COMPREHENSIVE REGIONAL WATER PLAN

FINAL

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OPUS DAYTONKNIGHT CONSULTANTS LTD.

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COMPREHENSIVE REGIONAL WATER PLAN

1.0 EXECUTIVE SUMMARY

This Comprehensive Regional Water Plan (CRWP) provides the Sunshine Coast Regional District (SCRD) with a review of the Regional Water Service Area (RWSA) and provides direction for the SCRD to meet the sustainability goals as identified in the *2011 We Envision Plan* and the *Corporate Strategic Plan*. The CRWP provides guidance for water conservation and system expansion / improvement measures to accommodate growth projections identified in the various Official Community Plans to the year 2036. The RWSA includes the Chapman water system (10,000 connections and bulk water supply to Gibsons) and the smaller Langdale, Soames Point, Granthams Landing, Eastbourne, Cove Cay and Egmont water systems (representing 648 connections combined). The Plan excludes the North and South Pender Harbour Water Service Areas, which are addressed in the Area A Water Master Plan and are currently the subject of separate 10 Year Master Plan development processes. There are certain areas in the SCRD that are populated but not currently serviced by community water systems. A policy is in development to address water needs in these areas.

The CRWP provides a detailed analysis of the Chapman water system which is the largest water system and supplies over 90% of the Coast's residents and businesses within the RWSA. The Langdale, Soames Point, Granthams Landing, Eastbourne, Cove Cay and Egmont Cove systems are also analyzed and included as a separate Small water systems section in this report.

Analysis of the Chapman and the small water systems result in recommended actions, such as intensive demand management, additional source supply capacities, additional treatment capacities, reservoir upgrades and distribution system upgrades, which are summarized in a

Strategic Plan for the Chapman and Small water systems. Capital and operations costs for these recommendations are evaluated and prioritized in a preliminary 10-year capital plan.

Demand management programs to effect water conservation have been in place since 2001. SCRD policy is to reduce water demand by 33% from 2010 levels by 2020. Existing demand management (EDM) programs include education, toilet rebate, fixture replacement, 4-stage sprinkling restrictions and enforcement measures. Since 2003 the programs have been successful in reducing average day demand by 12% (674 to 592 L/c/d) and maximum day demand by 23% (1,482 to 1,137 L/c/d) in the Chapman service area. Compared with geographically similar communities, however, the existing water demands remain high.

An intensive demand management (IDM) program should reduce demands to a target of 480 L/c/d for average day and 940 L/c/d for maximum day demand (similar to other communities). The proposed IDM program includes universal metering at an estimated life cycle cost of $8 million. Further measures may include mandatory Stage 2 and/or Stage 3 sprinkling restrictions until metering is implemented, a conservation based rate structure, leak detection and additional education/outreach programs. While the initial cost is high, lower demands will not only reduce long-term infrastructure upgrade requirements but will also allow deferment of infrastructure upgrades in the short term.

In order to better evaluate the merits of an intensive demand management program, all water system infrastructure upgrade and expansion requirements for year 2036 water demands have been analyzed and costed under conditions of both existing demand management (EDM) and intensive demand management (IDM).

Chapman Water System Strategic Plan

The projected 2036 water demands (high population growth rate of 2%) under these two demand management options for the Chapman water system are as follows:

TABLE 1-1
CHAPMAN WATER SYSTEM
PROJECTED 2036 DEMANDS

Water Demand	EDM	IDM
Average Day (ML/d)	21.3	17.0
Maximum Day (ML/d)	44.4	33.3

The Chapman Creek source relies on a combination of natural creek flow supplemented with release of water from storage in lakes (Chapman and Edwards). SCRD policy on source water supply (for surface water sources) is to maintain sufficient storage to meet water demands under a 1:25 year drought return period scenario, which is consistent with Provincial guidelines (Ministry of Environment Dealing with Drought handbook 2009). The analysis determined that the 2011 water demand could be met in a 1:21 year drought, which is already less than the 1:25 year goal, and reduces to a 1:11 year drought by 2036 under the EDM condition. With intensive demand management, the 2036 condition improves to a 1:15 year drought, but still unable to meet the 1:25 year criteria. Additional source capacities of 0.43 Mm^3 (under IDM) and 0.76 Mm^3 (under EDM) are needed to meet the 1:25 year drought condition under the 2036 water demand.

The Chapman Creek water treatment plant is presently operating close to its design capacity of 25 ML/d. Under the existing demand management scenario, plant expansion is an immediate priority with Stage 2 and 3 sprinkling restrictions to be implemented until expansion is completed. Under the IDM scenario, universal metering and Stage 2 and 3 sprinkling restrictions are anticipated to allow deferment of the timing for expansion until about the year 2020.

The SCRD WaterCAD model was used to analyze the transmission and distribution system within the Chapman service area. The analysis involves the application of maximum day demand (under both EDM and IDM conditions) coincident with fire flow requirements. Throughout the Province, most rural areas utilize a 30 L/s fire flow. Because much of the service area is rural, the system was analyzed under two conditions; 60 L/s fire flow for urban and rural areas and 60 L/s fire flow for urban areas with 30 L/s fire flow in rural areas. The results indicate a 60 L/s fire flow for urban and rural areas required approximately $7.1 million in upgrades while the 60 L/s urban and 30 L/s rural fire flow required only $0.50 million in upgrades. A 30 L/s fire flow requirement in rural areas and a 60 L/s requirement in urban areas are recommended.

Maximum service elevations for each pressure zone within the Chapman service area were also reviewed. The current system is unable to service higher elevation properties in the Roberts Creek, West Sechelt and Halfmoon Bay areas. As the current water system cannot support the current water service area boundaries, it is recommended that development priorities be restricted to the current service area boundaries and that future development plans that may look to expand service to these or other higher elevations be reviewed on a case by case basis.

Following analysis of the Chapman water system, a Strategic Plan was developed with a 25 year planning horizon, summarized as follows:

1) Previous studies were updated to allow comparison of three options for increasing the Chapman Creek source capacity, as summarized in Table 1-2.

TABLE 1-2
CHAPMAN CREEK SOURCE OPTIONS

Option	Life Cycle Cost	
	EDM	IDM
Engineered Lake	$8,000,000	$4,750,000
Floating Pump Station	$1,900,000	$1,200,000
Raise Chapman Lake	$5,500,000	$3,300,000

Construction of the floating pump station (or alternative system), future construction of the engineered lake, continued use of the Chaster Well during drought conditions, use of Gray Creek for emergency supply only and a groundwater investigation program are recommended for increasing the water source capacity.

2) The existing Chapman Creek water treatment plant comprises of two 12.5 ML/d treatment trains. Expansion includes the addition of a third train to increase the capacity to 37.5 ML/d at an estimated cost of $6.4 million. Under the IDM scenario, plant expansion is delayed to about the year 2020 and the service life of the expanded plant will extend beyond 2036. Under the EDM scenario, plant expansion is required immediately and the 37.5 ML/d design capacity will be reached around 2028. The plant would need to be further expanded to 45.0 ML/d at a cost of $10.0 million to provide service to 2036.

3) Transmission mains require upgrade to supply 2036 water demands. Under EDM, the upgrade cost is estimated at $7.55 million, reducing to $2.1 million with IDM.

4) Chapman reservoirs are able supply the existing and future balancing demand for the entire Chapman water system. Additional fire storage volumes are required in Zone 1 during the future 2036 EDM scenario. The cost for reservoir upgrades is $1.5 million for EDM, reducing to $0 if IDM is implemented.

5) To provide 2036 water demand and the required rural and urban fire flows requires upgrading of the distribution system (watermains, booster pump stations, pressure reducing stations, dead end elimination). The cost if EDM is continued is $13.74 million reducing to $12.84 million if IDM is implemented.

6) The financial significance of implementing an intensive demand management program compared with continuing the existing demand management program is illustrated below. Life cycle costs include the operations and maintenance costs to the year 2036.

TABLE 1-3
CHAPMAN WATER SYSTEM STRATEGIC PLAN
SUMMARY OF COSTS – EDM VS IDM

Item	Total Cost	
	EDM	IDM
Demand Management Programs	$120,000	$8,510,000
Source Supply	$10,270,000	$6,320,000
Water Treatment	$10,100,000	$6,500,000
Water Transmission / Reservoirs / Distribution	$22,790,000	$14,940,000
Total Estimated Cost	**$43,280,000**	**$36,270,000**

IDM is estimated to reduce overall costs by approximately $7.01 million and is recommended.

Small Water Systems Strategic Plan

The Langdale, Soames Point, Granthams Landing and Eastbourne water systems are supplied through shallow groundwater wells and the Cove Cay and Egmont Cove water systems are supplied through surface water from naturally occurring lakes in the SCRD. There is insufficient information to assess the drought risk of each of the small water system sources, but analysis was undertaken to compare the source capacity at each water system to supply water for the 2011 and 2036 water demand. It was determined that the source capacities were adequate for all water systems with the exception of the supply in the Eastbourne community. It was identified that a groundwater investigation program would be required to provide additional well supply to the area.

Treatment capacities at each of the small water systems were compared to the maximum day demands anticipated for 2011 and 2036. Treatment facilities are currently providing enough capacity to meet 2011 and 2036 maximum day demand for all the small water systems except for Eastbourne. The Eastbourne water system experiences periods of low flow at the well sources during the summer. To address this, each individual homeowner in the Eastbourne community has a water storage tank to provide water during these low demand periods.

The SCRD WaterCAD model was used to analyze the distribution network in the small water systems. The analysis involves the application of maximum day demand (under both EDM and IDM conditions) coincident with a 30 L/s fire flow requirement for the small water systems.

Following analysis of the small water systems, a Strategic Plan was developed with a 25 year planning horizon, summarized as follows:

1) A groundwater investigation to find additional suitable supply wells is recommended to improve the water supply to the Eastbourne community. Additionally, outstanding Source to Tap Assessments and Well Protection Plans should be completed for the small water systems.

2) Automation of the chlorination supply at the Soames Point well should be carried out by the SCRD. Further, the treatment capacity expansion for the Eastbourne community may be required upon commissioning of any additional groundwater wells that may be found and put into service.

3) There are fire storage deficiencies in the Langdale, Soames Point and Granthams Landing water systems under 2036 water demands. However, because of the interconnectivity of the zones and especially the Fisher PRV, water from the Chapman water system can be supplied to the small water systems during the fire flow condition. A budget of $10,000 per year is recommended for SCRD staff to confirm operation of the valves which will open to provide Chapman water under these emergency conditions. The 25-year life cycle cost of providing this service is $175,000.

4) To provide 2036 water demand and the required fire flows requires upgrading of the distribution system (watermains, booster pump stations, pressure reducing stations, dead end elimination). The cost is $1,855,000 under both EDM and IDM.

5) The financial significance of implementing an intensive demand management program compared with continuing the existing demand management program is illustrated below.

TABLE 1-4
SMALL WATER SYSTEMS STRATEGIC PLAN
SUMMARY OF COSTS – EDM VS IDM

Item	Total Cost	
	EDM	IDM
Demand Management Programs*	$0	$0
Source Supply	$200,000	$200,000
Water Treatment	$60,000	$60,000
Water Transmission / Reservoirs / Distribution	$2,030,000	$2,030,000
Total Estimated Cost	**$2,290,000**	**$2,290,000**

* Demand management costs are included in the Chapman Water System Strategic Plan

IDM is estimated have the same overall cost as the EDM condition for the small water systems. The cost savings are mostly realized in the work saved in the Chapman water system.

Preliminary 10-Year Capital Plan

The CRWP concludes with recommendations for priority work for the intensive and existing demand management scenarios presented as a preliminary 10-year capital plan. The intensive demand management scenario is recommended for the SCRD due to reduced costs as well as a timeframe where certain immediate upgrades to the system are delayed so that costs are spread out and more manageable for the SCRD.

Note that the detailed business / financial plan and rate structure design will be part of a separate document. The plan totals $30.5 million, as summarized in Table 1-5.

TABLE 1-5
PRELIMINARY 10-YEAR CAPITAL PLAN RECOMMENDATIONS

Recommendation	Construction Target	10 Year Capital Cost
Demand Management		
Implementation of Stage 2 and Stage 3 water sprinkling restrictions with enforcement	2014-2015	$ 120,000
Install Universal Metering	2014-2015	$ 5,280,000
Metering - Reading, Data Entry, Billing and O&M costs	2014-2023	$ 1,470,000
Assess Futher Demand Management Strategies	2014	$ 40,000
Additional Intensive Demand Mangement Programs	2019	$ 250,000
Water Source		
Obtain permits for floating pump station or alternative system	2014	$ 20,000
Construction of floating pump station or alternative system	2015	$ 660,000
Upkeep of floating pump station or alternative system	2016-2023	$ 320,000
Groundwater test drilling program	2016-2017	$ 300,000
Obtain property rights for construction of man-made lake	2021	$ 50,000
Small Systems: Groundwater Investigation to find suitable additional wells for Eastbourne	2019	$ 100,000
Small Systems: Complete Source to Tap Assessments and Well Protection Plans	2014	$ 100,000
Water Quality		
Initiate Pre-Design Study for Chapman Water Treatment Plant Expansion	2019	$ 100,000
Construction of Chapman Water Treatment Plant Expansion to 37.5 ML/d	2020-2021	$ 6,400,000
Small Systems: Automation of chlorination at the Soames Point Well	2018	$ 30,000
Small Systems: Pre-Design for Treatment Expansion at the Eastbourne Wells	2020	$ 30,000
System Infrastructure		
Chapman Transmission Main Upgrades (see Table 8-3)	2016	$ 2,100,000
Chapman Fire Protection Upgrades (see Table 8-5)	2017-2021	$ 11,000,000
Eliminate dead ends in the Chapman distribution system	2018-2023	$ 900,000
Small Systems: Annual check for interconnectivity	2014-2023	$ 100,000
Small Systems: Fire Protection Upgrades (see Table 9-2)	2016	$ 880,000
Small Systems: Eliminate dead ends	2017-2022	$ 300,000
	TOTAL	**$ 30,550,000**

Overall, the RWSA is well managed. The SCRD management team should be supported in their ongoing work to better the water supply service to the communities it serves.

2.0 INTRODUCTION

This section provides the context in which the Comprehensive Regional Water Plan is developed, and the rationale, purpose and intent for the document.

2.1 Context

Community plans and initiatives in the lower Sunshine Coast region are informed and guided by the Regional Sustainability Plan. The plan, entitled We Envision: One Coast, Together In Nature, Culture and Community, is the community's long range vision, action and policy document. It outlines a set of Core Values for a sustainable community and thirteen interconnected Strategic Directions towards our best possible future. Each Strategic Direction is guided by a Vision for 2060, and a set of targets to be achieved by 2020.

The Sunshine Coast Regional District's (SCRD's) Corporate Strategic Plan is a directional document that looks at the future of the organization in the context of its changing environment and addresses the needs and desires of its citizens. The Strategic Plan is aligned with the Regional Sustainability Plan and outlines the vision and goals the organization is aspiring to achieve.

The plan describes the specific objectives, targets and actions the Sunshine Coast Regional District wants to accomplish over a three year period. Together, the Regional Sustainability Plan and Corporate Strategic Plan inform the way in which the SCRD develops plans, makes decisions, and provides service and political leadership to the community.

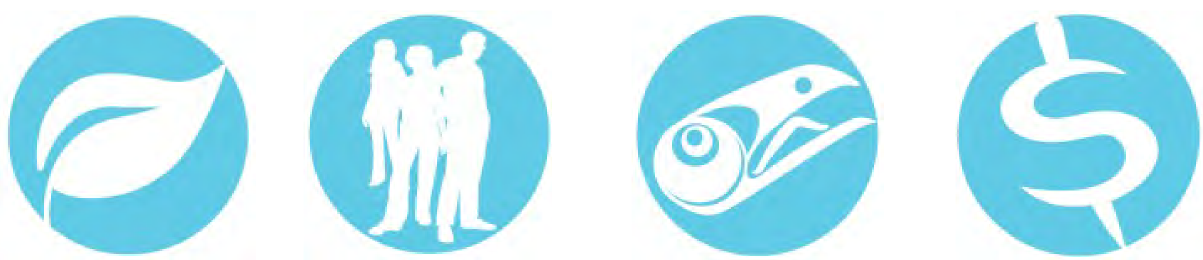
Regional Sustainability Plan

The Regional Sustainability Plan includes a description of current conditions within the lower Sunshine Coast Region, a set of Core Values for sustainable communities and thirteen interconnected Strategic Directions towards a sustainable future.

Core Values for a Sustainable Community

The following values make up the compass that will, in guiding us towards sustainability, keep our focus pointed in the necessary strategic directions:

Environmental Responsibility | **Health and Social Well-being** | **Cultural Vitality** | **Economic Vitality**



Strategic Directions

The following thirteen strategic directions represent critical paths towards a more sustainable future. Each is linked to, and interacts with, the rest. Each strategic direction includes a long term vision for 2060 and set of targets to be achieved by 2020.

Water Stewardship

High water quality and sufficient supply are critical elements of the Sunshine's Coast's long term health and sustainability as a community. Stewardship of our water is one of 13 different areas of strategic focus in the Regional Sustainability Plan. The following is an excerpt from the Regional Sustainability Plan entitled We Envision: One Coast, Together in Nature, Culture and Community:

Water is the central ingredient of life on Earth. As part of a thriving ecosystem, public health depends on healthy, ecologically diverse watersheds. We are a major influence on local ecosystems, and a protected, high-quality drinking water supply is important to us.

Vision for 2060

We envision all people on the Sunshine Coast having access to sufficient high-quality drinking water to meet their present and future needs.

Targets for 2020

1. *Reduce our water consumption by 33% per person*
2. *Increase the supply of potable water to meet the demand of projected population growth*
3. *Protect community drinking watersheds, aquifers and sensitive habitat areas*

Corporate Strategic Plan

The SCRD's Strategic Plan identifies three principles that will guide decisions within the organization: collaborative leadership; cultural, social, economic and environmental sustainability; and financial sustainability.

The key strategic directions identified in the Strategic Plan are:

- To have sufficient high quality drinking water to meet current and future needs.
- To reduce the amount of waste disposed of per person by 90% by 2060 relative to 2009 levels.
- To have community development on the coast that is planned in a collaborative manner that achieves social, cultural, economic and environmental targets.

The SCRD undertakes Comprehensive Regional Water Planning to ensure the continued provision of high quality drinking water to the region. To achieve the SCRD sustainability goals identified in *We Envision* and the *Corporate Strategic Plan*, this plan acknowledges the importance of protected watersheds as the basis for a secure drinking water supply, regular investments in repairing and upgrading infrastructure, and aggressive water conservation programs.

Comprehensive planning for the RWSA was initiated in 1983 and over the years has been updated every five to ten years; most recently in 2002. This update of the 2002 plan will provide direction for both water conservation and system expansion / improvement measures to accommodate growth projections over the next 25 years, including a 10-year capital plan.

The SCRD decision-making model can align conclusions from this report with SCRD Board priorities to create meaningful opportunities for public participation and decision making.

The SCRD infrastructure services department can recommend a number of strategies based on this report to better inform Board decision making related to provision of a safe and secure water supply for its citizens.

2.2 Background

The Sunshine Coast Regional District (SCRD) supplies water to over 25,000 residents on the Sunshine Coast. Development follows a narrow band along the coastline, extending approximately 85 km from Egmont to Langdale. Water is provided by way of three separate water service areas as illustrated on Figure 2-1.

- North Pender Harbour Water Service Area
- South Pender Harbour Water Service Area
- Regional Water Service Area (all remaining water systems)

This Plan focuses on the Regional Water Service Area (RWSA), which utilizes Chapman Creek as its primary water source.

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SUNSHINE COAST REGIONAL DISTRICT

WATER SERVICE SYSTEMS

FIGURE 2-1

The North Pender and South Pender Harbour Water Service Areas were incorporated into the Regional District in 2007 and 2008, respectively. Long range plans for both systems have been incorporated into the Area A Water Master Plan that was developed in 2007 and updated in 2011, and 10 year capital plans are currently being developed under a separate process. As the transfer of the North and South Pender Harbour water systems is still relatively fresh and that both systems are undergoing separate planning processes, these two systems and are not included in this report at this time.

The RWSA supplies bulk water to a portion of Gibsons, however, Gibsons owns and operates its own water system.

2.3 Scope of Work

Set out in the SCRD scope of work are four tasks. These tasks are summarized as follows:

<u>Task 1 – Engineering Analysis and System Modelling</u>

- Construct WaterCAD model for the SCRD.
- Project water demand over 25 year planning horizon with consideration for water conservation and varying growth rates.
- Assess source capacity for 1:25 year drought with consideration for climate change.
- Assess harmonisation of fire flow and storage requirements.
- Assess water quality related to mixing Chapman Creek water with that from Gray Creek and Chaster Well.
- Deliverables:
    - A technical report outlining system weakness and recommending improvements to accommodate water demand.

Task 2 – Strategic Planning and Service Level Definition

- Work with SCRD's Technical Team to develop strategies and goals to guide the planning process.
- Address service level options with consideration for environmental, social and economic sustainability.
- Consider Task 1 System Analysis in developing the strategic plan and service levels.
- Deliverables:
  - A strategic plan that defines the service levels best suited for the RWSA.

Task 3 – 10 Year Capital Plan

- Prepare capital plan incorporating recommendations from Tasks 1 and 2.
- Provide cost estimates.
- Deliverables:
  - A 10-year Capital Plan outlining construction program and funding requirements.

Task 4 – Business Plan and Rates Development

- Analyse cost of service using SCRD model.
- Address construction options, equity of service provided, cost effectiveness of metering/conservation measures.
- Determine revenue required to support 10 year operating and capital budgets.
- Identify funding sources.
- Develop development cost charge (DCC) schedule.
- Update capital assets and depreciation schedule.
- Develop rate schedule including water conservation based metered rates.
- Deliverables:

- 10 year cash flow projection with computer model.
- DCC schedule.
- Rate schedule.

For each of Tasks 1 to 4 the SCRD will provide available information, co-ordinate committee meetings and will provide draft report review comments.

Task 4 – "Business Plan and Rates Development" will be completed under a separate cover for the SCRD and is not included in this Comprehensive Regional Water Plan.

2.4 Previous Studies

Previous studies that have been reviewed during development of this plan include:

- 2002 Update of the Ten Year Waterworks Development Plan for the Chapman Water System (Dayton & Knight Ltd. 2002)
- Universal Metering Report (Stantec 2002)
- Town of Gibsons Water Supply Strategic Plan (Delcan 2005)
- Chapman Creek Watershed Drinking Water Source Assessment (Triton 2006)
- Risk Associated with Summer Water Shortages (Dayton & Knight Ltd. 2006)
- Chapman Water Treatment Plant Upgrade (Dayton & Knight Ltd. 2007-1)
- Source Development Options (Dayton & Knight Ltd. 2007-2)
- Long Term Source Development (Dayton & Knight Ltd. 2007-3)
- SCRD Water Systems Assessment (Dayton & Knight Ltd. 2007-4)
- Chapman and Edwards Lake Soundings (Theed 2010)
- Draft Bulk Water Supply Agreement with Town of Gibsons (SCRD 2011)
- Official Community Plans for the District of Sechelt (2010), Elphinstone (2008), Halfmoon Bay (1990), Roberts Creek (2012), West Howe Sound (2011) and Town of Gibsons (2005).

- Emergency Response Plans for the Chapman, Langdale, Soames, and Eastbourne Water Systems (SCRD 2011).
- Chapman Creek Source Assessment Response Plan (SCRD 2012)

2.5 Plan Development

The tasks outlined in the scope of work have been addressed through a sequence of sub-tasks and interactive exchange with SCRD staff as follows:

- Assemble, review and analyze past studies, operating data, relevant by-laws and planning documents.
- Participate in strategic planning session with SCRD Technical Team to establish service levels and growth scenarios with due consideration for demand management measures and OCP guidelines.
- Analyze historic water consumption and project future water demand for the selected growth scenarios.
- Analyze water system (using computer model) under conditions of existing and future water demand scenarios and service levels.
- Evaluate water system upgrade requirements for future demand scenarios in order to recommend the 10-year capital plan.
- Develop the business plan and rate structures based on the 10-year capital plan.
- Submit drafts of report to SCRD for staff review and comment.
- Present report to SCRD Infrastructure Services Committee.
- Present report to the public through open house format.

2.6 Abbreviations

ADD	Average Day Demand
CRWP	Comprehensive Regional Water Plan
DCC	Development Cost Charge
DFO	Department of Fisheries and Oceans
DWO	Drinking Water Officer
EDM	Existing Demand Management
FF	Fire Flow
ICI	Industrial / Commercial / Institutional
IDM	Intensive Demand Management
L/s	litres per second
L/c/d	litres per capita per day
Mm^3	million cubic metres
ML/d	million litres per day
MDD	Maximum Day Demand
MV	Metro Vancouver
NTU	Nephelometric Turbidity Unit
O&M	Operations and Maintenance
OCP	Official Community Plan
Psi	pounds per square inch
PRV	Pressure Reducing Valve
RWSA	Regional Water Service Area
SCRD	Sunshine Coast Regional District
SIGD	Sechelt Indian Government District
TOG	Town of Gibsons
VCHA	Vancouver Coastal Health Authority
WTP	Water Treatment Plant

3.0 EXISTING REGIONAL WATER SYSTEM

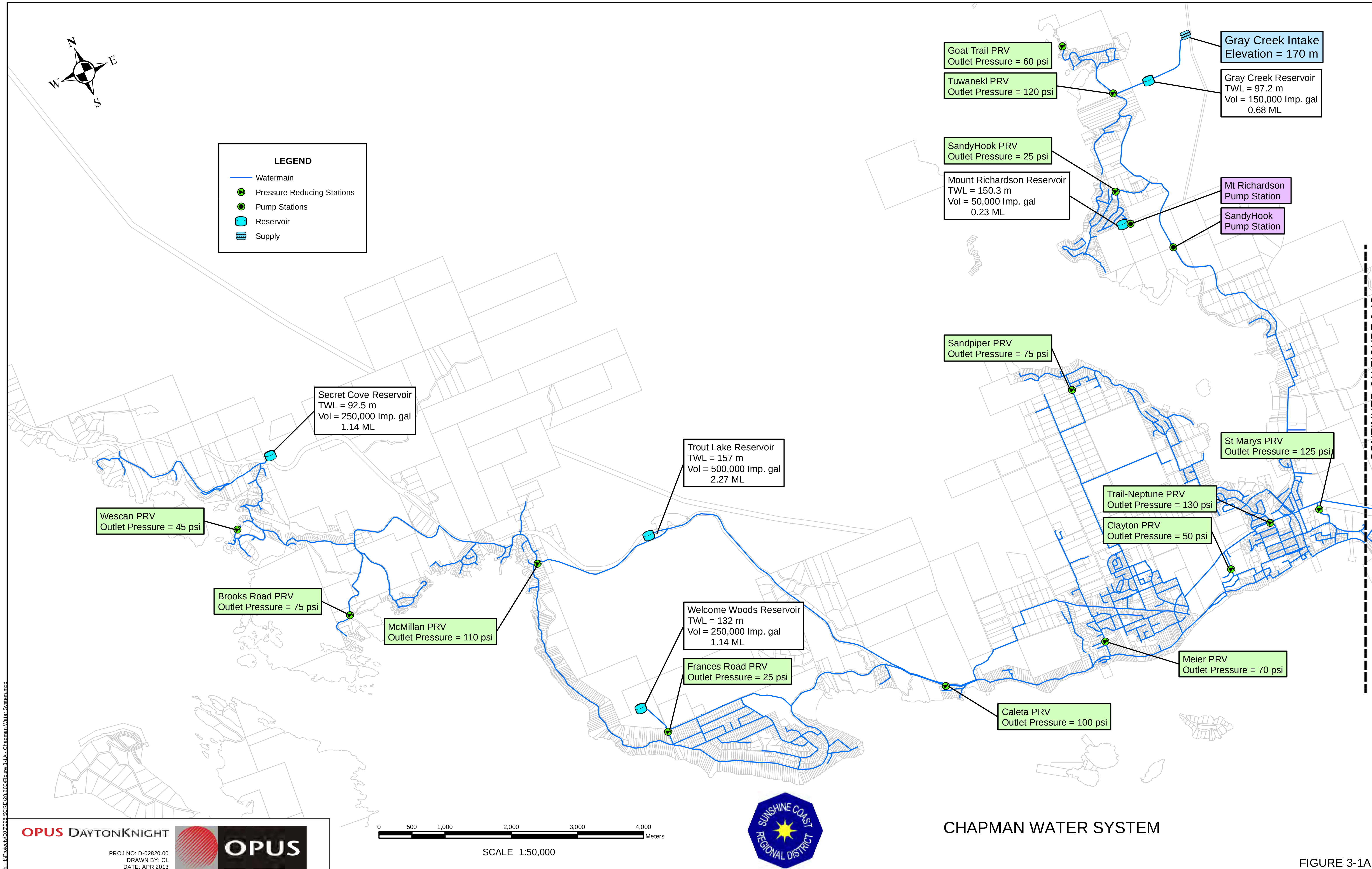
A brief description of the existing water system within the Regional Water Service Area is presented in this section.

3.1 System Overview

The Regional Water Service Area comprises of the following water supply systems:

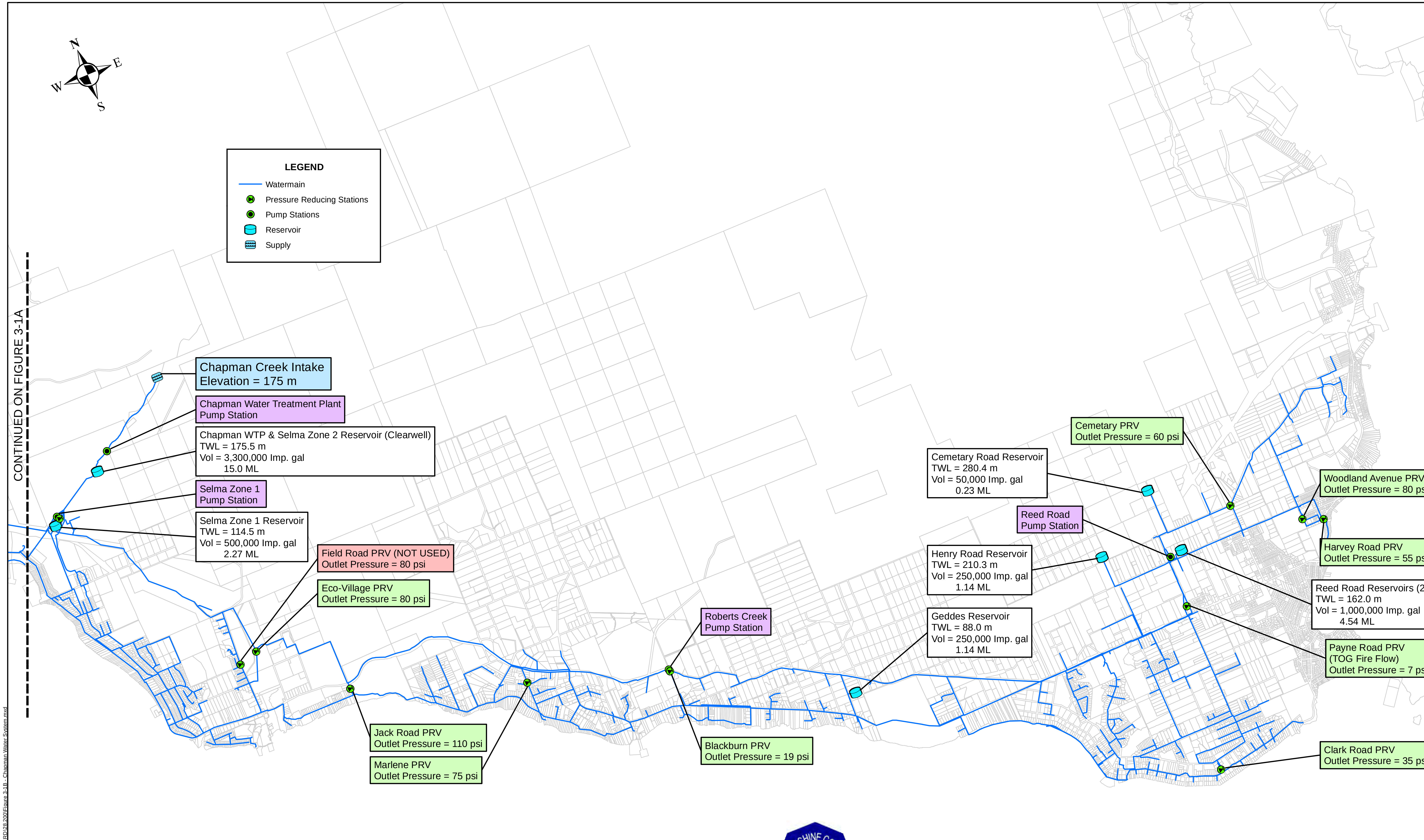
- Chapman water system (Chapman Creek, 10,000 connections plus bulk supply to Gibsons) – Figures 3-1A and 3-1B.
- Langdale water system (Langdale Well, 220 connections) – Figure 3-1C.
- Soames Point water system (Soames Point Well, 80 connections) – Figure 3-1D.
- Granthams Landing water system (Granthams Landing Well, 83 connections) – Figure 3-1E.
- Eastbourne water system (Wells, 160 connections on Keats Island) – Figure 3-1F.
- Cove Cay water system (Ruby Lake, 77 connections) – Figure 3-1G.
- Egmont water system (Waugh Lake, 28 connections) – Figure 3-1H.

The Chapman water system is the primary water system in the Regional Water Service Area, servicing the majority (about 90%) of the Sunshine Coast's population. Chapman Creek is the primary water source for the Chapman water system. The Chapman system also utilizes a groundwater supply in Elphinstone (Chaster Well) to augment summer supply. Gray Creek also supplements the Chapman Creek system during the summer in



CHAPMAN WATER SYSTEM

FIGURE 3-1A



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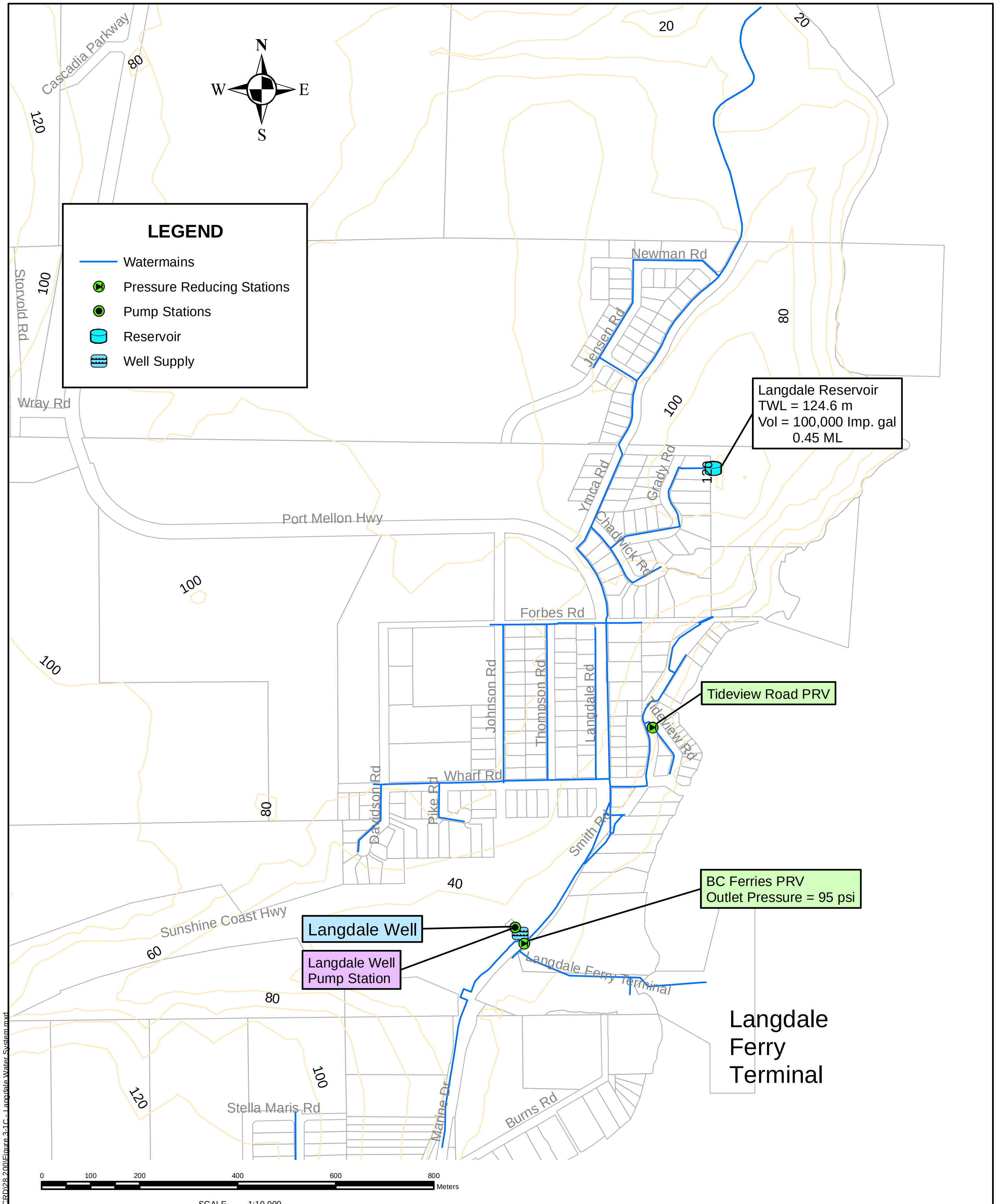
CHAPMAN WATER SYSTEM

FIGURE 3-1B

Path: H:\Projects\00\0028 SCRD\28.200\Figure 3-1B - Chapman Water System.mxd



Path: H:\Projects\0000\28 SCRD\28 200\Figure 3-1C - Langdale Water System.mxd

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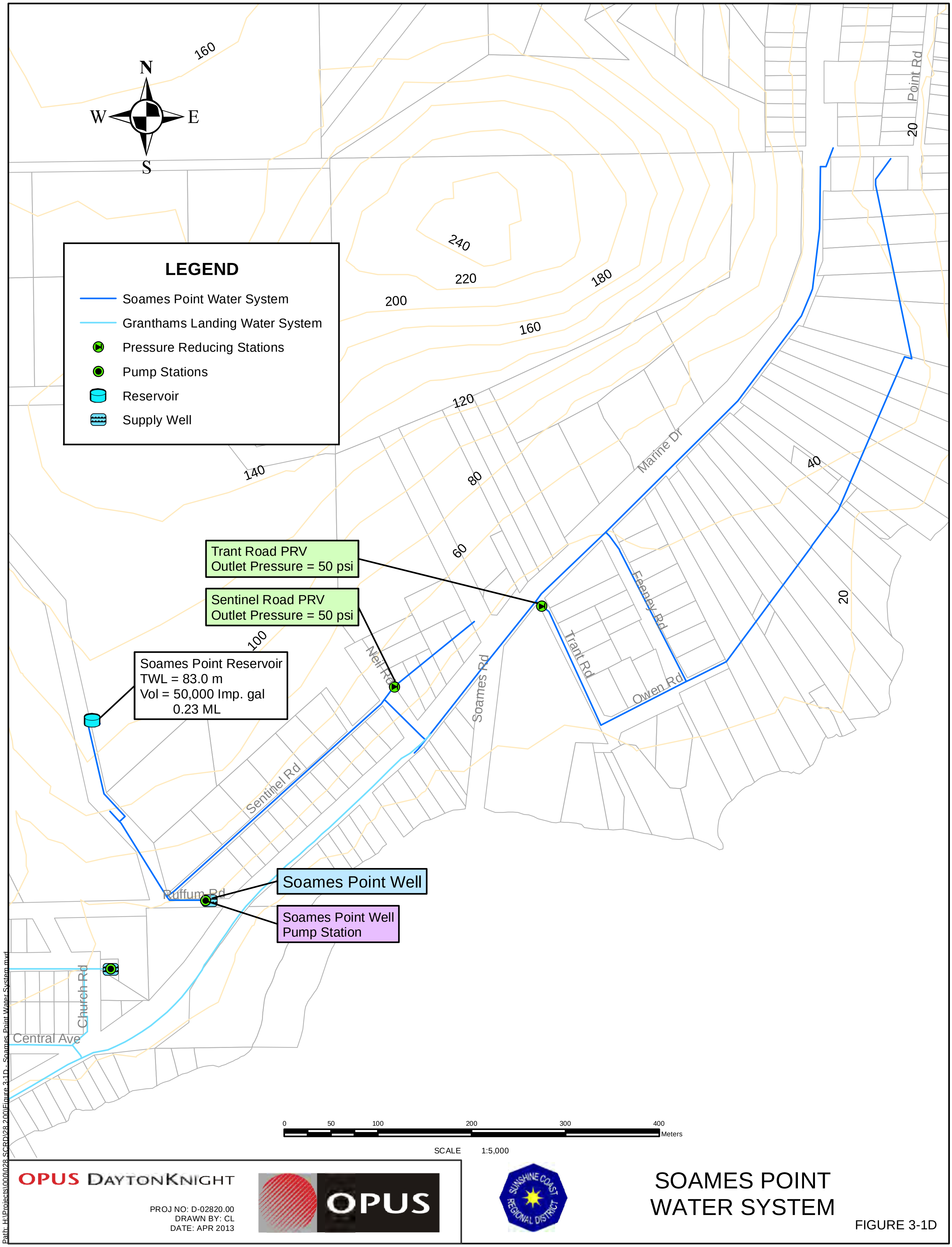
LANGDALE WATER SYSTEM

FIGURE 3-1C



N
E
S
W
LEGEND
Soames Point Water System
Granthams Landing Water System
Pressure Reducing Stations
Pump Stations
Reservoir
Supply Well
Trant Road PRV
Outlet Pressure = 50 psi
Sentinel Road PRV
Outlet Pressure = 50 psi
Soames Point Reservoir
TWL = 83.0 m
Vol = 50,000 Imp. gal
0.23 ML
Soames Point Well
Soames Point Well
Pump Station
Marine Dr
Feeney Rd
Trant Rd
Owen Rd
Soames Rd
Neil Rd
Sentinel Rd
Ruffum Rd
Church Rd
Central Ave
Point Rd
240
220
200
180
160
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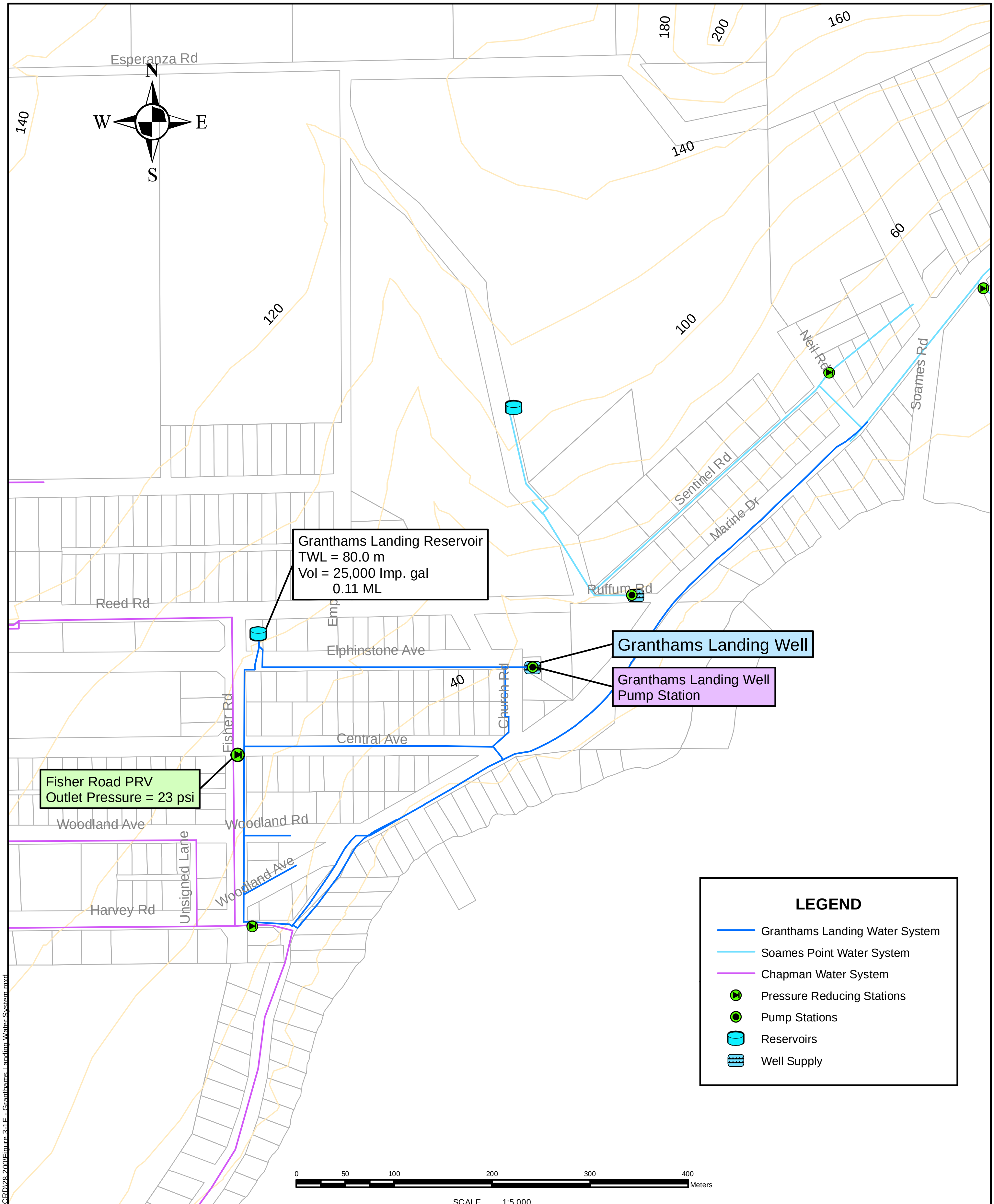
SOAMES POINT
WATER SYSTEM
FIGURE 3-1D



