Sewer System Capacity Study

FINAL

KGS Group 12-2214-002
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File No. 12-2214-002

Red River Exhibition Association
3977 Portage Avenue
Winnipeg, Manitoba
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ATTENTION: Mr. Garth Rogerson

RE: Sewer System Capacity Study
Final Report

Dear Mr. Rogerson:

Please find enclosed three (3) hard copies of the Final Report of the Sewer System Capacity Study.

KGS Group sincerely appreciates the opportunity to be of service on this project. If you have any questions, please do not hesitate to contact the undersigned.

Yours truly,

Roy J. Houston, P.Eng.
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RJH/jr
Enclosure

EXECUTIVE SUMMARY

This Sewer System Capacity Study evaluated the existing conditions of the Red River Exhibition Park in order to determine the capacity of the existing infrastructure and develop the basis for expansion projections. Once developed, these expansion projections were used to assess the performance of the existing systems under future conditions. It was found that the current site infrastructure will not be sufficient to meet future demands. Upgrade recommendations were prepared that would ensure that the new development's infrastructure needs would be met. The recommended upgrades are:

- Replacement of the existing 7.5HP lift station pumps with 15HP pumps;
- Abandonment of approximately 306m of existing 250mm PVC sewer and placement of approximately 300m of new 300mm PVC sewer on a new alignment; and
- Replacement of approximately 64m of 250mm PVC sewer with 300mm PVC sewer on the same alignment.

In addition to these upgrades, proposed alignments for several new sections of 250mm and 300mm PVC sewer pipe were recommended, to service the proposed new RREX Park developments. It was found that neither the existing forcemain nor the City of Winnipeg interceptor sewer would require upgrades as part of the RREX Park development.

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1.0 INTRODUCTION

The purpose of this study is to analyze the impact of the facilities proposed in the Red River Exhibition (RREX) Park Master Plan on the existing sanitary sewer system. This will be accomplished by analyzing current and historical flow data where available, projecting future, full-development sewer loads, and analyzing the performance of the existing sewer infrastructure under these projected loads. Once the behaviour of the sewer infrastructure is determined under the projected loads, the system will be analyzed to determine what improvements may be required. The report will then make recommendations regarding required infrastructural improvements in order to maintain an acceptable level of service.

2.0 BACKGROUND

The RREX Park site is the venue for the Red River Exhibition, a 10 day festival that will draw a large number of attendees to the site. It is understood that all site infrastructure must be able to accommodate this extremely large demand spike, and as such the design and analysis in this report will be based on the peak values determined to be appropriate for the festival.

The existing sanitary sewer system of the RREX Park consists of a collection system draining to a lift station, located on the land adjacent to the existing RV Park. Wastewater is pumped from the lift station to the City of Winnipeg sanitary sewer collection system through a 200 mm forcemain at the forcemain discharge. The wastewater is then conveyed by a 600 mm sewer main to the West End Water Pollution Control Centre wastewater treatment facility.

Six holding tanks, with a combined capacity of 227m^3, are located near the lift station. Before the sewage lift station was built in 2008, the sewage was collected in the holding tanks and then trucked to the West End Water Pollution Control Centre. Pumping records from the tanks were made available for several years prior to the installation for the lift station for the purpose of estimating past and current flow volumes.

An additional component of the RREX Master Plan is the Westport Festival, a proposed commercial development located between the Park and Portage Avenue. The impacts of the Westport Festival and RREX Park were analyzed separately.

The following proposed facilities within RREX Park will be connected to the sanitary sewer system:

- a 100-bed hotel;
- a 100-space recreational vehicle park;
- a 2,000 m^2 Dairy Farmers of Manitoba building;
- a 14,600 m^2 Multipurpose Exposition Building;
- a 5,000 m^2 Event Centre;
- a 3,200 m^2 agricultural office building;
- a 10,100 m^2 Agricultural Commodities Park building; and
- a 5,000 m^2 expansion to the Agricultural Commodities Park building.

3.0 EXISTING CONDITIONS

This section of the report will review the existing site conditions in terms of flows, system information such as pipe types and sizes, and lift station operating information.

3.1 FLOW RATES

Records of the flow rates from the existing lift station were not available at the time of this report. However, an estimation of the existing flows was performed based on the following records:

- water usage records from 2011 and 2012
- Red River EX visitor records from 2012
- holding tank pumping records from the years 1999 – 2007

These values will be evaluated both individually and relative to each other in order to determine an accurate representation of the peak flow conditions during the Exhibition, which will serve as the design value for evaluating the performance of the sewer system.

3.1.1 Water Usage Records

Water usage records are often indicative of sewage flows for the purposes of design. The water usage data from January 20th, 2011 to January 12th, 2012, was recorded by 8 water meters in the RREX Park. The values recorded by those meters are shown in Table 3.1.

It is important to note that the March 29th to July 5th time period includes both the Red River EX and the baseline daily flow for the entire period. Since the intent is to determine the flow from the Exhibition specifically, which is understood to represent the highest flow volume that the system receives, the consumption data for the Exhibition will be separated from the total flow for this period.

