SEWPCC Upgrading/Expansion
Conceptual Design Report

SECTION 19 - Site Development Master Plan

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19.0 Site Development Master Plan

19.1 PURPOSE OF SITE DEVELOPMENT MASTER PLAN

The primary purpose of creating a Site Development Master Plan for the SEWPCC is to help prevent problems related to the feasibility of providing future wastewater upgrades or expansion treatment upgrades or expansion on the site. The design year for the current Upgrade and Expansion project is the year 2031 (23 years from the present). However, many of the SEWPCC components are designed to have a useful life of longer than 25 years, and for some items longer than 50 years. In that context, the creation of the Master Plan plays a critical role in assessing whether additional treatment capacity can be feasibly added beyond the current design target year (2031) without having to abandon, relocate, or significantly disrupt existing treatment systems. This assessment reflects on the cost-effectiveness of all of the treatment construction phases.

The long-range planning horizon for the SEWPCC program has been selected to be the year 2050 (42 years into the future). Assessing, through the Master Plan, whether treatment can be provided on the site for plant influent flowrates projected for the time period between 2031 and 2050 helps confirm that the pending Upgrade and Expansion for the design year 2031 will represent a sound investment.

The year 2050 population and wastewater flow projections adopted for this study do not necessarily represent the ultimate build-out quantities that might occur for all potentially developable lands in the area at maximum density. However, it is believed that they represent a current best estimate of probable population and flow for year 2050 within the City's service boundaries.

By its nature, the Master Plan incorporates approximate and conservative estimates of space requirements for additional future treatment capacity. Technologies advance at a rapid rate, allowing for increased treatment capacity to be accomplished within a smaller space. However, in projecting site space requirements for the planning horizon, conservative current guidelines are used. This approach ensures that the treatment required in the future can be provided on the site with a high degree of certainty. Reductions in area needs which may be accomplished by design performed in subsequent years are considered to be a potential benefit, but not a guarantee. At the same time, projections of future treatment requirements also incorporate some uncertainty. The Site Development Master Plan embodies a balancing between these determinants.

The Site Development Master Plan provides:

- An assessment of space for future expansion and upgrade.

- Coordination between near-term and future expansion.
- A conceptual planning-level estimate of area requirements for future treatment needs.
- A preliminary layout showing some possible general future treatment unit locations.

19.2 ELEMENTS OF THE SITE DEVELOPMENT MASTER PLAN

Creation of a Site Development Master Plan for the SEWPCC facility incorporates the following steps:

- Adoption of the current preliminary design plan layout for Upgrade and Expansion for the design year 2031, particularly related to the use of available space on site.
- Projection of future plant wastewater flowrates and characteristics for the year 2050.
- Preliminary planning-level estimate of additional treatment capacity that will be required.
- Preliminary planning-level estimate of the space requirements for the new treatment capacity, using recognized unit loading factors.
- Preparation of preliminary scaled layout figure showing the footprint of treatment unit expansion items, as a way of confirming that treatment can be expanded on the site to handle the projected future wastewater from the future population.
- Review of the draft projections and treatment equipment layout with plant operational personnel, to obtain input.

In addition to projected future population and effluent constraints, the particular features of the existing treatment plant units and site (including the pending upgrade) represent the other major set of determinants that will affect the future expansion for the year 2050 horizon.

The design for the SEWPCC upgrade and expansion to meet year 2031 flows and loads is currently in the developmental stage. Substantial preliminary engineering including sizing of treatment units has been done; as well as scaled layout sketches on site plans. Preparation of final design drawings and documents for construction tender is anticipated to start in the Fall of 2008.

When considering Site Development Master Plan treatment elements to meet future flows and loads, Stantec has adopted several key premises, including the following:

- The Site Development Master Plan addresses the projected long-term planning horizon year 2050.

- It is assumed that the pending plant upgrade/expansion for the design year 2031 will have been constructed and operating.
- Future regulatory constraints and treatment requirements can only be generally estimated at this time.
- Conservative assumptions are made for space planning.
- Space requirements are estimated only for relatively large treatment units. Many smaller treatment system components would be added or modified in an expansion/upgrade from 2031 to 2050; however, those items would not consume enough space to affect the overall viability of providing the additional treatment on the site. Those smaller items are not evaluated in this section.