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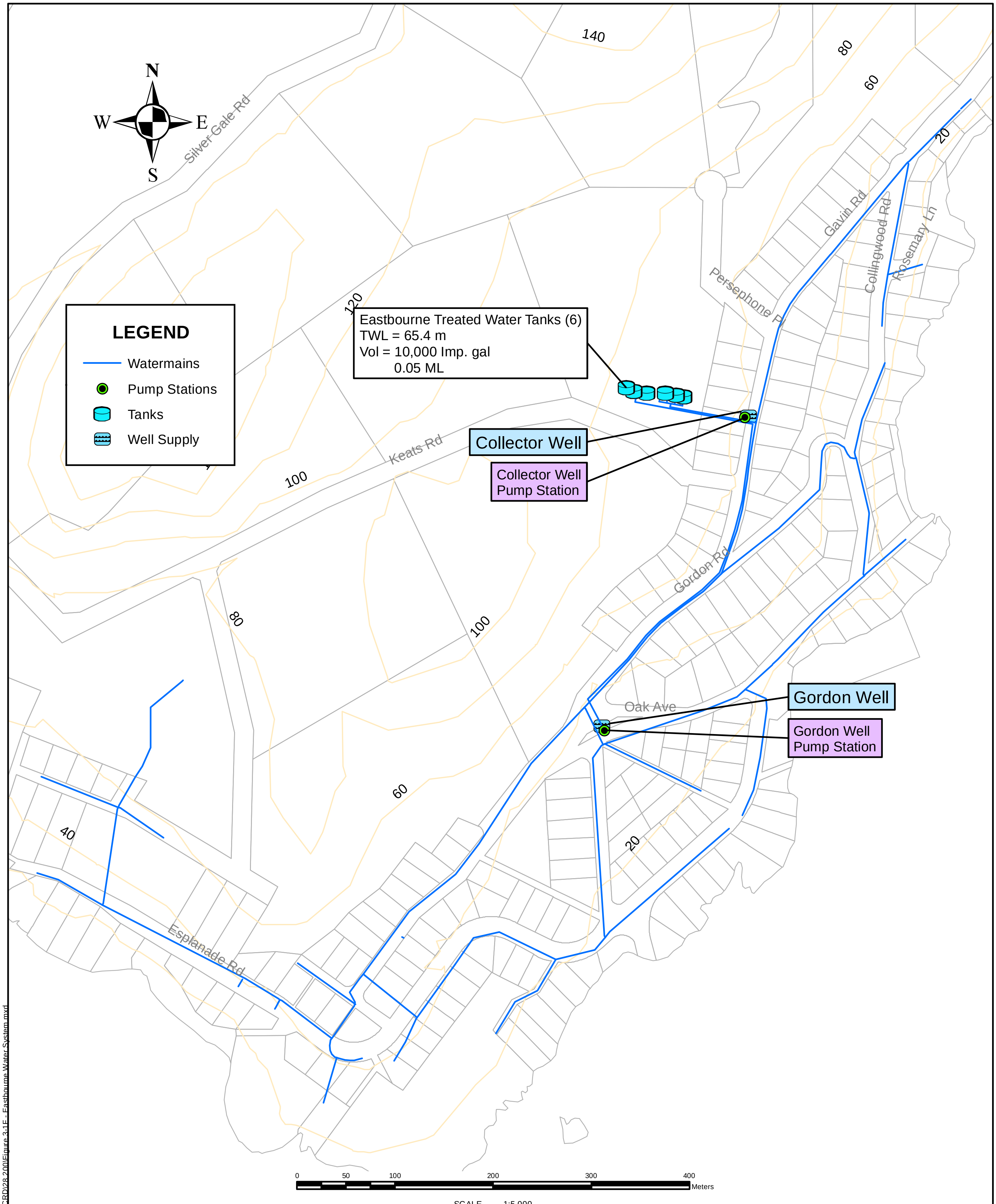
GRANTHAMS LANDING WATER SYSTEM

FIGURE 3-1E



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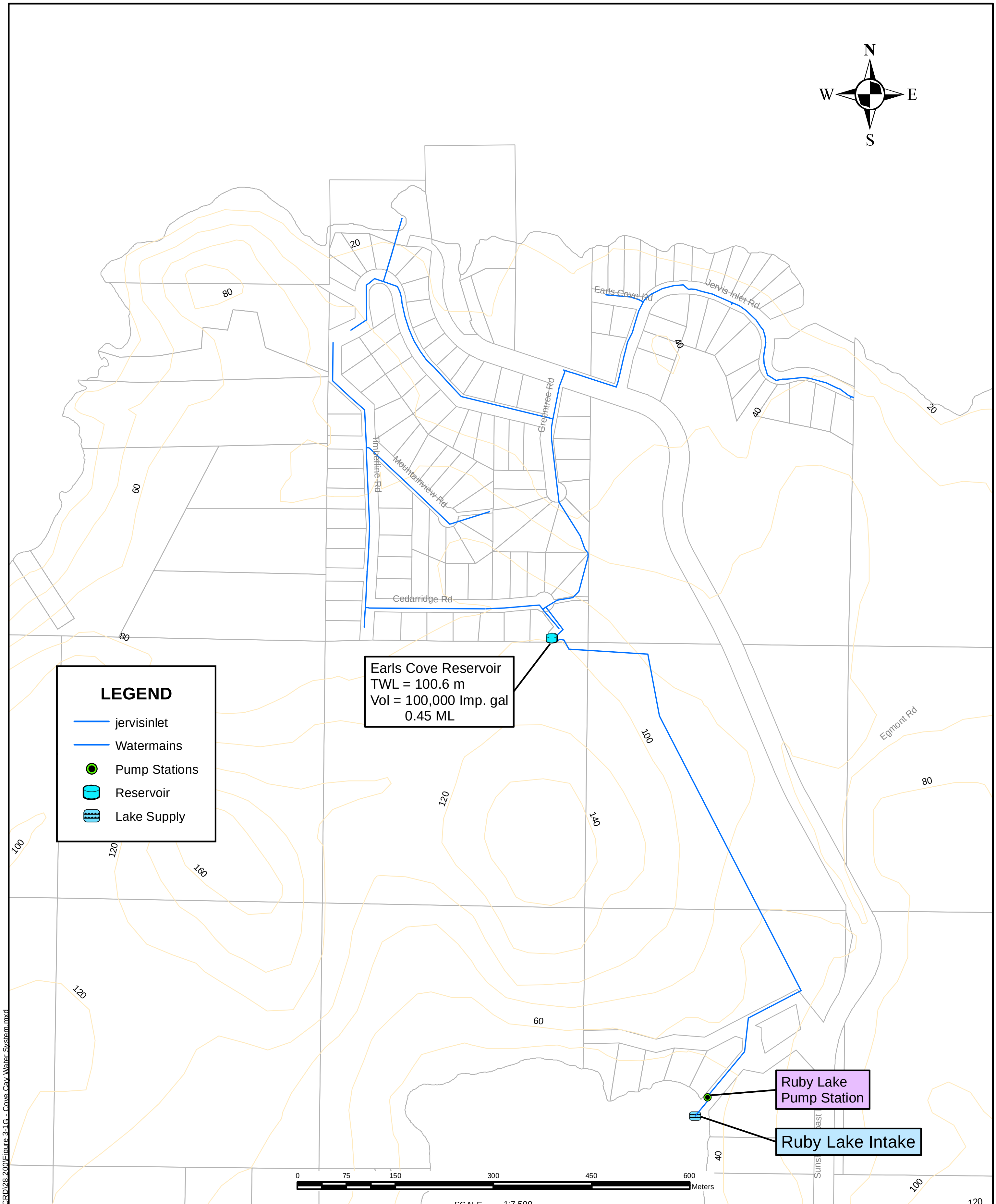
SUNSHINE COAST REGIONAL DISTRICT

EASTBOURNE WATER SYSTEM

FIGURE 3-1F

Path: H:\Projects\0000\028 SCRD\28 200\Figure 3-1F - Eastbourne Water System.mxd



Path: H:\Projects\000\028 SCRD\28.200\Figure 3-1G - Cove Cay Water System.mxd

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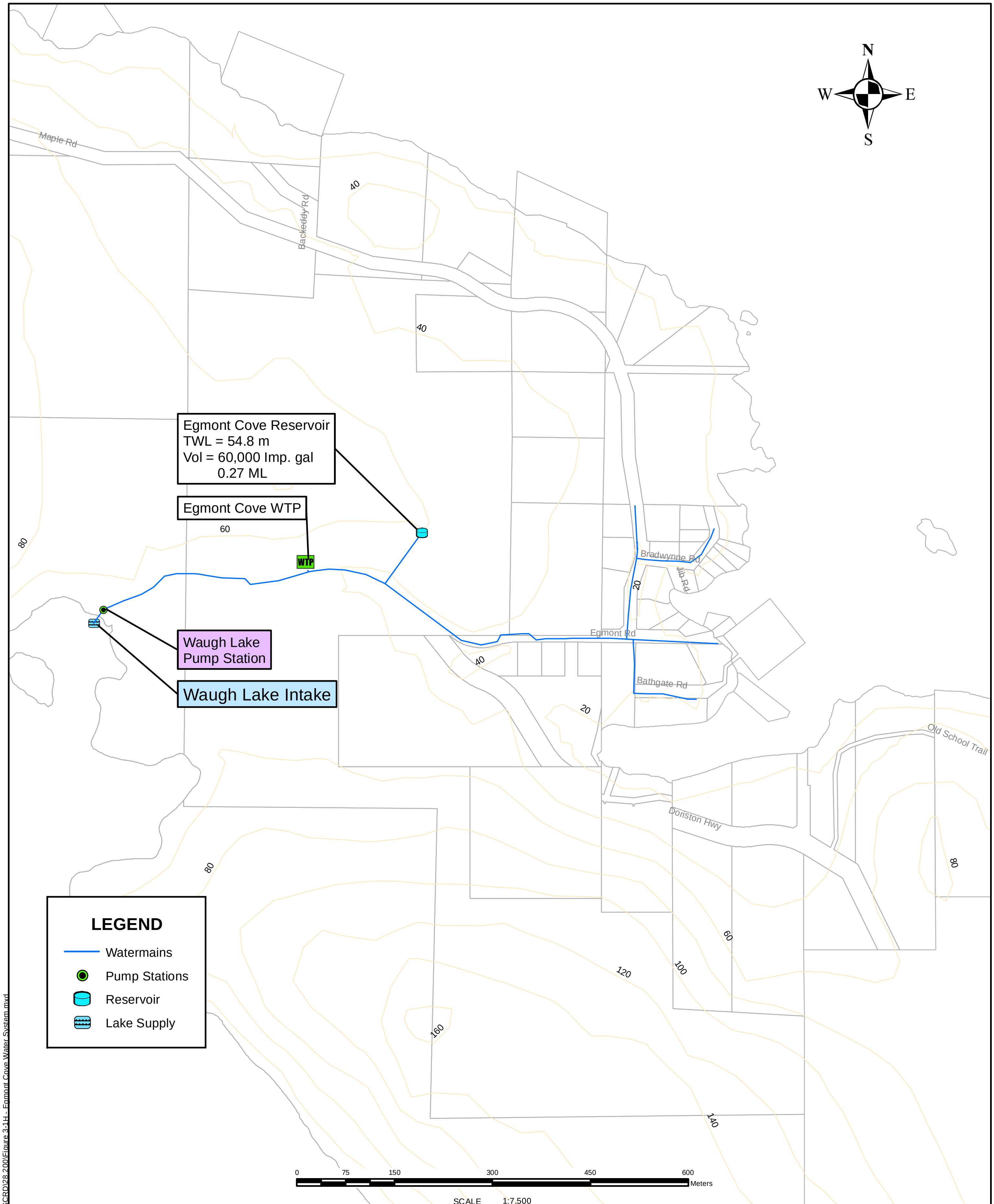
SUNSHINE COAST REGIONAL DISTRICT

COVE CAY WATER SYSTEM

FIGURE 3-1G



Path: H:\Projects\0000\28.SCRD\28.200\Figure 3-1H - Egmont Cove Water System.mxd

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SUNSHINE COAST REGIONAL DISTRICT

EGMONT COVE WATER SYSTEM

FIGURE 3-1H

the Tuwanek and Sandy Hook areas. Trout Lake is available as an emergency backup supply source to the Halfmoon Bay area of the Chapman system, but is not considered for operational supply purposes.

There are certain areas in the SCRD that are populated but not currently serviced by community water systems. A policy is in development to address water needs in these areas.

3.2 Water Licences

The SCRD holds eight waterworks and water storage licenses on Chapman Creek. The licenses allow withdrawal of a maximum daily flow of 33.3 ML/d (7.325 Mgal/day) and an average annual flow of 20.5 ML/d (4.5 Mgal/day) from Chapman Creek. The SCRD holds a water license (No. 50724) to store 0.91 Mm^3 (735 ac·ft) of water in Chapman Lake and a water license (No. 69966) to store 0.86 Mm^3 (700 ac.ft.) of water in Edwards Lake; or a total of 1.77 Mm^3.

The SCRD has a license (No. 110344) to withdraw an average daily flow of 3.4 ML/d (0.75 Mgal/day) from Gray Creek, and one license (No. 42036) to withdraw an average daily flow of 0.23 ML/d (0.05 Mgal/d) and a license (No. 18422) to store 0.049 Mm^3 (40 ac·ft) of water from Trout Lake.

The SCRD also holds a licence (No. 127866) to withdraw 0.114 ML/d (41,510 m3/y) of water from Waugh Lake and a licence (No. 044630) to withdraw 0.218 ML/d (79,647 m3/y) of water from Ruby Lake.

In addition to the SCRD licenses, the Sunshine Coast Salmonid Enhancement Society has a license (No. 65123) to withdraw 24.5 ML/d (10 ft^3/s) from Chapman Creek. Fisheries and Oceans Canada (DFO) has requested that a minimum flow of 24.5 ML/d be maintained in Chapman Creek downstream of the intake to support fish habitat and water quality conditions. The SCRD, however, does not have a low flow agreement in place with DFO (Triton 2006). The SCRD's current procedure is to maintain a flow of 24.5 ML/d below the intake during normal operation and a minimum flow of 19 ML/d during the summer dry period. The SCRD is in constant communication with the hatchery to ensure adequate flows are maintained in the creek during the summer. Recent streamflow data from below the intake indicates that controlled low flows during the summer do not achieve the targeted DFO required flows. Conflicting water requirements during periods of low flow have been a concern between the SCRD and DFO for some time (Triton 2006).

3.3 Water Sources

The SCRD extracts water from four surface and five groundwater sources in the Regional Water Service Area. A fifth surface water source, Waugh Lake supplies the Egmont water system that was commissioned in December 2012.

Primary Sources

- Chapman Creek
- Langdale Well
- Soames Point Well
- Granthams Landing Well
- Eastbourne Wells
- Ruby Lake
- Waugh Lake

Secondary Sources

- Gray Creek
- Chaster Well
- Trout Lake (Emergency only)

3.3.1 Chapman Water System

The Chapman water system is supplied from Chapman Creek watershed, Gray Creek watershed and the Chaster Well. Water from Gray Creek and Chaster Well is only used when required to supplement the Chapman Creek supply, usually during the dry summer months.

An Emergency Response Plan for the Chapman water system was completed in 2010 (Dayton & Knight Ltd. 2010).

Chapman Creek

Chapman Creek watershed encompasses an area of 8.6 km^2. The watershed contains two lakes, Chapman and Edwards, which have outlet structures enabling them to be utilized for water storage. Water is released from these lakes to the creek over the dry summer period to maintain sufficient flow at the water treatment plant (located approximately 14 km downstream of the lakes). The maximum quantity of diversion allowed from Chapman Creek is 33.3 ML/d.

Available storage within Chapman Lake is estimated to be 0.751 Mm^3 from the crest of the weir to the bottom of the inlet (Theed 2010). The estimated storage volume for Edwards Lake is 0.907 Mm^3 based on a storage depth of 3.5 m. The total available storage in the Chapman Creek watershed is estimated to be 1.658 Mm^3. It should be noted that the 1.658 Mm^3 storage is less than the historical estimate of 1.94 Mm^3.

A drinking water source assessment study completed in 2006 by Triton Environmental Consultants Ltd. identified area vulnerabilities and natural hazards in the Chapman Creek watershed and their potential effects to the quality or quantity of raw, untreated drinking water in Chapman Creek. The study developed risk management options to be used in the preparation of the Emergency Response Plan and the Source Assessment Response Plan, which was adopted by the SCRD Board on July 12, 2012.

Gray Creek

Gray Creek watershed has an area of 1.45 km^2. The licensed diversion allowed is 3.4 ML/d; however, only about 1.0 ML/d is historically available from Gray Creek during the dry summer months. During the summer high demand periods Gray Creek has been used to service the residents of SandyHook and Tuwanek. The use of Gray Creek water has been gradually reduced in recent years and was not used to supply water to the Sandy Hook and Tuwanek areas in 2008 and 2010.

The Gray Creek supply does not currently meet treatment requirements for surface water systems. A Source to Tap Assessment for the Gray Creek watershed has been requested by the local Drinking Water Officer but has not been completed.

Chaster Well

The capacity of Chaster Well is 1.3 ML/d. It is usually turned on from June to September to supplement the Chapman Creek supply. A well protection plan has not been completed.

Trout Lake

Trout Lake is located to the north of the Halfmoon Bay residential area. It is no longer in active use; however, it does provide an emergency backup to the Chapman water system. The water license allows for a maximum diversion of 0.23 ML/d.

3.3.2 Other Water Systems

Langdale

This system serves the community of Langdale (220 connections), including the Langdale Elementary School and BC Ferries. The well has a capacity of 1.2 ML/d.

An emergency response plan for the Langdale water system was completed in 2010. A well protection plan is outstanding.

Soames Point

The water from this source serves the Soames Point community (80 connections). The well has a capacity of 1.39 ML/d. The Soames Point water system has recently been connected to the Granthams Landing system.

An emergency response plan for the Soames water system was completed in 2010. A well protection plan is outstanding.

Granthams Landing

The Granthams Landing water system was transferred from the Granthams Landing Improvement District to the SCRD in 2009 and consists of 83 connections. The supply capacity of the well is 0.23 ML/d.

An emergency response plan for the Granthams Landing water system will be completed in 2013. A well protection plan is outstanding.

The SCRD has recently interconnected the Granthams Landing and Soames Point water systems. The Granthams Landing and Soames Point systems have also been connected to the Chapman water system through the new Fisher Road PRV that will allow emergency supply from the Chapman Creek source.

Eastbourne

The Eastbourne water system services 160 connections on Keats Island. Water supplied from shallow groundwater wells is limited. The community water system was assumed by the SCRD in 2002. Due to limited water supply, the system is not conventional and is operated as a low flow system. The SCRD has implemented innovative strategies such as the requirement for 4,500 litre water storage tanks and flow restrictions on services at each property to mitigate peak demands on the system and allow for supply uncertainty. Well capacity varies from 0.02 ML/d in the dry season to over 0.07 ML/d.

An emergency response plan for the Eastbourne water system was completed in 2010.

Cove Cay

Ruby Lake serves the Cove Cay and Jervis Inlet Road communities (77 connections) near Earls Cove. The maximum allowed diversion from Ruby Lake is 0.22 ML/d. The supply capacity at the lake is 1.20 ML/d.

An emergency response plan for the Cove Cay water system was completed in 2010.

Egmont

Waugh Lake supplies the Egmont water system (28 connections). The SCRD holds one licence with a maximum withdrawal of 0.11 ML/d. The supply capacity at the lake is 0.22 ML/d.

An emergency response plan for the Egmont water system will be completed in 2013.

3.3.3 Combined Sources

Table 3-1 summarizes the total capacities for the water sources that service the Regional Water Service Area.

TABLE 3-1
REGIONAL WATER SERVICE AREA
WATER SOURCE CAPACITIES

Water System	Source	Capacity (ML/d)
Langdale	Langdale Well	1.2
Soames Point	Soames Point Well	1.39
Granthams Landing	Granthams Landing Well	0.23
Eastbourne	Eastbourne Wells	0.02
Cove Cay	Ruby Lake	1.20
Egmont	Waugh Lake	0.22
Sub-total	-	**4.3**
Chapman	Chapman Creek Gray Creek Chaster Well Trout Lake	33.3[(1)] 1.0[(2)] 1.3 0.23[(1)]
Sub-total	-	**35.8**
TOTAL		**40.1**

Notes: [(1)] Maximum allowable diversion by the SCRD.
[(2)] License allows 3.4 ML/d, however, only 1.0 ML/d available in dry months.

3.4 Water Treatment

The SCRD manages the water treatment of all the water sources in the Regional Water Service Area.

3.4.1 Chapman Water System

Water is treated at Chapman Creek, Gray Creek, Chaster Well and Trout Lake. Trout Lake water is only used and treated under emergency situations.

Chapman Creek

The Chapman Creek Water Treatment Plant (WTP) was commissioned in 2004 and has a design capacity of 25 ML/d in normal operation. The plant can be operated at 26.9 ML/d with a third pump in operation and no redundancy.

Table 3-2 shows the maximum day and maximum week flows that the treatment plant has experienced in recent years and the number of days each year the WTP capacity of 25 ML/d has been exceeded. The plant is operating beyond its design capacity during peak demand periods in the dry summer months (currently 10 to 12 days a year).

TABLE 3-2
CHAPMAN CREEK WATER TREATMENT PLANT
HISTORICAL PEAK FLOWS

Year	Maximum Day Demand		Days WTP Capacity Exceeded	Maximum Week Demand (ML/d)
	(ML/d)	Date		
2004	**26.5**	July 28	5	24.6
2005	**26.6**	August 1	9	24.9
2006	**26.6**	July 27	11	25.3
2007	**26.7**	July 10	2	23.6
2008	**27.1**	July 24	10	24.6
2009	**28.5**	June 4	12	**25.1**
2010	**28.1**	Aug 16	11	**25.3**
2011	**23.8**	Aug. 8	0	**21.8**

Raw water quality parameters in Chapman Creek previously identified as potential concerns include pH, turbidity, colour, total organic carbon and faecal coliform (Triton 2006). The Drinking Water Officer (DWO) has noted that security of the water supply from source to lot line needs review. There are also dead ends in the system identified by the DWO as requiring evaluation. A complete source to tap assessment for the Chapman Creek and Gray Creek systems has been requested by the DWO.

The treatment processes at the plant include coagulation, flocculation, DAF clarification, filtration, and UV primary and chlorine gas secondary disinfection. The treatment processes comply with the "B.C. Drinking Water Protection Regulation" and the treated water consistently meets guidelines (despite operation in excess of design capacity).

The Vancouver Coastal Health Authority (VCHA) provides a guideline of a minimum of 0.2 mg/l chlorine residual throughout water distribution systems. The local DWO currently works closely with the operators to maintain an acceptable minimum chlorine residual. The VCHA has confirmed that the SCRD is currently meeting its expectations for residuals in Chapman water system and all its small water systems.

<u>Gray Creek</u>

Gray Creek is a secondary source used to supplement the Chapman Creek source. The only treatment is sodium hypochlorite for disinfection.

The treatment does not meet the guidelines for surface water treatment as outlined in the B.C Drinking Water Protection Regulation and the source water does not meet water quality guidelines.

The DWO requires that the SCRD close off the supply at the Sandy Hook PRV/Pump Station to limit the distribution of water to only the Sandy Hook and Tuwanek areas and prevent Gray Creek water entering the rest of the Chapman water system. The current system includes online chlorine and turbidity monitoring with an automatic shut off if the turbidity exceeds 1.0 NTU or the chlorine residual drops below 0.4 mg/L. A complete source to tap assessment for the Chapman Creek and Gray Creek water systems has been requested by the DWO.

Chaster Well

The Chaster well is also used to supplement the Chapman Creek source. The Chaster well water meets water quality guidelines. Treatment is limited to sodium hypochlorite for disinfection in compliance with the DWO requirements.

Trout Lake

Trout Lake is an emergency source for the Chapman water system. The Trout Lake treatment facility has pressure filters and a chlorine injection system. The treatment does not meet the guidelines for surface water treatment as outlined in the B.C. Drinking Water Protection Regulation. Treated water quality has not been tested recently.

3.4.2 Other Water Systems

The SCRD is also responsible for water treatment of other water systems in the Regional Water Service Area. Table 3-3 summarizes the treatment for each of these water systems.

TABLE 3-3
REGIONAL WATER SERVICE AREA
WATER SYSTEM TREATMENT

Water System	Source	Treatment Processes
Langdale	Langdale Well	Chlorination
Soames Point	Soames Point Well	Chlorination
Granthams Landing	Granthams Landing Well	Chlorination
Eastbourne	Eastbourne Wells	Filtration, UV and Chlorination
Cove Cay	Ruby Lake	Chlorination
Egmont Cove	Waugh Lake	UV and Chlorination
Chapman	Chapman Creek	Filtration, UV and Chlorination
	Gray Creek	Chlorination
	Chaster Well	Chlorination
	Trout Lake	Filtration, Chlorination

The DWO has identified and requested the automation of chlorination in Soames Point to maintain residuals in the water system. This has yet to be completed.

3.5 Supply Transmission

Transmission watermains are designed to convey large amounts of water from one part of the system to another. In the Chapman water system, the transmission mains transport water from the Chapman Water Treatment Plant 19 km east to the Cemetary Road Reservoir and 13.5 km west to the Secret Cove Reservoir. The transmission mains are illustrated on Figure 3-2A/B.

Transmission mains in the Chapman water system are isolated from the smaller systems via closed valves or PRVs and only deliver water to Langdale, Soames Point, Granthams Landing and the privately owned Hopkins Landing water systems on an emergency basis.

3.6 Water Storage Reservoirs

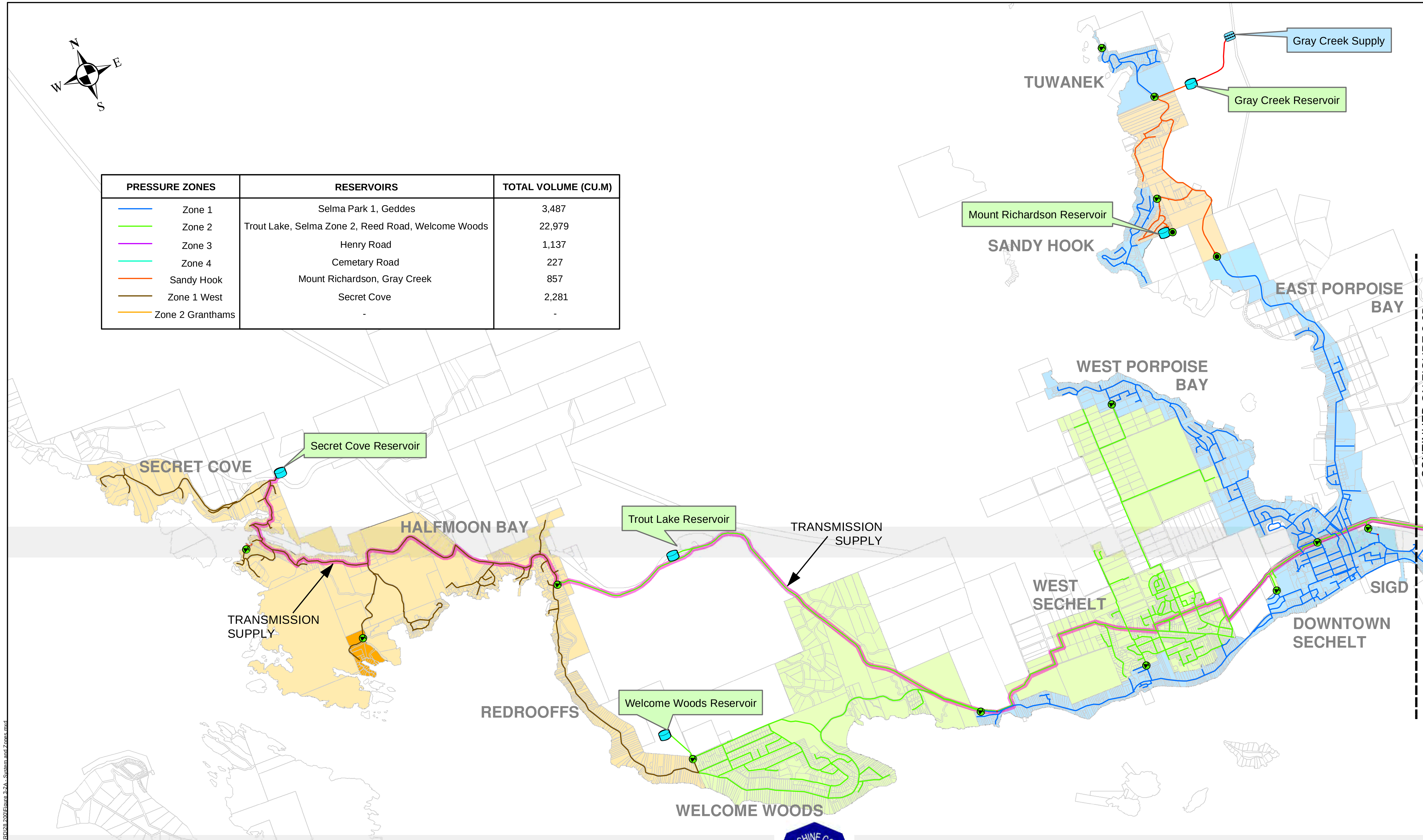
Water storage reservoirs are located at specific elevations to establish pressure zones within the distribution system. Typical design pressures within a zone vary from a minimum of 30 to 40 psi to a maximum of 120 to 150 psi; however, there are zones that currently operate at up to 200 psi. During a 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. Calculation of the reservoir capacity is based from the MMCD Design Guideline Manual (MMCD 2005). Balancing storage is typically designed as 25% of maximum day demand, while fire storage volume is based on the Fire Underwriters Survey (FUS) guidelines and is specific to the type of development in each zone. For Zones 1 and 2, fire storage is calculated at 225 L/s for 4.0 hours based on FUS fire flow requirements for industrial sites within these two zones. For all other zones, fire storage is 60 L/s for 2.0 hours based on FUS fire flow requirements for residential properties within these zones.

The reservoirs and pressure zones are illustrated on Figure 3-2A/B.

The capacity of existing reservoirs, including fire storage requirements, is summarized in Table 3-4.

PRESSURE ZONES	RESERVOIRS	TOTAL VOLUME (CU.M)
Zone 1	Selma Park 1, Geddes	3,487
Zone 2	Trout Lake, Selma Zone 2, Reed Road, Welcome Woods	22,979
Zone 3	Henry Road	1,137
Zone 4	Cemetary Road	227
Sandy Hook	Mount Richardson, Gray Creek	857
Zone 1 West	Secret Cove	2,281
Zone 2 Granthams	-	-



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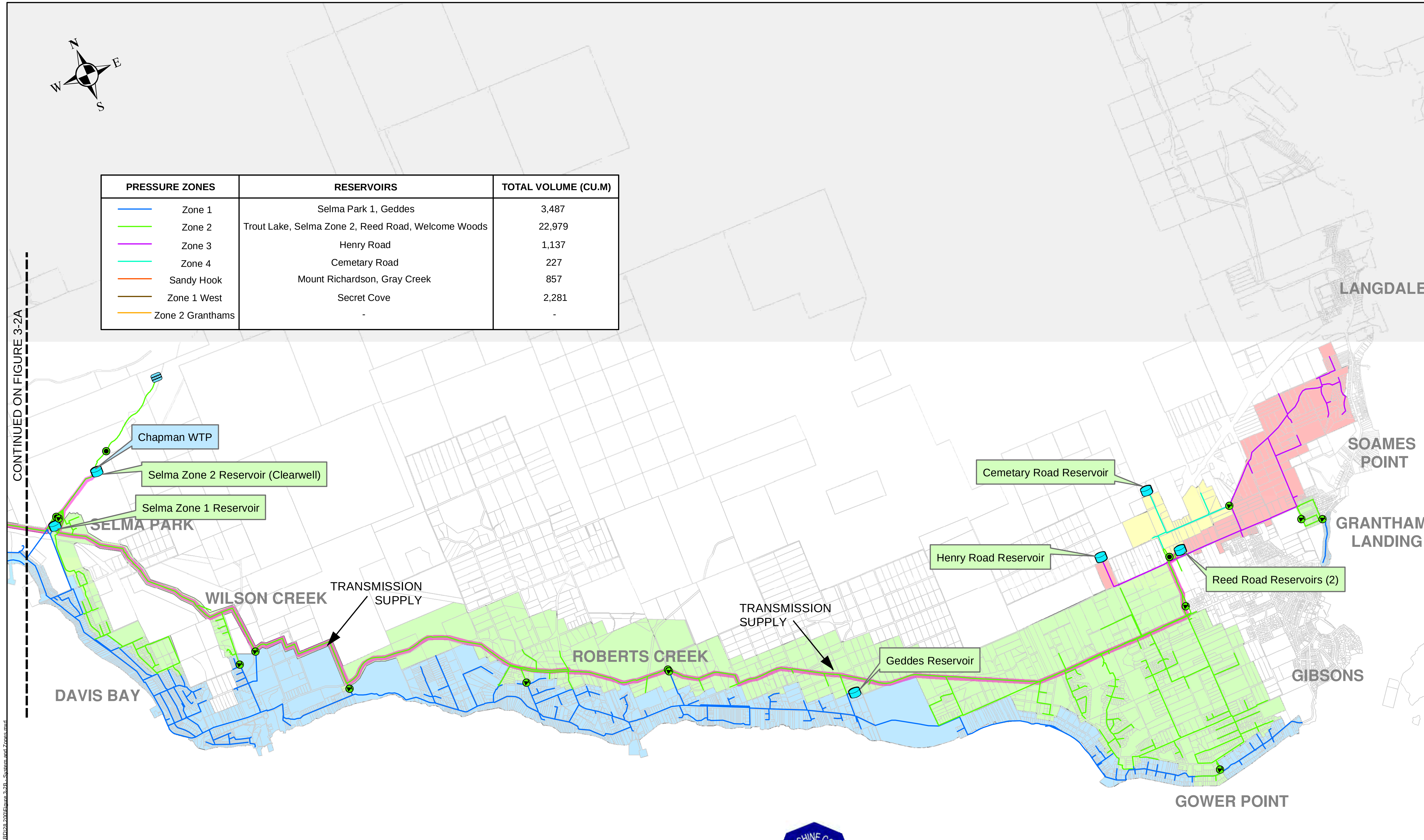
CHAPMAN WATER SYSTEM
TRANSMISSION SYSTEM AND PRESSURE ZONES

FIGURE 3-2A



PRESSURE ZONES	RESERVOIRS	TOTAL VOLUME (CU.M)
Zone 1	Selma Park 1, Geddes	3,487
Zone 2	Trout Lake, Selma Zone 2, Reed Road, Welcome Woods	22,979
Zone 3	Henry Road	1,137
Zone 4	Cemetary Road	227
Sandy Hook	Mount Richardson, Gray Creek	857
Zone 1 West	Secret Cove	2,281
Zone 2 Granthams	-	-

OPUS DAYTONKNIGHT

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DRAWN BY: CL
DATE: APR 2013

CHAPMAN WATER SYSTEM
TRANSMISSION MAINS AND PRESSURE ZONES

FIGURE 3-2B

TABLE 3-4
CHAPMAN WATER SYSTEM
EXISTING RESERVOIR STORAGE

Area	Existing Storage (m^3)	Required Balancing Storage (m^3)	Available Fire Storage (m^3)	Required Fire Storage (m^3)
Zone 1	3,487	2,705	782	3,240
Zone 2	22,979	2,867	20,112	3,240
Zone 3	1,137	700	437	432
Zone 4	227	58	169	432
Sandy Hook Area	857	138	719	432
Zone 1 West	2,281	292	1,989	432

The existing reservoirs provide enough capacity to accommodate balancing storage and fire storage in all areas except Zones 1 and 4. Zones 1 and 4 have a deficient fire storage volume of 2,458 m^3 and 263 m^3 respectively. Because fire storage can flow from higher zones to lower zones and can be pumped from lower zones to higher zones, these deficiencies are currently resolved by using fire storage from Zone 2.

3.7 Distribution Systems

Illustrated on Figure 3-1(A to H) are the distribution systems within the RWSA. All systems are owned and operated by the SCRD, including the system within the District of Sechelt. The system within the Town of Gibsons is owned and operated by the Town.

Distribution systems are the physical infrastructure that deliver water from a water source to the intended end point user. The distribution system is a closed system under pressure and provides communities with a desired level of service for domestic use within a home for cooking, cleaning and drinking, for domestic use plus fire protection, and for domestic use plus commercial, industrial, institutional and agricultural use.

The Chapman water system serves over 15 communities on the Lower Sunshine Coast. Communities that are part of the distribution system include:

- Secret Cove
- Halfmoon Bay
- Redrooffs
- Welcome Woods
- West Sechelt
- West Porpoise Bay
- Sechelt Village
- East Porpoise Bay
- Sandy Hook
- Tuwanek
- Selma Park
- Davis Bay
- Wilson Creek
- Sechelt Indian Government District (SIGD)
- Squamish First Nation
- Roberts Creek
- Elphinstone
- Upper Gibsons

There are certain areas in the SCRD that are populated but not currently serviced by community water systems. A policy is in development to address water needs in these areas.

A hydraulic water model is developed to detail the water network on the street by street level and provide insight into the level of service provided to each parcel. The analysis reviews the available pressures, pipe velocities and fire flows for each community in the SCRD. Hydraulic modeling results for the Chapman water system are presented in Section 6.3.3 and results for the remaining small water systems are presented in Section 7.3.3.

3.8 Demand Management Programs

The SCRD Board direction is to undertake an aggressive water conservation program aimed at reducing average annual and maximum day consumption by approximately 30% (Stantec 2002). The 2012 update of the SCRD Strategic Plan further provides direction to reduce consumption by 33% relative to 2010 levels by 2020.

Bylaw 422 (Water Rates and Regulations) regulates the demand management programs currently in place within the SCRD. Bylaw 399 (Municipal Ticketing) and Bylaw 638 (Bylaw Enforcement Notice) authorizes the Bylaw Enforcement Officer to ticket a non-conforming situation.

Highlights of existing demand management programs follow:

1) Bylaw 422

- Meters required on all new or upgraded residential service connections. These meters are not currently being used for billing.

- Metering required for Industrial/Commercial/Institutional (ICI) users. These meters are used for billing.
- Requires low flush toilets (6.0 L/flush) and low water use fixtures in new buildings

2) General Provisions

- Active leak detection program (under development)
- Irrigation Bylaw (under development)
- Education Programs
  - Waterwise gardening and rain barrel information
  - Water efficiency assessment toolkit
  - Water conservation tips
  - ICI awards program
  - Golden Lawn (Residential) Award
  - Rain water harvesting information

3) Toilet Rebate and Bathroom Fixture Replacement Programs

- Toilet rebate program initiated in 2001.
- Bathroom Fixture Replacement programs initiated in 2006 (ICI added in 2008) to provide low flush toilets, water efficient showerheads, faucet aerators and disposal of old toilets/fixtures.
- Investment in these programs totals over $2 million to the end of 2011.
- To end of 2011; 8,882 toilets, 2,938 showerheads and 4,183 faucet aerators have been replaced.
- Annual reduction in water consumption from these SCRD programs is estimated at 150,000 m^3/yr (411 m^3/d).

- The bathroom fixture replacement program ended in 2011 within the RWSA. The toilet rebate program will continue in the RWSA.

4) Sprinkling Restrictions (SCRD Drought Management Plan):

- Stage 1 Sprinkling Three Days a Week

The following sprinkling regulations for stage 1 are in effect from May 1 to September 30 unless otherwise determined by the General Manager. A person may:

a) Use a sprinkler to water a lawn, trees, shrubs, flower or vegetables during the following scheduled times on a property with;
   i. An even numbered address on Tuesday, Thursday and Saturday mornings between the hours of 7:00 a.m. to 10:00 a.m. and in the evenings of Tuesday and Thursday between the hours of 7:00 p.m. and 9:00 p.m.; and
   ii. An odd numbered address on Monday, Wednesday and Friday mornings between the hours of 7:00 a.m. to 10:00 a.m. and in the evenings of Monday and Wednesday between the hours of 7:00 p.m. and 9:00 p.m.

- Stage 2 Sprinkling Evenings Only

If the General Manager gives Notice that a reduction in Water Sprinkling is necessary requiring Stage 2 restrictions, a person may;

a) Use a sprinkler to water a lawn, trees, shrubs, flower or vegetables during the following scheduled times on a property with;

i. An even number address on Tuesday and Thursday evenings between the hours of 7:00 p.m. and 9:00 p.m.

ii. An odd numbered address on Monday and Wednesday evenings between the hours of 7:00 p.m. and 9:00 p.m.

b) At any time water trees, shrubs, flowers and vegetables by;

i. Hand using a hose with a shut-off device, or

ii. Hand-held container.

c) Not use;

i. A hose to wash sidewalks and driveways.

- Stage 3 Ban on Sprinkling and Other Water Use

If the General Manager gives Notice that a reduction in water use is necessary requiring Stage 3 restrictions, a person may:

a) Water trees, shrubs, flowers or vegetables by hand-held container;

b) Not;

i. Use a sprinkler to water a lawn, trees, shrubs, flowers or vegetables including newly seeded or sodded lawns at any time;

ii. Use a hose to wash sidewalks, driveways, exterior build surfaces, or windows at any time;

iii. Use a hose to wash a vehicle, boat or equipment;

iv. Fill residential swimming pools, hot tubs, wading pools, garden ponds, or decorative fountains.

- Stage 4 Complete ban on outside water use

  If the General Manager gives Notice that a reduction in water use is necessary requiring Stage 4 restrictions, then all outdoor water use is banned. Main line water pressures will also be reduced where possible.

Stage 1 Sprinkling restrictions have been in effect since 1995.
Stage 2 Sprinkling restrictions have been applied twice, in 2009 and 2012.
Stage 3 and Stage 4 restrictions have been imposed once in 2012.

Between 2005 and 2011 there have been 315 “warnings” and 7 “tickets” (fines) issued to homeowners who did not comply with the sprinkling restrictions. Challenges faced by the SCRD in bylaw enforcement include a general lack of resources. The SCRD currently has one bylaw enforcement officer whose regular duties do not include enforcing water restrictions and a summer student working from May to the end of August every year.

4.0 HISTORICAL WATER CONSUMPTION

In this section the historical water consumption records are analyzed in order to determine the past trends in average annual and maximum day water consumption.

4.1 Serviced Population

When the SCRD was formed in 1966, there were 8,490 people living on the Sunshine Coast. By 1986 the population had almost doubled to 16,634 people. The 2011 census population was 28,619, an increase of 3.1 percent from the 2006 Census. This equates to an average annual growth rate of 0.61 percent.

The population served by the Chapman water system has grown at an even faster rate from 3,000 in 1971 to an estimated 21,722 in 2011, or over a six fold increase (6.8% annual growth rate). This is due to higher growth in the service area and also the addition of previously independently operated community systems. The Chapman water system serves Electoral Area B (Halfmoon Bay), D (Roberts Creek), E (Elphinstone) and F (West Howe Sound), District of Sechelt, Sechelt Indian Government District, Squamish First Nation, and the upper portion of the Town of Gibsons.

