City of Richmond

Report to Committee

To:	Public Works and Transportation Committee	**Date:**	June 27, 2014
From:	John Irving, P.Eng. MPA Director, Engineering	**File:**	10-6060-04-01/2014-Vol 01
Re:	**East Richmond Agricultural Water Supply**		

Staff Recommendation

That the report titled "East Richmond Agricultural Water Supply Update 2013" as attached to the staff report titled "East Richmond Agricultural Water Supply", dated June 27, 2014, from the Director, Engineering, be used as input in the five year capital program process.

John Irving, P.Eng. MPA
Director, Engineering
(604-276-4140)

Att. 3

REPORT CONCURRENCE		
ROUTED TO:	**CONCURRENCE**	**CONCURRENCE OF GENERAL MANAGER**
Sewerage & Drainage	☑	
REVIEWED BY STAFF REPORT / AGENDA REVIEW SUBCOMMITTEE	**INITIALS:**	**APPROVED BY CAO**

Staff Report

Origin

In 2006, the City, in partnership with the Ministry of Agriculture and the Richmond Farmer's Institute (RFI), completed the original East Richmond Agricultural Water Supply Study (the Study) to address flood protection and irrigation needs for agricultural lands in East Richmond. Approximately $4.7M of drainage upgrades identified in the Study have been implemented or are included in Council approved capital projects that are scheduled for completion by the end of 2014.

The Study's update was started in 2013 to review progress and build upon the original study. This report presents the 2013 Study Update report (attachment 1) to Council for consideration and endorsement.

Findings of Fact

East Richmond land use is primarily agricultural. Approximately 2,788 Ha is available for agriculture and approximately 1,994 Ha are in agricultural production. This represents a 210 Ha (12%) increase in land in agricultural production since the 2006 study.

The drainage system in East Richmond serves both flood protection and irrigation purposes. Planning and operating the system to serve both of these purposes is a balancing act as drainage is fundamentally the opposite of irrigation. The complexity of the system requires hydraulic models and creative planning work for ongoing improvements that reduce flooding and improve irrigation which is ultimately required to improve the agricultural viability of the ALR.

The 2006 Study was a comprehensive review of the drainage system in the East Richmond ALR with a focus on improvements required to improve conditions for farming. The study identified a catalogue of proposed drainage and irrigation improvements based on hydraulic modeling and input from the farm community. From this catalogue, $4.7M of improvements have been implemented or are included in Council approved capital projects that are scheduled for completion by the end of 2014. They include:

- 7.3 km of new or re-profiled ditches on Granville, No. 7 Road, Westminster, Francis, and No. 8 Road (listed from longest to shortest improvements),
- Five control structures,
- Three pump station improvements,
- One new drainage pump station (currently under construction at No. 8 Road and Granville); and
- Remote salinity monitoring.

The goal of the 2013 Study Update was to review progress and build upon the original study. The 2013 Study Update report includes:

- A catalogue of infrastructure projects completed since the 2006 Study,
- Updated hydraulic model that includes infrastructure improvements completed since the 2006 Study,

- A stakeholder consultation process,
- An updated catalogue of proposed drainage and irrigation infrastructure improvements for East Richmond (Attachments 2 and 3); and
- A cost benefit analysis of proposed drainage and irrigation infrastructure improvements.

Stakeholder Consultation

The project team consulted with the Agricultural Advisory Committee (AAC), and hosted a public open house and hosted a workshop with City operations staff. The identified issues and concerns are documented in the 2013 Study Update report and were utilized in developing the recommended upgrade strategy.

On May 22, 2014, the completed 2013 Study Update report was presented to the Agricultural Advisory Committee. There was discussion regarding the hydraulic modeling work as well as some of the results. In particular, committee members were interested in the recommended Sidaway Road improvements and the impacts of a proposed development at No. 6 Road and Steveston Highway. The committee indicated general satisfaction with the update.

Improvement Strategy

The 2013 Study Update builds on the previous study and a number of the original recommendations are maintained in the update. The majority of the irrigation and flood protection problems identified by the farming community are south of Highway 91. As such, the majority of the recommended and completed improvements are south of Highway 91. Both the original 2006 study and the 2013 study update identify supplying water from the north arm of the Fraser River to the farm land south of Highway 91 as the preferred option. Primary reasons for this preference are:

- The water in the north arm of the Fraser River is of better quality for farming purposes than the water in the south arm,
- Topography and low ground elevations limit the distance water from the south arm of the Fraser can be pushed north; and
- It is the more cost effective option.

The update improves on the original study by:

- Adding detail to Sidaway and No. 6 Road ditch re-grading,
- Recommending additional ditch cleaning on No. 7 Road,
- Recommending new settings for No. 6 Road South Pump Station; and
- Recommending additional control structures in the south west quarter of the study area.

The additional control structures recommended at No. 7 Road and Westminster and No. 7 Road and Granville are key to accomplishing irrigation objectives in the south west area without flooding the south west area.

Recommended improvements for the next ten years are:

1. Ditch re-grading and culvert upgrades Sidaway Road south of Francis Road,
2. Ditch re-grading and culvert upgrades No. 6 Road south of Blundell Road,
3. New culvert on Blundell Road east of Sidaway Road,
4. New culvert on Burrows Road,
5. Clean ditches on No. 7 Road, No. 8 Road and Cambie Road,
6. Ditch re-grading and culvert upgrades on Westminster Highway west of No. 7 Road; and
7. Irrigation improvements including the addition of 2 flap gates, 5 gates with automated controls, re-grade ditch on Sidaway from north of Blundell Road to Westminster Highway, and new ditch on Granville Road from No. 6 Road to Sidaway.

Maps of recommended drainage and irrigation improvement projects are attached as Attachments 2 and 3 respectively. A benefit to cost ratio of 3 was calculated for the recommended improvements based on potential revenue for un-used agricultural land and the estimated cost of improvement projects.

With Council's endorsement, staff will include recommended projects for Council's consideration in the five year capital program.

Financial Impact

None at this time. Recommended projects will be submitted for Council's consideration as part of the City's Five Year Capital Program.

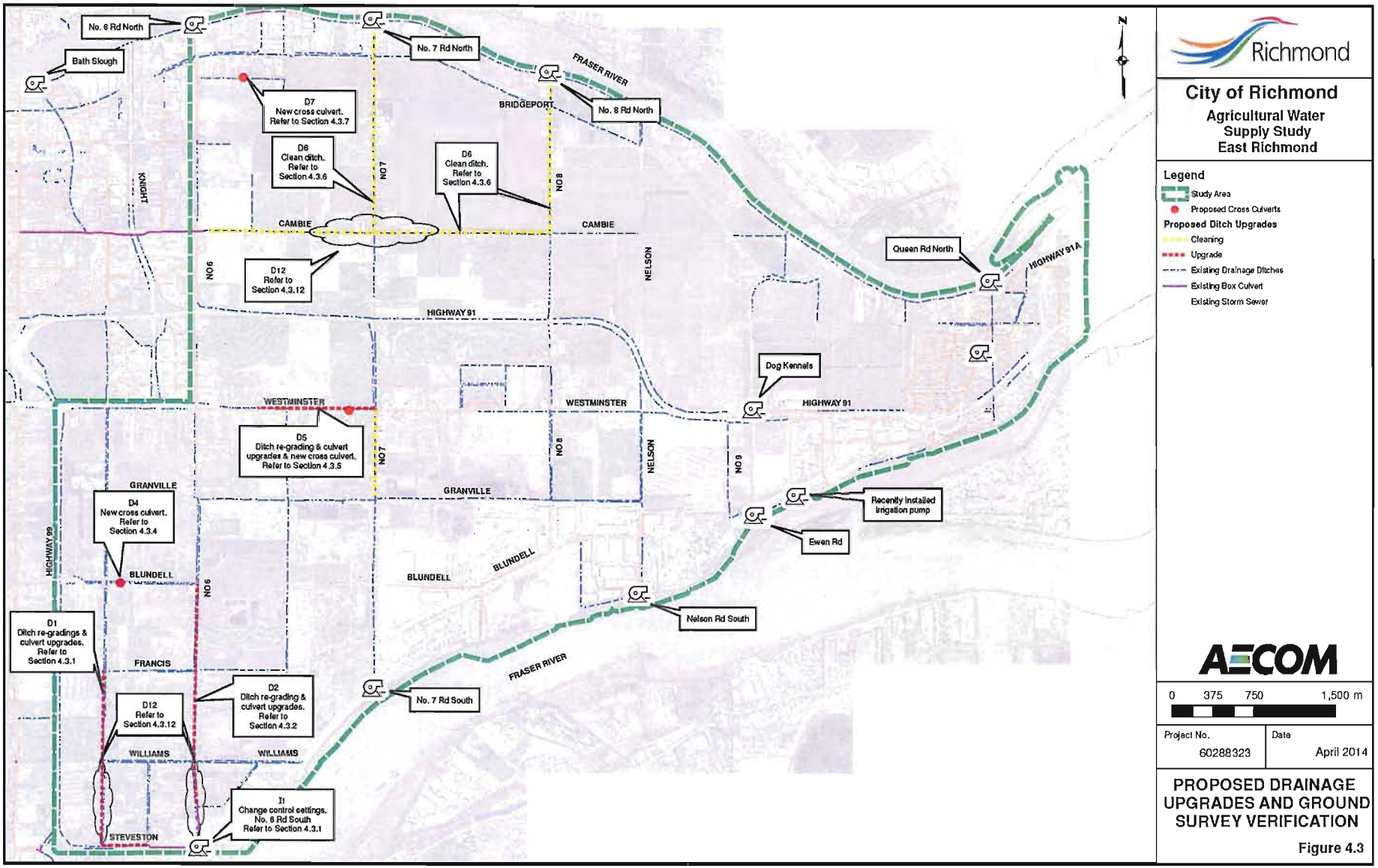
Conclusion

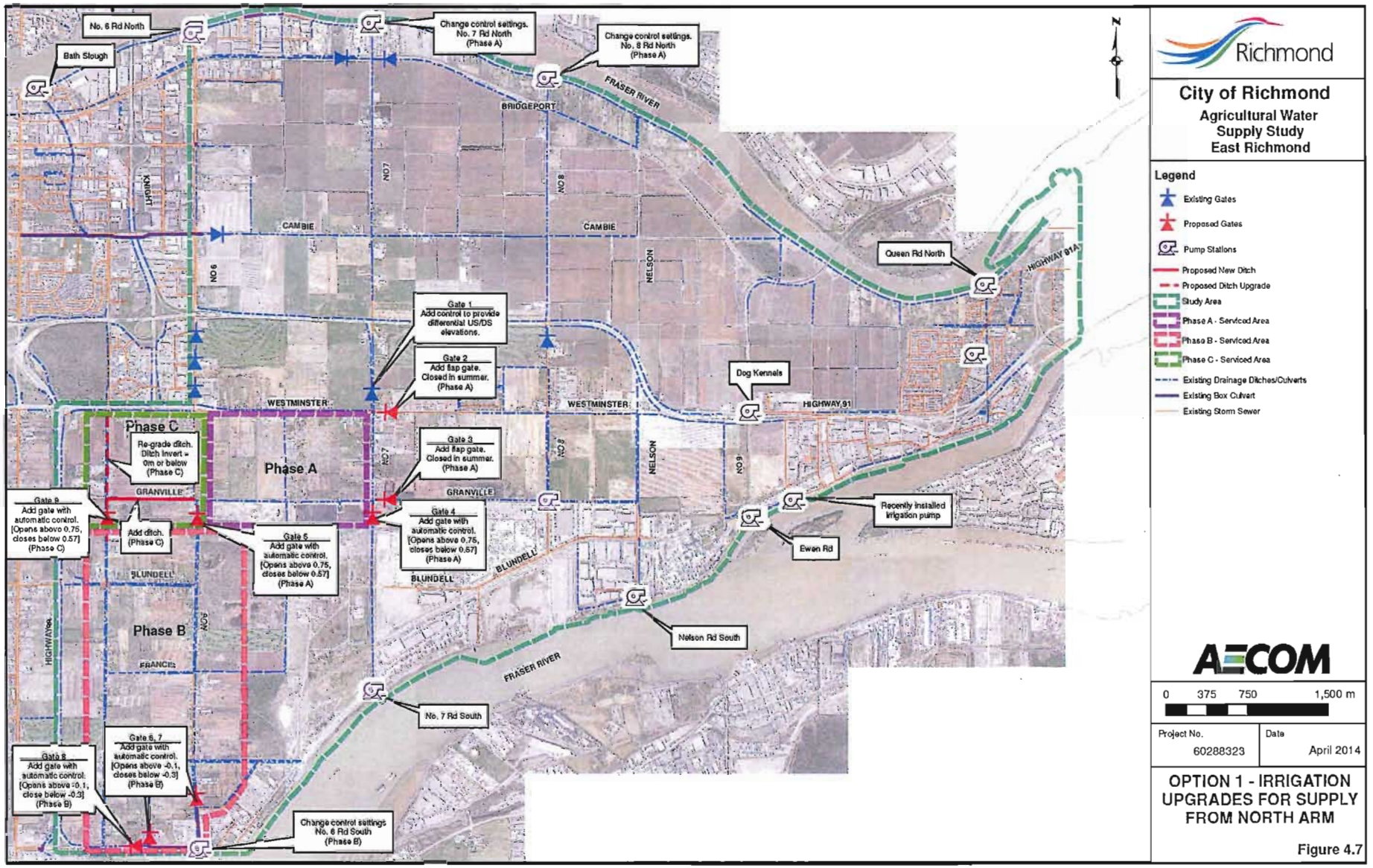
East Richmond land use is primarily agricultural and the drainage system provides both flood control and irrigation for local farms. The 2006 Study was a comprehensive review of demands on the system and recommended a number of improvements. Since 2006, approximately $3.7M of drainage improvements have been implemented in East Richmond. The 2013 Study Update incorporates these improvements, reviews current stakeholder input, confirms the overall irrigation and drainage strategy and identifies an updated catalogue of improvements for the East Richmond drainage system.

Lloyd Bie, P.Eng.
Manager, Engineering Planning
(604-276-4075)

LB:lb

Att. 1: Plan Showing Proposed Drainage Upgrades
Att. 2: Plan Showing Proposed Irrigation Upgrades
Att. 3: 2013 East Richmond Agricultural Water Supply Update (REDMS 4226898)


No. 6 Rd North
Bath Slough
No. 7 Rd North
FRASER RIVER
No. 8 Rd North
BRIDGEPORT
D7
New cross culvert.
Refer to Section 4.3.7
D6
Clean ditch.
Refer to Section 4.3.6
D6
Clean ditch.
Refer to Section 4.3.6
KNIGHT
NO7
NO8
CAMBIE
CAMBIE
NO6
D12
Refer to Section 4.3.12
NELSON
HIGHWAY 91
Queen Rd North
HIGHWAY 91A
Dog Kennels
WESTMINSTER
WESTMINSTER
HIGHWAY 91
D5
Ditch re-grading & culvert upgrades & new cross culvert.
Refer to Section 4.3.5
NO7
NO8
NELSON
NO9
GRANVILLE
GRANVILLE
D4
New cross culvert.
Refer to Section 4.3.4
Recently Installed Irrigation pump
Ewen Rd
HIGHWAY 99
BLUNDELL
BLUNDELL
BLUNDELL
NO6
Nelson Rd South
D1
Ditch re-gradings & culvert upgrades.
Refer to Section 4.3.1
FRANCIS
FRASER RIVER
D12
Refer to Section 4.3.12
D2
Ditch re-grading & culvert upgrades.
Refer to Section 4.3.2
No. 7 Rd South
WILLIAMS
WILLIAMS
I1
Change control settings.
No. 6 Rd South
Refer to Section 4.3.1
STEVESTON
N
Richmond
City of Richmond
Agricultural Water Supply Study
East Richmond
Legend
Study Area
Proposed Cross Culverts
Proposed Ditch Upgrades
Cleaning
Upgrade
Existing Drainage Ditches
Existing Box Culvert
Existing Storm Sewer
AECOM
0 375 750 1,500 m
Project No. 60288323
Date April 2014
PROPOSED DRAINAGE UPGRADES AND GROUND SURVEY VERIFICATION
Figure 4.3


No. 6 Rd North
Bath Slough
Change control settings. No. 7 Rd North (Phase A)
Change control settings. No. 8 Rd North (Phase A)
FRASER RIVER
BRIDGEPORT
KNIGHT
NO 7
NO 8
CAMBIE
NO 6
NELSON
Queen Rd North
HIGHWAY 91A
Gate 1 Add control to provide differential US/DS elevations.
Gate 2 Add flap gate. Closed in summer. (Phase A)
Dog Kennels
HIGHWAY 91
WESTMINSTER
Phase C
Re-grade ditch. Ditch Invert = 0m or below (Phase C)
Phase A
Gate 3 Add flap gate. Closed in summer. (Phase A)
NO 9
GRANVILLE
Gate 8 Add gate with automatic control. [Opens above 0.75, closes below 0.57] (Phase C)
Add ditch. (Phase C)
Gate 5 Add gate with automatic control. [Opens above 0.75, closes below 0.57] (Phase A)
Gate 4 Add gate with automatic control. [Opens above 0.75, closes below 0.57] (Phase A)
Recently installed irrigation pump
Ewen Rd
BLUNDELL
Phase B
HIGHWAY 99
NO 5
FRANCIS
Nelson Rd South
No. 7 Rd South
Gate 6, 7 Add gate with automatic control. [Opens above -0.1, closes below -0.3] (Phase B)
Gate 9 Add gate with automatic control. [Opens above -0.1, close below -0.3] (Phase B)
Change control settings No. 6 Rd South (Phase B)
N
Richmond
City of Richmond
Agricultural Water Supply Study
East Richmond
Legend
Existing Gates
Proposed Gates
Pump Stations
Proposed New Ditch
Proposed Ditch Upgrade
Study Area
Phase A - Serviced Area
Phase B - Serviced Area
Phase C - Serviced Area
Existing Drainage Ditches/Culverts
Existing Box Culvert
Existing Storm Sewer
AECOM
0 375 750 1,500 m
Project No. 60288323
Date April 2014
OPTION 1 - IRRIGATION UPGRADES FOR SUPPLY FROM NORTH ARM
Figure 4.7

Water AECOM

City of Richmond

FINAL REPORT
East Richmond Agricultural Water Supply Update 2013

Prepared by:

AECOM
3292 Production Way, Floor 4 604 444 6400 tel
Burnaby, BC, Canada V5A 4R4 604 294 8597 fax
www.aecom.com

Project Number:
60288323

Date:
April 2014

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- represents Consultant's professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
- may be based on information provided to Consultant which has not been independently verified;
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
- must be read as a whole and sections thereof should not be read out of such context;
- was prepared for the specific purposes described in the Report and the Agreement; and
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AECOM
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Burnaby, BC, Canada V5A 4R4
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604 444 6400 tel
604 294 8597 fax

April 28, 2014

Mr. Andy Bell, M.Eng., P.Eng.
Engineering Planning
City of Richmond
6911 No. 3 Road
Richmond, BC
V6Y 2C1

Dear Andy:

Project No: **60288323**

Regarding: **FINAL REPORT**
East Richmond Agricultural Water Supply Update 2013

Please find attached three copies of the Final Report for the East Richmond Agricultural Water Supply Update 2013. This report includes an assessment of the current and future drainage conveyance and irrigation water supply, as well as proposed recommendations for both the drainage and irrigation systems.

We have enjoyed working with City Staff on this project and we look forward to providing our continued services to the City of Richmond. If there are any questions or concerns please don't hesitate to contact me at 604.444.6400

Sincerely,
AECOM Canada Ltd.

Sumandeep Singh

Suman Shergill, P.Eng.
Project Engineer

Encl.
cc:
SB:ss

Distribution List

# of Hard Copies	PDF Required	Association / Company Name
1	Yes	City of Richmond
1	Yes	City of Richmond
3	Yes	City of Richmond

Revision Log

Revision #	Revised By	Date	Issue / Revision Description
0	SB	Sept 9, 2013	Draft Report – Drainage Only
1	SB/SS	Oct 2, 2013	Draft Final Report
2	SB/SS	Dec 18 2013	Final Report –Version1
3	SS	Jan 4,2014	Updated Final Report
4	SS	April 28, 2014	Final Report

AECOM Signatures

Report Prepared By:

Sumandeep Singh

Suman Shergill, P. Eng.
Project Engineer

Executive Summary

In the 2041 OCP the City of Richmond identified that it shall maintain and improve Agricultural Land Reserve (ALR) drainage and irrigation systems to support agriculture. To meet this objective, the City requested an update of its East Richmond Agriculture Water Supply Study that includes a hydraulic assessment for the drainage and irrigation system under existing agricultural land use conditions and future land use conditions (OCP 2041), and provides a prioritized list of recommended upgrades for Capital Planning purposes.

The City's objectives for drainage and irrigation in East Richmond are to:

- Continue to protect agricultural land in the Agricultural Land Reserve (ALR).
- Enhance the long term viability, opportunities for innovation, infrastructure and environmental impacts of the agricultural sector.
- Ensure prioritized drainage improvements are implemented according to Agricultural and Rural Development Subsidiary Agreement Criteria (ARDSA) performance standards and in consultation with the agricultural community and relevant City departments.
- Encourage sufficient notification to the agricultural sector of ditch cleaning plans to achieve beneficial, effective, timely drainage.
- Facilitate the improvement of irrigation and drainage infrastructure to provide secure and affordable water supplies that support the agricultural sector.

The study area is approximately 3,918 Hectares (Ha) and the portion of land for agricultural use is approximately 2,788 Ha (based on 2010 Land Use Inventory data) of which approximately 1,994 Ha is used for farming. Agricultural land uses include cranberries, blueberries, strawberries, raspberries, vegetables, fruit and nut trees and forage crops for livestock. Cranberries take up the majority of the land area and dominate the area north of Highway 91. A functional drainage and irrigation system is critical to successful crop production and the diverse crops have varying requirements and are sensitive to drainage patterns.

Project stakeholders include the City of Richmond, Agricultural Advisory Committee, Richmond Farmers' Institute, Ministry of Agriculture and Lands, and Fisheries and Oceans Canada. Feedback from individual farmers and AAC members was obtained at the AAC meeting and Open House and has been incorporated in this report. A workshop with City Operations Staff was also held where valuable information was obtained pertaining to known problem areas and previous works completed.

Design criteria for the Study area include the ARDSA criteria and irrigation growth, harvest and frost protection conditions. ARDSA criteria include removing runoff from the 10-Year 5-day winter storm event within 5 days in the dormant period (November 1 to February 28) and removing runoff from the 10-Year 2 day storm event within 2 days in the growing period (March 1 to October 31). Between storm events and in periods when drainage is required, the ARDSA criteria require that base flow in channels is maintained between 0.9m to 1.2m below field elevation where possible. Irrigation criteria that were applied include use of a uniform growth irrigation rate (determined to be 5.33mm/day as per the 2006 Study) across the study area as well as addition of known estimates for water discharged during cranberry harvest periods. Model analysis for the frost protection period has not been completed as no concerns were expressed for this scenario. Tidal information from stations at Nelson Road PS, No. 6 Road South PS and Queens Pump Station are also applied in the model to represent the boundary conditions at the Fraser River.

Once the design criteria were re-established and areas of concern identified, the hydraulic model was updated to DHI's Mike Urban software and infrastructure upgrades completed since 2006 were added. The next step was to review the drainage and irrigation pump operational parameters. This is particularly pertinent for No 7 Rd North and

No 8 Rd North pump stations as the operational settings for pumps and gravity intakes at these locations are changed from season to season to allow for irrigation water supply.

The existing system assessment included a review of conveyance and pump station capacities. The existing system peak HGLs for the dormant winter period (10-Year 5 day storm event with 7 day high tide) was determined using the model. Areas with hydraulic constraints were then determined and improvements were proposed. The pump station analysis indicates that five of nine pump stations have a peak inflow (10-Year 5 day) greater than the theoretical pump station capacity at high tide. With exception of No. 7 Road South PS, all of the flood box outlets have capacity to covey 10-Year 5 day peak flow during low tide. At No. 7 Road South the combined capacity of flood box and pump station is adequate to convey 10-Year 5 day peak inflow.

Two irrigation improvement options were considered to irrigate the southwest lands. Option1 – Supply water from the Fraser River's North Arm using the existing river intakes and Option 2- Build a new irrigation pump station at the foot of No 6 Rd. Option 2 was rejected primarily because of high cost of construction. In addition, there are limitations on how far north irrigation water can be supplied based on the topography and low ground elevations, particularly along Sidaway Rd north of Blundell Rd.

Prioritized drainage and irrigation improvement projects for the ten year Capital Plan are provided in ***Table E.1.*** Additional information for each drainage and irrigation project is provided in ***Section 4.3 and 4.4*** respectively, which includes a discussion on the system improvements, before and after water level profiles, and detailed cost breakdowns. The projects generally include a combination of ditch cleaning and re-grading, culvert upgrades, and installation of new cross culverts to connect roadside ditches. A key component of upgrades in the Southwest (Sidaway Rd, Steveston Hwy and No 6 Rd areas) is the lowering of No 6 Rd South PS pump ON OFF levels.

Table E.1 Prioritized List of Upgrades

Priority	Project ID	Project Description	Cost Estimate	Time Horizon
1	D1	Sidaway Road South of Francis Alignment (Section 4.3.1)	$1,176,000	1-2 years
2	D2	No 6 Road South of Blundell Road (Section 4.3.2)	$693,000	3-5 years
3	D4	Blundell Road East of Sidaway (Section 4.3.4)	$46,000	3-5 years
4	D7	Burrows Road (Section 4.3.7)	$50,000	3-5 years
5	D6	Cambie Road East to No 8 Rd, No 7 Rd & No 8 Rd from Cambie to PS (Section 4.3.6)	$1,595,000	5-10 years
6	D5	Westminster Highway West of No 7 Road (Section 4.3.5)	$981,000	5-10 years
7	(I-1). Irrigation-Option 1 Upgrades for Supply	Phase A	$647,000	5-10 years (or sooner if funds are available)
		Phase B	$812,000	
		Phase C	$722,000	
		Total Cost	**$6,722,000**	

Note: "D" represents drainage projects and "I" represent irrigation projects.

A cost benefit analysis was completed to assess the economic, social and environmental impacts of the proposed drainage and irrigation improvements. The methodology applied is similar to the 2006 Study where the average potential revenue for un-used agricultural land was compared with the cost of infrastructure upgrades. Essentially, the net result is a benefit to cost ratio of approximately 3. Other factors that were explored include the potential savings to farmers for City supplied potable water, additional costs of drainage pump station maintenance and power, and potential reduced risk of economic impacts from flooding or loss of crops.

Further recommendations and improvements that were discussed at the Staff workshop and require additional investigation prior to inclusion in the current Capital Plan include the following items:

- Survey ground elevation (field elevations) along existing ditch on Cambie Rd (east and west of No 7 Rd). The ground elevation survey should also be completed for low lying areas along Sidaway and No 6 Rd south of Williams Road.
- Review capacity of the No. 7 Road South PS and flood box as it was identified as under capacity in ***Table 4.1***
- Consider implementing the following projects identified in the 2006 Study as low priority works:
    - Construct 600m of ditch along Sidaway-East to connect the Blundell and Francis ditch systems
    - Upgrade ditch on east side of No 6 Rd between Granville Rd and Blundell Rd. This will further increase conveyance along No 6 Rd and facilitate supply of irrigation water from North Arm.

