Wastewater Master Servicing Plan

WESTBANK FIRST NATION

304 - 1353 Ellis Street,
Kelowna, BC V1Y 1Z9 | T: 250.762.2517
Jeremy Clowes, P.Eng.
URBAN systems
jclowes@urbansystems.ca
urbansystems.ca

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

1.1 Background and Objectives

Urban Systems Ltd. (Urban) prepared a Wastewater Master Servicing Plan (MSP) for Westbank First Nation (WFN) in 2016/17. WFN lands are comprised of five reserves totaling 2161 hectares. Tsinstikeptum IR 9 and IR 10 are the main developed community reserves, boarding Okanagan Lake and West Kelowna. The Wastewater MSP was completed for IR 9 and IR 10. The key objectives of the plan were to:

- Review growth scenarios and identify capacity deficiencies (for gravity mains, lift stations and forcemains) over a 50 year planning horizon,
- Support the asset management investment plan (AMIP),
- Identify costs, priority and schedule for upgrades to address condition, capacity and compliance based deficiencies, and,
- Identify funding sources for proposed upgrades.

The growth driven upgrade needs that were identified will inform a planned update to WFNs Development Cost Charges (DCCs).

1.2 Infrastructure Overview

IR 9 and IR 10 each have their own sanitary collection system that discharges to Regional District of Central Okanagan (RDCO) trunkmains at various locations. Flow from both reserves is conveyed to the RDCO Westside Regional Waste Water Treatment Plant located on Gellatly Road in West Kelowna. Each reserve has both WFN and privately owned infrastructure.

IR 9 includes approximately 17 km of sanitary gravity mains, 120 m of forcemains and 1 lift station that are owned by WFN. IR 9 gravity pipe sizes range from 100 mm to 450 mm.

IR 10 includes approximately 12 km of sanitary gravity mains, 4.78 km of forcemains (pumped and gravity/siphon) and 2 lift stations that are owned by WFN. IR 10 gravity pipe sizes range from 150 mm to 450 mm. Note that IR 10 also includes a WFN owned 103 m^3 dosing chamber to maintain cleansing velocities through the 250 mm siphon that parallels Highway 97 and connects to the RDCO trunkmain on Campbell Road.

RDCO is contracted by WFN to operate and maintain their sanitary infrastructure. In addition, WFN pays a service fee to the RDCO to convey and treat their wastewater.

2.0 CAPACITY BASED REVIEW

This section of the report summarizes the methodology and results for the capacity analysis.

2.1 Sanitary Base Map

An extensive update to the sanitary GIS base maps was completed at the onset of the project. The update involved adding pipes that were constructed since the base map was last updated and adding pipe invert elevations to the base map data. Refer to **Appendix E** for maps of the existing collection systems for IR 9 and IR 10.

2.2 Existing and Projected Populations

The existing population and projected populations for three growth scenarios were reviewed. See summary of existing and projected populations in the table below. The table includes equivalent populations for Institutional, commercial, and industrial lands (ICI). Refer to **Appendix A** for more detailed information on the population projections.

Table 2.1 – Equivalent Populations

Location	Year	Residential Population	ICI Equivalent Population	Total Equivalent Population
IR 9	2016	7,906	5,621	13,257
IR 9	2026	9,190	7,868	17,058
IR 9	2036	11,014	8,589	19,603
IR 9	2066	15,574	8,859	24,163
IR 10	2016	1,613	642	2,255
IR 10	2026	4,253	2,976	7,229
IR 10	2036	7,373	3,565	10,938
IR 10	2066	15,173	3,565	18,738

2.3 Existing and Projected Flows

Appendix A contains detailed information on the methodology used to establish sanitary flow values. The following summarizes the key criteria identified in **Appendix A**:

- Average dry weather flow (ADWF) of 350 l/d/c for existing population and 280 l/d/c for growth was used. Lower per capita flows are expected for growth due to a decrease in water consumption.
- 70% of the Harmon peaking factor was applied to the ADWF
- Infiltration and inflow (I/I) allowance of 5,000 L/d/ha and 10,000 L/d/ha was used for new and old pipes, respectively. Pipes installed over 40 years ago or longer were considered old for the purposes of determining the I/I allowance in each scenario.

The next table identifies the overall existing and projected flows for IR 9 and IR 10.