Major large treatment items that are considered in this evaluation include the following:

- Primary Settling Tanks (PST).
- Bioreactors.
- Secondary Clarifiers.
- Possible Polishing Treatment Units (Tertiary Treatment).
- Possible Sludge Treatment Systems.
- Possible Intermediate Pumping Station.
- Possible Wet-Weather Flow Treatment Units.
- Effluent Disinfection.

Other possible future treatment plant expansion items which would have smaller footprint impacts include such items as the influent pumping station, the outfall pipeline system, and the Control / Administration Building complex.

19.3 SUMMARY OF PENDING 2012 EXPANSION DESIGN FOR THE YEAR 2031

SEWPCC design flowrates for the pending upgrade/expansion for the design year 2031 are summarized in Table 19.1 These are the projected plant influent flowrates.

Table 19.1 - Projected Design Flowrates for the Pending 2012 Upgrade/Expansion for the Design Year 2031

	Flowrate (ML/d)			
	Winter	Spring	Summer	Fall
Average Day	68.4	88.9	88.9	78.7
Maximum Month	69.8	111.2	131.6	92.0
Maximum Week	74.0	143.4	177.7	104.0
Maximum Day	79.1	225.1	300.2	132.1

The peak hourly plant influent flowrate is projected to be limited by the capacity of the trunk sewer leading to the plant to a value of 415 ML/d, which is the maximum installed design capacity goal for the upgraded influent pump station.

Table 19.2 provides a summary of the treated wastewater discharge limits for key parameters as anticipated through the discharge license for the pending 2012 upgrade/expansion. The values in this table reflect the limits contained in the March 3, 2006 issuance of License Number 2716, as modified by a July, 2008 draft revision. These values are the limits that will be in effect on and after December 31, 2012.

Table 19.2 - Summary of Key Manitoba Conservation License Effluent Limits for the Planned 2012 Upgrade/Expansion for the Design Year 2031

Parameter:	**Concentration Limit after December 2012**	**Units**
Carbonaceous BOD_5 ($CBOD_5$), 30-day average	25	mg/L
Total Suspended Solids (TSS), 30-day average	25	mg/L
Total Phosphorus (TP), 30-day average	1	mg/L
Total Nitrogen (TN), 30-day average	15	mg/L
Fecal Coliform, MPN, monthly geometric mean	200	number/100mL
E. Coli, MPN, monthly geometric mean	200	number/100mL

The license contains limits on Ammonia Nitrogen on a mass flux basis (kg/d), which vary by month.

In addition, the license contains a daily limit of 30 mg/L of Carbonaceous BOD_5 ($CBOD_5$). The City is currently in discussions with Manitoba Conservation to have this clause removed and has instructed Stantec to proceed based on the 30-day rolling average.

The capacities of the plant and major treatment units that will exist following completion of the pending upgrade/expansion project are summarized in Table 19.3, below.

Table 19.3 - Projected Capacities of Major Treatment Plant Components Following Planned 2012 Upgrade/Expansion for the Year 2031

	Active Feature, Total Installed units/trains	Firm Capacity	Max Installed Capacity, Summer	Max Installed Capacity, Year-round
		(ML/d)	(ML/d)	(ML/d)
Influent Pump Station	4	300	415	415
Grit Removal System	4	315	415	415
PSTs Surface Area Feature (m^2):	3 1,939	100	200	200
Bioreactors Volume Feature (ML):	4 26.6	131	175	125
Secondary Clarifiers Surface Area Feature (m^2):	5 6,680	132	175	175
UV Disinfection System	4	132	175	175

It should be noted that some of the active units for some of the treatment steps are different sizes (e.g. the four pumps of the influent pump station include two different pump capacities). The firm capacity is therefore derived based on the specific units installed, and not necessarily from a common denominator.

