



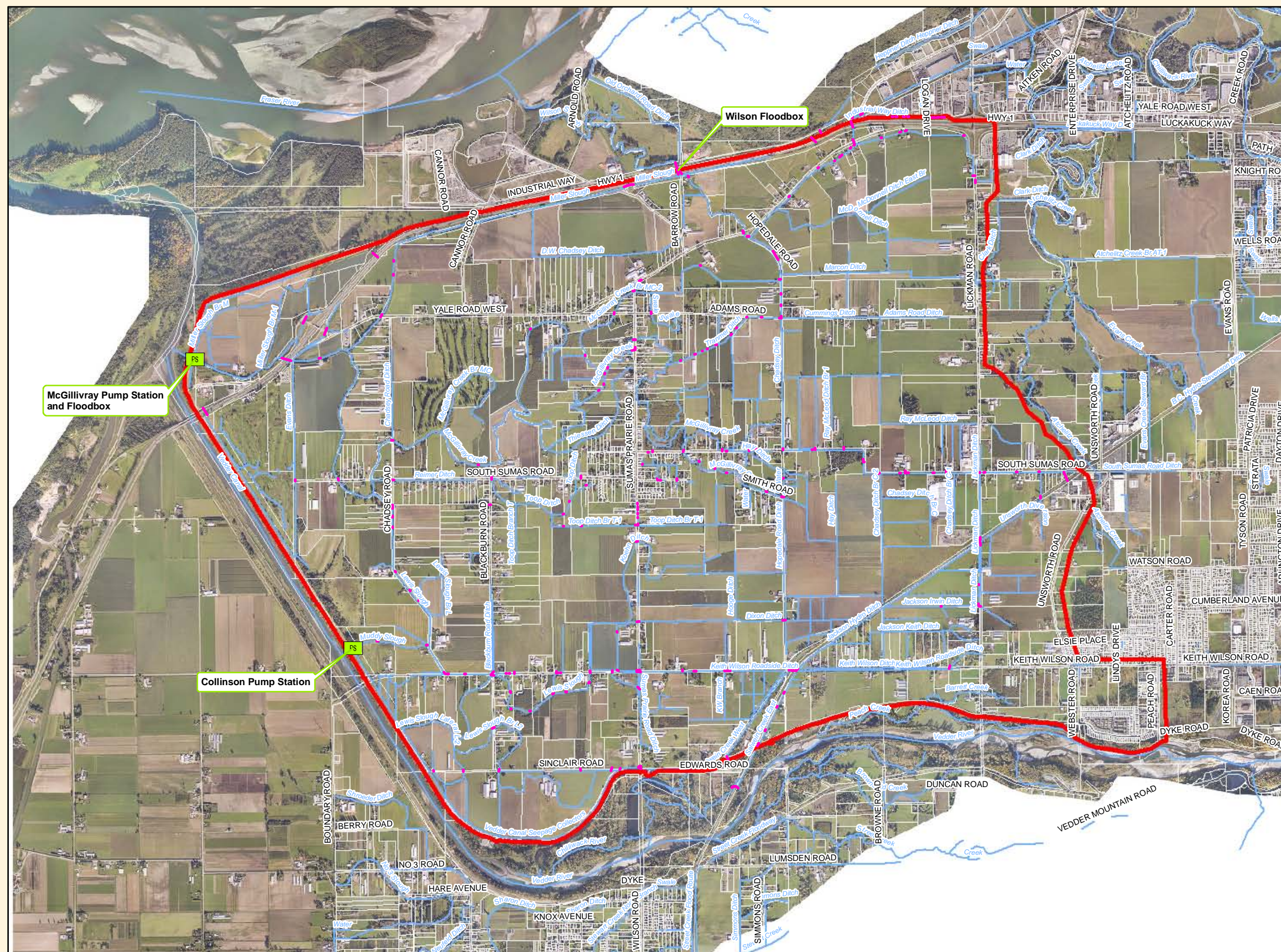
Figures



City of Chilliwack

Legend

- Pump Station
- Waterways
- Culvert
- Cadastral
- Study Boundary



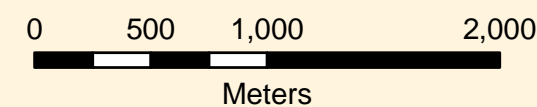
Greendale Flood Study

Study Area

Figure 1



THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.



0526



0530



0536



City of Chilliwack

Aerial photographs taken Friday January 9th, 2009, between 11am and 1pm.

0538



0539



0588



Greendale Flood Study
January Event
Aerial Photos

Figure 2



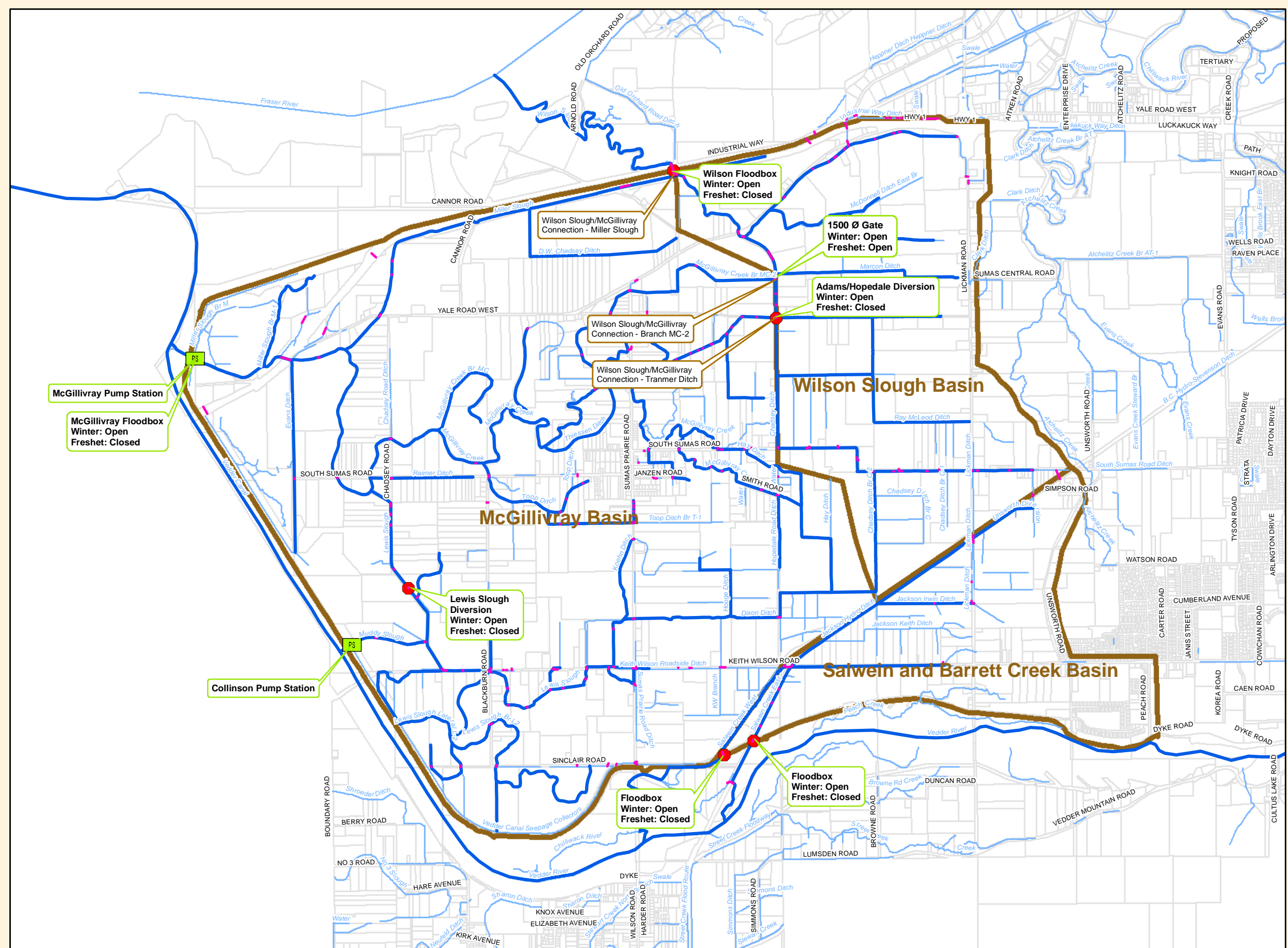
THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.



City of Chilliwack

Legend

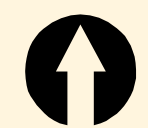
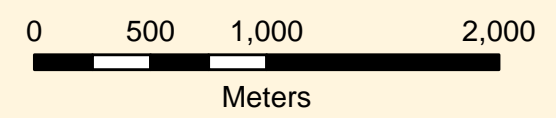
- Slide Gate or Floodbox
- PS Pump Station
- Culvert
- Waterway
- Modeled Waterway
- Drainage Boundary
- Cadastral



Greendale Flood Study Drainage System

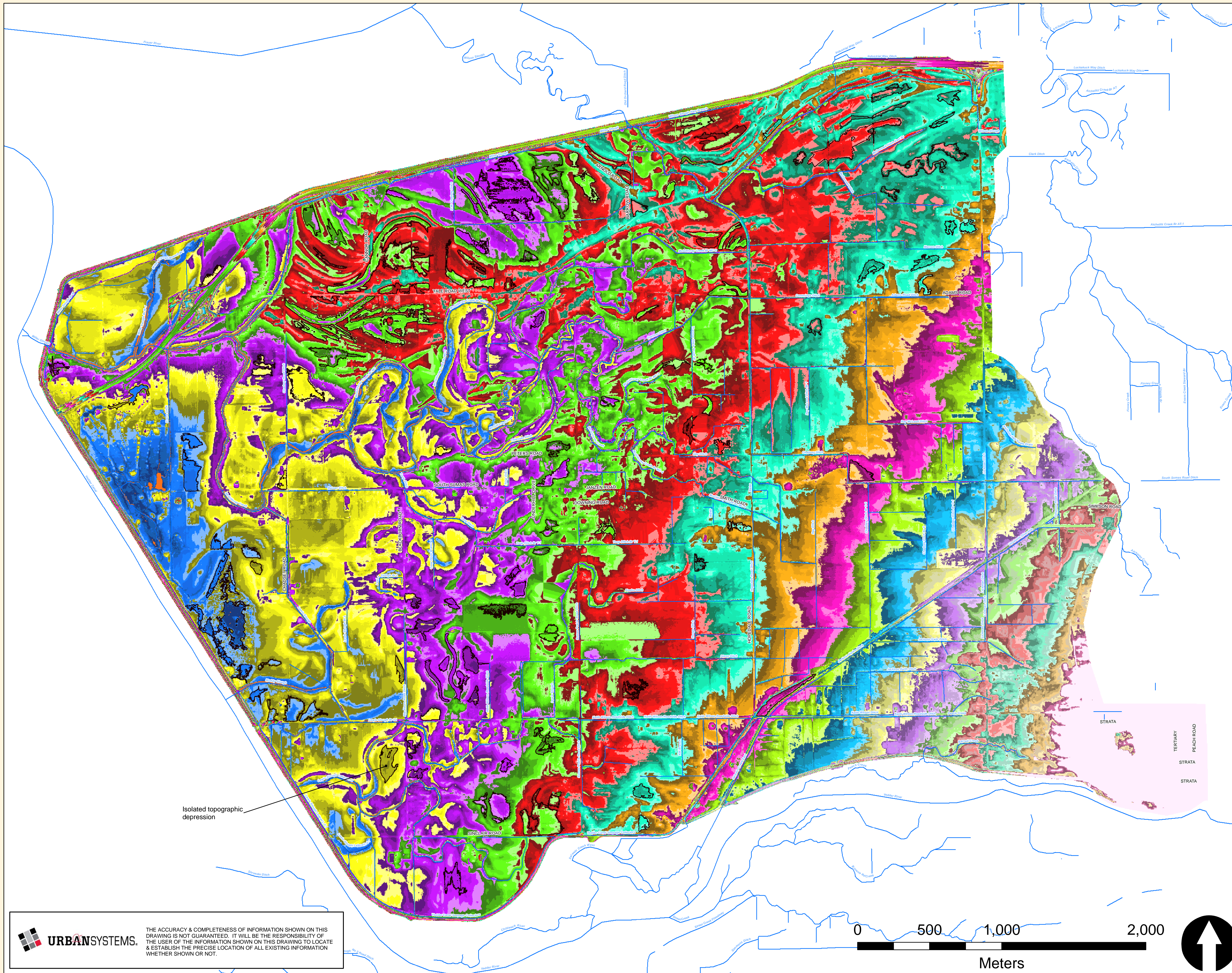
Figure 3

URBANSYSTEMS. THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.





City of Chilliwack



Isolated topographic depression

Legend

- Waterways
- Topographic Depression

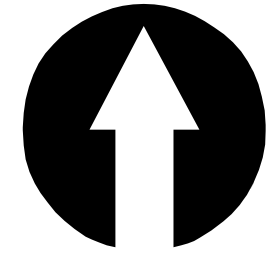
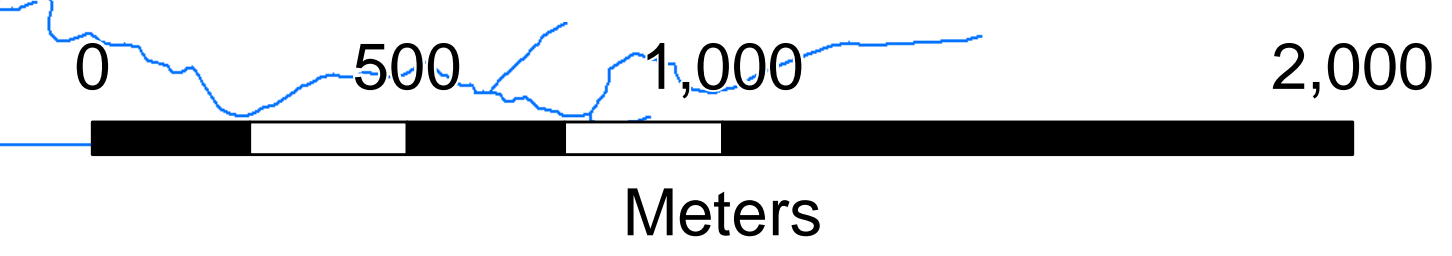
Elevation (m)

0.55 - 3	8.21 - 8.4	14.01 - 14.2
3.01 - 3.2	8.41 - 8.6	14.21 - 14.4
3.21 - 3.4	8.61 - 8.8	14.41 - 14.6
3.41 - 3.6	8.81 - 9	14.61 - 14.8
3.61 - 3.8	9.01 - 9.2	14.81 - 15
3.81 - 4	9.21 - 9.4	15.01 - 15.2
4.01 - 4.2	9.41 - 9.6	15.21 - 15.4
4.21 - 4.4	9.61 - 9.8	15.41 - 15.6
4.41 - 4.6	9.81 - 10	15.61 - 15.8
4.61 - 4.8	10.01 - 10.2	15.81 - 16
4.81 - 5	10.21 - 10.4	16.01 - 16.2
5.01 - 5.2	10.41 - 10.6	16.21 - 16.4
5.21 - 5.4	10.61 - 10.8	16.41 - 16.6
5.41 - 5.6	10.81 - 11	16.61 - 16.8
5.61 - 5.8	11.01 - 11.2	16.81 - 17
5.81 - 6	11.21 - 11.4	17.01 - 17.2
6.01 - 6.2	11.41 - 11.6	17.21 - 17.4
6.21 - 6.4	11.61 - 11.8	17.41 - 17.6
6.41 - 6.6	11.81 - 12	17.61 - 17.8
6.61 - 6.8	12.01 - 12.2	17.81 - 18
6.81 - 7	12.21 - 12.4	18.01 - 18.2
7.01 - 7.2	12.41 - 12.6	18.21 - 18.4
7.21 - 7.4	12.61 - 12.8	18.41 - 18.6
7.41 - 7.6	12.81 - 13	18.61 - 18.8
7.61 - 7.8	13.01 - 13.2	18.81 - 19
7.81 - 8	13.21 - 13.4	19.01 - 19.2
8.01 - 8.2	13.41 - 13.6	19.21 - 19.4
	13.61 - 13.8	> 19.41
	13.81 - 14	

Greendale Flood Study Detailed Surface Topography

Figure 5

URBANSYSTEMS. THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.



U:\Projects_VAM\1530808010-Drafting-Design-Analysis\GIS\Project\mxd\2010_01_29_FinalReport\Greendale\2010_01_29_Figure5\Topography.mxd Last revised by: bps on 04/03/2010 at 4:22:10 PM

0526



0536



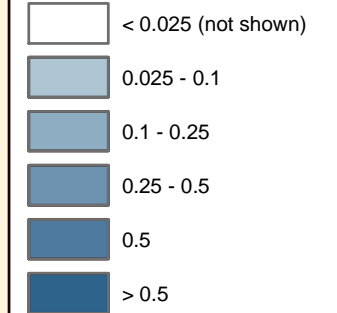
0588



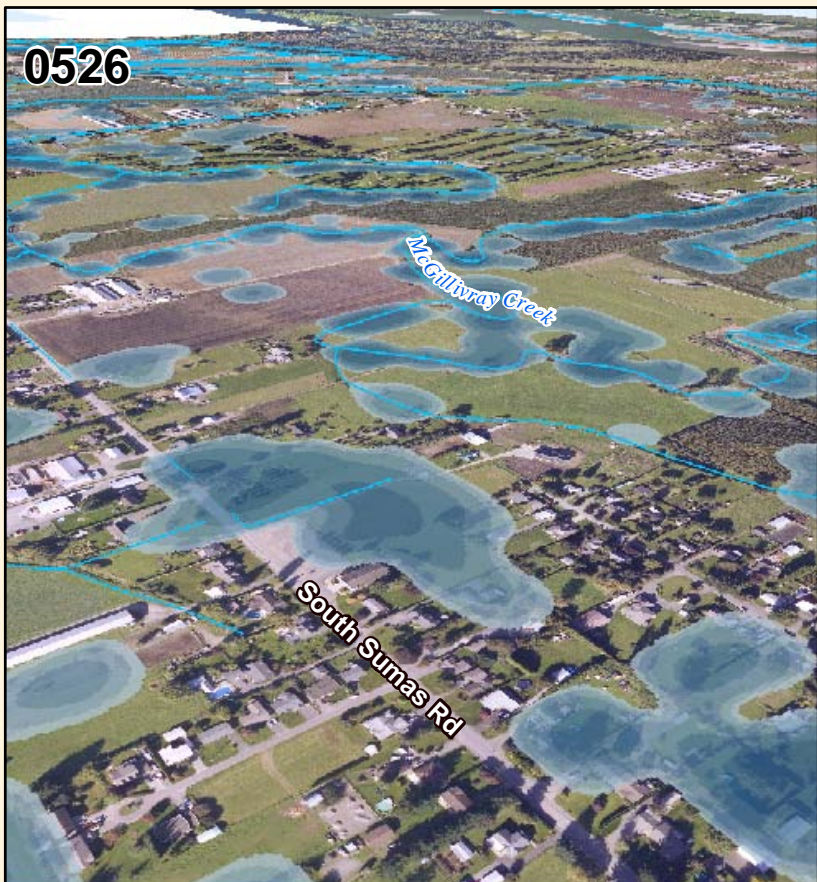
City of Chilliwack

Legend

Modeled Results Flood Depth (m)



0526



0536



0588



Note: Aerial photographs taken January 9th, 2009, between 11am and 1pm.

Model results extracted from timestep January 9th, 2009, 12:30pm







**Greendale Flood Study
Flood Extent
Photo Comparison**

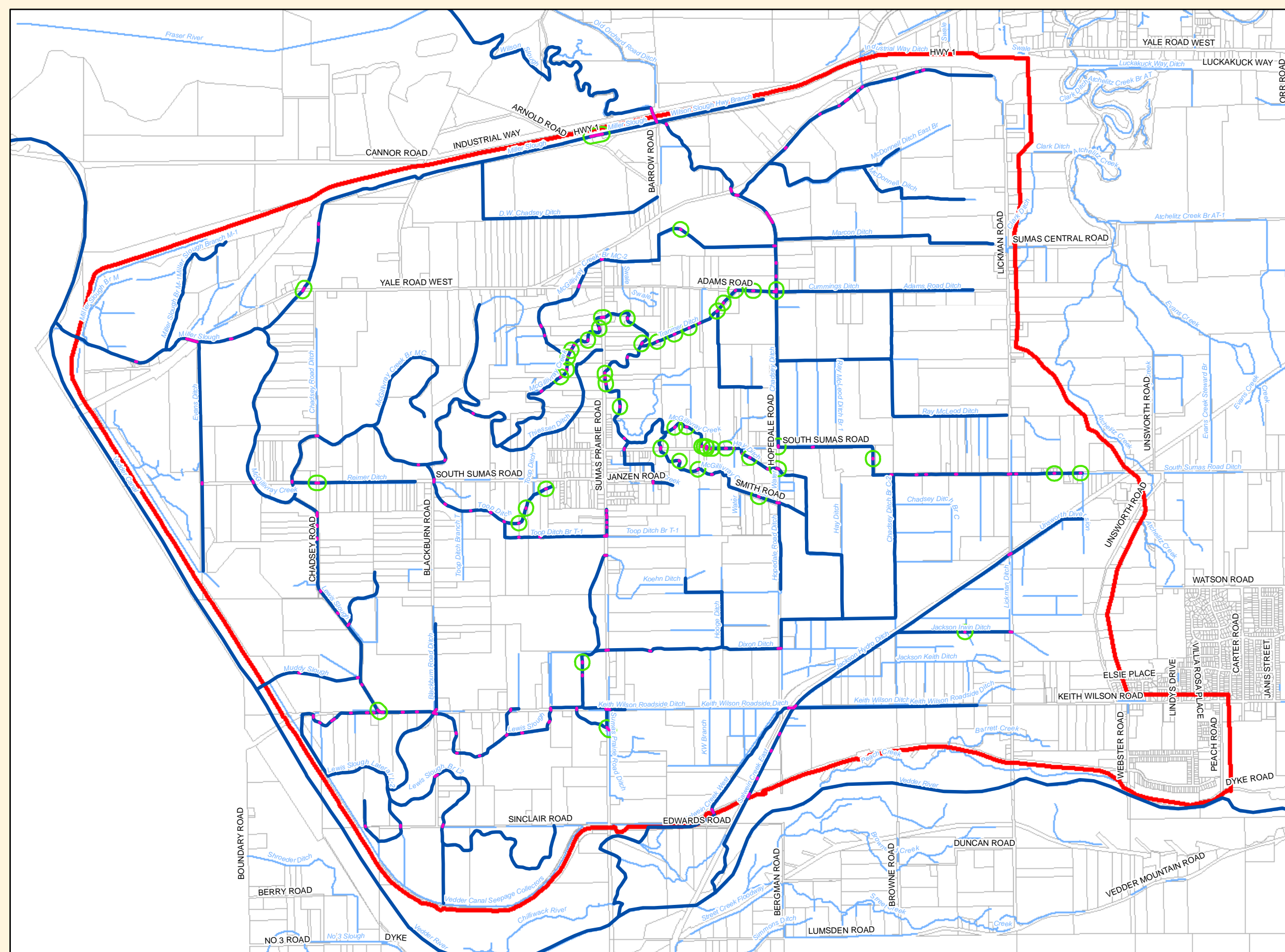
Figure 7



City of Chilliwack

Legend

-  Waterways
-  Modeled Waterways
-  Modeled Culverts
-  Culvert Upgrades
-  Cadastral
-  Study Boundary



Greendale Flood Study
Deficient Culverts
10 Year

Figure 8




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





City of Chilliwack

Legend

-  Waterways
-  Modeled Waterways
-  Study Boundary

Maximum Water Depth (m)*

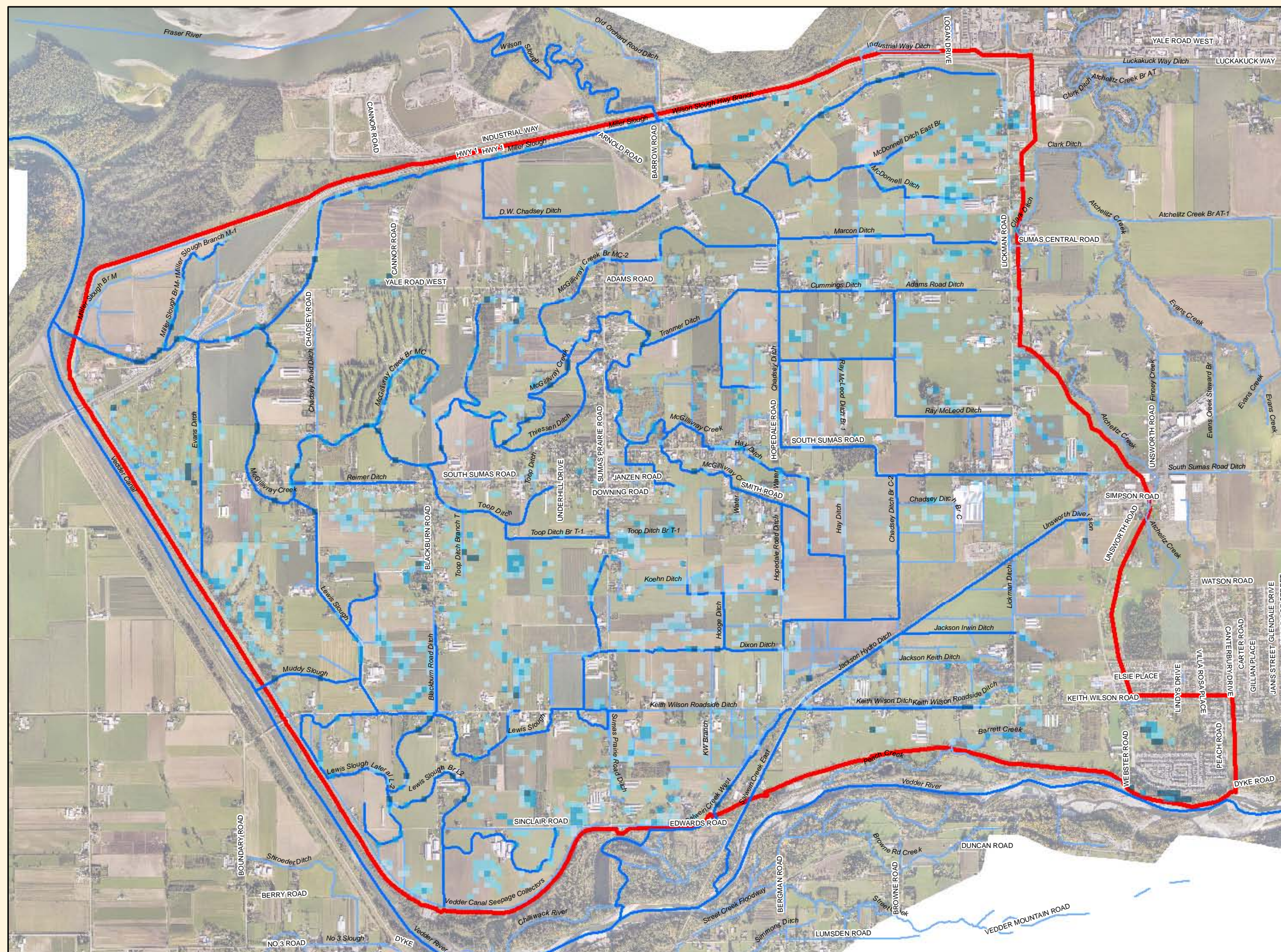
-  0.05 - 0.1
-  0.1 - 0.25
-  0.25 - 0.5
-  > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

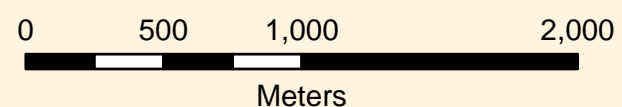
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study Baseline Performance: 10 Year

Figure 9



URBANSYSTEMS. THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.





City of Chilliwack

Legend

- Waterways
- Modeled Waterways
- Study Boundary

Maximum Water Depth (m) *

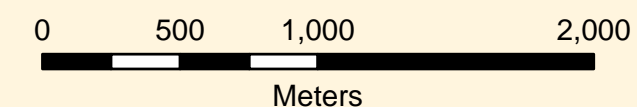
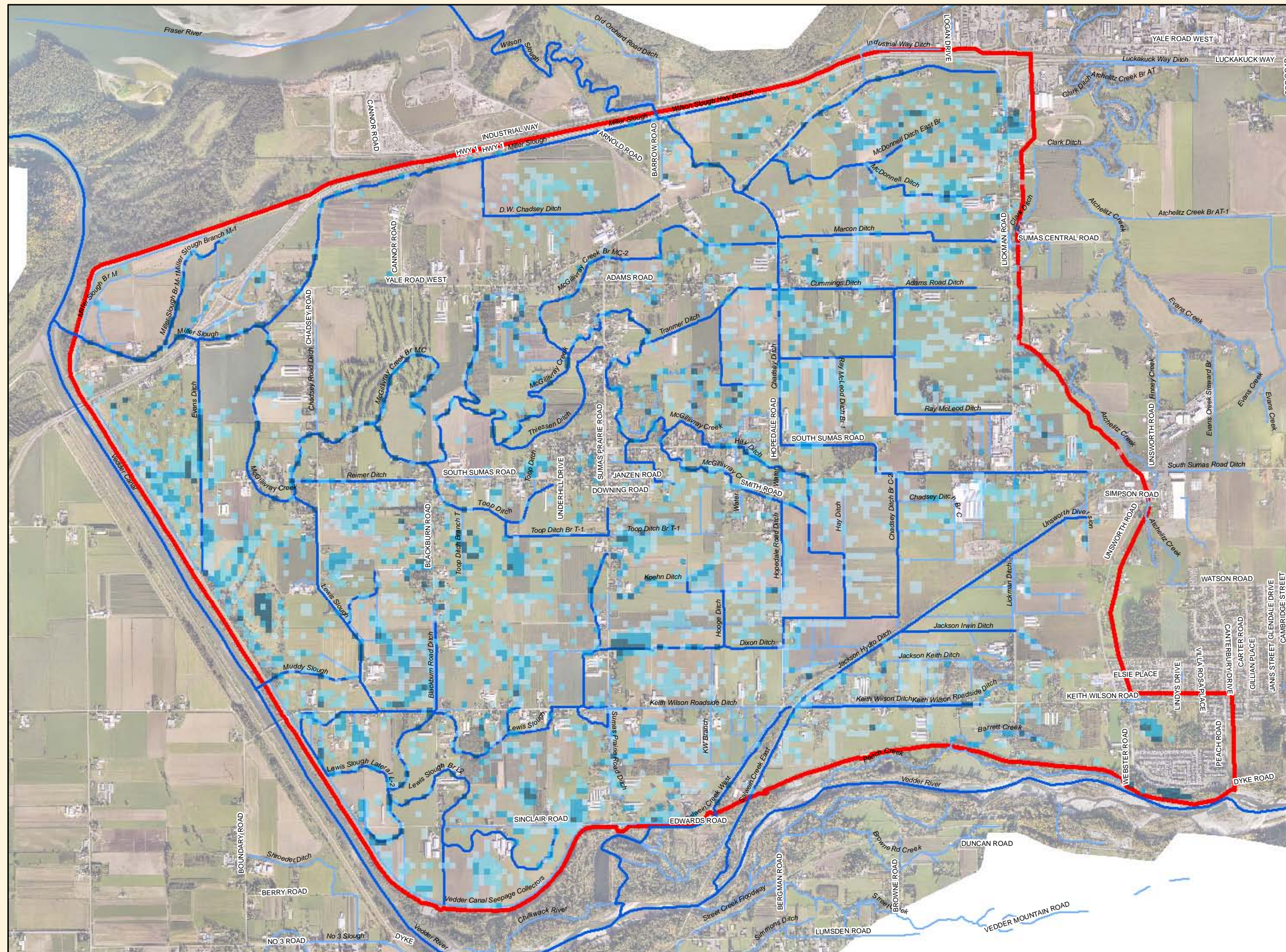
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Baseline
Performance:
25 Year

Figure 10



URBANSYSTEMS. THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.



City of Chilliwack

Legend

- Waterways
- Modeled Waterways
- Study Boundary

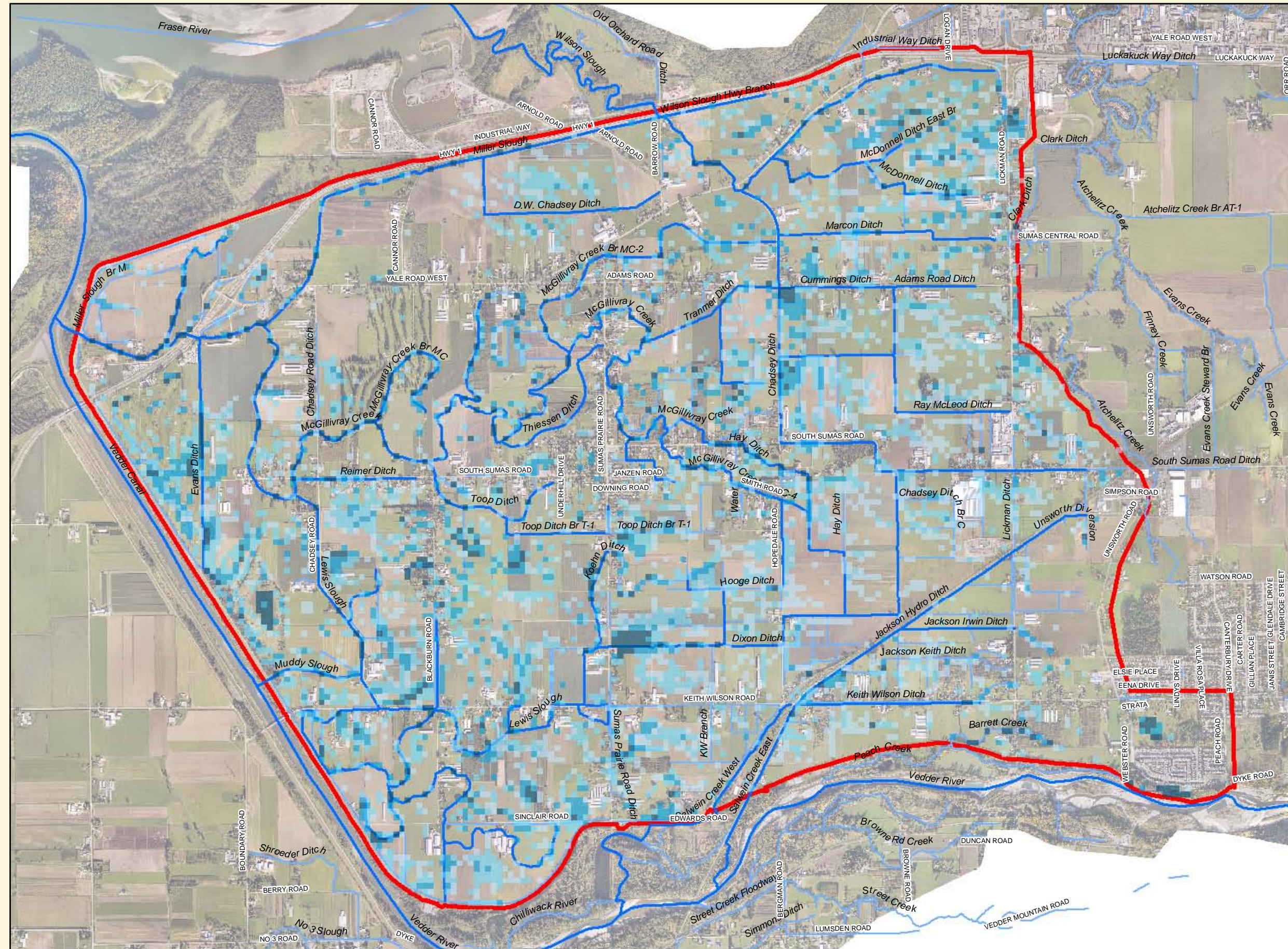
Maximum Water Depth (m)*

- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

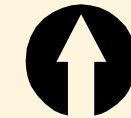
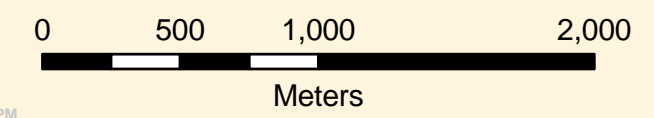
* Based on maximum water depth each gridcell experienced during entire duration of event.
 Note: Flooding depths less than 5cm not shown.

**Greendale Flood Study
 Baseline
 Performance:
 100 Year**

Figure 11



URBANSYSTEMS. THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.





City of Chilliwack

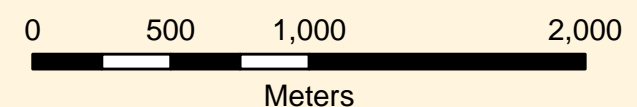
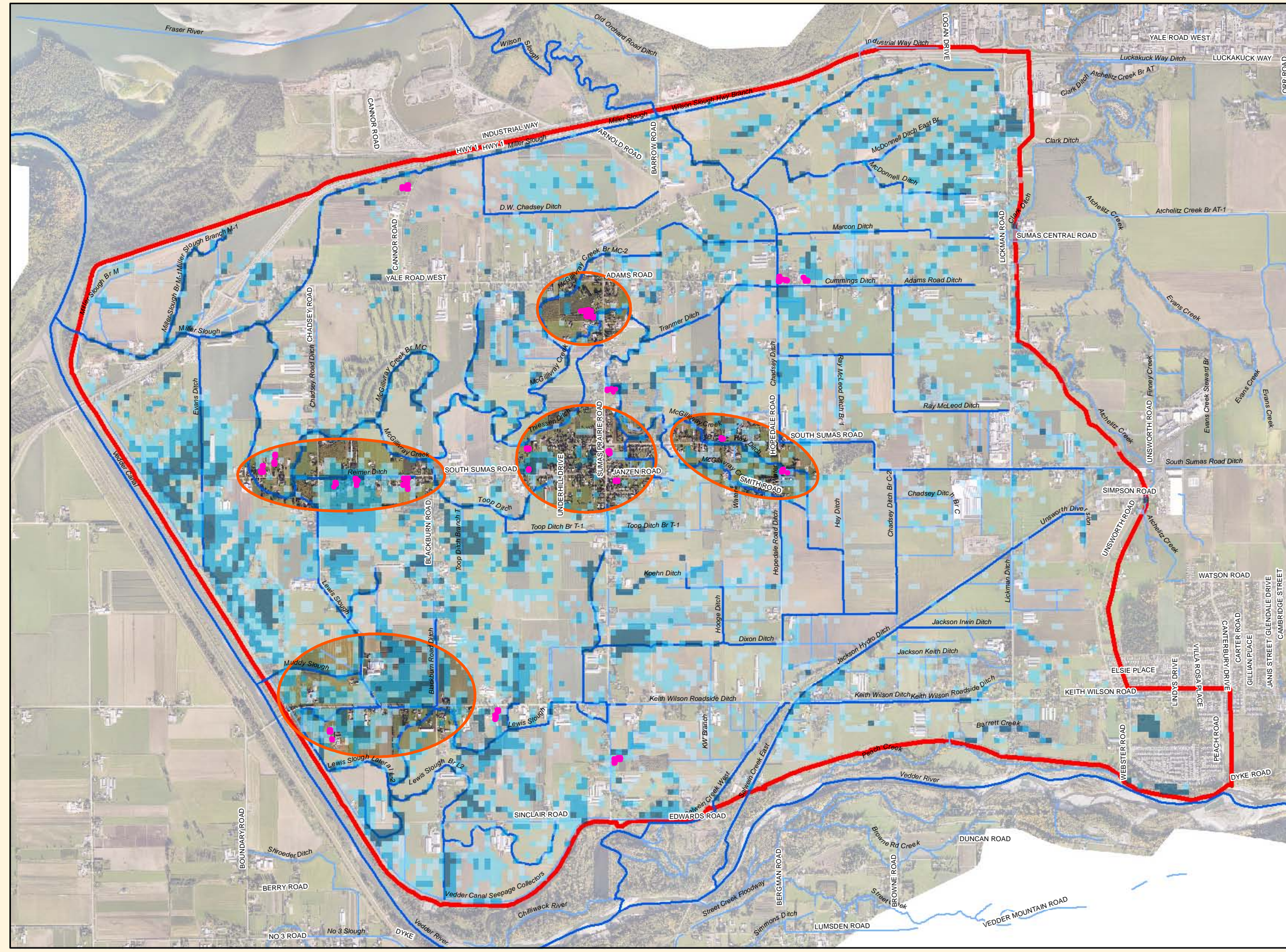
Legend

- Waterways
 - Modeled Waterways
 - Study Boundary
 - Primary Vulnerable Zones
- Maximum Water Depth (m)***
- 0.05 - 0.1
 - 0.1 - 0.25
 - 0.25 - 0.5
 - > 0.5
- Building Reported as Impacted at 2009 Open House

* Based on maximum water depth each gridcell experienced during entire duration of event.
 Note: Flooding depths less than 5cm not shown.

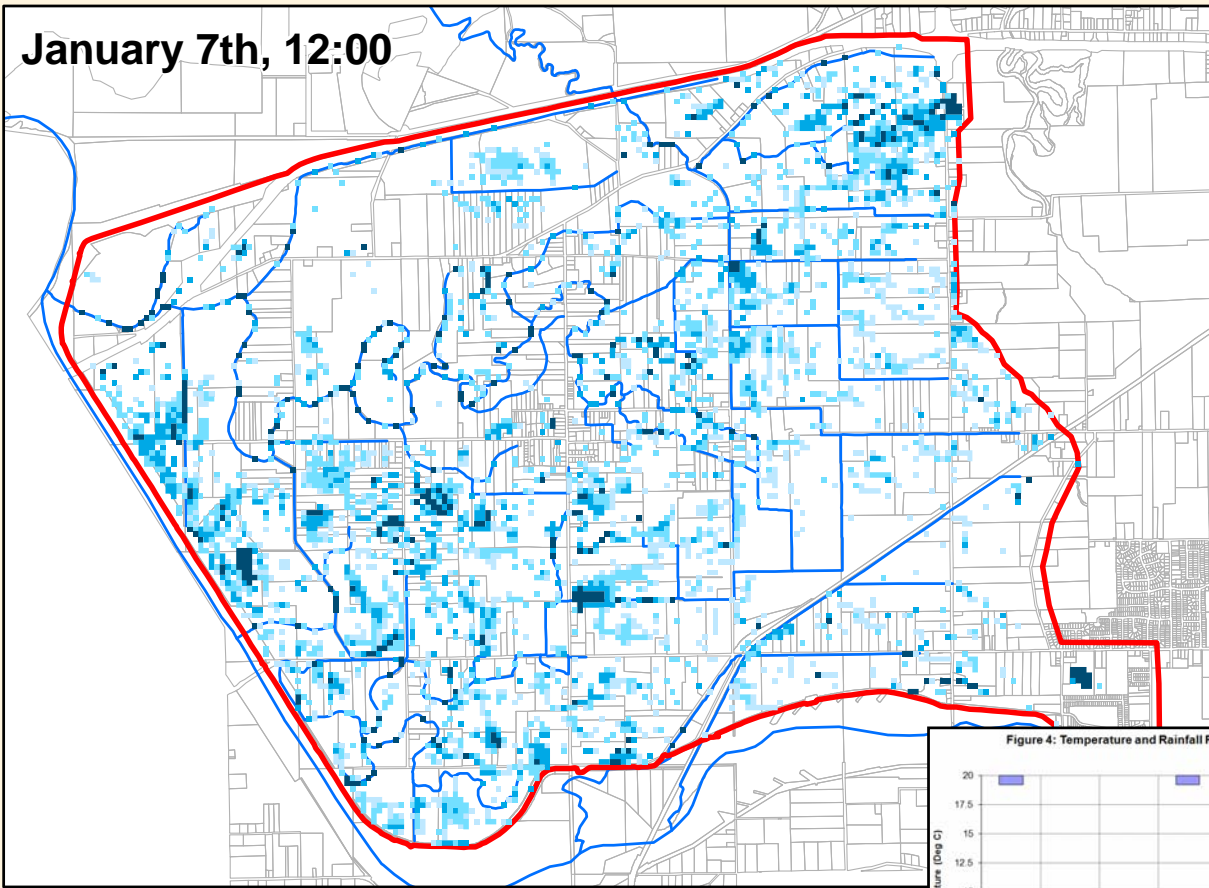
**Greendale Flood Study
 Baseline
 Performance:
 January Event**

Figure 12

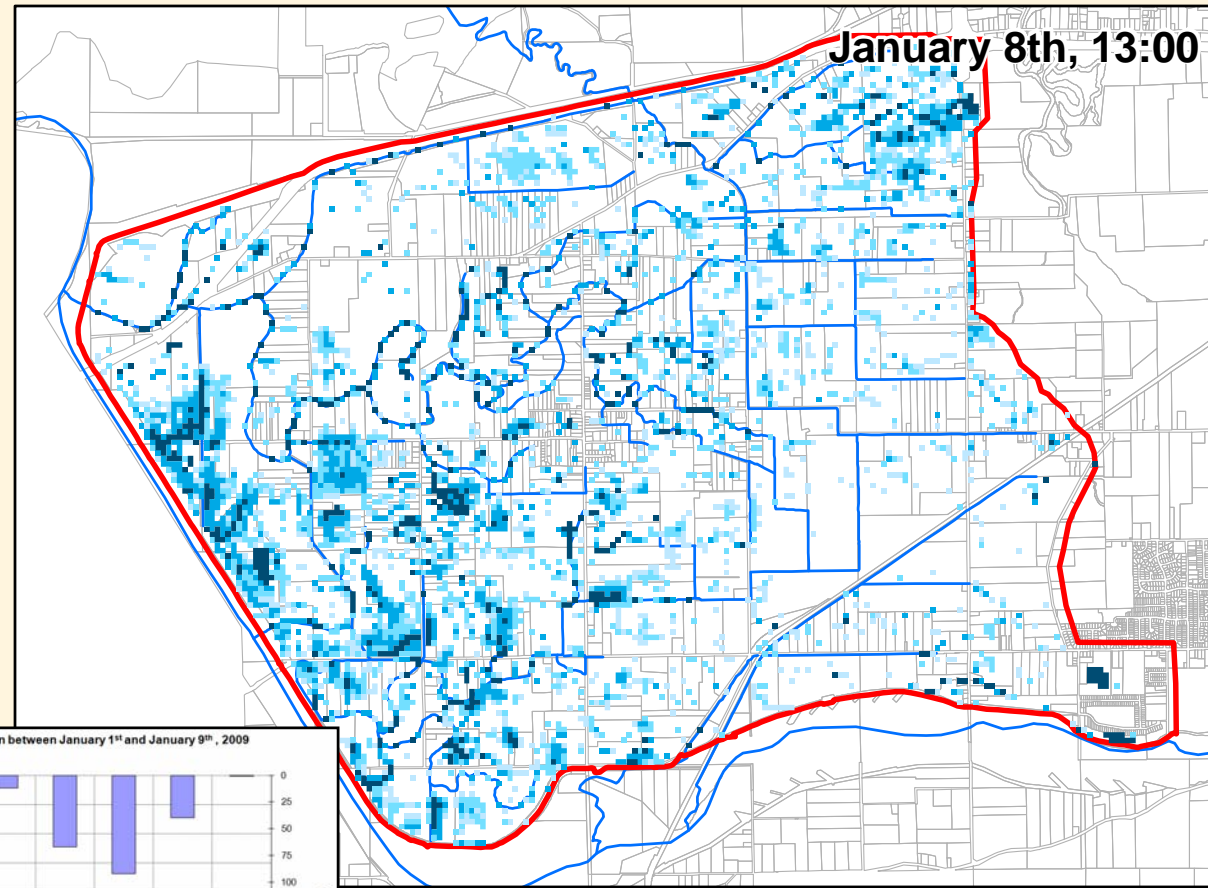


URBANSYSTEMS. THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.

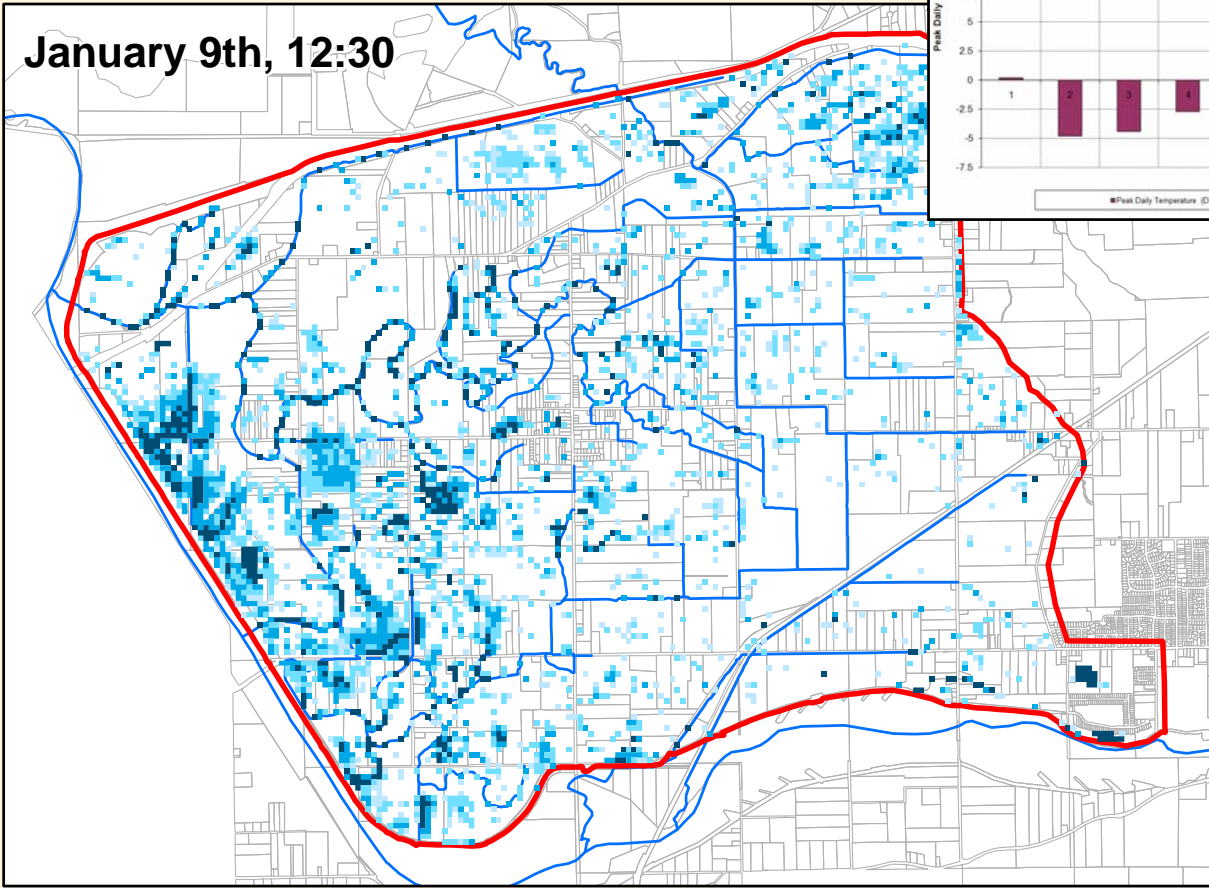
January 7th, 12:00



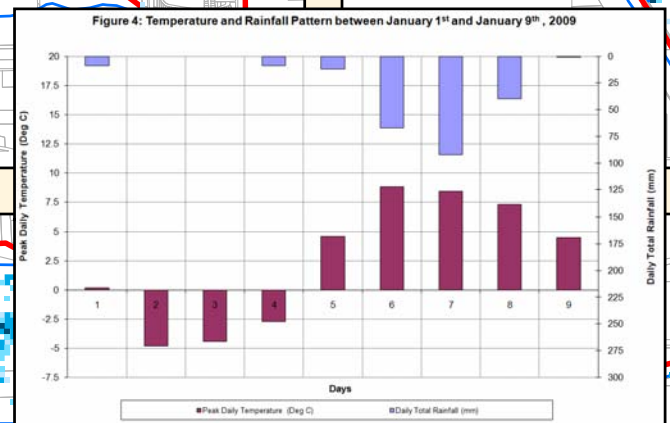
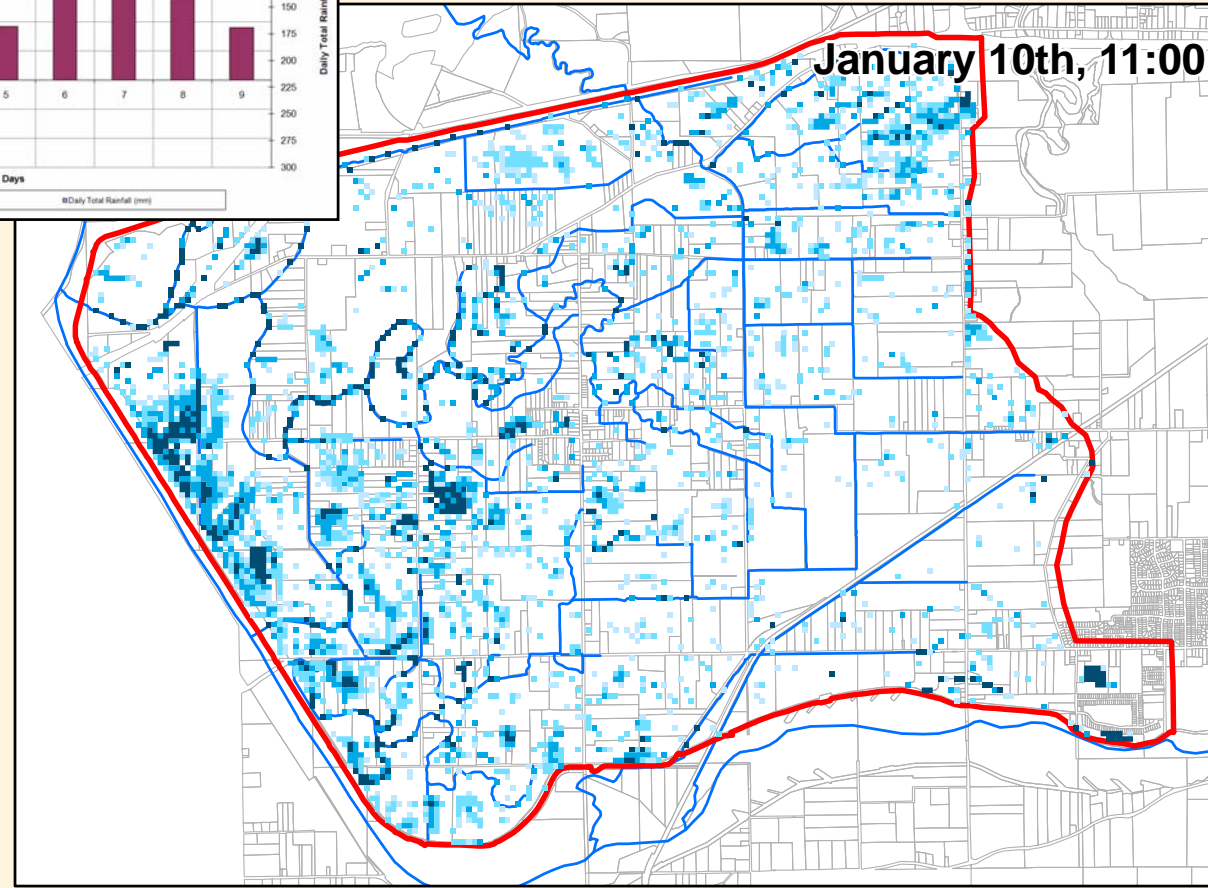
January 8th, 13:00



January 9th, 12:30



January 10th, 11:00



City of Chilliwack

Legend

- Modeled Waterways
- Study Boundary
- Cadastral

Maximum Water Depth (m)*

- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.
 Note: Flooding depths less than 5cm not shown.