Table 3.1 – Water Usage Records

		Recorded Water Usage [m^3]		
Meter Number		**2011**		**2011 / 2012**
	Jan 20 - Mar 28	**Mar 29 - Jul 5**	**Jul 6 - Sep 20**	**Sep 21 - Jan 12**
1	57.7	48.6	5.8	57.9
2	33.0	188.9	40.2	24.0
3	1.8	496.5	23.5	0.4
4	45.4	307.4	12.5	1.6
5	15.2	62.2	46.3	31.9
6	174.4	257.8	29.6	118.7
7	85.3	312.2	52.2	109.0
8	15.7	1025.1	92.6	39.8
Total	428.5	2698.7	302.7	383.3
Number of Days	68	99	77	114
Daily Average [m^3/day]	6.3	27.3	3.9	3.4

It is assumed that when the Exhibition is not underway, the average daily flow is roughly equivalent to the daily average flows of the other time periods presented in table 3.1. However, for the purposes of generating the most conservative estimate of the Red Exhibition flows, the average daily flow for the March 29th to July 5th period will be set equal to the lowest average daily flow from the data set, 3.4 m^3/day from the September 21st to January 12th period. This will generate the largest possible Exhibition flow as follows:

$$AEF = \frac{TWU - \left[AF * \left(AllDays - ExDays\right)\right]}{ExDays}$$

Where:

- $AEF = AverageExhibitionFlow$ = Daily average flow during the Exhibition
- $TWU = TotaWaterUsage$ = 2698.7 m³ for the March 29th to July 5th period
- $AF = AverageFlow$ = 3.4 m^3/day
- $Alldays$ = 99
- $ExDays$ = 10

$$AEF = \frac{2698.7 - \left[3.4 * \left(99 - 10\right)\right]}{10} = 239.6\ m^3/day$$

Based on this average daily flow, a peaking factor of 2.4, derived from festival attendance peaks, was applied and rounded up to account for the difference between an average day and a peak day. Therefore, the extrapolated peak day flow from this data set is **576.0 m^3/day.**

3.1.2 Red River EX Visitor Records

In 2012 the total attendance during the 10-day period of the Exhibition was 215,000 people. Of those visitors, the largest single day attendance was recorded on Sunday, June 24th, at 48,000 people. These values were used to estimate the average daily flow and peak day flow for the 2012 Exhibition. These estimations are shown in Tables 3.2 and 3.3 respectively, and are based on a typical value of 12 L/person/day for fairgrounds.

Table 3.2 – Daily Average Flow 2012

Area	Unit	Average Daily Attendance	Unit Flow (Event)	Daily Average Flow [m^3/d]
Fairground	visitor	21,500	12 L/unit-day	258

Table 3.3 – Peak Day Flow 2012

Area	Unit	Peak Attendance	Unit Flow (Event)	Peak Day Flow [m^3/d]
Fairground	visitor	48,000	12 L/unit-day	576

3.1.3 Holding Tank Pumping Records

Prior to the installation of the RREX Park sewage lift station, pumping of the septic tanks and portable toilets was conducted by D&S Industrial Inc. The pumping records during the Exhibition from 1999, 2002, 2003, 2004, 2005 and 2007 were analyzed to determine average and peak flow volumes. The data is summarized in Table 3.4, and detailed records for each year are provided in Appendix A. Using the data presented here, a daily average flow was calculated as 254 m^3/day, and the peak flow value observed was 559 m^3/day.

Table 3.4 – Septic Tanks Pumping Summary

Year	Total Flow [m^3]	Daily Average Flow [m^3/day]	Peak Day Flow [m^3/day]
1999	2332	233	341
2002	2427	270	382
2003	2128	213	368
2004	2414	241	450
2005	2973	330	**559 ***
2007	2387	239	450
Average	**2444**	**254 ***	*** - Selected Values**

3.1.4 Existing Flow Summary

Based on the sources analyzed the values in table 3.5 are presented as design average and peak flows for the RREX Park infrastructure assessment. They are based on the assumption that the Exhibition is the driving factor behind system sizing and performance due to its extremely high demand relative to the remainder of the year.

Table 3.5 – Records Summary

Record Source	Daily Average Flow [$m^{3/}$d]	Peak Day Flow [m^3/d]
2011 / 2012 Water Usage Records	240	575
2012 Visitor Records	258	576
1999 / 2008 Septic Tanks Pumping Records	254	559

Review of these results show that the flows derived from the three different sources are very similar. With no clear outliers or values that are demonstrably more accurate than any others, the maximum values of average and peak flows will be used in this report as the basis for analysis and recommendation of performance upgrades. These higher values will produce the most conservative and safest analysis of the system. The maximum values coincide in both cases with those based on the 2012 visitor records. These are:

Table 3.6 – Current Design Flows

Design Flow	Value [m^3/day]
Daily Average Flow	258
Peak Day Flow	576

3.2 EXISTING SITE SEWER INFRASTRUCTURE

The existing infrastructure was reviewed in order to determine the behaviour and performance of the pipe networks and pumping station on site.

3.2.1 Pipe Information

As-built record drawings were reviewed in order to ascertain the nature of the pipe network on site. Based on these drawings it was found that wastewater collected on site is conveyed through 250mm PVC pipes that drain by gravity to a central manhole near the existing septic tanks, north of the existing RV park. Wastewater then travels via a 300mm PVC pipe approximately 4 metres to a lift station. It is then pumped from the lift station via a 200mm HDPE forcemain to a manhole located northeast of the intersection of Portage Avenue and Race Track Road. From this point, the wastewater enters the City of Winnipeg interceptor sewer and is conveyed to the West End Water Pollution Control Centre.

Table 3.7 – Existing Pipe Information Table

Type	Diameter [mm]	Approximate Length [m]	Flow Type
PVC	200	1600	Gravity
PVC	300	4	Gravity
HDPE	200	860	Pressure

3.2.2 Lift Station information

The on-site lift station was designed by Stantec in 2008, and consists of a 1.83 m diameter wet well with two installed submersible 7.5 HP Xylem pumps. The Stantec drawings from September 2008 were reviewed as the basis for an evaluation of the lift station capacity.