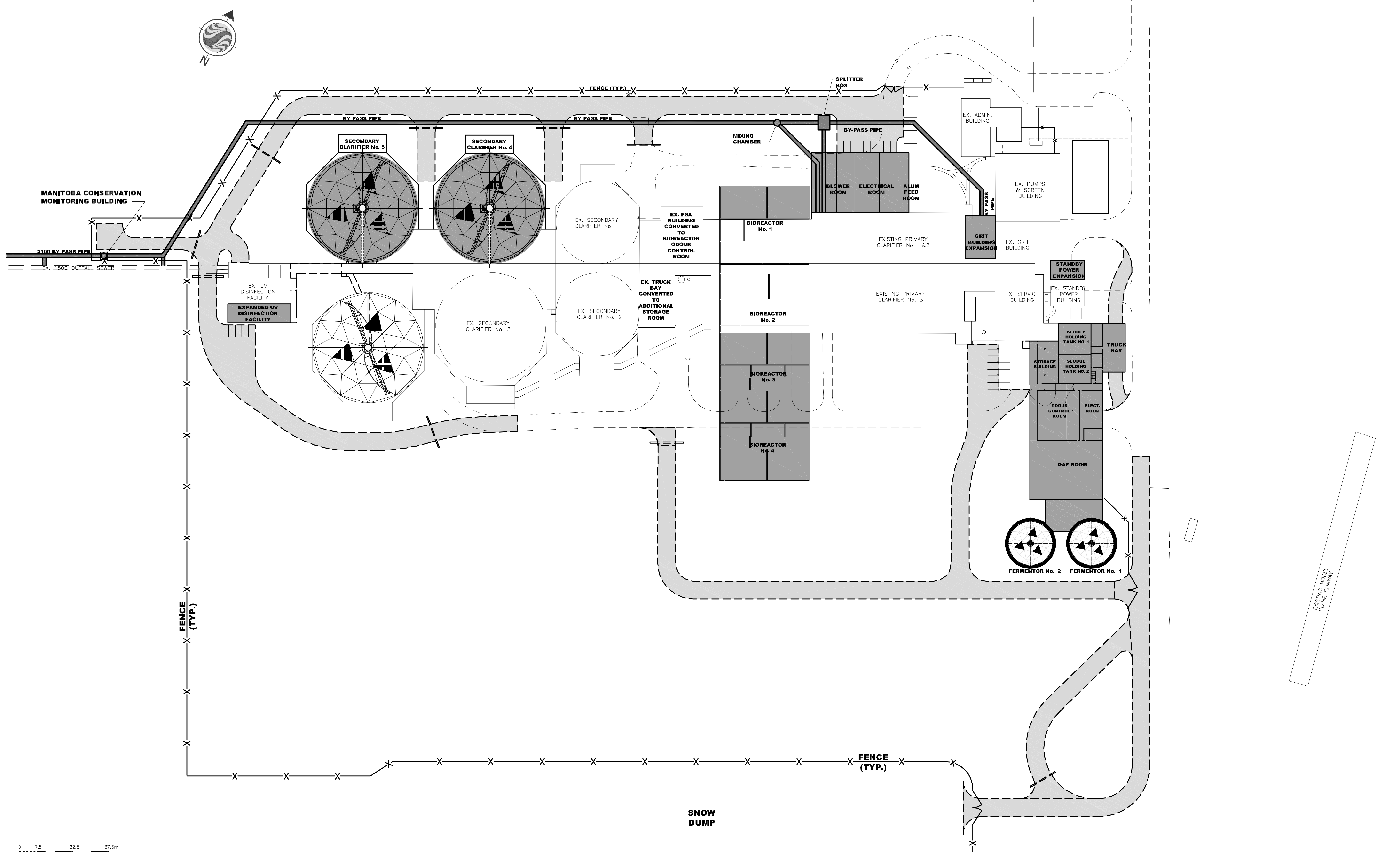
A simplified representation of the SEWPCC design configuration is shown on Figure 19.1. This figure indicates the plant configuration anticipated to exist following the currently planned expansion. Major planned expansion items include the addition of sludge handling equipment and two circular fermenter tanks in the eastern portion of the plant, conversion of the existing HPO activated sludge units to BNR IFAS activated sludge basins, addition of new BNR IFAS basins in the central portion of the site, addition of two new circular secondary clarifiers in the west-central portion of the plant and twinning of the existing UV disinfection facility. Other equipment including aeration blowers, sludge holding, dissolved air flotation (DAF) equipment for WAS thickening and other equipment will be housed in building expansions on the site. Details about each of the planned upgrade components have been previously provided in this report.

