calculated by Stantec were based on Ontario Ministry of Environment tables as the actual raw wastewater data were not considered reliable due to the location of the samplers and their inherent inaccuracies (settling in the channel). The flows available to the VW team were the actual data for period 2005-2010, with new samplers, properly located. The data from this period were accepted by VW in their design. This approach should provide the most accurate definition of influent characteristics. Two comments referring to:

Page 30 of 143: Section 4.2 – "…The SEWPCC per capita TSS load of 0.064 Kg/cap/day is lower than either the MOE or 10SS load of 0.09 Kg/cap/day but is within the range of typical residential wastewater and individual contributions."

C: Similarly to the comments by the IRT (Independent Review Team) before, one of the reasons why the TSS may be on the low side is the long detention time in the sewer and hydrolysis of the TSS to VFA. This was discussed during the Stantec PDR. While this can reduce the TSS and increase the VFA, it would not necessarily change the BOD/COD ratio – just its form: particulate vs soluble. This hypothesis is supported by the reported contribution of BOD/capita of 0.073kg/cap which is within the "typical" range.

Page 35 of 143: Table 14 Population Projections – "Negative numbers in the table indicate that the current projections are lower than in the PDR while positive numbers indicate that the current projections are higher."

C: It appears that Table 14 is indicating a significantly lower TSS loading to the SE facility in particular the maximum month loadings (34% to 53%) and the BOD loading is also significantly lower (14% to 38%). This certainly can change consideration of treatment options.

In order to provide a uniform base for comparing with the Stantec option it was agreed to conduct the design with flows projected for population of 250,000 in the year 2031.

The operating temperature selected by VW was 9^{o}C for Options 2, 3 and 4, and 10^{o}C for Option 1. Options 2, 3, 4 refer the reader to Table 18 for influent characteristics – the Table however has the minimum influent temperature 10 ^{o}C. Explanation needs to be provided why 10 ^{o}C was selected for the design as well as the historic minimum, the coldest month, the average wastewater temperature during the coldest month.

To illustrate the most stringent design conditions, convert ammonia discharge to concentrations, e.g.:

607 kg/d in August for 89 to 114 MLD = 5 mg/l

713 kg/d in September for 77 to 83 MLD = 9 mg/l

In summary, the VW approach to raw wastewater characterization is reasonable.

1.2. Design effluent quality

The Licence requirements are for TSS and $CBOD_5$ never to exceed 30 and 25 mg/L, respectively with TN<15 mg/L and TP<1 mg/L as 30 d rolling average. Ammonia discharge has been defined as never to exceed load which varies monthly. The design team, upon instruction from the CoW, conducted design as if the BOD and TSS were also determined on the basis of 30 d rolling average.

The issue of disinfection has not been fully resolved. At present it was assumed by the VW team that all flow (up to 300 MLD) will receive UV disinfection. This is an important economic factor in WWF management and therefore requires resolution as for example on-site generated chlorine dioxide could be used for WWF. As it affects all options equally it has little bearing on the main-stream process selection.

2. Process comparison

2.1. Option 1

The comments here pertain to other options – particularly in regards to wet weather flows WWF treatment. Option 1 was developed to compare to the Option C proposed by Stantec. Option 1, as presented in the Workshop, has been designed as a very different configuration than presented in PDR. The Figure in page 50 is an inaccurate description of the process – there is no separate internal recycle in the design – the reactor is an "oxidation ditch" i.e. racetrack configuration, operated in sequential aeration/non-aeration mode to nitrify and denitrify. It is a large reactor providing an overall retention of HRT=14.7 h at the 2031 average flow of 88 MLD and over 21 h at the 2005-2010 average flow of 60.5 MLD.