The population serviced by the Chapman water system is estimated in Table 4-1.

TABLE 4-1
CHAPMAN WATER SYSTEM
SERVICED POPULATION

	1996	2001	2006	2011
SCRD Total	24,914	25,599	27,759	28,619
minus Gibsons Zones 1 & 2	- 2,677	- 2,802	- 3,000	- 3,112
minus Electoral Area ‘A’	- 2,581	- 2,374	- 2,624	- 2,678
minus Langdale [(1)]	- 406	- 442	- 481	- 512
minus Soames Point [(1)]	- 190	- 207	- 225	- 240
minus Granthams Landing [(1)]	- 161	- 175	- 190	- 195
minus Eastbourne [(1)]	- 296	- 322	- 350	- 355
Chapman	18,603	19,277	20,889	21,722
annual growth rate		0.71%	1.62%	0.79%

[(1)] population values estimated based on number of water service connections multiplied by a typical persons/connection rate of 2.3.

The 2011 population of 21,722 is used as a base value to project future growth in the Chapman system as presented in Section 5.0.

There are certain areas in the SCRD that are populated but not currently serviced by community water systems. A policy is in development to address water needs in these areas.

4.2 Average Day Demand

Average Day Demand (ADD) is the average water usage during the year. The ADD includes all sectors (e.g. Industrial / Commercial / Institution (ICI) and Residential) served by the RWSA.

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4.2.1 Chapman Water System

The SCRD records the total water supplied by the Chapman water system including the usage by the Town of Gibsons, as presented in Table 4-2 for the years 2003 to 2011

TABLE 4-2
CHAPMAN WATER SYSTEM
HISTORICAL ADD

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Chapman Water Supply (m^3/y)	4,898,044	5,023,938	4,870,469	5,177,930	4,800,211	5,114,245	5,307,873	5,070,873	4,695,676
Serviced Population Estimate	19,906	20,229	20,556	20,889	21,053	21,218	21,385	21,553	21,722
ADD (L/c/d)	674	680	649	679	625	660	680	645	592

Since 2003, the ADD has reduced by approximately 12% (from 674 to 592 L/c/d). This reduction is most likely due to progressive intensification of demand management programs. A new bulk water supply agreement between the SCRD and the Town of Gibsons is currently being written that will extend the terms of the agreement for another 25 years.

Figure 4-1 illustrates the downward trend of maximum day water usage in the Chapman water system.

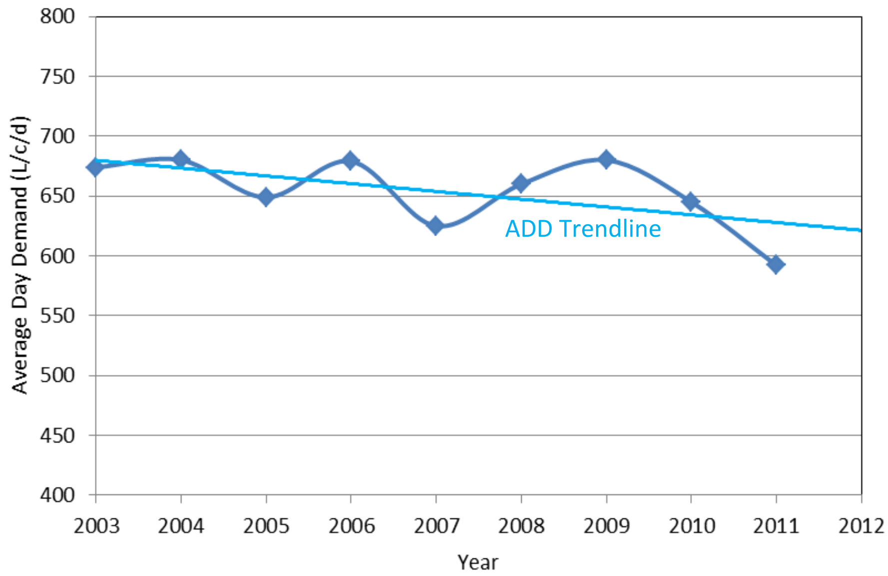

Figure 4-1 Trend of Average Day Demand in the SCRD

Based on Figure 4-1, the recommended value for demand projections in Section 5.0 and the Chapman system analysis in Section 6.0 is an ADD of 600 L/c/d, applicable to continued use of existing demand management programs.

4.2.2 Regional Water Service Area

Table 4-3 compares the ADD in 2011 from all the water sources within the RWSA.

TABLE 4-3
REGIONAL WATER SERVICE AREA
2011 ADD

Water System	Serviced Population	Total Demand (m^3/y)	Per Capita Demand (L/c/d)
Chapman	21,722	4,695,676	592
Langdale	512	146,501[(1)]	593
Soames Point	240	95,832[(2)]	604
Granthams Landing	195		
Eastbourne	355	6,305	49
Cove Cay	77	10,176	362
Total – RWSA[(3)]	**23,101**	**4,954,490**	**588**

(1) demand from BC Ferries, Langdale Elementary School and Camp Elphinstone of 35,630 m3/y was removed to develop the per capita demand.
(2) Soames and Granthams operated as single system for 2 months in 2011; consolidated figures provided.
(3) Egmont Cove water system was newly commissioned in 2011 and yearly demands were not available.

When North Pender and South Pender Harbour service area data is added to the RWSA, the total SCRD ADD for 2011 can be determined as presented in Table 4-4.

TABLE 4-4
SUNSHINE COAST REGIONAL DISTRICT
2011 ADD

Water System	Serviced Population	Total Demand (m^3/y)	Per Capita Demand (L/c/d)
Total – RWSA	23,101	4,954,490	588
North Pender Harbour[(1)]	1,163	210,030	495
South Pender Harbour[(1)]	2,196	375,128	468
Total – SCRD	**26,460**	**5,539,648**	**574**

(1) Serviced populations for North and South Pender Harbour are estimated based on number of water service connections multiplied by 2.3 persons per connection.

In 2011, the average per capita demand for the RWSA was 588 L/c/d and for the SCRD overall 574 L/c/d.

Table 4-5 compares the SCRD's ADD and MDD in 2011 to communities in the Metro Vancouver area and the City of Nanaimo. The per capita demands include both residential and ICI water use.

TABLE 4-5
2011 ADD AND MDD IN OTHER MUNICIPALITIES (L/c/d)

Municipality	ADD	MDD
Vancouver	485	596
Burnaby	452	645
New Westminster	332	598
Richmond	481	607
Delta	621	854
Surrey	368	519
District of North Vancouver	531	841
City of North Vancouver	414	525
Pitt Meadows	485	932
Nanaimo	484	801
Sunshine Coast Regional District	**574**	**1,102**

When compared with ADD in other communities, the water use in the RWSA and the SCRD is on the high side.

4.3 Maximum Day Demand

Maximum Day Demand (MDD) is the day of maximum water usage during the year.

4.3.1 Chapman Water System

The SCRD records the daily flows at the Chapman Creek water treatment plant. The SCRD also records monthly flows from the Gray Creek and Chaster Well sources. The maximum day over maximum month ratio for Chapman in 2011 was calculated at 1.17. An estimate of MDD for the Gray Creek and Chaster Well sources can be made by factoring the maximum month average flow by 1.17.

The estimated MDD, excluding water supplied to Gibsons, is provided in Table 4-6.

TABLE 4-6
CHAPMAN WATER SYSTEM
HISTORICAL MDD

Year	Population	Maximum Daily Demand 1,000 (m^3/d)				MDD (L/c/d)	Ratio to ADD
		Chapman	Gray	Chaster	Total		
2003	19,906	25.8	2.7	1.0	29.5	1,482	2.2
2004	20,229	26.5	1.9	0.9	29.3	1,448	2.1
2005	20,556	26.2	0.9	1.1	28.2	1,372	2.1
2006	20,889	26.6	1.3	1.3	29.2	1,398	2.1
2007	21,053	26.7	0.1	1.4	28.2	1,339	2.1
2008	21,218	27.1	0.0	1.2	28.3	1,334	2.0
2009	21,385	28.5	0.2	1.2	29.9	1,398	2.1
2010	21,553	28.1	0.0	2.3	30.4	1,410	2.2
2011	21,722	23.8	0.0	0.9	24.7	1,137	1.9

Since 2003, the MDD has reduced from 1,482 L/c/d to 1,137 L/c/d, or a drop of 23%. When compared with other communities (Table 4-5), however, the MDD in the Chapman service area remains high.

Figure 4-1 illustrates the downward trend of maximum day water usage in the Chapman water system.

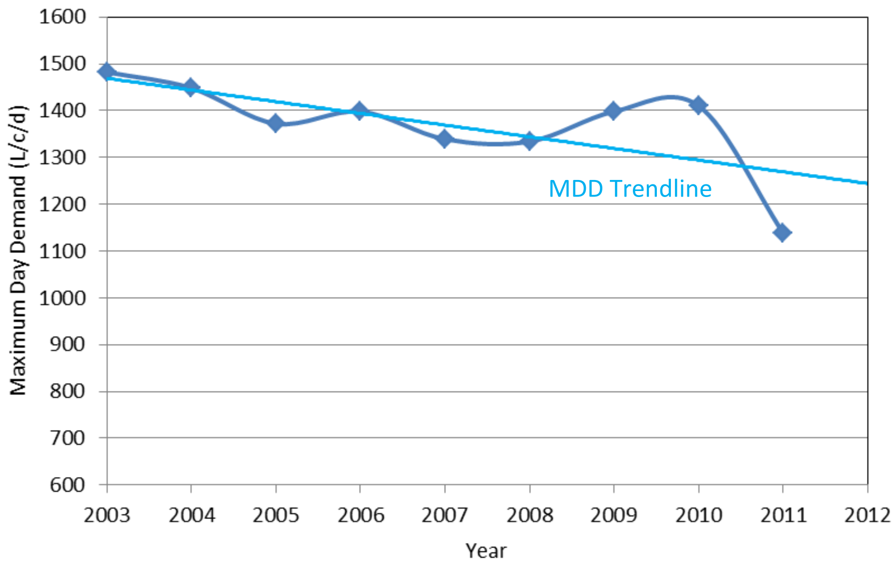

Figure 4-2 Trend of Maximum Day Demand in the SCRD

Based on Figure 4-2, the recommended value for demand projections in Section 5.0 and the Chapman system analysis in Section 6.0 is a MDD of 1,250 L/c/d. This unit flow only applies under conditions of continued existing demand management programs.

4.3.2 Regional Water Service Area

Maximum daily flows are not recorded in the RWSA. An estimate of MDD can be made by using the ratio of MDD to ADD for 2011 in the Chapman water system. Table 4-7 provides the estimate of the 2011 MDD in the RWSA.

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TABLE 4-7
REGIONAL WATER SERVICE AREA
2011 MDD

Water System	ADD (L/c/d)	MDD (L/c/d)
Chapman	592	1,137
Langdale	593	1,139
Soames Point	604	1,160
Granthams Landing		
Eastbourne	49	94
Cove Cay	362	695
Total – SCRD [1]	**574**	**1,102**

[1] Egmont Cove water system was newly commissioned in 2011 and yearly demands were not available.

5.0 WATER DEMAND FORECAST

Population projections through 2036 are combined with the unit flows analyzed in Section 4 to estimate average annual and maximum day water demands. The impact of climate change and more intensive demand management programs are factored into the water demand forecast.

5.1 SCRD Population Projections

Table 5-1 shows the population projections for the SCRD based on the Official Community Plans across the region.

TABLE 5-1
SCRD POPULATION PROJECTIONS

Location	2001	2006	2011	2016	2021	2026	2031	Annual Growth
Gibsons	3,906	4,182	4,437	4,756	5,098	5,466	5,859	1.4%
Sechelt	7,775	8,454	9,291	10,108	10,997	11,964	13,016	1.7%
Sechelt First Nation	792	827	797	829	863	898	935	0.8%
Electoral Areas	13,123	14,296	14,094	15,409	16,847	18,418	20,137	1.8%
SCRD TOTAL	25,299	27,759	28,619	31,102	33,805	36,746	39,947	1.7%

5.2 Chapman Water System Population Projections

The estimated 2011 Chapman water system population is 21,722 as detailed in Section 4.1. Based on the outcome of the SCRD's strategic planning workshop, future population projections include a low, medium and high growth rate; respectively 0.75%, 1.25% and 2%, as shown in Table 5-2.

TABLE 5-2
CHAPMAN WATER SYSTEM
PROJECTED POPULATION GROWTH

Year	Low (0.75%)	Medium (1.25%)	High (2%)
2011	21,722	21,722	21,722
2016	22,549	23,114	23,983
2021	23,407	24,595	26,479
2026	24,298	26,171	29,235
2031	25,223	27,848	32,278
2036	26,183	29,633	35,637

A conservative projection for the water system analysis is 2% which would see the Chapman water service population grow from 21,722 in 2011 to 26,479 in 10 years' time and to 35,637 by 2036. A 2% projection closely matches the OCP projections of 1.7% to 1.8% (Table 5-1), and will be used for population projections throughout the Regional Water Service Area within this study.

Note that these projected populations will be multiplied by per capita demand rates to develop the forecasts for water demand (in Section 5.5) and future improvements are subsequently analyzed based on forecasted flows.

5.3 Small Water Systems Population Projections

Current populations for the small water systems were estimated based on the number of water service connections multiplied by a typical persons/connection rate of 2.3. A 2% growth rate was applied for the next 25 years to develop the 2036 populations.

The SCRD analyzed the development potential of the Langdale, Soames Point, Grantham's Landing, Eastbourne and Cove Cay water systems and prepared maps indicating undeveloped properties and potential future parcels for each of the water systems. Full buildout populations were estimated based on the current population plus the total number of undeveloped properties and potential future parcels multiplied by 2.3 persons per connection. If the 2036 population estimated by the 2% growth rate exceeded the full buildout population, the full buildout population was used to represent the population in 2036.

Details of the population numbers are summarized in Table 5-3.

TABLE 5-3
REGIONAL WATER SYSTEM AREA
PROJECTED POPULATION GROWTH

Year	Langdale	Soames Point & Granthams	Eastbourne	Cove Cay	Egmont Cove
2011	512	435	355	77	64
2036 @ 2% Growth	840	552(1)	486(2)	126	105
Full Buildout	1,207	552	486	268	109

(1) Full buildout in the Soames Point and Grantham's Landing system is reached in 2023.
(2) Full buildout in the Eastbourne system is reached in 2027.

Note that these projected populations will be multiplied by per capita demand rates to develop the forecasts for water demand (in Section 5.5) and future improvements are subsequently analyzed based on the forecasted flows.

5.4 Climate Change, Climate Variability and Demand Management Impacts

The projections for future water demands need to account for the impacts that will be caused by climate change and demand side management.

5.4.1 Climate Change

Average monthly temperatures in the greater Vancouver area are predicted to rise by 3.5°C by 2100 (EC - 2000). Potential impacts noted in this Environment Canada (Pacific Region) report include prolonged summer droughts, increased landslides with winter rains, salt water intrusion into aquifers from rising sea levels and higher parasite survival in warmer surface waters.

A study undertaken by Environment Canada and University of British Columbia - (UBC 2006) for the Okanagan Basin predicted a 6% to 10 % increase in water demand by 2020 due to climate change; primarily due to increased ground oriented dwellings and increased outdoor water use. The report noted that demand side management resulted in dramatic reduction in water use; particularly water metering, retrofits and xeriscaping.

A field investigation by the University of British Columbia (UBC 2010) examined the relationship between snowmelt runoff and summer baseflow in creeks on the Sunshine Coast. Findings included the following:

- Climate change scenarios for 2050 indicate snow-water equivalent will diminish 50 to 80% in lower snowfed – dominate watersheds in the south coastal regions of British Columbia.
- This could trigger a shift from snow-water fed creeks (such as Chapman and Gray Creeks) to rainfall fed creeks.
- Previous studies suggest this change from snow-water fed to rainfall fed will negatively impact low summer flows in creeks.
- Specifically, Stephens Creek (Mt. Elphinstone) was monitored from fall 2008 to fall 2009:
    - Snowmelt and soil water comprised most of the streamflow, both at headwater (66% ±19%) and at the creek mouth (62% ±23%) during peak flow.
    - During July low flow period; snowmelt and soil water comprised 34% ±11% at headwater reducing to 7% ±4% at mouth of the creek.
- Preliminary streamflow analysis indicates that snowmelt – recharged headwater catchment at Stephens Creek can support higher summer baseflow than Roberts Creek (a much larger, but rainfall dominated watershed).
- It was concluded that watersheds that are dominated by snowmelt runoff will generate larger summer baseflow, compared with watersheds that are dominated by rainfall runoff.

In 2008 the City of Vancouver noted that while it is impossible to predict exactly what impacts climate change will have on the City, findings from the Intergovernmental Panel on climate change can be used to predict the following for Vancouver (C of V - 2008):

- Wetter winters due to increased storm activity.
- Ocean level rise, possibly up to a meter in the next 100 years.

- Reduction in snowpack over the next several decades causing increased winter run-off, increased landslides affecting water quality and reduction of water supply in dry summer months.
- Long dry summers will increase risk of fires.

A Pacific Institute report (PI-2009) noted the following due to climate change:

- Earlier peak stream flows (1 to 4 weeks).
- Decrease in snowpack, more rain during the winter.
- Increased lake temperatures (0.1 to 1.5ºC).
- Longer periods of drought.
- Increased demand for irrigation.
- Increased demand for industrial cooling water.

The Canadian climate change model CGCM1 suggests by 2030, BC will experience an increase in mean annual temperature of up to 2°C. The model also indicates a small increase in total annual precipitation, with the bulk of this occurring in the winter.

The impact of climate change on water demand is difficult to quantify. The SCRD should anticipate reduced snowpack, increased winter rain and dryer summer months that will result in less baseflow in creeks during dryer summer months. Climate change may also result in increased water demand for outdoor irrigation, due to dryer summer months. The degree to which these possible impacts will be noticeable during the next 25 years remains uncertain.

5.4.2 Climate Variability

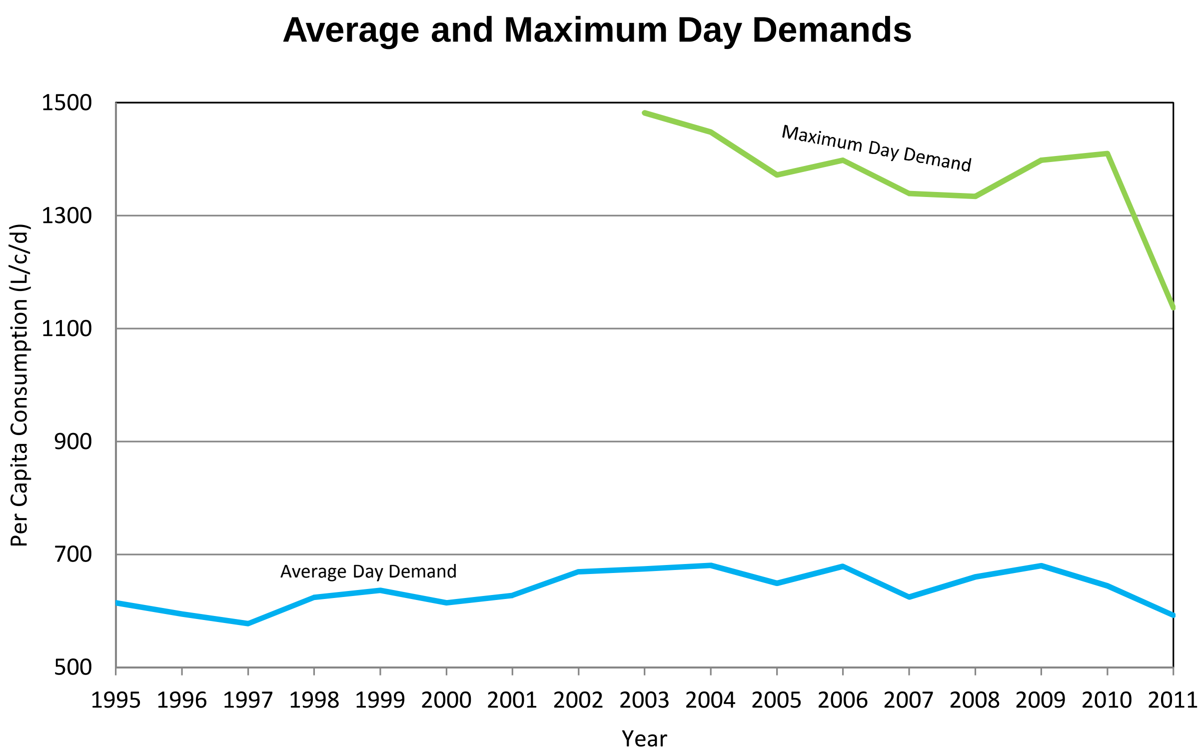
The magnitude and duration of low reservoir inflows in the summer and early fall are critical for water supply planning and operations for the Sunshine Coast Regional District.

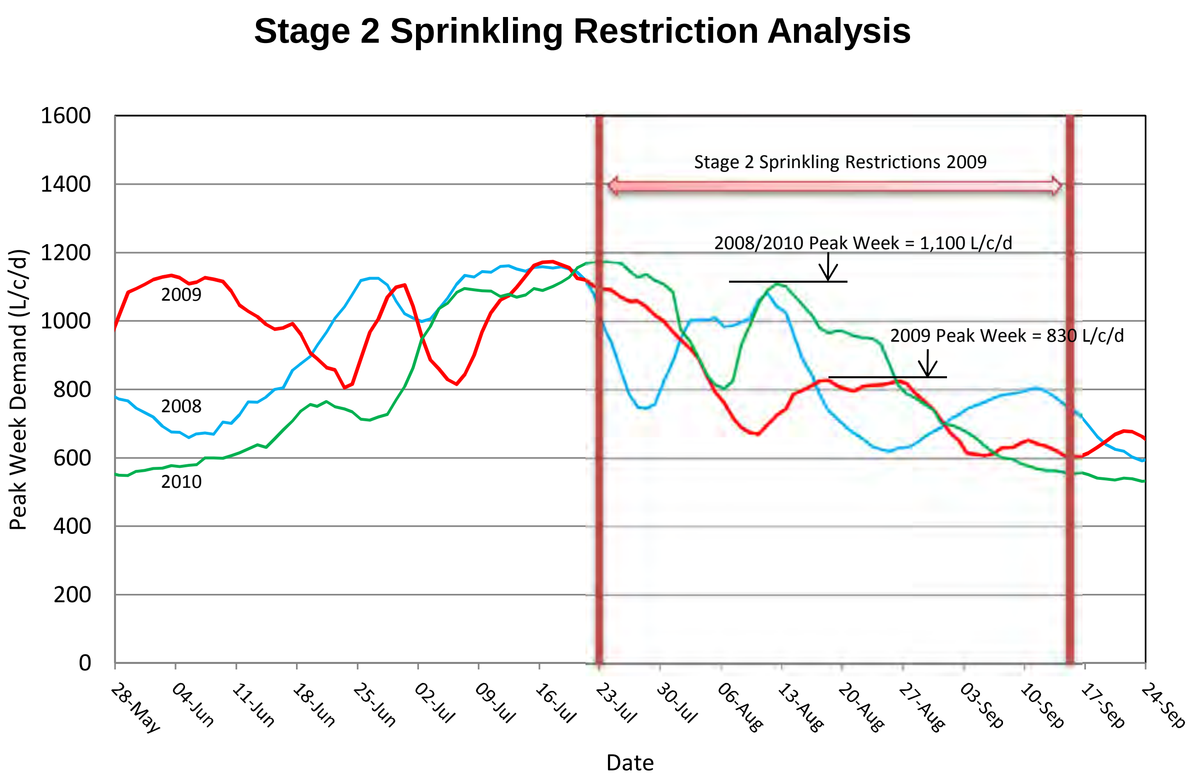
As outlined in the paper "Influence of the Pacific Decadal Oscillation and El Nino Southern Oscillation on Operation of the Capilano Water Supply Reservoir", Vancouver, B.C. (Sellars et al., 2008), as published in the Canadian Water Resources Journal, reservoir inflows in the Greater Vancouver Capilano water reservoir for the June to September period are affected by the El Nino Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO). Annual reservoir drawdown, defined as the annual extended period of no spill, was used as an indicator of stress on reservoir operations. The study concluded that the longest reservoir drawdown durations were almost always associated with warm ENSO and warm PDO conditions. The shortest periods of drawdown were normally associated with both cool ENSO and cold PDO conditions. Due to the proximity to the Sunshine Coast and the coastal nature of the Capilano reservoir, it is expected that these conclusions can be transferred to the Chapman and other watersheds on the Sunshine Coast and used to anticipate reservoir drawdown conditions.

5.4.3 Demand Side Management

Existing demand management (EDM) programs, which include the bathroom fixture replacement program along with the toilet rebate program, have been successful in reducing average annual water consumption within the SCRD by 1.6%. Analysis of historical water consumption in Section 4.0, however, indicates that both average annual and maximum day per capita use in the RWSA remain higher than in similar communities.

In order to meet SCRD water conservation goals, a more intensive demand management (IDM) program should be considered to effect reduction in water demand through universal metering, further education programs, revised water use rates, more intensive sprinkling regulations, etc. Some programs (universal metering in particular) involve capital investment in the early years to achieve reduced water demand that will, however,





CHAPMAN WATER SYSTEM
HISTORICAL WATER DEMANDS

Figure 5-1

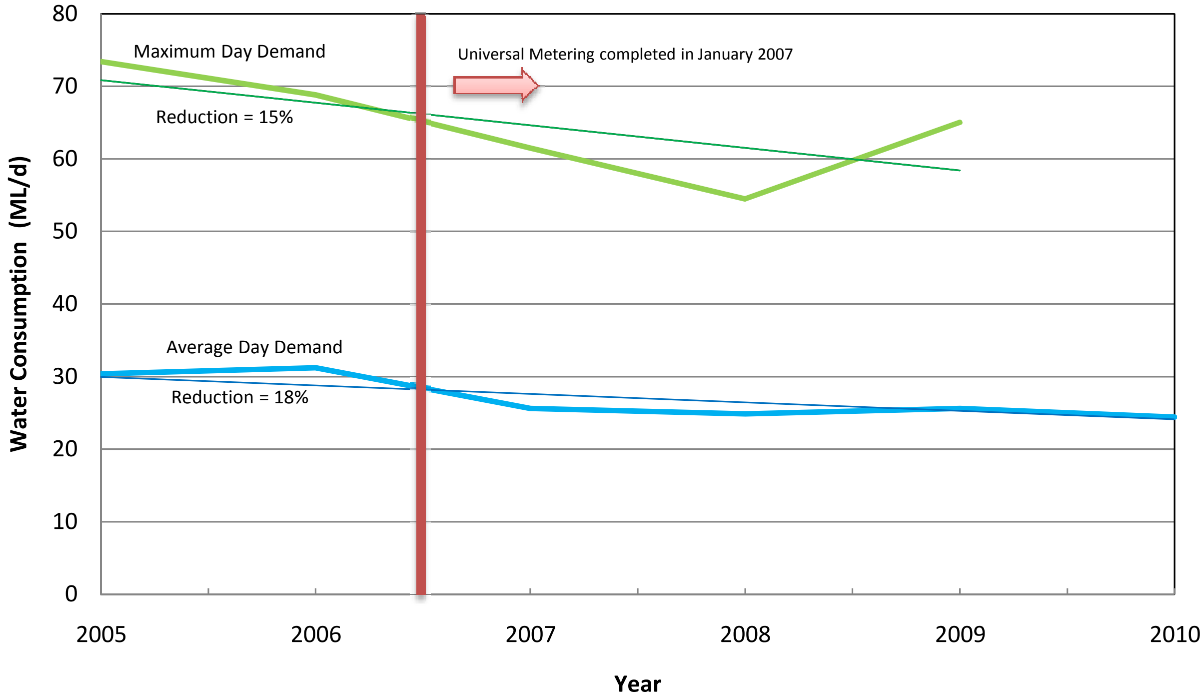
result in deferment of much larger capital investment for infrastructure expansion that otherwise would be required.

Universal Water Metering

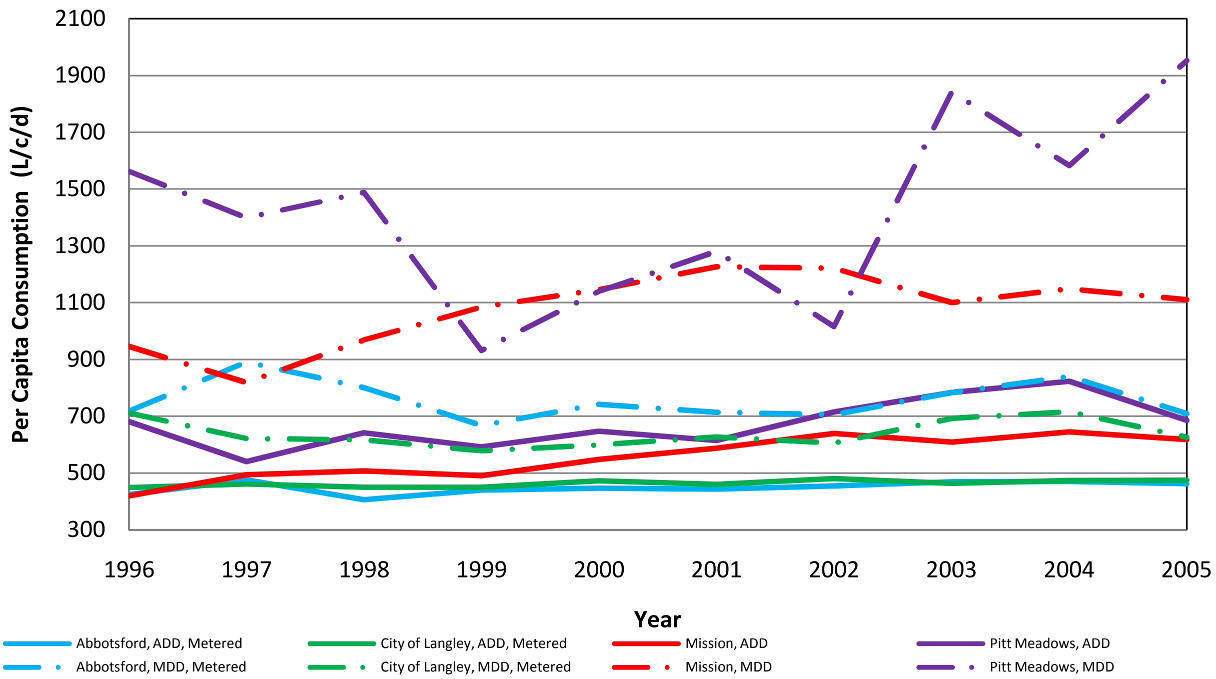
Universal metering (except for ICI and new residential development) is not included in the SCRD's present demand management programs. It is widely accepted as an industry "best practice" and is a cornerstone of most water management strategies. Universal metering is also a fundamental tool in assessing performance of demand management programs, and has proven to help achieve significant, long-term water savings.

Universal metering, subject to grant funding, is the current policy of the SCRD Board. A universal metering grant has been obtained for the North and South Pender Harbour water service areas and will be implemented in 2014 to 2015. An unsuccessful General Strategic Priorities Fund (GSPF) grant application to establish universal metering in the RWSA in the amount of $8 million was made in 2011. Meters have been installed on all new and upgraded service connections throughout all SCRD water systems since 2005.

West Vancouver Average Day Demand



Metered Vs Unmetered Consumption Patterns



UNIVERSAL METERING EFFECTS ON WATER USAGE

Figure 5-2

Impacts of Demand Management

It should be noted that demand management measures do not result in uniform reduction in average and maximum day demands.

Figure 5-1 illustrates the reduction in average and maximum day demand within the Chapman water system. Since 2003, ADD has reduced from 674 L/c/d, to 592 L/c/d, or 12%. Over the same time period MDD has reduced from 1,482 L/c/d to 1,137 L/c/d, or 23%. Of note on Figure 5-1 is the impact of implementing Stage 2 water restrictions on peak week demand in 2009 (830 L/c/d), compared with 2008 and 2010 (1,100 L/c/d). During the prolonged drought in 2012, water demand dropped to a low of 449 L/c/d following Stage 3 water restrictions and further to 398 L/c/d following Stage 4 water restrictions (based on 2011 service population estimate of 21,722 persons).

West Vancouver, which completed universal metering in 2006 and 2007, has experienced reductions in average day demand of about 18% while maximum day demand decreased by about 15%. Table 5-4 summarizes data collected by West Vancouver, while Figure 5-2 illustrates the data.

TABLE 5-4
DISTRICT OF WEST VANCOUVER
INFLUENCE OF UNIVERSAL METERING

Scenario	ADD (ML/d)	MDD (ML/d)
Prior to Metering (2000 to 2006)	31	71
Post Metering (2007 to 2009)	25	60*

*2009 was considered a dry summer.

The communities of Abbotsford and the City of Langley (both universal metered) and Mission and Pitt Meadows (both not metered) provide an interesting comparison as illustrated on Figure 5-2. ADD in Abbotsford and the City of Langley are similar and stable at about 480 L/c/d in contrast with Mission and Pitt Meadows at about 650 L/c/d and with a rising trend. MDD in Abbotsford has trended downward to about 700 L/c/d while Langley has been relatively stable at about 650 L/c/d. MDD in Mission has trended upward to about 1,100 L/c/d while Pitt Meadows has also trended upward to about 1,500 L/c/d.

Metro Vancouver has recently approved a new policy that restricts sprinkling to mornings only (4am to 9am) on two weekdays and one weekend day, from June 1 to September 30. It is estimated this change will reduce peak hour demand by 12% and maximum day demand by 3% (Metro - 2011). In Metro Vancouver, since sprinkling regulations were first imposed in 1993, the maximum day demand has declined by 25%, from 1,100 L/c/d to 825 L/c/d (Metro -2010).

It should be noted that District-wide public participation is important for the success of the demand management programs. While hard to quantify, educations programs by themselves have limited effect on public participation. However, when combined with regulations, financial incentives, and community-led initiatives, educational programs are invaluable in raising public awareness and in implementing successful demand management programs.

Anticipated Results

For the purposes of water system analysis, it is estimated the implementation of intensive demand management programs, including universal metering, will reduce the existing average day demand by 20% from 600 L/c/d to 480 L/c/d and the maximum day demand by 25% from 1,250 L/c/d to 940 L/c/d for the Chapman system. These reduced values are used in the Section 6 system analysis.

Similarly, water usage reductions of 20% for average day demand and 25% for maximum day demand could be expected in the Langdale, Soames and Granthams water systems. However, due to the low consumption in the Eastbourne and Cove Cay systems, significant demand reductions are not anticipated there. The Egmont Cove system is just starting to be monitored so it is unknown at this point whether or not water usage reductions are feasible or even required.

5.4.4 Intensified Demand Management Program

The following are intensified demand management strategies that the SCRD could pursue.

- Implementation of Universal Water Metering;
- Mandatory Stage 2 and/or Stage 3 sprinkling restrictions from May 1 to September 30 (Based on Metro Vancouver findings in 2011, consider revising Stage 2 sprinkling restrictions to morning only);
- Revise conservation-based meter rates when universal metering is in place;
- Leak detection and repair in areas of high water consumption;
- Use reclaimed water from sewage treatment plants;
- New incentive programs such as irrigation controls and rainwater harvesting; and,
- More education and public outreach programs as each of the above strategies are implemented.

5.5 Future Water Demands

Projected populations from Sections 5.2 and 5.3 are multiplied by per capita demand rates to develop the forecasted water demands for the RWSA water systems. The forecasted demands represent flows from current connections and flows from new connections from new buildings or expansion to service existing developments currently on private supply.

Projected water demands to 2036, for both existing and intensified demand management programs, are set out in the following sub-sections.

5.5.1 Average Day Demand

A unit flow of 600 L/c/d was used to project ADD under existing demand management (EDM) conditions. A unit flow of 480 L/c/d was used to project ADD under intensified demand management (IDM) conditions.

Unit flow rates for the rest of the Regional Water Service Area were taken from Table 4-3 to produce projections under EDM and IDM to the year 2036. A 20% reduction was assumed under IDM for the RWSA, with the exception of the demands in the Eastbourne and Cove Cay water systems. Table 5-5 summarizes the future ADD.

TABLE 5-5
REGIONAL WATER SYSTEM AREA
AVERAGE DAY DEMAND (ML/d)

Year	Growth at 2%											
	Chapman		Langdale		Soames Pt. & Granthams		Eastbourne		Cove Cay		Egmont Cove	
	EDM	IDM	EDM	IDM	EDM	IDM	EDM	IDM	EDM	IDM	EDM	IDM
2011	13.0	-	0.40	-	0.26	-	0.017	-	0.028	-	0.037	-
2016[(1)]	14.3	11.5	0.43	0.35	0.29	0.23	0.019	-	0.031	-	0.041	0.032
2021	15.8	12.7	0.47	0.37	0.32	0.26	0.021	-	0.034	-	0.045	0.036
2026	17.5	14.0	0.51	0.41	0.35	0.28	0.023	-	0.038	-	0.049	0.040
2031	19.3	15.4	0.55	0.44	0.39	0.31	0.026	-	0.041	-	0.055	0.044
2036	21.3	17.0	0.60	0.48	0.43	0.34	0.028	-	0.046	-	0.060	0.048

(1) assumed earliest full implementation of IDM is by 2016.

5.5.2 Maximum Day Demand

A unit flow of 1,250 L/c/d was used to project MDD for the Chapman water system under EDM. A unit flow of 940 L/c/d was used to project MDD under IDM.

Unit flow rates for the rest of the Regional Water Service Area were taken from Table 4-7 to produce future MDD projections under EDM and IDM. A 25% reduction was assumed under IDM for the RWSA, with the exception of the demands in the Eastbourne and the Cove Cay water systems. Table 5-6 summarizes the future MDD.

TABLE 5-6
REGIONAL WATER SYSTEM AREA
MAXIMUM DAY DEMAND (ML/d)

Year	Growth at 2%											
	Chapman		Langdale		Soames Pt. & Granthams		Eastbourne		Cove Cay		Egmont Cove	
	EDM	IDM	EDM	IDM	EDM	IDM	EDM	IDM	EDM	IDM	EDM	IDM
2011	27.1	-	0.69	-	0.50	-	0.033	-	0.054	-	0.071	-
2016(1)	29.9	22.4	0.75	0.56	0.56	0.42	0.037	-	0.059	-	0.078	0.058
2021	33.0	24.7	0.82	0.61	0.62	0.46	0.040	-	0.065	-	0.086	0.064
2026	36.4	27.3	0.89	0.67	0.68	0.51	0.045	-	0.072	-	0.095	0.071
2031	40.2	30.2	0.97	0.73	0.75	0.56	0.049	-	0.080	-	0.105	0.079
2036	44.4	33.3	1.06	0.80	0.83	0.62	0.054	-	0.088	-	0.116	0.087

(1) assumed earliest full implementation of IDM is by 2016.

6.0 CHAPMAN WATER SYSTEM ANALYSIS

This section presents the findings from an analysis of the Chapman water system. The analysis has been carried out for the 2011 water demands (existing conditions) and also for the projected 2036 water demands (under two conditions - existing and more intensive demand management programs). The analysis includes the water sources, water treatment, supply transmission, supply storage and the distribution systems. Included in the analysis is the evaluation of urban and rural fire flow requirements.

6.1 Water Sources

The primary source is Chapman Creek with its tributary Chapman and Edwards Lakes. Secondary sources include Gray Creek and the Chaster Well.

6.1.1 Chapman Creek

Water is released from Chapman and Edwards Lakes to the creek over the dry summer period to maintain sufficient flow for the treatment plant intake and for the fisheries resource.

The SCRD practice is to maintain a flow of 24.5 ML/d below the intake by releasing from the Mountain Lake storage dams the same volume of water that is being withdrawn at the Chapman Creek intake.

An estimate of low flow under drought conditions can be made by analyzing historical stream flow records. The probability of the low flow occurring is typically estimated for various return periods (2, 5, 25, 50 year, etc.). For municipal water supplies in British Columbia the generally accepted drought return period is 25 years; i.e. the low flow will occur on average once every 25 years.

The 2006 drought risk analysis (Dayton & Knight Ltd. 2006) and the 2007 source development study (Dayton & Knight Ltd. 2007-3) were updated to assess the capacity of the natural creek flow and existing lake storage volumes to handle drought conditions. This risk management assessment considers the number of years a municipality is willing to accept between years of drought in its system. A longer return period reduces the chances of running a risk for drought conditions in the system. A 1:25 year return period was selected to maintain consistency with the SCRD accepted level of risk for drought conditions.

The analysis was updated with the following information:

- The bathymetric survey (Theed 2010) revised the Chapman Lake existing storage volume to 0.751 Mm^3 from 0.87 Mm^3 and the Edwards Lake existing storage volume to 0.907 Mm^3 from 1.07 Mm^3; or a total of 1.658 Mm^3.
- The 1:25 year drought risk analysis is based on the following:
  - high growth of 2%.
  - average month water demand.

The 1:25 year drought analysis is presented in Technical Memorandum No. 2011-1 (Opus DaytonKnight 2011-1) that forms a supplement to this report.

A summary of the drought analysis results are shown in Table 6-1 and Table 6-2.

TABLE 6-1
CHAPMAN CREEK
1:25 YEAR DROUGHT STORAGE REQUIREMENT

Demand Management	Available Storage (Mm^3)	Volume Required 2011 (Mm^3)		Volume Required 2036 (Mm^3)	
		Total	Additional	Total	Additional
Existing Programs	1.66	1.77	0.11	2.42	0.76
Intensive Programs	1.66	-	-	2.09	0.43

TABLE 6-2
CHAPMAN CREEK
EXISTING STORAGE - DROUGHT RISK RETURN PERIOD

Demand Management	Drought Risk Return Period (Existing Storage = 1.66 Mm^3)
2011 - Existing Programs	1 in 21
2036 - Existing Programs	1 in 11
2036 - Intensive Programs	1 in 15

The drought analysis for the high 2% growth rate can be summarized as follows:

- The 1:25 year drought creek flow combined with the release of water from existing lake storage is insufficient to meet the 2011 water demands.
- Natural creek flow combined with release of water from existing lake storage can supply; 2011 water demand during a 1:21 year drought, 2036 water demand (existing demand management) during a 1:11 year drought and 2036 water demand (intensive demand management during a 1:15 year drought.

6.1.2 Effect of Climate Change

As noted in Section 5.3.1, climate change is predicted to result in an increase in winter rain events, decrease in snowpack, and prolonged, drier summers. The annual precipitation volumes are expected to remain similar to current volumes and, therefore, the impact on available summer lake storage through 2036 should be minimal.

6.2 Water Treatment

The Chapman Creek water treatment plant MDD design capacity of 25 ML/d has been exceeded on 60 occasions between 2004 and 2011. During this same period, maximum week demand exceeded plant design capacity in 2006, 2009 and 2010.

The "over design capacity" of 26.9 ML/d is not a recommended practice due to lack of redundancy. MDD exceeded the "over design capacity" in 2008, 2009 and 2010 on 8 occasions.

Table 6-3 shows the required MDD design capacity (2% growth rate) for the treatment plant through 2036 for conditions of existing and intensive demand management programs.

TABLE 6-3
CHAPMAN CREEK WATER TREATMENT PLANT
PROJECTED MDD CAPACITY REQUIREMENTS TO 2036 (ML/d)

Demand Management	Year					
	2011	2016	2021	2026	2031	2036
Existing Programs	27.1	29.9	33.0	36.4	40.2	44.4
Intensive Programs[(1)]	-	22.4	24.7	27.3	30.2	33.3

(1) assumed earliest full implementation of IDM is by 2016.

6.3 Water System Analysis

The SCRD WaterCAD model was used to analyze the transmission mains, the reservoir storage and the distribution system within the Chapman service area for both 2011 and 2036. The analysis was based on a 2% growth rate under both existing demand management programs and more intensive demand management programs.

The following design criteria were used in the analysis:

- ADD = 600 L/c/d (Existing Demand Management)
- MDD = 1,250 L/c/d (Existing Demand Management)
- ADD = 480 L/c/d (Intensive Demand Management)
- MDD = 940 L/c/d (Intensive Demand Management)
- Fire Flow:
  - 60 L/s (Sechelt bylaw; adopted for Sechelt Village and West Sechelt analysis)
  - 30 L/s (adopted for rural areas analysis)
- Minimum Pressures:
  - MDD + Fire Flow = 20 psi (Sechelt bylaw; adopted in analysis to be consistent with industry norm)
  - PHD = 40 psi (Sechelt bylaw; adopted in analysis to be consistent with industry norm)
- Maximum velocity = 3.0 m/s

The SCRD subdivision and servicing bylaw states that the minimum required fire flow in the distribution system is 60 L/s regardless of urban or rural development. In rural areas, the current absence of watermain looping and presence of undersized watermains will require significant system upgrades from the SCRD to provide a 60 L/s fire flow. A fire flow requirement of 30 L/s is recommended for rural properties. The classification of urban and rural lots is determined by parcel size, with all lots of quarter acre size or smaller classified as "urban" and all lots larger than quarter acre classified as rural. The 30 L/s requirement for rural fire flows is a common practice for water supply to rural communities in British Columbia (MOE 2007).

