Sanitary Servicing Strategy for the 21st Century

Technical Information Report
February 1999

Prepared by:

Drainage Strategic Planning
Drainage Services
Asset Management and Public Works Department

EXECUTIVE SUMMARY

Development in the City of Edmonton has reached a point where the existing sanitary sewer system can no longer accommodate anticipated flows generated from future home construction. Since 1994, Drainage Services has completed numerous sanitary servicing studies for servicing new development in the City. These studies have resulted in a recommendation to build a major sanitary trunk from each of these areas to the City's Gold Bar Wastewater Treatment Plant (GBWWTP) and the Capital Region Sewage Treatment Plant (CRSTP). In addition, two smaller areas of the City were studied and recommendations were made to build a new trunk and upgrade the existing system as part of the overall servicing scheme. These five recommended trunk systems are:

- The North Edmonton Sanitary Trunk (NEST);
- The South Edmonton Sanitary Sewer (SESS);
- The West Edmonton Sanitary Sewer (WESS);
- Clareview Sanitary Trunk (CST); and
- Terwillegar University Farms Sewer (TUFS)

Construction of the NEST system has already begun, as development in north Edmonton was at a standstill due to serious overloading of the existing sewer system. A solution was required to allow development to proceed in that area and was instrumental in initiating servicing studies for the remainder of the City. The five recommended trunk systems provide a long range servicing plan to facilitate development growth in the City of Edmonton for the next 75 years.

In 1997, the City of Edmonton was approached by the Urban Development Institute, Greater Edmonton Chapter, with a proposal for financing major sanitary trunk sewers to facilitate development needs. The funding proposal would form a new means to collect revenues to fund the five recommended trunk systems listed above. Drainage Services retained a financial consultant to evaluate the proposal to ensure it was a viable and financially feasible alternative to the existing Permanent Area Contribution system for major trunk sewer construction.

By combining the long range servicing plan with this new method for financing construction, Drainage Services has developed the Sanitary Servicing Strategy for the 21st Century. This strategy was approved by City Council on July 21, 1998, and includes the establishment of the Sanitary Servicing Strategy Fund (SSSF). Details of the fund management and revenue sources are documented in a separate report titled ‘Sanitary Servicing Strategy Fund Report' (December 1998).

This report complements the details outlined in the Sanitary Servicing Strategy Fund Report and describes the analysis completed to meet the following objectives:

- Ensure flows generated from new developments are accommodated by the construction of a new stage of the trunk system for temporary storage.

- Ensure flows generated by new developments can be accommodated by the treatment plants (GBWWTP and CRSTP).
- Refine the construction schedules established through the other servicing studies, to ensure all assumptions relating to population growth and development needs are consistent throughout the City.
- Review cost estimates established in the servicing studies to ensure they are reasonable and consistent.
- Assess the cash flow of the fund by utilizing a financial model to calculate revenue generated and compare it to construction expenditures based on the refined schedule to ensure a positive balance is maintained.

The assessments completed for each area determine the construction year for various stages of the trunk system. The sewer systems will be built in stages, with initial stages acting as storage tanks in wet weather. The storage will be used to collect all flows from new development to ensure that new flows do not increase the loading of downstream systems. These stored flows are pumped out in dry weather. Flows in dry weather are only allowed to grow to 25% of the downstream combined sewer capacity to limit the risk in downstream areas.

The increase in the flows to the two treatment plants the (Gold Bar Wastewater Treatment Plant and the Capital Region Sewage Treatment Plant) were tracked to see when expansion would be necessary. Timing is dependent on the trunk system components diverting flows to and from the plants. (Note that the SSSF will not pay for treatment plant expansions; these are the responsibility of the sanitary utilities).

The financial implications of the proposed construction schedule were investigated to determine if sufficient revenue could be generated to maintain a positive cash flow balance. The development and population growth forecasts were used to assess the potential income from land developed (the Expansion Assessment) and new homes built (Sanitary Sewer Trunk Charge). Assumptions were made based on these forecasts for the share that the Sanitary Utility would be responsible for when re-routing existing parts of the City to the new sewers. An assessment was also made of the share that the region would be responsible for as flows from Leduc, Beaumont, Nisku, and the International Airport will be utilizing the new trunk system.

This strategy outlines a servicing plan for the next 75 years. The work documented in this report is a one-time vision of a changing future. Many assumptions were made and the information contained here should be updated on an annual basis to account for changes in growth rates, technology, etc. In the future, a shorter time frame for forecasting development and determining construction needs is recommended. Annual updates of a ten year forecast would provide sufficient detail to estimate the strategy's needs.

Table of Contents

Table of Contents (Cont'd.)

List of Tables

List of Figures

1.0 INTRODUCTION

1.1 Background: Edmonton's Sanitary Servicing Strategy for the 21st Century

For most of Edmonton's history, up to about 1970, the City built all major sanitary trunks. In the development boom of the 1970's, the private development industry took on more of the responsibility for trunk sewer construction. In the 1970's and early 1980's, major trunk sewer construction was financed by the provincially administered revolving trunk fund. The construction of major sanitary trunks ended in the early 1980's with the end of the development boom.

Ongoing developments have used up most of the available capacity in existing sewers. This resulted in an end to new development in the north end of the City in 1988. Although a solution for north Edmonton was developed during 1992 to 1995, without the construction of other new trunk sewers, development in other areas of the City could become restricted as well.

The City conducted 18 studies (see References) between 1995 and 1998 that developed plans for new sewers to overcome these problems. These plans form the City's Sanitary Servicing Strategy. The technical studies have resulted in 3 major trunk systems being recommended for implementation. These include the North Edmonton Sanitary Trunk (NEST), the South Edmonton Sanitary Sewer (SESS), and the West Edmonton Sanitary Sewer (WESS). In addition, servicing for the Terwillegar and University Farms will require future upgrading of existing sewers (TUFS). The service areas for these recommended trunk systems are shown in Figure 1.1.

The Sanitary Servicing Strategy was approved by City Council on July 21, 1998 through an amendment to the Sewers Bylaw No. 9425. The Sanitary Servicing Strategy is a long range plan, and a funding strategy to provide sanitary servicing for the City of Edmonton over the next 75 years. The funding strategy is described briefly in the following section.

1.2 The Sanitary Servicing Strategy Fund

The front-end costs for the Sanitary Servicing Strategy are too high for the City's sanitary utility or any individual developers to finance. The Sanitary Servicing Strategy Fund was developed as a mechanism for combining the resources of the developers, the new home construction industry and the City to build the needed trunk sewers.

The Sanitary Servicing Strategy Fund (SSSF) pools the financial resources of the building industry, the development industry, and the sanitary utility for the construction of major sanitary trunks to service growth within the City and in new development areas.

The SSSF does not replace the Permanent Area Contribution (PAC) system. The SSSF takes care of the major trunk system that the PAC system never addressed. The SSSF will only be used to build sewers larger than 1050 mm in diameter that service areas greater than 1400 ha. These major trunks had been termed "Remote Off-site" trunks during initial efforts to develop PAC charges for them.

The charges in place for the fund are described fully in the Sanitary Servicing Strategy Fund Report (December, 1998), along with the details of how the fund will be managed.

1.3 Contents of this Report: The Technical Analysis Supporting the Sanitary Servicing Strategy

This document presents the technical background of the Sanitary Servicing Strategy Fund and how all related information was compiled to ensure that this strategy is financially feasible for the construction of remote off-site sanitary sewer trunks.
In total, there are three main sanitary service areas in the City that provide service to new suburban development. They are:

- North Edmonton Sanitary Trunk and Clareview Sanitary Trunk (NEST/CST).
- West Edmonton Sanitary Sewer (WESS).
- South Edmonton Sanitary Sewer (SESS).

Potential development in the Terwillegar and University Farms areas will require an upgrade to the existing downstream trunk system and this is referred to as the Terwillegar and University Farms Sanitary Trunk (TUFS). Refer to Figure 1.1 for a plan outlining these four service areas.

The report discusses the following:

- the analysis to determine the timing for construction (stage assessment) of each section of the major sanitary trunk sewer systems (NEST/Clareview, WESS. SESS, TUFS) and to develop a conceptual construction schedule,
- the analysis to determine when the Gold Bar Waste Water Treatment Plant and the Capital Region Sewage Treatment Plant will need to be expanded, and
- the financial model developed for the Sanitary Servicing Strategy Fund accounting for development projections, population growth, revenues and the conceptual construction schedule.

THE CITY OF Edmonton ASSET MANAGEMENT AND PUBLIC WORKS
DRAINAGE SERVICES

EXISTING AND PROPOSED TRUNK SERVICE AREAS

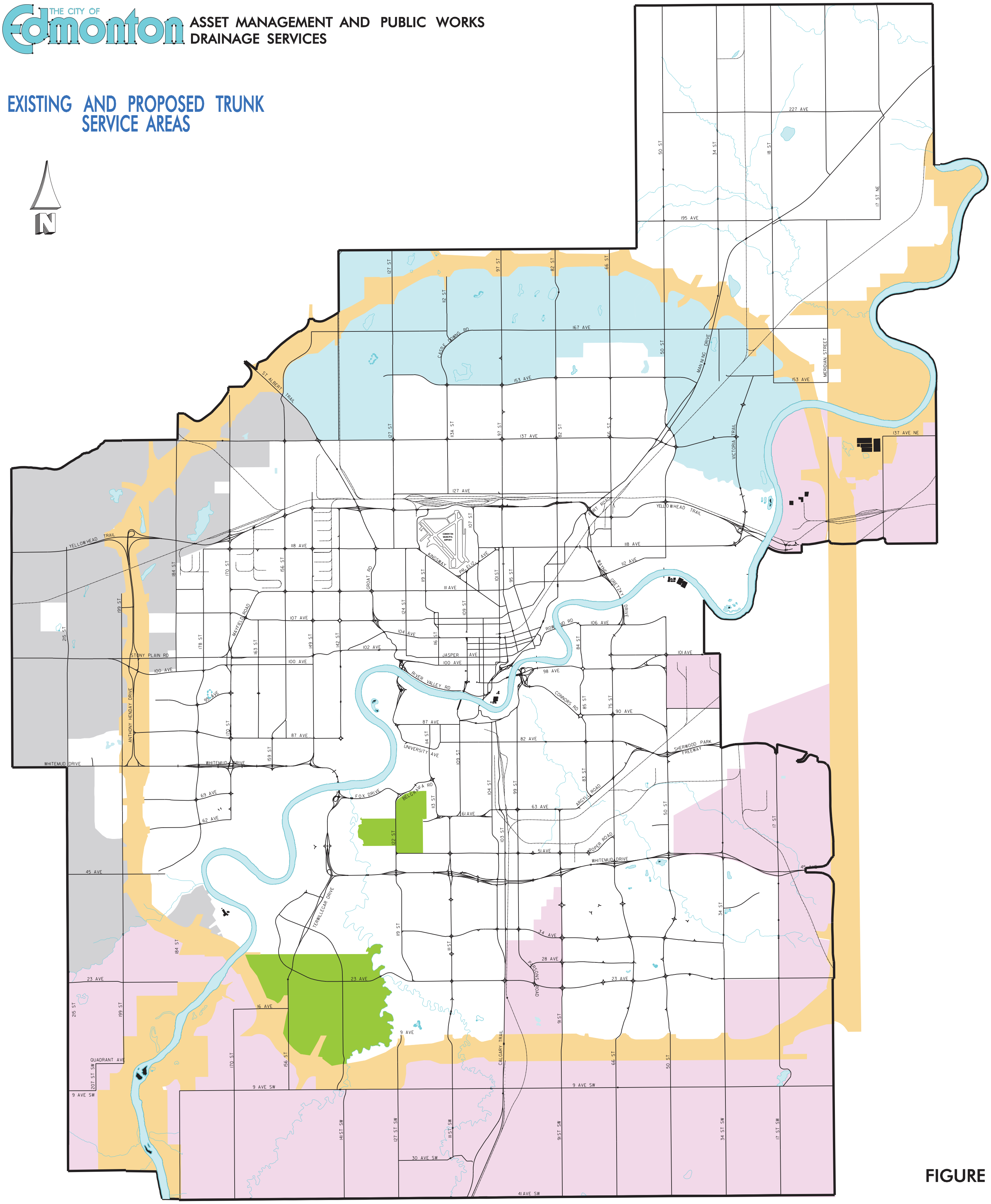


FIGURE 1.1

RESTRICTED DEVELOPMENT AREA (RDA)	W.E.S.S. CONTRIBUTING AREA	N.E.S.T. CONTRIBUTING AREA
C.S.T. CONTRIBUTING AREA	S.E.S.S. CONTRIBUTING AREA	T.U.F.S. CONTRIBUTING AREA

2.0 TRUNK SEWER CONSTRUCTION STAGING

The assessments of when to build the various stages for NEST/Clareview, WESS, SESS, and TUFS are based on the studies completed by City staff and consultants that evaluated all of the conveyance options and developed conceptual level costs. The stage assessments accounted for development projections and downstream capacity constraints to determine when stages of the trunk sewers would have to be constructed.

The concept behind building small stages of the trunk is:

- to avoid building extensive trunk systems all at once and incurring huge debts;
- to hold back flows in these pieces of trunks that will act as storage tanks during rainfall events when existing downstream systems are overloaded;
- to make use of the significant capacity available in the existing downstream system when it is not raining to provide service to new developments and to empty the trunk segment storage tanks;
- to add trunk segments as development needs and revenues accumulate and are able to pay for them; and
- to delay connecting the trunk segments and completing sewer systems to treatment plants until the money is available.

When downstream trunks exceed a set percentage of their free flow capacity during peak dry weather flows, a new stage will be constructed and used as storage during wet weather flows. In some cases, stages are triggered strictly for conveyance, system extension, plant capacity, or storage drawdown.

Certain allowances and assumptions were utilized to account for I/I, capacity constraints and drawdown times for the stage assessments. These are discussed in Sections 2.2 to 2.4.

2.2 Inflow and Infiltration

For the calculations of this assessment, the value of inflow and infiltration could be calculated in two ways:

a) based on the Servicing Standards: values of 0.28 l/s/ha for general inflow/infiltration and 0.4 l/s/sag manhole were combined with assumptions of 10 lots/ha, 3.5 people/lot, 3 manholes/ha and 10% of manholes in sag locations to give a general inflow/infiltration value of 0.0114 l/s/person.

b) based on the City-wide inflow/infiltration experienced at the plant: summer average flows of about 270 ML/d compared to cold weather average flows of 220 ML/d result in a value for inflow/infiltration of 23% of the average dry weather flow (this works out to be 0.0008 l/s/person, or 30% of the value calculated by using the City standards).

As the Servicing Standards were developed for very small systems, they would likely predict inflow/infiltration values that are too high when applied to large areas. Because of this, and a good level of confidence in the large data set of plant flow records, the estimates for storage and plant flows were based on the lower inflow/infiltration estimate.

When looking at the downstream trunks however, both methods were investigated to judge the time at which areas should begin to store flows, as the construction of storage segments was considered to require conservative estimates.

2.3 The 25% Usage Rate for Existing Combined Sewers

The downstream combined trunk sewer system is used to capacity during rainstorms, even though significant capacity is available in dry weather. Because of this, new areas must store flows during rainstorms to limit flow increases for older systems. If storage were not provided, new trunks would have to be built from the new development areas to the treatment plants, at a great cost.

The high wet weather flows also led to a decision that flows from new developments would not be allowed to use all of the sewer capacity available in existing pipes. A significant portion of the combined sewer system capacity would need to be reserved for handling stormwater. It was then left to determine how much capacity should be reserved (i.e. at what point would the requirement for storage begin).

Combined sewers carry both surface runoff and domestic and industrial wastewater. An assessment of the sewage and rainfall runoff generated from a 1 ha parcel revealed that, if combined sewers were to be built to today's standards (with a 1 in 5 year storm), 90% of the sewer's capacity would be required for storm related flows, and only 10% would be needed for wastewater.

Reserving 90% of the capacity of the existing combined system capacity for storm events was not practical. Most sewers were built a long time ago and had already exceeded that value. Using this criteria would therefore require construction of whole new sewer systems. A value of 25% was chosen for the following reasons:

- it represented a good balance between the risk to existing systems and the unaffordable costs of building whole new sewer systems immediately;
- some sewers in the City currently operate close to or above this value currently, and this level of risk is has been accepted by customers for many years; and
- it allowed an affordable construction schedule for stages of the new sewer systems.

The criteria for requiring areas to begin storage was therefore set at 25% of the free flow capacity of downstream combined sewer systems. As flows grow to this value in more and more sewers around the City, assessments can be made of the risk and the need to reduce it.

It should be noted that the average dry weather flow (ADWF) may grow beyond 25% of the downstream combined sewer capacity. However, by implementing the storage requirement, flows in excess of the 25% capacity limit can be shut off and stored when capacity in the sewer is needed to deal with storm related flow.

2.4 Storage Trunk Drawdown

The 25% rule ensures that flows can be restricted to 25% of the pipe capacity if the capacity is needed in wet weather. For a day or two following a major storm, it was felt that some level of additional risk could be accepted to allow stored flows to be passed through the system to the plant. Other studies have indicated that the probability having one storm event after another is not high. Typically, a period of 3.5 to 6 days of dry weather separates rainfall events that cause surcharging (Reference 1).

The level of usage in downstream sewers for both dry weather flow and storage drawdown was set at 50% of the pipe's free flow capacity immediately after the storm event. It was felt that this usage rate was a reasonable compromise between reserving capacity for storm flows from existing areas, and accelerating the construction schedules for new sewer segments.

The implementation of both rates is as follows: when the (ADWF) grows to 25% of the receiving system's capacity, storage must be provided. The ADWF and 1-day drawdown rate must never exceed 50% of the receiving sewer's free flow capacity.

3.0 THE SOUTH EDMONTON SANITARY SEWER (SESS) AREA

The South Edmonton Sanitary Sewer (SESS) serves the following areas:

- Leduc, Beaumont, Nisku and the International Airport,
- the area west of the river south of 45 Avenue,
- the area south of the Restricted Development area east of the river (Heritage, Ellerslie and South East Industrial);
- Mill Woods and the Meadows; and
- the industrial areas on the east edge of the City north of Whitemud Drive including the Aurum and Cloverbar Industrial areas.

The service basin for SESS is shown in Figure 3.1

The SESS consists of feeder trunks from the west and the east that join with a main trunk near 97 Street (approximately) and Quadrant Avenue. Flows from the west are pumped up into the main trunk at this point, while flows from the east basin south of the RDA and those from the communities served by the CRSC enter the northbound pipe by gravity.

The sewer continues north on 97 Street from Quadrant Avenue to 30th Avenue and then swings eastward, picking up Mill Woods. The SESS continues east and north through Mill Woods and the Industrial areas and continues northward along the river to reach the Capital Region Sewage Treatment Plant (CRSTP). The alignment of the sewer is shown in Figure 3.1.

Figure 3.1 also indicates the names of the various segments of the SESS. Segment labels start with “S” to indicate they are part of the SESS system. For the second letter, "SW' denotes the feeder trunk system extending west, “SE” denotes the feeder trunk system extending to the east, and "SA” denotes that the alignment of the main trunk is the alternative "A” alignment from the original SESS report.

The trunks shown on Figure 3.1 are those that meet the SSSF criteria of being larger than 1050mm in diameter and servicing an area greater than 1600 ha. Smaller trunks will be needed, but they will be funded through PAC's, not through the SSSF.

3.1 Flows From South of Edmonton

The projected flows from the communities serviced by the Capital Region Sewage commission (CRSC) south of the City were taken from the SESS report as provided by the CRSC. These flows are shown in Table 3.1

3.2 Assessment of Local Storage and Drawdown

The local storage needs were determined based on the projected population, the required storage of 1.6m^3/lot, and the value of 3.5 people/lot. Tables 3.1, 3.2, 3.3, and 3.4 show how the required storage was calculated.

Providing storage to meet the requirement was accomplished by constructing the various stages of SESS in years where the storage provided was less than the storage required. From the tables it can be seen that this assessment was completed individually for three areas as follows:

- the area south of the RDA (Table 3.1),
- the area between the RDA and the Sherwood Park Freeway (Table 3.2), and
- the area west of the river (Table 3.3).

Once enough segments had been built to interconnect the different areas, an assessment was made for the storage needs of the combined SESS basin (Table 3.4).

Another aspect of this analysis was the time required to empty the storage tanks, based on available downstream capacities. If the drawdown time exceeded 1 day, construction was required to carry the flows to an outlet with greater capacity. This occurred in the analysis as follows:

- in 2025, the dry weather flows from south of the RDA grow to a point where the storage drawdown time becomes excessive, and sections SA1 and SA2 must be built to connect the storage to the higher capacity Burnewood trunk.
- Again in 2053, the dry weather flows and storage grow to a point where the Burnewood trunk is inadequate, and a high capacity connection to the Capital Region Sewage Treatment Plant is needed.

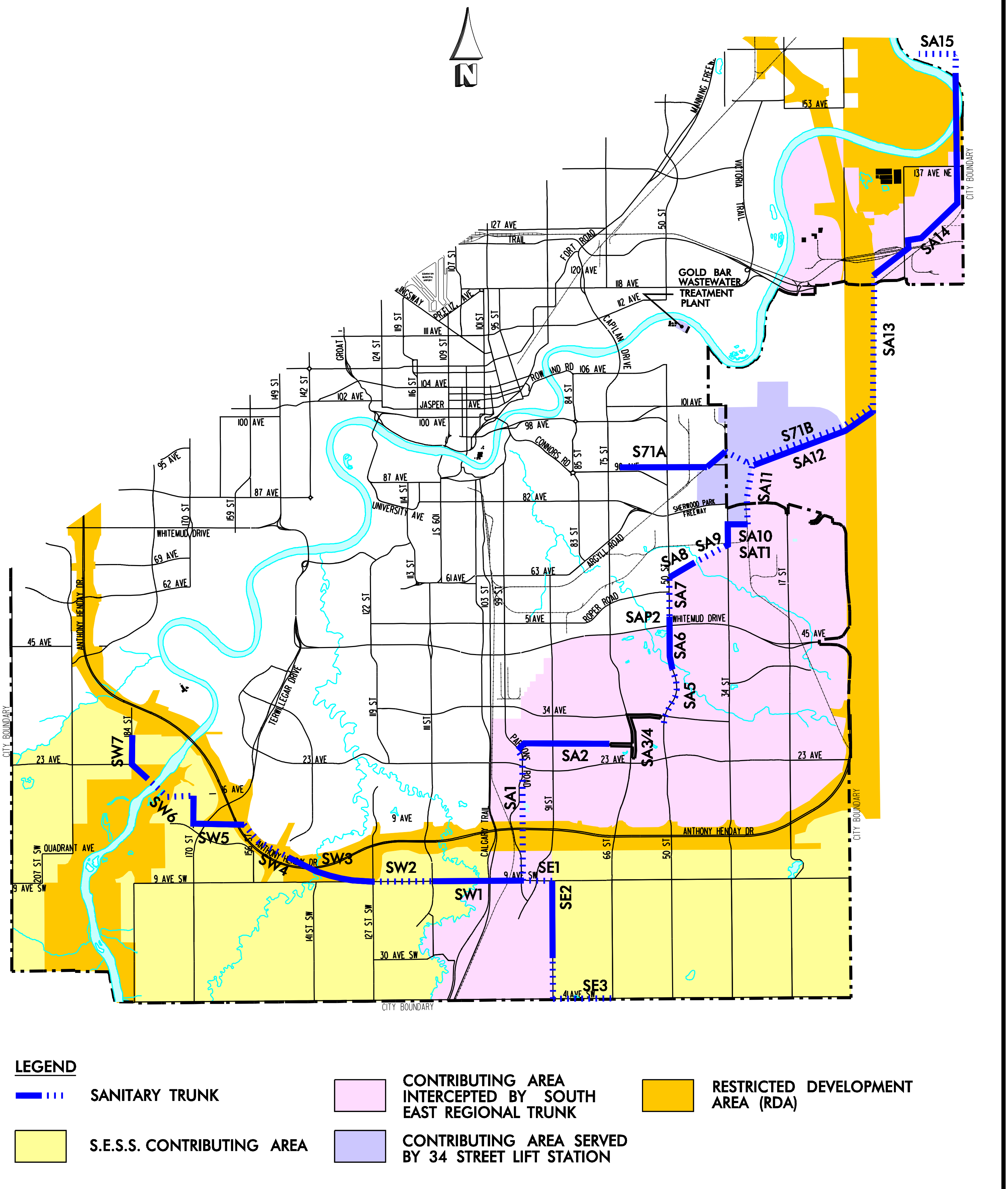
The year that individual stages are required is summarized in Table 3.5.

3.3 Downstream Trunk Sewer Assessment

For the area south of the RDA, storage is required immediately to overcome the low discharge (0.1 cms) allowed into the receiving trunk (the Capital Region Sewage Commission's South East Region Trunk Sewer following Calgary Trail and 97 Street) and that trunk's wet weather problems. The usage of the trunk at its constricted section increases to beyond 50% in 2005 using the high inflow/infiltration value and 2020 based on the low inflow/infiltration value (see Section 2.3). For a less constricted downstream section, the 50% usage is delayed until 2038, even for the high inflow/infiltration rate (Node 580010 vs. Node 560110, see Appendix A). Based on these assessments, 2017 was selected as the year when this section would need to be bypassed, triggering the construction of sections SA1 and SA2.