The pump curve provided by Xylem at the time of the lift station's construction was analyzed to evaluate the current operation of the lift station. The pump curve was plotted against the system curve based on the current design flow developed, and the point of intersection was used to determine the operating rate of flow and total dynamic head of the pump. The resulting parameters were as follows, with the plotted pump and system curve available in Appendix B, Figure 3.1:

- Pumping Rate = 36L/s
- Total Dynamic Head = 8.5 m

Based on these values, current average daily flow pumping times were developed. Using the design daily average flow of 258m³/day, the present average daily pumping time was calculated as follows:

$$DailyPumpingTime = \frac{AverageDailyFlow}{PumpingRate} = \frac{258\,{}^{m^3}\!/_{day} * 1000\,{}^{L}\!/_{m^3}}{36\,{}^{L}\!/_{s} * 3600\,{}^{s}\!/_{hour}} = 2hours$$

Since there are two pumps in the lift station, each pump would be expected to operate 1 hour per day under average design flow conditions. Similarly present-case peak day pumping times were estimated based on the design peak day flow of 576m³/day. Current peak day pumping time was calculated as follows:

$$PeakPumpingTime = \frac{PeakDayFlow}{PumpingRate} = \frac{576\,{}^{m^3}\!/_{day} * 1000\,{}^{L}\!/_{m^3}}{36\,{}^{L}\!/_{s} * 3600\,{}^{s}\!/_{hour}} = 4.4hours$$

Once again, the dual pump configuration of the existing lift station results in each pump operating approximately 2.2 hours per day.

4.0 FUTURE FLOW PREDICTIONS

Having determined the current design flow, infrastructure dimensions, pump parameters and pumping times, the report will now develop future flow projections based on planned developments in the RREX Park.

4.1 RREX PARK FUTURE FLOW

According to the RREX Master Plan, the following new buildings are planned at the Red River Exhibition Park:

- a 100-bed hotel;
- a 100-space recreational vehicle park;
- a 10,000 m^2 Dairy Farmers of Manitoba building;
- a 14,600 m^2 Multipurpose Exposition Building;
- a 5,000 m^2 Event Centre;
- a 3,200 m^2 agricultural office building;
- a 2,100 m^2 Agricultural Commodities Park office building; and
- a 5,000 m^2 expansion to the Agricultural Commodities Park office building.

Design flows were projected based on typical per capita or unit area values for each of the proposed facilities, Design flow estimations for each facility are shown in Table 4.1:

Table 4.1 – Red River Exhibition Park Projected Flows

Facility	Master Plan N	Unit	Quantity	Unit Flow	Average Daily Flow [m^3/day]
Hotel	**3**	bed space	100	225L/unit-day	22.5
RV Park- 1	**29**	space	100	800L/unit-day	80
Dairy Farmers of Manitoba - 2	**5**	m^2	2,000	6L/unit-day	12
Multipurpose Exposition Building	**14**	m^2	14,600	5L/unit-day	73
Event Centre	**21**	person	5,000	50L/unit-day	250

Facility	Master Plan N	Unit	Quantity	Unit Flow	Average Daily Flow [m^3/day]
Agricultural Building - 2	**27**	m^2	3,200	6L/unit-day	19.2
Agricultural Commodities Park Building - 2	**6**	m^2	10,100	6L/unit-day	60.6
Expansion of Agricultural Commodities Park Building - 2	**7**	m^2	5,000	6L/unit-day	30
Total					**547.3**

Note:

1. The RV Park was assumed to be connected to the water distribution system
2. Buildings # 5, 6, 7 and 27 were assumed to be office buildings for the purposes of design
3. Areas of all buildings in Table 4.1 were estimated based on the dimensions shown on the RREX Master Plan

4.2 WESTPORT FESTIVAL FUTURE FLOW

The Westport Festival portion of the retail development plan includes 18 proposed buildings. Although the areas of the proposed buildings were known at the time of this study, the function of each building had not yet been determined. For the purposes of the flow estimation, it was assumed that all 18 buildings would function akin to a conglomerated shopping centre, and projected flows were developed accordingly, as shown in Table 4.2.

Table 4.2 – Westport Festival Projected Flows

Facility	Master Plan N	Unit	Quantity (includes all 18 buildings)	Unit Flow	Average Daily Flow [m^3/day]
Retail Development	**1**	m^2	52,635	5L/unit-day	**263.2**

4.3 DESIGN FLOW CALCULATIONS

Using the values presented in tables 4.1 and 4.2, projected design flows were developed for the developed site, as follows.

4.3.1 RREX Park Design Flows

The daily average flow for the RREX Park was calculated as being the sum of the daily average flows for the existing site and the proposed new developments to the site.

$$DesignDailyAverageFlow = CurrentDailyAverageFlow + DevelopmentDailyAverageFlow$$

$$DDAF = 258 + 548 = 806 m^3 / day$$

Having generated a design daily average flow, a design peak flow was calculated based on the Ontario Design Guidelines for Sewage Works, where the peak flow, Qp, is expressed as follows:

$$Q_p = \frac{P * Q * M}{86.4} + (I * A)$$

where

- Q_p = Peak domestic sewage flow (including extraneous flows), in L/s
- P = Design population, in thousands of people
- Q = Average daily per capita domestic flow in L/person/day
- I = Unit of peak extraneous flow (infiltration), in L/hectare/s
- A = Gross tributary area, in hectares
- M = Peaking factor

The design population for the site was calculated as the equivalent population that would generate design daily average flow presented above. Using a typical value of average daily per capita domestic flow (Q) of 300 litres per person per day, the equivalent design population is calculated as follows:

$$P = \frac{(DDAF)}{300} = \frac{806}{300} = 2.687$$

A value of 0.28L/hectare/second was selected for the peak extraneous flow, based on the recommended values in the Design Guide. The tributary area was measured from the RREX

