KGS GROUP
CONSULTING ENGINEERS

TOWN OF FORT FRANCES

2018 SCOTT STREET SEWER CAPACITY STUDY

FINAL – REV 0

KGS Group 18-0048-001
October 2018

PREPARED BY:

Riley Fitzsimmons, B.Sc.(EnvE)
Municipal Engineer-in-Training

REVIEWED BY:

Phillip Pawluk, B.Sc.(CE), C.E.T.,
P.Eng., GSC
Municipal Engineer

APPROVED BY:

Roy Houston, B.Sc.(CE) P.Eng.
Manager, Civil / Municipal Services

TABLE OF CONTENTS

1.0 SUMMARY 1

2.0 INTRODUCTION 2
- 2.1 BACKGROUND 2
- 2.2 SCOPE 4

3.0 FIELD PROGRAM 5
- 3.1 MANHOLE INSPECTIONS 5
- 3.2 EAVESTROUGH AND SUMP PUMP DISCHARGE SURVEY 6

4.0 CAPACITY STUDY 8
- 4.1 PEAK WASTEWATER GENERATION 8
- 4.2 HYDRAULIC MODELLING 9

5.0 CONCLUSIONS 10

6.0 RECOMMENDATIONS 12

7.0 OPINION OF PROBABLE COSTS 13

8.0 STATEMENT OF LIMITATIONS 14
- 8.1 CAPITAL COST ESTIMATE STATEMENT OF LIMITATIONS 14

TABLES
FIGURES
APPENDICIES

LIST OF TABLES

7.1 Opinion of Probable Costs

LIST OF FIGURES

2.1 White Pine Catchment Area

4.1 Plot of Modelled Hydraulic Grade Line on Scott Street

LIST OF APPENDICES

A. Manhole Inspection Reports

B. Eavestrough and Sump Pump Discharge Survey Data

C. Sample Calculations

1.0 SUMMARY

Kontzamanis Graumann Smith MacMillan Inc. (KGS Group) was retained by the Town of Fort Frances to undertake a study of the sanitary sewer system in the White Pine Catchment Area (WPCA) to determine if upgrades to the sanitary sewer main along Scott Street between Williams Avenue and Reid Avenue are warranted. Using theoretical calculations and hydraulic modelling, we determined that upgrading the Scott Street sewer main from 300 mm diameter to 375 mm diameter will provide sufficient capacity for the area, including potential future development. In conjunction with this, enhancements to the White Pine Pump Station would improve efficiency, reduce maintenance requirements and allow the station to meet the Ontario Ministry of Environment Guidelines.

2.0 INTRODUCTION

2.1 BACKGROUND

Fort Frances is a town on the Canada-United States border in Northwestern Ontario where Rainy Lake narrows to become the Rainy River. The Town's population, as of the 2016 census, is 7739.

The Town of Fort Frances has identified potential capacity issues with the Scott Street sanitary sewer main, resulting from the potential future development of a 9.2 ha parcel of land in the WPCA. Furthermore, in June 2014, the Town experienced a substantial rainfall event which caused flooding in the Church Street Catchment Area which flows into the WPCA. The Town completed modifications to the sanitary sewer infrastructure in the White Pine and Church Street sewer catchments as a result of this event, however, to prepare for the potential development and to minimize the chance of future flooding, upgrade of the Scott Street sewer is planned in conjunction with pending road renewal works.

The WPCA, shown in Figure 2.1, contains approximately 310 properties. There are some multi-family residential (MFR) and commercial properties, though the majority is single-family residential (SFR). The Church Street and Front Street pump stations also discharge to the WPCA into manholes near the south end of Minnie Avenue.