Table 2.2 – Overall Existing and Projected Flows for IR 9 and IR 10

Location	Year	ADWF (l/s)	Peak Dry Weather Flow (PDWF) = ADWF * Peaking Factor (l/s)	I/I Allowance (l/s)	Peak Wet Weather Flow (PWWF) = PDWF + I/I (l/s)
IR 9	2016	55	109	28	137
IR 9	2026	66	127	38	165
IR 9	2036	74	139	66	205
IR 9	2066	89	161	76	237
IR 10	2016	9	23	8	31
IR 10	2026	25	55	18	73
IR 10	2036	37	76	26	102
IR 10	2066	63	118	36	154

The flows were allocated throughout IR 9 and IR 10 as documented in Appendix B. Note that the sum of the flows in **Appendix B** is higher than the total Peak Wet Weather Flow (PWWF) shown in the above table. This is because the above table uses a lower Harmon peaking factor when the overall IR 9 or IR 10 is reviewed when compared to calculating flows for each sub-catchment that have smaller populations.

2.4 Results

The capacity of the IR 9 and IR 10 collection systems were reviewed after the GIS base was updated and flows were calculated and allocated throughout each collection system. Manning's Equation was used to estimate the capacity of the gravity mains. It is noted that this method is conservative in nature and further analysis can be completed utilizing modeling software that allows for dynamic simulations prior to proceeding with upgrades identified later in this report. It is expected that the modelling results will yield lower peak flow rates and allow WFN to minimize upgrade costs.

No capacity deficiencies were found in IR 9 for any of the scenarios that were reviewed.

Two capacity deficiencies were identified in IR 10. Both deficiencies were triggered under the 2026 growth scenario that included:

- Ferry Wharf Road Lift Station
- Dosing Chamber and Siphon

While no gravity main deficiencies were found, it is recommended that WFN monitor growth to confirm the assumptions made in this plan remain accurate (if not update the plan) and complete temporary flow monitoring to verify actual flow rates prior to allowing significant developments to tie into the existing collection system.

3.0 PROPOSED UPGRADES AND COSTS FOR CAPACITY DEFICIENCIES

This section summarizes criteria used to size upgrades and identifies proposed upgrades to address capacity based deficiencies.

3.1 Design Criteria

WFN Subdivision, Development and Servicing Law (Servicing Law) was followed for sizing proposed upgrades. Criteria for gravity mains, lift stations and forcemains and other facilities are provided below.

Gravity Mains

No gravity main deficiencies were found as previously noted. Sizing criteria from the Servicing Law has been included for reference only.

Criteria	Parameter Value
Sizing Scenario	2066 PWWF
d/D ratio at PWWF	0.66 < d/D < 0.75
Minimum Velocity	0.6 m/s
Material	PVC
Manning n	0.011
Minimum Diameter	Residential = 200 mm
	ICI = 250 mm
Slope	Assume same slope as existing gravity main

Lift Stations

Lift station upgrades are sized to accommodate growth for a 20 year period which is consistent with the expected service life of mechanical and electrical components.

Forcemains and Siphons

Proposed upgrades to forcemains and siphons were sized using the Hazen Williams Equation. A friction factor or C value of 120 was used. A minimum cleansing velocity of 1.0 m/s and a maximum velocity of 3.5 m/s were used. One exception to this was the Ferry Wharf forcemain which utilized a minimum cleansing velocity of 0.6 m/s as previously agreed to by WFN staff and identified in the report prepared by CTQ that is titled “Ferry Wharf Road Lift Station (SLS-1) Preliminary Design Brief”, dated May 18, 2011.

Dosing Chamber

IR 10 contains a dosing chamber that fills with wastewater flows and then discharges to a siphon when full. The wasterwater is released into the siphon at flow rates that ensure solids do not settle out in the pipe. The dosing chamber was sized to store twice the volume of the siphon pipe. This same sizing methodology was used for the proposed siphon upgrade.

3.2 Proposed Upgrades and Cost Estimates

The proposed upgrades are shown in Figure 3 included in **Appendix D**. Detailed Class D cost estimates are also included in **Appendix D**.

