CITY OF PORT COQUITLAM

Coquitlam

Final Report

Maple Creek
Integrated Watershed Management Plan

July 2021
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Executive Summary

Introduction

The City of Port Coquitlam (Port Coquitlam) and City of Coquitlam (Coquitlam) initiated an Integrated Watershed Management Plan (IWMP) for the Maple Creek watershed, which spans both municipalities. The study was initiated in 2011 and mostly completed in 2012. The project was on hold for eight years and was finalized in 2021.

Maple Creek drains via the Maple Creek pump station and flood box to the Coquitlam River. When the Coquitlam River water level is high, the Maple Creek flood box closes and is unable to drain by gravity and relies on pumping only as a drainage outlet. There is existing flooding in low-lying areas near the mouth of the creek, some of which is developed. Maple Creek also has a diversion channel in Coquitlam that diverts high flows to the Coquitlam River with low flows only continuing in the creek through Port Coquitlam. There is also a groundwater well and pump located in the upper watershed which augments creek baseflows.

The goal of the Maple Creek study is to develop a comprehensive and integrated watershed management plan for improving the overall watershed system by minimizing the risk of flooding, preserving aquatic and riparian habitats, and identifying effective and affordable watercourse improvements.

The Cites of Port Coquitlam and Coquitlam developed the following objectives:

- Protect aquatic ecosystems and surface/groundwater for fish, wildlife, and ecological values;
- Minimize flood risks to life and property and preserve or re-establish natural hydrologic functions;
- Recommend pollution prevention and water quality control approaches;
- Involve the local stakeholders, agencies and public in a consultation process;
- Develop a cost effective strategy for municipal improvements, projects for streamkeeper groups, and improve community awareness of watershed issues;
- Develop land use integration strategies and plans.

Existing Flooding

Maple Creek has a history of flooding affecting Bedford Street and properties in the area. The flood assessment showed a number of conveyance constrictions along the creek including undersized culverts and narrow channel sections that have buildings immediately adjacent to the channel, particularly in between Kingsway and Bedford which is subjected to flooding.

Environment Values

Maple Creek has relatively poor watershed health in 2011 (B-IBI score 14.5). It is heavily impacted by urbanization with 48% total impervious area and low watershed forest cover and a moderately intact riparian corridor. Water and sediment quality is generally fair to poor – the largest issues are fecal coliform contamination and metals in the lower watershed. Several point sources of pollution in the watershed were previously identified. Despite this, six salmon and trout species were noted in the creek: Coho, Chum, Cutthroat Trout, and Steelhead/Rainbow Trout (spawning and rearing) as well as Chinook and Sockeye (rearing only). There are also two confirmed species at risk: Cutthroat Trout and Red-legged Frog, although others may be present. Significant fish populations that still exist in the watershed may be attributed to the baseflow augmentation measures and other habitat enhancements that have been implemented.

Land Use

The watershed is mostly built out with mixed land uses. Approximately two thirds of the watershed is residential use, while 15% is commercial and industrial uses. The remaining land is comprised of parks, civic institutional, and highway and road rights of way. Future development will include some densification with total impervious area expected to marginally increase from 48% to 51%.

Assessments

Hydrologic and hydraulic modelling results were used to assess the creek's conveyance capacity and extent of flooding, and evaluate flood management alternatives. Environmental and watershed health improvement opportunities were also explored, such as supplementing baseflow augmentation, allowing creek flushing flows past the Ozada high flow diversion, providing water quality treatment, and proposing aquatic and riparian improvements. Alternatives and options were compared and discussed with the City staff and stakeholders, and preferred choices brought forward into a watershed plan.

The Watershed Plan

The Integrated Stormwater Management Plan is summarized and prioritized in Table ES-1 including

- **Environmental enhancement projects** for baseflow augmentation, water quality treatment, upgrading fish passage impediments, and restoring instream complexity and riparian areas.
- **Combine flood management and environmental enhancement** for Ozada Diversion operation and removal of channel obstructions to improve conveyance & fish passage.
- **Flood management** including upgrading existing pump station, culvert and conveyance improvements, and constructing a Bedford Diversion.
- **Future development policy recommendations** furthering rainwater management implementation for volume reduction (groundwater recharge), rate control, water quality treatment for frequently occurring runoff events to mimic natural hydrology.
- **Municipal stormwater program additions** include updating City of Port Coquitlam's Subdivision Servicing Bylaw (No. 2241) and developing an Erosion & Sediment Control Bylaw (in addition to the Removal and Deposit of Soil Bylaw (No. 3331), further water quality studies to identify problems, watershed performance monitoring and adaptive management, and an education and outreach program for property owners adjacent to the creek.

The proposed projects, policies and programs are prioritized into 5-, 20-, and 50-year Plans.

Source controls (or green infrastructure) is encouraged to recharge groundwater to improve creek baseflows and to mimic natural hydrology and provide water quality treatment. They should be sized and designed to capture and hold a minimum of 55 mm of rainfall (equivalent to the 72% of the 2-year, 24 hour design rainfall event) from the subject site in order to have stormwater benefits. More can be infiltrated in areas of well draining soil.

Watershed performance indicators were identified for the watershed monitoring program consistent with Metro Vancouver's Monitoring and Adaptive Management Framework, together with a few other parameters. Refer to Table ES-2.

Table ES-1: Maple Creek IWMP & Implementation Strategy

Plan Components		Priority	Cost Estimate	Responsibility
ENVIRONMENTAL ENHANCEMENT PROJECTS				
1.	**BASEFLOW AUGMENTATION**			
	• Create a municipal program to encourage on-site rainwater management	Immediate	n/a	City Eng /Dev Services
	• Investigate long term baseflow augmentation alternatives. Figure 4-1. • Construct preferred alternative.	5 years 5 to 10 years	$50 K	City Engineering
2.	**WATER QUALITY TREATMENT**			
	• Add four structural water quality treatment or filtration features. Figure 7-1. • Three in Port Coquitlam, one in Coquitlam,	On-going	or $\$190/\text{m}^2$ $260 K/ea	Developer and/or Cities
	• Follow Spill Response Plan	Immediate	-	Operations
	• Inspect and maintain Ozada Ave Stormceptor regularly	Immediate	-	Operations
3.	**UPGRADE FISH PASSAGE IMPEDIMENTS**			
	• Remove fish passage impediments such as fences, creek obstructions & weirs.	On-going	$39 K	Developer and/or Cities
	• Flood box gate improvements with pump station upgrade – 2023	5 years	-	City Engineering
4.	**RESTORE IN-STREAM COMPLEXING**			
	• Remove concrete flume & replace with natural watercourse.	5 to 10 years	$65 K	City Engineering
	• Add spawning gravels & instream complexity in lower watersheds (with concurrent channel modifications to improve channel capacity)	On-going	TBD	Developer and/or Cities
5.	**RESTORE RIPARIAN AREAS**			
	• Remove invasive species & reforest with native species.	At redevelopment	$\$28/\text{m}^2$	Developer and/or Cities
	• Widen riparian setbacks during redevelopment & increase natural watershed & vegetation cover	On-going	TBD	
COMBINED FLOOD MANAGEMENT & ENVIRONMENTAL ENHANCEMENT				
6.	**OZADA DIVERSION OPERATION**			
	• Maintain operation as is but stop the practice of sandbagging during storms.	Immediate	-	Operations
	• Undertake feasibility study to determine preferred long-term alternative. Fig 4-2. Implement alternative.	20 to 50 years	$597-$772 K	City Engineering
7.	**REMOVE CREEK OBSTRUCTIONS**			
	• Remove channel obstructions & clean out overgrown vegetation to improve conveyance & fish passage	5 to 50 years	-	Operations
FLOOD MANAGEMENT				
8.	**UPGRADE DRAINAGE PUMP STATION**			
	• Construct large pump station at current location with a self-regulating tide gate and improve floodbox.	2023	$3.4M	City Engineering
9.	**CULVERT UPGRADES** • Add climate change & sea level rise considerations for major drainage system improvements (100- & 200-year return periods) prior to design. • See Table 7-4 for conveyance upgrade project costs & locations.			
	• Upgrade 1 culverts in Port Coquitlam. • Upgrade 1 culverts in Coquitlam.	5 to 10 years	$447K $341K	City Engineering City Engineering
	• Upgrade 1 culverts in Port Coquitlam.	10 to 20 years	$54K	City Engineering
	• Upgrade 5 culverts in Port Coquitlam. • Upgrade 2 culverts in Coquitlam.	50+ years	$2.02M $204K	City Engineering City Engineering
10.	**CONSTRUCT KINGSWAY BEDFORD DIVERSION**			
	• Provide a 100-year high flow diversion along Kingsway & Bedford to supplement the confined Kingsway Avenue to Bedford flumed channel section. Refer to Figure 7-5. • Add climate change and sea level rise considerations for major drainage system improvements (100 and 200 year return periods) prior to design.	5 to 10 years	$1.2 M	City Engineering
MITIGATION OF THE IMPACTS OF FUTURE DEVELOPMENT (Requirements for All New Development & Redevelopment)				
11.	**PROTECT RIPARIAN AREAS** to protect stream health, streambank stability & wildlife habitats			
	• No development within SPR (City of Port Coquitlam) or RAR (City of Coquitlam) setbacks unless compensation is provided – protection of riparian setbacks are critical to watershed health.	At redevelopment 20 to 50 years	-	Developer Cities' Env. & Dev. Services
12.	**CONSTRUCT HYDROLOGIC VOLUME REDUCTION MEASURES** to maintain baseflows & minimize downstream erosion & habitat degradation			
	• Maximize low impact development techniques. • Construct Stormwater Source Controls (bio-retention rain gardens or swales, pervious pavers, absorbent soil layers, green roofs, rainwater harvesting & reuse, etc.). Size to capture 72% of the 2-year, 24-hour event (55mm). • Regional facilities for base-flow augmentation (sustain base-flows).	At redevelopment 20 to 50 years	TBD	Developer Cities' Env. & Dev. Services
13.	**CONSTRUCT STORMWATER QUALITY TREATMENT MEASURES** to treat runoff prior to discharge to watercourses			
	• Size to treat 90% of average annual runoff (approx. 72% of the 2-year, 24-hour event (55 mm)). • Construct Stormwater Source Controls (rain gardens, vegetated swales, vegetated pervious pavers) to filter contaminants from roads & parking lots. • Alternatively consider regional water quality facilities such as wetlands & wet ponds. • Construct oil/grit separators. spill control devices for gas stations, high risk spill industry, parking lots. • Require & enforce *Erosion & Sediment Control* measures during construction phase of development.	At redevelopment 20 to 50 years	TBD	Developer Cities' Env. & Dev. Services
14.	**CONSTRUCT HYDROLOGIC RATE CONTROL MEASURES** to minimize downstream erosion, habitat degradation & flooding			
	• Size to detain 6-month, 2-year & 5-year post to pre-development levels. • Construct detention/infiltration facilities.	At redevelopment 20 to 50 years	TBD	Developer Cities' Env. & Dev. Services
MUNICIPAL STORMWATER MANAGEMENT PROGRAM				
15.	**BYLAWS & STANDARDS (APPLY MUNICIPALITY WIDE)**			
	• Develop Rainwater Management Policy and Erosion & Sediment Control Bylaw in Port Coquitlam • Enforce City of Coquitlam Erosion & Sediment Control Bylaws. • Update Development Bylaws to include climate change and sea level rise considerations for the major drainage system assessments (100 and 200 year storms).	5 to 10 years		City Development Services
16.	**FURTHER WATER QUALITY STUDIES IN MAPLE CREEK WATERSHED**			
	• Undertake further surveillance sampling to identify point-source discharges from previously identified problem sites.	20 year	$39,000	City Engineering
17.	**WATERSHED MONITORING**			
	• Conduct watershed performance monitoring & adaptive management approach	Every 5 years min.	$39 K/yr	Cities' Engineering
18.	**EDUCATION/OUTREACH PROGRAM**			
	• Begin education & outreach with private property owners who have watercourses with regards to stream and watershed health	Immediate		Cities' Env Services
		City of Port Coquitlam	$7.224M	
		City of Coquitlam	$1.367M	
		Both Municipalities	$1.079M	
		Total Plan Costs	$9.670M	

Table ES-2: Maple Creek Watershed MAMF Performance Indicators

Performance Indicator		Method of Analysis	2011	2021
Water Quality				
1.	Dissolved Oxygen	Water Quality testing on a 3- to 5-year cycle. See regional criteria set by Metro Vancouver.	No data	Regional criteria set by Metro Vancouver, as it changes from time to time.
2.	Average Summer Water Temperature (°C)			
3.	Turbidity (NTU)			
4.	Nutrients (Nitrate as N)			
5.	Fecal Coliforms (or E. Coli) (MPN/100mL)		High Levels	
6.	Total Metals in Water	Maximum values (Dry weather): Al: 0.405 Cd: 0.000041 Cu: 0.0056 Fe: 1.37 Pb: 0.00379 Zn: 0.0257		
Flow Regime				
7.	Summer Baseflow (L/s)	From existing well pump and future river intake	16 L/s (0.14 L/s/ha)	20 L/s
8.	Winter Baseflow (L/s)	Monitoring at Lincoln Avenue	No data	20 L/s
9.	2-Year Peak Flow (m^3/s)	Monitoring and/or modelling downstream of Railway triangle	2.34	Same or slight decrease
Add in MAMF parameters - $T_{Qmean,}$ High Pulse Duration (days), Low Pulse Duration, High & Low Pulse Count				
Benthic Invertebrate Biomonitoring				
10.	B-IBI Scores	As per MAMF	14.5	Stable or increasing
11.	Mean Taxa Richness			MAMF Fair or higher Category

1. Introduction

The City of Port Coquitlam (Port Coquitlam) together with the City of Coquitlam (Coquitlam) initiated this Maple Creek Integrated Watershed Management Plan (IWMP) in the fall of 2010. Most of the work was completed in 2011 and 2012. The project was on hold for eight years and was finalized in 2020/2021. Therefore, the field inventory is out of date and climate change considerations were not included in the hydrotechnical analysis and should be updated before design and construction of recommended works.

Maple Creek drains via the Maple Creek pump station and flood box to the Coquitlam River. When the Coquitlam River is high, Maple Creek is unable to drain by gravity and must rely only on pumped flow, resulting in flooding of the low areas near the mouth. Maple Creek also has a high flow diversion channel to the Coquitlam River in the upper section within Coquitlam which diverts a significant portion of the Coquitlam flows away from Port Coquitlam during storm events. There is also a groundwater well pump located in the upper section which supplies the upper sections of the creek with base flows.

Maple Creek is fish-bearing, however there are fish passage barriers limiting the fish use in portions of the watercourse.

The Integrated Stormwater Management Plan process strives to preserve watershed health as a whole, while meeting community needs and allowing development and redevelopment to occur. It allows for trade-offs so that environmental losses in one area within a watershed can be offset by gains in others, thereby meeting the regulatory guiding principle of no-net-loss.

The key to successful integrated stormwater management planning is having a framework that provides direction for the technical analyses and study process. This section outlines the study framework, watershed goals and objectives, key issues, regulatory requirements, and the applicable stormwater criteria.

1.1 Goals and Objectives

The goal of the Maple Creek study is to develop a comprehensive and integrated watershed management plan (IWMP) to improve the overall watershed system by minimizing the risk of flooding, preserving aquatic and riparian habitats, effective and affordable watercourse improvements.

The Cites of Port Coquitlam and Coquitlam have developed the following objectives for this study:

- Protect aquatic ecosystems and water resources (surface and groundwater) for their fish, wildlife, and ecological values;
- Minimize the risk to life and property associated with flooding and preserve or re-establish natural floodplain hydrologic functions;
- Provide or recommend pollution prevention and water quality control approaches;
- Involve the local stakeholders, agencies and public in a consultation process that will provide information on the current system and fully explore a range of options for improving the management of the watershed;
- Develop a cost effective strategy for municipal improvements, projects for streamkeeper groups, and improve community awareness of watershed issues;
- Develop land use integration strategies and plans.

The plan is to be cost-effective, scientifically defendable, supported by the public, and endorsed by the environmental agencies.

1.2 Scope of Assignment

The following table summarizes the major tasks in this study.

Table 1-1: Engineering Work Program

Phase	Major Tasks
Phase 1	1. Establish Framework
	2. Inventories and Environmental Assessment
	3. Geotechnical Inventory and Assessment
	4. Watershed Health Assessment
	5. Hydrologic/Hydraulic Modelling
	6. Phase 1 Reporting and Meetings
Phase 2	7. Develop Stormwater Management Solutions
	8. Pumping, Detention and Diversions
	9. Phase 2 Reporting and Meetings
Phase 3	10. Policy and Action Alternatives
	11. Phase 3 Reporting and Meetings
Phase 4	12. Develop Plan and Cost Estimates
	13. Draft and Final Report

The technical work in this study was completed in 2011/2012 and did not include climate change considerations. Recommended major system drainage improvements should be reassessed with climate change considerations prior to design.

1.3 Stakeholder Consultation Program

Steering/Advisory Committee Members

An Integrated Stormwater Management Plan Steering/Advisory Committee was created to include interested stakeholders, including:

City of Port Coquitlam

Allen Jensen, Manager of Environmental Services
Jing Niu, Engineering Technologist
Jennifer Little, Manager of Planning
Steve Brown, Assistant Operations Manager
Ron Myers, Manager of Parks Planning and Design

City of Coquitlam

Melony Burton, Project Manager
Margaret Birch, Environmental Services Coordinator

Fisheries and Oceans Canada

Bruce Clark, Habitat Biologist
Murray Manson, Habitat Biologist
Maurice Coulter - Boisvert, Community Advisor
Salmon Enhancement Program

Kwikwetlem First Nation Representatives

Fred Hulbert Sr., Councillor
Craig Orr
Ed Hall

Maple Creek Streamkeepers

Sandy Budd
Dianne Ramage

BC Ministry of Environment

Scott Barrett, Section Head Ecosystems

Metro Vancouver

Alison Evely, Natural Resource Management Specialist

Meetings

The stakeholder consultation program included four sets of meetings at key times at the end of each phase of the work program:

- Phase 1 – to inform stakeholders of the study and solicit input to ensure that all the key issues are identified, understood and addressed in the study (May 2011);
- Phase 2 – to present technical findings and potential solutions, solicit input regarding solution preferences, and identify additional alternatives. Comments and concerns were documented and addressed to the extent possible given the limitations of the IWMP study process (December 2011 and January 2012);
- Phase 3 – to evaluate alternatives and select preferred solutions (April 2012); and
- Phase 4 – to present the proposed draft plan and solicit final feedback (July 2012).

A Public Information Meeting was also held in April 2012; feedback was received and integrated. Appendix D summarizes key input.

1.4 Integrated Stormwater Management Plan Key Issues

Key issues for the watershed were identified as:

Existing Flooding

- Historical flooding at Coquitlam Glass on Bedford Street in the lower reaches of Maple Creek, requiring temporary pumping. Bedford Street and several properties are affected by flooding.

(a) Concrete Flume & buildings downstream of Kingsway

(b) Channel upstream of Bedford

Photo 1-1: Channel Constraints and Encroachment

Environmental

- Baseflow augmentation well – investigate long-term sustainable solutions.
- Desire for fish friendly flushing flows throughout system including at Ozada Diversion.
- Fish access through Maple Creek tide gate is poor.
- Poor water quality in Maple Creek and Coquitlam River.
- Riparian encroachment and lack of riparian forest cover.
- Barriers and obstructions to fish passage.
- Lack of large woody debris in spawning and rearing areas.

Effectiveness of Existing Infrastructure

- Ozada High Flow Diversion to Coquitlam River – operation and its impact on fish habitat and migration.
- Existing residential encroachment to creek – many foot bridges, fences, overgrown channels.
- Capacity assessment of hydraulic structures.
- Effectiveness of on-site infiltration measures to control minor and major rainfall events.
- Changes in stream discharge rates at the Coquitlam River confluence based on new flows resulting from the *Coquitlam River Water Use Plan* and the impacts this will have on lower Maple Creek's ability to convey high flows.

Mitigate the Impacts of Future Redevelopment

- Improve watershed health over long term redevelopment.

1.5 Stormwater and Drainage Criteria

Existing relevant municipal bylaws are summarized below and stormwater and drainage criteria is summarized in Table 1-2.

City of Port Coquitlam

Subdivision Servicing Bylaw No. 2241, 1987
Soil Removal and Deposit Bylaw No. 3331, 2002
Water Ways Protection Bylaw No. 917, 1969
Zoning Bylaw No. 3630, 2008
Official Community Plan Bylaw No. 3467, 2005
Port Coquitlam Streamside Development Permits

City of Coquitlam

Soil Removal and Deposition Bylaw No. 2454, 1994
Stream and Drainage System Protection Bylaw No. 4403, 2013
Stormwater Management Policy and Design Manual, 2003
Subdivision and Development Servicing Bylaw No. 3558, 2003
City of Coquitlam Rainwater Management – Source Controls Design Requirements & Guidelines, 2009
City of Coquitlam Zoning Bylaw No.3000, 1996 (includes Sections 519 (Flood Protection and Slope Control Measures) and 523 (Riparian Areas Regulation))

Summary of Stormwater Criteria

Table 1-2: Summary of Stormwater Criteria

Application		Criteria/Methodology
Flood and Erosion Protection	Minor drainage system	• 10-year return period for the rational formula.[1] • 5-year return period for modified rational method, SCS graphical method or computer modelling.[1] • 10-year return period design event.[2] • 25-year return period design event in high-value commercial / industrial/downtown business areas.[2]
	Major drainage system (Rural, Urban, Commercial-Industrial)	• 100-year return period design event.[1] • 200-year return period in floodplain HGL.[2] • 100-year return period design event for culverts with less than 3 meter span on BC Ministry of Transportation roads.[6]
Environmental Protection	Volume Reduction Source Controls	• On-site rainfall capture (runoff volume reduction) for 6-month 24-hour storm (72% of the 2-year 24-hour storm).[4] • Full source controls on multi-family, commercial, and institutional, industrial land uses and roads. 300 mm of absorbent topsoil on all pervious areas and grading hard surfaces to pervious areas on single family land uses.[3]
	Water Quality Treatment	• 6-month 24-hour storm (72% of the 2-year 24-hour storm).[4]
	Detention / Diversion Rate Control	• Control post-development flows to pre-development levels for 6-month, 2-year, and 5-year 24-hour event.[4] Include factor of safety.[2] • Limit the post-development flows to the pre-development levels for the 5-year return period.[1] • Limit flows to more stringent of the following criteria: Control the 5-year post-development flow to: 50% of the 2-year post development rate; or the 5-year pre-development rate.[2]
	Riparian[3]	• Establish riparian setbacks to comply with Riparian Areas Protection Regulation (RAPR) in Coquitlam and and Streamside Protection and Enhancement Area (SPEA) in Port Coquitlam.

[1] City of Port Coquitlam Schedule C to Subdivision Bylaw 2241- Design Criteria.
[2] City of Coquitlam Stormwater Management Policy and Design Manual, July 2003. It specifies that event-based detention sizing should include a factor of safety (1.1 for post-development imperviousness of 20%, increasing linearly up to 1.5 for post-development imperviousness of 100%).
[3] City of Coquitlam Rainwater Management – Source Controls Design Requirements and Guidelines, 2009.
[4] DFO Urban Stormwater Guidelines and BMPs for the Protection of Fish and Fish Habitat, 2001.
[5] GVRD Template for Integrated Stormwater Management Planning 2005, Dec. 2005.
[6] BC Ministry of Transportation supplement to TAC Geometric Design Guide, 2007.

Development Bylaws should be updated to include climate change and sea level rise considerations for the major drainage system assessments (100 and 200 year storms).

The technical work in this study was completed in 2011/2012 and did not include climate change considerations. Recommended major system drainage improvements should be reassessed with climate change considerations prior to design.

1.6 Study Team

The study team consists of inter-disciplinary professionals, as follows:

Table 1-3: Study Team

Municipality/Company	Team Members
City of Port Coquitlam	In 2020/2021 • Theo Mahdi, Civil Engineering Technologist • Melony Burton, Manager of Infrastructure Planning In 2011/2012: • Allen Jensen, Manager Engineering Services • Jing Niu, Environment
City of Coquitlam	In 2020/2021: Dana Soong, Infrastructure Manager In 2011/2012: Melony Burton, Infrastructure Management
Kerr Wood Leidal Associates Ltd.	• Crystal Campbell, P.Eng., Project Manager • Craig Kipkie, P.Eng., Acting Project Manager • Chris Johnston, P.Eng., Technical Reviewer • Jennifer Young, P.Eng., Project Engineer • Jack Lau, AScT, GIS/Mapping
Raincoast Applied Ecology	• Patrick Lilley, R.P.Bio., Biologist
HB Lanarc Consultants Ltd.	• Don Crockett, Planner/Landscape Architect
Piteau Associate Engineering Ltd.	• Kathy Tixier, Hydrogeology

2. Maple Creek Watershed

2.1 Background Material

Table 2-1 summarizes the background information reviewed as part of this study.

Table 2-1: Summary of Background Material

Date	Title
Sept 2010	Email Communication - 2010 Pump Failure Re: Engineering Phone Call, Dana Soong and Bill Susak
May 2010	City of Port Coquitlam Hydrodynamic Modelling for Emergency Response Planning and Floodplain Mapping, Water Management Consultants
July 2009	Email Communication - Precision Service Comments Re: Maple Creek Well Capacity, James Storey and Melony Burton
July 2009	Email Communication - Drawings for Wet Well Re: Maple Creek Groundwater Well, James Storey & Mike Lamont (Precision Service & Pump)
June 2009	Email Communication - DFO Flow Test Re: Maple Creek Well Capacity, Mike Landiak (DFO) and Dianne Ramage
May 2009	Email Communication - Dianne Ramage Re: Well Refurbishing, Diane Ramage (Streamkeepers) and Melony Burton (Coquitlam)
Oct 2008	Scott Creek Integrated Watershed Management Plan (Draft), CH2M Hill
Sept 2008	Coquitlam River Flood Management Plan - Design Flood Assessment, CDN Water Management Consultants Inc.
Jan 2006	Drainage System Study - Scott Creek Basin, Kerr Wood Leidal Associates Ltd.
April 2005	Coquitlam-Buntzen Project Water Use Plan, BC Hydro
July 2002	Northside Storm Sewer Relief Project, Dayton and Knight Ltd.
May 1997	Maple Creek Fish Habitat Enhancement Plan, Alan R. Thomson
April 1995	Bio-inventory of Maple Creek, ECL Envirowest Consultants Ltd.
May 1992	Maple Creek Drainage Study, Associated Engineering Ltd.
Sept 1990	Dyke Construction Plans, Maple Creek to Dewdney Trunk Road, Associated Engineering Ltd.
Sept 1974	Drainage Study of Maple Creek Tributary Area, Burnett Resources Surveys Ltd.

2.2 Drainage

The Maple Creek watershed is located in both the City of Port Coquitlam and the City of Coquitlam, with approximately 58% of the watershed within Port Coquitlam. The study area is approximately bounded by Gabriola Drive to the north, the Coquitlam River to the south and east, and Pipeline Road and Westwood Avenue to the west. The Scott Creek and the Coquitlam River watersheds are immediately west and east of the watershed, respectively.

- Watershed is approximately 192 ha with both the Port Coquitlam area (111 ha) and Coquitlam area (81 ha) largely developed;
- Drainage direction is generally toward the south, via storm sewers, culverts, creeks, and ditches;
- Watershed drainage discharges into the Coquitlam River via the Maple Creek Pump Station and flood box;
- Upper watershed baseflow augmentation ground water well that contributes 0.016 m^3/s to Maple Creek; and
- Upper watershed flow control includes high flow diversion to the Coquitlam River.

Refer to Figures 2-1 and 2-2 for the study area extents and drainage system overview.

Field Inventory

The inventory survey was completed between February 1 and 25, 2011 for the Maple Creek catchment. The creek bed was traversed on foot and locations of interest were identified and recorded with a Trimble R8 global positioning system (GPS) receiver. Measurements, photographs and additional observations were recorded as attributes associated with these positions to create a comprehensive geographical information system (GIS) database. Figure 2-3 shows the field inventory and locations of interest.

Field inventory work included locating creek crossings, erosion, deposition, obstructions, measuring channel cross-sections and a condition assessment of hydraulic structures. Of these features, obstructions were most significant in terms of potential impact to the hydraulic behaviour of the creek.

Obstruction sites were classified based on observed properties such as type, stability and cause. Typical obstructions included debris jams and weirs. Fences and foot bridges were also found to be obstructions in some cases. Tables 2-2 and 2-3 summarize the obstruction, bridge and erosion locations. In general, the following observations were made:

- Multiple obstructions sites noted;
- Fences crossing through creek collect debris and are a potential risk for flooding;
- Footbridges can obstruct flows at high water levels;
- Obstructions south of CPR triangle, including debris jams and a pipe crossing, increases the potential of flooding; and
- Minor erosion sites noted.

See Appendix A for photo overviews of the field inventory.

Table 2-2: Summary of Observed Obstructions

ID[1]	Cause	Stability	Type	Downstream Drop (m)	Photo No.[2]	Comment
O-1	Natural	Unstable	Debris Jam	0	63	Small Logs & Branches
O-2	Anthropogenic	Stable	Log Notched Wier	0.05	84	-
O-3	Anthropogenic	Stable	Pipe Crossing	0	215	Pipe Xing. Old Bridge
O-4	Anthropogenic	Stable	Stacked Rock Wier	0.2	254	Barrier At Low Flow?
O-5	Anthropogenic	Fixed	Chainlink Fence	0	275-277	-
O-6	Natural	Stable	Small Wd Debris	0	811	-
O-7	Natural	Stable	Large Wd Debris	0	814	-
O-8	Natural	Unstable	Cleared Dam	0	826	Old Beaver Dam
O-9	Natural	Stable	Log	0	831	2 Logs
O-10	Anthropogenic	Stable	Old Rail Bridge	0	832	Concrete Structure
O-11	Natural	Stable	Log Jam	0	840,844	-
O-12	Anthropogenic	Fixed	Conc Ledge	0.1	300	Ditch Outlet From West
O-13	Natural	Unstable	Log Jam	0	337	Small Logs
O-14	Anthropogenic	Fixed	Conc. Wier	0.05	372	-
O-15	Anthropogenic	Fixed	Wood Wier	0.2	392	Approx. 5M Wide
O-16	Anthropogenic	Fixed	Conc. Notched Wier	0.3	392	1.2 M Wide
O-17	Natural	Unstable	Log Jam	0.1	472	-
O-18	Natural	Unstable	Tree Limb	0	486	-
O-19	Natural	Unstable	Log And Boulder	0	-	-
O-20	Natural	Unstable	Log Jam	0	505	-
O-21	Anthropogenic	Fixed	Wood Wier	0.05	1735	-
O-22	Natural	Unstable	Log And Branch	0	891	-
O-23	Anthropogenic	Stable	Wire Fence	0	890	Fence At Pl
O-24	Anthropogenic	Stable	Wire Fence	0	881	Fence At Pl
O-25	Natural	Stable	Large Wd Debris	0.3	906	-
O-26	Natural	Stable	Log Jam	0	930-931	-
O-27	Anthropogenic	Stable	Old Log Bridge	0	947,948	Small Branches
O-28	Anthropogenic	Stable	Log Bridge	0.15	954	Temporary
O-29	Anthropogenic	Stable	Rock & Sand Bags	0.3	3,4	Diversion To Pool
O-30	Natural	Stable	Debris Jam	0.3	15	-

1. Refer to Figure 2-3
2. Refer to photos included on CD in Appendix A

Table 2-3: Summary of Bridge Locations

ID[1]	Length (m)	Span (m)	Height (m)	Thickness (m)	Material	Photo No.[2]	Comment
B-1	7	1	1.75	0.3	Wood	320	Footbridge to otherside of yard
B-2	3	1	0.75	0.1	Wood	359	Footbridge
B-3	3	1	0.75	0.1	Wood	361	Footbridge
B-4	3	1	0.75	0.1	Wood	363	Footbridge
B-5	3	1	0.75	0.1	Wood	363	Footbridge
B-6	7	1	1.5	0.1	Steel	388	Footbridge
B-7	5	1.5	0.75	0.1	Steel	440	Footbridge in park
B-8	10	7	1.2	0.6	Conc.	475	parking lot crossing
B-9	10	7	1.2	0.15	Conc.	481,484	road crossing
B-10	10	1	1.5	0.1	Wood	489,491	Footbridge
B-11	3	0.5	0.25	0.05	Wood	1711	Footbridge
B-12	3	1	0.15	0.1	Wood	1715	Footbridge
B-13	8	1.5	1.6	0.4	Conc.	1718	Pedestrian lane crossing
B-17	2.5	1	0.4	0.05	Wood	875	Footbridge
B-16	2.5	1	0.4	0.05	Wood		Footbridge
B-15	2.5	1	1	0.05	Wood		Footbridge
B-14	3	1.5	1	0.1	Wood		Footbridge
B-18	7	1.5	1.3	0.3	Steel	921,923 921,923	Footbridge to school
B-19	7	1.5	1.2	0.3	Wood	17	Footbridge to park

1. Refer to Figure 2-3
2. Refer to photos included on CD in Appendix A

Table 2-4: Summary of Erosion Sites

ID[1]	Location	Severity	Consequence	Length (m)	Depth (m)	Photo No.[2]	Comments
E-1	Left Bank	Low	Low	5	2.0	58-59	-
E-2	Left Bank	Low	Low	2	0.75	166	-
E-3	Right Bank	Low	Moderate	10	0.5-1	224-225	-
E-4	Right Bank	Low	Low	20	0.2-.5	419	-

1. Refer to Figure 2-3
2. Refer to photos included on CD in Appendix A

2.3 Hydrogeology

Hydrogeologic Setting

An assessment of hydrogeological conditions was conducted by the study team. A map of the surficial geology of study area is included as Figure 2-4. In general:

- Surficial sediments and soils comprise well drained sands and gravels throughout the Watershed. In lowland areas below the Railway triangle, drainage is impeded by a high water table;
- The sediments comprise a highly productive aquifer, with groundwater flow to the southeast. Water table depths range from 6 m in upland areas to near surface in lowland areas;
- Groundwater contributions to Maple Creek flows are significant below Patricia Avenue, and are interpreted to increase downstream. Upstream sections are interpreted to be perched; and
- Foundation subdrains and increased impervious area associated with increased development have likely caused lowering of the regional water table over time.

Stormwater Infiltration

Field measured subsurface infiltration rates ranged from 87 to 125 mm/hr across the Watershed. For groundwater modeling purposes, infiltration rates on the order of 100-200 mm/hr are considered appropriate for upland areas with deep water table.

Maple Creek Production Well

An assessment of the long-term viability of the Maple Creek well, a production well used to augment baseflows in Maple Creek, determined that:

- The well has experienced a 75% loss in well efficiency since it was first commissioned in 1996. Its current sustainable yield is approximately 16.4 L/s (261 USgpm). The well was originally rated to produce 44.2 L/s (700 USgpm);
- The likely cause of loss of performance is accumulation of biomass and packing of fine sediment in and around the well screen;
- Historical wear on the pump may have been caused by over-sizing of the pump (too little annular space) and repeat start-stops due to low pumping water levels; and
- The quality of water produced by the well continues to be suitable for discharge to Maple Creek.

Groundwater Quality

Groundwater beneath the watershed is hosted by shallow, unconfined, and coarse-textured sediments, making it vulnerable to above-ground sources of contamination. A search of properties within the Watershed listed on the BC Site registry (Figure B-5 in Appendix B) indicated that:

- The most common land-use practices posing a pollution hazard to groundwater include the storage and dispensing of petroleum products, and the manufacture, repair and salvaging of machinery and vehicles;
- Associated contaminants of concern are mainly hydrocarbons and metals;

- Most of these practices are concentrated along major transportation corridors (e.g., Pipeline Road, Lougheed Highway); and
- Potential impacts to Maple Creek will depend on the chemical nature of identified contaminants, their proximity to the Creek, and the hydraulic connection of groundwater to surface water in receiving reaches.

2.4 Land Use

The type, location and density of land use in the watershed have a direct bearing on the quality and quantity of runoff. Each type of land use is associated with a percentage of pervious and impervious cover that affects rainwater capture, absorption and infiltration, depending on building coverage and surface materials. Also, various stormwater management best practices are specific to different types of land use.

Land use information including past, existing and potential future conditions was examined from a variety of sources, including municipal GIS data, ortho-photography, Google Earth, Bing Maps and personal observation. From GIS data provided by the municipalities, a series of maps and tables were generated that examine existing and future land use characteristics and associated land area and zoning. It was noted that the two municipalities have slightly different land use classifications. Similar zoning and development permit guidelines should be adopted to ensure a consistent approach to watershed health.

Historical Land Use

- Industrial and commercial land development began in the vicinity of the Railway triangle and Lougheed Highway in the early 1900s. Operation of a quarry at present-day Lafarge Lake also began at this time;
- Lands north of the Railway triangle to Patricia Avenue were cleared between the 1940s and 1970s for mainly residential and some commercial use;
- Land clearing north of Patricia Avenue began in the 1960s and was completed in the early 1980s; and
- Increased densification and loss of impervious area is noted from the 1980s onward.

Existing Land Use

- The watershed is currently comprised of a mix of land uses, which is illustrated in Figure 2-5, Zoning. Approximately two thirds of the watershed is residential use, while 15% is commercial and industrial uses. The remaining land is comprised of parks, civic institutional, and highway and road rights of way;
- Approximately one-half of the watershed is currently single family residential. Single-family residential housing stock in Coquitlam is generally in good condition and not expected to change in the next 30 to 50 years. However, the RS1 housing stock in Port Coquitlam is typically older and on larger lots than in Coquitlam. Consequently, Port Coquitlam is experiencing a pattern of larger single-family lots being subdivided into smaller parcels. Please refer to the following section “Implications of Changes from Zoning to Future Land Use” for a discussion on this pattern of change and future TIA estimates. High and Medium Density Residential areas are focused to the north of Lincoln Avenue along Pipeline Road and are within a short walk of Coquitlam City Centre. Another pocket of medium density residential flanks Lougheed Highway in Port Coquitlam;

- The Light and Medium Intensity Industrial use is concentrated at the southern portion of the watershed in the Kingsway/Westwood vicinity serviced by the railway corridors. Approximately one third of the existing Medium Intensity Industrial parcel is forested (2.2 Ha);
- Commercial uses in the area are typically high site coverage with large paving areas for parking or service;
- There is a very small proportion of park space within the watershed, comprising approximately 1% of the watershed study area; and
- There are three significant parcels of Institutional land north of Lougheed Highway:
  - the 3.25 Ha parcel that houses the Learning Disabilities Association of BC in Port Coquitlam;
  - the 7 Ha Maple Creek Middle School site, located opposite to the north of Lincoln ROW;
  - the 1.8 Ha Nestor Elementary School site at the northern extremity of the watershed; and
  - there are two small parcels housing places of worship on the south side of Kingsway in Port Coquitlam.

TIA percentages were estimated by spectral analysis of ortho-photographs to identify pervious/impervious areas for each parcel. See Figure 2-6.

Future Land Use

- Zoning (existing land use) was compared to the OCP (future) land use (Figure 2-5) to identify anticipated changes in land use, density, and perviousness. An increase in density signaled an increase in impervious area, which is estimated from surrounding parcels of same land use. From that comparative analysis, several graphics (Figures 2-8 and 2-9) and a comprehensive table (not included in this report) were produced that illustrate the anticipated change in land use and TIA values. Where changes in land use are anticipated, TIA's were applied to the new land use based on similar values for existing land use parcels; and
- Densification of parcels was considered while determining the future land use. There is a tendency for increased TIA's on single-family parcels over time. This tendency is a result of increased site coverage due to larger homes and associated paved surfaces, and the tendency for sites to incrementally increase in TIA's due to such things as house additions, the addition of ancillary buildings, increased paving for driveways and parking, and increased paved outdoor living spaces such as patios.

Implications of Current Zoning vs. Future Land Use

Zoning regulates the permitted use along with the general siting, massing and orientation of development. OCP land use indicates the communities' desired use, and general form and character of future development. As noted above, current zoning and land use information was assembled for the watershed from each municipality and consolidated to highlight anticipated changes and implications on TIA values. (See Figures 2-5 Zoning and 2-6 Land Use).

Several areas have been highlighted in Figure 2-9, "TIA Changes from Land Use or from Lot Consolidation" that identify either increases in density from the development of vacant lands, or increase in density resulting from a change in land use.

- Areas in light tan indicate that although the desired future land use is different from current zoning and use, there is no associated increase in density or TIA's anticipated with this change as the coverage is roughly the same between existing and desired future uses.

- Areas in gray indicate no change in land use, and so no change in TIA.
- Effective impervious area is lower in the mid to upper watershed due to infiltration of runoff into the well draining soils (Figure 2-4).
- The triangle of land bound by the railway tracks is identified as a land use change from zoned Medium Intensity Industrial to future High Intensity Industrial. Currently the land is forested. Although the change in land use would infer a higher TIA, it is unlikely that development would occur, as it is unlikely it would achieve approvals from Fisheries and Oceans Canada or Ministry of Environment due to impacts to fish and fish habitat. Therefore, the future TIA has been left in the current 0-20 percent category.
- It is difficult to require source controls on existing as well as future single-family uses and as such, there will be an increased runoff into the receiving body over time due to the gradual increase in imperviousness of these areas. Alternatively, restrictions can be placed on homeowners' site coverage, although it can be difficult to monitor and enforce due to the incremental nature of increases in impervious surfaces.
- With respect to more intense housing development in Port Coquitlam, we expect that there will be increased impervious areas resulting from the conversion of existing low density residential to small lot residential over the next thirty years. To provide estimates based on more empirical data, we developed a more detailed analysis of residential properties and provide the following summary of the method and results:
  - From existing data we identified single family lots for each municipality where the age of the dwelling is pre-1974. These represent the older housing stock that by 2035 will be more likely to be replaced;
  - From BC Assessment data that listed land and improvement values for each RS1 parcel, we prepared a ratio of Improvement Value/Land Value and identified parcels with a ratio of less than 0.2. This ratio identifies parcels having a relatively low value dwelling on a relatively high value lot, which represents a market opportunity for redevelopment;
  - Using a minimum lot frontage of 12 m, we identified contiguous frontage that through assembly might result in large-lot to small-lot housing developments. For example, two existing adjacent lots with a frontage of 36 m could be assembled and divided into three 12 m parcels. Under this scenario, TIA values increase, and from similar developments in the area, TIA's for these developments are expected to be approximately 51%;
  - Some lots were identified as redevelopment candidates, but due to frontage limitations and adjacent higher value developments, were not subject to consolidation and subdivision (for example a single lot with frontage less than 24m). These lots were considered to be candidates for redevelopment, but at perhaps a townhouse or condominium housing form with a Future TIA of 45; and
  - Future TIA estimated values were tabulated for each parcel in the watershed and provided to the consulting team for input to the modelling exercise.
- Civic Institutional land use remains essentially unchanged. Notable sites are the Maple Creek Middle School, Nestor Elementary School, and the Learning Disabilities Association of BC property.
- Areas of significant densification and changes to TIA are anticipated in the extreme southern portion of the watershed and in the existing high-density residential areas in the vicinity of Lincoln Avenue.

2.5 Environmental Inventory and Assessment

An environmental inventory of the Maple Creek IWMP study area was undertaken to summarize watershed conditions and trends, and information on water and sediment quality, benthic invertebrate communities, aquatic species and habitats, vegetation and land cover patterns, and terrestrial habitats and wildlife use. In addition, habitat restoration sites and enhancement strategies were also identified.

Water Quality

Water quality sampling was undertaken on September 15, 2011 during baseflow conditions. While one-time water quality sampling provides a limited snapshot of parameter concentrations, it is a useful way to screen for issues of potential concern that should be managed as part of the Integrated Stormwater Management Plan[1]. Sampling consisted of discrete (grab) sampling for the following parameters:

- Fecal and total coliforms;
- Nutrients (nitrate, ammonia nitrogen, and orthophosphate);
- Alkalinity and hardness;
- Total suspended solids (TSS); and
- Total and dissolved metals.

Sampling sites are illustrated in Figure 2-10.

- Fecal coliform levels were well above the BC AWQG for primary contact recreation of 200 MPN/100 ml (guideline is for five samples in 30 days) at two sites, downstream of Lougheed Highway and downstream of the CPR railway line along Davies Ave (sample taken upstream of large pond in the CPR Triangle). Levels measured at both sites were greater than 1600 MPN/100 ml, exceeding the upper detection limit for the lab method used. Therefore, it is not possible to know how high levels are at these sites without additional sampling. The levels measured suggest the potential for point sources such as a sanitary-storm sewer cross-connection. Further sampling is needed to determine the magnitude, extent, and source of the high values.

- Metals contamination is also highest downstream of Lougheed Highway and downstream of the CPR railway line along Davies Ave. High total metal levels were detected for a suite of metals typically associated with urban or industrial sources: zinc (vehicle tires, galvanized building materials, paint, industrial activities), copper (vehicle brake dust, plumbing, industrial activities), lead (old paint and gasoline, old car batteries, industrial activities), cadmium (electroplating, batteries), and aluminum (cars). Levels of these five metals exceeded the BC Approved Water Quality Guidelines and/or CCME (federal) Water Quality Guidelines at these two sites, with the exception of zinc (although levels were approaching the guideline). Very few other high values or exceedances were detected on the Maple Creek mainstem.

- Fox Creek also shows elevated fecal coliform levels, though not as high as the Maple Creek mainstem, as well as comparably high metal levels. Metals that were found to be high are typical of sources - zinc, copper, lead, cadmium, and aluminum - and generally exceeded provincial and federal guidelines.

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[1] Because of a limited budget for sampling, water and sediment sampling did not include the replication (e.g., five samples in 30 days) or broader spatial sampling needed to more rigorously characterize environmental contaminants and for proper comparisons to appropriate federal or provincial guidelines. However, it is still useful to undertake such comparisons as a screening-level analysis to flag issues of concern, and as part of a weight-of-evidence approach used in ISMPs.

- We compared metals to other urban watersheds in Metro Vancouver with similar levels of urbanization and found levels in Maple Creek are either average or above average compared to these sites (Wagg Creek in North Vancouver, Still Creek in Vancouver/Burnaby, Booming Grounds Creek at UBC, and Serpentine River in Surrey).
- Nutrient concentrations, alkalinity, and TSS were well below provincial guidelines at all sites and were similar to or lower than other urban streams in Metro Vancouver.

Full water quality sampling data can be found in Appendix C-1.

Sediment Quality

Sediment quality sampling was undertaken on October 3, 2010 (1 site) and February 23, 2011 (4 sites). Sediment samples were taken at five sites (same as grab water quality samples minus one lowland site which could not be sampled) and tested for total metals. Where possible, each sample was a composite of surface and shallow sub-surface fine sediment collected from 10–15 sites from within the active stream channel. Sampling sites are illustrated in Figure 2-10.

- Iron levels were above the BC Interim Sediment Quality Guidelines (ISQGs) below the dyke in the outlet channel to the Coquitlam River. Levels were two times higher than any other sites sampled. However, levels were below the Probable Effect Levels (PELs) [2] known to cause severe effects on aquatic life;
- Lead levels were also above the BC ISQGs (but below the PELs) for aquatic life downstream of Lougheed Highway (at Jervis Street);
- For other metals, higher levels were generally found lower in the watershed, although levels did not exceed the BC ISQGs or CCME Sediment Quality Guidelines for Freshwater Aquatic Life. Elevated levels of antimony, cadmium, chromium, copper, and zinc were found downstream of Lougheed Highway. Elevated levels of chromium and nickel were found downstream of the CPR rail line running parallel to Davies Avenue Elevated levels of antimony, arsenic, barium, manganese, and vanadium were found downstream of dyke. All of these metals are often associated with urban runoff from diffuse sources, although they can also originate from specific industrial processes and products that may be present in the watershed;
- It should be noted that levels of metals in sediments were assessed only from a single sample at each site. Further assessment is needed; and

Full sediment quality sampling data can be found in Appendix C-2.

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[2] Probably Effects Levels (PELs) are defined as “levels which, if exceeded, will cause severe effects on aquatic life” (Nagpal et al., 2006).

Benthic Invertebrates

Benthic invertebrate sampling was undertaken on October 3, 2010 within the mainstem of Maple Creek between the lower CPR railway culvert (upstream of Kingsway Avenue) and the confluence with the Coquitlam River. Sampling followed the field sampling protocol described in the GVRD Benthic Macroinvertebrate B-IBI Guide (EVS, 2003); samples were taken at four stations within an approximately 500 m long sampling reach (reach was somewhat longer to due to the availability of suitable habitat for sampling). Each station consisted of a single composite sample of three Serber sampler placements (3 min substrate disturbance each) within the same or adjacent riffles. Sample processing, subsampling, taxonomic identification, and B-IBI scoring (used as an index of watershed health) was completed by Rhithron Associates (Missoula, MT). Sampling sites are illustrated in Figure 2-10.

- The sampling results indicate that Maple Creek is in poor condition based on its benthic invertebrate communities. However, this result is not unexpected given the high levels of urbanization within the watershed, high total impervious area, and low riparian forest integrity (see Watershed and Riparian Forest Cover Assessment section);
- B-IBI scores across the four sampling sites ranged from 14 to 16 (Table 2-5)[3]. The overall mean B-IBI score for the watershed is 14.5 (SD 0.9).
- Across all four sites, mean taxa richness was 13.5 (SD 0.9, min 13, max 15). Variability in taxa richness accounts for the variability observed in B-IBI scores between sites.

Table 2-5: Benthic Invertebrate Sampling Results (October 2010)

Site	C-1		C-2		C-3		C-4		Mean	
Metric	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**
Taxa Richness	13	1	13	1	13	1	15	3	13.5	1
E Richness	0	1	1	1	0	1	0	1	0.25	1
P Richness	0	1	0	1	0	1	0	1	0	1
T Richness	0	1	0	1	1	1	1	1	0.5	1
Intolerant Taxa Richness	0	1	0	1	0	1	0	1	0	1
Clinger Richness	0	1	1	1	1	1	2	1	1	1
Long-lived Richness	1	1	2	1	2	1	2	1	1.75	1
% Tolerant	9.03	5	4.55	5	5.73	5	4.80	5	6.03	5
% Predator	1.62	1	1.59	1	2.75	1	1.44	1	1.85	1
% Dominance (3)	88.66	1	92.05	1	88.53	1	80.58	1	87.45	1
Sample Score		**14**		**14**		**14**		**16**		
Site Score										**14**
Mean BIBI	**14.5 (SD=0.9)**									

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[3] Under the 10-metric B-IBI scoring system, for each metric, each sample is given a score from 1 to 5. Therefore, the minimum possible B-IBI score is 10 and the maximum score is 50 (Page et al., 2008).

Maple Creek had a mean B-IBI site score of 14.5 indicating very poor watershed health typical of watersheds with high levels of urban development and/or agricultural activity.

Full taxonomic data and individual B-IBI scores are available in Appendix C-3.

Fish Communities

Fish species present in Maple Creek and its tributaries have not been comprehensively assessed in any one study. Existing data on fish communities was derived from several sources: historical observations by First Nations and local residents, data from fish salvages for instream works, and inventory activities conducted by the Maple Creek Streamkeepers. In addition, a small amount of fish sampling was undertaken in the lower reaches of Maple Creek as part of the IWMP.

- The known fish community in Maple Creek consists of six salmonid species, four native non-salmonid species, and at least one introduced fish species (Table 2-6);
- Coho Salmon and Cutthroat Trout are thought to be the two most abundant salmonid species in the watershed, although anecdotal evidence suggests their abundance was likely much higher historically and has declined over the last 40 years (Thomson, 1997). Both species use virtually the whole mainstem of Maple Creek for rearing. Most spawning likely occurs in the major gravel reaches from below Raleigh Street upstream to Lincoln Avenue Coho fry have also been observed in the lower reaches of Fox Creek (ditch along Davies Street; also known as Tributary 2) and Tributary 3 (downstream of Patricia Avenue). They are not known from the other tributaries. Cutthroat Trout fry are more abundant above Lougheed Highway (Maple Creek Streamkeepers, pers. comm.);
- Chum Salmon are known historically from Maple Creek but likely disappeared when lowland areas were initially dyked and have since been re-established as a result of enhancement activities. Populations are now maintained largely by annual fry releases into the watershed although adult returns do occasionally occur (Maple Creek Streamkeepers, pers. comm.). Chum spawning is likely limited to suitable areas below Lougheed Highway (BC MOE, 1978);
- Juvenile Chinook and Sockeye salmon have been documented in the watershed suggesting they move in from the Coquitlam River to rear at certain times of year. Local First Nations report sockeye as present historically in Maple Creek when it was a side channel of the Coquitlam River (Maple Creek Streamkeepers, pers. comm.). Recent observations of sockeye smolts (Maple Creek Streamkeepers, pers. comm.) are the result of releases into the Coquitlam River below the dam that began in 2008 (to re-establish a sockeye run to Coquitlam Lake). Other fish species may be periodically be present in Maple Creek as a result of exchange with the Coquitlam River;
- Steelhead (anadromous) were present in Maple Creek historically and are thought to be still present in the watershed, although their numbers are thought to be very low (DFO, 2001). Rainbow Trout (resident) have also been reported in the watershed (Maple Creek Streamkeepers, pers. comm.). Rainbow Trout and Steelhead appear virtually identical as juveniles;
- Brook Trout, a non-native fish species, was introduced to Maple Creek in the 1980s, likely a as a result of stocking in Lafarge Lake, although no connections between the lake and creek are currently known. Brook Trout have not been seen since 2005 after the installation of a Stormceptor near Ozada Avenue. Rainbow Trout may also be present in Maple Creek as result of the regular stocking of Lafarge Lake with this species (Freshwater Fisheries Society of BC, 2011); and
- Other native fish species present are typical of low gradient streams in the lower Fraser Valley.

Fish presence (salmonids only) in the watercourses is illustrated in Figure 2-11.

Table 2-6: Fish Species Present

Species			Source(s)	Notes
CO	Coho Salmon	*Oncorhynchus kisutch*	LFV Streams Strategic Review, 1999; Coast River, 2001; DFO, 2001; Envirowest, 2009; trapping for this study	Anadromous; overwinters as fry; annual fry releases into Ozada Pond.
CM	Chum Salmon	*Oncorhynchus keta*	D. Ramage (Maple Creek Streamkeepers) & M. Coulter-Boisvert (DFO Community Advisor), pers. comm.	Known historically; likely re-established through recent annual fry releases; few adults returning to spawn.
CH	Chinook Salmon	*Oncorhynchus tshawytscha*	D. Ramage (Maple Creek Streamkeepers), pers. comm.	Known historically; juveniles come in from Coquitlam River to rear at certain times of year.
SK	Sockeye Salmon	*Oncorhynchus nerka*	D. Ramage (Maple Creek Streamkeepers) & M. Coulter-Boisvert (DFO Community Advisor), pers. comm.	Known historically by First Nations; smolts detected in 2010; from recent releases to reestablish sockeye run on Coquitlam Lake.
CT	Cutthroat Trout	*Oncorhynchus clarkii*	Coast River, 2001; Envirowest, 2009; trapping for this study	Known historically; recent resident populations; anadromous may also be present
ST / RB	Steelhead / Rainbow Trout	*Oncorhynchus mykiss*	DFO, 2001; D. Ramage (Maple Creek Streamkeepers), pers. comm.	Steelhead known historically; anadromous; juvenile fish trapping at 25 sites caught three in 2001; Rainbow Trout difficult to distinguish from Steelhead; may be a result of stocking of Lafarge Lake.
CAS	Prickly Sculpin	*Cottus asper*	Coast River, 2001; Envirowest, 2009; trapping for this study	Found in lower reaches.
DC	Dace (General)	*Rhinichthys* sp.	D. Ramage (Maple Creek Streamkeepers), pers. comm.; N. Page, pers. obs.	Caught in benthic sampler d/s of Bedford Street on Oct. 23, 2010; likely Longnose Dace (*Rhinichthys cataractae*) but not definitively ID'ed.
EB	Brook Trout*	*Salvelinus fontinalis*	D. Ramage (Maple Creek Streamkeepers), pers. comm.	Introduced in 1980s as a result of stocking of Lafarge Lake; not seen since 2005 (installation of Ozada Stormceptor).
L	Lampreys (General)	*Lampetra sp.*	Envirowest, 2009; D. Ramage (Maple Creek Streamkeepers), pers. comm.	Found during fish salvage at Chine Dr. (2009); observed spawning in middle reaches above Lougheed Highway.
TSB	Threespine Stickleback	*Gasterosteus aculeatus*	Coast River, 2001; Envirowest, 2009; Coast River, pers. comm.	Found during several fish salvages for instream works; likely present throughout.
CRA	Signal Crayfish	*Pacifastacus leniusculus*	Coast River, 2001; Envirowest, 2009; Coast River, pers. comm.	Found in pump intake pond above dyke during fish salvage for instream works (2001); also near Jervis Street & Gail Ave. (2008); and Chine Dr. (2009).
*Denotes an introduced (non-native) species.				

Amphibians

Two amphibian species have also been found to inhabit aquatic areas within the study area (Table 2-7). Both are native species.

- Northwestern Salamanders are one of the more common amphibian species in our region. Mesic forests are the main terrestrial habitat. Breeding habitats include ponds, wetlands, lakes, road ditches, and slow moving creeks; and
- Red-legged Frogs are a species of Special Concern in Canada (Species at Risk Act, Schedule 1) and a blue-listed species in B.C. in acknowledgement of their sensitivity to habitat loss, habitat degradation, and other threats. They are associated with mature forest, and prefer areas with plentiful leaf litter and fallen logs. They breed in ponds, slow-moving streams, or marshes with emergent vegetation.

Table 2-7: Amphibian Species Present

Species		Source(s)	Notes
Northwestern Salamander	*Ambystoma gracile*	D. Ramage (Maple Creek Streamkeepers), pers. comm.	Found frequently in open wetlands, ditches, and sloughs
Red-legged Frog	*Rana aurora*	D. Ramage (Maple Creek Streamkeepers), pers. comm.	Found in streams, ponds, and marshes with emergent vegetation and adjacent forest

Instream Fish Habitat

Fish habitat characteristics (channel conditions, substrates, complexity, etc.) were assessed during field visits in February 2011. To understand the distribution of different habitat types, habitat conditions were assessed by reach and measured at representative reach points (data found in Appendix C-3). Mapped reaches based on the assessment are shown in Figure 2-12. The following points summarize available instream fish habitat within the Maple Creek watershed.

- Maple Creek passes through the Coquitlam River lowlands dyke approximately 150 m upstream of its confluence with the Coquitlam River. Below the dyke, the creek is confined to a straight outlet channel with steep banks. Substrates are a mix of cobbles and gravels (and some riprap) but are overlain by fine sediment and organic debris in many areas. Riparian vegetation along both banks is relatively intact. Large woody debris has been placed in the channel to improve instream cover for rearing salmonids.
- Upstream of the dyke, the lower reaches of Maple Creek (from dyke upstream to approximately Raleigh Street) contain a mix wider, slow-moving sections (e.g., dyke to Chine Drive, Gordon Street and Jervis Street) with finer substrates and instream infestations of Reed Canarygrass (*Phalaris arundinacea*) and narrow, confined sections (e.g., between Chine Drive to Kingsway Avenue, between Davies Street to Gordon Street) that have been channelized and/or modified as a result of development. Below Kingsway Avenue, the creek travels a 50 m long concrete flume.
- In general, the lower reaches have few areas of gravel/cobble habitat suitable for spawning, although small pockets of spawning gravels exist in several locations (e.g., at City-owned lane right-of-way halfway between Bedford and Kingsway, immediately upstream of Kingsway culvert). These are important spawning habitat for Chum Salmon, which are limited to the lower reaches of the watershed. Riparian vegetation is lacking and development occurs right up to the stream edge in many locations. Exceptions are the large park/habitat areas between dyke and Chine and in the CPR Triangle.

- Habitat for rearing salmonids, primarily Coho, has been improved in the lower reaches through the addition of several large ponds (two downstream of Chine Drive, one in the CPR Triangle, and one downstream of Lougheed Highway at Jervis Street). Large wood debris has been placed in the lowermost pond to improve instream cover for rearing salmonids.
- The middle reaches (from Raleigh upstream to Lincoln, above and below Lougheed) historically contained the best quality fish habitat and spawning habitat for Coho Salmon, Cutthroat Trout, and Steelhead/Rainbow Trout. These reaches are slightly higher gradient and contain large areas of gravel and cobble substrates suitable for spawning and rearing. Urbanization heavily encroaches on both streambanks with many retaining walls, landscaping, and lawns extending right to the creek. Streamside trees are sparse and associated understory vegetation is often entirely absent.
- The upper reaches (upstream of Lincoln Avenue and parallel to Ozada Avenue) have a mix of fine and gravel/cobble substrates and a wider riparian buffer through the grounds of Maple Creek Middle School and along Ozada Avenue Natural large wood debris and undercut banks are more common in these reaches than in areas further downstream. Anadromous salmonid species (Coho, Steelhead) may occasionally migrate up to and spawn in these areas but instream habitat is more likely to be important for resident species (Cutthroat Trout and Rainbow Trout).
- The current-day headwater reaches of the Maple Creek watershed have been culverted and developed. Historically, Maple Creek was a side channel of Coquitlam River.
- Currently, the best spawning habitat for salmonids can be found at the following locations:
    1. in small pockets between Bedford Street upstream to the CPR Triangle (Chum and possibly Coho);
    2. from 40 m downstream of Raleigh Street to downstream of Lougheed Highway (Coho, Chum);
    3. from south of Gail Avenue (at 3346 Jervis Street) upstream to Lincoln Avenue (Coho, Cutthroat Trout, and Steelhead/Rainbow Trout); and
    4. along Ozada Avenue to outfall (Cutthroat, Rainbow Trout, and occasionally Coho).

    However, due to several fish passage barriers, this habitat may not be available to all anadromous species in any given year (see section below).
- No suitable spawning locations are known in any of the tributaries of Maple Creek, although rearing Coho Salmon were observed in the ditch running west from Maple Creek along Davies Avenue (Fox Creek; also known at Maple Trib. 2).
- An additional tributary originating from an outfall on the south side of the Hastings Place cul-de-sac (herein called Maple Trib. 3) was mapped as part of the IWMP. This tributary was not mapped in watercourse data provided by the City of Port Coquitlam. According to local residents, the watercourse is groundwater-fed and flows year-round. Rearing salmonids have been observed up to the outfall; spawning use has not been observed.

A reach-by-reach description of fish habitat in the watershed (with representative photos) is found in Appendix C-4. Reach summary data, including data on channel widths, substrates, degree of channelization, frequency of large wood debris and fish presence, is found in Appendix C-5.

Fish Barriers

The following structures or crossings may present barriers to fish passage within the watershed:

- Coquitlam River dyke flood box flapgate (downstream end) (Photo 2-1a): The floodbox consists of rectangular culvert (1.7 m x 1.7 m) and with a heavy steel, side-mounted flapgate on the outlet end. The flapgate has been previously identified as an impediment to fish passage because of the low frequency with which the gate remains open to fish passage (M. Coulter-Boisvert, pers. comm.). Access was recently improved by adding a weight to the back of the flapgate to increase the time that the flapgate stays open and reduces the size of flows needed to re-open the gate. However, the flapgate may still impede fish passage at certain times during the migration period; and
- Coquitlam River dyke floodbox grill (upstream end) (Photo 2-1b): The grill on the upstream end of the floodbox is to capture garbage and debris. It has previously been identified as an impediment to fish passage (Thomson, 1997). The grill was modified slightly to improve fish passage (one bar removed). However, the grill can still become clogged and block fish passage if it is not regularly cleaned. Streamkeepers have suggested that the grill is not necessary and could be removed.

(a) Dyke Floodbox and Flapgate

(b) Dyke Culvert Grill (upstream end)

Photo 2-1: Known and Potential Barriers to Fish Passage

- Instream fence at 2617 Kingsway Avenue (Photo 2-2a): A submerged chain-link fence on private property crosses the creek and can provide a barrier when clogged with wood and debris. The Streamkeepers have attempted to improve fish access at this location by lifting the fence;
- Concrete weir downstream of Lougheed Highway (outlet of Jervis Street Pond) (Photo 2-2b): This two-step concrete weir is located at the outlet to the inline pond at Jervis Street Because of its height, the weir is a partial barrier to fish passage, especially for Chum Salmon. Also, sediment appears to be accumulating at the base of the weir steps and is filling in the jump pools. In the long-term, this could further restrict fish passage;

(a) Instream Fence at 2617 Kingsway Ave. (b) Concrete Weir Downstream of Lougheed Hwy

Photo 2-2: Known and Potential Barriers to Fish Passage

- Instream fences at 3691 McRae Crescent (Photo 2-3a): Similar to the fence mentioned above, two submerged stucco wire fences cross the creek on the north and south property lines at this location. They could provide a barrier to fish passage when clogged with wood and debris; and
- Diversion at south end of Ozada Avenue (Photo2-3b): The diversion wall previously had a side-mounted flapgate on the upstream side of the opening. This flapgate was a barrier to fish passage and has since been removed. However, the opening conveying flow to Maple Creek is only 30 cm in diameter and could easily be blocked (either intentionally or otherwise) which would block fish passage but could dry out Maple Creek downstream.

(a) Instream fences at 3691 McRae Crescent *(b) Diversion at South End of Ozada Ave.*

Photo 2-3: Known and Potential Barriers to Fish Passage

- Davies Avenue/Fox Street culvert on Fox Creek (Photo 2-4): The 120 m long culvert which conveys flows from Fox Park to the ditch along Davies is not passable to fish and the outlet is raised 20 to 30 cm above the water surface in the ditch. Maple Creek Streamkeepers have proposed daylighting this part of Fox Creek to improve fish access;

Davies Ave./Fox St. Culvert on Fox Creek

Photo 2-4: Known and Potential Barriers to Fish Passage

- Although three other culverts do not meet the current Ministry of Transportation design criteria for fish passage, all are open bottom culverts, and exceedances of the criteria are minor. Based on field inspections, these culverts are unlikely to be barriers to fish passage at this time; and
- Partial and complete barriers to fish passage may also periodically occur as a result of debris jams and fallen logs and root wads along the creek.

Previous Fish Habitat Enhancements and Compensation

Several fish habitat enhancement projects have been already undertaken in the watershed. Most of the projects have been led by Maple Creek Streamkeepers. Some improvements have also occurred as compensation for development impacts elsewhere in the watershed. Many of the enhancements have been following the recommendations of a 1997 Fish Habitat Enhancement Plan developed in 1997 for the watershed (Thomson, 1997) and have been supported BC Ministry of Environment and DFO. Example projects include:

- Bedford Habitat Ponds (Photo 2-5a): Two off-channel ponds were created between the dyke and Chine Drive (at the foot of Bedford Street) to provide rearing habitat, primarily for Coho Salmon. Both ponds contain large woody debris (logs, root wads) placed to provide additional cover for rearing fish;
- CPR Triangle Habitat Pond (Photo 2-5b): This inline pond was expanded in 1996 to provide rearing habitat, primarily for Coho Salmon;

(a) Lowermost Bedford Habitat Pond (b) CPR Triangle Habitat Pond

Photo 2-5: Examples of Previous Fish Habitat Enhancements

- Ozada Habitat Pond (Photo 2-6a): This off-channel pond was created to provide additional rearing habitat capacity in the upper reaches of the watershed. The pond is the site of annual juvenile Coho Salmon releases;
- Ozada Stormceptor: A stormwater interceptor was installed upstream of the outfall near the diversion at the south end of Ozada Avenue to remove suspended solids and hydrocarbons from developed areas west of Ozada Avenue;
- Spawning Gravel Placements: Spawning gravels have been placed instream at several locations in the watershed to improve spawning habitat; and
- Riparian Plantings: Native trees and shrubs have been planted in locations throughout the watershed to restore or enhance riparian vegetation. For example, a 15 m riparian buffer was recently reestablished along one side of Maple Creek west of Bedford Street as part of the adjacent townhouse development (Photo 2-6b). Other plantings have been conducted by Maple Creek Streamkeepers to improve existing riparian vegetation.

(a) Ozada Habitat Pond (b) Riparian Restoration West of Bedford St.

Photo 2-6: Examples of Previous Fish Habitat Enhancements

Watershed and Riparian Forest Cover Assessment

A desktop evaluation of watershed and riparian forest cover was undertaken to assess the amount and distribution of tree canopy cover within different parts of the Maple Creek watershed and identify areas for potential riparian forest restoration. Forest cover was digitized on 2009 orthophotos by the City of Coquitlam. A standard 30 m buffer on either side of the stream centrelines (60 m total width) across all permanent streams was used to assess riparian forest integrity (RFI) across the study watersheds.

- Approximately 16.1% (30.9 ha) of the Maple Creek watershed is forested. Across three subcatchments representing the upper, middle, and lower portions of the watershed, watershed forest cover ranged from 13.3% (upper watershed) to 27.9% (lower watershed);
- Watershed forest cover was 18.0% in the Port Coquitlam portion of the study area versus 13.5% in the Coquitlam portion;
- In contrast, riparian forest integrity is 45.4%. The low watershed forest cover and higher RFI values indicated that much of the intact forest cover in the watershed occurs along the watercourses. The remainder is scattered around the study area in smaller public parks, street medians, and private yards;
- Across the three subcatchments (upper, middle, and lower portions of the watershed), RFI ranged from 32.2% (middle watershed) to 68.6% (upper watershed); and
- RFI was 36.8% in the Port Coquitlam portion of the watershed and 66.1% in the Coquitlam portion.

Table 2-8: Watershed Health Indicators – Watershed and Riparian Forest Cover

Watershed/ Land Area	Total Watershed Area (ha)	Watershed Forest Cover (ha)	Watershed Forest Cover (%)	Total Riparian Area (ha)	Riparian Forest Cover (ha)	Riparian Forest Integrity (RFI) (%)
Upper Watershed[1]	72.5	9.7	13.3	6.5	4.5	68.6
Middle Watershed[2]	90.6	13.2	14.6	13.4	4.4	32.3
Lower Watershed[3]	29.0	8.1	27.9	6.8	3.3	49.3
Coquitlam Portion	81.1	10.0	13.5	7.9	5.2	66.1
Port Coquitlam Portion	111.1	20.0	18.0	18.9	6.9	36.8
Total Study Area	**192.2**	**30.9**	**16.1**	**26.7**	**12.1**	**45.4**

[1] Upper Watershed = north of Lincoln Ave. (Coquitlam-Port Coquitlam border).
[2] Middle Watershed = south of Lincoln Ave. and north of CPR railway parallel to David Ave.
[3] Lower Watershed = south of CPR railway parallel to David Ave.

Because of the urbanized condition of the Maple Creek watershed and the high degree of riparian encroachment, opportunities to improve riparian cover exist throughout. However, particular areas with a very low amount of riparian forest cover include the Maple Creek mainstem from Chine Drive upstream to and along Kingsway Avenue to the CPR Triangle, and from Davis Avenue upstream to Gail Avenue (above and below Lougheed Highway).

RFI values for individual reaches and tributaries can be found as part of the fish habitat assessment in Appendix C-3.

Terrestrial Species and Habitat

Terrestrial species and their habitats were assessed using existing information supplemented by minor amounts of fieldwork. Our focus was primarily on rare species which may be found in the watershed.

- The only confirmed Species at Risk from the Maple Creek watershed are Cutthroat Trout, *clarkii* subspecies (S3S4; blue-listed in BC), Red-legged Frog (S3S4; Special Concern under SARA; blue-listed in BC), Great Blue Heron, *fannini* subspecies (S2S3B, S4N; Special Concern under SARA; blue-listed in BC) and Green Heron (S3S4B, blue-listed in BC). Location information is shown in Table 2-8. Additional Species at Risk that may potentially inhabit the study area based on typical habitat associations and/or that have known occurrence records within close proximity to the study area. These are also included in the table; and
- In addition to watercourses and riparian areas, other ecologically-important features present in the Maple Creek watershed include the created fish habitat ponds (see above for list), mature forest patches (below Chine Dr, CPR Triangle, Fox Park, east of Ozada Ave), and scattered large trees (e.g., Black Cottonwood along Maple Creek downstream of Lougheed Highway). These features, in addition to serving important watershed functions (e.g., interception of rainfall), are also important for their inferred ecological value as breeding or foraging habitat for wildlife found within the watershed.

Invasive Plant Species

The following invasive non-native plant species were observed during field surveys of riparian areas along Maple Creek:

- Reed canarygrass (*Phalaris arundinacea*) – grows on moist stream banks and directly in slow-moving portions of Maple Creek with fine substrates; not tolerant of shading so tends to grow where riparian tree cover is lacking;
- English ivy (*Hedera helix*) and other related ivy species – garden escapee; observed frequently on ground and climbing native trees;
- Japanese knotweed (*Polygonum* spp.) – several large infestations in watershed: (1) between Bedford Street and Kingsway Avenue; and (2) immediately upstream of Shaftsbury Place;
- Small-flowered periwinkle (*Vinca minor*) – garden escapee; observed in several locations where yards are close to creek;
- English holly (*Ilex aquifolium*) – infrequently observed;
- Yellow (or false) lamium (*Lamium galeobdolon*) – garden escapee; also associated with yard waste dumping; present in riparian corridor upstream of Shaftsbury Place;
- European bittersweet (*Solanum dulcamara var. dulcamara*) – only observed at single site upstream of Davies Avenue; deciduous so difficult to detect based on timing of survey; likely present at more locations;
- Bamboo – several areas in middle reaches where growing adjacent to stream;
- Cherry-laurel (*Prunus laurocerasus*) – garden escapee; infrequently observed, but common in middle reaches; and
- Himalayan blackberry (*Rubus armeniacus*) – common throughout.

Our inventory was not comprehensive but suggests that the most problematic areas for invasive plants in the watershed are the lower reaches of the watershed between Bedford Street and Kingsway Avenue, and in the middle reaches from Davies Street to Lincoln Avenue Both areas have narrow, disturbed riparian areas or lack native riparian vegetation entirely.

2.6 Watershed Health Tracking System

The watershed health tracking system uses two watershed health indicators: (1) riparian forest; and (2) watershed imperviousness. Maintaining riparian forest and minimizing imperviousness are the two most effective methods of preserving watershed health.

Importance of Imperviousness (Indicator #1)

Research shows a strong relationship between the impervious area in the watershed and a stream's health (based on its fish and benthic insect community) as outlined in the following table:

Table 2-9: Stream Health Relative to Impervious Area

Health	Total Impervious Area (%TIA)
Stressed (minor changes to watershed health)	1 - 10 %
Impacted (moderate changes to watershed health)	11 - 25 %
Degraded (severe changes to watershed health)	26 - 100%

The Importance of Imperviousness, 1994, by T.R. Schueler.

Importance of Riparian Forest Integrity (Indicator #2)

Riparian areas are those adjacent to watercourses that may be subject to temporary, frequent, or seasonal inundation, and which support plant life typical of the wetter soil conditions. These riparian areas provide natural features, functions and conditions that support a productive fish community, such as:

- multi-canopied forest and ground cover that:
    - moderates water temperature,
    - provides a source of food, nutrients, and organic matter,
    - stabilizes the soil with root systems, thereby minimizing erosion,
    - filters sedimentation and pollution;
- sources of large woody debris;
- active floodplain areas;
- side channels, intermittent streams; and
- infiltration that can aid in sustaining baseflows.

Figure 2-12 shows the Riparian Forest Integrity (RFI) assessment areas on the permanent watercourses.

Maple Creek Existing and Future Watershed Health Indicators

Watershed health indicators were used to quantify predicted changes between existing and future conditions and to define targets to be achieved. They are:

- B-IBI (benthic index of biological integrity);
- TIA and EIA (Total and Effective Impervious Area) – meet the DFO Stormwater Guidelines to mitigate the hydrologic impacts of development; and
- RFI (Riparian Forest Integrity).

The watershed health was estimated using the Watershed Health Tracking System (WHTS) which uses the indicators of impervious percentage and riparian forest integrity to estimate the benthic index of biotic integrity (B-IBI) score. Figure 2-13 shows the WHTS graphs for a number of locations in the study area.

The existing and post-development values associated with the indicators are summarized in Table 2-10 for two locations in the watershed. The land use analysis shows that imperviousness is predicted to increase by approximately 3%. Riparian corridors are expected to decrease by approximately 10% due to the RAPR setbacks in Coquitlam and variances to the SPR setbacks in Port Coquitlam.

The goal of the Integrated Stormwater Management Plan is to achieve a no-net-loss of ecological health for the watershed as a whole and strive to maintain the indicators at 2011 levels. One way to define no-net-loss of ecological health is within the context of the Watershed Health Tracking System (WHTS) – mitigating the hydrologic impacts of impervious area using source controls and detention, and protecting riparian areas.

Both existing and unmitigated future land use scores are predicted based on the relationship between TIA, RFI, and B-IBI. These predicted scores are compared to the actual measures B-IBI values obtained from creek samples in 2011. The future predicted B-IBI score changes assume the impacts of the proposed development:

- without mitigation measures to reduce EIA; and
- with partial protection of RFI based on the City of Coquitlam RAPR setbacks and City of Port Coquitlam SPR setbacks with potential variances .

As shown, both locations are predicted to undergo equal watershed health degradation, due to riparian loss and increasing imperviousness, if not mitigated. The goal of the Integrated Stormwater Management Plan is to propose works that will prevent future B-IBI degradation, and therefore the mitigated B-IBI values should match or be higher than the existing B-IBI values. The following sections describe the proposed plan to achieve a no-net-loss of watershed health.

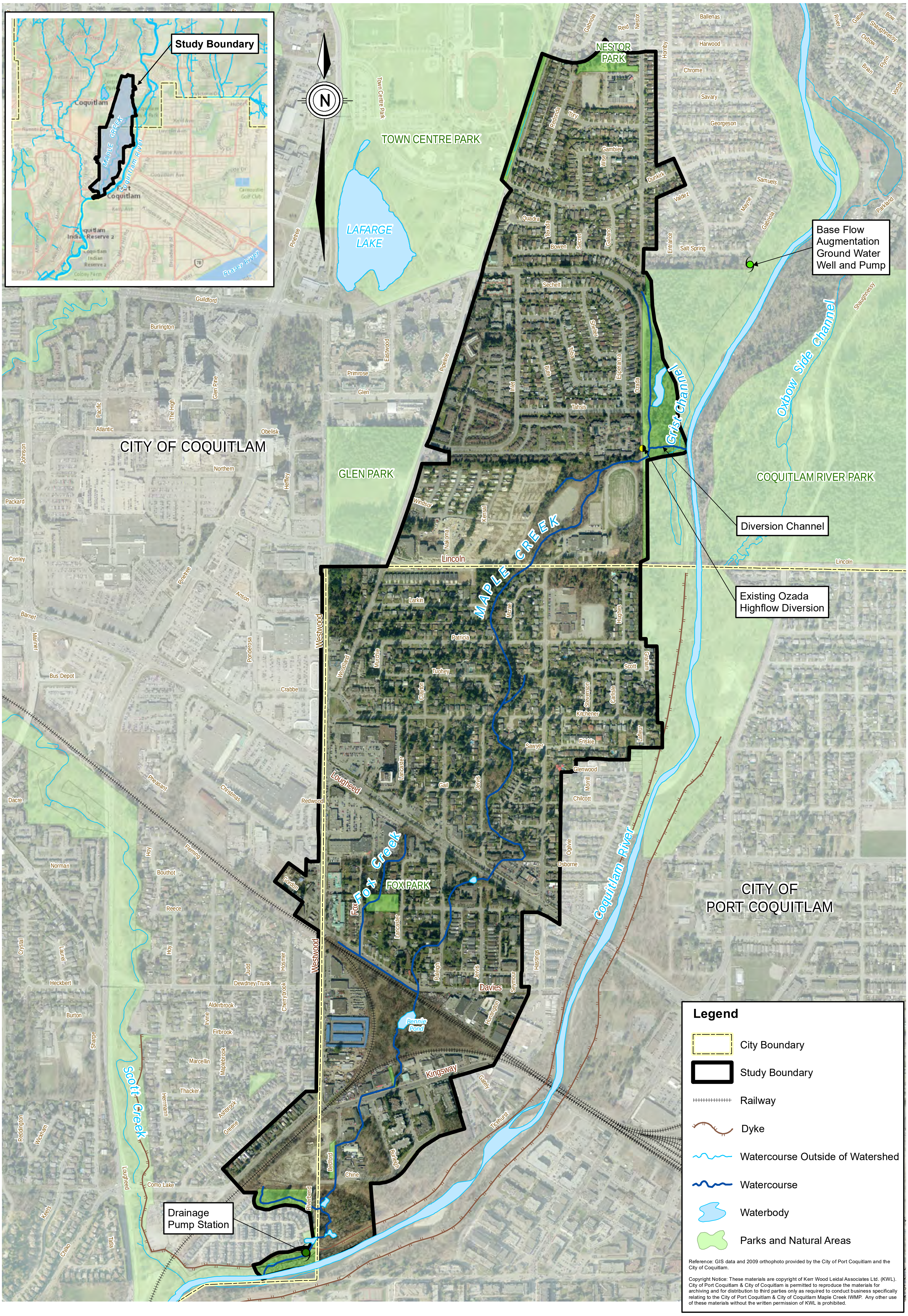
Table 2-10: Measured and Predicted Watershed Health Indicators (TIA, RFI, B-IBI Scores)

Site	2011 Measured B-IBI	Existing			Unmitigated Future		
		Imp. Area	Riparian Integrity	Predicted B-IBI	Imp. Area	Riparian Integrity	Predicted B-IBI Change
City Boundary	14.5	48%	66%	14.3	51%	56%	-1
Maple Pump Station	14.5	48%	45%	13.3	51%	35%	-1

Table 2-11: Confirmed and Potential Species at Risk

Common Name	Scientific Name	Conservation Status				Status and Habitat in Shaw Creek Watershed	Reference(s)
		Global Rank	Prov. Rank	COSEWIC	BC List		
Fish							
Cutthroat Trout, *clarkii* subspecies	*Oncorhynchus clarkii clarkii*	G4T4	S3S4	-	Blue	Confirmed present in Maple Creek	FISS database
Nooksack Dace	*Rhinichthys cataractae – Chehalis lineage*	G3	S1	E (2007)	Red	Possible; recently found in Brunette River	
Amphibians and Reptiles							
Red-Legged Frog	*Rana aurora*	G4	S3S4	SC (2004)	Blue	Confirmed present in Maple Creek watershed	D. Ramage (Maple Creek Streamkeepers), pers. comm.
Birds							
Great Blue Heron, *fannini* subspecies	*Ardea herodias fannini*	G5T4	S2S3B, S4N	SC (2008)	Blue	Forages along most waterways in study area; no occupied breeding sites currently known	P. Lilley, pers. obs.
Green Heron	*Butorides virescens*	G5	S3S4B	-	Blue	Photo from Bedford Ponds (below Chine Dr); not known if breeds in watershed but possible	Maple Creek Streamkeepers slide show on YouTube
American Bittern	*Botaurus lentiginosus*	G4	S3B	-	Blue	Possible; known from nearby Colony Farm Regional Park	
Olive-Sided Flycatcher	*Contopus cooperi*	G4	S3S4B	T (2007)	Blue	Unlikely; known from Colony Farm Regional Park but little suitable habitat in study area	
Barn Swallow	*Hirundo rustica*	G5	S3S4B		Blue	Unlikely; known from Colony Farm Regional park but little suitable habitat in study area	
Mammals							
Pacific Water Shrew	*Sorex bendirii*	G4	S1S2	E (2006)	Red	Possible; known from adjacent Hoy Creek watershed, NW of study area	

Common Name	Scientific Name	Conservation Status				Status and Habitat in Shaw Creek Watershed	Reference(s)
		Global Rank	Prov. Rank	COSEWIC	BC List		
Invertebrates							
Blue Dasher	*Pachydiplax longipennis*	G5	S3S4	-	Blue	Known from several wetland areas in south Surrey; becoming more common in lower mainland	
Vascular Plants							
Streambank Lupine	*Lupinus rivularis*	G2G4	S1	E (2002)	Red	Possible; known from persisting population along railway tracks by Coquitlam River at Lougheed Highway	Lomer, 2011
Vancouver Island Beggarticks	*Bidens amplissima*	G3	S3	SC (2001)	Blue	Possible; nearest known occurrence is Douglas Island on Fraser River; seeds dispersed by ducks	Lomer, 2011
Two-edged Water-starwort	*Callitriche heterophylla var. heterophylla*	G5T5	S2S3	-	Blue	Possible; known sites along the Coquitlam River in Coquitlam River Park	Lomer, 2011
Green-fruited Sedge	*Carex interrupta*	G4	S2	-	Red	Possible; known from muddy banks and boggy ditches in Lower Fraser Valley	Lomer, 2011
Pointed Broom Sedge	*Carex scoparia*	G5	S2S3	-	Blue	Possible; known from wet, disturbed sites in Lower Fraser Valley	Lomer, 2011
COSEWIC Ranks: E = Endangered; T = Threatened; SC = Special Conc							



Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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Maple Creek IWMP

Project No.	Date
646-017	June, 2012

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2009 Air Photo of Study Area

Figure 2-1

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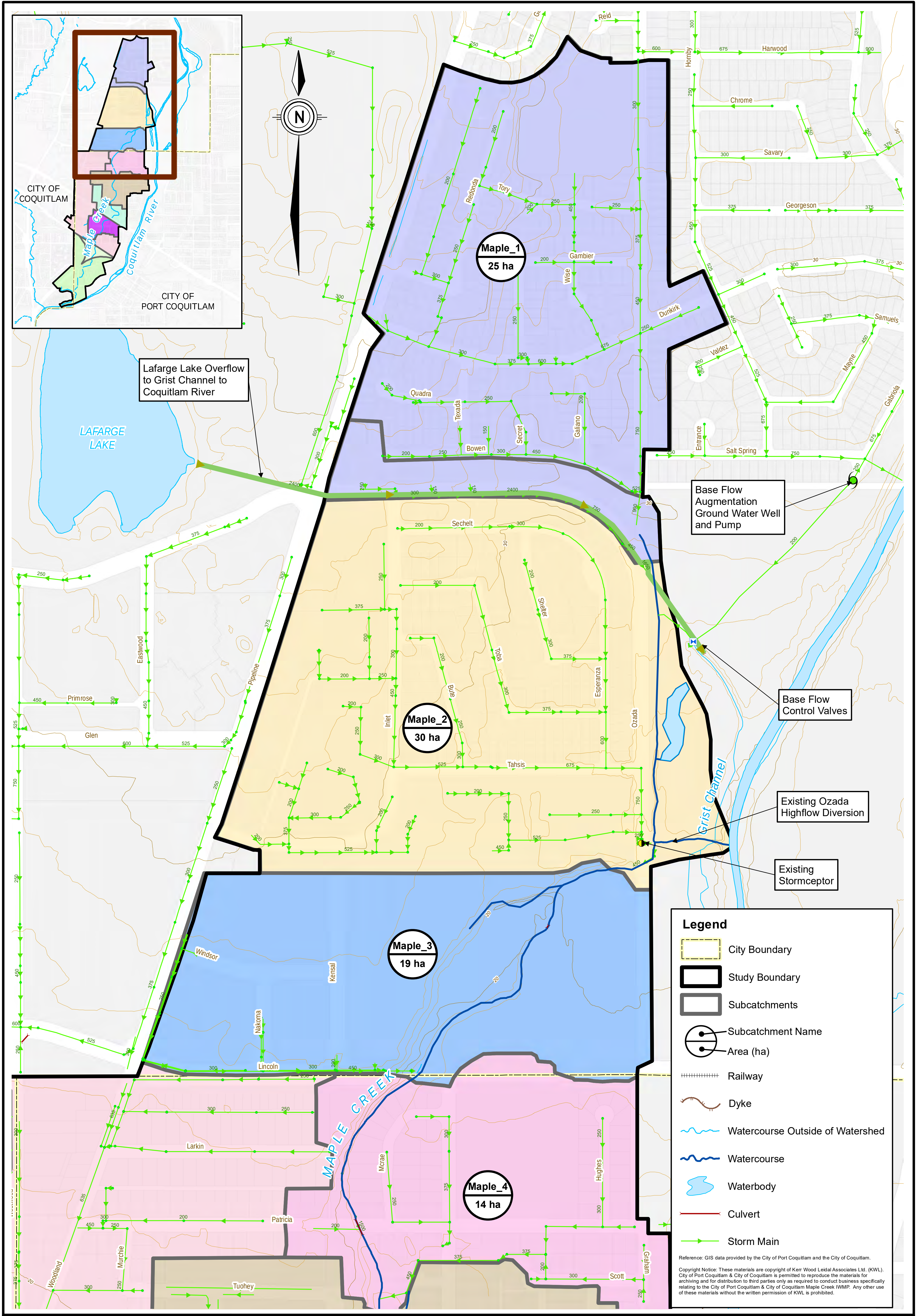

Reference: GIS data provided by the City of Port Coquitlam and the City of Coquitlam.

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Maple Creek IWMP

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646-017	June, 2012

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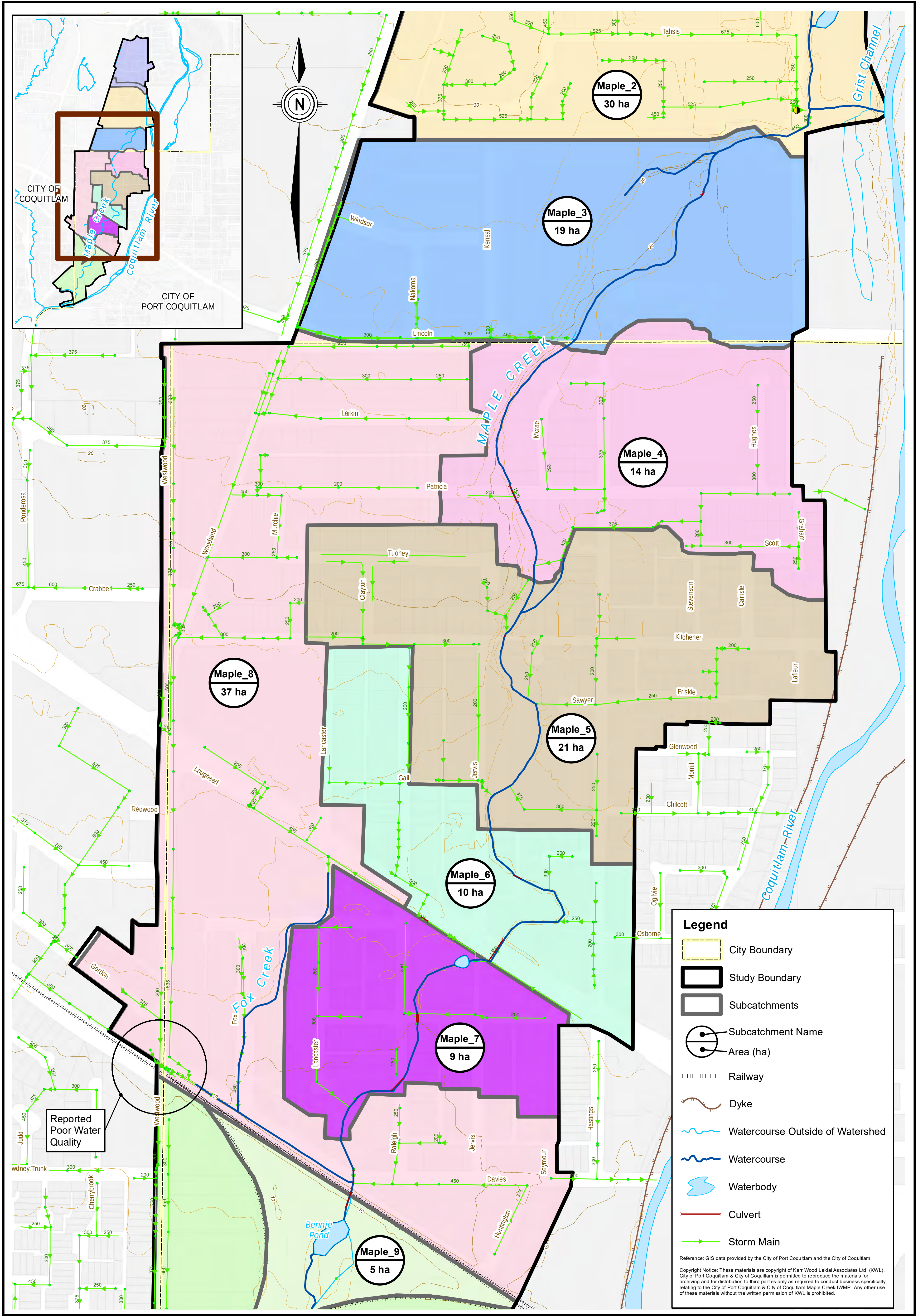
Drainage Overview

Figure 2-2A



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Project No.	Date
646-017	June, 2012

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Drainage Overview

Figure 2-2B

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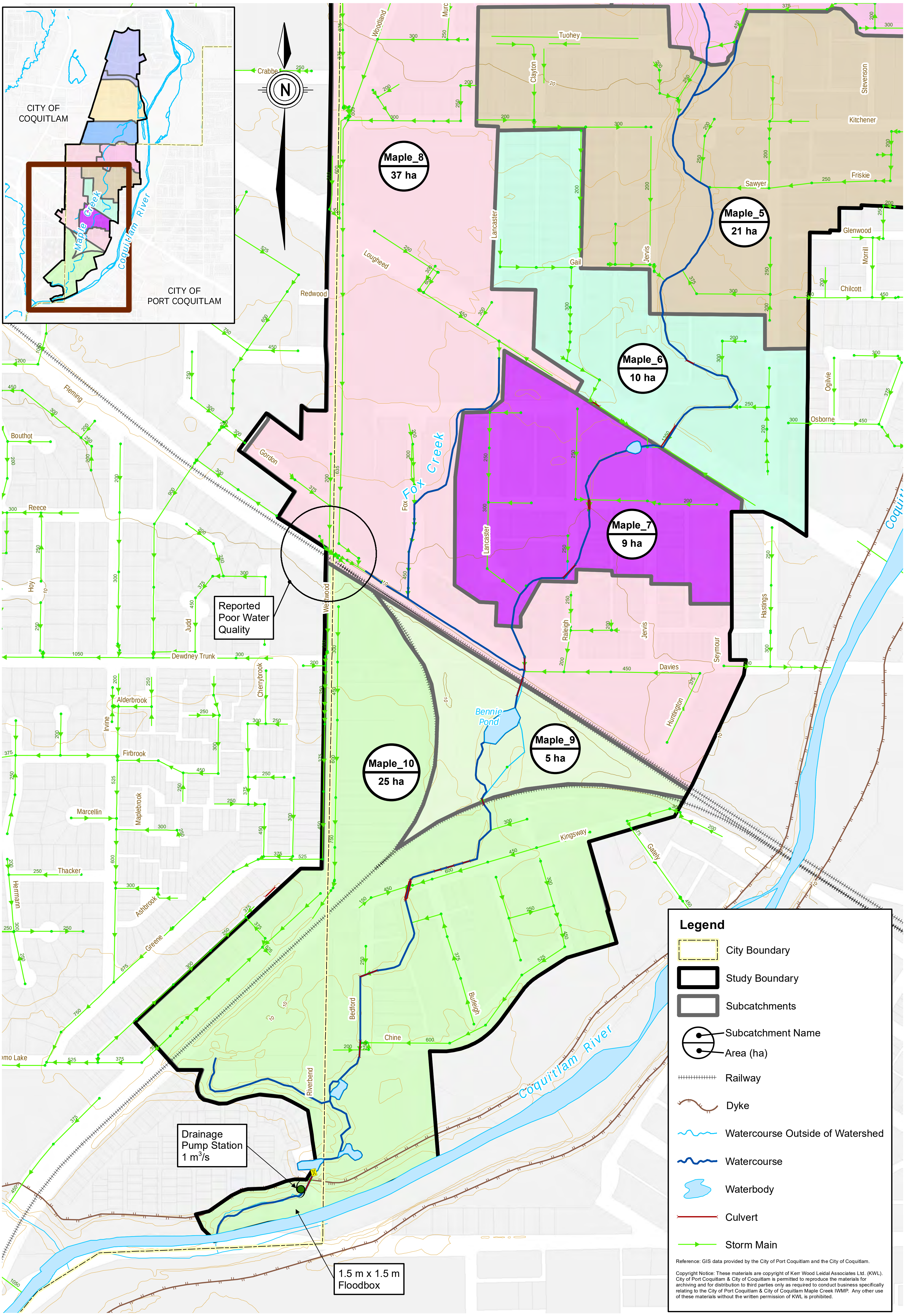

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Maple Creek IWMP

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646-017	June, 2012

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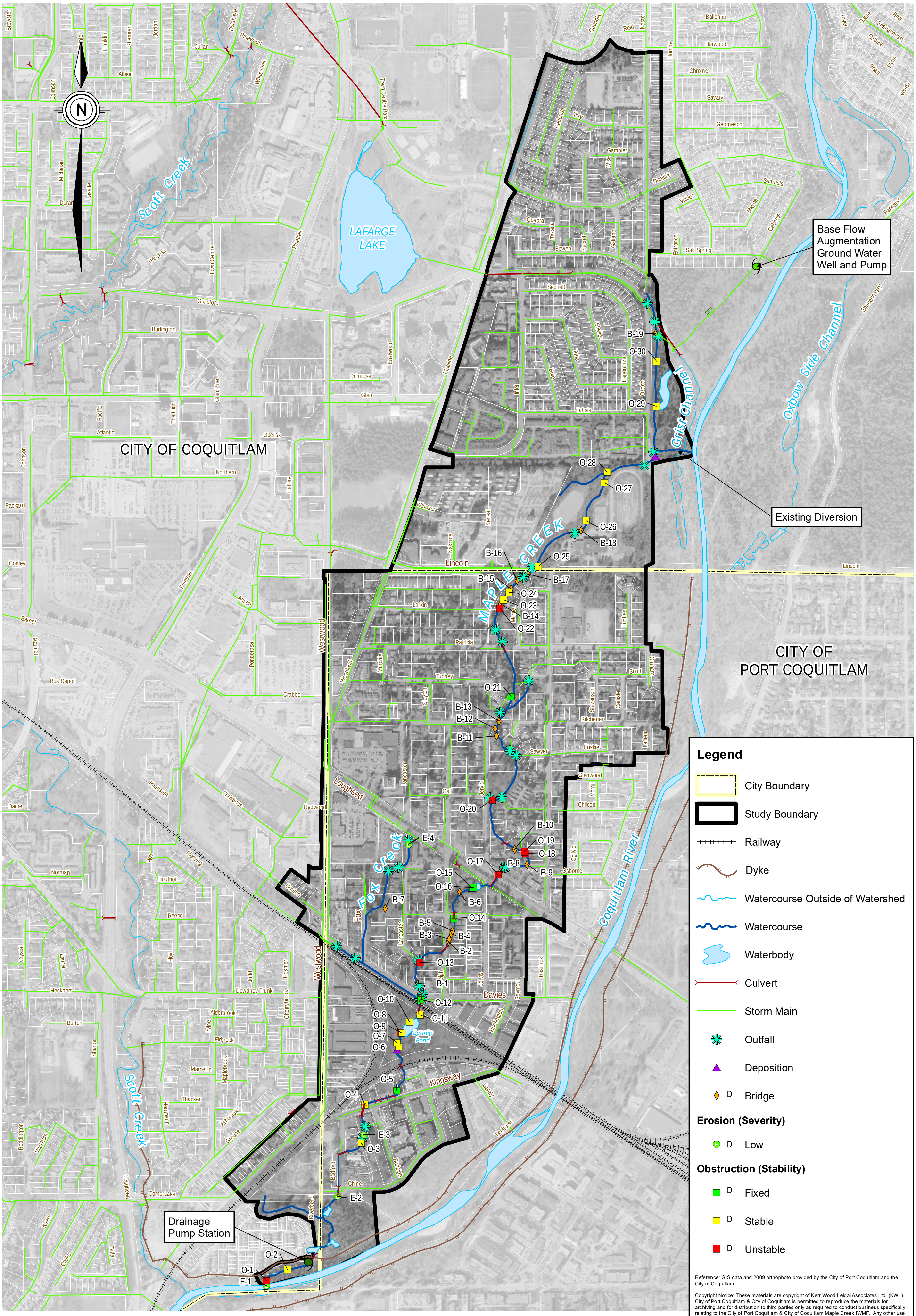
Drainage Overview

Figure 2-2C



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Erosion and Obstruction Inventory (February 2011)

Figure 2-3

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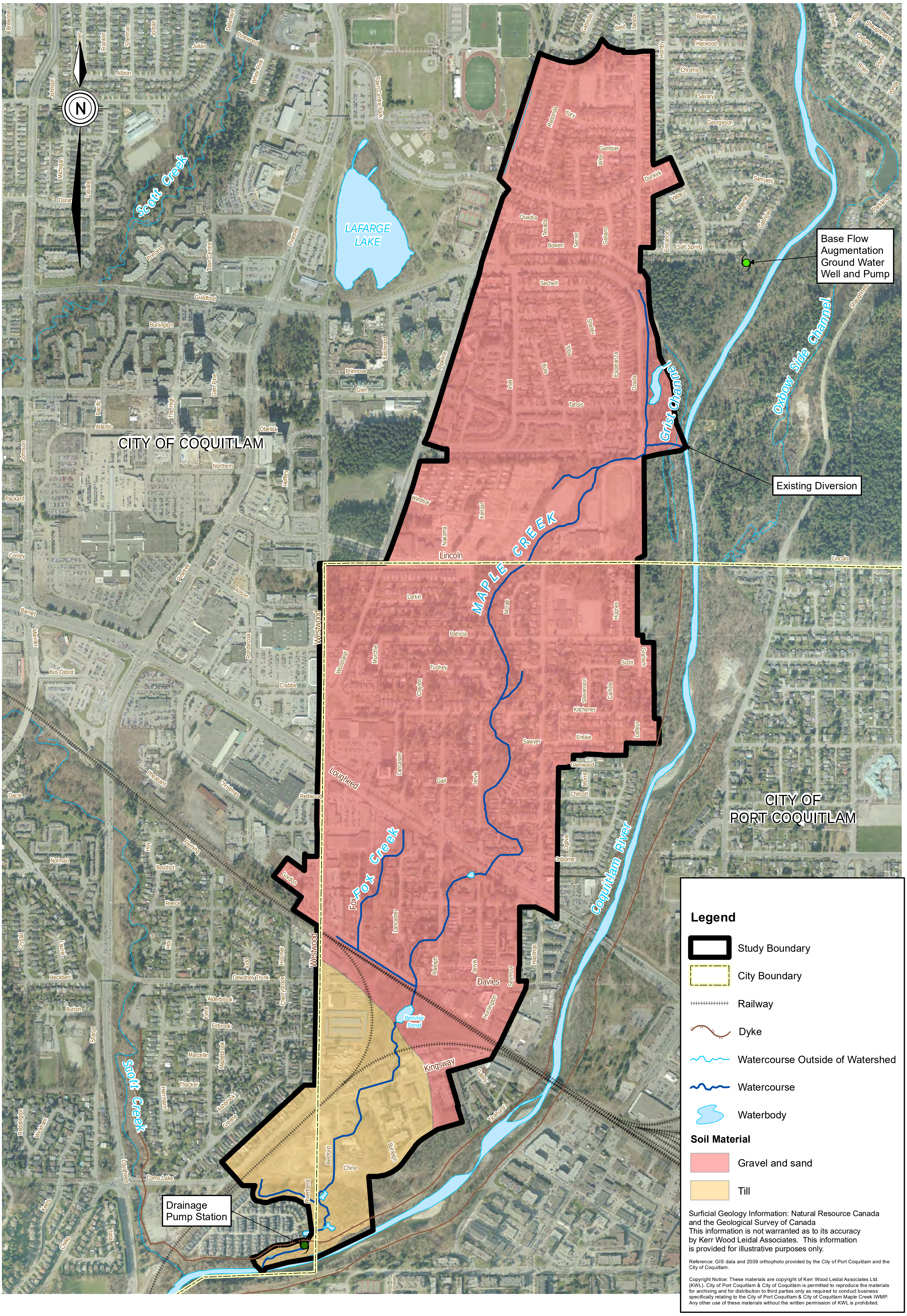

Surficial Geology Information: Natural Resource Canada and the Geological Survey of Canada
This information is not warranted as to its accuracy by Kerr Wood Leidal Associates. This information is provided for illustrative purposes only.

Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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Soils Map

Figure 2-4

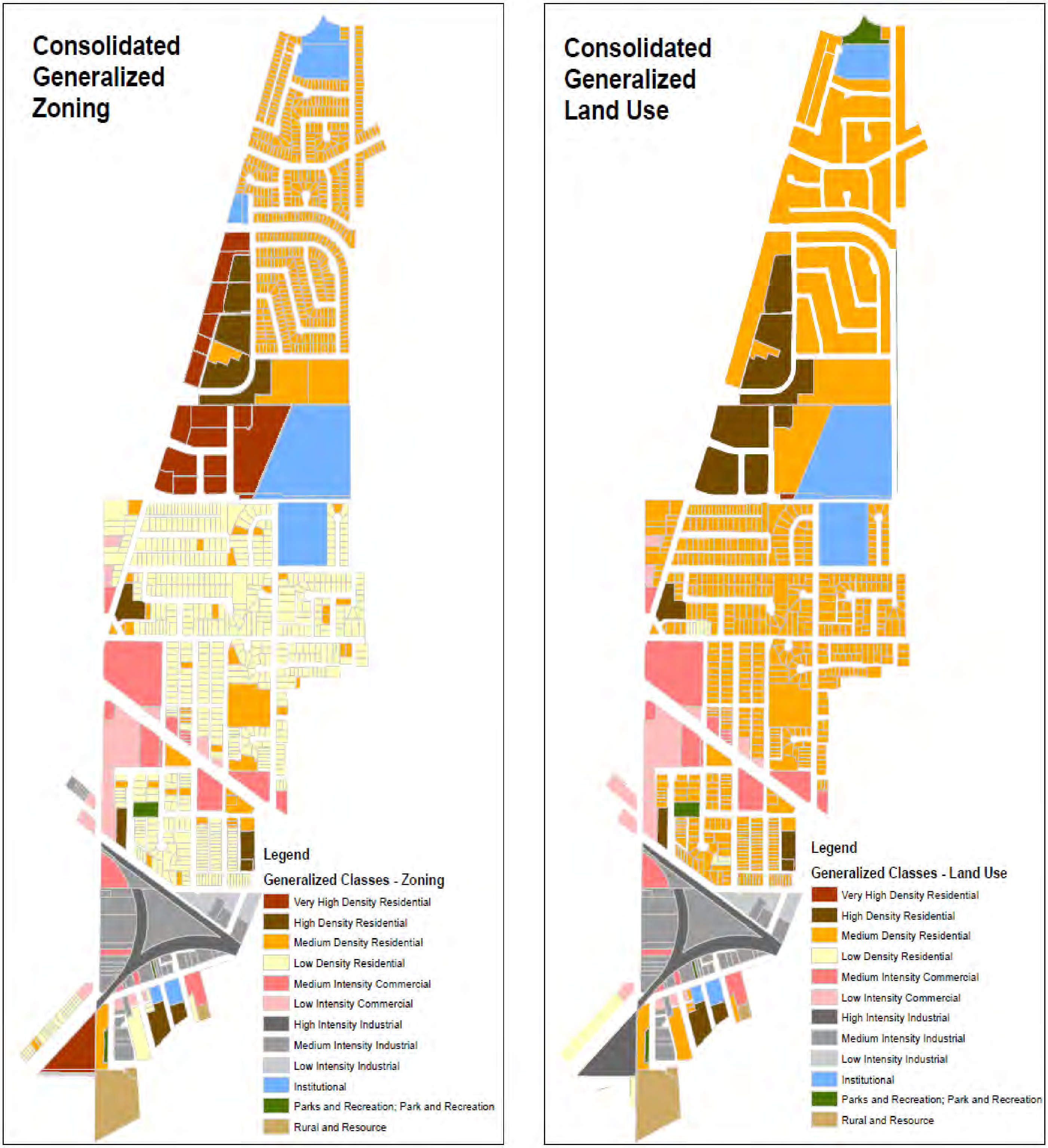
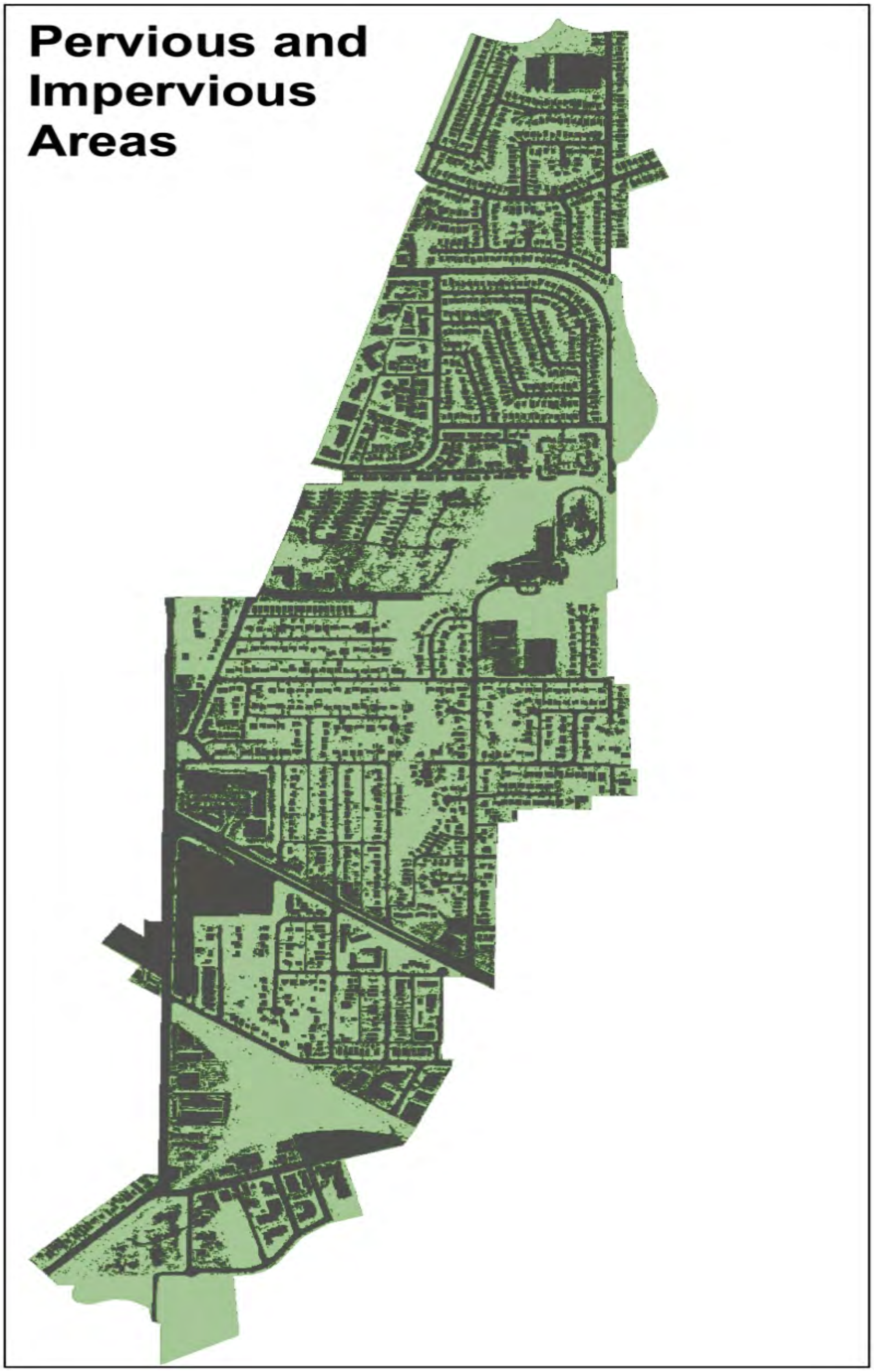


Figure 2-5: Zoning and Land Use



KWL File No. 646.017-300

Figure 2-6: Existing Pervious and Impervious Areas from 2010 Ortho photography

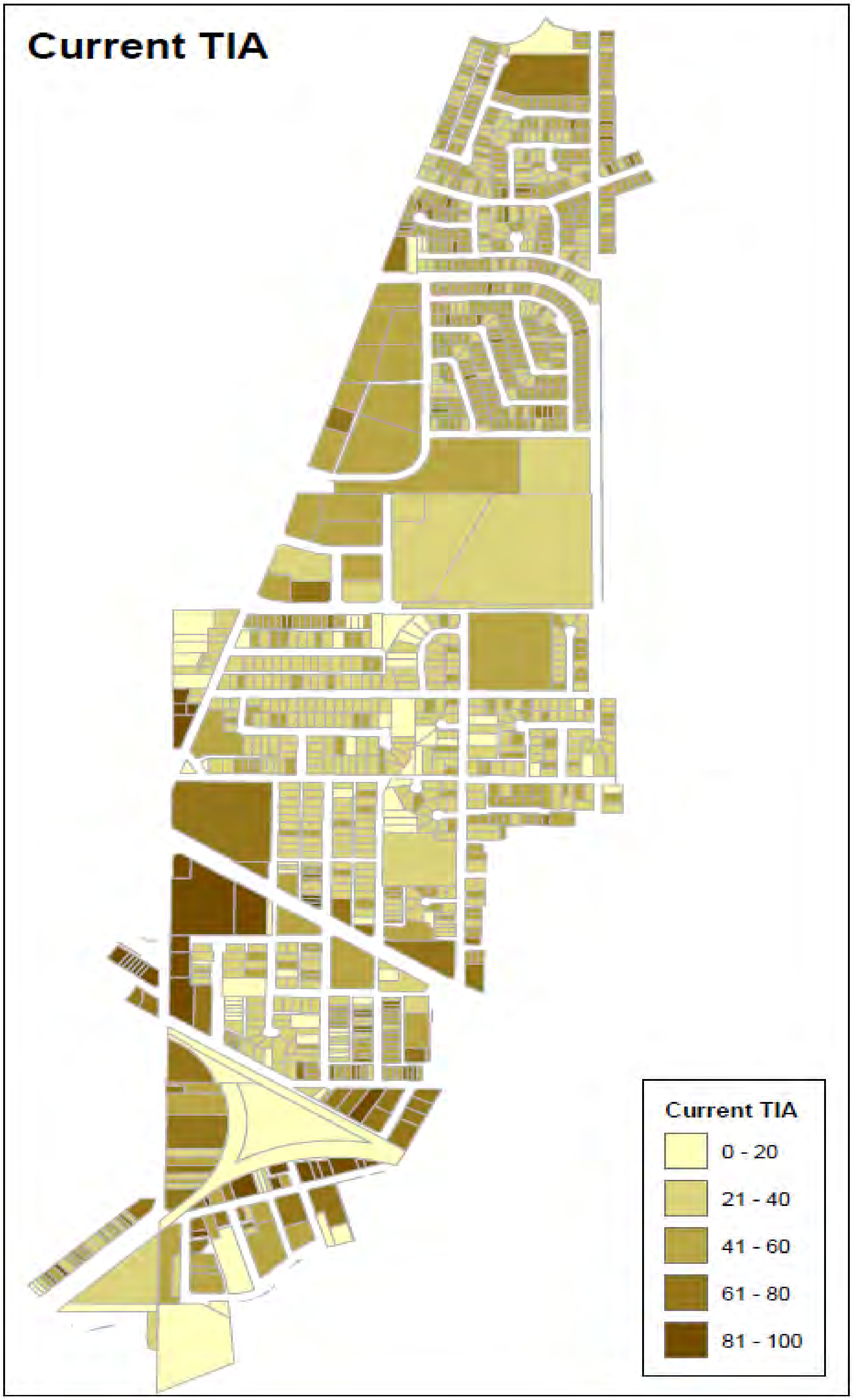


Figure 2-7: Current TIA

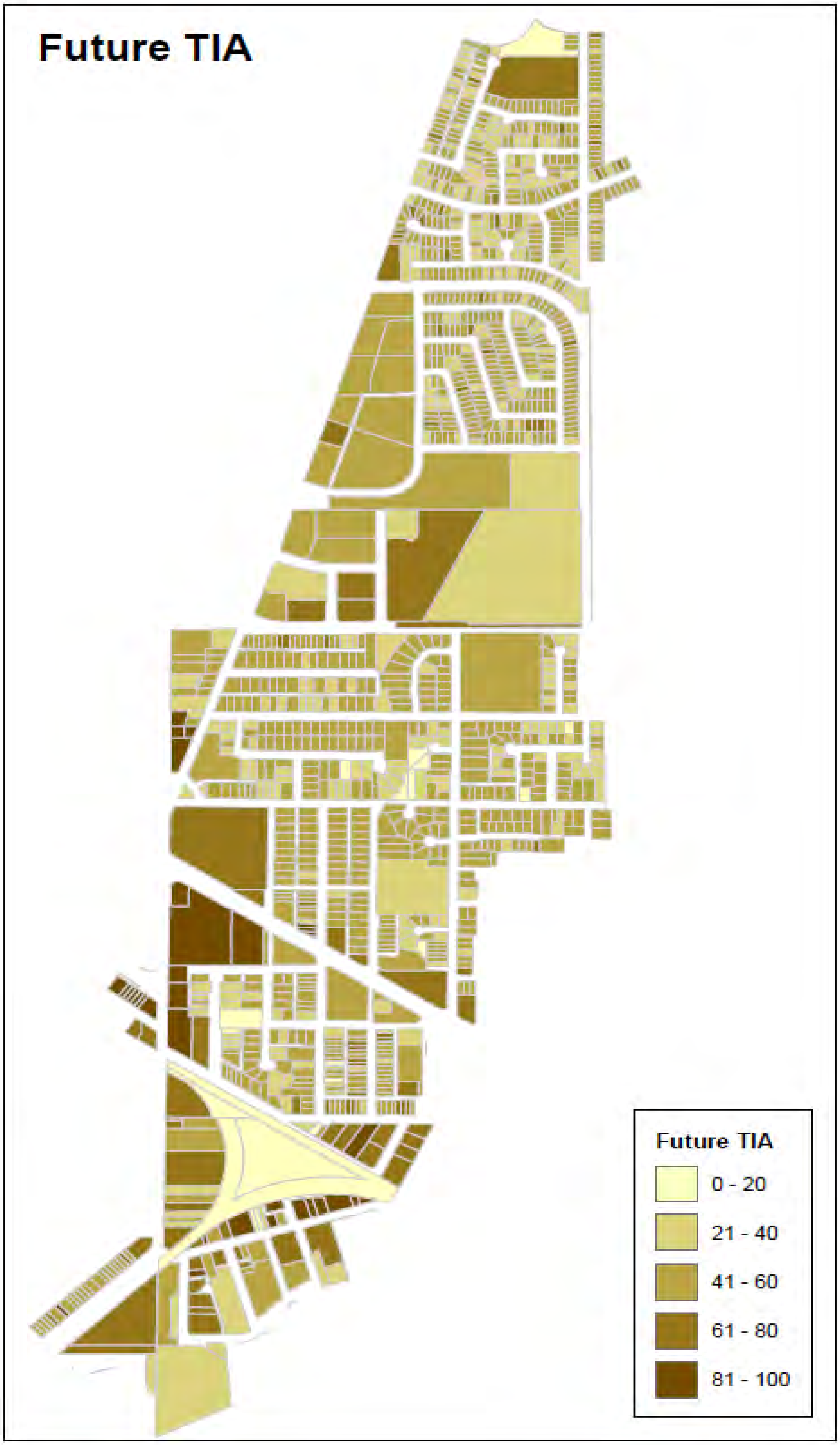


Figure 2-8: Future TIA

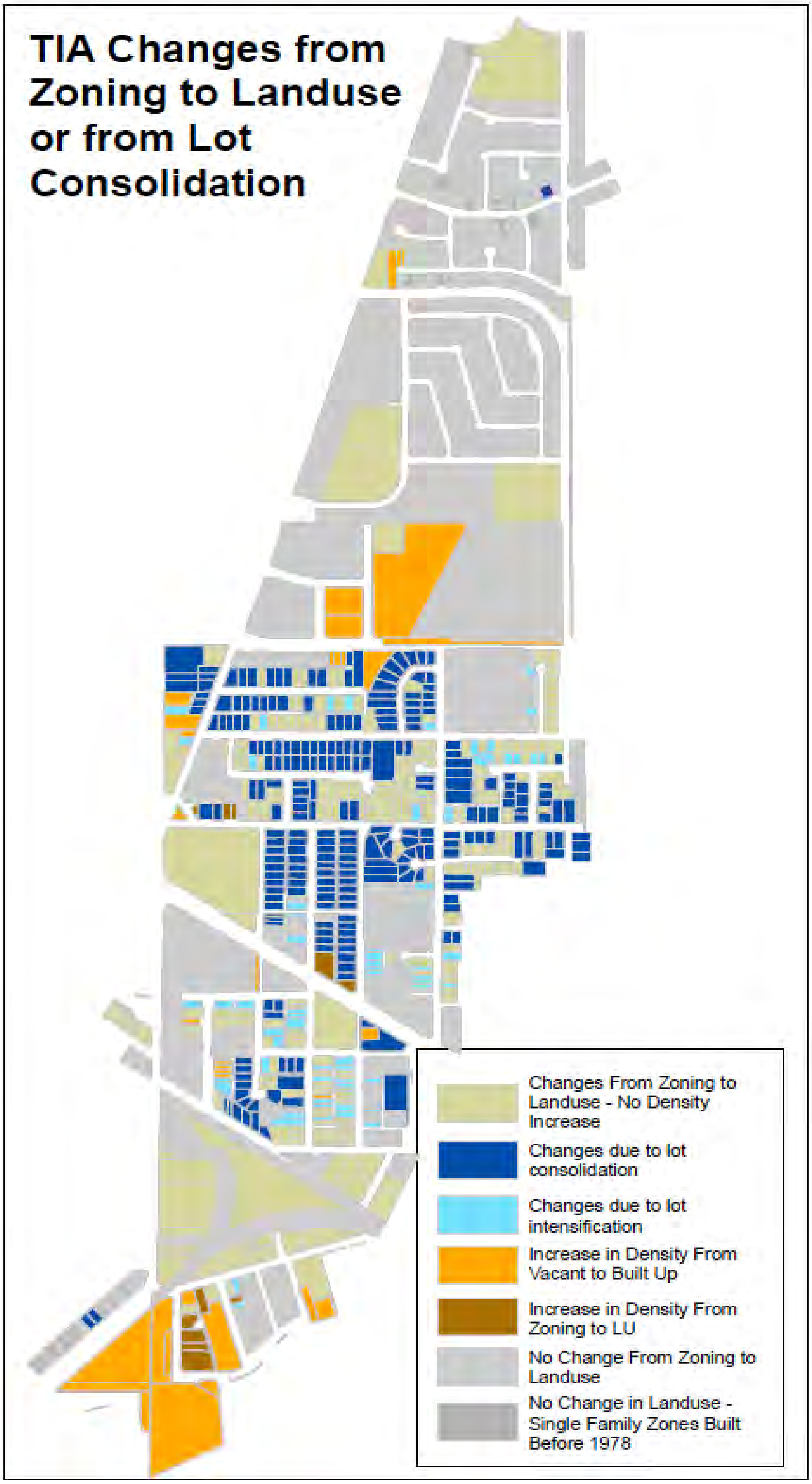
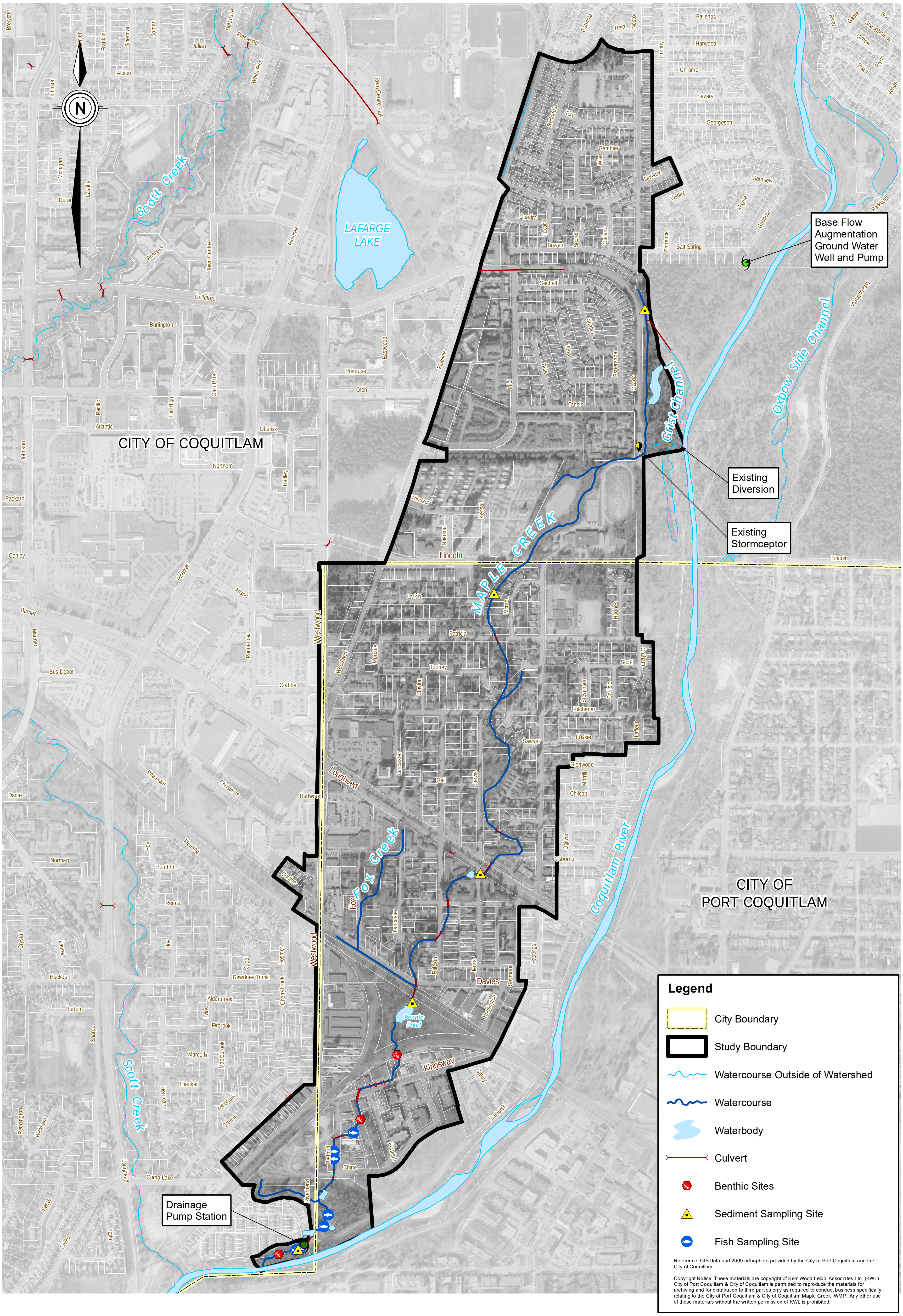


Figure 2-9: Changes from Zoning to Land Use

Path: O:\0600-0699\646-017\430-GIS\MXD-Rp\646017Fig2-10.mxd Date Saved: 4/3/2012 2:13:10 PM
Author: jlau



Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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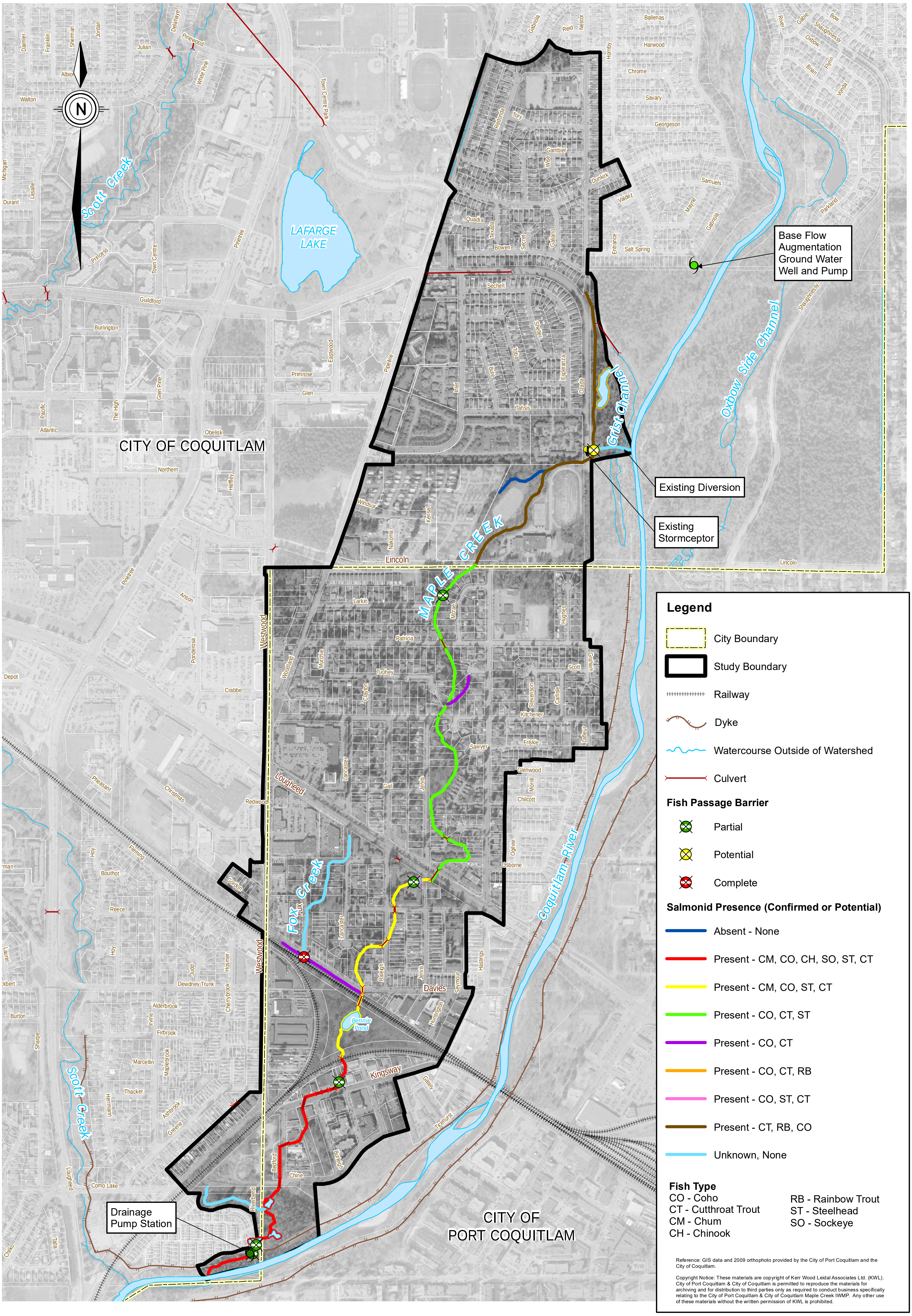
Project No.	Date
646-017	June, 2012

100 0 100
(m)
1:10,000

Sample Site Locations

Figure 2-10

Path: O:\0600-0699\646-017\430-GIS\MXD-Rp\646017Fig2-11.mxd Date Saved: 4/3/2012 2:13:48 PM
Author: jlau



Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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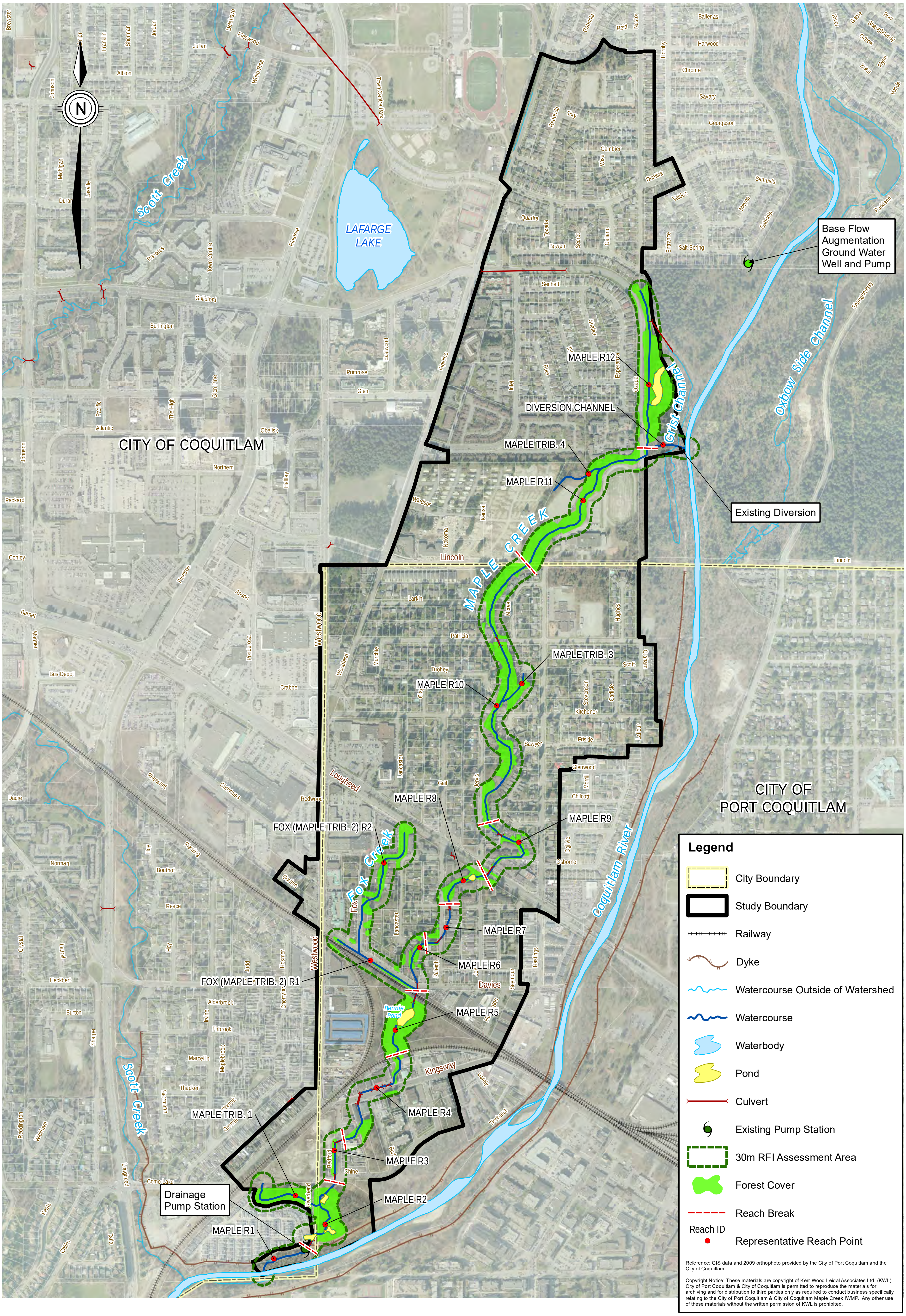
Fish Communities

Figure 2-11

Path: O:\0600-0699\646-017\430-GIS\MXD-Rp\646017Fig2-12.mxd Date Saved: 4/3/2012 2:19:07 PM
Author: jlau



Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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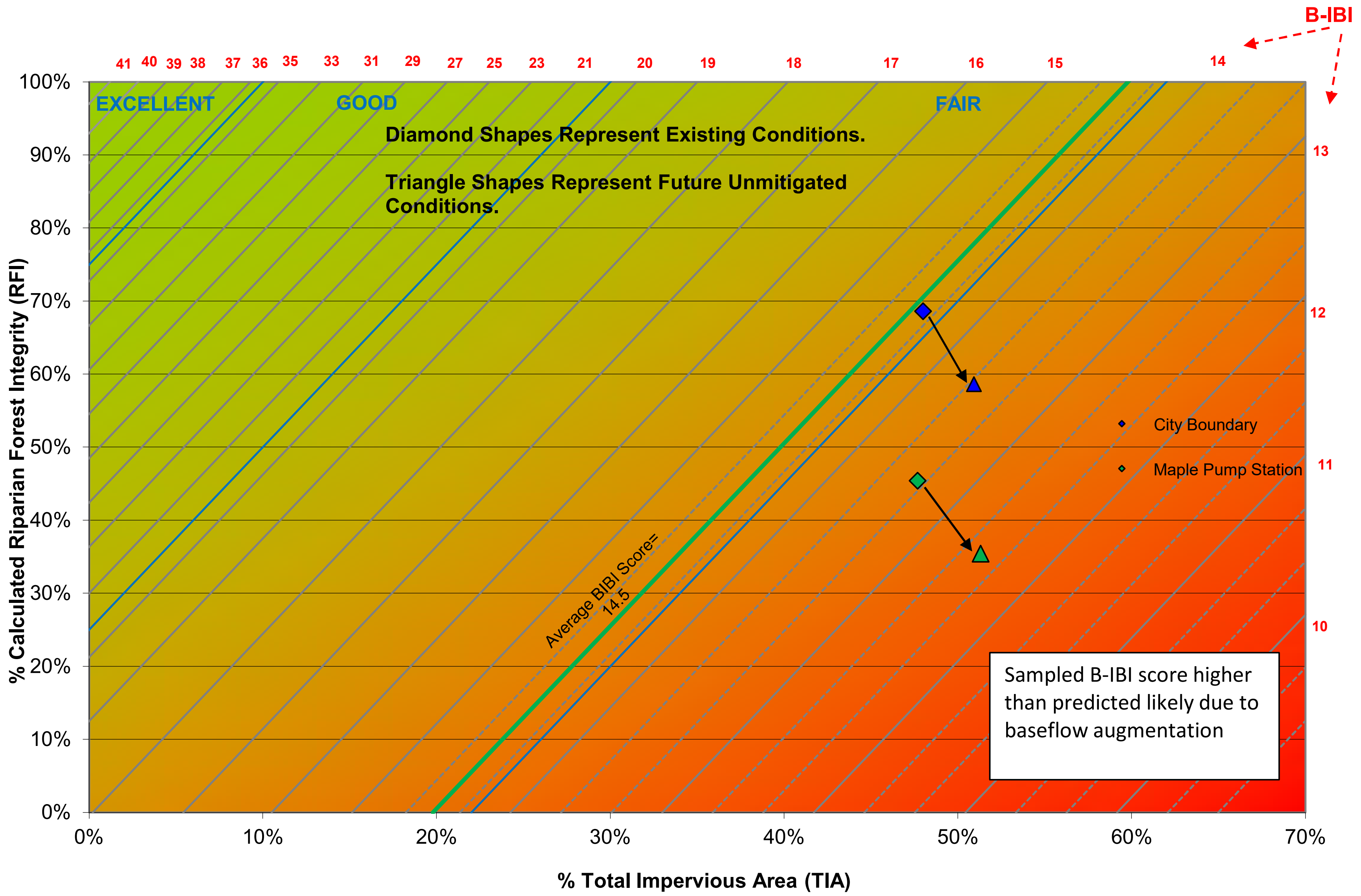
Existing Riparian Corridors and Fish Habitat Reaches

Figure 2-12



Diamond Shapes Represent Existing Conditions.

Triangle Shapes Represent Future Unmitigated Conditions.

Sampled B-IBI score higher than predicted likely due to baseflow augmentation

Figure 2-13: Watershed Health Tracking System
Maple Creek Watershed

3. Hydrologic/Hydraulic Analysis

3.1 Hydrologic/Hydraulic Models

XP-SWMM Model Development

The drainage system is shown in Figure 2-2 and includes portions of both Port Coquitlam and Coquitlam. For this study, the Maple Creek basin is separated into major sections for assessment, known as lumped catchment modelling.

A portion of the hydrologic and hydraulic models were developed for previous work done for Coquitlam and were updated and expanded on for this project. An XP-SWMM model was developed for the Maple Creek Watershed for hydrology (RUNOFF) and hydraulics. XP-SWMM RUNOFF uses inputs such as rainfall and catchment characteristics (area, slope, soil type, etc.) to estimate catchment flows. XP-SWMM HYDRAULICS use hydraulic system inputs (culvert/pipe/channel characteristics) to simulate flow routing, water levels, and flooding.

The model was not calibrated during the course of this study. The infiltration and groundwater parameters used in the models were based on KWL's database of calibrated model parameters for similar soil conditions in the Lower Mainland.

XP-SWMM Overview

The Scott Creek model that was developed for the 2006 Scott Creek Basin Drainage System Study was used as a base for the XP-SWMM modelling. This model was used for both the hydrologic and hydraulic model.

This model was cut down to form the base of the Maple Creek watershed model. The Scott Creek model included the portion of the Maple Creek watershed east of Pipeline Road and North of Tahasis Street.

The hydrologic and hydraulic model was developed with the aid of the City of Port Coquitlam and City of Coquitlam GIS databases, with information gathered during the drainage inventory, and with additional survey done by Port Coquitlam to fill in data gaps.

XP-SWMM Model Catchments

The Maple Creek watershed was discretized into sub-catchments using contours, field watercourse information, and existing drainage information. The major model sub-catchments for the Maple Creek study area are shown on Figure 2-2.

In total, 10 catchments were created and imported into the XP-SWMM model. Catchments were assigned the following attributes:

- Areas;
- Slopes, using contour information;
- Impervious percentage values; and
- Infiltration and groundwater parameters.

Impervious Percentage

Existing land use impervious percentages were estimated based on an examination of Land Use information from a variety of sources, including municipal GIS data, ortho-photography, Google Earth, Bing Maps and personal observation. From GIS data provided by the two municipalities, a series of maps and tables were generated that examine existing land use and associated land area, zoning, and future land use.

TIA percentages were estimated by spectral analysis of ortho-photographs to identify pervious/ impervious areas for each parcel.

The future land use impervious percentages were derived using the OCP zoning information combined with typical impervious percentage values.

Soil Parameters

The groundwater portion of XP-SWMM – RUNOFF was used to estimate the groundwater and interflow portions of the runoff hydrograph. Figure 2-4 shows the surficial geology that was used to determine soil parameters. The majority of the watershed is gravel and sand soils, with some till in the areas South of Kingsway.

The infiltration and groundwater parameters used in the models were based on KWL's database of calibrated model parameters for similar soil conditions.

Modelling Data Collection

The hydraulic model requires various scales of topographic and infrastructure data to build the computational framework.

To develop the model, the area was initially delineated using two primary sources of information:

- Infrastructure mapping from the Port Coquitlam and Coquitlam GIS system; and
- Data collected during the field inventory work.

The Port Coquitlam survey department supplied survey information for culverts on the Maple Creek mainstem. The model network was built to include only the Maple Creek mainstem and major culverts. Each culvert was assigned a unique identifier.

All other required data was obtained from Port Coquitlam and Coquitlam record drawings, pump curves, floodbox and pump station inventory manuals, and drainage operation manuals.

The inventory survey was completed between February 1 and 25, 2011 for the Maple Creek catchment. To accomplish this, the creek bed was traversed on foot and locations of interest were identified and recorded with a Trimble R8 global positioning system (GPS) receiver. Measurements, photographs and additional observations were recorded as attributes associated with these positions to create a comprehensive geographical information system (GIS) database. The goals of the inventory field work program were to identify:

- Locations of significant erosion and to rate these sites based on relative severity and potential risk;
- Natural and anthropogenic channel obstructions and to rate their relative stability; and
- Locations of significant deposition.

See Appendix A for photo overviews of the field inventory.

Channel Sections

Typical creek channel sections were measured during the field visits. Section properties such as bank height, bed width and material, and bank material were recorded. This information was incorporated into the hydrologic/hydraulic model. Typical Creek sections were extended along the flood plain to allow for more capacity and to provide an accurate representation of the creek flows.

Drainage Pump Stations

The Maple Creek Pump Station currently consists of two permanent pumps and two temporary pumps that are brought in during high flow events. The temporary pumps were not modelled as part of this study.

The two permanent pumps are Flygt model C-3300 submersible pumps, one with an 804 impeller and one with an 805 impeller. The pump curves for these pumps were examined to determine the pump rate for the Maple Creek Pump Station. Both pumps are rated for much higher heads then those seen in Maple Creek and as a result are outside of their best efficiency range. The pump capacity for the 805 impeller pump is 0.5 m^3/s and for the 804 impeller pump is 0.55 m^3/s. Pump on/off settings were provided by the POCO. Table 3-1 shows the on/off settings for the pumps adjusted to geodetic elevation.

Table 3-1: Pump On /Off Settings in Geodetic Elevation

Pump	Start Level (m)	Stop Level (m)
1	4.0	3.7
2	4.1	3.8
Provided by the City of Port Coquitlam		

Model Construction

The model was constructed in North American Datum 1987 (NAD 87) UTM horizontal coordinate system, the spatial coordinate system used by the Port Coquitlam and Coquitlam GIS and engineering systems. To simplify the spatial analyses, all model structures (ditches, culverts, etc.) were input into the model with approximately accurate spatial locations.

Model Update

The RUNOFF portion of the XP-SWMM model was updated with the following information:

- catchment areas were refined and updated north of Tahsis Road; and
- added catchment areas and parameters south of Tahsis Road.

The HYDRAULICS portion of the XP-SWMM model was modified to include the rest of Maple Creek downstream of the existing model. The hydraulics model was updated with the following information:

- Added Maple Creek channel details south of Tahsis Road;
- Added Maple Creek culvert details south of Tahsis Road;
- Added railway triangle habitat pond storage areas;
- Added the Ozada baseflow pump input;
- Added pump station and floodboxes at lower end of Maple Creek; and
- Checked the Ozada Bypass flow control structure.

3.2 Boundary Conditions

Rainfall Input

The drainage system analysis required the creation of design storms for the various scenarios that were modelled. The design storms were developed using the IDF curves and rainfall distributions for the Port Coquitlam City Works Yard rain gauge (AES 1106256). The modified AES design storm was used to develop the 1, 2, 6, 12, and 24 hour duration design storm for the Port Coquitlam City Works Yard station. Table 3-2 shows precipitation totals.

Table 3-2: Total Precipitation Amounts for Port Coquitlam City Works Yard Station

Duration	Total Rainfall (mm)				
	2-year	5-year	10-year	25-year	100-year
1 Hour	12.2	17.2	20.6	24.7	30.9
2 Hour	17.6	21.8	24.6	28.0	33.2
6 Hour	36.0	41.4	45.0	49.7	56.4
12 Hour	55.1	63.5	69.5	76.9	87.5
24 Hour	77.0	93.7	103.0	115.0	134.3

Water Level Boundaries

The outlet to the Coquitlam River includes a flood box and a pump station and was simulated using water level boundary conditions. Historical water level information for Maple Creek at the dyke is not available. The nearest station with historical information is the Coquitlam River at Port Coquitlam (08MH002); water levels for various return periods were calculated. Based on the Provincial Floodplain Mapping, adjustments were made to approximate the water levels for the Maple Creek outfall at the Coquitlam River. These water levels do not include any possible increase in water level due to the influence of flows within Maple Creek. Table 3-3 shows the water levels calculated for the two locations.

Table 3-3: Model Boundary Conditions

Return Period	Water Level (m)	
	Coquitlam River at Port Coquitlam	Maple Creek at Coquitlam River Outfall[1]
2-year	6.41	5.22
5-year	6.87	5.69
10-year	7.13	6.08
20-year	7.35	6.50
50-year	7.61	7.09
100-year	7.77	7.58
200-year	7.92	8.1

[1] Adjusted based on British Columbia Dept. of Environment Coquitlam River Floodplain Mapping (1976)

The installation of a level sensor at the outfall and the collection of continuous data for several years would confirm the water levels calculated for Maple Creek.

The existing drainage system was assessed for the various return periods. The design storms were matched with like design water levels. For example, a 2-year design storm was simulated with 2-year water level in the Coquitlam River.

The May 2010 *Hydrodynamic Modelling for Emergency Response Planning and Floodplain Mapping*, was checked to confirm the above water levels. The 200-year water levels calculated for the Coquitlam River at the mouth of Maple Creek in the 2010 modelling were consistent with the 200-year water level based on the Provincial Floodplain Mapping. The 20-year water level was not calculated as part of the 2010 report. The 2010 200-year water level did not significantly change the calculated return period water levels in Table 3-3.

3.3 Results of Hydrologic/Hydraulic Modelling

Peak Flow Estimates at Strategic Locations

The XP-SWMM software was used to model the hydrology and upland hydraulics and to determine peak flows at strategic locations in the watershed. Flows were estimated for the 6-month, 2-year, 5-year, 10-year, 25-year, and 100-year storms for the following four scenarios:

- Existing land use conditions with free outfall;
- Existing land use conditions with fixed backwater;
- Future land use conditions with free outfall; and
- Future land use conditions with fixed backwater.

Peak flow estimates are shown in Table 3-4.

Unit peak flows from the model were checked against unit flows estimated for similar creeks in the Lower Mainland. In general, the unit flows from the model were in line with the estimates for similar creeks.

Lowland Flood Assessment

The lowlands of the Maple Creek watershed were assessed by plotting hydraulic grade lines for the critical duration for each return period and compared to ground elevations provided by HB Lanarc and the Minimum Floor Elevation from the Port Coquitlam Zoning.

Figures 3-1 and 3-2 show the 2-year, 5-year, 10-year, 25-year, and 100-year water level profiles for the existing and future OCP land uses. The bridge deck or road overflow elevations for the major crossings as well as the flood construction level are also shown.

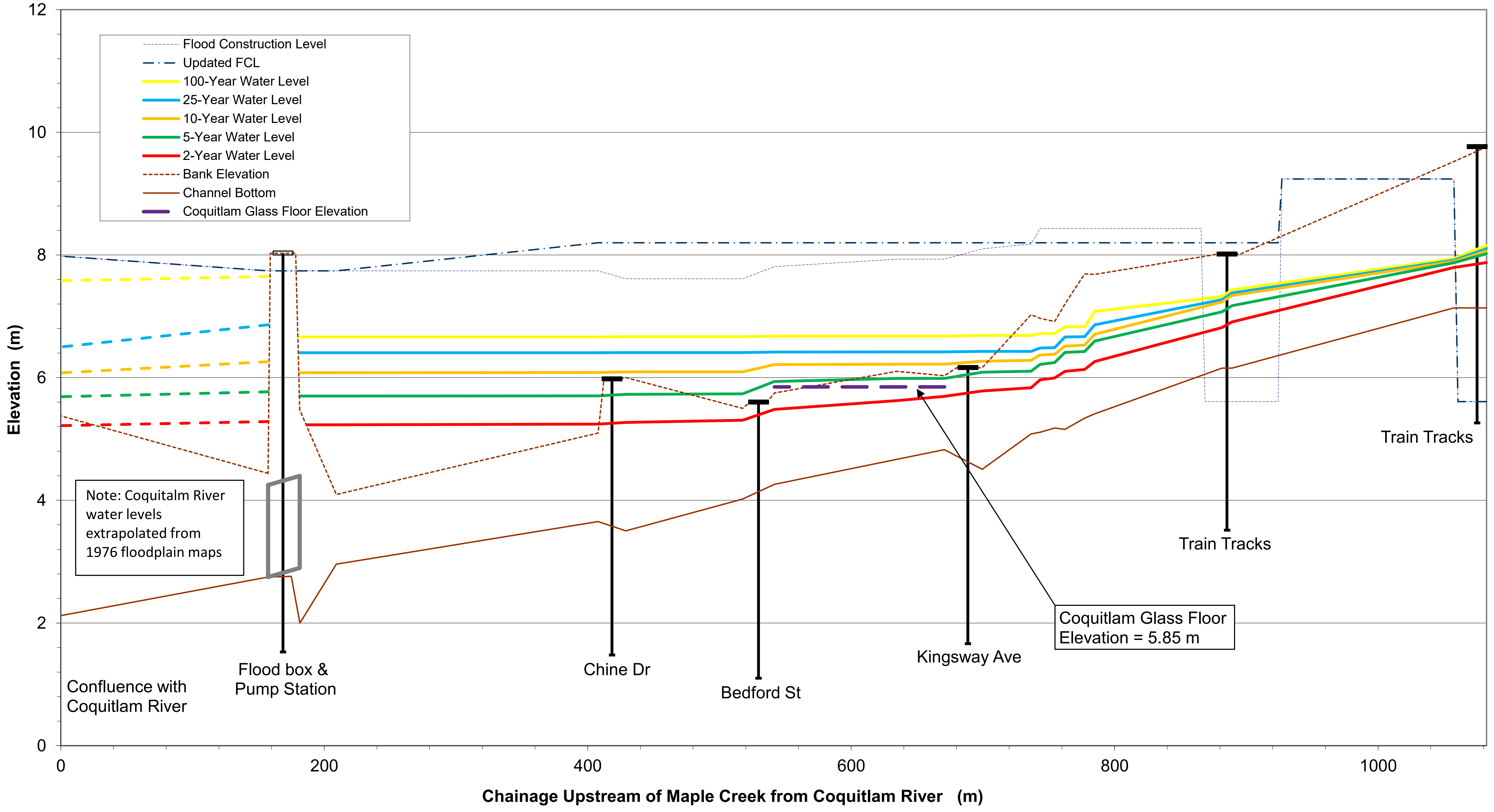
The existing and future land use water levels are similar to each other as there is little change in the impervious percentage in the catchment. The profiles that flooding takes place in the low lying areas close to the dyke starting in the 2-year event. This flooding is of less concern as the low lying ground in this area is undeveloped woodlot and the new residential development located at the Maple Creek Dyke looks to have been constructed to the minimum Flood Construction Level (FCL) and should not be at risk. Chine Drive and Kingsway Avenue are overtopped starting in the 10-year event and Bedford Street is overtopped starting in the 25-year event. The creek section between Bedford and Kingsway where historical flooding has occurred starts to flood in a 5-year event. The dyke is not overtopped in any event and the downstream water level appears to have approximately 0.4 m of freeboard.

Table 3-4: Peak Flow Estimates for Existing and Future Land Uses

Location	Peak Instantaneous Flow Estimate (m^3/s)																			
	Existing Land Use										Future Land Use									
	Free Outfall					Fixed Backwater					Free Outfall					Fixed Backwater				
	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year	2-year	5-year	10-year	25-year	100-year
Diversion Channel to Coquitlam River	1.57	2.16	2.67	3.31	4.34	1.57	2.16	2.68	3.31	4.34	1.64	2.22	2.79	3.41	4.46	1.65	2.23	2.80	3.41	4.47
Diversion Pipe to Maple Creek	0.16	0.16	0.17	0.17	0.18	0.16	0.16	0.17	0.17	0.18	0.16	0.16	0.17	0.18	0.18	0.16	0.16	0.17	0.18	0.18
City Boundary	0.65	0.86	0.99	1.33	1.72	0.65	0.86	0.99	1.33	1.72	0.71	0.91	1.11	1.48	1.83	0.71	0.91	1.22	1.48	1.83
Patricia Ave.	0.85	1.14	1.34	1.68	2.12	0.85	1.14	1.34	1.68	2.12	0.91	1.21	1.43	1.80	2.20	0.91	1.21	1.44	1.80	2.20
Lougheed Highway	1.45	1.89	2.12	2.37	2.98	1.45	1.89	2.12	2.37	2.98	1.49	1.93	2.16	2.43	3.02	1.49	1.93	2.16	2.43	3.02
Gordon Ave.	1.53	2.01	2.27	2.51	2.92	1.53	2.01	2.27	2.51	2.92	1.58	2.06	2.31	2.55	2.93	1.58	2.06	2.31	2.55	2.93
Raleigh St.	1.51	1.93	2.15	2.47	3.04	1.51	1.93	2.15	2.47	3.04	1.55	1.97	2.19	2.51	3.08	1.55	1.97	2.19	2.51	3.09
Davies Ave.	2.00	2.53	2.82	3.05	3.42	2.00	2.53	2.82	3.06	3.42	2.03	2.56	2.84	3.07	3.44	2.04	2.56	2.84	3.07	3.44
CPR Culvert	1.99	2.52	2.80	3.05	3.42	1.99	2.52	2.80	3.05	3.42	2.02	2.55	2.83	3.07	3.44	2.02	2.55	2.83	3.06	3.44
CPR Culvert	1.99	2.60	2.90	3.05	3.46	1.99	2.60	2.86	2.97	3.46	2.05	2.71	2.91	3.08	3.48	2.05	2.72	3.00	3.09	3.48
Kingsway Ave.	2.34	2.98	3.16	3.48	3.79	2.34	2.97	3.14	3.45	3.74	2.41	3.05	3.21	3.52	3.81	2.41	3.04	3.19	3.50	3.80
Maple Creek Flood Box	2.28	2.89	3.06	3.36	3.58	0 m^3/s, Flood box closed					2.36	2.94	3.10	3.39	3.62	0 m^3/s, Flood box closed				
Maple Creek Pump Flows	No Pumping, Free Outfall					1.00	1.01	1.01	1.02	1.02	No Pumping, Free Outfall					1.00	1.01	1.01	1.02	1.02

Red text indicates peak flow estimates are slightly lower for the fixed backwater conditions as compared to free outfall as expected.
Shading indicates slight increase in peak flow estimates from existing to future land use conditions.

Maple Creek Water Level Profiles:
Existing Land Use - Flood Box Closed



Kerr Wood Leidal Associates Ltd.
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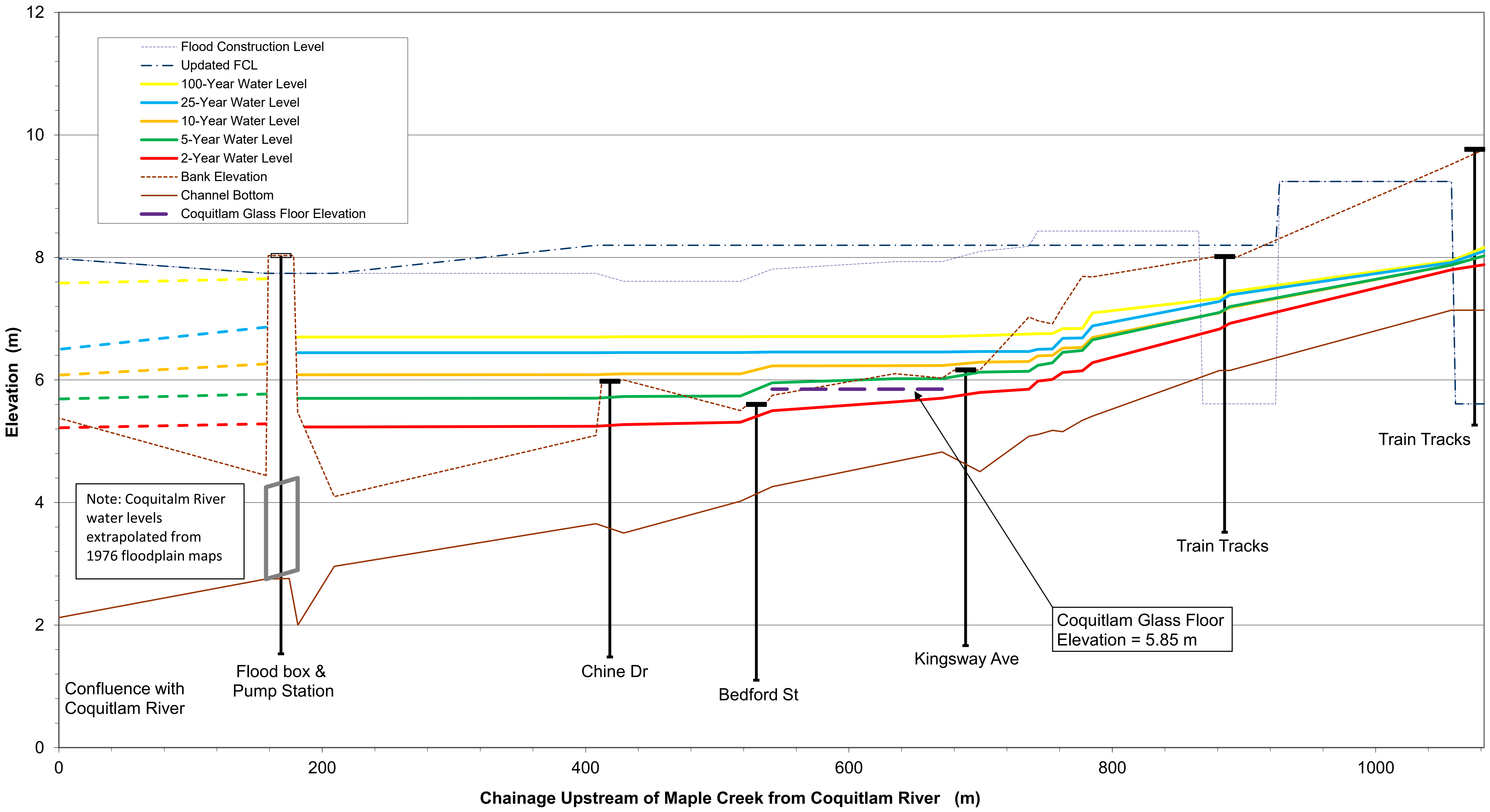
Figure 3-1

Maple Creek Water Level Profiles: Future Land Use - Flood Box Closed



Kerr Wood Leidal Associates Ltd.

O:\0600-0699\646-017\400-model\Copy of Profile_FINAL.xlsm[Figure 3-2]

Figure 3-2

4. Environmental/Watershed Health Improvements

Many environmental improvements were considered in Maple Creek including:

1. Stream baseflow augmentation;
2. Water quality treatment options;
3. Improving fish passage impediments;
4. Riparian reforestation and instream complexing projects; and
5. Long term policies to reduce creek and riparian encroachment and restore creek buffers.

4.1 Baseflow Augmentation

Current Baseflow Augmentation

Baseflow in Maple Creek is currently augmented by a production well located in Coquitlam at Salt Spring Avenue and Gabriola Drive. The current production well has experienced a 75% loss in well efficiency since it was first commissioned in 1996. Its current sustainable yield is approximately 16.4 L/s (260 gal/min). The well was originally rated to produce 44.2 L/s (700 gal/min). The likely cause of loss of performance is accumulation of biomass and packing of fine sediment in and around the well screen.

Because of the declining trend of the existing well, baseflow augmentation alternatives were investigated with the goal of providing at least 20 L/s (317 gal/min) to match the current augmentation.

Base Flow Augmentation Alternatives

Long Term Strategy: Measures to Improve and Sustain Baseflows

To help increase the groundwater contribution to the Maple Creek baseflow and to reduce flood flows, onsite rainwater management measures to maximize groundwater recharge can be implemented. This will mimic the natural hydrology of the watershed and help to sustain creek base flows. These measures could include increased volume of soil in landscaped areas, water infiltration trenches, rain gardens and roof leaders which could be disconnected where possible. They are especially effective in areas with well-draining soils (Figure 2-4). On-site rainwater management measures could be done for both re-developing lots and existing lots provided that the measures do not negatively impact adjacent, down-slope neighbours.

In addition to on-site rain water management measures, the following alternatives were also investigated (shown on Figure 4-1).

Alternative 1: Rehabilitate Existing Well and Pump

Rehabilitation of the existing groundwater well is estimated to cost approximately $130,000 and similar rehabilitations have demonstrated low long-term success, high maintenance/replacement costs, and short service life. It is unlikely that this option would continue to provide 20 L/s and is not favoured by the City of Coquitlam.

Alternative 2: Drill New Production Well at Different Location

Drill a new production well in another location. This could be coordinated with potential wells for other purposes, such as irrigation in Coquitlam Town Centre Park. Further investigation would be required to locate the ideal location.

Alternative 3: Divert Baseflow from Coquitlam River to Maple Creek

This could be achieved either though gravity flow from a higher elevation intake in the Coquitlam River or by placing an intake and pump in the river.

- **Option 3A: Gravity Diversion:** Using the existing gravity flow storm sewer system appears feasible with minor modifications, the existing production well piping, and some new piping to convey the flows to Maple Creek. New sections of pipe would be required to connect the separate systems and flow control orifices to limit the flows to baseflows only and to prevent large flows from entering and overloading the downstream sewer system. Refer to Figure 4-1.
- **Option 3B: Pump from River near Existing Groundwater Well:** Two locations are possible for the pump placement. One location is close to the existing production well and would pump into the existing well piping through the park. This will provide baseflow to the same location in the creek as the current production well. This location will require cutting trees for access to the pump and should be able to use the existing power supply.
- **Option 3B-1: Pump from Upstream River:** An alternate pumping from river location is upstream at the David Ave. crossing. This pump would require new piping to connect to the existing storm system on Gabriola Drive. Refer to Figure 4-1. A small section of new pipe would also be required to connect the two storm systems on Nestor Street at Harwood Avenue. A flow control orifice would be required to ensure only baseflow continues between the storm systems to Maple Creek. Baseflows would enter the top of Maple Creek main stem and provide wetted aquatic habitat for the whole length. This could potentially provide additional year round aquatic habitat. It would also not require any tree cutting as the pump would be accessible from the bridge (easy for maintenance as well) and the pipe could be constructed in the road ROW. A new power supply would be needed.

These options would require maintenance for the intake structure in Coquitlam River to ensure screens were clear of obstacles and sediment deposition. This alternative could provide the required 20 L/s.

The *Coquitlam – Buntzen Project Water Use Plan* (BC Hydro, 2005), defines the minimum and target flows that will be released from the Coquitlam Dam each month. The minimum flow is 1100 l/s for April, May, June, July, August and September (Reduced Instream Flow Release Target), without considering additional input to the river from catchments downstream of the dam. These flows are sufficient to support the removal of 20 L/s with minimal Impact on the Coquitlam River water levels and not adversely affecting its aquatic life. A water removal / discharge licence would likely be required.

Alternative 4: Construct Storage and Slow Release Facility

Construct an underground tank to store flow from the upper watershed and release baseflow slowly to the creek. The tank could be located under the sports field at the school adjacent to the diversion. A pump could be used to pump the stored water into Maple Creek during the months that baseflow is required. Water quality treatment (stormceptor, etc.) prior to storage would be required to ensure that cleaner water was pumped into the creek. For this option to provide the required 20 L/s, a very large facility would be required – 4 ha of land. The available space under the sports field would provide approximately 5 L/s for four months or 6 L/s for three months.

Alternative 5: Divert Baseflow from Local Storm System to Maple Creek

The existing storm system draining and outletting to Maple is not providing much baseflow to the creek. Storm sewers outside of the current Maple Creek catchment area could be diverted to Maple Creek.

Figure 4-1 shows the storm system east of Hornby as a possibly. There are three discharges to Coquitlam River (at Harwood, Savary, Dunkik) that could use the gravity flow system by using existing storm pipes with minor modifications, the existing production well piping, and some new piping to convey the flows to Maple Creek. Using the existing storm sewer system would require new sections of pipe to connect the separate systems and flow control orifices to limit the flows to baseflows only and to prevent large flows from entering the downstream sewer system and overloading it. Flow splitters would be required to ensure high flows continue to the river, while low flows go to the creek.

Further investigation would be required to determine if there are enough baseflows in the storm sewer system to warrant the project and to check the feasibility of it.

Alternative 6: Divert Flows from Lafarge Lake

Diverting flow from Lafarge Lake was considered by the Cities before. Hoy Creek is diverted to feed Lafarge Lake and in the summer the lake outlet to Grist Channel is above the lake water level. Lafarge Lake has suffered from low water levels the past few years and was ruled out as baseflow source for Maple Creek.

Alternative 7: Augment with Potable Water

Stakeholders also suggested the use of potable water to top up baseflow in Maple Creek. A connection could be made to the potable water supply on Ozada Drive. It should be de-chlorinated prior to discharge to Maple Creek. Using potable water is the least sustainable alternative.

Comparison of Baseflow Augmentation Alternatives

On-site rainwater management measures should be implemented where possible where adjacent and downslope properties are not negatively affected. The other alternatives were further compared in Table 4-1 based on cost, operation and maintenance, and environmental impacts. A full option evaluation was beyond the scope of this study, but initial comparisons were made. Further study and investigation is recommended to evaluate and determine the best option.

Cost estimates were based on similar work and represent the best prediction of actual 2012 costs. The costs were scaled up by 29% to reflect 2020 cost estimates based on the Engineering News Record Construction Cost Index.

In 2012 Piteau Associates estimated costs for well rehabilitation and a new well as noted in Table 4-1. Present day costs could be significantly increased with regulated well drilling and other recent changes. For example, AECOM provided the City of Coquitlam with a 2021 cost estimate for a well installation at Coquitlam’s Town Centre Park (~50m deep with ~120GPM) for $443,000. This may be more indicative of current costs. The $54,000 cost estimate was estimated in 2012 for 20 l/s (317 USGPM), and the same depth (32m) & diameter (8”) as the existing well. For the purposes of cost comparisons in this initial assessment, a new well cost estimate has been extrapolated to $500,000. A detailed cost estimate should be undertaken in a feasibility study.

Two viable options stand out for long-term success:

Option 2. Drill New Production Well at New Location Near Existing Well (assume $500,000 for comparison)

Option 3. Divert Base-flows from Coquitlam River to Maple Creek ($1,900,000)

The gravity diversion from Coquitlam River is the most sustainable option because it does not rely on pumping (lower long term operating cost), although it has a higher construction cost at $1,900,000. Drilling a new groundwater well will give more control over water quantity and quality and may be the most cost effective option. A detailed construction cost estimate and lifecycle costing should be undertaken in a feasibility study.

The City is looking into a groundwater well for irrigation within Town Centre Park, and excess well capacity could be used to increase base flows in Maple Creek and/or to fill Lafarge Lake.

Table 4-1: Evaluation of Baseflow Augmentation Alternatives

Alternative		Capital Cost Estimate[1]	Operation & Maintenance Considerations	Environmental Considerations
1	Rehabilitate Existing Well and Pump	$130,000[2]	Similar rehabilitations have demonstrated low long-term success, high maintenance / replacement costs, and short service life. It is unlikely that this option would continue to provide 20 L/s and is not favoured by the City of Coquitlam	
2.	Drill New Production Well at Different Location	~~$54,000~~[2] assume $500,000[2]	- Would require maintenance and on-going operating costs. Less maintenance than diverting from Coquitlam River.	n/a
3.	Divert Base-flows from Coquitlam River to Maple Creek		See below	- Coquitlam River has ample water supply year-round. Not depleting groundwater.
	A. Gravity Diversion - Convey through Existing Storm Sewers and Well Piping	$1,900,000 Possibly use existing production well piping	- No pumping, no mechanical reliance. - More sustainable because energy independent. - Maintenance for inlet structure in river, multiple site visits required.	n/a
	B. Pump From River Near Existing Well	Not Costed[3] Possibly use existing production well piping	- Maintenance for inlet structure and pump in river, multiple site visits required.	n/a
	B-1. Pump from Upstream River to Top of Maple Channel	Not Costed[3] (easier access, storm sewer connections & flow control)	- Maintenance for inlet structure and pump in river, multiple site visits required. David Ave site easier to access. Storm sewer control structures.	- Provide baseflow further upstream on Maple Main Stem – Cutthroat Trout, Rainbow Trout, Coho present. - No/minimal riparian disturbance with access at David Ave crossing.
4.	Construct Storage/Slow Release Baseflow Augmentation Facility	N/A expensive	- Some maintenance required	- Keeps water cool
5.	Divert Baseflow from Local Storm System to Maple Creek	N/A	- Determine if there are sustained low flows in this pipe network	
6.	Divert Flows from Lafarge Lake	N/A	- Not recommended as it would draw down levels in Lafarge Lake	
7.	Augment with Potable Water	Monthly water costs	- Would require de-chlorination equipment and maintenance.	n/a

Refer to Figure 4-1.

1. Cost estimates were based on similar work and the best prediction of actual 2012 costs. They were scaled up by 29% to reflect 2020 cost estimates based on the Engineering News Record Construction Cost Index.
2. Rehabilitating and drilling well cost estimates could be significantly increased with regulated well drilling and other recent changes. The $54,000 cost estimate was estimated in 2012 for 20 l/s, and the same depth (32m) & diameter (8") as the existing well. AECOM provided the City of Coquitlam with a 2021 cost estimate for a well installation at Coquitlam's Town Centre Park (~50m deep with ~120GPM) for $443,000. This may be more indicative of current costs.
3. Options 3B and 3B-1 were not costed because the gravity option was preferred in 2012.

4.2 Operation of Ozada High Flow Diversion

The existing Ozada High Flow Diversion consists of a concrete headwall with a 300 mm concrete pipe on Maple Creek, with high flows diverted to a channel to the east toward Grist Channel and discharges directly to the Coquitlam River.

(a) 300 mm pipe to Maple is on left, 900 mm outfall from stormceptor & residential area on right.

(b) Diversion Channel to Coquitlam River

Photo 4-1: Ozada High Flow Diversion and Diversion Channel

Flood Flows Diverted to Coquitlam River

According to the SWMM modelling results, approximately 0.16 m^3/s (160 l/s) is discharged through the 300 mm pipe during the 2-year event (0.4 m surcharge above crown of pipe) and 0.18 m^3/s (180 l/s) discharged during the 100-year event (0.7 m surcharge above crown of pipe). Flows greater than 0.2 m^3/s are diverted easterly through a channel to the Coquitlam River. Modelling reveals that 1.6 m^3/s is diverted during the 2-year event and 4.4 m^3/s during the 100-year event.

It is unlikely that flow through the Ozada Diversion is contributing to downstream flooding. This amount is approximately 6% of the total flow at the Maple Creek pump station during the 100-year event. The current diversion appears to allow low flows to pass through to the lower portion of Maple Creek while limiting storm flows that could cause flooding.

Low Flows Continue Along Maple Creek

The 300 mm pipe conveys approximately 200 l/s to Maple Creek during the 100-year event; this is substantially more than the 20 L/s desired baseflow. The 200 l/s is only about 10 – 15% of the 2-year flow for the contributing, or 7% of the 10-year flow, or 5% of the 100-year flow.

Good flushing flows for the creek system would be in the order of a few 2-year (1.6 m^3/s) flows up to a 5-year (2.2 m^3/s) flow every once in a while to stir up gravels and wash out silts, etc. However, this would exacerbate flooding downstream. The flood analysis results shown on Figure 5-1 show a number of undersized culverts downstream of the diversion with the current operation of the diversion.

Substantial flow increases would be seen at the pump station, approximately:

2-year peak flow: 1.6 m^3/s (upper watershed) + 2.3 m^3/s (mid & lower watershed) = 3.9 m^3/s
= 60% increase in flow
= about existing 100 year flow (3.6 m^3/s) at pump station

5-year peak flow: 2.2 m^3/s (upper watershed) + 2.9 m^3/s (mid & lower watershed) = 5.1 m^3/s
= 57% increase in flow

Given this, the 200 l/s release is probably a good compromise of being more than desired baseflow but not so much to exacerbate downstream flooding.

Operation and Maintenance of Diversion

The City of Port Coquitlam currently blocks the 300 mm pipe with sand bags during flood events to minimize the flooding experienced downstream. Stakeholders are concerned that these sand bags are sometimes left in place reducing low flows to the mid and lower creek during times when they are needed for survival of aquatic life.

A potential solution for this is to install an automated gate to be remotely activated to close during high flows when the pump station is overwhelmed and be re-opened after the flood risk has passed. This would eliminate the need for an operations worker to do multiple trips to the diversion and would also allow the flow to be restored much faster.

However, based on this analysis, the need for cutting off this flow is minimal, especially when the pump station is upgraded in the future.

Long-term Diversion Alternatives

The current configuration of the Ozada diversion is a potential impediment to fish passage, although it is unclear to what extent. The 300 mm orifice opening to Maple Creek could easily be blocked (either intentionally or otherwise) which would not only block fish passage, but could dry out Maple Creek downstream in the dry summer months when the creek relies on baseflow augmentation. To address both the fish-passage and baseflow issues, two long-term alternatives have been identified to modify and improve diversion operation. There are three storm outfalls that enter Maple Creek upstream of the diversion that would be affected by the alternatives. The storm outlets from Bowen Drive and the north end of Ozada Drive currently enter the top end of Maple Creek, while the outlet from the south end of Ozada Drive enters just upstream of the existing diversion structure. The alternatives are shown on Figure 4-2 and are discussed in the sections below.

Alternative 1: Divert Upper Maple Flows to Ozada Storm System and Remove Diversion

The Bowen Drive outlet could be connected to the Ozada Drive storm sewer with a length of storm sewer. A flow splitter would be placed in a manhole just downstream of the new connection to send baseflows to the upstream end of Maple Creek, while large flows would be carried in a new storm sewer down Ozada Ave. to the south outfall. The flow from the storm sewer system west of the south end of Ozada Drive would be split in a similar manner with baseflows continuing to Maple Creek while large flows would be piped underneath the creek to a new outfall in the existing east-west diversion channel to the Coquitlam River. The west end of the diversion channel would be blocked to prevent backwater flows into Maple Creek.

A new fish-friendly culvert should replace the existing culvert at the school access.

Alternative 2: Divert Upper Maple Flows to LaFarge Lake Overflow and Remove Diversion

Alternative 2 is similar in function to Alternative 1 except that instead of constructing a new high flow pipe along Ozada Drive, the high flows from the Bowen Drive and north Ozada Drive storm sewer would be piped into the large, deep LaFarge Lake overflow pipe that discharges to Grist Channel. The Lafarge Lake pipe has ample capacity to carry up to the 100 year flows from these two outfalls

The flow from the storm sewer system west of the south end of Ozada Drive would be split in the same fashion as Alternative 1.

A new fish-friendly culvert should replace the existing culvert at the school access.

4.3 Water Quality Treatment

Because of specific water quality concerns raised by stakeholders and water quality sampling results, several locations for installing water quality treatment features were investigated. Possibilities for treatment include either a structural feature (e.g., Stormceptor) or a natural filtration feature, such as a water quality treatment wetland.

Figure 4-3 and Table 4-2 summarize potential water quality improvement opportunities.

Stakeholders raised another option to construct a diversion from the outfall at Davies and Westwood to the lower portion of Maple Creek below Chine Drive (shown on Figure 4-3 in dark orange box). The treatment area available in the ditch running along Westwood beside the railway tracks is too small to provide adequate treatment for 90% of the annual average runoff.

Stormwater Facilities in McAuley Triangle

There is adequate treatment area within the railway McAuley triangle, owned by the Province.

It is a relatively easy process to apply to the Province for Crown Land Tenure to place stormwater facilities on their land. However this triangle is surrounded by railways that would need to be crossed for construction and ongoing maintenance and would require permits. Railways can be extremely difficult and time consuming to deal with. Although this is a preferred treatment option for the poor water quality discharging from the Westwood area, it may be difficult to implement..

Further Studies

Based on water quality sampling results, further sampling should be undertaken to identify the potential for sanitary-storm cross-connections in residential areas between Patricia Ave and Davies Ave. Also, we recommend further surveillance sampling to examine potential point-source discharges of pollutants. Sampling undertaken during the Integrated Stormwater Management Plan was insufficient to identify the current scope and risk to water quality from sites that have been problematic in the past but does suggest that water quality concerns continue to exist in the watershed.

Spill Control Plan

To protect the watercourses, aquatic habitat and species, and groundwater a Spill Control Plan aids in ensuring that the appropriate authorities and work crews are aware of how to deal with contaminated spills to minimize their damage.

The City of Coquitlam's procedures for responding to spills are outlined in its Operations Policy and Procedure Manual (2008) and the City of Port Coquitlam's in its Environmental Spill Response Plan (2012). Both municipalities typically record and respond to spills based on reports from the public about odour, colour, turbidity or fish kills. The Cities respond to spill reports through a defined procedure, which includes sending staff to investigate, calling the fire department if dangerous materials are involved, containing and cleaning up the spill, and in some cases, tracing the spill. Spills on land are blocked from entering the catch basins and watercourses. In the event of substantial spills, additional support is provided by other agencies, the Provincial Emergency Program, Environment Canada, and private contractors.

Table 4-2: Water Quality Improvements

Category	Potential Project	Priority	Jurisdiction
Water Quality Projects	Add structural water quality treatment or filtration feature to outfall east of Westwood St., on south side of Davies Ave or add new culvert under CPR railway tracks and construct a water quality treatment pond inside CPR Railway Triangle to treat runoff prior to discharge to Maple Creek.	High	Port Coquitlam
	Add structural water quality treatment or filtration feature at upstream end of Tributary 1.	Medium	
	Add structural water quality treatment or filtration feature on Fox Creek downstream of Lougheed Highway.		
	Add structural water quality treatment or filtration feature to outfall at north end of Ozada Ave.	Medium	Coquitlam
O & M	Create inspection and maintenance schedule for Stormceptor at south end of Ozada Ave. to ensure proper long-term functioning.	High	Coquitlam
Further Studies	Investigate potential for sanitary-storm sewer cross-connections in residential areas between Patricia Ave. and Davies Ave.	High	Port Coquitlam
	Conduct further surveillance sampling to identify point-source discharges from the previously identified problem sites and undertake measures to reduce risks. Previously identified problem sites include: (1) CPR Automobile Salvage Yard; (2) Auto salvage/storage facility east of the creek on south side of Davies Ave.; and (3) Metro Motors on north side of Lougheed Highway.		

See Figure 4-2 for Locations
Green text - within Port Coquitlam's jurisdiction, Blue text - within Coquitlam's jurisdiction, Black text - within both jurisdictions

4.4 Proposed Aquatic and Riparian Improvements

Proposed aquatic, riparian, and other watershed health improvements for the Maple Creek watershed are shown in Table 4-3 and Figure 4-4. High priority projects include removing or modifying existing fish passage impediments, addressing riparian encroachment, riparian plantings and/or or invasive plant control at several sites, and water quality treatment.

Fish Passage Impediments

Five of the existing fish passage impediments in the watershed should be removed or modified to improve access to and from spawning and rearing habitats. These are all listed as High priority because of their importance or risk to the productivity of fish habitat in the watershed. Of all of the projects proposed, these projects are likely to have the most benefit for the least cost and effort.

Improve Fish Access through Flood Gate

Improving fish access through the dyke (both the in-migration of adult spawners and out-migration of smolts) is a streamkeeper priority for this watershed. Self-regulating tide gates have been installed successfully in several watersheds in Metro Vancouver (e.g., Musqueam Creek in Vancouver, Wilson Farm in Coquitlam) and allow more control over the frequency with which the tide gate is open for fish passage while maintaining the same level of flood protection (see Appendix E for further information). It is recommended that the Maple Creek and Coquitlam River water levels be monitored to assess the suitability of self-regulating tide gates.

As a short-term measure, changes to tide gate operation could be made. The weights could be modified and the access ladder for the flood gate be moved to allow more access when the gate is partially closed. An upstream debris interception structure (e.g., trash struts – series of posts placed upstream of floodbox inlet), rather than a grill, on the upstream end of the floodbox would also alleviate concerns of debris clogging the existing grill and impeding fish passage.

Private Creek Crossings, Fences, Overgrown Channels

Fish passage impediments on private property are most effectively dealt with at the municipal level. Most municipalities have an existing *Watercourse Protection Bylaw* to protect the drainage functions of natural watercourses[4]. As barriers can present a risk for flooding as well as an impediment to fish passage, these bylaws can usually be used effectively to resolve fish passage issues.

The City has authority to remove, or ask for removal, if it is a flood hazard. In Port Coquitlam, obstructing a stream is in violation of the City's *Waterways Protection Bylaw (No. 917)*. To address obstructions such as private fences or other instream structures, it is recommended that a letter from a bylaw enforcement officer be issued to the affected landowner(s) (cc to Fisheries and Oceans Canada and BC Ministry of Environment) requesting that the obstruction be removed. The letter should state that if the obstruction is not removed by a certain date, consequences will result under the Bylaw, such as a fine or completion of the work by the City at the owner's expense.

The violation letter should also advise the landowner on their obligations under the *Fisheries Act* as well as the BC *Water Act* to protect fish habitat while conducting the restoration work, as well as what permits may be required or requirements met. Although DFO would likely not require a *Fisheries Act* authorization or restrict work to the instream window, landowners should consult with DFO and BC Ministry of Environment prior to any works being undertaken to verify if approvals required.

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[4] Although obstructions to fish passage is also a violation of Section 35(1) of the *Fisheries Act*, enforcement of the *Act* by DFO is unlikely to result in quick resolution of the issue, because the *Act* requires DFO to prove that the barrier is a harmful alteration of fish habitat.

Table 4-3: Potential Environmental and Watershed Health Improvements

Category	Key Issue	Potential Project	Priority	Jurisdiction
Aquatic / Instream Improvement	Fish Passage Impediment	Improve flapgate management or replace with self-regulating tide gate.	High	Port Coq / Coq
		Remove grill at upstream end of dyke floodbox. If necessary, replace with an upstream structure to catch large debris.		
		Remove instream fence upstream of Kingsway Ave.	High	Port Coquitlam
		Remove instream fences at 3691 McRae Crescent.		
		Remove or modify step-weir downstream of Lougheed Highway.		
	Habitat Enhancement	Add spawning gravels & instream complexity in lower watershed (complete only in conjunction with channel modifications to improve conveyance capacity).	Medium	
	Culvert Replacement	Replace existing 450 mm Ozada Ave culvert with 600 mm dia open-bottomed (fish-friendly) culvert to improve habitat connectivity	Medium	Coquitlam
	Stream Daylighting	Daylight 35 m culvert at south end of Ozada Ave by relocating cul-de-sac 75 m north, eliminating a road crossing and provide an enhanced north-south greenway connection between Glen Park and the Coquitlam River. (longer-term option to line above)	Low	
	Stream Daylighting / Fish Passage Impediment	Daylight 125 m of Fox Creek by replacing culverted section with open channel and riparian area along east side of Fox St. during re-development (requires expansion of Fox Park to include two existing residences south of current park).	Low	Port Coquitlam
	Channelization	Replace Davies Ave. ditch portion of Fox Creek with new culvert under CPR Railway tracks and 150 m of meandering channel within CPR Railway Triangle. Convert existing Davies Ave. ditch to infiltration swale.		
Riparian Corridor Improvement	Riparian Encroachment	Address both instream & riparian encroachment by reducing stream crossings, bank hardening, & channel modifications by private landowners. Encourage use of native plantings &/or bioengineering methods to stabilize banks & create a small riparian buffer zone. Priority sites include: (1) industrial portion of lower watershed from Bedford St. to Kingsway Ave.; (2) residential front yards from Raleigh St. upstream to Gordon Ave.; (3) various lowbank residential backyards from Shaftsbury Pl. to Kitchener Ave.; (4) various lowbank backyards on east side of creek from Patricia Ave. to Lincoln Ave.; and (5) 4 residential properties backyards back onto Fox Creek on west side of Lancaster St., between Shaftsbury & Gordon Avenues	High / Medium	

Category	Key Issue	Potential Project	Priority	Jurisdiction
	Riparian Encroachment	Widen riparian setbacks to 30 m during re-development, particularly in the following locations: (1) lower watershed from Chines Dr. to the Railway Triangle; and (2) from Davies Ave. upstream to Lincoln Ave. (above and below Lougheed Highway).	High	
	Riparian Planting	Plant native shrubs in Fox Park to stabilize streambanks and restore riparian understory.		
		Plant riparian trees in clearing on floodplain west of creek opposite Gail St.	Medium	
		Plant low-growing shrubs in pocket sites along channelized section along Kingsway Ave.		
	Riparian Encroachment	Use strategically-placed street trees and parking lot landscaping to create a riparian canopy in the section that runs parallel to and north of Kingsway Ave. Consider amalgamating driveway crossings in this area during re-development.	Low	
	Invasive Plants	Remove and/or treat problematic invasive plants and replant with native species. Priority species and sites for control include knotweeds, ivy, and yellow lamium include: (1) lower watershed downstream of Chines Dr. (knotweed, reed canarygrass); (2) between Bedford St. and Kingsway Ave. (knotweed, blackberry); and (3) lowbank backyards from Davies Ave. to Lincoln Ave. (knotweed, ivy, yellow lamium, periwinkle, daphne-laurel, etc.).	High	Port Coq / Coq
Terrestrial Habitat Improvement	Forest Cover	Increase natural watershed forest and vegetation cover through: (1) reforesting a portion of development parcels during re-development; (2) street tree plantings; and (3) encouraging use of native plants in landscaping during re-development.		

See Figure 4-3 for Locations
Green text - within Port Coquitlam's jurisdiction, Blue text - within Coquitlam's jurisdiction, Black text - within both jurisdictions

Riparian Encroachment

From an ecological health perspective, the most important proposed watershed improvement is to reduce stream and riparian encroachment and restore natural riparian vegetation. Efforts should be made to substantially enlarge riparian setbacks as redevelopment of the watershed occurs, with the goal of 30 m setbacks throughout the watershed. Additionally, educational and outreach efforts can be used to inform owners of private properties with watercourses or environmentally sensitive areas about the positive actions they can take to improve watershed health. As gains are likely to be incremental, goals must be long-term and progress measured over several decades.

Riparian Plantings

At sites not undergoing redevelopment, opportunities may exist to work with private landowners to reduce bank hardening, channelization, and, where possible, restore narrow riparian areas (e.g., row plantings of overhanging shrubs or trees). In addition, several priority areas for larger riparian tree plantings and invasive plant removal have been identified (both on City-owned and private land).

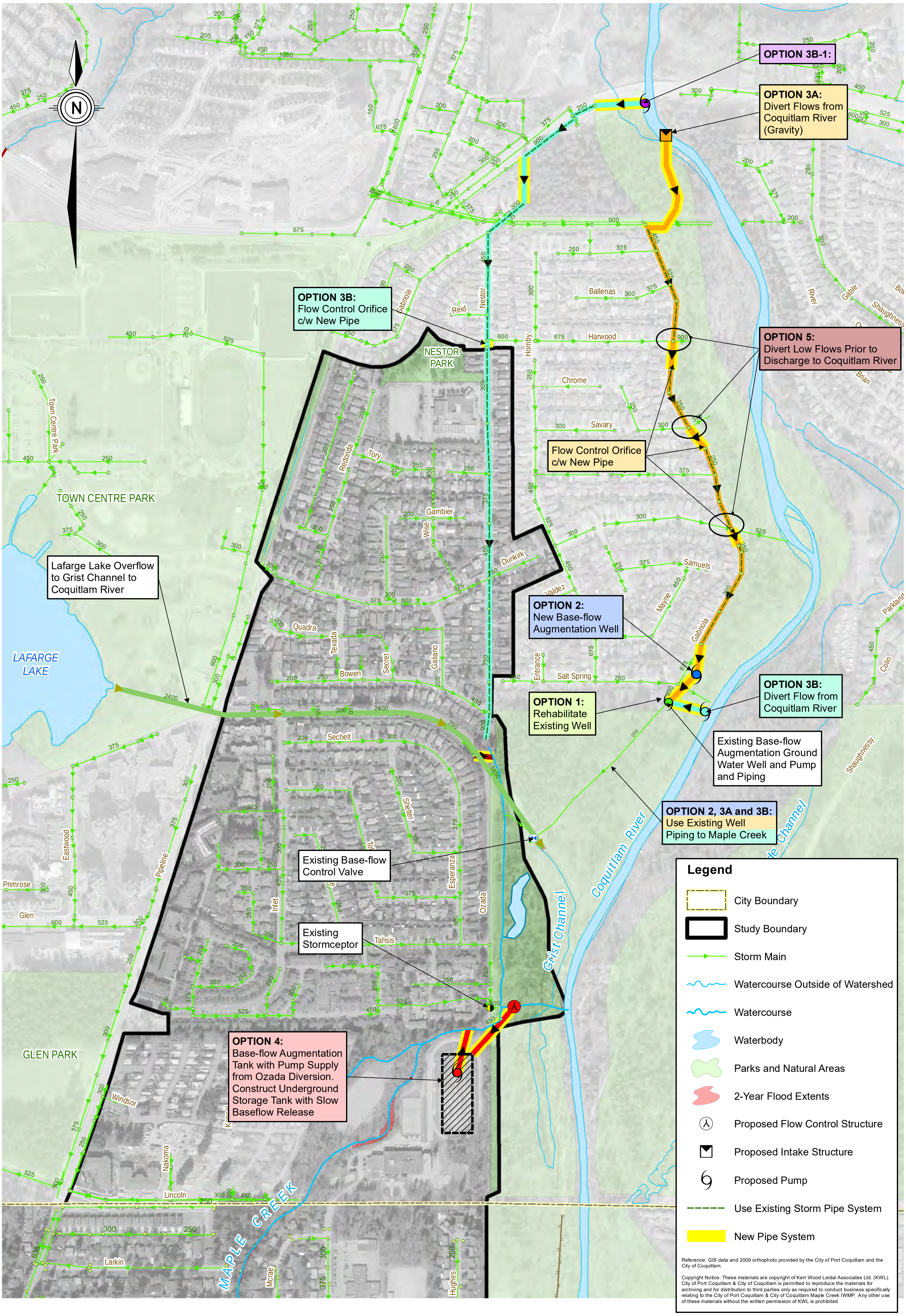
Instream Habitat Enhancements

Although instream complexity and spawning gravels are lacking in some reaches, particularly in the lower watershed, it is not recommended that habitat enhancements such as gravel placements or the addition of instream structures (boulders or large wood debris) be undertaken unless channel conveyance capacity is first increased. Without concurrent increases to channel conveyance capacity, instream habitat enhancements will exacerbate existing flooding concerns.

Stream Daylighting

Fox Creek upstream and downstream Davies Ave. is a longer-term opportunity identified for stream daylighting and channel restoration:

This would require planning and coordination prior to implementation. Such projects could be partially funded from outside sources, such as Pacific Salmon Foundation or constructed by developers as compensation to offset development impacts.



OPTION 3B-1:

OPTION 3A:
Divert Flows from Coquitlam River (Gravity)

OPTION 3B:
Flow Control Orifice c/w New Pipe

OPTION 5:
Divert Low Flows Prior to Discharge to Coquitlam River

Flow Control Orifice c/w New Pipe

Lafarge Lake Overflow to Grist Channel to Coquitlam River

OPTION 2:
New Base-flow Augmentation Well

OPTION 3B:
Divert Flow from Coquitlam River

OPTION 1:
Rehabilitate Existing Well

Existing Base-flow Augmentation Ground Water Well and Pump and Piping

OPTION 2, 3A and 3B:
Use Existing Well Piping to Maple Creek

Existing Base-flow Control Valve

Existing Stormceptor

OPTION 4:
Base-flow Augmentation Tank with Pump Supply from Ozada Diversion. Construct Underground Storage Tank with Slow Baseflow Release

Legend

▭	City Boundary
▭	Study Boundary
→	Storm Main
~	Watercourse Outside of Watershed
~	Watercourse
	Waterbody
	Parks and Natural Areas
	2-Year Flood Extents
⅄	Proposed Flow Control Structure
◪	Proposed Intake Structure
6	Proposed Pump
- - -	Use Existing Storm Pipe System
🟨	New Pipe System

Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

KERR WOOD LEIDAL
consulting engineers

City of Port Coquitlam & City of Coquitlam
Maple Creek IWMP

Project No.	Date
646-046	November, 2020

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Base-Flow Augmentation Alternatives

Figure 4-1

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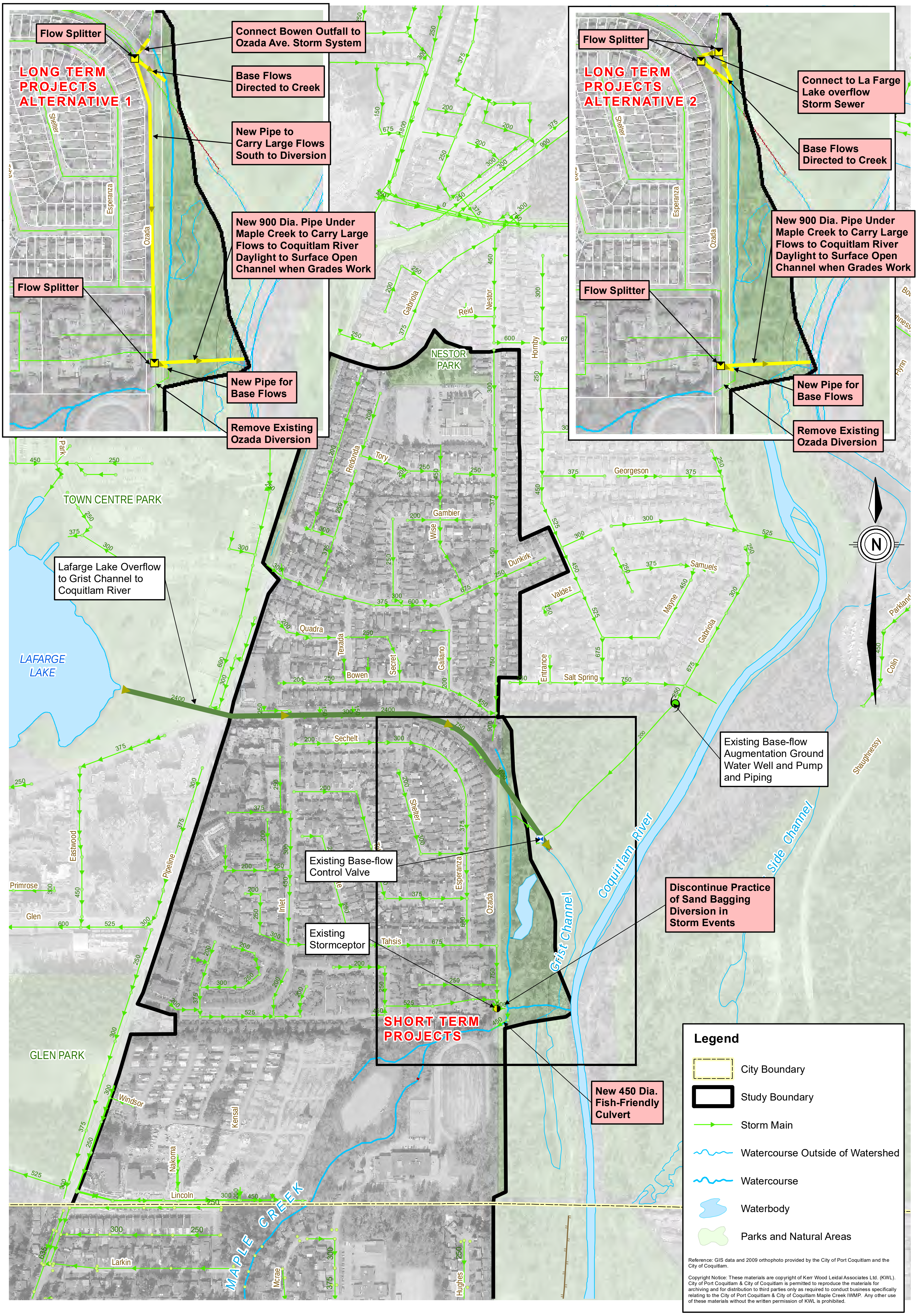
Author: JLau



Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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City of Port Coquitlam & City of Coquitlam
Maple Creek IWMP

Project No.	Date
646-046	December, 2020

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Ozada Diversion
Short and Long Term Alternatives

Figure 4-2

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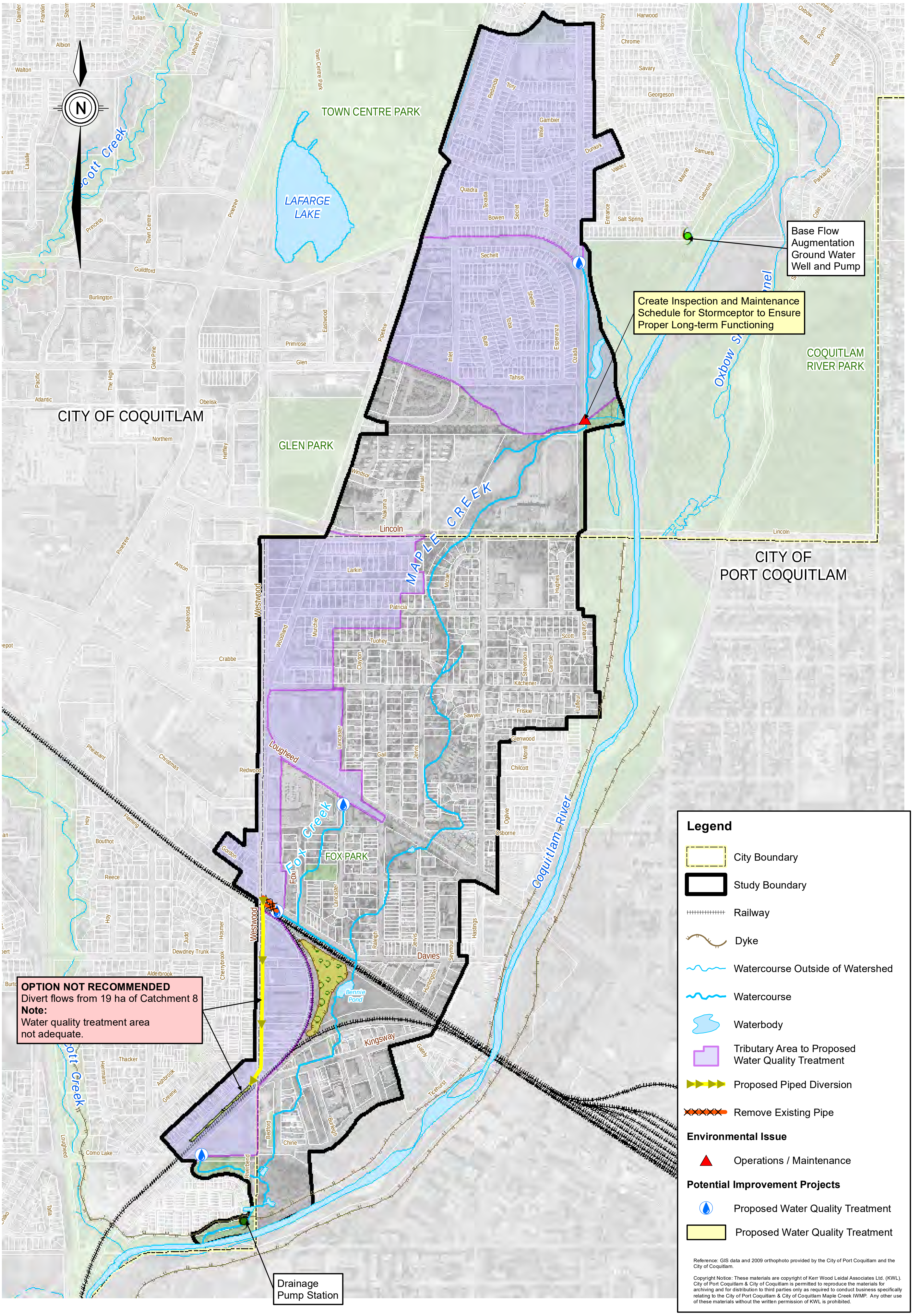

Base Flow Augmentation Ground Water Well and Pump

Create Inspection and Maintenance Schedule for Stormceptor to Ensure Proper Long-term Functioning

OPTION NOT RECOMMENDED
Divert flows from 19 ha of Catchment 8
Note:
Water quality treatment area not adequate.

Drainage Pump Station

Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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consulting engineers

City of Port Coquitlam & City of Coquitlam
Maple Creek IWMP

Project No.
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Date
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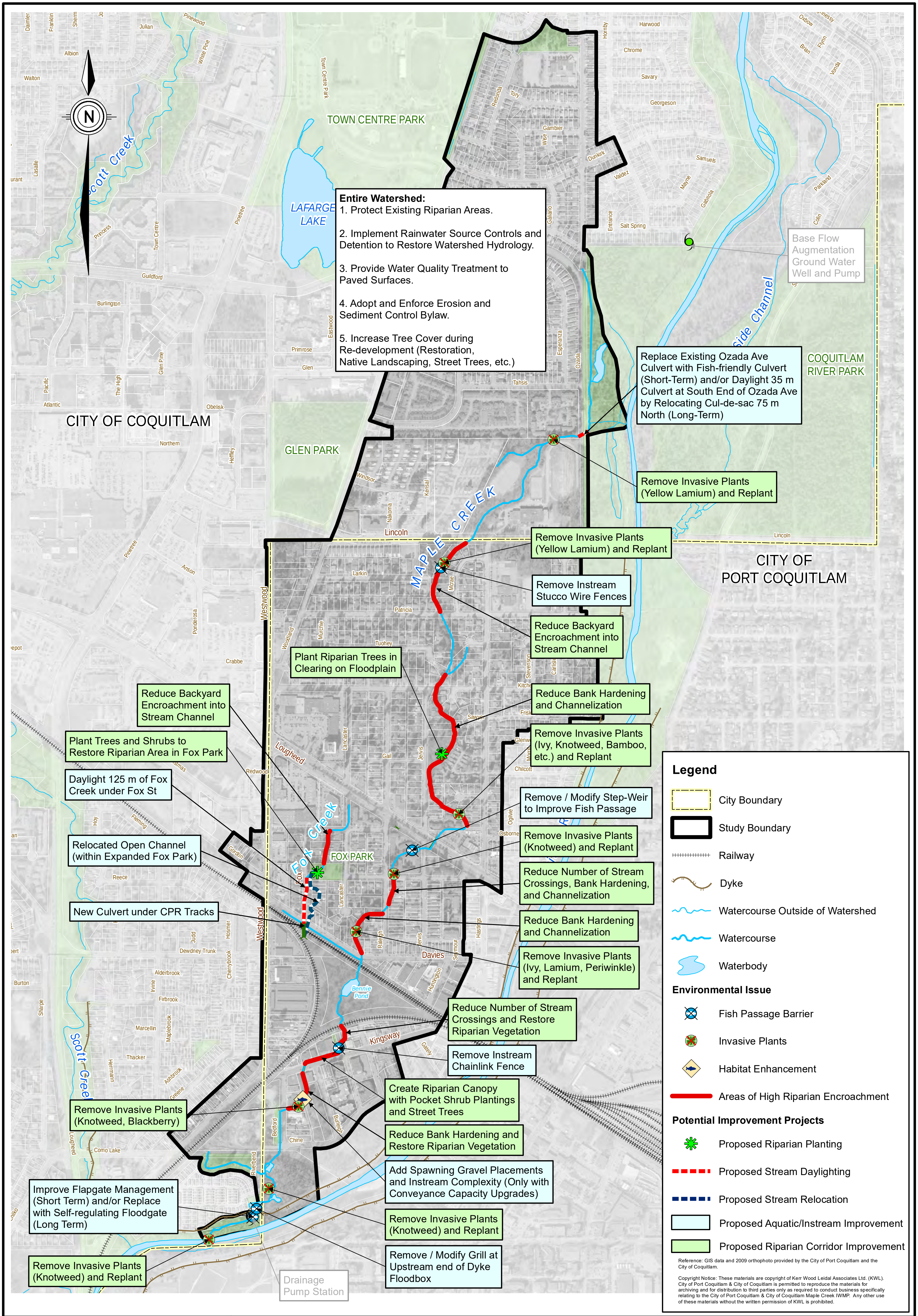
Water Quality Improvements

Figure 4-3



Entire Watershed:
1. Protect Existing Riparian Areas.
2. Implement Rainwater Source Controls and Detention to Restore Watershed Hydrology.
3. Provide Water Quality Treatment to Paved Surfaces.
4. Adopt and Enforce Erosion and Sediment Control Bylaw.
5. Increase Tree Cover during Re-development (Restoration, Native Landscaping, Street Trees, etc.)

Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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City of Port Coquitlam & City of Coquitlam
Maple Creek IWMP

Project No.	Date
646-046	April, 2021

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Environmental and Watershed Health Improvements

Figure 4-4

5. Flood Assessment and Alternatives

5.1 Creek Conveyance Capacity and Extent of Flooding

The hydrologic and hydraulic modelling results were used to analyze the cause and extent of flooding in the Maple Creek watershed. It is unlikely that the Ozada Diversion is contributing to flooding, as there is a constant inflow to Maple Creek of approximately 0.2 m^3/s in all design storms. This amount is approximately 6% of the total flow seen at the Maple Creek pump station. The analysis showed that the two main causes of flooding are undersized culverts/channels and undersized pump station.

Culvert Assessment

Conveyance constraints are undersized culverts and channels and/or obstructions or depositions that reduce conveyance capacity. There are many areas where the Maple Creek channel is constrained or obstructed. The worst of these areas are shown in photos in Appendix A and Figure 5-4.

The model results from the 100-year event, future land use, free outfall (flood box open) conditions were used to determine the maximum conveyance capacity. The existing Maple Creek channel has several areas where the channel is unable to convey the flow and results in flooding of the surrounding property. These areas are shown on Figure 5-1. The creek appears to be unable to convey the 100-year flow without flooding in upper residential areas. This analysis also showed that the sections of Maple Creek between Kingsway and Bedford (Coquitlam Glass) and downstream of Chine are unable to convey the large flows in a free-outfall scenario. A close-up view of the future free outfall water levels for the lower watershed area is shown on Figure 5-2.

Culvert Assessment Criteria

The model results and field inventory were used to assess the culverts on their ability to pass the required future peak flows (2-year, 10-year or 100-year) while limiting surcharging, and without flooding the land upstream. Private bridges built by property owners were not included in the model or assessed. Culverts were flagged as undersized if the upstream surcharge depth exceeded 50% of the culvert height above the culvert obvert for greater than 15 minutes.

Since several of the culverts in the watershed have low or negative slopes, a second check was done to determine if the head loss across the culvert during the future peak flow (100-year) was contributing to the flooding issues immediately upstream. Culverts were additionally flagged for improvements if they showed a drop in head while the upstream water level was above the crown and the slope of the upstream water profile was flat (backwatered).

Summary of Culvert Assessment Results

Under the future land use conditions, one culvert failed in the 2-year, one culvert failed in the 10-year and five culverts failed in the 100-year. Nine culverts that are not identified for replacement for conveyance need improvement or replacement to limit head loss. The culvert analysis is summarized in Table 5-1 and results are shown on Figure 5-1.

A larger pump station will not fix these flooding issues, as the creek is unable to convey water to the pump station. Creek conveyance improvements, especially to the lower creek downstream of Kingsway are required. The existing flood box appears to be adequate during free outflow events.

Pump Station Assessment

The *1992 Maple Creek Drainage Study* recommended a 1.5 m^3/s pump station together with 12,000 m^3 for storage directly upstream of the pump station to provide a 10-year level of service. The current permanent pumps on Maple Creek are rated for much higher heads (water levels) then those seen in Maple Creek, and as a result are outside of their best efficiency range and only pump a maximum of 1.0 m^3/s during peak flow events. The model was used to predict maximum creek water levels while the flood box was closed due to high Coquitlam River water levels. The adequacy of the existing pumping configuration was assessed under this condition. As the pumps become overwhelmed, water backs up in the lower area of the catchment. Refer to Figure 5-3.

As shown in Figure 3-2, it is assumed that the Coquitlam River water levels are high (extrapolated from provincial floodplain mapping) while the Maple Creek water levels are high, and therefore the flood box would be closed during design events. The extents of the flooding are shown on Figure 5-3 and water level profiles shown on Figure 3-2. The creek sections downstream of Kingsway show moderate flooding starting in the 2-year event. The channel downstream of Chine shows a much larger area of flooding; which is less of a concern at this time because the area is an undeveloped woodlot; however this area may be slated for future development. The 10- and 100-year events show widespread flooding of existing developed areas that have not been constructed to the recommended Coquitlam River Flood Construction Levels (FCL).

With the floodbox closed, five buildings are flooded during the 10-year and eleven during the 100-year event. When this area redevelops in the future, buildings and habitable areas will be constructed to the FCLs around El. Eight metre current pumping is inadequate to alleviate flooding.

5.2 Flood Management Alternatives

Culvert improvements above Davies Avenue are required in all proposed alternatives, including six culverts to be replaced and two to be improved.

The following alternatives were investigated to provide flood relief to the lower Maple Creek catchment. Section 7.11 provides more details and conceptual ‘ball park’ cost estimates for the alternatives. The alternatives are shown on Figures 5-5 and 5-6.

Alternative 1: Large Pump Station at Current Location with Conveyance Improvements

In addition to the aforementioned conveyance upgrades, construct a new higher capacity pump station in the current location. This alternative would solve the flooding problems, but conveyance upgrades would also be required in the lower watershed. Some buildings in the lower area were built much lower than the Coquitlam River Flood Construction Level (FCL) and may require an overly large pump to drain water levels below low-lying land.

Alternative 1A: Conveyance Improvements

A portion of the creek is in a narrow concrete channel abutted by existing buildings immediately downstream of Kingsway Avenue. This channel does not have sufficient capacity to convey the 100-year peak flow. A new culvert from the upstream end of Kingsway to the end of the concrete channel would be required. The new culvert would have to be lower than the existing channel to accommodate a larger culvert. An additional nine culvert replacements are needed in this alternative. Figure 5-5 shows this alternative.

The primary channel constraints occur downstream of Kingsway and upstream of Bedford (Coquitlam Glass), with buildings in close proximity. This makes channel widening challenging, therefore other options were explored in this area. A close up of this area is shown on Figure 5-4.

Alternative 1B: Constricted Channel Flood Bypass

Construct a high flow diversion downstream of Kingsway that bypass the constricted channel area between Kingsway and Bedford. This area is currently under construction and three options are shown to avoid possible conflict with the new development. Eight additional culvert replacements may be required depending on the bypass location and no channel improvements are needed. Refer to Figure 5-5 Option B.

Alternatives 1C: Flood Wall & Individual Pumps for Low-lying Properties until Redevelopment

Provide temporary protection to Coquitlam Glass with an impermeable wall and sump pump system until the property is redeveloped. This option is only valid if the Coquitlam Glass property is scheduled to be re-zoned and redeveloped in the near future. The developer would be required to raise the land to the FCL and provide a ROW on Maple Creek for improvements. An additional eight culvert replacements and one culvert improvement are needed in this scenario. Figure 5-5 shows this alternative.

Alternative 2: High Flow Diversion Above Railway McAuley Triangle

High Flow Diversion from Maple Creek to Coquitlam River

Construct a high flow diversion at Davis Avenue to divert flow greater than 2-year event away from Maple Creek directly to Coquitlam River. Refer to Figure 5-6. There is no dyke on the west side of the Coquitlam River between the Lougheed Bridge and the Railway Bridge, making this location ideal for a diversion pipe. The diversion would allow base and fish flows up to the 2-year peak flow to continue in Maple Creek while diverting larger flows to the Coquitlam River. A smaller upgraded pump station with a self-regulated flood gate would be required to service the lower portion of the catchment. This would not require most of the channel and culvert improvements in the lowlands. No additional culvert replacements or improvements are needed in this alternative.

High Flow Diversion from Culvert Westwood Catchment at Davies to Lower Maple Creek

Stakeholders raised another option to be considered: construct a diversion from the outfall at Davies and Westwood to the lower portion of Maple Creek below Chine Drive to alleviate flooding, and the need to upgrade culverts, between the railway and Riverbend. Refer to Figure 4-2. This option was investigated, but did not sufficiently reduce flows to a level to eliminate the need for drainage upgrades, and is therefore not recommended. This option was not recommended for water quality treatment either, as a treatment facility in the railway triangle had more treatment area (Section 4.3).

Alternative 3: 100-Year Detention in CPR Railway McAuley Triangle

Construct a 27,000 m^2, 1 m deep detention pond in the railway triangle to detain 100-year flows down to the existing 2-year peak flows. Refer to Figure 5-6. The detention pond would allow baseflows and flows up to the 2-year peak flow to continue down Maple Creek while detaining the larger flows. A smaller upgraded pump station with a self-regulated flood gate would be required to service the lower portion of the catchment. This would not require most of the channel and culvert improvements in the lowlands. No additional culvert replacements or improvements are needed in this alternative.

DFO does not support inline or in riparian detention and would prefer a different option. Also access permits from railway would be difficult to obtain. This option is not brought forward in Table 5-2

5.3 Emergency Flood Response Plan

General

The City takes the lead role in flood emergency response, with appropriate delegation to Owners. Staff, equipment and materials should be readily available to respond to emergency conditions. Assistance from the Ministry of Environment may be requested during severe events.

Should failure of the flood protection works be considered possible, the local RCMP should be alerted immediately. It is the RCMP's responsibility to notify the public.

Culverts, Bridges and Channel Works

The Section 11 Regulation under the *Water Sustainability Act* provides for certain emergency response actions by a City. In the event of a channel blockage during a flood, mobilization of heavy equipment is likely. The primary focus during flood events should be to remove channel obstructions at culverts, bridges and accessible creek channel locations.

Emergency Repairs

Emergency repairs may be required during and/or after significant flood events in response to possible damage that jeopardizes the integrity of the system, and thereby increases risk factors to unacceptable levels. Emergency repairs will normally be limited to the following:

- Repair of damaged channel bottom and bank protection by use of replacement riprap;
- Repair of training berm slopes and upper channel banks damaged by sloughing and erosion;
- removal of sedimentation;
- Removal of debris blockages and/or accumulations;
- Repair of any damage to culvert structures and headwalls; and
- Repairs to access roads.

Any emergency in-stream work will require approval from the environmental agencies prior to implementation.

Under extreme circumstances, endangered residents or area users should be advised of the situation, by the local RCMP. Such circumstances could result (though they are NOT anticipated) from:

- The possibility of major and uncontrollable flood overtopping; and/or
- The possibility of major, uncontrollable debris floods.

After the Flood

As soon as possible after a major flood, the City shall commission an inspection of the creek channel by a professional engineer. The City shall retain a copy of the inspection report, and provide a copy to the Regional Water Manager of Ministry of Environment. Any recommended creek channel restoration works shall be outlined in the inspection report.

Where an inspection report recommends immediate post-flood restoration work, these shall be implemented in accordance with the direction of the Regional Water Manager. For gravel removal activities, the provisions of Section 5.3 shall apply.

Table 5-1: Major Culverts and Bridges Undersized for Future Land Use

Culvert ID	Location	Diameter or Width x Height (m)	Shape	Material	Pipe Capacity (m^3/s)	Ratio of Water Depth / Culvert Height		100-Year Peak Flow (m^3/s)	100-Year Weir Flow[2]	Surcharge Time (min)	Meets Conveyance Criteria (Y/N)	Fails During	Replace or Improve
						U/S d/D[1]	D/S d/D[1]						
STPI15657	Lowflow Pipe to Lower Maple Creek @ Ozada Diversion	0.3	Circular	Concrete	0.1	3.2	1.6	0.2		105	Y		
STPI15658	School	0.45	Circular	Concrete	0.2	1.1	1.3	0.2		3	Y		
7820.1	School	0.6	Circular	Concrete	0.6	2.9	1.0	1.1		55	N	2-year	Replace
7821.1	City Boundary (Lincoln Ave.)	1.3	Arch	CMP	0.9	1.5	0.9	1.8	0.0	35	N	100-year	Replace
7812.1	Patricia Avenue	1.5	Arch	CMP	1.0	1.9	0.9	1.9	0.0	55	N	100-year	Replace for headloss
7824.1	Kitchener Avenue	3.5 x 1.2	Box	Concrete	14.9	0.8	0.7	3.8	0.0	0	Y		
7822.1	Lane	1.5	Arch	CMP	2.4	1.8	1.5	2.6	1.3	75	N	100-year	Replace
7868.1	Shaftsbury Place	7 x 1.2	Box	Concrete	31.0	1.0	1.1	3.2	0.0	10	Y		
7872.1	Car Lot Entrance	7 x 1.2	Box	Concrete	63.5	1.3	1.5	3.0	0.0	45	Y		
7811.1	Lougheed Highway	1.3	Circular	Concrete	3.1	1.5	1.1	3.0	0.0	75	Y		Improve Headwall
DM04750.1	Gordon Avenue	0.75 x 0.9	Box	Concrete	1.1	1.5	1.1	1.5	0.2	85	Y		Replace with Single Box Culvert
DM04751		0.75 x 0.9	Box	Concrete	1.3	1.5	1.1	1.5		85	N	100-year	
7819.1	Raleigh Street	1.4	Arch	CMP	2.1	1.9	1.4	2.2	0.9	95	N	10-year	Replace
7816.1	Davies Avenue	1.25 x 1.1	Box	Concrete	2.3	1.4	0.9	3.4	0.0	125	Y		Clear Vegetation from Channel Remove Gravel from Culvert
7823.1	Railway	2.5 x 1.5	Box	Concrete	0.6	0.7	0.5	3.4	0.0	0	Y		
7817.1	Railway	Irregular	Irregular	Concrete	0.0	0.9	0.9	3.5	0.0	0	Y		
KWL_C_7R	Kingsway Driveway Culvert	1.2	Circular	CMP	2.4	1.4	1.2	2.0	0.0	115	Y		Replace for headloss Replace with Single Box Culvert
KWL_C_7L		1.2	Circular	CMP	2.4	1.4	1.2	2.0		125	Y		
KWL_C_8R	Kingsway Driveway Culvert	1.2	Circular	CMP	1.1	1.4	1.2	2.0	0.0	125	Y		Replace for headloss Replace with Single Box Culvert
KWL_C_8L		1.2	Circular	CMP	3.1	1.3	1.2	1.9		135	Y		
KWL_C_9R	Kingsway Driveway Culvert	1.2	Circular	CMP	2.0	1.2	1.0	1.9	0.0	120	Y		Replace for headloss Replace with Single Box Culvert
KWL_C_9L		1.2	Circular	CMP	1.7	1.2	1.0	1.9		120	Y		
DM04757.1	Kingsway Avenue	1.6 x 1.0	Arch	CMP	2.8	1.5	1.6	1.9	0.5	140	N	100-year	Replace with Single Box Culvert Extend Culvert to End of Flume
DM04758		1.6 x 1.0	Arch	CMP	1.9	1.5	1.4	1.9		140	N	100-year	
7810.1	Bedford Street	1.5 x 1.2	Pipe Arch	CMP	4.2	1.3	1.0	3.6	0.0	135	Y		Replace for headloss
7813.1	Chine Drive	2.1 x 1.6	Box	Concrete	12.9	0.8	0.8	3.6	0.0	0	Y		
DM06778.1	Flood Box	1.5 x 1.5	Box	Concrete	7.1	0.6	0.6	3.6	0.0	0	Y		

Dark shaded entries exceed the conveyance criterion - conveyance of the 100-year peak flow while limiting the upstream surcharge depth to 50% of the culvert height above the culvert obvert for at least 15 minutes.

Light shaded entries exceed the headloss criterion - surcharge above culvert obvert and headloss occurs across the culvert during the 100-year event and upstream water surface slope

See Figures 9-1 for locations.

[1] U/S= Upstream D/S = Downstream ; d/D =depth / Diameter, >1 above crown

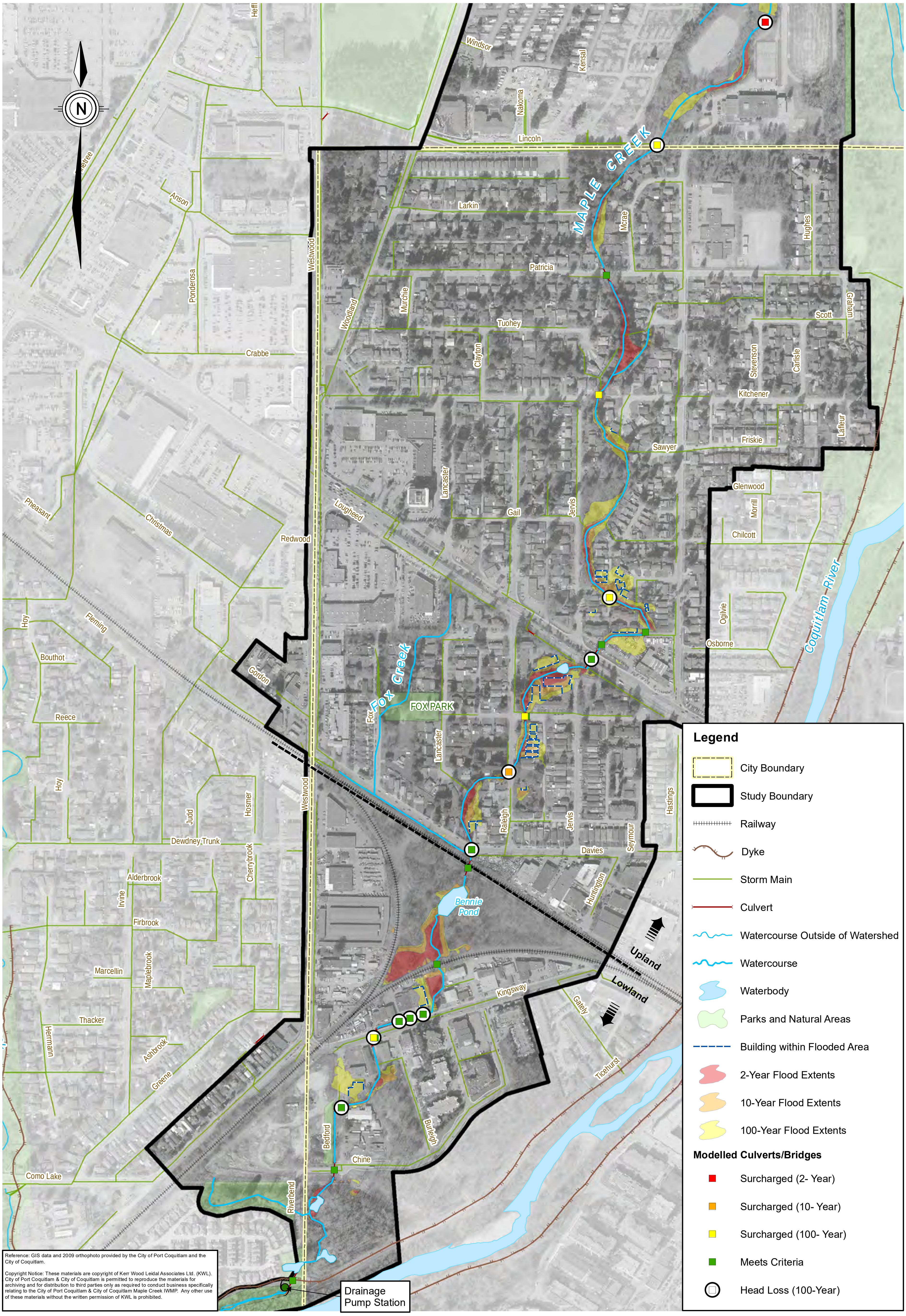
[2] flow over road, bridge, or path

Detailed design of improvements should include climate change and sea level rise considerations for major drainage system improvements (100 year return period).

Table 5-2: Flood Management Alternatives and Evaluation

Key Issue	Alternative				Improve Culverts	Capital Cost Estimate	Operation & Maintenance	Other	Environmental
Flood conveyance Issues	Improvements to channel (widening, berming, flood walls) & culvert upgrades & improvements (add / modify headwalls, sediment or vegetation removal)				6 / 2 U/S of Davies	▪ Required for all alternatives to provide 100-year flood conveyance. Flood Conveyance Improvements Required for All Alternatives (Figure 5-1).			
Flooding from Pump Station Backwatering	1	Large Pump Station at Current Location (Figure 5-5)				Pump not costed	▪ Uses existing location of pump station (PS) & floodbox. ▪ Channel improvements required to convey flow to PS; challenging due to existing building encroachment & shallow slope. See Options A – C below. Instream complexing to existing channel not recommended due to conveyance capacity limitations		
		A		Option 1A: Fit in Open Flumes to convey 100-year event	8	$1.2 M (Culverts) $1.2 M excl pump	▪ Pump Station maintenance	▪ Conveys flood flows. ▪ On private property, very close to existing buildings. ▪ Vertical wails should be fenced for safety, unattractive.	▪ Enclosing flume would be fish barrier, try to use open flume. ▪ Not fish friendly.
			Constructed Channels with Existing Building Encroachments – Bypass Options Diverts flow around constricted channels and areas of high risk of flooding. < 2-year flow remains in creek.						
		B	a)	Option 1Ba: Bedford Rd High Flow Bypass	6	$280,000 (Culverts) $890,000 (Pipe/Flow Control) $1.2 M excl pump	▪ Pump Station maintenance	▪ Kingsway and Bedford culvert upgrade not required ($1.9M). • Disruption to traffic during construction	• Could enhance existing flume d/s of Kingsway w/ instream complexing.
			b)	Option 1Bb: Burleigh Rd High Flow Bypass to new open channel	6	$280,000 (Culverts) $880,000 (Pipe/Flow Control) $260,000 (Channel) $1.4 M excl pump	▪ Pump Station maintenance	▪ Kingsway and Bedford culvert upgrade not required ($1.9M).	▪ Destruction of forest to construct overflow channel. ▪ Could enhance existing flume d/s of Kingsway w/ instream complexing. (no additional fish habitat because high flow overflow may be backwatered)
		C		Flood Wall & Individual Pump Protection of Low-lying properties Until Redevelopment	8	$1.2 M (Culverts) $260,000 (Pumps/Floodwall) $1.5 M excl pump	▪ Pump Station maintenance ▪ Maintenance of individual pumps	▪ Protect development today, raise ground to FCL during redevelopment. ▪ Pump Station may be slightly smaller with smaller water level drawdown.	n/a
	2	High Flow Gravity Diversion Above Railway Triangle (Figure 5-6) ▪ Reduce flows through high risk flood areas to 2-yr flows or less			0	(Pump not costed) $2.6 M (diversion) $2.6 M	▪ Smaller pump station upgrade. ▪ Increased maintenance for flow control structure, diversion, PS.	▪ Kingsway and Bedford culvert upgrade not required ($1.9M).	▪ Could add instream complexing d/s of railway.

Refer to Figures 5-5 and 5-6.
Preferred Alternative



Legend

▭	City Boundary
■	Study Boundary
++++	Railway
~	Dyke
—	Storm Main
—	Culvert
~	Watercourse Outside of Watershed
~	Watercourse
🟦	Waterbody
🟩	Parks and Natural Areas
- - -	Building within Flooded Area
🟥	2-Year Flood Extents
🟧	10-Year Flood Extents
🟨	100-Year Flood Extents

Modelled Culverts/Bridges

🟥	Surcharged (2- Year)
🟧	Surcharged (10- Year)
🟨	Surcharged (100- Year)
🟩	Meets Criteria
○	Head Loss (100-Year)

Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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consulting engineers

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Maple Creek IWMP

Project No.	Date
646-017	June, 2012

100 0 100 (m)
1:6,000

2-Year, 10-Year, 100-Year
Future Maximum Water Level, Floodbox Open

Figure 5-1

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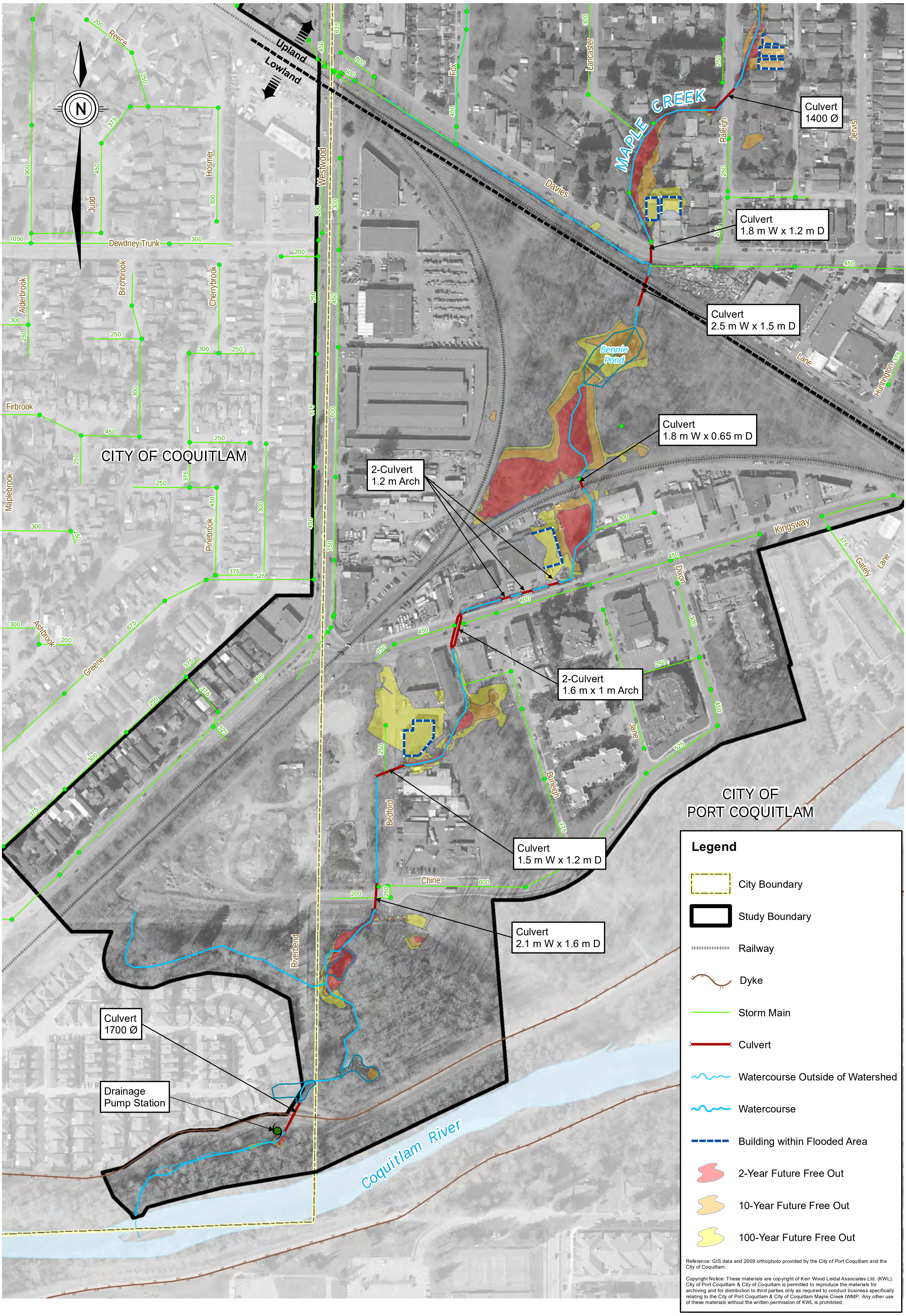
Author: jlau



Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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Maple Creek IWMP

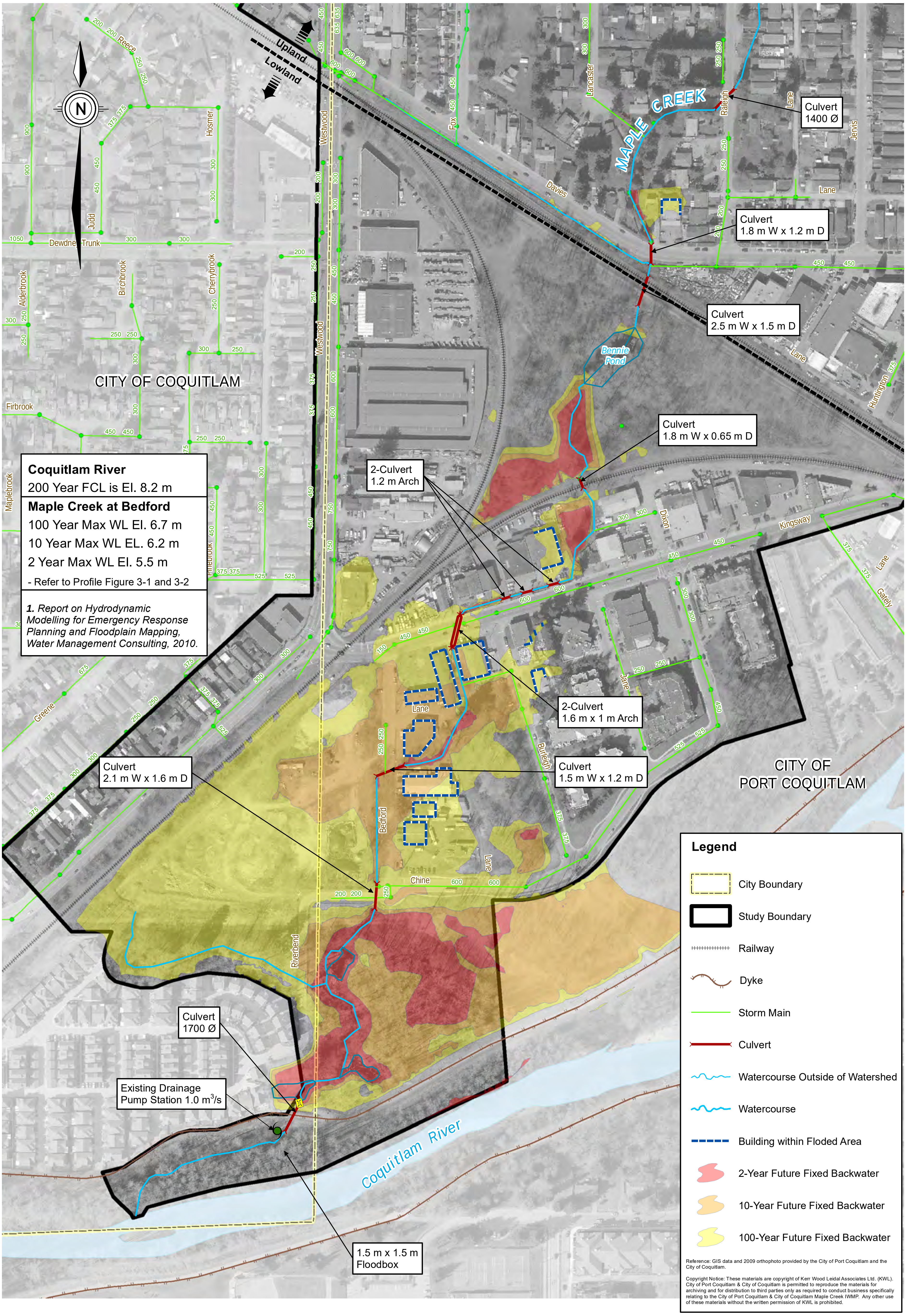
Project No.	Date
646-017	June, 2012

30 0 30
(m)
1:3,000

2-Year, 10-Year,100- Year
Future Maximum Lowland Water Level, Floodbox Open

Figure 5-2

Path: O:\0600-0699\646-017\430-GIS\MXD-Rp\646017Fig5-3_FutureBW_100_Year.mxd Date Saved: 4/3/2012 2:25:58 PM
Author: jlau



Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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Maple Creek IWMP

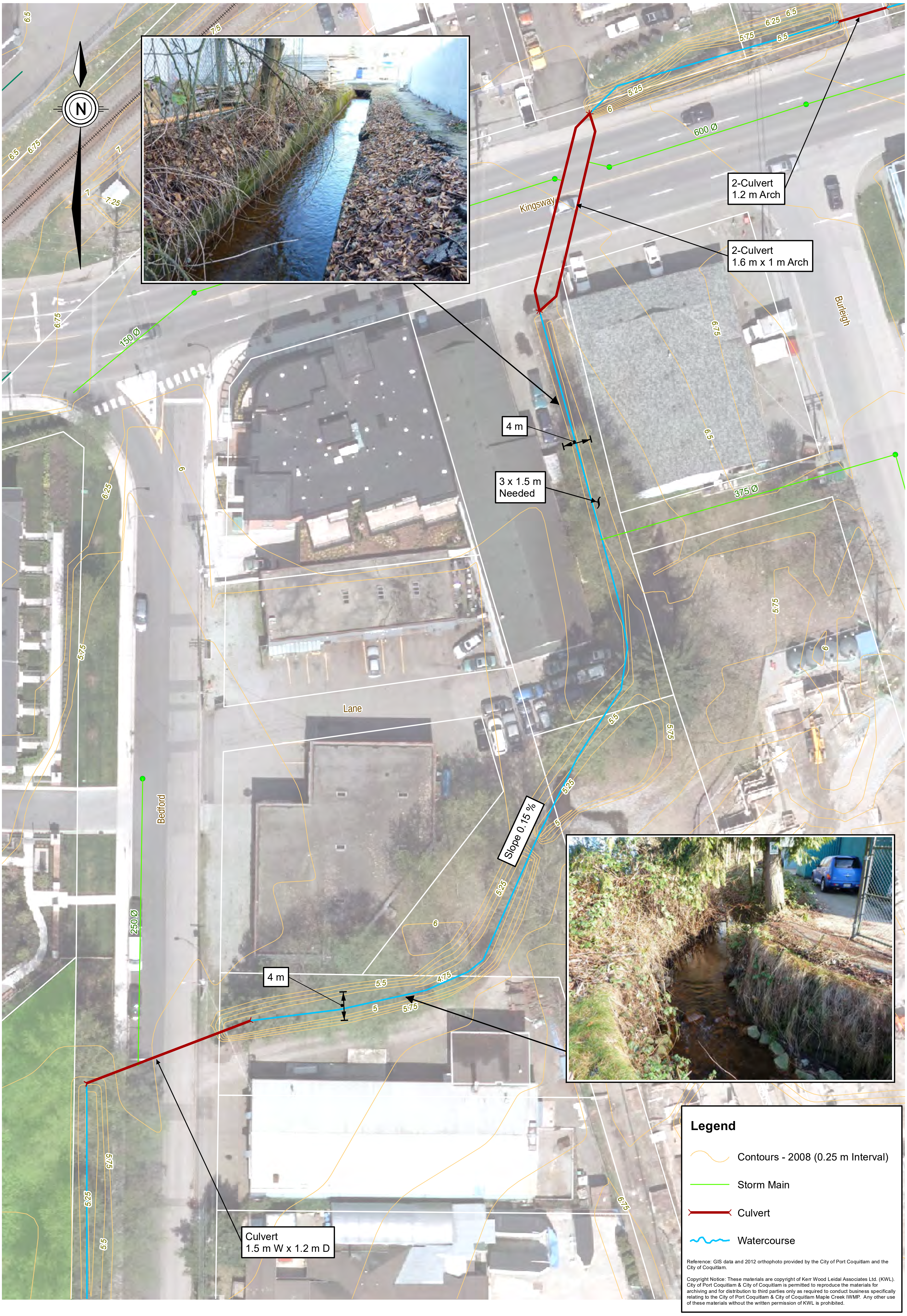
Project No.	Date
646-017	June, 2012

30 0 30 (m)
1:3,000

2-Year, 10-Year, 100- Year Future Maximum Lowland Water Level, Floodbox Closed

Figure 5-3

Path: Z:\0000-0999\0600-0699\646-046\430-GIS\MXD-Rp\646046Fig5-4_CriticalCreek.mxd Date Saved: 2021-04-12 3:11:13 PM
Author: JLau



Reference: GIS data and 2012 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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Maple Creek IWMP

Project No.	Date
646-046	April, 2021

10 0 10 (m)
1:500

Critical Creek Channel with Existing Building Encroachment

Figure 5-4

Path: Z:\0000-0999\0600-0699\646-046\430-GIS\MXD-Rp\646046_Fig5-5_Alternative1.mxd Date Saved: 2021-04-12 1:30:09 PM
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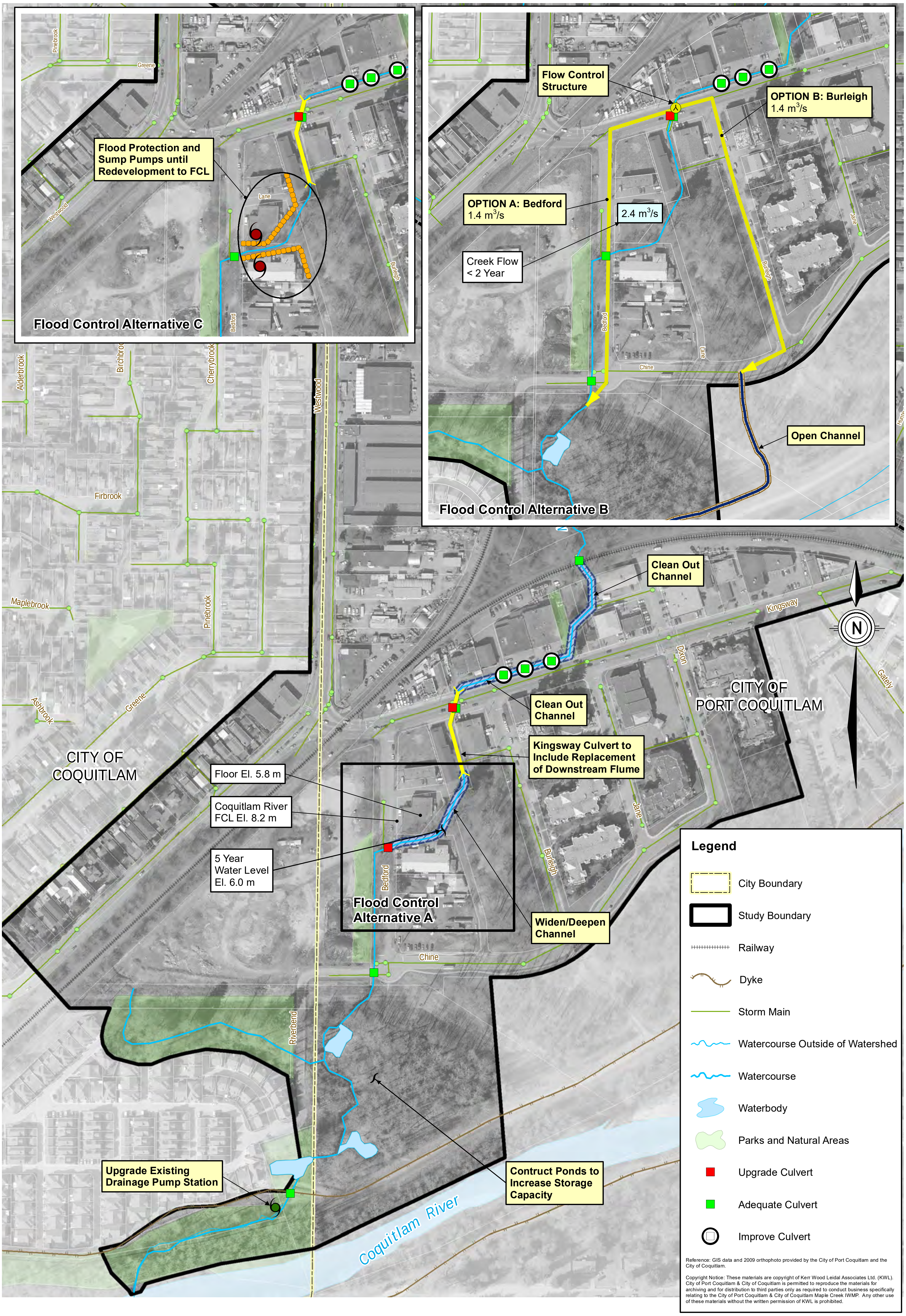

Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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Maple Creek IWMP

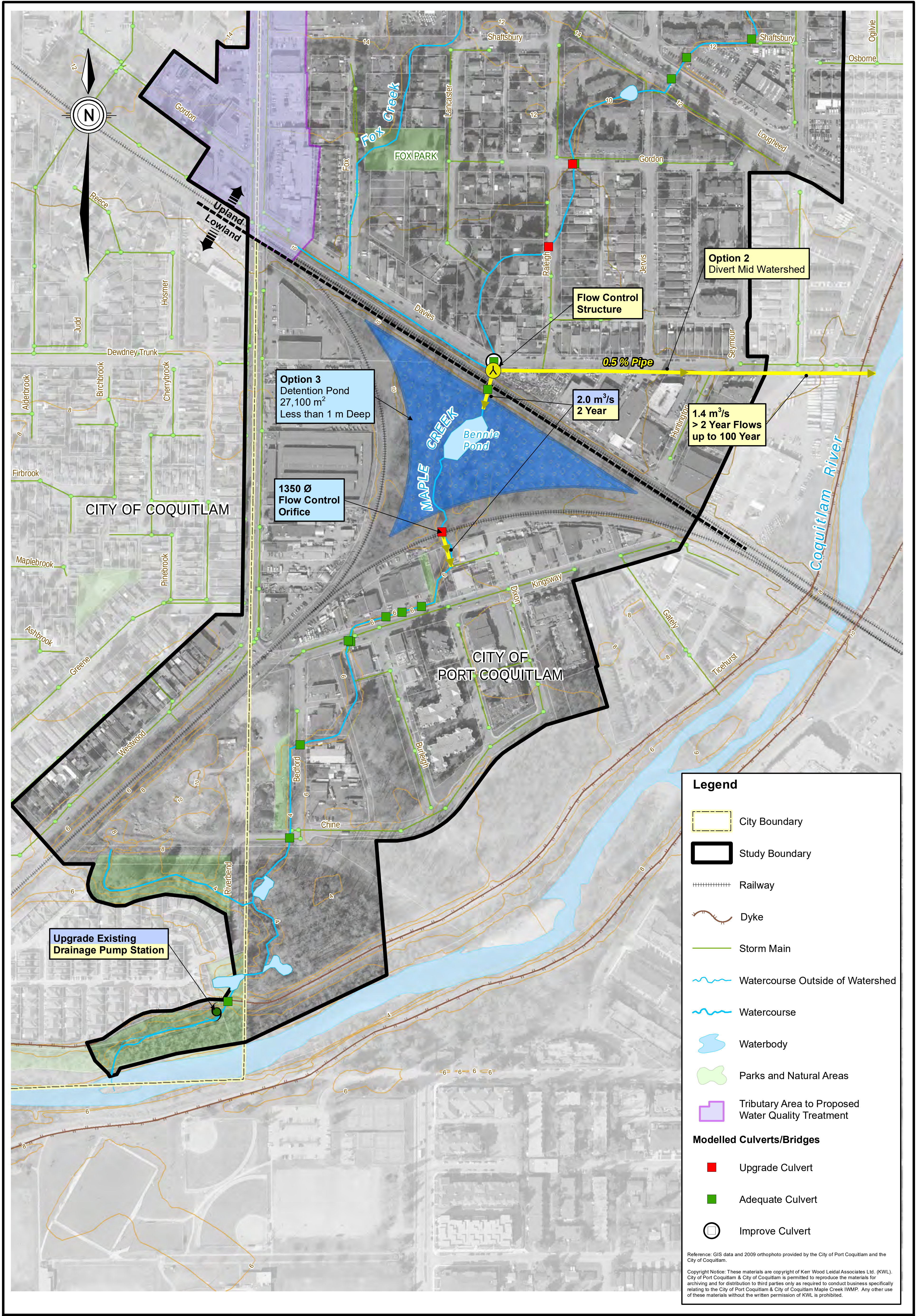
Project No.	Date
646-046	April, 2021

30 0 30 (m)
1:3,000

Alternative 1- Large Pump Station at Current Location

Figure 5-5

Path: O:\0600-0699\646-017\430-GIS\MXD-Rp\646017Fig5-6_Alternative2.mxd Date Saved: 4/3/2012 2:29:17 PM
Author: jlau



Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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Maple Creek IWMP

Project No.	Date
646-017	June, 2012

80 0 80 (m)
1:4,000

Alternative 2 and 3 - High Flow Diversion or Detention Pond at Railway Triangle

Figure 5-6

6. Mitigation of the Impacts of Future Land Development

Unmitigated development and redevelopment can result in hydrologic impacts that negatively affect watercourses causing flooding, erosion and degradation of fish habitat, reduced baseflows and water quality problems. Guidance to mitigate the impacts of development and redevelopment is one of the most important components of an IWMP.

6.1 Impacts of Development

Appendix F describes typical impacts of land development on watercourses including:

- Increased volumes and faster responding runoff peak flow rates can cause flooding and erosion.
- Increased frequency in peak flows and increased volumes can trigger watercourse instability and deteriorate aquatic habitat.
- Decreased infiltration reduces base flows during dry weather periods, which reduces the fish supporting capacity of a watercourse.
- Decreased stream water quality.

One of the primary objectives of this Integrated Stormwater Management Plan is to develop a plan to mitigate future development impacts.

6.2 Environmental Hydrologic Impacts Associated with Development

Stormwater Mitigation for the Protection of Watershed Health

Because of the significance of the baseflow, fish habitat and flood risk issues within the Maple Creek watershed, it is recommended that all future development and redevelopment be implemented with Low Impact Development (LID) approaches and source controls to mitigate the impacts of development on the health of the watershed. It is important to investigate measures to provide:

- **Water Quality Treatment** to treat stormwater runoff from pollutant-generating surfaces prior to discharge to watercourses;
- **Reduce Runoff Volumes** to preserve baseflows & minimize downstream erosion and habitat degradation; and
- **Reduce Post-development Peak Flows** to minimize downstream erosion and flooding.

LID planning should be included at the initial stages, as the most important aspect of LID is to retain existing natural hydrologic elements as much as possible.

The plan of the development must allow sufficient space, either open space, green space or underground space, for the implementation of mitigation source controls. This should be acknowledged and planned as the site is laid out, so that the mitigation is not just an afterthought for which there is no space allowed. Planning space for mitigation in the initial phases will keep design costs lower than re-designing a site at a later stage to introduce the space for mitigation.

Need for Low Impact Development Design

The goal of LIDs is to minimize the impacts of redevelopment and return to the natural hydrological+ function of the land as much as possible. Methods that should be used in the Maple watershed include:

- Forest cover should be protected and maintained as much as possible in conjunction with redevelopment. Construction should be staged and managed to retain existing trees, singly and in groups, wherever possible as large and mature trees provide significant interception and detention for rainfall whereas new landscape trees and shrubs provide very little until they mature.
- Riparian areas should be rigorously protected, and riparian setbacks increased where possible to provide shade and improve fish habitat.
- Impervious surfaces should be reduced where possible, such as road widths, surface parking requirements, and building sprawl.

Other potentially useful LID approaches are discussed in Appendix G.

Source Controls

In assessing the application of source controls within the Maple Creek watershed, a number of factors were considered such as land use and soils. There is also high groundwater table in the lower reaches of Maple Creek (Port Coquitlam) and infiltration may not be achievable there. Alternatively, storage detention facilities, green roofs, and rainwater harvesting should be considered instead.

Soils are divided into two categories of soil type based on geotechnical information as “Good” soils which consist of sand and gravel soils with infiltration rates of approximately 100 mm/hr and “Poor” soils which consist of till soils with infiltration rates of approximately 0-1.5 mm/hr.

Source Controls for Different Soil Types

A significant portion of the lowland area within the watershed is underlain by glacially deposited till soils. Concern regarding the use of various types of source controls in areas underlain by till is common, but evidence has shown that properly designed facilities work well even in these conditions. Till soils have a low hydraulic conductivity relative to sandier soils, on the order of 1.5 mm/hr, vs. 25 mm/hr or higher for sandy types of soils. The low conductivity means that water can infiltrate and travel in the soil layer very slowly, which places limitations on the use of infiltration source controls, but not on retention source controls, for volume reduction and water quality treatment.

When infiltration is limited as it is in till soils, source controls can rely on retention of runoff to achieve the volume reduction targets and achieve water quality treatment. Retention simply allows storage of the target volume of runoff that can then be infiltrated very slowly into till soils.

The types of source controls recommended for the Maple Creek watershed include on-site source control facilities to mitigate the runoff from a single site or lot, and regional source controls to mitigate a group of lots or sites together. In-ground source controls such as infiltration or retention rain gardens, trenches and galleries, swales and bio-retention are generally the default for a site, but they require space for in-ground installation. It may not be possible to mitigate a high-density development on-site given space, soils, slope and other limitations. For these cases, regional facilities on separate dedicated land may be the solution or alternatives to in-ground source controls may be necessary.

Typical above-ground source controls include storage and re-use tanks located either on the ground or on the roof. Stormwater harvesting and re-use can be allocated to irrigation, but a more efficient non-potable usage would be a "purple pipe" or grey water system for residential, institutional, or industrial uses. This type of system is covered by the British Columbia Building Code, Section 7, and can be permitted and approved by municipalities similar to any other building system.

Another above-ground approach is a green roof to mitigate the impervious building footprint. A green roof is most cost-effective on mid- to high-rise structures in an urban setting, but could be applied in any commercial, industrial, or institutional context[5]. The application of source controls based on land use, slope and soil conditions is described in Section 7.7.

Source Control Prescriptions Based on Land Use

The application of source controls to the various land use, slope and soil combinations was developed into "Prescriptions" described in Section 7.8. Source controls should be sized and designed to capture and hold 55 mm of rainfall from the subject site in order to have stormwater benefits. This is equivalent to the 72% of the 2-year, 24 hour design rainfall event.

Source Control Stormwater Target for Maple Creek Watershed: 55 mm

Supplement with Baseflow Augmentation Facilities

If the full 55 mm of rain source control volume reduction cannot be met, alternatively baseflow augmentation type facilities can be considered such that water is released to the storm conveyance system to the creek at a very low rate. The baseflow discharge rate is approximately 0.5 L/s/ha in the Maple Creek watershed. Such a slow discharge rate can lead to long storage times within these facilities and therefore they should be located underground to keep the water temperature cool and minimize mosquito problems.

6.3 Detention Criteria for Maple Creek Watershed

The detention criteria applied in the Maple Creek watershed needs to address multiple issues: flood protection, erosion, and aquatic habitat. Possible criteria include:

a) **Flood Protection Criteria for Maple Creek:**

    1. City of Port Coquitlam: control the post-development to pre-development levels for 5-year return period.
    2. City of Coquitlam: limit flows to the more stringent of the following criteria; Control the 5-year post-development flow to: 50% of the 2-year post-development rate; or the 5-year pre-development rate.

b) **Aquatic Habitat Protection Criteria:** DFO: 6-month Volume Reduction and WQ treatment and flow control 6-month, 2-year, and 5-year 24-hour post-development flows to pre-development levels.

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[5] Metro Vancouver "Design Considerations for the Implementation of Green Roofs", 2009.

6.4 Mitigating the Impacts of Future Development Alternatives

The ecological health of a watershed is affected by numerous factors: water quality, baseflows, peak flows and their durations, riparian forest integrity, watershed forest cover, wildlife habitat and corridors, fish habitat, etc. The watershed ecological health can be maintained or improved with the following:

a) **Construct water quality treatment facilities:** To treat the runoff from paved or pollutant-generating surfaces, facilities such as vegetated swales, rain gardens, wetlands, or manufactured treatment systems could be used. Fencing of creeks to exclude access, sediment and erosion control during construction, and spill emergency response plans help to protect water quality.

b) **Construct baseflow protection facilities:** To maintain the natural baseflows in creeks, infiltration trenches, rain gardens, baseflow release facilities, or well-based augmentation could be used.

c) **Construct peak flow and duration reduction facilities:** To limit the flows to pre-development conditions, use stormwater capture facilities in conjunction with peak flow reduction facilities or existing diversion pipes targeting all storms up to the 2-year or 5-year event. Rain gardens, infiltration trenches, stormwater harvesting and reuse, green roofs could be used in conjunction with detention tanks and ponds to maintain pre-development stream flows. In Coquitlam, diversion pipes and outfalls at several locations take peak flows to the Coquitlam River instead of Maple Creek.

Table 6-1 outlines development criteria recommended for the Maple Creek watershed.

Table 6-1: Potential Maple Creek Watershed Criteria

Category		Purpose/Criteria/Solutions
Development Restricted		**To Protect Watershed Health** No development within Streamside Protection areas – protection of riparian setbacks are critical to watershed health.
Stormwater	**Water Quality Treatment**	**To Treat Stormwater Prior to Discharge to Watercourses** Size to treat 90% of average annual runoff (equivalent to 72% of the 2-year, 24-hour event (55mm)) from paved surfaces exposed to vehicular traffic. • Construct Stormwater Source Controls (rain gardens, vegetated swales, vegetated pervious pavers) to filter contaminants from roads and parking lots. • Alternatively consider regional water quality facilities (wetlands and wet ponds). • Construct oil/grit separators as spill control devices for gas stations, high risk spill industry, large parking lots. • Require and Enforce Erosion & Sediment Control measures during construction.
	Reduce Runoff Volume	**To Preserve Baseflows & Minimize Downstream Erosion and Habitat Degradation** Maximize infiltration in well-draining soils. In poor-draining soils, size source controls to capture 72% of the 2-year, 24-hour event (55mm) as a minimum. • Maximize low impact development techniques • Construct Stormwater Source Controls and regional facilities

Category		Purpose/Criteria/Solutions
	Reduce Runoff Peaks	**To Minimize Downstream Erosion and Habitat Degradation** Size to detain the 6-month, 2-year, 5-year post-development flows to pre-development levels. • Construct detention/infiltration facilities and use existing diversion pipes to Coquitlam River
Municipal Stormwater Program		**Develop, adopt and enforce the following:** • Erosion & Sediment Control & Streamside Protection bylaws • Rainwater Management Bylaw – emphasis on 6-month Volume Reduction • Examples and standards for Stormwater Source Controls to aid with implementation

7. The Plan

7.1 Introduction

The overall IWMP for the Maple Creek watershed, developed together with the Cities and stakeholders, consists of the preferred options for addressing:

- Baseflow augmentation;
- Operation of the Ozada high flow diversion;
- Water quality treatment;
- Aquatic and riparian improvements; and
- Flood protection.

Table 7-1 summarizes and prioritizes all the IWMP components, including cost estimates, implementation priority, and responsibility for implementation. Although much of the implementation work will be done by the Cities, the various municipal divisions and personnel will have different roles to play, and the interactions between the Cities, regulatory agencies, and all other stakeholders in the community will be a large part of the successful implementation of the IWMP. The implementation includes 5-10 year, 10-20 year, and 50+ year initiatives, as well as ongoing works.

Stakeholder input on the alternatives is summarized in Appendix D.

7.2 Baseflow Augmentation Plan

The baseflows in Maple Creek are currently supplemented with a groundwater well and pump which has been losing capacity over the years. In order to increase the amount of baseflow in Maple Creek, the following works are proposed:

1. Create a municipal program to encourage on-site rainwater management (see Figure 2-4).
2. Further investigate the long term baseflow augmentation alternatives to determine the most suitable solution. Construct the selected alternative. Figure 4-1 shows the baseflow augmentation alternatives.

On-site Rainwater Management

A long term strategy to maximize groundwater recharge to sustain baseflows in Maple Creek is to improve the onsite capture and infiltration of water into the ground to sustain creek base flows. These measures could include increased volume of soil in landscaped areas, water infiltration trenches, rain gardens and roof leaders which could be disconnected where possible in areas with well-draining soils (Figure 2-4). On-site rainwater management measures could be done for both re-developing lots and existing lots provided that the measures do not negatively impact adjacent, down-slope neighbours. These measures are discussed further in Section 7.7. However, given the extent to which baseflows have been diverted away and not infiltrated and that re-development is a long-term strategy that will over a very long time frame, baseflow augmentation will still be required.

The short-term baseflow augmentation plan is to drill a new production well in another location. Further investigation would be required to locate the ideal location. This will allow the City of Coquitlam to investigate the feasibility of the two long-term baseflow augmentation options without risking further reduction in baseflows in the Maple Creek.

Table 7-1: Maple Creek IWMP and Implementation Strategy

Plan Components	Priority	Cost Estimate	Responsibility
ENVIRONMENTAL ENHANCEMENT PROJECTS			
1. BASEFLOW AUGMENTATION			
• Create a municipal program to encourage on-site rainwater management	Immediate	n/a	City Eng /Dev Services
• Investigate long term baseflow augmentation alternatives. Figure 4-1. • Construct preferred alternative.	5 years 5 to 10 years	$50K	City Engineering
2. WATER QUALITY TREATMENT			
• Add four structural water quality treatment or filtration features. Figure 7-1. • Three in Port Coquitlam, one in Coquitlam,	On-going	or $\$190/m^2$ $260 K/ea	Developer and/or Cities
• Follow Spill Response Plan	Immediate	-	Operations
• Inspect and maintain Ozada Ave Stormceptor regularly	Immediate	-	Operations
3. UPGRADE FISH PASSAGE IMPEDIMENTS			
• Remove fish passage impediments such as fences, creek obstructions & weirs.	On-going	$39 K	Developer and/or Cities
• Flood box gate improvements with pump station upgrade – 2023	5 years	-	City Engineering
4. RESTORE IN-STREAM COMPLEXING			
• Remove concrete flume & replace with natural watercourse.	5 to 10 years	$65 K	City Engineering
• Add spawning gravels & instream complexity in lower watersheds (with concurrent channel modifications to improve channel capacity)	On-going	TBD	Developer and/or Cities
5. RESTORE RIPARIAN AREAS			
• Remove invasive species & reforest with native species.	At redevelopment On-going	$\$28/m^2$	Developer and/or Cities
• Widen riparian setbacks during redevelopment & increase natural watershed & vegetation cover		TBD	
COMBINED FLOOD MANAGEMENT & ENVIRONMENTAL ENHANCEMENT			
6. OZADA DIVERSION OPERATION			
• Maintain operation as is but stop the practice of sandbagging during storms.	Immediate	-	Operations
• Undertake feasibility study to determine preferred long-term alternative. Fig 4-2. Implement alternative.	20 to 50 years	$597-$772 K	City Engineering
7. REMOVE CREEK OBSTRUCTIONS			
• Remove channel obstructions & clean out overgrown vegetation to improve conveyance & fish passage	5 to 50 years	-	Operations
FLOOD MANAGEMENT			
8. UPGRADE DRAINAGE PUMP STATION			
• Construct large pump station at current location with a self-regulating tide gate and improve floodbox.	2023	$3.4M	City Engineering
9. CULVERT UPGRADES • Add climate change & sea level rise considerations for major drainage system improvements (100- & 200-year return periods) prior to design. • See Table 7-4 for conveyance upgrade project costs & locations.			
• Upgrade 1 culverts in Port Coquitlam. • Upgrade 1 culverts in Coquitlam.	5 to 10 years	$447K $341K	City Engineering City Engineering
• Upgrade 1 culverts in Port Coquitlam.	10 to 20 years	$54K	City Engineering
• Upgrade 5 culverts in Port Coquitlam. • Upgrade 2 culverts in Coquitlam.	50+ years	$2.02M $204K	City Engineering City Engineering
10. CONSTRUCT KINGSWAY BEDFORD DIVERSION			
• Provide a 100-year high flow diversion along Kingsway & Bedford to supplement the confined Kingsway Avenue to Bedford flumed channel section. Refer to Figure 7-5. • Add climate change and sea level rise considerations for major drainage system improvements (100 and 200 year return periods) prior to design.	5 to 10 years	$1.2 M	City Engineering
MITIGATION OF THE IMPACTS OF FUTURE DEVELOPMENT (Requirements for All New Development & Redevelopment)			
11. PROTECT RIPARIAN AREAS to protect stream health, streambank stability & wildlife habitats			
• No development within SPR (City of Port Coquitlam) or RAR (City of Coquitlam) setbacks unless compensation is provided – protection of riparian setbacks are critical to watershed health.	At redevelopment 20 to 50 years	-	Developer Cities' Env. & Dev. Services
12. CONSTRUCT HYDROLOGIC VOLUME REDUCTION MEASURES to maintain baseflows & minimize downstream erosion & habitat degradation			
• Maximize low impact development techniques. • Construct Stormwater Source Controls (bio-retention rain gardens or swales, pervious pavers, absorbent soil layers, green roofs, rainwater harvesting & reuse, etc.). Size to capture 72% of the 2-year, 24-hour event (55mm). • Regional facilities for base-flow augmentation (sustain base-flows).	At redevelopment 20 to 50 years	TBD	Developer Cities' Env. & Dev. Services
13. CONSTRUCT STORMWATER QUALITY TREATMENT MEASURES to treat runoff prior to discharge to watercourses			
• Size to treat 90% of average annual runoff (approx. 72% of the 2-year, 24-hour event (55 mm)). • Construct Stormwater Source Controls (rain gardens, vegetated swales, vegetated pervious pavers) to filter contaminants from roads & parking lots. • Alternatively consider regional water quality facilities such as wetlands & wet ponds. • Construct oil/grit separators. spill control devices for gas stations, high risk spill industry, parking lots. • Require & enforce *Erosion & Sediment Control* measures during construction phase of development.	At redevelopment 20 to 50 years	TBD	Developer Cities' Env. & Dev. Services
14. CONSTRUCT HYDROLOGIC RATE CONTROL MEASURES to minimize downstream erosion, habitat degradation & flooding			
• Size to detain 6-month, 2-year & 5-year post to pre-development levels. • Construct detention/infiltration facilities.	At redevelopment 20 to 50 years	TBD	Developer Cities' Env. & Dev. Services
MUNICIPAL STORMWATER MANAGEMENT PROGRAM			
15. BYLAWS & STANDARDS (APPLY MUNICIPALITY WIDE)			
• Develop Rainwater Management Policy and Erosion & Sediment Control Bylaw in Port Coquitlam • Enforce City of Coquitlam Erosion & Sediment Control Bylaws. • Update Development Bylaws to include climate change and sea level rise considerations for the major drainage system assessments (100 and 200 year storms).	5 to 10 years		City Development Services
16. FURTHER WATER QUALITY STUDIES IN MAPLE CREEK WATERSHED			
• Undertake further surveillance sampling to identify point-source discharges from previously identified problem sites.	20 year	$39,000	City Engineering
17. WATERSHED MONITORING			
• Conduct watershed performance monitoring & adaptive management approach	Every 5 years min.	$39 K/yr	Cities' Engineering
18. EDUCATION/OUTREACH PROGRAM			
• Begin education & outreach with private property owners who have watercourses with regards to stream and watershed health	Immediate		Cities' Env Services
	City of Port Coquitlam City of Coquitlam Both Municipalities Total Plan Costs	$7.224M $1.367M $1.079M $9.670M	

Other Baseflow Augmentation Alternatives

There are several solutions for maintaining adequate baseflows in Maple Creek to replace the lost capacity of the existing groundwater well. Further study and investigation is recommended in order to determine the best option:

- Drill a new production well at different location (assume approximately $500,000 but an updated cost estimated is needed)
- Upstream Gravity Diversion from Coquitlam River with conveyance through existing storm sewers and well piping; connect local system where required ($1.9M)
- Pump from Coquitlam River and use existing well piping; connect local system where required (not costed because the gravity option was preferred in 2012)
- Pump from Coquitlam River with discharge at top of Maple Creek channel (not costed because the gravity option was preferred in 2012)

The stream baseflow augmentation options listed in Table 4-1 should be evaluated and, if feasible, implemented. The gravity diversion from Coquitlam River is the most sustainable option because it doesn't rely on ongoing pumping, although it has the highest construction cost at $1.9M. Drilling a new groundwater well may be the most cost effective option although lifecycle costing is required to confirm this.

7.3 Operation of Ozada High Flow Diversion

The existing Ozada High Flow Diversion consists of a concrete headwall with a 300 mm concrete pipe that acts as an orifice delivering flow to Maple Creek and a high flow channel towards Grist Channel. During baseflows, the existing 300mm pipe allows the desired 20 L/s to continue downstream to Maple Creek. During storms, the orifice limits that peak flows to Maple Creek to 200 L/s. The City of Port Coquitlam currently blocks the 300 mm pipe with sand bags during flood events to minimize the flooding experienced downstream. However, modelling shows that the 200 L/s conveyed by the 300 mm pipe is a small fraction of the Maple Creek flows in the downstream sections that experience flooding. Therefore, is unlikely that the Ozada diversion is contributing significantly to downstream flooding in its current configuration.

Short Term Operation and Maintenance of Diversion

In the short term, it is recommended that Ozada Diversion be retained as-is, with no modifications to the existing structure as it is sufficient to maintain baseflow without exacerbating downstream flooding. It is recommended that the sandbag placement by the City of Port Coquitlam be immediately removed after large storm events and permanently removed when the pump station is upgraded and flood improvements constructed (see Section 7.3). A new fish-friendly culvert will replace the existing culvert at the school access.

This is a short-term solution that will be in effect until one of the two long-term alternatives is implemented to improve fish passage to Maple Creek upstream of the Ozada Diversion.

Long-term Diversion Alternatives

The current configuration of the Ozada diversion is a potential impediment to fish passage, although it is unclear to what extent. The 300 mm orifice opening to Maple Creek could easily be blocked (either intentionally or otherwise) which would not only block fish passage, but could dry out Maple Creek downstream in the dry summer months when the creek relies on baseflow augmentation. To address both the fish-passage and baseflow issues, two long-term alternatives were identified to modify and improve how this diversion is operated. Both alternatives require the removal of the existing diversion and 450 mm culvert at the base of Ozada Drive. The alternatives are described in Section 4.2 and are shown on Figure 4-2.

It is recommended that a feasibility study be completed to determine which of the long-term diversion alternatives is preferred. The study should take into account any water quality, volumetric reduction and peak flow control measures recommended later in this report (Section 7.7), as well as costs, ease of implementation, and City/stakeholder preference. The Class C cost estimates for both alternatives are included in Appendix H.

7.4 Water Quality Improvements

Water quality improvement projects are summarized in this section and are shown in Figure 7-1. Three types of water quality improvements were identified: construction projects, operation and maintenance, and studies. Projects have been prioritized as high, medium, or low depending on a range of factors. Sites for potential water quality improvement projects are summarized and prioritized in Table 7-2 and shown in Figure 7-1.

1. **Water Quality Projects**

   Add structural water quality treatment or filtration features to the identified locations, including:

   WQ1. Outfall east of Westwood St. on south side of Davies Ave;

   WQ2. Upstream end of Tributary1;

   WQ3. Fox Creek downstream of Lougheed Highway; and

   WQ4. Outfall at north end of Ozada Ave.

2. **Operation and Maintenance**

   Emergency Spill Control Plans to protect the watercourses, aquatic habitat and species, and groundwater were developed and adopted by both the City of Port Coquitlam (*Draft Environmental Spill Response Plan, 2012)* and the City of Coquitlam (*Spill Response Guidelines (May, 2019, CEDMS# 2915259)).*

   Inspection and maintenance schedules for the existing Stormceptor at Ozada Avenue and all future water quality treatment or filtration features should be created and adhered to, to ensure proper long-term function.

3. Further Studies

Based on water quality sampling results, further sampling should be undertaken to examine potential point-source discharges of pollutants. Previously identified problem sites include:

- CPR Automobile Salvage Yard;
- Auto salvage/storage facility east of the creek on south side of Davies Ave.; and
- Metro Motors on north side of Lougheed Highway.

Investigate potential for sanitary-storm sewer cross-connections in residential areas between Patricia Avenue and Davies Avenue.

Table 7-2: Proposed Water Quality Improvements

Category	Potential Project	Priority	Cost	Jurisdiction
Water Quality Projects	WQ1. Add structural water quality treatment or filtration feature to outfall east of Westwood St., on south side of Davies Ave	High	Stormceptor = $260K; Biofiltration wetland = $190/m2	Port Coquitlam
	WQ2. Add structural water quality treatment or filtration feature at upstream end of Tributary 1.	Medium	Stormceptor = $260K; Biofiltration wetland = $190/m2	
	WQ3. Add structural water quality treatment or filtration feature on Fox Creek downstream of Lougheed Highway.	Medium	Stormceptor = $260K; Biofiltration wetland = $190/m2	
	WQ4. Add structural water quality treatment or filtration feature to outfall at north end of Ozada Ave.	Medium	Stormceptor = $260K; Biofiltration wetland = $190/m2	Coquitlam
O & M	Create inspection and maintenance schedule for Stormceptor at south end of Ozada Ave. to ensure proper long-term functioning.	High	Within existing operational budgets	Coquitlam
Further Studies	Investigate potential for sanitary-storm sewer cross-connections in residential areas between Patricia Ave. and Davies Ave.	High	$6,500-13,000	Port Coquitlam
	Conduct further surveillance sampling to identify point-source discharges from the previously identified problem sites and undertake measures to reduce risks. Previously identified problem sites include: (1) CPR Automobile Salvage Yard; (2) Auto salvage/storage facility east of the creek on south side of Davies Ave.; and (3) Metro Motors on north side of Lougheed Highway.	High	$13,000	

Notes:
See Figure 4-3 for Locations
Green text - within Port Coquitlam's jurisdiction, Blue text - within Coquitlam's jurisdiction, Black text - within both jurisdictions

7.5 Aquatic and Riparian Improvements

Aquatic and riparian improvement projects are summarized in this section and are shown in Figures 7-2 and 7-3 and are summarized in Table 7-3.

Aquatic / Instream Improvements

In order to restore and enhance the aquatic habitat in Maple Creek the following works are proposed (see Figure 7-2):

1. **Remove Fish Passage Impediments**

   Five of the existing fish passage impediments in the watershed are to be removed or modified to improve access to and from spawning and rearing habitats. This are all listed as high priority because of their importance or risk to the productivity of fish habitat in the watershed. Fish passage impediments on private property are to be dealt with at the municipal level though existing Watercourse Protection Bylaws.

2. **Habitat Enhancement**

   Add spawning gravels and instream complexity in the lower watershed in conjunction with channel modifications to improve conveyance capacity. Due to past impacts and modifications, these important fish habitat features are lacking in some sections of the lower part of the watershed. The channel capacity must be upgraded prior to placement of gravel or instream structures to ensure flooding is not exacerbated.

3. **Address Channelization**

   Remove the channelized portion of the Davies Avenue ditch portion of Fox Creek; and replace with natural watercourse channels.

4. **Culvert Replacement and Stream Daylighting**

   One short-term project is replacing the existing 450 mm Ozada Avenue culvert with a larger (600 mm) gravel bottom (fish-friendly) culvert, while maintaining the existing Ozada diversion. A longer-term stream daylighting project at Fox Creek was identified upstream and downstream Davies Avenue (175 m of channel). It would require substantial planning and coordination prior to implementation.

Table 7-3: Proposed Aquatic and Riparian Improvements

Category	Key Issue	Potential Project	Priority	Cost	Jurisdiction
Aquatic / Instream Improvement	Fish Passage Impediment	FP1. Improve flapgate management or replace with self-regulating tide gate.	High	Improve: $6K, Replace with self-regulating floodgate $40,000	Port Coq / Coq
		FP2. Remove grill at upstream end of dyke floodbox. If necessary, replace with an upstream structure to catch large debris.	High	$6500-13,000	
		FP3. Remove instream fence upstream of Kingsway Ave.	High	Within existing operational budgets	Port Coquitlam
		FP4. Remove instream fences at 3691 McRae Crescent.	High	Within existing operational budgets	
		FP5. Remove or modify step-weir downstream of Lougheed Highway.	High	$13,000-19,000	
	Habitat Enhancement	H1. Add spawning gravels & instream complexity in lower watershed (complete only in conjunction with channel modifications to improve conveyance capacity).	Medium	Spawning gravels = $\$100/\mathrm{m}^3$ / $\$26/\mathrm{m}^2$; Complexing (logs, boulders, etc.) = $6500/structure or $32k per 100 m	
	Channelization	H2. Remove concrete flume & replace with natural watercourse during re-development in the long term.	Medium	$1000/m	
	Culvert Replacement	H3. Replace existing 450 mm Ozada Ave culvert with larger (600 mm) gravel bottom (fish-friendly) culvert to improve instream habitat connectivity	Medium	$1900-2600/m	Coquitlam
	Stream Daylighting	H4. Daylight 35 m culvert at south end of Ozada Ave by relocating cul-de-sac 75 m north, eliminating a road crossing & provide an enhanced north-south greenway connection between Glen Park & the Coquitlam River. (longer-term option to line above)	Low	Included in Ozada Alternatives Cost Estimate	
	Stream Daylighting / Fish Passage Impediment	H5. Daylight 125 m of Fox Creek by replacing culverted section with open channel & riparian area along east side of Fox St. during re-development (requires expansion of Fox Park to include two existing residences south of current park).	Low	$1900-2600/m	Port Coquitlam
Riparian Corridor Improvement	Riparian Encroachment	Address both instream & riparian encroachment by reducing stream crossings, bank hardening, & channel modifications by private landowners. Encourage use of native plantings and/or bioengineering methods to stabilize banks & create a small riparian buffer zone. Priority sites include: R1. Industrial portion of lower watershed from Bedford St. to Kingsway Ave.; R2. Residential front yards from Raleigh St. upstream to Gordon Ave.; R3. Various lowbank residential backyards from Shaftsbury Pl. to Kitchener Ave.; R4. Various lowbank backyards on east side of creek from Patricia Ave. to Lincoln Ave.; & R5. Backyards of four residential properties that back onto Fox Creek on west side of Lancaster St., between Shaftsbury Ave. & Gordon Ave.	High / Medium	Landowner costs but municipalities could consider providing plants & other materials free of charge (plants = $15/m2)	
	Riparian Encroachment	Widen riparian setbacks per RAR (Coquitlam) or SPEA (Port Coquitlam) during re-development, particularly in the following locations: R6. lower watershed from Chines Dr. to the Railway Triangle; & R7. from Davies Ave. upstream to Lincoln Ave. (above & below Lougheed Highway).	High	n/a	
	Riparian Planting	R8. Plant native shrubs in Fox Park to stabilize streambanks & restore riparian understory.	High	$15/m2 for planting (into native soil), $6/m2 for site prep (add soil, etc.)	
		R9. Plant riparian trees in clearing on floodplain west of creek opposite Gail St.	Medium		
		R10. Plant low-growing shrubs in pocket sites along channelized section along Kingsway Ave.	Medium		
	Riparian Encroachment	R11. Use strategically-placed street trees & parking lot landscaping to create a riparian canopy in the section that runs parallel to & north of Kingsway Ave. Consider amalgamating driveway crossings in this area during re-development.	Low		
	Invasive Plants	Remove and/or treat problematic invasive plants & replant with native species. Priority species for control include knotweeds, ivy, & yellow lamium. Priority sites include: R12. Lower watershed downstream of Chines Dr. (knotweed, reed canarygrass); R13. Between Bedford St. & Kingsway Ave. (knotweed, blackberry); & R14. Lowbank backyards from Davies Ave. to Lincoln Ave. (knotweed, ivy, yellow lamium, periwinkle, daphne-laurel, etc.).	High	Invasive removal = $6/m2 (but depends on species); $15/m2 for planting (into native soil), $6/m2 for site prep (add soil, etc.)	Port Coq / Coq
	Landowner Education	R15. Create municipal programs to educate landowners on the importance of riparian areas.	Medium	n/a	
Terrestrial Habitat Improvement	Forest Cover	Increase natural watershed forest & vegetation cover through: (1) Reforesting a portion of development parcels during re-development; (2) Planting street trees; & (3) Encouraging use of native plants in landscaping during re-development.	High		

Notes: See Figure 4-3 for Locations
Green text - within Port Coquitlam's jurisdiction, Blue text - within Coquitlam's jurisdiction, Black text - within both jurisdictions

Riparian Corridor / Terrestrial Habitat Improvement

In order to restore and enhance the riparian corridor / terrestrial habitat in Maple Creek the following works are proposed (see Figure 7-3):

1. **Address Riparian Encroachment**

   From an ecological health perspective the most important improvement is to reduce stream and riparian encroachment and restore natural riparian vegetation. Efforts should be made to substantially enlarge riparian setbacks as redevelopment of the watershed occurs, with the long term goal of re-establishing RAPR and SPEA setbacks throughout the watershed.

2. **Riparian Plantings / Invasive Species**

   At sites not undergoing redevelopment, opportunities may exist to work with private landowners to reduce bank hardening, channelization, remove invasive plant species and, were possible, restore narrow riparian areas. Owners should be encouraged to use row plantings of overhanging shrubs or trees to help improve the riparian areas. The larger riparian areas (projects identified in Table 7-3) should be planted with larger trees. The Cities are encouraged to develop programs to help private landowners identify invasive species and areas that would benefit from replanting, while provide guidance and incentives to landowners. A landowner education program should also be developed to educate the public on the importance of riparian areas.

7.6 Flood Management Plan

In order to prevent flooding in Maple Creek, the following works are proposed:

1. Complete required conveyance upgrades;
2. Construct a new higher capacity pump station at the current pump location. This must be done in conjunction with several culvert and channel upgrades immediately upstream; and
3. Construct the Bedford diversion.

Figures 7-4 and 7-5 show the proposed Flood Management Plan. The technical work in this study was completed in 2011/2012 and did not include climate change considerations. Recommended major system drainage improvements should be reassessed with climate change considerations prior to design.

Conveyance upgrades, and instream and riparian enhancements could be considered through redevelopment opportunities and watercourse development permits

Proposed Conveyance Upgrades

The proposed conveyance upgrade projects include both culvert and channel upgrades and are shown on Figure 7-4 and in Table 7-4. The projects have been ranked according to priority and have been grouped into initiatives for 5-10 years, 10-20 years, and 50+ years.

Sizing of the conveyance upgrades in the Integrated Stormwater Management Plan is conceptual in nature and should be thoroughly assessed during pre-design.

Table 7-4: Proposed Conveyance Improvement Projects

Replace with Kingsway Bedford High Flow Diversion

Proj. No.	Link Name	Location	Existing Size (m)	Priority	Timeline[1]	Length (m)	Upgrade Material	Upgrade Size (mm)	Cost Estimate	
1	Pump Station & Floodbox Improvements			High	5-10 years				$3,400,000	Port Coquitlam
~~2~~	~~KWL_C_7R~~	~~Kingsway D/W~~	~~1.2~~			~~7.74~~	~~CO BOX~~	~~3.05 x 1.5~~	~~$263,965~~	
	~~KWL_C_7L~~		~~1.2~~							
	~~KWL_C_8R~~	~~Kingsway D/W~~	~~1.2~~			~~7.82~~		~~3.05 x 1.5~~	~~$257,463~~	
	~~KWL_C_8L~~		~~1.2~~							
	~~KWL_C_9R~~	~~Kingsway D/W~~	[illegible]			[illegible]		~~3.05 x 1.5~~	~~$257,463~~	
	~~KWL_C_9L~~		[illegible]							
	~~DM04757.1~~	~~Kingsway Ave~~	[illegible]			[illegible]		~~3.05 x 1.5~~	~~$1,392,838~~	
	~~DM04758~~		~~1.6 x 1.0~~							
	~~WC17~~	~~Channel~~	~~0.55 m deep 2 m bottom width 0.75:1 side slopes~~			~~100~~	~~Natural Channel~~	~~1.2 m deep 2 m bottom width 2:1 side slopes~~	~~$40,000~~	
	~~7810.1~~	~~Bedford Street~~	~~1.5 x 1.2~~			~~24.12~~	~~CMP ARCH~~	~~3.4 x 1.7~~	~~$546,134~~	
Figure 7-5: Kingsway Bedford High Flow Diversion				High	5-10 years				$1,200,000	
3	7819.1	Raleigh Street	1.4			22.69	CMP ARCH	2.2 x 1.1	$446,898	
4	7811.1	Lougheed Hwy	1.3	Medium	10-20 years	34.60	Improved tapered headwall		$53,747	
7	7812.1	Patricia Ave	1.5	Low	50+ years	21.80	CMP ARCH	2.3 x 1.15	$446,898	
8	7822.1	Lane	1.5			10.08		2.3 x 1.15	$282,104	
9	DM04750.1	Gordon Ave	0.75 x 0.9			13.24	CO BOX	1.8 x 1.2	$230,763	
	DM04751		0.75 x 0.9							
10	7816.1	Davies Ave	1.25 x 1.1			14.65		2.4 X 1.2	$449,369	
11	7811.1	Lougheed Hwy	1.3			34.60		1.8 x 1.2	$610,674	
								Port Coquitlam Summary	**$7,120,453**	
5	7820.1	School Path	0.6	Low	50+ years	3.22	CO	1.2	$109,769	Coquitlam
6	7821.1	City Boundary Path	1.3			2.00	CMP ARCH	1.7 x 0.85	$94,620	
12	STPI15658	School Access	0.45	High	5-10 years	32.79	CO	0.6	$340,922	
								Coquitlam Summary	**$545,311**	

Notes: Refer to Figure 7-4 for Culvert Upgrade Locations and 7-5 for Kingsway Bedford High Flow Diversion
1 50-year is an end-of-life upgrade. D/W = driveway
Detailed design of improvements should include climate change and sea level rise considerations for major drainage system improvements (100/200 yr return periods).

Pump Station Upgrades

Construct a new higher capacity, fish-friendly pump station in the current location (Figure 7-5) replacing the existing portable pumps. The pump station would require two 1.5 m^3/s fish-friendly pumps for a total capacity of 3.0 m^3/s to effectively drain the creek when the Coquitlam River is high. The lead pump would have the same on / off levels as the existing pumps, and the lag pump would have the same off level but the on level would be 0.1m higher than the lead pump. The pump station would require a new forebay. The pump station makes use of the natural storage available in the undeveloped area downstream of Chine Drive, using 10,560 m^3 of storage.

Figures 7-7 (whole watershed) and 7-8 (lowland area) show 100-year future maximum flood extents with the floodbox closed with the upgraded pump station.

A new self-regulating tide gate is needed to improve fish access though the dyke, both during in-migration of adult spawners and out-migration of smolts. It is recommended that the Maple Creek and Coquitlam River water levels be monitored to assess the suitability of mechanical self-regulating tide gates. If the water levels prove to be unsuitable, an electronic tide gate should be installed to ensure fish passage, as power will be available on site for the pump station.

A Pump Station Preliminary Design Report is included in Appendix I.

Emergency Flood Response Plan

Culverts, Bridges and Channel Works

The Section 11 Regulation under the *Water Sustainability Act* provides for certain emergency response actions by a City. In the event of a channel blockage during a flood, mobilization of heavy equipment is likely. The primary focus during flood events should be to remove channel obstructions at culverts, bridges and accessible creek channel locations.

Emergency Repairs

Emergency repairs may be required during and/or after significant flood events in response to possible damage that jeopardizes the integrity of the system, and thereby increases risk factors to unacceptable levels. Emergency repairs will normally be limited to the following:

- repair of damaged channel bottom and bank protection by use of replacement riprap;
- repair of training berm slopes and upper channel banks damaged by sloughing and erosion;
- removal of sedimentation;
- removal of debris blockages and/or accumulations;
- repair of any damage to culvert structures and headwalls; and
- repairs to access roads.

Any emergency in-stream work will require approval from the environmental agencies prior to implementation.

Under extreme circumstances, endangered residents or area users should be advised of the situation, by the local RCMP. Such circumstances could result (though they are NOT anticipated) from:

- the possibility of major and uncontrollable flood overtopping; and/or
- the possibility of major, uncontrollable debris floods.

After the Flood

As soon as possible after a major flood, the City shall commission an inspection of the creek channel by a professional engineer and a professional biologist. The City shall retain a copy of the inspection report, and provide a copy to the Regional Water Manager of Ministry of Environment. Any recommended creek channel restoration works shall be outlined in the inspection report.

Where an inspection report recommends immediate post-flood restoration work, these shall be implemented in accordance with the direction of the Regional Water Manager. For gravel removal activities, the provisions of Section 5.3 shall apply.

7.7 Mitigation of the Impacts of Future Development

Unmitigated development and redevelopment can result in hydrologic impacts that negatively affect watercourses causing flooding, erosion and degradation of fish habitat, reduced baseflows and water quality problems. Guidance to mitigate the impacts of development and redevelopment is one of the most important components of an IWMP.

Recommended Criteria

Table 7-5 outlines development guidance criteria recommended for the Maple Creek watershed:

Table 7-5: Recommended Maple Creek Watershed Criteria

Category		Purpose/Criteria/Solutions
Development Restricted		**To Protect Watershed Health** No development within SPEA or RAPR setbacks unless compensation is provided – protection of riparian setbacks are critical to watershed health.
Stormwater	**Water Quality Treatment**	**To Treat Stormwater Prior to Discharge to Watercourses** Size to treat 90% of average annual runoff (equivalent to 72% of the 2-year, 24-hour event (55mm)) from paved surfaces exposed to vehicular traffic. • Construct rainwater management measures (rain gardens, vegetated swales, vegetated pervious pavers) to filter contaminants from roads and parking lots. • Alternatively consider regional water quality facilities (wetlands and wet ponds). • Construct oil/grit separators as spill control devices for gas stations, high risk spill industry, large parking lots. • Require and Enforce Erosion & Sediment Control measures during construction.
	Reduce Runoff Volume	**To Preserve Baseflows & Minimize Downstream Erosion and Habitat Degradation** Maximize (Size for more than 6-month return period) infiltration in well-draining soils. In poor-draining soils, size rainwater management measures to capture 72% of the 2-year, 24-hour event (55mm) as a minimum. • Maximize low impact development techniques • Construct rainwater management measures. Regional facilities can be used to make up for any on-site shortcomings in meeting targets. • City of Coquitlam *Source Controls Design Requirements and Guidelines* restricts on-lot source controls for Single Family Residential lots to 300 mm of absorbent soil with impervious areas graded to pervious areas. Regional facilities are required to ensure targets are met.

Category		Purpose/Criteria/Solutions
	Reduce Runoff Peaks	**To Minimize Downstream Erosion and Habitat Degradation** Size to detain the 6-month, 2-year, 5-year post-development flows to pre-development levels. • Construct detention/infiltration facilities
Municipal Stormwater Program		**Develop, adopt and enforce the following:** • Erosion & Sediment Control & Streamside Protection bylaws • Rainwater Management Bylaw – emphasis on 6-month Volume Reduction • Examples and standards for Stormwater Source Controls to aid with implementation

Watercourse Preservation

Stream setbacks provide protection for both the stream channel and the adjacent riparian area which also provides important functions through provision of cover, organic matter, and wood debris. A secondary emphasis is to maintain wildlife populations including landscape-level connectivity.

City of Port Coquitlam

Stream setbacks for redevelopment will generally follow the City of Port Coquitlam *Official Community Plan* (Bylaw No. 3467, 2005). This document outlines areas that are designated as Watercourse Protection Development Permit areas that are based on the former provincial Streamside Protection Regulations (SPR). These areas are not a setback area, but an area within which proposals to develop or otherwise alter land must be considered though a Development Permit process.

The SPR defines a streamside protection and enhancement areas (SPEA) which are also known as stream setbacks, buffers or leave strips. These widths are based on the existing or *potential* streamside vegetation conditions and are shown in Table 7-6 below.

Table 7-6: Maple Creek IWMP Plan and Implementation Strategy

Existing or Potential Streamside Vegetation Conditions	Streamside Protection and Enhancement Area Width*		
	Fish Bearing	Non-Fish Bearing	
		Permanent	Non-Permanent
Continuous areas >30m or discontinuous but occasionally >30 to 50 m	30 m		Minimum of 15 m
Narrow but continuous areas = 15 m or discontinuous but occasionally > 15 m to 30 m	Greater of: - existing width or - potential width or - 15 m	15 m	
Very narrow but continuous areas up to 5 m or discontinuous but occasionally >5 m to 15 m		Minimum of 5 m Maximum of 15 m	
*SPEA is measured from top of bank			

It is recommended that the SPEA widths recommended by the SPR be applied in the Port Coquitlam portions of Maple Creek. Because of the particular environmental sensitivities in the study area, adoption of a **no-net-loss protection policy on stream setbacks** is recommended the Integrated Stormwater Management Plan study area. Adoption of such a policy would mean that you cannot build within the riparian setback unless riparian compensation is provided in another location. This would prevent any further loss to the riparian areas of the creek and to the RFI value.

This policy would apply to redevelopment and development parcels and would allow road and utility crossings of streams, and other site specific conditions where necessary.

City of Coquitlam

To meet regulatory requirements, the City of Coquitlam amended its Zoning Bylaw to adopt the Riparian Areas Regulation (now known as Riparian Areas Protection Regulation, RAPR) – a provincial standard for riparian protection in urban areas that has been endorsed by DFO. RAPR setbacks will be applied to all streams within the Maple Creek watershed.

Detailed RAPR methods typically result in riparian setbacks that are 3 x channel width (minimum 10 m; maximum 30 m) measured from the high water mark and extend on both sides of the stream channel. Detailed survey of the high water marks and top of ravine banks will be required to accurately define the riparian setbacks at the time of development.

It is recommended that the RAPR widths be applied in the Coquitlam portions of Maple Creek. Because of the particular environmental sensitivities in the study area, adoption of a **no-net-loss protection policy on stream setbacks** is recommended the Integrated Stormwater Management Plan study area. Adoption of such a policy would mean that you cannot build within the riparian setback unless riparian compensation is provided in another location. However, this may not fully prevent the RFI value from decreasing. Therefore, riparian losses within the area between the edge of the RAPR setback and 30 m from the creek bank (where the RAPR setback is less than 30 m) should also be quantified and riparian compensation provided at another location in the watershed.

This policy would apply to redevelopment and development parcels and would allow road and utility crossings of streams, and other site specific conditions where necessary.

Requirement for Rainwater Management Measures

Because of the significance of the baseflow and flood risk issues within the Maple watershed, it is recommended that all future development and redevelopment be implemented with Low Impact Development (LID) approaches and rainwater management measures to mitigate the impacts of development on watershed health. The proposed criterion for source controls is summarized in the sections below.

The application of source controls to various land uses, soil combinations and municipal jurisdiction were separated into “Prescriptions” with specific targets and unit sizing summarized in Table 7-7 and spatially shown on Figure 7-6.

Tree Retention

While not strictly a source control, ordinary planted street trees can be a useful tool in a re-developing watershed. Trees provide interception of rainfall before it reaches the ground to become runoff, promoting evapotranspiration of rainfall and reducing the sharp runoff peaks seen in urban areas by slowing the intensity of the rainfall that lands on pavement below the trees. While trees do not replace source controls as they cannot provide water quality treatment for runoff, they provide assistance to source controls in mitigating the hydrologic impacts of impervious area. This is primarily an advantage for street trees and other trees that intercept rainfall before it reaches the impervious area on the ground. Trees over pervious soils also help to promote evapotranspiration of rainfall, but do not provide as much improvement in mitigating hydrologic impacts of development. Street trees are a useful tool for a municipality to employ in either a developed or a developing watershed for rainfall interception. A key consideration is that large and mature trees provide these significant benefits; planting smaller or decorative varieties of trees will not provide the same level of benefits and larger variety trees must be allowed to grow to maturity and high enough to be effective in this role. Similarly, preservation of existing healthy and mature street trees should be a priority for municipalities for their stormwater benefits in addition to other recognized benefits of mature trees.

Wide Distribution of Infiltration / Retention Systems

It is generally preferred to have a wide distribution of infiltration systems introducing water into different areas and material types, rather than a few concentrated areas discharging into one material type. This will reduce the potential for water table mounding. Infiltration systems should be designed to have sufficient storage to release the required volumes, but after that capacity is reached, it should be bypassed and discharged to the storm sewer system.

Cost and Maintenance of Stormwater Source Controls

In the proposed approach, the costs and maintenance of most stormwater source controls are associated with private land. This is consistent with the philosophy of ‘polluter pays’, where in this case the ‘pollution’ is impervious developed area. For cases where source controls are not provided on private land, a mechanism is needed to provide funds for downstream mitigation by the Cities.

The exception to this is the installations on City roads and lanes. Construction of roads and lanes would be funded by the Cities, or in partnership through local improvement projects, by development cost charges, or by frontage improvement at time of redevelopment.

Maintenance of roads and lanes is to be done by the Cities; however maintenance of boulevard vegetation is the responsibility of the property owner as per the City of Coquitlam *Boulevard Maintenance Bylaw* No. 3214, 1998 and the City of Port Coquitlam *Boulevard Maintenance Bylaw* No. 2646, 1992 which typically include a requirement for boulevard maintenance. Maintenance for on-lot source controls is to be done by the property owner.

Requirements for Source Controls for the City of Port Coquitlam

All surfaces (impervious and pervious) will be required to incorporate on-site source controls.

Volumetric Reduction (6-month 24-hour = 55 mm)

The target should be met on-site to the greatest extent possible as site conditions permit and any shortfall made up in downstream regional facilities (see Table 7-7).

Water Quality (80% TSS Removal) (6-month 24-hour = 55 mm or 90% of the annual runoff)

The 80% TSS removal target for a 55 mm storm or for 90% of the annual runoff should be met on-site to the greatest extent possible as site conditions permit (see Table 7-7).

Flow Rate Control (6-month, 2-year, and 5-year events)

The proposed method for flow rate control is partial 5-year infiltration on-site for all land use types including urban roads in both good and poor soil areas. The overflow from these facilities will be less than the existing land use flow (see Table 7-7).

Table 7-7: Recommended Source Control Strategy

Land Use		Category	Target	Prescription	Strategy	Unit Size	Depths
City of Port Coquitlam							
Good Soil Areas	Single Family	Water Quality (80% TSS removal)	6-month 24-hour = 55 mm or 90% of annual runoff	On-site source controls such as rain gardens and swales	Rain garden with lawn basin for paved surfaces	110 m^2/ ha of development	450 mm amended soil
		Volumetric Reduction	6-month 24-hour = 55 mm or capture or 90% of the annual flow	Amended soil for all pervious areas On-site source controls such as rain gardens and swales Disconnected roof leaders	Volumetric reduction and flow rate control to use the same facility	70 m^2/ ha of development	300 mm amended soil for pervious areas 450 mm amended soil for rain gardens 1 m drain rock
		Flow Rate Control	Up to 5-year event	On-site partial 5-year infiltration in underground infiltration trenches, overflow will be less than existing land use flows			
	Multi Family, Commercial, Industrial, Institutional	Water Quality (80% TSS removal)	6-month 24-hour = 55 mm or 90% of annual runoff	On-site source controls such as rain gardens and swales	Rain garden with lawn basin for paved surfaces. Alternatively, use structural water quality measures such as stormceptors prior to discharge to infiltration tank.	200 m^2/ ha of development	450 mm amended soil
		Volumetric Reduction	6-month 24-hour = 55 mm or capture or 90% of the annual flow	Amended soil for all pervious areas On-site source controls such as rain gardens and swales Disconnected roof leaders	Volumetric reduction and flow rate control to use the same facility.	130 m^2/ ha of development	300 mm amended soil for pervious areas 450 mm amended soil for rain gardens 1 m drain rock
		Flow Rate Control	Up to 5-year event	On-site partial 5-year infiltration in underground infiltration trenches, overflow will be less than existing land use flows			
	Urban Roadways (Assume 70% impervious)	Water Quality (80% TSS removal)	6-month 24-hour = 55 mm or 90% of annual runoff	Roadside source controls such as rain gardens and swales	Rain garden with lawn basin for paved surfaces	155 m^2/ ha of ROW	450 mm amended soil
		Volumetric Reduction	6-month 24-hour = 55 mm or capture or 90% of the annual flow	Amended soil for all pervious areas and below grade retention trenches	Volumetric reduction and flow rate control to use the same facility	100 m^2/ ha of ROW	300 mm amended soil 1 m drain rock
		Flow Rate Control	Up to 5-year event	Partial 5-year infiltration in roadside underground infiltration trenches, overflow will be less than existing land use flows			
Poor Soil Areas	Single Family	No Single Family in poor soils in OCP					
	Multi Family, Commercial, Industrial, Institutional	Water Quality (80% TSS removal)	6-month 24-hour = 55 mm or 90% of annual runoff	On-site source controls such as rain gardens and swales	Rain garden with lawn basin. Alternatively, use structural water quality measures such as Stormceptors prior to discharge to infiltration tank.	200 m^2/ ha of development	450 mm amended soil
		Volumetric Reduction	6-month 24-hour = 55 mm or capture or 90% of the annual flow	Amended soil for all pervious areas On-site source controls such as rain gardens and swales with base-flow release	Volumetric reduction and flow rate control to use the same facility	1,300 m^2/ ha of development	300 mm amended soil for pervious areas 450 mm amended soil for rain gardens 1 m drain rock
		Flow Rate Control	Up to 5-year event	On-site partial 5-year infiltration in underground infiltration trenches, overflow will be less than existing land use flows			
	Urban Roadways (Assume 70% impervious)	Water Quality (80% TSS removal)	6-month 24-hour = 55 mm or 90% of annual runoff	Roadside source controls such as rain gardens and swales	Rain garden with lawn basin for paved surfaces	155 m^2/ ha of ROW	450 mm amended soil
		Volumetric Reduction	6-month 24-hour = 55 mm or capture or 90% of the annual flow	Amended soil for all pervious areas and below grade retention trenches with base-flow release	Volumetric reduction and flow rate control to use the same facility	910 m^2/ ha of ROW	300 mm amended soil 1 m drain rock
		Flow Rate Control	Up to 5-year event	Partial 5-year infiltration in roadside underground infiltration trenches, overflow will be less than existing land use flows			
High Groundwater Table Areas	Single Family	No infiltrating source controls or facilities.					
	Multi Family, Commercial, Industrial, Institutional	No infiltrating source controls or facilities. Consider green roofs, rainwater harvesting and reuse or detention facilities.					
	Urban Roadways (Assume 70% impervious)	No infiltrating source controls or facilities. Consider detention facilities.					

Land Use		Category	Target	Prescription	Strategy	Unit Size	Depths
City of Coquitlam							
Good Soil Areas	Single Family	Volumetric Reduction	6-month 24-hour = 55 mm or capture or 90% of the annual flow	Amended soil for all pervious areas Disconnected roof leaders			300 mm amended soil for pervious area
	Multi Family, Commercial, Industrial, Institutional	Water Quality (80% TSS removal)	6-month 24-hour = 55 mm or 90% of annual runoff	On-site source controls such as rain gardens and swales	Rain garden with lawn basin for paved surfaces. Alternatively, use structural water quality measures such as Stormceptors prior to discharge to infiltration tank.	200 m^2/ ha of development	450 mm amended soil
		Volumetric Reduction	6-month 24-hour = 55 mm or capture or 90% of the annual flow	Amended soil for all pervious areas On-site source controls such as rain gardens and swales Disconnected roof leaders	Volumetric reduction and flow rate control to use the same facility.	130 m^2/ ha of development	300 mm amended soil for pervious areas 450 mm amended soil for rain gardens 1 m drain rock
		Flow Rate Control	Up to 5-year event	On-site partial 5-year infiltration in underground infiltration trenches, overflow will be less than existing land use flows			
	Urban Roadways (Assume 70% impervious)	Water Quality (80% TSS removal)	6-month 24-hour = 55 mm or 90% of annual runoff	Roadside source controls such as rain gardens and swales	Rain garden with lawn basin for paved surfaces	155 m^2/ ha of ROW	450 mm amended soil
		Volumetric Reduction	6-month 24-hour = 55 mm or capture or 90% of the annual flow	Amended soil for all pervious areas and below grade retention trenches	Volumetric reduction and flow rate control to use the same facility	100 m^2/ ha of ROW	300 mm amended soil for pervious areas 450 mm amended soil for rain gardens 1 m drain rock
		Flow Rate Control	Up to 5-year event	Partial 5-year infiltration in roadside underground infiltration trenches, overflow will be less than existing land use flows			
Poor Soil Areas	Single Family	Volumetric Reduction	6-month 24-hour = 55 mm or capture or 90% of the annual flow	Amended soil for all pervious areas			300 mm amended soil for pervious areas
	Multi Family, Commercial, Industrial, Institutional	Water Quality (80% TSS removal)	6-month 24-hour = 55 mm or 90% of annual runoff	On-site source controls such as rain gardens and swales	Rain garden with lawn basin. Alternatively, use structural water quality measures such as Stormceptors prior to discharge to infiltration tank.	200 m^2/ ha of development	450 mm amended soil
		Volumetric Reduction	6-month 24-hour = 55 mm or capture or 90% of the annual flow	Amended soil for all pervious areas On-site source controls such as rain gardens and swales with base-flow release	Volumetric reduction and flow rate control to use the same facility	1300 m^2/ ha of development	300 mm amended soil for pervious areas 450 mm amended soil for rain gardens 1 m drain rock
		Flow Rate Control	Up to 5-year event	On-site partial 5-year infiltration in underground infiltration trenches, overflow will be less than existing land use flows			
	Urban Roadways (Assume 70% impervious)	Water Quality (80% TSS removal)	6-month 24-hour = 55 mm or 90% of annual runoff	Roadside source controls such as rain gardens and swales	Rain garden with lawn basin for paved surfaces	155 m^2/ ha of ROW	450 mm amended soil
		Volumetric Reduction	6-month 24-hour = 55 mm or capture or 90% of the annual flow	Amended soil for all pervious areas and below grade retention trenches with base-flow release	Volumetric reduction and flow rate control to use the same facility	910 m^2/ ha of ROW	300 mm amended soil for pervious areas 450 mm amended soil for rain gardens 1 m drain rock
		Flow Rate Control	Up to 5-year event	partial 5-year infiltration in roadside underground infiltration trenches, overflow will be less than existing land use flows			
Refer to Figure 7-6.							

