Appendix H
TM #4B – Distribution System Upgrades – Water Modelling

KERR WOOD LEIDAL
consulting engineers

Vancouver Island
201 - 3045 Douglas Street
Victoria, BC V8T 4N2
T 250 595 4223
F 250 595 4224

Technical Memorandum

REVISION 1

DATE: June 2, 2014

TO: Umar Alfaruq, CH2M Hill

CC: Mike Squire, Englishman River Water Service

FROM: Eric Morris, Kerr Wood Leidal Associates
Rose Sinnott, Kerr Wood Leidal Associates

RE: **ERWS WATER INTAKE, TREATMENT PLANT AND SUPPLY MAINS**
TM#4B: Distribution System Upgrades- Water Modelling
Our File 468.010-300

1. Introduction

1.1 Scope

This memorandum (TM#4B) forms part of the deliverables for the design of the Englishman River Water Service (ERWS) Water Intake, Treatment Plant and Supplymains Project. The purpose of the memorandum is to outline the required water system upgrades to integrate the water treatment plant.

The scope of work focusses on the **transmission system** (sizing typically governed by maximum day demands) and does not include an analysis of smaller diameter water mains in the **distribution system** (sizing typically governed by fire flow).

The following items are described in this memorandum;

- Water model build for existing system;
- Water model build for future system;
- Modelling scenarios;
- Water model results for existing and future scenarios;
- Required upgrades and phasing;
- Capital cost estimate.

The demands used for the modelling are summarized in Technical Memorandum TM#4A- Distribution System Upgrades- Demands.

1.2 Abbreviations

ASR	Aquifer Storage and Recovery
BD	Base Demand (Typical Indoor Winter Water Usage)
ca	Capita (Person)
COM	Commercial
CoP	City of Parksville

EPS	Extended Period Simulation
FUS	Fire Underwriters Survey
GD	Geodetic Datum
ha	Hectare
HGL	Hydraulic Grade Line
HP	Horsepower
ICI	Industrial, Commercial and Institutional
IND	Industrial
INST	Institutional
KWL	Kerr Wood Leidal Associates Ltd.
MDD	Maximum Day Demand
MF	Multi Family
MMCD	Master Municipal Construction Documents
NBP	Nanoose Bay Peninsula
PE	Population Equivalent
PHD	Peak Hour Demand
PRV	Pressure Reducing Valve
PRS	Pressure Reducing Station
RDN	Regional District of Nanaimo
RES	Residential
SCADA	Supervisory Control and Data Acquisition
SD	Seasonal Demand (Irrigation Demand on MDD; BD+SD = MDD
SF	Single Family
TWL	Top Water Level
UFW	Unaccounted for Water
VFD	Variable Frequency Drive
WSA	Water Service Area

2. Water Model Build for Existing System

2.1 Introduction

The water distribution system which will be supplied by the water treatment plant is comprised of two historically separate systems:

- the City of Parksville system which is owned and operated by the CoP; and
- the Nanoose Bay Peninsula Water Service Area which is owned and operated by the RDN.

Since 2007 the two water systems have been connected by the Craig Bay Pump Station which pumps from the CoP System to the NBP WSA.

The water model was built using the following sources of data:

City of Parksville System

- GIS shapefiles (watermains.shp – Parksville)- source of water main data;
- 2004 WaterCAD model of Parksville system (pv2004.wtg)- source of majority of facilities data, operational controls and setpoints;
- Springwood Complex schematic (Springwood Complex.pdf) - used to model the Springwood Complex;

- City of Parksville 2012 Annual Water Report- used for background information and well capacities; and
- LiDAR elevation data file from the City of Parksville (flown April 22, 2010)- used to determine elevations where data was lacking from the GIS or water model.

Nanoose Bay Peninsula WSA

- GIS shapefiles (WaterUtility_Lines.shp)- source of water main data;
- 2006 WaterCAD model of Nanoose Bay Peninsula (RDN_2006.wtg)- source of water main, facilities data, and elevation information;
- 60 HP pump curve (Grundfos CR 90-4-1)for the pump at Craig Bay Pump Station;
- Dolphin Drive PRV Chamber and Dolphin Reservoir Altitude Valve Chamber Drawings (Koers & Associates Drawing No. 1028-02, 1028-03, and 0814-01);
- Beachcomber Reservoir Tie-In Details Drawing (Koers & Associates Drawing No. 0934-02);
- Regional District of Nanaimo Water Service Area 2012 Annual Report, Nanoose Bay Peninsula Water System- used for background information; and
- Average well capacity data for RDN wells from weekly pump data (Weekly Pump Data.xlsx for 07-Nov-2013) supplemented with updated well capacity data from Mr. Mike Donnelly of the RDN received on May 29, 2014.

The water model was built using Bentley WaterCAD software. The pipe network was imported from GIS shapefiles and was checked for connectivity. Edits made to the pipe network were documented in a shapefile and were provided to CoP and RDN for review.

The CoP and NBP water systems are described in detail below.

2.2 Existing Parksville Water System

The Parksville water transmission system is shown on Figure 1 (highlighted water mains) and a schematic of the system is shown in Figure 2. Water system facilities included in the model are described below.

Pressure Zones

The CoP distribution system has two pressure zones:

- the Low Zone with a nominal HGL of 74 m which encompasses the bulk of the distribution system with pressure set by Reservoirs 3, 4 and 5; and
- the smaller High Zone at the western end of the system which has a nominal HGL of 108 m is supplied by the Springwood Pump Station and has no dedicated gravity storage.

Water Mains

Water mains were assigned actual inside diameters and roughness coefficients based on material type and nominal diameters, according to the table included in Appendix A.

Ground Water Wells

There are 16 active ground water wells in the CoP water system including 8 wells at the Springwood Well Complex and 8 wells at the Railway Well Complex. The capacity of each well is described in the Table B-1 included in Appendix B. The well fields were combined and modelled as a single reservoir with an elevation set at the nominal HGL of the low zone and a flow control valve limiting the well output to the total combined capacity (86.9 L/s).

The Springwood Well Complex includes Reservoirs #1 and #2 and the Springwood Pump Station which are part of the water treatment system – providing a means to achieve the required contact time for chlorine disinfection; these reservoirs and pump station were not included in the water model because they are not directly part of the transmission system.

River Intakes

There are two water intake pumps on the Englishman River. The intakes are used May to October to provide water to meet demands in the summer. The licensed capacity is 12.2 MLD (141 L/s). The operational settings of the intakes are described in Table B-2 included in Appendix B.

Reservoirs

The CoP water system has three water storage reservoirs in the transmission system. Reservoir #4 is located in the Springwood Water Complex on Despard Road. Reservoirs #3 and #5 are located in the Top Bridge Park area on the east side of the water system.

Reservoirs #3, #4 and #5 provide fire, emergency, and balancing storage for the Low Pressure Zone. There are no reservoirs providing storage for the High Pressure Zone.

Table B-3 in Appendix B summarizes the dimensions of the water storage reservoirs.

Pump Stations

There are two water pump stations in the CoP water transmission system.

- Springwood Booster Pump Station - pumps water directly to the High Pressure Zone; and
- River Intake Pump Station - pumps water from the surface water treatment system to the Low Pressure Zone.

Data and operational settings for each station are summarized in Table B-4 in Appendix B.

Pressure Reducing Valve Stations

There is one PRV station in the CoP system, located on Pym Street North at Doehle Avenue. The valve supplies water from the High Pressure Zone to the Low Pressure Zone at peak hour and for local fireflows. PRV station data is summarized in Table B-5 included in Appendix B.

2.3 Existing Nanoose Bay Peninsula Water System

The Nanoose Bay Peninsula (NBP) water transmission system is shown on Figure 1 (highlighted water mains) and a schematic of the system is shown in Figure 3; the water system facilities included in the model are described below.

Pressure Zones

The NBP water system has seven pressure zones ranging from 170 m HGL on Notch Hill to 60 m HGL in the lowest areas. Most of the pressures zones have storage reservoirs except for Andover (84 m HGL), Gary Oak (90 m HGL), and West Bay (90 m HGL) which are supplied with water via PRV stations (from higher zones with water storage).

Water Mains

Water mains were assigned actual inside diameters and roughness coefficients based on material type and nominal diameters, according to the table included in Appendix A.

Ground Water Wells

There are 7 ground water wells in the NBP water system. The capacity of each well is described in Table C-1 included in Appendix C. The wells were modelled as reservoirs with elevations set to the values listed in Table C-1 and a flow control valve limiting the well output to an appropriate value.

The long term well capacity in the RDN has been assumed to be 70% of the existing capacity as directed by RDN staff.

Note that wells supplying the 125 m pressure zone (Fairwinds, West Bay, and Wallbrook are assumed to be able to pump to 160 m HGL to enable them to fill the Fairwinds Reservoirs.

Bulk Water Supply from Parksville

The water supply to NBP is supplemented seasonally with water from the CoP water system via the Craig Bay Pump Station.

Reservoirs

The NBP water system has seven water storage reservoirs. Table C-2 included in Appendix C summarizes the dimensions of the water storage reservoirs.

Pump Stations

There are two booster pump stations in the NBP water system

- Craig Bay Pump Station – pumps water from the CoP System to the NBP WSA (located on Northwest Bay Road, east of Langara Place).
- Arbutus Pump Station - pumps water from the Fairwinds 125 m pressure zone to the Arbutus 170 m pressure zone (located on Fairwinds Drive at Anchor Drive).

The characteristics and operational settings of the pump stations are described in Table C-2 included in Appendix C.

Pressure Reducing Valve Stations

There are 10 PRV stations in the NBP system. The location and description of the stations are described in Table C-4 included in Appendix C. The settings of the PRVs on Dolphin Drive and Claudette Road have been adjusted to 73.0 m in accordance with 2014 proposed operational changes[1] in the Nanoose

[1] Email from Chris Downey (Koers & Associates Engineering Ltd.),February 18, 2014 and Dave Welz (Regional District of Nanaimo), May 29, 2014

Zone. It should be noted that these settings raise the zone pressure higher than the top of the Dolphin and Eagle Heights Reservoirs.