Page 50 PSR: "…The design of the biological treatment has been carried out using the software SIMULO®. Design is based on a low load biological reactor for biological carbon, nitrogen and phosphorus removal. In addition FeCl3 is added to the biological reactors for further chemical phosphorus removal"

The VW team agreed (Minutes of the Workshop) that Simulo® does not model enhanced biological phosphorus removal (bio-P), therefore the sizing of the anaerobic portion of the process for biological phosphorus removal is questionable. Addition of ferric, which most likely is featured in the mixed liquor VSS/TSS, is typically not required in a MJHB configuration. The ferric feed facilities are typically provided to manage Bio-P upset conditions, or provide some trimming of the effluent TP to meet monthly permits. As demonstrated in WEWPCC there is very little need for any chemicals in a suspended growth process designed in a quasi-plug-flow WestBank or MJHB configuration.

Selected comments to the option:
Page 44 of 143 Section 9.5 Simulations – "The most stringent case for air blower sizing is spring max month at 17 °C rather than summer max month at 19°C"

C: Based on the other two items in this section being statement of facts, does the reader assume that this is based on simulations or is this an assumption?

Page 48 of 143 –Table 25 : Expected performances for primary settling – Options 1 to 3

C: It is not clear at all what is the basis of predicting any of these removal efficiencies at maximum month conditions. The reported values do not agree with the operator stated values and need to be verified. These low removal values have a profound impact on the biological portion of the plant. Higher primary effluent TSS will increase the mass of inert and unhelpful organic material in the biological reactor, thus requiring a higher MLSS concentration to achieve equivalent treatment performance.

Page 50 of 143 – Section 12.3 Biological Reactor

C: Why is the primary effluent entering the pre-anoxic zone? The purpose of the pre-anoxic zone is to reduce dissolved oxygen and nitrate concentration prior to the anaerobic zone so not to reduce the effectiveness of the anaerobic (Bio-P) process. The process diagram needs to be updated as well to reflect the actual design.

Page 50 of 143: - Table 28 : Sizing of the biological reactors – Option 1

C: Sludge Age at 14 days – define how this was calculated. Was this including solids in the final settling tanks, did this include the entire biological reactor or just the aerobic zones?

C: Was the sludge age at 14 days equal to maximum loading (125 MLD at settled concentrations of …. ?)

Page 54 of 143: Table 34 : Clarification characteristics – Option 1

C: SVI of 150 is very conservative when assuming the use of 15 mg/l $FeCl_3$ addition to the MLSS. This would be appropriate for non-ferric feed conditions.

C: Overall recommendation of 0.6 m/hr is extremely low for peak hydraulic loading rate and compared to Option 2 with 0.8 m/hr which has the same hydraulic and solids loading rate and SVI

C: Solids loading rate of 4.5 kg/m^2hr is also very low for a peak loading condition

Page 59 of 143 Table 41 - Inlet water quality in CSO stream – Option 1

C: It appears that there is a significant loading being assumed when the flow increases from 120 MLD to 240 MLD for the maximum spring week. Essentially the same influent concentration whether the flow is 120 MLD or 240 MLD to the SEWPCP….does this make sense based on past data? What is the basis of the higher sustained influent loading for this entire week? Where are all of the non-dry solids and pollutants coming from for the entire week?

Page 60 of 143: Table 43 : Expected performances of ballasted settling – Option 1

C: Was there an analysis done to show that it is necessary to go to high rate primary treatment? A possible alternative would be to use chemically enhanced primary treatment (CEPT) which can achieve TSS removals in the 75% to 80% range.

C: Performance of the Actiflo system was slightly better than CEPT. Was CEPT considered, that is, including a number of additional primary settling tanks dedicated to CEPT? These tanks could be used to store minor storm and when the flow goes high enough, allow for CEPT to meet monthly discharge limits.

Option 1 has been collectively deleted during the Workshop from further comparison due to its size and expected largest capital costs as proposed by the VW design team – the Stantec CDR listed Option C as similar in net present value to Option G. It was considered redundant to evaluate further two very similar Options # 1 and #2.