Requirements for Source Controls for the City of Coquitlam

All surfaces (impervious and pervious) will be required to incorporate on-site and regional source controls as per the City's *Rainwater Management – Source* Controls – *Design Requirements and Guidelines* (March 2009).

Volumetric Reduction (6-month 24-hour = 55 mm)

The target should be met on-site to the greatest extent possible as site conditions permit and any shortfall made up in downstream regional facilities (see Table 7-7 and Figure 7-6).

Full source controls to meet the Maple Creek watershed stormwater target of 55 mm will be implemented on all land uses except for single family residential as per the City's policy. Volumetric reduction source controls in poor soils will be built with a baseflow release at a rate of 0.5 L/s/ha. Partial source controls (listed above) will be applied to single family land uses. Water Quality (80% TSS Removal) (6-month 24-hour = 55 mm or 90% of the annual runoff)

The 80% TSS removal target for a 55 mm storm or for 90% of the annual runoff should be met on-site to the greatest extent possible as site conditions permit and any shortfall made up in downstream regional facilities (see Table 7-7).

Flow Rate Control (6-month, 2-year, and 5-year events)

Since the majority of flows from the City of Coquitlam are diverted from Maple Creek to the Coquitlam River and will continue to be diverted in the future, flow rate control is not required by single family residential lots. On-site 5-year infiltration facilities are proposed for all other land use types including urban roads in both good and poor soil areas. The overflow from these facilities will be less than the existing land use flow (see Table 7-7)

7.8 Implementation Plan

The proposed works, studies and regulations described in the preceding sections are categorized below as 5-10 Year Plan, 10-20 Year Plan, 50-Year+ Plan or Ongoing Works.

The 5-10 Year Plan works include:

1. Ensure sandbags are removed from the Ozada diversion 300mm outlet immediately following large storm events to allow low flows to continue downstream.
2. Remove high priority fish obstructions and clean out overgrown vegetation from channel to improve conveyance and fish passage, $39,000 estimated cost, immediate implementation.
3. Complete required 5-year conveyance upgrades and flood prevention works
    a. Complete high priority Kingsway Bedford High Flow Diversion (Figure 7-5) , estimated cost $1.2 million.
    b. Construct a new higher capacity pump station in current location with self-regulating flood gate.
    c. Upgrade high priority culvert Project 3 Figure 7-4, estimated cost $456,000 (Port Coquitlam) and Project 12 Figure 7-4, estimated at $341,000 (Coquitlam).
4. Bylaws and Standards – Update Port Coquitlam's Development Bylaw (1987) with the following ($39,000 estimated cost):
    a. add capture target (6-month 24-hour event Volume Reduction);

   b. develop green road standards for stormwater treatment and volume reduction; and
   c. develop examples and standards for Stormwater Source Controls to aid with implementation.
   d. Coquitlam to enforce its Riparian Areas Protection Regulation with no-net-loss except for creek crossings, and enforce the Erosion and Sediment Control Bylaw.
   e. Port Coquitlam to develop, implement and enforce an Erosion & Sediment Control Bylaw.
   f. Conduct an education and outreach program to inform private property owners with watercourses about stream and watershed health and best practices for riparian and water quality protection and enhancements.
5. Conduct long term baseflow augmentation feasibility study within 5 years, and implement solution within 5 to 10 years.

The 10-20 Year Plan works include the following.

1. Complete 20-year Capacity Upgrades – improve Lougheed Highway headwall, $54,000 estimated cost (Project 4 on Figure 7-4 and Table 7-4).
2. Add structural water quality treatment at indicated locations –as needed for compensation during redevelopment, $260,000 per structure estimated cost.
3. Restore riparian areas – remove invasive species, reforest with native species, and widen riparian setbacks during redevelopment, $28/m^2 of removal and planting estimated cost, complete works over next 20 years.
4. Complete feasibility study to determine preferred Ozada long-term alternative $65,000 estimated cost. Construct preferred alternative, $597,000 to $772,000.
5. Further Studies – undertake further surveillance sampling to identify point-source discharges to the creek, $39,000 estimate cost.

The 50+ Year Plan works include recommended studies and capacity upgrades.

1. 50-year Capacity Upgrades – Upgrade 8 culverts, $2.2 million estimated cost.
2. Add structural water quality treatment at indicated locations –as needed for compensation during redevelopment, $260,000 per structure estimated cost.
3. Restore riparian areas – remove invasive species, reforest with native species, and widen riparian setbacks during redevelopment, $28/m^2 of removal and planting.

Ongoing works include periodic maintenance, monitoring, and long term projects.

1. Vegetation Management – continue vegetation management in Maple Creek.
2. Roof Leader Disconnection – encourage home owners to disconnect roof leaders to maximize infiltration capacity in Maple Creek existing development well-draining soils areas.
3. Conduct ongoing watershed performance monitoring and evaluate progress every 5 years. Implement adaptive management to adjust the development requirements to protect the watershed as required. Budget $39,000 per year for monitoring and assessment.
4. Restore in-stream complexing – add spawning gravels and instream complexity in conjunction with channel capacity improvements, costs to be determined.

5. Protect riparian areas – no development within SPEA and RAPR setbacks unless compensation is provided.
6. Construct hydrologic volume reduction measures – maximize low impact development techniques, construct Stormwater Source Controls (bio-retention rain gardens or swales, pervious pavers, absorbent soil layers, green roofs, rainwater harvesting & reuse, etc.) sized to capture 72% of the 2-year, 24-hour event (55 mm), and construct regional facilities for baseflow augmentation (to sustain baseflows).
7. Construct stormwater quality treatment measures – construct rainwater source controls (rain gardens, vegetated swales, vegetated pervious pavers) sized to treat 90% of average annual road and parking lot runoff, alternatively consider regional water quality facilities such as wetlands and wet ponds, construct oil/grit separators as spill control devices for gas stations, high risk spill industry, and large parking lots, and provide Erosion and Sediment Control measures during construction.
8. Construct hydrologic rate control – construct detention/infiltration facilities sized to detain 5-year post to pre-development for Maple Creek catchment. Combine where possible with volume reduction measures.

7.9 Performance Monitoring and Adaptive Management

Metro Vancouver's Monitoring and Adaptive Management

Condition 7 of the BC Minister of Environment's approval of Metro Vancouver's 2011 Integrated Liquid Waste Resource Management Plan (ILWRMP) requires that all municipalities, with coordination from Metro Vancouver, monitor stormwater to assess and report on the effectiveness of Integrated Stormwater Management Plan implementation. To fulfill this provincial requirement, Metro Vancouver and its member municipalities developed a *Monitoring and Adaptive Management Framework for Stormwater (MAMF) (Metro Vancouver, 2014)*. The MAMF takes a weight of evidence approach, using several types of monitoring and indicators to develop an overall assessment of watershed conditions. Through repeated sampling, watershed health and the response to specific watershed protection measures and management actions can be tracked over time.

The MAMF recommends a monitoring framework and core parameters for higher gradient streams, grouped into three categories:

- Water quality monitoring indicators – selected general water quality parameters, nutrient, bacteriological parameters, and metals;
- Flow monitoring Indicators – seven flow-related metrics characterizing watershed hydrology; and
- Benthic invertebrates biomonitoring indicators – benthic index of biotic integrity (B-IBI) scores and mean taxa richness.

Table 7-8 summarizes the recommended parameters for monitoring implementation of the Integrated Stormwater Management Plan, as well supplemental performance indicators that may provide a more comprehensive assessment of watershed health and Integrated Stormwater Management Plan implementation over time depending on watershed values and issues.

Table 7-8: MAMF ISMP Performance Monitoring Indicators

Performance Indicator	Indicator Type	Short-term Trend/Target	Long-term Target
Water Quality Performance Indicators			
Dissolved Oxygen	Primary	Increasing	Good or Satisfactory as per MAMF classification levels
Water Temperature		Decreasing in dry season	
Turbidity		Decreasing in wet season	
Nutrients (Nitrate as N)		Decreasing	
Bacteriological Parameters (*E. coli* and fecal coliform)		Decreasing, esp. in wet season	
Metals (Fe, Cd, Cu, Pb, Zn)		Decreasing, esp. in wet season	
pH	Secondary	Stable	
Conductivity		Decreasing	
Flow Monitoring Performance Indicators			
T_{Qmean}	Primary	Stable or increasing	Same as short-term
High Pulse Duration (days)			
Low Pulse Duration			
Winter Baseflow (L/s)			
High Pulse Count		Stable or decreasing	
Low Pulse Count			
Summer Baseflow (L/s)		Stable	
Benthic Invertebrate Biomonitoring Performance Indicators			
B-IBI Scores	Primary	Stable or increasing	MAMF Fair or higher Category
Mean Taxa Richness			
Additional Recommended Performance Indicators			
No. of Erosion Sites	Supplemental	Decreasing	No high consequence sites
No. of Fish Passage Barriers			No human-made passage barriers
Effective Impervious Area (EIA)		n/a (for tracking only)	n/a (for tracking only)
Riparian Forest Integrity (RFI)		Stable or increasing	Increasing
No. of Species / Locations of Spawners			Increase in spawners from current levels

The table also indicates the priority of each parameter for measurement (primary or secondary), whether baseline data has or is being collected, and sets short- and long-term targets for trends for different parameters.

Maple Creek MAMF Performance Indicators

In order to measure and track the levels and changes in the watershed, Table 7-9 lists the MAMF performance indicators that may be measured and tracked over time. Measurement of each indicator is performed separately; many indicators require specific tests or specific analyses of data and/or modelling results. The general measurement approach, as well as the 2011 baseline values, and expected changes for each watershed performance indicator are summarized.

Each indicator is to be tracked over the long term in order to be useful in evaluating changes in the watershed. The indicators do not have to all move in a particular direction, up or down, in order to show improvement or degradation in overall watershed health. Rather the tracked suite of indicators should be reviewed every few years to:

- Note movement in particular indicators,
- Evaluate possible causes of the movement,
- Determine if the movement of the indicators represents an impact or improvement,
- Evaluate if the indicator movement is expected or unforeseen, and
- Review the goals, elements, and implementation plan of the IWMP to assess if changes should be made to the plan in order to remain on track and achieve the overall watershed goals over the implementation timeline for the IWMP.

The schedule for a full assessment and review for the watershed health indicators should be at least once every five years, to be tracked and utilized in association with the timeline for IWMP implementation. Therefore, four full reviews of the indicators should occur during a 20-year expected timeline for implementation, and tracking to assess the impacts of full implementation should be continued, at least once every five years, beyond that horizon.

Table 7-9: Maple Creek MAMF Watershed Performance Indicators

Performance Indicator		Method of Analysis	2011	2021
Water Quality				
1.	Dissolved Oxygen	Water Quality testing on a 3- to 5-year cycle. See regional criteria set by Metro Vancouver.	No data	Regional criteria set by Metro Vancouver, as it changes from time to time.
2.	Average Summer Water Temperature (°C)			
3.	Turbidity (NTU)			
4.	Nutrients (Nitrate as N)			
5.	Fecal Coliforms (or E. Coli) (MPN/100mL)		High Levels	
6.	Total Metals in Water	Maximum values (Dry weather): Al: 0.405 Cd: 0.000041 Cu: 0.0056 Fe: 1.37 Pb: 0.00379 Zn: 0.0257		

Performance Indicator		Method of Analysis	2011	2021
Flow Regime				
7.	Summer Baseflow (L/s)	From existing well pump and future river intake	16 L/s (0.14 L/s/ha)	20 L/s
8.	Winter Baseflow (L/s)	Monitoring at Lincoln Avenue	No data	20 L/s
9.	2-Year Peak Flow (m^3/s)	Monitoring &/or modelling d/s of Railway triangle	2.34	Same or slight decrease
Add MAMF parameters: $T_{Qmean,}$ High Pulse Duration (days), Low Pulse Duration, High & Low Pulse Count				
Benthic Invertebrate Biomonitoring				
10.	B-IBI Scores	As per MAMF	14.5	Stable or increasing
11.	Mean Taxa Richness			MAMF Fair or higher Category

Performance monitoring is the repeated collection of measurements to measure changes or trends in environmental condition. The proposed monitoring program focuses on answering two essential questions:

1. Is development/redevelopment negatively impacting the ecological health of creeks?
2. Are stormwater management activities resulting in no-net-loss of the overall health of the creeks?

Additional Performance Indicators

Several forms of ongoing monitoring could be implemented in addition to the Metro Vancouver baseline monitoring recommendations. They are:

Table 7-10: Additional Watershed Performance Indicators

Performance Indicator		Method of Analysis	2011	2021
Flood Protection Plan				
1.	Flooding	Recorded flooding	Coquitlam Glass	To 100-year level of service
2.	No. of Obstructions	Inventory mapping	30 sites (2011) Reassess in 2021	Same or Decrease
Mitigation of Impacts of Future Development				
3.	No. of Erosion Sites	Inventory mapping	4 low severity sites (2011) Reassess in 2021	Same or Decrease
4.	TIA (% of Watershed Area)	GIS Analysis of Aerial Photos and Assessment Data	48%	50% (51% build out)
5.	RFI (% of Riparian Area)	GIS Analysis of Aerial Photos every 2 to 5 years	45%	Same or Increase
6.	Watershed Forest Cover (% of Watershed Area)	GIS Analysis of Aerial Photos every 2 to 5 years	16%	Decrease expected due to development

Performance Indicator		Method of Analysis	2011	2021
7.	Benthic Invertebrates B-IBI scores	Use methods used in this study	14 to 16 mean = 14.5	Same or increase
8.	Fish Populations	Annual spawner counts in accessible reference reaches	To be provided by Streamkeepers	Same or increase
9.	Fish Passage Barriers	Inventory Mapping	Manmade Barriers 9	Progressive Removal of Barriers
10.	Sediment Quality	Ranges: Cu: 8.4 – 22.0 Pb: 7.2 – 53.5 Zn: 22.7 – 94.1		Same or improvement

Fecal coliform monitoring: Bacteriological contamination is an ongoing concern because of previously detected high levels at several locations in the watershed and because of ongoing sensitive water uses in the Maple Creek watershed. Ongoing monitoring work should use the sites and methods used previously. Sampling should consist of five samples in 30 days and should occur every two years at three sites.

Continuous water quality monitoring. Data analysis costs are $1,900–$11,600 per year depending level of detail and data quality. **Flow monitoring:** Flow monitoring should be implemented in Maple Creek below the diversion and downstream of the Railway triangle. A rating curve will need to be created. The results of the flow monitoring can be used to estimate the effectiveness of the source controls that are proposed for the redevelopment.

Benthic invertebrate monitoring: Benthic invertebrate communities are a useful indicator of trends or stability in watershed health and tie in directly to the IWMP Watershed Health Tracking System. Annual sampling using consistent field, lab and analysis methods is recommended at three sites as were sampled in 2011. The estimated annual cost is $1,300 per site (sampling, taxonomy, data analysis, brief report).

Sediment quality monitoring: As an additional monitoring tool, sediment sampling should be conducted every two years at six sites as were sampled in 2011. The estimated annual cost for five sites is $2,400 for total metals ($900 for field sampling, $700 for lab analysis, and $800 for letter report). Sampling for PAHs or other contaminants will increase costs substantially.

Total watershed and riparian forest cover monitoring: Total watershed forest cover and riparian forest cover (within 30 m of permanently flowing streams) should be measured every 2–5 years (dependent on availability of orthophoto) as a broad indicator of hydrologic function and riparian-stream channel interactions. Forest is all woody vegetation greater than 5 m in height and a closed canopy. Forest cover should be measured by an experienced GIS technician in ArcView using recent orthophotos, with assistance from a biologist or forest ecologist. It should be expressed as a percentage and total amount of forest for the overall watershed and by municipality.

Fish population monitoring: Additionally, annual spawner counts should be conducted in accessible reference reaches (e.g., 500 m reach) on Maple Creek to monitor fish populations over time. Counts could be carried out by the local Streamkeeper group.

7.10 Operation and Maintenance

Regular drainage system and stormwater facility maintenance is required to effectively convey design flows, minimize flooding and erosion, and mitigate the impacts of development. The following general inspection and maintenance procedures are recommended.

Inspection	The drainage systems should be inspected annually during low flow conditions, ideally in the spring so that identified problems can be undertaken during the dry summer months. The purpose of the inspection is to assess the condition of the conveyance facilities including creek channels for erosion locations and hydraulic structures, and identify the need for maintenance. The annual inspection should include all open channels, culverts, detention facilities, diversions, flow splitters, and floodboxes. An overall drainage system inspection should also be completed after major storm events.
Vegetation Maintenance	Conveyance channels should be maintained to prevent the growth of weeds, small trees and bushes to maintain hydraulic conveyance capacities balanced with fish habitat requirements. Channel maintenance should occur annually.
Debris Control	Debris blockages at hydraulic structures can cause flooding problems. Regular debris removal (at least annually) from the ditches, culverts and floodboxes is necessary.
Wet Pond	Inspect periodically during wet weather to observe function, clean sediment forebay every 5 to 7 years or when 50% capacity has been lost, remove accumulated sediment form pond bottom when 10 to 15% of pool volume is lost, inspect hydraulic and structural facilities annually and mow side-slopes, embankments and spillways as required to prevent over growth.
Detention Tanks	Inspect annually and remove floating debris and oil.
Wetlands	Inspect annually and after each major storm event. At beginning of wet season remove trash and floatables and unclog outlet structures.
Grassed Swales	Inspect routinely especially after large storm events. Correct erosion problems as necessary, mow to keep grass in the active growth phase, remove clippings to prevent clogging of outlets, and remove trash and debris.
Bioretention with Underdrain	Remove leaves each autumn, inspect overflow, hydraulic and structural facilities annually.

7.11 Capital Cost Estimates and Funding

Capital Cost Estimate

The sizing of facilities in the IWMP is conceptual in nature and should be thoroughly assessed during pre-design. The cost estimates of the overall proposed works in the IWMP are summarized in Table 7-1. The detailed cost estimates are included in Appendix H.

Class 'C' Cost Estimate and Assumptions

The cost estimates provided in this study are of Class 'C' accuracy. This means that the general requirements for upgrading including size and approximate depth of excavation, as well as some limited site conditions are known. The projects identified have not considered the following factors affecting construction:

- relocation of adjacent services (gas, hydro, telephone, etc.);
- special permitting requirements (fisheries windows, contaminated site, etc.);
- geotechnical issues requiring special construction such as pile-supported piping, buoyancy problems or rock blasting; and
- critical market shortages of materials.

As the above factors have not been allowed for in estimating construction unit rates or project design, the following factors are applied to all projects:

- Contractor Markup/Overhead – 6% (included in unit price);
- PST at 7% (included in unit price);
- Mobilization/Demobilization – 6%;
- Bonding/Insurance – 2%;
- Engineering – 10%; and
- Contingency – 40%.

The unit prices were determined based on KWL's 2012 experience with similar work and represented the best prediction of actual 2012 costs. These cost estimates were scaled up by 29% to reflect 2020 cost estimates based on the Engineering News Record Construction Cost Index. Actual tendered costs would depend on such things as market conditions generally, remoteness factor the time of year, contractors' workloads, any perceived risk exposure associated with the work, and unknown conditions.

The following unit prices were used:

- \$22/m^2 for riparian planting;
- \$52/m^3 of excavation;
- \$52/m^3 of drain rock; and
- \$2.80/m^2 of hydroseeding.

Funding Strategies

Funding opportunities from senior governments should be pursued for some of the items for example:

- Fish barrier removals and complexing – Wildlife Habitat Canada Conservation Grant;
- Riparian enhancement and conservation areas – Environment Canada Habitat Stewardship Program; and
- Conveyance upgrades – Infrastructure grant programs.

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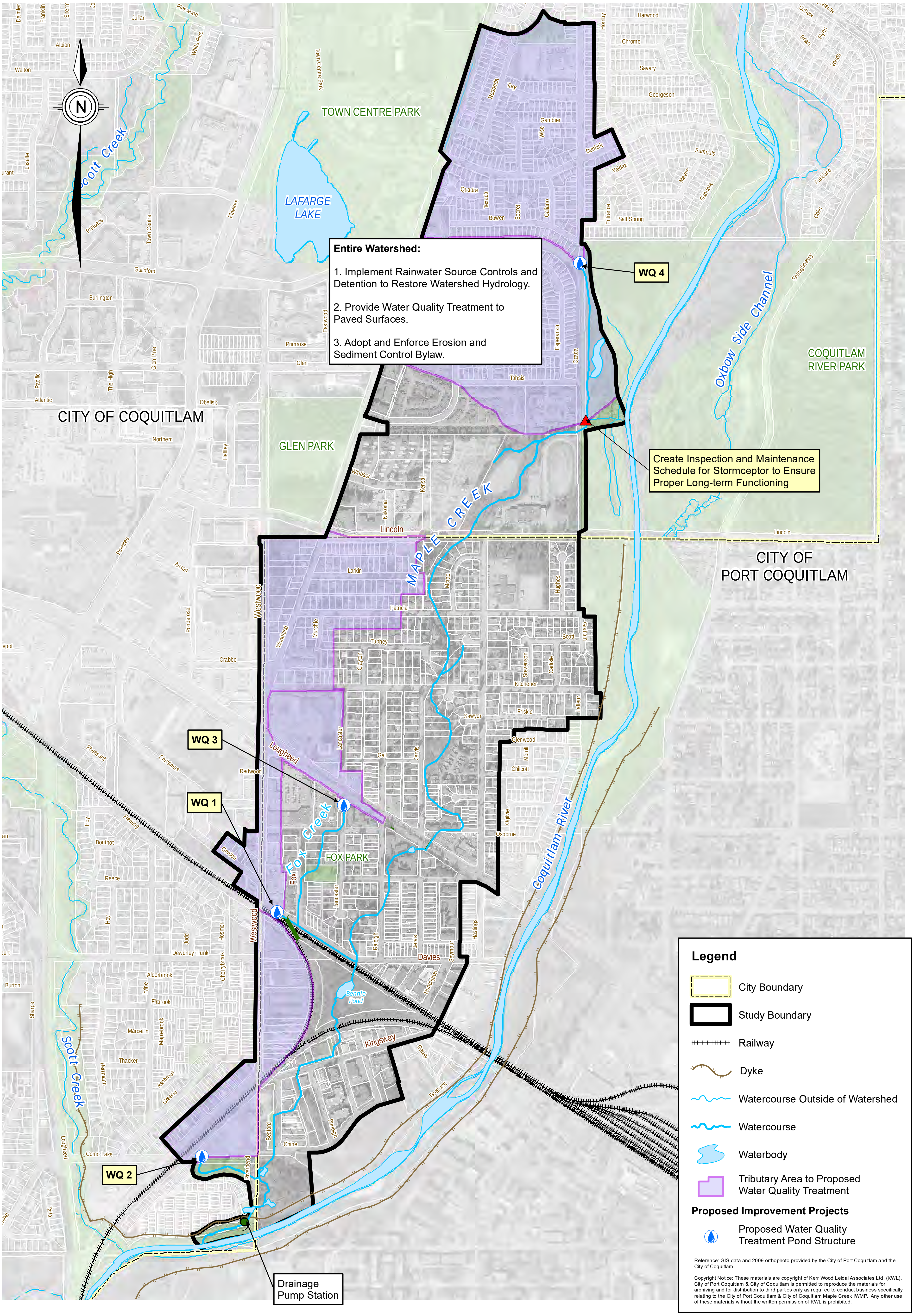

Entire Watershed:

1. Implement Rainwater Source Controls and Detention to Restore Watershed Hydrology.

2. Provide Water Quality Treatment to Paved Surfaces.

3. Adopt and Enforce Erosion and Sediment Control Bylaw.

Create Inspection and Maintenance Schedule for Stormceptor to Ensure Proper Long-term Functioning

Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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consulting engineers

City of Port Coquitlam & City of Coquitlam
Maple Creek IWMP

Project No.
646-046

Date
December, 2020

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Water Quality Improvements

Figure 7-1

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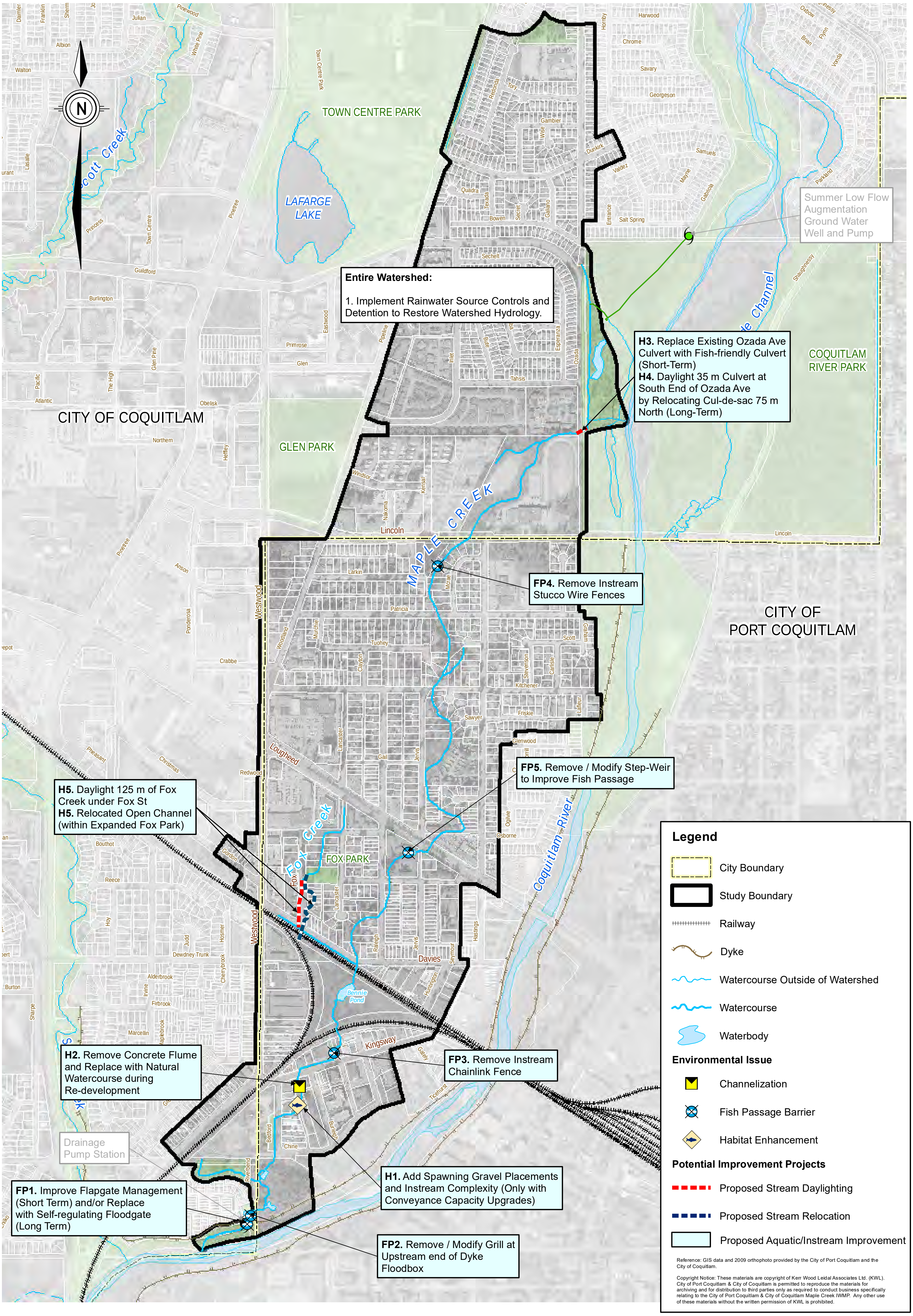

Entire Watershed:

1. Implement Rainwater Source Controls and Detention to Restore Watershed Hydrology.

Summer Low Flow Augmentation Ground Water Well and Pump

H3. Replace Existing Ozada Ave Culvert with Fish-friendly Culvert (Short-Term)
H4. Daylight 35 m Culvert at South End of Ozada Ave by Relocating Cul-de-sac 75 m North (Long-Term)

FP4. Remove Instream Stucco Wire Fences

FP5. Remove / Modify Step-Weir to Improve Fish Passage

H5. Daylight 125 m of Fox Creek under Fox St
H5. Relocated Open Channel (within Expanded Fox Park)

H2. Remove Concrete Flume and Replace with Natural Watercourse during Re-development

FP3. Remove Instream Chainlink Fence

Drainage Pump Station

H1. Add Spawning Gravel Placements and Instream Complexity (Only with Conveyance Capacity Upgrades)

FP1. Improve Flapgate Management (Short Term) and/or Replace with Self-regulating Floodgate (Long Term)

FP2. Remove / Modify Grill at Upstream end of Dyke Floodbox

Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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Maple Creek IWMP

Project No.	Date
646-046	December, 2020

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Aquatic/Instream Improvements

Figure 7-2

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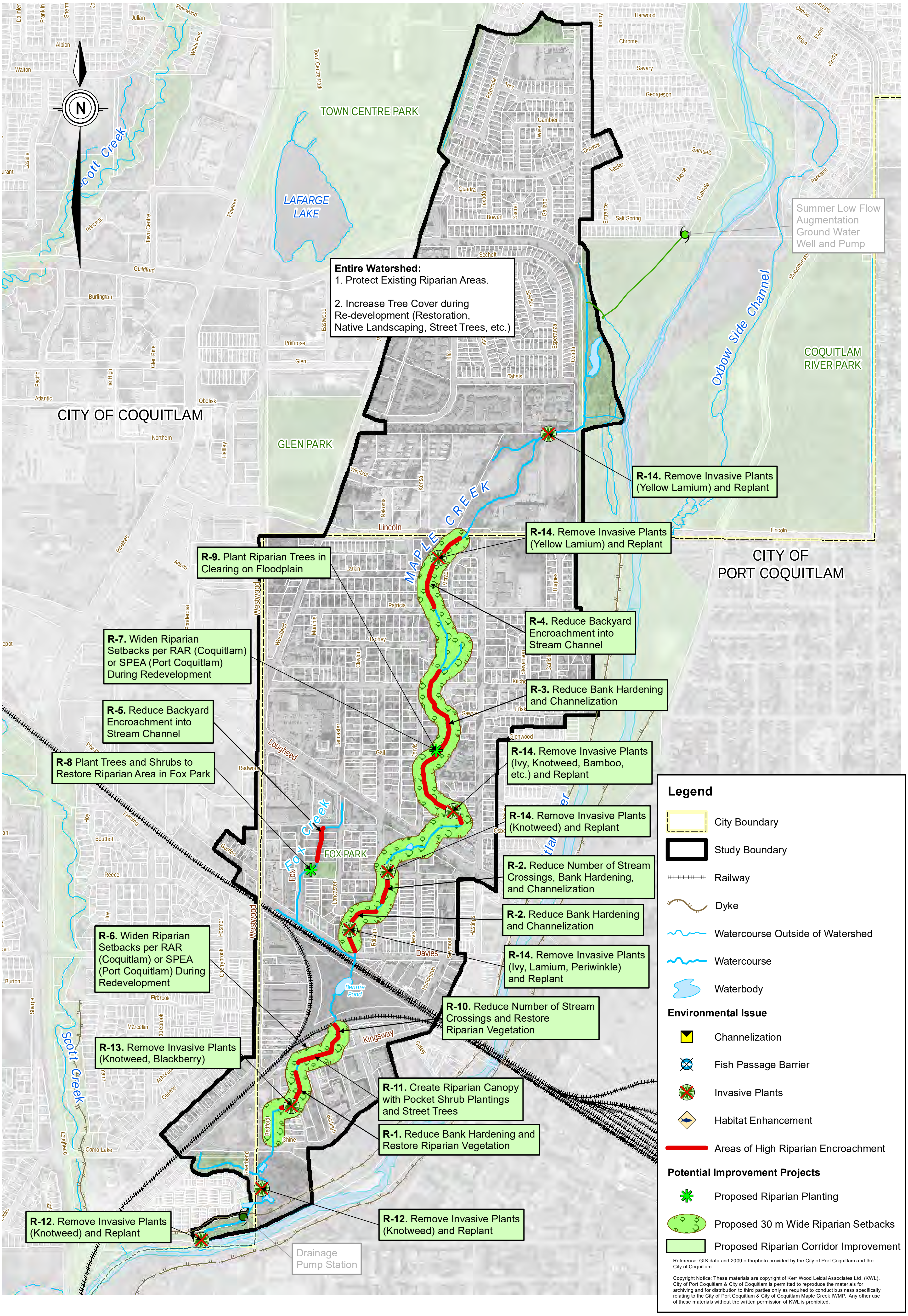

Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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Maple Creek IWMP

Project No. 646-046
Date December, 2020

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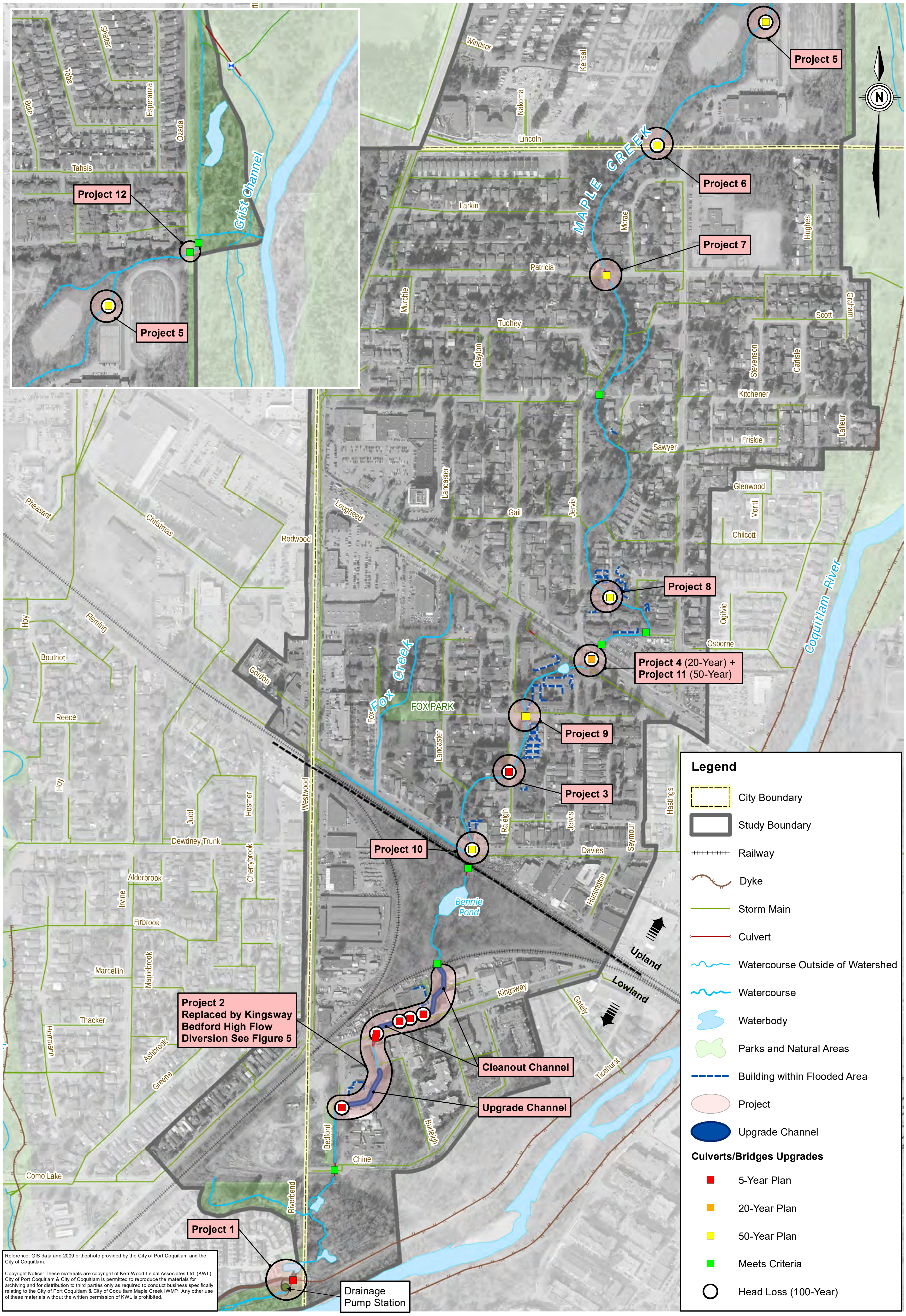
Riparian Corridor/Terrestrial Habitat Improvements

Figure 7-3



Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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Maple Creek IWMP

Project No.	Date
646-046	April, 2021

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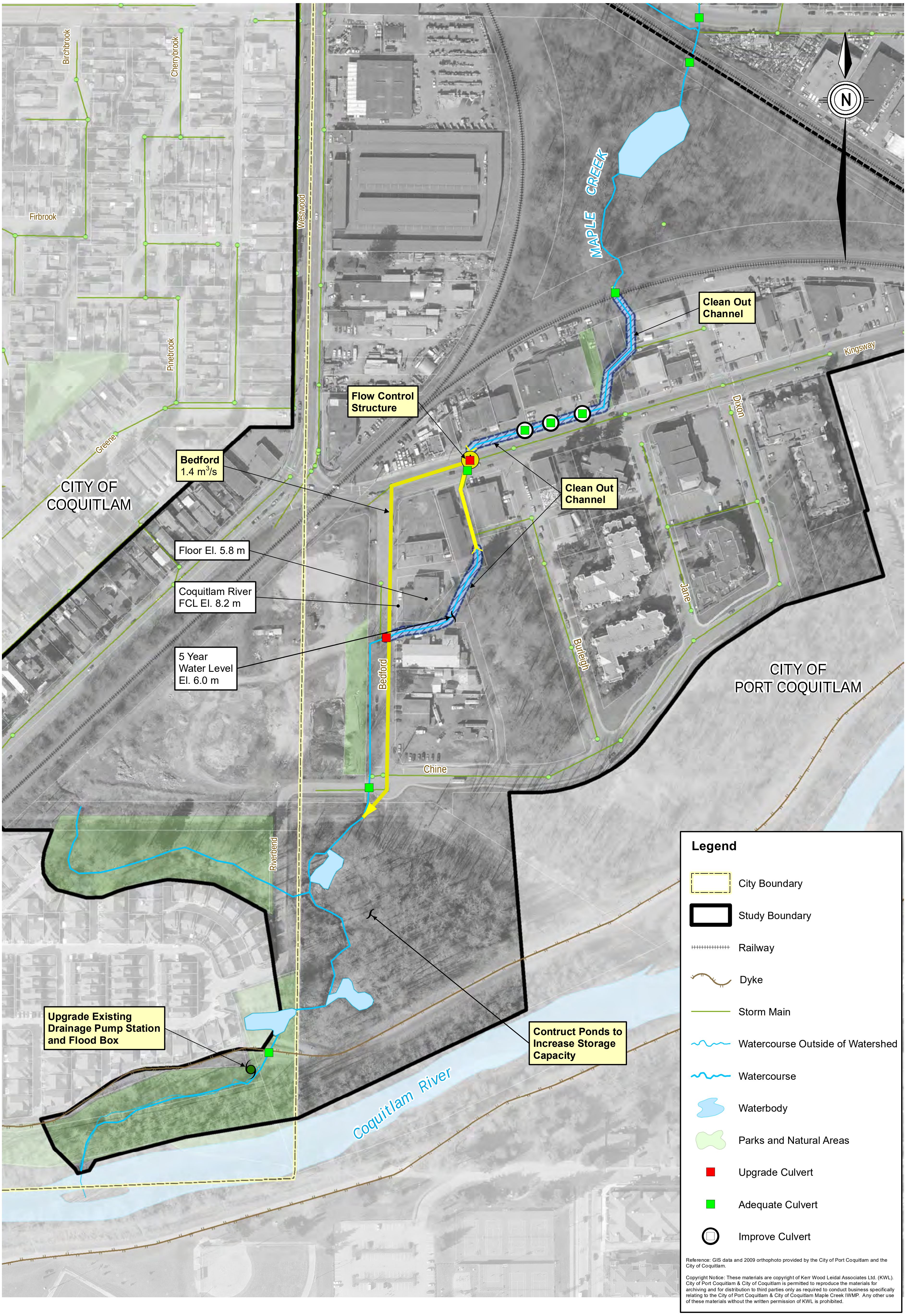
Conveyance Upgrade Projects

Figure 7-4



Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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Project No.	Date
646-017	April, 2021

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Flood Management Plan

Figure 7-5

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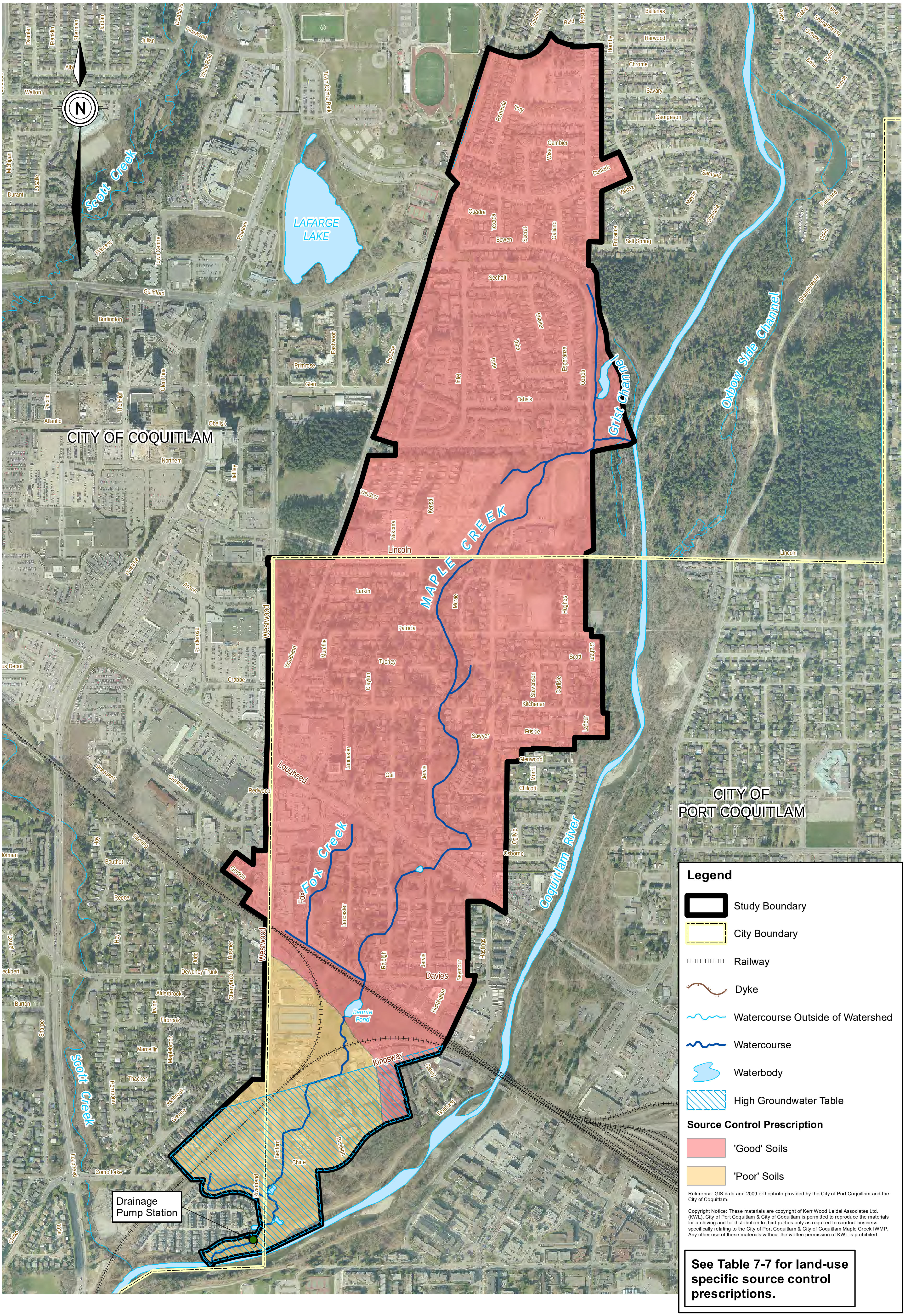

Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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See Table 7-7 for land-use specific source control prescriptions.

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Maple Creek IWMP

Project No.	Date
646-046	December, 2020

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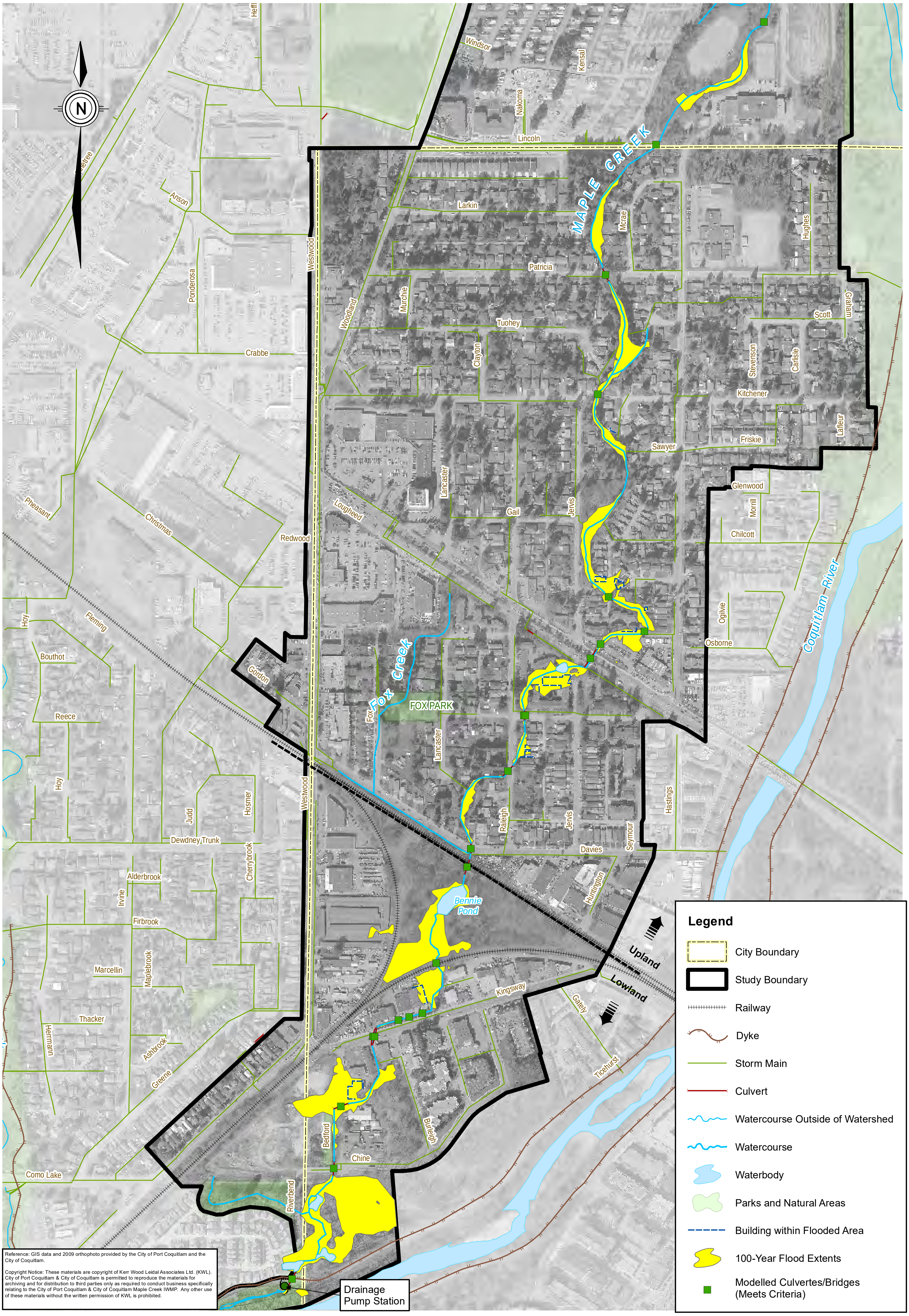
Soils and Source Control Locations

Figure 7-6



Legend

⬚	City Boundary
▬	Study Boundary
┼┼┼	Railway
∼	Dyke
─	Storm Main
─	Culvert
∼	Watercourse Outside of Watershed
∼	Watercourse
▨	Waterbody
▨	Parks and Natural Areas
- - -	Building within Flooded Area
▨	100-Year Flood Extents
🟩	Modelled Culverts/Bridges (Meets Criteria)

Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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Maple Creek IWMP

Project No.	Date
646-046	June, 2012

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100-Year Future Maximum Water Level, Floodbox Closed with Upgraded Pump Station

Figure 7-7

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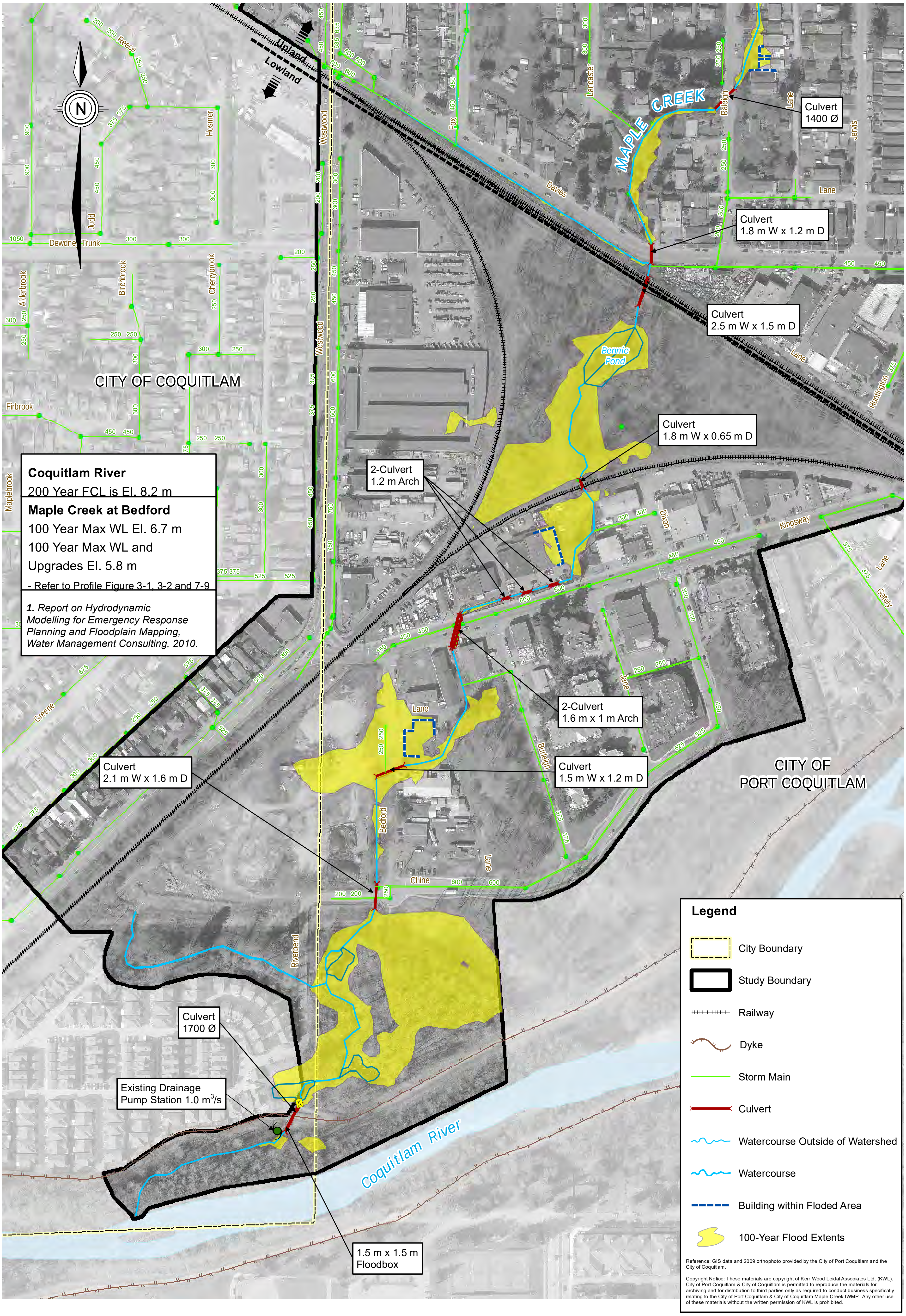

Coquitlam River
200 Year FCL is El. 8.2 m

Maple Creek at Bedford
100 Year Max WL El. 6.7 m
100 Year Max WL and Upgrades El. 5.8 m
- Refer to Profile Figure 3-1, 3-2 and 7-9

1. Report on Hydrodynamic Modelling for Emergency Response Planning and Floodplain Mapping, Water Management Consulting, 2010.

Reference: GIS data and 2009 orthophoto provided by the City of Port Coquitlam and the City of Coquitlam.

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City of Port Coquitlam & City of Coquitlam
Maple Creek IWMP

Project No.	Date
646-046	June, 2012

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100- Year Future Maximum Lowland Water Level, Floodbox Closed with Pump Station Upgrades

Figure 7-8

8. Summary and Recommendations

8.1 Summary of Findings

Key Watershed Characteristics and Issues

Description	Maple Creek Watershed
Drainage Area	• 192 ha • Discharges to Coquitlam River
Stream Structure	• 111 ha in Port Coquitlam • 81 ha in Coquitlam
Topography	• Fairly flat terrain. El. 46 m – El. 3 m
Land Use	• Existing land use is mostly developed or industrial / commercial land • Future development proposed in OCP includes higher density, residential, as well as commercial / industrial use • Total impervious area increases from 48% to 51% over the 192 ha area
Drainage System	• Storm sewer network all areas • Ditches, channels, culverts, bridges, including private crossings

Baseflow Augmentation

1. Maple Creek has a ground water production well used to augment the baseflows. The well has experienced a 75% loss in well efficiency since 1996 and currently provides 16.4 L/s (261 USgpm) to Maple Creek.

Environmental Values

1. Maple Creek and its tributaries support a diverse fish community of at least 11 species including anadromous, and resident fish communities. Six salmon and trout species reside in the watershed: Coho, Cutthroat Trout, Chum, Chinook, Sockeye and Steelhead. Brook Trout are also present.
2. Water quality sampling in Maple Creek shows fecal coliform levels greater than 1600 MPN/100ML at several locations, suggesting a possible sanitary-storm cross-connection. Metals contamination exceeded BC Approved Water Quality and/or CCME Water Quality Guidelines for zinc, copper, lead, cadmium, and aluminium at several locations. Nutrient concentrations, alkalinity, and TSS were well below provincial guidelines for all sites.
3. Fox Creek also shows elevated fecal coliform levels and metals that were found to be high.
4. Sediment quality sampling in Maple Creek shows high iron and lead levels that were above the BC ISQGs but below the PELs). Other metals were elevated, but did not exceed the BC ISQGs or the CCME Sediment Quality Guidelines for Freshwater Aquatic Life.
5. The watershed encompasses several species at risk, including Red-legged Frog, Cutthroat Trout (*clarkia* subspecies), Great Blue Heron (*fannini* subspecies), and Green Heron.

Flooding

1. Historical flooding at Coquitlam Glass on Bedford Street in the lower reaches of Maple Creek requires temporary pumping.
2. Modelling showed flooding in the lowland areas where historical flooding starts in a 5-year event.

Effectiveness of Existing Infrastructure

1. The existing Ozada high flow diversion consists of a concrete headwall with a 300 mm concrete pipe on Maple Creek, with high flows diverted to a channel to the east toward Grist Channel and discharges directly to the Coquitlam River. It is unlikely that the flow from the diversion is contributing to flooding in lower reaches.
2. The City of Port Coquitlam currently blocks the 300 mm pipe with sandbags during flood events to minimize the flooding experienced downstream. Stakeholders are concerned that these sandbags are sometimes left in place reducing low flows to the mid and lower creek during times when they are needed for survival of aquatic life.
3. The current pumps on Maple Creek are rated for much higher heads (water levels) than those seen in Maple Creek, and as a result are outside of their best efficiency range and only pump a maximum of 1.0 m^3/s during peak flow events.

Mitigating the Impacts of Future Development

1. Unmitigated development typically results in increased runoff peak flows and volumes, and increased frequency of peak flows that can cause flooding, erosion and deterioration of fish habitat; decreased infiltration can cause reduced creek baseflows and poor water quality.
2. The Watershed Health Tracking System shows that, if left unmitigated, future development would result in degradation of watershed health (1 B-IBI point drop over entire study area).
3. The baseflows in Maple Creek are augmented (approximately 16 L/s all year) and are essential to aquatic life. Maintaining baseflows while allowing redevelopment to proceed can be accomplished by incorporating infiltration/retention source controls, constructing baseflow release facilities, preserving wetlands and maximizing input to natural recharge areas, or supplementing creek flows with well water in the summer.
4. Mitigating the impacts of development should include:
   - Construction of volume reduction facilities to capture the 6-month 24-hour event or 90% of the typical year;
   - Construction of detention facilities (retention facilities) to reduce peak flows; and
   - Construction of water quality treatment facilities.

Stakeholder Program

1. Public meetings were held to solicit input to the key issues (April 2012).
2. Five Advisory Committee meetings were held in December 2010, May and December 2011, and January and April 2012.

3. Both written and verbal feedback were received and documented. Stakeholder comments and input has been included and integrated in this study.

8.2 Recommendations

Based on the forgoing, it is recommended that the City of Port Coquitlam and the City of Coquitlam:

General

1. Commit to monitoring and review of Maple Creek Watershed Performance Indicators on a recurring basis, minimum every five years and undertake adaptive management measures if needed.

Base-Flow Augmentation

2. Improve stream baseflows by encouraging on-site rainwater management. Explore other options for baseflow augmentation measures.

Operation of the Ozada High Flow Diversion

3. Plan to implement the recommended short-term operation and maintenance of the diversion. Ensure sandbags are removed from the 300mm outlet immediately following large storm events. Allocate funding and a timeline for replacing the Ozada culvert with a larger fish-friendly culver and proceed with design, instream approvals, etc.
4. Conduct a feasibility study to determine which of the long-term diversion alternatives is preferred. The study should take into account any water quality, volumetric reduction and peak flow control measures recommended in this report, as well as ease of implementation, and City/Stakeholder preference.

Water Quality Improvements

5. Plan to implement the recommended water quality improvement projects. Proceed with feasibility, design, instream approvals, etc.

Aquatic and Riparian Improvements

6. Remove or modify fish passage impediments in the watershed to improve access to and from spawning and rearing habitats.
7. Plan to implement habitat enhancement projects in the lower watershed in conjunction with channel modifications to improve conveyance capacity. Proceed with feasibility, design, instream approvals, etc.
8. Replace the existing 450 mm Ozada Avenue culvert with a larger gravel bottom (fish-friendly) culvert and maintain the existing Ozada diversion. Allocate funding and a timeline for construction and proceed with design, instream approvals, etc.
9. After completion of the recommended feasibility study, implement the preferred long-term alternative for removal of the existing Ozada diversion. Remove the short-term fish-friendly culvert and daylight that portion of Maple Creek. Allocate funding and a timeline for construction and proceed with design, instream approvals, etc.
10. Daylight 175 m of Fox Creek upstream and downstream of Davies Avenue.
11. Address riparian encroachment by enlarging riparian setbacks as redevelopment of the watershed occurs.

12. Develop municipal programs to educate and guide landowners to reduce bank hardening, channelization, remove invasive plant species, and, where possible, restore narrow riparian areas. Consider incentives to encourage landowners.

Flood Management Plan

13. Add climate change and sea level rise considerations to major drainage system improvements (100 and 200 year return periods) prior to design.
14. Complete required to 5-year, 20-year, and 50-year conveyance upgrades. Allocate funding and a timeline for culvert replacements and proceed with design, instream approvals, etc.
15. Construct a high flow diversion along Kingsway and Bedford to supplement the confined Kingsway Avenue to Bedford flumed channel section.
16. Construct a new higher capacity pump station with a self-regulating tide gate at the current pump location. This must be done in conjunction with several culvert and channel upgrades immediately upstream. Allocate funding and a timeline for construction and proceed with design, instream approvals, etc.

Mitigation of the Stormwater Impacts of Future Development

17. Require volumetric reduction, water quality, and peak flow attenuation source controls/facilities for future redevelopment. Include less common source control options, such as green roofs.
18. Ensure the rainwater management source controls meet the stormwater target for Maple Creek to capture 55 mm of runoff.
19. Develop typical details and specifications for common stormwater source controls on roads and in developments and incorporate Development Bylaws.
20. Produce a summary of requirements for developers. This would be a simplified summary of the criteria to be achieved or the prescriptive approach to be followed for each type of redevelopment.

Other Municipal Initiatives

21. Develop examples and standards for stormwater source controls, and green road standards.
22. Develop a Sediment and Erosion Control Bylaw to protect water quality in Port Coquitlam and enforce existing bylaw in Coquitlam.
23. Conduct educational outreach about watercourse health to private property owners with watercourses.

Report Submission

KERR WOOD LEIDAL ASSOCIATES LTD.

Prepared by:

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July 16/2021

Crystal Campbell, P.Eng.
Project Manager

Reviewed by:

Chris Johnston, P.Eng.
Technical Review

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Revision History

Revision #	Date	Status	Revision	Author
0	July 2021	Final	Issued as final for client copy.	CC
C	April 2021	Draft		CC
B	March 2021	Draft		CC
A	December 18, 2020	Draft	Address client comments	CC
Phase 1-4	June 2012	Draft	Added alternatives and proposed plan	JY
Phase 1-3	March 2012	Draft	Addressed City & stakeholder comments from Phases 1 & 2	JY
Phase 2	December 2, 2011	Draft		JY
Phase 1	April 12, 2011	Draft		JY

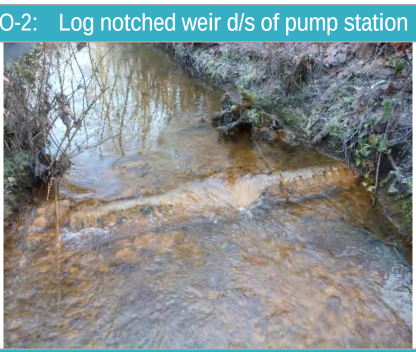
Appendix A

Drainage Inventory Photo Overview

Contents

Appendix A – Photo Overview

1.1 Observed Obstructions

O-1: Debris jam d/s of pump station	O-2: Log notched weir d/s of pump station	O-3: Pipe Crossing d/s of Kingsway Ave
		
O-4: Stacked rock weir u/s of Kingsway Ave culvert	O-5: Chain link fence d/s of Railway Triangle	O-6: Small wood debris in Railway Triangle
		
O-7: Large wood debris in Railway Triangle	O-8: Cleared dam in Railway Triangle	O-9: Log in Railway Triangle
		

O-10: Old rail bridge in Railway Triangle

O-11: Log jam in Railway Triangle

O-12: Concrete Ledge Davies Ave ditch

O-13: Log jam between Davies Ave and Jervis St

O-14: Concrete weir d/s of Gordon Ave

O-15 & O-16: Weirs at strata lot d/s of Lougheed Hwy

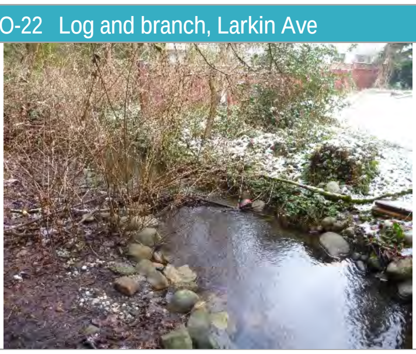
O-17: Log jam u/s of Lougheed Hwy

O-18: Tree limb, Shaftsbury Pl

O-20: Log jam, Gail Ave

02/02/2011

O-21: Wood weir u/s of Kitchener Ave



O-22 Log and branch, Larkin Ave

O-23: Wire fence, Larkin Ave

O-24: Wire fence, Larkin Ave

O-25: Large wood debris, Lincoln Ave

O-26: Log jam, Maple Creek Middle School

O-27: Old log bridge, Maple Creek Middle School

O-28: Log bridge, Maple Creek Middle School

O-29: Debris jam, Ozada Ave

O-30: Debris Jam, Ozada Ave

1.2 Bridge Locations

B-1: Footbridge u/s of Davis Ave

B-2: Footbridge between Jervis St and Gordon Ave

B-3: Footbridge between Jervis St and Gordon Ave

B-4 & B-5: Footbridges between Jervis St and Gordon Ave

B-6: Footbridge at strata lot d/s of Lougheed Hwy

B-7: Footbridge in Fox Park

B-8: Parking lot crossing, Metro Motors

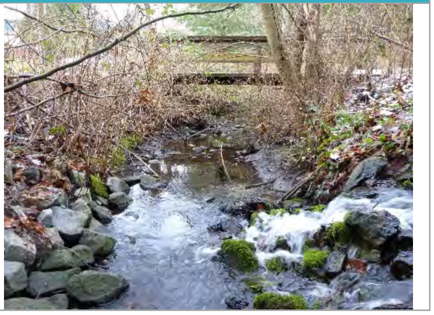
B-9: Road crossing, Shaftsbury Pl

B-10: Footbridge u/s of Shaftsbury Pl

B-11: Footbridge d/s of Kitchener Ave

B-12: Footbridge d/s of Kitchener Ave

B-13: Pedestrian Crossing at Kitchener Ave

B-17: Footbridge u/s of Patricia Ave	B-18: Footbridge to Maple Creek Middle School	B-19: Footbridge to Ozada Tot Park
		

1.3 Observed Erosion Sites

E-1: Low severity site d/s of pump station

E-2: Low severity site d/s of Chine Dr

E-3: Low severity site d/s of Kingsway Ave

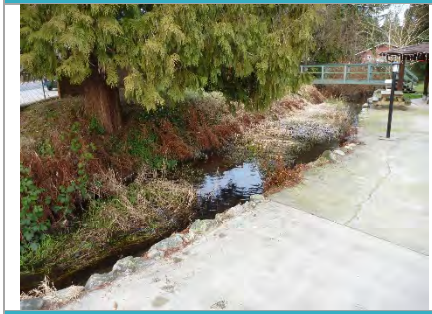
E-4: Low severity site Fox Creek

1.4 Confined and Encroached Channels


Confined channel at Coquitlam Glass, u/s of Bedford culvert


Confined channel, Concrete flume at Kingsway culvert outlet


Confined / overgrown channel, d/s of Railway Triangle


Confined channel, u/s of Davies culvert


Confined / overgrown channel, d/s Raleigh culvert


Confined Channel between Raleigh and Gordon


Confined Channel between Raleigh and Gordon


Confined Channel between Raleigh and Gordon


Encroachment u/s Shaftsbury Pl


Encroachment u/s Shaftsbury Pl

Encroachment near Gail Ave

Encroachment d/s of Kitchener Ave

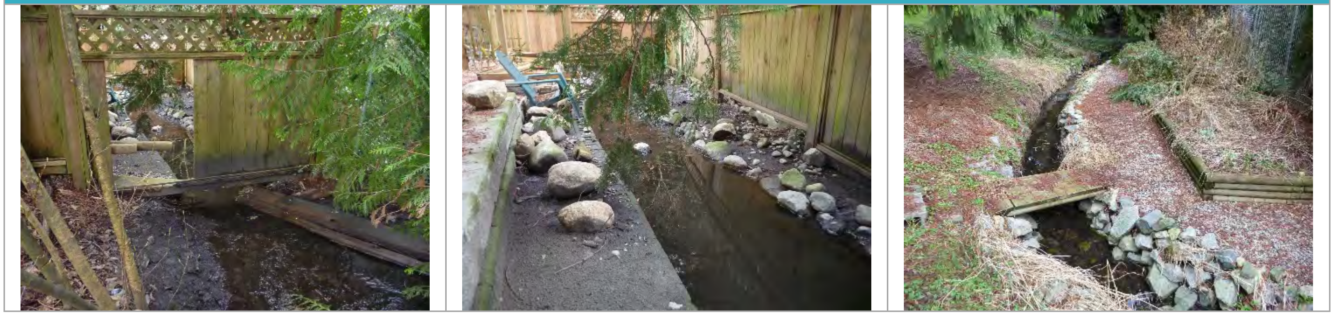
Encroachment u/s Kitchener Ave

Encroachment at Kitchener Ave

Encroachment u/s Kitchener Ave

Encroachment u/s Kitchener Ave

Encroachment on Fox Creek u/s of Fox Park



Appendix B

Hydrogeological Assessment

PITEAU ASSOCIATES
GEOTECHNICAL AND
HYDROGEOLOGICAL CONSULTANTS

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Our file: 3081

March 26, 2012

Kerr Wood Leidal Associates Ltd.
200-4185A Still Creek Drive
Burnaby, BC
V5C 6G9

Attention: Mr. Craig Kipkie, P.Eng.

Dear Sirs:

Re: Hydrogeological Assessment for Integrated Water Management Plan, Maple Creek, Coquitlam and Port Coquitlam, B.C.

Piteau Associates Engineering Ltd. (Piteau) was retained by Kerr Wood Leidal Associates Ltd. (KWL) to conduct a hydrogeological assessment of the Maple Creek Watershed (the Study Area), which extends across the Cities of Coquitlam and Port Coquitlam, BC. This assessment addresses groundwater-related aspects for development of an Integrated Water Management Plan (IWMP) for the Study Area.

OBJECTIVES AND SCOPE OF WORK

The objectives of the hydrogeological assessment have been to:

- Characterize the groundwater flow regime within the Study Area;
- Evaluate areas with potential for stormwater infiltration enhancement works;
- Evaluate impacts of development on groundwater quality and quantity; and
- Assess the long-term viability of current baseflow enhancement measures (i.e., Maple Creek well).

To meet these objectives, the following tasks were carried out:

- A desktop review of:
    - Maps of topography, surficial geology, shallow soils, surface water drainage, and current land use;
    - Historical stereo-paired aerial photographs;
    - Pertinent consultant reports;
    - Water well logs available from the B.C. Ministry of Natural Resource Operations (MNRO)[1] and other sources; and

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[1] Available online via MNRO's Water Resource Atlas: http://www.env.gov.bc.ca/wsd/data_searches/wrbc/

  - Information available from the Site Registry maintained by the BC Ministry of Environment (MOE) Land Remediation division[2].
- Visits to the site to:
  - Ground-truth soil types and pertinent hydrogeological features;
  - Conduct percolation tests at select locations to estimate infiltration rates;
  - Survey current land use activities in areas having a history of soil and/or groundwater contamination; and
  - Supervise an inspection and flow testing of the Maple Creek well and collect samples of well discharge for water quality testing.

PHYSICAL SETTING

The Study Area is bounded by the Coquitlam River to the south, Nestor Park to the north, Lougheed Highway and Pipeline Road to the west, and (almost) the Coquitlam River to the east (Fig. 1). The northern portion of the Study Area lies in the City of Coquitlam and the southern portion in the City of Port Coquitlam. It constitutes an irregular-shaped, 192 ha area that is roughly 3.5 km long and 0.8 km wide. The boundaries of the watershed have been drawn to include all surface runoff reporting to Maple Creek, both above and below ground.

The terrain within and surrounding the Study Area slopes gently to the southeast from an elevation of approximately 90 m-asl at the north end of Lafarge Lake to approximately 40 m-asl at the Coquitlam River. The topographic grade is relatively flat (<0.5%) between the Coquitlam River and Lougheed Highway, then steepens moving northward to a grade of approximately 1%.

CLIMATE

The Coquitlam Como Lake Avenue climate station is located approximately 6 km southwest of the Study Area at an elevation of 120 m-asl. Monthly and daily precipitation records for this station are available from 1953 onward[3]. Based on the normalized record for the period 1971 to 2000, the station receives about 1,924mm of precipitation annually. The highest monthly average occurs in November (299mm), and the lowest in July (62mm). There are no temperature data available for this station online.

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[2] Available online via MOE's Site Registry: https://www.bconline.gov.bc.ca/

[3] Available online via: http://climate.weatheroffice.gc.ca/climate_normals/index_e.html

SURFACE DRAINAGE

Maple Creek (the Creek) originates in the City of Coquitlam and flows approximately 3 km across the Study Area before eventually emptying into the Coquitlam River. Flow is sustained by a combination of groundwater and stormwater inputs along its reach. Anecdotal accounts claim that the Creek may have historically been a side channel of the Coquitlam River.

The Creek begins at a stormwater pipe at the top of Ozada Avenue and flows are augmented at a well sump located approximately 100m downstream (Maple Creek well, Photo 1). Near the foot of Ozada Avenue, the Creek intercepts a high flow diversion structure that relays excess creek flow and City of Coquitlam stormwater to the Coquitlam River during peak runoff periods. The remainder of the flow enters a 300mm diameter pipe at a headwall and continues southwest alongside the grounds of Maple Creek Middle School. Below Lincoln Avenue, the Creek follows a narrow riparian zone through predominantly residential neighbourhoods to Davies Avenue. At this point, it creek crosses the Railway triangle, which has been designated an ecological restoration zone. From Kingsway Avenue southward, it crosses a commercial / industrial lands and a natural area before its confluence with the Coquitlam River.

The downstream reaches of the Study Area, particularly south of Kingsway Avenue, are prone to flooding during heavy storm events. To mitigate these impacts, there is a flood box structure and gate controlled by Coquitlam River water levels, and temporary pumps in cages to assist drainage of the Creek into the river.

No hydrometric data (continuous flow or stage monitoring) for the Creek was available at the time of this investigation. Anecdotal accounts indicate that the Creek historically flowed year-round along its entire reach. Over time, flows decreased until some sections experienced no flow during the late spring and summer. In 1996, Fisheries and Oceans Canada (DFO) initiated a creek restoration program that involved augmenting flows in the upper reaches of Maple Creek using the Maple Creek well.

CURRENT AND HISTORICAL LAND USE

Evolution in land use across the Study Area has been analyzed using a series of aerial photographs taken between 1949 and 2004. Copies of select photos have been included with Appendix A. In general, areas to the south near the Railway triangle and Lougheed Highway were developed first, with ensuing development moving northward.

South of the Railway triangle to Chine Drive, Maple Creek has flowed across developed commercial / industrial lands since the 1940's. Below Chine Drive to the Coquitlam River, the Creek has flowed across vegetated and marshy areas since the 1940's. Development of a new residential neighbourhood along Riverside Drive was initiated in the early 1980's.

Between Patricia Avenue and the Railway triangle, land clearing for residential and commercial use is evident from the 1940's to the late 1970's. This is followed by increased densification and urbanization to present. Notable commercial developments include the Coquitlam Centre in the 1963 photo, and PoCo Place Mall in the 1984 photo. Sometime in the early 1970's, Coquitlam River dyke network was installed, and Maple Creek appears to have been rerouted to accommodate increased housing encroachment.

North of the Patricia Avenue, lands were relatively undeveloped until the early 1960's. It appears from the 1949 and 1954 photos that the Creek was originally sourced at the Coquitlam River. In 1963, a five hectare housing development is visible along Pipeline Road below and Inlet Street, possibly to house workers at the quarry at present-day Lafarge Lake. This quarry had been in operation since before the First World War and reached its most extensive footprint in the early 1970's. In 1979, the Maple Creek Middle School and playing fields were constructed, and the area between Ozada Avenue and Inlet Street were partially cleared of vegetation. By the early 1980's, virtually all residential lots between Patricia Avenue and Nestor Park had been built-out.

SURFICIAL GEOLOGY AND SHALLOW SOILS

As indicated on Fig. 2, the Study Area is predominantly underlain by Pleistocene-aged sand and gravel sediments deposited by pro-glacial streams. Referred to as the Capilano Sediments (Cc), they range in texture from medium sand to cobble gravel, are up to 15m thick, and are commonly underlain by silt to silty clay loam. These sands and gravels are exposed at a large excavation at Pipeline Road and Lincoln Avenue (Photo 2).

The southern tip of the Study Area sits atop younger, post-glacial mountain stream channel fill deposits (Saj) and mountain stream deltaic deposits (Sai). The former comprise medium to coarse gravel and minor sand up to 8m thick, and the latter comprise medium to coarse gravel with minor sand up to 15m thick (Photo 3). The Salish deposits are bounded to the south by finer-grained Fraser River Sediments that are normally up to 2m thick. These are described as overbank silty to silt clay loam deposits overlying sandy to silt loam.

Upland areas to the northwest to northeast of the Study Area consist of bedrock blanketed by less than 8m of Capilano and Vashon Drift sediments (VC). These are comprised of pro-glacial lodgement and minor flow till, interbeds of substratified glaciofluvial sand to gravel, and lenses of glacio-lacustrine laminated stony silt. At higher elevations, these sediments yield to lodgement till and minor flow till with interbeds of glaciolacustrine stony silt (Va), and ultimately, exposed Mesozoic granitic bedrock.

Limited information on shallow soil types in the Coquitlam portion of the Study Area (soil types in the Port Coquitlam area have not been classified) indicate that the Capilano Sediments are overlain by coarse-textured, stony and boulder Seymour soils (Luttmerding, 1981). These soils are described as rapidly pervious, although discontinuous cemented layers in some locations can retard downward movement of water, resulting in occasional flooding during high runoff periods.

Detailed information on local lithology was obtained from water well logs sourced from the MNRO database and from consultant's reports (Piteau, 1991; Golder, 2006). Copies of these logs are included with Appendix B, and well locations are shown on Fig. 1. The logs generally indicate that the Study Area is underlain by sand and gravel to depths of 22m, which in turn are underlain by silt and/or clay to depths of 30m. Just outside the northeast corner of the Study Area, two well logs report a till horizon above the sand and gravel deposits, possibly belonging to the Vashon Drift and Capilano (VC) sequence.

GROUNDWATER CONDITIONS

Within the Study Area, the Capilano (Cc) and Salish (SAij) sediments comprise a highly productive unconfined aquifer identified by the MNRO as Aquifer #70. This aquifer covers a total area of approximately 25 km^2, and likely is recharged by mountain runoff flowing atop less permeable units to the northwest and northeast, as well as incident precipitation. As shown on Fig. 2, groundwater is interpreted to flow in a southeasterly direction, consistent with the regional topographic gradient. This is also shown in cross-section on Fig. 3. Groundwater velocities are likely to be on the order of 0.5 to 1.5 m/day, based on representative estimates of hydraulic gradient and hydraulic conductivity.

Based on a 1979 bathometric survey[4], Lafarge Lake is up to 8m deep in some places; hence, is likely to be a surface expression of the local water table. The lake also receives stormwater inputs from the Grist and Scott/Hoy Creek watersheds. City officials have reported unusually low water levels in the lake during recent summers, probably as a result of decreased stormwater inputs and a depressed water table.

A temporary construction dewatering well installed in 1991 at a high rise development on Glen Drive (PW91-1) encountered sand and gravel to 20m, and produced flows of up to 25 L/s during a pumping test. At this location, the water table was measured at 5.8 m-bgl. Aquifer transmissivity estimated from test drawdown trends was 6 x 10^{-3} m^2/s, indicative of highly permeable sediments. This building relies on foundation subdrains and a continuously operating sump pump to maintain the water table below basement levels. It is our understanding that the discharge enters the storm sewer system and ultimately the Coquitlam River.

Approximately 400m to the southeast of this development, several groundwater monitoring wells were installed at the Windsor Glen residential development as part of a pre-construction infiltration assessment (Golder, 2006). Depths to the water table ranged from about 4 to 8 m-bgl, and groundwater flow was interpreted to be to the southeast. A representative hydraulic conductivity of 1 x 10^{-4} m/s was estimated for the sands and gravels underlying this site, which is in the highly permeable range.

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[4] Obtained on-line at http://a100.gov.bc.ca/pub/fidq/bath_images/pdf/00268301.pdf

Low-lying areas of the aquifer are likely drained by overlying surface watercourses where the ground surface intercepts the water table. This is believed to be the case for Maple Creek below Lincoln Avenue, based on:

- Late summer water table elevations measured to be at or above streambed elevations using temporarily installed piezometers by ECL Envirowest (1996), as summarized below:

Location	**Water Table Depth below Streambed (cm)**		**Stream Flow Rate (L/s)**
	September 24, 1996	October 1, 1996	
Adjacent to Ozada Ave. (upstream)	15	>37.5	0
Adjacent to Ozada Ave. (downstream)	8.2	>37.5	0
Adjacent to [Hastings] Maple Creek Middle School	10.5	21.2	0
At Lincoln Ave. ROW	8.5	13.5	0
Upstream of Kitchener Ave. and Tributary	-4.5 (flowing at surface)	-3.8 (flowing at surface)	2.9
Between Gordon Ave. and Raleigh St.	0 (at surface)	15.0 (piezometer tampered with)	0
Between Kingsway Ave. and Bedford St.	-1.5 (flowing at surface)	-1.0 (flowing at surface)	0.024(?)

Note: These measurements were made before commissioning of the Maple Creek Well to augment flows in the Creek.

- A flowing spring observed between the Hastings Place and Tuohey cul-de-sacs downstream of Kitchener Avenue. This spring was identified during Piteau's March 8, 2011 site visit. Groundwater seepage into Maple Creek (the Creek) is also likely occurring along the ravined section at the eastern end of Lincoln Avenue (Photo 4).

As these lower reaches are interpreted to be gaining reaches, flows are largely controlled by water table elevation during the drier times of year when stormwater contributions are negligible. The amount of groundwater flow into the Creek will depend on the texture of bed sediments and the head differential between the water table and the Creek.

MAPLE CREEK WELL

In September 1996, the Maple Creek production well was drilled near Salt Spring Avenue and Gabriola Drive as part of the Maple Creek Habitat Improvement Project (Piteau, 1996). This well, also referred to as the Maple Creek "Wet Well" or "PW96-1," was intended to augment summer baseflows in Maple Creek and Grist Channel at a targeted flow rate of 28 L/s (400 USgpm). A photo of the wellhead is provided as Photo 5.

The well was drilled using a truck-mounted air rotary rig operated by A&H Construction Ltd., and developed by surging with compressed air (air lifting). Sediments encountered during borehole advancement are as follows:

0 to 0.9m:	topsoil
0.9 to 7.0m:	till and boulders
7.0 to 14.0m:	sand and gravel with clay
14.0 to 21.3m:	fine silty sand
21.3 to 32.0m:	coarse sand and gravel

The well is nominally 200mm (8”) in diameter and withdraws groundwater through a 4.6m (15 ft) length of nominal 200mm (8”) diameter telescopic well screen positioned between 27.4 and 32.0 m-bgl. Based on the uniform slot size of 2.5mm, the maximum transmitting capacity of the screen is approximately 47 L/s (745 USgpm). The original driller’s log and a graphical depiction of the well’s civil / mechanical components are included with Appendix C.

The well was originally tested for a 10.5-hour period at a constant rate of 25.8 L/s. Drawdown measured at the end of the test was 5.4m, corresponding to a specific capacity of 4.8 L/s/m. A flattening of the drawdown trend after two hours is indicative of possible induced recharge from the Coquitlam River.

Laboratory analytical results obtained for groundwater samples collected near the conclusion of the 1996 pumping test indicate that the groundwater is neutral in pH and moderately soft (TDS 99.1 mg/L as $CaCO_3$). Predominant ions include calcium and sodium, and bicarbonate (likely) and chloride. Of the trace metals, iron concentrations (0.42 mg/L) were elevated enough to potentially cause some staining.

Based on these results, the well was rated to be capable of sustaining a flow rate of 44.2 L/s (700 USgpm). In February 1997, a 190mm (7.5”) diameter submersible pump and 150mm (6”) 15 horsepower motor capable of producing 44.2 L/s were installed in the well. It was agreed between the City of Coquitlam (the City) and DFO that the City would continue to operate and maintain the well during at least the summer months, in order to sustain flows in Maple Creek.

Since then, records obtained from the city indicate a number of pump failures and substantial loss of well productivity. The pump was replaced in February 1998, December 2004, and August 2010. The December 2004 pump inspection sheet indicated a break in the pump housing between the bowl and suction, and the pump replaced in August 2010 exhibited severe physical wear (Photo 6). In May 2009, a City representative measured a discharge rate on the order of 12.6 L/s (200 USgpm) from the well. One month later, DFO estimated a discharge rate on the order of 37.9 L/s (600 USgpm) and measured the pumping water level to be approximately 14.8 m-bgl. These latter measurements give a specific capacity of about 2.8 L/s/m, which is about 42% less than that originally measured in 1996. Various email correspondences cite overpumping and/or the migration and compaction of fine sediment around the well screen to be potential causes of loss of well performance.

MAPLE CREEK WELL TESTING

Field Activities

A video inspection and short-term variable-rate aquifer pumping test were performed with the well on February 15, 2011. Both were performed by Precision Service & Pumps Ltd. (Precision) of Abbotsford, BC under the supervision of Ms. Marion Kehoe of Piteau. During the aquifer pumping test, the well was pumped using the existing pump at incrementally increasing rates of 9.1,11.0, and 16.0 L/s, for steps of 30, 30, and 60 minutes in duration.

It was originally intended that the well be pumped up to 25.8 L/s and for a longer period; however, a blown fuse delayed the start of the test, and the maximum discharge achieved from the existing pump was only 16.0 L/s. During the test, water levels in the well were measured manually using a graduated electric tape, and flow rates were measured at the discharge point using an orifice plate measurement device. All discharge was relayed to the nearby storm sewer on Gabriola Drive (Photo 7).

Near the conclusion of the pumping test, samples of well discharge were collected for water quality analysis in bottles provided by ALS Environmental, and shipped to their laboratory in Burnaby in an ice-packed cooler. The samples were analyzed within recommended holding times for all analytes requested. On March 8, 2011, a second suite of well water samples were submitted to I.G. Micromed Laboratories in Richmond, B.C. for additional bacteriological analyses.

Results and Discussion

Considerable rust-coloured staining (oxidized iron) was noted on the drop pipe during withdrawal of the pump (Photo 8). It was also noted that the well is not plumb, causing abrasion of the pump and associated wiring on the walls of the well casing during displacement (Photo 9). As there is very little clearance (<1 cm) between the pump and the inside of the well casing, it is possible that this misalignment may have caused the pump to vibrate against the side of the casing, increasing physical wear.

Images obtained during the down-hole camera inspection indicated significant build-up of soft, yellowish material and occasional bluish-coloured filaments on the inside of the well screen and casing. Visibility within the standing water column was impaired by suspended masses of this material; however, the vertical rods and horizontal slots of the well screen were discernable along most of its length. Blockage of the slot openings generally decreased with increasing depth from about 80% to 30% (Photos 10 and 11). No significant accumulation of yellowish material or sediment was noted at the bottom of the well.

Drawdown measurements taken throughout the variable-rate pumping test are tabulated in Table D-1 of Appendix D, and are plotted graphically on the upper portion Fig. 4. The lower portion of Fig. 4 shows pumping rate (Q) versus drawdown, and Q versus specific capacity (Sc)[5]. Drawdown increased from 5.4 to 10.9m at the end of each step, and Sc decreased from 1.7 to 1.5 L/s/m. This decrease in Sc with increasing pumping rate is expected given increased frictional losses from water moving at incrementally higher velocities across the well screen. Had the well been tested at 25.8 L/s, the Sc would probably have been around 1.2 L/s/m, which is 75% less than the Sc measured during original testing of the well at the same rate in 1996.

The current sustainable yield for the well was calculated using the following methodology, as set out in Table I:

- The total available drawdown was calculated by subtracting the static water level, plus an allowance for seasonal decline in water level (1.0m) from the recommended maximum pumping level (low water shut-off, approximately 0.75m above current pump intake).
- The total allowable drawdown was calculated by subtracting a factor of safety (30%) from the total available drawdown.
- The long-term specific capacity was calculated by dividing the pumping rate of the final step by the projected drawdown at 100 days.
- The estimated sustainable yield was obtained by multiplying the long-term specific capacity by the total allowable drawdown.

Based on the above, the current sustainable yield for the well is 16.4 L/s (261 USgpm). This is roughly a third of its original estimated yield of 44.2 L/s (700 USgpm).

The most likely causes of this loss in well productivity are biofouling and possibly compaction of fine sediment around the well screen. These conditions may have been exacerbated by overpumping of the well at rates that approached the screen capacity. They may also have been worsened by repeat cycling of the pump. Observed iron staining oxidation along the entire length of the pump riser pipe suggests that the water level has repeatedly dropped to the low water shut-off probe. Low head levels above the pump and high velocities through the tight annular space may also induce cavitation of the pump, possibly an explaining the severe pump wear depicted in Photo 6. An additional visit by Precision to the wellhead on March 8, 2011 to re-check various pump settings could not confirm why the existing pump cannot produce flows greater than 16 L/s (254 USgpm).

The results of laboratory analyses performed on the February 2011 samples (Appendix E) indicate a slight decrease in concentrations of major ions compared to the September 1996 samples (Table II). In particular, iron concentrations have dropped below the method detection limit of 0.03 mg/L. This may be partially attributable to increased flushing of the aquifer by

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[5] Specific capacity is the ration of pumping rate to water level drawdown.

precipitation or Coquitlam River recharge during the wetter winter months. All water quality parameters tested comply with BC's Approved Water Quality Guidelines (AWQG)[6] and/or the Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines[7] for the protection of freshwater aquatic life. Hence, the groundwater continues to be a suitable supplemental source of water to the Creek.

Recommendations

In our opinion, this well is not expected to yield sufficient or reliable flows to Maple Creek given its demonstrated loss in specific capacity and questionable condition of the pump.

As a general rule, a well that has lost 10 to 15% of its specific capacity is likely to regain this capacity after rehabilitation. Beyond a 30% loss in specific capacity, well performance declines at an accelerated rate, and the success of rehabilitative work is less certain. The Maple Creek well has already seen a 75% loss in specific capacity and is also not plumb, which may continue to inhibit reliable operation of the existing pump.

In a best-case scenario, it may be possible to gain another ten years of service from this well if rehabilitation activities double its current specific capacity. This would increase the well's sustainable yield to 32 L/s (507 USgpm). Consultation with a professional fisheries biologist should be solicited to determine if these flows would be adequate. An additional increase of about 2 L/s could be gained by lowering the pump assembly closer to the K-packer. The existing pump should be replaced with a smaller diameter model that would meet these flows, and would benefit from more annular space.

If rehabilitation is pursued, it would likely involve initial mechanical breakdown of the biomass and packed sediment by surging and bailing, followed by injection of a bioacid, followed by additional surging and bailing. A conventional cable tool rig would be suitable for this work. Careful planning of chemical dosing, monitoring of water quality, and handling of spent chemical and materials would be required to maximize the effectiveness of these steps and ensure a safe and environmentally sound operation.

SOIL PERMEABILITY TESTING

Field Activities

Percolation tests were conducted at three locations within the Study Area, as indicated on Fig. 1. These include a vacant lot at the western end of Bowen Drive, and park (municipal) land at the southern end of Ozada Avenue and in Fox Park. All tests were conducted in areas mapped as Capilano sands and gravels (Cc). No percolation test was conducted in the VC sands and

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[6] Available on-line at http://www.llbc.leg.bc.ca/public/pubdocs/bcdocs/409645/approved_wq_guide.pdf
[7] Available on-line at http://st-ts.ccme.ca/?chems=all&chapters=1

gravels south of the Railway triangle, since the high flooding risk renders this area unsuitable for water infiltration works.

Percolation tests were conducted on March 8, 2011 in accordance with the methodology described in the BC Ministry of Health Sewerage System Regulation[8]. Each test involved excavating a two-foot deep, one-foot square test hole and filling it with water twice (Photo 12). After this pre-soak step, the hole was refilled to six inches from the bottom multiple times and the time for the water level to drop one inch was recorded. The test was concluded after consecutive trials did not vary by more than two minutes per inch. The final (slowest) percolation time was taken to be the most representative value of the suite.

Results and Discussion

The percolation times measured at the three test locations are tabulated in Table III. A correction factor of 0.33 has been applied to correct for flow across the side walls of the hole, and to facilitate comparison to infiltration rates measured elsewhere using a double ring infiltrometer. Average corrected infiltration rates ranged from 125 to 78 mm/hr. These rates are slower than typical rates for outwash sand and gravel (100-200 mm/hr), which is possibly due to finer-grained and/or cemented horizons or to the loamy fraction of the near-surface soils.

Recommendations

Throughout British Columbia, ground infiltration of stormwater runoff has yielded a number of benefits, including reduction of peak flows and enhancement of summer low flows in local streams, and filtering out of contaminants and suspended sediments prior to discharge to streams.

Shallow infiltration systems could be designed to infiltrate water throughout most of the Maple Creek watershed, namely that region covered by well-drained, permeable sands and gravels (Cc). Areas where the water table is more than 5m below surface offer substantial storage capacity for stormwater infiltration, so long as it is controlled to prevent excessive water table mounding and ground seepage in other areas.

Possible source control measures that could be implemented to minimize stormwater runoff and/or augment groundwater recharge include perforated storm pipes in shallow trenches, seepage basins, soak-away pits, infiltration chambers, absorbent landscapes, rain gardens, vegetated swales, and pervious paving. It is generally preferred to have a wide distribution of infiltration systems introducing water into different areas and material types, rather than a few concentrated areas discharging into one material type. This will reduce the potential for water table mounding.

---

[8] Available on-line at http://www.health.gov.bc.ca/protect/lup_standards.html

Systems that collect and store stormwater runoff for eventual infiltration to ground should have a number of considerations, such as adequate storage volume and a clarification system to eliminate sediments and floating detritus that could cause clogging. Infiltration systems should be designed to have sufficient storage to release the required volumes, but after that capacity is reached, it should be bypassed and discharged to the storm sewer system.

Ground infiltration of stormwater is not recommended in areas underlain by VC sands and gravels, since this area experiences high water table conditions and/or flooding during storm events. Furthermore, associated contributions to baseflow would be of limited value in this reach of the Creek just above its confluence with the Coquitlam River.

GROUNDWATER QUALITY AND GROUNDWATER POLLUTION HAZARDS

Given the shallow, unconfined, and highly transmissive properties of the aquifer underlying the Study Area, there is a high potential for contaminants to impact groundwater quality. Where groundwater contributes to surface water flow, these contaminants may also impact Maple Creek.

To date, there is very little information on groundwater quality available from municipal or government sources. As the area is serviced by the water distribution grid for its potable water needs, monitoring of groundwater quality has not been a priority. Piteau searched the Site Registry database maintained by the MOE for registered sites within 5 km of the Study Area centre. This database lists properties for which site profiles, contaminated sites investigations and/or remediation works have been completed. Those sites with confirmed contamination represent potential groundwater pollution hazards.

A summary of the Site Registry search results is included in Table IV, and locations of sites in the vicinity of the Study Area are shown on Fig. 5. Detailed reports were obtained for all sites located within or bordering the Study Area. The most relevant portions of these reports are included with Appendix F.

As of March 17, 2011, there are five sites that are noted as “active.” All are located near the western boundary of the Study Area at distances ranging from 150 to 550m from Maple Creek. These sites are currently undergoing environmental assessment and/or remediation works, as summarized below:

- Site ID 1054, located at Pipeline Road and Glen Drive, has undergone an underground storage tank (UST) removal and assessment of surrounding soil quality. Petroleum product storage and dispensing, as well as mixed industrial activities have historically taken place at this site.

- Hazardous wastes and construction debris are reported to have been handled at Site ID 9352, located at 3646 Westwood Street.

- Site IDs 8218 and 8993, located on Westwood Street and Lougheed Highway, respectively, have reported possible/actual migration of substances off-site, and are currently undergoing remediation. These substances are associated with the storage and dispensing of petroleum hydrocarbons.

- Site ID 5795, located on Bedford Street, has undergone remediation for contaminants related to a variety of industrial on-site practices.

Based on the information provided in the Site Registry reports, potential groundwater pollution hazards at the above five locations include hydrocarbons and metals. Household materials used on neighbouring residential lots, such as pest and weed control products, can also represent a hazard. Of the active sites listed on the Site Registry, that which constitutes the greatest potential known risk to Maple Creek is Site 8218, owing to its close proximity. Additional research to obtain further information on the types and distribution of potential groundwater contaminants is beyond our current scope of work.

It should be noted that inclusion of a property in the Site Registry does not indicate that contamination is present. Conversely, the absence of a listing for a particular property does not indicate that contamination is not present. Other unknown activities with the potential to result in groundwater contamination may also exist.

CONCLUSIONS AND RECOMMENDATIONS

1. The Maple Creek watershed is underlain by a relatively thick (>20m) deposits of sand and gravel. These comprise a productive aquifer wherein the water table lies less than 6 m-bgl. Below Patricia Avenue, this aquifer is interpreted to contribute to flows in Maple Creek, particularly during periods of high water table. Upstream reaches of Maple Creek are interpreted to be perched above the water table and less hydraulically connected with the aquifer.

2. The sands and gravels underlying the Study Area are relatively permeable and offer good potential for infiltration of stormwater. However, it is not recommended that enhanced infiltration measures be implemented below Kingsway Avenue, where the water table is nearer surface and occasional flooding is known to occur.

3. More detailed hydrogeological assessments should be carried out by a qualified professional in those areas where ground infiltration measures are being considered. These would typically involve digging test pits or trenches for in-situ permeability testing and installing standpipe piezometer tubes for water table monitoring over at least a six-month period.

4. New developments proposing to install permanent foundation subdrains should be encouraged to pursue other options (e.g., waterproofing), or assess potential impacts of their system to ambient water table elevations and baseflows to Maple Creek.

5. The Maple Creek well is not expected to reliably produce flows in its current condition. A 75% decrease in well efficiency has been measured since it was first commissioned in 1996, likely as a result of bacterial growth and compaction of fine sediment in the aquifer matrix surrounding the well screen.

6. The existing pump in the Maple Creek well (nominal 7") is oversized and should be replaced with a smaller diameter model (nominal 6") capable of producing desired flows. This would increase the annular space between the pump and well casing, thereby decreasing flow velocities and potential wear on the pump.

7. Rehabilitation measures are recommended to improve the well's current yield (16 L/s or 254 USgpm) and extend its operating life. An increase in yield to 32 L/s (507 USgpm) is considered possible. Consultation with a fisheries biologist is recommended to determine what flows would be acceptable to sustain downstream fish habitat.

8. The aquifer is, by its nature, vulnerable to contamination from above-ground sources of contamination. Some contamination may have already occurred from historical industrial activities along major transportation routes, such as Pipeline Road, Westwood Road, and Lougheed Highway. These are related mainly to the storage and dispensing of petroleum hydrocarbons, and manufacturing, repair, and salvaging of machinery, vehicles, and various wastes. An aquifer protection program is recommended to protect the aquifer, and ultimately, Maple Creek from potential impacts.

9. A hydrometric station should be set up on Maple Creek to provide data to continuously monitor seasonal flow fluctuations and baseflow.

LIMITATIONS

This report was prepared for the exclusive use of Kerr Wood Leidal Associates Ltd. and their clients, the Cities of Coquitlam and Port Coquitlam. The investigation has been conducted using a standard of care consistent with that expected of scientific and engineering professionals undertaking similar work under similar conditions in BC. No warranty is expressed or implied. Any use, interpretation, or reliance on this information by any third party, is at the sole risk of that party, and Piteau accepts no liability for such unauthorized use.

CLOSURE

We trust that this is sufficient for your present purposes

Yours very truly,

PITEAU ASSOCIATES ENGINEERING LTD.

KTix

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Mar 26, 2012

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ANDREW T. HOLMES

March 26/2012

Andy Holmes, P.Eng.
Principal, Chief Hydrogeologist

KCT/ATH/slc

Att.

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TABLE

TABLE I

SUSTAINABLE WELL YIELD CALCULATION

LEVELS AND RATES	UNIT	SEPT 1996 PUMPING TEST	FEB 2011 PUMPING TEST
DEPTH TO STATIC WATER TABLE - February 15, 2011	m-bgl	2.13	1.98
ESTIMATED SEASONAL LOW DEPTH TO STATIC [1]	m-bgl		2.48
ESTIMATED INTERFERENCE FROM OTHER WELLS	m		0.00
ESTIMATED MAXIMUM DEPTH TO STATIC	m	2.13	2.48
DEPTH TO TOP OF K-PACKER [2]	m-bgl	26.61	26.61
TOTAL WELL DEPTH	m-bgl	32.00	32.00
CURRENT DEPTH TO PUMP INTAKE [2]	m-bgl		22.87
CURRENT DEPTH TO LOW WATER SHUT-OFF PROBE [3]	b-bgl		22.12
RECOMMENDED MAXIMUM DEPTH TO PUMPING LEVEL [4]	m-bgl		22.12
AVAILABLE DRAWDOWN [5]	m		19.64
ALLOWABLE DRAWDOWN [6]	m		13.75
DRAWDOWN AT END OF PUMPING TEST	m	5.42	10.90
DRAWDOWN PROJECTED TO 1 YEAR	m		13.40
PROJECTED LONG TERM SPECIFIC CAPACITY [7]	L/s/m		1.20
TEST PUMPING RATE	L/s	25.8	16.0
	m^3/day	2229.5	1385.0
	USgpm	409	254
	IGPM	341	212
ESTIMATED SUSTAINABLE SAFE YIELD [8]	L/s	44.2	**16.4**
	m^3/day	3819	1421
	USgpm	700	261
	IGPM	584	217
MAXIMUM SCREEN CAPACITY [9]	L/s	47.0	47.0
	m^3/day	4061	4061
	USgpm	745	745
	IGPM	621	621

Notes

1. Allow 0.5m drop to seasonal low levels in late summer.
2. Measured by Precision Service and Pumps on February 15, 2011.
3. From DFO As-built schematic D2061-2 (Drawing Nu. 11-134-2).
4. Allows 3m of head above the pump intake.
5. Available drawdown is recommended maximum depth to pumping level minus estimated maximum depth to static.
6. Allowable drawdown incorporates a 30% factor of safety (i.e. allowable drawdown = 70% of available drawdown).
7. Long-term specific capacity is flow rate of pump test divided by pump test drawdown projected to one year.
8. Estimated safe yield is calculated as allowable drawdown times long-term specific capacity.
9. Maximum screen capacity is calculated as screen opening area times recommended maximum entrance velocity of 0.1 ft/s.