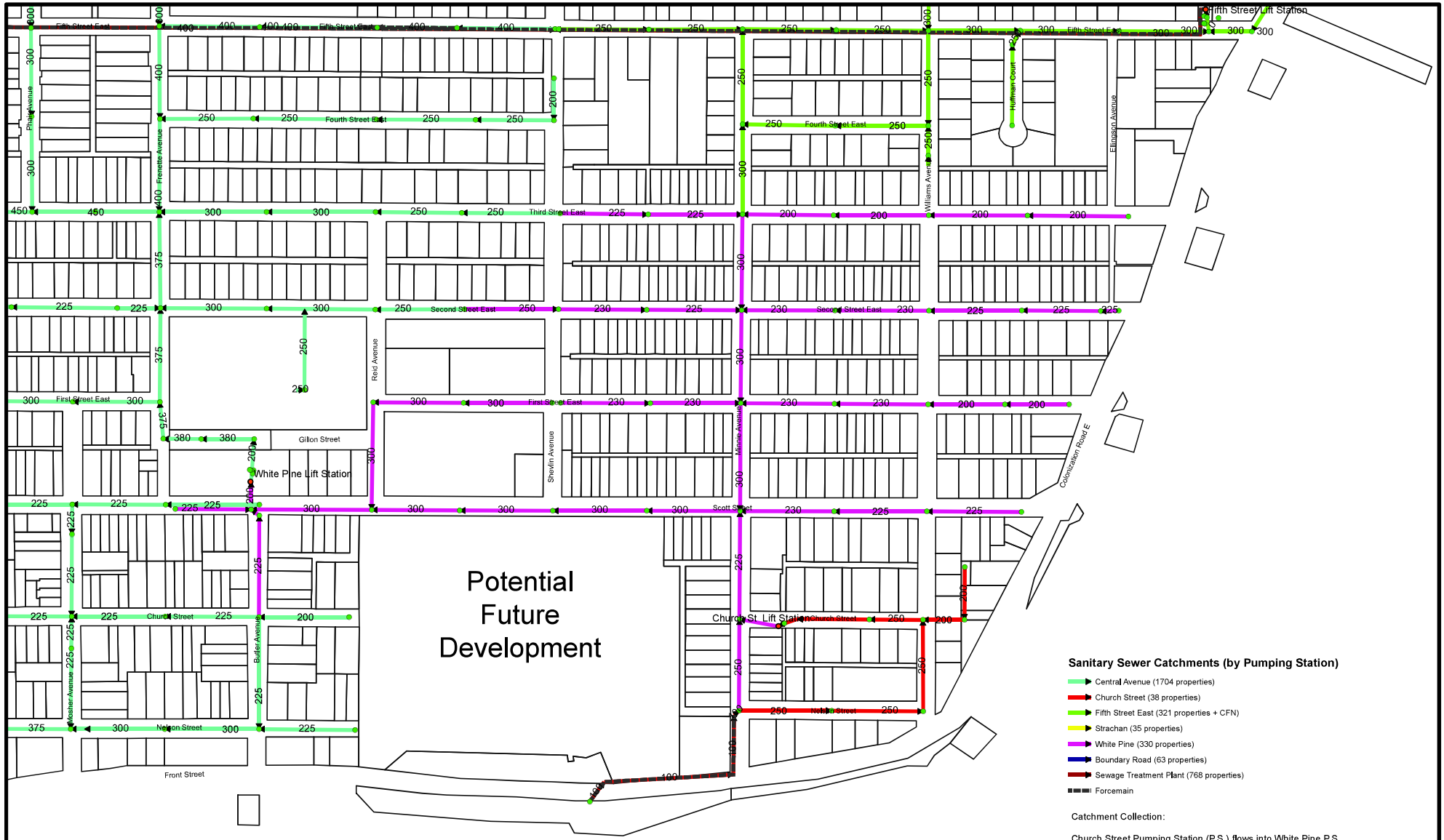


Figure 2.1 - White Pine and Church Street Sanitary Catchment Areas

The Scott Street sewer collects sewage in the WPCA and conveys it to the White Pine Pumping Station (WPPS). The pumping station is outfitted with two Smith and Loveless Model 4B2B centrifugal pumps rated at 47 L/s at 7.8 m total dynamic head (TDH) each equipped with 7.5 hp, 1170 rpm, 600 V, 3-phase motors. Sewage is pumped approximately 40 m to the manhole to the north of the pump station on Gillon Street through a 200 mm diameter PVC force main.

2.2 SCOPE

The scope of work for the Fort Frances Scott Street Sanitary Sewer Capacity Study consists of the following:

- Review the flow and pumping records and reports from the existing pump stations, including the Church Street, White Pine, and Central Avenue stations.
- Review the previous I&I studies and CCTV data to evaluate potential causes of high wet-weather flows.
- Conduct a survey of property owners in the WPCA to determine if properties' eavestrough or sump pump discharge is directed to the sanitary sewer.
- If unable to determine manhole conditions from CCTV videos, perform visual inspections of the manholes in the WPCA.
- Review data obtained during the 2014 flood event including a report authored by Hatch Corporation dated October 2, 2017.
- Conduct flow modelling using the existing sanitary sewer model of the Town of Fort Frances to determine a sufficient size of sewer upgrades on Scott Street and to identify potential impacts on downstream systems.
- Provide recommendations addressing the Scott Street sewer main sizing and potential downstream upgrades.
- Provide a cost estimate for the recommended upgrades.

3.0 FIELD PROGRAM

Historically, the sanitary sewer system in the WPCA has been subject to high inflow[1] and infiltration[2]. To identify and minimize these sources, which reduce the efficiency of treatment and contribute flows which may exceed design capacities, KGS Group conducted an eavestrough and sump pump discharge survey in the WPCA.

During the week ending August 25, 2018, KGS Group field staff completed manhole inspections and an eavestrough and sump pump discharge survey in the WPCA utilizing the Survey123 application for ArcGIS for data collection.

3.1 MANHOLE INSPECTIONS

Manhole inspections were conducted based on the Level 1 inspection as outlined by the National Association of Sewer Service Companies (NASSCO) Manhole Assessment Certification Program® (MACP®) standards. From each inspection, a short report is generated providing a basic summary of the manhole condition. The complete reports can be found in Appendix A – Manhole Inspection Reports.

The inspection identified the manholes listed below exhibiting evidence of infiltration.

- S03002
- S03003
- S03004
- S03012
- S03013
- S03014
- S03021
- S03022
- S03028
- S03034
- S03036

These manholes were taken into account in the hydraulic model as potential sources of higher than normal infiltration.

[1] Non-sewage contributions from sources like eavestroughs, sump pumps and weeping tile.
[2] Seepage of groundwater or runoff into the system via compromised piping or manholes.

3.2 EAVESTROUGH AND SUMP PUMP DISCHARGE SURVEY

Residents in the WPCA were asked two questions to assist in identifying potential sources of inflow to the sanitary sewer:

1. Does the property have a sump pump and if so, does the sump pump discharge to the sanitary sewer?
2. Do the building's eavestroughs discharge to the surface or the sanitary sewer?

KGS Group conducted the study over a three day period, primarily in the evenings, with some properties surveyed during the day if the occupants were home. Occupants were available to answer the sump pump question in 162 of the 308 properties visited; eavestroughs on all properties were visually inspected. Raw survey data is provided in Appendix B – Sump Pump and Eavestrough Survey Data.

The survey identified that the following properties may be contributing to increased flow in the sanitary sewer:

- Properties with eavestroughs to the Sanitary Sewer:
  - 1221 First St. E.
  - 1016 Scott St.
- Properties with eavestroughs entering the ground – discharge unknown and occupant not available:
  - 1202 Second St. E.
  - 930 Second St. E.
  - 1214 Third St. E.
  - 1113 Third St. E.
- Properties with sump pumps discharging to the sanitary sewer:
  - 1201 First St. E.
  - 1222 Second St. E.
  - 1229 Third St. E.
  - 1124 Scott St.

- Properties with sump pumps that discharge to the sanitary sewer in winter, but to the surface in summer with a manual switch or valve:
  - 1132 First St. E.
  - 1217 Second St. E.
  - 1200 Scott St.

While only 13 of the 308 properties visited potentially contribute inflow to the sanitary sewer, these inflows may have a significant impact on pump station flow capacity.

For example, assuming a typical house sump pump discharges at a rate of 1 L/s, the properties with sump pumps discharging to the sanitary sewer in the WPCA may contribute up to 7 L/s during wet weather conditions (typically in the spring). This, combined with discharge from eavestroughs, which, in a 1-in-10 year, 30-minute duration storm may contribute a peak flow of 2.5 L/s for a house with 120 m^2 roof area (similar to 1016 Scott St), totals 22 L/s. Based on the monthly flow records provided by the Town's Public Works Department, a single pump at the White Pine Pump Station pumps at an average of 33.2 L/s.

In wet-weather conditions with both pumps operating, these peak inflows could use up to 33% of the pump station's capacity.

4.0 CAPACITY STUDY

Demand calculations and hydraulic modelling methods were used to determine peak sewer flow to the WPPS. Calculation methods conform to the *Province of Ontario Design Guidelines For Sewage Works*. To account for the future development of the 9.2 ha area south of Scott Street between Minnie Avenue and Reid Avenue (recently acquired by the Town), we made the assumption of one half single-family residences and one half multi-family residences in this area as directed by the Town.

4.1 PEAK WASTEWATER GENERATION

The WPCA has a total area of approximately 47 ha, distributed as follows (including future development):

- 39 ha – Single-family residences.
- 5.0 ha – Multi-family residences.
- 3.0 ha – Commercial.

The City of Winnipeg Wastewater Flow Estimation and Servicing Guidelines provides the following values to estimate the average sewage flow to the WPPS:

- Per capita wastewater generation: 270 L/cap/day.
- Single-family dwellings:
  - 12.29 Dwellings per hectare (Town of Fort Frances average is approximately 11.2).
  - 3.05 people per dwelling.
- Multi-family dwellings:
  - 74.13 Dwellings per hectare.
  - 2.3 people per dwelling.
- Commercial:
  - 16,800 Litres per hectare per day.
  - 28,100 Litres per hectare per day (peak flow).