- Repair or replacement of the failing headwall at the south ditch box culvert inlet on Cambie Rd just east of No 6 Road
- Ditch cleaning and re-profiling along CN Rail corridor between No 7 Rd and No 8 Rd (City needs permission from the railway for access)
- Ditch cleaning and re-profiling for south side of River Rd from the CN box (Cambie Rd alignment) east to Queens PS
- Box culvert flushing and cleaning for No 6 Rd north drainage corridor and further investigation of the jet fuel pipeline elevations
- Review the need and methods to remove invasive species such as Japanese Knotweed and Parrot Feather.
- Review possibility of lowering the No 7 Rd North PS culvert and impact this would have on the downstream ditch systems
- Create a culvert inspection program for entire study area and in particular a review of who is responsible for maintenance of culverts crossing Hwy 91
- Consider implementing a procedure that requires farmers to identify when and where new outfalls from fields to municipal ditches are constructed
- Coordinate operation of the CN box gravity intake (River Rd and Cambie Rd alignment) between farmers and Operations staff
- Facilitate farmers to coordinate water use from No 7 Rd North PS during harvest

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Appendices

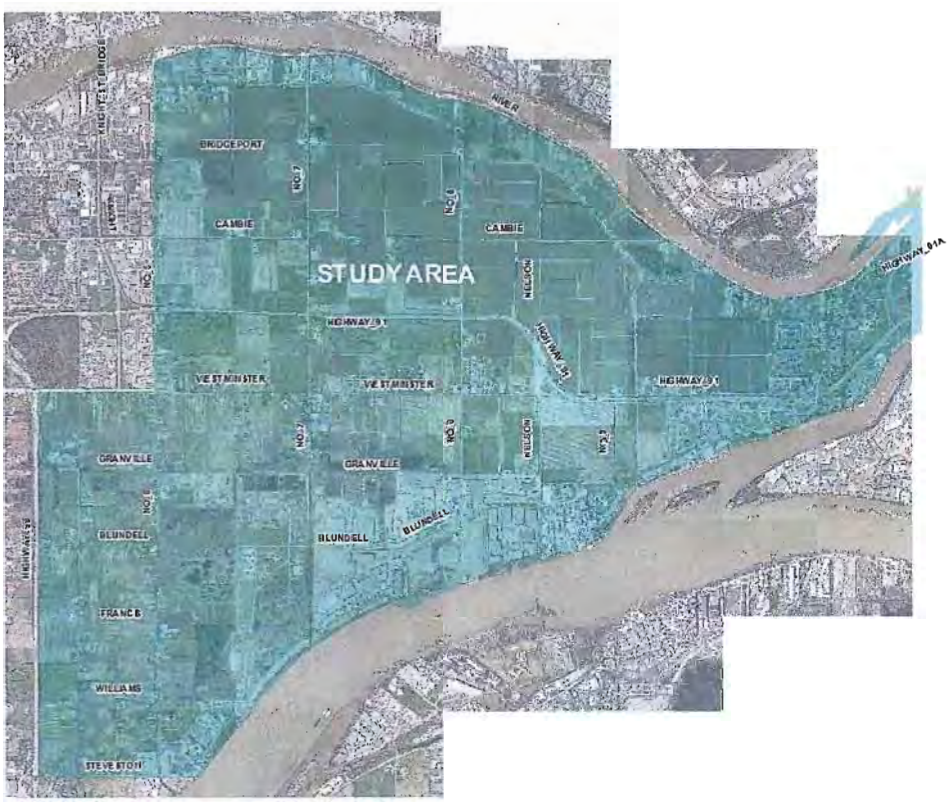
1. Introduction

The City of Richmond requested an update of its East Richmond Agriculture Water Supply Study that provides a prioritized list of recommended upgrades for Capital Planning purposes. To achieve this objective, a hydraulic assessment for the East Richmond drainage and irrigation system under existing agricultural land use conditions and future land use conditions (OCP 2041) was completed.

1.1 Background

The study area as shown in ***Figure 1.1*** is approximately 3,918 Hectares (Ha) and the portion of land for agricultural use is approximately 2,788 Ha (based on 2010 Land Use Inventory data) of which approximately 1,994 Ha is used for farming. Agricultural land uses include cranberries, blueberries, strawberries, raspberries, vegetables, fruit and nut trees and forage crops for livestock. Cranberries take up the majority of the land area and dominate the area north of Highway 91. A functional drainage and irrigation system is critical to successful crop production. The diverse crops have varying requirements and are sensitive to drainage patterns.

Figure 1.1 Study Area



In 2006, the previous East Richmond Agricultural Water Supply Study was completed by UMA/AECOM (referred as "2006 study" in this report) and included a list of proposed irrigation and drainage projects within the Agricultural Land Reserve (ALR) east of Highway 99. Since the 2006 study was completed, approximately $3.5M in capital projects have been implemented and were added to the hydraulic model as part of this study. Projects recommended in the 2006 Study and their completion status is provided in ***Tables 1.1*** and ***1.2***. ***Tables 1.1*** also include projects identified and completed subsequent to the 2006 study. Projects are shown in the same priority order as in the 2006 study.

Table 1.1 Drainage & Irrigation Upgrade Projects Completed Since 2006

YEAR	LOCATION	SCOPE OF WORK
2007	Granville Avenue Alignment (No. 6 Road to Kartner Road)	1600m of ditch constructed and/or upgraded
	No. 7 Rd (Granville to No. 7 Rd Pump Station South)	1700m of ditch re-profiled
2008	Westminster Hwy (No. 8 Rd to Nelson Road)	800m of ditch re-profiled (scope revised from No. 7 Rd to No. 8 Rd due to environmental restrictions)
	No. 6 Rd	Flap gates installed at 3 locations: • Commerce Parkway • Wireless Way • International Place
	No. 7 Rd	Temporary flap gate installed at No. 7 Rd and Westminster Hwy to prevent cranberry water from discharging to the south
	No. 8 Rd	Temporary flap gate installed at No. 8 Rd south of HWY 91 to prevent cranberry water from discharging to the south
	No. 8 Rd (south of Westminster Hwy)	Culvert installed in No. 8 Rd's east ditch (south of Westminster Hwy) to increase ditch connectivity
	No. 8 Road Pump Station North	New Programmable Logic Controller (PLC) & sonar installed
2009	Granville Alignment (Kartner Road to Nelson Road)	1600m of ditch constructed and re-profiled (scope modified slightly due to Terason gas main conflict between No. 8 Rd and Nelson Rd causing the City to construct on either side of the conflict)
	No. 8 Rd (Westminster Hwy to Granville Avenue Alignment)	800m of ditch re-profiled (original project scope revised from Highway 91 to Westminster Hwy due to most of the area between Highway 91 and Westminster Hwy being culverted)
	No. 6 Rd Pump Station South	New Programmable Logic Controller (PLC), sonar, salinity meter, and automated irrigation system installed
2010	Francis Rd Alignment (Sidaway Rd to No. 6 Rd)	800m of ditch constructed
	Sidaway (west side from Francis Rd to Steveston HWY)	1600m of major ditch maintenance (original project scope revised from upgrading ditch to major ditch maintenance due to existing culverts)
2011	No. 7 Rd Pump Station South	1 pump replaced to improve reliability and reduce low level water elevations & new Programmable Logic Controller (PLC) and control cell installed
2012	Sidaway Road (at Francis Road Alignment)	New culvert installed to connect Sidaway Road's east and west drainage ditches
	Ewen Road Irrigation Pump Station	New irrigation pump station and piping to supply irrigation water to a local farm in the vicinity of pump station.
2013	No. 8 Road and Granville Avenue Alignment	New 25 HP drainage pump station (planned for summer 2013)
	No. 6 Rd Pump Station North	1 pump replaced to improve reliability and reduce low level water elevations (Summer 2013)

Note:

Drainage Projects
Irrigation Projects

Table 1.2 Drainage & Irrigation Upgrade Projects Under Review

LOCATION	SCOPE OF WORK
Sidaway (Blundell to Francis)	Construct 600m of ditch along Sidaway-east to connect the Blundell and Francis ditch systems
No. 6 Rd (Highway 91 to No. 6 Rd Pump Station North)	Re-profile and smooth inverts through 2650m of ditches and storm sewers (delayed due to Kinder Morgan jet fuel pipeline conflicts and scope issues)
Cambie Rd	Re-profile 4000m of ditches
Blundell Rd (No. 6 Rd to No. 7 Rd)	Construct 1600m of ditch
West Boundary	Install an additional 6 flap gates with manual override along Highway 99 and No. 6 Rd. (1 of the initial 7 proposed was installed in 2008)
No. 7 Rd (south of Granville)	Install 1 drop leaf gate to prevent potential irrigation water discharging at the No. 7 Rd South Pump Station
No. 8 Rd (east side between Highway 91 and Westminster Highway)	Upgrade 400m of storm sewers
Westminster Highway (No. 6 Rd to ditch near Kartner)	Upgrade / realign 2400m of storm sewers
No. 6 Rd (Westminster to Granville)	Upgrade / realign 800m of storm sewers
No. 6 Rd (Granville to No. 6 Rd Pump Station South)	Upgrade 3200m of ditches and storm sewers
Williams, Blundell, & Francis	Upgrade ditches (scope undetermined)
Granville Avenue Alignment (Sidaway to No. 6 Road)	Construct 800m of ditch to connect Sidaway to No. 6 Rd.
Granville & No. 6 Rd	Install screw pump and 2 drop leaf gates (to irrigate Sidaway Rd)
No. 7 Road North	Install irrigation pump
Blundell Rd (east of No. 6 Rd)	Install 1 drop leaf gate
General Study Wide Upgrades	These upgrades had a low priority in the 2006 Study: • Culvert connecting Nelson to Ewen • Culvert connecting ditches on the west side of No. 6 Rd to Granville Avenue Alignment • Flap gates with manual override at No. 8 Rd and Westminster Hwy • Manually operated gate at Nelson-east and Westminster Hwy • Drop-leaf gate at No. 6 Rd, north of Bridgeport Rd • Drop-leaf gates at No. 7 Rd and Cambie (both sides of No. 7 Rd) • Drop-leaf gate at No. 8 Rd and Cambie (on west side of No. 8 Rd) • Deepen ditch along Westminster Hwy between Nelson Rd and Ewen Rd

Note

Drainage Projects
Irrigation Projects

In addition to individual farm owners and their specific requirements, there are a number of stakeholders including the City of Richmond, Agricultural Advisory Committee, Richmond Farmers' Institute, Ministry of Agriculture and Lands, and Fisheries and Oceans Canada. Feedback from individual farmers and AAC members was obtained at the AAC meeting and open house and is incorporated in the study. A workshop with City operations staff was also held and resulted in additional valuable information for input into the overall development of a prioritized list of recommendations.

1.2 Goals and Objectives

In Section 7.1 of its 2041 OCP, the City recognizes the importance of agriculture as a food source, environmental resource, a heritage asset and important contributor to the local economy. Most of the ALR in Richmond is outside of Greater Vancouver Regional District's (GVRD) servicing boundary.

It is the City's objective to maintain and improve ALR drainage and irrigation systems to support agriculture (Section 12.6, 2041 OCP). Goals and objectives identified in Section 7 of the 2041 OCP that relate to drainage and irrigation have been incorporated into this study and include the following statements:

Drainage:

- Continue to protect agricultural land in the ALR
- Enhance all aspects of the agricultural sector including long term viability, opportunities for innovation, infrastructure and environmental impacts
- Ensure drainage improvements to the ALR occur in a prioritized order and according to Agricultural and Rural Development Subsidiary Agreement Criteria (ARDSA) performance standards
- Ensure drainage improvements are considered in a comprehensive manner in consultation with the agricultural community and relevant City departments
- Encourage sufficient notification to the agricultural sector of ditch cleaning plans to achieve beneficial, effective, timely drainage

Irrigation:

- Facilitate the improvement of irrigation and drainage infrastructure to provide secure and affordable water supplies that support the agricultural sector

The scope for the 2013 East Richmond Water Supply Update are as follows:

- Review all current information available from the City and Ministry of Agriculture pertaining to water supply and land use changes in the study area;
- Complete a field reconnaissance to verify current irrigation and drainage infrastructure and locations for proposed upgrades;
- Gather first-hand information from farming community stakeholders through an open house and attendance at an AAC meeting;
- Update the current East Richmond hydraulic model with drainage and irrigation infrastructure constructed since 2006 and identify ways to optimize the model performance;
- Complete a comprehensive assessment with the updated model and develop a prioritized list of drainage and irrigation system improvements;
- Review feasibility of irrigation water supply transfer from the north to the south; and
- Develop cost estimates for the proposed upgrades based on current market conditions.

1.3 Land Use

1.3.1 Agricultural Land Use

A comprehensive review of current agricultural land uses was completed by the Ministry of Agriculture in 2010 and is provided in the Ministry's Draft Land Use Inventory (LUI) Report (January 2013). Information presented in the LUI report was collected by completing drive-by surveys for all properties in the Agricultural Land Reserve.

During the LUI survey, data was collected on general land use and land cover including agricultural practices, irrigation, crop production methods, livestock, agricultural support (e.g. storage, compost and waste), and activities which add value to raw agricultural products. General land cover information collected in the LUI is presented in ***Table 1.3*** and ***Figure 1.2***. Agricultural land uses include berry cultivation (including cranberries, blueberries, strawberries, and raspberries), vegetables (including greenhouses), fruit and nut trees, and forage crops for livestock. ***Figure 1.3*** shows the location of various cultivated crops in the area.

Cultivation of cranberries is the major land use for the area north of Highway 91. Cranberry production involves significant investment by farmers in infrastructure such as ditches, reservoirs, control structures, and pumping irrigation equipment. Most of the cranberry crops in the north are supplied to Ocean Spray for the juice and canned cranberry market, and farming tends to be cooperative and organized with farmer's coordinating their schedules and sharing water resources.

South of Hwy 91 the most significant crops are blueberry, vegetable and forage along with nurseries and greenhouses. In the southwest portion of the study area, west of No 6 Road, there are numerous small urban lot developments and the area has a high amount of un-used farmland and land used for non-agricultural uses.

Table 1.3 Crop Coverage & Irrigation Area

Cultivated Field Crops	Area* (Ha)	% of Cultivated Land	% of Crop Area Irrigated
Berries	1,433	54	71
(cranberries)	(873)	(61)	(98)
(blueberries)	(492)	(34)	(31)
(strawberries)	(62)	(4)	(30)
(raspberries)	(7)	(<1)	(na)
Vegetables	647	24	54
Forage & Pasture	402	15	24
Nursery & Tree Plantations	64	2	84
Grains, Cereals, Oilseeds	37	1	na
Other**	73	19	na
Total	**2656 Ha* (Includes land outside the study area)**		

Notes:
- Area based on the Ministry of Agriculture 2010 survey data that includes ALR in west Richmond. 1994 ha are located in east Richmond

** Other includes tree fruits, turf, vines, floriculture, nut trees, bare cultivated land, fallow land, land in crop transition
Source: 2010 Land Use Inventory

In addition, the LUI report includes data on irrigation water use recorded by crop type and irrigation system type (e.g. sprinkler, trickle, giant gun or sub-surface). The report notes that sprinkler systems are the most common type of irrigation system and are used on a broad range of crops, while trickle systems are the next most common and used

exclusively on berry, vegetable, nursery and vine crops. Subsurface systems were third and used on several types of crops. The coverage for each irrigation type as per the data collected for the LUI report is presented in ***Figure 1.4*** and ***Table 1.1***. As shown in the table, 71% of all berry crops and 54% of all vegetable field crops are irrigated.

1.3.2 Other Land Uses

Other land uses in the study area include golf courses, large rural residential lots, industrial properties and the Hamilton residential area. At present there are five golf courses and driving ranges in East Richmond that use surface water for irrigation supplemented with City supplied water. Several of the large residential lots have hobby farms on the property that also draw water for irrigation and require drainage.

Industrial areas are located along the North and South Arm's of the Fraser River in East Richmond and are generally not included in the hydraulic model as they have their own drainage systems and do not draw water for irrigation purposes. Larger industrial properties located along the South Arm of the Fraser are occupied by Lafarge (concrete production) and Port Metro Vancouver. Each of these areas drain surface water directly into the Fraser River.

The Hamilton area is serviced by a local drainage system and only the major ditches and trunk sewers are included in the East Richmond hydraulic model. The area is serviced by the gravity outlets to the Fraser River during low tide and the Queen Road North Pump Station during high water levels, as well as a smaller pump station inland at 22740 Westminster Hwy.

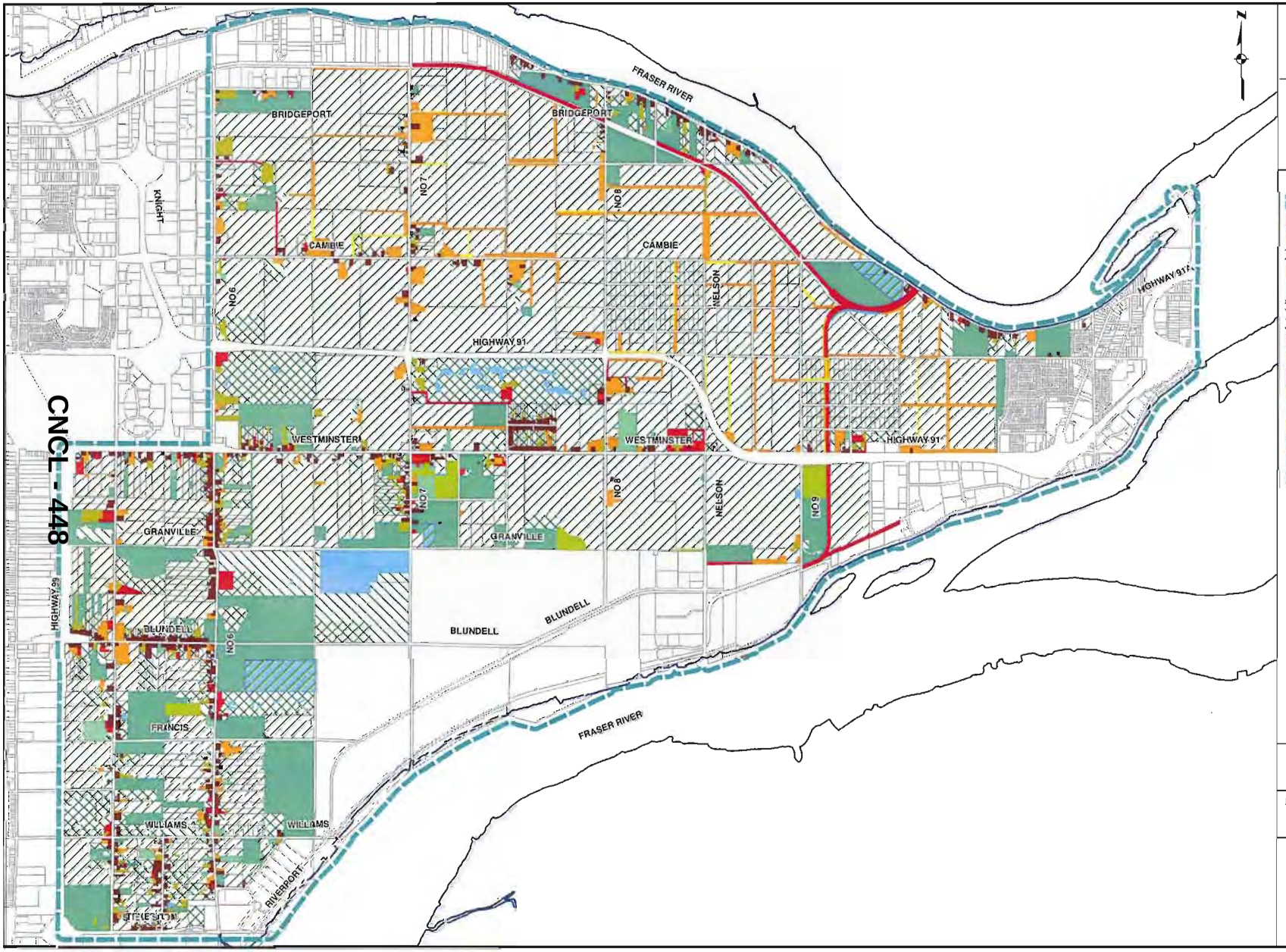
1.3.3 OCP Future Land Use

The 2041 OCP future land use information was obtained from the City and is shown in ***Figure 1.5***. There are no major changes from the current land use in the study area and the primary land use remains agricultural meaning that land imperviousness is unlikely to significantly change.

An additional land use plan is currently being developed for the Hamilton area; however, its findings are not expected to significantly impact the outcome of this study.

1.3.4 Integrated Rainfall Resource Management Strategy (IRRMS)

The City's IRRMS is being completed in parallel to this study, and it makes recommendations to protect and enhance Riparian Management Areas (RMA's) to protect and improve water quality. Many of the East Richmond's watercourses have designated RMA's. The detailed design of drainage and irrigation capacity upgrades recommended through the East Richmond Agricultural Water Supply Update should aim to incorporate relevant IRRMS recommendations, such as protecting RMA setbacks and enhancing RMA's.



CNCL - 448

Richmond

City of Richmond

Agricultural Water Supply Study East Richmond

Legend

- Study Area
- Built up - Other
- Crop barn
- Cultivated field crops
- Farm Infrastructure
- Greenhouses
- Managed vegetation
- Non Built or Bare
- Residential footprint
- Settlement
- Transportation
- Unmaintained field crops
- Unmaintained greenhouses
- Utilities
- Vegetated
- Waterbodies
- Wetlands

Source:
2010 Land Use Inventory

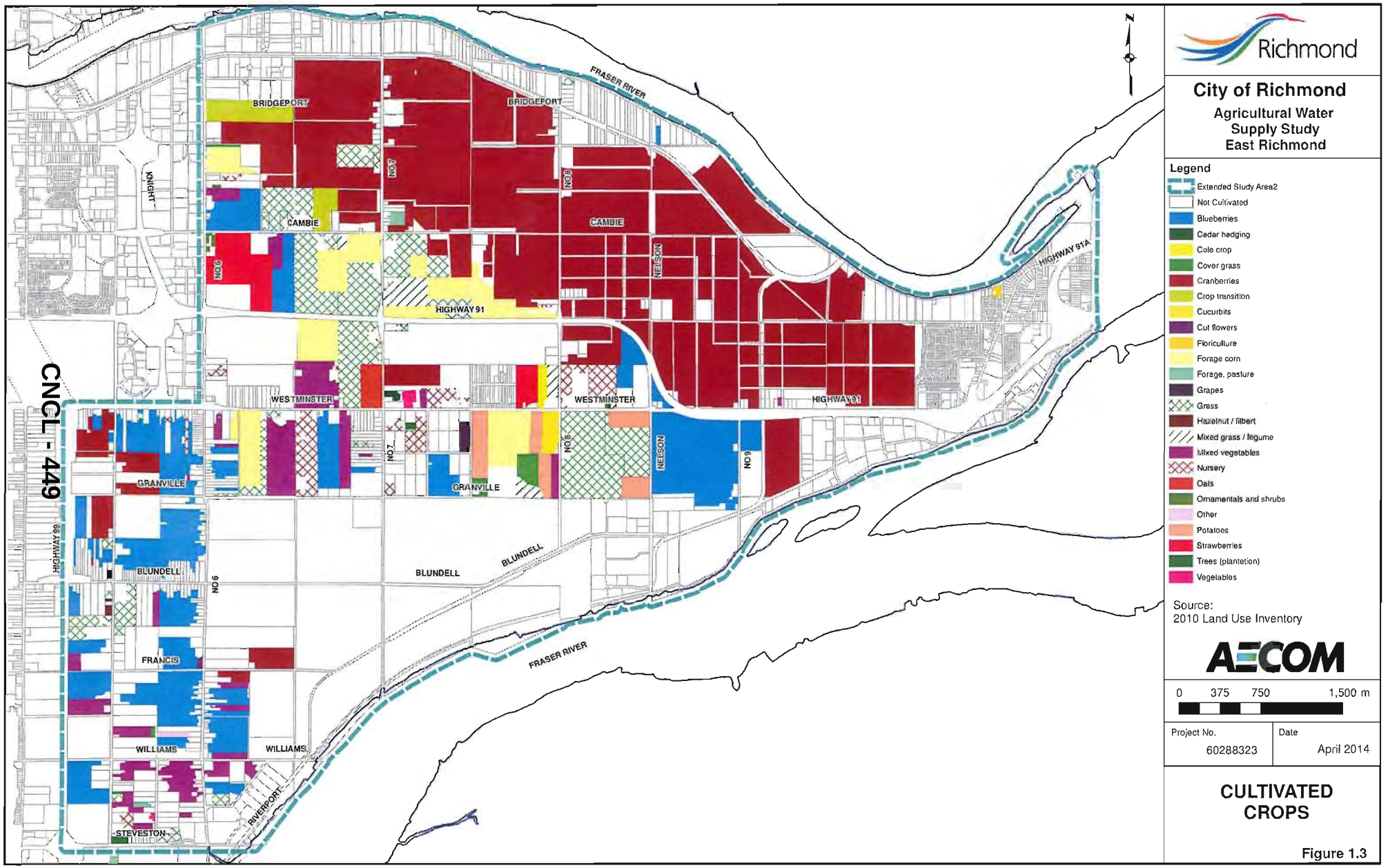
AECOM

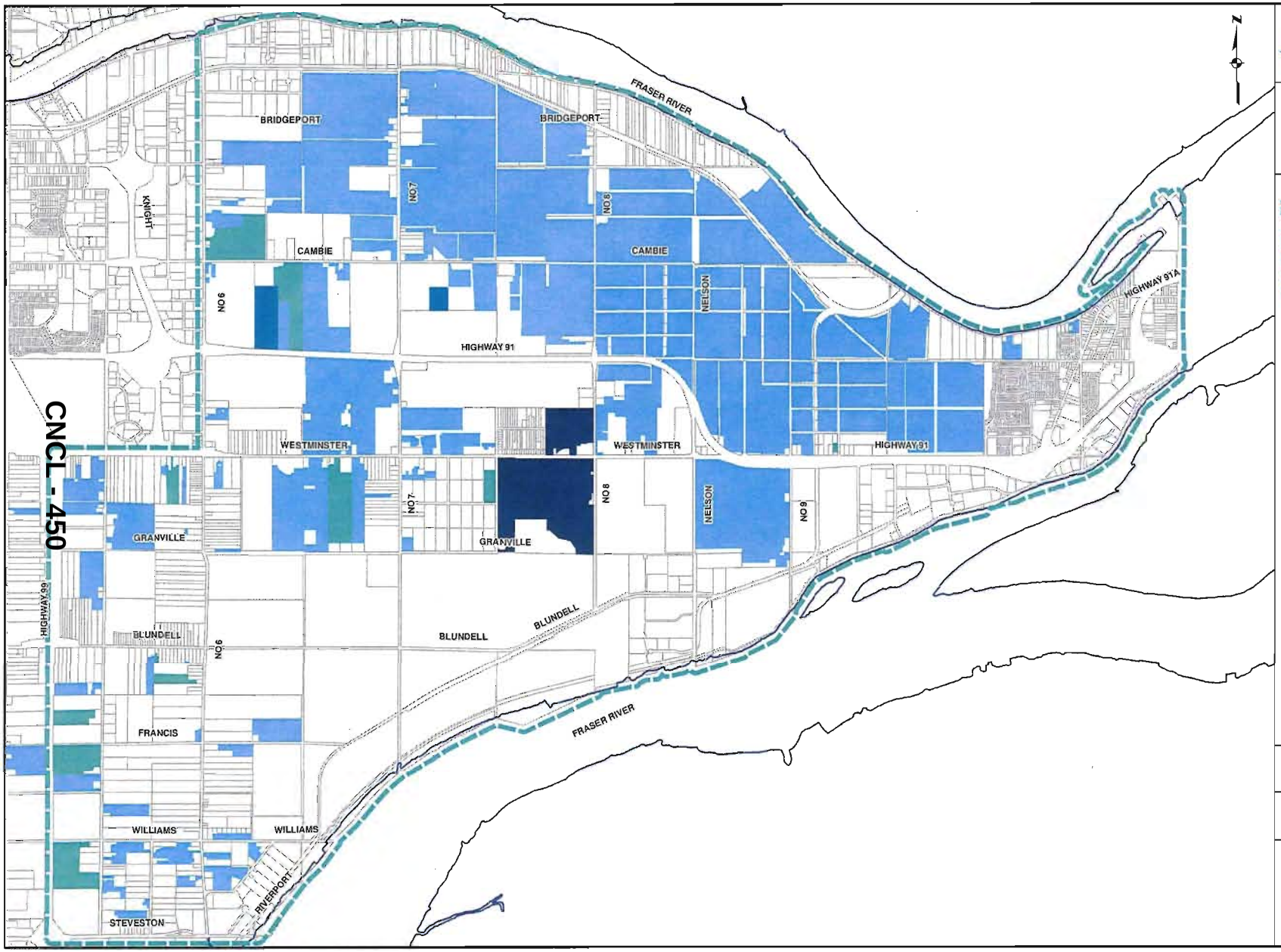
0 375 750 1,500 m

Project No.	Date
60288323	April 2014

GENERAL LAND-USE COVER

Figure 1.2


FRASER RIVER
BRIDGEPORT
BRIDGEPORT
KNIGHT
CAMBIE
CAMBIE
NO7
NO8
NO6
HIGHWAY 91
NELSON
HIGHWAY 91A
WESTMINSTER
WESTMINSTER
HIGHWAY 91
GRANVILLE
GRANVILLE
NO7
NO8
NELSON
NO9
BLUNDELL
BLUNDELL
BLUNDELL
NO6
FRANCIS
FRASER RIVER
WILLIAMS
WILLIAMS
RIVERPORT
STEVESTON
N
Richmond
City of Richmond
Agricultural Water Supply Study
East Richmond
Legend
Extended Study Area2
Not Cultivated
Blueberries
Cedar hedging
Cole crop
Cover grass
Cranberries
Crop transition
Cucurbits
Cut flowers
Floriculture
Forage corn
Forage, pasture
Grapes
Grass
Hazelnut / filbert
Mixed grass / legume
Mixed vegetables
Nursery
Oats
Ornamentals and shrubs
Other
Potatoes
Strawberries
Trees (plantation)
Vegetables
Source:
2010 Land Use Inventory
AECOM
0 375 750 1,500 m
Project No.
60288323
Date
April 2014
CULTIVATED CROPS
Figure 1.3