Current planning is for construction of the expansion and upgrade to be completed by December of 2012. That expansion is planned to meet the City's needs for the SEWPCC until 2031, the current program design year. The Site Development Master Plan, which is the focus of this section is intended to address subsequent additional needs through the planning horizon year of 2050.

Related to the fact that the SEWPCC is subject to periodic high flows associated with wet weather, the existing treatment plant as well as the planned 2012 upgraded and expanded plant incorporate design features for internal bypassing of portions of the plant for certain flowrates, following a specific flow-based algorithm. The planned 2012 upgraded and expanded plant will be able to treat higher flowrates than the existing plant. The 2012 upgraded and expanded treatment plant will also bypass some treatment components during periods of very high total flowrates. The degree of high-flow bypassing anticipated is indicated generally by a review of the treatment capacities shown in Table 19.4 in comparison with historical high wet weather flowrates. Those flowrates have in recent years periodically approached 400 ML/d. It is expected that such periodic high flowrates will continue to occur in the future. In the pending upgraded plant, biological treatment will be provided in the summer for 175 ML/d, which corresponds approximately to the projected summer maximum week plant flowrate. Primary clarification will be provided for flow up to 200 ML/d, using chemical addition to enhance settling. Flowrates exceeding these values will bypass the primary and/or secondary treatment. All flows up to 175 ML/d will be undergo UV disinfection. Flows in excess of that will bypass UV disinfection. The controlled high-flow internal plant bypassing will be accomplished though a modified bypass pipeline system incorporated as part of the 2012 upgrade/expansion

19.4 POPULATION AND FLOWRATE PROJECTIONS FOR THE YEAR 2050

As noted in the Preliminary Design Report, the projected Year 2031 SEWPCC service population is 229,800 persons. The projected Year 2050 SEWPCC service population is 278,100 persons. These numbers represents the low-growth rate indicated by input provided at the July, 2006 review workshop. It should be noted that this number is a projection of the actual human resident occupant population. The associated wastewater flowrates which are projected in the Preliminary Design Report and in this section represent all projected wastewater flows, including residential and industrial, commercial, and institutional (ICI) wastewater flow components in the SEWPCC service area. However, in the Preliminary Design Report and in this section, the population number which is provided does not differentiate the ICI portion of the wastewater flow as being represented as a "population equivalent" component. The City has recently initiated efforts to more accurately assess the ICI flow components. As the City



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WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

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Certificate of Authorization
Stantec Consulting Ltd.
No. 1301 Expiry: April 30, 2009

LOCATION APPROVED
UNDERGROUND STRUCTURES

SUPV. U/G STRUCTURES COMMITTEE | DATE

NOTE:
LOCATION OF UNDERGROUND STRUCTURES AS SHOWN ARE BASED ON THE BEST INFORMATION AVAILABLE BUT NO GUARANTEE IS GIVEN THAT ALL EXISTING UTILITIES ARE SHOWN OR THAT THE GIVEN LOCATIONS ARE EXACT. CONFIRMATION OF EXISTENCE AND EXACT LOCATION OF ALL SERVICES MUST BE OBTAINED FROM THE INDIVIDUAL UTILITIES BEFORE PROCEEDING WITH CONSTRUCTION.

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ELEV.

NO.	REVISIONS	DATE	BY

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DRAWN BY	APPROVED BY
HOR. SCALE: VERTICAL:	RELEASED FOR CONSTRUCTION:
DATE 08.08.08	DATE

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TENDER NO.

