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To:	**Town of Okotoks**	Date:	**February 11, 2020**
Attention:	**Rob Dickinson, P.Eng.**	Project No.:	**27471**
Cc:	**Sanitary Master Plan Update Project Team**		
Reference:	**Okotoks Sanitary Servicing Master Plan Update Memorandum**		
From:	**Geoffrey Schulmeister, P.Eng., SCPM, Sarah Barbosa, P.Eng., ENV SP**		

1.0 Introduction

In 2016, ISL Engineering and Land Services Ltd. (ISL) completed the Sanitary Servicing Master Plan (SMP) for the Town of Okotoks (the Town). The Town has requested ISL to complete an update to adopt the recommended servicing strategy to fit with the Town's updated Growth Strategy and provide additional staging to reach the ultimate growth horizon.

The SMP completed in 2016 worked to review logical servicing considerations for ultimate servicing (60 years), with an interim horizon at 30 years. Options were reviewed in a global sense. Typically after this, interim staging is considered to assist in the overall capital planning process, but a growth direction is required such that growth does not occur in all directions. At the time of the completion of the SMP, this planned direction was not yet known.

The Town has recently adopted a new Growth Strategy, which will define growth priorities, including direction and staging. Based on this, it was deemed time to revisit the SMP to undertake an assortment of minor updates, to amend the overall servicing concept to suit the Town's direction at this time, to prepare additional staging steps up to the ultimate servicing horizon, and to assist in preparing staging plans for capital planning and off-site levy development.

The study area amounts to a sewershed area of over 1,950 hectares within the pre-annexation Town boundary, plus the lands annexed in 2017. In all, the total study area including the recently annexed lands reaches over 4,000 hectares. The study area is illustrated in Figure 1.1. The Town is transected by the Sheep River, which generally flows from northwest to southeast. As a result, land to the north of the river generally drains south, while land to the south generally drains to the north. The topography ranges from 1,165 m near the Foothills Country Hospice Society to 1,032 m at the Sheep River on the east boundary of the Town. A topographical map is illustrated in Figure 1.2.

This deliverable is intended to be an update / amendment memorandum attached to the SMP. The purpose of this deliverable is as follows:

- To update baseline data and the MIKE URBAN model based on growth since the completion of the SMP.
- To update the overall servicing concept based on the updated growth plans.
- To prepare servicing options based on the refined overall servicing plan for the 5 year, 10 year, 25 year, and ultimate servicing horizons.
- To prepare staging plans for existing system upgrades in conjunction with future system expansion, along with costs and cost assignments (Town / Off-site Levy / Developer).

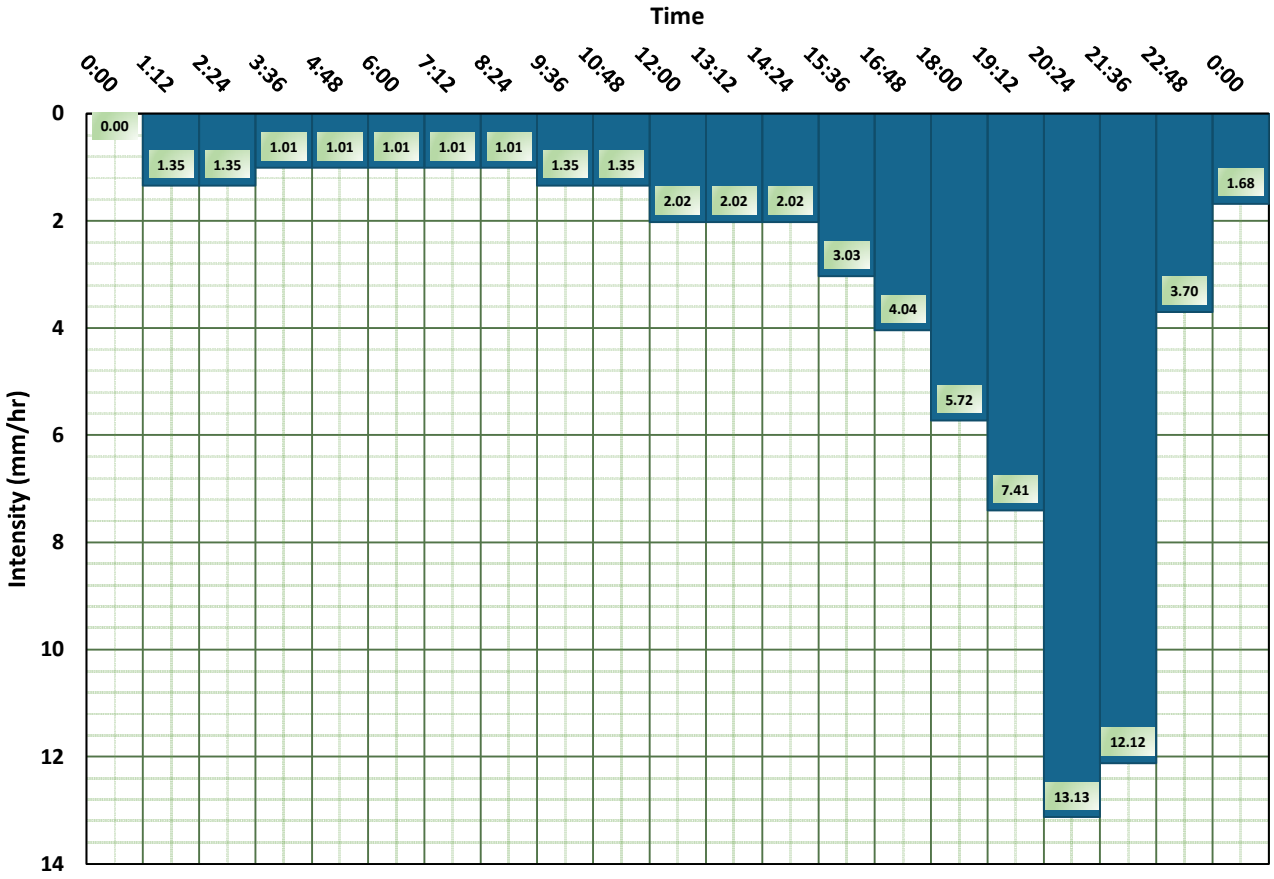
2.0 Design Criteria

In large, the design criteria determined and discussed in the SMP was also assumed for this memorandum. A summary of the design criteria that was utilized is provided in the sections below.

2.1 Level of Service (LOS)

For the purpose of this memorandum, a single LOS was applied for both the existing and future system assessments. The chosen LOS is the 50 year 24 hour Q4 Huff Storm, to be consistent with the criteria selected by The City of Calgary. A Huff rainfall distribution replicates a storm with a moderate peak intensity, which is ideal for wastewater system analysis. The initial RDII boundary condition for the root zone storage (L_{ini}) for each catchment was adjusted such that the L/L_{max} ratio is 50% at the beginning of the design storm simulations. This design storm has been implemented as the Town's level of service for wet weather flow due to its proximity to Calgary and the Town's request. The rainfall hyetograph for this event is shown in Figure 2.1.

Figure 2.1: 50 Year 24 Hour Q4 Huff Storm Rainfall Hyetograph



2.2 Assessment Criteria

The performance of the sanitary system is ultimately determined based on the available freeboard between the ground elevation and high water level elevation (represented by the maximum hydraulic grade line (HGL)) at each manhole for each assessment design rainfall storm. Based on this, the maximum allowable surcharge in the gravity portion of the sanitary sewer systems must remain at least 2.5 metres from the ground surface.

The following exceptions to this criterion are as follows:

- Catchment areas that have experienced re-occurring basement flooding following less than 50-year return period rainfall events in the past. In those instances, upgrades may be triggered even if modelling results indicate that a surcharge level is below 2.5 metres from the ground surface.
- In gravity pipe sections where there are no service connections and therefore no basement, the freeboard may be less than 2.5 metres. For example:
  - Siphon locations at the creek/water body crossing
  - Sewers running within green spaces

Existing forcemains should be analyzed to maintain a minimum velocity of 1.0 m/s however should not exceed a velocity of 3.0 m/s, with the preferred velocity being 2.5 m/s. Existing siphons should be analyzed to maintain a minimum velocity of 1.0 m/s based on average dry weather flow conditions or reach a velocity of 1.0 m/s at least once a day, with two times being preferred.

2.3 Population Density

A density of 55 persons per hectare was applied for single-family residential development types. This density is consistent with the methodology applied in the SMP, and aligns with the sizing methodology in The City of Calgary. For comparison, the following densities have been applied to studies in neighbouring municipalities:

- Strathmore Water Master Plan (residential) – 44.3 persons per gross hectare
- RVC Springbank ASP Servicing Study (urban residential) – 53.4 persons per gross hectare
- High River Utility Master Plan (Spitzee Crossing) – 57.6 persons per gross hectare
- Airdrie Utility Master Plan – 45 persons per gross hectare

High density residential development types remain consistent with the densities applied in the SMP. In this update, these high density residential development types include:

- Residential Low Density Multi-Unit (R-2) – 2.15 persons per unit
- Residential Medium Density Multi-Unit (R-3) – 1.98 persons per unit
- Mixed-Use Medium Density (MUM) – 1.98 persons per unit
  - *Note that a density for this land use type was not derived in the SMP, however is considered to be similar to R-3, thus an equivalent persons per unit density was assumed.*

2.4 Dry Weather Flow (DWF) Generation Rates

Infrastructure included in the SMP remains consistent in terms of the rates utilized during that study. That said, existing generation rates were derived through the DWF calibration process. Parcels that have been added to the existing system that had not been included in the SMP (i.e., any newly built infrastructure since the SMP), as well as all future catchments, were assigned the following rates:

- Residential Areas – 255 L/p/d
- Non-Residential Areas – 8,525 L/ha/d (based on a density of 55 persons per hectare)

Additionally, a groundwater infiltration (DWF baseflow) rate of 0.033 L/ha/s was incorporated in the model for all added and future infrastructure as per The City of Calgary's modelling guidelines. Previously included existing system parcels were assigned baseflows based on the DWF calibration process.

2.5 Peaking Factors

Similar to the DWF generation rates, parcels included in the SMP maintained the peaking factors based on the DWF calibration process. Any parcels that have been added since the completion of the SMP were also assigned peaking factors derived during the DWF calibration process, based on a general land use type. For future developments the ideology applied in the SMP was adhered to, as detailed below for both the servicing network design and the assessment of the impact on the existing system.

2.5.1 Servicing Network Design (Spreadsheet)

Peaking factors for the future sanitary system were calculated in accordance with the Alberta Environment and Parks' (AEP) guidelines. These include the following:

- Peaking factor derived based on Harmon's formula for residential areas:
  - $PF = 1 + 14/(4+P^{1/2})$ where P is the design contributing population in thousands
  - PF must be at least 2.5
- Peaking factor for non-residential areas
  - $PF = 6.659(Q_{AVE}{}^{-0.168})$
  - PF can have a maximum value of 5.0

Consequently, the residential peaking factors ranged from 2.5 to 4.5, with an average value of 3.32. While, the non-residential factors ranged from 4.05 to 5.0, with an average value of 4.76.

2.5.2 Assessment of the Impact on the Existing System (MIKE URBAN)

Peaking factors derived during the DWF calibration process, based on the observed flow monitoring data, were applied to build-out growth catchments for each land use. As expected, the observed modelled peaking factors tend to be lower than those stipulated by the AEP's guidelines as they fluctuate between 1.66 and 1.80 for residential areas, and 1.49 to 2.19 for ICI areas.

2.6 Wet Weather Flow (WWF) Component

2.6.1 Servicing Network Design (Spreadsheet)

A constant inflow-infiltration allowance of 0.28 L/s/ha as per the Alberta Environment and Parks' guidelines was applied to each proposed development area to simulate the wet weather response to prepare conceptual sewer sizing up to the point of connection to the existing sewer network.

2.6.2 Assessment of the Impact on the Existing System (MIKE URBAN)

The wet weather flow response from all future catchments were produced based on The City of Calgary's 1 in 50-year 24-hour 4th Quartile Huff Storm with the catchments being assigned calibrated hydrological properties reflective of a similar land use type and newer development areas within the existing Town's boundary that produced a variable I-I rate of 0.28 L/s/ha. Consequently, the percent impervious area and RDII percent area contributing to RDII of 0.39% and 10.0% respectively, were applied. This is consistent with the approach that was applied in the SMP.

3.0 Existing Model Updates

The hydrodynamic model constructed and calibrated for the SMP was updated to reflect the most recent condition of the sanitary system. The update consisted of incorporating numerous new pipes and manholes, and adding parcels that have come online since the SMP. The added infrastructure and parcels are illustrated in Figure 3.1.

Once all the data was in the model, it was inspected to determine what newly added data appeared missing or erroneous. The majority of the added sewer system data was missing information pertaining to inverts, thus record drawings were obtained by the Town in order to fill in the information gaps. Longitudinal profiles of each section of added infrastructure were reviewed in the model to ensure proper connectivity and that inverts aligned.

Sanitary catchments were derived on a per parcel basis, which is consistent with the methodology applied in the SMP. Thus, an updated parcel shapefile provided by the Town was compared to aerial imagery, Google Earth, and Google Street View to determine if each individual parcel (omitting those already included in the SMP) has been developed since the SMP. That said, as these sources are only current as of 2017, it was necessary to perform a site visit to confirm whether or not the remaining parcels have been developed. This visual inspection was conducted by ISL on October 31st, 2019. Parcels were spatially assigned land uses and corresponding areas and populations (if applicable). The catchments were subsequently imported into the model and connected to the nearest appropriate manhole. Boundary conditions were assigned to each sanitary catchment based on the design parameters described in Section 2.0.

The updated sanitary pipe network in terms of pipe size and pipe material are shown in Figures 3.2 and 3.3. A summary of the total lengths with respect to pipe size and pipe material are detailed below in Tables 3.1 and 3.2.

Table 3.1 Pipe Length

Size	Total Length
mm	m
Forcemain	
150	1,932
200	1,331
Siphon	
350	620
Gravity Sewer	
100	94
150	1,748
200	83,826
250	25,572
300	9,022
350	119
375	4,902
400	120
450	4,591
525	1,679
675	3
900	73
Total	**135,632**

Table 3.2 Pipe Material

Material	Total Length
	m
Forcemain	
PVC	3,263
Siphon	
HDPE	620
Gravity Sewer	
AC	1,022
HDPE	8,269
PVC	119,782
Steel	5
VCT	2,671
Total	**135,632**

4.0 Existing System Assessment

The existing system model was assessed by utilizing the LOS criteria defined above. A DWF assessment was also performed for comparison purposes. Results from these assessments are shown in Figures 4.1 to 4.4 as follows:

- Figure 4.1: DWF Conditions – maximum hydraulic grade line (HGL) elevation relative to the ground and peak discharge relative to pipe capacity
- Figure 4.2: DWF Conditions – spare capacity
- Figure 4.3: WWF Conditions – maximum HGL elevation relative to the ground and peak discharge relative to pipe capacity
- Figure 4.4: WWF Conditions – spare capacity

The corresponding maximum HGL longitudinal profiles are provided in Appendix A. These longitudinal profiles include the HGLs under existing conditions as well as future conditions to illustrate the differences visually.

Due to the added catchments since the SMP, generated sewage is greater here than in the original SMP. The following table (Table 4.1) details the differences in terms of areas and populations between this update and the SMP.

Table 4.1 Existing System Comparison to SMP

Parameter	Unit	2016 SMP	2019 Update
Residential Area	ha	420	502
Non-Residential Area	ha	179	239
Road Area	ha	220	243
Total Area	ha	819	984
Population		24,505	28,993

The assessment that follows has been completed for the Town's LOS; the 50 year 24 hour Q4 Huff Storm. It is noted that the DWF results are not discussed in detail, as the flow results from the WWF event will govern. Note that for the DWF results on Figure 4.1, the nodes that show an HGL of less than 3.5 m to ground are generally indicative of shallower sewer depths, as opposed to any hydraulic constrictions and sewer backup (this is supported by the fact there are no gravity sewers on Figure 4.2 with no spare capacity).

4.1 Areas of Concern

North Railway Street

The most notable surcharging under existing conditions is along North Railway Street, east of Veterans Way. This location was also a concern in the original SMP, with a recommendation to plug the east invert within the manhole at the intersection of Elizabeth Street and Veterans Way. This is described in Section 6.4 of the SMP as Recommendation #1. The goal here was to divert flows to the south onto South Railway Street. Since the SMP, the Town has implemented a mechanical plug at this intersection to divert flows south. This is reflected in the existing system model updates.

The result with this upgrade is a reduction of the HGL within the section of pipe along North Railway Street of approximately 0.5 m, however noting that some very minor surcharging remains evident. That said, surcharging extends very minimally above the crown of the pipes along North Railway Street (maximum surcharge is 127%). Given that properties with services along this sewer require a 10 m set back with a 2% minimum slope for sanitary services, an additional 0.2 m is gained. This makes it unlikely that property flooding is a concern, unless a larger

storm even is exhibited. A longitudinal profile of this portion of sewer is illustrated in Figure 4.5, and compared to the original SMP results.

With that in mind, the Town has noted that North Railway Street from McRae Street to Poplar Avenue has been identified for a Downtown Vitalization project, which includes deep utility replacements. The main will be upsized to 300 mm as part of this upgrade, thus removing the bottlenecking at this location and mitigating any surcharging. This upgrade was applied to the existing system model, and subsequently simulated to observe the potential improvements. A longitudinal profile of this upgrade is illustrated in Figure 4.6. This profile suggests that upsizing to a 300 mm PVC pipe would remove all surcharging in this section of sewer.

Clark Avenue

The other location of note is along Clark Avenue, from Wilson Street south to North Railway Street, where there are localized pockets of surcharged sewers. This longitudinal profile is illustrated in Figure 4.7. At the upstream end of the profile, the HGL from this deliverable is minimally greater than the original assessment, while at the downstream end, the HGL is lower due to the diverted flows at Veterans Way and Elizabeth Street.

Comparatively, as the variations between this deliverable and the SMP are so minimal, the findings from the SMP remain valid. This was discussed in Section 6.4 of the SMP under the Optional Recommendation. This upgrade consists of upsizing approximately 165 m of sewer along Clark Avenue between 45 Clark Avenue to Knight Street to a 300 mm sewer. The total cost for this upgrade stipulated in the SMP was $254,000, noting that the cost in the SMP was based on twinning the existing line, thus is less than the cost of replacing the existing sewer. Assuming 10% for inflation, this would have a cost today of $279,400. Replacing the existing sewer to a 300 mm sewer as opposed to twinning would have a 2020 cost of $338,000. The difference in cost between twinning versus replacing the sewer is attributed to the bypass pumping that is required if the replacement option is chosen, and to a lesser degree removing and disposing the existing sewer.

As an alternative to upsizing, the Town has also considered the removal of the two 90 degree bends on Clark Avenue between Mountain Street and Knight Street. This removal is part of the Town's lifecycle replacement and asset management initiative, which involves replacing the existing VCT pipes with PVC. A simulation was run which considers the removal of these bends, changing the VCT with PVC pipes, and interpolating (and as such increasing) the slopes between Wilson Street and Patterson Street, resulting in a slope of approximately 2%. The results of this simulation are shown in the longitudinal profile provided in Figure 4.8. As shown, these upgrades would provide sufficient capacity to accommodate the 50 year 24 hour Q4 Huff Storm.

Floodplain / Flood Fringe Manholes

The recommendation to also seal the manholes within the 100-year floodplain and flood fringe that was identified as part of the SMP also remains valid in this update. This upgrade was proposed to reduce the inflow into the sanitary system in the event of severe flooding events, and is independent of future development. This upgrade had an estimated cost of $131,000 in the SMP, thus considering 10% for inflation would result in a present day cost of $144,100. It is understood that these upgrades have been completed by EPCOR.

5.0 Proposed Servicing Concept

5.1 Updates to Service Areas

The revised servicing concept is intended to follow the recommended 60-year concept proposed in the SMP as closely as possible. Minor changes have been made to reflect the updates in land use as stipulated in the recent Growth Strategy. The adjustments that were applied to agree with the Growth Strategy are described below.

5.1.1 Changes in Land Use Type

As stipulated in the Servicing Strategy Brief to Accommodate the Draft Growth Strategy (ISL, 2019), servicing areas were based on the Scenario 3 land use outlined in the Comprehensive Growth Strategy Report. In a number of service areas, Scenario 3 differs from the land uses identified in the SMP, thus updates were required. The derived future sanitary service areas are a combination of the existing SMP service areas and the Scenario 3 land use types.

The original future sanitary service areas utilized in the SMP were applied as a starting point, to ensure the divisions to reflect topographical changes in each quarter section were maintained. Then, the land uses were cross referenced to Scenario 3, and updated where necessary to ensure consistency with the most recent land use plans. In some cases, this involved dividing the catchments further to introduce multiple land use types (for example, Scenario 3 includes commercial nodes in many predominantly residential quarter sections, which was not accounted for in the SMP). The area of each quarter section used in the SMP were carried forward in this deliverable, and prorated where needed to reflect quarter sections with a variety of land uses/service areas. The updated future sanitary catchments along with their associated land use type are illustrated in Figure 5.1.

5.1.2 Updates to Sanitary Service Area Naming Convention

The naming convention applied in the SMP consists of the growth horizon (being either the 30-year or 60-year horizon), plus a unique identifier. In the Servicing Strategy Brief to Accommodate the Draft Growth Strategy, the future developable area was divided per benefiting area. Thus, again to ensure consistency with the Growth Strategy, it was determined that implementing a similar naming convention for the updated SMP would provide a key link between the studies. That said, the future sanitary service areas were given either a north or south benefiting area ID. As many quarter sections were divided into a number of service areas, a suffix was added to the ID to ensure each catchment ID was unique. These updated IDs are also shown in Figure 5.1. Table 5.1 lists all future service areas considered in the SMP, along with the new IDs applied.

Table 5.1 Service Area Naming Convention Comparison

Service Area ID	
SMP	**Update**
30-1	N-1A; N-1A.2; N-1A.3; N-1A.4; N-1A.5; N-1A.6; N-1A.7; N-1A.8; N-1A.9; N-1B; N-1B.11
30-2a	N-1B.2; N-1B.4; N-1B.5; N-1B.6; N-1B.7; N-1B.8; N-1B.9; N-1B.10
30-2b	N-1B.3
30-3a	N-2
30-3b	N-2.2
30-3c	N-2.3
30-4a	N-2.4
30-4b	N-2.5
30-4c	N-2.6

Service Area ID	
SMP	Update
30-4d	N-2.7
30-4e	N-2.8
30-4f	N-2.9
30-4g	N-2.10
30-6a	N-5; N-5.2; N-5.5; N-5.6
30-6b	N-5.3; N-5.4
30-7a	N-3; N-3.2; N-3.5; N-3.6; N-3.7; N-3.8; N-3.9; N-3.10; N-3.11
30-7b	N-3.3
30-7c	N-3.4
30-8a	N-4B; N-4B.2
30-8b	N/A - Developed
30-9	N-6; N-6.2; N-6.3
30-10	N-9; N-9.2; N-9.3
30-11a	N-7A; N-7A.2; N-7A.3
30-11b	N-7B; N-7B.2
30-12	N-17; N-17.2; N-17.3
30-13	N-13; N-13.2
30-14	S-7
30-15	S-8; S-8.2
30-16	S-3
30-17	S-4
30-18	S-11
30-19	S-12; S-12.3
30-20	S-12.2
30-21	S-13; S-13.2; S-13.3
30-22	S-2A; S-2A.2
30-23	S-2B; S-2B.2
60-1	N-8; N-8.2
60-2	N-10; N-10.2
60-3	N-12; N-12.2
60-4a	N-11A
60-4b	N-11B; N-11B.2
60-5	N-20; N-20.2
60-6	N-18
60-7	N-19; N-19.2
60-8	N-16; N-16.2
60-9	N-15
60-10a	N-14A
60-10b	N-14B
60-11	N/A - Defensive Area; See Section 5.1.4
60-12	S-9
60-16	S-14
60-17	S-6

5.1.3 Adjustments based on Recent Growth

Rapid growth with the Town of Okotoks has resulted in a number of sanitary service areas being added to existing conditions, as discussed above in Section 3.0. Many of these catchments are located within the future sanitary service areas identified in the SMP, predominantly within D'Arcy Ranch and Wedderburn. As some of these parcels are now accounted for under existing conditions, they were required to be clipped from the future sanitary service areas to avoid double counting any areas. This is reflected in Figure 5.1 as well.

5.1.4 Removal of Certain Future Sanitary Service Areas

In order to reflect Scenario 3 of the Growth Strategy, a service area was also removed from the future system analysis, as it has not been proposed for development. In large, this service area represents a defensive area within Scenario 3, and is therefore not developable. In terms of the original SMP IDs, this service area is 60-11.

Additionally, a number of service areas were adjusted to match the boundaries stipulated in Scenario 3 of the Growth Strategy.

5.1.5 Accounting for Follow-up Analyses

Following the completion of the SMP, there was continued dialogue between ISL and the Town regarding a number of future service areas. The two refinements to the SMP that occurred after the submission of the final report included revising the tie-in point for the Wind Walk and Gold Medal developments, and splitting the Wedderburn service area to eliminate the need for an additional costly sanitary main down Northridge Drive. Both of these refinements have been accounted for within this update, noting that the Wind Walk development is limited to 47.1 ha due to downstream constraints. An additional tie-in point, #18D, has been added to account for the revised Wind Walk/Gold Medal development tie-in. This is shown on Figure 5.2. In addition, the original tie-in point #1 was split into #1A and #1B, as sewers have been constructed upstream of the original tie-in point #1 since the SMP.

Also of note are service areas N-7A, N-7A.2, N-7B, N-7B.2. The property developer and engineer have confirmed that the entire quarter section will drain to the southwest towards the 32nd Street Trunk. The exact alignment of the servicing concept is currently not available for the area, but the assumption is that the property will convey all sewer flows to tie-in point #8.

5.1.6 Comparison to SMP

Due to the updates noted above that were completed as part of this memorandum, the total system areas and populations differ from the SMP. The following table (Table 5.2) details these. The difference in total area is attributed to removing 60-11 and adjusting the boundaries of various other service areas, as discussed in Section 5.1.4.

Table 5.2 Future System Comparison to SMP

Parameter	Unit	2016 SMP	2019 Update
Residential Area	ha	2,079	1,633
Non-Residential Area	ha	560	871
Road Area	ha	220	243
Total Area[1]	ha	2,859	2,747
Population		114,856	91,185

[1] *Areas stipulated above represented the net areas applied to the model, thus environmental reserves and parks have been deducted from the balance.*

5.2 Build-out Growth Horizon

As mentioned above, generally speaking the concept proposed in the SMP remains valid for this update as well. The proposed servicing concept at the build-out growth horizon is illustrated in Figure 5.2. The pipe sizing for the proposed concept was determined through the spreadsheet approach noted in Section 2.0, and is included in Appendix B.

Key differences when compared to the original concept proposed in the SMP are described below.

1. Only a single concept has been recommended. This concept considered pipe upsizing as the preferred implementation option, rather than pipe twinning. Pipe upsizing was identified as the implementation option of choice by the Town. Given life cycle replacement requirements of existing sewers, this has been deemed preferable. It is noted that if ultimate upsizing is undertaken anywhere, however, that flow velocities be carefully checked to ensure that lower current flows do not result in potential maintenance issues due to deposition and blockages.
2. In D'Arcy Ranch, as a portion of the sewer proposed in the SMP has been built, the revised concept only includes the remaining upstream 250 mm gravity sewers that are required to complete this part of the network. Two new tie-in points, #1A and #1B, have been created to reflect these updates.
3. As the east and west areas of Wedderburn have been diagonally divided, an additional 250 mm gravity sewer was added for the east portion of this community. As well, due to a smaller land mass contributing to the west portion of the community, the existing 375 mm gravity sewer has been downsized to a 250 mm gravity sewer.
4. The 250 mm gravity sewer servicing N-7B and N-7B.2 (previously 30-11b) is no longer required as it is assumed that the property developer/engineer will be conveying flows to the southwest towards 32nd Street.
5. Due to changes in land use, the 375 mm gravity sewer between N-18 and N-19 (previously 60-6 and 60-7) has been downsized to a 300 mm gravity sewer.
6. The 150 mm forcemain servicing the service area previously referred to as 60-11 is no longer needed, as that area has been flagged as being undevelopable.
7. Due to changes in land use, the 375 mm gravity sewer servicing S-7 (previously 30-14) has been downsized to a 300 mm gravity sewer.
8. The gravity sewer from the Wind Walk development has been upsized to a 375 mm gravity sewer (from 300 mm) as the Gold Medal commercial development is also intended to tie into the same location.
9. A 675 mm gravity sewer is maintained along the length of Highway 7 (as opposed to beginning at 600 mm, upsizing to 675 mm, then again to 750 mm in the SMP). This is because in this concept service area S-11 (previously 30-18) ties into the minimum elevation point along Westland Street and Highway 7 as opposed to further downstream. As well, in this scenario the Gold Medal development (S-4 in this update, 30-17 in the original SMP) does not contribute flows to this portion of the network (ties-in to #18D). This is also reflected downstream, where the previously proposed sewer conveying flows from south to north is downsized from a 900 mm gravity sewer to a 750 mm gravity sewer.

5.3 Servicing Cost Estimates

The summary of cost estimates for the recommended servicing option is summarized in Table 5.3 below. For a detailed cost breakdown, refer to Appendix C. Cost have been divided based on the benefiting areas described in the Servicing Strategy Brief to Accommodate the Draft Growth Strategy (ISL, 2019), and illustrated in Figure 5.3.

Table 5.3 Cost Estimates for Recommended Servicing Concept

Benefiting Area	Gravity Sewers[1]	Lift Stations	Forcemains	Siphons	Benefiting Area Total
Northwest	$549,000	$0	$0	$0	**$549,000**
North-central	$5,322,000	$0	$0	$0	**$5,322,000**
Northeast	$11,653,000	$5,423,000	$1,185,000	$0	**$18,261,000**
South	$6,275,000	$1,914,000	$1,081,000	$9,150,000	**$18,420,000**
West	$709,000	$1,914,000	$430,000	$0	**$3,053,000**
Item Total	**$24,508,000**	**$9,251,000**	**$2,696,000**	**$9,150,000**	**$45,605,000**

[1] *The recommended servicing concept is assumed to be greenfield, and if along road allowances, costs assume sewer installation prior to roadway construction.*

6.0 Future System Assessment and Upgrades

6.1 System Assessment

Assessment of the existing system with future population was performed for the build-out growth horizon only, as it represents the maximum peak wet weather flows that are entering the existing system. The assessment was based on the Town's LOS described in Section 2 1, and the assessment criteria stipulated in Section 2.2 was adhered to for this analysis. The future system assessment figures in terms of HGL relative to the surface and discharge relative to pipe capacity, as well as the spare capacity of pipes are shown in Figures 6.1 and 6.2. The corresponding maximum HGL longitudinal profiles are provided in Appendix A. These longitudinal profiles include the HGLs under existing conditions as well as future conditions to illustrate the differences visually.

A description of the general areas of concern with respect to the gravity system are provided below in Table 6.1. In Figure 6.1, there are a number of locations where the maximum HGL elevation relative to ground is greater than zero (a red dot signifying surface flooding), however the peak discharge relative to pipe capacity is below 100% (either a green or orange line). This will occur at locations where downstream capacity constraints are causing pipe backups upstream. These pipes, without downstream restrictions, have sufficient capacity. Thus, once the constraints at the downstream end are removed, surcharging at these locations will no longer be problematic. The pipes where this occurs are not included in Table 6.1 below.

Table 6.1 includes a column for the degree of surcharge in each case. The classifications for this column are summarized as follows:

- **Minimal** – peak discharge relative to pipe capacity exceeds a value of 1, however these sections exhibit minor surcharging, and are well below the surface. Upgrades are not recommended for these sewer sections, however these sewers should be monitored in the future. If additional flows not accounted for in this deliverable are ultimately routed through one of these sections, the need for upgrades should be revisited.
- **Moderate** – the HGL in these sewer sections increases due to pipe capacity constraints (peak discharge relative to pipe capacity is greater than 100%), however the HGL remains below the surface. Upgrades for these sewer sections are recommended, as basement flooding may be a concern.
- **Significant** – the maximum HGL elevation relative to ground is greater than zero, indicating flooding to surface. The peak discharge relative to pipe capacity exceeds 100%. Upgrades for these sewer sections are necessary if growth upstream of these areas is to progress.

Peak modelled wet weather flow results of the build-out growth horizon for both forcemains and siphons are detailed in Table 6.2.

Table 6.1 Affected Sewer Sections under the Build-out Growth Horizon

Sewer Section	Location	Affected Sizes	Section Length	Associated Longitudinal Profile(s)	Degree of Surcharge	Upgrade ID[1]
		mm	m			
2103_2 to 1623	32nd Street E and Crystal Green Way	200	660	LP #6.1	Significant	UPG 5 – 32nd St N
1633 to 1624	Crystal Shores Drive and Crystal Shores Place	300	697	LP #5.1	Minimal	N/A
1635	Crystal Shores Manor	200	130	LP #14.1	Minimal	N/A
15B8 to 1456	Fisher Gate	450, 525, 900	829	LP #5.3	Significant	UPG 4 – 32nd St S
137B to 137D	Clark Avenue	200, 250	275	LP #3.3 & LP#3.4	Significant	UPG 3 – Banister Dr
137A	Clark Avenue	200	96	LP #3.4	Moderate	
132 to 14K3	North Railway Street	250	295	LP #1.3	Moderate	
2062 to 1356	Riverside Drive	200, 250, 300	546	LP #2.1 & LP#2.2	Significant	UPG 2 - SRS
1694	Elk Street	200	18	LP #15.1	Minimal	N/A
1338 to 14KB	South Railway Street	375	418	LP #2.2	Minimal	N/A
2095	South Railway Street	375	119	LP #2.2	Minimal	N/A
Y13 to 1444	West River Crossing	525	795	LP #9.4	Minimal[2]	N/A
152D	North of Cimmaron Way	300	63	LP #12.2	Minimal	N/A
13B4	Woodbend Way	450	13	LP #9.4	Minimal	N/A
12B5 to 12C8	Hunters Place	250	63	LP #9.2	Minimal	N/A
1793 to 1796	Cimarron Parkway	200	170	LP #16.1	Minimal	N/A
1777 to 556	Cimarron Boulevard and Cimarron Trail	250	509	LP #12.1	Minimal	N/A

[1] *UPG 1 – NRS, upstream of the wastewater treatment plant (WWTP), is not shown in this table, as it is triggered by upsizing the pipes as part of UPG 2 – SRS thus releasing additional flows. UPG 1 – NRS should be completed before UPG 2 – SRS.*
[2] *At the West River Crossing (Y13 to 1444), surcharging to surface is noted, however these are due to downstream constraints that if rectified improve issues here.*

Table 6.2 Forcemain and Siphon Wet Weather Flow Results under LOS Design Storm

Name	Size	Capacity	Peak WWF	Resultant Velocity
	mm	L/s	L/s	m/s
Stockton Forcemain	150	26.5	39.0	2.21
Sheep River Forcemain	150	26.5	25.8	1.46
Westmount Forcemain	150	26.5	24.8	1.40
Drake Landing Forcemain	150	26.5	43.0	2.43
Southbank Forcemain	200	47.1	36.2	1.15
Nexen Forcemain	150	26.5	19.3	1.09
South Siphon	350	186.0	66.2	0.69
West Siphon	350	190.0	194.5	2.02

The review of the above peak WWFs and corresponding velocities indicates that each forcemain operates within an acceptable velocity range of 1.0 m/s to 3.0 m/s and below the preferred velocity of 2.5 m/s for existing forcemains. There is sufficient capacity in the South Siphon, while flows through the West Siphon exceed the siphon's capacity minimally. As mentioned above in Table 6.1, many of the sewers downstream of the West Siphon are surcharged quite significantly. This is largely due to downstream constraints, which are improved with upgrades implemented downstream near the WWTP, as discussed below in Section 6.2. To completely rectify the surcharging in these sewers, upsizing by a pipe size to 600 mm would be required. As this area is undeveloped with no service connections, and appears to exhibit minimal surcharging once system upgrades are implemented, upsizing here is not necessarily recommended. That said, however, this area should be monitored to observe if conditions worsen.

It is noted that in the SMP, the South Siphon was lacking capacity in the full build-out (60-year) growth horizon. Upgrades to the existing siphon, or the addition of a new South Siphon were both considered. Ultimately, the recommended concept includes a new South Siphon. Thus, upgrades to the South Siphon would not be needed. This holds true in this update, as the proposed build-out concept includes an additional siphon from the south to accommodate the new development.

The service area south of Highway 7, between Range Road 294A and AB-783, consists solely of the Gold Medal development. The assumption is that the remainder of the quarter section will not be serviced at this time. That said, with a sewer installed for this area, the Town may receive requests to connect existing properties exhibiting sewer issues. A connection fee for contributing to the system and treatment plant would require assessment prior to this implementation. Any potential connections would be required to tie-into the 675 mm east-west trunk along Highway 7 due to capacity restrictions in the existing system from Gold Medal and Wind Walk. The limiting spare capacity in the proposed servicing concept downstream of this quarter section (675 mm sewer along Highway 7 followed by a 750 mm sewer on 32nd Street) is 38.5 L/s. This includes consideration for the flow rate being 86% of the sewer full capacity, per Alberta Environment's criteria.

6.2 System Upgrades

Sewer sections that were identified as having either a moderate or significant degree of surcharge were flagged for upgrades. These upgrades would be required prior to completion of the full build-out horizon, further described in Section 7. Upgrades are summarized below in Table 6.3 and illustrated in Figure 6.3. All upgrades are intended to be installed by upsizing the existing sewers as opposed to twinning the existing infrastructure. UPG 5 – 32nd St N is the one project where twinning should be considered instead of replacement. This is because 32nd Street has not yet been twinned, presenting the opportunity to install a twinned sewer in virtually a greenfield space prior to roadway improvements. This option should be considered in further detail during the detailed design phase of UPG 5 – 32nd St N. Costs stipulated in this document are reflective of sewer replacements.

In some instances, the length of upgraded sewer required is greater than the section length stipulated in Table 6.1. This is because during the upgrading process, the removal of capacity constraints in upstream sewers resulted in greater flows in downstream sections, which in turn exhibited additional capacity constraints. These sewers also require upsizing due to the added flows. This holds true for UPG 1 - NRS too, which requires upgrades once flows are released upstream, thus is not presented in Table 6.1.

In terms of timing of upgrades for UPG1 – NRS and UPG 2 – SRS, the Town has noted that they may be willing to accept a higher level of surcharge to defer the timing. These upgrade projects are located along North Railway Street and South Railway Street, near the WWTP and industrial parcels with no basements. Additionally, a large portion of South Railway Street is either undeveloped or commercial. That said, surcharging at these locations may be acceptable as it would not pose a significant risk to residents or business owners.

Table 6.3 Summary of Required Upgrades to Existing Infrastructure

Upgrade ID	Location	OSL Project ID	Length	Existing Size	Proposed Size	Timing of Upgrades
			m	mm	mm	
UPG 1 – NRS	North Railway Street / Fisher Gate	SAN-9	152	450	525	5 – Year (2024)
		SAN-10	196	525	750	
UPG 2 – SRS	South Railway Street	SAN-7	53	200	450	5 – Year (2024)
		SAN-7	484	250		
		SAN-8	9	300		
		SAN-8	889	375		
UPG 3 – Banister Dr	Banister Drive	SAN-11	Plug Manholes on Banister Drive			10 – Year (2029)
UPG 4 – 32nd St S	32nd Street (South End)	SAN-16	150	375	450	25 – Year (2044)
		SAN-US12	186	450	900	
		SAN-DS12	570	525		
UPG 5 – 32nd St N	32nd Street (North End)	SAN-15	150	200	375	25 – Year (2044)
		SAN-14A	265	N/A[1]	450	
		SAN-14B	282	300	450	
		SAN-13	448	375	525	

[1] *Represents a new sewer along 32nd Street East, thus there is no existing sewer here.*

Along 32nd Street, there are two proposed upgrades; UPG 4 – 32nd St S and UPG 5 – 32nd St N. UPG 5 – 32nd St N is upstream, on the north end of 32nd Street while UPG 4 – 32nd St S is downstream of UPG 5 – 32nd St N at the south end of 32nd Street. The downstream portion of UPG 5 – 32nd St N is proposed to be 525 mm, while the upstream portion of UPG 4 – 32nd St S is proposed to be 450 mm. Between these two upgrades, there is a middle section of sewer that is 375 mm in diameter. This middle section has not been flagged for upgrades as the steeper slopes in this area provide sufficient pipe capacity to accommodate the flows. Steeper slopes at the upstream end of UPG 4 – 32nd St S also indicate that a smaller pipe diameter is required when compared to the downstream end of UPG 5 – 32nd St N. With the middle section of pipe left as is, upgrading the upstream end of UPG 4 – 32nd St S to 450 mm would be sufficient as it is incrementally larger than the pipe section directly upstream (i.e., a 375 mm flowing into a 450 mm).

An additional analysis was undertaken to assess the inlet capacity of the 375 mm sewer section between UPGs 4 – 32nd St S and 5 – 32nd St N, as the model has not been calibrated to specifically account for inlet constraints. Table 6.4 summarizes the peak WWFs under the upgraded future system conditions for the section of pipe between UPGs 4 – 32nd St S and 5 – 32nd St N, and compares this to inlet and pipe capacities.

Table 6.4 32nd Street Inlet Assessment

Pipe ID	Diameter	Q_{PWWF}	Q_{Inlet}	$Q_{Manning}$
	mm	L/s		
1659	375	273	127	380
1660	375	279	127	379
15B5	375	279	127	448
1954	375	279	127	559
1973	375	311	127	543

Table 6.4 indicates that capacities are limited by inlet conditions, thus in actuality there could be some very localized spikes in HGL that are not being reflected in the model. Though this is the case, the HGL observed in the model is within the pipe, with 3 m to 6 m of cover and likely no service connections along 32nd Street. Increases to the HGL as a result of inlet constraints therefore pose generally less risk to the Town. That said, the Town may wish to consider upgrading this section of sewer while the remainder of the upgrades along 32nd Street are being constructed, to avoid potentially multiple construction projects on the arterial road. To meet the inlet capacity requirements, a 525 mm sewer is needed. In this event, the upstream end of UPG 4 – 32nd St S should also be upsized to 525 mm as opposed to the proposed 450 mm sewer.

6.3 Upgrade Cost Estimates

In total, there are five upgrades to the existing system that are required to accommodate the growth from the build-out growth horizon. A summary of the costs associated with the recommended servicing concept are detailed below in Table 6.5. A full breakdown of costs has been provided in Appendix C.

Table 6.5 Cost Estimates for Recommended Upgrades to the Existing System under Build-out Conditions

ID	Location	OSL Project ID	Upgrade	Apportionment	Benefiting Areas	Total Cost[1]
UPG 1 – NRS	North Railway Street	SAN-9, SAN-10	525mm and 750mm gravity sewer upsizing upstream of WWTP.	Off-site Levy	North-central, Northwest, South, & West	$864,000
UPG 2 – SRS	South Railway Street	SAN-7, SAN-8	450mm gravity sewer upsizing along Riverside Drive.	Off-site Levy	Northwest	$3,889,000
UPG 3 – Banister Dr	Banister Drive	SAN-11	Plug manholes along Banister Drive to divert flows to east, away from Clark Avenue.	Off-site Levy	North-central	$7,000
UPG 4 – 32nd St S	32nd Street (South End)	SAN-US12, SAN-DS12, SAN-16	450mm and 900mm gravity sewer upsizing along Fisher Gate, south of 32nd Street East.	Off-site Levy	North-central & Northeast	$2,988,000
UPG 5 – 32nd St N	32nd Street (North End)	SAN-13, SAN-14A, SAN-14B, SAN-15	375mm, 450mm, and 525mm gravity sewer upsizing along 32nd Street East.	Off-site Levy	North-central	$3,687,000
					Total:	**$11,435,000**

[1] *Total costs represent 2020 dollars, and are not indexed for staging.*

6.4 North Railway Street (NRS) Upgrade Alternatives

Following the completion of the SMP, the Town engaged ISL to undertake a more detailed analysis on alternate options directly upstream of the WWTP, with the focus of offloading the NRS Trunk. The final conceptual upgrade consisted of diverting flows through the west side of the WWTP yard, thus eliminating the required upgrades along the Main Operations Access Road, south of NRS and Fisher Gate. This differed from the upgrade option proposed in the SMP, which consisted of upsizing the sewers along Fisher Gate down to the WWTP. As part of this update, both options were considered in further detail to determine the preferred recommendation. Additionally, a third option was analyzed to represent a hybridized concept between the SMP option and the follow-up NRS analysis

option. These three options are illustrated on Figure 6.6, and described below. It is noted that the upgrades proposed north of NRS (part of UPG 4 – 32nd St S) are required in all three variations. Detailed cost estimates for the three options are included in Appendix C.

6.4.1 Option 1

This option reflects the recommendation proposed in the SMP as well as above in this document. At the confluence between the NRS Trunk and the SRS Trunk, the existing 450 mm sewer is upsized to 525 mm, and then further upsized to a 750 mm sewer at the confluence point with the West Siphon Trunk. The 750 mm sewer is intended to replace the existing twinned 525 mm sewer, all the way to the WWTP. These upgrades are included in UPG 1 – NRS. As well, this scenario required the existing 450 mm sewer (currently parallel to the 525 mm sewer) to be replaced with a 900 mm sewer, representing the southernmost portion of UPG 4 – 32nd St S. This option would require work along NRS and the Main Operations Access Road, as well as the removal and disposal of the existing sanitary sewers. It is noted that sewer installation along the Main Operations Access Road is viewed as more challenging and disruptive, as the area is highly congested with utilities and serves as a principal access to the WWTP and Town fleet buildings. The total cost of this upgrade, in 2020 dollars, would be $1,388,000.

6.4.2 Option 2

Option 2 considers a new 1200 mm sewer from the intersection of Fisher Gate and NRS to the west, towards where the NRS Trunk converges with the SRS Trunk. Subsequently, the proposed sewer is intended to flow southeast along the west boundary of the WWTP yard, ultimate tying into the WWTP. The existing sewers on NRS would be abandoned (plugging at the upstream manholes) to ensure flows from the NRS/SRS Trunks and the West Siphon Trunk are diverted to the new 1200 mm sewer. Upgrades along the Main Operations Access Road, are avoided in this concept, however there is still the need to conduct construction work along NRS. In the original NRS Trunk analysis, a 1200 mm by 600 mm was considered due to the limited cover, however circular sewers are generally preferred to box sewers in sanitary sewer applications. A 1200 mm circular pipe is thus proposed in this update, which has been sized to ensure adequate capacity when compared to the capacity of a 1200 mm by 600 mm box sewer. The key limitations to this option would be construction work along NRS, shallow depths of cover that do not meet standard guidelines (ranging from 1.2 m to 4.4 m), and flat slopes (~0.1% throughout). The total cost of this upgrade, in 2020 dollars, would be $1,232,000.

6.4.3 Option 3

The intent of this option is to avoid significant construction on NRS by implementing the benefitting attributes of Options 1 and 2 to form a hybridized upgrade concept. In this option, a 675 mm sewer is constructed along the west boundary of the WWTP yard to divert flows from the NRS and SRS Trunks. Doing so removes the necessity of any upgrades along NRS. It is noted that minimum slope requirements were assumed to size the 675 mm sewer as opposed to the existing grades that were utilized to size the upgrades along NRS in Option 1, accounting for the difference in size requirements. The 900 mm upsize recommended as part of UPG 4 – 32nd St S (also noted in Option 1) is also required in this scenario to accommodate the flows from the north along 32nd Street. It is noted that sewer installation along the Main Operations Access Road is viewed as more challenging and disruptive, as the area is highly congested with utilities and serves as a principal access to the WWTP and Town fleet buildings. Depth of cover improves along the WWTP yard as a smaller pipe size is required, and approximately 0.7 m of depth is gained by beginning the sewer at the NRS/SRS Trunk confluence as opposed to the intersection of NRS and Fisher Gate. The total cost of this upgrade, in 2020 dollars, would be $1,210,000. Option 3 is therefore the recommended upgrade option based principally on cost.

7.0 Staging Plan

A staging plan was developed for the 5, 10, and 25 year growth horizons. To do so, information pertaining to a phasing plan and population growth numbers were both required.

The framework for the phasing plan was obtained from Figure 5.3 – Benefiting Area Phasing within the Servicing Strategy Brief to Accommodate the Draft Growth Strategy. The phasing of a number of benefiting areas were subsequently adjusted to align with the Town's strategy of primarily growing within a specific direction (i.e., north-central, northeast, northwest, south, or west). It is understood that developing to the north is the general growth direction, noting that this does not by any means limit growth in other directions. Precedence was also given to developments that have the intent of proceeding in the shorter term. The growth horizons within this document are intended to provide an overall outline for staging. That said, actual growth horizons will depend on uptake, given that there are simultaneous ASP areas currently moving forward. The phasing plan applied in this document is illustrated in Figure 7.1.

The Population Projection memorandum provided by the Town was applied in order to determine the projected populations for each horizon. For the purposes of this study, the low growth scenario was utilized. The low growth scenario stipulates projected low annual increases of 668 and 680 people per year to 2041 and 2076, respectfully.

With the knowledge of where and by how much the Town intends to grow within the next 25 years, service areas were grouped as either 2024, 2029, 2044, or ultimate. Some service areas overlap between two growth horizons, due to only a portion of the population fitting within the population projection that specific horizon. A summary of these projections is provided in Table 7.1, and shown in Figure 7.2.

7.1 5 Year Growth Horizon

At the 5 year growth horizon, in the year 2024, it is anticipated that Okotoks will have grown by 3,340 to a population of 32,333. It is expected that all densification parcels will be developed as part of this stage, resulting in an increase of 1,573 people (28.60 ha). This leaves an additional 32.13 ha, equivalent to 1,767. The Phase 1 benefiting area is within D'Arcy Ranch, where construction is currently underway. The remaining growth under this horizon will occur within this benefiting area.

The majority of sanitary infrastructure has already been installed in D'Arcy Ranch, with the entire development ultimately connecting to the downstream SRS trunk system. This triggers the need to complete the upgrades along SRS (UPG 2 – SRS). As these upgrades will in turn release flows downstream, it is necessary to complete the upgrades along NRS (UPG 1 – NRS) prior to UPG 2- SRS. The staging plan for the 5 year growth horizon is shown in Figure 7.3. Costs required for this growth horizon are $4,753,000, with a summary of costs shown in Appendix C.

Count	Horizon	Growth[1]	Population[2]	Phases[3]	Service Areas[4]
0	Existing (2019)	0	28,993	Densification - All (1,573 people) 1 - 32.13 ha (1,767 people)	**N-1A; N-1A.2; N-1A.3; N-1A.4; N-1A.5N-1A.5; N-1A.6; N-1A.7; N-1A.8; N-1A.9; N-1B; N-1B.2; N-1B.3; N-1B.4; N-1B.5; N-1B.6; N-1B.7; N-1B.8; N-1B.9; N-1B.10; N-1B.11**
1	2020	668	29,661		
2	2021	668	30,329		
3	2022	668	30,997		
4	2023	668	31,665		
5	**2024**	**668**	**32,333**		
6	2025	668	33,001	1 - 19.94 ha (1,097 people) 2 - All (1,989 people) 3 - 4.62 ha (254 people)	**N-1A; N-1A.2; N-1A.3; N-1A.4; N-1A.5N-1A.5; N-1A.6; N-1A.7; N-1A.8; N-1A.9; N-1B; N-1B.2; N-1B.3; N-1B.4; N-1B.5; N-1B.6; N-1B.7; N-1B.8; N-1B.9; N-1B.10; N-1B.11;** N-3; N-3.2; N-3.3; N-3.4; N-3.5N-3.5; N-3.6; N-3.7; N-3.8; N-3.9; N-3.10; N-3.11; **S-3; S-4**
7	2026	668	33,669		
8	2027	668	34,337		
9	2028	668	35,005		
10	**2029**	**668**	**35,673**		
11	2030	668	36,341	3 - 51.48 ha (2,831 people) 4 - All (2,299 people) 5 - All (2,088 people) 6 - All (1,344 people) 7 - 27.16 ha (1,494 people)	**S-3; S-4;** S-2B; S-2B.2; N-4B; N4B.2; N-2; N-2.2; N-2.3; N-2.4N-2.4; N-2.5; N-2.6; N-2.7; N-2.8; N-2.9; N-2.10; **N-7A; N-7A.2; N-7A.3; N-7B; N-7B.2N-7B.2; N-15; N-17; N-17.2; N-17.3**
12	2031	668	37,009		
13	2032	668	37,677		
14	2033	668	38,345		
15	2034	668	39,013		
16	2035	668	39,681		
17	2036	668	40,349		
18	2037	668	41,017		
19	2038	668	41,685		
20	2039	668	42,353		
21	2040	668	43,021		
22	2041	668	43,689		
23	2042	680	44,369		
24	2043	680	45,049		
25	**2044**	**680**	**45,729**		

[1] Growth obtained from the Population Projection Memorandum provided by the Town. Low growth is assumed herein, at 668 people per year to 2041 and 680 people per year to 2076.

[2] Existing (2019) population based on serviced population applied in SMP Update.

[3] Calculated phase areas are based on a residential density of 55 persons per hectare.

[4] Bolded IDs represent service areas that are divided across two growth horizons.

7.2 10 Year Growth Horizon

In 2029, the Town will reach the 10 year growth horizon. Okotoks is expected to grow by another 3,340 people for a total population of 35,673. This stage includes the final build-out of the D'Arcy Ranch development (an additional population of 1,097), the full build-out of the Wedderburn development (population of 1,989), and a small portion of the Wind Walk / Gold Medal developments (population of 254).

All service areas anticipated for development under this growth horizon tie into the existing system. At this stage, as a portion of the construction within D'Arcy Ranch occurs under the 5 year growth horizon, it is expected that all upgrades required for this service area have been implemented. Wedderburn connects to the existing sanitary system at tie-in point #5, at the intersection of Banister Gate and Banister Drive. Thus, UPG 3 – Banister Dr is needed to divert flows away from Clark Avenue and down Banister Drive. For Wind Walk and Gold Medal, these developments tie into the existing system at tie-in point #18D, at the corner of Cimarron Grove Close and Cimarron Grove Way. A 250 mm gravity sewer, followed by a 375 mm gravity sewer are needed to service this area. The Wind Walk development is capped to an area of 47.1 ha in order to avoid any upgrades to the existing downstream infrastructure. The staging plan for the 10 year growth horizon is shown in Figure 7.4. Costs required for this growth horizon (independent of costs required in the previous growth horizon) are $383,000, with a summary of costs shown in Appendix C.