- Inflow and infiltration:
  - Manholes: 12 Litres per minute per manhole, 1.6 manholes per hectare.
  - Groundwater infiltration: 2,200 Litres per hectare per day.
  - Weeping tile inflow: 4.55 Litres per minute per service connection.

Combined peak flow from single-family, multi-family, and commercial properties, along with inflow and infiltration is estimated to total **61.9 L/s** for the WPCA. Detailed calculations can be found in Appendix C – Sample Calculations.

4.2 HYDRAULIC MODELLING

An existing hydraulic model of the sanitary sewer system in Fort Frances, initially developed by R.J. Burnside & Associates Ltd. and adapted by KGS Group, was used to supplement theoretical calculations to determine the effects that future development might have on the existing infrastructure in the WPCA.

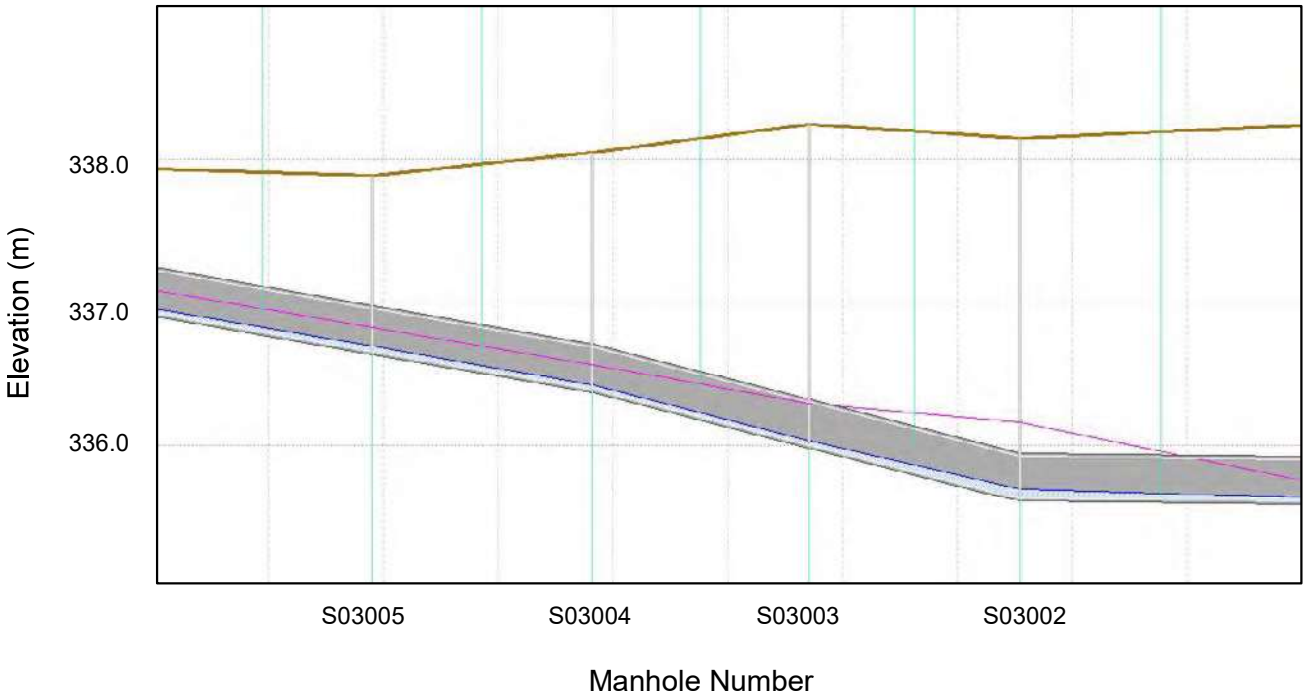
The model was previously constructed to simulate the actual and theoretical flow conditions in Fort Frances for both dry and wet weather scenarios. The wastewater system's physical properties were compiled based primarily on the Town's GIS database records and augmented with record drawings, CCTV inspection videos and reports.

The inflow values for the dry weather flow model were applied on a manhole-by-manhole basis, with individual sub-catchments applied to the manhole that was deemed to service each area. Domestic sewage inflow was computed based on a tabulated person-density per hectare (obtained from ward and poll information) multiplied by an average per capita wastewater generation rate. This wastewater generation was distributed using a typical residential temporal variation (diurnal) pattern that varies the inflow throughout the day and the week based on estimated usage patterns. Industrial, commercial, and institutional (ICI) wastewater inflows are applied as a dry weather flow in the hydraulic mode of the model. These flows were based on historical water usage records from the Town and are applied between the hours of 8 am and 4 pm using a temporal variation pattern.

The Fort Frances DWF XP-SWMM model was updated to include the estimated dry weather, inflow and infiltration flow rates for the future development in the WPCA. The model results show that free flow conditions occur for the majority of the length of sewer along Scott Street, except near MH S03002, which is at the downstream end of the proposed new development. Here, as shown in **Error! Reference source not found.**, the hydraulic grade line elevation (purple) (336.16 m) lies above the crown of the sewer (335.93 m), indicating a surcharged condition and confirming the 300 mm diameter sewer main is undersized when the flow from the future development is considered.

FIGURE 4.1

PLOT OF MODELLED HYDRAULIC GRADE LINE ON SCOTT STREET



5.0 CONCLUSIONS

Through the WPCA field program and capacity study, KGS Group identified several notable findings:

- According to monthly flow records, there is a discrepancy between rated and actual pump flow rates in the WPPS. The average single-pump flow rate is 33.2 L/s, though the pumps are rated at 47 L/s at 7.8 m TDH. This discrepancy could be due to undersized head loss assumptions during design, pump wear, or a restricted (unclean) force main, which may increase the TDH and reduce the flow rate.
- While the pumps in the WPPS are sized sufficiently to convey peak flows with both pumps running, the Ontario Ministry of Environment's (MOE) *Design Guidelines for Sewage Works* recommends that the pumps be sized so one pump is capable of pumping peak flows in the event the other pump is out-of-service. In addition to this, the cross-sectional area of the existing wet well (2.4 m^2, 1.75m diameter) does not meet the MOE Guideline of a minimum of 4.9 m^2 (2.5 m diameter).
- There are some sump pump and eavestrough connections to the sanitary sewers in the WPCA which may contribute significant amounts of inflow to the sanitary sewer during wet weather.
- KGS Group observed infiltration evidence in several manholes in the WPCA. These defects, in addition to the presence of sandy soil in the area, could permit a high amount of infiltration flow to the sanitary sewer during wet weather.