Master Plan drawing, and a peaking factor (M) of 3.5 was applied based the Harmon peaking factor formula, executed as follows:

$$M = 1 + \frac{14}{4 + P^{0.5}} = 1 + \frac{14}{4 + 2.687^{0.5}} = 3.5$$

Based on these values, the design peak flow was calculated as:

$$Q_p = \frac{2.687 * 300 * 3.5}{86.4} + (0.26 * 76) = 52.4 \, L/s$$

The design peak flow of 52 L/s is roughly equivalent to 4530 m^3/day. This peak value is based on the application of peaking factors to both the existing and projected average daily flows. In order to verify the accuracy of this value, the process was repeated excluding the current daily average flow, to generate a peak flow for the new development only. In this case the design daily average flow was 543 m^3/day, resulting in the following values:

$$P = \frac{DDAF}{300} = \frac{548}{300} = 1.827$$

$$M = 1 + \frac{14}{4 + P^{0.5}} = 1 + \frac{14}{4 + 1.827^{0.5}} = 3.6$$

$$Q_p = \frac{P * Q * M}{86.4} + (I * A) = \frac{1.827 * 300 * 3.6}{86.4} + (0.26 * 76) = 42.7 \, L/s$$

This is the peak flow for the RREX Park new development case only. The current peak flow of 586m^3/day (6.8L/s) ,calculated in Section 4.1,was added to this total to yield a peak flow of 49.5 L/s. This value is slightly lower than the 52 L/s case based on peaking of the total daily average flow. In the interest of designing to the worst case, the higher of these two values will be selected. Therefore, the summary of design flows for the RREX Park development is as follows:

Table 4.3 – RREX Park Projected Design Flows

Design Flow	Value
Average Daily Flow	806 m^3/day
Peak Flow	52 L/s

4.3.2 Westport Festival Design Flows

The daily average flow for the Westport development was set equal to the projected flows of it component buildings, since the current Exhibition daily flow had already been accounted for in the projected design flow for the RREX Park. Therefore, for the Westport Festival site:

$$DesignDailyAverageFlow = DevelopmentDailyAverageFlow = 263.2\, m^3/day$$

Having generated a design daily average flow, a design peak flow was calculated based on the Ontario Design Guidelines for Sewage Works, where the peak flow, Qp, is expressed as follows:

$$Q_p = \frac{P * Q * M}{86.4} + (I * A)$$

Where:

- Q_p = Peak domestic sewage flow (including extraneous flows), in L/s
- P = Design population, in thousands of people
- Q = Average daily per capita domestic flow in L/person/day
- I = Unit of peak extraneous flow (infiltration), in L/hectare/s
- A = Gross tributary area, in hectares
- M = Peaking factor

The design population for the site was calculated as the equivalent population that would generate design daily average flow presented above. Using a typical value of average daily per capita domestic flow (Q) of 300 litres per person per day, the equivalent design population is calculated as follows:

$$P = \frac{DDAF}{300} = \frac{263.2}{300} = 0.877$$

A value of 0.28L/hectare/second was selected for the peak extraneous flow, based on the recommended values in the Design Guide. The tributary area was measured from the RREX Master Plan drawing, and a peaking factor (M) of 3.8 was applied based the Harmon peaking factor formula, executed as follows:

$$M = 1 + \frac{14}{4 + P^{0.5}} = 1 + \frac{14}{4 + 0.877^{0.5}} = 3.8$$

Based on these values, the design peak flow was calculated as:

$$Q_p = \frac{.0877 * 300 * 3.8}{86.4} + (0.26 * 17) = 16.1 \, L/s$$

The design peak flow of 52 L/s is roughly equivalent to 1390 m^3/day. Therefore, the summary of design flows for the Westport Festival development is as follows:

Table 4.4 – Westport Festival Projected Design Flows

Design Flow	Value
Average Daily Flow	263 m^3/day
Peak Flow	16 L/s

4.4 PROJECTED DESIGN FLOW SUMMARY

The design flows for RREX Park and Westport Festival are summarized in Table 4.3

Table 4.5 –Design Flows Summary

Site	Daily Average Flow [m^3/d]	Peak Flow [L/s]
RREX Park	806	52
Westport Festival	263	16

5.0 LIFT STATION CAPACITY

The existing lift station capacity was evaluated based on the projected RREX Park flows in order to determine whether upgrades would be required. The Westport Festival projected flows were not considered in this calculation since it was assumed that they would be conveyed to the City's sewer collection system in a separate, gravity-drained system.

Based on the maximum pumping rate of the lift station of 36L/s and the peak flow of 52 L/s generated for the RREX Park development plan, peak flows in the development will eventually exceed the capacity of the existing lift station by 44%. If no changes or upgrades were made to the system, then sewer backups and overflows would be expected to occur under peak flow conditions. Three lift station upgrade alternatives will be considered in order to determine which remediation method is most feasible. These three remediation methods to be evaluated are:

- lift station pump replacement
- external lift station storage
- forcemain diameter upgrade

5.1 LIFT STATION PUMP REPLACEMENT

One potential method of upgrading the existing lift station would be to replace the current 7.5 HP with 15 HP pumps. The pump curve for these 15 HP pumps was plotted against the existing forcemain's system curve, and it was found that the new pumps would be able to perform adequately to meet the design peak flow of 52 L/s. Pump and system curves are available in Appendix B, Figure 3.2. The coordinates of intersection point of the curves indicated that the operating flowrate and total dynamic head of the pump were:

- Pumping Rate = 53L/s
- Total Dynamic Head = 14 m

An evaluation of the pumping cycle time was performed based on these pumping rates in order to ensure that the proposed new pumps in the station do not exceed their manufacturer-recommended maximum of 10 starts per hour. In the case of pumping stations, the worst-case

cycle time occurs at half the maximum pump capacity, or 26.5 L/s in this case. At the half-capacity flow rate, the cycle time can be expressed as:

$$T = \frac{4V}{q}$$

Where:

- T = Duration of pumping cycle
- V = Lift station storage volume
- q = Maximum pump capacity

Based on a review of the as-built drawings for the existing lift station, the storage volume between the high- and low-water marks is approximately 3160 litres. Therefore, the duration of the pumping cycle is:

$$T = \frac{4 * 3160}{53} = 238\,\text{sec} \approx 4\,\text{min}$$

A cycle time of 4 minutes equates to 15 cycles per hour, or 7.5 cycles per hour for each pump. This value is within the recommended range of operation for the proposed new pumps.