CNCL - 450

Richmond

City of Richmond

Agricultural Water Supply Study East Richmond

Legend

- Study Area
- Not Irrigated
- Giant Gun
- Sprinkler
- Sub-surface
- Trickle

Source:
2010 Land Use Inventory

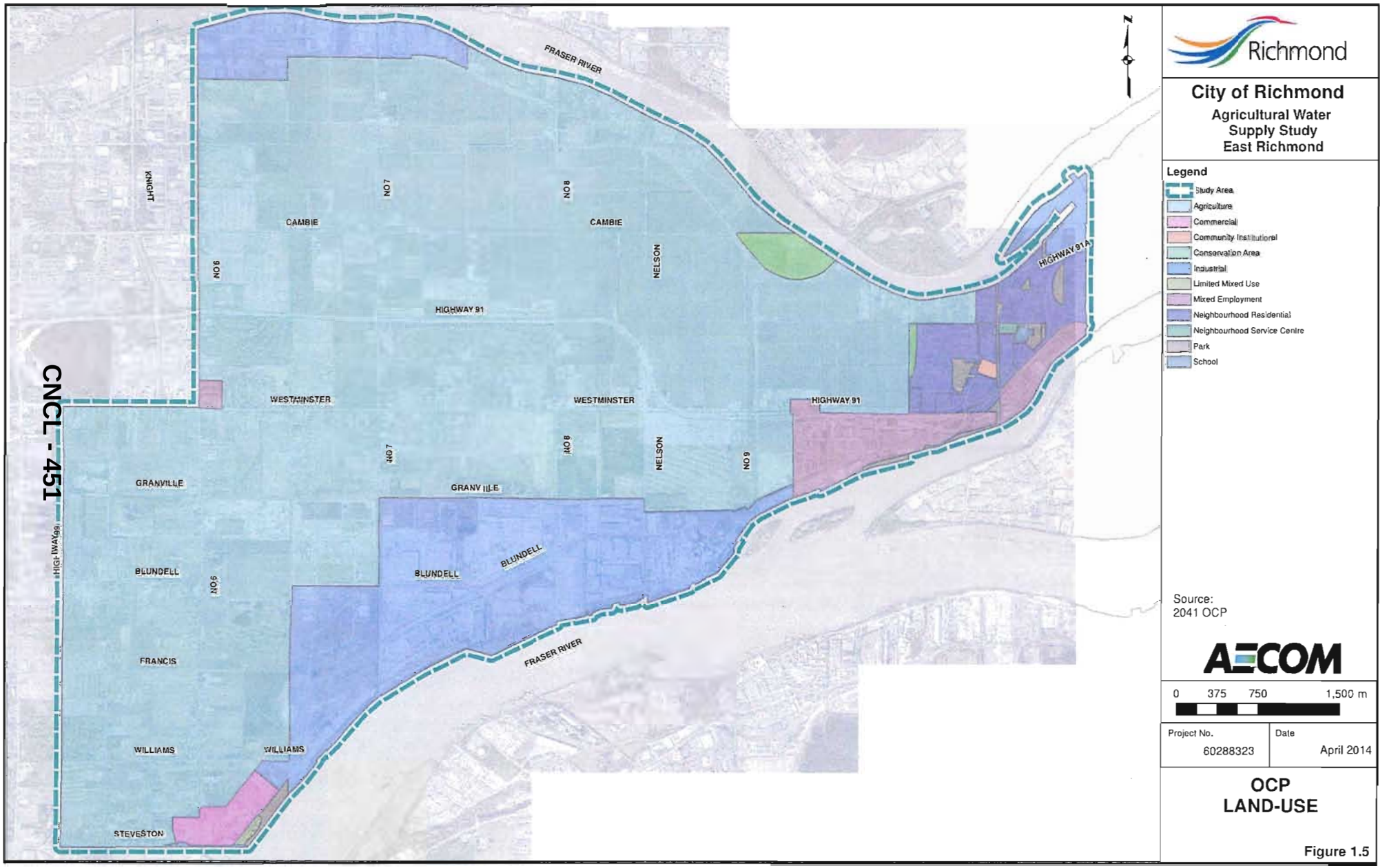
AECOM

0 375 750 1,500 m

Project No.	Date
60288323	April 2014

IRRIGATION TYPE/SYSTEM

Figure 1.4


FRASER RIVER
KNIGHT
NO 7
NO 8
CAMBIE
CAMBIE
NELSON
HIGHWAY 91A
NO 6
HIGHWAY 91
WESTMINSTER
WESTMINSTER
HIGHWAY 91
NO 7
NO 8
NELSON
NO 9
GRANVILLE
GRANVILLE
HIGHWAY 99
BLUNDELL
BLUNDELL
BLUNDELL
NO 6
FRANCIS
FRASER RIVER
WILLIAMS
WILLIAMS
STEVESTON
N
Richmond
City of Richmond
Agricultural Water Supply Study
East Richmond
Legend
Study Area
Agriculture
Commercial
Community Institutional
Conservation Area
Industrial
Limited Mixed Use
Mixed Employment
Neighbourhood Residential
Neighbourhood Service Centre
Park
School
Source:
2041 OCP
AECOM
0 375 750 1,500 m
Project No.
60288323
Date
April 2014
OCP
LAND-USE
Figure 1.5

1.4 Irrigation and Drainage Infrastructure Overview

1.4.1 Current Drainage and Irrigation Infrastructure

Figure 1.6 shows the current drainage and irrigation infrastructure in East Richmond. Major pump station catchments are also shown in the above figure. These are approximate boundaries as the ditches may be interconnected at some locations. The majority of the water supply for the area north of Highway 91 is provided through three gravity intakes at No 7 Road North PS and No 8 Road North PS and the CN Box on the North Arm of the Fraser River. During low tide periods water is also pumped into the drainage canals at No 8 Road Pump Station. Inland, there is a network of canals/ditches and control gates that convey drainage and irrigation water and are generally well maintained. In addition, there are two other drainage pump stations on the North Arm of the Fraser River, No 6 Rd North PS and Queens North PS, that do not provide irrigation water supply.

Irrigation and drainage infrastructure in the north is primarily geared towards cranberry production and water supply for frost protection and harvesting. The majority of the infrastructure was constructed in the 1990s as a result of an ARDSA funding program.

Water supply in the south is more challenging, particularly for the western region where there are known issues with a lack of fresh water supply and water quality. The primary source of irrigation water is from the No 6 Road South PS gravity intake and is limited due to the presence of salt water. Salt water is a particular concern in late summer and early fall when river flows are at their lowest level. There is a conductivity meter in place at the pump station that automatically closes the intake when salinity levels reach 700 micro Siemens. In addition, during summer months there is less rainfall and river water available to flush the system which can lead to water stagnation. Also there are a series of hold back structures that keep the water in the system during summer. Farmers have reported elevated iron levels in this area. As a result, many of the farmers in the southwestern portion of the study area use City supplied potable water.

There are three other drainage pump stations on the South Arm of the Fraser, No 7 Road South PS, Nelson Road South PS, and Ewen PS. None of these pump stations are able to supply irrigation water. In 2012 a low capacity irrigation pump and piping system was built near Ewen PS to service farms local to that area. There are two existing drainage pump stations inland: Dog Kennels at Dhillon Way and Westminster Highway that serves a small low lying area, and one at 22740 Westminster Highway. Both these station do not provide irrigation water supply. The City is also constructing a new drainage pump station at No 8 Road and the Granville Avenue alignment that will discharge into the Port Metro Vancouver drainage system to the south. A summary of the major drainage infrastructure is provided in ***Table 1.4***.

It should be noted that farmers typically have private pumps and canals within their properties that have not been included in this study. This is particularly prevalent for cranberry farmers that have extensive private ditches and reservoirs to balance water requirements.

In addition to the pump stations and gravity/irrigation intakes listed above there are several flap gates and slide gates that are used to retain water in the ditch system. These exist at the following locations:

- Manual slide gates at the intersection of No 6 Rd and Triangle Rd as well as Westminster Hwy and Palmberg Rd;
- Flap gates along No. 6 Rd at Commerce Parkway, Wireless Way and International Place to stop water from flowing west;
- A flap gate at No. 7 Rd and Westminster Hwy to prevent cranberry water from discharging to the south; and
- A flap gate at No. 8 Rd south of HWY 91 to prevent cranberry water from discharging to the south.

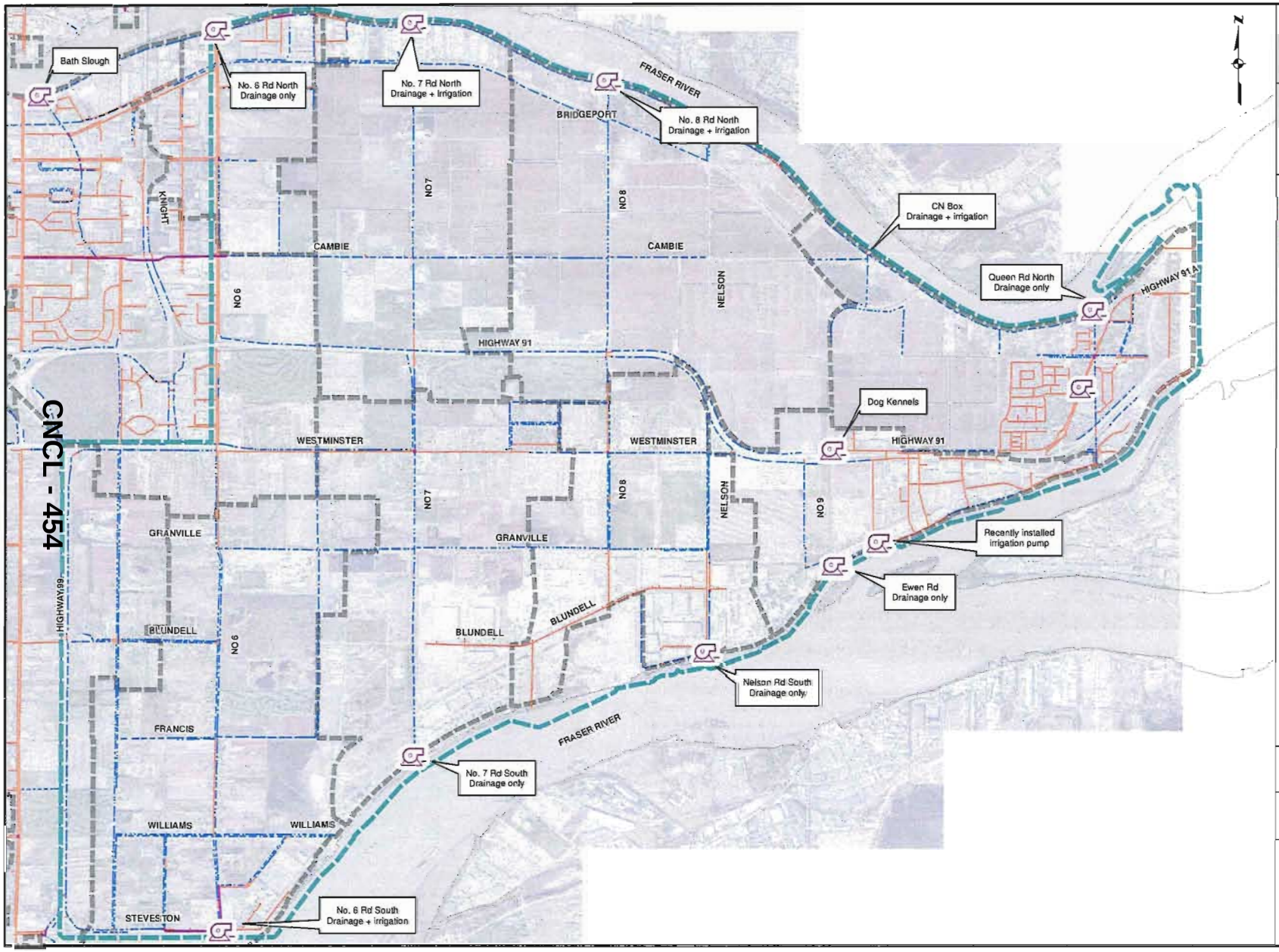
Table 1.4 Summary of Major Drainage Infrastructure

Structure & Name	Theoretical PS Capacity (see note below)	Intake/ Flood Box Dimensions	Description
No. 6 Road North PS	1.14 m^3/s	Flood Box 2.8m X 1.5m	No change to pump start/stop levels between seasons, flap gates on river side for gravity outflows during low tides
No. 7 Road North PS & Irrigation Intake at No. 7 Rd North	2.09 m^3/s	Flood Box 3.4m X 2.0m Intake dia. 1200mm	Fully automated with controls for low tide outflow slide gate & drainage PS for high tide, plus inflow slide gate for irrigation water during high tide events. Gravity inflow pipe reported to be installed too high but cannot be lowered due to ditch elevation.
No. 8 Road North PS & Irrigation Intake at No. 8 Rd North	2.41 m^3/s	Flood Box 3.7m X 2.3m Intake dia. 1200mm	Drainage PS with integrated drainage flood box and separate irrigation PS
Queens PS (North)	3.07 m^3/s	Flood Box 2.7m X 2.0m	No change to pump start/stop levels between seasons, flap gates on river side for gravity outflows during low tides
CN Drainage Flood Box (No. 9 North)		3.7m X 2.3m	Provides irrigation water and drainage for No 9 Rd ditch system and is manually controlled
Ewen PS (South) & Drainage Flood Box at Ewen	2.35 m^3/s -	Flood Box dia. 900mm	No change to pump start/stop levels between seasons, separate flood box structure with flap gates on river side for gravity outflows during low tides 50m away
Nelson Road South PS	1.62 m^3/s	Flood Box dia. 1600mm	No change to pump start/stop levels between seasons, flap gates on river side for gravity outflows during low tides
No. 7 Road South PS	2.90 m^3/s	Flood Box 1.37m X 1.0m (Twin Box)	No change to pump start/stop levels between seasons, flap gates on river side for gravity outflows during low tides
No. 6 Road South PS	2.16 m^3/s	Flood Box 3.4m X 1.5m	Drainage by gravity outflow during low tide and pumped flows for high tide events. Irrigation water supplied by 200mm valve structure.
Dog Kennels PS (Westminster Hwy)	0.17 m^3/s	NA	Drainage for a small low lying area

Note: Theoretical pump rates as provided by the City based on previous studies

1.4.2 Connectivity with West Richmond

There are three locations where the model is hydraulically connected to West Richmond; however, it is assumed that there is no flow entering the East model. The connections are modelled as a set boundary condition that was determined during the model development phase in 2006 and based on the 10-year 2 day event peak HGL.



CNCL - 454

Richmond

City of Richmond

Agricultural Water Supply Study East Richmond

Legend

- Study Area
- Existing Drainage Ditches/Culverts
- Existing Box Culvert
- Existing Storm Sewer
- Pump Station Catchment Areas

AECOM

0 375 750 1,500 m

Project No.	Date
60288323	April 2014

EXISTING DRAINAGE/IRRIGATION NETWORK

Figure 1.6

1.5 Design Criteria

1.5.1 Drainage Design Criteria

The City's Engineering Design Criteria includes design storms that are geared towards urban areas and not suitable for agricultural areas. Drainage Criteria defined by the Ministry of Agriculture was used for the model assessment in the 2006 Study and has also been used in this update.

All ALR lands follow the Agricultural and Rural Development Subsidiary Agreement Criteria (ARDSA). The BC Agricultural Drainage Manual provides information on the design of farmland drainage systems. This manual looks at crop types to be planted, soil types, water table depth, and local climate conditions. For farmers, an important issue for managing agricultural stormwater is the duration it takes for land to drain. The length of time in which crops are saturated in water is much more critical to farmers than flooding. Different crops are sensitive to different flood periods; therefore, it is important that any changes implemented to upland areas also take into consideration the impacts to downstream farm areas.

The ARDSA criteria are as follows:

- Remove runoff from the 10-year, 5-day storm, within 5 days in the dormant period (November 1 to February 28);
- Remove runoff from the 10-year, 2 day storm, within 2 days in the growing period (March 1 to October 31);
- Between storm events and in periods when drainage is required, the base flow in channels must be maintained at 1.2m below field elevation; and,
- The conveyance system must be sized appropriately for both base flow and design storm flow.

It is also important to note that the freeboard, which is the elevation difference between the base flow water level in the channel and the field elevation, should be 1.2m as noted above; however, a freeboard of 0.9m may be acceptable in some areas depending on the crop usage because drainage of the plant/ crop root zone may still be viable.

ARDSA design hyetographs for the 10-Year Winter (Harvest) and 10-Year growing season storm events were developed in the 2006 study and have been used for this study update. The hyetograph plots are shown in ***Appendix B***.

In the hydraulic model the roughness coefficient (Manning's n value) used for all ditches cleaned since 2006 was 0.04, while for all others a value of 0.06 was used.

1.5.2 Irrigation Design Criteria

Due to the diversity of crops grown, irrigation requirements vary within the study area. ***Figure 1.3*** (previously referred to) shows various cultivated crops and was used to verify the locations of irrigation demands in the hydraulic model. As a part of the LUI, information about type of irrigation used in the area was also collected and is discussed in ***Section 1.3.1***. ***Figure 1.4*** (previously referred to) shows various irrigation systems used in the area.

Irrigation demands can be separated into three different categories as follows-

I. *Growth Irrigation:* Irrigation water is mainly required for crop growth. The 2006 study assumed growth irrigation rate of 5.33mm/day throughout the area. This study adopted the same rate for growth irrigation.

II. *Frost Irrigation:* Cranberry growers, mainly north of Hwy 91, require irrigation for frost protection. Majority of cranberry farmers in this area rely on sprinkler irrigation system as shown in ***Figure 1.4***. Freezing

temperature in the early spring or late fall can result in considerable damage to cranberries. The guidelines for frost protection of cranberries (BC Frost Protection guide published by B.C. Ministry of Agriculture and Fisheries-1988) are summarized in the following paragraph:

Low growing plants such as cranberries generally require approximately 1.5mm/hr to 2.0mm/hr of water to be applied by overhead irrigation system. Dew point temperatures, wind velocity and sprinkler rotation speed have an effect on the level of protection achieved. To effectively protect against frost with an irrigation system, the system must be operated continuously from onset of frost until the ice encasement has sufficiently begun to melt. A large amount of water is required to provide this protection. Assuming an application rate of 2.0mm/hr, the flow rate required is 90gpm/hectare (or 5.7 L/s/ha). That means a 10hectare farm will require a flow rate of 900gpm (or 57 L/s/ha). It is difficult to achieve these high flowrates.

Most farmers in this area have built private storage ponds to supply water for frost irrigation. Ideally, the storage reservoir should be large enough to allow for 3 nights of frost protection at 10hours per night. Based on the information provided in 2006 study, no shortage of water for frost irrigation was reported by farmers. Farmers use the same pumps for growth irrigation and frost irrigation to withdraw water from ditches. So even though more intense rate is required for frost protection, for modelling purposes it is the same. Farmers extract water over extended period to fill local reservoirs. The stored water is then used for frost protection when required.

III. *Harvest Irrigation:* The most widely-known use of flooding in cranberry cultivation is for harvest. Approximately 90 percent of the crop is harvested this way. Flood harvesting occurs after the berries are well colored and the flood waters have lost their summer heat. The bogs are flooded with up to one foot of water. In order to conserve water, harvest is managed so water is reused to harvest as many sections of bog as possible before the water is released from the system. Flood water is recycled in the cranberry bog system, passed from bog to bog through canals and flume holding ponds and reused, often shared by several growers.

As a part of 2006 study, UMA completed an *ad hoc* survey of farmers. This survey gathered information about farmers schedule for flooding the fields. Please refer to Section 4.0 of 2006 Study for details about harvest water demands. Similar to frost irrigation, it is assumed that farmers fill local reservoirs over extended period and use stored water to flood the fields.

1.5.3 Tides

As a part of 2006 Study tidal information was acquired from three recording stations located at Nelson Road Pump Station, No. 6 Road South Pump Station and Queens Pump Station. Representative tides were developed for each station. For stations where no tidal data is available, representative tide from the nearest station is used for the following modelling scenarios:

- *Scenario 1* - To model winter drainage conditions during dormant period, a 7 day high tide cycle was developed and used with 10-year 5 day winter storm
- *Scenario 2* - To model summer drainage during growing period, *a* 4 day high tide cycle was developed and used with 10-year 2 day summer storm.
- *Scenario 3* - To model irrigation during growing period, a 3 day low tide cycle was developed to represent worst case scenario.

Please refer to section 4.2.1 of 2006 study for detailed tide information.

2. Data Collection & Review

2.1 Background Information Review

In the 2006 study, a number of issues were identified:

- Poor drainage and ditch maintenance south of Highway 91
- Concerns over competition for irrigation water and high cost of City supplied water
- Stagnant water and poor water quality, particularly the Sidaway / No. 6 Road area
- Limited options for increasing ditch capacity due to topography, high ground water levels, private property limitations, and traffic safety considerations
- Balance between ditches providing both irrigation and positive drainage
- High cost for system upgrades

To alleviate some of these concerns the City has implemented several infrastructure improvements, some of which were recommended based on the previous analysis of the system under winter and summer conditions. The model scenarios corresponded with the water intensive cranberry growing and harvesting seasons as this is a primary land use in the study area. Infrastructure improvements that were implemented include installation of flow control structures, ditch re-grading, construction of new ditches and new pump station upgrades. A summary of the works completed since 2007 is provided in Section 3 ***Table 3.1***.

In order to evaluate whether these same issues are still valid or if there are new concerns with the drainage and irrigation water supply the project team initiated meetings with the AAC and Operations Staff as well as an Open House to garner input from the general public.

2.2 Agricultural Advisory Committee Meeting, Open House and Staff Workshop

2.2.1 AAC Meeting

AECOM and City staff attended the Richmond AAC meeting on March 14, 2013. The AAC is appointed by City Council and there are ten voting members on the Committee, five of whom are nominated by the Richmond Farmer's Institute.

Background information on the project was presented along with the City's primary objective of identifying a prioritized list of drainage and irrigation upgrades within the ALR east of Highway 99. The goal for meeting with the AAC was to seek assistance from committee members and ultimately the farming community to identify drainage and irrigation issues, crop catalogue changes and any other pertinent information.

During the March 14, 2013 meeting, a Ministry of Agriculture representative gave a presentation on the latest Richmond Land Use Inventory (LUI) report (issued in 2013 and based on 2010 roadside survey). A brief description of the LUI report is provided in ***Section 1.3.1***.

During the AAC meeting, several members provided comments on known drainage and irrigation issues. A summary of the comments recorded include the following items:

- Review ditch profile and survey for Sidaway Rd between Williams and Steveston as conveyance is not good
- Water quantity and quality in vicinity of Westminster Hwy and No 6 Rd needs to be improved
- Review proposed upgrades from 2006 that have not yet been completed
- Review ditch capacity improvements on No 6 Rd north of Cambie as it is already wide with steep side slopes
- Confirm plans for re-profiling Cambie Rd ditch between No 6 Rd and No 7 Rd

2.2.2 Open House

An Open House was held on April 18, 2013 at City Hall to educate residents and farmers and encourage the community to voice their drainage and irrigation concerns. Poster boards including maps of the study area showing the Agricultural Land Use Inventory findings and East Richmond drainage and irrigation system upgrades, as well as descriptions for upgrade projects completed since 2006, were presented at the Open House. Attendees were asked to complete feedback forms or go to LetsTalkRichmond.ca to provide comments online.

A few drainage and irrigation concerns were raised at the Open House and are summarized below. The completed questionnaire forms that were received are included in ***Appendix A.***

- Drainage ditches located on north and south sides of Westminster Hwy east of No 6 Rd are not effective in winter and spring and the ditches have been observed to flow in both directions. In summer there is no water for irrigation and City water is used by local area farmers. One vegetable farmer stated that City water is too cold and chlorinated such that vegetable quality is reduced and adds operational cost to buy water.
- Concern over increased impervious areas due to development of large houses on Blundell Rd between Sidaway Rd and No 6 Rd. The increased runoff may cause drainage problems in the area.

2.2.3 Workshop with Operations Staff

A workshop was held with City Operations Staff on May 1, 2013 to discuss known drainage and irrigation issues in the study area. The workshop was followed by a field trip with Operations Staff to visit several of the problem areas as well gain a further understanding of the system operation.

During the workshop it was noted that several of the cranberry farmers are increasing the size of their fields by amalgamating smaller plots into larger plots putting increased pressure on the drainage and irrigation systems. This is occurring at a number of locations north of Hwy 91 and one location in particular is west of No 6 Road between Bridgeport Rd and Cambie Rd.

The following locations were discussed as areas where maintenance works are required:

- Ditch cleaning and re-profiling on the south side of the Cambie Rd ditch between No 6 Rd and No 8 Rd. It was noted that east of No 8 Rd the ditch is on private land
- Repair or replacement of the failing headwall at the south ditch box culvert inlet on Cambie Rd just east of No 6 Road
- Ditch cleaning and re-profiling along CN Rail corridor between No 7 Rd and No 8 Rd (City needs permission from the railway for access)
- Ditch cleaning and re-profiling for south side of River Rd from the CN box (Cambie Rd alignment) east to Queens PS
- Box culvert flushing and cleaning for No 6 Rd north drainage corridor
- Removal of invasive species (Japanese Knotweed) and training for staff to do this (areas to be determined based on further field inspection)

In addition to the areas identified above, other known problem areas and concerns include:

- Sidaway Rd from Steveston Hwy to Granville Ave is prone to flooding due to low topography. Solutions discussed include removal (or lowering) of culverts, additional ditch re-profiling and combination of automated gate structures and level sensors.
- The area between Nelson Rd at Hwy 91 to Westminster Hwy is prone to flooding due to fields from the north draining south.
- A lack of irrigation water in the south west area between Steveston Hwy and Highway 99. Concerns include:
    - Water quality and quantity-Farmers are currently supplementing ditch flows with City water which has chlorine, temperature and cost implications; and
    - Salinity at the No 6 Rd irrigation intake during periods when the salt wedge is present in the Fraser River South Arm.
- Limited ditch and box culvert capacity in No 6 Rd between Cambie Rd and No 6 Road North PS, including the known obstruction of the Kinder Morgan jet fuel pipeline crossing on No 6 Road between Cambie Rd and Bridgeport Rd.
- Sloughing in ditch along No 8 Road north of CN railway tracks to River Road.

Other items discussed that are to be reviewed and may be potential study recommendations include:

- Lowering the No 7 Rd North PS culvert and the impact this would have on the downstream ditch systems
- A culvert inspection program of the entire study area and in particular a review of who is responsible for maintenance of culverts crossing Hwy 91
- Procedures that requires farmers to identify when and where new outfalls from fields to municipal ditches are constructed
- Coordination of operation for CN box gravity intake (River Rd and Cambie Rd alignment) with farmers and Operations staff
- Coordinated water use by farmers from No 7 Rd North gravity intake and No 8 Rd North PS during harvest

2.3 Field Reconnaissance

At the onset of the project AECOM staff completed a site reconnaissance of the study area on March 12, 2013. A second site visit was completed on May 1, 2013 with City Staff. During the site visits further anecdotal information about the system's operation was recorded and has been incorporated into this report.

3. Model Update

3.1 Conversion from DHI's Mouse to Mike Urban

The 2005 version of DHI's (Danish Hydraulic Institute's) MOUSE software was used for modelling in the 2006 study. This software is no longer available nor is it supported by DHI. The existing scenario model files from the 2006 study were converted from MOUSE into MIKE URBAN 2012.

3.2 Infrastructure Updates Completed after 2006

The model network was then updated based on the upgrades completed since 2006 as shown in ***Table 1.1*** (previously referred to in ***Section 1.1***). Record drawings and survey information for the infrastructure improvements listed in the table were provided by the City and incorporated into the updated model. ***Figure 3.1*** shows the location of completed upgrades. Many were recommended in the 2006 East Richmond Agricultural Water Supply Study as high priority upgrades while other additional projects have also been completed based on input from Operations Staff. The upgrades were entered into the hydraulic model for both the drainage and irrigation scenarios.

3.3 Pump Station Operations

Details for the pump models and seasonal settings at each pump station are provided in ***Table 3.1*** below. The information summarized in the table was provided by the City and also extracted from the 2006 Study.

To assist with meeting water requirements for different seasons, City Operations Staff alter the drainage pump start/ stop levels at two northern pump stations: No 7 Rd North and No 8 Rd North. In addition, operational settings of the irrigation gate at No 7 Rd North and No 8 Rd North irrigation pump station are also changed from season to season. These two pump stations are the only stations where settings are altered from season to season to allow for irrigation water supply. Settings at all other pump stations are not changed over the course of the year unless Operations Staff are conducting routine maintenance or ditch cleaning works.