2.2. Option 2.

Option 2 is similar to Stantec's Option G, however different loads and flows and different temperatures were used by the VW design team. Option 2 retains the full biological nutrient removal capabilities of Option 1. The basic difference is in the use of carrier media in the aerobic section of the bioreactor which allowed for significant decrease of the suspended growth SRT and HRT of the reactors. Another difference between Options 1 and 2 is in the type of reactors used – the reactors resemble the quasi-plug-flow configuration used in Western Canada rather than the oxidation ditch configuration proposed by VW for Option 1.

Option 2 has an extensive track record in Western Canada (e.g. Pine Creek Calgary, Kelowna BC; Bonnybrook –plant C; Saskatoon SK) and USA, with the attached growth IFAS configuration for nitrification becoming common place in colder climates (e.g. Broomfield CO). Option 2 maximizes the use of existing infrastructure. The proposed process is such that the plant operators should be familiar with due to their training at the WEWPCC in the sense that it relies on biological phosphorus and nitrogen removal. The use of fixed media to enhance nitrification will be a new process to Winnipeg operations. While this process uses more new concrete than Option 4, it would have significantly reduced operating costs when compared to Options 3 and particularly to Option 4 since it virtually eliminates the need for continuous chemical feed for phosphorus removal – only retained as a backup.

The main perceived drawback of Option 2 is constructability - that is the ability to do the plant upgrade while maintaining the effluent quality as per licence valid to the end of 2012. Flow routing during construction will cause a disruption of plant operations. This item has not been resolved at this stage – potentially it could add cost due to the difficulty of having to stage the work, as currently there are four parallel bio-trains. One option to mitigate process impacts during construction could be through enhancement of the primary BOD/TSS removals using CEPT to reduce the load on the secondary process that remains online during this construction period. The cost to mitigate the constructability issues need to be better defined prior to eliminating this option.

Option 2 features large un-aerated zones for pre-denitrification, anaerobic and anoxic processes with a very large internal recycle. The comments in our discussion of Option 1 (above) that Simulo® is unable to model the anaerobic zones pertain here as well: BioWin (or another applicable process simulator) should best be used to model this process as the un-aerated/anaerobic zones need to be optimized.

Suspended growth options that include biological phosphorus removal lend themselves to phosphorus recovery through a side-stream process such as RAS or WAS-stripping. This opportunity has not been explored in Option 2 or in Option 3, but can be pursued as the possibility of phosphorus recovery is one of the criteria stipulated by the Province.

Detailed comments (**C**) follow:

Page 67 of 143: 18.3 BIOLOGICAL REACTORS

C: Why is the primary effluent entering the pre-anoxic zone?

Page 68 of 143: Table 47: Sizing of the biological reactors – Option 2

C: Sludge age is noted as 8.5 d – is this the entire volume of just the aerobic zone? Please provide how this was calculated.

C: $FeCl_3$ addition is noted as 6 mg/L versus 15 mg/L for Option 1… why the difference? Also, is the value based on Ferric Chloride or Iron? Whenever mentioning $FeCl_3$ dose for chemical phosphorus removal (and Actiflo), please state the reference of the mg/L – is it pure product, Fe, commercial solution?

Page 70 of 143 Table 51: Media characteristics – Option 2

C: Confirm that the basis of design is for all nitrification to be performed by the nitrifiers on the IFAS media….this appears to be the design criteria.
If true, then why is the MLSS still being maintained at 3.6 g/L? This impacts the clarifier sizing

Page 72 of 143: Table 54: Mixed liquor circulation design – Option 2

C: Why is the Internal Mixed Liquor Recycle (IMLR) 450%? At peak flow it appears to be well over sized to achieve the permit limit of 15 mg/l TN. Recycling too much IMLR will reduce nitrogen removal due to additional dissolved oxygen concentration.

C: Following up on the IMLR rates, does the Simulo® model assume the dissolved oxygen concentration in the anoxic zone to be zero, or does it account for the dissolved oxygen entering the anoxic zone from the upstream tankage (if there is any) and the IMLR which is coming from the end of the aeration tank?

