

**Sanitary Sewer Utility Master  
Plan**



Prepared for:  
The District of West Kelowna

Prepared by:  
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Date:  
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## Executive Summary

The District of West Kelowna (DWK) retained Stantec Consulting Ltd. to complete a review and assessment of the sanitary sewer utility system in West Kelowna. The objectives were to determine the capacity of the sanitary collection system to service the existing and future development of the District based on the Official Community Plan (OCP) and to meet current standard set by the Subdivision Servicing Bylaw. The Sanitary Sewer Utility Master Plan (SMP) will provide the basis in setting the priorities for the residents in West Kelowna.

The Regional District of Central Okanagan (RDCO) operates and maintains the Westbank Wastewater Treatment Plant (WWTP) and the regional trunk mains, forcemains, and lift stations that are shared with Westbank First Nations (WFN) and surrounding municipalities. The cost of these services are assessed and collected by the RDCO on a flow monitoring basis. The remaining infrastructure is maintained and operated by the District of West Kelowna.

The existing sanitary sewer system currently meets the capacity needs of the residents in West Kelowna however this master plan identifies the potential system short comings to achieve the ultimate build out set be the Official Community Plan. The Sanitary Sewer Utility Master Plan (SMP) will provide the direction for maintaining the necessary infrastructure for the residents of West Kelowna.

Figure 2.1 shows the legal boundaries of the District of West Kelowna and areas currently serviced by sanitary sewer collection. The estimated costs to upgrade the system are as follows:

• Replacement of Abestos Cement (AC) pipes to Polyvinyl Chloride (PVC) pipe	\$ 2.63 million
• Upgrading of Lift Stations to current standards	\$ 3.88 million
• System upgrades to service 20 year development areas	<u>\$ 1.96 million</u>
Total	\$ 8.47 million

The opinion of probable costs are preliminary, based on a conceptual level of analysis and are subject to review in detailed design. The estimated costs are based on 2013 construction dollars, include an additional 40% for engineering and contingency, and include pavement restoration where applicable.

The report recommends that the District proceed as follows:

- The District's overall Capital Projects plan in the upcoming years should utilize the prioritized schedule and budget detailed in this report.
- Monitor flows from the Westbank Centre, Shannon Lake and Glenrosa trunks and West Kelowna Estates to confirm estimated flows and determine the impacts of I&I in AC pipes.
- Update the Master Plan to include the results of the additional monitoring and modeling over a five-year timeframe.
- Conduct a program of I&I reduction and sewer waste disposal to potentially save the District from some expensive upgrades and maintenance costs such as:
  - A public education program to encourage downspout extension and lot grading improvements
  - A public education program to encourage users to dispose of waste products in the proper locations not just down the sewer pipes.
  - Implement an I&I study to determine the actual flows and validate the replacement of old AC pipes. Implement a manhole inventory program that assesses the condition and remedial work required to minimize infiltration.
  - Implement a program to identify the sources of odour within the community

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# District of West Kelowna

Sanitary Sewer Utility Master Plan

# 1 Introduction

The District of West Kelowna (DWK) is a growing community located in British Columbia's Okanagan Basin, with a population of approximately 30,900 residents. Prior to incorporation in December 2007, the municipality formed part of the Regional District of Central Okanagan (RDCO).

At the time of incorporation, DWK assumed responsibility for the sanitary sewer infrastructure within its new boundaries from RDCO except for the communities that jointly share pumping stations forcemain, trunk sewer and The Westbank Waste Water Treatment Plant (WWTP) which remains with RDCO.

Infrastructure capital and operations costs are often the largest expenditures a community faces. The effective management of the infrastructure systems and their associated life-stlye costs has an impact on the economic growth and prosperity of a community. Effective management requires comprehensive planning by experienced professionals to ensure that there is inherent 'value' in the future capital, operation, and maintenance projects and programs – specifically prioritized and implemented based on the needs and values of the community.

The Sanitary Sewer Utility Master Plan (SMP) will incorportate both the existing and the future development areas with the District boundary based on the Official Community Plan (OCP). These areas will be futher explained in Section 3 of this report.

The objectives of this study are to provide an evaluation of the existing sanitary sewer system and identify areas that need capital to bring the infrastructure up to current standards. This study will provide the District the budget information necessary to objectively plan the upgrading and renewal required in the years ahead.

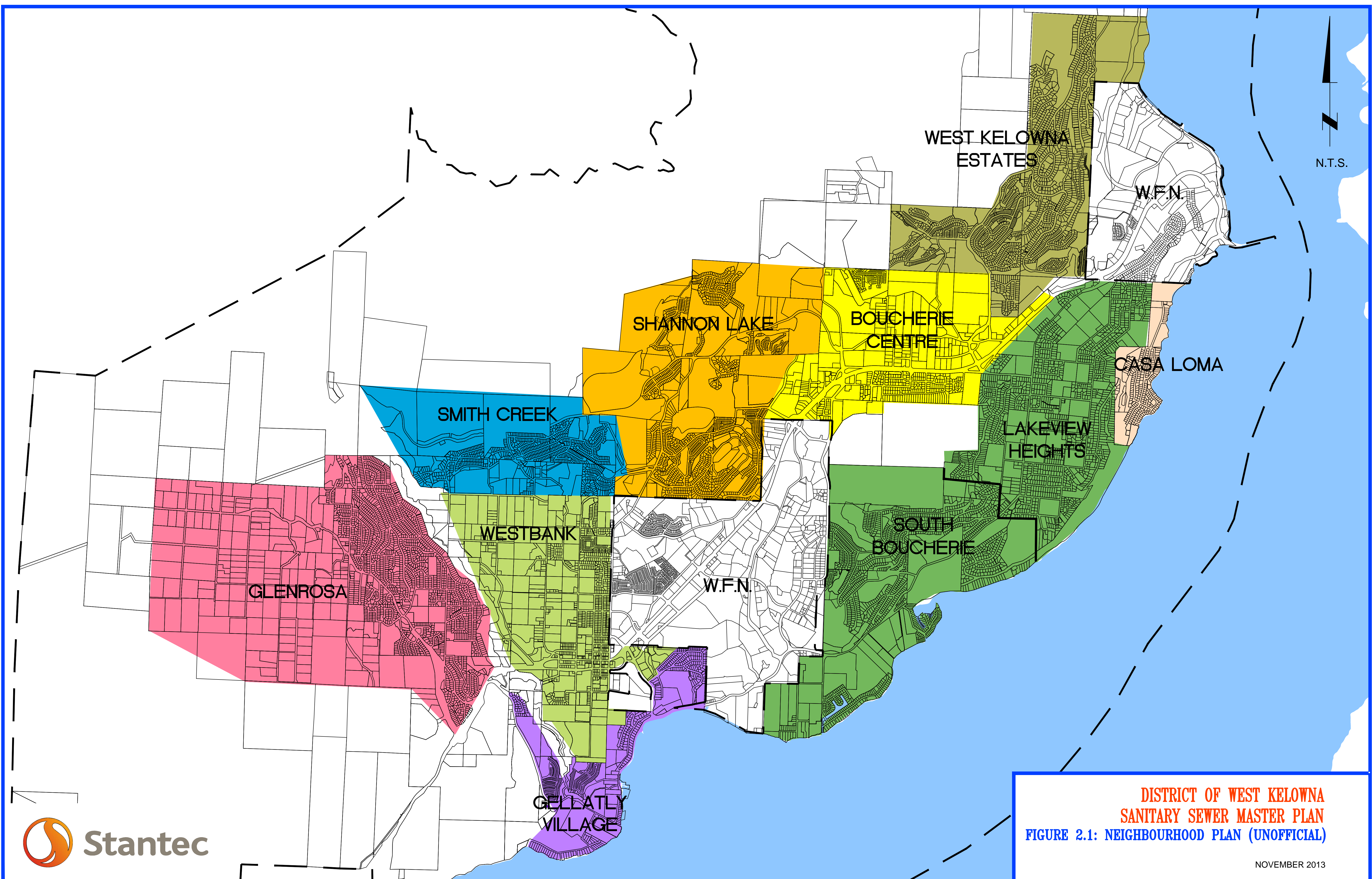


## 2 Existing Infrastructure

The Sanitary Sewer System, operated by the District of West Kelowna (DWK), consists of approximately of 180 km of existing sewer mains and 3200 manholes, and 26 Pump stations and associated forcemains. There are approximately 10,000 sanitary sewer connections currently. Also within the District boundaries are a number of trunk mains, both gravity and pressurized, and lift stations which are maintained and operated by the Regional District of Okanagan (RDCO). All sanitary sewer is collected and conveyed to the WWTP, maintained and operated by the RDCO, located at the south west corner of the DWK on Gellatly Road South.

The District has unofficially been categorized into ten (10) different neighbourhood areas.

The area's and also the land owned by First Nations, I.R. #9 and I.R. #10, are shown on Figure 2.1.



**DISTRICT OF WEST KELOWNA  
SANITARY SEWER MASTER PLAN  
FIGURE 2.1: NEIGHBOURHOOD PLAN (UNOFFICIAL)**

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## 2.1 Collection System

### RDCO Operated Infrastructure

A collection system is designed to convey flow from the Sewer Serviced Area (SSA) of a District to the ultimate end point. This is typically a Waste Water Treatment Plant (WWTP) or outfall. The DWK is different in that it effectively consists of a large number of small collection systems which all outlet to the RDCO trunk mains, the major one being the East Trunk which runs from the east boundary of the District and borders the north shore of the Okanagan Lake to the south west corner of the District where it terminates at the Westside Regional WWTP. There are a number of other trunk mains in the DWK operated by the RDCO, including:

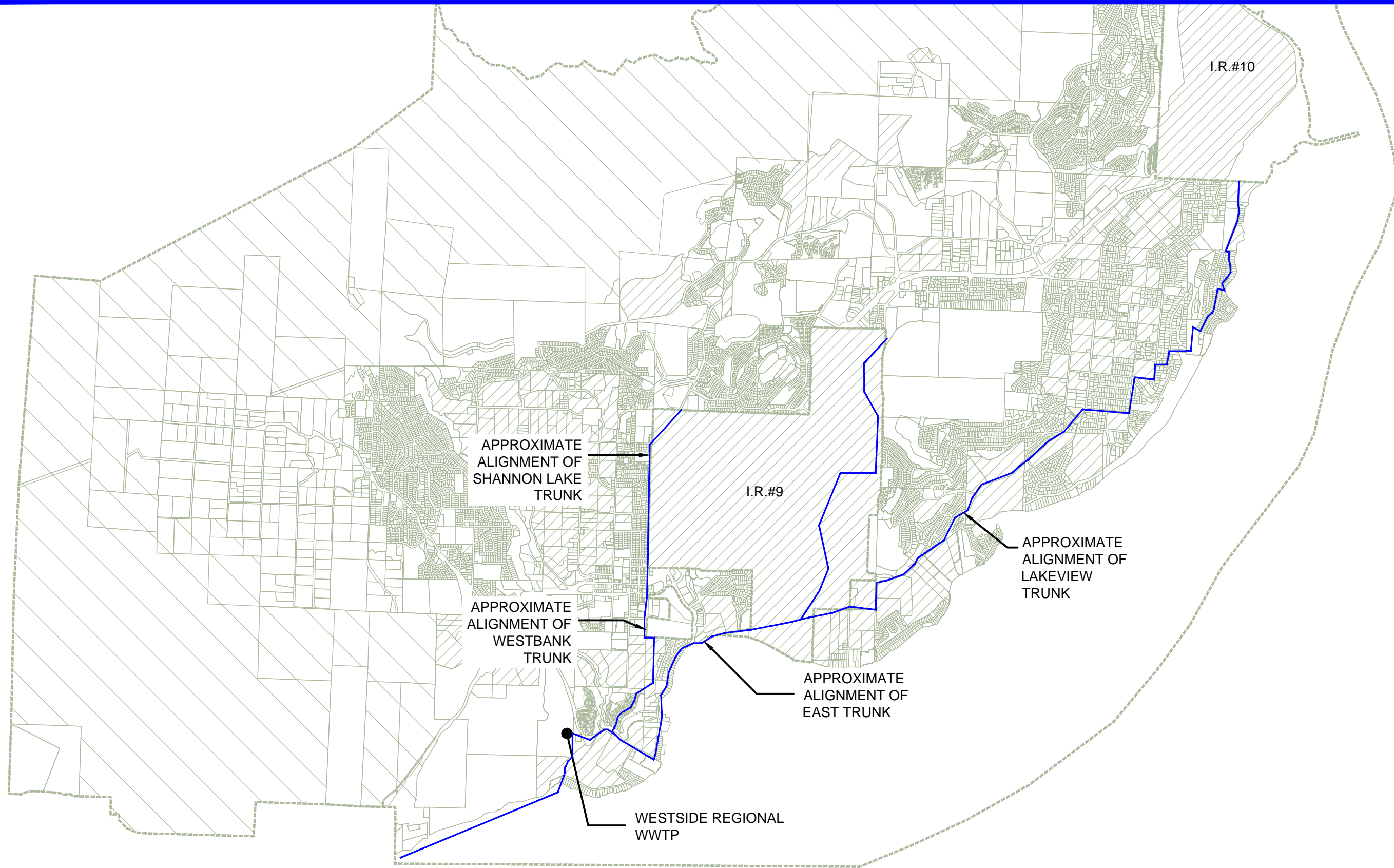
- The Shannon Lake Trunk, which takes flow from the Shannon Lake Area, through the I.R.#9, and outlets into the First Avenue Sewer Trunk,
- The First Avenue Trunk, which services various properties on the Old Okanagan Highway in the Downtown Core and also takes the flow from the Shannon Lake Trunk. This trunk outlets into the DWK system on the Old Okanagan Highway south of Dobbin Road where it runs south to the connection with the Westbank Trunk,
- The Westbank Trunk, which flows from the Downtown Area at the intersection of Ingram Avenue and the Old Okanagan Highway to the WWTP. The East Trunk forcemain also outlets into this gravity main approximately 100m east of the WWTP.
- Gellatly East Trunk, which flows from the intersection of Gellatly and Witt Road to the East Trunk.
- East Boundary Trunk, which flows along the eastern boundary of the Westbank First Nations (WFN) land from the north east corner to the connection to the east trunk.

The Westbank First Nations is also serviced by sanitary sewer, and these lines are also owned and operated by the RDCO as well as the District of Peachland.

The primary RDCO Trunk mains are shown on Figure 2.2.



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DISTRICT OF WEST KELOWNA  
SANITARY SEWER MASTER PLAN  
FIGURE 2.2: RDCO TRUNK MAINS

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## Existing DWK Infrastructure

The DWK maintains and operates the collection systems which outlet into RDCO owned and operated infrastructure. The system is relatively new and primarily consists of PVC pipes no smaller than 200mm diameter. There are isolated cases where pipes are smaller than 200mm diameter (end of cul-de-sacs etc.), but primarily the minimum diameter is 200mm diameter. There are two areas of aging piping installed in the 1960s made from Asbestos Cement (AC); the downtown core and in the Pritchard Road Areas. The DWK operations staff have indicated that the pipes in these areas are suspected of extraneous flows largely due to stormwater ingress, or Inflow and Infiltration (I & I) flows within the District. AC pipe is not desirable for a number of reasons and as it is likely reaching or has exceeded its serviceable life, consideration should be given to its replacement.

Due to the topography of the land in the DWK, the slopes on the pipes are typically relatively steep and therefore the hydraulic capacity of the collection system is generally exceeding current flow requirements.

The location of the RDCO East Trunk, runs from east to west across the southern section of the DWK. There are a number of smaller collection systems that discharge into the East Trunk either by gravity (if north of the trunk) or either pumped by means of a pump station via forcemain (if south of the trunk). The local collection systems in these smaller catchment areas primarily consist of 200mm diameter gravity mains.

The larger diameter sewer mains in the DWK system are a result of larger catchment areas. The Glenrosa neighbourhood area is serviced by the Glenrosa trunk which increases in size as the catchment area becomes larger to the south, but is no larger than 450mm diameter PVC at any point along its run. There is one exception to this trunk sewer as the slope gradient across Highway 97 decreases and a larger 525mm diameter pipe was installed to match the capacity of the steeper 450mm pipe upstream and downstream.

The other large catchment area is a result of development in the north east area of the DWK. (Neighbourhood areas West Kelowna Estates and Boucherie Centre) This catchment area ultimately outlets into the West Kelowna Trunk, and the area effectively services all properties north of Westbank First Nations, I.R. #9, as far west as Shannon Lake, including a well developed residential area in the north east corner of the DWK (Neighbourhood area West Kelowna Estates). This area has a number of smaller catchment areas which are directed to a local pump station, but all the flow from the large catchment eventually discharges from the DWK system at the West Kelowna Trunk.

## 2.2 Pump Stations

There are 26 lift stations that the District operates and maintains. The stations have been identified by number and name. A summary of the stations are listed in Table 2.2.1. Each station has been reviewed and assessed based on a scoring matrix where one (1) point was assessed if the item was not provided or not functional to a maximum of ten (10) points where the item is in good operating condition and functional. The summary of the findings are tabulated in Appendix D. The opinion of probable costs for upgrades the lift station are tabulated in Appendix E. In review of the District's new Works and Service Bylaw No. 0120 that at the time of this report has received third reading from council. This report has addressed the service and design requirements particularly the upgrading requirements of the existing lift stations. The opinion of probable costs in Appendix E provides the cost breakdown for each station. The recommended installation of backup generators was based on the location in proximity of Okanagan Lake or whether it was classified a major type station as listed in Table 2.2.1



**Table 2.2.1 List of Sanitary Lift Stations**

Lift Station Number	Lift Station Name	Lift Station Location	Install Year	Classification
1	Inverness	2856 Inverness Road	2011	Intermediate
2	Glengary	3676 Glengary Road	2011	Minor
3	Whitworth	2505 Whitworth Road	2000	Minor
4	Pineridge Place	2527 Pineridge Place	2010	Minor
5	Hitchner-Jennens	4081 Hitchner Road	2000	Minor
6	Newport Road	1764 Newport Road	1993	Intermediate
7	Pritchard Drive	1599 Pritchard Drive	1993	Minor
8	Green Bay	1361 Green Bay Road	1992	Minor
9	Boucherie Road A	3745 Westbay Road	2004	Private
10	Boucherie Road B	3750 Westbay Road	2004	Private
11	Sunnyside	1021 Sunnyside Road	2004	Intermediate
12	King Road	3271 King Road	2007	Minor
13	Thacker Road	3169 Thacker Drive	2007	Intermediate
14	Collens Hills	3050 Collens Hill Road	2006	Minor
15	Casa Rio	481 Casa Rio Drive	1991	Minor
16	Stevens Rd	1500 Stevens Rd	1997	Minor
17	Somerset Crt	2325 Somerset Crt	2007	Minor
18	Devon Crt	2329 Devon Crt	2007	Minor
19	Faulkner Crk Park	2150 Horizon Drive	1997	Major
20	Horizon Village	2100-2155 Horizon Drive	1999	Major
21	Kelkoa Dr	1750 Kelkoa Drive	2000	Minor
22	Ross Rd	2484 Ross Road	1997	Minor
23	Brentwood Rd	2610 Ross Road	1997	Intermediate
24	Sunnybrae Rd	1210 Sunnybrae Road	2001	Minor
25	Ensign Way	2100 Old Okanagan Hwy	1990	Minor
26	Hayman Rd	2415 Hayman Road	2012	Intermediate
27	Bridgeview Rd	2252 Bridgeview Road	2012	Minor
28	East Boundary Rd	2811 East Boundary Road	1993	Major

The importance of each station was also assessed based on whether they are operating in locations that have only one localized catchment area or a station that has multiple catchment areas to convey sanitary sewage to the RDCO regional collection system. The stations were then classified as Minor having only one catchment area; Intermediate having two catchment areas and Major having multiple catchment areas. The distinction between these stations provides a basis in prioritizing the importance and impact the station has in the overall sanitary sewer system.

## 2.3 Regional Systems

The Regional District of Central Okanagan (RDCO) operations and maintains the trunk sewers, lift stations and associated forcemains that collect and convey sanitary sewer flows from contributory areas outside the DWK boundaries. The sanitary sewer is conveyed to the Westside Regional Wastewater Treatment Plant (WRWWTP) for treatment and disposal as per the Ministry of Environment regulations.

Figure 2.2 indicated the RDCO system and location of the Westside Regional WRWWTP. There was no assessment or evaluation provided on these systems.

The cost of the regional system is assessed by RDCO based on the volume of sanitary flow contributed from DWK and is split between the users from WFN and the District of Peachland. The current costs are approximately \$2,600,000 annually for DWK. There is a potential of reducing the volume of sanitary flow by replacing the old AC pipes within the District. Further investigation and flow monitoring in the areas of AC pipes is required to provide a business case for strategic AC pipe replacement. Also a manhole inspection and monitoring program will also assist in reducing potential infiltration and inflow (I&I) flows.



In review of the October 21, 2013 report named Westside Regional Wastewater Treatment Plant Odour Mitigation and Foul Air Assessment Study letter Report by AECOM focused mainly on the plant location and adjacent neighbourhood. In the summary results indicated that no reduced sulphur compound could be identified, however H<sub>2</sub>S concentration were detected and there was one exception measured exceeding the British Columbia short-term exposure limit of 10(ppm) Parts Per Million. The report states that when H<sub>2</sub>S concentration is below 1ppm there is low risk of adverse health effects to the surrounding residents. This should be the recommended basis for H<sub>2</sub>S concentration in the collection and pumping system within the District. In August 2013, Discovery Research was engaged to complete a public survey of residents of the District of West Kelowna, Westbank First Nation and Peachland to assess the impacts of originating odour from WRWWTP and other sources in the community. The result of the Odour Survey dated September 23, 2013 within the 0-3km, 4-6km and 7+ km proximity bands indicated odours from sanitary sewer collection (14%) and garbage and yard waste storage/collection (11%) impact more residents than the wastewater treatment plant (8%).

The District should consider implementing educational programs to provide residents in awareness of odour generating and acceptable products permitted to be discharged into the sanitary sewer collection system. The Districts current Sanitary Sewer use Bylaw No. 0072 adopted on April 12, 2011 are in similar context with the RDCO Sewer Systems Bylaw No. 1171 adopted on June 26, 2006. Current bylaws need to continue to be implemented and comply with the at source discharge into the collection system which will minimize the impact of process and operation at the WRWWTP.

There are not any items presently identified that require to be addressed or revised in the bylaw. The District should continue to consult with the District of Peachland, Westbank First Nations and RDCO with any potential treatment conditions that the shareholders can discuss and address in their respective sanitary sewer collection and conveyance system.

