SECTION 5.0
OPTIMIZATION OF EXISTING PLANTS

5.1 INTRODUCTION

This section considers the potential ability of the existing three wastewater treatment plants to reduce effluent ammonia concentrations without the need for the City of Winnipeg to undertake an extensive capital program. The ability of the plants to achieve ammonia reductions varies among the three plants, depending upon the type of plant and the present and projected loading characteristics.

Generally, the strategies developed are based on downloading a portion of the facility so that it is able to nitrify, without unduly stressing the remainder of the plant.

5.2 OPTIMIZATION OF THE NORTH END WATER POLLUTION CONTROL CENTRE (NEWPCC)

Flows and loads used to assess potential optimization strategies for the NEWPCC are based on those developed in Section 2.0. Projected primary effluent characteristics for the four seasons of the design year (2041) are repeated in Table 5.1.

Table 5.1: Projected Primary Effluent Characteristics for the Year 2041 – NEWPCC

Periods	Flow (ML/d)	Flow Used in Load Calculation (ML/d)	TSS (kg/d)	BOD (kg/d)	COD (kg/d)	TKN (kg/d)	TP (kg/d)
Winter							
Average	211	211	22,809	34,414	68,828	8,862	1,245
Maximum Month	237	237	27,682	41,475	82,950	10,144	1,398
Maximum Week	250	223	32,335	47,053	94,106	11,373	1,650
Maximum Day	260	211	42,036	61,169	122,338	14,785	2,145
Spring							
Average	390	390	34,905	33,969	67,938	9,672	1,443
Maximum Month	571	571	59,670	46,023	92,045	11,249	1,827
Maximum Week	705	437	89,107	58,968	117,936	13,322	2,228
Maximum Day	710	390	115,839	76,658	153,317	17,319	2,896
Summer							
Average	291	291	27,674	30,380	60,761	8,352	1,251
Maximum Month	381	381	40,424	37,338	74,676	9,639	1,524
Maximum Week	449	352	52,800	53,856	107,712	13,376	2,042
Maximum Day	686	291	68,640	70,013	140,026	17,389	2,654
Fall							
Average	250	250	21,100	30,975	61,950	8,425	1,125
Maximum Month	312	312	29,640	36,941	73,882	9,890	1,373
Maximum Week	364	258	34,248	43,003	86,005	10,300	1,828
Maximum Day	526	250	44,522	55,903	111,807	13,390	2,377

The NEWPCC is a high purity oxygen activated sludge treatment plant with a relatively short hydraulic retention time (HRT). This HRT limits the sludge retention time (SRT) at which the plant can be operated because high SRTs would result in extremely high MLSS concentrations. At these concentrations, solids loading to the secondary clarifiers would overload this unit process. Presently, the NEWPCC is operated at sludge retention times of 2.0 to 2.5 days. Analysis summarized in Section 4.0 illustrated that to achieve an ammonia concentration of less than 2.0 mg/L during the summer months, the plant SRT would have to be increased to greater than 8 days during this period. Longer SRTs are required during the late winter and spring months due to the low wastewater temperatures.

There are six HPO bioreactors, arranged in three pairs. Each pair of reactors has a dedicated set of secondary clarifiers. It would be possible to restrict the flow to some of the process trains so that they could achieve nitrification while increasing the flow to the remainder of the reactors. In Section 4.0, it was determined that each bioreactor could reasonably handle 5.6 percent of the flow, while maintaining nitrification. At the same time, modifications would need to be made to allow pH modification. This modification would be done by opening the last zone so excess CO_2 could be removed by stripping. Hence, if one bioreactor was controlled to achieve nitrification, 5.6 percent of the flow would be nitrified and the remainder would be treated in the other five bioreactors to meet conventional standards. If two bioreactors were converted, 11.2 percent of the flow would be nitrified and the remaining 88.8 percent of the flow would be treated conventionally. Table 5.2 illustrates the predicted effluent characteristics for the NEWPCC with one, two, and three nitrifying bioreactors.

Table 5.2: Secondary Effluent Ammonia Concentrations – Optimization Options

Number of Nitrifying Reactors	Number of Conventional Reactors	Effluent Ammonia concentration, mg/L (Summer)		
		Nitrifying	Conventional	Combined
1	5	1.0	19.0	18.0
2	4	1.0	18.5	16.5
3	3	1.0	18.0	15.2

To achieve the conversion of the plant summarized above, it would be necessary to operate the conventional bioreactors at more aggressive loading rates. Without any allowance for nitrification, it would be possible to operate the bioreactors at an SRT of 2.0 to 2.5 days without overloading the secondary clarifiers. With an increasing number of bioreactors operating in nitrifying mode, there would be less bioreactor capacity available for conventional treatment. To ensure that the secondary clarifiers were not overloaded, the SRT would have to be lowered to decrease the solids inventory in the treatment system. For this analysis, it has been assumed that the limiting MLSS during maximum month summer conditions would be 3,500 mg/L. With one nitrifying bioreactor, the SRT could be maintained in the 2.0 to 2.5 day range. For two nitrifying bioreactors, the SRT would be lowered to a maximum of 2.0 days. An SRT of about 1.5 days would be considered the maximum possible if three bioreactors were converted to nitrification. An SRT below 1.5 days could not be accommodated while maintaining adequate process robustness. Hence, converting three bioreactors to nitrifying mode would not be feasible due to the impact on clarification in the conventional bioreactor-clarifier sections of the plant.