6.0 RECOMMENDATIONS

As a result of the findings of the 2018 Scott Street Sewer Capacity Study, KGS Group recommends the following improvements:

- A pump drawdown test should be completed in the WPPS to determine the actual pump flow rates for each pump running individually and the maximum flow rate with both pumps running.
- Upgrade the existing 300 mm diameter sewer main along Scott Street from Minnie Avenue to the WPPS to a new 375 mm diameter PVC sewer main.
- Retrofit the pumps in the WPPS with variable-speed pumps capable of pumping 65 L/s at 7.8 m TDH. This would provide the capacity to meet MOE Guidelines, along with minimum pump cycle times, appropriate fill times and would minimize impacts on downstream infrastructure that non-variable-speed pumps may have. The capacity of the existing force main and receiving sewer is sufficient to accept this recommended flow rate.
- Upgrade the existing wet well to a minimum 2.5 m diameter well, or install a new minimum 1.8 m diameter manhole upstream of the existing wet well to act as an addition to the wet well to meet the minimum cross-sectional area requirement of 4.9 m^2. A mechanical bar screen can be installed in this new manhole to improve safety by decreasing the need for maintenance personnel to enter the well.
- Separate any existing sump pump or eavestrough connections to the sanitary sewer to significantly reduce the loading to the sewer during wet weather.
- Repair or replace defective manholes in the WPCA to reduce the amount of infiltration into the sanitary sewer.

7.0 OPINION OF PROBABLE COSTS

Table 7.1 provides KGS Group's opinion of probable costs of upgrading the sanitary sewer along Scott Street from Minnie Avenue to the WPPS. Upgrades would include:

- Replacing the existing 300 mm diameter sewer main with 375 mm diameter PVC sewer main (approximately 575 m).
- Replacement of five manholes (excluding the recently replaced one at Scott Street and Minnie Avenue).
- Retrofitting the pumps in the WPPS with variable-speed pumps capable of pumping 65 L/s at 7.8 m TDH.
- Installing a new manhole with mechanical bar screen to act as an expansion of the existing wet well.

These estimates do not include the cost of road renewals.

TABLE 7.1

OPINION OF PROBABLE COSTS

ITEM	OPINION OF PROBABLE COST
Upgrade of Scott Street Sewer	$300,000
Upgrade of WPPS Pumps	$60,000
Expansion of WPPS Wet Well (new MH and mechanical bar screen)	$150,000

8.0 STATEMENT OF LIMITATIONS

8.1 CAPITAL COST ESTIMATE STATEMENT OF LIMITATIONS

The cost estimates included with this report have been prepared by KGS Group using its professional judgment and exercising due care consistent with the level of detail required for the stage of the project for which the estimate has been developed. These estimates represent KGS Group's opinion of the probable costs and are based on factors over which KGS has no control. These factors include, without limitation, site conditions, availability of qualified labour and materials, the present workload of the Bidders at the time of tendering and overall market conditions. KGS does not assume any responsibility to the Client, in contract, tort or otherwise in connection with such estimates and shall not be liable to the Client if such estimates prove to be inaccurate or incorrect.

APPENDIX B

EAVESTROUGH AND SUMP PUMP DISCHARGE SURVEY DATA

2018 Fort Frances Eavestrough and Sump Pump Discharge Survey

Street	House Number	Eaves Discharge	Other Type of Eaves Discharge	Surveyed	Sump Pump	Sump Pump Discharge	Other Type of Sump Pump	Northing	Easting
Butler Ave	400	Yard/Surface		Yes	No			5384063.359	471872.0479
Butler Ave	402	Yard/Surface		No				5384078.144	471890.6592
Butler Ave	404	Other	No eaves	No				5384096.859	471892.115
Butler Ave	407	Yard/Surface		Yes	No			5384097.564	471870.3494
Butler Ave	408	Yard/Surface		No				5384120.272	471895.9488
Butler Ave	411	Yard/Surface		Yes	No			5384108.906	471879.6662
Colonization Rd E	523	Yard/Surface		Yes	Yes	Yard/Surface		5384280.611	472695.1299
Colonization Rd E	715	Yard/Surface		Yes	Yes	Yard/Surface		5384458.082	472845.6332
First St E	900	Yard/Surface		No	No			5384306.487	472006.1912
First St E	901	Yard/Surface		Yes	Yes	Other	Two pumps, both discharge to surface	5384260.818	472036.6006
First St E	910	Yard/Surface		No	No			5384295.701	472171.1613
First St E	1000	Yard/Surface		Yes	Yes	Yard/Surface		5384308.494	472204.9999
First St E	1005	Other	No eaves	No				5384272.118	472225.8767
First St E	1007	Yard/Surface		No				5384261.936	472234.3025
First St E	1008	Yard/Surface		Yes	No			5384297.41	472251.905
First St E	1009	Yard/Surface		Yes	Yes	Yard/Surface		5384298.705	472234.2392
First St E	1009	Yard/Surface		Yes	No			5384272.8	472252.5623
First St E	1010	Yard/Surface		No				5384289.836	472268.8819
First St E	1011	Other	No eaves	No				5384262.134	472264.8882
First St E	1016	Yard/Surface		No				5384294.718	472282.9835
First St E	1018	Yard/Surface		Yes	No			5384397.229	472293.6554
First St E	1020	Yard/Surface		No				5384285.203	472296.3482
First St E	1021	Other	No eaves	Yes	No			5384274.225	472297.7142
First St E	1021	Yard/Surface		No				5384374.514	472299.3595
First St E	1022	Yard/Surface		Yes	Yes	Yard/Surface		5384293.356	472333.4762
First St E	1023	Yard/Surface		Yes	Yes	Yard/Surface		5384268.036	472326.6385
First St E	1024	Other	No eaves	Yes	No			5384300.986	472339.7689
First St E	1026	Yard/Surface		Yes	No			5384295.163	472343.2523
First St E	1031	Yard/Surface		No				5384274.213	472349.6196
First St E	1032	Yard/Surface		No				5384302.434	472362.5549
First St E	1033	Other	No eaves	No				5384270.541	472360.9526
First St E	1034	Yard/Surface		No				5384300.887	472371.9381
First St E	1035	Other	No eaves	No				5384268.009	472374.7393
First St E	1036	Yard/Surface		Yes	No			5384299.719	472373.0169
First St E	1037	Yard/Surface		No				5384365.409	472394.8984
First St E	1100	Other	No eaves	Yes	No			5384289.434	472416.7941
First St E	1101	Yard/Surface		No				5384283.794	472395.8223
First St E	1103	Yard/Surface		Yes	Yes	Yard/Surface		5384254.093	472202.8182
First St E	1105	Yard/Surface		No				5384276.597	472419.6868
First St E	1107	Yard/Surface		No				5384277.917	472433.0525
First St E	1108	Other	No eaves	Yes	Yes	Yard/Surface		5384290.033	472453.2758