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

SOUTH END WATER POLLUTION CONTROL CENTRE

SITE PLAN
PENDING UPGRADE 2031 DESIGN

CITY DRAWING NUMBER: FIGURE 19.1 | SHEET | OF

U:\111208959\594_Drawing\FIG 19.1_19.2.dwg 2008-11-20 10:39AM By: kremorooe

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progresses with that assessment, for all presentations of wastewater flowrate and unit flowrate factors, it will be extremely important to be very clear about the basis for the numbers presented, in relation to populations and flowrates. It is beneficial to have an understanding of the different flowrate components. However, it is important to consistently confirm the basis for flowrate and population numbers which are presented, to preclude any misunderstanding.

The year 2050 projected population represents an increase of 21% over the projection for the year 2031. As a baseline for comparison, the service population in 2005 was estimated to be 179,400 persons.

The projected SEWPCC plant flowrates for the future design year 2050 are summarized in Table 19.4. These flowrate values were developed from projections of sanitary wastewater and infiltration and inflow components summed for the array of service area districts. For comparison, the percentage increase over the corresponding 2031 values are noted.

Table 19.4 - Projected Year 2050 Design Flowrates

Average Dry Weather Flow (Winter):	79 ML/d	(16% over 2031)
Summer Average	103 ML/d	(14 % over 2031)
Maximum Month (Summer)	153 ML/d	(16% over 2031)
Maximum Week (Summer)	206 ML/d	(16 % over 2031)
Maximum Day (Summer)	348 ML/d	(16 % over 2031)

It is possible that development within the SEWPCC service area will continue beyond the year 2050 such that ultimate buildout of all possible lands to maximum density would result in higher future flowrates. This condition is not evaluated as part of this site development assessment.

It is also possible that the City's developing program for control of combined sewer system overflows will result in an overall increase in the quantity of wastewater to be managed. However, there are sewer hydraulic capacity limitations, particularly in the plant influent trunk sewer, where flowrates above 415 ML/d would result in surcharging and basement flooding. It is estimated that the cost of twinning significant portions of the sewer system would be so high as to drive the selection of other management options such as local treatment of wet weather overflows with techniques such as enhanced clarification or diversion to the NEWPCC.

The related plant influent flux of pollutants will increase between the years 2031 and 2050. A detailed projection of influent pollutant flux loadings for the year 2050 is not within the scope of this evaluation. General estimates of future regulatory requirements are provided below.

19.5 POTENTIAL FUTURE REGULATORY LICENSE REQUIREMENTS

Planning-level estimates of future regulatory requirements for the year 2050 related to the SEWPCC include the following:

- Potential new regulatory constraints will require additional removal of Phosphorus, and to a lesser degree Total Nitrogen.
- Further restrictions on wet weather flow bypassing of treatment will be imposed.
- Pharmaceutical and personal care product compounds (PPCPs, “Compounds of Emerging Concern") will be a concern to be addressed.

The following assumptions were made for planning purposes:

- Further restrictions could limit effluent P to ≤ 0.5 mg/L and possibly ≤ 0.3 mg/L.
- Any further N removal required could be addressed through BNR operational modifications, subsequent to 25 years of MJ-IFAS BNR performance data.
- All wet weather flow could be required to undergo at least enhanced clarification.
- Any limits on PPCP/ Compounds of Emerging Concern could be addressed through the BNR process supplemented with ozonation.
- The City’s developing biosolids program could result in a need for local sludge stabilization treatment at the SEWPCC.

19.6 ESTIMATED YEAR 2050 TREATMENT UPGRADES AND EXPANSION

19.6.1 Primary Clarification

The pending 2031 upgrade will provide capacity for 200 ML/d in existing PCs 1, 2 and 3 by providing for chemical addition for enhanced clarification. No additional PSTs are planned for installation in 2012. The total surface area is 1,939 m2.

The pending 2012 upgrade for the year 2031 will provide the following surface overflow rates (SORs):

- 3.8 m/h at 174 ML/d, without chemical addition.
- 4.2 m/h at 200 ML/d, with chemical addition.