For the area between the RDA and the Park Freeway, the Burnewood Trunk never becomes a constraint. Farther downstream however, the 71 Street trunk exceeds the 25% rule in 2030 using the low inflow/infiltration rate, and in 2006 using the high inflow/infiltration value. A construction year of 2015 was selected as the year storage would start being required, this year representing a time when the money would likely be available for the construction. As a result, section SA6 is built in 2020 to accommodate the storage requirements that began to accumulate with the population in 2015.

The Burnewood trunk begins to exceed 50% capacity in 2035 using the high inflow/infiltration rate. The 50% limit is never exceeded when the low inflow/infiltration rate is used. 2050 was selected as the time when a bypass of this trunk would be needed. Figure 3.1 illustrates the staging of the SESS trunk system and Table 3.5 summarizes each stage.



SOUTH EDMONTON SANITARY SEWER (SESS)

The City of Edmonton
ASSET MANAGEMENT & PUBLIC WORKS
DRAINAGE SERVICES

FIGURE 3.1

Table 3.1 - Stage Assessment for Lands South of the RDA Based on Drawdown

Assume:

1.6	m^3/Lot Storage Required	23%	I/I compared to ADWF
3.5	People/Lot	300	L/c/day Residential Sewage Generation Rate
0.1	Maximum dry weather discharge rate (m^3/s) into Burnewood trunk	0.2	L/sec/ha Non-residential Sewage Generation Rate
0.19	Dry weather discharge rate (m^3/s) downstream of SERTS.	1.5	Residential Peaking Factor
1.48	Dry weather discharge rate (m^3/s) into Calgary Trail & Burnewood Trunk after connection	2.5	Non-residential Peaking Factor

Year	Growth			Storage Required m^3	Stage Built (name/year)	Storage Provided (m^3)	Storage Balance (m^3)	Increased ADWF&I/I (m^3/s)	Increased ADWF from south[2] (m^3/s)	Total ADWF&I/I Increase (m^3/s)	Increased PDWF from Area (m^3/s)	Allowable Discharge Capacity (m^3/s)	Storage for Drawdown	Drawdown Rate (m^3/s)	Drawdown Time (Days)
	West of Calgary Trail	East of Calgary Trail	Total Increase												
1994	775	525	0	0		0	0	0.000	0.000	0.000	0.000	0.100	0	0.100	0.000
1995	936	525	161	0		0	0	0.001	0.000	0.001	0.001	0.100	0	0.099	0.000
2005	2541	525	1766	807	SW1/1999 SE1/2000[1]	4301 4301	3494	0.008	0.016	0.024	0.035	0.100	2221	0.076	0.336
2010	3344	525	2569	1174		4301	3127	0.011	0.025	0.036	0.054	0.100	2588	0.064	0.468
2015	4147	525	3372	1541		4301	2760	0.014	0.035	0.049	0.074	0.100	2955	0.051	0.675
2020	4950	525	4175	1909		4301	2392	0.018	0.045	0.063	0.094	0.100	3323	0.037	1.033
2025	15491	11870	26061	11914	SA1/SA2	27953	16039	0.111	0.056	0.167	0.250	0.190	13328	0.023	6.689
2025 - SA2 Built, System Connected															
2030	26032	23216	47948	21919		39564	17645	0.204	0.068	0.272	0.408	0.190	23333	-0.082	-3.289
2035	36573	34561	69834	31924		39564	7640	0.297	0.081	0.378	0.567	0.190	33338	-0.188	-2.049
2040	47114	45907	91721	41930	SW2	48165	6235	0.390	0.095	0.485	0.728	0.190	43344	-0.295	-1.698
2045	57655	57252	113607	51935	SW3	56766	4831	0.484	0.111	0.595	0.892	0.190	53349	-0.405	-1.526
2050	68195	68598	135493	61940	SW4	63217	1277	0.577	0.127	0.704	1.056	0.190	63354	-0.514	-1.427
2075	120900	125325	244925	111966	SW5	62357	-49609	1.043	0.207	1.250	1.874	0.190	113380	-1.060	-1.238

[1] Storage required+ SE storage for Industrial areas(counted in drawdown, but not residential storage provided)

[2] South indicated areas served by the CRSC south of the City including Leduc, Beaumont, Nisku, and the International Airpor

Note: SE stages are sized for conveyance only.

Table 3.2 - Stage Assessment for Lands between the RDA and the Sherwood Park Freeway Based on Drawdown

Assume:

1.6	m^3/Lot Storage Required	23%	I/I compared to ADWF
3.5	People/Lot	300	L/c/day Residential Sewage Generation Rate
0.19	Dry weather discharge rate (m^3/s) downstream of SERTS.	0.2	L/sec/ha Non-residential Sewage Generation Rate
1.48	Dry weather discharge rate (m^3/s) into Calgary Trail & Burnewood Trunk after connection	1.5	Residential Peaking Factor
1.29	Maximum dry weather discharge rate (m^3/s) into Burnewood trunk	2.5	Non-residential Peaking Factor

Year	Growth			Storage Required m^3	Stage Built (name/year)	Storage Provided (m^3)	Storage Balance (m^3)	Increased ADWF&I/I (m^3/s)	Increased PDWF (m^3/s)	Allowable Discharge Capacity (m^3/s)	Storage for Drawdown	Drawdown Rate (m^3/s)	Drawdown Time (Days)
	Meadows	Mill Woods	Total Increase										
1994	2900	81425	0	0		0	0	0.000	0.000	1.29	0	1.290	0.000
1995	4294	81749	1718	0		0	0	0.007	0.011	1.29	0	1.283	0.000
2005	18234	84987	18896	0		0	0	0.080	0.121	1.29	0	1.210	0.000
2010	25205	86607	27487	0	SA9[1]	0	0	0.117	0.176	1.29	6697	1.173	0.066
2015	32175	88226	36076	0		0	0	0.154	0.230	1.29	6697	1.136	0.068
2020	39145	89845	44665	3926	SA6/2020	6451	2525	0.190	0.285	1.29	10623	1.100	0.112
2025	40757	90035	46467	4750	SA5/2025	12902	8152	0.198	0.297	1.29	11447	1.092	0.121
2025- SA2 Built, system connected													
2030	42370	90226	48271	5575		12902	7327	0.205	0.308	1.290	12272	1.085	0.131
2035	43982	90416	50073	6399		12902	6503	0.213	0.320	1.290	13096	1.077	0.141
2040	45594	90607	51876	7223		12902	5679	0.221	0.331	1.290	13920	1.069	0.151
2045	47206	90797	53678	8047		12902	4855	0.229	0.343	1.290	14744	1.061	0.161
2050	48819	90988	55482	8871		12902	4031	0.236	0.354	1.290	15568	1.054	0.171
2075	56880	91940	64495	12992		12902	-90	0.275	0.412	1.290	19689	1.015	0.224

[1] SA9 storage needed for Industrial areas, not counted as residential storage provided.

Table 3.3 - Storage Based Stage Assessment for Lands West of the River

Assume:	1.6	m^3/Lot Storage Required
	3.5	People/Lot

Year	Growth		Storage Required m^3	Stage Built name/year	Storage Provided m^3	[1]Storage Balance m^3
	Total	Total Increase				
1994	350	0	0		0	0
1995	379	29	13		0	-13
2005	671	321	147		0	-147
2010	817	467	213		0	-213
2015	963	613	280		0	-280
2020	1109	759	347		0	-347
2025	5716	5366	2453	SW7/2025	1126	-1327
2030	10324	9974	4560		1126	-3434
2035	14931	14581	6666		1126	-5540
2040	19538	19188	8772		1126	-7646
2045	24146	23796	10878		1126	-9752
2050	28753	28403	12984		1126	-11858
2075	51790	51440	23515		1126	-22389

[1] SW7 is built as the City's obligation for storage in this area to service the Grange area south of 45Avenue and will be pumped out to the WE.SS system. Additional storage is either an onsite concern, or development is delayed until the river crossing and downstream stages of SESS are complete. Much of this population will be a result of country residential development and will not require storage as they are not connected to the system. After about 2020, this area will require a reassessment to determine storage needs.

Table 3.4 - Stage Assessment for SESS After Connection Through Mill Woods Completed

Assume:

1.60	m^3/Lot Storage Required
3.50	People/Lot
1.29	Maximum dry weather discharge rate (m^3/s) into Burnewood trunk
0.19	Dry weather discharge rate (m^3/s) downstream of South East Regional Trunk Sewer (SERTS)
1.48	Dry weather discharge rate (m^3/s) into Calgary Trail & Burnewood Trunk after connection
23%	I/I compared to ADWF @ plant.

Year	Growth					Storage Required m^3	Stage Built (name/year)	Storage Provided (m^3)	Storage Balance (m^3)	Increased ADWF&I/I (m^3/s)	Increased ADWF from South[1] (m^3/s)	Total ADWF&I/I Increase (m^3/s)	Increased PDWF (m^3/s)	Allowable Discharge Capacity (m^3/s)	Storage for Drawdown (m^3)	Drawdown Rate (m^3/s)	Drawdown Time (Days)
	West of Calgary Trail	East of Calgary Trail	Meadows	Mill Woods	Total Increase												
1994	775	525	2900	81425	0	0											
1995	936	525	4294	81749	1879	859											
2005	2541	525	18234	84987	20662	9445											
2010	3344	525	25205	86607	30056	13740											
2015	4147	525	32175	88226	39448	18033											
2020	4950	525	39145	89845	48840	22327											
2025	15491	11870	40757	90035	72528	33156											
2025 - SA2 Built, System Connected								27953+12902									
2030	26032	23216	42370	90226	96219	43986	SW2	49456	5470	0.334	0.068	0.402	0.603	2.690	52097	1.760	0.34
2035	36573	34561	43982	90416	119907	54815	SW3	58057	3242	0.416	0.081	0.497	0.746	2.690	62926	1.640	0.44
2040	47114	45907	45594	90607	143597	65644	SW4&5	70099	4455	0.499	0.095	0.594	0.890	2.690	73755	1.530	0.56
2045	57655	57252	47206	90797	167285	76473	SA7	76796	323	0.581	0.111	0.692	1.038	2.690	84584	1.410	0.69
2050	68195	68598	48819	90988	190975	87303	SA8&10	91529	4226	0.663	0.127	0.790	1.185	2.690	95414	1.290	0.86
2075	120900	125325	56880	91940	309420	141449	SA11&12	140414	-1035	1.074	0.207	1.281	1.922	2.690	149560	0.700	2.47

[1] South indicated areas served by the CRSC south of the City including Leduc, Beaumont, Nisku, and the International Airport

Table 3.5 - SESS Staging (Option A from 1996 RCPL Report)

Name	Location	Length (km)	Diameter (mm)	Reason for Construction				
				Residential Storage	Industrial Storage	System extension	Conveyance Capacity (50% of Cap.)	[1]Plant Capacity
				Year Required				
SE1	East of SERTS	0.8	1500	-	**2000**			
SE2	South of SE1	2.7	1050	>2050		**2015**		
SE3	South of SE2	3.0	1050	>2050		**2040**		
SW1	111 St. to SERTS	1.0	2340	**1999**				
SWP1	PS & fm: SW1 to SERTS			**1999**				
SW2	West of SW1	2.0	2340	**2030**				
SWP2	Upgrade PS&fm to 0.9cms			**2030**				
SW3	West of SW2	2.0	2340	**2035**				
SW4	West of SW3	1.5	2340	**2045**				
SW5	West of SW4	1.3	2340	**2046**		2044		
SW6	River Crossing	1.5	1050				**2047**	
SW7	West of river,pump to WESS	1.3	1050	**2025**				
SA1	North of RDA pump station	2.8	2340	2025		2017	**2017**	
SA2	Connect SA1 to ex. tunnel	2.7	2340	2025		2017	**2017**	
SAP1	PS to divert Mill Woods							**2055**
SA5	Section north of Mill Woods tunnel	1.5	2340	**2025**				
SA6	North of SA5	1.5	2340	**2020**				
SAP2	Pump into Burnewood Trunk			**2020**				
SA7	North of SA6 (Incl. Pump Station)	1.0	2920	**2045**				
SA8	North of SA7 (no Pump Station)	1.0	2920	**2050**				
SA9	North of SA8 (Include Pump Sta.)	1.0	2920		**2008**			
SA10		1.2	2920	2050			2050	**2036**
SA11		1.6	2920	2052			2050	**2037**
SA12		3.6	2920	2057			2050	**2038/39**
SA13		3.7	2920	2068			2050	**2040/41**
SA14	Complete to the plant	6.2	2340				2050	**2042/43**
SA15		1.8	1800				2050	**2044**
S71A	71 St. - 90 Ave	3.1	fm					
S71P1	71 St. - 90 Ave							
S71B	34 St. - N of 92 Ave	4.1	fm					
S71P2	71 St. - 90 Ave							
S71P3	71 St. - 90 Ave							
S71P4	71 St. - 90 Ave							
S71P5	71 St. - 90 Ave							

[1] Note that several combinations of conveyance diversions and treatment expansions are possible. These have been assessed separately and Table 7.1 shows the results of the assessment.

4.0 THE WEST EDMONTON SANITARY SEWER (WESS) AREA

The West Edmonton Sanitary Sewer (WESS) will provide sewer servicing to undeveloped areas on the western edge of the City between St. Albert Trail and 45 Avenue. The basin and the trunks that form the WESS are shown in Figure 4.1. The area north of Yellowhead Trail is served by a system of pumpstations and forcemains extending west to service Big Lake and northwest to service Mistatim and Kinokamau Plains. New pumpstations and forcemains along 79 Avenue and 62 Avenue will extend to service the Grange and south Lewis Farms. A storage and pumping facility on 100 Avenue will extend to service the Grange and south Lewis Farms. A storage and pumping facility on 100 Avenue will extend service to north Lewis Farms and Winterburn. Only the system on 100 Avenue provides service to enough land to qualify for funding by the SSSF. Other systems feeding into WESS will be paid for by developers through a traditional PAC process.

The studies done for this area selected storage tanks, pumpstations, and forcemains as the most cost effective solution for sanitary servicing of West Edmonton. The reasons for using this type of system for west Edmonton include:

- poor soil conditions for tunneling, and
- a trunk sewer that does not pass through the basins it serves giving little opportunity for combining storage and conveyance needs.

4.1 Local Storage

The WESS service area was divided into three separate areas for evaluation as each required their own separate outfalls. The first is Mistatim, Kinokamau, and Big Lake (Area 1), the second is Winterburn and Lewis Farms North (Area 2), and the third is Lewis Farms South and the Grange (Area 3). Presently, Areas 1 and 2 do not have a permanent sanitary sewer outfall and Area 3 only has a sanitary outfall for South Lewis Farms but not the Grange. Refer to Figure 4.1 for the area names mentioned above.

4.1.1 Area 1

An outfall is scheduled to be constructed for Kinokamau in 2000 (by developers), with the remaining areas to receive a connection around 2020. Storage will be required to store all wet weather flows. The system for this area is not considered part of main WESS trunk and will not be constructed through the Sanitary Servicing Strategy Fund but rather through the Permanent Area Contribution (PAC) system. The local storage needs of Area 1 are calculated in Table 4.1. Refer to Figure 4.1 for the location of this trunk.

4.1.2 Area 2

An outfall is scheduled to be constructed through the Sanitary Servicing Strategy Fund in 2003. It is considered the first stage of WESS and will consist of a storage facility for wet weather flows, and a lift station and forcemain for conveyance. The local storage needs of Area 2 are calculated in Table 4.2. Refer to Figure 4.1 for the location of this stage.

4.1.3 Area 3

In 1999, a sanitary outfall will be constructed by the developers for the Grange into the existing 62 Avenue trunk. As identified in the Area Master Plan (AMP) for the Grange, storage will be required to store all wet weather flows. The system for this area is not considered part of the main WESS trunk and will not be constructed through the Sanitary Servicing Strategy Fund but rather through the PAC system. Currently, the sanitary flows from Lewis Farms South discharge into the existing 79 Avenue trunk. Conveyance capacity is available for all future flows from Lewis Farms South, however, storage may be required in the future to store wet weather flows. The local storage needs of Area 3 are calculated in Table 4.3. Refer to Figure 4.1 for the location of this trunk.

4.2 Downstream Trunk Sewer Assessment

The stages of WESS are constructed in years where storage provided is less than the storage required. The downstream combined sewer system was analyzed to determine when the dry weather flow would achieve 25% of the sewer's free flow capacity.

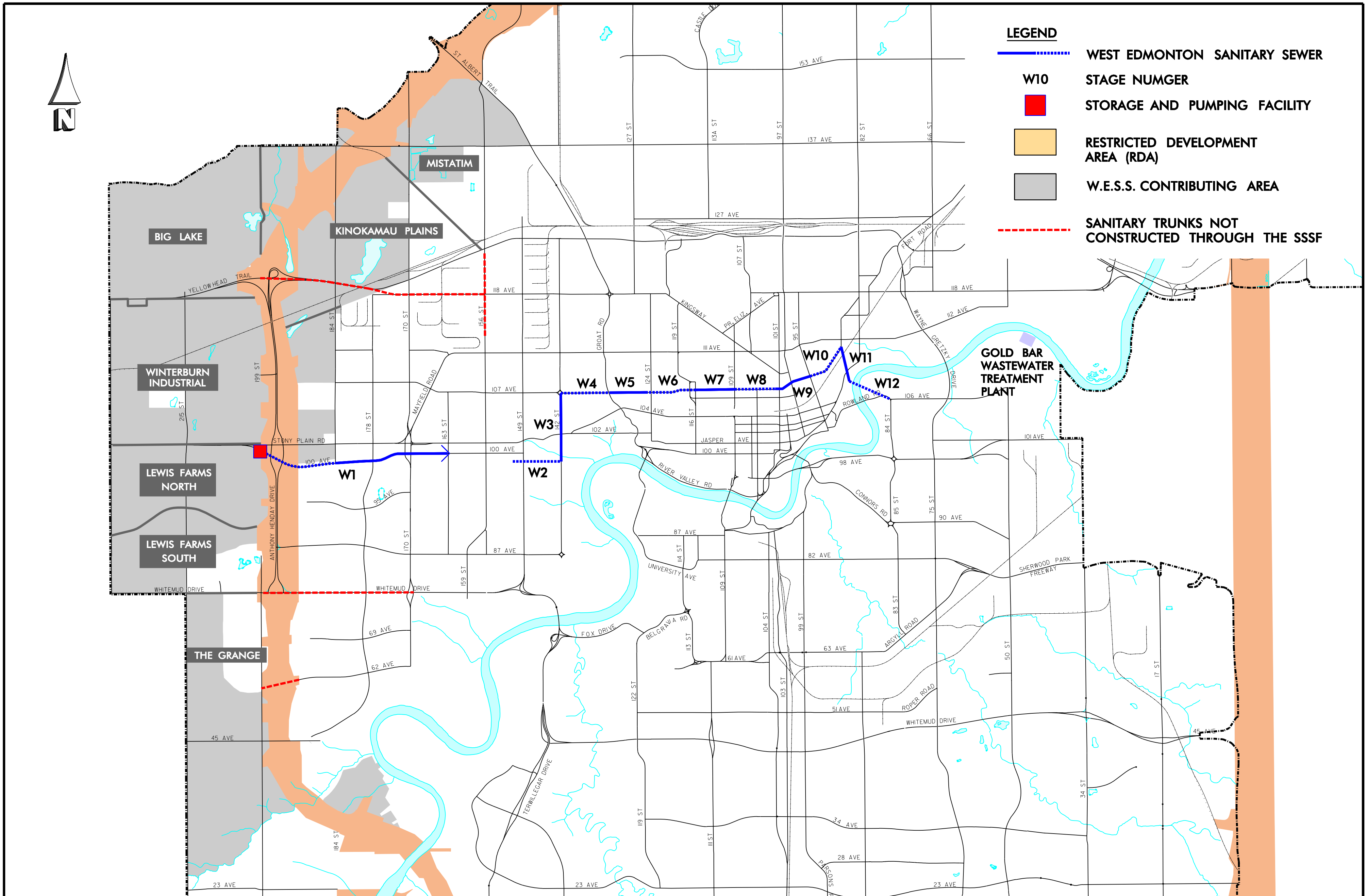
In order to provide servicing to the WESS basin, the first stage will involve the construction of a shallow storage facility with a forcemain to convey flows to the existing sanitary trunk system at 151 Street and 99 Avenue. This will allow for the development of North Lewis Farms and the Winterburn Industrial Area, as there is currently no sanitary outfall for this area of the basin.

The second stage of WESS is not required for some time as the first stage (forcemain) will be connected to an existing sanitary sewer at 151 Street and 99 Avenue. This sanitary sewer has sufficient additional conveyance capacity to meet the needs of future development until additional storage capacity is required in 2050. This pipe cannot be used for additional storage during wet weather as monitoring results have proven that the peak wet weather flow rate is quite high, suggesting significant I/I in the existing upstream system.

As mentioned earlier, all developments will be required to store wet weather flows. As the latter stages of WESS are constructed (downstream reaches), storage capacity will be available for wet weather flows and may eliminate the need for developments in the WESS service area to build additional local storage facilities.

However, depending on the cash flow of the Sanitary Servicing Strategy Fund, the latter stages of WESS may have to be delayed. This would necessitate construction of local storage facilities for PDWF shaving, in order to meet the 25% restriction mentioned earlier (Section 2.3).

In 2011, a diversion from the Rat Creek outfall to the Highlands Interceptor is required to reduce the frequency of CSOs at Rat Creek. All other stages of the WESS system will be built based on the needs of development, and storage required to meet the 25% PDWF restriction in the combined sewer system. Table 4.4 is an assessment of the storage needs of the WESS service area. A summary of the individual stages is shown in Table 4.5.