2.4 Model Validation

Model validation and calibration has not been completed as part of the transmission system analysis. Hydrant flow tests and model validation will be included as part of the distribution system analysis.

3. Water Model Build for Future System

The initial water model build for the future systems are the same as for the existing system with the following exceptions:

- The new water treatment plant, modelled as a reservoir with a discharge HGL of 79 m, is added to the model at the City of Parksville Public Works Yard and is connected to the transmission system;
- The existing Parksville surface water intake and pump station on the Englishman River is taken out for service;
- The Beachcomber Reservoir in the RDN Nanoose system is taken out of service due to the condition of the roof structure (Mr. Mike Donnelly Personal Communication, December 11, 2013);

4. Demands and Water Treatment Plant Sizing

4.1 Demands

The existing and projected water demands for Parksville and Nanoose Bay Peninsula WSA are summarized in Table 1 below. Detailed information on the derivation of these demands is provided in Technical Memorandum TM#4A- Distribution System Upgrades- Demands. Appendix D includes the demands broken down by pressure zone.

Safety factors of 1.25 and 1.15 were applied to the demands for the City of Parksville and NBP WSA respectively for the purpose of sizing infrastructure and upgrades. This factor of safety accounts for uncertainties in potential climate change and its effects on irrigation, future growth and population predictions, and changes in existing water use. The safety factors for each service area were developed in consultation with the CoP and RDN are based on their confidence in growth projections, historical precedents in safety factors used for water system sizing and general tolerance for risk.

Table 1: ERWS – Water Demands

Forecast Year	Population (ca)	Un-factored Demands				Factored Demands			
		BD		MDD		BD		MDD	
		MLD	L/s	MLD	L/s	MLD	L/s	MLD	L/s
2013 (Existing)	17,550	4.5	52.1	22.9	265	5.5	63.6	28.0	324
2018	19,033	4.9	56.7	24.1	279	5.9	68.3	29.5	314
2035	24,290	6.1	70.6	27.8	322	7.4	85.6	33.9	392
2050	29,348	7.3	84.5	31.3	362	8.9	103	38.1	441
2050 (high growth scenario)	35,818	9.0	104.1	36.2	419	11.0	127	44.2	511

It should be noted that the 2013 unfactored MDD of 22.9 MLD exceeds the supply capacity of the combined Parksville and Nanoose Bay Peninsula WSA systems (surface water plus ground water based on licenced ground water supply capacity) of 22.5 MLD (NBP at 100% of existing capacity) indicating that supply challenges would occur if a hot summer with high seasonal demands occurred with the current population.

4.2 Water Treatment Plant Sizing

The proposed water treatment plant is to be constructed in or adjacent to the City of Parksville Public Works Yard by 2016. This treatment plant will be fed from the Englishman River and will replace the existing intake on the Englishman River close to Highway 19A.

After the construction of the treatment plant, the combined CoP and NBP WSA systems will be supplied by the water treatment plant, ground water wells and potentially ASR wells. For the purposes of sizing the water treatment plant, the existing well capacity for the CoP system is assumed to be maintained through 2050 (i.e. no net change in well capacity or ASR contribution), and the well capacity of the NBP WSA system will be 70% of the existing capacity. As ASR sizing, feasibility and location is ongoing, initial sizing assumes that the ASR wells do not supply any capacity under design MDD/PHD scenarios. Further, it is assumed that there is sufficient balancing storage in the combined CoP and NBP WSA systems such that the water treatment plant can be sized for the factored MDD less the existing well capacity. The required water treatment plant capacity, based on factored demands at each demand horizon is summarized in Table 2.

Table 2: Required Water Treatment Plant Capacity

Forecast Year	Factored MDD		Ground Water Well Capacity[1]		Required Firm Treatment Plant Capacity (MLD)	
	MLD	L/s	MLD	L/s	MLD	L/s
2013 (Existing)	28.0	324	9.5	110	18.5	214
2018	29.5	314	9.5	110	20.0	231
2035	33.9	392	9.5	110	24.4	282
2050	38.1	441	9.5	110	28.6	331
2050 (high growth scenario)	44.2	511	9.5	110	34.7	402

Notes:
1) NBP wells at long term capacity (70% of existing capacity).

5. Design Criteria

Design criteria provided by ERWS to be used for transmission system evaluation is summarized in the sections below. The ERWS criteria have been supplemented with criteria from the Master Municipal Construction Document (MMCD) Design Guideline Manual[2] as required.

Required Fire Flows

The required fire flow is based on land use type and is summarized in Table 3. The fire storage required for each pressure zone is calculated based on the governing ICI land use, summarized in Table 4. CoP

[2] Master Municipal Construction Documents Association, Design Guideline Manual, 2005.

provided required fire flows (based on Fire Underwriter's Survey) to be used to evaluate the transmission system in Parksville[3]. The required fire flow for NBP was developed though discussions with Koers & Associates[4] and verified with RDN staff[5].

Table 3: Minimum Required Fire Flows by Land Use Type

Land Use Type	Required Fire Flow (L/s)	Duration (hr)	Storage Volume (ML)
Single Family Residential (CoP)	75	1.625	0.44
Multi Family Residential	150	2	1.08
Comprehensive Development	90	1.85	0.60
Downtown Commercial	250	3.25	2.93
Resort / Recreational	250	3.25	2.93
Institutional	250	3.25	2.93
Industrial	200	2.5	1.80
Rural	75[1]	1.625	0.44
Single Family Residential (NBP)	60	1.4	0.30
Institutional, Commercial, Industrial (NBP)	150	2	1.08

Notes:
1) Where fire hydrant protection is available.

[3] Email from Mike Squire – August 21, 2013.

[4] Email from Chis Downey (Koers & Associates Engineering Ltd .)– February 11, 2014.

[5] Email from Mike Donnelly – February 12, 2014.

Table 4: Governing Land Use and Fire Flow Requirements by Pressure Zone

Pressure Zone	Existing		Future 2050	
	Governing Land Use	Required Fire Flow (L/s)	Governing Land Use	Required Fire Flow (L/s)
CoP Low Zone	Downtown Commercial	250	Downtown Commercial	250
CoP High Zone	Downtown Commercial	250	Downtown Commercial	250
NBP Madrona	Single Family Residential	60	Single Family Residential	60
NBP Nanoose	Marina	150	Mixed Use, Marina	150
NBP Andover	Golf course	60	Golf course	60
NBP Garry Oak	Oyster Farm	60	Oyster Farm	60
NBP West Bay	School, Community Hall, Grocery	150	School, Community Hall, Mixed Retail	150
NBP Fairwinds	Fairwinds Centre	150	Mixed Use, School	150
NBP Supply	Single Family Residential	60	Single Family Residential	60
NBP Arbutus	Single Family Residential	60	Mixed Use	150

System Pressure

Desired minimum pressures from the MMCD Design Criteria Guideline are outlined in Table 5 below.

Table 5: Desired Minimum Pressures

Design Case Description	Desired Minimum Pressure
Peak Hour Demand (PHD)	300 kPa / 44 psi
Fire Flow plus Maximum Day Demand	150 kPa / 22 psi

6. Modelling Results and Required Upgrades

6.1 Scenarios

The existing and future water models have been run using extended period simulation (to model peak hour demands and reservoir levels) and maximum day demand plus fire flow scenarios for various planning horizons. Existing and year 2050 horizons are modelled to determine existing deficiencies and ultimate upgrade requirements along with year 2035 and year 2018 scenarios to determine construction phasing. For the year 2018 scenario, model runs are conducted with and without Aquifer Storage and

Recovery (ASR) to determine the changes in the ultimate upgrading requirements. The modelled scenarios are summarized in Table 6.

Table 6: Summary of Modelled Scenarios

Scenario #	Scenario Name	Model	Demands	Water Sources
1	Existing Peak Hour Demand (PHD)	Existing	Unfactored Existing EPS	Wells River Intake
2	Existing Maximum Day Demand (MDD)+ Fire Flow (FF)	Existing	Unfactored Existing MDD	Wells River Intake
3	2050 PHD	Future	Factored 2050 EPS- High Growth	Wells WTP
4	2050 MDD + FF	Future	Factored 2050 MDD- High Growth	Wells WTP
5	2035 PHD	Future	Unfactored 2035 EPS	Wells WTP
6	2035 MDD + FF	Future	Unfactored 2035 MDD	Wells WTP
7	2018 PHD	Future	Unfactored 2018 EPS	Wells WTP
8	2018 MDD + FF	Future	Unfactored 2018 MDD	Wells WTP
9	2018 PHD- with ASR	Future	Unfactored 2018 EPS	Wells WTP ASR at Nanoose Well Site

6.2 Existing Peak Hour and Fire Flow (Scenarios 1 and 2)

A 72 hour extended period simulation was conducted for the existing water system with 2013 unfactored demands to determine the baseline performance of the existing system. This simulation consists of 3 consecutive days of maximum day demand and is therefore somewhat conservative.

Model results for peak hour demand are presented in Figure 4. The existing transmission and distribution system performs well, with acceptable peak hour pressures in most areas with the following exceptions:

- CoP Low Zone, at the south end on Despard Ave., Alberni Highway and Bernard Ave. and along the western side at the boundary with the High Zone;
- NBP WSA West Bay Zone, on Schira Dr. Weston Pl., and Nanoose Rd.;
- NBP WSA Nanoose Zone, on Davenham Rd. around the Eagle Heights Reservoir;
- NBP WSA Nanoose Zone, on Swallow and Harlequin Cres.;
- NBP WSA Nanoose Zone, on Sea Otter Pl. and Eagle Ridge Pl.;
- NBP WSA Supply Zone, on the suction side of the Arbutus Pump Station;
- NBP WSA Fairwinds Zone on Simmons Pl.; and
- NBP WSA Fairwinds Zone, on Bonnington Dr.

Many of the reservoirs are empty or are less than 10% full after 3 consecutive days of maximum day demand. This is mainly the result of the demand exceeding the supply capacity (rather than transmission system inadequacies).