TABLE II

SUMMARY OF WATER QUALITY RESULTS FOR MAPLE CREEK WELL

	Well Name:	Maple Creek Well	Maple Creek Wet Well	Approved Water Quality Guidelines for British Columbia	NOTES	CCME Water Quality Guidelines	NOTES
	Date Sampled:	23-Sep-96	15-Feb-2011				
	Lab File:	Norwest Labs 20948	ALS L978807-1				
	UNITS			(mg/L)		(mg/L)	
Physical Chemistry							
pH	pH	7.05	7.5		5	6.5-9.0	
pH (field)	pH	-	6.0			6.5-9.0	
Colour True	CU	-	<5.0		5		5
Conductivity (lab)	μs/cm	316	292.0				
Specific Conductance (field)	μs/cm	-	462				
Turbidity	NTU	-	0.7				5
Hardness (as $CaCO_3$)	mg/L	99.1	91.3				
Total Dissolved Solids	mg/L	-	185.0				
Total Dissolved Solids (field)	mg/L	-	221				
Temperature (field)	deg. C	-	6.6		5		5
Anions							
Alkalinity $CaCO_3$	mg/L	-	74.4				
Chloride	mg/L	54.7	40.8				
Sulphate	mg/L	12.2	11.20				
Fluoride	mg/L	-	0.025				
Nutrients							
Nitrate (as N)	mg/L	-	0.645			13	
Nitrite (as N)	mg/L	-	<0.0010			0.06	
Nitrate + Nitrite (as N)	mg/L	0.24					
Ammonium (as N)	mg/L	<0.1					
Total Metals							
Aluminum	mg/L	-	<0.010	0.05	3		
Antimony	mg/L	-	<0.00050				
Arsenic	mg/L	-	0.00073	5		0.005	
Barium	mg/L	-	<0.020				
Boron	mg/L	0.06	<0.10	1.2		1.5	
Cadmium	mg/L	-	<0.00020			0.00031	4
Calcium	mg/L	30.40	29.0				
Chromium	mg/L	-	<0.0020				
Copper	mg/L	<0.01	0.0016	0.00004	4	0.0022	4
Iron	mg/L	0.42	<0.030			0.3	
Lead	mg/L	-	0.00124	0.00331	4	0.0029	4
Magnesium	mg/L	5.60	4.60				
Manganese	mg/L	0.03	<0.0020	1.0	4		
Mercury	mg/L	-	<0.00020	0.00002			
Potassium	mg/L	2.6	1.97				
Selenium	mg/L	-	<0.0010	0.002		0.001	
Sodium	mg/L	26.60	21.7				
Uranium	mg/L	-	0.00011			0.015	
Zinc	mg/L	-	<0.050	0.033	4	0.03	
Bacteriological							
Total Coliform	MPN/100mL	<1	<1				
E. coli	MPN/100mL	<1	<1				

1. From British Columbia Approved Water Quality Guidelines, 2006 Edition
   Guidelines listed are for the protection of freshwater aquatic life and where applicable, are to protect from long-term, sub-lethal effects (30-day average value)
2. From Canadian Environmental Quality Guidelines
3. Guideline is pH dependent and applies to dissolved Al
4. Guideline is hardness dependent
5. See CCME or AWQG narrative

TABLE III
SUMMARY OF PERCOLATION TEST RESULTS

Location Number	Easting[1]	Northing[1]	Elevation (m-asl)[1]	Location Description	Surficial Sediment Type	Shallow Soil Type	Test Hole Lithology	Test	Measured Percolation Rate		Corrected Percolation Rate[3] (mm/hr)
									(min/inch)	(mm/hr)	
1	515758.75	5459342.96	42	Empty lot at western end of Bowen Drive, Coquitlam	Sand and Gravel	Seymour (SY)	0-20 cm: Dark brown, medium to coarse sand and gravel, some cobbles, dry 20-60 cm: Light brown-orange, medium to coarse sand and gravel, some cobbles, dry - moist	1	0:03:13		
								2	0:03:24		
								3	0:04:08		
								4	0:03:50		
								Representative Result[2]	**0:04:08**	373.5	124.5
2	516126.55	5458708.86	26	Walking trail at southern end of Ozada Avenue, near Maple Creek School oval.	Sand and Gravel	Seymour (SY)	0-20 cm: Black-brown, organic fine to medium silty sand and gravel, some cobbles, roots, moist 20-30 cm: Red-brown, fine to medium silty sand with some gravel and cobbles, dry 30-55 cm: Light brown, fine to coarse silty sand and gravel, some cobbles, dry-moist	1	0:04:30		
								2	0:04:47		
								3	0:05:10		
								4	0:05:30		
								Representative Result[2]	**0:05:30**	287.5	95.8
3	5153838.19	5457449.18	12	Fox Park, Fox Street, Port Coquitlam	Sand and Gravel	Seymour (SY)	0-3 cm: Grass cover, black-brown organic silty sand, some roots 3-55 cm: Dark brown-black, fine to coarse silty sand, some gravel and rounded cobbles, organic, dry	1	0:05:40		
								2	0:06:15		
								3	0:06:45		
								4	0:06:50		
								Representative Result[2]	**0:06:50**	234	78

Notes:
1. Measured using Google Earth (UTM).
2. The slowest percolation rate taken is considered the most representative value.
3. Factor of 0.33 applied to corrected for infiltration across side walls of test pits for comparison to double ring infiltrometer results.

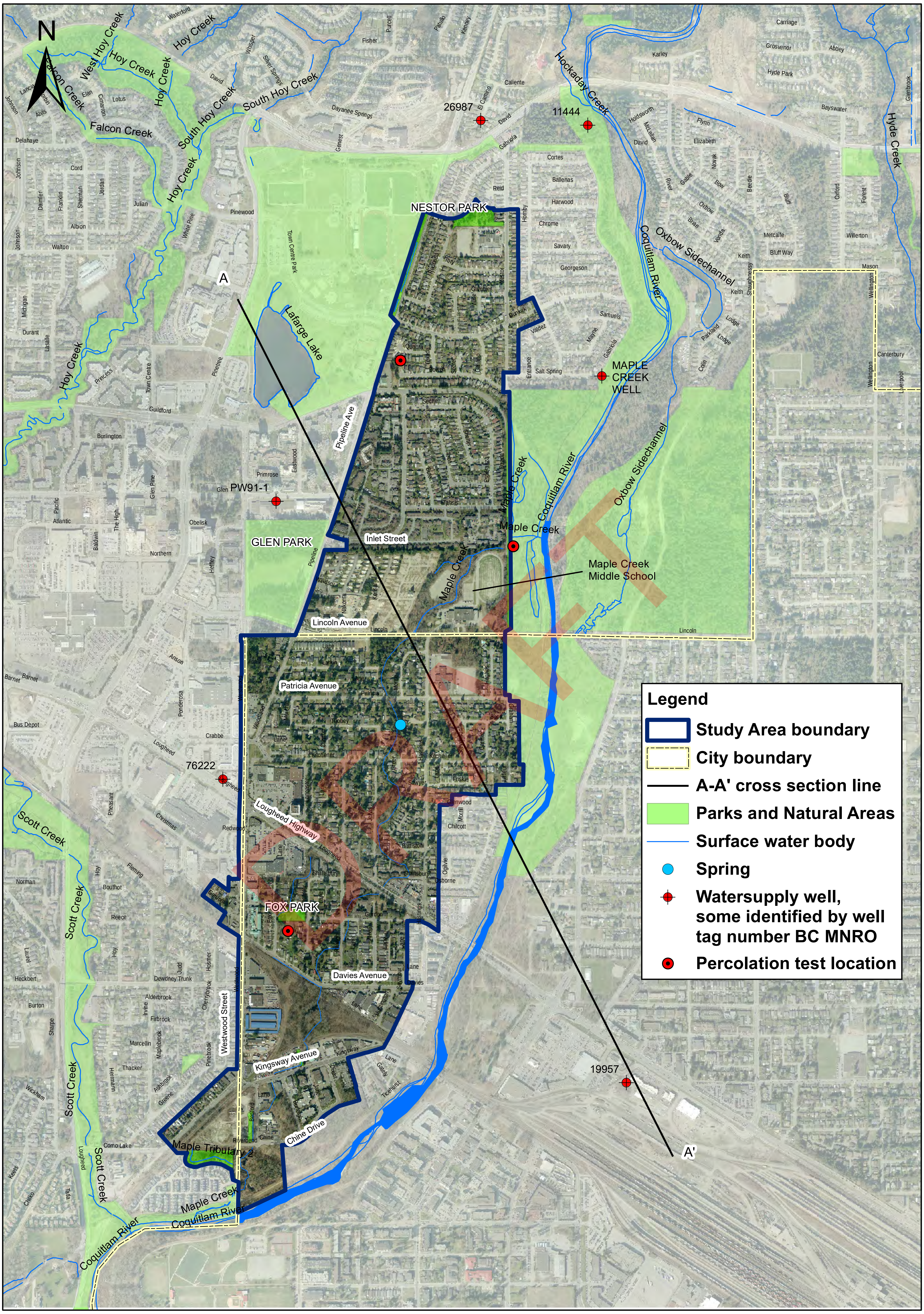
TABLE IV
SUMMARY OF SITE REGISTRY SEARCH RESULTS

Site ID	ADDRESS	CITY	Registered	Detail Removed	Updated	Status	Description	Historical / Current Site Activities
1054	**1190 PIPELINE ROAD AND 1199 EASTWOOD STREET**	**COQUITLAM**	**23-Dec-97**	**17-Jun-02**	**2-Jun-02**	**Active - under assessment**	**Removal of underground storage tank and evaluation of potential soil contamination**	**Electrical equipment manufacturing/storage (historical)** **Metal milling (historical)** **Asbestos storage (historical)** **Petroleum product storage (historical)**
1275	942 WESTWOOD STREET	COQUITLAM	9-Oct-97	3-Feb-06	3-Feb-06	Inactive - remediation complete	Environmental assessment and remediation of the Poco Gas and Grocery	Petroleum product storage / dispensing
1398	1204 PIPELINE ROAD	COQUITLAM	9-Oct-97	3-Oct-03	3-Oct-03	Inactive - remediation complete	Removal of underground storage tank and confirmatory soil quality inspection	Metal fabricating plant (processing and storage) Tank truck servicing depot
3658	2649 LOUGHEED HIGHWAY	PORT COQUITLAM	8-Oct-97	9-Mar-01	22-Mar-01	Unknown status	Unknown	Unknown
4714	3288 HASTINGS STREET	PORT COQUITLAM	11-Feb-98	7-Dec-04	8-Dec-04	Inactive - remediation complete	Site investigation and remediation for rezoning purposes	Appliance/engine repair/cleaning/salvaging Petroleum product storage / dispensing Road salt storage
4929	2664 KINGSWAY AVENUE	PORT COQUITLAM	13-Mar-98	30-Jan-04	4-Feb-04	Inactive - no further action	Site profile completed	Appliance / engine repair/cleaning/salvaging Vehicle repair/salvage/wrecking
5795	**2643, 2659, 2665, 2669 BEDFORD STREET**	**PORT COQUITLAM**	**9-Apr-99**	**19-Mar-10**	**19-Mar-10**	**Active - remediation complete**	**Site investigation, remediation, and risk assessment**	**Electrical equipment manufacturing/storage** **Asbestos storage** **Appliance/engine repair/cleaning/salvaging** **Asphalt Tar manufacturing/storage** **Petroleum product storage** **Vehicle repair/salvage/wrecking** **Sandblasting waste** **Barrel/tank reconditioning/salvage**
8218	**858 WESTWOOD STREET**	**COQUITLAM**	**9-May-03**	**4-May-10**	**7-May-10**	**Active - under assessment**	**Initiation of remediation of likely/actual substance migration to neighbouring site**	**Petroleum product storage / dispensing**
8993	**3051 LOUGHEED HIGHWAY**	**COQUITLAM**	**26-May-04**	**21-Apr-05**	**2-May-05**	**Active - under remediation**	**Initiation of remediation of likely/actual substance migration to neighbouring site**	**Petroleum product storage / dispensing**
9337	2710 LOUGHEED HIGHWAY	PORT COQUITLAM	18-May-05			Inactive - no further action	Site profile	Vehicle repair/salvage/wrecking
9352	**3646 WESTWOOD STREET**	**PORT COQUITLAM**	**24-Mar-05**	**5-Apr-05**	**12-Apr-05**	**Active - under assessment**	**Site profile**	**Construction/demolition material** **Hazardous waste storage/treatment/disposal**
10386	2567 LOUGHEED HIGHWAY	PORT COQUITLAM	17-May-07			Inactive - no further action	Site profile	Appliance/engine repair/cleaning/salvaging
10636	3540 WESTWOOD STREET	PORT COQUITLAM	26-Oct-07	6-May-08	13-Jan-09	Inactive - no further action	Preliminary site investigation and decommissioning activities	Petroleum product storage / dispensing
10830	2660 KINGSWAY AVENUE	PORT COQUITLAM	4-Apr-08	26-May-08	30-May-08	Inactive - remediation complete	Remediation	Unknown
12157	2505 LOUGHEED HIGHWAY	PORT COQUITLAM	19-Mar-10			Inactive - no further action	Site profile	Unknown

Note:
1. Bold font indicate active sites as of March 17, 2011

FIGURES

H:\Project\3081\ArcGIS\ArcGIS\Arcmaps\WorkingMaps\3081 Fig.1.mxd



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NOTE: GIS Data and 2009 Orthophoto provided by the City of Port Coquitlam and the City of Coquitlam

0 100 200 300 400 m

SCALE: 1:12,500

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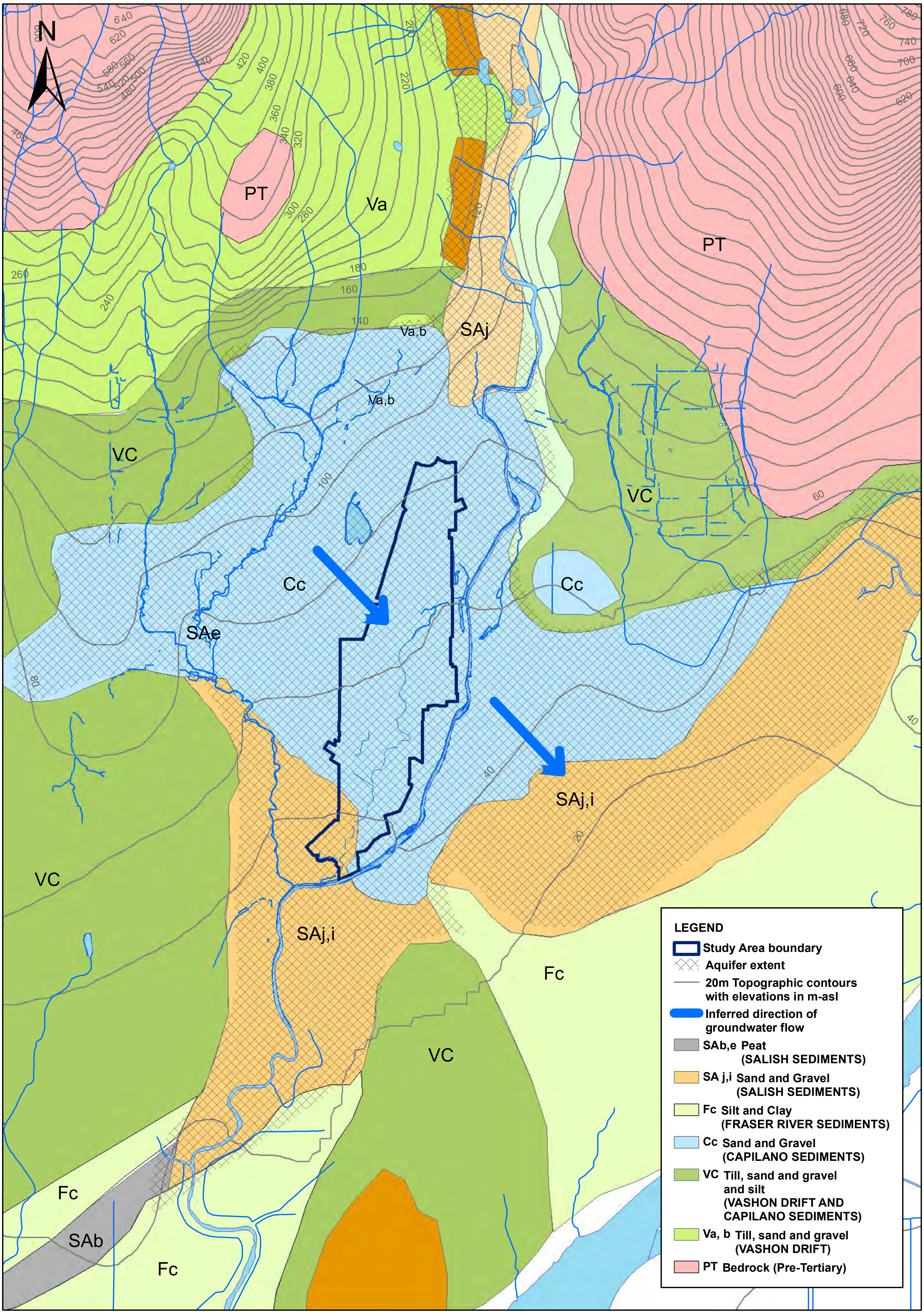
GEOTECHNICAL AND HYDROGEOLOGICAL CONSULTANTS

HYDROGEOLOGICAL ASSESSMENT FOR MAPLE CREEK INTEGRATED WATER MANAGEMENT PLAN

SITE PLAN WITH CROSS SECTION A-A'

BY: MK	DATE: MAR 11
APPROVED: KT	FIG: 1

H:\Project\3081\ArcGIS\ArcGIS\Arcmaps\WorkingMaps\3081 Fig. 2.mxd



NOTE: Surficial Geology modified from Armstrong and Hicock (1979)

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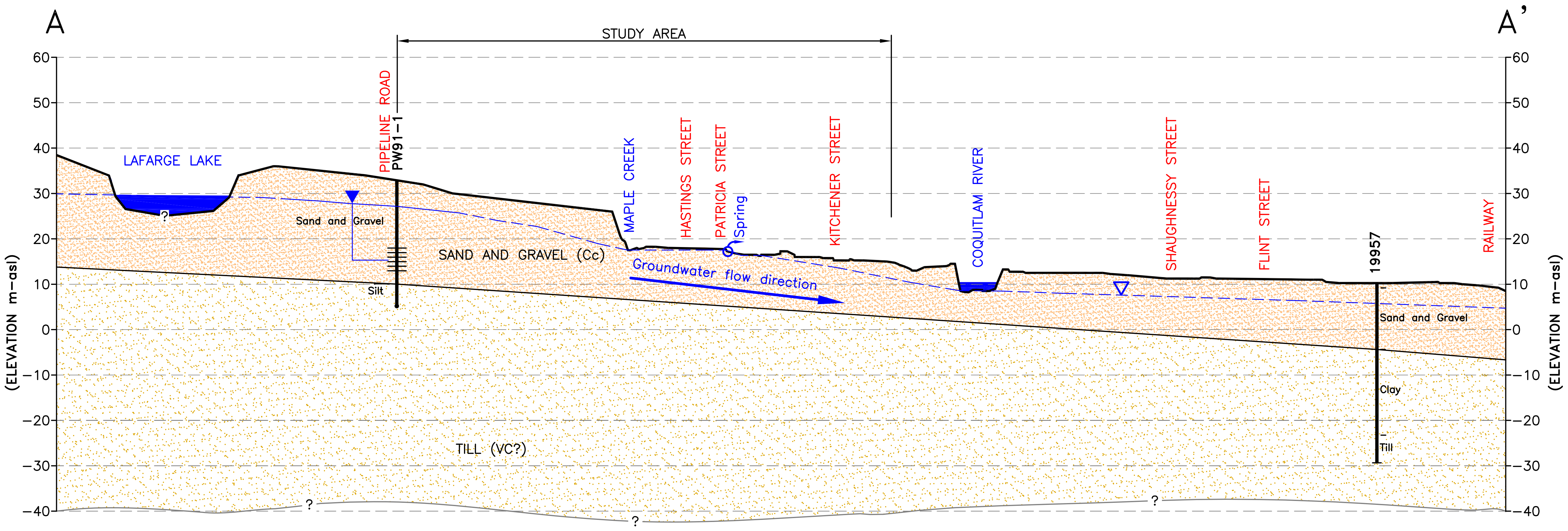
0 500 1,000 1,500
m
SCALE: 1:30,000

HYDROGEOLOGICAL ASSESSMENT
FOR MAPLE CREEK INTEGRATED
WATER MANAGEMENT PLAN

SURFICIAL GEOLOGY AND GROUNDWATER FLOW CONCEPTS

BY:	DATE:
MK	MAR 11
APPROVED:	FIG:
KT	2

DWG. NUMBER: K:\3081\Cadd\3081-001.dwg (Fig 3)



NOTES:

SEE FIG. 1 FOR SECTION LOCATION.

LEGEND

- ⚲ SPRING
- ▼ MEASURED GROUNDWATER ELEVATION
- ▽ INFERRED GROUNDWATER ELEVATION
- → INFERRED DIRECTION OF GROUNDWATER FLOW
- ╪ WATER WELL WITH SCREENED INTERVAL SHOWN (IF AVAILABLE)

0 100 200 300 400 500m

SCALE 1:10000

10X VERTICAL EXAGGERATION

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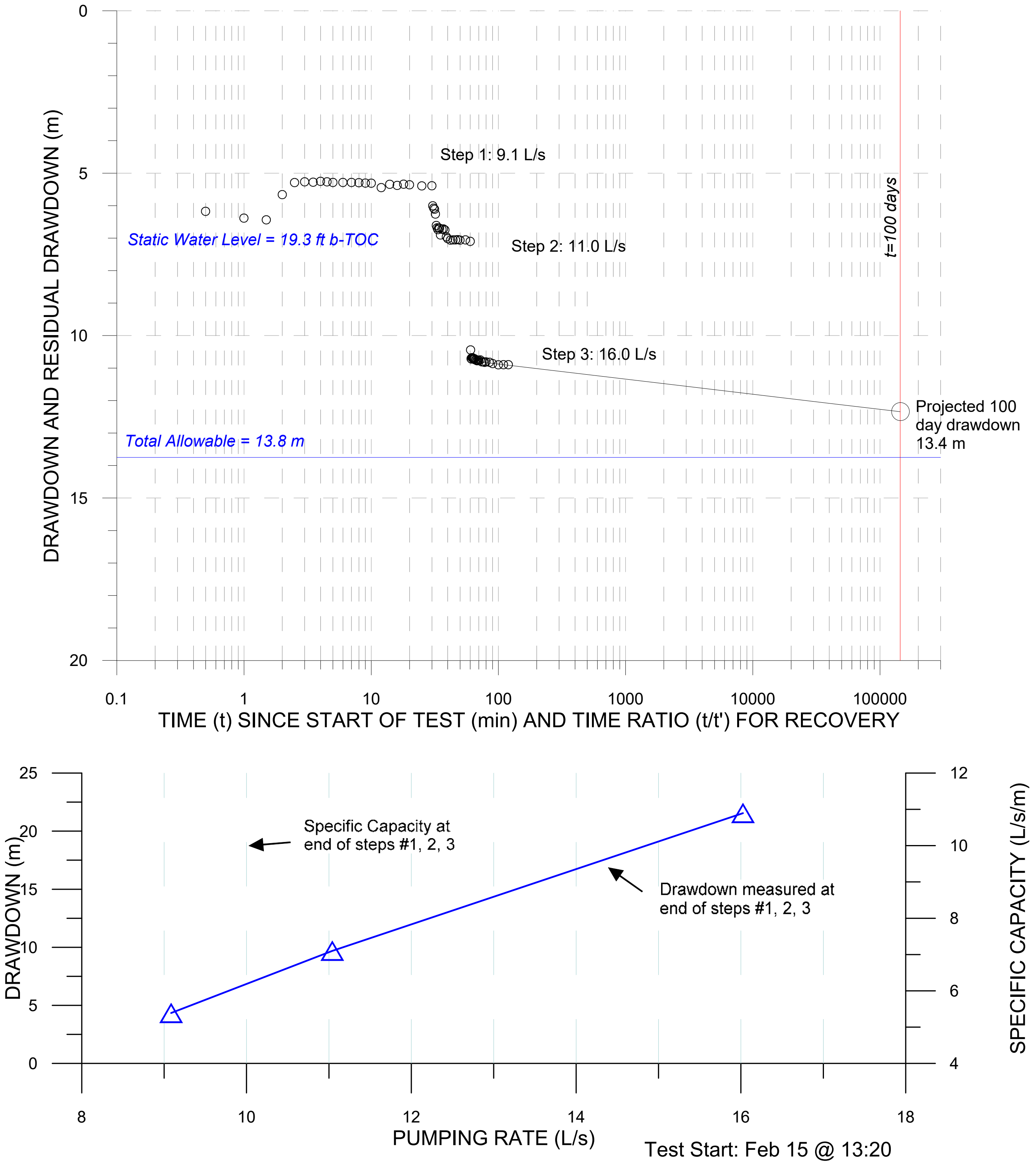
HYDROGEOLOGICAL ASSESSMENT FOR MAPLE CREEK INTEGRATED WATER MANAGEMENT PLAN

HYDROGEOLOGICAL CROSS SECTION A-A'

BY: MK/sl
DATE: MAR. 11
APPROVED: KT
FIG: 3

H:\Project\3081\Pump Test with Maple Creek Well\Feb15_PumpingTest.grf



Test Start: Feb 15 @ 13:20
Test Duration: 2 hours (120 mins)
Pre-Test Static Water Level: 1.98 m-bgl

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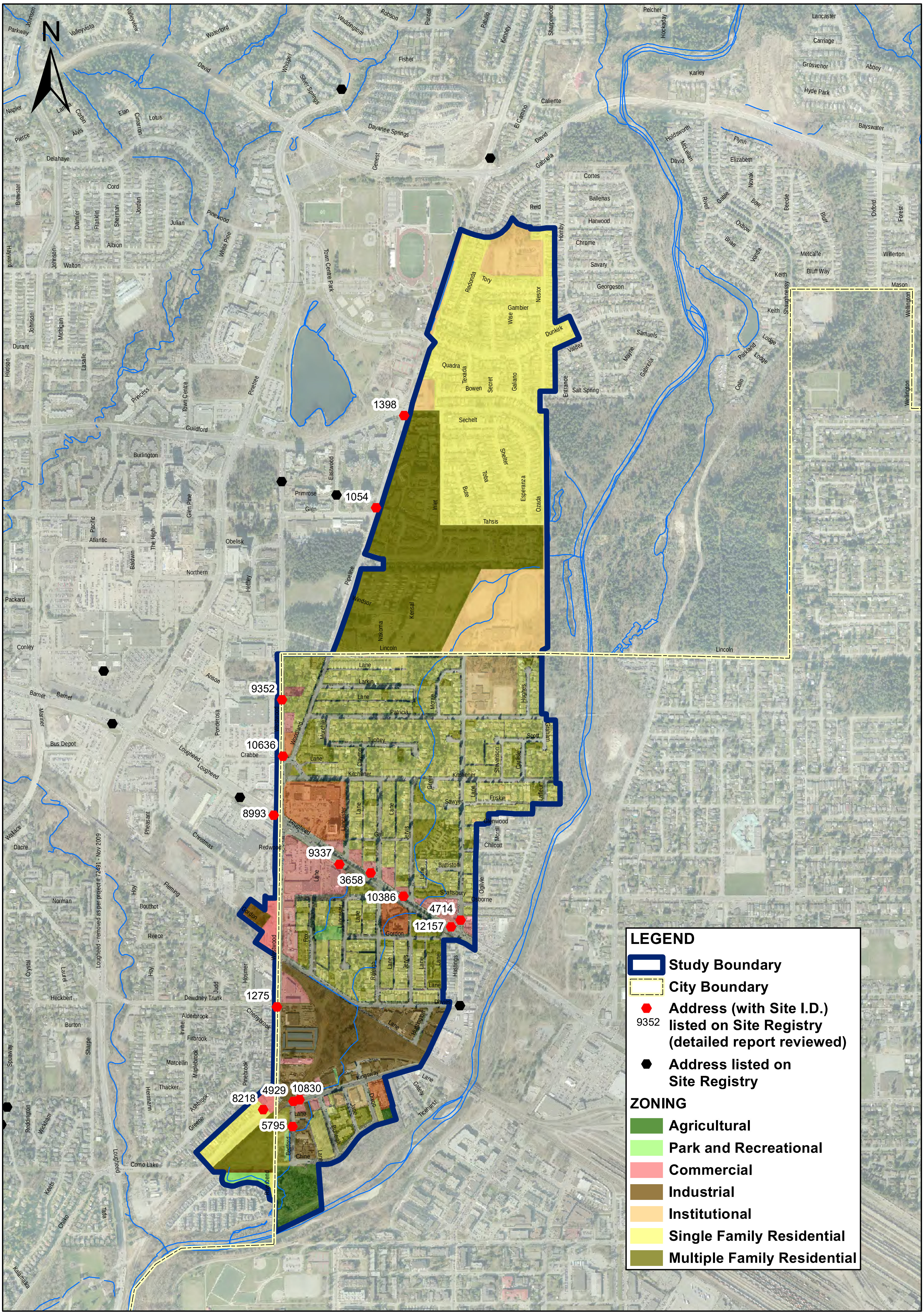
HYDROGEOLOGICAL ASSESSMENT FOR
MAPLE CREEK WATER MANAGEMENT PLAN
PORT COQUITLAM / COQUITLAM, B.C.

AQUIFER PUMPING
TEST DATA FOR
MAPLE CREEK WELL

BY: KT
DATE: MAR 11
APPROVED: KT
FIG: 4



NOTE: GIS Data and 2009 Orthophoto provided by the City of Port Coquitlam and the City of Coquitlam

0 100 200 300 400
m

SCALE: 1:12,500

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GEOTECHNICAL AND HYDROGEOLOGICAL CONSULTANTS

HYDROGEOLOGICAL ASSESSMENT
FOR MAPLE CREEK INTEGRATED
WATER MANAGEMENT PLAN

CURRENT ZONING AND SITE
REGISTRY SEARCH RESULTS

BY: MK
DATE: MAR 11.
APPROVED: KT
FIG: 5

PHOTOS

Photo 1.
Groundwater discharge from Maple Creek well sump into Creek.

Photo 2.
Exposed sands and gravels in construction excavation at Lincoln Ave. and Pipeline Rd.

FILE: P:/Photos/3081/Mar-2011-Report_Photos

Photo 3.
Coquitlam River bank section near Riverbend Dr.

Photo 4.
Ravined section of Maple Creek at eastern end of Patricia Ave., February 10, 2011.

FILE: P:/Photos/3081/Mar-2011-Report_Photos

Photo 5.
Surface completion of Maple Creek well.

Photo 6.
Damaged pump pulled from Maple Creek well in September 2010.

FILE: P:/Photos/3081/Mar-2011-Report_Photos

Photo 7.
Well discharge configuration during aquifer pumping tests, Feb. 15, 2011.

Photo 8.
Pump and drop pipe pulled from Maple Creek well Feb. 16, 2011.

FILE: P:/Photos/3081/Mar-2011-Report_Photos

Photo 9.
Close-up of Maple Creek Well Pump bowls, intake, and motor, Feb. 16, 2011.

Photo 10.
Snapshot of partially-obstructed slot openings in upper 1.5m of well screen during camera inspection February 15, 2011.

FILE: P:/Photos/3081/Mar-2011-Report_Photos

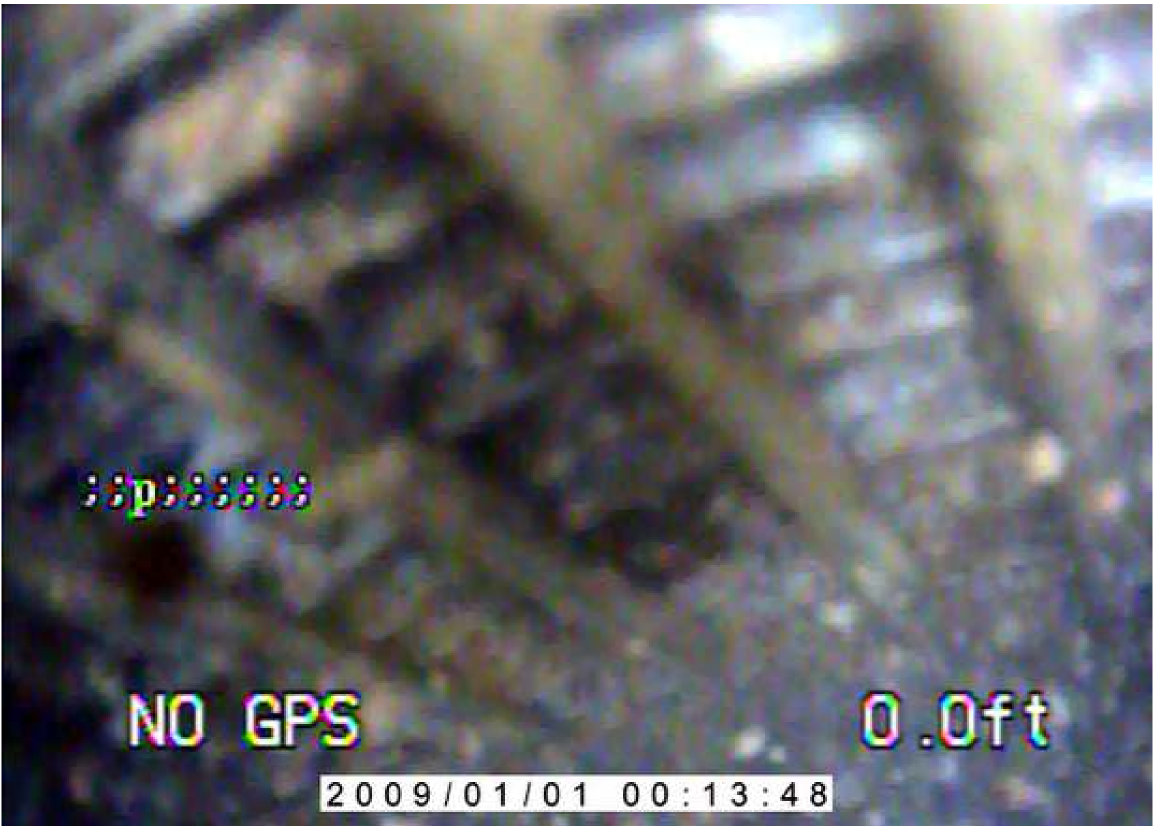


Photo 11.
Snapshot of relatively unobstructed slot openings in lower 0.5m of well screen during camera inspection February 15, 2011.

Photo 12.
Percolation test at foot of Ozada Ave., near school.

APPENDIX A

SELECT HISTORICAL AERIAL PHOTOGRAPHS

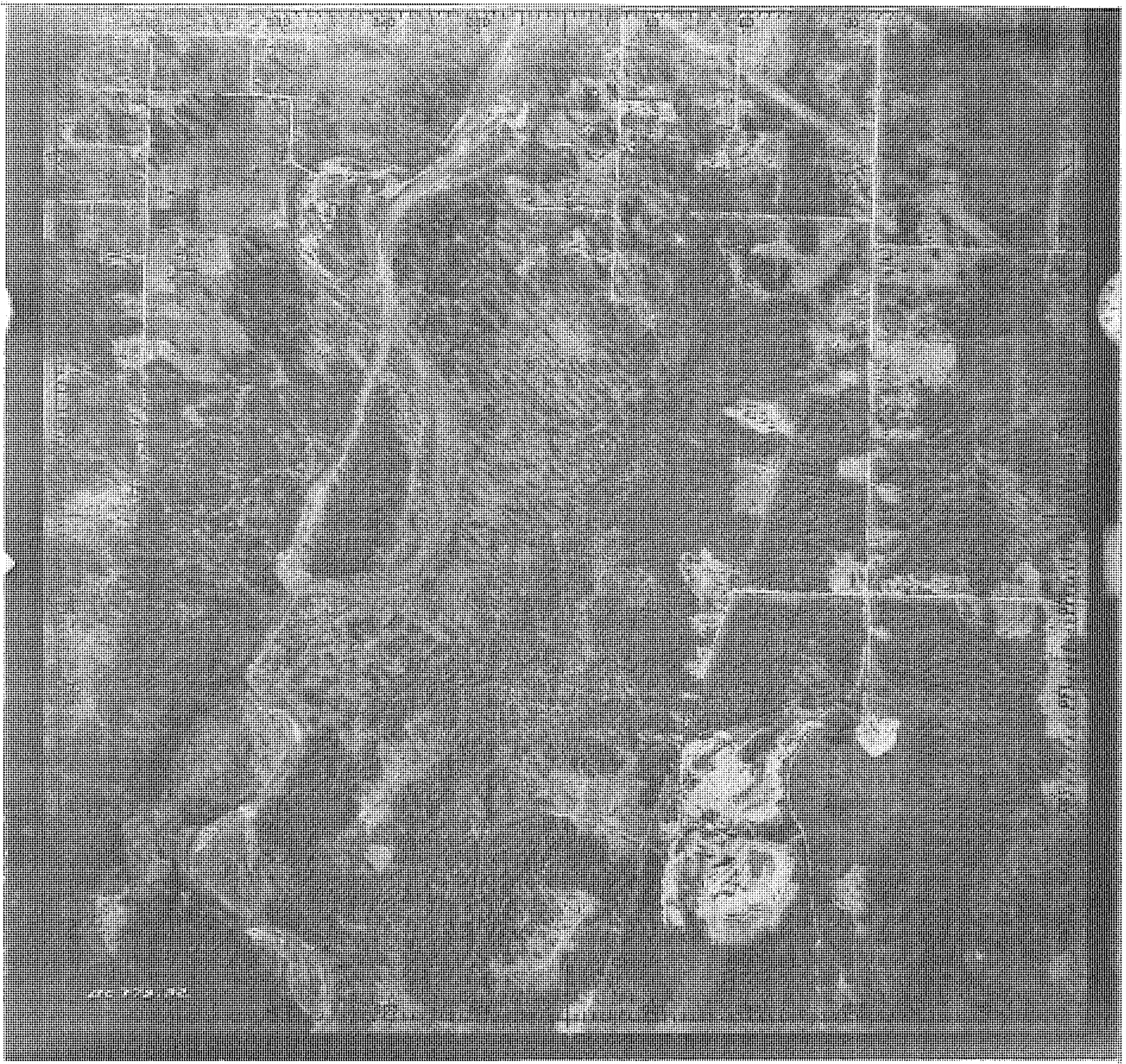
1949-2004

↑N

1949

1949

N



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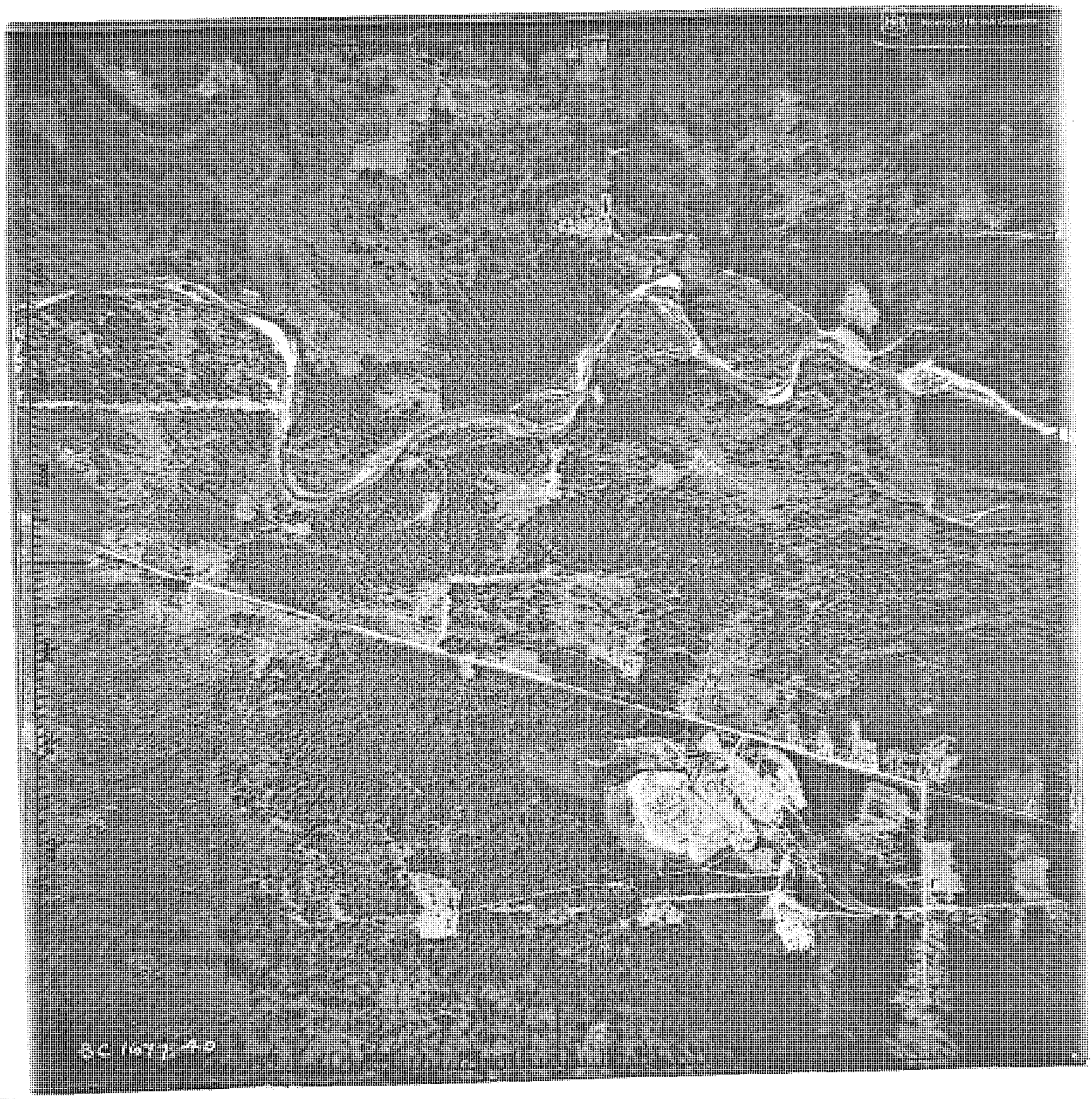
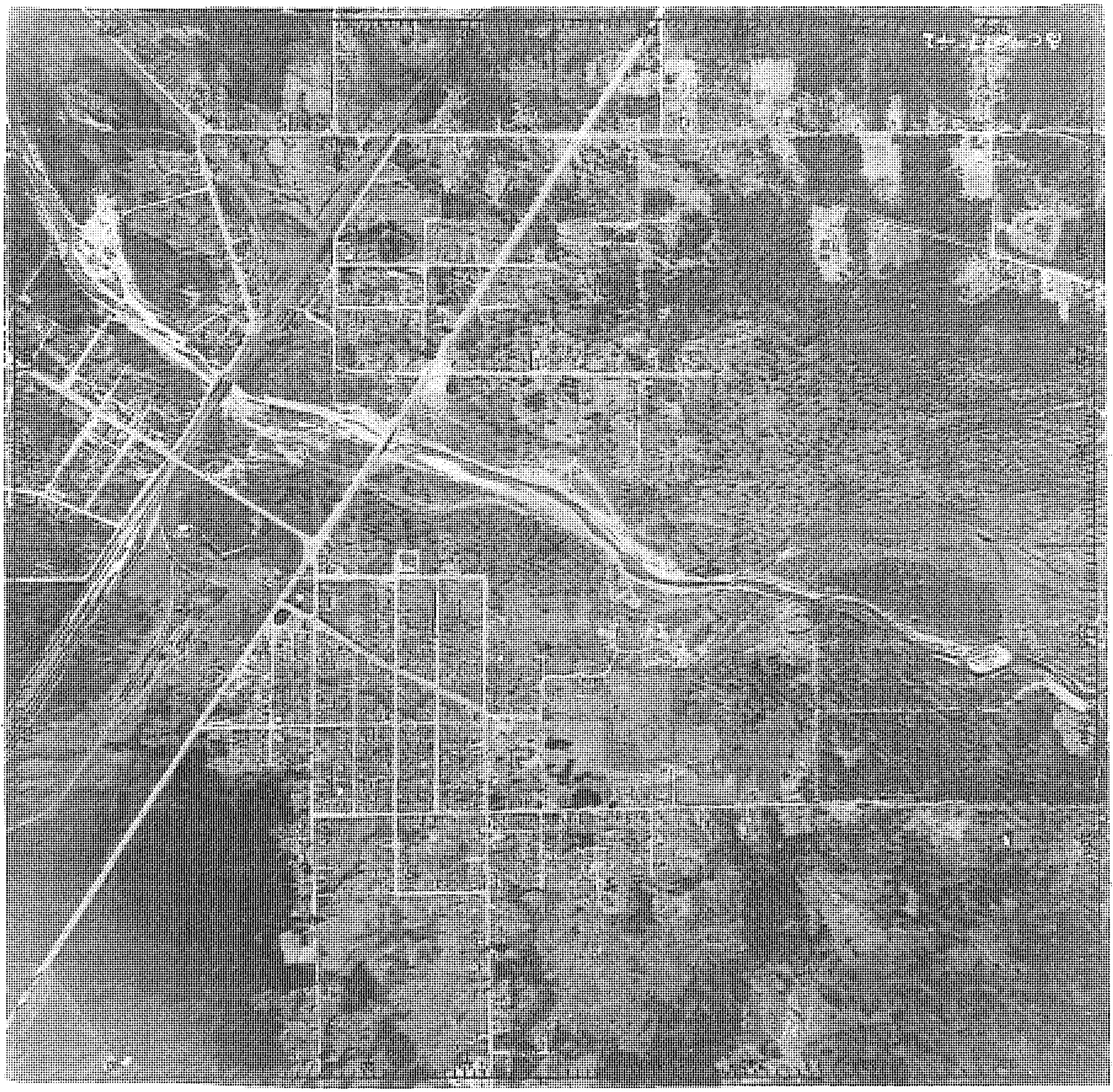
1954





1954

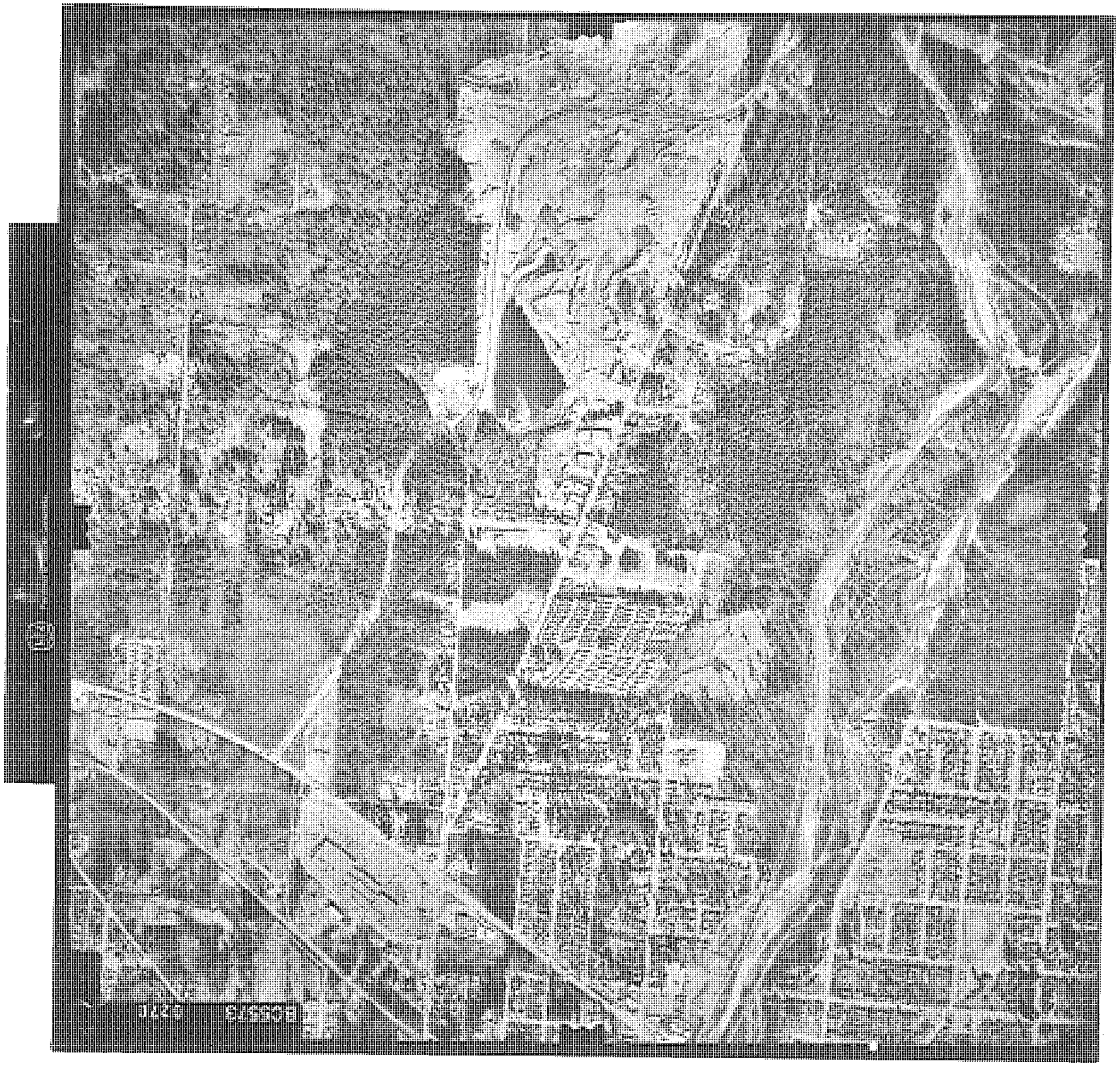
N

N
↑

1963

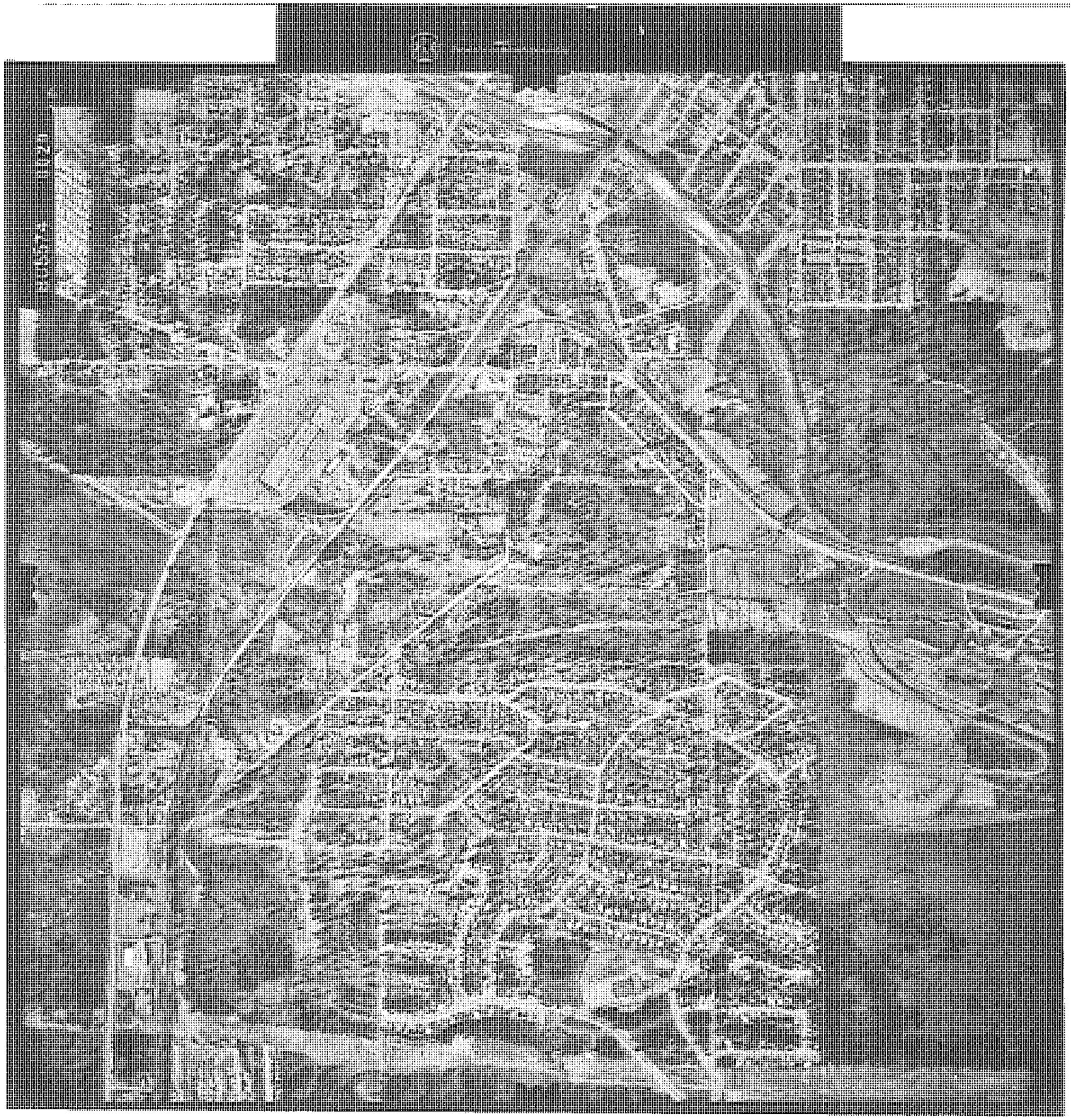
N↑

1974



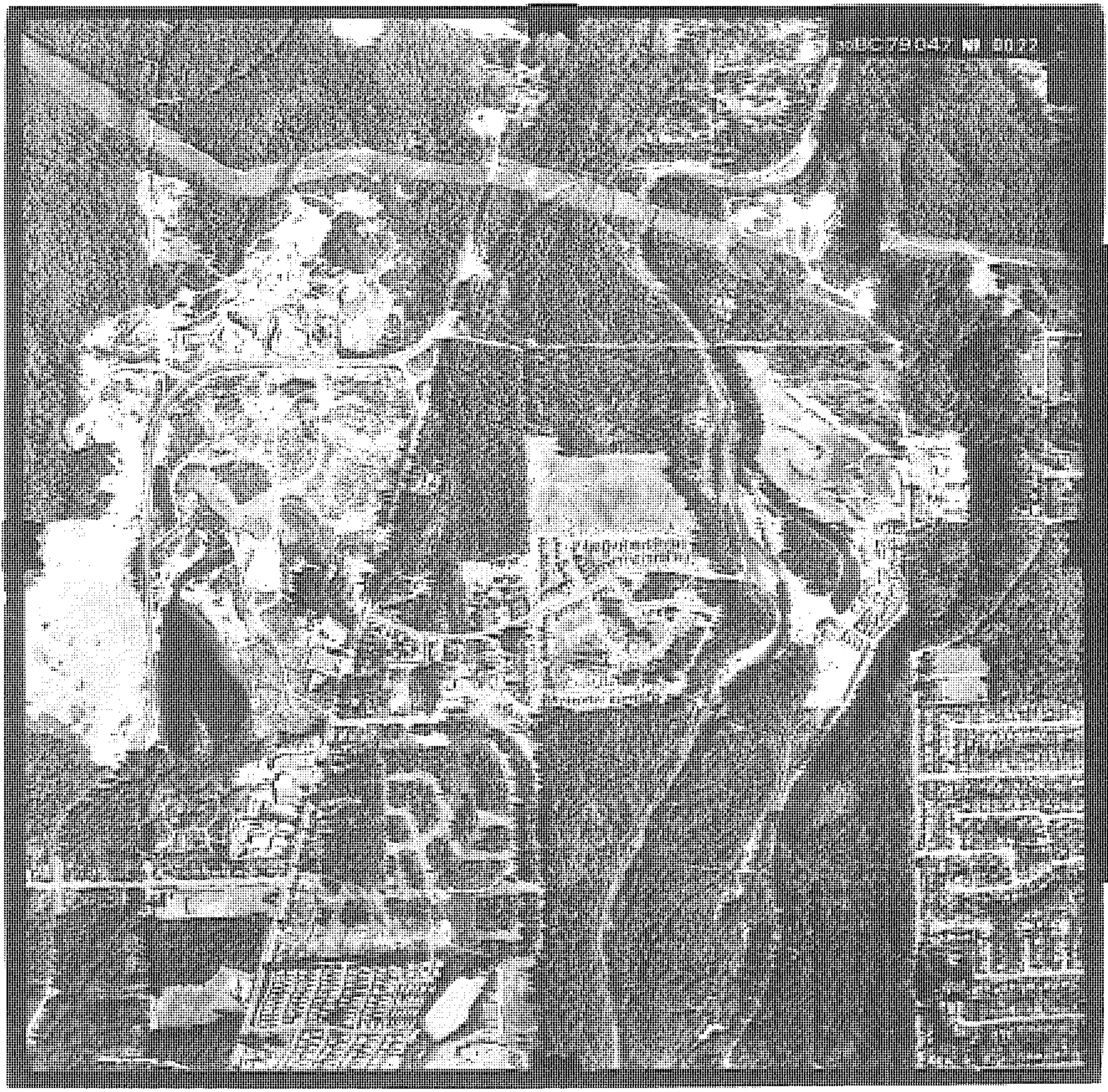
N ←

1974



N ↑

1979

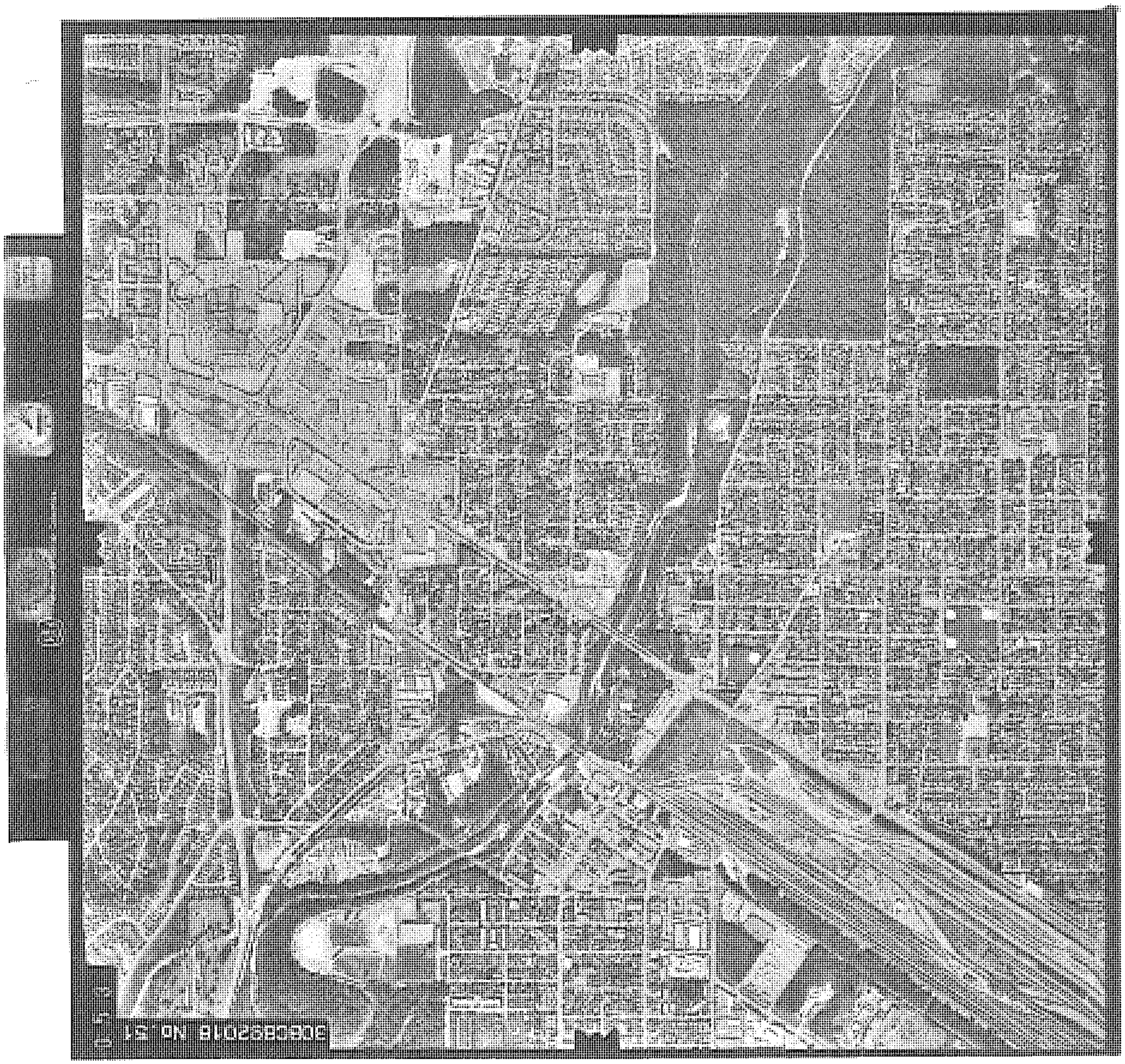


↑N

1984

N
↑

1992




. FFC VCR9700 L-7 18
30,000
97/09/22
FS125 1/ 360 f/4.0 FF2.0 EC 0 SP- v/h.02036 00% dt028.1 ds008 27.2V -68mb ER00 CAM5283

↑N

1997

2004

N

APPENDIX B

LOCAL WELL BOREHOLE LOGS

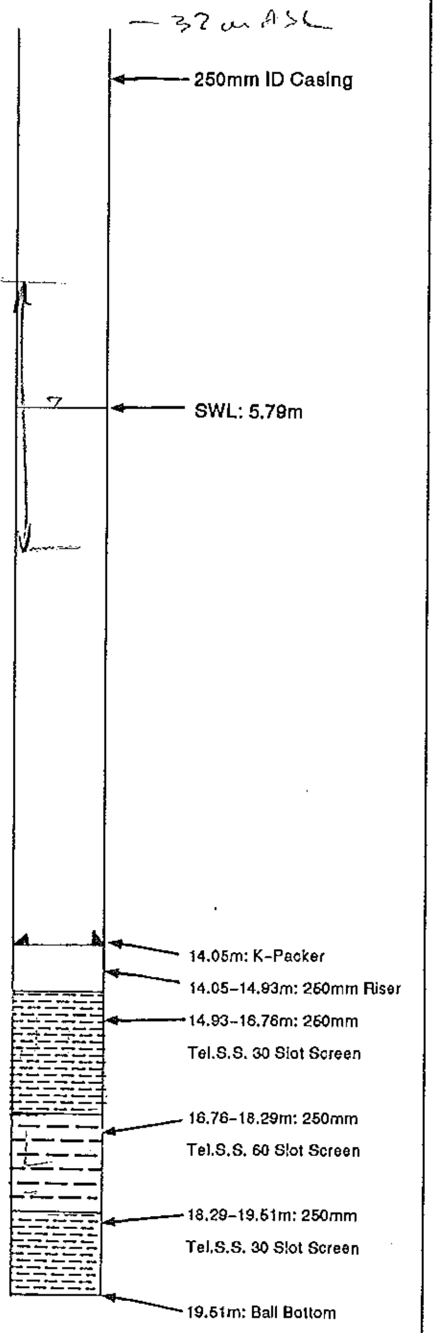
HYDROGEOLOGIC LOG

DRILLHOLE No.: PW91-1
Sheet 1 of 1

Project: GROUNDWATER EVALUATION IN COQUITLAM, B.C.
Purpose of Well: DEWATERING WELL
Type of Drilling: CABLE TOOL
Reference Elevation: GROUND SURFACE

Depth	Lithology	Depth	Sample
0m		0.00m	
	Grey, cohesive, fine SAND to fine GRAVEL with some silt and clay		
5m		5.08m	
	Grey, fine to medium SAND with coarse sand to medium gravel, some cobbles	7.32m	
	Grey, uniform, fine to medium SAND	9.14m	
	Grey, medium SAND to fine GRAVEL with medium gravel	9.75m	
10m	Grey, coarse SAND to fine GRAVEL with cobbles	11.58m	
	Grey, medium SAND to fine GRAVEL with some medium gravel, cobbles	12.19m	GS: 12.19m
	Grey, fine to medium SAND with some coarse sand	14.02m	GS: 14.02m
15m	Grey, fine to medium SAND with some coarse sand, fine to medium gravel	16.46m	GS: 16.46m
	Grey, medium SAND to fine GRAVEL, with some fine sand	17.68m	GS: 17.07m
	Grey, medium SAND to medium GRAVEL, with some coarse gravel	18.29m	
	Grey, fine to medium SAND with coarse SAND to medium gravel	19.51m	
20m	Grey, fine SAND with some fine to medium gravel	20.73m	
	END OF BOREHOLE		

Completed Construction



Comments
0m
5m
10m
15m
20m

LEGEND
GS: Location of grab sample seived
SWL: Static water level (October 4, 1991)

Contractor: Field Drilling Contractors Ltd.
Date Started: October 1, 1991
Date Finished: October 24, 1991

Logged by: L. Stevens
Checked by: D.J. Tiplady

Report 1 - Detailed Well Record

Well Tag Number: 11444

Owner: HANS QUITZAU

Address: MASON AVE. & 168TH ST.

Area: PT COQUITLAM

WELL LOCATION:
NEW WESTMINSTER Land District
District Lot: Plan: 18967 Lot: 1
Township: 39 Section: 12 Range:
Indian Reserve: Meridian: Block: 1
Quarter:
Island:
BCGS Number (NAD 27): 092G027334 Well: 1

Class of Well:
Subclass of Well:
Orientation of Well:
Status of Well: New
Well Use: Unknown Well Use
Observation Well Number:
Observation Well Status:
Construction Method: Drilled
Diameter: 6.0 inches
Casing drive shoe:
Well Depth: 141 feet
Elevation: 0 feet (ASL)
Final Casing Stick Up: inches
Well Cap Type:
Bedrock Depth: feet
Lithology Info Flag:
File Info Flag:
Sieve Info Flag:
Screen Info Flag:

Site Info Details:
Other Info Flag:
Other Info Details:

Construction Date: 1950-01-01 00:00:00.0

Driller: Western Water Wells
Well Identification Plate Number:
Plate Attached By:
Where Plate Attached:

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield: 15 (Driller's Estimate) Gallons per Minute (U.S./Imperial)
Development Method:
Pump Test Info Flag:
Artesian Flow:
Artesian Pressure (ft):
Static Level:

WATER QUALITY:
Character:
Colour:
Odour:
Well Disinfected: N
EMS ID:
Water Chemistry Info Flag:
Field Chemistry Info Flag:
Site Info (SEAM):

Water Utility:
Water Supply System Name:
Water Supply System Well Name:

SURFACE SEAL:
Flag:
Material:
Method:
Depth (ft):
Thickness (in):

WELL CLOSURE INFORMATION:
Reason For Closure:
Method of Closure:
Closure Sealant Material:
Closure Backfill Material:
Details of Closure:

Screen from	to feet	Type	Slot Size

Casing from	to feet	Diameter	Material	Drive Shoe

GENERAL REMARKS:

LITHOLOGY INFORMATION:

From	0	to	27	Ft.	Nolog
From	27	to	60	Ft.	Till
From	60	to	76	Ft.	Till and boulders
From	76	to	122	Ft.	Till
From	122	to	141	Ft.	Sand - (W.B.)

- Return to Main
- Return to Search Options
- Return to Search Criteria

Report 1 - Detailed Well Record

Well Tag Number: 19957

Owner: GOLDEN & ASSOCIATES

Address: LOUGHEED HIGHWAY

Area: PORT COQUITLAM

WELL LOCATION:
NEW WESTMINSTER Land District
District Lot: Plan: Lot:
Township: Section: Range:
Indian Reserve: Meridian: Block:
Quarter:
Island:
BCGS Number (NAD 27): 092G027314 Well: 1

Class of Well:
Subclass of Well:
Orientation of Well:
Status of Well: New
Well Use: Unknown Well Use
Observation Well Number:
Observation Well Status:
Construction Method: Drilled
Diameter: 0.0 inches
Casing drive shoe:
Well Depth: 130 feet
Elevation: 0 feet (ASL)
Final Casing Stick Up: inches
Well Cap Type:
Bedrock Depth: feet
Lithology Info Flag:
File Info Flag:
Sieve Info Flag:
Screen Info Flag:

Site Info Details:
Other Info Flag:
Other Info Details:

Construction Date: 1966-05-16 00:00:00.0

Driller: Pacific Water Wells
Well Identification Plate Number:
Plate Attached By:
Where Plate Attached:

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield: 0 (Driller's Estimate)
Development Method:
Pump Test Info Flag:
Artesian Flow:
Artesian Pressure (ft):
Static Level:

WATER QUALITY:
Character:
Colour:
Odour:
Well Disinfected: N
EMS ID:
Water Chemistry Info Flag:
Field Chemistry Info Flag:
Site Info (SEAM):

Water Utility:
Water Supply System Name:
Water Supply System Well Name:

SURFACE SEAL:
Flag:
Material:
Method:
Depth (ft):
Thickness (in):

WELL CLOSURE INFORMATION:
Reason For Closure:
Method of Closure:
Closure Sealant Material:
Closure Backfill Material:
Details of Closure:

Screen from	to feet	Type	Slot Size

Casing from	to feet	Diameter	Material	Drive Shoe

GENERAL REMARKS:

LITHOLOGY INFORMATION:

From	0	to	3.5	Ft.	Fill
From	3.5	to	48	Ft.	Sand and gravel, thin clay interbeds
From	48	to	110	Ft.	Soft blue clay
From	110	to	130	Ft.	Till

- Return to Main

BRITISH COLUMBIA

Report 1 - Detailed Well Record

Well Tag Number: 26987

Owner: MARK ANDERSON

Address: PATHAN AVE.

Area:

WELL LOCATION:
NEW WESTMINSTER Land District
District Lot: Plan: 29278 Lot: 7
Township: 39 Section: 13 Range:
Indian Reserve: Meridian: Block:
Quarter:
Island:
BCGS Number (NAD 27): 092G027333 Well: 1

Class of Well:
Subclass of Well:
Orientation of Well:
Status of Well: New
Well Use: Unknown Well Use
Observation Well Number:
Observation Well Status:
Construction Method: Drilled
Diameter: 5.0 inches
Casing drive shoe:
Well Depth: 39 feet
Elevation: 0 feet (ASL)
Final Casing Stick Up: inches
Well Cap Type:
Bedrock Depth: feet
Lithology Info Flag:
File Info Flag:
Sieve Info Flag:
Screen Info Flag:

Site Info Details:
Other Info Flag:
Other Info Details:

Construction Date: 1972-09-22 00:00:00.0

Driller: Western Water Wells
Well Identification Plate Number:
Plate Attached By:
Where Plate Attached:

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield: 5 (Driller's Estimate) Gallons per Minute (U.S./Imperial)
Development Method:
Pump Test Info Flag:
Artesian Flow:
Artesian Pressure (ft):
Static Level: 18 feet

WATER QUALITY:
Character:
Colour:
Odour:
Well Disinfected: N
EMS ID:
Water Chemistry Info Flag:
Field Chemistry Info Flag:
Site Info (SEAM):

Water Utility:
Water Supply System Name:
Water Supply System Well Name:

SURFACE SEAL:
Flag:
Material:
Method:
Depth (ft):
Thickness (in):

WELL CLOSURE INFORMATION:
Reason For Closure:
Method of Closure:
Closure Sealant Material:
Closure Backfill Material:
Details of Closure:

Screen from	to feet	Type	Slot Size

Casing from	to feet	Diameter	Material	Drive Shoe

GENERAL REMARKS:
BAIL TEST 29' @ 10 GPH, REC. PUMP SETTING 34' REC. MAX. PUMP OUTPUT, 5 GPM, TEST FOR 1/2 HR.

LITHOLOGY INFORMATION:

From	0	to	24	Ft.	Dug well
From	24	to	30	Ft.	SAnd and gravel (clay)
From	30	to	35	Ft.	Sand and gravel (less clay)
From	35	to	39	Ft.	Sand and gravel
From	0	to	0	Ft.	Customer instructed to backfill dug well

- Return to Main
- Return to Search Options
- Return to Search Criteria

BRITISH COLUMBIA

Report 1 - Detailed Well Record

Well Tag Number: 76222

Owner: ROLAND BOUCHER

Address: 3033 LOUGHEED HWY

Area:

WELL LOCATION:
Land District
District Lot: Plan: Lot:
Township: Section: Range:
Indian Reserve: Meridian: Block:
Quarter:
Island:
BCGS Number (NAD 27): 092G027313 Well: 1

Class of Well:
Subclass of Well:
Orientation of Well:
Status of Well: New
Well Use:
Observation Well Number:
Observation Well Status:
Construction Method:
Diameter: 6 inches
Casing drive shoe:
Well Depth: 370 feet
Elevation: 0 feet (ASL)
Final Casing Stick Up: inches
Well Cap Type:
Bedrock Depth: feet
Lithology Info Flag: N
File Info Flag: N
Sieve Info Flag: N
Screen Info Flag: N

Site Info Details:
Other Info Flag:
Other Info Details:

Construction Date: 1998-08-13 00:00:00.0

Driller: A. & H. Construction
Well Identification Plate Number:
Plate Attached By:
Where Plate Attached:

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield: 15 (Driller's Estimate) Gallons per Minute (U.S./Imperial)
Development Method:
Pump Test Info Flag: N
Artesian Flow:
Artesian Pressure (ft):
Static Level: 300 feet

WATER QUALITY:
Character:
Colour:
Odour:
Well Disinfected: N
EMS ID:
Water Chemistry Info Flag:
Field Chemistry Info Flag:
Site Info (SEAM):

Water Utility:
Water Supply System Name:
Water Supply System Well Name:

SURFACE SEAL:
Flag: N
Material:
Method:
Depth (ft):
Thickness (in):

WELL CLOSURE INFORMATION:
Reason For Closure:
Method of Closure:
Closure Sealant Material:
Closure Backfill Material:
Details of Closure:

Screen from	to feet	Type	Slot Size
0	0		0
0	0		0

Casing from	to feet	Diameter	Material	Drive Shoe
null	null	0	null	null

GENERAL REMARKS:
3033 LOUGHEED HWY

LITHOLOGY INFORMATION:

From	0 to	8 Ft.	BROKEN BEDROCK	
From	8 to	370 Ft.	BEDROCK	

- Return to Main
- Return to Search Options
- Return to Search Criteria

APPENDIX C

MAPLE CREEK WELL
ORIGINAL DRILLER’S LOG AND
WELL COMPLETION DRAWING

DAILY REPORT

A & H CONSTRUCTION LIMITED **WELL DRILLERS**

1681 SALTON ROAD, P.O. BOX 38, ABBOTSFORD, B.C. V2S 4N7 - PHONE 853-2513

FISHERIES & OCEANS

Location MAPLE CREEK Date SEPT 18 1996

Hole No. Shift from 9 AM to 4.30 PM

Depth at end of shift

Depth at start of shift

1. Size of Casing inserted
2. Feet of Casing inserted
3. Machine Hours
4. Chargeable Machine Hours

STATIC H_2O – 7 2"

FROM	TO	AMOUNT	GEOLOGY

Remarks POLL RODS OUT OF WELL
PREPARE TO SET 15' OF 100 SLOT
JOHNSTON S-STEEL SCREENS - K-PACKER
BAIL BOTTOM
SET SCREENS & DEV WELL - 6 HRS
WELL PRO APP - 800+ G.P.M.

Driller JOHN McDONALD Hours

Helper GEORGE REIMER Hours

Supt.

Drill No. № 6713

DAILY REPORT

A & H CONSTRUCTION LIMITED **WELL DRILLERS**

1681 SALTON ROAD, P.O. BOX 38, ABBOTSFORD, B.C. V2S 4N7 - PHONE 853-2513

FISHERIES & OCEANS

Location MAPLE CREEK Date SEPT 17 1996

Hole No. Shift from 9 AM to 5 PM

21-7
21-0
21-0
21-1
21-1
~~21-1~~
105-6

Depth at end of shift 105

Depth at start of shift 0

1. Size of Casing inserted 8"
2. Feet of Casing inserted
3. Machine Hours
4. Chargeable Machine Hours

1 X 8" DRIVE SHOE

FROM	TO	AMOUNT	GEOLOGY
0		3	TOP SOIL
3		23	TILL & BOULDERS
23		46	SAND & GRAVEL CLAY BINDER
46		70	FINE SILTY SAND
70			COARSE SAND & GRAVEL

Remarks

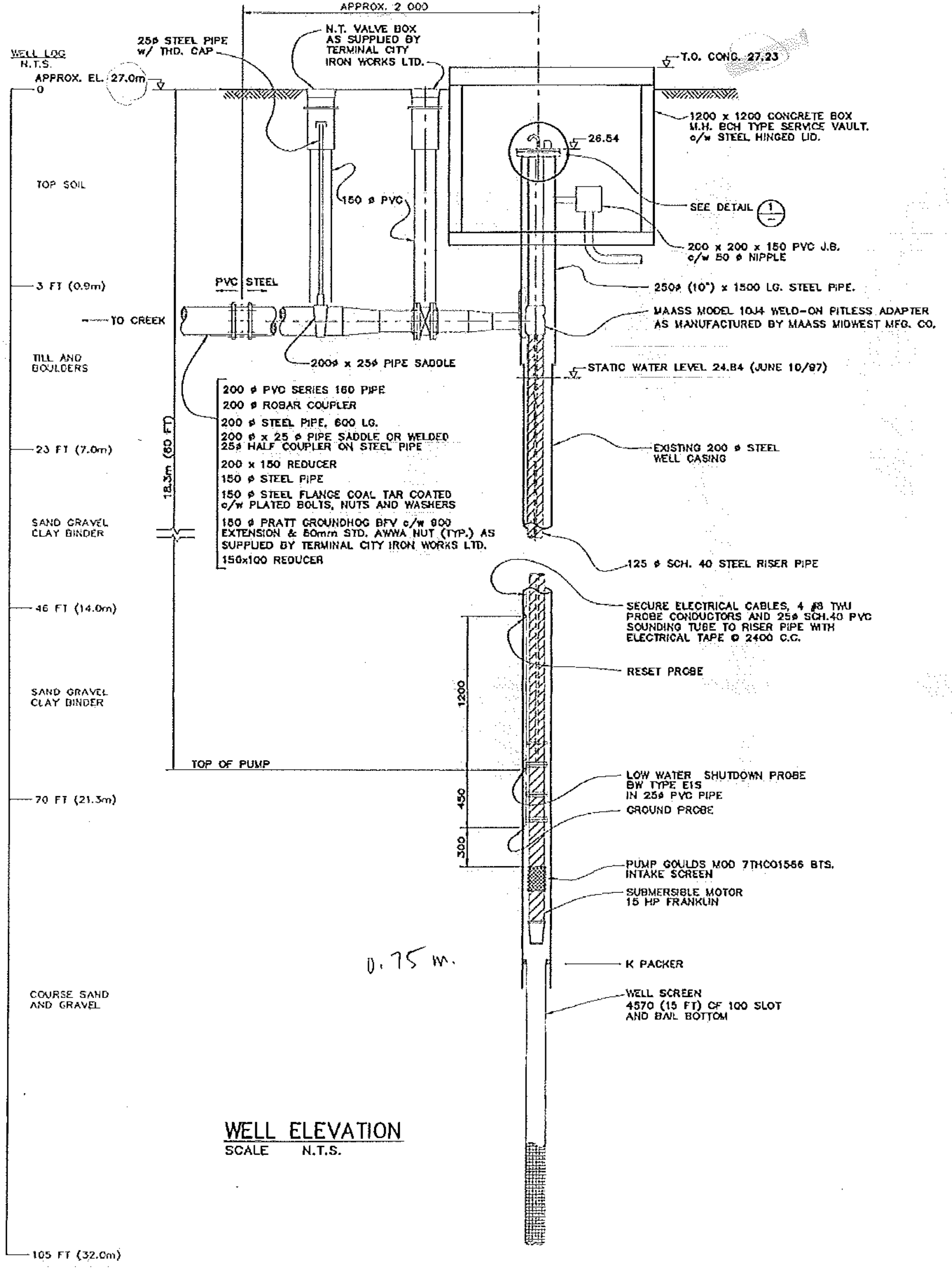
Driller JOHN McDONALD Hours

Helper GEORGE REIMER Hours

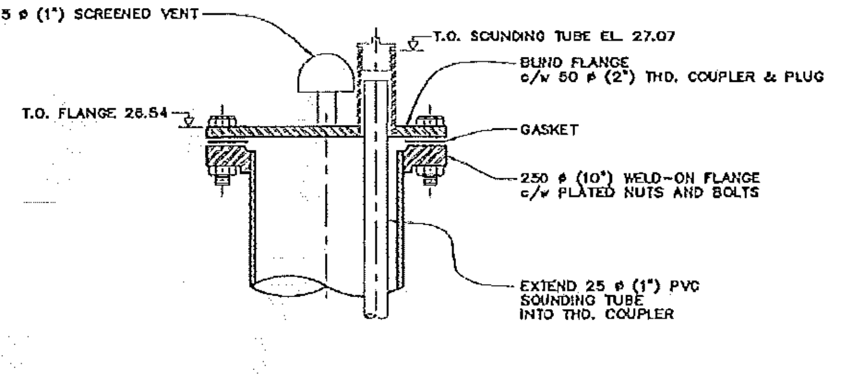
Supt.

Drill No. № 6712

Maple Creek Wtr Well



WELL ELEVATION
SCALE N.T.S.



DETAIL 1
SCALE 1:5

[redacted]

D2061-2

DEPARTMENT OF FISHERIES AND OCEANS
HABITAT AND ENHANCEMENT BRANCH

NO.	DATE	REVISIONS	
1	FEB. 18, 1997	SECTION OF WELL CASING REPLACED WITH 250ø (10") STEEL PIPE; WELDED PLATE USED INSTEAD OF CAP; AIR VALVE ADDED. I.M.	
2	JUNE 97	AS-BUILT	M.L./D.T.

DESIGNED D.R.
DRAWN D.T./I.M.
CHECKED
RECOMMENDED
APPROVED
APPROVED

MAPLE CREEK
HABITAT IMPROVEMENT PROJECT
WELL ELEVATION
AND COMPLETION

SCALE AS SHOWN
DATE NOV. 1996
DRAWING NUMBER 11-134-2
REVISION 2

DWG. NO.	REFERENCE DRAWINGS	NOTES

APPENDIX D

AQUIFER PUMPING TEST DATA

TABLE D-1

SUMMARY OF AQUIFER PUMPING TEST DATA WITH MAPLE CREEK WELL

Date	Time	Water Level (ft-bTOC)	Water Level (m-bTOC)	Elapsed Time (min)	Drawdown		Recovery		Pumping Rate		Specific Capacity		Comments
					(ft)	(m)	Time Interval t' (min)	t/t'	(USgpm)	(L/s)	(USgpm/ft)	(L/s/m)	
15-Feb-11	15:20:00	8.000	2.438	0.0	0.000	0.000							Start of test with Maple Creek Well
15-Feb-11	15:20:30	28.270	8.617	0.5	20.270	6.178							27 IN. AT ORIFICE
15-Feb-11	15:21:00	28.950	8.824	1.0	20.950	6.386							WATER VERY DIRTY
15-Feb-11	15:21:30	29.120	8.876	1.5	21.120	6.437							VALVE DOWN
15-Feb-11	15:22:00	26.580	8.102	2.0	18.580	5.663							
15-Feb-11	15:22:30	25.360	7.730	2.5	17.360	5.291			144.0	9.09	8.29	1.72	WATER CLEARING
15-Feb-11	15:23:00	25.280	7.705	3.0	17.280	5.267							18 IN. AT ORIFICE = 144 USGPM
15-Feb-11	15:23:30	25.320	7.718	3.5	17.320	5.279							
15-Feb-11	15:24:00	25.240	7.693	4.0	17.240	5.255							WATER CLEAR
15-Feb-11	15:24:30	25.280	7.705	4.5	17.280	5.267			144.0	9.09	8.33	1.72	
15-Feb-11	15:25:00	25.350	7.727	5.0	17.350	5.288							
15-Feb-11	15:26:00	25.350	7.727	6.0	17.350	5.288							
15-Feb-11	15:27:00	25.350	7.727	7.0	17.350	5.288							
15-Feb-11	15:28:00	25.370	7.733	8.0	17.370	5.294							
15-Feb-11	15:29:00	25.410	7.745	9.0	17.410	5.307			144.0	9.09	8.27	1.71	
15-Feb-11	15:30:00	25.420	7.748	10.0	17.420	5.310							
15-Feb-11	15:32:00	25.870	7.885	12.0	17.870	5.447							
15-Feb-11	15:34:00	25.530	7.782	14.0	17.530	5.343							
15-Feb-11	15:36:00	25.650	7.818	16.0	17.650	5.380							
15-Feb-11	15:38:00	25.520	7.779	18.0	17.520	5.340			144.0	9.09	8.22	1.70	
15-Feb-11	15:40:00	25.580	7.797	20.0	17.580	5.358							
15-Feb-11	15:45:00	25.690	7.830	25.0	17.690	5.392			144.0	9.09	8.14	1.68	
15-Feb-11	15:50:00	25.680	7.827	30.0	17.680	5.389							VALVE UP
15-Feb-11	15:50:30	27.710	8.446	30.5	19.710	6.008							Step 2
15-Feb-11	15:51:00	27.940	8.516	31.0	19.940	6.078							20 IN. AT ORIFICE
15-Feb-11	15:51:30	28.060	8.553	31.5	20.060	6.114							
15-Feb-11	15:52:00	28.540	8.699	32.0	20.540	6.261							
15-Feb-11	15:52:30	29.690	9.050	32.5	21.690	6.611							VALVE UP
15-Feb-11	15:53:00	29.930	9.123	33.0	21.930	6.684							26.5 IN. AT ORIFICE
15-Feb-11	15:53:30	30.110	9.178	33.5	22.110	6.739			175.0	11.04	7.91	1.64	
15-Feb-11	15:54:00	29.940	9.126	34.0	21.940	6.687							
15-Feb-11	15:54:30	29.980	9.138	34.5	21.980	6.700							
15-Feb-11	15:55:00	30.650	9.342	35.0	22.650	6.904							
15-Feb-11	15:56:00	30.080	9.168	36.0	22.080	6.730			175.0	11.04	7.93	1.64	
15-Feb-11	15:57:00	30.040	9.156	37.0	22.040	6.718							WATER CLEAR
15-Feb-11	15:58:00	30.140	9.187	38.0	22.140	6.748							
15-Feb-11	15:59:00	30.840	9.400	39.0	22.840	6.962							
15-Feb-11	16:00:00	31.020	9.455	40.0	23.020	7.016			175.0	11.04	7.60	1.57	
15-Feb-11	16:02:00	31.170	9.501	42.0	23.170	7.062							
15-Feb-11	16:04:00	31.150	9.495	44.0	23.150	7.056							26.5 IN. AT ORIFICE
15-Feb-11	16:06:00	31.150	9.495	46.0	23.150	7.056							
15-Feb-11	16:08:00	31.120	9.485	48.0	23.120	7.047			175.0	11.04	7.57	1.57	
15-Feb-11	16:10:00	31.170	9.501	50.0	23.170	7.062							
15-Feb-11	16:15:00	31.150	9.495	55.0	23.150	7.056			175.0	11.04	7.56	1.56	
15-Feb-11	16:20:00	31.300	9.540	60.0	23.300	7.102							VALVE UP

TABLE D-1

SUMMARY OF AQUIFER PUMPING TEST DATA WITH MAPLE CREEK WELL

Date	Time	Water Level (ft-bTOC)	Water Level (m-bTOC)	Elapsed Time (min)	Drawdown		Recovery		Pumping Rate		Specific Capacity		Comments
					(ft)	(m)	Time Interval t' (min)	t/t'	(USgpm)	(L/s)	(USgpm/ft)	(L/s/m)	
15-Feb-11	16:20:30	42.260	12.881	60.5	34.260	10.442							Step 3
15-Feb-11	16:21:00	43.140	13.149	61.0	35.140	10.711							
15-Feb-11	16:21:30	43.180	13.161	61.5	35.180	10.723			254.0	16.03	7.22	1.49	56 IN. AT ORIFICE = 254 USGPM
15-Feb-11	16:22:00	43.050	13.122	62.0	35.050	10.683							
15-Feb-11	16:22:30	43.050	13.122	62.5	35.050	10.683							
15-Feb-11	16:23:00	43.100	13.137	63.0	35.100	10.698							WATER CLEAR
15-Feb-11	16:23:30	43.100	13.137	63.5	35.100	10.698							
15-Feb-11	16:24:00	43.170	13.158	64.0	35.170	10.720							
15-Feb-11	16:24:30	43.220	13.174	64.5	35.220	10.735			254.0	16.03	7.21	1.49	56 IN. AT ORIFICE = 254 USGPM
15-Feb-11	16:25:00	43.150	13.152	65.0	35.150	10.714							
15-Feb-11	16:26:00	43.270	13.189	66.0	35.270	10.750							STORM DRAIN HANDLES WATER FINE
15-Feb-11	16:27:00	43.300	13.198	67.0	35.300	10.759							
15-Feb-11	16:28:00	43.350	13.213	68.0	35.350	10.775							
15-Feb-11	16:29:00	43.290	13.195	69.0	35.290	10.756			254.0	16.03	7.20	1.49	
15-Feb-11	16:30:00	43.320	13.204	70.0	35.320	10.766							
15-Feb-11	16:32:00	43.270	13.189	72.0	35.270	10.750							
15-Feb-11	16:34:00	43.460	13.247	74.0	35.460	10.808							
15-Feb-11	16:36:00	43.450	13.244	76.0	35.450	10.805			254.0	16.03	7.17	1.48	
15-Feb-11	16:38:00	43.510	13.262	78.0	35.510	10.823							
15-Feb-11	16:40:00	43.470	13.250	80.0	35.470	10.811							56 IN. AT ORIFICE = 254 USGPM
15-Feb-11	16:45:00	43.500	13.259	85.0	35.500	10.820							
15-Feb-11	16:50:00	43.640	13.302	90.0	35.640	10.863							WATER CLEAR
15-Feb-11	17:00:00	43.760	13.338	100.0	35.760	10.900			254.0	16.03	7.10	1.47	
15-Feb-11	17:10:00	43.750	13.335	110.0	35.750	10.897							WATER SAMPLES TAKEN
15-Feb-11	17:20:00	43.750	13.335	120.0	35.750	10.897			254.0	16.03	7.10	1.47	
15-Feb-11	17:20:30	14.420	4.395	120.5	6.420	1.957	0.00						Start of recovery with Maple Creek Well
15-Feb-11	17:21:00	12.090	3.685	121.0	4.090	1.247	0.50	242.0					
15-Feb-11	17:21:30	11.500	3.505	121.5	3.500	1.067	1.00	121.5					
15-Feb-11	17:22:00	11.240	3.426	122.0	3.240	0.988	1.50	81.3					
15-Feb-11	17:22:30	11.050	3.368	122.5	3.050	0.930	2.00	61.2					
15-Feb-11	17:23:00	10.960	3.341	123.0	2.960	0.902	2.50	49.2					
15-Feb-11	17:23:30	10.840	3.304	123.5	2.840	0.866	3.00	41.2					
15-Feb-11	17:24:00	10.690	3.258	124.0	2.690	0.820	3.50	35.4					
15-Feb-11	17:24:30	10.610	3.234	124.5	2.610	0.796	4.00	31.1					
15-Feb-11	17:25:00	10.560	3.219	125.0	2.560	0.780	55.00	2.3					
15-Feb-11	17:26:00	10.500	3.200	126.0	2.500	0.762	56.00	2.2					
15-Feb-11	17:27:00	10.320	3.146	127.0	2.320	0.707	57.00	2.2					
15-Feb-11	17:28:00	10.280	3.133	128.0	2.280	0.695	58.00	2.2					
15-Feb-11	17:29:00	10.160	3.097	129.0	2.160	0.658	59.00	2.2					
15-Feb-11	17:30:00	10.110	3.082	130.0	2.110	0.643	60.00	2.2					
15-Feb-11	17:32:00	10.070	3.069	132.0	2.070	0.631	62.00	2.1					
15-Feb-11	17:42:00	9.600	2.926	142.0	1.600	0.488	72.00	2.0					End Recovery

APPENDIX E

LABORATORY ANALYSIS REPORTS

PITEAU ASSOC. ENGINEERING LTD.
ATTN: MARION KEHOE
215 - 260 WEST ESPLANADE
NORTH VANCOUVER BC V7M 3G7

Phone: 604-986-8551

Date Received: 16-FEB-11
Report Date: 21-FEB-11 11:10 (MT)
Version: FINAL

Certificate of Analysis

Lab Work Order #: L978807
Project P.O. #: NOT SUBMITTED
Job Reference: 3081 MAPLE CREEK
Legal Site Desc:
C of C Numbers: 10-038191

Natasha Markovic-Mirovic
Account Manager

ALS LABORATORY GROUP ANALYTICAL REPORT

	Sample ID	L978807-1				
	Description					
	Sampled Date	15-FEB-11				
	Sampled Time	17:10				
	Client ID	MAPLE CREEK WET WELL				
Grouping	**Analyte**					
WATER						
Physical Tests	Colour, True (CU)	<5.0				
	Conductivity (uS/cm)	292				
	Hardness (as CaCO3) (mg/L)	91.3				
	pH (pH)	7.50				
	Total Dissolved Solids (mg/L)	185				
	Turbidity (NTU)	0.67				
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	74.4				
	Chloride (Cl) (mg/L)	40.8				
	Fluoride (F) (mg/L)	0.025				
	Nitrate (as N) (mg/L)	0.645				
	Nitrite (as N) (mg/L)	<0.0010				
	Sulfate (SO4) (mg/L)	11.2				
Bacteriological Tests	E. coli (MPN/100mL)	<1				
	Coliform Bacteria - Total (MPN/100mL)	<1				
Total Metals	Aluminum (Al)-Total (mg/L)	<0.010				
	Antimony (Sb)-Total (mg/L)	<0.00050				
	Arsenic (As)-Total (mg/L)	0.00073				
	Barium (Ba)-Total (mg/L)	<0.020				
	Boron (B)-Total (mg/L)	<0.10				
	Cadmium (Cd)-Total (mg/L)	<0.00020				
	Calcium (Ca)-Total (mg/L)	29.0				
	Chromium (Cr)-Total (mg/L)	<0.0020				
	Copper (Cu)-Total (mg/L)	0.0016				
	Iron (Fe)-Total (mg/L)	<0.030				
	Lead (Pb)-Total (mg/L)	0.00124				
	Magnesium (Mg)-Total (mg/L)	4.60				
	Manganese (Mn)-Total (mg/L)	<0.0020				
	Mercury (Hg)-Total (mg/L)	<0.00020				
	Potassium (K)-Total (mg/L)	1.97				
	Selenium (Se)-Total (mg/L)	<0.0010				
	Sodium (Na)-Total (mg/L)	21.7				
	Uranium (U)-Total (mg/L)	0.00011				
	Zinc (Zn)-Total (mg/L)	<0.050				

Reference Information

Test Method References:

<table>
<tr><th>ALS Test Code</th><th>Matrix</th><th>Test Description</th><th>Method Reference**</th></tr>
<tr><td>ALK-COL-VA</td><td>Water</td><td>Alkalinity by Colourimetric (Automated)</td><td>APHA 310.2</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.</td></tr>
<tr><td>ANIONS-CL-IC-VA</td><td>Water</td><td>Chloride by Ion Chromatography</td><td>APHA 4110 B.</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".</td></tr>
<tr><td>ANIONS-F-IC-VA</td><td>Water</td><td>Fluoride by Ion Chromatography</td><td>APHA 4110 B.</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".</td></tr>
<tr><td>ANIONS-NO2-IC-VA</td><td>Water</td><td>Nitrite by Ion Chromatography</td><td>APHA 4110 B.</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Specifically, the nitrite detection is by UV absorbance and not conductivity.</td></tr>
<tr><td>ANIONS-NO3-IC-VA</td><td>Water</td><td>Nitrate by Ion Chromatography</td><td>APHA 4110 B.</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Specifically, the nitrate detection is by UV absorance and not conductivity.</td></tr>
<tr><td>ANIONS-SO4-IC-VA</td><td>Water</td><td>Sulfate by Ion Chromatography</td><td>APHA 4110 B.</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".</td></tr>
<tr><td>COLOUR-TRUE-VA</td><td>Water</td><td>Colour (True) by Spectrometer</td><td>APHA 2120 "Color"</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 2120 "Color". Colour (True Colour) is determined by filtering a sample through a 0.45 micron membrane filter followed by analysis of the filtrate using the platinum-cobalt colourimetric method. Aparent Colour is determined without prior sample filtration. Colour is pH dependent. Unless otherwise indicated, reported colour results pertain to the pH of the sample as received, to within +/- 1 pH unit.</td></tr>
<tr><td>COLOUR-TRUE-VA</td><td>Water</td><td>Colour (True) by Spectrometer</td><td>APHA 2120 Color</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 2120 "Color". Colour (True Colour) is determined by filtering a sample through a 0.45 micron membrane filter followed by analysis of the filtrate using the platinum-cobalt colourimetric method. Aparent Colour is determined without prior sample filtration. Colour is pH dependent. Unless otherwise indicated, reported colour results pertain to the pH of the sample as received, to within +/- 1 pH unit.</td></tr>
<tr><td>EC-PCT-VA</td><td>Water</td><td>Conductivity (Automated)</td><td>APHA 2510 Auto. Conduc.</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.</td></tr>
<tr><td>ECOLI-COLI-HLTH-VA</td><td>Water</td><td>E.coli by Colilert</td><td>APHA METHOD 9223</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 9223 "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture hydrolyzable substrates and then sealed in a multi-well packet. The packet is incubated for 18 or 24 hours and then the number of wells exhibiting a positive response are counted. The final result is obtained by comparing the positive responses to a probability table.</td></tr>
<tr><td>HARDNESS-CALC-VA</td><td>Water</td><td>Hardness</td><td>APHA 2340B</td></tr>
<tr><td colspan="4">Hardness is calculated from Calcium and Magnesium concentrations, and is expressed as calcium carbonate equivalents.</td></tr>
<tr><td>HG-TOT-DW-CVAFS-VA</td><td>Water</td><td>Total Mercury in Water by CVAFS</td><td>EPA 245.7</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry (EPA Method 245.7).</td></tr>
<tr><td>MET-TOT-DW-ICP-VA</td><td>Water</td><td>Total Metals in Water by ICPOES</td><td>EPA SW-846 3005A/6010B</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).</td></tr>
<tr><td>MET-TOT-DW-MS-VA</td><td>Water</td><td>Total Metals in Water by ICPMS</td><td>EPA SW-846 3005A/6020A</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).</td></tr>
<tr><td>PH-PCT-VA</td><td>Water</td><td>pH by Meter (Automated)</td><td>APHA 4500-H "pH Value"</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode</td></tr>
</table>

Reference Information

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

TCOLI-COLI-HLTH-VA Water Total coliform by Colilert APHA METHOD 9223

This analysis is carried out using procedures adapted from APHA Method 9223 "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture hydrolyzable substrates and then sealed in a multi-well packet. The packet is incubated for 18 or 24 hours and then the number of wells exhibiting a positive response are counted. The final result is quantified by a statistical estimation of bacteria density (most probable number).

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TURBIDITY-VA Water Turbidity by Meter APHA 2130 "Turbidity"

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

TURBIDITY-VA Water Turbidity by Meter APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
VA	ALS LABORATORY GROUP - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

10-038191

GLOSSARY OF REPORT TERMS

Surrogate A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg milligrams per kilogram based on dry weight of sample.
mg/kg wwt milligrams per kilogram based on wet weight of sample.
mg/kg lwt milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L milligrams per litre.
< - Less than.
D.L. The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

quest Form
19878

10-038191

Page 1 of 1

Report To
Company: PITEAU ASSOCIATES
Contact: M.KEHOE
Address: 215-260 WEST ESPLANADE
NORTH VANCOUVER BC V7M 3G7
Phone: 604-986-8551 Fax: 604-985-7286

Report Format / Distribution
Standard: X Other (specify):
Select: PDF X Excel X Digital ___ Fax ___
Email 1: mkehoe@piteau.com
Email 2: ktixier@piteau.com

Service Requested: (Rush subject to availability)
☒ Regular (Standard Turnaround Times))
☐ Priority, Date Req'd: ________ (Surcharges apply)
☐ Emergency (1 Business Day) - 100% Surcharge
☐ For Emergency < 1 Day, ASAP or Weekend - Contact ALS

Invoice To Same as Report ? (circle) [✓ Yes] or No (if No, provide details)
Copy of Invoice with Report? (circle) [✓ Yes] or No
Company:
Contact:
Address:
Phone: Fax:

Client / Project Information
Job #: 3081 MAPLE CREEK
PO / AFE:
LSD:
Quote #:

Lab Work Order # (lab use only) L978604

ALS Contact: NATASHA M-M
Sampler: M. KEHOE

Analysis Request
(Indicate Filtered or Preserved, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Full Drinking H2O Pkg	E.Coli	Total coliform										Number of Containers
	~~PWQ~~ MAPLE CREEK WET WELL	15-FEB-11	17:00	WATER	X	X	X										

Special Instructions / Regulations / Hazardous Details

NOTE: TOTAL METALS ONLY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: M.Kehoe	Date: 16-2-11	Time: 8:00	Received by: JP	Date: Feb 16/11	Time: 9:40	Temperature: 6 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

IG MicroMed Environmental Inc.
190 - 12860 Clarke Place, Richmond, B.C. V6V 2H1
Tel: (604) 279-0666 Fax: (604) 279-0663

CERTIFICATE OF ANALYSIS

Kathy

Attn: David Tiplady
Piteau Associates Engineering Ltd.
215 – 260 West Esplanade Street
North Vancouver, B.C.
V7M 3G7

Phone: (604) 986-8551

24 March, 2011

Your Project Number: Not Provided.
Reference No: 220056.

These are the results of the sample received March 9

Product Sampled: One water sample was received in the laboratory for analysis.

Sample:	Standard Plate Count/cfu/100mL	Bacterial Identification	Iron Bacteria
Sample #1 Maple Creek	35	Pseudomonas species	Iron bacteria not detected in centrifuged sample

Gillian Geere, B.Sc.
Microbiologist.

GG/cf

Methodology:

Heterotrophic Plate Count (9215 D)- Standard Methods for the Examination of Water and Wastewater –21st Edition.

Please Note: Results for water samples that are processed after the **30 hour time limit** (ie: from time of sampling to time of analysis) are **possibly invalid**.