To provide clarification for projected 2050 Maximum Day flowrate of 348 ML/d and eliminate untreated bypasses, it is projected that two additional primary settling tanks would be added, PST 4 and PST 5, increasing the area by 1,500 m2 to a total primary settling surface area of 3,439 m^2.

The year 2050 SOR values would then be:

- For Maximum Day (348 ML/d): 4.2 m/h, with chemical addition.
- For Maximum Week (206 ML/d): 2.5 m/h, without chemicals.
- For Maximum Month (153 ML/d): 1.8 m/h, without chemicals.

The dimensions of new PSTs 4 and 5 would be:

- Length: 50 m.
- Width (each): 15 m.

New PCs would be constructed adjacent to existing PSTs. These SOR values and projected footprint areas are based on unimpeded settling in plain tanks, and thus represent a conservative estimate of area requirements. Use of a more efficient technique such as lamella plate separators would reduce the area requirement.

19.6.2 Biological Treatment System

The pending 2012 upgrade to MJ BNR with IFAS will provide summer treatment for 175 ML/d, which is approximately equal to the summertime Maximum Week plant flowrate; and 125 ML/d year-round. This will remove P to $\leq$1 mg/L and TN to 15 mg/L on a 30-day rolling average basis. This upgrade for loads to the year 2031 will result in approximately 26.6 ML of BNR bioreactor volume. This will be provided in four parallel BNR trains.

Potential further limitations beyond the year 2031 on TN would require modification and addition of bioreactor capacity. It was estimated for planning purposes that further expansion of the bioreactors would be required for the year 2050 to provide BNR capacity for the year 2050 summer Maximum Week flowrate of 206 ML/d. This represents a 16% increase in BNR capacity. This could be provided by the addition of one BNR train similar to one of the four year 2012 design BNR trains. Adding a fifth BNR train would add 6.65 ML of bioreactor volume, for an actual future installed capacity of approximately 213 ML/d. This flowrate is slightly higher than the projected year 2050 summer Maximum Week plant flowrate. However, it would be beneficial to keep the parallel BNR trains as similar as possible, for operational uniformity and ease of control.

The fifth BNR bioreactor train could be added adjacent to the four trains to be constructed in 2012, on the south side.

19.6.3 Secondary Clarification

The pending 2012 upgrade and expansion for the year 2031 will add two new secondary clarifiers, SC 4 and SC 5, each 45 m in diameter, for a new total secondary clarifier surface area of 6,680 m2.

To provide clarification for the year 2050 summer Maximum Week flowrate of at least 206 ML/d (213 ML/d to match the BNR system), one additional 45 m diameter clarifier could be added, SC- 6. This would add a further 1,590 m^2 for a new total of 8,270 m^2 of secondary clarifier settling area. This would represent an increase of approximately 23 % over the year 2012 area. The corresponding flowrate represents an increase of about 16%. Thus, the SOR values in the year 2050 would be slightly lower (for corresponding flowrates) than with the year 2012 design. A 45-m diameter is recommended to match the operational features of the other large secondary clarifiers.

A promising location for SC 6 is adjacent to and west of existing SC 3.

19.6.4 Polishing Filtration for Additional P Removal

It is estimated that chemical addition/coagulation with granular media filtration of secondary effluent would be required to achieve TP to 0.3 mg/L or lower. The filtration would be sized for the summer Maximum Week flowrate of 206 ML/d

High-rate mixed-media filtration was estimated at 200 L/min-m^2; with the area doubled to account for two filter compartments, one of which might be in backwash mode. The required active filtration surface area is 715 m^2. Adding 10% for peripheral zones would require 787 m^2.

The total filter area would be 787 x 2, or 1,574 m^2. This could be provided in a 40 m x 40 m tank structure. An additional 5 m of width for backwash supply water and backwash waste tanks is estimated. A superstructure would cover the filter beds, and pumps, chemical storage could be placed over the backwash waste tank compartment. Pumps would convey gravity-settled backwash waste to the solids handing portion of the plant.

The filters could be located southeast of the UV disinfection channels, and possibly northwest as a second option.