A fire flow simulation was conducted for the existing water system with 2013 unfactored demands. Only the transmission system (highlighted on Figure 1) was evaluated using the required fire flow criteria from Table 4 for the various pressure zones. There are fire flow deficiencies in the following areas:

- CoP High Zone;
- CoP Low Zone, western border; and
- Fairwinds Zone.

6.3 Future Peak Hour and Fire Flow (Scenarios 3 through 8)

72 hour extended period and fire flow simulations were conducted for the future transmission system with *factored* 2050 demands for the high growth scenario, and *unfactored* demands for the 2035 and 2018 phasing scenarios.

As previously mentioned, upgrade requirements have been determined for the transmission system only. The upgrades recommended to maintain adequate system performance are shown on Figure 5. The upgrades are colour coded according to their required phasing.

The earliest phasing horizon is 2018. The demands in 2018 are 5% higher than the demands in 2013; therefore the projects that are required in 2018 are effectively required immediately. However, not all of the 2018 projects are required for the water treatment plant to function: i.e. if they are not constructed, the water system will continue to perform with the same performance it has currently. In order to identify projects that must be constructed with the water treatment plant, a “2016” time horizon has been added to the phasing.

Transmission Main Upgrades

Transmission main upgrades are listed in Table 7. This table provides the length, diameter, location and required phasing for each upgrade. Also provided is the reason for the upgrade (peak hour demand, fire flow, etc.) and whether it is a new water main (i.e. new alignment) or replacement of an existing water main.

Table 7: Water Main Upgrades

Task No.	Length (m)	Dia-meter (mm)	Location	Required For[1]	Phasing (year required)	Replace / New
W1	4,850	600	WTP to Springwood Reservoir #4, via Martindale Rd, private property and the E&N ROW. New ROW required.	WTP Tie-in, Supply Redundancy, PH	2016	New
W2	1,110	400	WTP to Industrial Reservoirs via the E&N ROW and Top Bridge Park. New ROW required.	WTP Tie-in, PH	2016	New
W4	460	400	NBP Supply Pump Station on Industrial Way to NW Bay Rd via Island Hwy E (including existing highway crossing).	PH	2018	New
W6	2,520	300	NW Bay Rd to Anchor Way via. private property, Harold Rd, Transtide Dr and Florence Dr. New ROW required.	PH	2035	New
W8	2,240	300	Schooner Cove Drive Loop water main.	FF	2035	New
W11	160	250	High Zone Loop, Ackeman Rd to Stanhope Rd. Scheduled to be completed as part of a DCC project in 2014.	FF	N/A	New
W12	220	350	ROW between Lodgepole Dr and Chestnut St.	FF	2050	Replace
W13	240	400	Springwood Booster Station to Chestnut St.	FF	2050	Replace

Notes:
1.) FF = Fire Flow, PH = Peak Hour

Task W1 is a second crossing of the Englishman River; the existing crossing is at a bridge at Highway 19A. This upgrade is required in 2016 to provide adequate pressures in the west side of Parksville and is also recommended for construction to provide a redundant supply across the river. An alternate solution would be to shorten the transmission main by approximately 1 km by connecting to the distribution system at Corfield Street. However, the transmission main task recommended connects directly to Springwood Reservoir to improve water quality and facilitate the operation of the system.

Reservoir Upgrades

Reservoir upgrades will be required to provide adequate balancing, fire and emergency storage. The balancing storage requirement is calculated as 25% of the zone MDD. The fire storage required for each pressure zone calculated based on the governing land use which is summarized in Table 4. The emergency storage is calculated as 25% of the sum of the balancing storage and fire storage requirements. The total storage requirements for factored 2050 high growth demands for each service area is summarized in Table 8.

The Parksville High zone fire flow requirement is supplied from the Low zone via a fire pump. The Madrona, Fairwinds, Andover, West Bay and Nanoose zones are supplied with fire flows from the Fairwinds Reservoirs. The Arbutus zone is supplied with fire flows from the Fairwinds Reservoirs via a fire pump.

Table 8: Reservoir Upgrades for Factored 2050 High Growth Demands by Fire Flow Service Area

<table>
<tr><th rowspan="2">Reservoir</th><th rowspan="2">Existing Volume (ML)</th><th colspan="4">Required Storage (ML)</th><th rowspan="2">Deficiency (ML)</th></tr>
<tr><th>Balancing</th><th>Fire</th><th>Emergency</th><th>Total</th></tr>
<tr><td colspan="6">CoP Low Zone, CoP High Zone</td><td></td></tr>
<tr><td>Industrial 3</td><td>0.7</td><td rowspan="4">8.0</td><td rowspan="4">2.9</td><td rowspan="4">2.7</td><td rowspan="4">13.6</td><td rowspan="4">4.1</td></tr>
<tr><td>Springwood 4</td><td>4.5</td></tr>
<tr><td>Reservoir 5</td><td>4.3</td></tr>
<tr><td>Total</td><td>9.5</td></tr>
<tr><td colspan="6">NBP Fairwinds, NBP Madrona, NBP Andover, NBP West Bay, NBP Nanoose, NBP Arbutus</td><td></td></tr>
<tr><td>Fairwinds 1</td><td>0.9</td><td rowspan="8">3.0</td><td rowspan="8">1.1</td><td rowspan="8">1.0</td><td rowspan="8">5.1</td><td rowspan="8">1.0</td></tr>
<tr><td>Fairwinds 2</td><td>0.9</td></tr>
<tr><td>Beachcomber</td><td>Not in Service</td></tr>
<tr><td>Madrona</td><td>0.5</td></tr>
<tr><td>Eagle Heights</td><td>0.7</td></tr>
<tr><td>Dolphin</td><td>0.5</td></tr>
<tr><td>Arbutus</td><td>0.6</td></tr>
<tr><td>Total</td><td>4.1</td></tr>
</table>

Based on the foregoing, the recommended reservoir upgrades are summarized in Table 9.

It is noted that the upgrade to the Fairwinds Reservoirs ***(Task R2)*** in 2018 is primarily driven by fire flow requirements. Sizing of this reservoir should be reviewed based on detailed local fire flow calculations.

Table 9: Reservoir Upgrades

Task No.	Task Name	Serves Zones	Required For	Volume (ML)	Phasing (year required)
R1	Springwood Reservoir Upgrade	CoP Low Zone, CoP High Zone	Balancing, fire and emergency storage	4.1	2035
R2	Fairwinds Reservoir Upgrade	Fairwinds, Madrona. Nanoose, West Bay, Andover, Garry Oak, Arbutus (via fire pump)	Balancing, fire and emergency storage	1.0	2018

Pump Station Upgrades

The recommended pump station upgrades are summarized in Table 10.

Table 10: Pump Station Upgrades

Task No.	Task Name	Installed Power (kW)	Phasing (year required)
P0	Pump station in water treatment plant	N/A[1]	2016 - 2050
P1	New NBP Supply Pump Station	270	2018
P3	Springwood Booster Station fire pump upgrade	160	2018
P4	Arbutus fire pump upgrade	100	2050
P5	Decommission Existing Craig Bay Pump Station	N/A	2018

Notes:
1) Treated water booster pump station sizing is discussed in the water treatment plant pre-design report.

Task P0 is the booster pump station in the water treatment plant that pumps from the clearwell to the Parksville 74 m low zone. The particulars of this pump station are not discussed in this report since they are covered in the water treatment plant pre-design report.

Task P1 and the accompanying ***Task P5*** is the decommissioning of the existing Craig Bay Pump Station and the construction of a new pump station (and associated water main ***Task W4***) close to the existing station at the eastern end of Industrial Way. KWL has been informed that the Northwest Bay Road supply main can operate at a hydraulic grade of 160 m GD[6] (215 psi at elevation 8 m), and therefore a single pump station can deliver the required flow from the proposed NBP Supply Pump Station site to the Fairwinds Reservoirs.

In addition to capacity limitations, the existing Craig Bay Pump Station only has a single duty pump (there is a 20 hp jockey pump), and is a critical supply source for the NBP (roughly 60% of the supply capacity). Given the station's critical role, it is recommended that it be replaced with a duplex (or triplex) station with a redundant pump as a high priority project.

Two pump station upgrades are also required to provide adequate fire protection to the CoP High Zone ***(Task P3)*** and Arbutus Zone ***(Task P4)***. The CoP High zone (Springwood) fire pump upgrade is required in 2018 to address an existing fire flow deficiency. The Arbutus zone fire pump upgrade is listed as being required in 2050 but will be triggered by the development of the Mixed-Use Zoned lot in the Arbutus zone.

6.4 2018 Peak Hour with Aquifer Storage and Recovery (Scenario 9)

An aquifer storage and recovery (ASR) well may be constructed at the Nanoose Well Field (see Figure 5). This well field would have an expected initial yield of about 6 MLD with an ultimate yield of 15 MLD.

An additional scenario was modelled to determine the impacts of the construction of a 6 MLD ASR well on the 2018 transmission system upgrades. The model run consisted of a 72 hour extended period

[6] Mr. Chris Downey, P.Eng., Koers and Associates, Personal Communication May 28th, 2014.

simulation. The results indicate that the new NBP Supply Pump Station (replacing the exiting Craig Bay Station) could be deferred past 2018 on the basis of capacity. However, due to redundancy and level of service considerations, the new NBP Supply Pump Station is still recommended.

The ultimate ASR capacity of 15 MLD is greater than the expected 2050 MDD of the NBP water service area, therefore some excess capacity can be fed to the CoP system via a PRV.

7. Capital Costs

Class "D", indicative capital cost estimates have been developed for each proposed upgrade. These estimates have been assembled with little or no site information and are considered to be suitable for long term capital planning.

Parameters used in cost estimating are summarized as follows:

- Site specific project conditions have been considered only at a high level. These site specific conditions include clearing requirements, traffic control requirements, surface restoration, utility conflicts, bedrock blasting and dewatering and diversion requirements.
- The costs include a 15% allowance for engineering / field inspections and 25% allowance for contingencies;
- Land acquisition costs are not included; and
- All costs are in 2014 dollars with no allowance for inflation.