7.3 25 Year Growth Horizon

The 25 year growth horizon occurs in 2044, with a total population of 45,729 resulting in an increase of 10,056 from the 10 year growth horizon. In this horizon, the remainder of Wind Walk and Gold Medal will be developed, adding a population of 2,831. Full build-out will also occur in Phases 4 (population of 2,299), 5 (population of 2,088), and 6 (population of 1,344). As well, a portion of Phase 7 will be developed, accounting for the remaining 1,494 population growth.

This horizon requires both upgrades to the existing system and additional servicing. It is assumed that the infrastructure required for Wind Walk and Gold Medal has been fully developed by this point, as development is anticipated to progress in the 10 year growth horizon. Phase 4 in the southwest connects to the existing system at tie-in point #22. A short distance of 300 mm gravity sewer is required to convey flows from this development to the tie-in point at the intersection of Sheep River Drive and Big Rock Trail. Phase 5 connects to tie-in point #7 north of Crystal Shores Grove. Flows are ultimately conveyed to the 32nd Street Trunk, thus requiring UPG 4 – 32nd St S and UPG 5 – 32nd St N. Phase 6 connects into the D'Arcy Ranch system, through two 250 mm gravity sewers. Upgrades to the SRS and NRS are assumed to be complete by this point. A portion of Phase 7 (service areas N-7A, N-7A.2, N-7B, and N-7B.2) tie into the 32nd Street Trunk at tie-in point #8, located at the intersection of 32nd Street and Crystal Green Lane. UPG 4 – 32nd St S and UPG-5 – 32nd St N are required for this development as well, however should be completed prior to Phase 5. The remainder of Phase 7, consisting of the two quarter sections directly east of the one already mentioned, require new servicing which ultimately connects back into the 32nd Street Trunk. The staging plan for the 25 year growth horizon is shown in Figure 7.5. Costs required for this growth horizon (independent of costs required in previous growth horizons) are $13,000,000, with a summary of costs shown in Appendix C.

8.0 Conclusions

The Town requested that ISL complete an update to adopt the recommended servicing strategy to fit with the Town's updated Growth Strategy and provide additional staging to reach the ultimate growth horizon. This deliverable is intended to be an update / amendment memorandum attached to the SMP. The purpose of this deliverable is as follows:

- To update baseline data and the MIKE URBAN model based on growth since the completion of the SMP.
- To update the overall servicing concept based on the updated growth plans.
- To prepare servicing options based on the refined overall servicing plan for the 5 year, 10 year, 25 year, and ultimate servicing horizons.
- To prepare staging plans for existing system upgrades in conjunction with future system expansion, along with costs and cost assignments (Town / Off-site Levy / Developer).

The hydrodynamic model constructed and calibrated for the SMP was updated to reflect the most recent condition of the sanitary system. The updated model was then assessed under existing conditions to determine areas lacking capacity, and areas with spare capacity. The assessment was performed for the selected LOS; the 50 year 24 hour Q4 Huff Storm. Results from this analysis highlighted two areas of concern:

1. North Railway Street, east of Veterans Way – minor surcharging within the section of pipe along North Railway Street. Surcharging is mitigated by upsizing this main to 300 mm.
2. Clark Avenue, from Wilson Street to North Railway Street – localized pockets of surcharged sewers are evident. Surcharging is mitigated by removing 90 degree bends, replacing existing VCT sewers with PVC, and regrading the section to provide a slope of 2% throughout.

The recommended servicing concept identified in the SMP was revised to reflect a number of changes, noted below:

1. Changes in land use type in order to be in line with the land use outlined in Scenario 3 of the Comprehensive Growth Strategy Report.
2. Updates to the sanitary service area naming convention to be consistent with the naming convention utilized for the benefiting areas in the Servicing Strategy Brief to Accommodate the Draft Growth Strategy.
3. Removal of certain parcels from future conditions, as they have been developed since the SMP and are now accounted for under existing conditions.
4. Removal of service area 60-11, as it is no longer proposed for development. Some service area boundaries were also refined to match the Servicing Strategy Brief to Accommodate the Draft Growth Strategy.
5. Accounting for refinements occurring after the final submission of the SMP. This includes the revised tie-in location for the Wind Walk and Gold Medal developments, and splitting the Wedderburn service area to eliminate the need for a costly sanitary main down Northridge Drive.

A single build-out growth horizon servicing concept was developed for the purpose of this update. Generally speaking, the concept is similar to the recommended concept identified in the SMP, but accounts for the changes to existing infrastructure and land use noted above. This concept is illustrated in Figure 5.2.

An assessment was performed to analyze the impact of the additional development to the existing sanitary system. A number of affected sewer sections were noted, representing sections where the peak discharge relative to sewer capacity exceeded 100%. In total four locations with a significant degree of surcharging, two locations with a moderate degree of surcharging, and eleven locations with a minimal degree of surcharging were highlighted. Upgrades were recommended for pipes with moderate or significant surcharging, noting that pipes with minimal surcharging should be monitored in the future to ensure there is no risk of basement or surface flooding. In all, five upgrades were proposed, as shown in Figure 6.3.

9.0 Authorization

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2020-02-11

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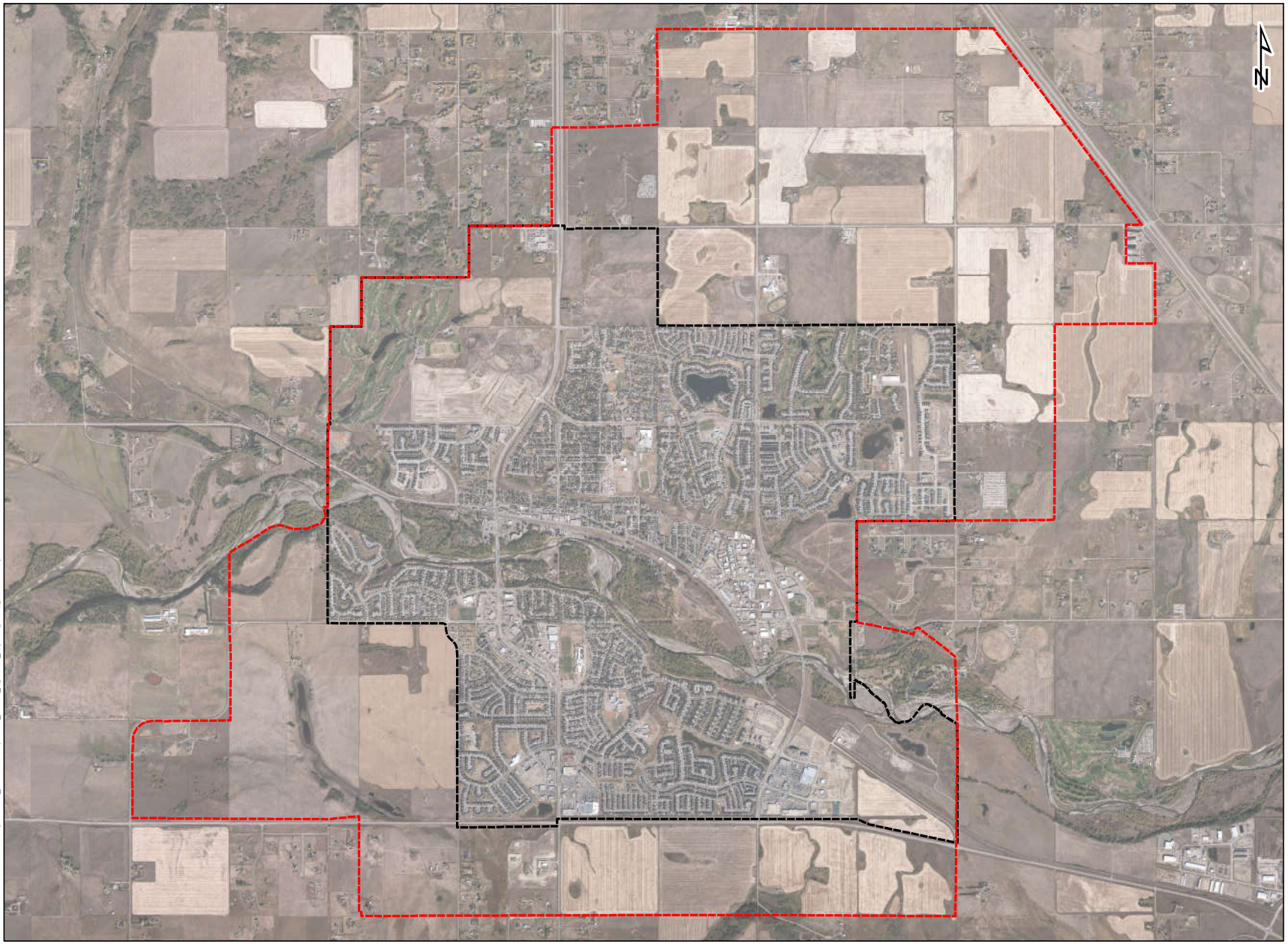
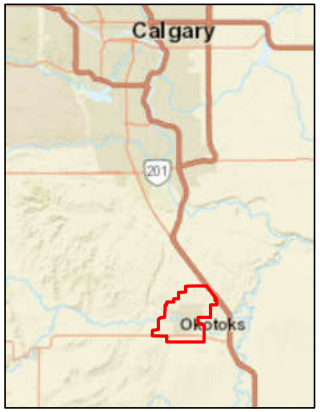
Technical Author

Geoffrey Schulmeister, P.Eng., SCPM
Senior Reviewer



Legend

- Pre-Annexation Boundary
- Post-Annexation Boundary



Coordinate System:
CANA83-3TM114

1:30,000

0 300 600 1,200 Meters

FIGURE 1.1
STUDY AREA
SANITARY MASTER PLAN UPDATE

Okotoks
Historic Past. Sustainable Future

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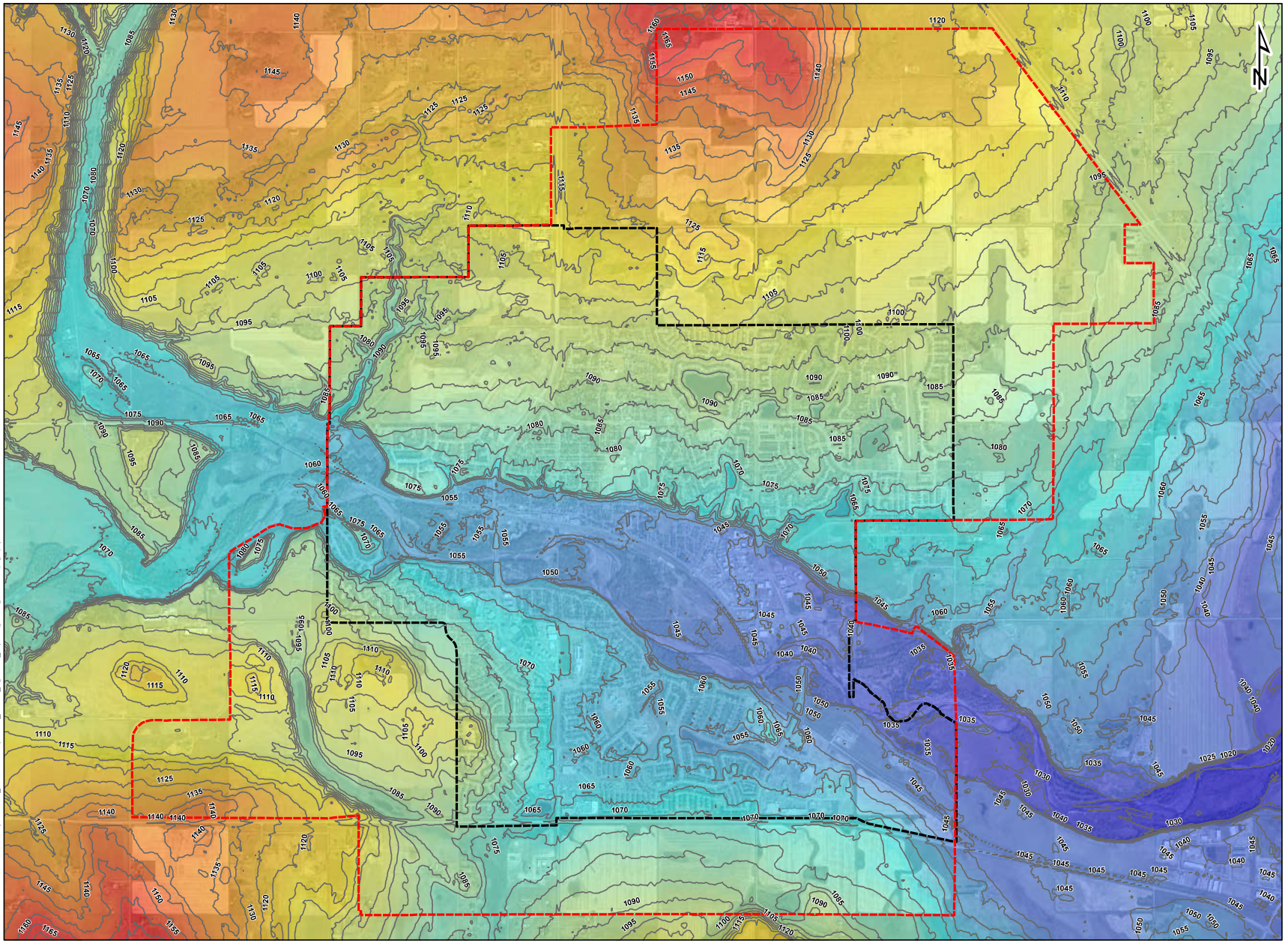

FIGURE 1.2
TOPOGRAPHY
SANITARY MASTER PLAN UPDATE

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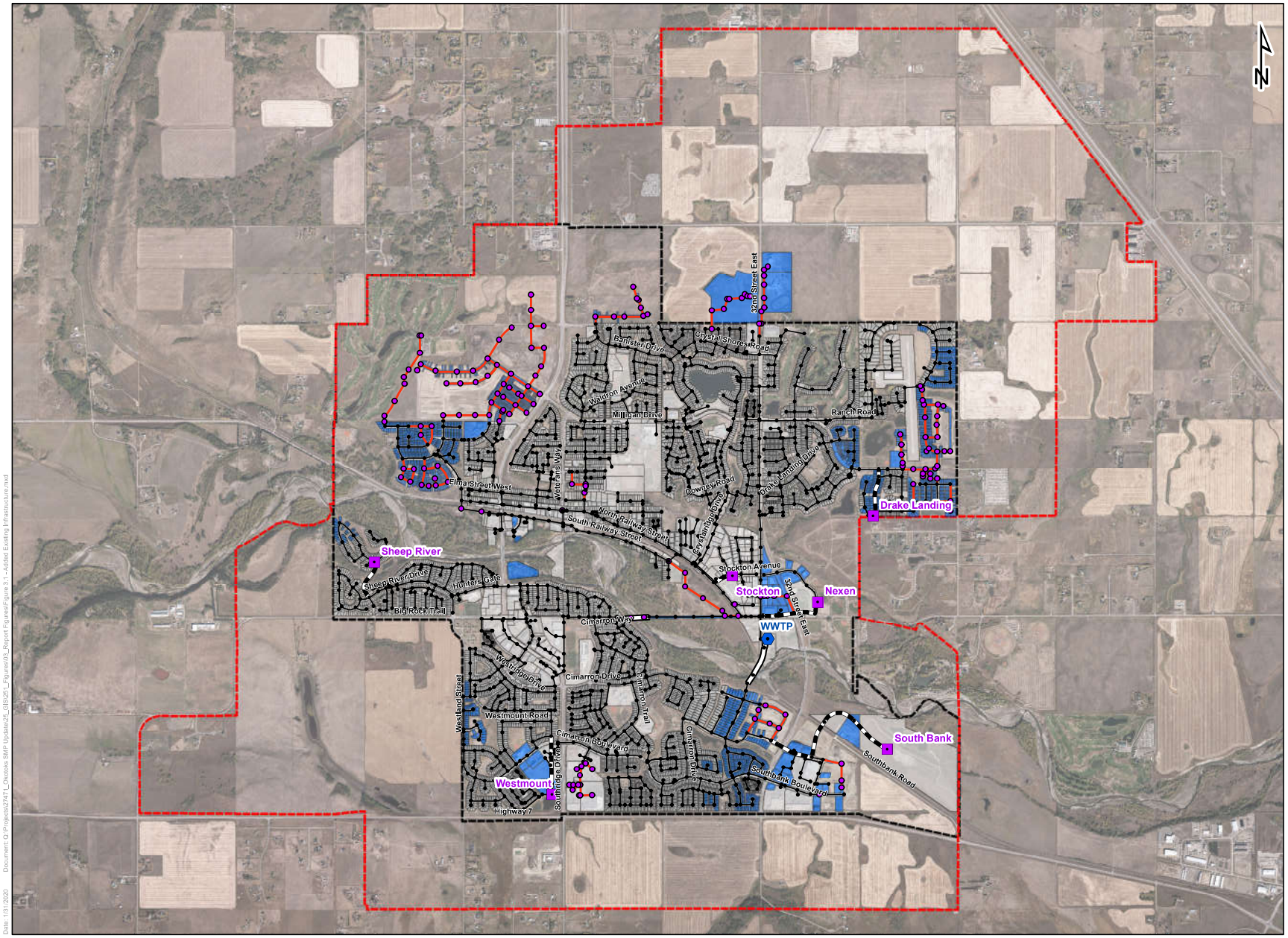
Date: 11/4/2020
Document Q:\Projects\247\1_Okotoks SMP Update\2_CIS\25_GIS\mxd\Figures\Figure 1.2 - Topography.mxd



Legend

- Lift Station
- Wastewater Treatment Plant
- Forcemain
- Siphon
- Pre-Annexation Boundary
- Post-Annexation Boundary

Manholes

- Added
- Existing

Pipes

- Added
- Existing

Parcels

- Added
- Existing

Coordinate System:
CANA83-3TM114

1:30,000

0 300 600 1,200 Meters

FIGURE 3.1
ADDED INFRASTRUCTURE
SANITARY MASTER PLAN UPDATE

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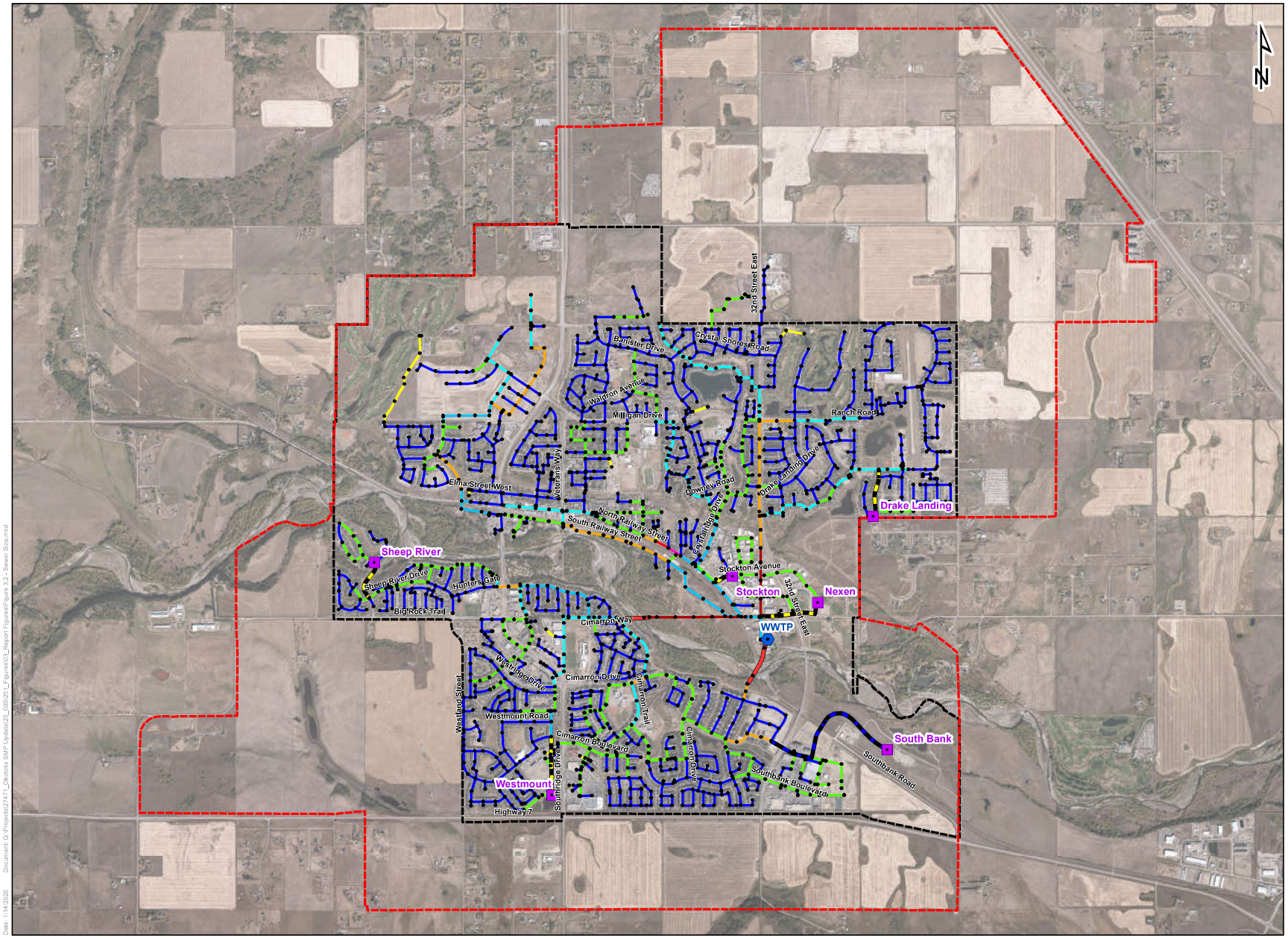
Date: 1/31/2020
Document G:\Projects\2747\1_Okotoks SMP Update\2_GIS\2R_Figures\02_Report Figures\Figure 3.1 - Added Existing Infrastructure.mxd



Legend

- Manhole
- Lift Station
- Wastewater Treatment Plant
- Pre-Annexation Boundary
- Post-Annexation Boundary

Pipe Size

- 150mm Forcemain
- 200mm Forcemain
- 350mm Siphon
- 100-150mm Gravity Sewer
- 200mm Gravity Sewer
- 250mm Gravity Sewer
- 300mm Gravity Sewer
- 350mm Gravity Sewer
- 375mm Gravity Sewer
- 400mm Gravity Sewer
- 450mm Gravity Sewer
- 525mm Gravity Sewer
- 675mm Gravity Sewer
- 900mm Gravity Sewer

Coordinate System:
CANA83-3TM114

1:30,000

0 300 600 1,200 Meters

FIGURE 3.2
SEWER SIZE
SANITARY MASTER PLAN UPDATE

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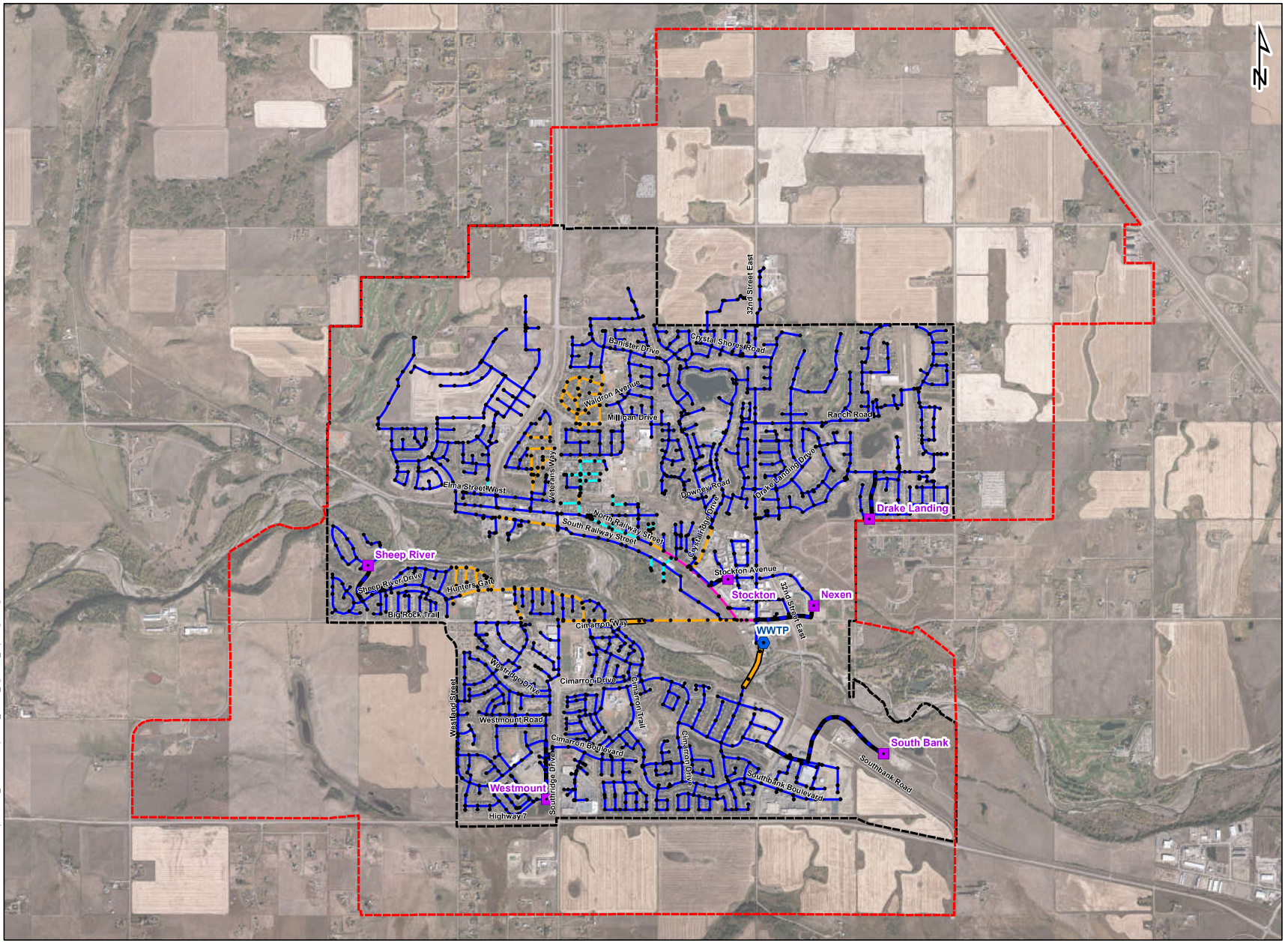
Date: 11/4/2020
Document Q:\Projects\247471_Okotoks SNP Update\2_GIS\25_GFigures\01_Report Figures\Figure 3.2 - Sewer Size.mxd



Legend

- Manhole
- Lift Station
- Wastewater Treatment Plant
- Pre-Annexation Boundary
- Post-Annexation Boundary

Pipe Material

- PVC Forcemain
- HDPE Siphon
- PVC Gravity Sewer
- Asbestos Cement Gravity Sewer
- HDPE Gravity Sewer
- Steel Gravity Sewer
- Vitrified Clay Tile Gravity Sewer

Coordinate System:
CANA83-3TM114

1:30,000

0 300 600 1,200 Meters

FIGURE 3.3
SEWER MATERIAL
SANITARY MASTER PLAN UPDATE

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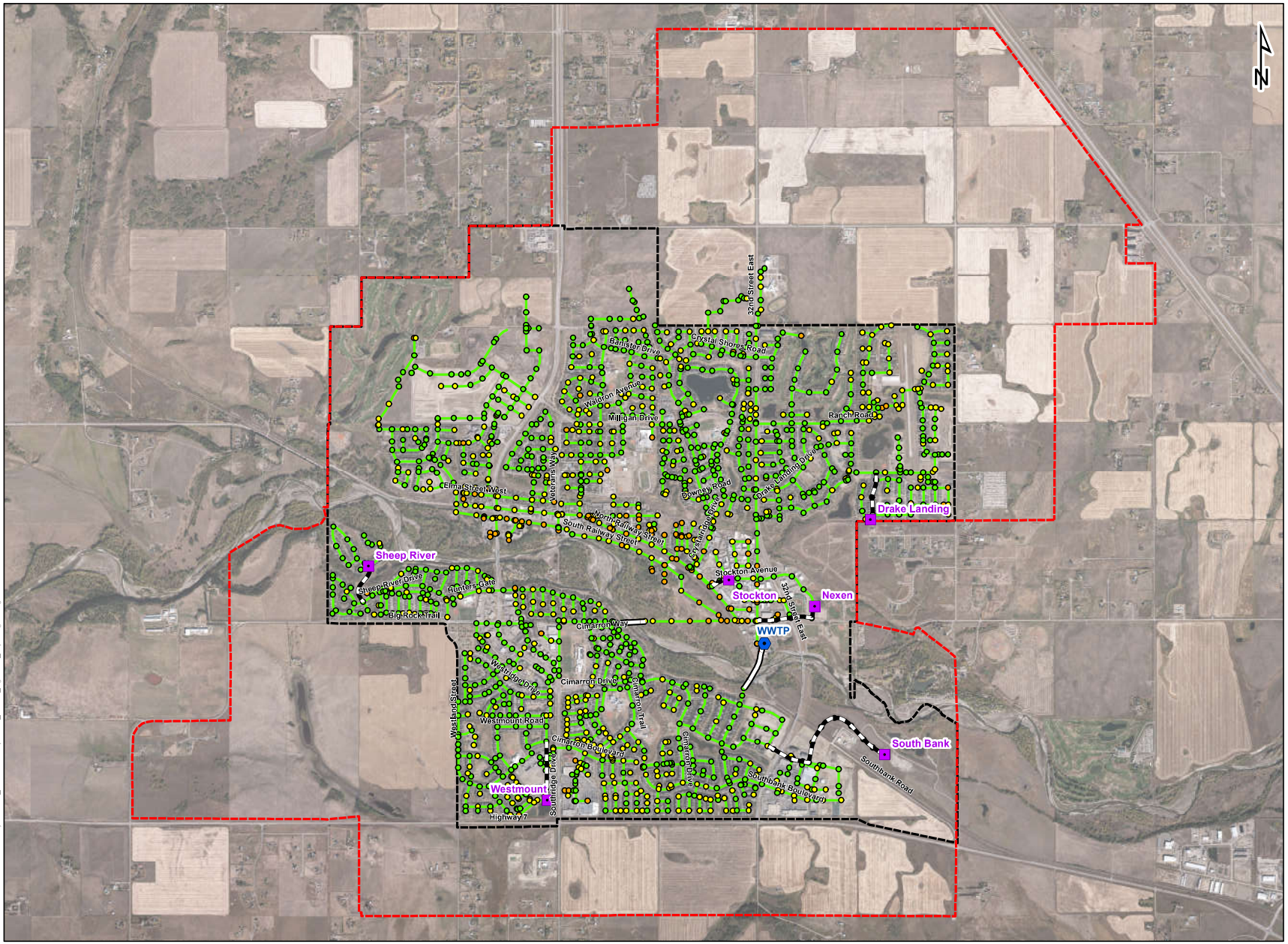
Date: 11/4/2020
Document Q:\Projects\247471_Okotoks SNP Update\2_GIS\25_GFigures\01_Report Figures\Figure 3.3 - Sewer Material.mxd



Legend

- Lift Station
- Wastewater Treatment Plant
- Forcemain
- Siphon
- Pre-Annexation Boundary
- Post-Annexation Boundary

Maximum HGL Elevation Relative to Ground

- Less than -3.50m
- Between -3.50m and -2.50m
- Between -2.50m and 0.00m
- Greater than 0.00m

Peak Discharge Relative to Pipe Capacity

- Greater than 100%
- Between 86% and 100%
- Less than 86%

Coordinate System:
CANA83-3TM114

1:30,000

0 300 600 1,200 Meters

FIGURE 4.1
EXISTING SYSTEM RESULTS
DWF CONDITIONS
SANITARY MASTER PLAN UPDATE

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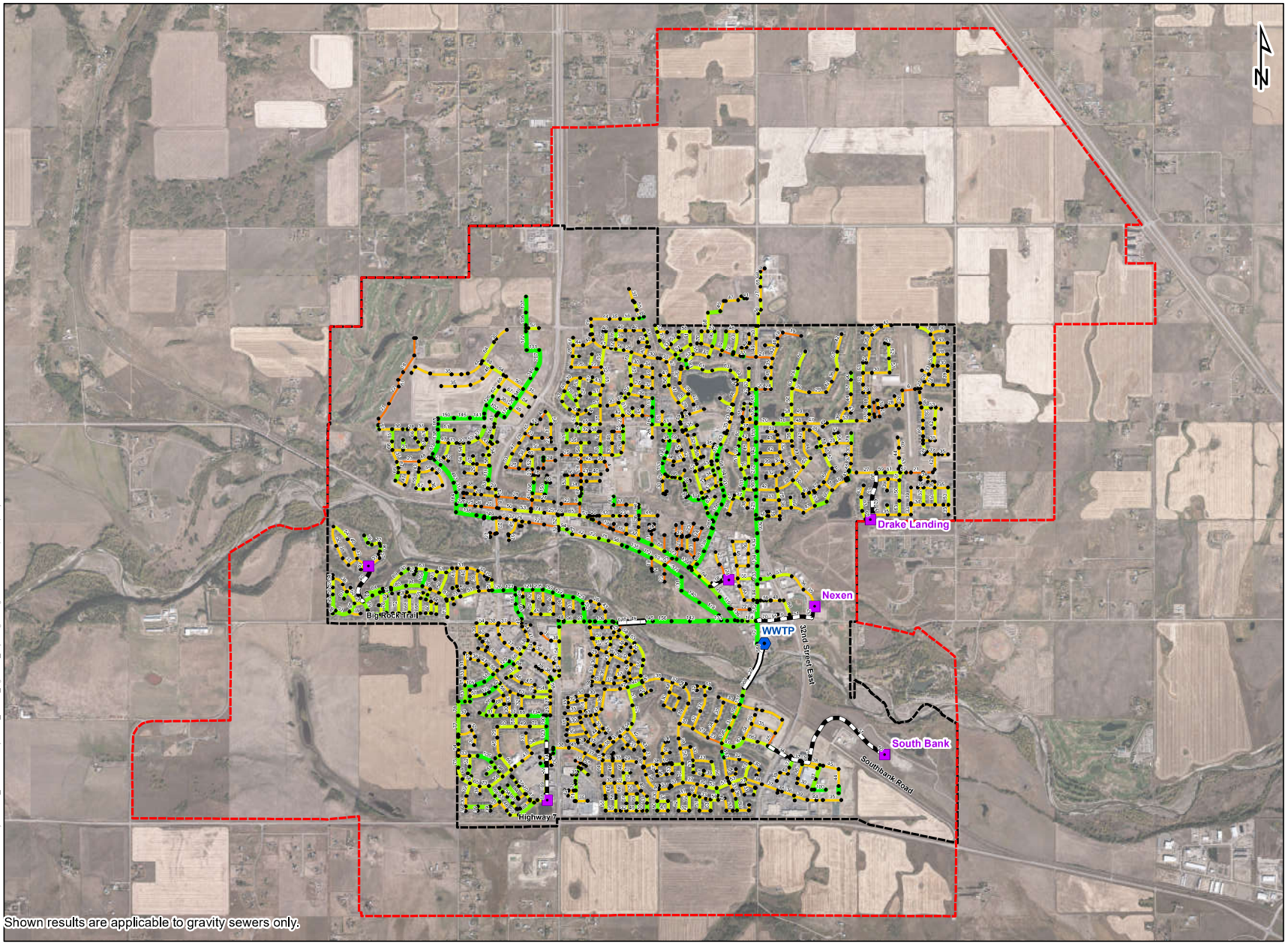
Date: 1/29/2020 Document Q:\Projects\2747\1_Okotoks SMP Update\2_GIS\2R_Figures\01_Report Figures\Figure 4.1 - EX DWF (Q-Omin and Node Flood.mxd



Legend

- Manhole
- Lift Station
- Wastewater Treatment Plant
- Forcemain
- Siphon
- Pre-Annexation Boundary
- Post-Annexation Boundary

Spare Capacity

- Less than 0L/s
- 0 - 25L/s
- 25 - 50L/s
- 50 - 75L/s
- 75 - 100L/s
- Greater than 100L/s

**Please note that spare capacity labels are in L/s.*

Coordinate System:
CANA83-3TM114

1:30,000

0 300 600 1,200 Meters

FIGURE 4.2
EXISTING SYSTEM RESULTS
DWF CONDITIONS
SPARE CAPACITY
SANITARY MASTER PLAN UPDATE

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Shown results are applicable to gravity sewers only.

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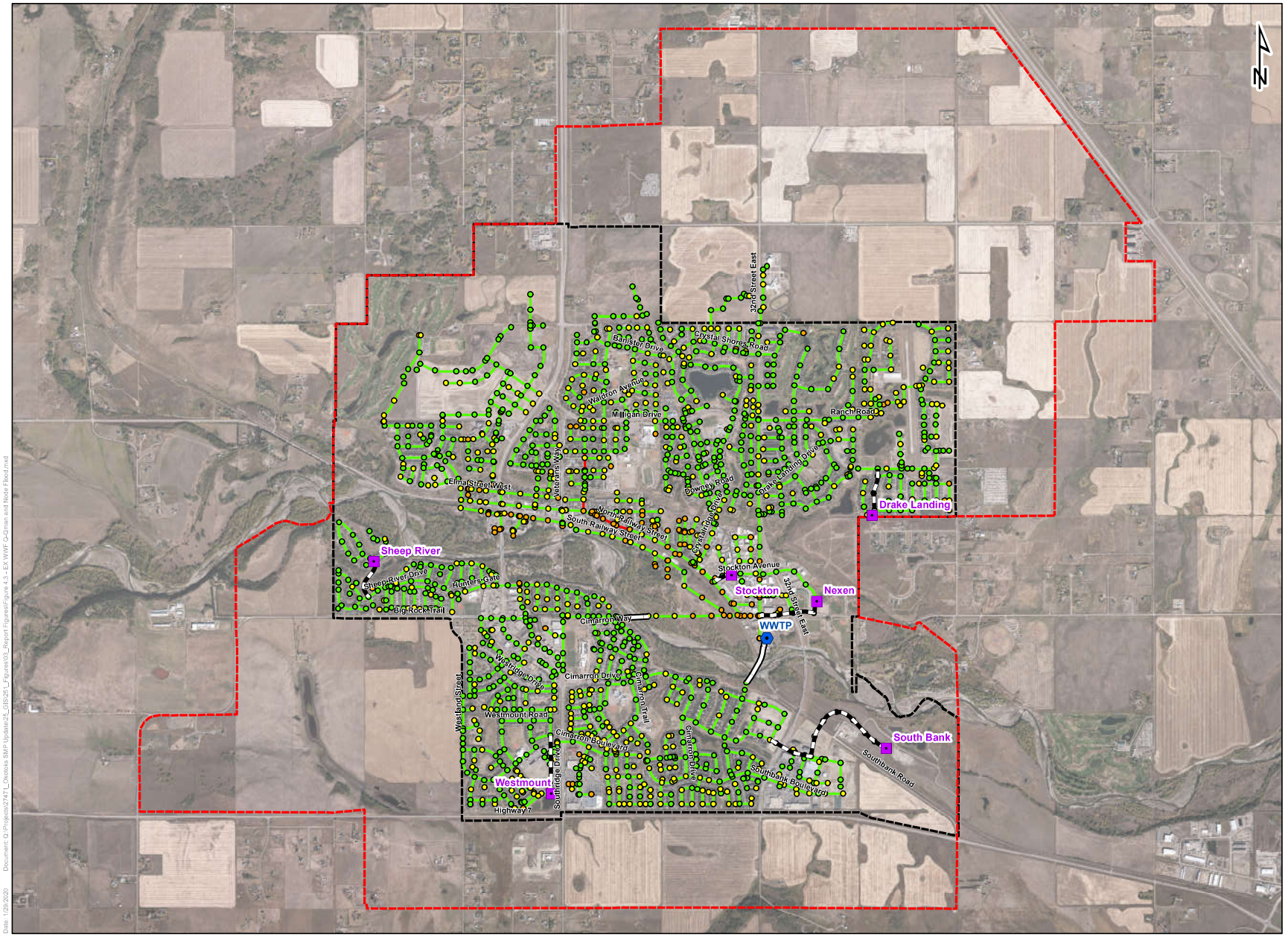

Legend

- Lift Station
- Wastewater Treatment Plant
- Forcemain
- Siphon
- Pre-Annexation Boundary
- Post-Annexation Boundary

Maximum HGL Elevation Relative to Ground

- Less than -3.50m
- Between -3.50m and -2.50m
- Between -2.50m and 0.00m
- Greater than 0.00m

Peak Discharge Relative to Pipe Capacity

- Greater than 100%
- Between 86% and 100%
- Less than 86%

Coordinate System:
CANA83-3TM114

1:30,000

0 300 600 1,200 Meters

FIGURE 4.3
EXISTING SYSTEM RESULTS
WWF CONDITIONS
SANITARY MASTER PLAN UPDATE

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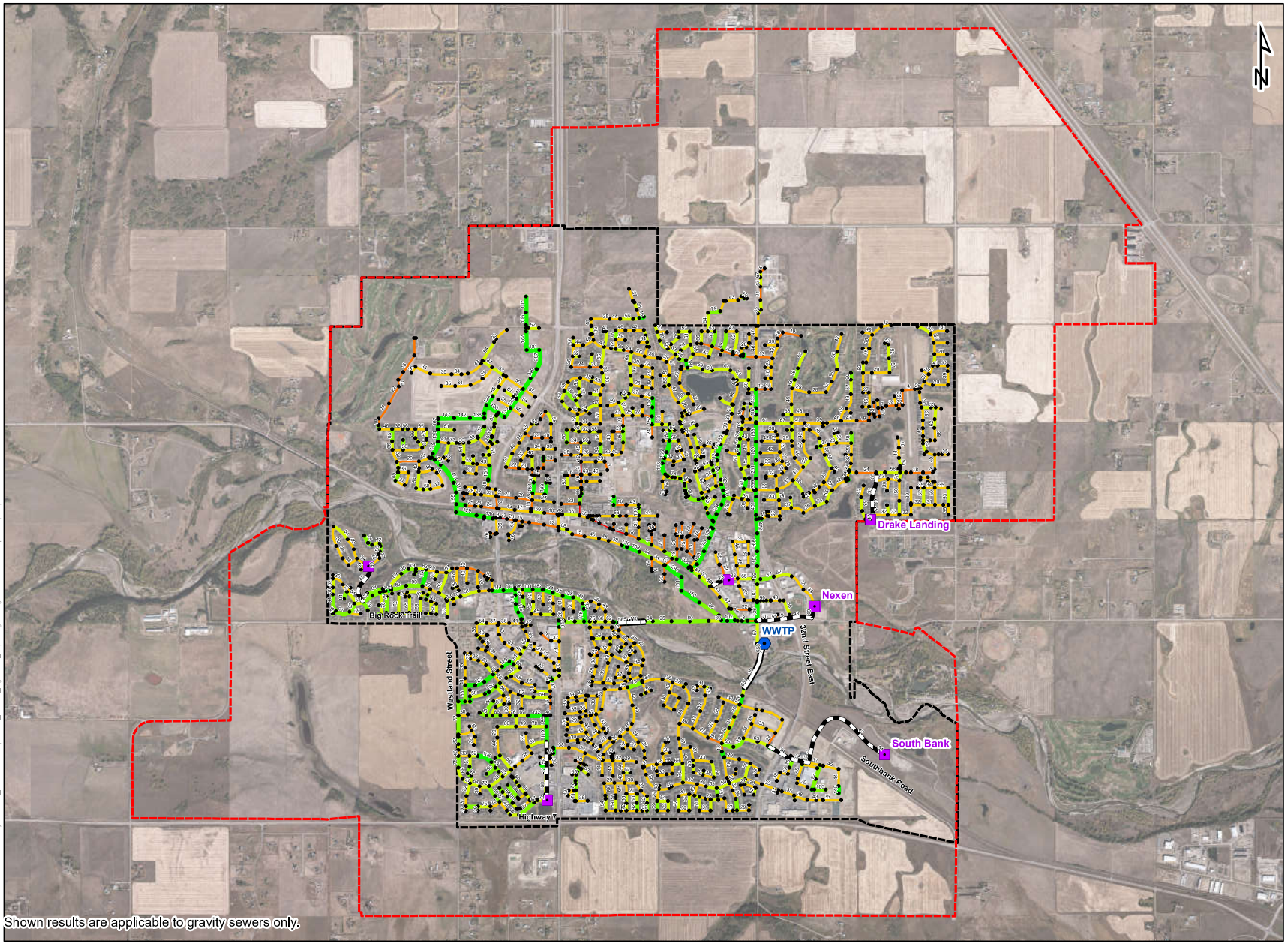
Date: 1/20/2020
Document Q:\Projects\2747\1_Okotoks SMP Update\2_GIS\2R_Figures\01_Report Figures\Figure 4.3 - EX WWF Q+Oman and Note Flood.mxd



Shown results are applicable to gravity sewers only.

Legend

- Manhole
- Lift Station
- Wastewater Treatment Plant
- Forcemain
- Siphon
- Pre-Annexation Boundary
- Post-Annexation Boundary

Spare Capacity

- Less than 0L/s
- 0 - 25L/s
- 25 - 50L/s
- 50 - 75L/s
- 75 - 100L/s
- Greater than 100L/s

**Please note that spare capacity labels are in L/s.*

Coordinate System:
CANA83-3TM114

1:30,000

0 300 600 1,200 Meters

FIGURE 4.4
EXISTING SYSTEM RESULTS
WWF CONDITIONS
SPARE CAPACITY
SANITARY MASTER PLAN UPDATE

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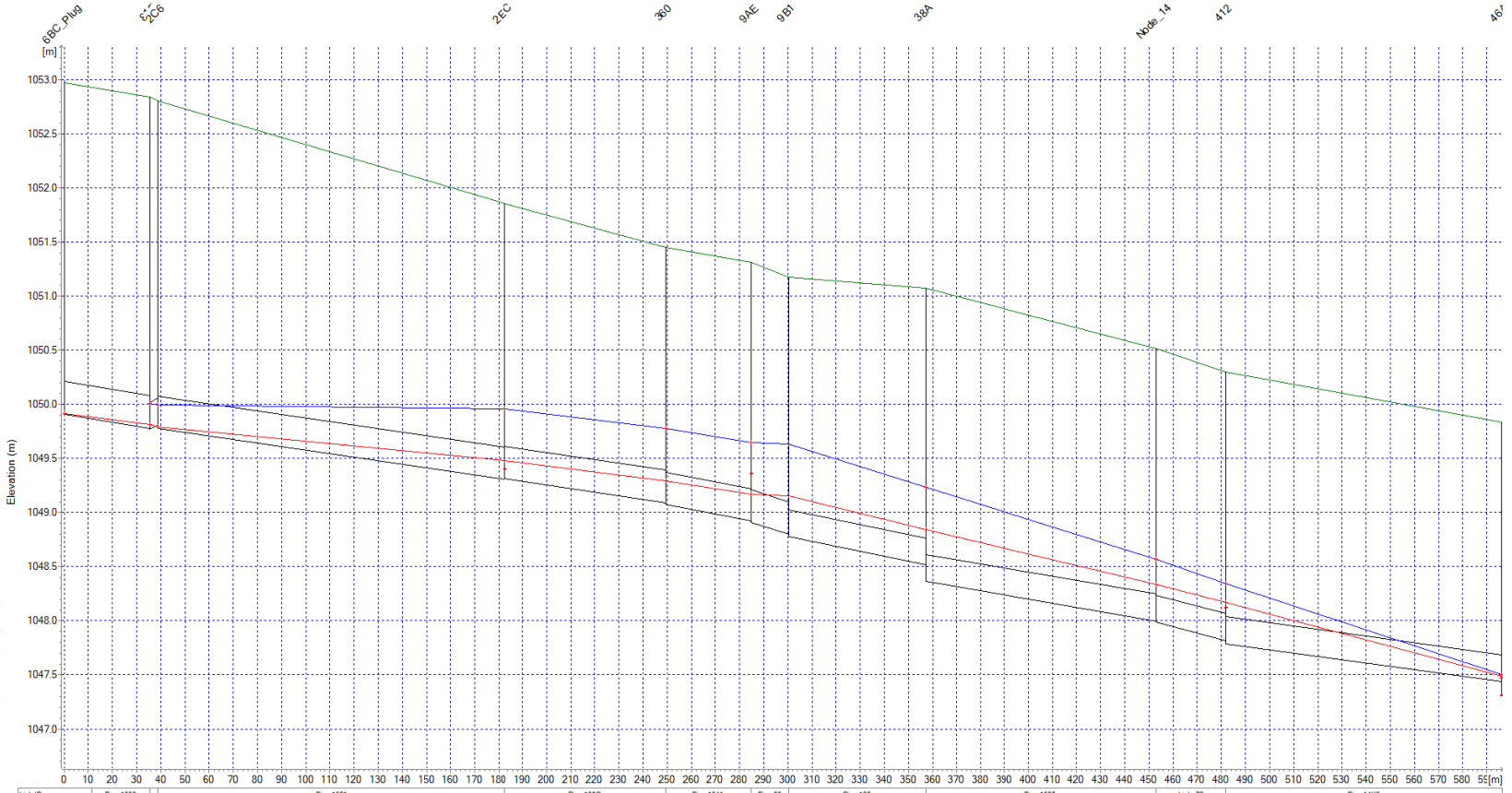
Service Layer Credits:

Date: 7/23/2020 Document Q:\Projects\2747\1_Okotoks SMP Update\2_CIB\2R_Figures\10_Report Figures\Figure 4.4 - EX WWF Spare Capacity.mxd



Link ID	Pipe 1693	Pipe 1021		Pipe 136C	Pipe 1341	Pipe 26	Pipe 132	Pipe 1388		Link_72	Pipe 14K3	
Link Diameter (m)	0.3000	0.3000					0.2500					
Ground Level (m)	1052.84	1052.81	1051.85	1051.45	1051.31	1051.18	1051.07	1050.52			1050.30	1049.84
Invert Level (m)	1049.77	1049.78	1049.31	1049.07	1048.91	1048.78	1048.36	1047.99			1047.79	1047.31
Link Slope (%)	0.37	0.33			0.43	0.73	0.46	0.38		0.58	0.31	
Capacity	0.0693	0.0653		0.0655	0.0748	0.0974	0.0350	0.0319		0.0393	0.0286	
Original SMP PWWF	0.0226	0.0229		0.0564	0.0566	0.0407	0.0408	0.0410			0.0414	
Updated SMP PWWF	0.0000	0.0004		0.0354	0.0355	0.0356	0.0358	0.0359			0.0364	

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Legend

- Original SMP HGL
- Updated SMP HGL

Coordinate System:
CANA83-3TM114

1:20,000

0 200 400 800 Meters

FIGURE 4.5
EXISTING SYSTEM RESULTS
WWF CONDITIONS
LP ALONG NORTH RAILWAY STREET
SANITARY MASTER PLAN UPDATE

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Where Past, Future & Landscape Meet

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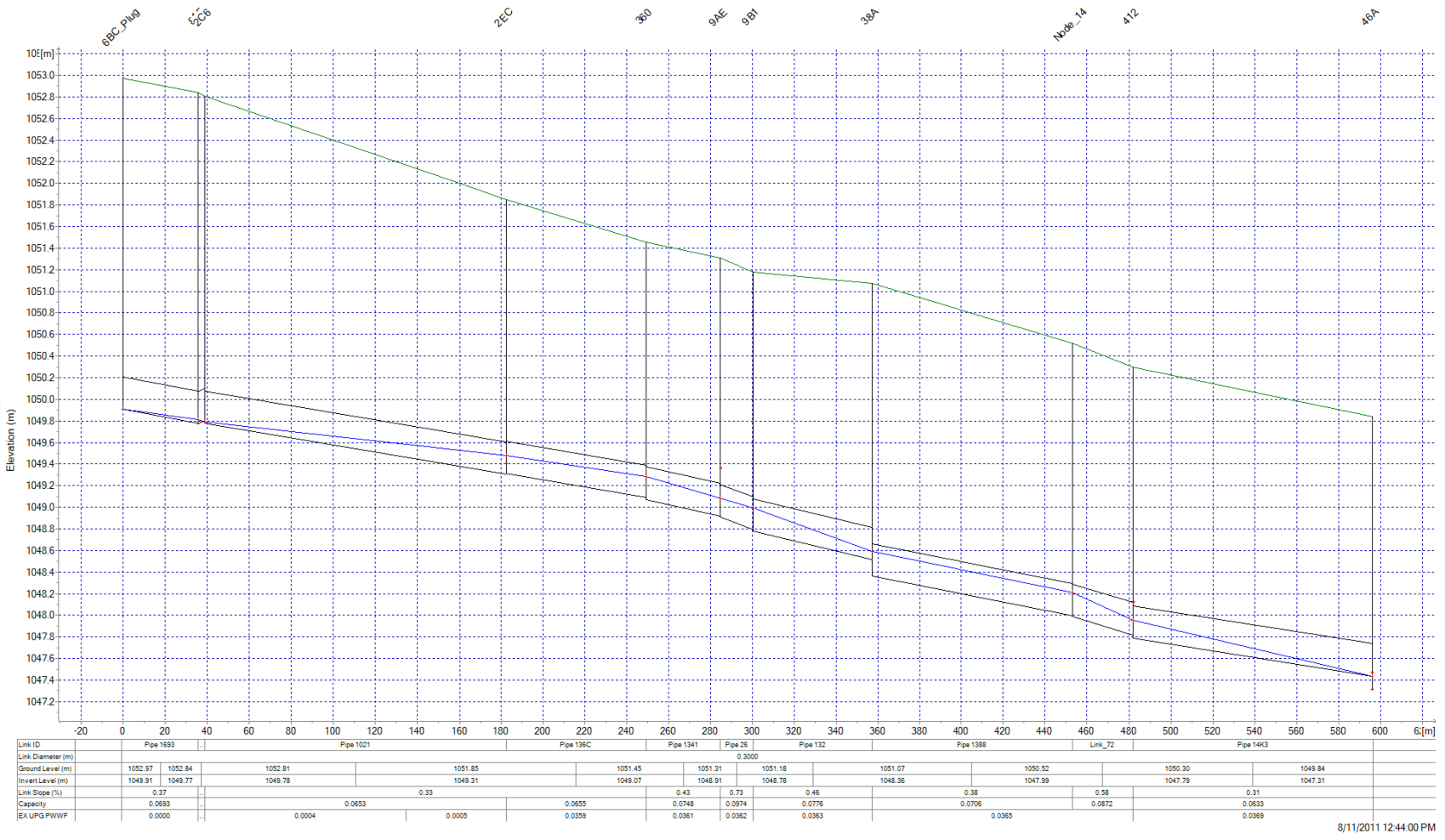
Date: 11/6/2020 Document: Q:\Projects\21471_Okotoks SMP Update\2d_GIS\25_LF\gures\03_Report Figures\Figure 4.5 - EX WWF North Railway Street LP.mxd