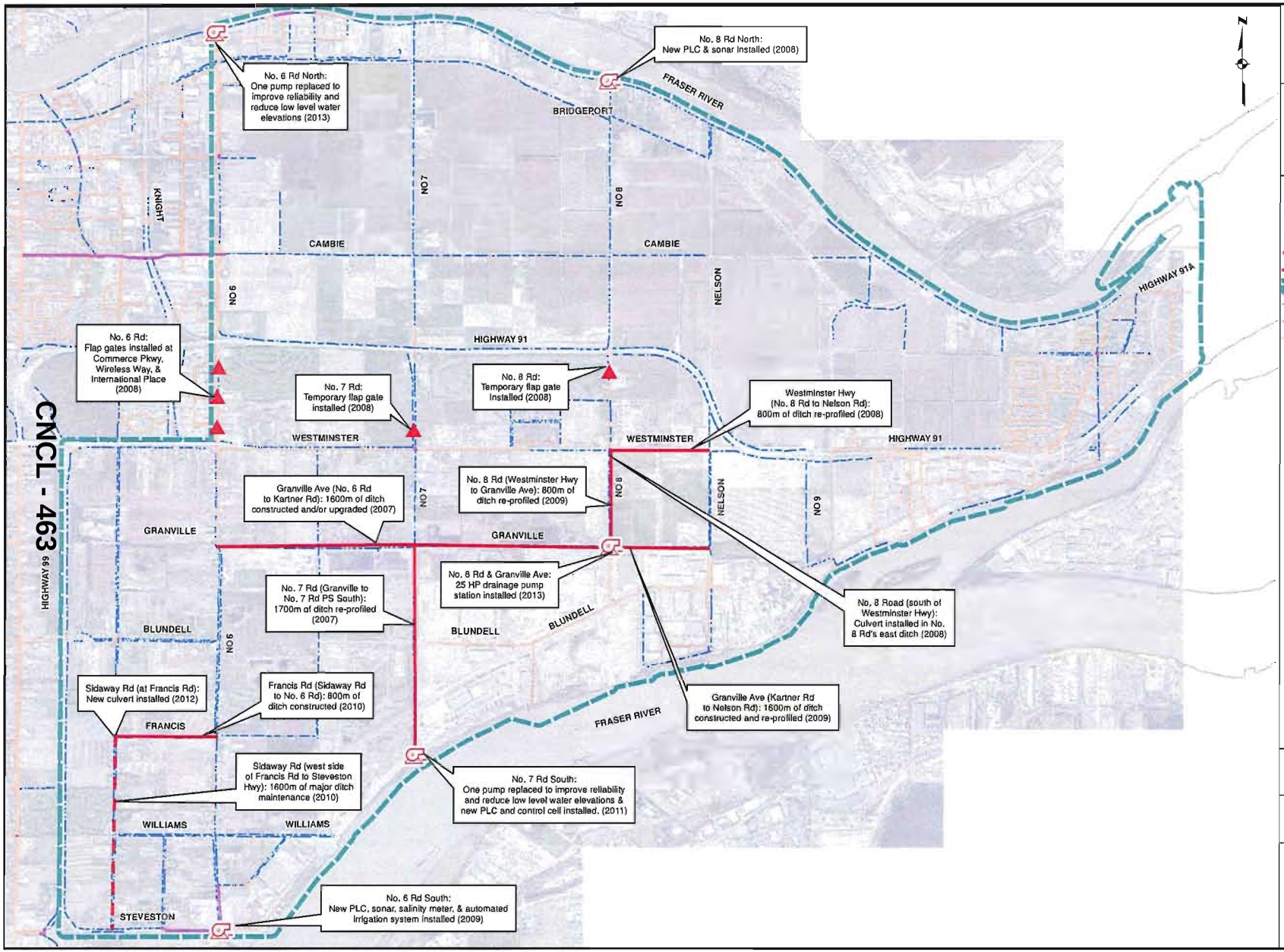
The alternate irrigation season pump start and stop settings for No 7 Rd North and No 8 Rd North pump stations are in place so that target water level elevations in the irrigation ditches can be achieved. The target levels for No 7 Rd North and No 8 Rd North Pump Stations are currently 0.217m and 0.575m geodetic elevations respectively (as shown in ***Figure 3.2 and Figure 3.3)***.

Control logic for the No 8 Rd North irrigation pump station is as follows:

- Under normal irrigation mode when the ditch water level drops 0.25m below the target water level (elevation 0.575m) the gravity inlet gate will open, but only if the tide is high enough to provide water. However, if at this time the tide is too low to deliver water then the irrigation pump will start.
- If the gravity inlet is delivering water and the tide drops then the gate will close. After the gate has closed the pump will not start unless the ditch water level reaches an elevation of 0.25m or more below the target level.
- Typically gravity inflows are sufficient to maintain water levels above the start level (0.25 m below target) and the pump rarely turns on through the summer. However, the gravity inflow typically cannot maintain the upper water level (0.5m above target) required during cranberry harvest and frost protection periods when farmers are drawing heavily on the ditch water.
- To maintain a consistent water level of 0.5m above the target both the gravity gate and pump controls are overridden. The pump start and stop levels are increased by 0.5m (pump start 0.825 and stop at 1.575).

At No 8 Rd North the irrigation pump has been noted to pump continuously for a week such that the upper water level is not attained or only attained intermittently. At this time the gravity inlet gate elevations are also set higher so that the pump operates before the gate has an opportunity to open. This could possibly be caused by short circuiting of flow back to the river at No 7 Rd North PS as existing drainage pumps at No 7 Rd North start at 0.4m elevation which is lower than No 8 Rd North target level (0.575m).

There is no dedicated irrigation pump at No 7 Rd North so inflows via the 1200mm diameter gravity irrigation intake pipe are controlled by the tides and the gate structure on the intake pipe. During the irrigation season the gate is set to be open between elevation 0.14m and 0.37m geodetic.



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Legend

- Flap Gates installed since 2006
- Completed Pump Station Upgrades
- Ditch Maintenance Only
- Completed Ditch Upgrades
- Study Area
- Existing Drainage Ditches
- Existing Box Culvert
- Existing Storm Sewer

AECOM

0 375 750 1,500 m

Project No.	Date
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PROJECTS COMPLETED SINCE 2006

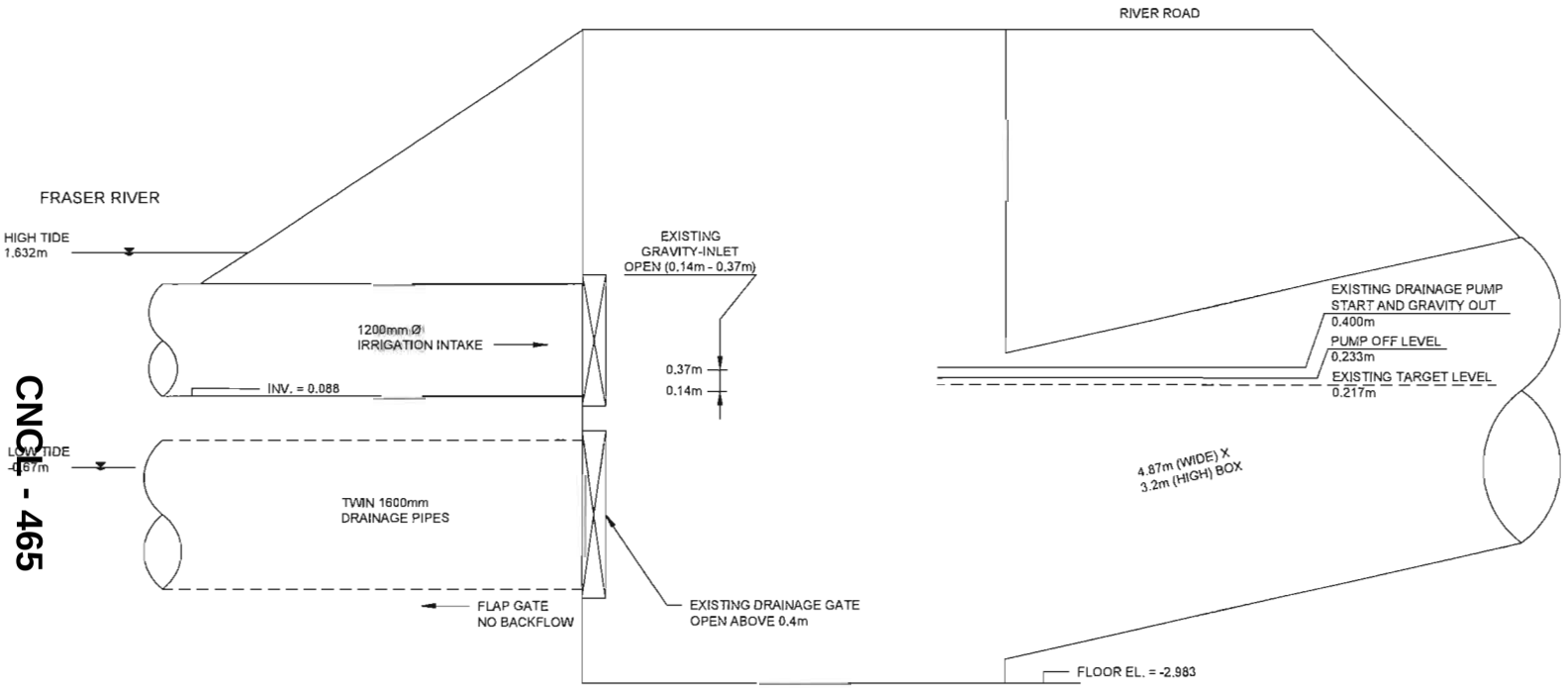
Figure 3.1

Table 3.1 Pump Station Information

Station	Pump Model	Impeller #	Pump Unit	Power (Hp)	Pumping Levels (m – geodetic)			
					Drainage		Irrigation	
					On	Off	On	Off
No. 6 Road North PS	Flygt 7050-680	15	P1	60	-0.04	-0.26	No Change	
	Flygt 7050-680	15	P2	60	0.13	-0.26		
	Flygt CP3152-120	614	P3 (jockey)	20	-0.22	-0.47		
No. 7 Road North PS	Flygt 7060-770	16	P1	84	-0.10	-0.41	0.42	0.23
	Flygt 7060-770	16	P2	84	-0.07	-0.41	0.45	0.23
	Flygt CP3300-180	814	P3 (jockey)	77	-0.10	-0.41	0.40	0.23
No. 8 Road North PS	Flygt 7060-760	16	P1	60	0.08	-0.52	1.11	0.65
	Flygt 7060-760	16	P2	60	0.24	-0.52	1.14	0.65
	Flygt 7060-760	16	P3	60	0.38	-0.52	1.17	0.65
	Flygt CP3300-180	814	P4 (jockey)	32	-0.32	-0.61	1.19	0.65
Queens PS (North)	Flygt 7080-820	16	P1	70	-0.53	-0.72	No Change	
	Flygt 7080-820	814	P2	70	-0.26	-0.72		
	Flygt 7080-820	16	P3	70	0.01	-0.72		
	Flygt CS3300-180	814	P4 (jockey)	35	-0.56	-0.87		
Ewen PS	Gen Elec	N/A	P1	60	0.15	-0.16	No Change	
	Gen Elec	N/A	P2	60	0.21	-0.09		
	Gen Elec	N/A	P3	60	0.30	0.00		
	Flygt 3300	N/A	P4 (jockey)	20	0.07	-0.16		
Nelson Road South PS	Flygt 7060-760	16	P1	60	0.04	-0.54	No Change	
	Flygt 7060-760	16	P2	60	0.21	-0.54		
	Flygt CP3201-120	614	P3 (jockey)	35	-0.17	-0.47		
No. 7 Road South PS	KSB	N/A	P1	130	-0.08	-0.38	No Change	
	Westinghouse	N/A	P2	125	0.22	-0.38		
	Flygt CP3300	N/A	P3 (jockey)	60	-0.39	-0.69		
No. 6 Road South PS	Flygt 7060	20	P1	84	-0.46	-0.80	No Change	
	Flygt 7060	20	P2	84	-0.28	-0.80		
	Flygt CP3300	804	P3 (jockey)	32	-0.64	-1.00		

No. 7 ROAD NORTH SCHEMATIC FOR IRRIGATION SETTINGS

NOT TO SCALE



WET-WELL SECTION

NOTES:

1. ALL ELEVATIONS ARE GEODETIC
2. LOW TIDE AND HIGH TIDE BASED ON DESIGN TIDE USED IN MODEL
3. ABOVE SKETCH IS SCHEMATIC TO SHOW ELEVATIONS ONLY

EXISTING SETTINGS:

1. TARGET LEVEL IS 0.217m
2. IRRIGATION INTAKE OPENS AT 0.14m AND CLOSES AT 0.37m
3. DRAINAGE PUMPS START AND GRAVITY-OUT FALLS OPEN AT 0.4m OR ABOVE (TO PREVENT FLOODING DURING SUMMER STORMS)

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East Richmond

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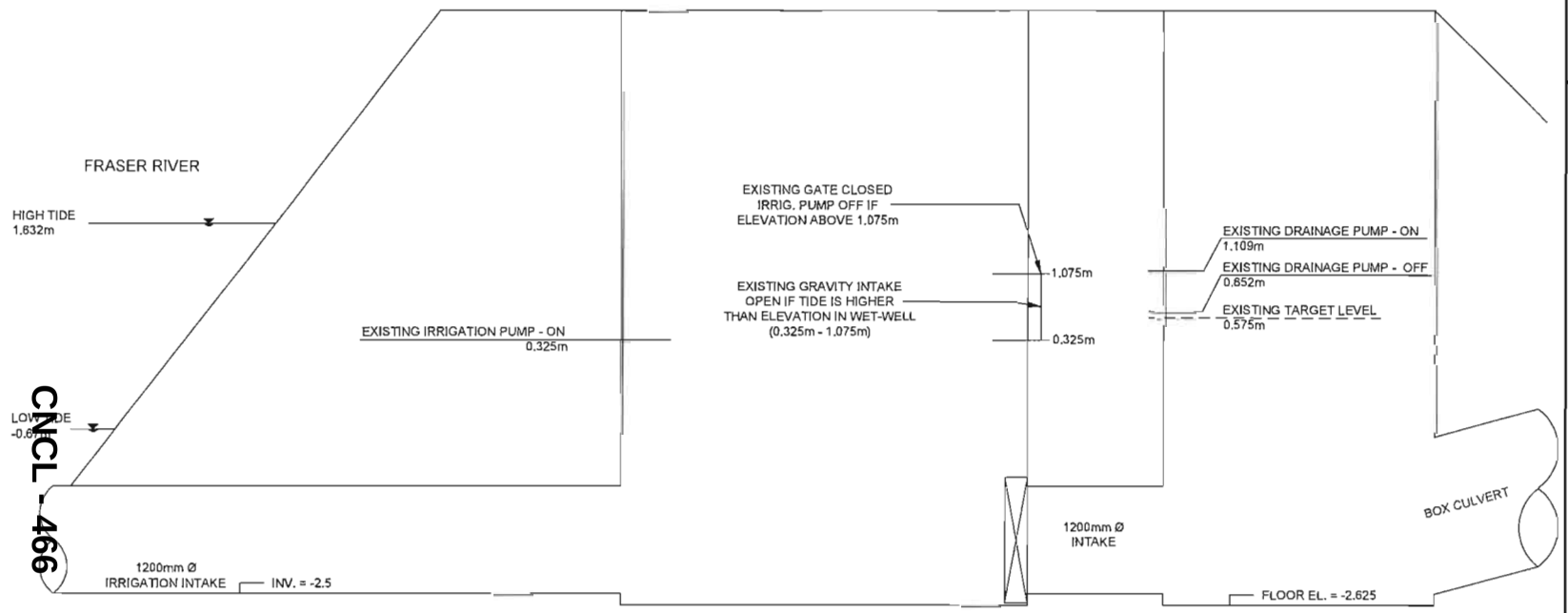
No. 7 Rd. North Schematic for Existing Irrigation Settings

Figure 3.2

No. 8 ROAD NORTH SCHEMATIC FOR IRRIGATION SETTINGS

NOT TO SCALE



IRRIGATION PUMP STATION CHAMBER

No. 8 ROAD DRAINAGE PUMP STATION WET-WELL

NOTES:

1. ALL ELEVATIONS ARE GEODETIC
2. ONLY ONE IRRIGATION-INFLOW TAKES PLACE (PUMP OR GRAVITY) AT ONE TIME
3. LOW TIDE AND HIGH TIDE BASED ON DESIGN TIDE USED IN MODEL
4. ABOVE SKETCH IS SCHEMATIC TO SHOW ELEVATIONS ONLY

EXISTING SETTINGS:

1. TARGET LEVEL IS 0.575m
2. IRRIGATION PUMP TURNS ON ONLY IF LEVEL DROPS BELOW 0.325m. ONCE IT TURNS ON THEN IT TURNS OFF AT 1.075m
3. PUMP/GATE CONTROLS ARE MANUALLY OVERRIDDEN WITH A TEMPORARY SETTING TO MAINTAIN A HIGHER WATER LEVEL (START 0.825, STOP 1.575) DURING CRANBERRY HARVEST & SPRING FROST PROTECTION
4. GRAVITY INTAKE GATE OPENS AT 0.325m AND CLOSES AT 1.075m

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No. 8 Rd. North Schematic for Existing Irrigation Settings

Figure 3.3

4. Existing System Assessment

4.1 Drainage System Assessment Scenarios

Assessment of existing drainage system was completed for the following two worst case scenarios:

4.1.1 *Scenario 1- Dormant Winter Period*

For this scenario 10-Year 5-day design storm (as shown in Appendix B) and 7-day winter high tide (boundary condition) was used to evaluate the performance of drainage network.

In addition to storm runoff, cranberry harvest discharges were added as constant inflow into the model. Cranberry discharges vary from year to year depending upon the schedule developed between Ocean Spray and farmers. For modelling purposes, the volume and schedule of discharges was assumed to be same as per the 2006 Study. The model was set to run for 7 days with start date of November 1. A total cranberry harvest discharge volume of 308,447 m^3 was added at two separate locations in the model for this scenario. This is equivalent to discharge from a 68.5 hectare farm with 0.45m of standing water. Since all the cranberry farmers do not discharge water on the same day and tend to coordinate water supply for reuse during harvest periods, this is a conservative assumption.

4.1.2 Scenario 2- Summer Growth Period

For this scenario 10-Year 2-day design storm (as shown in Appendix B) and 4-day summer high tide (boundary condition) was used to evaluate the performance of drainage network. The two day storm has higher peak rainfall intensity but lower total rain (volume) than the five day storm.

Since the cranberry harvest is at the cusp of the growing and dormant period, harvest discharges were added as constant inflow into the model. Based on the schedule assumed in the 2006 study, a total discharge of 252,678 m^3 was added at two separate locations. For this scenario, the model was run for a period of 5-days to evaluate system performance after the storm is over.

4.2 Drainage Model Results

Analysis of the existing system indicates that there are several different factors that affect the maximum HGL at any location. The East Richmond drainage network is similar to the West Richmond drainage system as there are a lot of interconnected ditches but differs in that it serves the dual purposes of irrigation water supply and drainage conveyance.

4.2.1 System Conveyance

Several factors that contribute to conveyance problems and lack of irrigation water supply include capacity constraints, reliance on tide elevations, back water effects from pump stations and gravity outlets, and localized low ground elevations. For instance, at several locations the ground elevations in the hydraulic model were found to be very low when compared to neighbouring ground elevations (or attributes of adjacent ditch/culvert conduits), resulting in localized flooding. Locations where localized flooding was reported due to major discrepancies in ground elevations were often resolved by reviewing the digital elevation model (DEM) data for the study area as shown in ***Figure 4.1*** and information available on Google Street View. The DEM raster image was generated using data supplied by the City for the 2006 Study. It should also be noted that the elevation data does not take into account infill areas since the topographic data was recorded.

To better understand if flooding in a certain area is caused by capacity constraints or back water from a pump station, the model was simulated with no boundary conditions (i.e. no tide at outfalls) to allow the system to drain

freely. Subsequently all ditch improvements discussed in the following section were first analysed with no boundary conditions prior to running the model with high tides. This also assisted in gaining a better understanding of pump station operation, capacities and on-off levels.

The existing model results for the dormant winter period (10-Year 5 day storm event) with tides are shown in ***Figure 4.2a***. Flooding is predicted at several locations and is color coded based on the height of the maximum HGL above and below existing ground elevation. ***Figure 4.2b*** shows existing systems HGL after the 10-Year 5 day storm event has passed (on day 5).

All model nodes were set to allow ponding in Mike Urban, which means even though the maximum HGL goes above the existing ground elevation, no water is lost in the model. This helps in keeping the total volume within the system to review the downstream capacity. The HGL results are conservative as no flood cells were modelled (in the 2006 study as well as this study) due to lack of detailed survey of adjoining fields. Flooding at each location was analysed in further detail to identify the cause of flooding and determine if ditch upgrades are required. In ***Section 4.3***, various problem areas are identified and improvement options are recommended.

4.2.2 Drainage Pump Station Capacity Review

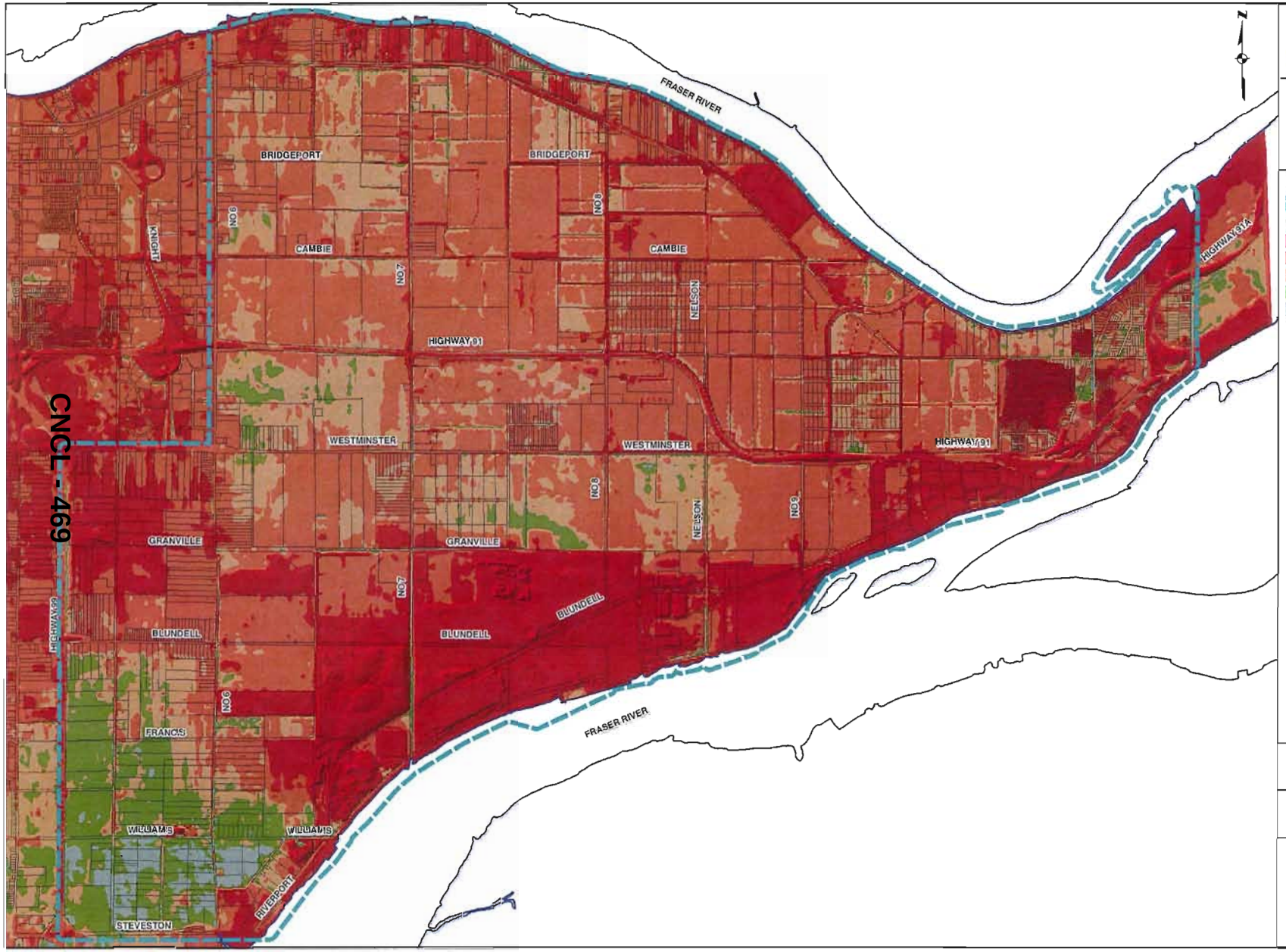
Drainage pump station capacities under Scenario 1 for the dormant winter period (10-Year 5-day design storm and 7-day winter high tide) were reviewed and the results are summarized in ***Table 4.1***. For all locations where there is a flood box outlet, the capacity will vary as the tide level changes such that ultimately no flow occurs when the tide is higher than the wet well or upstream ditch water level.

Table 4.1 Summary of Pump Station Capacities

Structure & Name	Theoretical PS Capacity m^3/s	Flood Box Size	Flood Box Capacity* m^3/s	10-Year 5 day Peak Inflow m^3/s	Comments
No. 6 Road North PS	1.14	2.8m X 1.5m	6.4	2.35	PS under capacity during high tide periods
No. 7 Road North PS	2.09	3.4m X 2.0m	12.0	3.35	Pump station under capacity during high tide periods
No. 8 Road North PS	2.41	3.7m X 2.3m	16.0	2.0	PS capacity is adequate
Queens PS	3.07	2.7m X 2.0m	9.0	3.05	PS capacity is adequate
Ewen PS	2.35	NA	NA	1.80	PS capacity is adequate
Nelson Road South PS	1.62	1600mm dia.	2.6	2.55	Pump station under capacity during high tide periods
No. 7 Road South PS	2.90	1.37m X 1.0m (Twin Box)	3.3	4.10	PS and flood box individually under capacity. Combined capacity is adequate.
No. 6 Road South PS	2.16	3.4m X 1.5m	8.0	3.65	Pump station under capacity during high tide periods
Dog Kennels PS (Westminster Hwy)	0.17	NA	NA	0.10	PS capacity is adequate

*Note: * Flood box capacity stated is calculated assuming HGL slope of 0.1%*

As shown in ***Table 4.1***, there are several pump stations where the capacity is less than the model predicted 10-Year 5 day inflow. With exception of No. 7 Road South PS, all of the flood box outlets have capacity to covey 10-Year 5 day peak flow during low tide. At No. 7 Road South the combined capacity of flood box and pump station is adequate to convey 10-Year 5 day peak flow.