Unit costs used in the preparation of the cost estimates are provided in Table 11.

Table 11: Unit Rates

Size	Unit	Unit Rate Including Engineering and Contingency
Water Mains in Paved Road ROWs		
250	m	$550
300	m	$670
350	m	$700
400	m	$810
600	m	$1220
Water Mains in Unpaved ROWs- No Clearing Required		
350	m	$410
400	m	$480
600	m	$820
Water Mains in New ROWs- Access and Clearing Required		
300	m	$470
400	m	$570
600	m	$920
Englishman River Crossing at Levirs Rd- Buried Installation		
600	m	$2250
Pump Stations		
> 200 kW	kW	$8,000

Size	Unit	Unit Rate Including Engineering and Contingency
< 200 kW	kW	$10,000
Fire Pump Upgrade (without structural upgrades)		
Fire Pump & Controls	kW	$500
Reservoirs		
< 1.5 ML	m^3	$900
>1.5 ML	m^3	$600

Cost estimates for each task are tabulated in Appendix E; the total costs for each phase are summarized in Table 12. The cost estimates do not include the following items:

- Water treatment plant, site servicing, raw water main and access road;
- Booster pump station from water treatment plant to Parksville 74 m Zone (in WTP);
- ASR wells.

Table 12: Summary of Capital Costs ($M 2014)

Phase	Water Main Upgrades	Reservoir Upgrades	Pump Station Upgrades	Total
by 2016	$5.11	$0.00	$0.00	$5.11
2016 - 2018	$0.37	$0.90	$2.27	$3.54
2018 - 2035	$2.43	$2.46	$0.00	$4.89
2035 -2050	$0.35	$0.00	$0.05	$0.40
Total	**$8.26**	**$3.36**	**$2.32**	**$13.94**

8. Summary and Recommendations

The Englishman River Water Service (ERWS) is proposing to construct a water intake on the Englishman River just upstream of the Highway 19 bridge and a water treatment plant at the City of Parkville Public Works Yard on the north side of the highway. This memorandum identifies the transmission system upgrades required to integrate the water treatment plant into the water system. The required date of construction (phasing) has been determined based on the expected growth in demands.

The most significant transmission system upgrades include:

- A new 4850 m long, 600 mm diameter transmission main from the water treatment plant to Springwood Reservoir #4 (Task W1);
- A new 400 mm diameter water main from the water treatment plant to the Industrial (#3 & #5) Reservoir site in Parkville (Task W2);
- A new booster pump station on Industrial Way pumping to the Nanoose Bay Water Service Area, replacing the Craig Bay Pump Station (Task P1);
- A new 400 mm diameter water main from the new booster pump station on Industrial Way to the Regional District of Nanaimo Boundary at Northwest Bay Road (Task W4);
- A new 300 mm diameter water main from Northwest Bay Rd to Anchor Way (Task W6);
- Reservoir capacity upgrades at Springwood and Fairwinds Reservoirs to increase balancing, emergency and fire storage (Tasks R1 and R2);
- Upgrades to the fire pumps in the Springwood and Arbutus Pump Stations to increase fire flow capacity (Tasks P3 and P4).

In addition, it is recommended that:

- ERWS monitor the growth in system-wide demands on an ongoing basis to update the required construction timing for each task;
- the sizing and alignment of each task be confirmed at the detailed design phase to account for any changes that have been made to the water distribution system;
- investigations be made into acquiring land and rights of-way for the proposed infrastructure that is on private property;
- ERWS initiate/continue design for tasks that are recommended for construction in 2016 and 2018.

8.1 Submission

KERR WOOD LEIDAL ASSOCIATES LTD.

Prepared by:

Rose Sinnott, E.I.T.
Project Engineer

Prepared by:

Eric Morris, M.A.Sc., P.Eng.
Project Manager

Reviewed by:

Neal Whiteside, M.A.Sc., P.Eng.
Technical Reviewer

RS/am

Encl. Figure 1: Existing Water System
Figure 2: Existing Water System Schematic City of Parksville
Figure 3: Existing Water System Schematic RDN Nanoose Bay Peninsula Water Service Area
Figure 4: Existing Water System 2013 Unfactored Demands Peak Hour Pressure Results
Figure 5: Future Growth Scenarios Recommended Upgrades and Phasing
Appendix A: Water Main Diameters and C Factors
Appendix B: City of Parksville Water System Facility Information
Appendix C: Nanoose Bay Peninsula Water System Facility Information
Appendix D: Modelled Maximum Day Demands by Pressure Zone
Appendix E: Cost Estimate

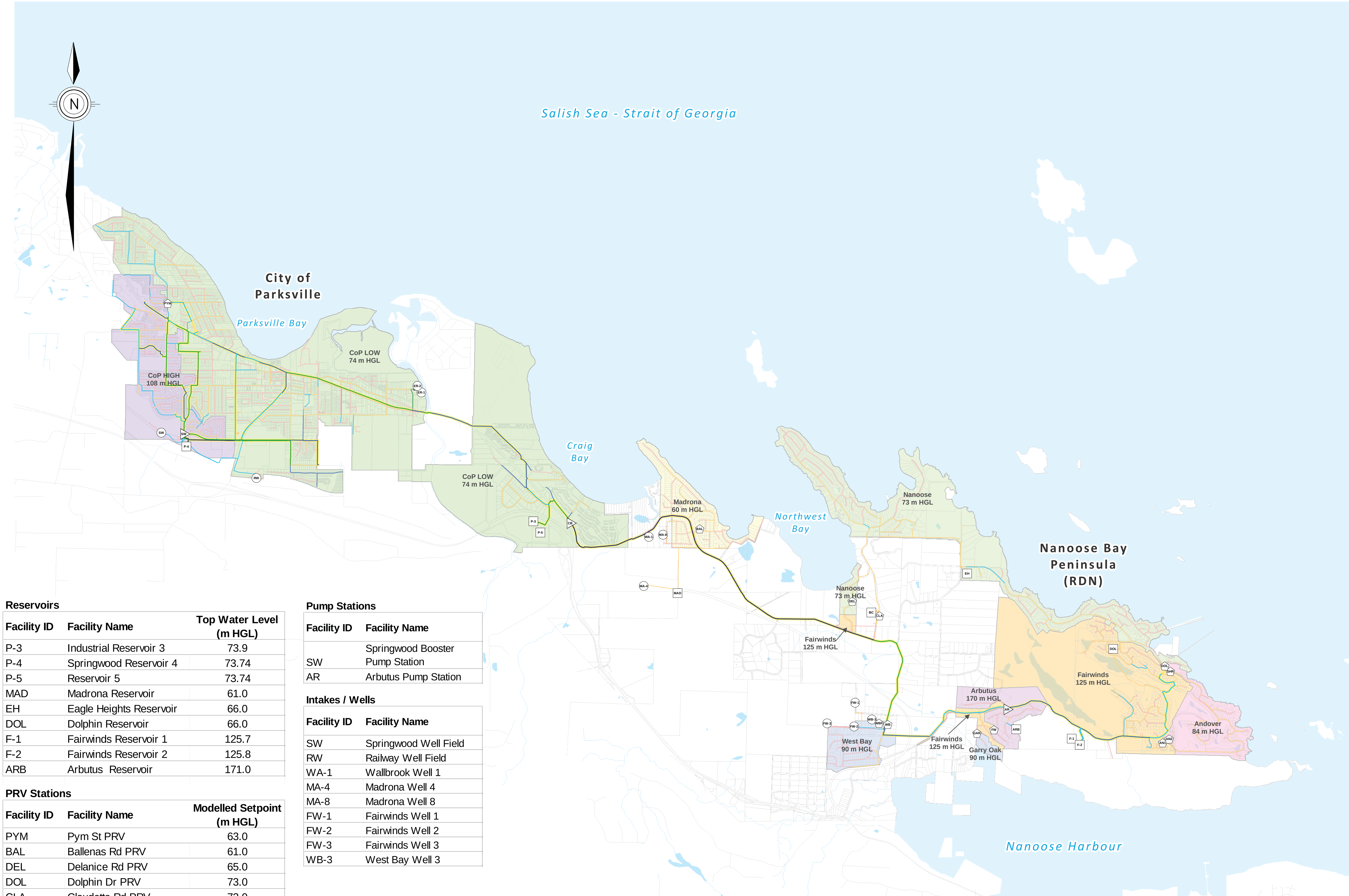
Statement of Limitations

Copyright Notice

Revision History

Revision #	Date	Status	Revision	Author
0	Nov. 19, 2013	Interim Draft		RS / EM
1	Dec 23, 2013	Interim Draft 2	Updated design criteria and facility data based on feedback from COP and RDN. Added modelling results and recommendations.	RS / EM
2	Jan 15, 2014	Interim Draft 3	Revised location of proposed pump stations. Completed storage assessment calculations to be reviewed by ERWS.	RS / EM
3	March, 2014	Draft 4	Revised fire flow requirements Revised elevations of nodes in RDN using contour data provided. Completed phasing and cost estimates for required upgrades.	RS / EM
4	April 25. 2014	Final	Revise alignment of Task 4B. Finalize	RS / EM
5	June 2, 2014	Revision 1	Revised NBP Demands and Well Capacities. Revisions to transmission main upgrades.	RS / EM

ERWS
Water Intake, Treatment Plant and Supply Mains



Reservoirs

Facility ID	Facility Name	Top Water Level (m HGL)
P-3	Industrial Reservoir 3	73.9
P-4	Springwood Reservoir 4	73.74
P-5	Reservoir 5	73.74
MAD	Madrona Reservoir	61.0
EH	Eagle Heights Reservoir	66.0
DOL	Dolphin Reservoir	66.0
F-1	Fairwinds Reservoir 1	125.7
F-2	Fairwinds Reservoir 2	125.8
ARB	Arbutus Reservoir	171.0

PRV Stations

Facility ID	Facility Name	Modelled Setpoint (m HGL)
PYM	Pym St PRV	63.0
BAL	Ballenas Rd PRV	61.0
DEL	Delanice Rd PRV	65.0
DOL	Dolphin Dr PRV	73.0
CLA	Claudette Rd PRV	73.0
AN1	Andover PRV 1	84.0
AN2	Andover PRV 2	80.0
SHR	Sherbrooke Rd PRV	82.0
GAR	Garry Oak Dr PRV	90.0
WB	West Bay PRV	90.0
WBF	West Bay Fire Hall PRV	83.0
FW	Fairwinds PRV	123.0

Pump Stations

Facility ID	Facility Name
SW	Springwood Booster Pump Station
AR	Arbutus Pump Station

Intakes / Wells

Facility ID	Facility Name
SW	Springwood Well Field
RW	Railway Well Field
WA-1	Wallbrook Well 1
MA-4	Madrona Well 4
MA-8	Madrona Well 8
FW-1	Fairwinds Well 1
FW-2	Fairwinds Well 2
FW-3	Fairwinds Well 3
WB-3	West Bay Well 3

Legend

- Well / Intake
- Pump Station
- PRV Station
- Reservoir
- Pressure Zone Boundary
- Existing Transmission System

Water Main Diameter (mm)

- < 150
- 200
- 250
- 300
- 350, 400
- > 400

Reference: GIS background data from the City of Parksville and the Regional District of Nanaimo.