WEST EDMONTON SANITARY SEWER (WESS)

THE CITY OF Edmonton ASSET MANAGEMENT AND PUBLIC WORKS DRAINAGE SERVICES

FIGURE 4.1

Table 4.1 - Mistatim/Kinokamau Plains/Big Lake Storage Based Stage Assessment (Area 1)

Assume:

1.6	m3/lot Storage Required	300	L/c/day Residential Sewage Generation Rate
3.5	People/Lot	0.2	L/sec/ha Non-residential Sewage Generation Rate
25.1	m3/ha Non-residential Storage Required	1.5	Residential Peaking Factor
23%	Inflow/Infiltration compared to ADWF	2.5	Non-residential Peaking Factor
2.350	Maximum dry weather discharge rate (M^3/s) into existing system		

Year	Growth								Storage Required (m^3)	[1]Stage Built Name/Year	Storage Provided (m^3)	Storage Balance (m^3)	Increased ADWF & I/I (m^3/s)	Increased PDWF (m^3/s)	Allowable Discharge Capacity (m^3/s)	Drawdown Rate (m^3/s)	Drawdown Time (Days)
	Mistatim		Kinokamau Plains		Big Lake		Total Increase										
	Residential Population	Non Res Area(ha)	Residential Population	Non Res Area(ha)	Residential Population	Non Res Area(ha)	Residential Population	Non Res Area(ha)									
1994	25	193.2	150	85.1	125		0	0.0									
1995	25	193.2	150	85.1	213	-	88	0.0	40			(40)	0.000	0.001	2.350	2.350	0.00
2000	25	203	150	94.9	443	-	318	19.6	637	2-4-5E/2000	4392	3755	0.006	0.014	2.350	2.344	0.02
2005	25	213.4	150	105.3	1,098	-	973	40.4	1459		4392	2933	0.014	0.031	2.350	2.336	0.02
2010	25	224.4	150	116.3	1,540	-	1415	62.4	2213		4392	2179	0.021	0.047	2.350	2.329	0.02
2015	25	236.2	150	128.1	1,983	-	1858	86.0	3008		4392	1384	0.029	0.065	2.350	2.321	0.02
2020	25	248.7	150	140.6	2,425	-	2300	111.0	3838		4392	554	0.037	0.083	2.350	2.313	0.02
										1-2&3-4/2022	6983						
2025	25	262	1073	153.9	4,491	-	5289	137.6	5872		6983	1111	0.056	0.118	2.350	2.294	0.04
2030	25	276.2	1995	168.1	6,557	-	8277	166.0	7950	NWSTA/2030	11089	3139	0.076	0.155	2.350	2.274	0.06
2035	25	291.3	2918	183.2	8,623	-	11266	196.2	10075		11089	1014	0.096	0.192	2.350	2.254	0.06
2040	25	307.3	3841	199.2	10,689	-	14255	228.2	12244	NWSTB/2040	15195	2951	0.117	0.231	2.350	2.233	0.08
2045	25	324.4	4764	216.3	12,755	-	17244	262.4	14469		15195	726	0.138	0.271	2.350	2.212	0.08
2050	25	342.6	5686	234.5	14,820	-	20231	298.8	16748	NWSTC/2050	19301	2553	0.159	0.312	2.350	2.191	0.10
2055	25	361.9	6609	253.8	16,886	-	23220	337.4	19084		19301	217	0.182	0.355	2.350	2.168	0.10
2060	25	382.5	7532	274.4	18,952	-	26209	378.6	21484	NWSTD&E/2060	27513	6029	0.204	0.399	2.350	2.146	0.15
2065	25	404	8455	296.3	21,018	-	29198	422.0	23940		27513	3573	0.228	0.445	2.350	2.122	0.15
2070	25	414.1	9377	319.7	23,084	-	32186	455.5	26147		27513	1366	0.249	0.485	2.350	2.101	0.15
2075	25	414.1	10,300	319.7	25,150	-	35,175	455.5	27513		27,513	(0)	0.261	0.504	2.350	2.089	0.15

[1] STAGES WILL NOT BE CONSTRUCTED THROUGH THE SANITARY SERVICING STRATEGY FUND (CONSIDERED ON-SITE COSTS)

Table 4.2 - Winterburn Industrial/Lewis Farms North Storage Based Stage Assessment (Area 2)

Assume:

1.6	m3/lot Storage Required	300	L/c/day Residential Sewage Generation Rate
3.5	People/Lot	0.2	L/sec/ha Non-residential Sewage Generation Rate
25.1	m3/ha Non-residential Storage Required	1.5	Residential Peaking Factor
23%	Inflow/Infiltration compared to ADWF	2.5	Non-residential Peaking Factor
0.382	Maximum dry weather discharge rate (M^3/s) into existing system		

Year	Growth						Storage Required (m^3)	Stage Built Name/Year	Storage Provided (m^3)	[1]Storage Balance (m^3)	Increased ADWF & I/I (m^3/s)	Increased PDWF & I/I (m^3/s)	Allowable Discharge Capacity (m^3/s)	Drawdown Rate (m^3/s)	Drawdown Time (Days)
	Winterburn		Lewis Farms		Total Increase										
	Residential Population	Non Res Area(ha)	Residential Population	Non Res Area(ha)	Residential Population	Non Res Area(ha)									
1994	1950	323.4	125	0.0	0	0.0									
1995	1950	323.4	239	7.8	114	7.8	247.9			-247.9	0.002	0.006	0.382	0.380	0.00
2000	1950	333.2	573	17.6	448	27.4	892.3			-892.3	0.009	0.020	0.382	0.373	0.00
								W1STA;W1FMA/2003	2725						
2005	1950	343.6	1,384	28.0	1,259	48.2	1,785.4		2725	939.6	0.017	0.038	0.382	0.365	0.09
2010	1950	354.6	1,956	39.0	1,831	70.2	2,599.0	W1STB/2010	4546	1947.0	0.025	0.055	0.382	0.357	0.15
2015	1950	366.4	2,528	50.8	2,403	93.8	3,452.9		4546	1093.1	0.033	0.073	0.382	0.349	0.15
2020	1950	378.9	3,100	63.3	2,975	118.8	4,341.9		4546	204.1	0.042	0.092	0.382	0.340	0.15
								W1STC/2022	6618						
2025	1950	392.2	3,758	76.6	3,633	145.4	5,310.3		6618	1307.7	0.051	0.112	0.382	0.331	0.23
2030	1950	406.4	4,416	90.8	4,291	173.8	6,324.0	W1STD/2030	8871	2547.0	0.061	0.134	0.382	0.321	0.32
2035	1950	421.5	5,074	105.9	4,949	204.0	7,382.8		8871	1488.2	0.071	0.157	0.382	0.311	0.33
2040	1950	437.5	5,732	121.9	5,607	236.0	8,486.8	W1STE/2040	11335	2848.2	0.082	0.180	0.382	0.300	0.44
2045	1950	454.6	6,390	139.0	6,265	270.2	9,646.0		11335	1689.0	0.093	0.206	0.382	0.289	0.45
2050	1950	472.8	7,048	157.2	6,923	306.6	10,860.5	W1STF;W1FMB/2050	14030	3169.5	0.105	0.232	0.382	0.277	0.59
2055	1950	492.1	7,706	176.5	7,581	345.2	12,130.1		14030	1899.9	0.117	0.260	0.382	0.265	0.61
2060	1950	512.7	8,364	197.1	8,239	386.4	13,465.0	W1STG; W1FMC/2060	17327	3862.0	0.130	0.289	0.382	0.252	0.80
2065	1950	534.6	9,022	219.0	8,897	430.2	14,865.2		17327	2461.8	0.143	0.321	0.382	0.239	0.84
2070	1950	576.8	9,680	236.8	9,555	490.2	16,672.0	W1STH/2070	20163	3491.0	0.161	0.362	0.382	0.221	1.06
2075	1950	676.0	10,338	236.8	10,213	589.4	19,462.7		20163	700.3	0.188	0.427	0.382	0.194	1.20

[1] INITIAL STORAGE DEFICIT IS ASSUMED TO BE TAKEN CARE OF BY PRIVATE ON SITE SEPTIC SYSTEMS.

Table 4.3 - Lewis Farms South/The Grange Storage Based Stage Assessment (Area 3)

Assume:

1.6	m3/lot Storage Required	300	L/c/day Residential Sewage Generation Rate
3.5	People/Lot	0.2	L/sec/ha Non-residential Sewage Generation Rate
25.1	m3/ha Non-residential Storage Required	1.5	Residential Peaking Factor
23%	Inflow/Infiltration compared to ADWF	2.5	Non-residential Peaking Factor
0.589	Maximum dry weather discharge rate (M^3/s) into existing system		

Year	Growth						Storage Required (m^3)	[1]Stage Built Name/Year	Storage Provided (m^3)	Storage Balance (m^3)	Increased ADWF & I/I (m^3/s)	Increased PDWF (m^3/s)	Allowable Discharge Capacity (m^3/s)	Drawdown Rate (m^3/s)	Drawdown Time (Days)
	Lewis Farms South		The Grange		Total Increase										
	Residential Population	Non Res Area(ha)	Residential Population	Non Res Area(ha)	Residential Population	Non Res Area(ha)									
1994	459	-	150	-	0	-									
1995	702	-	442	-	535	-	244.6	10E-11E(EXISTING)	407	162	0.002	0.003	0.589	0.587	0.01
								12-13E/1999	703	865					
2000	1216	-	2212	-	2819	-	1288.5	GSTA/2000	3856	2568	0.012	0.018	0.589	0.577	0.08
2005	3134	-	4865	-	7390	-	3378.3		3856	478	0.031	0.047	0.589	0.558	0.08
2010	4350	-	7076	-	10817	-	4944.9	GSTB/2010	7009	2064	0.046	0.069	0.589	0.543	0.15
2015	5565	-	9289	-	14245	-	6512.0		7009	497	0.061	0.091	0.589	0.528	0.15
2020	6781	-	11500	-	17672	-	8078.6	GSTC/2020	10162	2083	0.075	0.113	0.589	0.514	0.23
2025	7439	-	12212	-	19042	-	8704.9		10162	1457	0.081	0.122	0.589	0.508	0.23
2030	8097	-	12925	-	20413	-	9331.7		10162	830	0.087	0.130	0.589	0.502	0.23
2035	8755	-	13637	-	21783	-	9957.9	[2]GSTD/2035	13315	3357	0.093	0.139	0.589	0.496	0.31
2040	9413	-	14349	-	23153	-	10584.2		13315	2731	0.099	0.148	0.589	0.490	0.31
2045	10071	-	15061	-	24523	-	11210.5		13315	2104	0.104	0.157	0.589	0.485	0.32
2050	10729	-	15774	-	25894	-	11837.3		13315	1478	0.110	0.165	0.589	0.479	0.32
2055	11387	-	16486	-	27264	-	12463.5		13315	851	0.116	0.174	0.589	0.473	0.33
2060	12045	-	17198	-	28634	-	13089.8		13315	225	0.122	0.183	0.589	0.467	0.33
2065	12703	-	17910	-	30004	-	13716.1		13315	(401)	0.128	0.192	0.589	0.461	0.33
2070	13361	-	18623	-	31375	-	14342.9		13315	(1028)	0.134	0.200	0.589	0.455	0.34
2075	17169	-	19335	-	35895	-	16409.1		13315	(3094)	0.153	0.229	0.589	0.436	0.35

[1] STAGES WILL NOT BE CONSTRUCTED THROUGH THE SANITARY SERVICING STRATEGY FUND (CONSIDERED ON-SITE COSTS)

[2] STAGE MAY NOT BE REQUIRED AS DOWNSTREAM TRUNK SYSTEM MAY HAVE SUFFICIENT SPARE STORAGE CAPACITY.

Table 4.4 - WESS Area Storage Based Stage Assessment Summary

Assume:

1.6	m3/lot Storage Required	300	L/c/day Residential Sewage Generation Rate
3.5	People/Lot	0.2	L/sec/ha Non-residential Sewage Generation Rate
25.1	m3/ha Non-residential Storage Required	1.5	Residential Peaking Factor
23%	Inflow/Infiltration compared to ADWF	2.5	Non-residential Peaking Factor
1.753	Maximum dry weather discharge rate (M^3/s) into existing system		

Year	Growth													
	WESS Res Pop	WESS Non Res Area(ha)	WESS ADWF & I/I	WESS PDWF	WJP,JP Res Pop	WJP,JP PDWF	WESS PDWF & WJP,JP PDWF	Storage Required (m^3)	Stage Built Name/Year	Storage Provided (m^3)	Storage Balance (m^3)	Allowable Discharge Capacity (m^3/s)	Draw-Down Rate (m^3/s)	Draw-Down Time (Days)
1994	-	-			109,200									
1995	737	7.8	0.005	0.009	495	0.003	0.012	533			-532.7	1.753	1.748	0.00
										1,979	1446.3			
2000	3,584	47.0	0.027	0.052	2,477	0.013	0.065	2,818		9,524	6705.9	1.753	1.726	0.06
									W1STA;W1FMA/2003	12,249				
2005	9,622	88.6	0.063	0.116	5,449	0.028	0.144	6,622	W3/2005	15,076	8453.5	1.753	1.690	0.10
									W6/2006; W7/2007	19,586				
2010	14,063	132.6	0.092	0.171	7,926	0.041	0.212	9,757	W1STB/2010	24,560	14802.9	1.753	1.661	0.17
									W12/2011	24,560				
2015	18,506	179.8	0.123	0.228	10,403	0.054	0.283	12,973	W5	26,596	13623.1	1.753	1.630	0.19
2020	22,947	229.8	0.154	0.287	12,880	0.067	0.354	16,258	W4	31,823	15565.0	1.753	1.599	0.23
									W1STC/2022	36,486				
2025	27,964	283.0	0.188	0.352	13,392	0.070	0.422	19,887		36,486	16599.2	1.753	1.565	0.27
2030	32,981	339.8	0.224	0.419	13,905	0.072	0.491	23,606	W1STD/2030	42,845	19239.0	1.753	1.529	0.32
2035	37,998	400.2	0.260	0.488	14,417	0.075	0.563	27,416		42,845	15429.5	1.753	1.493	0.33
2040	43,015	464.2	0.297	0.559	14,929	0.078	0.637	31,315	W1STE/2040	49,415	18099.6	1.753	1.456	0.39
2045	48,032	532.6	0.335	0.633	15,441	0.080	0.714	35,326	W9/2045	51,279	15953.3	1.753	1.418	0.42
									W8/2047	52,921				
2050	53,048	605.4	0.374	0.710	15,954	0.083	0.793	39,446	W1STF; W1FMB/2050	59,722	20275.9	1.753	1.379	0.50
									W2/2052	62,072				
2055	58,065	682.6	0.415	0.789	16,466	0.086	0.875	43,677	W10/2055; W11/2055	65,514	21836.7	1.753	1.338	0.57
									9.5 km Trunk Built to Highlands					
2060	63,082	765.0	0.456	0.872	16,978	0.088	0.960	48,039	[1]W1STG; W1FMC/2060	72,917	24878.0	1.753	1.297	0.65
2065	68,099	852.2	0.499	0.957	17,490	0.091	1.048	52,521		72,917	20395.8	1.753	1.254	0.67
2070	73,116	945.7	0.543	1.047	18,003	0.094	1.140	57,162	[1]W1STH/2070	75,753	18591.5	1.753	1.210	0.72
2075	81,283	1,044.9	0.602	1.160	18,515	0.096	1.256	63,385		75,753	12368.1	1.753	1.151	0.76

[1] STAGE MAY NOT BE REQUIRED AS DOWNSTREAM TRUNK SYSTEM MAY HAVE SUFFICIENT SPARE STORAGE CAPACITY.

Table 4.5 - WESS Staging (Option 1C from 1997 UMA Report)

[1]Name	Location	Length (km)	Diameter (mm)	Reason for Construction: For Res. Storage	For CSO Reduction	For Sys. extension	For 25% PDWF Restriction
				Year Required			
W1STA	Stony Plain Rd. - W 199 St.	-	-	**2003**			
W1FMA	Stony Plain Rd. - W 199 St.	4.4	fm			**2003**	
W1STB	Stony Plain Rd. - W 199 St.	-	-	**2010**			
W1STC	Stony Plain Rd. - W 199 St.	-	-	**2022**			
W1STD	Stony Plain Rd. - W 199 St.	-	-	**2030**			
W1STE	Stony Plain Rd. - W 199 St.	-	-	**2040**			
W1STF	Stony Plain Rd. - W 199 St.	-	-	**2050**			
W1FMB	Stony Plain Rd. - W 199 St.	4.4	fm			**2050**	
W1STG	Stony Plain Rd. - W 199 St.			**2060**			
W1FMC	Stony Plain Rd. - W 199 St.	4.4	fm			**2060**	
W1STH	Stony Plain Rd. - W 199 St.	-	-	**2070**			
W2	151 St. - 99 Ave.	1.1	1650			**>2050**	
W3	142 St. - 99 Ave.	1.3	1650				**2005**
W4	142 St. - 107 Ave.	1.0	1650				**2020**
W5	Groat Rd. - 107 Ave.	1.0	1650				**2015**
W6	124 St. - 107 Ave.	1.2	1650				**2006**
W7	116 St. - 107 Ave.	0.9	1650				**2007**
W8	109 St. - 107 Ave.	0.8	1650				**2047**
W9	101 St. - 107 Ave.	0.9	1650				**2045**
W10	95 St. - 107 Ave.	0.8	1650				**>2050**
W11	86 St. - 111 Ave	0.7	1650				**>2050**
W12	River Crossing @Rat Creek	1.0	1650		**2011**		

[1] ST=Storage, FM=Forcemain. Stage 1 (W1) of WESS will be constructed as a storage/forcemain system, rather than a large diameter trunk sewer. It has been introduced in smaller phases every ten years to facilitate development growth.

5.0 THE NEST AND CLAREVIEW AREAS

The North Edmonton Sanitary Trunk (NEST) and the Clareview Sanitary Trunk (CST) are shown on Figure 5.1 along with their service basins. The NEST provides service to areas bounded generally by 153 Avenue, St. Albert Trail, the Restricted Development Area (RDA) and 66 Street. The CST service basin is to the east of the NEST basin and is bounded by the river to the east, the RDA to the north, 50^{th} Street and 66 Street on the west, and 153 Avenue and the Kennedale ravine to the south.

5.1 Assessment for Storage and Conveyance

The timing for trunk construction to meet the development needs in north and northeast Edmonton was assessed using a spreadsheet model developed in 1997 (Clareview Sanitary Trunk/North Edmonton Sanitary Trunk Conceptual Design Refinement, Cochrane Engineering, December 1997). The input parameters were modified in the following way:

- The storage existing prior to the construction of stage NC1 was set at 3,827 m^3 including 2,225m^3 in the 127 Street, 1200 mm trunk, 541 m^3 in the 900 mm trunk on 153 Avenue (west of 127 Street), and 1,061 m^3 of storage estimated by the model for developments prior to 1995 (i.e. storage was not required prior to this time).

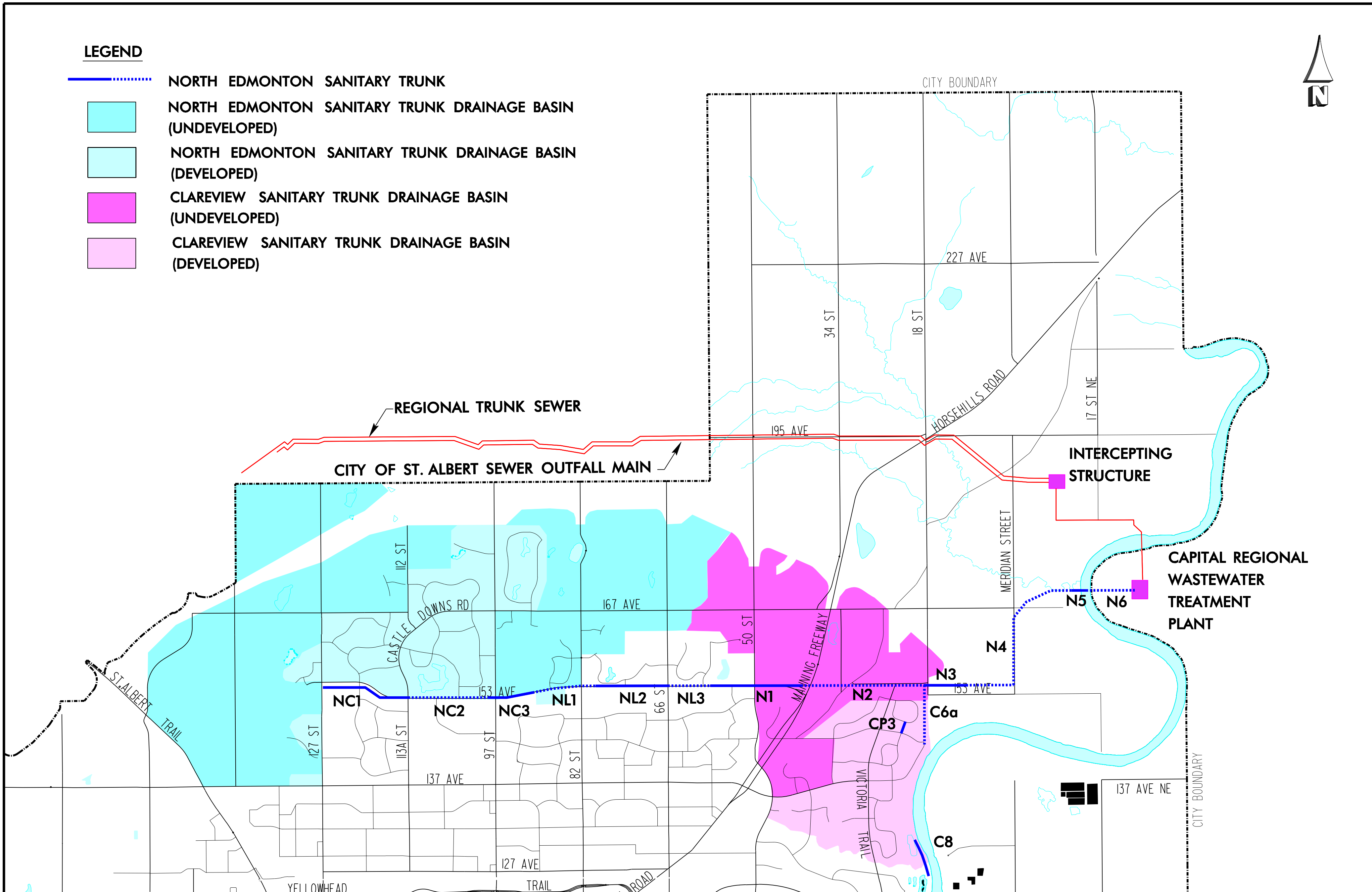
- The storage capacity of stage NL1 was increased to account for additional capacity in a major connecting lateral (the Belle Rive Trunk). This was done by increasing the diameter in the model to 2825 mm, achieving the separately calculated total storage of 6,579 m^3 (see Appendix C for calculation).

- Assuming that the south Clareview diversion has been built (it will be in 2000), and all of Clareview's dry weather flow will be diverted to the Gold Bar Wastewater Treatment Plant, with wet weather flows draining to the CRSTP.

- Assuming the inflow/infiltration for new developments is better than the current experience in the existing parts of Clareview, and is the same as for Pilot Sound.

- The pump out rate was doubled to use 50% of the available downstream capacity for drawdown rather than the 25% used in the previous report.

Appendix C contains the results of the model runs, and Table 5.1 summarizes these results. Using the above parameters, it can be seen that the outlet capacity in existing trunks is a constraint. Doubling the outlet rate (i.e. using 50% rather than 25% of the available downstream capacity), significantly delays projects by making available storage the criteria for new construction rather than outlet capacity.



THE CITY OF Edmonton
ASSET MANAGEMENT AND PUBLIC WORKS
DRAINAGE SERVICES

NORTH EDMONTON SANITARY TRUNK (NEST) & CLAREVIEW SANITARY TRUNK (CST) STAGING PLAN

FIGURE 5.1

PROJECT NO. 23–9089

Table 5.1 - NEST/CST Staging - Scenario 7 from 1997 CEI Report

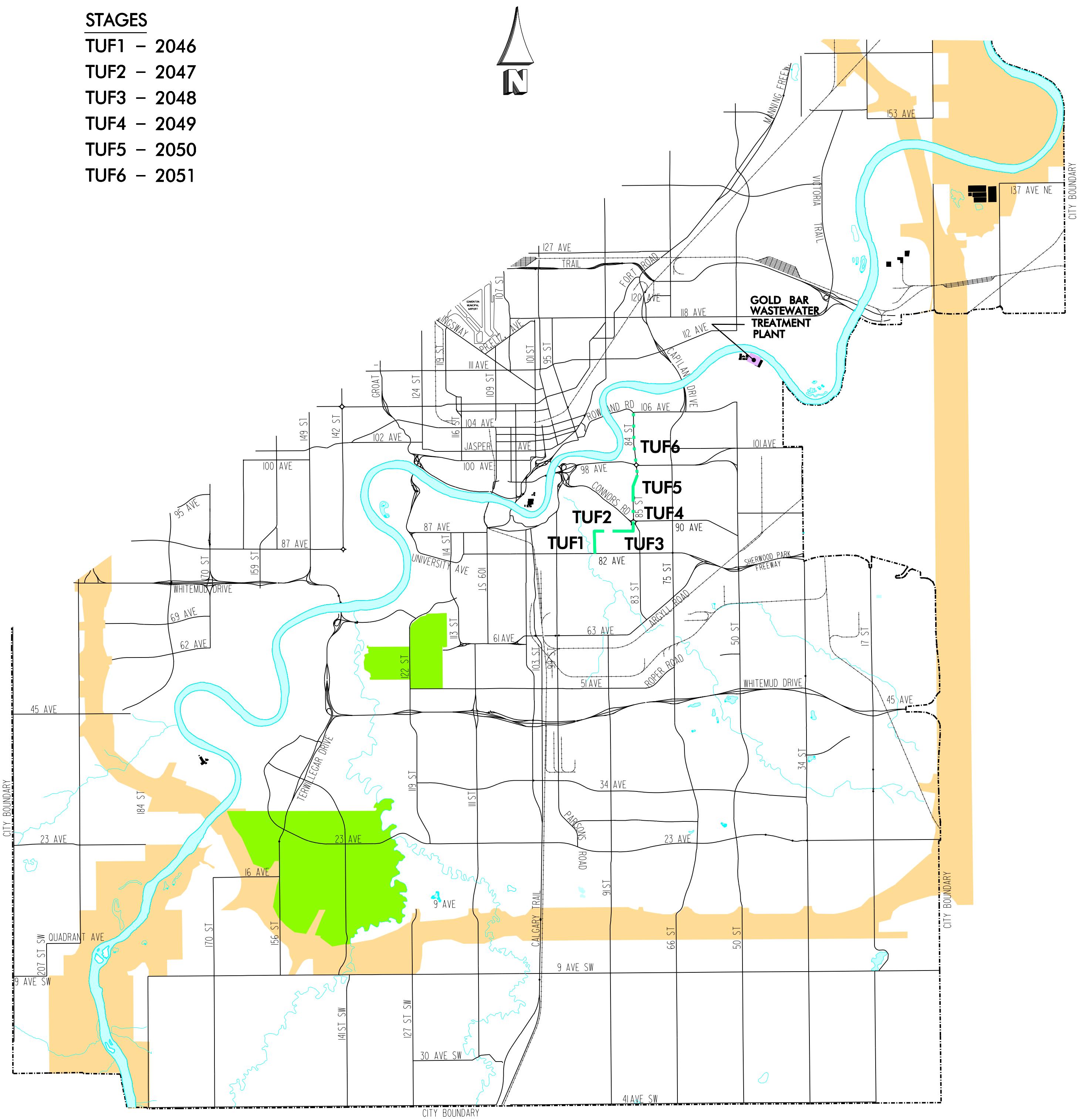
Name	Location	Length (km)	Diameter (mm)	Reason for Construction				
				Residential Storage	Outlet Capacity	Plant Capacity	Conveyance Capacity	Rehabilitation
				Year Required				
NC1	127 St. - 153 Ave.	1.7	1050	**2000**				
NC2	Castle Downs Rd. - 153 Ave.	1.7	1350		**2009**			
NC3	97 St. - 153 Ave.	1.0	1350		**2019**			
NL1	93 St. - 153 Ave.	1.0	2340	**1994**				
NL2	E of 82 St. - 153 Ave.	0.8	1500		**2010**			
NL3	66 St. - 153 Ave.	1.4	1500		**2015**			
N1	59A St. - 153 Ave.	1.7	1500		**2025**			
N2*	Manning Dr. - 153 Ave.	2.3	1350			**2021**		
N3	18 St. - 153 Ave.	1.0	1350		**2029**			
N4	W of 18 St. - 153 Ave.	3.0	1350				**2029**	
N5	River Crossing to C1/N6	0.4	fm				**2029**	
C1/N6	Connection to CRSTP	1.4	fm				**1995**	
C6a	20 St. - 144 Ave.	1.2	1500		**2029**			
C7		N/A	N/A					**2034**
C8	N of 130 Ave. - E of 22 St.	0.7	900 & 300				**2000**	
CP3		0.1	1200				**2032**	

*After Stage N2 is built, NEST flows can be diverted to the CRSTP.