**Greendale Flood Study
 January Event
 Flood Progression**

Figure 13

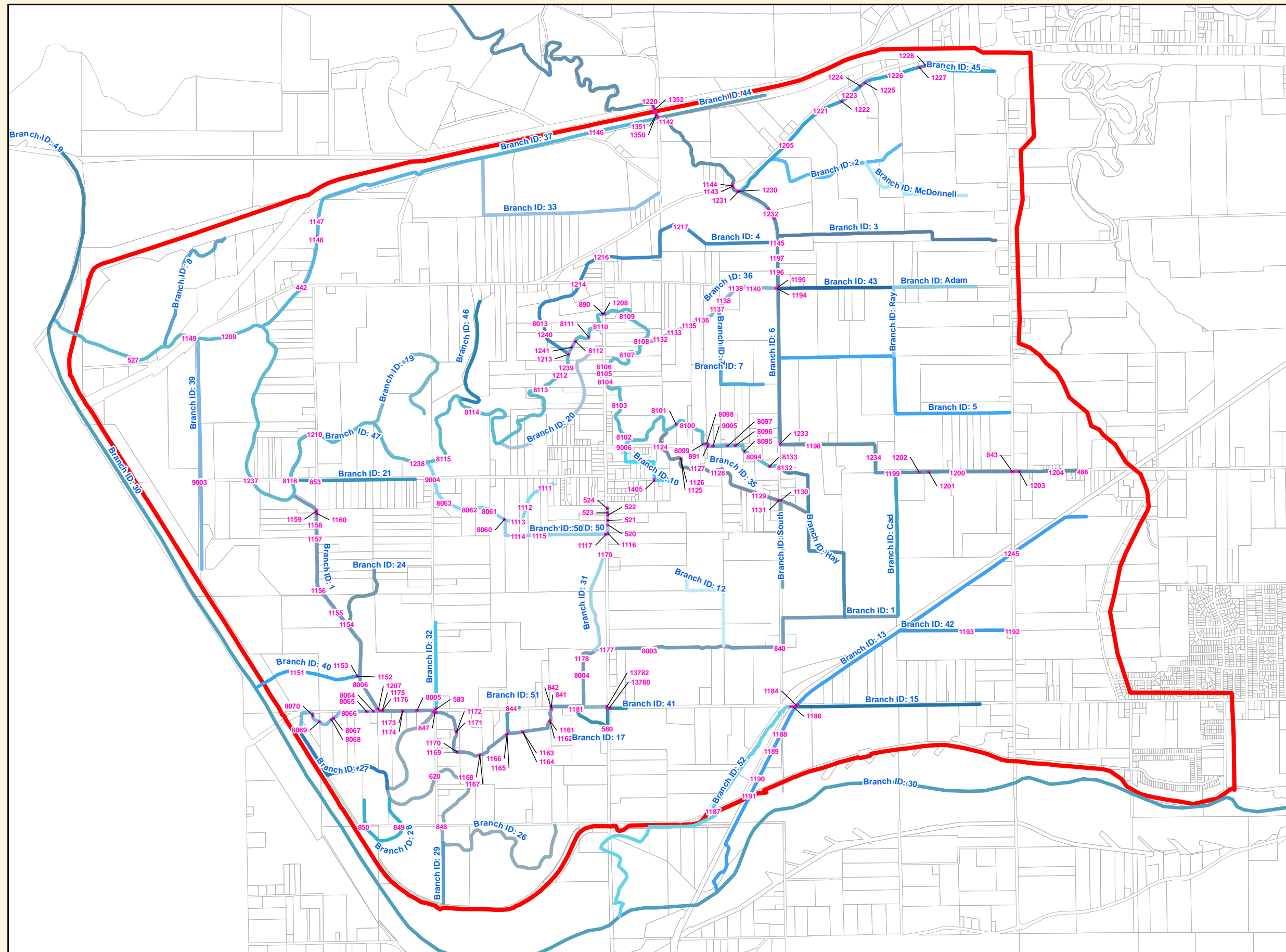
THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.



City of Chilliwack

Legend

- Modeled Waterways (shades of blue to distinguish reaches)
- Modeled Culverts
- Cadastral
- Study Boundary



Greendale Flood Study Conveyance System Key Plan

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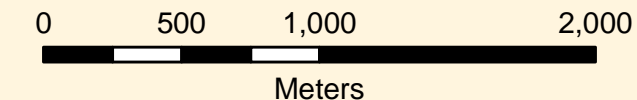


Figure 15



City of Chilliwack

Legend

- Pump Station Upgrades
- Waterways
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

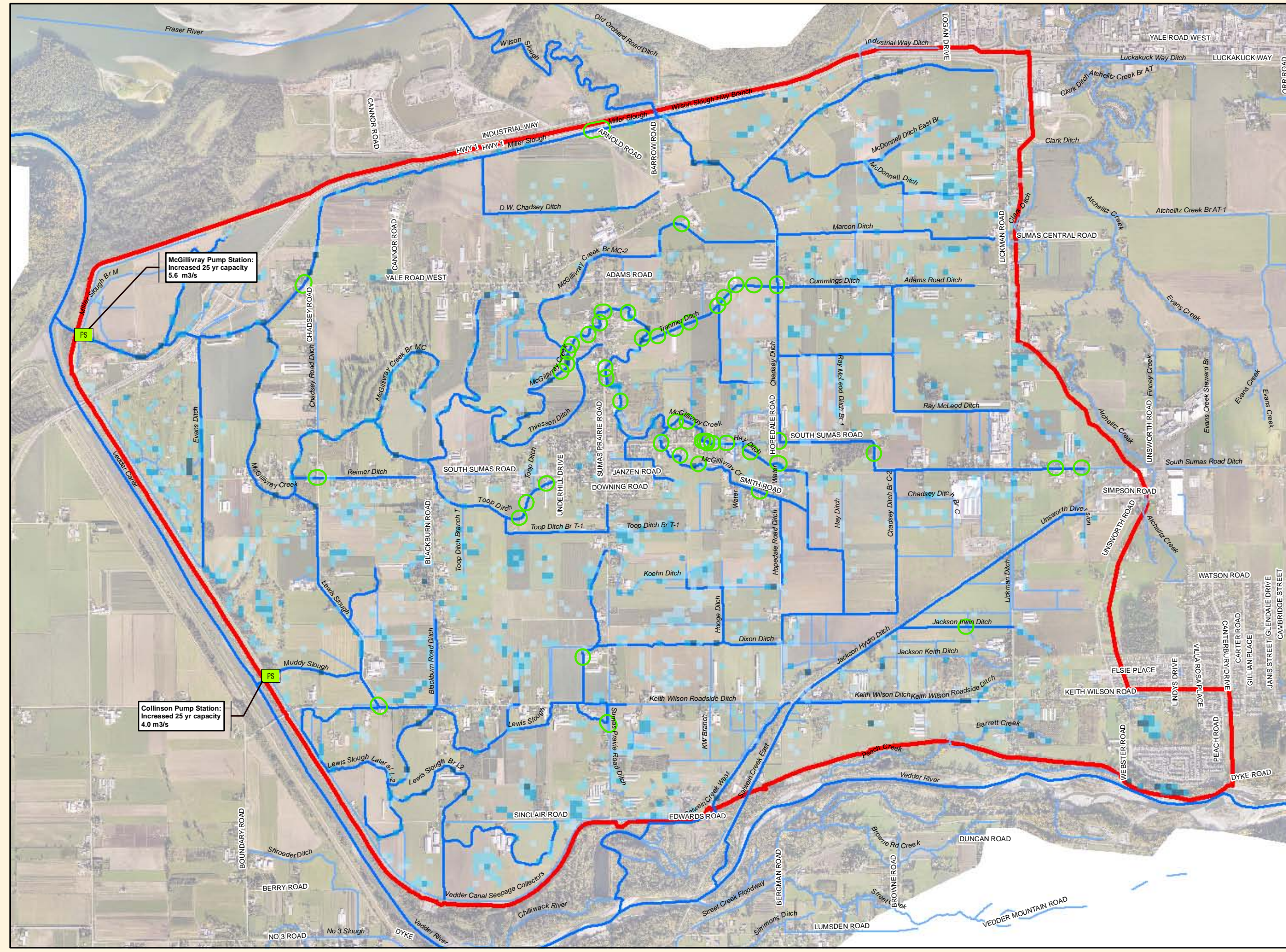
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

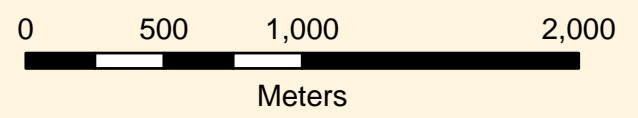
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 1
Performance:
10 Year

Figure 16.10



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City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

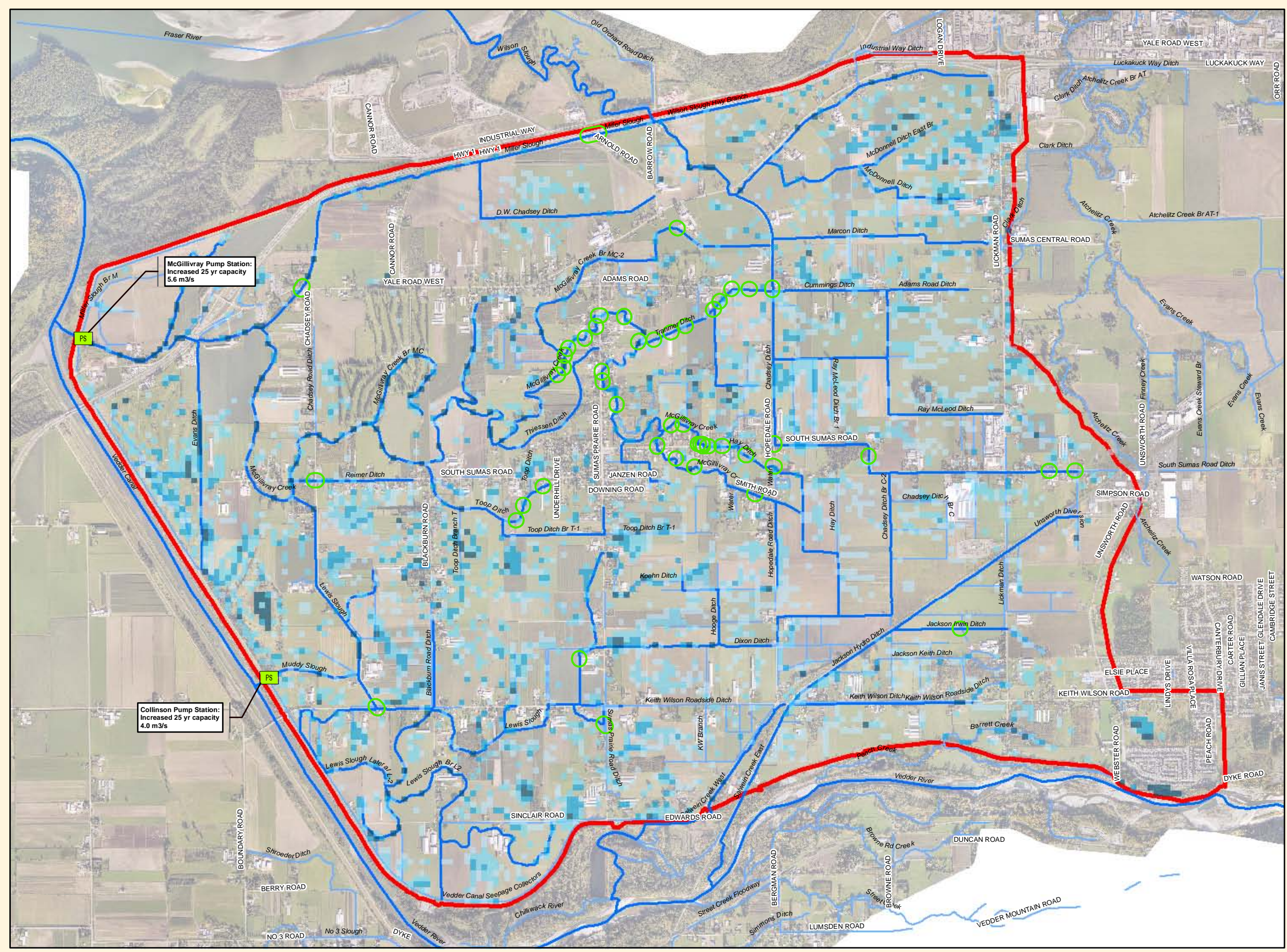
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

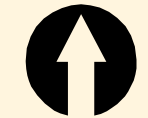
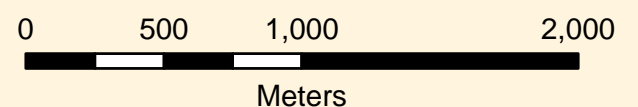
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 1
Performance:
25 Year

Figure 16.25



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City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

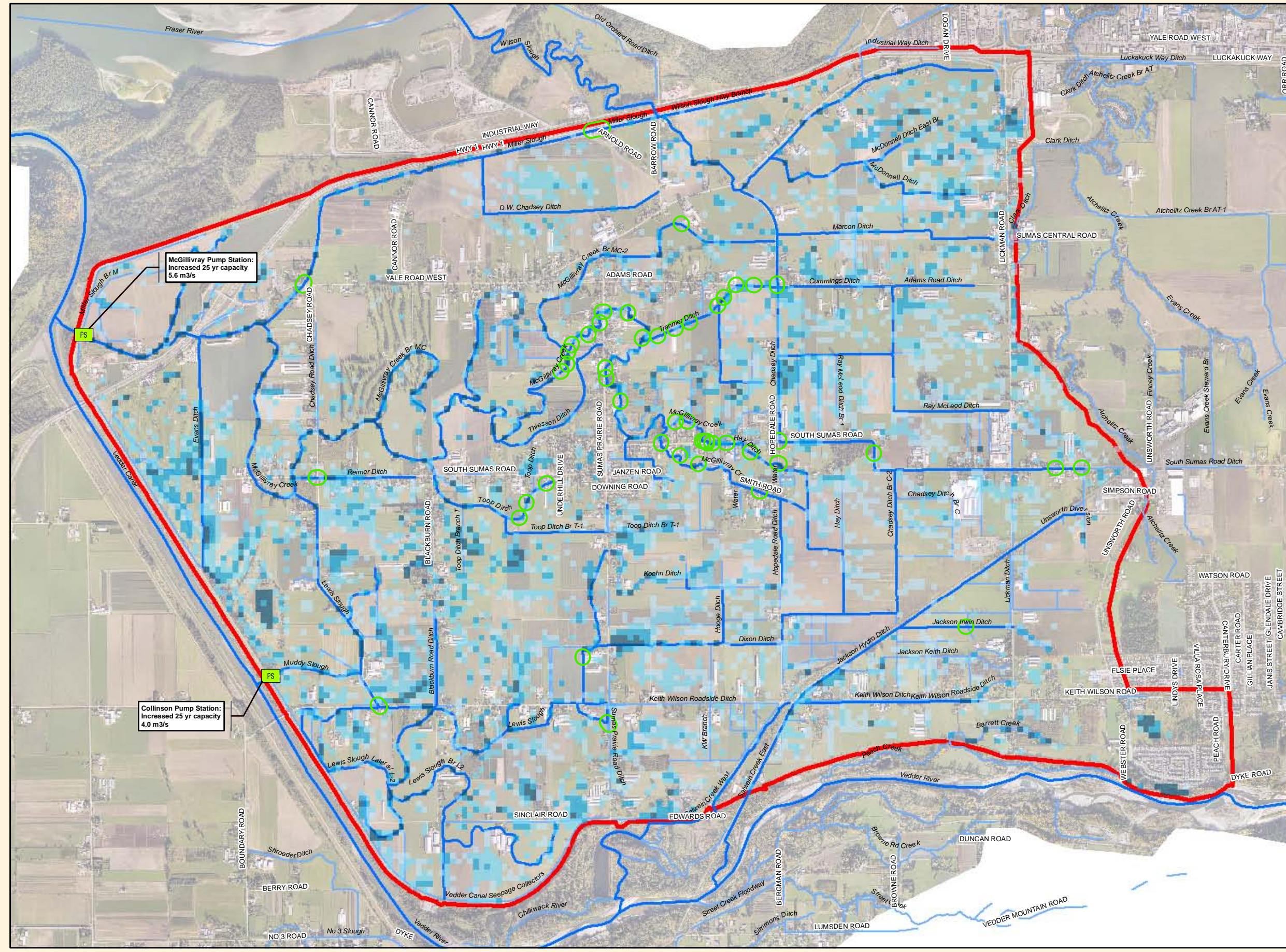
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

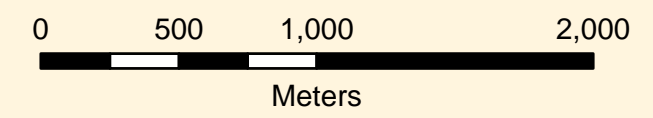
Note: Flooding depths less than 5cm not shown.

**Greendale Flood Study
Option 1
Performance:
100 Year**

Figure 16.100



URBANSYSTEMS. THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.





City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

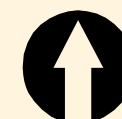
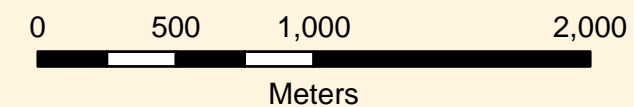
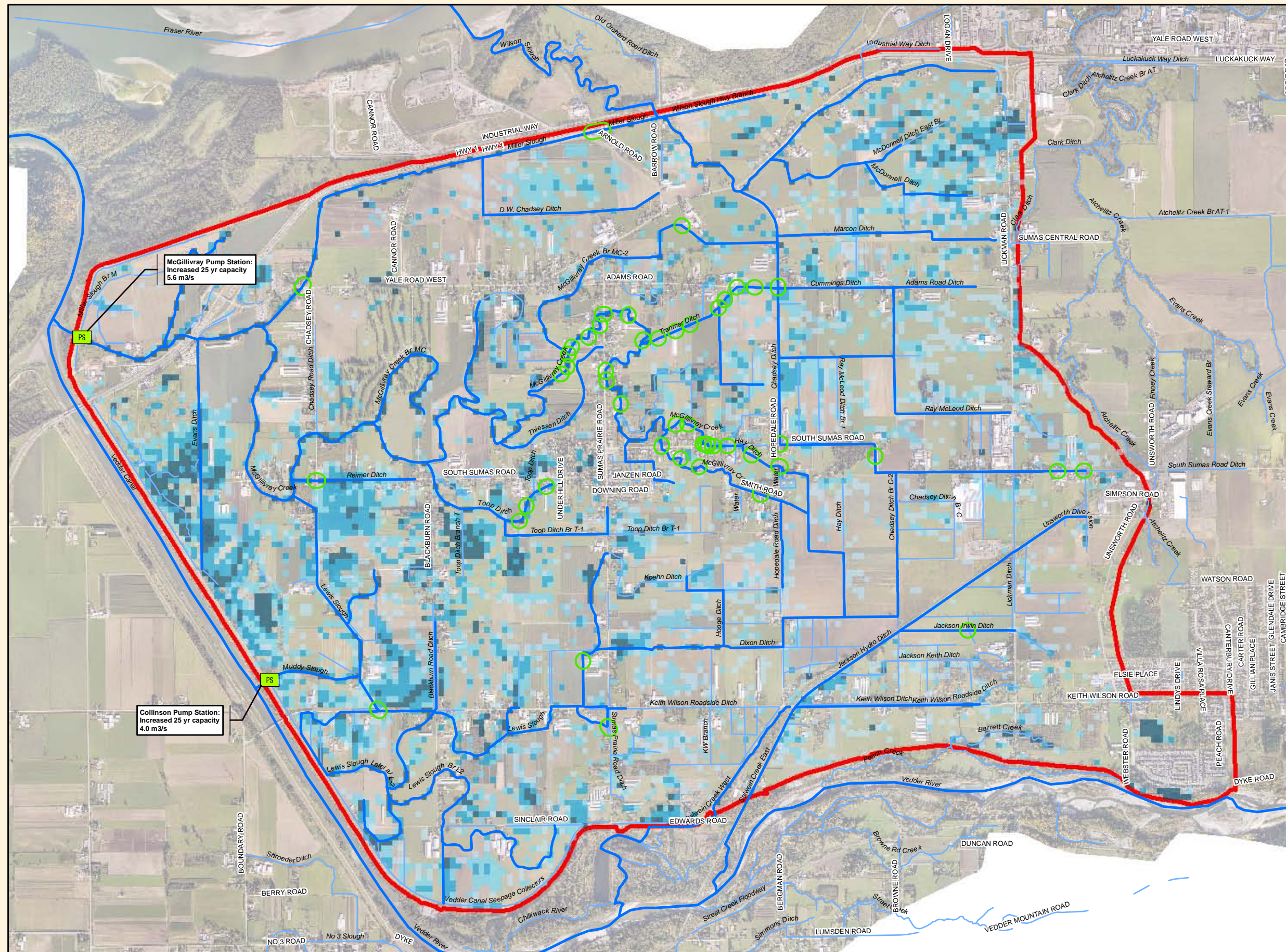
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 1
Performance:
January Event

Figure 16. Jan



URBANSYSTEMS. THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.

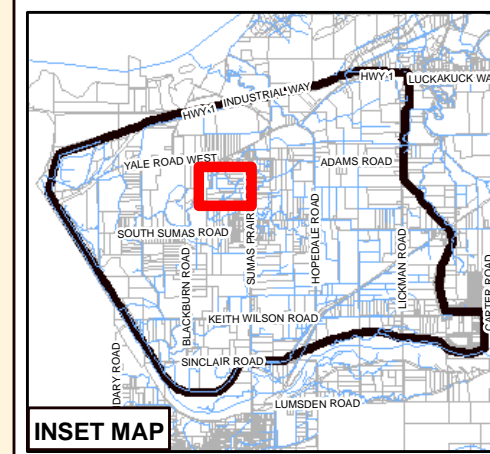


City of Chilliwack

Legend

- Proposed Channel Centerline
- Proposed Top of Bank (approx. 4-6m from centerline)
- Easement Limit
- Existing Waterway
- Cadastral

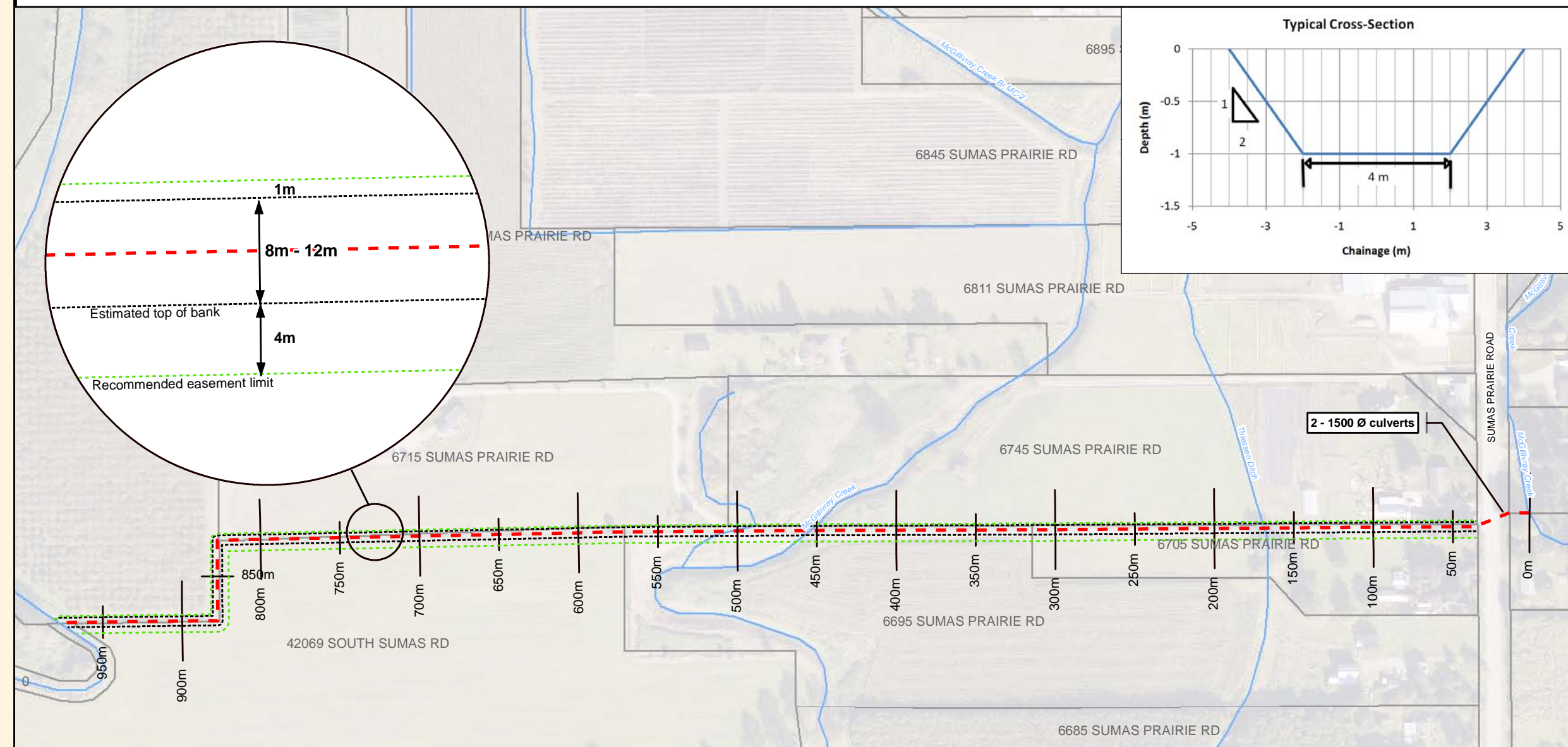
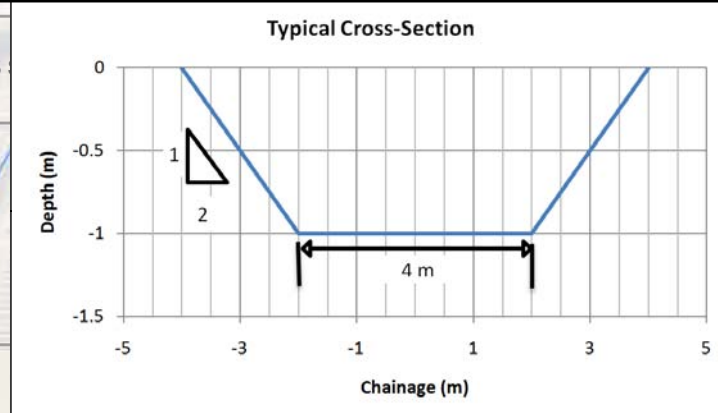
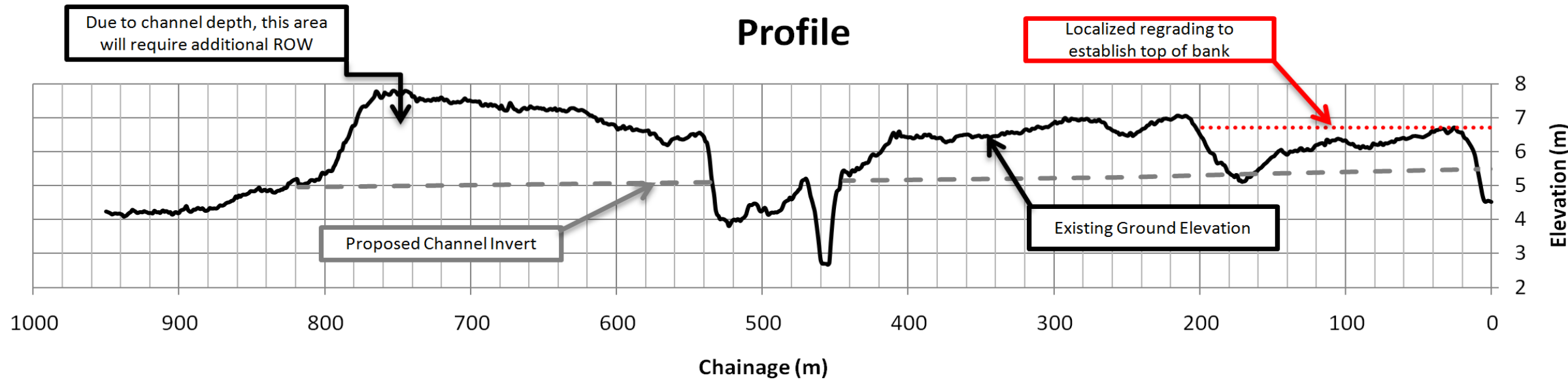
Final alignment and limits of easement subject to agreements with property owners and detailed design.



Greendale Flood Study McGillivray Supplemental Channel

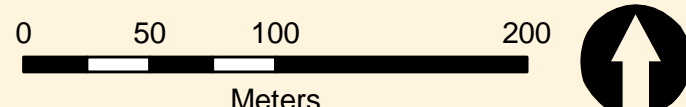
Figure 17A

Profile



2 - 1500 Ø culverts

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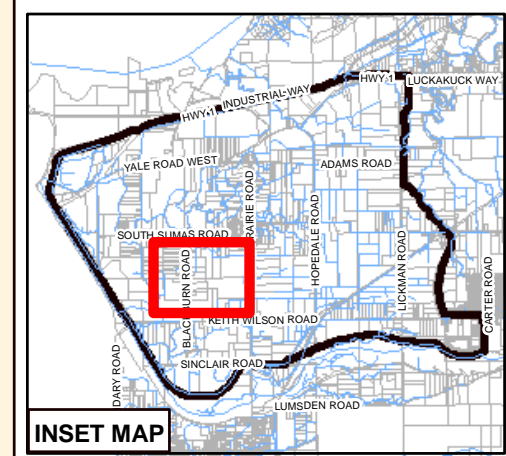


City of Chilliwack

Legend

- - - Proposed Channel Centerline
- - - - - Proposed Top of Bank (approx. 4-6m from centerline)
- - - - - Easement Limit
- Existing Waterway
- Cadastral

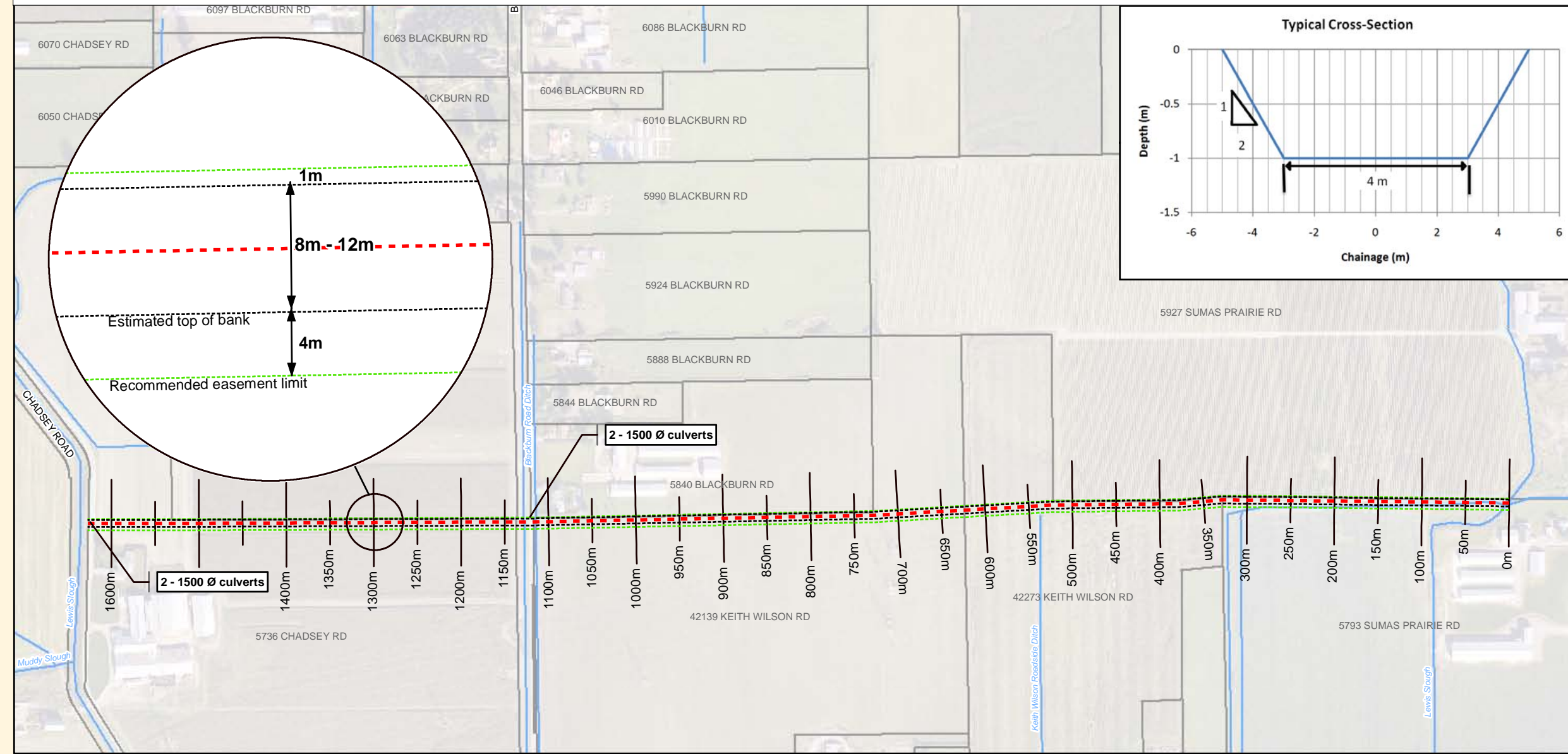
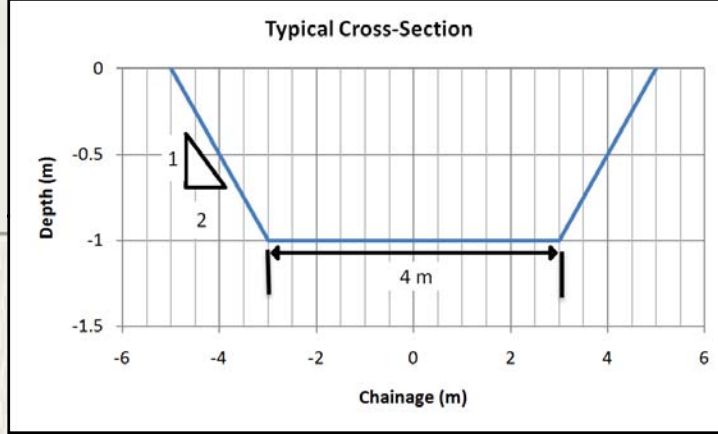
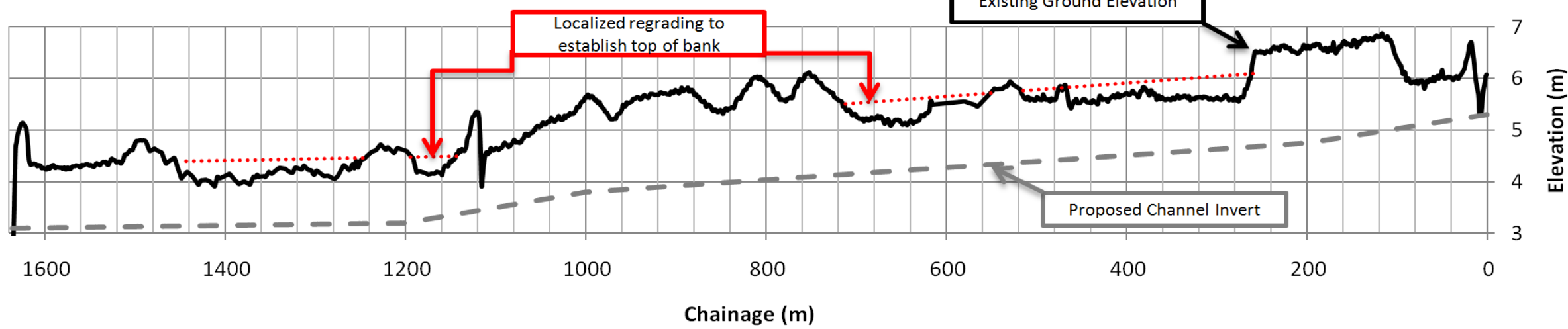
Final alignment and limits of easement subject to agreements with property owners and detailed design.



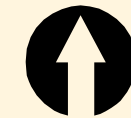
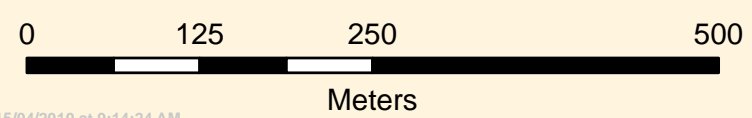
Greendale Flood Study Lewis Slough Supplemental Channel

Figure 17B

Profile



URBANSYSTEMS. THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.





City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- - - Added Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

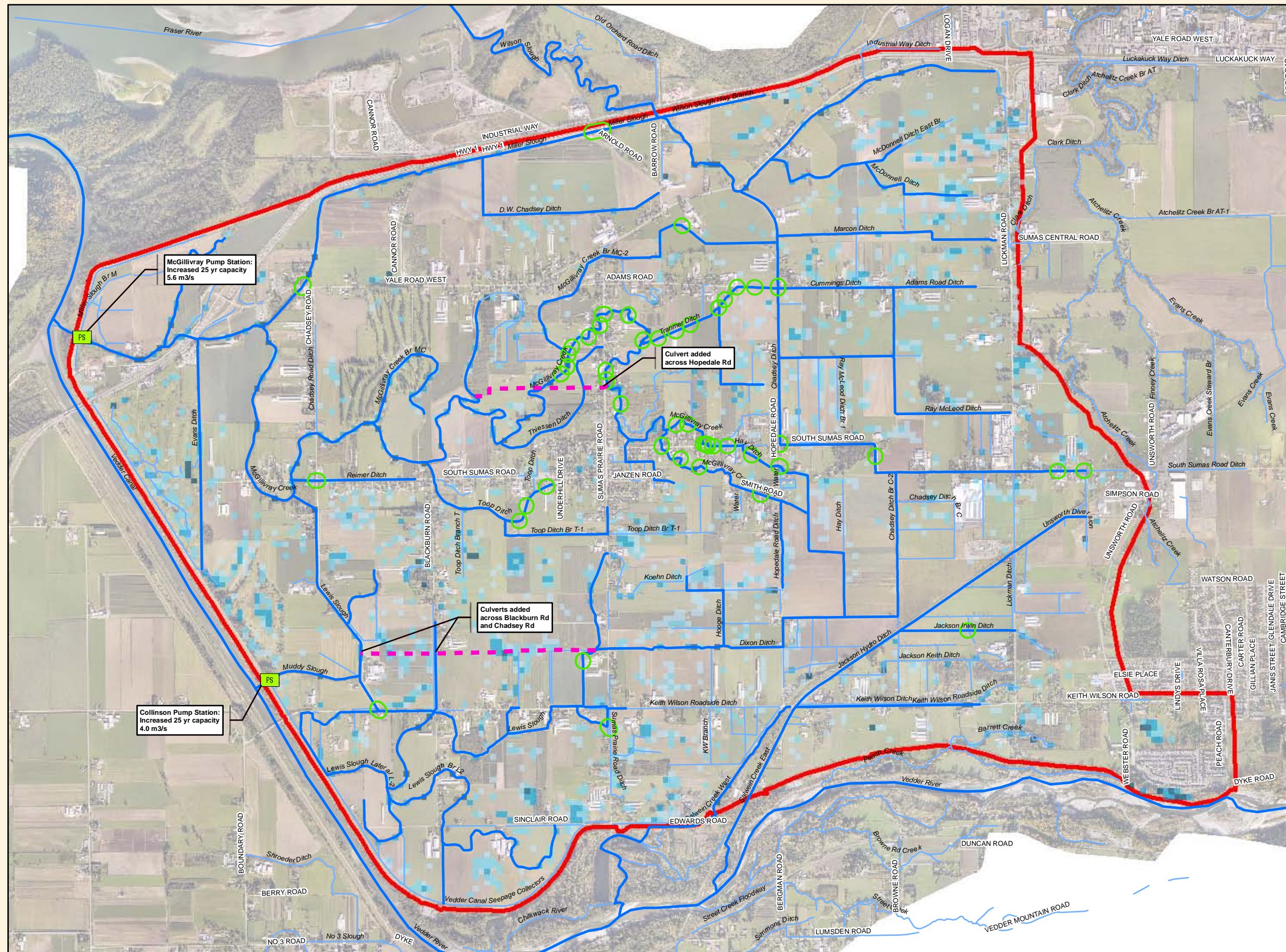
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

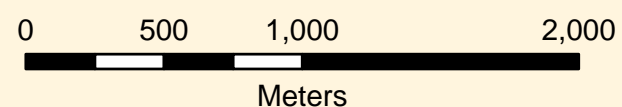
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 1B
Performance:
10 Year

Figure 18.10



URBANSYSTEMS
 THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.





City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Added Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

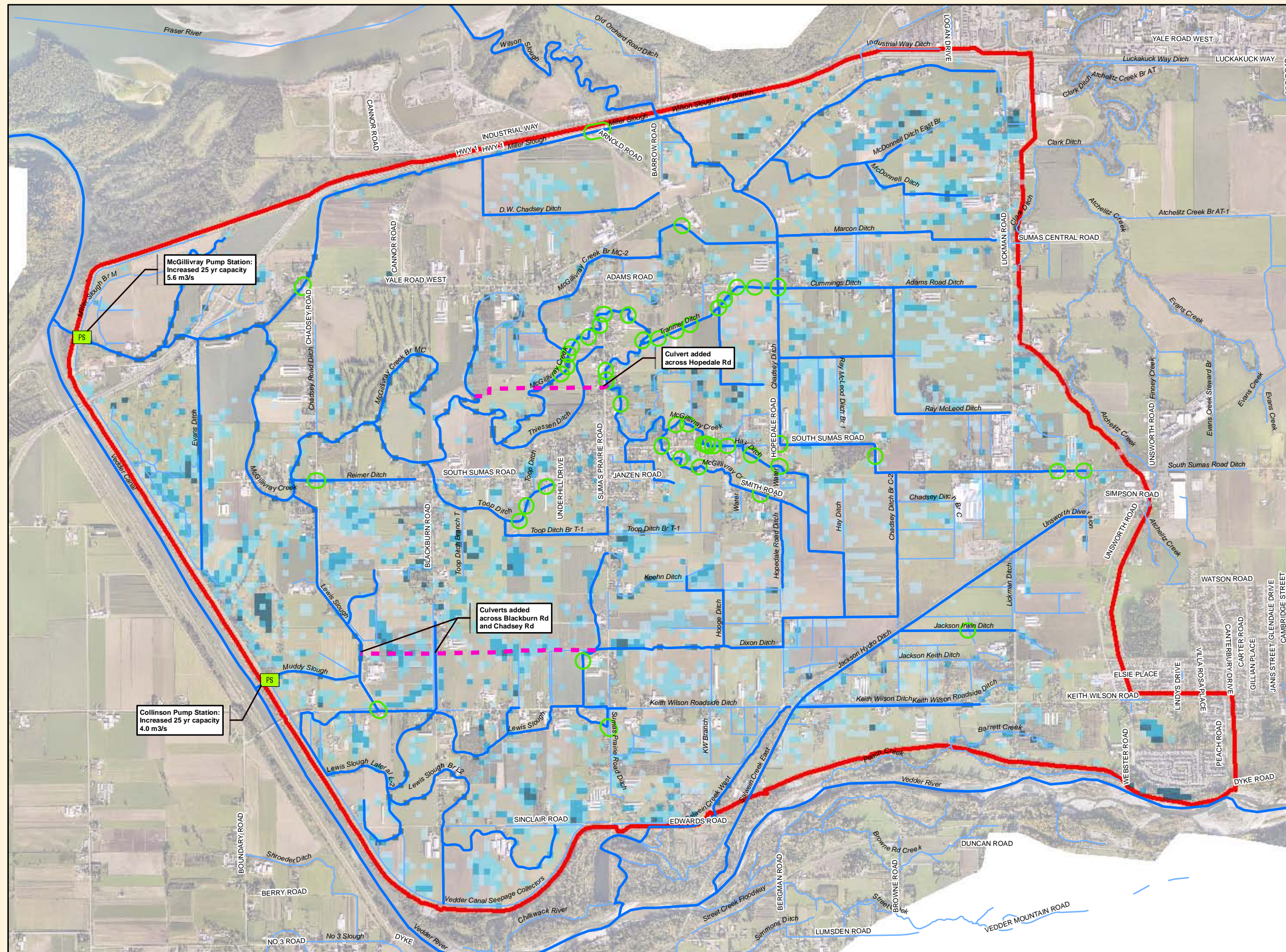
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

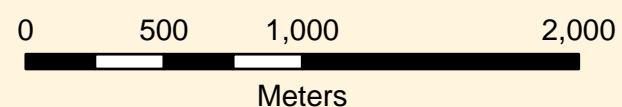
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 1B
Performance:
25 Year

Figure 18.25



URBANSYSTEMS
 THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.





City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Added Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

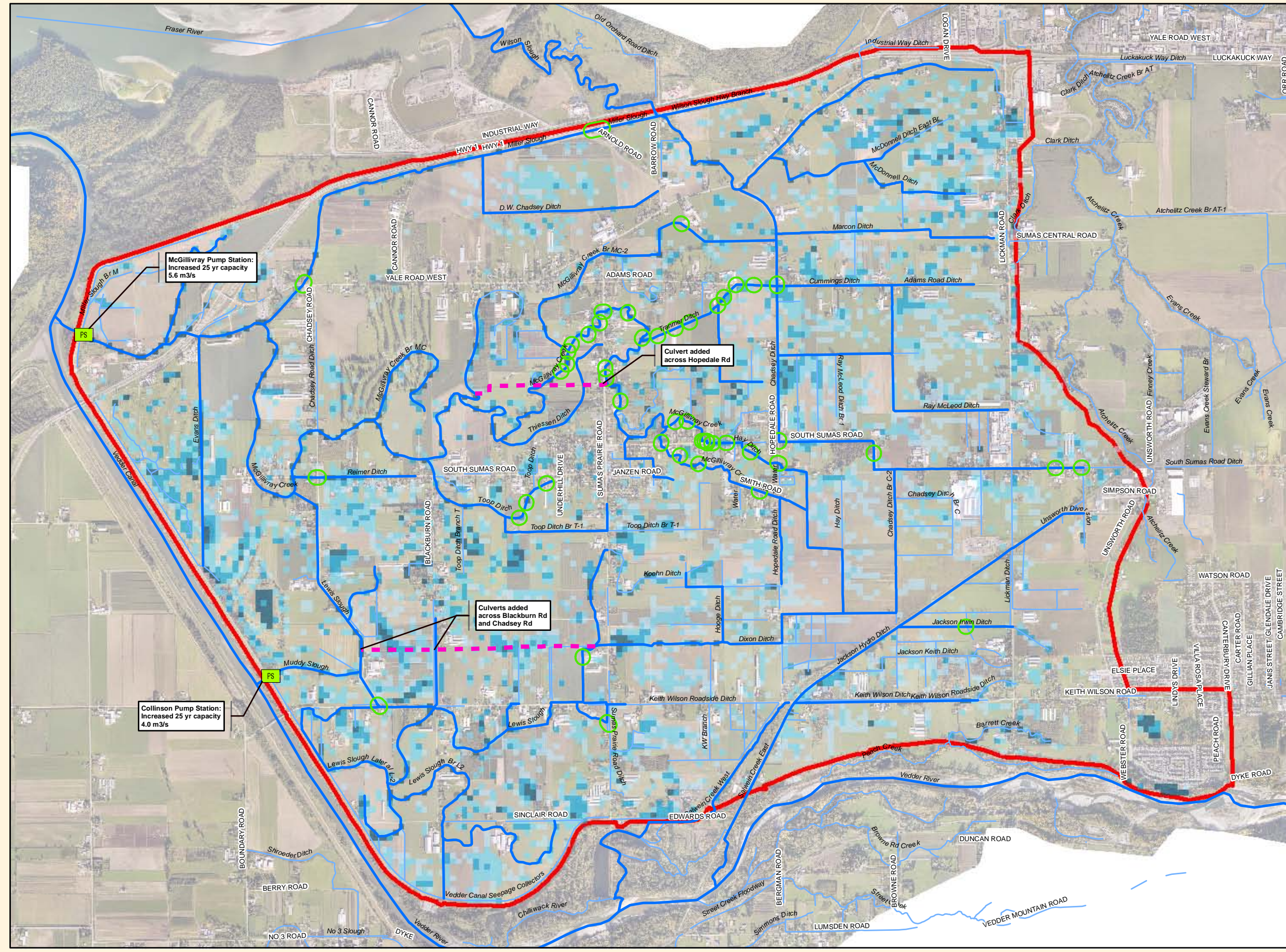
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

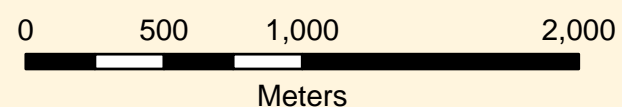
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 1B
Performance:
100 Year

Figure 18.100



URBANSYSTEMS. THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.