To illustrate the importance of developing rural fire flow guidelines for the SCRD, Opus DaytonKnight developed an infrastructure improvement program for the SCRD to meet both the 60 L/s requirement and the 30 L/s requirement in rural areas. The analysis found that the total capital cost for improvements to bring the rural areas to the 60 L/s fire flow requirement was about $7.1 million, while the cost to provide the rural areas with 30 L/s of fire flow was about $0.5 million.

From the results of the rural system analysis, it is not cost effective to upgrade the majority of the water system to meet the 60 L/s fire flow requirement at this time. Because of the existing deficiencies and with concern to public safety, fire departments in the SCRD should be advised that the use of pumper trucks to augment the fire flows should always be involved in the event of a fire in the SCRD. For the moment, the SCRD should ensure that rural areas have 30 L/s of fire flow, while denser urban areas have the 60 L/s fire flow. This will allow the SCRD to focus more of its budget to improve other water system infrastructure. The SCRD should re-assess its fire flow requirements and ultimately upgrade its watermains to provide 60 L/s of fire flow to the entire District when funds allow.

Implications of a rural fire flow requirement include:

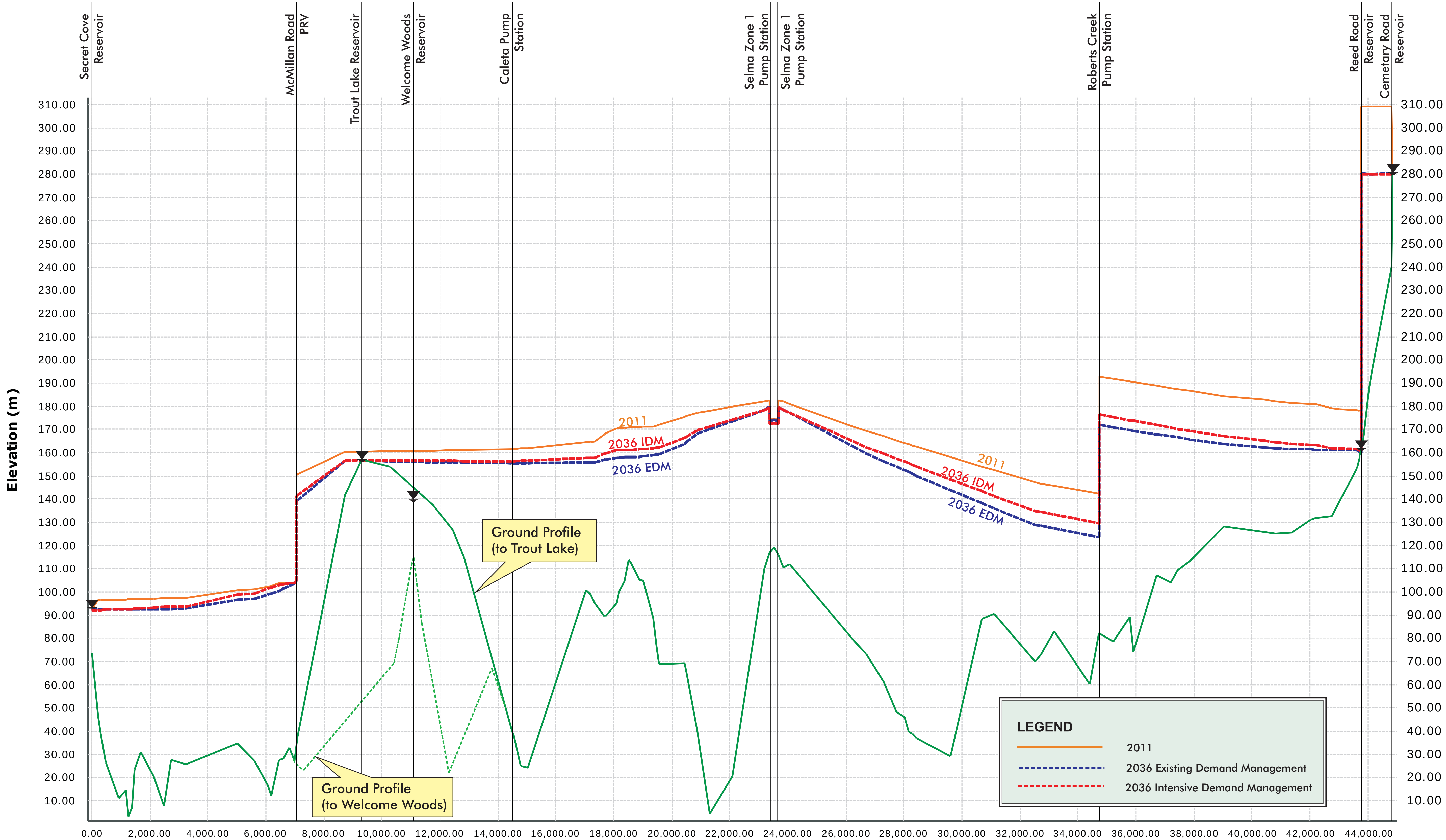
- A risk assessment study should be completed to determine the risk involved with 30 L/s fire flow in the rural locations. There may be properties in rural locations which may require a higher fire flow requirement and efforts to provide higher flows to these locations should be considered initially. It should be noted that a large part of the existing system currently receives only 30 L/s fire protection.
- Because properties may face higher insurance rates if located too far from a fire hydrant, the SCRD should review its fire hydrant locations. If hydrants are found to be located too far from many properties (check on insurer's requirements), the fire department has tanker trucks which transport water from a source to the fire and may be considered by the insurer as an equivalent to fire-hydrant protection.
- Based on the risk assessment, amend the bylaw to incorporate a 30 L/s fire flow requirement in rural areas.

For the purposes of the water system hydraulic analysis, industry norms of a minimum pressure of 20 psi during fire flow coincident with maximum day demand, and 40 psi during peak hour demand are used.

Following sub-sections present the findings from the water system analysis.

6.3.1 Supply Transmission

The supply analysis determines the system's ability to fill reservoirs in 24 hours during conditions of maximum day demand. The hydraulic gradeline (HGL) along the transmission mains was modeled from the Secret Cove reservoir in the west to the Reed Road reservoir in the east. Results of the analysis are captured in Figure 6-1 and are summarized hereafter.



Chapman Water System
Hydraulic Supply Analysis

OPUS DAYTONKNIGHT

Figure 6-1

SCRD D-02820.00 FIGURE 6-1.cdr Feb 20, 2013 Drawn by: cww

2011 Maximum Day Demand

The SCRD operator activates on the Selma Zone 1 pumps to add around 15 psi of head in Zone 2 to assist in refilling of the Secret Cove and Welcome Woods reservoirs. The pumps also add capacity to allow the Roberts Creek pump station to fill the Reed Road reservoirs. Model results indicate the system is able to replenish its reservoirs over a 24 hour maximum day condition.

2036 Maximum Day Demand – Existing Demand Management

The analysis concludes that the Secret Cove, Trout Lake, Welcome Woods, Reed Road and Cemetary Road reservoirs will not be able to be filled during maximum day demand. Transmission main upgrades are required and are described and costed in Section 8.4.

2036 Maximum Day Demand – Intensive Demand Management

With more intensive demand management in place, the Secret Cove, Trout Lake, Reed Road and Cemetary Road reservoirs are not filled during maximum day demand. Section 8.4 describes and costs the required improvements.

6.3.2 Storage Reservoirs

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. Table 6-4 summarizes the existing reservoir capacities, the required balancing storage and the required fire flow storage for both 2011 and 2036 conditions.

The required fire storage for all zones (except Zones 1 and 2) is 30 L/s for 2.0 hours based on the fire flow requirements for rural areas. The required fire storage for Zones 1 and 2 includes 60 L/s for 2.0 hours for urban residential and 225 L/s for 4.0 hours for industrial.

TABLE 6-4
CHAPMAN WATER SYSTEM
RESERVOIR STORAGE REQUIREMENTS

Area	Existing Storage (m^3)	Required Balancing Storage (m^3)	Available Fire Storage (m^3)	Required Fire Storage (m^3)
2011 - Existing Demand Management.				
Zone 1	3,487	2,705	782	3,240
Zone 2	22,979	2,867	20,112	3,240
Zone 3	1,137	700	437	216
Zone 4	227	58	169	216
Sandy Hook Area	857	138	719	216
Zone 1 West	2,281	292	1,989	216
2036 - Existing Demand Management.				
Zone 1	3,487	4,432	0	3,240
Zone 2	22,979	4,697	18,282	3,240
Zone 3	1,137	1,146	0	216
Zone 4	227	96	131	216
Sandy Hook Area	857	227	630	216
Zone 1 West	2,281	478	1,803	216
2036 - Intensive Demand Management.				
Zone 1	3,487	3,373	114	3,240
Zone 2	22,979	3,492	19,487	3,240
Zone 3	1,137	843	294	216
Zone 4	227	71	156	216
Sandy Hook Area	857	167	690	216
Zone 1 West	2,281	361	1,920	216

2011 Storage Requirements

Existing storage reservoirs provide enough capacity to accommodate balancing storage, while Zone 1 and Zone 4 have deficient storage volume to meet fire flows. However, as noted in Section 3.6, when fire storage is assessed cumulatively, such that water can cascade from Zone 2 to Zone 1 and can be pumped from Zone 2 to Zone 4, there are no immediate concern for the upgrade of reservoirs. Use of the Zone 2 reservoir storage to supplement fire storage in other zones is an acceptable practice by the SCRD.

2036 Storage Requirements – Existing Demand Management

For the 2036 condition with existing demand management, Zone 1 has insufficient balancing storage. Further, fire storage deficiencies are present in Zones 1, 3 and 4. Zone 1, 3 and 4 fire storage deficiencies can be addressed through water storage from Zone 2, an acceptable practice carried out by the SCRD. However, the balancing storage deficiency in Zone 1 requires that additional storage capacity be added to Zone 1.

Section 8.5 identifies the additional storage requirements and provides cost estimates.

2036 Storage Requirements – Intensive Demand Management

For the 2036 condition with intensive demand management, balancing storage is adequate in all the pressure zones. However, fire storage is inadequate in Zones 1 and 4. Zones 1 and 4 fire storage can be supplied from Zone 2, an acceptable practice carried out by the SCRD.

Section 8.5 identifies the additional storage requirements and provides cost estimates.

6.3.3 Distribution System

Distribution systems are the physical infrastructure that deliver water from a water source to the intended end point user. A hydraulic water model was developed for the Chapman water system on a street by street level and provides insight into the level of service provided.

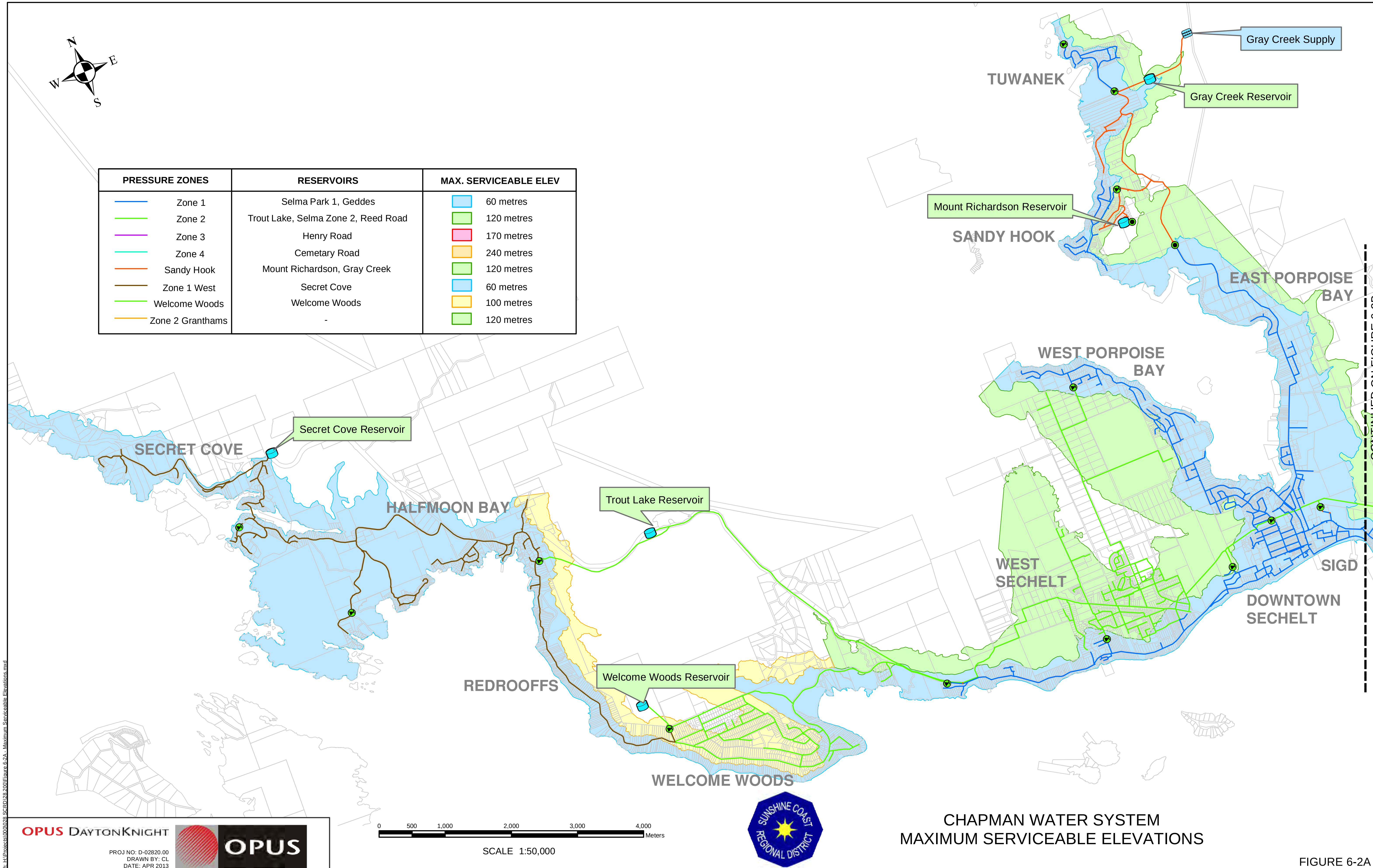
Service pressures, pipe velocities, and fire flows were analyzed for the following conditions:

- 2011 MDD
- 2036 MDD (Existing Demand Management)
- 2036 MDD (Intensive Demand Management)

Results from the analysis are presented in the sub-sections that follow. Section 8.6 identifies and provides cost estimates for the recommended upgrade requirements.

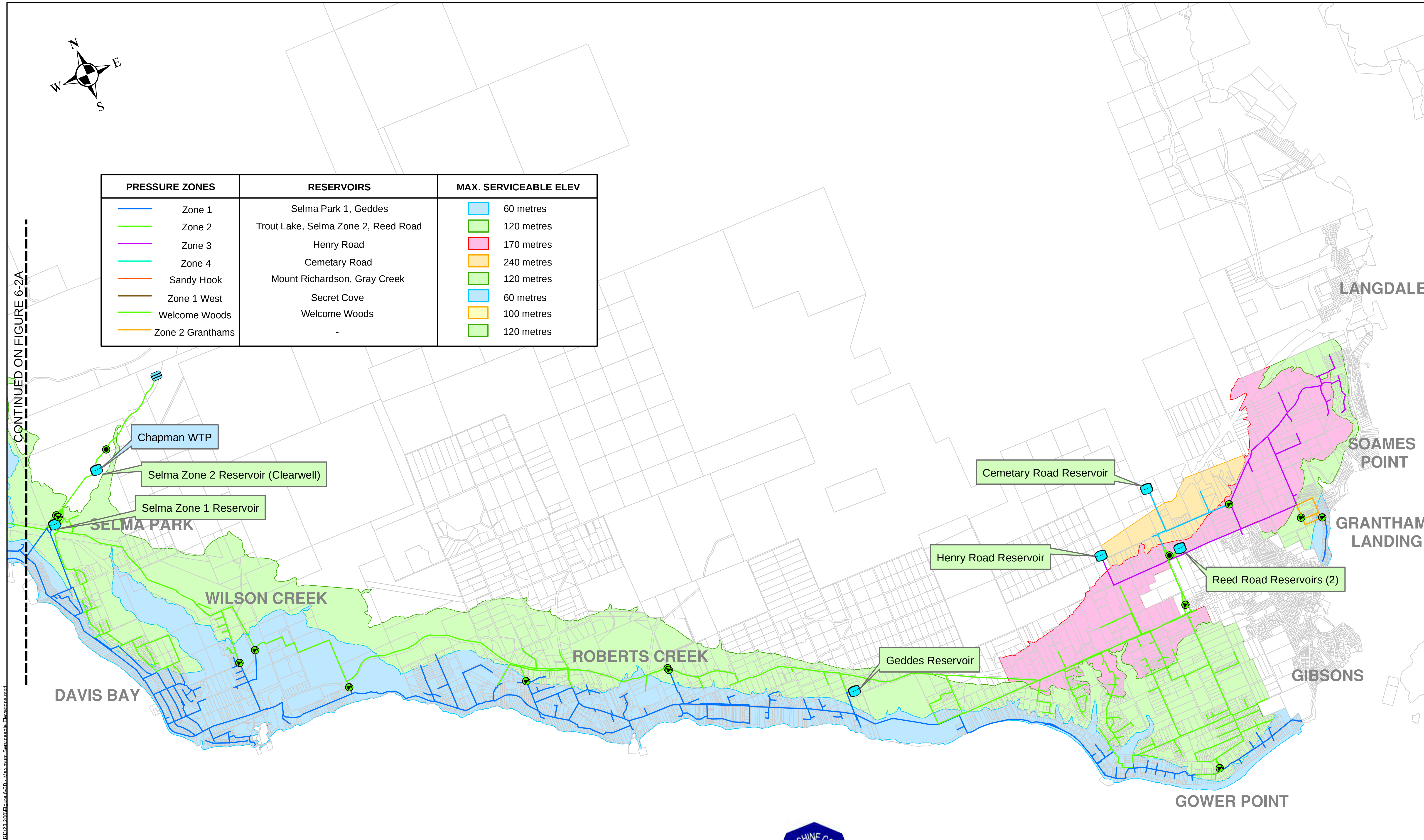
6.3.3.1 Service Pressures

The following hydraulic analysis are based on the extent of current pressure zones and do not extend beyond what is currently represented in the model. The maximum serviceable elevation for Zone 1 and Zone 2 pressure has historically limited development up to an elevation of 60 metres and 120 metres respectively. Figures 6-2A and 6-2B show the maximum serviceable elevations for each of the zones within the Chapman distribution system. These elevations shall form the maximum development limits for each zone and any subsequent development applications for construction beyond these limits shall require an additional review for feasibility.



CHAPMAN WATER SYSTEM
MAXIMUM SERVICEABLE ELEVATIONS

FIGURE 6-2A



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CHAPMAN WATER SYSTEM
MAXIMUM SERVICEABLE ELEVATIONS

FIGURE 6-2B

The SCRD should note that residents will have issues with low pressure at locations with pressures below 40 psi, and that the water system will have areas of high head loss at locations with velocities above 3.0 m/s. Table 6-5 summarizes the results in terms of pressures below 40 psi and velocities above 3.0 m/s for 2011 and 2036 conditions.

TABLE 6-5
CHAPMAN WATER SYSTEM
SERVICE PRESSURES

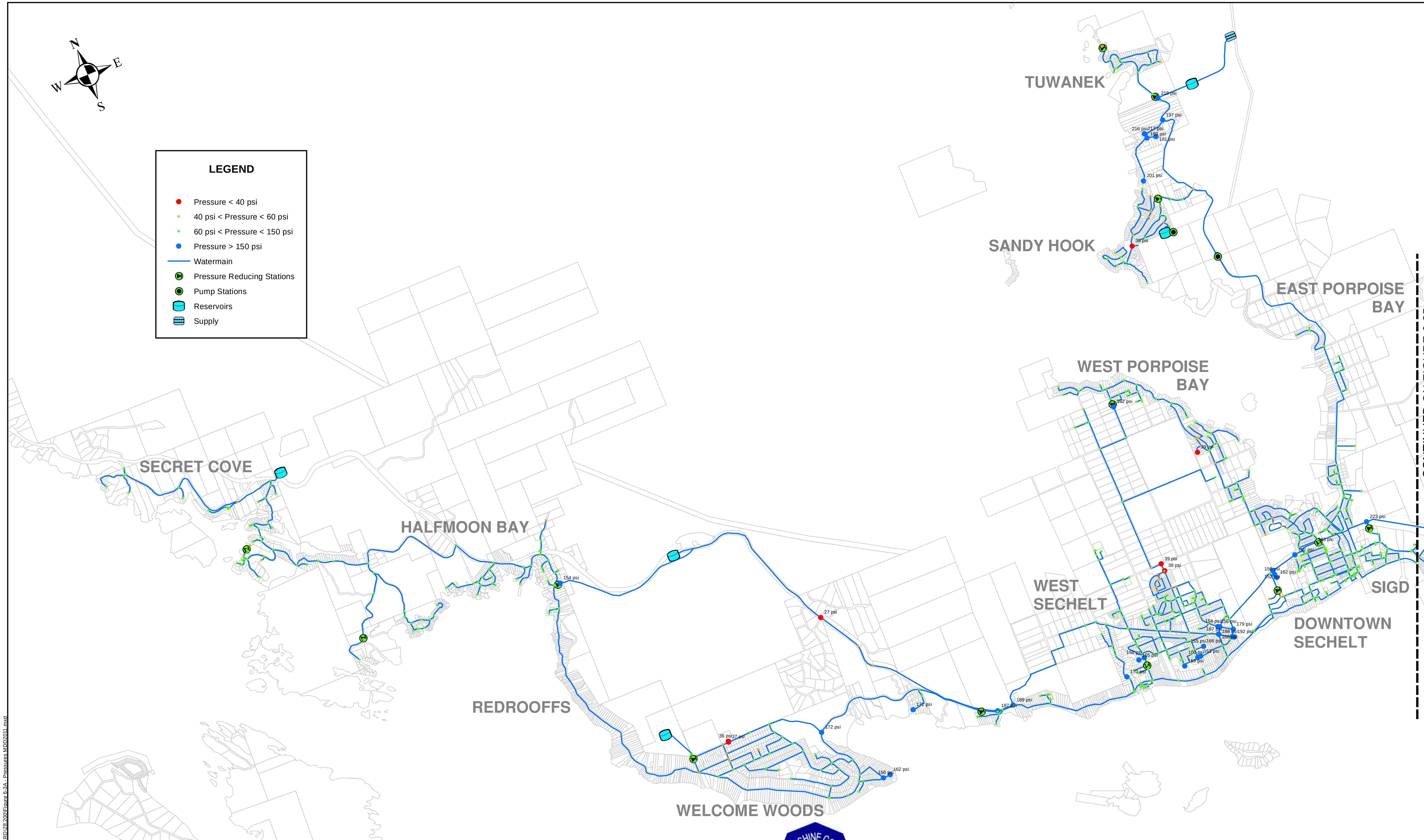
Demand Scenarios	# of Nodes with pressure < 40 psi		# of pipes with velocity > 3.0 m/s	
	2011	2036	2011	2036
MDD - Existing Demand Management	12	30	0	0
MDD - Intensive Demand Management	-	16	-	0

Figures 6-3A and 6-3B illustrate the locations within the service area where pressures are less than 40 psi under conditions of 2011 MDD.

- Zone 1 – Roberts Creek (1 node), West Porpoise Bay (1)
- Zone 2 – Elphinstone (4), West Sechelt (2), Welcome Woods (3)
- Sandy Hook – Lower Sandy Hook (1)

Figures 6-4A and 6-4B illustrate the locations where pressures are less that 40 psi under 2036 MDD (Existing Demand Management). Low pressures are found in the following areas:

- Zone 1 – Roberts Creek (1 node), West Porpoise Bay (1)
- Zone 2 – Elphinstone (13), West Sechelt (8), Welcome Woods (3), Roberts Creek (3)
- Sandy Hook – Lower Sandy Hook (1)



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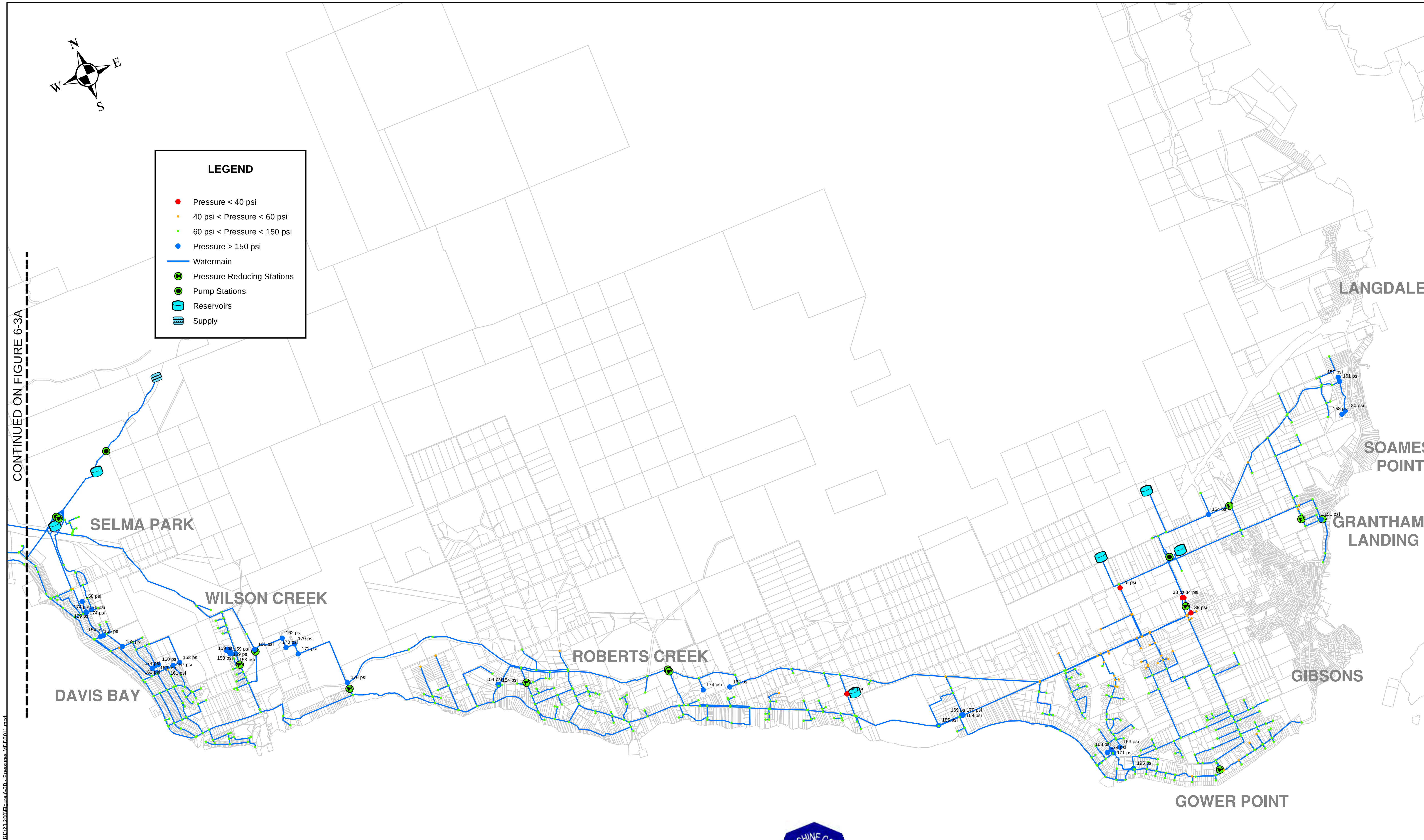
CHAPMAN WATER SYSTEM
2011 MAXIMUM DAY DEMAND PRESSURES

FIGURE 6-3A



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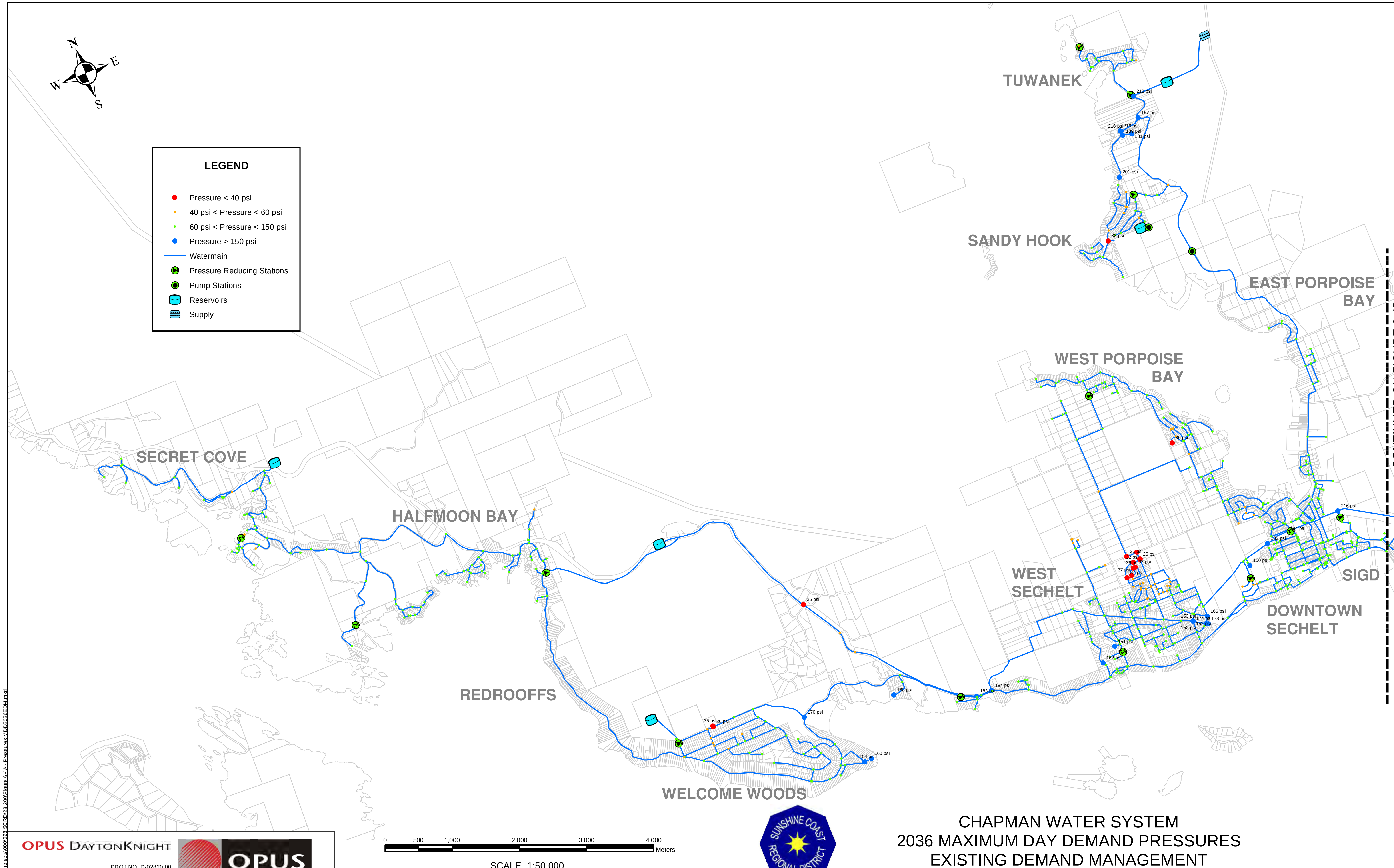
CHAPMAN WATER SYSTEM
2011 MAXIMUM DAY DEMAND PRESSURES

FIGURE 6-3B



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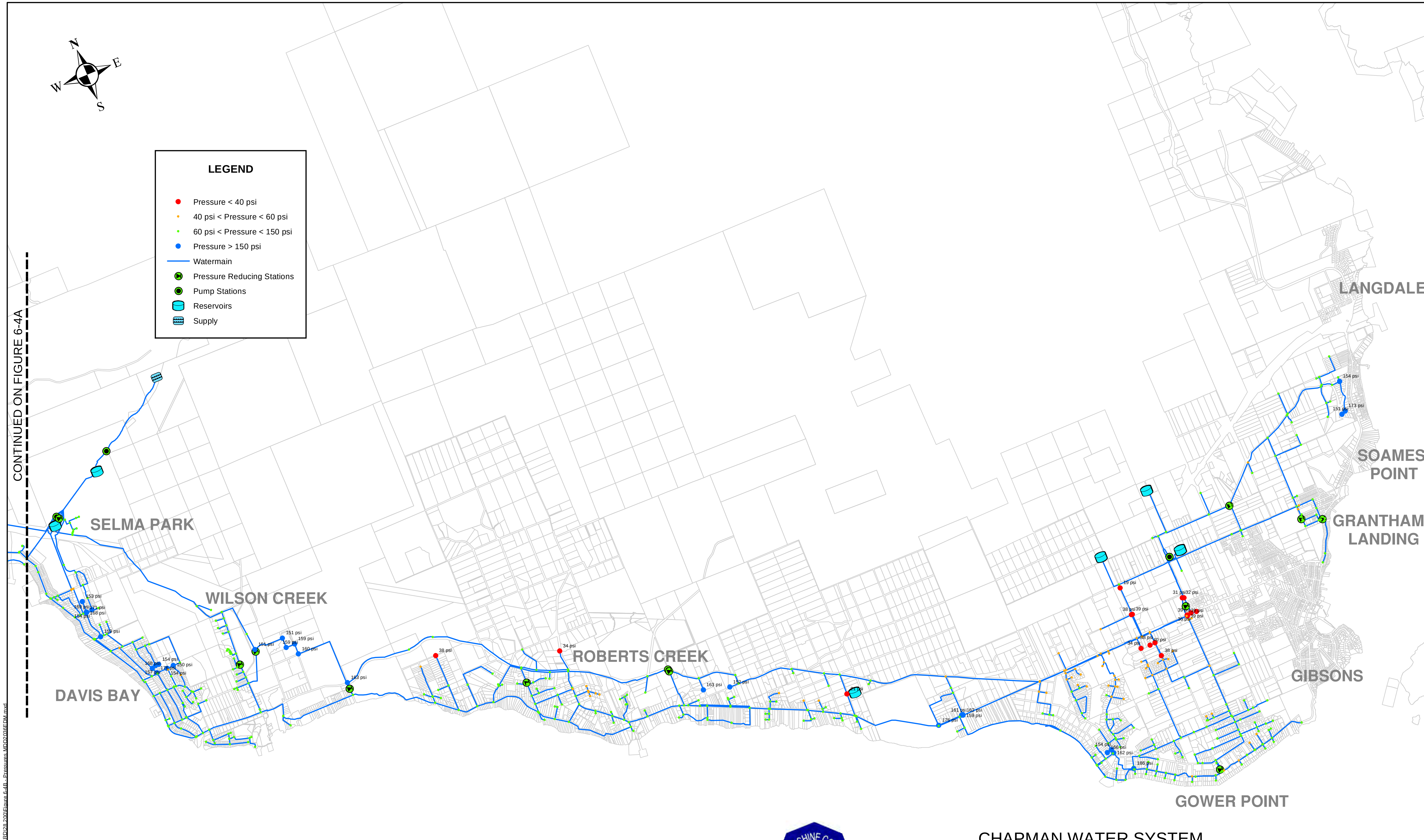
CHAPMAN WATER SYSTEM
2036 MAXIMUM DAY DEMAND PRESSURES
EXISTING DEMAND MANAGEMENT

FIGURE 6-4A



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SUNSHINE COAST REGIONAL DISTRICT

CHAPMAN WATER SYSTEM
2036 MAXIMUM DAY DEMAND PRESSURES
EXISTING DEMAND MANAGEMENT

FIGURE 6-4B

Figures 6-5A and 6-5B illustrate the locations where pressures are less that 40 psi under 2036 MDD (Intensive Demand Management). Low pressures are found in the following areas:

- Zone 1 – Roberts Creek (1 node), West Porpoise Bay (1)
- Zone 2 – Elphinstone (6), West Sechelt (4), Welcome Woods (3)
- Sandy Hook – Lower Sandy Hook (1)

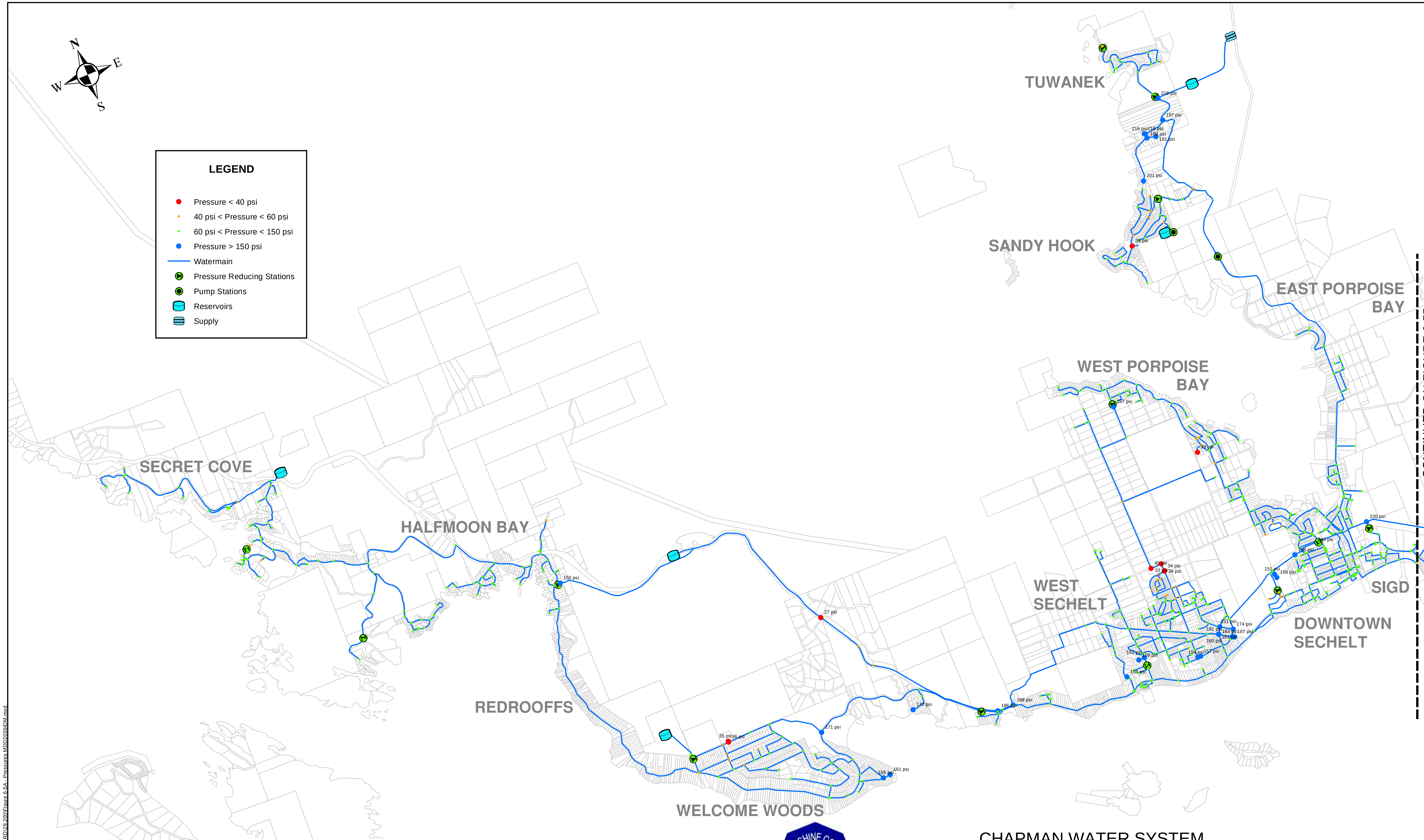
In general, service pressures and velocities in the distribution system do not account for many deficiencies in the current and future modeled scenarios. The fire flow analysis which follows reveals the critical locations for distribution system upgrades which will also address the pressure concerns noted above.

6.3.3.2 Fire Flows

Table 6-6 summarizes the fire flow analysis carried out under various scenarios while applying the 60 L/s urban and the 30 L/s rural fire flow requirements. The scenarios included are 2011 and 2036 conditions under existing and intensive demand management programs.