6.0 THE TUFS AREA

Potential development in the Terwillegar and University Farms areas will require an upgrade to the existing downstream trunk system that is referred to as the Terwillegar and University Farms Sanitary Trunk (TUFS). The proposed improvements include twinning approximately 5.6km of the existing combined trunk sewer from 82 Avenue and 95 Street to the McNalley shaft at 84 Street and 106 Avenue. Figure 6.1 illustrates the staging of the TUFS trunk.

In 1997, an assessment of the impacts of development in the Terwillegar and University Farms on the existing sewer system during dry weather was completed. Although the assessment shows that this upgrade is not needed for some time (around 2050), it has been included as part of the overall construction schedule. Future modeling of the impacts of removing the Millwoods area to the SESS system may reduce and/or eliminate the upgrading required for the TUFS trunk.



LEGEND

- SANITARY TRUNK
- RESTRICTED DEVELOPMENT AREA (RDA)
- T.U.F.S. CONTRIBUTING AREA

TERWILLEGAR / UNIVERSITY FARM SEWER (TUFS)

The City of Edmonton
ASSET MANAGEMENT & PUBLIC WORKS
DRAINAGE SERVICES

FIGURE 6.1

7.0 GOLD BAR WASTE WATER TREATMENT PLANT

7.1 Plant Capacity Assessment

The impact of the increased flows and storage on the Gold Bar Waste Water Treatment Plant (GBWWTP) was analyzed to determine when the sustainable capacity would be exceeded. The plant's sustainable capacity is 310 ML/d. For maintenance purposes, clarifier no. 11 will be added in 2004. This tank will be used to take over from clarifiers undergoing maintenance. If all clarifiers are in operation, the capacity of the plant will temporarily be increased to 341 ML/d. As the plant cannot guarantee that all clarifiers will be working when a storm appears, this extra tank has no bearing on the rated and licensed capacity of the plant. However, for drawdown of wet events, this capacity will be utilized. Using this higher capacity has the benefit of delaying many of the diversion projects by 10 years.

A table showing a sanitary flow summary based on population projections to 2075 and a flow assessment for GBWWTP the City-wide growth of population and sanitary wastewater discharges can be found in Appendix D. The GBWWTP Basin analysis lists the construction segments that impact the flow rate into the plant. The shaded boxes show the timing for construction of the various segments to keep the flows to the plant within the plant's sustainable capacity. For the Capital Region Sewage Treatment Plant (CRSTP), five 37.5 ML/d expansion units are anticipated to be needed to process increasing City flow. A flow assessment for the CRSTP can be found in Appendix D. Timing for the expansion of the plants is dependent on the system components diverting flows to and from the plants. An analysis of the possible scenarios is presented in Section 7.2.

7.2 Staging for Major System Construction and Treatment Plant Works

Construction for system components affecting the flows to the treatment plants can be staged in various ways. Diversions away from the GBWWTP and CRSTP expansions can be used to postpone GBWWTP expansions. Alternately, GBWWTP expansions can be built earlier to postpone construction of diversion systems and CRSTP expansions.

Analysis of these three scenarios began when it was determined that the 71 Street diversion was only needed for a 10 year period prior to completion of the SESS. A plant expansion at the right time eliminated the need for the 71 Street diversion, as demonstrated in Scenarios D, C and E of Table 7.1. This appears top be a justifiable plan as the plant expansion is estimated to cost $15 million while the 71 Street diversion is estimated to cost $20 million.

Table 7.1 lists the 5 possible scenarios for staging the plant and system diversion construction. These scenarios were developed based on the analysis of flows to the treatment plant discussed in Section 7.1. For all alternatives, NEST is completed in 2021, the CST diversion begins in 2000, and the 1st new unit of CRSTP in 2021. Scenario A uses the 71 Street diversion to unload the GBWWTP, keeping expansions at GBWWTP to a minimum. Scenario B brings forward the second new GBWWTP unit in an attempt to delay CRSTP expansions and later parts of the 71 Street diversion.

Scenario C eliminates the 71 Street diversion by completing the second GBWWTP expansion early (as for “B”), and completing the SESS system 10 years earlier. Scenario D adds a third unit at the GBWWTP to delay completing SESS by 9 years over Scenario C. Scenario E adds a fourth unit at the GBWWTP to delay the SESS completion by a further 9 years.

The present worth of the various scenarios was calculated, and scenario ‘E’ was found to have the least cost of $ 76.58 million. This points to the significant financial benefits of expanding the GBWWTP in the future. However, no decision on this is needed for approximately 15 years at the present rate of growth.

Table 7.1 - Possible Wastewater Treatment Plant Scenarios

Scenario	A			B			C			D			E			1998 Cost	Capacity
	Year Built	FV[1]	PV[2]	Year Built	FV	PV	Year Built	FV	PV	Year Built	FV	PV	Year Built	FV	PV	($ Millions)	(ML/day)
base year																	
1998																	
System Options																	
Add South CST Diversion	2000	($0.37)	$0.33	2000	($0.37)	$0.33	2000	($0.37)	$0.33	2000	($0.37)	$0.33	2000	($0.37)	$0.33	0.35	3.7/'98
Remove NEST Area	2021	($18.45)	$4.83	2021	($18.45)	$4.83	2021	($18.45)	$4.83	2021	($18.45)	$4.83	2021	($18.45)	$4.83	11.70	4/'21-13/'75
Remove CST Diversion	2045	($9.79)	$0.63	2045	($9.79)	$0.63	2030	($7.28)	$1.13	2030	($7.28)	$1.13	2030	($7.28)	$1.13	3.86	5.4/'75
SESS Completion & Diversion	2045	($253.28)	$16.38	2045	($253.28)	$16.38	2035	($207.78)	$24.06	2044	($248.31)	$17.02	2053	($296.75)	$12.04	99.86	5/'35-110/'75
71 Street Diversion - I	2015	($10.14)	$3.77	2015	($10.14)	$3.77										7.24	17.3
71 Street Diversion - II	2025	($17.36)	$3.60	2035	($21.16)	$2.45										10.17	25.9
71 Street Diversion - III	2025	($1.47)	$0.31	2040	($1.98)	$0.17										0.86	34.6
71 Street Diversion - IV	2030	($1.63)	$0.25	2040	($1.98)	$0.17										0.86	47.5
71 Street Diversion - V	2035	($3.59)	$0.42	2040	($3.96)	$0.34										1.72	60.5
						$0.00											
TOTAL			*$30.51*			*$29.07*			*$30.34*			*$23.30*			*$18.32*	*136.64*	
GBWWTP Options																	
Bioreactor/Clarifier #11	2005	($12.29)	$8.17	2005	($12.29)	$8.17	2005	($12.29)	$8.17	2005	($12.29)	$8.17	2005	($12.29)	$8.17	10.7	31
Bioreactor/Clarifier #12	2060	($61.10)	$1.65	2025	($30.55)	$6.34	2025	($30.55)	$6.34	2025	($30.55)	$6.34	2025	($30.55)	$6.34	17.9	31
Bioreactor/Clarifier #13										2035	($31.00)	$3.59	2035	($31.00)	$3.59	14.9	31
Bioreactor/Clarifier #14													2045	($39.31)	$2.54	15.5	31
TOTAL			*$9.82*			*$14.51*			*$14.51*			*$18.10*			*$20.64*	*59.00*	
CRSTP Options																	
Unit 1	2021	($61.97)	$16.22	2021	($61.97)	$16.22	2021	($61.97)	$16.22	2021	($61.97)	$16.22	2021	($61.97)	$16.22	39.3	37.5
Unit 2	2031	($75.54)	$11.04	2036	($83.41)	$9.11	2035	($81.77)	$9.47	2036	($83.41)	$9.11	2036	($83.41)	$9.11	39.3	37.5
Unit 3	2043	($95.81)	$6.96	2045	($99.68)	$6.45	2035	($81.77)	$9.47	2044	($97.72)	$6.70	2053	($116.79)	$4.74	39.3	37.5
Unit 4	2054	($119.12)	$4.56	2054	($119.12)	$4.56	2054	($119.12)	$4.56	2054	($119.12)	$4.56	2054	($119.12)	$4.56	39.3	37.5
Unit 5	2065	($148.12)	$2.99	2065	($148.12)	$2.99	2065	($148.12)	$2.99	2065	($148.12)	$2.99	2065	($148.12)	$2.99	39.3	37.5
TOTAL			*$41.77*			*$39.33*			*$42.71*			*$39.58*			*$37.62*	*196.50*	
SCENARIO TOTAL			*$82.10*			*$82.90*			*$87.56*			*$80.98*			*$76.58*	*392.14*	

NOTES: 1. FV (future value) is equal to the option cost in 1998 dollars, and inflated (by 2%/yr.), to the proposed year of option construction dollars.
2. PV (present value) is equal to the option cost in 1998 dollars, and inflated (by 2%/yr.), to the proposed year of option construction dollars, and deflated (by 6%/yr.) back to option cost in 1998 dollars.

8.0 THE FINANCIAL MODEL

8.1 Introduction

The financial model used to assess the feasibility of the Sanitary Servicing Strategy Fund (SSSF) accounts for all future development, population growth, and construction of remote off-site sanitary sewer trunks in the four service areas discussed in Section 1.0.

By including these four areas, the model accounts for all new development that has been forecasted until the year 2090. The model also includes and accounts for infill developments, as they have also become a source of revenue for the SSSF.

8.1.1 Sources of Revenue

The revenue sources for the SSSF are described in detail in Section 8.2.2, 8.2.3 and 8.2.4 are:

Expansion Assessment (EA) - a charge to new developments based on the area of land developed. These charges are paid in much the same way as the traditional permanent area contribution (PAC) charges. The 1999 expansion assessment charges are as follows:

- NEST/CST $10,000/ha
- SESS $10,000/ha
- TUFS $10,000/ha
- WESS $12,500/ha

Sanitary Sewer Trunk Charge (SSTC) - a new charge that will be paid when development permits are issued, and applied to all new developments, and all redevelopments that increase the land use intensity of an area. The 1999 rates for the charge will be:

- Premise with one or two dwellings: $700/dwelling
- Premise with three or more dwellings: $500/dwelling
- Commercial/Industrial/Institutional: $3500/ha

This charge is now applied to all development, not just development in the outer suburbs.

Utility Contribution - The sanitary utility will contribute to the fund to pay for the reconnection of existing developments to the new trunk systems. In order to make the SSSF work, the utility will pay its share early, before seeing the benefits of reduced flows. Payments will begin at $2.6 million in 1999 and continue until 2014.

8.1.2 Use of the Model

Initially, the model was used to determine if the current and proposed PAC rates for all of the major basins would generate sufficient funds to complete construction of the sanitary trunks. Given the planned costs and schedule (based on completed studies for these areas), the model proved that a large funding shortfall will result if current funding methods are continued.

The model assessed the new funding proposal suggested by UDI (as discussed in the Sanitary Servicing Strategy Fund Report, 1998) and determined that sufficient funding could be generated if construction schedules are extended to more closely reflect basin development requirements.

8.2 Development of the Financial Model

The model was developed by a financial consultant with input from the City's Drainage Services Branch. A brief overview of the model's calculations is given in the following paragraph. The model is described in detail in the following sections.

In order for the model to account for all development within the City, it was necessary to determine population growth rates and development projections within each of the four service areas, as well as redevelopment in the Inner City. Once the development forecast was established, the model calculated all of the revenue generated through the Expansion Assessment, the Sanitary Sewer Trunk Charge and the share that is attributable to the Sanitary Utility. Now that annual recoveries were determined, the model subtracted the construction costs based on a construction schedule that would meet the needs of development. With this information, the model was able to determine an annual cash flow for the Sanitary Servicing Strategy Fund. A flow chart of the model is depicted on Figure 8.1. The model is made up of six separate Excel™ workbooks. They are:

- Development Forecaste5.xls
- Expansion Calculation COE5.xls
- Upgrading Calculation5.xls
- City Share Calculations5.xls
- costsMR05rev2.xls
- Cashflow Model City5.xls

8.2.1 Development Forecast (Development Forecast5.xls)

Each of the four major basins are broken down into Area Structure Plan (ASP) boundaries. Drainage Services obtained future population growth data from the Transportation Master Plan and allocated the growth to each ASP. The annual growth rate was approximately 1.5%.

As much as possible, the consultant studies completed for each ASP, NASP or NSP were used to determine the developable area for residential and/or industrial developments. For areas that do not have an Area Structure Plan in place, the developable area was based on a percentage calculated from an average value for areas that do have an Area Structure Plan.

8.2.2 Expansion Assessment (Expansion Calculation COE5.xls)

The annual recovery for the Expansion Assessment is calculated by applying the approved per hectare charge to the total projected developed hectares in each of the four service areas for each year of development. The Expansion Assessment is only levied against developments that do not have an approved NSP as of January 1, 1998, and/or do not already have an approved downstream receiving system for sanitary flows. It will also be assessed against any areas requiring additional sewer capacity to enable development.

8.2.3 The Sanitary Sewer Trunk Charge (Upgrading Calculation5.xls)

The annual recovery for the Sanitary Sewer Trunk Charge (SSTC) is calculated by estimating the number of single and multi family units that will be developed in each of the four service areas for each year. Initially, the developable residential areas are divided into two groups assuming 89.8% for single family developments and 10.2% for multi family developments. These areas are then converted to the number of lots by assuming 15.58 units/ha for single family dwellings and 57.25 units/ha for multi family dwellings. Upon estimating the number of lots to be developed, the Sanitary Sewer Trunk Charge is applied to calculate the revenue from this source. The commercial/industrial revenues are added to the suburban and inner city revenues to determine the total annual recovery.

The financial model also estimates the number of lots that will be developed in the Inner City, including both single and multi family developments based on population growth. The SSTC is applied to the estimated lots developed and to the projected developable hectares for commercial industrial developments throughout the City.

8.2.4 The Utility's Share (City Share Calculations5.xls)

The model calculates a share of the cost recovery that is attributable to the Sanitary Utility based on the existing developed areas that will be off-loaded into the new trunk system (the areas shown in Figure 3.1 and 4.1 as developed areas included in the basin). These include parts of Castle Downs and the Palisades, all of Mill Woods, and a portion of the Meadows. As existing homes and businesses in these areas cannot be charged the SSTC, the City will pay the equivalent of their share through the sanitary utility rate. Throughout the four service areas, approximately one quarter of the area is already developed. The City's share for this developed area amounts to approximately $15.6 million and will be injected into the fund over a 15 year period beginning in 1999. This injection is necessary to initiate the fund and sustain it through the initial construction period. Once the City has completed paying its share, the fund will generate enough revenue through private development to sustain itself.

The $15.6 million represents 25% of the total cost, matching the 25% area represented.

8.2.5 Construction Costs (costsMR05rev2.xls)

The construction costs that have been input into the financial model are based on the studies completed for each service area. Costs for each basin are normalized and then inflated 2% per year beginning in 1998 (see Section 2.6). A factor of 1.58 was applied to the bare construction cost to include engineering, overhead, contingency, and GST. For these projects, a contingency of 25% was allocated within the 1.58 factor.

8.2.6 Regional/County Share (costsMR05rev2.xls)

Currently, sanitary flows from the town of Beaumont, the City of Leduc, and surrounding areas discharge to the South East Region Trunk Sewer (SERTS). Eventually, the SERTS will be diverted into the SESS system. The SESS system has been sized to account for future increases in development from these areas. A share of the cost recovery that is attributable to the region/county has been allocated in the financial model. The amount calculated is approximately 10% of the total cost for the construction of the SESS system. Payments were included on an annuity basis and begin in 2015. This is when the current SWAP Agreement with CRSC expires, and a new one will be negotiated to include payments for regional use of the SESS. Other methods of estimating the Regional/County share will be examined in more detail, as a new agreement becomes more imminent.

8.2.7 The SSSF Cash Flow (Cashflow Model City5.xls)

The model totals all of the recoveries from the SSTC, the Expansion Assessment, and the Utility's contribution to the fund. It also includes money from existing PAC trust funds collected for NEST and SESS, as well as an allowance for regional contributions for areas south of Edmonton that will utilize the SESS trunk.

The annual construction costs for each service area are totaled and subtracted from the total revenue. Existing over expenditures in the NEST basin are accounted for and are also subtracted from the revenue to arrive at an annual cash flow balance. The model assumes surplus years for the fund earn 4% per year and deficit years for the fund borrow at a rate of 6%.

8.3 Financial Model Assumptions

8.3.1 Development Assumptions

- Single Family units are estimated at 15.6 units per hectare and this is based on net residential area. This is a conservative estimate when compared to lot densities used in various ASP/NSP documents. The following table illustrates the various lot densities for different neighbourhoods with an approved ASP/NSP.

Neighbourhood	ASP/NSP Approval	Assumed Lot Density (lots/ha.)
Grange	1990	20
Meadows	1987	14.5-15.5
Burnewood	1997 (amendment)	15.9
Elsinore	1997	19.8
Fraser	1994	18
Terwillegar Towne	1995	25

  Net residential area is defined as follows:
  Gross area of a neighbourhood is 100% of the land area. Gross developable area is determined by removing existing pipeline or utility Rights Of Way, arterial roads, or natural features such as a ravine, from the land area. Net residential area is determined by removing stormwater lakes, circulation (collector/residential roads or walkways), municipal reserves (schools or park sites), and commercial sites (shopping centers).

- The residential area was divided into 89.8% for single and 10.2% for multi family. Although this estimate of the multi family proportion is low, it is a conservative approach for determining the SSTC recovery.

- The projected population growth rate used in the model is 1.5% per year.

- Alignment options chosen from servicing studies:
  WESS - Option 1 C (UMA Engineering Ltd., West Edmonton Sanitary Serving Study, Final Report, March 1997.)
  SESS - Option A (Reid Crowther & Partners Ltd., South Edmonton Sanitary Sewerage Servicing Study (SESS), Final Report - Volume II, March 1996.)
  NEST/CST - Single common trunk for the downstream portions of both systems.

8.3.2 Financial Assumptions

- The model accounts for 2% inflation per year. The fund's earning and borrowing rates are 4% and 6% respectively. The Net Present Value rate used is 6%.

- Construction costs are multiplied by 1.58 to include overheads, GST, contingency, etc. (refer to example). Capital costs are represented in 1997 dollars.

- The initial fund balance in 1998 is based on the existing NEST and SESS PAC trust fund. This amount equals $5.2 million.

- City, CRSC and County of Strathcona funding is provided as an annuity or continuous funding stream based on their total contribution.

FINANCIAL MODEL FLOW CHART

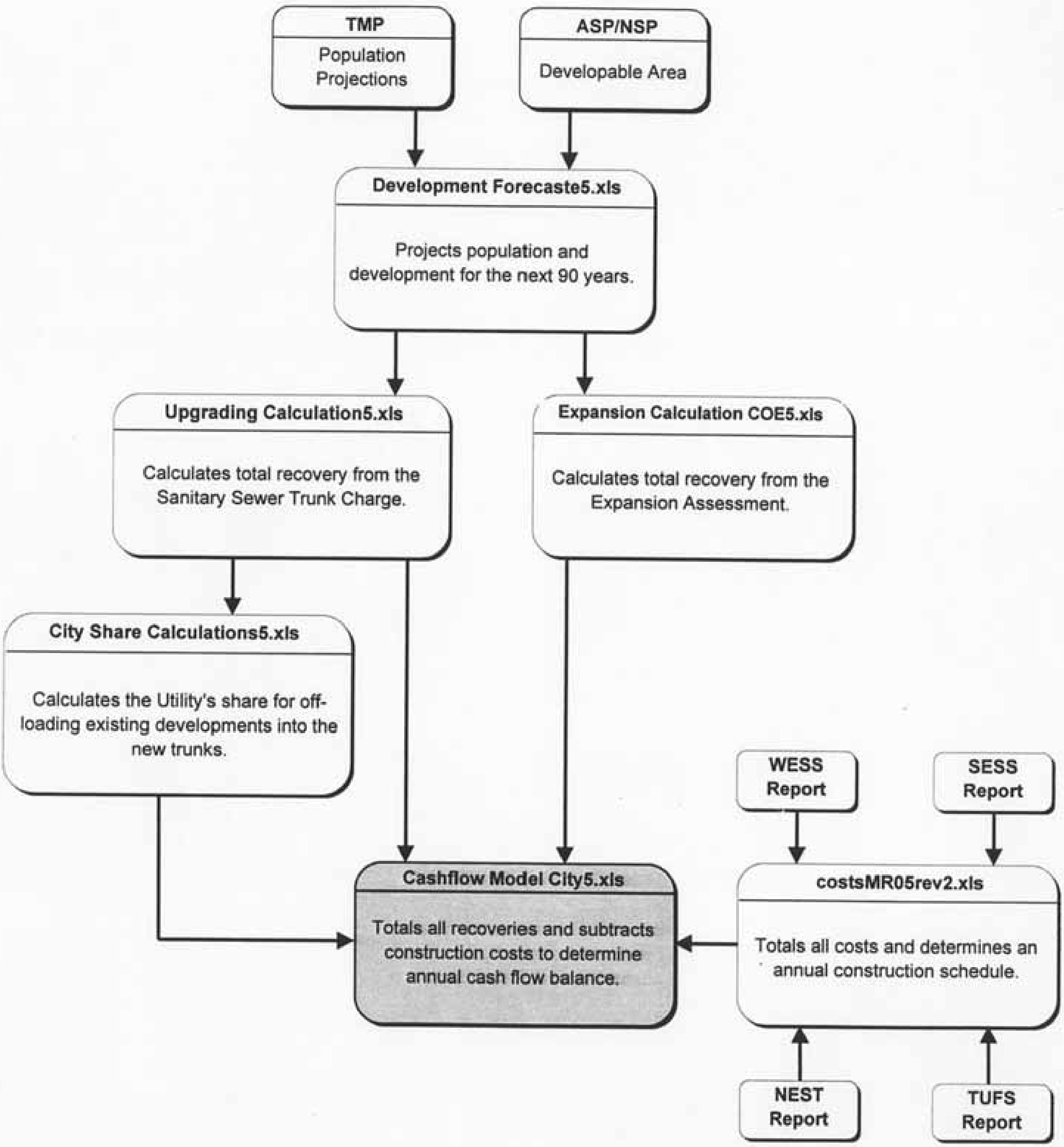


FIGURE 8.1

9.0 CONCLUSIONS

9.1 Overall Construction Schedule

The planned expenditures (in 1998 dollars) for the SSSF are illustrated on figure 9.1. Details of the construction are outlined in Appendix E as well as the estimated costs for each stage. Although the first 10 years of construction expenditures versus fund revenues are fairly balanced, there are heavy construction periods between 2017 and 2022, and between 2040 and 2050 that will substantially impact the fund causing a negative balance (i.e. borrowing). As time progresses, the assessments presented in this report will be revised, and the construction schedule in those periods will be refined to more realistic expenditure levels.