Street	House Number	Eaves Discharge	Other Type of Eaves Discharge	Surveyed	Sump Pump	Sump Pump Discharge	Other Type of Sump Pump	Northing	Easting
First St E	1110	Yard/Surface		Yes	No			5384294.275	472479.5777
First St E	1111	Yard/Surface		Yes	No			5384278.061	472478.9778
First St E	1113	Yard/Surface		No				5384274.269	472472.6725
First St E	1116	Yard/Surface		Yes	No			5384296.256	472493.1046
First St E	1117	Yard/Surface		Yes	No			5384276.904	472484.2195
First St E	1118	Yard/Surface		No				5384310.584	472500.9076
First St E	1119	Yard/Surface		No				5384269.349	472291.5229
First St E	1119	Yard/Surface		No				5384269.989	472511.2189
First St E	1120	Yard/Surface		No				5384303.141	472521.3691
First St E	1121	Yard/Surface		Yes	No			5384266.284	472511.5805
First St E	1123	Yard/Surface		No				5384274.414	472527.259
First St E	1125	Yard/Surface		Yes	Yes	Other	Unknown	5384276.923	472525.8001
First St E	1127	Yard/Surface		No				5384267.952	472548.5871
First St E	1128	Yard/Surface		No				5384293.61	472535.8613
First St E	1129	Yard/Surface		No				5384267.566	472559.6192
First St E	1132	Other	No eaves	Yes	Yes	Other	Summer: yard, winter:San sewer	5384293.346	472564.5205
First St E	1134	Yard/Surface		No				5384297.05	472570.8267
First St E	1139	Yard/Surface		Yes	Yes	Yard/Surface		5384272.765	472583.7376
First St E	1140	Yard/Surface		Yes	No			5384309.435	472591.2672
First St E	1200	Yard/Surface		No				5384311.501	472611.9369
First St E	1201	Yard/Surface		Yes	Yes	Sanitary Sewer		5384262.567	472611.519
First St E	1205	Yard/Surface		Yes	No			5384276.961	472636.7066
First St E	1210	Yard/Surface		No				5384299.106	472651.3038
First St E	1212	Yard/Surface		Yes	No			5384301.409	472668.459
First St E	1216	Yard/Surface		Yes	No			5384292.924	472686.9836
First St E	1217	Yard/Surface		Yes	Yes	Other	To 1221 then to storm sewer	5384284.111	472652.7373
First St E	1221	SS		Yes	Yes	Other	To storm sewer	5384283.14	472687.3767
First St E	1222	Yard/Surface		Yes	Yes	Other	Unknown	5384279.679	472688.6798
First St E	1229	Yard/Surface		Yes	No			5384281.769	472691.8177
First St E	1230	Yard/Surface		No				5384296.547	472704.6131
First St E	1231	Yard/Surface		No				5384275.955	472704.2428
First St E	1232	Yard/Surface		Yes	No			5384290.714	472727.399
First St E	1234			Yes	Yes	Yard/Surface		5384308.398	472737.0188
First St E	1244	Yard/Surface		Yes	Yes	Yard/Surface		5384305.268	472773.4249
Minnie Ave	302	Yard/Surface		No				5383966.025	472428.4457
Minnie Ave	307	Yard/Surface		Yes	No			5383991.636	472378.1548
Minnie Ave	310	Yard/Surface		No				5383983.062	472406.46
Minnie Ave	311	Yard/Surface		No	Yes	Yard/Surface		5383983.012	472383.9008
Minnie Ave	312	Other	No eaves	No				5383988.077	472412.0218
Minnie Ave	315	Yard/Surface		No				5384004.688	472378.9818
Minnie Ave	316	Other	No eaves	Yes	No			5383984.205	472407.626
Minnie Ave	318	Yard/Surface		No				5384014.167	472409.8759
Minnie Ave	319	Yard/Surface		Yes	Yes	Yard/Surface		5384027.552	472386.7325
Minnie Ave	320	Yard/Surface		Yes	Yes	Yard/Surface		5384020.856	472406.9411

Street	House Number	Eaves Discharge	Other Type of Eaves Discharge	Surveyed	Sump Pump	Sump Pump Discharge	Other Type of Sump Pump	Northing	Easting
Minnie Ave	323	Yard/Surface		No				5384024.921	472382.1588
Minnie Ave	324	Yard/Surface		No	Yes	Yard/Surface		5384046.138	472406.5246
Minnie Ave	327	Yard/Surface		No	Yes	Yard/Surface		5384052.597	472386.3285
Minnie Ave	331	Yard/Surface		No				5384062.984	472381.7265
Minnie Ave	400	Yard/Surface		No				5384073.754	472404.6805
Minnie Ave	405	Other	No eaves	Yes	Yes	Yard/Surface		5384077.543	472390.2561
Minnie Ave	409	Yard/Surface		Yes	Yes	Other	2 pumps,unknown discharge	5384096.081	472388.1981
Minnie Ave	411	Yard/Surface		Yes	No			5384107.146	472397.3268
Scott St	719	Yard/Surface		No				5384167.104	471782.1639
Scott St	723	Yard/Surface		No				5384169.65	471788.6352
Scott St	725	Other	No eaves	Yes	No			5384171.077	471806.4408
Scott St	727	Other	No eaves	Yes	No			5384169.425	471818.1061
Scott St	729	Yard/Surface		Yes	No			5384167.975	471829.7997
Scott St	731	Yard/Surface		No				5384163.755	471848.2069
Scott St	800	Yard/Surface		No				5384185.886	471910.504
Scott St	801	Yard/Surface		Yes	No			5384164.409	471891.7542
Scott St	804	Yard/Surface		No				5384183.396	471913.1455
Scott St	808	Yard/Surface		Yes	Yes	Yard/Surface		5384185.147	471941.2741
Scott St	809	Yard/Surface		Yes	No			5384158.637	471939.1335
Scott St	811	Yard/Surface		Yes	No			5384158.995	471944.9355
Scott St	813	Yard/Surface		No				5384162.512	471964.7071
Scott St	815	Yard/Surface		No				5384165.197	471965.5426
Scott St	922	Yard/Surface		Yes	Yes	Yard/Surface		5384196.265	472044.395
Scott St	990	Yard/Surface		Yes	Yes	Yard/Surface		5384176.995	472175.0429
Scott St	1002	Yard/Surface		No				5384188.117	472222.7606
Scott St	1004	Yard/Surface		Yes	No			5384185.015	472218.6112
Scott St	1006	Yard/Surface		Yes	No			5384180.721	472225.0146
Scott St	1008	Yard/Surface		Yes	No			5384180.045	472234.5951
Scott St	1010	Yard/Surface		No				5384181.154	472248.5695
Scott St	1014	Other	No eaves	Yes	No			5384181.397	472277.5391
Scott St	1016	SS		Yes	No			5384184.637	472282.6404
Scott St	1018	Yard/Surface		No				5384189.883	472291.4219
Scott St	1022	Yard/Surface		No				5384186.175	472304.108
Scott St	1025	Yard/Surface		Yes	No			5384158.944	472321.2832
Scott St	1027	Other	No eaves	No				5384168.865	472335.4381
Scott St	1028	Yard/Surface		No				5384194.968	472324.0142
Scott St	1030	Yard/Surface		Yes	No			5384175.39	472325.0787
Scott St	1031	Other	No eaves	No				5384163.821	472358.8442
Scott St	1033	Yard/Surface		No				5384164.81	472366.8533
Scott St	1036	Yard/Surface		No				5384187.487	472368.5913
Scott St	1037	Yard/Surface		Yes	No			5384159.995	472382.7373
Scott St	1040	Other	No eaves	Yes	No			5384178.567	472367.691
Scott St	1042	Yard/Surface		No				5384187.299	472380.7929
Scott St	1100	Yard/Surface		Yes	No			5384200.657	472405.1902