TABLE 6-6
CHAPMAN WATER SYSTEM
AVAILABLE FIRE FLOWS

Condition	# of Nodes with Fire Flows in Urban Areas < 60 L/s		# of Nodes with Fire Flows in Rural Areas < 30 L/s	
	2011	2036	2011	2036
MDD - Existing Demand Management	74	213	54	139
MDD - Intensive Demand Management	-	182	-	58



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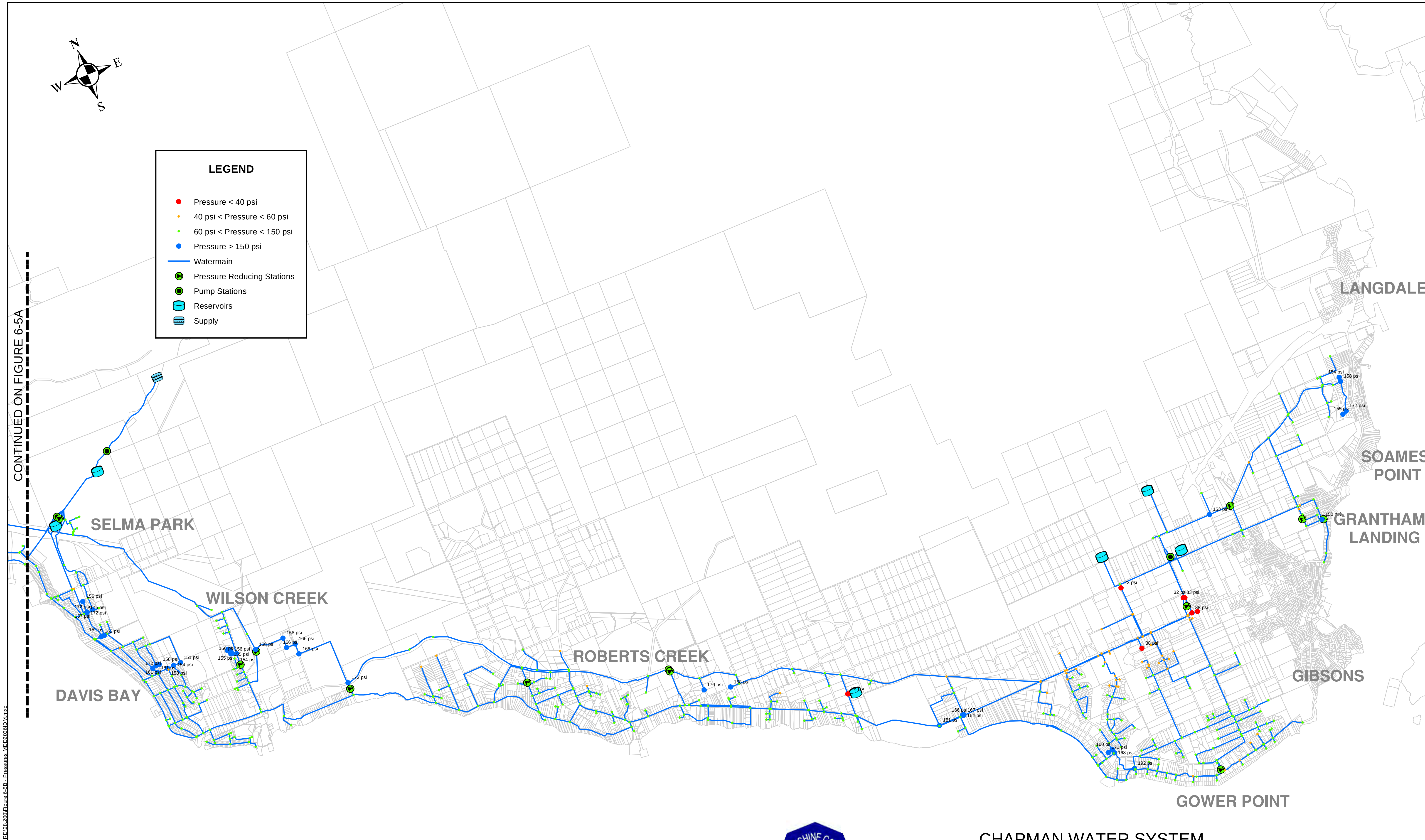
CHAPMAN WATER SYSTEM
2036 MAXIMUM DAY DEMAND PRESSURES
INTENSIVE DEMAND MANAGEMENT

FIGURE 6-5A



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SUNSHINE COAST REGIONAL DISTRICT

CHAPMAN WATER SYSTEM
2036 MAXIMUM DAY DEMAND PRESSURES
INTENSIVE DEMAND MANAGEMENT

FIGURE 6-5B

Path: H:\Projects\0000\028 SCRD\28.200\Figure 6-5B - Pressures MDD2036IDM.mxd

Figures 6-6A and 6-6B illustrate the areas within the distribution system where flows do not meet the fire flow requirements of 60 L/s (urban properties) and 30 L/s (rural properties) under 2011 conditions. A summary of the locations and the number of nodes deficient under the urban and rural fire flow requirements follows:

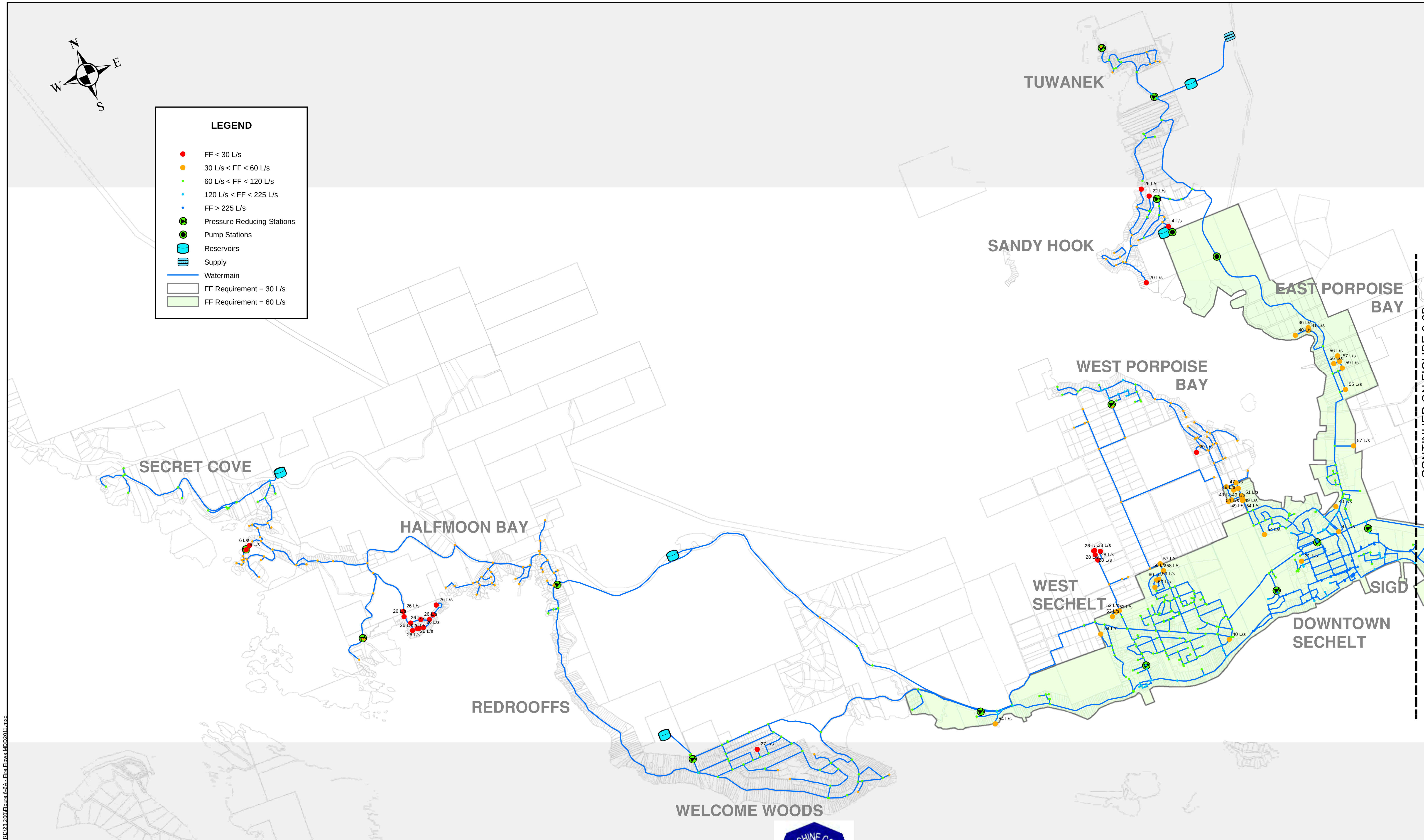
<u>60 L/s Requirement</u>

- Zone 1 – Davis Bay (17 nodes), West Sechelt (1), Sechelt (4), East Porpoise Bay (9), West Porpoise Bay (11)
- Zone 2 – Elphinstone (2), West Sechelt (11), Davis Bay (19)

<u>30 L/s Requirement</u>

- Zone 1 – Roberts Creek (17 nodes), West Porpoise Bay (1), Elphinstone (4)
- Zone 1 West – Halfmoon Bay (13)
- Zone 2 – Roberts Creek (6), Welcome Woods (1), West Sechelt (5), Elphinstone (2)
- Zone 3 – North of Gibsons (1)
- Sandy Hook – Lower Sandy Hook (3), Mt. Richardson (1)

Figures 6-7A and 6-7B illustrate areas with the distribution system where flows less than 60 L/s (urban properties) and 30 L/s (rural properties) are found under 2036 - Existing Demand Management condition. A summary of the locations and the number of nodes deficient under the urban and rural fire flow requirements follows:



Path: H:\Projects\D0028 SCRD\28.2\Figure 6-6A - Fire Flows MDD2011.mxd

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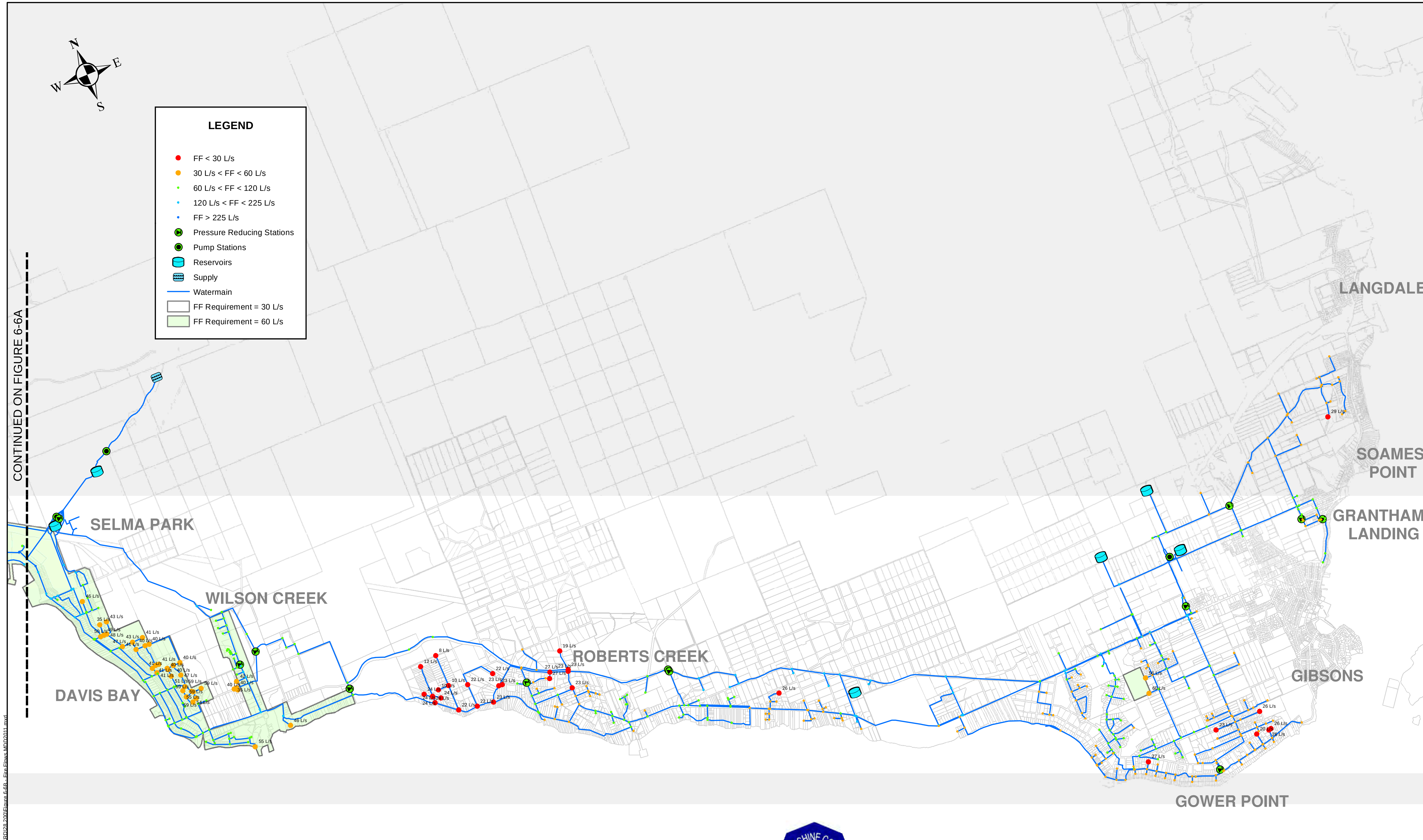
SUNSHINE COAST REGIONAL DISTRICT

CHAPMAN WATER SYSTEM
2011 MAXIMUM DAY DEMAND FIRE FLOWS

FIGURE 6-6A



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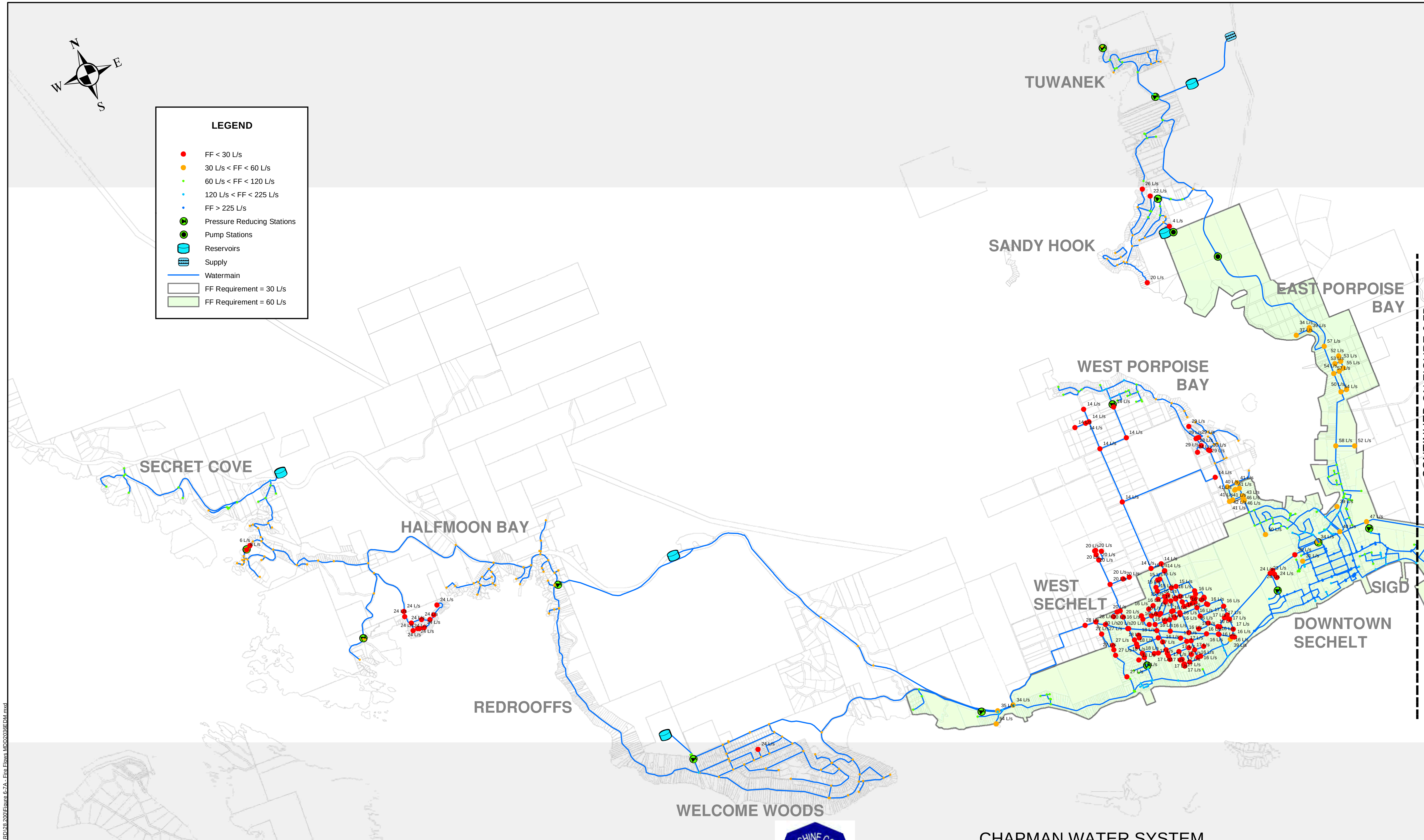
CHAPMAN WATER SYSTEM
2011 MAXIMUM DAY DEMAND FIRE FLOWS

FIGURE 6-6B



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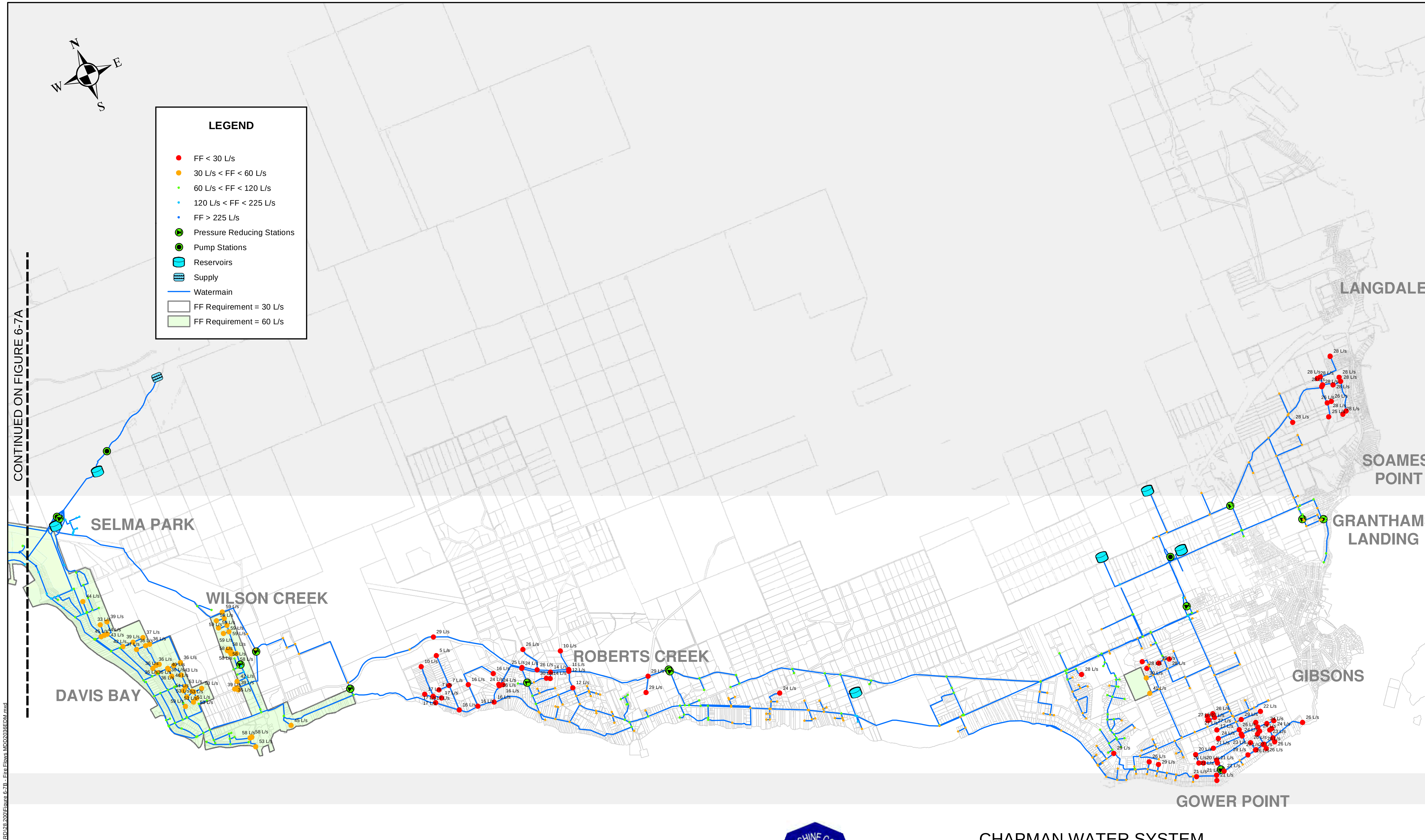
CHAPMAN WATER SYSTEM
2036 MAXIMUM DAY DEMAND FIRE FLOWS
EXISTING DEMAND MANAGEMENT

FIGURE 6-7A



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CHAPMAN WATER SYSTEM
2036 MAXIMUM DAY DEMAND FIRE FLOWS
EXISTING DEMAND MANAGEMENT

FIGURE 6-7B

Path: H:\Projects\0000\28 SCRD\28.200\Figure 6-7B - Fire Flows MDD2036EDM.mxd

60 L/s Requirement

- Zone 1 –Davis Bay (20 nodes), West Sechelt (1), Sechelt (4), East Porpoise Bay (14), West Porpoise Bay (11)
- Zone 2 – Elphinstone (2), West Sechelt (121), Davis Bay (33), Sechelt (7)

30 L/s Requirement

- Zone 1 – Roberts Creek (17), West Porpoise Bay (8), Elphinstone (15)
- Zone 1 West – Halfmoon Bay (13)
- Zone 2 – Roberts Creek (16), Elphinstone (32), Welcome Woods (1), West Sechelt (19)
- Zone 3 – North of Gibsons (14)
- Sandy Hook – Lower Sandy Hook (3), Mt. Richardson (1)

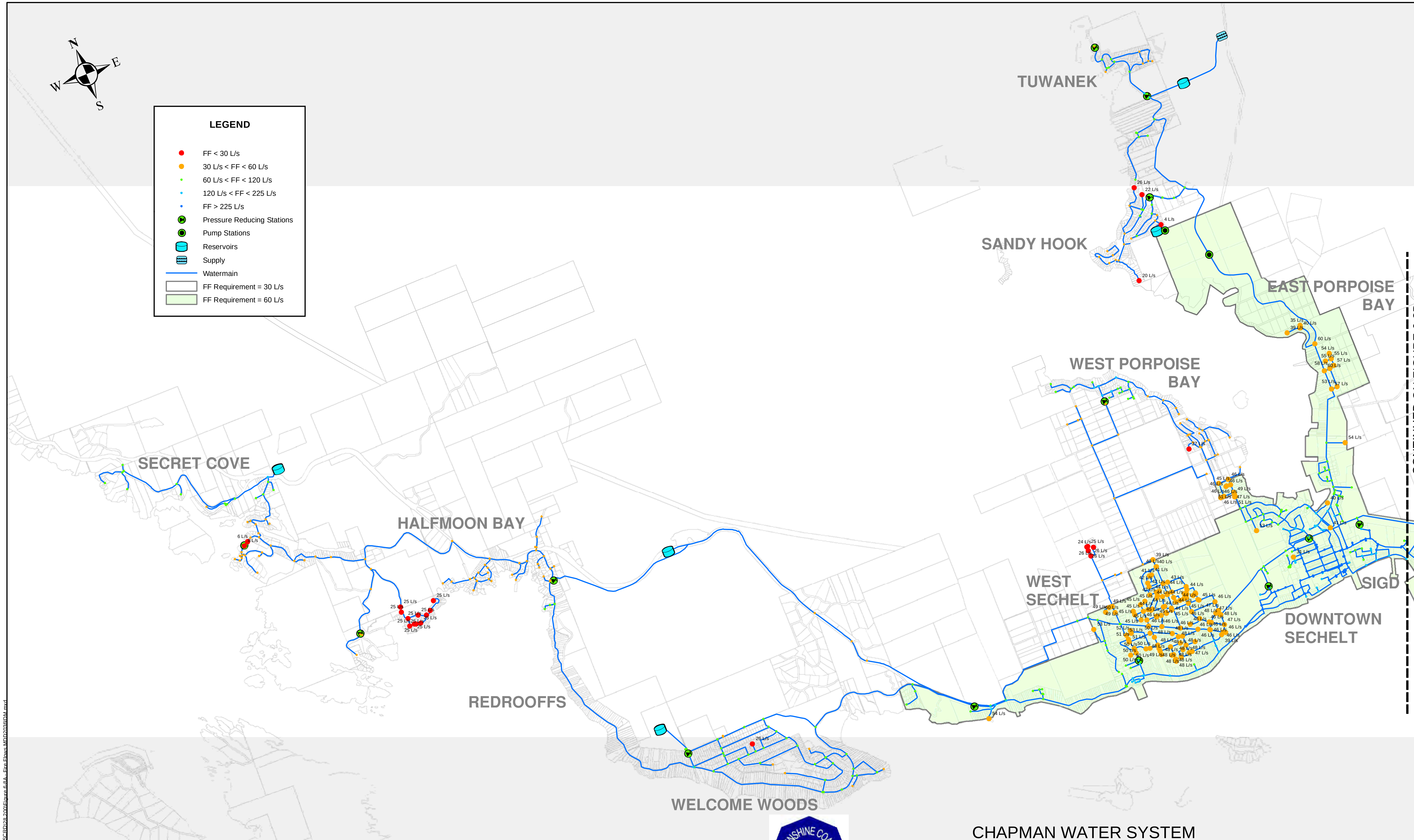
Figures 6-8A and 6-8B illustrate the areas within the distributions system where flows less than 60 L/s (urban properties) and 30 L/s (rural properties) are found under 2036 - Intensive Demand Management condition. A summary of the locations and the number of nodes deficient under the urban and rural fire flow requirements follows:

60 L/s Requirement

- Zone 1 –Davis Bay (18 nodes), West Sechelt (1), Sechelt (4), East Porpoise Bay (14), West Porpoise Bay (11)
- Zone 2 – Elphinstone (2), West Sechelt (113), Davis Bay (19)

30 L/s Requirement

- Zone 1 – Roberts Creek (17), West Porpoise Bay (1), Elphinstone (5)
- Zone 1 West – Halfmoon Bay (13)
- Zone 2 – Roberts Creek (6), Welcome Woods (1), West Sechelt (5), Elphinstone (3)
- Zone 3 – North of Gibsons (3)
- Sandy Hook – Lower Sandy Hook (3), Mt. Richardson (1)



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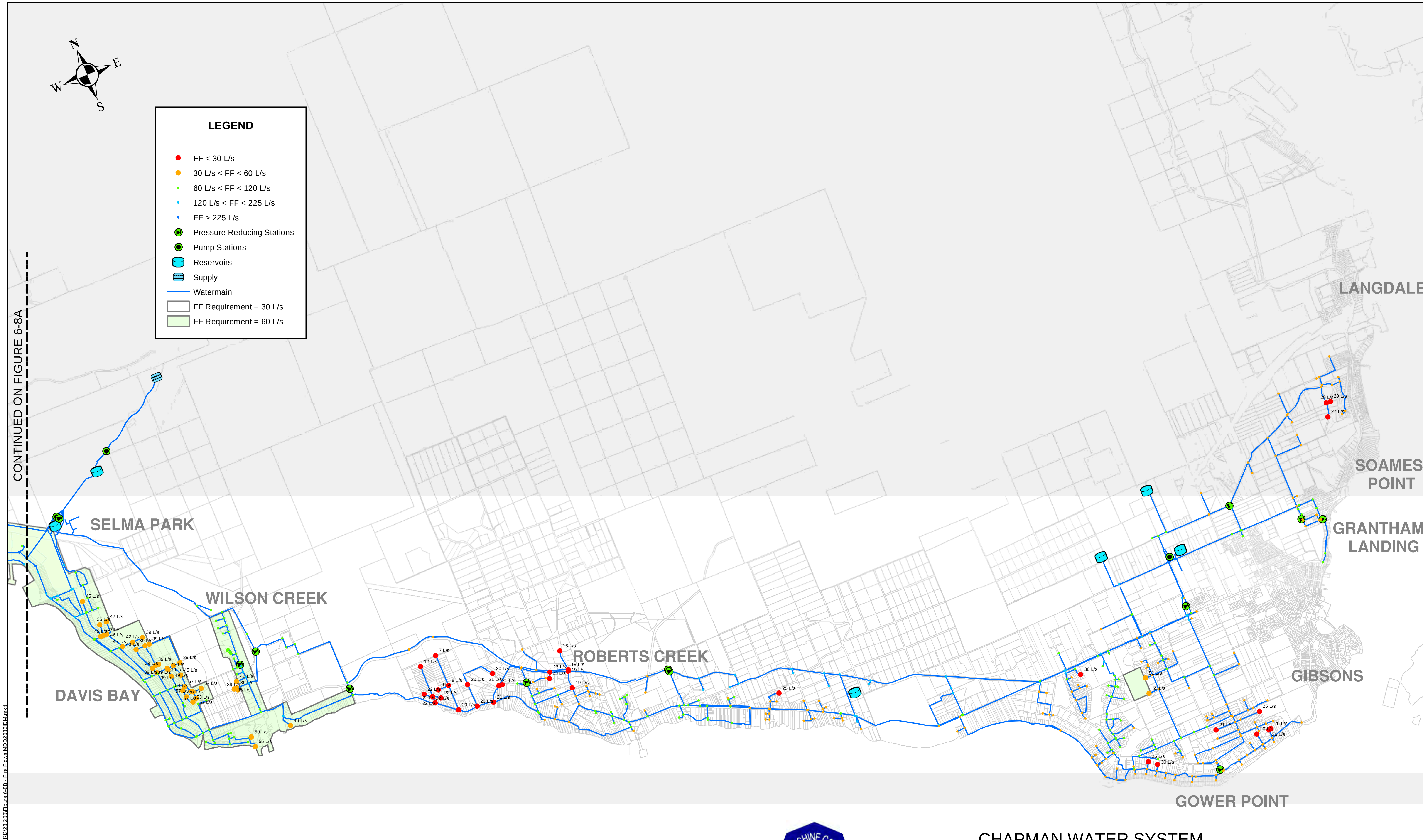
CHAPMAN WATER SYSTEM
2036 MAXIMUM DAY DEMAND FIRE FLOWS
INTENSIVE DEMAND MANAGEMENT

FIGURE 6-8A



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SUNSHINE COAST REGIONAL DISTRICT

CHAPMAN WATER SYSTEM
2036 MAXIMUM DAY DEMAND FIRE FLOWS
INTENSIVE DEMAND MANAGEMENT

FIGURE 6-8B

In general, fire flow deficiencies in the distribution system are concentrated in Davis Bay and West Sechelt for the urban areas and in Roberts Creek and areas of West of Gibsons for the rural areas. The 2036 EDM condition reveals 352 nodes which do not meet fire flow requirements. At 30% (352 / 1161 nodes), the system is considered to be moderately deficient. Fire flow upgrading can be gradually addressed with West Sechelt, Roberts Creek, Elphinstone, and Davis Bay as priority work.

Fire flow deficiencies in the Chapman water system are concentrated in the areas of Davis Bay and West Sechelt for the urban analysis, and in Roberts Creek and Elphinstone for the rural analysis.

6.4 Linked Water Systems

The Langdale, Soames Point, Grantham's Landing, the privately owned Hopkins water systems are all linked to each other and linked to the Chapman water system via closed valves or PRVs. The benefit of this existing configuration is that each system can serve as a backup to the Chapman water system or vice-versa. At the moment, the systems have not been modeled to see how easily water can be moved between each system.

7.0 SMALL WATER SYSTEMS ANALYSIS

This section presents the findings from an analysis of the remaining water systems in the Regional Water Service Area excluding North and South Pender Harbour. The analysis has been carried out for the 2011 water demands (existing conditions) and also for the projected 2036 water demands (under two conditions - existing and more intensive demand management programs). Analysis includes the water sources, water treatment, supply transmission, supply storage and the distribution systems. The fire flow requirement used for the properties is 30 L/s at 20 psi residual pressures.

The projected population growth for the small water systems is found in Section 5.3. There is limited development potential in the Soames Point, Granthams Landing and Eastbourne water systems and full buildout is expected to be reached before 2036 at an assumed 2% growth rate.

The small water systems’ average day and maximum day water usage projections are calculated in Section 5.5. With the exception of the Eastbourne and Cove Cay water systems, whose per capita demands were already at a low rate, future demand for the small water systems were also analyzed under the influence of intensive demand management.

Eastbourne is a unique low flow system which serves a large influx of summer residents on Keats Island. The Eastbourne water system has limitations to the supply system to support growth.

The Langdale, Soames Point, Granthams Landing and the privately owned Hopkins water systems are all interconnected between themselves and the Chapman water system via closed valves or PRVs, but operate independently under normal circumstances. The benefit of this existing configuration is that each system can serve as a backup to the Chapman water system or vice-versa. At the moment, the systems have not been modeled to see how easily water can be moved between each system.

There are no plans in place to operate these smaller systems as an integrated system with the Chapman water system at this time. The communities have demonstrated a preference of keeping the systems separate. There are no plans to integrate the North and South Pender Harbour water systems with Chapman at this time either. Once all the water master plans are completed, the next update of the CRWP will look at the potential to integrate all systems.

7.1 Water Sources

The SCRD extracts water from both surface and groundwater sources throughout its small water systems.

7.1.1 Langdale

The Langdale Well is located at 1409 Marine Drive just outside the BC Ferries Langdale property. This system serves three pressure zones in the Langdale community and includes BC Ferries, the Langdale Elementary School and Camp Elphinstone among its connections. The well has a pumping capacity of 1.2 ML/d and a well depth of 45.7 metres.

The well protection plan has not been completed for the Langdale Well.

7.1.2 Soames Point

The Soames Point Well is located at 876 Ruffum Road and serves two pressure zones in the Soames Point community. The SCRD inherited the system in 1990 from the Soames Point Improvement District. The well has a pumping capacity of 1.39 ML/d and a well depth of 36.9 metres.

The well protection plan has not been completed for the Soames Point Well.

7.1.3 Granthams Landing

The supply capacity of the Granthams Landing Well is 0.23 ML/d. The system is connected to the Chapman water system through the Fisher Road PRV, which would provide an emergency supply from the Chapman Creek source. This water can also reach the Soames Point, Langdale and privately owned Hopkins water systems if required. The well protection plan for the Granthams Landing Well has not been completed.

7.1.4 Eastbourne

The SCRD was approached to take over the Eastbourne private water system in 2001.

Water is supplied from two shallow groundwater wells and is limited in volume. The water system is operated as a self-contained, independent, sustainable and safe low flow water system making the best use of the existing infrastructure with a limited island water supply. Residents are required to install mandatory 1,000 gallon tanks on their property to augment the existing storage and assist them through the dry months when the well levels are low. The Collector and Gordon Wells capacities range from 0.02 ML/d in the dry season to over 0.07 ML/d.

In order to promote water conservation, water meters have been installed on all service connections in the Eastbourne community and outdoor water usage has been completely banned in the Eastbourne water system. The Eastbourne water system currently serves as a model for other water deficient island communities. Well capacities in the Eastbourne system are as follows:

- From late November through early April - the maximum daily sustainable flow is governed by the treatment plant capacity of 0.06 mL/d.

- From early April through late November - the maximum sustainable daily flow is governed by well capacity, falling from 0.06 mL/d to 0.015 mL/d.

- Maximum available (treated) storage is 0.075 mL, so, starting with full storage - the one-day maximum flows are 0.135 mL/d and 0.09 mL/d.

- Well protection plans have not been completed for the Collector and Gordon Wells.

7.1.5 Cove Cay

The SCRD was approached to take over the Cove Cay private water system in 1995.

The Cove Cay water system draws its water from Ruby Lake, which is the second largest lake on the lower Sunshine Coast with a surface area of 456 hectares. The lake has a mean depth of 55 metres and a maximum depth of 112 metres. Ruby Lake water is pumped to the Cove Cay and Earl's Cove subdivisions. The supply capacity at the lake is 1.2 ML/d.

7.1.6 Egmont Cove

Waugh Lake supplies water to the Egmont Cove water system. The supply elevation of Waugh Lake is 36.02 metres and the supply capacity is 0.22 ML/d.

7.2 Water Treatment

The SCRD is responsible for the management and treatment of each of the water sources in the Regional Water Service Area.

7.2.1 Langdale

The Langdale well is currently chlorinated at the supply source. Water quality data meets or exceeds the Canadian Drinking Water Guidelines at this location.

7.2.2 Soames Point

The Soames Point well is currently chlorinated at the supply source. Water quality data meets or exceeds the Canadian Drinking Water Guidelines at this location. However, the DWO has requested that the chlorination treatment process be automated at this location.

7.2.3 Granthams Landing

The Granthams Landing well is currently chlorinated at the supply source. Water quality data meets or exceeds the Canadian Drinking Water Guidelines at this location.

7.2.4 Eastbourne

The source supply from the Collector and Gordon wells is currently pretreated with a combination UV and filter system at the six 2000 gallon treated water storage tanks just west of the Collector wells. Water entering the supply lines from the tanks is treated with sodium hypochlorite to maintain a free chlorine residual in the system. Water quality data meets or exceeds the Canadian Drinking Water Guidelines in the community.

7.2.5 Cove Cay

Water from Ruby Lake is pumped and then chlorinated on its way to the Earls Cove reservoir. Water quality data meets or exceeds the Canadian Drinking Water Guidelines at this location.

7.2.6 Egmont Cove

Water from Waugh Lake is pumped and then UV treated and chlorinated on its way to the Egmont Cove Reservoir. Water quality data meets or exceeds the Canadian Drinking Water Guidelines at this location.

7.3 Water System Analysis

A separate WaterCAD model was developed to analyze the reservoir storage and the distribution system within the small water systems for both 2011 and 2036. The analysis was based on a 2% growth rate under both existing demand management programs and more intensive demand management programs.

Demands of each of the small water systems are summarized in Section 5.5.

The following design criteria were used in the analysis:

- Fire Flow = 30 L/s
- Minimum Pressures:
  - MDD + Fire Flow = 20 psi (Sechelt bylaw; adopted in analysis to be consistent with industry norm)
  - PHD = 40 psi (Sechelt bylaw; adopted in analysis to be consistent with industry norm)
- Maximum velocity = 3.0 m/s

7.3.1 Supply Transmission

The supply analysis determines the system's ability to fill reservoirs in 24 hours during conditions of maximum day demand. The Chapman transmission system is isolated from the smaller systems via closed valves or PRVs. No analysis is carried out on transmission watermains under the small systems analysis.

7.3.2 Storage Reservoirs

Table 7-1 summarizes the existing reservoir capacities, the required balancing storage and the required fire flow storage for both 2011 and 2036 conditions. The required fire storage for the small water systems (except for Eastbourne) is 30 L/s for 2.0 hours based on the fire flow requirements for rural areas.

The Eastbourne water system is operated as a domestic use system and its residents understand there is a limited resource of water from its supply wells. Eastbourne residents have installed tanks on their property to augment the existing storage and assist them through the dry months. The reservoirs in Eastbourne are not designed to carry fire storage volumes.

TABLE 7-1
SMALL WATER SYSTEMS
RESERVOIR STORAGE REQUIREMENTS

Area	Existing Storage (m^3)	Required Balancing Storage (m^3)	Available Fire Storage (m^3)	Required Fire Storage (m^3)
2011 - Existing Demand Management.				
Langdale	455	173	282	216
Soames Point & Granthams Landing	341	125	216	216
Eastbourne	45	8	-	-
Cove Cay	480	14	466	216
Egmont Cove	265	18	247	216
2036 - Existing Demand Management.				
Langdale	455	265	190	216
Soames Point & Granthams Landing	341	208	133	216
Eastbourne	45	14	-	-
Cove Cay	480	22	458	216
Egmont Cove	265	29	236	216
2036 - Intensive Demand Management.				
Langdale	455	200	255	216
Soames Point & Granthams Landing	341	155	186	216
Eastbourne	-	-	-	-
Cove Cay	-	-	-	-
Egmont Cove	265	23	242	216

2011 Storage Requirements

Existing storage reservoirs provide enough capacity to accommodate balancing and fire storage in each of the small water systems.

2036 Storage Requirements – Existing Demand Management

For the 2036 condition with existing demand management, each small water system has sufficient balancing storage. However, there is a fire storage deficiency in the Langdale, Soames Point and Granthams Landing water systems. To address these deficiencies, the existing interconnection between these systems allows each system to increase its fire storage volumes if required in emergency. Further, if more volume is required, the connection to the Chapman water system via the Fisher PRV in Granthams Landing will also provide additional volume.

2036 Storage Requirements – Intensive Demand Management

For the 2036 condition with intensive demand management, each of the small water systems has sufficient balancing storage. The small water systems have sufficient fire storage except for the Soames Point and Granthams Landing systems. Again, the existing interconnection to the Chapman Water System will provide the required additional fire storage volumes to these communities.

7.3.3 Distribution System

Service pressures, pipe velocities, and fire flows were analyzed for the following conditions:

- 2011 MDD
- 2036 MDD (Existing Demand Management)
- 2036 MDD (Intensive Demand Management)

Results from the analysis are presented in the sub-sections that follow. Section 9.6 identifies and provides cost estimates for the recommended upgrade requirements.

7.3.3.1 Service Pressures

The SCRD should note that residents will have issues with low pressure at locations with pressures below 40 psi, and that the water system will have areas of high head loss at locations with velocities above 3.0 m/s. Table 7-2 summarizes the results in terms of pressures below 40 psi and velocities above 3.0 m/s for 2011 and 2036 maximum day demand conditions.

TABLE 7-2
SMALL WATER SYSTEMS
SERVICE PRESSURES

Demand Scenarios	# of Nodes with pressure < 40 psi		# of pipes with velocity > 3.0 m/s	
	2011	2036	2011	2036
Langdale EDM	1	1	0	0
Langdale IDM	-	1	-	0
Soames Point & Granthams EDM	4	4	2	2
Soames Point & Granthams IDM	-	4	-	2
Eastbourne EDM	5	5	0	0
Eastbourne IDM	-	-	-	-
Cove Cay EDM	4	4	0	0
Cove Cay IDM	-	-	-	-
Egmont Cove EDM	2	2	0	0
Egmont Cove IDM	-	2	-	0

In general, service pressures and velocities in the small water system account for only a small number of deficiencies and not covered in detail in this report. Figures 7-1A to 7-1F and their respective notes should be taken into account for the deficiencies in the small water systems and properties with low pressures should be individually addressed as needed by the SCRD.

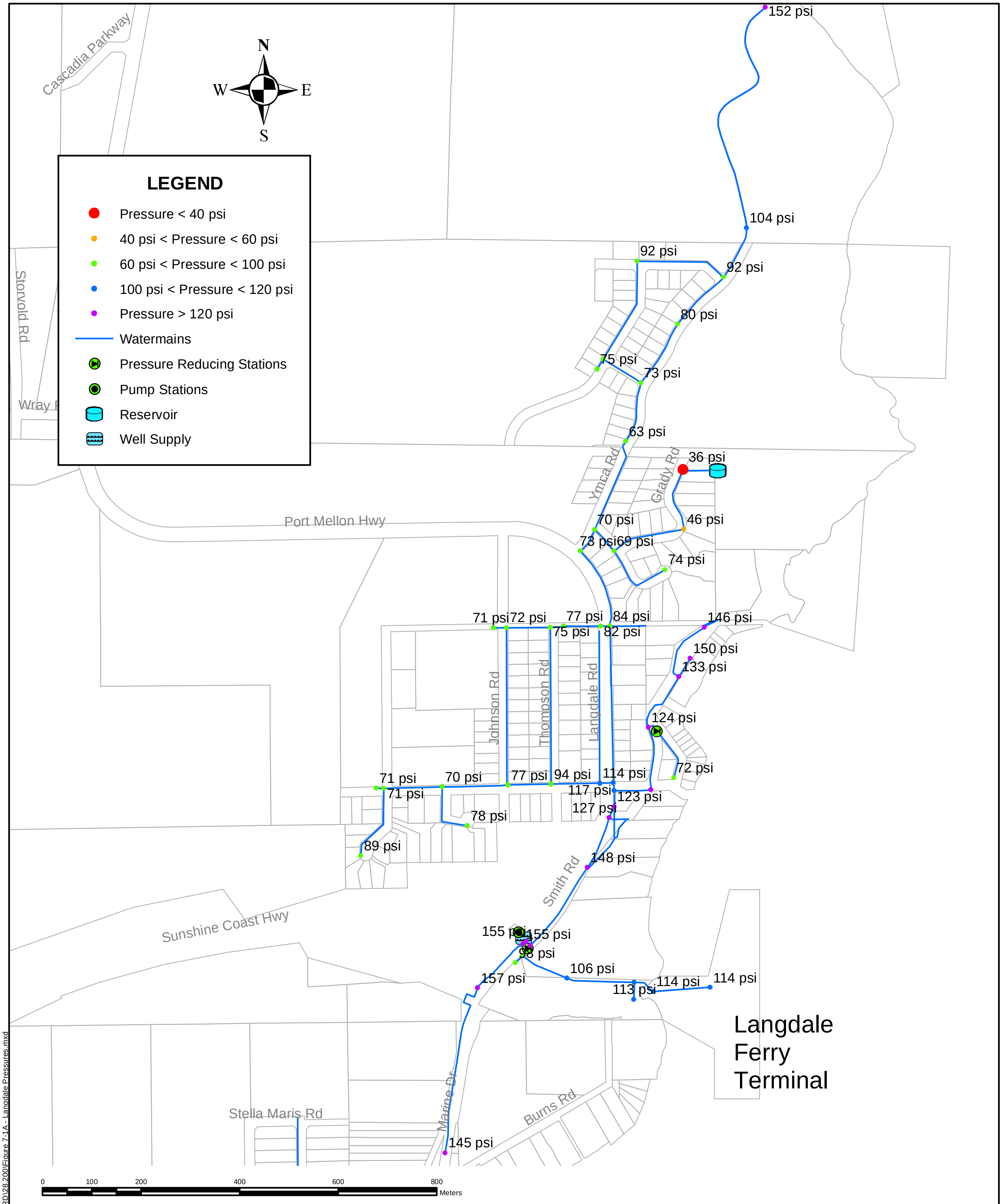
The fire flow analysis which follows will determine the more critical improvement items for the SCRD in its small water systems analysis.

7.3.3.2 Fire Flows

Table 7-3 summarizes the fire flow analysis carried out under various scenarios while applying the 30 L/s rural fire flow requirements. The Eastbourne system is not included in this analysis. The scenarios included are 2011 and 2036 conditions under existing and intensive demand management programs.