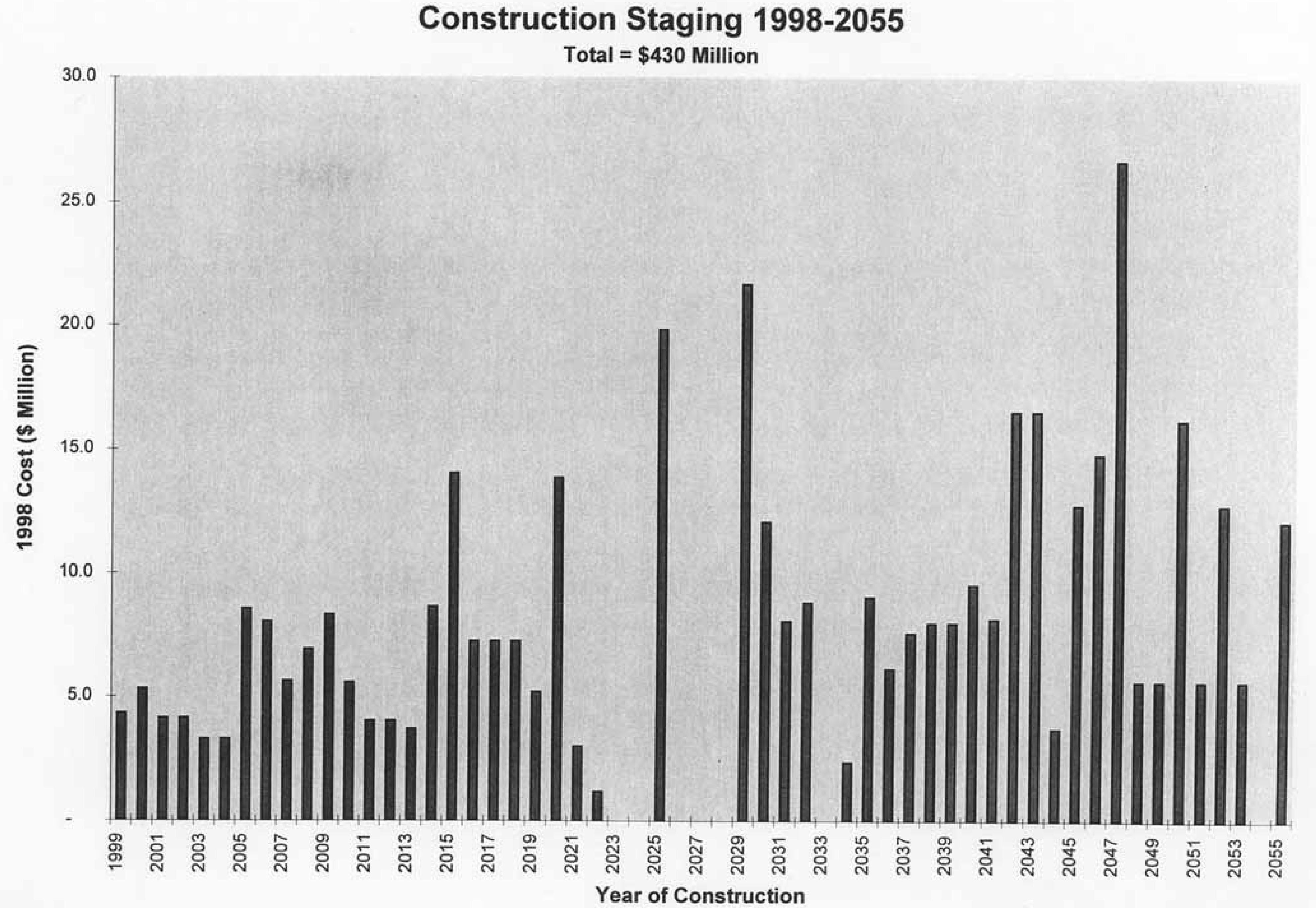
9.2 Financial Model

Upon revising the construction schedule (based on parameters outlined in the previous sections), the financial model was run to determine the new cash flow. The revised construction schedule versus fund balance is shown on Figure 9.2.

The financial model includes a rate adjustment of approximately 20% for both the Expansion Assessment and the SSTC in the years 2005, 2010 and 2015. The rate increases were included to boost the cash flow during the earlier years of the fund's inception. The model also indexes these levies annually 2% to account for inflation.

The 20% rate adjustments were removed from the model to illustrate the impact on the overall cash flow. As shown on Figure 9.3, this will have a drastic affect on the fund during heavy years of construction starting in 2017. The difference between Figure 9.2 and 9.3 indicates that some increases beyond inflation will be necessary to sustain a positive fund balance during the first 20 years of this strategy.

In some cases, the construction expenditures for certain stages were too aggressive and were spread out over a two year period. This helps to balance the cash flow during periods of heavy construction.



Construction Staging 1998-2055
Total = $430 Million
1998 Cost ($ Million)
Year of Construction
30.0
25.0
20.0
15.0
10.0
5.0
-
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
2021
2023
2025
2027
2029
2031
2033
2035
2037
2039
2041
2043
2045
2047
2049
2051
2053
2055

FIGURE 9.1

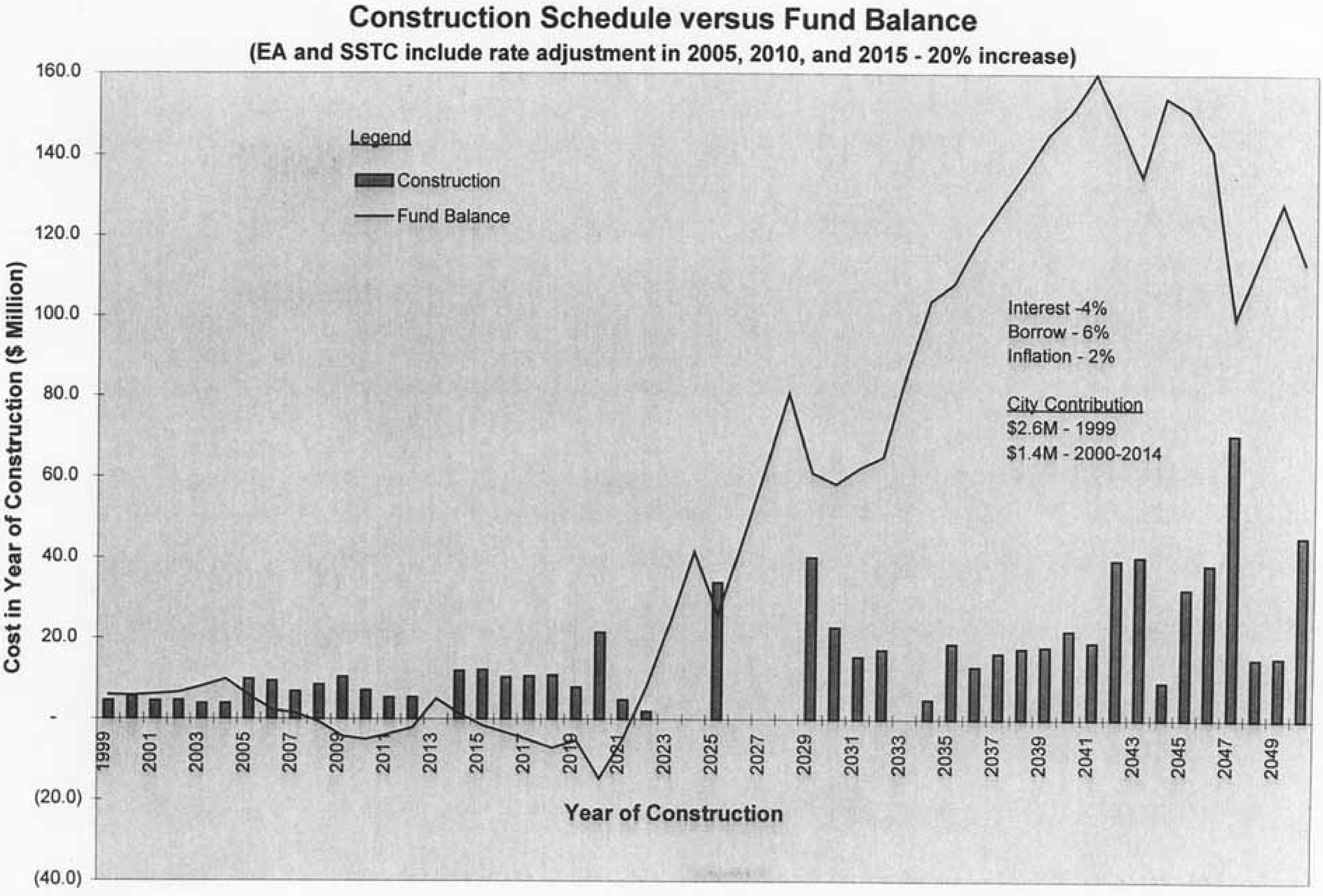

Construction Schedule versus Fund Balance
(EA and SSTC include rate adjustment in 2005, 2010, and 2015 - 20% increase)
Legend
Construction
Fund Balance
Interest -4%
Borrow - 6%
Inflation - 2%
City Contribution
$2.6M - 1999
$1.4M - 2000-2014
Cost in Year of Construction ($ Million)
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
-
(20.0)
(40.0)
Year of Construction
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
2021
2023
2025
2027
2029
2031
2033
2035
2037
2039
2041
2043
2045
2047
2049

FIGURE 9.2

Construction Schedule versus Fund Balance

(EA and SSTC with no rate adjustments)

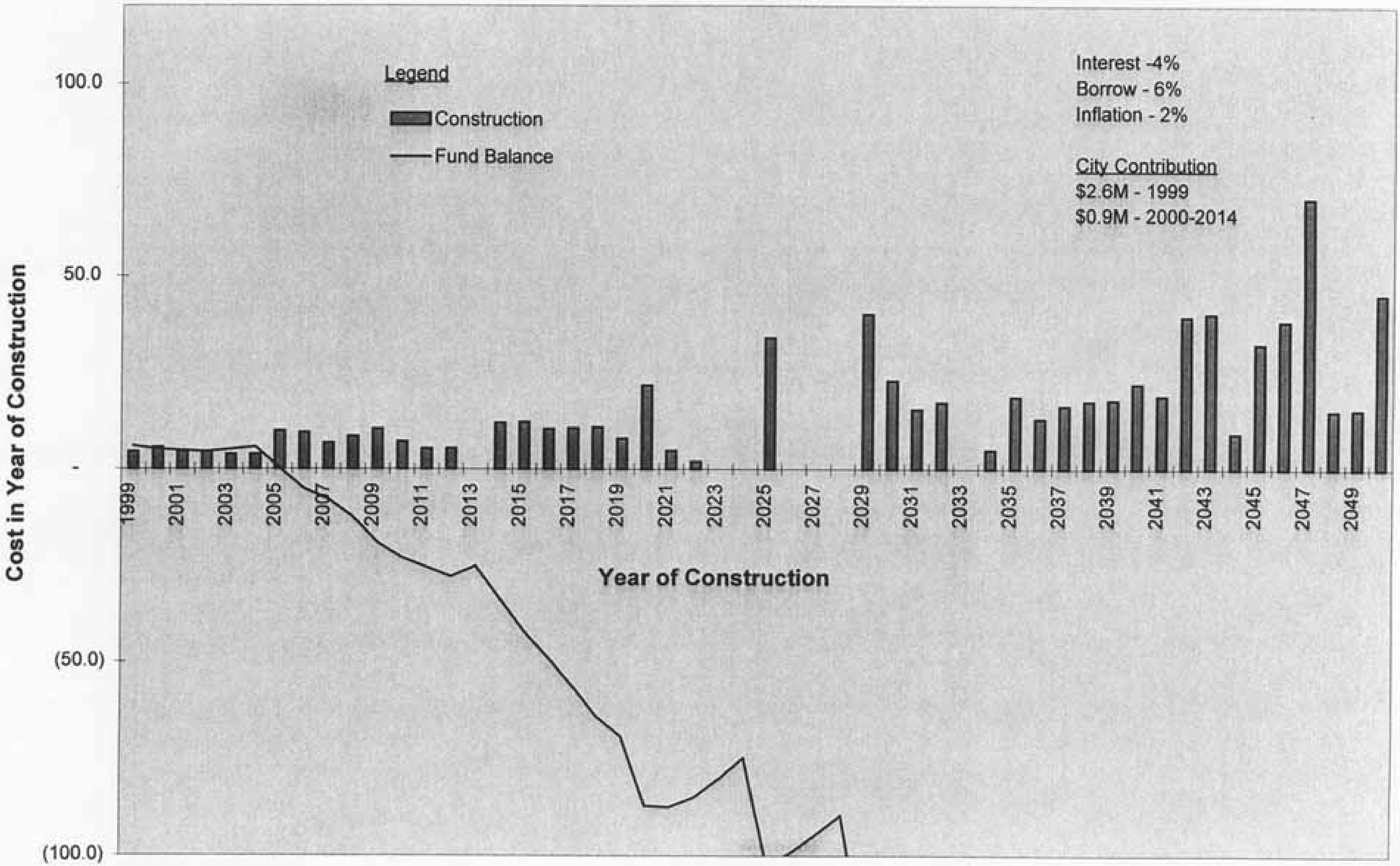


FIGURE 9.3

10.0 RECOMMENDATIONS AND RESIDUAL ISSUES

The following is a list of recommendations or residual issues that should be carried out for the Sanitary Servicing Strategy. These items will ensure the strategy is kept current and accurate in the following years:

- Annual review of the proposed construction schedule and the associated costs.
- Refine the construction schedule to only include a 10 year time period. Break projects down into a typical project period to include the study and design phases.
- Produce a 10 year financial model based on the refined construction schedule.
- Annual review of actual revenue generated through the development industry and compare with the initial projections forecasted in the current financial model. Adjust the future projections in the financial model accordingly.
- Annual review of actual development and population growth rates and compare with forecasted rates in the model. Adjust the future projections in the financial model accordingly.
- In order to determine the Utility's share (as outlined in Section 8.2.4), the financial model used a percentage of developed land to the total area in the basins to be off loaded to the new trunk system. To ensure this calculation is accurate, population data should be used to re-calculate the Utility's share.
- The regional share of the SESS trunk was determined based on the rate of usage. Other cost-sharing formulas are possible and need to be explored prior to negotiating an agreement for cost sharing.
- General assumptions for interest, borrow and inflation rates were used in the current model. These should be reviewed annually to ensure they are accurate.
- The model indexes the Expansion Assessment and the SSTC annually by 2% to account for inflation. The model includes a rate adjustment for the Expansion Assessment and the SSTC in the years 2005, 2010 and 2015 by approximately 20%. A major review of these rates should be completed every five years to determine if a rate adjustment is necessary.
- The financial model has not accounted for the lot inventory buy out to the NEST owners. This buy out is for lots in developments that have paid the current NEST PAC but have not yet been built on. These undeveloped lots will be required to pay the SSTC starting January 1, 1999. In effect, these lots would be paying twice without the inventory buy out. Initial estimates for the lot inventory buy out is $800,000. Depending on the total of the inventory buy out, it should be accounted for in the financial model next year.
- The funding for the sanitary system that services the 65 ha development in the Cumberland neighbourhood along 127 Street (which is not part of the NEST basin), will have to be reviewed by the Management Committee.
- Stage W12 in the WESS system (river crossing at the RAT Creek CSO - refer to Figure 4.1), will require an evaluation to determine cost sharing with the CSO Program.

- Maximizing the use and expansion possibilities at the GBWWTP should be pursued as it is cost effective.

11.0 REFERENCES

City Wide

1. Drainage Monitoring and Assessment, City of Edmonton, Wastewater Sewerage System Global Trunk Model Technical Memorandum 4.4 - Short Duration Rainfall Statistics, March 1997.

2. Drainage Strategic Planning, City of Edmonton, Transportation Department, City of Edmonton Wastewater Treatment Plant Service Area Study. July 1995.

3. Drainage Strategic Planning, City of Edmonton Transportation Department, City wide Sewage Flow Projections for the City of Edmonton, July 1995.

4. Drainage Strategic Planning, City of Edmonton, Transportation Department Analysis of the Gold Bar Wastewater Treatment Plant Operation, July 19 to August 5, 1996 May 1996.

5. Reid Crowther & Partners Ltd., Sanitary Servicing Plan for New Development Areas - Phase I, November 1997.

6. UMA Engineering Ltd. Sanitary Servicing Plan for New Development Areas - Phase II, to be completed in December 1998.

South Edmonton

7. Reid Crowther Ltd., South Edmonton Sanitary Sewerage Servicing Study - Final Report Volume I (Executive Summary), March 1996.

8. Reid Crowther & Partners Ltd., South Edmonton Sanitary Sewerage Servicing Study (SESS), Final Report - Volume II, March 1996.

9. Thurber Engineering Ltd., South Edmonton Sanitary Sewerage Servicing Study (SESS) - Preliminary Geotechnical Evaluation for Plans A, B and C, March 1996.

10. Drainage Strategic Planning, City of Edmonton Transportation Department, Assessment of the Impacts of development in Terwillegar, Heritage, and the University Farms on the Existing Sewer System Serving Southwest Edmonton During Dry Weather, October, 1997.

North Edmonton

11. Drainage Strategic Planning, The City of Edmonton, Transportation Department, North Edmonton Sanitary Trunk Study, January 1994.

12. Engineering Ltd. and UMA Engineering Ltd., North Edmonton Sanitary Trunk (NEST): Conceptual Design Report, April 1994.

13. Engineering Ltd. and UMA Engineering Ltd., North Edmonton Sanitary Trunk, Preliminary Design Report, Stage L1 153 Avenue - 76 to 88 Streets. May 1994.

14. Reid Crowther & Partners Ltd: Clareview Sanitary Sewer System Hydraulic Assessment, April 1993.

15. Thurber Engineering Ltd., Northeast Sanitary Trunk (NEST) Tunnel: Geotechnical Investigation, May 1994.

16. Hanscombe Consultant Inc., Clareview, NEST: Value Analysis Sturdy for the Clareview Sanitary Trunk and the North Edmonton Sanitary Trunk (NEST): Final Report, December 1995.

17. Cochrane Engineering Ltd., Clareview Sanitary Edmonton Sanitary Trunk Conceptual Design Refinement, December 1997.

West Edmonton

18. UMA Engineering Ltd., West Edmonton Sanitary Serving Study, Final Report, March 1997.

19. UMA Engineering Ltd., West Edmonton Sanitary Servicing Study Value Engineering Report, May 1996.

Appendices

APPENDIX A

COMBINED SEWER TRUNK USAGE ASSESSMENT – DOWNSTREAM OF SESS

Combined Sewer Trunk Usage Assessment - Downstream of SESS(I/I = 0.0114 l/s/cap)

AREA	1994	1995	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2075
Population increase													
Terwillegar-Riverbend	0	1308.5	14393	20935	27478	34020	34399	34777	35156	35535	35913	36292	38185
South of RDA	0	161	1766	2569	3372	4175	26061	47948	69834	91721	113607	135493	244925
RDA to Sh. Park Fwy.	0	1718	18896	27487	36076	44665	46467	48271	50073	51876	53678	55482	64495
Leduc/Beau. Flow Incr. (cms)	0.000	0.000	0.016	0.025	0.035	0.045	0.056	0.068	0.081	0.095	0.111	0.127	0.207
Check Conduit 560110: Downstream of Mill Woods													
Total Population Increase	0	1469	16159	23504	30850	38195	60460	82725	104990	127256	149520	171785	283110
Total I/I Increase (m^3/s)	0.000	0.017	0.185	0.269	0.353	0.437	0.691	0.945	1.200	1.454	1.709	1.963	3.236
San. Flow Increase (m^3/s)	0	0.0051	0.0721	0.1066	0.1421	0.1776	0.2659	0.3552	0.4455	0.5369	0.6302	0.7235	1.190
Increase+ ADWF+ I/I (m^3/s)	**0.624**	**0.646**	**0.881**	**0.999**	**1.119**	**1.238**	**1.581**	**1.925**	**2.269**	**2.615**	**2.963**	**3.311**	**5.050**
% Pipe usage	12%	13%	18%	20%	22%	25%	32%	38%	45%	52%	59%	66%	101%
Peak Incr.+PDWF+I/I (m^3/s)	**0.936**	**0.960**	**1.205**	**1.327**	**1.449**	**1.571**	**1.942**	**2.312**	**2.683**	**3.053**	**3.424**	**3.794**	**5.646**
% Pipe usage	19%	19%	24%	27%	29%	31%	39%	46%	54%	61%	68%	76%	113%
Allowable drawdown rate	1.88	1.85	1.62	1.50	1.38	1.26	0.92	0.58	0.23	-0.12	-0.46	-0.81	-2.55
Drawdown Rate (m^3/s)	1.88	1.85	1.62	1.50	1.38	1.26	0.92	0.58	0.23	0.00	0.00	0.00	0.00
% usage with drawdown	50%	50%	50%	50%	50%	50%	50%	50%	50%	52%	59%	66%	101%
Check Conduit 520260: Downstream of Burnewood Trunk													
Total Population Increase	0	1718	18896	27487	36076	44665	46467	48271	50073	51876	53678	55482	64495
Total I/I Increase (m^3/s)	0.000	0.020	0.216	0.314	0.412	0.510	0.531	0.552	0.572	0.593	0.613	0.634	0.737
San. Flow Increase (m^3/s)	0.000	0.006	0.082	0.120	0.160	0.200	0.217	0.236	0.255	0.275	0.297	0.320	0.431
Increase+ ADWF+ I/I (m^3/s)	**0.059**	**0.084**	**0.356**	**0.493**	**0.631**	**0.769**	**0.807**	**0.846**	**0.886**	**0.927**	**0.970**	**1.012**	**1.227**
% Pipe usage	2%	3%	13%	18%	23%	29%	30%	31%	33%	34%	36%	38%	46%
Peak Incr.+PDWF+I/I (m^3/s)	**0.088**	**0.117**	**0.418**	**0.570**	**0.723**	**0.876**	**0.917**	**0.959**	**1.002**	**1.046**	**1.092**	**1.138**	**1.368**
% Pipe usage	3%	4%	16%	21%	27%	33%	34%	36%	37%	39%	41%	42%	51%
Allowable drawdown rate	1.29	1.26	0.99	0.85	0.71	0.58	0.54	0.50	0.46	0.42	0.38	0.33	0.12
Drawdown Rate (m^3/s)	1.29	1.26	0.99	0.85	0.71	0.58	0.54	0.50	0.46	0.42	0.38	0.33	0.12
% usage with drawdown	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%

Combined Sewer Trunk Usage Assessment - Downstream of SESS(I/I = 0.0114 l/s/cap)

Check Conduit 520170: Downstream of Mill Woods & Burnewood Trunk													
Total Population Increase	0	3187	35055	50991	66926	82860	106927	130996	155063	179132	203198	227267	347605
Total I/I Increase (m^3/s)	0.000	0.036	0.401	0.583	0.765	0.947	1.222	1.497	1.772	2.047	2.322	2.597	3.973
San. Flow Increase (m^3/s)	0	0.0111	0.1377	0.2021	0.2674	0.3327	0.4273	0.5228	0.6194	0.717	0.8165	0.9161	1.414
Increase+ ADWF+ I/I (m^3/s)	**1.117**	**1.164**	**1.655**	**1.901**	**2.149**	**2.396**	**2.766**	**3.137**	**3.508**	**3.881**	**4.255**	**4.630**	**6.503**
% Pipe usage	16%	17%	24%	27%	31%	34%	40%	45%	50%	55%	61%	66%	93%
Peak Incr.+PDWF+I/I (m^3/s)	**1.675**	**1.728**	**2.274**	**2.548**	**2.823**	**3.099**	**3.510**	**3.922**	**4.336**	**4.750**	**5.167**	**5.583**	**7.665**
% Pipe usage	24%	25%	32%	36%	40%	44%	50%	56%	62%	68%	74%	80%	110%
Allowable drawdown rate	2.38	2.34	1.84	1.60	1.35	1.10	0.73	0.36	-0.01	-0.38	-0.76	-1.13	-3.00
Drawdown Rate (m^3/s)	2.38	2.34	1.84	1.60	1.35	1.10	0.73	0.36	0.00	0.00	0.00	0.00	0.00
% usage w/drawdown (model)	50%	50%	50%	50%	50%	50%	50%	50%	50%	55%	61%	66%	93%
Check Conduit 580010: Downstream of Mill Woods													
Total Population Increase	0	1469	16159	23504	30850	38195	60460	82725	104990	127256	149520	171785	283110
Total I/I Increase (m^3/s)	0.000	0.017	0.185	0.269	0.353	0.437	0.691	0.945	1.200	1.454	1.709	1.963	3.236
San. Flow Increase (m^3/s)	0	0.0051	0.0721	0.1066	0.1421	0.1776	0.2659	0.3552	0.4455	0.5369	0.6302	0.7235	1.19
Increase+ ADWF+ I/I (m^3/s)	**0.373**	**0.395**	**0.630**	**0.749**	**0.868**	**0.987**	**1.330**	**1.674**	**2.019**	**2.365**	**2.712**	**3.060**	**4.799**
% Pipe usage	30%	32%	51%	61%	71%	80%	108%	136%	164%	192%	221%	249%	390%
Peak Incr.+PDWF+I/I (m^3/s)	**0.560**	**0.584**	**0.845**	**0.976**	**1.108**	**1.240**	**1.622**	**2.004**	**2.388**	**2.772**	**3.159**	**3.545**	**5.477**
% Pipe usage	46%	48%	69%	79%	90%	101%	132%	163%	194%	225%	257%	288%	445%
Allowable drawdown rate	0.24	0.22	-0.02	-0.13	-0.25	-0.37	-0.72	-1.06	-1.40	-1.75	-2.10	-2.45	-4.18
Drawdown Rate (m^3/s)	0.24	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% usage w/drawdown (model)	50%	50%	51%	61%	71%	80%	108%	136%	164%	192%	221%	249%	390%

Combined Sewer Trunk Usage Assessment - Downstream of SESS (I/I = 23% ADWF)