C: With RAS nitrates the recycle is actually 550% Q - has RAS been included in the internal recycle calculations?

Page 73 of 143 Table 55: Clarification characteristics – Option 2

C: The hydraulic, SVI and solids loading rate on the final settling tanks is similar to option 1. It is unclear why Option 1 would have 125% more surface area versus Option 2. What is the basis for selection of SVI and MLSS concentrations, can they be optimised to reduce clarifier size?

C: Could the clarifiers be optimized for the zone settling velocity and the smaller concentration of biomass as nitrifiers are fixed?

C: The CoW Operations have been concerned about the biomass settleability and suggested Biogradex as one technology to assure settling even when sludge has bulking tendencies. This could be investigated as a way of deleting one clarifier. Other options to improve sludge settleability (floc loading in selectors) should be explored, and may be tested in existing plants.

Page 74 of 143: Table 58 : Excess biological sludge production – Option 2

C: There appears to be a disconnect between Option 1 and Option 2 in biological solids production. Option 1 operating at a sludge age of 14 days produces 10,800 kg/d at design while Option 2 operating at a sludge age of 8.5 days produces 15,000 kg/d. Essentially, the design is stating that if the SRT were increased by 5.5 days, the solids production can be reduced by 4,200 kg/d. This appears to be an overestimation of solids destruction for an additional 5.5 days SRT. Also, there is less ferric chloride addition in Option 2 which should reduce the inert solids production. There seems to be a different methodology being used here.

Page 76 of 143 Table 60 : Clarified effluent characteristics – Option 2

C: The TN removal of 60% for option 2 versus 54.5% removal for Option 1 appears to indicate the use of 450% IMLR has a minimal benefit. Unclear – could this be improved by using another modeling software like BioWin?

General comments. Whenever choosing a design value, please justify and explain – that goes for depth of diffusion, velocities, solids concentrations and sludge ages, overflow rates, recirculations, bed height – how would a change in any of those parameters affect the design? Please provide the explanation whether the most optimized values were chosen.

C : Why are new aeration basins 7 m deep? Always justify better the parameters chosen like sludge age, SVI, solids loading etc… Justify size and number of filters, give references for similar plants.

C : For each option, one should calculate what flow and load can be handled with the existing facilities, once converted (to Bio-P basins, for instance) - and then decide if it is worthwhile to add new facilities right away for the future load, or progress in a modular manner.

C : Explain better the oxygen calculations and concepts like : Total daily "Real" O_2 (AOR), why and how is clean water transfer chosen

In summary Option 2 has the potential of completely removing nutrients without the use of chemicals. The option has to be optimized in respect to sizes of clarifiers, flow-rates of return streams and the bio-P removal. Sludge production and aeration also need to be re-evaluated for consistency – are they just the result of Simulo predictions? Is other methodology (Biowin, ATV ?) confirming those predictions?

2.3. Option 3 and 3 b

Option 3 combines the benefits of un-aerated suspended growth processes for removal of TP and nitrates with the advantage of attached growth nitrification the latter more resistant to washout and temperature fluctuations. The option appears somewhat more flexible in the constructability than Option 2 as there is a potential of using the BAF reactors to treat the whole flow for carbon removal while changes are being made to the suspended growth portion of the train. The operating costs may be somewhat increased over Option 2 – this still requires assessment.

A new Option 3b was introduced during the Workshop - a portion of the effluent from nitrifying BAF is recycled to suspended growth process in order to reduce or eliminate the denitrifying BAF units and decrease the amount of methanol needed to meet denitrification requirements. This option will increase the use of primary effluent carbon to reduce nitrate concentrations. Detailed and optimized design of Option 3b will be prepared by VW. The option requires serious optimization of design in order to identify limiting parameters (Clarifiers ?) and options to overcome them.