APPENDIX F

SITE REGISTRY SEARCH RESULTS

```
                    Detail Report
SITE LOCATION
      Site ID:      1054                    Latitude:  49d 16m 59.3s
Victoria File: 26250-20/0840                Longitude: 122d 47m 12.4s
Regional File: 26250-20/0194
       Region: SURREY, LOWER MAINLAND

Site Address: 1190 PIPELINE ROAD AND 1199 EASTWOOD STREET
        City: COQUITLAM                  Prov/State: BC
 Postal Code:

Registered: DEC 23, 1997  Updated: JUN 26, 2002  Detail Removed: JUN 17, 2002

Notations:   3   Participants:  14    Associated Sites:   0
Documents:   2 Susp. Land Use:   4 Parcel Descriptions: 287

Location Description: CONDOS ON SITE.  LOCATION DERIVED BY BC ENVIRONMENT
 REFERENCING RECTIFIED NAD 83 ORTHOPHOTOGRAPHY - NOV.6,1996

Record Status: ACTIVE - UNDER ASSESSMENT
 Fee category: UNRANKED

= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
NOTATIONS

 Notation Type: SITE INVESTIGATION REPORT SUBMITTED
Notation Class: ADMINISTRATIVE
     Initiated: FEB 13, 1992              Approved: FEB 13, 1992

Ministry Contact: OUELLET, LOUISE (MINISTRY)

Notation Participants                     Notation Roles
DISTRICT OF COQUITLAM (COQUITLAM)                  SUBMITTED BY

Note: PRELIMINARY SITE HISTORY
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Notation Type: SITE INVESTIGATION REPORT SUBMITTED
Notation Class: ADMINISTRATIVE
     Initiated: FEB 13, 1992              Approved: FEB 13, 1992

Ministry Contact: OUELLET, LOUISE (MINISTRY)

Notation Participants                     Notation Roles
DISTRICT OF COQUITLAM (COQUITLAM)                  SUBMITTED BY
```

```
Note: SOIL TESTING AND TANK REMOVAL
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Notation Type: REVIEW REQUESTED (REFERRAL)
Notation Class: ADMINISTRATIVE
     Initiated: FEB 13, 1992              Approved: FEB 13, 1992

Ministry Contact: OUELLET, LOUISE (MINISTRY)
```

```
NOTATIONS

Notation Participants                     Notation Roles
DISTRICT OF COQUITLAM (COQUITLAM)                  REQUESTED BY
= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
SITE PARTICIPANTS

  Participant: BOSA DEVELOPMENT COMPANY (BURNABY)
      Role(s): DEVELOPER/ASSOCIATED COMPANY
   Start Date: JUL 07, 1989                 End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: BOSA, SISTO
      Role(s): ALTERNATE MINISTRY CONTACT
   Start Date: NOV 10, 1993                 End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: DISTRICT OF COQUITLAM (COQUITLAM)
      Role(s): MUNICIPAL/REGIONAL CONTACT
   Start Date: JAN 11, 1990                 End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: FRASER & BEATTY (VANCOUVER, B.C.)
      Role(s): LAWYER/SOLICITOR
   Start Date: NOV 02, 1993                 End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: HATCH, BRENDA
      Role(s): ALTERNATE MINISTRY CONTACT
   Start Date: NOV 15, 1993                 End Date: DEC 24, 1993
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: MACKENZIE FUJISAWA BREWER STEVENSON KOENIG (VANCOUVER)
      Role(s): LAWYER/SOLICITOR
   Start Date: NOV 15, 1993                 End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: MCCAMMON, ALAN (SURREY) W
      Role(s): MAIN MINISTRY CONTACT
```

```
   Start Date: JUN 01, 1998              End Date:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: NORECOL, DAMES & MOORE INC (VANCOUVER)
      Role(s): ENVIRONMENTAL CONSULTANT/CONTRACTOR
   Start Date: DEC 14, 1989              End Date:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: OUELLET, LOUISE (MINISTRY)
      Role(s): MAIN MINISTRY CONTACT
   Start Date: FEB 13, 1992              End Date: SEP 30, 1993
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: OWNERS OF STRATA PLAN LMS1480 (THE MACKENZIE)
      Role(s): PROPERTY OWNER
   Start Date: OCT 03, 1997              End Date:
        Notes: DATE ENTERED
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: OWNERS OF STRATA PLAN LMS2167 (THE SELKIRK)
      Role(s): PROPERTY OWNER
   Start Date: OCT 03, 1997              End Date:
        Notes: DATE ENTERED
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

```
SITE PARTICIPANTS

  Participant: POPE, DOUGLAS
      Role(s): MAIN MINISTRY CONTACT
   Start Date: SEP 30, 1993              End Date: JUN 01, 1998
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: POTTINGER GAHERTY ENVIRONMENTAL CONSULTANTS LTD (WEST PENDER
               STREET)
      Role(s): ENVIRONMENTAL CONSULTANT/CONTRACTOR
   Start Date: FEB 20, 1992              End Date:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: SCS ENGINEERING LTD. (VANCOUVER, B.C.)
      Role(s): ENVIRONMENTAL CONSULTANT/CONTRACTOR
   Start Date: JUL 07, 1989              End Date:
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
DOCUMENTS

 Title: REMOVAL OF UNDERGROUND STORAGE TANK AND EVALUATION OF POTENTIAL SOIL
        CONTAMINATION 1100 BLOCK PIPELINE ROAD, COQUITLAM, BC
              Authored: JUL 11, 1990        Submitted: FEB 13, 1992
 Participants                                Role
```

```
 NORECOL, DAMES & MOORE INC (VANCOUVER)              AUTHOR
 BOSA DEVELOPMENT COMPANY (BURNABY)                  COMMISSIONER
 DISTRICT OF COQUITLAM (COQUITLAM)                   RECIPIENT
 OUELLET, LOUISE (MINISTRY)                          REVIEWER
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Title: ENVIRONMENTAL LIABILITY SITE ASSESSMENT OF 1100 BLOCK PIPELINE ROAD,
        COQUITLAM
              Authored: JAN 04, 1990        Submitted: FEB 13, 1992
 Participants                                Role
 NORECOL, DAMES & MOORE INC (VANCOUVER)              AUTHOR
 BOSA DEVELOPMENT COMPANY (BURNABY)                  COMMISSIONER
 DISTRICT OF COQUITLAM (COQUITLAM)                   RECIPIENT
 OUELLET, LOUISE (MINISTRY)                          REVIEWER
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
SUSPECTED LAND USE

 Description: ASBESTOS MINING, MILLING, WHOLESALE BULK STORAGE OR SHIPPING
       Notes: HISTORICAL
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Description: ELECTRICAL EQUIPMENT INDUSTRIES AND ACTIVITIES
       Notes: HISTORICAL
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Description: NONFERROUS METAL MINING OR MILLING
       Notes: HISTORICAL
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Description: PETRO. PROD., /PRODUCE WATER STRG ABVEGRND/UNDERGRND TANK
       Notes: HISTORICAL
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
PARCEL DESCRIPTIONS

  Date Added: AUG 10, 1995             Crown Land PIN#:
   LTO PID#: 017760313              Crown Land File#:
```

```
PARCEL DESCRIPTIONS

  Land Desc: LOT 1, EXCEPT: FIRSTLY: PART SUBDIVIDED BY PLAN LMP6455;
             SECONDLY: PART SUBDIVIDED BY PLAN LMP13705; SECTION 11
             TOWNSHIP 39 NEW WESTMINSTER DISTRICT PLAN LMP4282
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: OCT 03, 1997             Crown Land PIN#:
   LTO PID#: 018574084              Crown Land File#:
  Land Desc: LOT C SECTION 11 TOWNSHIP 39 NEW WESTMINSTER DISTRICT PLAN
```

```
           LMP13705
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Date Added: MAR 16, 1997                 Crown Land PIN#:
   LTO PID#: 023234393                  Crown Land File#:
  Land Desc: LOT A  SECTION 11  TOWNSHIP 39  NEW WESTMINSTER DISTRICT  PLAN
           LMP25682
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Date Added: MAR 16, 1997                 Crown Land PIN#:
   LTO PID#: 023234407                  Crown Land File#:
  Land Desc: LOT B  SECTION 11  TOWNSHIP 39  NEW WESTMINSTER DISTRICT  PLAN
           LMP25682
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Date Added: APR 03, 1997                 Crown Land PIN#:
   LTO PID#: 023234423                  Crown Land File#:
  Land Desc: STRATA LOT 1  SECTION 11  TOWNSHIP 39  NEW WESTMINSTER DISTRICT
           STRATA PLAN LMS2167
           TOGETHER WITH AN INTEREST IN THE COMMON PROPERTY IN PROPORTION
           TO THE UNIT   ENTITLEMENT OF THE STRAT
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Date Added: APR 03, 1997                 Crown Land PIN#:
   LTO PID#: 023234431                  Crown Land File#:
  Land Desc: STRATA LOT 2  SECTION 11  TOWNSHIP 39  NEW WESTMINSTER DISTRICT
           STRATA PLAN LMS2167
           TOGETHER WITH AN INTEREST IN THE COMMON PROPERTY IN PROPORTION
           TO THE UNIT   ENTITLEMENT OF THE STRAT
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Date Added: APR 03, 1997                 Crown Land PIN#:
   LTO PID#: 023234440                  Crown Land File#:
  Land Desc: STRATA LOT 3  SECTION 11  TOWNSHIP 39  NEW WESTMINSTER DISTRICT
           STRATA PLAN LMS2167
           TOGETHER WITH AN INTEREST IN THE COMMON PROPERTY IN PROPORTION
           TO THE UNIT   ENTITLEMENT OF THE STRAT
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Date Added: APR 03, 1997                 Crown Land PIN#:
   LTO PID#: 023234458                  Crown Land File#:
  Land Desc: STRATA LOT 4  SECTION 11  TOWNSHIP 39  NEW WESTMINSTER DISTRICT
           STRATA PLAN LMS2167
           TOGETHER WITH AN INTEREST IN THE COMMON PROPERTY IN PROPORTION
           TO THE UNIT   ENTITLEMENT OF THE STRAT
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Date Added: APR 03, 1997                 Crown Land PIN#:
   LTO PID#: 023234466                  Crown Land File#:
  Land Desc: STRATA LOT 5  SECTION 11  TOWNSHIP 39  NEW WESTMINSTER DISTRICT
           STRATA PLAN LMS2167
```

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                      Detail Report
SITE LOCATION
     Site ID:      1275                       Latitude:  49d 16m 04.1s
 Victoria File: 26250-20/0733                    Longitude: 122d 47m 27.5s
 Regional File: 26250-20/0479
      Region: SURREY, LOWER MAINLAND

 Site Address: 942 WESTWOOD STREET
       City: COQUITLAM                    Prov/State: BC
  Postal Code:

 Registered: OCT 09, 1997  Updated: FEB 06, 2003  Detail Removed: FEB 06, 2003

 Notations:   9   Participants:  12    Associated Sites:   0
 Documents:   3 Susp. Land Use:   2 Parcel Descriptions:   3

Location Description: LOCATION DERIVED BY BC ENVIRONMENT REFERENCING RECTIFIED
 NAD 83 ORTHOPHOTOGRAPHY - NOV.6,1996

Record Status: INACTIVE - REMEDIATION COMPLETE
 Fee category: UNRANKED

 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
NOTATIONS

  Notation Type: LETTER OF COMFORT ISSUED
 Notation Class: ADMINISTRATIVE
     Initiated: SEP 21, 1994                    Approved: SEP 21, 1994

 Ministry Contact: HACKINEN, COLEEN (SURREY)

 Notation Participants                          Notation Roles
 POCO GAS AND GROCERY (COQUITLAM)                  REQUESTED BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: CONCENTRATION CRITERIA APPROACH USED
 Notation Class: ADMINISTRATIVE
     Initiated: SEP 21, 1994                    Approved: SEP 21, 1994

 Ministry Contact: HACKINEN, COLEEN (SURREY)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: REMEDIATED TO RESIDENTIAL/RECREATIONAL/AGRICULTURAL LEVELS
               (DRAFT CMCS 21/11/89)
 Notation Class: ADMINISTRATIVE
     Initiated: SEP 21, 1994                    Approved: SEP 21, 1994
```

```
 Ministry Contact: HACKINEN, COLEEN (SURREY)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE INVESTIGATION REPORT SUBMITTED
 Notation Class: ADMINISTRATIVE
     Initiated: SEP 15, 1994                    Approved: SEP 15, 1994

 Ministry Contact: HACKINEN, COLEEN (SURREY)
```

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NOTATIONS

 Notation Participants                          Notation Roles
 MORROW ENVIRONMENTAL CONSULTANTS INC (BURNABY       SUBMITTED BY
 (COMMERCE COURT))
 POCO GAS AND GROCERY (COQUITLAM)                  REQUESTED BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: REMEDIATION COMPLETION REPORT SUBMITTED
 Notation Class: ADMINISTRATIVE
     Initiated: JUL 15, 1994                    Approved: JUL 15, 1994

 Ministry Contact: POPE, DOUGLAS

 Notation Participants                          Notation Roles
 MORROW ENVIRONMENTAL CONSULTANTS INC (BURNABY       SUBMITTED BY
 (COMMERCE COURT))
 POCO GAS AND GROCERY (COQUITLAM)                  REQUESTED BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: CONCENTRATION CRITERIA APPROACH USED
 Notation Class: ADMINISTRATIVE
     Initiated: MAY 24, 1994                    Approved: MAY 24, 1994

 Ministry Contact: POPE, DOUGLAS
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: DETERMINED HISTORICAL SPECIAL WASTE CONTAMINATED SITE
 Notation Class: LEGAL REQUIREMENT
     Initiated: JUN 30, 1993                    Approved: JUN 30, 1993

 Ministry Contact: OUELLET, LOUISE (MINISTRY)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: WASTE MANAGEMENT APPROVAL ISSUED
 Notation Class: LEGAL REQUIREMENT
     Initiated: JUN 30, 1993                    Approved: SEP 30, 1994
```

Ministry Contact: OUELLET, LOUISE (MINISTRY)

Notation Participants Notation Roles
POCO GAS AND GROCERY (COQUITLAM) REQUESTED BY

Note: AS-12254, DELISTED ON 94-05-24 (POPE) AND 94-07-11 (POPE)
- -
Notation Type: SITE INVESTIGATION REPORT SUBMITTED
Notation Class: ADMINISTRATIVE
Initiated: MAY 25, 1993 Approved: MAY 25, 1993

Ministry Contact: OUELLET, LOUISE (MINISTRY)

Notation Participants Notation Roles
MORROW ENVIRONMENTAL CONSULTANTS INC (BURNABY SUBMITTED BY
(COMMERCE COURT))
POCO GAS AND GROCERY (COQUITLAM) REQUESTED BY
= =

SITE PARTICIPANTS

Participant: AMARJIT, KAUR KHERA
Role(s): PROPERTY OWNER
Start Date: OCT 19, 1993 End Date:
- -
Participant: ANALYTICAL SERVICE LABORATORIES LTD (VANCOUVER)
Role(s): ANALYTICAL LAB
Start Date: NOV 12, 1993 End Date:
- -
Participant: BUCKINGHAM DEVELOPMENTS LANDFILL (DELTA, B.C.)
Role(s): FILL RECIPIENT
LANDFILL OPERATOR/OWNER
Start Date: JAN 17, 1994 End Date:
- -
Participant: CANTEST LIMITED (VANCOUVER)
Role(s): ANALYTICAL LAB
Start Date: FEB 10, 1993 End Date:
- -
Participant: CITY OF COQUITLAM (COQUITLAM (BRUNETTE AVENUE))
Role(s): MUNICIPAL/REGIONAL CONTACT

Start Date: OCT 19, 1993 End Date:
- -
Participant: CORNS, DEBORAH
Role(s): ALTERNATE MINISTRY CONTACT
Start Date: APR 19, 1993 End Date: SEP 30, 1997
- -
Participant: DEPARTMENT OF FISHERIES AND OCEANS (NEW WESTMINSTER)
Role(s): ASSOCIATED FEDERAL GOVERNMENT CONTACT
Start Date: OCT 19, 1993 End Date:
- -
Participant: HACKINEN, COLEEN (SURREY)
Role(s): MAIN MINISTRY CONTACT
Start Date: MAY 25, 1993 End Date:
- -
Participant: MORROW ENVIRONMENTAL CONSULTANTS INC (BURNABY (COMMERCE
COURT))
Role(s): ENVIRONMENTAL CONSULTANT/CONTRACTOR
Start Date: FEB 09, 1993 End Date:
- -
Participant: OUELLET, LOUISE (MINISTRY)
Role(s): ALTERNATE MINISTRY CONTACT
Start Date: APR 19, 1993 End Date: SEP 30, 1993
- -
Participant: POCO GAS AND GROCERY (COQUITLAM)
Role(s): FORMER OPERATOR
FORMER PROPERTY OWNER
Start Date: FEB 09, 1993 End Date: OCT 18, 1993
- -
Participant: POPE, DOUGLAS
Role(s): MAIN MINISTRY CONTACT
Start Date: OCT 15, 1993 End Date: MAY 21, 2002
= =

DOCUMENTS

Title: CONFIRMATORY INVESTIGATION AND CLOSURE PLAN 942 WESTWOOD STREET,
COQUITLAM, BC
Authored: SEP 12, 1994 Submitted: SEP 15, 1994
Participants Role
MORROW ENVIRONMENTAL CONSULTANTS INC (BURNABY AUTHOR
(COMMERCE COURT))
POCO GAS AND GROCERY (COQUITLAM) COMMISSIONER

```
HACKINEN, COLEEN (SURREY)                REVIEWER
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Title: PROGRESS REPORT FOR SPECIAL WASTE APPROVAL AS-12254, PCO GAS &
     GROCERY, 942 WESTWOOD STREET, COQUITLAM, BC
         Authored: JUL 13, 1994        Submitted: JUL 15, 1994
Participants                          Role
MORROW ENVIRONMENTAL CONSULTANTS INC (BURNABY     AUTHOR
(COMMERCE COURT))
POCO GAS AND GROCERY (COQUITLAM)             COMMISSIONER
POPE, DOUGLAS                          REVIEWER
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Title: ENVIRONMENTAL ASSESSMENT OF THE POCO GAS AND GROCERY, 942 WESTWOOD
     STREET, COQUITLAM, BC
         Authored: MAR 19, 1993        Submitted: MAY 25, 1993
Participants                          Role
MORROW ENVIRONMENTAL CONSULTANTS INC (BURNABY     AUTHOR
(COMMERCE COURT))
POCO GAS AND GROCERY (COQUITLAM)             COMMISSIONER
OUELLET, LOUISE (MINISTRY)               REVIEWER
= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
SUSPECTED LAND USE

Description: PETRO. PROD., /PRODUCE WATER STRG ABVEGRND/UNDERGRND TANK
    Notes:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Description: PETRO. PROD., DISPENSE FACILITY, INC. SERV STA./CARDLOT
    Notes:
= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
PARCEL DESCRIPTIONS

 Date Added: JUL 02, 1996           Crown Land PIN#:
  LTO PID#: 004067037             Crown Land File#:
 Land Desc: LOT 49 BLOCK 8 DISTRICT LOT 378 GROUP 1 NEW WESTMINSTER DISTRICT
         PLAN 2695A
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Date Added: JUL 02, 1996           Crown Land PIN#:
  LTO PID#: 004067061             Crown Land File#:
 Land Desc: LOT 50 BLOCK 8 DISTRICT LOT 378 GROUP 1 NEW WESTMINSTER DISTRICT
         PLAN 2695A
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Date Added: JUL 02, 1996           Crown Land PIN#:
  LTO PID#: 018525504             Crown Land File#:
 Land Desc: LOT 1 BLOCK 8 DISTRICT LOT 378 GROUP 1 NEW WESTMINSTER DISTRICT
         PLAN LMP12992
```

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PARCEL DESCRIPTIONS

No activities were reported for this site

                    End of Detail Report
```

```
 As of: MAR 13, 2011      BC Online: Site Registry                11-03-17
                For: PB84923  PITEAU ASSOCIATES ENGINEERING      10:36:03
 Folio:                                              Page   1
                        Detail Report
SITE LOCATION
     Site ID:      1398                        Latitude:  49d 17m 11.1s
 Victoria File: 26250-20/0773                    Longitude: 122d 47m 05.9s
 Regional File: 26250-20/0669
      Region: SURREY, LOWER MAINLAND

 Site Address: 1204 PIPELINE ROAD
       City: COQUITLAM                   Prov/State: BC
  Postal Code: V3B 4S1

 Registered: OCT 09, 1997  Updated: OCT 09, 2003  Detail Removed: OCT 09, 2003

 Notations:   6   Participants:  15    Associated Sites:   0
 Documents:   2 Susp. Land Use:   3 Parcel Descriptions: 197

Location Description: INCLUDES 1204-1210 PIPELINE ROAD.LAT/LONG DERIVED BY BC
 ENVIRONMENT REFERENCING RECTIFIED NAD 83 ORTHOPHOTOGRAPHY - JAN.23,1997

Record Status: INACTIVE - NO FURTHER ACTION
 Fee category: UNRANKED

 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
NOTATIONS

  Notation Type: CONCENTRATION CRITERIA APPROACH USED
 Notation Class: ADMINISTRATIVE
     Initiated: NOV 09, 1994                    Approved: NOV 09, 1994

 Ministry Contact: HACKINEN, COLEEN (SURREY)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: REMEDIATED TO RESIDENTIAL/RECREATIONAL/AGRICULTURAL LEVELS
                (DRAFT CMCS 21/11/89)
 Notation Class: ADMINISTRATIVE
     Initiated: NOV 09, 1994                    Approved: NOV 09, 1994

 Ministry Contact: HACKINEN, COLEEN (SURREY)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: LETTER OF COMFORT ISSUED
 Notation Class: ADMINISTRATIVE
     Initiated: NOV 09, 1994                    Approved: NOV 09, 1994

 Ministry Contact: HACKINEN, COLEEN (SURREY)

 Notation Participants                          Notation Roles
```

```
 POLYGON DEVELOPMENT 51 LTD (VANCOUVER)            REQUESTED BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE INVESTIGATION REPORT UNDER REVIEW
 Notation Class: ADMINISTRATIVE
     Initiated: AUG 08, 1994                    Approved: AUG 08, 1994

 Ministry Contact: CORNS, DEBORAH







 As of: MAR 13, 2011      BC Online: Site Registry                11-03-17
                For: PB84923  PITEAU ASSOCIATES ENGINEERING      10:36:03
 Folio:                                              Page   2
NOTATIONS

 Notation Participants                          Notation Roles
 POLYGON DEVELOPMENT 51 LTD (VANCOUVER)            RECEIVED BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: CONCENTRATION CRITERIA APPROACH USED
 Notation Class: ADMINISTRATIVE
     Initiated: JUL 08, 1994                    Approved: JUL 08, 1994

 Ministry Contact: POPE, DOUGLAS
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE INVESTIGATION REPORT SUBMITTED
 Notation Class: ADMINISTRATIVE
     Initiated: JUL 08, 1994                    Approved: JUL 08, 1994

 Ministry Contact: POPE, DOUGLAS

 Notation Participants                          Notation Roles
 CASTOR CONSULTANTS LTD. (COQUITLAM, B.C.)          SUBMITTED BY
 POLYGON DEVELOPMENT 51 LTD (VANCOUVER)            REQUESTED BY
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
SITE PARTICIPANTS

   Participant: ANALYTICAL SERVICE LABORATORIES LTD (VANCOUVER)
      Role(s): ANALYTICAL LAB
    Start Date: FEB 21, 1994                     End Date:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   Participant: ANNTHENA INVESTMENTS LTD. (NEW WESTMINSTER)
      Role(s): FORMER PROPERTY OWNER
    Start Date: APR 12, 1994                     End Date: NOV 15, 1994
        Notes: FORMER PROPERTY OWNER OF 1204 PIPELINE RD.
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   Participant: ATHOPA DEVELOPMENT CO.
```

```
    Role(s): FILL RECIPIENT
             LANDFILL OPERATOR/OWNER
  Start Date: AUG 08, 1994                End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: BFI CALGARY LANDFILL (CALGARY)
    Role(s): FILL RECIPIENT
             LANDFILL OPERATOR/OWNER
  Start Date: AUG 08, 1994                End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: BURNS DEVELOPMENT LTD. (DELTA)
    Role(s): LANDFILL OPERATOR/OWNER
  Start Date: APR 26, 1994                End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: CANTEST LIMITED (VANCOUVER)
    Role(s): ANALYTICAL LAB
  Start Date: MAR 28, 1994                End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: CASTOR CONSULTANTS LTD. (COQUITLAM, B.C.)
    Role(s): ENVIRONMENTAL CONSULTANT/CONTRACTOR
  Start Date: FEB 17, 1994                End Date:




 As of: MAR 13, 2011     BC Online: Site Registry          11-03-17
              For: PB84923  PITEAU ASSOCIATES ENGINEERING      10:36:03
 Folio:                                        Page   3
SITE PARTICIPANTS

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: CITY OF COQUITLAM (COQUITLAM (BRUNETTE AVENUE))
    Role(s): MUNICIPAL/REGIONAL CONTACT
  Start Date: JUL 08, 1994                End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: CORNS, DEBORAH
    Role(s): ALTERNATE MINISTRY CONTACT
  Start Date: AUG 08, 1994                End Date: SEP 30, 1997
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: FELLER DRYSDALE (COQUITLAM)
    Role(s): LAWYER/SOLICITOR
  Start Date: MAY 16, 1994                End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: HACKINEN, COLEEN (SURREY)
    Role(s): MAIN MINISTRY CONTACT
  Start Date: NOV 09, 1994                End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: NOVATEC CONSULTANTS INC. (VANCOUVER, B.C.)
    Role(s): ENVIRONMENTAL CONSULTANT/CONTRACTOR
```

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  Start Date: FEB 17, 1994                End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: POLYGON DEVELOPMENT 51 LTD (VANCOUVER)
    Role(s): PROPERTY OWNER
  Start Date: NOV 15, 1994                End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: POPE, DOUGLAS
    Role(s): ALTERNATE MINISTRY CONTACT
  Start Date: JUL 08, 1994                End Date: MAY 21, 2002
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: SRK-ROBINSON INC (BURNABY)
    Role(s): ENVIRONMENTAL CONSULTANT/CONTRACTOR
  Start Date: APR 12, 1994                End Date:
= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
DOCUMENTS

 Title: UNDERGROUND STORAGE TANK (UST) REMOVAL AND INSPECTION OF SOILS 1204
       PIPELNE ROAD, COQUITLAM, B.C.
           Authored: APR 22, 1994          Submitted: SEP 14, 1994
 Participants                              Role
 SRK-ROBINSON INC (BURNABY)                        AUTHOR
 ANNTHENA INVESTMENTS LTD. (NEW WESTMINSTER)         COMMISSIONER
 CORNS, DEBORAH                            REVIEWER
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Title: PHASE 2 ENVIRONMENTAL SITE INVESTIGATION REPORT
           Authored: MAR 01, 1994          Submitted: JUL 08, 1994
 Participants                              Role
 CASTOR CONSULTANTS LTD. (COQUITLAM, B.C.)         AUTHOR
 POLYGON DEVELOPMENT 51 LTD (VANCOUVER)              COMMISSIONER
 POPE, DOUGLAS                             REVIEWER
= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =




 As of: MAR 13, 2011     BC Online: Site Registry          11-03-17
              For: PB84923  PITEAU ASSOCIATES ENGINEERING      10:36:03
 Folio:                                        Page   4
SUSPECTED LAND USE

 Description: DRY DOCKS, SHIP BUILDING OR BOAT REPAIR INCL. PAINT REMOVAL
     Notes:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Description: METAL SMELTING/PROCESSING/FINISHING INDUSTRIES/ACTIVITIES
     Notes: METAL FABRICATING PLANT (PROCESSING AND STORAGE)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Description: PETRO. PROD., /PRODUCE WATER STRG ABVEGRND/UNDERGRND TANK
```

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     Notes: TANK TRUCK SERVICING DEPOT
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
PARCEL DESCRIPTIONS

  Date Added: OCT 03, 1995                 Crown Land PIN#:
    LTO PID#: 000840114                 Crown Land File#:
   Land Desc: LOT 63 SECTION 11 TOWNSHIP 39 NEW WESTMINSTER DISTRICT
              PLAN 42239A
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: OCT 03, 1995                 Crown Land PIN#:
    LTO PID#: 009487239                 Crown Land File#:
   Land Desc: LOT "B" EXCEPT: PART SUBDIVIDED BY PLAN 42239A,
              SECTION 11 TOWNSHIP 39 NEW WESTMINSTER DISTRICT
              PLAN 12467
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: JUN 12, 1997                 Crown Land PIN#:
    LTO PID#: 019074581                 Crown Land File#:
   Land Desc: LOT 1 EXCEPT FIRSTLY: PHASE ONE STRATA PLAN LMS2134;
              SECONDLY: PHASE TWO STRATA PLAN LMS2134;
              SECTION 11 TOWNSHIP 39 NEW WESTMINSTER DISTRICT PLAN LMP20200
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: JUN 20, 1997                 Crown Land PIN#:
    LTO PID#: 023197846                 Crown Land File#:
   Land Desc: STRATA LOT 1  SECTION 11  TOWNSHIP 39  NEW WESTMINSTER DISTRICT
              STRATA PLAN LMS2134
              TOGETHER WITH AN INTEREST IN THE COMMON PROPERTY IN PROPORTION
              TO THE UNIT   ENTITLEMENT OF THE STRAT
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: JUN 20, 1997                 Crown Land PIN#:
    LTO PID#: 023197854                 Crown Land File#:
   Land Desc: STRATA LOT 2  SECTION 11  TOWNSHIP 39  NEW WESTMINSTER DISTRICT
              STRATA PLAN LMS2134
              TOGETHER WITH AN INTEREST IN THE COMMON PROPERTY IN PROPORTION
              TO THE UNIT   ENTITLEMENT OF THE STRAT
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: JUN 20, 1997                 Crown Land PIN#:
    LTO PID#: 023197862                 Crown Land File#:
   Land Desc: STRATA LOT 3 SECTION 11 TOWNSHIP 39 NEW WESTMINSTER DISTRICT
              STRATA PLAN LMS2134 TOGETHER WITH AN INTEREST IN THE COMMON
              PROPERTY IN     PROPORTION TO THE UNIT ENTITLEMENT OF THE
              STRATA LOT AS SHOWN ON FORM 1
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: JUN 20, 1997                 Crown Land PIN#:
    LTO PID#: 023197871                 Crown Land File#:
```

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PARCEL DESCRIPTIONS

   Land Desc: STRATA LOT 4  SECTION 11  TOWNSHIP 39  NEW WESTMINSTER DISTRICT
              STRATA PLAN LMS2134
              TOGETHER WITH AN INTEREST IN THE COMMON PROPERTY IN PROPORTION
              TO THE UNIT   ENTITLEMENT OF THE STRAT
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: JUN 20, 1997                 Crown Land PIN#:
    LTO PID#: 023197889                 Crown Land File#:
   Land Desc: STRATA LOT 5  SECTION 11  TOWNSHIP 39  NEW WESTMINSTER DISTRICT
              STRATA PLAN LMS2134
              TOGETHER WITH AN INTEREST IN THE COMMON PROPERTY IN PROPORTION
              TO THE UNIT   ENTITLEMENT OF THE STRAT
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: JUN 20, 1997                 Crown Land PIN#:
    LTO PID#: 023197897                 Crown Land File#:
   Land Desc: STRATA LOT 6 SECTION 11 TOWNSHIP 39 NEW WESTMINSTER DISTRICT
              STRATA PLAN     LMS2134 TOGETHER WITH AN INTEREST IN THE COMMON
              PROPERTY IN PROPORTION TO    THE UNIT ENTITLEMENT OF THE STRATA
              LOT AS SHOWN ON FORM 1
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: JUN 20, 1997                 Crown Land PIN#:
    LTO PID#: 023197901                 Crown Land File#:
   Land Desc: STRATA LOT 7 SECTION 11 TOWNSHIP 39 NEW WESTMINSTER DISTRICT
              STRATA PLAN LMS2134
              TOGETHER WITH AN INTEREST IN THE COMMON PROPERTY IN PROPORTION
              TO THE UNIT   ENTITLEMENT OF THE STRAT
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: JUN 20, 1997                 Crown Land PIN#:
    LTO PID#: 023197919                 Crown Land File#:
   Land Desc: STRATA LOT 8  SECTION 11  TOWNSHIP 39  NEW WESTMINSTER DISTRICT
              STRATA PLAN LMS2134
              TOGETHER WITH AN INTEREST IN THE COMMON PROPERTY IN PROPORTION
              TO THE UNIT   ENTITLEMENT OF THE STRAT
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: JUN 20, 1997                 Crown Land PIN#:
    LTO PID#: 023197927                 Crown Land File#:
   Land Desc: STRATA LOT 9 SECTION 11 TOWNSHIP 39 NEW WESTMINSTER DISTRICT
              STRATA PLAN LMS2134 TOGETHER WITH AN INTEREST IN THE COMMON
              PROPERTY IN     PROPORTION TO THE UNIT ENTITLEMENT OF THE
              STRATA LOT AS SHOWN ON FORM 1
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: JUN 20, 1997                 Crown Land PIN#:
    LTO PID#: 023197935                 Crown Land File#:
   Land Desc: STRATA LOT 10  SECTION 11  TOWNSHIP 39  NEW WESTMINSTER DISTRICT
              STRATA PLAN LMS2134
              TOGETHER WITH AN INTEREST IN THE COMMON PROPERTY IN PROPORTION
              TO THE UNIT   ENTITLEMENT OF THE STRAT
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: JUN 20, 1997                 Crown Land PIN#:
    LTO PID#: 023197943                 Crown Land File#:
```

Land Desc: STRATA LOT 11 SECTION 11 TOWNSHIP 39 NEW WESTMINSTER DISTRICT
STRATA PLAN LMS2134

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                              Detail Report
SITE LOCATION
      Site ID:      3658                         Latitude:  49d 16m 19.5s
 Victoria File:                                Longitude: 122d 47m 11.0s
 Regional File: 26250-20/0634
       Region: SURREY, LOWER MAINLAND

 Site Address: 2649 LOUGHEED HIGHWAY
        City: PORT COQUITLAM                 Prov/State: BC
  Postal Code:

 Registered: OCT 08, 1997  Updated: MAR 22, 2001  Detail Removed: MAR 09, 2001

 Notations:   1   Participants:   5    Associated Sites:   0
 Documents:   0 Susp. Land Use:   0 Parcel Descriptions:   1

Location Description: LAT/LONG DERIVED BY BC ENVIRONMENT REFERENCING RECTIFIED
 NAD 83 ORTHOPHOTOGRAPHY - JAN.23,1997

Record Status: UNKNOWN STATUS
 Fee category: UNRANKED

 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
NOTATIONS

  Notation Type: OTHER WASTE SYSTEM NUMBERS
 Notation Class: ADMINISTRATIVE
     Initiated: JUN 13, 1994                    Approved: JUN 13, 1994

 Ministry Contact: POPE, DOUGLAS

 Note: BCG REGISTRATION FORM RECEIVED.
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
SITE PARTICIPANTS

   Participant: MCCAMMON, ALAN (SURREY) W
       Role(s): MAIN MINISTRY CONTACT
    Start Date: JUN 01, 1998                    End Date:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   Participant: MOHAWK CANADA LIMITED (HEAD OFFICE)
       Role(s): LEASEE/RENTER/TENANT
    Start Date: JUN 13, 1994                    End Date:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   Participant: MORROW ENVIRONMENTAL CONSULTANTS INC (BURNABY (COMMERCE
              COURT))
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       Role(s): ENVIRONMENTAL CONSULTANT/CONTRACTOR
    Start Date: JUN 13, 1994                    End Date:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   Participant: POPE, DOUGLAS
       Role(s): MAIN MINISTRY CONTACT
    Start Date: JUN 13, 1994                    End Date: JUN 01, 1998
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   Participant: SUTHERLAND PROPERTIES LTD (VANCOUVER)
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SITE PARTICIPANTS

       Role(s): PROPERTY OWNER
    Start Date: MAR 12, 1997                    End Date:
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
PARCEL DESCRIPTIONS

  Date Added: APR 23, 1997                  Crown Land PIN#:
    LTO PID#: 012509612                  Crown Land File#:
   Land Desc: LOT 7, EXCEPT; PART ON SRW PLAN 54908 BLOCK 5 DISTRICT LOT 380
            GROUP 1       NEW WESTMINSTER DISTRICT PLAN 2153
No activities were reported for this site

                           End of Detail Report
```

Detail Report

SITE LOCATION
Site ID: 4714 Latitude: 49d 16m 16.4s
Victoria File: 26250-20/4714 Longitude: 122d 46m 50.3s
Regional File: 26250-20/4714
Region: SURREY, LOWER MAINLAND

Site Address: 3288 HASTINGS STREET
City: PORT COQUITLAM Prov/State: BC
Postal Code: V3B 4M7

Registered: FEB 11, 1998 Updated: DEC 08, 2004 Detail Removed: DEC 07, 2004

Notations: 12 Participants: 8 Associated Sites: 0
Documents: 1 Susp. Land Use: 4 Parcel Descriptions: 43

Location Description: SITE CREATED BY SITE PROFILE, ENTERED 97-12-22

Record Status: INACTIVE - REMEDIATION COMPLETE
Fee category: LARGE SITE, SIMPLE CONTAMINATION

= =
NOTATIONS

Notation Type: CERTIFICATE OF COMPLIANCE ISSUED (WMA 27.6(2))
Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
Initiated: NOV 16, 1999 Approved: NOV 16, 1999

Ministry Contact: HANEMAYER, VINCENT (SURREY) C

Notation Participants	Notation Roles
DONALD, WILLIAM	ROSTERED EXPERT UNDER PROTOCOL SIX
BC BUILDINGS CORPORATION (KAMLOOPS (COLUMBIA STREET))	RECEIVED BY
MCCAMMON, ALAN (SURREY) W	ISSUED BY

Note: ISSUED ON THE ADVICE OF A ROSTERED PROFESSIONAL EXPERT UNDER PROTOCOL 6 OF THE CONTAMINATED SITES REGULATION

- -

Notation Type: CERTIFICATE OF COMPLIANCE REQUESTED WITHOUT INSPECTION
Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
Initiated: NOV 01, 1999 Approved: NOV 01, 1999

Ministry Contact: HANEMAYER, VINCENT (SURREY) C

Notation Participants	Notation Roles
KEYSTONE ENVIRONMENTAL LTD (RICHMOND)	SUBMITTED BY
BC BUILDINGS CORPORATION (KAMLOOPS (COLUMBIA STREET))	REQUESTED BY
DONALD, WILLIAM	ROSTERED EXPERT UNDER PROTOCOL SIX

NOTATIONS

Note: LOW TO MODERATE RISK SITE. REQUESTED ON THE ADVICE OF A ROSTERED PROFESSIONAL EXPERT UNDER PROTOCOL 6 OF THE CONTAMINATED SITES REGULATION.

- -

Notation Type: NOTICE OF INDEPENDENT REMEDIATION COMPLETION SUBMITTED (WMA 28(2))
Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
Initiated: OCT 13, 1999 Approved: OCT 13, 1999

Ministry Contact: MCCAMMON, ALAN (SURREY) W

Notation Participants	Notation Roles
KEYSTONE ENVIRONMENTAL LTD (RICHMOND)	SUBMITTED BY

- -

Notation Type: NOTICE OF INDEPENDENT REMEDIATION INITIATION SUBMITTED (WMA 28(2))
Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
Initiated: JUN 01, 1999 Approved: JUN 01, 1999

Ministry Contact: HANEMAYER, VINCENT (SURREY) C

Notation Participants	Notation Roles
KEYSTONE ENVIRONMENTAL LTD (RICHMOND)	SUBMITTED BY

- -

Notation Type: SITE PROFILE - FURTHER INVESTIGATION REQUIRED BY THE MINISTRY
Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
Initiated: MAR 16, 1998 Approved:

Ministry Contact: POPE, DOUGLAS

Required Actions: PRELIMINARY SITE INVESTIGATION REPORT REQUIRED

- -

Notation Type: SITE PROFILE REVIEWED - FURTHER INVESTIGATION REQUIRED BY THE MINISTRY
Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
Initiated: MAR 16, 1998 Approved:

Ministry Contact: POPE, DOUGLAS

Required Actions: PRELIMINARY SITE INVESTIGATION REPORT REQUIRED
- -
Notation Type: SITE PROFILE RECEIVED
Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
Initiated: FEB 26, 1998 Approved:

Ministry Contact: POPE, DOUGLAS

Notation Participants	Notation Roles
BC BUILDINGS CORPORATION (VICTORIA)	SITE PROFILE SUBMITTED BY
BC BUILDINGS CORPORATION (VICTORIA)	SITE PROFILE SUBMITTED BY

- -
Notation Type: SITE PROFILE RECEIVED
Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
Initiated: FEB 26, 1998 Approved:

Ministry Contact: POPE, DOUGLAS

Notation Participants	Notation Roles
BC BUILDINGS CORPORATION (VICTORIA)	SITE PROFILE SUBMITTED BY
BC BUILDINGS CORPORATION (VICTORIA)	SITE PROFILE SUBMITTED BY

- -
Notation Type: SITE PROFILE REVIEWED - NO FURTHER INVESTIGATION REQUIRED BY THE MINISTRY
Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
Initiated: DEC 30, 1997 Approved:

Ministry Contact: POPE, DOUGLAS

Note: FOR THE PURPOSE OF ISSUANCE OF A DEMOLITION PERMIT, NO INVESTIGATION IS NECESSARY.

Required Actions: BEFORE REZONING OF THE PROPERTY IS APPROVED, THE MINISTRY REQUIRES THE SUBMISSION OF A PRELIMINARY SITE INVESTIGATION REPORT FOR REVIEW.
- -
Notation Type: SITE PROFILE - NO FURTHER INVESTIGATION REQUIRED BY THE MINISTRY
Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
Initiated: DEC 30, 1997 Approved:

Ministry Contact: POPE, DOUGLAS

Note: FOR THE PURPOSE OF ISSUANCE OF A DEMOLITION PERMIT, NO INVESTIGATION IS NECESSARY.

Required Actions: BEFORE REZONING OF THE PROPERTY IS APPROVED, THE MINISTRY REQUIRES THE SUBMISSION OF A PRELIMINARY SITE INVESTIGATION REPORT FOR REVIEW.
- -
Notation Type: SITE PROFILE RECEIVED
Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
Initiated: DEC 22, 1997 Approved:

Ministry Contact: POPE, DOUGLAS
- -
Notation Type: SITE PROFILE RECEIVED
Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
Initiated: DEC 22, 1997 Approved:

Ministry Contact: POPE, DOUGLAS
= =
SITE PARTICIPANTS

Participant: BC BUILDINGS CORPORATION (KAMLOOPS (COLUMBIA STREET))
Role(s): PROPERTY OWNER
Start Date: OCT 28, 1999 End Date:

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- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: BC BUILDINGS CORPORATION (PORT COQUITLAM)
     Role(s): PROPERTY OWNER
              SITE PROFILE COMPLETOR
              SITE PROFILE CONTACT
   Start Date: DEC 22, 1997              End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: BC BUILDINGS CORPORATION (VICTORIA)
     Role(s): PROPERTY OWNER
              SITE PROFILE COMPLETOR
              SITE PROFILE CONTACT
   Start Date: FEB 26, 1998              End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: DONALD, WILLIAM
     Role(s): ROSTERED EXPERT UNDER PROTOCOL SIX
   Start Date: NOV 01, 1999              End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: HANEMAYER, VINCENT (SURREY) C
     Role(s): MAIN MINISTRY CONTACT
   Start Date: JUN 01, 1999              End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: KEYSTONE ENVIRONMENTAL LTD (RICHMOND)
     Role(s): ENVIRONMENTAL CONSULTANT/CONTRACTOR
   Start Date: JUN 01, 1999              End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: MCCAMMON, ALAN (SURREY) W
     Role(s): ALTERNATE MINISTRY CONTACT
   Start Date: OCT 13, 1999              End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: POPE, DOUGLAS
     Role(s): MAIN MINISTRY CONTACT
   Start Date: DEC 22, 1997              End Date: JUN 30, 1999
= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
DOCUMENTS

 Title: SITE INVESTIGATION & REMEDIAL ACTION CLOSURE REPORT, 3288 HASTINGS
        STREET, PORT COQUITLAM, BC
           Authored: OCT 28, 1999       Submitted: NOV 01, 1999
 Participants                              Role
 KEYSTONE ENVIRONMENTAL LTD (RICHMOND)              AUTHOR
 BC BUILDINGS CORPORATION (KAMLOOPS (COLUMBIA       COMMISSIONER
 STREET))
= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
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SUSPECTED LAND USE

 Description: APPLIANCE/EQUIP OR ENGINE REPAIR/RECONDITION/CLEANING/SALVAG
      Notes: INSERTED FOR SITE PROFILE DATED 97-12-15(described on Site
             Profile dated 97-12-15)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Description: PETRO. PROD., /PRODUCE WATER STRG ABVEGRND/UNDERGRND TANK
      Notes: INSERTED FOR SITE PROFILE DATED 97-12-09(described on Site
             Profile dated 97-12-09)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Description: PETRO. PROD., DISPENSE FACILITY, INC. SERV STA./CARDLOT
      Notes: INSERTED FOR SITE PROFILE DATED 97-12-15(described on Site
             Profile dated 97-12-15)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Description: ROAD SALT STORAGE FACILITIES
      Notes: INSERTED FOR SITE PROFILE DATED 97-12-09(described on Site
             Profile dated 97-12-09)
= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
PARCEL DESCRIPTIONS

  Date Added: DEC 15, 1997               Crown Land PIN#:
   LTO PID#: 011993910                Crown Land File#:
  Land Desc: PARCEL "B" (REFERENCE PLAN 21658) LOT "A" DISTRICT LOT 380 GROUP
             1 PLAN 21200AND OF LOT 5 DISTRICT LOT 380 GROUP 1 PLAN 1106 NEW
             WESTMINSTER DISTRICT
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: DEC 15, 1997               Crown Land PIN#:
   LTO PID#: 011994061                Crown Land File#:
  Land Desc: LOT 6 EXCEPT: FIRSTLY: PART SUBDIVIDED BY PLAN 58919;
             SECONDLY: PART ON STATUTORY RIGHT OF WAY PLAN 39103;
             DISTRICT LOT 380 GROUP 1 NEW WESTMINSTER DISTRICT PLAN 1106
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: MAY 05, 2001               Crown Land PIN#:
   LTO PID#: 025004697                Crown Land File#:
  Land Desc: LOT 1 DISTRICT LOT 380 GROUP 1 NEW WESTMINSTER DISTRICT PLAN
             LMP49519
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: MAY 05, 2001               Crown Land PIN#:
   LTO PID#: 025004701                Crown Land File#:
  Land Desc: LOT 2 DISTRICT LOT 380 GROUP 1 NEW WESTMINSTER DISTRICT PLAN
             LMP49519
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: MAY 05, 2001               Crown Land PIN#:
   LTO PID#: 025004719                Crown Land File#:
  Land Desc: LOT 3 DISTRICT LOT 380 GROUP 1 NEW WESTMINSTER DISTRICT PLAN
             LMP49519
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: MAY 05, 2001               Crown Land PIN#:
   LTO PID#: 025004727                Crown Land File#:
  Land Desc: LOT 4 DISTRICT LOT 380 GROUP 1 NEW WESTMINSTER DISTRICT PLAN
             LMP49519
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Date Added: MAY 05, 2001 Crown Land PIN#:

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                          Detail Report
SITE LOCATION
     Site ID:      4929                        Latitude:  49d 15m 53.6s
 Victoria File: 26250-20/4929                       Longitude: 122d 47m 22.7s
 Regional File:
      Region: SURREY, LOWER MAINLAND

 Site Address: 2664 KINGSWAY AVENUE
       City: PORT COQUITLAM                Prov/State: BC
  Postal Code: V3C 1T8

 Registered: MAR 13, 1998  Updated: FEB 04, 2004  Detail Removed: JAN 30, 2004

 Notations:   8   Participants:   3    Associated Sites:   0
 Documents:   0 Susp. Land Use:   2 Parcel Descriptions:   2

Location Description: SITE CREATED BY SITE PROFILE, ENTERED 98-03-06.
 LAT/LONG CONFIRMED USING GOAT BY MINISTRY STAFF.

Record Status: INACTIVE - NO FURTHER ACTION
 Fee category: NOT APPLICABLE

 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
NOTATIONS

  Notation Type: SITE PROFILE REVIEWED - NO FURTHER INVESTIGATION REQUIRED BY
             THE MINISTRY
 Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
     Initiated: JAN 09, 2003                     Approved:

 Ministry Contact: WARD, JOHN E H
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE - NO FURTHER INVESTIGATION REQUIRED BY THE
             MINISTRY
 Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
     Initiated: JAN 09, 2003                     Approved:

 Ministry Contact: WARD, JOHN E H
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE RECEIVED
 Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
     Initiated: JAN 06, 2002                     Approved:

 Ministry Contact: WARD, JOHN E H
```

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 Notation Participants                    Notation Roles
 610298 BC LTD. (LANGLEY)                            SITE PROFILE SUBMITTED
                                            BY
 610298 BC LTD. (LANGLEY)                            SITE PROFILE SUBMITTED
                                            BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE RECEIVED
 Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
```

```
NOTATIONS

     Initiated: JAN 06, 2002                     Approved:

 Ministry Contact: WARD, JOHN E H

 Notation Participants                    Notation Roles
 610298 BC LTD. (LANGLEY)                            SITE PROFILE SUBMITTED
                                            BY
 610298 BC LTD. (LANGLEY)                            SITE PROFILE SUBMITTED
                                            BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE - NO FURTHER INVESTIGATION REQUIRED BY THE
             MINISTRY
 Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
     Initiated: MAR 06, 1998                      Approved:

 Ministry Contact: WARD, JOHN E H
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE REVIEWED - NO FURTHER INVESTIGATION REQUIRED BY
             THE MINISTRY
 Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
     Initiated: MAR 06, 1998                      Approved:

 Ministry Contact: WARD, JOHN E H
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE RECEIVED
 Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
     Initiated: MAR 05, 1998                      Approved:

 Ministry Contact: WARD, JOHN E H

 Notation Participants                    Notation Roles
```

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 CHENNELL HOLDINGS (MAPLE RIDGE)                 SITE PROFILE SUBMITTED
                               BY
 CHENNELL HOLDINGS (MAPLE RIDGE)                 SITE PROFILE SUBMITTED
                               BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE RECEIVED
 Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
     Initiated: MAR 05, 1998                Approved:

 Ministry Contact: WARD, JOHN E H

 Notation Participants                    Notation Roles
 CHENNELL HOLDINGS (MAPLE RIDGE)                 SITE PROFILE SUBMITTED
                               BY
 CHENNELL HOLDINGS (MAPLE RIDGE)                 SITE PROFILE SUBMITTED
                               BY
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
SITE PARTICIPANTS

   Participant: CHENNELL HOLDINGS (MAPLE RIDGE)
```

```
SITE PARTICIPANTS

      Role(s): PROPERTY OWNER
               SITE PROFILE COMPLETOR
               SITE PROFILE CONTACT
   Start Date: MAR 05, 1998                     End Date:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   Participant: WARD, JOHN E H
      Role(s): MAIN MINISTRY CONTACT
   Start Date: MAR 05, 1998                     End Date:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   Participant: 610298 BC LTD. (LANGLEY)
      Role(s): PROPERTY OWNER
               SITE PROFILE COMPLETOR
               SITE PROFILE CONTACT
   Start Date: JAN 06, 2002                     End Date:
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
SUSPECTED LAND USE

 Description: APPLIANCE/EQUIP OR ENGINE REPAIR/RECONDITION/CLEANING/SALVAG
      Notes: INSERTED FOR SITE PROFILE DATED 97-12-12(described on Site
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             Profile dated 97-12-12)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Description: AUTO/TRUCK/BUS/SUBWAY/OTHER VEHICLE REPAIR/SALVAGE/WRECKING
      Notes:
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
PARCEL DESCRIPTIONS

  Date Added: DEC 12, 1997                 Crown Land PIN#:
   LTO PID#: 009239103                  Crown Land File#:
   Land Desc: LOT 1 DISTRICT LOT 379 GROUP 1 NEW WESTMINSTER DISTRICT PLAN
             10061
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: JUL 10, 2004                 Crown Land PIN#:
   LTO PID#: 025971051                  Crown Land File#:
   Land Desc: LOT A  DISTRICT LOT 379  GROUP 1  NEW WESTMINSTER DISTRICT  PLAN
             BCP11307
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
CURRENT SITE PROFILE INFORMATION (Sec. III to X)
                       Site Profile Completion Date: DEC 19, 2002

Local Authority        Received: DEC 19, 2002

Ministry Regional Manager Received:                    Decision: JAN 09, 2003
   Decision: INVESTIGATION NOT REQUIRED

Site Registrar       Received: JAN 06, 2002           Entry Date: JAN 02, 2003

AREAS OF POTENTIAL CONCERN
 Petroleum, solvent or other polluting substance spills to the environment
    greater than 100 litres?...............................................NO
 Residue left after removal of piled materials such as chemicals, coal,
    ore, smelter slag, air quality control system baghouse dust?...........NO
```

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 Discarded barrels, drums or tanks?.........................................NO
 Contamination resulting from migration of substances from other
    properties?...........................................................NO

FILL MATERIALS
 Fill dirt, soil, gravel, sand or like materials from a contaminated site
    or from a source used for any of the activiities listed under Schedule
    2?....................................................................NO
 Discarded or waste granular materials such as sand blasting grit, asphalt
```

paving or roofing material, spent foundry casting sands, mine ore,
waste rock or float?...NO
Dredged sediments, or sediments and debris materials originating from
locations adjacent to foreshore industrial activities, or municipal
sanitary or stormwater discharges?.....................................NO

WASTE DISPOSAL
Materials such as household garbage, mixed municipal refuse, or demolition
debris?...NO
Waste or byproducts such as tank bottoms, residues, sludge, or
flocculation precipitates from industrial processes or wastewater
treatment?...NO
Waste products from smelting or mining activities, such as smelter slag,
mine tailings, or cull materials from coal processing?..................NO
Waste products from natural gas and oil well drilling activities, such as
drilling fluids and muds?..NO
Waste products from photographic developing or finishing laboratories;
asphalt tar manufacturing; boilers, incinerators or other thermal
facilities (eg. ash); appliance, small equipment or engine repair or
salvage; dry cleaning operations (eg. solvents); or automobile and
truck parts cleaning or repair?..NO

TANKS OR CONTAINERS USED OR STORED
Underground fuel or chemical storage tanks?................................NO
Above ground fuel or chemical storage tanks?..............................NO

SPECIAL (HAZARDOUS) WASTES OR SUBSTANCES
PCB-containing electrical transformers or capacitors either at grade,
attached above ground to poles, located within buildings, or stored?....NO
Waste asbestos or asbestos containing materials such as pipe wrapping,
blown-in insulation or panelling buried?................................NO
Paints, solvents, mineral spirits or waste pest control products or pest
control product containers stored in volumes greater than 205 litres?...NO

LEGAL OR REGULATORY ACTIONS OR CONSTRAINTS
Government orders or other notifications pertaining to environmental
conditions or quality of soil, water, groundwater or other
environmental media?...NO
Liens to recover costs, restrictive covenants on land use, or other
charges or encumbrances, stemming from contaminants or wastes remaining
onsite or from other environmental conditions?..........................NO
Government notifications relating to past or recurring environmental
violations at the site or any facility located on the site?............NO

X ADDITIONAL COMMENTS AND EXPLANATIONS

End of Detail Report

Detail Report

SITE LOCATION
Site ID: 5795 Latitude: 49d 15m 51.6s
Victoria File: 26250-20/5795 Longitude: 122d 47m 26.4s
Regional File: 26250-20/5795
Region: SURREY, LOWER MAINLAND

Site Address: 2643, 2659, 2665, 2669 BEDFORD STREET
City: PORT COQUITLAM Prov/State: BC
Postal Code: V3C 3K7

Registered: APR 09, 1999 Updated: MAR 19, 2010 Detail Removed: MAR 19, 2010

Notations: 9 Participants: 17 Associated Sites: 0
Documents: 9 Susp. Land Use: 8 Parcel Descriptions: 43

Record Status: ACTIVE - REMEDIATION COMPLETE
Fee category: UNRANKED

= =

NOTATIONS

Notation Type: CERTIFICATE OF COMPLIANCE ISSUED USING RISK BASED STANDARDS
Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
Initiated: MAR 16, 2010 Approved: MAR 16, 2010

Ministry Contact: LOCKHART, DAVE

Notation Participants	Notation Roles
2526 WESTWOOD LP	RECEIVED BY
WALTON, DOUG G	ISSUED BY
KEYSTONE ENVIRONMENTAL	APPROVED PROFESSIONAL
ZAPF-GILJE, REIDAR	APPROVED PROFESSIONAL

Note: ISSUED ON THE RECOMMENDATION OF AN APPROVED PROFESSIONAL (KENNETH EVANS
AND REIDAR ZAPF-GILJE) UNDER PROTOCOL 6 OF THE CONTAMINATED SITES REGULATION
THIS NOTICE WAS GIVEN FOR 2643, 2659, 2665 AND 2669 BEDFORD STREET AS WELL AS
835 WESTWOOD STREET, PORT COQUITLAM

- -

Notation Type: CERTIFICATE OF COMPLIANCE REQUESTED
Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
Initiated: MAR 08, 2010 Approved: MAR 08, 2010

Ministry Contact: HEWLETT, LUCY

Notation Participants	Notation Roles
2526 WESTWOOD LP	REQUESTED BY
EVANS, KENNETH A	APPROVED PROFESSIONAL

- -

Notation Type: APPROVAL IN PRINCIPLE ISSUED
Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
Initiated: AUG 06, 2009 Approved: AUG 06, 2009

NOTATIONS

Ministry Contact: HEWLETT, LUCY

Notation Participants	Notation Roles
2526 WESTWOOD LP	RECEIVED BY
WALTON, DOUG G	ISSUED BY
ZAPF-GILJE, REIDAR	APPROVED PROFESSIONAL
EVANS, KENNETH A	APPROVED PROFESSIONAL

Note: ISSUED ON THE RECOMMENDATION OF AN APPROVED PROFESSIONAL (KENNETH EVANS
& REIDAR ZAPF-GILJE) UNDER PROTOCOL 6 OF THE CONTAMINATED SITES REGULATION
THIS NOTICE INCLUDES ALL PIDS EXCEPT 005-023-281 AND 012-548-620

- -

Notation Type: NOTICE OF INDEPENDENT REMEDIATION INITIATION SUBMITTED
Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
Initiated: AUG 04, 2009 Approved: AUG 04, 2009

Ministry Contact: ROSSER, CRAIG L

Notation Participants	Notation Roles
KEYSTONE ENVIRONMENTAL LTD.	SUBMITTED BY

Note: START: 2008-06-24

- -

Notation Type: APPROVAL IN PRINCIPLE REQUESTED
Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
Initiated: JUL 31, 2009 Approved: JUL 31, 2009

Ministry Contact: HEWLETT, LUCY

Notation Participants	Notation Roles
2526 WESTWOOD LP	REQUESTED BY

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ZAPF-GILJE, REIDAR                  APPROVED PROFESSIONAL
EVANS, KENNETH A                    APPROVED PROFESSIONAL
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Notation Type: SITE PROFILE - FURTHER INVESTIGATION REQUIRED BY THE MINISTRY
Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
    Initiated: APR 07, 1999            Approved:

Ministry Contact: MCCAMMON, ALAN (SURREY) W

Note: PRELIMINARY SITE INVESTIGATION REPORT REQUIRED
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Notation Type: SITE PROFILE REVIEWED - FURTHER INVESTIGATION REQUIRED BY THE
             MINISTRY
Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
    Initiated: APR 07, 1999            Approved:

Ministry Contact: MCCAMMON, ALAN (SURREY) W

Note: PRELIMINARY SITE INVESTIGATION REPORT REQUIRED
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
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NOTATIONS

 Notation Type: SITE PROFILE RECEIVED
Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
    Initiated: MAR 05, 1999            Approved:

Ministry Contact: MCCAMMON, ALAN (SURREY) W

Notation Participants               Notation Roles
NATHAWAD, YOGESH                         SITE PROFILE SUBMITTED
                                            BY
NATHAWAD, YOGESH                         SITE PROFILE SUBMITTED
                                            BY
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Notation Type: SITE PROFILE RECEIVED
Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
    Initiated: MAR 05, 1999            Approved:

Ministry Contact: MCCAMMON, ALAN (SURREY) W

Notation Participants               Notation Roles
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NATHAWAD, YOGESH                         SITE PROFILE SUBMITTED
                                            BY
NATHAWAD, YOGESH                         SITE PROFILE SUBMITTED
                                            BY
= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
SITE PARTICIPANTS

  Participant: EVANS, KENNETH A
     Role(s): ENVIRONMENTAL CONSULTANT/CONTRACTOR
   Start Date: JUL 23, 2009               End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: FAR WEST DEVELOPMENT CORPORATION (PORT COQUITLAM)
     Role(s): PROPERTY OWNER
   Start Date: MAR 05, 1999               End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: GEOENVIROLOGIC CONSULTING LTD.
     Role(s): ENVIRONMENTAL CONSULTANT/CONTRACTOR
   Start Date: JUL 23, 2009               End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: HACKINEN, COLEEN (SURREY)
     Role(s): ALTERNATE MINISTRY CONTACT
   Start Date: AUG 06, 2009               End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: HEWLETT, LUCY
     Role(s): ALTERNATE MINISTRY CONTACT
   Start Date: JUL 31, 2009               End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: HILDEBRAND, JANE MARIE
     Role(s): ALTERNATE MINISTRY CONTACT
   Start Date: MAY 05, 1999               End Date: MAR 31, 2003
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: KEYSTONE ENVIRONMENTAL
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SITE PARTICIPANTS

     Role(s): ENVIRONMENTAL CONSULTANT/CONTRACTOR
   Start Date: MAR 16, 2010               End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: KEYSTONE ENVIRONMENTAL LTD.
     Role(s): ENVIRONMENTAL CONSULTANT/CONTRACTOR
   Start Date: SEP 11, 2003               End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

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  Participant: LOCKHART, DAVE
     Role(s): ALTERNATE MINISTRY CONTACT
   Start Date: MAR 16, 2010                    End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: MCCAMMON, ALAN (SURREY) W
     Role(s): MAIN MINISTRY CONTACT
   Start Date: MAR 05, 1999                    End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: NATHAWAD, YOGESH
     Role(s): SITE PROFILE COMPLETOR
            SITE PROFILE CONTACT
   Start Date: MAR 05, 1999                    End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: POPE, DOUGLAS
     Role(s): ALTERNATE MINISTRY CONTACT
   Start Date: MAR 05, 1999                    End Date: MAY 21, 2002
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: ROSSER, CRAIG L
     Role(s): ALTERNATE MINISTRY CONTACT
   Start Date: AUG 04, 2009                    End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: SZEFER, GEORGE (SURREY) A
     Role(s): MAIN MINISTRY CONTACT
   Start Date: MAY 12, 1999                    End Date: MAY 09, 2001
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: WALTON, DOUG G
     Role(s): ALTERNATE MINISTRY CONTACT
   Start Date: AUG 06, 2009                    End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: ZAPF-GILJE, REIDAR
     Role(s): ENVIRONMENTAL CONSULTANT/CONTRACTOR
   Start Date: JUL 31, 2009                    End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: 2526 WESTWOOD LP
     Role(s): PROPERTY OWNER
   Start Date: JUL 31, 2009                    End Date:
= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
DOCUMENTS

 Title: RESPONSES TO REVIEW COMMENTS HUMAN HEALTH AND ECOLOGICAL ASSESSMENT
        2643, 2659, 2665 & 2669 BEDFORD ST., PORT COQUITLAM BC AND 835
        WESTWOOD ST., COQUI
           Authored: FEB 24, 2010          Submitted: MAR 08, 2010
 Participants                            Role
```

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DOCUMENTS

 KEYSTONE ENVIRONMENTAL LTD.                       AUTHOR
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Title: REPORT OF FINDINGS REMEDIAL ACTION CLOSURE AND HUMAN HEALTH AND
        ECOLOGICAL RISK ASSESSMENT UPDATE 2643, 2659 & 2669 BEDFORD ST., PORT
        COQUITLAM, BC AN
           Authored: FEB 01, 2010          Submitted: MAR 08, 2010
 Participants                            Role
 KEYSTONE ENVIRONMENTAL LTD.                       AUTHOR
Notes: EXACT DOCUMENT DATE UNKNOWN
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Title: SUMMARY OF SITE CONDITION
           Authored: JUL 23, 2009          Submitted: JUL 31, 2009
 Participants                            Role
 EVANS, KENNETH A                                 AUTHOR
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Title: RISK ASSESSMENT ROSTER REVIEW COMMENTS, BEDFORD STREET, PORT
        COQUITLAM BC
           Authored: JUL 23, 2009          Submitted: JUL 31, 2009
 Participants                            Role
 GEOENVIROLOGIC CONSULTING LTD.                    AUTHOR
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Title: VOL 1&2 REPORT OF FINDINGS PSI STAGE 1 & 2, DETAILED SITE
        INVESTIGATION, REMEDIATION, HUMAN HEALTH AND ECOLOGICAL RISK
        ASSESSMENT, AND REMEDIAL PLAN
           Authored: JUL 01, 2009          Submitted: JUL 31, 2009
 Participants                            Role
 KEYSTONE ENVIRONMENTAL LTD.                       AUTHOR
Notes: EXACT DOCUMENT DATE UNKNOWN
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Title: RESPONSES TO REVIEW COMMENTS, HUMAN HEALTH AND ECOLOGICAL RISK
        ASSESSMENT, 2643, 2659, 2665 & 2669 BEDFORD ST., PORT COQUITLAM, BC &
        835 WESTWOOD ST.,
           Authored: JUN 22, 2009          Submitted: JUL 31, 2009
 Participants                            Role
 KEYSTONE ENVIRONMENTAL LTD.                       AUTHOR
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Title: REPORT OF FINDINGS, PRELIMINARY SITE INVESTIGATION STAGE 2, 2643,
        2659, 2665, 2669 BEDFORD ST., PORT COQUITLAM & 835 WESTWOOD STREET,
        COQUITLAM, BC
           Authored: JAN 01, 2004          Submitted: JUL 31, 2009
 Participants                            Role
 KEYSTONE ENVIRONMENTAL LTD.                       AUTHOR
Notes: EXACT DOCUMENT DATE UNKNOWN
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Title: REPORT OF FINDINGS, PRELIMINARY SITE INVESTIGATION STAGE 2, 2643,
        2659, 2665, 2669 BEDFORD ST., PORT COQUITLAM & 835 WESTWOOD STREET,
        COQUITLAM, BCREP
           Authored: NOV 01, 2003          Submitted: JUL 31, 2009
 Participants                            Role
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 KEYSTONE ENVIRONMENTAL LTD.                     AUTHOR
Notes: EXACT DOCUMENT DATE UNKNOWN
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DOCUMENTS

 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Title: GEOTECHNICAL REPORT, PROPOSED MIMISTORAGE, BEDFORD STREET, COQUITLAM,
        BC
            Authored: SEP 11, 2003             Submitted: JUL 03, 2009
 Participants                                Role
 KEYSTONE ENVIRONMENTAL LTD.                     AUTHOR
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
SUSPECTED LAND USE

 Description: APPLIANCE/EQUIP OR ENGINE REPAIR/RECONDITION/CLEANING/SALVAG
      Notes: INSERTED FOR SITE PROFILE DATED 1999-02-17(described on Site
            Profile dated 99-02-17)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Description: ASBESTOS MINING, MILLING, WHOLESALE BULK STORAGE OR SHIPPING
      Notes: INSERTED FOR SITE PROFILE DATED 1999-02-17(described on Site
            Profile dated 99-02-17)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Description: ASPHALT TAR MANUFACTURE/WHOLESALE STORAGE/DISTRIBUTE
      Notes: INSERTED FOR SITE PROFILE DATED 1999-02-17(described on Site
            Profile dated 99-02-17)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Description: AUTO/TRUCK/BUS/SUBWAY/OTHER VEHICLE REPAIR/SALVAGE/WRECKING
      Notes: INSERTED FOR SITE PROFILE DATED 1999-02-17(described on Site
            Profile dated 99-02-17)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Description: BARREL, DRUM OR TANK RECONDITIONING OR SALVAGE
      Notes: INSERTED FOR SITE PROFILE DATED 1999-02-17(described on Site
            Profile dated 99-02-17)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Description: ELECTRICAL EQUIPMENT MANU/REFURBISH/WHOLESALE BULK STORAGE
      Notes: INSERTED FOR SITE PROFILE DATED 1999-02-17(described on Site
            Profile dated 99-02-17)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Description: PETRO. PROD., /PRODUCE WATER STRG ABVEGRND/UNDERGRND TANK
      Notes: INSERTED FOR SITE PROFILE DATED 1999-02-17(described on Site
            Profile dated 99-02-17)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
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 Description: SANDBLASTING WASTE DISPOSAL
      Notes: INSERTED FOR SITE PROFILE DATED 1999-02-17(described on Site
            Profile dated 99-02-17)
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
PARCEL DESCRIPTIONS

  Date Added: FEB 17, 1999                  Crown Land PIN#:
   LTO PID#: 003560627                   Crown Land File#:
   Land Desc: LOT 366 DISTRICT LOT 378 GROUP 1 NEW WESTMINSTER DISTRICT
            PLAN 65014
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: JUL 31, 2009                  Crown Land PIN#:
   LTO PID#: 003560686                   Crown Land File#:
   Land Desc: LOT 119 DISTRICT LOT 379 GROUP 1 NEW WESTMINSTER DISTRICT
```

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PARCEL DESCRIPTIONS

            PLAN 65023
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: FEB 17, 1999                  Crown Land PIN#:
   LTO PID#: 005023281                   Crown Land File#:
   Land Desc:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: FEB 17, 1999                  Crown Land PIN#:
   LTO PID#: 012548600                   Crown Land File#:
   Land Desc: LOT "A" EXCEPT: PART SUBDIVIDED BY PLAN 65023,
            DISTRICT LOT 379 GROUP 1 NEW WESTMINSTER DISTRICT
            PLAN 2161
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: FEB 17, 1999                  Crown Land PIN#:
   LTO PID#: 012548620                   Crown Land File#:
   Land Desc:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: JUL 31, 2009                  Crown Land PIN#:
   LTO PID#: 012548626                   Crown Land File#:
   Land Desc: LOT "B" DISTRICT LOT 379 GROUP 1 NEW WESTMINSTER DISTRICT
            PLAN 2161
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Date Added: FEB 17, 1999                  Crown Land PIN#:
   LTO PID#: 013656937                   Crown Land File#:
   Land Desc: LOT 17 DISTRICT LOT 379 GROUP 1 NEW WESTMINSTER DISTRICT
            PLAN 2161
```

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- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Date Added: JUN 17, 2010                  Crown Land PIN#:
  LTO PID#: 028233603                    Crown Land File#:
  Land Desc: LOT 1  DISTRICT LOT 379  GROUP 1  NEW WESTMINSTER DISTRICT  PLAN
            BCP44877
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Date Added: JAN 15, 2011                  Crown Land PIN#:
  LTO PID#: 028440510                    Crown Land File#:
  Land Desc: STRATA LOT 1  DISTRICT LOT 379  GROUP 1  NEW WESTMINSTER
            DISTRICT            STRATA PLAN BCS4015
            TOGETHER WITH AN INTEREST IN THE COMMON PROPERTY IN PROPORTION
            TO THE UNIT   ENTITLEMENT OF THE STRAT
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Date Added: JAN 15, 2011                  Crown Land PIN#:
  LTO PID#: 028440528                    Crown Land File#:
  Land Desc: STRATA LOT 2  DISTRICT LOT 379  GROUP 1  NEW WESTMINSTER
            DISTRICT            STRATA PLAN BCS4015
            TOGETHER WITH AN INTEREST IN THE COMMON PROPERTY IN PROPORTION
            TO THE UNIT   ENTITLEMENT OF THE STRAT
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Date Added: JAN 15, 2011                  Crown Land PIN#:
  LTO PID#: 028440536                    Crown Land File#:
  Land Desc: STRATA LOT 3  DISTRICT LOT 379  GROUP 1  NEW WESTMINSTER
            DISTRICT            STRATA PLAN BCS4015
            TOGETHER WITH AN INTEREST IN THE COMMON PROPERTY IN PROPORTION
            TO THE UNIT   ENTITLEMENT OF THE STRAT
```

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 As of: MAR 13, 2011       BC Online: Site Registry                  11-03-17
                    For: PB84923  PITEAU ASSOCIATES ENGINEERING      10:43:06
 Folio:                                                    Page   1
                              Detail Report
SITE LOCATION
       Site ID:       8218                         Latitude:  49d 15m 55.4s
 Victoria File: 26250-20/8218                    Longitude: 122d 47m 27.6s
 Regional File: 26250-20/8218
       Region: SURREY, LOWER MAINLAND

 Site Address: 858 WESTWOOD STREET
         City: COQUITLAM                    Prov/State: BC
  Postal Code: V3C 3L2

 Registered: MAY 09, 2003  Updated: MAY 07, 2010  Detail Removed: MAY 04, 2010

 Notations:   6   Participants:   6    Associated Sites:   0
 Documents:   0 Susp. Land Use:   1 Parcel Descriptions:   1

Location Description: SITE CREATED BY SITE PROFILE, ENTERED 2003-04-22.
 LAT/LONG CONFIRMED USING GOAT BY MINISTRY STAFF

Record Status: ACTIVE - UNDER ASSESSMENT
 Fee category: UNRANKED

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NOTATIONS

  Notation Type: NOTICE OF INDEPENDENT REMEDIATION INITIATION SUBMITTED
 Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
      Initiated: MAY 04, 2010                      Approved: MAY 04, 2010

 Ministry Contact: SAMWAYS, JENNIFER

 Notation Participants                             Notation Roles
 ENTECH ENVIRONMENTAL CONSULTANTS LTD.             SUBMITTED BY

 Note: START:  2010-01-09
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: NOTIFICATION RECEIVED ABOUT LIKELY OR ACTUAL SUBSTANCE
                 MIGRATION TO NEIGHBOURING SITE
 Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
      Initiated: MAY 04, 2010                      Approved: MAY 04, 2010

 Ministry Contact: SAMWAYS, JENNIFER

 Notation Participants                             Notation Roles
 ENTECH ENVIRONMENTAL CONSULTANTS LTD.             SUBMITTED BY
```

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 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE - FURTHER INVESTIGATION REQUIRED BY THE MINISTRY
 Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
      Initiated: APR 22, 2003                      Approved:

 Ministry Contact: MCCAMMON, ALAN (SURREY) W

 Note: PRELIMINARY SITE INVESTIGATION REPORT REQUIRED
```

```
 As of: MAR 13, 2011       BC Online: Site Registry                  11-03-17
                    For: PB84923  PITEAU ASSOCIATES ENGINEERING      10:43:06
 Folio:                                                    Page   2
NOTATIONS

 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE REVIEWED - FURTHER INVESTIGATION REQUIRED BY THE
                 MINISTRY
 Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
      Initiated: APR 22, 2003                      Approved:

 Ministry Contact: MCCAMMON, ALAN (SURREY) W

 Note: PRELIMINARY SITE INVESTIGATION REPORT REQUIRED
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE RECEIVED
 Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
      Initiated: FEB 06, 2003                      Approved:

 Ministry Contact: MCCAMMON, ALAN (SURREY) W

 Notation Participants                             Notation Roles
 JUTT MOTORS LTD.                                  SITE PROFILE SUBMITTED
                                BY
 JUTT MOTORS LTD.                                  SITE PROFILE SUBMITTED
                                BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE RECEIVED
 Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
      Initiated: FEB 06, 2003                      Approved:

 Ministry Contact: MCCAMMON, ALAN (SURREY) W

 Notation Participants                             Notation Roles
 JUTT MOTORS LTD.                                  SITE PROFILE SUBMITTED
                                BY
```

JUTT MOTORS LTD.   SITE PROFILE SUBMITTED
BY

= =

SITE PARTICIPANTS

Participant: A&A CONSTRUCTION LTD
Role(s): PROPERTY OWNER
Start Date: MAY 04, 2010   End Date:

- -

Participant: DANKEVY, STEPHEN (SURREY) NEIL
Role(s): MAIN MINISTRY CONTACT
Start Date: APR 22, 2003   End Date:

- -

Participant: ENTECH ENVIRONMENTAL CONSULTANTS LTD.
Role(s): ENVIRONMENTAL CONSULTANT/CONTRACTOR
Start Date: MAY 04, 2010   End Date:

- -

Participant: JUTT MOTORS LTD.
Role(s): PROPERTY OWNER
SITE PROFILE COMPLETOR

SITE PARTICIPANTS

SITE PROFILE CONTACT
Start Date: FEB 06, 2003   End Date:

- -

Participant: MCCAMMON, ALAN (SURREY) W
Role(s): ALTERNATE MINISTRY CONTACT
Start Date: FEB 06, 2003   End Date:

- -

Participant: SAMWAYS, JENNIFER
Role(s): ALTERNATE MINISTRY CONTACT
Start Date: MAY 04, 2010   End Date:

= =

SUSPECTED LAND USE

Description: PETRO. PROD., DISPENSE FACILITY, INC. SERV STA./CARDLOT
Notes: INSERTED FOR SITE PROFILE DATED 2003-02-03(described on Site
Profile dated 03-02-03)

= =

PARCEL DESCRIPTIONS

Date Added: FEB 03, 2003   Crown Land PIN#:
LTO PID#: 001068857   Crown Land File#:
Land Desc: PARCEL "ONE" DISTRICT LOT 378 GROUP 1 NEW WESTMINSTER DISTRICT
REFERENCE PLAN 68873

= =

CURRENT SITE PROFILE INFORMATION (Sec. III to X)
Site Profile Completion Date: FEB 03, 2003

Local Authority   Received:

Ministry Regional Manager Received: FEB 06, 2003   Decision: APR 22, 2003
Decision: INVESTIGATION REQUIRED

Site Registrar   Received: Entry Date:

III COMMERCIAL AND INDUSTRIAL PURPOSES OR ACTIVITIES ON SITE
Schedule 2
Reference   Description
F5   PETRO. PROD., DISPENSE FACILITY, INC. SERV STA./CARDLOT

AREAS OF POTENTIAL CONCERN
Petroleum, solvent or other polluting substance spills to the environment
greater than 100 litres?...NO
Residue left after removal of piled materials such as chemicals, coal,
ore, smelter slag, air quality control system baghouse dust?............NO
Discarded barrels, drums or tanks?..YES
Contamination resulting from migration of substances from other
properties?..NO

FILL MATERIALS
Fill dirt, soil, gravel, sand or like materials from a contaminated site
or from a source used for any of the activiities listed under Schedule

2?...NO
Discarded or waste granular materials such as sand blasting grit, asphalt
paving or roofing material, spent foundry casting sands, mine ore,
waste rock or float?...NO
Dredged sediments, or sediments and debris materials originating from
locations adjacent to foreshore industrial activities, or municipal
sanitary or stormwater discharges?.....................................NO

WASTE DISPOSAL

Materials such as household garbage, mixed municipal refuse, or demolition
debris?..NO
Waste or byproducts such as tank bottoms, residues, sludge, or
flocculation precipitates from industrial processes or wastewater
treatment?...NO
Waste products from smelting or mining activities, such as smelter slag,
mine tailings, or cull materials from coal processing?.................NO
Waste products from natural gas and oil well drilling activities, such as
drilling fluids and muds?..NO
Waste products from photographic developing or finishing laboratories;
asphalt tar manufacturing; boilers, incinerators or other thermal
facilities (eg. ash); appliance, small equipment or engine repair or
salvage; dry cleaning operations (eg. solvents); or automobile and
truck parts cleaning or repair?..NO

TANKS OR CONTAINERS USED OR STORED
Underground fuel or chemical storage tanks?...............................YES
Above ground fuel or chemical storage tanks?..............................YES

SPECIAL (HAZARDOUS) WASTES OR SUBSTANCES
PCB-containing electrical transformers or capacitors either at grade,
attached above ground to poles, located within buildings, or stored?....NO
Waste asbestos or asbestos containing materials such as pipe wrapping,
blown-in insulation or panelling buried?...............................NO
Paints, solvents, mineral spirits or waste pest control products or pest
control product containers stored in volumes greater than 205 litres?...NO

LEGAL OR REGULATORY ACTIONS OR CONSTRAINTS
Government orders or other notifications pertaining to environmental
conditions or quality of soil, water, groundwater or other
environmental media?...NO
Liens to recover costs, restrictive covenants on land use, or other
charges or encumbrances, stemming from contaminants or wastes remaining
onsite or from other environmental conditions?.........................NO
Government notifications relating to past or recurring environmental
violations at the site or any facility located on the site?............NO

X ADDITIONAL COMMENTS AND EXPLANATIONS

End of Detail Report

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 As of: MAR 13, 2011      BC Online: Site Registry               11-03-17
                For: PB84923  PITEAU ASSOCIATES ENGINEERING      10:38:54
 Folio:                                              Page   1
                         Detail Report
SITE LOCATION
      Site ID:      8993                     Latitude:  49d 16m 26.9s
 Victoria File:                             Longitude: 122d 47m 27.1s
 Regional File: 26250-20/8993
      Region: SURREY, LOWER MAINLAND

 Site Address: 3051 LOUGHEED HIGHWAY
       City: COQUITLAM                    Prov/State: BC
  Postal Code: V3B 1C6

 Registered: MAY 26, 2004  Updated: MAY 02, 2005  Detail Removed: APR 21, 2005

 Notations:   2   Participants:   5    Associated Sites:   0
 Documents:   0 Susp. Land Use:   0 Parcel Descriptions:   1

Location Description: LAT/LONG CONIRMED USING GOAT BY MINISTRY STAFF

Record Status: ACTIVE - UNDER REMEDIATION
 Fee category: UNRANKED

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NOTATIONS

  Notation Type: NOTIFICATION RECEIVED ABOUT LIKELY OR ACTUAL SUBSTANCE
              MIGRATION TO NEIGHBOURING SITE
 Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
     Initiated: MAR 11, 2005                    Approved: MAR 11, 2005

 Ministry Contact: DUNDAS, KERRI (SURREY) L

 Notation Participants                          Notation Roles
 MORROW ENVIRONMENTAL CONSULTANTS INC (BURNABY       RECEIVED BY
 (COMMERCE COURT))
 DUNDAS, KERRI (SURREY) L                        RECEIVED BY
 SHELL CANADA PRODUCTS LIMITED (CALGARY)           ISSUED BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: NOTICE OF INDEPENDENT REMEDIATION INITIATION SUBMITTED (WMA
              28(2))
 Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
     Initiated: MAR 12, 2004                    Approved:

 Ministry Contact: SMITH, ASHLEY (SURREY) N

 Notation Participants                          Notation Roles
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 MORROW ENVIRONMENTAL CONSULTANTS INC (BURNABY       SUBMITTED BY
 (COMMERCE COURT))
 SHELL CANADA PRODUCTS LIMITED (CALGARY)           REFERRED BY
 CITY OF COQUITLAM                               RECEIVED BY

 Note: MAY 20, 2004 - SHELL INTENDS TO UPGRADE THE FACILITY SOMETIME IN 2004.

 Required Actions: AWAITING SITE PROFILE SUBMISSION.




 As of: MAR 13, 2011      BC Online: Site Registry               11-03-17
                For: PB84923  PITEAU ASSOCIATES ENGINEERING      10:38:54
 Folio:                                              Page   2
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
SITE PARTICIPANTS

   Participant: CITY OF COQUITLAM
      Role(s): MUNICIPAL/REGIONAL CONTACT
    Start Date: MAR 12, 2004                   End Date:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   Participant: DUNDAS, KERRI (SURREY) L
      Role(s): ALTERNATE MINISTRY CONTACT
    Start Date: MAR 11, 2005                   End Date:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   Participant: MORROW ENVIRONMENTAL CONSULTANTS INC (BURNABY (COMMERCE
              COURT))
      Role(s): ENVIRONMENTAL CONSULTANT/CONTRACTOR
    Start Date: MAR 12, 2004                   End Date:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   Participant: SHELL CANADA PRODUCTS LIMITED (CALGARY)
      Role(s): PROPERTY OWNER
    Start Date: MAR 12, 2004                   End Date:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   Participant: SMITH, ASHLEY (SURREY) N
      Role(s): MAIN MINISTRY CONTACT
    Start Date: MAR 12, 2004                   End Date:
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
PARCEL DESCRIPTIONS

  Date Added: NOV 03, 1995                 Crown Land PIN#:
    LTO PID#: 002403536                  Crown Land File#:
   Land Desc: PARCEL "ONE" DISTRICT LOT 381 GROUP 1 NEW WESTMINSTER DISTRICT
             REFERENCE PLAN 60219
No activities were reported for this site

                       End of Detail Report
```

```
                     Detail Report
SITE LOCATION
     Site ID:      9337                      Latitude:  49d 16m 20.6s
 Victoria File: 26250-20/9337                    Longitude: 122d 47m 17.5s
 Regional File:
      Region: SURREY, LOWER MAINLAND

 Site Address: 2710 LOUGHEED HIGHWAY
       City: PORT COQUITLAM               Prov/State: BC
  Postal Code: V3B 6P2

 Registered: MAR 18, 2005  Updated:            Detail Removed:

 Notations:   4   Participants:   3    Associated Sites:   0
 Documents:   0 Susp. Land Use:   1 Parcel Descriptions:   1

Location Description: SITE CREATED BY SITE PROFILE, ENTERED 2005-03-02

Record Status: INACTIVE - NO FURTHER ACTION
 Fee category: NOT APPLICABLE

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NOTATIONS

  Notation Type: SITE PROFILE - NO FURTHER INVESTIGATION REQUIRED BY THE
             MINISTRY
 Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
     Initiated: MAR 02, 2005                     Approved:

 Ministry Contact: WARD, JOHN E H
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE REVIEWED - NO FURTHER INVESTIGATION REQUIRED BY
             THE MINISTRY
 Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
     Initiated: MAR 02, 2005                     Approved:

 Ministry Contact: WARD, JOHN E H
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE RECEIVED
 Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
     Initiated: FEB 28, 2005                    Approved:

 Ministry Contact: WARD, JOHN E H

 Notation Participants                        Notation Roles
```

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 TECK CONSTRUCTION LTD (LANGLEY)                  SITE PROFILE SUBMITTED
                                             BY
 TECK CONSTRUCTION LTD (LANGLEY)                  SITE PROFILE SUBMITTED
                                             BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE RECEIVED
 Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
     Initiated: FEB 28, 2005                    Approved:
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NOTATIONS


 Ministry Contact: WARD, JOHN E H

 Notation Participants                        Notation Roles
 TECK CONSTRUCTION LTD (LANGLEY)                  SITE PROFILE SUBMITTED
                                             BY
 TECK CONSTRUCTION LTD (LANGLEY)                  SITE PROFILE SUBMITTED
                                             BY
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
SITE PARTICIPANTS

   Participant: TECK CONSTRUCTION LTD (LANGLEY)
     Role(s): SITE PROFILE COMPLETOR
            SITE PROFILE CONTACT
    Start Date: FEB 28, 2005                     End Date:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   Participant: WARD, JOHN E H
     Role(s): MAIN MINISTRY CONTACT
    Start Date: FEB 28, 2005                     End Date:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   Participant: WHITE SPOT SERVICES LTD
     Role(s): PROPERTY OWNER
    Start Date: FEB 28, 2005                     End Date:
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SUSPECTED LAND USE

 Description: AUTO/TRUCK/BUS/SUBWAY/OTHER VEHICLE REPAIR/SALVAGE/WRECKING
     Notes: INSERTED FOR SITE PROFILE DATED 2005-01-31(described on Site
          Profile dated 05-01-31)
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
PARCEL DESCRIPTIONS
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Date Added: JAN 31, 2005 Crown Land PIN#:
LTO PID#: 009665196 Crown Land File#:
Land Desc: PARCEL 3 DISTRICT LOT 380 GROUP 1 NEW WESTMINSTER DISTRICT
REFERENCE PLAN 76534
= =

CURRENT SITE PROFILE INFORMATION (Sec. III to X)
Site Profile Completion Date: JAN 31, 2005

Local Authority Received:

Ministry Regional Manager Received: Decision: MAR 02, 2005
Decision: INVESTIGATION NOT REQUIRED

Site Registrar Received: FEB 28, 2005 Entry Date: MAR 02, 2005

III COMMERCIAL AND INDUSTRIAL PURPOSES OR ACTIVITIES ON SITE
Schedule 2

Reference	Description
G2	AUTO/TRUCK/BUS/SUBWAY/OTHER VEHICLE REPAIR/SALVAGE/WRECKING

AREAS OF POTENTIAL CONCERN
Petroleum, solvent or other polluting substance spills to the environment greater than 100 litres?...NO
Residue left after removal of piled materials such as chemicals, coal, ore, smelter slag, air quality control system baghouse dust?............NO
Discarded barrels, drums or tanks?...NO
Contamination resulting from migration of substances from other properties?..NO

FILL MATERIALS
Fill dirt, soil, gravel, sand or like materials from a contaminated site or from a source used for any of the activiities listed under Schedule 2?...NO
Discarded or waste granular materials such as sand blasting grit, asphalt paving or roofing material, spent foundry casting sands, mine ore, waste rock or float?...NO
Dredged sediments, or sediments and debris materials originating from locations adjacent to foreshore industrial activities, or municipal sanitary or stormwater discharges?......................................NO

WASTE DISPOSAL
Materials such as household garbage, mixed municipal refuse, or demolition debris?..NO
Waste or byproducts such as tank bottoms, residues, sludge, or flocculation precipitates from industrial processes or wastewater treatment?...NO
Waste products from smelting or mining activities, such as smelter slag, mine tailings, or cull materials from coal processing?..................NO
Waste products from natural gas and oil well drilling activities, such as drilling fluids and muds?..NO
Waste products from photographic developing or finishing laboratories; asphalt tar manufacturing; boilers, incinerators or other thermal facilities (eg. ash); appliance, small equipment or engine repair or salvage; dry cleaning operations (eg. solvents); or automobile and truck parts cleaning or repair?..NO

TANKS OR CONTAINERS USED OR STORED
Underground fuel or chemical storage tanks?................................NO
Above ground fuel or chemical storage tanks?...............................NO

SPECIAL (HAZARDOUS) WASTES OR SUBSTANCES
PCB-containing electrical transformers or capacitors either at grade, attached above ground to poles, located within buildings, or stored?....NO
Waste asbestos or asbestos containing materials such as pipe wrapping, blown-in insulation or panelling buried?................................NO
Paints, solvents, mineral spirits or waste pest control products or pest control product containers stored in volumes greater than 205 litres?...NO

LEGAL OR REGULATORY ACTIONS OR CONSTRAINTS
Government orders or other notifications pertaining to environmental conditions or quality of soil, water, groundwater or other environmental media?...NO

Liens to recover costs, restrictive covenants on land use, or other charges or encumbrances, stemming from contaminants or wastes remaining onsite or from other environmental conditions?..........................NO
Government notifications relating to past or recurring environmental violations at the site or any facility located on the site?.............NO

X ADDITIONAL COMMENTS AND EXPLANATIONS

End of Detail Report

```
 As of: MAR 13, 2011       BC Online: Site Registry                  11-03-17
                 For: PB84923  PITEAU ASSOCIATES ENGINEERING      10:37:08
 Folio:                                                Page   1
                           Detail Report
SITE LOCATION
      Site ID:       9352                         Latitude:  49d 16m 39.1s
 Victoria File:                                 Longitude: 122d 47m 23.9s
 Regional File: 26250-20/9352
       Region: SURREY, LOWER MAINLAND

 Site Address: 3646 WESTWOOD STREET
        City: PORT COQUITLAM                Prov/State: BC
  Postal Code:

 Registered: MAR 24, 2005  Updated: APR 12, 2005  Detail Removed: APR 05, 2005

 Notations:   4   Participants:   3    Associated Sites:   0
 Documents:   0 Susp. Land Use:   2 Parcel Descriptions:   1

Location Description: LAT/LONG CONFIRMED ON GOAT

Record Status: ACTIVE - UNDER ASSESSMENT
 Fee category: NOT APPLICABLE

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NOTATIONS

  Notation Type: SITE PROFILE REVIEWED - FURTHER INVESTIGATION REQUIRED BY THE
              MINISTRY
 Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
     Initiated: MAR 30, 2005                     Approved:

 Ministry Contact: HANEMAYER, VINCENT (SURREY) C

 Note: PRELIMINARY SITE INVESTIGATION REQUIRED
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE - FURTHER INVESTIGATION REQUIRED BY THE MINISTRY
 Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
     Initiated: MAR 30, 2005                     Approved:

 Ministry Contact: HANEMAYER, VINCENT (SURREY) C

 Note: PRELIMINARY SITE INVESTIGATION REQUIRED
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE RECEIVED
 Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
     Initiated: MAR 21, 2005                     Approved:
```

```
 Ministry Contact: HANEMAYER, VINCENT (SURREY) C

 Notation Participants                        Notation Roles
 SY TRADING CORP.                                   SITE PROFILE SUBMITTED
                                          BY
 SY TRADING CORP.                                   SITE PROFILE SUBMITTED
                                          BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
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 As of: MAR 13, 2011       BC Online: Site Registry                  11-03-17
                 For: PB84923  PITEAU ASSOCIATES ENGINEERING      10:37:08
 Folio:                                                Page   2
NOTATIONS

  Notation Type: SITE PROFILE RECEIVED
 Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
     Initiated: MAR 21, 2005                     Approved:

 Ministry Contact: HANEMAYER, VINCENT (SURREY) C

 Notation Participants                        Notation Roles
 SY TRADING CORP.                                   SITE PROFILE SUBMITTED
                                          BY
 SY TRADING CORP.                                   SITE PROFILE SUBMITTED
                                          BY
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SITE PARTICIPANTS

   Participant: HANEMAYER, VINCENT (SURREY) C
      Role(s): MAIN MINISTRY CONTACT
    Start Date: MAR 21, 2005                        End Date:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   Participant: LEE, NORMAN L M
      Role(s): ALTERNATE MINISTRY CONTACT
    Start Date: FEB 03, 2005                      End Date: MAR 31, 2005
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   Participant: SY TRADING CORP.
      Role(s): PROPERTY OWNER
             SITE PROFILE COMPLETOR
             SITE PROFILE CONTACT
    Start Date: MAR 21, 2005                        End Date:
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
SUSPECTED LAND USE

 Description: CONST. DEMO. MATERIAL INCL. CONCRETE AND ASHPALT, LANDFILLIN
```

Notes: INSERTED FOR SITE PROFILE DATED 2005-02-03(described on Site
Profile dated 05-02-03)
- -
Description: HAZARDOUS WASTE STORAGE, TREATMENT, DISPOSAL
Notes: INSERTED FOR SITE PROFILE DATED 2005-02-03(described on Site
Profile dated 05-02-03)
= =
PARCEL DESCRIPTIONS

Date Added: FEB 03, 2005 Crown Land PIN#:
LTO PID#: 024256358 Crown Land File#:
Land Desc: LOT A EXCEPT: PART DEDICATED ROAD ON PLAN LMP46442; DISTRICT LOT
4 GROUP 1 TOWNSHIP 39 NEW WESTMINSTER DISTRICT PLAN
LMP39378
= =
CURRENT SITE PROFILE INFORMATION (Sec. III to X)
Site Profile Completion Date: FEB 03, 2005

Local Authority Received: FEB 03, 2005

Ministry Regional Manager Received: MAR 21, 2005 Decision: MAR 30, 2005
Decision: INVESTIGATION REQUIRED

Site Registrar Received: FEB 03, 2005 Entry Date: MAR 21, 2005

III COMMERCIAL AND INDUSTRIAL PURPOSES OR ACTIVITIES ON SITE
Schedule 2

Reference	Description
H20	HAZARDOUS WASTE STORAGE, TREATMENT, DISPOSAL
H6	CONST. DEMO. MATERIAL INCL. CONCRETE AND ASHPALT, LANDFILLIN

AREAS OF POTENTIAL CONCERN
Petroleum, solvent or other polluting substance spills to the environment
greater than 100 litres?..NO
Residue left after removal of piled materials such as chemicals, coal,
ore, smelter slag, air quality control system baghouse dust?............NO
Discarded barrels, drums or tanks?...NO
Contamination resulting from migration of substances from other
properties?..YES

FILL MATERIALS

Fill dirt, soil, gravel, sand or like materials from a contaminated site
or from a source used for any of the activiities listed under Schedule
2?...YES
Discarded or waste granular materials such as sand blasting grit, asphalt
paving or roofing material, spent foundry casting sands, mine ore,
waste rock or float?...YES
Dredged sediments, or sediments and debris materials originating from
locations adjacent to foreshore industrial activities, or municipal
sanitary or stormwater discharges?.....................................NO

WASTE DISPOSAL
Materials such as household garbage, mixed municipal refuse, or demolition
debris?..YES
Waste or byproducts such as tank bottoms, residues, sludge, or
flocculation precipitates from industrial processes or wastewater
treatment?...NO
Waste products from smelting or mining activities, such as smelter slag,
mine tailings, or cull materials from coal processing?..................NO
Waste products from natural gas and oil well drilling activities, such as
drilling fluids and muds?..NO
Waste products from photographic developing or finishing laboratories;
asphalt tar manufacturing; boilers, incinerators or other thermal
facilities (eg. ash); appliance, small equipment or engine repair or
salvage; dry cleaning operations (eg. solvents); or automobile and
truck parts cleaning or repair?..NO

TANKS OR CONTAINERS USED OR STORED
Underground fuel or chemical storage tanks?................................NO
Above ground fuel or chemical storage tanks?...............................NO

SPECIAL (HAZARDOUS) WASTES OR SUBSTANCES
PCB-containing electrical transformers or capacitors either at grade,

attached above ground to poles, located within buildings, or stored?....NO
Waste asbestos or asbestos containing materials such as pipe wrapping,
blown-in insulation or panelling buried?...............................YES
Paints, solvents, mineral spirits or waste pest control products or pest
control product containers stored in volumes greater than 205 litres?...NO

LEGAL OR REGULATORY ACTIONS OR CONSTRAINTS
Government orders or other notifications pertaining to environmental
conditions or quality of soil, water, groundwater or other

environmental media?..NO
Liens to recover costs, restrictive covenants on land use, or other charges or encumbrances, stemming from contaminants or wastes remaining onsite or from other environmental conditions?..........................NO
Government notifications relating to past or recurring environmental violations at the site or any facility located on the site?............NO

X ADDITIONAL COMMENTS AND EXPLANATIONS

End of Detail Report

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 As of: MAR 13, 2011       BC Online: Site Registry                  11-03-17
                  For: PB84923  PITEAU ASSOCIATES ENGINEERING       10:41:03
 Folio:                                                 Page   1
                             Detail Report
SITE LOCATION
      Site ID:      10386                        Latitude:  49d 16m 17.1s
 Victoria File: 26250-20/10386                     Longitude: 122d 47m 05.4s
 Regional File:
       Region: SURREY, LOWER MAINLAND

 Site Address: 2567 LOUGHEED HIGHWAY
        City: PORT COQUITLAM                Prov/State: BC
  Postal Code: V3B 1B4

 Registered: MAY 17, 2007  Updated:             Detail Removed:

 Notations:   4   Participants:   2    Associated Sites:   0
 Documents:   0 Susp. Land Use:   1 Parcel Descriptions:   2

Location Description: SITE CREATED BY SITE PROFILE, ENTERED 2007-05-03

Record Status: INACTIVE - NO FURTHER ACTION
 Fee category: UNRANKED

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NOTATIONS

  Notation Type: SITE PROFILE REVIEWED - NO FURTHER INVESTIGATION REQUIRED BY
                THE MINISTRY
 Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
     Initiated: MAY 01, 2007                      Approved:

 Ministry Contact: WARD, JOHN E H
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE - NO FURTHER INVESTIGATION REQUIRED BY THE
                MINISTRY
 Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
     Initiated: MAY 01, 2007                      Approved:

 Ministry Contact: WARD, JOHN E H
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE RECEIVED
 Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
     Initiated: APR 19, 2007                      Approved:

 Ministry Contact: WARD, JOHN E H

 Notation Participants                            Notation Roles
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 HARCUS HOLDINGS LIMITED                         SITE PROFILE SUBMITTED
                                            BY
 HARCUS HOLDINGS LIMITED                         SITE PROFILE SUBMITTED
                                            BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE RECEIVED
 Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
     Initiated: APR 19, 2007                      Approved:




 As of: MAR 13, 2011       BC Online: Site Registry                  11-03-17
                  For: PB84923  PITEAU ASSOCIATES ENGINEERING       10:41:03
 Folio:                                                 Page   2
NOTATIONS


 Ministry Contact: WARD, JOHN E H

 Notation Participants                            Notation Roles
 HARCUS HOLDINGS LIMITED                         SITE PROFILE SUBMITTED
                                            BY
 HARCUS HOLDINGS LIMITED                         SITE PROFILE SUBMITTED
                                            BY
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SITE PARTICIPANTS

   Participant: HARCUS HOLDINGS LIMITED
      Role(s): PROPERTY OWNER
               SITE PROFILE COMPLETOR
               SITE PROFILE CONTACT
    Start Date: APR 19, 2007                       End Date:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   Participant: WARD, JOHN E H
      Role(s): MAIN MINISTRY CONTACT
    Start Date: APR 19, 2007                       End Date:
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
SUSPECTED LAND USE

 Description: APPLIANCE/EQUIP OR ENGINE REPAIR/RECONDITION/CLEANING/SALVAG
      Notes: INSERTED FOR SITE PROFILE DATED 2007-04-12(described on Site
           Profile dated 07-04-12)
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
PARCEL DESCRIPTIONS

  Date Added: APR 12, 2007                   Crown Land PIN#:
   LTO PID#: 006532039                    Crown Land File#:
```

Land Desc: LOT 77 DISTRICT LOT 380 GROUP 1 NEW WESTMINSTER DISTRICT PLAN
30436
- -
Date Added: APR 09, 2009 Crown Land PIN#:
LTO PID#: 027867706 Crown Land File#:
Land Desc: LOT 1 DISTRICT LOT 380 GROUP 1 NEW WESTMINSTER DISTRICT PLAN
BCP40307
= =
CURRENT SITE PROFILE INFORMATION (Sec. III to X)
Site Profile Completion Date: APR 12, 2007

Local Authority Received: APR 12, 2007

Ministry Regional Manager Received: Decision: MAY 01, 2007
Decision: INVESTIGATION NOT REQUIRED

Site Registrar Received: APR 19, 2007 Entry Date: MAY 01, 2007

III COMMERCIAL AND INDUSTRIAL PURPOSES OR ACTIVITIES ON SITE
Schedule 2

Reference	Description
E1	APPLIANCE/EQUIP OR ENGINE REPAIR/RECONDITION/CLEANING/SALVAG

AREAS OF POTENTIAL CONCERN
Petroleum, solvent or other polluting substance spills to the environment
greater than 100 litres?...NO
Residue left after removal of piled materials such as chemicals, coal,
ore, smelter slag, air quality control system baghouse dust?............NO
Discarded barrels, drums or tanks?..NO
Contamination resulting from migration of substances from other
properties?..NO

FILL MATERIALS
Fill dirt, soil, gravel, sand or like materials from a contaminated site
or from a source used for any of the activiities listed under Schedule
2?...NO
Discarded or waste granular materials such as sand blasting grit, asphalt
paving or roofing material, spent foundry casting sands, mine ore,
waste rock or float?...NO

Dredged sediments, or sediments and debris materials originating from
locations adjacent to foreshore industrial activities, or municipal
sanitary or stormwater discharges?.....................................NO

WASTE DISPOSAL
Materials such as household garbage, mixed municipal refuse, or demolition
debris?..NO
Waste or byproducts such as tank bottoms, residues, sludge, or
flocculation precipitates from industrial processes or wastewater
treatment?..NO
Waste products from smelting or mining activities, such as smelter slag,
mine tailings, or cull materials from coal processing?.................NO
Waste products from natural gas and oil well drilling activities, such as
drilling fluids and muds?..NO
Waste products from photographic developing or finishing laboratories;
asphalt tar manufacturing; boilers, incinerators or other thermal
facilities (eg. ash); appliance, small equipment or engine repair or
salvage; dry cleaning operations (eg. solvents); or automobile and
truck parts cleaning or repair?..NO

TANKS OR CONTAINERS USED OR STORED
Underground fuel or chemical storage tanks?...............................NO
Above ground fuel or chemical storage tanks?..............................NO

SPECIAL (HAZARDOUS) WASTES OR SUBSTANCES
PCB-containing electrical transformers or capacitors either at grade,
attached above ground to poles, located within buildings, or stored?....NO
Waste asbestos or asbestos containing materials such as pipe wrapping,
blown-in insulation or panelling buried?...............................NO
Paints, solvents, mineral spirits or waste pest control products or pest
control product containers stored in volumes greater than 205 litres?...NO

LEGAL OR REGULATORY ACTIONS OR CONSTRAINTS
Government orders or other notifications pertaining to environmental
conditions or quality of soil, water, groundwater or other
environmental media?...NO
Liens to recover costs, restrictive covenants on land use, or other
charges or encumbrances, stemming from contaminants or wastes remaining
onsite or from other environmental conditions?..........................NO
Government notifications relating to past or recurring environmental
violations at the site or any facility located on the site?............NO

X ADDITIONAL COMMENTS AND EXPLANATIONS

End of Detail Report

Detail Report

SITE LOCATION
Site ID: 10636 Latitude: 49d 16m 32.9s
Victoria File: Longitude: 122d 47m 25.3s
Regional File: 26250-20/10636
Region: SURREY, LOWER MAINLAND

Site Address: 3540 WESTWOOD STREET
City: PORT COQUITLAM Prov/State: BC
Postal Code: V3B 4S8

Registered: OCT 26, 2007 Updated: JAN 13, 2009 Detail Removed: MAY 06, 2008

Notations: 6 Participants: 7 Associated Sites: 0
Documents: 3 Susp. Land Use: 2 Parcel Descriptions: 1

Location Description: SITE CREATED BY SITE PROFILE, ENTERED 2007-10-19

Record Status: INACTIVE - NO FURTHER ACTION
Fee category: NOT APPLICABLE

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NOTATIONS

Notation Type: FINAL DETERMINATION OF CONTAMINATED SITE ISSUED - SITE NOT CONTAMINATED
Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
Initiated: APR 14, 2008 Approved: APR 14, 2008

Ministry Contact: LOCKHART, DAVE

Notation Participants	Notation Roles
SHELL CANADA PRODUCTS LIMITED (CALGARY)	RECEIVED BY
WALTON, DOUG G	ISSUED BY
NEWTON, DAVE	APPROVED PROFESSIONAL

Note: ISSUED ON THE RECOMMENDATION OF AN APPROVED PROFESSIONAL (DAVID NEWTON) UNDER PROTOCOL 6 OF THE CONTAMINATED SITES REGULATION FOR A PORTION OF PID: 011-200-839

- -

Notation Type: PRELIMINARY DETERMINATION OF CONTAMINATED SITE ISSUED - SITE NOT CONTAMINATED
Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
Initiated: FEB 18, 2008 Approved: FEB 18, 2008

Ministry Contact: LOCKHART, DAVE

Notation Participants	Notation Roles
SHELL CANADA PRODUCTS LIMITED (CALGARY)	RECEIVED BY
WALTON, DOUG G	ISSUED BY
NEWTON, DAVE	APPROVED PROFESSIONAL

Note: ISSUED ON THE RECOMMENDATION OF AN APPROVED PROFESSIONAL (DAVID NEWTON)

NOTATIONS

UNDER PROTOCOL 6 OF THE CONTAMINATED SITES REGULATION FOR A PORTION OF PID: 011-200-839 THIS NOTICE WAS GIVEN FOR A PORTION OF BLOCK E EXCEPT: PART SUBDIVIDED BY PLAN 23560, DISTRICT LOT 4, TOWNSHIP 39, PLAN 6866 NEW WESTMINSTER DISTRICT AND A PORTION OF PID: 011-200-839

- -

Notation Type: SITE PROFILE REVIEWED - FURTHER INVESTIGATION REQUIRED BY THE MINISTRY
Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
Initiated: OCT 24, 2007 Approved:

Ministry Contact: HANEMAYER, VINCENT (SURREY) C

Note: RELEASE OF THE DEMOLITION PERMIT GRANTED BECAUSE IN THE OPINION OF THE DIRECTOR THE RELEASE WOULD NOT POSE SIGNIFICANT THREAT OR RISK.