The filters would probably incur 1-2 m of headloss, requiring additional plant pumping in order to maintain adequate need to discharge the treated effluent through the outfall to the Red River. The pumping station could be located before or after the filters. For planning purposes, a dual screw pump station was assumed. Dimensions: were estimated to be approximately 10 m wide x 30 m long.

Although technologies such as continuous backwash filter systems (e.g. Dynasand) are available to accomplish the same removal of TP to 0.3 mg/L or less, this estimate for granular media filtration provides a conservative footprint area for planning purposes.

19.6.5 Disinfection / Oxidation

The pending 2012 upgrade for 2031 will increase the UV disinfection capacity to 175 ML/d.

For the year 2050, it was assumed that the disinfection system would no longer be subject to untreated bypasses. It is projected that technology-based practices will be required to address PPCPs / CECs, with treatment by the BNR system and ozonation considered appropriate. Therefore, for planning purposes, addition of ozone generating and contact chambers was estimated. Ozone accomplishes rapid oxidation in a short contact time, but has high energy consumption.

It was estimated that the ozone generator and contact tanks would be located near the UV system, which would be kept in service complimentary to the ozonation system. Ozonation would offer the option of contributing to oxidation of residual ammonia nitrogen; and might also be appropriate to play a role in sidestream treatment. Features of the ozone contact tanks for a year 2050 design flowrate of 348 ML/d (summer maximum day) include the following:

- Contact tank volume for 10 minutes contact: 2,420 m^3
- Area, for assumed depth of 6 m: 403 m^2
- Possible dimensions, partitioned tank: 20 m x 20 m

Ozone generators would be required, along with feed gas dryers, off-gas destruct units, and controls. The ozonation system could be located near the UV system and possibly near the new filters.

19.6.6 Biosolids/Sludge Treatment

SEWPCC sludge is currently sent to NEWPCC anaerobic digesters. The City's overall biosolids program is currently in evolutionary stages. The pending 2012 upgrade for 2031 will add fermentors for primary sludge and DAF thickening for BNR WAS; with continued hauling at about 5% SS to the NEWPCC for further treatment and/or disposal. For site planning purposes, it is possible that continued low-solids hauling and treatment/disposal at the NEWPCC could be terminated for a variety of reasons; and, that local sludge stabilization treatment at the SEWPCC could be required at some point in the future.

Options for sludge stabilization include such techniques as anaerobic digestion, aerobic digestion, and physical/chemical methods including advanced oxidation. Mesophilic anaerobic digestion was assumed for planning purposes; with 2-stage digestion including mixing and settling/thickening. Approximate design features include the following:

- 1st- stage mixed tank: 20,000 m^3, 48 m diameter x 12 m SWD.
- 2nd stage tank: 32 m diameter.

The digesters could be located across from the fermentors. Compact devices such as centrifuges or rotary presses could be used to thicken and dewater sludge, which has undergone some initial thickening in the second digester tank. Dewatered sludge could be hauled away for disposal at significantly lower volume rates.

If anaerobic digestion is selected for the future program, it will be necessary to review and address potential re-dissolution of P from BNR sludge and recirculation of that P back to the plant liquid stream in the digester system decant return.