Page 82 of 143: Process Option 3

C: The sketch of the reactor shows an anaerobic →aerobic reactor. The 3b option has changed to anaerobic→anoxic reactor with nitrates coming in from the nitrifying BAF. Possibly there is a need (to be found by simulation) to achieve at least 150-200% recycle to achieve the denitrification – but limiting clarifier loading and velocity should be tested. One needs to remember that the final clarifiers are followed by the BAF units providing solids removal.

C: The use of Simulo® is possibly not providing representative results as, based on VW own assessment, the software does not simulate anaerobic activated sludge for biological phosphorus removal well.

Page 90 of 143: Process Option 3

C: Nitrification could be performed by a MBBR process. How would this stack up against a BAF unit? MBBR does not require pumping although it may require a DAF unit to remove TSS. The operators in CoW are familiar with and are very satisfied with DAF.

C: TSS information is not provided in the tables. It is unclear what the TSS concentration from the activated sludge to the Biostyr-NIT® unit is and what the expected effluent TSS value. This is particularly important with the phosphorus concentration noted as 1.4 mg/Lin the discharge from the Biostyr-NIT®

C: Why there is no table showing effluent quality from the Biostyr-NIT®? Accordingly it is unclear how the effluent TP goal is to be met. There doesn't appear to be any mechanism other than TSS removal in the Biostyr-NIT® for phosphorus removal. The only chemical noted is methanol in a range of 58/18 = 3.1 g Methanol/g NO_x-N.

C: The use of denitrifying BAFs needs to be revisited – are they really necessary? This should be modeled with the recycle of nitrified effluent to the anoxic activated sludge. Since BAF is a filter can the clarifiers work at a higher load as the risk of solids carry-over is less important? The effluent TN is 15 mg N/L so we are really not seeking a high degree of nitrate removal.

In summary, Option 3b has significant potential to achieve TP and TN removal with little or no chemicals while providing the robustness of fixed film nitrification, relatively undisturbed by low temperature. The configuration includes the existing structures to the fullest extent, as well as Bio-P. Option 3b has been formulated during the Workshop and therefore the VW team had little time to size and optimize the proposed process.

2.4. Option 4 and 4b

Option 4 has the smallest footprint and potentially would be the easiest to implement as it can be built outside the existing units maintaining the undisturbed operation of the current HPOAS. Option 4 had proposed to abandon the existing facility, except for the preliminary and primary treatment. The option has the heaviest use of chemicals as phosphorus is removed only chemically with ferric chloride while nitrates are removed with indigenous carbon in the NDN BAF (a simultaneous nitrification-denitrification BAF) and polished in a denitrifying BAF with methanol.

During the Workshop a variant of the Option 4 was proposed – Option 4b, which utilizes the existing final clarifiers (FC) as backwash settling tanks instead of the Actiflo. The Option 4b will be slightly more difficult to construct as the clarifiers would have to be retrofitted and connected to the BAF units. This can be phased-in following completion of the BAF construction. Option 4b has been formulated during the Workshop and therefore the VW team had little time to size and optimize the proposed process. The key feature of Option 4b is the ubiquitous use of ferric – in PC as CEPT, into the polishing post denitrifying BAF and into FC utilized for solids separation from backwash. In all cases ferric will be dosed to WWF stream – here the ballasted clarifier in Option 4 has been changed to Actiflo.

Some comments follow:

Page 99 The figure (Option 4) shows 132 MLD going to BAF.

C: This has been corrected now to 125 MLD in Option 4b

Page 100 "..The existing primary clarifiers are reused to act mainly as FOG / scum removal as well as removal of the easily settleable solids...".

Table 85

C: The hydraulic loading rate on the existing primary settling tanks is approximately 70 m/d which is well within loading rates demonstrated to have 75% TSS removal with CEPT (Ferric chloride and polymer in the range of 30 mg/L $FeCl_3$ and 1 – 2 mg/L polymer).