City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- - - Added Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

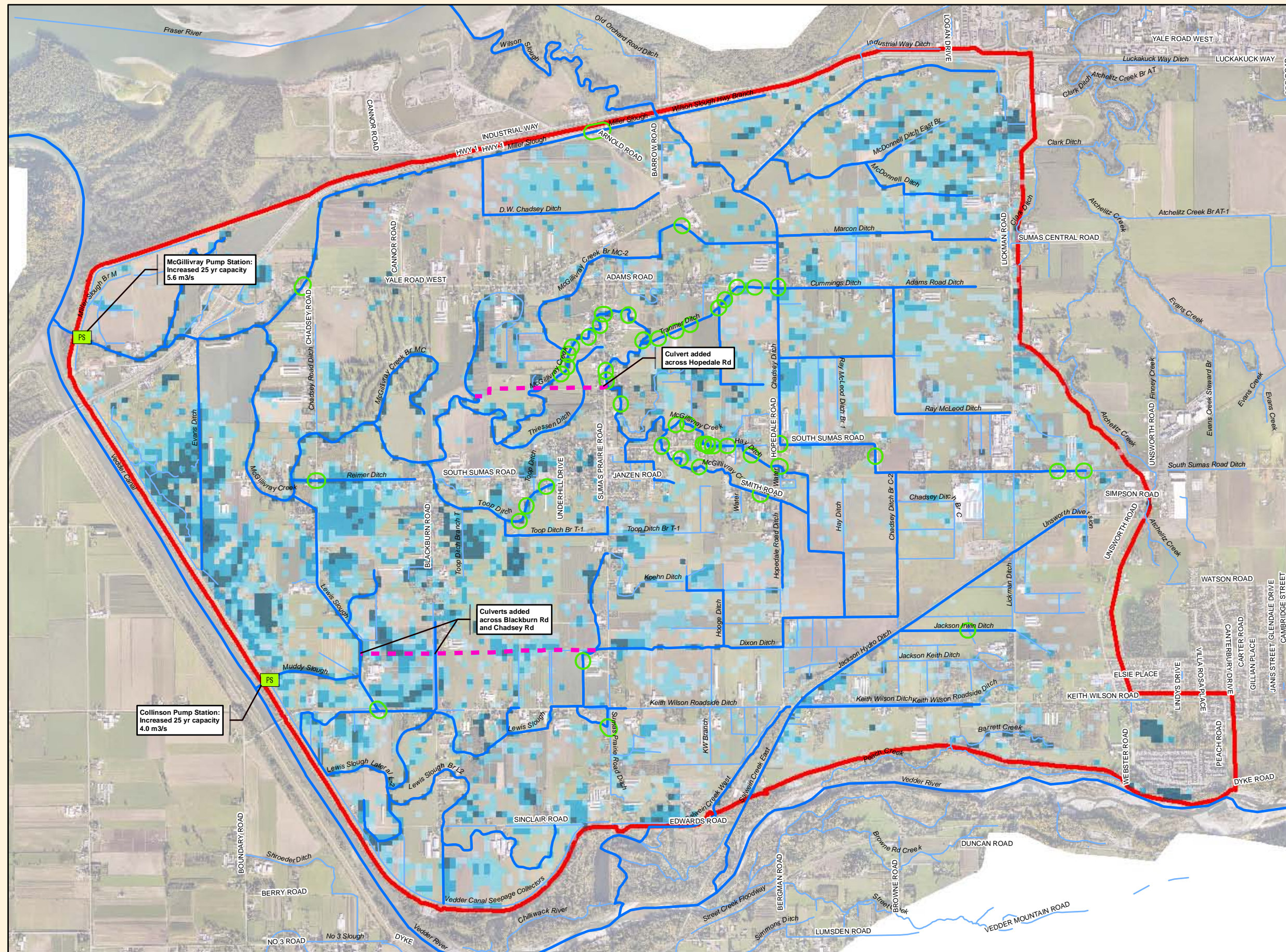
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

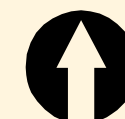
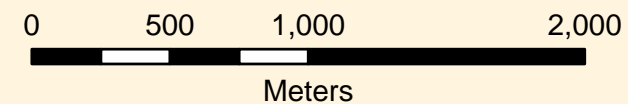
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 1B
Performance:
January Event

Figure 18. Jan



URBANSYSTEMS. THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.





City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

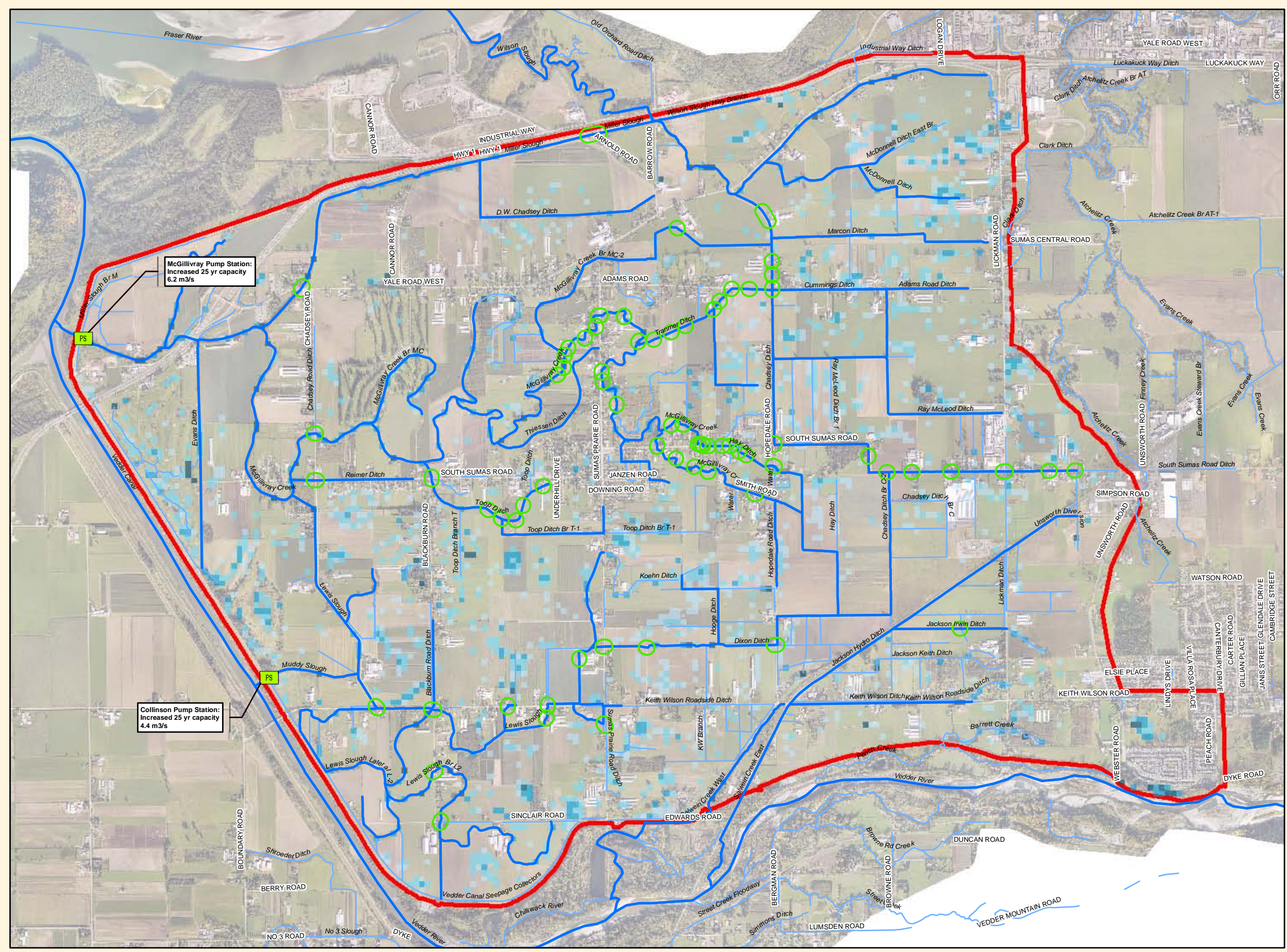
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

Note: Flooding depths less than 5cm not shown.

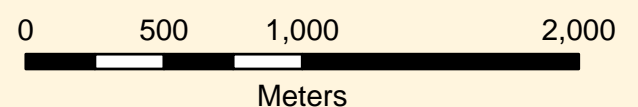
Greendale Flood Study
Option 2
Performance:
10 Year

Figure 19.10



URBANSYSTEMS

THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.





City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

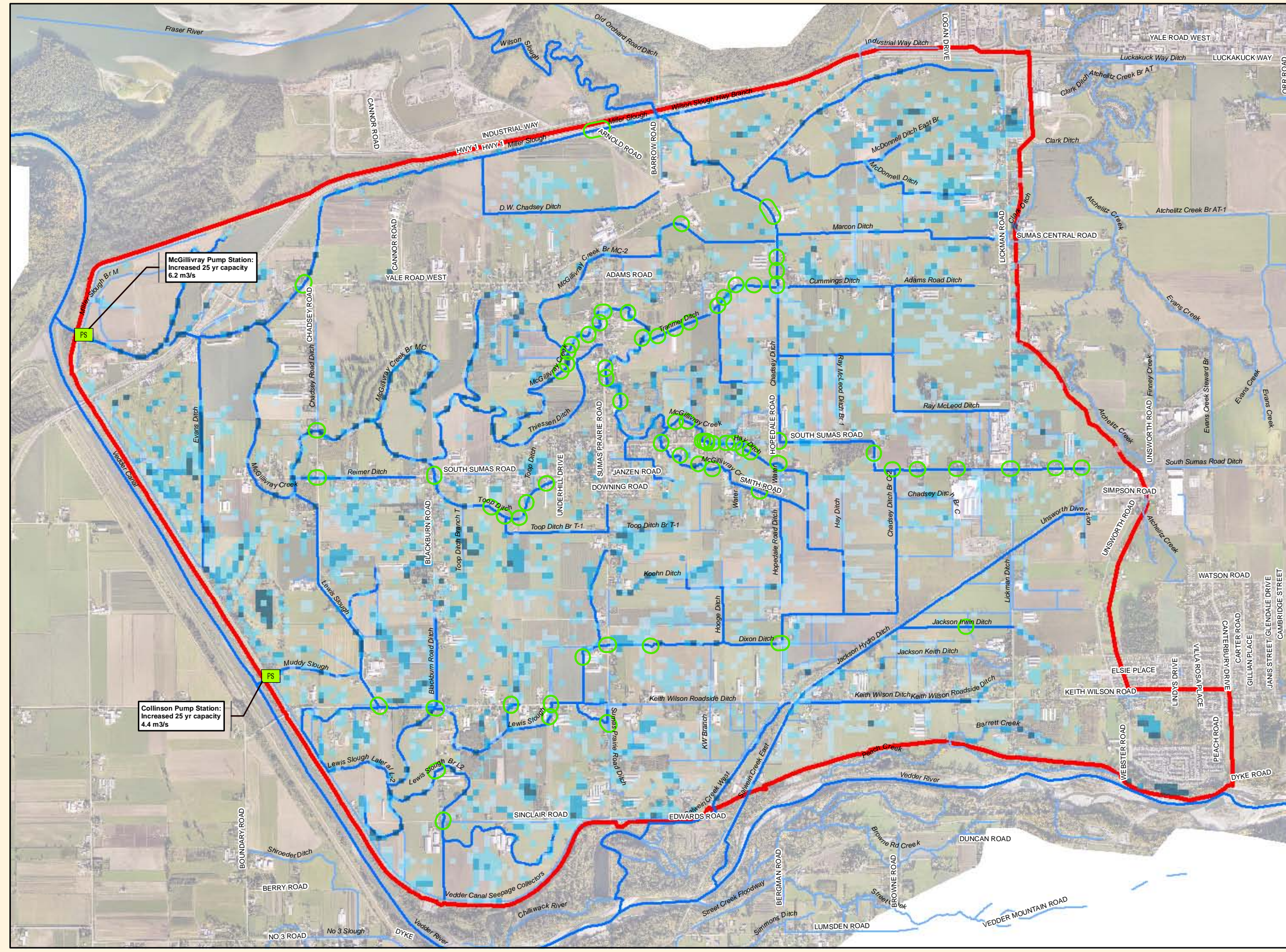
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

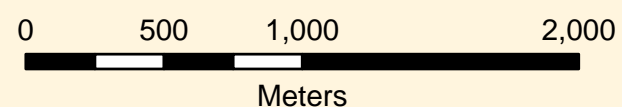
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 2
Performance:
25 Year

Figure 19.25



URBANSYSTEMS. THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.





City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

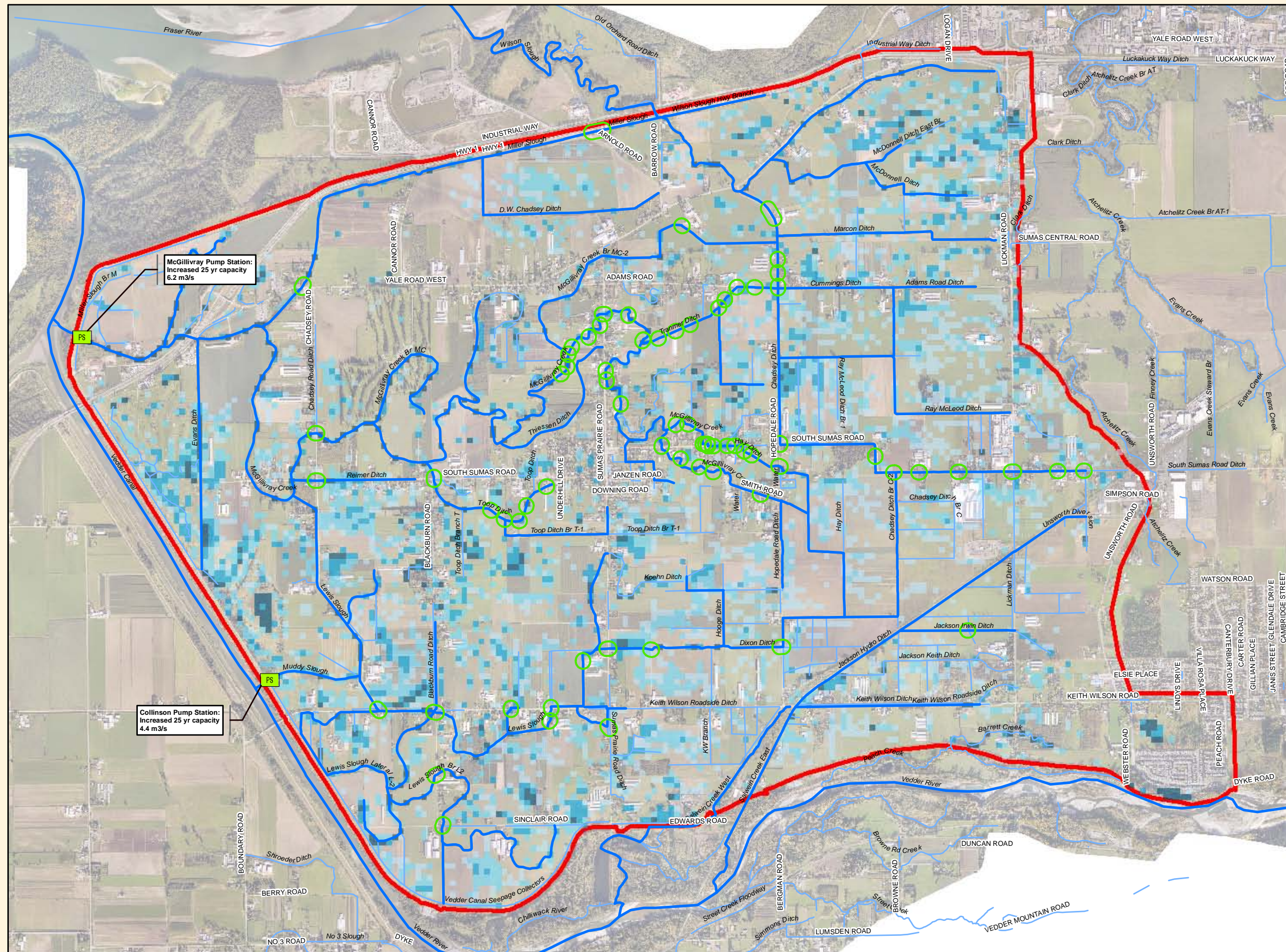
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

Note: Flooding depths less than 5cm not shown.

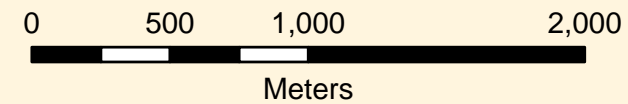
Greendale Flood Study
Option 2
Performance:
100 Year

Figure 19.100



URBANSYSTEMS

THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.





City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

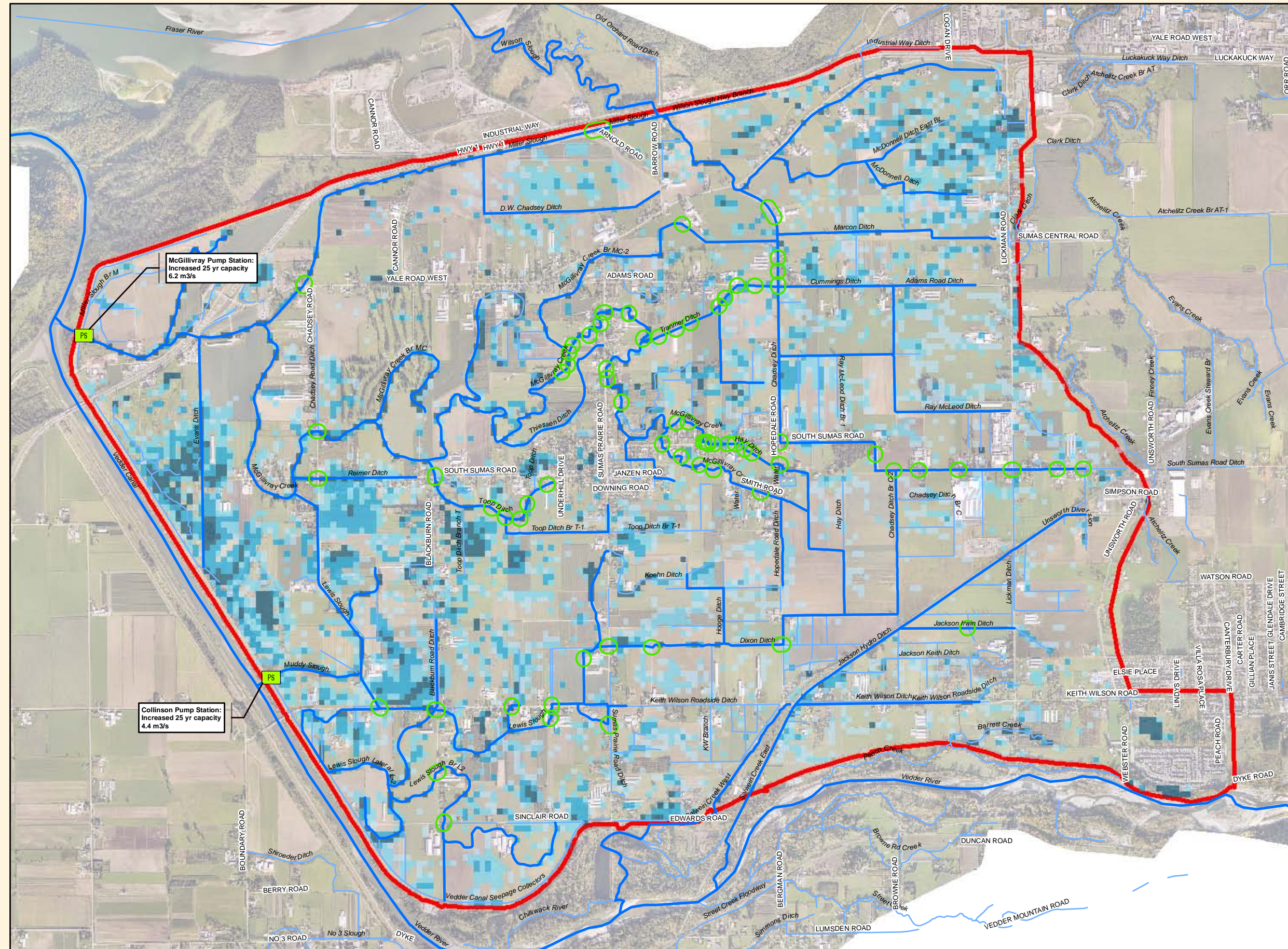
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

Note: Flooding depths less than 5cm not shown.

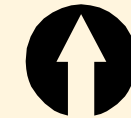
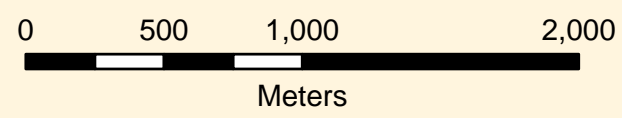
Greendale Flood Study
Option 2
Performance:
January Event

Figure 19. Jan



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THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.





City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

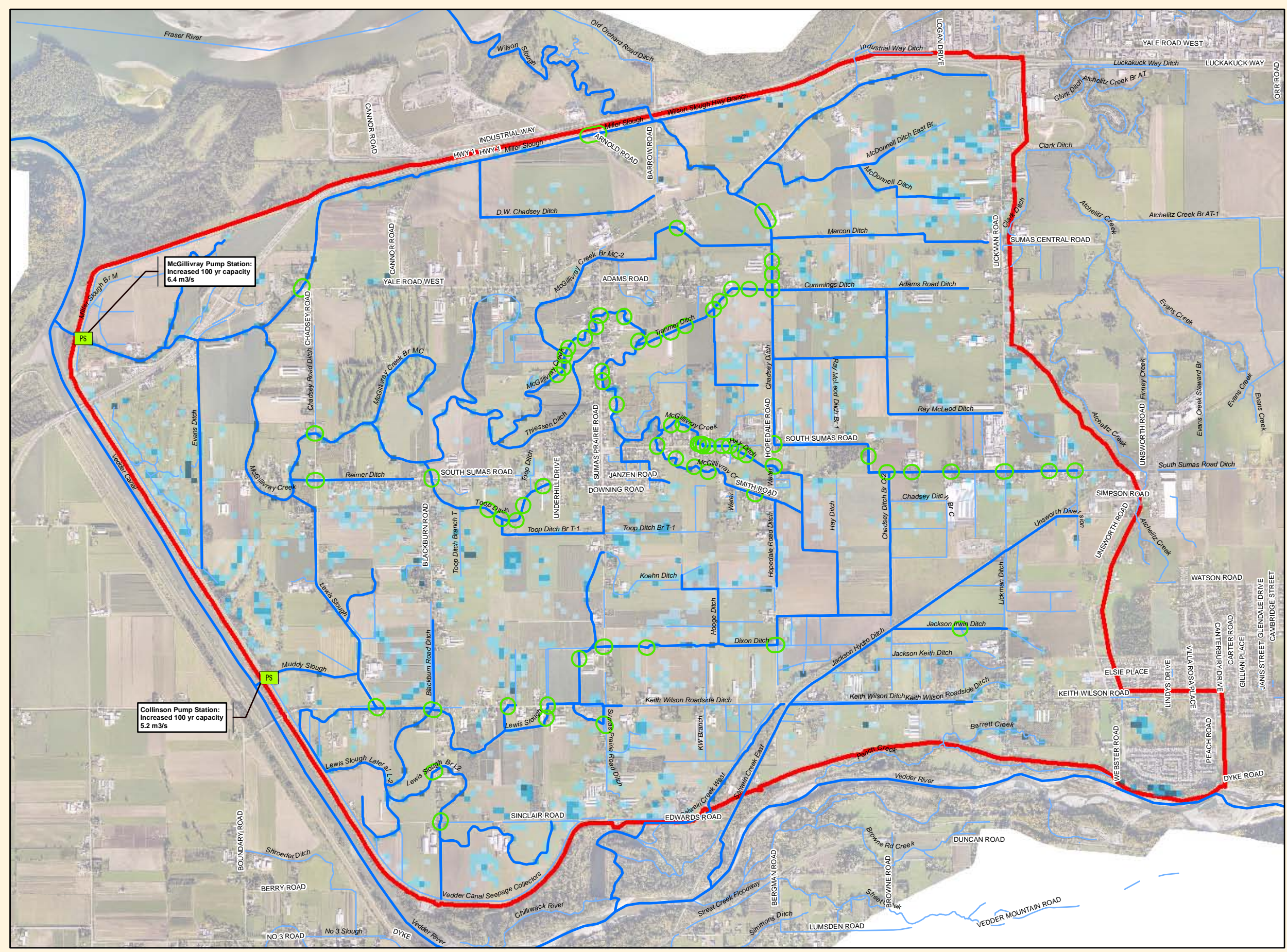
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

Note: Flooding depths less than 5cm not shown.

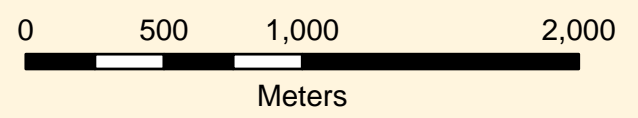
Greendale Flood Study Option 3 Performance: 10 Year

Figure 20.10



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City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

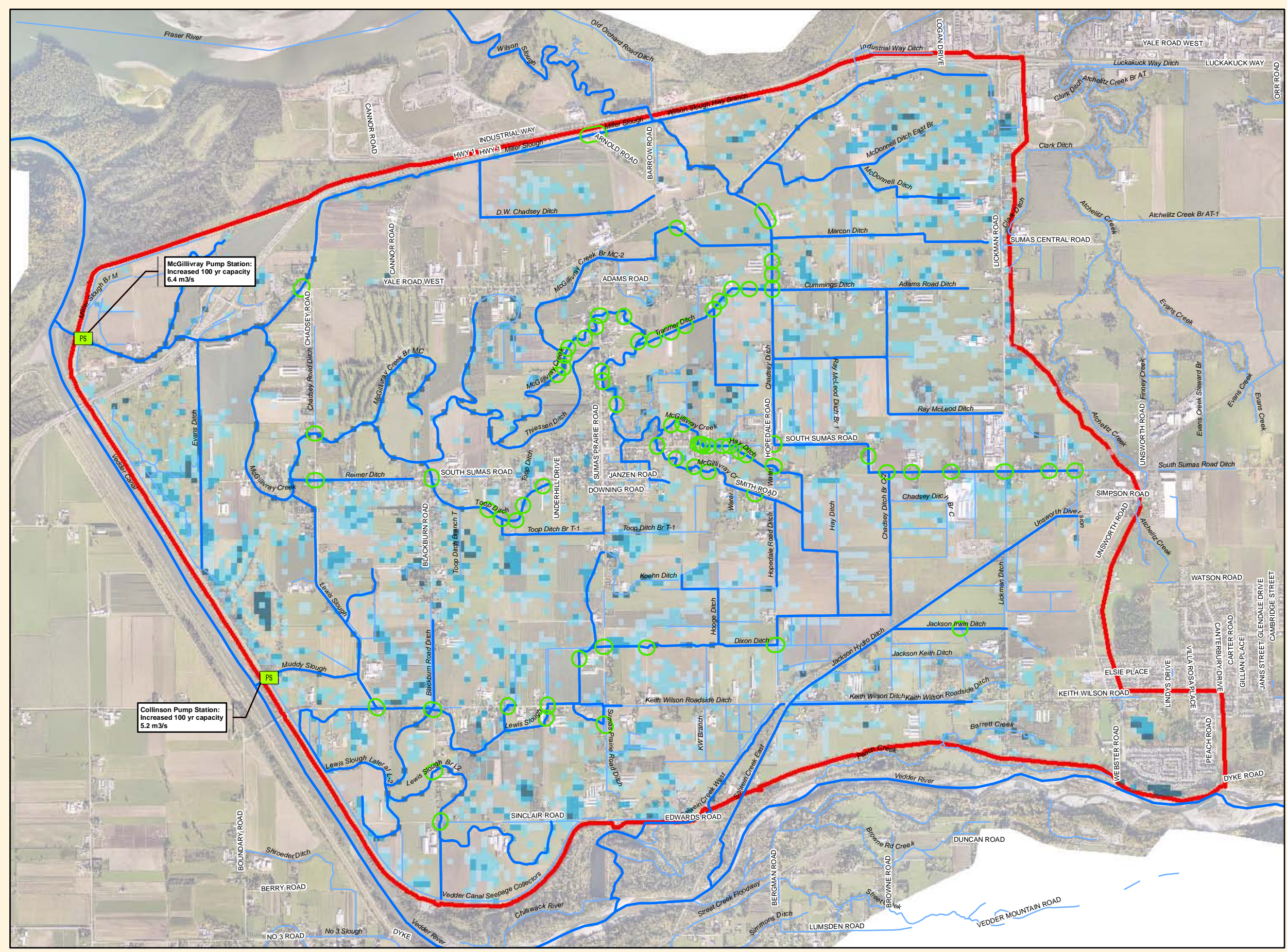
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

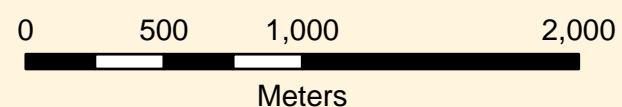
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 3
Performance:
25 Year

Figure 20.25



URBANSYSTEMS. THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.





City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

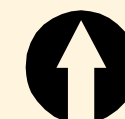
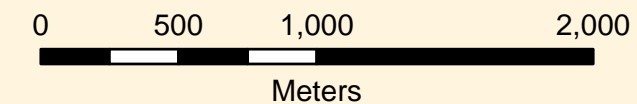
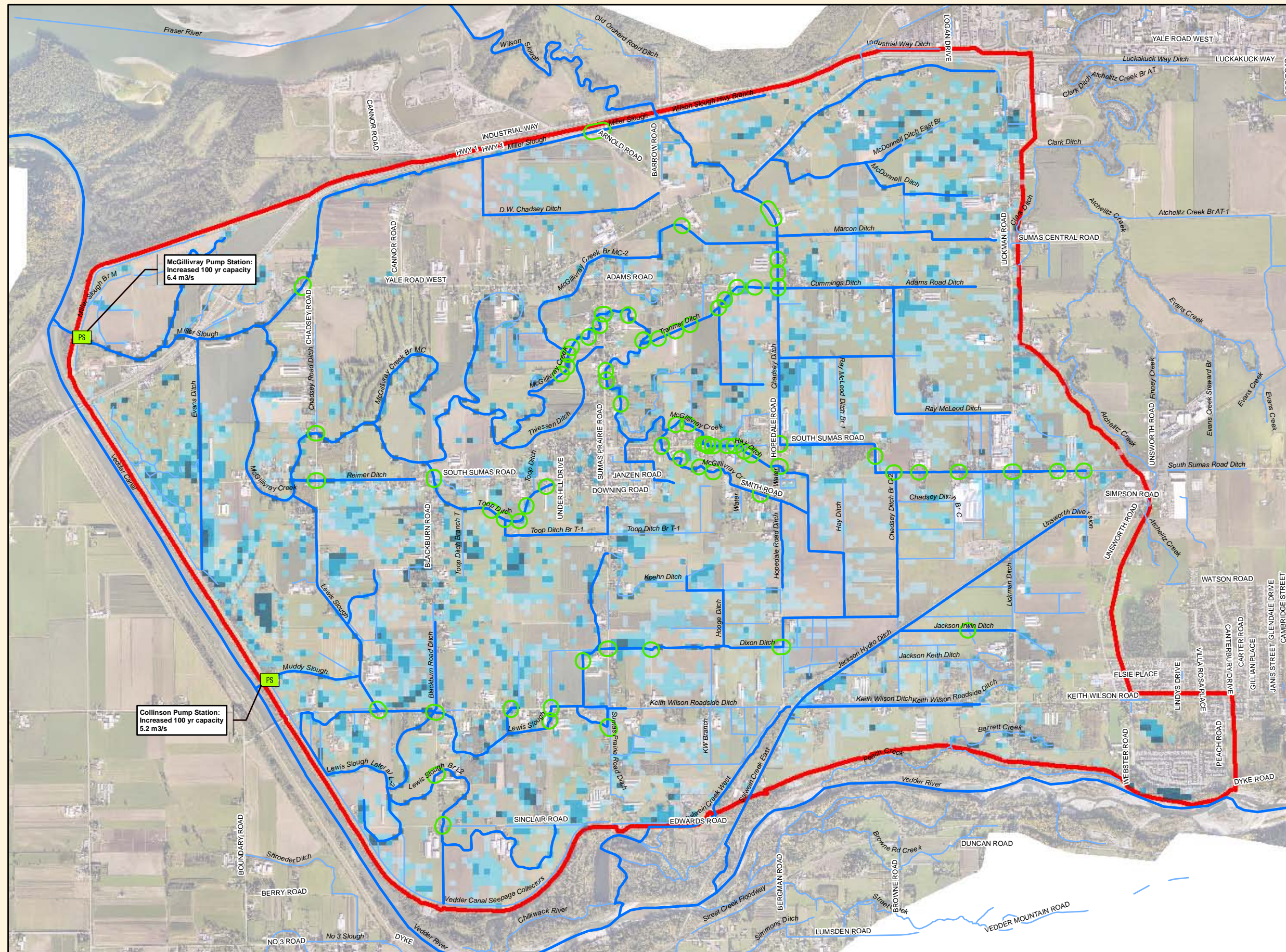
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 3
Performance:
100 Year

Figure 20.100



THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.



City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

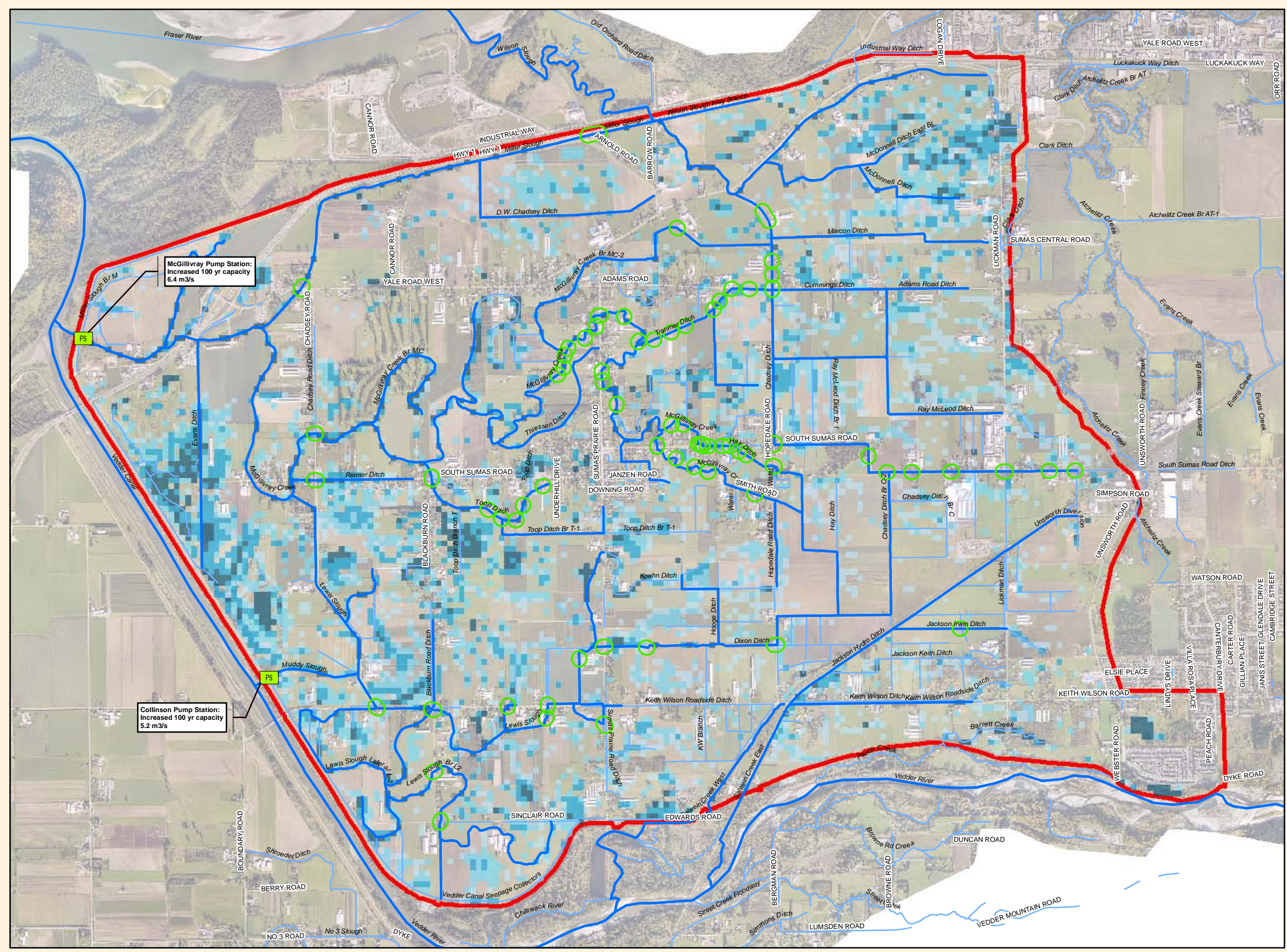
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

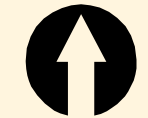
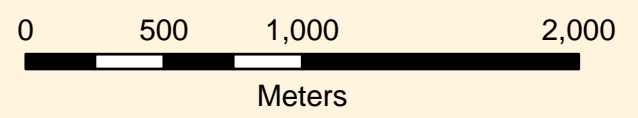
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 3
Performance:
January Event

Figure 20. Jan



URBANSYSTEMS. THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.





City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Added Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

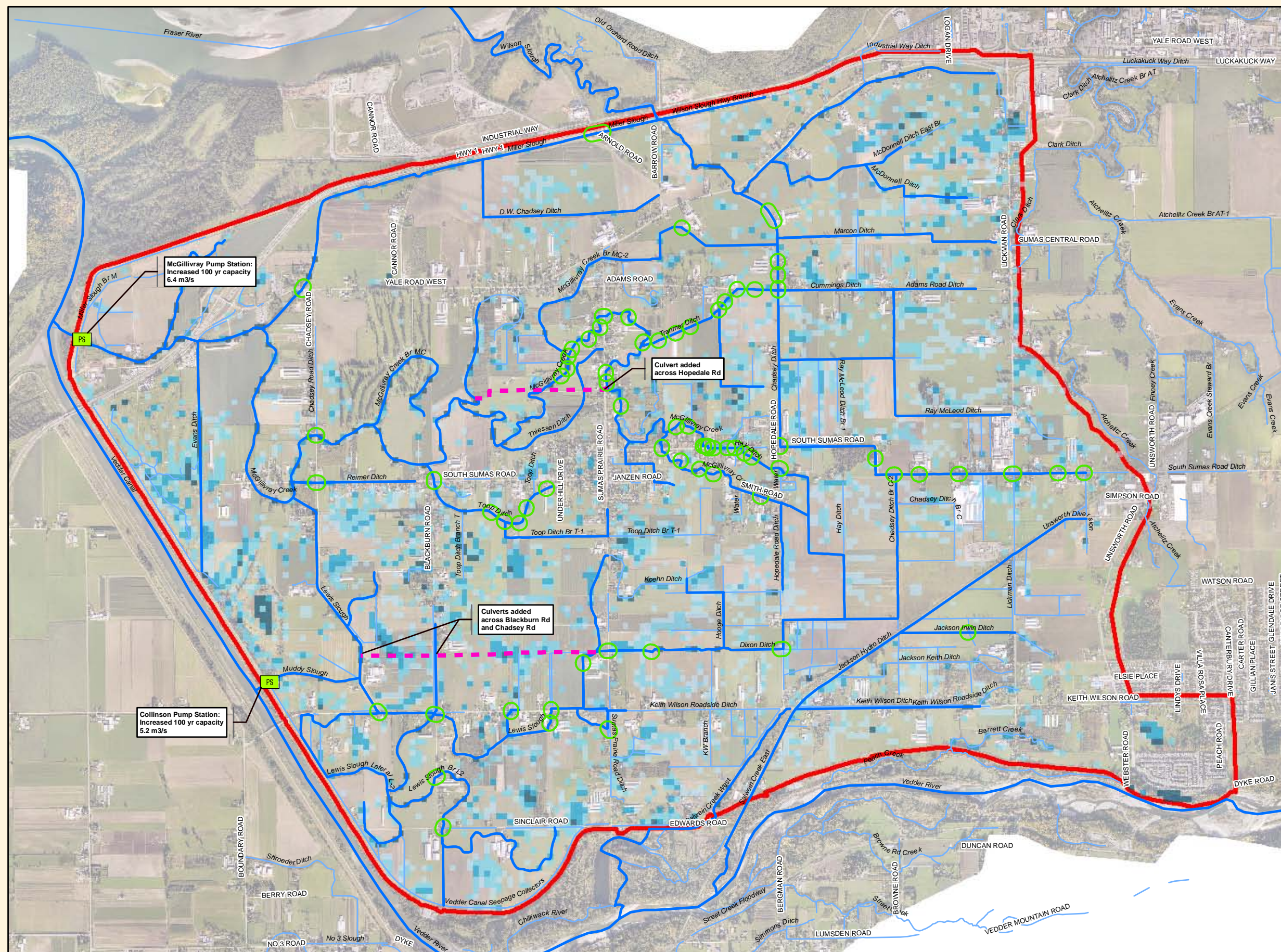
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

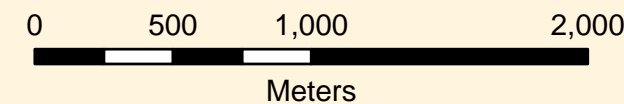
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 3B
Performance:
10 Year

Figure 21.10



URBANSYSTEMS
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City of Chilliwack

Legend

- Pump Station Upgrades
- Waterways
- Added Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

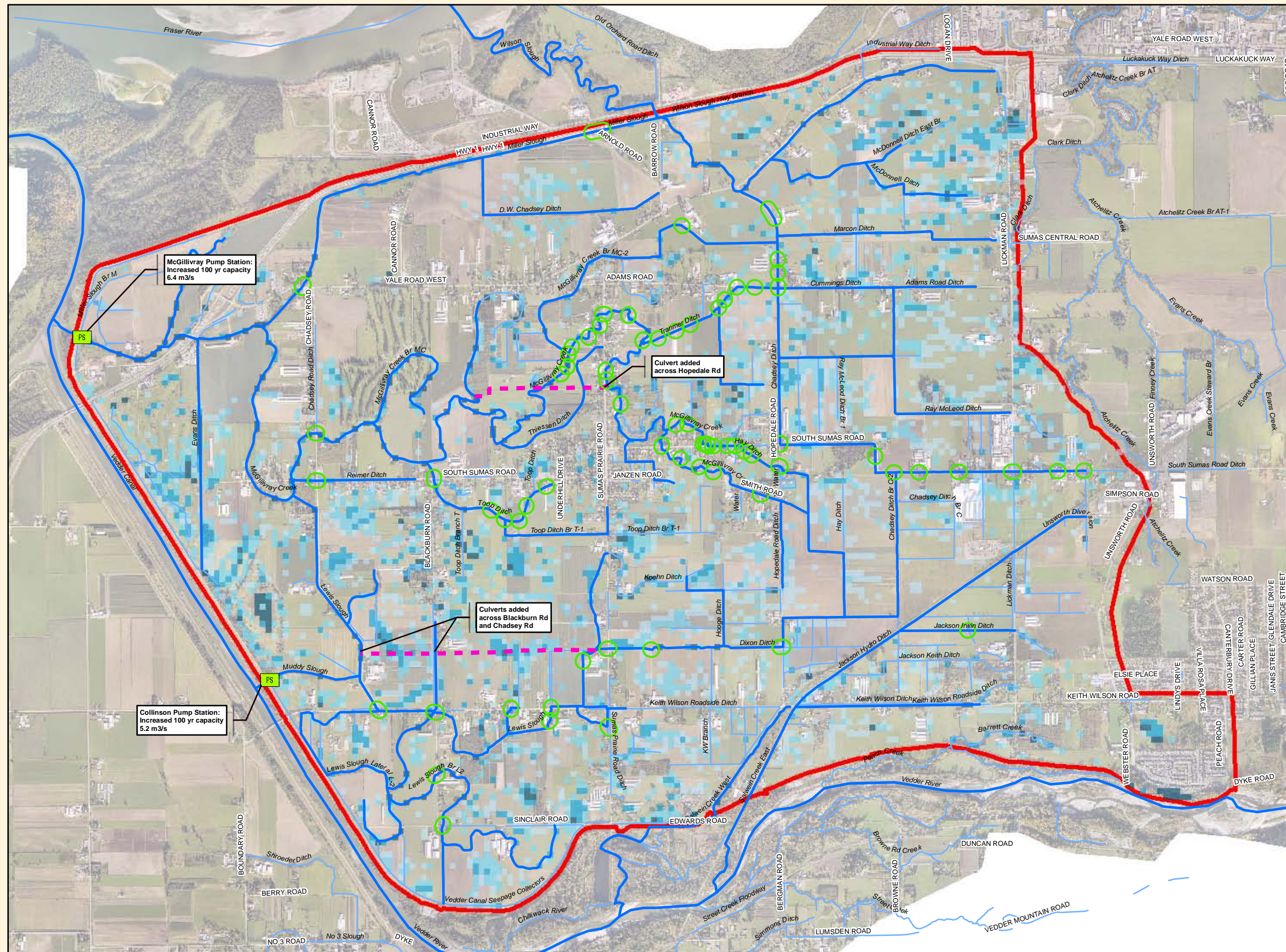
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

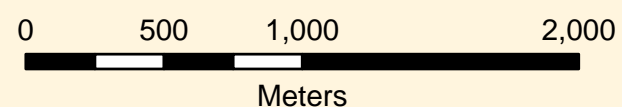
Note: Flooding depths less than 5cm not shown.

**Greendale Flood Study
Option 3B
Performance:
25 Year**

Figure 21.25



URBANSYSTEMS. THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.





City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Added Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

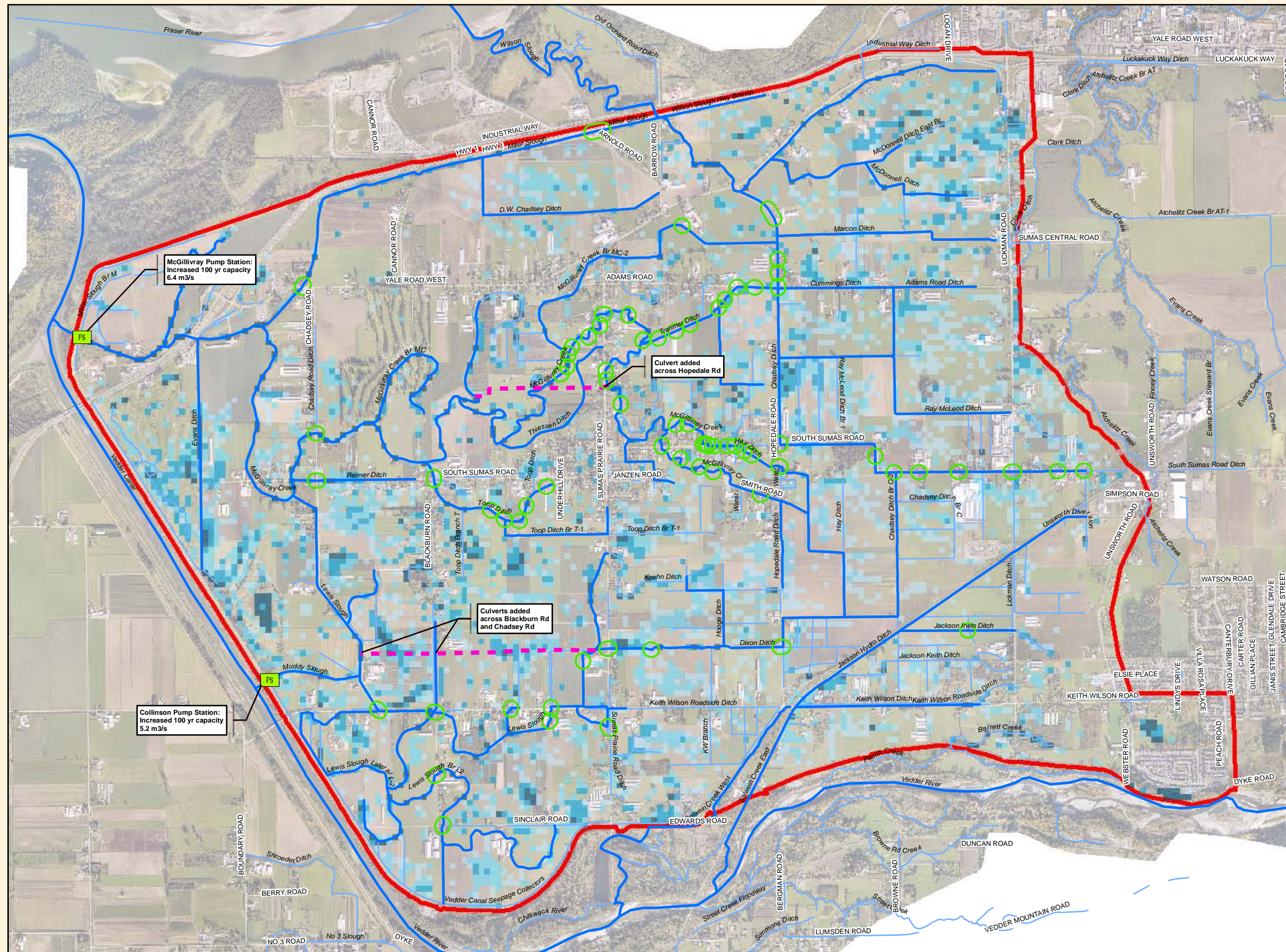
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

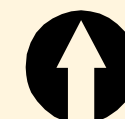
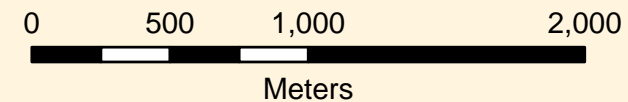
Note: Flooding depths less than 5cm not shown.

**Greendale Flood Study
Option 3B
Performance:
100 Year**

Figure 21.100



URBANSYSTEMS. THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.