AREA	1994	1995	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2075
Population increase													
Terwillegar-Riverbend	0	1308.5	14393	20935	27478	34020	34399	34777	35156	35535	35913	36292	38185
South of RDA	0	161	1766	2569	3372	4175	26061	47948	69834	91721	113607	135493	244925
RDA to Sh. Park Fwy.	0	1718	18896	27487	36076	44665	46467	48271	50073	51876	53678	55482	64495
Leduc/Beau. Flow Incr. (cms)	0.000	0.000	0.016	0.025	0.035	0.045	0.056	0.068	0.081	0.095	0.111	0.127	0.207
Check Conduit 560110: Downstream of Mill Woods													
Total Population Increase	0	1469	16159	23504	30850	38195	60460	82725	104990	127256	149520	171785	283110
Total I/I Increase (m^3/s)	0.000	0.001	0.013	0.018	0.024	0.030	0.047	0.065	0.082	0.100	0.117	0.135	0.222
San. Flow Increase (m^3/s)	0	0.0051	0.0721	0.1066	0.1421	0.1776	0.2659	0.3552	0.4455	0.5369	0.6302	0.7235	1.190
Increase+ ADWF+ I/I (m^3/s)	**0.624**	**0.630**	**0.709**	**0.749**	**0.790**	**0.832**	**0.937**	**1.044**	**1.152**	**1.261**	**1.372**	**1.482**	**2.036**
% Pipe usage	12%	13%	14%	15%	16%	17%	19%	21%	23%	25%	27%	30%	41%
Peak Incr.+PDWF+I/I (m^3/s)	**0.936**	**0.945**	**1.049**	**1.102**	**1.156**	**1.210**	**1.354**	**1.500**	**1.646**	**1.794**	**1.943**	**2.093**	**2.840**
% Pipe usage	19%	19%	21%	22%	23%	24%	27%	30%	33%	36%	39%	42%	57%
Allowable Drawdown Rate	1.876	1.870	1.791	1.751	1.710	1.668	1.563	1.456	1.348	1.239	1.128	1.018	0.464
Drawdown Rate (m^3/s)	1.88	1.87	1.79	1.75	1.71	1.67	1.56	1.46	1.35	1.24	1.13	1.02	0.46
% usage with drawdown	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
Check Conduit 520260: Downstream of Burnewood Trunk													
Total Population Increase	0	1718	18896	27487	36076	44665	46467	48271	50073	51876	53678	55482	64495
Total I/I Increase (m^3/s)	0.000	0.001	0.015	0.022	0.028	0.035	0.037	0.038	0.039	0.041	0.042	0.044	0.051
San. Flow Increase (m^3/s)	0.000	0.006	0.082	0.120	0.160	0.200	0.217	0.236	0.255	0.275	0.297	0.320	0.431
Increase+ ADWF+ I/I (m^3/s)	**0.059**	**0.066**	**0.155**	**0.201**	**0.247**	**0.294**	**0.313**	**0.332**	**0.353**	**0.375**	**0.398**	**0.422**	**0.540**
% Pipe usage	2%	2%	6%	7%	9%	11%	12%	12%	13%	14%	15%	16%	20%
Peak Incr.+PDWF+I/I (m^3/s)	**0.088**	**0.098**	**0.217**	**0.278**	**0.339**	**0.401**	**0.423**	**0.445**	**0.469**	**0.494**	**0.521**	**0.548**	**0.682**
% Pipe usage	3%	4%	8%	10%	13%	15%	16%	17%	17%	18%	19%	20%	25%
Allowable Drawdown Rate	1.286	1.279	1.190	1.144	1.098	1.051	1.032	1.013	0.992	0.970	0.947	0.923	0.805
Drawdown Rate (m^3/s)	1.29	1.28	1.19	1.14	1.10	1.05	1.03	1.01	0.99	0.97	0.95	0.92	0.80
% usage with drawdown	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%

Combined Sewer Trunk Usage Assessment - Downstream of SESS (I/I = 23% ADWF)

Check Conduit 520170: Downstream of Mill Woods & Burnewood Trunk													
Total Population Increase	0	3187	35055	50991	66926	82860	106927	130996	155063	179132	203198	227267	347605
Total I/I Increase (m^3/s)	0.000	0.003	0.028	0.040	0.053	0.065	0.084	0.103	0.122	0.141	0.160	0.179	0.273
San. Flow Increase (m^3/s)	0	0.0111	0.1377	0.2021	0.2674	0.3327	0.4273	0.5228	0.6194	0.717	0.8165	0.9161	1.414
Increase+ ADWF+ I/I (m^3/s)	**1.117**	**1.130**	**1.282**	**1.359**	**1.437**	**1.514**	**1.628**	**1.742**	**1.858**	**1.974**	**2.093**	**2.211**	**2.804**
% Pipe usage	16%	16%	18%	19%	21%	22%	23%	25%	27%	28%	30%	32%	40%
Peak Incr.+PDWF+I/I (m^3/s)	**1.675**	**1.694**	**1.901**	**2.006**	**2.111**	**2.217**	**2.372**	**2.528**	**2.685**	**2.844**	**3.004**	**3.164**	**3.966**
% Pipe usage	24%	24%	27%	29%	30%	32%	34%	36%	38%	41%	43%	45%	57%
Allowable Drawdown Rate	2.383	2.370	2.218	2.141	2.063	1.986	1.872	1.758	1.642	1.526	1.407	1.289	0.696
Drawdown Rate (m^3/s)	2.38	2.37	2.22	2.14	2.06	1.99	1.87	1.76	1.64	1.53	1.41	1.29	0.70
% usage w/drawdown (model)	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
Check Conduit 580010: Downstream of Mill Woods													
Total Population Increase	0	1469	16159	23504	30850	38195	60460	82725	104990	127256	149520	171785	283110
Total I/I Increase (m^3/s)	0.000	0.001	0.013	0.018	0.024	0.030	0.047	0.065	0.082	0.100	0.117	0.135	0.222
San. Flow Increase (m^3/s)	0	0.0051	0.0721	0.1066	0.1421	0.1776	0.2659	0.3552	0.4455	0.5369	0.6302	0.7235	1.19
Increase+ ADWF+ I/I (m^3/s)	**0.430**	**0.436**	**0.515**	**0.555**	**0.596**	**0.638**	**0.743**	**0.850**	**0.958**	**1.067**	**1.178**	**1.288**	**1.842**
% Pipe usage	35%	35%	42%	45%	48%	52%	60%	69%	78%	87%	96%	105%	150%
Peak Incr.+PDWF+I/I (m^3/s)	**0.560**	**0.585**	**0.682**	**0.736**	**0.790**	**0.845**	**0.990**	**1.137**	**1.284**	**1.434**	**1.583**	**1.797**	**2.464**
% Pipe usage	46%	48%	55%	60%	64%	69%	81%	92%	104%	117%	129%	146%	200%
Allowable Drawdown Rate	0.185	0.179	0.100	0.060	0.019	-0.023	-0.128	-0.235	-0.343	-0.452	-0.563	-0.673	-1.227
Drawdown Rate (m^3/s)	0.19	0.18	0.10	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% usage w/drawdown (model)	50%	50%	50%	50%	50%	52%	60%	69%	78%	87%	96%	105%	150%

APPENDIX B

COMBINED SEWER TRUNK USAGE ASSESSMENT – DOWNSTREAM OF WESS

Combined Sewer Trunk Usage Assessment
(I/I = 23% of ADWF)

Assume: 1.6 Residential Flow
3.5 Industrial Flow
300 l/c/day
0.20 l/sec/ha
23% I/I (of ADWF)

Year	Growth																		
	Total Increase																		
	Residential Population	Non Res Area(ha)	ADWF Flow+I/I (m^3/sec)	Model Conduit **420100** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **420060** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **420080** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **420075** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)
1994	-	-	0.000	2.330	0.623	0.623	27%	3.200	0.652	0.652	20%	2.340	0.652	0.652	28%	2.730	0.652	0.652	24%
1995	737	7.80	0.005	2.330	0.623	0.628	27%	3.200	0.652	0.657	21%	2.340	0.652	0.657	28%	2.730	0.652	0.657	24%
2000	3,584	47.00	0.027	2.330	0.623	0.650	28%	3.200	0.652	0.679	21%	2.340	0.652	0.679	29%	2.730	0.652	0.679	25%
2005	9,622	88.60	0.063	2.330	0.623	0.686	29%	3.200	0.652	0.715	22%	2.340	0.652	0.715	31%	2.730	0.652	0.715	26%
2010	14,063	132.60	0.093	2.330	0.623	0.716	31%	3.200	0.652	0.745	23%	2.340	0.652	0.745	32%	2.730	0.652	0.745	27%
2015	18,506	179.80	0.123	2.330	0.623	0.746	32%	3.200	0.652	0.775	24%	2.340	0.652	0.775	33%	2.730	0.652	0.775	28%
2020	22,947	229.80	0.155	2.330	0.623	0.778	33%	3.200	0.652	0.807	25%	2.340	0.652	0.807	34%	2.730	0.652	0.807	30%
2025	27,964	283.00	0.189	2.330	0.623	0.812	35%	3.200	0.652	0.841	26%	2.340	0.652	0.841	36%	2.730	0.652	0.841	31%
2030	32,981	339.80	0.224	2.330	0.623	0.847	36%	3.200	0.652	0.876	27%	2.340	0.652	0.876	37%	2.730	0.652	0.876	32%
2035	37,998	400.20	0.261	2.330	0.623	0.884	38%	3.200	0.652	0.913	29%	2.340	0.652	0.913	39%	2.730	0.652	0.913	33%
2040	43,015	464.20	0.298	2.330	0.623	0.921	40%	3.200	0.652	0.950	30%	2.340	0.652	0.950	41%	2.730	0.652	0.950	35%
2045	48,032	532.60	0.336	2.330	0.623	0.959	41%	3.200	0.652	0.988	31%	2.340	0.652	0.988	42%	2.730	0.652	0.988	36%
2050	53,048	605.40	0.375	2.330	0.623	0.998	43%	3.200	0.652	1.027	32%	2.340	0.652	1.027	44%	2.730	0.652	1.027	38%
2055	58,065	682.60	0.416	2.330	0.623	1.039	45%	3.200	0.652	1.068	33%	2.340	0.652	1.068	46%	2.730	0.652	1.068	39%
2060	63,082	765.00	0.458	2.330	0.623	1.081	46%	3.200	0.652	1.110	35%	2.340	0.652	1.110	47%	2.730	0.652	1.110	41%
2065	68,099	852.20	0.500	2.330	0.623	1.123	48%	3.200	0.652	1.152	36%	2.340	0.652	1.152	49%	2.730	0.652	1.152	42%
2070	73,116	945.70	0.545	2.330	0.623	1.168	50%	3.200	0.652	1.197	37%	2.340	0.652	1.197	51%	2.730	0.652	1.197	44%
2075	81,283	1,044.90	0.604	2.330	0.623	1.227	53%	3.200	0.652	1.256	39%	2.340	0.652	1.256	54%	2.730	0.652	1.256	46%

Combined Sewer Trunk Usage Assessment
(I/I = 23% of ADWF)

Assume:
- 1.6 Residential Flow
- 3.5 Industrial Flow
- 300 l/c/day
- 0.20 l/sec/ha
- 23% I/I (of ADWF)

Year	Growth – Total Increase			Model Conduit **420040** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **420020** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **433180** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **433190** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)
	Residential Population	Non Res Area(ha)	ADWF Flow+I/I (m^3/sec)																
1994	-	-	0.000	3.090	0.651	0.651	21%	3.120	0.768	0.768	25%	3.160	0.767	0.767	24%	1.110	0.767	0.767	69%
1995	737	7.80	0.005	3.090	0.651	0.656	21%	3.120	0.768	0.773	25%	3.160	0.767	0.772	24%	1.110	0.767	0.772	70%
2000	3,584	47.00	0.027	3.090	0.651	0.678	22%	3.120	0.768	0.795	25%	3.160	0.767	0.794	25%	1.110	0.767	0.794	72%
2005	9,622	88.60	0.063	3.090	0.651	0.714	23%	3.120	0.768	0.831	27%	3.160	0.767	0.830	26%	1.110	0.767	0.830	75%
2010	14,063	132.60	0.093	3.090	0.651	0.744	24%	3.120	0.768	0.861	28%	3.160	0.767	0.860	27%	1.110	0.767	0.860	77%
2015	18,506	179.80	0.123	3.090	0.651	0.774	25%	3.120	0.768	0.891	29%	3.160	0.767	0.890	28%	1.110	0.767	0.890	80%
2020	22,947	229.80	0.155	3.090	0.651	0.806	26%	3.120	0.768	0.923	30%	3.160	0.767	0.922	29%	1.110	0.767	0.922	83%
2025	27,964	283.00	0.189	3.090	0.651	0.840	27%	3.120	0.768	0.957	31%	3.160	0.767	0.956	30%	1.110	0.767	0.956	86%
2030	32,981	339.80	0.224	3.090	0.651	0.875	28%	3.120	0.768	0.992	32%	3.160	0.767	0.991	31%	1.110	0.767	0.991	89%
2035	37,998	400.20	0.261	3.090	0.651	0.912	30%	3.120	0.768	1.029	33%	3.160	0.767	1.028	33%	1.110	0.767	1.028	93%
2040	43,015	464.20	0.298	3.090	0.651	0.949	31%	3.120	0.768	1.066	34%	3.160	0.767	1.065	34%	1.110	0.767	1.065	96%
2045	48,032	532.60	0.336	3.090	0.651	0.987	32%	3.120	0.768	1.104	35%	3.160	0.767	1.103	35%	1.110	0.767	1.103	99%
2050	53,048	605.40	0.375	3.090	0.651	1.026	33%	3.120	0.768	1.143	37%	3.160	0.767	1.142	36%	1.110	0.767	1.142	103%
2055	58,065	682.60	0.416	3.090	0.651	1.067	35%	3.120	0.768	1.184	38%	3.160	0.767	1.183	37%	1.110	0.767	1.183	107%
2060	63,082	765.00	0.458	3.090	0.651	1.109	36%	3.120	0.768	1.226	39%	3.160	0.767	1.225	39%	1.110	0.767	1.225	110%
2065	68,099	852.20	0.500	3.090	0.651	1.151	37%	3.120	0.768	1.268	41%	3.160	0.767	1.267	40%	1.110	0.767	1.267	114%
2070	73,116	945.70	0.545	3.090	0.651	1.196	39%	3.120	0.768	1.313	42%	3.160	0.767	1.312	42%	1.110	0.767	1.312	118%
2075	81,283	1,044.90	0.604	3.090	0.651	1.255	41%	3.120	0.768	1.372	44%	3.160	0.767	1.371	43%	1.110	0.767	1.371	124%

Combined Sewer Trunk Usage Assessment
(I/I = 23% of ADWF)

Assume:

1.6	Residential Flow
3.5	Industrial Flow
300	l/c/day
0.20	l/sec/ha
23%	I/I (of ADWF)

Year	Growth																		
	Total Increase			Model Conduit **433195** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **433220** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **433260** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **433290** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)
	Residential Population	Non Res Area(ha)	ADWF Flow+I/I (m^3/sec)																
1994	-	-	0.000	3.140	0.767	0.767	24%	4.740	0.801	0.801	17%	4.690	0.800	1.044	22%	8.120	0.861	1.030	13%
1995	737	7.80	0.005	3.140	0.767	0.772	25%	4.740	0.801	0.806	17%	4.690	0.800	1.046	22%	8.120	0.861	1.031	13%
2000	3,584	47.00	0.027	3.140	0.767	0.794	25%	4.740	0.801	0.828	17%	4.690	0.800	1.053	22%	8.120	0.861	1.036	13%
2005	9,622	88.60	0.063	3.140	0.767	0.830	26%	4.740	0.801	0.864	18%	4.690	0.800	1.064	23%	8.120	0.861	1.043	13%
2010	14,063	132.60	0.093	3.140	0.767	0.860	27%	4.740	0.801	0.894	19%	4.690	0.800	1.074	23%	8.120	0.861	1.050	13%
2015	18,506	179.80	0.123	3.140	0.767	0.890	28%	4.740	0.801	0.924	19%	4.690	0.800	1.084	23%	8.120	0.861	1.056	13%
2020	22,947	229.80	0.155	3.140	0.767	0.922	29%	4.740	0.801	0.956	20%	4.690	0.800	1.093	23%	8.120	0.861	1.063	13%
2025	27,964	283.00	0.189	3.140	0.767	0.956	30%	4.740	0.801	0.990	21%	4.690	0.800	1.104	24%	8.120	0.861	1.070	13%
2030	32,981	339.80	0.224	3.140	0.767	0.991	32%	4.740	0.801	1.025	22%	4.690	0.800	1.116	24%	8.120	0.861	1.077	13%
2035	37,998	400.20	0.261	3.140	0.767	1.028	33%	4.740	0.801	1.062	22%	4.690	0.800	1.127	24%	8.120	0.861	1.085	13%
2040	43,015	464.20	0.298	3.140	0.767	1.065	34%	4.740	0.801	1.099	23%	4.690	0.800	1.139	24%	8.120	0.861	1.093	13%
2045	48,032	532.60	0.336	3.140	0.767	1.103	35%	4.740	0.801	1.137	24%	4.690	0.800	1.151	25%	8.120	0.861	1.101	14%
2050	53,048	605.40	0.375	3.140	0.767	1.142	36%	4.740	0.801	1.176	25%	4.690	0.800	1.164	25%	8.120	0.861	1.109	14%
2055	58,065	682.60	0.416	3.140	0.767	1.183	38%	4.740	0.801	1.217	26%	4.690	0.800	1.177	25%	8.120	0.861	1.118	14%
2060	63,082	765.00	0.458	3.140	0.767	1.225	39%	4.740	0.801	1.259	27%	4.690	0.800	1.190	25%	8.120	0.861	1.127	14%
2065	68,099	852.20	0.500	3.140	0.767	1.267	40%	4.740	0.801	1.301	27%	4.690	0.800	1.204	26%	8.120	0.861	1.136	14%
2070	73,116	945.70	0.545	3.140	0.767	1.312	42%	4.740	0.801	1.346	28%	4.690	0.800	1.218	26%	8.120	0.861	1.145	14%
2075	81,283	1,044.90	0.604	3.140	0.767	1.371	44%	4.740	0.801	1.405	30%	4.690	0.800	1.237	26%	8.120	0.861	1.157	14%

Combined Sewer Trunk Usage Assessment
(I/I = 23% of ADWF)

Assume:
1.6 Residential Flow
3.5 Industrial Flow
300 l/c/day
0.20 l/sec/ha
23% I/I (of ADWF)

Year	Growth															
	Total Increase			Model Conduit **433300** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **430020** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **430010** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)
	Residential Population	Non Res Area(ha)	ADWF Flow+I/I (m^3/sec)													
1994	-	-	0.000	8.120	0.861	1.084	13%	39.800	1.994	2.121	5%	39.800	2.023	2.156	5%
1995	737	7.80	0.005	8.120	0.861	1.084	13%	39.800	1.994	2.121	5%	39.800	2.023	2.156	5%
2000	3,584	47.00	0.027	8.120	0.861	1.085	13%	39.800	1.994	2.122	5%	39.800	2.023	2.157	5%
2005	9,622	88.60	0.063	8.120	0.861	1.088	13%	39.800	1.994	2.122	5%	39.800	2.023	2.157	5%
2010	14,063	132.60	0.093	8.120	0.861	1.090	13%	39.800	1.994	2.123	5%	39.800	2.023	2.157	5%
2015	18,506	179.80	0.123	8.120	0.861	1.092	13%	39.800	1.994	2.124	5%	39.800	2.023	2.157	5%
2020	22,947	229.80	0.155	8.120	0.861	1.094	13%	39.800	1.994	2.125	5%	39.800	2.023	2.158	5%
2025	27,964	283.00	0.189	8.120	0.861	1.096	14%	39.800	1.994	2.126	5%	39.800	2.023	2.158	5%
2030	32,981	339.80	0.224	8.120	0.861	1.099	14%	39.800	1.994	2.127	5%	39.800	2.023	2.158	5%
2035	37,998	400.20	0.261	8.120	0.861	1.101	14%	39.800	1.994	2.128	5%	39.800	2.023	2.159	5%
2040	43,015	464.20	0.298	8.120	0.861	1.104	14%	39.800	1.994	2.129	5%	39.800	2.023	2.159	5%
2045	48,032	532.60	0.336	8.120	0.861	1.106	14%	39.800	1.994	2.130	5%	39.800	2.023	2.159	5%
2050	53,048	605.40	0.375	8.120	0.861	1.109	14%	39.800	1.994	2.131	5%	39.800	2.023	2.160	5%
2055	58,065	682.60	0.416	8.120	0.861	1.112	14%	39.800	1.994	2.132	5%	39.800	2.023	2.160	5%
2060	63,082	765.00	0.458	8.120	0.861	1.115	14%	39.800	1.994	2.133	5%	39.800	2.023	2.160	5%
2065	68,099	852.20	0.500	8.120	0.861	1.118	14%	39.800	1.994	2.134	5%	39.800	2.023	2.161	5%
2070	73,116	945.70	0.545	8.120	0.861	1.121	14%	39.800	1.994	2.135	5%	39.800	2.023	2.161	5%
2075	81,283	1,044.90	0.604	8.120	0.861	1.125	14%	39.800	1.994	2.137	5%	39.800	2.023	2.162	5%

Combined Sewer Trunk Usage Assessment
(I/I = 0.0114 l/s/cap - residential and 0.4 l/s/ha - Industrial)

1.6 Residential Flow
3.5 Industrial Flow
0.0114 l/s/person (I/I residential)
300 l/c/day
0.20 l/sec/ha
0.40 l/s/ha (I/I industrial)

Year	Growth			Model Conduit **420100** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **420060** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **420080** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **420075** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)
	Total Increase																		
	Residential Population	Non Res Area(ha)	ADWF Flow+I/I (m^3/sec)																
1994	-	-	0.000	2.330	0.623	0.623	27%	3.200	0.652	0.652	20%	2.340	0.652	0.652	28%	2.730	0.652	0.652	24%
1995	737	7.80	0.016	2.330	0.623	0.639	27%	3.200	0.652	0.668	21%	2.340	0.652	0.668	29%	2.730	0.652	0.668	24%
2000	3,584	47.00	0.082	2.330	0.623	0.705	30%	3.200	0.652	0.734	23%	2.340	0.652	0.734	31%	2.730	0.652	0.734	27%
2005	9,622	88.60	0.196	2.330	0.623	0.819	35%	3.200	0.652	0.848	27%	2.340	0.652	0.848	36%	2.730	0.652	0.848	31%
2010	14,063	132.60	0.289	2.330	0.623	0.912	39%	3.200	0.652	0.941	29%	2.340	0.652	0.941	40%	2.730	0.652	0.941	34%
2015	18,506	179.80	0.383	2.330	0.623	1.006	43%	3.200	0.652	1.035	32%	2.340	0.652	1.035	44%	2.730	0.652	1.035	38%
2020	22,947	229.80	0.479	2.330	0.623	1.102	47%	3.200	0.652	1.131	35%	2.340	0.652	1.131	48%	2.730	0.652	1.131	41%
2025	27,964	283.00	0.586	2.330	0.623	1.209	52%	3.200	0.652	1.238	39%	2.340	0.652	1.238	53%	2.730	0.652	1.238	45%
2030	32,981	339.80	0.694	2.330	0.623	1.317	57%	3.200	0.652	1.346	42%	2.340	0.652	1.346	58%	2.730	0.652	1.346	49%
2035	37,998	400.20	0.805	2.330	0.623	1.428	61%	3.200	0.652	1.457	46%	2.340	0.652	1.457	62%	2.730	0.652	1.457	53%
2040	43,015	464.20	0.918	2.330	0.623	1.541	66%	3.200	0.652	1.570	49%	2.340	0.652	1.570	67%	2.730	0.652	1.570	58%
2045	48,032	532.60	1.034	2.330	0.623	1.657	71%	3.200	0.652	1.686	53%	2.340	0.652	1.686	72%	2.730	0.652	1.686	62%
2050	53,048	605.40	1.152	2.330	0.623	1.775	76%	3.200	0.652	1.804	56%	2.340	0.652	1.804	77%	2.730	0.652	1.804	66%
2055	58,065	682.60	1.273	2.330	0.623	1.896	81%	3.200	0.652	1.925	60%	2.340	0.652	1.925	82%	2.730	0.652	1.925	71%
2060	63,082	765.00	1.397	2.330	0.623	2.020	87%	3.200	0.652	2.049	64%	2.340	0.652	2.049	88%	2.730	0.652	2.049	75%
2065	68,099	852.20	1.524	2.330	0.623	2.147	92%	3.200	0.652	2.176	68%	2.340	0.652	2.176	93%	2.730	0.652	2.176	80%
2070	73,116	945.70	1.655	2.330	0.623	2.278	98%	3.200	0.652	2.307	72%	2.340	0.652	2.307	99%	2.730	0.652	2.307	84%
2075	81,283	1,044.90	1.836	2.330	0.623	2.459	106%	3.200	0.652	2.488	78%	2.340	0.652	2.488	106%	2.730	0.652	2.488	91%

Combined Sewer Trunk Usage Assessment
(I/I = 0.0114 l/s/cap - residential and 0.4 l/s/ha - Industrial)

1.6 Residential Flow
3.5 Industrial Flow
0.0114 l/s/person (I/I residential)
300 l/c/day
0.20 l/sec/ha
0.40 l/s/ha (I/I industrial)