It should be noted that the suggested replacement pumps are equipped with three phase motors. Since the existing station's pumps have single phase motors, it is likely that the existing power supply to the lift station will also need to be upgraded, either by replacing the Hydro service connection or installing a phase converter at the station.

A class D cost estimate for replacing the existing 7.5 HP pumps with 15 HP pumps was prepared. The estimate assumed that no modifications would be necessary to the lift station to set the new pumps, and did not account for any salvage value of the current pumps or costs to upgrade the power supply to the station. The approximate installed construction cost of replacing the existing pumps was found to be $50,000.00.

5.2 EXTERNAL LIFT STATION STORAGE

A second option to improve the capacity would be the addition of additional storage tanks upstream of the lift station. This additional volume would then store sewage that exceeded the maximum pumping rate of the existing station during peak hours, and would allow it to be pumped at a later point when system demand had subsided.

Calculations for the required storage were conducted both for the average exhibition day and the peak flow day. The exhibition working schedule was assumed to be similar to the 2012. In 2012 the RREX was open for 9 hours (from 3:00 pm to 12:00 midnight) on 5 days, 12 hours (from 12:00 noon to 12:00 midnight) on 5 days, and 13.5 hours (from 10:30 pm to12:00 midnight) on the peak day.

5.2.1 Average Exhibition Day

On the average exhibition day, the following parameters apply:

- Open time = 9 hr
- Incoming flow volume = 806 m³
- Pumping flowrate = 36 L/s

The volume that could be pumped by the lift station in continuous operation for 9 hours would be:

$$V_{out} = \frac{Q_{\max} * 3600\,{}^{s}\!/_{hr} * 9hr}{1000\,{}^{L}\!/_{m^3}} = 1116m^3$$

Assuming that the full daily average of 806 m^3 of sewage was observed during the nine hour festival period, the volume of wastewater arriving at the pump station is less than the volume that can be pumped out during the same time period. Therefore, it is estimated that in general the capacity of the existing lift station will be sufficient during an average exhibition day. However, this case assumed continuous operation of the pumps in the station, no loss of efficiency of pumps over time, and does not consider the effect of peaks in the incoming flow

rate. Furthermore, this case does not consider the impact of higher festival attendance on off-peak days. Specifically, if the current peak day attendance of approximately 50,000 visitors was to become a standard daily attendance, the daily sewage volume would increase by approximately 330 m^3, and the capacity of the lift station would be exceeded each day.

In order to pump the full daily volume of 806 m^3, the existing pumps in the lift station would have to pump for a total of 5.9 out of 9 hours, or 2.95 hours per pump. This value is within the operating range of the pumps in question.

5.2.2 Peak Exhibition Day

On the peak exhibition day, the following parameters apply:

- Open time = 13.5 hr
- Incoming flow volume = 1,810 m^3
- Pumping flowrate = 36 L/s

The volume that could be pumped by the lift station in continuous operation for 13.5 hours would be:

$$V_{out} = \frac{Q_{\max} * 3600 \, {}^{s}\!/\!_{hr} * 13.5 hr}{1000 \, {}^{L}\!/\!_{m^3}} = 1750 m^3$$

In this case a factor of 2.25 was applied to the average day to generate a peak day value to account for both the longer duration of the day and a higher demand during that day. Note that a continuous peak flow of 52L/s, presented earlier, was not applied for the 13.5 hour duration. This type of peak flow tends to occur over very short periods, such as between events, and projecting it over a full day would be unnecessarily conservative. Nonetheless, the volume of wastewater arriving at the pump station in the case presented is greater than the volume that can be pumped out during the same time period. The pumps are once again assumed to be running continuously at perfect efficiency and no peaks in flow are considered.

In this case, the minimum required site storage would be:

$$Storage = V_{in} - V_{out} = 1810 - 1750 = 60m^3$$

To store this additional volume, the existing septic tanks whose combined volume total 60,000 IG (227 m³) would be sufficient. However, it is possible that these tanks would have to be removed and reset at an elevation appropriate to the gravity sewers draining to the lift station. Also, a secondary pump may be required to force the sewage from the storage tank to the lift station. Finally, a storage tank bypass line and shutoff valve would be advisable for periods where flow volumes justify additional storage, and to allow for maintenance of the tank.

In order to pump the full peak day volume of 1810 m^3, the existing pumps in the lift station would have to pump continuously for a total of 14 hours, or 7 hours per pump. This value is within the operating range of the pumps in question, although controlling system adjustments may be required to force a pump cycle even though the station has not been emptied.

A class D cost estimate was prepared for an external storage tank. The estimate was based on the installation cost of 4 new 5,000 gallon (19 m^3) tanks to meet the storage requirements of the site. The approximate construction cost of installing external lift station storage was found to be $100,000.00.