City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Added Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

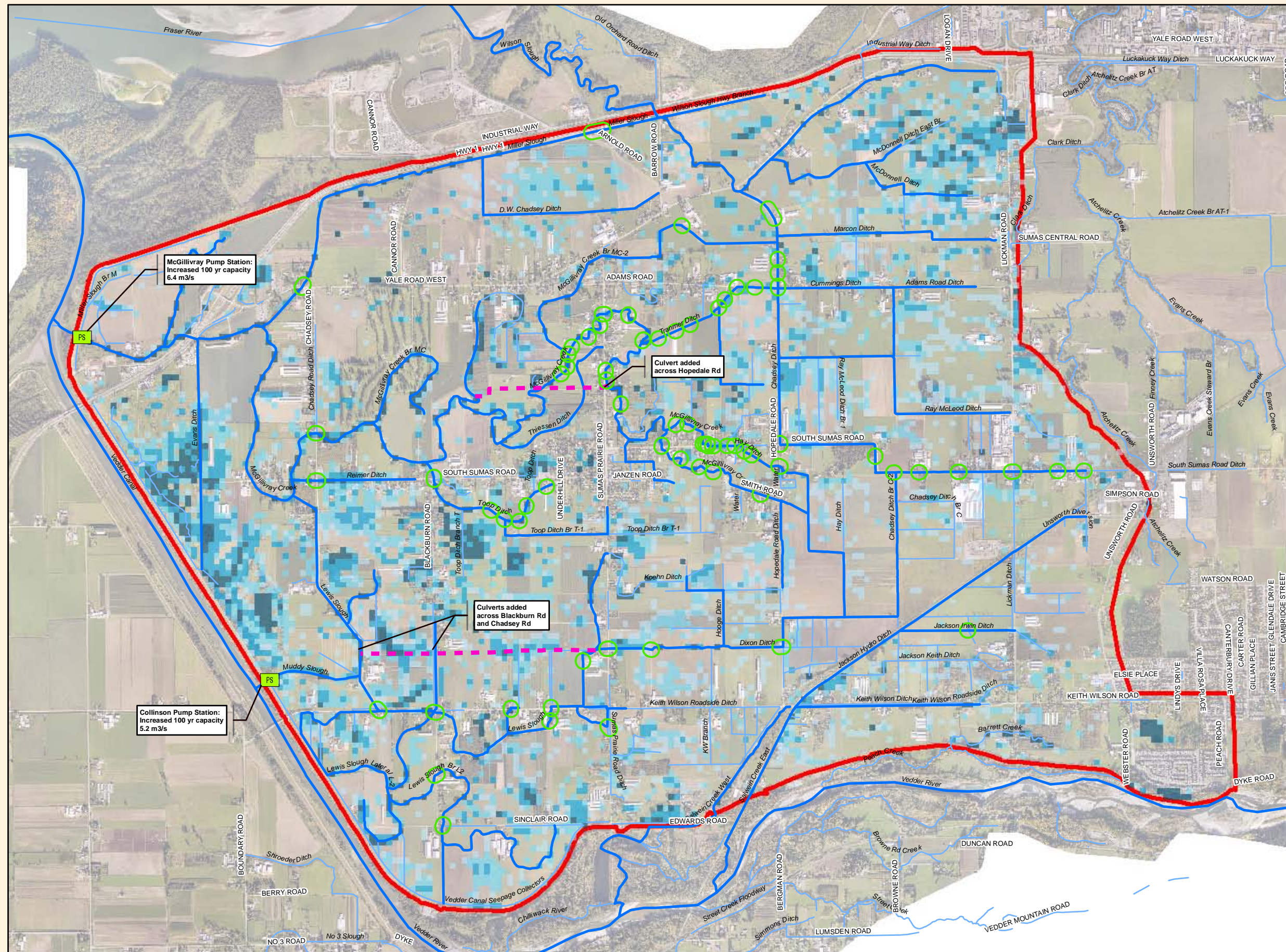
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

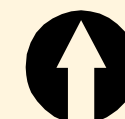
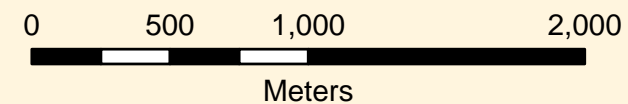
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 3B
Performance:
January Event

Figure 21. Jan

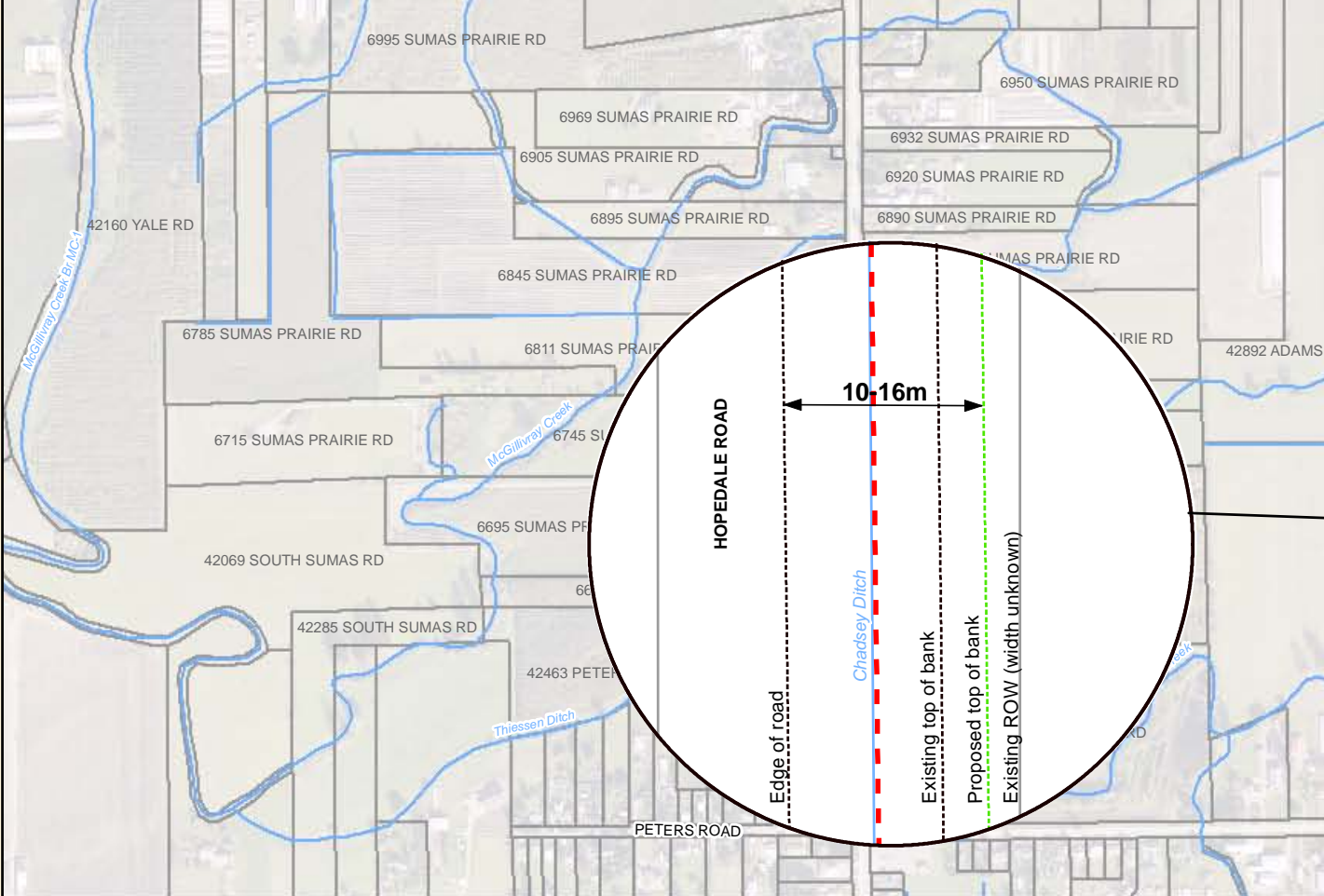
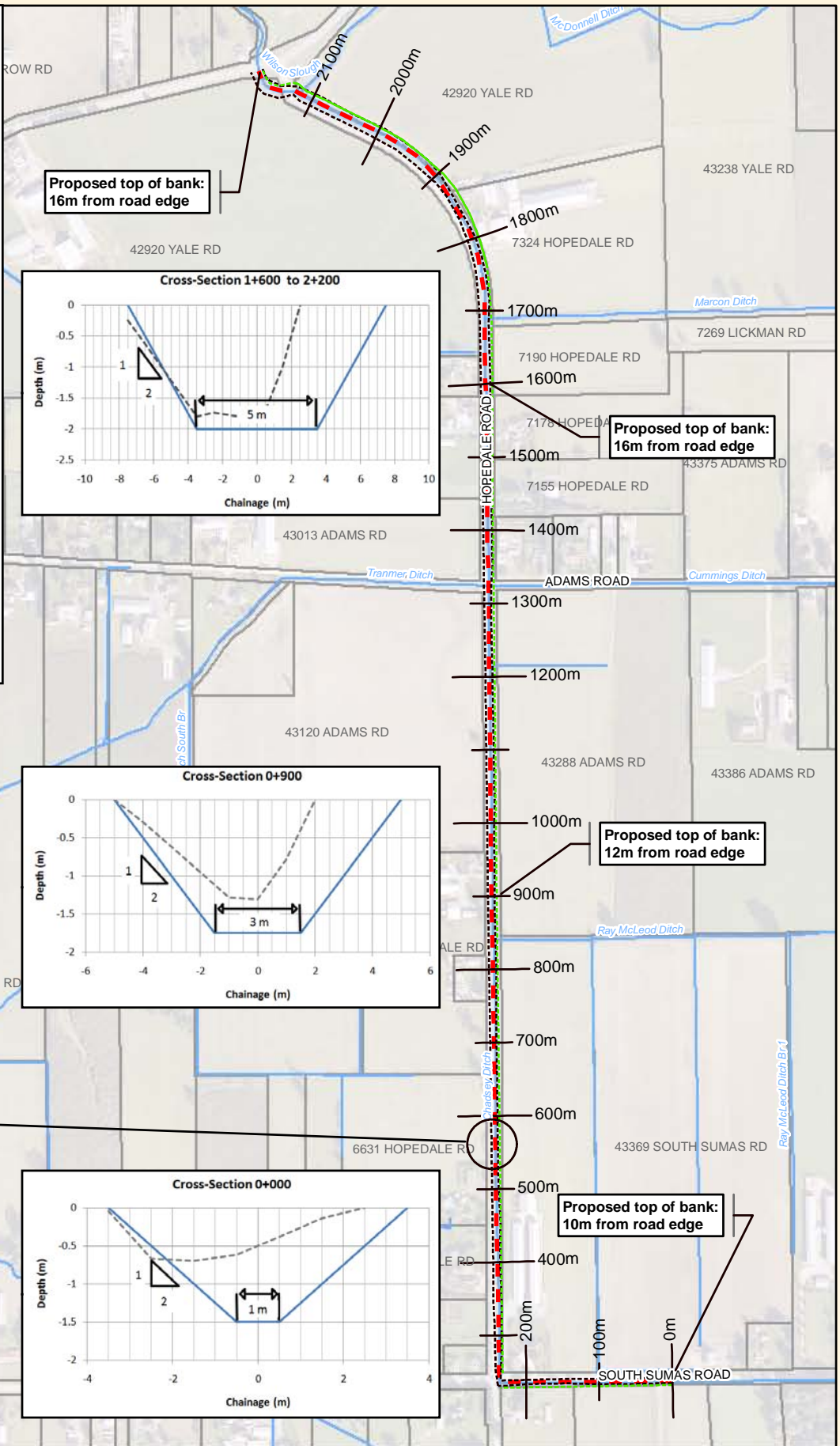
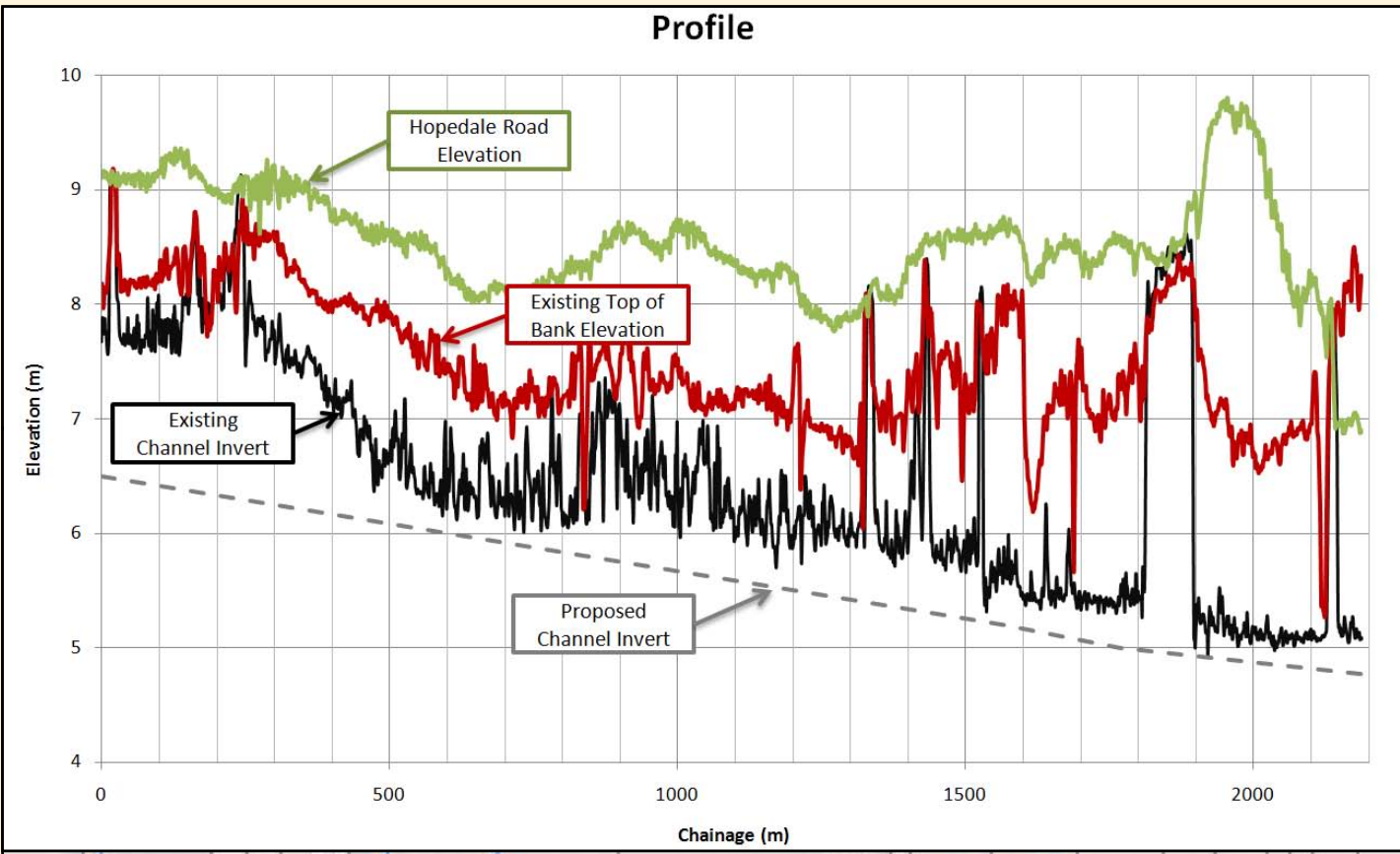


URBANSYSTEMS. THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.



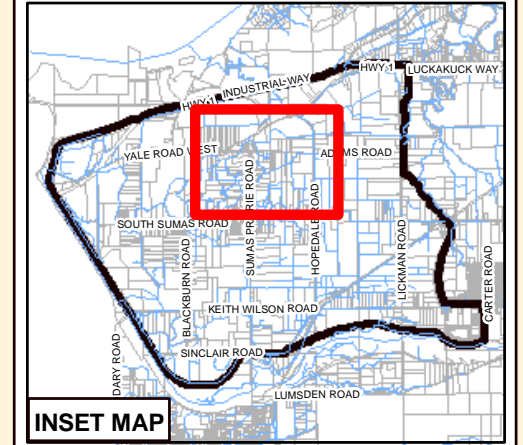


City of Chilliwack



- Legend**
- Proposed Channel Centerline
 - Proposed Top of Bank
 - Existing Top of Bank
 - Existing Waterway
 - Cadastral

The channel is shown conceptually at this stage. Its feasibility and cost will need to be proven through further investigation to resolve alignment discrepancies between topography and legal boundaries.



**Greendale Flood Study
Hopedale Road
Channel
(North Section)**

URBANSYSTEMS

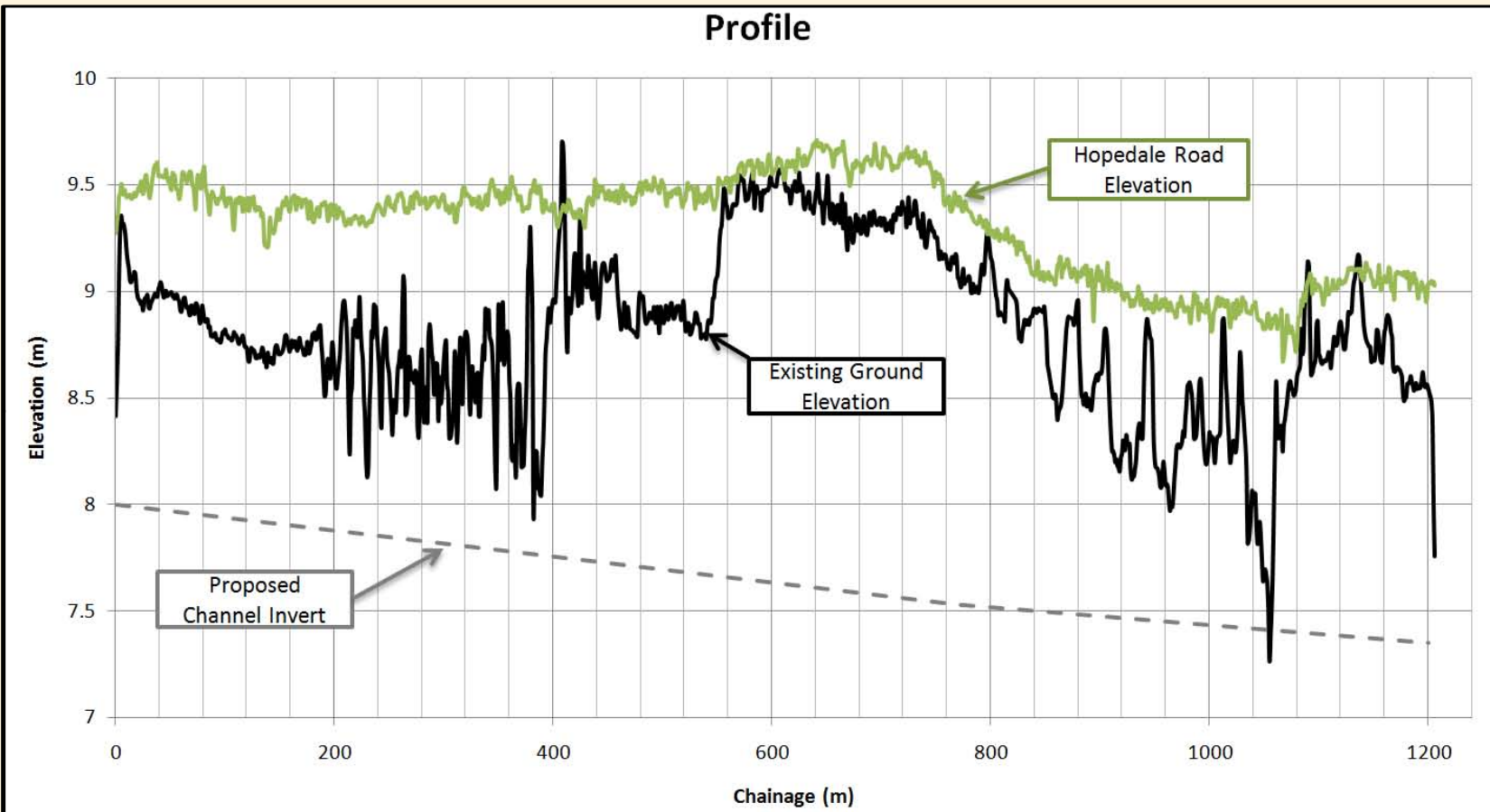
THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.



Figure 22

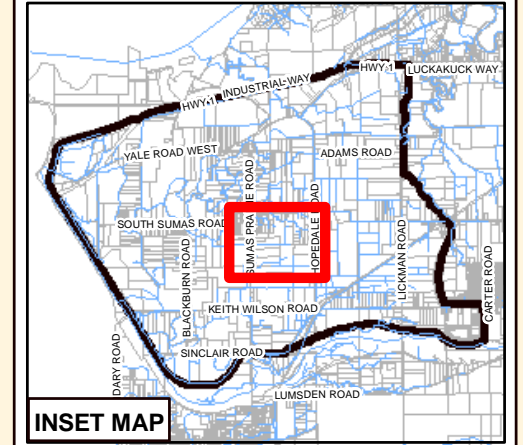
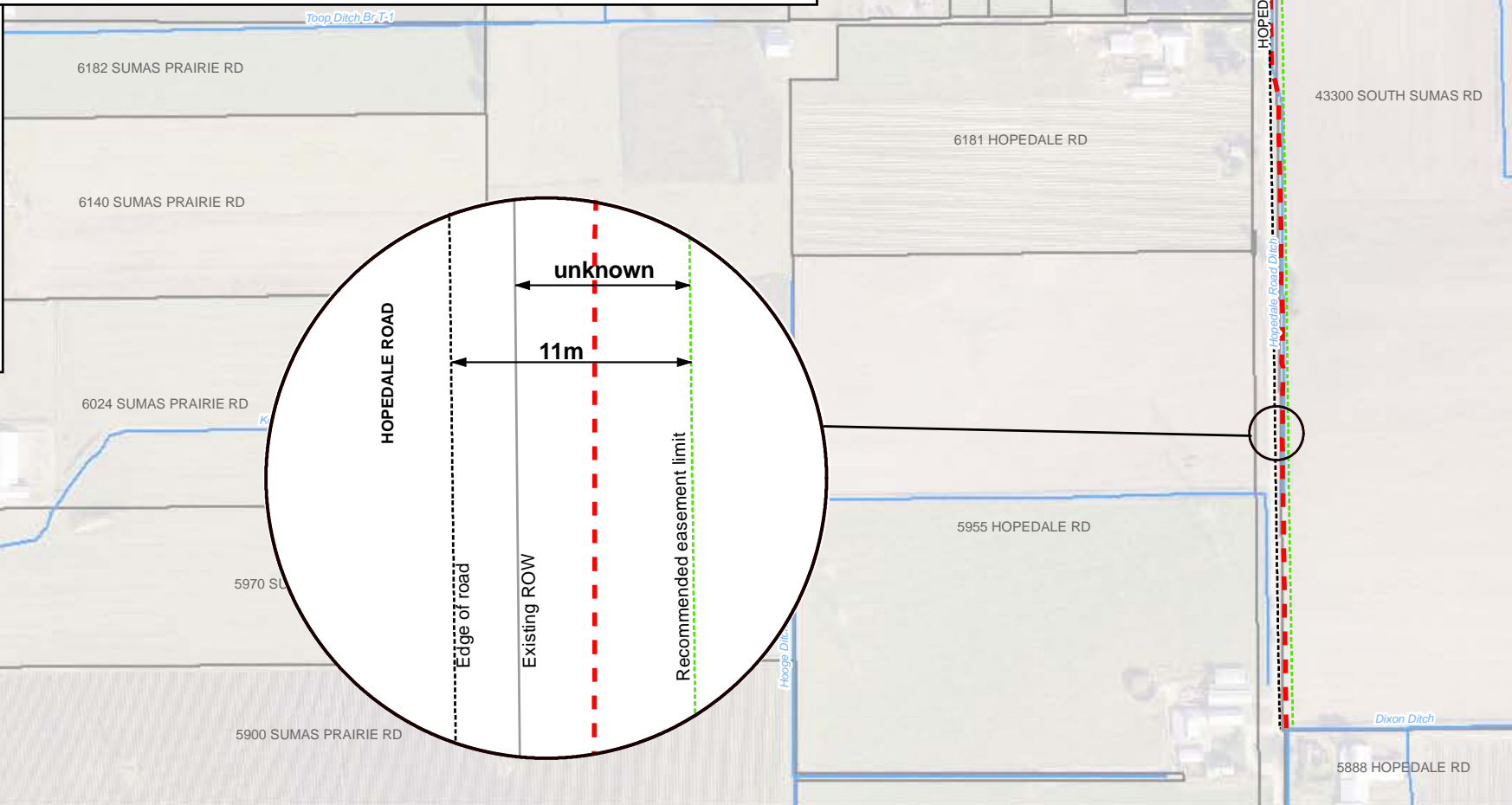
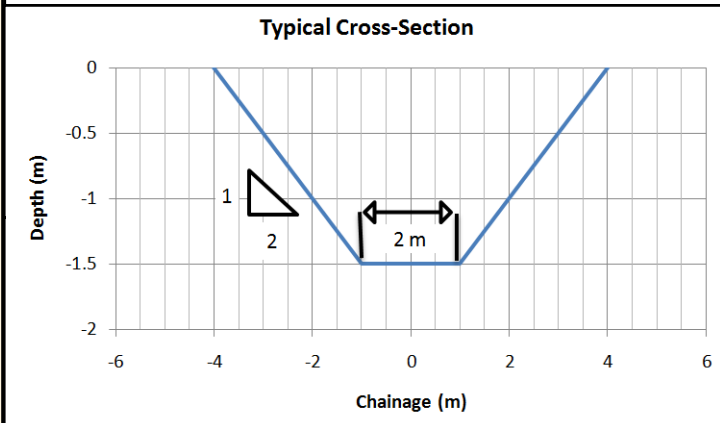


City of Chilliwack



- Legend**
- Proposed Channel Centerline (Red dashed line)
 - Proposed Top of Bank (Green dashed line)
 - Edge of Road (Black dashed line)
 - Existing Waterway (Blue line)
 - Cadastral (Grey outline)

The channel is shown conceptually at this stage. Its feasibility and cost will need to be proven through further investigation to resolve alignment discrepancies between topography and legal boundaries.



**Greendale Flood Study
Hopedale Road
Channel
(South Section)**

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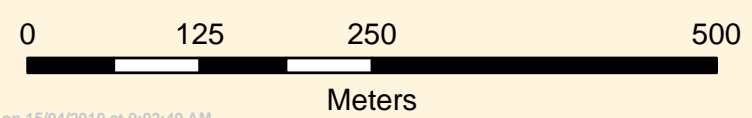


Figure 23



City of Chilliwack

Legend

- Pump Station Upgrades
- Waterways
- Added/Upgraded Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

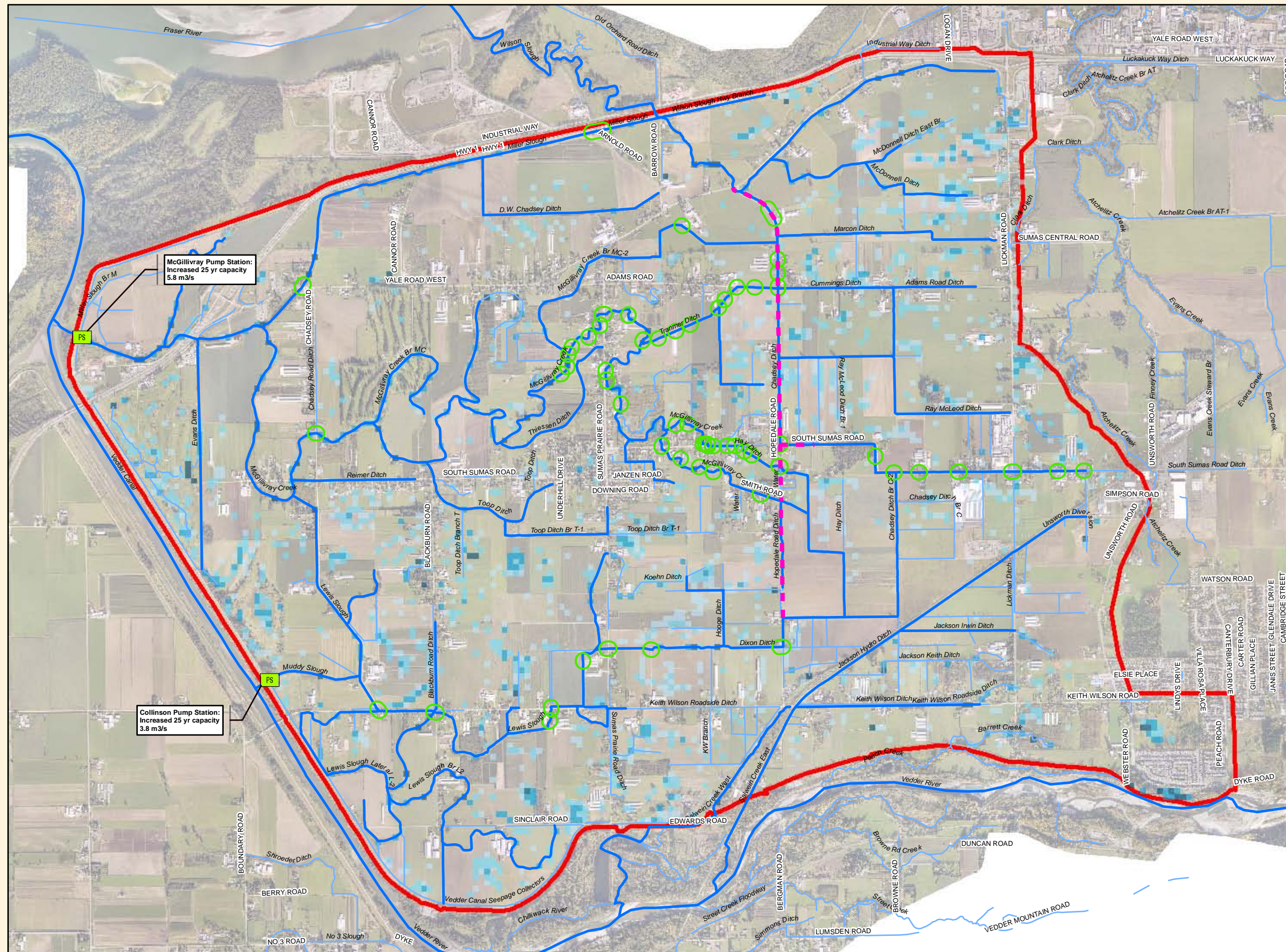
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

Note: Flooding depths less than 5cm not shown.

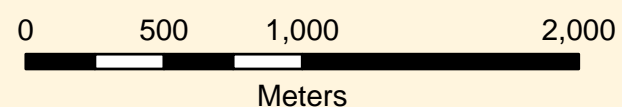
Greendale Flood Study
Option 4
Performance:
10 Year

Figure 24.10



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City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Added/Upgraded Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

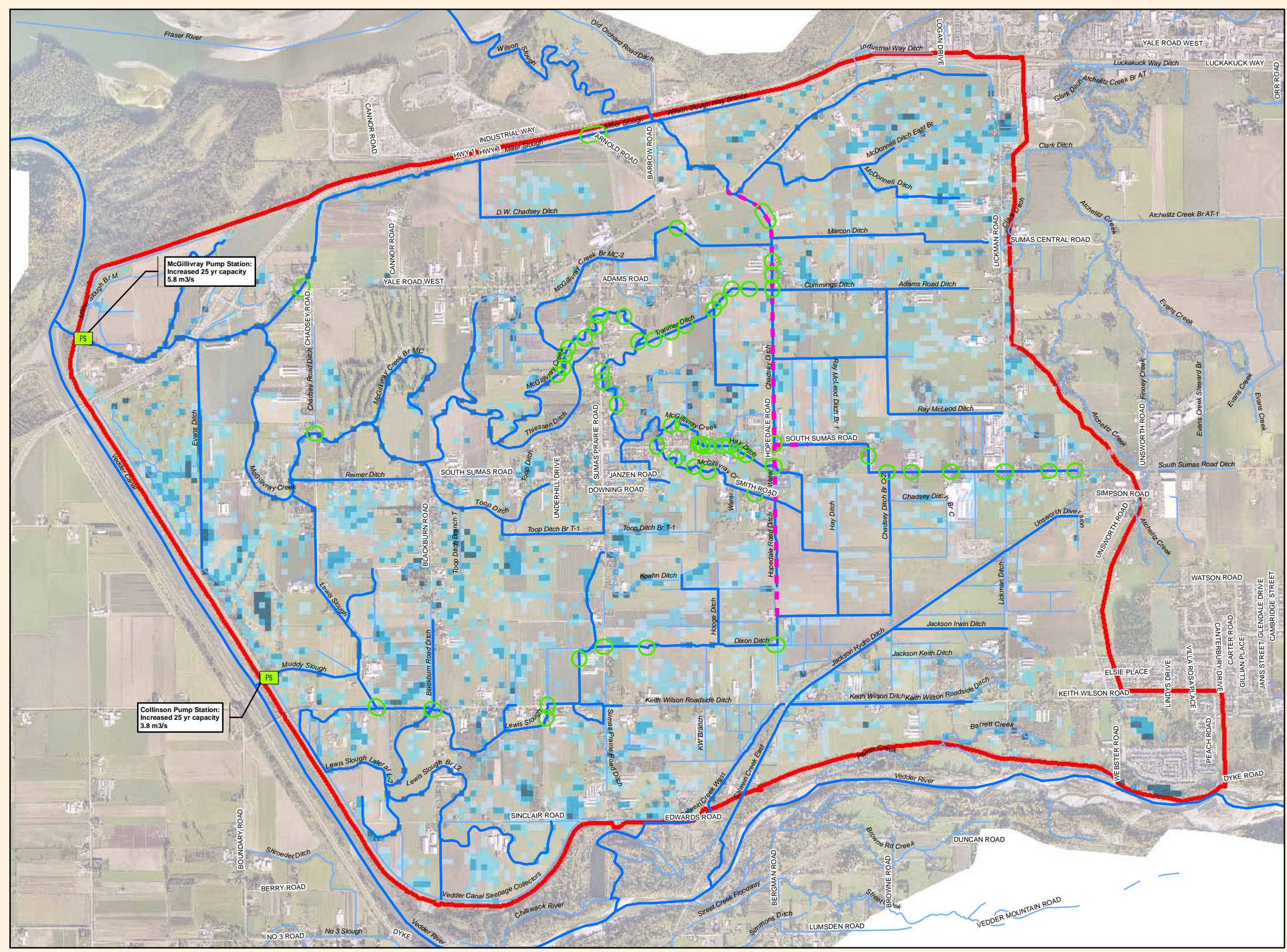
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

Note: Flooding depths less than 5cm not shown.

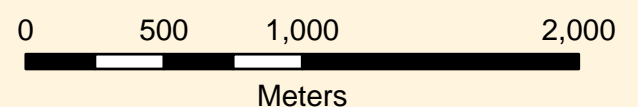
Greendale Flood Study Option 4 Performance: 25 Year

Figure 24.25



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City of Chilliwack

Legend

- Pump Station Upgrades
- Waterways
- Added/Upgraded Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

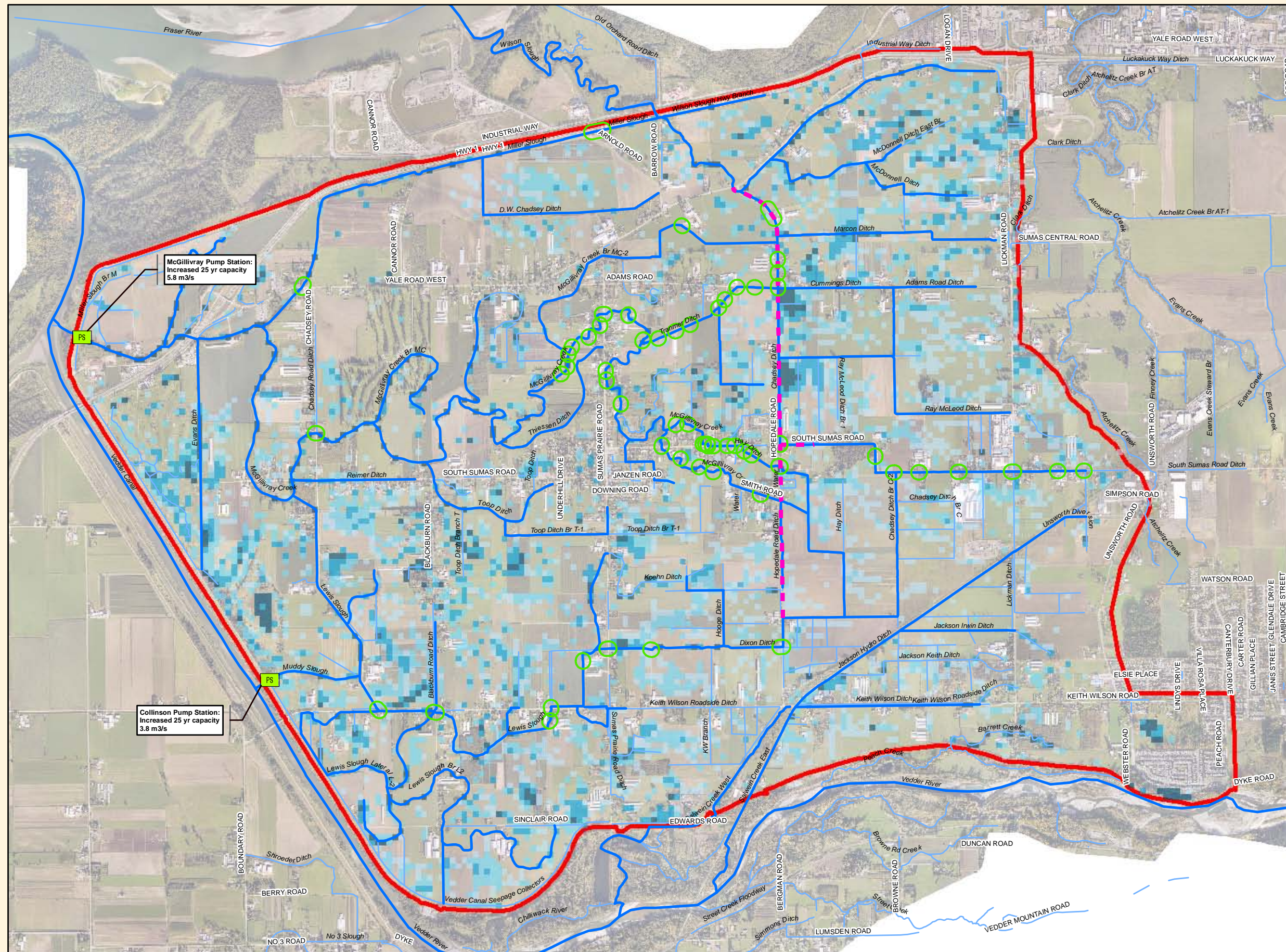
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

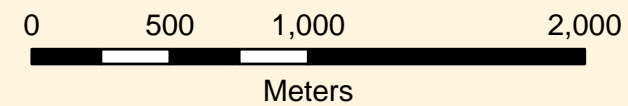
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 4
Performance:
100 Year

Figure 24.100



THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.





City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Added/Upgraded Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

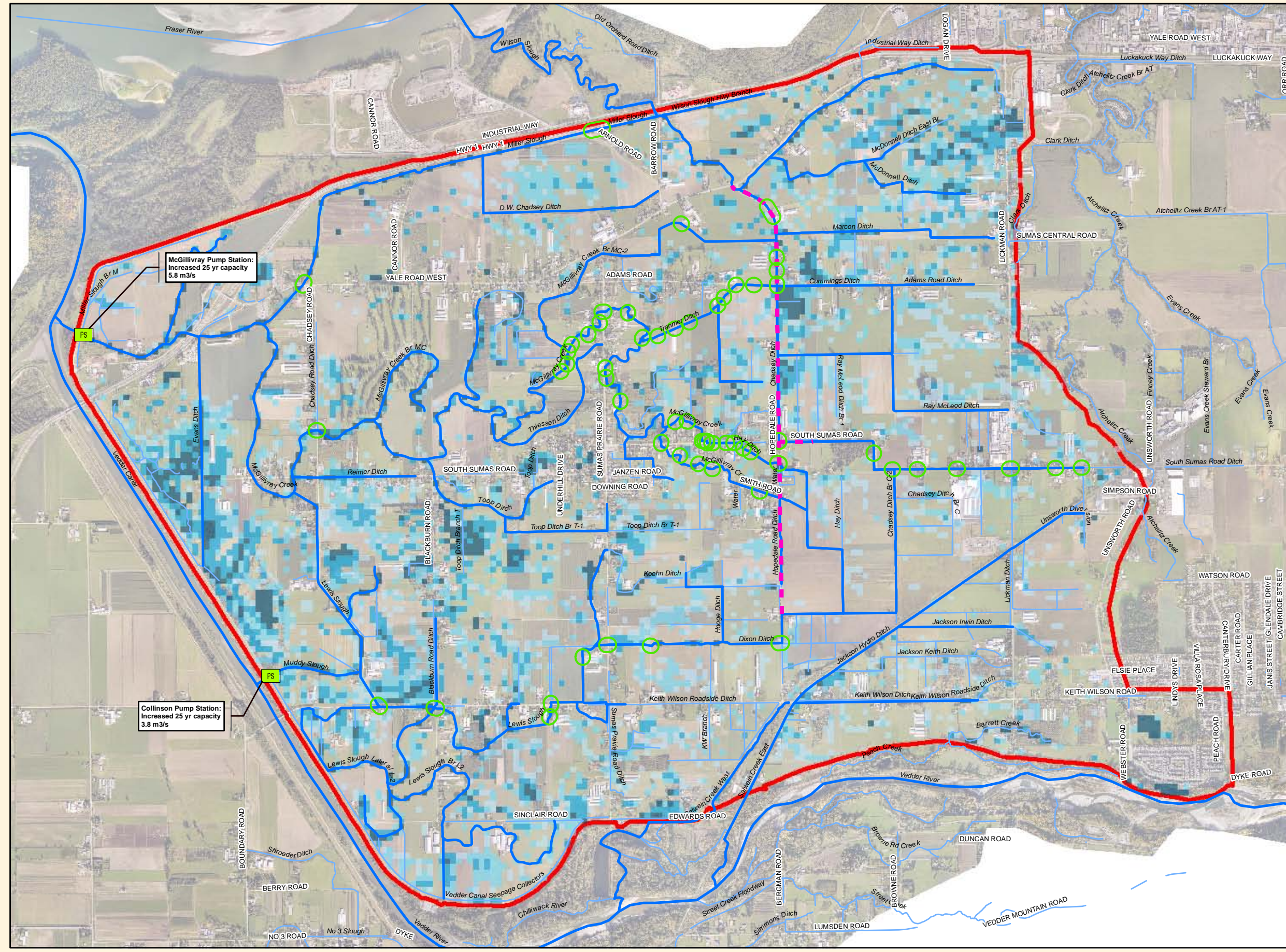
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

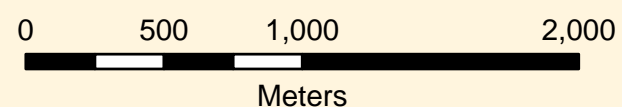
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 4
Performance:
January Event

Figure 24. Jan



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City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Added/Upgraded Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

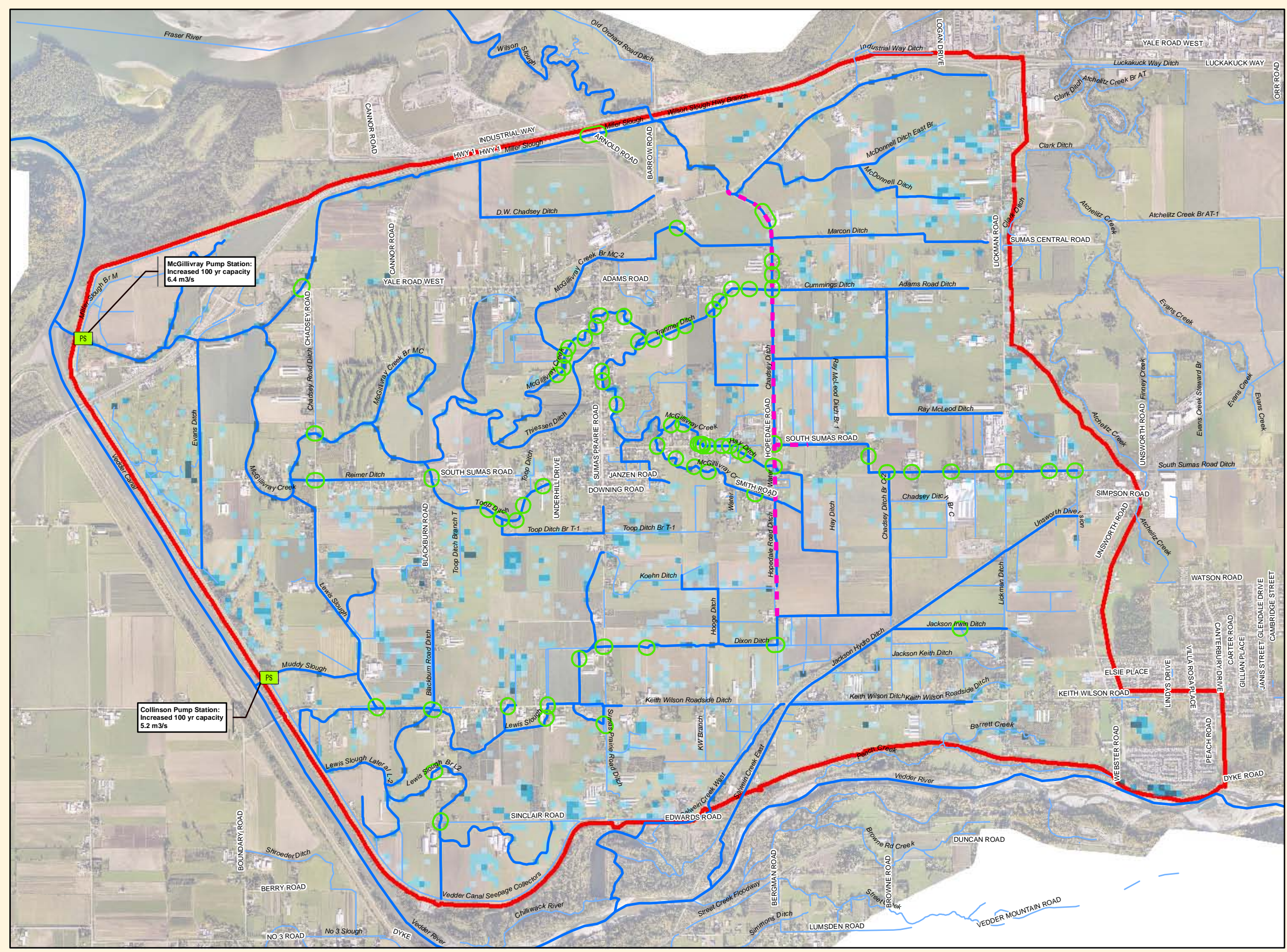
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

Note: Flooding depths less than 5cm not shown.

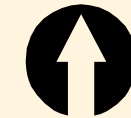
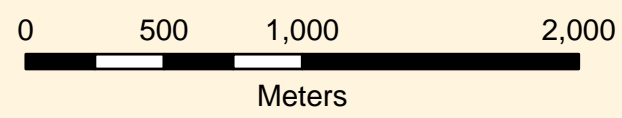
Greendale Flood Study
Option 5
Performance:
10 Year

Figure 25.10



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City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Added/Upgraded Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

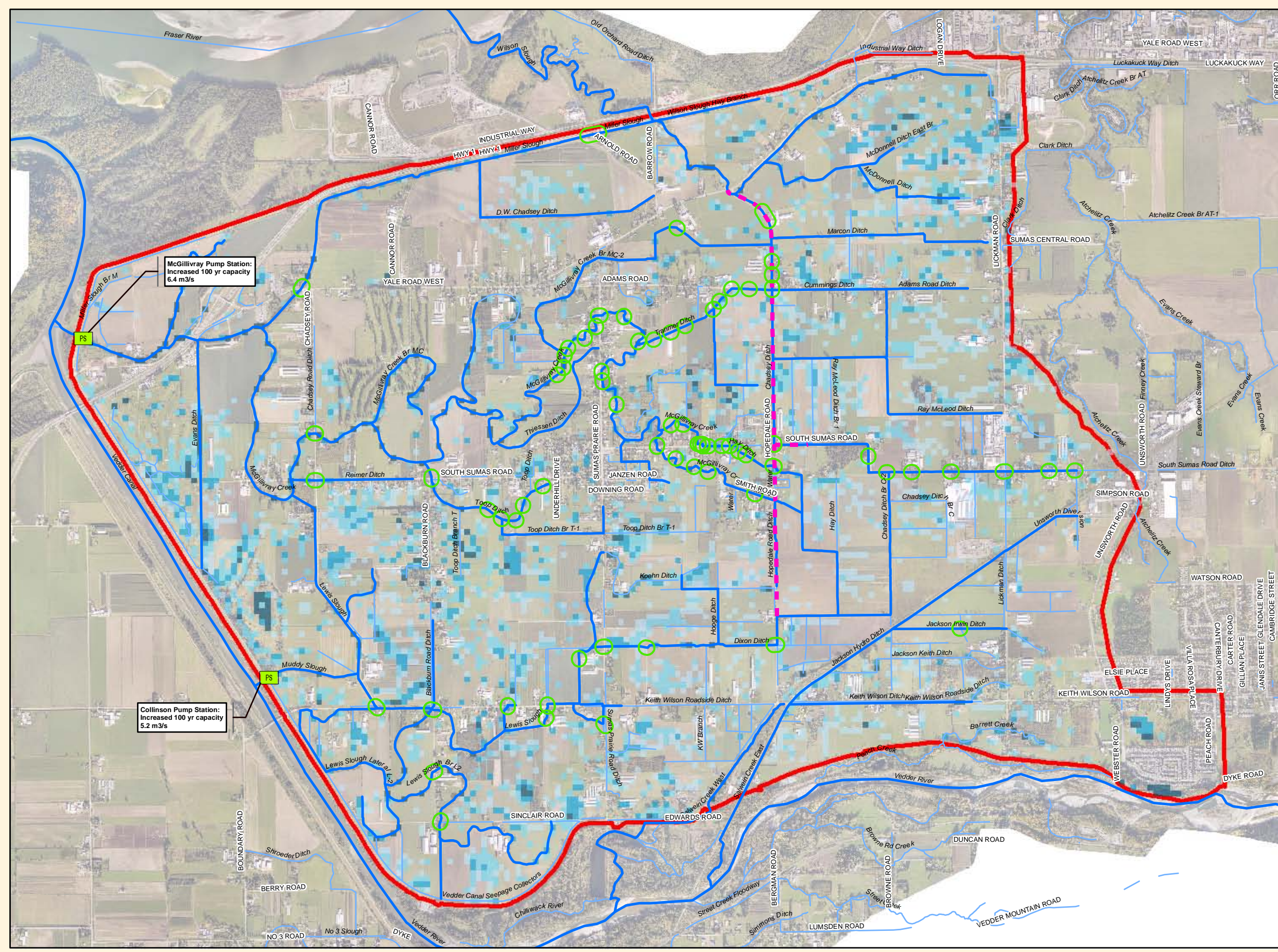
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

Note: Flooding depths less than 5cm not shown.