C: Mass balance and some jar testing could help better assess the performance of CEPT. There may be the issue of too much phosphorus removed to sustain the biological process in the subsequent BAF units

C : When proposing partial bypass of DN filters, how will that flow be controlled with the varying load conditions ?

C : The cleaned backwash waters after Actiflo should have water characteristics that meet effluent standards – is it really necessary to return them to Biofilter N inlet?

3. General issues requiring resolution

3.1. Phosphorus recovery Options 2, 3b, 4b

The Province prides itself on being the leader in sustainability hence it is appropriate to consider the potential for phosphorus recovery. This was not addressed in the VW proposal. The NPV (net present value) costs will help make the decision on feasibility of phosphorus recovery. Phosphorus recovery is feasible in Option 2 and 3b as these options include biological phosphorus removal and the phosphorus can be released during storage of WAS/RAS with primary sludge (PS) and then precipitated with magnesium as struvite. The current technology development includes carbon dioxide stripping of the supernatant to minimize the need for sodium hydroxide. The new unit operations of P-stripping and recovery would have to be balanced against the costs of ferric use (purchase, storage, chemical sludge production and the resulting cost of additional sludge handling and disposal).

Alternatively the waste sludge from Options 2 and 3b could be separately transported to the NEWPCC for processing and phosphorus recovery there together with the WEWPCC and NEWPCC solids that do not have ferric in them. NEWPCC sludge train includes digestion which uses ferric to keep struvite from precipitating and maintaining low H_2S in the gas, thus reducing odours, boiler corrosion and centrifuge deposition of struvite plaque.

Option 4b uses ferric in various points and therefore cannot accommodate struvite recovery. Therefore the only possible recovery would be from the ash of a thermal oxidation facility – if such would be the target process change in the NEWPCC.

3.2. Septage

Septage handling has not been clearly defined in the VW proposal. Septage was shown by the EnviroSim/University of Manitoba study to affect the nitrifier growth rate. Equalization and flow-proportional dosing would be one solution to address septage loading impacts. On a daily load basis there should be no process impact. The main problem for the plant is that septage typically arrives during daily hours increasing the high-load conditions.

3.3. Sludge management

The VW proposal assumes that sludge trucking to the NEWPCC will continue to be the solids management option for SEWPCC. The solids management at SEWPCC is therefore intricately tied to the operations at the NEWPCC. We recommend that a Masterplan be developed to consider the overall solids management for the City.

Preliminary data show that not all sludge is land applied, some goes to landfill. The portion of digested sludge going to landfill is in the same order of magnitude as SEWPCC sludge production, and Brady Road landfill is close to SEWPCC. The logical solution to avoid un-necessary trucking would be to send all SEWPCC solids to landfill, and find out if there is an easy way to meet the landfill requirements.

Trucking of raw sludge is presently working in Winnipeg well but it may run into complications in the future – it is banned in some states in USA and many EU countries. On-site treatment of solids should be considered. One may consider stabilizing (digestion, disinfecting, or other technologies) and dewatering the sludge at SEWPCC and then trucking to Brady Rd landfill. This will reduce the transportation costs and simplify phosphorus recovery with biological phosphorus removal options. Elimination or reduction of sludge hauling has significant cost, safety, and sustainability benefits that should be weighed against the construction and operating costs of other sludge management options.

There are a number of direct disinfection processes of which some, like Neutralizer®, add small quantity of chlorine dioxide and nitric acid to achieve Class B or Class A product with minimal space required and minimal odour as compared to conventional lime treatment. Having a chlorine dioxide generator for sludge treatment could be utilized in the disinfection of WWF.

3.4. Disinfection

The VW design included in one case the use of peracetic acid for WWF disinfection. This is an expensive chemical and it would be most likely more advantageous to generate the disinfectant on site. Some on-site generated disinfectants include ozone and chlorine dioxide:

- Ozone could be produced from pure oxygen while the oxygen generators remain in service. However, none of the options considered retains the HPO plant and it needs to be checked if the capacity is compatible and if there are any economic benefits to maintaining the HPO generators only to feed disinfection requirements.

