MERRITT

COUNTRY MUSIC CAPITAL OF CANADA

WATER UTILITY MASTER PLAN

DECEMBER 2012

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D-36406.00

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WATER UTILITY MASTER PLAN

1.0 EXECUTIVE SUMMARY

1.1 Background

The Water Utility Master Plan for the City of Merritt is developed to provide the City a long term plan for decision making. The objective of the study is to assess the existing water system in terms of its capacity to meet current requirements and the City's OCP future development plans for the next 20 years. It also provides recommendations for necessary upgrades in order to meet those requirements based on the established level of service. The main system components that the study covers are source supply, source quality, storage, and fire protection. Furthermore, the study also includes a financial model to estimate the sustainable price for water, which would ensure the continuous and feasible operations of the water system for the 20-year horizon period and beyond.

1.2 Population Projections and Water Demands

1.2.1 2010 Population and Water Demands

In 2010, the population in the City was estimated at 7,285 people according to BC statistics. For the same year, the metered total water production from the source wells was 2,926 million litres. This corresponds to a daily average of 8 million litres per day, whereas the recorded maximum was 18.5 million litres per day (ML/d) in August 2010. The water production per capita in the City was equivalent to an average day demand (ADD) of 1,100 L/cap/d and a maximum day demand (MDD) of 2,540 L/cap/d. This includes water consumed by residents, Industrial, Commercial and Institutional (ICI) users, and unaccounted-for water, including leakage in the system.

The demand analysis in section 4.3.2 discusses the distribution of residential and ICI demands. It concluded that during average day demand (ADD) approximately 64% of the total water production is consumed by residents and during maximum day demand (MDD) it is approximately 77 %. As such, the residential per capita ADD is 707 L/cap/d and MDD is 1,950 L/cap/d as listed in Table 4-7. These figures are among the highest in communities in the southern interior BC region.

1.2.2 Projected Population and Water Demands

Two population growth scenarios were considered in the scope of the master plan for the 20-year planning horizon. The first growth scenario is 1.1% per year which is based on the average annual historical population growth in the City between 2006 and 2010. The second growth scenario is 3.5% per year plus a 20% water conservation reduction which is based on the OCP criteria prepared in 2011.

Based on the per capita average and maximum day demand for the two population growth scenarios, the water demand requirements in 2030 are as summarized in the Table 1-1.

TABLE 1-1
POPULATION AND WATER DEMAND PROJECTIONS SUMMARY

Year	2010 (Current)	2030 (@ 1.1% growth)	2030 (@ 3.5% growth plus 20% water conservation reduction)
Population (Capita)	7,285	9,067	14,496
Average Day Demand (ML/d)	8.0	9.7	11.6
Maximum Day Demand (ML/d)	18.5	22.5	27.7

1.3 Source Supply Analysis

The objective of the source water supply analysis is to assess if there is sufficient capacity in the existing wells to meet current and future demands.

The source supply analysis was based on the capacity of the five existing well pumps. These are namely Collettville, Fairley Park, Voght Park #1, Voght Park #2 and Kengard. The long term sustainable yield of the wells was being developed under a separate study and was not available at the time of writing this report.

The total maximum capacity of all pumps is 372 L/s (32.1 ML/d). Voght Park #1 is the largest pump with a capacity of 106 L/s (9.2 ML/d). Voght Park #2 has a capacity of 83.3 L/s (7.2 ML/d) and is the only pump that can run during power failure.

The source supply analysis compares the water demand in the City versus the capacity of water under three different supply scenarios. The analysis is summarized in Table 1-2 and shows that:

- <u>Supply Scenario-</u>1. All pumps are online: there is sufficient capacity in the existing pumps to meet MDD at present and at both future growth projection scenarios.

- <u>Supply scenario-2</u>. The largest pump is offline: there is sufficient capacity in the existing pumps to meet MDD at present and at the 1.1% growth scenario. There would be a supply deficiency during MDD at the 3.5% growth scenario.

- <u>Supply scenario-3</u>. During power failure. The City would be unable to meet average day demand at the present, and both growth scenarios.

TABLE 1-2
SOURCE SUPPLY ANALYSIS SUMMARY

	Year		
	2010	2030 (@ 1.1% growth)	2030 (@ 3.5% growth plus 20% water conservation reduction)
Maximum Supply (ML/d)	32.1		
Maximum Supply with largest pump offline (ML/d)	22.9		
Maximum Supply during power failure (ML/d)	7.2		
ADD (ML/d)	8.0	9.7	11.6
MDD (ML/d)	18.5	22.5	27.7

1.3.1 Recommendations (Source Supply)

It is recommended to install back-up power at the Fairley Park well as additional supply during a power failure. This would increase the water supply capacity by an additional 75.8 L/s (6.5 ML/d) to a total of 13.7 ML/d and therefore meet the ADD requirements at present and at both growth scenarios. The cost associated with this upgrade is approximately $160,000 and it is recommended within the short term.

1.4 Source Quality Analysis

The City draws its water from two aquifers, a shallow unconfined aquifer and a deep aquifer. Kengard is the only well located within the deep aquifer, whereas the remaining wells exist within the boundaries of the shallow aquifer. The shallow aquifer is classified as a GUDI (Groundwater Under Direct Influence of surface water) source according to the available hydro-geological information and the deep aquifer may also be at risk of classified as GUDI, however there is considerable uncertainty at this time.

Water quality from the shallow aquifer is routinely monitored and is a high quality water with low turbidity and moderate hardness. Iron and manganese measurements are generally within the recommended guidelines and do not warrant any treatment. The Kengard well is relatively new and has limited available water quality data which has indicated high hardness ($CaCO_3$) and elevated manganese levels which exceed the aesthetic objectives. It is recommended that the City initiate a routine flushing program around the Kengard well when it is in operation.

The City currently has only a single barrier treatment through chlorination as a disinfection mechanism at wells. The shallow wells are currently considered GUDI wells and as such require additional disinfection. Furthermore, to meet health guidelines for dual barrier treatment, an ultra-violet (UV) disinfection system is recommended for shallow aquifer wells. This would provide the 3-log inactivation of protozoa. A preliminary review for three options to locate the recommended system was prepared as detailed in Section 6.2.2 and Table 6-2. The review concluded that installing a common UV facility for the wells in the shallow aquifer at Voght Park is more economical and more practical in terms of operations and maintenance requirements.

1.4.1 Recommendations (Source Quality)

1. Install a common UV facility for the shallow wells to provide the disinfection appropriate for a GUDI well. The cost associated with this upgrade is approximately $1,800,000 and it is recommended within the short-medium term.

2. Install on-line UVT analysers at the shallow wells in order to initiate the collection of UVT data which would be required for the design of a UV system. The cost associated with this is approximately $25,000 and it is recommended within the short term.

3. Initiate preliminary design studies for UV facility work in 2013/2014 and have the necessary documentation in place to apply for a grant to support the construction of

the system. The cost associated with this is approximately $50,000 and it is recommended within the short term.

4. Complete a sanitary survey for the shallow wells, update the City's emergency response plan to address elevated turbidity in the shallow aquifer wells and complete a vulnerability study as recommended in the Health Canada guidelines for unfiltered sources.

5. As the Kengard well is utilized implement a flushing program for all the pipes around the Kengard well to address the potential for manganese precipitation in the pipe network.

6. Initiate a semi-annual Microscopic Particulate Analysis (MPA) testing program for the Kengard well. A bi-weekly manganese monitoring program on the raw well water using handheld equipment should be initiated and completed as part of the routine testing completed by City staff.

7. Develop a standard municipal response to address potential complaints associated with the change in hardness and potential impact of the manganese due to the use of the Kengard well.

8. Isolate the watermain along Merritt Ave from the Kengard Well water supply line, forcing the well water to first flow down the 350 mm diameter trunk main to Nicole Ave to achieve the required chlorine contact time.

1.5 Storage Analysis

The objective of the storage analysis is to assess if there is sufficient capacity in the existing reservoirs to meet current and future requirements for fire and balancing storage.

There are five existing reservoirs distributed across the City with a total storage capacity of 10.32 ML. Three reservoirs have a Top Water Level (TWL) of 680 m, these are Grimmett, Nicola and South East reservoirs. Whereas, Grandview Heights reservoir and Active Mountain reservoir have TWL of 745 m and 747 m, respectively. This divides the existing water system to three pressure zones. A fourth pressure zone would be created in the future as the development plans in Gateway 286 progress.

The storage analysis is summarized in Table 1-3 and indicates that:

- In 2010: Storage requirements for the three zones are met with the existing reservoirs.
- In 2030: Zone-1 will require the surplus capacity in Active Mountain reservoir and therefore a PRV station would be necessary between zones 1 and 3. Storage requirements in zones 2, 3 and 4 can be met with the existing reservoirs and without expanding Active Mountain reservoir.

TABLE 1-3
STORAGE ANALYSIS SUMMARY

Capacity (ML)	**2010**	**2030 (@ 1.1% growth)**	**2030 (@ 3.5% growth plus 20% water conservation reduction)**
Zone-1 (TWL 680 m)			
Required Fire Storage	2.43		
Required Balancing Storage	4.62	5.63	6.93
Total Required Storage	7.05	8.06	9.36
Available Capacity	8.04(1)	12.58(2)	12.58(2)
Zone-2 (TWL 745 m)			
Required Fire Storage	0.32		
Required Balancing Storage	0.02	0.22(3)	0.18(3)
Total Required Storage	0.35	0.55	0.50
Available Capacity	0.55(4)		

TABLE 1-3 (cont'd.)
STORAGE ANALYSIS SUMMARY

Capacity (ML)	**2010**	**2030 (@ 1.1% growth)**	**2030 (@ 3.5% growth plus 20% water conservation reduction)**
Zone-3 (TWL 747 m)			
Required Fire Storage	1.08		
Required Balancing Storage	0	0.08	0.26
Total Required Storage	1.08	1.16	1.34
Available Capacity	2.28	4.55(5)	4.55(5)
Zone-4 (TWL(6))			
Required Fire Storage	0	0.65	
Required Balancing Storage	0	0.42	1.36
Total Required Storage	0	1.07	2.01
Available Capacity	2.27(7)		

(1) Includes the capacity of Grimmett, Nicola, South East and Grandview Heights reservoir.

(2) Includes the capacity of all reservoirs in (1) plus the maximum capacity of Active Mountain reservoir. Assuming a PRV station is installed between pressure zones 1 and 3.

(3) Assuming maximum population of 460 people in 2030.

(4) Includes the capacity of Grandview Heights reservoir only.

(5) Assuming Active Mountain reservoir is expanded to its future planned capacity.

(6) TWL of Zone-4 is determined in the future based on Gateway 286 development plans.

(7) Includes the capacity of South East reservoir only.

The City reported that there are currently operational difficulties with filling and emptying South East reservoir. This is mainly due to the location of the reservoir which is further away from the main water source and the reduced hydraulic capacity relative to the network supporting the Government reservoir. The well pumps are currently controlled by the level in Grimmett reservoir. To overcome this issue, it is recommended to install control valves at each reservoir in order to operate and control the hydraulics at each reservoir independently.

1.5.1 Recommendations (Storage)

1. Install a PRV station between Active Mountain reservoir (Zone-3) and Zone-1 to meet the future additional balancing storage requirement in Zone-1. The cost associated with installing the new PRV is approximately $125,000 and it is recommended within the medium term.

2. Install control valves at reservoirs to enhance the filling and emptying of reservoirs. The cost associated with installing new control valves is $125,000 and it is recommended within the short term.

1.6 Transmission, Distribution and Fire Flow Analysis

The objective of the analysis is to assess if the pressure in the system during ADD, MDD and fire flow is sufficient and to identify where the system deviates from the level of service.

A hydraulic model was developed in WaterCAD based on the existing system information and record drawings such as, but not limited to, pipe sizes, reservoir TWL, PRV settings, pump capacity-head curves, etc. The model was used to assess the existing system under ADD, MDD and fire flow conditions, and PHD for the current (2010) demands and for the two future projected demand scenarios.

The hydraulic analysis of the existing system for 2010 water demands and for the two future projected demands indicated that there is adequate head in the well pumps to transmit water from the source wells to the reservoirs.

The analysis also indicated that at ADD, pressures in the majority of distribution pipes in the City ranged between 100 psi and 140 psi. These are considered high for the required level of service which is typically between 40 psi to 80 psi. These elevated pressures will increase water use, leakage and watermain failure. Two alternative plans for pressure management were reviewed which would reduce the system pressure. The proposed plans suggest creating a new pressure zone in the system. Based on the initial analysis the financial benefits were not favourable in a 20 year period. However, many of the non-tangible benefits were excluded. As such we recommend a pressure zone feasibility study be carried out in the short-term to have a better understanding of the costs and benefits. It is estimated that the study would cost approximately $30,000.

The fire flow analysis at MDD for the existing system identified that there are likely fire flow deficiencies in parts of the City. The deficiencies identified occur at dead-end pipes and/or at locations where the pipes are under sized to accommodate the required fire flow. To eliminate those deficiencies, a number of existing pipes require upgrading to a larger diameter and installation of a number of new pipes are also proposed to improve fire flow in the City. The proposed upgrades can be completed in stages ranging from the short to medium to long term. The total cost of upgrades is estimated at approximately $1,390,000. However, it is recommended that the City does field validation to check and confirm the sizes of these identified pipes prior to undertaking the upgrade works. In addition, mapping out the existing fire hydrants in the City indicated that there are areas where spacing between hydrants is more than the design target of 150 m. It was determined that 33 additional fire hydrants are required to cover the spacing shortfall. The cost of installing these hydrants is estimated at approximately $135,000 and it is recommended in the short-term. It is also recommended that a hydrant infill risk evaluation and prioritization study be carried out prior to installing the hydrants. The budget for the study is estimated at $15,000.

Section 7.3 discusses the hydraulic analysis of the system based on the future projected population for both scenarios. The analyses indicates that by implementing the improvements recommended for the existing system, the requirements of future demands can also be met. Additional infrastructure within the Gateway 286 development will be required for this area due to the proposed development elevations relative to the City’s existing storage and hydraulics. As such, the City's existing infrastructure will provide the necessary pressure and flow at the Southeast reservoir, but the development will require boosters to service the proposed high elevations. We would anticipate that this infrastructure will be completed by the developer. As such, it is not recommended that the City plan to complete the additional works.

1.7 Financial Analysis

1.7.1 Background

A comprehensive Financial Model loaded with asset (PSAB 3150), financial (2006-2010), water usage and future recommended capital investment data, has been used to evaluate the water utility revenue envelope required to achieve financial sustainability over the period from 2010 until 2110.

Adjustments have been made to the data and assumptions are recorded in Section 9.6. The most important of these are: an average population growth rate of 0.12% p.a. which equals the value calculated from the latest 5 year census and a 25% increase in the cost of constructing linear infrastructure under "green field" conditions to derive the rehabilitation cost which would be associated with a replacement process in a developed and operating urban environment.

Evaluation of the sensitivity of the variables revealed that service life, rehabilitation cost, population growth, the level of debt (interest charges) and operating expenses are important variables affecting the cost of service. Some of these are able to be influenced by the City to varying degrees.

1.7.2 Review of Cases

A review of Case 1, Case 2 and Case 3 results in the following (ref. Section 9 Financial Model Figures):

1. The Service Life of assets, especially linear assets, is the key uncertainty impacting the financial sustainability of the utility. Compare the Total 100 Year Projected Expenses.
2. Current revenue is adequate should the 30% Change to Service Life be realistic, but may be inadequate without that change. Note that current revenue from sale of water is in balance with the need to fund long term debt associated with the bulk system upgrades completed recently. However, over time the need for rehabilitation will drive capital expenditure and the rate structure will become out of balance with the revenue needs.
3. Case 1 results in the utility exceeding its calculated Maximum Borrowing Capacity and results in high interest costs.
4. Case 3 – 1%p.a. growth till 2030 renders the utility financially stable but the calculated Maximum Borrowing Capacity may be exceeded.
5. The Service Rates currently reflect the cost of service. However, over the modeling period, revenue from sale of water will exceed the cost of production while the revenue from service delivery will not meet the cost of operating and rehabilitating the distribution system.

1.7.3 Discussion

The required funding envelope is influenced by a number of variables, some of which are difficult to quantify. Setting the appropriate level is therefore a process of progressive evaluation and adjustment. By maintaining the model, which will be made available to the City, this process can be simplified.

The key variable viz. the service life of the assets needs to be monitored with a view to confirming the assumptions made and to allow the revenue envelope to be adjusted. This can be undertaken by reviewing the corrosion conditions both inside and outside the pipes together with sampling of the pipes to determine rates of corrosion. The service life of pipes is likely to vary depending on the above factors as well as the quality of installation and the level of criticality of each element. Since failure of critical elements of the infrastructure may be most undesirable, the service life of these is effectively shortened. Non-critical infrastructure can be allowed to deteriorate until the cost of maintenance and the deterioration in level of service drives rehabilitation. This can significantly extend the effective service life. This determination is a component of an Asset Management program. Since asset management is a process of incremental improvement, the City would benefit from having ongoing access to high level asset management expertise.

The current revenue envelope, assumed to be in place until 2031, appears adequate but should be reviewed as better information becomes available. This envelope should be adjusted for inflation as the model reports in Base Year (2010) dollars. Adjustment is desirable to keep the utility within borrowing limits and to manage interest costs.

While the revenue envelope may be adequate to fund future needs, the rates which are currently equitable will become progressively more inequitable as the funding need moves towards rehabilitation.

While growth of the City would ease the funding of rehabilitation, the prospects of growth at the rate assumed (1% p.a.) over an extended period would need to be underpinned by significant economic drivers. An ageing population would counter this potential growth.

The City is moving towards metered billing for ICI consumers. This change together with the rate structure currently in place leaves revenue generation exposed to possible usage reduction by high ICI consumers. A review of the rate structure guided by the cost of service could improve the sustainability of the revenue stream.

1.7.4 Recommendations

1. The City should maintain the current revenue envelope with adjustment for inflation in the short term until re-evaluation is undertaken.
2. A program for continuous evaluation of the service life, especially of linear assets should be initiated
3. Based on the information gained from the above activities a review of the rate structure is recommended.
4. The City should intensify its asset management process with high level input as required.
5. Critical infrastructure should be identified and actively managed.

1.8 Summary of Recommendations

1.8.1 Capital Investments

The summary of recommendations and cost associated are shown in Table 1-5 below:

TABLE 1-4
RECOMMENDATIONS SUMMARY

System component	Description	Cost	Implementation Plan
Capital Works			
Supply	Install back-up power at the Fairley Park Well	$160,000	Short term
Treatment	Install a UV disinfection system.	$1,800,000	Short to Medium term
	Complete a sanitary survey for the shallow wells, update the City's emergency response plan to address elevated turbidity in the shallow aquifer wells and complete a		

TABLE 1-4 (cont'd)
RECOMMENDATIONS SUMMARY

System component	Description	Cost	Implementation Plan
	vulnerability study as recommended in the Health Canada guidelines for unfiltered sources.		
	Implement a flushing program for all the pipes around the Kengard well.		
	Initiate a semi-annual MPA testing program for the Kengard well. A bi-weekly manganese monitoring program on the raw well water as part of the routine testing.		
	Develop a standard municipal response to address potential complaints associated with the change in hardness and potential impact of the manganese due to the use of the Kengard well.		
Treatment cont'd	Isolate the watermain along Merritt Ave from the Kengard Well water supply line to achieve the required chlorine contact time.		
Storage	Install PRV station between zones 1 and 3	$125,000	Medium term
	Install control valves at reservoirs	$125,000	Short term
Distribution system	Upgrade existing pipes and install new pipes	$1,390,000	In phases
	Install new fire hydrants (33 Nos.)	$135,000	Short term
Total for Capital Costs		**$3,735,000**	
Studies	Treatment: UV water quality monitoring / UVT analysis	$25,000	Short term
	Treatment: UV disinfection concept study / Preliminary design	$50,000	Short term
	Distribution system: Pressure zone feasibility study	$30,000	Short term
	Distribution system: Hydrant infill risk evaluation and prioritization	$15,000	Short term
	Asset Management: Asset inventory database update	$65,000	Short term
Total for Studies		**$185,000**	

1.8.2 Financial

1. The City should maintain the current revenue envelope with adjustment for inflation in the short term until re-evaluation is undertaken.
2. A program for continuous evaluation of the service life, especially of linear assets should be initiated
3. Based on the information gained from the above activities a review of the rate structure is recommended.
4. The City should intensify its asset management process with high level input as required.
5. Critical infrastructure should be identified and actively managed.

2.0 INTRODUCTION

The City of Merritt (City) retained Opus DaytonKnight Consultants Ltd. (Opus DaytonKnight) to develop a water utility master plan which includes a computerized hydraulic network model that is field calibrated, and a financial plan and schedule for any recommended upgrade works. The hydraulic model will enable the City to perform analysis of the water system in order to:

- Assess the existing hydraulic performance and current operational settings. Thus, determining the necessary short and/or medium term improvements and the costs associated with such works.

- Assess the existing system's capability in coping with the City's future projected water demands generated through development and population growth. Thus, determining the necessary long term improvements and upgrade works necessary to serve the projected growth and the estimated costs associated with such works.

- Carry out extended period simulation of the water system for the existing and future projected scenarios. Thus, evaluating the system's response to daily and seasonal fluctuations.

- Evaluate the City's current utility rates by taking into account the budgets for future upgrading works and plans.

The water utility master plan covers the City's existing water supply sources, storage reservoirs and transmission and distribution network.

2.1 Scope of Work

The main project requirements, as outlined in Section 4 of the City's RFP, are:

- **Project familiarization:** reviewing pertinent reports, documents, facility drawings, existing sites and facilities, computer programs, and files in coordination with the Engineering, Public Works and Planning Division and Fire Department.

- **Meetings:** hosting and chairing a project start up meeting with City staff, meeting with the Engineering, Public Works and Planning Divisions and the Fire Department to review model development, undertaking facility visits and field calibration, assessing existing and future needs, holding an interim discussion with City Staff to review the preliminary results of the draft report and to present the recommended upgrading program and costs.

- **Water modelling:** building and developing a hydraulic computer model for the entire City's system and which is capable of analysing the existing system and the projected future expansion for ADD, MDD, PHD and fire flows under steady state conditions and extended period simulations.

- **Water system evaluation:** assessing the City's system and propose recommendations for upgrade works complete with cost estimates and schedules. Such recommendations may include water demands for the various water supply zones, placement of zonal water flow meters, water reduction strategies, reservoir management strategies, maintaining residual chlorine levels, water pump stations, capacity and emergency power, transmission mains and capacity (domestic and fire), distribution mains and capacity (domestic and fire), reservoir size (fire and balancing storage requirements) and location.

- **Reports:** producing a report, including maps using the 2007 digital air photo, this covers the existing and future water systems. The final report is to be submitted under the seal of a Professional Engineer registered in the Province of British Columbia.

- **Cost estimates:** identifying required improvement works according to the 5, 10 and 20 year capital plans and including costs of engineering, construction, contingency and HST.

Based on the above project requirements, the tasks that were undertaken by Opus DaytonKnight project team to complete the water utility master plan were as follows:

- Gathered and reviewed all existing information from the City pertinent to the water supply, storage and distribution network such as studies, reports, drawings, water quality data, operational data, etc.

- Met with the City operations staff and conducted a site visit to various facilities to obtain and to compile all relevant operational data.

- Obtained historical measured data on average day, maximum day and peak hour demands for residential and ICI water usage in the City.

- Estimated the per capita water demand rates based on historical metered water usage data and input from City staff.

- Assessed existing population (as of 2010) and project future population (in 2030) based on two growth rate scenarios; 1.1% and 3.5% growth with 20% water conservation reduction.

- Estimated residential and ICI water demands for existing and for future growth scenarios.

- Performed hydrant flow testing to calibrate the hydraulic model to actual field conditions.

- Analysed the distribution system and reservoir capacities to provide adequate pressure, flow and storage during ADD, MDD, PHD and fire flow scenarios.

- Identified the existing and future water system deficiencies and proposed recommendations for upgrading works to the City.

- Prepared cost estimates and schedule for proposed upgrades.

2.2 Previous Studies

Previous studies that were reviewed during development of this master plan include:

- Regional Water and Sewer Study, Urban Systems, 1978
- Collettville Water System Study, Stanley Associates Eng., 1994
- City of Merritt Water and Sewerage Update, 1988
- Collettville Water and Sewer Project, 1997
- Uni-Directional Flushing Program Final Report, S.F.E., 2007
- Uni-Directional Flushing Program, 2004
- Joeyaska Water and Sewer Report, Urban Systems (1999)
- City of Merritt Zoning Bylaw
- City of Merritt Integrated Growth Strategy (2010)
- City of Merritt Asset Management Case Study (2011)
- Fire Hydrant Flow Records – various dates
- Aquifer Protection Plan (EBA Engineering, December 2002)
- Water Conservation Strategy (Urban Systems, May 2003)
- Universal Water Meter Implementation Phase-1 (Urban Systems, March 2008)

- Universal Water Meter Implementation Phase-2 (Urban Systems, October 2008)
- City of Merritt Community Water System Annual Report (2005 - 2010)
- City or Merritt 2010 Annual Report (June 28, 2011)
- City of Merritt Official Community Plan Bylaw 2116 (2011)
- Technical Memorandum #1: Demand Analysis (Opus DaytonKnight, August 2011)
- Technical Memorandum #2: Software Selection (Opus DaytonKnight, August 2011).
- Technical Memorandum #3: Hydrant Flow Testing Program, (Opus DaytonKnight, August 2011).
- Technical Memorandum #4: Hydraulic Model Development and Calibration, (Opus DaytonKnight, September 2011).
- Construction of the Kengard Well Pump Station – Field Report Review (KWL Associates Ltd, May 30 2011)
- Construction of the Kengard Well Pump Station – Technical Memorandum (KWL Associates Ltd, Nov 10, 2009)
- Water Works for Reservoir 286 – Record drawing set (Civic Consultants, June 2011)
- Water Main Looping – drawing set (Urban Systems, Nov 21, 2006)

2.3 Acknowledgements

Opus DaytonKnight acknowledges the support and cooperation of the City of Merritt and extends its appreciation to Shawn Boven, AScT, Public Works Manager and Danielle Cass, Engineering Technologist, for their assistance to the project team at Opus DaytonKnight in preparing the report and completing the master plan.

The model development, analysis and report were prepared by Zaid Azaizeh, EIT, and Clive Leung, EIT, for Opus DaytonKnight with supervision and direction from Walt Bayless, P.Eng. and Gurjit Sangha, P.Eng.

The financial analysis and model were prepared by Ian Rose-Innes, P.Eng. and Bernadette O’Connor, NZCE (Civil), ETPract, IET.

2.4 Abbreviations

ADD	Average Day Demand
BC	British Columbia
FUS	Fire Underwriters Survey
HGL	Hydraulic Grade Line
GIS	Geographic Information System
ICI	Industrial/Commercial/Institutional
kPa	kilopascal
L/c/d	Litres per capita per day
L/s	Litres per second
MDD	Maximum Day Demand
ML	Million Litres
ML/d	Million Litres per Day
MoE	Ministry of Environment
OCP	Official Community Plan
PHD	Peak Hour Demand
PRV	Pressure Reducing Valve
psi	pounds per square inch
WTP	Water Treatment Plant

3.0 EXISTING WATER SYSTEM

This section provides an overview and a general description of the existing water system in the City of Merritt as of 2010.

3.1 System Overview

The City of Merritt provides quality potable water and fire protection to over 7,285 residents[1], numerous Industrial and Commercial Institutions (ICI) and a domestic airport. The majority of development in the City is concentrated between Coldwater River and Nicola Highway in addition to some residential areas to the North of Nicola Highway and North of Voght Street.

The City obtains its water from a groundwater aquifer that lies below the City limits. The water network is made up of mainly two pressure zones at 680 m (Zone-1) and 745 m (Zone-2) Hydraulic Grade Line (HGL) elevations in addition to pressure zone 747 m (Zone-3) which is presently small and serviced by Active Mountain reservoir. As of 2010, the system was compromised of production wells, storage reservoirs, transmission and distribution system, fire hydrants and two booster stations and a Pressure Reducing Valves (PRV) as summarised in Table 3-1 and shown in Figure 3-1. An overall hydraulic schematic of the existing system is provided as Figure 3-2.

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[1] 2010 Population estimate.

TABLE 3-1
WATER SYSTEM SUMMARY

Water System Component	Quantity
Production wells	5
Storage reservoirs	5
Transmission and distribution pipes	74,486 m
Booster station with PRV	1 station with 2 PRV's.
Fire Hydrants (Owned by City)	315
Fire Hydrants (Private)	71

The City of Merritt has 121 water meters installed on the connections to some ICI users. Based on discussions with the City during the course of this project, this number of meters represents 46% of the actual total number of ICI users in the city. Residential water consumption is not universally metered.

3.2 Water Sources

The source of water supply to the City of Merritt is from a groundwater aquifer generally below the City. The aquifer covers an area approximately 6.5 Km^2 which extends from the Coquihalla Highway No. 5 (East of Merritt) to the Collettville area (West) and from North Nicola area (North) to South Merritt area (South). The two figures[2,3] enclosed in Appendix A show the boundaries of the aquifer.

Based on the City of Merritt Community Water System Annual Reports (2005 - 2010), the aquifer provides high quality water. Since 2008, the City has been injecting the raw water with approximately 0.9 mg/l of 12% Sodium Hypochlorite at each pump station to maintain a minimum of 0.5 mg/l of chlorine residual in the distribution system. It is noted

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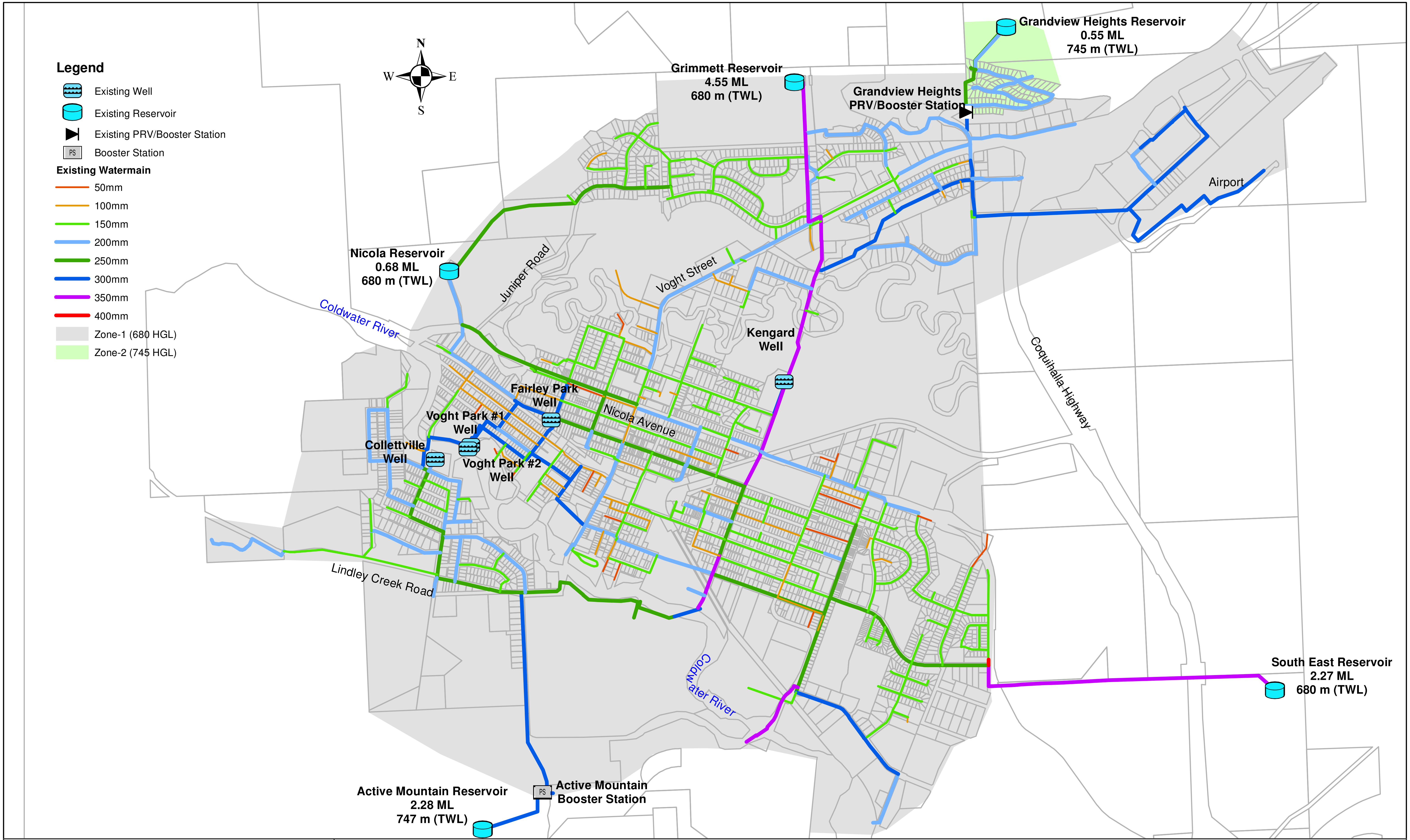
[2] Source: Ministry of Environment BC Water Resources Atlas, http://www.env.gov.bc.ca/wsd/data_searches/wrbc/index.html

[3] Source: Aquifer Protection Plan, EBA Engineering Consultants Ltd, December 2002, Figure 1



OPUS DAYTONKNIGHT

PROJ NO: 364.06
DRAWN BY: ZA
DATE: JUN 2012

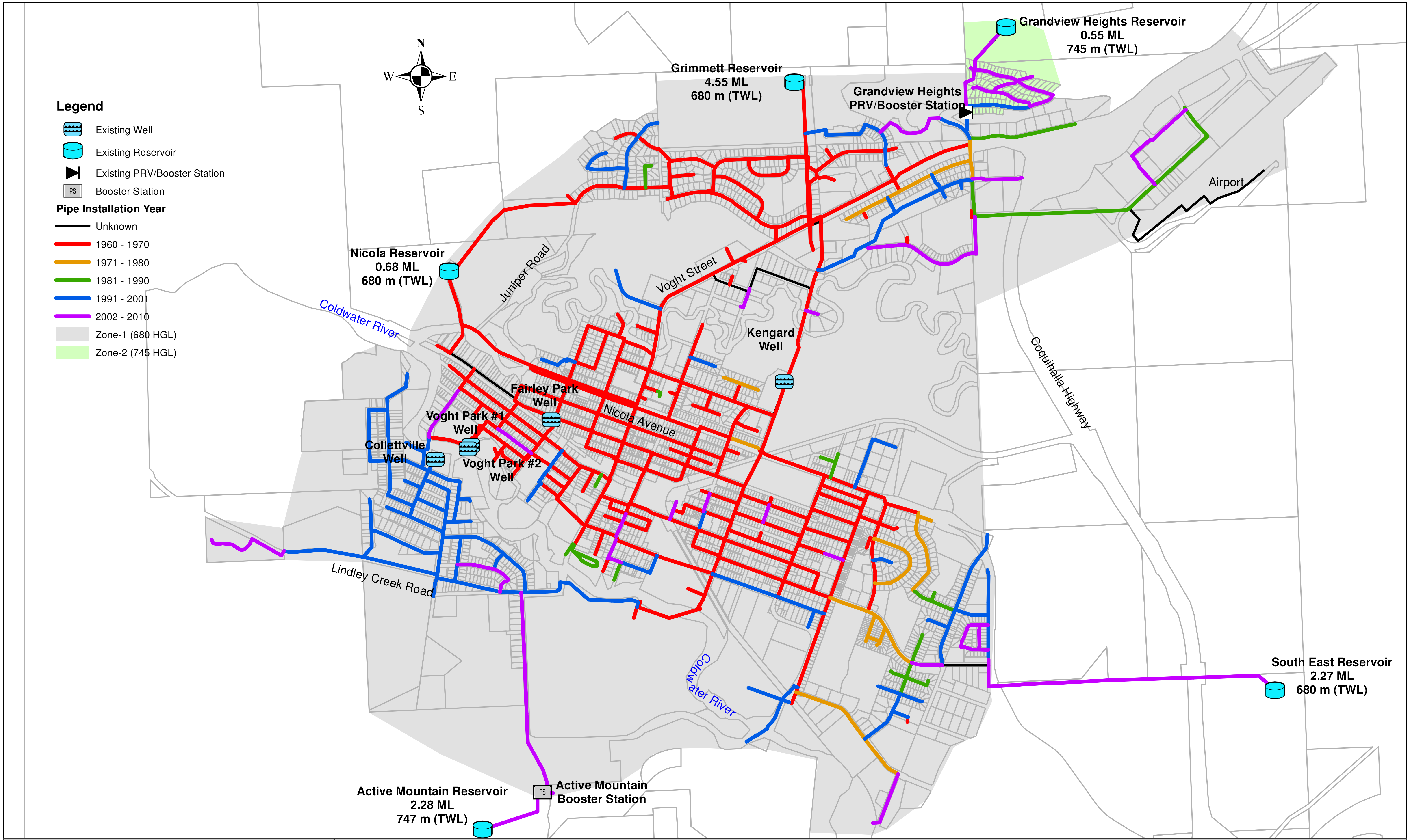
0 187.5 375 750 1,125 1,500 Meters

SCALE 1:17,500

MERRITT
COUNTRY MUSIC CAPITAL OF CANADA

WATER UTILITY MASTER PLAN
EXISTING SYSTEM

FIGURE 3-1



OPUS DAYTONKNIGHT

PROJ NO: 364.06
DRAWN BY: ZA
DATE: JUN 2012

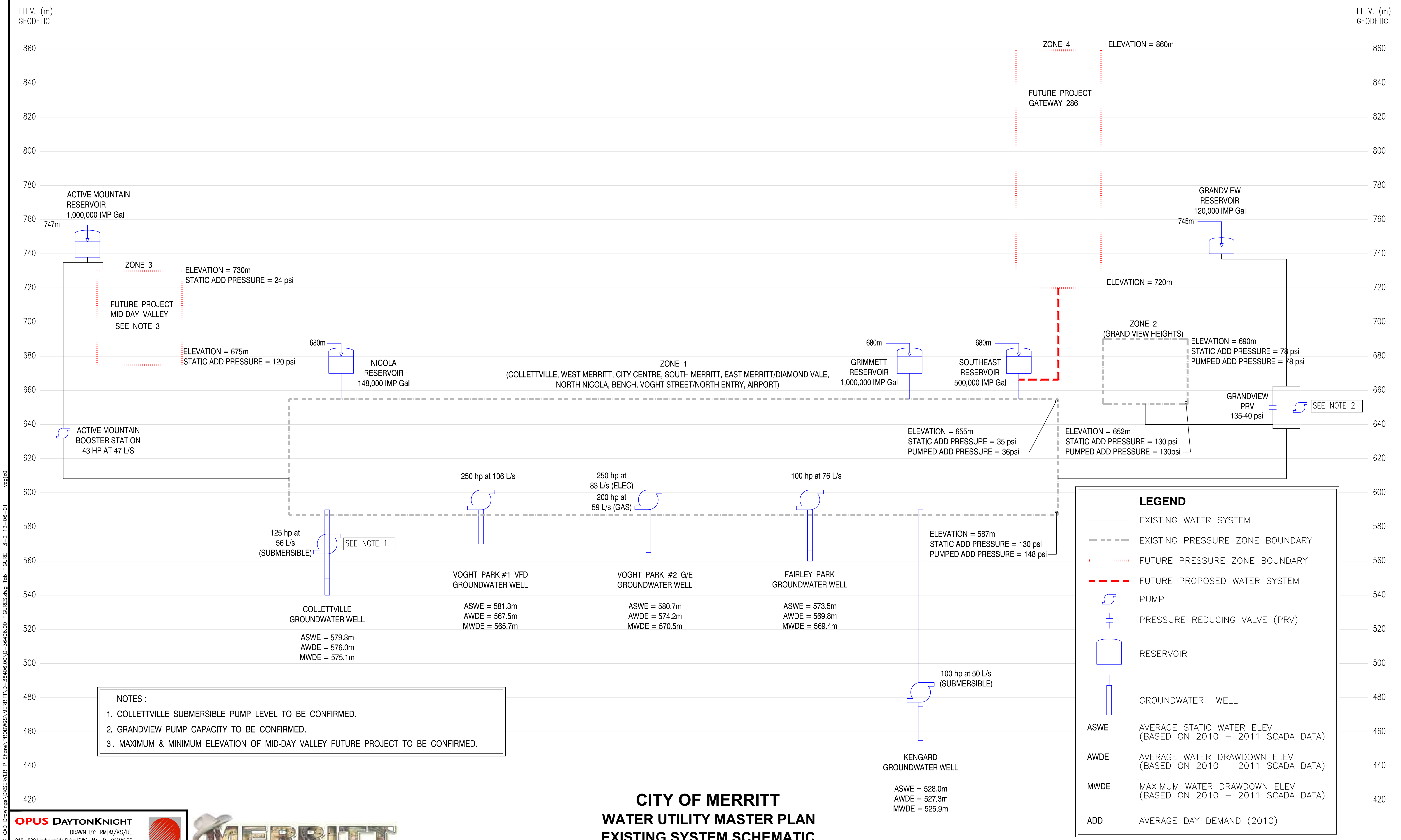
0 187.5 375 750 1,125 1,500 Meters

SCALE 1:17,500

MERRITT
COUNTRY MUSIC CAPITAL OF CANADA

WATER UTILITY MASTER PLAN
EXISTING SYSTEM - INSTALLATION YEAR

FIGURE 3-1a



NOTES :

1. COLLETTVILLE SUBMERSIBLE PUMP LEVEL TO BE CONFIRMED.
2. GRANDVIEW PUMP CAPACITY TO BE CONFIRMED.
3. MAXIMUM & MINIMUM ELEVATION OF MID-DAY VALLEY FUTURE PROJECT TO BE CONFIRMED.

CITY OF MERRITT
WATER UTILITY MASTER PLAN
EXISTING SYSTEM SCHEMATIC

FIGURE 3-2

OPUS DAYTONKNIGHT
DRAWN BY: RMDM/KS/RB
210 - 889 Harbourside Drive
DWG. No. D–36406.00
North Vancouver, BC
North Vancouver Office
V7P 3S1, CANADA
604-990-4800

MERRITT
COUNTRY MUSIC CAPITAL OF CANADA

FILE: G:\D&K CAD Drawings\DKSERVER P Share\PRODWGS\MERRITT\D-36406.00\D-36406.00 FIGURES.dwg Tab FIGURE 3-2 12-06-01 vcgjz0 that the aquifer is classified by MoE as “1A” which is the category for highly developed and highly vulnerable aquifers[4]. This is due to factors such as the unconfined nature of the aquifer, the close proximity to Coldwater River, the relatively shallow depths of wells and high water table.

Five production wells are currently used to extract water from the aquifer; May Street well was abandoned in March 2007 and Kengard well was commissioned in April 2011. Voght Park #2 is equipped with two pump motors, one that runs on electric power and the other is powered by gas. The names and capacities of the wells are listed in Table 3-2[5] and their locations are shown in Figure 3-1.

TABLE 3-2
PRODUCTION WELLS

Well Name	Pump Rate	Well Depth	Depth to Bottom of Suction
Voght Park #1	250 hp at 106 L/s	35 m	24 m
Voght Park #2 Gas/Electric	200 hp at 83 L/s (Electric pump) 200 hp at 59 L/s (Gas pump)	30 m	20 m
Fairley Park	100 hp at 76 L/s	30 m	17 m
Collettville	125 hp at 56 L/s (Submersible)	49 m	32 m
Kengard	100 hp at 50 L/s (Submersible)	135 m	113 m
Total Well Capacity	371 L/s		

From 2005 to 2010, the annual contribution to total water production of each well significantly changed. This is as summarized below and illustrated in Table 3-3.

3.3.1 Voght Park #2 G/E

Annual production was generally increasing. Production increased by 4.5 times from 129.2 ML in 2005 to 613.9 ML in 2010 and its contribution to total production increased

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[4] Source: Aquifer Protection Plan, EBA Engineering Consultants Ltd, December 2002, Page 1

[5] Source: City of Merritt Community Water System Annual Report (2010)

from 4% to 21%, respectively. The highest record was in 2009 at 1,059 ML production and 32% contribution.

3.3.2 Voght Park #1 VFD

Annual production was generally decreasing. Production decreased by 36% from 1,710 ML in 2005 to 1,085 ML in 2010 and its contribution to total production decreased from 53% to 37%, respectively. The lowest record was in 2008 at 763 ML production and 26% contribution.

3.3.3 Fairley Park

Annual production was generally constant from 2005 to 2008 then it decreased in the following two years. This decrease is due to the increased production at Voght Park #2 G/E. Production decreased by 18% from 1,015 ML in 2005 to 834 ML in 2010 and its contribution to total production decreased from 32% to 29%, respectively. The lowest record was in 2009 at 690 ML production and 22% contribution.

3.3.4 Collettville

Annual production was generally constant from 2005 to 2008 then it decreased in the following two years; the later decrease is due to the increased production at Voght Park #2 G/E. Production slightly increased by 16% from 339 ML in 2005 to 393 ML in 2010 and its contribution to total production decreased from 11% to 13%, respectively. The highest record was in 2008 at 691 ML production and 23% contribution.

TABLE 3-3
WATER PRODUCTION BY WELL

Year		**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Voght Park #1 VFD	Production (ML)	1,710	1,713	1,404	763	984	1,085
	Contribution to Total Production	53%	50%	42%	26%	32%	37%
Voght Park #2 G/E	Production (ML)	129	153	277	334	1,059	614
	Contribution to Total Production	4%	4%	8%	11%	34%	21%
Fairley Park	Production (ML)	1,015	1,176	1,186	1,192	690	834
	Contribution to Total Production	32%	34%	35%	40%	22%	29%
Collettville	Production (ML)	339	372	475	691	343	393
	Contribution to Total Production	11%	11%	14%	23%	11%	13%
May Street	Production (ML)	23	22	-	-	-	-
	Contribution to Total Production	< 1%	< 1%	0%	0%	0%	0%
Total Production (ML)		3,215	3,437	3,342	2,980	3,076	2,926

Water production followed a relatively consistent monthly pattern every year showing higher production volumes during the summer months of May to August as shown in Figure 3-3.

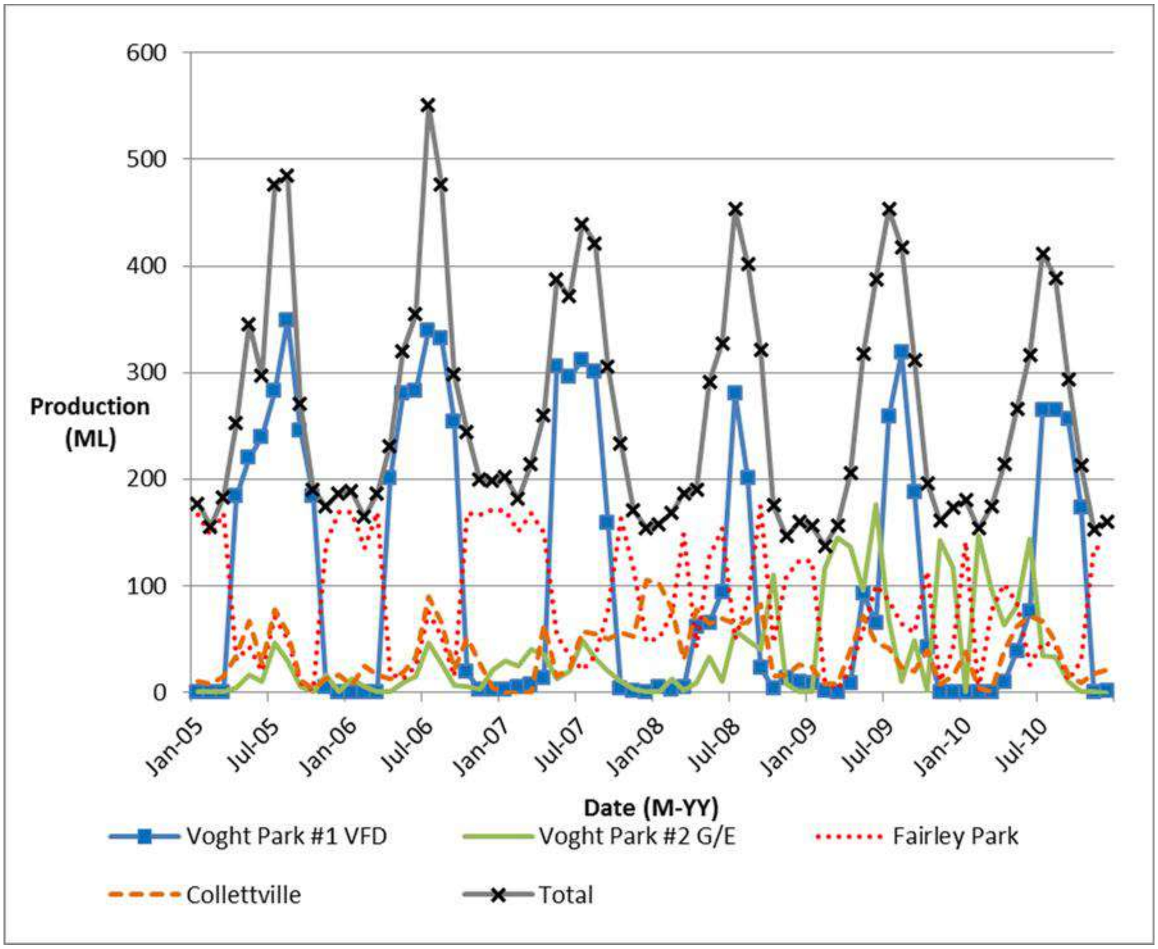

Figure 3-3 Water Production Pattern

3.3 Water Licences

The City of Merritt holds a number of water licenses issued by the Ministry of Environment in BC which are published on the Water Stewardship Licenses Directory[6]. These are listed in Table 3-4 and copies are attached in Appendix B. The water licenses are not currently used by the City but are maintained.

City's licenses are used for wells because shallow aquifers are considered as surface water by the Province.

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[6] Source: http://www.env.gov.bc.ca/wsd/water_rights/scanned_lic_dir/

TABLE 3-4
CITY OF MERRITT WATER LICENSES

License No	Stream Name	Quantity (ML)	License Status	Precedence Date
C025311	Coldwater River	1,659	Current	July 9, 1958
C026589	Coldwater River	25	Current	February 21, 1931
C030750	Coldwater River	768	Current	March 2, 1939
C030751	Coldwater River	768	Current	June 16, 1965
TOTAL		**3,221**		

3.4 Storage Reservoirs

Water storage reservoirs are located at specific elevations to establish pressure zones within the distribution system. Typical design pressures within a zone vary from a minimum of 30 to 40 psi to a maximum of 120 to 150 psi. During a fire event, minimum pressures are allowed to drop to 20 psi.

Water storage is used to balance and optimize supply and delivery of water. If properly sized, reservoirs will store water during low demand periods and supplement the source supply during peak hour demand. Reservoirs are also sized to provide a minimum volume for fire flows. Balancing storage is typically designed as 25% of maximum day demand, while fire storage is calculated per the fire flow requirements for each zone.

In 2011, five storage reservoirs, with a combined storage capacity of 10.3 ML, were operating to cover the storage requirements of the City. These are Nicola, Grimmett, South East, Grandview Heights and Active Mountain reservoirs; South East balancing reservoir was recently commissioned in early 2011. The reservoir capacities and top water elevation details are listed in Table 3-5 and the locations are as shown in Figure 3-1.

TABLE 3-5
STORAGE RESERVOIRS

Reservoir	Capacity (ML)	Top Water Elevation (m)
Grimmett	4.55	680
Nicola	0.67	680
Grandview Heights	0.55	745
South East	2.27	680
Active Mountain[7]	2.28	747
TOTAL	**10.32**	

Grimmett reservoir is the main controlling reservoir for all the lead pumps connected to the City's water system. Pumps are set to start pumping into the system when Grimmett reservoir is at 80% capacity. Pumps stop pumping when the capacity is at 84%.

All of the reservoirs are located in Zone-1 with the exception of Grandview Heights and Active Mountain which are in Zone-2 and Zone-3 respectively.

Zone-1 and Zone-2 are connected by two PRV's located at the Grandview Heights booster station which makes Grandview Heights reservoir available to serve the water demand in Zone-1 when required. Details of the PRV's are listed in Table 3-6.

TABLE 3-6
PRV PARAMETERS

Location	Elevation (m)	Diameter (mm)	Discharge pressure (psi)
Grandview Heights Booster Station	650	75 and 100	40

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[7] According to information and drawings from the City, the existing Active Mountain reservoir is the first phase of the plan. Future phases allow for doubling the capacity of the existing reservoir when required.

Water from Zone-1 is supplied to Zone-3 reservoir through the existing Active Mountain booster station. However, there is presently no PRV existing between these two zones, which mean that if Active Mountain reservoir was to serve Zone-1, it would cause a significant increase in pressure in the distribution system.

3.5 Transmission and Distribution Systems

The transmission and distribution system for the City of Merritt consists of about 71 kilometres of watermains supplying about 7,285 residents in the City and all the industrial and commercial institutions including the airport. The distribution pipes range in diameter from 100 mm to 350 mm many of which were installed in the 1960's. Figure 3-1a illustrates the installation period of the pipes. A summary of the approximate lengths of existing pipes to diameters are listed in Table 3-7, which is based on the 2010 asset information provided by the City.

TABLE 3-7
EXISTING WATERMAINS

Diameter (mm)	Total Length (m)
100	6,741
150	27,807
200	16,826
250	8,924
300	7,855
350	2,867
TOTAL	**71,020**

4.0 WATER DEMAND

This section primarily focuses on the methodology of deriving the future water demand projections in the City of Merritt based on a 20-year time horizon to support the development plans as outlined in Merritt's OCP. The section also discusses the historic population growth and historic water consumption trends in the City as discussed in Technical Memorandum #1: Demand Analysis by Opus DaytonKnight, August 2011.

4.1 Historic Population and Growth Rates

The City's historic population growth is tabulated in Table 4-1 and presented graphically in Figure 4-1. The City of Merritt had a population growth from 1981 to 1996, but a population decrease from 1996 to 2006. According to BC Stats, the population of the City of Merritt in 2010 is estimated at 7,285 based on an annual growth of 1.0% from 2006 to 2010. Over the period of 1981 to 2010 the growth has averaged 0.6% per year.

TABLE 4-1
HISTORICAL POPULATION

Year	Census Population	Annual growth (%)
1981	6,110	-
1986	6,180	0.23
1991	6,253	0.24
1996	7,631	4.06
2001	7,088	-1.47
2006	6,998	-0.26
2010	7,285	1.00

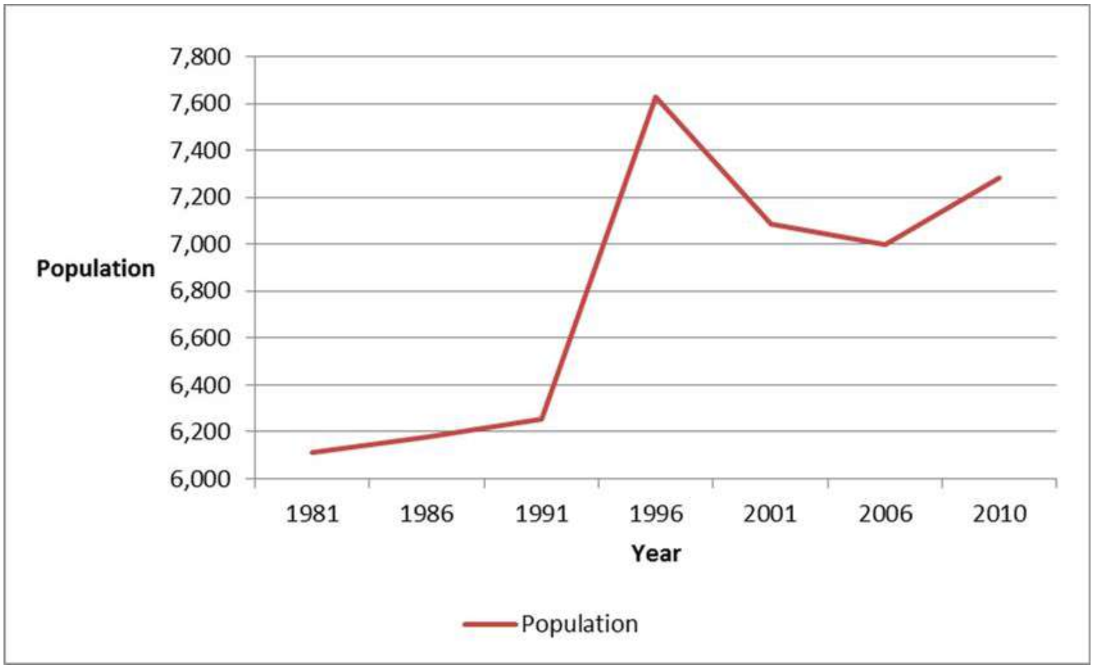


Figure 4-1 Historic Population

Based on discussions with the City of Merritt, two annual population growth rate scenarios have been selected to project future populations. The first is 1.1% per year, which is based on the growth rate in the city from 2006 to 2010, and the second is 3.5% per year, which is based on the OCP (City of Merritt Bylaw 2116, 2011). The two growth rate scenarios are based on population growth due to new development and due to densification; this is outlined in further detail in Technical Memorandum #4: Hydraulic Model Development and Calibration, (Opus DaytonKnight, September 2011).