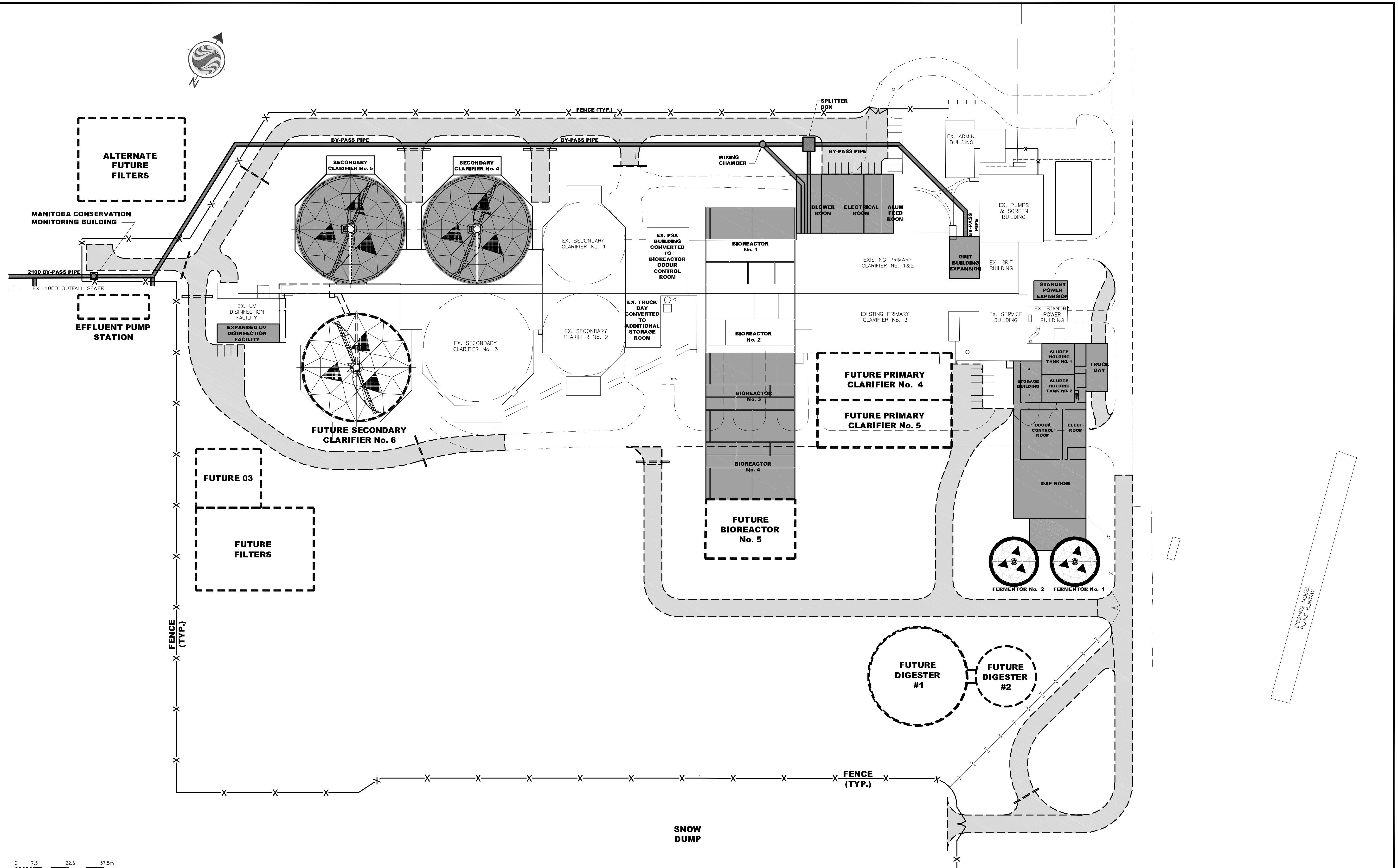
Aerobic digestion and physical/chemical oxidation techniques have similar or smaller area requirements.

19.6.7 Potential Future Expansion Layout

A potential layout of the major treatment unit areas projected for the planning horizon year 2050 is shown on Figure 19.2.

19.7 PRELIMINARY CONCLUSIONS

- Additional treatment units have been estimated to meet projected planning horizon year 2050 requirements.
- There is sufficient space on the SEWPCC site to accommodate these long-term needs.
- The Conceptual Design for the pending upgrades for the design year 2031 is compatible with the projected long-term site development requirements.



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Stantec Consulting Ltd.
No. 1301 Expiry: April 30, 2009

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LOCATION APPROVED
UNDERGROUND STRUCTURES

SUPV. U/G STRUCTURES COMMITTEE DATE

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DATE 08.08.08	DATE

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TENDER NO.

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

SOUTH END WATER POLLUTION CONTROL CENTRE

SITE DEVELOPMENT MASTER PLAN
FOR DESIGN YEAR 2050

CITY DRAWING NUMBER
FIGURE 19.2

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