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Legend

- Study Area
- Elevation (Geodetic, m)
  - > 2
  - 1 to 2
  - 0.5 to 1
  - 0 to 0.5
  - -1 to 0

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0 375 750 1,500 m

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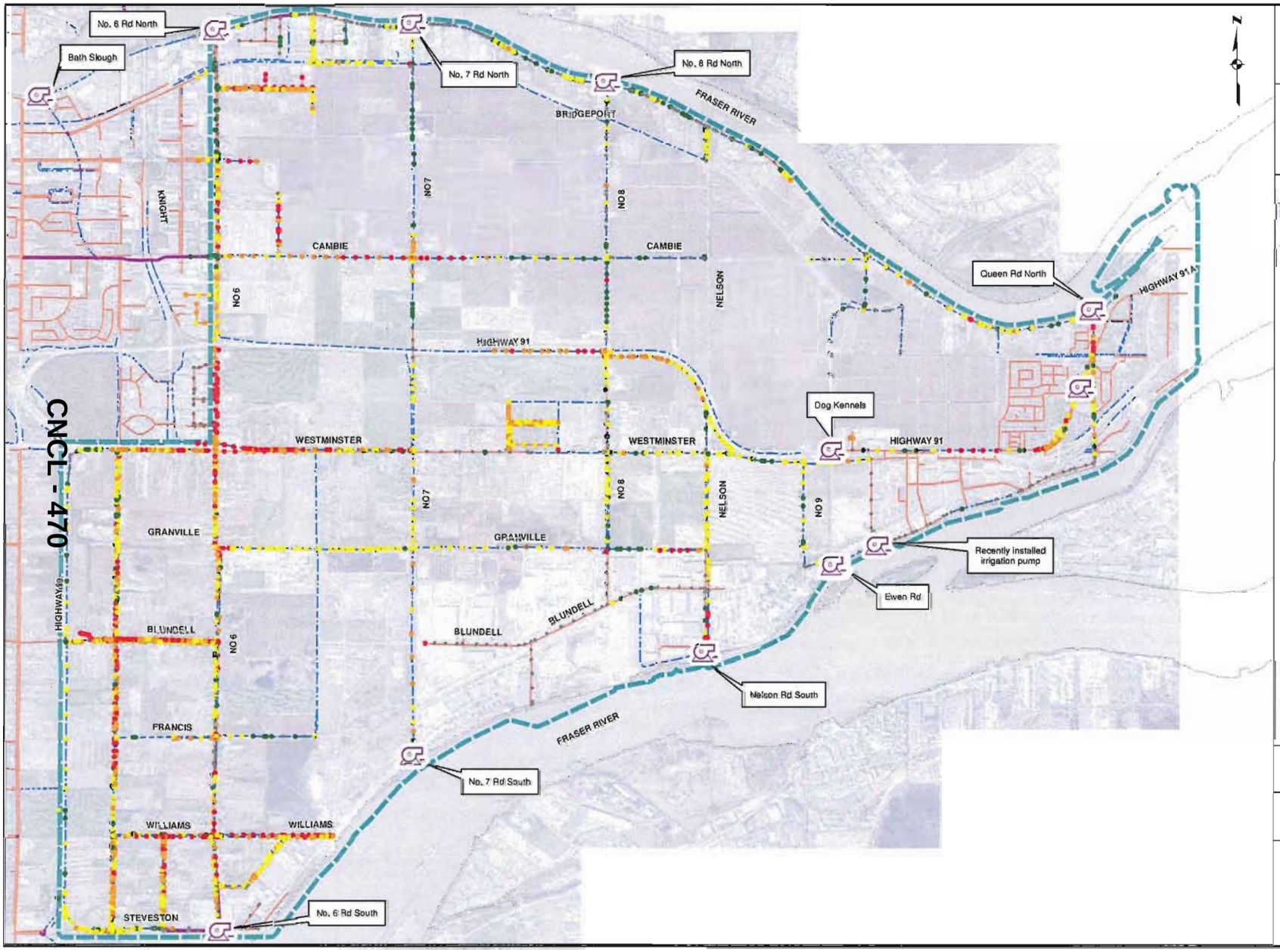
GENERAL GROUND ELEVATION

Figure 4.1



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Legend

- Study Area
- Existing Drainage Ditches/Culverts
- Existing Box Culvert
- Existing Storm Sewer

HGL Depth Below Ground

- Lower than 1.2m
- 1.2m to 0.9m
- 0.9m to 0.3m
- 0.3m to 0.0m
- Above 0.0m / Flooded

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0 375 750 1,500 m

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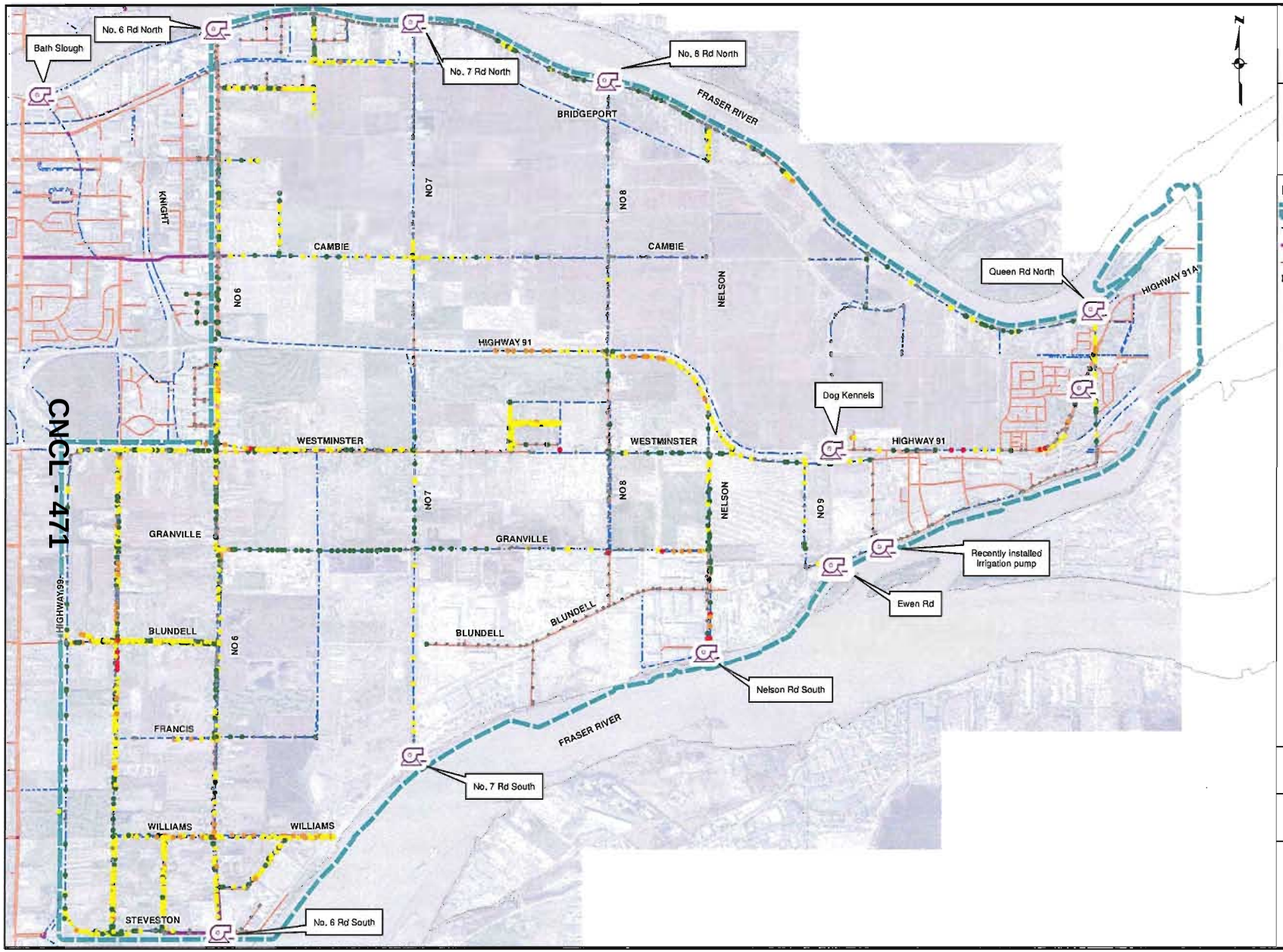
EXISTING SYSTEM PEAK HGL DORMANT WINTER PERIOD 10-YR 5-DAY STORM EVENT WITH TIDE

Figure 4.2a



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Legend

- Study Area
- Existing Drainage Ditches/Culverts
- Existing Box Culvert
- Existing Storm Sewer

HGL Depth

- Lower than 1.2m
- 1.2m to 0.9m
- 0.9m to 0.3m
- 0.3m to 0.0m
- Above 0.0m / Flooded

AECOM

0 375 750 1,500 m

Project No.	Date
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EXISTING SYSTEM HGL ON DORMANT WINTER PERIOD 10-YR 5-DAY STORM EVENT WITH TIDE [ON DAY 5]

Figure 4.2b

4.3 Proposed Drainage Improvements

The following sections highlight the problems areas identified using the existing model and proposed upgrades for each area. In each case the hydraulic model was simulated for the winter (10-Year 5 day storm) and summer (10-Year 2 day storm with maximum summer tide) events to confirm the proposed upgrades have the desired effects. An overview of the proposed drainage upgrades is shown in ***Figure 4.3***.

Please note that the ditch inverts as shown in the profiles in this section are conceptual elevations for modelling purposes. Elevations should be surveyed and verified during the detail design stage prior to construction. Additionally the areas identified on Figure 4.3 should be surveyed and data verified against current model elevations to confirm potential flood issues.

ARDSA criteria (discussed in ***Section 1.5.1***) requires that in periods when drainage is required, the base flows should generally be maintained at 1.2 m below field elevation, although a freeboard of 0.9 m may also be acceptable. The criteria further requires that drainage ditches remove runoff from the 10-Year 5-day storm within 5 days in the dormant period and remove runoff from 10-Year 2 day storm within 2 days in the growing period. The purpose of these criteria is to allow for the free-drainage of outlets of local field drainage systems.

As discussed in the 2006 Study (Section 5.3) there are several issues to consider when reviewing these criteria. The first is that the areas dominated by cranberries are well established and successful under current drainage and irrigation conditions. In such case, minimal changes are proposed for these areas regardless of the ditch water levels being able to meet the ARDSA criteria. Only ditch cleaning is proposed as part of the drainage infrastructure upgrades.

Ditches in the study area serve the dual purpose of supplying irrigation water and removing drainage water. Meeting the 1.2 m freeboard requirement (or even 0.9m) is a challenge as the ditches are generally full supplying irrigation water throughout most of the area or conveying stormwater runoff that is backed up in the system due to high tide conditions. Model results for the drainage system with improvements following the 10-Year 5 day storm event are shown in ***Figure 4.6***. The model predicted ditch HGLs are shown using 0.3m increments from ground level to represent the freeboard from the top of ditch level, which is assumed to correspond closely with the surrounding field elevations in most cases.

There are several locations where the 1.2m (or 0.9m) ARDSA freeboard criteria are not met. These include the Sidaway Rd west side ditches from Steveston Hwy to Westminster Hwy, Williams Rd east of No 6 Rd, Kartner Rd and Fedoruk Rd (which is a residential area), along Hwy 91 near No 8 Rd, and Granville Ave East of Neslon Rd, Nelson Rd South to the pump station, as well other isolated locations. Rationale for why these areas are not able to meet the freeboard criteria five days after the storm event is primarily due to the fact that the existing ditches are shallow and have a maximum depth of 1.2 m in many areas (even after improvement measures are implemented).

One option would be to construct deeper ditches; however, in the 2006 Study farmers reported the groundwater table to be approximately 300 mm to 900 mm (average of 700 mm) below ground level, so deeper ditches would potentially result in more pumping requirements and in areas with high iron content, possibly iron-affected water quality. The structural integrity of soils in East Richmond, which are predominantly silt and clay with silty and sandy loams, is also limiting factor such that steepening side slopes of the existing ditches is not possible is most areas. Furthermore, most of the area is already developed up to existing property lines, roadways, and ditches such that deeper ditches could require property acquisition, which is an expensive proposition.

4.3.1 Sidaway Road South of Francis Road Alignment (D1)

Figure 4.3.1 shows the existing ditch profile along the west side of Sidaway Rd from the Francis alignment to its entry point into the box culvert at Steveston Hwy. This ditch has large variation in bottom invert and shallow culverts

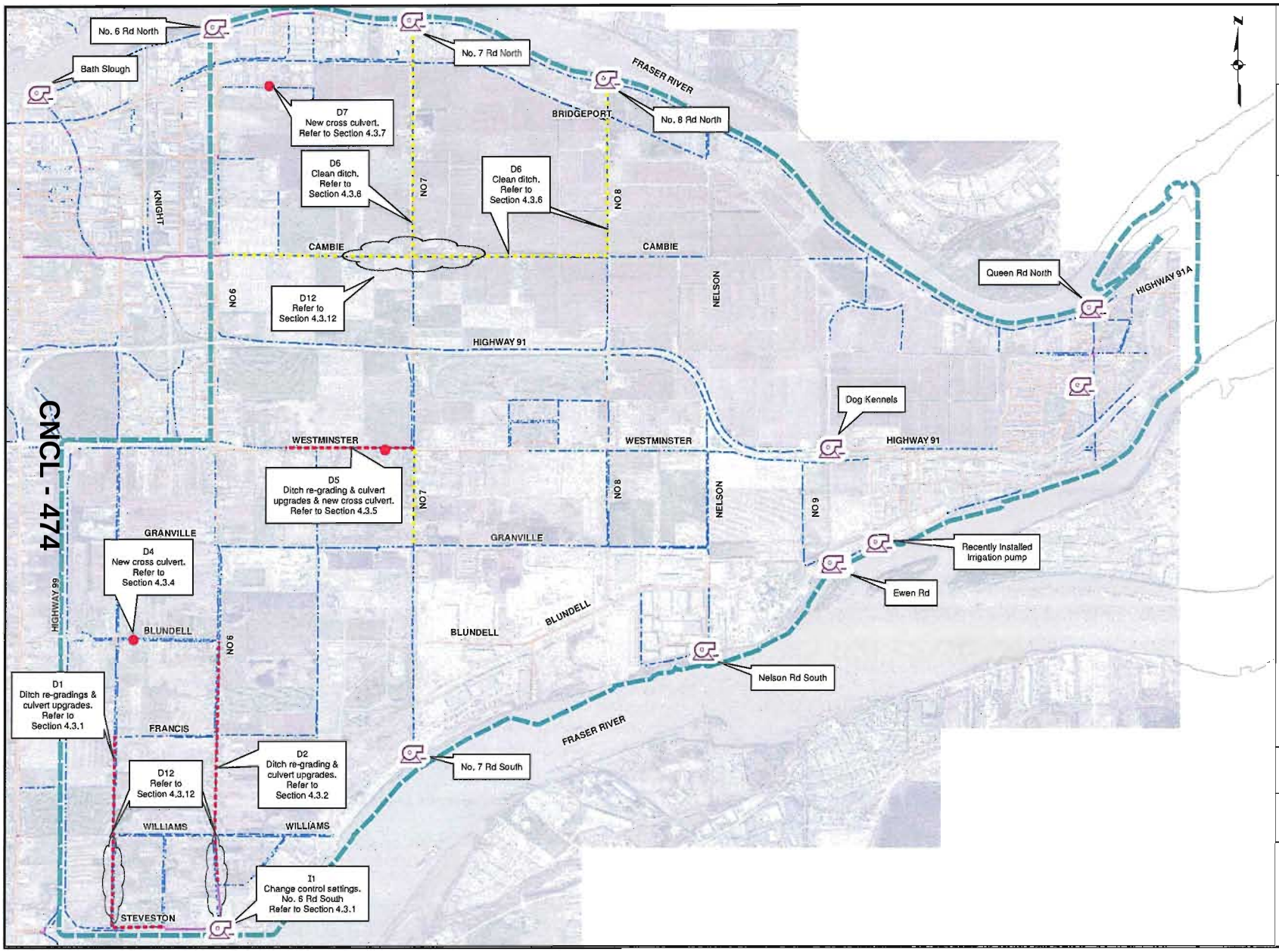
at several locations. As shown in the figure, the area south of Williams Rd is generally lower in elevation as compared to surrounding areas which is reflected in the ditch profile.

In order to reduce flooding in this area the following improvements are recommended:

- Re-grade the existing ditch along Steveston Hwy and Sidaway Rd with uniform slope starting from its entry point into box culvert at Steveston Hwy to Francis Rd alignment. This includes clearing and re-grading of 350m of existing ditch along North side of Steveston Hwy from Palmberg Rd to Sideway Rd and 1,450m along West Side of Sideway Rd from Steveston Hwy to Francis Rd alignment.
- Upgrade five existing 900mm diameter culverts along the North side of Steveston Hwy from Palmberg Rd to Sideway Rd to 1050mm diameter (for a total length of 55m of pipe) and match proposed ditch inverts
- Upgrade 15 existing culverts (ranging in diameter from 600mm to 750mm) along the West Side of Sideway Rd from Steveston Hwy to Francis Rd alignment to 900mm diameter (for a total length of 120m of pipe) and match proposed ditch inverts

It was noted that lowering the No.6 Rd South PS ON/OFF elevation had a significant impact on the maximum HGL upstream. Given that the wet well floor is -2.9m geodetic elevation (based on information from the City), it was assumed that the jockey pump ON elevation could be adjusted to -0.9m (from -0.64m currently) and OFF elevation to -1.3m (from -1.0m currently). Similarly the ON/OFF elevations of lead and lag pump was lowered by 0.3m.

Figure 4.3.2 shows the maximum HGL after the system improvements were incorporated. Under the 10-Year 2 day storm with maximum summer tide the maximum HGL with improvements was found to be slightly lower than the winter 5 day storm.



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Richmond

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Agricultural Water Supply Study East Richmond

Legend

- Study Area
- Proposed Cross Culverts

Proposed Ditch Upgrades

- Cleaning
- Upgrade
- Existing Drainage Ditches
- Existing Box Culvert
- Existing Storm Sewer

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0 375 750 1,500 m

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PROPOSED DRAINAGE UPGRADES AND GROUND SURVEY VERIFICATION

Figure 4.3

Figure 4.3.1 Existing Ditch HGL: Sidaway Rd West Side from Francis Alignment to Box Culvert at Steveston Hwy (10-Year 5 day storm with winter tide)

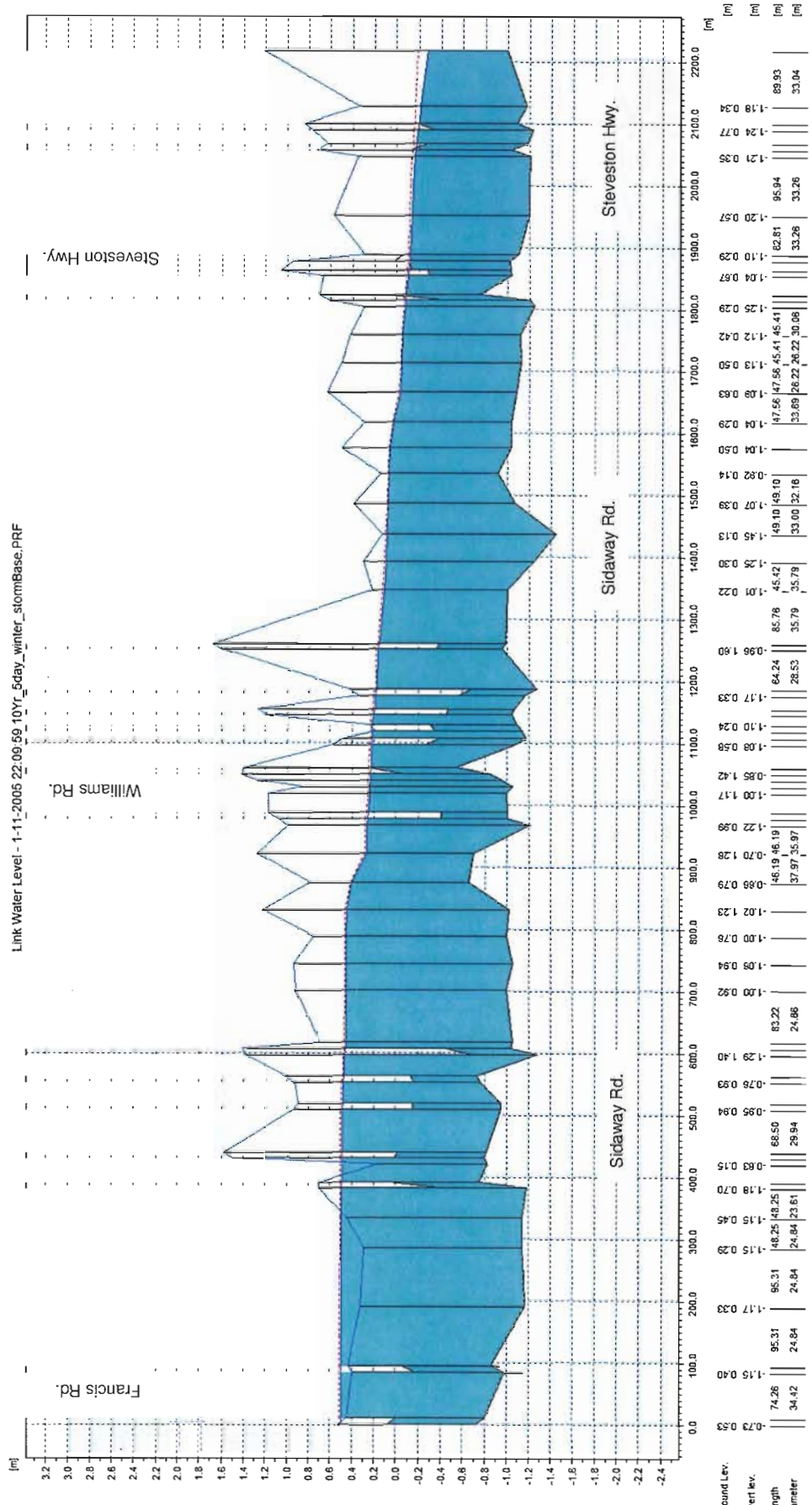
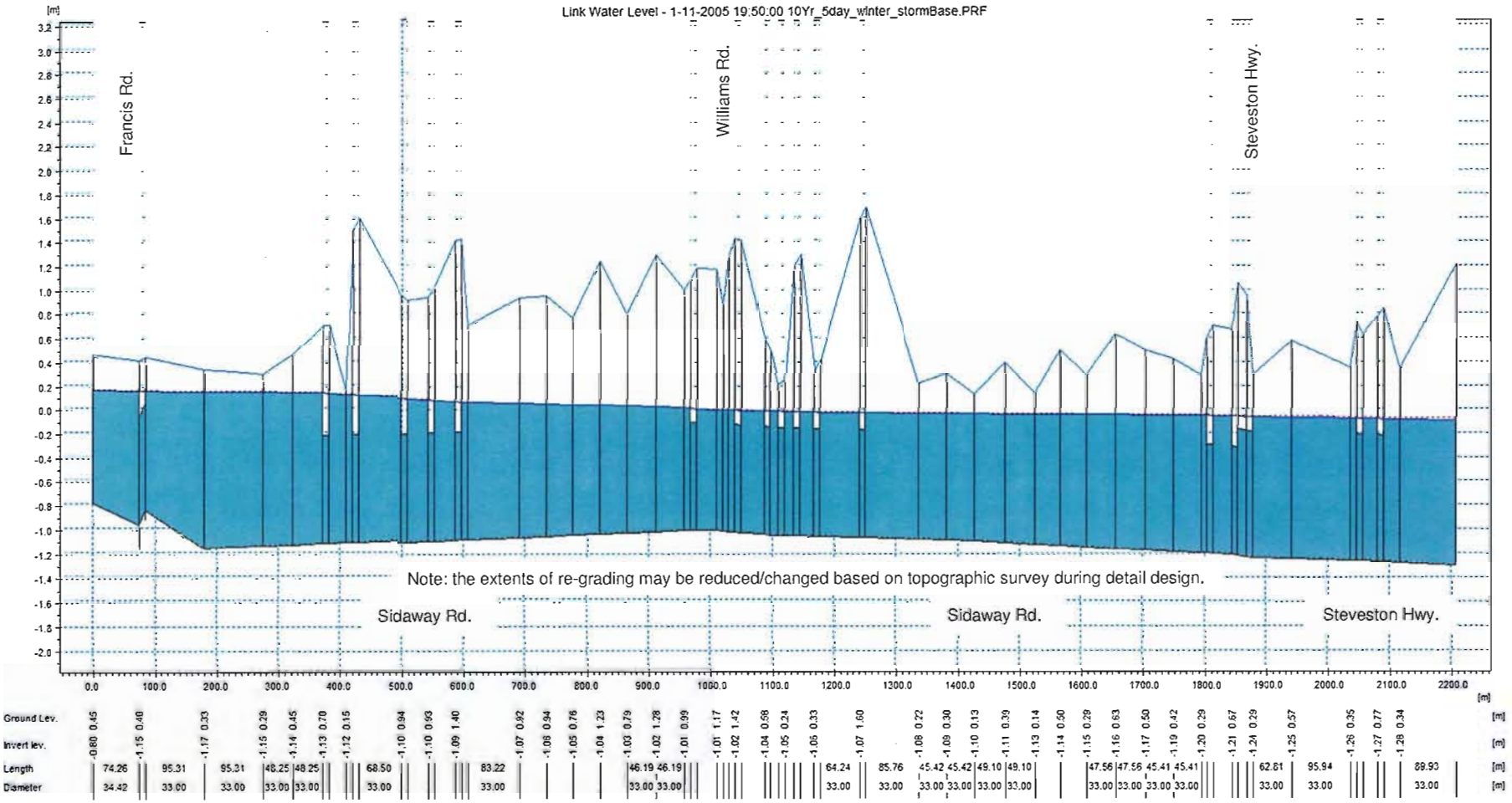


Figure 4.3.2 HGL After Improvements: Sidaway Rd West Side from Francis Alignment to Box Culvert at Steveston Hwy (10-Year 5 day storm with winter tide)



4.3.2 No. 6 Road South of Blundell Road (D2)

Figure 4.3.3 shows the existing ditch profile along the East side of No.6 Rd from Blundell Rd to its entry point into the box culvert near Triangle Rd. Similar to the Sidaway Rd ditch, this ditch has a large variation in bottom invert and has shallow culverts at few locations.

In order to reduce flooding in this area the following improvements are recommended:

- Re-grade the existing ditch assuming a uniform slope starting from its entry point into the box culvert near Triangle Rd to Blundell Rd. This includes a total of 2,000m of clearing and re-grading of the existing ditch along East side of No.6 Rd
- Upgrade two existing 600mm diameter culverts along the above alignment to 1050mm diameter (total length of 25m of pipe) and match proposed ditch inverts.
- Modifying the No.6 Rd South PS ON/OFF levels as described in ***Section 4.3.1*** above.

Figure 4.3.4 shows the maximum HGL after the system improvements were incorporated.

4.3.3 Williams Road Right of Way East and West of No 6 Road (D3)

Upgrades of existing ditches along Sidaway Rd and No 6 Rd as described in the above two sections will lower the maximum HGL in connected ditches including ditches along Williams Rd. The model shows significant improvement in flooding along Williams Rd after the above improvements were incorporated. So, no further ditch upgrades may be required along Williams Rd alignment.

4.3.4 Blundell Road East of Sidaway (D4)

Flows from the existing ditch on the East side of Sidaway Rd (north of Blundell) are currently diverted east along Blundell Rd. The model results show flooding along this ditch on the north side of Blundell Rd, East of Sidaway Rd. This ditch crosses a lot of driveways with varying culvert diameters.

The existing network does not show any cross connection between North side and South side ditch along Blundell Road. To reduce flooding in this area the following improvements are recommended:

- Install a new 15m long 600mm diameter cross culvert on Blundell Road, 100m east of Sidaway

After this upgrade was incorporated into the improvements model, the results show significant reduction in flooding along this ditch.