4.2 Projected Population

Based on the above two growth scenarios, the projected population for Merritt in the year 2030 is provided in Table 4-2. For the next 20 years, the population in Merritt is estimated to grow by approximately 25% at the 1.1% rate and by almost 99% at the 3.5% rate.

TABLE 4-2
PROJECTED POPULATION

Year	Total Population	
	1.1% growth	3.5% growth
2010	7,285	7,285
2015	7,695	8,652
2020	8,127	10,276
2025	8,584	12,205
2030	9,067	14,496

4.3 Historic Demand

Information on historic water demands is ideally obtained from actual water meter readings. This would not be practical for the City since the number of metered connections is limited to less than half of the ICI users and none of the residential users. The City measures and records the volumes of bulk water pumped from the wells and this can be used as a source of information for historic water demands. This approach takes into account all the water pumped into the system including unaccounted-for water usage and leakage, in addition to the actual water consumption by various users.

The total bulk water production was obtained from the City of Merritt’s Community Water System Annual Report from 2005 – 2010. The total annual water supply volume decreased by almost 9% from 3,215 ML in 2006 to 2,926 ML in 2010. The peak maximum water demand in that period was in 2006 at 3,437 ML. This is summarized in Table 4-3.

TABLE 4-3
HISTORICAL DEMAND

Year	Total Water Demand (ML)	Average Day Demand (ML/d)	Maximum Day		Minimum Day	
			Demand (ML/d)	Date	Demand (ML/d)	Date
2005	3,215	8.7	25.6	Aug 9, 2005	4.5	Jan 01, 2005
2006	3,437	9.4	22.0	Jul 24, 2006	4.5	Feb 11, 2006
2007	3,342	9.2	18.5	Jul 27, 2007	3.8	Dec 17, 2007
2008	2,980	8.1	19.6	Jul 2, 2008	4.4	Dec 17, 2007
2009	3,076	8.4	17.7	Jul 22, 2009	4.5	Feb 28, 2009
2010	2,926	8.0	18.5	Aug 2, 2010	4.7	Dec 25, 2010

Based on the above historic total water demands and population, the average and maximum per capita water demands in the city were calculated. Since, the per capita demand is based on all the water supplied to the city as shown in Table 4-4, it includes residential, ICI, leakage and unaccounted-for water.

ADD is the average daily demand per capita in a year regardless of season. The value is useful in analyzing historic demands and patterns and in estimating future demands, which are then used to determine the future volume requirements of the water system. MDD is the maximum water demand per capita per day in a given year, it usually occurs during summer months and it is used for sizing the system’s storage capacity in reservoirs. PHD is the maximum water demand in an hour during a day in a certain year and it usually occurs on or around the day when MDD occurs. PHD is recorded through water demand from the source, as well as balancing storage in the system reservoirs.

Between 2005 and 2010 in Merritt, ADD and MDD have both decreased from 1,246 L/c/d to 1,100 L/c/d and from 3,651 L/c/d to 2,537 L/c/d, respectively. ADD peaked at 1,341 L/c/d in 2006 whereas MDD peaked at 3,651 in 2005. This is summarized in Table 4-4.

TABLE 4-4
PER CAPITA HISTORICAL DEMAND

Year	Population	ADD		MDD	
		(ML/d)	(L/c/d)	(ML/d)	(L/c/d)
2005	7,016	8.7	1,246	25.6	3,651
2006	6,998	9.4	1,341	22.0	3,148
2007	7,070	9.2	1,295	18.5	2,619
2008	7,142	8.1	1,140	19.6	2,738
2009	7,213	8.4	1,165	17.7	2,448
2010	7,285	8.0	1,100	18.5	2,537

4.3.1 Regional Demand Comparison

Table 4-5 compares ADD and MDD for communities in the Southern Interior BC region[1]. The ADD and MDD include both residential, ICI water use and leakage.

TABLE 4-5
WATER DEMAND IN SOUTHERN INTERIOR BC COMMUNITIES

Community	ADD (L/c/d)	MDD (L/c/d)
Vernon (Fully Metered)	550	1,280
Penticton (Fully Metered)	580	1,200
Kelowna (Fully Metered)	600	1,300
Salmon Arm	690	1,490
Kamloops	790	1,800
Merritt	1,100	2,537

Despite the fact that Merritt's per capita demand decreased since 2005, it is still significantly higher than other communities in the Southern Interior BC region.

---

[1] Kamloops 2010 – "Universal Water Meter Recommendation Report", City of Kamloops, March 2010.

4.3.2 Residential and ICI demands

Water consumption in Merritt is divided to two main categories, residential use and ICI use. As discussed previously in Section 3.1, the existing water meters in the City cover approximately 46% of the total ICI water usage and none of the residential usage. Based on the available data from production wells and water meter records, total ICI and residential water demands were calculated. These calculations are detailed in Technical Memorandum #1: Demand Analysis (Opus DaytonKnight, August 2011). Table 4-6 summarizes the existing (2010) ADD, MDD and PHD for residential and ICI use based on the calculated peaking factors. These peaking factors are also used in calculations of MDD and PHD of future demand projections.

In 2010, residential ADD accounted for 64% of the total demand whereas MDD and PHD represented 77% and 82% of the total demand, respectively. This is inclusive of the leakage and unaccounted-for water usage in the system.

TABLE 4-6
DEMANDS (EXISTING 2010) AND PEAKING FACTORS

Land Use	Demand (ML/d)			Peaking Factors		
	ADD	MDD	PHD	ADD	MDD	PHD
Residential	5.1	14.2	25.7	1.00	2.75	5.00
ICI	2.9	4.3	5.7	1.00	1.50	2.00
TOTAL	**8.0**	**18.5**	**31.5**	**1.00**	**2.30**	**3.93**

Based on a residential population of 7,285 in 2010, the per capita daily residential demands are as shown in Table 4-7. These figures do not include ICI demands whereas the figures in Table 4-4 do.

TABLE 4-7
PER CAPITA RESIDENTIAL DEMAND (EXISTING 2010)

Year	Per Capita Residential Demand (L/c/d)		
	ADD	MDD	PHD
2010	707	1,946	3,533

4.4 Future Demand

Future water demand projections in the year 2030 are explained in detail in Technical Memorandum #1: Demand Analysis (Opus DaytonKnight, August 2011). Residential and ICI demands were analyzed separately to develop more accurate projections of the total water demands based on the two annual population growth scenarios of 1.1% and 3.5%. According to Merritt's OCP and water strategy policy, the City plans to implement water conservation programs which aim at gradually reducing water consumption where demands rate in the year 2030 would be 20% less than the existing 2010 rates. This conservation reduction value was accounted for under the 3.5% growth scenario but not for the 1.1% scenario.

Future demand projections in the year 2030 at 1.1% growth rate are based on the following assumptions:

- Additional Residential population = 1,782 people at ADD 707 L/c/d
- Additional Large ICI = 1 at ADD 0.173 ML/d
- Additional Small ICI = 26 at ADD 0.008 ML/d

Future demand projections in the year 2030 at the 3.5% growth rate with 20% water conservation reduction are based on the following assumptions:

- Additional Residential population = 7,211 people at ADD 565 L/c/d
- Additional Large ICI = 3 Nos. at ADD 0.138 ML/d
- Additional Small ICI = 116 Nos. at ADD 0.006 ML/d

Based on the future population projections provided in Table 4-2, the per capita ADD in Table 4-5, the assumptions above and the peaking factors calculated in Table 4-6, the future ADD, MDD and PHD in 2030 for the two growth scenarios are as listed in Table 4-8.

TABLE 4-8
FUTURE DEMANDS (2030)

Land Use	ADD (ML/d)		MDD (ML/d)		PHD (ML/d)	
	1.1%	3.5%	1.1%	3.5%	1.1%	3.5%
Residential	6.4	8.2	17.6	22.6	32.0	41.0
ICI	3.2	3.4	4.9	5.2	6.5	6.9
TOTAL	**9.7**	**11.6**	**22.5**	**27.7**	**38.5**	**47.9**

Based on the projected residential populations in the year 2030, listed in Table 4-2, the per capita daily residential demands are as summarized in Table 4-9.

TABLE 4-9
PER CAPITA RESIDENTIAL DEMAND (FUTURE 2030)

Year	Per Capita Residential Demand (L/c/d)					
	ADD		MDD		PHD	
	1.1%	3.5%	1.1%	3.5%	1.1%	3.5%
2030	707	565	1,946	1,556	3,531	2,826

4.5 Demand Distribution by Zone

Table 4-10 summarizes the distribution of existing and future demands by pressure zone in the City. MDD demands are used for supply and storage reservoir analysis as presented later in Section 6.0.

TABLE 4-10
DEMAND DISTRIBUTION BY ZONE

Zone	Type	2010 Demand (ML/d)			2030 Demand at 1.1% Growth (ML/d)			2030 Demand at 3.5% Growth (ML/d)		
		ADD	MDD	PHD	ADD	MDD	PHD	ADD	MDD	PHD
1	Residential	5.1	14.1	25.6	5.6	15.5	28.2	5.8	16.0	29.1
	ICI	2.9	4.3	5.7	3.1	4.7	6.3	3.2	4.8	6.3
	Sub-Total	*8.0*	*18.4*	*31.3*	*8.8*	*20.2*	*34.5*	*9.0*	*20.7*	*35.4*
2	Residential	0.03	0.089	0.2	0.3	0.7	1.3	0.2	0.6	1.0
	ICI	0	0	0	0	0	0	0	0	0
	Sub-Total	*0.03*	*0.09*	*0.16*	*0.3*	*0.7*	*1.3*	*0.2*	*0.6*	*1.0*
3	Residential	0	0	0	0.1	0.3	0.6	0.4	1.0	1.9
	ICI	0	0	0	0	0	0	0	0	0
	Sub-Total	*0*	*0*	*0*	*0.1*	*0.3*	*0.6*	*0.4*	*1.0*	*1.9*
4	Residential	0	0	0	0.6	1.7	3.1	2.0	5.4	9.9
	ICI	0	0	0	0.1	0	0	0.4	1.0	0.7
	Sub-Total	*0*	*0*	*0.0*	*0.7*	*1.8*	*3.3*	*2.3*	*6.4*	*10.6*
Total		8.0	18.5	31.5	9.9	23.1	39.7	11.9	28.8	48.9

5.0 LEVEL OF SERVICE

The design criteria used to review the system’s minimum service pressures and available fire flows are described under this section. The City of Merritt Subdivision and Development Servicing Bylaw, as well as the Fire Underwriters Survey (FUS) Report were reviewed.

5.1 System Redundancy

Redundancy in the system is required to maintain the operations and reduce service disruptions during maintenance, repair, power outage or unexpected malfunction. Some of the measures that allow redundancy are:

- More than one river/creek crossing such as across Coldwater River and Nicola River.
- Alternative power supply to pumps at wells and booster stations.

5.2 Service Pressures

Minimum service pressures are required to ensure an adequate flow and pressure of water at all serviced properties in the City of Merritt. There are, in most cases, two conditions under which systems should be analyzed or designed for minimum service pressures; these are maximum day demand plus fire flow (MDD+FF) condition and peak hour demand (PHD) condition. Furthermore, maximum service pressures in the system also need to be regulated to prevent over-pressurizing of the system.

Bylaw 1187 of the City notes the following regarding minimum and maximum service pressures during peak hour demand:

<u>Clause 401.1.1:</u>

"Generally, water systems shall be designed for pressures in the range of 210 KPa to 900 KPa, with 210 KPa measured under peak hourly demand conditions and the 900 KPa measured under static conditions."

<u>Clause 401.1.2:</u>

"Where the main pressure at the service exceeds 517 kPa the service shall be protected with a pressure reducing valve at the structure on private property."

The maximum allowable pressure according to the bylaw is 130 psi (900 kPa); however, the hydraulic analysis takes into consideration pressures of up to 140 psi. Moreover, the analysis regards pressures in excess of 100 psi during ADD and PHD as high whereas pressures in the range of 40 psi to 80 psi are regarded as optimum operating pressures. Although the bylaw allows for pressures as low as 30 psi under PHD, standard design recommends using 40 psi as the target. We recommend the target of 40 psi be used and exceptions reviewed case-by-case.

The minimum service pressure during maximum day demand plus fire flow is based on the FUS guidelines and is set at 150 kPa (20 psi).

Table 5-1 summarizes the range of service pressures under various demand conditions used in the hydraulic analysis.

TABLE 5-1
SERVICE PRESSURES

During MDD+FF	Minimum	20 psi (150 kPa)
During PHD	Minimum	40 psi (250 kPa)
	Maximum	140 psi (970 kPa)

5.3 Maximum Velocity

The recommended maximum acceptable velocity for flows in the water system is 3.0 L/s. Constrictions in the water system will introduce high head losses in the water system and is identified through these increased velocities.

5.4 Fire Protection and Storage

Water distribution systems must be able to deliver large volumes of water for fire protection in addition to domestic water demands. Fire protection considerations are:

1. Only one fire will be fought at any one time
2. To ensure pumpers of the fire department obtain adequate water supplies from hydrants, a minimum residual pressure is required on the street main during fires
3. Fire flow is coincident with maximum day demand

Fire protection requirements in Merritt are outlined in Schedule F, Design and Construction Manual, in the City's Subdivision and Development Servicing Bylaw 1187 of 1987. The bylaw refers to the Insurers' Advisory Organization (IAO) standards which are now known as Fire Underwriters Survey (FUS). The following clauses pertaining to flow, duration and spacing requirements are quoted from the bylaw:

Clause 401.1.4:

"Water systems shall also be designed to insure that fire flows as required by the Insurers' Advisory Organization (lAO) are available for required durations and within acceptable pressure limits."

Clause 402.4:

"Fire hydrant spacing shall conform to the latest issue of the Insurers' Advisory Organization (IAO) recommendation. However, in any case, Fire hydrants shall not exceed spacing of 150 m apart."

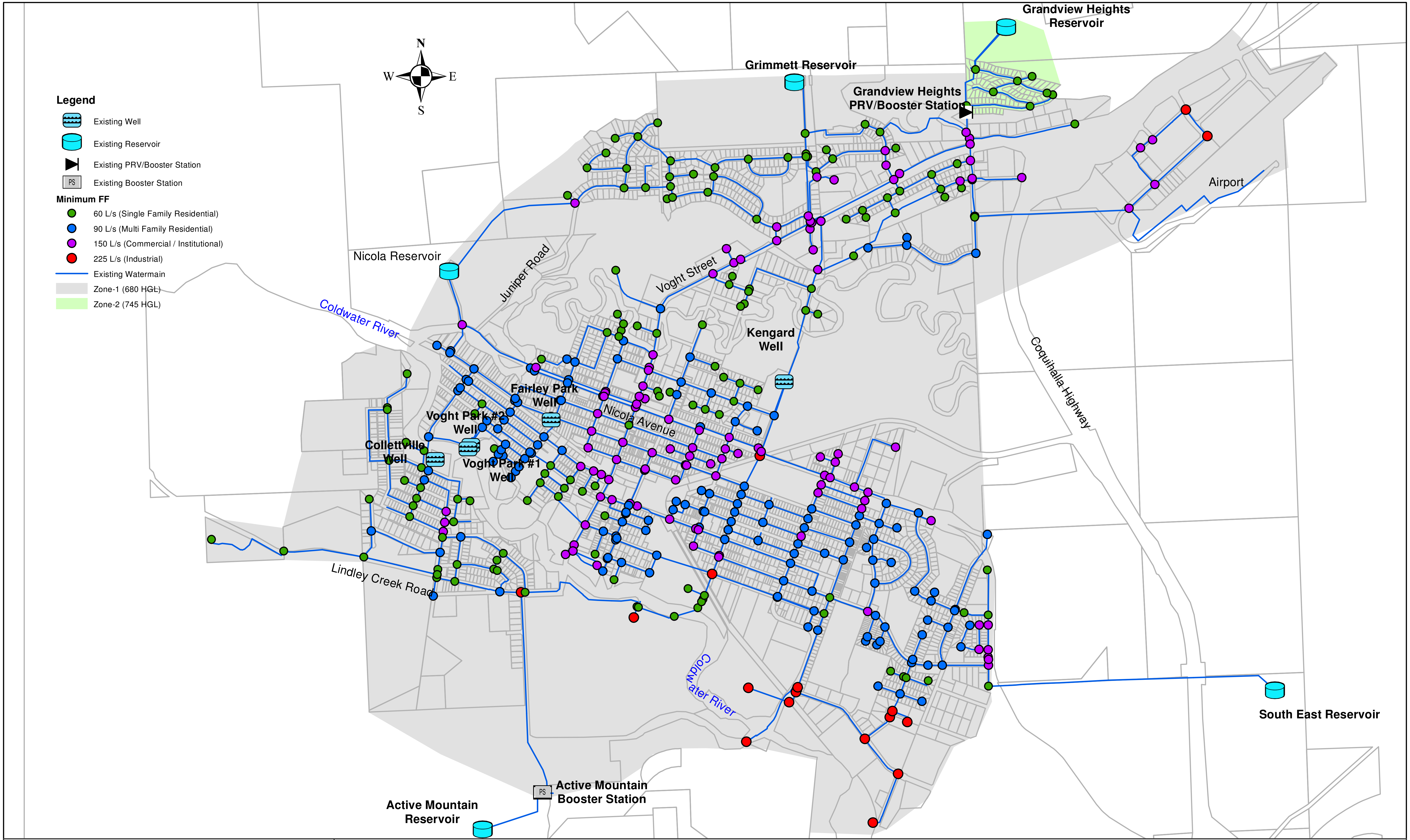
Table 5-2 shows the recommended minimum fire flow requirements for various land use areas and required fire flow durations for Merritt based on the FUS guidelines, Water Supply for Public Fire Protection, published in 1999. Figure 5-1 shows the locations within the City where these various fire flow requirements were assigned in the water model based on the land use zoning in Merritt.

TABLE 5-2
RECOMMENDED FIRE FLOW REQUIREMENTS

Land Use	Required Minimum Fire Flow	Required Duration of Fire Flow
	(L/s)	(Hours)
Single Family Residential	60	1.5
Multi Family Residential	90	2.0
Commercial / Institutional	150	2.0
Industrial	225	3.0

5.5 Supply Storage

The existing water system in Merritt is made up of two pressure zones in order to maintain a reasonable range of high and low pressures throughout the City.



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0 187.5 375 750 1,125 1,500 Meters

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RECOMMENDED FIRE FLOW

FIGURE 5-1

Typically, reservoirs are designed to refill every day and to have adequate storage capacity to provide for balancing storage, which is estimated as 25% of maximum day demand, and fire storage based on the FUS recommended flow and duration listed in Table 5-2. Storage volumes requirements are estimated based on the following formula:

$$Volume = 0.25 \times (MDD) + (FF) \times (D)$$

Where:

MDD = total maximum day demand in the entire zone serviced by reservoir(s)
FF = highest fire flow requirement for land uses in the zone
D = required duration of fire flow as noted in the Fire Underwriter's Survey regulations

6.0 EXISTING HYDRAULIC ANALYSIS

This section of the report covers the hydraulic analysis of the existing waster system in Merritt, based on the year 2010-2011 conditions. The objective of the analysis is to assess the system's performance with respect to compliance with the level of service outlined in Section 5 and to highlight existing deficiencies in the system and appropriate upgrading options for the short term.

The four components of the system namely, source supply capacity, water treatment and quality, storage, and transmission and distribution system are discussed in the following subsections.

6.1 Source Supply Capacity

The analysis for source water supply is based on the maximum production levels from each of the existing wells. As of mid 2011, there were five production wells operating to supply water to the City as listed in Table 6-1. Collettville has the largest maximum production capacity which corresponds to approximately 28% of the City's total maximum production capacity of 371.9 L/s. Kengard is the newest well and was commissioned in April 2011.

The quantitative water source analysis is based on two scenarios. The first scenario assumes that all production wells are operating at maximum capacity and the second scenario assumes that the largest well is out of service. The second scenario is considered a worst case scenario and provides an indication of the level of water source security and supply redundancy within the system.

Table 6-1 lists the pump design capacity of the production wells and compares them to the existing ADD and MDD for the year 2010. It is noted that:

- Scenario-1: With all the wells operating at maximum production and simultaneously, there is an excess of 158 L/s during MDD.
- Scenario-2: With the largest well out of service and all the other wells operating at maximum production and simultaneously, there is an excess of 51.6 L/s during MDD.

TABLE 6-1
WATER SUPPLY ANALYSIS (EXISTING 2010-2011)

Item	Description	Capacity (L/s)
	Maximum Supply Capacity (L/s)	
A	Voght Park#1 VFD	106.4
B	Voght Park#2 G/E	83.3
C	Fairley Park	75.8
D	Collettville	56.4
E	Kengard	50.0
F	Total Production, = A+B+C+D+E	371.9
G	Total Production (with largest well out of service), = F-A	265.5
	Existing Demand (L/s)	
H	ADD	92.8
I	MDD	213.9
	Maximum Supply – Existing Demand (L/s)	
J	Total Production – ADD, = F-H	279.1
K	Total Production (with largest well out of service) – ADD, = G-H	172.7
L	Total Production – MDD, = F-I	158
M	Total Production (with largest well out of service) – MDD, = G-I	51.6

A third scenario that is worthwhile analyzing is water supply during power failure. Currently the city has one natural gas motor for the pump at Voght Park #2. The gas motor has a capacity of 59 L/s. As a result, the City has deficiency of 155 L/s during MDD and 34 L/s during ADD.

Recommendations:

The quantitative water source analysis concludes that there is sufficient capacity in the production wells to meet current maximum day demands of the city. However, during an extended power failure the city's water demands cannot be met solely from the production wells and the balance demand would be provided from the storage in reservoirs.

The available capacity during a power failure is considered deficient to meet both ADD and MDD. It is recommended that backup power be added to Fairley Park production well in order to provide two wells with reasonable separation in the system that would have a combined capacity of the ADD.

The City currently follows an operational scheme where the contribution of wells to total production varies on a daily and seasonal basis; this is explained in Section 3.3. It is recommended that the City maintains this scheme.

6.2 Water Treatment and Quality

6.2.1 Regulations

The BC Drinking Water Protection Act and Regulation implemented in 2003 formed the preliminary stages for water treatment requirements in the Province. The Act and Regulation outline specific requirements that a water purveyor must meet, specifically:

- water monitoring;
- emergency response plans;
- maintenance plans;
- minimum levels of training; and
- maximum E.Coli and total coliform levels for treated water.

The required treatment is determined with the local Health Authority and typically follows the Canadian Drinking Water Quality Guidelines. The current treatment requirements in BC for all surface waters (and Groundwater Under the Direct Influence of surface waters, GUDI) are typically as follows:

- 99.99% (4-log) removal of viruses;
- 99.9% (3-log) removal of Giardia and Cryptosporidium;
- Dual treatment; and
- 1 NTU turbidity;
- 0 Fecal and Total Coliform (or E. Coli).

Health Canada is currently in the process of updating the Turbidity Guidelines. Those guidelines recommend that the treatment requirements for a GUDI well are equivalent to those for a surface water source, which requires filtration. However, as the turbidity of the well system is historically below 1.0 NTU the well system would likely comply with the filtration deferral as permitted by the IHA. The requirements for an unfiltered source are as follows, based on the 2011 draft turbidity guidelines:

- Vulnerabilities assessment – review of the current understanding of the hazards inherent to the water source,
- Source water protection – a thorough understanding of measures being taken by all stakeholders to protect the source water should be maintained and documented over time.

- Sanitary survey – undertake adequate inspection and preventative maintenance from source to tap on a regular basis.
- Treatment – Provide 3-log reduction of Giardia and Cryptosporidium and 4-log reduction of viruses.
- Distribution – Ensure monitoring and integrity of the distribution system.
- Contingency or emergency response plan – provide a well developed site-specific emergency response plan for episodes of elevated turbidity.

Groundwater which is microbially secure as determined from aquifer pump tests and hydro-geological assessment typically will only require some form of secondary disinfection (usually chlorination). It is however, good practice, and recommended by Health Canada that sufficient disinfection be provided to achieve 99.99% virus disinfection (4-Log). This is readily achieved with a chlorination system. Furthermore, a minimum chlorine residual of 0.2 mg/L in the distribution of the water is required by the Interior Health Authority and is recommended by Health Canada. This residual would be provided through the same chlorination system as the source disinfection system.

6.2.2 Disinfection

The City of Merritt draws water from two aquifers, the shallow unconfined aquifer and the deep aquifer. Based on the available hydro-geotechnical reviews completed the shallow aquifer appears to be classified as a GUDI source. Work completed by B.C. Groundwater indicates that the deep aquifer may be at risk of being a GUDI source; however, further dialogue has been on-going with the Interior Health Authority to determine if the source is truly a GUDI well or subject to elevated MPA testing. MPA testing completed to-date during the well development indicated a risk factor of “high”, largely driven by the presence of plant debris.

Shallow Aquifer

The addition of chlorine to the shallow wells addresses the requirement for residual chlorine in the distribution system. At present, the City does not achieve the recommended 4-log virus treatment prior to the first consumer. Furthermore, the City does not provide dual barrier treatment on the system. Typically, this is provided through the application of a UV system, which provides both the 3-log protozoan treatment and the dual barrier.

As part of the City's long term water plan it is recommended that the City budget for the installation of a secondary disinfection, such as UV, on the wells located in the shallow aquifer. The City should also prepare a letter to the IHA providing the historic turbidity data and analysis to support the criteria for filtration deferral. As a general rule, the IHA does not provide an exemption from filtration as some water sources are subject to water quality deterioration over time. As such, a deferral is provided such that there is a mechanism for routine re-evaluation of the water quality parameters.

The UV system could be installed at each well site, or as a common facility with each well pumped to the treatment plant. We have completed a preliminary review of the various options which is summarized in the following Table 6-2.

TABLE 6-2
UV FACILITY SITING EVALUATION

Scenario	Treatment Building Costs	Pipe Costs	Total[2]
Each well provided with separate UV facilities each with duty/stand-by provisions	Fairley = $800,000	Nominal	$2,400,000
	Voght = $1,000,000		
	Collettville = $600,000		
One system for Voght and Collettville, a separate system for Fairly	Fairly = $800,000	320 m @ 300 $/m + $30,000[1] = $126,000	$2,200,000
	Voght/Collettville = $1,200,000		
All wells treated at a new Voght Park Facility	$1,400,000	320 m @ 300 $/m + $30,000[1] = $126,000 800 m @ 350 $/m = $240,000	$1,800,000

[1] – Allowance for bridge crossing

[2] – Prices for comparison purposes only.

In addition to having a lower capital cost for construction a single UV facility would reduce the operating costs associated with maintenance, security, operations time and insurance. As such, we would recommend that a common facility at Voght Park be constructed.

Deep Aquifer

Based on the Kengard well design brief provisions were made to permit the future installation of a UV disinfection system. The available data for the well is based on information collected during the well pump test; as such we would recommend that further monitoring be undertaken prior to the implementation of additional treatment given the uncertainty in the available hydro-geotechnical evaluations. However, we would recommend that the well be operated such that a 4-log virus disinfection be provided at all times to provide a level of protection given the GUDI uncertainty.

We reviewed the current connection of the well to the City's distribution system to determine the chlorine contact time (CT) currently achieved. The CT value is compared to the requirements outlined in the Canadian Drinking Water Quality Guidelines to determine the achieved log reduction of viruses. The calculation is as follows:

- Current well capacity	= 50 L/s (3 m^3/min)
- Length of pipe to connection to the distribution system	= 260 m
- Diameter of tie-in pipe	= 0.6 mg/L
- Baffle Factor (plug flow pipe hydraulics)	= 1.0

$$\mathrm{CT} = \frac{\left[\dfrac{(0.3\,\mathrm{m}^2)*\text{®}}{4}\,x260\,\mathrm{m}\right]}{3\,\mathrm{m}^3/\mathrm{min}}\,x\,1.0\;x\;0.6\;\;\mathrm{mg/L} = 3.7\;\;\mathrm{mg/L} - \mathrm{min}$$

The required CT to achieve 4-log virus reduction is 8 mg/L-min for 5ºC water or 6 mg/L-min for 10ºC water. As such, the current contact time does not provide sufficient disinfection prior to the first consumer at the initial flow rates.

The first consumer of this water is the Kengard School. As such we would recommend that a valve be installed between the distribution pipe along Merritt Ave and the connection to the Kengard supply main. This will force the water to flow first down the 350 mm diameter trunk main to Nicola Avenue at which point the water will have achieve the required contact time.

In order to achieve the required flow rate based on the available pipe length a 450 mm diameter pipe is required. Upon expansion of the well to the potential ultimate of 150 L/s the contact pipe requirements based on a 260 m length to the tie-in would be two parallel 600 mm diameter mains.

6.2.3 Water Quality

The City's current water supply from the shallow aquifer is very high quality with low turbidity and moderate hardness (125 mg/L $CaCO_3$). Since routine water quality monitoring was initiated there have been a few iron and manganese samples which exceeded the recommended guidelines. The Collettville well tested high for iron in 1999 all other tests were below the guideline levels. In 2003 and 2008 the Voght park G/E well measured above the manganese guideline; however, all other tests were within guideline levels. Given that the majority of the tests are within the guideline levels no treatment for iron or manganese is recommended.

The Kengard well was installed in 2010 and has not yet been routinely operated. As such, there is limited available water quality information. The available data indicates that the well has a hardness of around 390 mg/L $CaCO_3$ and a manganese level of 0.076 mg/L. The hardness exceeds the recommended aesthetic level of 120 mg/L in the Drinking Water Quality Guidelines. In order to reduce the hardness to the recommended level either ion exchange or precipitation softening techniques are utilized. Both these treatment methods would result in a multi-million dollar filtration system. Typically, most municipalities elect to operate at elevated hardness rather than install the necessary filtration. At this time, we would not recommend the City purse treatment for the hardness unless there is a significant level of public complaints about calcium deposition.

The recommended guideline for manganese is 0.05 mg/L. The elevated manganese will likely result in discoloured water at the consumer taps along with an increase in solids in the distribution network. Manganese will be present in the untreated well water as a dissolved metal, upon exposure to chlorine the manganese will be slowly converted from a dissolved metal to a precipitate. The precipitate will add a brown colour to the water and will settle in the distribution system, primarily around the well. Due to the City's common distribution/ transmission network dilution of this water with the shallow aquifer water will not be practical.

As with hardness, treating this well for manganese will necessitate a multi-million dollar filtration system. As such, the City should not proceed with this type of work based on the available water quality information. We would recommend that the manganese be monitored in the well following routine and continuous operation of the system. We would also recommend that the City implement a routine flushing program of the distribution system around the Kengard well to minimize the long term build-up of solids in the pipes. This will reduce the long term chlorine demand and minimize the risk of positive coliform tests taken in the distribution system.

6.2.4 Recommendations

Based on the foregoing the following are recommended:

1. Install UV disinfection on the shallow aquifer wells. The City should initiate preliminary design studies for this work in 2013/2014 and have the necessary documentation in place to apply for a grant to support the construction of this work.

2. Install UV analyzers at the shallow wells in order to initiate the collection of UVT data which would be required for the design of a UV system.

3. Complete a sanitary survey for the shallow wells, update the City’s emergency response plan to address elevated turbidity in the shallow aquifer wells and complete a vulnerability study as recommended in the Health Canada guidelines for unfiltered sources.

4. As the Kengard well is utilized implement a flushing program for all the pipes around the Kengard well to address the potential for manganese precipitation in the pipe network.

5. Initiate a semi-annual MPA testing program for the Kengard well. A bi-weekly manganese monitoring program on the raw well water using handheld equipment should be initiated and completed as part of the routine testing completed by City staff.

6. Develop a standard municipal response to address potential complaints associated with the change in hardness and potential impact of the manganese due to the use of the Kengard well.

7. Isolate the watermain along Merritt Ave from the Kengard Well water supply line, forcing the well water to first flow down the 350 mm diameter trunk main to Nicole Ave to achieve the required chlorine contact time.

6.3 Storage

Analysis of the storage capacity in the City was conducted to determine whether the existing reservoirs have sufficient volume to maintain enough balancing storage during MDD and fire storage during fire events.

Table 6-3 summarizes the storage reservoirs that contribute to each pressure zone in the City's water system. It also presents the existing total capacities and storage requirements for balancing and fire demands. The balancing storage and fire storage figures in Table 6-3 are calculated based on the following:

- Zone-1 is made up of multi-family, commercial and industrial areas. Fire demand is based on industrial fire rate of 225 L/s for 3 hrs duration.
- Grandview reservoir is located in Zone-2 and can contribute to domestic and fire demands of Zone-1 when necessary.
- Zone-2 is made up of single-family residential areas. Fire demand is based on residential fire rate of 60 L/s for 1.5 hrs duration.
- Zone-2 population is assumed at 46 capita, based on 20 houses in 2010 at 2.3 capita per house. MDD is calculated at 1,941 L/c/d.
- Zone-3 is a multi-family/commercial future development; no balancing storage required at present. Fire demand is based on 150 L/s for 2 hrs duration. Active Mountain reservoir cannot contribute to domestic and fire demands in Zone-1 because there is no PRV between the two zones.

- No more than one fire occurrence at a time in all zones combined, i.e. simultaneous fire events in the City are not considered.

TABLE 6-3
STORAGE ANALYSIS (EXISTING 2010)

Zone	Contributing Reservoirs	Total Capacity (ML)	Required Balancing Storage (ML)	Required Fire Storage (ML)	Total Required Storage (ML)	Surplus Storage (ML)
1	Grimmett	4.55				
	Nicola	0.67				
	South East	2.27				
	Grandview (Zone-2)	0.55				
	Sub-Total	8.04	4.62	2.43	7.05	0.99
2	Grandview	0.55	0.02	0.32	0.35	0.20
3	Active Mountain	2.28	0	1.08	1.08	1.20

Based on the foregoing, the following is noted:

- **Zone-1:** With four reservoirs servicing this zone, including Grandview Heights reservoir, the current total storage capacity meets the minimum storage requirements for fire demand during maximum domestic consumption, with a surplus of approximately 0.99 ML (990 m^3).

  The existing PRV's between the Grandview Heights pressure zone and Zone-1 are 75 mm and 100 mm diameter which can provide a maximum flow of approximately 30 L/s and 50 L/s, respectively, which exceeds the MDD of 15 L/s in 2030 in Grandview Heights (Zone-2). Also, the combined capacity of the PRV's is 80 L/s which also exceeds the fire flow requirements of 60 L/s in Zone 2. However, we understand the mainline gate valve is normally closed therefore unless the operators intervene, the Grandview Heights reservoir (0.55ML capacity) is not available to serve Zone-1. In this case, the surplus 990 m^3 noted above for Zone-1 is only 440 m^3.

- **Zone-2:** Grandview Heights area currently has sufficient storage in the Grandview reservoir to meet the minimum requirement for fire demand during maximum domestic consumption in the area, with a surplus of approximately 200 m^3.

- **Zone-3:** Active Mountain reservoir has surplus storage capacity for balancing which can be utilized to serve Zone-1. However, this may not be practical with the existing system since there is presently no PRV between the zones.

The City currently operates 3 reservoirs which all have the same top water level. Presently there is no control at the reservoirs which permit the water to be directed to individual tanks. Furthermore, there are not altitude valves. As such, the City will be unable to routinely fill all the tanks as one will fill faster than the other and go to overflow. As the wells are controlled only using the Grimmett reservoir, which fills the fastest, the Southeast Reservoir will not normally fill. To resolve this issue the reservoirs would require, as a minimum, control valves to allow each tank to operate hydraulically independently.

Recommendations:

- Adjust the Grandview Heights PRV pressure settings so that during a fire event in Zone-1, Grandview reservoir can simultaneously contribute to the fire demand in Zone-1 along with other reservoirs.
- Install a new PRV between Zone-1 and Zone-3. This would allow Active Mountain reservoir to serve pressure zone-1 and enhance the water availability to the zone.

6.4 Transmission and Distribution

A hydraulic analysis of the watermains was performed using the WaterCAD model as outlined in technical memorandum No. 4 issued by Opus DaytonKnight, enclosed in Appendix D.

6.4.1 Transmission

An analysis of the supply hydraulic mains under existing MDD conditions was conducted to assess the ability to fill the reservoirs. The water system in Merritt has enough hydraulic capacity in the wells and Grandview Heights booster station to deliver sufficient quantities of water at adequate pressures to the storage reservoirs. Head losses in the transmission pipes are also within acceptable range which means that the pipe sizes adequately serve the existing demands of the City.

6.4.2 Distribution

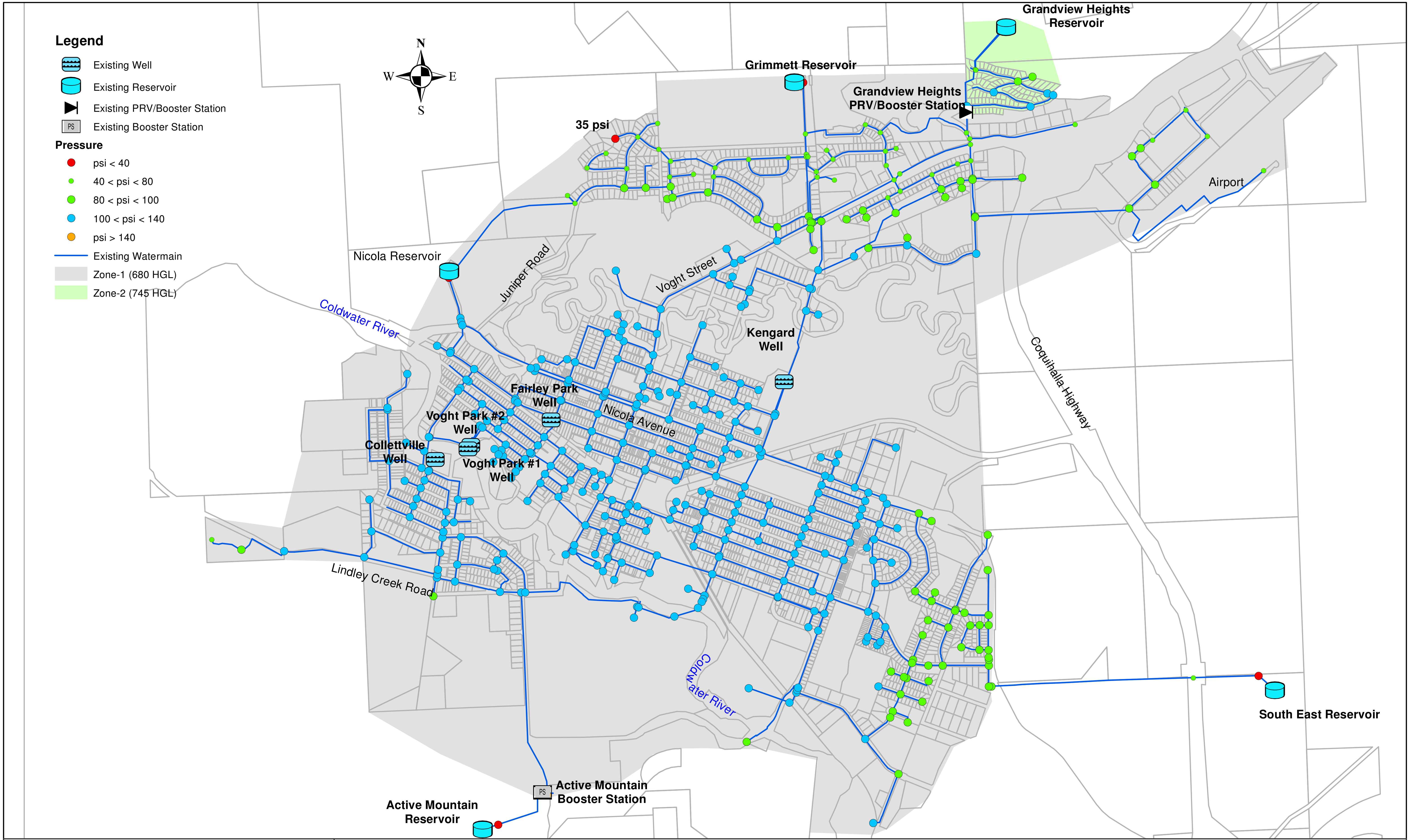
The system was modeled in order to assess the baseline conditions, including:

- Average Day Demand was assessed to evaluate the normal operating conditions and provide a baseline for MDD comparison.
- Minimum residual pressure (20 psi) and maximum recommended velocity (3.0 m/s) during MDD coincident with fire flow. Fire flow is based on one fire event in the entire system.
- Minimum pressure (40 psi) during PHD.
- Maximum recommended pressure (140 psi) during ADD, MDD and PHD

The analysis is discussed in further details in the following sub sections.

6.4.2.1 Average Day Demand

Results from the ADD hydraulic analysis are as summarized in Figure 6-1 and discussed below.



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WATER UTILITY MASTER PLAN
ADD ANALYSIS (EXISTING 2010)

FIGURE 6-1

Zone-1:

Maximum recommended pressure is not exceeded. The maximum pressure is 132 psi at an elevation of 587 m. The ADD analysis shows that pressure in most of the distribution system within this zone exceeds 100 psi.

Zone-2:

Maximum recommended pressure is not exceeded. The maximum pressure is 130 psi at an elevation of 653 m. Pressures above 100 psi also occur in this zone.

6.4.2.2 Maximum Day Demand + Fire Flow

The results from the MDD + FF hydraulic analysis are as summarized in Figure 6-2 which classifies various ranges of fire flow availability throughout the system and identifies where deficiencies are occurring.

Zone-1:

Residual pressure and flow do not meet the minimum fire requirements in some areas of the zone as discussed below:

- Hydraulic nodes with available flow rate of less than 30 L/s are noted with the red dots. These locations are further than 75 m from existing hydrants which have adequate fire flow. The locations are mainly at dead ends and are generally connected to 50 mm diameter service connections. They do not meet the minimum fire flow requirements.

- Areas with fire flow rate of 30 - 60 L/s are noted with orange dots. These locations are further than 75 m from existing hydrants which have adequate fire flow. These locations are mainly at dead ends and are connected by 100 mm or 150 mm diameter service connections. They are identified as P-1 to P-5 in Figure 6-2 and Table 6-4. They do not meet the minimum fire flow requirements.

- Areas with fire flow at 60 – 90 L/s are noted with green dots. Some of these nodes do not meet the minimum fire flow requirements shown in Figure 5-1. These areas are identified as P-6 and P-7 in Figure 6-2 and Table 6-4.

- Areas with fire flow of 90 – 150 L/s are noted with yellow dots. Some of these nodes do not meet the minimum fire flow requirements shown in Figure 5-1. These areas are identified as P-8 and P-15 in Figure 6-2 and Table 6-4.

- Areas with fire flow of 150 – 225 L/s are noted with blue dots. Some of these nodes do not meet the minimum fire flow requirements shown in Figure 5-1. These areas are identified as P-16 and P-18 in Figure 6-2 and Table 6-4.

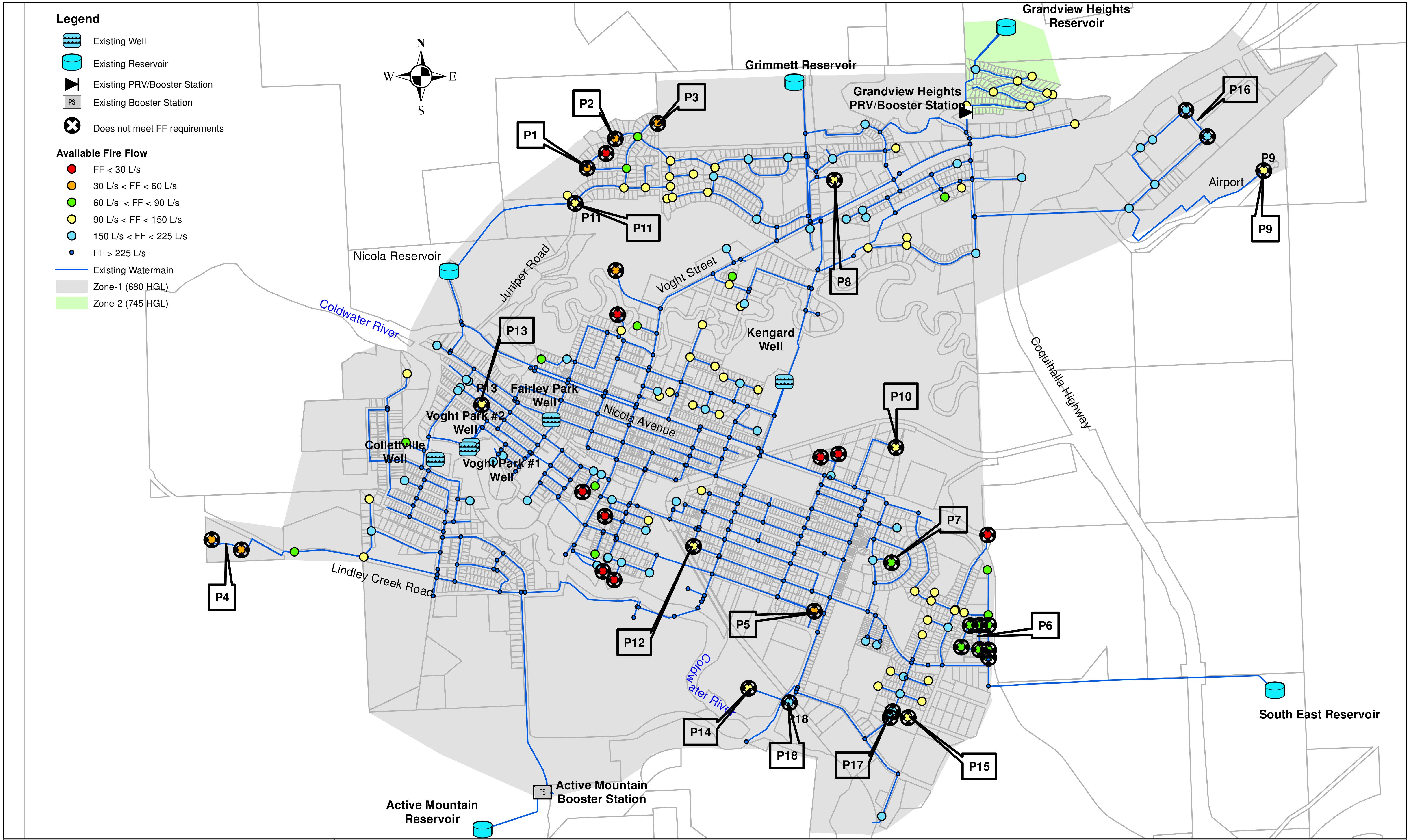
Maximum recommended pressure is slightly exceeded. The maximum pressure is 141 psi at an elevation of 587.4 m located at the Northern end of Pine Street, adjacent to address 801, in Collettville Area.

System pressures are typically lower during MDD then during ADD. The analysis above shows the opposite mainly because more pumps are operating during MDD scenario to supply the higher demands. This consequently increases the pressure in the system because the existing well pumps have different pump curves.

Maximum recommended velocity is not exceeded. The maximum velocity is 1.5 m/s.

Zone-2:

Residual pressure and flow meet minimum fire requirements throughout the zone. The minimum residual pressure at total flow needed is 69.9 psi and the minimum available



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WATER UTILITY MASTER PLAN
MDD+FF ANALYSIS (EXISTING 2010)

FIGURE 6-2

flow is 136.4 L/s, which exceeds the minimum fire flow requirements of 60 L/s in the zone.

Maximum recommended pressure is not exceeded. The maximum pressure achieved is 130.1 psi at an elevation of 652.8 m.

The maximum velocity achieved is 0.94 m/s, which is below the recommended limit.

TABLE 6-4
DISTRIBUTION SYSTEM ANALYSIS AT MDD+FF (EXISTING 2010)

Item	Zone	Location	City Sector
P-1	1	Intersection of Wildrose Way & Sunflower Ave.	Bench
		• Required Fire Flow = 60 L/s. • Flow available = 58.5 L/s. Corresponding residual pressure = 20.0 psi • Connecting pipe size = 150 mm • Elevation = 643.2 m	
P-2	1	Cul-de-sac adjacent to 1602 Ponderosa Way	Bench
		• Required Fire Flow = 60 L/s. • Flow available = 43.6 L/s. Corresponding residual pressure = 20.0 psi • Connecting pipe size = 150 mm • Elevation = 654.7 m	
P-3	1	End of Pine Ridge Dr., adjacent to address #3487	Bench
		• Required Fire Flow = 60 L/s. • Flow available = 55.8 L/s. Corresponding residual pressure = 20.0 psi • Connecting pipe size = 150 mm • Elevation = 648.9 m	
P-4	1	Road A – 20 Lot subdivision	Lindley Creek/Collettville
		• Required Fire Flow = 60 L/s. • Flow available = 52.4 L/s. Corresponding residual pressure = 20.0 psi • Connecting pipe size = 200 mm • Elevation = 630.4 m	
P-5	1	Priest Ave., adjacent to address #2689	East Merritt / Diamond Vale

TABLE 6-4 (cont'd.)
DISTRIBUTION SYSTEM ANALYSIS AT MDD+FF (EXISTING 2010)

Item	Zone	Location	City Sector
		• Required Fire Flow = 90 L/s. • Flow available = 42.8 L/s. Corresponding residual pressure = 20.9 psi • Connecting pipe size = 100 mm • Elevation = 601.6 m	
P-6	1	East of Bann Street and North of Thorpe Road	East Merritt / Diamond Vale
		• Required Fire Flow = 150 L/s. • Flow available = 72.6 L/s. Corresponding residual pressure = 20.7 psi • Connecting pipe size = 150 mm • Elevation = 618.3 m	
P-7	1	Cul-de-sac adjacent at end of Langstaff Place	East Merritt / Diamond Vale
		• Required Fire Flow = 90 L/s. • Flow available = 62.1 L/s. Corresponding residual pressure = 20.0 psi • Connecting pipe size = 100 mm • Elevation = 601.4 m	
P-8	1	Connection to Nicola Valley Health Centre, from Grimmett Street.	Voght Street / North Entry
		• Required Fire Flow = 150 L/s. • Flow available = 134.0 L/s. Corresponding residual pressure = 20.0 psi • Connecting pipe size = 150 mm • Elevation = 630.2 m	
P-9	1	Airport new watermain extension	Airport
		• Required Fire Flow = 225 L/s. • Flow available = 143.4 L/s. Corresponding residual pressure = 20.0 psi • Connecting pipe size = 300 mm • Elevation = 632.6 m	
P-10	1	End of Marian Ave, adjacent to address #2785	East Merritt / Diamond Vale
		• Required Fire Flow = 150 L/s. • Flow available = 91.7 L/s. Corresponding residual pressure = 20.0 psi • Connecting pipe size = 150 mm	

TABLE 6-4 (cont'd.)
DISTRIBUTION SYSTEM ANALYSIS AT MDD+FF (EXISTING 2010)

Item	Zone	Location	City Sector
		• Elevation = 598.5 m	
P-11	1	On Junpier Drive, adjacent to address #1701	Bench
		• Required Fire Flow = 150 L/s. • Flow available = 135.5 L/s. Corresponding residual pressure = 20.0 psi • Connecting pipe size = 250 mm • Elevation = 624.9 m	
P-12	1	Intersection of Blair Street and Clapperton Ave.	East Merritt / Diamond Vale
		• Required Fire Flow = 150 L/s. • Flow available = 124.5 L/s. Corresponding residual pressure = 20.0 psi • Connecting pipe size = 100 mm • Elevation = 598.5 m	
P-13	1	Hydrant # 226 at intersection of Wilson Street and Coldwater Ave.	Collettville
		• Required Fire Flow = 60 L/s. • Flow available = 47.6 L/s. Corresponding residual pressure = 20.8 psi • Connecting pipe size = 50 mm • Elevation = 589.8 m	
P-14	1	End of Houston Street, adjacent to address	East Merritt / Diamond Vale
		• Required Fire Flow = 225 L/s. • Flow available = 96.4 L/s. Corresponding residual pressure = 20.0 psi • Connecting pipe size = 150 mm • Elevation = 602.6 m	
P-15	1	Hydrant # 260 at address #1120 Macflarlane Rd.	East Merritt / Diamond Vale
		• Required Fire Flow = 225 L/s. • Flow available = 127.3 L/s. Corresponding residual pressure = 20.0 psi • Connecting pipe size = 150 mm • Elevation = 612.6 m	
P-16	1	Hydrant # 234 on Airport Road, East side	Voght Street / North Entry
		• Required Fire Flow = 225 L/s.	

TABLE 6-4 (cont'd.)
DISTRIBUTION SYSTEM ANALYSIS AT MDD+FF (EXISTING 2010)

Item	Zone	Location	City Sector
		• Flow available = 176 L/s. Corresponding residual pressure = 20.0 psi • Connecting pipe size = 300 mm • Elevation = 629.0 m	
P-17	1	End of Macflarlane Road, adjacent to FH # 43	East Merritt / Diamond Vale
		• Required Fire Flow = 225 L/s. • Flow available = 186.7 L/s. Corresponding residual pressure = 20.0 psi • Connecting pipe size = 150 mm • Elevation = 610.0 m	
P-18	Same as in P-14		

6.4.2.3 Peak Hour Demand

PHD hydraulic analysis results are as summarized in Figure 6-3 and discussed below.

Zone-1:

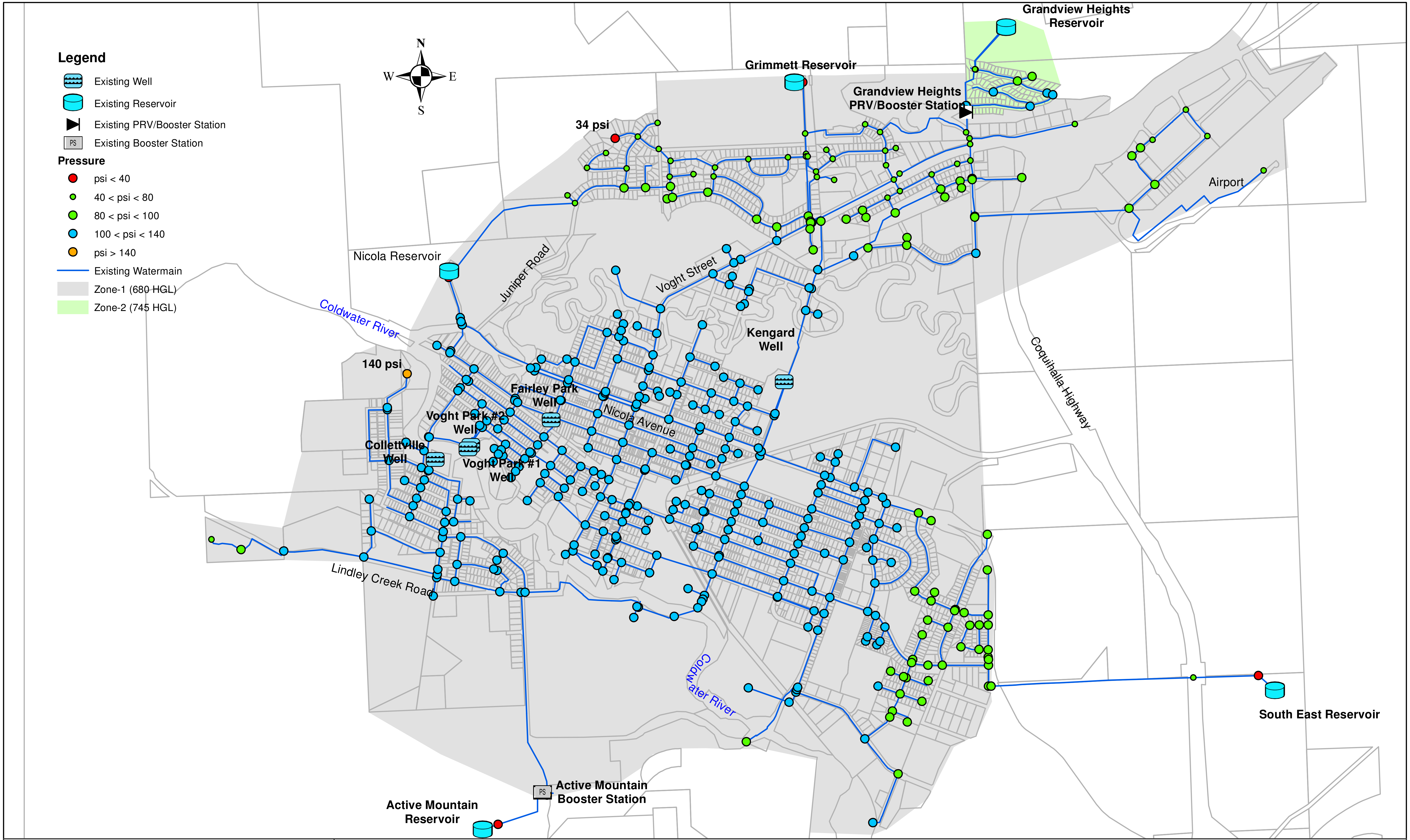
Pressure does not meet minimum requirements in one area noted in Figure 6-3. It occurs at the cul-de-sac adjacent to 1602 Ponderosa Way in Bench area. Elevation at that location is 655 m and the pressure is 34 psi.

Maximum recommended pressure of 140 psi occurs at an elevation of 587 m located at the Northern end of Pine Street, adjacent to address 801, in Collettville Area.

Maximum recommended velocity is not exceeded. The maximum velocity is 1.7 m/s.

Zone-2:

Pressure is more than the minimum requirements throughout the zone. The minimum pressure is 77 psi at an elevation of 690 m.