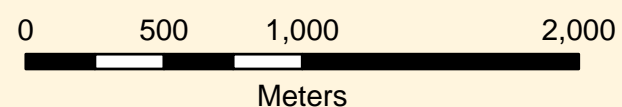
Greendale Flood Study
Option 5
Performance:
25 Year

Figure 25.25



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City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Added/Upgraded Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

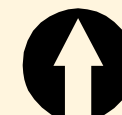
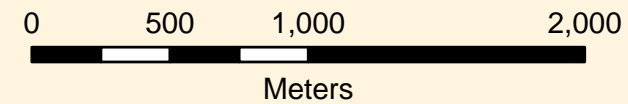
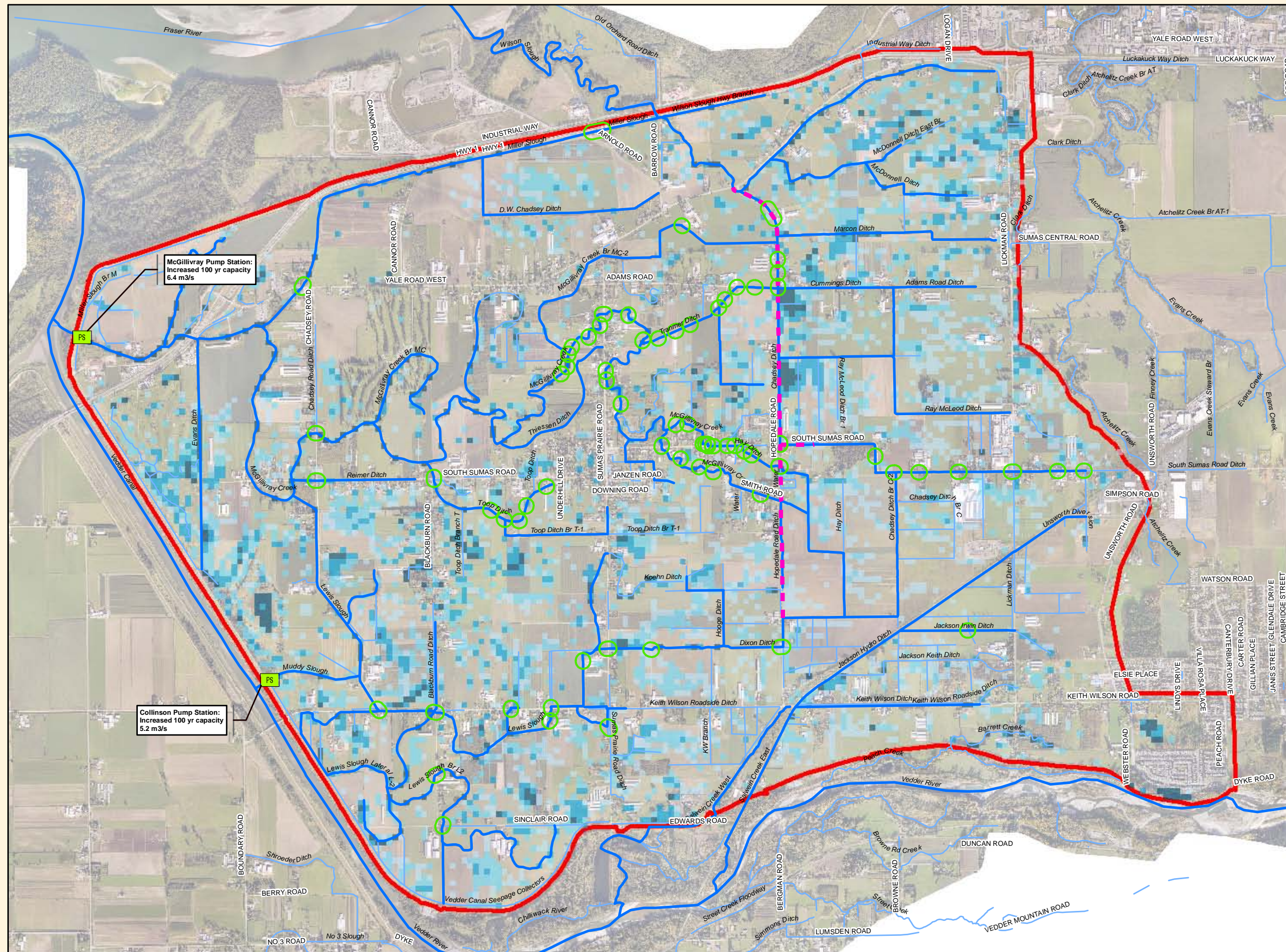
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 5
Performance:
100 Year

Figure 25.100



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City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Added/Upgraded Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

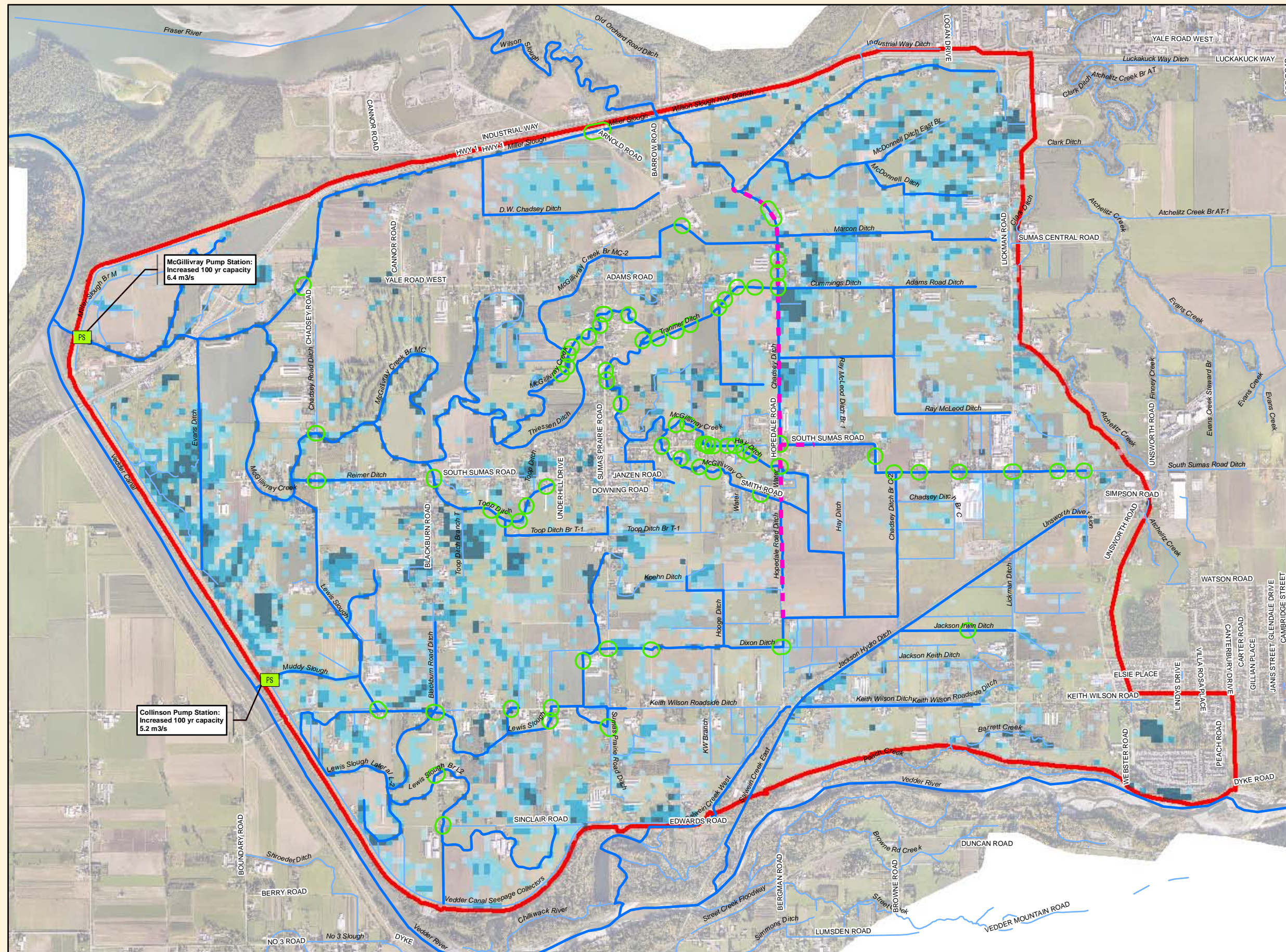
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

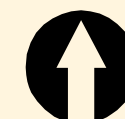
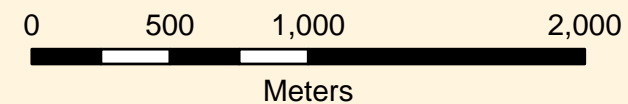
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 5
Performance:
January Event

Figure 25. Jan



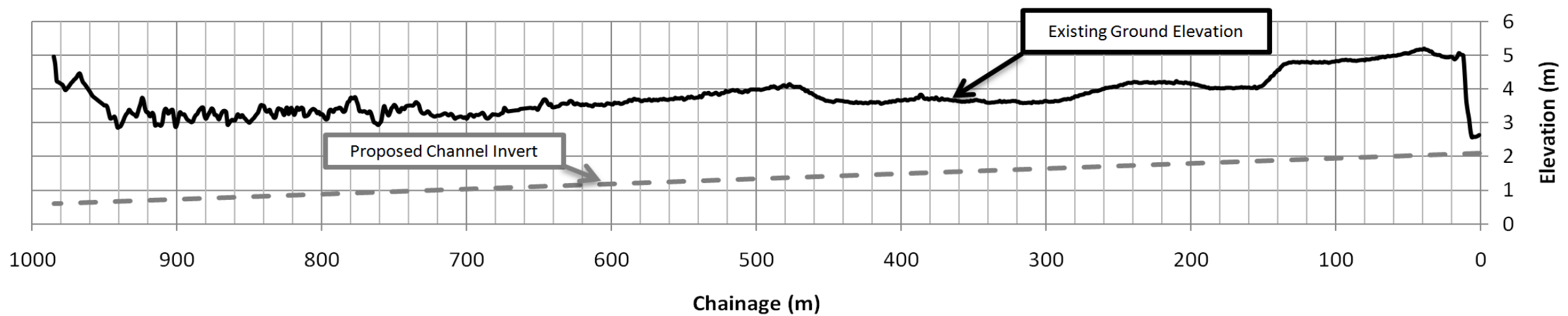
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City of Chilliwack

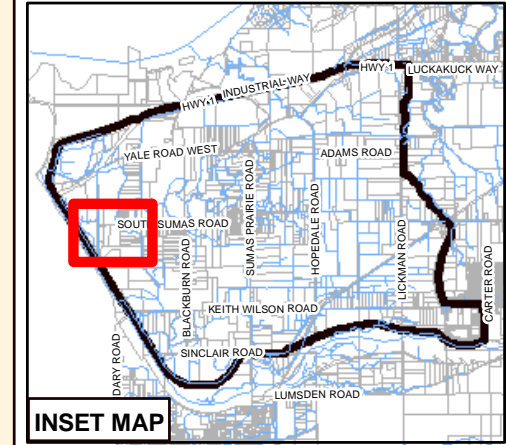
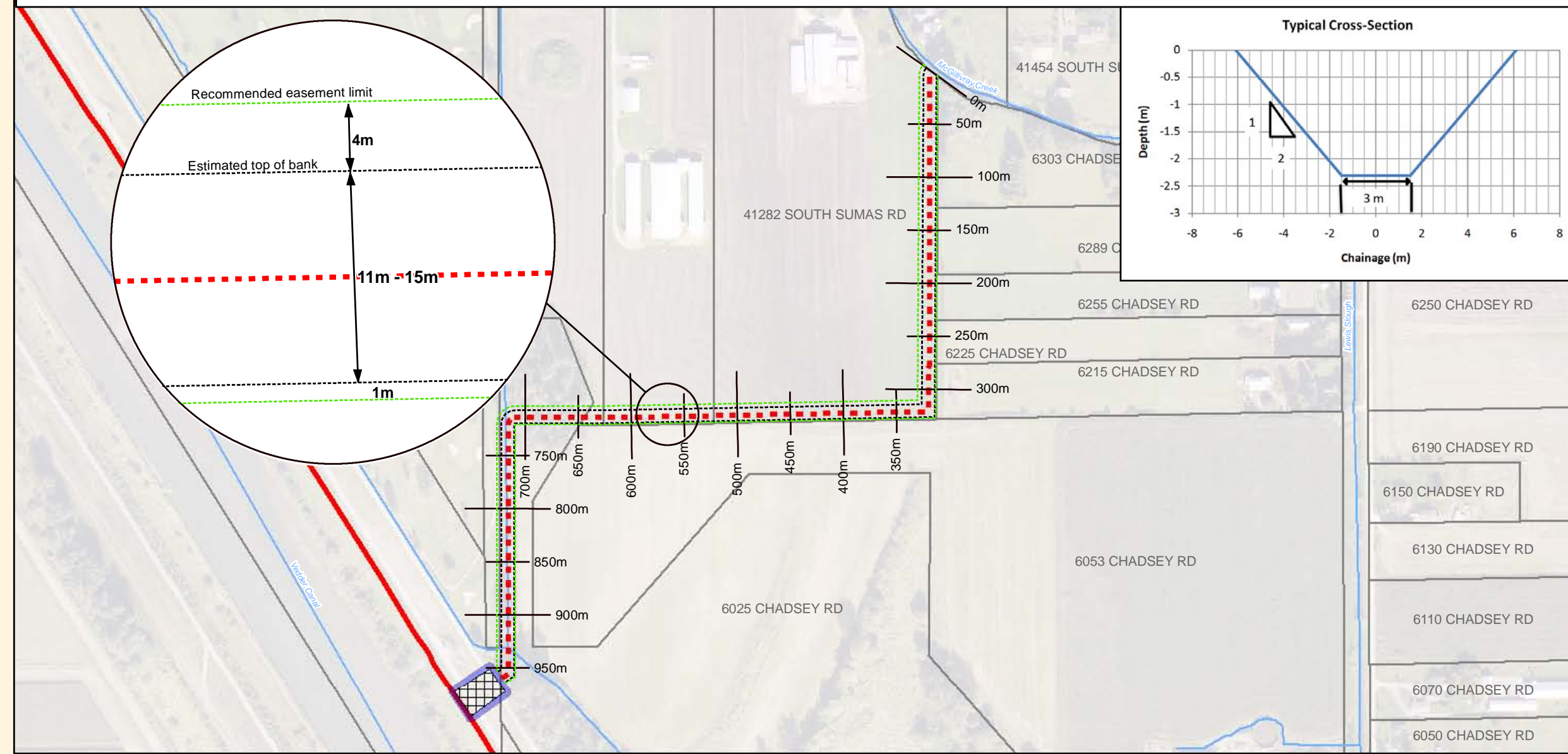
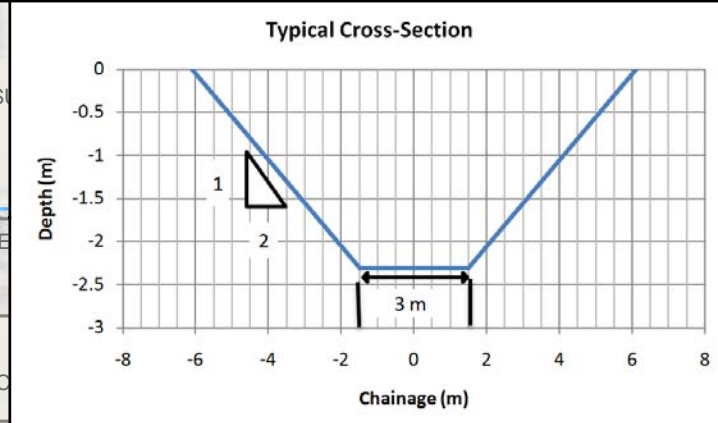
Profile



Legend

- - - Proposed Channel Centerline
- - - - - Proposed Top of Bank (approx. 6-8m from centerline)
- - - - - Easement Limit
- Existing Waterway
- Estimated Pump Station Footprint (28m x 40m)
- Estimated Pump Station 5m ROW Buffer
- Cadastral

Final alignment and limits of easement subject to agreements with property owners and detailed design.



Greendale Flood Study New Pump Station and Channel

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Figure 26



City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Added Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

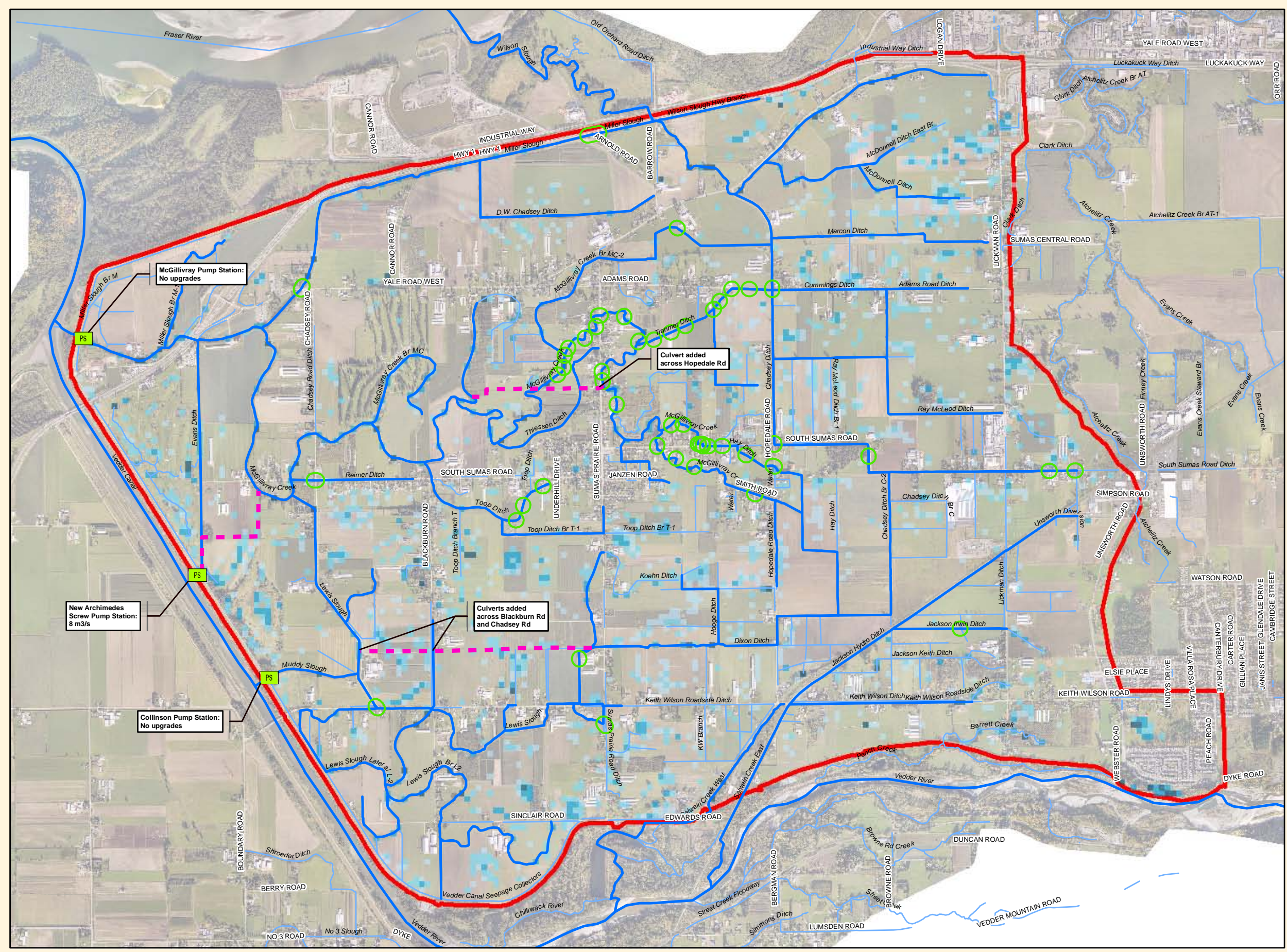
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

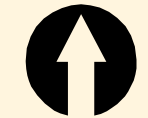
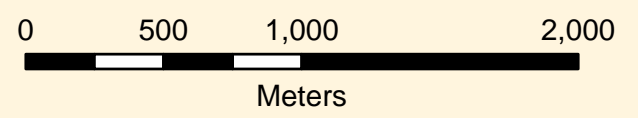
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 6
Performance:
10 Year

Figure 27.10



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City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- - - Added Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

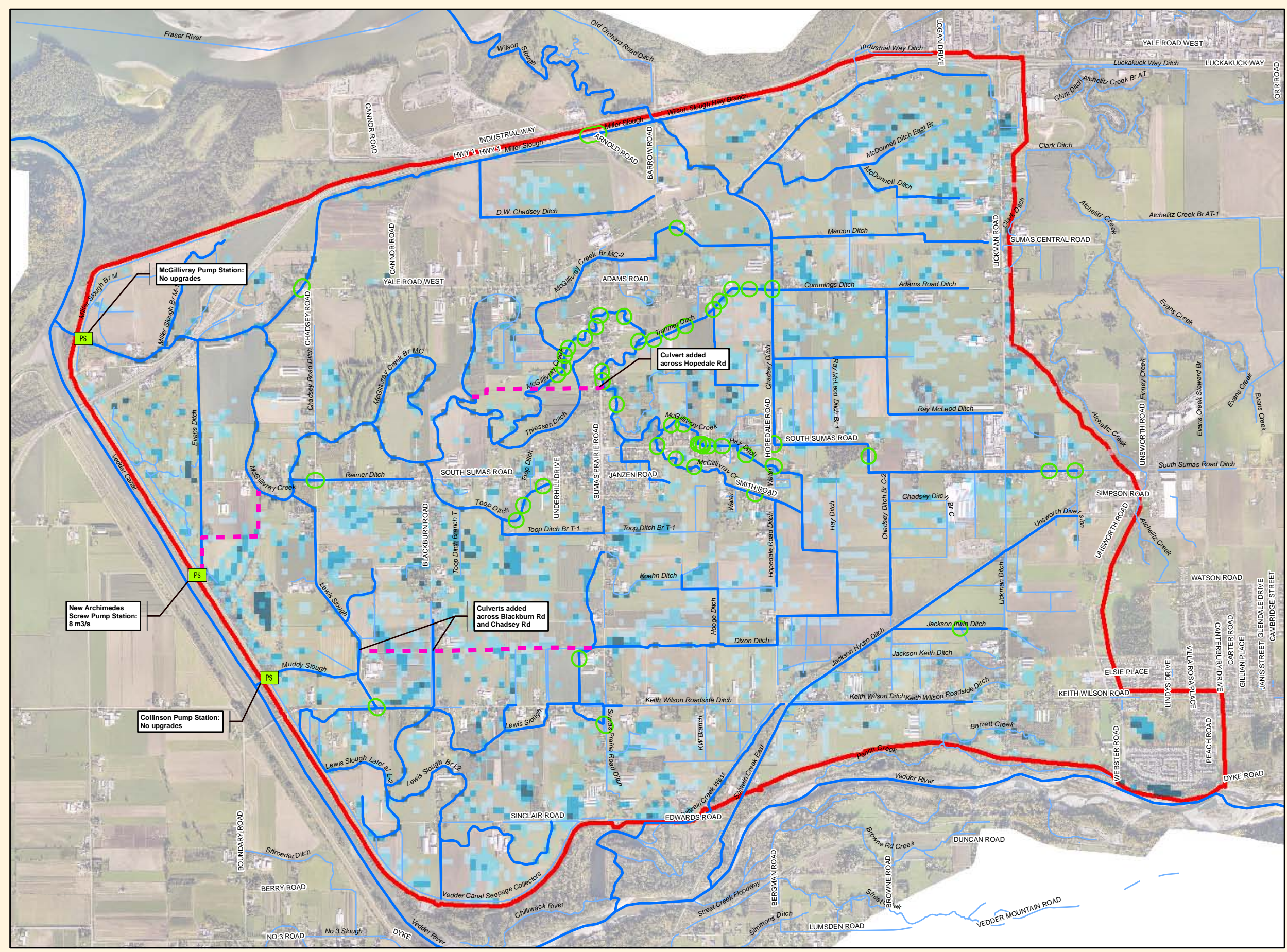
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

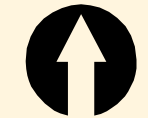
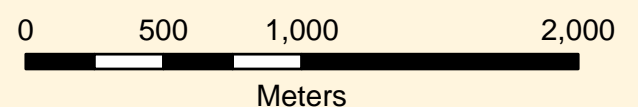
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 6
Performance:
25 Year

Figure 27.25



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City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- - - Added Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

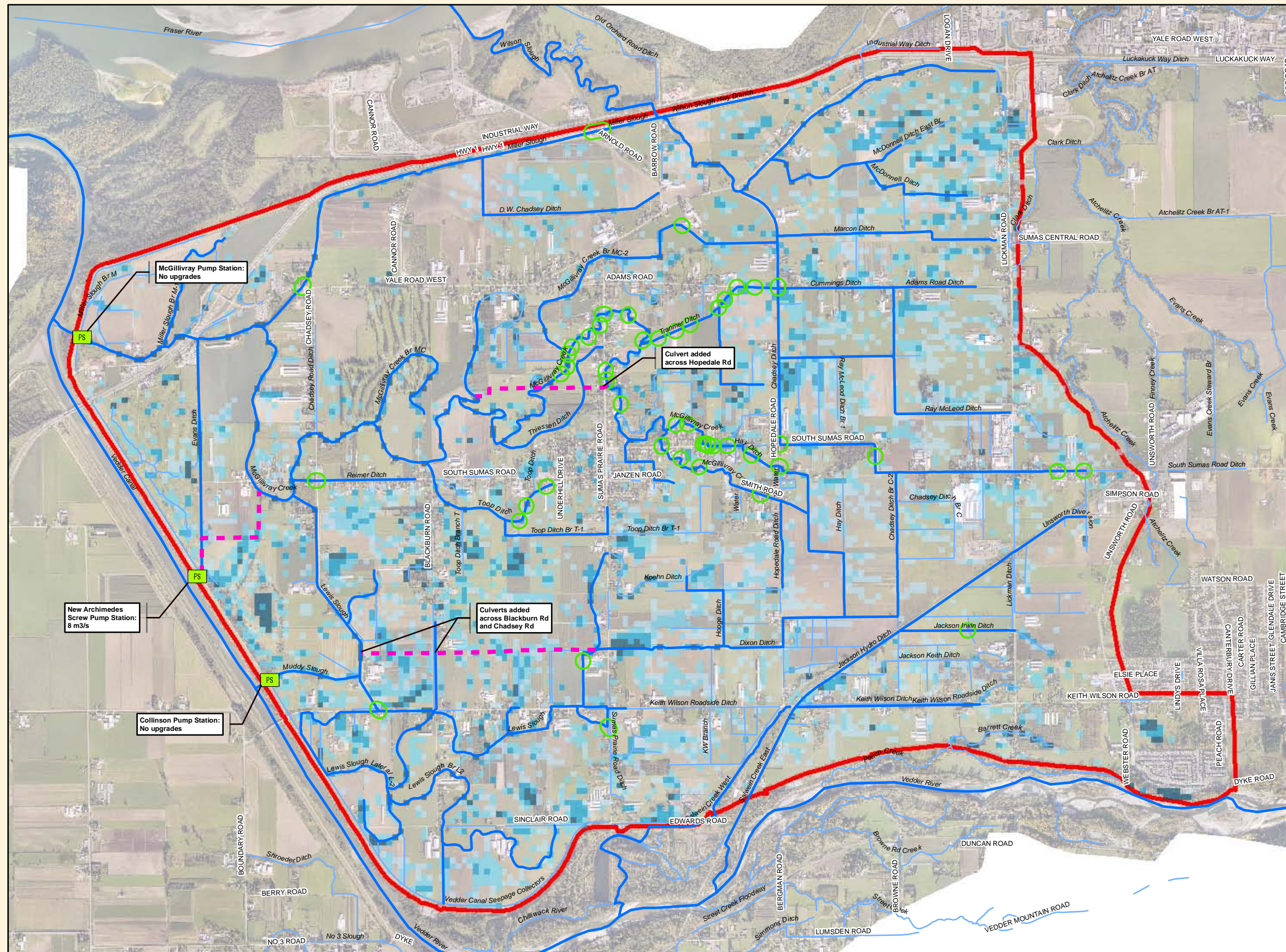
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

Note: Flooding depths less than 5cm not shown.

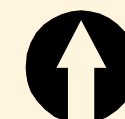
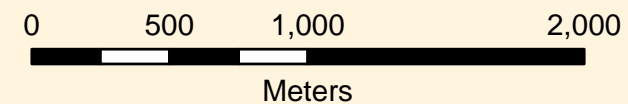
Greendale Flood Study
Option 6
Performance:
100 Year

Figure 27.100



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City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Added Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

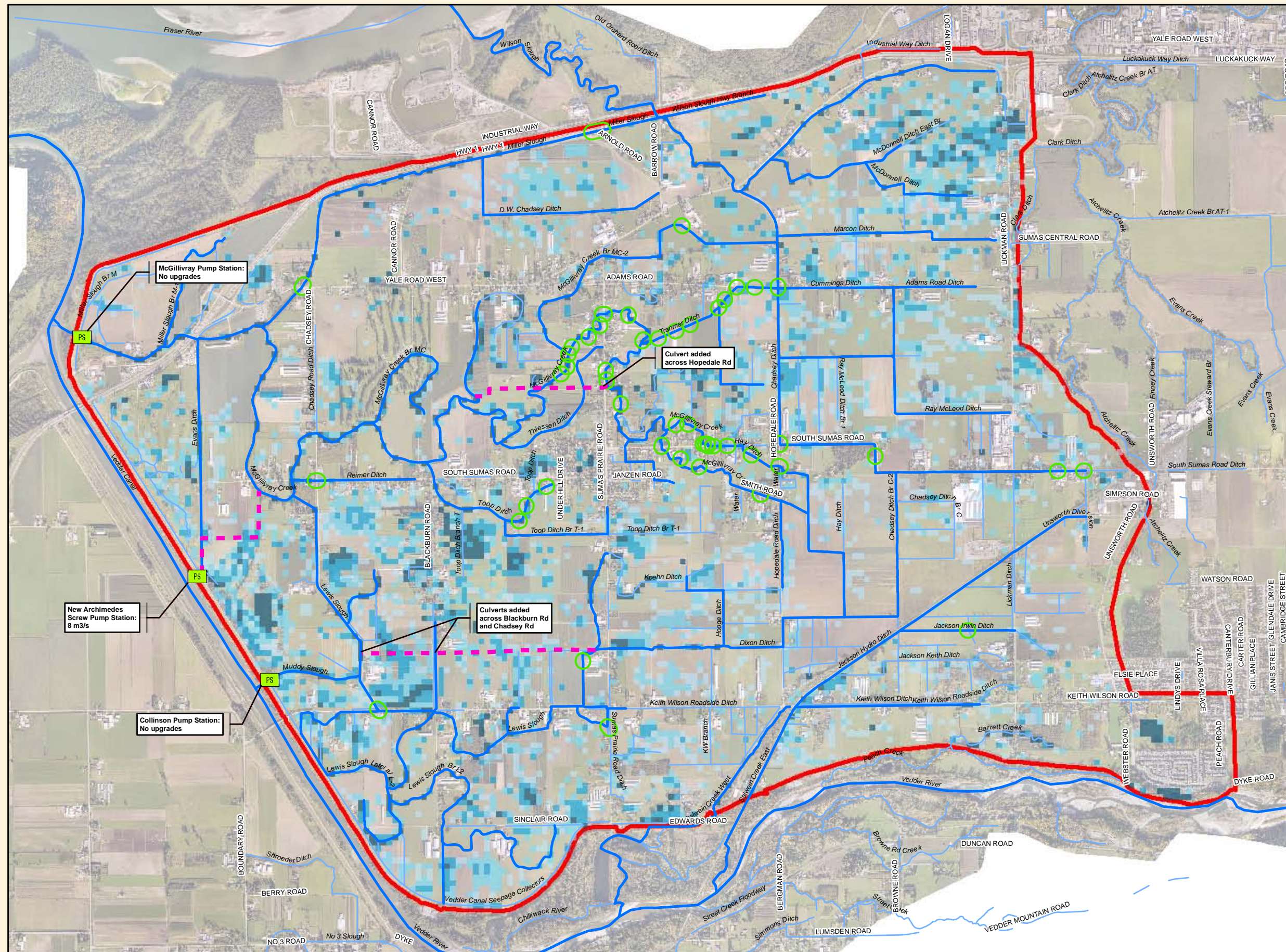
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

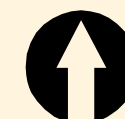
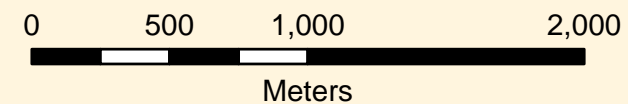
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 6
Performance:
January Event

Figure 27 Jan



THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.





City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- - - Added Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

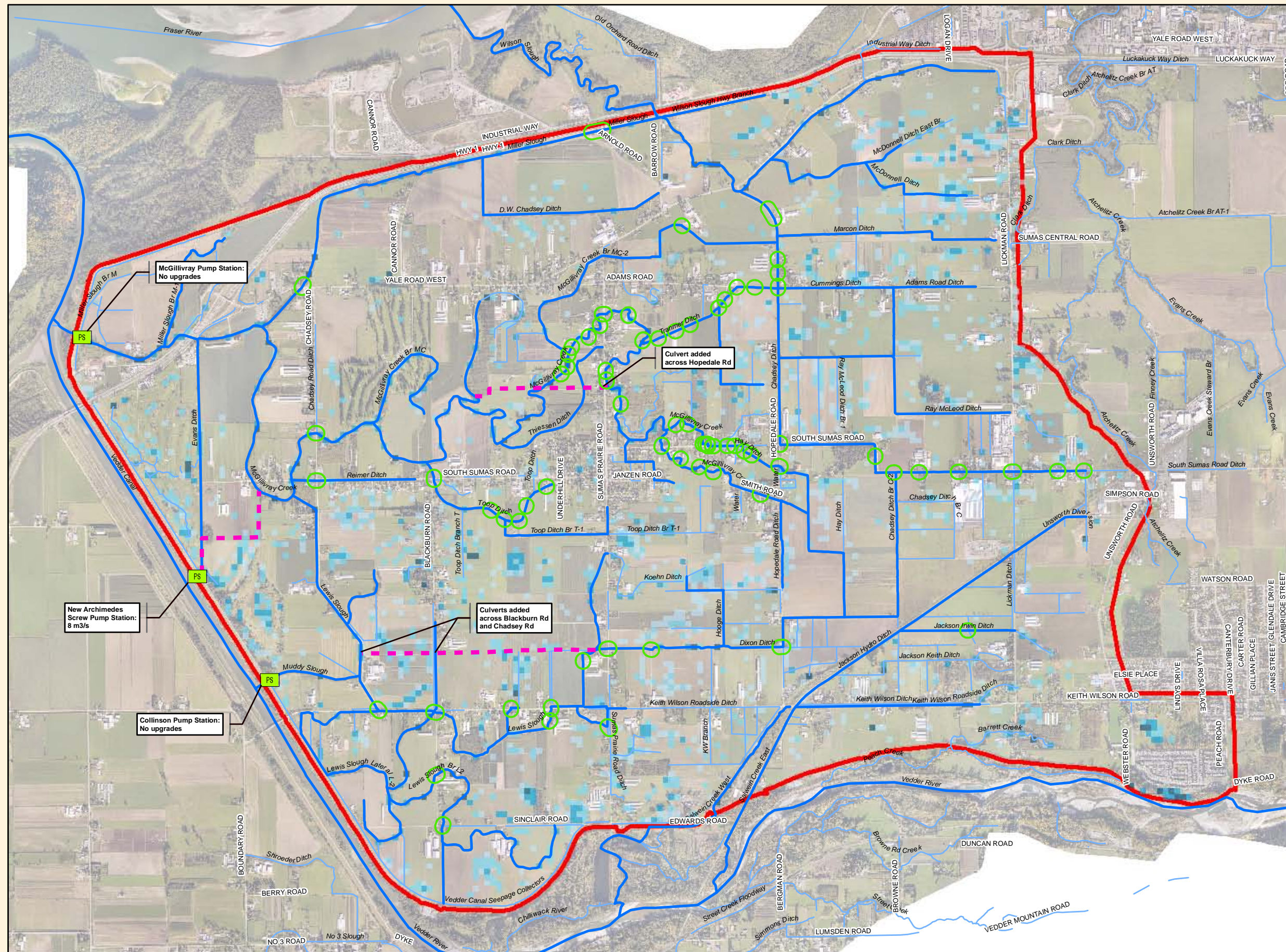
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

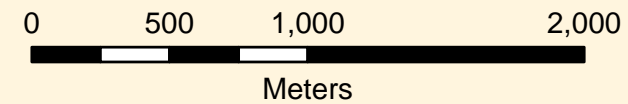
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 6B
Performance:
10 Year

Figure 28.10



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City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Added Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

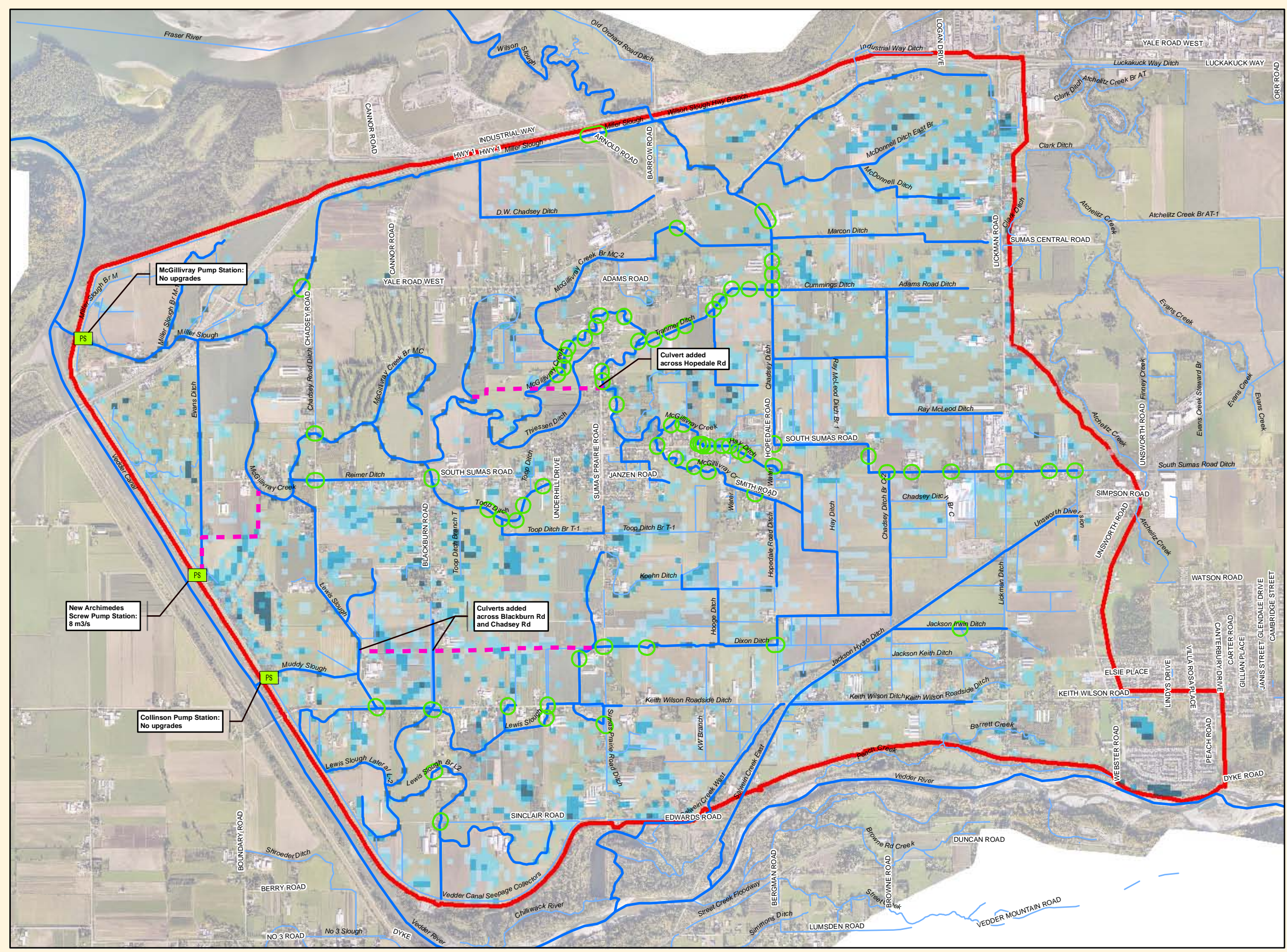
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

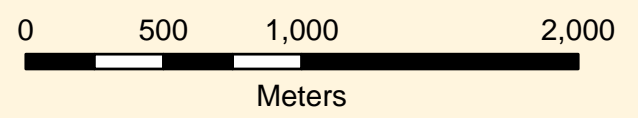
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 6B
Performance:
25 Year

Figure 28.25



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City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Added Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

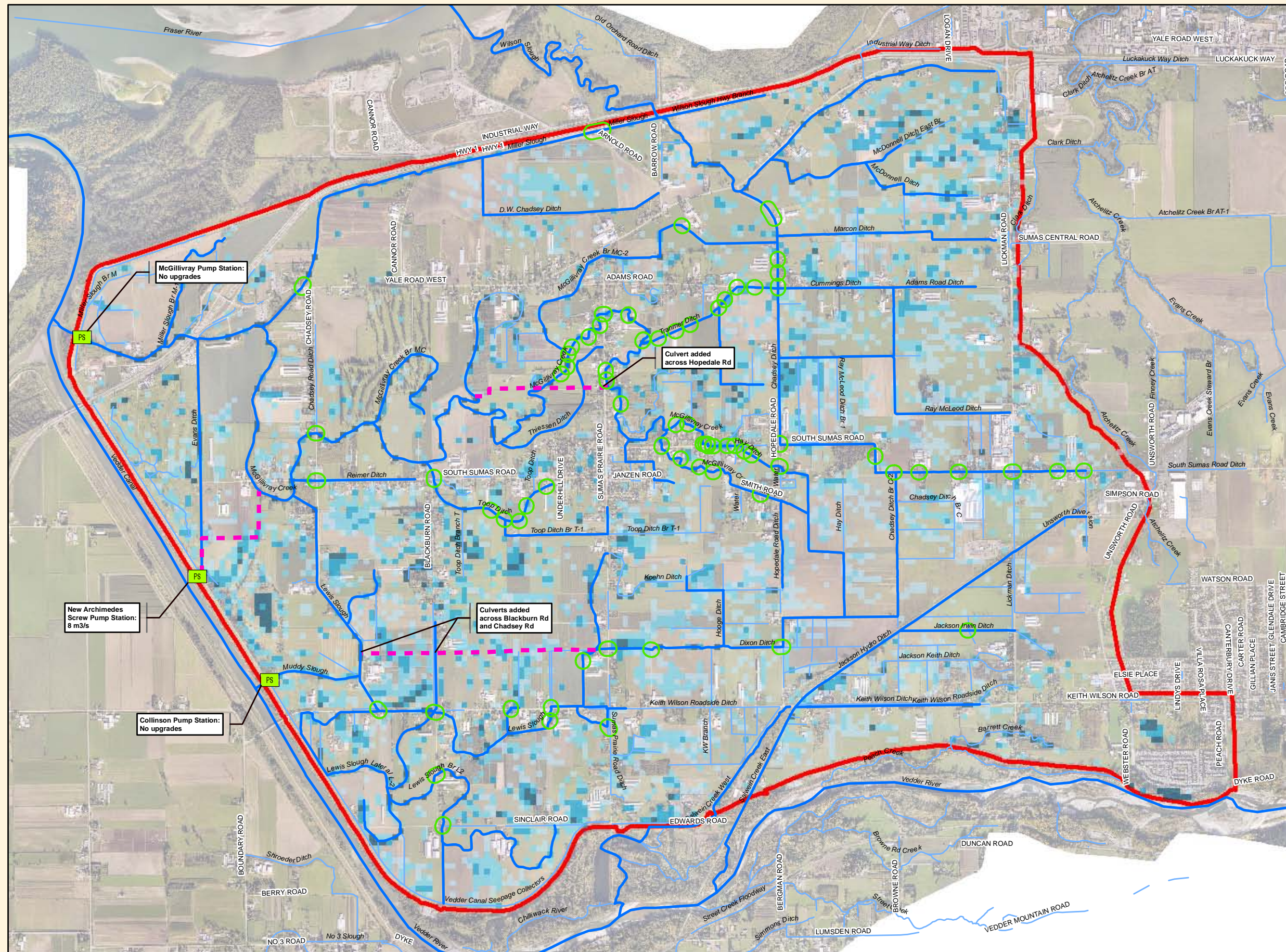
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

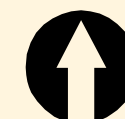
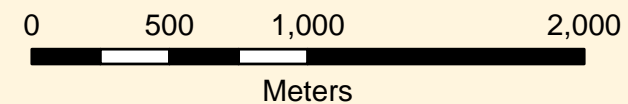
Note: Flooding depths less than 5cm not shown.

Greendale Flood Study
Option 6B
Performance:
100 Year

Figure 28.100



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City of Chilliwack

Legend

- PS Pump Station Upgrades
- Waterways
- Added Channel
- Modeled Waterways
- Upgraded Culverts
- Study Boundary

Maximum Water Depth (m)*

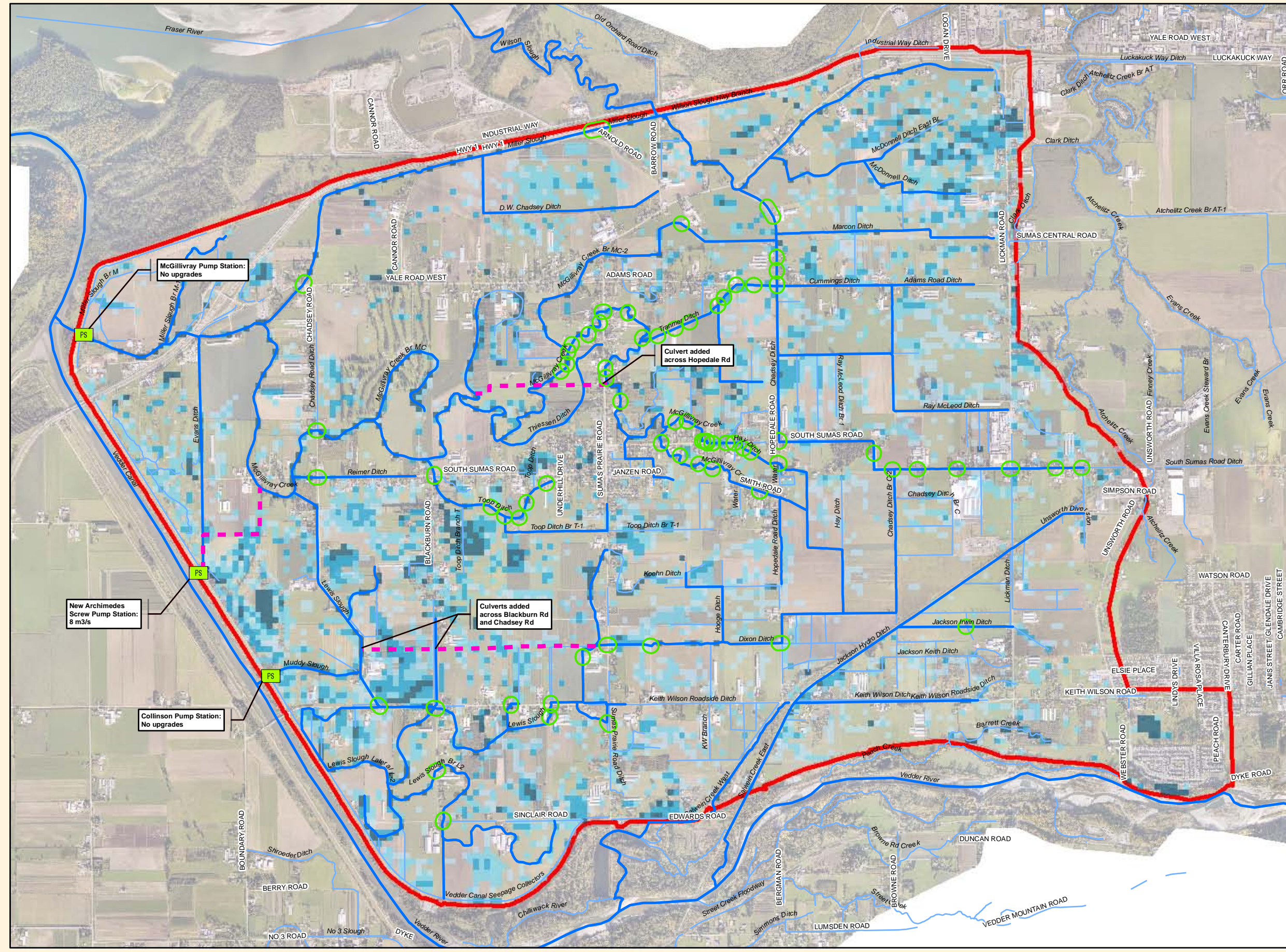
- 0.05 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- > 0.5

* Based on maximum water depth each gridcell experienced during entire duration of event.

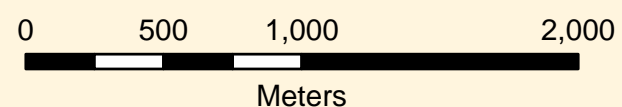
Note: Flooding depths less than 5cm not shown.

**Greendale Flood Study
Option 6B
Performance:
January Event**

Figure 28.Jan



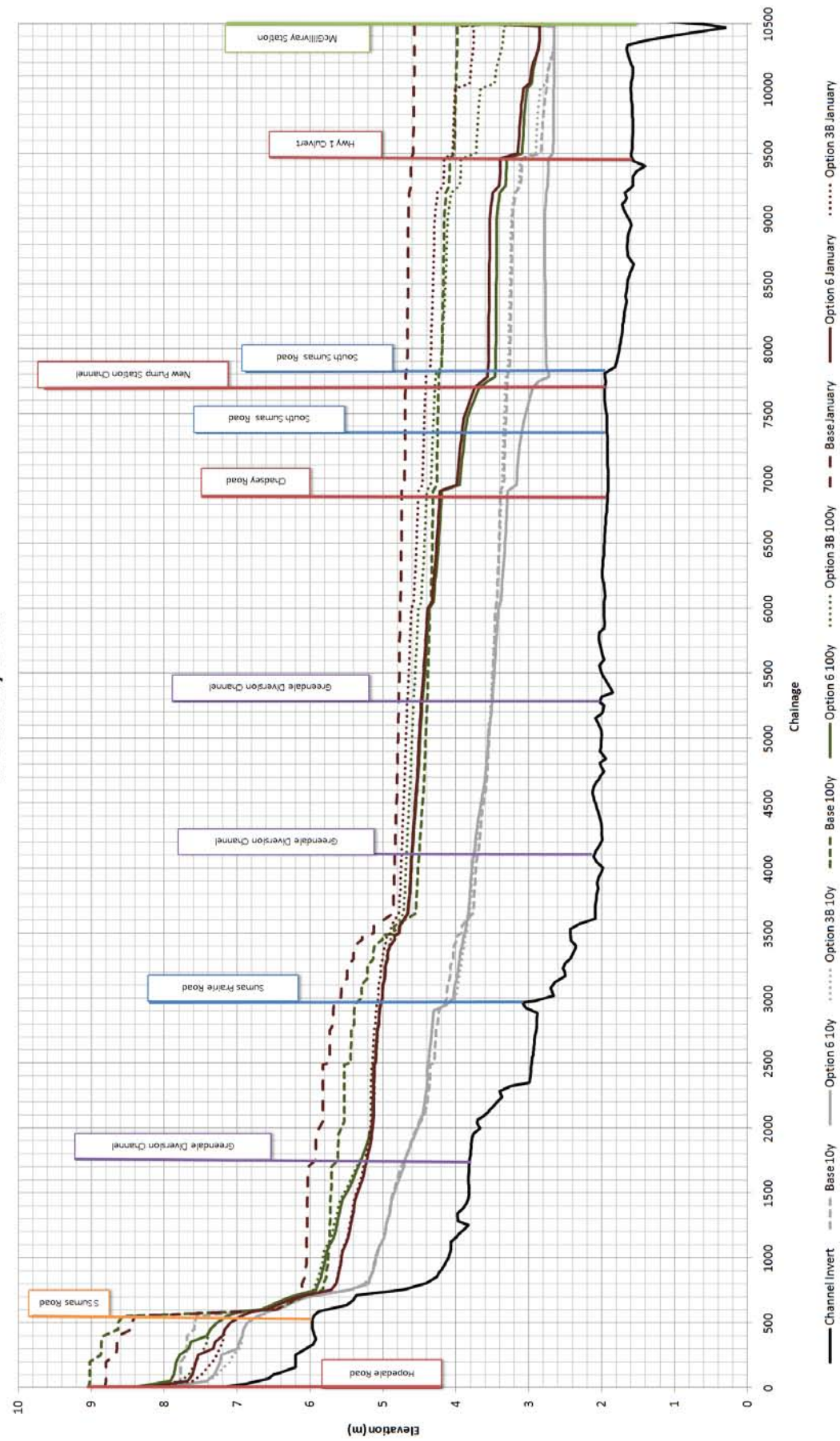
URBANSYSTEMS
 THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.



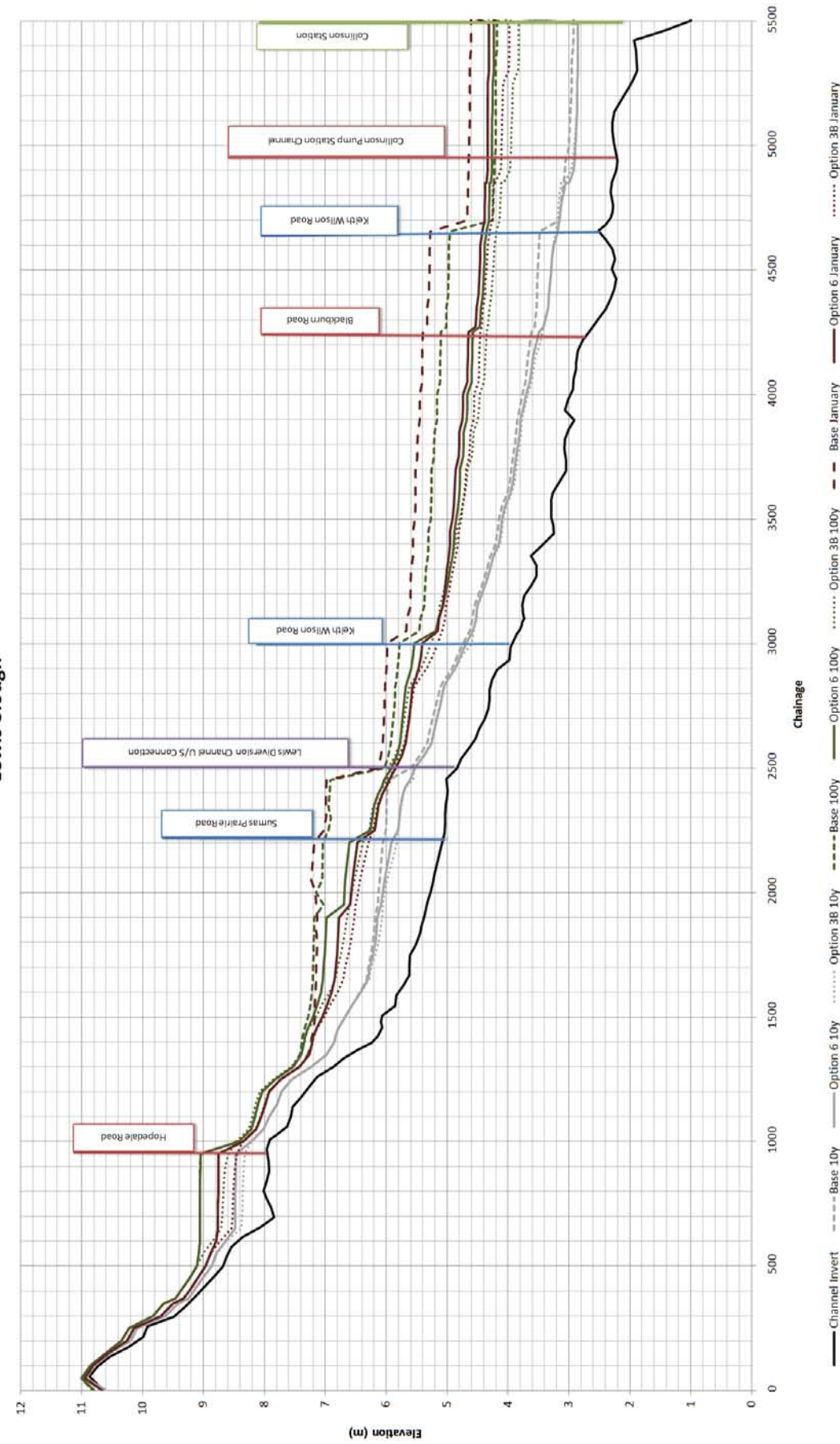


City of Chilliwack

McGillivray Creek



Lewis Slough



Greendale Flood Study
McGillivray Creek
and Lewis Slough
Hydraulic Profiles





Figure 29

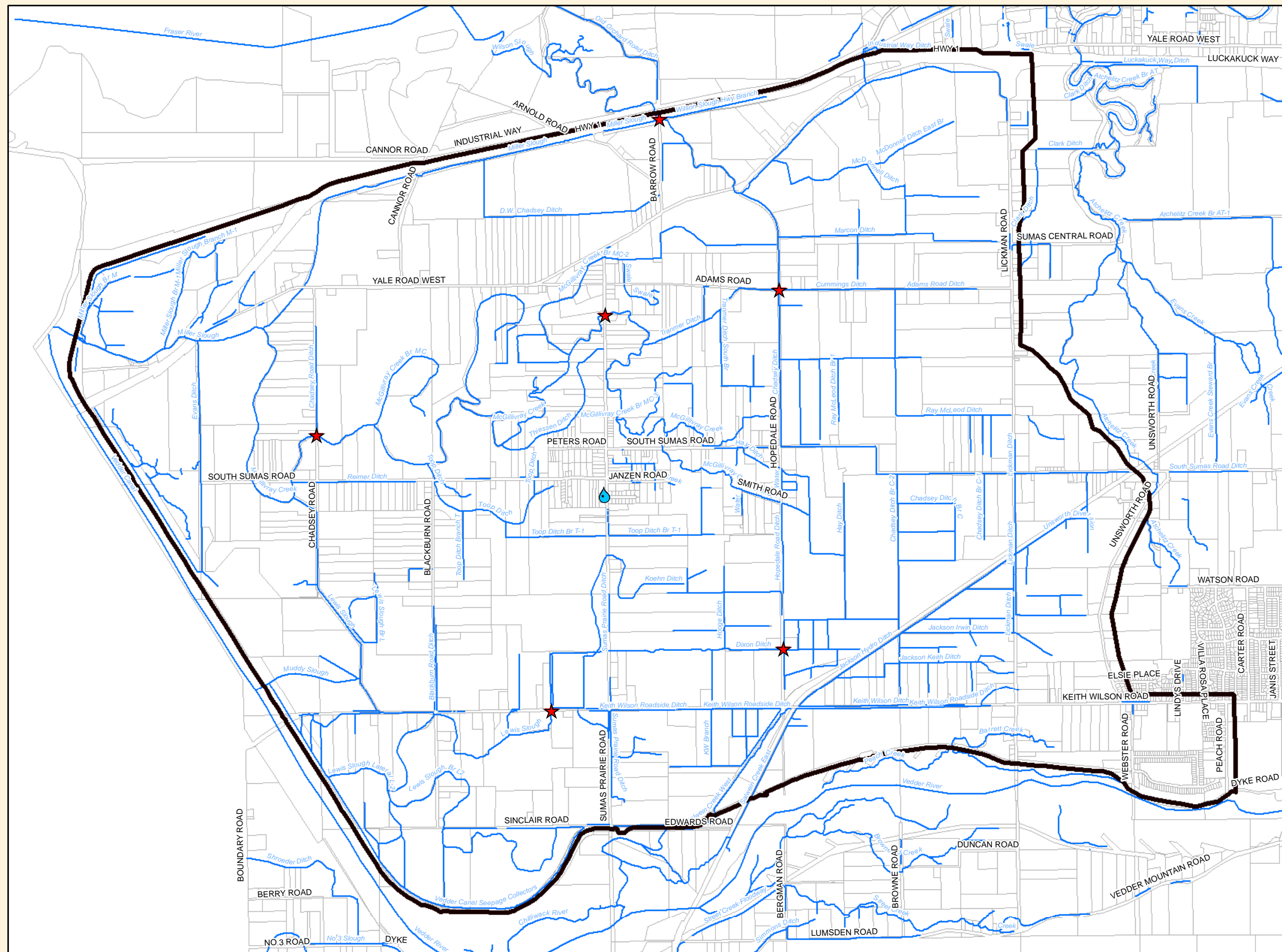
URBANSYSTEMS. THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.