At lower SRTs, there is greater biological sludge generation. When greater biological sludge is produced, there is a parallel increase in sludge management costs.

With the maximum of two bioreactors nitrifying, the effluent ammonia concentration would be lowered approximately 2.5 mg/L, or about 13 percent. This reduction in effluent ammonia is minimal. However to achieve this reduction, the secondary treatment plant would have to be segregated into two separate and distinct operations. Some minor modifications would be required in the nitrifying sections to minimize pH depression so that nitrification was not inhibited. The conventional and nitrifying operations would have separate secondary clarifiers and RAS streams. More importantly, the operating parameters used for each would differ substantially.

The potential reduction in ammonia concentrations achievable with NEWPCC optimization is minimal, while some capital costs would be incurred and operating complexity would be substantially increased. For these reasons, it is not recommended that plant optimization at the NEWPCC be considered a feasible option and it will not be pursued further.

5.3 OPTIMIZATION OF THE SOUTH END WATER POLLUTION CONTROL CENTRE (SEWPCC)

Flows and loads used to assess potential optimization strategies for the SEWPCC are based on those summarized in Section 2.0. Projected primary effluent characteristics for the four seasons of the design year (2041) are repeated in Table 5.3.

Table 5.3: Projected Primary Effluent Characteristics for the Year 2041 – SEWPCC

Periods	Flow (ML/d)	TSS (kg/d)	BOD (kg/d)	TKN (kg/d)	TP (kg/d)
Winter					
Average	75	6,050	12,415	2,637	478
Maximum Month	79.3	6,390	14,140	2,800	522
Maximum Week	81.5	6,045	19,320	3,328	704
Maximum Day	125				
Spring					
Average	112.6	9,515	14,350	2,538	542
Maximum Month	151.6	12,230	18,725	3,065	768
Maximum Week	205.3	16,045	30,275	4,218	1,210
Maximum Day	270				
Summer					
Average	94.2	7,825	12,870	2,317	427
Maximum Month	109.9	8,620	23,300	2,537	684
Maximum Week	144.5	10,795	30,315	3,171	843
Maximum Day	270				
Fall					
Average	84.5	7,195	12,565	2,426	433
Maximum Month	105.1	8,600	14,375	2,730	488
Maximum Week	119.9	8,945	16,975	3,064	539
Maximum Day	200				

The SEWPCC is a high purity oxygen activated sludge treatment plant with a relatively short hydraulic retention time (HRT). This HRT limits the sludge retention time (SRT) at which the plant can be operated because high SRTs would result in solids loading to the secondary clarifiers that would overload this unit process.

Presently, the plant is operated at sludge retention times of 2.0 to 2.5 days. Analysis summarized in Section 4.0 illustrated that to achieve an ammonia concentration of less than 2.0 mg/L during the summer months, the plant HRT would have to be increased to about 6.2 hours to maintain a minimum SRT of approximately 8.0 days during this period. Longer SRTs were required during the late winter and spring months due to the low wastewater temperatures. One of the four bioreactors has a volume of approximately 1,620 m^3, so would be able to treat approximately 6.3 ML/d, or about 7 percent of the 2041 design flow. One of the small clarifiers would be dedicated to this flow while the remaining three (two existing and one new) would be dedicated to the conventional bioreactors. Channel and piping changes would be required to accommodate this change.

In this scenario, 93 percent of the flow would receive conventional treatment in the remaining existing bioreactors and three secondary clarifiers – two existing and one new unit. In the short term, it would not be necessary to expand the plant further. However, the conventional plant would not be able to handle the 2041 flows and loads. Either additional bioreactors would have to be added or the secondary clarifier planned in the short term would have to be substantially increased in size.

Without any allowance for nitrification, the SEWPCC effluent ammonia concentration is expected to be approximately 17.5 mg/L. With 7 percent of the flow being nitrified to a residual concentration of about 1.0 mg/L, the combined effluent ammonia concentration during the summer months would be approximately 16.2 mg/L, a reduction of 1.3 mg/L from the baseline condition. Given the potential cost of the modification, the added operational complexity, and the fact that the plant would have to be further expanded in the near future to accommodate growth, this option does not appear feasible and will not be pursued further.

5.4 OPTIMIZATION OF THE WEST END WATER POLLUTION CONTROL CENTRE (WEWPCC)

The WEWPCC differs from the other two wastewater treatment plants – it is an air activated sludge facility designed with a longer hydraulic retention time. Accordingly, it is better able to sustain the longer solids retention times necessary to achieve nitrification. As shown in Section 4.0, no additional tankage is required to attain 'best practicable' ammonia removal. As is shown in the later Section 10.0 – Moderate Ammonia Removal at the WEWPCC, continued use of the existing lagoon to polish the plant effluent achieves some level of nitrification. Because the plant is able to remove ammonia without very costly modifications, optimization is not a priority at this facility. Refer to Section 4.0 for the modifications necessary to achieve less than 2.0 mgNH_3/L.