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SCALE 1:17,500

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WATER UTILITY MASTER PLAN
PHD ANALYSIS (EXISTING 2010)

FIGURE 6-3

Maximum recommended pressure is not exceeded. The maximum pressure in this zone is 130 psi at an elevation of 653 m.

Maximum recommended velocity is not exceeded. The maximum velocity is approximately 0.06 m/s.

6.5 Recommendations

The recommendations to overcome the deficiencies above are detailed below and are illustrated in Figure 6-4.

- R-G: Recommendation- (General): Where possible, upgrade all 50 mm pipe within the distribution system to at least 100 mm and connect dead ends to the closest water main in order to form loops and eliminate dead ends. In certain locations, the deficiency is solved by installing a new fire hydrant, with sufficient fire flow, within 75 m radius of the deficiency location. Figure 6-6 illustrates the proposed locations of new fire hydrants.

- R-1: Upgrade existing 100 mm pipe to 150 mm, approximately 130 m long, from the intersection of Wildrose Way & Sunflower Avenue to cul-de-sac adjacent to 3360 Wildrose Way.

- R-2: Install new 150 mm pipe, approximately 95 m long, to connect the existing pipe ending at cul-de-sac adjacent to 3360 Wildrose Way with pipe ending at cul-de-sac adjacent to 1602 Ponderosa way. This pipe currently crosses through private property, however it would eliminate dead ends and enhance the fire flow requirements in the area, where deficiency location P-1 would have 57.8 L/s compared to the existing available flow of 43.6 L/s. The City should provide for a Right-of-Way through the property if available in the future.

- R-3: Install new 150 mm pipe, approximately 136 m, to connect existing pipe ending at cul-de-sac at Pine Ridge drive to the existing 150 mm pipe at the intersection of Ponderosa Way with Parker Avenue.

- R-4: Upgrade existing 150 mm pipe to 200 mm, approximately 420 m long, along Lindley Creek road from the existing 150 mm pipe at adjacent to Aspen Street to Road-A in the new 20 Lot residential subdivision.

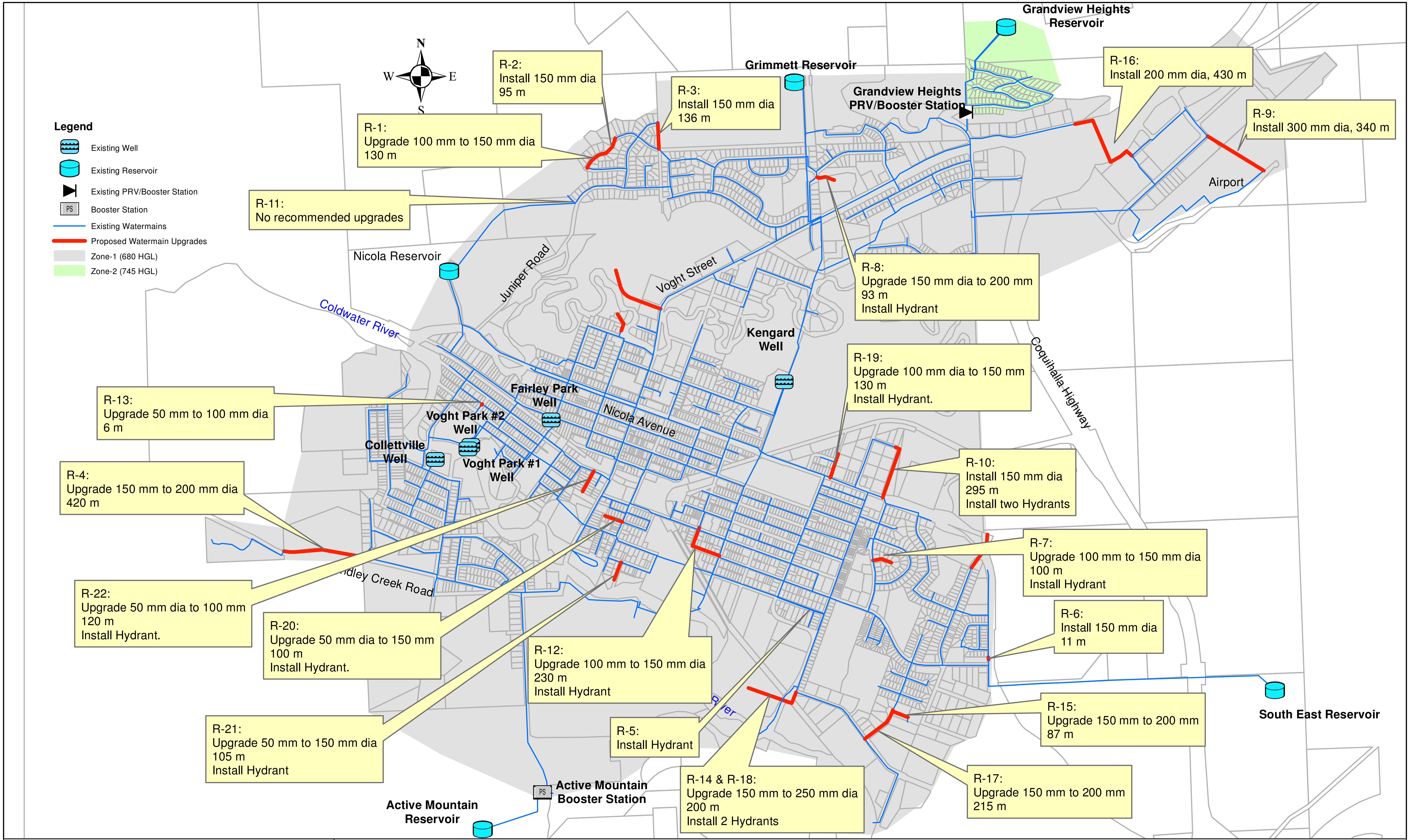
- R-5: Install new fire hydrant within 75 m radius connected to the existing 250 mm main along Priest Avenue.

- R-6: Install a new 150mm diameter pipe, approximate 11.0m long, to connect the existing 400mm diameter to the existing 150mm diameter pipes located parallel to Nicola Avenue (Princeton-Kamloops Highway) and to the North of the junction at Thorpe road in East Merritt/Diamond Vale.

- R-7: Upgrade existing 100 mm pipe to 150 mm, approximately 100 m long, from Menzies Street to end of Langstaff Place and install new fire hydrant at cul-de-sac.

- R-8: Upgrade existing 150 mm pipe to 200 mm, approximately 93 m long, from Grimmett Street to end of connection to Nicola Valley Health Centre and install new fire hydrant adjacent to the building.

- R-9 & R-16: Install a new 300 mm diameter pipe, approximately 340 m long, to connect the end of the new 300 mm extension to the existing 300 mm on Airport road and install a new 200 mm diameter pipe, approximately 430 m long, to connect the exiting 200 mm diameter pipe at the end of DeWolf Street to the existing 200 mm diameter pipe at the intersection of Voght Street with Gordon Street.



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COUNTRY MUSIC CAPITAL OF CANADA

WATER UTILITY MASTER PLAN
PROPOSED UPGRADES

FIGURE 6-4

- R-10: Install a new 150 mm diameter, approximately 295 m long, to form a loop from the end of the existing 150 mm diameter pipe at Marian Avenue and tie to Nicola Avenue (Princeton-Kamloops Highway); the tie-in is opposite to Menzies Street and install two new fire hydrants.

- R-11: This hydrant is adjacent to the golf course which, based on the FUS flow, requires 150 L/s fire flow. The achieved flow is 136 L/s. As this location is above the natural bench, the direct use of this hydrant for the golf course is unlikely. It does meet the residential requirement of 60 L/s which is more likely to be used for. Therefore, we do not recommend any upgrades for this location.

- R-12: Upgrade existing 100 mm pipe to 150 mm, approximately 230 m long, from the intersection of Blair Street and Coldwater Avenue to the intersection of Blair Street and Clapperton Avenue ending at the intersection of Clapperton Avenue and Maye Street. In addition, install a new fire hydrant on Clapperton Avenue between Maye Street and Blair Street.

- R-13: Upgrade existing 50 mm pipe connection to hydrant #226 to 100 mm, approximately 6 m long.

- R-14 & R-18: Upgrade existing 150 mm to 250 mm, approximately 300 m long, from the intersection of Houston Street and Pooley Avenue continuing southwest on Houston Street. In addition, install a new fire hydrant on Houston Street. Install two new fire hydrants.

- R-15: Upgrade existing 150 mm to 200 mm, approximately 87 m long, from cul-de-sac adjacent to 1120 Macfarlane Way to fire hydrant #260. This would increase the FF currently available FF from 127 L/s to 198 L/s, which is closer to the required FF of 225 L/s.

- R-16: See R-9.

- R-17: Upgrade existing 150 mm to 200 mm, approximately 215 m, on McFarlane Way starting from the intersection with Pooley Avenue heading north to the existing fire hydrant # 43 located at the end of the way.

- R-18: See R-14.

Table 6-5 summarizes the recommended upgrade works to overcome the existing deficiencies.

TABLE 6-5
DISTRIBUTION SYSTEM UPGRADE RECOMMENDATIONS

Item	Zone	Proposed work	Deficiency resolved
R-1	1	• Upgrade existing pipe, 100 mm to 150 mm. Length = 130 m	P-1
R-2	1	• Install new pipe, 150 mm. Length = 95 m	P-2
R-3	1	• Install new pipe, 150 mm. Length = 136 m	P-3
R-4	1	• Upgrade existing pipe, 150 mm to 200 mm. Length = 420 m	P-4
R-5	1	• Install new fire hydrant	P-5
R-6	1	• Install new pipe, 150 mm. Length = 11 m	P-6
R-7	1	• Upgrade existing pipe, 100 mm to 150 mm. Length = 100 m • Install new fire hydrant	P-7
R-8	1	• Upgrade existing 150 mm pipe to 200 mm. Length = 93 m • Install new fire hydrant	P-8
R-9	1	• Install new 300 mm diameter pipe. Length = 340 m	P-9 & P-16
R-10	1	• Install new pipe, 150 mm. Length = 295 m • Install two new fire hydrant	P-10
R-11	1	• No upgrades recommended. Refer to bullet point R-11 above.	P-11

TABLE 6-5 (cont'd.)
DISTRIBUTION SYSTEM UPGRADE RECOMMENDATIONS

Item	Zone	Proposed work	Deficiency resolved
R-12	1	• Upgrade 100 mm pipe to 150 mm. Length = 230 m. • Install new fire hydrant	P-12
R-13	1	• Upgrade 50 mm pipe 100 mm. Length = 6 m.	P-13
R-14	1	• Upgrade 150 mm pipe 250 mm. Length = 300 m. • Install two new fire hydrants	P-14 & P-18
R-15	1	• Upgrade 150 mm to 200 mm. Length = 87 m	P-15
R-16	1	• Install new 200 mm diameter pipe. Length = 430 m	P-9 & P-16
R-17	1	• Upgrade 150 mm to 200 mm. Length = 215 m.	P-17
R-18	1	• Same as R-14	
R-19	1	• Upgrade 100 mm dia to 150 mm. Length = 130 m • Install Hydrant	
R-20	1	• Upgrade 50 mm dia to 150 mm. Length = 100 m • Install Hydrant	
R-21	1	• Upgrade 50 mm dia to 150 mm. Length = 105 m • Install Hydrant	
R-22	1	• Upgrade 50 mm dia to 100 mm. Length = 120 m • Install Hydrant	

6.6 Fire Hydrants

A mapping of the hydrant distribution was done to determine the area of influence and coverage of existing hydrants based on the criteria outlined in section 5.4, which is 150 m separation between hydrants. Figure 6-5 illustrates the existing hydrant coverage mapping and identifies areas where coverage is deficient and Figure 6-6 shows the recommended locations of new hydrants.

In addition to the 11 recommended new fire hydrants in Table 6-6, 31 additional hydrants would be required to overcome the hydrant coverage deficiency. Further study with the local fire department should be conducted to prioritize the need for all these hydrants.

6.7 Cost Estimate and Schedule

The estimated capital costs of the recommended improvements required in each zone, as noted in Section 6.5, for the existing system is summarized below.

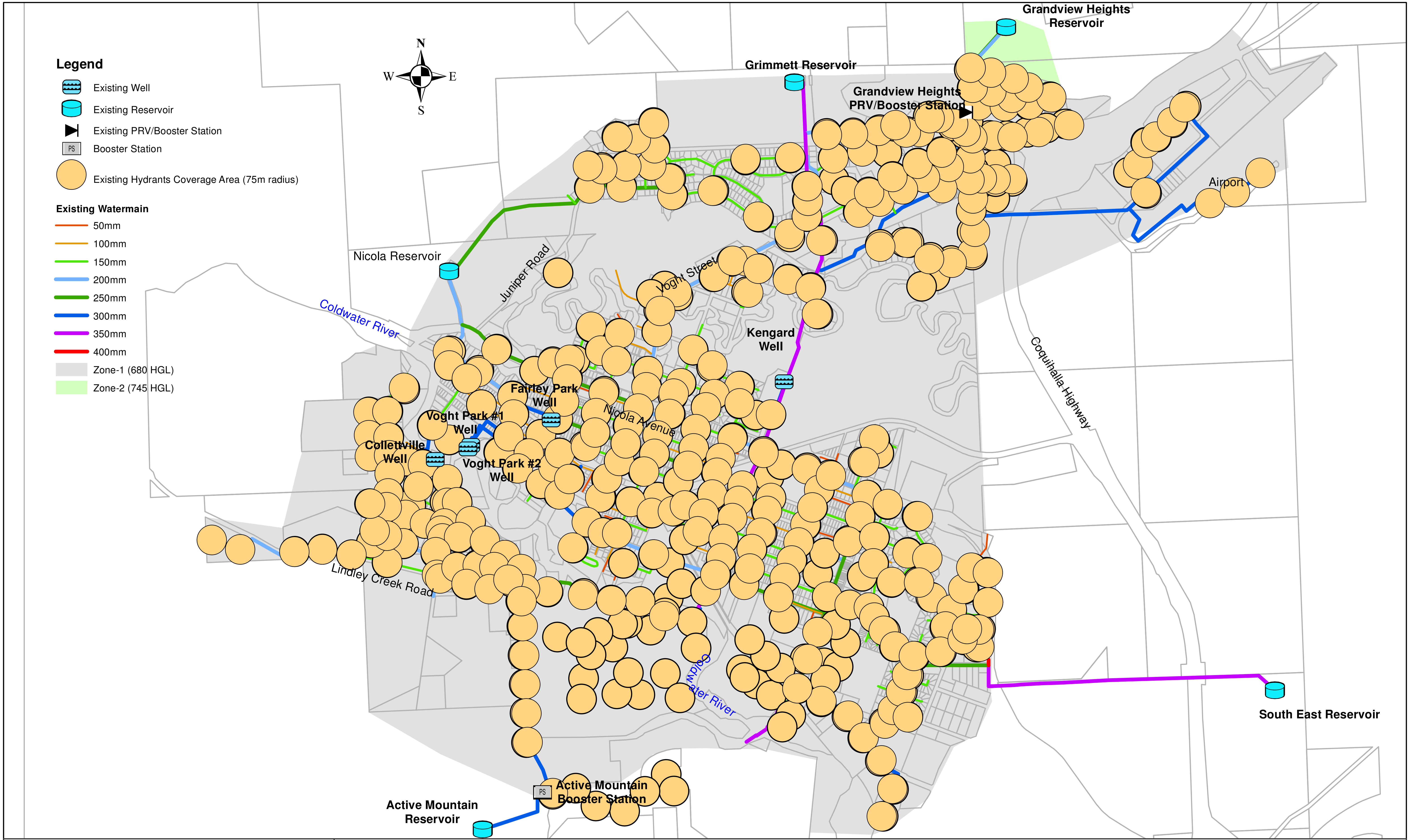
The recommended upgrades are required to improve the efficiency of the existing system under the current demands and conditions. However, the suggested schedule of upgrades is provided as an indication and to stage the works. It is categorized to short term (within 0-5 years), medium term (within 5-12 years) and long term (within 12-20 years). Other factors such as availability of funding and capital budget in the City to undertake these upgrade works are not taken into account and are dependent on the City's decision and investment priorities.

TABLE 6-6
EXISTING WATER SYSTEM UPGRADES

Item	Zone	Proposed Work	Capital Cost	Suggested Schedule
R-1	1	Upgrade existing pipe, 100 mm to 150 mm. Length = 130 m	43,000	Long term
R-2	1	Install new pipe, 150 mm. Length = 95 m	31,000	Long term
R-3	1	Install new pipe, 150 mm. Length = 136 m	45,000	Long term
R-4	1	Upgrade existing pipe, 150 mm to 200 mm. Length = 420 m	183,000	Medium term
R-5	1	Install new fire hydrant	4,000	Short term
R-6	1	Install new pipe, 150 mm. Length = 11 m	4,000	Short term
R-7	1	Upgrade existing pipe, 100 mm to 150 mm. Length = 100 m Install new fire hydrant	37,000	Medium term

TABLE 6-6 (cont'd.)
EXISTING WATER SYSTEM UPGRADES

Item	Zone	Proposed Work	Capital Cost	Suggested Schedule
R-8	1	Upgrade existing 150 mm pipe to 200 mm. Length = 93 m Install new fire hydrant	45,000	Short term
R-9	1	Install new 300 mm diameter pipe. Length = 340 m	223,000	Short term
R-10	1	Install new pipe, 150 mm. Length = 295 m Install two new fire hydrant	105,000	Short term
R-11	1	No upgrade recommendations		
R-12	1	Upgrade 100 mm pipe to 150 mm. Length = 230 m. Install new fire hydrant	75,000	Medium term
R-13	1	Upgrade 50 mm pipe 100 mm. Length = 6 m.	10,000	Short term
R-14	1	Upgrade 150 mm pipe 250 mm. Length = 300 m. Install two new fire hydrants	168,000	Short term
R-15	1	Upgrade 150 mm to 200 mm. Length = 87 m	38,000	Medium term
R-16	1	Install new 200 mm diameter pipe. Length = 430 m	188,000	Short term
R-17	1	Upgrade 150 mm to 200 mm. Length = 215 m.	94,000	Short term
R-19	1	Upgrade 100 mm dia to 150 mm. Length = 130 m Install Hydrant	29,000	Medium term
R-20	1	Upgrade 50 mm dia to 150 mm. Length = 100 m Install Hydrant	19,000	Short term
R-21	1	Upgrade 50 mm dia to 150 mm. Length = 105 m Install Hydrant	20,000	Short term
R-22	1	Upgrade 50 mm dia to 100 mm. Length = 120 m Install Hydrant	25,000	Short term
	1	Install Hydrant, 33 Nos.	135,000	Medium term
		Install UV System	1.8 M	Short term
		Total	**$3,731,000**	



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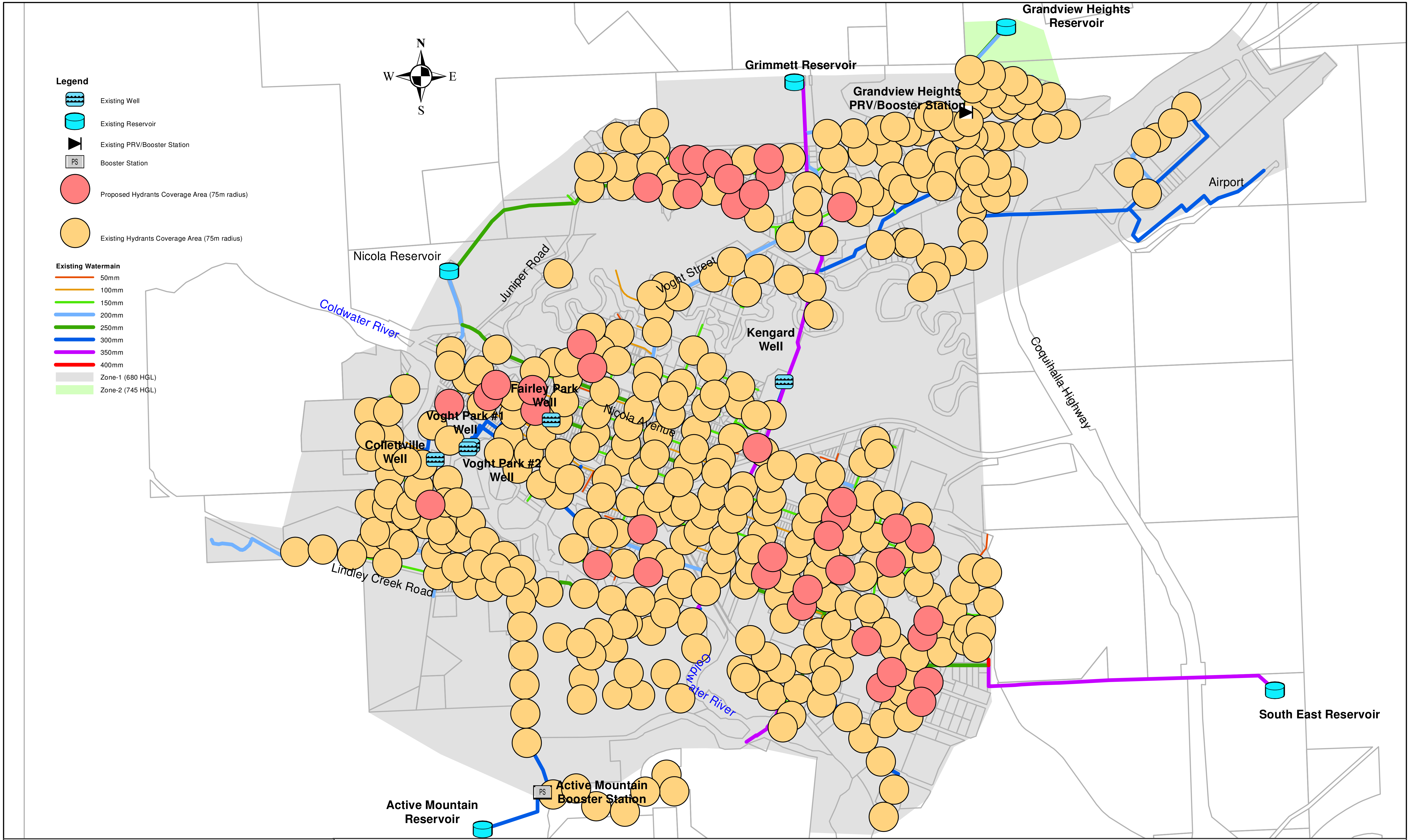
WATER UTILITY MASTER PLAN
EXISTING HYDRANT COVERAGE

FIGURE 6-5



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WATER UTILITY MASTER PLAN
PROPOSED & EXISTING HYDRANT COVERAGE

FIGURE 6-6

7.0 FUTURE HYDRAULIC ANALYSIS

This section of the report covers the hydraulic analysis of the system in Merritt as projected in the year 2030. The analysis is performed for the two growth scenarios of 1.1% and 3.5% plus 20% conservation reduction with the objective of assessing the system's performance with respect to compliance with the minimum requirements and with the level of service, as outlined in Section 5, in order to service the future population and support the development plans of the City as outlined in the OCP.

The four components of the system namely, source supply capacity, water treatment and quality, storage, and transmission and distribution system are discussed in the following subsections.

The proposed Gateway development is planned between elevations 720 m and 860 m. The existing South East reservoir has a top water level of 680 m below the proposed development. The future analysis is based on the construction of a peak hour plus fire flow booster station which would be required as part of the development.

7.1 Source Supply Capacity

For the same reason previously mentioned in Section 6.1, the future analysis for source of water supply was based on the maximum production levels from each of the wells rather than the yield capacity of the aquifer.

The future analysis assumes that production levels from wells in the future are the same as the existing levels in the year 2010-2011. Moreover, according to the design brief by

KWL Ltd issued on November 10th 2009[1], Kengard well production levels can be increased to 75 L/s or 150 L/s from the initial current capacity of 50 L/s. This increase in production capacity would require an environmental assessment for groundwater withdrawals.

For each of the future growth projections, the quantitative water source analysis is based on two scenarios. The first scenario assumes that all production wells are operating at maximum capacity and the second scenario assumes that the largest well is out of service for any reason such as during maintenance. The second scenario is considered a worst case scenario and provides an indication of the level of water source security and supply redundancy within the system.

7.1.1 Growth at 1.1%

Table 7-1 summarizes the comparison between the future ADD and MDD at 1.1% growth scenario to the maximum design capacity of the production wells. The following is noted:

- Scenario-1: With all the wells operating at maximum production and simultaneously, there is an excess of 111 L/s during MDD.

- Scenario-2: With the largest well out of service and all the other wells operating at maximum production and simultaneously, there is an excess of 5 L/s during MDD.

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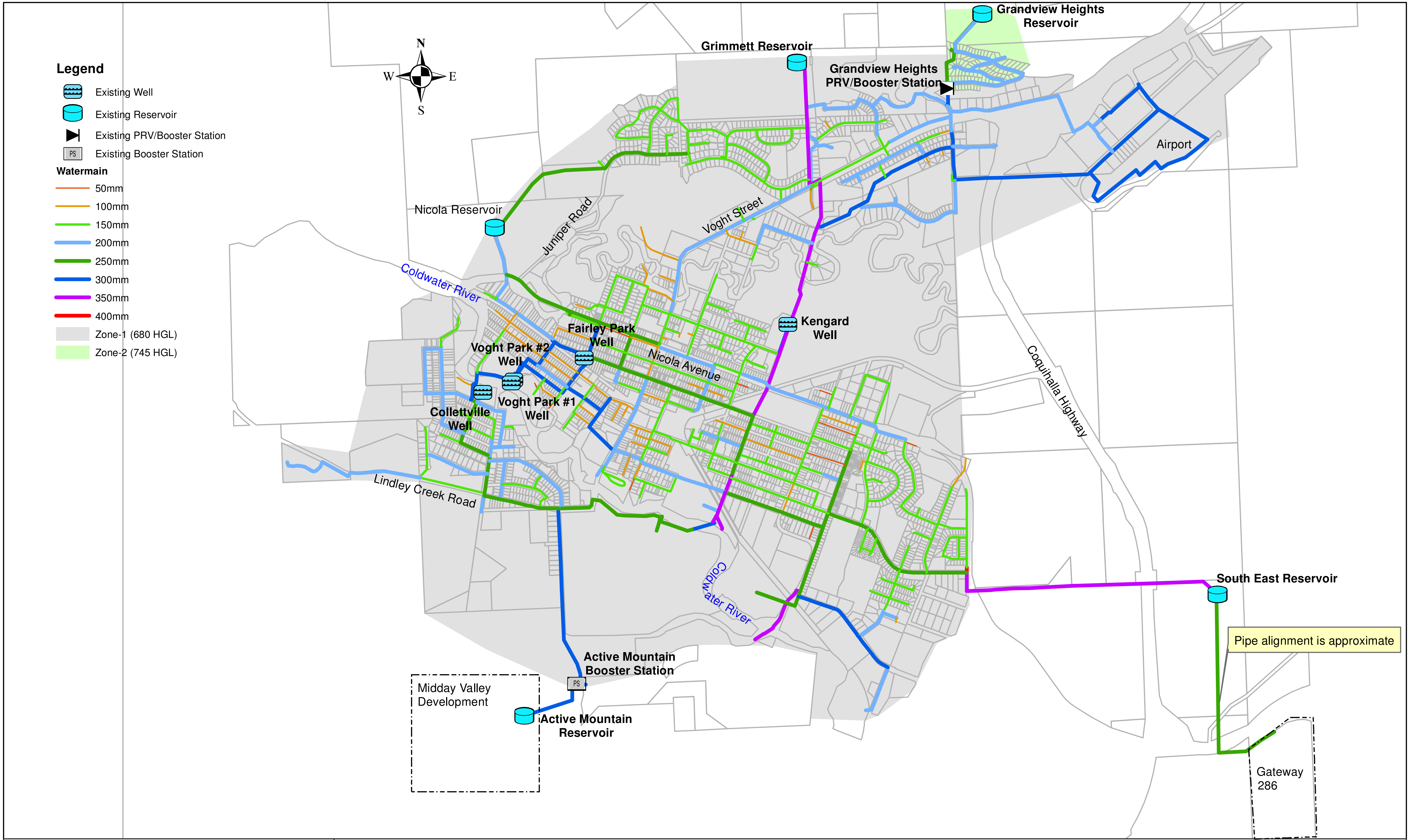
[1] Source: Technical Memorandum – Kengard Well Design Brief – File # 2848.001-300 by KWL Consulting Engineers, issued on November 10, 2009.



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0 220 440 880 1,320 1,760 Meters

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WATER UTILITY MASTER PLAN
FUTURE SYSTEM

FIGURE 7-1

TABLE 7-1
WATER SUPPLY ANALYSIS (FUTURE 2030 AT 1.1% GROWTH)

Item	Description	Capacity (L/s)
	Maximum Supply Capacity (L/s)	
A	Voght Park#1 VFD	106.4
B	Voght Park#2 G/E	83.3
C	Fairley Park	75.8
D	Collettville	56.4
E	Kengard	50.0
F	Total Production, = A+B+C+D+E	371.9
G	Total Production (with largest well out of service), = F-A	265.5
	Future Demand at 1.1% Growth (L/s)	
H	ADD	111.8
I	MDD	260.6
	Maximum Supply – Future Demand at 1.1% Growth (L/s)	
J	Total Production – ADD, = F-H	260.1
K	Total Production (with largest well out of service) – ADD, = G-H	153.7
L	Total Production – MDD, = F-I	111.3
M	Total Production (with largest well out of service) – MDD, = G-I	4.9

A third scenario that is worthwhile analyzing is water supply during power outage. Currently the city has one natural gas motor for the pump at Voght Park #2. The gas motor has a capacity of 59 L/s. As a result, the City has deficiency of 202 L/s during MDD and 53 L/s during ADD.

7.1.2 Growth at 3.5% plus 20% conservation reduction

Table 7-2 summarizes the comparison between the future ADD and MDD at 3.5% growth plus 20% conservation reduction scenario to the maximum design capacity of the production wells. The following is noted:

- Scenario-1: With all the wells operating at maximum production and simultaneously, there is an excess of 51 L/s during MDD.

- Scenario-2: With the largest well out of service and all the other wells operating at maximum production and simultaneously, there is a deficiency of 56 L/s during MDD. Upgrading Kengard well capacity to 150 L/s will make up for the deficiency during MDD and provide an additional 44 L/s.

TABLE 7-2
WATER SUPPLY ANALYSIS (FUTURE 2030 AT 3.5% GROWTH)

Item	Description	Capacity (L/s)
	Maximum Supply Capacity (L/s)	
A	Voght Park#1 VFD	106.4
B	Voght Park#2 G/E	83.3
C	Fairley Park	75.8
D	Collettville	56.4
E	Kengard	50.0
F	Total Production, = A+B+C+D+E	371.9
G	Total Production (with largest well out of service), = F-A	265.5
	Future Demand at 3.5% Growth (L/s)	
H	ADD	134.7
I	MDD	321.1
	Maximum Supply – Future Demand at 3.5% Growth (L/s)	
J	Total Production – ADD, = F-H	237.2
K	Total Production (with largest well out of service) – ADD, = G-H	130.8
L	Total Production – MDD, = F-I	50.8
M	Total Production (with largest well out of service) – MDD, = G-I	-55.6

A third scenario that is worthwhile analyzing is water supply during power outage. Currently the city has one natural gas motor for the pump at Voght Park #2. The gas motor has a capacity of 59 L/s. As a result, the City has deficiency of 262 L/s during MDD and 76 L/s during ADD.

7.2 Storage

Analysis of the storage capacity in the City's was conducted to determine whether the existing reservoirs have sufficient volume to maintain enough balancing storage during MDD and fire storage during fire events in the future.

This section discusses the future storage requirements in the year 2030 based on the two growth projection scenarios. Fire storage requirements in the future remain the same as the existing requirements for the year 2010 since the criteria for fire flow rate and land use zoning are constant. Future balancing storage is mainly determined by the maximum day domestic water consumption. The analysis is based on the following:

- Zone-1 is made up of multi-family, commercial and industrial areas. Fire demand is based on industrial fire rate of 225 L/s for 3 hrs. duration.
- Grandview and Active Mountain reservoirs are located in Zone-2 and Zone-3, respectively, and can contribute to domestic and fire demands of Zone-1 when necessary.
- Zone-2 is made up of single-family residential areas. Fire demand is based on residential fire rate of 60 L/s for 1.5 hrs. duration.
- Zone-3 is made up of multi-family residential and commercial areas. Fire demand is based on commercial fire rate of 150 L/s for 2 hrs. duration.
- Zone-4: made up of multi-family residential areas. Fire demand is based on commercial fire rate of 90 L/s for 2 hrs. duration.
- No more than one fire occurrence at a time in all zones combined, i.e. simultaneous fire events in the City are not considered.

7.2.1 Growth at 1.1%

Table 7-3 lists the storage reservoirs that contribute to each pressure zone in the City's water system. It also compares the existing total storage capacities to the future storage requirements for balancing and fire demands. The balancing storage figures in Table 7-3 are calculated based on the following:

- Population of Zone-2 (Grandview Heights) is assumed at 460 capita, based on 200 houses in 2030 at 2.3 capita per house. MDD is calculated at 1,941 L/c/d.
- Population of Zone-3 (Midday Valley) is assumed at 165 capita in 2030. MDD is 1,941 L/c/d.
- Population of Zone-4 (Gateway-286) is assumed at 865 capita in 2030. MDD is 1,941 L/c/d.

TABLE 7-3
FUTURE STORAGE - 1.1% GROWTH

Zone	Contributing Reservoirs	Total Capacity (ML)	Required Balancing Storage (ML)	Required Fire Storage (ML)	Total Required Storage (ML)	Surplus Storage (ML)
1	Grimmett	4.55				
	Nicola	0.67				
	South East	2.27				
	Grandview (Zone-2)	0.55				
	Active Mountain (Zone-3)	4.55				
	Sub-Total	12.58	5.63	2.43	8.06	4.52
2	Grandview	0.55	0.22	0.32	0.55	0.00
3	Active Mountain	4.55	0.08	1.08	1.16	3.39
4	South East	2.27	0.42	0.65	1.07	1.21

Based on the foregoing, the following is noted:

- **Zone-1:** With five reservoirs servicing this zone, including Grandview and Active Mountain reservoirs, the total storage capacity would meet the minimum requirement with a surplus of 4.52 ML. It is therefore necessary that PRV's be installed the zone boundaries which are capable of passing fire flow from the upper zones (Zone-2, 3 and 4) to the lower zone (Zone-1)

- **Zone-2:** Grandview Heights area is expected to have a population of 460 in the year 2030. Based on the MDD and fire flow requirements of the area, the reservoir would have sufficient capacity to cover the storage requirement with no contingency for further growth in the area.

- **Zone-3:** Midday Valley development is expected to have a population of 165 in the year 2030, based on 1.1% growth projection rate. Active Mountain reservoir will have sufficient capacity to cover the storage requirement of the development with a surplus storage of approximately 3.39 ML.

- **Zone-4:** Gateway-286 development is expected to have a population of 865 in the year 2030, based on 1.1% growth projection rate. South East reservoir will have sufficient capacity to cover the storage requirement of the development with a surplus storage of approximately 1.21 ML.

7.2.2 Growth at 3.5% plus 20% conservation reduction

Table 7-4 lists the storage reservoirs that contribute to each pressure zone in the City's water system. It also compares the existing total capacities to the future storage requirements base for balancing and fire demands. The balancing storage figures in Table 7-4 are calculated based on the following:

- Population of Zone-2 (Grandview Heights) is assumed at 46 capita, based on 20 houses in 2010 at 2.3 capita per house. MDD is calculated at 1,553 L/c/d.
- Population of Zone-3 (Midday Valley) is assumed at 667 capita in 2030. MDD is 1,553 L/c/d.
- Population of Zone-4 (Gateway-286) is assumed at 3,500 capita in 2030. MDD is 1,553 L/c/d.

TABLE 7-4
FUTURE STORAGE – 3.5% GROWTH

Zone	Contributing Reservoirs	Total Capacity (ML)	Required Balancing Storage (ML)	Required Fire Storage (ML)	Total Required Storage (ML)	Surplus Storage (ML)
1	Grimmett	4.55				
	Nicola	0.67				
	South East	2.27				
	Grandview (Zone-2)	0.55				
	Active Mountain (Zone-3)	4.55				
	Sub-Total	12.58	6.93	2.43	9.36	3.22
2	Grandview	0.55	0.18	0.32	0.50	0.04
3	Active Mountain	4.55	0.26	1.08	1.34	3.21
4	South East	2.27	1.36	0.65	2.01	0.27

The following can be inferred from Table 7-4:

- **Zone-1:** With five reservoirs servicing this zone, including Grandview and Active Mountain reservoirs, the total storage capacity would meet the minimum requirement with a surplus of 3.22 ML.

- **Zone-2:** Grandview Heights area is expected to have a population of 460 in the year 2030. Based on the MDD and fire flow requirements of the area, the reservoir would have sufficient capacity to cover the storage requirement with a surplus storage of approximately 0.04 ML.

- **Zone-3:** Midday Valley development is expected to have a population of 667 in the year 2030, based on 3.5% growth projection rate. Active Mountain reservoir will have sufficient capacity to cover the storage requirement of the development with a surplus storage of approximately 3.21 ML.

- **Zone-4:** Gateway-286 development is expected to have a population of 3,500 in the year 2030, based on 3.5% growth projection rate. South East reservoir will have sufficient capacity to cover the storage requirement of the development with a surplus storage of approximately 0.27 ML.

7.3 Transmission and Distribution

The hydraulic analysis of the watermains was performed using the model built in WaterCAD as outlined in technical memorandum No. 4 issued by Opus DaytonKnight, enclosed in Appendix D.

7.3.1 Transmission

Analyses of the supply hydraulic mains under 2030 projected MDD conditions for the 1.1% growth scenario and the 3.5% growth scenario plus 20% conservation reduction were conducted to assess the ability to fill the reservoirs. Based on the existing 2010 pump capacity, the water system in Merritt would have enough hydraulic capacity in wells, Grandview Heights and Active Mountain booster stations to deliver sufficient quantities of water at adequate pressures to the storage reservoirs in the future under both growth scenarios.

7.3.2 Distribution

The system was modeled under static conditions for the two growth scenarios in the future to analyze:

- Average Day Demand was assessed to evaluate the normal operating conditions and provide a baseline for MDD comparison.
- Minimum residual pressure (20 psi) and maximum recommended velocity (3.0 m/s) during MDD coincident with fire flow. Fire flow is based on one fire event in the entire system.
- Minimum pressure (40 psi) during PHD.
- Maximum recommended pressure (140 psi) during ADD, MDD and PHD

The future analyses are based on the upgrade recommendations to the system outlined in section 6.5. The analysis for future projected scenarios is discussed in further details in the following sub sections.

Zone-3 is a future development and is still in the planning stage as of 2012; therefore the analysis is limited to assessing if there is sufficient pressure in the existing system to fill the existing Active Mountain reservoir.

Zone-4 is a future development in the planning stages as of 2012 and there is also presently no water main connecting the South East reservoir to development Gateway-286. In addition, HGL at the reservoir is 680 m whereas grade elevations in the zone range between 720 m and 860 m. A booster station and a transmission main, approximately 1,300 m long, would be required to lift water from the reservoir to the development. The following analysis for Zone-4 is limited to assessing the pressure achieved at the lowest elevation in the zone, 720 m, using a 250 mm diameter transmission main 1,300 m long starting at South East reservoir.

7.3.2.1 Growth at 1.1%

Average Day Demand

Results from the ADD hydraulic analysis are as summarized in Figure 7-2 and discussed below.

- **Zone-1:** Maximum recommended pressure is not exceeded. The maximum pressure is 132 psi at an elevation of 588 m. The ADD analysis shows that pressure in most of the distribution system within this zone exceeds 100 psi.

- **Zone-2:** Maximum recommended pressure is not exceeded. The maximum pressure is 130 psi at an elevation of 653 m. Pressures above 100 psi also occur in this zone.

- **Zone-3:** At ADD, the HGL at Active Mountain reservoir inlet is higher than the Top Water Level (TWL) therefore there is sufficient pressure from the booster station to fill the reservoir.

- **Zone-4:** At ADD, HGL is 679 m at 720 m elevation. HGL required to achieve a minimum 40 psi is 748 m. Therefore, a minimum pumping head of 98 psi is required at ADD.

Maximum Day Demand + Fire Flow

The results from the MDD + FF hydraulic analysis are as summarized in Figure 7-3 which classifies various ranges of fire flow availability throughout the system and identifies where deficiencies are occurring.

Few deficiencies occur and are mainly at dead ends in Zone-1 and deficiency in Zone-4 is due to the difference in HGL of South East reservoir and grade elevations in the development which was discussed earlier. The future booster station should allow for a fire flow of 90 L/s in Zone-4.

Peak Hour Demand

PHD hydraulic analysis results are as summarized in Figure 7-4 and discussed below.

- **Zone-1:** Pressure does not meet minimum requirements in one area noted in Figure 7-4. It occurs at the cul-de-sac adjacent to 1602 Ponderosa Way in Bench area. Elevation at that location is 655 m and the pressure is 34 psi.

  Maximum recommended pressure of 140 psi occurs at an elevation of 587 m located at the Northern end of Pine Street, adjacent to address 801, in Collettville Area.

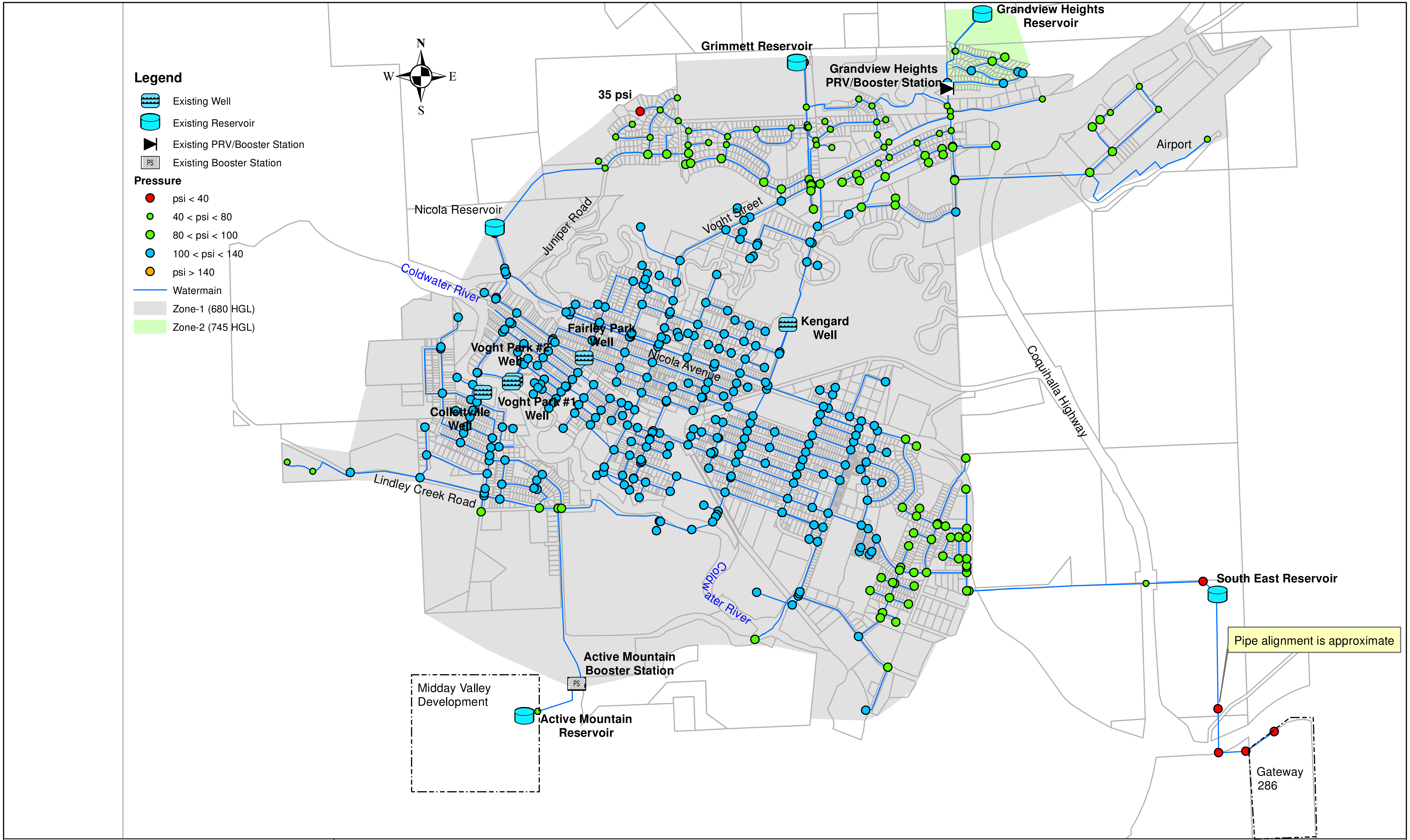
  Maximum recommended velocity is not exceeded. The maximum velocity is 2.6 m/s.

- **Zone-2:** Pressure is more than the minimum requirements throughout the zone. The minimum pressure is 77 psi at an elevation of 690 m.

  Maximum recommended pressure is not exceeded. The maximum pressure in this zone is 130 psi at an elevation of 653 m.

  Maximum recommended velocity is not exceeded. The maximum velocity is approximately 0.42 m/s.

- **Zone-3:** At PHD, the HGL at Active Mountain reservoir inlet is higher than the Top Water Level (TWL) therefore there is sufficient pressure from the booster station to fill the reservoir.



OPUS DAYTONKNIGHT

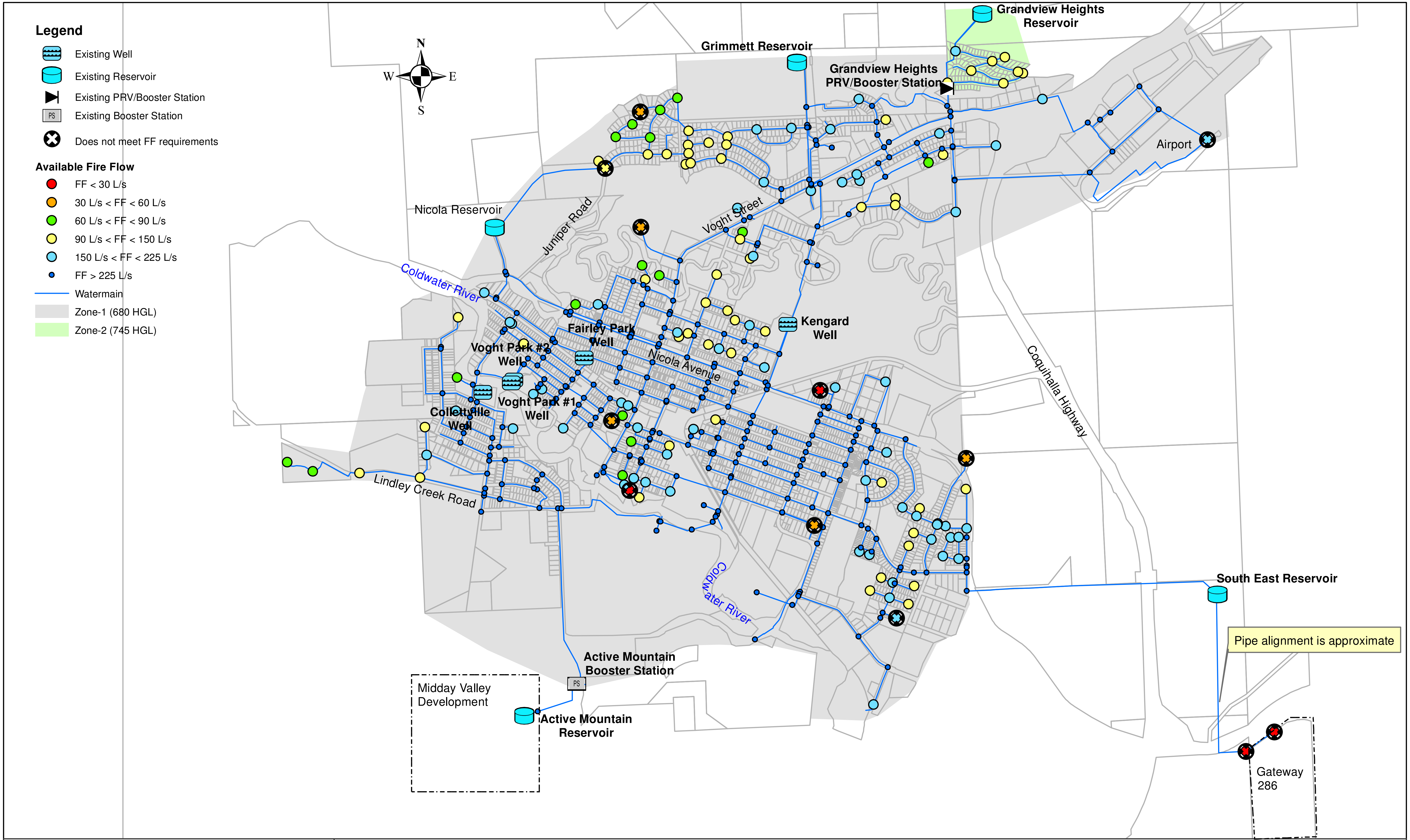
PROJ NO: 364.06
DRAWN BY: ZA
DATE: JUN 2012

0 220 440 880 1,320 1,760 Meters
SCALE 1:20,000

MERRITT
COUNTRY MUSIC CAPITAL OF CANADA

WATER UTILITY MASTER PLAN
ADD ANALYSIS (2030 @ 1.1% GROWTH)

FIGURE 7-2



OPUS DaytonKnight

PROJ NO: 364.06
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DATE: JUN 2012

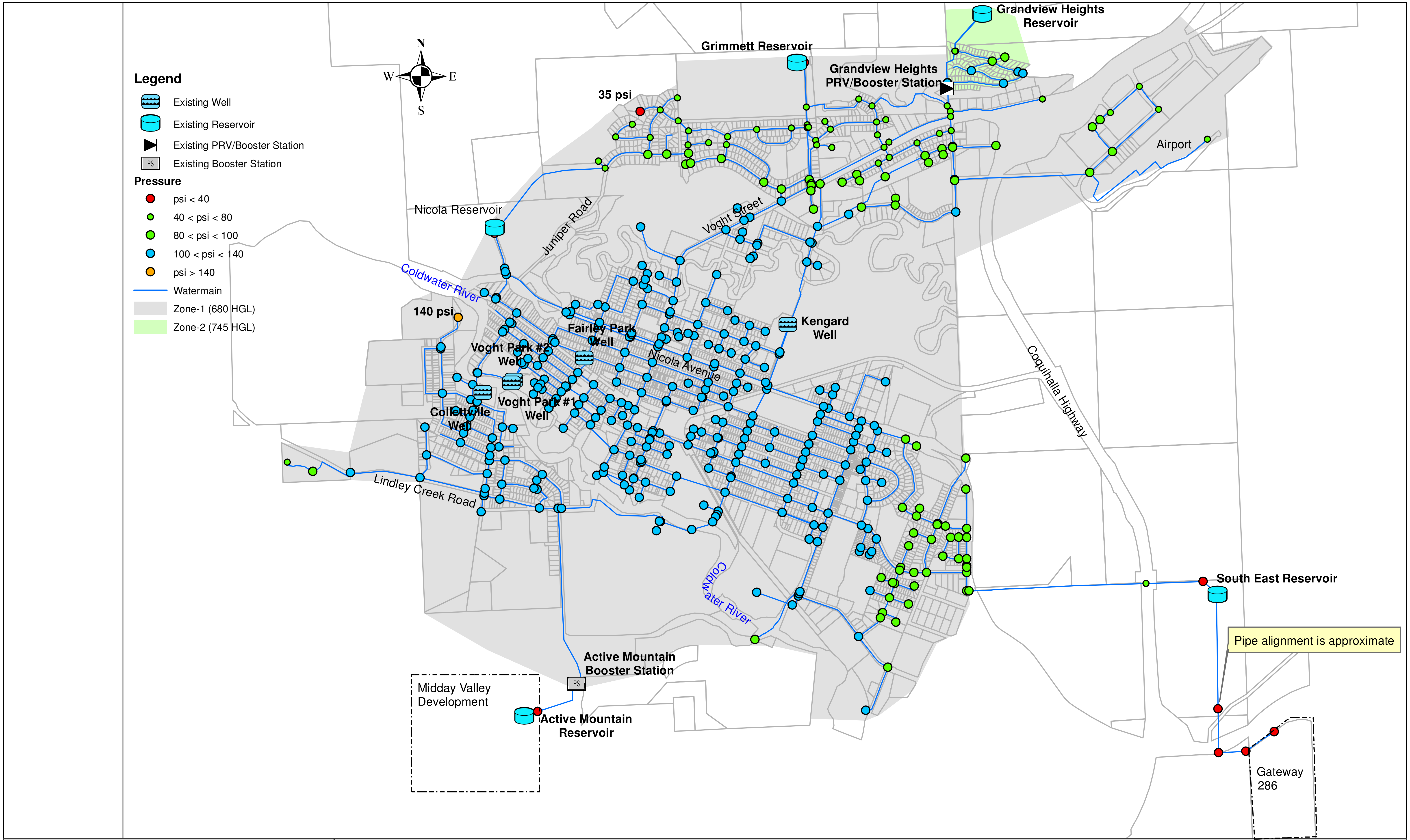
0 220 440 880 1,320 1,760 Meters

SCALE 1:20,000

MERRITT
COUNTRY MUSIC CAPITAL OF CANADA

WATER UTILITY MASTER PLAN
MDD+FF ANALYSIS (2030 @ 1.1% GROWTH)

FIGURE 7-3



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SCALE 1:20,000

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WATER UTILITY MASTER PLAN
PHD ANALYSIS (2030 @ 1.1% GROWTH)

FIGURE 7-4

- **Zone-4:** At PHD, HGL is 676 m at 720 m elevation. HGL required to achieve a minimum 40 psi is 748 m. Therefore, a minimum pumping head of 102 psi is required at PHD.

7.3.2.2 Growth at 3.5% plus 20% conservation reduction

Average Day Demand

Results from the ADD hydraulic analysis are as summarized in Figure 7-5 and discussed below.

- **Zone-1:** Maximum recommended pressure is not exceeded. The maximum pressure is 132 psi at an elevation of 588 m. The ADD analysis shows that pressure in most of the distribution system within this zone exceeds 100 psi.

- **Zone-2:** Maximum recommended pressure is not exceeded. The maximum pressure is 130 psi at an elevation of 653 m. Pressures above 100 psi also occur in this zone.

- **Zone-3:** At ADD, the HGL at Active Mountain reservoir inlet is higher than the Top Water Level (TWL) therefore there is sufficient pressure from the booster station to fill the reservoir.

- **Zone-4:** At ADD, HGL achieved is 678 m at 720 m elevation. HGL required to maintaining a minimum 40 psi is 748 m. Therefore, a minimum pumping head of 100 psi is required at ADD.

Maximum Day Demand + Fire Flow

The results from the MDD + FF hydraulic analysis are as summarized in Figure 7-6 which classifies various ranges of fire flow availability throughout the system and identifies where deficiencies are occurring.

Few deficiencies occur and are mainly at dead ends in Zone-1 and deficiency in Zone-4 is due to the difference in HGL of South East reservoir and grade elevations in the development which was discussed earlier. The future booster station should allow for a fire flow of 90 L/s in Zone-4.

Peak Hour Demand

PHD hydraulic analysis results are as summarized in Figure 7-7 and discussed below.

- **Zone-1:** Pressure does not meet minimum requirements in one area noted in Figure 7-7. It occurs at the cul-de-sac adjacent to 1602 Ponderosa Way in Bench area. Elevation at that location is 655 m and the pressure is 34 psi.

  Maximum recommended pressure of 140 psi occurs at an elevation of 587 m located at the Northern end of Pine Street, adjacent to address 801, in Collettville Area.