Link ID		Pipe 1693		Pipe 1021			Pipe 136C	Pipe 1341	Pipe 25	Pipe 132	Pipe 1388		Link_72	Pipe 14K3	
Link Diameter (m)							0.3000								
Ground Level (m)	1052.97	1052.84	1052.81		1051.85		1051.45	1051.31	1051.18	1051.07	1050.52		1050.30	1049.84	
Invert Level (m)	1049.91	1049.77	1049.78		1049.31		1049.07	1048.91	1048.78	1048.36	1047.99		1047.79	1047.31	
Link Slope (%)	0.37		0.33				0.43	0.73	0.46	0.38		0.58	0.31		
Capacity	0.0693		0.0653		0.0655		0.0748	0.0974	0.0776	0.0706		0.0872	0.0633		
EX UPG PWWF	0.0000		0.0004	0.0005	0.0359		0.0361	0.0362	0.0363	0.0365			0.0369		

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Legend

Existing System Upgrades HGL

N

Coordinate System:
CANA83-3TM114

1:20,000

0 200 400 800 Meters

FIGURE 4.6
UPGRADED EXISTING SYSTEM RESULTS
WWF CONDITIONS
LP ALONG NORTH RAILWAY STREET
SANITARY MASTER PLAN UPDATE

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Where Past Embraces Future

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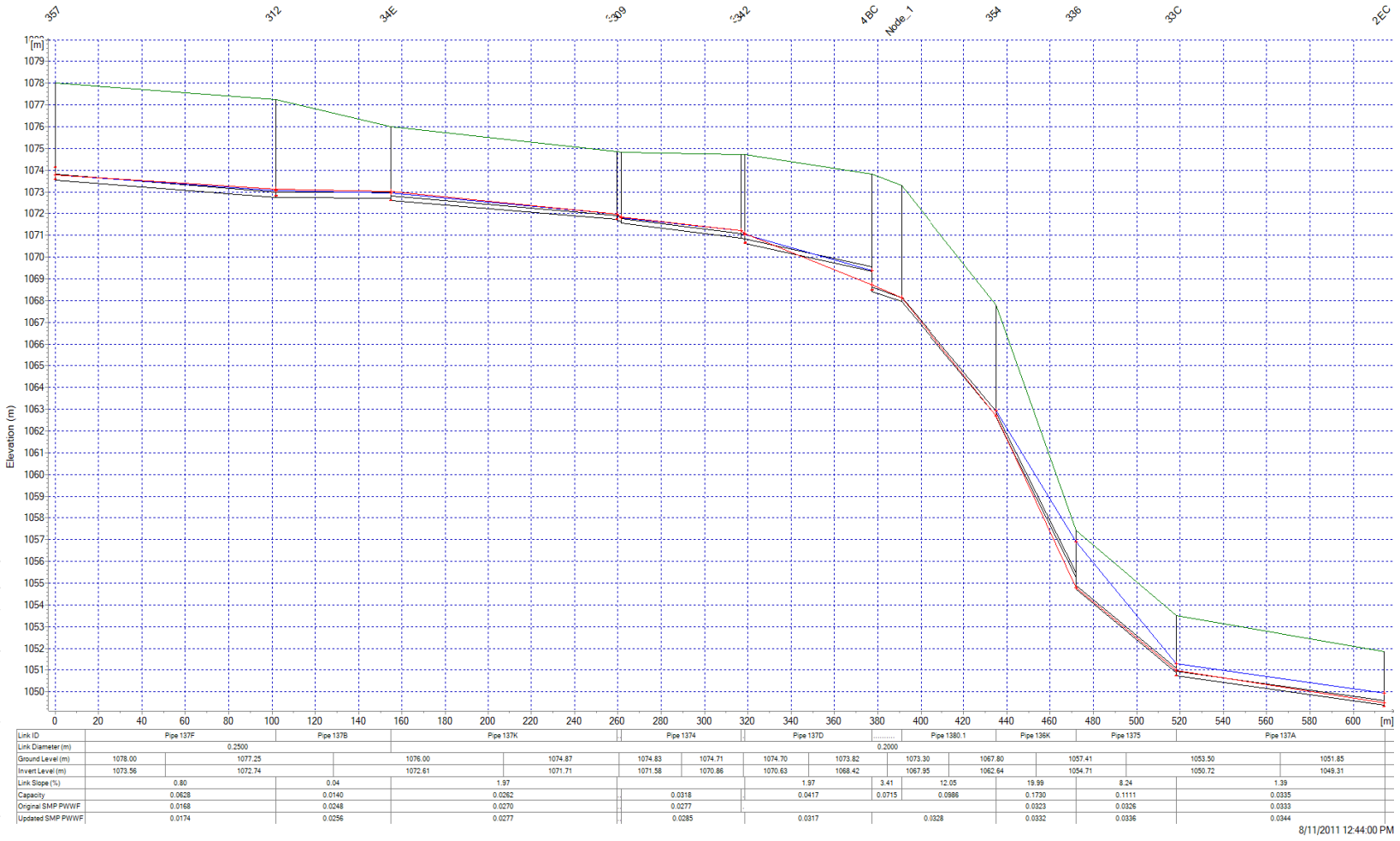
Date: 1/15/2020 Document: Q:\Projects\21471_Okotoks SMP Update\2d_GIS\25 LF\grass\03_Report Figures\Figure 4.6 - EX WWF North Railway Street LP - Upgraded.mxd

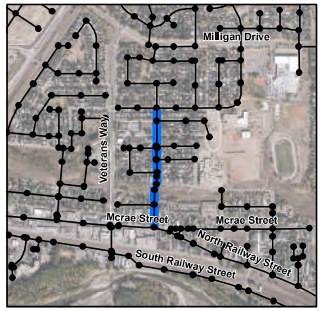


Link ID	Pipe 137F	Pipe 137B	Pipe 137K	Pipe 1374	Pipe 137D	Pipe 1380.1	Pipe 136K	Pipe 1375	Pipe 137A	
Link Diameter (m)	0.2500				0.2000					
Ground Level (m)	1078.00	1077.25	1076.00	1074.87	1074.83	1074.71	1074.70	1073.82	1073.30	1067.80	1057.41	1053.50	1051.85
Invert Level (m)	1073.56	1072.74	1072.61	1071.71	1071.58	1070.86	1070.63	1068.42	1067.95	1062.64	1054.71	1050.72	1049.31
Link Slope (%)	0.80	0.04	1.97		1.97	3.41	12.05	19.99	8.24	1.39			
Capacity	0.0628	0.0140	0.0262	0.0318	0.0417	0.0715	0.0986	0.1730	0.1111	0.0335			
Orginal SMP PWWF	0.0168	0.0248	0.0270	0.0277				0.0323	0.0326	0.0333			
Updated SMP PWWF	0.0174	0.0256	0.0277	0.0285	0.0317	0.0328		0.0332	0.0336	0.0344			

Legend

Original SMP HGL

Updated SMP HGL



Coordinate System:
CANA83-3TM114

1:20,000

0 200 400 800 Meters

FIGURE 4.7
EXISTING SYSTEM RESULTS
WWF CONDITIONS
LP ALONG CLARK AVENUE
SANITARY MASTER PLAN UPDATE

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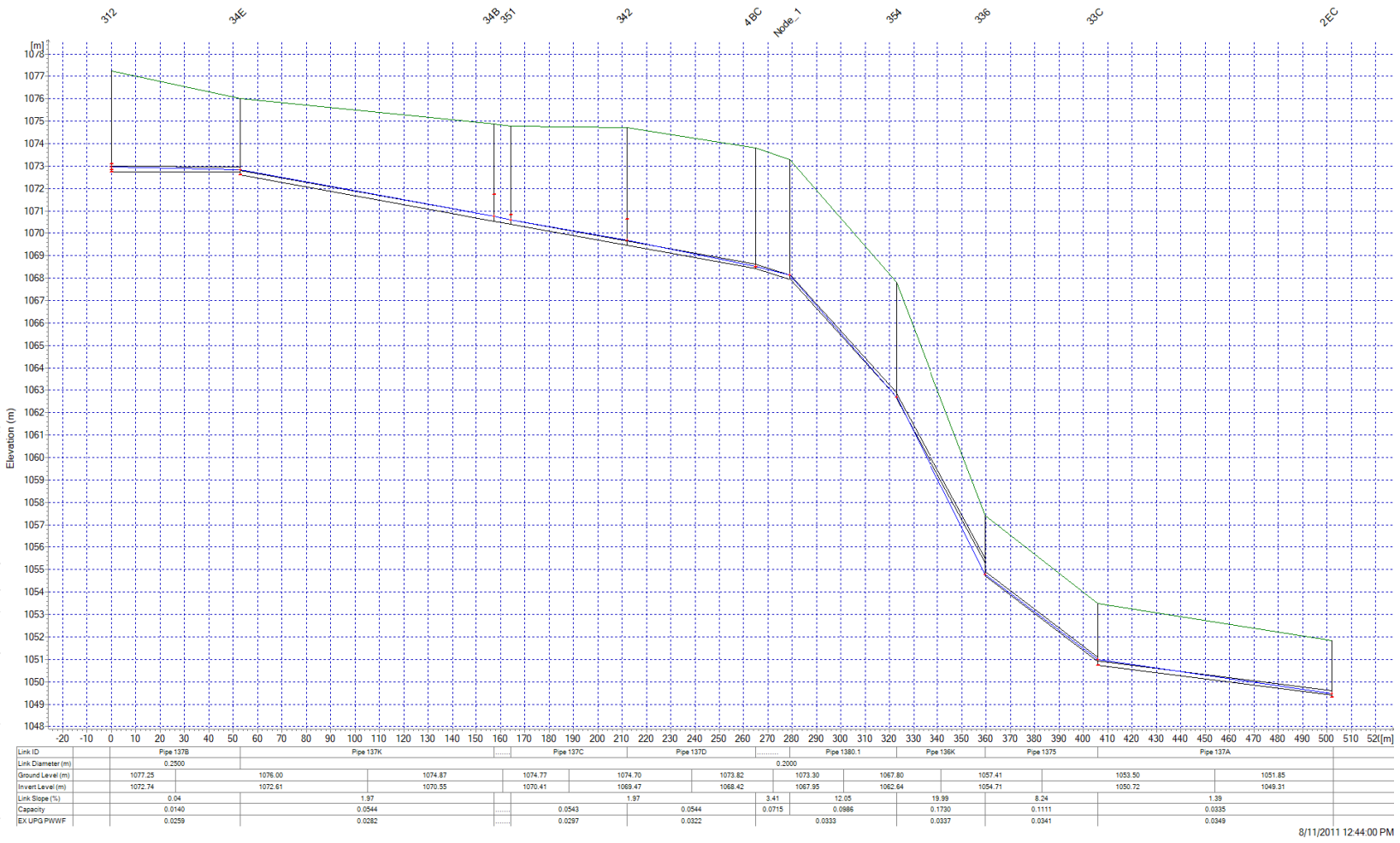
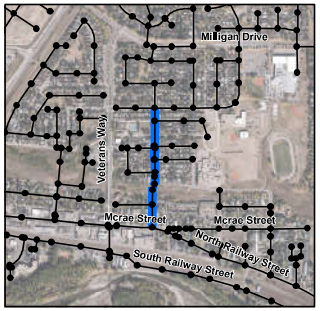
Date: 11/6/2020

Document: Q:\Projects\21471_Okotoks SMP Update\2d_GIS\25_LF\gures\03_Report Figures\Figure 4.7 - EX WWF Clark Avenue LP.mxd



Legend

Existing System Upgrades HGL



Coordinate System:
CANA83-3TM114

1:20,000

0 200 400 800 Meters

FIGURE 4.8
UPGRADED EXISTING SYSTEM RESULTS
WWF CONDITIONS
LP ALONG CLARK AVENUE
SANITARY MASTER PLAN UPDATE

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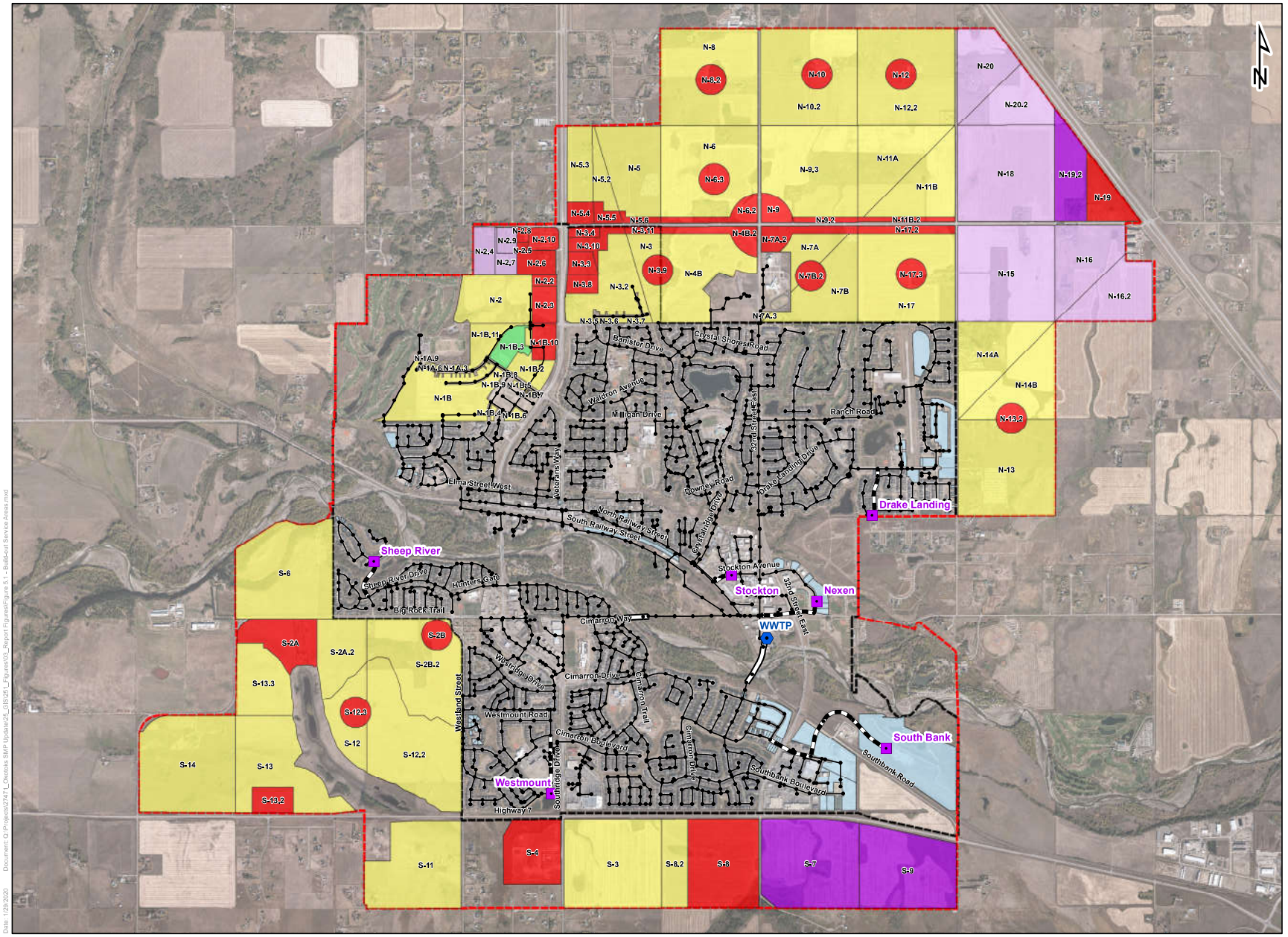
Date: 1/15/2020 Document: Q:\Projects\21471_Okotoks SMP Update\2d_GIS\2D5_LF\gures\03_Report Figures\Figure 4.8 - EX WWF Clark Avenue LP - Upgraded.mxd



Legend

- Manhole
- Lift Station
- Wastewater Treatment Plant
- Sanitary Pipe
- Forcemain
- Siphon
- Pre-Annexation Boundary
- Post-Annexation Boundary

Service Area by Land Use

- Densification
- Commercial
- Industrial
- Institutional
- Residential
- Surplus Industrial

Coordinate System:
CANA83-3TM114

1:30,000

0 300 600 1,200 Meters

FIGURE 5.1
BUILD-OUT SERVICE AREAS
SANITARY MASTER PLAN UPDATE

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Date: 1/29/2020 Document Q:\Projects\21471_Okotoks SMP Update\2_GIS\2R_Figures\02_Report Figures\Figure 5.1 - Build-out Service Areas.mxd

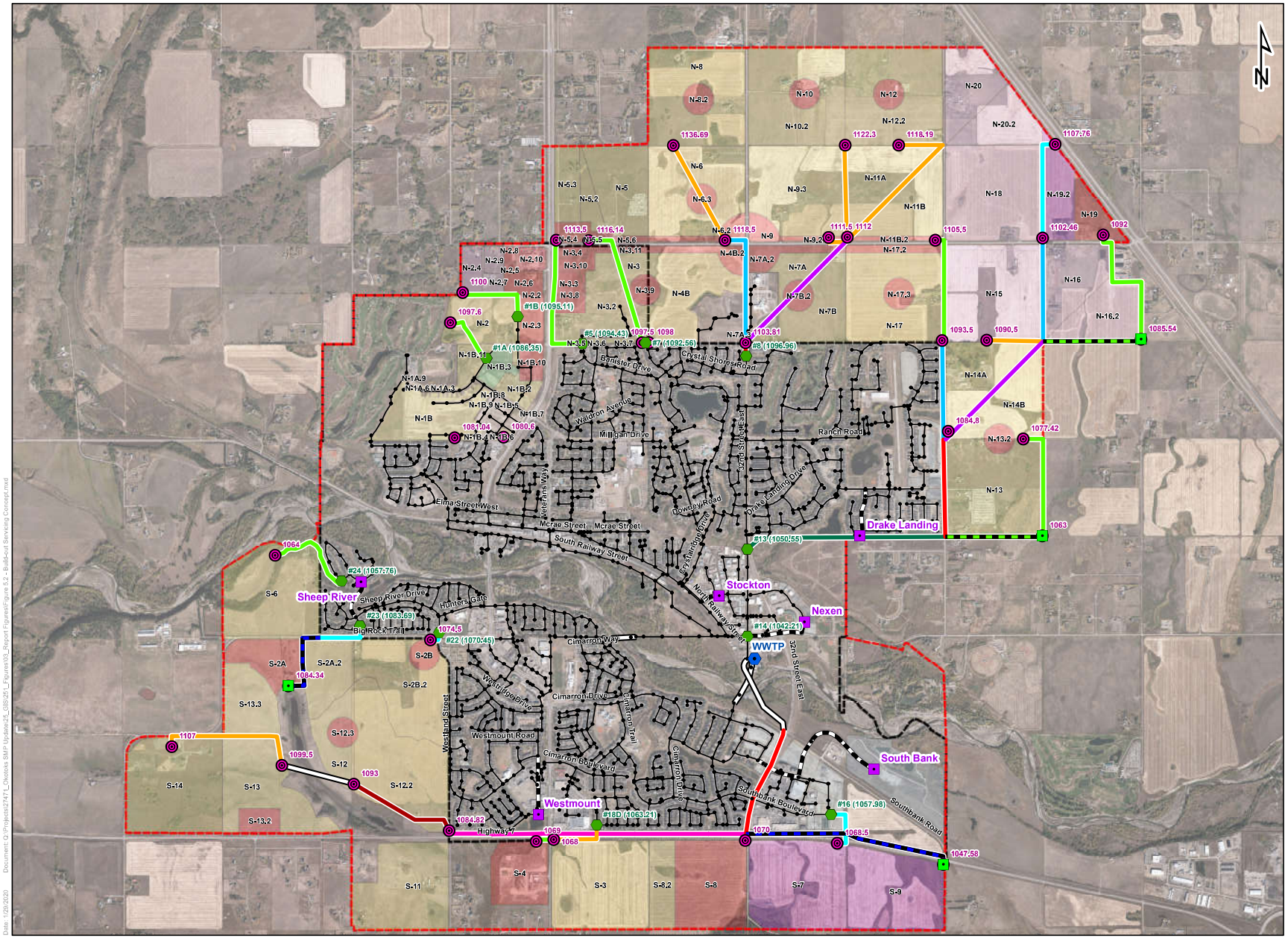

FIGURE 5.2
BUILD-OUT SERVICING CONCEPT
SANITARY MASTER PLAN UPDATE

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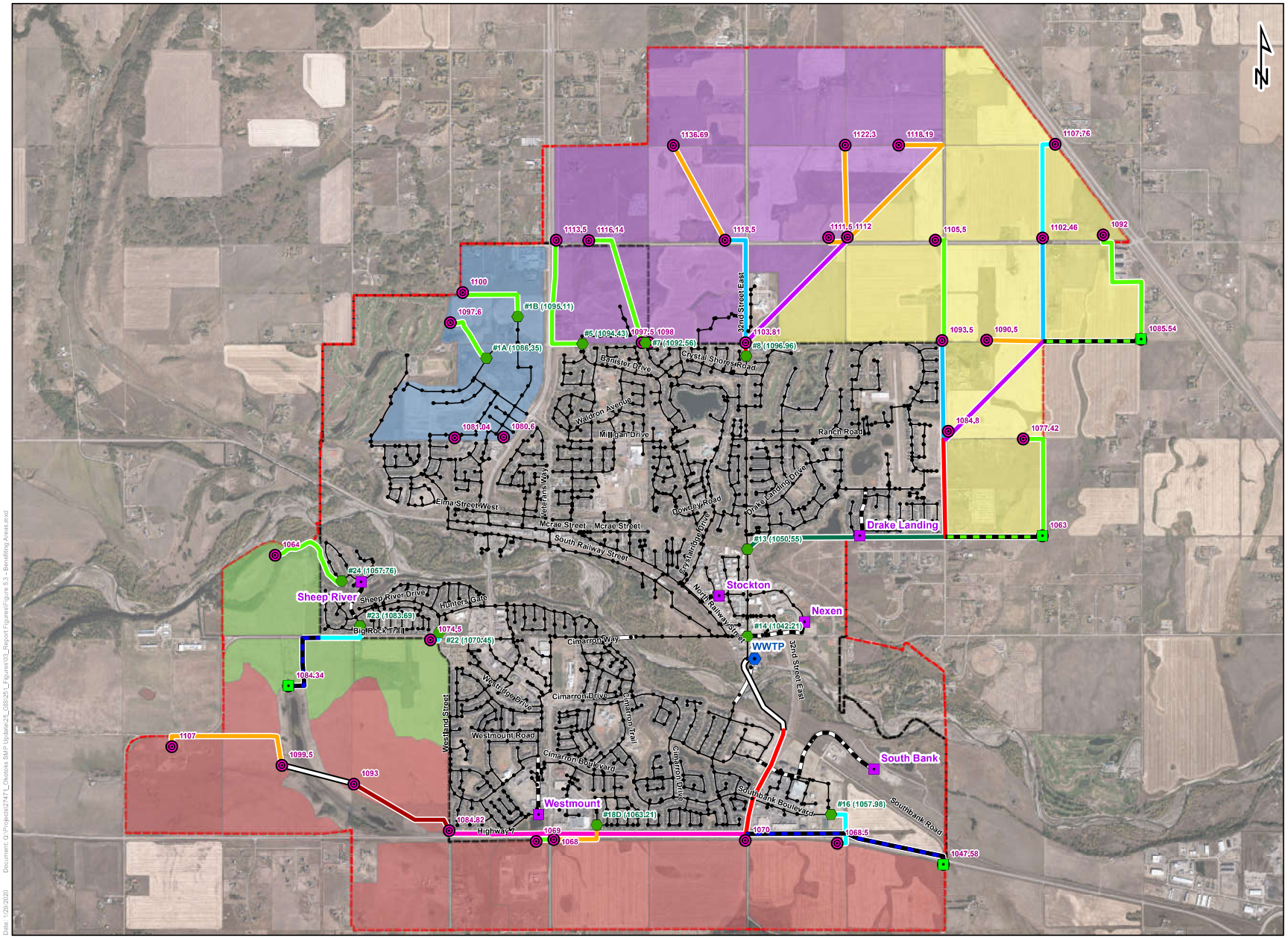

Legend

- Manhole
- Lift Station
- Proposed Lift Station
- Wastewater Treatment Plant
- Gravity Tie-in Location
- Lowest Elevation Within Service Area
- Sanitary Pipe
- Forcemain
- Siphon
- Pre-Annexation Boundary
- Post-Annexation Boundary

Pipe Size

- 200mm Gravity Sewer
- 250mm Gravity Sewer
- 300mm Gravity Sewer
- 375mm Gravity Sewer
- 450mm Gravity Sewer
- 525mm Gravity Sewer
- 600mm Gravity Sewer
- 675mm Gravity Sewer
- 750mm Gravity Sewer
- 900mm Gravity Sewer
- Siphon (Size Varies)
- 200mm Forcemain
- 250mm Forcemain

Region

- North-central
- Northeast
- Northwest
- South
- West

Coordinate System:
CANA83-3TM114

1:30,000

0 300 600 1,200 Meters

FIGURE 5.3
BENEFITING AREA REGIONS
SANITARY MASTER PLAN UPDATE

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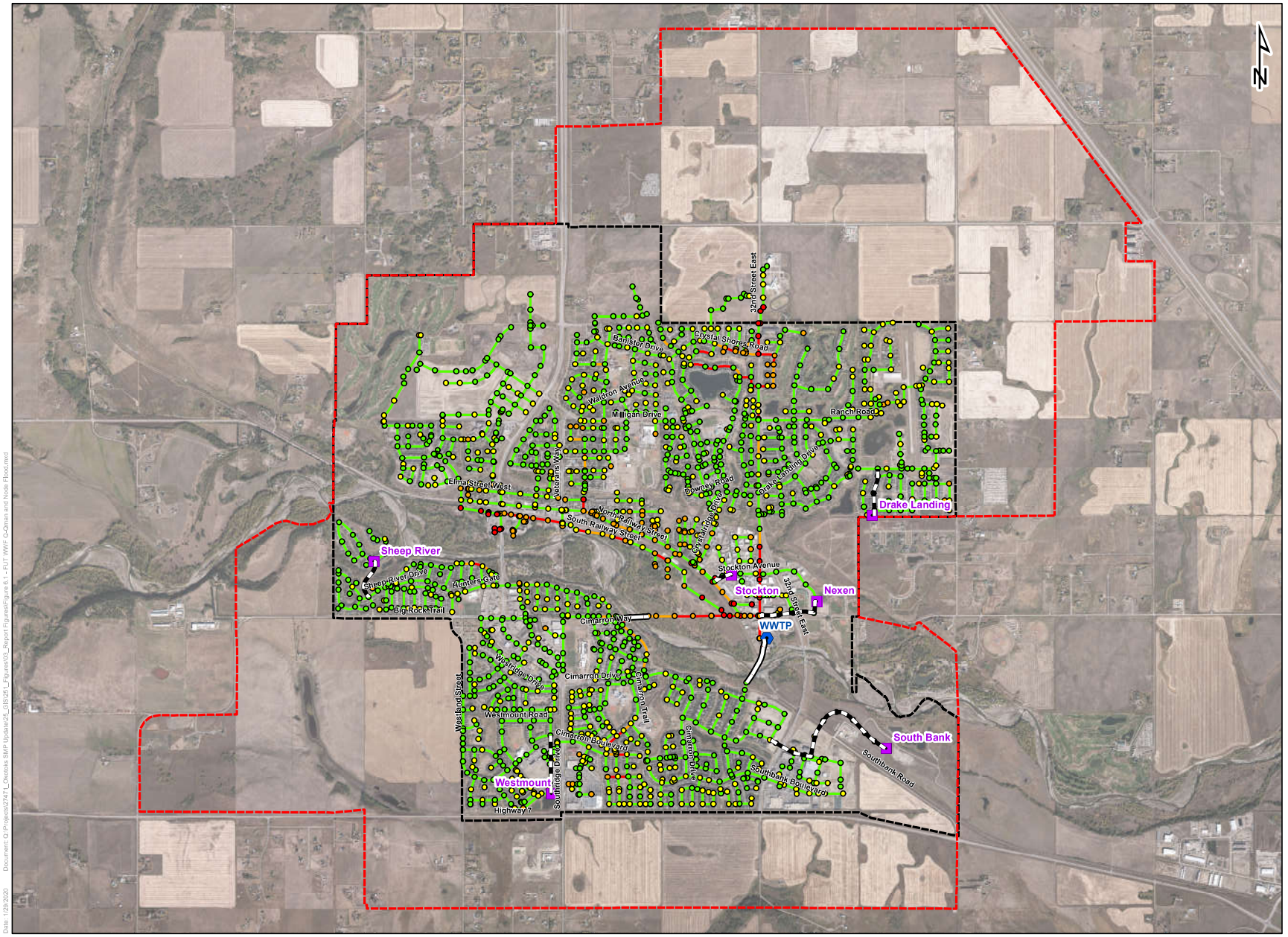
Date: 1/20/2020 Document G:\Projects\2747\1_Okotoks SMP Update\2_GIS\25_Figures\10_Report Figures\Figure 5.3 - Benefiting Areas.mxd



Legend

- Lift Station
- Wastewater Treatment Plant
- Forcemain
- Siphon
- Pre-Annexation Boundary
- Post-Annexation Boundary

Maximum HGL Elevation Relative to Ground

- Less than -3.50m
- Between -3.50m and -2.50m
- Between -2.50m and 0.00m
- Greater than 0.00m

Peak Discharge Relative to Pipe Capacity

- Greater than 100%
- Between 86% and 100%
- Less than 86%

Coordinate System:
CANA83-3TM114

1:30,000

0 300 600 1,200 Meters

FIGURE 6.1
FUTURE SYSTEM RESULTS
WWF CONDITIONS
SANITARY MASTER PLAN UPDATE

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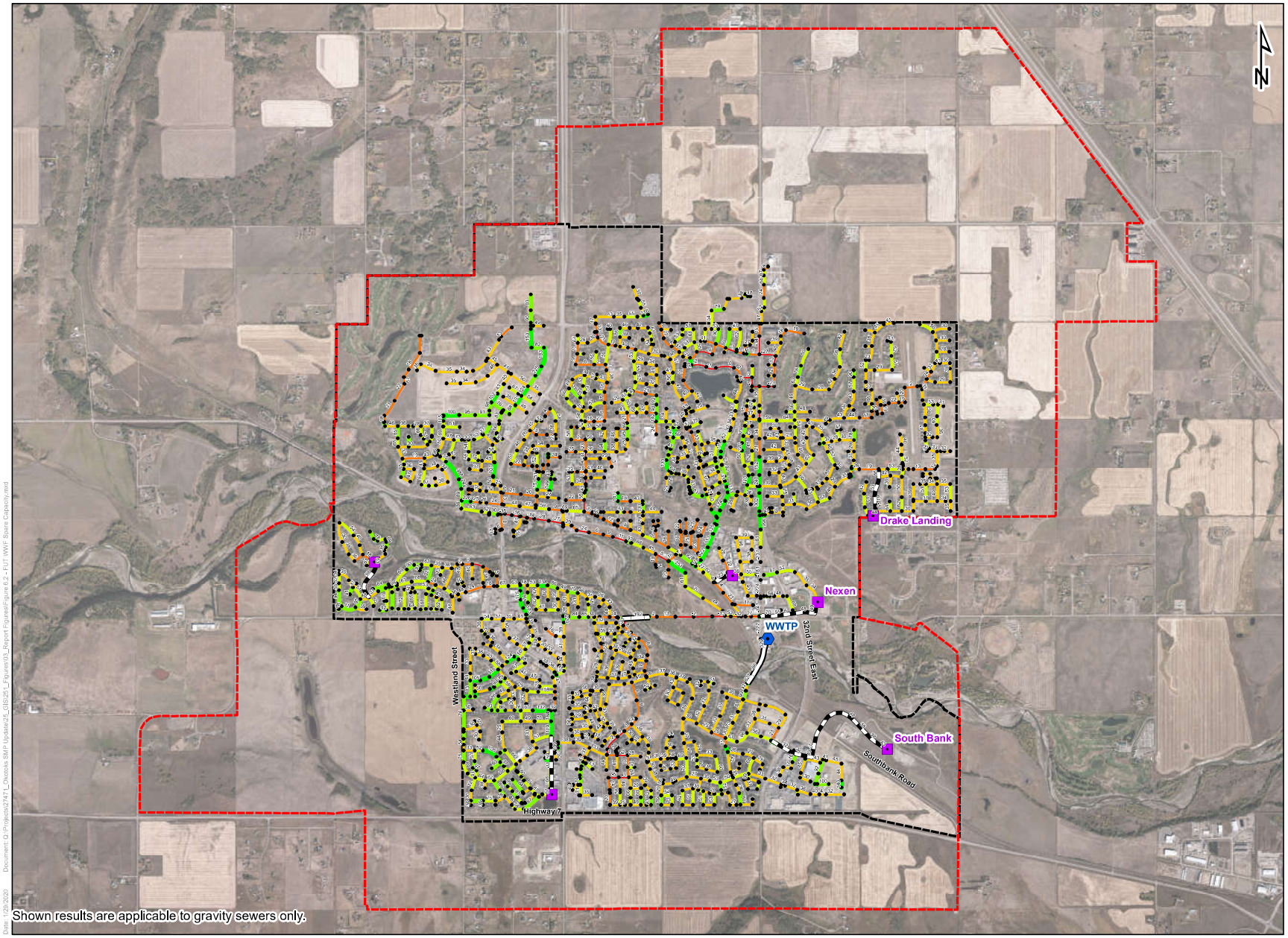
Date: 1/29/2020
Document Q:\Projects\2747\1_Okotoks SMP Update\2_GIS\2K Figures\10_Report Figures\Figure 6.1 - FUT WWF Q-Driven and Node Flows.mxd



Legend

- Manhole
- Lift Station
- Wastewater Treatment Plant
- Forcemain
- Siphon
- Pre-Annexation Boundary
- Post-Annexation Boundary

Spare Capacity

- Less than 0L/s
- 0 - 25L/s
- 25 - 50L/s
- 50 - 75L/s
- 75 - 100L/s
- Greater than 100L/s

**Please note that spare capacity labels are in L/s.*

Coordinate System:
CANA83-3TM114

1:30,000

0 300 600 1,200 Meters

FIGURE 6.2
FUTURE SYSTEM RESULTS
WWF CONDITIONS
SPARE CAPACITY
SANITARY MASTER PLAN UPDATE

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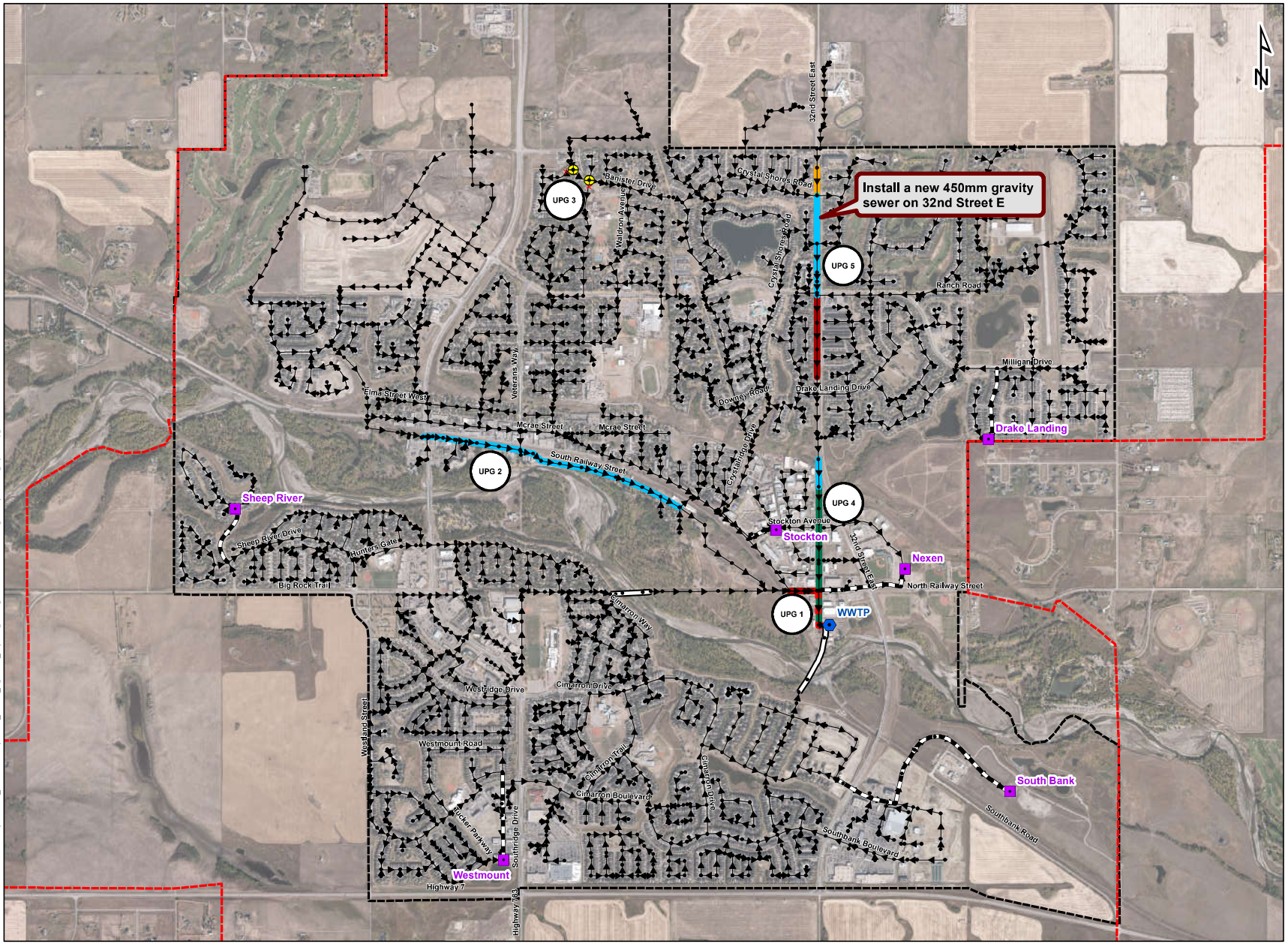
Date: 1/23/2020 Document G:\Projects\2747\1_Okotoks SMP Update\2_CIS\25_Figures\10_Report Figures\Figure 6.2 - FUT WWF Spare Capacity.mxd



Legend

- Manhole
- Lift Station
- Wastewater Treatment Plant
- Proposed Plug To Divert Flows
- Sanitary Pipe
- Forcemain
- Siphon
- Pre-Annexation Boundary
- Post-Annexation Boundary

Upgrade

- 375mm Gravity Sewer Upsize
- 450mm Gravity Sewer Upsize
- 525mm Gravity Sewer Upsize
- 750mm Gravity Sewer Upsize
- 900mm Gravity Sewer Upsize

Coordinate System:
CANA83-3TM114

1:20,000

0 200 400 800 Meters

FIGURE 6.3
BUILD-OUT GROWTH HORIZON
RECOMMENDED UPGARDES
TO EXISTING SYSTEM
SANITARY MASTER PLAN UPDATE

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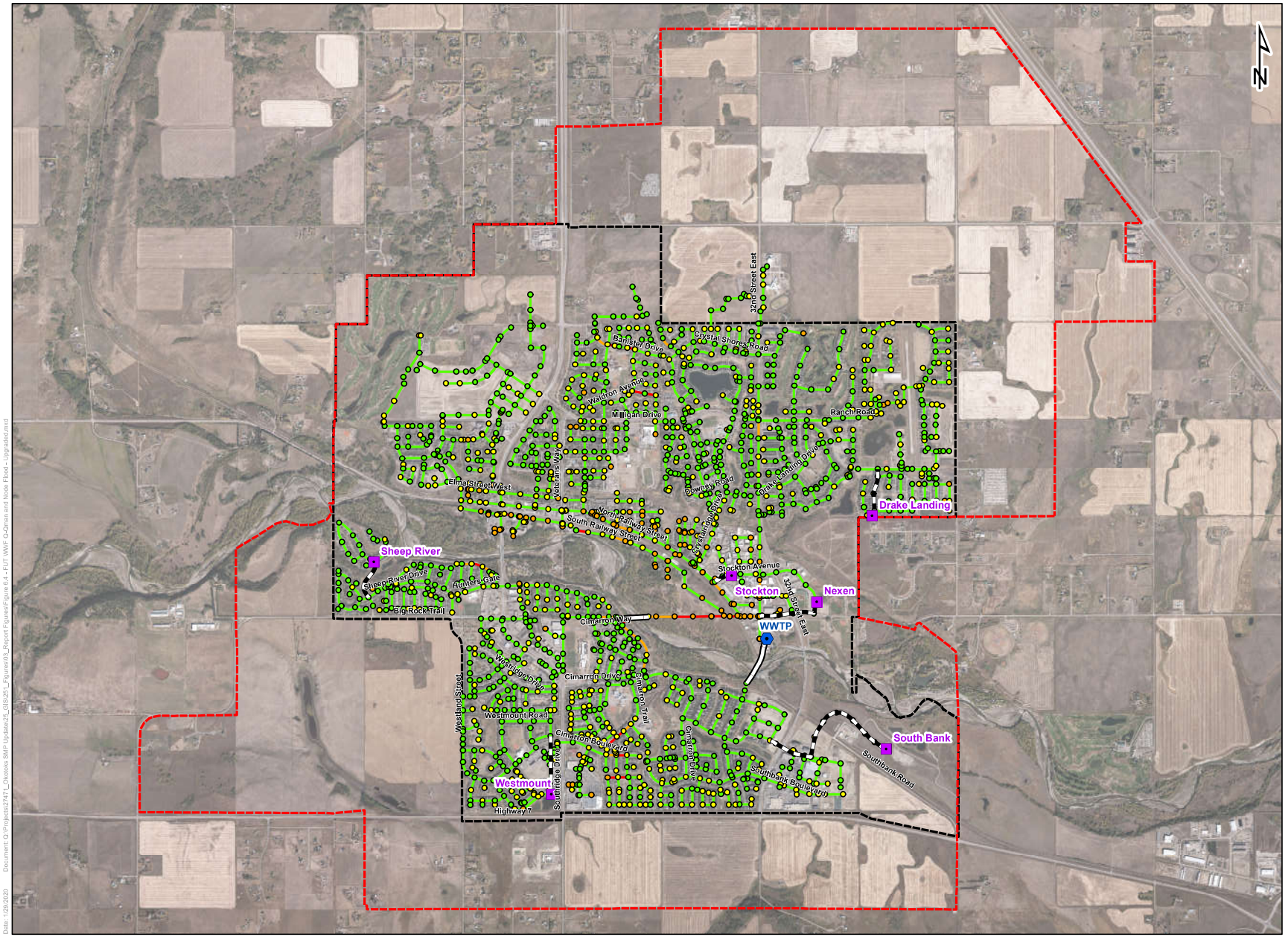
Date: 1/30/2020

Document G:\Projects\2747\1_Okotoks SMP Update\2_CIS\2D\1_Figures\02_Report Figures\Figure 6.3 - Build-out Servicing Concept – Existing System Upgrades.mxd



Legend

- Lift Station
- Wastewater Treatment Plant
- Forcemain
- Siphon
- Pre-Annexation Boundary
- Post-Annexation Boundary

Maximum HGL Elevation Relative to Ground

- Less than -3.50m
- Between -3.50m and -2.50m
- Between -2.50m and 0.00m
- Greater than 0.00m

Peak Discharge Relative to Pipe Capacity

- Greater than 100%
- Between 86% and 100%
- Less than 86%

Coordinate System:
CANA83-3TM114

1:30,000

0 300 600 1,200 Meters

FIGURE 6.4
FUTURE SYSTEM RESULTS - UPGRADES
WWF CONDITIONS
SANITARY MASTER PLAN UPDATE

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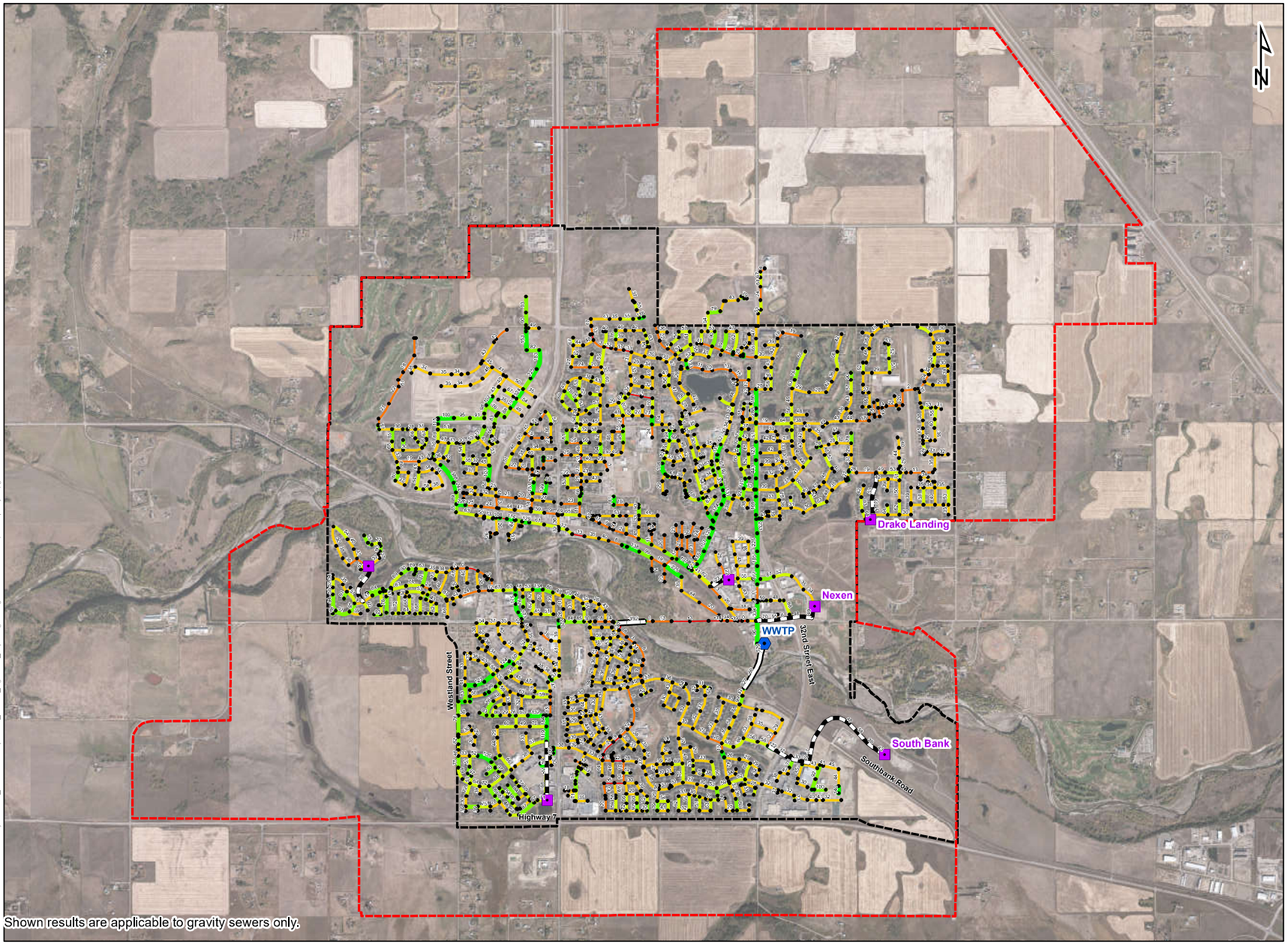
Date: 1/29/2020
Document Q:\Projects\2747\1_Okotoks SMP Update\2_CIS\25_Figures\10_Report Figures\Figure 6.4 - FUT WWF Q-Driven and Node Flood - Upgraded.mxd



Legend

- Manhole
- Lift Station
- Wastewater Treatment Plant
- Forcemain
- Siphon
- Pre-Annexation Boundary
- Post-Annexation Boundary

Spare Capacity

- Less than 0L/s
- 0 - 25L/s
- 25 - 50L/s
- 50 - 75L/s
- 75 - 100L/s
- Greater than 100L/s

**Please note that spare capacity labels are in L/s.*

Coordinate System:
CANA83-3TM114

1:30,000

0 300 600 1,200 Meters

FIGURE 6.5
FUTURE SYSTEM RESULTS - UPGRADES
WWF CONDITIONS
SPARE CAPACITY
SANITARY MASTER PLAN UPDATE

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Shown results are applicable to gravity sewers only.