TABLE 7-3
SMALL WATER SYSTEMS
AVAILABLE FIRE FLOWS

Demand Scenarios	# of Nodes with Fire Flows < 30 L/s	
	2011	2036
Langdale EDM	1	1
Langdale IDM	-	1
Soames Point & Granthams EDM	8	8
Soames Point & Granthams IDM	-	8
Cove Cay EDM	7	7
Cove Cay IDM	-	-
Egmont Cove EDM	0	0
Egmont Cove IDM	-	0



Path: H:\Projects\000028 SCRD\28.200\Figure 7-1A - Langdale Pressures.mxd

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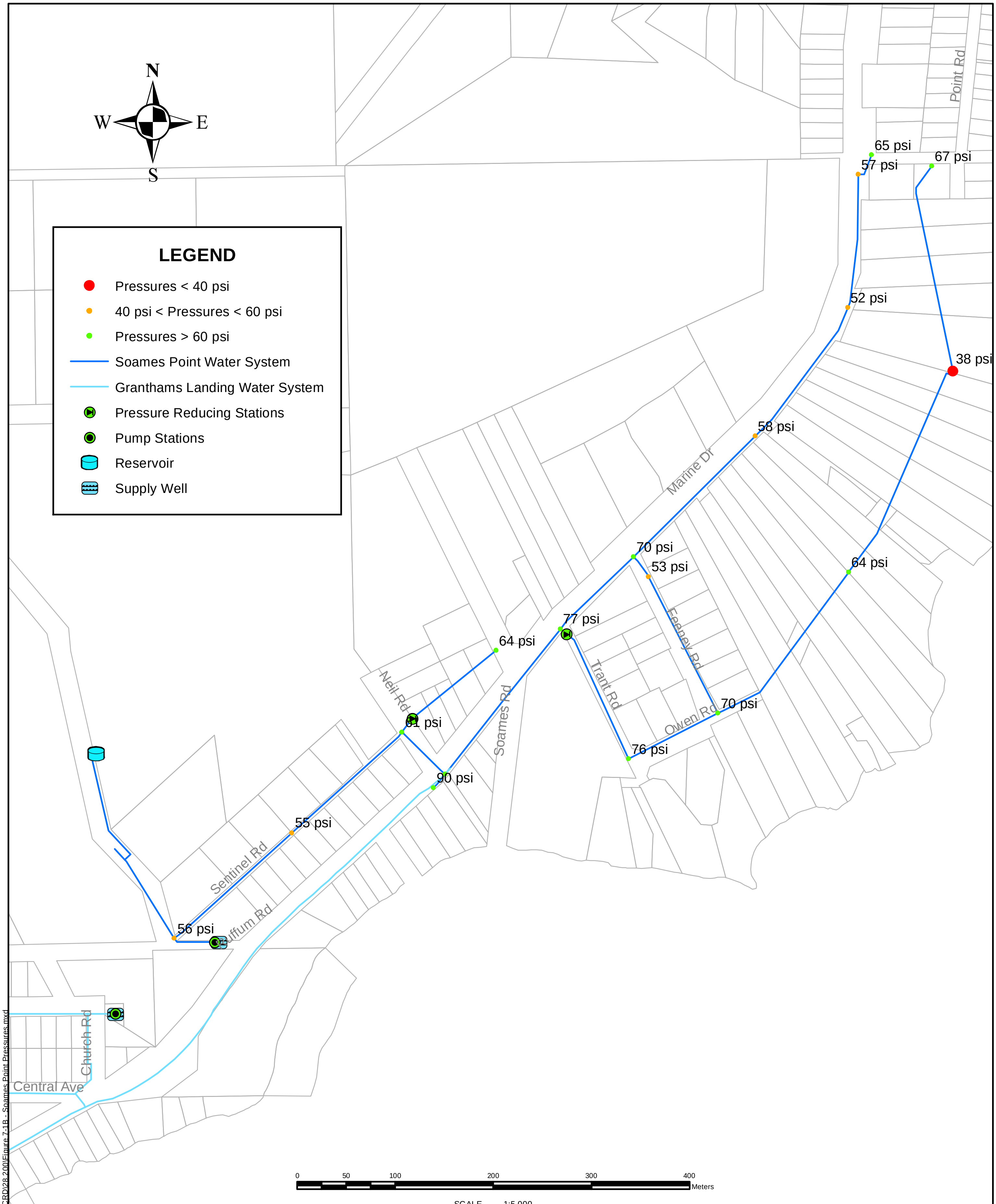
LANGDALE WATER SYSTEM EXISTING SERVICE PRESSURES

FIGURE 7-1A



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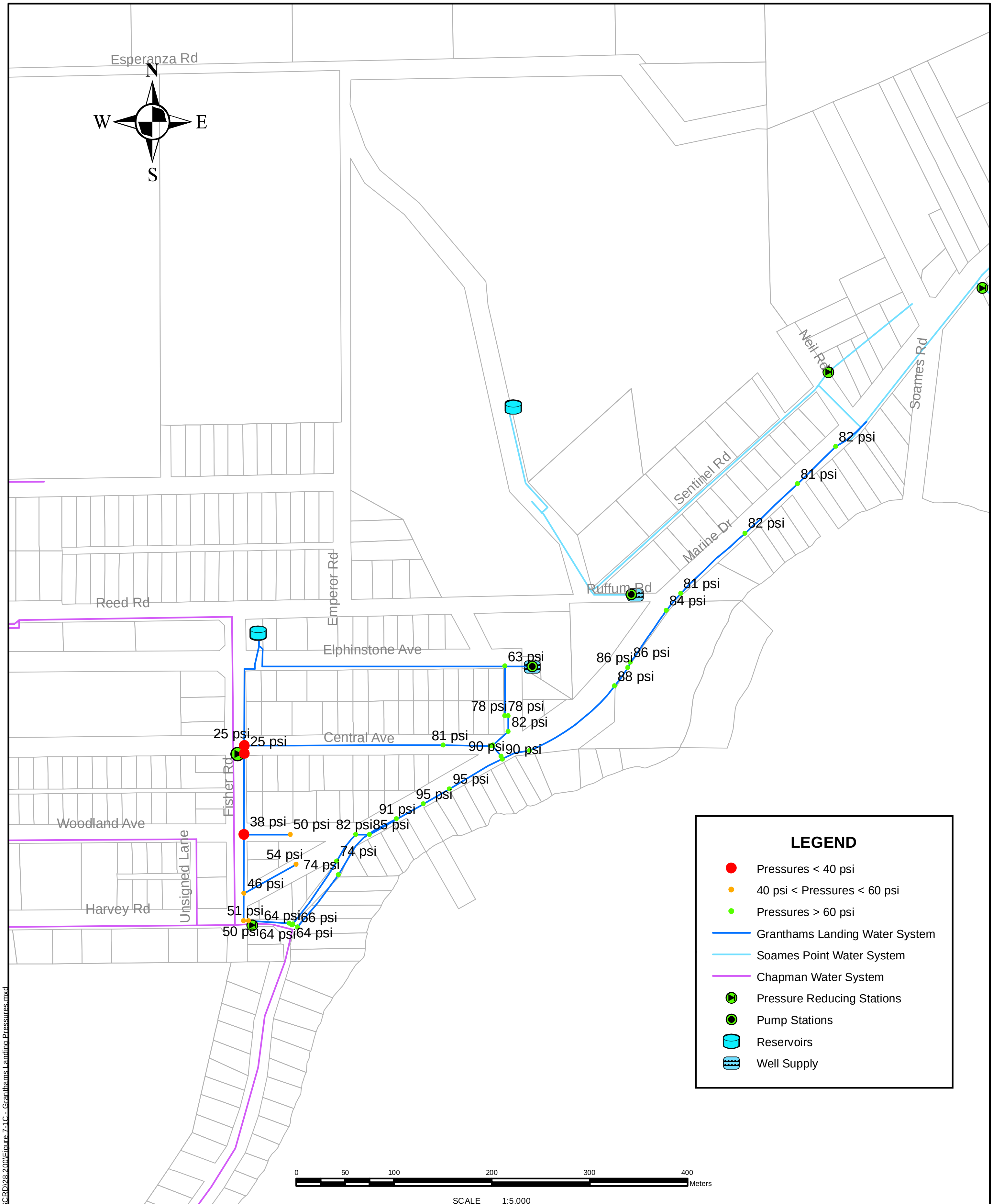
SOAMES POINT WATER SYSTEM EXISTING SERVICE PRESSURES

FIGURE 7-1B

Path: H:\Projects\0000028.SCRD\28.200\Figure 7-1B - Soames Point Pressures.mxd



Path: H:\Projects\00028 SCRD\28.200\Figure 7-1C - Granthams Landing Pressures.mxd

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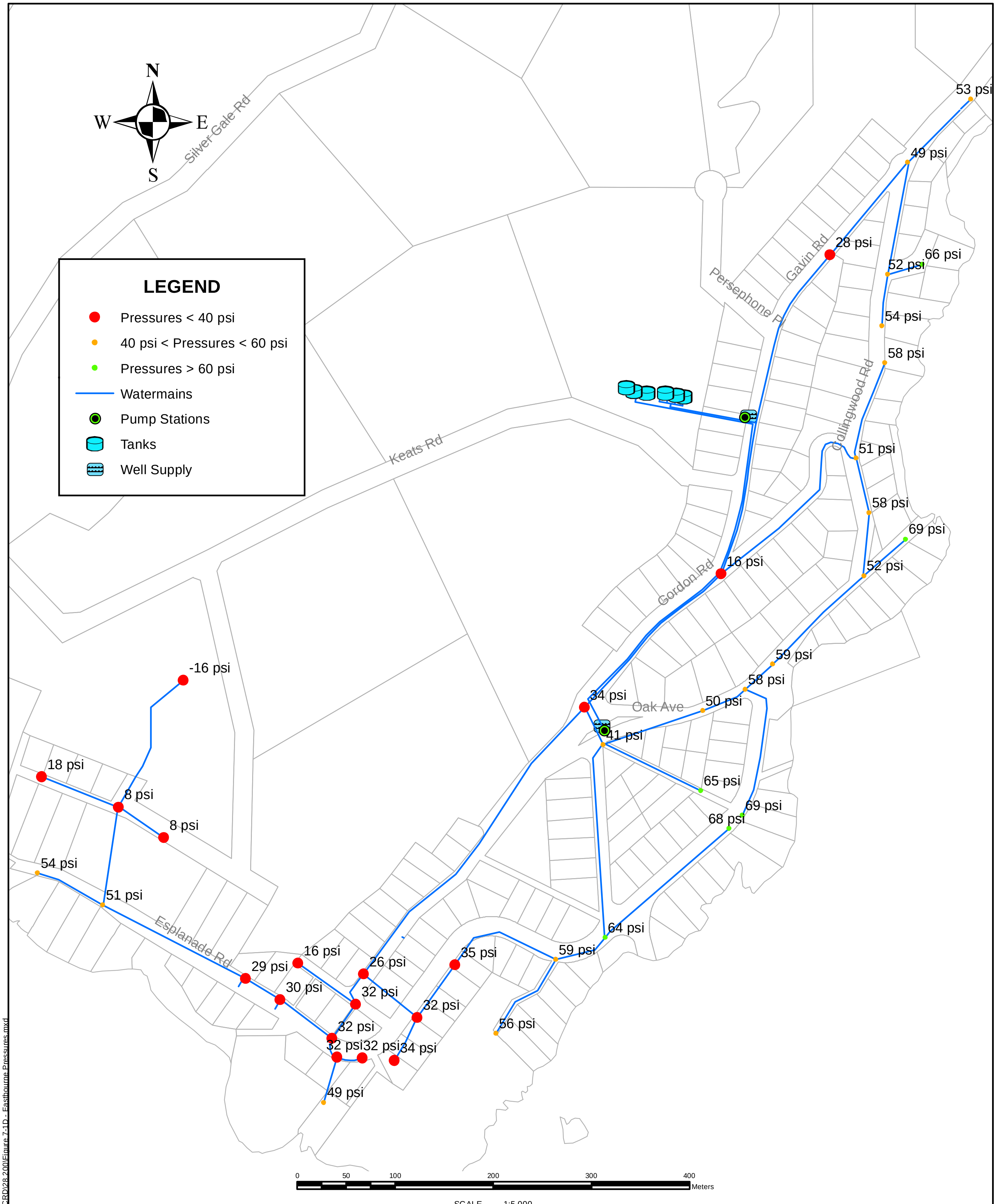
GRANTHAMS LANDING WATER SYSTEM
EXISTING SERVICE PRESSURES

FIGURE 7-1C



Path: H:\Projects\000028 SCRD\28.200\Figure 7-1D - Eastbourne Pressures.mxd

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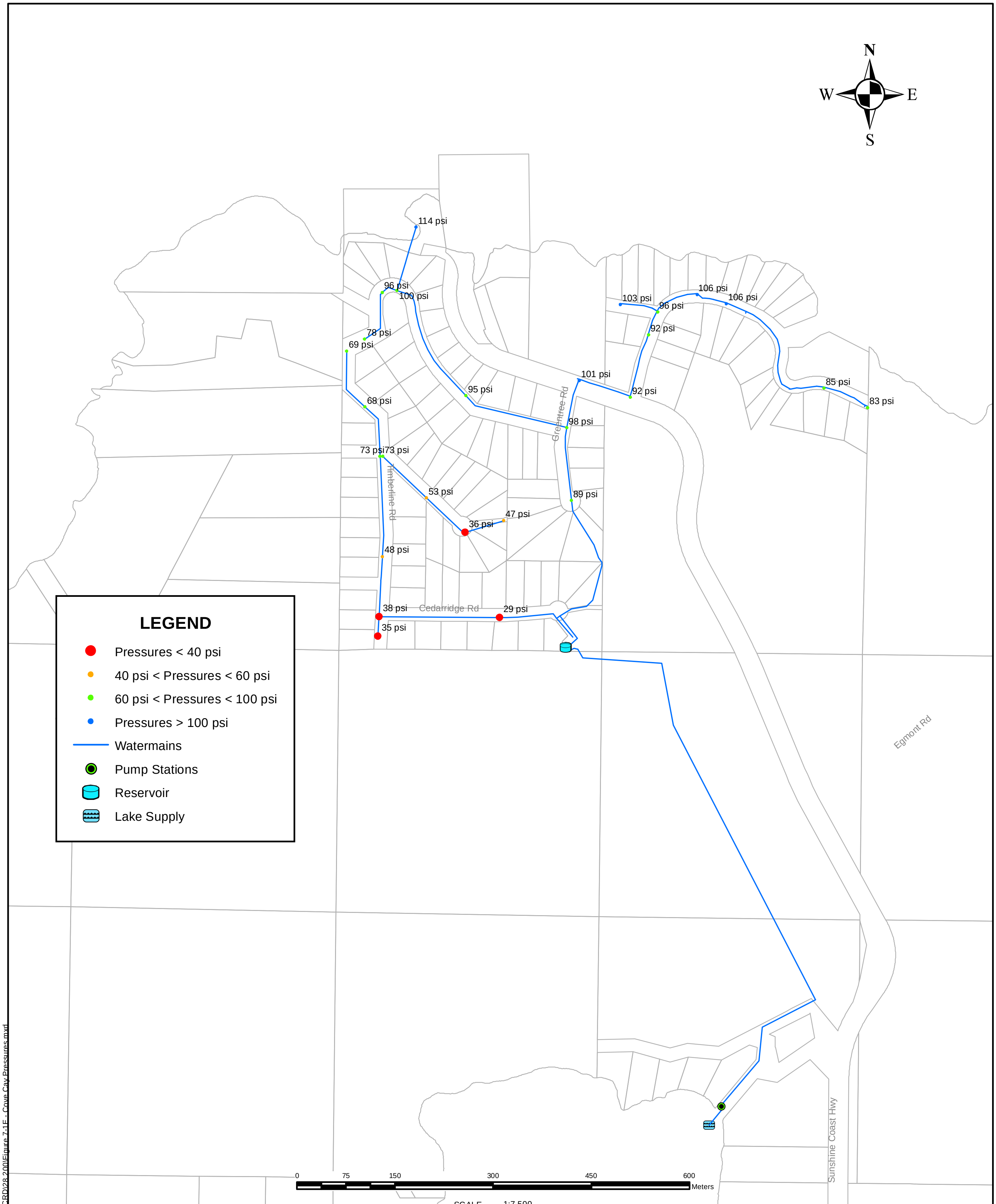
EASTBOURNE WATER SYSTEM EXISTING SERVICE PRESSURES

FIGURE 7-1D



Path: H:\Projects\000028 SCRD\28.200\Figure 7-1E - Cove Cay Pressures.mxd

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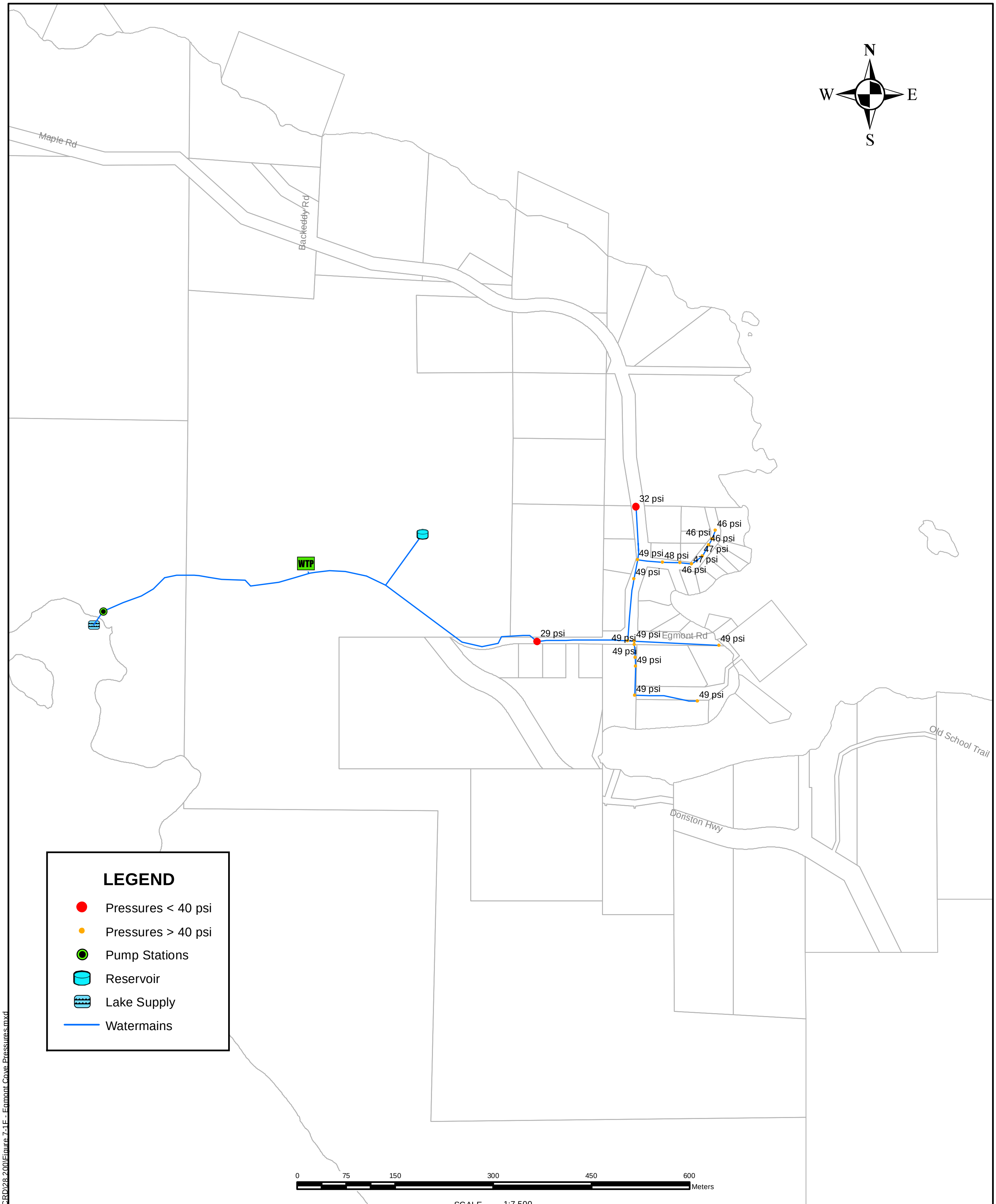
COVE CAY WATER SYSTEM EXISTING SERVICE PRESSURES

FIGURE 7-1E



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SUNSHINE COAST REGIONAL DISTRICT

EGMONT COVE WATER SYSTEM EXISTING SERVICE PRESSURES

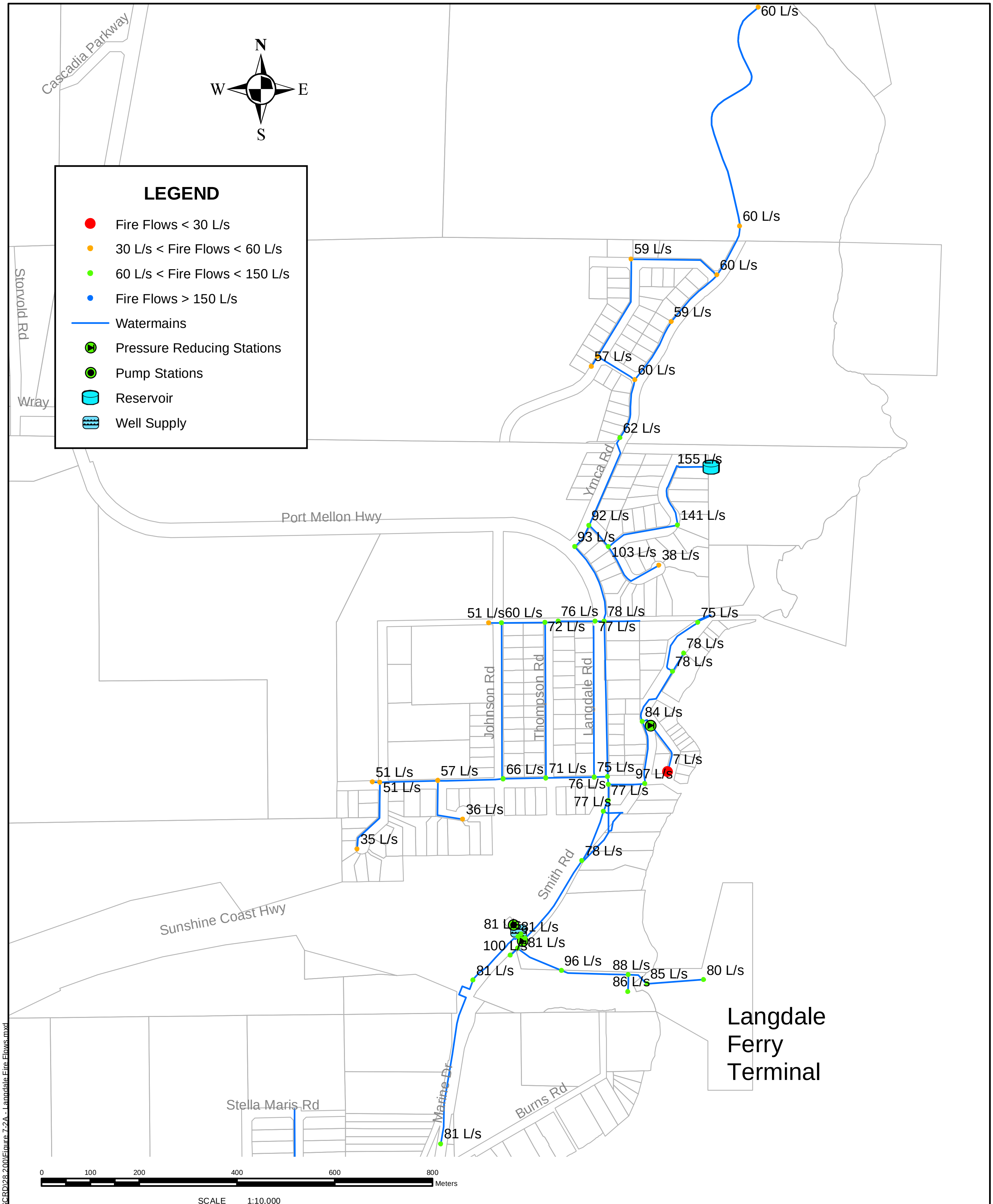
FIGURE 7-1F

Path: H:\Projects\00\0028 SCRD\28.200\Figure 7-1F - Egmont Cove Pressures.mxd

Figures 7-2A to 7-2E illustrate the areas within the distribution system where flows do not meet the fire flow requirement under 2011 conditions.

7.4 Integration of Small Water Systems

Plans to develop an integration strategy between the Chapman water system and the small water systems should be considered in the next water master plan update. Only the Cove Cay and Egmont Cove water systems would not be considered for integration. The SCRD should formalize system plans to run water through to the small systems.



Path: H:\Projects\000028 SCRD\28.200\Figure 7-2A - Langdale Fire Flows.mxd

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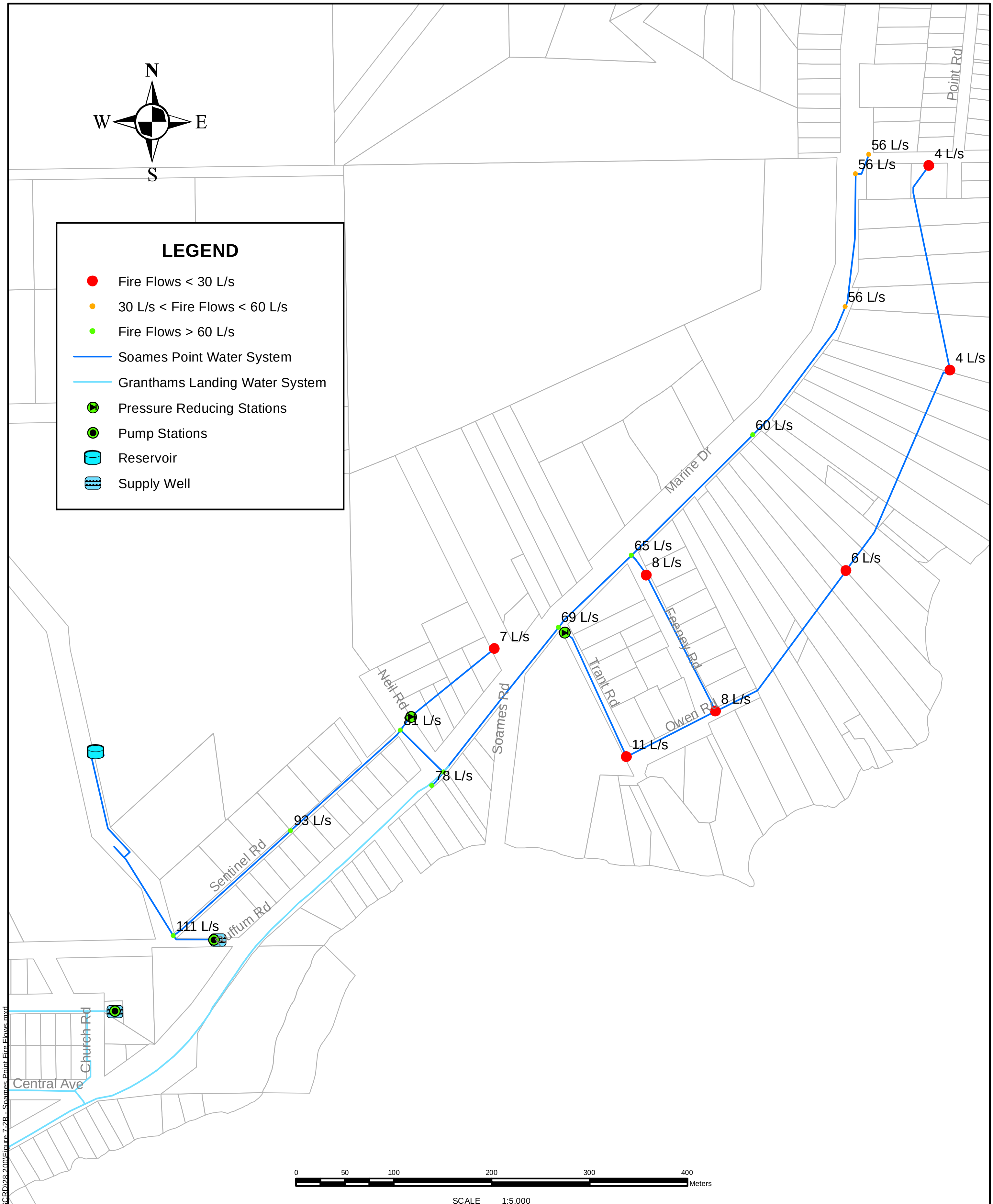
LANGDALE WATER SYSTEM EXISTING FIRE FLOWS

FIGURE 7-2A



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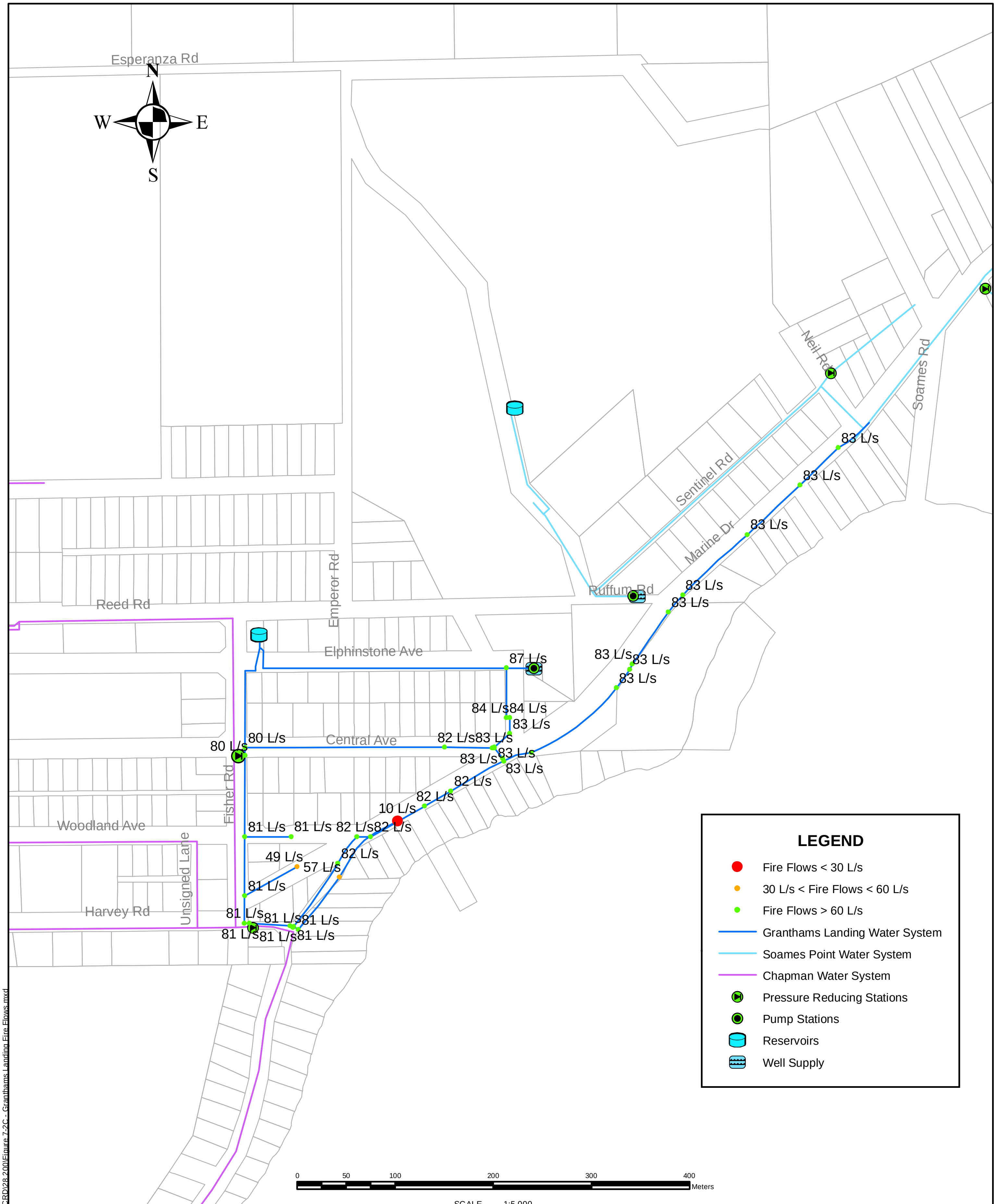
SOAMES POINT WATER SYSTEM EXISTING FIRE FLOWS

FIGURE 7-2B



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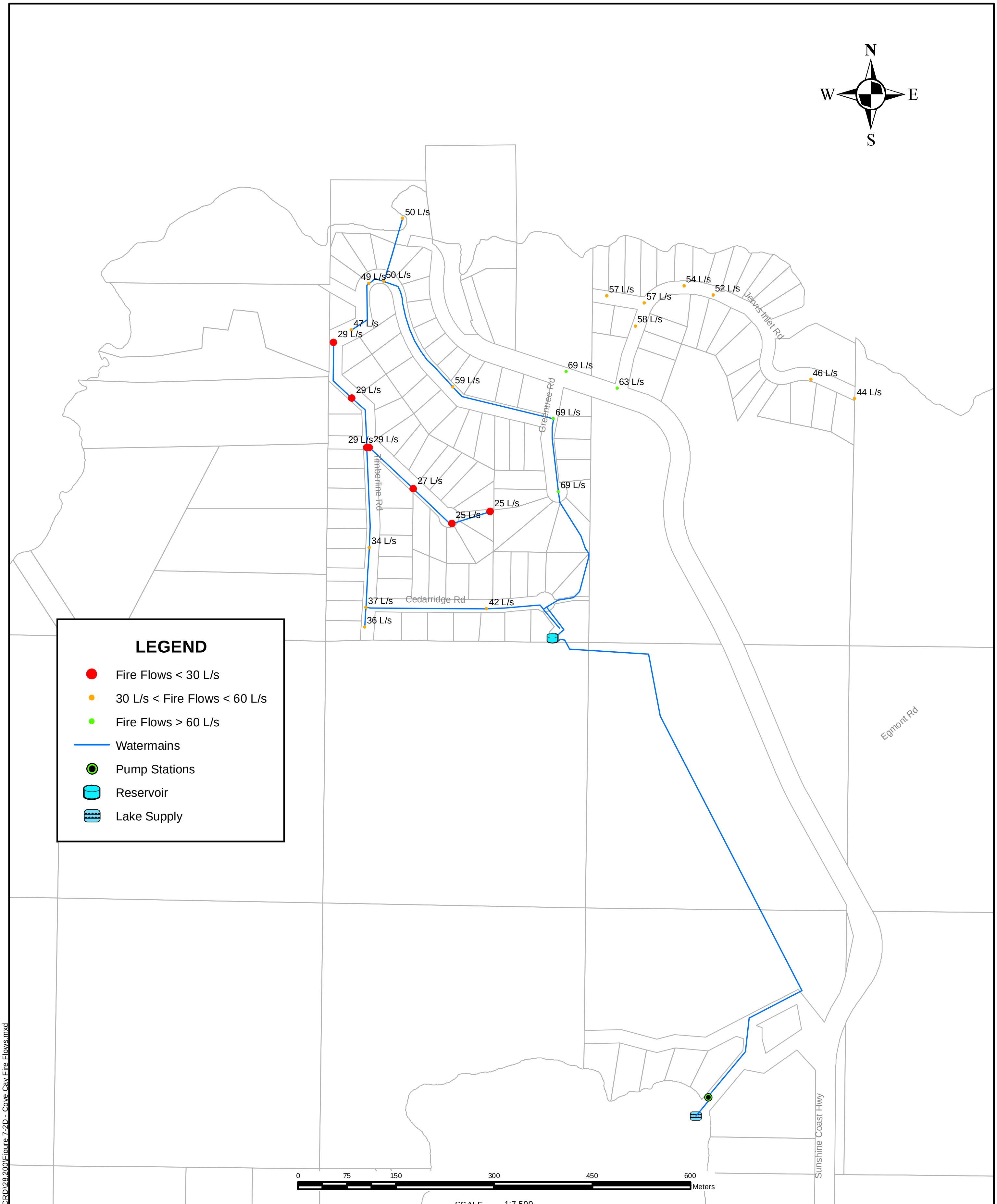
GRANTHAMS LANDING WATER SYSTEM
EXISTING FIRE FLOWS

FIGURE 7-2C

Path: H:\Projects\00\0028 SCRD\28.200\Figure 7-2C - Granthams Landing Fire Flows.mxd



Path: H:\Projects\000028 SCRD\28.200\Figure 7-2D - Cove Cay Fire Flows.mxd

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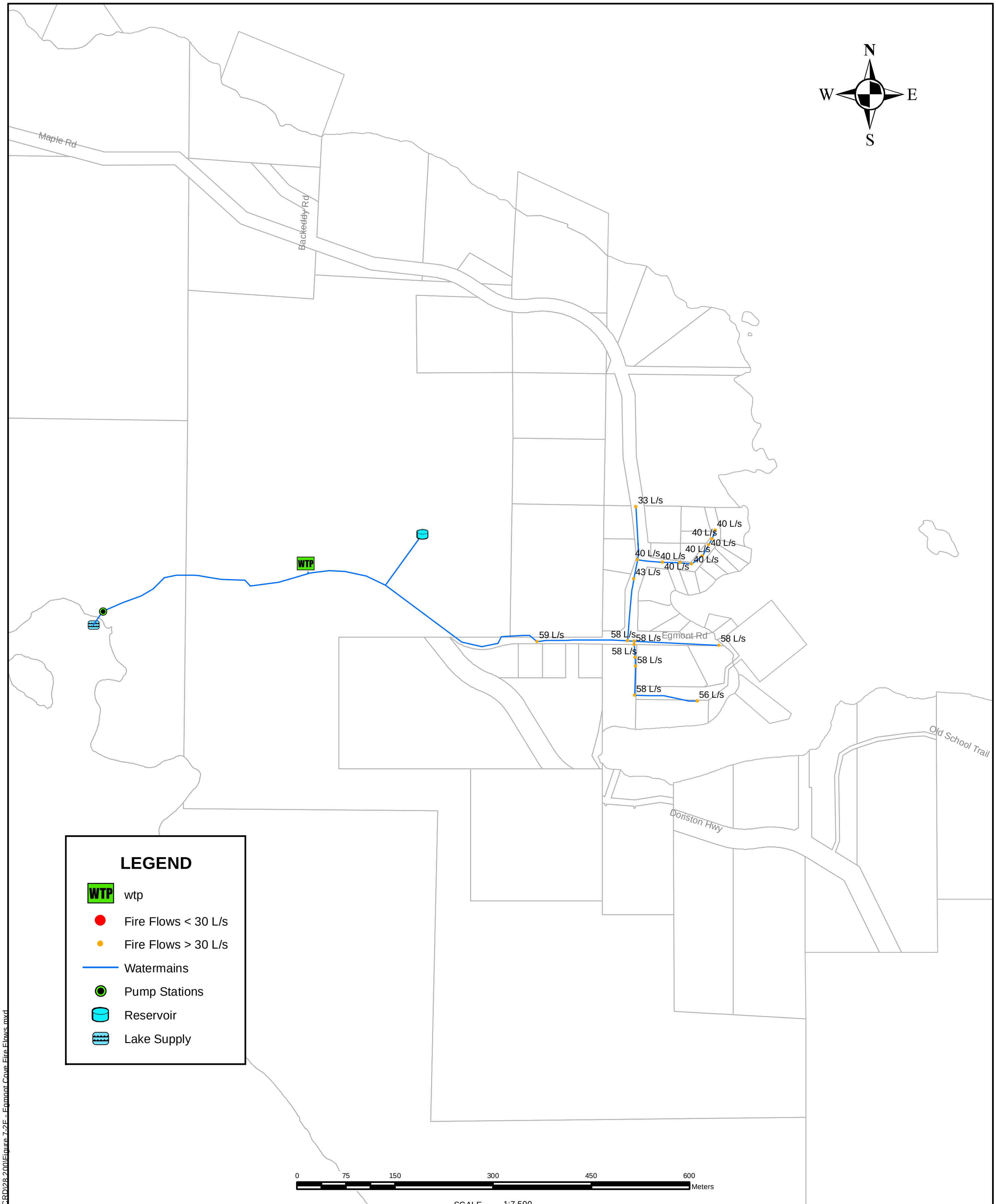
COVE CAY WATER SYSTEM EXISTING FIRE FLOWS

FIGURE 7-2D



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Path: H:\Projects\000\028 SCRD\28.200\Figure 7-2E - Egmont Cove Fire Flows.mxd

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EGMONT COVE WATER SYSTEM EXISTING FIRE FLOWS

FIGURE 7-2E

8.0 CHAPMAN WATER SYSTEM STRATEGIC PLAN

System improvements have been developed and are evaluated in this section to address deficiencies identified in the Section 6.0 Chapman Water System Analysis. The evaluation of system improvements considers the merits of demand side versus supply side strategies and the appropriate levels of service within the Chapman service area. A summary of the cost implications of continuing with the existing demand management program or adopting a more intensive demand management program is presented to allow an informed decision to be made in developing the strategic plan.

8.1 Demand Management

Noteworthy in the Section 4.0 water consumption analysis are the high per capita flows relative to other similar communities, especially those that have implemented universal metering. The Section 6.0 Chapman water system analysis highlighted the inability of the Chapman Creek source to supply maximum day demand during drought conditions. Even under today's conditions, much of the system is stressed during the dry summer months when water demand is highest, with this condition becoming more extreme when projected through 2036.

Section 6.0 also highlighted the difference in upgrade work to transmission, reservoir and distribution systems needed in 2036 under existing and intensive demand management programs.

8.1.1 Demand Management Recommendations

The cost implications of either retaining existing demand management or implementing more intensive demand management programs are listed hereafter and are further developed in the subsections that follow.

1. For either program, a budget of $60,000 per year to implement yearly Stage 2 and Stage 3 water restrictions with enforcement is recommended until the completion of the universal meter installations (IDM) or construction of the Water Treatment Plant Expansion (EDM);
2. For the intensive demand management program, a budget of $8.1 million for the life cycle cost of the universal metering program is recommended;
3. For the intensive demand management program, a budget of $40,000 is recommended for technical assistance in further assessing demand management strategies, in revising the bylaw and educational programs, and to modify the water rate structure to encourage conservation; and,
4. For the intensive demand management program, a budget of $250,000 to roll out additional intensive demand management programs such as irrigation controllers, rain barrels and rainwater harvesting is recommended.

8.2 Water Sources

Water sources include Chapman Creek as the primary source and Gray Creek and the Chaster Well as the secondary sources. Combined, these sources are unable today to meet the drought risk conditions within the Chapman water service area.

Additional water can be obtained by adding storage on the Chapman Creek source, by using additional surface water sources or by developing additional groundwater sources.

8.2.1 Chapman Creek

Ideally, Chapman Creek should be able to supply MDD to the water treatment plant. Recent streamflow data below the Chapman Creek intake indicates that controlled flows during the summer are below the fish hatchery licensed flow of 24.5 ML/d. The 2011 MDD of 27.1 ML/d combined with a hatchery licence flow of 24.5 ML/d totals 51.6 ML/d.

Any expansion of the creek storage should be designed for the long term 2036, 2% growth requirements. The projected 2036 MDD is 44.4 ML/d (Existing Demand Management). If more intensive demand management programs are implemented, then the 2036 MDD reduces to 33.3 ML/d.

In order to provide MDD and maintain the SCRD low flow policies in the year 2036, it will be necessary to add storage volume to supplement low creek flows during a 1:25 year drought condition. The additional storage volume required under existing and more intensive demand management programs is:

- Existing Demand Management – 0.76 Mm^3
- Intensive Demand Management – 0.43 Mm^3

Technical Memorandum No. 3 "Source Development Options" (Dayton & Knight Ltd. May 2007) identified and costed out three options for increasing storage volume in the Chapman Creek watershed.

- Constructing an engineered lake in an adjacent gravel quarry;
- Constructing a pumping facility at Chapman Lake to access water below the lake outlet;
- Increasing the height of the existing dam on Chapman Lake

The important findings in the memo, along with updated Class 'D' estimates of cost (2011 dollars), are presented in the following sub sections.

Engineered Lake

The 2002 Update of the 10 Year Waterworks Development Plan (Dayton & Knight Ltd.- 2002) initiated the concept of a storage reservoir in the gravel quarry adjacent to Chapman Creek. At the time the quarry was scheduled for closure around 2020.

In 2007, the concept was further developed in Technical Memorandum No. 3. Discussions were held with Lehigh (Construction Aggregates Ltd.), the highlights of which follow:

- Lehigh are in negotiations with the Sechelt First Nation to buy Crown Land within the site.
- Existing permit is being extended from 2038 to 2050.
- Extraction is between 2 and 5 million tonnes per year.
- There is sufficient material to last to at least 2050.
- Bedrock elevation ranges from 20 m to 185 m below the surface.

Although the concept of a engineered lake fits within the rehabilitation plan for the quarry, the 2050 timeline is not compatible with the SCRD needs for additional storage in the near term. It was noted, however, that the SCRD could pursue an agreement such that portions of the quarry are mined at an early date to permit the SCRD to acquire the land.

The depth of the engineered lake should be restricted to 10-15 m. This permits access for servicing and liner placement. Maintenance, such as sediment removal, will be required on a 10 to 15 year basis. To provide storage of 0.43 Mm^3 (IDM) the surface area would be approximately 40,000 m^2, allowing for side slopes of 3:1 and 1 m of freeboard. The engineered lake would occupy approximately 1/25 of the overall quarry area. For the 0.76 Mm^3 (EDM) storage requirement, the surface area increases to 75,000 m^2.

The cost estimate for the 0.43 Mm^3 engineered lake is $4,500,000 and for the 0.76 Mm^3 lake is $7,500,000.