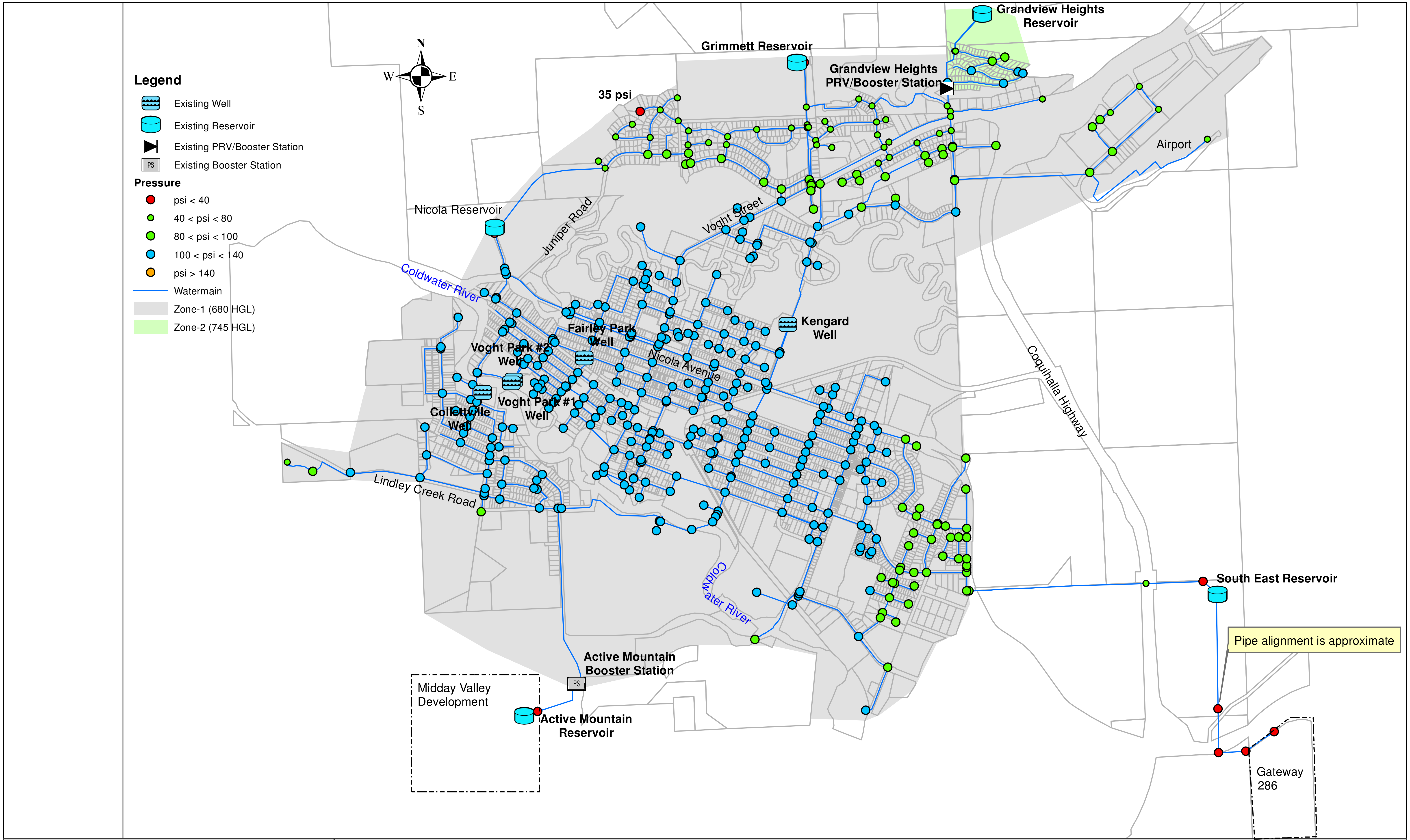
  Maximum recommended velocity is not exceeded. The maximum velocity is 2.5 m/s.

- **Zone-2:** Pressure is more than the minimum requirements throughout the zone. The minimum pressure is 77 psi at an elevation of 690 m.

  Maximum recommended pressure is not exceeded. The maximum pressure in this zone is 130 psi at an elevation of 653 m.

  Maximum recommended velocity is not exceeded. The maximum velocity is approximately 0.42 m/s.

- **Zone-3:** At PHD, the HGL at Active Mountain reservoir inlet is higher than the Top Water Level (TWL) therefore there is sufficient pressure from the booster station to fill the reservoir.



OPUS DAYTONKNIGHT

PROJ NO: 364.06
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0 220 440 880 1,320 1,760 Meters
SCALE 1:20,000

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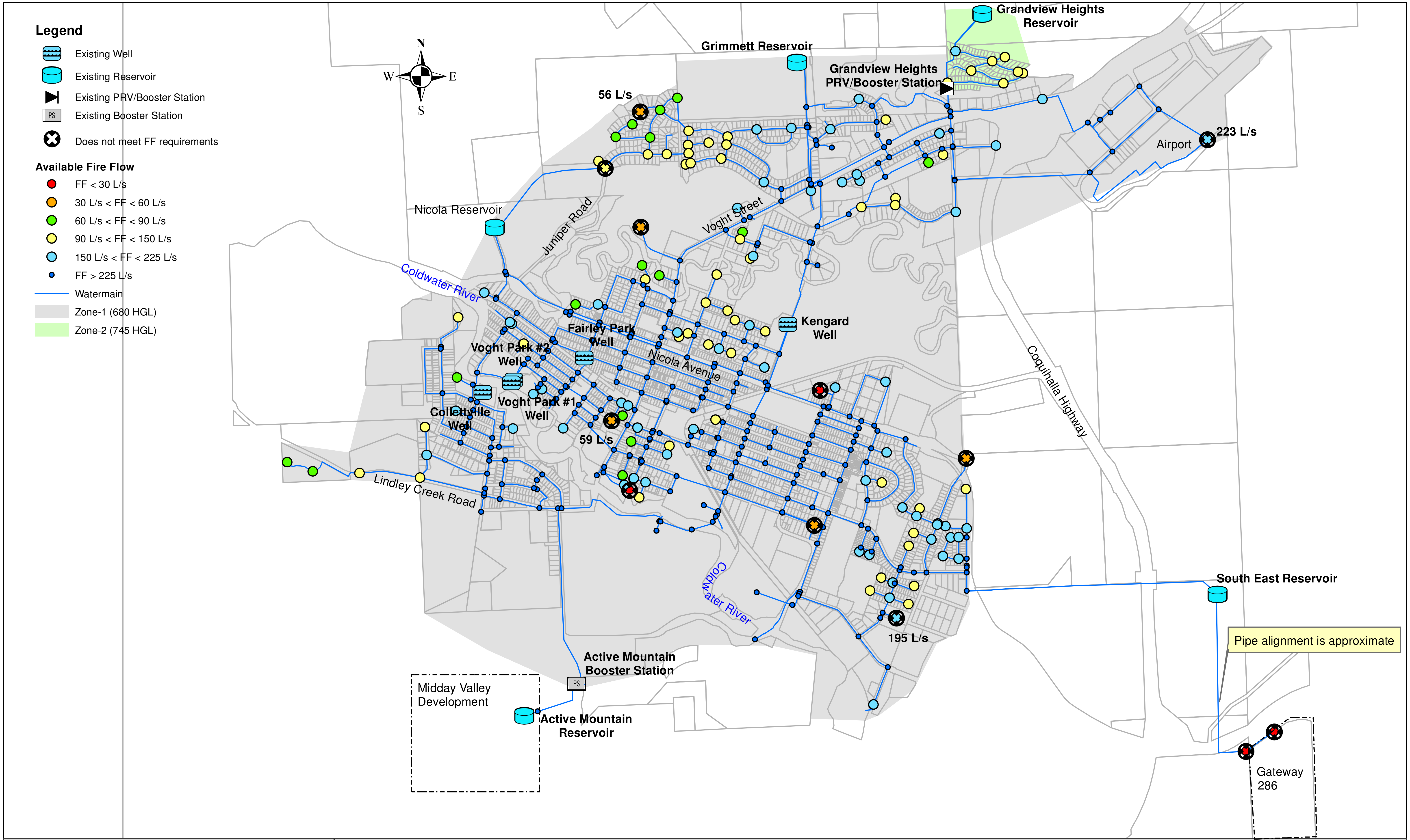
WATER UTILITY MASTER PLAN
ADD ANALYSIS (2030 @ 3.5% GROWTH)

FIGURE 7-5



OPUS DAYTONKNIGHT

PROJ NO: 364.06
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0 220 440 880 1,320 1,760 Meters

SCALE 1:20,000

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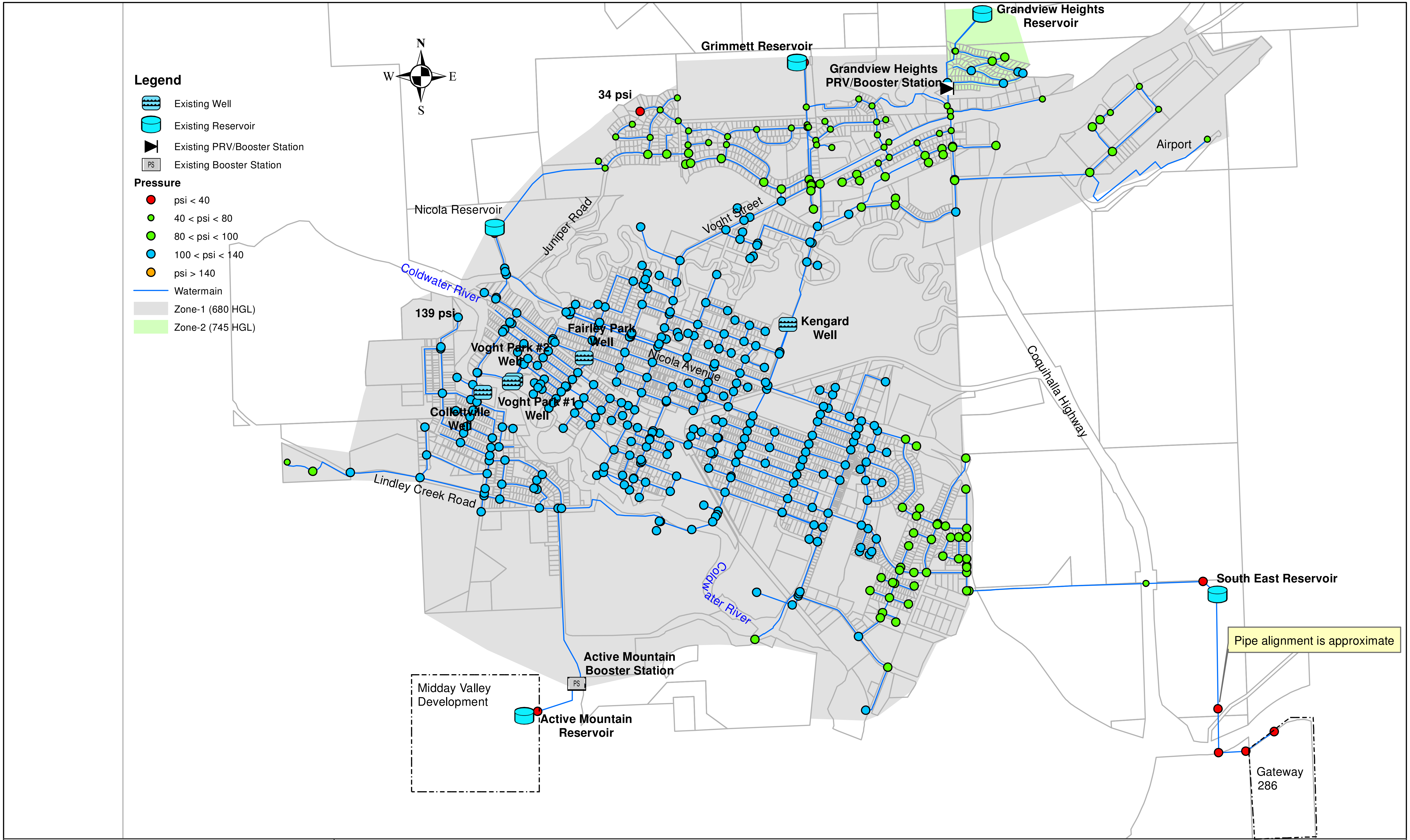
WATER UTILITY MASTER PLAN
MDD+FF ANALYSIS (2030 @ 3.5% GROWTH)

FIGURE 7-6



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DATE: JUN 2012

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SCALE 1:20,000

MERRITT
COUNTRY MUSIC CAPITAL OF CANADA

WATER UTILITY MASTER PLAN
PHD ANALYSIS (2030 @ 3.5% GROWTH)

FIGURE 7-7

- **Zone-4:** At PHD, HGL achieved is 653 m at 720 m elevation. HGL required to maintaining a minimum 40 psi is 748 m. Therefore, a minimum pumping head of 135 psi is required at PHD.

7.4 Pressure Management

The City's water system operates at relatively high pressure for a municipal water system. Typically, the recommended upper pressure is 100 psi, whereas in Merritt most the lower elevation developments operate well over 130 psi and as high as 140 psi in the Collettville area. The City's distribution system is engineered to accommodate such pressures so risk of a catastrophic failure is not an issue. However, elevated pressures result in several long term concerns:

1. Leakage from watermains is proportional to the square of the pressure. As pressure increases, leakage increases by the square.

2. Aging infrastructure is more likely to fail when exposed to higher pressures than lower pressures.

3. Power consumption is higher as the City's water system is pumped and therefore higher pressures require more power.

4. Household water consumption will be higher due to an increase in flow rate to hose bibs, taps and irrigation systems which may not be flow limited.

Based on the average day demands approximately 80% of the communities demands are located in areas where the pressure exceeds 100 psi.

As part of this study we reviewed options to reduce the operating pressures within the City. Due to the nature of the City's distribution system and reservoir locations reducing the pressure will require some significant capital improvements. We investigated two options:

1. The construction of a separate high pressure transmission system to connect the existing wells to a new upper zone. This would also require the construction of up to 4 new pressure reducing valve stations, Figure 7-8a and Figure 7-8b.

2. Separate the City's current Zone 1 into two zones, the upper zone which would include the Bench and the Airport areas and the lower zone which would include the balance of Zone 1. The well pumps would require replacement to operate at a lower discharge head (approximately 30 m lower) and two booster pump stations would be required to boost the water from the lower part of the zone to the Bench zone and provide reservoir recovery, both in the Bench and the Southeast reservoir. Three additional PRV stations would be required to provide fire flow and peaking water from the reservoirs in the upper zone, Figure 7-9a and Figure 7-9b.

The cost to install a high pressure transmission system in the City is high due to the location of the existing reservoirs. Furthermore, this option does not reduce the total amount of power required to pressurize the water as all the water is pumped to the reservoirs and pressure reduced back to the new lower zone. As such, this option is not reviewed further.

The attached Figure 7-8 and 7-9 provide a layout schematic of the proposed system modifications. Generally, the following is noted:

- System pressures in the lower zone are reduced from a current range of 85 - 130 psi to 40 - 90 psi, a 30% reduction.
- Only water required for the upper zone and the balancing storage is pumped to the 680 m elevation, the remaining water is only boosted to the 650 m elevation.

The scope of the study is not sufficient to undertake a detailed analysis of the cost/benefits of this new system. However, we have completed a preliminary analysis to assess the viability of this change.

The following are assumed:

- The upper zone demand is approximately 22% of the current zone 1 demand.
- An allowance of 20% of the demand is required for balancing storage.
- The analysis is based on the average day demands.
- Leakage due to the reduced pressure is reduced by 10%.
- Per capita demand is reduced from 1,100 L/c/d to 900 L/c/d due to reduced pressure. As noted in Section 4 this is still 30% higher than most Okanagan Municipalities.
- The variable component of the waste cost is 0.1 $/m^3, including costs related to the cost of power and chemicals for the existing infrastructure. It should be noted that this cost can vary significantly between municipalities. For example in Metro Vancouver the cost is 0.40-0.50 $/m^3.

Table 7-5 summarizes the comparison of the current system to a new system based on the assumptions above.

TABLE 7-5
SUMMARY OF COST SAVING FOR EXISTING AND PROPOSED SYSTEM

		One Zone	Two Zones
POWER CONSUMPTION COMPARISON			
Lower Zone			
Average Flow	L/s	112	41
Required Head	m	110	75
Power	kW	155	38
Upper Zone			
Average Flow	L/s	0	42
Required Head	m	75	35

TABLE 7-5 (cont'd.)
SUMMARY OF COST SAVING FOR EXISTING AND PROPOSED SYSTEM

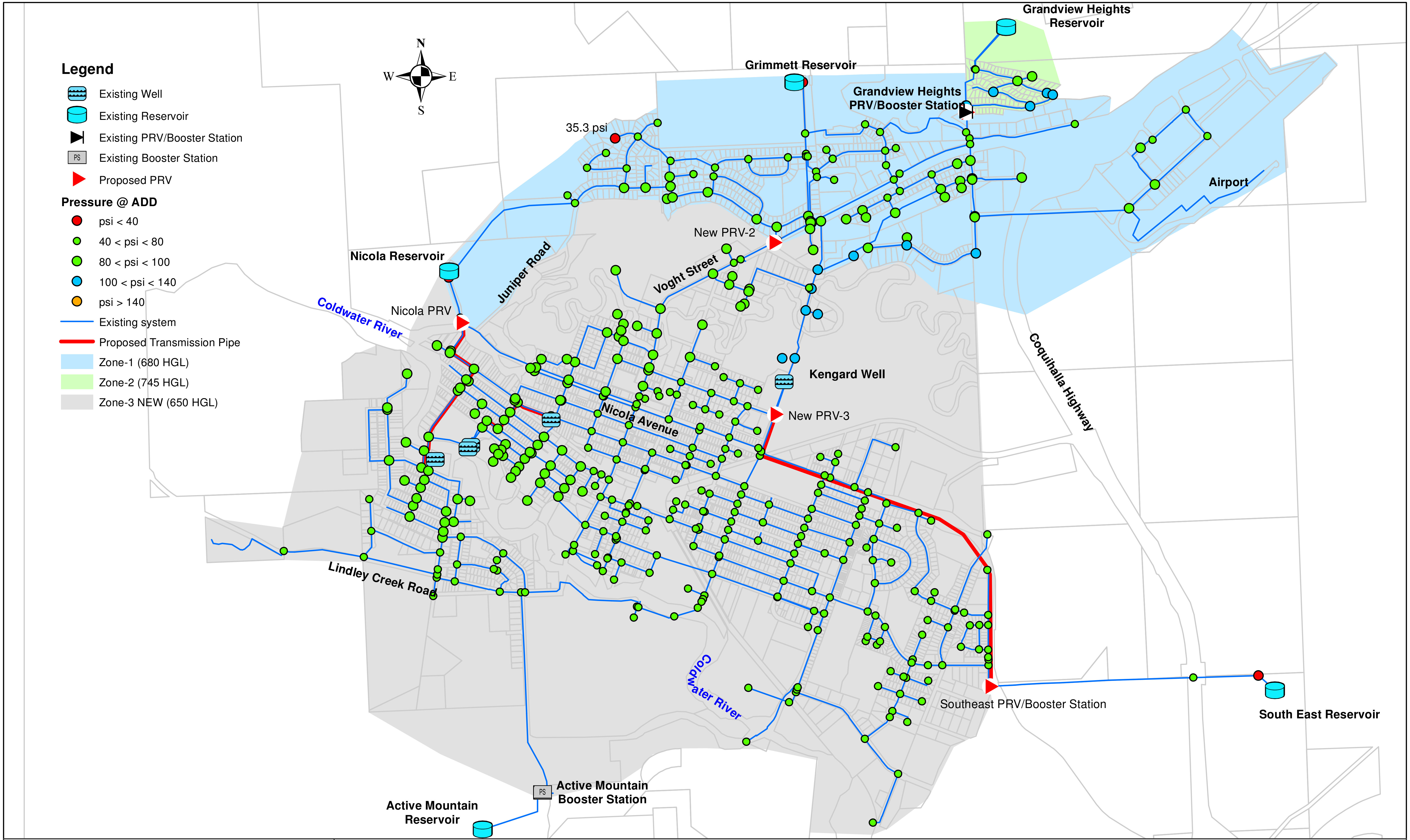
		One Zone	Two Zones
Power	kW	0	18
Summary			
Total Power	kW	155	57
Total Annual Power	kW-hr/yr	1,356,103	496,395
Cost of power	$/kW-hr	$0.07	$0.07
Annual Cost	$/yr	$94,927	$34,748
20-Yr present worth	$	$ 1,005,659	$ 368,116
		POWER SAVINGS	**$637,543**
WATER CONSUMPTION COMPARISON (REDUCED DEMAND & LEAKAGE)			
Consumption	L/s	112	82
Cost of Water	$/m3	0.1	0.1
Annual Cost	$/yr	$353.205	$260,086
20-Yr present worth	$	$3,741,860	$2,755,355
		CONSUMPTION SAVINGS	**$986,505**
TOTAL SAVINGS (20-yr present worth)			**$1,624,050**

The estimated capital costs for the proposed system are as follows:

1. Nicola PRV = $125,000
2. 2 – 30 hp Pump Stations & PRVs 2 x $800,000 = $1,600,000
3. New lower head well pumps 5 x $100,000 = $500,000

Sub-Total = $2,225,000
35% E&C = $780,000
Total (rounded) = $3,000,000

Based on the above analysis the 20 year savings does not provide a net benefit and overall cost savings. If a 40 year return period is assumed, the present with savings



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0 187.5 375 750 1,125 1,500 Meters

SCALE 1:17,500

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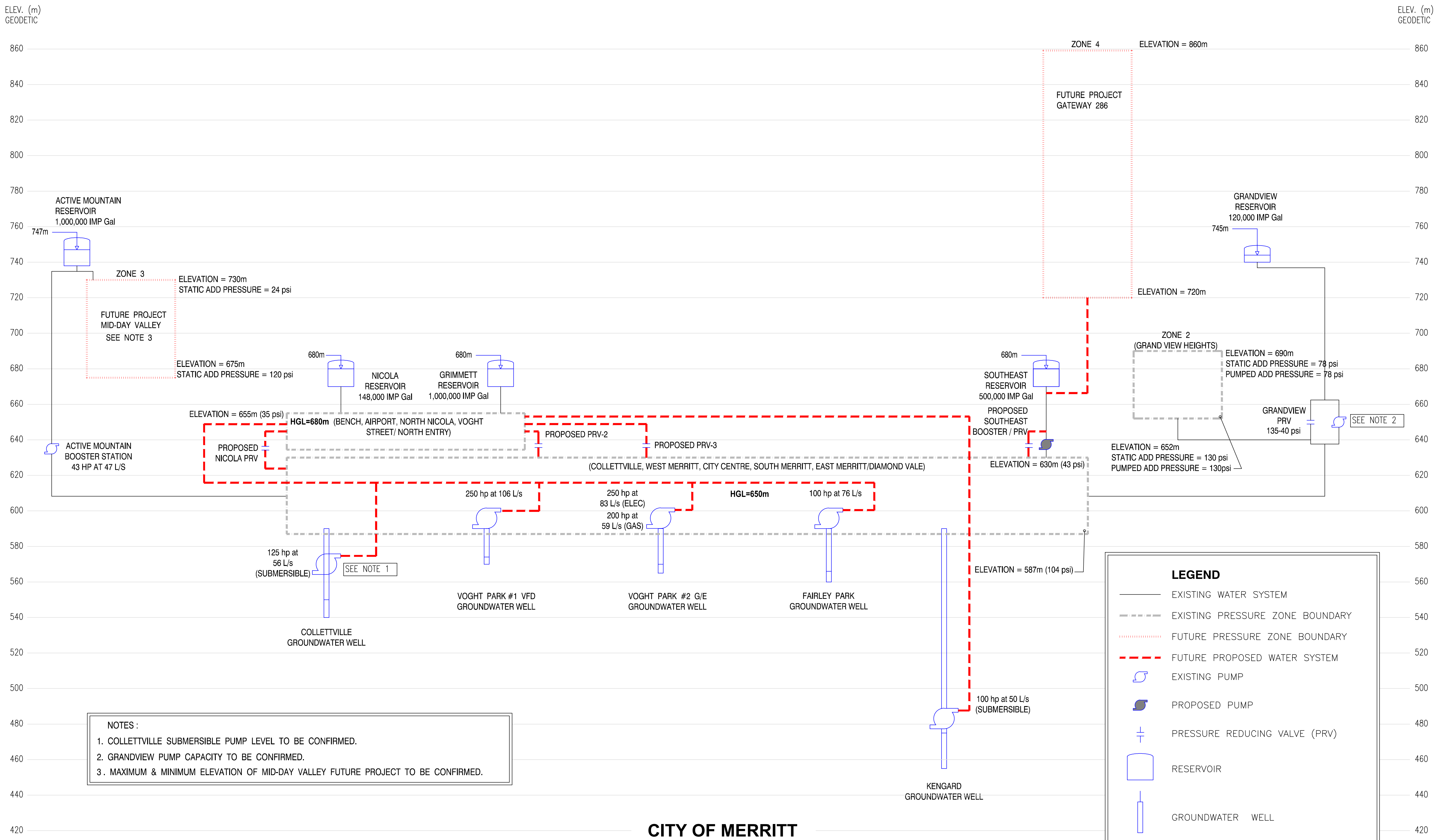
WATER UTILITY MASTER PLAN
PRESSURE MANAGEMENT
Alternative 1

FIGURE 7-8a



NOTES :

1. COLLETTVILLE SUBMERSIBLE PUMP LEVEL TO BE CONFIRMED.
2. GRANDVIEW PUMP CAPACITY TO BE CONFIRMED.
3. MAXIMUM & MINIMUM ELEVATION OF MID-DAY VALLEY FUTURE PROJECT TO BE CONFIRMED.

FILE: G:\D&K CAD Drawings\DKSERVER P Share\PRODWGS\MERRITT\D-36406.00\D-36406.00 FIGURES.dwg Tab FIGURE 7-8b 12-06-01 vcgjz0

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North Vancouver Office
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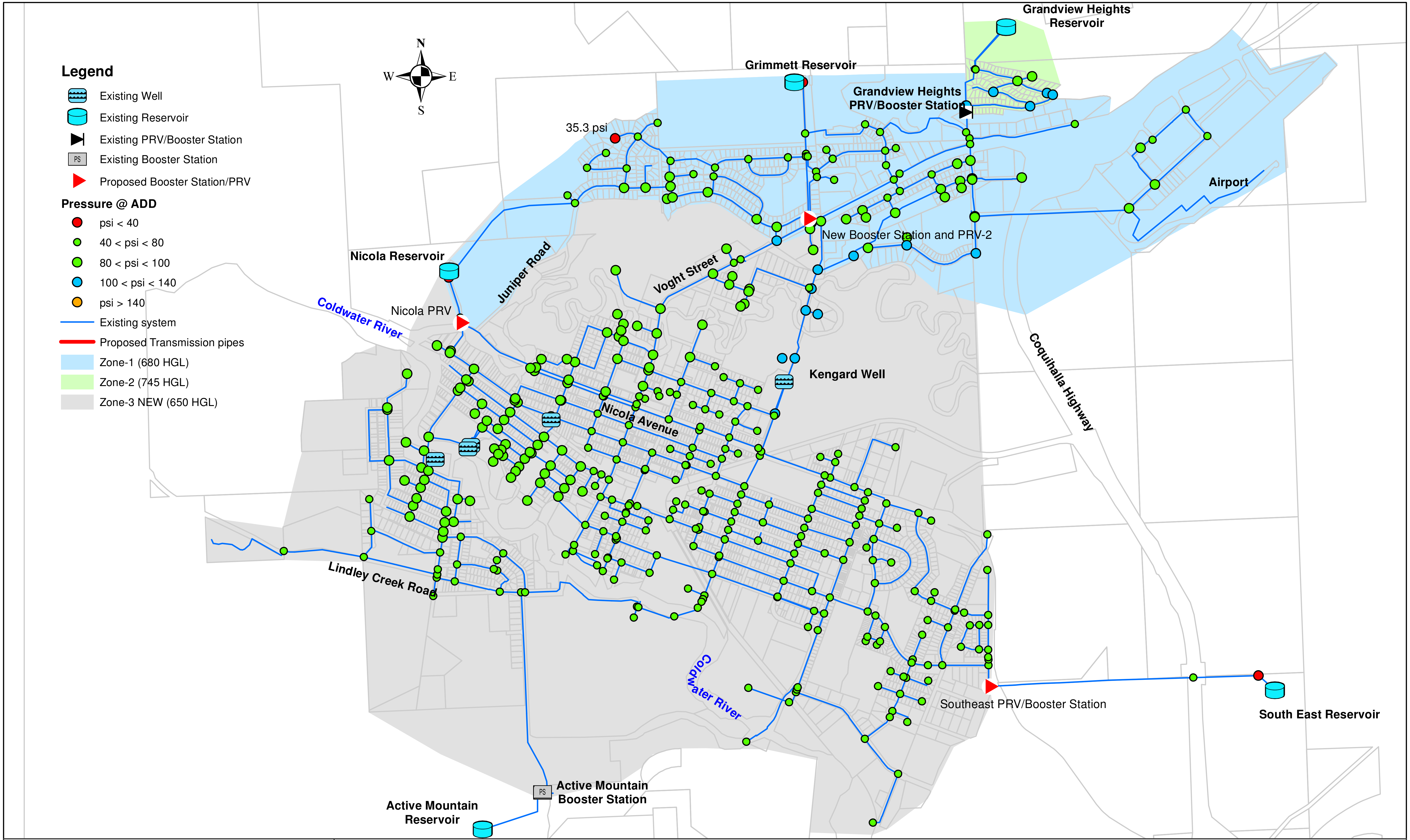
CITY OF MERRITT
WATER UTILITY MASTER PLAN
PRESSURE MANAGEMENT SCHEMATIC
ALTERNATIVE - 1

FIGURE 7-8b



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DATE: JUN 2012

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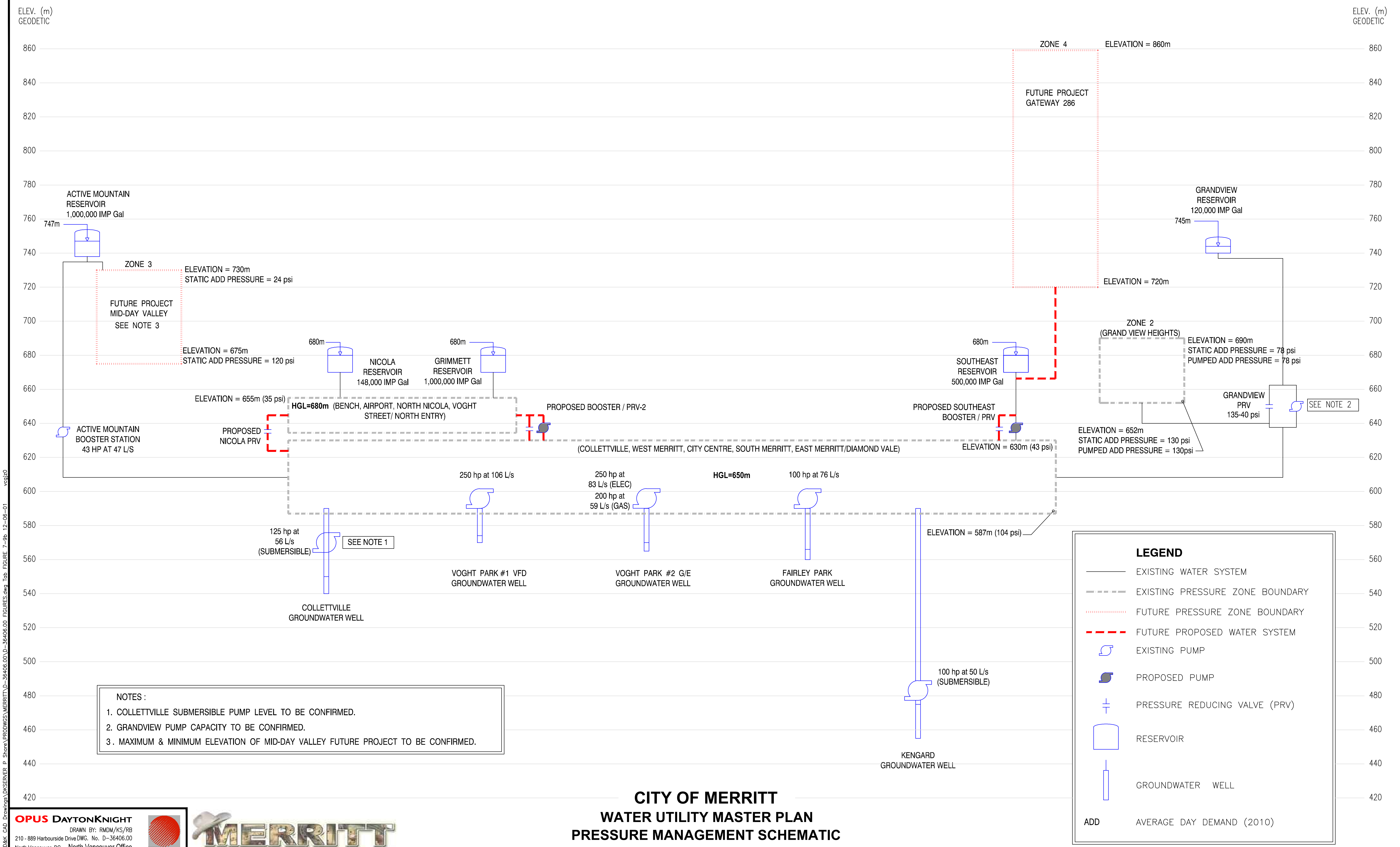
0 187.5 375 750 1,125 1,500 Meters

SCALE 1:17,500

MERRITT
COUNTRY MUSIC CAPITAL OF CANADA

WATER UTILITY MASTER PLAN
PRESSURE MANAGEMENT
Alternative 2

FIGURE 7-9a



NOTES :

1. COLLETTVILLE SUBMERSIBLE PUMP LEVEL TO BE CONFIRMED.
2. GRANDVIEW PUMP CAPACITY TO BE CONFIRMED.
3. MAXIMUM & MINIMUM ELEVATION OF MID-DAY VALLEY FUTURE PROJECT TO BE CONFIRMED.

CITY OF MERRITT
WATER UTILITY MASTER PLAN
PRESSURE MANAGEMENT SCHEMATIC
ALTERNATIVE - 2

FIGURE 7-9b

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FILE: G:\D&K CAD Drawings\DKSERVER P Share\PRODWGS\MERRITT\D–36406.00\D–36406.00 FIGURES.dwg Tab FIGURE 7–9b 12–06–01 vcgjz0 equals the cost that is a cost benefit ratio of 1. Furthermore, this analysis does not include any savings which may be witnessed due to reduced wear and tear on the existing distribution system associated with elevated pressures.

As this type of modification would provide savings over a long period, we would recommend the City pursue funding to complete a feasibility assessment of the above system configuration and refine the data. It would also be beneficial to complete a leakage assessment within the system at a reduced pressure in order to refine the assumed benefit associated with leakage and reduced consumption.

7.5 Recommendations

The recommendations indicated in Section 6.7 are required for the future scenario. The only additional recommendation would be a feasibility study for reduced pressure operation per Section 7.4.

7.6 Cost Estimate and Schedule

It is foreseen that development Gateway 286 would require some capital investment in the future such as a booster station and a transmission pipe to pump from the existing Southeast reservoir to the development. Furthermore, it is anticipated that a storage reservoir is required within the development. Due to the big difference in elevations between the highest and lowest points in the proposed development (approximately 140 m difference), at least two pressure zones are forecasted. As such, one PRV station is expectedly required. The capital investment to build this infrastructure is most likely funded by the developers when their development plans progress, as such no cost is allowed for the City.

The cost of the pressure reduction feasibility study would be estimated at $15,000 to $30,000 and would likely be eligible for funding.

8.0 STAGED UPGRADING PLAN AND COSTS

Sections 6.0 and 7.0 set out the recommended system improvements to address water demand requirements in the existing and future (2030) conditions. In this section the required water system upgrade requirements are prioritized in order to develop a detailed 20 year capital plan.

8.1 20 Year Capital Plan Development

The recommendations in the report are tabulated below along with a recommended installation year. These dates were used in the financial model in Section 9. The recommendation for construction was based on other short term (0 – 5 years), medium term (5 – 15 years) or long term (15 – 20 years). Each item was then distributed to balance the annual capital costs over the period. Some items, such as UV systems, are needed in the short term, however due to the planning required, it is unlikely that any construction would occur along the medium term. These costs are all presented in current (2012 dollars) and do not include inflation.

TABLE 8-1
STAGED UPGRADING PLAN

Recommendation	Construction Target	Capital Cost	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Capital Works			SHORT TERM						MEDIUM TERM									LONG TERM					
R-1 - Upgrade Existing Pipe, 100mm to 150mm. Length = 130 m	2028	$ 43,000																43,000					
R-2 - Install new pipe, 150mm. Length = 95 m	2029	$ 31,000																	31,000				
R-3 - Install new pipe, 150mm. Length = 136 m	2030	$ 45,000																		45,000			
R-4 - Upgrade existing pipe, 150mm to 200mm. Length = 136 m	2024	$ 183,000												183,000									
R-5 - Install new hydrant	2013	$ 4,000	4,000																				
R-6 - Install new pipe, 150mm. Length = 11 m	2013	$ 4,000	4,000																				
R-7 - Upgrade existing pipe, 100 mm to 150 mm. Length = 100 m	2023	$ 37,000											37,000										
R-8 - Upgrade existing 150 mm pipe to 200 mm. Length = 93 m	2014	$ 45,000		45,000																			
R-9 - Install new 300 mm diameter pipe. Length = 340 m	2016	$ 223,000				223,000																	
R-10 - Install new pipe, 150 mm. Length = 295 m	2014	$ 105,000		105,000																			
R-12 - Upgrade 100 mm pipe to 150 mm. Length = 230 m.	2021	$ 75,000									75,000												
R-13 - Upgrade 50 mm pipe 100 mm. Length = 6 m.	2013	$ 10,000	10,000																				
R-14 - Upgrade 150 mm pipe 250 mm. Length = 300 m.	2015	$ 168,000			168,000																		
R-15 - Upgrade 150 mm to 200 mm. Length = 87 m	2016	$ 38,000				38,000																	
R-16 - Install new 200 mm diameter pipe. Length = 430 m	2013	$ 188,000	188,000																				
R-17 - Upgrade 150 mm to 200 mm. Length = 215 m.	2014	$ 94,000		94,000																			
R-19 - Upgrade 100 mm dia to 150 mm. Length = 130 m	2021	$ 29,000									29,000												
R-20 - Upgrade 50 mm dia to 150 mm. Length = 100 m	2013	$ 19,000	19,000																				
R-21 - Upgrade 50 mm dia to 150 mm. Length = 105 m	2013	$ 20,000	20,000																				
R-22 - Upgrade 50 mm dia to 100 mm. Length = 120 m	2017	$ 25,000					25,000																
Hydrant Infill Program	2017	$ 135,000					135,000																
Primary Disinfection Upgrade on Shallow Wells (UV System)	2019	$ 1,800,000							1,800,000														
PRV between the Active Mountain Reservior and the Collettville	2022	$ 125,000										125,000											
Fairly Park Generator	2017	$ 160,000					160,000																
Reservoir Control Valves	2015	$ 125,000			125,000																		
Studies																							
Pressure Zone Feasibility Study	2014	$ 30,000		30,000																			
UV Water Quality Monitoring Study/UVT Analyzers	2013	$ 25,000	25,000																				
UV Disinfection Concept Study/Preliminary Design	2014	$ 50,000		50,000																			
Hydrant Infill Risk Evalation and Priorization	2013	$ 15,000	15,000																				
Asset Invenstory Database Update	2015	$ 65,000			65,000																		
			285,000	324,000	358,000	261,000	320,000	0	1,800,000	0	104,000	125,000	37,000	183,000	0	0	0	43,000	31,000	45,000	0	0	0

9.0 FINANCIAL MODEL

This section of the report covers the deployment of a comprehensive Financial Model for the City of Merritt's water utility. The analysis is performed for scenarios as set out in Case 1, Case 2 and Case 3. To model the financial sustainability of the water utility, a modelling end year of 2110 was used to capture the costs of aging infrastructure. An extended period is required to capture the life expectancy of municipal infrastructure.

The following subsections discuss the methodology of the Financial Model and how the Financial Model was developed using Merritt's PSAB 3150 inventory, expenditures and revenues, water demand, and recommendations for capital investments presented earlier in this report. This section of the report concludes with the results and recommendations.

9.1 Methodology

The objective of the Financial Model is to provide guidance to enable the utility to recover the cost of the supply and distribution system required to service the utility's customers over the long term, by setting equitable utility tariff rates which yield a revenue stream sufficient to achieve a financially sustainable utility.

The cost of supplying the service includes the following:

- Ongoing management, billing, operation and maintenance
- Capital development including debt servicing

- Provision for investments, refurbishment and replacement of aging infrastructure
- Additional operating costs associated with expanding the area serviced by the system through funding by developers

Revenue sources to fund these costs could include:

- Parcel charges ($/parcel)
- User charges ($\$/m^3$) on revenue water
- Interest received from reserves
- External funding (federal government, provincial government, or developer)

The model is designed to find the required revenue envelope necessary to achieve a desired debt goal within a set timeframe. For the Merritt model, the desired goal has been set as being $0 debt by 2110. This is fully customizable for any specified debt goal and modeling period.

For each year of the set period, the model estimates the costs and revenues for that year and adds or deducts them from the previous year balance. The model then carries the utility account balance over to the next year and repeats the process.

Interest is added or subtracted from the utility account balance. The model allows for two different interest rates to be applied respective of the overall account balance. Parcel taxes and user charges are automatically adjusted by the model to achieve a desired utility account balance (a debt goal) at the end of the set period while servicing all costs. The effects of inflation are initially ignored in the model and all values are reported in 2010 dollars. Provision is made for inflation of the revenue stream and rates once the sustainable values have been determined.

The model provides separate accounts for the bulk system and distribution system. The parcel tax is allocated to the distribution system account and the user charges to the bulk system account. The accounts are summed to form the utility account.

The model reports the following key parameters:

- Illustrative Average Cost Per Parcel = Total Revenue / Number of Parcels

This is calculated for the present revenue and for the required sustainable revenue. The difference represents the adjustment recommended.

These values are further broken down into:

- Frontage Utility Service Rate ($/m year)
- Usage Rate ($/m^3 of Revenue Water)

Revenue water is all water that reaches or is attributed to the customer. Water that is lost through leaks in the water distribution system, used for watering of community parks and gardens, system flushing and fire suppression use is considered non-revenue water. Non-revenue water creates an expense related to pumping and treatment from which the City cannot generate revenue. It is debited to the distribution account. This can be entered in the model as a percentage of total demand.

The bulk system and the distribution system are defined as follows:

9.1.1 Bulk System

The bulk system incorporates all components of the water system involved in the supply of water. It includes the following components in the water system:

- Wells
- Pumphouses
- Control buildings
- Reservoirs
- PRV stations
- Chlorination system
- Mains > 325 mm diameter

Costs associated with the bulk system are related to the operation and the rehabilitation and investment in any of the above components. Rehabilitation expenses are calculated using the PSAB 3150 inventory and replacement values. Bulk investments are included as set out elsewhere in this report, see Sections 7.6 and 8.1.

Operating costs are predicted from historic records. The historic records are used to divide the operating costs into several categories. Operating costs including administration, operation and maintenance have decreased steadily in the 4 year period 2007 through 2010. Therefore the base costs (2010), from which projections are made, have been adjusted to equal the average of the four years. The following categories are considered relevant to the operation and maintenance of the bulk water supply system:

- Value Dependent Expenses
    - 20% of the cost of water supply administration (the remaining 80% is carried as part of the distribution costs)
- Demand Dependent Expenses
    - 100% of the cost of treatment and/or disinfection
    - 100% of the costs of wells and pumping

Value dependent expenses increase with future upgrades and investments in the bulk system. Demand dependent expenses are proportionally related to population growth rate and future per capita water demand.

9.1.2 Distribution System

The distribution system includes all the distribution mains up to the point where the service connections meet the property lines. The components include:

- Distribution watermains size ≤ 325 mm
- Valves
- Fire hydrants
- Hydrant Leads
- Curb stops (service connections)

Costs associated with the distribution system are related to the operation of and the rehabilitation and investment in any of the above components. Findings from Section 7.6 and 8.1 were used to determine the required upgrades and investments in the distribution system.

The operating costs associated with the distribution system are predicted from historic records. Operating costs including administration, operation and maintenance have decreased steadily in the 4 year period 2007 through 2010. Therefore the base costs, from which projections are made, have been adjusted to equal the average of the four years. The following value dependent expenses are considered relevant to the distribution system:

- 80% of water supply administration (the remaining 20% is carried as part of the bulk system costs)
- 100% of water transmission and distribution expenses

The operating costs increase with future upgrades and investments in the distribution system funded by the City and are proportionally related to a set growth rate of the distribution system.

9.2 PSAB 3150 Inventory

The City of Merritt’s 2010 PSAB 3150 Inventory (asset inventory) provided the information necessary for the Financial Model to estimate rehabilitation costs of the water utility and the corresponding rehabilitation timeline. The asset inventory provides a database of the in-service year, service life, length, diameter and replacement cost or original cost of most of the components of the system.

The information provided in the asset inventory was largely generalized and therefore, to develop a more accurate representation of the current system and replacement values, certain data adjustments were required. The assets assigned to the bulk and distribution systems and the respective data adjustments are described in the following sections.

9.2.1 Bulk System Inventory

Based on the criteria outlined is Section 9.1.1, the assets in the worksheets *F&E 10, Water Machine & Equip 2010, and Buildings 10* of the asset inventory we assigned to the bulk system account of the Financial Model. The asset inventory reported the original cost of each asset at the time of installation; therefore, to calculate a replacement value, the ENR Cost Index was used. For example, the Nicola Reservoir cost $35,090 to build in 1965, using the ENR Cost Index; the Nicola Reservoir would cost $318,087 to replace in 2010 dollars. The Airport Pumphouse and Well were not included in the Bulk Asset inventory as they will be decommissioned with the airport expansion project.

The values of bulk assets in Table 9-1 were not included in the inventory provided and therefore replacement value and installation date were assumed. We have based the capital costs on estimated prices based on cost curves as we were unable to obtain specific costs from the City.

TABLE 9-1
DISTRIBUTION ASSET SERVICE LIFE AND REPLACEMENT VALUE

Asset	Service Life	Replacement Value*
Grandview Reservoir	60	$60,000
Grandview PRV and Booster Station	50	$600,000
Southeast Reservoir	60	$2,000,000
Kengard Pump Station	50	$1,000,000
Kengard Well	60	$500,000
Active Mountain Reservoir	60	$2,000,000
Active Mountain Booster Station	50	$100,000

**Construction costs are estimated based on cost curves for similar work*

9.2.2 Distribution System Inventory

Based on the criteria outlined is Section 9.1.2, the assets in the worksheets *Hydrants 10, Water Valves 10*, *Curb Stops 10*, and *Water Mains 10* we assigned to the distribution system account of the Financial Model. Table 9-2, below, summarizes the service life and replacement value of the assets included in the distribution system (see Section 9.1.2).

TABLE 9-2
DISTRIBUTION ASSET SERVICE LIFE AND REPLACEMENT VALUE

Asset	Service Life	Replacement Value*
Watermain – 50 mm dia	70	$200/m
Watermain – 100 mm dia	70	$200/m
Watermain – 150 mm dia	70	$250/m
Watermain – 200 mm dia	70	$250/m

TABLE 9-2
DISTRIBUTION ASSET SERVICE LIFE AND REPLACEMENT VALUE (CONT'D)

Asset	Service Life	Replacement Value*
Watermain – 250 mm dia	70	$300/m
Watermain – 300 mm dia	70	$300/m
Watermain – 350 mm dia	70	$325/m
Watermain – 600 mm dia	70	$967/m
Curb Stop (service connection)	50	$1,657 each
Fire Hydrant	50	$5,500 each
Valve	65	$1,500 each

**Costs were provided in the PSAB 3150 Inventory*

The *Water Valves 10* and *Curb stops 10* asset inventories reported that 99% of the assets have an installation year of 1965.

However, in 1996 there were reportedly 8,152 m of watermains installed which is equivalent to 11% of the total length of watermains in the distribution system. There are a total of 2184 curb stops and 940 water valves connected to the distribution system. Therefore, it can be assumed that 11% of the curb stops and water valves, 244 curb stops and 105 water valves, were installed in 1996. The data was adjusted accordingly.

Other observations and comments based on our review of the inventory data provided include:

- A uniform service life has been used for all watermains. This is a reasonable first estimate for Merritt because the majority of the water distribution system is ductile iron. In reality however, lifespan is impacted by material type, installation conditions and in-service circumstances. Therefore a change in service life has been included in the Scenarios evaluated.

- A service life value of 70 years for all watermains is relatively low for ductile iron pipes. This value should be reviewed because if the average pipe lifespan is greater, the average annual cost for pipe replacements would be less and the required funding envelope would be reduced.

- The service life value for fire hydrants is less than we would expect and the service life for curb stops is greater than we would expect as an average.

- The accuracy of replacement unit rates provided for distribution assets has not been reviewed under this component of the project. An increase in replacement cost has been included in the scenarios to illustrate the impact on the funding envelope.

9.3 Expenditures and Revenues

The City of Merritt provided financial information for the Water Utility Fund for 2007 through 2011. Historical financial information is necessary to develop a baseline year that is representative of a typical fiscal year for the water utility; 2010 was used as a baseline year for the Financial Model. The following subsections discuss the allocation and omission of operation and maintenance expenditures and revenues between the bulk and distribution systems and how operation and maintenance expenditures and revenues are projected from the baseline year.

9.3.1 Expenditures

A review of the expenditures for the water utility fund resulted in expenditures being omitted or re-allocated in the Financial Model. The City of Merritt spent approximately $265,000 in 2011 and under $6,000 in 2009 on consultant studies. Due to this variability, expenditures on consultant studies were removed from the water utility fund, averaged, and the average of $70,000 was applied to the baseline year of 2010. It is recognized that in 2010, several major infrastructure projects were completed, including the Kengard Well and Pump Station. Amortization expenses and Transfers to Own Funds and Reserves were removed from the expenditures as the goal of the Financial Model is to develop a sustainable tariff that will draw sufficient revenue to fund the costs of the current and future utility. Including Amortization and Transfers to Own Funds and Reserves would overstate the baseline expenditures and result in higher tariffs.

It was noted that the resulting expenditures decreased steadily from $685,522 in 2007 to $233,619 in 2010. The operations expenditure in the Base Year (2010) was increased to yield expenditure equal to the average of the 4 years as a Base.

Expenditures were separated into value dependent expenses and demand dependent expenses.

9.3.1.1 Value Dependent Expenses

Value dependent expenses include the costs associated with water supply administration. The Financial Model assumes that the bulk system must fund 20% of the water supply administration expenses while the distribution system must fund the remaining 80%. Bulk system value dependent expenses are projected to increase with future upgrades and investments in the bulk system. Distribution system value dependent expenses are projected to increase with future upgrades and investments in the distribution system and with developer funded growth of the system.

9.3.1.2 Demand Dependent Expenses

Demand dependent expenses include the costs associated with the demand for water and the model assumes the bulk system funds 100% of these costs. Demand dependent expenses are projected to increases proportionally with population growth rate and future per capita water demand.

9.3.2 Revenues

The Water Utility Fund draws revenues from Property Taxation, Sale of Services, Conditional Grants, Transfers from Own Sources, and Other Revenues. Conditional Grants were omitted as revenue in the Financial Model as grant funding is difficult to predict and only accounts for a small portion of overall revenue; the model allows for a percentage of external funding to be applied to all costs associated with the capital expenditures of rehabilitation and allows for a percentage of external funding to be applied to each investment or upgrade. Transfers from Own Sources were also omitted as revenue as the goal of the Financial Model is to produce a tariff that will draw sufficient revenue to fund the costs of the current and future water utility.

9.3.2.1 Bulk Revenues

Sale of Services revenues were $1,183,393 in 2010. The financial model adjusts the user charge ($\$/m^3$) during the rate change period such that the balance of the Water Utility Fund is zero in the year 2110.

9.3.2.2 Distribution Revenues

Property Taxation revenues were $530,747 in 2010. The Financial Model adjusts the required revenue during the rate change period such that the balance of the Water Utility Fund is zero in the year 2110.

Table 9-5 summarizes the total expenditures and revenues for each system.

TABLE 9-3
TOTAL EXPENDITURES AND REVENUES (2010) (ADJUSTED)

System	Total Expense	Total Revenues
Bulk System (incl. long term debt)	$533,881 (67%)	$(1,183,393) (69%)
Distribution System	$252,909 (32%)	$(530,747) (31%)
Total	**$786,790**	**$(1,714,140)**

Table 9-3 shows that the expenditures on the bulk and distribution system are proportional to the respective revenue. However, a significant portion of the expenditure and revenues relate to funding long term debt for bulk system upgrades.

9.4 Water Demand

A baseline year of 2010, which coincides with the year chosen for the Water Utility Master Plan, was used to project population growth until the year 2030. Section 4.0 of this report discusses water demand in detail and the numbers used in the Financial Model are summarized here.

TABLE 9-4
BASELINE VALUES (2010)

Parameter	Value in 2010	Units
Population	7,285	Persons
Total Water Demand	2,926	Million Litres
Number of Parcels	3,756	Parcels

9.5 Recommended Upgrades and Investments

Section 7.6 and Section 8.1 provide recommendations for the required upgrades of the existing bulk and distribution systems and new installations to meet current and future demands. The costs and schedule associated with these investments are included in the Financial Model.

9.6 Adjustments and Variables

The setup of the model is documented in the print-outs of the various sheets included in Appendix E - Financial Model Set-up and in the three Cases analysed, printouts of which follow this section.

9.6.1 Adjustments

Key adjustments and inclusions are as follows:

1. Investments made after the Base Date of 2010 and the recommended upgrades and investments have been included in 2.3 Linear Assets and 2.4 Major Point Assets. The rehabilitation costs of these assets have therefore been included in the model.
2. Long Term Debt has been included.
3. The Operating and Consumable Expenses shown in the financial statements for the years 2006 through 2010 have shown a continuous decline from $685,522 to $389,728. Since the value in the Base Year is used for projection of future expenses the Operation Expenses have been increased by $132,000 in the Base Year to bring the Total Expenses in the Base Year up to the average of Total Expenses over the period 2006 through 2010.
4. Population Growth and Parcel Growth – Population growth scenarios used in the evaluation of the required system capacity of 1%p.a. and 3.5%p.a. are not appropriate for financial modeling. This is because growth rates of this order taken over a long modeling period would increase the tax base substantially and result in unrealistic and excessive projections of revenue. For the purposes of financial modeling, the average

growth rate derived from census data of 0.12%p.a. for the period 2006 – 2011 has been used and projected to 2030. Thereafter growth of zero has been assumed.

5. Growth in Value of Distribution/Collection Assets has been taken as half the population growth rate to take account of increases in density.
6. Change to Linear Asset Rehabilitation Unit Costs. These costs which were obtained from the City may be appropriate for “green field” construction. However, rehabilitation would normally be undertaken in a more challenging environment due to existing services and pedestrian and road traffic and may include the need to resurface roads and sidewalks. These costs have therefore been factored up by 25% to allow for the more challenging environment.
7. Based on the Tornado Plot – (See below) - The impact of Change to Service Life by 30% has been evaluated in Case 2. This value has been chosen because the Service Life of 70 years provided by the City for the ductile iron pipe is lower than that given in the British Columbia Guide to the Amortization of Tangible Capital Assets of 100 years. A 30% increase results in a Service Life of 91 years, which may still be conservative.

9.6.2 Variables

The model allows for many variables to be tested for the impact on the Illustrative Average Costs. To determine the sensitivity of the result to each of the costs a Tornado Diagram has been created based on running all the permutations set out in the print-out of 0.2 Tornado Plots included in Appendix E. The results indicate the following parameters as being important:

1. Change to Service Life – Addressed above. Illustrates the importance of rehabilitation costs and the need for active asset management.
2. Change to Linear Asset Rehabilitation Costs – Addressed above. Illustrates the importance of rehabilitation costs and the need for active asset management.