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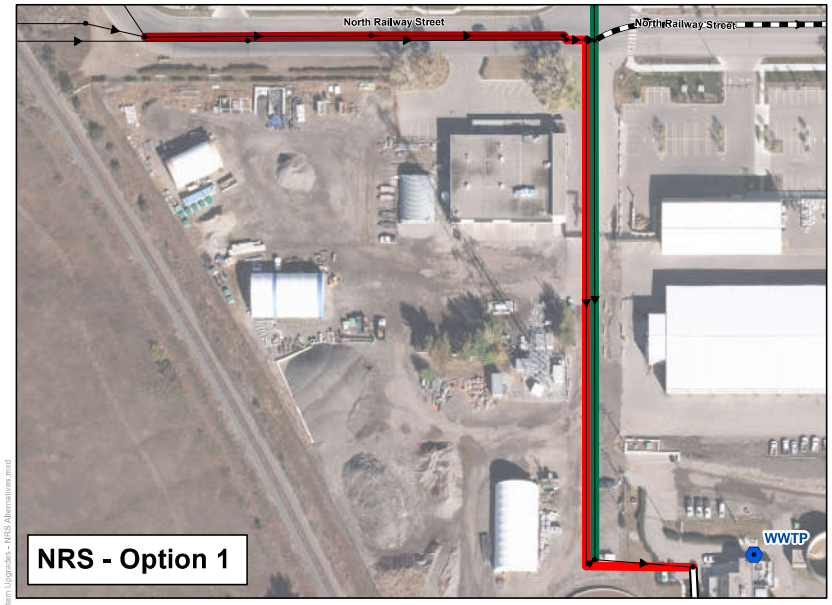

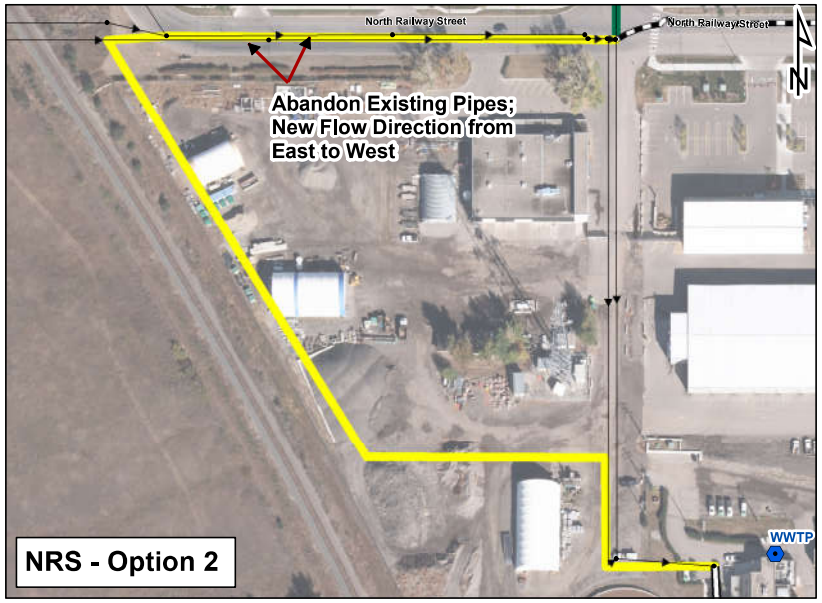

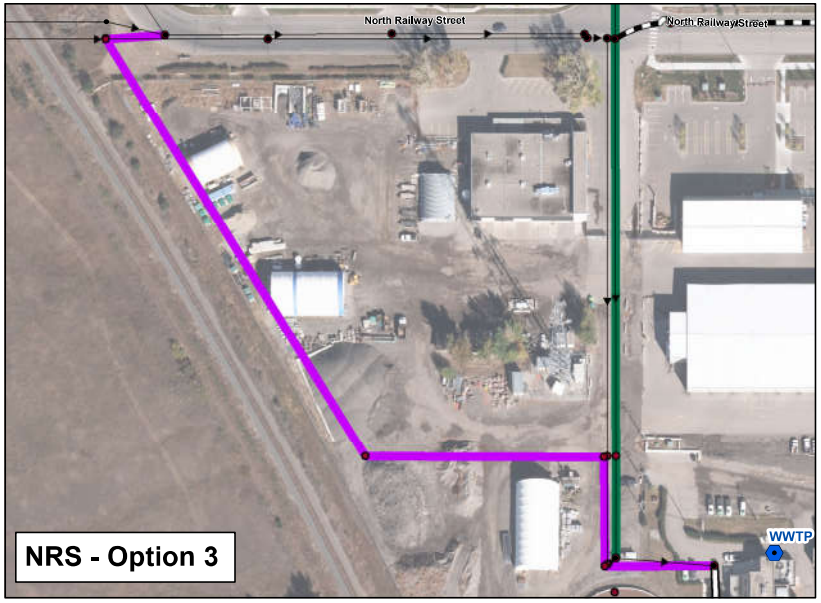

Legend

- Manhole
- Wastewater Treatment Plant
- Sanitary Pipe
- Forcemain
- Siphon

Upgrade

- 525mm Gravity Sewer Upsize
- 675mm Gravity Sewer
- 750mm Gravity Sewer Upsize
- 900mm Gravity Sewer Upsize
- 1200mm Gravity Sewer

Coordinate System:
CANA83-3TM114

1:1,750

0 15 30 60 Meters

FIGURE 6.6
BUILD-OUT GROWTH HORIZON
RECOMMENDED UPGARDES
NRS ALTERNATIVES
SANITARY MASTER PLAN UPDATE

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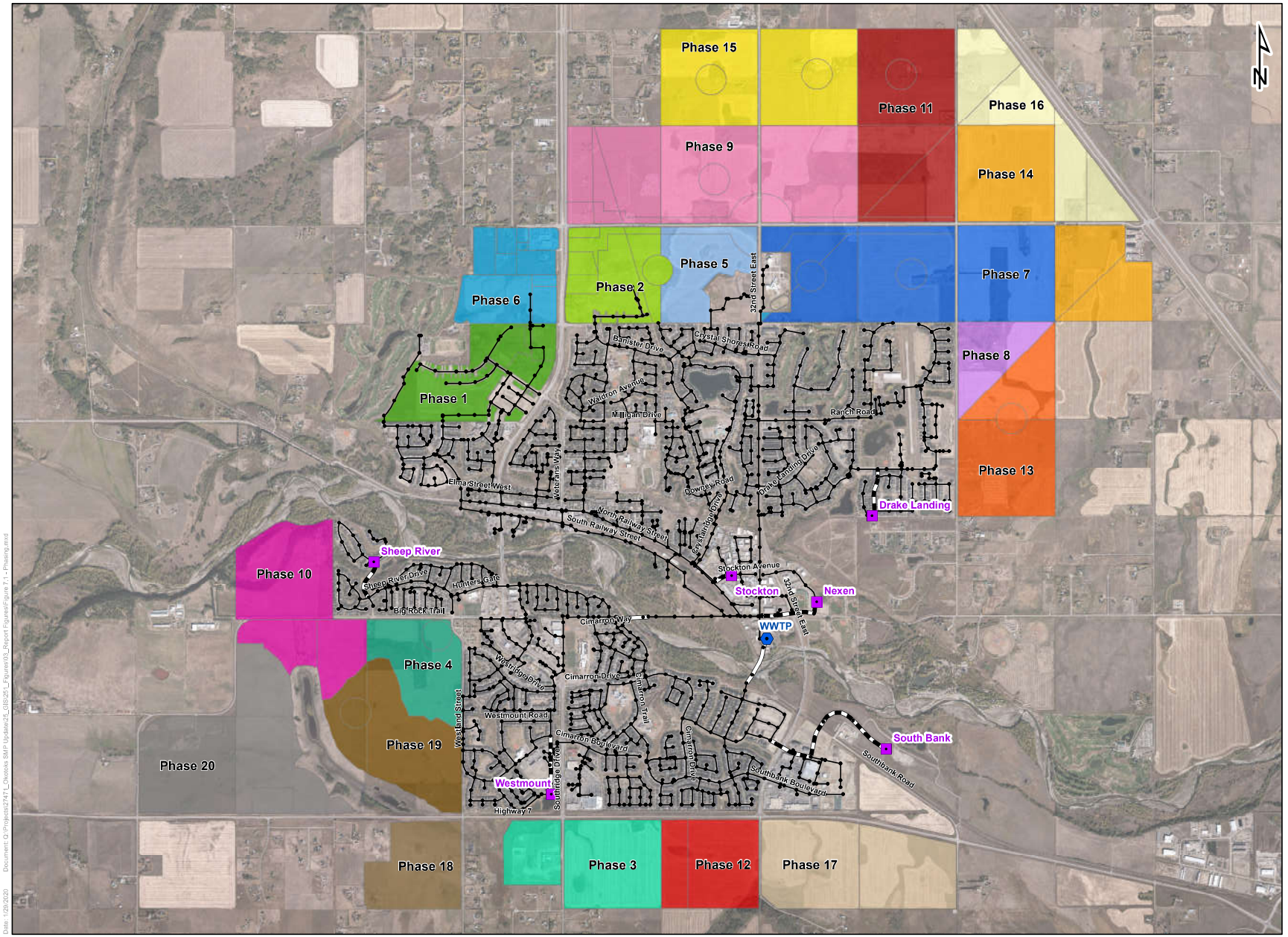
Service Layer Credits:



Legend

- Manhole
- Lift Station
- Wastewater Treatment Plant
- Sanitary Pipe
- Forcemain
- Siphon
- Pre-Annexation Boundary
- Post-Annexation Boundary

Phase

- Phase 1
- Phase 2
- Phase 3
- Phase 4
- Phase 5
- Phase 6
- Phase 7
- Phase 8
- Phase 9
- Phase 10
- Phase 11
- Phase 12
- Phase 13
- Phase 14
- Phase 15
- Phase 16
- Phase 17
- Phase 18
- Phase 19
- Phase 20

Coordinate System:
CANA83-3TM114

1:30,000

0 300 600 1,200 Meters

FIGURE 7.1
SERVICE AREA PHASING
SANITARY MASTER PLAN UPDATE

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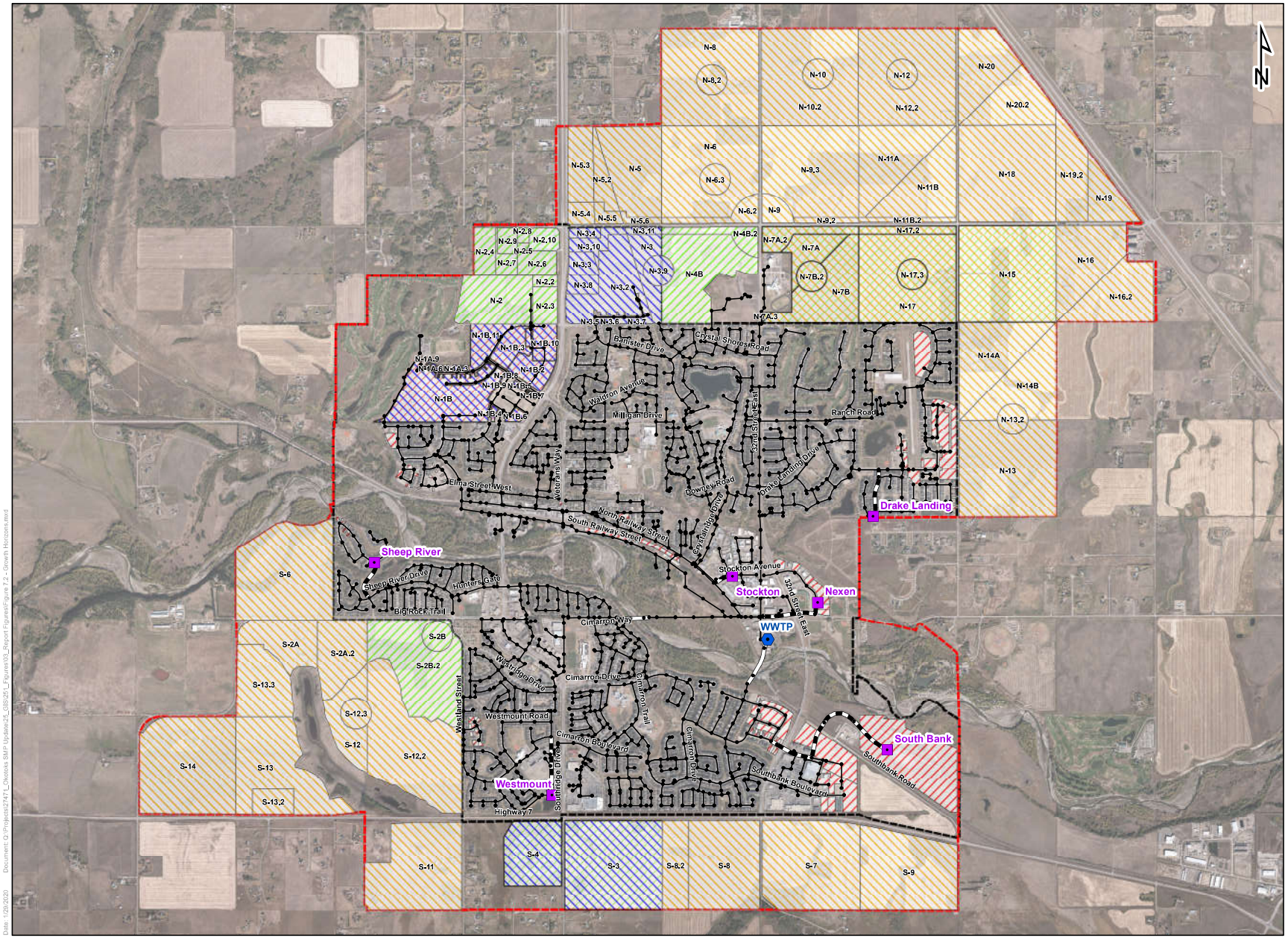

Legend

- Manhole
- Lift Station
- Wastewater Treatment Plant
- Sanitary Pipe
- Forcemain
- Siphon
- Pre-Annexation Boundary
- Post-Annexation Boundary

Growth Horizon

- 2024 (Includes Densification)
- 2024 / 2029
- 2029
- 2029 / 2044
- 2044
- 2044 / Ultimate
- Ultimate

Coordinate System:
CANA83-3TM114

1:30,000

0 300 600 1,200 Meters

FIGURE 7.2
GROWTH HORIZONS
SANITARY MASTER PLAN UPDATE

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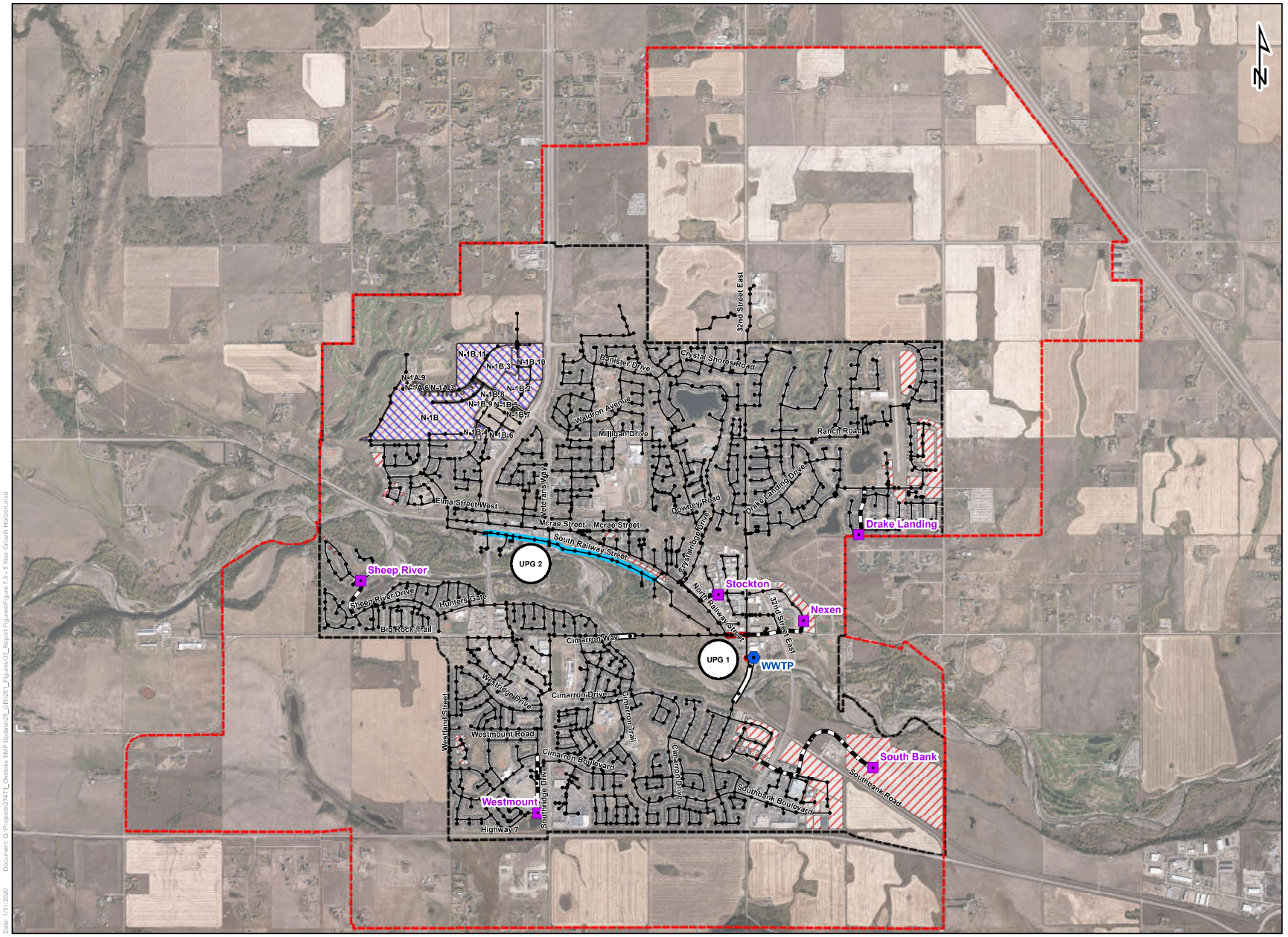
Document G:\Projects\2747\1_Okotoks SMP Update\2_CIS\2R_Figures\01_Report Figures\Figure 7.2 - Growth Horizons.mxd


N
Legend
Manhole
Lift Station
Wastewater Treatment Plant
Sanitary Pipe
Forcemain
Siphon
Pre-Annexation Boundary
Post-Annexation Boundary
Growth Horizon
2024 (Includes Densification)
2024 / 2029
Upgrade
450mm Gravity Sewer Upsize
525mm Gravity Sewer Upsize
750mm Gravity Sewer Upsize
Sheep River
Stockton
Nexen
Drake Landing
South Bank
Westmount
WWTP
UPG 1
UPG 2
Elma Street West
Mcrae Street
South Railway Street
North Railway Street
Sheep River Drive
Hunters Gate
Big Rock Trail
Cimarron Way
Cimarron Drive
Cimarron Boulevard
Cimarron Trail
Westmount Road
Westland Street
Southridge Drive
Highway 7
Southbank Boulevard
Southbank Road
Drake Landing Drive
Dowtney Road
Ranch Road
Milligan Drive
Walton Avenue
Banister Drive
Crystal Shores Road
32nd Street East
Coordinate System:
CANA83-3TM114
1:30,000
0
300
600
1,200
Meters
FIGURE 7.3
FIVE YEAR GROWTH HORIZON
SANITARY MASTER PLAN UPDATE
Okotoks
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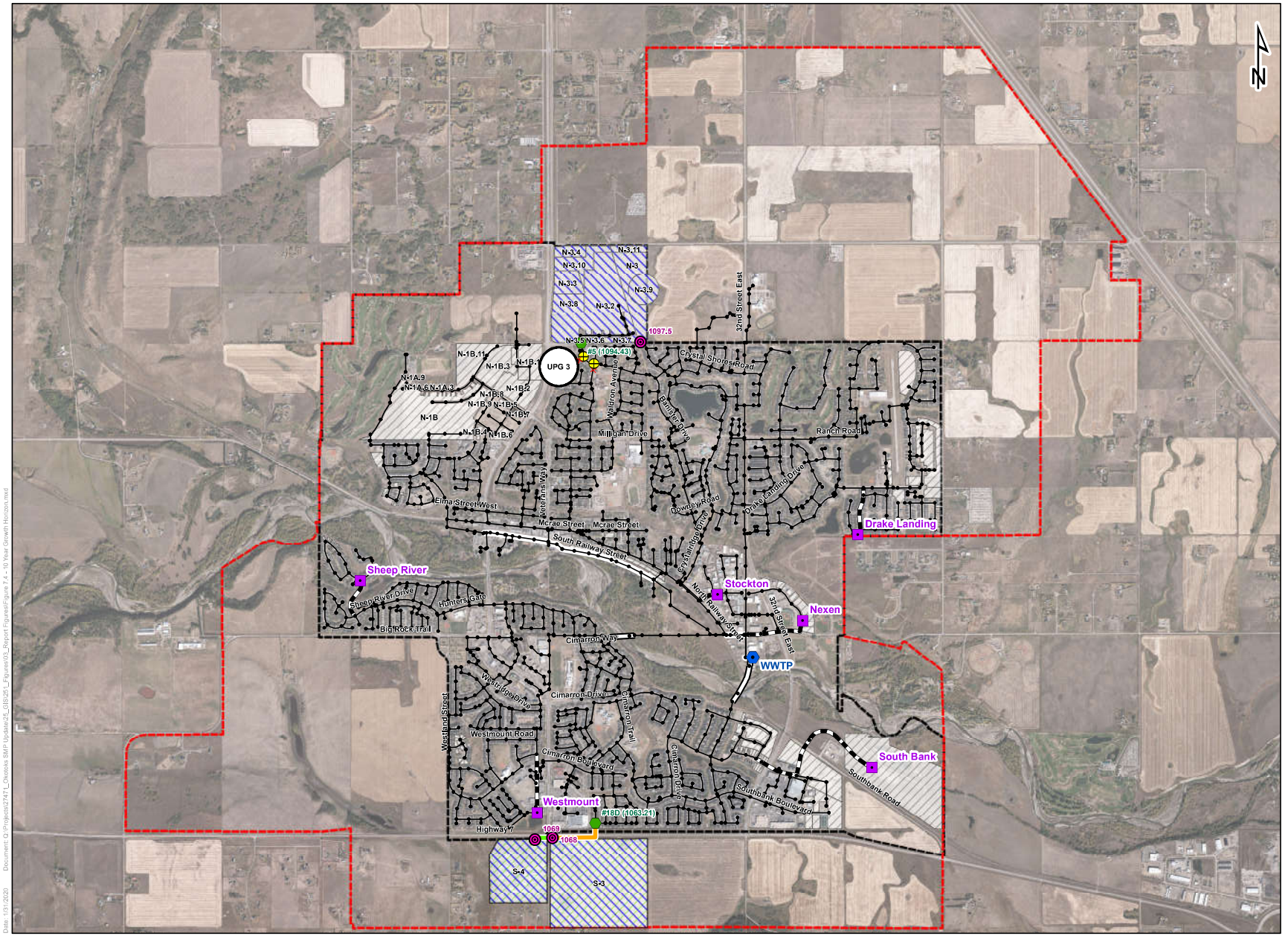

Legend

- Manhoole
- Lift Station
- Wastewater Treatment Plant
- Gravity Tie-in Location
- Lowest Elevation Within Service Area
- Proposed Plug To Divert Flows
- Sanitary Pipe
- Forcemain
- Siphon
- Pre-Annexation Boundary
- Post-Annexation Boundary

Growth Horizon

- Developed Service Areas Prior to 2029
- 2029
- 2029 / 2044

Servicing Concept

- 250mm Gravity Sewer
- 375mm Gravity Sewer

**Infrastructure developed prior to the 10 year horizon shown in white.*

Coordinate System:
CANA83-3TM114

1:30,000

0 300 600 1,200 Meters

FIGURE 7.4
TEN YEAR GROWTH HORIZON
SANITARY MASTER PLAN UPDATE

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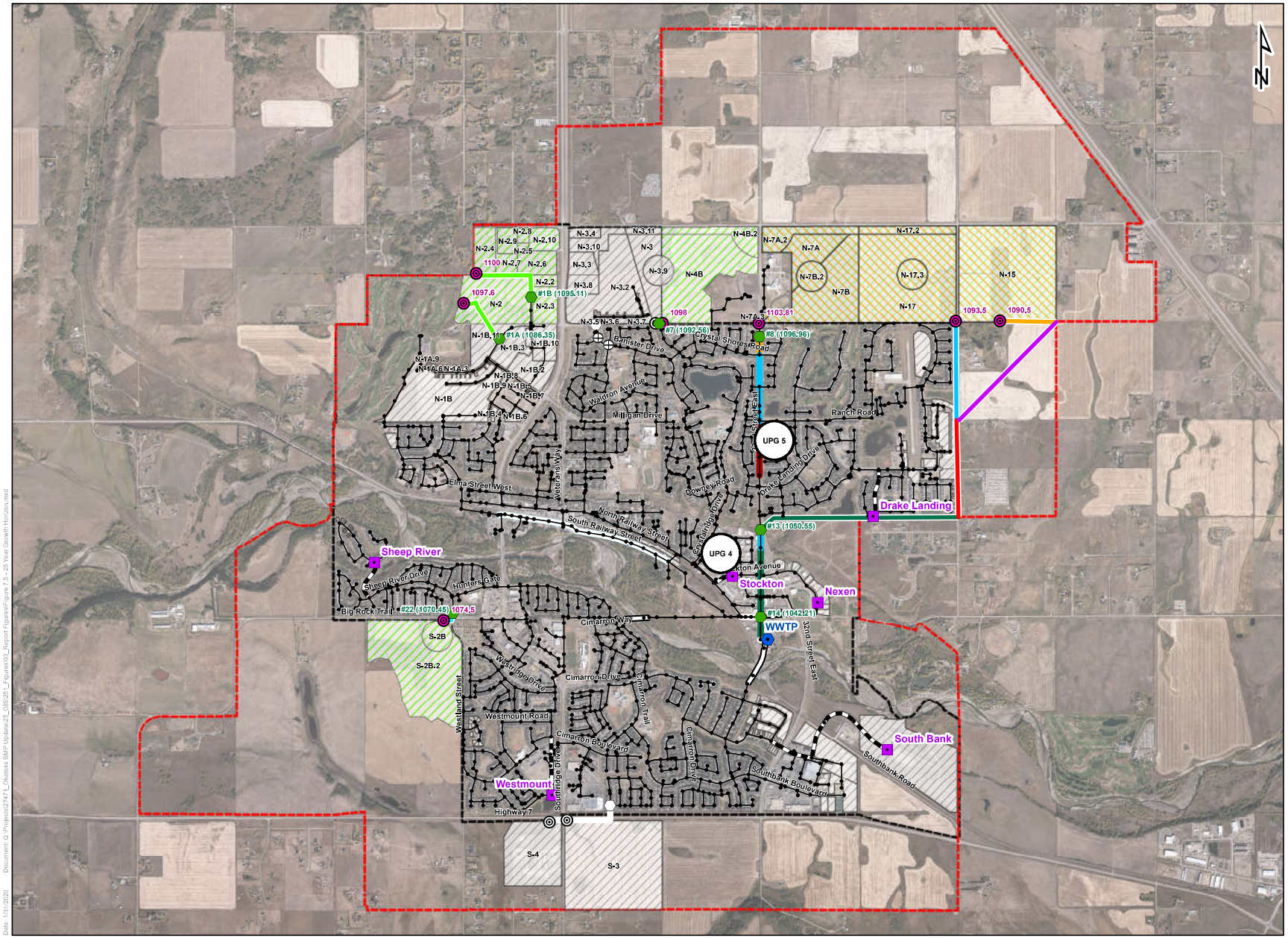

FIGURE 7.5
TWENTY-FIVE YEAR GROWTH HORIZON
SANITARY MASTER PLAN UPDATE

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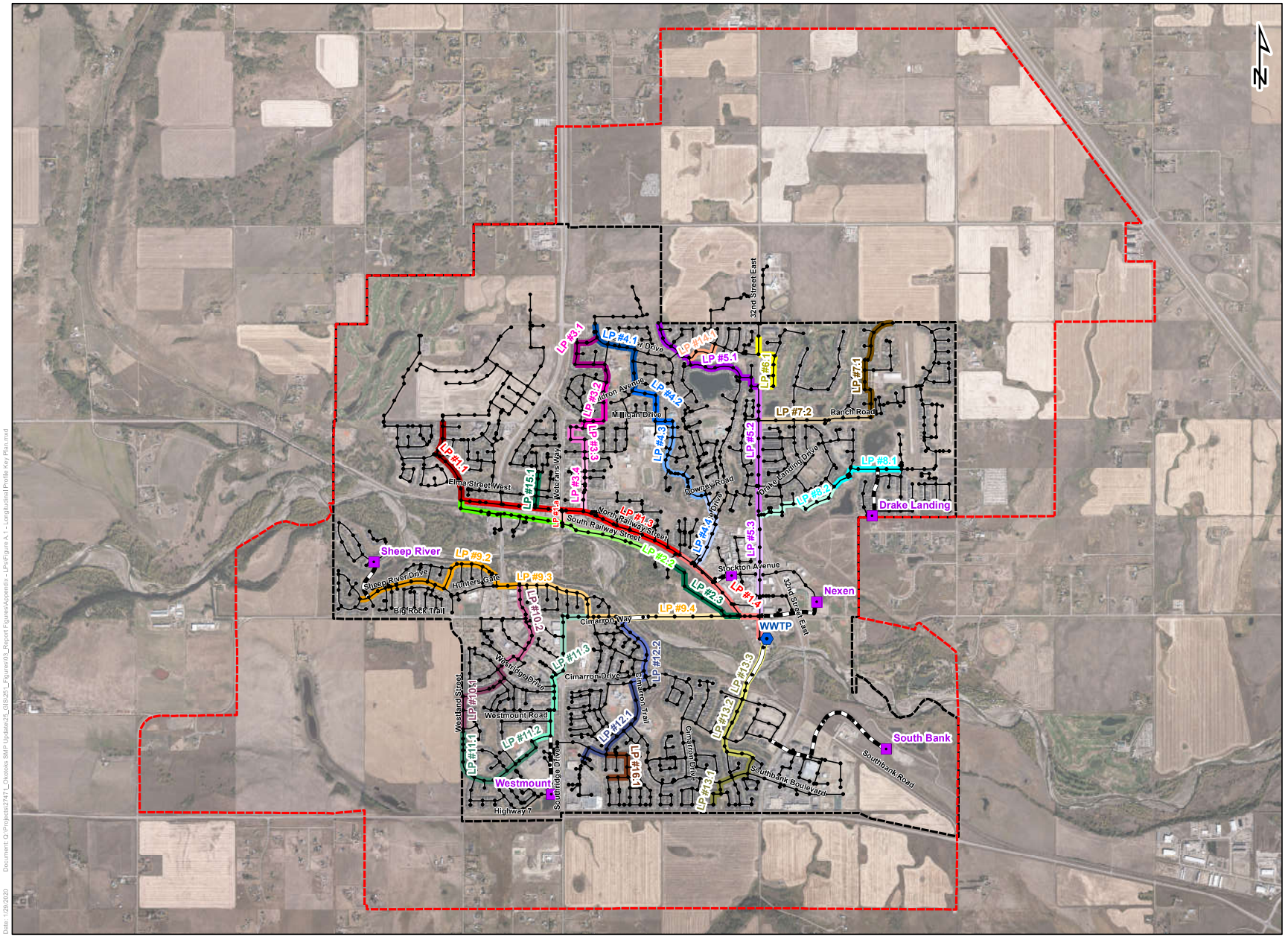
APPENDIX A
Longitudinal Profiles


N
Legend
Manhole
Lift Station
Wastewater Treatment Plant
Sanitary Pipe
Forcemain
Siphon
Pre-Annexation Boundary
Post-Annexation Boundary
Profile ID
LP #1.1
LP #1.2
LP #1.3
LP #1.4
LP #1a
LP #2.1
LP #2.2
LP #2.3
LP #3.1
LP #3.2
LP #3.3
LP #3.4
LP #4.1
LP #4.2
LP #4.3
LP #4.4
LP #5.1
LP #5.2
LP #5.3
LP #6.1
LP #7.1
LP #7.2
LP #8.1
LP #8.2
LP #9.1
LP #9.2
LP #9.3
LP #9.4
LP #10.1
LP #10.2
LP #11.1
LP #11.2
LP #11.3
LP #12.1
LP #12.2
LP #13.1
LP #13.2
LP #13.3
LP #14.1
LP #15.1
LP #16.1
Sheep River
Drake Landing
Nexen
WWTP
South Bank
Westmount
32nd Street East
Elma Street West
Veterans Way
North Railway Street
South Railway Street
Downey Road
Drake Landing Drive
Ranch Road
Milligan Drive
Stockton Avenue
Sheep River Drive
Hunters Gate
Big Rock Trail
Cimarron Way
Cimarron Drive
Cimarron Trail
Westridge Drive
Westland Street
Westmount Road
Southridge Drive
Highway 7
Southbank Boulevard
Southbank Road
Coordinate System:
CANA83-3TM114
1:30,000
0
300
600
1,200
Meters
FIGURE A.1
LONGITUDINAL PROFILE KEY PLAN
SANITARY MASTER PLAN UPDATE
Okotoks
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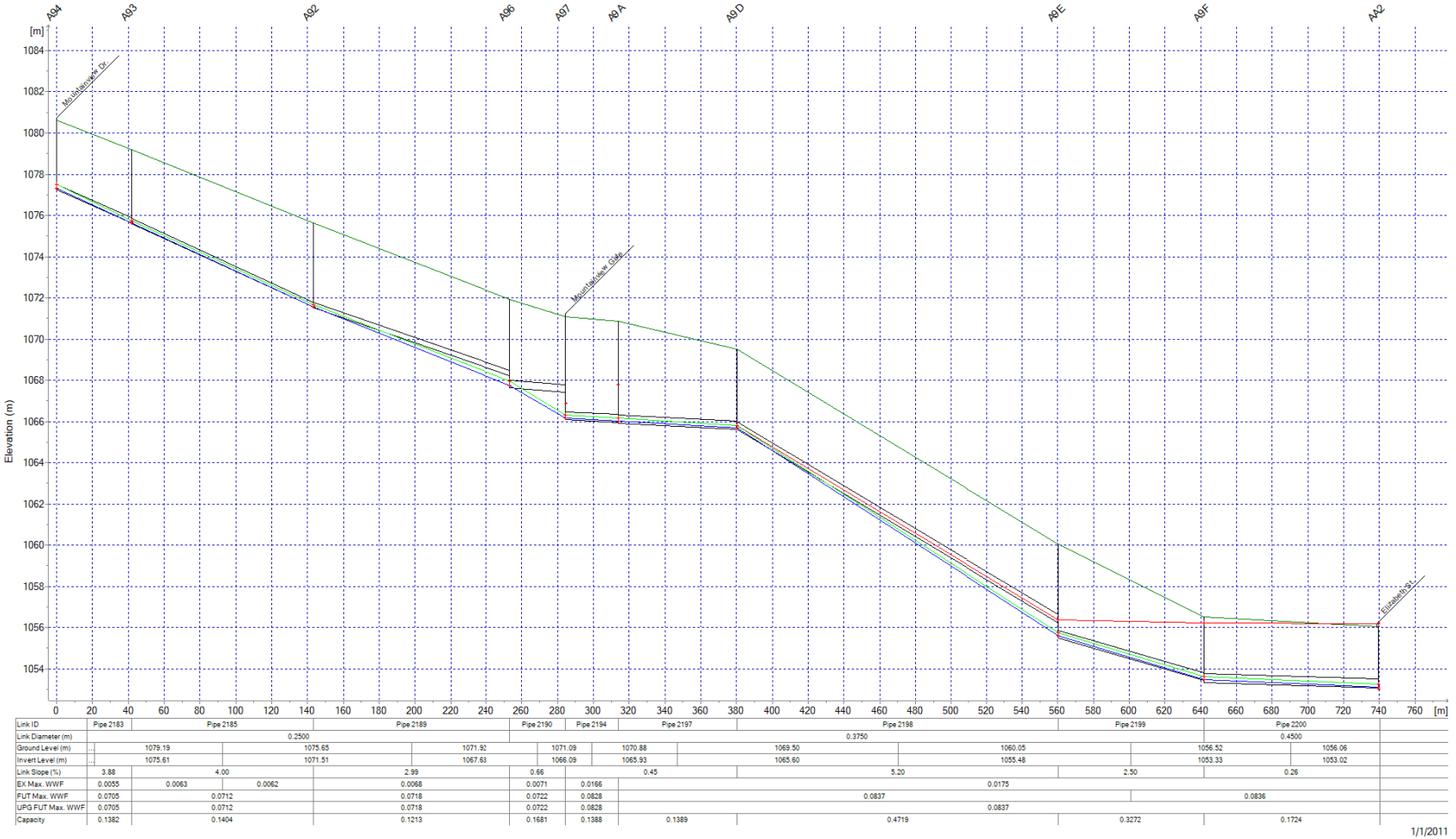
Document G:\Projects\2747\1_Okotoks SMP Update\2_CIS\25_Figures\10_Report Figures\Appendix - LPs\Figure A.1 - Longitudinal Profile Key Plan.mxd



Link ID	Pipe 2183	Pipe 2185	Pipe 2189	Pipe 2190	Pipe 2194	Pipe 2197	Pipe 2198	Pipe 2199	Pipe 2200
Link Diameter (m)		0.2500					0.3750		0.4500
Ground Level (m)	1079.19	1075.65	1071.92	1071.09	1070.88	1069.50	1060.05	1056.52	1056.06
Invert Level (m)	1075.61	1071.51	1067.63	1066.09	1065.93	1065.60	1055.48	1053.33	1053.02
Link Slope (%)	3.88	4.00	2.99	0.66	0.45	5.20	2.50	0.26	
EX Max. WWF	0.0055	0.0063	0.0062	0.0068	0.0071	0.0166	0.0175		
FUT Max. WWF	0.0705	0.0712	0.0718	0.0722	0.0828	0.0837		0.0836	
UPG FUT Max. WWF	0.0705	0.0712	0.0718	0.0722	0.0828	0.0837			
Capacity	0.1382	0.1404	0.1213	0.1681	0.1388	0.1389	0.4719	0.3272	0.1724

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

FIGURE A.2
MAXIMUM HGL PROFILE - LP#1.1
SANITARY MASTER PLAN UPDATE

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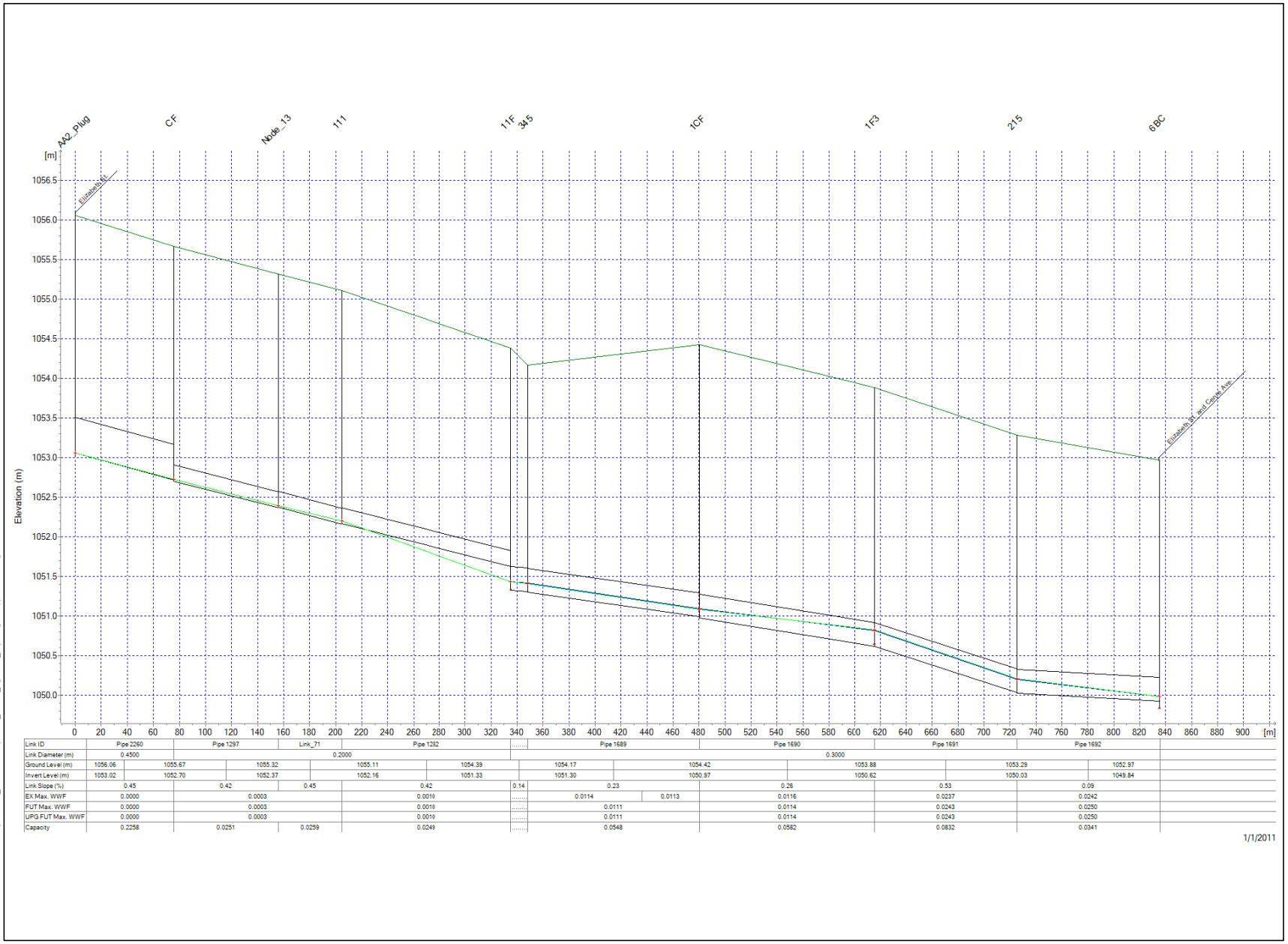

Link ID	Pipe 2260	Pipe 1297	Link_71	Pipe 1282	Pipe 1689	Pipe 1690	Pipe 1691	Pipe 1692
Link Diameter (m)	0.4500	0.2000			0.3000			
Ground Level (m)	1056.06	1055.67	1055.32	1055.11	1054.39	1054.17	1054.42	1053.88	1053.29	1052.97
Invert Level (m)	1053.02	1052.70	1052.37	1052.16	1051.33	1051.30	1050.97	1050.62	1050.03	1049.84
Link Slope (%)	0.45	0.42	0.45	0.42	0.14	0.23	0.26	0.53	0.09	
EX Max. WWF	0.0000	0.0003		0.0016		0.0114	0.0113	0.0116	0.0237	0.0242	
FUT Max. WWF	0.0000	0.0003		0.0016		0.0111		0.0114	0.0243	0.0250	
UPG FUT Max. WWF	0.0000	0.0003		0.0016		0.0111		0.0114	0.0243	0.0250	
Capacity	0.2258	0.0251	0.0259	0.0249		0.0548		0.0582	0.0832	0.0341	

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

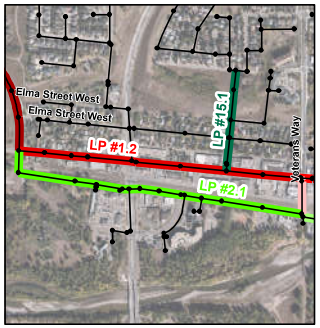

FIGURE A.3
MAXIMUM HGL PROFILE - LP#1.2
SANITARY MASTER PLAN UPDATE

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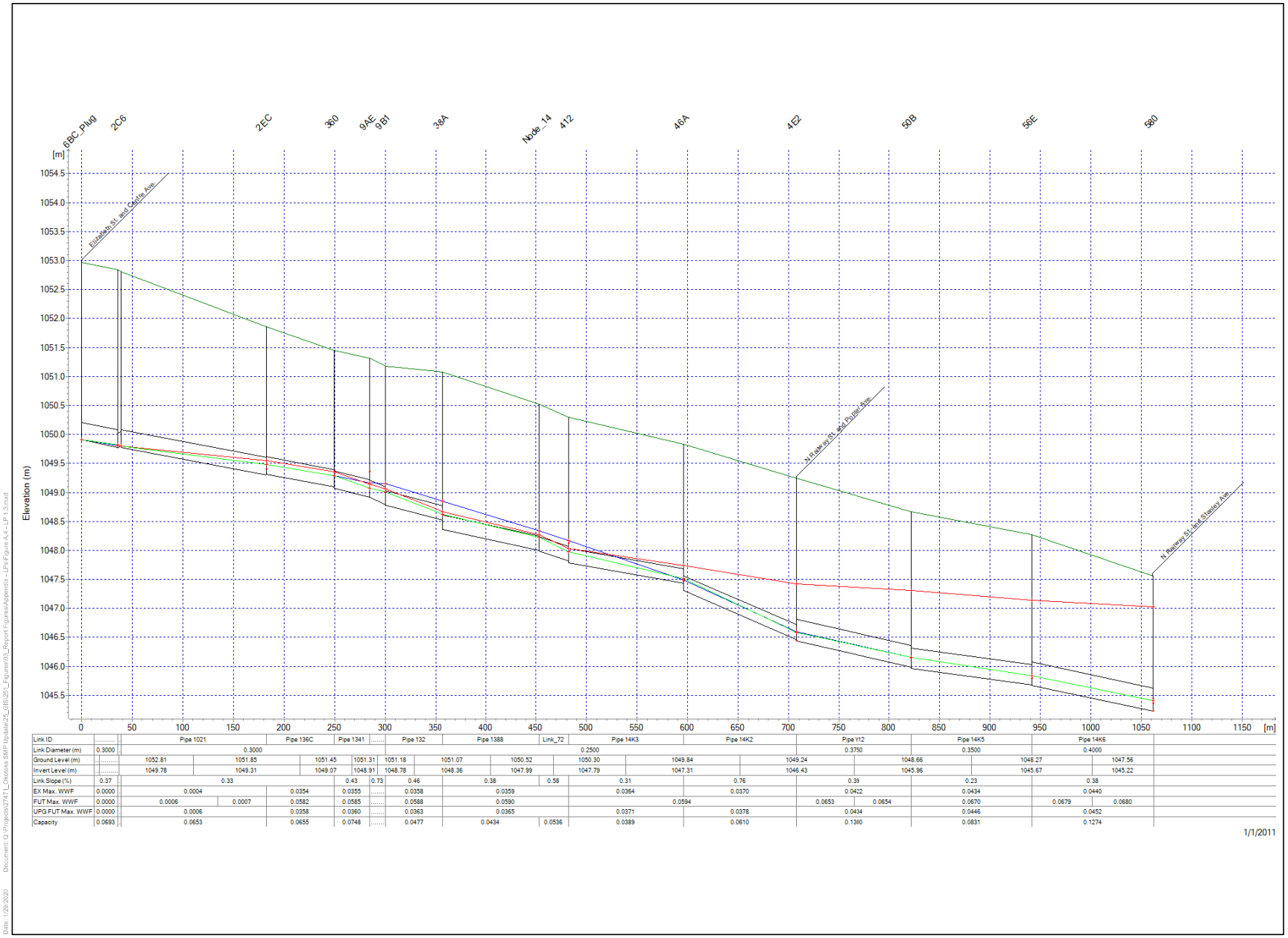

Link ID		Pipe 1021		Pipe 136C	Pipe 1341		Pipe 132	Pipe 1388	Link_72	Pipe 14K3	Pipe 14K2	Pipe Y12	Pipe 14K5	Pipe 14K6
Link Diameter (m)	0.3000	0.3000								0.2500		0.3750	0.3500	0.4000
Ground Level (m)		1052.81	1051.85	1051.45	1051.31	1051.18	1051.07	1050.52	1050.30	1049.84	1049.24	1048.66	1048.27	1047.56
Invert Level (m)		1049.78	1049.31	1049.07	1048.91	1048.78	1048.36	1047.99	1047.79	1047.31	1046.43	1045.96	1045.67	1045.22
Link Slope (%)	0.37	0.33		0.43	0.73	0.46	0.38	0.58	0.31	0.76	0.39	0.23	0.38	
EX Max. WWF	0.0000	0.0004	0.0354	0.0355		0.0358	0.0359		0.0364	0.0370	0.0422	0.0434	0.0440	
FUT Max. WWF	0.0000	0.0006	0.0007	0.0582	0.0585		0.0588	0.0590	0.0594		0.0653	0.0654	0.0670	0.0679	0.0680
UPG FUT Max. WWF	0.0000	0.0006		0.0358	0.0360		0.0363	0.0365		0.0371	0.0378	0.0434	0.0446	0.0452	
Capacity	0.0693	0.0653		0.0655	0.0748		0.0477	0.0434	0.0536	0.0389	0.0610	0.1360	0.0831	0.1274	

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

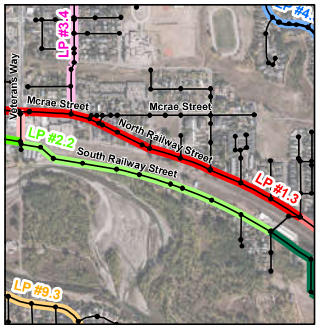

FIGURE A.4
MAXIMUM HGL PROFILE - LP#1.3
SANITARY MASTER PLAN UPDATE

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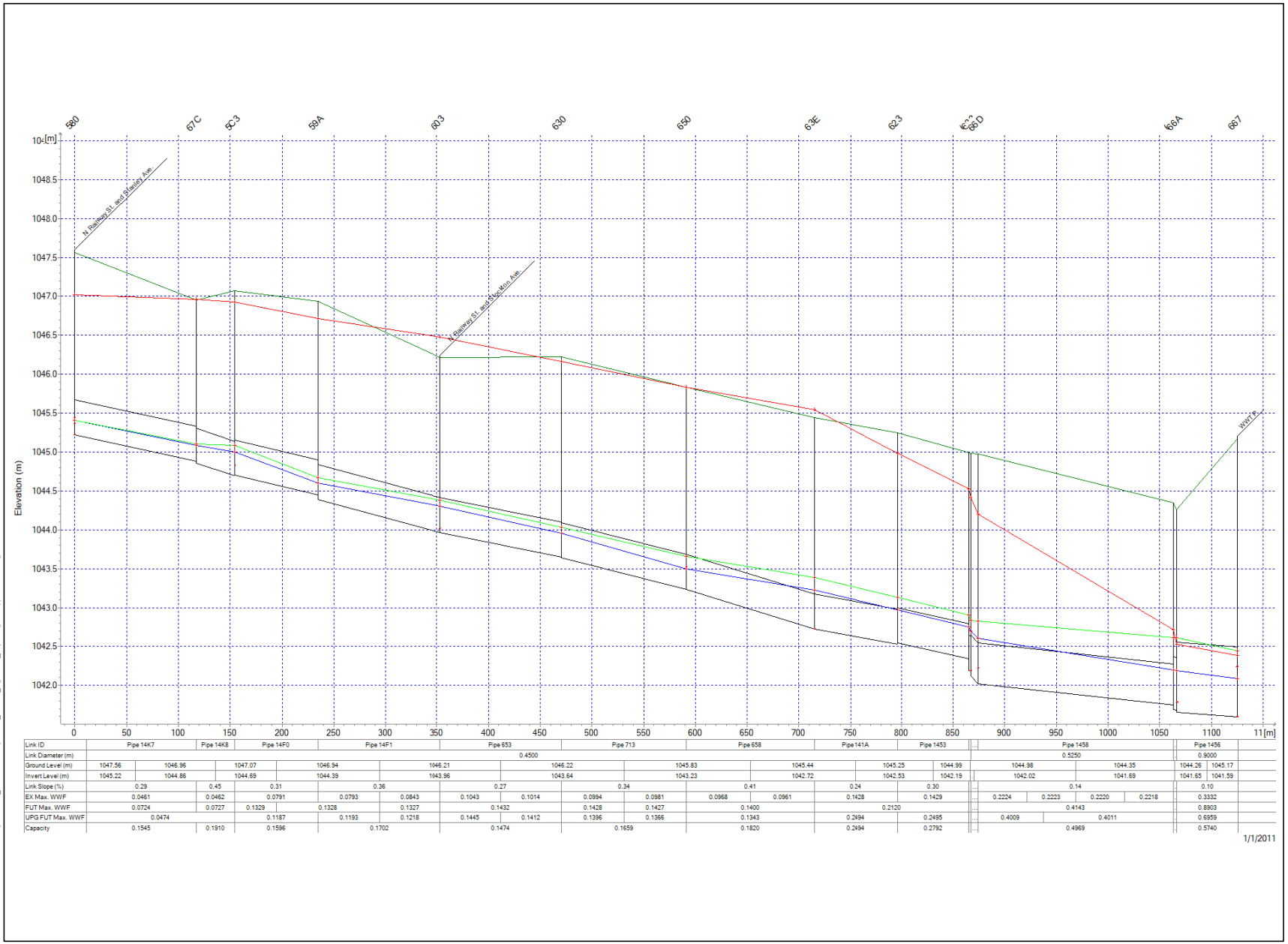

Link ID	Pipe 14K7		Pipe 14K8	Pipe 14F0	Pipe 14F1		Pipe 653		Pipe 713		Pipe 658		Pipe 141A	Pipe 1453		Pipe 1458				Pipe 1456	
Link Diameter (m)	0.4500															0.5250				0.9000	
Ground Level (m)	1047.56	1046.96	1047.07	1046.94	1046.21		1046.22		1045.83		1045.44		1045.25	1044.99		1044.98		1044.35		1044.26	1045.17
Invert Level (m)	1045.22	1044.86	1044.69	1044.39	1043.96		1043.64		1043.23		1042.72		1042.53	1042.19		1042.02		1041.69		1041.65	1041.59
Link Slope (%)	0.29	0.45	0.31	0.36	0.27		0.34		0.41		0.24		0.30	0.14						0.10	
EX Max. WWF	0.0461	0.0462	0.0791	0.0793	0.0843	0.1043	0.1014	0.0994	0.0981	0.0968	0.0961	0.1428	0.1429	0.2224	0.2223	0.2220	0.2218			0.3332	
FUT Max. WWF	0.0724	0.0727	0.1329	0.1328	0.1327	0.1432	0.1428	0.1427	0.1400		0.2120			0.4143						0.8903	
UPG FUT Max. WWF	0.0474		0.1187	0.1193	0.1218	0.1445	0.1412	0.1396	0.1366	0.1343		0.2494	0.2495	0.4009		0.4011				0.6959	
Capacity	0.1545	0.1910	0.1596	0.1702	0.1474		0.1659		0.1820		0.2494		0.2792	0.4969						0.5740	

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

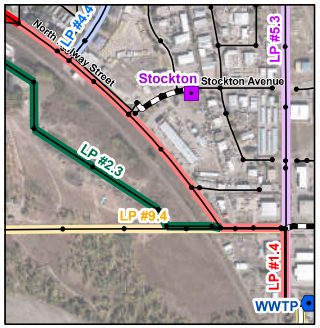

FIGURE A.5
MAXIMUM HGL PROFILE - LP#1.4
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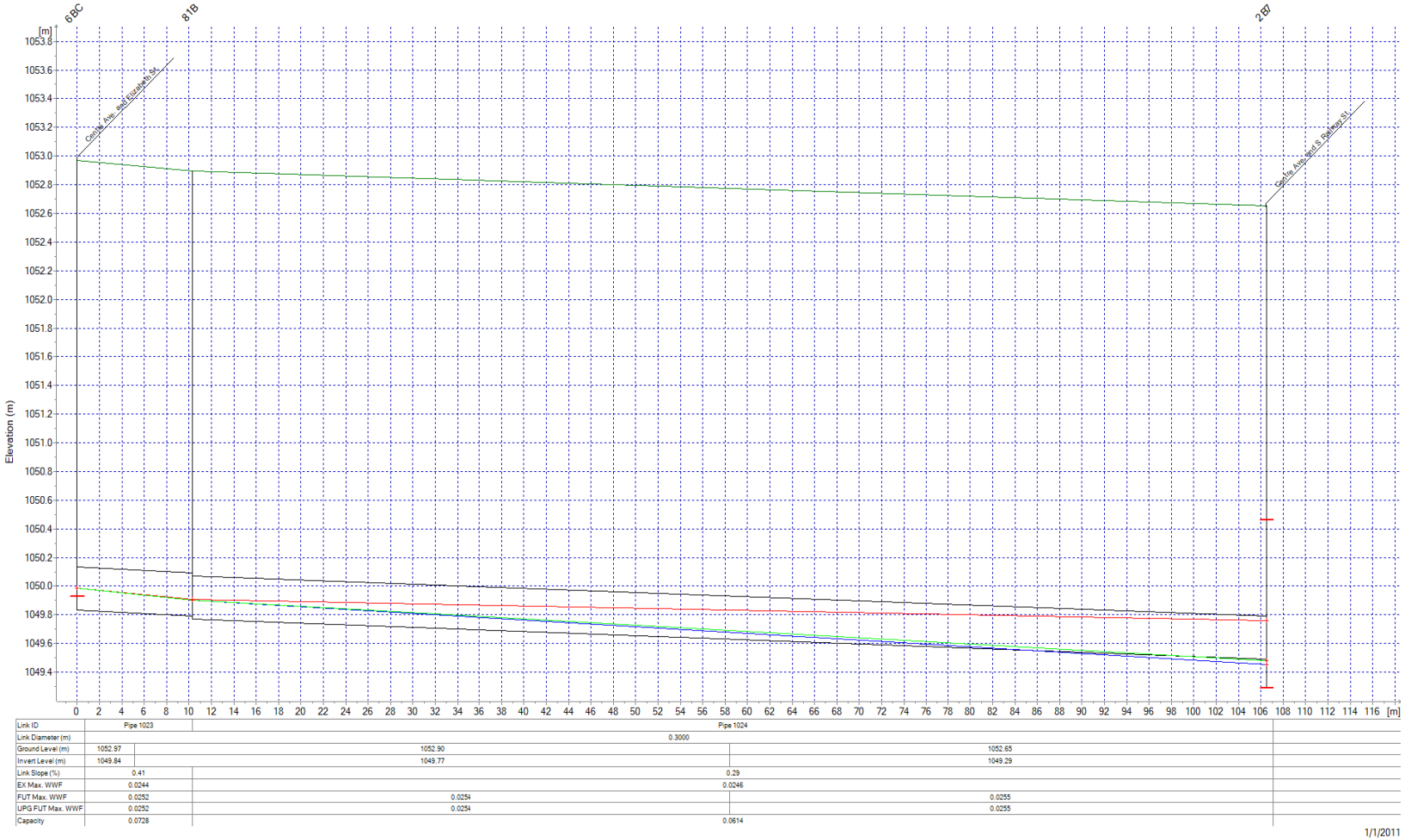

Link ID	Pipe 1023	Pipe 1024		
Link Diameter (m)	0.3000			
Ground Level (m)	1052.97	1052.90	1052.65	
Invert Level (m)	1049.84	1049.77	1049.29	
Link Slope (%)	0.41	0.29		
EX Max. WWF	0.0244	0.0246		
FUT Max. WWF	0.0252	0.0254	0.0255	
UPG FUT Max. WWF	0.0252	0.0254	0.0255	
Capacity	0.0728	0.0614		