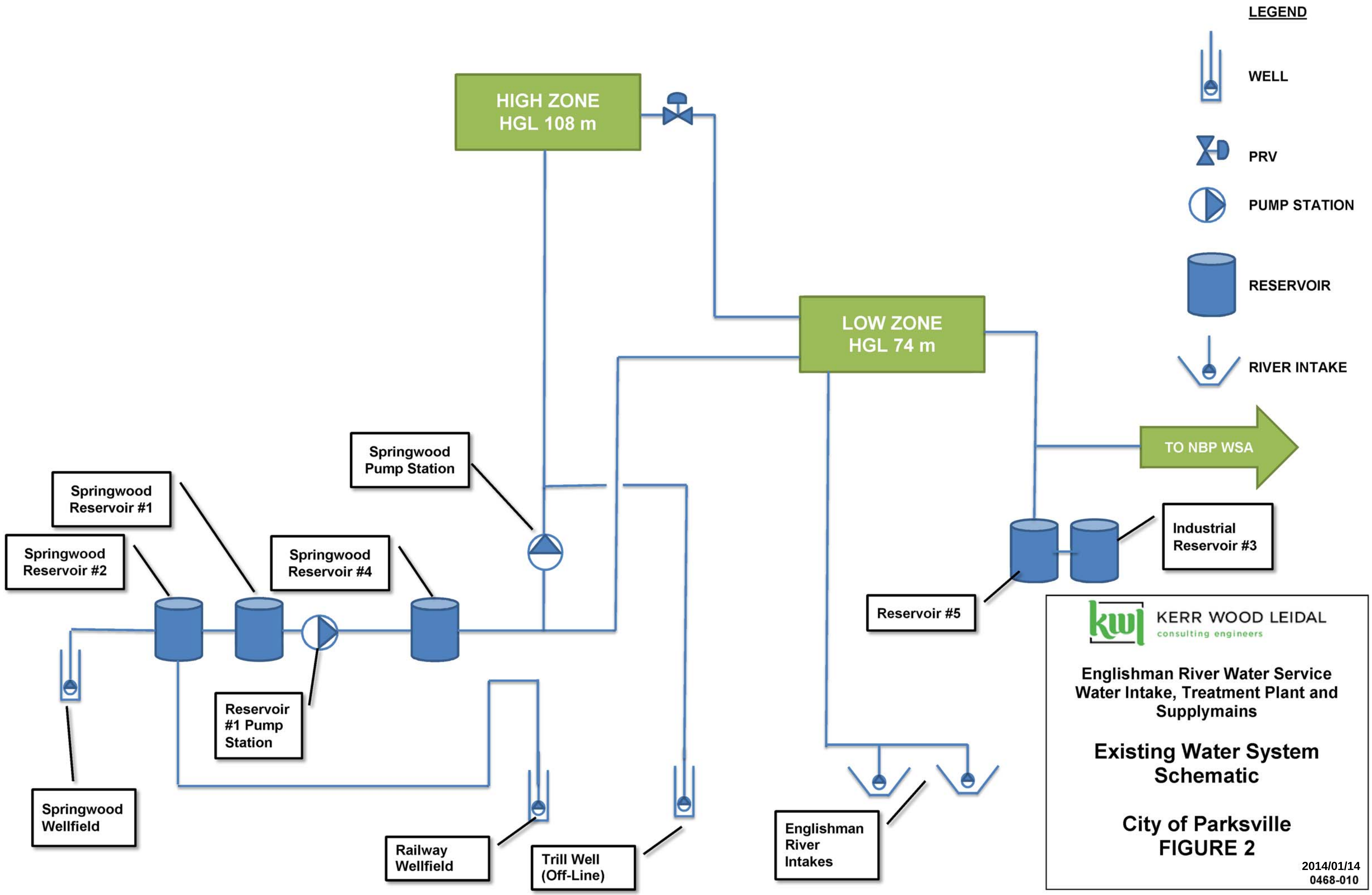
KERR WOOD LEIDAL
consulting engineers

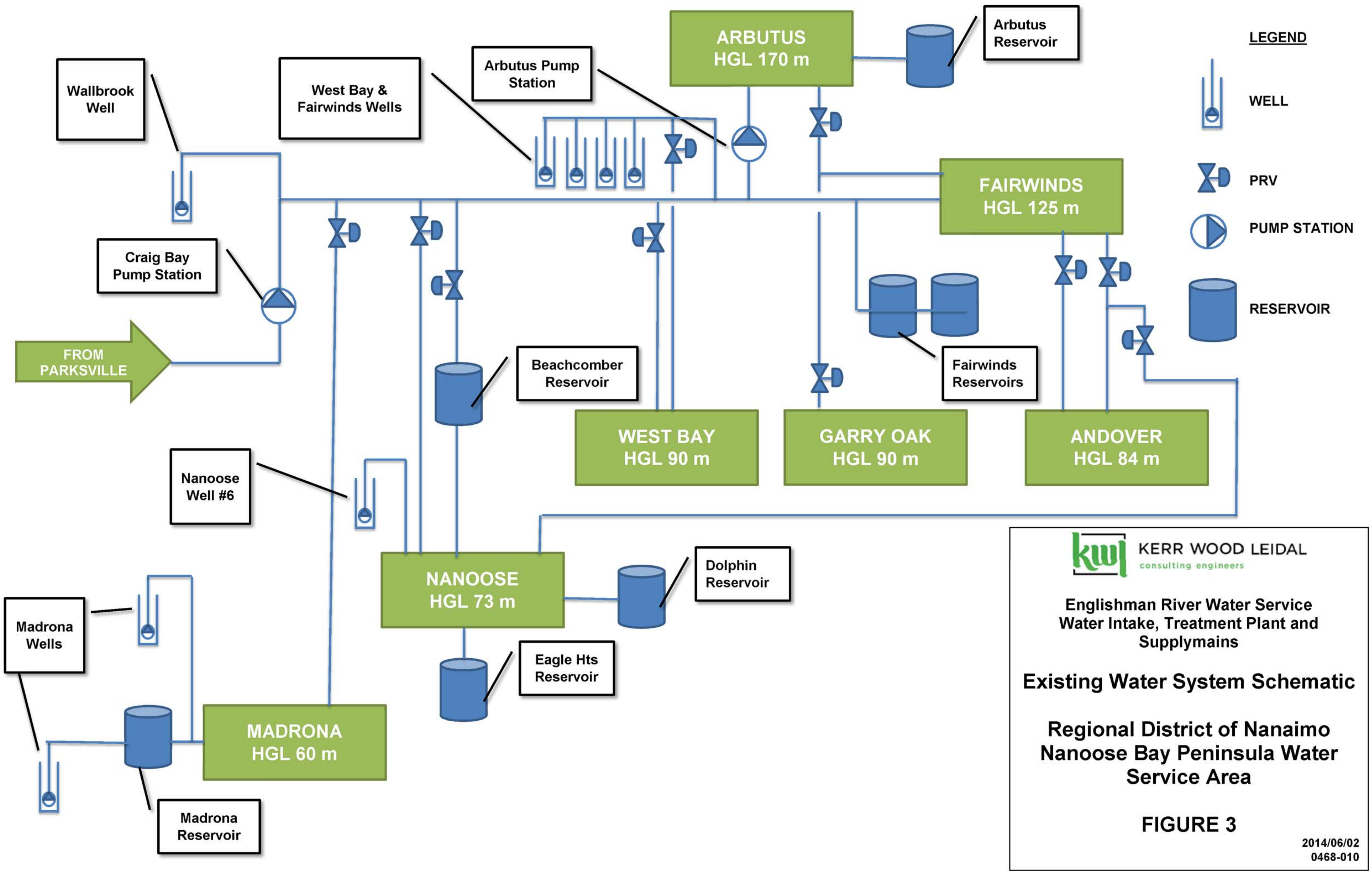
1,000 0 1,000 (m)
1:30,000

Project No.	Date	Drawn By
468-010	June 2014	RS

Existing Water System

Figure 1


LEGEND
WELL
PRV
PUMP STATION
RESERVOIR
RIVER INTAKE
HIGH ZONE
HGL 108 m
LOW ZONE
HGL 74 m
TO NBP WSA
Springwood Pump Station
Springwood Reservoir #1
Springwood Reservoir #2
Springwood Reservoir #4
Reservoir #1 Pump Station
Springwood Wellfield
Railway Wellfield
Trill Well (Off-Line)
Englishman River Intakes
Reservoir #5
Industrial Reservoir #3
KERR WOOD LEIDAL
consulting engineers
Englishman River Water Service
Water Intake, Treatment Plant and Supplymains
Existing Water System Schematic
City of Parksville
FIGURE 2
2014/01/14
0468-010