Ferry Wharf Road Lift Station

The concept for upgrading this lift station is outlined in a report prepared by CTQ that is titled "Ferry Wharf Road Lift Station (SLS-1) Preliminary Design Brief" and dated May 18, 2011. The Ferry Wharf Road Lift Station (Ferry Wharf LS) pumps from a site adjacent to Okanagan Lake (elev. 339.65 m) to a gravity main (elev. 398.8 m) upstream of the dosing chamber. The proposed upgrade will involve adding a third pump to the existing building, installing a 250 mm forcemain and abandoning the existing 150 mm forcemain. It is proposed that the forcemain be upsized as the larger pipe will decrease the pumping head by approximately 50% due to excessive friction losses.

The existing lift station has a capacity of 28 l/s and the upgrade will increase the station capacity to 56 L/s (equivalent to the 2046 growth scenario).

As alternative to the planned upgrade approach for the Ferry Wharf LS, it is recommended that WFN consider having the Ferry Wharf LS pump to another lift station that is located near the mid-point elevation between the Ferry Wharf LS and the gravity main it pumps to (referred to as the "Two Lift Station Option"). This approach would limit the pumping head of the Ferry Wharf LS, reduce energy costs, and potentially delay upgrade needs. It is recommended that WFN explore this option during the predesign of the Ferry Wharf LS.

The estimated cost for the Ferry Wharf LS upgrade is estimated to be $2.62M (in 2024 dollars and including 50% for contingency and engineering). This estimate allows for implementing the Two Lift Station Option which includes upgrading the Ferry Wharf LS, addition of a second packaged lift station and upgrading the forcemain. Land acquisition costs are not included.

Dosing Chamber and Main Siphon

The dosing chamber upgrade will involve expanding storage to ensure a minimum cleansing velocity within the siphon is maintained. The existing tank has a storage capacity of approx. 103 m^3 and the siphon has a capacity of 50 l/s. It is proposed that up to 200 m^3 storage be added and the siphon be twinned with another 400 mm main. The combined capacity of the proposed 400 mm and existing 250 mm siphon is approx. 200 L/s. Detailed modeling is recommended to verify storage requirements and the proposed pipe size. The storage requirements will be significantly higher if the future PWWF must be attenuated. It is recommended that WFN review design approach for the dosing chamber and siphon with RDCO and confirm the capacity of the downstream RDCO trunkmain.

The estimated cost for the dosing chamber and siphon upgrade is estimated to be $2.65M (in 2019 dollars and including 50% for contingency and engineering) based on above assumptions. The cost estimate allows for expanding the dosing chamber storage tank and building, providing odour control and twinning the existing siphon with a 400 mm pipe. Land acquisition costs are not included.

Alexandria Siphon

The Alexandria Siphon is located in IR 10 and has required frequent flushing to prevent solids buildup and minimize odours. This upgrade is not required strictly to address a capacity issue but is required to deal

with operational challenges. WFN reports that they spend $15,000 to $20,000 annually to flush the Alexandria siphon. WFN has had a design completed to improve the siphon operation and has scheduled this upgrade to be constructed by 2019. The estimated cost for this siphon upgrade is $175,000 (including contingency and engineering, estimate prepared by others).

4.0 COMPLIANCE BASED REVIEW

The compliance based review considered redundancy and standby power for lift stations and risks for surcharging in critical trunkmains that could cause property and/or environmental damage.

The lift station review is summarized in the table below.

Table 4.1 – Lift Station Review

Lift Station	Adequate Redundancy?	Onsite Standby Power?
Elk Road	Yes	No
Westside Road	Yes	Yes
Ferry Wharf Road	Yes	Yes

Per the above table, the Elk Road lift station does not have standby power. WFN staff noted that their preference is to have a generator installed at the Elk Road station rather than using portable genset. Staff also noted concerns with the pumps continuously clogging and guide rails being too short at the Elk Road station. It is estimated to cost $155,000 (in 2021 dollars and including 50% for contingency and engineering) to address these items. The upgrade is based on replacing pumps with another style that is more capable of handling solids (e.g., chopper, vortex) and installing a pad mounted genset with an enclosure. The upgrade is recommended to be completed within five years to eliminate these operation and maintenance issues. It is also recommended that WFN review if it is feasible to eliminate the lift station by extending a gravity sewer prior to upgrading the station.

No capacity deficiencies were found with the existing gravity mains. As such, no compliance based upgrades are identified for trunkmains.