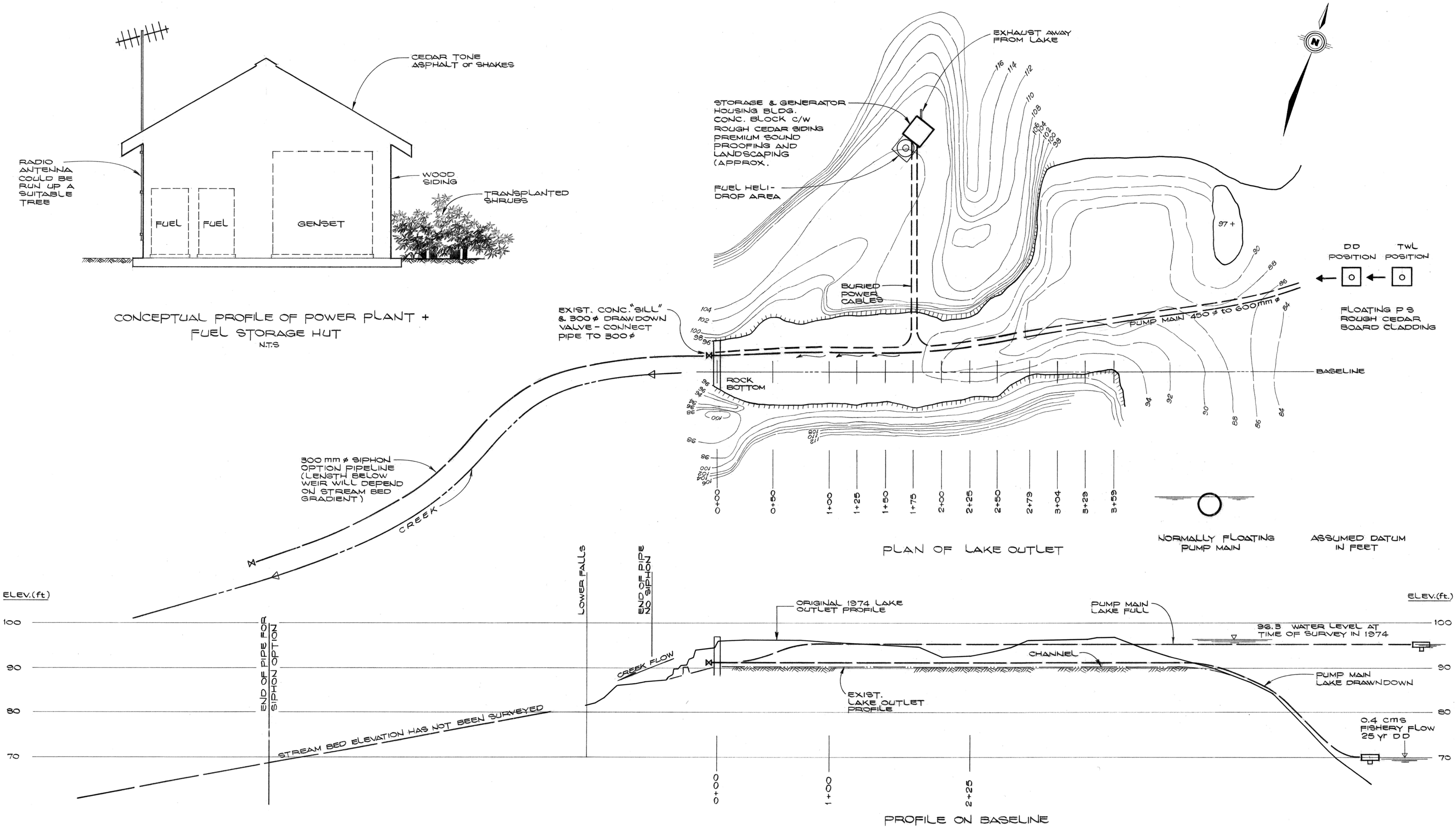
Floating Pump Station

The concept of a floating pump station in Chapman Lake was first introduced in 1997 and received regulatory approvals in 1999. The project was further developed in Technical Memo No. 3. The station would be used only during severe droughts or emergency situations when lake levels dropped below the outlet control level. The remote location requires the pump to be powered by a propane generator. Fuel delivery is assumed by helicopter. A schematic of the proposed system is shown in Figure 8-1.

To achieve the required increase in storage of 0.43 Mm^3 (IDM) the lake would have to be drawn down from the current low level of 973 m to 971.5 m (or 1.5 m). For the 0.76 Mm^3 (EDM) storage requirement, the draw down level is 970 m (3.0 m).

The capital cost for the 0.43 Mm^3 floating pump station is $660,000 and for the 0.76 Mm^3 pump station is $1,100,000.

Other alternatives that would enable access to the lower reaches of Chapman Lake, such as tunnelling and directional drilling, are scheduled to be assessed in 2013 to determine if they are viable options to a floating pump station.



SUNSHINE COAST REGIONAL DISTRICT

PROPOSED CHAPMAN LAKE FLOATING PUMP STATION

N.T.S

OPUS DAYTONKNIGHT
North Vancouver Office
604-990-4800
210 - 889 Harbourside Drive, North Vancouver, BC, V7P 3S1, CANADA
DRAWN BY: RB
DWG. No. D-02820.00

FIGURE 8-1

FILE: G:\D&K CAD Drawings\DKSERVER P Shore\PRODWGS\SCRD\D-02820-00\FIGURES\D-02820 FIGURES.dwg Tab FIGURE 8-1 13-03-07 vcrab0

Raise Chapman Lake Dam

Technical Memorandum No. 3 determined that it is not feasible to raise the existing control structure. A new control structure will be needed. The increased lake level would impact the shoreline area of the lake which is used by the public. Consultation with Provincial Parks and other stakeholders will be essential. To achieve the required increase in storage of 0.43 Mm^3 (IDM), the lake would have to be increased from the current top water level of 976 m to 977.5 m (1.5 m). For the 0.76 Mm^3 storage, the level increases to 979 m (3.0 m).

Materials for construction of the control structure include concrete, gravel and silt/clay, all of which will likely have to be imported.

The estimated capital cost is $2,600,000 for the 0.43 Mm^3 storage, increasing to $4,300,000 for 0.76 Mm^3 storage.

Water Licenses

If additional storage is provided, an amendment to the existing storage licence on Chapman Lake or a new storage licence for the engineered lake will be required.

- Chapman Lake – Amend storage licence to add either 0.27 Mm^3 (IDM) or 0.60 Mm^3 (EDM).
- Engineered Lake – Apply for new storage licence of 0.43 Mm^3 (IDM) or 0.76 Mm^3 (EDM).

The existing diversion licence on Chapman Creek will also need to be amended to increase the withdrawal rate to 44.4 ML/d from the existing rate of 33.3 ML/d for the

EDM Condition. Since the calculated future withdrawal rate under the IDM scenario is 33.3 ML/d, a licence increase will not be required.

8.2.2 Gray Creek and Chaster Well

Gray Creek

Gray Creek as a water source was assessed in detail in the 2007 Water System Assessment draft report (Dayton & Knight Ltd.-2007-4). The following important findings from the report are:

- Gray Creek flow data are limited. It is estimated about 1 ML/d is available in the dry summer months.
- In order to comply with the Drinking Water Protection Regulation, water treatment utilizing filtration is required at a cost of $5.0 million (2007 dollars).
- A “deferral” to the filtration requirement can be applied for but would unlikely be accepted. At a minimum, turbidity and colour monitoring and two stage disinfection (UV and chlorine) will be needed at a cost of $1.2 million (2007 dollars). If turbidity levels exceed 1 NTU, the source must be shut down.

Chaster Well

Chaster Well water quality meets guidelines, the water is disinfected and the well provides 1.3 ML/d. This well should remain in service.

8.2.3 Other Water Sources

For surface water source development from the smaller local sources, significant storage is also required unless the local source is a major lake in the SCRD. Many creeks such as the McNair, Dakota, Langdale, Carson and Twins Creeks have been assessed and are not considered as feasible additional long-term water supplies for the purposes of the strategic plan.

Technical Memorandum No. 4 (Dayton & Knight Ltd.-2007-3) assessed the feasibility of developing additional supply for the Chapman water system by adding new sources including Sakinaw Lake, Clowhom Lake, Rainy River and additional groundwater.

Development of the surface water sources requires an intake, raw water storage, water treatment plant, pumping and transmission mains to convey the water to the Chapman water system. Class ‘D’ cost estimates (2007 dollars) were as follows:

Source	Capital Cost	O&M Cost
• Sakinaw Lake	$54 million	$1.2 million/year
• Clowhom Lake	$57 million	$1.5 million/year
• Rainy River	$38 million	$1.2 million/year

The 2007 memo concluded the development of additional surface water sources was too costly in comparison to the Chapman Lake development options.

The groundwater assessment relied on the Provincial aquifer mapping to identify 14 aquifers (Table 8-1) in the Chapman service area. Seven of these aquifers are bedrock; meaning a very low potential for a large water supply. The remaining seven aquifers are sand/gravel that have a good potential for a large water supply.

TABLE 8-1
AQUIFERS WITHIN THE SCRD

No.	Description / Location	Materials	Size (km^2)
552	Langdale	Sand/Gravel	0.6
553	Soames Point	Sand/Gravel	0.2
554	Gibsons Landing	Sand/Gravel	0.5
555	Sechelt	Bedrock	24.7
556	Chapman Creek	Sand/Gravel	0.9
557	Sargeant Bay	Sand/Gravel	1.7
558	Halfmoon Bay	Bedrock	10.3
559	Mixel Lake	Bedrock	8.7
560	Chaster Creek	Sand/Gravel	10
561	Kleindale	Bedrock	4.2
562	Sechelt	Bedrock	4.1
564	Porpoise Bay	Bedrock	0.4
565	Francis Penn.	Bedrock	3.7
566	Angus Creek	Sand/Gravel	1.3

The volume of water needed by the SCRD will require a highly productive aquifer, namely sand/gravel material. The Langdale, Gibsons Landing and Chaster Creek aquifers are currently utilized by the SCRD and Town of Gibsons. Ultimate capacities of these aquifers are unknown because detailed hydrological evaluation has not been completed. The Chapman Creek aquifer and the Angus Creek aquifer would also warrant exploration.

A hydrological investigation would involve a Stage 1 desk study to determine the most promising aquifer locations relative to the Chapman service area, followed by a Stage 2 test drilling program to determine the safe yields of the aquifers and water quality. The estimated cost for the investigation is $300,000.

8.2.4 Evaluation of Water Sources

In terms of cost, the three options for increasing storage capacity in the Chapman Creek watershed are compared in Table 8-2.

TABLE 8-2
CHAPMAN CREEK SOURCE OPTIONS

Option	Capital Cost (1)		O&M Cost (1)		Life Cycle Cost (2)	
	EDM	IDM	EDM	IDM	EDM	IDM
Engineered Lake(3)	$7,500,000	$4,500,000	$40,000	$23,000	$8,000,000	$4,750,000
Floating Pump Station	$1,100,000	$660,000	$65,000	$40,000	$1,900,000	$1,200,000
Raise Chapman Lake	$4,300,000	$2,600,000	$95,000	$57,000	$5,500,000	$3,300,000

(1) 2011 dollars; Class D estimate.

(2) 20 year; 5 % discount rate (pwf =12.46)

(3) Excludes land costs.

The least expensive option is the floating pump station followed by raising Chapman Lake.

The floating pump station option has the drawback of being in a remote area with security and maintenance concerns. It is also located in a Class A Provincial Park and there will be a need for extensive discussions with Park officials regarding the impact of operating a propane pump station and public use of the Park. A thorough environmental impact assessment (Whitehead, April 8, 1999) and public process on the lowering of the lake by 3.0 metres was completed in 1999 that received acceptance from regulatory agencies, Sechelt Indian Band and the Tetrahedron Advisory Committee at the time.

Similar concerns apply to the option of raising the dam on Chapman Lake. In this case, additional flooding due to lake level increase by 3.0 m will result in environmental impacts due to increased turbidity, disruption of wildlife and flooding of approximately 2.0 ha of shoreline vegetation.

Apart from cost (excluding land cost), the major drawback of the engineered lake option is that a site within the quarry is not available in the short term. If the SCRD is able to negotiate for the closure of a portion of the quarry in the near future, then the engineered lake avoids the perceived negative impacts associated with the options located within the Park. The provision of a lake, suitably lined and landscaped, will fit well with the reclamation plans for the quarry. A further benefit of the engineered lake is that storage licence approval should be less onerous than for Chapman Lake options. In terms of operations, the engineered lake should limit turbidity spikes and result in reduced chemical use for treatment.

In the short term, the recommended option is the floating pump station (or alternative system), while for the longer term, the best option for increasing storage remains the engineered lake that was identified as the preferred option by the SCRD Board in 2007.

Gray Creek

Gray Creek has limited and uncertain capacity that will take 5 to 10 years of creek flow data to enable a reasonable estimate of seasonal flow variations.

An obvious drawback to additional use of this source is the high cost ($1.2 million, 2007 dollars) to allow a “deferral” of the filtration requirement. If turbidity levels exceed 1.0 NTU, then the source must be shut down. Accordingly the source is not reliable. To provide filtration treatment results is a cost that exceeds $5.0 million (2007 dollars) which is not cost effective given the limited 1.0 ML/d capacity.

Gray Creek should remain an emergency source for only the Sandy Hook and Tuwanek communities.

Chaster Well

Chaster Well should remain in service to supplement the Chapman Creek source by 1.3 ML/d during drought conditions.

Other Water Sources

The distant location of the Sakinaw Lake, Clowhom Lake and Rainy River make them prohibitively expensive as additional water sources for the Chapman water system.

Additional groundwater sources have merit for both the short and long term. The singular drawback is that a test well drilling program ($300,000) may not find adequate water quantity or quality. The risk, however, is reasonable given the successful well development in the Chaster Creek, Langdale and Gibsons Landing aquifers.

8.2.5 Water Source Recommendations

1. The SCRD should re-initiate discussions with Provincial Park and Environment ministries regarding the construction of a floating pump station (or alternative system) in the near-term. A budget of $20,000 is recommended.

2. A budget item is required for the interim solution to access the source volumes in the lower reaches of the Chapman Lake storage. In 2013, the SCRD will investigate several alternative options to the floating pump station. A preliminary budget of $660,000 is recommended for the construction of a floating pump station. A $40,000 O&M cost is recommended for upkeep of the floating pump station. A budget of

$1.2 million for the life cycle cost of the floating pump station for the next 25 years is recommended.

3. For the longer term, the SCRD should initiate negotiations with (Lehigh Construction Aggregates Ltd.) to acquire a parcel of land within a mined out area of the quarry for construction of an engineered lake. A budget of $50,000 is recommended for technical support in the future.

4. The SCRD should undertake a groundwater investigation to determine the feasibility of supplying groundwater to meet the source requirements in the long term. A budget of $300,000 is recommended over two years.

5. Gray Creek should be limited to its present role of emergency supply to Sandy Hook and Tuwanek residents.

6. Chaster Well should remain in service to supplement the Chapman Creek source with 1.3 ML/d during drought conditions.

8.3 Water Treatment

Maximum day demand within the Chapman system has reached 28.5 ML/d and maximum week demand has reached 25.3 ML/d at the treatment plant. In the last two years, however, improvements to the SCADA system have reduced the maximum day demand at the plant to 23.8 ML/d in 2011 and 25.8 ML/d in 2012. Chapman Water Treatment plant capacity requirements through 2036 are noted in Table 6-3. These water demands compare with the plant design flow of 25 ML/d and its “over design” capacity of 26.9 ML/d.

An increase in plant capacity has been a critical item for the SCRD for the last five years but the SCRD believes that a combination of universal metering and further sprinkling restrictions will further decrease the maximum day demands and therefore delay the requirement for plant expansion.

Should the reduction in maximum day demand be realized and a 25% reduction in maximum day demand is achieved through the intensive demand management programs, expansion of the Water Treatment Plant to 37.5 ML/d can be delayed to 2020. However, the timing of the plant expansion should be closely monitoring through recording and analyzing the maximum day demands every year. Expansion of the plant capacity to 37.5 ML/d will extend the service life beyond 2036 at a 2% growth rate and with intensive demand management programs in place.

If existing demand management programs are continued, the 37.5 ML/d plant capacity will be reached by 2028, and the plant would need expansion to 45.0 ML/d to service 2036 maximum day demand. The recommended budget to expand the treatment plant by 25 ML/d is $10,000,000.

8.3.1 Water Treatment Recommendations

The existing treatment plant utilizes two treatment trains, each sized at 12.5 ML/d. By adding a third treatment train, the plant can be expanded to 37.5 ML/d. Technical Memorandum No 2 (Dayton & Knight Ltd.-2007-1) developed a concept design to increase the plant capacity by 50% to 37.5 ML/d. The cost was $5,620,000 (2007 dollars). The current recommended budget is $6,400,000. The SCRD applied for a funding grant in 2008 but was unsuccessful.

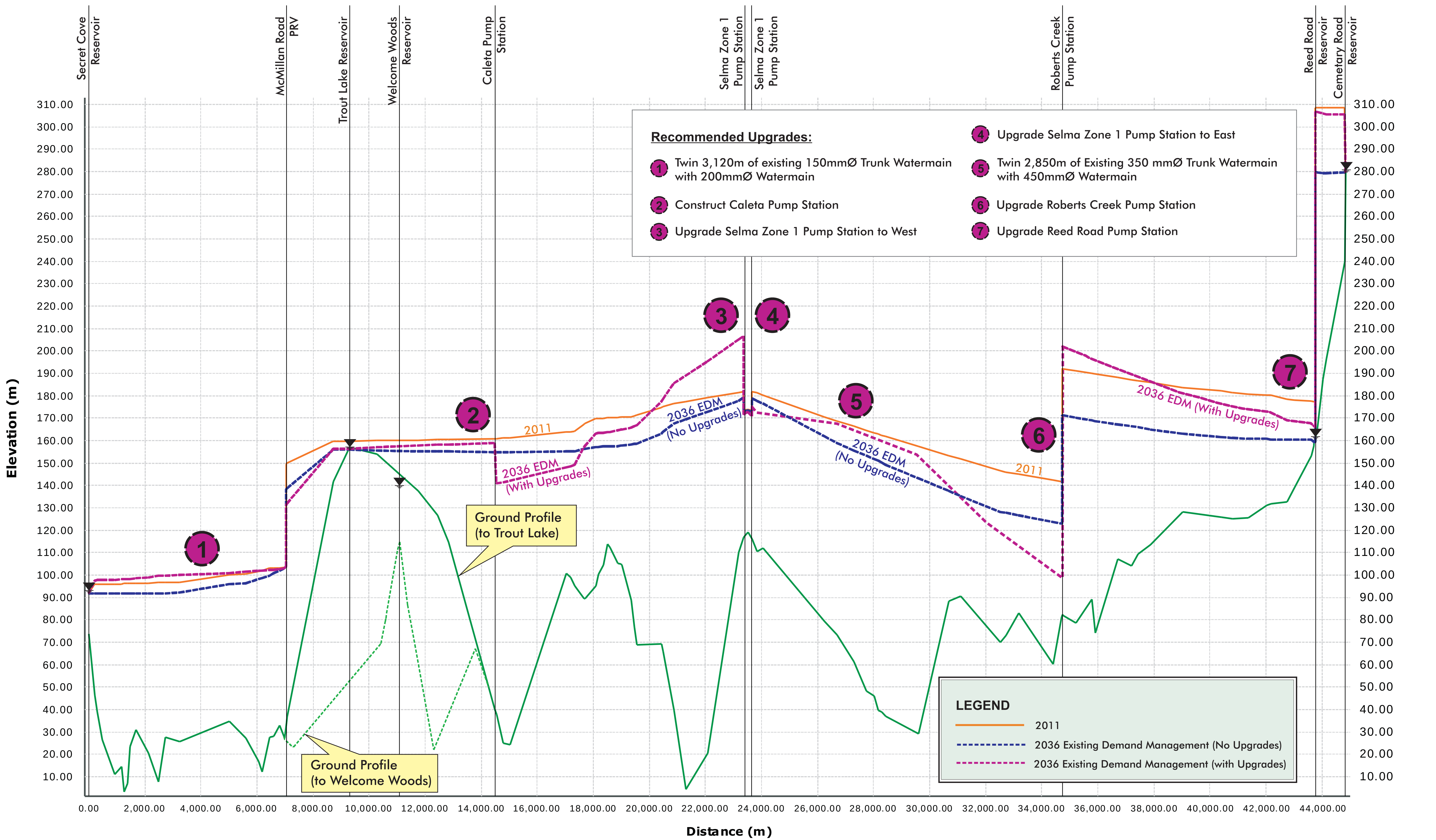
This next stage of plant expansion to 37.5 ML/d should be advanced with a pre-design report that develops and evaluates treatment options (continued use of DAF, microfiltration, etc.) and that further assesses the ability of storage capacity in Selma Park reservoir to balance MDD (thus allowing a reduced design flow). A budget of $100,000 for the pre-design study that will also develop Class 'C' cost estimates suitable for project funding is recommended.

8.4 Supply Transmission

The transmission supply should be designed to fill system reservoirs within 24 hours during maximum day demand. Figures 8-2 and 8-3 show the hydraulic analysis and transmission system improvements required under 2036 existing and intensive demand management conditions.

Supply to the West

Under 2036 maximum day demand with existing demand management, three upgrades are required along the transmission mains to improve the supply to the Secret Cove, Trout Lake and Welcome Woods reservoirs. The Selma Zone 1 pump station should be reconfigured to provide water to the west and east independently. Additional capacity is provided through upgrading the Selma Park Zone 1 pump to the west, as well as the



SCRD D-02820.00 FIGURE 8-2.cdr Feb 20, 2013 Drawn by: cww

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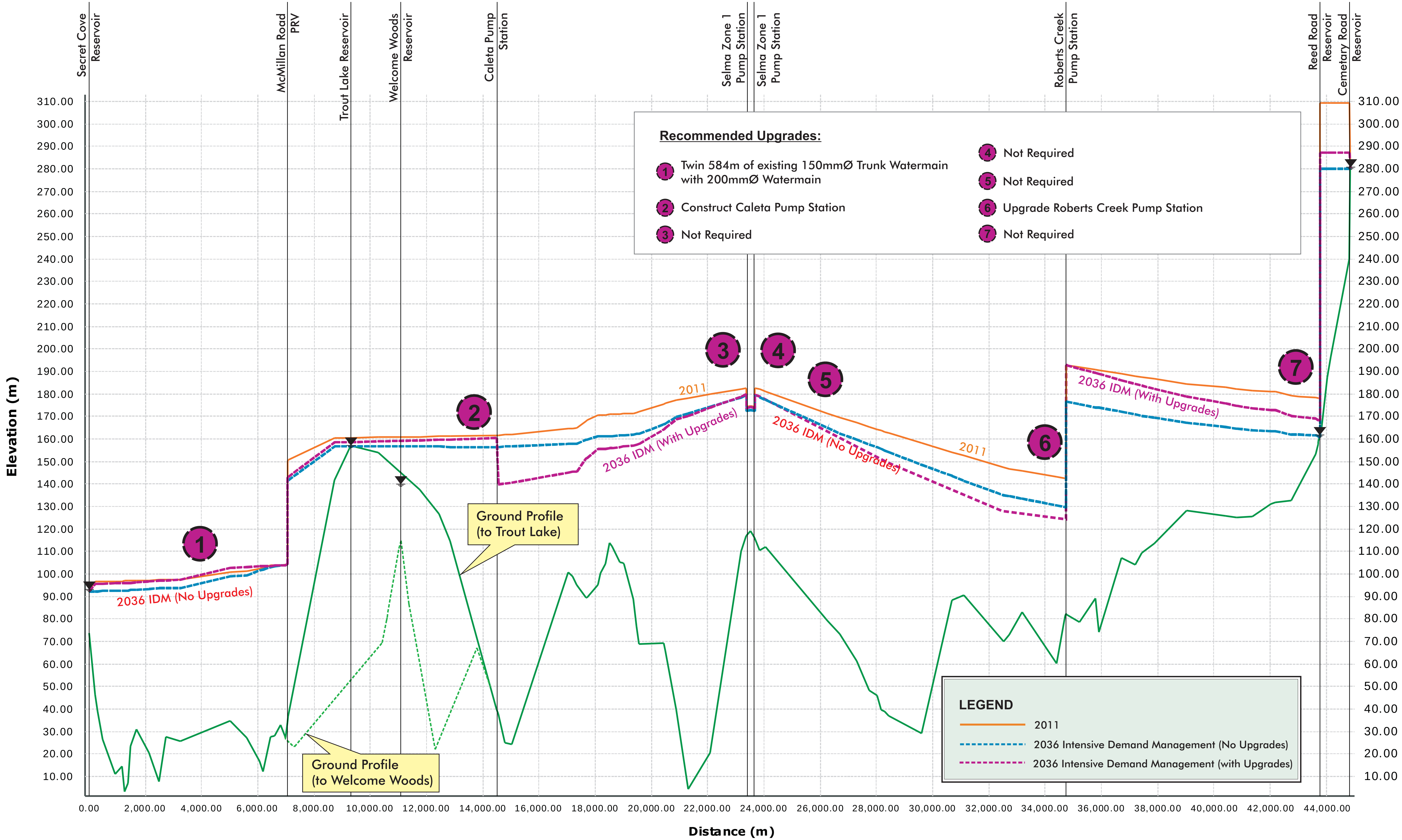
Chapman Water System
Hydraulic Supply Analysis
Proposed HGL under Existing Demand Management

Figure 8-2



SCRD D-02820.00 FIGURE 7-3.cdr Feb 20, 2013 Drawn by: cww

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Chapman Water System
Hydraulic Supply Analysis
Proposed HGL under Intensive Demand Management

Figure 8-3

reconstruction of the Caleta pump station. Further, in order to supply the Secret Cove reservoir, 3,120 metres of existing 150mm ø watermain west of the Trout Lake Reservoir should be twinned with a 200mm ø watermain.

Under 2036 maximum day demand with more intensive demand management, the configuration and upgrade of the Selma Park Zone 1 pump is not required. However, the Caleta Pump Station and the construction of 584 metres of 200mm ø watermain west of the Trout Lake Reservoir are required.

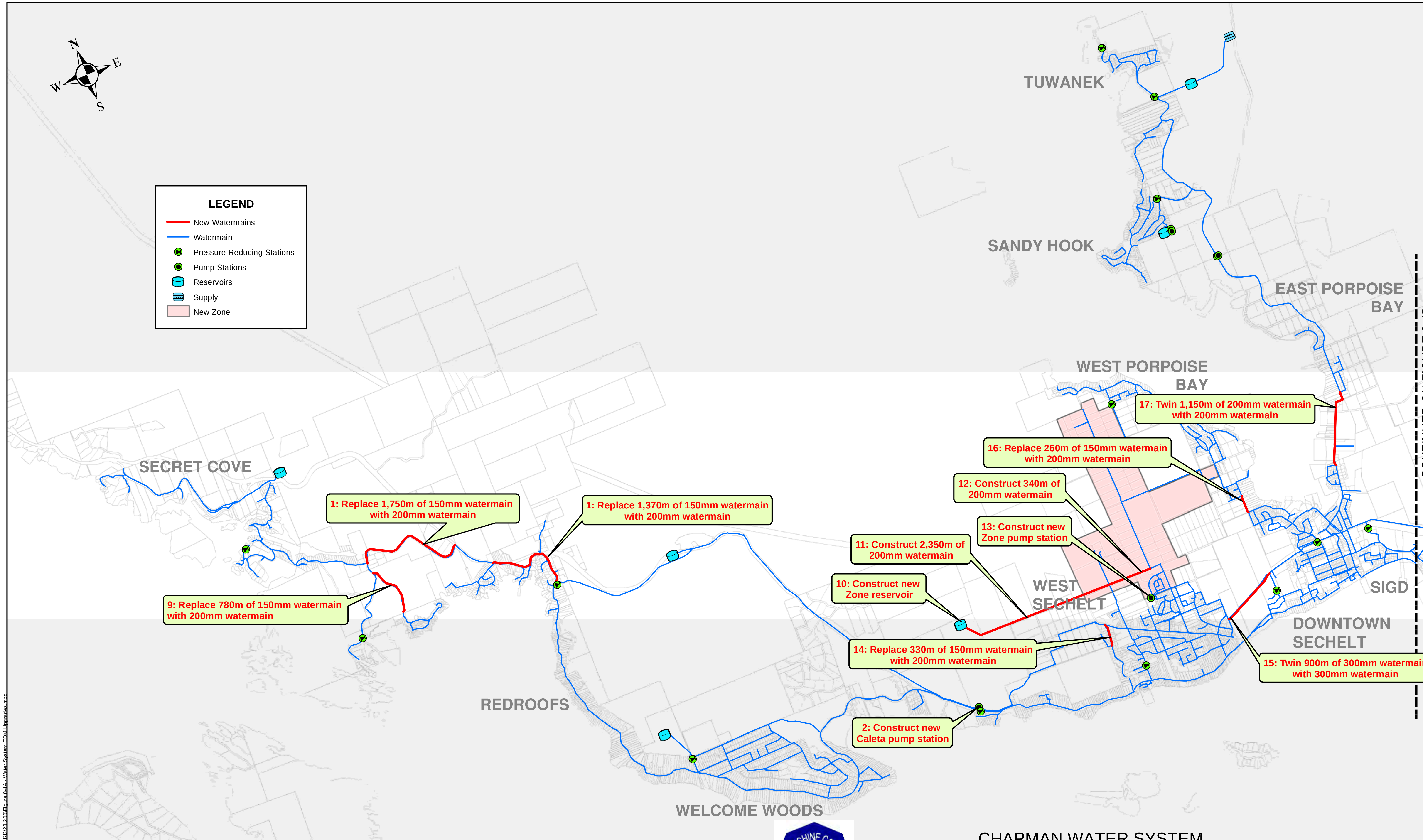
Supply to the East

Under 2036 maximum day demand with existing demand management, three upgrades are required along the transmission mains to improve the supply to the Reed Road and Cemetary Road reservoirs. Further to reconfiguring the pumps, additional capacity is provided through upgrading the Selma Park Zone 1 pump to the east, as well as the Roberts Creek pump and Reed Road pumps (to Zone 4). 2,875 metres of existing 350mm ø transmission main east of the Selma Park Zone 1 pumps require twinning with a 450mm ø transmission main.

Under 2036 maximum day demand with intensive demand management, the upgrades of the Selma Park Zone 1 pump and the twinning of the transmission main are not required. However, upgrades to the Roberts Creek Pump Station are still required.

8.4.1 Supply Transmission Recommendations

The upgrade requirements for both existing demand management and intensive demand management are costed (Class "D" estimate) in Table 8-3. Figures 8-4A/B and 8-5A/B illustrate where the new infrastructure upgrades are required.



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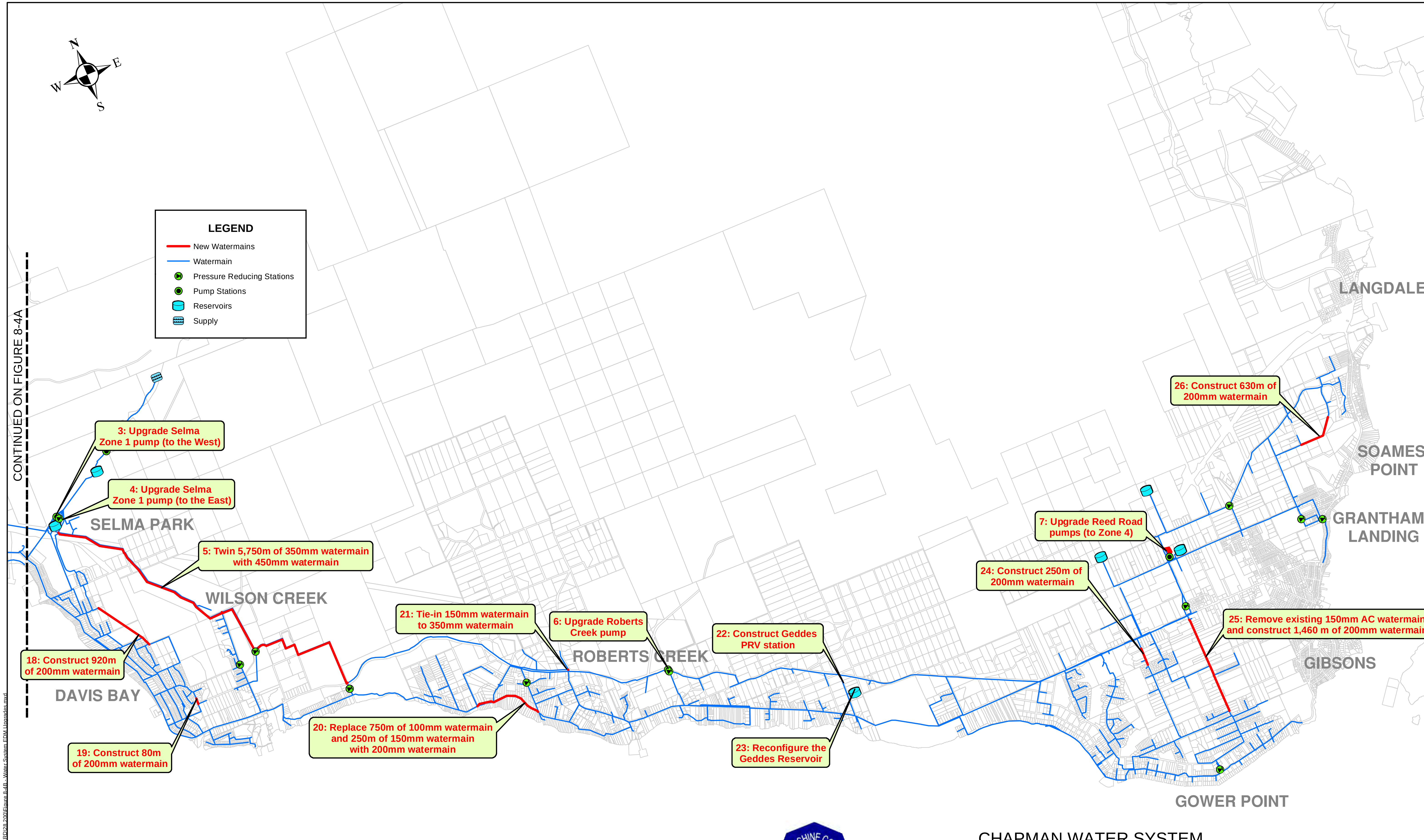
SUNSHINE COAST REGIONAL DISTRICT

CHAPMAN WATER SYSTEM
2036 EXISTING DEMAND MANAGEMENT
RECOMMENDED UPGRADES

FIGURE 8-4A



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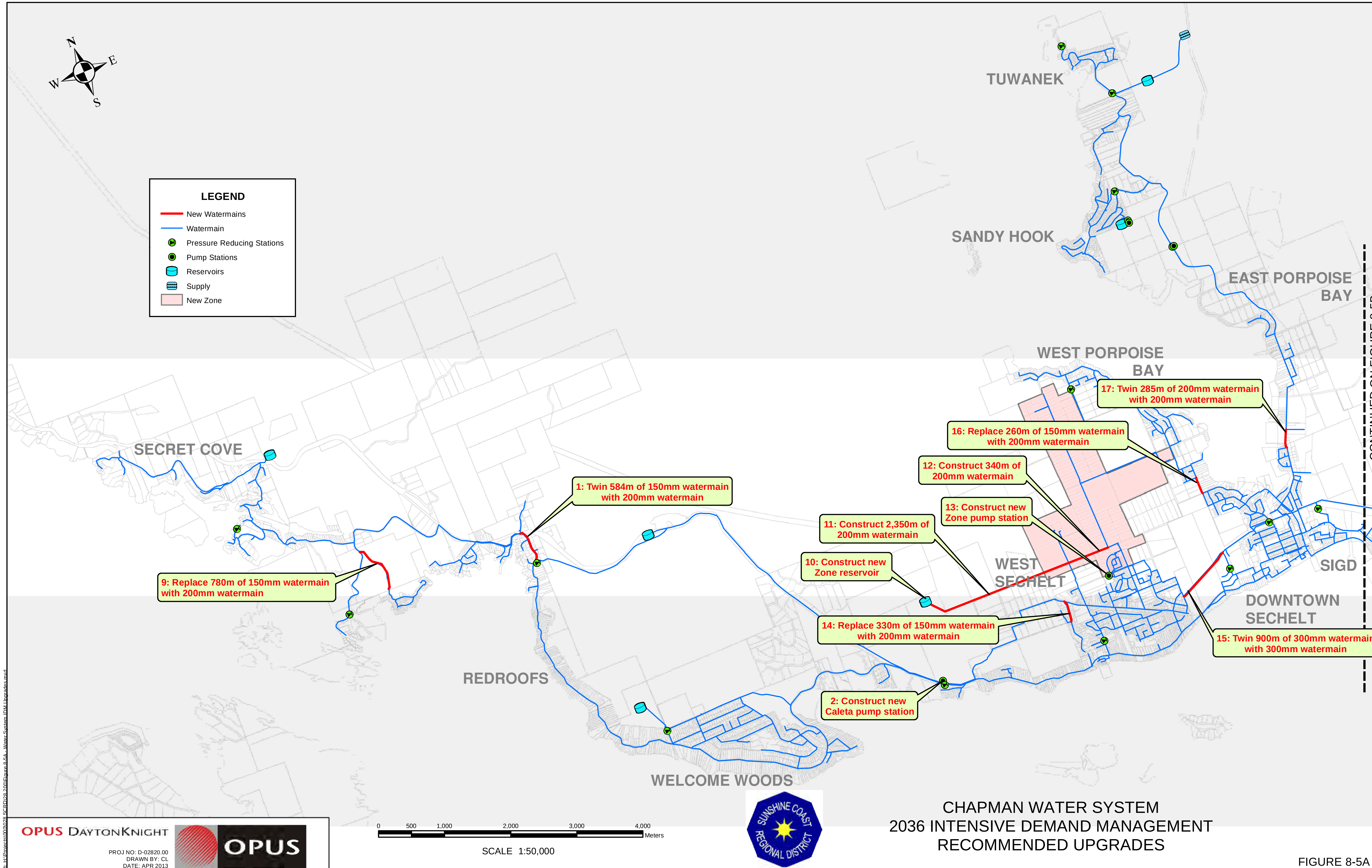
SUNSHINE COAST REGIONAL DISTRICT

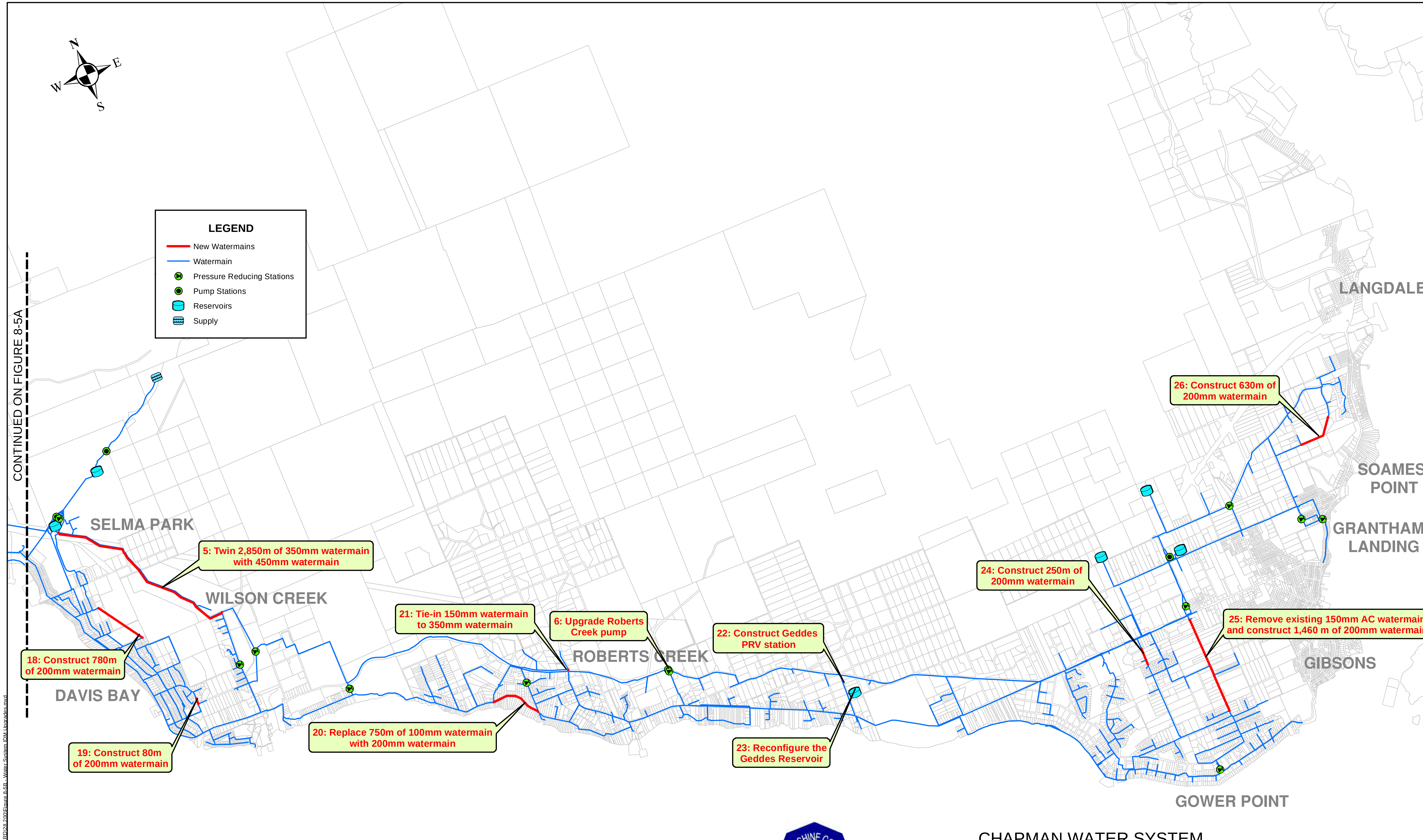
CHAPMAN WATER SYSTEM
2036 EXISTING DEMAND MANAGEMENT
RECOMMENDED UPGRADES

FIGURE 8-4B



CHAPMAN WATER SYSTEM
2036 INTENSIVE DEMAND MANAGEMENT
RECOMMENDED UPGRADES

FIGURE 8-5A



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CHAPMAN WATER SYSTEM
2036 INTENSIVE DEMAND MANAGEMENT
RECOMMENDED UPGRADES

FIGURE 8-5B

TABLE 8-3
CHAPMAN WATER SYSTEM
TRANSMISSION MAIN UPGRADES

Upgrade	Area	Community	Recommended System Upgrade	EDM Cost (in Millions)	IDM Cost (in Millions)
1	Zone 1 West	Halfmoon Bay	Twin the existing 150 mm watermain with a 200 mm watermain west of Trout Lake Reservoir.	$1.60	$0.35
2	Zone 2	West Sechelt	Construct a new Caleta Pump Station near the former Caleta Building	$1.50	$1.50
3	Zone 2	Selma Park	Reconfigure the Selma Park Zone 1 Pump Station and upgrade pumps for Western Distribution	$1.10	-
4	Zone 2	Selma Park	Reconfigure the Selma Park Zone 1 Pump Station and upgrade pumps for Eastern Distribution	$1.00	-
5	Zone 2	Wilson Creek	Twin the existing 350 mm watermain with a 450 mm watermain from Selma Zone 1 Reservoir towards the East	$1.35	-
6	Zone 2	Roberts Creek	Upgrade the Roberts Creek Pump	$0.50	$0.25
7	Zone 4	North Gibsons	Upgrade the Reed Road Pumps	$0.50	-
TOTAL				$7.55	$2.10

Of note, the provision of intensive demand management reduces the recommended upgrade costs from $7.55 million to $2.1 million.

8.5 Water Storage Reservoirs

Under the 2036 existing demand management condition, Zone 1 was found to have deficient balancing and fire storage, while Zones 3 and 4 were found to have deficient fire storage only. The fire storage deficiencies in Zone 1, 3 and 4 can be met by utilizing storage from Zone 2. A new reservoir is needed to provide an adequate balancing storage capacity for Zone 1.

Under the 2036 intensive demand management condition, balancing storage is found adequate in all pressure zones. Fire storage is adequate in all areas except Zone 1 and Zone 4. The fire storage deficiencies in Zone 1 and Zone 4 can be met by utilizing storage from Zone 2.

8.5.1 Water Storage Recommendations

A Class "D" cost estimate and reservoir upgrade requirements under existing and intensive demand management is presented in Table 8-4. The upgrade requirements are illustrated in Figures 8-4A/B and 8-5A/B.