Required Actions: PRELIMINARY SITE INVESTIGATION.

- -

Notation Type: SITE PROFILE - FURTHER INVESTIGATION REQUIRED BY THE MINISTRY
Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
Initiated: OCT 24, 2007 Approved:

Ministry Contact: HANEMAYER, VINCENT (SURREY) C

Note: RELEASE OF THE DEMOLITION PERMIT GRANTED BECAUSE IN THE OPINION OF THE DIRECTOR THE RELEASE WOULD NOT POSE SIGNIFICANT THREAT OR RISK.

Required Actions: PRELIMINARY SITE INVESTIGATION.

- -

Notation Type: SITE PROFILE RECEIVED
Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
Initiated: OCT 05, 2007 Approved:

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Ministry Contact: HANEMAYER, VINCENT (SURREY) C

Notation Participants                Notation Roles
SNC LAVALIN ENVIRONMENTAL INC.                SITE PROFILE SUBMITTED
                                   BY
SNC LAVALIN ENVIRONMENTAL INC.                SITE PROFILE SUBMITTED
                                   BY
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Notation Type: SITE PROFILE RECEIVED
Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
    Initiated: OCT 05, 2007              Approved:

Ministry Contact: HANEMAYER, VINCENT (SURREY) C

Notation Participants                Notation Roles
SNC LAVALIN ENVIRONMENTAL INC.                SITE PROFILE SUBMITTED
                                   BY
SNC LAVALIN ENVIRONMENTAL INC.                SITE PROFILE SUBMITTED
                                   BY
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SITE PARTICIPANTS

  Participant: CARONEL ENTERPRISES LTD
      Role(s): PROPERTY OWNER
   Start Date: OCT 05, 2007              End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: HANEMAYER, VINCENT (SURREY) C
      Role(s): MAIN MINISTRY CONTACT
   Start Date: OCT 05, 2007              End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: LOCKHART, DAVE
      Role(s): ALTERNATE MINISTRY CONTACT
   Start Date: FEB 18, 2008              End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: NEWTON, DAVE
      Role(s): ENVIRONMENTAL CONSULTANT/CONTRACTOR
   Start Date: JAN 25, 2008              End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: SHELL CANADA PRODUCTS LIMITED (CALGARY)
      Role(s): SITE PROFILE CONTACT
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   Start Date: OCT 05, 2007              End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: SNC LAVALIN ENVIRONMENTAL INC.
      Role(s): SITE PROFILE COMPLETOR
   Start Date: SEP 12, 2007              End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: WALTON, DOUG G
      Role(s): ALTERNATE MINISTRY CONTACT
   Start Date: FEB 18, 2008              End Date:
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DOCUMENTS

Title: SUMMARY OF SITE CONDITION
       Authored: JAN 25, 2008          Submitted: JAN 25, 2008
Participants                         Role
NEWTON, DAVE                               AUTHOR
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Title: STAGE 2 PRELIMINARY SITE INVESTIGATION AND DECOMMISSIONING
       ACTIVITIES, FORMER SHELL SERVICE STATION AT 3540 WESTWOOD STREET,
       PORT COQUITLAM, BC, LOCAT
       Authored: JAN 25, 2008          Submitted: JAN 25, 2008
Participants                         Role
SNC LAVALIN ENVIRONMENTAL INC.                AUTHOR
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Title:  STAGE 1 PRELIMINARY SITE INVESTIGATION, FORMER SHELL SERVICE STATION
       AT 3540 WESTWOOD STREET, PORT COQUITLAM, BC, LOCATION CODE: C44243
       Authored: SEP 12, 2007          Submitted: SEP 12, 2007
Participants                         Role
SNC LAVALIN ENVIRONMENTAL INC.                AUTHOR
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SUSPECTED LAND USE

Description: PETRO. PROD., /PRODUCE WATER STRG ABVEGRND/UNDERGRND TANK
      Notes: INSERTED FOR SITE PROFILE DATED 2007-09-19(described on Site
             Profile dated 07-09-19)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Description: PETRO. PROD., DISPENSE FACILITY, INC. SERV STA./CARDLOT
      Notes: INSERTED FOR SITE PROFILE DATED 2007-09-19(described on Site
             Profile dated 07-09-19)
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PARCEL DESCRIPTIONS

Date Added: SEP 19, 2007 Crown Land PIN#:
LTO PID#: 011200839 Crown Land File#:
Land Desc: BLOCK "E" EXCEPT: PART SUBDIVIDED BY PLAN 23560,
DISTRICT LOT 4 TOWNSHIP 39 NEW WESTMINSTER DISTRICT
PLAN 6866

= =

CURRENT SITE PROFILE INFORMATION (Sec. III to X)
Site Profile Completion Date: SEP 19, 2007

Local Authority Received: SEP 19, 2007

Ministry Regional Manager Received: OCT 05, 2007 Decision: OCT 24, 2007
Decision: INVESTIGATION REQUIRED

Site Registrar Received: Entry Date:

III COMMERCIAL AND INDUSTRIAL PURPOSES OR ACTIVITIES ON SITE
Schedule 2

Reference	Description
F5	PETRO. PROD., DISPENSE FACILITY, INC. SERV STA./CARDLOT
F7	PETRO. PROD., /PRODUCE WATER STRG ABVEGRND/UNDERGRND TANK

AREAS OF POTENTIAL CONCERN
Petroleum, solvent or other polluting substance spills to the environment greater than 100 litres?...NO
Residue left after removal of piled materials such as chemicals, coal, ore, smelter slag, air quality control system baghouse dust?............NO
Discarded barrels, drums or tanks?..NO
Contamination resulting from migration of substances from other properties?..NO

FILL MATERIALS
Fill dirt, soil, gravel, sand or like materials from a contaminated site or from a source used for any of the activiities listed under Schedule 2?...NO
Discarded or waste granular materials such as sand blasting grit, asphalt paving or roofing material, spent foundry casting sands, mine ore, waste rock or float?...NO
Dredged sediments, or sediments and debris materials originating from locations adjacent to foreshore industrial activities, or municipal sanitary or stormwater discharges?.....................................NO

WASTE DISPOSAL
Materials such as household garbage, mixed municipal refuse, or demolition debris?..NO
Waste or byproducts such as tank bottoms, residues, sludge, or flocculation precipitates from industrial processes or wastewater treatment?..NO
Waste products from smelting or mining activities, such as smelter slag, mine tailings, or cull materials from coal processing?.................NO
Waste products from natural gas and oil well drilling activities, such as drilling fluids and muds?..NO
Waste products from photographic developing or finishing laboratories; asphalt tar manufacturing; boilers, incinerators or other thermal facilities (eg. ash); appliance, small equipment or engine repair or salvage; dry cleaning operations (eg. solvents); or automobile and truck parts cleaning or repair?..NO

TANKS OR CONTAINERS USED OR STORED
Underground fuel or chemical storage tanks?................................YES
Above ground fuel or chemical storage tanks?..............................NO

SPECIAL (HAZARDOUS) WASTES OR SUBSTANCES
PCB-containing electrical transformers or capacitors either at grade, attached above ground to poles, located within buildings, or stored?....NO
Waste asbestos or asbestos containing materials such as pipe wrapping, blown-in insulation or panelling buried?...............................NO
Paints, solvents, mineral spirits or waste pest control products or pest control product containers stored in volumes greater than 205 litres?...NO

LEGAL OR REGULATORY ACTIONS OR CONSTRAINTS
Government orders or other notifications pertaining to environmental conditions or quality of soil, water, groundwater or other environmental media?..NO
Liens to recover costs, restrictive covenants on land use, or other charges or encumbrances, stemming from contaminants or wastes remaining onsite or from other environmental conditions?.........................NO
Government notifications relating to past or recurring environmental violations at the site or any facility located on the site?............NO

X ADDITIONAL COMMENTS AND EXPLANATIONS

End of Detail Report

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                    Detail Report
SITE LOCATION
     Site ID:     10830                     Latitude:  49d 15m 53.5s
Victoria File: 26250-20/10830                Longitude: 122d 47m 22.8s
Regional File:
      Region: SURREY, LOWER MAINLAND

Site Address: 2660 KINGSWAY AVENUE
       City: PORT COQUITLAM              Prov/State: BC
 Postal Code: V3C 1T8

Registered: APR 04, 2008  Updated: MAY 30, 2008  Detail Removed: MAY 26, 2008

Notations:   3   Participants:   7    Associated Sites:   0
Documents:   5 Susp. Land Use:   0 Parcel Descriptions:   1

Location Description: LAT AND LONG COORDINATES FROM (2008-03-14) NOTICE OF
INDEPENDENT REMEDIATION

Record Status: INACTIVE - REMEDIATION COMPLETE
Fee category: UNRANKED

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NOTATIONS

 Notation Type: CERTIFICATE OF COMPLIANCE ISSUED USING NUMERICAL STANDARDS
Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
    Initiated: MAY 05, 2008                  Approved: MAY 05, 2008

Ministry Contact: LOCKHART, DAVE

Notation Participants                    Notation Roles
BURDETT, RANDY                                RECEIVED BY
WALTON, DOUG G                                ISSUED BY
JOCHEMS, CHUCK                                APPROVED PROFESSIONAL

Note: ISSUED ON THE RECOMMENDATION OF AN APPROVED PROFESSIONAL (CHUCK
JOCHEMS) UNDER PROTOCOL 6 OF THE CONTAMINATED SITES REGULATION
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Notation Type: NOTICE OF INDEPENDENT REMEDIATION COMPLETION SUBMITTED
Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
    Initiated: MAR 14, 2008                  Approved: MAR 14, 2008

Ministry Contact: ROSSER, CRAIG L
```

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Notation Participants                    Notation Roles
NEXT ENVIRONMENTAL                                SUBMITTED BY

Note: COMPLETED: 2008-03-05
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Notation Type: NOTICE OF INDEPENDENT REMEDIATION INITIATION SUBMITTED
Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
    Initiated: JAN 21, 2008                 Approved: JAN 21, 2008
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NOTATIONS


Ministry Contact: ROSSER, CRAIG L

Notation Participants                    Notation Roles
NEXT ENVIRONMENTAL                                SUBMITTED BY

Note: STARTED: 2008-01-17
= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
SITE PARTICIPANTS

  Participant: BURDETT, RANDY
     Role(s): PROPERTY OWNER
  Start Date: MAY 05, 2008                  End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: JOCHEMS, CHUCK
     Role(s): ENVIRONMENTAL CONSULTANT/CONTRACTOR
  Start Date: APR 23, 2008                  End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: LOCKHART, DAVE
     Role(s): ALTERNATE MINISTRY CONTACT
  Start Date: MAY 05, 2008                  End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: NEXT ENVIRONMENTAL
     Role(s): ENVIRONMENTAL CONSULTANT/CONTRACTOR
  Start Date: JAN 27, 2006                  End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: ROSSER, CRAIG L
     Role(s): MAIN MINISTRY CONTACT
  Start Date: MAR 14, 2007                  End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Participant: ULTIMATE DEVELOPMENTS LTD.
```

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    Role(s): PROPERTY OWNER
  Start Date: MAR 14, 2008            End Date:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 Participant: WALTON, DOUG G
    Role(s): ALTERNATE MINISTRY CONTACT
  Start Date: MAY 05, 2008            End Date:
= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
DOCUMENTS

Title: Summary of Site Condition, 2660 Kingsway Avenue, Port Coquitlam, BC
        Authored: APR 23, 2008        Submitted: APR 23, 2008
Participants                         Role
JOCHEMS, CHUCK                            AUTHOR
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Title: Confirmation of Remediation Report, 2660 Kingsway Avenue, Port
    Coquitlam, BC
        Authored: APR 07, 2008        Submitted: APR 07, 2008
Participants                         Role
NEXT ENVIRONMENTAL                             AUTHOR
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
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DOCUMENTS

Title: Detailed Site Investigation, 2660 Kingsway Avenue, Port Coquitlam, BC
        Authored: FEB 12, 2008        Submitted: FEB 12, 2008
Participants                         Role
NEXT ENVIRONMENTAL                             AUTHOR
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Title: Environmental Stage 2 Preliminary Site Investigation and Underground
    Storage Tank Removal, 2660 Kingsway Avenue, Port Coquitlam, BC
        Authored: JAN 11, 2008        Submitted: JAN 11, 2008
Participants                         Role
NEXT ENVIRONMENTAL                             AUTHOR
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Title: Environmental Stage 1 Preliminary Site Investigation, 2660 Kingsway
    Avenue, Port Coquitlam, BC
        Authored: JAN 27, 2006        Submitted: JAN 27, 2006
Participants                         Role
NEXT ENVIRONMENTAL                             AUTHOR
= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
PARCEL DESCRIPTIONS
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```
 Date Added: APR 03, 2008             Crown Land PIN#:
  LTO PID#: 009034692               Crown Land File#:
 Land Desc: LOT 10 DISTRICT LOT 379 GROUP 1 NEW WESTMINSTER DISTRICT
        PLAN 10061
No activities were reported for this site

                  End of Detail Report
```

```
              Detail Report
SITE LOCATION
     Site ID:     12157                 Latitude:  49d 16m 13.2s
 Victoria File: 26250-20/12157          Longitude: 122d 46m 57.9s
 Regional File:
      Region: SURREY, LOWER MAINLAND

 Site Address: 2505 LOUGHEED HIGHWAY
       City: PORT COQUITLAM             Prov/State: BC
  Postal Code: V3B 1B2

 Registered: MAR 19, 2010  Updated:        Detail Removed:

 Notations:   4   Participants:   3    Associated Sites:   0
 Documents:   0 Susp. Land Use:   1 Parcel Descriptions:   1

Location Description: SITE CREATED BY SITE PROFILE, ENTERED 2010-03-18

Record Status: INACTIVE - NO FURTHER ACTION
 Fee category: UNRANKED

 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
NOTATIONS

  Notation Type: SITE PROFILE REVIEWED - NO FURTHER INVESTIGATION REQUIRED BY
              THE MINISTRY
 Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
     Initiated: MAR 18, 2010              Approved:

 Ministry Contact: WARD, JOHN E H
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE - NO FURTHER INVESTIGATION REQUIRED BY THE
              MINISTRY
 Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
     Initiated: MAR 18, 2010              Approved:

 Ministry Contact: WARD, JOHN E H
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE RECEIVED
 Notation Class: WASTE MANAGEMENT ACT: CONTAMINATED SITES NOTATIONS
     Initiated: MAR 08, 2010              Approved:

 Ministry Contact: WARD, JOHN E H

 Notation Participants                Notation Roles
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 MPB CONSTRUCTION LTD                    SITE PROFILE SUBMITTED
                                         BY
 MPB CONSTRUCTION LTD                    SITE PROFILE SUBMITTED
                                         BY
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  Notation Type: SITE PROFILE RECEIVED
 Notation Class: ENVIRONMENTAL MANAGEMENT ACT: GENERAL
     Initiated: MAR 08, 2010              Approved:
```

```
NOTATIONS


 Ministry Contact: WARD, JOHN E H

 Notation Participants                Notation Roles
 MPB CONSTRUCTION LTD                    SITE PROFILE SUBMITTED
                                         BY
 MPB CONSTRUCTION LTD                    SITE PROFILE SUBMITTED
                                         BY
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
SITE PARTICIPANTS

   Participant: BOWRON INVESTMENTS LTD
      Role(s): PROPERTY OWNER
    Start Date: FEB 26, 2010              End Date:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   Participant: MPB CONSTRUCTION LTD
      Role(s): SITE PROFILE COMPLETOR
            SITE PROFILE CONTACT
    Start Date: MAR 08, 2010              End Date:
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
   Participant: WARD, JOHN E H
      Role(s): MAIN MINISTRY CONTACT
    Start Date: MAR 08, 2010              End Date:
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
SUSPECTED LAND USE