The District should consider implementing a program that registers any complaints of odours within the community. Odours can be detected when H<sub>2</sub>S concentration are as low as 0.01 to 0.3ppm in which case could have a detrimental impact on the economic development within the community. The District has installed carbon filters on some lift stations in areas of odour concern from residents in the newer Sanitary Sewer installations. The District should complete a monitoring program of odour and H<sub>2</sub>S sampling within areas of concern identified by residents within the community.

## 3 Design Criteria

Although every effort has been made to ensure the modeling process accurately depicts the conditions within the actual DWK system, the criteria used to load the sewer model are only estimations based on good engineering practice, experience, and supporting literature such as the Master Municipal Construction Documents (MMCD), which the DWK have adopted. However, there are variables involved in estimating sewage flows through a system which vary between locations, such as:

- Sewage flow/capita,
- Density of people living in residential area (average people per home),
- I & I Rates (dependent on the age and pipe materials of the collection system),
- Commercial and Industrial properties vary significantly depending on the exact use.

The model has, as part of this investigation, been calibrated to more accurately reflect the actual conditions, and this has been made possible due to the flow data collected from the DWK pump stations, and assisted further by the large number of pump stations allowing more localized calibration to take place. There are some areas where further flow monitoring is recommended to further refine the model, and these recommendations are outlined further later in this report.

Collection systems should be designed to accommodate the largest expected flows which could be expected for the users in the area. This is the peak instantaneous flow expected from the system, which would be at peak times of the day and during a rainfall event where I & I rates are at the highest.

This section has been prepared to summarize the design criteria and concepts used in the review of the gravity mains, forcemains and pump stations for the District of West Kelowna Sewer Master Plan

### 3.1 Pumping Station Design Criteria

The pumping stations were reviewed using the following criteria:

- Pump Capacity = Peak hour calculated flow, including infiltration allowance
- Total Head = Static lift plus friction losses in station piping and forcemains
- Standby Pump Capacity = 100%
- Limiting Velocities:
  - Forcemain, Maximum 3.5 m/s
  - Forcemain, Minimum 1.0 m/s
- Power = 347v/600v (pumps greater than 5hp 600V, 3 phase)
- Pump Start Frequency = Less than 4 starts per hour per pump

## 3.2 Gravity Sewers Design Criteria

The gravity sewers were reviewed using the following design criteria

- Design zoning density legend : see Appendix A for Design Criteria Technical Memorandum
- Average Dry Weather Flow = 350 liters per day per person
- Peaking factor: A Diurnal Peaking Pattern has been used, developed through sewer modeling of similar size study areas.
- Infiltration and Inflow :
  - > New pipes not in water table = 5,000L/ha/day
  - > New pipes not in Water table = 8,000L/ha/day
  - > Old pipes = 10,000L/ha/day
- Gravity mains : Manning formula  $n = 0.011$  for PVC and AC;  $n=0.013$  concrete
- Pressure mains: Hazen Williams formula  $C = 120$  for PVC re-calculate using  $C=145$
- Pressure mains: minimum velocity 1.0 meter per second for scouring purposes
- Pressure mains: Minimum size 100 mm



## 4 Model Analysis

### 4.1 Sewer Model Overview

Four scenarios were selected by the District to be modeled;

- The Existing Conditions model,
- The 10 year horizon,
- The 20 year horizon,
- The Ultimate Build out scenario (to the current Official Community Plan (OCP)).

These scenarios have been modeled to allow the District to adequately plan for capital upgrades as the population of the District develops. It should be noted that the model only reflects capacity deficiencies within the system; it doesn't reflect when replacements of mains will be required as a result of aging pipes.

While OCP's can change, and are often reviewed as a community develops its vision, the models listed above are based on the current OCP as of June 2013. Any future changes to the OCP will likely have an effect on the results of the model, and this should be taken into account when reading the Master Sewer Plan.

#### 4.1.1 Existing Conditions Model

This model is intended to represent the existing conditions within the DWK Sanitary Sewer system as accurately as possible. The model was originally loaded with the design criteria as indicated in the previous section, and then calibrated to better reflect the flows being seen at certain points throughout the system. The pump stations maintained and operated by the District are on a SCADA system, which reports flows and other measurements back to the District's central mainframe. The SCADA reports provided by the District have been used to calibrate the model.

The current population of West Kelowna, as indicated in the 2011 Census, is approximately 30,900.

#### 4.1.2 10 Year Horizon Model

The "10 Year Horizon" model predicts the flows within the system in 2023. This is based upon a predicted uniform growth across the District of 2% per annum. This method of predicting medium to long term populations is an accepted method in the absence of more specific information which may indicate areas of intensive development.

The 2023 population for the District is estimated at approximately 37,800.

#### 4.1.3 20 Year Horizon Model

This "20 Year Horizon" Model has been constructed in the same way as the "10 Year Horizon" model, extending the population prediction another 10 years into 2033.

The 2033 population for the District is estimated at approximately 46,000.

#### 4.1.4 Ultimate Build Out Model

The "Ultimate Build Out" Model predicts the absolute maximum sewer flows through the system if the District was to be completely built out to its maximum density as per the OCP. This model predicts far higher flows than the 10 and 20 year horizons, and there are significant areas where lots could be subdivided into numerous smaller lots, and the Industrial and Commercial lots have the potential to produce much larger sewer flows than is currently being produced. Industrial and Commercial flows are widely variable depending on the specific use of each lot; for example, a large office building or general retail store may only have a small number of washrooms as the only contributing sewer fixtures, whereas a restaurant or laundrette would contribute far greater sewer flows to the system and yet may be allowed under the same zoning designation.

The following issues should be noted regarding the construction of the "Ultimate Build Out" Model;

- Industrial and Commercial Loadings have been based solely on the equivalent population by area, as indicated in Appendix B. This method is a generic method of loading sanitary models when more specific information is not available regarding the exact use of the commercial and industrial lots.

- The model reviews the maximum build out based on area of lots and the minimum lot sizes detailed for each zoning designation within the District's zoning bylaw. No review of the practicality of developing the lots has been made; it is highly unlikely that all lots will be developed to maximum build out due to the costs involved in developing land on steep hillsides.
- No design of collection systems outside of the current DWK system was carried out. Hence properties outside the current collection system were loaded into the model by applying the additional load to the nearest existing manhole.

## 4.2 Model Construction

### 4.2.1 Software

The District selected the software Info SWMM from Innovyze as the modeling software to be used during this Sewer Master Plan preparation. There are numerous SWMM software products on the market available, all of which are fundamentally based on the EPA (United States Environmental Protection Agency) SWMM modelling process, which is a dynamic rainfall runoff/subsurface runoff simulation model. This software has two components: a hydrologic component which is used to estimate stormwater runoff volumes and timings for various catchment areas dependent on the topography of a region, and a hydraulics component which models how the water/sewage is conveyed through the system of closed pipes, open channels, ponds, storage, and various flow regulators. When used for Sanitary Sewer plans, only the hydraulics component of the software is utilized, and flow inputs into the system are based on the use/zoning designation of each property (residential/commercial/institutional/industrial).

As mentioned above, the SWMM software products on the market are all derived from the EPA SWMM model, with varying interfaces. Popular software products include PCSWMM and Info SWMM. The District required the selected software to be compatible with the District's GIS systems and also to be similar in operation to Info Water by Innovyze. Considering this requirement Info SWMM by Innovyze was selected to be the preferred software package for the project. This will bring the following benefits to the District;

- Be fully integrated with Arc GIS. Info SWMM is built directly into the ArcGIS interface,
- Is very similar in interface to Info Water and as such will require limited additional training for District staff once they are fully trained in the operation of Info Water.

### 4.2.2 Model Construction Overview

The model was constructed using as-built information provided by the District. The as-built records for the District are generally complete, although holes do exist in the information, particularly in older areas of the system where the pipes were installed prior to accurate as-builds being maintained.

The information was provided to Stantec in the form of GIS Shape Files. The shape files were brought into Info SWMM in a form that Info SWMM is able to take the information contained in those shape files (manhole coordinates, invert elevations, pipe sizing/material/slopes etc.) and process it into a working sewer model which simulates the physical characteristics of the system.

As mentioned above, the information provided to Stantec did contain some gaps. (Refer to Figure 4.1)

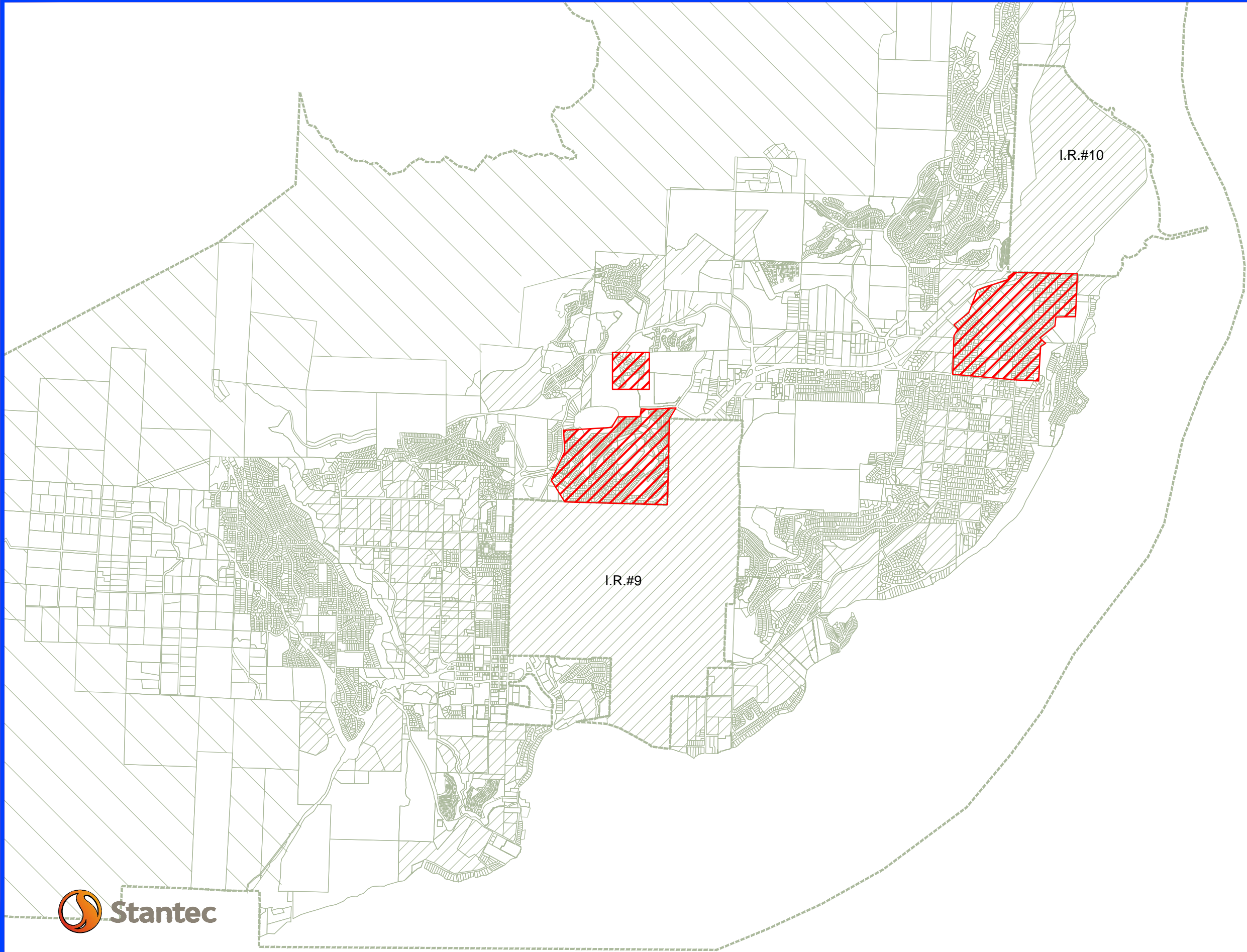
- Westbank Centre Core: The information in this area was originally limited and unreliable. Although information regarding manhole locations appeared complete, invert elevations were either absent or incorrect, and as such the hydraulic capacity of the model was not able to be accurately determined in this area.