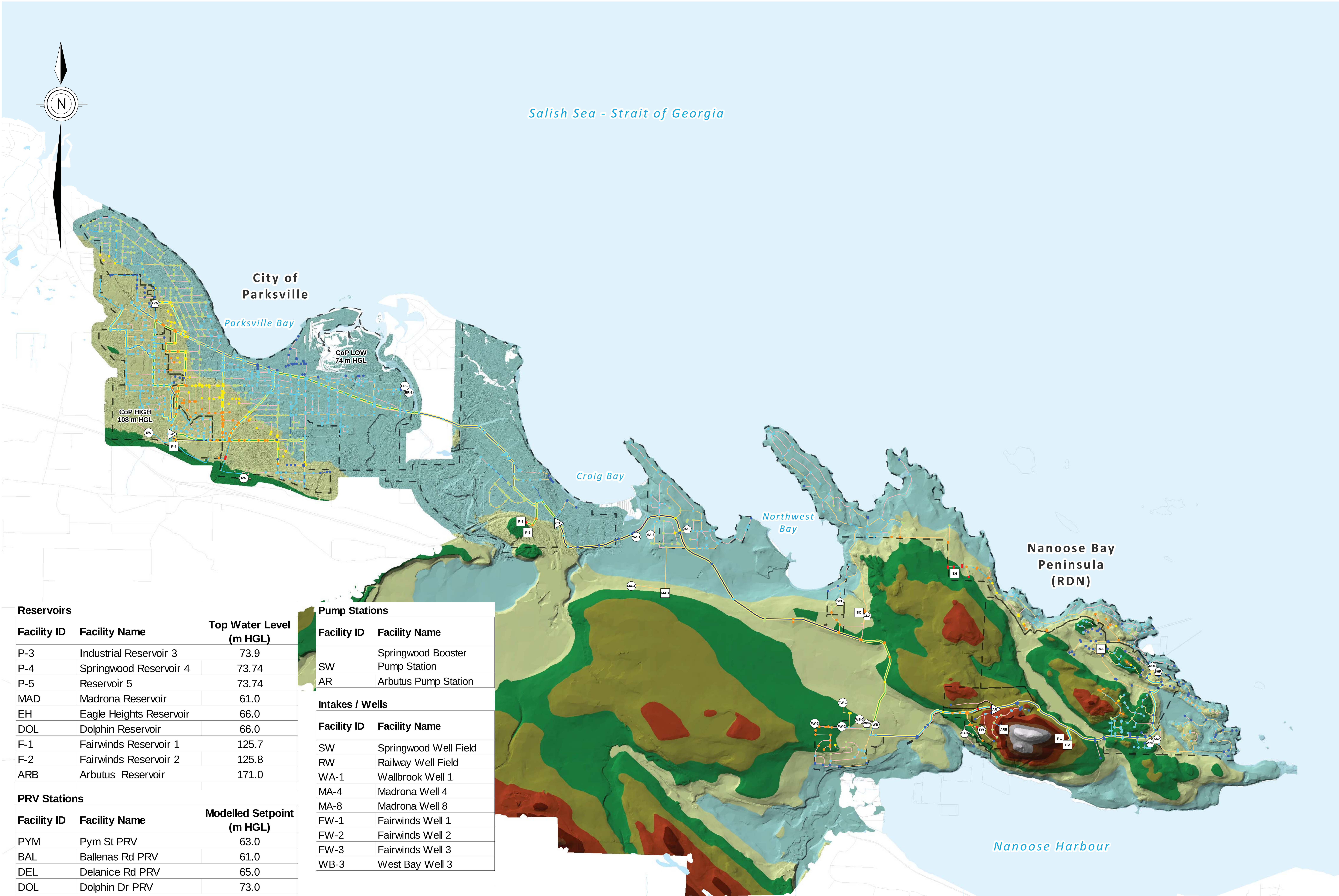
Englishman River Water Service
Water Intake, Treatment Plant and
Supplymains

Existing Water System Schematic

Regional District of Nanaimo
Nanoose Bay Peninsula Water Service Area

FIGURE 3

2014/06/02
0468-010



Reservoirs

Facility ID	Facility Name	Top Water Level (m HGL)
P-3	Industrial Reservoir 3	73.9
P-4	Springwood Reservoir 4	73.74
P-5	Reservoir 5	73.74
MAD	Madrona Reservoir	61.0
EH	Eagle Heights Reservoir	66.0
DOL	Dolphin Reservoir	66.0
F-1	Fairwinds Reservoir 1	125.7
F-2	Fairwinds Reservoir 2	125.8
ARB	Arbutus Reservoir	171.0

PRV Stations

Facility ID	Facility Name	Modelled Setpoint (m HGL)
PYM	Pym St PRV	63.0
BAL	Ballenas Rd PRV	61.0
DEL	Delanice Rd PRV	65.0
DOL	Dolphin Dr PRV	73.0
CLA	Claudette Rd PRV	73.0
AN1	Andover PRV 1	84.0
AN2	Andover PRV 2	80.0
SHR	Sherbrooke Rd PRV	82.0
GAR	Garry Oak Dr PRV	90.0
WB	West Bay PRV	90.0
WBF	West Bay Fire Hall PRV	83.0
FW	Fairwinds PRV	123.0

Pump Stations

Facility ID	Facility Name
SW	Springwood Booster Pump Station
AR	Arbutus Pump Station

Intakes / Wells

Facility ID	Facility Name
SW	Springwood Well Field
RW	Railway Well Field
WA-1	Wallbrook Well 1
MA-4	Madrona Well 4
MA-8	Madrona Well 8
FW-1	Fairwinds Well 1
FW-2	Fairwinds Well 2
FW-3	Fairwinds Well 3
WB-3	West Bay Well 3

ERWS
Water Intake, Treatment Plant and Supply Mains

Legend

- Well / Intake
- Pump Station
- PRV Station
- Reservoir
- Pressure Zone Boundary
- Existing Transmission System

Water Main Diameter (mm)

- < 150
- 200
- 250
- 300
- 350, 400
- > 400

Peak Hour Pressure (psi)

- < 20
- 20.1 - 44.0
- 44.1 - 50.0
- 50.1 - 60.0
- 60.1 - 80.0
- 80.1 - 120.0
- > 120

Surface Elevation (m)

- 218.9 - 246
- 191.8 - 218.9
- 164.7 - 191.8
- 137.6 - 164.7
- 110.4 - 137.6
- 83.3 - 110.4
- 56.2 - 83.3
- 29.1 - 56.2
- 2 - 29.1

Reference: GIS background data from the City of Parksville and the Regional District of Nanaimo.

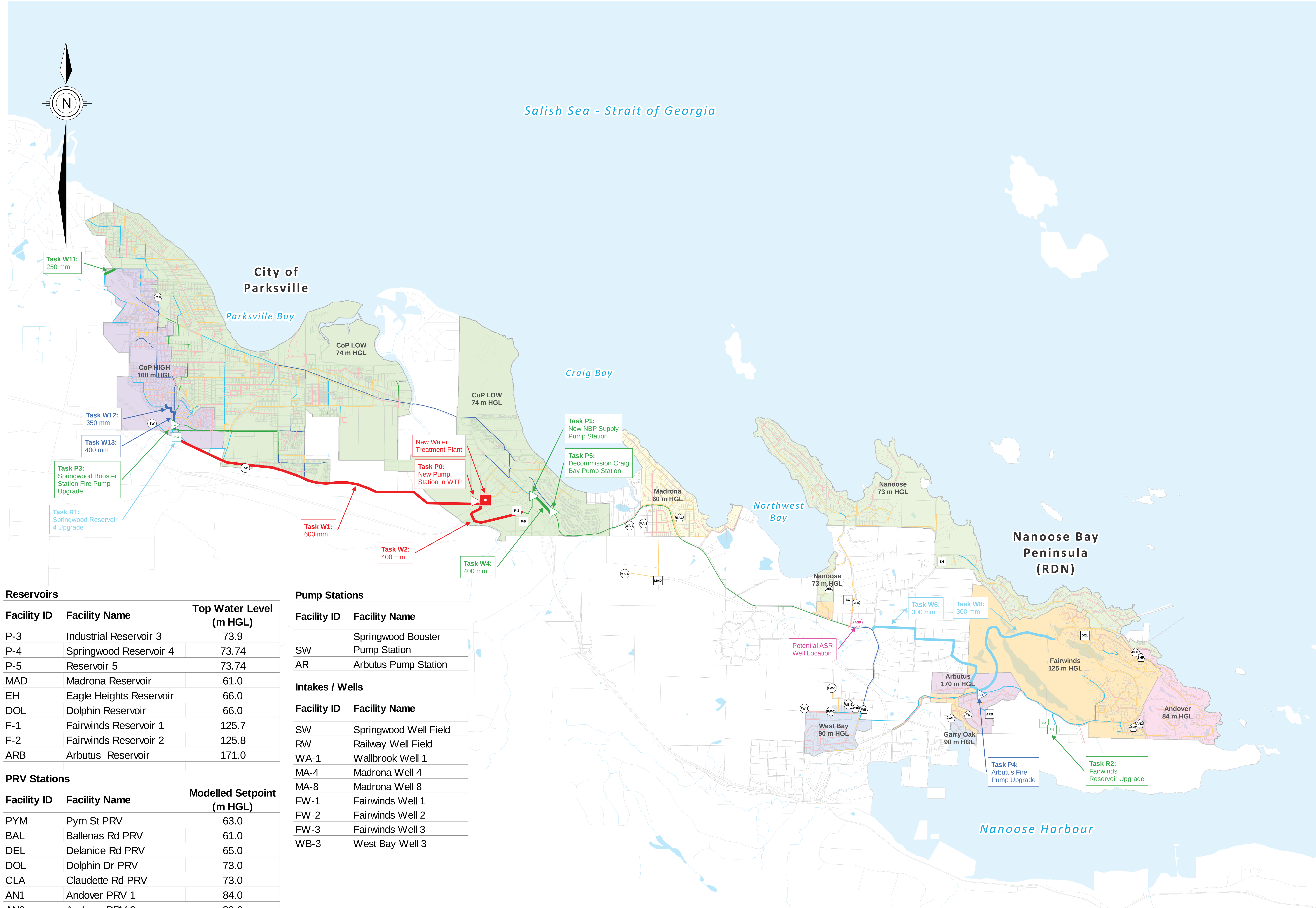
KERR WOOD LEIDAL
consulting engineers

1,000 0 1,000 (m)
1:30,000

Project No.	Date	Drawn By
468-010	June 2014	RS

Existing Water System
2013 Unfactored Demands
Peak Hour Pressure Results

Figure 4



Reservoirs

Facility ID	Facility Name	Top Water Level (m HGL)
P-3	Industrial Reservoir 3	73.9
P-4	Springwood Reservoir 4	73.74
P-5	Reservoir 5	73.74
MAD	Madrona Reservoir	61.0
EH	Eagle Heights Reservoir	66.0
DOL	Dolphin Reservoir	66.0
F-1	Fairwinds Reservoir 1	125.7
F-2	Fairwinds Reservoir 2	125.8
ARB	Arbutus Reservoir	171.0