 Description: AUTO/TRUCK/BUS/SUBWAY/OTHER VEHICLE REPAIR/SALVAGE/WRECKING
      Notes: INSERTED FOR SITE PROFILE DATED 2010-02-26(described on Site
           Profile dated 10-02-26)
 = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
PARCEL DESCRIPTIONS
```

Date Added: FEB 26, 2010 Crown Land PIN#:
LTO PID#: 000914894 Crown Land File#:
Land Desc: ALL THAT PORTION OF LOT 12 DISTRICT LOT 380 GROUP 1 NEW
WESTMINSTER DISTRICT PLAN 1392 LYING NORTH OF HIGHWAY
SHOWN ON PLAN 10030 EXCEPT: PART SHOWN ON SRW PLAN 54908
= =

CURRENT SITE PROFILE INFORMATION (Sec. III to X)
Site Profile Completion Date: FEB 26, 2010

Local Authority Received: MAR 08, 2010

Ministry Regional Manager Received: Decision: MAR 18, 2010
Decision: INVESTIGATION NOT REQUIRED

Site Registrar Received: MAR 08, 2010 Entry Date: MAR 18, 2010

III COMMERCIAL AND INDUSTRIAL PURPOSES OR ACTIVITIES ON SITE
Schedule 2
Reference Description

G2 AUTO/TRUCK/BUS/SUBWAY/OTHER VEHICLE REPAIR/SALVAGE/WRECKING

AREAS OF POTENTIAL CONCERN
Petroleum, solvent or other polluting substance spills to the environment
greater than 100 litres?...NO
Residue left after removal of piled materials such as chemicals, coal,
ore, smelter slag, air quality control system baghouse dust?...........NO
Discarded barrels, drums or tanks?..NO
Contamination resulting from migration of substances from other
properties?...NO

FILL MATERIALS
Fill dirt, soil, gravel, sand or like materials from a contaminated site
or from a source used for any of the activiities listed under Schedule
2?..NO
Discarded or waste granular materials such as sand blasting grit, asphalt
paving or roofing material, spent foundry casting sands, mine ore,
waste rock or float?...NO
Dredged sediments, or sediments and debris materials originating from
locations adjacent to foreshore industrial activities, or municipal
sanitary or stormwater discharges?.....................................NO

WASTE DISPOSAL (QUESTIONS AS OF JANUARY 1 2009)
Materials such as household garbage, mixed municipal refuse, or demolition
debris?...NO
Waste or byproducts such as tank bottoms, residues, sludge, or
flocculation precipitates from industrial processes or wastewater
treatment?..NO
Waste products from smelting or mining activities, such as smelter slag,
mine tailings, or cull materials from coal processing?.................NO
Waste products from natural gas and oil well drilling activities, such as
drilling fluids and muds?..NO
Waste products from photographic developing or finishing laboratories;
asphalt tar manufacturing; boilers, incinerators or other thermal
facilities (eg. ash); appliance, small equipment or engine repair or
salvage; dry cleaning operations (eg. solvents); for from the cleaning
or repair of parts of boats, ships, barges, automobiles or trucks,
including sandblasting grit or paint scrapings?........................NO

TANKS OR CONTAINERS USED OR STORED, OTHER THAN TANKS USED FOR RESIDENTIAL
HEATING FUEL
Underground fuel or chemical storage tanks other than storage tanks for
compressed gases?..NO
Above ground fuel or chemical storage tanks other than storage tanks for
compressed gases?..NO

HAZARDOUS WASTES OR HAZARDOUS SUBSTANCES
PCB-containing electrical transformers or capacitors either at grade,
attached above ground to poles, located within buildings, or stored?....NO
Waste asbestos or asbestos containing materials such as pipe wrapping,
blown-in insulation or panelling buried?................................NO
Paints, solvents, mineral spirits or waste pest control products or pest
control product containers stored in volumes greater than 205 litres?...NO

LEGAL OR REGULATORY ACTIONS OR CONSTRAINTS
Government orders or other notifications pertaining to environmental
conditions or quality of soil, water, groundwater or other
environmental media?...NO
Liens to recover costs, restrictive covenants on land use, or other
charges or encumbrances, stemming from contaminants or wastes remaining
onsite or from other environmental conditions?.........................NO
Government notifications relating to past or recurring environmental

violations at the site or any facility located on the site?.............NO

X ADDITIONAL COMMENTS AND EXPLANATIONS
NO PAST OR PRESENT ISSUES THE SAID PROPERTY HAS BEEN OWNED SINCE 1965 BY BOWRON INVESTMENTS AND HAS BEEN CONTINOUSLY OPERATED AS A FORD DEALERSHIP SINCE THAT DATE THE PROPERTY OWNERS OPERATED THE DEALERSHIP FROM 1965-1998 THE CURRENT DEALER HAS OPERATED IT SINCE THAT DATE (1998) THE PROPERTY OWNERS, THE DEALER AND THE APPLICATN ATTEST THAT THE ABOVE INFORMATION IS ACCURATE TO THE BEST OF THEIR KNOWLEDGE.

End of Detail Report

Appendix C

Environmental Inventory and Assessment

Appendix C
Table of Contents

Table C-1: Bacteriological, Anion, Nutrient, and Metal Concentrations in Water Samples from Maple Creek IWMP Sampling Sites (September 2011)

Sample ID	Units	Detection Limits	OZADA U/S	D/S OF LINCOLN	D/S OF LOUGHEED	FOX CREEK	RAILWAY TRIANGLE U/S	D/S OF KINGSWAY	D/S OF DYKE	BC Approved (A) and Working (W) Water Quality Guidelines	CCME Water Quality Guidelines for the Protection of Aquatic Life
Date Sampled			14-SEP-11	14-SEP-11	14-SEP-11	14-SEP-11	14-SEP-11	14-SEP-11	14-SEP-11	(A - Jan 2010, W - Aug 2006)	(December 2007)
Time Sampled			12:30	12:45	13:00	13:15	13:25	13:45	14:10	BCWQ 2009	CCME 2010
Bacteriological Tests											
Coliform Bacteria - Fecal	MPN/100mL	2	49	79	**>1600**	**540**	**>1600**	33	33	200	
Coliform Bacteria - Total	MPN/100mL	2	>1600	>1600	>1600	>1600	>1600	>1600	>1600		
Anions and Nutrients											
Alkalinity, Total (as CaCO3)	mg/L	2	33.2	66.7	45.8	13.3	41.4	40.8	40.0		
Ammonia as N	mg/L	0.02	0.0054	0.0068	0.0087	<0.0050	0.0131	0.141	0.118	20.0 (at pH 7, T=13.0ºC) (A)	5.74 (at pH 7, T=15.0ºC)
Nitrate (as N)	mg/L	0.005	1.89	0.708	0.855	0.168	0.774	0.181	0.240	31.3 (max); 3.0 (30-d avg) (A)	2.935 (interim)
Orthophosphate-Dissolved as P	mg/L	0.001	0.0014	0.0108	0.0073	0.0010	0.0074	0.0011	<0.0010		
Total Metals											
Aluminum (Al)-Total	mg/L	0.0050	0.0153	0.0140	**0.405**	**0.284**	**0.280**	0.0259	0.0124	5.0 (wildlife water supply) (A)	0.005 @ pH<6.5; 0.1@ pH>6.5
Antimony (Sb)-Total	mg/L	0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.02** (W)	
Arsenic (As)-Total	mg/L	0.00050	<0.00050	0.00052	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.005 (A)	0.005
Barium (Ba)-Total	mg/L	0.020	0.020	<0.020	<0.020	<0.020	<0.020	0.034	0.034	5 (max); 1 (30-d avg) (W)	
Beryllium (Be)-Total	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0053 (chronic criterion) (W)	
Boron (B)-Total	mg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	1.2 (A)	29 (short-term exp.); 1.5 (long-term exp.)
Cadmium (Cd)-Total	mg/L	0.000017	0.000021	<0.000017	**0.000041**	**0.000030**	**0.000022**	<0.000017	<0.000017	(=10 exp (0.86[log{hardness}]-3.2)/1000) (W)	(=(10 exp (0.86[log{hardness}]-3.2)/1000)
Calcium (Ca)-Total	mg/L	0.10	14.7	29.6	21.6	2.54	19.9	16.3	16.0		
Chromium (Cr)-Total	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.001 Cr(VI) (max); 0.0089 Cr(III) (max) (W)	0.001 Cr(VI); 0.0089 Cr(III)
Cobalt (Co)-Total	mg/L	0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	0.00037	<0.00030	0.110 (max); 0.004 (30-d avg) (A)	
Copper (Cu)-Total	mg/L	0.0010	<0.0010	<0.0010	**0.0036**	**0.0056**	**0.0025**	<0.0010	<0.0010	(0.094*(hardness)+2)/1000 (max); 0.002 @ CaCO3 ≤ 50 mg/L, 0.00004 @ CaCO3 > 50 mg/L (30-d avg) (A)	($e^{0.8545[\ln(\text{hardness})]-1.465]}$)*200 (or 0.002)
Iron (Fe)-Total	mg/L	0.030	0.039	<0.030	**0.461**	**0.372**	**0.454**	**1.37**	**0.947**	1.0 (A)	0.3
Lead (Pb)-Total	mg/L	0.00050	<0.00050	<0.00050	**0.00379**	**0.00323**	**0.00254**	<0.00050	<0.00050	0.003 @ CaCO3 ≤ 8 mg/L, ($e^{[1.273 \ln(\text{hardness})-1.460])/1000}$ @ CaCO3 > 8 mg/L (max); (3.31 + e[1.273 ln(hardness)-4.704])/1000 @ CaCO3 > 8 mg/L (30-d avg) (A)	($e^{[1.273 \ln(\text{hardness})-4.705]}$)*1000 (or 0.001)
Lithium (Li)-Total	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.014 (secondary chronic); 0.096 (final chronic); 0.870 (aquatic max) (W)	
Magnesium (Mg)-Total	mg/L	0.10	1.90	4.53	3.38	0.33	3.08	2.14	2.07		
Manganese (Mn)-Total	mg/L	0.00030	0.00363	0.00183	0.0148	0.00514	0.0118	0.0376	0.0306	0.8-1.1 @ CaCO3 = 25-50 mg/L (max); 0.7-0.8 @ CaCO3 = 25-50 mg/L (30-d avg) (A)	
Mercury (Hg)-Total		0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.0001 (max); 0.00002 or less (30-d avg) (A)	

Table C-1: Bacteriological, Anion, Nutrient, and Metal Concentrations in Water Samples from Maple Creek IWMP Sampling Sites (September 2011)

Sample ID			OZADA U/S	D/S OF LINCOLN	D/S OF LOUGHEED	FOX CREEK	RAILWAY TRIANGLE U/S	D/S OF KINGSWAY	D/S OF DYKE	BC Approved (A) and Working (W) Water Quality Guidelines	CCME Water Quality Guidelines for the Protection of Aquatic Life
Date Sampled			14-SEP-11	14-SEP-11	14-SEP-11	14-SEP-11	14-SEP-11	14-SEP-11	14-SEP-11	(A - Jan 2010, W - Aug 2006)	(December 2007)
Time Sampled			12:30	12:45	13:00	13:15	13:25	13:45	14:10	BCWQ 2009	CCME 2010
	Units	Detection Limits									
Molybdenum (Mo)-Total	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0001 (max); 0.00002 or less (30-d avg) (A)	
Nickel (Ni)-Total	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	2 (max); 1 (30-d avg) (A)	0.073
Potassium (K)-Total	mg/L	2.0	<2.0	2.3	2.0	<2.0	2.0	2.7	2.7	373-432 (W)	
Selenium (Se)-Total	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.002 (mean) (A)	0.001
Silver (Ag)-Total	mg/L	0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	0.0001 @ CaCO3 < 100 mg/L (max); 0.00005 @ CaCO3 < 100 mg/L (30-d avg) (A)	0.0001
Sodium (Na)-Total	mg/L	2.0	8.2	20.8	16.9	8.3	16.9	17.5	17.2		
Thallium (Tl)-Total	mg/L	0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020		
Tin (Sn)-Total	mg/L	0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		
Titanium (Ti)-Total	mg/L	0.010	<0.010	<0.010	0.020	0.012	0.017	<0.010	<0.010	0.3 (max); 0.5*** (W)	0.033 (short-term exp.); 0.015 (long-term exp.)
Uranium (U)-Total		0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	0.3 (max); 0.5*** (W)	0.033 (short-term exp.); 0.015 (long-term exp.)
Vanadium (V)-Total	mg/L	0.0010	<0.0010	0.0010	0.0017	<0.0010	0.0016	0.0044	0.0011	0.006***; 0.020 (secondary chronic) (W)	
Zinc (Zn)-Total	mg/L	0.0050	<0.0050	<0.0050	0.0111	0.0257	0.0085	<0.0050	0.0063	(33+0.75*(hardness-90))/1000 (max); 7.5+0.75*(hardness-90)/1000 (30-d avg) (A)	0.03
Dissolved Metals											
Aluminum (Al)-Dissolved	mg/L	0.0050	<0.0050	0.0066	0.0177	0.0293	0.0152	0.0094	<0.0050		
Antimony (Sb)-Dissolved	mg/L	0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		
Arsenic (As)-Dissolved	mg/L	0.00050	<0.00050	0.00054	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		
Barium (Ba)-Dissolved	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.032	0.032		
Beryllium (Be)-Dissolved	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		
Boron (B)-Dissolved	mg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		
Cadmium (Cd)-Dissolved	mg/L	0.000017	<0.000017	<0.000017	<0.000017	0.000020	<0.000017	<0.000017	<0.000017		
Calcium (Ca)-Dissolved	mg/L	0.10	14.7	29.5	21.7	2.45	19.4	16.4	16.1		
Chromium (Cr)-Dissolved	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		
Cobalt (Co)-Dissolved	mg/L	0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	0.00037	<0.00030		
Copper (Cu)-Dissolved	mg/L	0.0010	<0.0010	<0.0010	<0.0010	0.0025	<0.0010	<0.0010	<0.0010		
Iron (Fe)-Dissolved	mg/L	0.030	<0.030	<0.030	<0.030	0.106	0.032	**0.897**	0.171	0.35 (A)	
Lead (Pb)-Dissolved	mg/L	0.00050	<0.00050	<0.00050	<0.00050	0.00052	<0.00050	<0.00050	<0.00050		
Lithium (Li)-Dissolved	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050		
Magnesium (Mg)-Dissolved	mg/L	0.10	1.85	4.45	3.18	0.26	2.91	2.05	1.99		
Manganese (Mn)-Dissolved	mg/L	0.00030	0.00304	0.00146	0.00179	0.00075	0.00222	0.0359	0.0288		
Mercury (Hg)-Dissolved	mg/L	0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010		
Molybdenum (Mo)-Dissolved	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		

Table C-1: Bacteriological, Anion, Nutrient, and Metal Concentrations in Water Samples from Maple Creek IWMP Sampling Sites (September 2011)

Sample ID			OZADA U/S	D/S OF LINCOLN	D/S OF LOUGHEED	FOX CREEK	RAILWAY TRIANGLE U/S	D/S OF KINGSWAY	D/S OF DYKE	BC Approved (A) and Working (W) Water Quality Guidelines	CCME Water Quality Guidelines for the Protection of Aquatic Life
Date Sampled			14-SEP-11	14-SEP-11	14-SEP-11	14-SEP-11	14-SEP-11	14-SEP-11	14-SEP-11	(A - Jan 2010, W - Aug 2006)	(December 2007)
Time Sampled			12:30	12:45	13:00	13:15	13:25	13:45	14:10	BCWQ 2009	CCME 2010
	Units	Detection Limits									
Nickel (Ni)-Dissolved	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		
Potassium (K)-Dissolved	mg/L	2.0	<2.0	2.1	<2.0	<2.0	<2.0	2.3	2.3		
Selenium (Se)-Dissolved	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		
Silver (Ag)-Dissolved	mg/L	0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020		
Sodium (Na)-Dissolved	mg/L	2.0	7.2	18.7	14.9	7.2	14.6	15.3	14.8		
Thallium (Tl)-Dissolved	mg/L	0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020		
Tin (Sn)-Dissolved	mg/L	0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		
Titanium (Ti)-Dissolved	mg/L	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010		
Uranium (U)-Dissolved	mg/L	0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020		
Vanadium (V)-Dissolved	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0020	<0.0010		
Zinc (Zn)-Dissolved	mg/L	0.0050	<0.0050	<0.0050	<0.0050	0.0175	<0.0050	<0.0050	0.0065		
Physical Tests											
Hardness (as CaCO3)	mg/L	0.50	44.2	91.9	67.3	7.18	60.5	49.4	48.5		
Total Suspended Solids	mg/L	3.0	-	24.9	10.9	7.6	18.2	-	-	25 (24 h change); 5 (30 day change) (A)	

🟨 noticeably higher levels at site(s) compared with other sites in the study area

**proposed Ontario guideline
***Ontario water quality objective

Sampling Sites	UTM-E	UTM-N	Location Description
OZADA U/S	516129	5459134	40-50 m d/s of outfall, 20 m u/s of footbridge to children's playground area
D/S OF LINCOLN	515712	5458350	20-30 m d/s of Lincoln Ave alignment (trail crossing)
D/S OF LOUGHEED	515674	5457575	5-10 m d/s of Lougheed Highway culvert
FOX CREEK	515477	5457258	Ditch along Davies Ave, 5 m u/s of confluence with Maple Creek
RAILWAY TRIANGLE U/S	515486	5457220	10-15 m d/s of CPR Railway culvert south of Davies Ave
D/S OF KINGSWAY	515343	5456904	40-50 m d/s of Kingway Ave culvert, 5 m d/s of end of concrete flume
D/S OF DYKE	515170	5456537	20-30 m d/s of floodgates on Coquitlam River dyke

Coordinates in UTM Zone 10 (NAD83).

\\kwl.ca\bby\0000-0999\0600-0699\646-046\300-Report\Appendices\AppC-Environmental\[AppendixC-1_LabWaterQualityData_Sep2011.xlsm]Lab Water Quality Data

Table C-2: Metal concentrations in sediment samples from Maple Creek IWMP sampling sites (October 2010-September 2011)

Sample ID Date Sampled			OZADA U/S 23-FEB-11	D/S OF LINCOLN 23-FEB-11	D/S OF LOUGHEED 23-FEB-11	FOX CREEK 14-SEP-11	RAILWAY TRIANGLE U/S 23-FEB-11	D/S OF DYKE 03-OCT-10	BC Working Sediment Quality Guidelines - Freshwater (August 2006)		CCME Sediment Quality Guidelines - Freshwater (Update 2002)		Other Comparative Values		
	Units	Detection Limits							ISGQ BC 2006	PEL BC 2006	ISGQ CCME 2002 (Aquatic Life)	PEL CCME 2002 (Aquatic Life)	SStill Creek ubbasin 1995 (median)	Brunette Rv. Subbasin 1995 (median)	Oh (2003) thesis Table 2-3
Metals															
Aluminum (Al)	mg/kg	50	7500	6380	7500	8570	7740	7790							
Antimony (Sb)	mg/kg	0.10	0.19	0.13	1.56	0.86	0.26	1.10							
Arsenic (As)	mg/kg	0.050	1.37	1.87	3.42	1.59	1.23	5.15	5.9	17	5.9	17.0			
Barium (Ba)	mg/kg	0.50	29.1	22.2	36.3	33.4	27.3	52.9							
Beryllium (Be)	mg/kg	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20							
Bismuth (Bi)	mg/kg	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20							
Cadmium (Cd)	mg/kg	0.10	<0.10	<0.10	0.17	0.123	<0.10	0.10	0.6	3.5	0.6	3.5	141	103	
Calcium (Ca)	mg/kg	50	2830	1590	3620	3150	2390	2920							
Chromium (Cr)	mg/kg	0.50	8.73	6.52	20.7	11.0	20.9	9.69	37.3	90	37.3	90.0			
Cobalt (Co)	mg/kg	0.10	3.12	3.03	4.00	3.67	3.75	4.69							18
Copper (Cu)	mg/kg	0.50	15.3	8.43	22.0	21.5	13.9	13.3	35.7	197	35.7	197.0	130	51	33-210
Iron (Fe)	mg/kg	50	10800	11100	13500	10900	10500	**27300**	21200	43766			2.10%	2.10%	4.00%
Lead (Pb)	mg/kg	0.50	10.4	7.18	**53.5**	30.7	15.1	12.6	35	91	35.0	91.3	130	55	10-223
Lithium (Li)	mg/kg	1.0	4.5	3.7	4.0	4.2	3.9	3.8							
Magnesium (Mg)	mg/kg	20	3130	2950	3090	3430	3410	3570							
Manganese (Mn)	mg/kg	1.0	164	200	189	201	179	265					576	807	
Molybdenum (Mo)	mg/kg	0.50	0.50	<0.50	0.84	<0.50	<0.50	1.18							
Nickel (Ni)	mg/kg	0.50	7.13	4.12	9.43	6.27	12.2	4.65	16	75			17	12	32-340
Phosphorus (P)	mg/kg	50	314	299	354	322	322	364							
Potassium (K)	mg/kg	100	560	430	390	450	400	520							
Selenium (Se)	mg/kg	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	2						
Silver (Ag)	mg/kg	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.5*						
Sodium (Na)	mg/kg	100	270	170	320	280	220	260							
Strontium (Sr)	mg/kg	0.50	22.1	13.7	27.5	23.4	18.1	25.2							
Thallium (Tl)	mg/kg	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050							
Tin (Sn)	mg/kg	2.0	3.5	<2.0	<2.0	<2.0	<2.0	<2.0							
Titanium (Ti)	mg/kg	1.0	369	280	465	512	448	457							
Uranium (U)	mg/kg	0.050	0.177	0.202	0.270	0.203	0.171	0.250							
Vanadium (V)	mg/kg	0.20	26.8	27.5	35.1	30.5	27.4	51.9							
Zinc (Zn)	mg/kg	1.0	37.2	22.7	94.1	86.1	51.1	59.8	123	315	123.0	315.0	251	128	159-983
Physical Tests															
pH	pH	0.10	6.95	6.42	7.23	6.91	7.03	6.85							

*Ontario sediment quality guideline

🟨 elevated levels (though not exceeding guidelines) compared with other sites in the study area

Sampling Sites	UTM-E	UTM-N	Location Description
OZADA U/S	516129	5459134	40-50 m d/s of outfall, 20 m u/s of footbridge to children's playground area
D/S OF LINCOLN	515712	5458350	20-30 m d/s of Lincoln Ave alignment (trail crossing)
D/S OF LOUGHEED	515674	5457575	5-10 m d/s of Lougheed Highway culvert
FOX CREEK	515477	5457258	Ditch along Davies Ave, 5 m u/s of confluence with Maple Creek
RAILWAY TRIANGLE U/S	515486	5457220	10-15 m d/s of CPR Railway culvert south of Davies Ave
D/S OF DYKE	515170	5456537	20-30 m d/s of floodgates on Coquitlam River dyke

Analysis of biological samples:
Technical summary of methods and quality assurance procedures
Prepared for Raincoast Applied Ecology
Nick Page, Project Manager
March 8, 2011

by
W. Bollman, Chief Biologist
Rhithron Associates, Inc.
Missoula, Montana

METHODS

Sample processing

Four macroinvertebrate samples from Maple Creek were delivered to Rhithron's laboratory facility in Missoula, Montana on December 10, 2010. All samples arrived in good condition. An inventory document containing sample identification information was provided by the Raincoast Applied Ecology (RAE) Project Manager. Upon arrival, samples were unpacked and examined, and checked against the RAE inventory. An inventory spreadsheet was created and sent to the RAE Project Manager. This spreadsheet included project code and internal laboratory identification numbers and was verified by the RAE Project Manager prior to upload into the Rhithron database.

Samples were preserved in formalin. Upon arrival all samples were rinsed to remove formalin preservative. Samples were re-preserved in 95% ethanol. Standard sorting protocols were applied to achieve representative subsamples of a minimum of 400 organisms. Caton subsampling devices (Caton 1991), divided into 30 grids, each approximately 5 cm by 6 cm were used. Each individual sample was thoroughly mixed in its jar(s), poured out and evenly spread into the Caton tray, and individual grids were randomly selected. The contents of each grid were examined under stereoscopic microscopes using 10x-30x magnification. All aquatic invertebrates from each selected grid were sorted from the substrate, and placed in 95% ethanol for subsequent identification. Grid selection, examination, and sorting continued until at least 400 organisms were sorted. All unsorted sample fractions were retained and stored at the Rhithron laboratory.

Organisms were individually examined by certified taxonomists, using 10x – 80x stereoscopic dissecting scopes (Leica S8E and S6E) and identified to target taxonomic levels consistent with Washington LPTL (Plotnikoff and White 1996) protocols and data generated for previous RAE projects, using appropriate published taxonomic references and keys.

Identification, counts, life stages, and information about the condition of specimens were recorded on bench sheets. Organisms that could not be identified to the taxonomic targets because of immaturity, poor condition, or lack of complete current regionally-applicable published keys were left at appropriate taxonomic levels that were coarser than those specified. To obtain accuracy in richness measures, these organisms were designated as "not unique" if other specimens from the same group could be taken to target levels. Organisms designated as "unique" were those that could be definitively distinguished from other organisms in the sample. Identified organisms were preserved in 95% ethanol in labeled vials, and archived at the Rhithron laboratory.

Representatives of each unique identified taxon were placed in labeled vials. Each reference specimen was internally verified by three Rhithron taxonomists. Specimens added to the collection and their verifications were continuously tracked on a reference collection form.

Quality control procedures

Quality control procedures for initial sample processing and subsampling involved checking sorting efficiency. These checks were conducted on 100% of the samples by independent observers who microscopically re-examined at least 20% of sorted substrate from each sample. Quality control procedures for each sample proceeded as follows:

The quality control technician poured the sorted substrate from a processed sample out into a Caton tray, redistributing the substrate so that 20% of it could be accurately lifted out by removing entire grids in a random fashion. Grids were selected, and re-examined until 20% of the substrate was re-sorted. All organisms that were missed were counted and this number was added to the total number obtained in the original sort. Sorting efficiency was evaluated by applying the following calculation:

$$SE = \frac{n_1}{n_1 + n_2} \times 100$$

where: SE is the sorting efficiency, expressed as a percentage, n_1 is the total number of specimens in the first sort, and n_2 is the total number of specimens expected in the second sort, based on the results of the re-sorted 20%.

Quality control procedures for taxonomic determinations of invertebrates involved checking accuracy, precision and enumeration. One sample was randomly selected and all organisms re-identified and counted by an independent taxonomist. Taxa lists and enumerations were compared by calculating a Bray-Curtis similarity statistic (Bray and Curtis 1957) for the selected sample. Routinely, discrepancies between the original identifications and the QC identifications are discussed among the taxonomists, and necessary rectifications to the data are made. Discrepancies that cannot be rectified by discussions are routinely sent out to taxonomic specialists for identification.

Six taxonomists independently reviewed the reference collection to verify consistency of identifications.

Data analysis

Taxa lists and counts for each sample were constructed. Metric calculations and scoring for the B-IBI for Puget Sound Lowlands streams (Karr and Chu 1999) were performed using Rhithron's customized database software. A sites-by-taxa and sites-by-metrics data matrix was compiled in Microsoft Excel XP.

RESULTS

Quality Control Procedures

Results of quality control procedures for subsampling and taxonomy are given in Table 1. Sorting efficiency averaged 98.31%, taxonomic precision for identification and enumeration was 97.69% for the randomly selected macroinvertebrate QA sample, and data entry efficiency averaged 100% for the project. These similarity statistics fall within acceptable industry criteria (Stribling et al. 2003).

Data analysis

Taxa lists and counts and metric summary pages for each sample are given in the Appendix. Electronic spreadsheets containing macroinvertebrate identifications and metric values and scores were provided to the RAE Project Manager via email. The complete verified reference collection was held at the Rhithron laboratory and will be delivered to the RAE Project Manager upon completion of all City of Surrey projects.

Table 1. *Results of internal quality control procedures for subsampling and taxonomy.* Maple Creek ISMP, Fall 2010.

RAI Sample ID	Station name	Client ID	Sorting efficiency	Bray-Curtis similarity for taxonomy and enumeration
RAE10CS2078	Maple Creek	C-1	100.00%	
RAE10CS2079	Maple Creek	C-2	96.68%	
RAE10CS2080	Maple Creek	C-3	98.86%	97.69%
RAE10CS2081	Maple Creek	C-4	97.69%	

REFERENCES

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Caton, L. W. 1991. Improving subsampling methods for the EPA's "Rapid Bioassessment" benthic protocols. Bulletin of the North American Benthological Society. 8(3): 317-319.

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Plotnikoff, R.W. and J. S. White. 1996. Taxonomic Laboratory Protocol for Stream Macroinvertebrates Collected by the Washington State Department of Ecology. Washington State Department of Ecology, Environmental Assessment Publication No. 96-323.

Stribling, J.B., S.R Moulton II and G.T. Lester. 2003. Determining the quality of taxonomic data. J.N. Am. Benthol. Soc. 22(4): 621-631.

APPENDIX

Taxa lists and metric summaries

Maple Creek ISMP

Fall 2010

Taxa Listing

Project ID: RAE10CS2
RAI No.: RAE10CS2078

RAI No.: RAE10CS2078
Sta. Name: Maple Creek
Client ID: C-1
Date Coll.: 10/3/2010
No. Jars: 1
STORET ID: Maple Creek ISMP

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Non-Insect							
Acari	1	0.23%	Yes	Unknown		5	PR
Nematoda	4	0.93%	Yes	Unknown		5	UN
Oligochaeta	332	76.85%	Yes	Unknown		10	CG
Asellidae							
Caecidotea sp.	12	2.78%	Yes	Unknown		8	CG
Crangonyctidae							
Crangonyx sp.	2	0.46%	Yes	Unknown		6	CG
Physidae							
Physa sp.	2	0.46%	Yes	Unknown		8	SC
Planorbidae							
Promenetus sp.	24	5.56%	Yes	Unknown		6	SC
Sphaeriidae							
Sphaeriidae	21	4.86%	Yes	Unknown		8	CF
Odonata							
Coenagrionidae							
Coenagrionidae	1	0.23%	Yes	Larva	Early Instar	7	PR
Diptera							
Ceratopogonidae							
Ceratopogoninae	1	0.23%	Yes	Larva		6	PR
Empididae							
Neoplasta sp.	4	0.93%	Yes	Larva		5	PR
Tipulidae							
Tipula sp.	1	0.23%	Yes	Larva		4	SH
Chironomidae							
Chironomidae							
Chironomidae	26	6.02%	Yes	Larva		10	CG
Chironomidae	1	0.23%	No	Pupa		10	CG
Sample Count	432						

Taxa Listing

Project ID: RAE10CS2
RAI No.: RAE10CS2079

RAI No.: RAE10CS2079
Sta. Name: Maple Creek
Client ID: C-2
Date Coll.: 10/3/2010
No. Jars: 2
STORET ID: Maple Creek ISMP

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Non-Insect							
Acari	1	0.23%	Yes	Unknown		5	PR
Nematoda	2	0.45%	Yes	Unknown		5	UN
Oligochaeta	309	70.23%	Yes	Unknown		10	CG
Turbellaria	2	0.45%	Yes	Unknown		4	PR
Asellidae							
Caecidotea sp.	15	3.41%	Yes	Unknown		8	CG
Crangonyctidae							
Crangonyx sp.	5	1.14%	Yes	Unknown		6	CG
Planorbidae							
Promenetus sp.	5	1.14%	Yes	Unknown		6	SC
Sphaeriidae							
Sphaeriidae	14	3.18%	Yes	Unknown		8	CF
Ephemeroptera							
Baetidae							
Baetis tricaudatus	1	0.23%	Yes	Larva		4	CG
Coleoptera							
Elmidae							
Lara sp.	1	0.23%	Yes	Larva		1	SH
Diptera							
Ceratopogonidae							
Ceratopogoninae	1	0.23%	Yes	Larva		6	PR
Empididae							
Neoplasta sp.	3	0.68%	Yes	Larva		5	PR
Chironomidae							
Chironomidae							
Chironomidae	1	0.23%	No	Pupa		10	CG
Chironomidae	80	18.18%	Yes	Larva		10	CG
Sample Count	440						

Taxa Listing

Project ID: RAE10CS2
RAI No.: RAE10CS2080

RAI No.: RAE10CS2080
Sta. Name: Maple Creek
Client ID: C-3
Date Coll.: 10/3/2010
No. Jars: 1
STORET ID: Maple Creek ISMP

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Non-Insect							
Amphipoda	20	4.59%	No	Unknown	Damaged	4	CG
Nematoda	1	0.23%	Yes	Unknown		5	UN
Oligochaeta	115	26.38%	Yes	Unknown		10	CG
Turbellaria	6	1.38%	Yes	Unknown		4	PR
Asellidae							
Caecidotea sp.	17	3.90%	Yes	Unknown		8	CG
Crangonyctidae							
Crangonyx sp.	1	0.23%	Yes	Unknown		6	CG
Physidae							
Physa sp.	1	0.23%	Yes	Unknown		8	SC
Planorbidae							
Promenetus sp.	7	1.61%	Yes	Unknown		6	SC
Sphaeriidae							
Sphaeriidae	3	0.69%	Yes	Unknown		8	CF
Trichoptera							
Lepidostomatidae							
Lepidostoma sp.	6	1.38%	Yes	Larva		1	SH
Coleoptera							
Elmidae							
Lara sp.	1	0.23%	Yes	Larva		1	SH
Diptera							
Empididae							
Empididae	2	0.46%	No	Pupa		6	PR
Neoplasta sp.	4	0.92%	Yes	Larva		5	PR
Tipulidae							
Tipula sp.	1	0.23%	Yes	Larva		4	SH
Chironomidae							
Chironomidae							
Chironomidae	251	57.57%	Yes	Larva		10	CG
Sample Count	436						

Taxa Listing

Project ID: RAE10CS2
RAI No.: RAE10CS2081

RAI No.: RAE10CS2081
Sta. Name: Maple Creek
Client ID: C-4
Date Coll.: 10/3/2010
No. Jars: 1
STORET ID: Maple Creek ISMP

Taxonomic Name	Count	PRA	Unique	Stage	Qualifier	BI	Function
Non-Insect							
Amphipoda	1	0.24%	No	Unknown	Damaged	4	CG
Nematoda	34	8.15%	Yes	Unknown		5	UN
Oligochaeta	190	45.56%	Yes	Unknown		10	CG
Ancylidae							
Ferrissia sp.	2	0.48%	Yes	Unknown		6	SC
Asellidae							
Caecidotea sp.	10	2.40%	Yes	Unknown		8	CG
Crangonyctidae							
Crangonyx sp.	15	3.60%	Yes	Unknown		6	CG
Glossiphoniidae							
Helobdella stagnalis	1	0.24%	Yes	Unknown		10	PR
Physidae							
Physa sp.	1	0.24%	Yes	Unknown		8	SC
Planorbidae							
Planorbidae	1	0.24%	No	Immature		6	SC
Promenetus sp.	5	1.20%	Yes	Unknown		6	SC
Sphaeriidae							
Sphaeriidae	93	22.30%	Yes	Unknown		8	CF
Trichoptera							
Lepidostomatidae							
Lepidostoma sp.	1	0.24%	No	Pupa		1	SH
Lepidostoma sp.	2	0.48%	Yes	Larva		1	SH
Coleoptera							
Elmidae							
Lara sp.	1	0.24%	Yes	Larva		1	SH
Diptera							
Ceratopogonidae							
Ceratopogoninae	1	0.24%	Yes	Larva		6	PR
Empididae							
Empididae	1	0.24%	No	Larva	Early Instar	6	PR
Neoplasta sp.	3	0.72%	Yes	Larva		5	PR
Tipulidae							
Tipula sp.	2	0.48%	Yes	Larva		4	SH
Chironomidae							
Chironomidae							
Chironomidae	1	0.24%	No	Pupa		10	CG
Chironomidae	52	12.47%	Yes	Larva		10	CG
Sample Count	417						

Metrics Report

Project ID:	RAE10CS2
RAI No.:	RAE10CS2078
Sta. Name:	Maple Creek
Client ID:	C-1
STORET ID:	Maple Creek ISMP
Coll. Date:	10/3/2010

Abundance Measures

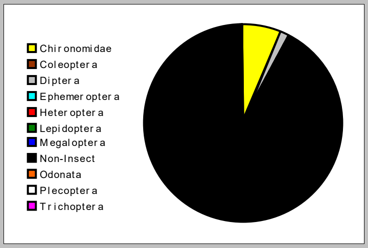
Sample Count:	432	
Sample Abundance:	617.14	70.00% of sample used

Coll. Procedure:

Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	8	398	92.13%
Odonata	1	1	0.23%
Ephemeroptera			
Plecoptera			
Heteroptera			
Megaloptera			
Trichoptera			
Lepidoptera			
Coleoptera			
Diptera	3	6	1.39%
Chironomidae	1	27	6.25%

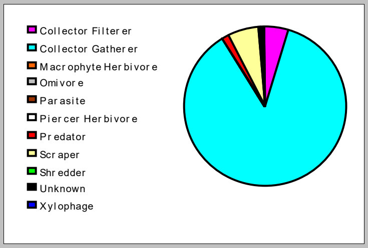


Dominant Taxa

Category	A	PRA
Oligochaeta	332	76.85%
Chironomidae	27	6.25%
Promenetus	24	5.56%
Sphaeriidae	21	4.86%
Caecidotea	12	2.78%
Neoplasta	4	0.93%
Nematoda	4	0.93%
Physa	2	0.46%
Crangonyx	2	0.46%
Tipula	1	0.23%
Coenagrionidae	1	0.23%
Ceratopogoninae	1	0.23%
Acari	1	0.23%

Functional Composition

Category	R	A	PRA
Predator	4	7	1.62%
Parasite			
Collector Gatherer	4	373	86.34%
Collector Filterer	1	21	4.86%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	2	26	6.02%
Shredder	1	1	0.23%
Omnivore			
Unknown	1	4	0.93%

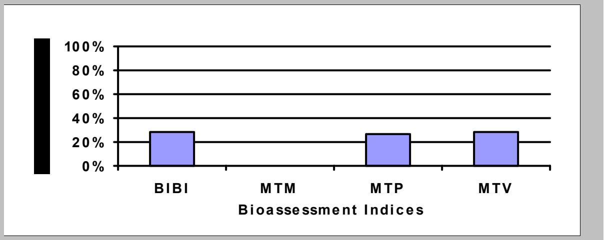


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	13	1	1		0
Non-Insect Percent	92.13%				
E Richness	0	1		0	
P Richness	0	1		0	
T Richness	0	1		0	
EPT Richness	0		0		0
EPT Percent	0.00%		0		0
Oligochaeta+Hirudinea Percent	76.85%				
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	76.85%		0		0
Dominant Taxa (2) Percent	83.10%				
Dominant Taxa (3) Percent	88.66%	1			
Dominant Taxa (10) Percent	99.31%				
Diversity					
Shannon H (loge)	0.971				
Shannon H (log2)	1.401		0		
Margalef D	1.978				
Simpson D	0.603				
Evenness	0.072				
Function					
Predator Richness	4		2		
Predator Percent	1.62%	1			
Filterer Richness	1				
Filterer Percent	4.86%			3	
Collector Percent	91.20%		1		0
Scraper+Shredder Percent	6.25%		1		0
Scraper/Filterer	1.238				
Scraper/Scraper+Filterer	0.553				
Habit					
Burrower Richness	3				
Burrower Percent	7.41%				
Swimmer Richness	0				
Swimmer Percent	0.00%				
Clinger Richness	0	1			
Clinger Percent	0.00%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	1				
Hemoglobin Bearer Percent	5.56%				
Air Breather Richness	1				
Air Breather Percent	0.23%				
Voltinism					
Univoltine Richness	9				
Semivoltine Richness	1	1			
Multivoltine Percent	7.41%		3		
Tolerance					
Sediment Tolerant Richness	3				
Sediment Tolerant Percent	82.64%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	3.889				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	9.03%	5		2	
Hilsenhoff Biotic Index	9.463		0		0
Intolerant Percent	0.00%				
Supertolerant Percent	91.20%				
CTQa	99.500				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	14	28.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	8	26.67%	Moderate
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	5	27.78%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	0	0.00%	Severe



Tuesday, March 08, 2011

Metrics Report

Project ID: RAE10CS2
RAI No.: RAE10CS2079
Sta. Name: Maple Creek
Client ID: C-2
STORET ID: Maple Creek ISMP
Coll. Date: 10/3/2010

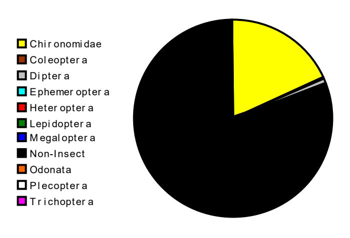
Abundance Measures

Sample Count: 440
Sample Abundance: 1,650.00 26.67% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	8	353	80.23%
Odonata			
Ephemeroptera	1	1	0.23%
Plecoptera			
Heteroptera			
Megaloptera			
Trichoptera			
Lepidoptera			
Coleoptera	1	1	0.23%
Diptera	2	4	0.91%
Chironomidae	1	81	18.41%

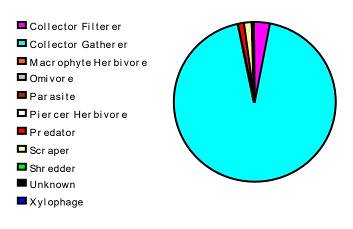


Dominant Taxa

Category	A	PRA
Oligochaeta	309	70.23%
Chironomidae	81	18.41%
Caecidotea	15	3.41%
Sphaeriidae	14	3.18%
Promenetus	5	1.14%
Crangonyx	5	1.14%
Neoplasta	3	0.68%
Turbellaria	2	0.45%
Nematoda	2	0.45%
Lara	1	0.23%
Ceratopogoninae	1	0.23%
Baetis tricaudatus	1	0.23%
Acari	1	0.23%

Functional Composition

Category	R	A	PRA
Predator	4	7	1.59%
Parasite			
Collector Gatherer	5	411	93.41%
Collector Filterer	1	14	3.18%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	1	5	1.14%
Shredder	1	1	0.23%
Omivore			
Unknown	1	2	0.45%

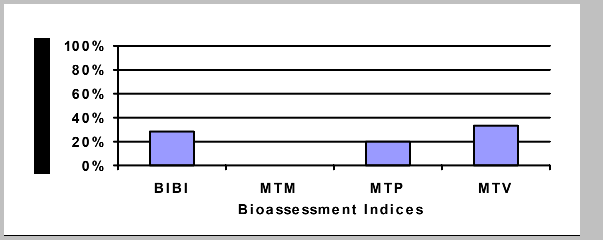


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	13	1	1		0
Non-Insect Percent	80.23%				
E Richness	1	1		0	
P Richness	0	1		0	
T Richness	0	1		0	
EPT Richness	1		0		0
EPT Percent	0.23%		0		0
Oligochaeta+Hirudinea Percent	70.23%				
Baetidae/Ephemeroptera	1.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	70.23%		0		0
Dominant Taxa (2) Percent	88.64%				
Dominant Taxa (3) Percent	92.05%	1			
Dominant Taxa (10) Percent	99.32%				
Diversity					
Shannon H (loge)	1.023				
Shannon H (log2)	1.476		0		
Margalef D	1.972				
Simpson D	0.530				
Evenness	0.093				
Function					
Predator Richness	4		2		
Predator Percent	1.59%	1			
Filterer Richness	1				
Filterer Percent	3.18%			3	
Collector Percent	96.59%		0		0
Scraper+Shredder Percent	1.36%		0		0
Scraper/Filterer	0.357				
Scraper/Scraper+Filterer	0.263				
Habit					
Burrower Richness	2				
Burrower Percent	19.09%				
Swimmer Richness	1				
Swimmer Percent	0.23%				
Clinger Richness	1	1			
Clinger Percent	0.23%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	1				
Hemoglobin Bearer Percent	1.14%				
Air Breather Richness	0				
Air Breather Percent	0.00%				
Voltinism					
Univoltine Richness	6				
Semivoltine Richness	2	1			
Multivoltine Percent	19.77%		3		
Tolerance					
Sediment Tolerant Richness	2				
Sediment Tolerant Percent	71.36%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	4.050				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	4.55%	5		3	
Hilsenhoff Biotic Index	9.639		0		0
Intolerant Percent	0.23%				
Supertolerant Percent	95.23%				
CTQa	103.100				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	14	28.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	6	20.00%	Moderate
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	6	33.33%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	0	0.00%	Severe



Tuesday, March 08, 2011

Metrics Report

Project ID: RAE10CS2
RAI No.: RAE10CS2080
Sta. Name: Maple Creek
Client ID: C-3
STORET ID: Maple Creek ISMP
Coll. Date: 10/3/2010

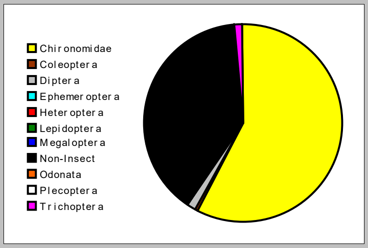
Abundance Measures

Sample Count: 436
Sample Abundance: 1,453.33 30.00% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	8	171	39.22%
Odonata			
Ephemeroptera			
Plecoptera			
Heteroptera			
Megaloptera			
Trichoptera	1	6	1.38%
Lepidoptera			
Coleoptera	1	1	0.23%
Diptera	2	7	1.61%
Chironomidae	1	251	57.57%

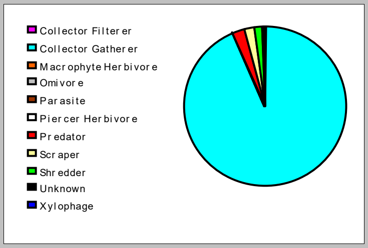


Dominant Taxa

Category	A	PRA
Chironomidae	251	57.57%
Oligochaeta	115	26.38%
Amphipoda	20	4.59%
Caecidotea	17	3.90%
Promenetus	7	1.61%
Turbellaria	6	1.38%
Lepidostoma	6	1.38%
Neoplasta	4	0.92%
Sphaeriidae	3	0.69%
Empididae	2	0.46%
Tipula	1	0.23%
Physa	1	0.23%
Nematoda	1	0.23%
Lara	1	0.23%
Crangonyx	1	0.23%

Functional Composition

Category	R	A	PRA
Predator	2	12	2.75%
Parasite			
Collector Gatherer	4	404	92.66%
Collector Filterer	1	3	0.69%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	2	8	1.83%
Shredder	3	8	1.83%
Omivore			
Unknown	1	1	0.23%

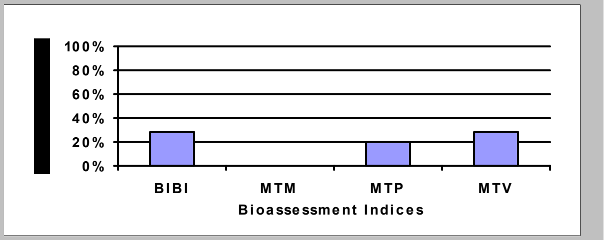


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	13	1	1		0
Non-Insect Percent	39.22%				
E Richness	0	1		0	
P Richness	0	1		0	
T Richness	1	1		0	
EPT Richness	1		0		0
EPT Percent	1.38%		0		0
Oligochaeta+Hirudinea Percent	26.38%				
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	57.57%		1		0
Dominant Taxa (2) Percent	83.94%				
Dominant Taxa (3) Percent	88.53%	1			
Dominant Taxa (10) Percent	98.85%				
Diversity					
Shannon H (loge)	1.135				
Shannon H (log2)	1.638		0		
Margalef D	1.991				
Simpson D	0.446				
Evenness	0.114				
Function					
Predator Richness	2		0		
Predator Percent	2.75%	1			
Filterer Richness	1				
Filterer Percent	0.69%			3	
Collector Percent	93.35%		1		0
Scraper+Shredder Percent	3.67%		1		0
Scraper/Filterer	2.667				
Scraper/Scraper+Filterer	0.727				
Habit					
Burrower Richness	3				
Burrower Percent	58.72%				
Swimmer Richness	0				
Swimmer Percent	0.00%				
Clinger Richness	1	1			
Clinger Percent	0.23%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	1				
Hemoglobin Bearer Percent	1.61%				
Air Breather Richness	1				
Air Breather Percent	0.23%				
Voltinism					
Univoltine Richness	8				
Semivoltine Richness	2	1			
Multivoltine Percent	59.17%		2		
Tolerance					
Sediment Tolerant Richness	3				
Sediment Tolerant Percent	28.21%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	3.951				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	5.73%	5		2	
Hilsenhoff Biotic Index	9.239		0		0
Intolerant Percent	1.61%				
Supertolerant Percent	88.76%				
CTQa	88.556				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	14	28.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	6	20.00%	Moderate
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	5	27.78%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	0	0.00%	Severe



Metrics Report

Project ID: RAE10CS2
RAI No.: RAE10CS2081
Sta. Name: Maple Creek
Client ID: C-4
STORET ID: Maple Creek ISMP
Coll. Date: 10/3/2010

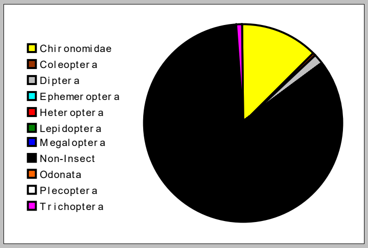
Abundance Measures

Sample Count:	417	
Sample Abundance:	1,563.75	26.67% of sample used

Coll. Procedure:
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Non-Insect	9	353	84.65%
Odonata			
Ephemeroptera			
Plecoptera			
Heteroptera			
Megaloptera			
Trichoptera	1	3	0.72%
Lepidoptera			
Coleoptera	1	1	0.24%
Diptera	3	7	1.68%
Chironomidae	1	53	12.71%

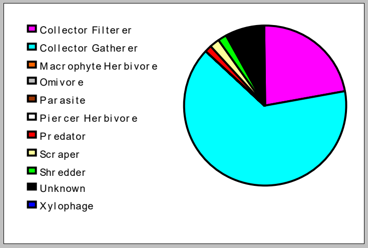


Dominant Taxa

Category	A	PRA
Oligochaeta	190	45.56%
Sphaeriidae	93	22.30%
Chironomidae	53	12.71%
Nematoda	34	8.15%
Crangonyx	15	3.60%
Caecidotea	10	2.40%
Promenetus	5	1.20%
Neoplasta	3	0.72%
Lepidostoma	3	0.72%
Tipula	2	0.48%
Ferrissia	2	0.48%
Planorbidae	1	0.24%
Physa	1	0.24%
Ceratopogoninae	1	0.24%
Amphipoda	1	0.24%

Functional Composition

Category	R	A	PRA
Predator	3	6	1.44%
Parasite			
Collector Gatherer	4	269	64.51%
Collector Filterer	1	93	22.30%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	3	9	2.16%
Shredder	3	6	1.44%
Omivore			
Unknown	1	34	8.15%

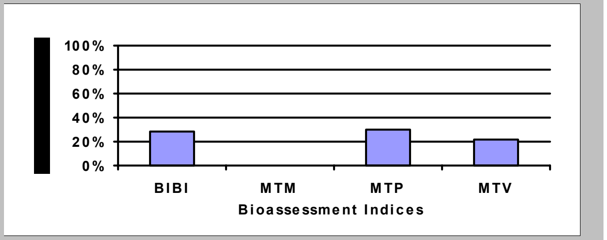


Metric Values and Scores

Metric	Value	BIBI	MTP	MTV	MTM
Composition					
Taxa Richness	15	1	1		0
Non-Insect Percent	84.65%				
E Richness	0	1		0	
P Richness	0	1		0	
T Richness	1	1		0	
EPT Richness	1		0		0
EPT Percent	0.72%		0		0
Oligochaeta+Hirudinea Percent	45.80%				
Baetidae/Ephemeroptera	0.000				
Hydropsychidae/Trichoptera	0.000				
Dominance					
Dominant Taxon Percent	45.56%		1		0
Dominant Taxa (2) Percent	67.87%				
Dominant Taxa (3) Percent	80.58%	1			
Dominant Taxa (10) Percent	97.84%				
Diversity					
Shannon H (loge)	1.596				
Shannon H (log2)	2.303		1		
Margalef D	2.325				
Simpson D	0.287				
Evenness	0.110				
Function					
Predator Richness	3		1		
Predator Percent	1.44%	1			
Filterer Richness	1				
Filterer Percent	22.30%			1	
Collector Percent	86.81%		1		0
Scraper+Shredder Percent	3.60%		1		0
Scraper/Filterer	0.097				
Scraper/Scraper+Filterer	0.088				
Habit					
Burrower Richness	3				
Burrower Percent	13.91%				
Swimmer Richness	0				
Swimmer Percent	0.00%				
Clinger Richness	2	1			
Clinger Percent	0.72%				
Characteristics					
Cold Stenotherm Richness	0				
Cold Stenotherm Percent	0.00%				
Hemoglobin Bearer Richness	1				
Hemoglobin Bearer Percent	1.44%				
Air Breather Richness	1				
Air Breather Percent	0.48%				
Voltinism					
Univoltine Richness	11				
Semivoltine Richness	2	1			
Multivoltine Percent	20.86%		3		
Tolerance					
Sediment Tolerant Richness	4				
Sediment Tolerant Percent	47.96%				
Sediment Sensitive Richness	0				
Sediment Sensitive Percent	0.00%				
Metals Tolerance Index	3.566				
Pollution Sensitive Richness	0	1		0	
Pollution Tolerant Percent	4.80%	5		3	
Hilsenhoff Biotic Index	8.688		0		0
Intolerant Percent	0.96%				
Supertolerant Percent	83.45%				
CTQa	92.091				

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	14	28.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	9	30.00%	Moderate
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	4	22.22%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	0	0.00%	Severe



Tuesday, March 08, 2011

Appendix C-4: Fish Habitat by Reach in the Maple Creek Watershed

Reach	Stream Class	Description	Photo
Maple R1 Confluence with Coquitlam River upstream to dyke flapgate	Permanent Fish-bearing	Straight channel with steep banks. Substrates a mix of cobbles and gravels (and some riprap downstream of floodbox) but overlain with fine sediment and organic debris in many areas. Gravels heavily embedded and largely unsuitable for spawning. Riparian vegetation relatively intact. Large woody debris placed throughout reach (fixed by rebar) provides good instream cover for rearing juvenile salmonids. Habitat Quality: Spawning – Low; Rearing – Moderate Riparian Forest Integrity (RFI) = 78.6%	
Maple R2 Dyke upstream to Chine Dr	Permanent Fish-bearing	Wide, slow-moving section with mostly fine substrates concentrated in several deposition areas. Reed canarygrass abundant in shallow instream areas and along both banks. Few cobble/gravel areas observed. Contains two large ponds (Bedford Ponds) with large woody debris created to provide rearing habitat for salmonids. Recent riparian shrub plantings on pond edges. Habitat Quality: Spawning – Low; Rearing – Moderate RFI = 65.0%	
Maple R3 Chine Dr upstream to Bedford St	Permanent Fish-bearing	Channelized section with steep banks and severe encroachment on left bank from road and sidewalk (Bedford St). Lack of channel complexity and instream cover although overhanging vegetation provides some cover. A 15 m wide riparian buffer on right bank was recently planted as part of adjacent townhouse development. Both Chine Dr and Bedford St culverts are open-bottomed. Habitat Quality: Spawning – Low; Rearing – Low RFI = 15.7%	

Reach	Stream Class	Description	Photo
Maple R4 Bedford St upstream to CPR rail line north of Kingsway Ave	Permanent Fish-bearing	Heavily encroached and modified section with some eroding bank areas. Industrial/commercial development within few meters of creek. Small sections of gravel at City-owned lane right-of-way and upstream of Kingsway Ave known to be used by spawning salmon (likely Chum). Confined to 50 m concrete flume downstream of Kingsway Ave. Several driveway crossings upstream of and along Kingsway Ave. Minimal natural instream cover. Riparian corridor less than meter wide throughout and mostly non-native Himalayan blackberry and Japanese knotweed. Habitat Quality: Spawning – Moderate; Rearing – Low RFI = 17.9%	
Maple R5 “CPR Triangle”	Permanent Fish-bearing	Natural, meandering section through large habitat protection area. Substrates dominated by fine sediment with few cobble/gravel deposits. Large inline pond at upstream end (downstream of Davies Ave) but lacks instream cover except at downstream end. Naturally occurring large woody debris provides good cover in stream section. Evidence of past beaver dams at pond outlet. Opportunities for enhancement. Habitat Quality: Spawning – Low; Rearing – Moderate RFI = 88.1%	
Maple R6 Davies Ave upstream to 40 m downstream of Raleigh Ave	Permanent Fish-bearing	Wide, slow-moving section with mostly fine substrates in several deposition areas. Reed canarygrass abundant in shallow instream areas within channel. Residential yards encroach on both banks. Several retaining walls right at stream bank. Fine sediments common throughout and few areas of exposed spawning gravels. Evidence of bioengineering (willow fences) to stabilize left bank in middle section of reach. Reed canarygrass abundant in shallow instream areas within channel. Invasive plants dominate vegetation on both banks (English ivy, yellow lamium, periwinkle, Japanese knotweed). Habitat Quality: Spawning – Low; Rearing – Low RFI = 21.6%	

Reach	Stream Class	Description	Photo
Maple R7 40 m downstream of Raleigh Ave upstream to Gordon Ave	Permanent Fish-bearing	Heavily encroached and channelized section. Retaining walls and lawns at stream edge on both banks virtually throughout. Cobble/gravel substrates abundant but covered by fine sediment in many areas and becoming embedded. Some small areas becoming choked with reed canarygrass. No natural instream cover. Little or no riparian vegetation. Habitat Quality: Spawning – Moderate; Rearing – Low RFI = 8.7%	
Maple R8 Gordon Ave upstream to Lougheed Highway	Permanent Fish-bearing	Semi-natural section through townhouse complex. Yards and patios right near stream edge. Small pocket with cobble/gravel substrates suitable for spawning. One small (downstream end) and one larger (upstream end) inline pond. Two-step concrete weir at outlet of larger pond (partial barrier to fish passage). Ponds have little cover for rearing fish. Riparian corridor narrow but more tree and shrub cover compared to reach below and mostly native species (western redcedar, salmonberry). Habitat Quality: Spawning – Moderate; Rearing – Moderate RFI = 35.2%	
Maple R9 Lougheed Highway upstream to 3346 Jervis St	Permanent Fish-bearing	Wide, slow-moving section dominated by fine substrates. Little to no suitable spawning gravels. Channelized north of Metro Motors from Lougheed Highway to Shaftsbury Pl. Residential yards encroach on both banks, including retaining walls at stream edge. Numerous private footbridges. Reed canarygrass abundant in shallow instream areas within channel above. Little instream cover. Riparian vegetation lacking or mostly non-native species, including Himalayan blackberry, Japanese knotweed, and bamboo. Ivy and yellow lamium abundant and hanging into stream in some areas. Habitat Quality: Spawning – Low; Rearing – Low RFI = 19.7%	

Reach	Stream Class	Description	Photo
Maple R10 3346 Jervis St upstream to Lincoln St	Permanent Fish-bearing	More naturally meandering section but with banks altered by development or lacking riparian vegetation in sections. Residential yards frequently encroach on one or both banks. Abundant cobble/gravel substrates suitable for spawning although covered by fine sediment and somewhat embedded in some areas. Evidence of spawning observed and reported by neighbours. Non-native species common along banks, including ivy, yellow lamium, periwinkle, and cherry-laurel. At least two submerged fences cross stream (partial barriers to fish passage). Habitat Quality: Spawning – Moderate (High?); Rearing – Low RFI = 63.3%	
Maple R11 Lincoln St upstream to diversion	Permanent Fish-bearing	Semi-natural, meandering section on perimeter of school grounds. Substrates dominated by fine sediment (some areas of reed canarygrass instream) above Lincoln Ave but with some cobble/gravel sections in upper areas. Fair amount of naturally occurring large woody debris and some undercut banks provide good cover. Wide riparian buffer dominated by native species but ivy, yellow lamium, and Himilayan blackberry choking sections north of playing field adjacent to townhouse complex. Habitat Quality: Spawning – Moderate; Rearing – Moderate RFI = 73.3%	
Maple R12 Diversion upstream to Ozada St outfall	Permanent Fish-bearing	Fairly straight section upstream of concrete diversion wall. Substrates dominated by large gravel suitable for spawning, except in upper section which has become filled with sand. Some instream woody debris and undercut banks provide good cover although channel complexity limited by lack of meander in channel. Wide riparian corridor in protected park area, although narrower on right bank due to proximity to Ozada Ave. Habitat Quality: Spawning – Moderate; Rearing – Moderate RFI = 78.6%	

Reach	Stream Class	Description	Photo
Maple Trib. 1 R1 Confluence with Maple Creek upstream to Terasen Gas ROW	Permanent Unknown fish presence	Constructed drainage channel. Deeply incised with steep banks. Substrates mostly mud. Instream wood present providing some cover. Originates from outfall north of Terasen Gas right-of-way. Headwaters appear to have been lost to past development. Habitat Quality: Spawning – Nil; Rearing – Low RFI = 55.4%	
Fox (Maple Trib. 2) R1 Ditch along Davies Ave	Permanent Fish-bearing	Ditch running along south side of Davies Ave. Substrates dominated by fine sediment. Lack of instream cover but overhanging shrub vegetation provides good cover in some sections. Riparian vegetation is generally confined to right bank in very narrow area. Instream garbage and debris present throughout. Receives runoff directly from roadway. Habitat Quality: Spawning – Low; Rearing – Moderate RFI = 14.0%	
Fox (Maple Trib. 2) R2 Upstream of Davies Ave to Lougheed Highway	Permanent Non fish-bearing	Lower section culverted beneath Fox St and Davies Ave for 120 m. Fox Park section is small channel with no riparian vegetation (few trees) and grass to both banks. Substrates mostly fine gravel and sand. Channel flows through backyards and greenbelt above. Heavy encroachment visible in yards with retaining walls, fence crossings, Instream garbage and debris present throughout greenbelt area. Habitat Quality: Spawning – Nil; Rearing – Low RFI = 33.6%	

Reach	Stream Class	Description	Photo
Maple Trib. 3 R1 Confluence with Maple Creek upstream to Hastings Pl	Permanent Fish-bearing	Small tributary of Maple Creek not mapped in City-provided GIS data. Originates from outfall south of Hastings Pl cul-de-sac and joins Maple Creek upstream of Kitchener Ave (total length = 104 m). Substrates dominated by large and small gravels. Upper section runs between lawn and rock wall. Neighbours report seeing juvenile salmonids regularly right up to outfall but spawning not observed. Flows year-round so likely groundwater-fed. Habitat Quality: Spawning – Low; Rearing – Low RFI = 42.2%	
Maple Trib. 4 R1 Confluence with Maple Creek upstream to NW side of playing field	Non-permanent Non fish-bearing	Small tributary wrapping around north side of small, secondary playing field west of school. Substrate mostly leaf litter, mud, and organic debris indicating lack of scouring flows typical of permanent stream. Minimal flow present at time of survey. Does not appear to be groundwater-fed. Enters Maple Creek across a muddy fan. Intact riparian vegetation. Habitat Quality: Spawning – Nil; Rearing – Nil RFI = 64.4%	
Maple Creek-Coquitlam River Diversion Channel	Non-permanent Unknown fish presence	Constructed, straight channel which carries diverted flow from Maple Creek to Coquitlam River. Substrates dominated by fine sediment with some large boulders. Channel dries out under low flow conditions. Some instream large wood debris but little channel complexity. Wide riparian corridor on either side in protected park area. Habitat Quality: Spawning – Low; Rearing – Low RFI = 100.0%	

Appendix C-5: Reach Summary Data

Table C-5A: Summary of Channel and Substrate Characteristics in the Maple Creek Watershed.

Reach	Length (m)	Bankfull Width (m)	Wetted Width (m)	Riffle Depth (cm)	Bankfull Depth (cm)	Residual Pool Depth (cm)	Gradient (%)	Embeddedness (%)	% Boulder	% Cobble	% Large Gravel	% Small Gravel	% Fines
Maple R1	156	2.5	1.9	12	30	10	1.5	30	0	2.5	50	40	7.5
Maple R2	252	2.9	2.4	15	66	15	< 1	25	0	5	40	40	15
Maple R3	134	2.0	1.7	30	50	10	1.5	40	2.5	10	20	30	37.5
Maple R4	347	2.3	1.8	12	25	5	2-5	25	5	20	25	40	10
Maple R5	210	2.8	1.5	20	40	20	2-5	30	0	0	5	60	35
Maple R6	148	3.6	3.2	30	45	20		40	5	20	25	15	35
Maple R7	150	2.2	2.2	20	25	5	3-5	35	5	20	35	20	20
Maple R8	151	3.0	2.5	10	20	15	2-3	30	5	20	25	15	35
Maple R9	273	5.5	4.5	20	30	5	1-2	40	0	5	10	45	40
Maple R10	838	2.5	2.3	7	0	9	5-7	35	2.5	10	30	50	7.5
Maple R11	510	2.4	1.6	17	20	5	2-5	35	10	25	10	25	30
Maple R12	439	2.0	1.8	8	26	15	5-7	55	2.5	15	45	25	12.5
Maple Trib. 1 R1	221	3.3	3.0	3	50	40	< 1	n/a	0	0	0	0	100
Fox (Maple Trib. 2) R1	258	1.6	1.2	10	30	25	1-2	n/a	0	0	0	0	100
Fox (Maple Trib. 2) R2	401	1.6	1.0	10	20	5	2-3	n/a	0	0	0	50	50
Maple Trib. 3 R1	104	0.9	0.7	8	12	5	2-3	25	0	17.5	35	40	7.5
Maple Trib. 4 R1	156	1.0	0.5	3	15	2	5-7	n/a	0	5	0	0	95
Maple Creek-Coq River Diversion Channel	113	1.9	0	0	20	0	3-5	10	2.5	5	10	15	67.5

Table C-5B: Summary of Channel Characteristics, Complexity, Erosion, and Fish Presence in the Maple Creek Watershed

Reach	% culverted	% channelized	LWD per 100 m	Erosion*	Fish Presence	Salmonid Presence	Salmonid Species (see codes in text)
Maple R1	0%	0%	20	Minor	Present	Present	CM, CO, CH, SO, ST, CT
Maple R2	10% (26 m)	0%	5	Minor	Present	Present	CM, CO, CH, SO, ST, CT
Maple R3	34% (45 m)	66% (89 m)	1-2	Minor	Present	Present	CM, CO, CH, SO, ST, CT
Maple R4	10% (36 m)	37% (128 m)	< 1	Minor	Present	Present	CM, CO, CH, SO, ST, CT
Maple R5	0%	0%	8-10	Minor	Present	Present	CM, CO, ST, CT
Maple R6	12% (18 m)	30% (44 m)	2-3	Minor	Present	Present	CM, CO, ST, CT
Maple R7	29% (44 m)	71% (116 m)	< 1	Minor	Present	Present	CM, CO, ST, CT
Maple R8	0%	0%	2-3	Minor	Present	Present	CM, CO, ST, CT
Maple R9	11% (30 m)	25% (68 m)	1-2	Minor	Present	Present	CO, CT, ST
Maple R10	3% (22 m)	0%	< 1	Minor	Present	Present	CO, CT, ST
Maple R11	6% (33 m)	0%	5-7	Minor	Present	Present	CT, RB, CO?
Maple R12	0%	0%	2-3	Minor	Present	Present	CT, RB, CO?
Maple Trib. 1 R1	8% (17 m)	79% (204 m)	5-7	Moderate	Unknown	Unknown	Unknown
Fox (Maple Trib. 2) R1	0%	100% (258 m)	< 1	Minor	Present	Present	CO, CT?
Fox (Maple Trib. 2) R2	30% (120 m)	4% (15 m)	< 1	Minor	Unknown	Absent?	None
Maple Trib. 3 R1	0%	0%	1-2	Minor	Present	Present	CO, CT?
Maple Trib. 4 R1	0%	0%	1-3	Minor	Absent	Absent	None
Maple Creek-Coquitlam River Diversion Channel	0%	100% (113 m)	3-5	Minor	Present	Present	Unknown

* note that the erosion rating is related to fish habitat concerns and is not as detailed as Section X-X.

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Appendix D

Summary of Stakeholder Input

Contents

Tables

D.1 Phase 2 Report Comments

From December 2011 Advisory Committee Meeting #4:

Environmental/Flow Conveyance

- Recommend moving parking to back of property to make room for proper channel for Kingsway industrial lot on north side.
- Distinguish between fish passage barriers and fish passage impediments.
- Self-regulated floodgate is desirable to improve fish access.
- Recommend removal of private bridges, creek modifications, fences, etc. to provide more conveyance capacity.

Water Quality

- Bring forward any additional sampling recommendations to City.
- Investigate option to redirect poor water quality flows from Fox Westwood area.
- Investigate using railway triangle for stormwater treatment.
- Investigate alternatives for spill containment to protect Coquitlam River water quality.
- Include recommendations for education on dumping chemicals/liquids/contaminants.

Baseflow Augmentation Alternatives

- Existing Coquitlam River intakes are successful.
- Add potable water top-up alternative.

Mitigation of the Impacts of Future Redevelopment

- Ensure source controls are included in recommendations.
- Include additional option for zoning recommendations to reclaim and restore adequate riparian setbacks through long term redevelopment.

Odaza High Flow Diversion

- Investigate/make recommendations regarding proper operation. Desire for additional flushing flows to creek for aquatic health. Current sandbagging practices are used to minimize extra pumping.

General

- More integration between engineering and environmental.
- Update air photo.

Written Comments Received:

City of Coquitlam

- Corrections to figures (Figure 4-1 200 mm pipe d/s of groundwater baseflow augmentation well, correction to Lafarge Lake outlet piping. Figure 5-1 “use existing well piping” note in wrong place, yellow line represents possible new piping route.)
- Lafarge outlet pipe is 3 m below Maple Creek therefore another reason it is not a feasible baseflow augmentation alternative.
- Alternative to daylighting culvert at south end of Ozada (Figure 6-1)

D.2 Phase 3 Report / Alternatives Comments

From April 2, 2012 Advisory Committee Meeting #5:

Baseflow Augmentation Alternatives

- Concerned about sediment levels in Coquitlam River if using as a source for base-flow.
- Look into a treatment or prevention system to prevent sediment from entering Maple.
- City of Coquitlam prefers Option 3A

Ozada Diversion Operation

- City of Coquitlam proposed an alternate option that would remove the existing diversion.
- Spill response plan needs to be finalized and implemented.
- Smoke testing of sewers has been schedule.

Water Quality

- Diversion of Westwood culvert may have regulatory issues as it is contrary to DFO regulation to take deleterious water and divert it.
- Investigate option to redirect poor water quality flows from Fox Westwood area.
- Investigate using railway triangle for stormwater treatment.
- Investigate alternatives for spill containment to protect Coquitlam River water quality.
- Include recommendations for education on dumping chemicals/liquids/contaminants.

Riparian and Watershed Improvements

- Riparian setbacks too small, should tax these properties higher for compensation.

Flood Control

- DFO does not support inline or in riparian detention and would prefer a different option.
- City of Port Coquitlam has concerns about diverting from the creek.
- City of Port Coquitlam and Streamkeepers prefer option 1C (purchase low-lying land).

Mitigation of the Impacts of Future Redevelopment

- Although maximizing infiltration in good soils is recommended, do not rule out other source controls such as green-roofs.
- DFO is supportive of other models, don't focus on draft guidelines.

Written Comments Received:

Craig Orr, Kwikwetlem Environmental Advisor

- Plan has substantial potential to improve the natural capital of Maple Creek, if due consideration is given to several options.
- Base-flows should be augmented with the gravity diversion.
- Water quality should be improved.
- Everything possible should be done to improve fish passage.

City of Port Coquitlam

- Concerned with the wording about development in streamside protection areas. There is some confusion on the meaning of variance. PoCo bylaws are based on SPR setbacks and there is no development allowed in these areas, but has a provision to recognize obstacles such as lot size / configuration, existing roads / infrastructure, or biophysical conditions which impair the ability to designate protection areas.

D.3 Public Open House Comments

From April 19, 2012 Open House Small Group Sessions:

Summer Low Flow Augmentation (CC)

- Group concerned about water quality if taking water from the Coquitlam River (Sediment load);
- Prefer to stay away from pumping for a long term solution;
- **Follow up:** KWL to look at a way to still use the gravity alternative but also address water quality of the water entering Maple Creek

Water Quality Treatment (MB, AJ)

- Industry pollution and road runoff big problem, need more riparian vegetation for filtering;
- Who looks after oil / water separators (maintenance and inspection);
- Lack of education / awareness.
- **Follow up:** Best management practices, source controls, more robust E&SC plans and inspection.

Proposed Aquatic and Riparian Improvements (PL)

- Improve fish access through floodgate;
- Prevent further / improve existing riparian encroachment, remove invasive plants;
- Public education needs to occur;
- **Follow up:** City led programs for riparian areas- City provides plants and advice, tax incentives.

Flood Management Alternatives (JY)

- Floodbox / fish passage is very important. Needs to be open as much as possible;
- Make sure pumps can safely transfer juveniles with no kills, make a safe landing point;
- **Follow up:** KWL to look at self-regulating gates and hydrostatic pumps. Design of pump outlets to prevent fish from trying to swim up it.

Written Comments Received:

See Table 1 attached.

Table D-1: Written Comments Received from Public Open House

Name	Base-Flow Augmentation	Flood Protection	Additional Environmental Features	Comments
Jeff Rudd	New Groundwater Well	Other- Highflow diversion at Davies and purchase low-laying properties	-	Concerned about uising water from the Coquitlam River when it is very silty. A new well appears cheaper than taking water form the River. Use of sandbags at the Ozada diversion should be stopped.
R. Schusler	Other- improve what is already there	Upgrade open flumes/channels and large pump station upgrade	Information for those who live along the creek (do's and don'ts	-
Donna Hall	1. New Groundwater Well- best quality water guaranteed 2. Gravity Pipe from Coquitlam River- no gauarantee of water quality (aka filtration)	Purchase low-laying properties and constuct proper creek channel, large pump station upgrade	Retain set backs or increase them back to original 50 m	-
Rick Gunnyon	1. New groundwater well 2. Gravity pipe from Coquitlam River		-	-
Neil Kauanaugh	Gravity Pipe from Coquitlam River- Close proximity of the river to the existing pump remove any chance of mechanical failure and minmal maintenance		Set backs and riparian areas more planting	-
Ted Wingrove	New Groundwater Well		all obstructions in Creek removed. Enhance sribarian areas and retian setbacks. Monitor water quality. Have silt safegards.	what safegaurds are there for industrial development (spills etc)?
Carole Edwards	New Groundwater Well- if this water could be taken from above the grave pit, however the river is once again on the endagered list		-	-
Elaine Lambert	1. Pump from the Coquitalm River 2. Gravity Pipe from Coquitalm River 3. New Groundwater Well		-	
Maggie Coqueira	New Groundwater Well- only if water quality is improved. Worried about pumping from the Coquitlam River becase it's an endangered river and needs help itself,	Purchase low-laying properties and constuct proper creek channel, large pump station upgrade- Long term solution coud be to buy all the properties in that nearby area and return the creek to its original condition.	Enforcing 30 m setback from creek	-
C. Boulos	New groundwater well- has the best water quality	Purchase low-laying properties and constuct proper creek channel, large pump station upgrade- allows creek to be unchannelezed and move	enforcement of setbacks , open bottom culverts	-
Patrick Alambets	Gravity Pipe from the Coquitlam River	Construct High flow diversion to Coquitalm River at Davies, small pump station upgrade	-	-
Art Weston	Pump from Coquitlam River	Construct high flow divertion under Bedford Rd. large pump station upgrade	-	The Coquitlam River from Kings way Bridge to the Red Bridge should be dreged out. It may stop some flooding at Maple Creek (ex. Coquitlam Glass)
Sandy Budd	1. New ground water well- because of water quality 2. Gravity pipe from Coquitlam River Combine #1 and #2, worried about Sediment pllutants freely going into Maple (no monitoring of what's going in to Maple?). If gravity feed from river- if water quality is too poor (sediment trubididty etc.) maybe a combination of well could be used in this case. auto switch to well for periods to maintain good water quality then back to gravity feed when water qulaity is better.	Purchase low-laying properties and constuct proper creek channel, large pump station upgrade. Fish friendly pump station, archimedes screw pump.	Monitoring of oil settling septors (who talkes care of them). Try to retain setbacks or enlarge them to what they were. 50 m setbacks. Replanting riparian after development, if any culverts, open bottom, more native planting.	Must make industrial more awaare of stream side etiquette (what is expected of industrial owners), how to dispose waste (not in the drains_. No habitat, no fish, most important to make the health of fish and people ? Together to make this community the best and healthiest. Density is important in areas not so close to the watercourses and eduation in the area about densification is importanat as well as envronment.
Ian McArthur	I can't support taking water from the Coquitlam River until silt and sediment loads are resolved. An option that was not included could be to divert water by gravity pipe from the outfall at the north end of Gabriola Drive and either release it directly into Maple Creek or pipe it to a storage area and slowly release it to Maple Creek when water is needed. A well is not a viable plan in the long term.	For flood protection, I prefer a combination of the alternatives listed. I would like to see low lying properties purchased sooner than later. If needed, I would prefer a high flow diversion to the Coquitlam River at Davies. I don't support a large pump station upgrade.	As stated in the draft report, a high priority needs to be given to improving riparian cover where private land has encroached and fish barriers need to be removed. Re-development should only occur if there is a reduction in impervious cover.	The Maple Creek Watershed's health is suffering from development decisions and planning that has happened in the past and is continuing to happen today when we know better. There is no better time than now to fix the mistakes we have made in the past. It is time that the health of the Creek is put first. Land needs to be purchased where development should have never been allowed. Riparian areas need to be protected and rehabilitated where encroachment has occurred.

Table D-1: Written Comments Received from Public Open House

Name	Base-Flow Augmentation	Flood Protection	Additional Environmental Features	Comments
Dianne Ramage	First choice is open channel constructed stream, with an electronic intake valve with water TSS and turbidly detector that immediately closes the valve when water quality entering the channel is degraded beyond the sediment and turbidity standards set for each/all/anyone of the gravel mining operations in the Coquitlam River Watershed, or from other causes. When the intake valve closes a backup groundwater well with pump would immediately come on and begin pumping water to ensure the flows in Maple Creek did not drop and dewater any portion of the creek. This option provides an enhanced public -park user experience as well as, additional fish, wildlife and ecosystem habitat. Second choice is a gravity fed intake pipe with the same water quality detection devise and auto shut off valve, with groundwater well/pump backup for the days each month when water quality in Coquitlam River does not meet optimum criteria for salmonids or their prey activities.	First choice is to purchase low lying properties with less than 30 metre setback , construct water course and riparian habitat in new channel which allows opportunity for flood relief, with appropriately sized fish friendly pumps with access and egress, and flood box which allows freedom of domain for all aquatic species as many days per year as possible.	In order of Priority: 1. fish passage- access and egress, Water quantity- not oly summer flows, but whenever the well goes down, even in winter, Water quality, and flow regimes are the most important. 2. Pollution prevention 3. instream structure 4. riparian integrity and rehabilitation. inadequate setbacs few natural / natural like riparian areas. 5. Public education, includes education of government, both elected and hired, and 6. public access these steps will go a very long way to improve this stream that is a significant overwintering & off channel habitat for Coquitlam mainstem species.	-
Elaine Golds, Burke Mountain Naturalists	Need to augment low summer flows, gravity system sounds good, but need to address the sediment isuses.	Purchase land to improve capacity and regain riparian. Self-regulating floodgate would be a good initiative.	urge homeowners to remove barriers and restore riparian. Investigate the possibility of sanitary-storm connections.	

Appendix E

Tide Gate Information

Contents

Figures

Appendix E – Tide Gate Information

E.1 Tide Gates

The Regulated Tide Gate and Non-regulated Tide Gate have been designed to allow simple operation and adjustments as required. The Regulated Tide Gate can be operated in Regulated and Non-regulated Mode while the Non-regulated Tide Gate only allows non-regulated operation. When the Regulated Tide Gate is in:

1. Regulated Mode the tide gate door remains in the open position during the incoming tide to allow water to pass into Maple Creek from the Coquitlam River. The Regulated Tide Gate closes once water levels in Maple Creek reach the pre-set trigger level. The Regulated Tide Gate opens on the outgoing tide once water level in the Coquitlam River fall below the water level in Maple Creek and the pressure on the backside of the gate opens the gate.

2. Non-regulated Mode the tide gate door closes as soon as water levels in the Coquitlam River rise above water levels in Maple Creek and water starts backflowing into Maple Creek. The Non-regulated Tide Gate always functions in this mode.

A diagram showing the function of the Regulated Tide Gate is shown in Figure E-1.

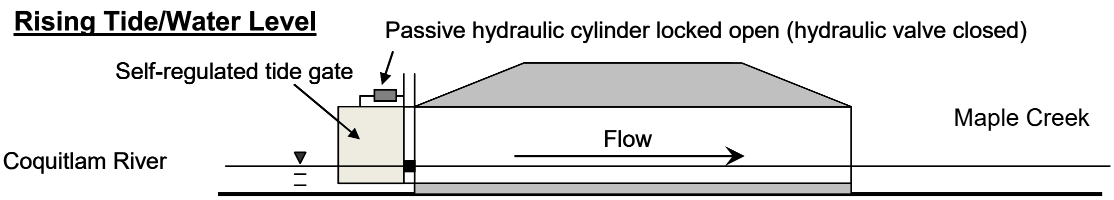
The following sections describe how the Regulated Tide Gate functions and provides instructions on how to operate the gate including setting the operation mode and making adjustments to the pre-set trigger water level for the Regulated Tide Gate.

Regulated Tide Gate Operation

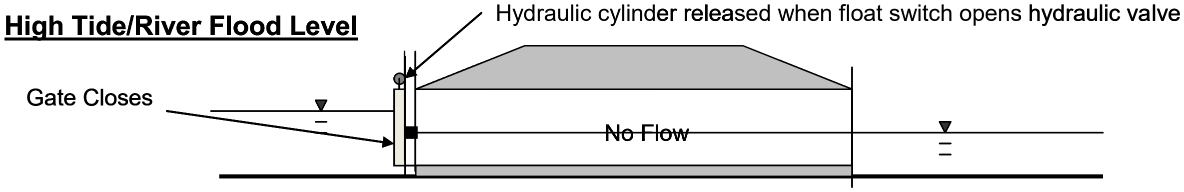
As previously described, in Regulated Mode the Regulated Tide Gate remains open during incoming tide until water levels in Maple Creek reach the pre-set trigger water level. This is achieved with a passive hydraulic loop which consists of a hydraulic piston attached between the tide gate door and the tide gate frame; a hydraulic manifold located in the control kiosk; and reinforced hydraulic hoses between the hydraulic manifold and the hydraulic piston. A copy of the hydraulic system diagram for the Regulated Tide Gate hydraulic system and a photo showing the inside of the control kiosk is shown in Figures E-2 and E-3, respectively.

In Regulated Mode, the Regulated Tide Gate is locked in the open position by a poppet valve inside the hydraulic manifold which prevents the hydraulic fluid from flowing and holds the hydraulic piston in place. When the pre-set trigger water level is reached, the poppet valve is opened by the trigger float rod which allows the hydraulic fluid to flow and the hydraulic piston to move. The rate at which the gate closes is controlled by a regulator valve mounted in the hydraulic manifold. A check valve also mounted in the hydraulic manifold always allows the hydraulic fluid to move in the opposite direction around the loop which allows the gate to open.

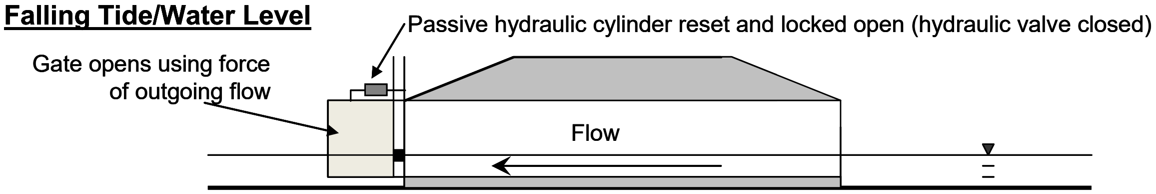
In Non-regulated Mode, the poppet valve is held in the open position which allows the Regulated Tide Gate to open and close freely. It should be noted that the regulator valve remains in operation in non-regulated mode which causes the Regulated Tide Gate to close slowly in comparison with the Non-Regulated Tide Gate.



1. On rising tide, the gate is locked in open position by passive hydraulic cylinder



2. The gate is closed when rising tide level triggers float switch and releases passive hydraulic cylinder



3. The gate is opened by ebbing tide and hydraulic cylinder locks when tide level falls below float switch

Figure E-1: Tide Gate Operation during Tidal Cycle

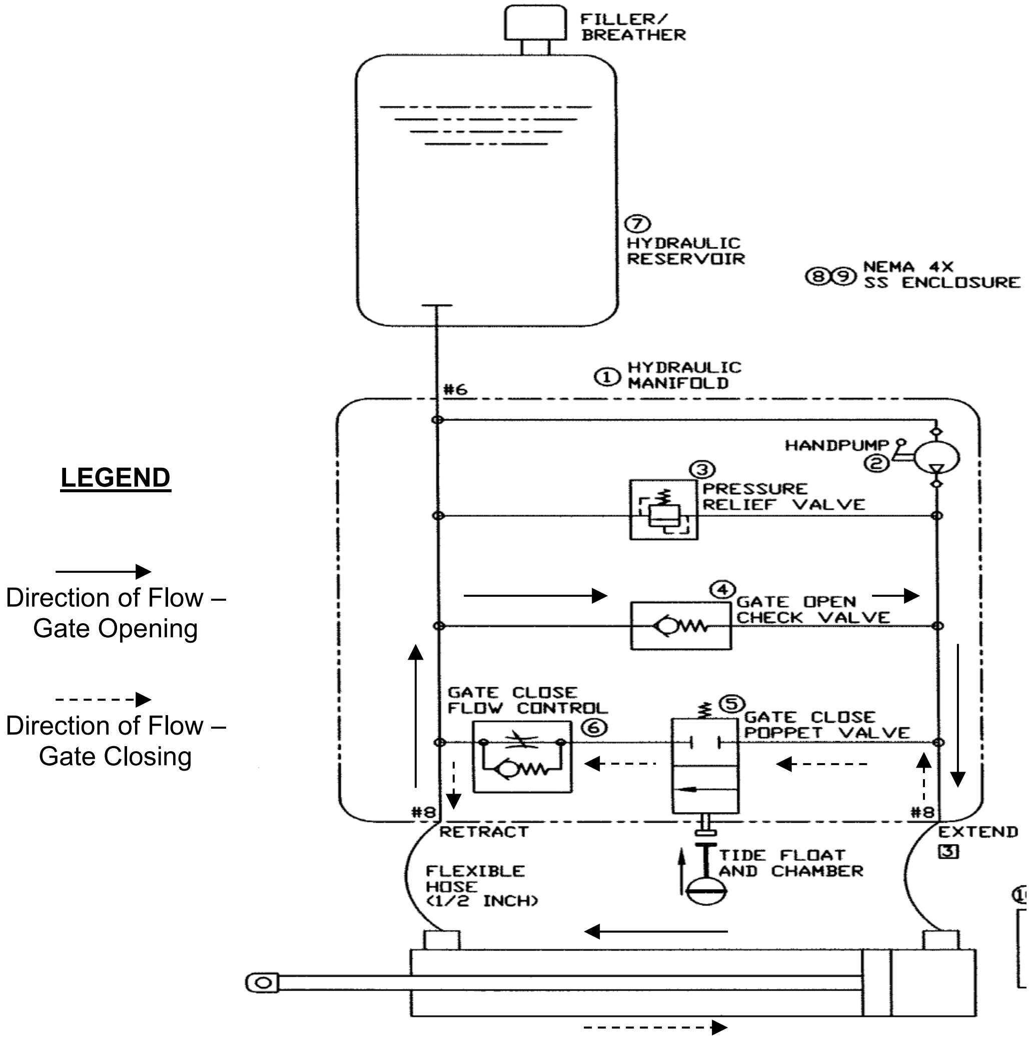


Figure E-2: Regulated Tide Gate Hydraulic System Diagram

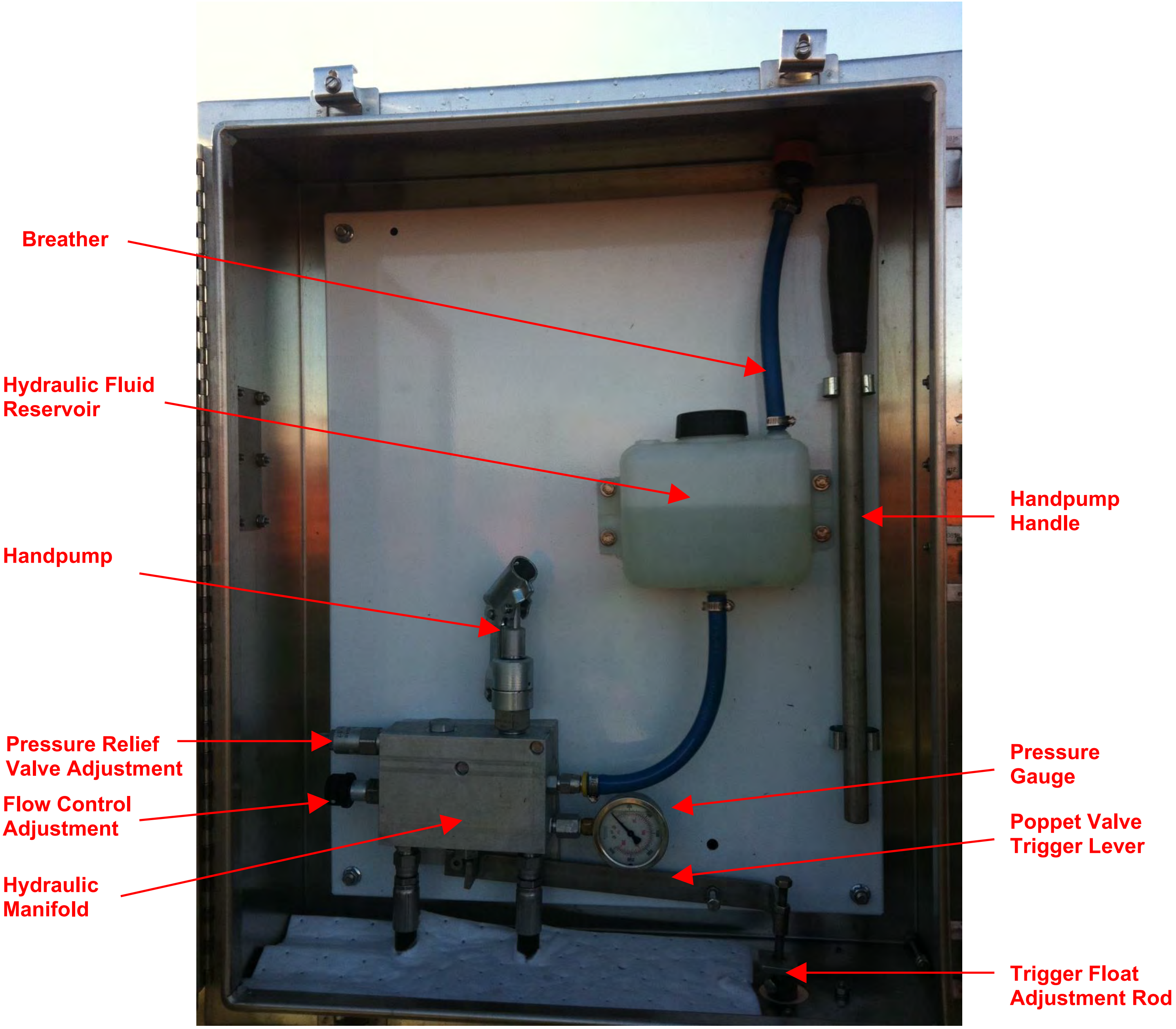


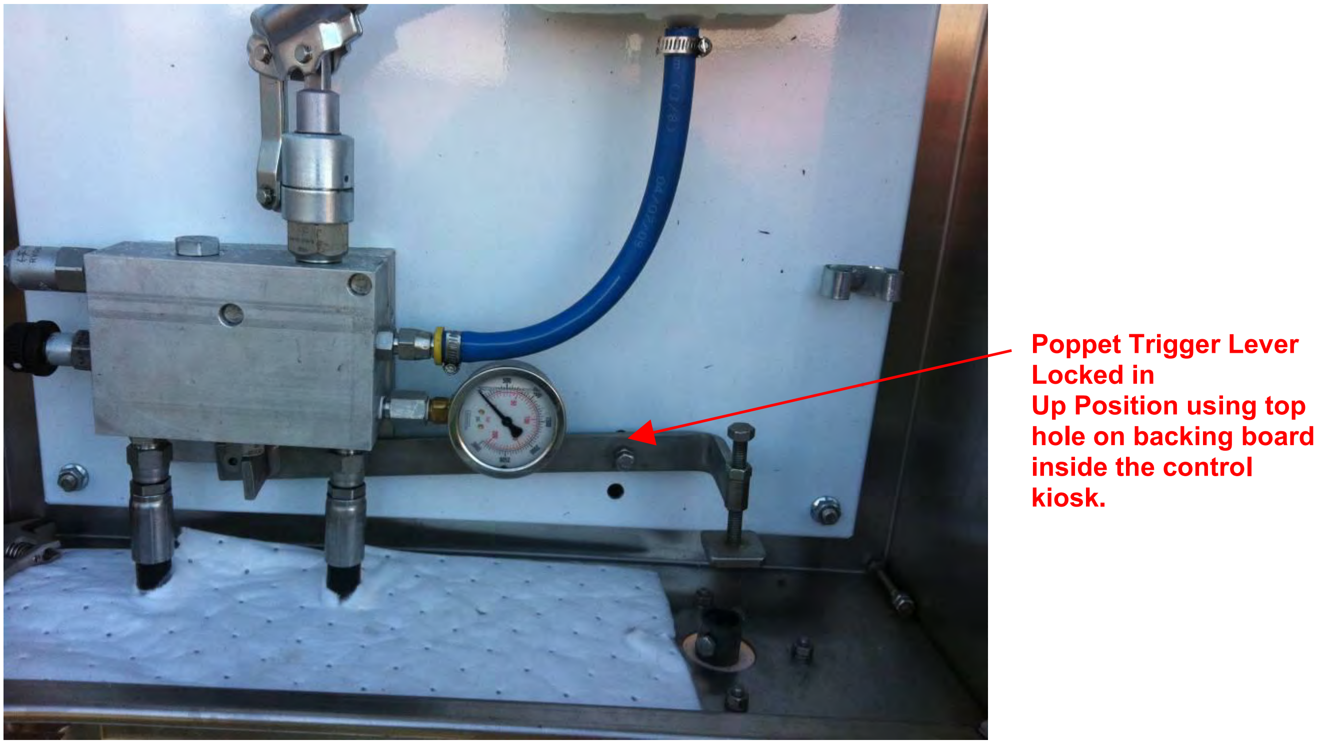
Figure E-3: Control Kiosk Components

Setting Regulated Tide Gate to Regulated Mode and Non-Regulated Mode

To set the Regulated Tide Gate to Non-Regulated Mode, follow the procedure below:

1. Unlock and open the control kiosk;
2. Loosen the nut/bolt on the poppet valve trigger lever;
3. Lift the poppet valve trigger lever;
4. Push the bolt on the poppet valve trigger lever into the top hole in the backing board on the back wall of the kiosk;
5. Tighten the bolt/nut; and
6. Close and lock the control kiosk.

Figure E-4 shows the tide gate set to Non-regulated Mode.



Poppet Trigger Lever Locked in Up Position using top hole on backing board inside the control kiosk.

Figure E-4: Tide Gate Set to Non-Regulated Mode

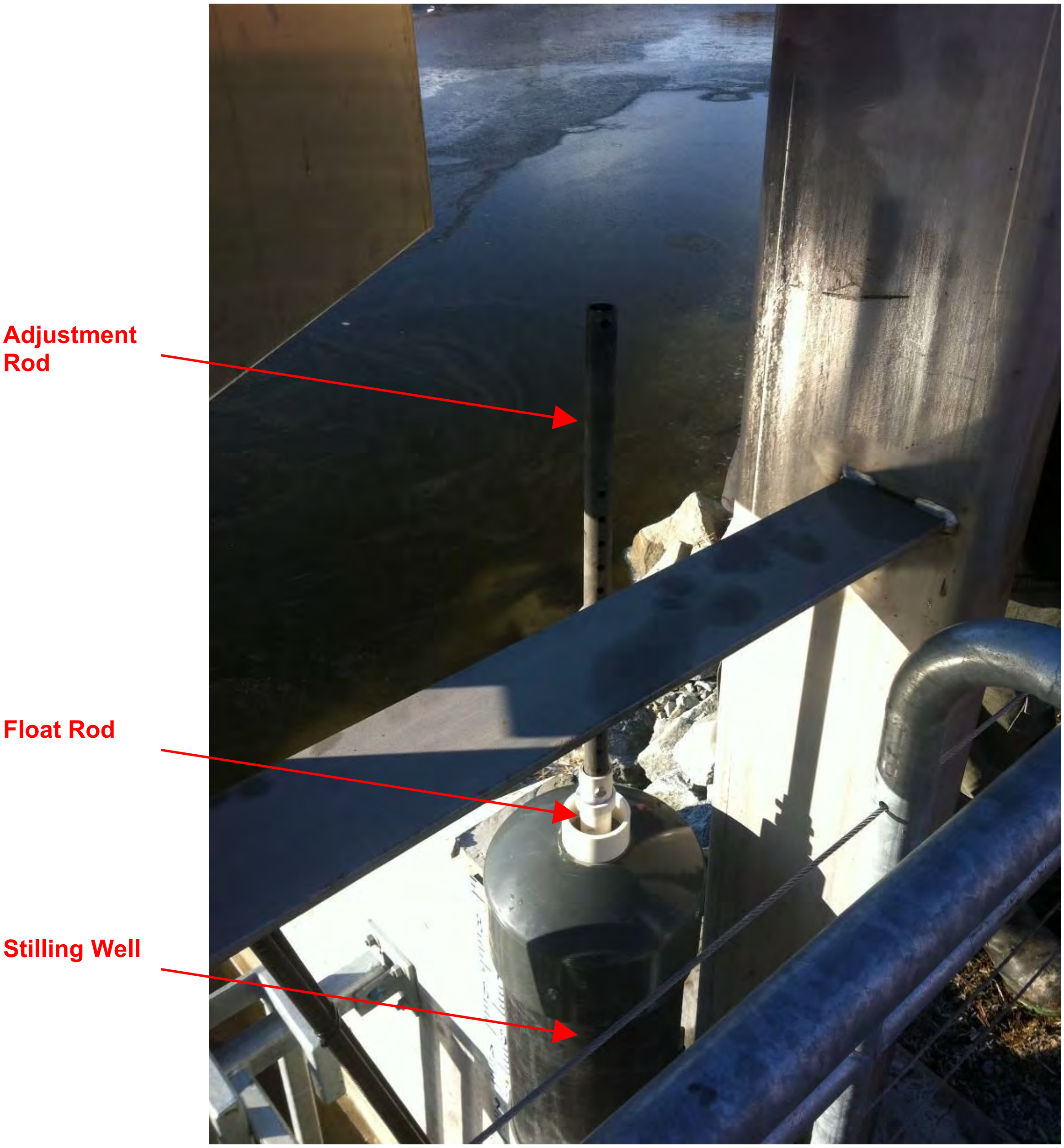
Adjusting Trigger Water Level

To adjust the trigger water level:

1. Unlock and open the control kiosk;
2. Loosen the pipe clamp under the kiosk which holds the bellows protecting the float rod;
3. Unscrew and remove nut/bolt at the top of the adjustment rod (black pipe) to allow the adjustment rod to pass through the hole in the bottom of the kiosk;
4. Unscrew and remove nut/bolt which fastens the float rod (white pipe) and adjustment rod (black pipe) together below the kiosk;
5. Adjust the length of the float control rod (i.e.: move the black pipe in or out of the white pipe). Increasing the length of the float control rod lowers the trigger water level while reducing the length of the float control rod raises the trigger water level. The holes in the adjustment rod (black pipe) are spaced at 25 mm.
6. Record the new trigger water level in the tide gate log (see Appendix C) by adding or subtracting the amount that the trigger rod has been adjusted;
7. Replace and tighten the nut/bolt which fastens the adjustment rod and float rod together;
8. Lift the adjustment rod (black pipe) back through the hole in the bottom of the cabinet;
9. Replace and tighten the bolt/nut at the top of the float control rod (black pipe);
10. Make sure that the rod is moving freely through the hole in the cabinet;
11. Raise the bellows and re-tighten the pipe clamp that holds the bellows to the underside of the kiosk;
12. Close and lock the control kiosk; and
13. Regulated Tide Gate should be monitored to confirm that gate is closing at the correct trigger water level. The staff gauge mounted to the headwall on the Maple Creek end of the tide gate culverts can be used to monitor Maple Creek water levels.

Figure E-5 shows the float rod and trigger rod.

It should be noted that fine adjustments to the trigger water level can be made by adjusting the pad on the end of the poppet trigger lever inside the control kiosk.



Note: Control kiosk has been swung out of the way for clarity but is not required to adjust the trigger water level setting.

Figure E-5: Float Control Rod (Float Rod and Adjustment Rod)

Manually Opening Tide Gate

The tide gate can be manually opened using the hand pump inside the control kiosk. IMPORTANT NOTE: the tide gate should only be opened manually when the water level on the Coquitlam River is below the pump station ON switch level. Refer to the staff gauge mounted on the headwall to confirm water levels.

To manually open the tide gate:

1. Unlock and open the control kiosk;
2. Insert handle into the hand pump at the top of the hydraulic manifold inside the kiosk;
3. SLOWLY pump the handle and watch the pressure gauge (see note below);
4. Continue pumping until the gate is fully open with the gate door at approximately 60 degrees to the face of the headwall.
5. Remove the handle from the hand pump; and
6. Close and lock the control kiosk.

When opening the tide gate using the hand pump, the system pressure should be carefully monitored. Should pressure rise above 1,000 psi pumping should be stopped in order to prevent the pressure relief valve from releasing high pressure into the reservoir. The pressure relief valve is set to 1,500 psi.

Figure E-6 shows the hand pump with handle attached.

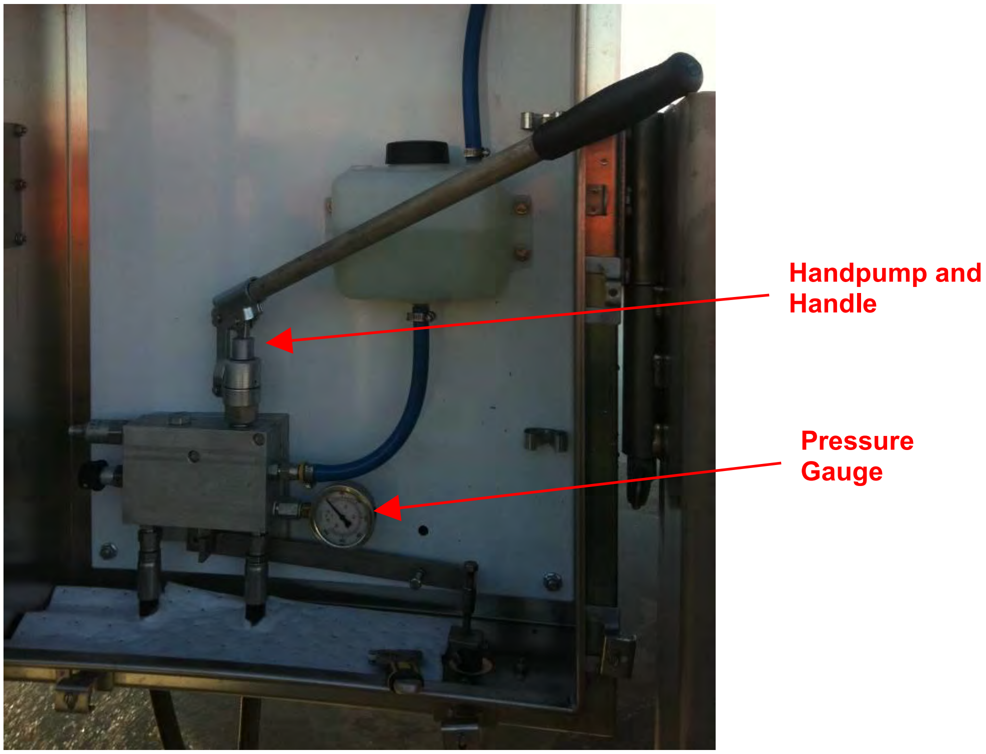


Figure E-6: Tide Gate Hydraulic Hand Pump

Opening Stilling Well for Inspection/Maintenance of Float

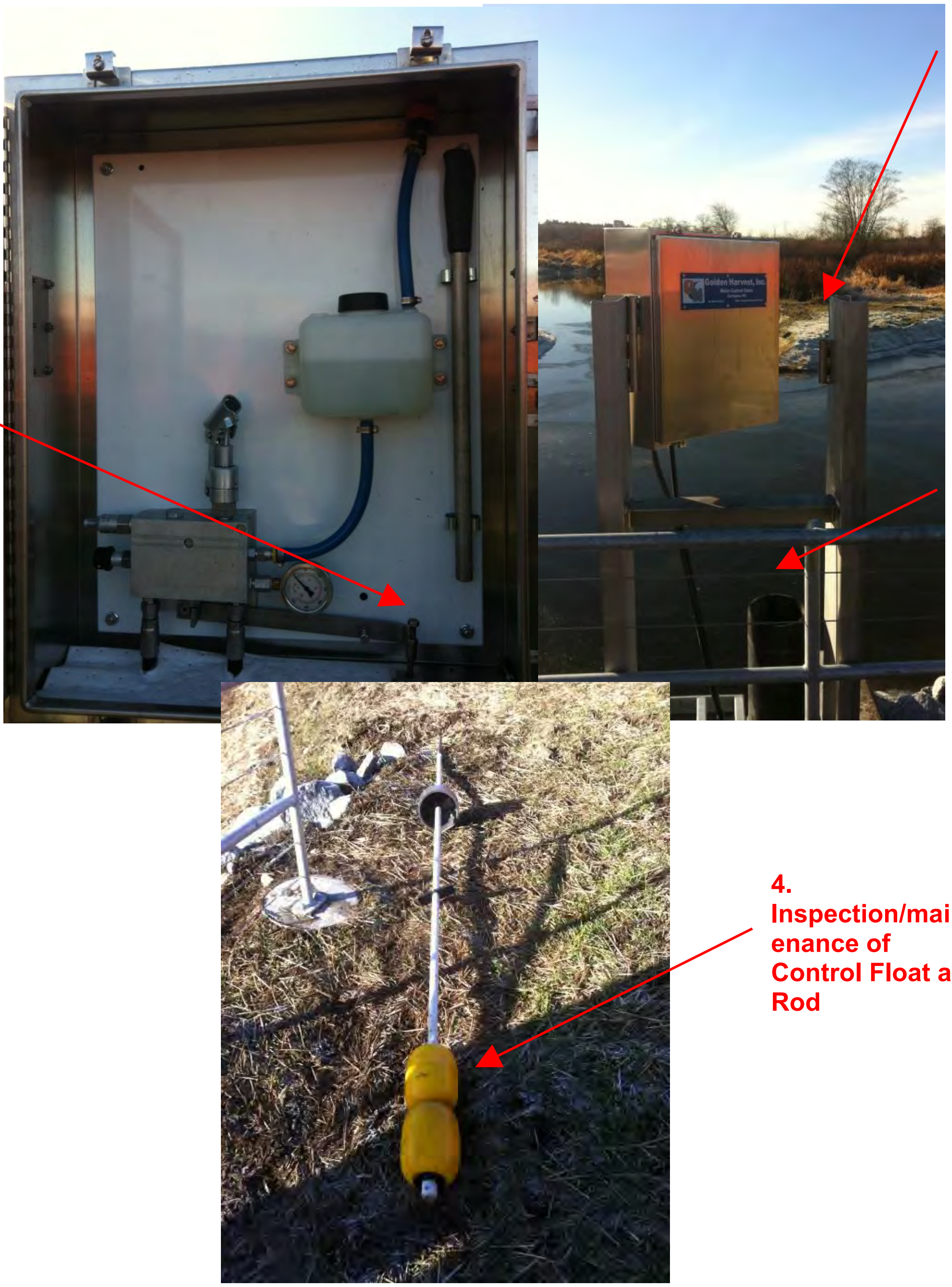
The float stilling well can be opened for inspection/maintenance.

To open the stilling well:

1. Unlock and open the control kiosk;
2. Loosen the pipe clamp under the kiosk which holds the bellows protecting the float rod and lower the bellows;
3. Unscrew and remove nut/bolt at the top of the adjustment rod (black pipe) to allow the adjustment rod to pass through the hole in the bottom of the kiosk;
4. Unlock and remove the pin supporting the control kiosk on right hand side;
5. Confirm that the adjustment rod is clear of the bottom of the kiosk and swing the kiosk outwards;
6. Remove cap from the top of the stilling well by unscrewing three screws holding the cap in-place; and
7. Remove the float by lifting on the float control rod.

When putting the float rod back into place be certain that the adjustment rod is inserted back into the hole in the bottom of the kiosk and the nut/bolt is replaced in the top of the adjustment rod to hold it in place.

Figure E-7 shows the steps for removing the float for inspection and maintenance.



1.

Open control kiosk and lower adjustment rod by removing nut/bolt at top of rod inside kiosk.

2.

Unlock and remove pin to swing control kiosk

3.

Remove cap from top of stilling well and remove float.

4.
Inspection/maintenance of Control Float and Rod

Figure E-7: Tide Gate Stilling Well Inspection/Maintenance

Appendix F

Impacts of Development

Contents

Figures

Tables

Appendix F – Typical Impacts of Development

F.1 Understanding Stormwater Management

Introduction

This section outlines stormwater impacts associated with land development. Impacts caused by both large, infrequent storm events and small, frequent storm events are discussed, and the primary factors affecting stream health are also reviewed.

Understanding the Impacts of Land Development

Land development typically involves replacing pervious forested area with agricultural land followed with impervious pavement, concrete and building structures. Redevelopment typically involves replacing developed areas with higher density land use with a further increase in total impervious area (TIA). Increasing impervious area results in two types of impacts:

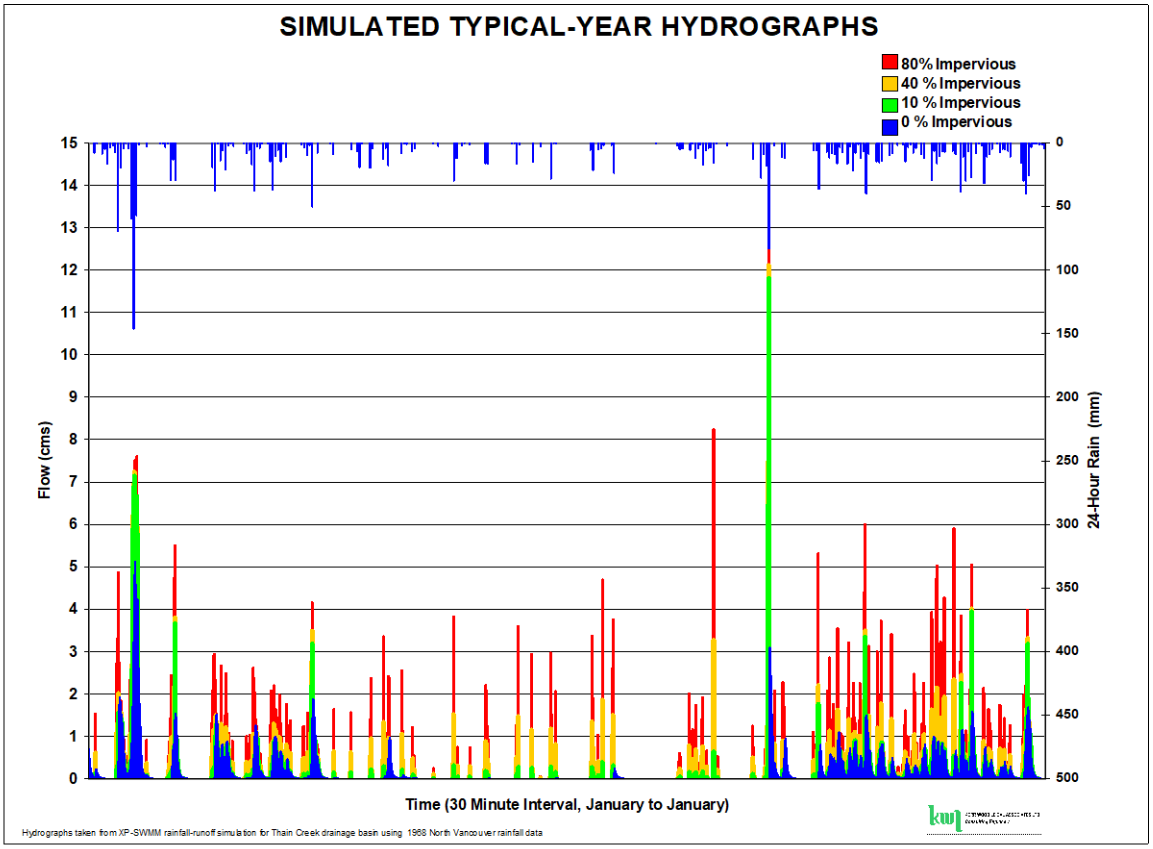
- **Stormwater Quantity Impacts:**Increased and faster responding peak flow rates during extreme rainfall-runoff events can cause flooding and erosion, and during typical rainfall events can trigger watercourse instability and deteriorate aquatic habitat. Baseflows during dry weather periods decrease and therefore reduce the fish support capacity of a watercourse.
- **Stormwater Quality Impacts:**Land development and building construction activities result in sedimentation of watercourses. It has been found that urbanization over 30% TIA also results in non-point source (NPS) pollution of receiving waters and poor stream water quality. Together, sediment and contaminants can significantly degrade the fisheries value of a creek system.

Stormwater Quantity Impacts

Stormwater quantity impacts can be segregated into two types, those associated with large infrequent storm/runoff events and those associated with smaller, more frequent ones, as follows:

Table F-1: Stormwater Quantity Impacts of Land Development

Storms	Return Period Event	Resulting Runoff	Potential Impacts of Development	Type of Assessment
Infrequently Occurring Large Storms	10-year to 100-year	Runoff results from both impervious and pervious areas for both the undeveloped and urbanized conditions, but a quicker, greater response occurs under the urbanized condition.	Flood and erosion damage	Hydrotechnical
Frequently Occurring Small Storms	Less than 2-year	Very little, if any, runoff is generated under natural forested conditions. Once land is urbanized, however, runoff results.	Stream corridor 'wear-and-tear' & deterioration of aquatic habitat	Environmental



Hydrographs taken from XP-SWMM rainfall-runoff simulation for Thain Creek drainage basin using 1968 North Vancouver rainfall data

Figure F-1: Simulated Typical-Event Hydrograph for Levels of Imperviousness

Prior to land development, minor rainfall events do not yield surface runoff. However, because of increased impermeable area, surface runoff from these minor storms is produced after land development. This is clearly shown in the typical-year hydrograph for various levels of development (refer to following figure).

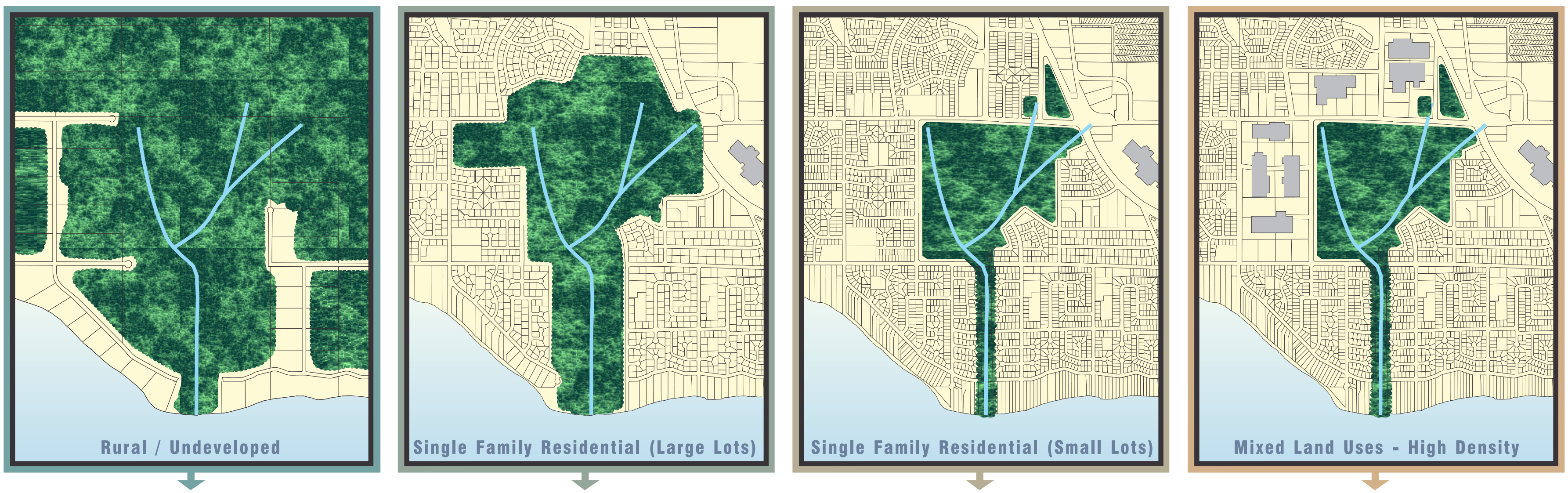
Research has shown that urban development, which typically increases impervious area and decreases riparian corridor, significantly impacts the abundance and diversity of fish populations and benthic macroinvertebrate communities. This is illustrated conceptually in Figure A-3.

The increased frequency of higher runoff rates and volumes causes watercourse wear and tear. The Mean Annual Flood (MAF) is a key parameter because watercourses tend to be in equilibrium under the MAF. The consequence of increasing the MAF is channel erosion until the channel widens or deepens to the point of establishing a new equilibrium. Erosion and sedimentation processes then progressively eliminate aquatic and riparian habitat.

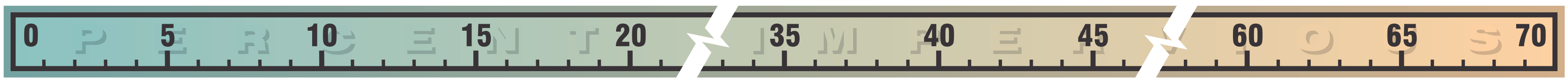
510-057\500-Drawings\510057FigA-2_Impacts.CDR

STORMWATER IMPACTS OF INCREASING URBANIZATION

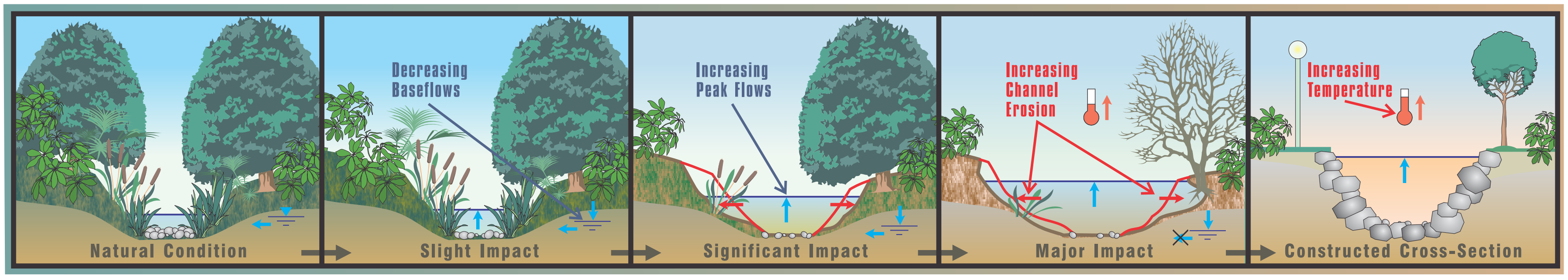
INCREASING URBANIZATION (NO BEST MANAGEMENT PRACTICES)



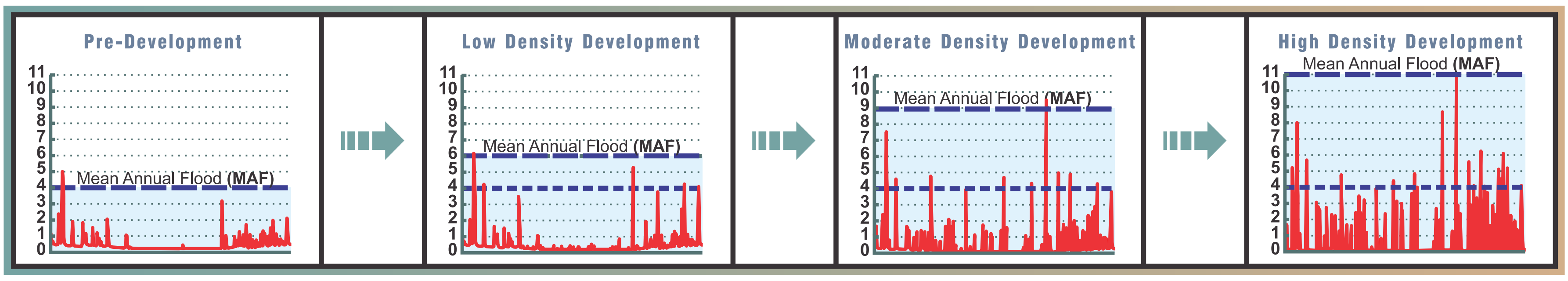
PROPORTION OF IMPERVIOUS LAND AREA (%)



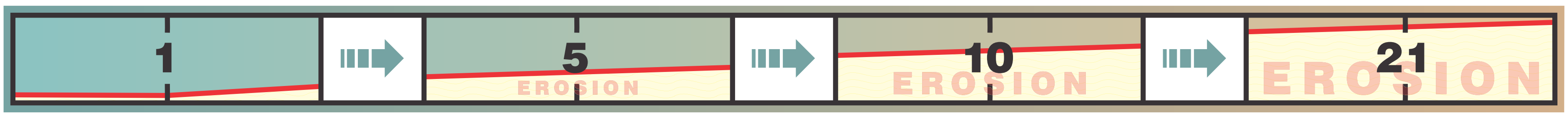
EFFECT ON WATER QUALITY AND AQUATIC HABITAT



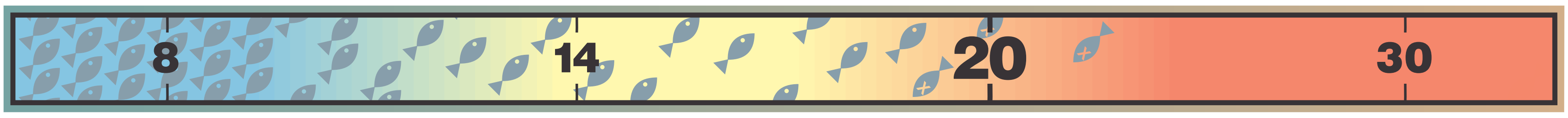
EFFECT ON TYPICAL YEAR HYDROGRAPH



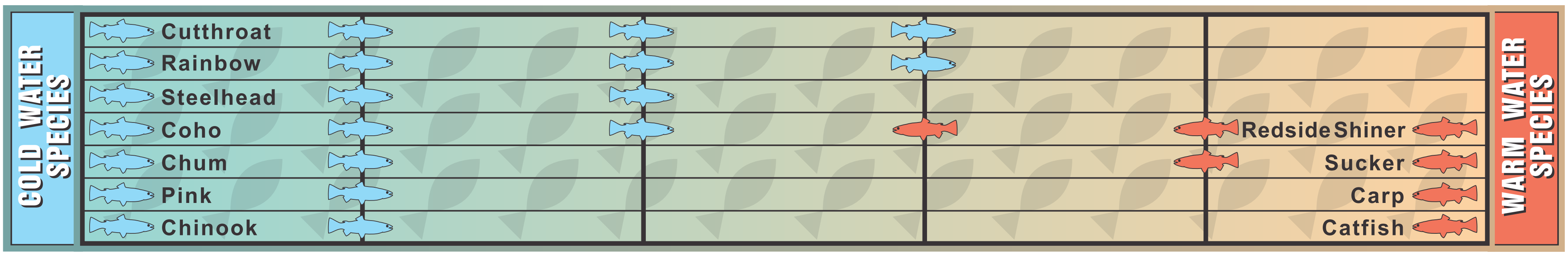
NUMBER OF STORM EVENTS AT OR ABOVE PREDEVELOPMENT MEAN ANNUAL FLOOD



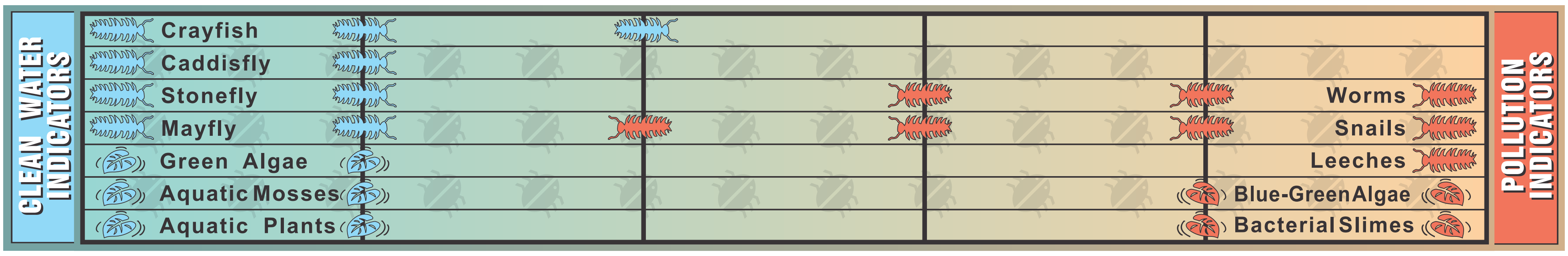
RATIO OF MEAN ANNUAL FLOOD TO WINTER BASE FLOW



EFFECT ON DIVERSITY AND ABUNDANCE OF THE FISHERIES RESOURCE



EFFECT ON BIOTIC INDICATORS FOR BENTHIC ORGANISMS



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CONSULTING ENGINEERS

Figure F-2

The reduction in groundwater infiltration and recharge results in lower baseflows, and hence higher ratios of peak flows to baseflows.

Primary Factors Limiting the Ecological Health of Urban Waterways

Recent research on urban streams indicates that four primary factors affect its ecological health. They are listed, in order of importance, as follows:

- changes in hydrology;
- disturbance to the riparian corridor;
- disturbances to fish habitat; and
- deterioration in water quality.

'Changes in hydrology' can be viewed as the paramount factor because it can impact the other factors. Increases in hydrology (flows and volumes and the frequency of their occurrence) accelerates natural rates of erosion and sedimentation, degrades or washes out aquatic and riparian habitat, and deteriorates water quality.

By the time pollutant loading is a significant water quality problem affecting fish survivability, the higher frequency of occurrence of increased flows resulting from land use densification have already degraded or disturbed the physical features associated with productive fish habitat.

Understanding the four limiting factors is key to developing guiding principles for an integrated approach to the environmental component of the ISMP. Address 'changes in hydrology' on a watershed basis, and there will be spin-off benefits in mitigating the other three factors.

Ecological Health Indicator/Performance Measure - Benthic Communities

During the past decade, environmental factors have become integral to stormwater management planning. It is now widely accepted that conventional stormwater management practices are ineffective in protecting aquatic habitat. Numerous problems include everything from the way cities are built, to the type of stormwater facilities built, and to the stormwater criteria used. Even today, many Best Management Practices (BMPs) and Low Impact Development (LID) methods are unproven, and the science behind them continues to evolve. LIDs methods encourage infiltration, evaporation, transpiration, and storage of rainfall on-site to minimize runoff. These methods are gaining popularity as a tool to help minimize the negative effects of stormwater. A measure, independent of the technology, methods, and criteria, is needed to determine whether the proposed stormwater management activities are achieving their objectives. The measure should also be reproducible in order to be defensible.

The biological integrity in a watershed can be measured in the form of the benthic macro-invertebrates community or streambed insects. Benthic macro-invertebrates occupy all watercourses, and their presence is independent of barriers and blockages, commercial and sport fishing quotas, and ocean survival of salmonids.

The Benthic Index of Biotic Integrity (B-IBI), developed by Karr (1996-1999), is a statistical rating system to measure benthic macro-invertebrate communities. The index reflects Pacific Northwest conditions and has proven to be reproducible across most creek systems. More information on the index and how to use it can be found at http://www.salmonweb.org/salmonweb/ and within the report *Environmental Effects of Stormwater Discharges on Small Streams - Habitat and Benthic Assessment*, April 2000 available from the GVRD.

The index ranges from a score of 10, which indicates the watershed health is in a“poor” condition, to a score of 50indicatingthe watershed health is “excellent”. Wild salmon are expected to be found in watersheds with high scores; while fewer fish species and lower salmonid densities are expected in watershed with scores below 25.

Land use changes, BMPs, and LID standards can be linked to the B-IBI scores or number and diversity of macroinvertebrates in a creek system. The index can also be used as a predictive planning tool.

Linking B-IBI Scores with a Watershed’s Total Impervious Area

‘Changes in hydrology’ is directly linked to the concept of ‘total’ versus ‘effective’ impervious area.

- **Total Impervious Area (TIA):** Paved surfaces, building roofs and areas sealed from the underlying soils that are directly and indirectly connected to the local piped drainage system.
- **Effective Impervious Area (EIA):** Paved surfaces, building roofs and areas sealed from the underlying soils that are directly connected to the local piped drainage system. Thus, any part of the TIA that drains onto pervious ground is excluded from the measurement of EIA.

TIA is a physical measurement of impermeable surfaces typically taken from air photos, while EIA is determined through flow monitoring, and the hydrologic model calibration and verification process.

Figure A-2 is a graph showing a strong relationship between B-IBI scores and TIA. As TIA increases (watershed becomes more developed), B-IBI decreases (fewer and less diverse macroinvertebrate communities and therefore decreasing watershed health). Reducing TIA by applying the EIA concept based on the premise that impervious surfaces can be disconnected from the piped drainage system and the creek for frequently occurring events can have great environmental benefit. Implementing LIDs/BMPs that reduce EIA through the use of infiltration, attenuation, evaporation, and transpiration will reduce TIA, and increase the health of the watershed (and its B-IBI score).

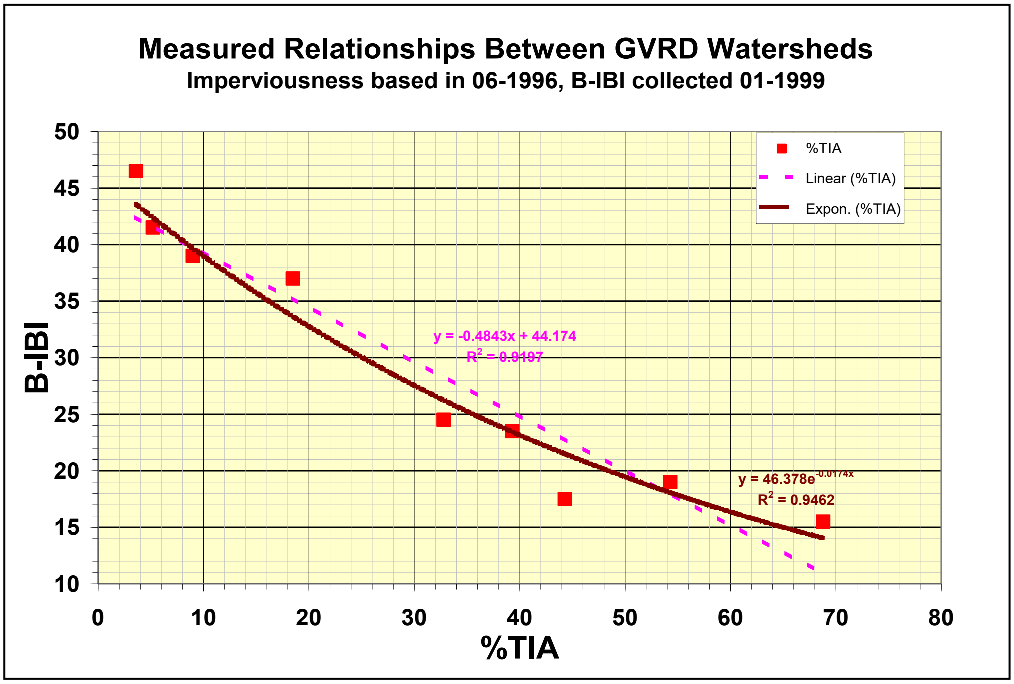

Figure F-3: Relationship between B-IBI Score and TIA

Summary of Findings

The key findings of this section are summarized as follows:

- Land development affects stormwater quantity and quality. With a TIA greater than 30%, increased peak flows and volumes for extreme events can cause flooding and erosion, and frequently occurring events can cause watercourse wear and tear resulting in erosion and deterioration of aquatic habitat. In addition, stream water quality is typically poor when the TIA is greater than 30%;
- The four primary factors affecting the ecological health of urban watercourses are, in order of importance: changes in hydrology, disturbances to riparian corridor, disturbances to fish habitat, and deterioration of water quality; and
- Benthic macroinvertebrate measurement is a biological indicator and performance measure of creek ecological health. It can be correlated with TIA and EIA.

Appendix G

Mitigation Measures

Contents

Appendix G – Mitigation Measures

G.1 Low Impact Development Practices

Introduction

Low Impact Development (LID) is a design with nature approach that reduces a development's ecological footprint. LID concepts embodied at the planning stage, often affords more opportunities to reduce the overall negative effects of development and reduce costs. Requirements for expensive traditional stormwater infrastructure may also be reduced as less runoff will be generated.

There are many best management practices (BMPs) commonly used in LID, however it is not always possible to incorporate all of them into a development, and even with adoption of all available LID options, there will still be changes to the hydrologic regime relative to the pre-development conditions and some additional measures or facilities will often be required. LID practices are most effective in mitigating adverse stormwater effects when used in combination with other BMPs, such as constructed source controls and detention. The *Puget Sound Action Team's LID Technical Guidance Manual*[1] is an excellent resource for LID planning and design.

Reduced Road Widths

Traditional road pavement widths may be larger than they need to be, particularly for streets that are residential access only, and not thoroughfares. Road widths can be narrowed to a minimum that allows necessary traffic flow, but that discourages excess traffic and excess speed, both of which are beneficial in a family- and pedestrian-oriented neighbourhood. Road widths do, however, need to meet the community's needs for utility and emergency vehicle access and these requirements will often determine acceptable minimum road widths.

Reduced Building Footprints

Building footprints, and impervious roof area, may be reduced without compromising floor area by increasing building height. This also allows greater flexibility to develop layouts that preserve naturally vegetated areas and provide space for infiltration facilities. Some relaxation of building height restrictions may be necessary to allow this type of design.

Reduced Parking Standards

Reducing the required number of parking spaces for a development reduces the impervious area and encourages pedestrian and public transit-friendly communities. Reducing the required parking spaces also reduces development costs.

Limiting Surface Parking

Limiting surface parking and restricting parking to below building roof areas, also directly reduces the impervious area in a development.

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[1] Low-Impact Development Technical Guidance Manual Puget Sound, 2005. http://www.psparchives.com/our_work/stormwater/lid.htm

Pervious Parking Surfaces

Use of pervious paving materials rather than impervious concrete or asphalt can reduce the runoff generated from parking areas. Pervious materials may include pavers, reinforced clean crushed gravel, reinforced turf, or engineered permeable pavements.

Reinforced Clean Crushed Gravel

Geogrid

Building Compact Communities

A complete and compact development plan preserves more natural watershed features and significantly reduces imperviousness. In some cases, compact communities have up to 75% less roadway pavement per dwelling unit, and parking needs are reduced because local services are more accessible by pedestrians and via public transit.

Preserving Naturally Significant Features

Preservation of natural areas in a watershed is always an important consideration, which can provide recreational as well as environmental benefits but some natural areas perform special aquatic ecosystem functions and as such are vital to maintaining watershed health. These areas, which include riparian forests, wetlands, floodplains and natural infiltration depressions with highly permeable soils, are particularly important to inventory and protect from alteration.

G.2 Stormwater Source Control Technologies

Stormwater source controls reduce the runoff that is discharged to the stream network by managing the water balance at the site level. Source controls play a key role in achieving Rainwater Management Criteria for volume reduction, water quality treatment, and runoff control and can be very effective at reducing runoff volumes and peak runoff rates from events smaller than the 50% of 2-year storm. Though they do provide some flow-detention benefits for the 2-year storms, source controls have limited ability to reduce peak runoff rates from large storms and must be designed with adequate overflow capacity. Additional stormwater infrastructure must be provided to safely convey stormwater offsite for the larger events.

Several standard source control technologies are described below. The *Metro Vancouver Stormwater Source Control Design Guidelines*[2] is an excellent reference for source control BMP design advice.

Absorbent Landscaping

Natural topsoil is generally permeable. The vegetation on topsoil provides a layer of organic matter which is mixed into the soil by worms and micro-organisms, creating voids, which allow rain water to percolate through, and making the soil more structurally capable of providing storage in the void spaces when saturated.

Standard construction practice is often to strip the existing topsoil, compact or excavate a site surface to the desired grade, and then cover it with a thin layer of imported topsoil. Although lawns and other ornamental landscaping will establish a vegetated surface, both the original surface and subsurface flows and storage capacities have been altered and surface runoff will be increased. Instead of stripping and removing, original topsoil it should be replaced on the site and augmented with organic matter and sand to improve soil structure and increase macropore development.

To increase absorbency, surface soils should have a minimum organic content to facilitate plant growth and a soil depth sufficient to meet the 50% of 2-year rainfall capture target. Increased soil depths also provide retention for runoff from adjacent hard surfaces. Surface vegetation should include herbaceous groundcovers with a thickly matted rooting zone, deciduous trees, or evergreens.

Some maintenance over the long term is required for the absorbent landscape to continue to provide stormwater benefits. Maintenance activities may include replacing soils that have eroded and replanting dead or dying vegetation.

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[2] Metro Vancouver, Stormwater Source Control Design Guidelines, 2005 http://www.gvrd.bc.ca/sewerage/stormwater_reports.htm

Absorbent Landscaping

Absorbent Landscaping

Surface Infiltration Facilities

Rainfall runoff is stored at or near the surface in a layer of absorbent soil, sand, gravel, or rock, and/or on the ground surface in a ponding area. The stored runoff that infiltrates into the soil becomes interflow and augments groundwater in the sub-surface.

Surface infiltration facilities can look like normal vegetated swales or ponds and can be aesthetically landscaped and integrated into the design of open spaces. They include bioretention facilities and rain gardens. Both surface and sub-surface infiltration facilities can be effective at the lot level, as well as at the neighbourhood level, where individual lot sizes or layouts don't support on-lot facilities or where more permeable soils or groundwater recharge areas are located off-site. Surface infiltration facilities can, depending on their design, provide some level of water quality treatment as well.

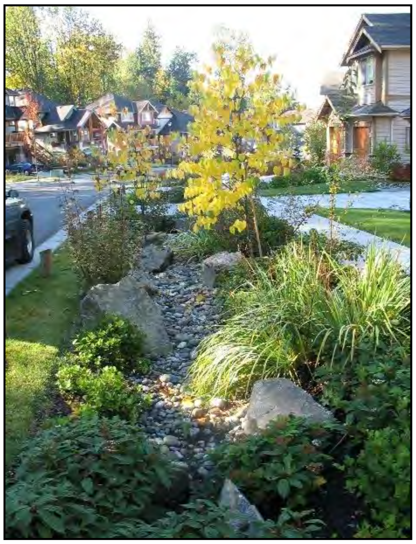
Surface infiltration can be combined with detention, where the detention release rate allows sufficient time for infiltration through the pond. Infiltration facilities are highly dependent on the hydrologic properties of the sub-surface soils.

Surface infiltration can also be promoted by the used of permeable pavers or other pervious surfacing materials.

Bio-Retention Facilities

If infiltration rates are low, such as is likely in clay and till soils, bio-retention facilities can be designed to store the volume reduction target in soil and rock trench voids and infiltrate it slowly over time.

Where applicable, a retention facility may also be designed as a baseflow augmentation facility that retains the design capture volume in a tank or pond and releases it at baseflow rates. These rates are very low and are based on measured summer baseflows in a watercourse divided by the contributing watershed area, and then applied to the area of the site contributing runoff. Baseflow augmentation facilities discharge the capture volume to the downstream stormwater system or watercourse at a maximum of the determined baseflow rates. Any volumes above the capture volume must be allowed to bypass the baseflow augmentation facility.



Bio-Retention Swale

Bio-Retention Swale

Sub-surface Infiltration Facilities

Sub-Surface Infiltration

A similar design process is used for sub-surface infiltration as for surface infiltration facilities. The main advantage of sub-surface facilities is that they often have vertical walls and do not require as much dedicated ground area, allowing them to be located beneath paved impervious areas.

Sub-surface facilities must be located at least 0.5 m above the level of the water table so that they can discharge through the sides and bottom of the structure and will not merely store infiltrated groundwater. Generally, the deeper an infiltration facility is located, the less-effective it will be. Subsurface infiltration facilities can be as simple as a trench filled with clean, free-draining rock that is protected from soil by a permeable membrane. There are numerous products available commercially for subsurface infiltration as well.

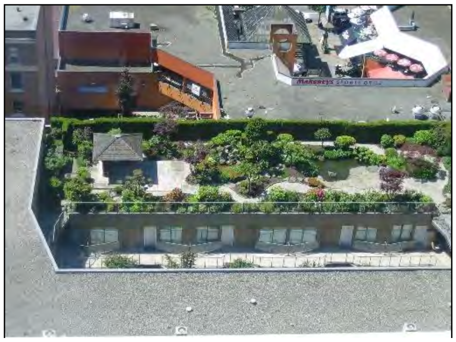
Green Roofs

Installing a green roof rather than a conventional impervious roof can significantly reduce the volume and rate of runoff from a building lot particularly for the smaller, more frequent storm events.

A green roof is essentially a roof with a layer of absorbent soil and vegetation on top of a drainage collection layer or system. Rainfall is absorbed or stored by the soil and vegetation for later evapotranspiration. The green roof has a limited storage capacity, so any excess rainfall percolates through and is collected by a drainage system. The excess rainfall is then routed to the ground for detention and conveyance.

Green roofs are more expensive to build as they have structural costs as well as landscaping costs and do require maintenance to ensure their ongoing functionality. However, when compared with land costs for alternate facilities in high density urban areas, the costs for a green roof may be favourable. Green roofs also have other benefits, in addition to stormwater benefits, that can include heating or cooling cost savings by insulating the building, aesthetic benefits, air quality benefits, and reduced solar gain that decreases the urban heat island effect. Green roofs should only be designed and constructed by qualified professionals as structural engineering, building envelope and landscape design as well as stormwater engineering are all critical components. Green roofs are the preferable source control in areas where ground surface controls are not possible. For more information on green roofs readers are referred to the *Green Roofs for Healthy Cities* website.

Green Roof



Green Roof

Rainwater Re-use

Rainwater re-use is commonly afforded by residential rain barrels which are effectively retention facilities for roof runoff. Limitations of rain barrels are that rainfall is seldom a reliable source for water during the dryer seasons and rain barrels are often not large enough to store the 50% of 2-year capture target. The most significant reductions in runoff volume from re-use are achieved by capturing and re-using rainwater for indoor grey-water uses, or for commercial and industrial applications with high water consumption rates or where water supplies are limited. Recycling rainwater reduces demands from surface waters and reservoirs and can reduce supply infrastructure costs. Rainwater re-use can also be combined with infiltration facilities.

Re-Use Tank

Re-Use Rain Barrel

Water Quality Best Management Practices

Changes in land use, loss of natural biofiltration capacity, increases in impervious area, and pollutant laden runoff associated with urban development can contribute to reduced water quality which impacts fish and fish habitat. BMPs designed to capture and treat runoff need to be incorporated into RWMPs.

Water Quality BMPs are physical, structural or management practices that reduce or prevent water quality degradation. Many of these are the same as, or similar to those used for runoff volume reduction and rate control and but have ancillary benefits for water quality. Source control remains the key means of reducing introduction of toxic and hazardous materials or organic and inorganic contaminants, originating from land and water use or as a result of commercial or industrial spills. Without source control, runoff water quality is limited by the effectiveness of treatment technology.

Treatment controls are point-source water quality management measures. They are generally constructed facilities and are often individual installations incorporated into the stormwater management infrastructure. They should be designed on a site-specific basis, after examining all alternative treatment technologies, and selecting the best available options based on cost and effectiveness. These controls should be designed and constructed by appropriately qualified environmental professionals.

Water Quality Best Practical Technologies

Several technologies have the ability to provide both water quality benefits and runoff control. Water quality benefits are derived from contaminant removal mechanisms that use biological and physical processes. Runoff control is accomplished by improving stormwater detention and retention which reduces peak runoff discharge rates and volumes.

Biofilters

Biofilters are vegetated filter strips, swales and rain gardens that remove deleterious substances, notably particulate contaminants, though some combination of physical (e.g.: adsorption) and biological (biodegradation) removal mechanisms. Biofilter technology is suitable for sheet flow runoff, typical of large linear impervious developments like roadways and parking lots.

Urban Forests and Leave Strips

Depending on the extent of tree canopy and ground cover retained, runoff reduction and pollutant removal can be achieved by maintaining natural well functioning urban forested areas. The contaminant removal processes forests and natural vegetation provide include: filtration, adsorption, absorption, and biological uptake and conversion by plant life. Urban forests also provide habitat refuges for many species whose habitats have been fragmented while riparian leave strips along watercourses, provide critical fish and wildlife habitat.

Infiltration Systems

Infiltration systems generally require pre-treatment for water quality to prevent clogging and binding-off of the permeable materials and contamination of underlying aquifers. Physical removal of deleterious substances by filtration and adsorption, as well as conversion of soluble pollutants by bacteria, also occurs within the infiltrating soils.

Constructed Wetlands

Physical, biological and chemical processes combine in wetlands to remove contaminants and either surface or subsurface flow wetlands can be constructed specifically to treat stormwater runoff. Constructed wetlands also offer retention benefits and can create preferred habitats for aquatic and terrestrial wildlife species. **The use of existing natural wetlands to treat stormwater however is not an acceptable practice**.

Small Wetland

Wetland

Wet Detention Ponds

Permanent wet ponds remove pollutants and other deleterious substances through physical processes such as sedimentation, filtration, absorption and adsorption and through biological mechanisms such as: uptake and conversion by plants, and microbial degradation. Wet ponds can also detain flows thereby contributing to rate control and volume reduction objectives. General design parameters need to include: vegetation types (floating, emergent and submergent vegetation), water depth and ponding area, and will often require consideration of detailed pond specific operational parameters.

Oil and Grit Separators

Oil and grit separators are suitable for spill control and removal of floatable petroleum-based contaminants as well as coarse grit and sediment from small areas, such as gas stations, automotive service areas and parking lots. Oil and grit separators have limited application in large-scale stormwater runoff applications and should be limited to small area generation sites.

Oil Grit Separator

Oil Grit Separator

Construction Best Practices

Construction Best Practices for instream stormwater management works include timing of the works to minimize impacts. Timing windows should be adhered to in order to minimize impacts to fish and wildlife and specifically to avoid sensitive periods for certain life history stages of fish (e.g.; adult spawning, egg and alevin intergravel incubation). Where information is available on critical life history stages and timing for any identified Species at Risk, these times should also be avoided. Clearing should only be undertaken immediately in advance of work, and only during vegetation clearing timing windows, where these have been identified for protection of nesting birds. To the extent possible, work should be restricted to cells and undertaken in a systematic manner to limit the area disturbed at any given time. Works should only be undertaken during favourable weather conditions and low water conditions.

Measures must be taken to prevent the release, from any work site, of silt, sediment, sediment-laden water, raw concrete, concrete leachate, or any other *deleterious substance* into any ditch, watercourse, stream, or storm sewer system. The work area should be isolated from flowing water as much as possible and diversions around the site should be provided for overland flow paths. Ensuring that all equipment used on-site is in good working order, and having a ready spill containment kit and staff trained in its use, are also critical measures.

For further information on managing erosion and sediment discharges during construction, see the Erosion and Sediment Control section of the *Land Development Guidelines and the Standards and Best Practices for Instream Works*.[3]

G.3 Stormwater Detention Systems

The rainwater detention objective is to limit the post-development runoff to the pre-development rate, volume, and approximate shape of the hydrograph for the 50% MAR, and 2-year/24-hour storm events and to maintain, as closely as possible, the natural pre-development flow pattern in the receiving watercourse.

These detention levels have been adopted to address increases in impervious areas in developments and the environmental impacts (e.g. stream erosion, sedimentation; loss of riparian habitat, changes in stream morphology, etc.) that are occurring due to the more frequent, smaller storm events being rapidly conveyed off hard surfaces into fish bearing waters.

G.4 Infiltration Systems

Stormwater infiltration systems can provide many benefits to urban streams. Infiltration systems can retain runoff, recharge groundwater and control peak flows. The soil, through which the stormwater runoff passes, also acts as a filter removing a large percentage of the common pollutants normally discharged to the stream or creek. Infiltration can recharge local groundwater which in turn feeds smaller streams and creeks through seepage. Groundwater which is slowly discharged back into streams and can constitute all or part of a stream's baseflow. This baseflow can be critical for fish and fish habitat during extended periods of little or no precipitation and runoff. It maintains preferred

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[3] BC Ministry of Water, Land and Air Protection's *Standards and Best Practices for Instream Works* (draft March 2004) http://wlapwww.gov.bc.ca/sry/iswstdsbpsmarch2004.pdf.

spawning conditions for several salmon species which key on groundwater seepage areas for spawning and egg incubation.

In areas with well-draining soils, stormwater runoff from a site can be collected and discharged into an infiltration system where there are no conventional stormwater removal systems, or infrastructure, which reduces the costs of providing offsite conveyance.

Appendix H

Capital Cost Estimates

Table H-1: Base-flow Augmantation and Ozada Long-term Alternatives Cost Estimate

Project	Timeline	Number of Days for Construction	Crew Cost	Material Cost	Crane Cost	Pumping Cost	Total Cost	Total Cost with Mobilization, Construction & Contingency (excl. HST)
Base-Flow Augmentation	20-year	72	$688,550	$402,403	$23,220	$12,900	$1,127,073	$1,893,483
Ozada Alternative 1: Divert Upper Maple Flows to Ozada Storm System and Remove Diversion	20-year	26	$211,766	$126,710	$10,320	$6,450	$355,247	$596,814
Ozada Alternative 2: Divert Upper Maple Flows to LaFarge Lake Overflow and Remove Diversion	20-year	36	$295,668	$127,452	$10,320	$25,800	$459,240	$771,523
Notes: Only one Ozada alternative will be selected								

Table H-2: Culvert Upgrade Cost Estimate

Project No.	Link Name	Location	Existing Size (m)	Priority	Timeline^1	Length (m)	Upgrade Material	Upgrade Size (mm)	Number of Days for Culvert Replacement	Crew Cost	Material Cost	Crane Cost	Pumping Cost	Total Cost	Total Cost with Mobilization, Construction & Contingency (excl. HST)
2	KWL_C_7R	Kingsway D/W	1.2	2	5-year	7.74	CO BOX	3.05 x 1.5	8	$65,403	$67,209	$15,480	$9,030	$157,122	$263,965
	KWL_C_7L		1.2												
	KWL_C_8R	Kingsway D/W	1.2			7.82	CO BOX	3.05 x 1.5	8	$65,403	$67,209	$11,610	$9,030	$153,252	$257,463
	KWL_C_8L		1.2												
	KWL_C_9R	Kingsway D/W	1.2			6.78	CO BOX	3.05 x 1.5	8	$65,403	$67,209	$11,610	$9,030	$153,252	$257,463
	KWL_C_9L		1.2												
	DM04757.1	Kingsway Avenue	1.6 x 1.0			64.94	CO BOX	3.05 x 1.5	35	$332,936	$396,804	$58,050	$41,280	$829,070	$1,392,838
	DM04758		1.6 x 1.0												
	7810.1	Bedford Street	1.5 x 1.2			24.12	CMP ARCH	3.4 x 1.7	13	$119,261	$167,120	$27,090	$11,610	$325,080	$546,134
3	7819.1	Raleigh Street	1.4	3	5-year	22.69	CMP ARCH	2.2 x 1.1	12	$109,121	$118,190	$27,090	$11,610	$266,011	$446,898
4	7811.1	Lougheed Hwy	1.3	4	20-year	34.60	Improved tapered headwall		3	$13,932	$9,675	$3,225	$5,160	$31,992	$53,747
5	7820.1	School Path	0.6	5	50-year	3.22	CO	1.2	5	$34,895	$22,704	$0	$7,740	$65,339	$109,769
6	7821.1	City Boundry Path	1.3	5	50-year	2.00	CMP ARCH	1.7 x 0.85	5	$33,359	$17,802	$0	$5,160	$56,321	$94,620
7	7812.1	Patricia Avenue	1.5	5	50-year	21.80	CMP ARCH	2.3 x 1.15	12	$109,121	$118,190	$27,090	$11,610	$266,011	$446,898
8	7822.1	Lane	1.5	5	50-year	10.08	CMP ARCH	2.3 x 1.15	8	$68,564	$65,816	$23,220	$10,320	$167,919	$282,104
9	DM04750.1	Gordon Avenue	0.75 x 0.9	5	50-year	13.24	CO BOX	1.8 x 1.2	7	$65,184	$61,856	$0	$10,320	$137,359	$230,763
	DM04751		0.75 x 0.9												
10	7816.1	Davies Avenue	1.25 x 1.1	5	50-year	14.65	CO BOX	2.4 X 1.2	13	$119,312	$105,599	$27,090	$15,480	$267,482	$449,369
11	7811.1	Lougheed Hwy	1.3	5	50-year	34.60	CO BOX	1.8 x 1.2	24	$161,353	$147,963	$25,800	$28,380	$363,496	$610,674
12	STPI15658	School Access	0.45	Fish Enh.	5-year	32.79	CO	0.6	15	$101,549	$73,001	$0	$28,380	$202,930	$340,922
Total Costs for Culvert Upgrades														$3,443,000	$5,784,000

Notes: 1 50-year is an end of life upgrade.

Table H-3: Channel Upgrade Costs

Description	Existing												Upgrade															Unit Costs Costs						
	Type	Pipe Size or Channel Depth (mm)	Bottom Width (mm)	Left Side Slope 1v:x h	Right Side Slope 1v:x h	Length (m)	Up Invert (m)	Dn Invert (m)	Slope %	Top Width (m)	Channel Area (m^2)	Average Top Bank (m)	Type	Pipe Size or Channel Depth (mm)	Bottom Width (mm)	Left Side Slope 1v:x h	Right Side Slope 1v:x h	Length (m)	Up Invert (m)	Dn Invert (m)	Slope %	New Channel Area (m^2)	Berm XS Area (m^2)	Excavation Needed (m^3)	Width (m)	Deepening (m)	Seeded Area (m^2)	Equipment	Fill Supply	Equipment and Fill	Fill Supply	Culvert	Seeding 2.8	Total
Maple Creek Channel Upgrades																																		
Between Kingsway and Bedford Ave.	Trapezoidal	550	2000	0.5	0.5	100.00	4.67	4.26	0.41	2.55	1.3	5.85	Trapezoidal	1200	2000	2	2.00	100	4.342	4.3	0.08	5.28	0	403	6.8	0.65	680.00	$ 52	$ 35	$ 20,788	$ -	$ -	$ 1,904	$ 22,692
SUBTOTAL COSTS																																		**$ 23,000**
Mobilization/Demobilization and Bonding (8%)																																		$ 1,800
Construction Engineering (20%)																																		$ 4,600
Contingency (40%)																																		$ 9,200
City Overhead (6%)																																		$ 1,400
Not including HST																																		
TOTAL COSTS																																		**$ 40,000**

June 20, 2012

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Appendix I

Pump Station Preliminary Design Report

KERR WOOD LEIDAL
consulting engineers

Greater Vancouver
200 - 4185A Still Creek Drive
Burnaby, BC V5C 6G9
T 604 294 2088
F 604 294 2090

Technical Memorandum

DATE: July 17, 2012

TO: Jing Niu, City of Port Coquitlam
Melony Burton, City of Port Coquitlam

CC: Jennifer Young, P.Eng.

FROM: Pádraig Harrington, P.Eng.

RE: **MAPLE CREEK DRAINAGE PUMP STATION**
Option for the Upgrade of the Existing Station
Our File 0646.017-300

1. Introduction

Maple Creek discharges to Coquitlam River by means of a flood box. The existing dyke and flood box structure prevents flooding upstream of the Dyke system by isolating the creek from high tidal flows using a flapgate. When the flapgate is closed water from Maple Creek is pumped over the dyke.

The purpose of this report is to review the existing flood prevention arrangement and summarize the issues currently experienced with this arrangement. Two possible solutions to the ongoing issues are reviewed including cost estimates for each. Finally, a recommendation of the most advantageous option is presented.

This Technical Memorandum is to be included in Appendix I of the "Maple Creek Integrated Watershed Management Plan - Phases 1-3" report. (Reference herein as the "Watershed Management Report".)

2. Existing Flood Prevention System

2.1 General Arrangement

The existing flood prevention system was designed and constructed in 1990. The system consists of a dyke with an impermeable core. The top of dyke is set at elevation 8.03 m which provides a downstream (Coquitlam River side) height of 5.53 m above stream bed level.

A concrete culvert or "flood box" passes through the dyke allowing the creek to discharge to the Coquitlam River. A heavy steel, side mounted flapgate is located on the downstream side of the culvert and permits the passage of fish through the dyke structure. The gate is open at low flows and closes when downstream water level increases above a critical point, thus prevent potential flooding upstream of the dyke.

A steel trash-rack is located on the upstream side of the flood box, prevents large debris from entering the culvert and possibly interfering with the flood box operation.

During flood events (i.e. high water level in the Coquitlam River closes the flood gate) water from Maple Creek is discharged to the Coquitlam River by means of two submersible pumps. The pumps are located in two large cage structures adjacent to the inlet of the flood box.

2.2 Existing Pump Station (Photo 2-1)

The existing pumping system consists of the following:

- **Pumps:** Two Flygt pumps (Model No. CP3300LT804/804) pump a combined flow of approximately 1cu.m/sec with each pump capable of pumping approximately 0.5 cu.m/sec.
- **Discharge Piping:** Each pump discharges separately to the downstream side of the dyke through 300mm diameter discharge piping. The steel piping is a combination of above and below ground piping. Pump No.1 discharge piping goes through the dyke while Pump No.2 piping is routes over the dyke by means of a pipe sleeve arrangement. The piping has no coating but appears to be in good condition.
- **Pump Enclosure:** Each pump is located within a metal cage. The cages are difficult to access with no direct access point for maintenance personnel. Electrical cables to the pumps are unsupported and in contact with cage edges. The cages prevent debris from entering the pumps. The pumps can only be removed by use of a crane and pose some safety concerns for maintenance personnel.
- **Pump Control:** The pumps are controlled using an ultrasonic level transducer mounted on the headwall of the flood box inlet. The signal is relayed to a wooden pole mounted control box located 5m west of the flood box structure. Pump 1 turns on when water level is at 4.0 m geodetic and Pump 2 turns on when water level is 4.1 m geodetic. Pump shut off is when water level is at 3.7 m geodetic.
- **Power Supply:** A BC Hydro pole is located west of the existing flood box structure and supplies power to the wooden control box via a 600V to 460V step down pole mount transformer.
- **Power and Control Box:** Unable to access for observation.

Photo 2-1: Existing Pump Arrangement

2.3 Issues with Existing System

A number of issues have been identified with the existing arrangement as follows:

1. **Pump Capacity:** The existing capacity of both pumps is approximately 1 cu.m/sec. The modelling analysis undertaken as part of the Watershed Management Report indicates a worst 100 year storm flow of 3.0 cu.m/s and a base flow of 1.1 cu./s, thus the existing pump do not have sufficient capacity to meet the predicted creek flows. This is supported by recent reports of flooding within the Maple Creek Watershed and the use of portable pumps during 2 – 5 year storm flows in order to provide adequate capacity.
2. **Pump Selection:** The existing pumps operate to the right of their curve and close to their run out point. Thus, this selection is inefficient in terms of power consumption while also increasing pump wear.
3. **Access:** There is no direct access to the pump units. The pump cages are located approximately 1 m from the dyke. The cage height above water varies from approximately 0.9 m - 1.4 m. This makes maintenance access to the pumps is very difficult and could possible lead to safety concerns.

4. **Fish Passage:** During flood events when the downstream flap gate is closed fish passage through the dyke is prevented. Thus the fish can be held in the fore-bay for a number of days during flood events. The existing pump arrange is not fish friendly and can endanger fish life due to the velocity of water entering the cage when the pumps are running. This can cause fish to be sucked against the cage thus endangering fish life. The city have reported fish passage to be an important consideration in this review.

3. Options for Pump System Improvement

3.1 Replacement of Pumping System

Two fish friendly pumping systems were considered to address the issues outlined in the previous section. In this section each system will be described and the suitability of the system for this application will be assessed.

3.1.1 Hidrostal Pumps

Photo 3-1: Dry Pit Hidrostal Pump (Red Bluff, California)

Hidrostal is manufacturer of “fish friendly” pumps. The pumps are designed with an impeller that has a conical shape capable of passing large solids or in this case, fish. Hydrostal pumps have been used in number of fish applications including Wilson Farm in Port Coquitlam (currently under construction), Maple Pump Station in Surrey (under Construction) and the Red Bluff Pump Station in California.

The proposed system would include two dry-pit pumps (36" impeller diameter) capable of pumping a combined flow of 3.0 cu.m/s with a lift of 4.3m and one pump capable of meeting the 1.1 cu.m/s base flow requirement i.e. 1.5 cu.m/s each (similar to the pump shown in Photo 3-1). The dry pit pumps would be located at river bed level with two suction bells providing the intake for the creek. Suction pipe diameter is estimated to be 900mm. (See Figure 1 for conceptual layout.)

The conceptual drawing indicates a control room located above the dry pit where the pump motors and electrical equipment will be housed. An overhead crane will allow the pump volutes to be removed. The floor elevation of the control room will include adequate freeboard above the design flood level.

Two independent 600 mm diameter discharge pipes will be laid over top the dyke and discharge below expected downstream water level to accommodate return of fish to the downstream waters.

A grille will be installed upstream of the suction bells of sufficient spacing as to allow fish to pass through but prevent large debris from damaging the pumps.

The estimated cost of the pumping system is $4.76 M. A breakdown of the estimate is attached to this report.

3.1.2 Screw Pumps

The traditional "fish friendly" method for bypassing flood structures is the Archimedes screw pump. Archimedes screw pump stations have been used throughout the lower mainland. The Archimedes screw allows fish to pass safely over the dyke since the screw rotates relatively slowly and allows large solids to pass

The proposed system would include two screw pumps, each capable of pumping 1.5 cu.m/s with a lift of 4.3 m. Each screw will have a diameter of 2.1 m with a plan length of 9.35 m and an inclined angle of 30 degrees. Each screw pump will require a 110 kW motor. (See Figure 2 for proposed layout)

The pumps would discharge into 3m x 1m box culvert which will convey the water over the dyke and fish stairs will allow the water to discharge to the downstream side of the dyke without harming the fish. A masonry building will house the motor and electrical equipment.

Re-grading of the existing dyke will be required to facilitate the culvert construction. Raising the level of the dyke locally around the proposed station will not impact the adjacent housing.

The estimated cost of the proposed screw pump station is $ 3.5 M. A breakdown of the estimate is attached to this report.

Photo 3-2: Typical Screw Pump Installation

4. Proposed Flood Box Upgrades

The existing flood box has adequate capacity to pass the peak design flows from the Maple Creek Watershed. Improvements can be made to the flood box operation to enhance fish passage.

4.1 Replacement of Flap Gate

As mentioned on page 2-17 of the Watershed Management Report, the flapgate has been previously identified as an impediment to fish passage because of the low frequency with which the gate remains open to fish passage. A weight was retrofitted to the gate to allow it to open during low flow periods and reduces the size of flows required to open the gate. In spite of these changes there have been reports of the gate being observed closed on sunny, low flow days resulting in the pumps operating to pump the base flow.

Photo 4-1: Existing Flapgate (with weight attached)

The proposed gate system will have a control mechanism that asserts an adjustable amount of bias (in the form of a moment/torque) causing the gate to open. The bias can be zero, in which case the flap gate will operate as it does now. A small amount of bias will cause the flap gate to be partially open when there is no seating head. Increasing the bias will cause the gate to be more wide-open when the water levels are equal upstream and downstream from the gate.

The backflow rate through the open gate will increase as the flood tide progresses. At some point, the “draft force” which is drawing the open gate closed will be sufficient to overcome the bias in the control mechanism and the gate will be drawn closed.

The estimated budget cost for the supply, installation and removal of the existing gate is $45,000 (not including dewatering). The total estimated cost of this option is thus $45,000.

4.2 Removal of Inlet Grille

The grille on the upstream side of the flood box is designed to prevent garbage and debris from entering the flood box and possibly plugging the flood box structure which may result in flooding upstream of the dyke. Stream keepers have identified the grille as an impediment to fish passage. Some bars have been removed to enhance fish passage.

Removal of the inlet grille will allow fish to pass freely through the flood box. If debris build-up remains a concerns, a more appropriately sized grille could be installed to reduce the impediment to fish passage.

Photo 4-2: Inlet Grille

5. Cost Estimates

A breakdown of the cost for each pumping option is attached to this report. The summary of the option costs is as follows:

Table 5-1: Summary of Option Costs

Item Description	Estimated Cost*
Pumping System Upgrade:	
Option 1: Fish Friendly Hydrostal Pumps	$4.76M
Option 2: Archimedean Screw Pump	$3.50M
Flood Box Improvements:	
Replacement Flapgate	$55,000
Grille Removal	$5,000

*Estimated cost is based on Class C estimates and includes contingency and engineering costs appropriate to that level of estimate.

6. Analysis and Recommendation

The existing flood prevention structure and system poses a number of issues for the Maple Creek Watershed including inadequacy of the existing pumping system to meet predicted peak flows and inability of the pump system to provide safe fish passage during flood periods. Issues with fish passage through the existing flood box during low flows were also discussed in this report.

Two pump system solutions were proposed to resolve the current issues 1) Fish Friendly Hydrostal Pumps, and 2) Archimedes Screw Pump;

Options 1 is less conventional but there is a growing body of research available with confirms the suitability of these pumps for fish passage applications. Studies have been undertaken which show comparable mortality rates to that of the Archimedean screw pump system. The pumps themselves are quite large and require a significant foot print. The costs of the units alone are relatively expensive, in the order or $800 – 900k (total for two pumps).

Option 2 is considered the most conventional fish pump system. It has been used in the lower mainland and has a proven track-record for low fish mortality rates and reduced fish injury. The cost for both Archimedes screw pumps is in the order of $300,000.

We recommend proceeding with **Option 2** for the replacement of the existing drainage pump arrangement.

We also recommend proceeding with both flood box improvement options as these will improve the fish passage at low flows periods.

KERR WOOD LEIDAL ASSOCIATES LTD.

Prepared by:

Pádraig Harrington, P.Eng.
Design Engineer

Reviewed by:

Anton Benes, P.Eng.
Technical Reviewer

PH/
Encl. Option 1 and 2 Cost Estimate; Figure 1 and Figure 2

Statement of Limitations

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Revision History

Revision #	Date	Status	Revision	Author
A	July 17, 2012	Approval		PH

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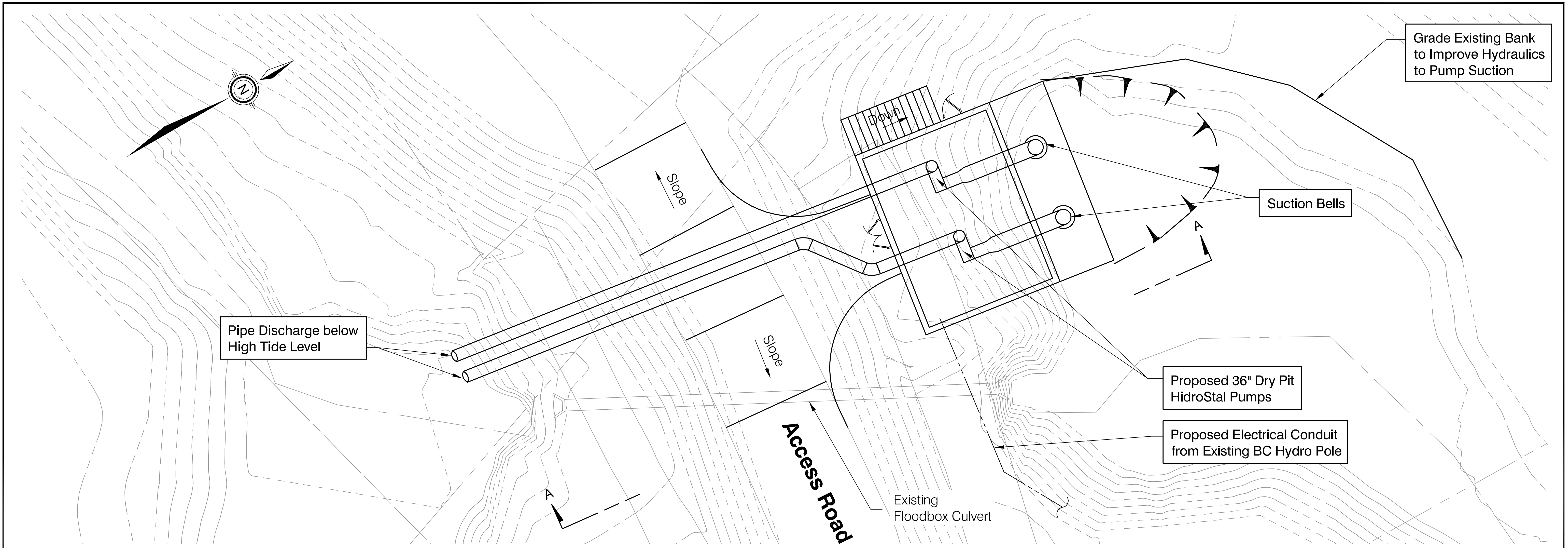

Plan

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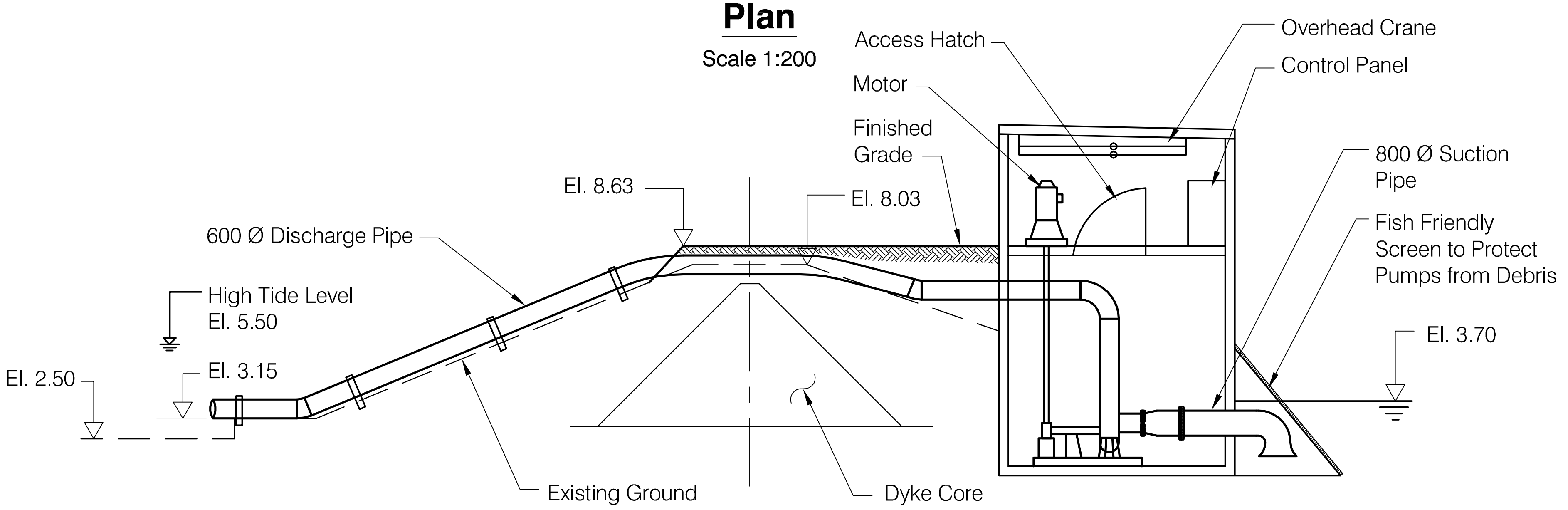

Section A-A

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Maple Creek Pump Station
HidroStal Fish Friendly Pump

Figure 1

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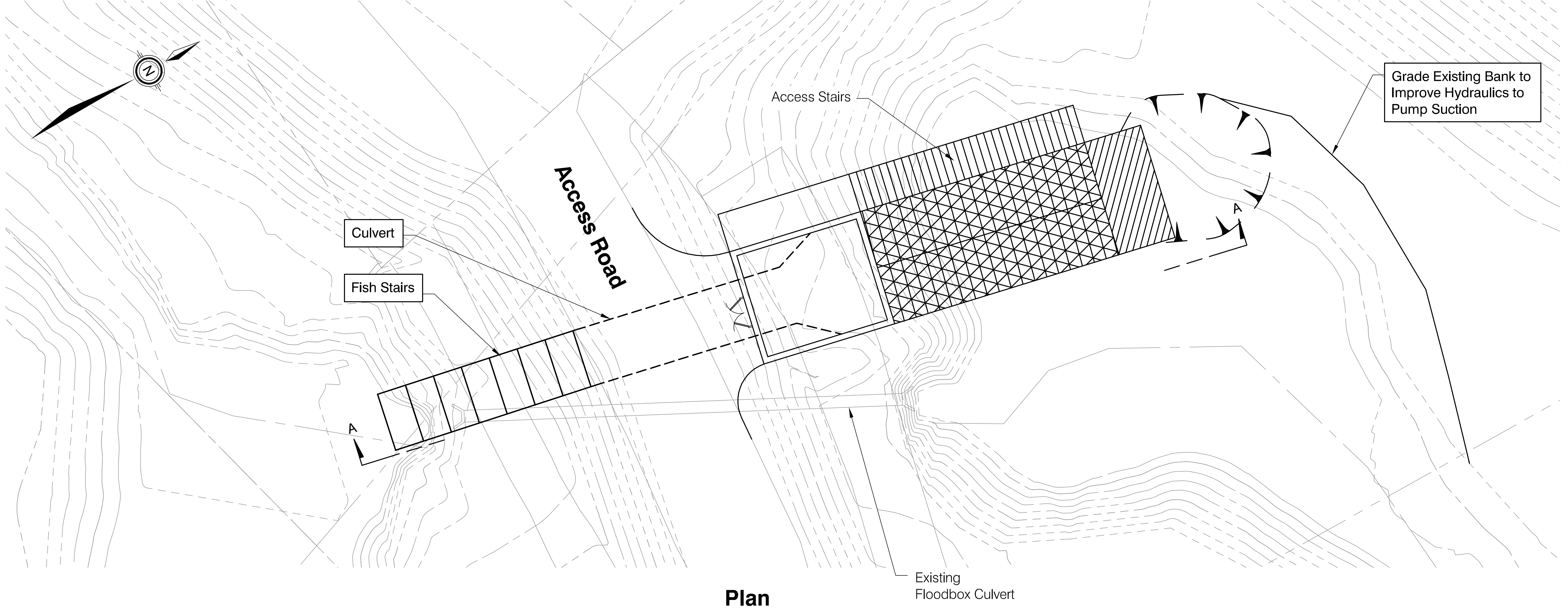
7/13/2012 9:34 AM



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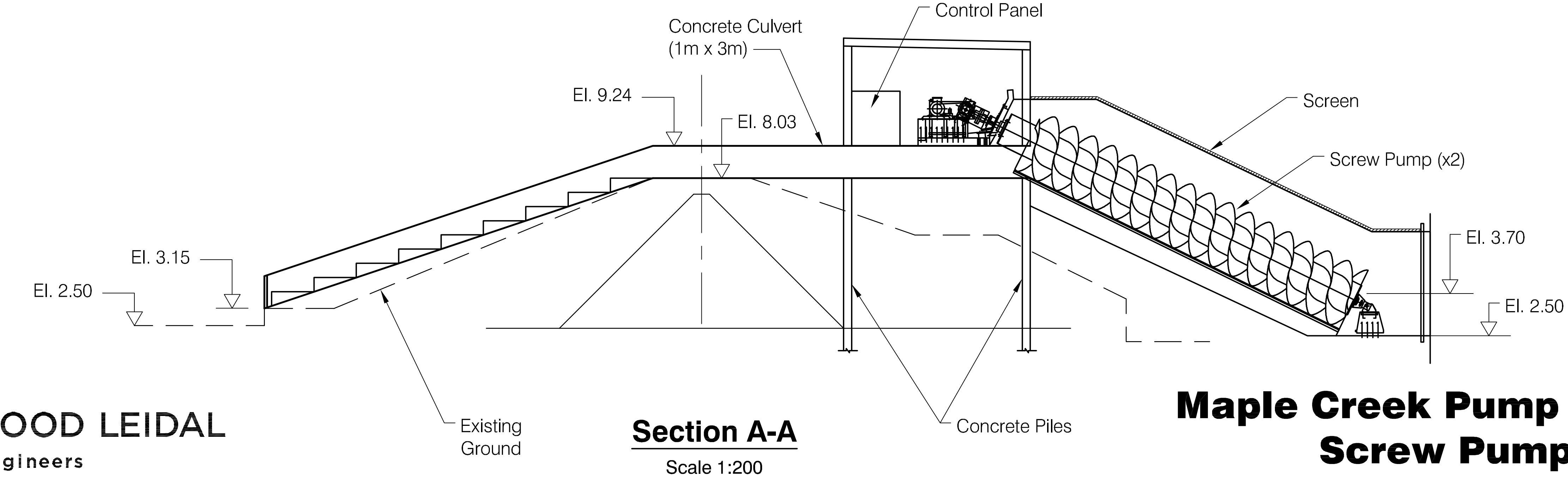

Section A-A

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Maple Creek Pump Station
Screw Pump

Figure 2

Jul-12

City of Port Coquitlam

Option 1 - Hidrostall Pump

Item	Description	Unit	Quantity	Unit $	Total
Div. 1	**General Requirements**				
1.01	Bonding & Insurance	L.S.	1	$26,589	$26,589
1.02	Mobilization & Demobilization	L.S.	1	$132,945	$132,945
	Subtotal				$159,534
Div. 2	**Site Work**				
2.01	Site Clearing and Scrubbing	L.S.	1	$25,000	$25,000
2.02	Abandon Existing Pump Station	Allow	1	$30,000	$30,000
2.03	Excavation	Cu.m	328	$150	$49,200
2.04	Backfilling	Cu.m	100	$100	$10,000
2.05	Dewatering	days	90	$1,000	$90,000
2.06	600mm Dia CS Underground Piping	Lin.m	30	$650	$19,500
2.07	Shoring	sq.m	288	$250	$72,000
	Subtotal				$295,700
Div. 3	**Concrete**				
3.01	Cast-in-place Concrete	Cu.m	192	$2,100	$403,200
	Subtotal				$403,200
Div. 7	**Thermal and Moisture Protection**				
7.01	Station Thermal and Moisture Protection	L.S.	1	$30,000	$30,000
	Subtotal				$30,000
Div. 8	**Doors**				
8.01	Doors	L.S.	1	$10,000	$10,000
	Subtotal				$10,000
Div. 9	**Finishes**				
9.01	Station Coating	L.S.	1	$10,000	$10,000
	Subtotal				$10,000
Div. 11	**Equipment**				
11.01	Supply of Two Fish-friendly Hydrotal Pumps	L.S.	2	$450,000	$900,000
					$900,000
Div. 14	**Conveying Systems**				
14.1	Overhead Crane and Hoist	L.S.	1	$40,000	$40,000
	Subtotal				$40,000
Div. 15	**Mechanical Work**				
15.01	Station Mechanical	L.S.	1	$550,000	$550,000
15.02	Commissioning	L.S.	1	$20,000	$20,000
	Subtotal	Allow			$570,000
	Subtoal				
Div. 16	**Electrical Work**				
16.01	Supply and Installation of Electrical Control Kiosk Incl. Pump Control Panel, SCADA Control Panel, Antenna, etc.	L.S.	1	$400,000	$400,000
	Subtoal				$400,000
	Item Total				**$2,818,434**
	Engineering and Construction Management				**$563,687**
	Contingency				**$845,530**
	Environmental Monitoring	L.S.			$20,000
	Estimated Subtotal				**$4,247,651**
	HST				**$509,718**
	TOTAL ESTIMATED COST (Rounded)				**$4,757,369**

Note: Estimates have been prepared with little or no site information and as such indicates the approximate magnitude of the cost of the capital tasks, for project planning purposes only. The estimate has been derived from unit costs for similar projects.

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Jul-12

City of Port Coquitlam — Option 2 - Archimedes Screw Pump

Item	Description	Materials			
		Unit	Quantity	Unit $	Total
Div. 1	**General Requirements**				
	Bonding & Insurance	L.S.	1.00	$19,710	$19,710
	Mobilization & Demobilization	L.S.	1.00	$98,550	$98,550
	Subtotal				$118,260
Div. 2	**Site Work**				
	Site Clearing and Scrubbing	L.S.	1.00	$25,000	$25,000
	Abandon Existing Pump Station	Allow	1.00	$30,000	$30,000
	Excavation	Cu.m	100.00	$150	$15,000
	Backfilling	Cu.m	340.00	$100	$34,000
	Dewatering	Allow	90.00	$1,000	$90,000
	3m x 1m culvert	Lin.m	20.00	$3,000	$60,000
	Concrete Piles	Allow	12.00	$30,000	$360,000
	Shoring	Allow	60.00	$250	$15,000
	Subtotal				$629,000
Div. 3	**Concrete**				
	Cast-in-place Concrete	Cu.m	120.00	$2,100	$252,000
	Subtotal				$252,000
Div. 5	**Metals**				
	Miscellaneous Metals	L.S.	1.00	$50,000	$100,000
	Subtotal				$100,000
Div. 7	**Thermal and Moisture Protection**				
	Station Thermal and Moisture Protection	L.S.	1.00	$20,000	$20,000
	Subtotal				$20,000
Div. 8	**Doors**				
	Station Doors	L.S.	1.00	$10,000	$10,000
	Subtotal				$10,000
Div. 9	**Finishes**				
	Station Coating	L.S.	1.00	$20,000	$20,000
	Subtotal				$20,000
Div. 11	**Equipment**				
	Supply of Two Screw Pumps	L.S.	2.00	$160,000	$320,000
					$320,000
Div. 14	**Conveying Systems**				
	Overhead Crane and Hoist	L.S.	1.00	$20,000	$20,000
	Subtotal				$20,000
Div. 15	**Mechanical Work**				
	Station Mechanical	L.S.	1.00	$250,000	$250,000
	Commissioning	L.S.	1.00	$20,000	$20,000
	Subtotal	Allow			$270,000
	Subtoal				
Div. 16	**Electrical Work**				
	Power Supply and Transformer (utility).	L.S.	1.00	$30,000	$30,000
	Supply and Installation of Electrical Control Kiosk Incl. Pump Control Panel, SCADA Control Panel, Antenna, etc.	L.S.	1.00	$300,000	$300,000
	Subtoal				$330,000
	Item Total				**$2,069,260**
	Engineering and Construction Management	L.S.	20%		**$413,852**
	Contingency	L.S.	30%		**$620,778**
	Environmental Monitoring	L.S.			$10,000
	Estimated Subtotal				**$3,113,890**
	HST				**$373,667**
	TOTAL ESTIMATED COST (Rounded)				**$3,487,557**

Note: Estimates have been prepared with little or no site information and as such indicates the approximate magnitude of the cost of the capital tasks, for project planning purposes only. The estimate has been derived from unit costs for similar projects.

KERR WOOD LEIDAL
consulting engineers