TABLE 8-4
CHAPMAN WATER SYSTEM
RESERVOIR UPGRADES

Upgrade	Area	Additional Storage Required		EDM Cost (in millions)	IDM Cost (in millions)
		EDM	IDM		
8	Zone 1	1,200 m^3 (balancing)	0 m^3	$1.50	$0
Total				$1.50	$0

Of note, the implementation of intensive demand management reduces the recommended upgrade costs from $1,500,000 to $0.

8.6 Distribution System

System upgrades are required to resolve low pressures and deficient fire flows assessed in the Chapman distribution system as noted in Section 6.0. Each of the system upgrades are assessed for both existing demand management (EDM) and intensive demand management (IDM) conditions in the year 2036, and are applied to the main distribution lines, while deficiencies at dead ends are not addressed.

Fire flow boundaries of 30 L/s and 60 L/s for rural and urban areas as noted in Section 6.0 have been used. All the recommended system upgrades are illustrated in Figures 8-4A/B and 8-5A/B.

8.6.1 Watermain Upgrades

Upgrade Recommendation 5 – EDM & IDM – With respect to the transmission main upgrade in Table 8-3, further upgrade to the transmission main is required to provide adequate pressures and fire flows in the distribution system east of Chapman Creek under both the EDM and IDM scenarios. The transmission main upgrade would be a total of 5,750 metres (EDM) or 2,850 metres (IDM) as shown in Figures 8-4B and 8-5B.

Upgrade Recommendation 9 – EDM & IDM - A new pressure reducing station is recommended in West Sechelt to improve fire flows along the western end of Zone 1. The new pressure reducing station is proposed to be located at the new Caleta pump station building. Upon completion of the above upgrade, the minimum available fire flow in the area increases from 21 L/s to 72 L/s in the surrounding areas.

Upgrade Recommendation 10, 11, 12 and 13 – EDM & IDM - A new pressure zone, herein called Zone 2A, should be established to increase the minimum pressures and required fire flows. A booster pump station is required at the intersection of Tower Road and Tyler Road. Initially, the pump station should consist of three pumps (one duty, one back-up and one fire), to meet fire servicing needs in the near future. Ultimately, if funds permit, a reservoir shall be constructed for Zone 2A and the fire pump will be removed from the station.

Isolation of the new Zone 2A would require:

1) construction of 640 metres of 300mm ø watermain along Reeves Road between Mason Road and Nickerson Road;
2) a pump station at the intersection of Tower Road and Tyler Road;
3) a new Zone 2A reservoir at a TWL of 180 metres;
4) construct 2,350 metres of 300mm ø watermain along Reeves Road to connect the reservoir to Mason Road.

Upon completion of these upgrades, pressures in the upper areas in West Sechelt will increase from 22 psi to above 54 psi, and fire flows will increase from 0 L/s to 60 L/s.

Upgrade Recommendation 14 – EDM & IDM – Replacement of 330 metres of 150mm ø watermain with 200mm ø watermain is recommended along Wakefield Road from Norwest Bay Road to Acorn Road. This upgrade improves the fire flows in the area from around 51 L/s to above 60 L/s.

Upgrade Recommendation 15 – EDM & IDM – Twinning of 900 metres of 300mm ø watermain with 300mm ø watermain is recommended to connect West Sechelt to Sechelt east of Granite Road. This upgrade is associated with the hydraulic pressure drop with the introduction of both the Caleta and the new Zone 2A pump station. This upgrade generally improves all pressures and fire flows in Zone 2 of West Sechelt.

Upgrade Recommendation 16 – EDM & IDM – Replacement of 260 metres of 150mm ø watermain with 200mm ø watermain is recommended along Reef Road from Links Street to Marine Way. This upgrade improves the fire flows in the area from around 40 L/s to above 60 L/s.

Upgrade Recommendation 17 – EDM & IDM – Twinning of 1,150 metres (EDM) or 285 metres (IDM) of 200mm ø watermain with 200mm ø watermain along Sechelt Inlet Road between Sechelt Inlet Crescent and Boxwood Road is recommended to improve fire flows in East Porpoise Bay. Upon completion of the upgrade, the minimum available fire flow in the area increases from 51 L/s to 60 L/s.

Upgrade Recommendation 18 and 19 – EDM & IDM - The construction of 780 metres (IDM) or 920 metres (EDM) of 200mm ø watermain south of Snodgrass Road and 90 metres of 200mm ø watermain at the end of Davis Bay Road to Mission Road are recommended to improve fire flows in the area. Fire flows increase from a low of 33 L/s to above 60 L/s in the surrounding areas.

Upgrade Recommendation 20 – EDM only - Twinning of 750 metres of 100mm ø watermain with 150mm ø along Beach Avenue between Marlene Road and Flume Road is recommended to improve fire flows in Roberts Creek. This upgrade increases fire flows from 25 L/s to above 44 L/s in the surrounding areas.

Upgrade Recommendation 21 – EDM & IDM – The recommendation is to tie-in the 150mm ø watermain to the 350mm ø watermain at Sunshine Coast Highway and Roberts Creek Road. This upgrade increases fire flows from 21 L/s to above 60 L/s in the surrounding areas.

Upgrade Recommendation 22 and 23 – EDM & IDM – The construction of a new Pressure Reducing Station is recommended at the Geddes reservoir to improve pressure and fire flows for Zone 1 in Roberts Creek. The Geddes Reservoir is recommended to be reconfigured for the system as the level of the reservoir is much lower than the hydraulic grade of the zone and stagnation occurs as a result. These upgrades generally improve pressures and fire flows in Roberts Creek, and remove the water quality problems at the Geddes Reservoir.

Upgrade Recommendation 24 and 25 – EDM & IDM - The recommendation is to construct 250 metres of 200mm ø watermain from Carmen Road to King Road and to construct 1,460 m of 200mm ø watermain to replace the 150mm ø AC watermain along Pratt Road from the Sunshine Coast Highway to Malaview Road. These upgrades generally increase the fire flows of the entire Zone 2 in Elphinstone.

Upgrade Recommendation 26 – EDM & IDM – the construction of 630 metres of 200mm ø watermain to connect Bridgeman Road watermains is recommended to improve fire flows in the area north of Gibsons. This upgrade increases fire flows from a low of 22 L/s to above 40 L/s in the surrounding areas.

Table 8-5 summarizes the upgrade requirements for 2036 water demands under both existing and intensive demand management along with class "D" cost estimates for the distribution system. The implementation of intensive demand management reduces the recommended upgrade costs from $10.52 million to $9.62 million.

TABLE 8-5
CHAPMAN WATER SYSTEM
DISTRIBUTION SYSTEM UPGRADES

Upgrade No.	Zone	Community	Existing Demand Management		Intensive Demand Management	
			Recommended System Upgrade	Capital Cost (in Millions)	Recommended System Upgrade	Capital Cost (in Millions)
5	2	Wilson Creek	Additional 2,850 metres of 450mm watermain to twin the watermain to the east	$1.35	Twin the existing 350 mm watermain with a 450 mm watermain from Selma Zone 1 Reservoir to the east	$1.35
9	1	West Sechelt	Replacement of 780 metres of 150mm ø watermain with 200mm ø watermain along Truman Road	$0.50	Replacement of 780 metres of 150mm ø watermain with 200mm ø watermain along Truman Road	$0.50
10	2	West Sechelt	Construct a new Zone 2A Reservoir at TWL 180 m	$1.50	Construct a new Zone 2A Reservoir at TWL 180 m	$1.50
11	2	West Sechelt	Construct 2,350 m of 300 mm watermain on Reeves Road west of Mason Road.	$2.00	Construct 2,350 m of 300 mm watermain on Reeves Road west of Mason Road.	$2.00
12	2	West Sechelt	Construct 640 metres of 300 mm watermain along Reeves Road between Mason Road and Nickerson Road	$0.55	Construct 640 metres of 300 mm watermain along Reeves Road between Mason Road and Nickerson Road	$0.55
13	2	West Sechelt	Construct a new Zone 2A Pump Station at the intersection of Tower Road and Tyler Road.	$1.00	Construct a new Zone 2A Pump Station at the intersection of Tower Road and Tyler Road.	$1.00
14	2	West Sechelt	Replacement of 330 metres of 150mm ø watermain with 200mm ø watermain along Wakefield Road	$0.25	Replacement of 330 metres of 150mm ø watermain with 200mm ø watermain along Wakefield Road	$0.25
15	2	West Sechelt	Twin 900 metres of 300mm with 300mm watermain east of Granite Road.	$0.75	Twin 900 metres of 300mm with 300mm watermain east of Granite Road.	$0.75

TABLE 8-5 (CONT'D)
CHAPMAN WATER SYSTEM
DISTRIBUTION SYSTEM UPGRADES

Upgrade No.	Zone	Community	Existing Demand Management		Intensive Demand Management	
			Recommended System Upgrade	Capital Cost (in Millions)	Recommended System Upgrade	Capital Cost (in Millions)
16	1	Sechelt	Replacement of 260 metres of 150mm ø watermain with 200mm ø watermain along Reef Road	$0.20	Replacement of 260 metres of 150mm ø watermain with 200mm ø watermain along Reef Road	$0.20
17	1	West Porpoise Bay	Twin 1,150 metres of 200mm with 200mm watermain along Sechelt Inlet Road	$0.90	Twin 285 metres of 200mm with 200mm watermain along Sechelt Inlet Road	$0.30
18	1	Davis Bay	Construct 920 m of 200 mm watermain from Snodgrass Road to Ridgeview Drive.	$0.50	Construct 780 m of 200 mm watermain from Snodgrass Road to Havies Road.	$0.40
19	1	Davis Bay	Construct 90 metres of 150 mm watermain at the east end of Davis Bay Road to connect with Mission Road	$0.07	Construct 90 metres of 150 mm watermain at the east end of Davis Bay Road to connect with Mission Road	$0.07
20	1	Roberts Creek	Twin 1,000 metres of 100mm and 150mm with 200mm watermain along Beach Avenue	$0.60	Twin 750 metres of 100mm with 200mm watermain along Beach Avenue	$0.40
21	1	Roberts Creek	Tie-in 150 mm watermain into a 350 mm watermain at the intersection of Sunshine Coast Highway and Roberts Creek Road.	$0.05	Tie-in 150 mm watermain into a 350 mm watermain at the intersection of Sunshine Coast Highway and Roberts Creek Road.	$0.05
22	1	Roberts Creek	Construct a Pressure Reducing Station near the Geddes Reservoir.	$0.10	Construct a Pressure Reducing Station near the Geddes Reservoir.	$0.10

TABLE 8-5 (CONT'D)
CHAPMAN WATER SYSTEM
DISTRIBUTION SYSTEM UPGRADES

Upgrade No.	Zone	Community	Existing Demand Management		Intensive Demand Management	
			Recommended System Upgrade	Capital Cost (in Millions)	Recommended System Upgrade	Capital Cost (in Millions)
23	1	Roberts Creek	Reconfiguration of the existing Geddes Reservoir.	$0.05	Reconfiguration of the existing Geddes Reservoir	$0.05
24	2	Elphinstone	Construct 250 metres of 200 mm watermain from Carmen Road to King Road	$0.20	Construct 250 metres of 200 mm watermain from Carmen Road to King Road	$0.20
25	2	Elphinstone	Replace 1,460m of existing 150 mm AC watermain with 200 mm watermain from Sunshine Coast Highway to Malaview Road	$1.00	Replace 1,460m of existing 150 mm AC watermain with 200 mm watermain from Sunshine Coast Highway to Malaview Road	$1.00
26	3	North of Gibsons	Construct 650 metres of 200 mm watermain to connect Bridgeman Road watermain	$0.30	Construct 650 metres of 200 mm watermain to connect Bridgeman Road watermain	$0.30
TOTAL				**$11.87**		**$10.97**

8.6.2 Dead End Elimination

A budget of $150,000 per year to eliminate dead ends in the distribution system is recommended. This improves both fire flows and water quality. The present worth for a yearly program to eliminate dead ends from 2017 to 2036 is $1,870,000.

8.7 Recommended Chapman Water System Strategic Plan

Presented in the previous subsections are the recommended water system improvements to accommodate water demands through 2036 under conditions of either existing demand management programs or a more intensive demand management program.

Summarized in Table 8-6 are the Strategic Plan life cycle costs under conditions of existing demand management and intensive demand management. Life cycle costs include the operations and maintenance costs to the year 2036.

Figure 8-6 shows a visual representation of treated water versus demand capacity over time under the existing and intensive demand management programs. The graph also shows the timing of universal metering and water treatment plant expansion and their impacts on capacity, as well as the remaining capacity in 2036.

TABLE 8-6
CHAPMAN WATER SYSTEM STRATEGIC PLAN
COST COMPARISON – EDM VS IDM

Item	Life Cycle Cost	
	Existing Demand Management	Intensive Demand Management
1. Demand Management	$120,000	$8,510,000
2. Water Sources	$370,000	$370,000
2.1 Engineered Lake	$8,000,000	$4,750,000
2.2 Floating Pump Station	$1,900,000	$1,200,000
3. Water Treatment	$10,100,000	$6,500,000
4. Supply Transmission	$7,550,000	$2,100,000
5. Storage Reservoirs	$1,500,000	$0
6. Distribution System	$13,740,000	$12,840,000
TOTAL	**$43,280,000**	**$36,270,000**

Based on the reduced overall cost of system improvements required in the long term to 2036, it is recommended that the SCRD adopt the intensive demand management program as part of its Strategic Plan. Implementation of the Chapman Water System Strategic Plan will require the following:

1. Adoption of the demand management recommendations set out in Section 8.1.1
2. Adoption of the water source recommendations set out in Section 8.2.5.
3. Expansion of the Chapman Creek Water Treatment Plant as set out in Section 8.3.1
4. Completion of transmission, storage and distribution system upgrades as set out in Sections 8.4, 8.5 and 8.6, respectively.
5. Amendment of the bylaws to incorporate rural and urban fire flow criteria.
6. Establish expansion limits for new construction to maximum serviceable elevations as shown in Figures 6-4A and 6-4B.

9.0 SMALL WATER SYSTEMS STRATEGIC PLAN

System improvements have been developed and are evaluated in this section to address deficiencies identified in the Section 7.0 Small Water Systems Analysis. The evaluation of system improvements considers the merits of demand side versus supply side strategies and the appropriate levels of service within the small water systems. A summary of the cost implications of continuing with the existing demand management program or adopting a more intensive demand management program is presented at the end of this section.

9.1 Demand Management

Similar to Section 8.1, demand management programs implemented in the Chapman water service area will also be affected in the small water systems, especially those small systems adjacent to the Chapman water system. Demand reduction will occur to a lower extent in the Eastbourne, Cove Cay, and Egmont Cove communities due to their already low demands and their physical location from the Chapman water system.

Section 7.0 highlighted the difference in upgrade work to transmission, reservoir and distribution systems needed to accommodate projected water demand in 2036 under conditions of existing and intensive demand management programs and 30 L/s fire flow requirements.

9.2 Water Sources

Due to a lack of data, analysis could not be performed to assess the drought risk of the individual water sources in the small water systems.

Additional water can be obtained by adding storage on the surface water sources or by developing additional groundwater sources.

9.2.1 Langdale

The source capacity of the Langdale water system is 1.2 ML/d. From Section 5.5, the 2036 maximum day demand calculated for the Langdale community is 1.06 ML/d (EDM) and 0.80 ML/d (IDM) respectively. Source capacity at the Langdale Well is adequate.

9.2.2 Soames Point and Granthams Landing

The source capacities at the Soames Point Well and the Granthams Landing Well are 1.39 ML/d and 0.23 ML/d respectively. The 2036 maximum day demand for these two water systems is 0.43 ML/d (EDM) and 0.34 ML/d (IDM). Source capacity at the Soames Point and Granthams Landing Well is adequate.

9.2.3 Eastbourne

The Collector and Gordon Well capacities are as low as 0.02 ML/d in the dry season, while the maximum day demand in 2036 for the Eastbourne community is 0.054 ML/d. The existing average day demand of 0.017 ML/d is currently barely met by the well capacities. However, the presence of water storage tanks at each property location has managed to provide the average day and maximum day demands for the residents in the Eastbourne community in the present condition.

To supplement supply and ensure self-sufficiency, other water sources need to be developed. One or two more horizontal collector wells may be installed to improve water supply. Exploratory test excavations will have to be conducted to find suitable locations.

9.2.4 Cove Cay

The supply capacity at the Ruby Lake pumping station is currently 1.2 ML/d. The 2036 maximum day demand for the Cove Cay community is 0.088 ML/d. Source capacity from Ruby Lake is adequate.

9.2.5 Egmont Cove

The supply capacity of the pumping station at Waugh Lake is 0.22 ML/d. This newly constructed system has adequate capacity for the present and future. A 2036 maximum day demand of 0.116 ML/d (EDM) and 0.087 ML/d (IDM) would be adequately supplied by the Waugh Lake source.

9.2.6 Water Source Recommendations

1. A groundwater investigation will be conducted to find suitable additional wells for the Eastbourne community to improve its water supply. A budget of $100,000 is recommended over two years.

2. A recommended budget of $100,000 to complete any outstanding Source to Tap Assessments and Well Protection Plans noted in Section 3.3.

9.3 Water Treatment

Water treatment is considered adequate by the local Drinking Water Officer for all the small community water systems in the SCRD. SCRD operators work closely with the DWO to ensure that adequate treatment is applied to all the water systems to provide clean drinking water to its residents. Vancouver Coastal Health Authority maintains that chlorine residuals are also adequately maintained throughout the small water systems.

Expansion of the treatment capacity at the Eastbourne wells may be required upon drilling of additional wells.

9.3.1 Water Treatment Recommendations

The existing treatment at the small water systems is currently adequate and water quality data meets or exceeds the Canadian Drinking Water Guidelines at each community.

The following recommendations summarize the improvements to be made to the water treatment for the small water systems:

1. The DWO has requested that the chlorination treatment process be automated at the Soames Point well. A budget of $30,000 is recommended for the construction and automation process.

2. Treatment expansion for the Eastbourne community wells may be required. A pre-design report that develops and evaluates treatment options (continued use of UV, filtration, and chlorination). A budget of $30,000 for the pre-design study that will also develop Class ‘C’ cost estimates suitable for project funding is recommended.

9.4 Supply Transmission

The transmission supply should be designed to fill system reservoirs within 24 hours during maximum day demand. There are no transmission mains in the small water systems.

9.5 Water Storage Reservoirs

Under the 2036 existing demand management condition, Langdale and Eastbourne were found to have deficient fire storage. A new reservoir is needed for the Langdale and Eastbourne water systems to provide an adequate fire storage capacity.

Under the 2036 intensive demand management condition, fire storage is adequate in all areas except Eastbourne. A new reservoir is needed for the Eastbourne water system.

9.5.1 Water Storage Recommendations

The existing water storage is currently adequate for balancing storage for each of the small water systems investigated in this report. When looking into 2036 EDM and IDM scenarios, it is found that there will be a fire storage deficiency in the Langdale, Soames Point and Granthams Landing water systems in the future.

The following recommendations summarize the tasks required to improve the reservoir supply in the small water systems:

1. The interconnection between the Langdale, Soames Point, Granthams Landing and Chapman water systems is critical in providing adequate fire flow volumes to each of the small water systems. The Fisher PRV and closed valves in between

each system should be checked regularly for proper operation so that the water systems are able to provide fire storage volume to those in need in case of emergency. Budget $10,000 for a yearly program to perform and document these checks. This equates to a 25-year life cycle cost of $175,000.

9.6 Distribution System

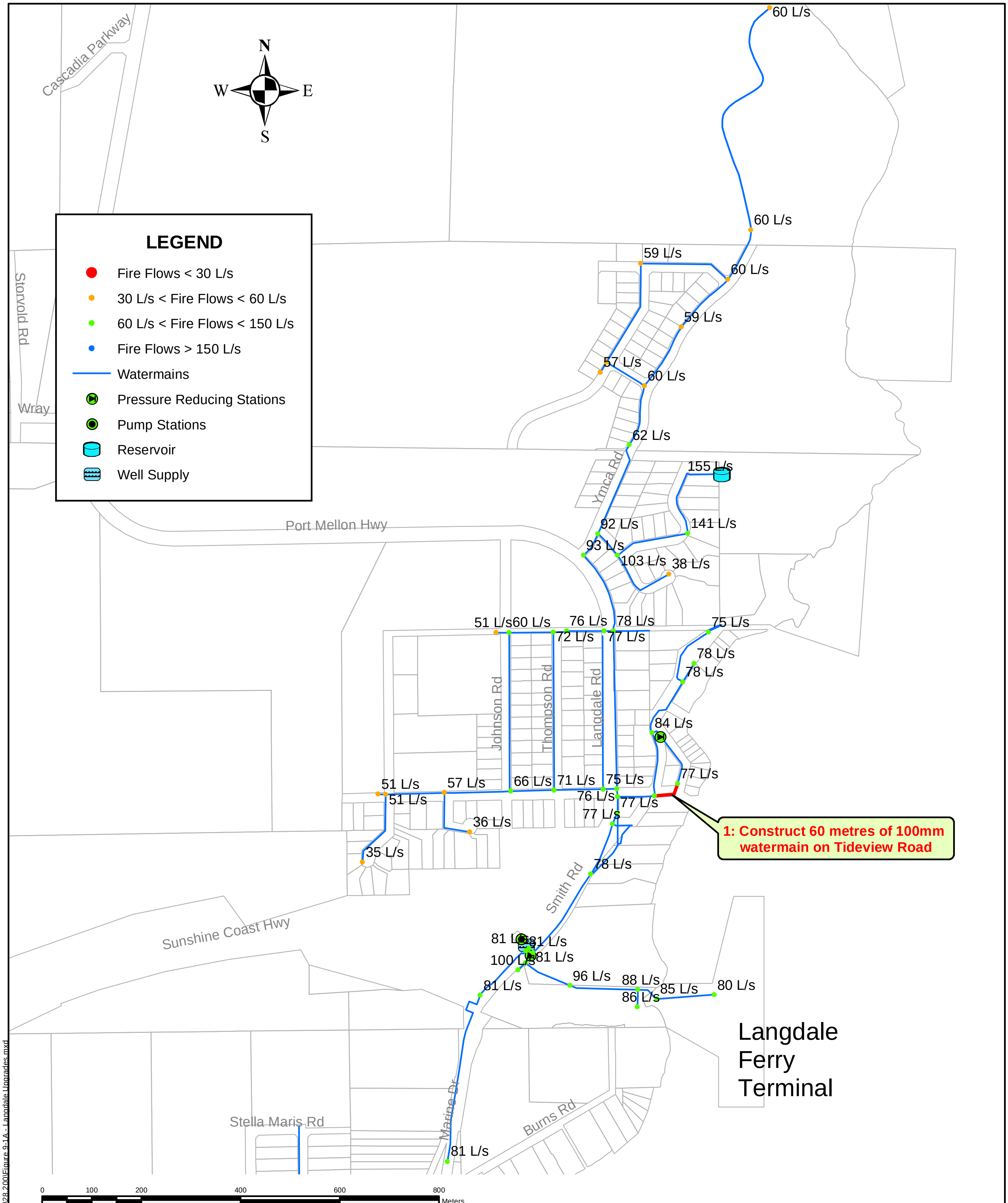
System upgrades are required to resolve low pressures and deficient fire flows assessed in the small water systems as noted in Section 7.0. Each of the system upgrades are assessed for both existing demand management (EDM) and intensive demand management (IDM) conditions in the year 2036, and are applied to the main distribution lines, while deficiencies at dead ends are not addressed.

30 L/s fire flow requirements as noted in Section 7.0 have been used. The recommended system upgrades are illustrated in Figures 9-1A to 9-1C.

9.6.1 Watermain Upgrades

Upgrade Recommendation 1 (Langdale) – EDM & IDM – The construction of 60 metres of 100 mm ø watermain is recommended to provide watermain looping on Tideview Road from Smith Road. This upgrade increases the fire flow on Tideview Road from 7 L/s to 68 L/s.

Upgrade Recommendation 2 (Soames) – EDM & IDM – Replacement of 110 metres of 50 mm ø watermain with 100 m ø watermain is recommended at the east end of Sentinel Road. This upgrade increases the fire flow on Sentinel Road from a minimum of 7 L/s to 42 L/s.



Path: H:\Projects\0000\28 SCRD\28.200\Figure 9-1A - Langdale Upgrades.mxd

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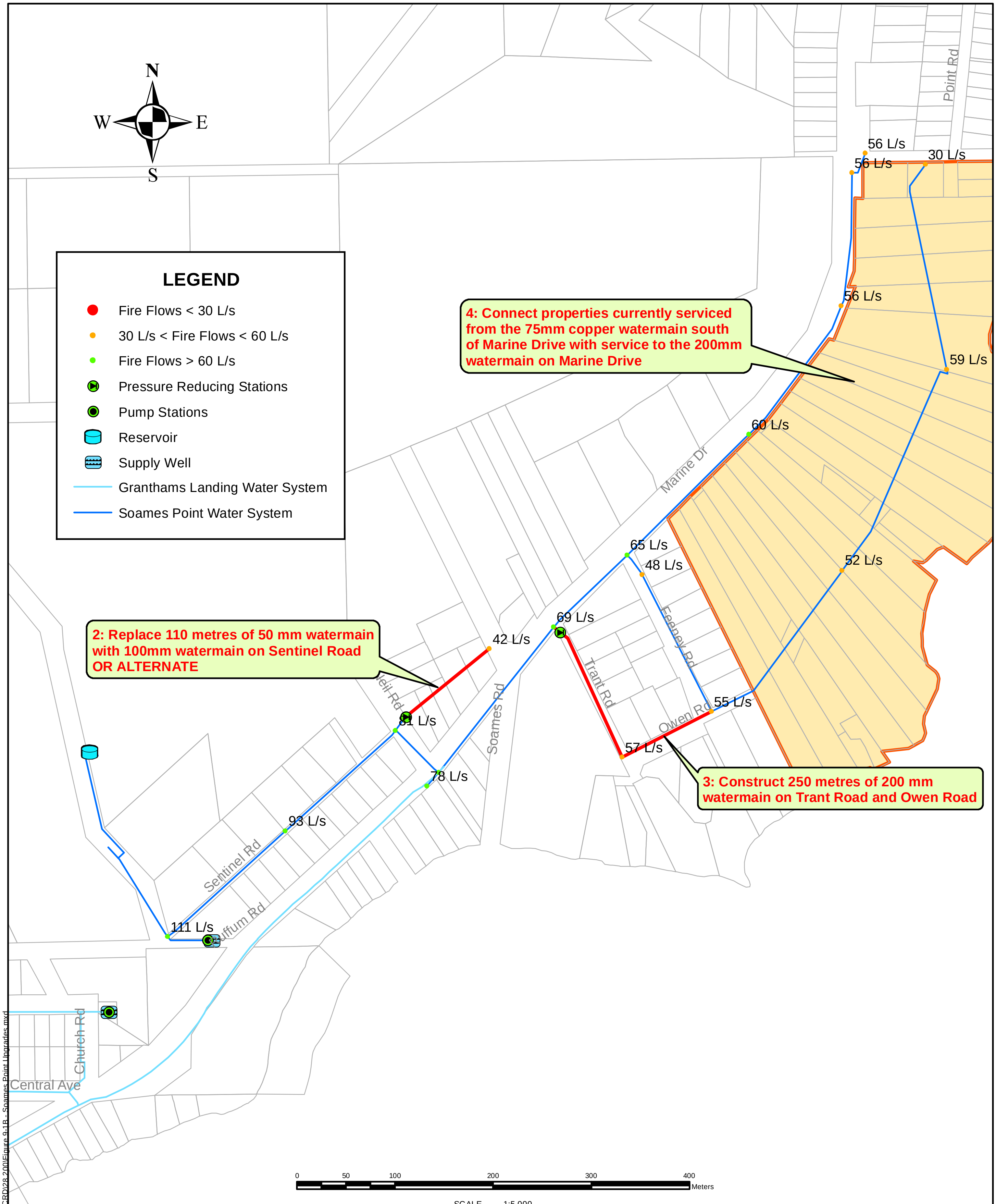
LANGDALE WATER SYSTEM RECOMMENDED UPGRADES

FIGURE 9-1A



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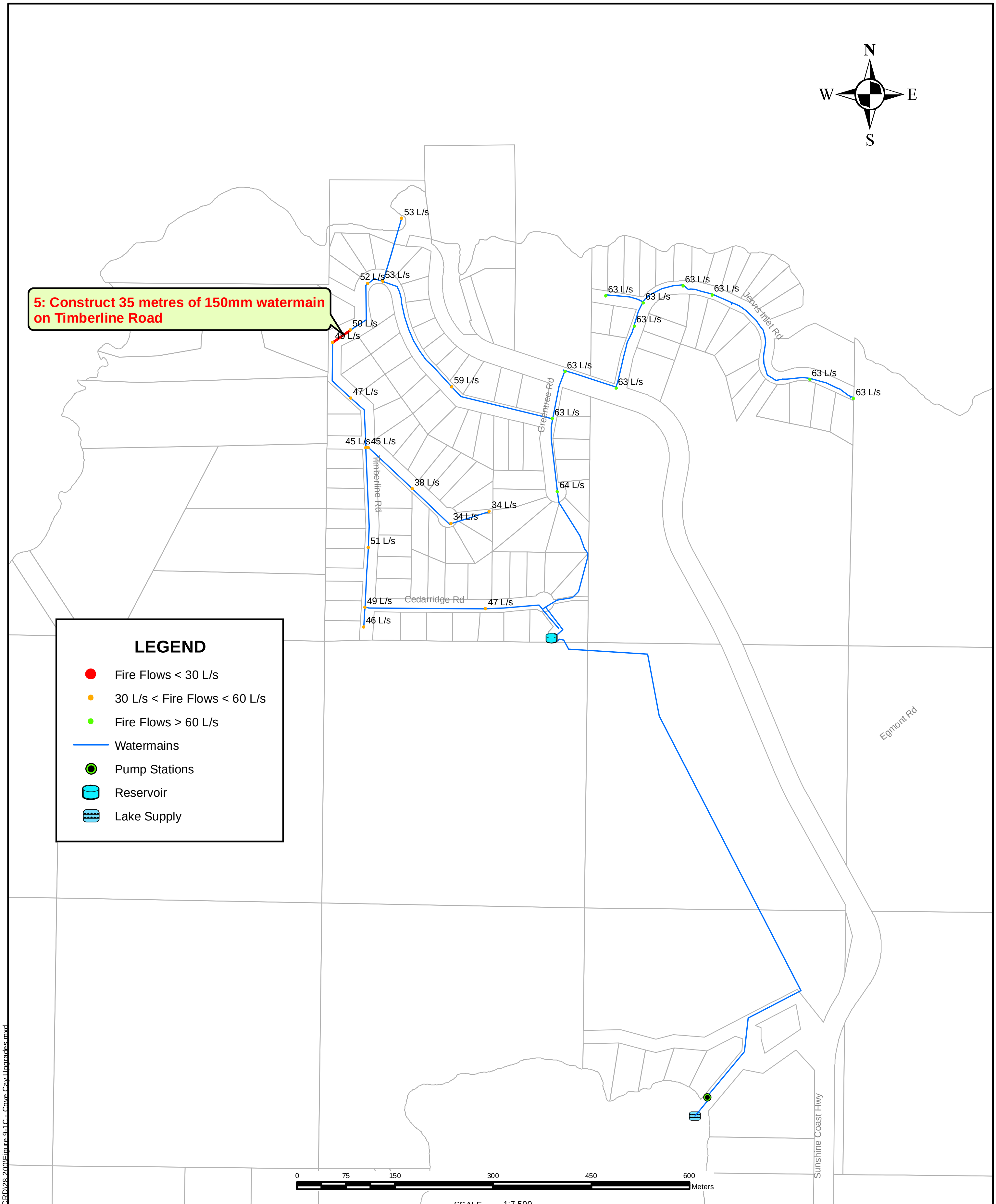
SOAMES POINT WATER SYSTEM RECOMMENDED UPGRADES

FIGURE 9-1B



Path: H:\Projects\000\028 SCRD\28 200\Figure 9-1C - Cove Cay Upgrades.mxd

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SUNSHINE COAST REGIONAL DISTRICT

COVE CAY WATER SYSTEM RECOMMENDED UPGRADES

FIGURE 9-1C

Upgrade Recommendation 3 and 4 (Soames) – EDM & IDM – The recommendation is to replace 250 metres of 75 mm ø watermain with 150 mm ø watermain on Trent Road and Owen Road. Providing service connections for properties south of Marine Drive to connect to the 200mm watermain on Marine Drive is also recommended. These upgrades improve minimum fire flows from 4 L/s to 30 L/s.

Upgrade Recommendation 5 (Cove Cay) – EDM & IDM – The recommendation is to construct 35 metres of 150 mm ø watermain to provide watermain looping along Timberline Road. This upgrade improves the fire flows in Cove Cay from a minimum of 25 L/s to 34 L/s.

TABLE 9-1
SMALL WATER SYSTEMS
DISTRIBUTION SYSTEM UPGRADES

Upgrade No.	Community	Existing Demand Management		Intensive Demand Management	
		Recommended System Upgrade	Capital Cost (in Millions)	Recommended System Upgrade	Capital Cost (in Millions)
1	Langdale	Construction of 60 metres of 100mm ø watermain on Tideview Road	$0.08	Construction of 60 metres of 100mm ø watermain on Tideview Road	$0.08
2	Soames	Replacement of 110 metres of 50mm ø watermain with 100mm ø watermain on Sentinel Road	$0.15	Replacement of 110 metres of 50mm ø watermain with 100mm ø watermain on Sentinel Road	$0.15
3	Soames	Replacement of 250metres of 75mm ø watermain with 150mm ø watermain on Trant Road, Owen Road and East of Owen Road	$0.30	Replacement of 910metres of 75mm ø watermain with 150mm ø watermain on Trant Road, Owen Road and East of Owen Road	$0.30
4	Soames	Providing service connections for properties south of Marine Drive to connect to the 200mm watermain on Marine Drive	$0.30	Providing service connections for properties south of Marine Drive to connect to the 200mm watermain on Marine Drive	$0.30
5	Cove Cay	Construction of 35 metres of 150mm ø watermain on Timberline Road	$0.05	Construction of 35 metres of 150mm ø watermain on Timberline Road	$0.05
TOTAL			**$0.88**		**$0.88**

9.6.2 Dead End Elimination

A budget of $50,000 per year to eliminate dead ends in the small water systems is recommended. This improves both fire flows and water quality. The present worth for a yearly program to eliminate dead ends from 2017 to 2036 is $625,000.

9.7 Recommended Small Water Systems Strategic Plan

Presented in the previous subsections are the recommended water system improvements to accommodate water demands through 2036 under conditions of either existing demand management programs or a more intensive demand management program.

Summarized in Table 9-2 are the Strategic Plan life cycle costs under conditions of existing demand management and intensive demand management. Life cycle costs include the operations and maintenance costs to the year 2036.

TABLE 9-2
SMALL WATER SYSTEMS STRATEGIC PLAN
COST COMPARISON – EDM VS. IDM

Item	Life Cycle Cost	
	Existing Demand Management	Intensive Demand Management
1. Demand Management	$0	$0
2. Water Sources	$200,000	$200,000
3. Water Treatment	$60,000	$60,000
4. Supply Transmission	$0	$0
5. Storage Reservoirs	$175,000	$175,000
6. Distribution System	$1,505,000	$1,505,000
TOTAL	**$1,940,000**	**$1,940,000**

There does not appear to be any reduction in Strategic Plan costs between the existing demand management and intensive demand management scenarios for the Small water systems Strategic Plan. As such, cost savings are mostly realized in the Chapman water system Strategic Plan.

10.0 PRIORITY UPGRADE REQUIREMENTS

Sections 8.0 and 9.0 both combine to set out the Regional Water Service Area Strategic Plan to assess the SCRD's water system infrastructure requirements for the next 25 years. This section prioritizes the water system upgrade requirements identified in the Strategic Plans to develop a Preliminary 10-Year Capital Plan.

10.1 IDM Preliminary 10-Year Capital Plan

There are many important tasks that the SCRD is faced with in the improvement of the Regional Water Service Area. The priority improvements are mainly focused on the Chapman water system while the remaining small water systems are currently in good shape and adequately managed by the SCRD. Implementation of intensive demand management programs (especially universal metering), increased communications to reduce outdoor water use during the summer, and the construction of a floating pump station (or alternative system) in Chapman Lake are priority items that should be completed in the next 5 years.

Priority items that should be started in the next 10 years include expansion of the Chapman Water Treatment Plant, transmission main upgrades, fire flow upgrades for the Chapman and small water systems, and negotiations with Lehigh (Construction Aggregates) regarding the purchase of land for the engineered lake to replace the interim floating pump station (or alternative system). Upgrades to the distribution system should be prioritized based on first addressing the deficiencies that exist today to ensure adequate delivery of maximum day demand coincident with appropriate fire flows.

Priority upgrades for fire flow servicing for the Chapman water system include improvements to West Sechelt (Table 8-5 Rec. 9 - 15), Roberts Creek (Table 8-5 Rec. 20 & 21), Elphinstone (Table 8-5 Rec. 24 & 25), and Davis Bay (Table 8-5 Rec. 18 & 19). Priority upgrades for fire flow servicing for the small water systems includes improvements to the Soames Point water system, then the Cove Cay water system and finally the Langdale water system.

Class 'D' cost estimates for the development of a Preliminary 10-Year Capital Plan are presented in Table 10-1. Actual timing of the water system infrastructure upgrades will be based on the financial plan.

The preliminary 10-year capital plan under the intensive demand management scenario totals $30.6 million over 10 years with $14.9 million in the first five years.

TABLE 10-1
INTENSIVE DEMAND MANAGEMENT
PRELIMINARY 10-YEAR CAPITAL PLAN

Recommendation	Construction Target	10 Year Capital Cost	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Demand Management			SHORT TERM					MEDIUM TERM				
Implementation of Stage 2 and Stage 3 water sprinkling restrictions with enforcement	2014-2015	$ 120,000	60,000	60,000								
Install Universal Metering	2014-2015	$ 5,280,000	2,640,000	2,640,000								
Metering - Reading, Data Entry, Billing and O&M costs	2014-2023	$ 1,470,000	55,000	90,000	125,000	150,000	175,000	175,000	175,000	175,000	175,000	175,000
Assess Futher Demand Management Strategies and revise bylaw, educational programs, and water rate structure	2014	$ 40,000	40,000									
Additional Intensive Demand Mangement Programs such as irrigation controllers, rain barrels, and rainwater harvesting	2019	$ 250,000						250,000				
Water Source												
Obtain permits for floating pump station or alternative system	2014	$ 20,000	20,000									
Construction of floating pump station or alternative system	2015	$ 660,000		660,000								
Upkeep of floating pump station or alternative system	2016-2023	$ 320,000			40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000
Groundwater test drilling program	2016-2017	$ 300,000			150,000	150,000						
Obtain property rights for construction of man-made lake	2021	$ 50,000								50,000		
Small Systems: Groundwater Investigation to find suitable additional wells for Eastbourne	2019	$ 100,000						100,000				
Small Systems: Complete Source to Tap Assessments and Well Protection Plans	2014	$ 100,000	100,000									
Water Quality												
Initiate Pre-Design Study for Chapman Water Treatment Plant Expansion	2019	$ 100,000						100,000				
Construction of Chapman Water Treatment Plant Expansion to 37.5 ML/d	2020-2021	$ 6,400,000							3,200,000	3,200,000		
Small Systems: Automation of chlorination at the Soames Point Well	2018	$ 30,000					30,000					
Small Systems: Pre-Design for Treatment Expansion at the Eastbourne Wells	2020	$ 30,000							30,000			
System Infrastructure												
Chapman Transmission Main Upgrades (see Table 8-3)	2016	$ 2,100,000			2,100,000							
Chapman Fire Protection Upgrades (see Table 8-5)	2017-2021	$ 11,000,000				2,200,000	2,200,000	2,200,000	2,200,000	2,200,000		
Eliminate dead ends in the Chapman distribution system	2018-2023	$ 900,000					150,000	150,000	150,000	150,000	150,000	150,000
Small Systems: Annual check for interconnectivity between Chapman, Langdale, Soames and Granthams Landing	2014-2023	$ 100,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Small Systems: Fire Protection Upgrades (see Table 9-2)	2016	$ 880,000			880,000							
Small Systems: Eliminate dead ends	2017-2022	$ 300,000					50,000	50,000	50,000	50,000	50,000	50,000
	TOTAL	**$ 30,550,000**	**2,925,000**	**3,460,000**	**3,305,000**	**2,550,000**	**2,655,000**	**3,075,000**	**5,855,000**	**5,875,000**	**425,000**	**425,000**

* Costs are in 2011 dollars

10.2 EDM Preliminary 10-Year Capital Plan

Under the existing demand management programs, the expansion of the Chapman water treatment plant, construction of a floating pump station (or alternative system) in Chapman Lake and transmission main improvements are all priority items that should be completed in the next 5 years.

Improvements in the next 10 years include reservoir upgrades and fire flow upgrades for the Chapman and small water systems, and negotiations with Lehigh (Construction Aggregates) regarding the purchase of land for the engineered lake to replace the interim floating pump station (or alternative system). Upgrades to the distribution system should be prioritized based on first addressing the deficiencies that exist today to ensure adequate delivery of maximum day demand coincident with appropriate fire flows.

Class 'D' cost estimates for the development of a Preliminary 10-Year Capital Plan are presented in Table 10-2. Actual timing of the water system infrastructure upgrades will be based on the financial plan.

The preliminary 10-year capital plan under the existing demand management scenario totals $34.7 million over 10 years with $26.5 million in the first five years.

TABLE 10-2
EXISTING DEMAND MANAGEMENT
PRELIMINARY 10-YEAR CAPITAL PLAN

Recommendation	Construction Target	10 Year Capital Cost	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
			SHORT TERM					MEDIUM TERM				
Demand Management												
Implementation of Stage 2 and Stage 3 water sprinkling restrictions with enforcement	2014-2015	$ 120,000	60,000	60,000								
Install Universal Metering	-	$ -										
Metering - Reading, Data Entry, Billing and O&M costs	-	$ -										
Assess Futher Demand Management Strategies and revise bylaw, educational programs, and water rate structure	-	$ -										
Additional Intensive Demand Mangement Programs such as irrigation controllers, rain barrels, and rainwater harvesting	-	$ -										
Water Source												
Obtain permits for floating pump station or alternative system	2014	$ 20,000	20,000									
Construction of floating pump station or alternative system	2015	$ 1,100,000		1,100,000								
Upkeep of floating pump station or alternative system	2016-2023	$ 520,000			65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000
Groundwater test drilling program	2016-2017	$ 300,000			150,000	150,000						
Obtain property rights for construction of man-made lake	2021	$ 50,000								50,000		
Small Systems: Groundwater Investigation to find suitable additional wells for Eastbourne	2019	$ 100,000						100,000				
Small Systems: Complete Source to Tap Assessments and Well Protection Plans	2014	$ 100,000	100,000									
Water Quality												
Initiate Pre-Design Study for Chapman Water Treatment Plant Expansion	2014	$ 100,000	100,000									
Construction of Chapman Water Treatment Plant Expansion to 45.0 ML/d	2015-2016	$ 10,000,000		5,000,000	5,000,000							
Small Systems: Automation of chlorination at the Soames Point Well	2018	$ 30,000					30,000					
Small Systems: Pre-Design for Treatment Expansion at the Eastbourne Wells	2020	$ 30,000							30,000			
System Infrastructure												
Chapman Transmission Main Upgrades (see Table 8-3)	2013-2017	$ 7,550,000	1,510,000	1,510,000	1,510,000	1,510,000	1,510,000					
Chapman Reservoir Upgrades (see Table 8-4)	2018	$ 1,500,000					1,500,000					
Chapman Fire Protection Upgrades (see Table 8-5)	2017-2021	$ 11,000,000				2,200,000	2,200,000	2,200,000	2,200,000	2,200,000		
Eliminate dead ends in the Chapman distribution system	2018-2023	$ 900,000					150,000	150,000	150,000	150,000	150,000	150,000
Small Systems: Annual check for interconnectivity between Chapman, Langdale, Soames and Granthams Landing	2014-2023	$ 100,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Small Systems: Fire Protection Upgrades (see Table 9-2)	2017	$ 880,000				880,000						
Small Systems: Eliminate dead ends	2018-2023	$ 300,000					50,000	50,000	50,000	50,000	50,000	50,000
	TOTAL	**$ 34,700,000**	**1,800,000**	**7,680,000**	**6,735,000**	**4,815,000**	**5,515,000**	**2,575,000**	**2,505,000**	**2,525,000**	**275,000**	**275,000**

* Costs are in 2011 dollars

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