Street	House Number	Eaves Discharge	Other Type of Eaves Discharge	Surveyed	Sump Pump	Sump Pump Discharge	Other Type of Sump Pump	Northing	Easting
Scott St	1101	Yard/Surface		No				5384180.941	472423.3888
Scott St	1102	Yard/Surface		No				5384189.293	472430.3306
Scott St	1104	Yard/Surface		No	Yes	Yard/Surface		5384187.43	472445.2028
Scott St	1109	Yard/Surface		No				5384147.266	472453.6229
Scott St	1110	Yard/Surface		Yes	No			5384184.841	472463.7843
Scott St	1113	Yard/Surface		No				5384159.443	472472.9957
Scott St	1114	Other	No eaves	Yes	No			5384182.45	472478.0351
Scott St	1117	Yard/Surface		No	Yes	Yard/Surface		5384164.057	472492.3661
Scott St	1118	Yard/Surface		Yes	Yes	Yard/Surface		5384179.74	472500.0281
Scott St	1119	Yard/Surface		Yes	Yes	Yard/Surface		5384155.061	472512.1932
Scott St	1120	Yard/Surface		No				5384197.914	472516.4772
Scott St	1123	Yard/Surface		No				5384164.831	472520.349
Scott St	1124	Yard/Surface		Yes	Yes	Sanitary Sewer		5384196.11	472534.3041
Scott St	1127	Yard/Surface		Yes	Yes	Yard/Surface		5384168.3	472531.379
Scott St	1128	Yard/Surface		No				5384194.606	472539.1011
Scott St	1132	Other	No eaves	Yes	No			5384183.242	472551.7214
Scott St	1136	Yard/Surface		No				5384195.064	472569.0214
Scott St	1147	Yard/Surface		Yes	Yes	Yard/Surface		5384160.066	472566.601
Scott St	1151	Yard/Surface		No				5384167.07	472583.2037
Scott St	1200	Yard/Surface		Yes	Yes	Other	Yard in summer, sewer in winter	5384178.275	472626.1139
Scott St	1204	Yard/Surface		No				5384190.99	472642.2619
Scott St	1207	Yard/Surface		Yes	No			5384160.775	472639.3165
Scott St	1210	Yard/Surface		Yes	Yes	Yard/Surface		5384194.896	472666.9231
Scott St	1214	Yard/Surface		No				5384196.096	472670.41
Scott St	1215	Yard/Surface		No				5384147.982	472667.0919
Scott St	1217	Yard/Surface		No				5384155.824	472671.764
Scott St	1220	Yard/Surface		No				5384198.051	472697.7791
Scott St	1224	Yard/Surface		Yes	No			5384188.456	472713.0931
Scott St	1225	Yard/Surface		Yes	No			5384161.236	472691.1126
Second St E	926	Yard/Surface		No				5384401.974	472116.4139
Second St E	930	Other	Enters ground, unknown exit - possibly beside house	No				5384399.776	472141.2465
Second St E	938	Yard/Surface		Yes	Yes	Yard/Surface		5384391.159	472150.5702
Second St E	1004	Other	No eaves	No				5384412.703	472206.8442
Second St E	1005	Yard/Surface		Yes	Yes	Yard/Surface		5384373.776	472218.888
Second St E	1006	Yard/Surface		No				5384408.437	472232.6218
Second St E	1007	Yard/Surface		Yes	No			5384369.865	472229.3825
Second St E	1008	Yard/Surface		Yes	No			5384387.429	472252.9329
Second St E	1011	Yard/Surface		No				5384387.871	472259.3137
Second St E	1012	Yard/Surface		Yes	No			5384411.146	472255.7298
Second St E	1013	Yard/Surface		Yes	Yes	Yard/Surface		5384389.614	472272.0294
Second St E	1014	Other	No eaves	Yes	No			5384402.893	472274.7084

Street	House Number	Eaves Discharge	Other Type of Eaves Discharge	Surveyed	Sump Pump	Sump Pump Discharge	Other Type of Sump Pump	Northing	Easting
Second St E	1015	Yard/Surface		No				5384373.999	472271.3499
Second St E	1017	Yard/Surface		Yes	Yes	Yard/Surface		5384386.401	472287.225
Second St E	1019	Yard/Surface		Yes	No			5384383.63	472302.5425
Second St E	1020	Yard/Surface		No				5384399.594	472305.4763
Second St E	1022	Other	No eaves, installing soon to go to yard	Yes	No			5384400.041	472314.7034
Second St E	1023	Other	No eaves	Yes	No			5384374.733	472318.4775
Second St E	1024	Yard/Surface		Yes	No			5384391.584	472315.988
Second St E	1025	Yard/Surface		Yes	Yes	Yard/Surface		5384386.033	472313.0853
Second St E	1026	Yard/Surface		Yes	No			5384396.259	472334.8322
Second St E	1027	Yard/Surface		Yes	Yes	Yard/Surface		5384374.493	472331.4806
Second St E	1028	Other	No eaves	No				5384402.513	472341.5181
Second St E	1029	Yard/Surface		No				5384375.65	472348.8677
Second St E	1030	Yard/Surface		Yes	No			5384391.564	472348.7693
Second St E	1032	Other	No eaves	No				5384399.484	472365.2031
Second St E	1033	Yard/Surface		Yes	No			5384377.472	472365.4214
Second St E	1034	Other	No eaves	No				5384404.594	472375.1362
Second St E	1035	Other	No eaves	No				5384379.021	472375.7406
Second St E	1038	Other	No eaves	No				5384396.44	472385.4584
Second St E	1103	Yard/Surface		No				5384411.687	472422.5165
Second St E	1104	Yard/Surface		Yes	Yes	Other	Unknown	5384391.956	472435.3757
Second St E	1107	Yard/Surface		Yes	Yes	Yard/Surface		5384360.65	472439.8582
Second St E	1108	Yard/Surface		Yes	Yes	Yard/Surface		5384393.282	472452.7619
Second St E	1110	Yard/Surface		No				5384391.681	472460.3384
Second St E	1111	Other	No eaves	No				5384376.327	472465.5958
Second St E	1112	Yard/Surface		No				5384397.801	472477.5929
Second St E	1113	Other	No eaves	No				5384374.665	472480.3476
Second St E	1114	Other	No eaves	No				5384396.294	472482.8457
Second St E	1115	Yard/Surface		Yes	No			5384356.462	472495.6485
Second St E	1116	Other	No eaves	No				5384395.545	472491.6802
Second St E	1118	Yard/Surface		Yes	No			5384375.172	472481.6791
Second St E	1119	Other	No eaves	No				5384376.797	472505.8298
Second St E	1120	Yard/Surface		Yes	No			5384392.083	472514.3048
Second St E	1121	Yard/Surface		No				5384372.721	472519.8061
Second St E	1122	Other	No eaves	Yes	No			5384391.398	472527.6094
Second St E	1123	Yard/Surface		Yes	No			5384374.758	472526.0869
Second St E	1124	Yard/Surface		No				5384389.232	472531.6184
Second St E	1125	Yard/Surface		Yes	Yes	Yard/Surface		5384378.141	472543.5489
Second St E	1126	Other	No eaves	No				5384398.684	472546.6706
Second St E	1128	Yard/Surface		No				5384401.5	472554.9763
Second St E	1130	Yard/Surface		No				5384389.939	472565.5484
Second St E	1131	Other	No eaves	Yes	No			5384378.56	472568.929
Second St E	1135	Yard/Surface		Yes	No			5384375.673	472583.9389