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

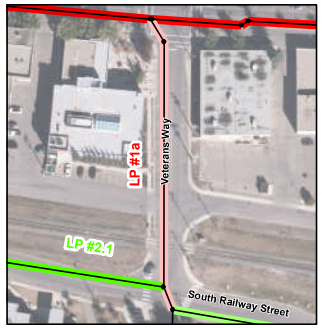

FIGURE A.6
MAXIMUM HGL PROFILE - LP#1.A
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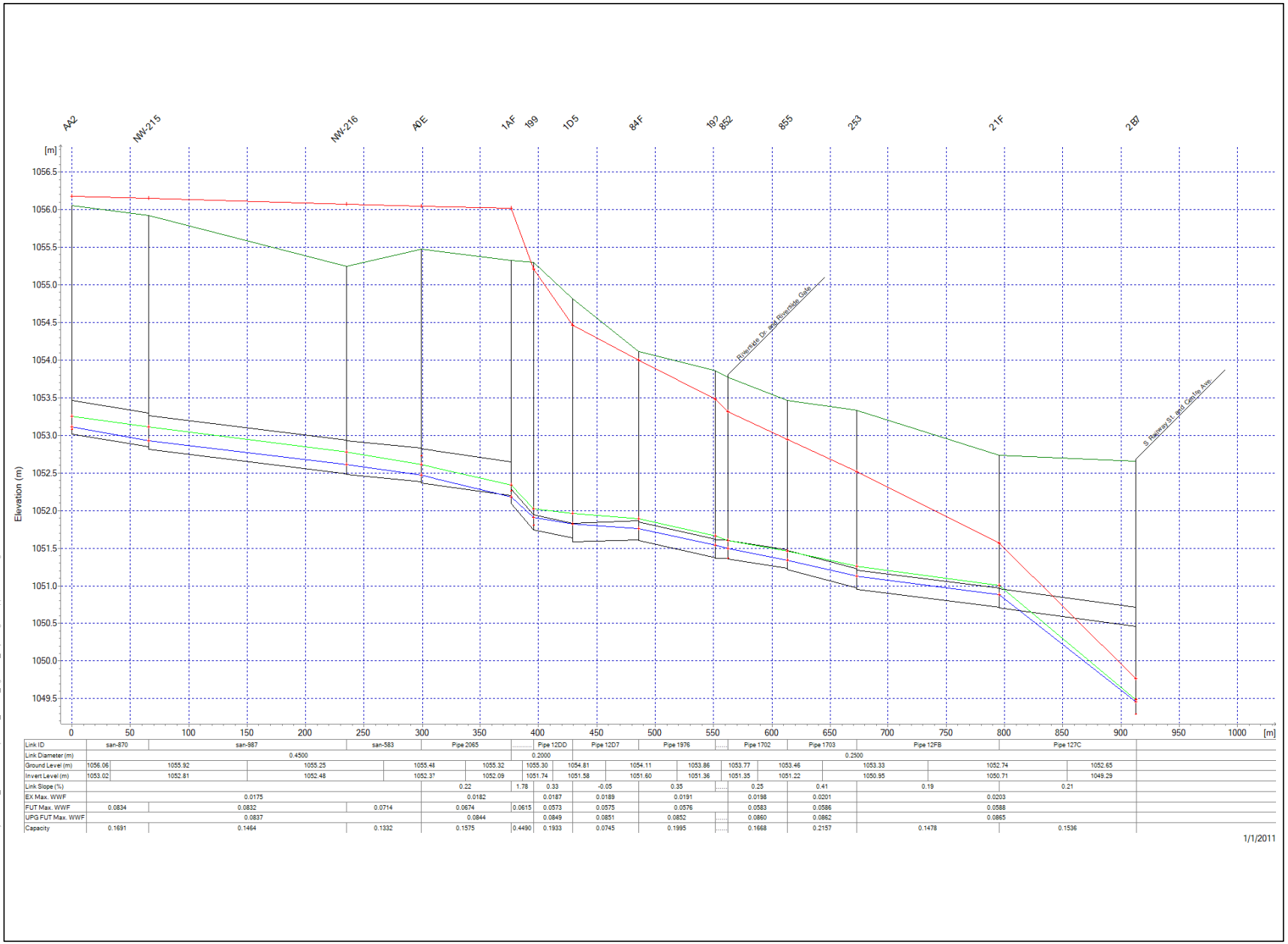

Link ID	san-870	san-987			san-583	Pipe 2065		Pipe 12DD	Pipe 12D7	Pipe 1976		Pipe 1702	Pipe 1703	Pipe 12FB		Pipe 127C	
Link Diameter (m)	0.4500							0.2000				0.2500					
Ground Level (m)	1056.06	1055.92	1055.25	1055.48	1055.32	1055.30	1054.81	1054.11	1053.86	1053.77	1053.46	1053.33	1052.74	1052.65			
Invert Level (m)	1053.02	1052.81	1052.48	1052.37	1052.09	1051.74	1051.58	1051.60	1051.36	1051.35	1051.22	1050.95	1050.71	1049.29			
Link Slope (%)	0.22					1.78	0.33	-0.05	0.35	0.25	0.41	0.19	0.21				
EX Max. WWF	0.0175			0.0182		0.0187	0.0189	0.0191		0.0198	0.0201	0.0203					
FUT Max. WWF	0.0834	0.0832	0.0714	0.0674	0.0615	0.0573	0.0575	0.0576		0.0583	0.0586	0.0588					
UPG FUT Max. WWF	0.0837			0.0844		0.0849	0.0851	0.0852		0.0860	0.0862	0.0865					
Capacity	0.1691	0.1464	0.1332	0.1575	0.4490	0.1933	0.0745	0.1995		0.1668	0.2157	0.1478	0.1536				

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

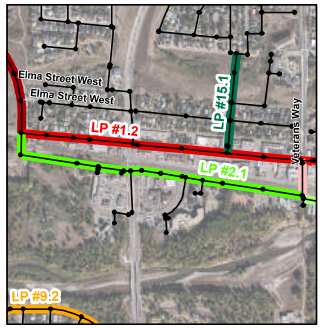

FIGURE A.7
MAXIMUM HGL PROFILE - LP#2.1
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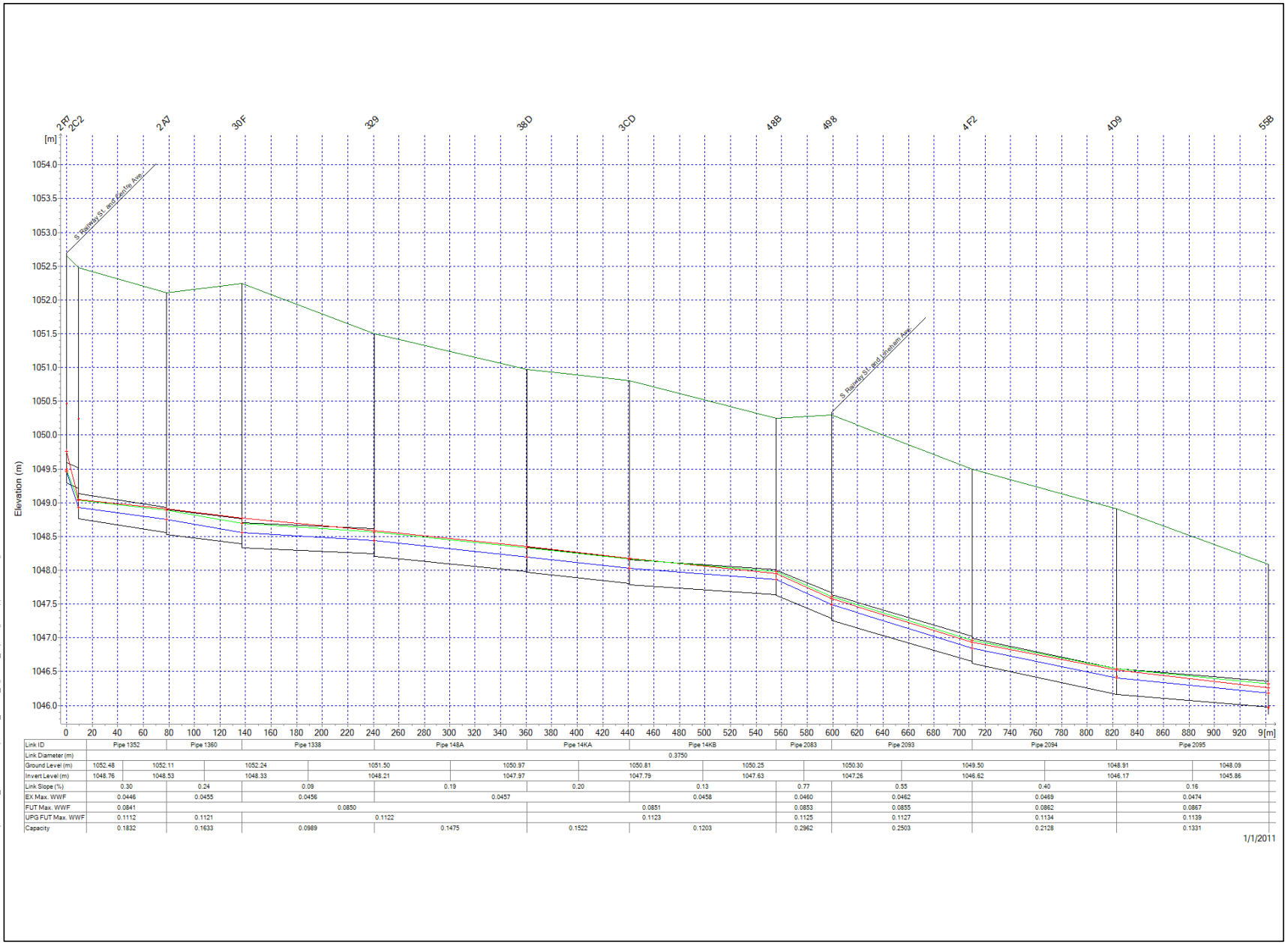

Link ID	Pipe 1352	Pipe 1360	Pipe 1338	Pipe 148A	Pipe 14KA	Pipe 14KB	Pipe 2083	Pipe 2093	Pipe 2094	Pipe 2095
Link Diameter (m)	0.3750									
Ground Level (m)	1052.48	1052.11	1052.24	1051.50	1050.97	1050.81	1050.25	1050.30	1049.50	1048.91	1048.09
Invert Level (m)	1048.76	1048.53	1048.33	1048.21	1047.97	1047.79	1047.63	1047.26	1046.62	1046.17	1045.86
Link Slope (%)	0.30	0.24	0.09	0.19	0.20	0.13	0.77	0.55	0.40	0.16	
EX Max. WWF	0.0446	0.0455	0.0456	0.0457		0.0458	0.0460	0.0462	0.0469	0.0474	
FUT Max. WWF	0.0841		0.0850			0.0851	0.0853	0.0855	0.0862	0.0867	
UPG FUT Max. WWF	0.1112	0.1121	0.1122			0.1123	0.1125	0.1127	0.1134	0.1139	
Capacity	0.1832	0.1633	0.0989	0.1475	0.1522	0.1203	0.2962	0.2503	0.2128	0.1331	

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

FIGURE A.8
MAXIMUM HGL PROFILE - LP#2.2
SANITARY MASTER PLAN UPDATE

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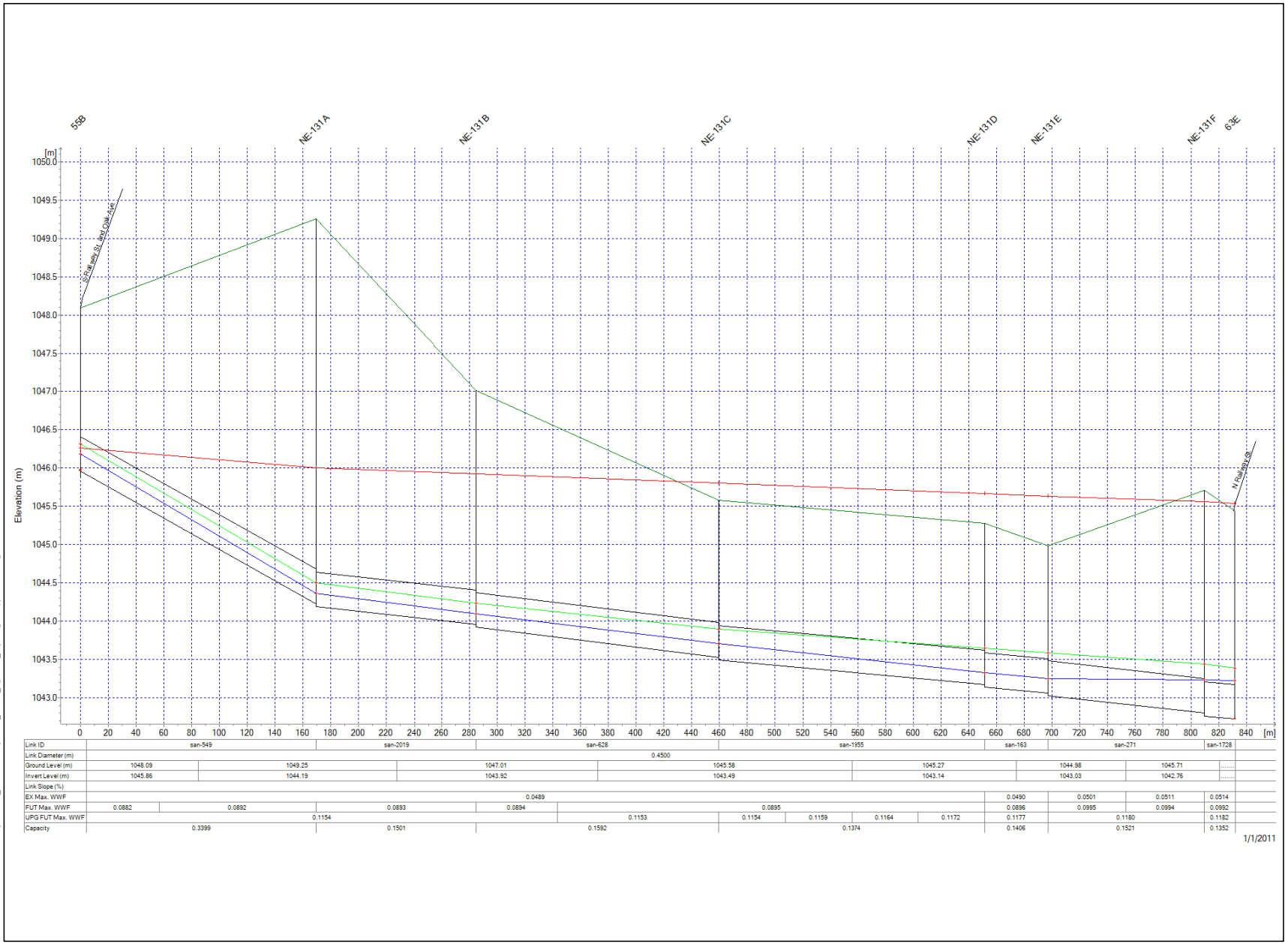

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

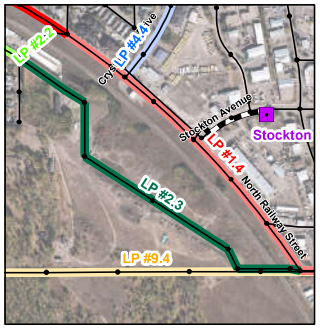

FIGURE A.9
MAXIMUM HGL PROFILE - LP#2.3
SANITARY MASTER PLAN UPDATE

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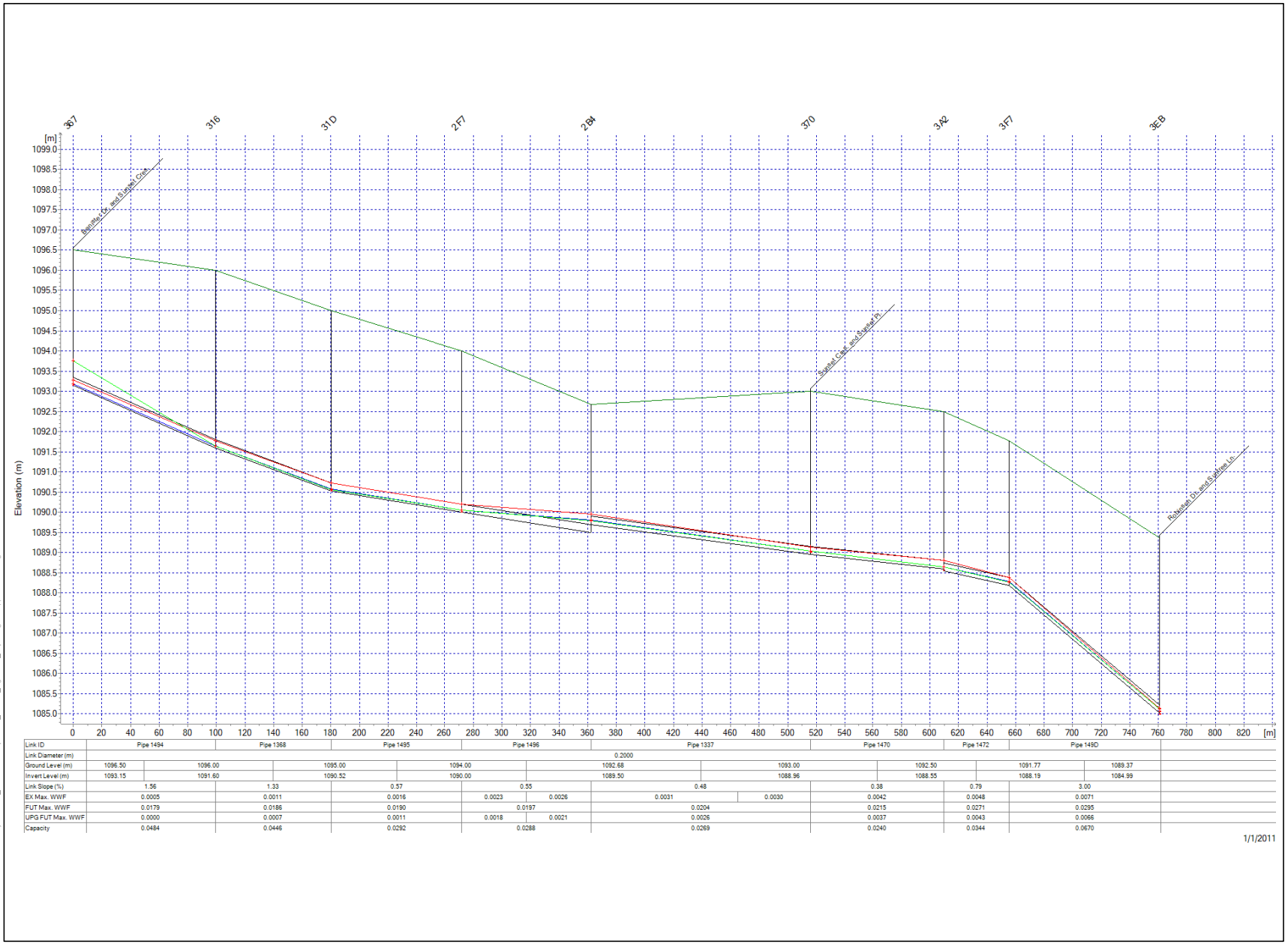

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

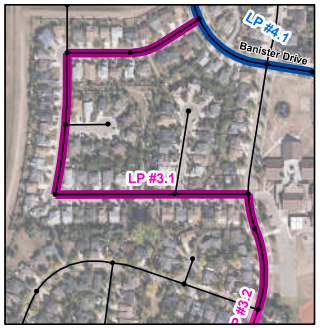

FIGURE A.10
MAXIMUM HGL PROFILE - LP#3.1
SANITARY MASTER PLAN UPDATE

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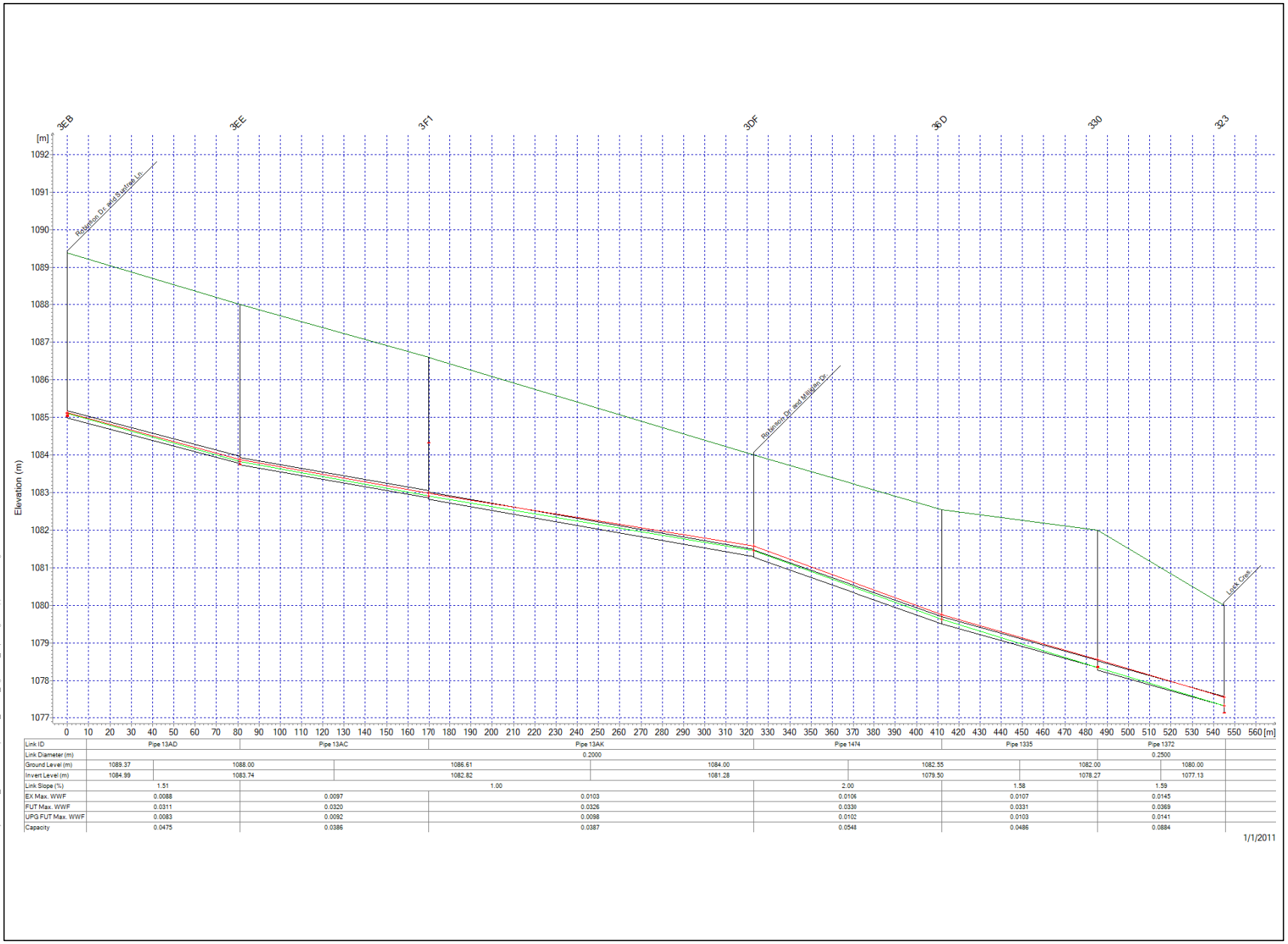

Link ID	Pipe 13AD	Pipe 13AC	Pipe 13AK	Pipe 1474	Pipe 1335	Pipe 1372
Link Diameter (m)			0.2000			0.2500
Ground Level (m)	1089.37	1088.00	1086.61	1084.00	1082.55	1082.00	1080.00
Invert Level (m)	1084.99	1083.74	1082.82	1081.28	1079.50	1078.27	1077.13
Link Slope (%)	1.51	1.00		2.00	1.58	1.59	
EX Max. WWF	0.0088	0.0097	0.0103	0.0106	0.0107	0.0145	
FUT Max. WWF	0.0311	0.0320	0.0326	0.0339	0.0331	0.0369	
UPG FUT Max. WWF	0.0083	0.0092	0.0098	0.0102	0.0103	0.0141	
Capacity	0.0475	0.0386	0.0387	0.0548	0.0486	0.0884	

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

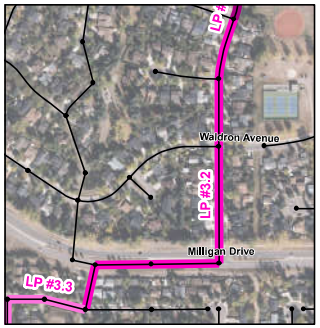

FIGURE A.11
MAXIMUM HGL PROFILE - LP#3.2
SANITARY MASTER PLAN UPDATE

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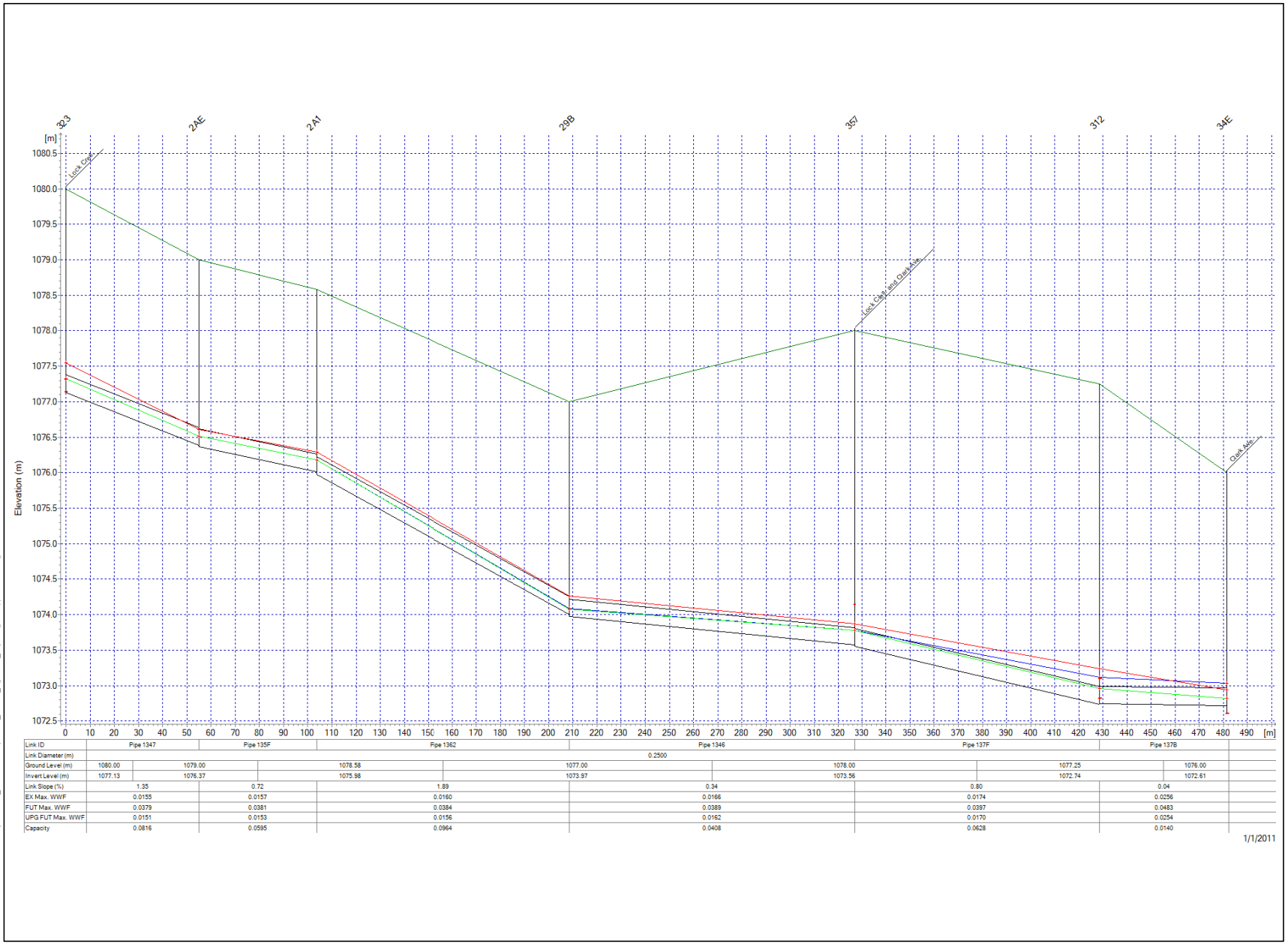

Link ID	Pipe 1347		Pipe 135F		Pipe 1362		Pipe 1346		Pipe 137F		Pipe 137B	
Link Diameter (m)	0.2500											
Ground Level (m)	1080.00	1079.00			1078.58		1077.00	1078.00		1077.25		1076.00
Invert Level (m)	1077.13	1076.37			1075.98		1073.97	1073.56		1072.74		1072.61
Link Slope (%)	1.35		0.72		1.89		0.34		0.80		0.04	
EX Max. WWF	0.0155		0.0157		0.0160		0.0166		0.0174		0.0256	
FUT Max. WWF	0.0379		0.0381		0.0384		0.0389		0.0397		0.0483	
UPG FUT Max. WWF	0.0151		0.0153		0.0156		0.0162		0.0170		0.0254	
Capacity	0.0816		0.0595		0.0964		0.0408		0.0628		0.0140	

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

FIGURE A.12
MAXIMUM HGL PROFILE - LP#3.3
SANITARY MASTER PLAN UPDATE

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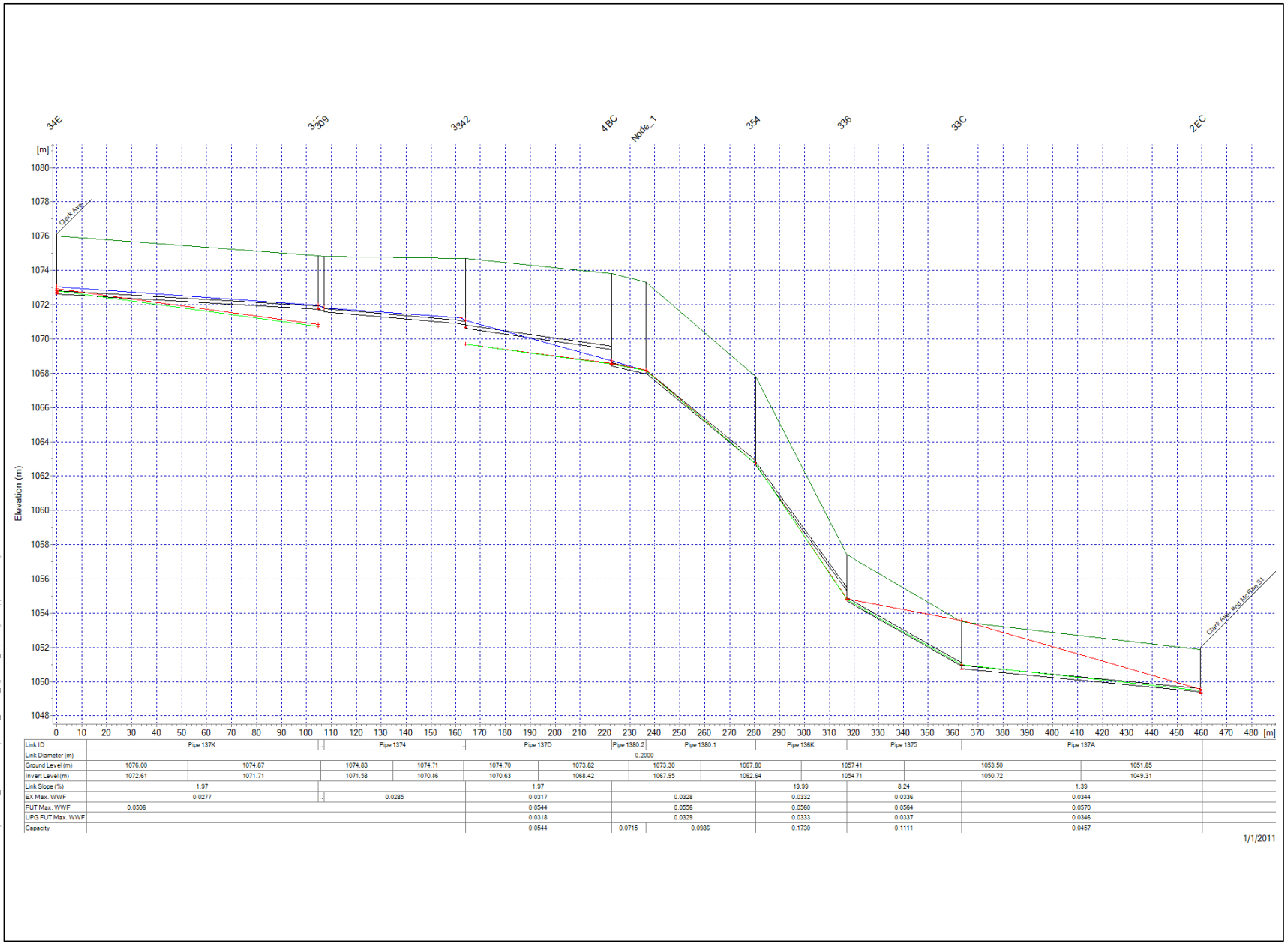

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

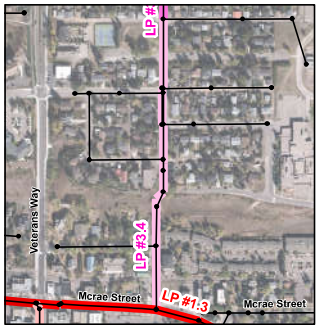

FIGURE A.13
MAXIMUM HGL PROFILE - LP#3.4
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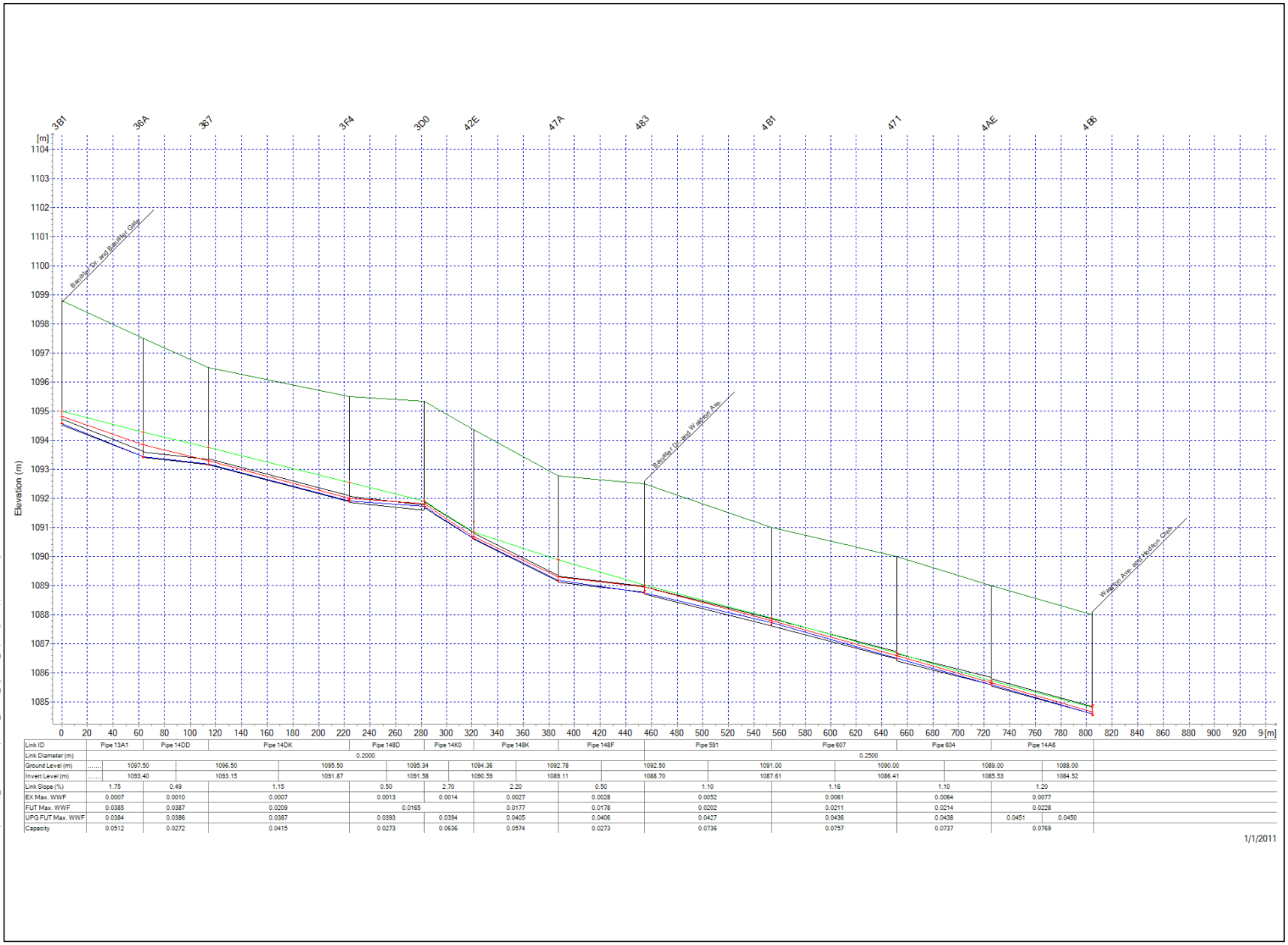

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

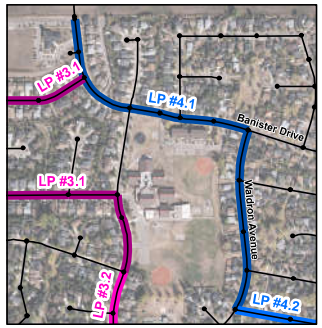

FIGURE A.14
MAXIMUM HGL PROFILE - LP#4.1
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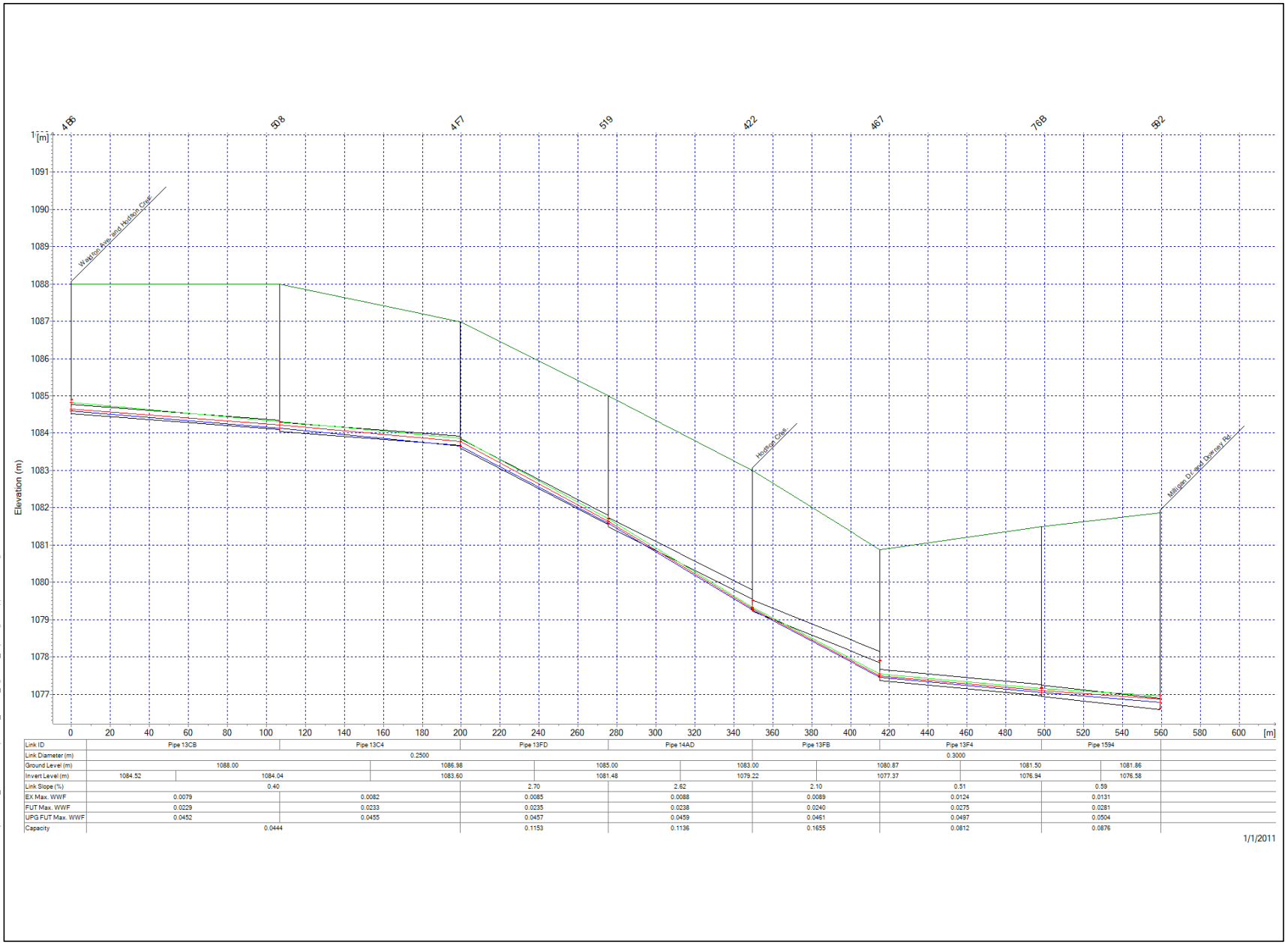

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

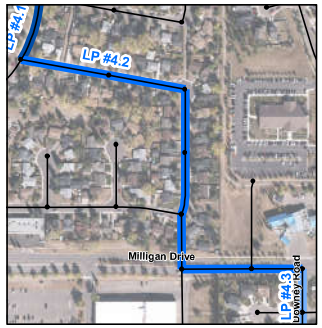

FIGURE A.15
MAXIMUM HGL PROFILE - LP#4.2
SANITARY MASTER PLAN UPDATE

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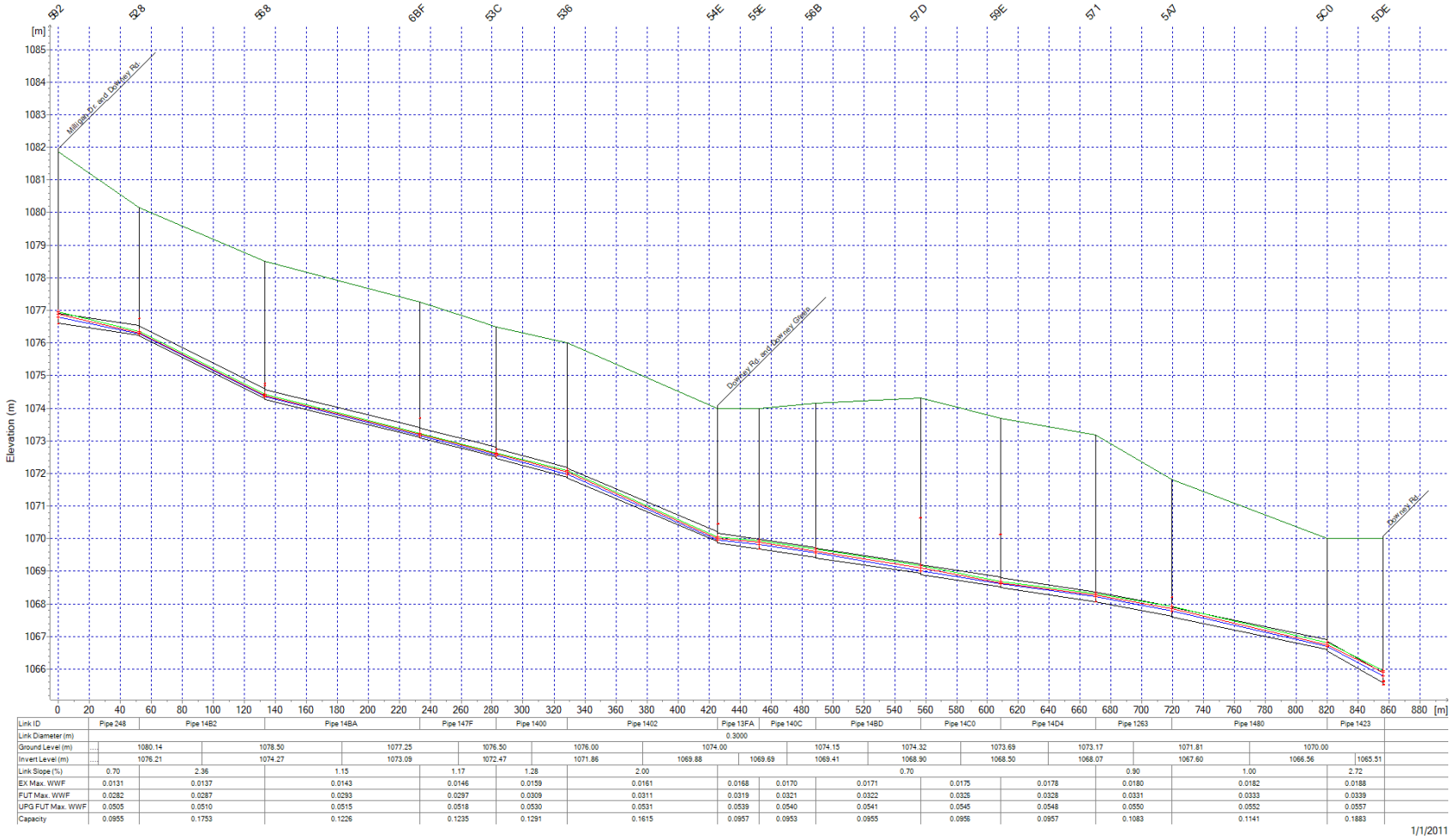

Link ID	Pipe 248	Pipe 14B2	Pipe 14BA	Pipe 147F	Pipe 1400	Pipe 1402	Pipe 13FA	Pipe 140C	Pipe 14BD	Pipe 14C0	Pipe 14D4	Pipe 1263	Pipe 1480	Pipe 1423
Link Diameter (m)	0.3000													
Ground Level (m)	1080.14	1078.50	1077.25	1076.50	1076.00	1074.00	1074.15	1074.32	1073.69	1073.17	1071.81	1070.00		
Invert Level (m)	1076.21	1074.27	1073.09	1072.47	1071.86	1069.88	1069.69	1069.41	1068.90	1068.50	1068.07	1067.60	1066.56	1065.51
Link Slope (%)	0.70	2.36	1.15	1.17	1.28	2.00	0.70				0.90	1.00	2.72	
EX Max. WWF	0.0131	0.0137	0.0143	0.0146	0.0159	0.0161	0.0168	0.0170	0.0171	0.0175	0.0178	0.0180	0.0182	0.0188
FUT Max. WWF	0.0282	0.0287	0.0293	0.0297	0.0309	0.0311	0.0319	0.0321	0.0322	0.0326	0.0328	0.0331	0.0333	0.0339
UPG FUT Max. WWF	0.0505	0.0510	0.0515	0.0518	0.0530	0.0531	0.0539	0.0540	0.0541	0.0545	0.0548	0.0550	0.0552	0.0557
Capacity	0.0955	0.1753	0.1226	0.1235	0.1291	0.1615	0.0957	0.0953	0.0955	0.0956	0.0957	0.1083	0.1141	0.1883

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

FIGURE A.16
MAXIMUM HGL PROFILE - LP#4.3
SANITARY MASTER PLAN UPDATE

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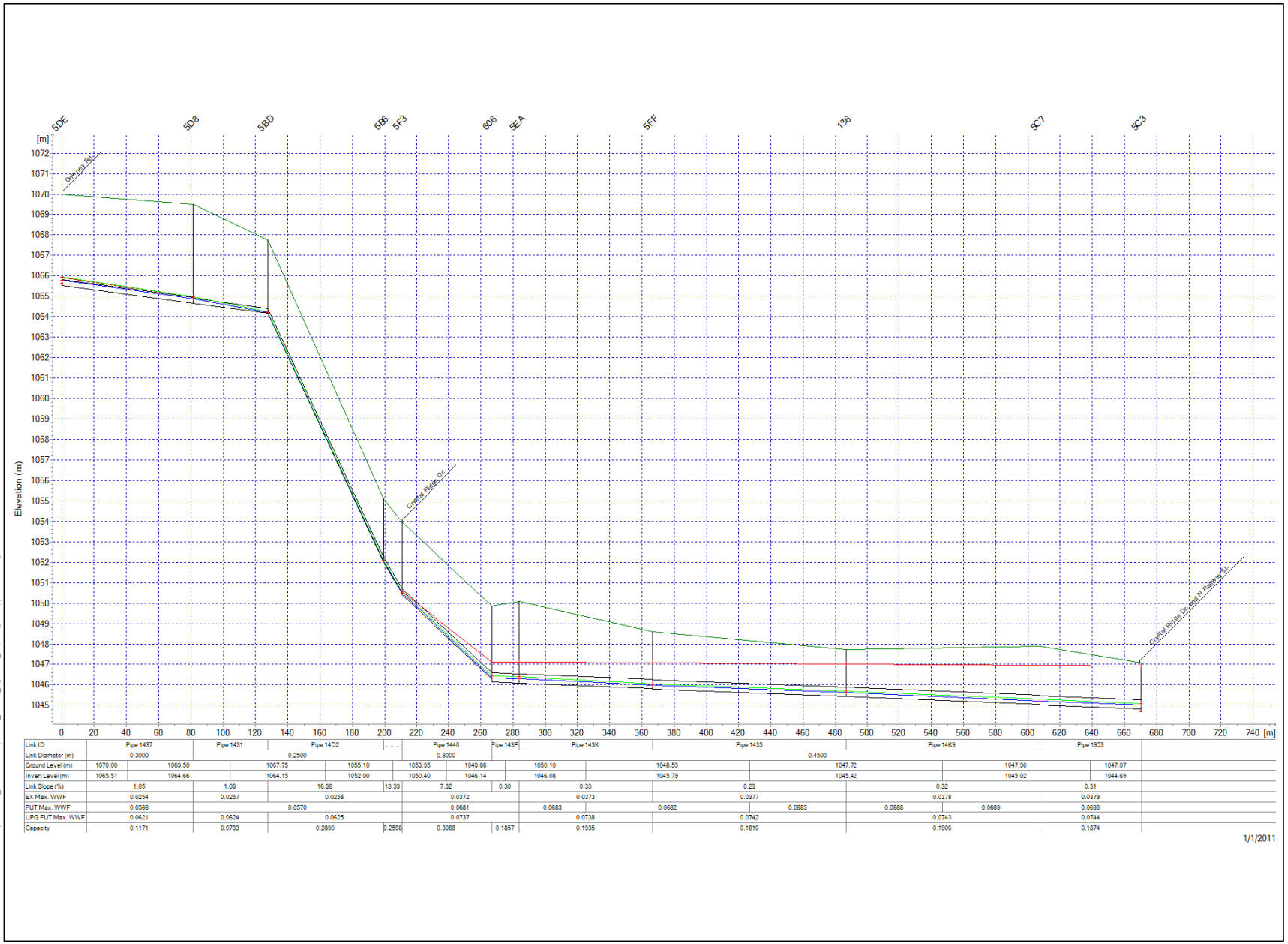

Link ID	Pipe 1437		Pipe 1431		Pipe 14D2			Pipe 1440		Pipe 143F	Pipe 143K		Pipe 1433		Pipe 14K9		Pipe 1953	
Link Diameter (m)	0.3000				0.2500			0.3000			0.4500							
Ground Level (m)	1070.00	1069.50		1067.75		1055.10		1053.95	1049.86		1050.10	1048.59		1047.72		1047.90		1047.07
Invert Level (m)	1065.51	1064.66		1064.15		1052.00		1050.40	1046.14		1046.08	1045.79		1045.42		1045.02		1044.69
Link Slope (%)	1.05		1.09		16.96		13.39	7.32		0.30	0.33		0.29		0.32		0.31	
EX Max. WWF	0.0254		0.0257		0.0258			0.0372			0.0373		0.0377		0.0378		0.0379	
FUT Max. WWF	0.0566			0.0570				0.0681			0.0683	0.0682	0.0683		0.0688	0.0689	0.0693	
UPG FUT Max. WWF	0.0621		0.0624		0.0625			0.0737			0.0738		0.0742		0.0743		0.0744	
Capacity	0.1171		0.0733		0.2890		0.2568	0.3088		0.1857	0.1935		0.1810		0.1906		0.1874	

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

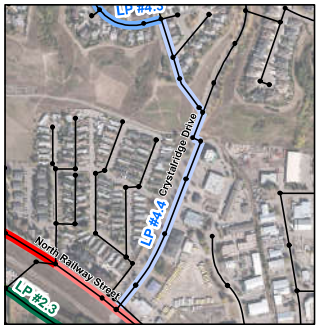

FIGURE A.17
MAXIMUM HGL PROFILE - LP#4.4
SANITARY MASTER PLAN UPDATE

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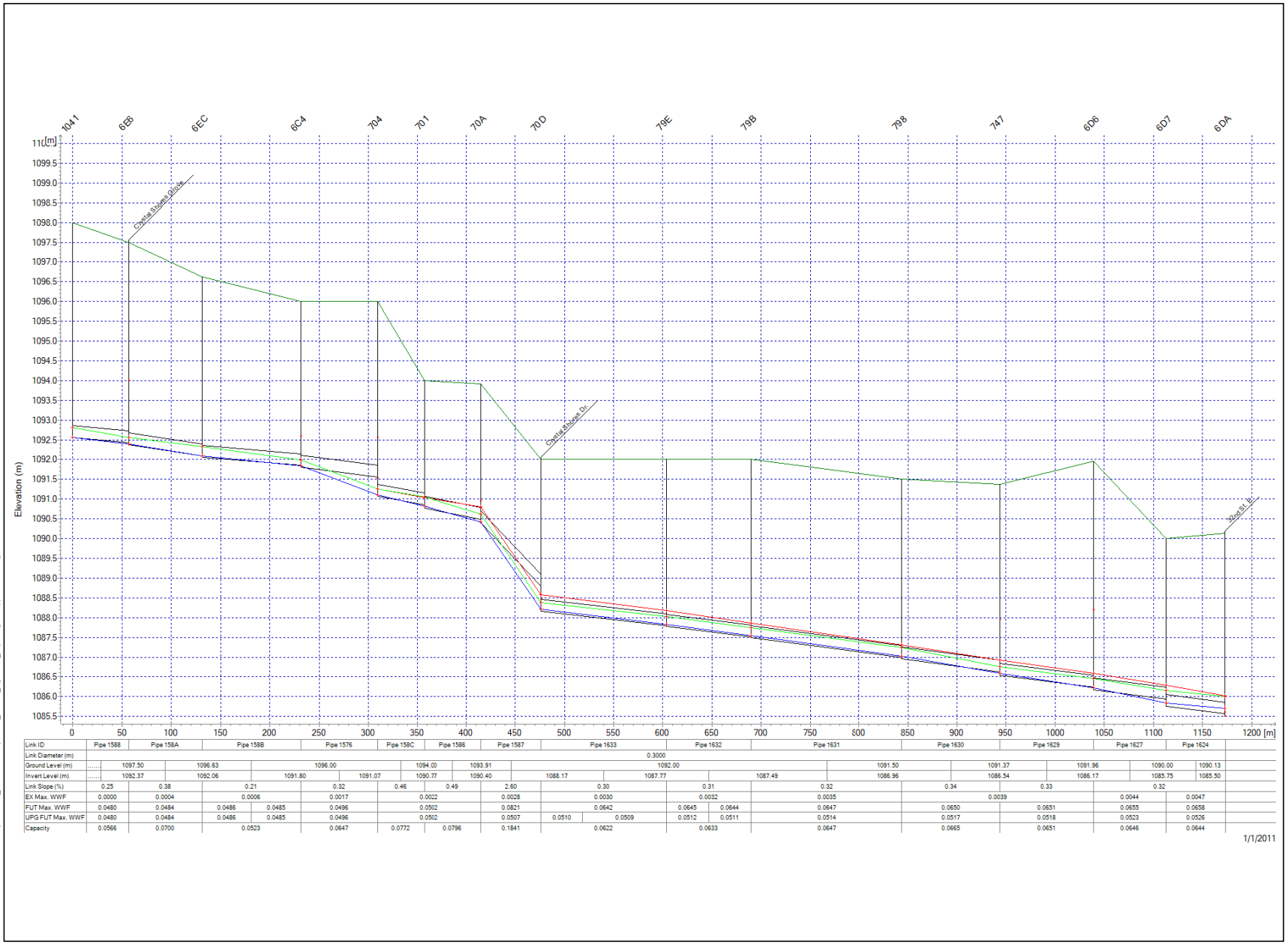