PRV Stations

Facility ID	Facility Name	Modelled Setpoint (m HGL)
PYM	Pym St PRV	63.0
BAL	Ballenas Rd PRV	61.0
DEL	Delanice Rd PRV	65.0
DOL	Dolphin Dr PRV	73.0
CLA	Claudette Rd PRV	73.0
AN1	Andover PRV 1	84.0
AN2	Andover PRV 2	80.0
SHR	Sherbrooke Rd PRV	82.0
GAR	Garry Oak Dr PRV	90.0
WB	West Bay PRV	90.0
WBF	West Bay Fire Hall PRV	83.0
FW	Fairwinds PRV	123.0

Pump Stations

Facility ID	Facility Name
SW	Springwood Booster Pump Station
AR	Arbutus Pump Station

Intakes / Wells

Facility ID	Facility Name
SW	Springwood Well Field
RW	Railway Well Field
WA-1	Wallbrook Well 1
MA-4	Madrona Well 4
MA-8	Madrona Well 8
FW-1	Fairwinds Well 1
FW-2	Fairwinds Well 2
FW-3	Fairwinds Well 3
WB-3	West Bay Well 3

ERWS
Water Intake, Treatment Plant and Supply Mains

Legend

- New Water Treatment Plant
- 2018 Reservoir Upgrade
- 2035 Reservoir Upgrade
- 2016 Pump Station Upgrade
- 2018 Pump Station Upgrade
- 2035 Pump Station Upgrade
- 2050 Pump Station Upgrade
- Potential ASR Well Location

Water Main Diameter (mm)

- < 150
- 200
- 250
- 300
- 350, 400
- > 400
- 2016 Upgrades For WTP
- 2018 Water Main Upgrade
- 2035 Water Main Upgrade
- 2050 Water Main Upgrade
- Existing Well
- Existing Pump Station
- Existing PRV Station
- Existing Reservoir
- Pressure Zone Boundary

Reference: GIS background data from the City of Parksville and the Regional District of Nanaimo.

KERR WOOD LEIDAL
consulting engineers

1,000 0 1,000 (m)
1:30,000

Project No.	Date	Drawn By
468-010	June 2014	RS

Future Growth Scenarios Recommended Upgrades and Phasing

Figure 5

KERR WOOD LEIDAL
consulting engineers

Appendix A

Water Main Diameters and C Factors

Table A-1: Water Main Diameters and C Factors

Material	Abbreviation	Nominal Diameter (mm)	Modelled Diameter (mm)	C Factor
Asbestos Cement	AC	100	101.6	110
	AC	150	152.4	110
	AC	200	203.2	110
	AC	250	254	110
	AC	300	304.8	110
	AC	350	355.6	110
	AC	400	406.4	110
Cast Iron	CI	150	152.4	90
Ductile Iron	DI	100	106	120
	DI	150	159.4	120
	DI	200	214	120
	DI	250	265.5	120
	DI	300	317.9	120
	DI	350	371.2	120
	DI	400	423.5	120
HDPE	HDPE	200	176.9	135
Permastrand	PS	150	150	100
	PS	200	200	100
PVC	PVC	25	25	135
	PVC	50	50	135
	PVC	75	75	135
	PVC	100	108	135
	PVC	150	155	135
	PVC	200	204.3	135
	PVC	250	250	135
	PVC	300	297	135
	PVC	350	345.4	135
	PVC	400	392.8	135
Stainless Steel	SS	100	102.3	120
	SS	150	154.1	120
	SS	200	202.7	120
	SS	250	254.5	120
	SS	300	304.8	120
	SS	350	336.6	120
	SS	400	387.35	120

Material	Abbreviation	Nominal Diameter (mm)	Modelled Diameter (mm)	C Factor
Steel	ST	100	102.3	120
	ST	150	154.1	120
	ST	200	202.7	120
	ST	250	254.5	120
	ST	300	304.8	120
	ST	350	336.6	120
	ST	400	387.40	120
Steel(Coated)	ST	100	102.3	120
	ST	150	154.1	120
	ST	200	202.7	120
	ST	250	254.5	120
	ST	300	304.8	120
	ST	350	336.6	120
	ST	400	387.4	120
	ST	1525	1525.0	120
Unknown	UNK	0	0	100
	UNK	25	25	100
	UNK	50	50	100
	UNK	75	75	100
	UNK	100	100	100
	UNK	150	150	100

\\nasvictoria.victoria.kerrwoodleidal.org\DATA\Victoria\Projects\0000-0999\0400-0499\468-010\300-Reports\WaterModel\AppendixA_WaterMainTable.docx

KERR WOOD LEIDAL
consulting engineers

Appendix B

City of Parksville Water System Facility Information

Table B-1: Parksville Well Summary

Model ID	Well Capacity L/s	Well Capacity MLD	Modelled Reservoir HGL
Springwood Well Field			
R-SW-1	0.9	0.08	See Note 1
R-SW-2	Off line		
R-SW-3	1.3	0.11	
R-SW-4	Off line		
R-SW-5	6.0	0.52	
R-SW-6	6.7	0.58	
R-SW-7	9.1	0.79	
R-SW-8	10.3	0.89	
R-SW-10	9.0	0.78	
R-SW-11	7.0	0.60	
Railway Well Field			
R-RW-1	5.0	0.43	See Note 1
R-RW-2	5.3	0.46	
R-RW-3	2.5	0.22	
R-RW-4	1.7	0.15	
R-RW-5	7.3	0.63	
R-RW-6	6.2	0.54	
R-RW-7	4.1	0.35	
R-RW-8	4.5	0.39	
Trill Well			
R-TW-1	Off line		Off line
Total CoP Well Capacity	**86.9**	**7.52**	**74 m**

Notes:
1. All wells modeled as one reservoir with a capacity of 86.9 L/s and an HGL of 74 m.

Table B-2: Parksville River Intake Summary

Model ID	Intake Level (m HGL)	Control Point in System	Max Day (Summer) Set Points		Base Day (Winter) Set Points	
			ON % Reservoir Level	OFF % Reservoir Level	ON % Reservoir Level	OFF % Reservoir Level
R-ER-1	1.0	Reservoir #4	92.7%	97.6%	Off	Off
R-ER-2	1.0	Reservoir #4	93.9%	97.6%	Off	Off

Table B-3: Parksville Water Storage Reservoir Summary

Model ID	Name	Purpose	Pressure Zone	Capacity (ML)	Base Elevation (m)	Top Water Level (m)	Diameter (m)	Area (m2)
T-1	Springwood Reservoir #1	Water Treatment – See Note 1	N/A	0.616	45.5	47.2	N/A	362.4
T-2	Springwood Reservoir #2	Water Treatment – See Note 1	N/A	2.023	45.5	48.4	29.8	697.6
T-3	Industrial Reservoir #3	Fire and Balancing Storage– See Note 2	Low	0.671	58.7	73.9	7.5	44.1
T-4	Springwood Reservoir #4	Fire and Balancing Storage	Low	4.559	57.0	73.74	18.6	272.3
T -5	Reservoir #5	Fire and Balancing Storage– See Note 2	Low	4.300	61.9	73.74	21.5	361.6

Notes:
1. Springwood Reservoir #1 and Springwood Reservoir #2 are not included in the water model.
2. Industrial Reservoir #3 and Reservoir #5 are modelled as one tank, with a combined volume of 4.971 ML and TWL of 73.74

Table B-4: Parksville Water Pump Station Summary

Model ID	HP	Pump Make / Model	Pump Curve Provided	Max Day (Summer)Set Points		
				Control Point in System	ON Set Point	OFF Set Point
Springwood Pump Station – See Note 1.						
PMP-S-1	25 HP	Grundfos CR 90 2-2	Yes	Unknown	Unknown	Unknown
PMP-S-2	25 HP	Grundfos CR 90 2-2	Yes	Unknown	Unknown	Unknown
PMP-S-3	25 HP	Grundfos CR 90 2-2	Yes	Unknown	Unknown	Unknown
PMP-S-4	25 HP	Grundfos CR 90 2-2	Yes	Unknown	Unknown	Unknown
PMP-S-5	25 HP	Grundfos CR 90 2-2	Yes	Unknown	Unknown	Unknown
PMP-S-6	25 HP	Grundfos CR 90 2-2	Yes	Unknown	Unknown	Unknown
Springwood Booster Station						
PMP-SWBS-15HP	25 HP	Unknown	Yes – from 2004 model	None	Always ON	Always ON
PMP-SWBS-40HP	40 HP	Unknown	Yes – from 2004 model	Flow rate (Q) to High Zone	Q > 51.7 L/s	Q < 46.0 L/s
PMP-SWBS-40HP	40 HP	Unknown	Yes – from 2004 model	Flow rate (Q) to High Zone	Q > 126.2 L/s	Q < 115.0 L/s
PMP-SWBS-100HP	100 HP	Unknown	Yes – from 2004 model	Flow rate (Q) to High Zone	Q > 190.5 L/s	Q < 170.0 L/s
River Intake Pump Station						
PMP-ER-1	Unknown	Unknown	Yes – from 2004 model	Reservoir #4	Reservoir Level < 92.7%	Reservoir Level > 97.6%
PMP-ER-2	Unknown	Unknown	Yes – from 2004 model	Reservoir #4	Reservoir Level < 93.9%	Reservoir Level > 97.6%

Notes:
1. Springwood Pump Station is not included in the water model.