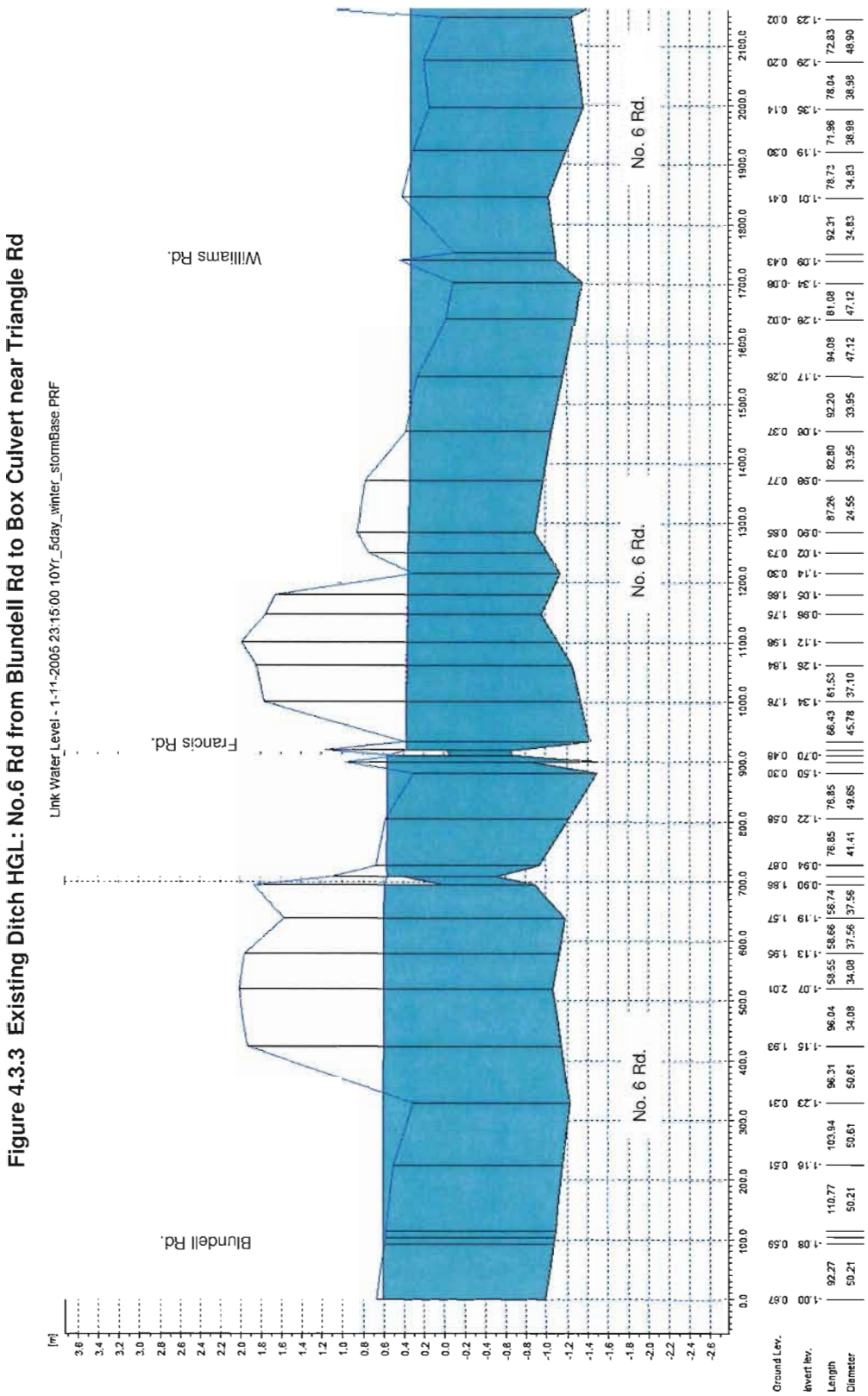
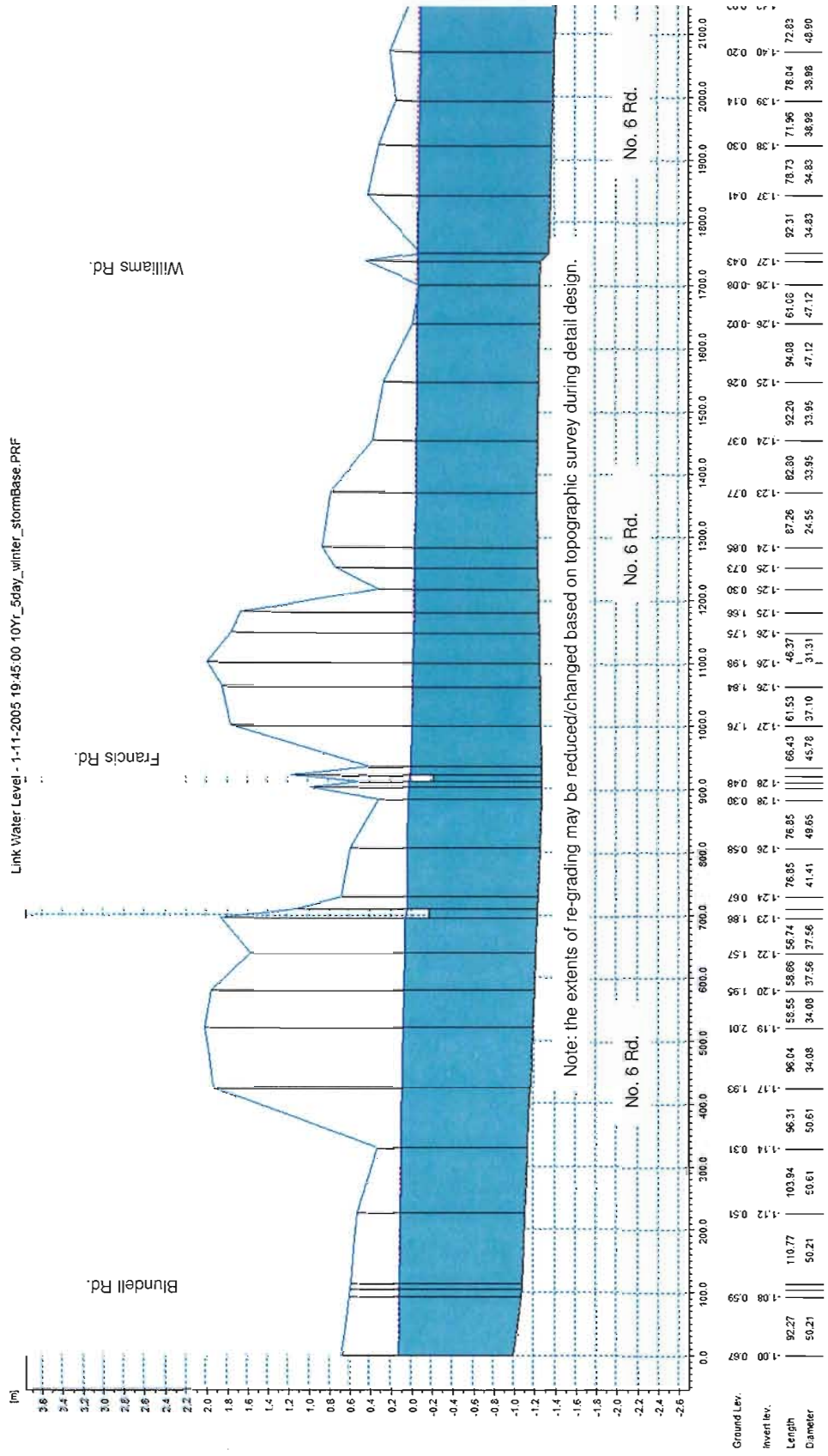


Figure 4.3.3 Existing Ditch HGL: No.6 Rd from Blundell Rd to Box Culvert near Triangle Rd
Link Water Level - 1-11-2005 23:15:00 10Yr_5day_winter_stormBase.PRF
Blundell Rd.
Francis Rd.
Williams Rd.
No. 6 Rd.
No. 6 Rd.
No. 6 Rd.
(10-year 5 day storm with winter tide)

Figure 4.3.4 HGL After Improvements: No.6 Rd from Blundell Rd to Box Culvert near Triangle Rd (10-year 5 day storm with winter tide)



4.3.5 Westminster Highway West of No. 7 Road (D5)

Figure 4.3.5 shows the existing ditch profile along the North side of Westminster Hwy from No 6 Rd to No 7 Rd. The model shows flooding in the low lying areas East of No. 6 Rd. Two homeowners in this area have reported drainage problems during the open house (please refer to ***Appendix A*** for property locations and issues).

To reduce flooding in this area the following improvements are recommended:

- Re-grade the existing ditch for 1400m
- Upgrade all existing culverts (ranging from 600 to 900mm) to a minimum 900mm diameter (total length of 153m of pipe)
- Install a new 16m long 900mm diameter cross culvert connecting the North side ditch with the existing 900mm storm sewer in street.

Once these improvements were incorporated into the model the peak HGL was lowered by 0.6m. ***Figure 4.3.6*** shows the maximum HGL after the system improvements were incorporated.

4.3.6 Cambie Road East and West of No 7(D6)

Under existing conditions, there is significant flooding along the Cambie Rd ditch. When the roughness coefficient is reduced in the model to simulate ditch cleaning the flooding in this area is greatly reduced. Cleaning works are recommended for following ditches:

- Cambie Road from the box culvert east of No 6 Road to No 8 Road for a length of 3200m
- No 7 Road from Cambie Road to No 7 Road North Pump Station for a length of 1965m
- No 8 Road from Cambie Road to No 8 Road North Pump Station for a length of 1461m

Once these maintenance works were incorporated into the model the HGL was lowered by 0.6m to 0.9m five days after the 10-Year 5 day storm event as shown in ***Figure 4.6***. There is still flooding predicted during the peak of the storm due to localized low elevations in the vicinity of Cambie Rd and No 7 Rd.

4.3.7 Burrows Road (D7)

The existing storm sewer along Burrows Rd East of No. 6 Rd shows flooding during a 10-Year 5 day event. The HGL in this section can be reduced by implementing the following upgrade:

- Installing a 15m long 600mm cross culvert connecting the storm manhole located East of Victory Street with existing ditch on South side of Burrows Street

4.3.8 CN Rail corridor between No 7 Rd and No 8 Rd (D8)

In addition to the above drainage upgrades, the City's operations staff has indicated the need for ditch cleaning and re-profiling along CN Rail corridor between No 7 Rd and No 8 Rd. Since this ditch is located in CN ROW, the City will need permission from the railway for access.

4.3.9 South Side of River Rd from the CN box (Cambie Rd alignment) east to Queens PS (D9)

The City's operations staff has also indicated the need for ditch cleaning and re-profiling for south side of River Rd from the CN box (Cambie Rd alignment) east to Queens PS.

4.3.10 Sidaway-East from Francis to Blundell (D10)

The 2006 study recommended construction of 600m of ditch along Sidaway-East to connect the Blundell and Francis ditch systems. This is a low priority project that should be completed after the proposed downstream ditch upgrades along Sidaway are completed (downstream of Francis Alignment –see section 4.3.1 above)

4.3.11 Storm sewers on No 6 Rd between Granville Rd to Blundell Rd (D11)

This project was also recommended as a part of 2006 study. This is a low priority project that should be completed after the proposed downstream ditch upgrades along No 6 Rd are completed (downstream of Blundell Alignment – see section 4.3.2 above)

4.3.12 Areas with Localized Low Ground Elevations in Model (D12)

Figures 4.4 and ***4.5*** show the model results for peak HGLs with all of the improvements incorporated with no tide or high tide, respectively. ***Figure 4.6*** shows the model results with improvements after the 10-Year 5 day storm event. Minor flooding is shown to occur at a few locations and is attributed due to localized low ground elevations. These elevations should be verified in the field. To prevent local flooding it may be necessary to build soil berms at these locations.

Further recommendations and improvements that are low priority and require additional investigation prior to inclusion in the current Capital Plan include the following items:

- Review the pump station and flood box capacity at No 7 Rd South as well as Nelson Rd as it may be impacting the water level elevations in upstream ditches
- Install a manually operated flap gate at Nelson-east and Westminster Hwy (as identified in the 2006 Study)
- Box culvert flushing and cleaning for No 6 Rd north drainage corridor and further investigation of the jet fuel pipeline elevations

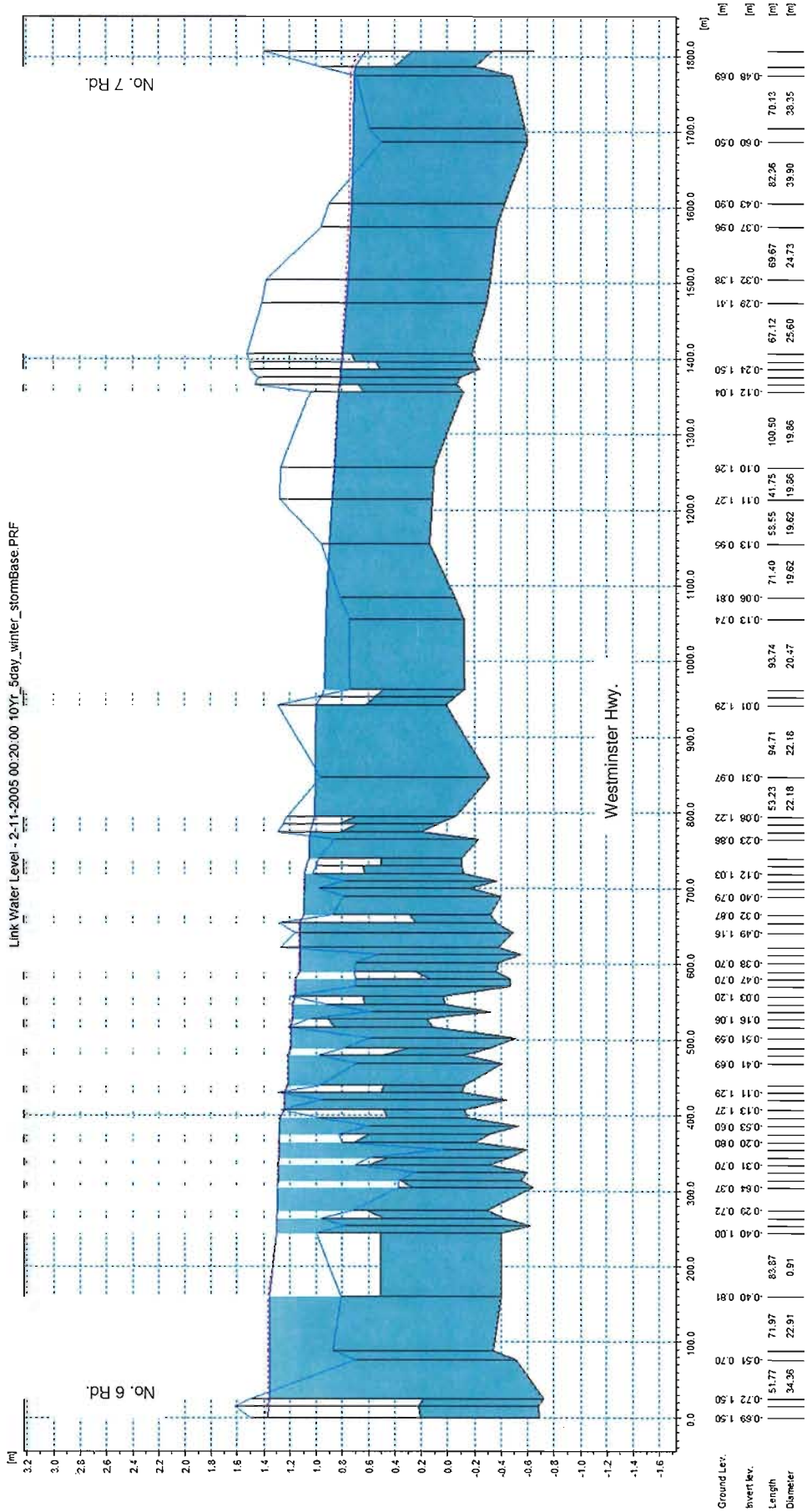
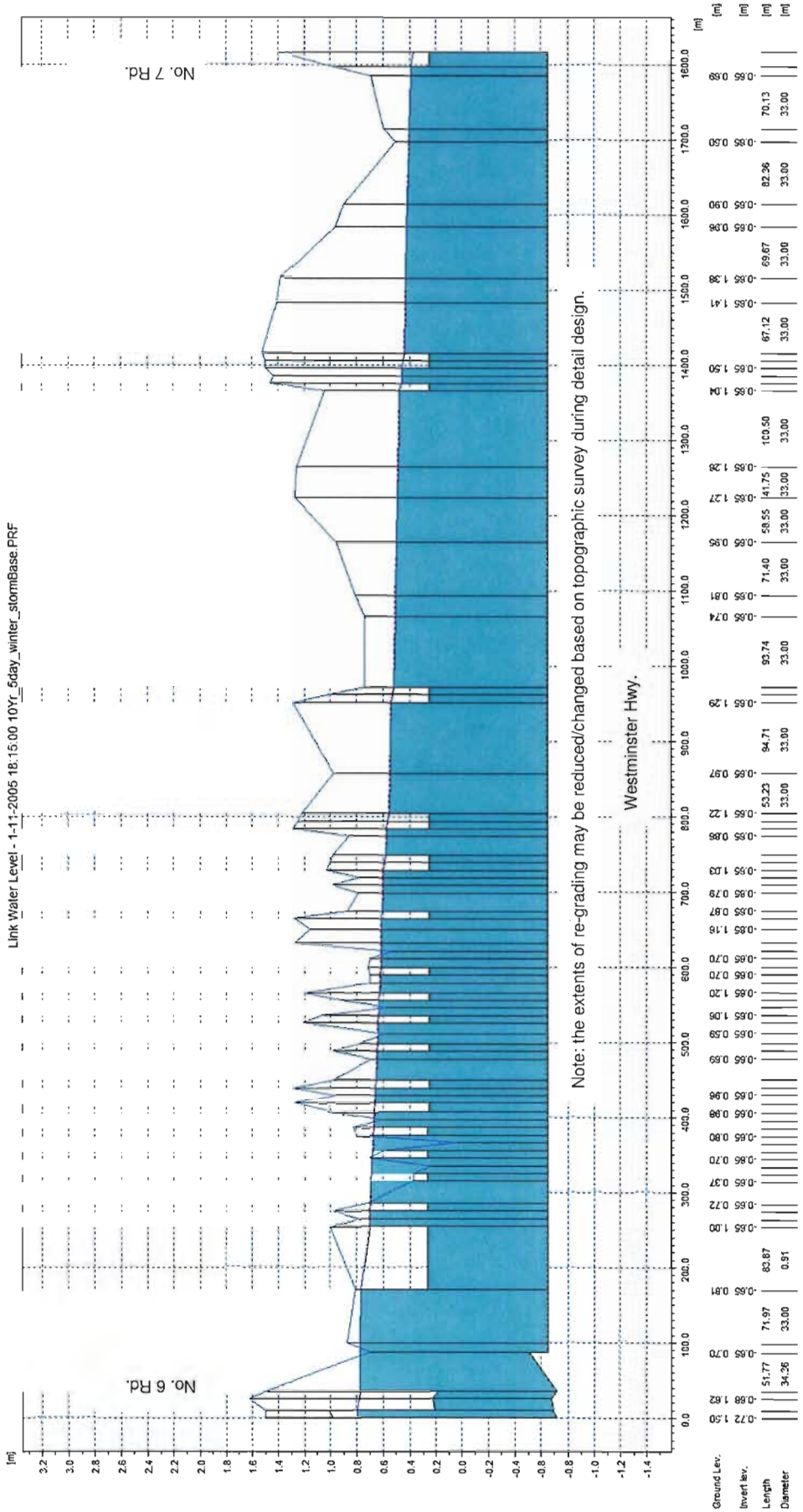
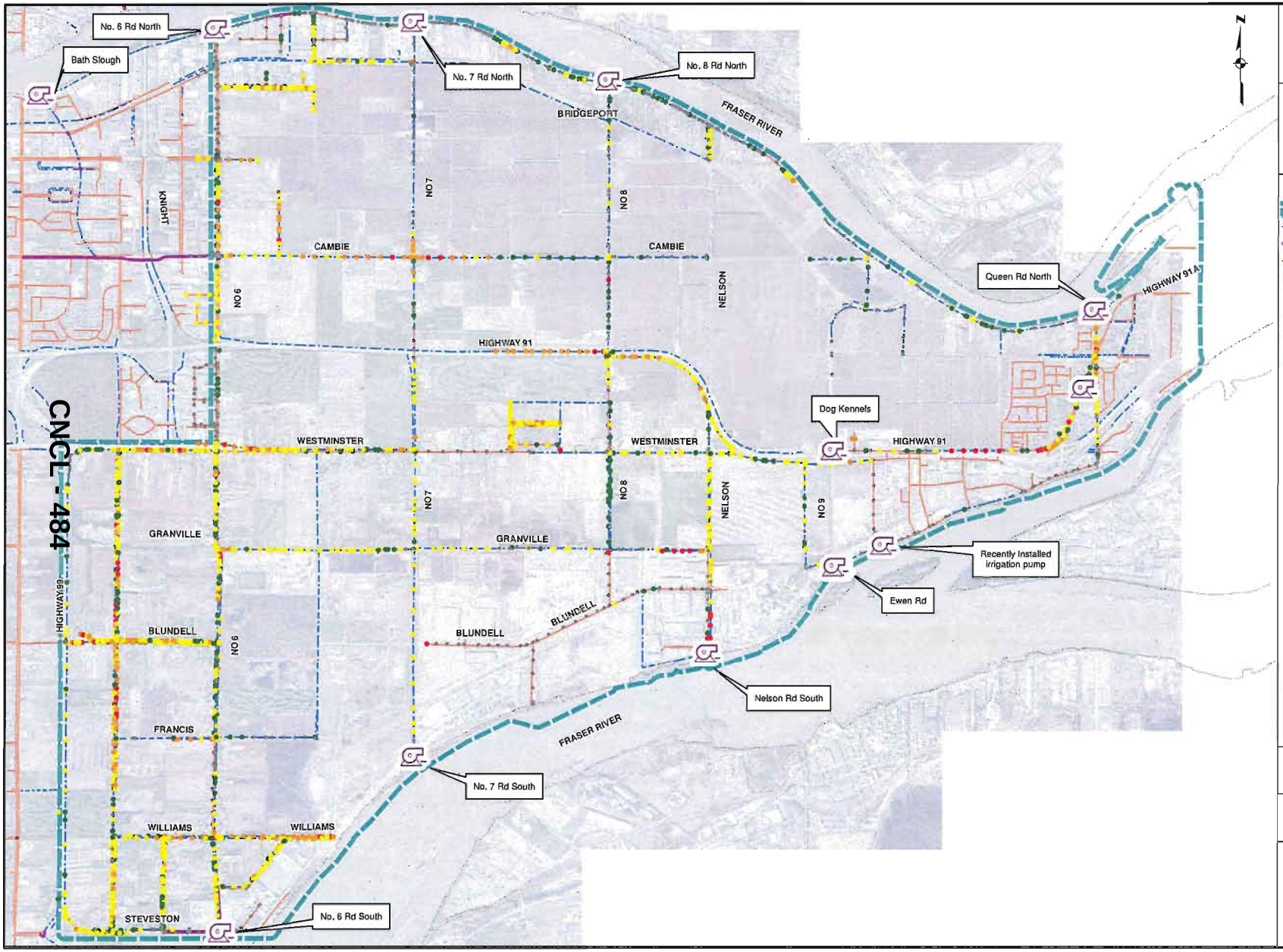


Figure 4.3.5 Existing Ditch HGL: Westminster Hwy from No. 6 Rd to No.7 Rd
(10-year 5 day storm with winter tide)

Figure 4.3.6 HGL After Improvements: Westminster Hwy from No. 6 Rd to No.7 Rd
(10-year 5 day storm with winter tide)





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Legend

- Study Area
- Existing Drainage Ditches/Culverts
- Existing Box Culvert
- Existing Storm Sewer

HGL Depth Below Ground

- Lower than 1.2m
- 1.2m to 0.9m
- 0.9m to 0.3m
- 0.3m to 0.0m
- Above 0.0m / Flooded

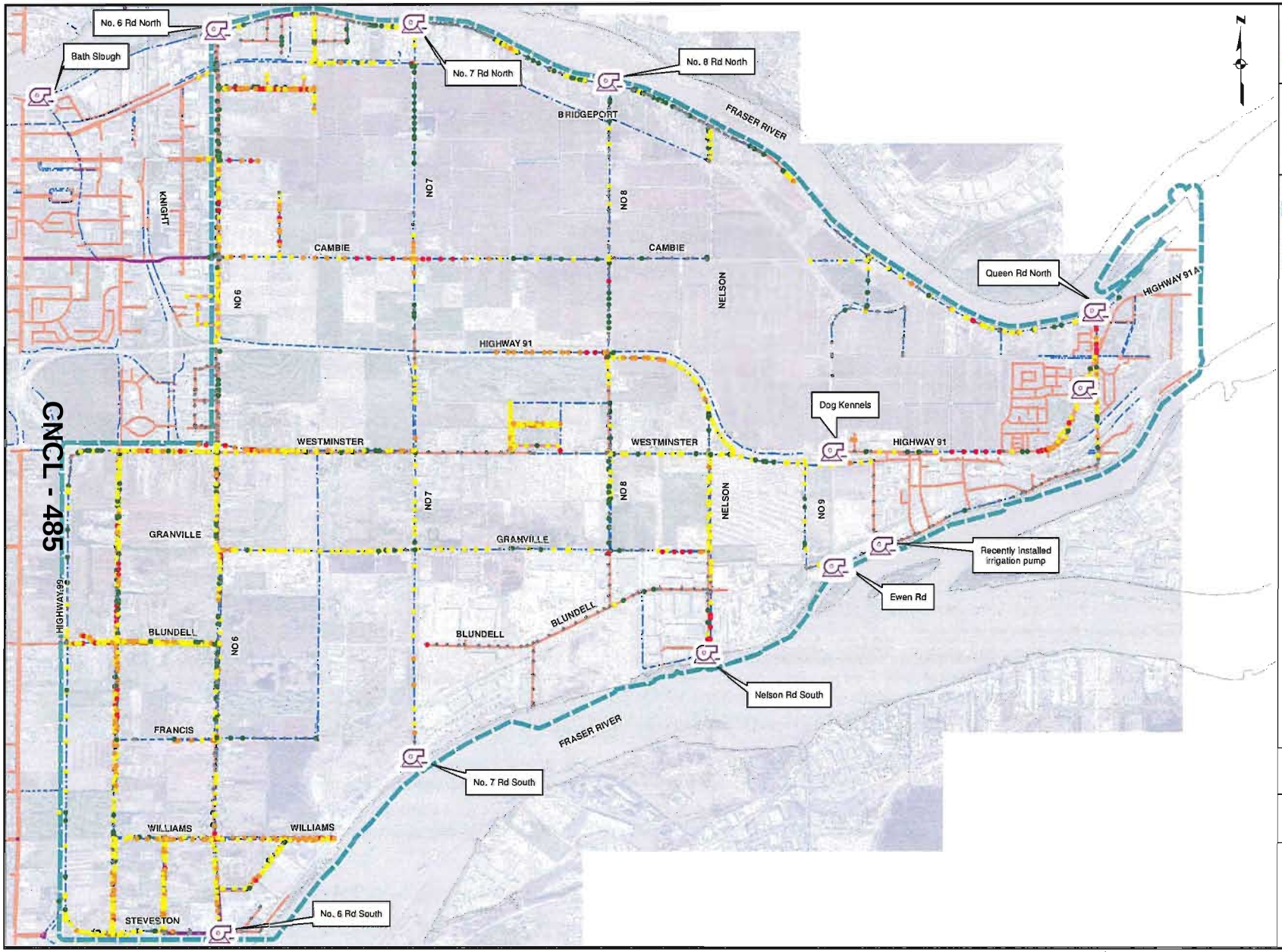
AECOM

0 375 750 1,500 m

Project No.	Date
60288323	April 2014

DRAINAGE SYSTEM PEAK HGL WITH IMPROVEMENTS 10-YR 5-DAY STORM EVENT NO TIDE

Figure 4.4



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Legend

- Study Area
- Existing Drainage Ditches/Culverts
- Existing Box Culvert
- Existing Storm Sewer

HGL Depth Below Ground

- Lower than 1.2m
- 1.2m to 0.9m
- 0.9m to 0.3m
- 0.3m to 0.0m
- Above 0.0m / Flooded

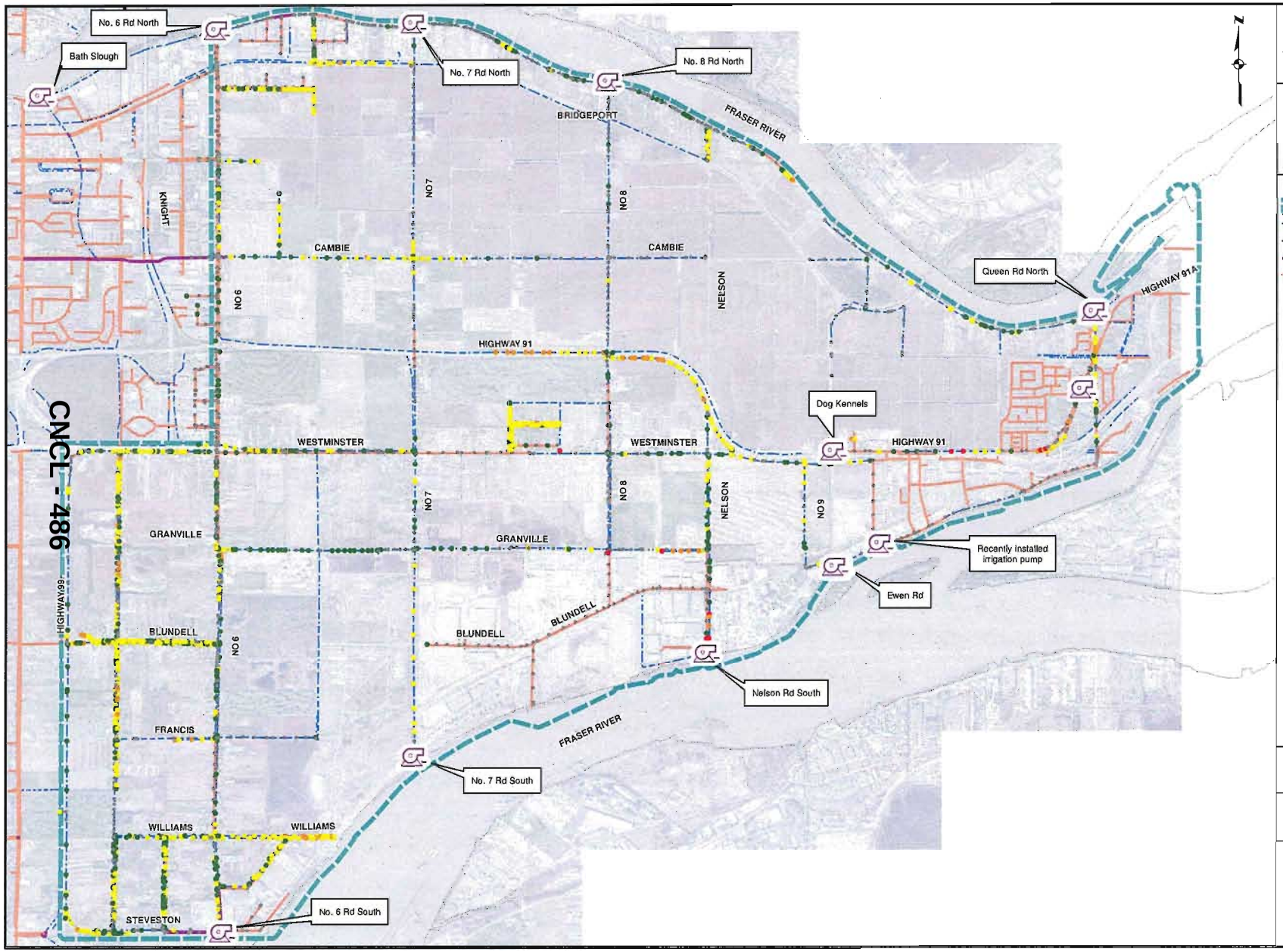
AECOM

0 375 750 1,500 m

Project No.	Date
60288323	April 2014

DRAINAGE SYSTEM PEAK HGL WITH IMPROVEMENTS 10-YR 5-DAY STORM EVENT WITH TIDE

Figure 4.5



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Legend

- Study Area
- Existing Drainage Ditches
- Existing Circular Culvert
- Existing Box Culvert
- Existing Storm Sewer

HGL Depth

- >0.9m below ground
- 0.9m to 0.6m below ground
- 0.6m to 0.3m below ground
- 0.3m to 0.0m below ground
- Flooded

AECOM

0 375 750 1,500 m

Project No.	Date
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DRAINAGE SYSTEM HGL WITH IMPROVEMENTS AFTER 10-YR 5-DAY STORM EVENT WITH TIDE (ON DAY 5)

Figure 4.6

4.3.13 Cost Estimates for High Priority Drainage Improvements

Cost estimates for the high priority drainage improvements discussed above are provided in ***Table 4.2***. All estimates are in 2013 CAD dollars. Cost estimate for low priority projects in not included in the above table.