After discussions with the District, it was agreed that this area should be a priority for surveying prior to finalizing the model. Additional survey was carried out in the downtown core in order to better define the physical characteristics of the system, although information is still incomplete.

- The neighbourhood area Shannon Lake and North of I.R. #9: No invert elevations were provided in this area. As such, it has been left out of the model construction at this time, and the estimated flow for the entire area was applied to one node .
- Residential development in the Golf Course Drive area off Shannon Lake Road: Limited and inconsistent information available, therefore not included in the model at this time. The area has been loaded to one node downstream, where the information is complete.



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LEGEND  
AREAS OF MISSING INFORMATION



DISTRICT OF WEST KELOWNA  
SANITARY SEWER MASTER PLAN  
FIGURE 4.1: GAPS IN INFORMATION

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- The neighbourhood area Lakeview Heights south of the Horizon Village Pump Station. The recently constructed Lakeview Heights Phase 2&6 and Boucherie Road projects have not been inserted in the Districts GIS mapping, therefore the piping has not been included in the model at this time and the area has been loaded to a downstream node, where the information is more complete.

It should be noted that, with the exception of the Westbank Centre area, these areas are typically at the higher regions of the District where the number of properties contributing sanitary flow upstream is relatively small i.e. these are not key areas where capacity issues are expected to be a concern such as in the main trunk lines. It is recommended that the District undertake surveys in these areas in order to complete the model.

No surveys were carried out by Stantec as part of this investigation, nor was the accuracy of the information provided verified.

### 4.3 Existing Conditions Model Analysis

The existing conditions model was loaded using the following procedure:

- The lots in the existing collection system were assigned to various nodes within the system. The loading from the lots is typically applied to the manhole upstream of the lot location, to ensure the “worst case scenario” is modeled.
- The nodes were then loaded with an average dry weather flow, based on the number and type of lots which were assigned to it. Inflow and Infiltration values were also applied to various nodes, based on the design criteria detailed in Section 3.
- This resulted in flows significantly greater than what the flow metering within the pump stations indicated the actual flows to be. The model was therefore calibrated as follows:
  - > The flow data from the East Boundary Pump Station was selected to be used as a control, as this station has the largest catchment area of all the DWK stations.
  - > The week with the lowest flows of the year was identified, and this was used as a basis to predict the dry weather flows. The average daily flow volume for that week was calculated and divided by the estimated number of SFE's in the station's catchment area. This resulted in an estimated calibrated DWF of 220L/day/capita.
  - > The Inflow and Infiltration allowance was then estimated by selecting the week with the greatest daily flows, and assuming the difference in flow between the highest and lowest flow weeks is due to inflow and infiltration. The I and I was then divided by the length of pipe within the catchment area to provide a more realistic representation of the actual stormwater ingress into the sanitary system.
- The pump station flow data was then reviewed and compared with the flow data produced by the model. The pump stations servicing primarily residential areas were used to calibrate the number of people per residential lot, in order to more accurately represent the flow within the system.

The undulating topography of West Kelowna results in the piping systems mostly being constructed on relatively steep grades. As a result, the capacity of the majority of the collection system is comfortably above the flows that the system is currently producing. However, there were a number of potential “bottlenecks” identified in the system where the capacity is limited due to flatter pipes. These are identified below and shown in Figures 4.4.1, 4.5.1 and 4.6.1:

- Highway 97 Crossing east of Shannon Lake from Byland to Ross Road. The existing pipe which crosses the Highway is a 200mm diameter pipe at 0.55%, which has a capacity when flowing full of approximately 28L/s. Although this pipe is not servicing a large upstream catchment area, there is significant potential for development upstream in the future, and this may become a capacity bottleneck.
- The Statutory Right-of-Way (SRW) at the east side of the West Kelowna Estates development which flows into Horizon Village Pump Station from the North. The existing pipe in this area is a 200m diameter PVC pipe running at 0.4% with a capacity of approximately 24L/s. This section of pipe could not be calibrated as no flow data is available for it, but the pipe is estimated to be running at approximately 40% full under existing peak flow conditions based on the flow measurements from the downstream Horizon Village pump station and the proportional number of service connections coming from the north through the easement.

- The West Kelowna Trunk main immediately to the North of the East Boundary Pump Station. The piping is 375mm diameter PVC with a number of sections running approximately 0.5% (capacity of 150L/s), but the West Kelowna Trunk accommodates flow from a very large catchment to the north of the District.
- The 250mm diameter main on Gorman Road between McNamara and Malcolm Road is laid at a very flat grade. This results in a capacity bottleneck of approximately 16.7L/s.

Despite these bottlenecks, the “Existing Conditions” Model (Appendix C) shows all pipes within the system are running within capacity.

The unit of sanitary flow which is used throughout this report is a Single Family Equivalent (SFE). This is the estimated Average Dry Weather Flow generated by a 3 person residential lot. The reason SFE's are useful in explaining sanitary flows within a system is because the flow from non-residential lots (commercial/industrial/institutional) can also be described in terms of SFE's by applying an equivalent population to the lots. In this way, all sanitary flow for areas of the system (or the system as a whole) can be described completely in an equivalent population.

## 4.4 10 Year Horizon Model Analysis

### 4.4.1 Collection System

The “10 Year Horizon” Model was loaded by increasing the “Existing Conditions” Model loading by a factor of 2% per year, which is approximately a 21% uniform increase across the whole District sewer system.

The existing collection system was reviewed to determine the impact if development occurred to the projected population at the 10 Year Horizon. Two upgrades were identified as being required within the 10 year horizon, as detailed below:

- A section of 200mm diameter pipe which crosses Horizon Drive at its south end from Node WH30 to Node WH31. The capacity of this pipe is roughly 27L/s, and this accommodates the flow from the Horizon Village Pump station (the Horizon Village pumps have an operating point of around 20.5L/s) which outlets into a manhole immediately upstream of this pipe, as well as a number of other properties by gravity. This pipe will need to be upsized to a 250mm diameter pipe to accommodate the 10 and 20 year horizons. It is unlikely that a 250mm diameter line would ever require replacing for capacity reasons, even at Ultimate Build Out Capacity (UBOC).
- A section of 250mm diameter pipe on Gorman Road between McNamara and Malcolm Road. This pipe is laid at a very flat grade, and should be upsized from 250mm to a 300mm diameter to provide additional capacity. Flow monitoring of this section is recommended prior to initiating the upgrade to confirm the modeled flows are similar to the actual flows being experienced in the system.

The upgrades required to accommodate the flow from the estimated 10 Year Horizon population are detailed on Figure 4.4.1.

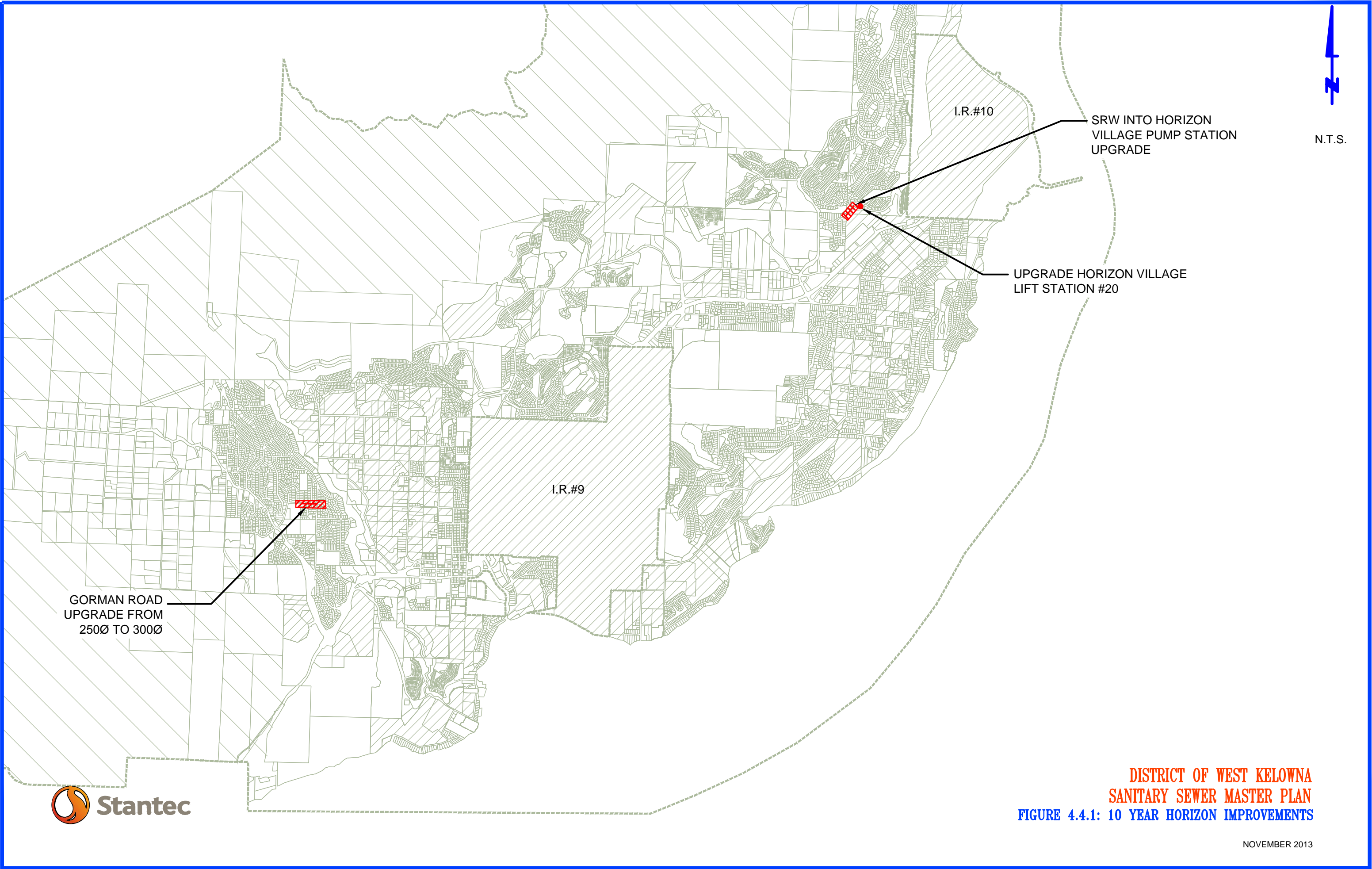
### 4.4.2 Pump Station Upgrade Timings

The pump station upgrade requirements required within the 10 year Horizon were estimated by using the following method:

- The flow data was analyzed to find the maximum day flow for the records available for each station.
- The average flow for this was taken by averaging out the volumetric flow rate over the day.
- A peaking factor was applied to the average flow in order to estimate the peak current flow.
- This peak flow had a 2% per annum growth added to it, and the estimated year of required upgrade is reached when the peak flow meets or exceeds the operating point of the pump station.