Year	Growth																		
	Total Increase			Model Conduit **420040** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **420020** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **433180** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **433190** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)
	Residential Population	Non Res Area(ha)	ADWF Flow+I/I (m^3/sec)																
1994	-	-	0.000	3.090	0.651	0.651	21%	3.120	0.768	0.768	25%	3.160	0.767	0.767	24%	1.110	0.767	0.767	69%
1995	737	7.80	0.016	3.090	0.651	0.667	22%	3.120	0.768	0.784	25%	3.160	0.767	0.783	25%	1.110	0.767	0.783	71%
2000	3,584	47.00	0.082	3.090	0.651	0.733	24%	3.120	0.768	0.850	27%	3.160	0.767	0.849	27%	1.110	0.767	0.849	76%
2005	9,622	88.60	0.196	3.090	0.651	0.847	27%	3.120	0.768	0.964	31%	3.160	0.767	0.963	30%	1.110	0.767	0.963	87%
2010	14,063	132.60	0.289	3.090	0.651	0.940	30%	3.120	0.768	1.057	34%	3.160	0.767	1.056	33%	1.110	0.767	1.056	95%
2015	18,506	179.80	0.383	3.090	0.651	1.034	33%	3.120	0.768	1.151	37%	3.160	0.767	1.150	36%	1.110	0.767	1.150	104%
2020	22,947	229.80	0.479	3.090	0.651	1.130	37%	3.120	0.768	1.247	40%	3.160	0.767	1.246	39%	1.110	0.767	1.246	112%
2025	27,964	283.00	0.586	3.090	0.651	1.237	40%	3.120	0.768	1.354	43%	3.160	0.767	1.353	43%	1.110	0.767	1.353	122%
2030	32,981	339.80	0.694	3.090	0.651	1.345	44%	3.120	0.768	1.462	47%	3.160	0.767	1.461	46%	1.110	0.767	1.461	132%
2035	37,998	400.20	0.805	3.090	0.651	1.456	47%	3.120	0.768	1.573	50%	3.160	0.767	1.572	50%	1.110	0.767	1.572	142%
2040	43,015	464.20	0.918	3.090	0.651	1.569	51%	3.120	0.768	1.686	54%	3.160	0.767	1.685	53%	1.110	0.767	1.685	152%
2045	48,032	532.60	1.034	3.090	0.651	1.685	55%	3.120	0.768	1.802	58%	3.160	0.767	1.801	57%	1.110	0.767	1.801	162%
2050	53,048	605.40	1.152	3.090	0.651	1.803	58%	3.120	0.768	1.920	62%	3.160	0.767	1.919	61%	1.110	0.767	1.919	173%
2055	58,065	682.60	1.273	3.090	0.651	1.924	62%	3.120	0.768	2.041	65%	3.160	0.767	2.040	65%	1.110	0.767	2.040	184%
2060	63,082	765.00	1.397	3.090	0.651	2.048	66%	3.120	0.768	2.165	69%	3.160	0.767	2.164	68%	1.110	0.767	2.164	195%
2065	68,099	852.20	1.524	3.090	0.651	2.175	70%	3.120	0.768	2.292	73%	3.160	0.767	2.291	73%	1.110	0.767	2.291	206%
2070	73,116	945.70	1.655	3.090	0.651	2.306	75%	3.120	0.768	2.423	78%	3.160	0.767	2.422	77%	1.110	0.767	2.422	218%
2075	81,283	1,044.90	1.836	3.090	0.651	2.487	80%	3.120	0.768	2.604	83%	3.160	0.767	2.603	82%	1.110	0.767	2.603	234%

Combined Sewer Trunk Usage Assessment
(I/I = 0.0114 l/s/cap - residential and 0.4 l/s/ha - Industrial)

1.6 Residential Flow
3.5 Industrial Flow
0.0114 l/s/person (I/I residential)
300 l/c/day
0.20 l/sec/ha
0.40 l/s/ha (I/I industrial)

Year	Growth			Model Conduit **433195** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **433220** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **433260** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **433290** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)
	Total Increase																		
	Residential Population	Non Res Area(ha)	ADWF Flow+I/I (m^3/sec)																
1994	-	-	0.000	3.140	0.767	0.767	24%	4.740	0.801	0.801	17%	4.690	0.800	1.044	22%	8.120	0.861	1.030	13%
1995	737	7.80	0.016	3.140	0.767	0.783	25%	4.740	0.801	0.817	17%	4.690	0.800	1.049	22%	8.120	0.861	1.033	13%
2000	3,584	47.00	0.082	3.140	0.767	0.849	27%	4.740	0.801	0.883	19%	4.690	0.800	1.070	23%	8.120	0.861	1.047	13%
2005	9,622	88.60	0.196	3.140	0.767	0.963	31%	4.740	0.801	0.997	21%	4.690	0.800	1.107	24%	8.120	0.861	1.071	13%
2010	14,063	132.60	0.289	3.140	0.767	1.056	34%	4.740	0.801	1.090	23%	4.690	0.800	1.136	24%	8.120	0.861	1.091	13%
2015	18,506	179.80	0.383	3.140	0.767	1.150	37%	4.740	0.801	1.184	25%	4.690	0.800	1.166	25%	8.120	0.861	1.111	14%
2020	22,947	229.80	0.479	3.140	0.767	1.246	40%	4.740	0.801	1.280	27%	4.690	0.800	1.197	26%	8.120	0.861	1.131	14%
2025	27,964	283.00	0.586	3.140	0.767	1.353	43%	4.740	0.801	1.387	29%	4.690	0.800	1.231	26%	8.120	0.861	1.154	14%
2030	32,981	339.80	0.694	3.140	0.767	1.461	47%	4.740	0.801	1.495	32%	4.690	0.800	1.265	27%	8.120	0.861	1.176	14%
2035	37,998	400.20	0.805	3.140	0.767	1.572	50%	4.740	0.801	1.606	34%	4.690	0.800	1.301	28%	8.120	0.861	1.200	15%
2040	43,015	464.20	0.918	3.140	0.767	1.685	54%	4.740	0.801	1.719	36%	4.690	0.800	1.337	29%	8.120	0.861	1.224	15%
2045	48,032	532.60	1.034	3.140	0.767	1.801	57%	4.740	0.801	1.835	39%	4.690	0.800	1.374	29%	8.120	0.861	1.248	15%
2050	53,048	605.40	1.152	3.140	0.767	1.919	61%	4.740	0.801	1.953	41%	4.690	0.800	1.411	30%	8.120	0.861	1.273	16%
2055	58,065	682.60	1.273	3.140	0.767	2.040	65%	4.740	0.801	2.074	44%	4.690	0.800	1.450	31%	8.120	0.861	1.299	16%
2060	63,082	765.00	1.397	3.140	0.767	2.164	69%	4.740	0.801	2.198	46%	4.690	0.800	1.489	32%	8.120	0.861	1.325	16%
2065	68,099	852.20	1.524	3.140	0.767	2.291	73%	4.740	0.801	2.325	49%	4.690	0.800	1.530	33%	8.120	0.861	1.352	17%
2070	73,116	945.70	1.655	3.140	0.767	2.422	77%	4.740	0.801	2.456	52%	4.690	0.800	1.571	34%	8.120	0.861	1.379	17%
2075	81,283	1,044.90	1.836	3.140	0.767	2.603	83%	4.740	0.801	2.637	56%	4.690	0.800	1.629	35%	8.120	0.861	1.417	17%

Combined Sewer Trunk Usage Assessment
(I/I = 0.0114 l/s/cap - residential and 0.4 l/s/ha - Industrial)

1.6 Residential Flow
3.5 Industrial Flow
0.0114 l/s/person (I/I residential)
300 l/c/day
0.20 l/sec/ha
0.40 l/s/ha (I/I industrial)

Year	Growth			Model Conduit **433300** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **430020** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)	Model Conduit **430010** Rated Capacity (m^3/sec)	June 5/1991 PDWF (m^3/sec)	Increase + PDWF (m^3/sec)	Pipe Usage (%)
	Total Increase														
	Residential Population	Non Res Area(ha)	ADWF Flow+I/I (m^3/sec)												
1994	-	-	0.000	8.120	0.861	1.084	13%	39.800	1.994	2.121	5%	39.800	2.023	2.156	5%
1995	737	7.80	0.016	8.120	0.861	1.085	13%	39.800	1.994	2.121	5%	39.800	2.023	2.157	5%
2000	3,584	47.00	0.082	8.120	0.861	1.089	13%	39.800	1.994	2.123	5%	39.800	2.023	2.157	5%
2005	9,622	88.60	0.196	8.120	0.861	1.097	14%	39.800	1.994	2.126	5%	39.800	2.023	2.158	5%
2010	14,063	132.60	0.289	8.120	0.861	1.103	14%	39.800	1.994	2.128	5%	39.800	2.023	2.159	5%
2015	18,506	179.80	0.383	8.120	0.861	1.110	14%	39.800	1.994	2.131	5%	39.800	2.023	2.160	5%
2020	22,947	229.80	0.479	8.120	0.861	1.116	14%	39.800	1.994	2.133	5%	39.800	2.023	2.160	5%
2025	27,964	283.00	0.586	8.120	0.861	1.123	14%	39.800	1.994	2.136	5%	39.800	2.023	2.161	5%
2030	32,981	339.80	0.694	8.120	0.861	1.131	14%	39.800	1.994	2.139	5%	39.800	2.023	2.162	5%
2035	37,998	400.20	0.805	8.120	0.861	1.138	14%	39.800	1.994	2.142	5%	39.800	2.023	2.163	5%
2040	43,015	464.20	0.918	8.120	0.861	1.146	14%	39.800	1.994	2.145	5%	39.800	2.023	2.164	5%
2045	48,032	532.60	1.034	8.120	0.861	1.154	14%	39.800	1.994	2.148	5%	39.800	2.023	2.165	5%
2050	53,048	605.40	1.152	8.120	0.861	1.162	14%	39.800	1.994	2.151	5%	39.800	2.023	2.166	5%
2055	58,065	682.60	1.273	8.120	0.861	1.170	14%	39.800	1.994	2.154	5%	39.800	2.023	2.167	5%
2060	63,082	765.00	1.397	8.120	0.861	1.179	15%	39.800	1.994	2.157	5%	39.800	2.023	2.168	5%
2065	68,099	852.20	1.524	8.120	0.861	1.187	15%	39.800	1.994	2.160	5%	39.800	2.023	2.169	5%
2070	73,116	945.70	1.655	8.120	0.861	1.196	15%	39.800	1.994	2.164	5%	39.800	2.023	2.170	5%
2075	81,283	1,044.90	1.836	8.120	0.861	1.208	15%	39.800	1.994	2.169	5%	39.800	2.023	2.172	5%

APPENDIX C

NEST TRUNK ASSESSMENT FROM 1997 COCHRANE REPORT

TABLE 4 - CONSTRUCTION TIMING

1 EXISTING - 4100 m3, 65 L/s (from 2225m3, 50 L/s), CITY PAY FOR S6,S7, S1 (BASE CASE)

RESET OUTLET CAPACITIES

SINGLE CST/NEST: YES

			CASTLE DOWNS				LAKE DISTRICT				CST - PILOT SOUND SUB TRUNK			NEST	S. DIV	CST TRUNK	CST/NEST TRUNK(S)			
			EXIST	C1	C2	C3	L1	L2	L3	N1	P1	P2	P3	N2	SD	S6	S7/N3	S3/4/N4	S2/N5	S1/N6
1	EXISTING PIPE										1050	1200	750			900	900	1050	2X750	750/500
2	EXISTING PIPE LENGTH	M									880	980	90			800	810	3010	300	820
3	EXISTING OUTLET CAPACITY	L/S	65	88	17	10	65	45	22	0	950	1070	649	0		650	650	819	1909	1909
4	EXIST OR INTERIM OUTLET			113A ST	98 ST	T5	T4	T3	T2	CST SUB	CST EX	CST EX	CST EX	CST EX			CST EX	CST EX	CST EX	CRSTP
	CST																			
5	PROPOSED PIPE										1200	1200	1200			1500	1500	1500	750	750
6	PROP PIPE CAPACITY												1070			2000	2000	2000	1500	1500
	NEST																			
7	PROPOSED PIPE	MM		2340	2340	2340	2825	2340	2340	1500				1350			1350	1350	900	900
8	LENGTH	M		1700	1650	1000	1050	750	1350	1700				2250						
	STORAGE CAPACITY	M3		1519	2438	1478	1915	1368	2463	3101										
9	{(COMPUTED)} STORAGE	M3	3827	7311	7096	4301	6581	3225	5806	3004				3221						
	UNITS SERVED @	1.60 M3/UNIT	2392	4569	4435	2688	4113	2016	3629											
	POP SERVED @	3.5 PPU	8372	15993	15522	9407	14397	7056	12700											
10	LOCAL STORAGE CAPACITY EXCEEDED		2002	2018	2032	2039	2016	2026	2042	2042				2042						
11	LOCAL OUTLET CAPACITY EXCEEDED		2003	2017	2020	2021	2008	2019	2024	2024				2024						
12	COMBINED STORAGE CAPACITY EXCEEDED						2031	2034	2040	2040				2040						
13	COMBINED OUTLET CAPACITY EXCEEDED						2016	2020	2022	2022				2022			**2022**	**2022**	**2022**	**2022**
14	NEST STORAGE CAPACITY REQUIRED			**2002**	2018	2032	**1994**	2016	2026	2040				2040			2060	2060	2060	2060
15	NEST OUTLET CAPACITY REQUIRED			2003	**2017**	**2020**	1994	**2008**	**2019**	**2022**				**2022**			2060	2060	2060	2060
16	CST CAPACITY UPGRADE REQUIRED										2060	2060	2060		**1999**	2052	2052	2060	2060	1995
17	TWINNED CAPACITY REQUIRED																2060	2060	2054	2054

ORIGINAL OUTLET CAPACITIES

EXIST	C1	C2	C3	L1	L2	L3	N1	P1	P2	P3	N2	SD	S6	S7	S3/4	S2	S1
50	88	17	10	65	45	22	0	950	1070	649	0		405	405	819	1909	556

NOTE. The model updates construction costs if the pipe size changes (in the Cntrol Panel), but not pipe capacity. The user must calculate and input pipe capacities directly

CONTROL PANEL

SCENARIO NAME: 1998 run to determine segment timing.

Constants	
Threshold Population	600000
Threshold Year	1993
Devel starts all areas	1994
Note changing constants may cause formulae ERRORS	

Input Variables - Population Growth	
Base Year	1994
Lots/Net Ha	15.2
Net Area/Gross Are	0.80
Projected Pop/lot	3.5
City wide pop. growth rate	1.0%
COE pop growth to new develop	90.0%
Pop available to NEST & CST	25.0%

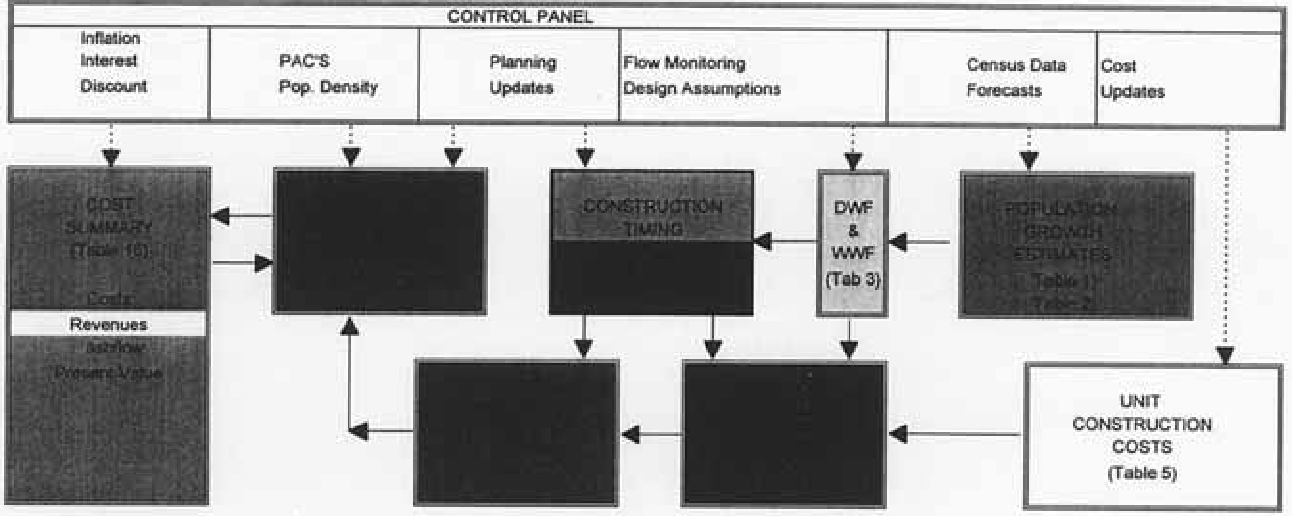
Sewage flows		
DWF/Cap/Day	LPCPD	300
Peak Factor	Min	1.5
WW Storage	m3/Lot	1.6
L/s/Cap	DWF	WWF
Pilot Sound	0.0035	0.006
North Clareview	0.0035	0.006
South Clareview	0	0.006

Financial		
[redacted]		
Interest rate (I)	%	6
Interest rate (R)	%	0
[redacted]		

UPDATE

	NEST												CLAREVIEW				
	C1	C2	C3	L1	L2	L3	N1	N2	N3	N4	N5	N6	S7	S6	S3/4	S2	S1
Diam.	[redacted]																
Qout	176	34	20	130	90	44	0	0									
Qinput	88	17	10	65	45	22	0	0									

NEST/CST IMPLEMENTATION MODEL SCHEMATIC



Notes: Pipe sizes for NEST - 1050, 1200, 1350, 1500, 2340

RESET INPUT VALUES

ORIGINAL INPUT VALUES

Constants		
Threshold Population		600000
Threshold Year		1993
Devel starts all areas		1994
Note changing constants may cause formulae ERRORS		
Input Variables - Population Growth		
Base Year		1994
Lots/Net Ha		15.2
Net Area/Gross Are		0.80
Projected Pop/lot		3.5
City wide pop. growth rate		1.5%
COE pop growth to new development		90.0%
Pop available to NEST & CST		25.0%
Sewage flows		
DWF/Cap/Day	LPCPD	300
Peak Factor (Harmon)	Min	1.5
WW Storage	m3/Lot	1.6
L/s/Cap	DWF	WWF
Pilot Sound	0.0035	0.006
North Clareview	0.004	0.018
South Clareview	0.004	0.018
Financial		
Initial PAC rate	$1000/HA	18
Inflation/yr	%	2
Interest rate (I)	%	6
Interest rate (R)	%	0
Clareview PAC rate	$1000/HA	11

		Diam.	Qout
NEST	C1	1050	88
	C2	1350	17
	C3	1350	10
	L1	2340	65
	L2	1500	45
	L3	1500	22
	N1	1500	0
	N2	1350	0
	N3	1350	
	N4	1350	
	N5	900	
	N6	900	
CST	S7	1500	
	S6	1500	
	S3/4	1500	
	S2	750	
	S1	750	

TABLE 4 - CONSTRUCTION TIMING 1998 run to determine segment timing.

RESET OUTLET CAPACITIES

SINGLE CST/NEST: YES

#	Item	Unit	EXIST	C1	C2	C3	L1	L2	L3	N1	P1	P2	P3	N2	SD	S6	S7/N3	S3/4/N4	S2/N5	S1/N6
				CASTLE DOWNS			LAKE DISTRICT				CST - PILOT SOUND SUB TRUNK			NEST	S DIV	CST TRUNK	CST/NEST TRUNK(S)			
1	EXISTING PIPE										1050	1200	750			900	900	1050	2X750	750/500
2	EXISTING PIPE LENGTH	M									880	980	90			800	810	3010	300	820
3	EXISTING OUTLET CAPACITY	L/S	100	176	34	20	130	90	44	0	950	1070	649	0		650	650	819	1909	1909
4	EXIST OR INTERIM OUTLET CST			113A ST	98 ST	T5	T4	T3	T2	CST SUB	CST EX	CST EX	CST EX	CST EX			CST EX	CST EX	CST EX	CRSTP
5	PROPOSED PIPE										1200	1200	1200			1500	1500	1500	750	750
6	PROP PIPE CAPACITY												1070			2000	2000	2000	1500	1500
	NEST																			
7	PROPOSED PIPE	MM		2340	2340	2340	2825	2340	2340	1500				1350			1350	1350	900	900
8	LENGTH	M		1700	1650	1000	1050	750	1350	1700				2250						
	STORAGE CAPACITY	M3		1519	2438	1478	1915	1368	2463	3101										
9	((COMPUTED)) STORAGE	M3	3827	7311	7096	4301	6581	3225	5806	3004				3221						
	UNITS SERVED @ 1.60 M3/UNIT		2392	4569	4435	2688	4113	2016	3629											
	POP SERVED @ 3.5 PPU		8372	15993	15522	9407	14397	7056	12700											
10	LOCAL STORAGE CAPACITY EXCEEDED		2002	2018	2032	2039	2016	2026	2042	2042				2042						
11	LOCAL OUTLET CAPACITY EXCEEDED		2009	2035	2040	2043	2024	2043	2060	2060				2060						
12	COMBINED STORAGE CAPACITY EXCEEDED						2031	2034	2040	2040				2040						
13	COMBINED OUTLET CAPACITY EXCEEDED						2035	2043	2046	2046				2046			**2046**	**2046**	**2046**	**2046**
14	NEST STORAGE CAPACITY REQUIRED			**2002**	**2018**	**2032**	**1994**	**2016**	**2026**	**2040**				**2040**			2060	2060	2060	2060
15	NEST OUTLET CAPACITY REQUIRED			2009	2035	2040	1994	2024	2043	2046				2046			2060	2060	2060	2060
16	CST CAPACITY UPGRADE REQUIRED										2060	2060	2060		**1999**	2052	2052	2060	2060	1995
17	TWINNED CAPACITY REQUIRED																2060	2060	2054	2054

ORIGINAL OUTLET CAPACITIES

EXIST	C1	C2	C3	L1	L2	L3	N1	P1	P2	P3	N2	SD	S6	S7	S3/4	S2	S1
50	88	17	10	65	45	22	0	950	1070	649	0		405	405	819	1909	556

NOTE: The model updates construction costs if the pipe size changes (in the Cntrol Panel), but not pipe capacity. The user must calculate and input pipe capacities directly

CONTROL PANEL

SCENARIO NAME: 1998 run to determine segment timing

Constants	
Threshold Population	600000
Threshold Year	1993
Devel starts all areas	1994
Note changing constants may cause formulae ERRORS	

Input Variables - Population Growth
[redacted]

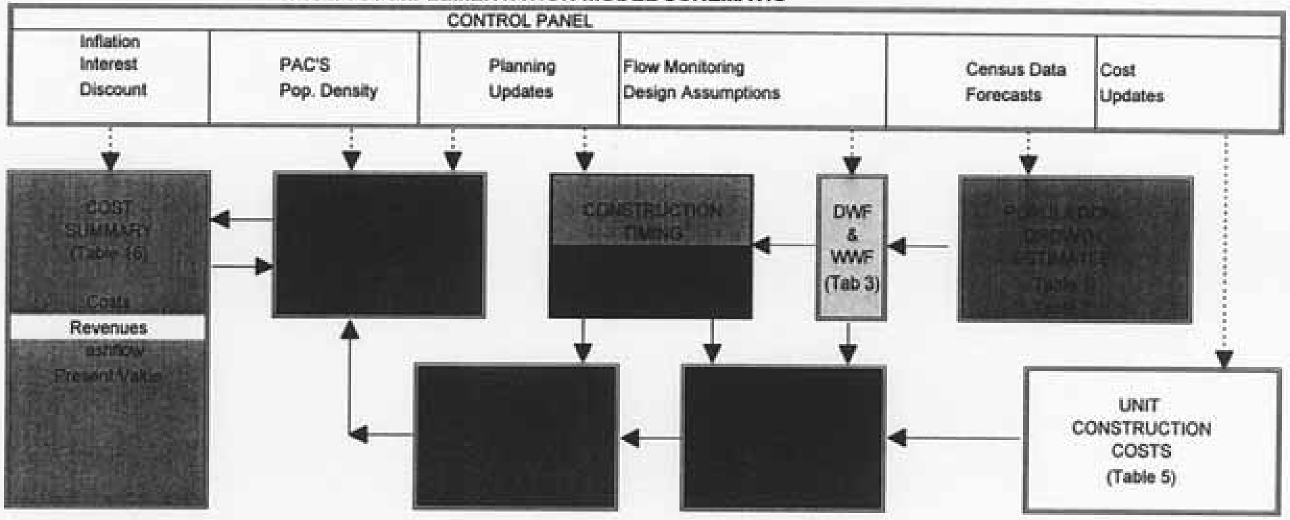
Sewage flows		
DWF/Cap/Day	LPCPD	300
Peak Factor	Min	1.5
WW Storage	m3/Lot	1.6
L/s/Cap	DWF	WWF
Pilot Sound	0.0035	0.006
North Clareview	0.0035	0.006
South Clareview	0	0.006

Financial		
[redacted]		
Interest rate (I)	%	6
Interest rate (R)	%	0
[redacted]		

UPDATE

	NEST												CLAREVIEW				
	C1	C2	C3	L1	L2	L3	N1	N2	N3	N4	N5	N6	S7	S6	S3/4	S2	S1
Diam.	[redacted]																
Qout	[redacted]																
Qinput	[redacted]																

NEST/CST IMPLEMENTATION MODEL SCHEMATIC



Notes: Pipe sizes for NEST - 1050, 1200, 1350, 1500, 2340

RESET INPUT VALUES

ORIGINAL INPUT VALUES

Constants	
Threshold Population	600000
Threshold Year	1993
Devel starts all areas	1994
Note changing constants may cause formulae ERRORS	

Input Variables - Population Growth	
Base Year	1994
Lots/Net Ha	15.2
Net Area/Gross Are	0.80
Projected Pop/lot	3.5
City wide pop. growth rate	1.5%
COE pop growth to new development	90.0%
Pop available to NEST & CST	25.0%

Sewage flows		
DWF/Cap/Day	LPCPD	300
Peak Factor (Harmon)	Min	1.5
WW Storage	m3/Lot	1.6
L/s/Cap	DWF	WWF
Pilot Sound	0.0035	0.006
North Clareview	0.004	0.018
South Clareview	0.004	0.018

Financial		
Initial PAC rate	$1000/HA	18
Inflation/yr	%	2
Interest rate (I)	%	6
Interest rate (R)	%	0
Clareview PAC rate	$1000/HA	11

		Diam.	Qout
NEST	C1	1050	88
	C2	1350	17
	C3	1350	10
	L1	2340	65
	L2	1500	45
	L3	1500	22
	N1	1500	0
	N2	1350	0
	N3	1350	
	N4	1350	
	N5	900	
	N6	900	
CST	S7	1500	
	S6	1500	
	S3/4	1500	
	S2	750	
	S1	750	

AREA MASTER PLAN - CASTLEDOWNS NORTH, THE PALISADES, AND RAMPART INDUSTRIAL

Storage Associated with Development

Existing Storage

Facility	Storage (m^3)	Area (ha)
127th St. Trunk (1200 mm dia.)	2225.00	
Storage Required By Existing Development [1]	255.36	15.96
Available Storage:	1969.64	
Lots Developable:	**1231**	

Assumed: 1. **10 lots/ha x area (ha) x 1.6 m3/lot**

Potential Storage and Construction Cost

Facility	Storage (m3)	Lots Based on Storage	Construction Cost
C1 Launch Pit [1,3]	640.00	400	$750,000 [4]
153rd Ave. Trunk (900 mm dia.) [2,3]	540.60	338	$685,000 [4]
Available Storage	1180.60		
Lots Developable		**738**	

Assumed: 1. **approximately 15 m deep, including undercut, 20 m of tunnel, and 20 m of "tail tunnel"**
Assumed: 2. **153 Ave. trunk is 850 m long at 5 - 6 m deep**
Assumed: 3. **m^3 storage/1.6 m^3/lot**
Assumed: 4. **construction costs include an additional 50% to to cover contingency and overheads**

Prepared by: Carl Sorensen/February 7, 1997

NEST LAUNCH PIT, NEST L1 TRUNK AND BELLE RIVE SANITARY TRUNK
(Assumed Surcharge Elevation of 675.5 m)

Available storage: *(from Belle Rive Sanitary Trunk Preliminary Design Report (Final); I. D. Group Inc., February 2, 1995 and as-built drawings)*

NEST L1 (launch pit)	**465 m^3** (includes transition chamber, stilling chamber, working shaft, 1 access manhole, and lift station)
NEST L1 Trunk	**2795 m^3** [1]
Belle Rive Sanitary Trunk (BRT)	
Trunk	**1675 m^3**
Manholes	**141 m^3**
Lindo Storage Tank	**1600 m^3** [2]
Total Volume	**5076 m^3** (doesn't include Lago Lindo)

Impact of Storage on Basements

- There shouldn't be any impact on basements adjacent to the Belle Rive Sanitary Trunk.
- Lowest basement openings are between 675.5 m and 676.0 m.
- A surcharge elevation of 675.5 m was assumed.