Link ID	Pipe 1588	Pipe 158A	Pipe 158B	Pipe 1576	Pipe 158C	Pipe 1586	Pipe 1587	Pipe 1633	Pipe 1632	Pipe 1631	Pipe 1630	Pipe 1629	Pipe 1627	Pipe 1624
Link Diameter (m)	0.3000													
Ground Level (m)	1097.50	1096.63	1096.00	1094.00	1093.91	1092.00		1091.50	1091.37	1091.96	1090.00	1090.13		
Invert Level (m)	1092.37	1092.06	1091.80	1091.07	1090.77	1090.40	1088.17	1087.77	1087.49	1086.96	1086.54	1086.17	1085.75	1085.50
Link Slope (%)	0.25	0.38	0.21	0.32	0.46	0.49	2.60	0.30	0.31	0.32	0.34	0.33	0.32	
EX Max. WWF	0.0000	0.0004	0.0006	0.0017	0.0022	0.0028	0.0030	0.0032	0.0035	0.0039		0.0044	0.0047	
FUT Max. WWF	0.0480	0.0484	0.0486	0.0485	0.0496	0.0502	0.0821	0.0642	0.0645	0.0644	0.0647	0.0650	0.0651	0.0655	0.0658
UPG FUT Max. WWF	0.0480	0.0484	0.0486	0.0485	0.0496	0.0502	0.0507	0.0510	0.0509	0.0512	0.0511	0.0514	0.0517	0.0518	0.0523	0.0526
Capacity	0.0566	0.0700	0.0523	0.0647	0.0772	0.0796	0.1841	0.0622	0.0633	0.0647	0.0665	0.0651	0.0646	0.0644

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

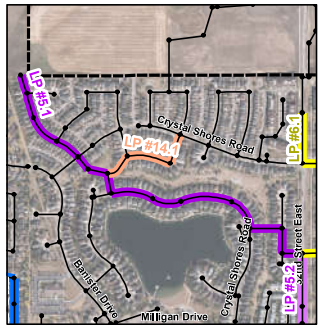

FIGURE A.18
MAXIMUM HGL PROFILE - LP#5.1
SANITARY MASTER PLAN UPDATE

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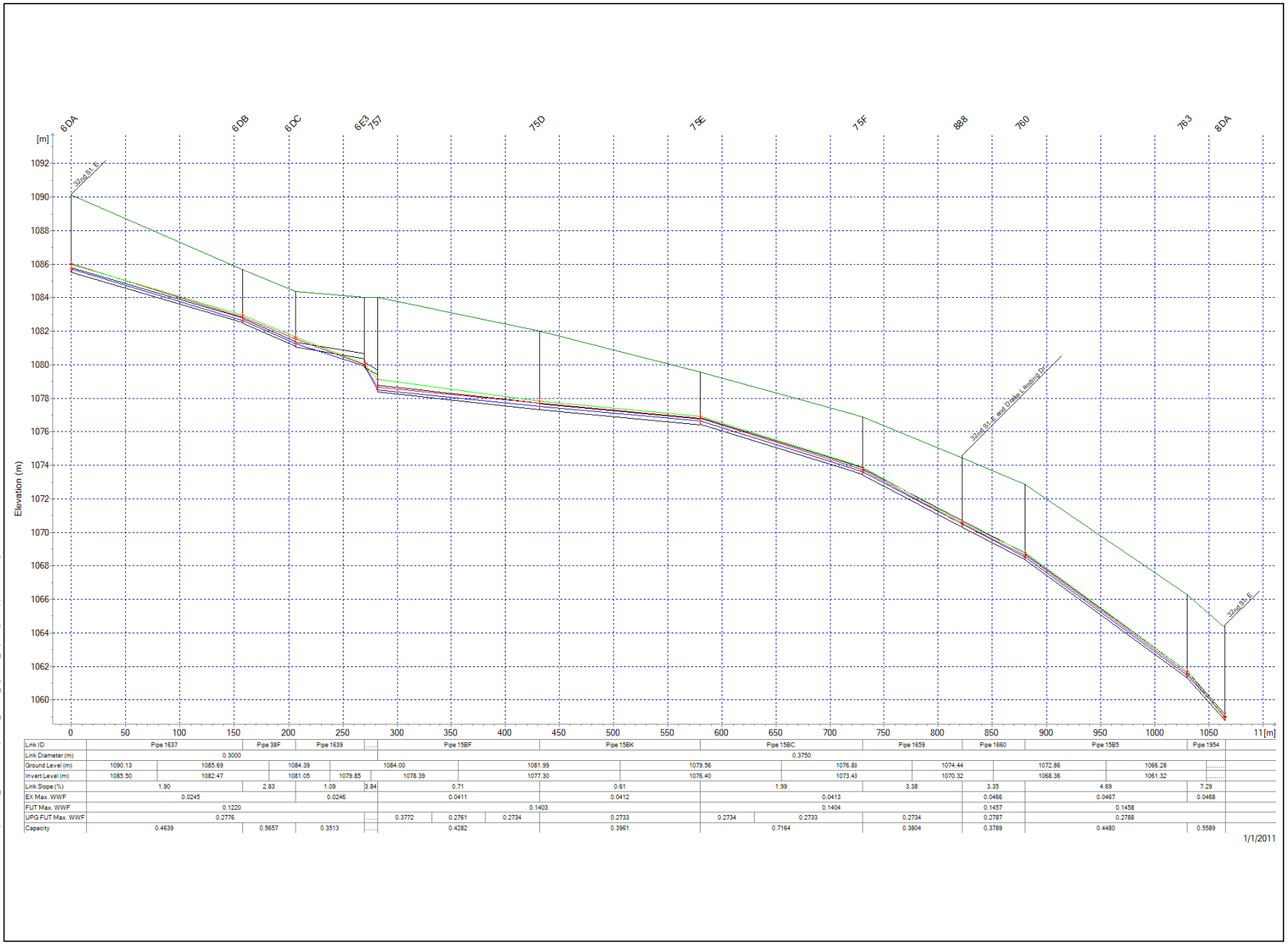

Link ID	Pipe 1637			Pipe 38F	Pipe 1639		Pipe 15BF			Pipe 15BK		Pipe 15BC		Pipe 1659	Pipe 1660	Pipe 15B5		Pipe 1954
Link Diameter (m)	0.3000						0.3750											
Ground Level (m)	1090.13	1085.69		1084.39		1084.00			1081.99			1079.56	1076.88	1074.44		1072.86	1066.28	
Invert Level (m)	1085.50	1082.47		1081.05	1079.85	1078.39			1077.30			1076.40	1073.43	1070.32		1068.36	1061.32	
Link Slope (%)	1.90		2.83	1.09	3.84	0.71			0.61			1.99	3.38	3.35		4.69	7.29	
EX Max. WWF	0.0245			0.0246		0.0411			0.0412			0.0413		0.0466		0.0467	0.0468	
FUT Max. WWF	0.1220					0.1403						0.1404		0.1457		0.1458		
UPG FUT Max. WWF	0.2776					0.3772	0.2761	0.2734	0.2733		0.2734	0.2733	0.2794	0.2787		0.2788		
Capacity	0.4639		0.5657	0.3513		0.4282			0.3961			0.7164	0.3804	0.3789		0.4480	0.5589	

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

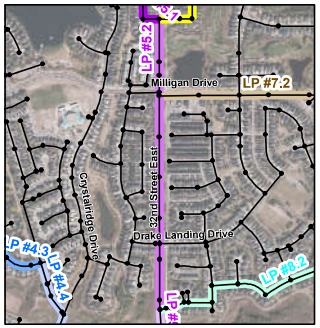

FIGURE A.19
MAXIMUM HGL PROFILE - LP#5.2
SANITARY MASTER PLAN UPDATE

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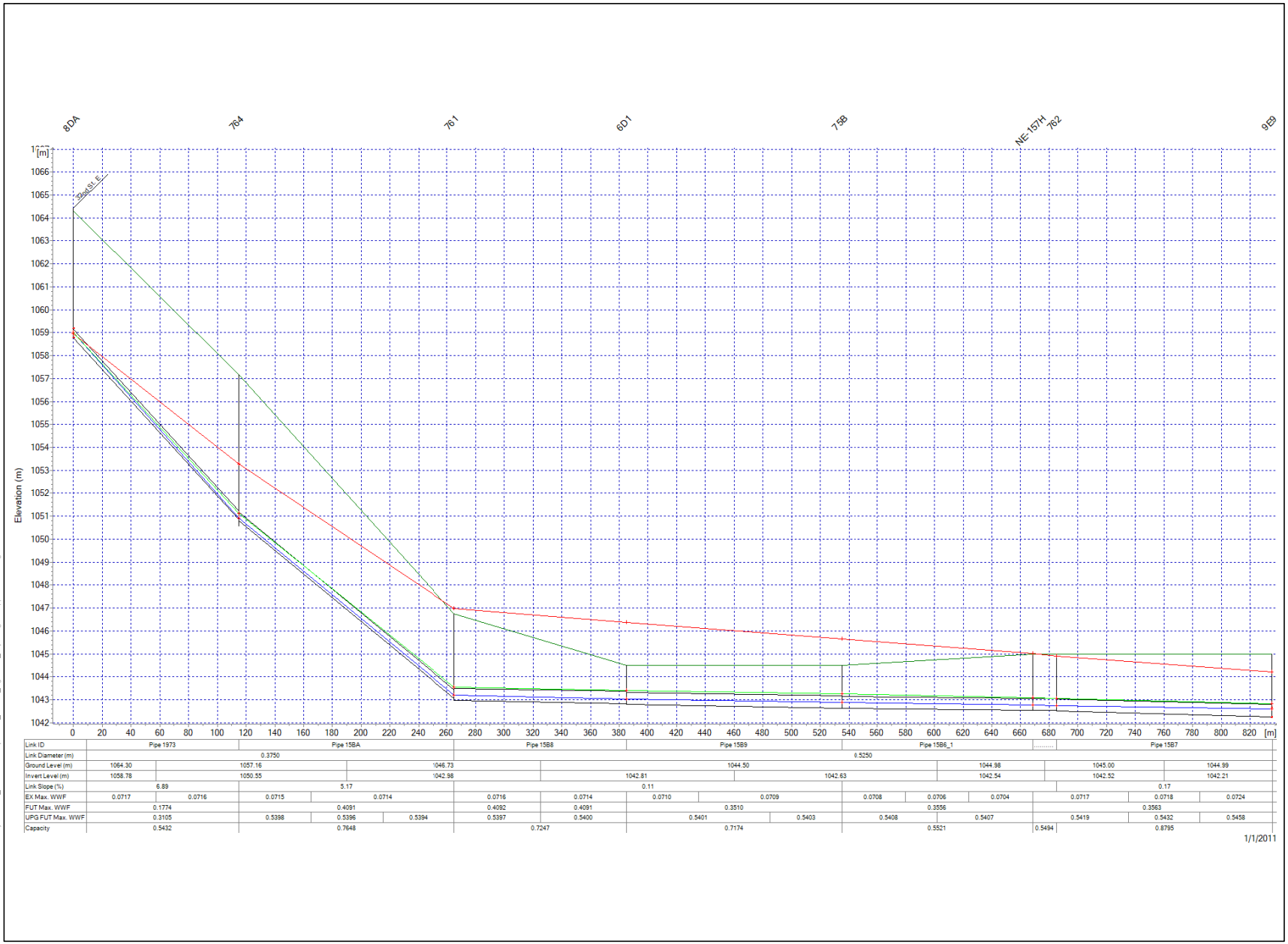

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

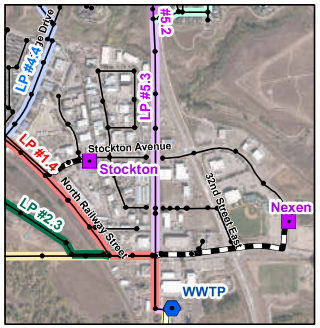

FIGURE A.20
MAXIMUM HGL PROFILE - LP#5.3
SANITARY MASTER PLAN UPDATE

Okotoks

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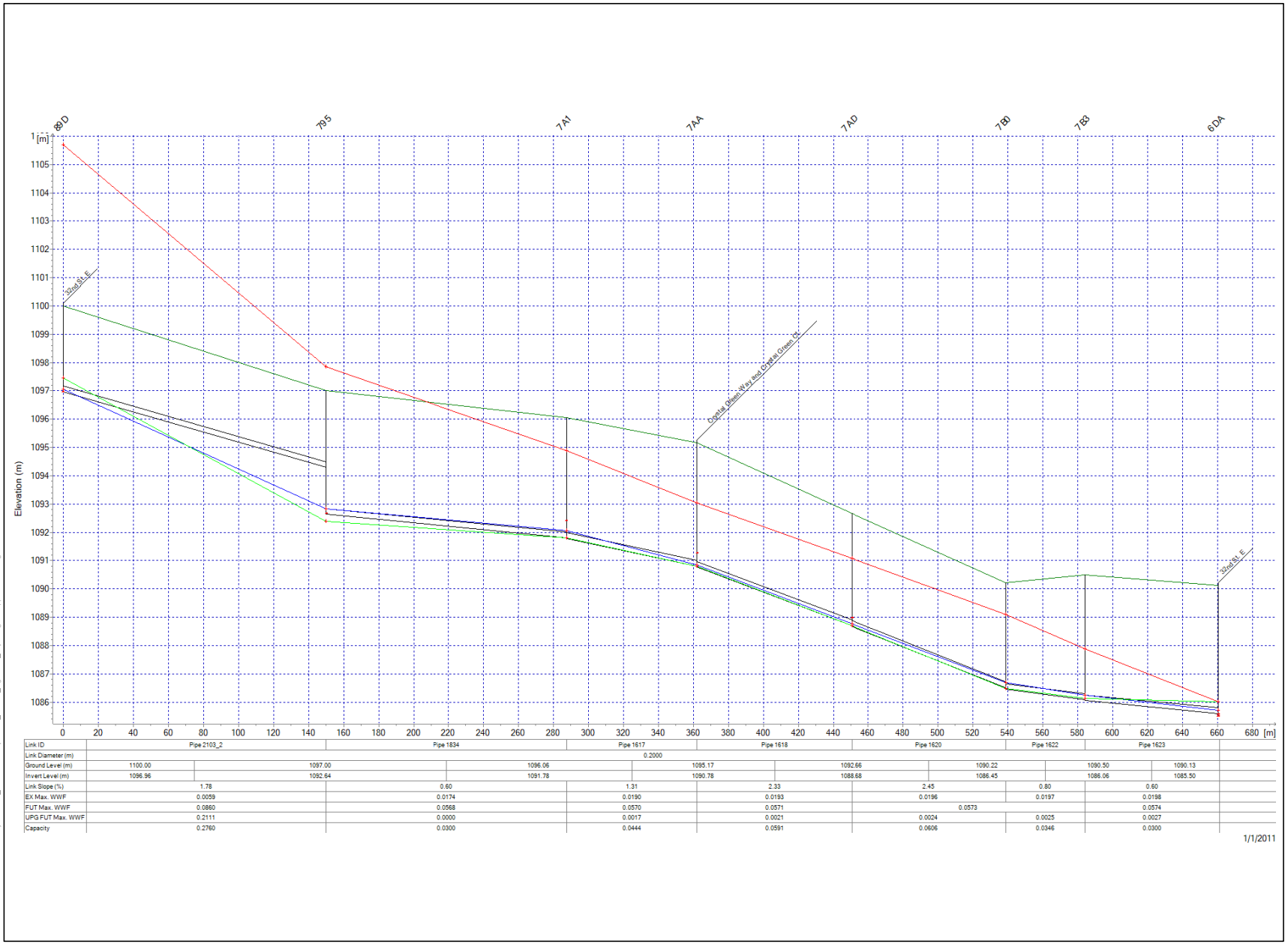

Link ID	Pipe 2103_2		Pipe 1834		Pipe 1617		Pipe 1618		Pipe 1620		Pipe 1622	Pipe 1623	
Link Diameter (m)	0.2000												
Ground Level (m)	1100.00	1097.00		1096.06		1095.17		1092.66		1090.22		1090.50	1090.13
Invert Level (m)	1096.96		1092.64		1091.78		1090.78		1088.68		1086.45		1086.06	1085.50
Link Slope (%)	1.78		0.60		1.31		2.33		2.45		0.80	0.60	
EX Max. WWF	0.0059		0.0174		0.0190		0.0193		0.0196		0.0197	0.0198	
FUT Max. WWF	0.0860		0.0568		0.0570		0.0571		0.0573			0.0574	
UPG FUT Max. WWF	0.2111		0.0000		0.0017		0.0021		0.0024		0.0025	0.0027	
Capacity	0.2760		0.0300		0.0444		0.0591		0.0606		0.0346	0.0300	

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

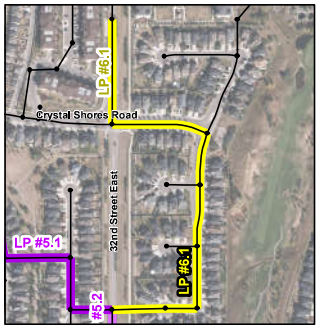

FIGURE A.21
MAXIMUM HGL PROFILE - LP#6.1
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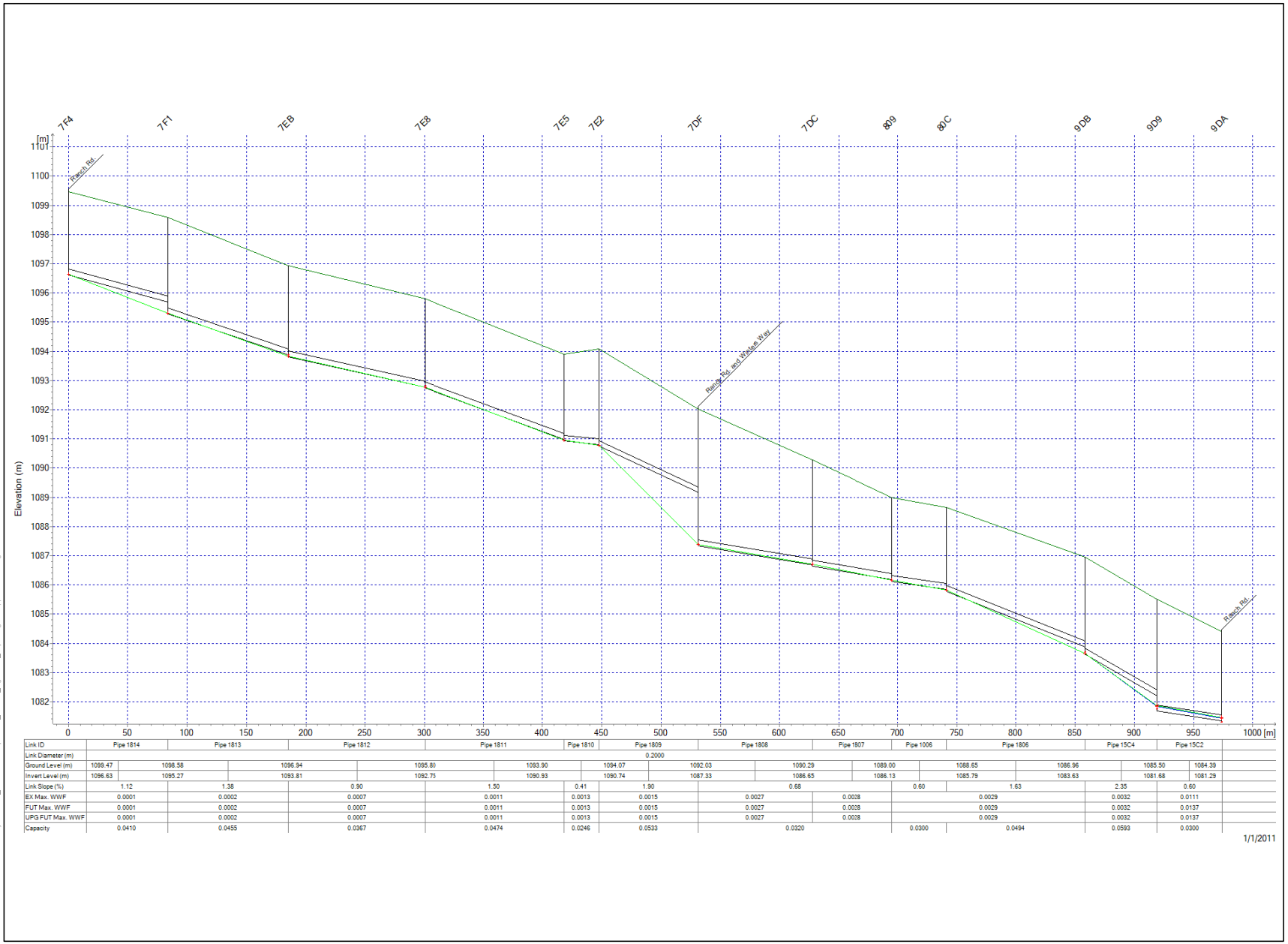

Link ID	Pipe 1814	Pipe 1813	Pipe 1812	Pipe 1811	Pipe 1810	Pipe 1809	Pipe 1808	Pipe 1807	Pipe 1006	Pipe 1806	Pipe 15C4	Pipe 15C2
Link Diameter (m)						0.2000						
Ground Level (m)	1099.47	1098.58	1096.94	1095.80	1093.90	1094.07	1092.03	1090.29	1089.00	1088.65	1086.96	1085.50	1084.39
Invert Level (m)	1096.63	1095.27	1093.81	1092.73	1090.93	1090.74	1087.33	1086.65	1086.13	1085.79	1083.63	1081.68	1081.29
Link Slope (%)	1.12	1.38	0.90	1.50	0.41	1.90	0.68		0.60	1.63	2.35	0.60	
EX Max. WWF	0.0001	0.0002	0.0007	0.0011	0.0013	0.0015	0.0027	0.0028		0.0029	0.0032	0.0111	
FUT Max. WWF	0.0001	0.0002	0.0007	0.0011	0.0013	0.0015	0.0027	0.0028		0.0029	0.0032	0.0137	
UPG FUT Max. WWF	0.0001	0.0002	0.0007	0.0011	0.0013	0.0015	0.0027	0.0028		0.0029	0.0032	0.0137	
Capacity	0.0410	0.0455	0.0367	0.0474	0.0246	0.0533	0.0320		0.0300	0.0494	0.0593	0.0300	

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

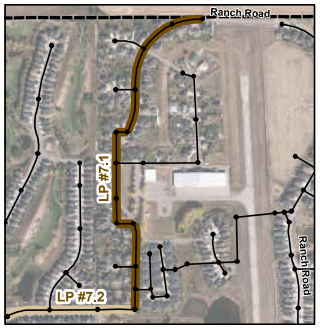

FIGURE A.22
MAXIMUM HGL PROFILE - LP#7.1
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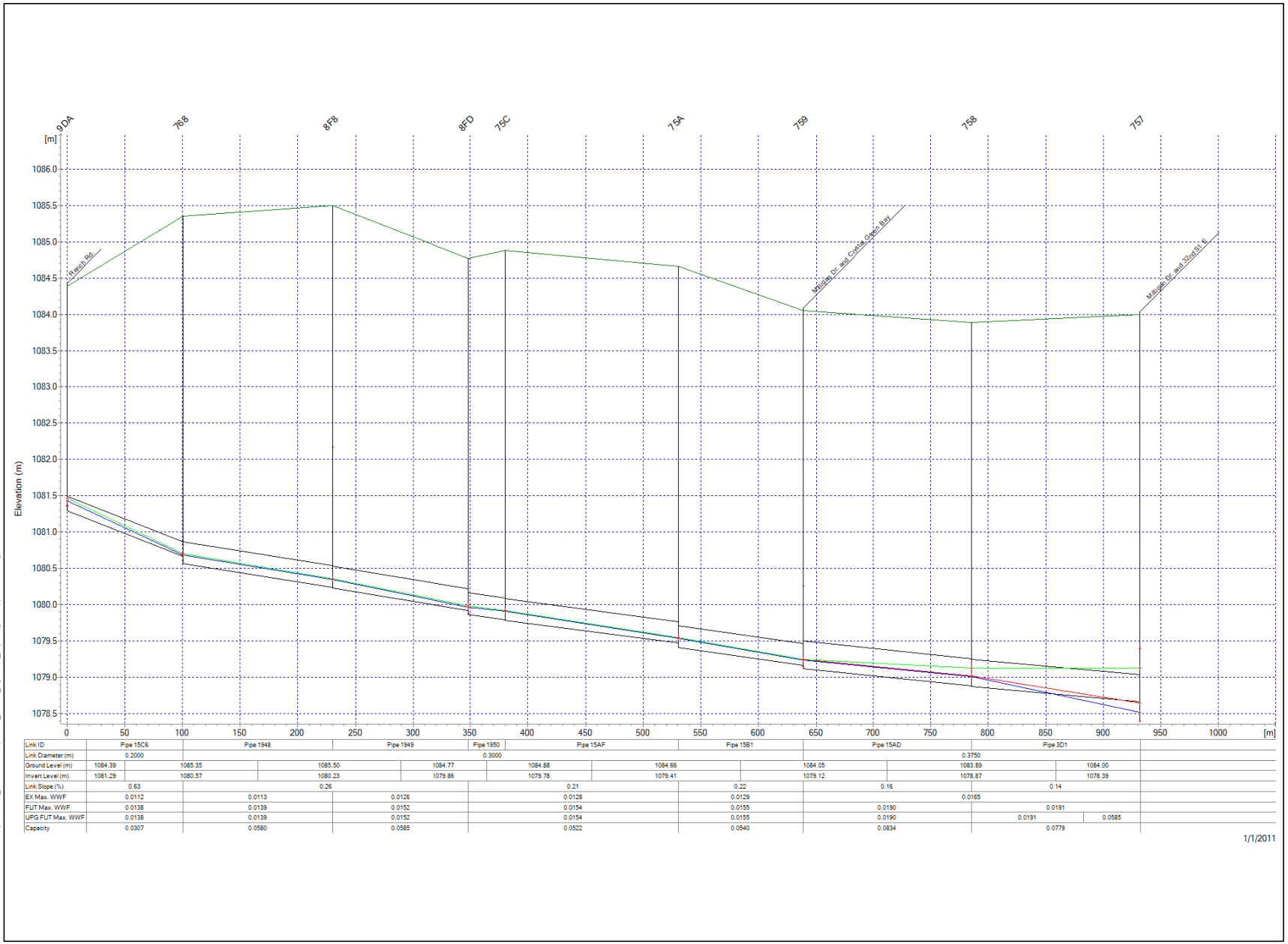

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

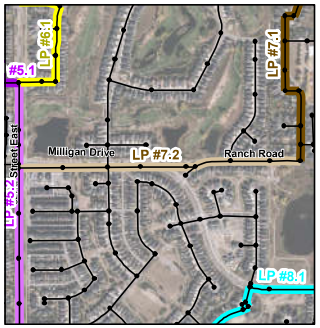

FIGURE A.23
MAXIMUM HGL PROFILE - LP#7.2
SANITARY MASTER PLAN UPDATE

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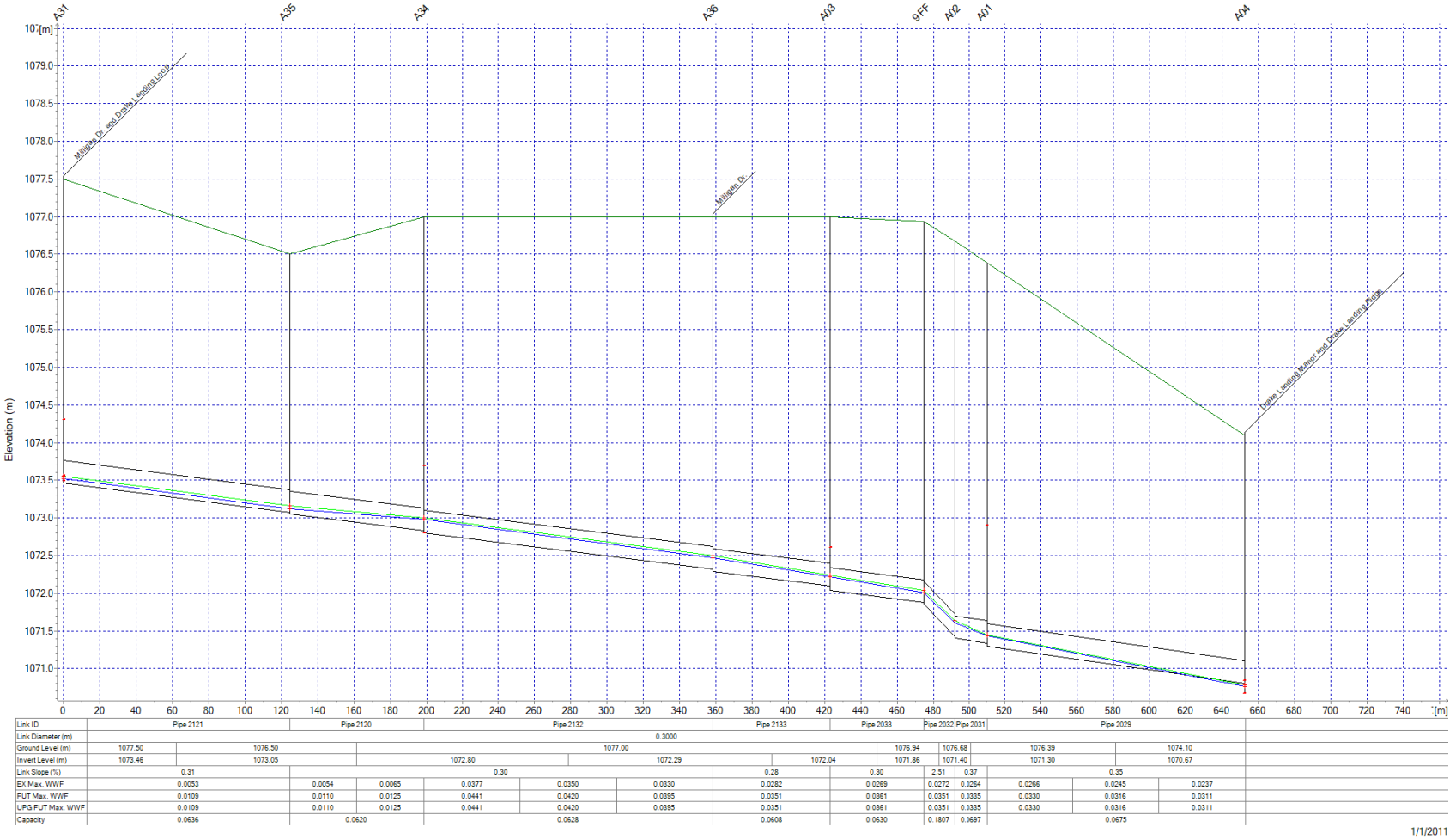

Link ID	Pipe 2121		Pipe 2120		Pipe 2132			Pipe 2133	Pipe 2033	Pipe 2032	Pipe 2031	Pipe 2029			
Link Diameter (m)	0.3000														
Ground Level (m)	1077.50	1076.50			1077.00				1076.94	1076.68	1076.39		1074.10		
Invert Level (m)	1073.46	1073.05			1072.80		1072.29	1072.04	1071.86	1071.40	1071.30		1070.67		
Link Slope (%)	0.31		0.30					0.28	0.30	2.51	0.37	0.35			
EX Max. WWF	0.0053		0.0054	0.0065	0.0377	0.0350	0.0330	0.0282	0.0269	0.0272	0.0264	0.0266	0.0245	0.0237	
FUT Max. WWF	0.0109		0.0110	0.0125	0.0441	0.0420	0.0395	0.0351	0.0361	0.0351	0.0335	0.0330	0.0316	0.0311	
UPG FUT Max. WWF	0.0109		0.0110	0.0125	0.0441	0.0420	0.0395	0.0351	0.0361	0.0351	0.0335	0.0330	0.0316	0.0311	
Capacity	0.0636		0.0620		0.0628			0.0608	0.0630	0.1807	0.0697	0.0675			

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

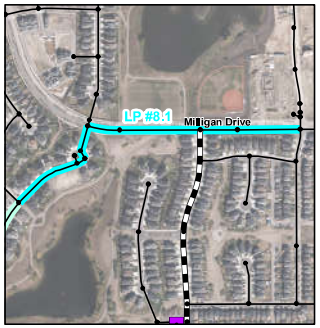

FIGURE A.24
MAXIMUM HGL PROFILE - LP#8.1
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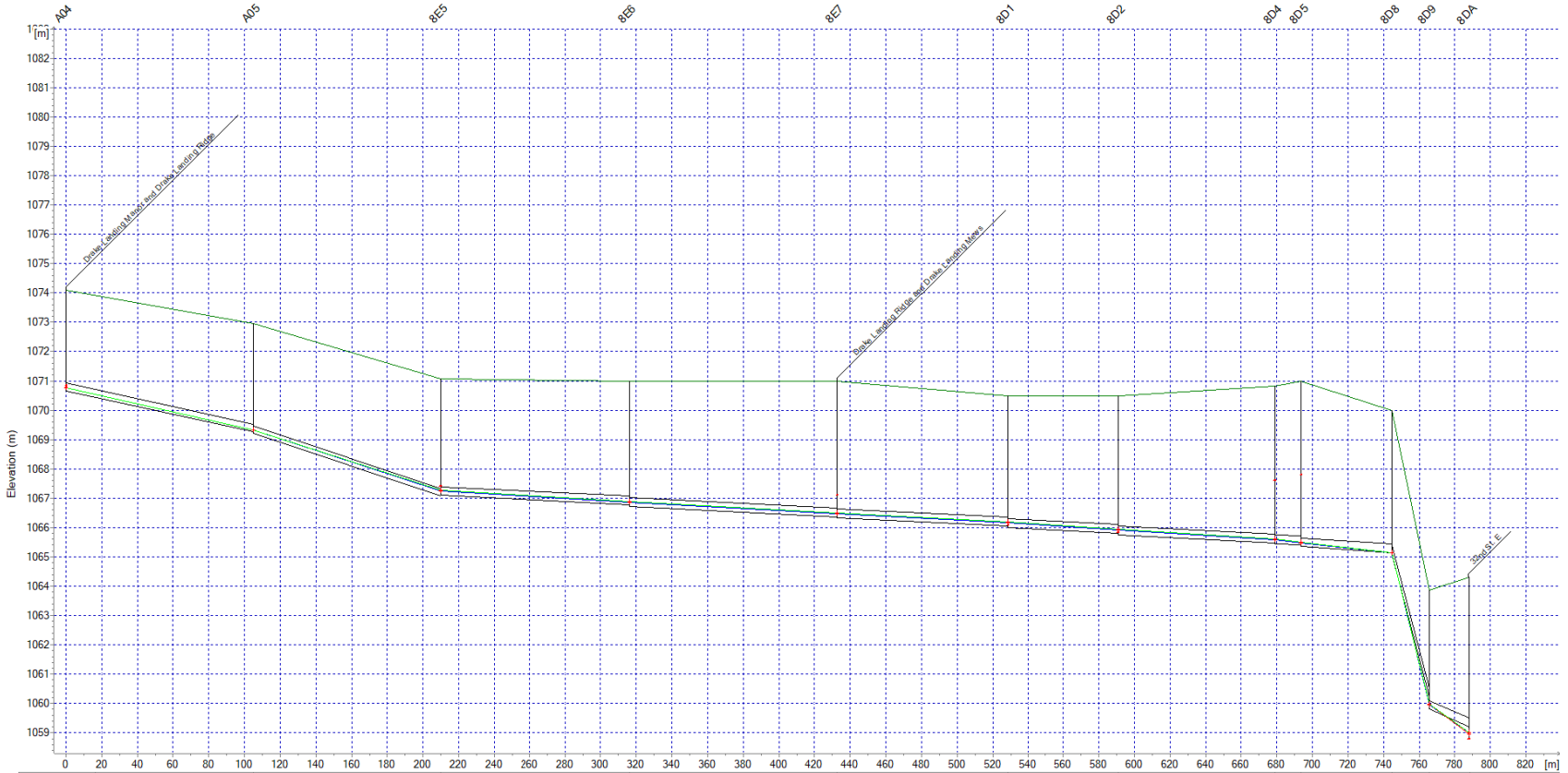

Link ID	Pipe 2034		Pipe 2035		Pipe 1915	Pipe 1914	Pipe 1912	Pipe 1909	Pipe 1907		Pipe 1903	Pipe 1902	Pipe 1901
Link Diameter (m)	0.2500						0.3000						
Ground Level (m)	1074.10	1072.96		1071.07	1071.00	1070.98		1070.50		1070.82	1071.00	1070.00	1063.87
Invert Level (m)	1070.67	1069.20		1067.08	1066.72	1066.34		1065.99	1065.74	1065.45	1065.35	1065.08	1059.80
Link Slope (%)	1.34		2.02			0.30					0.40	23.36	2.71
EX Max. WWF	0.0265	0.0264	0.0262	0.0254	0.0255	0.0257	0.0252	0.0248	0.0253	0.0248	0.0251	0.0252	0.0248	0.0247	0.0250	0.0251
FUT Max. WWF	0.0330	0.0328	0.0330	0.0328	0.0327	0.0322	0.0320	0.0316	0.0317		0.0320		0.0316	0.0317		
UPG FUT Max. WWF	0.0330	0.0328	0.0330	0.0328	0.0327	0.0322	0.0320	0.0316	0.0317		0.0320		0.0316	0.0317		
Capacity	0.0813		0.0997				0.0625							0.0624	0.0725	0.5516	0.1878

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

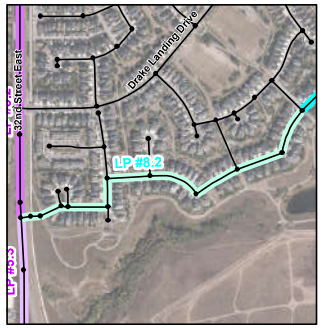

FIGURE A.25
MAXIMUM HGL PROFILE - LP#8.2
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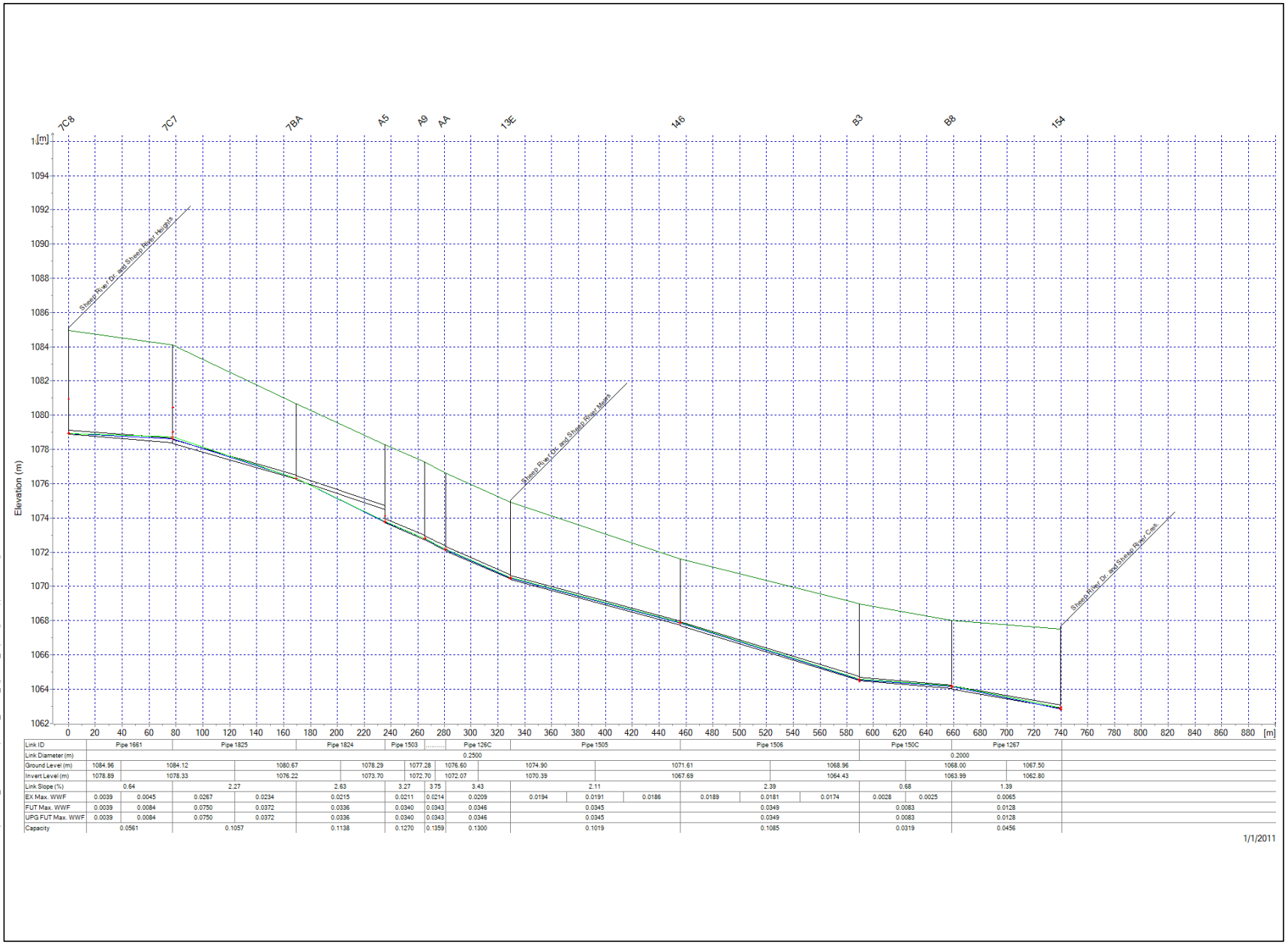

Link ID	Pipe 1661		Pipe 1825		Pipe 1824		Pipe 1503		Pipe 126C	Pipe 1505		Pipe 1506		Pipe 150C		Pipe 1267	
Link Diameter (m)	0.2500													0.2000			
Ground Level (m)	1084.96		1084.12		1080.67		1078.29	1077.28	1076.60	1074.90		1071.61		1068.96		1068.00	1067.50
Invert Level (m)	1078.89		1078.33		1076.22		1073.70	1072.70	1072.07	1070.39		1067.69		1064.43		1063.99	1062.80
Link Slope (%)	0.64		2.27		2.63		3.27	3.75	3.43	2.11		2.39		0.68		1.39	
EX Max. WWF	0.0039	0.0045	0.0267	0.0234	0.0215		0.0211	0.0214	0.0209	0.0194	0.0191	0.0186	0.0189	0.0181	0.0174	0.0028	0.0025	0.0065
FUT Max. WWF	0.0039	0.0084	0.0750	0.0372	0.0336		0.0340	0.0343	0.0346	0.0345		0.0349		0.0083		0.0128	
UPG FUT Max. WWF	0.0039	0.0084	0.0750	0.0372	0.0336		0.0340	0.0343	0.0346	0.0345		0.0349		0.0083		0.0128	
Capacity	0.0561		0.1057		0.1138		0.1270	0.1359	0.1300	0.1019		0.1085		0.0319		0.0456	

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

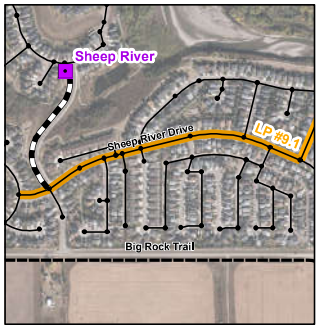

FIGURE A.26
MAXIMUM HGL PROFILE - LP#9.1
SANITARY MASTER PLAN UPDATE

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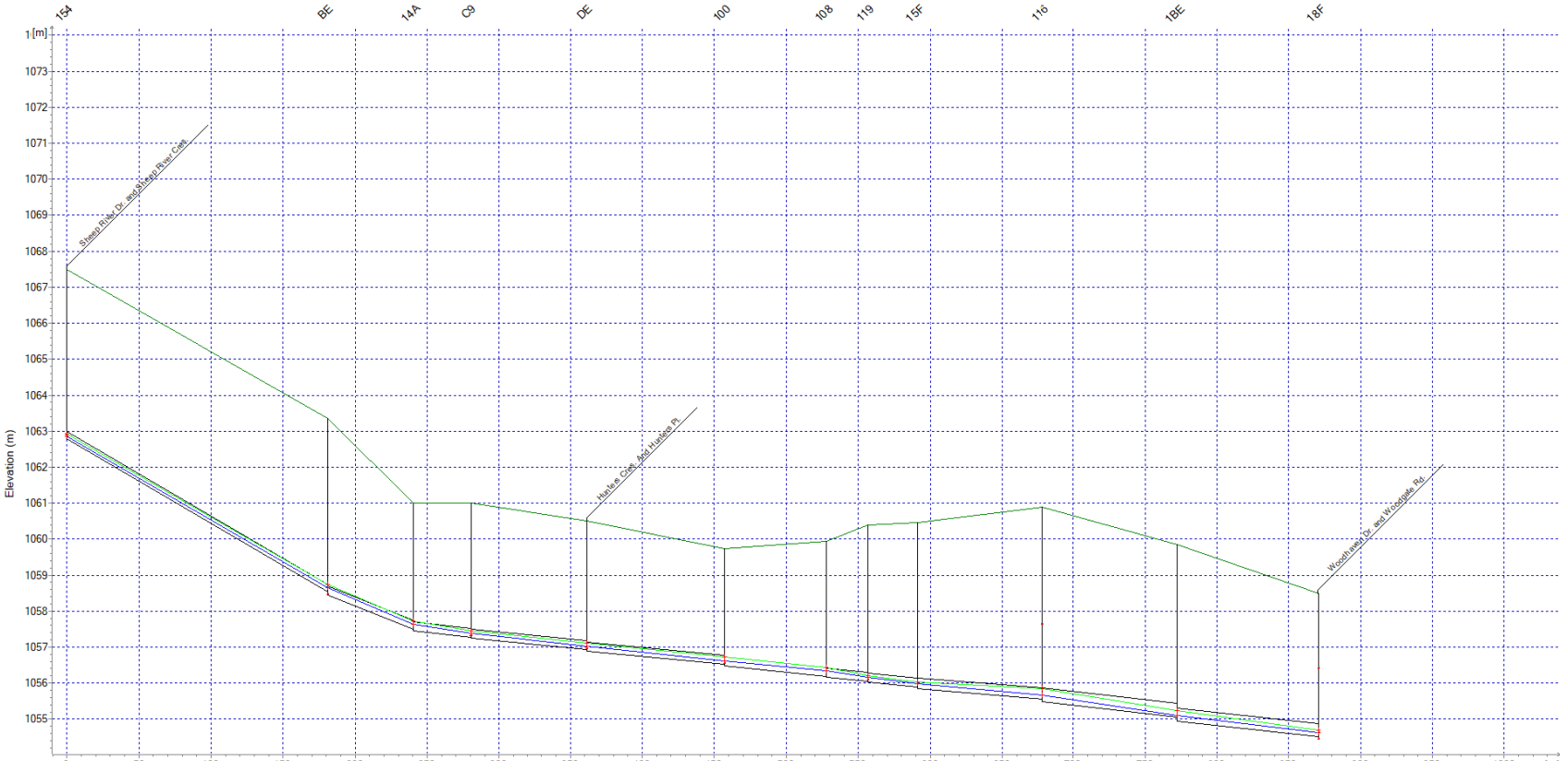

Link ID	Pipe 150D		Pipe 1294	Pipe 1293	Pipe 128C		Pipe 150K		Pipe 1510		Pipe 12B5	Pipe 12C8	Pipe 12C1		Pipe 1280		Pipe 12D6	
Link Diameter (m)	0.2000		0.2500										0.3000		0.3750			
Ground Level (m)	1067.50	1063.35		1061.00		1060.50		1059.73		1059.94	1060.40		1060.46	1060.90		1059.86		1058.50
Invert Level (m)	1062.80	1058.45		1057.44	1057.25		1056.90		1056.48		1056.16	1056.03	1055.84	1055.48		1054.93		1054.44
Link Slope (%)	2.36		1.60	0.41		0.40			0.41		0.37	0.40	0.32		0.46		0.44	
EX Max. WWF	0.0072	0.0073	0.0215		0.0222	0.0221	0.0226	0.0228	0.0233	0.0232	0.0231		0.0232		0.0256	0.0257	0.0259	0.0258
FUT Max. WWF	0.0135	0.0134	0.0430	0.0431	0.0440	0.0439	0.0444	0.0443	0.0448		0.0449		0.0450		0.0735			
UPG FUT Max. WWF	0.0135	0.0134	0.0430	0.0431	0.0440	0.0439	0.0444	0.0443	0.0448		0.0449		0.0450		0.0735			
Capacity	0.0594		0.0888	0.0447	0.0444				0.0451		0.0425	0.0445	0.0645		0.1401		0.1368	

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

FIGURE A.27
MAXIMUM HGL PROFILE - LP#9.2
SANITARY MASTER PLAN UPDATE

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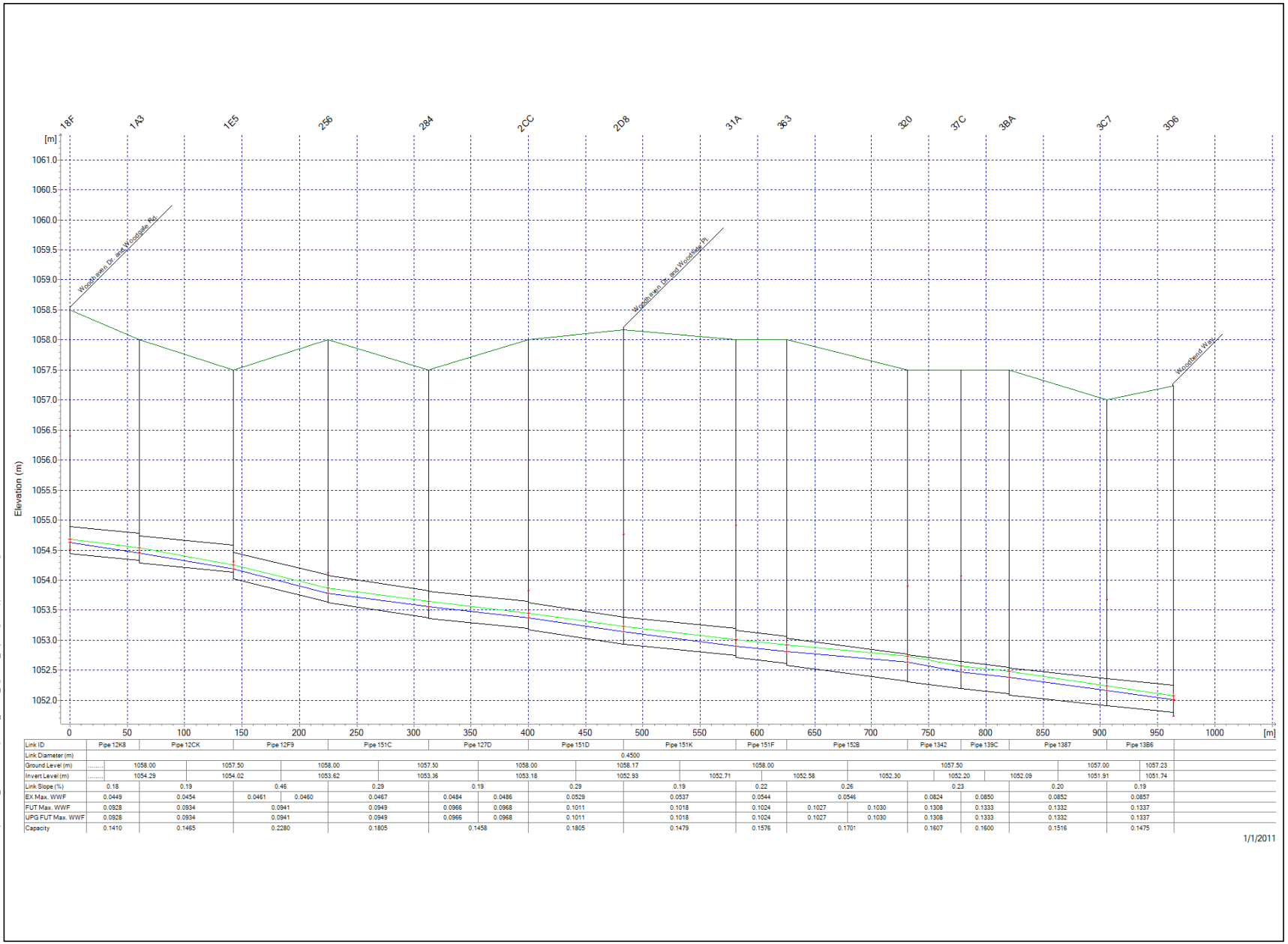