Street	House Number	Eaves Discharge	Other Type of Eaves Discharge	Surveyed	Sump Pump	Sump Pump Discharge	Other Type of Sump Pump	Northing	Easting
Second St E	1138	Yard/Surface		No				5384394.542	472577.3247
Second St E	1200	Yard/Surface		No				5384411.941	472607.5161
Second St E	1201	Yard/Surface		Yes	No			5384369.46	472622.2053
Second St E	1202	Other	Lead goes into ground	No				5384401.947	472629.9936
Second St E	1204	Yard/Surface		No	Yes	Yard/Surface		5384392.796	472637.7358
Second St E	1205	Yard/Surface		No				5384357.273	472631.1887
Second St E	1206	Yard/Surface		No				5384398.257	472655.342
Second St E	1208	Yard/Surface		No				5384402.897	472664.2564
Second St E	1209	Yard/Surface		No				5384368.123	472653.4733
Second St E	1210	Yard/Surface		No				5384400.446	472675.8577
Second St E	1212	Yard/Surface		Yes	No			5384390.462	472694.6765
Second St E	1213	Yard/Surface		No				5384374.308	472664.4841
Second St E	1215	Yard/Surface		No	Yes	Yard/Surface		5384366.601	472677.5598
Second St E	1216	Yard/Surface		Yes	Yes	Other	Weeping tile then to storm sewer	5384393.369	472720.8735
Second St E	1217	Yard/Surface		Yes	Yes	Other	SS in winter, yard in spring/summer	5384375.425	472697.891
Second St E	1218	Yard/Surface		Yes	Yes	Other	Unknown	5384399.535	472723.3616
Second St E	1219	Yard/Surface		No				5384371.718	472714.846
Second St E	1220	Yard/Surface		No				5384402.181	472743.9761
Second St E	1221	Yard/Surface		No				5384369.662	472729.4499
Second St E	1222	Yard/Surface		Yes	Yes	Other	Currently to SS, installing outdoor pipe soon	5384389.979	472746.6339
Second St E	1224	Yard/Surface		Yes	No			5384396.838	472763.5611
Second St E	1225	Yard/Surface		No				5384362.426	472758.3016
Second St E	1226	Yard/Surface		No				5384398.6	472773.5387
Second St E	1228	Yard/Surface		No				5384396.112	472788.6222
Second St E	1237	Yard/Surface		Yes	Yes	Yard/Surface		5384373.241	472778.0563
Third St E	1004	Yard/Surface		No				5384519.803	472215.2277
Third St E	1005	Yard/Surface		No				5384470.91	472225.123
Third St E	1007	Yard/Surface		No				5384470.944	472245.4821
Third St E	1010	Yard/Surface		No				5384502.058	472242.3091
Third St E	1011	Other	No eaves	Yes	No			5384475.202	472256.0749
Third St E	1014	Yard/Surface		Yes	No			5384494.494	472268.3066
Third St E	1015	Yard/Surface		No				5384464.231	472272.4915
Third St E	1016	Other	No eaves	Yes	No			5384495.903	472271.84
Third St E	1017	Other	No eaves	Yes	No			5384476.636	472289.698
Third St E	1018	Yard/Surface		No				5384495.312	472293.3001
Third St E	1019	Other	No eaves	No				5384472.035	472287.8371
Third St E	1021	Yard/Surface		Yes	No			5384474.038	472306.518
Third St E	1024	Other	No eaves	No				5384494.106	472313.0834
Third St E	1025	Yard/Surface		Yes	Yes	Yard/Surface		5384476.181	472315.6776
Third St E	1026	Yard/Surface		No				5384497.112	472328.2574