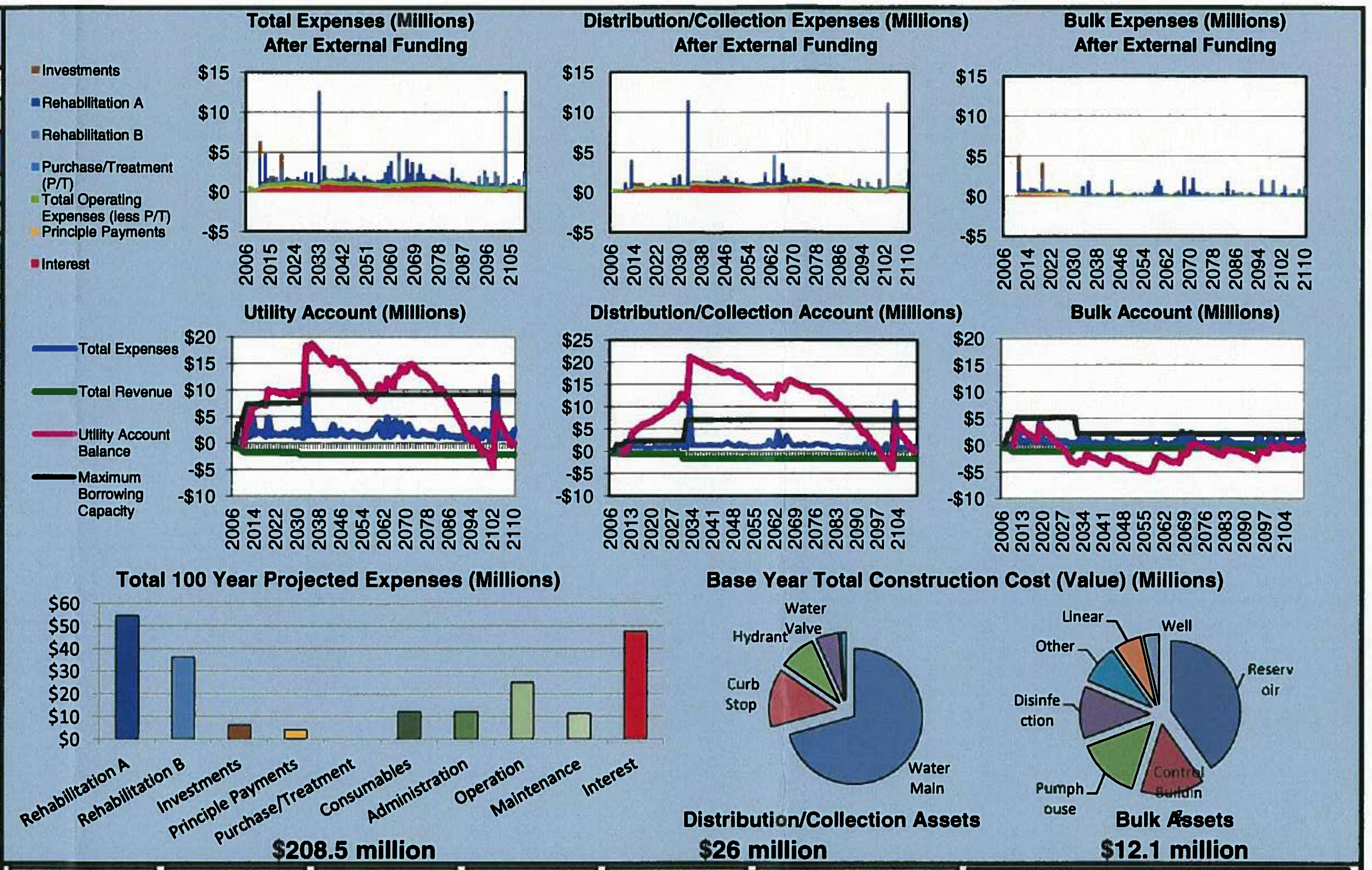
City of Merritt MERRITT COUNTRY MUSIC CAPITAL OF CANADA

Water Utility Financial Model

CASE 1 - 25% Increase Rehabilitation Costs

OPUS DAYTONKNIGHT

0.0	**Equitable Rates** Graph	**Base Year**	**End of Rate Change Period**	
0.1	Frontage Utility Service Rate *($ / m / Year)*	$5.39	**$16.15**	
0.2	Usage Rate *($ / m³ of Revenue Water)*	$0.55	**$0.23**	
0.3	**Illustrative Average Cost *($ / Parcel / Year)***	$456	$561	
1.0	**Modeling Period**	**Base Year** 2010	**End Year** 2110	
2.0	**Accounting**	**Goal**	**Achieved***	
2.1	Distribution/Collection Account Balance	$0	$0	
2.2	Bulk Account Balance	$0	$0	
3.0	**Revenue Adjustment**	**Rate**	**Start**	**End**
3.1	Manual Revenue Adjustment Period *(p.a., After, Until)*	0.0%	2011	2011
3.2	Automatic Revenue Adjustment Period *(After, Until)*		2030	2031
4.0	**Common Variables**	**Base**	**Until**	**Then**
4.1	Interest Rate on Reserves *(p.a.)*	1.5%	2020	2.0%
4.2	Interest Rate on Debt *(p.a.)*	4.5%	2020	5.0%
4.3	Change to Linear Asset Rehabilitation Unit Costs	25.00%		
4.4	Change to Point Asset Rehabilitation Unit Costs	0.00%		
4.5	Change to Service Life	0.00%		
4.6	Change to Administration Expenses *(p.a.)*	0.00%	2030	0.00%
4.7	Change to Operation Expenses *(p.a.)*	0.00%	2030	0.00%
4.8	Change to Maintenance Expenses *(p.a.)*	0.00%	2030	1.00%
4.9	External Backlog Rehabilitation Funding	0.00%		
4.10	External Rehabilitation Funding	0.00%		
5.0	**Population and Infrastructure Variables** Graph	**Base**	**Until**	**Then**
5.1	Population Growth *(p.a.)*	0.12%	2030	0.00%
5.2	Parcel Growth *(p.a.)*	0.12%	2030	0.00%
5.3	Growth** in Value of Distribution/Collection Assets *(p.a.)*	0.06%	2020	0.00%
5.4	Growth** in Value of Bulk Assets *(p.a.)*	0.12%	2030	0.00%
6.0	**Water Usage/Discharge/Treatment Variables** Graph	**Base**	**Until**	**Then**
6.1	Average Annual Water Purchase/Treatment Rate *($ / m³)*	$0.00		
6.2	Purchase/Treatment Cost Increase *(p.a.)*	0.00%	2030	0.00%
6.3	Change to per Capita Gross Water Usage/Treatment *(p.a.)*	0.00%	2030	0.00%
6.4	Non-rev % of Gross Water Usage/Treatment	25%		
6.5	Change to Non-rev % of Gross Water Usage/Treatment *(p.a.)*	0.00%	2020	0.00%
7.0	**Liability Limit**			
7.1	Percent of Total Revenue *(Debt Servicing Costs)*	25.00%		
7.2	Debt Term *(years)*	30		
8.0	**Economic Evaluation*** **			
8.1	Discount Rate *(p.a)*	0.00%		
8.2	Net Present Value of Total Projected Expenses in Year	2011	$208,531,610	



Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 | Scenario 5 | Review Scenario's | CLICK TO RUN MODEL

Select mode for running model on Dashboard: Manual

Run model with: All Variables

Avg. Annual Factored Distribution/Collection Rehabilitation Expenses: $591,031

Avg. Annual Factored Rehabilitation Bulk Expenses: $281,254

*If running model with 'Only Factored Rehabilitation and Associated Interest Expenses', the achieved account balance is set to equal zero such that interest is only calculated on expenses related to rehabiliation

**Developer Funded Growth

***See 1.0 Summary line 73

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City of Merritt

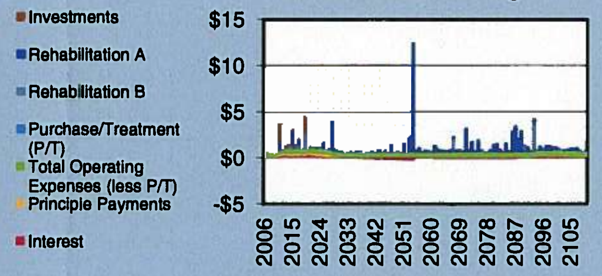
Water Utility Financial Model

CASE 2 - 25% Increase Rehabilitation Costs, 30% Increase Service Life

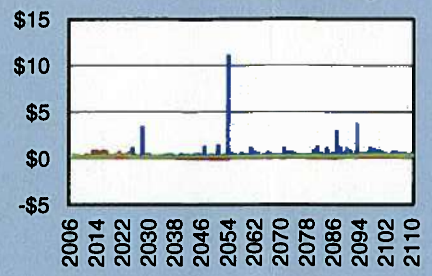
OPUS DAYTONKNIGHT

0.0	**Equitable Rates** Graph	**Base Year**	**End of Rate Change Period**	
0.1	Frontage Utility Service Rate *($ / m / Year)*	$5.39	**$8.18**	
0.2	Usage Rate *($ / m^3 of Revenue Water)*	$0.55	**$0.17**	
0.3	**Illustrative Average Cost** ***($ / Parcel / Year)***	$456	$314	
1.0	**Modeling Period**	**Base Year** 2010	**End Year** 2110	
2.0	**Accounting**	**Goal**	**Achieved***	
2.1	Distribution/Collection Account Balance	$0	$0	
2.2	Bulk Account Balance	$0	$0	
3.0	**Revenue Adjustment**	**Rate**	**Start**	**End**
3.1	Manual Revenue Adjustment Period *(p.a., After, Until)*	0.0%	2011	2011
3.2	Automatic Revenue Adjustment Period *(After, Until)*		2030	2031
4.0	**Common Variables**	**Base**	**Until**	**Then**
4.1	Interest Rate on Reserves *(p.a.)*	1.5%	2020	2.0%
4.2	Interest Rate on Debt *(p.a.)*	4.5%	2020	5.0%
4.3	Change to Linear Asset Rehabilitation Unit Costs	25.00%		
4.4	Change to Point Asset Rehabilitation Unit Costs	0.00%		
4.5	Change to Service Life	30.00%		
4.6	Change to Administration Expenses *(p.a.)*	0.00%	2030	0.00%
4.7	Change to Operation Expenses *(p.a.)*	0.00%	2030	0.00%
4.8	Change to Maintenance Expenses *(p.a.)*	0.00%	2030	1.00%
4.9	External Backlog Rehabilitation Funding	0.00%		
4.10	External Rehabilitation Funding	0.00%		
5.0	**Population and Infrastructure Variables** Graph	**Base**	**Until**	**Then**
5.1	Population Growth *(p.a.)*	0.12%	2030	0.00%
5.2	Parcel Growth *(p.a.)*	0.12%	2030	0.00%
5.3	Growth** in Value of Distribution/Collection Assets *(p.a.)*	0.06%	2020	0.00%
5.4	Growth** in Value of Bulk Assets *(p.a.)*	0.12%	2030	0.00%
6.0	**Water Usage/Discharge/Treatment Variables** Graph	**Base**	**Until**	**Then**
6.1	Average Annual Water Purchase/Treatment Rate *($ / m^3)*	$0.00		
6.2	Purchase/Treatment Cost Increase *(p.a.)*	0.00%	2030	0.00%
6.3	Change to per Capita Gross Water Usage/Treatment *(p.a.)*	0.00%	2030	0.00%
6.4	Non-rev % of Gross Water Usage/Treatment	25%		
6.5	Change to Non-rev % of Gross Water Usage/Treatment *(p.a.)*	0.00%	2020	0.00%
7.0	**Liability Limit**			
7.1	Percent of Total Revenue *(Debt Servicing Costs)*	25.00%		
7.2	Debt Term *(years)*	30		
8.0	**Economic Evaluation*** **			
8.1	Discount Rate *(p.a)*	0.00%		
8.2	Net Present Value of Total Projected Expenses in Year	2011	$132,468,274	

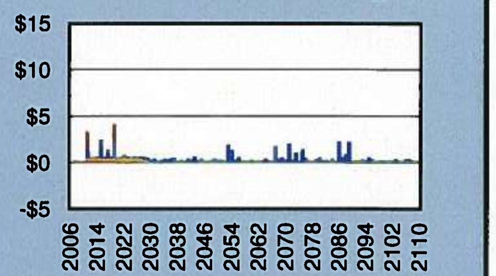
Total Expenses (Millions) After External Funding



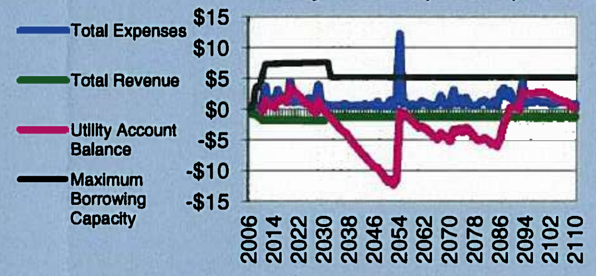
Distribution/Collection Expenses (Millions) After External Funding



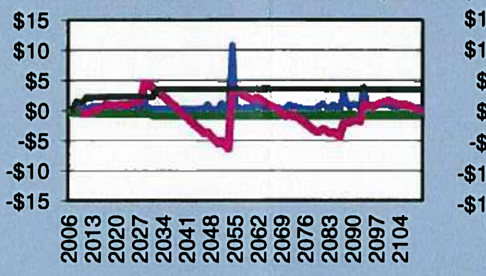
Bulk Expenses (Millions) After External Funding



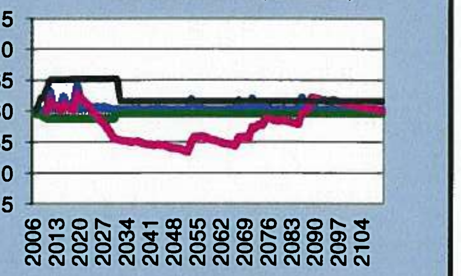
Utility Account (Millions)



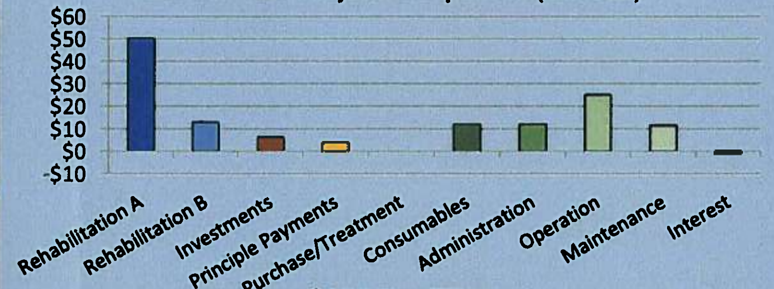
Distribution/Collection Account (Millions)



Bulk Account (Millions)

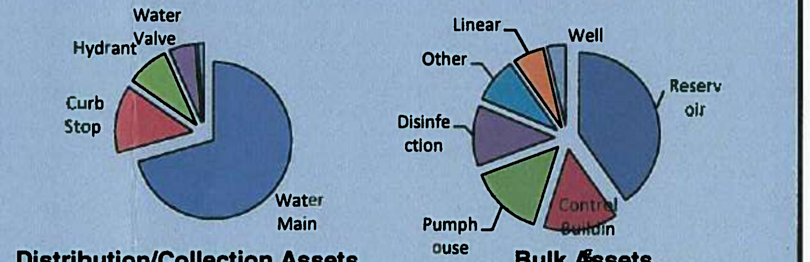


Total 100 Year Projected Expenses (Millions)



$132.5 million

Base Year Total Construction Cost (Value) (Millions)



Distribution/Collection Assets **$26 million**

Bulk Assets **$12.1 million**

Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 | Scenario 5 | Review Scenario's

CLICK TO RUN MODEL

Select mode for running model on Dashboard: Manual ▼

Run model with: All Variables ▼

Avg. Annual Factored Distribution/Collection Rehabilitation Expenses: $591,031

Avg. Annual Factored Rehabilitation Bulk Expenses: $281,254

*If running model with 'Only Factored Rehabilitation and Associated Interest Expenses', the achieved account balance is set to equal zero such that interest is only calculated on expenses related to rehabiliation

**Developer Funded Growth

***See 1.0 Summary line 73

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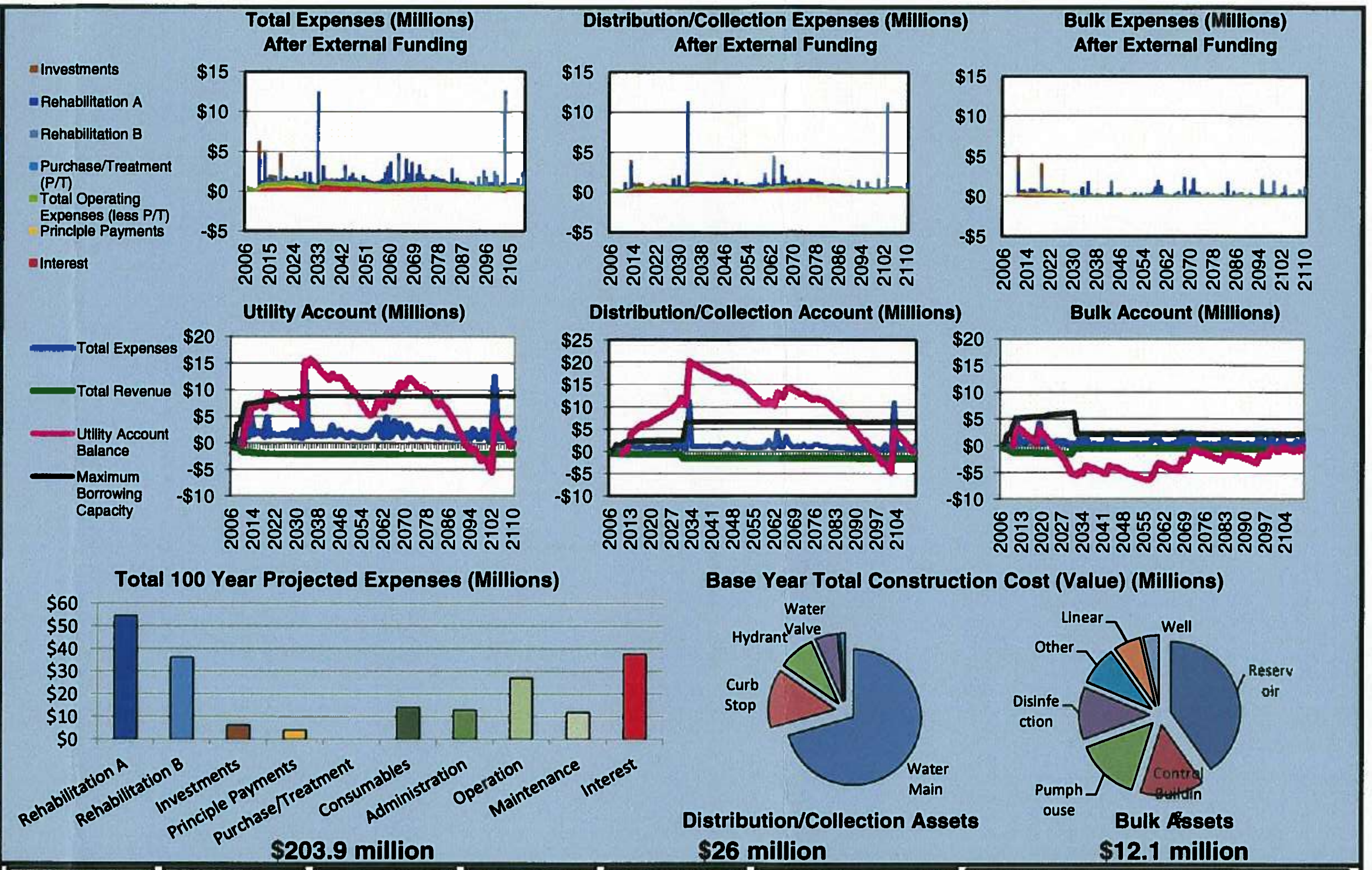
City of Merritt MERRITT COUNTRY MUSIC CAPITAL OF CANADA

Water Utility Financial Model

CASE 3 - 25% Increase Rehabilitation Costs - 1%p.a. Growth to 2030

OPUS DAYTONKNIGHT

0.0	**Equitable Rates** Graph	**Base Year**	**End of Rate Change Period**	
0.1	Frontage Utility Service Rate *($ / m / Year)*	$5.39	**$14.53**	
0.2	Usage Rate *($ / m^3 of Revenue Water)*	$0.55	**$0.19**	
0.3	**Illustrative Average Cost** ***($ / Parcel / Year)***	$456	$452	
1.0	**Modeling Period**	**Base Year**	**End Year**	
		2010	2110	
2.0	**Accounting**	**Goal**	**Achieved***	
2.1	Distribution/Collection Account Balance	$0	$0	
2.2	Bulk Account Balance	$0	$0	
3.0	**Revenue Adjustment**	**Rate**	**Start**	**End**
3.1	Manual Revenue Adjustment Period *(p.a., After, Until)*	0.0%	2013	2013
3.2	Automatic Revenue Adjustment Period *(After, Until)*		2030	2031
4.0	**Common Variables**	**Base**	**Until**	**Then**
4.1	Interest Rate on Reserves *(p.a.)*	1.5%	2020	2.0%
4.2	Interest Rate on Debt *(p.a.)*	4.5%	2020	5.0%
4.3	Change to Linear Asset Rehabilitation Unit Costs	25.00%		
4.4	Change to Point Asset Rehabilitation Unit Costs	0.00%		
4.5	Change to Service Life	0.00%		
4.6	Change to Administration Expenses *(p.a.)*	0.00%	2030	0.00%
4.7	Change to Operation Expenses *(p.a.)*	0.00%	2030	0.00%
4.8	Change to Maintenance Expenses *(p.a.)*	0.00%	2030	1.00%
4.9	External Backlog Rehabilitation Funding	0.00%		
4.10	External Rehabilitation Funding	0.00%		
5.0	**Population and Infrastructure Variables** Graph	**Base**	**Until**	**Then**
5.1	Population Growth *(p.a.)*	1.00%	2030	0.00%
5.2	Parcel Growth *(p.a.)*	1.00%	2030	0.00%
5.3	Growth** in Value of Distribution/Collection Assets *(p.a.)*	0.50%	2020	0.00%
5.4	Growth** in Value of Bulk Assets *(p.a.)*	1.00%	2030	0.00%
6.0	**Water Usage/Discharge/Treatment Variables** Graph	**Base**	**Until**	**Then**
6.1	Average Annual Water Purchase/Treatment Rate *($ / m^3)*	$0.00		
6.2	Purchase/Treatment Cost Increase *(p.a.)*	0.00%	2030	0.00%
6.3	Change to per Capita Gross Water Usage/Treatment *(p.a.)*	0.00%	2030	0.00%
6.4	Non-rev % of Gross Water Usage/Treatment	25%		
6.5	Change to Non-rev % of Gross Water Usage/Treatment *(p.a.)*	0.00%	2020	0.00%
7.0	**Liability Limit**			
7.1	Percent of Total Revenue *(Debt Servicing Costs)*	25.00%		
7.2	Debt Term *(years)*	30		
8.0	**Economic Evaluation*** **			
8.1	Discount Rate *(p.a)*	0.00%		
8.2	Net Present Value of Total Projected Expenses in Year	2011	$203,927,929	



Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 | Scenario 5 | Review Scenario's

CLICK TO RUN MODEL

Select mode for running model on Dashboard: Manual ▼

Run model with: All Variables ▼

Avg. Annual Factored Distribution/Collection Rehabilitation Expenses: $591,031

Avg. Annual Factored Rehabilitation Bulk Expenses: $281,254

*If running model with 'Only Factored Rehabilitation and Associated Interest Expenses', the achieved account balance is set to equal zero such that interest is only calculated on expenses related to rehabilitation

**Developer Funded Growth

***See 1.0 Summary line 73

RETURN TO INDEX

3. Change to per Capita Gross Water Usage/Treatment - This result is an artifact of the reduction in the revenue stream in the early modeling years and the result of increased interest charges. The change would not have a significant impact on the real system cost as the revenue envelope would be managed to avoid significant interest charges.
4. Interest Rate on Debt – This indicates that the amount of debt needs to be managed since interest rates are largely out of the control of the City.
5. Change to Operation Expenses – This signifies that all Operating Expenses (Administration, Operation and Maintenance) need to be managed.
6. Change to Point Asset Rehabilitation Costs – Illustrates the importance of rehabilitation costs and the need for active asset management.
7. Manual Revenue Adjustment – Manual revenue adjustment increasing the revenue in early years can result in a reduced level of debt, the resulting lower interest charges and lower long term total cost. Increasing revenue in early years results in lower interest charges and total cost.

Population growth, which is not included in the tornado plots, because it is not a stand-alone variable, is also significant as having a larger population, when rehabilitation is required, spreads the cost and allows more revenue generation.

9.7 Review of Cases and Discussion

9.7.1 Review of Cases

A review of Case 1, Case 2 and Case 3 results in the following:

1. The Service Life of assets, especially linear assets, is the key uncertainty impacting the financial sustainability of the utility. Compare the Total 100 Year Projected Expenses.

2. Current revenue is adequate should the 30% Change to Service Life be realistic, but may be inadequate without that change. Note that current revenue from sale of water is in balance with the need to fund long term debt associated with the bulk system upgrades completed recently. However, over time the need for rehabilitation will drive capital expenditure and the rate structure will become out of balance with the revenue needs from an equitable user pay perspective.
3. Case 1 results in the utility exceeding its calculated Maximum Borrowing Capacity and results in high interest costs.
4. Case 3 – 1%p.a. growth till 2030 renders the utility financially stable but the calculated Maximum Borrowing Capacity may be exceeded.
5. The Service Rates currently reflect the cost of service. However, over the modeling period, revenue from sale of water will exceed the cost of production while the revenue from service delivery will not meet the cost of operating and rehabilitating the distribution system.

9.7.2 Discussion

The required funding envelope is influenced by a number of variables, some of which are difficult to quantify. Setting the appropriate level is therefore a process of progressive evaluation and adjustment. By maintaining the model, which will be made available to the City, this process can be simplified.

The key variable viz. the service life of the assets needs to be monitored with a view to confirming the assumptions made and to allow the revenue envelope to be adjusted. This can be undertaken by reviewing the corrosion conditions both inside and outside the pipes together with sampling of the pipes to determine rates of corrosion. The service life of pipes is likely to vary depending on the above factors as well as the quality of installation and the level of criticality of each element. Since failure of critical elements of the infrastructure may be most undesirable, the service life of these is effectively shortened.

Non-critical infrastructure can be allowed to deteriorate until the cost of maintenance and the deterioration in level of service drives rehabilitation. This can significantly extend the effective service life. This determination is a component of an Asset Management program. Since asset management is a process of incremental improvement, the City would benefit from having ongoing access to high level asset management expertise.

The current revenue envelope, assumed to be in place until 2031, appears adequate but should be reviewed as better information becomes available. This envelope should be adjusted for inflation as the model reports in Base Year (2010) dollars. Adjustment is desirable to keep the utility within borrowing limits and to manage interest costs.

While the revenue envelope may be adequate to fund future needs, the rates which are currently equitable will become progressively more inequitable as the funding need moves towards rehabilitation.

While growth of the City would ease the funding of rehabilitation, the prospects of growth at the rate assumed (1% p.a.) over an extended period would need to be underpinned by significant economic drivers. An ageing population would counter this potential growth.

The City is moving towards metered billing for ICI consumers. This change together with the rate structure currently in place leaves revenue generation exposed to possible usage reduction by high ICI consumers. A review of the rate structure guided by the cost of service could improve the sustainability of the revenue stream.

9.8 Recommendations

1. The City should maintain the current revenue envelope with adjustment for inflation in the short term until re-evaluation is undertaken.

2. A program for continuous evaluation of the service life, especially of linear assets should be initiated

3. Based on the information gained from the above activities a review of the rate structure is recommended.

4. The City should intensify its asset management process with high level input as required.

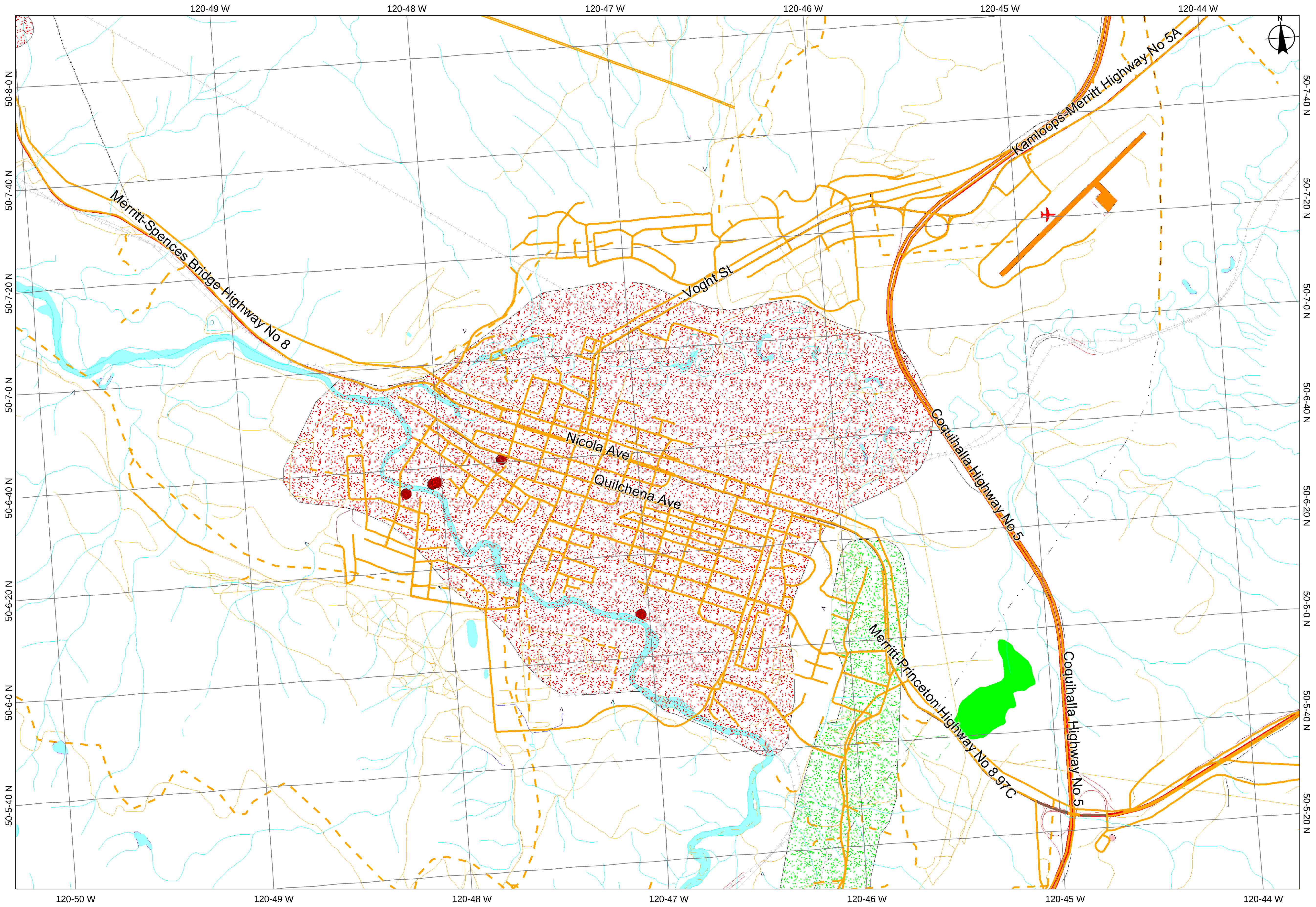
5. Critical infrastructure should be identified and actively managed.

MERRITT
COUNTRY MUSIC CAPITAL OF CANADA

WATER UTILITY MASTER PLAN

APPENDIX A

WATER AQUIFER



City of Merritt Aquifer Map

Legend

☐ **Aquifer Boundary - Outlined**

Aquifer Vulnerability - Colour Themed

- **Bedrock, High Vulnerability**
- **Bedrock, Moderate Vulnerability**
- **Bedrock, Low Vulnerability**
- **Unconsolidated, High Vulnerability**
- **Unconsolidated, Moderate Vulnerability**
- **Unconsolidated, Low Vulnerability**

Drinking Water Extraction Points - BC Health Authority

- ● **WS1: >300 Connections**
- ● **WS2: 15-300 Connections**
- ○ **WS3: 1-14 Connections**
- ■ **WS4: 1 Public Connection**
- ■ **Unknown**

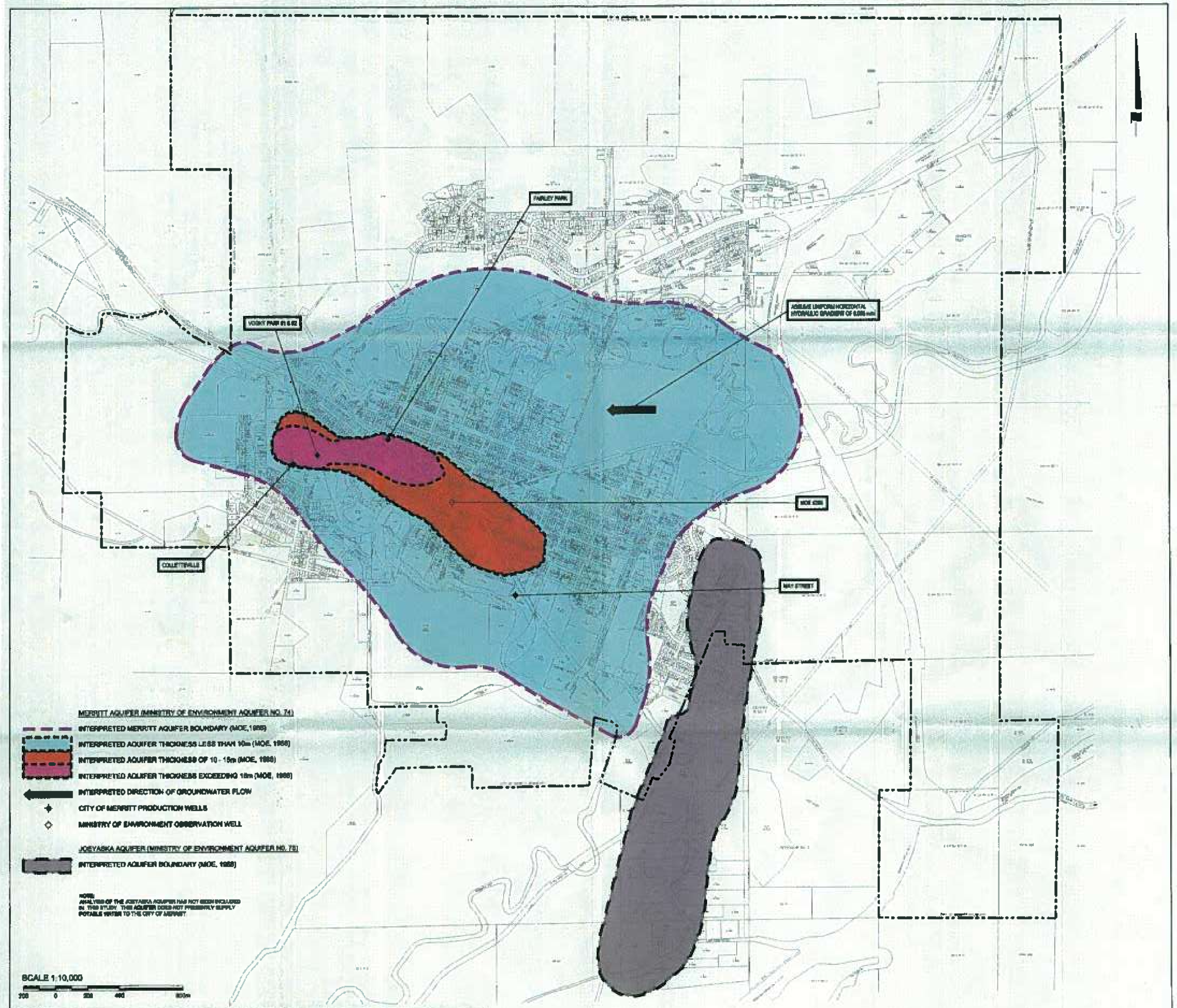
0 325 650 m.

Scale: 1:22,335

Copyright/Disclaimer

Datum/Projection: NAD83, Albers Equal Area Conic

Key Map of British Columbia



EBA Engineering Consultants Ltd.			PROJECT:	CITY OF MERRITT AQUIFER PROTECTION PLAN	
TITLE: PLAN OF MERRITT AND LOCAL AQUIFERS			LOCATION:	MERRITT, BC	
			CLIENT:	CITY OF MERRITT	
DATE: 19 DEC 2003	DWN: LM	CHKD: TC	FILE NO:	0805-2002-3879017	FIGURE 1

WATER UTILITY MASTER PLAN

APPENDIX B

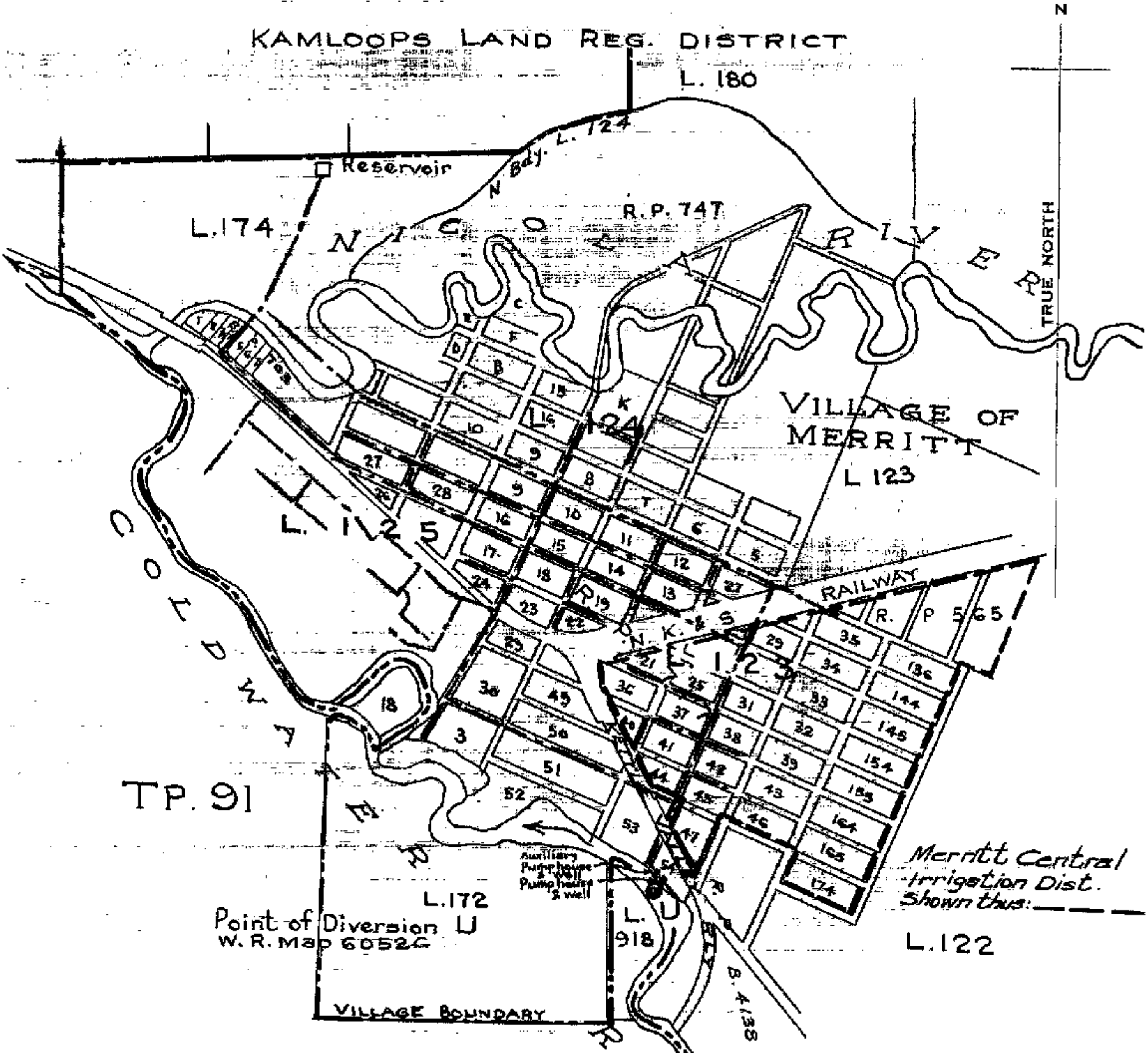
WATER LICENSE

British Columbia.

NICOLA WATER DISTRICT.

Scale, 1320 Feet to 1 Inch.

KAMLOOPS LAND REG. DISTRICT



Merritt Central Irrigation Dist. Shown thus:

Point of Diversion ●

Pipeline

The boundaries of the Corp. of the Village of Merritt are shown thus:

Signature

Date 1st Dec., 1959

C.L. 25311
File0225282

EXHIBIT "A"

W.R.B. 13—o

PROVINCE OF
BRITISH COLUMBIA

Water Rights Branch

DEPARTMENT OF
LANDS AND FORESTS

CONDITIONAL WATER LICENCE

The Corporation of the Village of Merritt, of Merritt, B. C.,

is/are hereby authorized to divert and use water as follows:—

(*a*) The source (s) of the water-supply is/are Coldwater River.

(*b*) The point (s) of diversion is/are located as shown on the attached plan.

(*c*) The date from which this licence shall have precedence is 9th July, 1958.

(*d*) The purpose for which the water is to be used is waterworks.

(*e*) The maximum quantity of water which may be diverted is 1,000,000 gallons a day, and such additional quantity as the Engineer may from time to time determine should be allowed for losses.

(*f*) The period of the year during which the water may be used is the whole year.

(*g*) The land upon which the water is to be used and to which this licence is appurtenant is the lands within the boundaries of the Corporation of the Village of Merritt.

(*h*) The works authorized to be constructed are pumps, wells and pipe, and they shall be located approximately as shown on the attached plan.

(*i*) The construction of the said works ~~shall~~ has been commenced ~~on or before the~~ ~~day~~ ~~of~~ ~~19~~, and shall be completed and the water beneficially used on or before the 31st day of December, 1963.

ENTERED ON
Map No. G952
By A=L

A. F. Paget,
Comptroller of Water Rights.

File No. 0225282 Date issued 1st December, 1959. Licence No. 25311

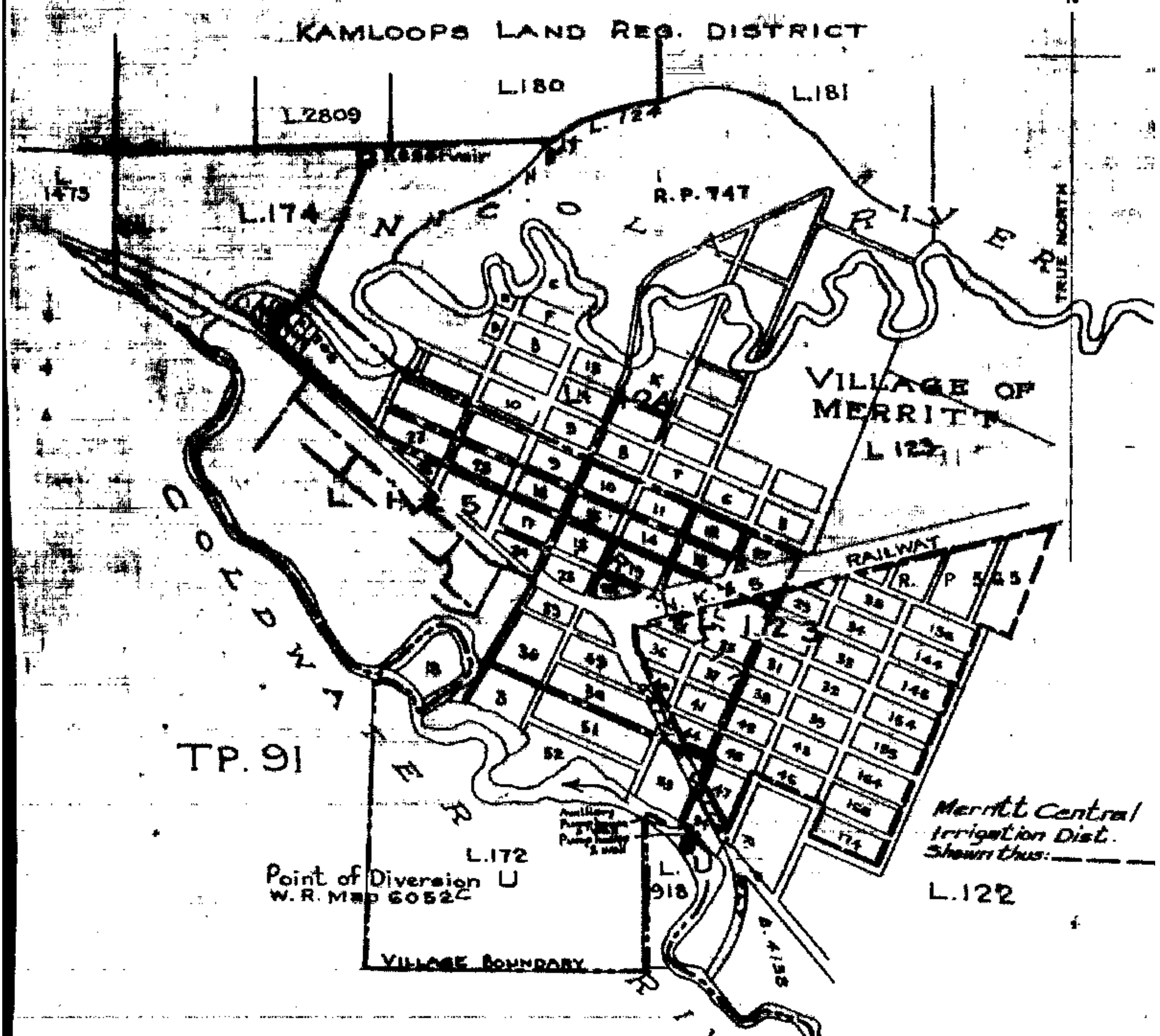
7

British Columbia.

7

NICOLA WATER DISTRICT.

Scale, 1320 Feet to 1 Inch.



Point of Diversion ●

Pipeline

The boundaries of the Corp. of the Village of Merritt are shown thus:

Signature A Paul

Date 1 Aug., 1961

C.L. 26589 for F.L. 9495

FM 0237469

EXHIBIT "A"

W.R.B. 13—0

PROVINCE OF
BRITISH COLUMBIA

Water Rights Branch

DEPARTMENT OF
LANDS AND FORESTS

CONDITIONAL WATER LICENCE

The Corporation of the Village of Merritt, of Merritt, B. C.

is/are hereby authorized to divert and use water as follows:—

(*a*) The source (s) of the water-supply is/are Coldwater River.

(*b*) The point (s) of diversion is/are located as shown on the attached plan.

(*c*) The date from which this licence shall have precedence is 21st February, 1931.

(*d*) The purpose for which the water is to be used is waterworks.

(*e*) The maximum quantity of water which may be diverted is 15,000 gallons a day, and such additional quantity as the Engineer may from time to time determine should be allowed for losses.

(*f*) The period of the year during which the water may be used is 1st April to 30th September.

(*g*) The land upon which the water is to be used and to which this licence is appurtenant is the lands within the boundaries of the Corporation of the Village of Merritt.

(*h*) The works authorized to be constructed are pumps, wells and pipe and they shall be located approximately as shown on the attached plan.

(*i*) The construction of the said works ~~shall be~~ has been commenced ~~on or before the~~ ~~day~~ ~~of~~ , ~~19xx~~ , and shall be completed and the water beneficially used on or before the 31st day of December , 19 63 .

(j) This licence does not authorize the construction or maintenance of any works upon or the use or occupation of any lands being part of the Railway Right-of-Way belonging to the Kettle Valley Railway Company, unless and until such construction or maintenance is approved, or such use or occupation authorized by the Board of Railway Commissioners of Canada.

(k) This licence is issued in substitution of Final Water Licence No. 9495, under change of purpose, change of appurtenancy and change of works.

ENTERED ON ✓
Map No. 6052
By R.M.

A. F. Paget,
Comptroller of Water Rights.

File No. 0237469

Date issued 1st August, 1961.

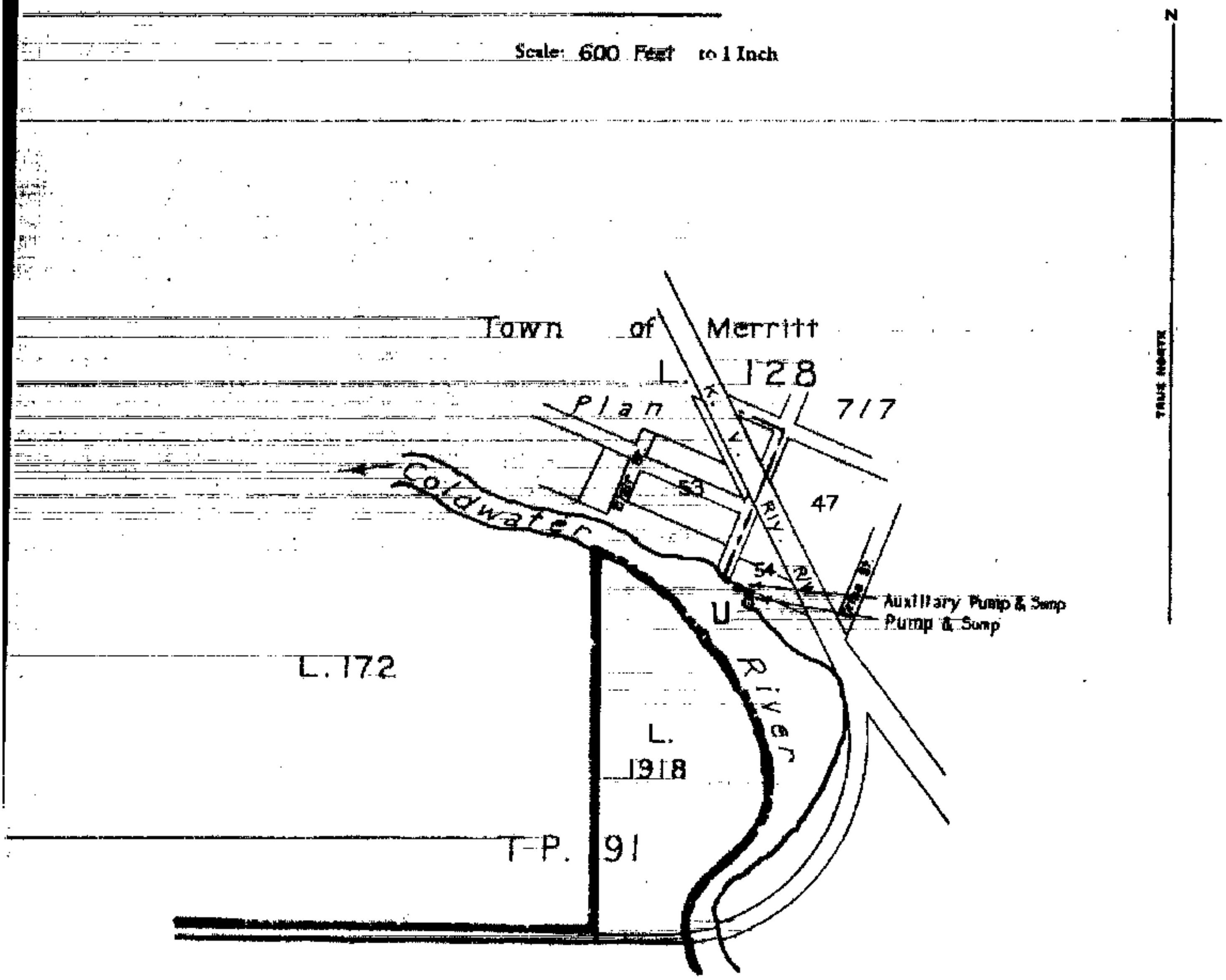
Licence No. 26589

British Columbia

NICOLA WATER DISTRICT

KAMLOOPS DIVISION OF YALE DISTRICT

Scale: 600 Feet to 1 Inch



Boundaries of the Corporation of the town of Merritt shown thus: ———

LEGEND

Point of Diversion ●

W.R. Map 6052^C

Pipe — - —

6

Signature

Date Mar. 16, 1966

CL 30750 for FL 10615

File 0127528

EXHIBIT "A"

206-1265-798

WATER RESOURCES SERVICE
WATER RIGHTS BRANCH

DEPARTMENT OF LANDS, FORESTS,
AND WATER RESOURCES

THE PROVINCE OF BRITISH COLUMBIA—WATER ACT

CONDITIONAL WATER LICENCE

Town of Merritt of **Box 189, Merritt, B.C.**

is/are hereby authorized to **divert and use** water as follows:—

(*a*) The source(s) of the water-supply is/are **Coldwater River.**

(*b*) The point(s) of **diversion** is/are located as shown on the attached plan.

(*c*) The date from which this licence shall have precedence is **2nd March 1939.**

(*d*) The purpose for which the water is to be used is **waterworks.**

(*e*) The maximum quantity of water which may be **diverted is 463,100 gallons a day,** and such additional quantity as the Engineer may from time to time determine should be allowed for losses.

(*f*) The period of the year during which the water may be **used is 1st April to 30th September.**

(*g*) The land upon which the water is to be used and to which this licence is appurtenant is **the lands within the boundaries of the Town of Merritt.**

(*h*) The works authorized to be constructed are **pumps, sumps, pipe and distribution system,** and they shall be located approximately as shown on the attached plan.

(*i*) The construction of the said works **has been commenced, and shall be completed and the water beneficially used on or before the 31st day of December, 1970.**

(j) **This licence is issued in substitution of Final Water Licence No. 10615, under Sections 15 and 16 of the Water Act.**

6052
R.M. BD

H. D. DeBeck,
Comptroller of Water Rights.

File No. 0127528 Date issued: 16 March 1966

Conditional Licence No. 30750

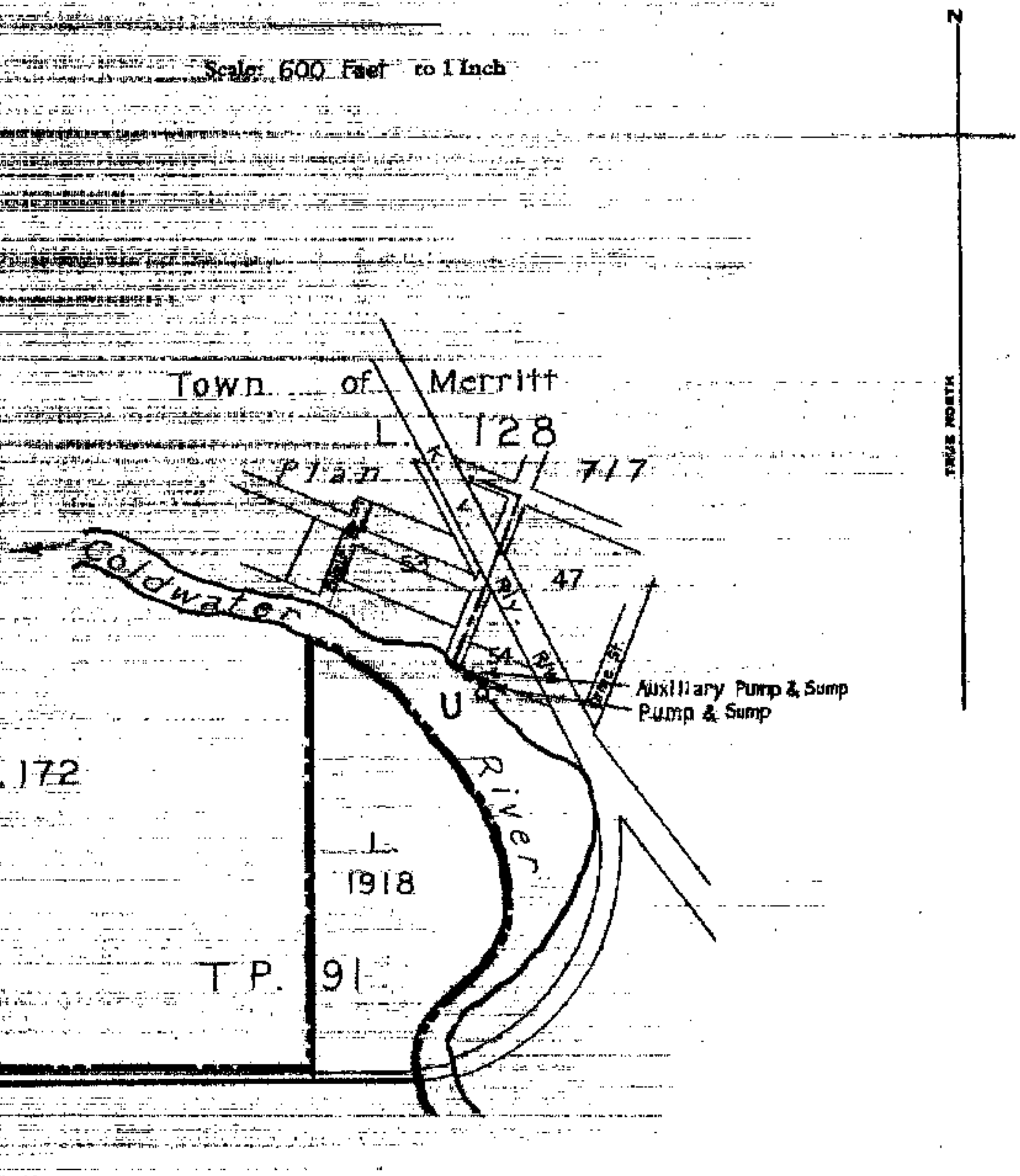
5M-365-3219

British Columbia

NICOLA WATER DISTRICT

KAMLOOPS DIVISION OF YALE DISTRICT

Scale: 600 Feet to 1 Inch



Boundaries of the Corporation of the town of Merritt shown thus: ▬▬▬

LEGEND

Point of Diversion ○
W.R. Map 6052 E
Pipe ▬ ▬

The boundaries of the land to which this licence is appurtenant are shown thus: ▬▬▬

EXHIBIT "A"

Signature

Date Mar. 16, 1966
CL 30751
File 0263044

WATER RESOURCES SERVICE
WATER RIGHTS BRANCH

DEPARTMENT OF LANDS, FORESTS, AND WATER RESOURCES

THE PROVINCE OF BRITISH COLUMBIA—WATER ACT

CONDITIONAL WATER LICENCE

Town of Merritt of **Box 189, Merritt, B.C.**

is/are hereby authorized to **divert and use** water as follows:—

(*a*) The source(s) of the water-supply is/are **Coldwater River.**

(*b*) The point(s) of **diversion** is/are located as shown on the attached plan.

(*c*) The date from which this licence shall have precedence is **16th June, 1965.**

(*d*) The purpose for which the water is to be used is **waterworks.**

(*e*) The maximum quantity of water which may be **diverted is 463,100 gallons a day,** and such additional quantity as the Engineer may from time to time determine should be allowed for losses.

(*f*) The period of the year during which the water may be **used is 1st October to 31st March.**

(*g*) The land upon which the water is to be used and to which this licence is appurtenant is **the lands within the boundaries of the Town of Merritt.**

(*h*) The works authorized to be constructed are **pumps; sumps, pipe and distribution system,** and they shall be located approximately as shown on the attached plan.

(*i*) The construction of the said works **has been commenced and shall be completed and the water beneficially used on or before the 31st day of December, 1970.**

ENTERED ON
Map No. 6052
By KM. BD

H. D. DeBeck,
Comptroller of Water Rights.

File No. **0263044** Date issued: **16 March 1966**

Conditional Licence No. **30751**

5M-365-3219

MERRITT

COUNTRY MUSIC CAPITAL OF CANADA

WATER UTILITY MASTER PLAN

APPENDIX C

WATER QUALITY TESTS

CERTIFICATE OF ANALYSIS

CARO
ANALYTICAL SERVICES

CLIENT	**Interior Health Authority - Kamloops** 519 Columbia Street Kamloops BC V2C 2T8	TEL FAX	1-250-851-7340 1-250-851-7341
ATTENTION	**Ted Mahler**		
RECEIVED / TEMP	Oct-02-09 09:35 / 10.0 °C	**WORK ORDER #**	K9J0050
REPORTED	Oct-15-09	**PROJECT FILE**	Ted Mahler - Should I Test my DW Pkg
		PROJECT NAME	Merrit Community Water System

General Comments:

CARO Analytical Services employs methods which are based on those found in "Standard Methods for the Examination of Water and Wastewater", 21st Edition, 2005, published by the American Public Health Association (APHA); US EPA protocols found in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846", 3rd Edition; and protocols published by the British Columbia Ministry of Environment (BCMOE).