The exact requirements of the upgrades are not detailed. Depending on the exact characteristics of the station, the upgrade could include:

- Addition of a third pump to make duplex stations into triplex stations and increase the capacity (only if the station was designed to allow for the addition of a third pump),
- Replacement of the pumps with larger capacity pumps,



GORMAN ROAD  
UPGRADE FROM  
250Ø TO 300Ø

I.R.#9

I.R.#10

SRW INTO HORIZON  
VILLAGE PUMP STATION  
UPGRADE

UPGRADE HORIZON VILLAGE  
LIFT STATION #20

N.T.S.



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**FIGURE 4.4.1: 10 YEAR HORIZON IMPROVEMENTS**

- Replacement of the station completely (this upgrade would depend on wet well sizing, general condition etc. and should be evaluated at the time of actual upgrading).

Following the procedure outlined above, none of the stations are calculated as requiring replacement due to capacity limitations within the 10 Year Horizon. However, the District has indicated certain stations such as East Boundary Lift Station #28 is having some capacity issues during peak events. This could be due to the peaks exceeding the peaking factors applied as part of this theoretical exercise; it is recommended that a flow monitoring exercise be carried out at these stations which can record instantaneous flows into the stations as opposed to the daily volume readings which are the only available readings at this time.

## 4.5 20 Year Horizon Model Analysis

### 4.5.1 Collection System

The “20 Year Horizon” Model was loaded by increasing the “Existing Conditions” Model loading by a factor of 2% per year until 2033, which is approximately a 48.5% uniform increase across the whole District sewer system.

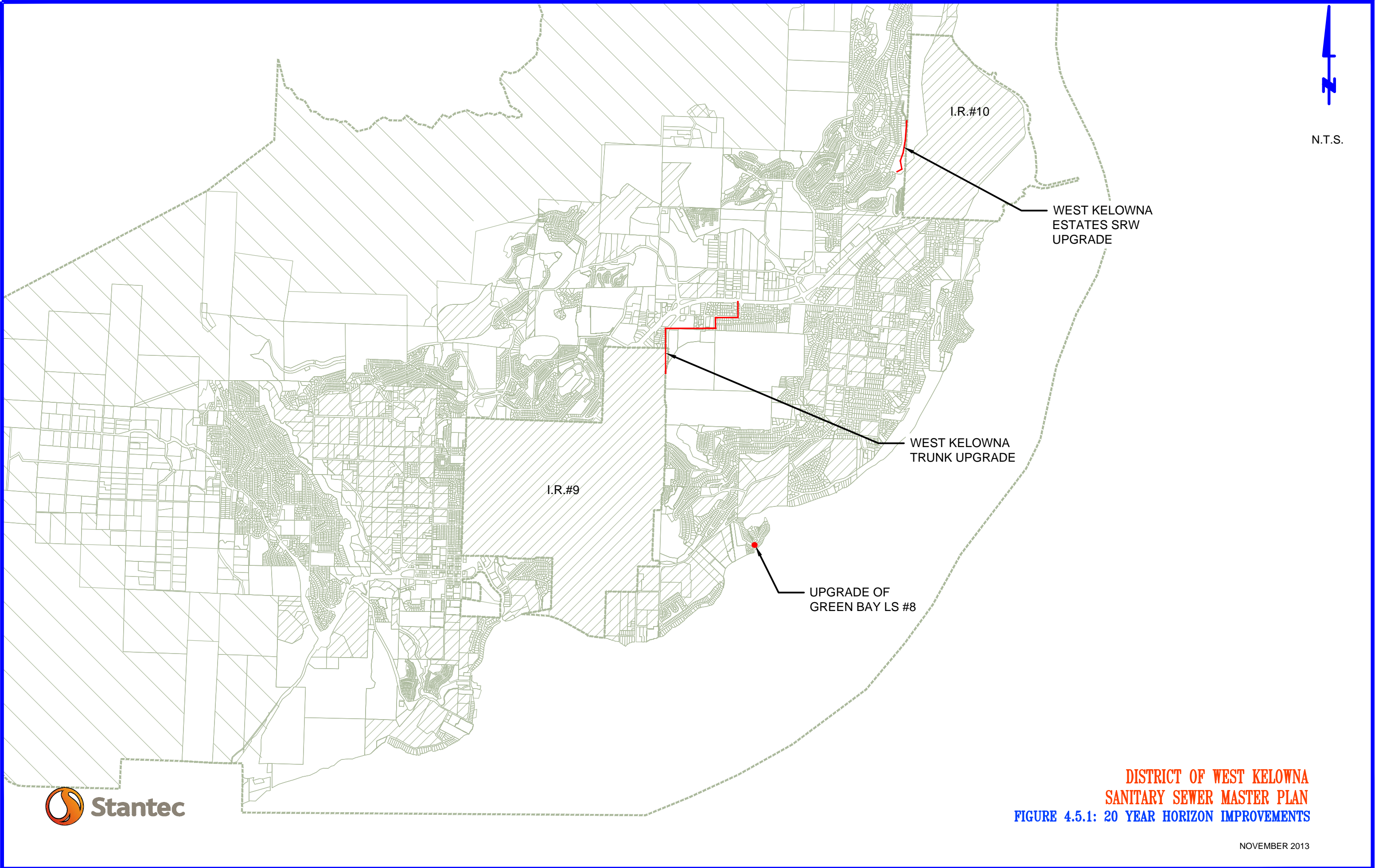
The existing collection area was reviewed to determine the impact if development occurred to the projected population at the 20 Year Horizon. Few upgrades are required to the system in order to accommodate the projected growth in 2033. Assuming a uniform growth rate across the District, the recommended upgrades are as follows:

- The West Kelowna Estates neighbourhood area, on the east side of the District bordering W.F.N, has two separate gravity systems (one which services the east side of the development, and the other which services the west side and south end), which ultimately outlet into the Horizon Village pump station. There is a 200mm diameter pipe, laid at a grade of approximately 0.4% for roughly 350m, which runs through an Statutory Right of Way (SRW) on the east side of the development, and which due to the potential for development in the north of the West Kelowna Estates area, and in the currently unserviced area to the north, this line will require upsizing to accommodate the 20 year horizon. It is recommended that this section is flow monitored to ascertain the exact flow through this section of piping in order to more accurately assess the timing of the upgrade.
- The West Kelowna Trunk System, from East Boundary Pump Station to Highway 97 where the forcemain from a number of pump stations outlets into the gravity system, services a large catchment area to the north. This gravity line is 375mm diameter, and runs at varying grades and therefore varying capacities. Some of the pipes are laid at between 0.4% and 0.5%, and therefore have a capacity of approximately 140L/s. It is good engineering practice to design collections system mains to run at no more than 60% full, to provide additional capacity for exceptional events without surcharging pipes, and at the 20 year horizon at 2% growth, this limit will likely have been reached.

The upgrades required to accommodate the 20 Year projected population are detailed on Figure 4.5.1.



N.T.S.



#### 4.5.2 Pump Station Upgrade Timings

The procedure used to estimate pump station upgrade timings for the 10 year horizon was applied to the 20 year horizon also. The investigation shows following stations, and their estimated year of required upgrade based on a 2% growth rate, will likely require upgrading within the 20 year horizon:

- Horizon Village LS #20: Scheduled for upgrading in 2015
- Faulkner Creek Park LS #19: upgraded in 2013
- Green Bay LS #8: 2031 (18 years from the date of report)

Note these are only estimates, and are subject to change depending on a number of variables such as actual growth rate, accuracy of flow data provided etc.

#### 4.6 Ultimate Build Out Condition (UBOC) Model

The “Ultimate Build-Out Condition” Model was loaded using the following procedure:

- The zoning bylaw for each zoning designation within the District was reviewed to determine the minimum lot size that is allowed.
- The area of all lots within the District was calculated, and then divided by the minimum lot size to calculate the maximum number of lots that each can be subdivided into.
- The Ultimate Build Out Equivalent Population was determined, based on the number of lots and zoning designations,
- The manholes within the DWK collection system were loaded as per the previous models i.e. each lot was loaded to the manhole upstream of the lot locations. The lots outside of the existing collection areas were loaded to the most appropriate nodes.

The flow values calculated for the UBOC model are very high, and highly unlikely to ever be experienced. The values are particularly high for the area to the north of I.R.#9. This is due to the large non-residential zoned West Side Industrial Park and potential development in the north of the District. The estimated sanitary loading for non-residential zones are based on equivalent populations per hectare, and given the large area of these zones, the estimated populations are very high for this area. The sanitary loading from these areas could vary considerably based on what commercial/industrial activities are actually installed there, so the loading calculations developed during this investigation are very conservative.

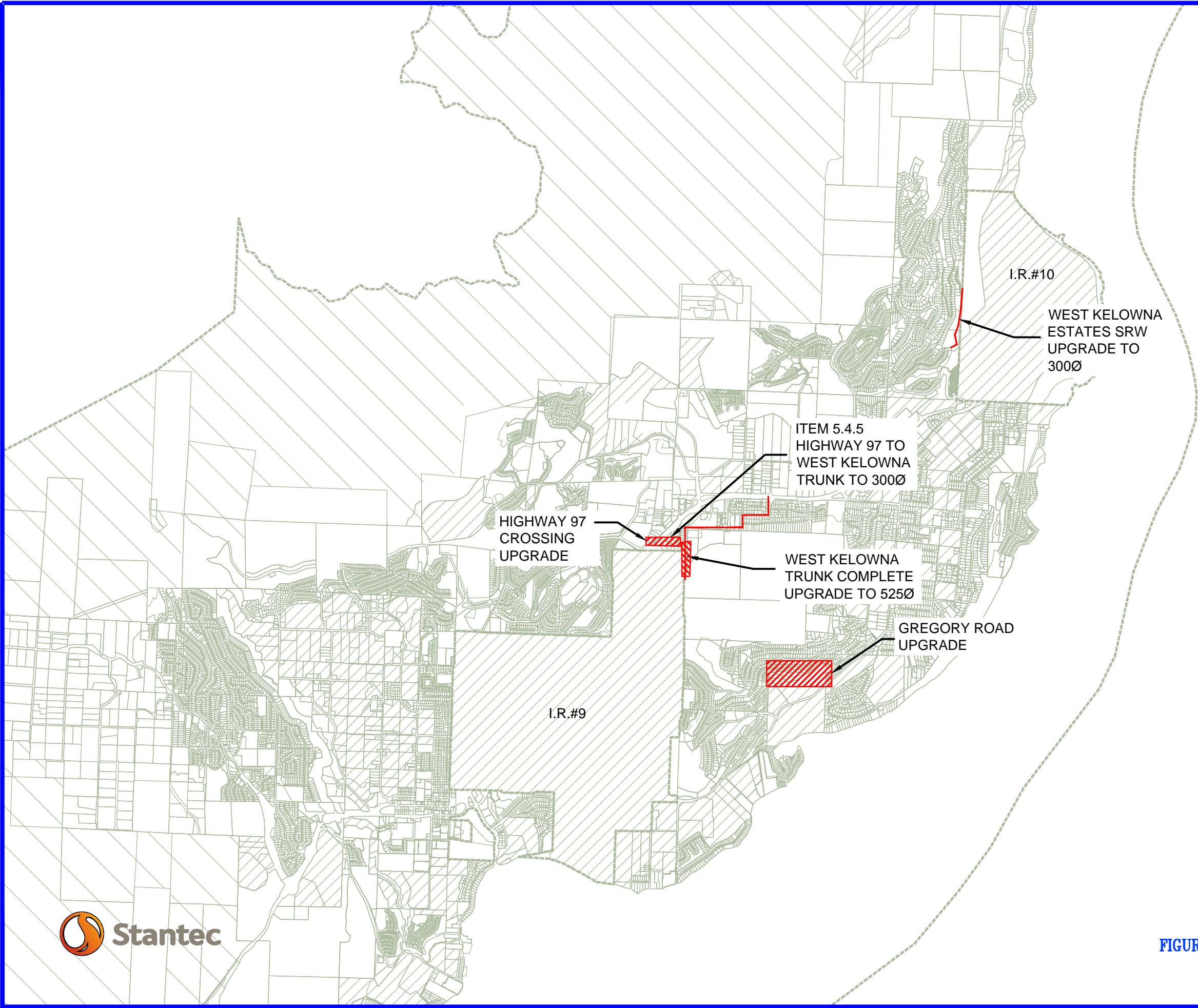
Another issue affecting the accuracy of a UBOC model is the uncertainties involving future systems which would have to be installed to service properties outside of the current SSA. How these systems would be designed cannot be known at this time, and as such the sanitary loads for properties outside of the SSA have been loaded to individual nodes for the purpose of this investigation. This method of loading the model may predict that sections of the collection system require upgrading in the future, where this may not be the case depending on the final sewer system design.