Link ID	Pipe 12K8	Pipe 12CK	Pipe 12F9	Pipe 151C	Pipe 127D	Pipe 151D	Pipe 151K	Pipe 151F	Pipe 152B	Pipe 1342	Pipe 139C	Pipe 1387	Pipe 13B6
Link Diameter (m)	0.4500												
Ground Level (m)	1058.00	1057.50	1058.00	1057.50	1058.00	1058.17	1058.00		1057.50			1057.00	1057.23
Invert Level (m)	1054.29	1054.02	1053.62	1053.36	1053.18	1052.93	1052.71	1052.58	1052.30	1052.20	1052.09	1051.91	1051.74
Link Slope (%)	0.18	0.19	0.46	0.29	0.19	0.29	0.19	0.22	0.26	0.23		0.20	0.19
EX Max. WWF	0.0449	0.0454	0.0461	0.0460	0.0467	0.0484	0.0486	0.0529	0.0537	0.0544	0.0546	0.0824	0.0850	0.0852	0.0857
FUT Max. WWF	0.0928	0.0934	0.0941		0.0949	0.0966	0.0968	0.1011	0.1018	0.1024	0.1027	0.1030	0.1308	0.1333	0.1332	0.1337
UPG FUT Max. WWF	0.0928	0.0934	0.0941		0.0949	0.0966	0.0968	0.1011	0.1018	0.1024	0.1027	0.1030	0.1308	0.1333	0.1332	0.1337
Capacity	0.1410	0.1465	0.2280	0.1805	0.1458	0.1805	0.1479	0.1576	0.1701			0.1607	0.1600	0.1516	0.1475	

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

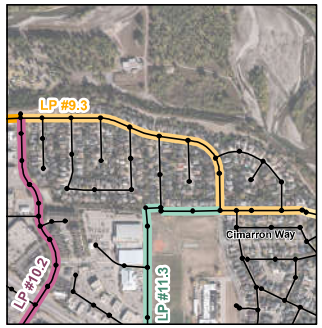

FIGURE A.28
MAXIMUM HGL PROFILE - LP#9.3
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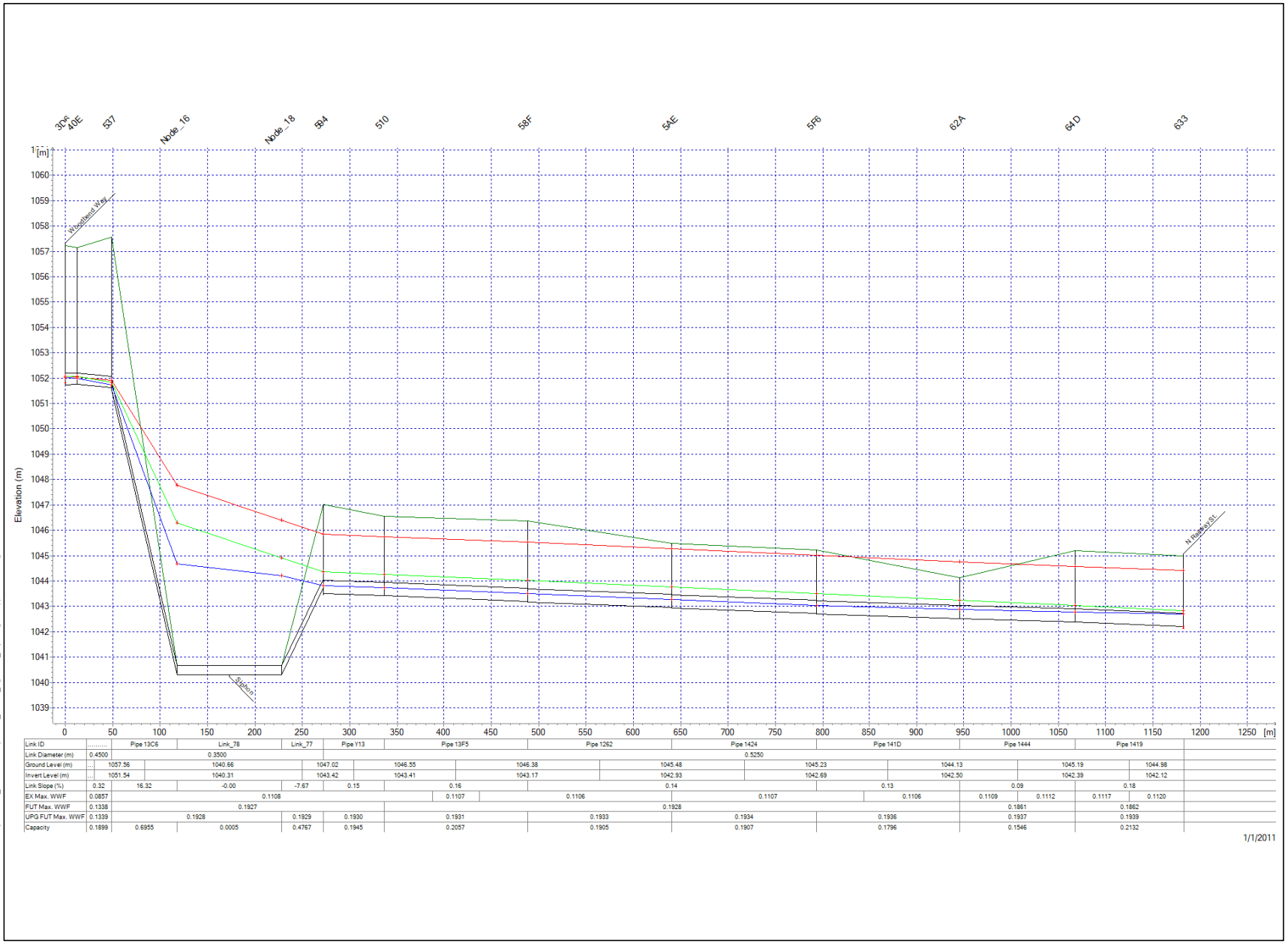

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

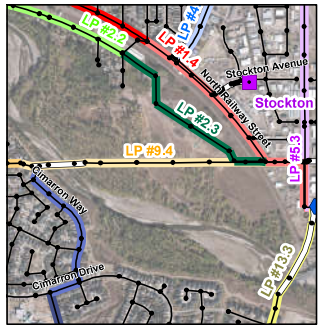

FIGURE A.29
MAXIMUM HGL PROFILE - LP#9.4
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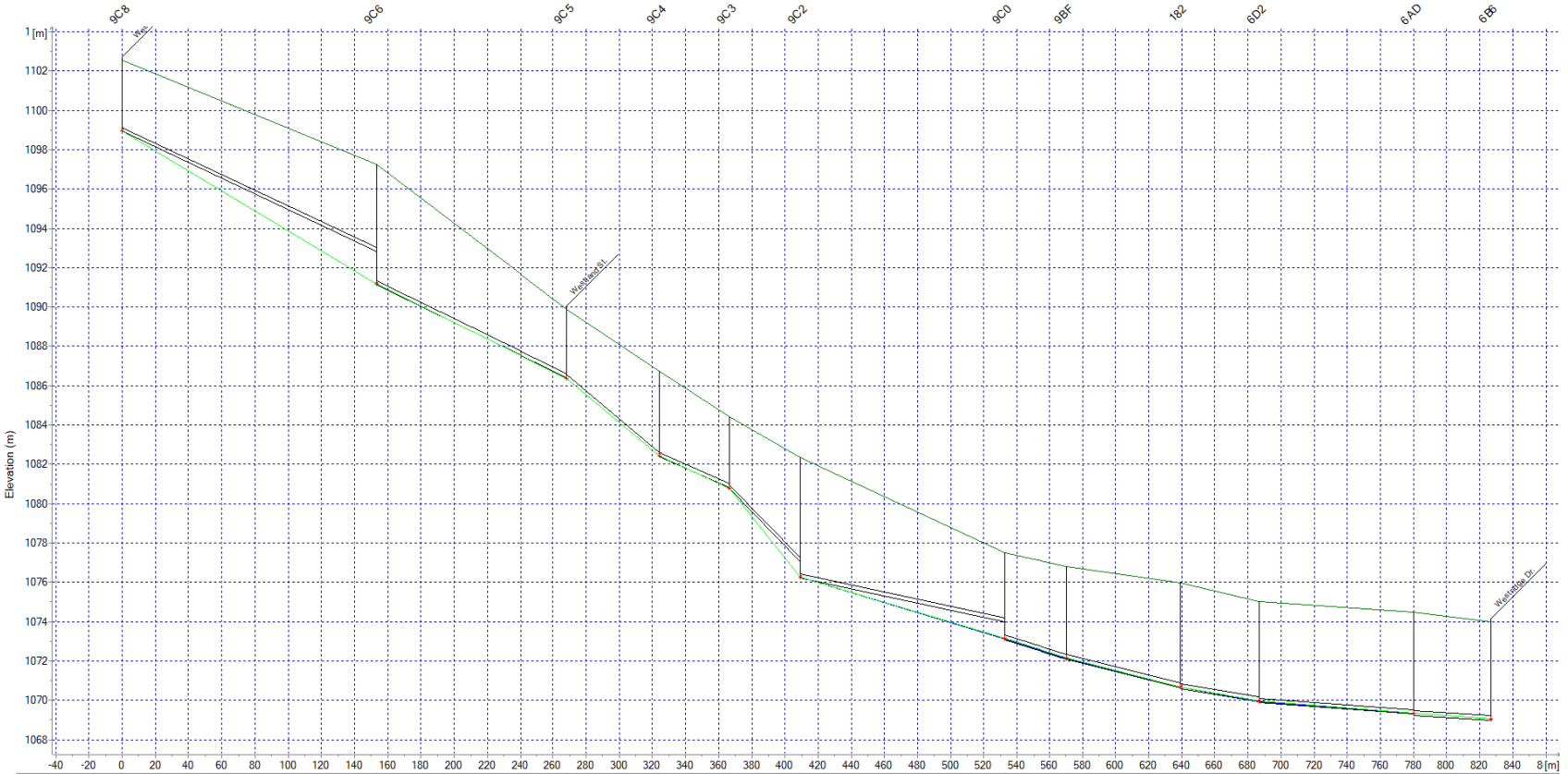

Link ID	Pipe 114	Pipe 112	Pipe 111	Pipe 110	Pipe 109	Pipe 134	Pipe 133	Pipe 128E	Pipe 12DK	Pipe 127F	Pipe 1289
Link Diameter (m)	0.2000						0.2500			0.2000	0.2500
Ground Level (m)	1102.57	1097.26	1089.89	1086.75	1084.41	1082.33	1077.50	1076.81	1075.97	1075.03	1074.50	1073.99
Invert Level (m)	1098.93	1091.14	1086.36	1082.38	1080.76	1076.24	1073.08	1072.08	1070.60	1069.88	1069.24	1068.97
Link Slope (%)	4.00	4.10	7.03	3.70	8.70	1.82	2.62	2.12	1.43	0.60	0.58	
EX Max. WWF	0.0007	0.0014		0.0015	0.0016	0.0020	0.0023	0.0025	0.0039	0.0041	0.0074	
FUT Max. WWF	0.0014	0.0020		0.0022		0.0027	0.0030	0.0032	0.0046	0.0048	0.0080	
UPG FUT Max. WWF	0.0014	0.0020		0.0022		0.0027	0.0030	0.0032	0.0046	0.0048	0.0080	
Capacity	0.0774	0.0784	0.1026	0.0745	0.1141	0.0522	0.1136	0.1022	0.0840	0.0300	0.0534	

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

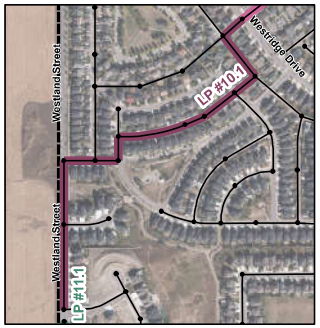

FIGURE A.30
MAXIMUM HGL PROFILE - LP#10.1
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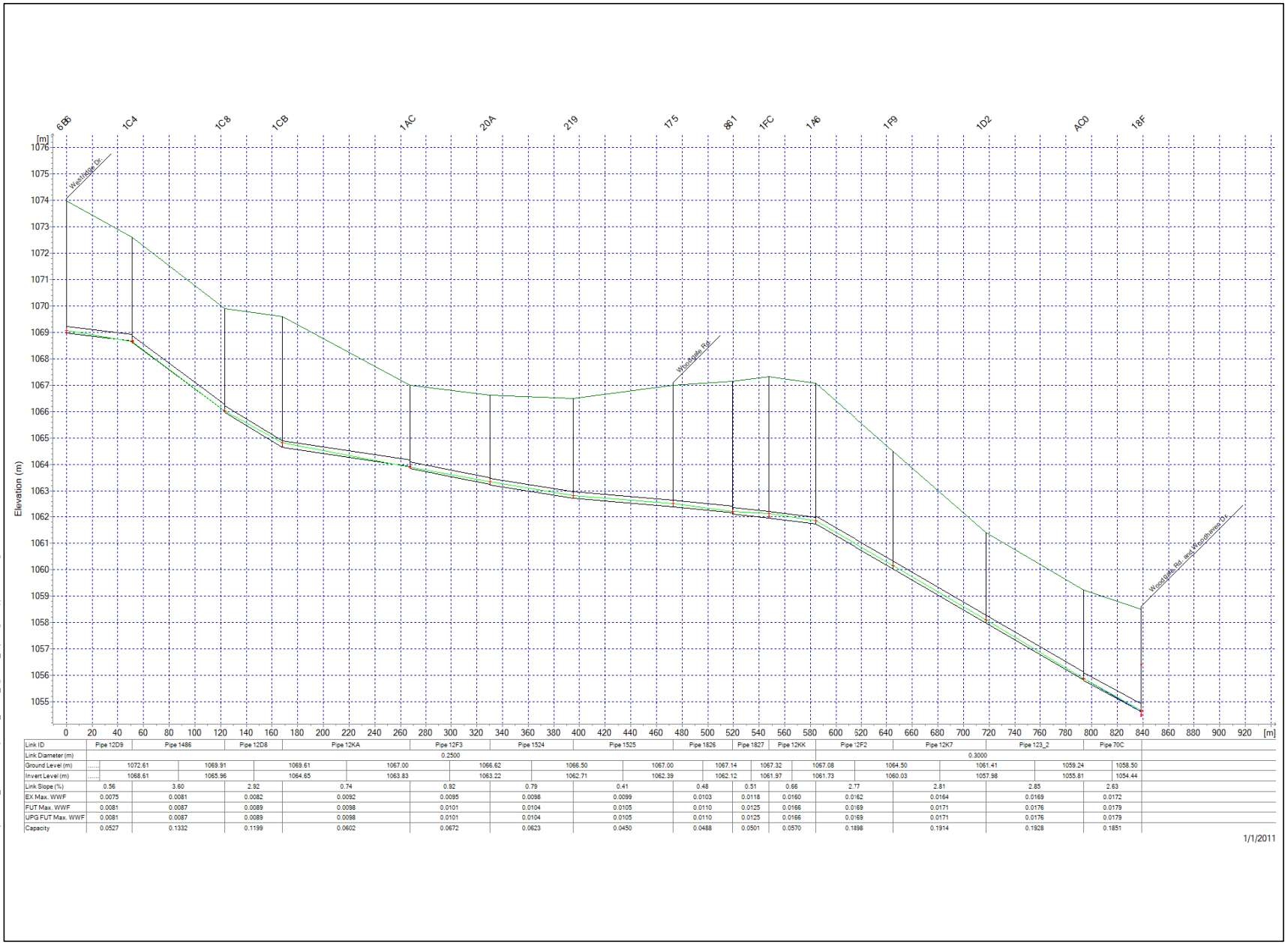

Link ID	Pipe 12D9	Pipe 1486	Pipe 12D8	Pipe 12KA	Pipe 12F3	Pipe 1524	Pipe 1525	Pipe 1826	Pipe 1827	Pipe 12KK	Pipe 12F2	Pipe 12K7	Pipe 123_2	Pipe 70C
Link Diameter (m)					0.2500							0.3000		
Ground Level (m)	1072.61	1069.91	1069.61	1067.00	1066.62	1066.50	1067.00	1067.14	1067.32	1067.08	1064.50	1061.41	1059.24	1058.50
Invert Level (m)	1068.61	1065.96	1064.65	1063.83	1063.22	1062.71	1062.39	1062.12	1061.97	1061.73	1060.03	1057.98	1055.81	1054.44
Link Slope (%)	0.56	3.60	2.92	0.74	0.92	0.79	0.41	0.48	0.51	0.66	2.77	2.81	2.85	2.63
EX Max. WWF	0.0075	0.0081	0.0082	0.0092	0.0095	0.0098	0.0099	0.0103	0.0118	0.0160	0.0162	0.0164	0.0169	0.0172
FUT Max. WWF	0.0081	0.0087	0.0089	0.0098	0.0101	0.0104	0.0105	0.0110	0.0125	0.0166	0.0169	0.0171	0.0176	0.0179
UPG FUT Max. WWF	0.0081	0.0087	0.0089	0.0098	0.0101	0.0104	0.0105	0.0110	0.0125	0.0166	0.0169	0.0171	0.0176	0.0179
Capacity	0.0527	0.1332	0.1199	0.0602	0.0672	0.0623	0.0450	0.0488	0.0501	0.0570	0.1898	0.1914	0.1928	0.1851

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

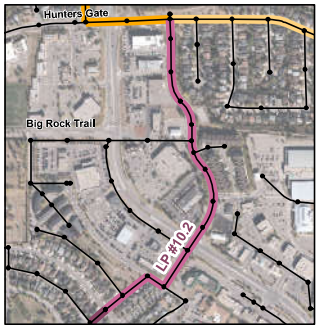

FIGURE A.31
MAXIMUM HGL PROFILE - LP#10.2
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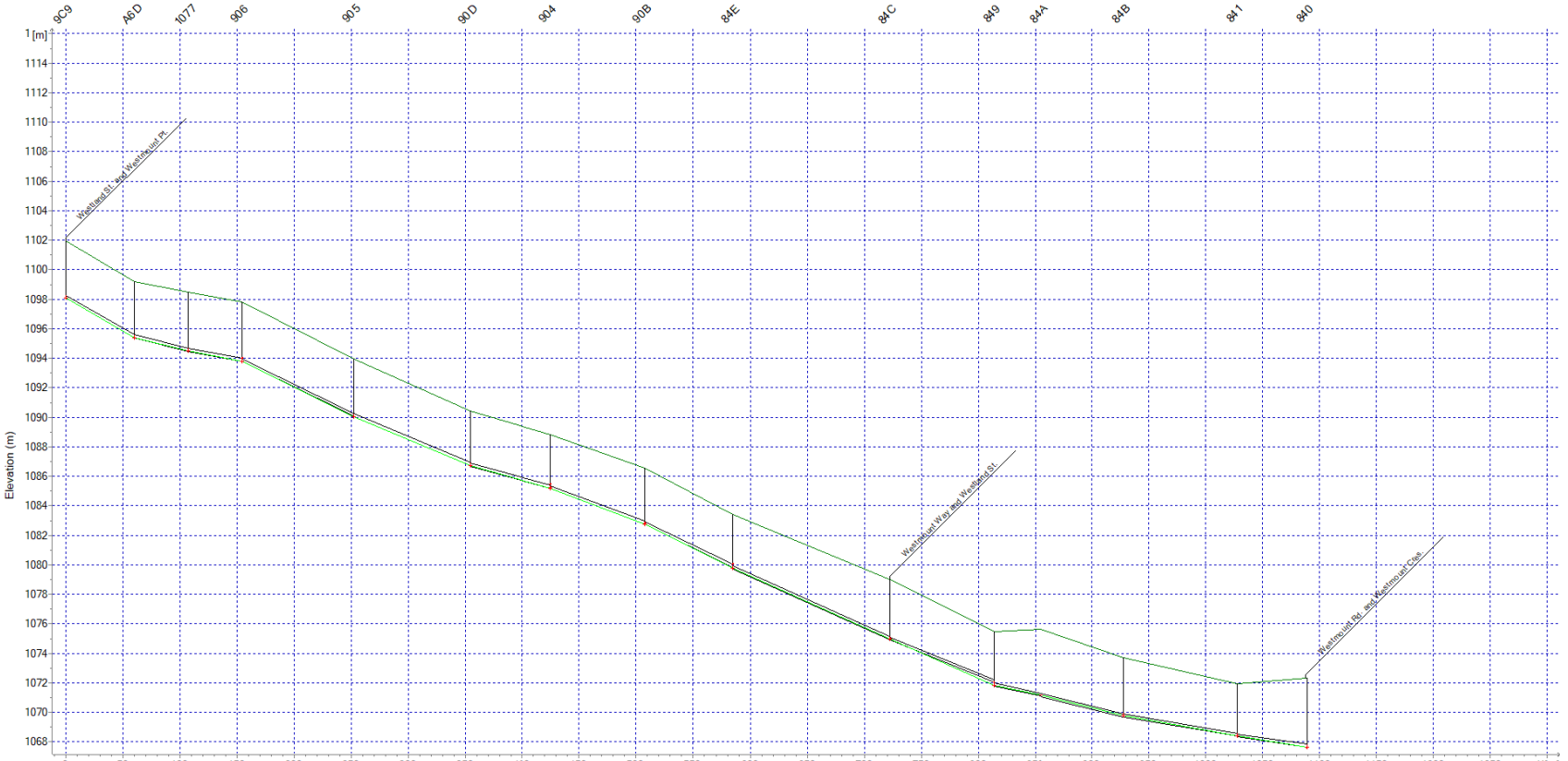

Link ID	Pipe 2104	Pipe 51D	Pipe 1861	Pipe 1860	Pipe 1859	Pipe 1858	Pipe 1855	Pipe 1856	Pipe 1720	Pipe 1718	Pipe 1721	Pipe 1723	Pipe 1725	Pipe 1726
Link Diameter (m)								0.2000						
Ground Level (m)	1099.19	1098.50	1097.83	1093.96	1090.43	1088.83	1086.57	1083.39	1079.02	1075.50	1075.62	1073.71	1071.96	1072.33
Invert Level (m)	1095.40	1094.47	1093.77	1090.04	1086.68	1085.16	1082.73	1079.73	1074.90	1071.80	1071.07	1069.68	1068.34	1067.58
Link Slope (%)	4.46	1.98	1.42	3.80	3.22	2.11	2.90	3.72	3.49	3.16	1.67	1.90	1.29	1.16
EX Max. WWF	0.0000	0.0002	0.0003	0.0004	0.0007	0.0010	0.0020	0.0026	0.0030	0.0046	0.0049	0.0051	0.0058	0.0060
FUT Max. WWF	0.0000	0.0002	0.0003	0.0004	0.0007	0.0010	0.0020	0.0026	0.0030	0.0046	0.0049	0.0051	0.0058	0.0060
UPG FUT Max. WWF	0.0000	0.0002	0.0003	0.0004	0.0007	0.0010	0.0020	0.0026	0.0030	0.0046	0.0049	0.0051	0.0058	0.0060
Capacity	0.0818	0.0544	0.0461	0.0755	0.0694	0.0562	0.0659	0.0746	0.0723	0.0688	0.0501	0.0534	0.0440	0.0416

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

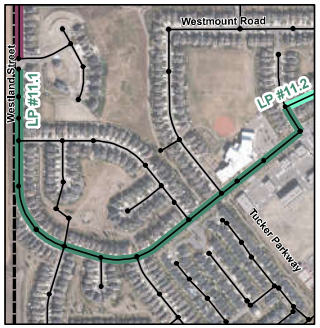

FIGURE A.32
MAXIMUM HGL PROFILE - LP#11.1
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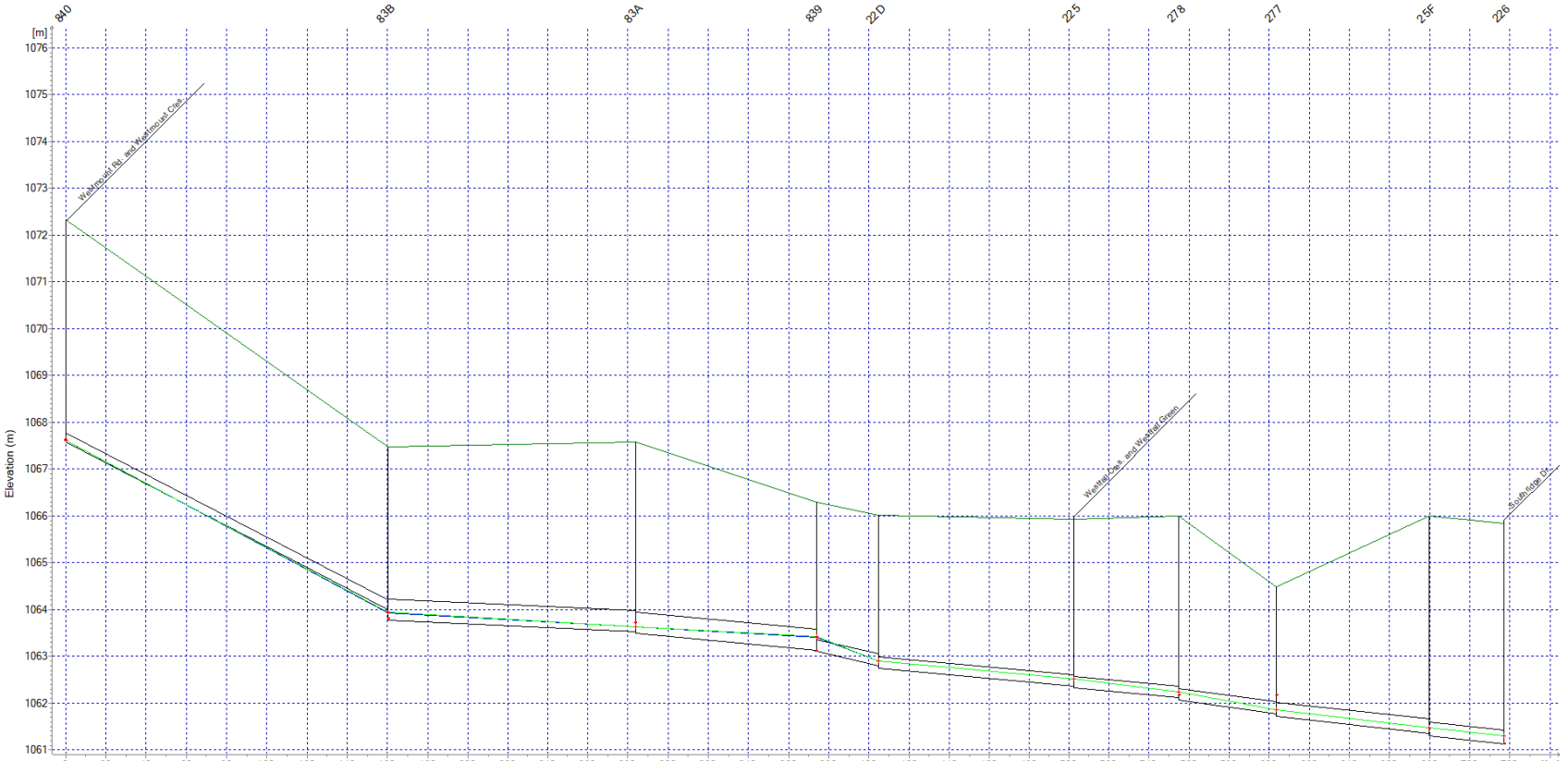

Link ID	Pipe 1728		Pipe 1729		Pipe 1710		Pipe 1705	Pipe 1326		Pipe 1325	Pipe 1324	Pipe 1549		Pipe 1312
Link Diameter (m)	0.2000		0.4500				0.2500					0.3000		
Ground Level (m)	1072.33	1067.47	1067.58		1066.30	1066.01	1065.92	1066.00		1064.48	1066.00	1065.84		
Invert Level (m)	1067.58	1063.77	1063.50		1063.10	1062.74	1062.32	1062.06		1061.72	1061.30	1061.12		
Link Slope (%)	2.23		0.20		0.41	0.96	0.40			0.59	0.47	0.48		
EX Max. WWF	0.0068		0.0312	0.0305	0.0313	0.0285	0.0286	0.0287	0.0282		0.0298	0.0313	0.0310	0.0307
FUT Max. WWF	0.0068		0.0312	0.0303	0.0312	0.0283	0.0297	0.0292	0.0282	0.0283	0.0299	0.0317		
UPG FUT Max. WWF	0.0068		0.0312	0.0303	0.0312	0.0283	0.0297	0.0292	0.0282	0.0283	0.0299	0.0317		
Capacity	0.0578		0.1505		0.2152		0.0689	0.0444			0.0538	0.0783		0.0791

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

FIGURE A.33
MAXIMUM HGL PROFILE - LP#11.2
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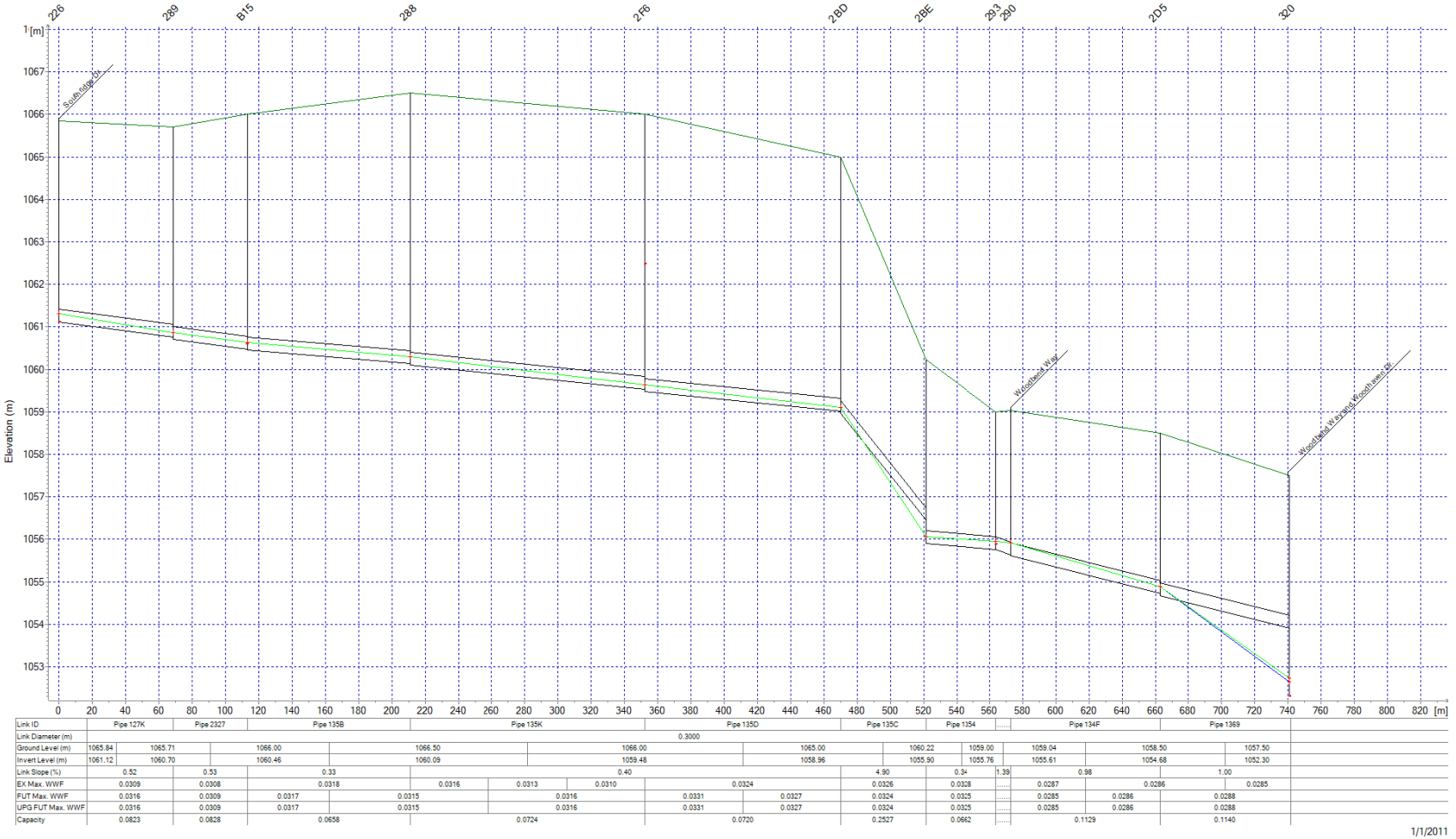

Link ID	Pipe 127K	Pipe 2327	Pipe 135B	Pipe 135K	Pipe 135D	Pipe 135C	Pipe 1354	Pipe 134F	Pipe 1369
Link Diameter (m)				0.3000					
Ground Level (m)	1065.84	1065.71	1066.00	1066.50	1066.00	1065.00	1060.22	1059.00	1059.04	1058.50	1057.50
Invert Level (m)	1061.12	1060.70	1060.46	1060.09	1059.48	1058.96	1055.90	1055.76	1055.61	1054.68	1052.30
Link Slope (%)	0.52	0.53	0.33	0.40		4.90	0.34	1.39	0.98	1.00	
EX Max. WWF	0.0309	0.0308	0.0318	0.0316	0.0313	0.0310	0.0324	0.0326	0.0328	0.0287	0.0286	0.0285
FUT Max. WWF	0.0316	0.0309	0.0317	0.0315	0.0316	0.0331	0.0327	0.0324	0.0325	0.0285	0.0286	0.0288
UPG FUT Max. WWF	0.0316	0.0309	0.0317	0.0315	0.0316	0.0331	0.0327	0.0324	0.0325	0.0285	0.0286	0.0288
Capacity	0.0823	0.0828	0.0658	0.0724	0.0720	0.2527	0.0662	0.1129	0.1140

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

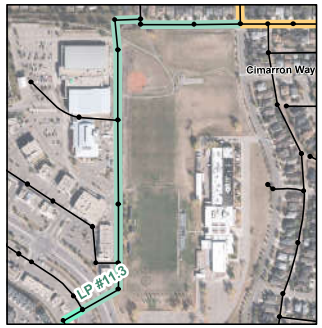

FIGURE A.34
MAXIMUM HGL PROFILE - LP#11.3
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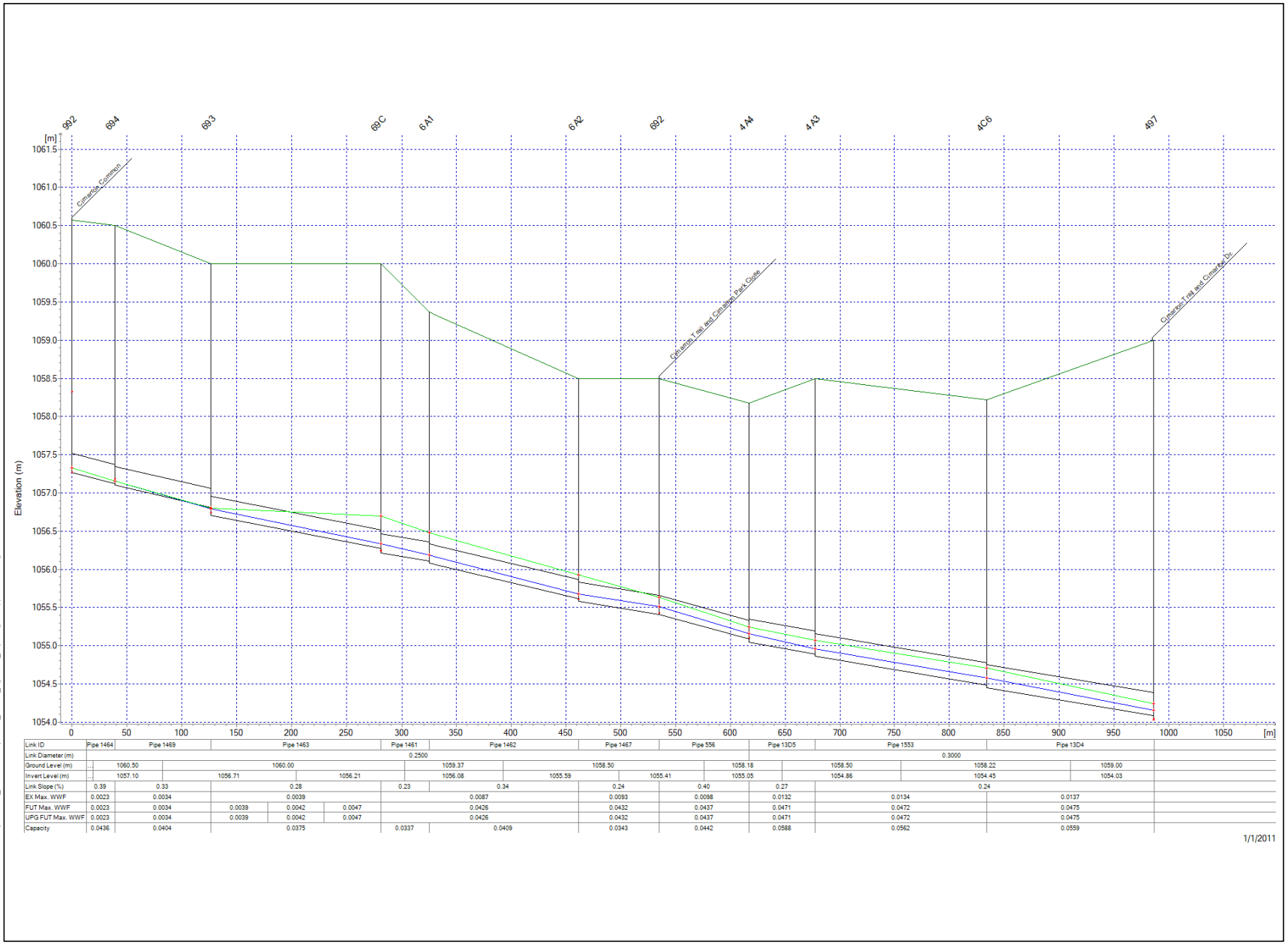

Link ID	Pipe 1464	Pipe 1469	Pipe 1463	Pipe 1461	Pipe 1462	Pipe 1467	Pipe 556	Pipe 13D5	Pipe 1553	Pipe 13D4
Link Diameter (m)				0.2500					0.3000	
Ground Level (m)	1060.50		1060.00		1059.37	1058.50	1058.18	1058.50	1058.22	1059.00
Invert Level (m)	1057.10	1056.71	1056.21		1056.08	1055.59	1055.41	1055.05	1054.86	1054.45	1054.03
Link Slope (%)	0.39	0.33	0.28	0.23	0.34	0.24	0.40	0.27	0.24	
EX Max. WWF	0.0023	0.0034	0.0039		0.0087	0.0093	0.0098	0.0132	0.0134	0.0137
FUT Max. WWF	0.0023	0.0034	0.0039	0.0042	0.0047	0.0426	0.0432	0.0437	0.0471	0.0472	0.0475
UPG FUT Max. WWF	0.0023	0.0034	0.0039	0.0042	0.0047	0.0426	0.0432	0.0437	0.0471	0.0472	0.0475
Capacity	0.0436	0.0404	0.0375	0.0337	0.0409	0.0343	0.0442	0.0588	0.0562	0.0559

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

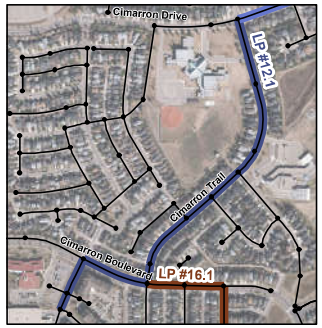

FIGURE A.35
MAXIMUM HGL PROFILE - LP#12.1
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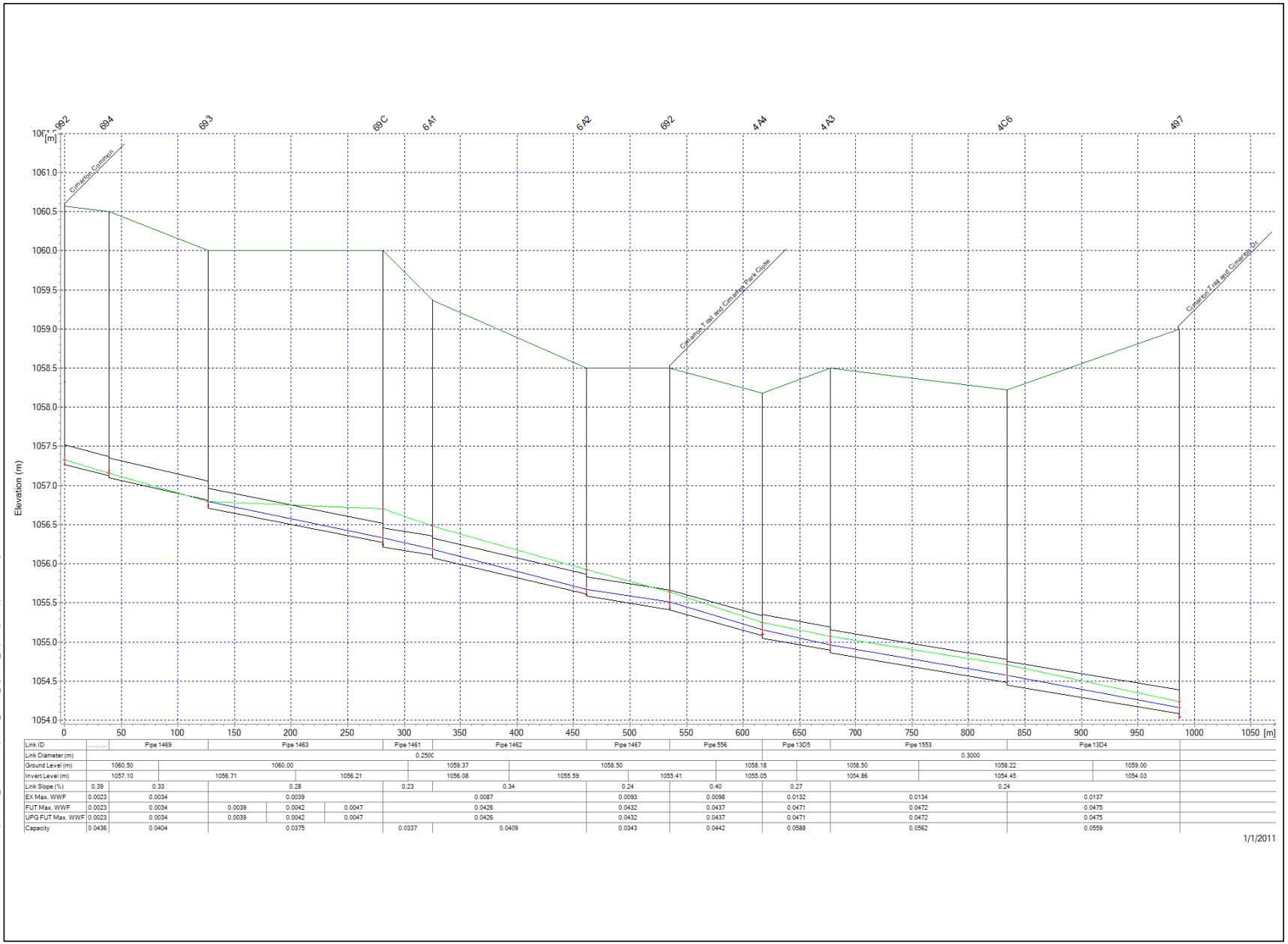

Link ID		Pipe 1469		Pipe 1463			Pipe 1461	Pipe 1462		Pipe 1467	Pipe 556	Pipe 13D5	Pipe 1553		Pipe 13D4	
Link Diameter (m)							0.2500						0.3000			
Ground Level (m)	1060.50		1060.00					1059.37		1058.50		1058.18	1058.50		1058.22	1059.00
Invert Level (m)		1057.10		1056.71		1056.21		1056.08	1055.59		1055.41	1055.05	1054.86		1054.45	1054.03
Link Slope (%)	0.39	0.33		0.28			0.23	0.34		0.24	0.40	0.27	0.24			
EX Max. WWF	0.0023	0.0034		0.0039			0.0087			0.0093	0.0098	0.0132	0.0134		0.0137	
FUT Max. WWF	0.0023	0.0034	0.0039	0.0042	0.0047		0.0426			0.0432	0.0437	0.0471	0.0472		0.0475	
UPG FUT Max. WWF	0.0023	0.0034	0.0039	0.0042	0.0047		0.0426			0.0432	0.0437	0.0471	0.0472		0.0475	
Capacity	0.0436	0.0404		0.0375			0.0337	0.0409		0.0343	0.0442	0.0588	0.0562		0.0559	

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

FIGURE A.36
MAXIMUM HGL PROFILE - LP#12.2
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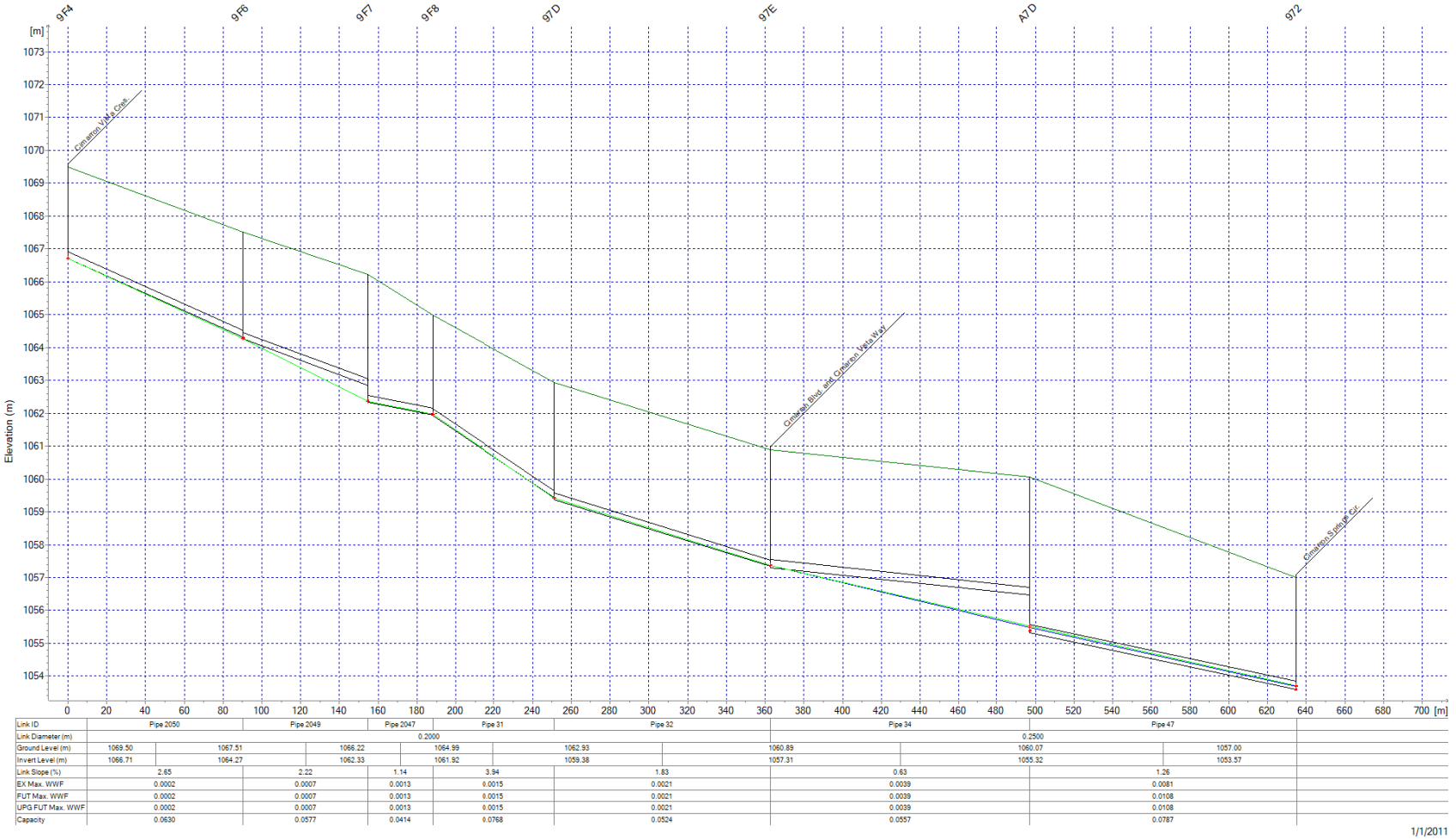

Link ID	Pipe 2050		Pipe 2049	Pipe 2047	Pipe 31	Pipe 32		Pipe 34		Pipe 47	
Link Diameter (m)	0.2000							0.2500			
Ground Level (m)	1069.50	1067.51	1066.22	1064.99	1062.93		1060.89	1060.07	1057.00		
Invert Level (m)	1066.71	1064.27	1062.33	1061.92	1059.38		1057.31	1055.32	1053.57		
Link Slope (%)	2.65	2.22	1.14	3.94	1.83		0.63	1.26			
EX Max. WWF	0.0002	0.0007	0.0013	0.0015	0.0021		0.0039	0.0081			
FUT Max. WWF	0.0002	0.0007	0.0013	0.0015	0.0021		0.0039	0.0108			
UPG FUT Max. WWF	0.0002	0.0007	0.0013	0.0015	0.0021		0.0039	0.0108			
Capacity	0.0630	0.0577	0.0414	0.0768	0.0524		0.0557	0.0787			

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

FIGURE A.37
MAXIMUM HGL PROFILE - LP#13.1
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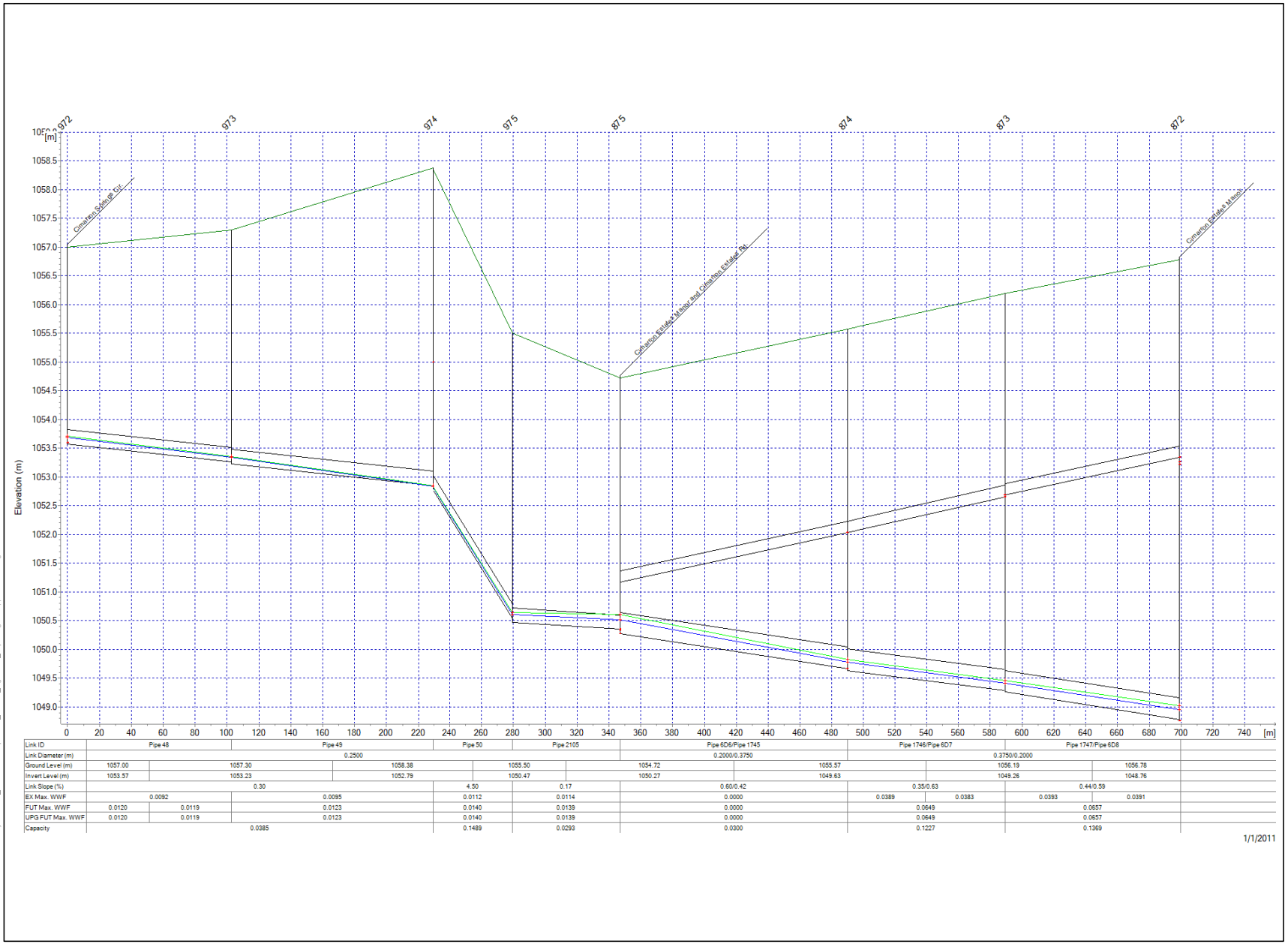

Link ID	Pipe 48		Pipe 49		Pipe 50	Pipe 2105	Pipe 6D6/Pipe 1745		Pipe 1746/Pipe 6D7		Pipe 1747/Pipe 6D8	
Link Diameter (m)	0.2500						0.2000/0.3750		0.3750/0.2000			
Ground Level (m)	1057.00	1057.30	1058.38		1055.50		1054.72	1055.57	1056.19		1056.78	
Invert Level (m)	1053.57	1053.23	1052.79		1050.47		1050.27	1049.63	1049.26		1048.76	
Link Slope (%)	0.30				4.50	0.17	0.60/0.42		0.35/0.63		0.44/0.59	
EX Max. WWF	0.0092		0.0095		0.0112	0.0114	0.0000		0.0389	0.0383	0.0393	0.0391
FUT Max. WWF	0.0120	0.0119	0.0123		0.0140	0.0139	0.0000		0.0649		0.0657	
UPG FUT Max. WWF	0.0120	0.0119	0.0123		0.0140	0.0139	0.0000		0.0649		0.0657	
Capacity	0.0385				0.1489	0.0293	0.0300		0.1227		0.1369	