Notes:

1. The storage in NEST L1 (exclusive of the launch pit) is 4395 m^3 based on a pipe diameter of 2340 mm, and a length of 1.022 km; 1600 m^3 of this storage is allocated to existing Belle Rive Stage 1
2. Lago Lindo storage volume reserved for Belle Rive Stage 1 swapped with equal volume in L1 section of NEST; this storage volume is to be used for new developments in the vicinity of the storage tank

NEST LAUNCH PIT, NEST L1 TRUNK AND BELLE RIVE SANITARY TRUNK
(Assumed Surcharge Elevation of 673.33 m)

Available storage: *(from Belle Rive Sanitary Trunk Preliminary Design Report (Final); I. D. Group Inc., February 2, 1995 and as-built drawings)*

NEST L1 (launch pit)	**440 m^3** (includes transition chamber, stilling chamber, working shaft, 1 access manhole, and lift station)
NEST L1 Trunk	**2795 m^3** [1]
Belle Rive Sanitary Trunk (BRT)	
Trunk	**1675 m^3**
Manholes	**69 m^3**
Lago Lindo Storage Tank	**1600 m^3** [2]
Total Volume	**4979 m^3** (doesn't include Lago Lindo)

Impact of Storage on Basements

- There shouldn't be any impact on basements adjacent to the Belle Rive Sanitary Trunk.
- Lowest basement openings are between 675.5 m and 676.0 m.
- A surcharge elevation of 673.33 m (obvert of u/s end of BRT) was assumed.

Notes:
1. the storage in NEST L1 (exclusive of the launch pit) is 4395 m^3 based on a pipe diameter of 2340 mm and a length of 1.022 km; 1600 m^3 of this storage is allocated to existing Belle Rive Stage 1
2. Lago Lindo storage volume reserved for Belle Rive Stage 1 swapped with equal volume in L1 section of NEST; this storage volume is to be used for new developments in the vicinity of the storage tank

APPENDIX D

SANITARY FLOW SUMMARY BASED ON POPULATION PROJECTIONS TO 2075 AND GBWWTP AND CRSTP - FLOW ASSESSMENT

SUMMARY OF TOTAL POPULATION TO THE YEAR 2075

AREA	1994	1995	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2075
CST	22,576	23,487	32,598	37,153	41,709	46,264	47,461	48,659	49,856	51,053	52,250	53,448	59,434
Ave. DSF (ML/day)	**7**	**7**	**10**	**11**	**13**	**14**	**14**	**15**	**15**	**15**	**16**	**16**	**18**
Peak DWF (L/sec.)	***149.23***	***154.64***	***207.71***	***233.66***	***259.29***	***284.64***	***291.26***	***297.87***	***304.46***	***311.03***	***317.59***	***324.13***	***356.63***
Peaking Factor	***1.90***	***1.90***	***1.84***	***1.81***	***1.79***	***1.77***	***1.77***	***1.76***	***1.76***	***1.75***	***1.75***	***1.75***	***1.73***
NEST	33,354	35,537	57,368	68,283	79,199	90,114	92,355	94,595	96,836	99,077	101,317	103,558	114,761
Ave. DSF (ML/day)	**10**	**11**	**17**	**20**	**24**	**27**	**28**	**28**	**29**	**30**	**30**	**31**	**34**
Peak DWF (L/sec.)	***212.04***	***224.49***	***345.45***	***404.08***	***461.77***	***518.67***	***530.27***	***541.83***	***553.37***	***564.88***	***576.36***	***587.82***	***644.76***
Peaking Factor	***1.83***	***1.82***	***1.73***	***1.70***	***1.68***	***1.66***	***1.65***	***1.65***	***1.65***	***1.64***	***1.64***	***1.63***	***1.62***
SESS	86,050	88,056	108,117	118,148	128,178	138,209	167,152	196,096	225,039	253,982	282,925	311,869	456,585
Ave. DSF (ML/day)	**26**	**26**	**32**	**35**	**38**	**41**	**50**	**59**	**68**	**76**	**85**	**94**	**137**
Peak DWF (L/sec.)	***497.57***	***508.00***	***611.06***	***661.86***	***712.22***	***762.19***	***904.44***	***1044.25***	***1181.99***	***1322.82***	***1473.57***	***1624.32***	***2378.05***
Peaking Factor	***1.67***	***1.66***	***1.63***	***1.61***	***1.60***	***1.59***	***1.56***	***1.53***	***1.51***	***1.50***	***1.50***	***1.50***	***1.50***
WESS	7,084	8,305	20,520	26,627	32,734	38,841	44,894	50,947	57,001	63,054	69,107	75,160	105,426
Ave. DSF (ML/day)	**2**	**2**	**6**	**8**	**10**	**12**	**13**	**15**	**17**	**19**	**21**	**23**	**32**
Peak DWF (L/sec.)	***52.58***	***60.67***	***136.94***	***173.13***	***208.49***	***243.19***	***277.05***	***310.45***	***343.46***	***376.11***	***408.46***	***440.52***	***597.36***
Peaking Factor	***2.14***	***2.10***	***1.92***	***1.87***	***1.83***	***1.80***	***1.78***	***1.75***	***1.74***	***1.72***	***1.70***	***1.69***	***1.63***
Terwillegar-Riverbend	18,800	20,108	33,193	39,735	46,278	52,820	53,199	53,577	53,956	54,335	54,713	55,092	56,985
Ave. DSF (ML/day)	**6**	**6**	**10**	**12**	**14**	**16**	**16**	**16**	**16**	**16**	**16**	**17**	**17**
Peak DWF (L/sec.)	***126.57***	***134.47***	***211.12***	***248.22***	***284.72***	***320.70***	***322.77***	***324.84***	***326.90***	***328.96***	***331.03***	***333.09***	***343.37***
Peaking Factor	***1.94***	***1.93***	***1.83***	***1.80***	***1.77***	***1.75***	***1.75***	***1.75***	***1.74***	***1.74***	***1.74***	***1.74***	***1.74***
NE Rural	80	80	80	80	80	80	10,459	20,838	31,217	41,596	51,975	62,355	114250
Ave. DSF (ML/day)	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**6**	**9**	**12**	**16**	**19**	**34**
Peak DWF (L/sec.)	***0.93***	***0.93***	***0.93***	***0.93***	***0.93***	***0.93***	***74.67***	***138.85***	***199.77***	***258.66***	***316.08***	***372.36***	***642.17***
Peaking Factor	***3.35***	***3.35***	***3.35***	***3.35***	***3.35***	***3.35***	***2.06***	***1.92***	***1.84***	***1.79***	***1.75***	***1.72***	***1.62***

Inner City	464,791	466,095	479,135	485,655	492,175	498,695	502,300	505,904	509,509	513,114	516,719	520,323	538,347
Ave. DSF (ML/day)	**139**	**140**	**144**	**146**	**148**	**150**	**151**	**152**	**153**	**154**	**155**	**156**	**162**
Peak DWF (L/sec.)	***2420.79***	***2427.58***	***2495.49***	***2529.45***	***2563.41***	***2597.37***	***2616.14***	***2634.92***	***2653.69***	***2672.47***	***2691.24***	***2710.02***	***2803.89***
Peaking Factor	***1.50***	***1.50***	***1.50***	***1.50***	***1.50***	***1.50***	***1.50***	***1.50***	***1.50***	***1.50***	***1.50***	***1.50***	***1.50***
TOTAL Population	632,735	641,669	731,011	775,682	820,352	865,023	917,820	970,617	1,023,414	1,076,210	1,129,007	1,181,804	1,445,788
Ave. DSF (ML/day)	**190**	**193**	**219**	**233**	**246**	**260**	**275**	**291**	**307**	**323**	**339**	**355**	**434**
Peak DWF (L/sec.)	***3295.49***	***3342.03***	***3807.35***	***4040.01***	***4272.67***	***4505.33***	***4780.31***	***5055.30***	***5330.28***	***5605.26***	***5880.24***	***6155.23***	***7530.15***
Peaking Factor	***1.50***	***1.50***	***1.50***	***1.50***	***1.50***	***1.50***	***1.50***	***1.50***	***1.50***	***1.50***	***1.50***	***1.50***	***1.50***

GBWWTP and CRSTP - Flow Assessment

Total City

Year	1994	1995	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2075
Population Increase	0	8,934	98,276	142,947	187,617	232,288	285,085	337,882	390,679	443,475	496,272	549,069	813,053
ADWF increase (ML/D)	**0**	**3**	**29**	**43**	**56**	**70**	**86**	**101**	**117**	**133**	**149**	**165**	**244**
I/I increase (ML/D)	**0**	**1**	**7**	**10**	**13**	**16**	**19**	**23**	**27**	**30**	**34**	**37**	**55**
Leduc/Beaumont ADWF Increase	0.0	0.0	1.4	2.2	3.0	3.9	4.8	5.9	7.0	8.2	9.6	11.0	17.9

GBWWTP Basin (no CST, Rural NE)

Year	1994	1995	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2075
Population with NEST	610,079	618,102	698,333	738,448	778,563	818,679	859,899	901,120	942,341	983,561	1,024,781	1,066,002	1,272,104
Population Increase	0	8,023	88,254	128,369	168,484	208,600	249,820	291,041	332,262	373,482	414,702	455,923	662,025
ADWF+I/I increase (ML/D)	**0**	**3**	**34**	**49**	**65**	**81**	**97**	**113**	**129**	**146**	**162**	**179**	**261**
Population w/o NEST	576,725	582,565	640,965	670,165	699,365	728,565	767,545	806,525	845,505	884,484	923,464	962,444	1,157,343
Population Increase	0	5,840	64,240	93,440	122,640	151,840	190,820	229,800	268,780	307,759	346,739	385,719	580,618
ADWF increase (ML/D)	**0**	**2**	**25**	**37**	**48**	**60**	**75**	**90**	**106**	**121**	**137**	**153**	**231**
FLOWS in ML/D													
Mean TDDF	221												
WWF allowance	50	0.226	I/I Ratio										
South CST Diversion	3.7	43 l/s now, rising to 63 l/s on ultimate development.											
Total with NEST (ML/D)	271	274	305	320	336	352	368	384	400	417	433	450	532
Add South CST diversion - 2000	275	278	309	324	340	355	371	388	404	420	437	453	536
Remove NEST area - 2021	275	277	300	311	323	334	350	365	381	396	412	428	506
Remove CST diversion - 2035	271	273	296	308	319	331	346	361	377	392	408	424	502
SESS completion & diversion	266	268	291	303	314	326	341	356	372	374	377	380	392
Total GBWWTP Flows (ML/D)	**271**	**273**	**309**	**308**	**319**	**331**	**346**	**361**	**372**	**374**	**377**	**380**	**392**

CRSTP Basin within the City (CST, Rural NE growth)

Year	1994	1995	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2075
Population with NEST	56,010	59,104	90,046	105,516	120,987	136,458	150,275	164,092	177,909	191,726	205,543	219,360	288,445
Population Increase	0	3,094	34,036	49,506	64,977	80,448	94,265	108,082	121,899	135,716	149,533	163,350	232,435
Population w/o NEST	22,656	23,567	32,678	37,233	41,789	46,344	57,920	69,497	81,073	92,649	104,226	115,802	173,684
Population Increase	0	911	10,022	14,577	19,133	23,688	35,264	46,841	58,417	69,993	81,570	93,146	151,028
ADWF increase (ML/D)													
Without NEST	0.0	0.3	3.0	4.4	5.7	7.1	10.6	14.1	17.5	21.0	24.5	27.9	45.3
With S. Clareview Removed -2000			-0.7	0.7	2.0	3.4	6.9	10.3	13.8	17.3	20.8	24.2	41.6
With NEST - 2021						20.4	24.6	28.7	32.9	37.0	41.1	45.3	66.0
With S. Clareview - 2035									36.6	40.7	44.9	49.0	69.7
Increase	0.0	0.3	-0.7	0.7	2.0	20.4	24.6	28.7	36.6	40.7	44.9	49.0	69.7
SESS Diversion (2035)									5	18	31	44	110
Total City flow to CRSTP(ML/D)	**8**	**8**	**7**	**8**	**10**	**28**	**32**	**36**	**44**	**66**	**84**	**101**	**188**
Current Flow rate	7.776												

CRSTP Expansions (45 ML/D)

2020 Diversion of NEST brings new flows to Plant.
2036 Growth in City flow exceeds 1 unit's capacity (45 ML/d).
2047 Growth in City flow exceeds capacity of 2 units (90ML/d).
2060 Growth in City flow exceeds capacity of 3 units (135 ML/d).

APPENDIX E

CITY OF EDMONTON EXISTING AND PROPOSED SANITARY TRUNKS

CITY OF EDMONTON EXISTING AND PROPOSED SANITARY TRUNKS

25% Contingency

	Stage	Length (m)	Depth (m)	Proposed Diameter (mm)	Slope (%)	Construction Method	Segment Cost	Total Cost ('98$)[1]	Year of Construction	Reference
CST	C8						***94$***		2000	CST/NEST Conceptual Design(Cochrane)/Table 4.3, p. 34
	south Clareview diversion structure						60,000	109,815		
	recommission abandoned trunk	400		900	0.10		20,000	36,605		
	siphon through Kennedale to supernatant/Celanese pipelines	145		300		trenched	49,000	89,682		
	siphon // supernatant/Celanese pipelines	190		300		trenched	63,000	115,305		
	Subtotal	***735***					192,000 ***Subtotal***	***351,407***		
	C7	1875	11	900	0.10	reline	2,109,375	3,860,671		CST/NEST Conceptual Design(Cochrane)/Table 4.4, p. 35
	CP3	90		1200	0.10		675,000	1,235,415		CST/NEST Conceptual Design(Cochrane)/App. F—Table 6 & 7
	C6A	1200		1500	0.10	trenched	1,293,600	2,367,604	2029	CST/NEST Conceptual Design(Cochrane)/App. B—Table B-9/B-10/B-11
	Total	***3900***					***Total***	***7,815,096***		
							94$			
NEST	NC1	1700	14	1050	0.18	tunneling	4,770,000	8,730,264	2002	CST/NEST Conceptual Design(Cochrane)/App. B—Table B-4/B-5
	NC2	1650	15	1350	0.15	tunneling	4,810,000	8,803,473	2009	CST/NEST Conceptual Design(Cochrane)/App. B—Table B-4/B-5
	NC3	1000	19	1350	0.13	tunneling	3,000,000	5,490,732	2019	CST/NEST Conceptual Design(Cochrane)/App. B—Table B-4/B-5
	NL1	1050		2340	0.13				1994	CST/NEST Conceptual Design(Cochrane)/App. B—Table B-4/B-5
	NL2	750	30	1500	0.18	tunneling	2,632,500	4,818,117	2010	CST/NEST Conceptual Design(Cochrane)/App. B—Table B-4/B-5
	NL3	1350	30	1500	0.18	tunneling	4,282,500	7,838,020	2015	CST/NEST Conceptual Design(Cochrane)/App. B—Table B-4/B-5
	N1(C4)	1700	30	1500	0.14	tunneling	4,875,000	8,922,439	2025	CST/NEST Conceptual Design(Cochrane)/App. B—Table B-4/B-5
	N2	2250	9	1350	0.27	open cut	1,615,500	2,956,759	2021	CST/NEST Conceptual Design(Cochrane)/App. B—Table B-7/B-8

	Stage	Length (m)	Depth (m)	Proposed Diameter (mm)	Slope (%)	Construction Method	Segment Cost	Total Cost ('98$)[1]	Year of Construction	Reference
	N3	950	9	1350	0.27	open cut	682,100	1,248,409	2029	CST/NEST Conceptual Design(Cochrane)/App. B—Table B-7/B-8
	N4	3002	9	1350	0.15	open cut	2,155,436	3,944,974	2029	CST/NEST Conceptual Design(Cochrane)/App. B—Table B-7/B-8
	N5	350		1-750 FM & 1-900 FM		river crossing	1,940,000	3,550,673	2029	CST/NEST Conceptual Design(Cochrane)/App. B—Table B-7/B-8
	N6	1400		1-750 FM		after crossing to CRSTP	903,700	1,653,991	1995	CST/NEST Conceptual Design(Cochrane)/App. B—Table B-7/B-8
	Total	***25,687***					***Total***	***56,303,860***		
	Total of CST & NEST	***29,587***				***Total of CST & NEST***		***64,118,956***		
							97$			
SESS (97$)	**SW7**	1300	16	1050	0.20	tunneling	2,900,000	5,307,707	2025	South Edmonton Sanitary Sewerage Servicing Study—Final Report/Volume 2; Reid Crowther and Partners Ltd.; March 1996 (Plan "A"); Cost Estimates—UMA submission of May 6 '98 to Sid Lodewyk from Faruk Kharadi—revisions!
	SW6	1500		1050	0.20	river crossing	10,000,000	18,302,439	2044	
	SW5	2100	32	2340	0.40	tunneling	5,700,000	10,432,391	2040	
	SW4	1500	34	2340	0.27	tunneling	4,400,000	8,053,073	2040	
	SW3	2000	34	2340	0.17	tunneling	5,600,000	10,249,366	2035	
	SW2	2000	44	2340	0.17	tunneling	5,700,000	10,432,391	2030	
	SW1	1000	48	2340	0.17	tunneling	3,400,000	6,222,829	1999	
	SWP1						1,500,000	2,745,366	1999	
	SWPFM	1000		250			400,000	732,098	1999	
	SWP2						1,000,000	1,830,244	2030	
	SWP3						10,000,000	18,302,439	2031/32	
								0		
	SE3	3000	10	1050	0.30	open cut	3,300,000	6,039,805	2040	
	SE2	2700	8	1050	0.30	open cut	2,300,000	4,209,561	2015	
	SE1	800	5	1350	0.20	open cut	600,000	1,098,146	2000	
								0		
	SA1	2800	5	2340	0.11	tunneling	6,900,000	12,628,683	2017	
	SAP1						1,000,000	1,830,244	2055	
	SA2	2700	10	2340	0.11		6,600,000	12,079,610	2017	
	SA3/4 (MW tunnel)									
	SA5	1500	26	2340	0.08	tunneling	4,200,000	7,687,025	2025	
	SA6	1500	26	2340	0.08	tunneling	4,200,000	7,687,025	2020	
	SA6A			(RTC/Burnewood Tunnel)			500,000	915,122	2001	
	SAP2						500,000	915,122	2020	
	SA7	1000	21	2920	0.08	tunneling	3,200,000	5,856,781	2045	

	Stage	Length (m)	Depth (m)	Proposed Diameter (mm)	Slope (%)	Construction Method	Segment Cost	Total Cost ('98$)[1]	Year of Construction	Reference
	SA8	1000	19	2920	0.08	tunneling	3,200,000	5,856,781	2050	
	SA9	1000	19	2920	0.08	tunneling	3,200,000	5,856,781	2008	
	SAT1						500,000	915,122	2008	
	SAT1FM	700		700			600,000	1,098,146	2008	
	SA10	1200	19	2920	0.08	tunneling	3,800,000	6,954,927	2053	
	SA11	1600	17	2920	0.08	tunneling	4,700,000	8,602,147	2053	
	SA12	3600	21	2920	0.08	tunneling	9,900,000	18,119,415	2053	
								0		
	SA13	3700	19	2920	0.08	tunneling	10,100,000	18,485,464	2053	
	SA14	6400	10	2340	varies	tunneling	20,500,000	37,520,001	2053	
	SA15	1800	6	1800	varies	open cut	2,300,000	4,209,561	2053	
	Total	***49,400***					***Total***	***261,175,811***		
							97$			
TUFS	TUF1	725	33	1050	0.17	tunneling	2,149,625	3,934,338	2046	Assessment of the Impacts of Development in Terwillegar, Heritage, and the University Farms on the Existing Sewer Trunk System Serving Southwest Edmonton During Dry Weather; Drainage Strategic Planning; October 1997.
	TUF2	320	34	1200	0.12	tunneling	1,026,560	1,878,855	2047	
	TUF3	635	37	1200	0.12	tunneling	2,117,725	3,875,953	2048	
	TUF4	633	44	1050	0.05	tunneling	2,173,089	3,977,283	2049	
	TUF5	584	40	1050	0.05	tunneling	1,905,592	3,487,698	2050	
	TUF6	1192	35	900	0.05	tunneling	3,397,200	6,217,705	2051	
	Total	***4089***					***Total***	***23,371,833***		
							97$			
WESS (97$)	W1STA;W1FMA	4400		400			4,081,750	7,470,598	2003	West Edmonton Sanitary Servicing Study—Final Report/Option 3, Alternative "1C"; UMA Engineering Ltd.; March 1997; Revisions Oct. 27 '98 by Dave Hostin
	W1STB						637,350	1,166,506	2010	
	W1STC						725,200	1,327,293	2022	
	W1STD						788,550	1,443,239	2030	
	W1STE						862,400	1,578,402	2040	
	W1STF;W1PB;W1FMB	4400		500			3,347,250	6,126,284	2050	
	W1STG;W1PC;W1FMC	4400		600			5,517,950	10,099,195	2060	
	W1STH						992,600	1,816,700	2070	

Stage	Length (m)	Depth (m)	Proposed Diameter (mm)	Slope (%)	Construction Method	Segment Cost	Total Cost ('98$)[1]	Year of Construction	Reference
W2	1099	25	1500	0.14	tunneling	4,415,782	8,081,958	2050	
W3	1322	30	1500	0.14	tunneling	5,311,796	9,721,882	2005	
W4	970	31	1500	0.14	tunneling	3,897,460	7,133,303	2020	
W5	952	32	1500	0.14	tunneling	3,825,136	7,000,932	2015	
W6	1240	34	1500	0.14	tunneling	4,982,320	9,118,861	2006	
W7	869	35	1500	0.14	tunneling	3,491,642	6,390,557	2007	
W8	768	37	1500	0.14	tunneling	3,085,824	5,647,811	2047	
W9	872	35	1500	0.14	tunneling	3,503,696	6,412,618	2045	
W10	920	35	1500	0.14	tunneling	3,696,560	6,765,607	2050	
W11	690	35	1500	0.14	tunneling	2,796,520	5,118,314	2050	
W12	1000		1500		river crossing	5,000,000	9,151,220	2011	
Total	***21,292***					***Total***	***90,536,139***		

NOTES: *1. Total costs in 1998$ include engineering, contingencies (@25%), and overheads. Also, an inflation factor of 2%/yr. was also added to these costs. The inflation factors were taken from Planning and Developments' Monthly Economic Reviews.*