5.3 FORCEMAIN DIAMETER UPGRADE

Increasing the diameter of the HDPE forcemain from 200mm to 250mm changes the system curve for the existing lift station, and correspondingly changes the point of intersection between the system and pump curves. Plotting the 250mm forcemain system curve against the existing 7.5 HP pump curve indicates that the existing lift station would be able to discharge 54 L/s with no alterations. This value exceeds the peak flow of 52 L/s generated in this report and is therefore an acceptable increase in lift station capacity. The plot of the system and pump curves is available in Appendix B, Figure 3.3.

A class D cost estimate for replacing the existing 960m of 200mm HDPE pipe with 250mm pipe was prepared. The estimate assumed that the existing line would be abandoned and left in

place. The approximate construction cost of replacing the forcemain was found to be $350,000.00.

5.4 UPGRADE RECOMMENDATION

Based on the three upgrade alternatives considered here, it is recommended that the existing lift station's 7.5 HP pumps be replaced with 15 HP pumps. This alternative has the lowest capital cost, does not require additional space near the lift station, and has a comparatively fast implementation period. Furthermore, this alternative's already lower cost is further offset by the salvage value of the existing pumps, and the improved system has been shown to meet or exceed demand under design loads.

5.5 UPGRADE SCHEDULING

For the purpose of evaluating the ideal schedule for the implementation of the proposed lift station upgrades, the present maximum pumping capacity of 36 L/s for the existing lift station was used to derive a theoretical maximum equivalent daily average flow. This was done by carrying out the peak flow calculation in reverse, as shown here:

$$Q_p = \frac{P * Q * M}{86.4} + (I * A)$$

Where:

$$M = 1 + \frac{14}{4 + P^{0.5}}$$

And:

$$P = \frac{DDAF}{300}$$

Combining these equations yields:

$$Q_p = \frac{\frac{DDAF}{300} * Q * \left[1 + \frac{14}{4 + \sqrt{\frac{DDAF}{300}}}\right]}{86.4} + (I * A)$$

Where:

- Q = Average daily per capita domestic flow, in L/person/day = 300
- Q_p = Existing pumping station maximum capacity, in L/s = 36
- I = Unit of peak extraneous flow (infiltration), in L/hectare/s = 0.26
- A = Gross tributary area, in hectares = 17
- $DDAF$ = Maximum design daily average flow based on the current lift station capacity, in m^3/day

Since the value of Q_p was known in this case, the formula could be solved for the DDAF, which was found to be approximately 376 m^3/day. This value includes the current Red River Exhibition daily average festival flow of 258 m^3/day, and so the estimated allowable increase in daily flow from both the development of the RREX site and any planned Red River Exhibition festival expansion is 118 m^3/day.

If the RREX Park development is considered independently of any festival attendance increase, then if the development's daily average flow was increased by 118 m^3/day from its current value, the lift station would be at risk of being undersized for peak flows during the Red River Exhibition. Table 5.1 lists the projected sewage loads of the various developments planned for the RREX Park site:

Table 5.1 – RREX Park Projected Development Flows

Facility	Daily Average Flow [m^3/day]
Hotel	22.5
RV Park	80
Dairy Farmers of Manitoba	12
Multipurpose Exposition Building	73
Event Centre	250

Facility	Daily Average Flow [m^3/day]
Agricultural Building	19.2
Agricultural Commodities Park Building	60.6
Expansion of Agr.Com. Park Building	30
Total	**547.3**

For the purposes of using this table in conjunction with expanding Red River Exhibition populations, every 1000 people in excess of the current average value of 21500 can be treated as the equivalent of an additional 12m^3/day. Therefore, based on this table, any combination of developments may be undertaken without upgrading the lift station so long as the sum of their projected daily average flows and the equivalent daily average flows from increased Red River Exhibition attendance is not more than 118 m^3/day. An example of application of Table 5.1 is as follows:

Assuming that both Agricultural Commodities Park Building and its expansion had been built, and the average attendance at the Red River Exhibition was projected to be 23,500 people per day, the total increase in daily average flow would be:

$$12.6 + 30 + \left[\frac{23{,}500 - 21{,}500}{1000}\right] * 12 = 114.6\, m^3/day$$

Since this value is less than the limiting 118 m^3/day, the existing lift station should still be adequate. However, new developments could be undertaken and Red River Exhibition attendance could not be expanded, without exceeding 118 m^3/day. Therefore, any further developments or expansion would require the upgrade of the lift station.

Based on Table 5.1 and the population expansion equivalents, the lift station must always be upgraded prior to construction of the Event Centre, or if the Red River Exhibition daily average attendance were to increase to 31,000 visitors.

6.0 GRAVITY SEWER CAPACITY

This section of the report will assess the capacity of the existing gravity sewer networks on site in order to determine what upgrades may be required to effectively convey the developed site's flows.

Preliminary calculations indicate that the existing RREX Park sanitary sewer collection system will mostly have the required capacity for future flows. However, these calculations indicate that the line from the proposed new event centre to the lift station, as shown in Appendix A, should to be upgraded to a 300mm diameter PVC pipe to meet peak flow conditions. Most of this length of pipe must be relocated as part of the construction of the Exposition Centre, and it is recommended that the upgrade be performed at this time.

Extensions to the existing system will be required in order to service new, outlying buildings. A conceptual layout was developed to indicate suggested servicing routes based on proposed development alignments and alignment cost optimization. The extend sewer routes are depicted in Appendix A.