Methods not described in these publications are conducted according to procedures accepted by appropriate regulatory agencies, and/or are done in accordance with recognized professional standards using accepted testing methodologies and quality control efforts except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirity. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

- All solids results are reported on a dry weight basis unless otherwise noted

- Units:
  - mg/kg = milligrams per kilogram, equivalent to parts per million (ppm)
  - mg/L = milligrams per litre, equivalent to parts per million (ppm)
  - ug/L = micrograms per litre, equivalent to parts per billion (ppb)
  - ug/g = micrograms per gram, equivalent to parts per million (ppm)
  - ug/m3 = micrograms per cubic meter of air

• "RDL"	Reported detection limit
• "<"	Less than reported detection limit
• "AO"	Aesthetic objective
• "MAC"	Maximum acceptable concentration (health-related guideline)
• "LAB"	RMD = CARO - Richmond location, KEL = CARO - Kelowna location, SUB = Subcontracted

Please contact CARO if more information is needed.

CARO Analytical Services

JShanko

Final Review Per: **Jennifer Shanko, AScT**
Coordinator, Operations/Admin

SAMPLE DATA

CLIENT	Interior Health Authority - Kamloops	**WORK ORDER #**	K9J0050
PROJECT FILE	Ted Mahler - Should I Test my DW Pkg	**REPORTED**	Oct-15-09

General Parameters

Merritt Community Water System (K9J0050-01) Matrix: Water Sampled: Oct-01-09 13:20

Analyte	Result	Canadian DW Guidelines (May 08)	RDL	Units	Analyzed	Method	Lab	Notes
Transmissivity @ 254nm	**95.1**		0.1	%	Oct-07-09	APHA 5910B	KEL	
Alkalinity, Total as CaCO3	**122**		1.0	mg/L	Oct-02-09	APHA 2320 B	KEL	
Chloride	**27.5**	AO ≤ 250	0.10	mg/L	Oct-02-09	APHA 4110 B	KEL	
Colour, True	<5	AO ≤ 15	5	Color Unit	Oct-02-09	APHA 2120 B	KEL	
Conductivity (EC)	**401**		5	uS/cm	Oct-02-09	APHA 2510 B	KEL	
Cyanide (total)	<0.01	MAC = 0.2	0.01	mg/L	Oct-07-09	APHA 4500-CN	KEL	
Fluoride	<0.10	MAC = 1.5	0.10	mg/L	Oct-02-09	APHA 4110 B	KEL	
Hardness, Total (Total as CaCO3)	**153**		2.54	mg/L	Oct-09-09	APHA 2340 B	RMD	
Nitrogen, Nitrate as N	**0.73**	MAC = 10	0.01	mg/L	Oct-02-09	APHA 4110 B	KEL	
pH	**7.38**	AO = 6.5 - 8.5	0.10	pH Units	Oct-02-09	APHA 4500-H+	KEL	
Solids, Total Dissolved	**228**	AO ≤ 500	5	mg/L	Oct-05-09	APHA 2540 C	KEL	
Sulfate	**37.6**	AO ≤ 500	1.0	mg/L	Oct-02-09	APHA 4110 B	KEL	
Turbidity	**0.2**	Varies, See Guidelines	0.1	NTU	Oct-02-09	APHA 2130 B	KEL	

Total Recoverable Metals by ICPMS

Merritt Community Water System (K9J0050-01) Matrix: Water Sampled: Oct-01-09 13:20

Analyte	Result	Canadian DW Guidelines (May 08)	RDL	Units	Analyzed	Method	Lab	Notes
Aluminum	<0.005	AO ≤ 0.1	0.005	mg/L	Oct-08-09	EPA 6020A	RMD	
Antimony	<0.0001	MAC = 0.006	0.0001	mg/L	Oct-08-09	EPA 6020A	RMD	
Arsenic	<0.0005	MAC = 0.01	0.0005	mg/L	Oct-08-09	EPA 6020A	RMD	
Barium	**0.0783**	MAC = 1	0.0005	mg/L	Oct-08-09	EPA 6020A	RMD	
Beryllium	<0.0001		0.0001	mg/L	Oct-08-09	EPA 6020A	RMD	
Bismuth	<0.0001		0.0001	mg/L	Oct-08-09	EPA 6020A	RMD	
Boron	**0.019**	MAC = 5	0.002	mg/L	Oct-08-09	EPA 6020A	RMD	
Cadmium	<0.00001	MAC = 0.005	0.00001	mg/L	Oct-08-09	EPA 6020A	RMD	
Calcium	**40.8**		1.0	mg/L	Oct-08-09	EPA 6020A	RMD	
Chromium	**0.0008**	MAC = 0.05	0.0005	mg/L	Oct-08-09	EPA 6020A	RMD	
Cobalt	<0.00005		0.00005	mg/L	Oct-08-09	EPA 6020A	RMD	
Copper	**0.0340**	AO ≤ 1	0.0001	mg/L	Oct-08-09	EPA 6020A	RMD	
Iron	**0.04**	AO ≤ 0.3	0.01	mg/L	Oct-08-09	EPA 6020A	RMD	
Lead	**0.0021**	MAC = 0.01	0.0001	mg/L	Oct-08-09	EPA 6020A	RMD	
Lithium	**0.0004**		0.0001	mg/L	Oct-08-09	EPA 6020A	RMD	
Magnesium	**12.3**		0.01	mg/L	Oct-08-09	EPA 6020A	RMD	
Manganese	**0.0004**	AO ≤ 0.05	0.0002	mg/L	Oct-08-09	EPA 6020A	RMD	
Mercury	<0.00005	MAC = 0.001	0.00005	mg/L	Oct-08-09	EPA 6020A	RMD	
Molybdenum	**0.0006**		0.0001	mg/L	Oct-08-09	EPA 6020A	RMD	
Nickel	**0.0009**		0.0002	mg/L	Oct-08-09	EPA 6020A	RMD	
Phosphorus	<0.02		0.02	mg/L	Oct-08-09	EPA 6020A	RMD	
Potassium	**1.47**		0.01	mg/L	Oct-08-09	EPA 6020A	RMD	
Selenium	<0.0003	MAC = 0.01	0.0003	mg/L	Oct-08-09	EPA 6020A	RMD	
Silicon	**6.4**		0.2	mg/L	Oct-08-09	EPA 6020A	RMD	
Silver	<0.00005		0.00005	mg/L	Oct-08-09	EPA 6020A	RMD	
Sodium	**12.7**	AO ≤ 200	0.01	mg/L	Oct-08-09	EPA 6020A	RMD	
Strontium	**0.312**		0.0005	mg/L	Oct-08-09	EPA 6020A	RMD	
Tellurium	<0.0002		0.0002	mg/L	Oct-08-09	EPA 6020A	RMD	
Thallium	<0.00002		0.00002	mg/L	Oct-08-09	EPA 6020A	RMD	

CLIENT	Interior Health Authority - Kamloops	**WORK ORDER #**	K9J0050
PROJECT FILE	Ted Mahler - Should I Test my DW Pkg	**REPORTED**	Oct-15-09

Total Recoverable Metals by ICPMS, Continued

Merritt Community Water System (K9J0050-01) Matrix: Water Sampled: Oct-01-09 13:20, Continued

Analyte	Result	Canadian DW Guidelines (May 08)	RDL	Units	Analyzed	Method	Lab	Notes
Thorium	<0.0001		0.0001	mg/L	Oct-08-09	EPA 6020A	RMD	
Tin	<0.0002		0.0002	mg/L	Oct-08-09	EPA 6020A	RMD	
Titanium	<0.005		0.005	mg/L	Oct-08-09	EPA 6020A	RMD	
Uranium	**0.00062**	MAC = 0.02	0.00002	mg/L	Oct-08-09	EPA 6020A	RMD	
Vanadium	<0.001		0.001	mg/L	Oct-08-09	EPA 6020A	RMD	
Zinc	**0.035**	AO ≤ 5	0.001	mg/L	Oct-08-09	EPA 6020A	RMD	
Zirconium	<0.0001		0.0001	mg/L	Oct-08-09	EPA 6020A	RMD	

CERTIFICATE OF ANALYSIS

CARO
ANALYTICAL SERVICES

CLIENT	**Interior Health Authority - Kamloops** 519 Columbia Street Kamloops BC V2C 2T8	TEL FAX	1-250-851-7340 1-250-851-7341
ATTENTION	**Ted Mahler**		
RECEIVED / TEMP	Oct-05-09 09:35 / 10.0 °C	**WORK ORDER #**	K9J0063
REPORTED	Oct-15-09	**PROJECT FILE**	Analysis For Ted Mahler
COC #(s)	See WO# K9J0050	**PROJECT NAME**	THMs for Merritt Community Water System

General Comments:

CARO Analytical Services employs methods which are based on those found in "Standard Methods for the Examination of Water and Wastewater", 21st Edition, 2005, published by the American Public Health Association (APHA); US EPA protocols found in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846", 3rd Edition; and protocols published by the British Columbia Ministry of Environment (BCMOE).

Methods not described in these publications are conducted according to procedures accepted by appropriate regulatory agencies, and/or are done in accordance with recognized professional standards using accepted testing methodologies and quality control efforts except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirity. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

- All solids results are reported on a dry weight basis unless otherwise noted

- Units:
  - mg/kg = milligrams per kilogram, equivalent to parts per million (ppm)
  - mg/L = milligrams per litre, equivalent to parts per million (ppm)
  - ug/L = micrograms per litre, equivalent to parts per billion (ppb)
  - ug/g = micrograms per gram, equivalent to parts per million (ppm)
  - ug/m3 = micrograms per cubic meter of air

• "RDL"	Reported detection limit
• "<"	Less than reported detection limit
• "AO"	Aesthetic objective
• "MAC"	Maximum acceptable concentration (health-related guideline)
• "LAB"	RMD = CARO - Richmond location, KEL = CARO - Kelowna location, SUB = Subcontracted

Please contact CARO if more information is needed.

CARO Analytical Services

JShanko

Final Review Per: **Jennifer Shanko, AScT**
Coordinator, Operations/Admin

SAMPLE DATA

CARO ANALYTICAL SERVICES

CLIENT Interior Health Authority - Kamloops
PROJECT FILE Analysis For Ted Mahler

WORK ORDER # K9J0063
REPORTED Oct-15-09

Volatile Organic Compounds by PT-GCMS

Merritt Community Water System (K9J0063-01) Matrix: Water Sampled: Oct-01-09 13:20

Analyte	Result	Canadian DW Guidelines (May 08)	RDL	Units	Analyzed	Method	Lab	Notes
Bromodichloromethane	**0.002**	MAC = 0.016	0.001	mg/L	Oct-06-09	EPA 5030B/8260B	RMD	
Bromoform	**0.001**		0.001	mg/L	Oct-06-09	EPA 5030B/8260B	RMD	
Chloroform	**0.001**		0.001	mg/L	Oct-06-09	EPA 5030B/8260B	RMD	
Dibromochloromethane	**0.003**		0.001	mg/L	Oct-06-09	EPA 5030B/8260B	RMD	
Trihalomethanes (total)	**0.007**	MAC = 0.1	0.004	mg/L	Oct-06-09	EPA 5030B/8260B	RMD	
Surrogate: Toluene-d8	*102 %*		*80-120*		*Oct-06-09*			
Surrogate: 1,4-Dichlorobenzene-d4	*89 %*		*80-120*		*Oct-06-09*			

GREG - F/I

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CITY OF MERRITT
SEP. - 2 2009
RECEIVED
☐ To:
☐ Cc:
☐ File No.

File Number: 38050-40/Merritt-74
August 31, 2009

City of Merritt
Public Works Manager
Attention: Shawn Boven
P.O. Box 189
Merritt BC V1K 1B8

Re: City of Merritt Wells – Chemical Analysis of Drinking Water

Dear Shawn Boven:

The Ministry of Environment collected ground water samples from four City of Merritt municipal wells and a provincial observation well on August 10, 2009. The chemical analyses reports for the ground water samples are included as attachments. A summary discussion for each water sample is provided below.

Fairley Park Well

These results indicate that the groundwater sample met the CDWG for parameters tested with the exception of the total hardness (as calcium carbonate). The groundwater sample had an elevated nitrate-nitrogen level. The 187 mg/L hardness value (as calcium carbonate) indicates that the groundwater is hard.

Colletteville Well

These results indicate that the groundwater sample met the CDWG for parameters tested with the exception of the total hardness (as calcium carbonate). The 204 mg/L hardness value (as calcium carbonate) indicates that the groundwater is hard.

Ministry of Environment
Water Stewardship Division
Thompson Region
Mailing/Location Address:
1259 Dalhousie Drive
Kamloops British Columbia V2C 5Z5
Telephone: (250) 371-6200
Facsimile: (250) 828-4000
Website: www.gov.bc.ca/env

Maxxam Job #: A942192
Report Date: 2009/08/27

MINISTRY OF ENVIRONMENT
Client Project #: AGME
Site Reference: E250650 CITY OF MERRITT FAIRLY PARK WELL
Sampler Initials: LL

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		Q19008		
Sampling Date		2009/08/10 10:35		
COC Number		50166816		
	Units	REG/1	RDL	QC Batch

Field Parameters				
Sample End Date	N/A	20090810	0	3338950
Sample End Time	N/A	10:35	0	3338950
Sample Start Date	N/A	20090810	0	3338950
Sample Start Time	N/A	10:35	0	3338950
Temperature at Arrival	C	5	1	3338942
Misc. Inorganics				
Bromide (Br)	mg/L	<0.4	0.4	3340554
Fluoride (F)	mg/L	0.06	0.01	3340608
Field-Vancouver				
Field Conductivity	uS/cm	370	0.1	ONSITE
Field pH	pH Units	8.4	0.1	ONSITE
Field Temperature	°C	11	0.1	ONSITE
Field Turbidity	NTU	<0.1	0.1	ONSITE
Calculated Parameters				
Nitrate (N)	mg/L	1.14	0.002	3338946
Demand Parameters				
Chemical Oxygen Demand	mg/L	<10	10	3345778
Misc. Inorganics				
Alkalinity (Total as CaCO3)	mg/L	140	0.5	3345894
Alkalinity (PP as CaCO3)	mg/L	<0.5	0.5	3345894
Bicarbonate (HCO3)	mg/L	170	0.5	3345894
Carbonate (CO3)	mg/L	<0.5	0.5	3345894
Anions				
Dissolved Sulphate (SO4)	mg/L	32	0.5	3349875
Dissolved Chloride (Cl)	mg/L	59	0.5	3349824
Nutrients				
Total Kjeldahl Nitrogen (Calc)	mg/L	<0.02	0.02	3337391
Total Organic Nitrogen (N)	mg/L	<0.02	0.02	3338948
Dissolved Phosphorus (P)	mg/L	0.003	0.002	3340376
Ammonia (N)	mg/L	<0.005	0.005	3346583
Nitrate plus Nitrite (N)	mg/L	1.14	0.002	3344399
Nitrite (N)	mg/L	<0.002	0.002	3344484

RDL = Reportable Detection Limit

mg/L

1.5 (≤08)

YSI measurements suspect to possible errors

500 (≥08)
250 (<08)

~~10~~
10 (≥08)

Maxxam Job #: A942192
Report Date: 2009/08/27

MINISTRY OF ENVIRONMENT
Client Project #: AGME
Site Reference: E250650 CITY OF MERRITT FAIRLY PARK WELL
Sampler Initials: LL

LOW LEVEL TOTAL METALS - WATER (WATER)

Maxxam ID		Q19008				
Sampling Date		2009/08/10 10:35				
COC Number		50168816				Compare to 2008
	Units	REG/1	RDL	QC Batch		
Calculated Parameters						
Total Hardness (CaCO3)	mg/L	187	0.5	3340012	80-100	(< 08)
Total Metals by ICPMS						
Total Aluminum (Al)	ug/L	1.0	0.2	3346491		
Total Antimony (Sb)	ug/L	0.03	0.02	3346491	0.002	(= 08)
Total Arsenic (As)	ug/L	0.09	0.02	3346491	0.010	(=)
Total Barium (Ba)	ug/L	88.7	0.02	3346491		
Total Beryllium (Be)	ug/L	<0.01	0.01	3346491		
Total Bismuth (Bi)	ug/L	<0.005	0.005	3346491		
Total Boron (B)	ug/L	<50	50	3346491	5	(=)
Total Cadmium (Cd)	ug/L	0.012	0.005	3346491	0.005	(>)
Total Chromium (Cr)	ug/L	<0.1	0.1	3346491	0.050	(<)
Total Cobalt (Co)	ug/L	0.010	0.005	3346491		(<)
Total Copper (Cu)	ug/L	1.77	0.05	3346491	1	(<)
Total Iron (Fe)	ug/L	<1	1	3346491	0.300	
Total Lead (Pb)	ug/L	1.88	0.005	3346491		
Total Lithium (Li)	ug/L	<0.5	0.5	3346491		
Total Manganese (Mn)	ug/L	<0.05	0.05	3346491	0.050	(=)
Total Molybdenum (Mo)	ug/L	0.33	0.05	3346491		
Total Nickel (Ni)	ug/L	0.09	0.02	3346491		
Total Selenium (Se)	ug/L	0.36	0.04	3346491	0.010	(<)
Total Silicon (Si)	ug/L	5600	100	3346491		
Total Silver (Ag)	ug/L	0.006	0.005	3346491		
Total Strontium (Sr)	ug/L	358	0.05	3346491		
Total Thallium (Tl)	ug/L	0.002	0.002	3346491		
Total Tin (Sn)	ug/L	0.07	0.01	3346491		
Total Titanium (Ti)	ug/L	<0.5	0.5	3346491		
Total Uranium (U)	ug/L	0.379	0.002	3346491	0.020	(<)
Total Vanadium (V)	ug/L	0.4	0.2	3346491		
Total Zinc (Zn)	ug/L	1.9	0.1	3346491	5	(>)
Total Zirconium (Zr)	ug/L	<0.1	0.1	3346491		
Total Calcium (Ca)	mg/L	52.8	0.05	3346602		
Total Magnesium (Mg)	mg/L	13.3	0.05	3346602		

RDL = Reportable Detection Limit

Maxxam Job #: A942188
Report Date: 2009/08/31

MINISTRY OF ENVIRONMENT
Client Project #: AGME
Site Reference: E250649 CITY OF MERRITT COLLETTEVILLE WELL
Sampler Initials: LL

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		Q18953		
Sampling Date		2009/08/10 09:40		
COC Number		50166815		
	Units	REG/1	RDL	QC Batch
Field Parameters				
Sample End Date	N/A	20090810	0	3338950
Sample End Time	N/A	9:40	0	3338950
Sample Start Date	N/A	20090810	0	3338950
Sample Start Time	N/A	9:40	0	3338950
Temperature at Arrival	C	5	1	3338942
Misc. Inorganics				
Bromide (Br)	mg/L	<0.4	0.4	3340554
Fluoride (F)	mg/L	0.06	0.01	3340608
Field-Vancouver				
Field Conductivity	uS/cm	150	0.1	ONSITE
Field pH	pH Units	6.3	0.1	ONSITE
Field Temperature	°C	10	0.1	ONSITE
Field Turbidity	NTU	0.2	0.1	ONSITE
Calculated Parameters				
Nitrate (N)	mg/L	0.118	0.002	3338946
Demand Parameters				
Chemical Oxygen Demand	mg/L	<10	10	3345778
Misc. Inorganics				
Alkalinity (Total as CaCO3)	mg/L	150	0.5	3345894
Alkalinity (PP as CaCO3)	mg/L	<0.5	0.5	3345894
Bicarbonate (HCO3)	mg/L	190	0.5	3345894
Carbonate (CO3)	mg/L	<0.5	0.5	3345894
Anions				
Dissolved Sulphate (SO4)	mg/L	71	0.5	3349875
Dissolved Chloride (Cl)	mg/L	9.7	0.5	3349824
Nutrients				
Total Kjeldahl Nitrogen (Calc)	mg/L	0.05	0.02	3337391
Total Organic Nitrogen (N)	mg/L	0.05	0.02	3338948
Dissolved Phosphorus (P)	mg/L	0.007	0.002	3340376
Ammonia (N)	mg/L	<0.005	0.005	3346583
Nitrate plus Nitrite (N)	mg/L	0.118	0.002	3344399
Nitrite (N)	mg/L	<0.002	0.002	3344484

RDL = Reportable Detection Limit

Maxxam Job #: A942188
Report Date: 2009/08/31

MINISTRY OF ENVIRONMENT
Client Project #: AGME
Site Reference: E250649 CITY OF MERRITT COLLETTEVILLE WELL
Sampler Initials: LL

LOW LEVEL TOTAL METALS - WATER (WATER)

Maxxam ID		Q18953		
Sampling Date		2009/08/10 09:40		
COC Number		50166815		
	Units	REG/1	RDL	QC Batch

Calculated Parameters				
Total Hardness (CaCO3)	mg/L	204	0.5	3340012
Total Metals by ICPMS				
Total Aluminum (Al)	ug/L	0.5	0.2	3346491
Total Antimony (Sb)	ug/L	0.04	0.02	3346491
Total Arsenic (As)	ug/L	0.51	0.02	3346491
Total Barium (Ba)	ug/L	54.0	0.02	3346491
Total Beryllium (Be)	ug/L	<0.01	0.01	3346491
Total Bismuth (Bi)	ug/L	<0.005	0.005	3346491
Total Boron (B)	ug/L	<50	50	3346491
Total Cadmium (Cd)	ug/L	0.005	0.005	3346491
Total Chromium (Cr)	ug/L	<0.1	0.1	3346491
Total Cobalt (Co)	ug/L	<0.005	0.005	3346491
Total Copper (Cu)	ug/L	2.57	0.05	3346491
Total Iron (Fe)	ug/L	3	1	3346491
Total Lead (Pb)	ug/L	0.091	0.005	3346491
Total Lithium (Li)	ug/L	0.7	0.5	3346491
Total Manganese (Mn)	ug/L	2.28	0.05	3346491
Total Molybdenum (Mo)	ug/L	1.69	0.05	3346491
Total Nickel (Ni)	ug/L	0.34	0.02	3346491
Total Selenium (Se)	ug/L	0.07	0.04	3346491
Total Silicon (Si)	ug/L	6920	100	3346491
Total Silver (Ag)	ug/L	<0.005	0.005	3346491
Total Strontium (Sr)	ug/L	298	0.05	3346491
Total Thallium (Tl)	ug/L	<0.002	0.002	3346491
Total Tin (Sn)	ug/L	0.01	0.01	3346491
Total Titanium (Ti)	ug/L	<0.5	0.5	3346491
Total Uranium (U)	ug/L	1.04	0.002	3346491
Total Vanadium (V)	ug/L	0.9	0.2	3346491
Total Zinc (Zn)	ug/L	1.6	0.1	3346491
Total Zirconium (Zr)	ug/L	<0.1	0.1	3346491
Total Calcium (Ca)	mg/L	55.4	0.05	3346602
Total Magnesium (Mg)	mg/L	16.0	0.05	3346602

RDL = Reportable Detection Limit

Maxxam Job #: A942199
Report Date: 2009/08/27

MINISTRY OF ENVIRONMENT
Client Project #: AGME
Site Reference: E250652 CITY OF MERRIT VOGHT PARK WELL # 1
Sampler Initials: LL

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		Q19057				
Sampling Date		2009/08/10 10:00				
COC Number		50166817				
	Units	REG/1	RDL	QC Batch	mg/L	(comparison 2008)
Field Parameters						
Sample End Date	N/A	20090810	0	3338950		
Sample End Time	N/A	10:00	0	3338950		
Sample Start Date	N/A	20090810	0	3338950		
Sample Start Time	N/A	10:00	0	3338950		
Temperature at Arrival	C	5	1	3338942		
Misc. Inorganics						
Bromide (Br)	mg/L	<0.4	0.4	3340654		
Fluoride (F)	mg/L	0.05	0.01	3340608	1.5	(=1
Field-Vancouver						
Field Conductivity	uS/cm	200	0.1	ONSITE	YSI readings suspect.	
Field pH	pH Units	6.2	0.1	ONSITE		
Field Temperature	°C	11	0.1	ONSITE		
Field Turbidity	NTU	0.1	0.1	ONSITE		
Calculated Parameters						
Nitrate (N)	mg/L	0.509	0.002	3338946		
Demand Parameters						
Chemical Oxygen Demand	mg/L	<10	10	3345778		
Misc. Inorganics						
Alkalinity (Total as CaCO3)	mg/L	100	0.5	3345894		
Alkalinity (PP as CaCO3)	mg/L	<0.5	0.5	3345894		
Bicarbonate (HCO3)	mg/L	130	0.5	3345894		
Carbonate (CO3)	mg/L	<0.5	0.5	3345894		
Anions						
Dissolved Sulphate (SO4)	mg/L	16	0.5	3345095	500	<
Dissolved Chloride (Cl)	mg/L	15	0.5	3344970	250	>
Nutrients						
Total Kjeldahl Nitrogen (Calc)	mg/L	<0.02	0.02	3337391		
Total Organic Nitrogen (N)	mg/L	<0.02	0.02	3338948		
Dissolved Phosphorus (P)	mg/L	0.003	0.002	3340376		
Ammonia (N)	mg/L	0.005	0.005	3342633		
Nitrate plus Nitrite (N)	mg/L	0.509	0.002	3341364	10	>
Nitrite (N)	mg/L	<0.002	0.002	3341366		

RDL = Reportable Detection Limit

Maxxam Job #: A942199
Report Date: 2009/08/27

MINISTRY OF ENVIRONMENT
Client Project #: AGME
Site Reference: E250652 CITY OF MERRIT VOGHT PARK WELL # 1
Sampler Initials: LL

LOW LEVEL TOTAL METALS - WATER (WATER)

Maxxam ID		Q19057				
Sampling Date		2009/08/10 10:00				
COC Number		50166817				
	Units	REG/1	RDL	QC Batch		
Calculated Parameters						
Total Hardness (CaCO3)	mg/L	121	0.5	3337291	80-100	(<)
Total Metals by ICPMS					mg/L	
Total Aluminum (Al)	ug/L	0.6	0.2	3346491		
Total Antimony (Sb)	ug/L	0.03	0.02	3346491	6	(<
Total Arsenic (As)	ug/L	0.06	0.02	3346491	10	<)
Total Barium (Ba)	ug/L	53.2	0.02	3346491	[illegible]	
Total Beryllium (Be)	ug/L	<0.01	0.01	3346491		
Total Bismuth (Bi)	ug/L	<0.005	0.005	3346491		
Total Boron (B)	ug/L	<50	50	3346491	5000	(=
Total Cadmium (Cd)	ug/L	<0.005	0.005	3346491	5	<
Total Chromium (Cr)	ug/L	<0.1	0.1	3346491	50	<)
Total Cobalt (Co)	ug/L	0.008	0.005	3346491		
Total Copper (Cu)	ug/L	1.67	0.05	3346491	1000	(>
Total Iron (Fe)	ug/L	<1	1	3346491	300	<)
Total Lead (Pb)	ug/L	0.411	0.005	3346491		
Total Lithium (Li)	ug/L	<0.5	0.5	3346491		
Total Manganese (Mn)	ug/L	<0.05	0.05	3346491	50	(=)
Total Molybdenum (Mo)	ug/L	0.44	0.05	3346491		
Total Nickel (Ni)	ug/L	0.07	0.02	3346491		
Total Selenium (Se)	ug/L	0.14	0.04	3346491	10	(=)
Total Silicon (Si)	ug/L	6160	100	3346491		
Total Silver (Ag)	ug/L	0.014	0.005	3346491		
Total Strontium (Sr)	ug/L	208	0.05	3346491		
Total Thallium (Tl)	ug/L	0.002	0.002	3346491		
Total Tin (Sn)	ug/L	0.04	0.01	3346491		
Total Titanium (Ti)	ug/L	<0.5	0.5	3346491		
Total Uranium (U)	ug/L	0.314	0.002	3346491	20	(<)
Total Vanadium (V)	ug/L	0.4	0.2	3346491		
Total Zinc (Zn)	ug/L	0.7	0.1	3346491	5000	(<)
Total Zirconium (Zr)	ug/L	<0.1	0.1	3346491		
Total Calcium (Ca)	mg/L	35.6	0.05	3346602		
Total Magnesium (Mg)	mg/L	7.87	0.05	3346602		

RDL = Reportable Detection Limit

Maxxam Job #: A942194
Report Date: 2009/08/27

MINISTRY OF ENVIRONMENT
Client Project #: AGME
Site Reference: E250653 CITY OF MERRITT VOGHT PARK WELL # 2
Sampler Initials: LL

2008 comparis

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		Q19020				
Sampling Date		2009/08/10 10:15				
COC Number		50166818				
	Units	REG/1	RDL	QC Batch		
Field Parameters						
Sample End Date	N/A	20090810	0	3338950		
Sample End Time	N/A	10:15	0	3338950		
Sample Start Date	N/A	20090810	0	3338950		
Sample Start Time	N/A	10:15	0	3338950		
Temperature at Arrival	C	5	1	3338942		
Misc. Inorganics						
Bromide (Br)	mg/L	<0.4	0.4	3340554		
Fluoride (F)	mg/L	0.05	0.01	3340608	1.5	(=)
Field-Vancouver						
Field Conductivity	uS/cm	250	0.1	ONSITE	} YSI units suspect	
Field pH	pH Units	6.2	0.1	ONSITE		
Field Temperature	°C	11	0.1	ONSITE		
Field Turbidity	NTU	0.1	0.1	ONSITE		
Calculated Parameters						
Nitrate (N)	mg/L	0.645	0.002	3338946		
Demand Parameters						
Chemical Oxygen Demand	mg/L	<10	10	3345778		
Misc. Inorganics						
Alkalinity (Total as CaCO3)	mg/L	110	0.5	3345894		
Alkalinity (PP as CaCO3)	mg/L	<0.5	0.5	3345894		
Bicarbonate (HCO3)	mg/L	140	0.5	3345894		
Carbonate (CO3)	mg/L	<0.5	0.5	3345894		
Anions						
Dissolved Sulphate (SO4)	mg/L	30	0.5	3349875	500	(7)
Dissolved Chloride (Cl)	mg/L	22	0.5	3349824	250	(>)
Nutrients						
Total Kjeldahl Nitrogen (Calc)	mg/L	0.06	0.02	3337391		
Total Organic Nitrogen (N)	mg/L	0.06	0.02	3338948		
Dissolved Phosphorus (P)	mg/L	0.003	0.002	3340376		
Ammonia (N)	mg/L	<0.005	0.005	3346583		
Nitrate plus Nitrite (N)	mg/L	0.645	0.002	3344399	10	(<)
Nitrite (N)	mg/L	<0.002	0.002	3344484		

RDL = Reportable Detection Limit

Maxxam Job #: A942194
Report Date: 2009/08/27

MINISTRY OF ENVIRONMENT
Client Project #: AGME
Site Reference: E250653 CITY OF MERRITT VOGHT PARK WELL # 2
Sampler Initials: LL

LOW LEVEL TOTAL METALS - WATER (WATER)

Maxxam ID		Q19020				
Sampling Date		2009/08/10 10:15				
COC Number		50166816				
	Units	REG/1	RDL	QC Batch		
Calculated Parameters						
Total Hardness (CaCO3)	mg/L	158	0.5	3337291	80 – 100	(>)
Total Metals by ICPMS					ug/L	
Total Aluminum (Al)	ug/L	1.5	0.2	3363427		
Total Antimony (Sb)	ug/L	0.02	0.02	3363427	6	(>)
Total Arsenic (As)	ug/L	0.08	0.02	3363427	10	(=)
Total Barium (Ba)	ug/L	63.7	0.02	3363427		
Total Beryllium (Be)	ug/L	<0.01	0.01	3363427		
Total Bismuth (Bi)	ug/L	<0.005	0.005	3363427		
Total Boron (B)	ug/L	<50	50	3363427	5000.	=
Total Cadmium (Cd)	ug/L	0.005	0.005	3363427	5	<
Total Chromium (Cr)	ug/L	<0.1	0.1	3363427	50	<
Total Cobalt (Co)	ug/L	<0.005	0.005	3363427		
Total Copper (Cu)	ug/L	1.30	0.05	3363427	1000	=
Total Iron (Fe)	ug/L	1	1	3363427	300	<
Total Lead (Pb)	ug/L	0.085	0.005	3363427		
Total Lithium (Li)	ug/L	<0.5	0.5	3363427		
Total Manganese (Mn)	ug/L	<0.05	0.05	3363427	50	<
Total Molybdenum (Mo)	ug/L	0.53	0.05	3363427		
Total Nickel (Ni)	ug/L	0.14	0.02	3363427		
Total Selenium (Se)	ug/L	0.21	0.04	3363427	10	>
Total Silicon (Si)	ug/L	6600	100	3363427		
Total Silver (Ag)	ug/L	<0.005	0.005	3363427		
Total Strontium (Sr)	ug/L	263	0.05	3363427		
Total Thallium (Tl)	ug/L	<0.002	0.002	3363427		
Total Tin (Sn)	ug/L	0.02	0.01	3363427		
Total Titanium (Ti)	ug/L	<0.5	0.5	3363427		
Total Uranium (U)	ug/L	0.554	0.002	3363427	20	>
Total Vanadium (V)	ug/L	0.4	0.2	3363427		
Total Zinc (Zn)	ug/L	1.2	0.1	3363427	5000	>
Total Zirconium (Zr)	ug/L	<0.1	0.1	3363427		
Total Calcium (Ca)	mg/L	45.8	0.05	3363530		
Total Magnesium (Mg)	mg/L	10.5	0.05	3363530		

RDL = Reportable Detection Limit

Maxxam Job #: A942204
Report Date: 2009/08/27

MINISTRY OF ENVIRONMENT
Client Project #: OBWT
Site Reference: E206918 OBS WELL 296-MERRIT
Sampler Initials: LL

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		Q19067				
Sampling Date		2009/08/10 13:45				
COC Number		50166819				
	Units	REG/1	RDL	QC Batch	mg/L	(Changes 2008)
Field Parameters						
Sample End Date	N/A	20090810	0	3338950		
Sample End Time	N/A	13:45	0	3338950		
Sample Start Date	N/A	20090810	0	3338950		
Sample Start Time	N/A	13:45	0	3338950		
Temperature at Arrival	C	5	1	3338942		
Misc. Inorganics						
Bromide (Br)	mg/L	<0.4	0.4	3340554		
Fluoride (F)	mg/L	0.04	0.01	3340608	1.5	(=)
Field-Vancouver						
Field Conductivity	uS/cm	130.	0.1	ONSITE	YSI readings suspect	
Field pH	pH Units	6.4	0.1	ONSITE		
Field Temperature	°C	10	0.1	ONSITE		
Calculated Parameters.						
Nitrate (N)	mg/L	0.068	0.002	3338946		
Demand Parameters						
Chemical Oxygen Demand	mg/L	<10	10	3346776		
Misc. Inorganics						
Alkalinity (Total as CaCO3)	mg/L	68	0.5	3345894		
Alkalinity (PP as CaCO3)	mg/L	<0.5	0.5	3345894		
Bicarbonate (HCO3)	mg/L	83	0.5	3345894		
Carbonate (CO3)	mg/L	<0.5	0.5	3345894		
Anions						
Dissolved Sulphate (SO4)	mg/L	6.8	0.5	3345095	500	(<)
Dissolved Chloride (Cl)	mg/L	12	0.5	3344970	250	(=)
Nutrients						
Total Kjeldahl Nitrogen (Calc)	mg/L	0.03	0.02	3337391		
Total Organic Nitrogen (N)	mg/L	<0.02	0.02	3338948		
Dissolved Phosphorus (P)	mg/L	<0.002	0.002	3340376		
Ammonia (N)	mg/L	0.008	0.005	3342633		
Nitrate plus Nitrite (N)	mg/L	0.068	0.002	3341364	10	(<)
Nitrite (N)	mg/L	<0.002	0.002	3341366		
Total Nitrogen (N)	mg/L	0.09	0.02	3344079		

RDL = Reportable Detection Limit

Maxxam Job #: A942204
Report Date: 2009/08/27

MINISTRY OF ENVIRONMENT
Client Project #: OBWT
Site Reference: E206918 OBS WELL 296-MERRIT
Sampler Initials: LL

LOW LEVEL TOTAL METALS - WATER (WATER)

Maxxam ID		Q19067				
Sampling Date		2009/08/10 13:45				
COC Number		50166819				
	Units	REG/1	RDL	QC Batch		
Calculated Parameters						
Total Hardness (CaCO3)	mg/L	73.7	0.5	3337291	80-100	(<)
Total Metals by ICPMS					ug/L	
Total Aluminum (Al)	ug/L	0.7	0.2	3346491		
Total Antimony (Sb)	ug/L	<0.02	0.02	3346491	6	(<)
Total Arsenic (As)	ug/L	0.05	0.02	3346491	10	(>)
Total Barium (Ba)	ug/L	36.3	0.02	3346491		
Total Beryllium (Be)	ug/L	<0.01	0.01	3346491		
Total Bismuth (Bi)	ug/L	<0.005	0.005	3346491		
Total Boron (B)	ug/L	<50	50	3346491	5000	(=)
Total Cadmium (Cd)	ug/L	0.006	0.005	3346491	5	(>)
Total Chromium (Cr)	ug/L	0.3	0.1	3346491	50	(>)
Total Cobalt (Co)	ug/L	0.024	0.005	3346491		
Total Copper (Cu)	ug/L	0.23	0.05	3346491	1000	(>)
Total Iron (Fe)	ug/L	210	1	3346491	300	(<) 1130 cm
Total Lead (Pb)	ug/L	0.013	0.005	3346491		
Total Lithium (Li)	ug/L	<0.5	0.5	3346491		
Total Manganese (Mn)	ug/L	4.22	0.05	3346491	50	(<)
Total Molybdenum (Mo)	ug/L	0.26	0.05	3346491		
Total Nickel (Ni)	ug/L	0.27	0.02	3346491		
Total Selenium (Se)	ug/L	<0.04	0.04	3346491	10	(=)
Total Silicon (Si)	ug/L	5170	100	3346491		
Total Silver (Ag)	ug/L	<0.005	0.005	3346491		
Total Strontium (Sr)	ug/L	132	0.05	3346491		
Total Thallium (Tl)	ug/L	<0.002	0.002	3346491		
Total Tin (Sn)	ug/L	0.04	0.01	3346491		
Total Titanium (Ti)	ug/L	<0.5	0.5	3346491		
Total Uranium (U)	ug/L	0.097	0.002	3346491	20	(>)
Total Vanadium (V)	ug/L	<0.2	0.2	3346491		
Total Zinc (Zn)	ug/L	0.2	0.1	3346491	5000	(>)
Total Zirconium (Zr)	ug/L	<0.1	0.1	3346491		
Total Calcium (Ca)	mg/L	22.3	0.05	3346602		
Total Magnesium (Mg)	mg/L	4.38	0.05	3346602		

RDL = Reportable Detection Limit

Appendix “A”

Weekly tests:

- Total Coliforms
- E. coli
- Turbidity
- PH
- Temperature

of 3

Annual Chemical Analyses Test Elements

aro Analytical Sces (Kelowna)

Alkalinity
Ammonia
Bicarbonate
Bromide
Carbonate
Chemical Oxygen Demand
Conductivity
Dissolved Chloride
Dissolved Phosphorus
Dissolved Sulphate
Fluoride
Hydroxide
Nitrate
Nitrite
Total Aluminum
Total Antimony
Total Arsenic
Total Barium
Total Beryllium
Total Bismuth
Total Boron
Total Cadmium
Total Calcium
Total Chromium

Total Cobalt
Total Copper
Total Dissolved Solids
Total Iron
Total Kjeldahi Nitrogen
Total Lead
Total Lithium
Total Manganese
Total Magnesium
Total Molybdenum
Total Nickel
Total Nitrogen
Total Organic Nitrogen
Total Phosphorus
Total Potassium
Total Selenium
Total Silver
Total Sodium
Total Strontium
Total Sulphur
Total Thallium
Total Titanium
Total Tin
Total Uranium
Total Vanadium
Total Zinc

Appendix “B”

Interior Health Authority - Kamloops
Ted Mahler - **WORK ORDER #**
PROJECT NAME Merritt Community Water System

REPORTED
K9J0050
Oct-15-09
SAMPLE DATA
Analyte Result RDL Units Analyzed Method Lab Notes
Canadian DW
Guidelines
(May 08)
General Parameters

Merritt Community Water System (K9J0050-01) Matrix: Water Sampled: Oct-01-09 13:20
Transmissivity @ 254nm **95.1** 0.1 % Oct-07-09 APHA 5910B KEL
Alkalinity, Total as CaCO3 **122** 1.0 mg/L Oct-02-09 APHA 2320 B KEL
Chloride **27.5** AO ≤ 250 0.10 mg/L Oct-02-09 APHA 4110 B KEL
Colour, True **<5** AO ≤ 15 5 Color Unit Oct-02-09 APHA 2120 B KEL
Conductivity (EC) **401** 5 uS/cm Oct-02-09 APHA 2510 B KEL
Cyanide (total) **<0.01** MAC = 0.2 0.01 mg/L Oct-07-09 APHA 4500-CN KEL
Fluoride **<0.10** MAC = 1.5 0.10 mg/L Oct-02-09 APHA 4110 B KEL
Hardness, Total (Total as CaCO3) **153** 2.54 mg/L Oct-08-09 APHA 2340 B RMD
Nitrogen, Nitrate as N **0.73** MAC = 10 0.01 mg/L Oct-02-09 APHA 4110 B KEL
PH **7.38** AO = 6.5 - 8.5 0.10 pH Units Oct-02-09 APHA 4500-H+ KEL
Solids, Total Dissolved **228** AO ≤ 500 5 mg/L Oct-05-09 APHA 2540 C KEL
Sulfate **37.6** AO ≤ 500 1.0 mg/L Oct-02-09 APHA 4110 B KEL
Turbidity **0.2** Varies, See Guidelines 0.1 NTU Oct-02-09 APHA 2130

Total Recoverable Metals by ICPMS
Merritt Community Water System (K9J0050-01)
Matrix: Water Sampled: Oct-01-09 13:20

Aluminum **<0.005** AO ≤ 0.1 0.005 mg/L Oct-08-09 EPA 6020A RMD
Antimony **<0.0001** MAC = 0.006 0.0001 mg/L Oct-08-09 EPA 6020A RMD
Arsenic **<0.0005** MAC = 0.01 0.0005 mg/L Oct-08-09 EPA 6020A RMD
Barium **0.0783** MAC = 1 0.0005 mg/L Oct-08-09 EPA 6020A RMD
Beryllium **<0.0001** 0.0001 mg/L Oct-08-09 EPA 6020A RMD
Bismuth **<0.0001** 0.0001 mg/L Oct-08-09 EPA 6020A RMD
Boron **0.019** MAC = 5 0.002 mg/L Oct-08-09 EPA 6020A RMD

Cadmium	**<0.00001** MAC = 0.005 0.00001 mg/L Oct-08-09 EPA 6020A RMD
Calcium	**40.8** 1.0 mg/L Oct-08-09 EPA 6020A RMD
Chromium	**0.0008** MAC = 0.05 0.0005 mg/L Oct-08-09 EPA 6020A RMD
Cobalt	**<0.00005** 0.00005 mg/L Oct-08-09 EPA 6020A RMD
Copper	**0.0340** AO ≤ 1 0.0001 mg/L Oct-08-09 EPA 6020A RMD
Iron	**0.04** AO ≤ 0.3 0.01 mg/L Oct-08-09 EPA 6020A RMD
Lead	**0.0021** MAC = 0.01 0.0001 mg/L Oct-08-09 EPA 6020A RMD
Lithium	**0.0004** 0.0001 mg/L Oct-08-09 EPA 6020A RMD
Magnesium	**12.3** 0.01 mg/L Oct-08-09 EPA 6020A RMD
Manganese	**0.0004** AO ≤ 0.05 0.0002 mg/L Oct-08-09 EPA 6020A RMD
Mercury	**<0.00005** MAC = 0.001 0.00005 mg/L Oct-08-09 EPA 6020A RMD
Molybdenum	**0.0006** 0.0001 mg/L Oct-08-09 EPA 6020A RMD
Nickel	**0.0009** 0.0002 mg/L Oct-08-09 EPA 6020A RMD
Phosphorus	**<0.02 0.02** mg/L Oct-08-09 EPA 6020A RMD
Potassium	**1.47** 0.01 mg/L Oct-08-09 EPA 6020A RMD
Selenium	**<0.0003** MAC = 0.01 0.0003 mg/L Oct-08-09 EPA 6020A RMD
Silicon	**6.4** 0.2 mg/L Oct-08-09 EPA 6020A RMD
Silver	**<0.00005** 0.00005 mg/L Oct-08-09 EPA 6020A RMD
Sodium	**12.7** AO ≤ 200 0.01 mg/L Oct-08-09 EPA 6020A RMD
Strontium	**0.312** 0.0005 mg/L Oct-08-09 EPA 6020A RMD
Tellurium	**<0.0002** 0.0002 mg/L Oct-08-09 EPA 6020A RMD
Thallium	**<0.00002** 0.00002 mg/L Oct-08-09 EPA 6020A RMD
Thorium	**<0.0001** 0.0001 mg/L Oct-08-09 EPA 6020A RMD
Tin	**<0.0002** 0.0002 mg/L Oct-08-09 EPA 6020A RMD
Titanium	**<0.005** 0.005 mg/L Oct-08-09 EPA 6020A RMD
Uranium	**0.00062** MAC = 0.02 0.00002 mg/L Oct-08-09 EPA 6020A RMD
Vanadium	**<0.001** 0.001 mg/L Oct-08-09 EPA 6020A RMD
Zinc	**0.035** AO ≤ 5 0.001 mg/L Oct-08-09 EPA 6020A RMD
Zirconium	**<0.0001** 0.0001 mg/L Oct-08-09 EPA 6020A RMD

MERRITT

COUNTRY MUSIC CAPITAL OF CANADA

WATER UTILITY MASTER PLAN

APPENDIX D

SITE VISIT REPORTS AND TECHNICAL MEMOS

MERRITT

COUNTRY MUSIC CAPITAL OF CANADA

CITY OF MERRITT
WATER SYSTEM INFRASTRUCTURE
JUNE 22nd, 2011

6/23/2011
Opus DaytonKnight
Clive

Contents

1.0 General Notes

- Controlling reservoir is the Grimmett (1,000,000 Impgal) reservoir. Lead pumps at the pump stations start when Grimmett is at 80%, and stop when the reservoir is at 84%
- Southeast balancing reservoir was constructed as a new 500,000 Impgal reservoir, and is currently experiencing operational issues... filling of the reservoir causes the existing Grimmett reservoir to overflow. Current operation is to use 300,000 Impgal and checks are being done at the moment.
- The 'Active Mountain' reservoir has been built on the southwest hill but is not connected to the City system. This reservoir will eventually be connected to the City water system.
- Pump operation is different from the summer and winter
    - Summer operation:
        1. Voght
        2. Collettville
        3. Fairly Park
    - Winter operation:
        1. Fairly Park
        2. Collettville
        3. Voght
- Kengard pump house is not operational at the moment
- Shallow wells @ Collettville, Voght, and Fairley Park (24-65m deep), these are considered surface sources
- Deep well @ Kengard (130m deep)
- Chlorination has only started since 2008
- 15 power failures last year, ranging from 30 minutes to 6 hours
- All reservoirs have only one pipe in and out
- Valve houses currently maintained every two years
- Chlorine is injected at the pump houses only at 0.9 mg/L
- In the last five years, secondary chlorination has only occurred once in each of the Nicola, Grimmett and Grandview Heights reservoirs

2.0 Collettville Pump House

Submersible Pump
Pumps at 680 USgpm
Pumps to 140 psi
Next to the Coldwater River

3.0 Voght Park G/E pump house

Pump just rebuilt last Wednesday
Previous capacity was 900 USgpm; hope to have >1000 USgpm once new pump starts.
Pump starts when level at Grimmett reservoir is 75%
Has ultrasonic flowmeter
G/E stands for gas and electric
Gas is natural gas, directly connected to the gas supply system, and is the backup power supply for the pump. If the electricity is down, the set up for the pump is connected to the natural gas powered genset to power the pump.

4.0 Voght VFD pump house

Has turbine flowmeter
This one currently in operation rather than Voght G/E pump house

5.0 Fairley Park Pump House

Pumps at 700 USgpm
Has ultrasonic flowmeter
Pump start = 76%
Pump stop = 79%
Flow = 57.79 Lps
Reservoir Level = 65.4%
Well Level = 28.1 ft

6.0 Kengard Pump House

Pumps at 600 USgpm (flow limited by size of motor)
Requires two years of monitoring for the Ministry of Environment to monitor well stability and impact on neighboring houses (some on well supply for irrigation) before higher levels of pumping are allowed.
Once flows reach >75 Lps, an aquifer protection study is required
Currently offline

7.0 Nicola Reservoir

25 feet deep, 30 feet in diameter
148,000 Impgal
Altitude valve to fill reservoir and flow water out
No check valves
Valving controlled by pressure both ways, currently pressures are at 30 psi
Norgaard ready-mix gravel pit currently operating below the reservoir site




8.0 Grimmett Reservoir

1,000,000 Impgal
The main controlling reservoir
Milltronics level in the reservoir shuts pumps off
Reservoirs turn over in 3 days, there is no stagnation
No mixer

9.0 Grandview Heights Pump House

2 Pumps with space for one additional pump
Downstream pressure = 40 psi
Upstream pressure = 135 psi
Cannot reduce flows from higher to lower zone?
Pump motor = 25 HP, 1770 RPM

TECHNICAL MEMORANDUM NO. 1

TO: Shawn Boven, A.Sc.T.
Danielle Cass, Engineering Technologist

FROM: Opus DaytonKnight Consultants Ltd.

DATE: September 20, 2011

RE: CITY OF MERRITT – WATER UTILITY MASTER PLAN DEMAND ANALYSIS

FILE: D-36406.00

This memorandum summarizes the historical water demands and projects future demands as assessed by OPUS DaytonKnight in the development of the City of Merritt (City) water utility master plan. The City shall review the proposed unit water demands for use in the development of its water model.

1.0 INTRODUCTION

OPUS DaytonKnight Ltd. was retained by the City of Merritt to construct a hydraulic model for its water distribution system. The model will be used to assist in the hydraulic analysis of the City's water system for existing and future demands.

The City of Merritt's water system supplies potable water to all of its residents and all industrial, commercial and institutional businesses within its City limits. The water system consists of over 74 kilometres of distribution mains, 4 reservoirs, 5 wells, one pressure reducing station, and one booster station. An additional reservoir is soon to be connected to the system.

The distribution system for Merritt is composed of three pressure zones.

2.0 OBJECTIVE

This memorandum reviews the City's historical population and per capita demand rates. A review of the City's flow records is provided and demands are projected based on the City's current zoning, Official Community Plan (OCP), and plans for major development areas.

3.0 LIMITATIONS

The following information was received from the City and used to develop unit water demands in this memorandum:

- Daily system flow records (1999-2010)
- Partial ICI flow records (2006-2010)
- City of Merritt Official Community Plan Update (2011)

ICI flow records account for approximately 46% of the total billed ICI properties in the City of Merritt. Further, it was noted by the City that meters were recorded in cubic metres, imperial gallons and cubic feet. Details of the measurement types were only provided for 2010.

4.0 POPULATION

4.1 Historical Population

Table 4-1 illustrates the historical populations of the City from 1981 to 2006. The City of Merritt had a population growth from 1981 to 1996, but a population decrease from 1996 to 2006. According to BC Stats, the population of the City of Merritt for 2010 is estimated at 7,285. Over the period of 1981 to 2010 the growth has averaged 0.6% per year.

TABLE 4-1
HISTORICAL POPULATION

Year	Census Population	% annual growth
1981	6,110	-
1986	6,180	0.23
1991	6,253	0.24
1996	7,631	4.06
2001	7,088	-1.47
2006	6,998	-0.26
2010	7,285	1.00

4.2 Population Projection

Recorded population growth averaged 0.6% per year for the past 30 years and 1.0% in 2010. The projected annual growth rate, based on linear regression of available data, yields a 1.1% growth rate, which was discussed with the City as a reasonable projection scenario in the City of Merritt. The second growth scenario is based on the City's OCP assumed future projections of 3.5% growth rate.

Table 4-2 illustrates the population increase for the years 2010 to 2030. Growth rates of 1.1% and 3.5% are used for the population projections.

TABLE 4-2
SERVICE POPULATION PROJECTION TO 2030

Year	Total Population	
	1.1% growth	3.5% growth
2010	7,285	7,285
2015	7,695	8,652
2020	8,127	10,276
2025	8,584	12,205
2030	9,067	14,496

The projected population in 2030 based on the 1.1% growth rate is 9,067, and the projected population based on the 3.5% growth rate is 14,496.

Figure 4-1 illustrates the projected population curves under the 1.1% and 3.5% growth rates.

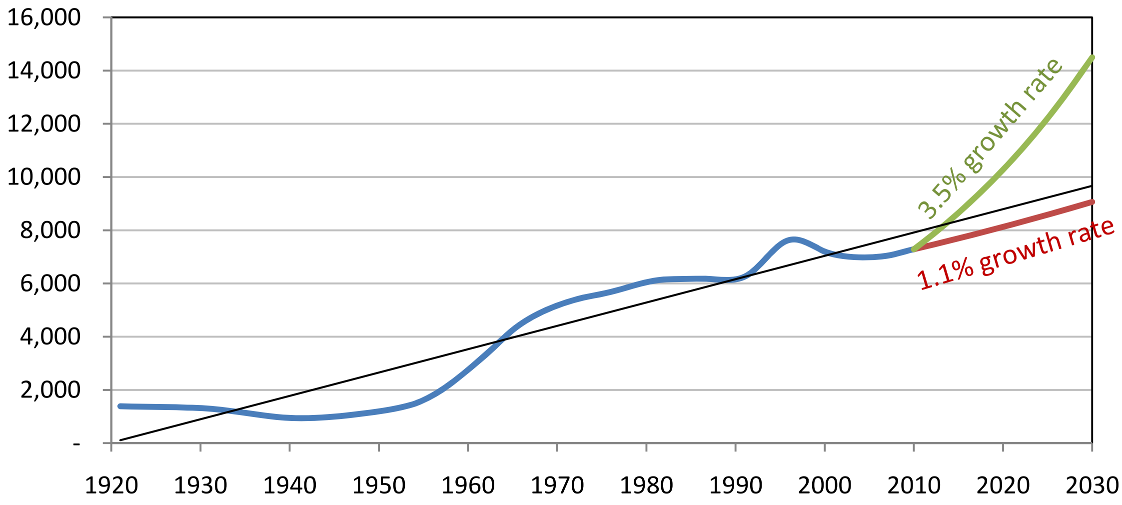


Figure 4-1 Historic and Projected Populations

The population growth trendline for the years 1921 to 2010 is projected to the year 2030 in Figure 4-1. The historical linear regression of the population trend produces the 1.1% growth rate which has been shown above. It is likely that the 1.1% growth rate is a reasonable growth scenario.

5.0 UNIT WATER DEMANDS

Historical data was collected from the City of Merritt to analyze water demands in the system, as well as to project water demands into the future. The process for developing these water demands are described in this section.

5.1 Review of Historical Consumption and Per Capita Demands

Historical demands of the City of Merritt from 1999 to 2010 were reviewed. Table 5-1 summarizes the total demands of the City, and the average day and maximum day per capita demands.

TABLE 5-1
HISTORICAL DEMANDS (1999 to 2010)

Year	Average Day Demand (ML)	Maximum Day Demand (ML)	Average Day Per Capita (L/c/d)	Maximum Day Per Capita (L/c/d)
1999	8.895	19.791	1,218	2,711
2000	8.276	21.937	1,150	2,911
2001	9.056	22.310	1,278	3,148
2002	8.749	24.105	1,237	3,410
2003	8.970	22.252	1,272	3,156
2004	8.867	20.951	1,261	2,979
2005	8.773	25.618	1,250	3,651
2006	9.418	22.029	1,346	3,148
2007	9.176	18.514	1,298	2,619
2008	8.255	19.553	1,156	2,739
2009	8.435	17.657	1,170	2,449
2010	8.016	18.481	1,101	2,538

The average day and maximum day per capita demand in 2010 was estimated at 1,101 L/c/d and 2,538 L/c/d respectively. This value includes all sectors (e.g. Industrial, Commercial, Institutional and Residential) within the water system.

The Environment Canada rainfall and cool degree days data was tabulated for each year to assess for any trends. No apparent trend was observed. We used cool degree days, which is a measure of the number of days the air temperature was above 18ºC rather than sunshine hours as it is a more common measure and it is not biased by winter sunshine.

Table 5-2 lists the average day and maximum day per capita demands for communities in the Southern Interior BC region. The demands include both residential and ICI water use.