City of Chilliwack

Legend

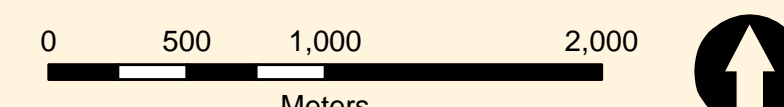
-  Tipping Bucket Rain Gauge at Municipal Firehall
-  Water Level Data Logger
-  Waterways
-  Study Boundary



Greendale Flood Study
Monitoring
Stations

Figure 30

URBANSYSTEMS. THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.

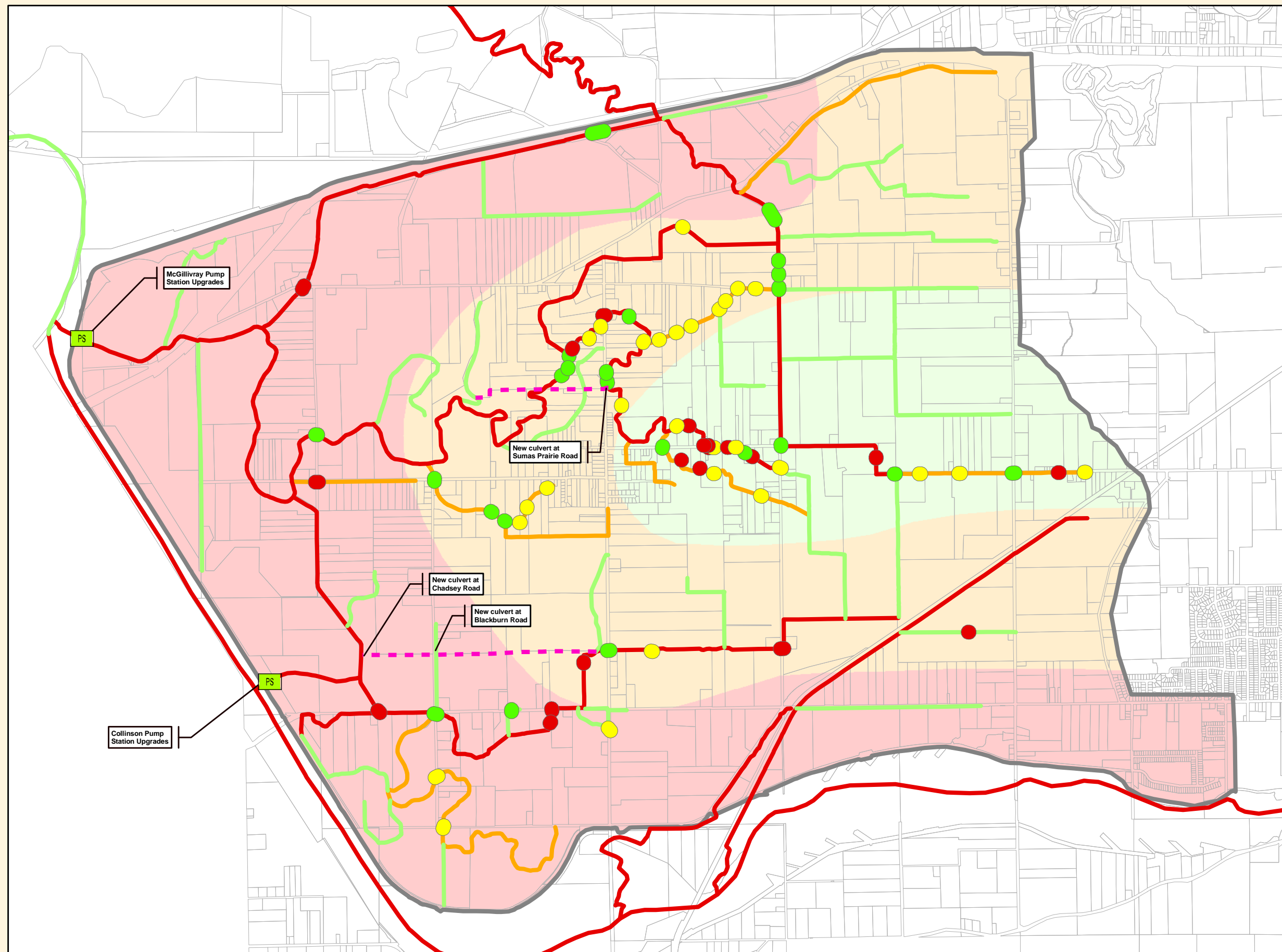




City of Chilliwack

Legend

- Recommended Pump Station Upgrades
- Supplementary Channels
- Study Boundary
- Dimension 1 - Zones Priority**
- Priority 1
- Priority 2
- Priority 3
- Dimension 2 - Reach Priority**
- Priority 1
- Priority 2
- Priority 3
- Dimension 3 - Culvert Priority**
- Priority 1
- Priority 2
- Priority 3



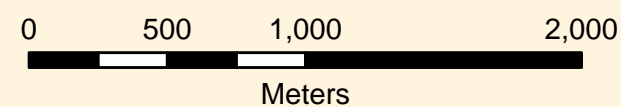
Greendale Flood Study

Priorities

Figure 31



THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.

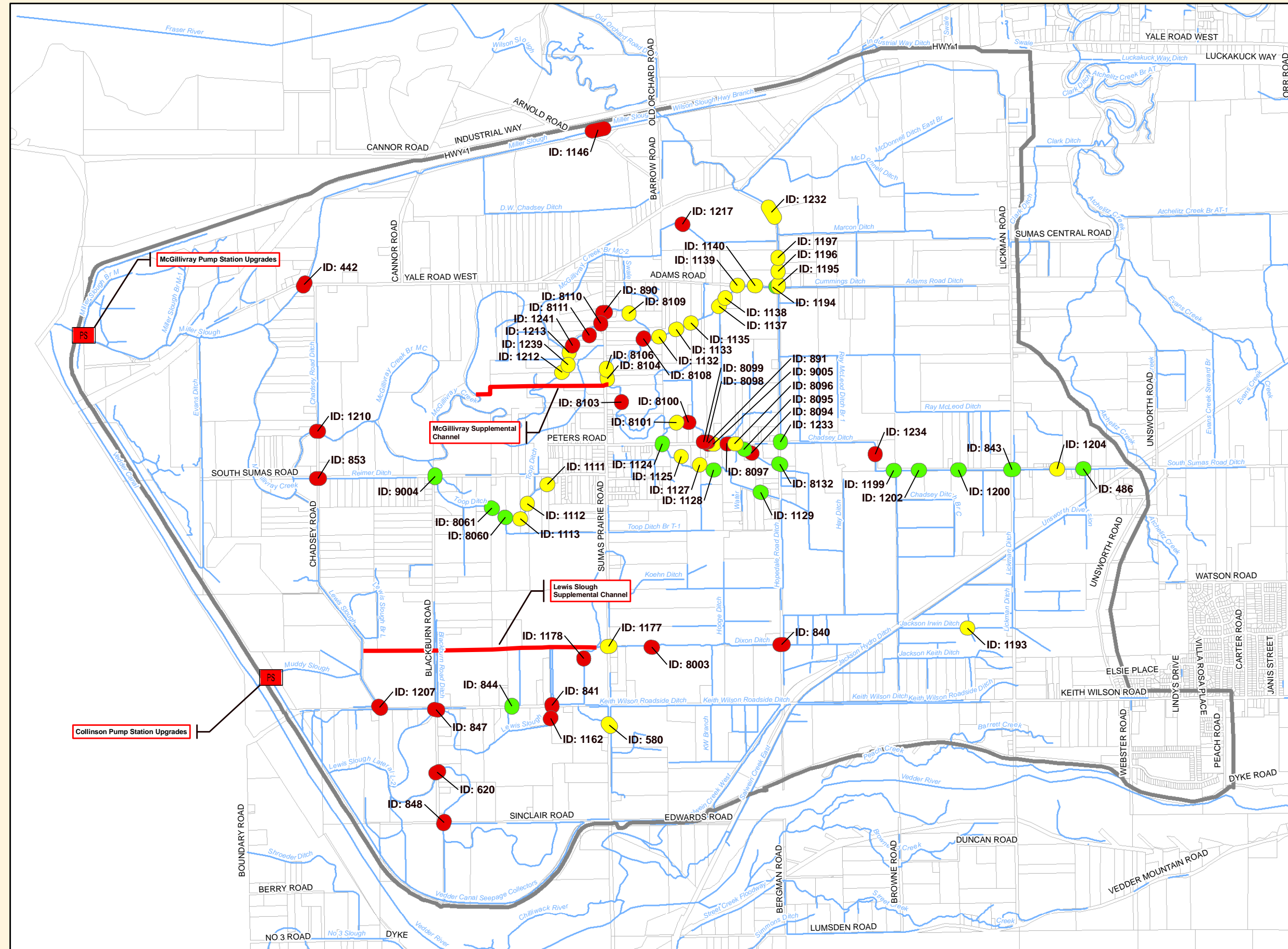




City of Chilliwack

Legend

- Red Items - Priority 1
- Yellow Items - Priority 2
- Green Items - Priority 3
- Waterways
- Study Boundary

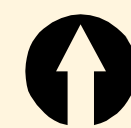


Refer to tables in Appendix C for culvert replacement details

Greendale Flood Study Implementation Plan

Figure 32

URBANSYSTEMS. THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.





APPENDIX A

RETROFIT EXISTING PUMP STATIONS



Technical Appendix - Pump Station Assessment

date: March 14,2010
to: File
cc: Glen Shkurhan P.Eng, Nazmun Nanar P.Eng
from: Julien Bell EIT, Steve Brubacher P.Eng
file #: 1036.0066.01

1. Introduction

The intent of this memo is to give an overview of the pump station review including: design flow requirements, pump sizing and selection, system curve, and review of Hydraulic Institute (HI) standards for the McGillivray and Collinson pump stations located in Chilliwack, BC. This review is part of the 2009 Drainage Study. Please refer to **2009 Drainage Study** for further details and information pertaining to the Study, and **Technical Appendix - Hydrologic & Hydraulic Analysis** for further details on the hydraulic and hydrologic modeling process.

2. Existing system

Two (2) pump stations currently service the Greendale area of Chilliwack BC. The larger of the two (2) pump stations, the McGillivray Station, is located just north of Highway 1, along the Dike located at the confluence of the Vedder Canal and Sumas River. The second pump station, the Collinson Station, is located just north of Keith Wilson Rd, along the Vedder Canal Dike.

The two (2) pump stations were constructed in the 1970's, and to our knowledge have not undergone any significant mechanical upgrades. The original O&M manual and the as constructed drawings of the pump stations, as provided by the City of Chilliwack (CoC) were used as the data source for information pertaining to the existing pump station pump mechanical & hydraulic information.

2.1. McGillivray Station

The following table contains all the McGillivray Station data used in the analysis.

Table 1 McGillivray Station Information

Motor Detail	
Motor Size	300 hp
Electrical Service	750 KVA 3 Phase Primary 480 Volt 3 Phase Secondary
Pump Details	
Curve No.	228649-50
Pump Type	48 MF
Bowl Diameter	1.2 m
Design flow (2 Pumps Operating)	2*(2.805 m ³ /s) = 5.61 m ³ /s
RPM	500
Min Pump Off elevation	2 m
Outlet Detail	
Diameter	1.2 m
Length	60 m
Static head (35,000 gpm/44,500 gpm)	7.5 m/ 3.65 m
TDH (35,000 gpm/44,500 gpm)	8.05 m/5.47 m
Outlet Elevation Normal Conditions ¹	5.9 m
Outlet Elevation Freshet Conditions	10.05 m
Station Details	
Sump floor elevation	-2.59 m
Center line pump spacing	3 m
Center line of pump to outside wing walls	1.5 m
Center line of pump to inside wall	0.92 m
HI (Z) value ²	7.13 m
*Please note that this pump station has no partitioning wall	

1: Controlled by Overflow Weir

2: As per HI Standard for Pump Intake Design (1998) Clause 9.8.2.1.4 ; figure 9.8.1

The existing pump curve is attached.

2.2. Collinson Station

The following table contains all the Collinson Station data used in the analysis.

Table 2 Collinson Station Information

Motor Detail	
Motor Size	200 hp
Electrical Service	500 KVA 3 Phase Primary 480 Volt 3 Phase Secondary
Pump Details	
Curve No.	228633
Pump Type	36 MF
Bowl Diameter	0.9 m
Design flow (2 Pumps Operating)	2*(1.526 m ³ /s) = 3.052 m ³ /s
RPM	700
Min Pump Off elevation	2 m
Outlet Details	
Diameter	0.9 m
Length	50 m
Static head (24,200 gpm)	6 m
TDH (24,200 gpm)	7 m
Outlet Elevation Normal Conditions ¹	7.6 m
Outlet Elevation Freshet Conditions	10.05 m
Station Details	
Sump floor elevation	1.75 m
Center line pump spacing	2.4 m
Center line of pump to outside wing walls	1.2 m
Center line of pump to inside wall	0.7 m
HI (Z) value ²	6.86 m
*Please note that this pump station has no partitioning wall	

1: Controlled by outlet pipe invert

2: As per HI Standard for Pump Intake Design (1998) Clause 9.8.2.1.4 ; figure 9.8.

The existing pump curve is attached.

2.3. Model Results

The existing Greendale drainage system was modeled using a coupled MIKE SHE and MIKE 11 model. The model was calibrated using historical climate data from the January 2009 flooding event. (See **Technical Appendix - Hydrologic & Hydraulic Analysis** for details)

The pump stations were modeled using a fixed design flow and assumed to have 2 pumps in operation during peak flow events. Based on the model calibration, it was found that the pump stations were operating at the following flow rates

- McGillivray Station: 2*(2.6 m³/s) = 4.9 m³/s
- Collinson Station : 2*(1.5 m³/s) = 2.7 m³/s

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To assess the performance of the system the 24 hour SCS type IA design was utilized. The system performance was reviewed under the 10y, 25y, and 100y return event storms.

3. Option Evaluation

3.1. Options

The following system upgrades were reviewed (see **2009 Drainage Study** document and **Technical Appendix - Hydrologic & Hydraulic Analysis** for details).

Option 1: Culverts upgraded to convey 10y storm event flows, and pump stations designed to 25 year storm event flows.

Option 2: Culverts upgraded to maximize 100y conveyance, and pump stations designed to 25 year storm event flows.

Option 3: Culverts upgraded to maximize 100y conveyance, and pump stations designed to 100 year storm event flows.

Option 4: Internal flow diversion along Hopedale Rd, culverts upgraded to maximize 100y conveyance along trunk system, and pump stations designed to 25 year storm event flows.

Option 5: Internal flow diversion along Hopedale Rd, conveyance culverts upgraded to maximize 100y conveyance, and pump stations designed to 100 year storm event flows.

The pump stations were modeled using fixed flow rate pumps. The flow rates were adjusted for each scenario until the pumps were just able to keep up with the incoming flow rate to each station.

3.2. Results

Using the selection criteria stated above, the following design flows were determined.

Table 3. Pump Station Modelling Results

Option	McGillivray	Collinson
	One Pump / Two Pumps Capacity (m ³ /s)	One Pump / Two Pumps Capacity (m ³ /s)
Design Flow	2.805/5.61	1.526/3.052
Calibrated Model Flow	2.45/4.9	1.35/2.7
1	2.8/5.6	2.0/4.0
2	3.1/6.2	2.2/4.4
3	3.2/6.4	2.6/5.2
4	2.9/5.8	1.9/3.8
5	3.2/6.4	2.6/5.2

The new design rates are either at or above the existing design flow. Note for McGillivray Option 1 while the design flow matches the current design the total dynamic head requirements have increased due to the increased 200 year freshet design level. As such pump station upgrades are required in all scenarios.

4. Pump Selection

4.1. Review of existing structure (HI)

The existing pump stations performance were assessed using Hydraulic Institute (HI) Standard for Pump Intake Design (9.8). Using the existing station geometry, see Sections 2.1 and 2.2, and the HI requirements listed below, the limiting pump geometry and flow rates are presented below.

Table 4: Pump Station Geometry Assessment

HI Requirement	McGillivray		Collinson	
	HI Requirements	Existing	HI Requirements	Existing
Min Liquid Level (m) depth/elevation	3.75/1.16	4.59/2.00	3/1.25	3.75/2.00
Max Can Diameter (m) Based on Fixed Bay Width	1.5	1.2	1.2	0.9
Max Can Diameter (m) Based on Fixed Z length	1.5	1.2	1.4	0.9
Max Station flow (m ³ /s) based on max velocity requirement	11.43	5.61	7.2	3.05

With the exception of clause 9.8.2.1.2 requiring a partition for stations with design flows greater than 0.315m³/s, both pump stations meet current HI pump intake design standards.

4.2. System Curves

Using the stations existing outlet geometry, see Sections 2.1 and 2.2, two (2) system curves were developed for each station. The system curves represent the following conditions:

- Low static head, representing normal flow conditions
 - Collinson: 7.6 m
 - McGillivray: 5.9 m
- High static head, representing the 200 year freshet outlet conditions
 - Collinson : 10.6 m
 - McGillivray: 10.6 m

The system curves where developed using the Hazen-Williams equation. For both scenario the system curves were developed using the following assumptions:

- Hazen-Williams C value of 110,
- total system minor loses of K=2.5 (Sudden entrance (1), Sudden exit (1), Bend (0.5),
- loses through the flap gate of 0.1m, and
- minimum inlet water elevation of 2 m.

The resulting system curves are attached.

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Using the system curves described above, and the design flows presented in Section 3.2.

Table 5: Pump Design Points

Option	McGillivray		Collinson	
	One Pump / Two Pumps Capacity (m ³ /s)	Static Head/TDH	One Pump / Two Pumps Capacity (m ³ /s)	Static Head/TDH
1	2.8/5.6	8.6/9.8	2.0/4.0	8.6/10.5
2	3.1/6.2	8.6/10.0	2.2/4.4	8.6/10.9
3	3.2/6.4	3.9/5.4	2.6/5.2	5.6/8.7
4	2.9/5.8	8.6/10.1	1.9/3.8	8.6/10.3
5	3.2/6.4	3.9/5.4	2.6/5.2	5.6/8.7

4.3. Pump Selection

Using the pump design points presented in Section 4.2, and through review with the pump manufacturer the following pumps have been selected:

- McGillivray Station
 - Two (2) Peerless 48 MF Single Stage Pumps, with 500 HP motor
- Collision Station
 - Two (2) Peerless 48 HH Single Stage Pumps with 450 HP motor

The critical design option was found to be Option 2. However all design points of the other options are able to be achieved by utilizing the same pumps and varying the pump speed.

Based on the proposed pump, the proposed pump stations capacities are presented in the table below.

Table 6: Pump Station Capacity

Option	One Pump / Two Pumps Capacity (m ³ /s)		Static Head / TDH (m)	
	Normal Outlet Conditions	200 year Freshet Level	Normal Outlet Conditions	200 year Freshet Level
McGillivray	3.85/7.7	3.1/6.2	3.9/6.0	8.6/10.0
Collinson	2.9/5.8	2.65/5.3	5.6/9.9	8.6/12

5. Pump Station Upgrading

The selected pumps geometry and design flow rates conform to limits set out in Section 4.1, thus no structural upgrades are required to achieve HI Standards. For the purposed of this study, it was assumed that the pump station will not be required to undergo seismic upgrades, and as such no allowance for seismic upgrades were included in the cost estimate.

The mechanical upgrades proposed for the station includes replacing the existing pumps and related piping, and upgrading the existing motors. The recommended pumps and motors are specified in Section

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4.3. The installation of a wet well partitioning wall will also be required. No upgrades to the discharge pipe through the dike and to the outlet structure are required for hydraulic reasons. However, the condition of the discharge pipe and outlet structure should be reviewed at the time of detailed design to determine if structural upgrades are required. It was assumed that the existing roof access hatches can accommodate the increased pump and motor size.

The proposed motor upgrades present a significant increase in horsepower over the existing motors and upgrades to the existing electrical service to both stations are required to accommodate the increased motor size. The electrical upgrades include:

- Upgrading the existing 480 Volt 3 Phase electrical services to 600 Volt 3 phase service with 1000kVA transformer
- The installation of VFDs and associated switchgear
- Construction of an electrical kiosk to accommodate the additional electrical infrastructure
- Stand-by generator and enclosure


The cost estimate assumes that the electrical service upgrade can be supplied from the same connection point to the grid and that the electrical kiosk can be constructed on the city land adjacent to the pump station without any significant earthworks.

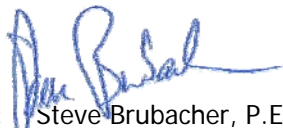
6. Cost Estimate

A breakdown of the cost estimate is attached along with supporting documentation. The cost estimate is based on Option 2. The relatively small change in pump design between the different options results in no significant change in cost between the different options.

The estimated cost of upgrading the existing pumps, and related mechanical and electrical upgrades, are **\$1,596,300** and **\$1,655,900** for the McGillivray and Collinson stations excluding contingency, engineering, and GST. The total estimated cost for both stations, including engineering and contingency but excluding GST, is **\$4,864,000**.

URBAN SYSTEMS LTD.


Julien Bell EIT
Water Resource Engineer

Reviewed By:  Steve Brubacher, P.Eng
Principal

/JB

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APPENDIX B

COST ESTIMATE

Cost Estimate of Recommended Works

**City of Chilliwack - 2009 Drainage Study
USL - April 2010
Culverts**

Existing Culvert Upgrades												
Culvert ID	Current Length (m)	Current Diameter (m)	Proposed Length (m)	Proposed Number of Culverts	Proposed Diameter (m)	Base Construction Cost	Contingency	Admin.	Engineering	Total Estimated Cost	Site Improvement Contingency	Total Estimated Cost with Contingency
442	23.1	1.05	23.1	3	1.20	\$ 57,622	\$ 20,168	\$ 5,763	\$ 8,644	\$ 93,000	\$ 27,000	\$ 120,000
486	5.8	0.90	5.8	1	1.50	\$ 35,427	\$ 12,400	\$ 3,543	\$ 5,315	\$ 57,000	\$ 16,000	\$ 73,000
580	24.6	0.60	24.6	2	0.90	\$ 36,251	\$ 12,688	\$ 3,626	\$ 5,438	\$ 59,000	\$ 16,000	\$ 75,000
620	23.2	0.60	23.2	1	1.20	\$ 29,606	\$ 10,363	\$ 2,961	\$ 4,441	\$ 48,000	\$ 20,000	\$ 68,000
840	24.2	0.60	24.2	2	1.20	\$ 44,653	\$ 15,629	\$ 4,466	\$ 6,698	\$ 72,000	\$ 23,000	\$ 95,000
841	14.7	1.00	14.7	3	1.20	\$ 45,451	\$ 15,908	\$ 4,546	\$ 6,818	\$ 73,000	\$ 31,000	\$ 104,000
843	21	1.53	21.0	2	1.50	\$ 64,906	\$ 22,718	\$ 6,491	\$ 9,736	\$ 104,000	\$ 38,000	\$ 142,000
844	13.8	0.60	13.8	1	0.90	\$ 21,773	\$ 7,621	\$ 2,178	\$ 3,266	\$ 35,000	\$ 17,000	\$ 52,000
847	24	1.50	24.0	2	1.80	\$ 83,382	\$ 29,251	\$ 8,359	\$ 12,538	\$ 134,000	\$ 40,000	\$ 174,000
848	17.9	0.60	17.9	1	1.20	\$ 27,046	\$ 9,467	\$ 2,705	\$ 4,057	\$ 44,000	\$ 21,000	\$ 65,000
853	22.1	0.60	22.1	2	1.20	\$ 42,624	\$ 14,919	\$ 4,263	\$ 6,394	\$ 69,000	\$ 24,000	\$ 93,000
890	18.9	1.20	18.9	2	1.80	\$ 74,374	\$ 26,031	\$ 7,438	\$ 11,157	\$ 119,000	\$ 43,000	\$ 162,000
891	15.8	0.60	15.8	2	1.50	\$ 58,089	\$ 20,332	\$ 5,809	\$ 8,714	\$ 93,000	\$ 41,000	\$ 134,000
1111	7.2	0.60	7.2	1	1.20	\$ 21,878	\$ 7,658	\$ 2,188	\$ 3,282	\$ 36,000	\$ 30,000	\$ 66,000
1112	6.6	0.60	6.6	1	1.20	\$ 21,588	\$ 7,556	\$ 2,159	\$ 3,239	\$ 35,000	\$ 32,000	\$ 67,000
1113	5.6	0.60	5.6	1	1.20	\$ 21,105	\$ 7,387	\$ 2,111	\$ 3,166	\$ 34,000	\$ 35,000	\$ 69,000
1124	13.8	0.90	13.8	2	0.90	\$ 29,171	\$ 10,210	\$ 2,918	\$ 4,376	\$ 47,000	\$ 20,000	\$ 67,000
1125	6	0.30	6.0	2	1.20	\$ 27,071	\$ 9,475	\$ 2,708	\$ 4,061	\$ 44,000	\$ 39,000	\$ 83,000
1127	4.9	0.60	4.9	2	1.80	\$ 49,097	\$ 17,184	\$ 4,910	\$ 7,365	\$ 79,000	\$ 79,000	\$ 158,000
1128	7.6	0.60	7.6	1	1.50	\$ 36,607	\$ 12,813	\$ 3,661	\$ 5,492	\$ 59,000	\$ 48,000	\$ 107,000
1129	10.1	0.53	10.1	1	1.20	\$ 23,279	\$ 8,148	\$ 2,328	\$ 3,492	\$ 38,000	\$ 26,000	\$ 64,000
1132	5.2	1.10	5.2	2	1.20	\$ 26,299	\$ 9,205	\$ 2,630	\$ 3,945	\$ 43,000	\$ 42,000	\$ 85,000
1133	9	1.10	9.0	2	1.20	\$ 29,969	\$ 10,490	\$ 2,997	\$ 4,496	\$ 48,000	\$ 32,000	\$ 80,000
1135	4.9	0.90	4.9	2	1.20	\$ 26,009	\$ 9,104	\$ 2,601	\$ 3,902	\$ 42,000	\$ 44,000	\$ 86,000
1137	10.3	0.60	10.3	1	1.20	\$ 23,375	\$ 8,182	\$ 2,338	\$ 3,507	\$ 38,000	\$ 26,000	\$ 64,000
1138	5.9	0.60	5.9	1	1.20	\$ 21,250	\$ 7,438	\$ 2,125	\$ 3,188	\$ 35,000	\$ 34,000	\$ 69,000
1139	6	0.60	6.0	1	1.20	\$ 21,298	\$ 7,455	\$ 2,130	\$ 3,195	\$ 35,000	\$ 33,000	\$ 68,000
1140	9.3	0.60	9.3	1	1.20	\$ 22,892	\$ 8,013	\$ 2,290	\$ 3,434	\$ 37,000	\$ 37,000	\$ 74,000
1146	81.2	1.50	81.2	2	1.50	\$ 143,829	\$ 50,341	\$ 14,383	\$ 21,575	\$ 231,000	\$ 30,000	\$ 261,000
1162	8	1.48	8.0	3	1.50	\$ 58,857	\$ 20,600	\$ 5,886	\$ 8,829	\$ 95,000	\$ 63,000	\$ 158,000
1177	19	1.60	19.0	2	1.50	\$ 62,284	\$ 21,800	\$ 6,229	\$ 9,343	\$ 100,000	\$ 39,000	\$ 139,000
1178	9	0.90	9.0	2	1.50	\$ 49,174	\$ 17,211	\$ 4,918	\$ 7,377	\$ 79,000	\$ 52,000	\$ 131,000
1193	5.2	0.75	5.2	1	1.80	\$ 39,195	\$ 13,719	\$ 3,920	\$ 5,880	\$ 63,000	\$ 64,000	\$ 127,000
1195	18	1.83	18.0	2	1.80	\$ 72,749	\$ 25,463	\$ 7,275	\$ 10,913	\$ 117,000	\$ 43,000	\$ 160,000
1196	9.7	1.83	9.7	2	1.80	\$ 57,764	\$ 20,218	\$ 5,777	\$ 8,665	\$ 93,000	\$ 55,000	\$ 148,000
1197	8.2	1.83	8.2	2	1.80	\$ 55,056	\$ 19,270	\$ 5,506	\$ 8,259	\$ 89,000	\$ 59,000	\$ 148,000
1199	9.2	1.20	9.2	2	1.20	\$ 30,163	\$ 10,558	\$ 3,017	\$ 4,525	\$ 49,000	\$ 32,000	\$ 81,000
1200	12	1.20	12.0	1	1.80	\$ 45,333	\$ 15,867	\$ 4,534	\$ 6,800	\$ 73,000	\$ 42,000	\$ 115,000
1202	9.5	1.20	9.5	1	1.80	\$ 43,077	\$ 15,077	\$ 4,308	\$ 6,462	\$ 69,000	\$ 46,000	\$ 115,000
1204	8.3	0.90	8.3	2	1.50	\$ 48,257	\$ 16,890	\$ 4,826	\$ 7,239	\$ 78,000	\$ 54,000	\$ 132,000
1207	21.8	1.20	21.8	3	1.50	\$ 85,995	\$ 30,099	\$ 8,600	\$ 12,900	\$ 138,000	\$ 43,000	\$ 181,000
1210	15.3	2.80	15.3	3	1.80	\$ 87,437	\$ 30,603	\$ 8,744	\$ 13,116	\$ 140,000	\$ 53,000	\$ 193,000
1212	8.5	1.83	8.5	2	1.80	\$ 55,597	\$ 19,459	\$ 5,560	\$ 8,340	\$ 89,000	\$ 58,000	\$ 147,000
1213	6.1	1.83	6.1	2	1.80	\$ 51,264	\$ 17,943	\$ 5,127	\$ 7,690	\$ 83,000	\$ 70,000	\$ 153,000
1217	8.2	0.90	8.2	2	1.20	\$ 29,197	\$ 10,219	\$ 2,920	\$ 4,380	\$ 47,000	\$ 33,000	\$ 80,000
1232	83.4	1.83	83.4	2	1.80	\$ 190,829	\$ 66,791	\$ 19,083	\$ 28,625	\$ 306,000	\$ 33,000	\$ 339,000
1233	12.1	2.00	12.1	2	2.00	\$ 75,222	\$ 26,328	\$ 7,523	\$ 11,284	\$ 121,000	\$ 57,000	\$ 178,000
1234	8.7	1.20	8.7	2	1.80	\$ 55,958	\$ 19,585	\$ 5,596	\$ 8,394	\$ 90,000	\$ 58,000	\$ 148,000
1239	6.7	1.83	6.7	2	1.80	\$ 52,347	\$ 18,322	\$ 5,235	\$ 7,853	\$ 84,000	\$ 66,000	\$ 150,000
1241	9.1	1.53	9.1	2	1.80	\$ 56,681	\$ 19,839	\$ 5,669	\$ 8,503	\$ 91,000	\$ 57,000	\$ 148,000
8003	9.5	1.20	9.5	2	1.50	\$ 49,830	\$ 17,441	\$ 4,983	\$ 7,475	\$ 80,000	\$ 51,000	\$ 131,000
8060	8.5	0.90	8.5	1	1.20	\$ 22,506	\$ 7,878	\$ 2,251	\$ 3,376	\$ 37,000	\$ 28,000	\$ 65,000
8061	11.5	0.90	11.5	1	1.20	\$ 23,955	\$ 8,385	\$ 2,396	\$ 3,594	\$ 39,000	\$ 24,000	\$ 63,000
8094	6	0.80	6.0	2	1.50	\$ 45,241	\$ 15,835	\$ 4,525	\$ 6,787	\$ 73,000	\$ 64,000	\$ 137,000
8095	3.5	1.60	3.5	2	1.50	\$ 41,964	\$ 14,688	\$ 4,197	\$ 6,295	\$ 68,000	\$ 91,000	\$ 159,000
8096	9	1.20	9.0	2	1.50	\$ 49,174	\$ 17,211	\$ 4,918	\$ 7,377	\$ 79,000	\$ 52,000	\$ 131,000
8097	13.5	0.80	13.5	2	1.50	\$ 55,074	\$ 19,276	\$ 5,508	\$ 8,262	\$ 89,000	\$ 44,000	\$ 133,000
8098	13	0.60	13.0	2	1.50	\$ 54,418	\$ 19,047	\$ 5,442	\$ 8,163	\$ 88,000	\$ 44,000	\$ 132,000
8099	7.5	0.90	7.5	2	1.50	\$ 47,208	\$ 16,523	\$ 4,721	\$ 7,082	\$ 76,000	\$ 57,000	\$ 133,000
8100	5.9	1.05	5.9	2	1.50	\$ 45,110	\$ 15,789	\$ 4,511	\$ 6,767	\$ 73,000	\$ 65,000	\$ 138,000
8101	6.8	1.20	6.8	2	1.50	\$ 46,290	\$ 16,202	\$ 4,629	\$ 6,944	\$ 75,000	\$ 60,000	\$ 135,000
8103	3.5	1.20	3.5	2	1.50	\$ 41,964	\$ 14,688	\$ 4,197	\$ 6,295	\$ 68,000	\$ 91,000	\$ 159,000
8104	12	1.56	12.0	2	1.50	\$ 53,107	\$ 18,588	\$ 5,311	\$ 7,967	\$ 85,000	\$ 46,000	\$ 131,000
8106	12	1.56	12.0	2	1.50	\$ 53,107	\$ 18,588	\$ 5,311	\$ 7,967	\$ 85,000	\$ 46,000	\$ 131,000
8108	7	1.60	7.0	2	1.80	\$ 52,889	\$ 18,512	\$ 5,289	\$ 7,934	\$ 85,000	\$ 65,000	\$ 150,000
8109	5	1.80	5.0	2	1.80	\$ 49,278	\$ 17,248	\$ 4,928	\$ 7,392	\$ 79,000	\$ 78,000	\$ 157,000
8110	6.5	1.60	6.5	2	1.80	\$ 51,986	\$ 18,196	\$ 5,199	\$ 7,798	\$ 84,000	\$ 67,000	\$ 151,000
8111	6	1.60	6.0	2	1.80	\$ 51,083	\$ 17,880	\$ 5,109	\$ 7,663	\$ 82,000	\$ 70,000	\$ 152,000
8132	20	1.20	20.0	2	1.50	\$ 63,595	\$ 22,259	\$ 6,360	\$ 9,540	\$ 102,000	\$ 38,000	\$ 140,000
9004	20.7	0.90	20.7	2	0.90	\$ 33,694	\$ 11,793	\$ 3,370	\$ 5,055	\$ 54,000	\$ 17,000	\$ 71,000
9005	59	1.00	59.0	1	1.80	\$ 87,763	\$ 30,718	\$ 8,777	\$ 13,165	\$ 141,000	\$ 28,000	\$ 169,000
Culvert Upgrade Total Cost						\$ 3,487,792	\$ 1,220,764	\$ 348,810	\$ 523,206	\$ 5,617,000	\$ 3,177,000	\$ 8,794,000

McGillivray Supplemental Channel Culvert											
Culvert ID	Proposed Length (m)	Proposed Number of Culverts	Proposed Diameter (m)	Base Construction Cost	Contingency	Admin.	Engineering	Total Estimated Cost	Site Improvement Contingency	Total Estimated Cost with Contingency	
Proposed for McGillivray Diversion	18.0	2	1.50	\$ 60,973	\$ 21,341	\$ 6,098	\$ 9,146	\$ 98,000	\$ 40,000	\$ 138,000	
McGillivray Supplemental Channel Culvert Upgrade Total Cost				\$ 60,973	\$ 21,341	\$ 6,098	\$ 9,146	\$ 98,000	\$ 40,000	\$ 138,000	

Lewis Supplemental Channel Culvert											
Culvert ID	Proposed Length (m)	Proposed Number of Culverts	Proposed Diameter (m)	Base Construction Cost	Contingency	Admin.	Engineering	Total Estimated Cost	Site Improvement Contingency	Total Estimated Cost with Contingency	
Proposed for Lewis Diversion at	20	2	1.5	\$ 63,595	\$ 22,259	\$ 6,360	\$ 9,540	\$ 102,000	\$ 39,000	\$ 141,000	
Proposed for Lewis Diversion at	20.0	2	1.50	\$ 63,595	\$ 22,259	\$ 6,360	\$ 9,540	\$ 102,000	\$ 39,000	\$ 141,000	
Lewis Supplemental Channel Culvert Total Cost				\$ 127,190	\$ 44,518	\$ 12,720	\$ 19,080	\$ 204,000	\$ 78,000	\$ 282,000	
All Culvert Total Cost										\$9,214,000	

CHANNEL

McGillivray Supplemental Channel											
Item #	Description	Unit	Quantity	Unit Price	Sub-total	Contingency	Admin.	Engineering	Total Estimated Cost		
1	Land Acquisition	m ²	16600	\$ 13	\$ 215,800	\$ 72,625	\$ 20,750	\$ 31,125	\$ 332,000		
2	Excavation	m ³	7000	\$ 33	\$ 231,000	\$ 80,850	\$ 23,100	\$ 34,650	\$ 370,000		
3	Control Structure	each	2	\$ 25,000	\$ 50,000	\$ 17,500	\$ 5,000	\$ 7,500	\$ 80,000		
McGillivray Supplemental Channel Total Cost					\$ 488,500	\$ 170,975	\$ 48,850	\$ 73,275	\$782,000		

Lewis Supplemental Channel											
Item #	Description	Unit	Quantity	Unit Price	Sub-total	Contingency	Admin.	Engineering	Total Estimated Cost		
1	Land Acquisition	m ²	27300	\$ 13	\$ 354,900	\$ 119,438	\$ 34,125	\$			

Cost Estimate - Culverts Option 1 & 6
City of Chilliwack - 2009 Drainage Study
USL - April 2009

Culvert ID	Current Length	Current Diameter	Proposed Length	Proposed Number of Culverts	Proposed Diameter	Culvert Cost	Excavation and Backfill Cost	Isolation Allowance	Surface Restoration	Mobilization	Base Construction Cost	Contingency	Admin.	Engineering	Total Estimated Cost	Site Improvement Contingency	Total Estimated Cost with Contingency
	(m)	(m)	(m)		(m)												
442	23.1	1.05	23.1	2	1.20	\$ 11,088	\$ 8,316	\$ 12,500	\$ 6,000	\$ 5,686	\$ 43,590	\$ 15,257	\$ 4,359	\$ 6,539	\$ 70,000	\$ 23,000	\$ 93,000
486	5.8	0.90	5.8	1	1.50	\$ 1,740	\$ 1,566	\$ 20,000	\$ 7,500	\$ 4,621	\$ 35,427	\$ 12,400	\$ 3,543	\$ 5,315	\$ 57,000	\$ 56,000	\$ 113,000
580	24.6	0.60	24.6	1	1.20	\$ 5,904	\$ 4,428	\$ 10,000	\$ 6,000	\$ 3,950	\$ 30,282	\$ 10,599	\$ 3,029	\$ 4,543	\$ 49,000	\$ 19,000	\$ 68,000
853	22.1	0.60	22.1	2	1.20	\$ 10,608	\$ 7,956	\$ 12,500	\$ 6,000	\$ 5,560	\$ 42,624	\$ 14,919	\$ 4,263	\$ 6,394	\$ 69,000	\$ 24,000	\$ 93,000
890	18.9	1.20	18.9	2	1.80	\$ 14,553	\$ 15,120	\$ 25,000	\$ 10,000	\$ 9,701	\$ 74,374	\$ 26,031	\$ 7,438	\$ 11,157	\$ 119,000	\$ 43,000	\$ 162,000
891	15.8	0.60	15.8	2	1.50	\$ 9,480	\$ 8,532	\$ 25,000	\$ 7,500	\$ 7,577	\$ 58,089	\$ 20,332	\$ 5,809	\$ 8,714	\$ 93,000	\$ 41,000	\$ 134,000
1111	7.2	0.60	7.2	1	1.20	\$ 1,728	\$ 1,296	\$ 10,000	\$ 6,000	\$ 2,854	\$ 21,878	\$ 7,658	\$ 2,188	\$ 3,282	\$ 36,000	\$ 30,000	\$ 66,000
1112	6.6	0.60	6.6	1	1.20	\$ 1,584	\$ 1,188	\$ 10,000	\$ 6,000	\$ 2,816	\$ 21,588	\$ 7,556	\$ 2,159	\$ 3,239	\$ 35,000	\$ 32,000	\$ 67,000
1113	5.6	0.60	5.6	1	1.20	\$ 1,344	\$ 1,008	\$ 10,000	\$ 6,000	\$ 2,753	\$ 21,105	\$ 7,387	\$ 2,111	\$ 3,166	\$ 34,000	\$ 35,000	\$ 69,000
1124	13.8	0.90	13.8	2	0.90	\$ 3,726	\$ 4,140	\$ 12,500	\$ 5,000	\$ 3,805	\$ 29,171	\$ 10,210	\$ 2,918	\$ 4,376	\$ 47,000	\$ 20,000	\$ 67,000
1125	6	0.30	6.0	2	0.90	\$ 1,620	\$ 1,800	\$ 12,500	\$ 5,000	\$ 3,138	\$ 24,058	\$ 8,421	\$ 2,406	\$ 3,609	\$ 39,000	\$ 31,000	\$ 70,000
1127	4.9	0.60	4.9	1	1.20	\$ 1,176	\$ 882	\$ 10,000	\$ 6,000	\$ 2,709	\$ 20,767	\$ 7,269	\$ 2,077	\$ 3,116	\$ 34,000	\$ 37,000	\$ 71,000
1129	10.1	0.53	10.1	1	1.20	\$ 2,424	\$ 1,818	\$ 10,000	\$ 6,000	\$ 3,037	\$ 23,279	\$ 8,148	\$ 2,328	\$ 3,492	\$ 38,000	\$ 26,000	\$ 64,000
1132	5.2	1.10	5.2	1	1.50	\$ 1,560	\$ 1,404	\$ 20,000	\$ 7,500	\$ 4,570	\$ 35,034	\$ 12,262	\$ 3,504	\$ 5,256	\$ 57,000	\$ 60,000	\$ 117,000
1133	9	1.10	9.0	1	1.50	\$ 2,700	\$ 2,430	\$ 20,000	\$ 7,500	\$ 4,895	\$ 37,525	\$ 13,134	\$ 3,753	\$ 5,629	\$ 61,000	\$ 44,000	\$ 105,000
1135	4.9	0.90	4.9	1	1.80	\$ 1,887	\$ 1,960	\$ 20,000	\$ 10,000	\$ 5,077	\$ 38,924	\$ 13,624	\$ 3,893	\$ 5,839	\$ 63,000	\$ 67,000	\$ 130,000
1137	10.3	0.60	10.3	1	1.20	\$ 2,472	\$ 1,854	\$ 10,000	\$ 6,000	\$ 3,049	\$ 23,375	\$ 8,182	\$ 2,338	\$ 3,507	\$ 38,000	\$ 26,000	\$ 64,000
1138	5.9	0.60	5.9	1	1.20	\$ 1,416	\$ 1,062	\$ 10,000	\$ 6,000	\$ 2,772	\$ 21,250	\$ 7,438	\$ 2,125	\$ 3,188	\$ 35,000	\$ 34,000	\$ 69,000
1139	6	0.60	6.0	1	1.20	\$ 1,440	\$ 1,080	\$ 10,000	\$ 6,000	\$ 2,778	\$ 21,298	\$ 7,455	\$ 2,130	\$ 3,195	\$ 35,000	\$ 33,000	\$ 68,000
1140	9.3	0.60	9.3	1	1.20	\$ 2,232	\$ 1,674	\$ 10,000	\$ 6,000	\$ 2,986	\$ 22,892	\$ 8,013	\$ 2,290	\$ 3,434	\$ 37,000	\$ 27,000	\$ 64,000
1146	81.2	1.50	81.2	2	1.50	\$ 48,720	\$ 43,848	\$ 25,000	\$ 7,500	\$ 18,761	\$ 143,829	\$ 50,341	\$ 14,383	\$ 21,575	\$ 231,000	\$ 30,000	\$ 261,000
1178	9	0.90	9.0	2	0.90	\$ 2,430	\$ 2,700	\$ 12,500	\$ 5,000	\$ 3,395	\$ 26,025	\$ 9,109	\$ 2,603	\$ 3,904	\$ 42,000	\$ 25,000	\$ 67,000
1193	5.2	0.75	5.2	1	1.50	\$ 1,560	\$ 1,404	\$ 20,000	\$ 7,500	\$ 4,570	\$ 35,034	\$ 12,262	\$ 3,504	\$ 5,256	\$ 57,000	\$ 60,000	\$ 117,000
1195	18	1.83	18.0	2	1.80	\$ 13,860	\$ 14,400	\$ 25,000	\$ 10,000	\$ 9,489	\$ 72,749	\$ 25,463	\$ 7,275	\$ 10,913	\$ 117,000	\$ 43,000	\$ 160,000
1204	8.3	0.90	8.3	1	1.50	\$ 2,490	\$ 2,241	\$ 20,000	\$ 7,500	\$ 4,835	\$ 37,066	\$ 12,974	\$ 3,707	\$ 5,560	\$ 60,000	\$ 46,000	\$ 106,000
1207	21.8	1.20	21.8	2	1.80	\$ 16,786	\$ 17,440	\$ 25,000	\$ 10,000	\$ 10,384	\$ 79,610	\$ 27,864	\$ 7,961	\$ 11,942	\$ 128,000	\$ 41,000	\$ 169,000
1212	8.5	1.83	8.5	2	1.80	\$ 6,545	\$ 6,800	\$ 25,000	\$ 10,000	\$ 7,252	\$ 55,597	\$ 19,459	\$ 5,560	\$ 8,340	\$ 89,000	\$ 58,000	\$ 147,000
1213	6.1	1.83	6.1	2	1.80	\$ 4,697	\$ 4,880	\$ 25,000	\$ 10,000	\$ 6,687	\$ 51,264	\$ 17,943	\$ 5,127	\$ 7,690	\$ 83,000	\$ 70,000	\$ 153,000
1217	8.2	0.90	8.2	1	1.20	\$ 1,968	\$ 1,476	\$ 10,000	\$ 6,000	\$ 2,917	\$ 22,361	\$ 7,827	\$ 2,237	\$ 3,355	\$ 36,000	\$ 28,000	\$ 64,000
1233	12.1	2.00	12.1	2	2.00	\$ 12,100	\$ 13,310	\$ 25,000	\$ 15,000	\$ 9,812	\$ 75,222	\$ 26,328	\$ 7,523	\$ 11,284	\$ 121,000	\$ 57,000	\$ 178,000
1234	8.7	1.20	8.7	2	1.20	\$ 4,176	\$ 3,132	\$ 12,500	\$ 6,000	\$ 3,872	\$ 29,680	\$ 10,388	\$ 2,968	\$ 4,452	\$ 48,000	\$ 32,000	\$ 80,000
1239	6.7	1.83	6.7	2	1.80	\$ 5,159	\$ 5,360	\$ 25,000	\$ 10,000	\$ 6,828	\$ 52,347	\$ 18,322	\$ 5,235	\$ 7,853	\$ 84,000	\$ 66,000	\$ 150,000
1241	9.1	1.53	9.1	2	1.50	\$ 5,460	\$ 4,914	\$ 25,000	\$ 7,500	\$ 6,432	\$ 49,306	\$ 17,258	\$ 4,931	\$ 7,396	\$ 79,000	\$ 52,000	\$ 131,000
8094	6	0.80	6.0	2	1.20	\$ 2,880	\$ 2,160	\$ 12,500	\$ 6,000	\$ 3,531	\$ 27,071	\$ 9,475	\$ 2,708	\$ 4,061	\$ 44,000	\$ 39,000	\$ 83,000
8097	13.5	0.80	13.5	2	1.20	\$ 6,480	\$ 4,860	\$ 12,500	\$ 6,000	\$ 4,476	\$ 34,316	\$ 12,011	\$ 3,432	\$ 5,148	\$ 55,000	\$ 27,000	\$ 82,000
8098	13	0.60	13.0	2	1.50	\$ 7,800	\$ 7,020	\$ 25,000	\$ 7,500	\$ 7,098	\$ 54,418	\$ 19,047	\$ 5,442	\$ 8,163	\$ 88,000	\$ 44,000	\$ 132,000
8099	7.5	0.90	7.5	2	1.50	\$ 4,500	\$ 4,050	\$ 25,000	\$ 7,500	\$ 6,158	\$ 47,208	\$ 16,523	\$ 4,721	\$ 7,082	\$ 76,000	\$ 57,000	\$ 133,000
8100	5.9	1.05	5.9	2	1.50	\$ 3,540	\$ 3,186	\$ 25,000	\$ 7,500	\$ 5,884	\$ 45,110	\$ 15,789	\$ 4,511	\$ 6,767	\$ 73,000	\$ 65,000	\$ 138,000
8101	6.8	1.20	6.8	2	1.50	\$ 4,080	\$ 3,672	\$ 25,000	\$ 7,500	\$ 6,038	\$ 46,290	\$ 16,202	\$ 4,629	\$ 6,944	\$ 75,000	\$ 60,000	\$ 135,000
8103	3.5	1.20	3.5	2	1.50	\$ 2,100	\$ 1,890	\$ 25,000	\$ 7,500	\$ 5,474	\$ 41,964	\$ 14,688	\$ 4,197	\$ 6,295	\$ 68,000	\$ 91,000	\$ 159,000
8104	12	1.56	12.0	2	1.50	\$ 7,200	\$ 6,480	\$ 25,000	\$ 7,500	\$ 6,927	\$ 53,107	\$ 18,588	\$ 5,311	\$ 7,967	\$ 85,000	\$ 46,000	\$ 131,000
8106	12	1.56	12.0	2	1.50	\$ 7,200	\$ 6,480	\$ 25,000	\$ 7,500	\$ 6,927	\$ 53,107	\$ 18,588	\$ 5,311	\$ 7,967	\$ 85,000	\$ 46,000	\$ 131,000
8108	7	1.60	7.0	2	1.80	\$ 5,390	\$ 5,600	\$ 25,000	\$ 10,000	\$ 6,899	\$ 52,889	\$ 18,512	\$ 5,289	\$ 7,934	\$ 85,000	\$ 65,000	\$ 150,000
8109	5	1.80	5.0	2	1.80	\$ 3,850	\$ 4,000	\$ 25,000	\$ 10,000	\$ 6,428	\$ 49,278	\$ 17,248	\$ 4,928	\$ 7,392	\$ 79,000	\$ 78,000	\$ 157,000
8110	6.5	1.60	6.5	2	1.80	\$ 5,005	\$ 5,200	\$ 25,000	\$ 10,000	\$ 6,781	\$ 51,986	\$ 18,196	\$ 5,199	\$ 7,798	\$ 84,000	\$ 67,000	\$ 151,000
8111	6	1.60	6.0	2	1.80	\$ 4,620	\$ 4,800	\$ 25,000	\$ 10,000	\$ 6,663	\$ 51,083	\$ 17,880	\$ 5,109	\$ 7,663	\$ 82,000	\$ 70,000	\$ 152,000
8132	20	1.20	20.0	2	1.20	\$ 9,600	\$ 7,200	\$ 12,500	\$ 6,000	\$ 5,295	\$ 40,595	\$ 14,209	\$ 4,060	\$ 6,090	\$ 65,000	\$ 24,000	\$ 89,000
9005	59	1.00	59.0	2	1.20	\$ 28,320	\$ 21,240	\$ 12,500	\$ 6,000	\$ 10,209	\$ 78,269	\$ 27,395	\$ 7,827	\$ 11,741	\$ 126,000	\$ 20,000	\$ 146,000
Total						\$ 309,198	\$ 279,257	\$ 880,000	\$ 360,500	\$ 274,356	\$ 2,103,311	\$ 736,184	\$ 210,349	\$ 315,522	\$ 3,391,000	\$ 2,115,000	\$ 5,506,000

Assumptions:

Assumed Aluminized steel pipe
 Assumed cost per unit meter of culvert: 750 mm -\$115; 900 mm-\$135; 1200mm-\$240; 1500mm-\$300;1800mm-\$385;2000 mm - \$500; 2100 mm - \$500.
 Assumed excavation and backfill cost/unit meter of culvert: 750mm-\$150; 900mm-\$150; 1200mm-\$180; 1500mm-\$270; 1800mm-\$400; 2000mm-\$550;2100mm-\$550.
 Assumed lump sum isolation cost: 750mm to1200mm-\$10,000; 1500mm to 2100mm- \$20,000.
 Assumed Lump sum surface restoration cost: 750mm-\$4000; 900mm-\$5000; 1200mm-\$6000; 1500mm-\$7500; 1800mm-\$10,000; 2000mm-\$15,000; 2100mm-\$15,000.
 Assumed mobilization cost= 15% of (Culvert cost+Excavation and backfill cost+Isolation cost+Surface restoration cost)
 Base Construction Cost=Culvert cost+Excavation and backfill cost+Isolation cost+Surface restoration cost+Mobilization cost
 Contingency = 35% of Base Cost
 Administration during construction = 10% of Base Cost
 Engineering = 15% of Base Cost
 Total Estimated Cost= Base construction cost+ Contingency+Administration cost +Engineering cost
 The 'Site Improvement Contingency' includes such things as headwalls, retaining wall, or local channel improvements. It is assumed that all works would not extend more than 6 m beyond the limit of the culvert.
 Total Estimated Cost with Site improvement contingency= Total estimated cost+site improvement contingency

Cost Estimate - Culverts Option 2, 3, 5&6B
City of Chilliwack - 2009 Drainage Study
USL - April 2009

Culvert ID	Current Length (m)	Current Diameter (m)	Proposed Length (m)	Proposed Number of Culverts	Proposed Diameter (m)	Culvert Cost	Excavation and Backfill Cost	Isolation Allowance	Surface Restoration	Mobilization	Base Construction Cost	Contingency	Admin.	Engineering	Total Estimated Cost	Site Improvement Contingency	Total Estimated Cost with Contingency
442	23.1	1.05	23.1	3	1.20	\$ 16,632	\$ 12,474	\$ 15,000	\$ 6,000	\$ 7,516	\$ 57,622	\$ 20,168	\$ 5,763	\$ 8,644	\$ 93,000	\$ 27,000	\$ 120,000
486	5.8	0.90	5.8	1	1.50	\$ 1,740	\$ 1,566	\$ 20,000	\$ 7,500	\$ 4,621	\$ 35,427	\$ 12,400	\$ 3,543	\$ 5,315	\$ 57,000	\$ 56,000	\$ 113,000
580	24.6	0.60	24.6	2	0.90	\$ 6,642	\$ 7,380	\$ 12,500	\$ 5,000	\$ 4,729	\$ 36,251	\$ 12,688	\$ 3,626	\$ 5,438	\$ 59,000	\$ 16,000	\$ 75,000
620	23.2	0.60	23.2	1	1.20	\$ 5,568	\$ 4,176	\$ 10,000	\$ 6,000	\$ 3,862	\$ 29,606	\$ 10,363	\$ 2,961	\$ 4,441	\$ 48,000	\$ 20,000	\$ 68,000
840	24.2	0.60	24.2	2	1.20	\$ 11,616	\$ 8,712	\$ 12,500	\$ 6,000	\$ 5,825	\$ 44,653	\$ 15,629	\$ 4,466	\$ 6,698	\$ 72,000	\$ 23,000	\$ 95,000
841	14.7	1.00	14.7	3	1.20	\$ 10,584	\$ 7,938	\$ 15,000	\$ 6,000	\$ 5,929	\$ 45,451	\$ 15,908	\$ 4,546	\$ 6,818	\$ 73,000	\$ 31,000	\$ 104,000
843	21	1.53	21.0	2	1.50	\$ 12,600	\$ 11,340	\$ 25,000	\$ 7,500	\$ 8,466	\$ 64,906	\$ 22,718	\$ 6,491	\$ 9,736	\$ 104,000	\$ 38,000	\$ 142,000
844	13.8	0.60	13.8	1	0.90	\$ 1,863	\$ 2,070	\$ 10,000	\$ 5,000	\$ 2,840	\$ 21,773	\$ 7,621	\$ 2,178	\$ 3,266	\$ 35,000	\$ 17,000	\$ 52,000
847	24	1.80	24.0	2	1.80	\$ 18,480	\$ 19,200	\$ 25,000	\$ 10,000	\$ 10,902	\$ 83,582	\$ 29,254	\$ 8,359	\$ 12,538	\$ 134,000	\$ 40,000	\$ 174,000
848	17.9	0.60	17.9	1	1.20	\$ 4,296	\$ 3,222	\$ 10,000	\$ 6,000	\$ 3,528	\$ 27,046	\$ 10,000	\$ 2,705	\$ 4,057	\$ 44,000	\$ 21,000	\$ 65,000
853	22.1	0.60	22.1	2	1.20	\$ 10,608	\$ 7,956	\$ 12,500	\$ 6,000	\$ 5,560	\$ 42,624	\$ 14,919	\$ 4,263	\$ 6,394	\$ 69,000	\$ 24,000	\$ 93,000
890	18.9	1.20	18.9	2	1.80	\$ 14,553	\$ 15,120	\$ 25,000	\$ 10,000	\$ 9,701	\$ 74,374	\$ 26,031	\$ 7,438	\$ 11,157	\$ 119,000	\$ 43,000	\$ 162,000
891	15.8	0.60	15.8	2	1.50	\$ 9,480	\$ 8,532	\$ 25,000	\$ 7,500	\$ 7,577	\$ 58,089	\$ 20,332	\$ 5,809	\$ 8,714	\$ 93,000	\$ 41,000	\$ 134,000
1111	7.2	0.60	7.2	1	1.20	\$ 1,728	\$ 1,296	\$ 10,000	\$ 6,000	\$ 2,854	\$ 21,878	\$ 7,658	\$ 2,188	\$ 3,282	\$ 36,000	\$ 30,000	\$ 66,000
1112	6.6	0.60	6.6	1	1.20	\$ 1,584	\$ 1,188	\$ 10,000	\$ 6,000	\$ 2,816	\$ 21,588	\$ 7,556	\$ 2,159	\$ 3,239	\$ 35,000	\$ 32,000	\$ 67,000
1113	5.6	0.60	5.6	1	1.20	\$ 1,344	\$ 1,008	\$ 10,000	\$ 6,000	\$ 2,753	\$ 21,105	\$ 7,387	\$ 2,111	\$ 3,166	\$ 34,000	\$ 35,000	\$ 69,000
1124	13.8	0.90	13.8	2	0.90	\$ 3,726	\$ 4,140	\$ 12,500	\$ 5,000	\$ 3,805	\$ 29,171	\$ 10,210	\$ 2,918	\$ 4,376	\$ 47,000	\$ 20,000	\$ 67,000
1125	6	0.30	6.0	2	1.20	\$ 2,880	\$ 2,160	\$ 12,500	\$ 6,000	\$ 3,531	\$ 27,071	\$ 9,475	\$ 2,708	\$ 4,061	\$ 44,000	\$ 39,000	\$ 83,000
1127	4.9	0.60	4.9	2	1.80	\$ 3,773	\$ 3,920	\$ 25,000	\$ 10,000	\$ 6,404	\$ 49,097	\$ 17,184	\$ 4,910	\$ 7,365	\$ 79,000	\$ 79,000	\$ 158,000
1128	7.6	0.60	7.6	1	1.50	\$ 2,280	\$ 2,052	\$ 20,000	\$ 7,500	\$ 4,775	\$ 36,607	\$ 12,813	\$ 3,661	\$ 5,492	\$ 59,000	\$ 48,000	\$ 107,000
1129	10.1	0.53	10.1	1	1.20	\$ 2,424	\$ 1,818	\$ 10,000	\$ 6,000	\$ 3,037	\$ 23,279	\$ 8,148	\$ 2,328	\$ 3,492	\$ 38,000	\$ 26,000	\$ 64,000
1132	5.2	1.10	5.2	2	1.20	\$ 2,496	\$ 1,872	\$ 12,500	\$ 6,000	\$ 3,431	\$ 26,299	\$ 9,205	\$ 2,630	\$ 3,945	\$ 43,000	\$ 42,000	\$ 85,000
1133	9	1.10	9.0	2	1.20	\$ 4,320	\$ 3,240	\$ 12,500	\$ 6,000	\$ 3,909	\$ 29,969	\$ 10,490	\$ 2,997	\$ 4,496	\$ 48,000	\$ 32,000	\$ 80,000
1135	4.9	0.90	4.9	2	1.20	\$ 2,352	\$ 1,764	\$ 12,500	\$ 6,000	\$ 3,393	\$ 26,009	\$ 9,104	\$ 2,601	\$ 3,902	\$ 42,000	\$ 44,000	\$ 86,000
1137	10.3	0.60	10.3	1	1.20	\$ 2,472	\$ 1,854	\$ 10,000	\$ 6,000	\$ 3,049	\$ 23,375	\$ 8,182	\$ 2,338	\$ 3,507	\$ 38,000	\$ 26,000	\$ 64,000
1138	5.9	0.60	5.9	1	1.20	\$ 1,416	\$ 1,062	\$ 10,000	\$ 6,000	\$ 2,772	\$ 21,250	\$ 7,438	\$ 2,125	\$ 3,188	\$ 35,000	\$ 34,000	\$ 69,000
1139	6	0.60	6.0	1	1.20	\$ 1,440	\$ 1,080	\$ 10,000	\$ 6,000	\$ 2,778	\$ 21,298	\$ 7,455	\$ 2,130	\$ 3,195	\$ 35,000	\$ 33,000	\$ 68,000
1140	9.3	0.60	9.3	1	1.20	\$ 2,232	\$ 1,674	\$ 10,000	\$ 6,000	\$ 2,986	\$ 22,892	\$ 8,013	\$ 2,290	\$ 3,434	\$ 37,000	\$ 27,000	\$ 64,000
1146	81.2	1.50	81.2	2	1.50	\$ 48,720	\$ 43,848	\$ 25,000	\$ 7,500	\$ 18,761	\$ 143,829	\$ 50,341	\$ 14,383	\$ 21,575	\$ 231,000	\$ 30,000	\$ 261,000
1162	8	1.48	8.0	3	1.50	\$ 7,200	\$ 6,480	\$ 30,000	\$ 7,500	\$ 7,677	\$ 58,857	\$ 20,600	\$ 5,886	\$ 8,829	\$ 95,000	\$ 63,000	\$ 158,000
1177	19	1.60	19.0	2	1.50	\$ 11,400	\$ 10,260	\$ 25,000	\$ 7,500	\$ 8,124	\$ 62,284	\$ 21,800	\$ 6,229	\$ 9,343	\$ 100,000	\$ 39,000	\$ 139,000
1178	9	0.90	9.0	2	1.50	\$ 5,400	\$ 4,860	\$ 25,000	\$ 7,500	\$ 6,414	\$ 49,174	\$ 17,211	\$ 4,918	\$ 7,377	\$ 79,000	\$ 52,000	\$ 131,000
1193	5.2	0.75	5.2	1	1.80	\$ 2,002	\$ 2,080	\$ 20,000	\$ 10,000	\$ 5,113	\$ 39,195	\$ 13,719	\$ 3,920	\$ 5,880	\$ 63,000	\$ 64,000	\$ 127,000
1195	18	1.83	18.0	2	1.80	\$ 13,860	\$ 14,400	\$ 25,000	\$ 10,000	\$ 9,489	\$ 72,749	\$ 25,463	\$ 7,275	\$ 10,913	\$ 117,000	\$ 43,000	\$ 160,000
1196	9.7	1.83	9.7	2	1.80	\$ 7,469	\$ 7,760	\$ 25,000	\$ 10,000	\$ 7,535	\$ 57,764	\$ 20,218	\$ 5,777	\$ 8,665	\$ 93,000	\$ 55,000	\$ 148,000
1197	8.2	1.83	8.2	2	1.80	\$ 6,314	\$ 6,560	\$ 25,000	\$ 10,000	\$ 7,182	\$ 55,056	\$ 19,270	\$ 5,506	\$ 8,259	\$ 89,000	\$ 59,000	\$ 148,000
1199	9.2	1.20	9.2	2	1.20	\$ 4,416	\$ 3,312	\$ 12,500	\$ 6,000	\$ 3,935	\$ 30,163	\$ 10,558	\$ 3,017	\$ 4,525	\$ 49,000	\$ 32,000	\$ 81,000
1200	12	1.20	12.0	1	1.80	\$ 4,620	\$ 4,800	\$ 20,000	\$ 10,000	\$ 5,913	\$ 45,333	\$ 15,867	\$ 4,534	\$ 6,800	\$ 73,000	\$ 42,000	\$ 115,000
1202	9.5	1.20	9.5	1	1.80	\$ 3,658	\$ 3,800	\$ 20,000	\$ 10,000	\$ 5,619	\$ 43,077	\$ 15,077	\$ 4,308	\$ 6,462	\$ 69,000	\$ 46,000	\$ 115,000
1204	8.3	0.90	8.3	2	1.50	\$ 4,980	\$ 4,482	\$ 25,000	\$ 7,500	\$ 6,295	\$ 48,257	\$ 16,890	\$ 4,826	\$ 7,239	\$ 78,000	\$ 54,000	\$ 132,000
1207	21.8	1.20	21.8	3	1.50	\$ 19,620	\$ 17,658	\$ 30,000	\$ 7,500	\$ 11,217	\$ 85,995	\$ 30,099	\$ 8,600	\$ 12,900	\$ 138,000	\$ 43,000	\$ 181,000
1210	15.3	2.80	15.3	3	1.80	\$ 17,672	\$ 18,360	\$ 30,000	\$ 10,000	\$ 11,405	\$ 87,437	\$ 30,603	\$ 8,744	\$ 13,116	\$ 140,000	\$ 53,000	\$ 193,000
1212	8.5	1.83	8.5	2	1.80	\$ 6,545	\$ 6,800	\$ 25,000	\$ 10,000	\$ 7,252	\$ 55,597	\$ 19,459	\$ 5,560	\$ 8,340	\$ 89,000	\$ 58,000	\$ 147,000
1213	6.1	1.83	6.1	2	1.80	\$ 4,697	\$ 4,880	\$ 25,000	\$ 10,000	\$ 6,687	\$ 51,264	\$ 17,943	\$ 5,127	\$ 7,690	\$ 83,000	\$ 70,000	\$ 153,000
1217	8.2	0.90	8.2	2	1.20	\$ 3,936	\$ 2,952	\$ 12,500	\$ 6,000	\$ 3,809	\$ 29,197	\$ 10,219	\$ 2,920	\$ 4,380	\$ 47,000	\$ 33,000	\$ 80,000
1232	83.4	1.83	83.4	2	1.80	\$ 64,218	\$ 66,720	\$ 25,000	\$ 10,000	\$ 24,891	\$ 190,829	\$ 66,791	\$ 19,083	\$ 28,625	\$ 306,000	\$ 33,000	\$ 339,000
1233	12.1	2.00	12.1	2	2.00	\$ 12,100	\$ 13,310	\$ 25,000	\$ 15,000	\$ 9,812	\$ 75,222	\$ 26,328	\$ 7,523	\$ 11,284	\$ 121,000	\$ 57,000	\$ 178,000
1234	8.7	1.20	8.7	2	1.80	\$ 6,699	\$ 6,960	\$ 25,000	\$ 10,000	\$ 7,299	\$ 55,958	\$ 19,586	\$ 5,596	\$ 8,394	\$ 90,000	\$ 58,000	\$ 148,000
1239	6.7	1.83	6.7	2	1.80	\$ 5,159	\$ 5,360	\$ 25,000	\$ 10,000	\$ 6,828	\$ 52,347	\$ 18,322	\$ 5,235	\$ 7,853	\$ 84,000	\$ 66,000	\$ 150,000
1241	9.1	1.53	9.1	2	1.80	\$ 7,007	\$ 7,280	\$ 25,000	\$ 10,000	\$ 7,394	\$ 56,681	\$ 19,839	\$ 5,669	\$ 8,503	\$ 91,000	\$ 57,000	\$ 148,000
8003	9.5	1.20	9.5	2	1.50	\$ 5,700	\$ 5,130	\$ 25,000	\$ 7,500	\$ 6,500	\$ 49,830	\$ 17,441	\$ 4,983	\$ 7,475	\$ 80,000	\$ 51,000	\$ 131,000
8060	8.5	0.90	8.5	1	1.20	\$ 2,040	\$ 1,530	\$ 10,000	\$ 6,000	\$ 2,936	\$ 22,506	\$ 7,878	\$ 2,251	\$ 3,376	\$ 37,000	\$ 28,000	\$ 65,000
8061	11.5	0.90	11.5	1	1.20	\$ 2,760	\$ 2,070	\$ 10,000	\$ 6,000	\$ 3,125	\$ 23,955	\$ 8,385	\$ 2,396	\$ 3,594	\$ 39,000	\$ 24,000	\$ 63,000
8094	6	0.80	6.0	2	1.50	\$ 3,600	\$ 3,240	\$ 25,000	\$ 7,500	\$ 5,901	\$ 45,241	\$ 15,835	\$ 4,525	\$ 6,787	\$ 73,000	\$ 64,000	\$ 137,000
8095	3.5	1.60	3.5	2	1.50	\$ 2,100	\$ 1,890	\$ 25,000	\$ 7,500	\$ 5,474	\$ 41,964	\$ 14,688	\$ 4,197	\$ 6,295	\$ 68,000	\$ 91,000	\$ 159,000
8096	9	1.20	9.0	2	1.50	\$ 5,400	\$ 4,860	\$ 25,000	\$ 7,500	\$ 6,414	\$ 49,174	\$ 17,211	\$ 4,918	\$ 7,377	\$ 79,000	\$ 52,000	\$ 131,000
8097	13.5	0.80	13.5	2	1.50	\$ 8,100	\$ 7,290	\$ 25,000	\$ 7,500	\$ 7,184	\$ 55,074	\$ 19,276	\$ 5,508	\$ 8,262	\$ 89,000	\$ 44,000	\$ 133,000
8098	13	0.60	13.0	2	1.50	\$ 7,800	\$ 7,020	\$ 25,000	\$ 7,500	\$ 7,098	\$ 54,418	\$ 19,047	\$ 5,442	\$ 8,163	\$ 88,000	\$ 44,000	\$ 132,000
8099	7.5	0.90	7.5	2	1.50	\$ 4,500	\$ 4,050	\$ 25,000	\$ 7,500	\$ 6,158	\$ 47,208	\$ 16,523	\$ 4,721	\$ 7,082	\$ 76,000	\$ 57,000	\$ 133,000
8100	5.9	1.05	5.9	2	1.50	\$ 3,540	\$ 3,186	\$ 25,000	\$ 7,500	\$ 5,884	\$ 45,110	\$ 15,789	\$ 4,511	\$ 6,767	\$ 73,000	\$ 65,000	\$ 138,000
8101	6.8	1.20	6.8	2	1.50	\$ 4,080	\$ 3,672	\$ 25,000	\$ 7,500	\$ 6,038	\$ 46,290	\$ 16,202	\$ 4,629	\$ 6,944	\$ 75,000	\$ 60,000	\$ 135,000
8103	3.5	1.20	3.5	2	1.50	\$ 2,100	\$ 1,890	\$ 25,000	\$ 7,500	\$ 5,474	\$ 41,964	\$ 14,688	\$ 4,197	\$ 6,295	\$ 68,000	\$ 91,000	\$ 159,000
8104	12	1.56	12.0														

Cost Estimate - Culverts Option 4
City of Chilliwack - 2009 Drainage Study
USL - April 2009

Culvert ID	Current Length	Current Diameter	Proposed Length	Proposed Number of Culverts	Proposed Diameter	Culvert Cost	Excavation and Backfill Cost	Isolation Allowance	Surface Restoration	Mobilization	Base Construction Cost	Contingency	Admin.	Engineering	Total Estimated Cost	Site Improvement Contingency	Total Estimated Cost with Contingency
	(m)	(m)	(m)		(m)												
442	23.1	1.05	23.1	3	1.20	\$ 16,632	\$ 12,474	\$ 15,000	\$ 6,000	\$ 7,516	\$ 57,622	\$ 20,168	\$ 5,763	\$ 8,644	\$ 93,000	\$ 27,000	\$ 120,000
486	5.8	0.90	5.8	1	1.50	\$ 1,740	\$ 1,566	\$ 20,000	\$ 7,500	\$ 4,621	\$ 35,427	\$ 12,400	\$ 3,543	\$ 5,315	\$ 57,000	\$ 56,000	\$ 113,000
840	24.2	0.60	24.2	2	1.20	\$ 11,616	\$ 8,712	\$ 12,500	\$ 6,000	\$ 5,825	\$ 44,653	\$ 15,629	\$ 4,466	\$ 6,698	\$ 72,000	\$ 23,000	\$ 95,000
841	14.7	1.00	14.7	3	1.20	\$ 10,584	\$ 7,938	\$ 15,000	\$ 6,000	\$ 5,929	\$ 45,451	\$ 15,908	\$ 4,546	\$ 6,818	\$ 73,000	\$ 31,000	\$ 104,000
843	21	1.53	21.0	2	1.50	\$ 12,600	\$ 11,340	\$ 25,000	\$ 7,500	\$ 8,466	\$ 64,906	\$ 22,718	\$ 6,491	\$ 9,736	\$ 104,000	\$ 38,000	\$ 142,000
847	24	1.80	24.0	2	1.80	\$ 18,480	\$ 19,200	\$ 25,000	\$ 10,000	\$ 10,902	\$ 83,582	\$ 29,254	\$ 8,359	\$ 12,538	\$ 134,000	\$ 40,000	\$ 174,000
890	18.9	1.20	18.9	2	1.80	\$ 14,553	\$ 15,120	\$ 25,000	\$ 10,000	\$ 9,701	\$ 74,374	\$ 26,031	\$ 7,438	\$ 11,157	\$ 119,000	\$ 43,000	\$ 162,000
891	15.8	0.60	15.8	2	1.50	\$ 9,480	\$ 8,532	\$ 25,000	\$ 7,500	\$ 7,577	\$ 58,089	\$ 20,332	\$ 5,809	\$ 8,714	\$ 93,000	\$ 41,000	\$ 134,000
1124	13.8	0.90	13.8	2	0.90	\$ 3,726	\$ 4,140	\$ 12,500	\$ 5,000	\$ 3,805	\$ 29,171	\$ 10,210	\$ 2,918	\$ 4,376	\$ 47,000	\$ 20,000	\$ 67,000
1125	6	0.30	6.0	2	1.20	\$ 2,880	\$ 2,160	\$ 12,500	\$ 6,000	\$ 3,531	\$ 27,071	\$ 9,475	\$ 2,708	\$ 4,061	\$ 44,000	\$ 39,000	\$ 83,000
1127	4.9	0.60	4.9	2	1.80	\$ 3,773	\$ 3,920	\$ 25,000	\$ 10,000	\$ 6,404	\$ 49,097	\$ 17,184	\$ 4,910	\$ 7,365	\$ 79,000	\$ 79,000	\$ 158,000
1128	7.6	0.60	7.6	1	1.50	\$ 2,280	\$ 2,052	\$ 20,000	\$ 7,500	\$ 4,775	\$ 36,607	\$ 12,813	\$ 3,661	\$ 5,492	\$ 59,000	\$ 48,000	\$ 107,000
1129	10.1	0.53	10.1	1	1.20	\$ 2,424	\$ 1,818	\$ 10,000	\$ 6,000	\$ 3,037	\$ 23,279	\$ 8,148	\$ 2,328	\$ 3,492	\$ 38,000	\$ 26,000	\$ 64,000
1132	5.2	1.10	5.2	2	1.20	\$ 2,496	\$ 1,872	\$ 12,500	\$ 6,000	\$ 3,431	\$ 26,299	\$ 9,205	\$ 2,630	\$ 3,945	\$ 43,000	\$ 42,000	\$ 85,000
1133	9	1.10	9.0	2	1.20	\$ 4,320	\$ 3,240	\$ 12,500	\$ 6,000	\$ 3,909	\$ 29,969	\$ 10,490	\$ 2,997	\$ 4,496	\$ 48,000	\$ 32,000	\$ 80,000
1135	4.9	0.90	4.9	2	1.20	\$ 2,352	\$ 1,764	\$ 12,500	\$ 6,000	\$ 3,393	\$ 26,009	\$ 9,104	\$ 2,601	\$ 3,902	\$ 42,000	\$ 44,000	\$ 86,000
1137	10.3	0.60	10.3	1	1.20	\$ 2,472	\$ 1,854	\$ 10,000	\$ 6,000	\$ 3,049	\$ 23,375	\$ 8,182	\$ 2,338	\$ 3,507	\$ 38,000	\$ 26,000	\$ 64,000
1138	5.9	0.60	5.9	1	1.20	\$ 1,416	\$ 1,062	\$ 10,000	\$ 6,000	\$ 2,772	\$ 21,250	\$ 7,438	\$ 2,125	\$ 3,188	\$ 35,000	\$ 34,000	\$ 69,000
1139	6	0.60	6.0	1	1.20	\$ 1,440	\$ 1,080	\$ 10,000	\$ 6,000	\$ 2,778	\$ 21,298	\$ 7,455	\$ 2,130	\$ 3,195	\$ 35,000	\$ 33,000	\$ 68,000
1140	9.3	0.60	9.3	1	1.20	\$ 2,232	\$ 1,674	\$ 10,000	\$ 6,000	\$ 2,986	\$ 22,892	\$ 8,013	\$ 2,290	\$ 3,434	\$ 37,000	\$ 27,000	\$ 64,000
1146	81.2	1.50	81.2	2	1.50	\$ 48,720	\$ 43,848	\$ 25,000	\$ 7,500	\$ 18,761	\$ 143,829	\$ 50,341	\$ 14,383	\$ 21,575	\$ 231,000	\$ 30,000	\$ 261,000
1162	8	1.48	8.0	3	1.50	\$ 7,200	\$ 6,480	\$ 30,000	\$ 7,500	\$ 7,677	\$ 58,857	\$ 20,600	\$ 5,886	\$ 8,829	\$ 95,000	\$ 63,000	\$ 158,000
1177	19	1.60	19.0	2	1.50	\$ 11,400	\$ 10,260	\$ 25,000	\$ 7,500	\$ 8,124	\$ 62,284	\$ 21,800	\$ 6,229	\$ 9,343	\$ 100,000	\$ 39,000	\$ 139,000
1178	9	0.90	9.0	2	1.50	\$ 5,400	\$ 4,860	\$ 25,000	\$ 7,500	\$ 6,414	\$ 49,174	\$ 17,211	\$ 4,918	\$ 7,377	\$ 79,000	\$ 52,000	\$ 131,000
1195	18	1.83	18.0	2	1.80	\$ 13,860	\$ 14,400	\$ 25,000	\$ 10,000	\$ 9,489	\$ 72,749	\$ 25,463	\$ 7,275	\$ 10,913	\$ 117,000	\$ 43,000	\$ 160,000
1196	9.7	1.83	9.7	2	1.80	\$ 7,469	\$ 7,760	\$ 25,000	\$ 10,000	\$ 7,535	\$ 57,764	\$ 20,218	\$ 5,777	\$ 8,665	\$ 93,000	\$ 55,000	\$ 148,000
1197	8.2	1.83	8.2	2	1.80	\$ 6,314	\$ 6,560	\$ 25,000	\$ 10,000	\$ 7,182	\$ 55,056	\$ 19,270	\$ 5,506	\$ 8,259	\$ 89,000	\$ 59,000	\$ 148,000
1199	9.2	1.20	9.2	2	1.20	\$ 4,416	\$ 3,312	\$ 12,500	\$ 6,000	\$ 3,935	\$ 30,163	\$ 10,558	\$ 3,017	\$ 4,525	\$ 49,000	\$ 32,000	\$ 81,000
1200	12	1.20	12.0	1	1.80	\$ 4,620	\$ 4,800	\$ 20,000	\$ 10,000	\$ 5,913	\$ 45,333	\$ 15,867	\$ 4,534	\$ 6,800	\$ 73,000	\$ 42,000	\$ 115,000
1202	9.5	1.20	9.5	1	1.80	\$ 3,658	\$ 3,800	\$ 20,000	\$ 10,000	\$ 5,619	\$ 43,077	\$ 15,077	\$ 4,308	\$ 6,462	\$ 69,000	\$ 46,000	\$ 115,000
1204	8.3	0.90	8.3	2	1.50	\$ 4,980	\$ 4,482	\$ 25,000	\$ 7,500	\$ 6,295	\$ 48,257	\$ 16,890	\$ 4,826	\$ 7,239	\$ 78,000	\$ 54,000	\$ 132,000
1207	21.8	1.20	21.8	3	1.50	\$ 19,620	\$ 17,658	\$ 30,000	\$ 7,500	\$ 11,217	\$ 85,995	\$ 30,099	\$ 8,600	\$ 12,900	\$ 138,000	\$ 43,000	\$ 181,000
1210	15.3	2.80	15.3	3	1.80	\$ 17,672	\$ 18,360	\$ 30,000	\$ 10,000	\$ 11,405	\$ 87,437	\$ 30,603	\$ 8,744	\$ 13,116	\$ 140,000	\$ 53,000	\$ 193,000
1212	8.5	1.83	8.5	2	1.80	\$ 6,545	\$ 6,800	\$ 25,000	\$ 10,000	\$ 7,252	\$ 55,597	\$ 19,459	\$ 5,560	\$ 8,340	\$ 89,000	\$ 58,000	\$ 147,000
1213	6.1	1.83	6.1	2	1.80	\$ 4,697	\$ 4,880	\$ 25,000	\$ 10,000	\$ 6,687	\$ 51,264	\$ 17,943	\$ 5,127	\$ 7,690	\$ 83,000	\$ 70,000	\$ 153,000
1217	8.2	0.90	8.2	2	1.20	\$ 3,936	\$ 2,952	\$ 12,500	\$ 6,000	\$ 3,809	\$ 29,197	\$ 10,219	\$ 2,920	\$ 4,380	\$ 47,000	\$ 33,000	\$ 80,000
1232	83.4	1.83	83.4	2	1.80	\$ 64,218	\$ 66,720	\$ 25,000	\$ 10,000	\$ 24,891	\$ 190,829	\$ 66,791	\$ 19,083	\$ 28,625	\$ 306,000	\$ 33,000	\$ 339,000
1233	12.1	2.00	12.1	2	2.00	\$ 12,100	\$ 13,310	\$ 25,000	\$ 15,000	\$ 9,812	\$ 75,222	\$ 26,328	\$ 7,523	\$ 11,284	\$ 121,000	\$ 57,000	\$ 178,000
1234	8.7	1.20	8.7	2	1.80	\$ 6,699	\$ 6,960	\$ 25,000	\$ 10,000	\$ 7,299	\$ 55,958	\$ 19,586	\$ 5,596	\$ 8,394	\$ 90,000	\$ 58,000	\$ 148,000
1239	6.7	1.83	6.7	2	1.80	\$ 5,159	\$ 5,360	\$ 25,000	\$ 10,000	\$ 6,828	\$ 52,347	\$ 18,322	\$ 5,235	\$ 7,853	\$ 84,000	\$ 66,000	\$ 150,000
1241	9.1	1.53	9.1	2	1.80	\$ 7,007	\$ 7,280	\$ 25,000	\$ 10,000	\$ 7,394	\$ 56,681	\$ 19,839	\$ 5,669	\$ 8,503	\$ 91,000	\$ 57,000	\$ 148,000
8003	9.5	1.20	9.5	2	1.50	\$ 5,700	\$ 5,130	\$ 25,000	\$ 7,500	\$ 6,500	\$ 49,830	\$ 17,441	\$ 4,983	\$ 7,475	\$ 80,000	\$ 51,000	\$ 131,000
8094	6	0.80	6.0	2	1.50	\$ 3,600	\$ 3,240	\$ 25,000	\$ 7,500	\$ 5,901	\$ 45,241	\$ 15,835	\$ 4,525	\$ 6,787	\$ 73,000	\$ 64,000	\$ 137,000
8095	3.5	1.60	3.5	2	1.50	\$ 2,100	\$ 1,890	\$ 25,000	\$ 7,500	\$ 5,474	\$ 41,964	\$ 14,688	\$ 4,197	\$ 6,295	\$ 68,000	\$ 91,000	\$ 159,000
8096	9	1.20	9.0	2	1.50	\$ 5,400	\$ 4,860	\$ 25,000	\$ 7,500	\$ 6,414	\$ 49,174	\$ 17,211	\$ 4,918	\$ 7,377	\$ 79,000	\$ 52,000	\$ 131,000
8097	13.5	0.80	13.5	2	1.50	\$ 8,100	\$ 7,290	\$ 25,000	\$ 7,500	\$ 7,184	\$ 55,074	\$ 19,276	\$ 5,508	\$ 8,262	\$ 89,000	\$ 44,000	\$ 133,000
8098	13	0.60	13.0	2	1.50	\$ 7,800	\$ 7,020	\$ 25,000	\$ 7,500	\$ 7,098	\$ 54,418	\$ 19,047	\$ 5,442	\$ 8,163	\$ 88,000	\$ 44,000	\$ 132,000
8099	7.5	0.90	7.5	2	1.50	\$ 4,500	\$ 4,050	\$ 25,000	\$ 7,500	\$ 6,158	\$ 47,208	\$ 16,523	\$ 4,721	\$ 7,082	\$ 76,000	\$ 57,000	\$ 133,000
8100	5.9	1.05	5.9	2	1.50	\$ 3,540	\$ 3,186	\$ 25,000	\$ 7,500	\$ 5,884	\$ 45,110	\$ 15,789	\$ 4,511	\$ 6,767	\$ 73,000	\$ 65,000	\$ 138,000
8101	6.8	1.20	6.8	2	1.50	\$ 4,080	\$ 3,672	\$ 25,000	\$ 7,500	\$ 6,038	\$ 46,290	\$ 16,202	\$ 4,629	\$ 6,944	\$ 75,000	\$ 60,000	\$ 135,000
8103	3.5	1.20	3.5	2	1.50	\$ 2,100	\$ 1,890	\$ 25,000	\$ 7,500	\$ 5,474	\$ 41,964	\$ 14,688	\$ 4,197	\$ 6,295	\$ 68,000	\$ 91,000	\$ 159,000
8104	12	1.56	12.0	2	1.50	\$ 7,200	\$ 6,480	\$ 25,000	\$ 7,500	\$ 6,927	\$ 53,107	\$ 18,588	\$ 5,311	\$ 7,967	\$ 85,000	\$ 46,000	\$ 131,000
8106	12	1.56	12.0	2	1.50	\$ 7,200	\$ 6,480	\$ 25,000	\$ 7,500	\$ 6,927	\$ 53,107	\$ 18,588	\$ 5,311	\$ 7,967	\$ 85,000	\$ 46,000	\$ 131,000
8108	7	1.60	7.0	2	1.80	\$ 5,390	\$ 5,600	\$ 25,000	\$ 10,000	\$ 6,899	\$ 52,889	\$ 18,512	\$ 5,289	\$ 7,934	\$ 85,000	\$ 65,000	\$ 150,000
8109	5	1.80	5.0	2	1.80	\$ 3,850	\$ 4,000	\$ 25,000	\$ 10,000	\$ 6,428	\$ 49,278	\$ 17,248	\$ 4,928	\$ 7,392	\$ 79,000	\$ 78,000	\$ 157,000
8110	6.5	1.60	6.5	2	1.80	\$ 5,005	\$ 5,200	\$ 25,000	\$ 10,000	\$ 6,781	\$ 51,986	\$ 18,196	\$ 5,199	\$ 7,798	\$ 84,000	\$ 67,000	\$ 151,000
8111	6	1.60	6.0	2	1.80	\$ 4,620	\$ 4,800	\$ 25,000	\$ 10,000	\$ 6,663	\$ 51,083	\$ 17,880	\$ 5,109	\$ 7,663	\$ 82,000	\$ 70,000	\$ 152,000
8132	20	1.20	20.0	2	1.50	\$ 12,000	\$ 10,800	\$ 25,000	\$ 7,500	\$ 8,295	\$ 63,595	\$ 22,259	\$ 6,360	\$ 9,540	\$ 102,000	\$ 38,000	\$ 140,000
9005	59	1.00	59.0	1	1.80	\$ 22,715	\$ 23,600	\$ 20,000	\$ 10,000	\$ 11,448	\$ 87,763	\$ 30,718	\$ 8,777	\$ 13,165	\$ 141,000	\$ 28,000	\$ 169,000
TOTAL:						\$ 508,085	\$ 481,548	\$ 1,270,000	\$ 476,500	\$ 410,438	\$ 3,146,571	\$ 1,101,330	\$ 314,682	\$ 472,018	\$ 5,064,000	\$ 2,849,000	\$ 7,913,000

Assumptions:

Assumed Aluminized steel pipe
 Assumed cost per unit meter of culvert: 750 mm -\$115; 900 mm-\$135; 1200mm-\$240; 1500mm-\$300;1800mm-\$385;2000 mm - \$500; 2100 mm - \$500.
 Assumed excavation and backfill cost/unit meter of culvert: 750mm-\$150; 900mm-\$150; 1200mm-\$180; 1500mm-\$270; 1800mm-\$4

Cost Estimate - Option 4&5 (Hopedale Road Channel N)

City of Chilliwack - 2009 Drainage Study

USL - April 2009

Item #	Description	Unit	Quantity	Unit Price	Sub-total
	(m)				(m)
HOPEDALE ROAD CHANNEL (North Section)					
1	Land Acquisition	m ²	Unknown	-	NA
2	Excavation	m ³	17100	\$33.00	\$564,300
3	Control Structure	each	2	\$25,000.00	\$50,000
	SUBTOTAL				\$614,300
	35% Contingency cost				\$215,005
	10% Administration cost during Construction				\$61,430
	Engineering cost				\$92,145
	TOTAL				\$982,880

Assumptions:

Does not include Land Acquisition Costs

Contingency = 35% of the cost of land acquisition, excavation and control structure

Administration during construction= 10% of the cost of land acquisition, excavation and control structure

Engineering = 15% of the cost of land acquisition, excavation and control structure

*** The channel feasibility and cost will need to be proven through further investigation to resolve alignment discrepancies between topography and legal boundaries**

Cost Estimate - Option 4&5 (Hopedale Road Channel S)
City of Chilliwack - 2009 Drainage Study

USL - April 2009

Item #	Description	Unit	Quantity	Unit Price	Sub-total
	(m)				(m)
HOPEDALE ROAD CHANNEL (South Section)					
1	Land Acquisition	m ²	Unknown	-	NA
2	Excavation	m ³	7200	\$33.00	\$237,600
3	Driveway Culvert Allowance	ea	6	\$50,000.00	\$300,000
	SUBTOTAL				\$537,600
	35% Contingency cost				\$188,160
	10% Administration cost during Construction				\$53,760
	Engineering cost				\$80,640
	TOTAL				\$860,160

Assumptions:

Does not include Land Acquisition Costs

Contingency = 35% of the cost of land acquisition, excavation and control structure

Administration during construction= 10% of the cost of land acquisition, excavation and control structure

Engineering = 15% of the cost of land acquisition, excavation and control structure

*** The channel feasibility and cost will need to be proven through further investigation to resolve alignment discrepancies between topography and legal boundaries**

Cost Estimate - Option 6 (New Pump Station)

City of Chilliwack - 2009 Drainage Study

USL - April 2009

Item #	Description (m)	Unit	Quantity	Unit Price	Sub-total (m)
New Pump Station					
1	Land Acquisition	m ²	1140	\$12.50	\$14,250
2	Pump Station	LS	1	\$4,000,000.00	\$4,000,000
	SUBTOTAL				\$4,014,250
	35% Contingency cost				\$1,404,988
	10% Administration cost during Construction				\$401,425
	Engineering cost				\$602,138
	TOTAL				\$6,422,800

Assumptions:

Does not include Land Acquisition Costs

Contingency = 35% of the cost of land acquisition, excavation and control structure

Administration during construction= 10% of the cost of land acquisition, excavation and control structure

Engineering = 15% of the cost of land acquisition, excavation and control structure

Cost Estimate - Option 6 (New Pump Station Channel)
City of Chilliwack - 2009 Drainage Study

USL - April 2009

Item #	Description	Unit	Quantity	Unit Price	Sub-total
	(m)				(m)
New Pump Station Channel					
1	Land Acquisition	m ²	19200	\$12.50	\$240,000
2	Excavation	m ³	20300	\$33.00	\$669,900
3	Driveway Culvert Allowance	ea	0	\$50,000.00	\$0
	SUBTOTAL				\$909,900
	35% Contingency cost				\$318,465
	10% Administration cost during Construction				\$90,990
	Engineering cost				\$136,485
	TOTAL				\$1,455,840

Assumptions:

Does not include Land Acquisition Costs

Contingency = 35% of the cost of land acquisition, excavation and control structure

Administration during construction= 10% of the cost of land acquisition, excavation and control structure

Engineering = 15% of the cost of land acquisition, excavation and control structure

*** The channel feasibility and cost will need to be proven through further investigation to resolve alignment discrepancies between topography and legal boundaries**

Cost Estimate - McGillivray Supplemental Channel
City of Chilliwack - 2009 Drainage Study
USL - April 2009

CULVERT

Culvert	Proposed Length (m)	Proposed Number of Culverts	Proposed Diameter (m)	Culvert Cost (\$)	Excavation and Backfill Cost (\$)	Isolation Allowance (\$)	Surface Restoration (\$)	Mobilization (\$)	Base Construction Cost (\$)	Contingency (\$)	Administration (\$)	Engineering (\$)	Total Estimated Cost	Site Improvement Contingency (\$)	Total Estimated Cost with Contingency (\$)
Proposed	18.0	2	1.50	10,800.00	9,720.00	25,000.00	7,500.00	7,953.00	60,973.00	21,341.00	6,098.00	9,146.00	98,000.00	40,000.00	138,000.00

CHANNEL

Item #	Description (m)	Unit	Quantity	Unit Price	Sub-total (m)
Channel					
1	Land Acquisition	m ²	16600	\$12.50	\$207,500
2	Excavation	m ³	7000	\$33.00	\$231,000
3	Control Structure	each	2	\$25,000.00	\$50,000
	SUBTOTAL				\$488,500
	35% Contingency cost				\$170,975
	10% Administration cost during Construction				\$48,850
	Engineering cost				\$73,275
	TOTAL				\$781,600

Assumptions for Culvert:

Assumed Aluminized steel pipe
 Assumed cost per unit meter of culvert: 750 mm -\$115; 900 mm-\$135; 1200mm-\$240; 1500mm-\$300;1800mm-\$385;2000 mm - \$500; 2100 mm - \$500.
 Assumed excavation and backfill cost/unit meter of culvert: 750mm-\$150; 900mm-\$150; 1200mm-\$180; 1500mm-\$270; 1800mm-\$400; 2000mm-\$550;2100mm-\$550.
 Assumed lump sum Isolation cost: 750mm to1200mm-\$10,000; 1500mm to 2100mm- \$20,000.
 Assumed Lump sum surface restoration cost: 750mm-\$4000; 900mm-\$5000; 1200mm-\$6000; 1500mm-\$7500; 1800mm-\$10,000; 2000mm-\$15,000; 2100mm-\$15,000.
 Assumed mobilization cost= 15% of (Culvert cost+Excavation and backfill cost+Isolation cost+Surface restoration cost)
 Base Construction Cost=Culvert cost+Excavation and backfill cost+Isolation cost+Surface restoration cost+Mobilization cost
 Contingency cost= 35% of Base Cost
 Administration during construction = 10% of Base Cost
 Engineering = 15% of Base Cost
 Total Estimated Cost= Base construction cost+ Contingency+Administration cost +Engineering cost
 The 'Site Improvement Contingency' includes such things as headwalls, retaining wall or local channel improvements. It is assumed that all works would not extend more than 6 m beyond the limit of the culvert.
 Total Estimated Cost with Site improvement contingency= Total estimated cost+site improvement contingency

Assumptions for channel:

Assumed 4 m offset on the south side and 1 m offset on the north side of the proposed channel.
 Contingency = 35% of the cost of land acquisition, excavation and control structure
 Administration during construction= 10% of the cost of land acquisition, excavation and control structure
 Engineering = 15% of the cost of land acquisition, excavation and control structure

*** The channel feasibility and cost will need to be proven through further investigation to resolve alignment discrepancies between topography and legal boundaries**

Cost Estimate - Lewis Supplemental Channel
City of Chilliwack - 2009 Drainage Study
USL - April 2009

CULVERT

Culvert	Proposed Length (m)	Proposed Number of Culverts	Proposed Diameter (m)	Culvert Cost (\$)	Excavation and Backfill Cost (\$)	Isolation Allowance (\$)	Surface Restoration (\$)	Mobilization (\$)	Base Construction Cost (\$)	Contingency (\$)	Administration (\$)	Engineering (\$)	Total Estimated Cost	Site Improvement Contingency (\$)	Total Estimated Cost with Contingency (\$)
Proposed	20	2	1.5	12,000.00	10,800.00	25,000.00	7,500.00	8,295.00	63,595.00	22,259.00	6,360.00	9,540.00	102,000.00	39,000.00	141,000.00
Proposed	20.0	2	1.50	12000	10,800.00	25,000.00	7,500.00	8,295.00	63,595.00	22,259.00	6,360.00	9,540.00	102,000.00	39,000.00	141,000.00
															282,000.00

CHANNEL

Item #	Description (m)	Unit	Quantity	Unit Price	Sub-total (m)
Channel					
1	Land Acquisition	m ²	27300	\$12.50	\$341,250
2	Excavation	m ³	14800	\$33.00	\$488,400
3	Control Structure	each	2	\$25,000.00	\$50,000
	SUBTOTAL				\$879,650
	35% Contingency cost				\$307,878
	10% Administration cost during Construction				\$87,965
	Engineering cost				\$131,948
	TOTAL				\$1,407,440

Assumptions for Culvert:

Assumed Aluminized steel pipe
 Assumed cost per unit meter of culvert: 750 mm -\$115; 900 mm-\$135; 1200mm-\$240; 1500mm-\$300;1800mm-\$385;2000 mm - \$500; 2100 mm - \$500.
 Assumed excavation and backfill cost/unit meter of culvert: 750mm-\$150; 900mm-\$150; 1200mm-\$180; 1500mm-\$270; 1800mm-\$400; 2000mm-\$550;2100mm-\$550.
 Assumed lump sum Isolation cost: 750mm to1200mm-\$10,000; 1500mm to 2100mm- \$20,000.
 Assumed Lump sum surface restoration cost: 750mm-\$4000; 900mm-\$5000; 1200mm-\$6000; 1500mm-\$7500; 1800mm-\$10,000; 2000mm-\$15,000; 2100mm-\$15,000.
 Assumed mobilization cost= 15% of (Culvert cost+Excavation and backfill cost+Isolation cost+Surface restoration cost)
 Base Construction Cost=Culvert cost+Excavation and backfill cost+Isolation cost+Surface restoration cost+Mobilization cost
 Contingency cost= 35% of Base Cost
 Administration during construction = 10% of Base Cost
 Engineering = 15% of Base Cost
 Total Estimated Cost= Base construction cost+ Contingency+Administration cost +Engineering cost
 The 'Site Improvement Contingency' includes such things as headwalls, retaining wall or local channel improvements. It is assumed that all works would not extend more than 6 m beyond the limit of the culvert.
 Total Estimated Cost with Site improvement contingency= Total estimated cost+site improvement contingency

Assumptions for channel:

Assumed 4 m offset on the south side and 1 m offset on the north side of the proposed channel.
 Contingency = 35% of the cost of land acquisition, excavation and control structure
 Administration during construction= 10% of the cost of land acquisition, excavation and control structure
 Engineering = 15% of the cost of land acquisition, excavation and control structure

*** The channel feasibility and cost will need to be proven through further investigation to resolve alignment discrepancies between topography and legal boundaries**

Cost Estimate - Culverts Option 1 & 6
City of Chilliwack - 2009 Drainage Study
USL - April 2009