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

FIGURE A.38
MAXIMUM HGL PROFILE - LP#13.2
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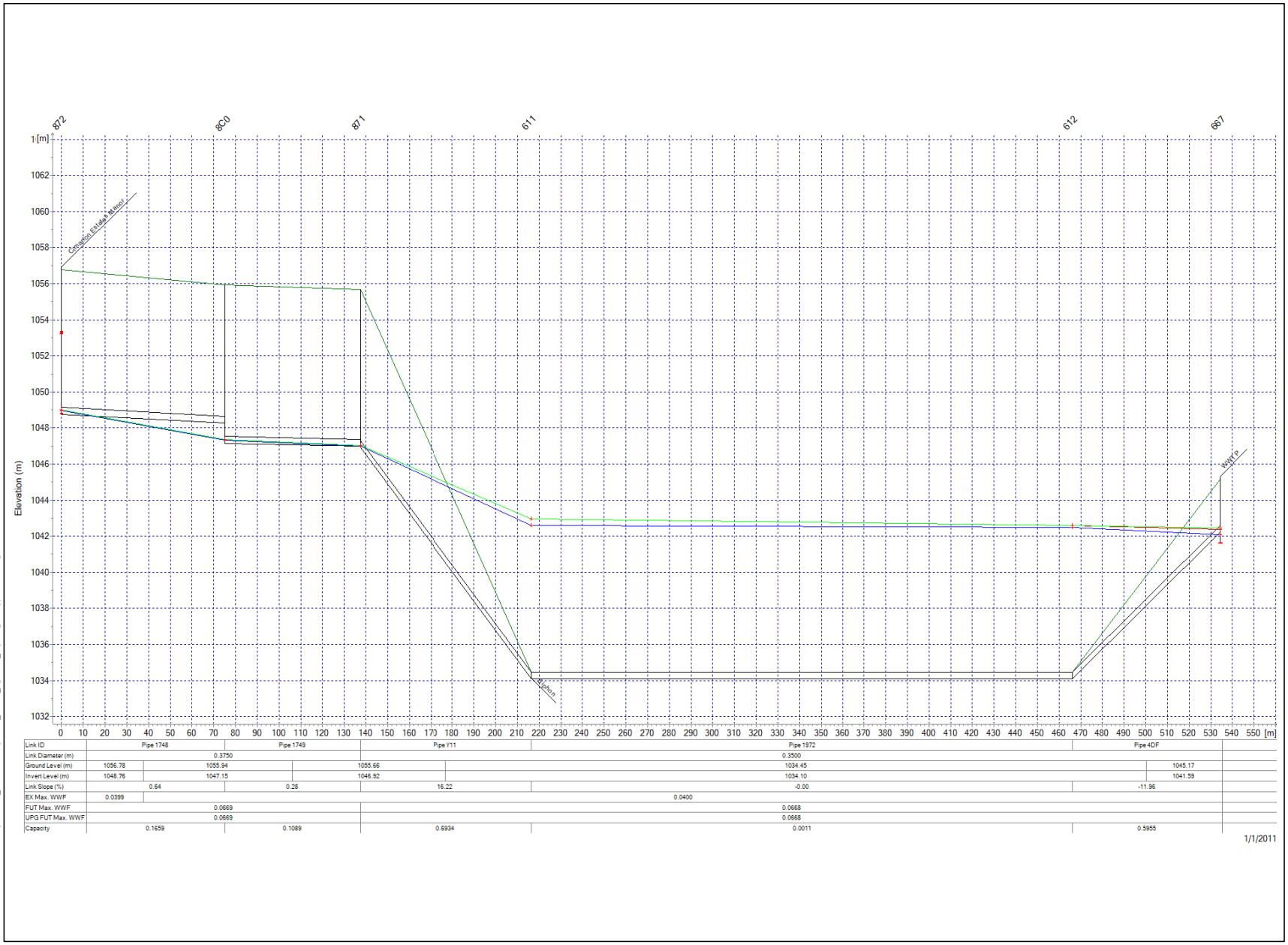

Link ID	Pipe 1748	Pipe 1749	Pipe Y11	Pipe 1972	Pipe 4DF	
Link Diameter (m)	0.3750			0.3500		
Ground Level (m)	1056.78	1055.94	1055.66	1034.45	1045.17	
Invert Level (m)	1048.76	1047.15	1046.92	1034.10	1041.59	
Link Slope (%)	0.64	0.28	16.22	-0.00	-11.96	
EX.Max. WWF	0.0399	0.0400				
FUT.Max. WWF	0.0669			0.0668		
UPG.FUT.Max. WWF	0.0669			0.0668		
Capacity	0.1659	0.1089	0.6934	0.0011	0.5955	

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

FIGURE A.39
MAXIMUM HGL PROFILE - LP#13.3
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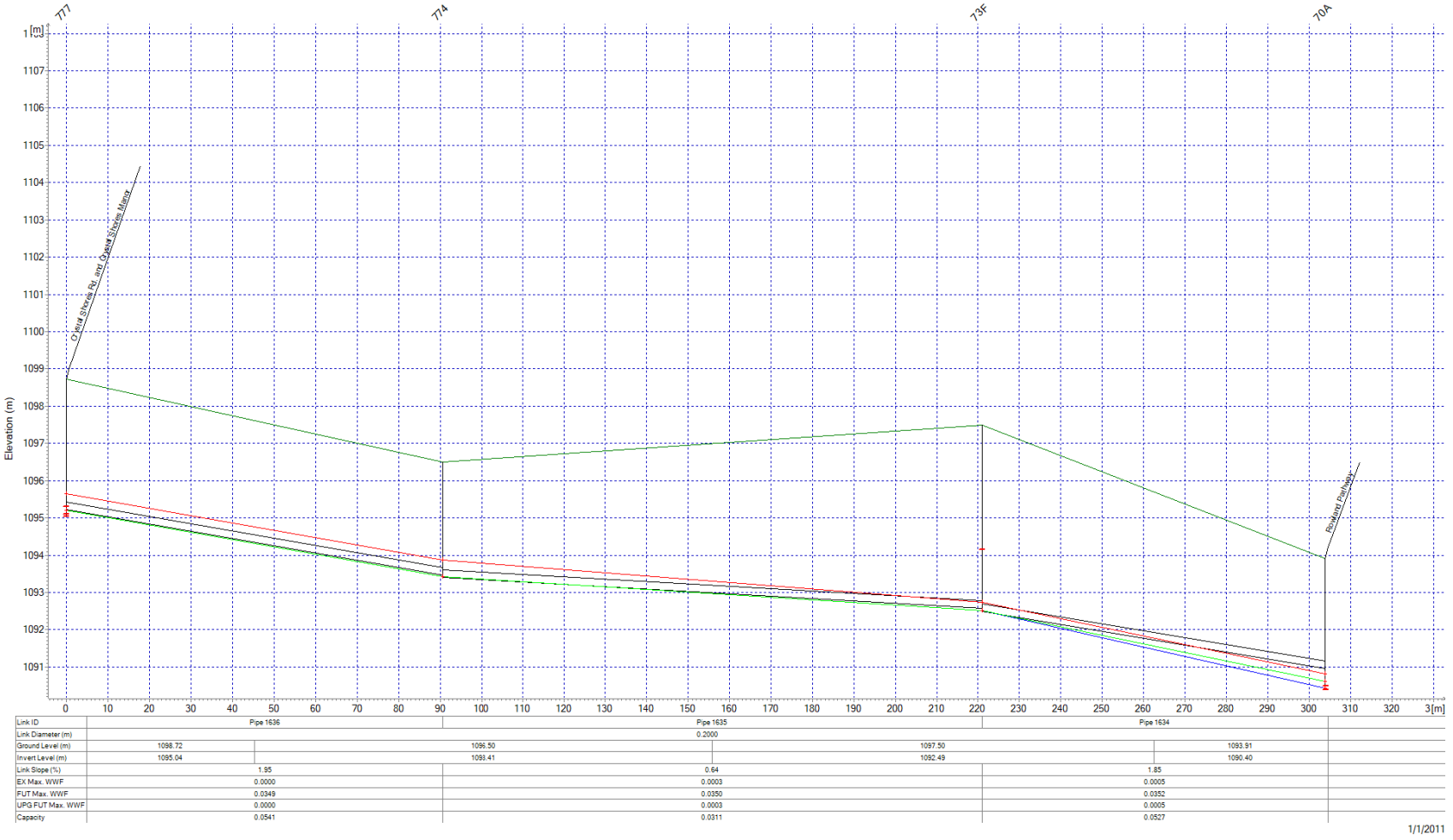

Link ID	Pipe 1636		Pipe 1635		Pipe 1634	
Link Diameter (m)	0.2000					
Ground Level (m)	1098.72	1096.50	1097.50	1093.91		
Invert Level (m)	1095.04	1093.41	1092.49	1090.40		
Link Slope (%)	1.95	0.64	1.85			
EX Max. WWF	0.0000	0.0003	0.0005			
FUT Max. WWF	0.0349	0.0350	0.0352			
UPG FUT Max. WWF	0.0000	0.0003	0.0005			
Capacity	0.0541	0.0311	0.0527			

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

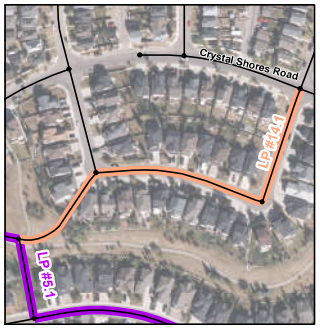

FIGURE A.40
MAXIMUM HGL PROFILE - LP#14.1
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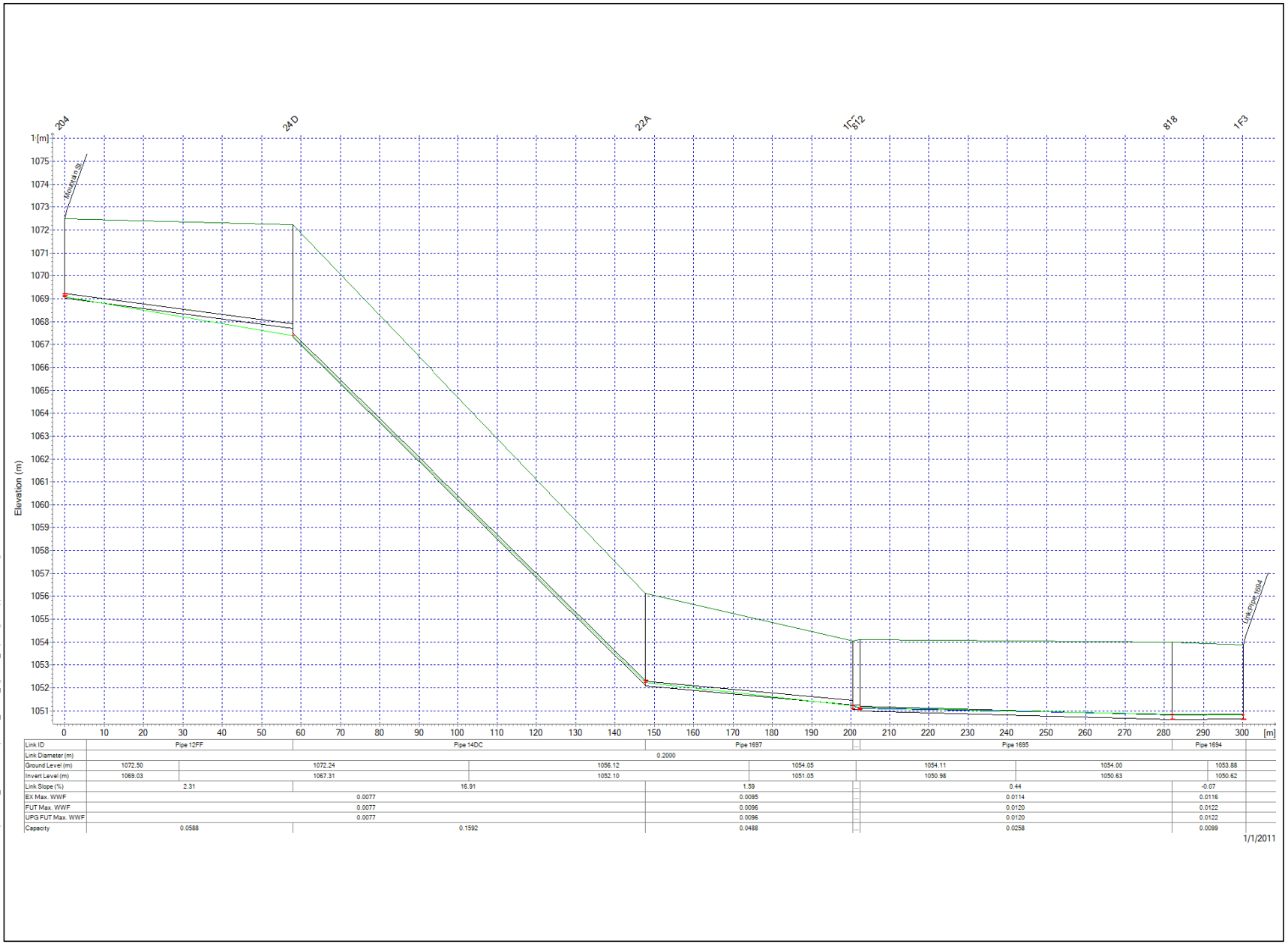

Link ID	Pipe 12FF		Pipe 14DC		Pipe 1697		Pipe 1695		Pipe 1694
Link Diameter (m)	0.2000								
Ground Level (m)	1072.50	1072.24	1056.12		1054.05	1054.11	1054.00	1053.88	
Invert Level (m)	1069.03	1067.31	1052.10		1051.05	1050.98	1050.63	1050.62	
Link Slope (%)	2.31	16.91		1.59		0.44		-0.07	
EX Max. WWF	0.0077		0.0095		0.0114		0.0116		
FUT Max. WWF	0.0077		0.0096		0.0120		0.0122		
UPG FUT Max. WWF	0.0077		0.0096		0.0120		0.0122		
Capacity	0.0588	0.1592		0.0488		0.0258		0.0099	

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

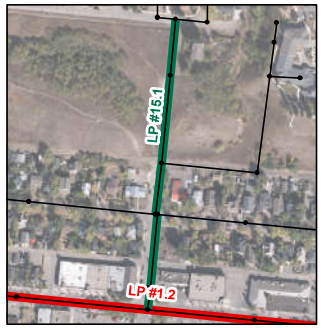

FIGURE A.41
MAXIMUM HGL PROFILE - LP#15.1
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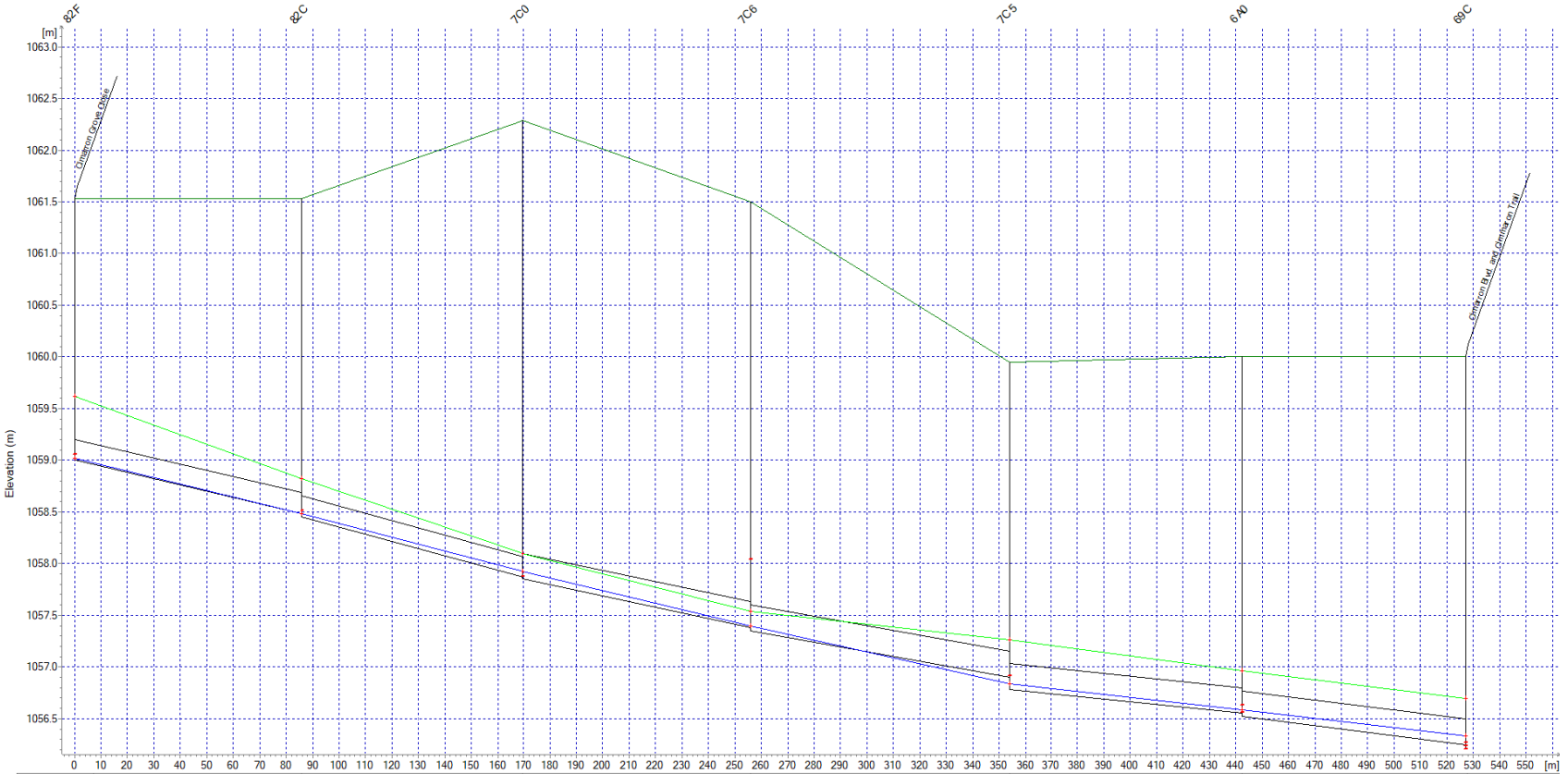

Link ID	Pipe 1793	Pipe 1796	Pipe 1780	Pipe 1779	Pipe 1777	Pipe 155C
Link Diameter (m)	0.2000			0.2500		
Ground Level (m)	1061.53	1062.29	1061.50	1059.95	1060.00	
Invert Level (m)	1059.00 / 1058.45	1057.85	1057.35	1056.79	1056.52 / 1056.21	
Link Slope (%)	0.60	0.70	0.54	0.46	0.27	0.32
EX Max. WWF	0.0007	0.0012	0.0031	0.0034	0.0038	0.0045
FUT Max. WWF	0.0352	0.0357	0.0375	0.0378 / 0.0375	0.0379	0.0385 / 0.0384
UPG FUT Max. WWF	0.0352	0.0357	0.0375	0.0378 / 0.0375	0.0379	0.0385 / 0.0384
Capacity	0.0300	0.0324	0.0518	0.0476	0.0363	0.0399

1/1/2011

Legend

Scenario (50yr 24hr Q4 Huff)

- Existing Peak WWF
- Future Peak WWF
- Upgraded Future Peak WWF

FIGURE A.42
MAXIMUM HGL PROFILE - LP#16.1
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APPENDIX B
Sanitary Servicing System Sizing

Tie-In	Pipe ID	Serviced Lands	Population	Residential Area	Commercial Area	Industrial Area	Non-Residential Area	Total Area	DWF Rate		Average DWF (L/s)		Peaking Factors	
									Residential	Non-Residential				
			(Persons)	(ha)	(ha)	(ha)	(ha)	(ha)	(L/p/d)	(L/ha/d)	Residential	Non-Residential	Residential	Non-Residential
#1	NW_1	N-2	1,344	24.4	0.0	0.0	0.0	24.4	255	8,525	3.97	0.00	3.71	0.00
	NW_2	N-2.4, N-2.7, N-2.9	0	0.0	0.0	14.4	14.4	14.4	255	8,525	0.00	1.42	4.50	5.00
	NW_3	N-2.4, N-2.7, N-2.9, N-2.2, N-2.5, N-2.6, N-2.8, N2.10	0	0.0	15.0	14.4	29.4	29.4	255	8,525	0.00	2.90	4.50	5.00
#5	NW_4	N-5.5, N-5.4, N-5.3, N-5.2	1,132	20.6	6.7	0.0	6.7	27.3	255	8,525	3.34	0.66	3.76	5.00
#7	NW_8	N-5, N-5.6	1,610	29.3	1.6	0.0	1.6	30.9	255	8,525	4.75	0.16	3.66	5.00
#8	NW_5	N-8, N-8.2	3,170	57.6	4.9	0.0	4.9	62.5	255	8,525	9.36	0.48	3.42	5.00
	NW_6	N-8, N-8.2, N-6, N-6.2, N-6.3	5,544	100.8	14.8	0.0	14.8	115.6	255	8,525	16.36	1.46	3.20	5.00
	NE_1	N-12, N-12.2	3,033	55.1	4.7	0.0	4.7	59.8	255	8,525	8.95	0.46	3.44	5.00
	NE_2	N-12, N-12.2	3,033	55.1	4.7	0.0	4.7	59.8	255	8,525	8.95	0.46	3.44	5.00
	NE_3	N-10, N-10.2	3,251	59.1	5.0	0.0	5.0	64.1	255	8,525	9.59	0.49	3.41	5.00
	NE_4	N-9, N-9.2, N-9.3	2,825	51.4	6.5	0.0	6.5	57.9	255	8,525	8.34	0.64	3.46	5.00
	NE_5	N-12, N-12.2, N-10, N-10.2, N-9, N-9.2, N-9.3, N-11A	10,707	194.7	16.2	0.0	16.2	210.9	255	8,525	31.60	1.60	2.93	5.00
	NW_7	N-8, N-8.2, N-6, N-6.2, N-6.3, N-12, N-12.2, N-10, N-10.2, N-9, N-9.2, N-9.3, N-11A, N-7A, N-7A.2, N-7A.3, N-7A, N-7A.2	17,572	319.5	39.3	0	39.3	358.8	255	8,525	51.86	3.88	2.71	5.00
#13	NE_6	N-11B, N-11B.2	1,446	26.3	6.1	0.0	6.1	32.4	255	8,525	4.27	0.60	3.69	5.00
	NE_7	N-11B, N-11B.2	1,446	26.3	6.1	0.0	6.1	32.4	255	8,525	4.27	0.60	3.69	5.00
	NE_9	N-11B, N-11B.2, N-7B.2, N-7B, N-17, N-17.2, N-17.3	4,173	75.9	15.6	0.0	15.6	91.5	255	8,525	12.32	1.54	3.32	5.00
	NE_10	N-20, N-20.2	0	0.0	0.0	48.1	48.1	48.1	255	8,525	0.00	4.74	4.50	5.00
	NE_11	N-18, N-20, N-20.2	0	0.0	0.0	105.0	105.0	105.0	255	8,525	0.00	10.36	4.50	4.50
	NE_12	N-19, N-19.2	0	0.0	13.1	20.1	33.2	33.2	255	8,525	0.00	3.27	4.50	5.00
	NE_13-FM	N-19, N-19.2, N-16, N-16.2	0	0.0	13.1	77.8	90.9	90.9	255	8,525	0.00	8.97	4.50	4.61
	NE_14	N-15	0	0.0	0.0	62.5	62.5	62.5	255	8,525	0.00	6.17	4.50	4.91
	NE_15	N-18, N-20, N-20.2, N-19, N-19.2, N-16, N-16.2, N-15	0	0.0	13.1	245.3	258.3	258.3	255	8,525	0.00	25.49	4.50	3.86
	NE_16	N-18, N-20, N-20.2, N-19, N-19.2, N-16, N-16.2, N-15, N-11B, N-11B.2, N-7B.2, N-7B, N-17, N-17.2, N-17.3, N-14A	5,595	101.7	28.7	245.3	273.9	375.7	255	8,525	16.51	27.03	3.20	3.83
	NE_17	N-14B, N-13.2	1,303	23.7	4.5	0.0	4.5	28.2	255	8,525	3.85	0.44	3.72	5.00
	NE_18	N-14B, N-13.2	1,303	23.7	4.5	0.0	4.5	28.2	255	8,525	3.85	0.44	3.72	5.00
	NE_19 - FM	N-14B, N-13.2, N-13	4,730	86.0	4.5	0.0	4.5	90.5	255	8,525	13.96	0.44	3.27	5.00
	NE_20	N-18, N-20, N-20.2, N-19, N-19.2, N-16, N-16.2, N-15, N-11B, N-11B.2, N-7B.2, N-7B, N-17, N-17.2, N-17.3, N-14A, N-14B, N-13.2, N-13	10,325	187.7	33.1	245.3	278.4	466.1	255	8,525	30.47	27.47	2.94	3.82
#24	SW_1	S-6	1,491	27.1	0.0	0.0	0.0	27.1	255	8,525	4.40	0.00	3.68	0.00
#23	SW_2-FM	S-2A, S-2A.2	1,067	19.4	17.8	0.0	17.8	37.1	255	8,525	3.15	1.75	3.78	5.00
	SW_3	S-2A, S-2A.2	1,067	19.4	17.8	0.0	17.8	37.1	255	8,525	3.15	1.75	3.78	5.00
#22	SW_4	S-2B.2, S-2B	2,299	41.8	4.6	0.0	4.6	46.4	255	8,525	6.79	0.46	3.54	5.00
#14	SW_5	S-14	3,425	62.3	0.0	0.0	0.0	62.3	255	8,525	10.11	0.00	3.39	0.00
	SW_6-SP	S-14, S-13, S-13.2, S-13.3	6,488	118.0	5.7	0.0	5.7	123.7	255	8,525	19.15	0.56	3.14	5.00
	SW_7	S-14, S-13, S-13.2, S-13.3, S-12, S-12.3	7,348	133.6	10.7	0.0	10.7	144.3	255	8,525	21.69	1.06	3.09	5.00
	SW_8	S-14, S-13, S-13.2, S-13.3, S-12, S-12.3, S-12.2, S-11	13,544	246.3	10.7	0.0	10.7	257.0	255	8,525	39.97	1.06	2.82	5.00
	SW_9	S-14, S-13, S-13.2, S-13.3, S-12, S-12.3, S-12.2, S-11	13,544	246.3	10.7	0.0	10.7	257.0	255	8,525	39.97	1.06	2.82	5.00
	SW_10	S-14, S-13, S-13.2, S-13.3, S-12, S-12.3, S-12.2, S-11	13,544	246.3	10.7	0.0	10.7	257.0	255	8,525	39.97	1.06	2.82	5.00
	SE_1	S-14, S-13, S-13.2, S-13.3, S-12, S-12.3, S-12.2, S-11	13,544	246.3	10.7	0.0	10.7	257.0	255	8,525	39.97	1.06	2.82	5.00
	SE_2	S-14, S-13, S-13.2, S-13.3, S-12, S-12.3, S-12.2, S-11	13,544	246.3	10.7	0.0	10.7	257.0	255	8,525	39.97	1.06	2.82	5.00
	SE_3	S-8, S-8.2	771	14.0	37.9	0.0	37.9	51.9	255	8,525	2.27	3.74	3.87	5.00
	SE_4-FM	S-9	0	0.0	0.0	47.2	47.2	47.2	255	8,525	0.00	4.66	4.50	5.00
	SE_6	S-14, S-13, S-13.2, S-13.3, S-12, S-12.3, S-12.2, S-11, S-8, S-8.2, S-9	14,315	260.3	48.6	47.2	95.8	356.1	255	8,525	42.25	9.46	2.80	4.57
	SE_7-SP	S-14, S-13, S-13.2, S-13.3, S-12, S-12.3, S-12.2, S-11, S-8, S-8.2, S-9	14,315	260.3	48.6	47.2	95.8	356.1	255	8,525	42.25	9.46	2.80	4.57
16	SE_5	S-7	0	0.0	0.0	56.1	56.1	56.1	255	8,525	0.00	5.54	4.50	5.00
18D	SW_11	S-4	0	0.0	16.7	0.0	16.7	16.7	255	8,525	0.00	1.65	4.50	5.00
	SW_12	S-4, S-3	3,086	56.1	16.7	0.0	16.7	72.8	255	8,525	9.11	1.65	3.43	5.00

Note:
1- Peak dry weather flow (DWF) and wet weather flow (WWF) as per the entry was used to size the future South Siphon

								GRAVITY SEWER DESIGN											FORCEMAIN DESIGN					
Tie-In	Pipe ID	RES Peak DWF	Non-RES Peak DWF	Total Peak DWF	I-I Flow Rate	Inflow - Infiltration	Total Peak WWF	System Type	Pipe Roughness	Min. Slope	Design Flow (Q_{design} / 0.86)	Actual Pipe Size	Design Pipe Size	Pipe Size/Min. Slope Check	Full-Flow Capacity	Full-Flow Pipe Area	Full-Flow Velocity	Design Q - Capacity Check	Required Capacity (100% of Q_{design})	Design Velocity	Actual Pipe Size	Design Pipe Size	Resultant Pipe Area	Resultant Velocity
		(L/s)	(L/s)	(L/s)	(L/s/ha)	(L/s)	(L/s)		"n"	(m/m)	(L/s)	(mm)	(mm)		(L/s)	(m^2)	(m/s)		(L/s)	(m/s)	(mm)	(mm)	(m^2)	(m/s)
#1	NW_1	14.73	0.00	14.73	0.28	6.84	21.57	Gravity	0.013	0.004	25.1	214.8	250	OK	37.61	0.049	0.77	OK	-	-	-	-	-	-
	NW_2	0.00	7.09	7.09	0.28	4.02	11.11	Gravity	0.013	0.004	12.9	167.5	250	OK	37.61	0.049	0.77	OK	-	-	-	-	-	-
	NW_3	0.00	14.50	14.50	0.28	8.23	22.73	Gravity	0.013	0.004	26.4	219.0	250	OK	37.61	0.049	0.77	OK	-	-	-	-	-	-
#5	NW_4	12.58	3.31	15.89	0.28	7.64	23.54	Gravity	0.013	0.004	27.4	221.9	250	OK	37.61	0.049	0.77	OK	-	-	-	-	-	-
#7	NW_8	17.37	0.80	18.17	0.28	8.65	26.81	Gravity	0.013	0.004	31.2	233.0	250	OK	37.61	0.049	0.77	OK	-	-	-	-	-	-
#8	NW_5	32.02	2.40	34.42	0.28	17.50	51.92	Gravity	0.013	0.0024	60.4	328.5	375	OK	85.89	0.110	0.78	OK	-	-	-	-	-	-
	NW_6	52.41	7.30	59.71	0.28	32.37	92.08	Gravity	0.013	0.0018	107.1	429.9	450	OK	120.96	0.159	0.76	OK	-	-	-	-	-	-
	NE_1	30.78	2.30	33.08	0.28	16.75	49.82	Gravity	0.013	0.0024	57.9	323.5	375	OK	85.89	0.110	0.78	OK	-	-	-	-	-	-
	NE_2	30.78	2.30	33.08	0.28	16.75	49.82	Gravity	0.013	0.0024	57.9	323.5	375	OK	85.89	0.110	0.78	OK	-	-	-	-	-	-
	NE_3	32.74	2.47	35.21	0.28	17.95	53.15	Gravity	0.013	0.0024	61.8	331.5	375	OK	85.89	0.110	0.78	OK	-	-	-	-	-	-
	NE_4	28.89	3.22	32.11	0.28	16.21	48.32	Gravity	0.013	0.0024	56.2	319.8	375	OK	85.89	0.110	0.78	OK	-	-	-	-	-	-
	NE_5	92.44	7.99	100.42	0.28	59.04	159.46	Gravity	0.013	0.0012	185.4	569.9	600	OK	212.70	0.283	0.75	OK	-	-	-	-	-	-
	NW_7	140.49	19.40	159.89	0.28	100.47	260.36	Gravity	0.013	0.001	302.7	708.7	750	OK	352.05	0.442	0.80	OK	-	-	-	-	-	-
#13	NE_6	15.75	3.01	18.76	0.28	9.07	27.82	Gravity	0.013	0.004	32.4	236.3	250	OK	37.61	0.049	0.77	OK	-	-	-	-	-	-
	NE_7	15.75	3.01	18.76	0.28	9.07	27.82	Gravity	0.013	0.004	32.4	236.3	250	OK	37.61	0.049	0.77	OK	-	-	-	-	-	-
	NE_9	40.85	7.70	48.55	0.28	25.62	74.17	Gravity	0.013	0.0018	86.2	396.4	450	OK	120.96	0.159	0.76	OK	-	-	-	-	-	-
	NE_10	0.00	23.71	23.71	0.28	13.46	37.17	Gravity	0.013	0.0032	43.2	274.6	300	OK	54.70	0.071	0.77	OK	-	-	-	-	-	-
	NE_11	0.00	46.57	46.57	0.28	29.39	75.96	Gravity	0.013	0.0018	88.3	399.9	450	OK	120.96	0.159	0.76	OK	-	-	-	-	-	-
	NE_12	0.00	16.37	16.37	0.28	9.29	25.66	Gravity	0.013	0.004	29.8	229.2	250	OK	37.61	0.049	0.77	OK	-	-	-	-	-	-
	NE_13-FM	0.00	41.31	41.31	0.28	25.45	66.75	Forcemain	0.013	0.0032	-	-	-	-	-	-	-	OK	66.75	1.5	238.0	250	0.049	1.36
	NE_14	0.00	30.25	30.25	0.28	17.50	47.75	Gravity	0.013	0.0024	55.5	318.4	375	OK	85.89	0.110	0.78	OK	-	-	-	-	-	-
	NE_15	0.00	98.52	98.52	0.28	72.34	170.86	Gravity	0.013	0.0012	198.7	584.8	600	OK	212.70	0.283	0.75	OK	-	-	-	-	-	-
	NE_16	52.83	103.44	156.28	0.28	105.19	261.47	Gravity	0.013	0.001	304.0	709.9	750	OK	352.05	0.442	0.80	OK	-	-	-	-	-	-
	NE_17	14.32	2.21	16.53	0.28	7.89	24.41	Gravity	0.013	0.004	28.4	225.0	250	OK	37.61	0.049	0.77	OK	-	-	-	-	-	-
	NE_18	14.32	2.21	16.53	0.28	7.89	24.41	Gravity	0.013	0.004	28.4	225.0	250	OK	37.61	0.049	0.77	OK	-	-	-	-	-	-
	NE_19 - FM	45.61	2.21	47.82	0.28	25.33	73.15	Forcemain	0.013	0.0024	-	-	-	-	-	-	-	OK	73.15	1.5	249.2	250	0.049	1.49
	NE_20	89.62	104.85	194.46	0.28	130.52	324.99	Gravity	0.013	0.001	377.9	770.2	900	OK	572.47	0.636	0.90	OK	-	-	-	-	-	-
#24	SW_1	16.20	0.00	16.20	0.28	7.59	23.78	Gravity	0.013	0.004	27.7	222.8	250	OK	37.61	0.049	0.77	OK	-	-	-	-	-	-
#23	SW_2-FM	11.91	8.76	20.66	0.28	10.40	31.06	Forcemain	0.013	0.0012	-	-	-	-	-	-	-	OK	31.06	1.5	162.4	200	0.031	0.99
	SW_3	11.91	8.76	20.66	0.28	10.40	31.06	Gravity	0.013	0.0032	36.1	256.8	300	OK	54.70	0.071	0.77	OK	-	-	-	-	-	-
#22	SW_4	24.01	2.28	26.29	0.28	13.00	39.29	Gravity	0.013	0.0032	45.7	280.4	300	OK	54.70	0.071	0.77	OK	-	-	-	-	-	-
#14	SW_5	34.30	0.00	34.30	0.28	17.44	51.73	Gravity	0.013	0.0024	60.2	328.1	375	OK	85.89	0.110	0.78	OK	-	-	-	-	-	-
	SW_6-SP	60.09	2.81	62.91	0.28	34.63	97.53	Gravity	0.013	0.0018	113.4	439.3	450	OK	120.96	0.159	0.76	OK	-	-	-	-	-	-
	SW_7	66.93	5.29	72.22	0.28	40.41	112.64	Gravity	0.013	0.0016	131.0	474.0	525	OK	172.02	0.216	0.79	OK	-	-	-	-	-	-
	SW_8	112.84	5.29	118.14	0.28	71.96	190.10	Gravity	0.013	0.001	221.0	629.9	675	OK	265.82	0.358	0.74	OK	-	-	-	-	-	-
	SW_9	112.84	5.29	118.14	0.28	71.96	190.10	Gravity	0.013	0.001	221.0	629.9	675	OK	265.82	0.358	0.74	OK	-	-	-	-	-	-
	SW_10	112.84	5.29	118.14	0.28	71.96	190.10	Gravity	0.013	0.001	221.0	629.9	675	OK	265.82	0.358	0.74	OK	-	-	-	-	-	-
	SE_1	112.84	5.29	118.14	0.28	71.96	190.10	Gravity	0.013	0.001	221.0	629.9	675	OK	265.82	0.358	0.74	OK	-	-	-	-	-	-
	SE_2	112.84	5.29	118.14	0.28	71.96	190.10	Gravity	0.013	0.001	221.0	629.9	675	OK	265.82	0.358	0.74	OK	-	-	-	-	-	-
	SE_3	8.80	18.70	27.50	0.28	14.53	42.03	Gravity	0.013	0.0024	48.9	303.5	375	OK	85.89	0.110	0.78	OK	-	-	-	-	-	-
	SE_4-FM	0.00	23.29	23.29	0.28	13.22	36.50	Forcemain	0.013	0.0032	-	-	-	-	-	-	-	OK	36.50	1.5	176.0	200	0.031	1.16
	SE_6	118.24	43.17	161.41	0.28	99.71	261.12	Gravity	0.013	0.001	303.6	709.5	750	OK	352.05	0.442	0.80	OK	-	-	-	-	-	-
	SE_7-SP	118.24	43.17	161.41	0.28	99.71	261.12	Gravity	0.013	0.001	303.6	709.5	750	OK	352.05	0.442	0.80	OK	-	-	-	-	-	-
16	SE_5	0.00	27.65	27.65	0.28	15.71	43.36	Gravity	0.013	0.0032	50.4	291.0	300	OK	54.70	0.071	0.77	OK	-	-	-	-	-	-
18D	SW_11	0.00	8.23	8.23	0.28	4.67	12.90	Gravity	0.013	0.004	15.0	177.1	250	OK	37.61	0.049	0.77	OK	-	-	-	-	-	-
	SW_12	31.25	8.23	39.48	0.28	20.38	59.86	Gravity	0.013	0.0024	69.6	346.6	375	OK	85.89	0.110	0.78	OK	-	-	-	-	-	-

APPENDIX C
Detailed Cost Estimates

Table C1: Cost (Servicing Concept)
Okotoks Sanitary Servicing Master Plan Update Memorandum
Town of Okotoks

Area	Item	Quantity	Units	Unit Cost	Sub-Total	Contingency (30%)	Engineering (15%)	Total Cost (Rounded)
North west	250mm Sewer	1,082	Metres	$ 350.00	$378,587	$113,576	$56,788	$549,000
				Sub-total	**$378,587**	**$113,576**	**$56,788**	**$549,000**
North-central	250mm Sewer	2,208	Metres	$ 350.00	$772,772	$231,832	$115,916	$1,121,000
	375mm Sewer	3,286	Metres	$ 440.00	$1,445,818	$433,745	$216,873	$2,096,000
	450mm Sewer	1,016	Metres	$ 530.00	$538,496	$161,549	$80,774	$781,000
	600mm Sewer	1,171	Metres	$ 690.00	$807,742	$242,322	$121,161	$1,171,000
	750mm Sewer	117	Metres	$ 900.00	$105,244	$31,573	$15,787	$153,000
				Sub-total	**$3,670,071**	**$1,101,021**	**$550,511**	**$5,322,000**
Northeast	250mm Sewer	3,039	Metres	$ 350.00	$1,063,768	$319,130	$159,565	$1,542,000
	300mm Sewer	880	Metres	$ 390.00	$343,177	$102,953	$51,476	$498,000
	375mm Sewer	464	Metres	$ 440.00	$204,350	$61,305	$30,653	$296,000
	450mm Sewer	1,652	Metres	$ 530.00	$875,387	$262,616	$131,308	$1,269,000
	600mm Sewer	1,140	Metres	$ 690.00	$786,441	$235,932	$117,966	$1,140,000
	750mm Sewer	804	Metres	$ 900.00	$723,746	$217,124	$108,562	$1,049,000
	900mm Sewer	1,720	Metres	$ 1,070.00	$1,840,400	$552,120	$276,060	$2,669,000
	900mm Sewer (Trenchless)	500	Metres	$ 4,400.00	$2,200,000	$660,000	$330,000	$3,190,000
	250mm Forcemain	1,634	Metres	$ 500.00	$817,239	$245,172	$122,586	$1,185,000
	Lift Station (67L/s)	1	Items	$ 1,815,000.00	$1,815,000	$544,500	$272,250	$2,632,000
	Lift Station (73L/s)	1	Items	$ 1,925,000.00	$1,925,000	$577,500	$288,750	$2,791,000
				Sub-total	**$12,594,508**	**$3,778,352**	**$1,889,176**	**$18,261,000**
South	250mm Sewer	146	Metres	$ 350.00	$51,078	$15,323	$7,662	$74,000
	300mm Sewer	426	Metres	$ 390.00	$166,198	$49,859	$24,930	$241,000
	375mm Sewer	1,706	Metres	$ 440.00	$750,488	$225,146	$112,573	$1,088,000
	525mm Sewer	923	Metres	$ 600.00	$553,744	$166,123	$83,062	$803,000
	675mm Sewer	2,473	Metres	$ 800.00	$1,978,537	$593,561	$296,781	$2,869,000
	750mm Sewer	920	Metres	$ 900.00	$827,689	$248,307	$124,153	$1,200,000
	250/150/150mm Siphon	618	Metres	$ 4,930.00	$3,046,740	$914,022	$457,011	$4,418,000
	Trenchless Pit	3	Pair	$ 82,500.00	$247,500	$74,250	$37,125	$359,000
	350/350mm Siphon	763	Metres	$ 3,520.00	$2,685,760	$805,728	$402,864	$3,894,000
	Trenchless Pit	4	Pair	$ 82,500.00	$330,000	$99,000	$49,500	$479,000
	200mm Forcemain	1,695	Metres	$ 440.00	$745,800	$223,740	$111,870	$1,081,000
	Lift Station (37L/s)	1	Items	$ 1,320,000.00	$1,320,000	$396,000	$198,000	$1,914,000
				Sub-total	**$12,703,534**	**$3,811,060**	**$1,905,530**	**$18,420,000**
West	250mm Sewer	783	Metres	$ 350.00	$274,145	$82,243	$41,122	$398,000
	300mm Sewer	549	Metres	$ 390.00	$214,245	$64,273	$32,137	$311,000
	200mm Forcemain	673	Metres	$ 440.00	$296,311	$88,893	$44,447	$430,000
	Lift Station (32L/s)	1	Items	$ 1,320,000.00	$1,320,000	$396,000	$198,000	$1,914,000
				Sub-total	**$2,104,700**	**$631,410**	**$315,705**	**$3,053,000**
				Grand-Total:	**$31,451,401**	**$9,435,420**	**$4,717,710**	**$45,605,000**

Table C2: Cost (Upgrade Based)
Okotoks Sanitary Servicing Master Plan Update Memorandum
Town of Okotoks

ID	OSL Project ID	Item	Quantity	Units	Unit Cost	Sub-Total	Contingency (30%)	Engineering (15%)	Total Cost (Rounded)
UPG 1 - NRS	SAN-9	525mm Sewer	152	Metres	$ 600	$91,200	$27,360	$13,680	$132,000
		Disposal	152	Metres	$ 210	$31,920	$9,576	$4,788	$46,000
	SAN-10	750mm Sewer	234	Metres	$ 900	$210,600	$63,180	$31,590	$305,000
		Disposal	234	Metres	$ 320	$74,880	$22,464	$11,232	$109,000
	SAN-9, SAN-10	Pavement Rehabilitation	152	Metres	$ 1,125	$171,000	$51,300	$25,650	$248,000
		Pumping	13	Day	$ 1,290	$16,598	$4,979	$2,490	$24,000
					Sub-Total:	$596,198	$178,859	$89,430	$864,000
UPG 2 - SRS	SAN-7, SAN-8	450mm Sewer	1435	Metres	$ 530	$760,550	$228,165	$114,083	$1,103,000
		Disposal	1435	Metres	$ 180	$258,300	$77,490	$38,745	$375,000
		Pavement Rehabilitation	1435	Metres	$ 1,125	$1,614,375	$484,313	$242,156	$2,341,000
		Pumping	48	Day	$ 1,010	$48,312	$14,494	$7,247	$70,000
					Sub-Total:	$2,681,537	$804,461	$402,231	$3,889,000
UPG 3 - Banister Dr	SAN-11	Plug	2	Items	$ 550	$1,100	$330	$165	$2,000
		Mobilization/Demobilization/Crew	2	Each	$ 1,650	$3,300	$990	$495	$5,000
					Sub-Total:	$4,400	$1,320	$660	$7,000
UPG 4 - 32nd St S	SAN-16	450mm Sewer	150	Metres	$ 530	$79,500	$23,850	$11,925	$115,000
		Disposal	150	Metres	$ 180	$27,000	$8,100	$4,050	$39,000
	SAN-US12, SAN-DS12	900mm Sewer	756	Metres	$ 990	$748,440	$224,532	$112,266	$1,085,000
		Disposal	756	Metres	$ 350	$264,600	$79,380	$39,690	$384,000
	SAN-US12, SAN-DS12, SAN-16	Pavement Rehabilitation	811	Metres	$ 1,125	$912,375	$273,713	$136,856	$1,323,000
		Pumping	27	Day	$ 1,060	$28,655	$8,597	$4,298	$42,000
					Sub-Total:	$2,060,570	$618,171	$309,086	$2,988,000
UPG 5 - 32nd St N	SAN-15	375mm Sewer	415	Metres	$ 440	$182,600	$54,780	$27,390	$265,000
		Disposal	150	Metres	$ 150	$22,500	$6,750	$3,375	$33,000
	SAN-14A/SAN-14B	450mm Sewer	547	Metres	$ 530	$289,910	$86,973	$43,487	$420,000
	SAN-14B	Disposal	282	Metres	$ 180	$50,760	$15,228	$7,614	$74,000
	SAN-13	525mm Sewer	448	Metres	$ 600	$268,800	$80,640	$40,320	$390,000
		Disposal	448	Metres	$ 210	$94,080	$28,224	$14,112	$136,000
	SAN-13, SAN-14A, SAN-14B, SAN-15	Pavement Rehabilitation	1410	Metres	$ 1,125	$1,586,250	$475,875	$237,938	$2,300,000
	SAN-13, SAN-14B, SAN-15	Pumping	47	Day	$ 1,010	$47,470	$14,241	$7,121	$69,000
					Sub-Total:	$2,542,370	$762,711	$381,356	$3,687,000
					Total	$7,885,075	$2,365,523	$1,182,761	$11,435,000

Table C3: Cost (NRS Options)
Okotoks Sanitary Servicing Master Plan Update Memorandum
Town of Okotoks

ID	Item	Quantity	Units	Unit Cost	Sub-Total	Contingency (30%)	Engineering (15%)	Total Cost (Rounded)
Option 1	525mm Sewer	152	Metres	$ 600	$91,200	$27,360	$13,680	$132,000
	Disposal	152	Metres	$ 210	$31,920	$9,576	$4,788	$46,000
	750mm Sewer	234	Metres	$ 900	$210,600	$63,180	$31,590	$305,000
	Disposal	234	Metres	$ 320	$74,880	$22,464	$11,232	$109,000
	900mm Sewer	186	Metres	$ 990	$184,140	$55,242	$27,621	$267,000
	Disposal	186	Metres	$ 350	$65,100	$19,530	$9,765	$94,000
	Pavement Rehabilitation	247	Metres	$ 1,125	$277,875	$83,363	$41,681	$403,000
	Pumping	19	Day	$ 1,140	$21,736	$6,521	$3,260	$32,000
				Total:	**$957,451**	**$287,235**	**$143,618**	**$1,388,000**
Option 2	1200mm Gravity Sewer	521	Metres	$ 1,300	$677,300	$203,190	$101,595	$982,000
	Plug (Sewer Abandonment)	2	Items	$ 550	$1,100	$330	$165	$2,000
	Pavement Rehabilitation	152	Metres	$ 1,125	$171,000	$51,300	$25,650	$248,000
				Total:	**$849,400**	**$254,820**	**$127,410**	**$1,232,000**
Option 3	900mm Sewer	186	Metres	$ 990	$184,140	$55,242	$27,621	$267,000
	Disposal	186	Metres	$ 350	$65,100	$19,530	$9,765	$94,000
	1200mm Gravity Sewer	360	Metres	$ 1,300	$468,000	$140,400	$70,200	$679,000
	Pavement Rehabilitation	95	Metres	$ 1,125	$106,875	$32,063	$16,031	$155,000
	Pumping	6	Day	$ 1,690	$10,478	$3,143	$1,572	$15,000
				Total:	**$834,593**	**$250,378**	**$125,189**	**$1,210,000**

Table C4: Cost per Growth Horizon
Okotoks Sanitary Servicing Master Plan Update Memorandum
Town of Okotoks

Horizon	ID	OSL Project ID	Apportionment	Item	Quantity	Units	Unit Cost	Sub-Total	Contingency (30%)	Engineering (15%)	Total Cost (Rounded)
5 Year Growth Horizon (2024)	UPG 1 - NRS	SAN-9	Off-site Levy	525mm Sewer	152	Metres	$ 600	$91,200	$27,360	$13,680	$132,000
				Disposal	152	Metres	$ 210	$31,920	$9,576	$4,788	$46,000
		SAN-10		750mm Sewer	234	Metres	$ 900	$210,600	$63,180	$31,590	$305,000
				Disposal	234	Metres	$ 320	$74,880	$22,464	$11,232	$109,000
		SAN-9, SAN-10		Pavement Rehabilitation	152	Metres	$ 1,125	$171,000	$51,300	$25,650	$248,000
				Pumping	13	Day	$ 1,290	$16,598	$4,979	$2,490	$24,000
							Sub-Total:	$596,198	$178,859	$89,430	$864,000
	UPG 2 - SRS	SAN-7, SAN-8	Off-site Levy	450mm Sewer	1435	Metres	$ 530	$760,550	$228,165	$114,083	$1,103,000
				Disposal	1435	Metres	$ 180	$258,300	$77,490	$38,745	$375,000
				Pavement Rehabilitation	1435	Metres	$ 1,125	$1,614,375	$484,313	$242,156	$2,341,000
				Pumping	48	Day	$ 1,010	$48,312	$14,494	$7,247	$70,000
							Sub-Total:	$2,681,537	$804,461	$402,231	$3,889,000
							5 Year Growth Horizon Total:	$3,277,735	$983,320	$491,660	$4,753,000
10 Year Growth Horizon (2029)	UPG 3 - Banister Dr	SAN-11	Off-site Levy	Plug	2	Items	$ 550	$1,100	$330	$165	$2,000
				Mobilization/Demobilization/Crew	2	Each	$ 1,650	$3,300	$990	$495	$5,000
							Sub-Total:	$4,400	$1,320	$660	$7,000
	Servicing	N/A	Developer Paid	250mm Sewer	146	Metres	$ 350.00	$51,078	$15,323	$7,662	$74,000
				375mm Sewer	473	Metres	$ 440.00	$207,936	$62,381	$31,190	$302,000
							Sub-Total:	$259,014	$77,704	$38,852	$376,000
							10 Year Growth Horizon Total:	$263,414	$79,024	$39,512	$383,000
25 Year Growth Horizon (2044)	UPG 4 - 32nd St S	SAN-16	Off-site Levy	450mm Sewer	150	Metres	$ 530	$79,500	$23,850	$11,925	$115,000
				Disposal	150	Metres	$ 180	$27,000	$8,100	$4,050	$39,000
		SAN-US12, SAN-DS12		900mm Sewer	756	Metres	$ 990	$748,440	$224,532	$112,266	$1,085,000
				Disposal	756	Metres	$ 350	$264,600	$79,380	$39,690	$384,000
		SAN-US12, SAN-DS12, SAN-16		Pavement Rehabilitation	811	Metres	$ 1,125	$912,375	$273,713	$136,856	$1,323,000
				Pumping	27	Day	$ 1,060	$28,655	$8,597	$4,298	$42,000
							Sub-Total:	$2,060,570	$618,171	$309,086	$2,988,000
	UPG 5 - 32nd St N	SAN-15	Off-site Levy	375mm Sewer	415	Metres	$ 440	$182,600	$54,780	$27,390	$265,000
				Disposal	150	Metres	$ 150	$22,500	$6,750	$3,375	$33,000
		SAN-14A/SAN-14B		450mm Sewer	547	Metres	$ 530	$289,910	$86,973	$43,487	$420,000
		SAN-14B		Disposal	282	Metres	$ 180	$50,760	$15,228	$7,614	$74,000
		SAN-13		525mm Sewer	448	Metres	$ 600	$268,800	$80,640	$40,320	$390,000
				Disposal	448	Metres	$ 210	$94,080	$28,224	$14,112	$136,000
		SAN-13, SAN-14A, SAN-14B, SAN-15		Pavement Rehabilitation	1410	Metres	$ 1,125	$1,586,250	$475,875	$237,938	$2,300,000
		SAN-13, SAN-14B, SAN-15		Pumping	47	Day	$ 1,010	$47,470	$14,241	$7,121	$69,000
							Sub-Total:	$2,542,370	$762,711	$381,356	$3,687,000
	Servicing	N/A	Developer Paid	250mm Sewer	1,082	Metres	$ 350.00	$378,587	$113,576	$56,788	$549,000
				300mm Sewer	122	Metres	$ 390.00	$47,617	$14,285	$7,143	$69,000
				375mm Sewer	464	Metres	$ 440.00	$204,350	$61,305	$30,653	$296,000
			Endeavor to Assist	450mm Sewer	817	Metres	$ 530.00	$433,156	$129,947	$64,973	$628,000
				600mm Sewer	1,140	Metres	$ 690.00	$786,441	$235,932	$117,966	$1,140,000
			Off-site Levy	750mm Sewer	804	Metres	$ 900.00	$723,746	$217,124	$108,562	$1,049,000
				900mm Sewer	1,672	Metres	$ 1,070.00	$1,788,719	$536,616	$268,308	$2,594,000
							Sub-Total:	$4,362,617	$1,308,785	$654,393	$6,325,000
							25 Year Growth Horizon Total:	$8,965,557	$2,689,667	$1,344,834	$13,000,000
							Total:	$12,506,706	$3,752,012	$1,876,006	$18,136,000