Street	House Number	Eaves Discharge	Other Type of Eaves Discharge	Surveyed	Sump Pump	Sump Pump Discharge	Other Type of Sump Pump	Northing	Easting
Third St E	1027	Yard/Surface		No				5384474.908	472340.5603
Third St E	1028	Yard/Surface		No				5384496.635	472336.7523
Third St E	1030	Yard/Surface		No				5384496.326	472347.5763
Third St E	1031	Yard/Surface		Yes	No			5384472.693	472365.7633
Third St E	1032	Yard/Surface		No				5384499.231	472359.5642
Third St E	1034	Yard/Surface		Yes	No			5384501.102	472368.295
Third St E	1035	Other	No eaves	No				5384473.422	472381.5383
Third St E	1036	Yard/Surface		No				5384499.772	472379.5959
Third St E	1037	Yard/Surface		No				5384472.567	472394.4986
Third St E	1038	Other	No eaves	No				5384494.299	472389.6127
Third St E	1100	Other	No eaves	Yes	No			5384501.588	472408.1562
Third St E	1101	Yard/Surface		Yes	No			5384467.195	472420.1541
Third St E	1104	Yard/Surface		Yes	Yes	Yard/Surface		5384500.312	472442.129
Third St E	1107	Other	No eaves	No				5384477.818	472448.9818
Third St E	1108	Yard/Surface		Yes	No			5384498.645	472458.881
Third St E	1109	Yard/Surface		Yes	No			5384463.7	472457.4431
Third St E	1112	Yard/Surface		No				5384503.612	472474.8278
Third St E	1113	Other	Potentially to weeping tile	No				5384476.828	472480.5166
Third St E	1114	Other	No eaves	No				5384514.947	472485.7884
Third St E	1116	Yard/Surface		Yes	No			5384485.344	472495.8385
Third St E	1117	Yard/Surface		No				5384480.744	472491.7999
Third St E	1119	Yard/Surface		No				5384469.737	472506.9417
Third St E	1120	Yard/Surface		Yes	No			5384503.4	472513.4689
Third St E	1122	Yard/Surface		Yes	No			5384499.16	472532.186
Third St E	1123	Other	No eaves	Yes	No			5384473.972	472535.8102
Third St E	1125	Yard/Surface		No				5384471.42	472551.4156
Third St E	1128	Yard/Surface		Yes	Yes	Yard/Surface		5384498.789	472569.1539
Third St E	1131	Yard/Surface		Yes	No			5384459.922	472559.625
Third St E	1133	Yard/Surface		No	Yes	Yard/Surface		5384473.139	472583.4617
Third St E	1134	Yard/Surface		Yes	No			5384495.217	472580.0309
Third St E	1135	Yard/Surface		Yes	No			5384473.077	472587.1289
Third St E	1200			No	Yes	Yard/Surface		5384499.641	472612.7587
Third St E	1202	Other	No eaves	Yes	No			5384495.901	472636.4312
Third St E	1204	Yard/Surface		Yes	No			5384497.436	472642.1419
Third St E	1205	Yard/Surface		No				5384490.62	472654.5855
Third St E	1206	Yard/Surface		No				5384503.215	472660.0858
Third St E	1207	Yard/Surface		Yes	No			5384478.093	472655.0523
Third St E	1209	Yard/Surface		No				5384466.697	472665.7496
Third St E	1210	Yard/Surface		No				5384499.925	472681.0306
Third St E	1211	Other	No eaves	No				5384476.662	472675.1035
Third St E	1212	Yard/Surface		Yes	No			5384494.177	472685.985
Third St E	1214	Other	Rear:yard, front:possibly SS	Yes	No			5384495.621	472696.4281

Street	House Number	Eaves Discharge	Other Type of Eaves Discharge	Surveyed	Sump Pump	Sump Pump Discharge	Other Type of Sump Pump	Northing	Easting
Third St E	1215	Yard/Surface		No				5384470.219	472706.4238
Third St E	1216	Yard/Surface		Yes	No			5384492.854	472711.4135
Third St E	1217	Yard/Surface		Yes	Yes	Yard/Surface		5384473.028	472716.324
Third St E	1218	Yard/Surface		No				5384503.146	472728.9864
Third St E	1219	Other	No eaves	No				5384471.729	472734.5895
Third St E	1221	Yard/Surface		Yes	No			5384471.925	472737.4712
Third St E	1222	Yard/Surface		Yes	No			5384499.934	472751.3921
Third St E	1223	Yard/Surface		Yes	No			5384471.736	472751.7615
Third St E	1224	Yard/Surface		No				5384504.938	472764.2674
Third St E	1225	Yard/Surface		Yes	Yes	Yard/Surface		5384486.672	472759.7695
Third St E	1226	Yard/Surface		Yes	No			5384498.187	472777.8573
Third St E	1227	Yard/Surface		Yes	No			5384479.481	472773.9916
Third St E	1228	Yard/Surface		Yes	Yes	Yard/Surface		5384491.816	472785.29
Third St E	1229	Yard/Surface		Yes	Yes	Sanitary Sewer		5384475.345	472785.9381

APPENDIX C

SAMPLE CALCULATIONS

FUTURE DEVELOPMENT PEAK FLOW CALCULATION

Demand and population density values obtained from City of Winnipeg Wastewater Flow Estimation and Servicing Guidelines, as noted in Section 3.1.

Future development area: 9.2 ha

- 4.6 ha Single-family residential (SF)
- 4.6 ha Multi-family residential (MF)

SF Average Demand:

$$Q_{SF} = (4.6\ \text{ha})\left(12.29\ {}^{\text{dw}}/_{\text{ha}}\right)\left(3.05\ {}^{\text{c}}/_{\text{dw}}\right)\left(270\ {}^{\text{L}}/_{\text{c}}/_{\text{d}}\right) = 46556\ {}^{\text{L}}/_{\text{d}} = 0.54\ {}^{\text{L}}/_{\text{s}}$$

MF Average Demand:

$$Q_{MF} = (4.6\ \text{ha})\left(74.13\ {}^{\text{dw}}/_{\text{ha}}\right)\left(2.3\ {}^{\text{c}}/_{\text{dw}}\right)\left(270\ {}^{\text{L}}/_{\text{c}}/_{\text{d}}\right) = 211760\ {}^{\text{L}}/_{\text{d}} = 2.45\ {}^{\text{L}}/_{\text{s}}$$

Harmon Peaking Factor:

$$PF = 1 + \frac{14}{4 + \sqrt{P/1000}}$$

$$P = (4.6\ \text{ha})\left(12.29\ {}^{\text{dw}}/_{\text{ha}}\right)\left(3.05\ {}^{\text{c}}/_{\text{dw}}\right) + (4.6\ \text{ha})\left(74.13\ {}^{\text{dw}}/_{\text{ha}}\right)\left(2.3\ {}^{\text{c}}/_{\text{dw}}\right) = 957$$

$$PF = 1 + \frac{14}{4 + \sqrt{957/1000}} = 3.81$$

Future development peak demand:

$$Q_{peak} = PF \times (Q_{SF} + Q_{MF}) = 3.81 \times \left(0.54\ {}^{\text{L}}/_{\text{s}} + 2.45\ {}^{\text{L}}/_{\text{s}}\right) = \mathbf{11.4\ L/s}$$

Future development inflow and infiltration:

- Groundwater infiltration:

$$Q_{GW} = (9.2\ \text{ha})\left(2200\ {}^{\text{L}}/_{\text{ha}}/_{\text{d}}\right) = 20240\ {}^{\text{L}}/_{\text{d}} = 0.23\ {}^{\text{L}}/_{\text{s}}$$

- Manhole infiltration:

$$Q_{MH} = (9.2\ \mathrm{ha})\left(1.6\ {}^{\mathrm{MH}}/_{\mathrm{ha}}\right)\left(12\ {}^{\mathrm{L}}/_{\mathrm{min}}/_{\mathrm{MH}}\right) = 177\ {}^{\mathrm{L}}/_{\mathrm{min}} = 2.94\ {}^{\mathrm{L}}/_{\mathrm{s}}$$

Total future development flow:

$$Q_{Total} = Q_{peak} + Q_{GW} + Q_{MH} = 11.4\ {}^{\mathrm{L}}/_{\mathrm{s}} + 0.23\ {}^{\mathrm{L}}/_{\mathrm{s}} + 2.94\ {}^{\mathrm{L}}/_{\mathrm{s}}$$

$$\boldsymbol{Q_{Total} = 14.6\ {}^{\mathbf{L}}/_{\mathbf{s}}}$$

KGS
GROUP
CONSULTING
ENGINEERS