All culvert upgrade project costs include an allowance for driveway restoration, headwalls and bypass pumping. Utility conflicts have not been investigated in this study. For ditch cleaning and re-grading projects, it is assume that the existing ditch cross sections will be reinstated. An allowance for engineering design and construction contingency of 25% is also added for each project area.

Table 4.2 Cost Estimates for Drainage Upgrades

ITEM NO.	Name (Ref Section)	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
D1	Sidaway Road South of Francis Alignment (Section 4.3.1)	Upgrade 5 culverts to 1050mm dia. along North side of Steveston Highway from Palmberg to Sideway	lin m	55	$2,625	$144,375
		Clean and re-grade existing ditch along North side of Steveston Highway from Palmberg to Sideway	lin m	350	$219	$76,650
		Upgrade 15 culverts to 900mm dia. along West side of Sideway from Steveston Highway to Francis Alignment	lin m	120	$2,363	$283,560
		Clean and re-grade existing ditch along West side of Sideway from Steveston Highway to Francis Alignment	lin m	1450	$219	$317,550
		Install new 600mm dia. cross culvert on Sidaway Rd at Francis Alignment	lin m	15	$2,188	$32,820
						$855,000
					Design (6%)	$51,300
					Eng. Satff Charges (4%)	$34,200
					Subtotal	$940,500
					Contingency (25%)	$235,125
					Project Total	$1,176,000
D2	No 6 Road South of Blundell Road (Section 4.3.2)	Clean and re-grade existing ditch along East side of No 6 Rd from Triangle Rd to Blundell Rd	lin m	2000	$219	$438,000
		Upgrade 2 culverts to 1050mm dia. along East side of No 6 Rd	lin m	25	$2,625	$65,625
						$504,000
					Design (6%)	$30,240
					Eng. Satff Charges (4%)	$20,160
					Subtotal	$554,400
					Contingency (25%)	$138,600
					Project Total	$693,000
D4	Blundell Road East of Sidaway (Section 4.3.4)	Install 1 new 600mm dia. cross culvert connecting the North and South side ditches along Blundell Rd	lin m	15	$2,188	$32,820
						$33,000
					Design (6%)	$1,980
					Eng. Satff Charges (4%)	$1,320
					Subtotal	$36,300
					Contingency (25%)	$9,075
					Project Total	$46,000
D5	Westminster Highway West of No 7 Road (Section 4.3.5)	Clean and re-grade existing ditch along North side of Westminster Hwy from No 6 Rd to No 7 Rd	lin m	1400	$219	$306,600
		Upgrade all existing culverts to 900mm dia.	lin m	153	$2,363	$361,539
		Install 1 new 900mm dia. cross culvert connecting the North side ditch with the 900mm storm sewer	lin m	16	$2,800	$44,800
						$713,000
					Design (6%)	$42,780
					Eng. Satff Charges (4%)	$28,520
					Subtotal	$784,300
					Contingency (25%)	$196,075
					Project Total	$981,000
D6	Cambie Road East and West of No 7 (Section 4.3.6)	Clean existing ditch on Cambie from the box culvert East of No 6 Road to No 8 Road	lin m	3200	$175	$560,000
		Clean existing ditch on No 7 Rd from Cambie Rd to No 7 Rd North PS	lin m	1965	$175	$343,875
		Clean existing ditch on No 8 Rd from Cambie Rd to No 8 Rd North PS	lin m	1461	$175	$255,675
						$1,160,000
					Design (6%)	$69,600
					Eng. Satff Charges (4%)	$46,400
					Subtotal	$1,276,000
					Contingency (25%)	$319,000
					Project Total	$1,595,000
D7	Burrows Road (Section 4.3.7)	Install 1 new 600mm dia. cross culvert to connect the storm sewer East of Victory Street with existing ditch on South side of Burrows Street	lin m	15	$2,363	$35,445
						$36,000
					Design (6%)	$2,160
					Eng. Satff Charges (4%)	$1,440
					Subtotal	$39,600
					Contingency (25%)	$9,900
					Project Total	$50,000
					Grand Total	*$4,541,000*

Note: *Items D3 and D8-D12 either have no associated project or are low priority projects and therefore not costed*

4.4 Irrigation Improvement Options

Irrigation options were analysed keeping in mind that irrigation deficiencies are of a biggest concern in the study areas south west portion. Although no major irrigation concern was reported in the area north of Hwy 91, the proposed ditch cleaning along No 7 Rd, No 8 Rd and Cambie will improve irrigation water flows in this area. The south-east portion of study area (south of Westminster Hwy and east of No 7 Rd) may warrant more detailed analysis in subsequent studies.

Two options were reviewed for the recommended irrigation system upgrades: Option 1 – Irrigation Upgrades for water supply from the Fraser River's North Arm and Option 2 – New Irrigation Pump Station near No 6 Rd South PS for water supply from the Fraser River's Main Arm. Details for these Options are summarized below.

4.4.1 Option 1 – Irrigation Upgrades for Supply from North Arm (I-1)

Option 1 includes a combination of items to facilitate the transfer of irrigation water from the North Arm of the Fraser River to the Southwest portion of the study area that do not have sufficient water supply during irrigation periods. The upgrades proposed are such that only surplus water from the area north of Westminister Hwy can be transferred south. The differential controls on the proposed automatic gate on No 7 Rd north of Westminister Hwy should be set in such a way that this gate only opens when the water level on north side exceeds the target level. This will make sure that the irrigation water supply for the north side is not affected by the proposed upgrades. It is assumed that all the proposed drainage upgrades North of Granville Ave are complete prior to implementing this option. Option 1 upgrades are divided into 3 phases. The following list of items are included in each phase of Option 1 and shown in ***Figure 4.7.*** The control settings for automatic gates as shown in ***Figure 4.7*** are preliminary elevations and can be easily adjusted based on field conditions and water demands.

Phase -1A

- Adjust settings at No 7 North irrigation intake and drainage pump station as shown in ***Figure 4.7.1*** and described below:
  - Increase target water level elevation from 0.217m to 0.575m (to match existing No 8 Rd North PS target level)
  - Modify irrigation gate settings such that it closes at elevation of 0.75m (gate open elevation to remain as is at 0.14m)
  - Set irrigation gate to only open if tide level is higher than wetwell/ditch water level
  - Apply a 20 minute delay before irrigation gate reopens to reduce frequency of unintended opening and closing due to fluctuating water levels
  - Modify drainage pump start level and gravity outlet elevation to 0.8m
- Adjust settings at No 8 North drainage pump stations as shown in ***Figure 4.7.2*** and described below:
  - Target water level elevation remains at 0.575m
  - Modify irrigation pump ON elevation to 0.575m if tide level is lower than wetwell/ditch elevation
  - Modify irrigation pump OFF elevation to 0.8m
  - Set the gravity gate to open only if the tide level is greater the wetwell/ditch water level
  - Set the gravity intake irrigation gate to close at 0.8m or above
  - Apply a 20 minute delay before irrigation gate reopens to reduce frequency of unintended opening and closing due to fluctuating water levels
- Install two new seasonal flap gates
  - East of No 7 Rd on Westminster Hwy
  - East of No 7 Rd on Granville Ave Alignment
- Install two new gates with automated controls
  - No 7 Rd south of Granville Ave
  - No 6 Rd south of Granville Ave
- Add controls to existing gate on No 7 Rd (North of Westminster) to provide differential upstream/downstream elevations such that area south of Westminster Hwy does not flood.

When the water level in No 7 Rd ditch north of Westminster Hwy exceeds the target water level, the automatic gate north of Westminster Hwy (Gate-1 in ***Figure 4.7***) opens to facilitate supply of surplus water to the south side. Gate-2 and Gate-3 will stay closed in summer to prevent flow towards east side. Automatic gates (4&5) will detain water in the ditches and prevent water from flowing south to the pump stations. These gates will stay closed until the water level in ditches rise to 0.75 (in case of a summer storm). Once the high level is reached they will automatically open to prevent flooding in upstream area. High level open setting is selected such that it is close to maximum level that can be achieved when No 7 Rd North gravity inlet is open. This will make sure there is no water flow to pump stations during dry irrigation period.

Phase -1B

Phase-1B should be initiated only after the successful completion of phase-1A. Following is the list of items included in this phase:

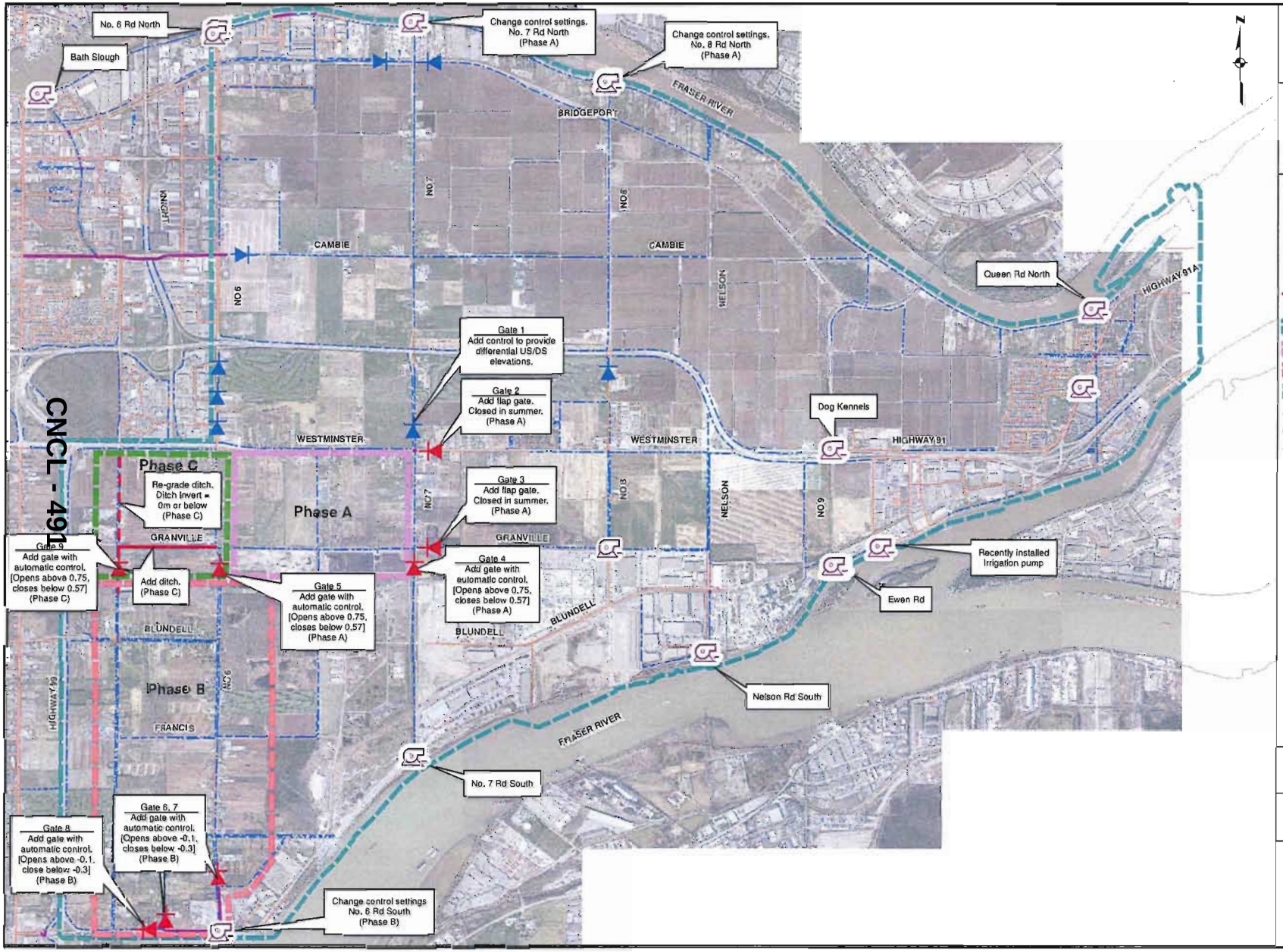
- Install three new gates with automated controls
  - Palmberg Road upstream of box culvert (Gate-6)
  - No 6 Rd and Triangle Road upstream of box culvert (Gate-7)
  - Steveston Hwy upstream of box culvert (Gate-8)

In phase-1B, the settings of Gate-5 can be adjusted such that it opens when the water level in Granville ditch exceeds its target level. Gates-6, 7 & 8 will detain water in the No 6 Rd and No 7 Rd ditches and prevent water from flowing south to the pump stations. Preliminary control settings are shown in ***Figure 4.7*** based on ground profile.

Phase -1C

This final phase will require construction of new ditch along Granville alignment between No 6 Rd and Sidaway. Prior to initiating this phase, we recommend that the City should look at the available right of way along this alignment. Following is the list of items included in this phase:

- Construct a new ditch along the Granville Alignment connecting No 6 Rd with Sidaway Rd (assuming 1m base width with 1.5H:1V side slopes and average depth of 1.5).
- Re-grade the existing ditch on the East side of Sidaway Rd for 1400m from North of Blundell Rd to Westminster Hwy
- Install a new gate (Gate-9) with automated control on Sidaway south of the proposed ditch.



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Legend

- Existing Gates
- Proposed Gates
- Pump Stations
- Proposed New Ditch
- Proposed Ditch Upgrade
- Study Area
- Phase A - Serviced Area
- Phase B - Serviced Area
- Phase C - Serviced Area
- Existing Drainage Ditches/Culverts
- Existing Box Culvert
- Existing Storm Sewer

AECOM

0 375 750 1,500 m

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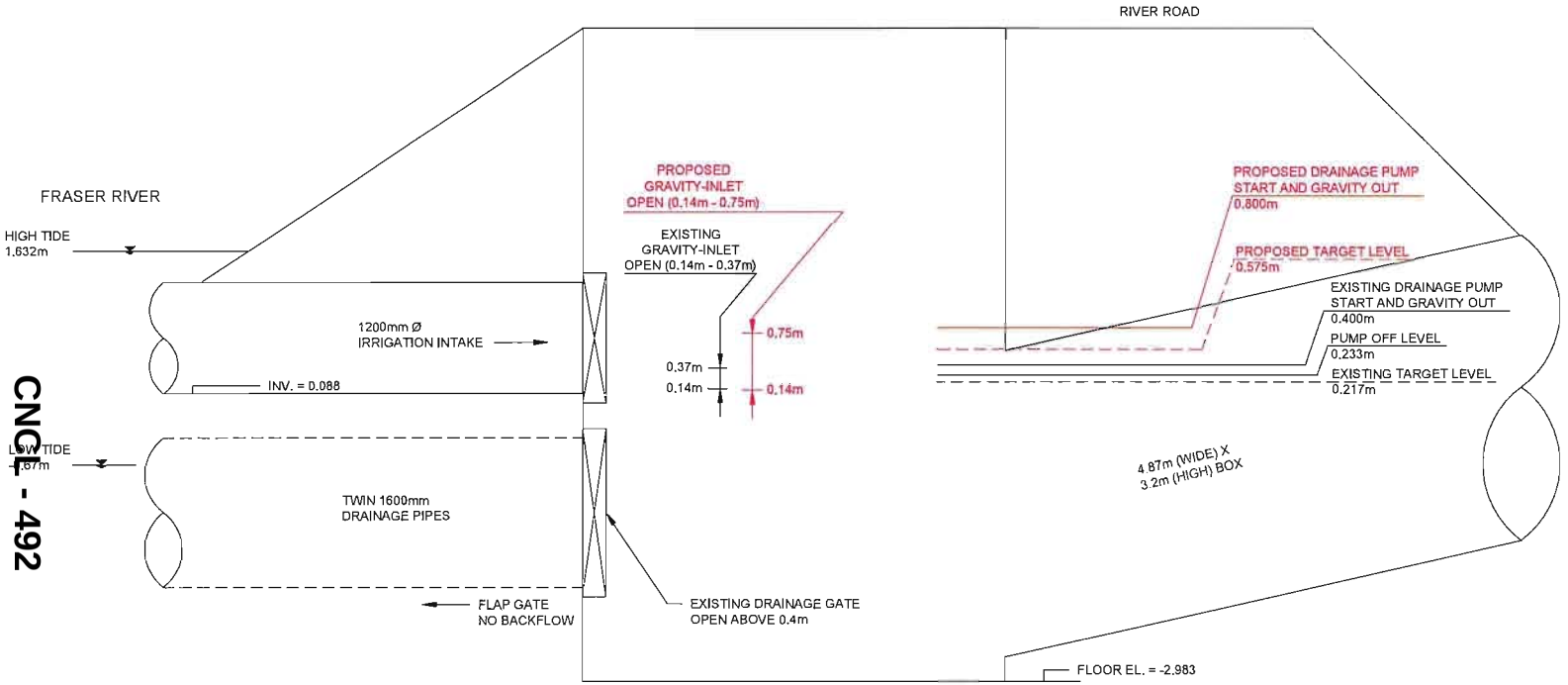
OPTION 1 - IRRIGATION UPGRADES FOR SUPPLY FROM NORTH ARM

Figure 4.7

No. 7 ROAD NORTH SCHEMATIC FOR IRRIGATION SETTINGS

NOT TO SCALE



WET-WELL SECTION

NOTES:

1. ALL ELEVATIONS ARE GEODETIC
2. LOW TIDE AND HIGH TIDE BASED ON DESIGN TIDE USED IN MODEL
3. ABOVE SKETCH IS SCHEMATIC TO SHOW ELEVATIONS ONLY

EXISTING SETTINGS:

1. TARGET LEVEL IS 0.217m
2. IRRIGATION INTAKE OPENS AT 0.14m AND CLOSES AT 0.37m
3. EXISTING DRAINAGE PUMPS START AND GRAVITY-OUT FALLS OPEN AT 0.4m OR ABOVE (TO PREVENT FLOODING DURING SUMMER STORMS)

PROPOSED SETTINGS:

1. THE PROPOSED TARGET LEVEL AT No. 7 ROAD IS 0.575m WHICH IS THE SAME AS THE EXISTING No. 8 TARGET LEVEL
2. IRRIGATION GATE OPENS AT 0.14m (NO CHANGE) AND GATE CLOSES AT 0.75m GEODETIC
3. IRRIGATION GATE OPENS ONLY IF TIDE IS HIGHER THAN WET-WELL/DITCH LEVEL
4. PROPOSED DRAINAGE PUMPS START AND GRAVITY OUT FALLS OPEN AT 0.8m OR ABOVE

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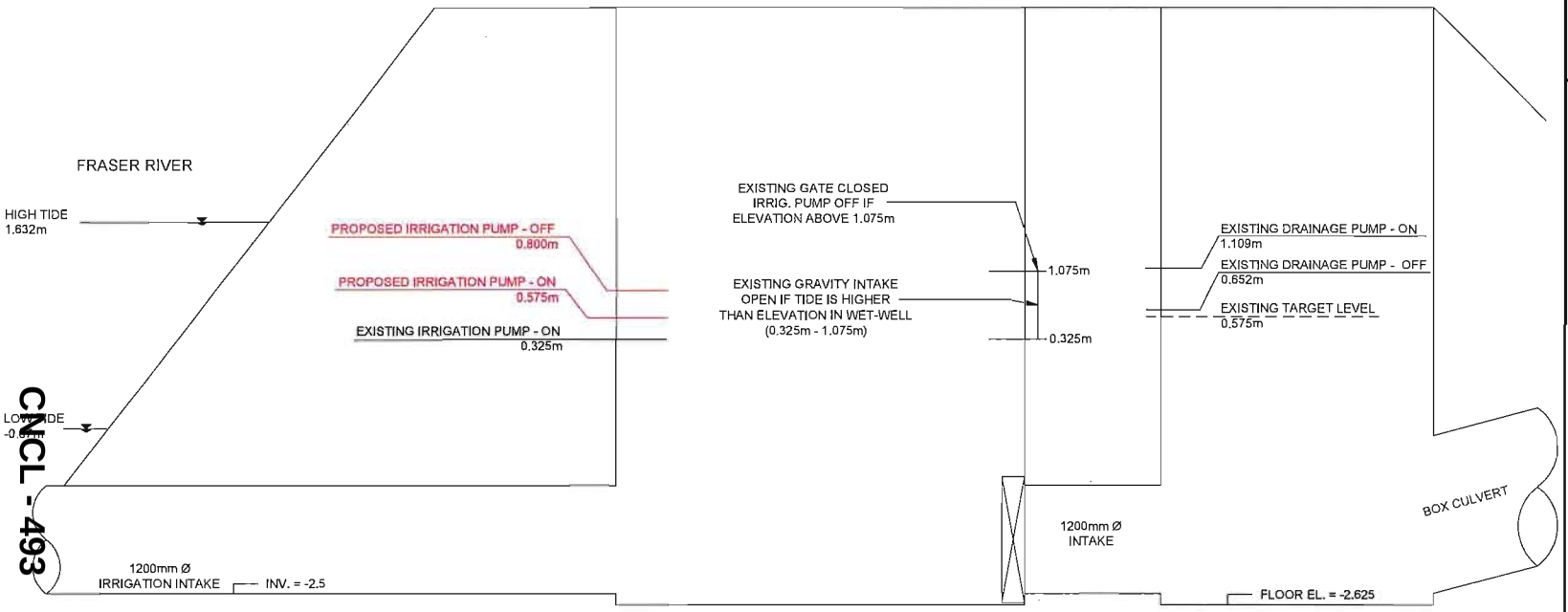
No. 7 Rd. North Schematic for Proposed Irrigation Settings

Figure 4.7.1

No. 8 ROAD NORTH SCHEMATIC FOR IRRIGATION SETTINGS

NOT TO SCALE



IRRIGATION PUMP STATION CHAMBER

No. 8 ROAD DRAINAGE PUMP STATION WET-WELL

NOTES:

1. ALL ELEVATIONS ARE GEODETIC
2. ONLY ONE IRRIGATION-INFLOW TAKES PLACE (PUMP OR GRAVITY) AT ONE TIME
3. LOW TIDE AND HIGH TIDE BASED ON DESIGN TIDE USED IN MODEL
4. ABOVE SKETCH IS SCHEMATIC TO SHOW ELEVATIONS ONLY

EXISTING SETTINGS:

1. TARGET LEVEL IS 0.575m
2. IRRIGATION PUMP TURNS ON ONLY IF LEVEL DROPS BELOW 0.325m. ONCE IT TURNS ON THEN IT TURNS OFF AT 1.075m
3. PUMP/GATE CONTROLS ARE MANUALLY OVERRIDDEN WITH A TEMPORARY SETTING TO MAINTAIN A HIGHER WATER LEVEL (START 0.825, STOP 1.575) DURING CRANBERRY HARVEST & SPRING FROST PROTECTION
4. GRAVITY INTAKE GATE OPENS AT 0.325m AND CLOSES AT 1.075m

PROPOSED SETTINGS:

1. NO CHANGE IN TARGET LEVEL (0.575m)
2. IRRIGATION PUMP ON IF LEVEL DROPS BELOW 0.575m AND TIDE IS LOWER THAN WET-WELL/DITCH LEVEL
3. IRRIGATION PUMP OFF AT 0.8m GEODETIC
4. GRAVITY IRRIGATION GATE OPENS ONLY IF TIDE IS HIGHER THAN WET-WELL/DITCH LEVEL
5. GRAVITY INTAKE IRRIGATION GATE CLOSED AT 0.8m OR ABOVE

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No. 8 Rd. North Schematic for Proposed Irrigation Settings

Figure 4.7.2

4.4.2 Option 2 – New Irrigation Pump Station near No 6 Rd South PS (I-2).

Option 2 includes construction of a new irrigation pump station in the south to supply water to the southwest part of the study area as shown in ***Figures 4.8***.

To provide water supply for growth irrigation (assuming an average rate of 5.33mm/day) for a 300hectare area, an irrigation pump station with a capacity of approximately 0.2 m^3/s (200L/s) is required. One possible option is to build a new pump station at the foot of No 6 Rd. Based on the surrounding existing ground elevations the maximum possible target water level for the pump station and ditches is approximately 0m geodetic.

A feasibility study for such a pump station and intake would need to be completed prior to initiating any conceptual design for this Option. The current location is preliminary and depended on available land. An alternative location may be the foot of Willams Rd as the Fraser River depth may be deeper in this area.

For Option 2, it is assumed that the drainage upgrades in the vicinity on Steveston Hwy, Sidaway Rd and No 6 Rd have been implemented. Costs for these items have not been included on the irrigation cost estimates.

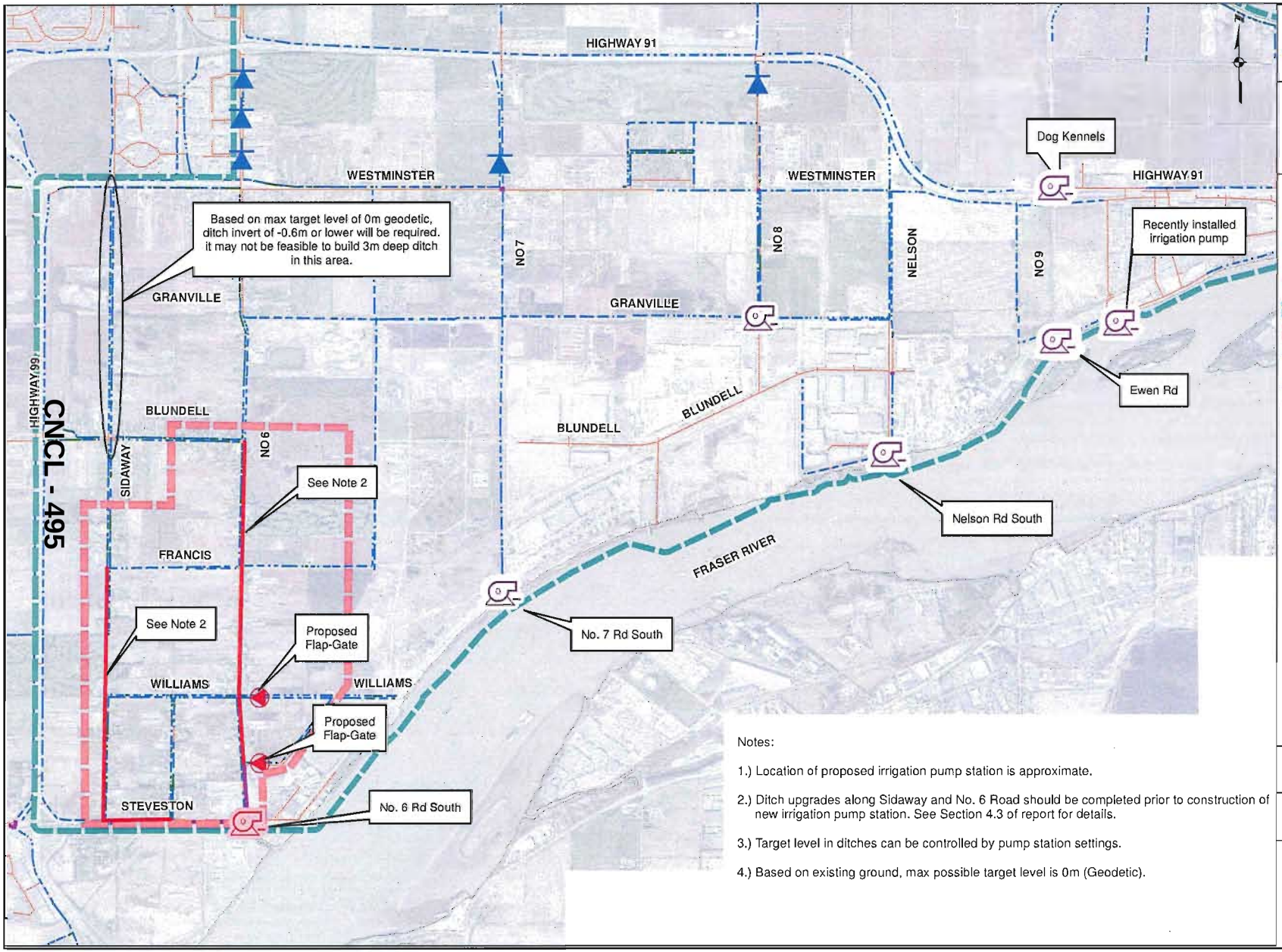
As shown in ***Figure 4.8***, the ditch along Sidaway Rd north of Blundell would need to have an invert of -0.6m elevation to facilitate the supply water from the new PS to this area. Based on the existing ground elevations, an approximately 3m deep ditch would be required, which may not be feasible.