The model indicates a number of upgrades will be required to the collection system to accommodate the UBOC condition. A summary of the capacity issues at UBOC is detailed below:

- The Glenrosa neighbourhood area appears to have adequate capacity within its trunk system to accommodate ultimate build out within the development and the extensive area to the west, predominantly zoned as Rural Residential, with the potential exception of the Gorman Road pipe identified in Section 4.3.
- The District has an extensive plan for the development of the Westbank Town Centre. Due to a lack of information in this area on the existing collection system, the model is incomplete in this area. It is recommended that the District update the model with the missing information to confirm capacities within this area.
- The smaller collection systems in South Boucherie neighbourhood areas, all discharge directly into the RDCO operated East Trunk. This area has relatively restricted development potential due to Lake Okanagan to the east, the natural impediment of the steep hillside immediately east of IR#9 and a



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**FIGURE 4.6.1: ULTIMATE BUILD OUT IMPROVEMENTS**

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number of ALR zoned properties. The only section which would potentially require upgrading is a section of 200mm diameter pipe on Gregory Road which is at a very flat grade of approximately 0.3%. This section is approximately 350m in length, and would need to be either upsized or re-laid at a steeper grade. This section should be flow monitored prior to any capital upgrades being performed to confirm the actual flows through the piping, as no flow data is currently available for calibration purposes.

- There is potential for development in the north west section of the District, which will be serviced by the Shannon Lake Trunk on Shannon Lake Road. This trunk line is 250mm diameter, and has a relatively large capacity with a bottleneck pipe of capacity 50L/s. It is highly unlikely that the capacity of this line will ever be met at UBOC.
- At UBOC, depending on the distribution of the growth, it is likely that the upsizing of the 200mm diameter crossing of Highway 97 north of I.R.#9, and the downstream pipes through the private property easement to the West Kelowna Trunk, with a 300mm diameter will be required.
- The West Kelowna Trunk System, from East Boundary Pump Station to Mount Boucherie High School to Ross Road to Highway 97 where the forcemain from a number of pump stations outlets into the gravity system, services a large catchment area to the north. This gravity line is 375mm diameter, and runs at varying grades and therefore varying capacities. Some of the pipes are laid at between 0.4% and 0.5%, and therefore have a capacity of approximately 140L/s. It is good engineering practice to design trunk mains to run at no more than 60% full, and at the UBOC significant sections of this line will require upgrading.

Stantec was asked to comment on the potential for additional trunks in the future to accommodate development within the District. It is our opinion that the trunk system currently in place is well suited for the potential development in the District, and as such no additional trunks will likely be needed.



## 5 Opinion of Probable Costs

Four scenarios were analyzed during this investigation as detailed in the previous section. The opinion of probable costs (Appendix B) has been developed with the following assumptions:

1. Pumping Stations designed for full build out
2. No provisions for easements or purchasing land
3. Depth of forcemain and LPS 1.2 meters
4. Depth of gravity mains 2.5 meters
5. No provision for rock excavation
6. No provision for environmental assessments, reports, permits or associated work
7. No provision for archeological assessments, reports, permits or associated work
8. No provision for additional sewer infrastructure outside of the current collection system for the UBOC. Costs only relate to the upgrades required to the existing infrastructure.

Because additional survey and design will have to be completed, and the number of outstanding variables which could affect the development of the system, the order of magnitude costs for the various scenarios are considered Class D estimates. Class D estimates have a 40 percent margin added to the estimate for engineering, administration and contingency. All costs are in 2013 dollars.

### 5.1 Existing Conditions

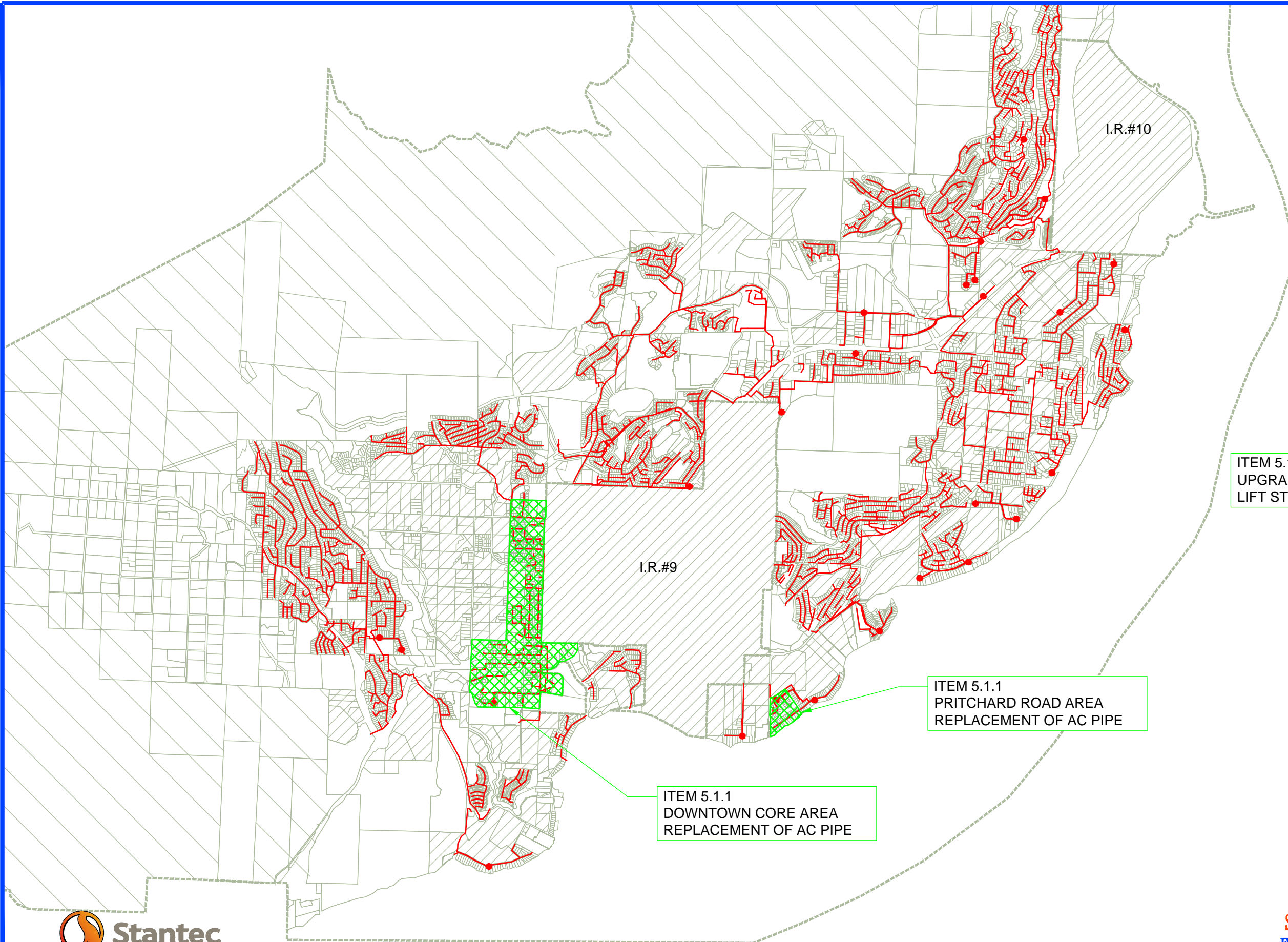
At this time, no upgrades are required to the collection system for capacity purposes, however there are the upgrades to replace old AC pipe with PVC pipe in the downtown core and Pritchard areas. There are also Sanitary lift stations that require upgrading to current codes and draft District Bylaws standards. A complete list is illustrated in Appendix E. The capacity of these stations will meet the projected 20 year population horizon except for the Green Bay LS #8. The cost of upgrading Green Bay LS #8 and Horizon Village LS #20 are removed from the below costs and these projects are eligible for DCC allocation.

**Table 5.1 Upgrades to Existing System (Refer to Figure 5.1)**

Item No.	Description	Quantity	Estimated Opinion of Probable Cost	Recommended DCC Allocation
1	Replacement of AC pipe with PVC pipe	7500m	\$2,625,000	0%
2	Upgrade of Existing Lift Stations	23ea	\$3,878,000	0%
<b>Total</b>			<b>\$6,503,000</b>	



N.T.S.



ITEM 5.1.2  
UPGRADE OF 23 EXISTING  
LIFT STATIONS - ●

ITEM 5.1.1  
PRITCHARD ROAD AREA  
REPLACEMENT OF AC PIPE

ITEM 5.1.1  
DOWNTOWN CORE AREA  
REPLACEMENT OF AC PIPE



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FIGURE 5.1: EXISTING CONDITIONS**

## 5.2 10 Year Horizon

The following Table 5.2 identifies the upgrades likely to be required to the collection system in the 10 Year Horizon, as detailed in the previous section and eligible for DCC allocation.

**Table 5.2 Upgrades within the 10 year Horizon (Refer to Figure 5.2)**

Item No.	Description	Quantity	Estimated Opinion of Probable Cost	Recommended DCC Allocation
1	Replacement of 200mm diameter line on Horizon Drive with 250mm diameter line.	85m	\$40,000	100%
2	Replacement of 250mm diameter line on Gorman Road with 300mm diameter line.	100m	\$58,000	100%
3	Upgrade Horizon Village LS#20	1ea	\$1,302,000	15%
<b>Total</b>			<b>\$1,400,000</b>	

It should be noted that it is not good engineering practice to have larger pipes downsize to smaller pipes, even if the slope increases and the required capacity could therefore be attained by a smaller pipe. However, for the purposes of cost estimating, only the sections where capacity may be an issue have been included for upsizing; downstream upsizing to ensure pipe sizes remain consistent has not been included.

## 5.3 20 Year Horizon

The following table 5.3 identifies the upgrades likely to be required to the collection system in the following 11 to 20 year horizon, as detailed in the previous section and eligible for DCC allocation.