7.0 FORCEMAIN CAPACITY

The capacity of the existing forcemain was evaluated to determine its performance if the lift station was upgraded to the recommended 15HP pumps. No information was available regarding the pipe wall thicknesses of the existing forcemain, so for the purposes of this comparison it was assumed that type DR17 HDPE pipe was used in the original construction. DR17 pipe is rated to an operating pressure of approximately 690 kPa (100 psi). Based on the pump curve for the recommended pumps, the maximum pressure that could be exerted by the upgraded lift station is approximately 226 kPa (32.8 psi). This value is based on the worst-case scenario of a complete blockage of the pipe downstream of pumps operating at full capacity. This offers a factor of safety of 3, which is acceptable for pipe design. Therefore, the existing forcemain should be sufficient for the increased pressures associated with upgraded lift station pumps.

8.0 CITY OF WINNIPEG INTERCEPTOR SEWER

It is estimated that the peak flow for the existing retail development in the north-west corner of the perimeter and Trans-Canada Highway is 16 L/s. Therefore, the total projected peak flow from the RREX Park, Westport Festival and retail development is 84 L/s. Preliminary calculations indicate that the 600 mm City of Winnipeg interceptor sewer to which the RREX Park development discharges will have the required capacity to convey the sewage from site to the West End Water Pollution Control Centre. It is important to note that this assessment is based on the pipe size alone, and not the City of Winnipeg's overall interceptor capacity based on the flows from surrounding developments. The RREX Park development's sanitary sewer plan would require review by the City of Winnipeg prior to construction to ensure that the sewage volumes generated by the site do not exceed the downstream capacity of the City infrastructure.

9.0 CONCLUSION

This study evaluated the existing conditions of the RREX Park in order to determine the capacity of the existing infrastructure and develop the basis for expansion projections. Based on these expansion projections, it was found that the current site infrastructure would not be sufficient to meet future demands. Upgrade recommendations were prepared that would ensure that the new developments infrastructure needs would be met. The upgrades that were recommended were:

- Replacement of the existing 7.5HP lift station pumps with 15HP pumps;
- Abandonment of approximately 306m of existing 250mm PVC sewer and placement of approximately 300m of new 300mm PVC sewer on a new alignment; and
- Replacement of approximately 64m of 250mm PVC sewer with 300mm PVC sewer on the same alignment.

In addition to these upgrades, proposed alignments for several new sections of 250mm and 300mm PVC sewer pipe were recommended, to service the proposed new RREX Park developments. It was found that neither the forcemain nor the City of Winnipeg interceptor sewer would require upgrades as part of the RREX Park development.

APPENDICES

APPENDIX A

EXISTING AND PROPOSED SEWER ALIGNMENTS

11x17

R.M. OF HEADINGLEY
CITY OF WINNIPEG

LEGEND

- EXISTING WASTEWATER SEWER
- PROPOSED WASTEWATER SEWER
- PROPOSED MANHOLE
- PROPOSED BUILDING

RIVER LOT 89

RIVER LOT 90

RIVER LOT 91

RIVER LOT 92

PORTAGE AVENUE

SASKATCHEWAN AVENUE

AG COMMODITIES EXPANSION

HOTEL

DAIRY FARMERS OF MB BLDG

AG COMMODITIES PARK

AG COMMODITIES PARK

EXIST. RETENTION POND

WESTPORT FESTIVAL

EVENT CENTRE

EXISTING 250 TO BE ABANDONED

MULTI-PURPOSE EXPOSITION BUILDING

EXISTING LIFT STATION

EXIST. RETENTION POND

RV PARK

AGRICULTURAL BUILDING

200 FORCEMAIN

EX. SEPTIC TANKS (60,000 GAL TOTAL)

EXIST. RETENTION POND

WESTPORT AUTO MALL

RETENTION POND OVERFLOW

ASSINIBOINE DOWNS

PERIMETER HIGHWAY (PTH No 101)

250 250 250

APPENDIX B

D&S PUMPING RECORDS

Pumping Records from June/July 1999

1 load = 3000IG

Exhibition Dates: June 25 - July 4

Date	N of loads	Pumped out, IG	Pumped out, m^3
June			
24	12	36000	163.7
25	16	48000	218.2
26	23	69000	313.7
27	17	51000	231.9
28	14	42000	190.9
29	15	45000	204.6
30	17	51000	231.9
July			
1	22	66000	300.0
2	25	75000	341.0
3	10	30000	136.4

Total Flow, m^3	**2332.1**
Number of Days	**10**
Daily Average Flow , m^3/d	**233.2**
Max Day Flow, m^3/d	**341.0**

Pumping Records from June 2002

1 load = 3000IG

Exhibition Dates: June 21 - June 30

Date	N of loads	Pumped out, IG	Pumped out, m^3
June			
21	25	75000	341.0
22	28	84000	381.9
23	20	60000	272.8
24	15	45000	204.6
25	15	45000	204.6
26	17	51000	231.9
27	16	48000	218.2
28	27	81000	368.2
29	15	45000	204.6

Total Flow, m^3	**2427.6**
Number of Days	**9**
Daily Average Flow , m^3/d	**269.8**
Max Day Flow, m^3/d	**381.9**

Pumping Records from June 2003

1 load = 3000IG

Exhibition Dates: June 20 - June 29

Date	N of loads	Pumped out, IG	Pumped out, m^3
June			
19	10	30000	136.4
20	19	57000	259.1
21	18	54000	245.5
22	17	51000	231.9
23	16	48000	218.2
24	15	45000	204.6
25	8	24000	109.1
26	15	45000	204.6
27	27	81000	368.2
28	11	33000	150.0

Total Flow, m^3	**2127.6**
Number of Days	**10**
Daily Average Flow , m^3/d	**212.8**
Max Day Flow, m^3/d	**368.2**