4.4.3 Cost Estimate for Irrigation Options

Cost estimates for irrigation improvement Options 1 and 2 are presented in ***Table 4.3***. As noted in ***Section 4.3.9***, all estimates are in 2013 CAD dollars and an allowance for engineering design and construction contingency of 25% has been added to each Option.

Table 4.3 Cost Estimate for Irrigation Options

ITEM NO.	Name (Ref Section)		DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
I-1	Option 1 – Irrigation Upgrades for Supply from North Arm (Section 4.4.1)	Phase1 A	Modify settings at No 7 North PS and No 6 North PS	LS	2	$0	$0
			Install two new seasonal flap gates	LS	2	$60,000	$120,000
			Install two new gates with automated controls	LS	2	$175,000	$350,000
		Phase1B	Re-grade existing ditch on East side of Sidaway Rd from North of Blundell Rd to Westminster Hwy	Lin m	1400	$219	$306,600
			Construct a new ditch along the Granville Alignment connecting No 6 Rd with Sidaway Rd	Lin m	835	$340	$283,900
		Phase1C	Install three new gates with automated controls	LS	3	$175,000	$525,000
							$1,586,000
						Design (6%)	$95,160
						Eng. Satff Charges (4%)	$63,440
						Subtotal	$1,744,600
						Contingency (25%)	$436,150
						Project Total	$2,181,000
I-2	Option 2 - New Irrigation Pump Station near No 6 Rd South PS (Section 4.4.2)		Irrigation Pump Station	LS	1	$1,400,000	$1,400,000
			Intake piping	LS	1	$500,000	$500,000
			Power supply	LS	1	$110,000	$110,000
			Install three new seasonal flap gates	LS	3	$60,000	$180,000
							$2,190,000
						Design (6%)	$131,400
						Eng. Satff Charges (4%)	$87,600
						Subtotal	$2,409,000
						Contingency (25%)	$602,250
						Project Total	$3,012,000



Notes:

1.) Location of proposed irrigation pump station is approximate.

2.) Ditch upgrades along Sidaway and No. 6 Road should be completed prior to construction of new irrigation pump station. See Section 4.3 of report for details.

3.) Target level in ditches can be controlled by pump station settings.

4.) Based on existing ground, max possible target level is 0m (Geodetic).

Richmond

City of Richmond

Agricultural Water Supply Study East Richmond

Legend

- Existing Gates
- Proposed Flap-Gates
- Existing Pump Stations
- Proposed Irrigation Pump Station
- Study Area
- Approx. Service Area of Pump Station
- Existing Drainage Ditches
- Existing Circular Culvert
- Existing Box Culvert
- Existing Storm Sewer

AECOM

0 250 500 1,000 m

Project No.	Date
60288323	April 2014

OPTION 2 - PROPOSED IRRIGATION UPGRADES FOR SUPPLY FROM SOUTH ARM

Figure 4.8

5. Cost Benefit Analysis

A cost benefit analysis typically includes a review of the costs and savings that can be realized in terms of the economic, social and environmental components resulting from implementation of a project. The analysis completed here is primarily economic in nature as the social and environmental costs and benefits are challenging to quantify. However, it is evident that there is motivation from stakeholders (including the farming community and the City) to maintain the viability of agricultural production in East Richmond's ALR areas such that the social impact of drainage and irrigation improvement projects are viewed as benefits. In terms of the environmental components, such as water quality and habitat enhancement, there are also benefits to be realized from the improvements.

In 2010, cranberries (33%), blueberries (19%), mixed vegetables (11%) and potatoes (5%) were the main irrigated field crops grown in Richmond, accounting for 67% of the cultivated farmland (2010 LUI report). Irrigation is a critical input for crop production with irrigation of about 71% of the berry area and 56% of the vegetables area.

In ***Table 5.1***, target yields, average prices and gross revenue per hectare are indicated for the various crops. Target yields are yields attainable for mature crops using good agricultural practices. Cranberry yields range widely, with the newer higher yielding strains capable of producing yields in excess of 34,000 kgs per hectare. While newer varieties of blueberries are higher yielding, yields also vary depending upon the harvest method with hand harvesting resulting in somewhat higher yields than machine harvesting.

Average prices are the farm gate prices received over the last 5 years. Over 90% of BC cranberries are marketed to the Ocean Spray cooperative under a schedule of Pool A pricing. Future prices are expected to be pressured somewhat by increasing production.

In the case of blueberries, the average price is the blended price of product going to the fresh and processed markets. The average farm gate price of blueberries is anticipated to decline over the near term future, compared to prices received historically, due to a significant increase in blueberry crop coming into mature production.

As ***Table 5.1*** shows, conventional mixed vegetable cropping, including potatoes, does not generate the returns per hectare that cranberries and blueberries do. However, organic vegetable production does occur in the area and farm gate pricing is considerably more favourable.

Table 5.1 Estimated Average Yields, Prices and Gross Revenues Associated with Main Irrigated Crop Types

Crop	Cranberries	Blueberries	Potatoes	Mixed Vegetables
Target Yield – Full Production (kgs/ha)	22,414- 33,600	14,569 – 18,000	33,621	5,940
Average Price ($/kg)	1.32	1.76	0.55	0.86
Gross Revenue per Hectare	29,640 – 44,460	25,688 – 35,568	18,525	5,105

For the purposes of this updated study, an average crop value of $30,000 per hectare has been selected, which is based on the anticipated conversion of un-used farmland to berries. An estimate of un-used land is provided in the 2010 LUI data (Map 6), which indicates that there is approximately 520 ha of additional land available or that has potential for farming in East Richmond, with potential average annual revenue from irrigated production of $15.6 million (Table 5.2).

It should also be noted that the crop value estimates do not reflect other economic and financial benefits that farmers may realize from improved drainage and irrigation such as improved crop yields or ability to growing higher value crops. Furthermore, the analysis presented herein assumes that all un-used farm lands will be under full production.

When comparing the cost estimates for the drainage upgrades and irrigation improvement options, as per ***Tables 4.2*** and ***4.3*** respectively, the potential revenue for un-used land is greater (as shown below in ***Table 5.2***) resulting in a positive benefit cost ratio.

Table 5.2 Average Annual Potential Revenue Vs. Cost of Infrastructure

Area of Un-used Agricultural Land for East Richmond	Average Annual Potential Revenue (based on $30,000 / Ha)	Cost of Infrastructure (drainage upgrades & irrigation options)
520 Ha	$15.6M	$6.0M to $7.0M

A few additional costs and savings that may influence the analysis include the following items:

- *Water Purchase Cost*: Savings for farmers that are currently irrigating with potable water supplied by the City. Based on an average irrigation rate of 5.33 mm/day (growth irrigation rate from ***Section 1.5.2***) this equates to a cost per Hectare of $63.83 / Ha / day using the City's current water rates (Schedule B to Bylaw 5637). Several farmers in the vicinity of Westminster Hwy and Sidaway Rd are currently using City supplied potable water for irrigation of vegetable farms such that implementation of Option 1 for the irrigation upgrades for water supply from the North Arm of the Fraser River would be a significant savings for these individuals.

- *Irrigation Pump Station Cost*: Cost of additional pump station maintenance and fuel due to longer pump run times for supplying more irrigation water from No 8 Rd North PS (or from a new irrigation pump station in the South). An estimate for pump station operations and maintenance cost per year can be made from data obtained through AECOM's National Stormwater Benchmarking Initiative. 2011 benchmarking data for thirteen major cities across Canada for pump station O&M costs per total pump station horsepower indicate that the average cost is $150 / PS Hp. For the No 8 Rd North PS (at 134 Hp) this equates to approximately $20,000 / year. The portion of annual expense due to additional pump run time combined with extra power costs is significant.

  It is also recommended that the City should contact DFO to determine potential environment concerns resulting from increased pumping from Fraser River.

- *Crop Failure:* Potential savings and reduced risk of economic impacts from flooding or loss of crops. This is difficult to quantify and would vary greatly across the study area. North for Hwy 91 for example, the primary crop is cranberries for which the farmers rely on the ability to flood the fields such that they typically have capability to drain there fields as well when required. In the Southwest where more vegetable crops are grown, there are typically water shortage issues during the growing season such that flooding is not a concern.

- *Right of Way:* Additional costs for purchase of rights-of-way for ditch enlargement or larger infrastructure would also increase the capital costs for infrastructure improvements. With exception of Irrigation improvement Option 1, there are no new ditches or rights-of-way recommended.

In summary, the cost benefit ratio for implementing the drainage and irrigation upgrades is positive when viewed from the perspective of the farming community. Improvements to system conveyance and irrigation water supply will increase the amount of land potentially available for farming and is likely to increase current crop yields.

From the City's perspective, the economics are not favourable given the farmers reap the benefits but the social and environmental gains are positive. In addition, the City has committed to maintaining and improving ALR drainage and irrigation systems to support agriculture as per the 2041 OCP. This commitment includes facilitating the improvement of irrigation and drainage infrastructure to provide secure and affordable water supplies that support the agricultural sector.

6. Recommendations

6.1 Review of 2006 Study Upgrades not Completed

At the onset of the project, a review of the drainage and irrigation upgrade recommendations from the 2006 Study was completed. ***Table 6.1*** provides a summary of the projects and the rationale for why they are either not included, no longer required or if the project has been included as a low priority for completion when funds are available.

There are four drainage upgrade projects on the list (projects 6.1 to 6.4). Project 6.1 is listed as low priority as proposed upgrades along Sidaway from Francis to Steveston will reduce this projects need. Project 6.2 is not feasible due to construction constraints resulting from jet fuel pipeline. The majority of project 6.3 is already included in the proposed drainage upgrades (with the remainder deemed not required) and project 6.4 is not required partly due to the proposed Ecowaste Facility that will change drainage pattern in this area.

Projects 6.5 to 6.23 are irrigation upgrade projects. Projects 6.6 & 6.12 are already included as part of the proposed Option 1 irrigation upgrades and four projects (6.9, 6.10, 6.19 & 6.23) are included as low priority. The remaining projects are not required based on the updated assessment and shift in strategy, particularly the previously recommended screw pump at Granville Ave and No 6 Rd, and No 7 Rd North irrigation pump station and associated ditch, culvert and flap gates.

6.2 Recommended Capital Projects

Drainage and irrigation upgrades recommended under the current study are listed in order of priority in ***Table 6.2***. Cost estimates include a 25% engineering design and construction contingency and all costs are in 2013 dollars.

Table 6.2 Prioritized List of Upgrades

Project ID	Project Description	Cost Estimate	Time Horizon
D1	Sidaway Road South of Francis Alignment (Section 4.3.1)	$1,176,000	1-2 years
D2	No 6 Road South of Blundell Road (Section 4.3.2)	$693,000	3-5 years
D4	Blundell Road East of Sidaway (Section 4.3.4)	$46,000	3-5 years
D7	Burrows Road (Section 4.3.7)	$50,000	3-5 years
D6	Cambie Road East to No 8 Rd, No 7 Rd & No 8 Rd from Cambie to PS (Section 4.3.6)	$1,595,000	5-10 years
D5	Westminster Highway West of No 7 Road (Section 4.3.5)	$981,000	5-10 years
(I-1). Irrigation-Option 1 Upgrades for Supply from	Phase A	$647,000	5-10 years (or sooner if funds are available)
	Phase B	$812,000	
	Phase C	$722,000	
	Total Cost	**$6,722,000**	

Note: "D" represents drainage projects and "I" represent irrigation projects.

As discussed in section 1.3.4, each projects detailed design should protect and enhance RMA's to protect and improve water quality.

Table 6.1 – Future Upgrades Recommended by the 2006 Study

Project ID	LOCATION	SCOPE OF WORK (AS PER 2006 STUDY)	RATIONALE IF EXCLUDED
6.1	Sidaway Rd (Blundell Rd to Francis Rd)	Construct 600m of ditch along Sidaway-East to connect the Blundell and Francis ditch systems	Upgrades proposed for Sidaway on Francis to Steveston will reduce the HGL such that this project is not required. Included as low priority project.
6.2	No 6 Rd (Highway 91 to No. 6 Rd Pump Station North)	Re-profile and smooth inverts through 2650m of ditches and storm sewers (delayed due to Kinder Morgan jet fuel pipeline conflicts and scope issues)	Not feasible due to jet fuel pipeline. Also of limited benefit and construction constraints present along No 6 Rd.
6.3	Cambie Rd	Re-profile 4000m of ditches	Approx. 3,200m of cleaning proposed for Cambie ditch. Additional length East of No 8 Rd deemed not required as no flooding is predicted after improvements to Cambie ditch as well as No 7 Rd and No 8 Rd ditches.
6.4	Blundell Rd (No 6 Rd to No 7 Rd)	Construct 1600m of ditch	Not required due to proposed upgrades on Sidaway and No 6 Rd. Proposed Ecowaste facility to drain south to Fraser which makes up significant portion of catchment area.
6.5	West Boundary	Install an additional 6 flap gates with manual override along Highway 99 and No. 6 Rd. (1 of the initial 7 proposed was installed in 2008)	Existing gate on Cambie ditch East of No 6 is closed during harvest to prevent water from agricultural areas draining to industrial lots west of No 6 Rd so additional gates are not required.
6.6	No 7 Rd (South of Granville Rd)	Install 1 drop leaf gate to prevent potential irrigation water discharging at the No. 7 Rd South Pump Station	Included as part of irrigation upgrades Option 1
6.7	No 8 Rd (East side between Hwy 91 and Westminster Hwy)	Upgrade 400m of storm sewers (existing sewer is 900mm)	Cannot find rationale for this project in 2006 Study. Irrigation water can be supplied by the temporary flap gate at Hwy 91 and No 8 Rd.
6.8	Westminster Hwy (No 6 Rd to ditch near Kartner Rd)	Upgrade / realign 2400m of storm sewers (existing sewer is 600mm increasing to 900mm)	Proposed drainage ditch upgrade in North side of Westminster Hwy between No 6 Rd and No 7 Rd will increase conveyance such that storm sewer upgrade is not required.
6.9	No 6 Rd (Westminster Hwy to Granville Ave)	Upgrade / realign 800m of storm sewers (existing sewer is 800mm)	Proposed drainage upgrade on No 6 Rd south of Blundell Rd to increase conveyance. Included as low priority project.
6.10	No 6 Rd (Granville Rd to No 6 Rd Pump Station South)	Upgrade 3200m of ditches and storm sewers	Proposed drainage upgrade on No 6 Rd South of Blundell Rd to No 6 Rd PS South increase conveyance. Granville Rd to Blundell Rd included as low priority.
6.11	Williams, Blundell & Francis Roads	Upgrade ditches (scope undetermined)	Proposed drainage upgrades on Sidaway Rd and No 6 Rd to improve conveyance such that Williams, Blundell and Francis ditch upgrades are not required.
6.12	Granville Ave Alignment (Sidaway Rd to No 6 Road)	Construct 800m of ditch to connect Sidaway to No. 6 Rd.	Included as part of irrigation upgrades Option 1
6.13	Granville Ave & No 6 Rd	Install screw pump and 2 drop leaf gates (to irrigate Sidaway Rd)	Not feasible or cost effective. See irrigation upgrades Option 1 as alternative solution
6.14	No 7 Rd North PS	Install irrigation pump	See irrigation upgrades Option 1 for alternative solution to adjust gravity intake settings and target irrigation water elevation level
6.15	Blundell Rd (East of No 6 Rd)	Install 1 drop leaf gate	Not required as project was related to new ditch between No 6 Rd and No 7 Rd that is not recommended
6.16	General study wide upgrades with low priority in the 2006 Study	Culvert connecting Nelson Rd to Ewen Rd	Not required due to Westminster Hwy improvements and modifications to surface drainage in the area
6.17		Culvert connecting ditches on the West side of No 6 Rd to Granville Ave Alignment	Not required as Granville Ave alignment ditch upgrades improved conveyance in area
6.18		Flap gates with manual override at No 8 Rd and Westminster Hwy	Existing gate at Hwy 91 serves same purpose and proposed irrigation Option 1 includes a gate at No 7 and Granville Ave for area isolation
6.19		Manually operated gate at Nelson-east and Westminster Hwy	Low priority and no concerns raised from local area farmers at time of study
6.20		Drop-leaf gate at No 6 Rd, North of Bridgeport Rd	Not required as existing gate on Cambie Rd ditch controls flow
6.21		Drop-leaf gates at No. 7 Rd and Cambie Rd ditch (both sides of No 7 Rd)	Not required as Cambie Rd ditch cleaning reduced HGL and increased conveyance
6.22		Drop-leaf gate at No 8 Rd and Cambie Rd ditch (on West side of No. 8 Rd)	Not required as Cambie Rd ditch cleaning reduced HGL and increased conveyance
6.23		Deepen ditch along Westminster Hwy between Nelson Rd and Ewen Rd	Low priority and no concerns raised from local area farmers at time of study

Drainage Projects
Irrigation Projects

6.3 Additional Recommendations

Further recommendations and improvements that were discussed at the Staff workshop and require additional investigation prior to inclusion in the current Capital Plan include the following items:

- Survey ground elevation (field elevations) along existing ditch on Cambie Rd (east and west of No 7 Rd). The ground elevation survey should also be completed for low lying areas along Sidaway and No 6 Rd south of Williams Road.
- Review capacity of the No. 7 Road South PS and flood box as it was identified as under capacity in ***Table 4.1***
- Consider implementing the following projects identified in the 2006 Study as low priority works:
    - Construct 600m of ditch along Sidaway-East to connect the Blundell and Francis ditch systems
    - Upgrade ditch on east side of No 6 Rd between Granville Rd and Blundell Rd. This will further increase conveyance along No 6 Rd and facilitate supply of irrigation water from North Arm.

- Repair or replacement of the failing headwall at the south ditch box culvert inlet on Cambie Rd just east of No 6 Road
- Ditch cleaning and re-profiling along CN Rail corridor between No 7 Rd and No 8 Rd (City needs permission from the railway for access)
- Ditch cleaning and re-profiling for south side of River Rd from the CN box (Cambie Rd alignment) east to Queens PS
- Box culvert flushing and cleaning for No 6 Rd north drainage corridor and further investigation of the jet fuel pipeline elevations
- Review the need and methods to remove invasive species such as Japanese Knotweed and Parrot Feather.
- Review possibility of lowering the No 7 Rd North PS culvert and impact this would have on the downstream ditch systems
- Create a culvert inspection program for entire study area and in particular a review of who is responsible for maintenance of culverts crossing Hwy 91
- Consider implementing a procedure that requires farmers to identify when and where new outfalls from fields to municipal ditches are constructed
- Coordinate operation of the CN box gravity intake (River Rd and Cambie Rd alignment) between farmers and Operations staff
- Facilitate farmers to coordinate water use from No 7 Rd North PS during harvest

APPENDIX A
Feedback from Open House

City of Richmond

East Richmond Agricultural Water Supply Study Update Public Feedback Form

Thank you for taking the time to provide feedback on East Richmond's drainage and irrigation system. Please describe below, successes, concerns or other relevant feedback relating to the City's irrigation and drainage system:

Feedback (*Please provide specific information and the property addresses of where it relates to*):

15391 Westminster Hwy

- Drainage not effective enough thru winter + spring (Ditch observed to flow in both directions)
- Summer – NO irrigation water.

to use City water

Water temp too cold

Chlorine is not good for plants – limits vegetable quality.

Cost concerns

Grow Daikon, Bok Choy, Tong Choy, You Choy

Chlorine makes Daikon crack

Cold water on ~~Daikon leaf in hot summer weather~~ Cabbage/Daikon in hot weather damages inside of plant.

Ditch water too high / field too low for City drainage to work well.

Better drainage will allow earlier planting + better production.

- If water was available in fronting ditch they would use for irrigation.
- Hot line ditch not draining into Westminster Hwy ditch (north side)

Please provide your contact details should City staff wish to further discuss your feedback:

Name: Jason Huang Zhi Gang Farm LTD farm owner

Contact Telephone Number: 604 374 0287 / 604-782-8520 (Mr. Su)

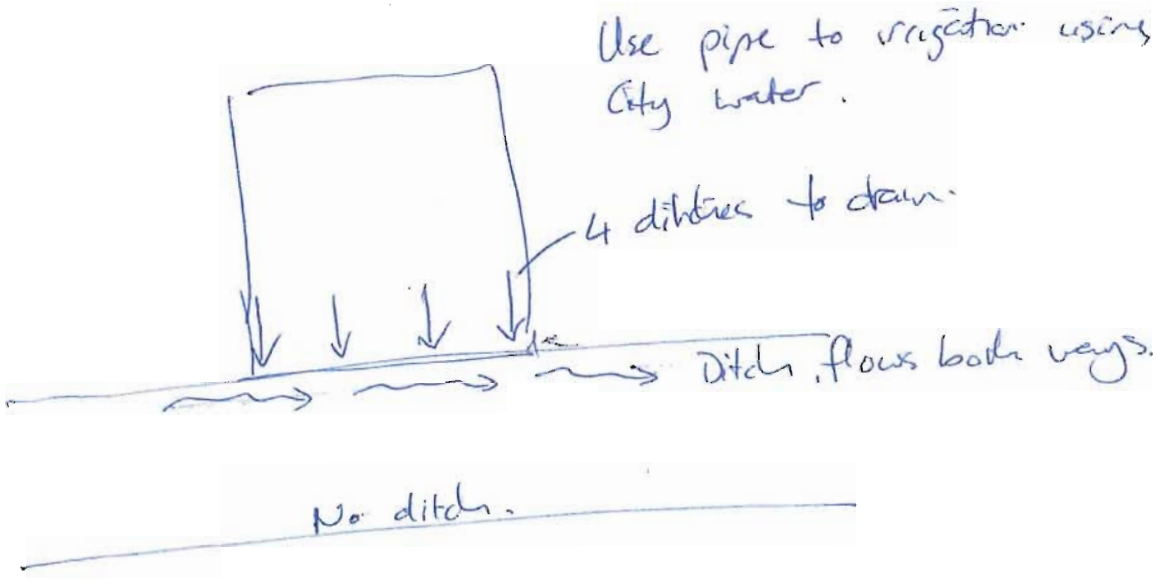
Email: Kanlove2000@hotmail.com

NOT land owner

Your input is important to us and will be compiled and considered within the East Richmond Agricultural Water Supply Study Update. Please submit your comments by **Friday, May 3, 2013 at 5:00 p.m.**

- **Fax:** 604-276-4197
- **Email:** andy.bell@richmond.ca
- **Mail or drop off at City Hall:** 6911 No. 3 Road, Richmond, BC V6Y 2C1
- **Online:** www.LetsTalkRichmond.ca

PTO


Use pipe to irrigation using City water.
4 ditches to drain.
Ditch. flows both ways.
No ditch.

City of Richmond

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Thank you for taking the time to provide feedback on East Richmond's drainage and irrigation system. Please describe below, successes, concerns or other relevant feedback relating to the City's irrigation and drainage system:

Feedback (*Please provide specific information and the property addresses of where it relates to*):

14780 Westminster Hwy
& 14540 " "
Mr Chan
South ditch - not enough irrigation water (it's there, but low)
No. 6 Rd
Sept. Rain starts. Internal drainage stops working as city ditch water level to high.

~~Lot time ditch not draining~~

Please provide your contact details should City staff wish to further discuss your feedback:

Name: Mr Chan

Contact Telephone Number: _____

Email: _____

Your input is important to us and will be compiled and considered within the East Richmond Agricultural Water Supply Study Update. Please submit your comments by **Friday, May 3, 2013 at 5:00 p.m.**

- **Fax:** 604-276-4197
- **Email:** andy.bell@richmond.ca
- **Mail or drop off at City Hall:** 6911 No. 3 Road, Richmond, BC V6Y 2C1
- **Online:** www.LetsTalkRichmond.ca

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Feedback (*Please provide specific information and the property addresses of where it relates to*):

15391 Westminster
No. 7 road north of Westminster
perhaps a culvert to cross road to provide
water to farm land on west side of
No. 7 road in summer
discharge/drainage ~~ditch~~ along Westminster Hwy
Granville ditch maybe too high of invert
need water in summer (14780 Westminster)
Westminster Infilled not
draining properly

Please provide your contact details should City staff wish to further discuss your feedback:

Name: _____

Contact Telephone Number: _____

Email: _____

Your input is important to us and will be compiled and considered within the East Richmond Agricultural Water Supply Study Update. Please submit your comments by **Friday, May 3, 2013 at 5:00 p.m.**

- **Fax:** 604-276-4197
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City of Richmond

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Thank you for taking the time to provide feedback on East Richmond's drainage and irrigation system. Please describe below, successes, concerns or other relevant feedback relating to the City's irrigation and drainage system:

Feedback (*Please provide specific information and the property addresses of where it relates to*):

I live on Blundell between Sideway & No 6 Road. It appears no drainage projects are planned for our area & that is ok with me. We have no ditch drainage problems. However we are seeing more large homes being built on old farm properties & then they build a guest house & tennis court/pool etc & pave everything in between. I can see that if enough homeowners do this, there could be drainage problems in the future as pavement & concrete do not perk.

Please provide your contact details should City staff wish to further discuss your feedback:

Name: D. Whalen

Contact Telephone Number: 604.230.3158

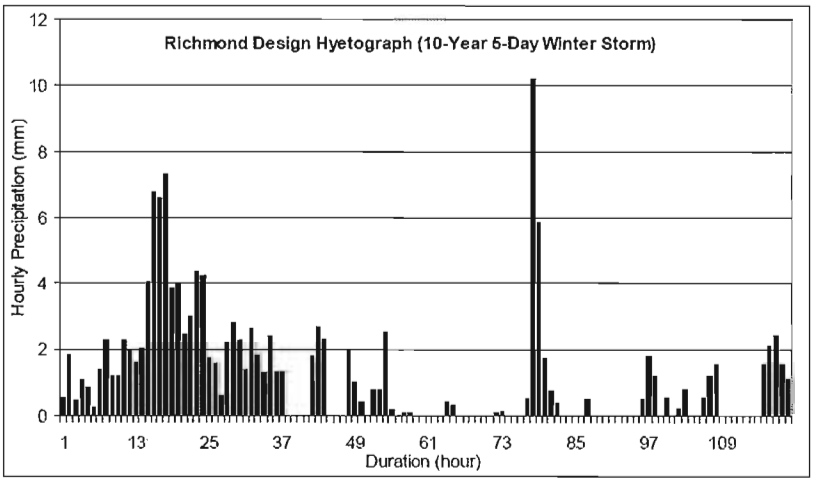
Email: de_whalen@hotmail.com

Your input is important to us and will be compiled and considered within the East Richmond Agricultural Water Supply Study Update. Please submit your comments by **Friday, May 3, 2013 at 5:00 p.m.**

- **Fax:** 604-276-4197
- **Email:** andy.bell@richmond.ca
- **Mail or drop off at City Hall:** 6911 No. 3 Road, Richmond, BC V6Y 2C1
- **Online:** www.LetsTalkRichmond.ca

APPENDIX B
Design Storm Hyetographs

Duration (hr)	1	2	6	12	24	48	72	96	120
Intensity (mm/hr)	10.19	8.03	5.43	4.21	3.05	2.05	1.60	1.32	1.18



Duration (hr)	1	2	6	12	24	48
Intensity (mm/hr)	8.80	7.20	4.80	3.45	2.38	1.55