5.0 CONDITION BASED REVIEW

An Asset Management Investment Plan (AMIP) was prepared for WFN by Urban in 2016/17. The condition or age based review was completed as part of the AMIP. Over a 20 year planning horizon the following was identified:

Table 5.1 – Condition Based Upgrades

Trigger Year	Asset	Description of Work
2030	Westside Road Lift Station	Replace process mechanical, electrical, instrumentation and HVAC mechanical components.

The AMIP identified a cost of $473,800 (in 2017 dollars) for the Westside Road Lift Station project which equates to a cost of $615,000 (in 2030 dollars and including a 30% for contingency and engineering). It is noted that no gravity mains require replacement within the next 20 years based on age as the 60 to 80 year expected service life (varies based on material) is not exceeded by any pipes. In addition, the AMIP recommends $50,000 per year be invested into wastewater infrastructure renewal or transferred into reserves for future renewal.

6.0 PRIORITIZING ALL CAPITAL PROJECTS

6.1 Prioritized Upgrades

The table below prioritizes the five upgrades previously identified. It is recommended that WFN monitor flow conditions and development to verify timing needs for the two capacity driven upgrade projects (Dosing Chamber and Siphon and Ferry Wharf Lift Station).

Table 6.1 – Prioritized Upgrades

Project	Priority Ranking	Project Name	Existing PWWF (L/s)	Existing Capacity (L/s)	Upgraded Capacity (L/s)	Description of Work	Trigger Year	Class D Cost Estimate[2]
WW-10-01	1.	Dosing Chamber and Siphon	32	50	185 (2066 growth scenario)	Add 200 m^3 of storage and twin siphon with 400 mm pipe.	2019[1]	$2,650,000
WW-10-02	2.	Alexandria Siphon	-[5]	-[5]	n/a[3]	Upgrade to prevent buildup of solids	2019	$175,000
WW-9-03	3.	Elk Road Lift Station	1.9	3.9	n/a[3]	Add standby power and replace guide rails	2021	$155,000
WW-10-04	4.	Ferry Wharf Road Lift Station and Forcemain	7.3	28	56 (2046 growth scenario)	Add third pump, install 250 mm forcemain and abandon existing 150 mm forcemain.	2024[1]	$2,620,000
WW-10-05	5.	Westside Road Lift Station	10	32	n/a[4]	Replace process mechanical, electrical, instrumentation and HVAC mechanical components.	2030	$615,000

Notes:

1. Based on linear interpolation of flows from 2016 to 2026.
2. Cost estimates include escalation allowance at 2% per year from 2017 to the trigger year.
3. Upgrade to eliminate operation and maintenance issues.
4. Upgrade to replace equipment at the end of its service life.
5. Capacity and maintenance issues reviewed separately and prior to the Wastewater MSP. Flows through the Alexandria siphon are not expected to increase significantly as potential for upstream growth is limited.

6.2 Cost Allocations

The table below identifies the cost allocation for the recommended projects. Projects that are required to increase capacity to accommodate growth have been fully allocated to growth. Projects that are required to address operational issues or renew infrastructure have been fully allocated to existing users.

Table 6.2 – Cost Allocation

Project	Class D Cost Estimate[1]	Benefit to Existing Users[2]	Attributable to Growth[3]
Dosing Chamber and Siphon	$2,650,000	0%	100%
Alexandria Siphon	$175,000	100%	0%
Elk Road Lift Station	$155,000	100%	0%
Ferry Wharf Road Lift Station and Forcemain	$2,262,000	0%	100%
Westside Road Lift Station	$615,000	100%	0%

Notes:

1. Cost estimates include escalation allowance at 2% per year from 2017 to the trigger year.
2. Funding to come from WFN wastewater rates or other sources.
3. Funding to come from DCCs or other fees charged to growth.

The images below show each of the facilities that are to be upgraded.

Dosing Chamber

Elk Road Lift Station

Ferry Wharf Road Lift Station

Westside Road Lift Station

7.0 OTHER CONSIDERATIONS

7.1 Shelter Bay Lands

There is a past agreement between WFN and RMD Group for WFN to "provide necessary water and sewer capacity equivalent of an attenuated flow of 11.2 l/s over a 24 hour period to service potential commercial, resort, hotel and high density multi-family developments on, and to support redevelopment of, the Shelter Bay Lands…"

The above flows were not allowed for in the Wastewater MSP. It is expected that the Shelter Bay Lands would be fully serviced by lift station(s) and that the forcemain(s) from this site would be routed to the same location as the existing 100 mm forcemain on the Shelter Bay Lands which discharges into a gravity trunkmain near the south boundary of IR 10 on Campbell Road.