TABLE 5-2
2010 DEMANDS

Community	Average Day Demand (L/c/d)	Maximum Day Demand (L/c/d)
Kelowna (metered)	600	1,300
Vernon (metered)	550	1,280
Penticton (metered)	580	1,200
Kamloops	790	1,800
Salmon Arm	690	1,490
Merritt	1,100	2,500

The City's per capita water usage is higher than most communities in the Southern Interior BC. This is in part due to a high ICI water usage in the City (approximately 36% as discussed later). However, Opus DaytonKnight believes this value can be decreased through an intensive demand management program should the City be willing to undertake it. The intensive demand management program includes complete metering of all ICI customers, universal water metering for all residential customers, extended sprinkling restrictions with enforcement, revision of water meter rates, leak detection and repair programs, and more intensive education and public outreach programs.

With more intensive demand management in place, an average day demand target of 900 L/c/d and maximum day demand target of 2,000 L/c/d can likely be achieved.

Figure 5-1 shows the water usage from 1977 to 2010 in relation to both average and maximum day per capita demands.

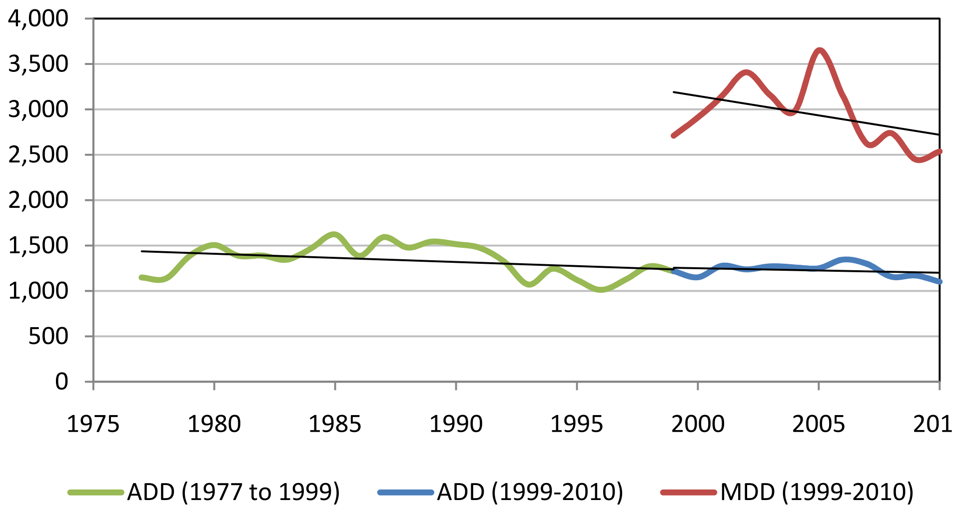


Figure 5-1 Historical Average and Maximum Day Demands

The average day demand trendline for the years 1977 to 1999 shows a gradual decrease in average day demands, which are further reduced from 1999 to 2010. The average annual reduction in average day demand can be attributed to the City's ongoing water conservation measures which affect indoor water usage, including public education programs, low water use toilet and fixture replacements, etc. These existing programs contribute to an annual average day water reduction of 0.91% annually. This annual reduction is minimal and has not been included in the future demand projections. Future average day demand is estimated using the 2010 average day per capita demand of 1,101 L/c/d.

The maximum day demand trendline for the years 1999 to 2010 also show a decrease in maximum day demands. The reduction can be attributed to many factors which affect outdoor water usage, including public education programs, seasonal variations of summer months, effective water sprinkling regulations with enforcement, etc. Annual reduction of maximum day demand is difficult to project due to a strong correlation between seasonal variations of summer temperatures and water usage. (e.g. a hot summer may result in residents watering their lawns and gardens and the maximum day demand will occur regardless.). Future maximum day demand is estimated using the 2010 maximum day per capita demand of 2,538 L/c/d.

The potential of intensive demand management may decrease future maximum day demand by approximately 20% and potentially decrease average day consumption. Water conservation strategies will likely have a significant effect on future water demand.

5.2 Existing Demands

The base condition for the City of Merritt water model will be the year 2010. The demands for the 2010 condition are based on recorded demands as shown in Table 5-3.

TABLE 5-3
EXISTING DEMANDS

Condition	Demand (L/s)	Demand (ML)*
Average Day	92.8	8.02
Maximum Day	213.9	18.48

* From Table 5-1

The average day demand for 2010 is 92.8 L/s. The maximum day demand was recorded on August 2nd, 2010 and is 213.9 L/s. The peaking factor for maximum day flow is 2.31.

Existing average day demands were then assigned based on residential and Industrial, Commercial, and Institutional (ICI) demands. Peaking factors for maximum day and peak hour demands are summarized in this section.

5.2.1 ICI Demands

Metering data was compiled from 121 ICI users and was analyzed to estimate the total industrial, commercial, and institutional demands. The average day demand in 2010 for all metered ICI users totalled 20.7 L/s.

According to the City, only 46% of the existing ICI users are represented in the metered data. Moreover, it is most likely that all large ICI users are metered, i.e. their demands are included in the total 20.7 L/s. The 46% factor was used to calculate the corrected demands for regular ICI users only. Hence, the resulting ICI demand for the City of Merritt is estimated at 33.2 L/s.

The ICI metered consumption is affected by large industrial users which increase the average ICI usage rates. Two separate usage rates are used to differentiate between large ICI users and regular commercial customers when projecting future demand. To achieve this, the top 5 ICI users were removed to develop separate regular ICI usage rates. Resulting usage rates are as follows:

- Large ICI = 2.00 L/s
- Regular ICI = 0.092 L/s

5.2.2 Residential Demands

Residential demand is calculated by subtracting the estimated total ICI demand (33.2 L/s) from the recorded average day demand (92.8 L/s) in the system. The resulting residential demand is 59.6 L/s. Based on an existing population of 7,285, this equates to a residential per capita demand rate of 706 L/c/d.

5.2.3 Peaking Factors

Typical peaking factors were assigned to average day demands to obtain maximum day demands and peak hour demands for the City of Merritt.

OPUS DaytonKnight, based on previous experience, considers multifamily developments to have lower peak hour rates as compared to single family developments. However, no details were provided by the City of current residential land uses corresponding to existing demand, and a general residential usage was used.

The peaking factor for ICI was approximated at 1.5 for MDD and 2.0 for PHD. These factors are used in calculating the maximum day and peak hour demand totals in Table 5-4. The peaking factor for residential properties was calculated at 2.75 for MDD and was assumed at 5.0 for PHD. The peaking factors for residential properties are reasonable.

TABLE 5-4
EXISTING DEMANDS AND PEAKING FACTORS

Land Use	Demand (L/s)			Peaking Factors		
	ADD	MDD	PHD	ADD	MDD	PHD
Residential	59.6	164.1	297.9	1.0	2.75	5.00
ICI	33.2	49.8	66.4	1.0	1.50	2.00
TOTAL	**92.8**	**213.9**	**364.3**	**1.0**	**2.31**	**3.93**

5.3 Future Demands

The future condition for the City of Merritt water model will be the year 2030. Average and maximum day demands for the 2030 condition will be calculated for the 1.1% growth rate and the 3.5% growth rate inclusive of a 20% water conservation reduction.

Future demands were also reviewed for the City of Merritt's proposed developments. The City of Merritt OCP and OCP Sector Map (attached) were reviewed for the anticipated extent and locations of future development.

5.3.1 ICI Demands

Based on the projections in the OCP, the City of Merritt would like to see at least 3 new large industries and 116 commercial businesses locate in the City to meet the needs of Merritt at an ideal population of 15,000. These ICI increases will be used for the 3.5% growth condition.

Under the 1.1% growth condition, the projected population is proportionally estimated to support one large industry and 26 commercial businesses in the year 2030.

Table 5-5 shows the future additional ICI demands based on anticipated future development and usage rates for large industry and commercial businesses as calculated in Section 5.2.1.

TABLE 5-5
FUTURE ADDITIONAL ICI DEMAND

Condition	Additional Demand (L/s)		
	Industrial	Commercial	**Total**
1.1% Growth Rate	2.0	2.4	**4.4**
3.5% Growth Rate	6.0	10.7	**16.7**
3.5% Growth Rate + 20% conservation reduction	4.8	8.6	**13.4**

Based on the 1.1% growth rate, the future ICI average day demand in the City of Merritt is estimated at 37.6 L/s.

Based on the 3.5% growth rate with 20% conservation reduction, the future ICI average day demand in the City of Merritt is estimated at 39.9 L/s

5.3.2 Residential Demands

Population growth was partly allocated through development plans provided by the City of Merritt for major residential projects including the Gateway 286 and Midday Valley Plan, and through densification of the Bench, East Merritt/Diamond Vale, North Nicola, City Centre, West Merritt and Collettville areas.

The Gateway 286 Plan represents the largest growth in the City. At full build out, projections in the OCP indicate the development of over 1,100 houses which will provide housing for 3,500 people.

The Midday Valley Plan consists of 90 single family houses, 200 townhouses, and a 125 room hotel. At full build out and an average household population of 2.3 persons per household, the estimated population increase in the Midday Valley Plan is 667 people.

The remaining population increase is through densification of the Bench, East Merritt/Diamond Vale, North Nicola, City Centre, West Merritt and Collettville areas. These are potential residential growth areas as noted in the OCP.

Projections are based on both scenarios as noted in Table 5-6 below.

TABLE 5-6
FUTURE POPULATION SUMMARY

Plan	1.1% growth population	3.5% growth population
Gateway 286	865*	3,500
Midday Valley	165*	667
Through Densification	752*	3,044
Total Increase	**1,782**	**7,211**
Existing Population	7,285	7,285
Future Population	**9,067**	**14,496**

* growth calculated based on percentage of growth for 7,211 people interpolated to 1,782 people.

At an average household population of 2.3 persons per household, the projected population increase of 1,782 under the 1.1% growth rate is calculated as an increase of 39 residential units per year until 2030. The projected population increase of 7,211 people under the 3.5% growth rate is calculated as an increase of 157 residential units per year until 2030.

At an existing average residential per capita usage rate of 706 L/c/d, the future residential average day demand under the 1.1% growth rate is 74.1 L/s, while the future residential average day demand under the 3.5% growth rate with 20% conservation reduction is 94.8 L/s based on 565 L/c/d.

5.3.3 Peaking Factor Assignment

Peaking factors calculated in Section 5.2.3 were assigned to average day demands to obtain maximum day demands and peak hour demands for residential and ICI properties under the 1.1% and the 3.5% (with 20% conservation reduction) growth conditions.

TABLE 5-7
FUTURE DEMANDS AND PEAKING FACTORS (1.1% GROWTH)

Land Use	Demand (L/s)			Peaking Factors		
	ADD	MDD	PHD	ADD	MDD	PHD
Residential	74.1	204.0	370.5	1.0	2.75	5.00
ICI	37.6	56.4	75.2	1.0	1.50	2.00
TOTAL	**111.7**	**260.4**	**445.7**	**1.0**	**2.33**	**3.99**

TABLE 5-8
FUTURE DEMANDS AND PEAKING FACTORS (3.5% GROWTH + 20% CONSERVATION REDUCTION)

Land Use	Demand (L/s)			Peaking Factors		
	ADD	MDD	PHD	ADD	MDD	PHD
Residential	94.8	261.0	474.1	1.0	2.75	5.00
ICI	39.9	59.9	79.8	1.0	1.50	2.00
TOTAL	**134.7**	**320.9**	**553.9**	**1.0**	**2.38**	**4.11**

Due to the significant difference in projected demands based on the 1.1% and the 3.5% (with 20% conservation reduction) growth rate to 2030, recommended infrastructure improvements may be significant based on the high growth rate.

6.0 CONCLUSION AND RECOMMENDATIONS

This memorandum provides a review of the historical water demand and provides demand projections based on the City of Merritt OCP. These demands provide a basis for developing the existing and future demand scenarios in the construction of the City’s water model.

Review of historical demands reveal that the City of Merritt currently experiences high demands, and that an intensive demand management program may help in reducing these demands by about 20% for both average day and maximum day demand. The City shall assess its capacity and the feasibility of undertaking an intensive demand management program.

Opus DaytonKnight recommends the following two scenarios to model in the City’s water model:

- High Growth 3.5% with 20% conservation reduction through metering, education and leak reduction
- Low Growth 1.1% with no water conservation

The above two scenarios have been chosen by Opus DaytonKnight. It is considered that if the high growth scenario may require some significant upgrading of the network, a water conservation program would be a more economical solution for the City. It was also considered that the low growth scenario would require less upgrading of the network and less public support will be garnered for a potential water conservation program if there is inherent water system capacity.

7.0 CLOSURE

We trust you will find the foregoing technical memorandum suitable. Please do not hesitate to contact the undersigned should you have any questions.

Prepared by:

Opus DaytonKnight Consultants Ltd.

Clive Leung, E.I.T.

Reviewed by:

Walt Bayless, P.Eng.

Gurjit Sangha, P.Eng.

CL/WB/ab
D-36406.00
Encls.

TECHNICAL MEMORANDUM NO. 2

TO: Shawn Boven, A.Sc.T.

FROM: Opus DaytonKnight Consultants Ltd.

DATE: August 10, 2011

RE: CITY OF MERRITT – WATER UTILITY MASTER PLAN
SOFTWARE SELECTION

FILE: D-36406.00

This memorandum reviews the available water modeling software for the water model being developed for the City of Merritt (City) and provides recommendations for the City's consideration. Included in this memorandum is a review of each software and cost estimates received from each supplier. The City shall review the memorandum and select the software best suited to its needs and ensure that it understands the associated advantages and disadvantages of each program.

1.0 INTRODUCTION

Opus DaytonKnight Ltd. is tasked with the production of a fully functional, extended period simulation model for use in this project and for future use by the City and its consultants.

The City of Merritt currently does not have a water model but is interested in developing suitable water model capable of containing the entire city water network with room for expansion. Opus DaytonKnight Ltd. was retained by the City of Merritt to review available water model programs which are compatible with GIS and EPANET to develop the water model as part of the Water Utility Master Plan.

2.0 SELECTION CRITERIA

The City's intention is to obtain a recommendation for the potential purchase of a water modeling software for short in-house modeling tasks and water network review. The purchase will be dependent on the training required and the City's available budget at the end of this project.

Requirements from the City of Merritt for the model are as follows:

- compatible with GIS and EPANET;
- includes all relevant hydraulic information including type of pipe, pipe age and C-values, water reservoirs, pump stations, booster stations, PRV's and control valves;

- includes calibrated pump curves and C-values based on age, material type and field calibration; and,
- should be parcel based, fully field calibrated, capable of extended period simulation and yield results accurate enough to undertake analysis to an engineering design level.

Opus DaytonKnight confirms that this amount of detail is adequately specified for the purposes of developing a fully functioning water model for the City of Merritt.

The licenses for water modeling software are based on the number of links (pipes) within a water model. The licenses limit the model to run at a maximum number of links, so the more links there are in the system, the higher the cost will become. An initial review of the system concludes that the system will have approximately 630 links. Many companies sell licenses for links in numbers of 1,000, 2,000, 5,000, 10,000, and unlimited. For the City of Merritt, the cost for the 1,000 link license has been procured.

3.0 SOFTWARE REVIEW

The selection criteria noted by the City have been used to determine the capabilities and the type of water modeling software required for the Water Utility Master Plan. The modeling software chosen for review for the City of Merritt is InfoWater and WaterCAD.

This section reviews the two softwares for their ease of use, ArcGIS integration, graphical representation, and cost.

3.1 InfoWater

InfoWater, developed by Innovyze, is a water modelling software preferred for its excellent graphical outputs.

InfoWater uses an enhanced version of the EPANET hydraulic and water quality analysis engines and operates within the ArcGIS environment, which requires the GIS license for its operation. Static and Dynamic models can be created in the software. InfoWater has good data management features using a tree based scenario manager which supports inheritance. The software has output tables which allows for easy copy and pasting to external programs such as excel. All functional processes require some time before they are familiarized.

The InfoWater modeling program runs on the ArcGIS platform.

Graphical representation is excellent for this program with the ability of producing many colour coded, and thematic maps straight from the ArcGIS environment.

Costs in US dollars for a 1,000 pipe version of InfoWater are as follows:

TABLE 3-1
INFOWATER COSTS

Pipe Limit	Retail Cost
1,000	$4,000*

* excludes $800 Annual Maintenance Cost

3.2 WaterCAD

WaterCAD, developed by Bentley Systems, is a water modelling software well-liked for its ease of use and good functionality.

WaterCAD is offered in a standalone version and also in an AutoCAD environment. The features of both packages are similar.

WaterCAD uses a modified version of the EPANET hydraulic simulation engine in its hydraulic and water quality calculations. Static and Dynamic models can be created in the software. WaterCAD has good data management features using a scenario manager that involves parent-child relationships. WaterCAD includes an active topology manager that helps isolate parts of the system being analyzed within the scenario. The software has output tables which allows for easy copy and pasting to external programs such as excel. All functional processes only take a short time before they are familiarized.

The GIS interface for this software is considered to be good with Shapefiles and other GIS formats easily imported as background layers.

WaterCAD offers the Pressure Zone Manager module that is not included in the InfoWater software. The Pressure Zone manager helps to identify pressure zones and confirm existing or new pressure zones.

Graphical representation is also good for this program with the ability of producing many colour coded, and thematic maps. The ACAD version of the software is recommended should there be a need for printing large number of plots for reports, etc.

Costs in US dollars for a 1,000 pipe version of WaterCAD are as follows:

TABLE 3-2
WATERCAD COSTS

Pipe Limit	Retail Cost
1,000	$*

*excludes $1,925 Annual Maintenance Cost

4.0 BUDGETARY REVIEW

There are four components to the water modeling budget. The components are shown in Table 4-1 and summarized as:

1. Software Selection
2. Annual Subscription
3. Staff Training
4. Modeling/Updating

The water modeling budget shall consist of components 1, 2, 3 and 4, while subsequent yearly modeling budgets will consist of only components 2 and 4.

TABLE 4-1
WATER MODELING BUDGET COMPONENTS

	Tasks	Approx. Hours	Cost	Total Amount
1) Software Selection (choose one of the following softwares below)				
InfoWater	Software Purchase Cost	-	$4,000	$4,000
WaterCAD	Software Purchase Cost	-		
2) Annual Subscription (cost of maintenance for each corresponding software)				
InfoWater	Annual Subscription Fee	-	$800	$800
WaterCAD	Annual Subscription Fee	-		
3) Staff Training (cost for training in first year)				
InfoWater	Staff Training by Opus DK	24	$7,500	$7,500
WaterCAD	Staff Training by Opus DK	16	$5,000	$5,000
4) Modeling/Updating (choose one of the following methodologies)				
InfoWater	One Semi-Trained Staff Member	60 – 120	$2,400 – $4,800*	$7,400 – $14,800
	Consultant Hydraulic Analyses	35 – 70	$5,000 – $10,000	
WaterCAD	One Semi-Trained Staff Member	30 – 60	$1,200 – $2,400*	$6,200 – $12,400
	Consultant Hydraulic Analyses	35 – 70	$5,000 – $10,000	

* rate for one staff member working at $40/hour, these costs are for reference as a total cost of the methodology

The cost for modeling ranges from $5,000 to $10,000 as different types of hydraulic analyses take varying amounts of time to complete. The approximate cost at the lower end describes simple hydraulic analyses while the cost at the higher end encompasses more detailed analyses.

5.0 DISCUSSION & RECOMMENDATION

Both software programs are considered excellent hydraulic models in terms of computational abilities. The following discussion and recommendation provides the City an opportunity to consider its selection requirements and the associated costs of each software.

Table 5-1 summarizes our review of the software.

TABLE 5-1
WATER DISTRIBUTION MODEL SUMMARY

Software Package	Features	Reliability / Stability	Modeling Tools	Ease of Use	Use within the Industry	GIS Integration	Graphical Representation	Available Technical Support	Cost for 1,000 pipe version (US dollars)
InfoWater	Excellent	Excellent	High	Moderate	High	Excellent	High	Good	$4,000
WaterCAD	Excellent	Excellent	Excellent	High	High	Good	Good	Excellent	$

InfoWater has gained a large share of the hydraulic modeling market within North America. The software offers many of the features of its competition at a reduced cost. InfoWater has a large number of local users within B.C. including Abbotsford, Richmond, City of North Vancouver, and the City of Prince George. Our experience is that there is a higher learning curve in using the software.

WaterCAD is used extensively by consultants, municipalities and Regional Districts in B.C. It is considered a reliable software package with good graphical displays and data management. Our experience is that municipalities find WaterCAD easier to learn and implement.

Should the City be interested in modeling software with good graphical outputs within the ArcGIS environment, the InfoWater option is the desirable option. However, should the City desire at some point in the future to maintain its own software and also retain some in-house modeling capability, we recommend the procurement of the WaterCAD software for its ease of use and good technical support.

The City should note that the model can be easily converted from one program to another, and that the decision on the water modeling software is not urgent as the model can be constructed produce required results for the Water Utility Master Plan. A final decision is requested from the City near the end of the project.

6.0 CLOSURE

We trust you will find the foregoing technical memorandum suitable. Please do not hesitate to contact the undersigned should you have any questions.

Prepared by:	Reviewed by:
Opus DaytonKnight Consultants Ltd.	
____________________________	____________________________
Clive Leung, E.I.T.	Walt Bayless, P.Eng.

CL/
D-36406.00
Encls.

TECHNICAL MEMORANDUM NO. 3

TO: Shawn Boven, A.Sc.T.
Danielle Cass, Engineering Technologist

FROM: Clive Leung, EIT
Gord Tycho, MScP, MCIP, E.I.T.

DATE: August 23, 2011

RE: CITY OF MERRITT
HYDRANT FLOW TESTING PROGRAM

FILE: D-36406.00

This memorandum outlines the proposed hydrant flow testing program developed for the City of Merritt for the purposes of data collection for the City's water model update. Also included in this memorandum are the proposed testing locations which are highlighted in the figures attached at the end of this report. We request the City to review the proposed hydrant locations for suitability and to confirm that the flow hydrants will not flood or damage adjacent properties. It is recommended that the testing period be in August in order to stress the water model during calibration.

1.0 INTRODUCTION

Measured field data (flows and pressures) are required to calibrate the City of Merritt's recently developed water model. A hydrant testing program is typically undertaken to collect this type of data. The proposed program is estimated to take two (2) days. During this time we will require City staff to operate the hydrants while we record flow and pressure readings.

2.0 APPROACH

Each hydrant flow testing process includes opening a pre-determined hydrant and measuring flow from it, while also recording residual pressures at other hydrants in the area. This measurement allows the same flow conditions to be simulated in the model while comparing the pressures at 2 or more locations.

Four (4) flow sets are scheduled, each consisting of four (4) spatially static pressure reading sites, and three (3) spatially variable flow sites (each flow site also has a single adjacent pressure site). This results in 30 pressure measurements per set (15 static, 15 flow residual) and a total of 120 pressure measurements (60 static and 60 flow residual) across the City of Merritt, to calibrate the model. The following are considered in the selection of the hydrant flow and pressure locations:

- All hydrants must be in the same pressure zone;
- The location of the flow entry points into the zone (to determine the total flow in);
- Low and high elevations to capture maximum and minimum pressures, respectively;
- General location and populated areas to obtain a representative coverage of the entire zone; and,
- Land use

Figures 2-1 to 2-4 illustrate the proposed hydrant testing sites for flows and pressures measurements. ***We require approval from the City on these sites***. Please also see Section 5.0.

3.0 METHODOLOGY

The procedure used to collect data for model calibration is multi-pressure monitoring, and is outlined as follows:

1. Four high resolution pressure loggers (±0.2% of full scale) will be installed on predetermined pressure hydrants, and one additional logger installed on a hydrant adjacent to the flow hydrant. After bleeding the air, the hydrants are opened completely.

2. A turbine flow meter shall be installed on a pre-determined flow hydrant port to measure full hydrant flow; alternatively, a pitot gauge shall be installed on the flow hydrants and the velocity pressures shall be recorded. These pressures will be later converted into hydrant flow.

3. The type of hydrant orifice or nozzle on the flow hydrant must be recorded, as this information affects flow characteristics. The actual internal diameter of the outlet or nozzle must be measured to the nearest sixteenth of an inch.

4. City crew need to monitor flow and supervise drainage and dechlorination. **Each hydrant flow period is anticipated to take 3-5 minutes**. **There will be 6 flows per day for two days.**

5. Pressure loggers will then be removed, stopped and downloaded into a computer program. This data provide the static and residual pressures needed to calibrate the model.

The residual pressure at the flow hydrant (measured at the hydrant adjacent to the flow hydrant) should never be allowed to drop below 20 psi (138 kPa). If it does, slowly close the flow hydrant to bring the pressure back to 20 psi. At 20 psi on the hydrant adjacent to the flow hydrant, read and record the pitot readings on the flow hydrant.

During this time,

- Records of reservoir levels must be provided from the City's SCADA system (real time or daily output) in order to estimate background levels during the testing.
- Pump capacities, pump curves, PRV settings, and elevations of the PRV stations must be verified by the City prior to model calibration.
- Information on daily demand and pump flow rates, as well as any special operational changes to the system (such as main closures, and which supply wells are running, etc.) will be provided by the City.

The acceptable tolerance between field and computer predicted results are within ten to fifteen percent, the accepted industry standard.

4.0 FIELD CALIBRATION PROGRAM

Four sets of hydrant flow tests shall be conducted as follows:

- Set 1 – see Figure 2-1
- Set 2 – see Figure 2-2
- Set 3 – see Figure 2-3
- Set 4 – see Figure 2-4

Field predicted results will be correlated with computer predicted results by Opus DaytonKnight Ltd. upon completion of the field program.

5.0 SUMMARY

In summary, Opus DaytonKnight will provide:

- One staff during this testing program to coordinate the works,
- the hydrant flow meter,
- the pressure loggers (5),
- necessary pressure logger software,
- assistance to City staff with respect to mounting the equipment on the hydrants.

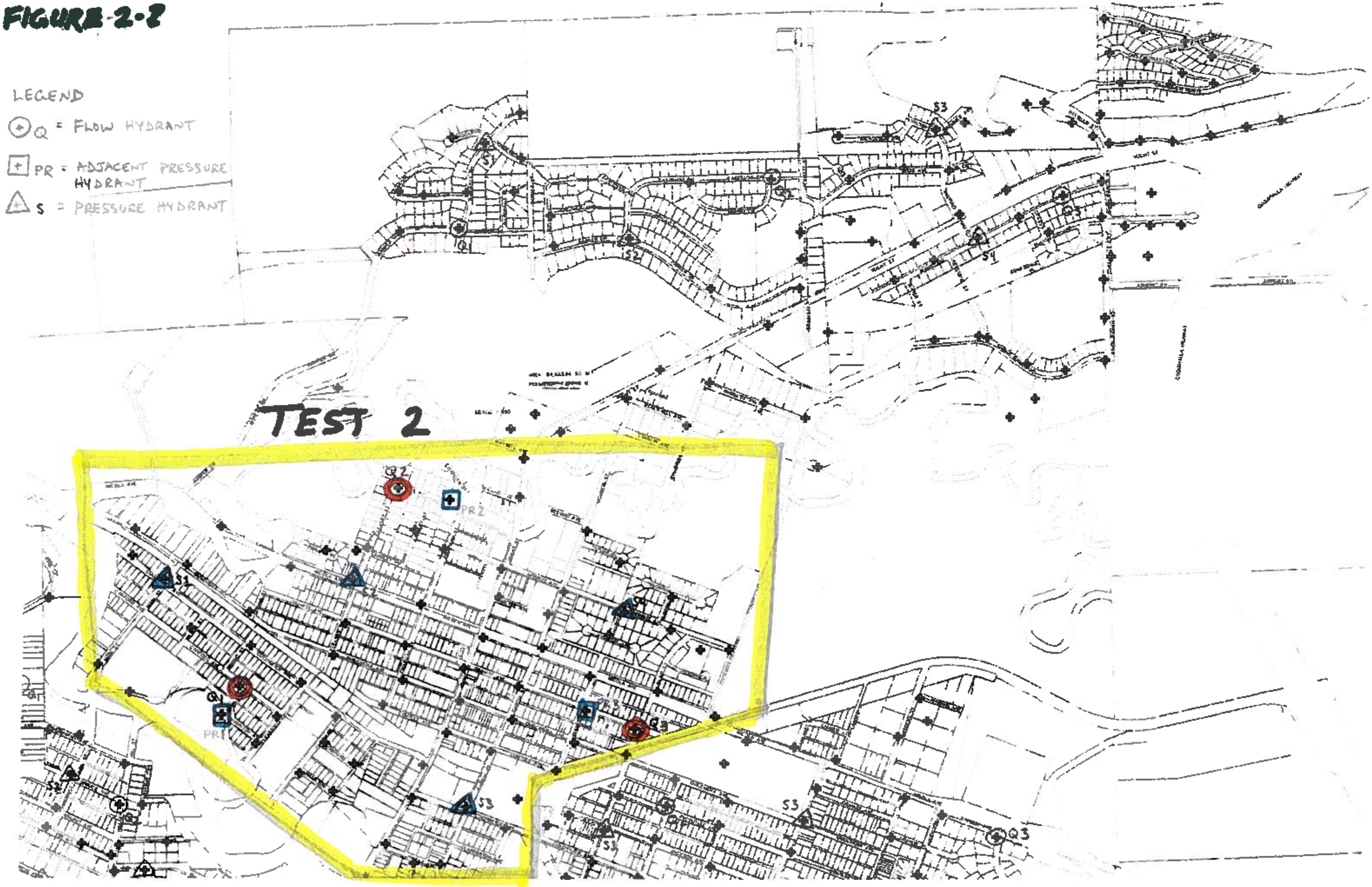
We require the City staff to:

- approve all hydrant pressure test sites,
- approve, in consultation with Opus DaytonKnight consultants, 3 hydrants that are appropriate (with respect to general safety, environmental, and property concerns) to act as flow hydrants in each of the four (4) test areas, and make recommendations for testing alternative hydrants if warranted,
- operate the hydrants for 3-5 minutes each, 6 hydrant flows per day over two (2) days,
- provide information (during the testing periods) relating to reservoir levels, the PRV setting, which pumps are operating, and any other operational changes that would affect the system (such as closed valves, etc).

FIGURE 2-1


TEST 1
LEGEND
Q = FLOW HYDRANT
PR = ADJACENT PRESSURE HYDRANT
S = PRESSURE HYDRANT
PR1
Q
S1
S2
PR2
Q2
S3
Q3
PR3
S4

FIGURE-2-2


LEGEND
Q = FLOW HYDRANT
PR = ADJACENT PRESSURE HYDRANT
S = PRESSURE HYDRANT
TEST 2
Q1
Q2
Q3
PR1
PR2
PR3
S1
S2
S3
S4

TEST 3

FIGURE 23

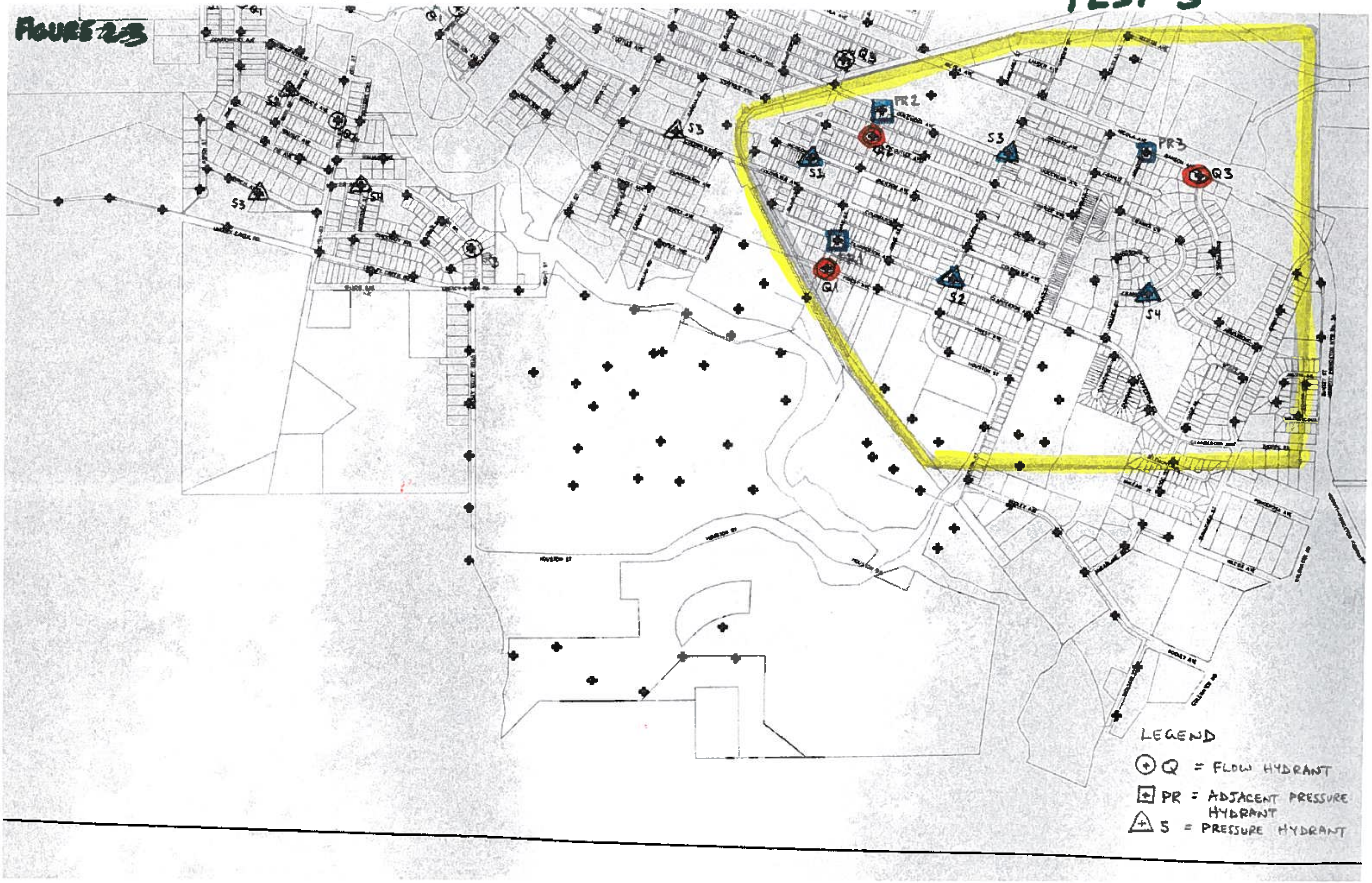
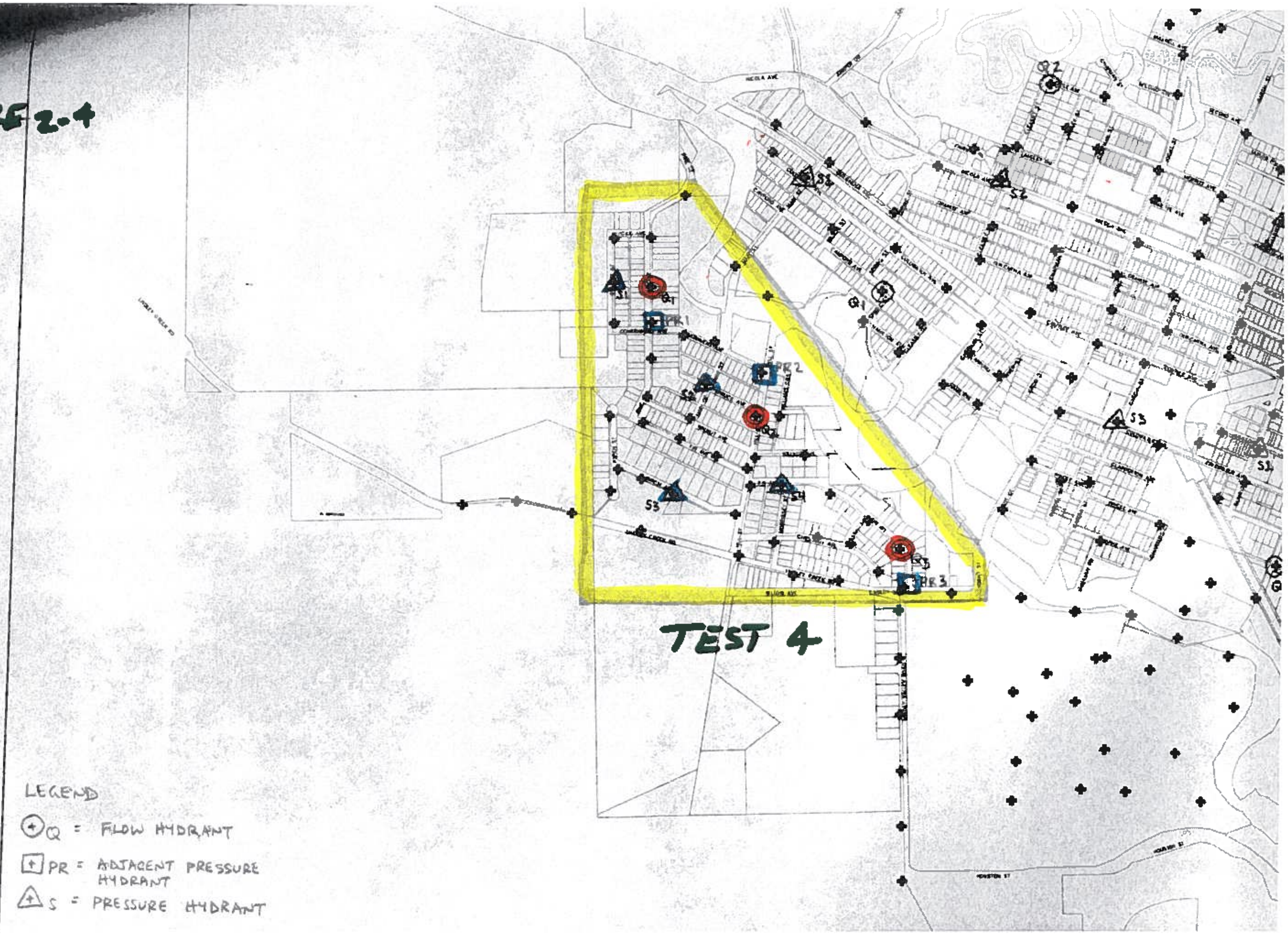


FIGURE 2-4


TEST 4
Q1
Q2
Q3
PR1
PR2
PR3
S1
S2
S3
S4
LEGEND
Q = FLOW HYDRANT
PR = ADJACENT PRESSURE HYDRANT
S = PRESSURE HYDRANT

TECHNICAL MEMORANDUM NO. 4

TO: Shawn Boven, A.Sc.T.

FROM: Opus DaytonKnight Consultants Ltd.

DATE: Sept 16, 2011

RE: CITY OF MERRITT – WATER UTILITY MASTER PLAN
HYDRAULIC MODEL DEVELOPMENT AND CALIBRATION

FILE: D-36406.00

This memorandum summarizes the structure of the hydraulic model, the methodology of building it from the various sources of information and the process of incorporating that information. The objective of this memo is to inform the City of Merritt about the hydraulic model structure in order to provide Opus DaytonKnight with comments and feedback prior to running the model and generating results.

This is the fourth memorandum issued for the subject project and it was preceded by:

1. Memo-1: Demand Analysis, issued on Aug 10, 2011 and revised on Sep 13, 2011.
2. Memo-2: Software Selection, issued on Aug 29, 2011.
3. Memo-3: Hydrant Flow Testing Program, issued on Aug 23, 2011.

1.0 INTRODUCTION

Opus DaytonKnight Ltd. is tasked with the production of a fully functional, extended period simulation model for use in this project and for future use by the City and its consultants.

The City of Merritt currently does not have a hydraulic model and has initiated the process of developing a suitable hydraulic model capable of containing the entire city's water distribution network with room for expansion. Opus DaytonKnight Ltd. was retained by the City of Merritt to review available hydraulic model programs which are compatible with GIS and EPANET to develop the water model as part of the Water Utility Master Plan.

2.0 OBJECTIVE

This memorandum summarizes the following:

- the sources of information used in the model
- the methodology of building the model and allocating demands

- the fire hydrant flow testing results
- the different scenarios prepared for the analysis

3.0 SOURCES OF INFORMATION

Information such as pipe network layout and sizes, locations of structures and appurtenances, water meter readings were obtained mainly from the following sources, provided by the City as outlined below:

- Merritt water composite map (CAD drawing), received on June 15, 2011.
- Fire hydrant flow map-1, (pdf drawing), revised on Sept 21, 2006.
- Fire hydrant inventory (Excel File No. 131B), dated January 2008.
- Water well capacities (pdf document), dated 1999.
- Merritt monitoring water well Data (excel file), dated Jan-Dec 2010.
- Gateway 286 new subdivision (pdf drawing No. 00-CP1001-Rev A), dated Dec 06, 2006.
- 968 Midday Valley road new subdivision (pdf Drawing No. 2161-P1-Rev1), dated Jul 15, 2010.
- Water Works for Reservoir 286 (pdf drawings by Civic Consultants Ltd), dated Jun 2011.
- Merritt Airport Servicing Extensions (pdf drawings by CTQ Consultants Ltd), dated Jul 2011.
- 1999 Merritt pump curves (pdf document), received on Jun 22, 2011.
- City of Merritt cadastral map.
- 2007 Merritt countours-1.0m.
- Site visit by Opus DaytonKnight personnel on Jun 22, 2011.
- Daily water consumption for 2010 (excel file).
- Reports by the City of Merritt and memorandums by other consultants relevant to the City’s water distribution works.

4.0 MODEL DEVELOPMENT

4.1 Pipe Network

The pipe network, in GIS shapefile, was imported to WaterCAD v8.0i. The imported information includes pipe diameters, pipe installation year, reservoir locations, pump station locations, PRV locations and fire hydrant locations. Gate (isolation) valves were not imported into the model in order to simplify the model and minimize control parameters.

For future growth scenarios, the existing distribution network was expanded by adding pipes to the model. The main additional pipes are those serving Gateway 286 and Midday Valley developments, and the new Airport extension projects.

4.2 Node Locations And Elevations

Typically the nodes in the hydraulic model were mainly located at:

- Pipe diameter changes
- Pipe intersections
- The end of pipelines

Although pipe elevations are technically below ground level, usually at 1.0m - 2.0m depth, ground elevations were used to represent the node elevations of the pipes in the model. This was done to simplify the network model and to base it on a more reliable source of data.

The ground elevations were extracted from the contour information, in shapefile format, provided by the City of Merritt in CAD format. By using these shapefiles, WaterCAD's TRex Tool was used to interpolate and assign elevations to all nodes in the water model.

5.0 DEMAND ALLOCATION

This section outlines the methodology of allocating the calculated demands to the nodes in the model.

The figures in this section correspond to the Average Day Demand (ADD). The Maximum Day Demand (MDD) and Peak Hour Demand (PHD) are generated from ADD on the basis of the peaking factors shown in Table 5-1.

TABLE 5-1
PEAKING FACTORS

Land Use	Peaking Factors		
	ADD	MDD	PHD
Residential	1.0	2.75	5.00
ICI	1.0	1.50	2.00

5.1 Existing Demands (2010):

Allocation of existing demands to nodes in the model is based on three categories, which are Large ICI, Regular ICI and Residential.

5.1.1 Large ICI Demand:

- Large ICI demand includes the five users with the highest demand according to the 2010 meter readings by the City of Merritt. These are: Tolko Industries Ltd, Conayt Friendship Society, The Board of School Trustees, Little Joe and Son Holdings Ltd, and Coldwater Hotel.

- Existing demand for each of the five large ICI is averaged at 2.0 l/s. This is outlined in Memo-1: Demand Analysis on Sept 13, 2011.

- A single node for each of these industries is selected and assigned the 2.0 l/s demand.

- The locations of the selected nodes in the model are approximate to the location of the actual existing water connection. The total large ICI existing demand is 10.0 l/s.

5.1.2 Regular ICI Demands:

- Total existing demand for Regular ICI is 23.3 l/s. This was calculated as follows:

  - Total measured existing demand for all ICI is 20.7 l/s.
  - A total corrected (actual) ICI demand is 33.2 l/s. Refer to Memo-1 on Sept 13, 2011 for calculations.
  - Regular ICI demand = Total corrected ICI – Total measured large ICI
    = 33.2 l/s – 10.0 l/s = 23.2 l/s.

- The total Regular ICI demand, 23.2 l/s, was distributed over the commercial and light industrial areas on the basis of percentage area coverage. Refer to the City of Merritt's Official Zoning Map-Schedule-A revised on July 24, 1996. The distribution was done as follows:

  - The plan area of each region within the commercial and light industrial zones was measured, C1 to C6 and M1. Part of C4 zone, which is adjacent to Gateway 286 development (approximately 6.14 ha), is not included in the existing water demand allocation because the development does not exist as of 2010.
  - The total area for all commercial and light industry regions was measured, which summed up to approximately 246 ha.
  - The percentage area covered by each zone, C1 to C6 and M1, to the total area of 246 ha was calculated.

  - The total existing demand of 23.2 l/s was distributed proportionally over the each zone, C1 to C6 and M1, on the basis of percentage area coverage calculated above.

- The existing water demand for each zone, C1 to C6 and M1, was further distributed evenly on all the nodes in the model surrounding that particular region.

5.1.3 Residential Demands:

- The total existing Residential demand is 59.6 l/s. Refer to Memo-1 Demand Analysis on Sept 13, 2011 for calculations.

- This total demand was evenly distributed over the residential area on the basis of percentage area coverage. Refer to the City of Merritt's Official Zoning Map-Schedule-A revised on July 24, 1996. This was done as follows:

  - The plan areas of each residential region, such as R1 to R7 as shown in the zoning map, were measured. Zone R8, which is the Gateway 286 area, is not included in the existing water demand calculations because the development does not exist as of 2010.
  - The total area of all residential regions was calculated, which summed up to approximately 397 ha.
  - The percentage area coverage of each zone, R1 to R7, to the total residential area of 397 ha was calculated.
  - The total demand of 59.6 l/s on the each zone, R1 to R7, was distributed proportionally on the basis of percentage area coverage calculated above.

- The existing water demand for each zone, R1 to R7, was further distributed evenly on all the nodes in the model surrounding each particular zone.

5.2 Future Demands (2030):

Allocation of future demands, for the low (1.1%) and the high (3.5%) projected growth scenarios, to nodes in the model is based on the same three categories as the existing demands in addition to three more categories, which are Gateway 286, Midday Valley and Airport Extension. The rates for each of these are outlined below:

5.2.1 Large ICI Demand:

- Low growth scenario: In addition to the existing large ICI demand, 1 new large ICI was added; refer to Table 5-5 in Memo-1 Demand Analysis on Sept 13, 2011. The 2.0 l/s was added to 1 node in the model within the zone of South Merritt. The total large ICI future demand for this scenario is 12.0 l/s.

- High growth scenario: The existing large ICI demands were reduced by 20% and 3 new large ICI's were added; refer to Table 5-5 in Memo-1 Demand Analysis on Sept

13, 2011. 1.6 l/s was added to three nodes in the model within the zones of South Merritt, Coletteville and East Merritt/Diamond Vale. The total large ICI future demand for this scenario is 12.8 l/s.

5.2.2 Regular ICI Demands:

- Future regular ICI demands were distributed within the 4 zones, which are City Centre, Voght Street/North Entry, North Nicola and Gateway 286.

- Low growth scenario: In addition to the existing regular ICI demands, an additional 2.4 l/s was added to this future scenario, which is based on 26 additional regular ICI's at the same unit demand of 0.092 l/s.

    - The additional 2.4 l/s was distributed over the commercial areas within the zones noted above. The distribution was proportional to the percentage of area coverage; i.e. ratio of total commercial areas in each zone to the total commercial areas in all the zones noted above.
    - The demand of each area was then evenly divided on the nodes surrounding the commercial areas in the zone. The total regular ICI demand for this growth scenario is 25.6 l/s.

- High growth scenario: The existing regular ICI demands were reduced by 20% and 8.6 l/s were added, based on 116 new regular ICI's at a unit rate of 0.074 l/s.

    - The 8.6 l/s was distributed over the commercial areas within the zones noted above. The distribution was proportional to the percentage of area coverage; i.e. ratio of total commercial areas in each zone to the total commercial areas in all the zones.
    - The demand of each area was then evenly divided on the nodes surrounding the commercial areas in the zone. The total regular ICI demand for this growth scenario is 27.1 l/s.

5.2.3 Residential Demands (by densification):

- Future residential demands occurring due to densification were distributed within the 6 zones, which are Bench, East Merritt/Diamond Vale, North Nicola, City Centre, West Merritt, and Colletteville.

- Low growth scenario: In addition to the existing residential demands, 6.2 l/s was added to this scenario which is based on an additional population of 752 at the same unit demand of 706 l/c/d.

    - The 6.1 l/s was then distributed over the residential areas within the six zones noted above. The distribution is proportional to the percentage of area coverage, as previously defined.

- High growth scenario: The existing residential demands were reduced by 20% and 19.9 l/s was added, based on an additional population of 3,044 at the reduced unit demand of 565 l/c/d.
    - The 19.9 l/s was distributed over the residential areas within the six zones noted above. The distribution was proportional to the percentage of area coverage, as previously defined.

5.2.4 Residential Demands (by new developments):

- Future residential demand occurring as a result of new developments was distributed over the areas of Gateway 286 and Midday Valley developments.

- Low growth scenario: At this growth rate, Gateway 286 and Midday Valley are projected to include 865 and 165 residents, respectively, in the year 2030. This is equivalent to 7.1 l/s and 1.4 l/s based on a unit demand of 706 l/c/d. Each of these demands was allocated to 1 node in the model adjacent to the location of the development.

- High growth scenario: At this growth rate, Gateway 286 and Midday Valley are projected to include 3,500 and 667 residents, respectively, in the year 2030. This is equivalent to 22.9 l/s and 4.4 l/s based on a reduced unit demand of 565 l/c/d. Each of these demands was allocated to 1 node in the model adjacent to the location of the development.

6.0 RESERVOIRS

Table 6-1 summarizes the information for reservoirs that was made available by the City and which was used to build the hydraulic network model.

Some of the information is still pending and would be useful to obtain that information in order to accurately run the model.

TABLE 6-1
RESERVOIR PARAMETERS

Reservoir	Current Status (year 2011)	Reservoir Parameters	
Grimmett	ONLINE	Volume	1,000,000 IMP Gal
		Max water elv.	680 m
Nicola	ONLINE	Volume	148,000 IMP Gal
		Max water elv.	680 m
Grandview	ONLINE	Volume	120,000 IMP Gal
		Max water elv.	745 m
South East	ONLINE	Volume	500,000 IMP Gal
		Max water elv.	680 m
		Diameter	19 m
Active Mountain	ONLINE	Volume	508,129 IMP Gal
		Max water elv.	747 m
		Min water elv.	738 m
		Finished Grnd Elv	738 m

7.0 PUMPS

Table 7-1 summarizes the information for pumps that was made available by the City and which was used to build the hydraulic network model. Some of the information is still pending and is required in order to accurately run the model.

TABLE 7-1
PUMP PARAMETERS

Well	Current Status (year 2011)	Pump Parameters	Pump Curve Points		
Fairley Park	ONLINE	Pump Start at 76 % of Grimmett reservoir level		Flow (l/s)	Head (m)
			Pt.1	0.00	140
		Pump Stop at 79 % of Grimmett reservoir level	Pt.2	40	130
			Pt.3	100	70
Voght VFD (Voght Park #1)	ONLINE	Pump Start at 80% of Grimmett Reservoir level		Flow (l/s)	Head (m)
			Pt.1	0	190
		Pump Stop at 84% of Grimmett Reservoir level	Pt.2	100	140
			Pt.3	200	52
Collettville	ONLINE			Flow (l/s)	Head (m)
			Pt.1	57	114
Kengard	ONLINE			Flow (l/s)	Head (m)
			Pt.1	0	180
			Pt.2	30	140
			Pt.3	68	80
Voght Park Gas/E (Voght Park #2)	ONLINE	Pump Start at75% of Grimmett Reservoir level		Flow (l/s)	Head (m)
			Pt.1	0	140
			Pt.2	40	130
			Pt.3	180	65
May Street	OFFLINE			Flow (l/s)	Head (m)
			Pt.1	6.31	118.87
			Pt.2	28.40	85.34
			Pt.3	39.44	54.86

8.0 BOOSTER STATIONS

Table 8-1 summarizes the information for reservoirs that was made available by the City and which was used to build the hydraulic network model.

Some of the information is still pending and would be useful to obtain that information in order to accurately run the model.

TABLE 8-1
BOOSTER STATIONS PARAMETERS

Booster Station	Current Status (year 2011)	Pump Parameters	Pump Curve Points		
Active Mountain (elv 635 m)	ONLINE			Flow (l/s)	Head (m)
			Pt.1	0	110
			Pt.2	30	80
			Pt.3	40	62
Grandview (elv. 649 m)	ONLINE			Flow (l/s)	Head (m)
			Pt.1	0	84
			Pt.2	19	73
			Pt.3	28	61

9.0 PRV

Table 9-1 summarizes the information for the Pressure Reducing Valve (PRV) that was made available by the City and which was used to build the hydraulic network model.

TABLE 9-1
PRV PARAMETERS

PRV	PRV Diameter	PRV Parameter
Grandview Booster Station	3 in and 4 in	40 psi at discharge up to maximum 135 psi.

10.0 MODEL CALIBRATION

Hydrant flow testing is a reliable method to determine the actual water quantity and flow rate available for fire fighting at various locations within the distribution system. The purpose of retrieving hydrant flow data is to calibrate the model and, in particular, the C-values of the pipes in the surrounding areas of the flow tests. A few iterations of the hydraulic model were carried out under the calibration to the hydrant flow testing results. During this time, boundary conditions such as reservoir elevations and pump statuses were retrieved as well.

10.1 Flow Test Methodology

Hydrant flow tests for the City of Merritt were conducted on August 30th and Sept 2nd, 2011 by a crew that was made up of City and Opus DaytonKnight personnel. Two sets of measurements were performed on August 30th and three sets on Sept 2nd. Each set corresponds to a certain area (zone) in the city and, ideally, three different measurements are proposed for each set. Table 10-1 summarizes the time and locations of the tests.

TABLE 10-1
TEST SETS – DATE AND LOCATION

Set No.	Zone No.	Date	Location	No. of Readings
1	2	Aug 30th, 2011 (Morning)	West Merritt / City Centre / North Nicola	3
2	3	Aug 30th, 2011 (Afternoon)	East Merritt / Diamond Vale	3
3	1	Sept 2nd, 2011 (Morning)	Bench	3
4	5	Sept 2nd, 2011 (Noon)	Bench (Grandview Heights)	2
5	4	Sept 2nd, 2011 (Afternoon)	Collettville	3

The procedure used to collect the required pressure and flow data for model calibration was a multi-pressure monitoring one. The procedure was applied to all of the above sets as outlined in Memo-3: Hydrant Flow Testing Program, issued on Aug 23, 2011.

Section 10.2 shows the data and results of the measurements taken for the 5 sets.

10.2 Field Calibration Results

10.2.1 Test Set # 1 (Zone 2)

Three flow measurements were conducted for test set #1. Table 10-2 summarizes the location of hydrants and hydrant numbers selected for this test set.

TABLE 10-2
TEST SET 1

	Logger ID	Hydrant #	Flow Start Time	Flow End Time	Location
PS1	DK01	85	-	-	Coldwater Ave. & Main St
PS2	DK02	87	-	-	Nicola Ave & Cleasby St.
PS3	DK03	146	-	-	Coldwater Ave. & Garcia St
PS4	DK04	95	-	-	Merritt Ave & Blaire Str (2290 Merritt Ave)
Q1	-	156	10:08	10:13	Canford Ave. & Spring Str.
PR1	DK05	254	-	-	S. end of Spring Str. - W. side
Q2	-	71	11:08	11:13	First Str. & Cleasby Str.
PR2	DK05	76	-	-	First Str. & Chapman Str.
Q3	-	96	11:38	11:43	Granite Ave. & Blair Str.
PR3	DK05	100	-	-	Granite Ave. & Charters Str.

Figure 10-1 illustrates the pressures logged by the four static pressure loggers, and the approximate flow test times for Set 1.

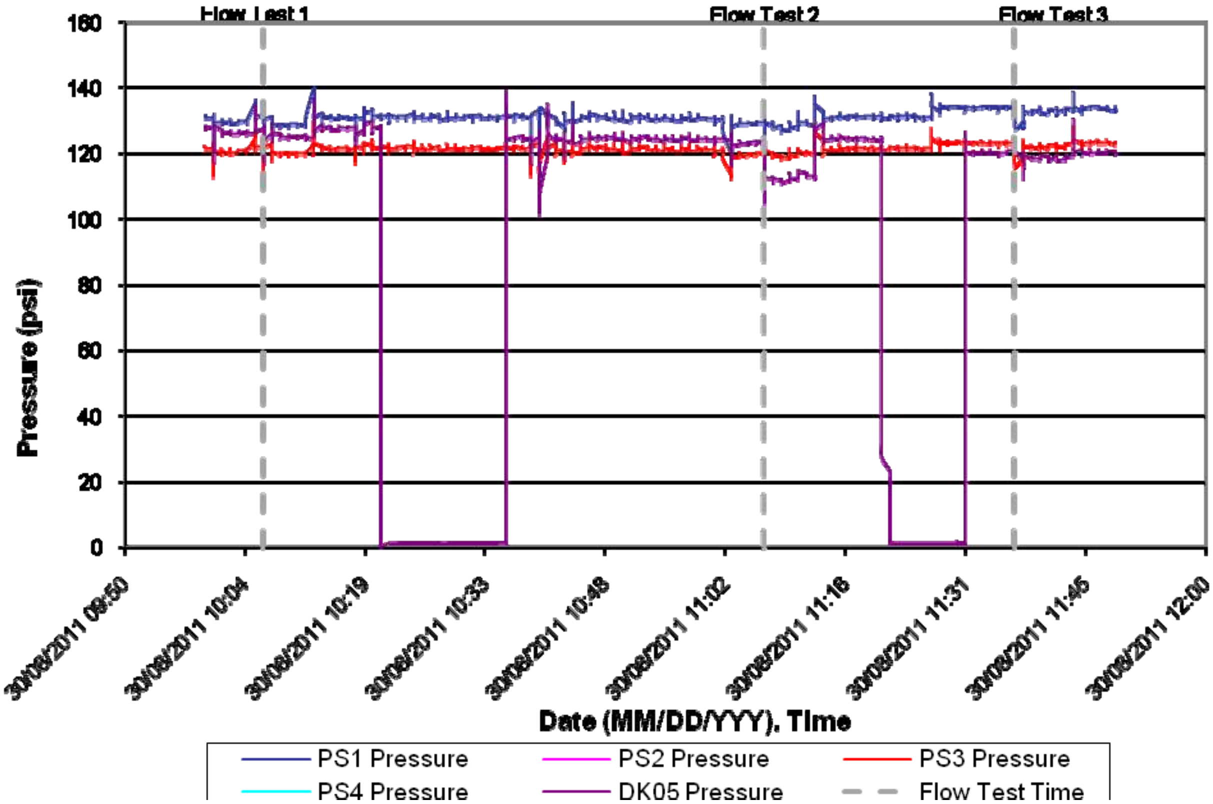


Figure 10-1: Static Pressure – Set 1

The zone covered for test set 1 includes West Merritt, City Centre and North Nicola. Water sources for these areas is from Voght Park well #2, Fairly Park well, and Nicola reservoir.