Pumping Records from June/July 2004

1 load = 3000IG

Exhibition Dates: June 25 - July 4

Date	N of loads	Pumped out, IG	Pumped out, m^3
June			
24	9	27000	122.7
25	15	45000	204.6
26	14	42000	190.9
27	33	99000	450.1
28	14	42000	190.9
29	14	42000	190.9
30	27	81000	368.2
July			
1	20	60000	272.8
2	14	42000	190.9
3	17	51000	231.9

Total Flow, m^3	**2414.0**
Number of Days	**10**
Daily Average Flow , m^3/d	**241.4**
Max Day Flow, m^3/d	**450.1**

Pumping Records from June/July 2005

1 load = 3000IG

Exhibition Dates: June 24 - July 3

Date	N of loads	Pumped out, IG	Pumped out, m^3
June			
24	18	54000	245.5
25	20	60000	272.8
26	19	57000	259.1
27	13	39000	177.3
28	18	54000	245.5
29	24	72000	327.3
30	39	117000	531.9
July			
1	41	123000	559.2
2	26	78000	354.6

Total Flow, m^3	**2973.1**
Number of Days	**9**
Daily Average Flow , m^3/d	**330.3**
Max Day Flow, m^3/d	**559.2**

Pumping Records from June 2007

1 load = 3000IG

Exhibition Dates: June 15 - June 24

Date	N of loads	Pumped out, IG	Pumped out, m^3
June			
16	26	78000	354.6
17	18	54000	245.5
18	10	30000	136.4
19	18	54000	245.5
20	11	33000	150.0
21	33	99000	450.1
22	20	60000	272.8
23	18	54000	245.5
24	10	30000	136.4
25	11	33000	150.0

Total Flow, m^3	**2386.7**
Number of Days	**10**
Daily Average Flow , m^3/d	**238.7**
Max Day Flow, m^3/d	**450.1**

APPENDIX C

SYSTEM AND PUMP CURVES

Figure 3.1 – Present Pump and System Curves

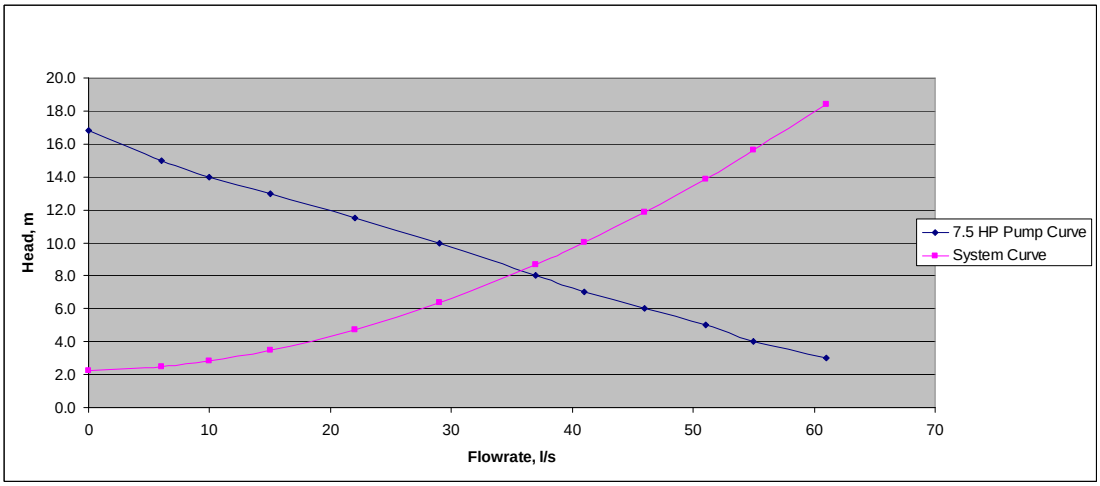

Figure 3.2 – 15 HP Pump and System Curves

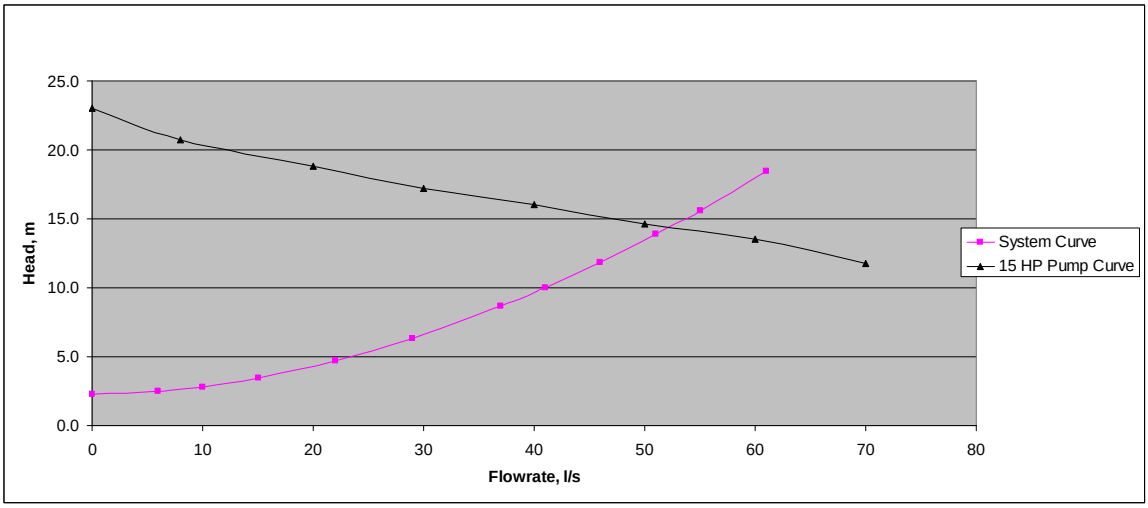

Figure 3.3 – 7.5 HP Pump and 300mm Forcemain