7.2 Coordination with RDCO on Master Servicing Plan

It is recommended that WFN review the Wastewater MSP with RDCO to inform them of future projected flows that will be directed to RDCO trunkmains and the Westside Regional Waste Water Treatment Plant.

7.3 Servicing Law Review

The Westbank's Subdivision, Development and Servicing Law identifies the following key sanitary sewer design criteria:

- Domestic flow rate equals 350 L/d/c.
- Infiltration rates are 5,000 l/ha/d and 8,000 l/ha/d for pipes not in the water and in the water table, respectively.
- Infiltration rates for old pipes are 10,000 l/ha/d.
- Peak design flow is determined by applying partial Harmon peaking factor to domestic and ICI flows and adding the I/I allowance.
- Manning's n of 0.013 and 0.011 is used for concrete and PVC, respectively.
- d/D equals 0.67 to 0.75 when conveying peak hour design flow.
- Minimum cleansing velocity of 0.6 m/s and 1.0 m/s for gravity sewers and forcemains, respectively.

The domestic flow rate allowances are reasonable. Lower flow allowances can be made for communities with a fully metered water system. It is recommended that WFN review residential flow rate allowances in the future once the system has been fully metered and data can be reviewed to establish a reduced per capita allowance. Note that the Wastewater MSP uses a lower flow rate allowance for growth as WFN intends to fully meter the water system. Any reduction to the domestic flow rate allowances should consider that Servicing Law design values are generally intended to be conservative in nature which is valuable for sizing of the local collection system.

The I/I values are reasonable for pipes in and above the water table. As such, no change is recommended to these values. The I/I value of 10,000 l/ha/d for old pipes is likely overly conservative and WFN could consider deleting this allowance which would make the Servicing Law consistent with some other nearby communities (e.g., Kelowna and Vernon).

The Harmon peaking factor continues to be used by several communities in BC and no change is recommended. WFN could however, consider adopting the peaking factor identified in the 2014 MMCD Design Guidelines as an alternative (i.e., PF = 3.2/P^0.105 with population being rounded to nearest thousand).

The Manning's n values are reasonable and no change is recommended.

The d/D criteria is reasonable and no changes are recommended.

A minimum cleansing velocity of 0.6 m/s for gravity pipes is reasonable and no change is recommended.

The minimum cleansing velocity of 1.0 m/s for forcemains is at the upper end of the typical range. It is recommended WFN consider lowering this to 0.75 m/s, which is consistent with the 2014 MMCD Design Guidelines.

8.0 SUMMARY AND RECOMMENDATIONS

IR 9 and IR 10 sanitary collections systems performed very well over the 50 year planning horizon that was reviewed. Five upgrades have been identified which are identified below in a prioritized list:

- IR 10 Dosing Chamber and Siphon
- IR 10 Alexandria Siphon
- IR 9 Elk Road Lift Station
- IR 10 Ferry Wharf Road Lift Station and Forcemain
- IR 10 Westside Road Lift Station

It is recommended that WFN complete the following:

- Modeling prior to designing upgrades to confirm sizing criteria.
- Monitor growth to confirm assumptions made in the Wastewater MSP remain accurate and update the plan periodically.
- Complete temporary flow monitoring to verify existing flows prior to allowing significant developments to tie-into the collection systems.
- Review design approach for the dosing chamber and siphon with RDCO to confirm if peak flow attenuation is required (which has not been allowed for in the Wasterwater MSP) and the capacity of the RDCO trunkmain downstream of the siphon.
- Review the overall Wasterwater MSP with RDCO.
- Review updating the Servicing Law (per Section 7.3)
- Invest $50,000/yr into wastewater infrastructure renewal or transfer into reserves for future renewal.

Appendix A

Technical Memo - W/WW Design Criteria and Projected Growth

Appendix B

Flow Allocation

Appendix C

Capacity Analysis Maps

Appendix D

IR 10 Capacity Upgrades Map and Cost Estimates

Appendix E

System Ownership Maps