10.2.2 Test Set # 2 (Zone 3)

Three flow measurements were conducted for test set #2. Table 10-3 summarizes the location of hydrants and hydrant numbers selected for this test set.

TABLE 10-3
TEST SET 2

	Logger ID	Hydrant #	Flow Start Time	Flow End Time	Location
PS1	DK01	108	-	-	Jackson Ave. & Blair Str.
PS2	DK02	116	-	-	Clapperton Ave. & Houston Str.
PS3	DK03	91	-	-	Quilichena Ave. & Houston Str.
PS4	DK04	35	-	-	2881 Cranna Cres.
Q1	-	130	13:50	13:55	Priest Ave. & May Str.
PR1	DK05	127	-	-	May Str. & Clapperton Ave.
Q2	-	103	14:09	14:15	May Str. & Coutlee Ave.
PR2	DK05	105	-	-	May Str.& Quilichena Ave.
Q3	-	18	13:21	13:26	Ransom Ave. & Armstong Str.
PR3	DK05	20	-	-	Menzies Ave. & Ransom Ave.

Figure 10-2 illustrates the pressures logged by the four static pressure loggers, and the approximate flow test times for Set 2.

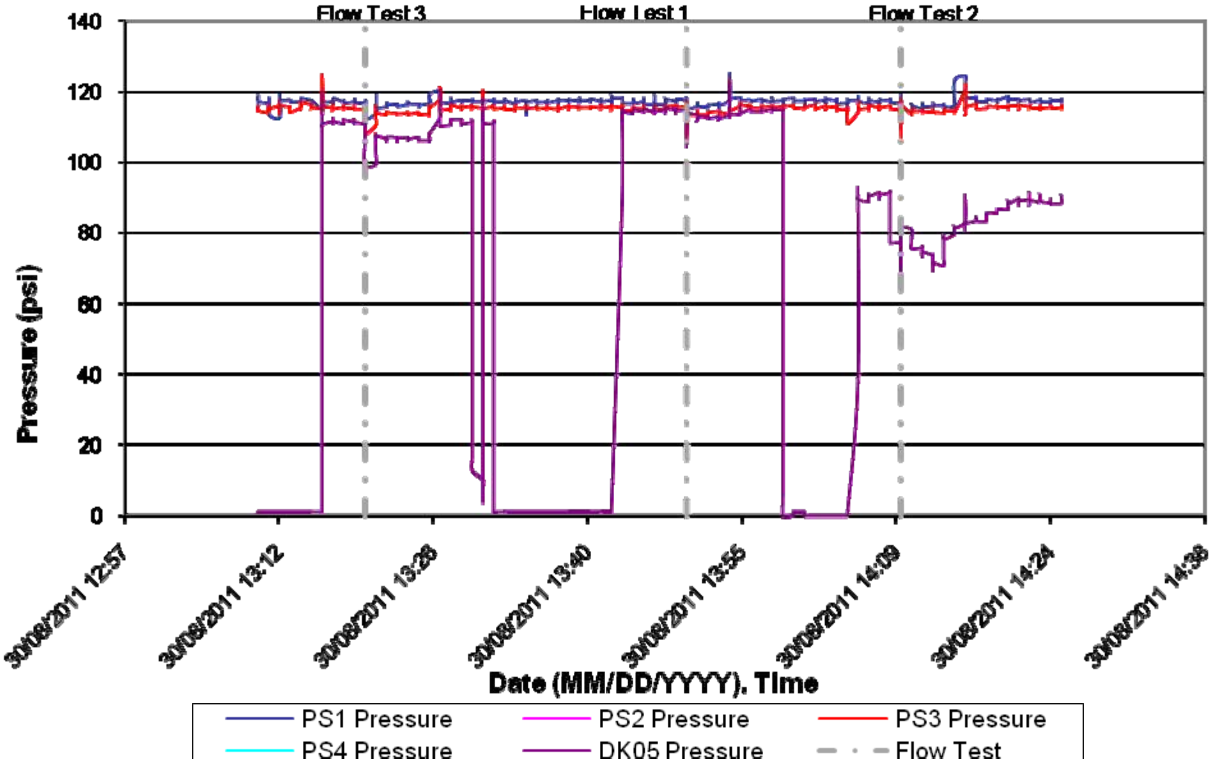


Figure 10-2: Static Pressure – Set 2

The zone covered for test set 2 is within East Merritt / Diamond Vale. Primary water sources for this area is from Voght Park well #2, Fairly Park well, and Nicola reservoir. Kengard well and May Street well are to the North and South of this area, however, they are currently offline as of 2010.

The pattern for DK-05 shows an unusual drop between Test flow 3 and test flow 1, around 13:30 hrs. This can be attributed to a procedural error while attempting to disconnect the logger from the hydrant. However, this has no effect the hydraulic results and analysis of the network calibration and flow tests because it occurs between the two tests and not within the flow test duration.

10.2.3 Test Set # 3 (Zone 1)

Three flow measurements were conducted for test set #3. Table 10-4 summarizes the location of hydrants and hydrant numbers selected for this test set.

TABLE 10-4
TEST SET 3

	Logger ID	Hydrant #	Flow Start Time	Flow End Time	Location
PS1	DK01	45	-	-	Ponderosa Way & Pine Ridge Dr. (3399 Pineridge Way)
PS2	DK02	54	-	-	Castillou Cres. & Parker Dr.
PS3	DK03	239	-	-	Walters St & Brenmer Ave (4133 Walters Str.)
PS4	DK04	8	-	-	Walters St & Irvine Ave. (2501 Irvine Ave.)
Q1	-	67	10:34	10:49	Pineridge Dr. & Juniper Dr.
PR1	DK05	68	-	-	1737 Juniper Dr.
Q2	-	49	9:43	9:48	Castillou Cr & Munro Cr (2202 Munro Cres.)
PR2	DK05	59	-	-	Castillou Cr & Munro Cr (2102 Munro Cres.)
Q3	-	229	9:18	9:23	Irvine Ave & River Ranch Rd. N.W.
PR3	DK05	4	-	-	Irvine Ave & River Ranch Rd West (2637 Irvine Ave.)

Figure 10-3 illustrates the pressures logged by the four static pressure loggers, and the approximate flow test times for Set 3.

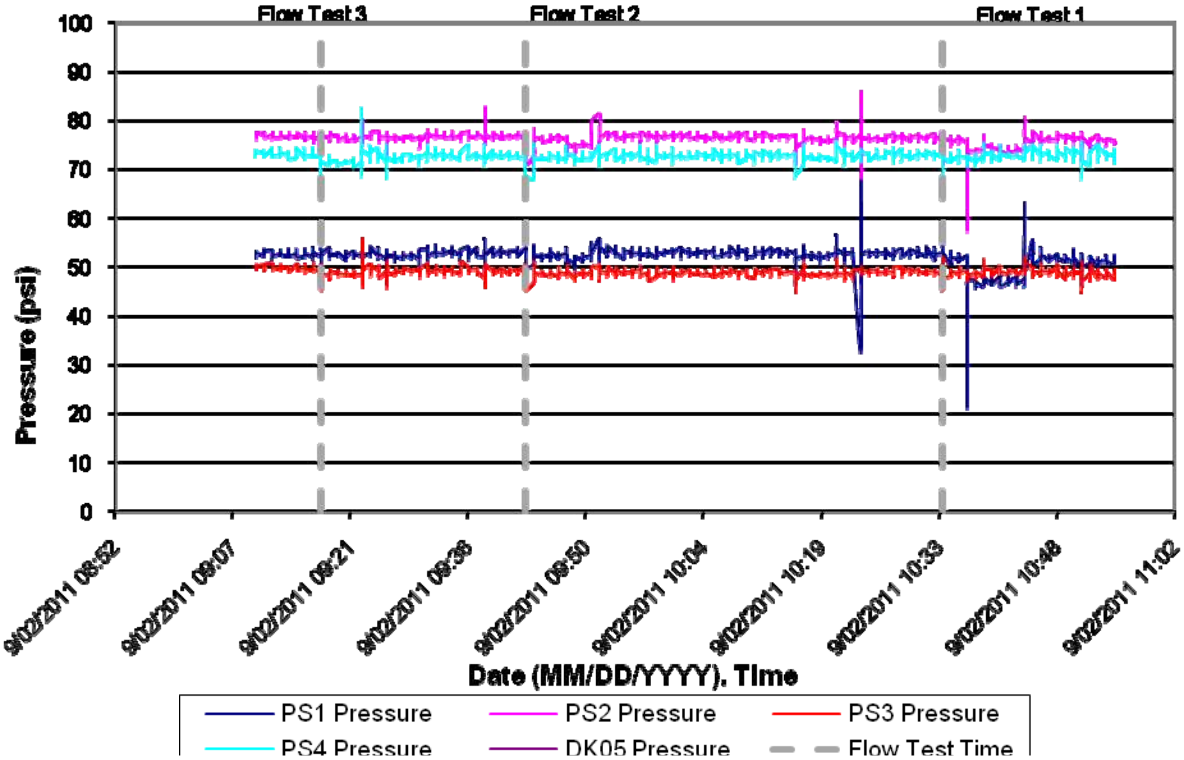


Figure 10-3: Static Pressure – Set 3

The zone covered for test set 3 is within Bench. Water source for this area is from Nicola reservoir and Grimmett Reservoir located to the West and Northeast of Bench, respectively. Kengard well is to the South of this area, however, it is currently offline as of 2010.

It can be observed that DK-05 logger does not show any readings for this test set. This is attributed to the fact that the equipment digitally ceased to log and to store the measured data. However, the visual readings from the gauge were recorded and used for the water network model calibration.

10.2.4 Test Set # 4 (Zone 5)

Two flow measurements were conducted for test set #4. Table 10-5 summarizes the location of hydrants and hydrant numbers selected for this test set.

TABLE 10-5
TEST SET 4

	Logger ID	Hydrant #	Flow Start Time	Flow End Time	Location
PS1	DK01	299	-	-	End of Peregrine Way
PS2	DK02	295	-	-	Grandview Heights & Peregrine Way
PS3	DK03	182	-	-	Eagle Cres & Falcon Cres Dr.
PS4	DK04	244	-	-	2717 Grandview Heights Rd
Q1	-	297	12:26	12:31	Peregrine Way (2nd from top)
PR1	DK05	298	-	-	Peregrine Way & Falcon Cres Dr.
Q2	-	178	12:55	13:00	Grandview Heights & Eagle Cres.
PR2	DK05	181	-	-	Eagle Cres.

Figure 10-4 illustrates the pressures logged by the four static pressure loggers, and the approximate flow test times for Set 4.

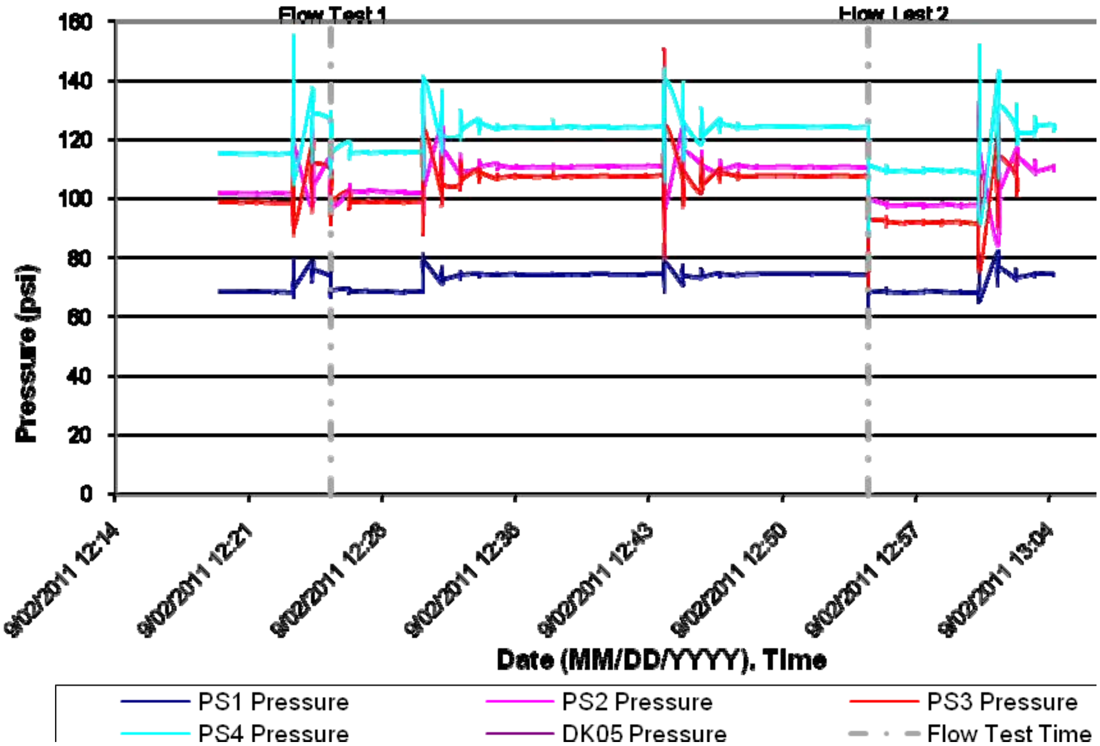


Figure 10-4: Static Pressure – Set 4

The zone covered for test set 4 is within a new area to the East of Bench at Grandview Heights. Water source for this area is from Nicola reservoir and Grimmett Reservoir located to the West and Northeast of Bench, respectively. Kengard well is to the South of this area, however, it is currently offline as of 2010.

It can be observed that DK-05 logger does not show any readings for this test set. This is attributed to the fact that the equipment digitally ceased to log and to store the measured data. However, the visual readings from the gauge were recorded and used for the water network model calibration.

10.2.5 Test Set # 5 (Zone 4)

Three flow measurements were conducted for test set #5. Table 10-6 summarizes the location of hydrants and hydrant numbers selected for this test set.

TABLE 10-6
TEST SET 5

	Logger ID	Hydrant #	Flow Start Time	Flow End Time	Location
PS1	DK01	205	-	-	(1416 Collett Str.)
PS2	DK02	196	-	-	Main St & Spruce Ave.
PS3	DK03	221	-	-	Birch Ave & 3rd from Aspen St
PS4	DK04	216	-	-	Fir Ave & Morrissey St
Q2	-	219	15:31	15:36	Fir Ave. & Hill Str.
PR2	DK05	198	-	-	Fir Ave. & Hill Str.
Q3	-	264	15:57	16:02	Fir Ave (2nd up from Lindley Crk Rd - 1624 Fir Rd.)
PR3	DK05	170	-	-	Fir Rd * Lindley Crk Rd
Q4	-	223	16:23	16:27	(2074 Birch Ave.)
PR4	DK05	214	-	-	Aspen Str. & Birch Ave.

Figure 10-5 illustrates the pressures logged by the four static pressure loggers, and the approximate flow test times for Set 5.

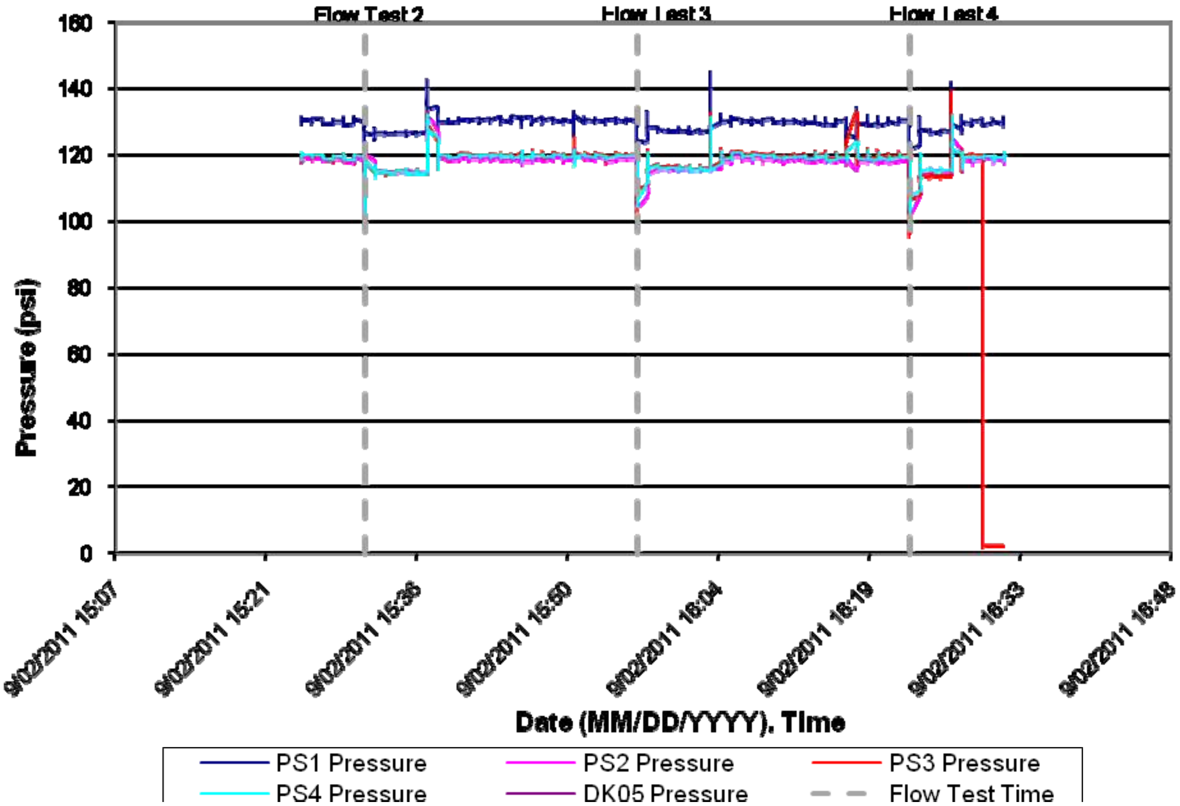


Figure 10-5: Static Pressure – Set 5

The zone covered for test set 5 is within Collettville. Water source for this area is mainly from Collettville well. The zone can also be supplied with water from Voght Park wells through the distribution network.

It can be observed that DK-05 logger does not show any readings for this test set. This is attributed to the fact that the equipment ceased to digitally log and to store the measured data. In addition, the pitot tube in the flow meter was blown away by the flowing water when the fire hydrant was opened.

10.3 Discussion

Model calibration is typically completed using one flow test per pressure zone. Due to the nature of the City's system, we were able to complete 5 tests within the pressure zone. As such, we have sufficient data to complete the calibration of the model.

Total average water demand for Aug 30th and Sept 2nd 2011, when the flow testing was carried out, are 12,697m^3 and 11,920m^3 respectively. This information was provided by the City of Merritt's Water and Wastewater SCADA system. Whereas, the recorded water demands for the same days in the year 2010 was 11,051 m^3 and 11,434 m^3, respectively.

TABLE 10-7
WATER DEMAND COMPARISON

	2010	2011	Ratio 2010 : 2011
Aug 30th	11,051 m^3	12,697 m^3	0.87
Sep 2nd	11,434 m^3	11,920 m^3	0.96
Average	11,242 m^3	12,309 m^3	0.91

11.0 SCENARIO DEFINITION

OPUS DaytonKnight was tasked to develop and evaluate the City's water system under the Average Day Demand (ADD), Maximum Day Demand (MDD), Peak Hour Demand (PHD) and Fire Flow (FF) scenarios. The existing and future systems are evaluated under population and land use, to review system capabilities in meeting estimated fire flows and peak hour pressure requirements. Future systems were analysed based on two population growth projection scenarios, low growth (1.1%) and high growth (3.5% with 20% water conservation reduction). The scenarios developed include:

- Existing:
  - ADD
  - ADD + FF
  - MDD
  - MDD + FF
  - PHD
- Future (2030 @ 1.1%):
  - ADD

  - ADD + FF
  - MDD
  - MDD + FF
  - PHD

- Future (2030 @ 3.5% + 20% conservation reduction):

  - ADD
  - ADD + FF
  - MDD
  - MDD + FF
  - PHD

Prepared by:	Reviewed by:
Opus DaytonKnight Consultants Ltd.	
______________________________	________________________________
Zaid Azaizeh, E.I.T.	Walt Bayless, P.Eng.

ZA/WB/
D-36406.00

26 August 2011

Dayton & Knight Ltd
Accounts Payable
210-889 Harbourside Drive
NORTH VANCOUVER-BRITISH BC V7P 3S1
CANADA

Attention: Mr. Clive Leung

Dear Mr. Leung,

Additional information about our products and the benefits of SELECT can be found at http://www.bentley.com. We look forward to receiving your purchase order and fulfilling our commitment to you, our valued customer!

If I may be of any further assistance, please do not hesitate to call the number below.

Thank you for your interest in Bentley products.

Yours sincerely,

Karl Woodeshick
+1 (610) 458-5000

Bentley Account Manager

Quotation

Quote Number: 40347572
Number of Pages: 2 / 3

Date: 26 August 2011
Valid Until: 26 September 2011
Customer ID: 4072253

Ship-to:
Dayton & Knight Ltd
Accounts Payable
210-889 Harbourside Drive
NORTH VANCOUVER-BRITISH BC V7P 3S1
CANADA

Tel No: +1 (6049904800)
Fax No: +1 (6049904805)

Bill-to:
Dayton & Knight Ltd
Accounts Payable
210-889 Harbourside Drive
NORTH VANCOUVER-BRITISH BC V7P 3S1
CANADA

Tel No: +1 (6049904800)
Fax No: +1 (6049904805)

If your organization is a subscriber to Bentley SELECT, the pricing listed on this page of the quote is prorated to the end of your current billing cycle. If applicable, future invoices will be generated based on the billing cycle shown on the following pages. The total from this first section of the quote is your immediate purchase value.

Products/Services

No.	Part # Description	Quantity	Unit Pricing		Total
200	6411/ Bentley WaterCAD Stand Alone Perp Lic	1	Gross Value	6,495.00	6,495.00
			Net Price	6,495.00	
				Products/Services Sub Total	**6,495.00**
				Taxes at 12.00%	**779.40**

Subscriptions

No.	Part # Description	Quantity	Unit Pricing		Total
300	6412/ Bentley WaterCAD Stand Alone SELECT Sub *Subscription Period **26 September 2011** Through **04 December 2011***	1	Gross Value Net Price	299.96 299.96	299.96
				Subscription Sub Total	**299.96**
				Taxes at 5.00%	**15.00**
				Taxes at 7.00%	**21.00**
				Total of Immediate Purchase	**7,610.36**
				Grand Total of Quote (over life of contract)	**7,610.36**
				Currency	**CAD**

**** Note:**

Pricing is only applicable to the products and quantities contained within this quote and may not be applied to a subset of the quotation. If you are a SELECT Subscriber, the terms of your SELECT Program Agreement shall apply to any purchases made pursuant to this quote.

Your payment term shall be: Net 30 Days

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Agreed and accepted by:

____
(Subscriber's Signature)

____
(Subscriber's Name)

____
(Title)

____
(Date)

Bentley Contact:
Name: Karl Woodeshick
Tel: +1 (610) 458-5000
Fax:

Innovyze®

618 Michillinda Avenue, Suite 200
Arcadia, CA 91007 USA
626 568-6868 Fax 626 568-6870

Quote

DATE: August 10, 2011

Quote To: Shawn Boven
City of Merritt
2185 Voght Street
Merritt, B.C.
V1K 1B8

Tel: (250) 562-0038
Fax: (250) 562-0058
e-mail: sboven@merritt.ca

Hello Shawn,

Please sign and date this quote, write “OK to bill” on it, and fax or e-mail it back to me. We can then process your order.

Kind Regards,

Chris Baxter Ph: (604) 639-7167
Fax: (888) 616-3568

QTY	DESCRIPTION	UNIT COST	AMOUNT
1	Fixed seat license of InfoWater v8.1 for ArcGIS Desktop v9.0 or later (1,000 links)	$4,000.00	$4,000.00
1	Year of the Gold Annual Subscription Program for InfoWater *Note: Costs for future years of the Gold Annual Subscription Program for InfoWater will be $800/year.*	$800.00	$800.00
		SUBTOTAL	$4,800.00
		CA Sales Tax (7.25%)	N/A
		TOTAL	$4,800.00

Licence keys and software to be delivered electronically. All prices in US Dollars.

Quote valid for 30 days from August 10, 2011

PLEASE CALL (604) 639-7167 WITH ANY QUESTIONS
Innovyze, Inc. FEIN: 95-4568279

Innovyze, Inc. is the only supplier of InfoWater software

THANK YOU FOR YOUR BUSINESS!

If you have any questions regarding this quote, call 604.639.7167

MERRITT

COUNTRY MUSIC CAPITAL OF CANADA

WATER UTILITY MASTER PLAN

APPENDIX E

FINANCIAL MODEL SET-UP

RETURN TO INDEX

Water/Sewer Utility Financial Model

OPUS DAYTONKNIGHT

City of Merritt

MERRITT
COUNTRY MUSIC CAPITAL OF CANADA

Model is loaded with:	Water Utility Data

Mac Address:

Licence:

Base Year Information

General Information

Base Year	2010
Population	7,285
Parcels	3,756
Average Frontage per Parcel *(m / Parcel)*	25.4
Gross Water Usage/Treatment *(L / capita / day)*	1100
Maximum Diameter of a Distribution Asset *(mm)*	325

Case Description

Case 1	Rehabilitation cost increased by 25% to allow for conditions more difficult than associted with green fields construction
Case 2	Case 1 Plus 30% increase in Service Life - considered possibly achievable to illustrate the impact
Case 3	
Case 4	
Case 5	

OPERATION NOTES:

The Water/Sewer Utility Financial Model was designed for use with Microsoft Excel 2010 for use with Windows 7. The model is not designed to be compatible with Microsoft Excel 2007 or older versions of Microsoft Excel. The model is not designed to be compatible with Windows XP, Windows Vista or Apple operating systems.

All calculations within the model are preset to 'manual'. Therefore, interdependent formulas will not update until the model is run on the dashboard. Once the model is run, all interdependent formulas will be recalculated prior to setting equitable and sustainable rates.

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0.2 Tornado Plots

A tornado plot is shown below to illustrate the relative sensitivity of the illustrative average cost for the "most likely" scenario to the minimum and maximum values for each of the user defined variables on the Dashboard. Base variables are applied automatically throughout modeling period (i.e. Then = Base). The wider the bar, the more sensitive the illustrative average cost is to change in that variable. Note that the Tornado Plots run time is likely to be long compared with other calculations

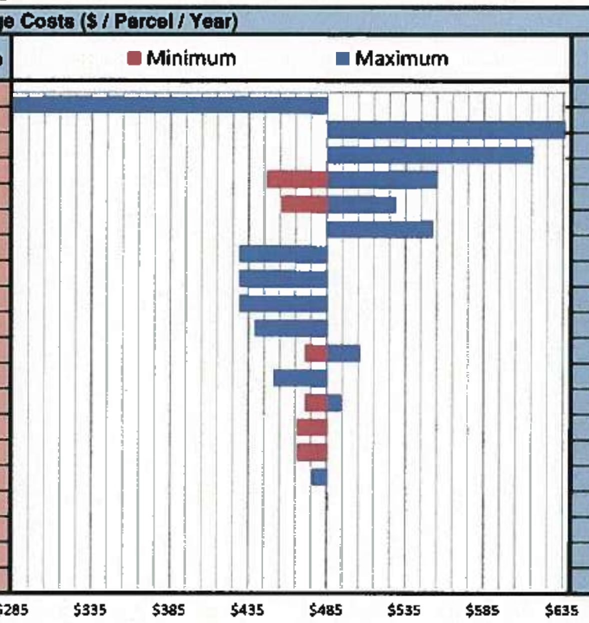
Variation in: Population Growth, Parcel Growth, Growth in Value of Distribution/Collection Assets and Growth in Value of Bulk Assets are interrelated. Sensitivity must be determined by running scenarios with combinations of these variables.

Abbreviated Description of Values			
Variables	**Most Likely**	**Minimum**	**Maximum**
Manual Revenue Adjustment Period (p.a., After, Until) - Rate	0.00%	0.0%	10.0%
Manual Revenue Adjustment Period (p.a., After, Until) - Start	2013	2013	2013
Manual Revenue Adjustment Period (p.a., After, Until) - End	2013	2013	2014
Automatic Revenue Adjustment Period (After, Until) - Start	2030	2013	2030
Automatic Revenue Adjustment Period (After, Until) - End	2031	2014	2031
Interest Rate on Reserves (p.a.)	1.5%	1.0%	3.0%
Interest Rate on Debt (p.a.)	4.5%	4.0%	6.0%
Change to Linear Asset Rehabilitation Unit Costs	0.00%	0.00%	50.00%
Change to Point Asset Rehabilitation Unit Costs	0.00%	0.00%	25.00%
Change to Service Life	0.00%	0.00%	30.00%
Change to Administration Expenses (p.a.)	0.00%	-1.00%	1.00%
Change to Operation Expenses (p.a.)	0.00%	-1.00%	1.00%
Change to Maintenance Expenses (p.a.)	0.00%	-1.00%	1.00%
External Backlog Rehabilitation Funding	0.00%	0.00%	10.00%
External Rehabilitation Funding	0.00%	0.00%	10.00%
Average Annual Water Purchase/Treatment Rate ($ / m3)	$0.00	$0.00	$0.00
Purchase/Treatment Cost Increase (p.a.)	$0.00	0.000%	0.500%
Change to per Capita Gross Water Usage/Treatment (p.a.)	0.00%	0.00%	-2.00%
Non-rev % of Gross Water Usage/Treatment	25.00%	20.00%	30.00%
Change to Non-rev % of Gross Water Usage/Treatment (p.a.)	0.00%	0.00%	-2.00%

Create Tornado Plot

Illustrative Average Costs for the Year: 2030

Illustrative Average Costs ($ / Parcel / Year)		
Variables	**Minimum**	**Maximum**
Change to Service Life	0.00%	30.00%
Change to Linear Asset Rehabilitation Unit Costs	0.00%	50.00%
Change to per Capita Gross Water Usage/Treatment (p.a.)	0.00%	-2.00%
Interest Rate on Debt (p.a.)	4.0%	6.0%
Change to Operation Expenses (p.a.)	-1.00%	1.00%
Change to Point Asset Rehabilitation Unit Costs	0.00%	25.00%
Manual Revenue Adjustment Period (p.a., After, Until) - Rate	0.00%	10.00%
Manual Revenue Adjustment Period (p.a., After, Until) - Start	2013	2013
Manual Revenue Adjustment Period (p.a., After, Until) - End	2013	2014
External Rehabilitation Funding	0.00%	10.00%
Change to Administration Expenses (p.a.)	-1.00%	1.00%
Change to Non-rev % of Gross Water Usage/Treatment (p.a.)	0.00%	-2.00%
Change to Maintenance Expenses (p.a.)	-1.00%	1.00%
Automatic Revenue Adjustment Period (After, Until) - Start	2013	2030
Automatic Revenue Adjustment Period (After, Until) - End	2014	2031
External Backlog Rehabilitation Funding	0.00%	10.00%
Interest Rate on Reserves (p.a.)	1.0%	3.0%
Average Annual Water Purchase/Treatment Rate ($ / m3)	0.00%	0.00%
Purchase/Treatment Cost increase (p.a.)	0.00%	0.50%
Non-rev % of Gross Water Usage/Treatment	20.00%	30.00%



Minimum	Most Likely	Maximum
$ 284.96	$485 /Parcel	$ 636.15

Illustrative Average Costs ($ / Parcel / Year)				
Variable Min	**ABS(Most Likely Min)**	**Total Difference**	**ABS(Max - Most likely)**	**Variable Max**
$ 485.46	$ -	$ 200.50	$ 200.50	$ 284.96
$ 485.46	$ -	$ 150.69	$ 150.69	$ 636.15
$ 485.46	$ -	$ 130.18	$ 130.18	$ 615.64
$ 446.50	$ 38.95	$ 108.38	$ 69.43	$ 554.88
$ 455.58	$ 29.88	$ 73.29	$ 43.41	$ 528.87
$ 485.46	$ -	$ 66.87	$ 66.87	$ 552.33
$ 485.46	$ -	$ 56.54	$ 56.54	$ 428.92
$ 485.46	$ -	$ 56.54	$ 56.54	$ 428.92
$ 485.46	$ -	$ 56.54	$ 56.54	$ 428.92
$ 485.46	$ -	$ 46.81	$ 46.81	$ 438.65
$ 471.23	$ 14.23	$ 34.88	$ 20.65	$ 506.10
$ 485.46	$ -	$ 34.44	$ 34.44	$ 451.02
$ 471.15	$ 14.31	$ 23.15	$ 8.85	$ 494.30
$ 465.99	$ 19.47	$ 19.47	$ -	$ 485.46
$ 465.99	$ 19.47	$ 19.47	$ -	$ 485.46
$ 485.46	$ -	$ 10.01	$ 10.01	$ 475.44
$ 485.60	$ 0.14	$ 0.41	$ 0.26	$ 485.19
$ 485.46	$ -	$ -	$ -	$ 485.46
$ 485.46	$ -	$ -	$ -	$ 485.46
$ 485.46	$ -	$ -	$ -	$ 485.46

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2.1 Linear Unit Costs

The user enters the Construction Cost and Rehabilitation Cost for each Linear Asset in their asset inventory; up to 150 assets may be entered. Sheet 2.3 Linear Assets references this sheet to assign a Construction Cost and Factored Rehabilitation Cost to each asset. Pipes of different materials and the same diameter will have varying service lives but equivalent Construction Costs. To generate a unique Construction Cost and Rehabilitation Cost for the Linear Asset inventory to reference, two of Category, Material and Diameter must be filled in; provide a heading if the Caterogy column if only using material and diameter.

All costs entered below are in Base Year dollars.

Original Construction Costs:
A Construction Cost Index table is provided and has been populated with historical values from the ENR Construction Cost Index. These values are referenced by Sheets 2.3 Linear Assets and 2.4 Point Assets to calculate the Original Construction Cost of all assets. The Original Construction Costs of all assets are summed to enable comparison with the Tangible Capital Asset value.

Note: Assets with unknown diameters are have been given a diameter of 5mm and are highlighted below.

Note: If only using Rehabilitation Cost A and Service Life A, ensure that BOTH Rehabilitation Cost B and Service Life B DO NOT have values in them. Failure to ensure this may lead to doubling or omittion of rehabilitaiton costs.

Linear Assets								Construction Cost Index	
								ENR	
Category	**Material**	**Diameter (mm)**	**Construction Cost (Base Year $)**	**Rehabilitation Cost A (Base Year $)**	**Rehabilitation Cost B (Base Year $)**	**Units**	**Category Name Check (number of characters)**	**Year**	**Index**
Pipe		50	$200	$200	$200		4	**Base Year**	**8802**
Pipe		100	$200	$200	$200		4	1908	97
Pipe		150	$250	$250	$250		4	1909	91
Pipe		200	$250	$250	$250		4	1910	96
Pipe		250	$300	$300	$300		4	1911	93
Pipe		300	$300	$300	$300		4	1912	91
Pipe		350	$325	$325	$325		4	1913	100
Pipe		600	$967	$967	$967		4	1914	89
								1915	93
								1916	130
Service Connection		25	$1,657	$1,657	$1,657		18	1917	181
								1918	189
	Hydrant	1	$5,500	$5,500	$5,500			1919	198
	Water Valve	1	$1,500	$1,500	$1,500			1920	251
								1921	202

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2.2 Linear Service Life

The user enters a unique service life for each material and diameter in each category in the Linear asset inventory. Up to 500assets may be entered. The category and material names must be exactly as they appear in the Linear asset inventory.

Note: Assets with unknown diameters are have been given a diameter of 5mm and are highlighted below.

Note: If only using Rehabilitation Cost A and Service Life A, ensure that BOTH Rehabilitation Cost B and Service Life B DO NOT have values in them. Failure to ensure this may lead to doubling or omittion of rehabilitaiton costs.

Linear Assets

Category	Material	Diameter (mm)	Service Life A (Years)	Service Life B (Years)	Category Name Check (number of characters)	Material Name Check (number of characters)
Pipe	Water Main	50	70	70	4	10
Pipe	Water Main	100	70	70	4	10
Pipe	Water Main	150	70	70	4	10
Pipe	Water Main	200	70	70	4	10
Pipe	Water Main	250	70	70	4	10
Pipe	Water Main	300	70	70	4	10
Pipe	Water Main	350	70	70	4	10
Pipe	Water Main	600	70	70	4	10
Pipe	Hydrant Lead	150	70	70	4	12
Service Connection	Curb Stop	25	50	50	18	9
Small Point	Hydrant	1	50	50	11	7
Small Point	Water Valve	1	65	65	11	11

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2.3 Linear Assets

Up to 100,000 Linear assets can be entered on this sheet. The service life, Factored Rehabilitation Date, Original Construction Cost, Construction Cost, and Factored Rehabilitation Cost are calculated for each asset based on information entered on Sheet 2.1 Linear Unit Costs, Sheet 2.2 Linear Service Life and the Dashboard. The category, material, and diameter of an asset MUST match one of the categories, materials, and diameters entered on Sheet 2.1 Linear Unit Costs and Sheet 2.2 Linear Service Life. The total Construction Cost for each category/material of Distribution asset (Linear assets with a diameter less than or equal to maximum diameter of a Distribution asset as set on the Setup sheet) is tabulated at the top of the page and sent to the Summary sheet where it is sorted and sent to the graphs on the Dashboard. Check 1 sums the total Construction Cost as summarized at the top of the page and Check 2 sums the Construction Cost column for all Distribution assets. The Original Construction Costs enables comparison with the Tangible Capital Asset (TCA) value. All costs, except Original Construction Costs, are in Base Year dollars. If an asset is removed using the Remove Asset column, the Factored Rehabilitation Date is zeroed and all formulas that reference the Linear asset inventory ignore costs associated with assets with a Factored Rehabilitation Date of zero.

Sheet 2.4 Point Assets references this sheet to calculate the total Construction Cost of Linear assets with diameters greater than the maximum diameter of a Distribution asset as set on the Setup sheet.

The Summary sheet:

1) References the Factored Rehabilitation Date column and Factored Rehabilitation Cost column for each asset and determines the total Rehabilitation Cost for each year of the modeling period.
2) Calculates the total Construction Cost of Distribution assets in the Base Year.
3) References the total Construction Cost of each asset for sorting purposes for the Dashboard pie charts.

Base Year Distribution/Collection Asset Construction Cost (Value)

Category/Material	Water Main	Curb Stop	Hydrant	Hydrant Lead	Water Valve					Construction Cost of Materials with Unknown Diameters	Check 1	Check 2
Total Construction Cost	$ 18,347,772	$ 3,617,231	$ 2,260,500	$ 324,061	$ 1,410,000	$ -	$ -	$ -	$ -		$ 25,959,563	$ 25,959,563
Category/Material												
Total Construction Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		

Adjusted PSAB 3150 Inventory of Linear Assets						Calculated Costs and Values						
GIS ID	Category	Material	Diameter (mm)	Quantity (#) OR Length (m)	Construction Date	Service Life A (Years)	Service Life B (Years)	Original Construction Cost	Construction Cost (Base Year $)	Rehabilitation Cost A (Base Year $)	Rehabilitation Cost B (Base Year $)	Remove Asset (Y/Blank)
1070	Small Point	Hydrant	1	1	1960	50	50	$515	$5,500	$5,500	$5,500	
1071	Small Point	Hydrant	1	1	1960	50	50	$515	$5,500	$5,500	$5,500	
1072	Small Point	Hydrant	1	1	1960	50	50	$515	$5,500	$5,500	$5,500	
1073	Small Point	Hydrant	1	1	1960	50	50	$515	$5,500	$5,500	$5,500	
1074	Small Point	Hydrant	1	1	1960	50	50	$515	$5,500	$5,500	$5,500	
1027	Small Point	Hydrant	1	1	1960	50	50	$515	$5,500	$5,500	$5,500	
1087	Small Point	Hydrant	1	1	1960	50	50	$515	$5,500	$5,500	$5,500	
1011	Small Point	Hydrant	1	1	1960	50	50	$515	$5,500	$5,500	$5,500	
1029	Small Point	Hydrant	1	1	1960	50	50	$515	$5,500	$5,500	$5,500	
1028	Small Point	Hydrant	1	1	1960	50	50	$515	$5,500	$5,500	$5,500	
1026	Small Point	Hydrant	1	1	1960	50	50	$515	$5,500	$5,500	$5,500	
1025	Small Point	Hydrant	1	1	1960	50	50	$515	$5,500	$5,500	$5,500	
1020	Small Point	Hydrant	1	1	1960	50	50	$515	$5,500	$5,500	$5,500	

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2.4 Major Point Assets

Up to 1,000 Point assets can be entered on this sheet and the Factored Rehabilitation Date, Original Construction Cost and the Factored Rehabilitation Cost are calculated. The Original Construction Costs enables comparison with the Tangible Capital Asset value. The total Construction Cost for each type of asset is tabulated at the top of the page and sent the Summary sheet where it is sorted and sent to the graphs on the Dashboard. Check 1 sums the total Construction Cost for the assets as summarized at the top of the page while Check 2 sums the Construction Cost column of all Point assets and Linear assets with a diameter greater than the maximum diameter of a Distribution asset as set on the Setup sheet. All costs, except Original Construction Costs, are in Base Year dollars. If an asset is removed using the Remove Asset column, the Factored Rehabilitation Date is zeroed and all formulas that reference the Linear asset inventory ignore costs associated with assets with a Factored Rehabilitation Date of zero.
The Summary sheet:

1) References the Factored Rehabilitation Date column and Factored Rehabilitation Cost colmn for each asset and determines the total Rehabilitation Cost for each year of the modeling period.
2) Calculates the total Construction Cost of Bulk Assets in the Base Year.

Note: If only using Rehabilitation Cost A and Service Life A, ensure that BOTH Rehabilitation Cost B and Service Life B DO NOT have values in them. Failure to ensure this may lead to doubling or omittion of rehabilitaiton costs.

Base Year Bulk Asset Construction Cost (Value)

Type	Well	Reservoir	Pumphouse	Control Building	Equipment	Tank	Other	Linear	Check 1	Check 2
Total Construction Cost	$544,166	$6,050,705	$2,187,743	$2,190,562	$180,238	$2,736	$1,333,939	$931,614	$15,221,703	$15,221,703
Type	Disinfection									
Total Construction Cost	$1,800,000	$0	$0	$0	$0	$0	$0			

Point Assets

GIS ID	Description	Type	Construction Date	Service Life A (Years)	Service Life B (Years)	Original Construction Cost	Construction Cost (Base Year $)	Rehabilitation Cost A (Base Year $)	Rehabilitation Cost B (Base Year $)	Remove Asset ("Y"/Blank)
100227	GALLON CAPACITY	Reservoir	1965	60	60	$ 35,090	$ 318,087	$ 318,087	$ 318,087	
100099	PUBLIC WORKS WATER WORKS STORAGE	Other	1965	40	40	$ 5,620	$ 50,945	$ 50,945	$ 50,945	
100228	NICOLA RESERVIOR CONTROL BUILDING	Control Building	1965	40	40	$ 2,140	$ 19,399	$ 19,399	$ 19,399	
100204	WELL	Well	1966	60	60	$ 1,320	$ 11,402	$ 11,402	$ 11,402	
100205	FAIRLY PARK PUMPHOUSE	Pumphouse	1966	50	50	$ 8,890	$ 76,791	$ 76,791	$ 76,791	
100230	WELL	Well	1970	60	60	$ 1,590	$ 10,134	$ 10,134	$ 10,134	
100231	MAY STREET PUMPHOUSE	Pumphouse	1970	50	50	$ 6,290	$ 40,090	$ 40,090	$ 40,090	
100168	WELL	Well	1971	60	60	$ 2,060	$ 11,469	$ 11,469	$ 11,469	
100169	VOGHT PARK PUMPHOUSE #1	Pumphouse	1971	50	50	$ 13,280	$ 73,935	$ 73,935	$ 73,935	
100222	GRIMMETT RESERVIOR, 1,000,000 GALLON CAPACITY	Reservoir	1975	60	60	$ 420,340	$ 1,672,619	$ 1,672,619	$ 1,672,619	
100223	GRIMMETT RESERVIOR CONTROL BUILDING	Control Building	1975	40	40	$ 5,110	$ 20,334	$ 20,334	$ 20,334	
100174	VOGHT PARK PUMPHOUSE #2	Pumphouse	1976	50	50	$ 38,000	$ 139,307	$ 139,307	$ 139,307	
100237	WELL	Well	1978	60	60	$ 3,520	$ 11,161	$ 11,161	$ 11,161	
100238	COLLETVILLE PUMPHOUSE	Pumphouse	1978	50	50	$ 26,010	$ 82,471	$ 82,471	$ 82,471	

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3.0 Investments

The user enters future asset investments. Calculations are then performed to determine the investment costs for each year in the modeling period. The total investment costs before and after external funding are sent to the Summary sheet to determine the Value of the Distribtion/Collection assets and the Value of the Bulk assets and the capital Investment Expenses, respectively, per year. All costs below are in Base Year dollars and up to 50 assets may be entered.

Future Asset Investments

Distribution/Collection Asset Investments

Description*	Construction Date	Cost Before Funding	External Funding	Cost After Funding
R-1 - Upgrade Existing Pipe, 100mm to 150mm. Length = 130 m	2028	$43,000	0%	$43,000
R-2 - Install new pipe, 150mm. Length = 95 m	2029	$31,000	0%	$31,000
R-3 - Install new pipe, 150mm. Length = 136 m	2030	$45,000	0%	$45,000
R-4 - Upgrade existing pipe, 150mm to 200mm. Length = 136 m	2024	$183,000	0%	$183,000
R-5 - Install new hydrant	2013	$4,000	0%	$4,000
R-6 - Install new pipe, 150mm. Length = 11 m	2013	$4,000	0%	$4,000
R-7 - Upgrade existing pipe, 100 mm to 150 mm. Length = 100 m	2023	$37,000	0%	$37,000
R-8 - Upgrade existing 150 mm pipe to 200 mm. Length = 93 m	2014	$45,000	0%	$45,000
R-9 - Install new 300 mm diameter pipe. Length = 340 m	2016	$223,000	0%	$223,000
R-10 - Install new pipe, 150 mm. Length = 295 m	2014	$105,000	0%	$105,000
R-12 - Upgrade 100 mm pipe to 150 mm. Length = 230 m.	2021	$75,000	0%	$75,000
R-13 - Upgrade 50 mm pipe 100 mm. Length = 6 m.	2013	$10,000	0%	$10,000
R-14 - Upgrade 150 mm pipe 250 mm. Length = 300 m.	2015	$168,000	0%	$168,000
R-15 - Upgrade 150 mm to 200 mm. Length = 87 m	2016	$38,000	0%	$38,000
R-16 - Install new 200 mm diameter pipe. Length = 430 m	2013	$188,000	0%	$188,000
R-17 - Upgrade 150 mm to 200 mm. Length = 215 m.	2014	$94,000	0%	$94,000
R-19 - Upgrade 100 mm dia to 150 mm. Length = 130 m	2021	$29,000	0%	$29,000
R-20 - Upgrade 50 mm dia to 150 mm. Length = 100 m	2013	$19,000	0%	$19,000
R-21 - Upgrade 50 mm dia to 150 mm. Length = 105 m	2013	$20,000	0%	$20,000
R-22 - Upgrade 50 mm dia to 100 mm. Length = 120 m	2017	$25,000	0%	$25,000
Hydrant Infill Program	2017	$135,000	0%	$135,000
Hydrant Infill Risk Evalation and Priorization	2013	$15,000	0%	$15,000
Asset Invenstory Database Update	2015	$65,000	0%	$65,000
Pressure Zone Feasibility Study	2014	$30,000	0%	$30,000
				$0
				$0
2011 Assets from Asset Database				$0
2485 Merritt Avenue 25mm Service	2011	$1,500	0%	$1,500
2485 Merritt Avenue Hydrant	2011	$4,500	0%	$4,500
2485 Merritt Avenue (Well) - Water Valve	2011	$3,000	0%	$3,000
2485 Merritt Avenue (Well) - Water Valve	2011	$500	0%	$500
2485 Merritt Avenue - Watermain - 600 mm. Length = 120 m	2011	$116,026	0%	$116,026
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0
				$0

Bulk Asset Investments

Description*	Construction Date	Cost Before Funding	External Funding	Cost After Funding
Primary Disinfection Upgrade on Shallow Wells (UV System)	2019	$1,800,000	0%	$1,800,000
PRV between the Active Mountain Reservior and the Collettville	2022	$125,000	0%	$125,000
Fairly Park Generator	2017	$160,000	0%	$160,000
Reservoir Control Valves	2015	$125,000	0%	$125,000
UV Water Quality Monitoring Study/UVT Analyzers	2013	$25,000	0%	$25,000
UV Disinfection Concept Study/Preliminary Design	2014	$50,000	0%	$50,000
				$0
Southeast Reservoir	2011	$2,000,000	0%	$2,000,000
				$0
				$0
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4.0 Finances

Selected Historical Revenues and Expenses for the utility are entered here (note that Revenues are entered as negative (-) and Expenses are entered as positive (+) values. The values assigned to the Base Year should be adjusted by the user to best reflect the normal situation as they are used to project future Revenues and Expenses. The Base Year values can then be allocated to the Distribution/Collection account and the Bulk account (both Demand and Value dependent).

The account information at the top of this sheet provides the necessary information to allow the Water/Sewer Utility Financial Model to achieve the Goals. The difference between the Revenues at end of Rate Change Period and Revenues at start of Rate Change Period drive the Rates, for the Rate Change Period, such that the Goal in the End Year is achieved. Information from this sheet is also sent to the Summary sheet and the Dashboard. The **brown text** is updated automatically by the Water/Sewer Utility Model while the Model solves for Goal in the End Year.

Checks are also performed here to ensure model is operating correctly. Check 1 is the Revenue as calculated on the Summary sheet at the end of the Rate Change Period; this value should always equal the Revenues at end of Rate Change Period. Check 2 is the Revenue in the End Year as calculated on the Summary sheet and should equal the Revenue at the end of the Rate Change Period when the population and parcel growth rates are set to zero on the Dashboard.

Account Information	Revenues at Start of Rate Change Period	Revenues at End of Rate Change Period	Check 1	Check 2
Distribution/Collection	-$551,753	-$1,654,756	-$1,654,756	-$1,654,756
Bulk	-$1,229,989	-$507,660	-$507,660	-$507,660
Total	-$1,781,742	-$2,162,416	-$2,162,416	-$2,162,416

Utility Account Information	
Base Year Utility Account Balance	-$408,431
% Assigned to Distribution/Collection Account	80%
Total Construction Cost - Asset Register (Not Required)	
Total Construction Cost - Model	$41,181,267
Total Construction Cost of Assets with Unknown Diameters	$0
Reported Tangible Capital Assets (Not Required)	$12,402,847
Total Original Construction Cost	$16,579,155

	Historical*				Base Year	Percent Allocation			
Revenues	2006	2007	2008	2009	2010	% to Distribution /Collection Account			% to Bulk Account
Revenues	$0	-$851,808	-$830,548	-$1,200,669	-$1,714,140				
Parcel Tax	$0	-$245,387	-$258,170	-$300,573	-$446,060	100%			0%
Sales of Services User Charges	$0	-$469,369	-$531,178	-$850,699	-$1,183,393	0%			100%
Return on Investments	$0	$0	$0	$0	$0	0%			0%
Other Revenue from Own Sources	$0	-$137,053	-$41,201	-$49,397	-$84,687	80%			20%
Rehabilitation Revenues	$0	$0	$0	$0	$0				
									0%
									0%
									0%
Total Revenues	$0	-$851,808	-$830,548	-$1,200,669	-$1,714,140	-$513,809			-$1,200,331
Expenses	2006	2007	2008	2009	2010	% to Value Dependent Distribution/Collection Account	% to Demand Dependent Distribution/Collection Account	% to Value Dependent Bulk Account	% to Demand Dependent Bulk Account
Administration	$0	$124,252	$144,716	$100,619	$107,148				
Administration minus Consultant Studies and amoritization expenses	$0	$54,252	$74,716	$30,619	$37,148	80%		20%	
Long Term Consultant Studies	$0	$70,000	$70,000	$70,000	$70,000	80%		20%	
								0%	
								0%	
								0%	
								0%	
Operation	$0	$246,296	$97,271	$94,815	$223,097				
Water Sampling	$0	$22,114	$18,177	$13,299	$16,641	0%		100%	
Supply and Distribution	$0	$169,729	$35,593	$58,708	$54,392	80%		20%	
Water Conservation	$0	$30,792	$30,914	$21,315	$14,816	100%		0%	
Meter Maintenance	$0	$23,660	$12,588	$1,493	$5,248	100%		0%	
Additonal to increase 2010 to average for 4 years					$132,000	80%		20%	
								0%	
Maintenance	$0	$145,135	$192,339	$159,397	$74,323				
Coldwater Gauge	$0	$8,200	$8,200	$5,000	$0	50%		50%	
Water Cross Connection Control	$0	$43,691	$47,125	$41,934	$12,575	100%		0%	
Valve Exercising	$0	$0	$0	$0	$0	100%		0%	
Hydrant Maintenance	$0	$24,826	$24,828	$22,365	$14,867	100%		0%	
Utility Mapping	$0	$22,321	$20,142	$10,680	$8,269	100%		0%	
Service Connection Maintenance	$0	$46,097	$92,044	$79,418	$38,611	100%		0%	
Purchase/Treatment	$0	$0	$0	$0	$0				
							25%		75%
Consumables	$0	$169,840	$120,821	$103,549	$117,160				
Wells and High Lift Pump Station	$0	$158,411	$115,659	$100,200	$112,175		25%		75%

Reservoirs	$0	$11,428	$5,161	$3,348	$4,985		25%		75%
							25%		75%
							25%		75%
Rehabilitation	$0	$0	$0	$0	$0	**% to Distribution /Collection Account**			**% to Bulk Account**
									0%
									0%
Total Expenses	**$0**	**$685,522**	**$555,147**	**$458,379**	**$521,728**	**$329,219**	**$29,290**	**$75,349**	**$87,870**

Long Term Debt	**Bylaw Number**	**Balance at End of Base Year**	**Current Rate per Annum (%)**	**Final Payment Due (MM/DD/YYYY)**	**% to Distribution/ Collection Account**	**% to Bulk Account**		**Base Year**	**Future Projection -->**
Purpose								**2010**	**2011**
							Total Principle Payments		**$194,882**
							Total Annual Interest Payment		**$178,091**
NE Sector Water	1520	$126,218.09	3.00%	1-Jun-16	0%	100%	Principle Payment		$19,513
							Annual Interest Payment		$3,787
							End of Year Balance	**$126,218.09**	**$106,705**
Collettvile Water	1609	$71,745.47	4.82%	5-Nov-12	0%	100%	Principle Payment		$35,029
							Annual Interest Payment		$3,458
							End of Year Balance	**$71,745.47**	**$36,717**
Grandview Heights Reservoir	1973	$420,730.47	4.82%	1-Dec-27	0%	100%	Principle Payment		$16,539
							Annual Interest Payment		$20,279
							End of Year Balance	**$420,730.47**	**$404,191**
Active Mountain Reservoir	1986	$1,074,205.46	4.82%	1-Dec-27	0%	100%	Principle Payment		$42,228
							Annual Interest Payment		$51,777
							End of Year Balance	**$1,074,205.46**	**$1,031,978**
Kingaard Well	1993	$1,094,504.54	4.65%	23-Apr-28	0%	100%	Principle Payment		$40,193
							Annual Interest Payment		$50,894
							End of Year Balance	**$1,094,504.54**	**$1,054,311**
Deep Aquifer Well	1993	$1,159,701.90	4.13%	13-Oct-29	0%	100%	Principle Payment		$41,380
							Annual Interest Payment		$47,896
							End of Year Balance	**$1,159,701.90**	**$1,118,322**
					0%	0%	Principle Payment		$0
							Annual Interest Payment		$0
							End of Year Balance	**$0.00**	**$0**