- Chlorine dioxide can be generated on-site and is a simpler option. Chlorine dioxide can also be used to disinfect solids.

VW report states "*The design of UV will be the same for all options*". However, the issue of using ferric in the process stream raises the concern of impact on the UV transmissivity. This is of particular concern in Options 4 and 4b and should be addressed and commented on by the VW design team. Potentially, some testing of the impact of small doses of ferric on UV effectiveness should be run to resolve the issue. Changing to alum (as done by VW in 25 MLD Boisbriand plant in Quebec to protect the UV disinfection) is not an option if land application of sludge is continued in Winnipeg.

3.5. Preliminary treatment

The preliminary treatment is assumed to be the same for all options hence little time was devoted to these units. Yet they are critical to downstream operation and should be addressed.
Grease is a large problem in the SEWPCC catchment and therefore removal is necessary. Grease must be handled separately until alternative means of grease handling is implemented by the City. The digesters at NEWPCC could receive grease only after the mixing improvements are implemented in all digesters.

Screening through 12 mm is presently practiced. Although 12 mm has been used extensively in the past and appears satisfactory, the current trend in the industry is to move to finer screens. Finer screens will improve downstream process operation and sludge quality sent to the NEWPCC since more debris is retained by the fine screens. Fine screens would be required to protect the Actiflo cyclones (if installed on WWF flow) and media retention screens of MBBR/IFAS system (Option 2). Finer screens might not be required if WWF is using CEPT in existing primary settlers, activated sludge and BAF (option 3), or option 4.

But since 6 mm are used today in many new plants, VW should consider the feasibility of either replacing the existing 12 mm screens with 6, 8, or 10 mm screens (depending on hydraulic limitations), and placing 6 mm screens downstream in the feed to the Actiflo. Therefore, the statement in VW report, *"Headworks upgrade/ expansion will be the same whatever solution is selected"*, will not be valid as screening requirements differ, they are most stringent for IFAS and Actiflo (6 mm) compared to less stringent for Biostyr and Activated sludge (Options 3 and 4).

Grit and sand removal has always been problematic at SEWPCC. Tea-cup grit removal tanks (e.g. Eutek) have proven to be a good process in nutrient removal plants and are proposed to replace the aerated grit tanks. The more sophisticated WWF flow technology requires good up-front grit removal.

3.6. Primary treatment

C : Clarify the statement in the report, *"Stantec report indicates existing PC depth of 4.3m while during our visit on site operator indicated 6 m depth.*" Probably the operator included the depth of sludge hopper.

C : The expected efficiency of the primaries needs to be compared to present performance, and the influent characteristics of the biological processes adjusted accordingly.

C : What is the fractionation of the effluent for the simulation after primary settling? How is it affected by the performance of the primaries?

C : Primary overflow rate is limited to 2.15 m/h, but without the new unit it would be 2.68 m/h – still not high– what are the consequences of slightly less quality in primary effluent?

3.7. Treatability studies and pilot demonstration

There are questions remaining about influent wastewater characterization, and in particular the efficiency of settling and chemically-enhanced settling, as this affects sizing of biological reactors. One way to resolve the question would be to conduct influent characterization studies and jar-tests to provide site specific information for the assumed removal efficiencies.

Should BAF technology be selected VW could pilot the BAF facility. The pilot would serve to assess the effluent quality and removal rates at various loadings as well as solids removal and waste biomass generation – particularly when the upstream processes feed variable quality. Such a facility could help introduce the technology to the operators.

4. Whole life cycle costs

The whole life cycle cost is a reasonable approach – one should however also consider for each option the replacement cost incorporated into a 30-year cycle. Specifically, while we can agree that concrete and most piping should have a 50+ year expectation, more intensive equipment options will require significantly more replacement costs.