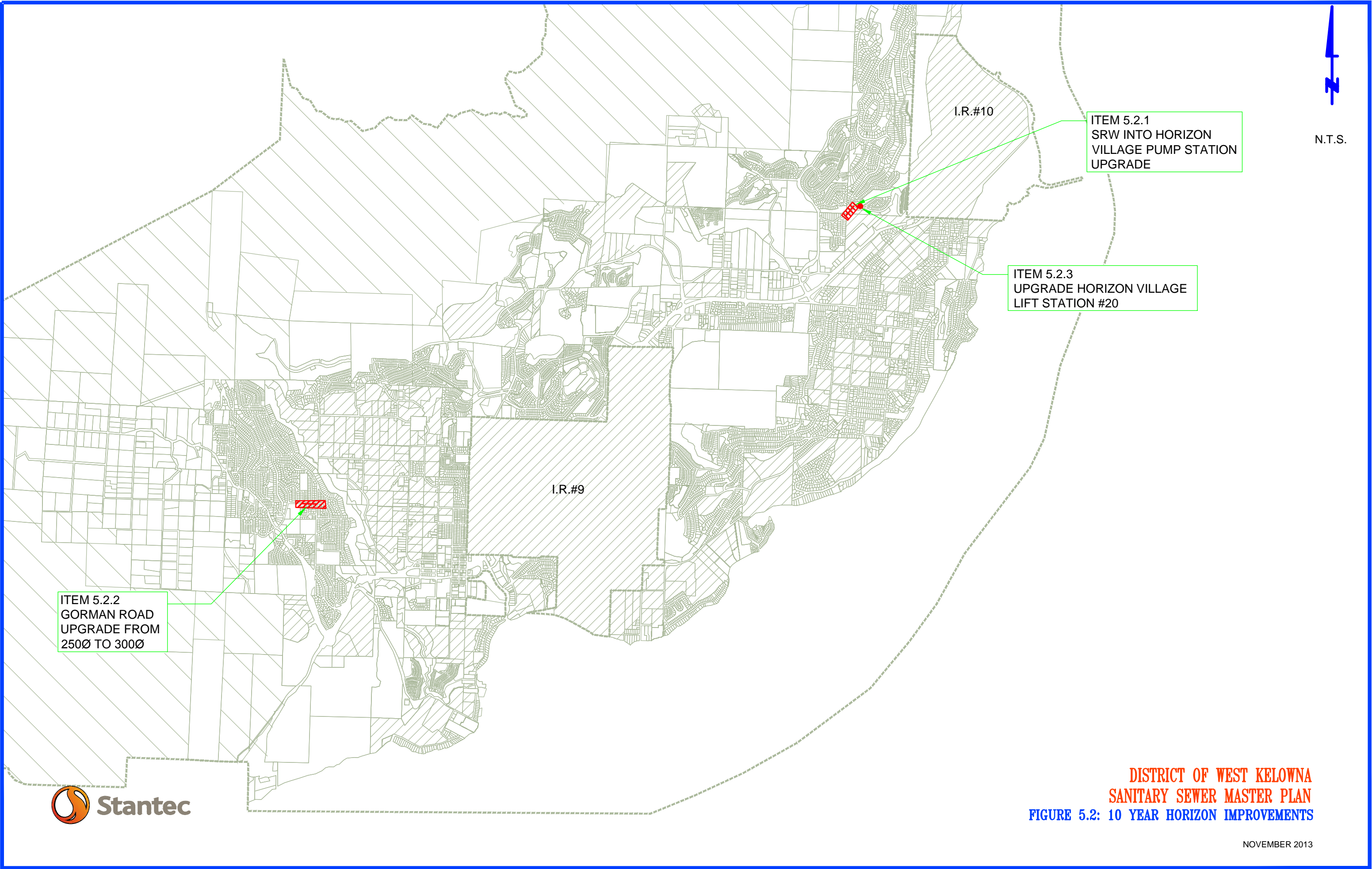
**Table 5.3 Upgrades within the 11 to 20 year Horizon (Refer to Figure 5.3)**

Item No.	Description	Quantity	Estimated Opinion of Probable Cost	Recommended DCC Allocation
1	Replacement of 200mm diameter line in West Kelowna Estates SRW with 250mm diameter line	300m	\$105,000	100%
2	Upsizing of West Kelowna Trunk to a 450mm diameter pipe in flat sections	400m	\$240,000	100%
3	Upgrade of Green Bay LS #8	1ea	\$217,000	15%
<b>Total</b>			<b>\$562,000</b>	

The projected population growth estimated within the 20 year horizon is 46,000 , an increase of 15,000 or over 5000 SFE units.



N.T.S.



ITEM 5.2.2  
GORMAN ROAD  
UPGRADE FROM  
2500 TO 3000

ITEM 5.2.3  
UPGRADE HORIZON VILLAGE  
LIFT STATION #20

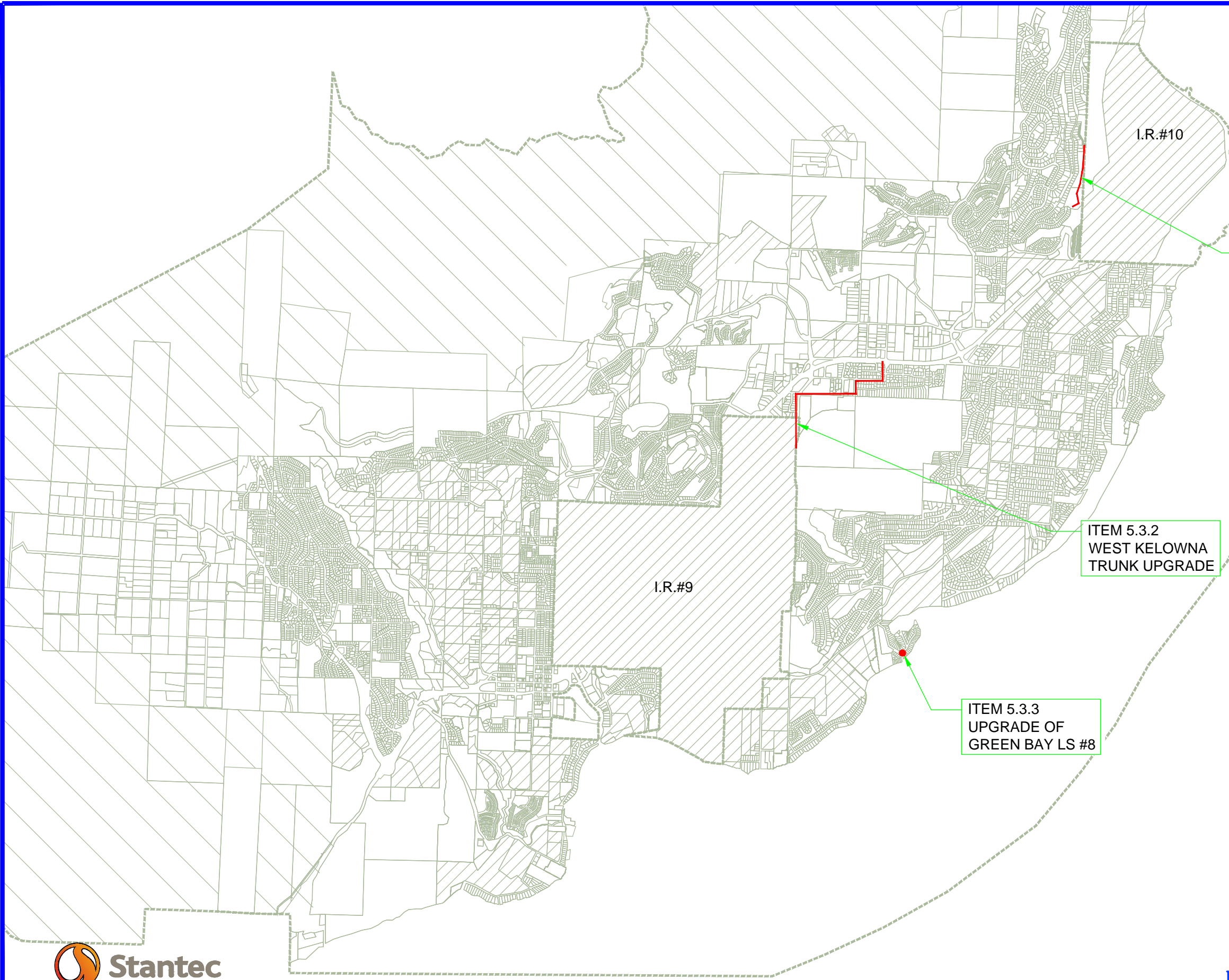
ITEM 5.2.1  
SRW INTO HORIZON  
VILLAGE PUMP STATION  
UPGRADE



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FIGURE 5.2: 10 YEAR HORIZON IMPROVEMENTS



N.T.S.



ITEM 5.3.1  
WEST KELOWNA  
ESTATES SRW  
UPGRADE

ITEM 5.3.2  
WEST KELOWNA  
TRUNK UPGRADE

ITEM 5.3.3  
UPGRADE OF  
GREEN BAY LS #8



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FIGURE 5.3: 20 YEAR HORIZON IMPROVEMENTS

## 5.4 Ultimate Build Out Conditions

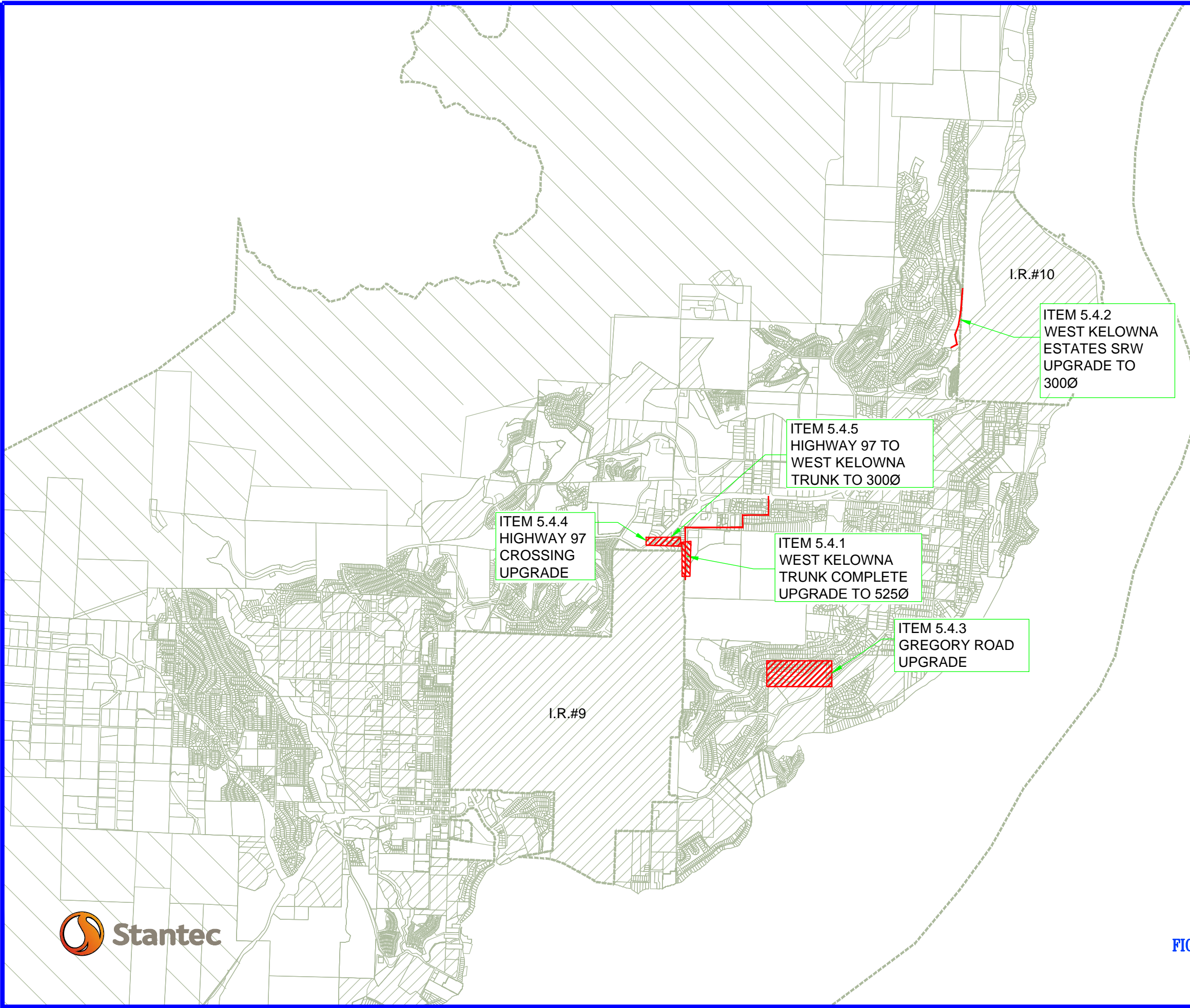
The following Table 5.4 identifies the upgrades required to the collection system to accommodate the UBOC (20+ years). These costs are in addition to the costs detailed in Sections 5.1 to 5.3.