Table B-5: Parksville PRV Station Summary

Model ID	Location	Supplies Zone	Valve Diameter (mm)	Modelled Valve Setting (m HGL)
PRV-1	Pym Street North at Doehle Avenue	Low Zone 74 m	200	63.0

\\nasvictoria.victoria.kerrwoodleidal.org\DATA\Victoria\Projects\0000-0999\0400-0499\468-010\300-Reports\WaterModel\AppendixB_COP_Tables.docx

KERR WOOD LEIDAL
consulting engineers

Appendix C

Nanoose Bay Peninsula Water System Facility Information

Table C-1: NBP Well Summary

Model ID	Well Capacity		Modelled Capacity[1]		Modelled Reservoir HGL
	L/s	MLD	L/s	MLD	
Wallbrook					
WALL-1	2.7	0.235	1.9	0.16	160 m
Madrona					
MAD-4	1.4	0.12	1.0	0.08	62 m
MAD-8	1.6	0.14	1.1	0.10	62 m
Nanoose					
NAN-2	Offline				
NAN-3	Offline				
NAN-4	Offline				
NAN-6	Offline				
Fairwinds					
FW-1	5.7	0.49	4.0	0.34	160 m
FW-2	5.3	0.46	3.7	0.32	160 m
FW-3	3.2	0.27	2.2	0.19	160 m
West Bay					
WEST-3	12.7	1.09	8.9	0.77	160 m
Total NBP Well Capacity	**32.6**	**2.81**	**22.8**	**1.97**	

Notes:
1. Modelled capacity is 70% of the well capacity.

Table C-2: NBP Water Storage Reservoir Summary

Model ID	Name	Purpose	Pressure Zone	Capacity (ML)	Base Elevation (m)	Top Water Level (m)	Diameter (m)	Area (m^2)
T-MAD	Madrona Reservoir	Fire and Balancing Storage	Madrona 60 m	0.537	57.3	61.0	N/A	146.8
T-BC	Beachcomber Reservoir	Fire and Balancing Storage	Nanoose 65 m	0.547	49.0	66.0	6.4	32.2
T-EH	Eagle Heights Reservoir	Fire and Balancing Storage	Nanoose 65 m	0.735	59.5	66.0	N/A	113.7
T-DOL	Dolphin Reservoir	Fire and Balancing Storage	Nanoose 65 m	0.471	60.0	66.0	10.0	78.5
T-FW1	Fairwinds Reservoir 1	Fire and Balancing Storage - – See Note 1	Fairwinds 125 m	0.853	122.0	125.7	17.25	233.7
T-FW2	Fairwinds Reservoir 2	Fire and Balancing Storage- – See Note 1	Fairwinds 125 m	0.876	122.0	125.8	17.25	233.7
T –ARB	Arbutus Reservoir	Fire and Balancing Storage	Arbutus 170 m	0.620	165.9	171.0	12.44	121.2

Notes:

1. Fairwinds Reservoir 1 and 2 are modelled as one tank, with a combined volume of 1.729 ML and TWL of 125.8m

Table C-3: NBP Water Pump Station Summary

Model ID	HP	Pump Make / Model	Pump Curve Provided	Max Day (Summer)Set Points		
				Control Point in System	ON Set Point	OFF Set Point
Craig Bay Pump Station						
PMP-CB-1	60	Grundfos CR 90-4-1	Yes	Fairwinds Reservoirs	Reservoir Level < 80%	Reservoir Level > 90%
Arbutus Pump Station						
PMP-ARB	Unknown	Unknown	Yes – from 2006 model	Arbutus Reservoir	Reservoir Level < 77.6%	Reservoir Level > 92.2%

Table C-4: NBP PRV Station Summary

Model ID	Location	Supplies Zone	Valve Diameter (mm)	Modelled Valve Setting (m HGL)
PRV-BALL	Ballenas Road	Madrona 60 m	150	61.0
PRV-DEL	Delanice Road	Nanoose 65 m	150	65.0
PRV-DOL	Dolphin Road	Nanoose 65 m	150	73.0
PRV-CLA	Claudette Road	Nanoose 65 m	150	73.0
PRV-AND-1	Andover Road at Fairwinds Drive	Andover 84 m	100	84.0
PRV-AND-2	Andover Road at Fairwinds Drive	Andover 84 m	100	80.0
PRV-SHR	Dolphin Drive and Sherbrooke Road	Andover 84 m	150	82.0
PRV-GARRY	Garry Oak Drive	Garry Oak 90 m	100	90
PRV-WBAY-FH	Nanoose Road, at Nanoose Bay Fire Hall	West Bay 90 m	150	83.0
PRV-WBAY	NW Bay Road at Nanoose Road	West Bay 90 m	150	90.0
PRV-ARB	Arbutus Crescent and Marine Drive	Fairwinds 125 m	150	123.0

\\nasvictoria.victoria.kerrwoodleidal.org\DATA\Victoria\Projects\0000-0999\0400-0499\468-010\300-Reports\WaterModel\AppendixC_NBP_Tables.docx

KERR WOOD LEIDAL
consulting engineers

Appendix D

Water Demands by Pressure Zone

KERR WOOD LEIDAL
consulting engineers

Table D-1: Modelled Maximum Day Demands by Pressure Zone

Pressure Zone	Nominal HGL (m)	Maximum Day Demand (L/s)					Maximum Day Demand (MLD)			
		2013 Unfactored	2018 Unfactored	2035 Unfactored	2050 Unfactored	2050 High Growth Factored	2013 Unfactored	2018 Unfactored	2035 Unfactored	2050 High Growth Factored
CoP High Zone	115	30.5	32.8	35.4	35.6	45.8	2.6	2.8	3.1	4.0
CoP Low Zone	74	158.7	164.9	186.8	204.9	325.0	13.7	14.2	16.1	28.1
Sub-Total		**189.2**	**197.7**	**222.1**	**240.6**	**370.8**	**16.3**	**17.1**	**19.2**	**32.0**
NBP Madrona	60	13.4	14.1	14.4	15.5	17.8	1.2	1.2	1.2	1.5
NBP Nanoose	65	28.7	30.4	31.5	35.2	40.5	2.5	2.6	2.7	3.5
NBP Andover	84	8.0	9.1	9.9	10.4	12.0	0.7	0.8	0.9	1.0
NBP West Bay	90	6.8	7.0	8.0	8.2	9.5	0.6	0.6	0.7	0.8
NBP Garry Oak	90	0.6	0.6	0.6	0.6	0.7	0.1	0.1	0.1	0.1
NBP Fairwinds	125	14.4	15.4	29.8	45.0	51.8	1.2	1.3	2.6	4.5
NBP Arbutus	170	4.2	4.4	5.6	6.8	7.9	0.4	0.4	0.5	0.7
Sub-Total		**76.1**	**81.0**	**99.7**	**121.9**	**140.2**	**6.6**	**7.0**	**8.6**	**12.1**
Total		**265.3**	**278.7**	**321.9**	**362.4**	**511.0**	**22.9**	**24.1**	**27.8**	**44.1**

KERR WOOD LEIDAL
consulting engineers

Appendix E

Cost Estimate

Table 1E- Capital Costs for Watermains- no ASR

Task No.	Phasing	Length (m)	Diameter (mm)	Conditions	Unit Rate ($/m)	Cost ($ 2014)
W1	2016	4850 (Total)	600	Uncleared ROW, River Crossing, Paved Road, Cleared Unpaved ROW	$820 - $2250	$4,501,000
W2	2016	1110 (Total)	400	Cleared, Unpaved ROW, Uncleared ROW	$480 - $570	$609,000
W4	2018	460	400	Existing Paved ROW	$810	$373,000
W6	2035	2520 (Total)	300	Uncleared ROW, Existing Paved Road	$470 - $670	$1,556,000
W8	2035	2,240	300	Cleared, Unpaved ROW	$390	$874,000
W11	N/A	160	250	Existing Paved ROW	N/A - DCC project scheduled for 2014 construction	N/A
W12	2050	220	350	Existing Paved ROW	$700	$154,000
W13	2050	240	400	Existing Paved ROW	$810	$194,000
					2016 TOTAL	$5,110,000
					2018 TOTAL	$373,000
					2035 TOTAL	$2,430,000
					2050 TOTAL	$348,000
					GRAND TOTAL	$8,261,000

Table 2E- Capital Costs for Reservoir Upgrades

Task No.	Phasing	Task Name	Description	Volume (ML)	Unit Cost ($/m^3)	Cost ($ 2014)
R1	2035	Springwood Reservoir Upgrade	Increase Existing	4.1	$600	$2,460,000
R2	2018	Fairwinds Reservoir Upgrade	Increase Existing	1.0	$900	$900,000
					2016 TOTAL	$0
					2018 TOTAL	$900,000
					2035 TOTAL	$2,460,000
					2050 TOTAL	$0
					GRAND TOTAL	$3,360,000

KERR WOOD LEIDAL
consulting engineers

Table 3E- Capital Costs for Pump Station Upgrades

Task No.	Phasing	Task Name	Power (kW)	Unit Cost ($/kW)	Cost ($ 2014)
P0	2016 - 2050	Pump station in water treatment	Cost Included in WTP Pre-Design Report		
P1	2018	NBP Supply Pump Station	270	$8,000	$2,160,000
P3	2018	Springwood Booster Station Fire Pump Upgrade	160	$500	$80,000
P4	2050	Arbutus Station Fire Pump Upgrade	100	$500	$50,000
P5	2018	Decommission Craig Bay Pump Station	N/A	$30,000	$30,000
				2016 TOTAL	$0
				2018 TOTAL	$2,270,000
				2035 TOTAL	$0
				2050 TOTAL	$50,000
				GRAND TOTAL	$2,320,000

KERR WOOD LEIDAL
consulting engineers