**Table 5.4 upgrades for the Ultimate Build Out Condition (Refer to Figure 5.4)**

Item No.	Description	Quantity	Estimated Opinion of Probable Cost
1	Upsizing of Entire West Kelowna Trunk to 525mm diameter	1800m	\$1,260,000
2	Upsizing of West Kelowna Estates 200mm diameter pipe to 300mm diameter pipe to accommodate additional flow from the north	2,000m	\$700,000
3	Upsizing of 200mm diameter pipe to 300mm diameter on Gregory Road	350m	\$125,000
4	Upsizing of 200mm diameter pipe to 300mm diameter at Highway 97 Crossing	70m	\$70,000
5	Upsizing of 200mm diameter pipe to 300mm diameter between Highway 97 and West Kelowna Trunk	400m	\$200,000
<b>Total</b>			<b>\$2,355,000</b>



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**FIGURE 5.4: ULTIMATE BUILD OUT IMPROVEMENTS**

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## 6 Conclusion

Based on the analysis described within this report, Stantec Consulting has drawn the following conclusions:

- Design population densities are conservative for existing developments, but they allow for infilling and diversification over time.
- There are currently no capacity constraints identified in the modeling for the existing conditions.
- Due to the topography of the study area there are 26 lift stations.
- The majority of the sewer mains are constructed in PVC which limits the amount of infiltration and inflow into the collection system. The areas in the Downtown Core and Pritchard areas are constructed of AC pipe and it is expected to have higher I&I flows from these areas. It should be noted that this Master Plan is **not** a detailed I&I study; estimates for I&I allowances were derived from pump station daily flow volumes only. If the District is interested in more accurately defining the I&I contribution into the system, a full I&I study with a detailed flow monitoring program would need to be implemented.
- Servicing of the future development areas will require the upgrading of the Hwy 97 crossing and downstream easement piping, and West Kelowna trunk sewer.
- Appendix D of the report indicates the assessment and criteria matrix to determine which lift stations needs upgrading.
- Recommended upgrades to the collection and lift stations will cost approximately \$2.63 million and \$3.878 million, respectively to bring those systems up to current standards.
- The cost of upsizing the systems to accommodate the projects growth from development within the next 20 year horizon is estimated to be \$1.96 million of which this would be allocated to District's DCC allocation.

As has been discussed earlier in the report, the capacity of the DWK sewer collection system is generally very good, due to the topography of the District resulting in steep slopes on pipes, and numerous outfalls into the RDCO trunk mains resulting in limited catchment areas contributing to the sanitary flow within the DWK system.

This report has identified the potential bottlenecks within the system, where the capacity of the system will likely be reached first and it is recommended that a flow monitoring procedure (which measures instantaneous flow within the pipes) be implemented in the following locations so the model may be better calibrated:

- West Kelowna Trunk Main upstream of the pump station,
- Highway 97 Crossing north of I.R. #9
- Glenrosa Trunk Crossing of Inverness Park and/or Highway #97
- 200mm diameter pipe in West Kelowna Estates within the east SRW, north of the Horizon Village pump station.
- Gregory Road SRW.

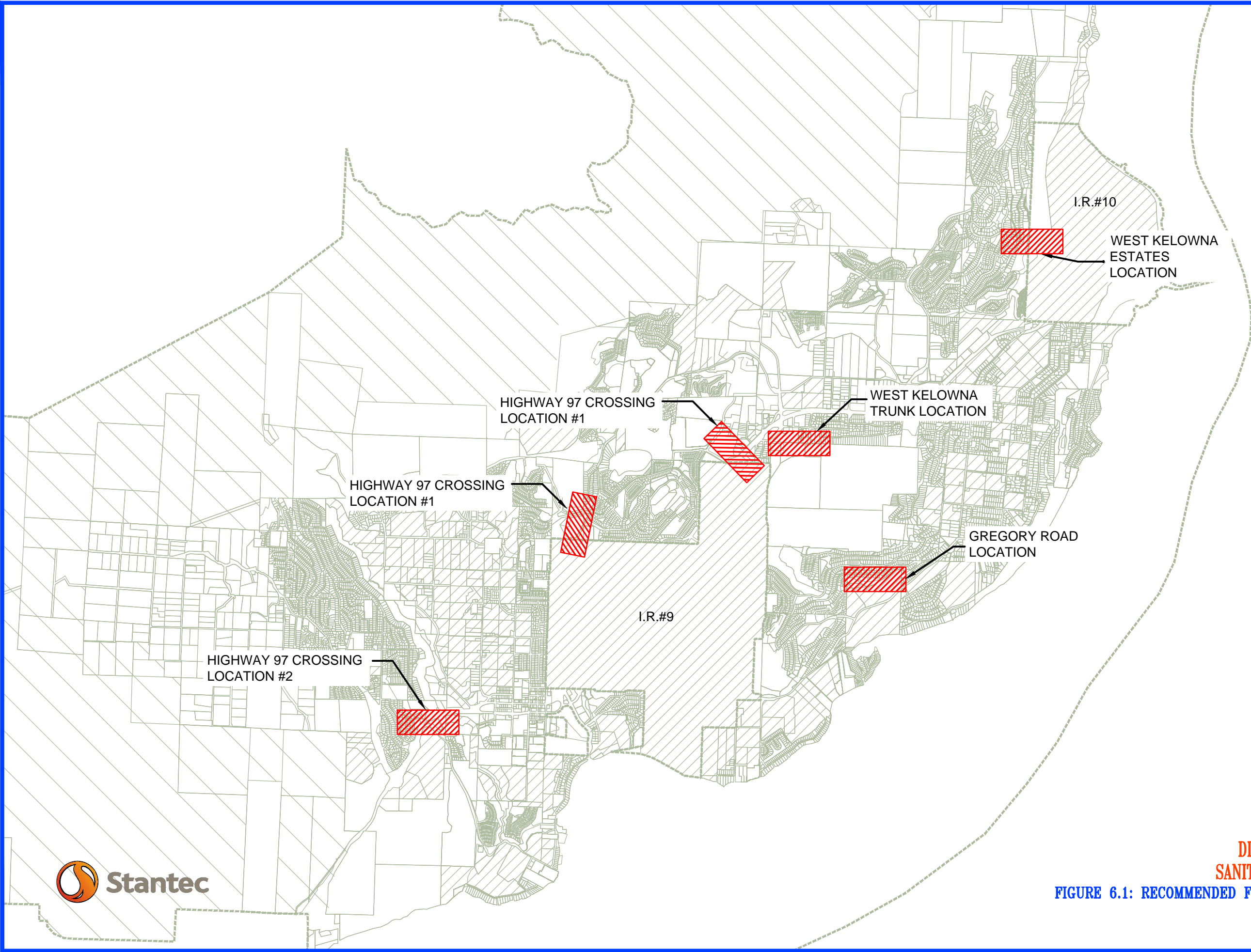
These flow monitoring locations are highlighted on Figure 6.1:

The timing of the recommended upgrades should be reviewed following these flow monitoring exercises. As these upgrades are dependent on a number of different variables, including actual growth rates and distribution and further calibration of the model following additional flow monitoring recommendations, the upgrade timings should be reviewed regularly to refine the estimates.

As was discussed during the report, the flows generated for the UBOC model are extremely high, particularly for the northern catchment area which ultimately flows through East Boundary Pump Station. It is unlikely that these flows will ever be reached, and as such the upgrades detailed for this model may never be required.



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**FIGURE 6.1: RECOMMENDED FLOW MONITORING LOCATIONS**

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## 7 Recommendations

Stantec Consulting recommends to the District to undertake the following:

- Utilize the prioritized schedule and budget with the District's overall Capital Projects plan in the upcoming years.
- Monitor flows from the Westbank Centre, Shannon Lake and Glenrosa trunks and West Kelowna Estates east SRW to confirm estimated flows and determine the impacts of I&I in AC pipes.
- Update the Master Plan to include the results of the additional monitoring and modeling over a five-year timeframe. Of particular priority should be the improvement of the model in the downtown core, given the incomplete information on the existing system in the area and the plans for significant development in the future.
- Conduct a program of I&I reduction and sewer waste disposal to potentially save the District from some expensive upgrades and maintenance costs such as:
  - A public education program to encourage downspout extension and lot grading improvements
  - A public education program to encourage users to dispose of waste products in the proper locations not just down the sewer pipes.
  - Implement an I&I study to determine the actual flows and to validate the replacement of old AC pipes.
  - Implement a manhole inventory program that assesses the condition and remedial work required to minimize infiltration.
  - Implement a program to identify odours and the sources within the community to assist the District in providing solutions.

Prepared by:

Stantec Consulting Ltd.

Jim Kentel, P.Eng.

Project Manager

Shaun Swarbrick, P.Eng.

Project Engineer



## 8 Assumptions and Limitations of the Report

As this report is a high level review of the system, and numerous assumptions had to be made regarding growth rates and distribution, the following aims to summarize those assumptions and subsequent limitations when interpreting the report:

- **Uniform 2% growth rates assumed over the District:** In the absence of more complete information, it was agreed at the outset of the report to model the growth as a 2% growth uniformly across the District. This is unlikely to be the case, as residential or commercial developments will create areas of high density growth when constructed, and there will be areas of low growth where restrictions to growth exist (area already close to maximum density, topography is restrictive, ALR lands etc.). As such, upgrade timings will likely vary.
- **Flow calibration:** The flow data available for calibrating the model is from January 2013 to September 2013 only. It was also available only in daily volumes, and not in instantaneous flow data. In collection system design, it is the instantaneous peak flows that must be accounted for, so the daily volume data had to be converted into peak flows. This was done in accordance with typical sewer modeling procedure, by averaging the flow over 24 hours and applying a peaking factor. However, the actual peak flows may vary from those calculated and as such, various recommendations such as upgrade timings may vary.
- **Service Connections:** It was assumed that all properties within the existing collection system are connected to the system, but the District has indicated that this is not the case.
- **Cost estimating assumptions:** Costs outlined are very preliminary and considered “ballpark” estimates only. There are numerous variables that are unknown at this time that will affect the cost of the projects that cannot be foreseen. Stantec does not accept liability for variations in the estimated costs detailed in this report.