Culvert ID	Current Length	Current Diameter	Proposed Length	Proposed Number of Culverts	Proposed Diameter	Culvert Cost	Excavation and Backfill Cost	Isolation Allowance	Surface Restoration	Mobilization	Base Construction Cost	Contingency	Admin.	Engineering	Total Estimated Cost	Site Improvement Contingency	Total Estimated Cost with Contingency
	(m)	(m)	(m)		(m)												
442	23.1	1.05	23.1	2	1.20	\$ 11,088	\$ 8,316	\$ 12,500	\$ 6,000	\$ 5,686	\$ 43,590	\$ 15,257	\$ 4,359	\$ 6,539	\$ 70,000	\$ 23,000	\$ 93,000
486	5.8	0.90	5.8	1	1.50	\$ 1,740	\$ 1,566	\$ 20,000	\$ 7,500	\$ 4,621	\$ 35,427	\$ 12,400	\$ 3,543	\$ 5,315	\$ 57,000	\$ 56,000	\$ 113,000
580	24.6	0.60	24.6	1	1.20	\$ 5,904	\$ 4,428	\$ 10,000	\$ 6,000	\$ 3,950	\$ 30,282	\$ 10,599	\$ 3,029	\$ 4,543	\$ 49,000	\$ 19,000	\$ 68,000
853	22.1	0.60	22.1	2	1.20	\$ 10,608	\$ 7,956	\$ 12,500	\$ 6,000	\$ 5,560	\$ 42,624	\$ 14,919	\$ 4,263	\$ 6,394	\$ 69,000	\$ 24,000	\$ 93,000
890	18.9	1.20	18.9	2	1.80	\$ 14,553	\$ 15,120	\$ 25,000	\$ 10,000	\$ 9,701	\$ 74,374	\$ 26,031	\$ 7,438	\$ 11,157	\$ 119,000	\$ 43,000	\$ 162,000
891	15.8	0.60	15.8	2	1.50	\$ 9,480	\$ 8,532	\$ 25,000	\$ 7,500	\$ 7,577	\$ 58,089	\$ 20,332	\$ 5,809	\$ 8,714	\$ 93,000	\$ 41,000	\$ 134,000
1111	7.2	0.60	7.2	1	1.20	\$ 1,728	\$ 1,296	\$ 10,000	\$ 6,000	\$ 2,854	\$ 21,878	\$ 7,658	\$ 2,188	\$ 3,282	\$ 36,000	\$ 30,000	\$ 66,000
1112	6.6	0.60	6.6	1	1.20	\$ 1,584	\$ 1,188	\$ 10,000	\$ 6,000	\$ 2,816	\$ 21,588	\$ 7,556	\$ 2,159	\$ 3,239	\$ 35,000	\$ 32,000	\$ 67,000
1113	5.6	0.60	5.6	1	1.20	\$ 1,344	\$ 1,008	\$ 10,000	\$ 6,000	\$ 2,753	\$ 21,105	\$ 7,387	\$ 2,111	\$ 3,166	\$ 34,000	\$ 35,000	\$ 69,000
1124	13.8	0.90	13.8	2	0.90	\$ 3,726	\$ 4,140	\$ 12,500	\$ 5,000	\$ 3,805	\$ 29,171	\$ 10,210	\$ 2,918	\$ 4,376	\$ 47,000	\$ 20,000	\$ 67,000
1125	6	0.30	6.0	2	0.90	\$ 1,620	\$ 1,800	\$ 12,500	\$ 5,000	\$ 3,138	\$ 24,058	\$ 8,421	\$ 2,406	\$ 3,609	\$ 39,000	\$ 31,000	\$ 70,000
1127	4.9	0.60	4.9	1	1.20	\$ 1,176	\$ 882	\$ 10,000	\$ 6,000	\$ 2,709	\$ 20,767	\$ 7,269	\$ 2,077	\$ 3,116	\$ 34,000	\$ 37,000	\$ 71,000
1129	10.1	0.53	10.1	1	1.20	\$ 2,424	\$ 1,818	\$ 10,000	\$ 6,000	\$ 3,037	\$ 23,279	\$ 8,148	\$ 2,328	\$ 3,492	\$ 38,000	\$ 26,000	\$ 64,000
1132	5.2	1.10	5.2	1	1.50	\$ 1,560	\$ 1,404	\$ 20,000	\$ 7,500	\$ 4,570	\$ 35,034	\$ 12,262	\$ 3,504	\$ 5,256	\$ 57,000	\$ 60,000	\$ 117,000
1133	9	1.10	9.0	1	1.50	\$ 2,700	\$ 2,430	\$ 20,000	\$ 7,500	\$ 4,895	\$ 37,525	\$ 13,134	\$ 3,753	\$ 5,629	\$ 61,000	\$ 44,000	\$ 105,000
1135	4.9	0.90	4.9	1	1.80	\$ 1,887	\$ 1,960	\$ 20,000	\$ 10,000	\$ 5,077	\$ 38,924	\$ 13,624	\$ 3,893	\$ 5,839	\$ 63,000	\$ 67,000	\$ 130,000
1137	10.3	0.60	10.3	1	1.20	\$ 2,472	\$ 1,854	\$ 10,000	\$ 6,000	\$ 3,049	\$ 23,375	\$ 8,182	\$ 2,338	\$ 3,507	\$ 38,000	\$ 26,000	\$ 64,000
1138	5.9	0.60	5.9	1	1.20	\$ 1,416	\$ 1,062	\$ 10,000	\$ 6,000	\$ 2,772	\$ 21,250	\$ 7,438	\$ 2,125	\$ 3,188	\$ 35,000	\$ 34,000	\$ 69,000
1139	6	0.60	6.0	1	1.20	\$ 1,440	\$ 1,080	\$ 10,000	\$ 6,000	\$ 2,778	\$ 21,298	\$ 7,455	\$ 2,130	\$ 3,195	\$ 35,000	\$ 33,000	\$ 68,000
1140	9.3	0.60	9.3	1	1.20	\$ 2,232	\$ 1,674	\$ 10,000	\$ 6,000	\$ 2,986	\$ 22,892	\$ 8,013	\$ 2,290	\$ 3,434	\$ 37,000	\$ 27,000	\$ 64,000
1146	81.2	1.50	81.2	2	1.50	\$ 48,720	\$ 43,848	\$ 25,000	\$ 7,500	\$ 18,761	\$ 143,829	\$ 50,341	\$ 14,383	\$ 21,575	\$ 231,000	\$ 30,000	\$ 261,000
1178	9	0.90	9.0	2	0.90	\$ 2,430	\$ 2,700	\$ 12,500	\$ 5,000	\$ 3,395	\$ 26,025	\$ 9,109	\$ 2,603	\$ 3,904	\$ 42,000	\$ 25,000	\$ 67,000
1193	5.2	0.75	5.2	1	1.50	\$ 1,560	\$ 1,404	\$ 20,000	\$ 7,500	\$ 4,570	\$ 35,034	\$ 12,262	\$ 3,504	\$ 5,256	\$ 57,000	\$ 60,000	\$ 117,000
1195	18	1.83	18.0	2	1.80	\$ 13,860	\$ 14,400	\$ 25,000	\$ 10,000	\$ 9,489	\$ 72,749	\$ 25,463	\$ 7,275	\$ 10,913	\$ 117,000	\$ 43,000	\$ 160,000
1204	8.3	0.90	8.3	1	1.50	\$ 2,490	\$ 2,241	\$ 20,000	\$ 7,500	\$ 4,835	\$ 37,066	\$ 12,974	\$ 3,707	\$ 5,560	\$ 60,000	\$ 46,000	\$ 106,000
1207	21.8	1.20	21.8	2	1.80	\$ 16,786	\$ 17,440	\$ 25,000	\$ 10,000	\$ 10,384	\$ 79,610	\$ 27,864	\$ 7,961	\$ 11,942	\$ 128,000	\$ 41,000	\$ 169,000
1212	8.5	1.83	8.5	2	1.80	\$ 6,545	\$ 6,800	\$ 25,000	\$ 10,000	\$ 7,252	\$ 55,597	\$ 19,459	\$ 5,560	\$ 8,340	\$ 89,000	\$ 58,000	\$ 147,000
1213	6.1	1.83	6.1	2	1.80	\$ 4,697	\$ 4,880	\$ 25,000	\$ 10,000	\$ 6,687	\$ 51,264	\$ 17,943	\$ 5,127	\$ 7,690	\$ 83,000	\$ 70,000	\$ 153,000
1217	8.2	0.90	8.2	1	1.20	\$ 1,968	\$ 1,476	\$ 10,000	\$ 6,000	\$ 2,917	\$ 22,361	\$ 7,827	\$ 2,237	\$ 3,355	\$ 36,000	\$ 28,000	\$ 64,000
1233	12.1	2.00	12.1	2	2.00	\$ 12,100	\$ 13,310	\$ 25,000	\$ 15,000	\$ 9,812	\$ 75,222	\$ 26,328	\$ 7,523	\$ 11,284	\$ 121,000	\$ 57,000	\$ 178,000
1234	8.7	1.20	8.7	2	1.20	\$ 4,176	\$ 3,132	\$ 12,500	\$ 6,000	\$ 3,872	\$ 29,680	\$ 10,388	\$ 2,968	\$ 4,452	\$ 48,000	\$ 32,000	\$ 80,000
1239	6.7	1.83	6.7	2	1.80	\$ 5,159	\$ 5,360	\$ 25,000	\$ 10,000	\$ 6,828	\$ 52,347	\$ 18,322	\$ 5,235	\$ 7,853	\$ 84,000	\$ 66,000	\$ 150,000
1241	9.1	1.53	9.1	2	1.50	\$ 5,460	\$ 4,914	\$ 25,000	\$ 7,500	\$ 6,432	\$ 49,306	\$ 17,258	\$ 4,931	\$ 7,396	\$ 79,000	\$ 52,000	\$ 131,000
8094	6	0.80	6.0	2	1.20	\$ 2,880	\$ 2,160	\$ 12,500	\$ 6,000	\$ 3,531	\$ 27,071	\$ 9,475	\$ 2,708	\$ 4,061	\$ 44,000	\$ 39,000	\$ 83,000
8097	13.5	0.80	13.5	2	1.20	\$ 6,480	\$ 4,860	\$ 12,500	\$ 6,000	\$ 4,476	\$ 34,316	\$ 12,011	\$ 3,432	\$ 5,148	\$ 55,000	\$ 27,000	\$ 82,000
8098	13	0.60	13.0	2	1.50	\$ 7,800	\$ 7,020	\$ 25,000	\$ 7,500	\$ 7,098	\$ 54,418	\$ 19,047	\$ 5,442	\$ 8,163	\$ 88,000	\$ 44,000	\$ 132,000
8099	7.5	0.90	7.5	2	1.50	\$ 4,500	\$ 4,050	\$ 25,000	\$ 7,500	\$ 6,158	\$ 47,208	\$ 16,523	\$ 4,721	\$ 7,082	\$ 76,000	\$ 57,000	\$ 133,000
8100	5.9	1.05	5.9	2	1.50	\$ 3,540	\$ 3,186	\$ 25,000	\$ 7,500	\$ 5,884	\$ 45,110	\$ 15,789	\$ 4,511	\$ 6,767	\$ 73,000	\$ 65,000	\$ 138,000
8101	6.8	1.20	6.8	2	1.50	\$ 4,080	\$ 3,672	\$ 25,000	\$ 7,500	\$ 6,038	\$ 46,290	\$ 16,202	\$ 4,629	\$ 6,944	\$ 75,000	\$ 60,000	\$ 135,000
8103	3.5	1.20	3.5	2	1.50	\$ 2,100	\$ 1,890	\$ 25,000	\$ 7,500	\$ 5,474	\$ 41,964	\$ 14,688	\$ 4,197	\$ 6,295	\$ 68,000	\$ 91,000	\$ 159,000
8104	12	1.56	12.0	2	1.50	\$ 7,200	\$ 6,480	\$ 25,000	\$ 7,500	\$ 6,927	\$ 53,107	\$ 18,588	\$ 5,311	\$ 7,967	\$ 85,000	\$ 46,000	\$ 131,000
8106	12	1.56	12.0	2	1.50	\$ 7,200	\$ 6,480	\$ 25,000	\$ 7,500	\$ 6,927	\$ 53,107	\$ 18,588	\$ 5,311	\$ 7,967	\$ 85,000	\$ 46,000	\$ 131,000
8108	7	1.60	7.0	2	1.80	\$ 5,390	\$ 5,600	\$ 25,000	\$ 10,000	\$ 6,899	\$ 52,889	\$ 18,512	\$ 5,289	\$ 7,934	\$ 85,000	\$ 65,000	\$ 150,000
8109	5	1.80	5.0	2	1.80	\$ 3,850	\$ 4,000	\$ 25,000	\$ 10,000	\$ 6,428	\$ 49,278	\$ 17,248	\$ 4,928	\$ 7,392	\$ 79,000	\$ 78,000	\$ 157,000
8110	6.5	1.60	6.5	2	1.80	\$ 5,005	\$ 5,200	\$ 25,000	\$ 10,000	\$ 6,781	\$ 51,986	\$ 18,196	\$ 5,199	\$ 7,798	\$ 84,000	\$ 67,000	\$ 151,000
8111	6	1.60	6.0	2	1.80	\$ 4,620	\$ 4,800	\$ 25,000	\$ 10,000	\$ 6,663	\$ 51,083	\$ 17,880	\$ 5,109	\$ 7,663	\$ 82,000	\$ 70,000	\$ 152,000
8132	20	1.20	20.0	2	1.20	\$ 9,600	\$ 7,200	\$ 12,500	\$ 6,000	\$ 5,295	\$ 40,595	\$ 14,209	\$ 4,060	\$ 6,090	\$ 65,000	\$ 24,000	\$ 89,000
9005	59	1.00	59.0	2	1.20	\$ 28,320	\$ 21,240	\$ 12,500	\$ 6,000	\$ 10,209	\$ 78,269	\$ 27,395	\$ 7,827	\$ 11,741	\$ 126,000	\$ 20,000	\$ 146,000
Total						\$ 309,198	\$ 279,257	\$ 880,000	\$ 360,500	\$ 274,356	\$ 2,103,311	\$ 736,184	\$ 210,349	\$ 315,522	\$ 3,391,000	\$ 2,115,000	\$ 5,506,000

Assumptions:

Assumed Aluminized steel pipe
 Assumed cost per unit meter of culvert: 750 mm -\$115; 900 mm-\$135; 1200mm-\$240; 1500mm-\$300;1800mm-\$385;2000 mm - \$500; 2100 mm - \$500.
 Assumed excavation and backfill cost/unit meter of culvert: 750mm-\$150; 900mm-\$150; 1200mm-\$180; 1500mm-\$270; 1800mm-\$400; 2000mm-\$550;2100mm-\$550.
 Assumed lump sum isolation cost: 750mm to1200mm-\$10,000; 1500mm to 2100mm- \$20,000.
 Assumed Lump sum surface restoration cost: 750mm-\$4000; 900mm-\$5000; 1200mm-\$6000; 1500mm-\$7500; 1800mm-\$10,000; 2000mm-\$15,000; 2100mm-\$15,000.
 Assumed mobilization cost= 15% of (Culvert cost+Excavation and backfill cost+Isolation cost+Surface restoration cost)
 Base Construction Cost=Culvert cost+Excavation and backfill cost+Isolation cost+Surface restoration cost+Mobilization cost
 Contingency = 35% of Base Cost
 Administration during construction = 10% of Base Cost
 Engineering = 15% of Base Cost
 Total Estimated Cost= Base construction cost+ Contingency+Administration cost +Engineering cost
 The 'Site Improvement Contingency' includes such things as headwalls, retaining wall, or local channel improvements. It is assumed that all works would not extend more than 6 m beyond the limit of the culvert.
 Total Estimated Cost with Site improvement contingency= Total estimated cost+site improvement contingency

Cost Estimate - Culverts Option 2, 3, 5&6B
City of Chilliwack - 2009 Drainage Study
USL - April 2009

Culvert ID	Current Length (m)	Current Diameter (m)	Proposed Length (m)	Proposed Number of Culverts	Proposed Diameter (m)	Culvert Cost	Excavation and Backfill Cost	Isolation Allowance	Surface Restoration	Mobilization	Base Construction Cost	Contingency	Admin.	Engineering	Total Estimated Cost	Site Improvement Contingency	Total Estimated Cost with Contingency
442	23.1	1.05	23.1	3	1.20	\$ 16,632	\$ 12,474	\$ 15,000	\$ 6,000	\$ 7,516	\$ 57,622	\$ 20,168	\$ 5,763	\$ 8,644	\$ 93,000	\$ 27,000	\$ 120,000
486	5.8	0.90	5.8	1	1.50	\$ 1,740	\$ 1,566	\$ 20,000	\$ 7,500	\$ 4,621	\$ 35,427	\$ 12,400	\$ 3,543	\$ 5,315	\$ 57,000	\$ 56,000	\$ 113,000
580	24.6	0.60	24.6	2	0.90	\$ 6,642	\$ 7,380	\$ 12,500	\$ 5,000	\$ 4,729	\$ 36,251	\$ 12,688	\$ 3,626	\$ 5,438	\$ 59,000	\$ 16,000	\$ 75,000
620	23.2	0.60	23.2	1	1.20	\$ 5,568	\$ 4,176	\$ 10,000	\$ 6,000	\$ 3,862	\$ 29,606	\$ 10,363	\$ 2,961	\$ 4,441	\$ 48,000	\$ 20,000	\$ 68,000
840	24.2	0.60	24.2	2	1.20	\$ 11,616	\$ 8,712	\$ 12,500	\$ 6,000	\$ 5,825	\$ 44,653	\$ 15,629	\$ 4,466	\$ 6,698	\$ 72,000	\$ 23,000	\$ 95,000
841	14.7	1.00	14.7	3	1.20	\$ 10,584	\$ 7,938	\$ 15,000	\$ 6,000	\$ 5,929	\$ 45,451	\$ 15,908	\$ 4,546	\$ 6,818	\$ 73,000	\$ 31,000	\$ 104,000
843	21	1.53	21.0	2	1.50	\$ 12,600	\$ 11,340	\$ 25,000	\$ 7,500	\$ 8,466	\$ 64,906	\$ 22,718	\$ 6,491	\$ 9,736	\$ 104,000	\$ 38,000	\$ 142,000
844	13.8	0.60	13.8	1	0.90	\$ 1,863	\$ 2,070	\$ 10,000	\$ 5,000	\$ 2,840	\$ 21,773	\$ 7,621	\$ 2,178	\$ 3,266	\$ 35,000	\$ 17,000	\$ 52,000
847	24	1.80	24.0	2	1.80	\$ 18,480	\$ 19,200	\$ 25,000	\$ 10,000	\$ 10,902	\$ 83,582	\$ 29,254	\$ 8,359	\$ 12,538	\$ 134,000	\$ 40,000	\$ 174,000
848	17.9	0.60	17.9	1	1.20	\$ 4,296	\$ 3,222	\$ 10,000	\$ 6,000	\$ 3,528	\$ 27,046	\$ 10,000	\$ 2,705	\$ 4,057	\$ 44,000	\$ 21,000	\$ 65,000
853	22.1	0.60	22.1	2	1.20	\$ 10,608	\$ 7,956	\$ 12,500	\$ 6,000	\$ 5,560	\$ 42,624	\$ 14,919	\$ 4,263	\$ 6,394	\$ 69,000	\$ 24,000	\$ 93,000
890	18.9	1.20	18.9	2	1.80	\$ 14,553	\$ 15,120	\$ 25,000	\$ 10,000	\$ 9,701	\$ 74,374	\$ 26,031	\$ 7,438	\$ 11,157	\$ 119,000	\$ 43,000	\$ 162,000
891	15.8	0.60	15.8	2	1.50	\$ 9,480	\$ 8,532	\$ 25,000	\$ 7,500	\$ 7,577	\$ 58,089	\$ 20,332	\$ 5,809	\$ 8,714	\$ 93,000	\$ 41,000	\$ 134,000
1111	7.2	0.60	7.2	1	1.20	\$ 1,728	\$ 1,296	\$ 10,000	\$ 6,000	\$ 2,854	\$ 21,878	\$ 7,658	\$ 2,188	\$ 3,282	\$ 36,000	\$ 30,000	\$ 66,000
1112	6.6	0.60	6.6	1	1.20	\$ 1,584	\$ 1,188	\$ 10,000	\$ 6,000	\$ 2,816	\$ 21,588	\$ 7,556	\$ 2,159	\$ 3,239	\$ 35,000	\$ 32,000	\$ 67,000
1113	5.6	0.60	5.6	1	1.20	\$ 1,344	\$ 1,008	\$ 10,000	\$ 6,000	\$ 2,753	\$ 21,105	\$ 7,387	\$ 2,111	\$ 3,166	\$ 34,000	\$ 35,000	\$ 69,000
1124	13.8	0.90	13.8	2	0.90	\$ 3,726	\$ 4,140	\$ 12,500	\$ 5,000	\$ 3,805	\$ 29,171	\$ 10,210	\$ 2,918	\$ 4,376	\$ 47,000	\$ 20,000	\$ 67,000
1125	6	0.30	6.0	2	1.20	\$ 2,880	\$ 2,160	\$ 12,500	\$ 6,000	\$ 3,531	\$ 27,071	\$ 9,475	\$ 2,708	\$ 4,061	\$ 44,000	\$ 39,000	\$ 83,000
1127	4.9	0.60	4.9	2	1.80	\$ 3,773	\$ 3,920	\$ 25,000	\$ 10,000	\$ 6,404	\$ 49,097	\$ 17,184	\$ 4,910	\$ 7,365	\$ 79,000	\$ 79,000	\$ 158,000
1128	7.6	0.60	7.6	1	1.50	\$ 2,280	\$ 2,052	\$ 20,000	\$ 7,500	\$ 4,775	\$ 36,607	\$ 12,813	\$ 3,661	\$ 5,492	\$ 59,000	\$ 48,000	\$ 107,000
1129	10.1	0.53	10.1	1	1.20	\$ 2,424	\$ 1,818	\$ 10,000	\$ 6,000	\$ 3,037	\$ 23,279	\$ 8,148	\$ 2,328	\$ 3,492	\$ 38,000	\$ 26,000	\$ 64,000
1132	5.2	1.10	5.2	2	1.20	\$ 2,496	\$ 1,872	\$ 12,500	\$ 6,000	\$ 3,431	\$ 26,299	\$ 9,205	\$ 2,630	\$ 3,945	\$ 43,000	\$ 42,000	\$ 85,000
1133	9	1.10	9.0	2	1.20	\$ 4,320	\$ 3,240	\$ 12,500	\$ 6,000	\$ 3,909	\$ 29,969	\$ 10,490	\$ 2,997	\$ 4,496	\$ 48,000	\$ 32,000	\$ 80,000
1135	4.9	0.90	4.9	2	1.20	\$ 2,352	\$ 1,764	\$ 12,500	\$ 6,000	\$ 3,393	\$ 26,009	\$ 9,104	\$ 2,601	\$ 3,902	\$ 42,000	\$ 44,000	\$ 86,000
1137	10.3	0.60	10.3	1	1.20	\$ 2,472	\$ 1,854	\$ 10,000	\$ 6,000	\$ 3,049	\$ 23,375	\$ 8,182	\$ 2,338	\$ 3,507	\$ 38,000	\$ 26,000	\$ 64,000
1138	5.9	0.60	5.9	1	1.20	\$ 1,416	\$ 1,062	\$ 10,000	\$ 6,000	\$ 2,772	\$ 21,250	\$ 7,438	\$ 2,125	\$ 3,188	\$ 35,000	\$ 34,000	\$ 69,000
1139	6	0.60	6.0	1	1.20	\$ 1,440	\$ 1,080	\$ 10,000	\$ 6,000	\$ 2,778	\$ 21,298	\$ 7,455	\$ 2,130	\$ 3,195	\$ 35,000	\$ 33,000	\$ 68,000
1140	9.3	0.60	9.3	1	1.20	\$ 2,232	\$ 1,674	\$ 10,000	\$ 6,000	\$ 2,986	\$ 22,892	\$ 8,013	\$ 2,290	\$ 3,434	\$ 37,000	\$ 27,000	\$ 64,000
1146	81.2	1.50	81.2	2	1.50	\$ 48,720	\$ 43,848	\$ 25,000	\$ 7,500	\$ 18,761	\$ 143,829	\$ 50,341	\$ 14,383	\$ 21,575	\$ 231,000	\$ 30,000	\$ 261,000
1162	8	1.48	8.0	3	1.50	\$ 7,200	\$ 6,480	\$ 30,000	\$ 7,500	\$ 7,677	\$ 58,857	\$ 20,600	\$ 5,886	\$ 8,829	\$ 95,000	\$ 63,000	\$ 158,000
1177	19	1.60	19.0	2	1.50	\$ 11,400	\$ 10,260	\$ 25,000	\$ 7,500	\$ 8,124	\$ 62,284	\$ 21,800	\$ 6,229	\$ 9,343	\$ 100,000	\$ 39,000	\$ 139,000
1178	9	0.90	9.0	2	1.50	\$ 5,400	\$ 4,860	\$ 25,000	\$ 7,500	\$ 6,414	\$ 49,174	\$ 17,211	\$ 4,918	\$ 7,377	\$ 79,000	\$ 52,000	\$ 131,000
1193	5.2	0.75	5.2	1	1.80	\$ 2,002	\$ 2,080	\$ 20,000	\$ 10,000	\$ 5,113	\$ 39,195	\$ 13,719	\$ 3,920	\$ 5,880	\$ 63,000	\$ 64,000	\$ 127,000
1195	18	1.83	18.0	2	1.80	\$ 13,860	\$ 14,400	\$ 25,000	\$ 10,000	\$ 9,489	\$ 72,749	\$ 25,463	\$ 7,275	\$ 10,913	\$ 117,000	\$ 43,000	\$ 160,000
1196	9.7	1.83	9.7	2	1.80	\$ 7,469	\$ 7,760	\$ 25,000	\$ 10,000	\$ 7,535	\$ 57,764	\$ 20,218	\$ 5,777	\$ 8,665	\$ 93,000	\$ 55,000	\$ 148,000
1197	8.2	1.83	8.2	2	1.80	\$ 6,314	\$ 6,560	\$ 25,000	\$ 10,000	\$ 7,182	\$ 55,056	\$ 19,270	\$ 5,506	\$ 8,259	\$ 89,000	\$ 59,000	\$ 148,000
1199	9.2	1.20	9.2	2	1.20	\$ 4,416	\$ 3,312	\$ 12,500	\$ 6,000	\$ 3,935	\$ 30,163	\$ 10,558	\$ 3,017	\$ 4,525	\$ 49,000	\$ 32,000	\$ 81,000
1200	12	1.20	12.0	1	1.80	\$ 4,620	\$ 4,800	\$ 20,000	\$ 10,000	\$ 5,913	\$ 45,333	\$ 15,867	\$ 4,534	\$ 6,800	\$ 73,000	\$ 42,000	\$ 115,000
1202	9.5	1.20	9.5	1	1.80	\$ 3,658	\$ 3,800	\$ 20,000	\$ 10,000	\$ 5,619	\$ 43,077	\$ 15,077	\$ 4,308	\$ 6,462	\$ 69,000	\$ 46,000	\$ 115,000
1204	8.3	0.90	8.3	2	1.50	\$ 4,980	\$ 4,482	\$ 25,000	\$ 7,500	\$ 6,295	\$ 48,257	\$ 16,890	\$ 4,826	\$ 7,239	\$ 78,000	\$ 54,000	\$ 132,000
1207	21.8	1.20	21.8	3	1.50	\$ 19,620	\$ 17,658	\$ 30,000	\$ 7,500	\$ 11,217	\$ 85,995	\$ 30,099	\$ 8,600	\$ 12,900	\$ 138,000	\$ 43,000	\$ 181,000
1210	15.3	2.80	15.3	3	1.80	\$ 17,672	\$ 18,360	\$ 30,000	\$ 10,000	\$ 11,405	\$ 87,437	\$ 30,603	\$ 8,744	\$ 13,116	\$ 140,000	\$ 53,000	\$ 193,000
1212	8.5	1.83	8.5	2	1.80	\$ 6,545	\$ 6,800	\$ 25,000	\$ 10,000	\$ 7,252	\$ 55,597	\$ 19,459	\$ 5,560	\$ 8,340	\$ 89,000	\$ 58,000	\$ 147,000
1213	6.1	1.83	6.1	2	1.80	\$ 4,697	\$ 4,880	\$ 25,000	\$ 10,000	\$ 6,687	\$ 51,264	\$ 17,943	\$ 5,127	\$ 7,690	\$ 83,000	\$ 70,000	\$ 153,000
1217	8.2	0.90	8.2	2	1.20	\$ 3,936	\$ 2,952	\$ 12,500	\$ 6,000	\$ 3,809	\$ 29,197	\$ 10,219	\$ 2,920	\$ 4,380	\$ 47,000	\$ 33,000	\$ 80,000
1232	83.4	1.83	83.4	2	1.80	\$ 64,218	\$ 66,720	\$ 25,000	\$ 10,000	\$ 24,891	\$ 190,829	\$ 66,791	\$ 19,083	\$ 28,625	\$ 306,000	\$ 33,000	\$ 339,000
1233	12.1	2.00	12.1	2	2.00	\$ 12,100	\$ 13,310	\$ 25,000	\$ 15,000	\$ 9,812	\$ 75,222	\$ 26,328	\$ 7,523	\$ 11,284	\$ 121,000	\$ 57,000	\$ 178,000
1234	8.7	1.20	8.7	2	1.80	\$ 6,699	\$ 6,960	\$ 25,000	\$ 10,000	\$ 7,299	\$ 55,958	\$ 19,586	\$ 5,596	\$ 8,394	\$ 90,000	\$ 58,000	\$ 148,000
1239	6.7	1.83	6.7	2	1.80	\$ 5,159	\$ 5,360	\$ 25,000	\$ 10,000	\$ 6,828	\$ 52,347	\$ 18,322	\$ 5,235	\$ 7,853	\$ 84,000	\$ 66,000	\$ 150,000
1241	9.1	1.53	9.1	2	1.80	\$ 7,007	\$ 7,280	\$ 25,000	\$ 10,000	\$ 7,394	\$ 56,681	\$ 19,839	\$ 5,669	\$ 8,503	\$ 91,000	\$ 57,000	\$ 148,000
8003	9.5	1.20	9.5	2	1.50	\$ 5,700	\$ 5,130	\$ 25,000	\$ 7,500	\$ 6,500	\$ 49,830	\$ 17,441	\$ 4,983	\$ 7,475	\$ 80,000	\$ 51,000	\$ 131,000
8060	8.5	0.90	8.5	1	1.20	\$ 2,040	\$ 1,530	\$ 10,000	\$ 6,000	\$ 2,936	\$ 22,506	\$ 7,878	\$ 2,251	\$ 3,376	\$ 37,000	\$ 28,000	\$ 65,000
8061	11.5	0.90	11.5	1	1.20	\$ 2,760	\$ 2,070	\$ 10,000	\$ 6,000	\$ 3,125	\$ 23,955	\$ 8,385	\$ 2,396	\$ 3,594	\$ 39,000	\$ 24,000	\$ 63,000
8094	6	0.80	6.0	2	1.50	\$ 3,600	\$ 3,240	\$ 25,000	\$ 7,500	\$ 5,901	\$ 45,241	\$ 15,835	\$ 4,525	\$ 6,787	\$ 73,000	\$ 64,000	\$ 137,000
8095	3.5	1.60	3.5	2	1.50	\$ 2,100	\$ 1,890	\$ 25,000	\$ 7,500	\$ 5,474	\$ 41,964	\$ 14,688	\$ 4,197	\$ 6,295	\$ 68,000	\$ 91,000	\$ 159,000
8096	9	1.20	9.0	2	1.50	\$ 5,400	\$ 4,860	\$ 25,000	\$ 7,500	\$ 6,414	\$ 49,174	\$ 17,211	\$ 4,918	\$ 7,377	\$ 79,000	\$ 52,000	\$ 131,000
8097	13.5	0.80	13.5	2	1.50	\$ 8,100	\$ 7,290	\$ 25,000	\$ 7,500	\$ 7,184	\$ 55,074	\$ 19,276	\$ 5,508	\$ 8,262	\$ 89,000	\$ 44,000	\$ 133,000
8098	13	0.60	13.0	2	1.50	\$ 7,800	\$ 7,020	\$ 25,000	\$ 7,500	\$ 7,098	\$ 54,418	\$ 19,047	\$ 5,442	\$ 8,163	\$ 88,000	\$ 44,000	\$ 132,000
8099	7.5	0.90	7.5	2	1.50	\$ 4,500	\$ 4,050	\$ 25,000	\$ 7,500	\$ 6,158	\$ 47,208	\$ 16,523	\$ 4,721	\$ 7,082	\$ 76,000	\$ 57,000	\$ 133,000
8100	5.9	1.05	5.9	2	1.50	\$ 3,540	\$ 3,186	\$ 25,000	\$ 7,500	\$ 5,884	\$ 45,110	\$ 15,789	\$ 4,511	\$ 6,767	\$ 73,000	\$ 65,000	\$ 138,000
8101	6.8	1.20	6.8	2	1.50	\$ 4,080	\$ 3,672	\$ 25,000	\$ 7,500	\$ 6,038	\$ 46,290	\$ 16,202	\$ 4,629	\$ 6,944	\$ 75,000	\$ 60,000	\$ 135,000
8103	3.5	1.20	3.5	2	1.50	\$ 2,100	\$ 1,890	\$ 25,000	\$ 7,500	\$ 5,474	\$ 41,964	\$ 14,688	\$ 4,197	\$ 6,295	\$ 68,000	\$ 91,000	\$ 159,000
8104	12	1.56	12.0														

Cost Estimate - Culverts Option 4
City of Chilliwack - 2009 Drainage Study
USL - April 2009

Culvert ID	Current Length	Current Diameter	Proposed Length	Proposed Number of Culverts	Proposed Diameter	Culvert Cost	Excavation and Backfill Cost	Isolation Allowance	Surface Restoration	Mobilization	Base Construction Cost	Contingency	Admin.	Engineering	Total Estimated Cost	Site Improvement Contingency	Total Estimated Cost with Contingency
	(m)	(m)	(m)		(m)												
442	23.1	1.05	23.1	3	1.20	\$ 16,632	\$ 12,474	\$ 15,000	\$ 6,000	\$ 7,516	\$ 57,622	\$ 20,168	\$ 5,763	\$ 8,644	\$ 93,000	\$ 27,000	\$ 120,000
486	5.8	0.90	5.8	1	1.50	\$ 1,740	\$ 1,566	\$ 20,000	\$ 7,500	\$ 4,621	\$ 35,427	\$ 12,400	\$ 3,543	\$ 5,315	\$ 57,000	\$ 56,000	\$ 113,000
840	24.2	0.60	24.2	2	1.20	\$ 11,616	\$ 8,712	\$ 12,500	\$ 6,000	\$ 5,825	\$ 44,653	\$ 15,629	\$ 4,466	\$ 6,698	\$ 72,000	\$ 23,000	\$ 95,000
841	14.7	1.00	14.7	3	1.20	\$ 10,584	\$ 7,938	\$ 15,000	\$ 6,000	\$ 5,929	\$ 45,451	\$ 15,908	\$ 4,546	\$ 6,818	\$ 73,000	\$ 31,000	\$ 104,000
843	21	1.53	21.0	2	1.50	\$ 12,600	\$ 11,340	\$ 25,000	\$ 7,500	\$ 8,466	\$ 64,906	\$ 22,718	\$ 6,491	\$ 9,736	\$ 104,000	\$ 38,000	\$ 142,000
847	24	1.80	24.0	2	1.80	\$ 18,480	\$ 19,200	\$ 25,000	\$ 10,000	\$ 10,902	\$ 83,582	\$ 29,254	\$ 8,359	\$ 12,538	\$ 134,000	\$ 40,000	\$ 174,000
890	18.9	1.20	18.9	2	1.80	\$ 14,553	\$ 15,120	\$ 25,000	\$ 10,000	\$ 9,701	\$ 74,374	\$ 26,031	\$ 7,438	\$ 11,157	\$ 119,000	\$ 43,000	\$ 162,000
891	15.8	0.60	15.8	2	1.50	\$ 9,480	\$ 8,532	\$ 25,000	\$ 7,500	\$ 7,577	\$ 58,089	\$ 20,332	\$ 5,809	\$ 8,714	\$ 93,000	\$ 41,000	\$ 134,000
1124	13.8	0.90	13.8	2	0.90	\$ 3,726	\$ 4,140	\$ 12,500	\$ 5,000	\$ 3,805	\$ 29,171	\$ 10,210	\$ 2,918	\$ 4,376	\$ 47,000	\$ 20,000	\$ 67,000
1125	6	0.30	6.0	2	1.20	\$ 2,880	\$ 2,160	\$ 12,500	\$ 6,000	\$ 3,531	\$ 27,071	\$ 9,475	\$ 2,708	\$ 4,061	\$ 44,000	\$ 39,000	\$ 83,000
1127	4.9	0.60	4.9	2	1.80	\$ 3,773	\$ 3,920	\$ 25,000	\$ 10,000	\$ 6,404	\$ 49,097	\$ 17,184	\$ 4,910	\$ 7,365	\$ 79,000	\$ 79,000	\$ 158,000
1128	7.6	0.60	7.6	1	1.50	\$ 2,280	\$ 2,052	\$ 20,000	\$ 7,500	\$ 4,775	\$ 36,607	\$ 12,813	\$ 3,661	\$ 5,492	\$ 59,000	\$ 48,000	\$ 107,000
1129	10.1	0.53	10.1	1	1.20	\$ 2,424	\$ 1,818	\$ 10,000	\$ 6,000	\$ 3,037	\$ 23,279	\$ 8,148	\$ 2,328	\$ 3,492	\$ 38,000	\$ 26,000	\$ 64,000
1132	5.2	1.10	5.2	2	1.20	\$ 2,496	\$ 1,872	\$ 12,500	\$ 6,000	\$ 3,431	\$ 26,299	\$ 9,205	\$ 2,630	\$ 3,945	\$ 43,000	\$ 42,000	\$ 85,000
1133	9	1.10	9.0	2	1.20	\$ 4,320	\$ 3,240	\$ 12,500	\$ 6,000	\$ 3,909	\$ 29,969	\$ 10,490	\$ 2,997	\$ 4,496	\$ 48,000	\$ 32,000	\$ 80,000
1135	4.9	0.90	4.9	2	1.20	\$ 2,352	\$ 1,764	\$ 12,500	\$ 6,000	\$ 3,393	\$ 26,009	\$ 9,104	\$ 2,601	\$ 3,902	\$ 42,000	\$ 44,000	\$ 86,000
1137	10.3	0.60	10.3	1	1.20	\$ 2,472	\$ 1,854	\$ 10,000	\$ 6,000	\$ 3,049	\$ 23,375	\$ 8,182	\$ 2,338	\$ 3,507	\$ 38,000	\$ 26,000	\$ 64,000
1138	5.9	0.60	5.9	1	1.20	\$ 1,416	\$ 1,062	\$ 10,000	\$ 6,000	\$ 2,772	\$ 21,250	\$ 7,438	\$ 2,125	\$ 3,188	\$ 35,000	\$ 34,000	\$ 69,000
1139	6	0.60	6.0	1	1.20	\$ 1,440	\$ 1,080	\$ 10,000	\$ 6,000	\$ 2,778	\$ 21,298	\$ 7,455	\$ 2,130	\$ 3,195	\$ 35,000	\$ 33,000	\$ 68,000
1140	9.3	0.60	9.3	1	1.20	\$ 2,232	\$ 1,674	\$ 10,000	\$ 6,000	\$ 2,986	\$ 22,892	\$ 8,013	\$ 2,290	\$ 3,434	\$ 37,000	\$ 27,000	\$ 64,000
1146	81.2	1.50	81.2	2	1.50	\$ 48,720	\$ 43,848	\$ 25,000	\$ 7,500	\$ 18,761	\$ 143,829	\$ 50,341	\$ 14,383	\$ 21,575	\$ 231,000	\$ 30,000	\$ 261,000
1162	8	1.48	8.0	3	1.50	\$ 7,200	\$ 6,480	\$ 30,000	\$ 7,500	\$ 7,677	\$ 58,857	\$ 20,600	\$ 5,886	\$ 8,829	\$ 95,000	\$ 63,000	\$ 158,000
1177	19	1.60	19.0	2	1.50	\$ 11,400	\$ 10,260	\$ 25,000	\$ 7,500	\$ 8,124	\$ 62,284	\$ 21,800	\$ 6,229	\$ 9,343	\$ 100,000	\$ 39,000	\$ 139,000
1178	9	0.90	9.0	2	1.50	\$ 5,400	\$ 4,860	\$ 25,000	\$ 7,500	\$ 6,414	\$ 49,174	\$ 17,211	\$ 4,918	\$ 7,377	\$ 79,000	\$ 52,000	\$ 131,000
1195	18	1.83	18.0	2	1.80	\$ 13,860	\$ 14,400	\$ 25,000	\$ 10,000	\$ 9,489	\$ 72,749	\$ 25,463	\$ 7,275	\$ 10,913	\$ 117,000	\$ 43,000	\$ 160,000
1196	9.7	1.83	9.7	2	1.80	\$ 7,469	\$ 7,760	\$ 25,000	\$ 10,000	\$ 7,535	\$ 57,764	\$ 20,218	\$ 5,777	\$ 8,665	\$ 93,000	\$ 55,000	\$ 148,000
1197	8.2	1.83	8.2	2	1.80	\$ 6,314	\$ 6,560	\$ 25,000	\$ 10,000	\$ 7,182	\$ 55,056	\$ 19,270	\$ 5,506	\$ 8,259	\$ 89,000	\$ 59,000	\$ 148,000
1199	9.2	1.20	9.2	2	1.20	\$ 4,416	\$ 3,312	\$ 12,500	\$ 6,000	\$ 3,935	\$ 30,163	\$ 10,558	\$ 3,017	\$ 4,525	\$ 49,000	\$ 32,000	\$ 81,000
1200	12	1.20	12.0	1	1.80	\$ 4,620	\$ 4,800	\$ 20,000	\$ 10,000	\$ 5,913	\$ 45,333	\$ 15,867	\$ 4,534	\$ 6,800	\$ 73,000	\$ 42,000	\$ 115,000
1202	9.5	1.20	9.5	1	1.80	\$ 3,658	\$ 3,800	\$ 20,000	\$ 10,000	\$ 5,619	\$ 43,077	\$ 15,077	\$ 4,308	\$ 6,462	\$ 69,000	\$ 46,000	\$ 115,000
1204	8.3	0.90	8.3	2	1.50	\$ 4,980	\$ 4,482	\$ 25,000	\$ 7,500	\$ 6,295	\$ 48,257	\$ 16,890	\$ 4,826	\$ 7,239	\$ 78,000	\$ 54,000	\$ 132,000
1207	21.8	1.20	21.8	3	1.50	\$ 19,620	\$ 17,658	\$ 30,000	\$ 7,500	\$ 11,217	\$ 85,995	\$ 30,099	\$ 8,600	\$ 12,900	\$ 138,000	\$ 43,000	\$ 181,000
1210	15.3	2.80	15.3	3	1.80	\$ 17,672	\$ 18,360	\$ 30,000	\$ 10,000	\$ 11,405	\$ 87,437	\$ 30,603	\$ 8,744	\$ 13,116	\$ 140,000	\$ 53,000	\$ 193,000
1212	8.5	1.83	8.5	2	1.80	\$ 6,545	\$ 6,800	\$ 25,000	\$ 10,000	\$ 7,252	\$ 55,597	\$ 19,459	\$ 5,560	\$ 8,340	\$ 89,000	\$ 58,000	\$ 147,000
1213	6.1	1.83	6.1	2	1.80	\$ 4,697	\$ 4,880	\$ 25,000	\$ 10,000	\$ 6,687	\$ 51,264	\$ 17,943	\$ 5,127	\$ 7,690	\$ 83,000	\$ 70,000	\$ 153,000
1217	8.2	0.90	8.2	2	1.20	\$ 3,936	\$ 2,952	\$ 12,500	\$ 6,000	\$ 3,809	\$ 29,197	\$ 10,219	\$ 2,920	\$ 4,380	\$ 47,000	\$ 33,000	\$ 80,000
1232	83.4	1.83	83.4	2	1.80	\$ 64,218	\$ 66,720	\$ 25,000	\$ 10,000	\$ 24,891	\$ 190,829	\$ 66,791	\$ 19,083	\$ 28,625	\$ 306,000	\$ 33,000	\$ 339,000
1233	12.1	2.00	12.1	2	2.00	\$ 12,100	\$ 13,310	\$ 25,000	\$ 15,000	\$ 9,812	\$ 75,222	\$ 26,328	\$ 7,523	\$ 11,284	\$ 121,000	\$ 57,000	\$ 178,000
1234	8.7	1.20	8.7	2	1.80	\$ 6,699	\$ 6,960	\$ 25,000	\$ 10,000	\$ 7,299	\$ 55,958	\$ 19,586	\$ 5,596	\$ 8,394	\$ 90,000	\$ 58,000	\$ 148,000
1239	6.7	1.83	6.7	2	1.80	\$ 5,159	\$ 5,360	\$ 25,000	\$ 10,000	\$ 6,828	\$ 52,347	\$ 18,322	\$ 5,235	\$ 7,853	\$ 84,000	\$ 66,000	\$ 150,000
1241	9.1	1.53	9.1	2	1.80	\$ 7,007	\$ 7,280	\$ 25,000	\$ 10,000	\$ 7,394	\$ 56,681	\$ 19,839	\$ 5,669	\$ 8,503	\$ 91,000	\$ 57,000	\$ 148,000
8003	9.5	1.20	9.5	2	1.50	\$ 5,700	\$ 5,130	\$ 25,000	\$ 7,500	\$ 6,500	\$ 49,830	\$ 17,441	\$ 4,983	\$ 7,475	\$ 80,000	\$ 51,000	\$ 131,000
8094	6	0.80	6.0	2	1.50	\$ 3,600	\$ 3,240	\$ 25,000	\$ 7,500	\$ 5,901	\$ 45,241	\$ 15,835	\$ 4,525	\$ 6,787	\$ 73,000	\$ 64,000	\$ 137,000
8095	3.5	1.60	3.5	2	1.50	\$ 2,100	\$ 1,890	\$ 25,000	\$ 7,500	\$ 5,474	\$ 41,964	\$ 14,688	\$ 4,197	\$ 6,295	\$ 68,000	\$ 91,000	\$ 159,000
8096	9	1.20	9.0	2	1.50	\$ 5,400	\$ 4,860	\$ 25,000	\$ 7,500	\$ 6,414	\$ 49,174	\$ 17,211	\$ 4,918	\$ 7,377	\$ 79,000	\$ 52,000	\$ 131,000
8097	13.5	0.80	13.5	2	1.50	\$ 8,100	\$ 7,290	\$ 25,000	\$ 7,500	\$ 7,184	\$ 55,074	\$ 19,276	\$ 5,508	\$ 8,262	\$ 89,000	\$ 44,000	\$ 133,000
8098	13	0.60	13.0	2	1.50	\$ 7,800	\$ 7,020	\$ 25,000	\$ 7,500	\$ 7,098	\$ 54,418	\$ 19,047	\$ 5,442	\$ 8,163	\$ 88,000	\$ 44,000	\$ 132,000
8099	7.5	0.90	7.5	2	1.50	\$ 4,500	\$ 4,050	\$ 25,000	\$ 7,500	\$ 6,158	\$ 47,208	\$ 16,523	\$ 4,721	\$ 7,082	\$ 76,000	\$ 57,000	\$ 133,000
8100	5.9	1.05	5.9	2	1.50	\$ 3,540	\$ 3,186	\$ 25,000	\$ 7,500	\$ 5,884	\$ 45,110	\$ 15,789	\$ 4,511	\$ 6,767	\$ 73,000	\$ 65,000	\$ 138,000
8101	6.8	1.20	6.8	2	1.50	\$ 4,080	\$ 3,672	\$ 25,000	\$ 7,500	\$ 6,038	\$ 46,290	\$ 16,202	\$ 4,629	\$ 6,944	\$ 75,000	\$ 60,000	\$ 135,000
8103	3.5	1.20	3.5	2	1.50	\$ 2,100	\$ 1,890	\$ 25,000	\$ 7,500	\$ 5,474	\$ 41,964	\$ 14,688	\$ 4,197	\$ 6,295	\$ 68,000	\$ 91,000	\$ 159,000
8104	12	1.56	12.0	2	1.50	\$ 7,200	\$ 6,480	\$ 25,000	\$ 7,500	\$ 6,927	\$ 53,107	\$ 18,588	\$ 5,311	\$ 7,967	\$ 85,000	\$ 46,000	\$ 131,000
8106	12	1.56	12.0	2	1.50	\$ 7,200	\$ 6,480	\$ 25,000	\$ 7,500	\$ 6,927	\$ 53,107	\$ 18,588	\$ 5,311	\$ 7,967	\$ 85,000	\$ 46,000	\$ 131,000
8108	7	1.60	7.0	2	1.80	\$ 5,390	\$ 5,600	\$ 25,000	\$ 10,000	\$ 6,899	\$ 52,889	\$ 18,512	\$ 5,289	\$ 7,934	\$ 85,000	\$ 65,000	\$ 150,000
8109	5	1.80	5.0	2	1.80	\$ 3,850	\$ 4,000	\$ 25,000	\$ 10,000	\$ 6,428	\$ 49,278	\$ 17,248	\$ 4,928	\$ 7,392	\$ 79,000	\$ 78,000	\$ 157,000
8110	6.5	1.60	6.5	2	1.80	\$ 5,005	\$ 5,200	\$ 25,000	\$ 10,000	\$ 6,781	\$ 51,986	\$ 18,196	\$ 5,199	\$ 7,798	\$ 84,000	\$ 67,000	\$ 151,000
8111	6	1.60	6.0	2	1.80	\$ 4,620	\$ 4,800	\$ 25,000	\$ 10,000	\$ 6,663	\$ 51,083	\$ 17,880	\$ 5,109	\$ 7,663	\$ 82,000	\$ 70,000	\$ 152,000
8132	20	1.20	20.0	2	1.50	\$ 12,000	\$ 10,800	\$ 25,000	\$ 7,500	\$ 8,295	\$ 63,595	\$ 22,259	\$ 6,360	\$ 9,540	\$ 102,000	\$ 38,000	\$ 140,000
9005	59	1.00	59.0	1	1.80	\$ 22,715	\$ 23,600	\$ 20,000	\$ 10,000	\$ 11,448	\$ 87,763	\$ 30,718	\$ 8,777	\$ 13,165	\$ 141,000	\$ 28,000	\$ 169,000
TOTAL:						\$ 508,085	\$ 481,548	\$ 1,270,000	\$ 476,500	\$ 410,438	\$ 3,146,571	\$ 1,101,330	\$ 314,682	\$ 472,018	\$ 5,064,000	\$ 2,849,000	\$ 7,913,000

Assumptions:

Assumed Aluminized steel pipe
 Assumed cost per unit meter of culvert: 750 mm -\$115; 900 mm-\$135; 1200mm-\$240; 1500mm-\$300;1800mm-\$385;2000 mm - \$500; 2100 mm - \$500.
 Assumed excavation and backfill cost/unit meter of culvert: 750mm-\$150; 900mm-\$150; 1200mm-\$180; 1500mm-\$270; 1800mm-\$4

Cost Estimate - Option 4&5 (Hopedale Road Channel N)

City of Chilliwack - 2009 Drainage Study

USL - April 2009

Item #	Description	Unit	Quantity	Unit Price	Sub-total
	(m)				(m)
HOPEDALE ROAD CHANNEL (North Section)					
1	Land Acquisition	m ²	Unknown	-	NA
2	Excavation	m ³	17100	\$33.00	\$564,300
3	Control Structure	each	2	\$25,000.00	\$50,000
	SUBTOTAL				\$614,300
	35% Contingency cost				\$215,005
	10% Administration cost during Construction				\$61,430
	Engineering cost				\$92,145
	TOTAL				\$982,880

Assumptions:

Does not include Land Acquisition Costs

Contingency = 35% of the cost of land acquisition, excavation and control structure

Administration during construction= 10% of the cost of land acquisition, excavation and control structure

Engineering = 15% of the cost of land acquisition, excavation and control structure

*** The channel feasibility and cost will need to be proven through further investigation to resolve alignment discrepancies between topography and legal boundaries**

Cost Estimate - Option 4&5 (Hopedale Road Channel S)
City of Chilliwack - 2009 Drainage Study

USL - April 2009

Item #	Description	Unit	Quantity	Unit Price	Sub-total
	(m)				(m)
HOPEDALE ROAD CHANNEL (South Section)					
1	Land Acquisition	m ²	Unknown	-	NA
2	Excavation	m ³	7200	\$33.00	\$237,600
3	Driveway Culvert Allowance	ea	6	\$50,000.00	\$300,000
	SUBTOTAL				\$537,600
	35% Contingency cost				\$188,160
	10% Administration cost during Construction				\$53,760
	Engineering cost				\$80,640
	TOTAL				\$860,160

Assumptions:

Does not include Land Acquisition Costs

Contingency = 35% of the cost of land acquisition, excavation and control structure

Administration during construction= 10% of the cost of land acquisition, excavation and control structure

Engineering = 15% of the cost of land acquisition, excavation and control structure

*** The channel feasibility and cost will need to be proven through further investigation to resolve alignment discrepancies between topography and legal boundaries**

Cost Estimate - McGillivray Supplemental Channel
City of Chilliwack - 2009 Drainage Study
USL - April 2009

CULVERT

Culvert	Proposed Length (m)	Proposed Number of Culverts	Proposed Diameter (m)	Culvert Cost (\$)	Excavation and Backfill Cost (\$)	Isolation Allowance (\$)	Surface Restoration (\$)	Mobilization (\$)	Base Construction Cost (\$)	Contingency (\$)	Administration (\$)	Engineering (\$)	Total Estimated Cost	Site Improvement Contingency (\$)	Total Estimated Cost with Contingency (\$)
Proposed	18.0	2	1.50	10,800.00	9,720.00	25,000.00	7,500.00	7,953.00	60,973.00	21,341.00	6,098.00	9,146.00	98,000.00	40,000.00	138,000.00

CHANNEL

Item #	Description (m)	Unit	Quantity	Unit Price	Sub-total (m)
Channel					
1	Land Acquisition	m ²	16600	\$12.50	\$207,500
2	Excavation	m ³	7000	\$33.00	\$231,000
3	Control Structure	each	2	\$25,000.00	\$50,000
	SUBTOTAL				\$488,500
	35% Contingency cost				\$170,975
	10% Administration cost during Construction				\$48,850
	Engineering cost				\$73,275
	TOTAL				\$781,600

Assumptions for Culvert:

Assumed Aluminized steel pipe
 Assumed cost per unit meter of culvert: 750 mm -\$115; 900 mm-\$135; 1200mm-\$240; 1500mm-\$300;1800mm-\$385;2000 mm - \$500; 2100 mm - \$500.
 Assumed excavation and backfill cost/unit meter of culvert: 750mm-\$150; 900mm-\$150; 1200mm-\$180; 1500mm-\$270; 1800mm-\$400; 2000mm-\$550;2100mm-\$550.
 Assumed lump sum Isolation cost: 750mm to1200mm-\$10,000; 1500mm to 2100mm- \$20,000.
 Assumed Lump sum surface restoration cost: 750mm-\$4000; 900mm-\$5000; 1200mm-\$6000; 1500mm-\$7500; 1800mm-\$10,000; 2000mm-\$15,000; 2100mm-\$15,000.
 Assumed mobilization cost= 15% of (Culvert cost+Excavation and backfill cost+Isolation cost+Surface restoration cost)
 Base Construction Cost=Culvert cost+Excavation and backfill cost+Isolation cost+Surface restoration cost+Mobilization cost
 Contingency cost= 35% of Base Cost
 Administration during construction = 10% of Base Cost
 Engineering = 15% of Base Cost
 Total Estimated Cost= Base construction cost+ Contingency+Administration cost +Engineering cost
 The 'Site Improvement Contingency' includes such things as headwalls, retaining wall or local channel improvements. It is assumed that all works would not extend more than 6 m beyond the limit of the culvert.
 Total Estimated Cost with Site improvement contingency= Total estimated cost+site improvement contingency

Assumptions for channel:

Assumed 4 m offset on the south side and 1 m offset on the north side of the proposed channel.
 Contingency = 35% of the cost of land acquisition, excavation and control structure
 Administration during construction= 10% of the cost of land acquisition, excavation and control structure
 Engineering = 15% of the cost of land acquisition, excavation and control structure

*** The channel feasibility and cost will need to be proven through further investigation to resolve alignment discrepancies between topography and legal boundaries**

Cost Estimate - Lewis Supplemental Channel
City of Chilliwack - 2009 Drainage Study
USL - April 2009

CULVERT

Culvert	Proposed Length (m)	Proposed Number of Culverts	Proposed Diameter (m)	Culvert Cost (\$)	Excavation and Backfill Cost (\$)	Isolation Allowance (\$)	Surface Restoration (\$)	Mobilization (\$)	Base Construction Cost (\$)	Contingency (\$)	Administration (\$)	Engineering (\$)	Total Estimated Cost	Site Improvement Contingency (\$)	Total Estimated Cost with Contingency (\$)
Proposed	20	2	1.5	12,000.00	10,800.00	25,000.00	7,500.00	8,295.00	63,595.00	22,259.00	6,360.00	9,540.00	102,000.00	39,000.00	141,000.00
Proposed	20.0	2	1.50	12000	10,800.00	25,000.00	7,500.00	8,295.00	63,595.00	22,259.00	6,360.00	9,540.00	102,000.00	39,000.00	141,000.00
															282,000.00

CHANNEL

Item #	Description (m)	Unit	Quantity	Unit Price	Sub-total (m)
Channel					
1	Land Acquisition	m ²	27300	\$12.50	\$341,250
2	Excavation	m ³	14800	\$33.00	\$488,400
3	Control Structure	each	2	\$25,000.00	\$50,000
	SUBTOTAL				\$879,650
	35% Contingency cost				\$307,878
	10% Administration cost during Construction				\$87,965
	Engineering cost				\$131,948
	TOTAL				\$1,407,440

Assumptions for Culvert:

Assumed Aluminized steel pipe
 Assumed cost per unit meter of culvert: 750 mm -\$115; 900 mm-\$135; 1200mm-\$240; 1500mm-\$300;1800mm-\$385;2000 mm - \$500; 2100 mm - \$500.
 Assumed excavation and backfill cost/unit meter of culvert: 750mm-\$150; 900mm-\$150; 1200mm-\$180; 1500mm-\$270; 1800mm-\$400; 2000mm-\$550;2100mm-\$550.
 Assumed lump sum Isolation cost: 750mm to1200mm-\$10,000; 1500mm to 2100mm- \$20,000.
 Assumed Lump sum surface restoration cost: 750mm-\$4000; 900mm-\$5000; 1200mm-\$6000; 1500mm-\$7500; 1800mm-\$10,000; 2000mm-\$15,000; 2100mm-\$15,000.
 Assumed mobilization cost= 15% of (Culvert cost+Excavation and backfill cost+Isolation cost+Surface restoration cost)
 Base Construction Cost=Culvert cost+Excavation and backfill cost+Isolation cost+Surface restoration cost+Mobilization cost
 Contingency cost= 35% of Base Cost
 Administration during construction = 10% of Base Cost
 Engineering = 15% of Base Cost
 Total Estimated Cost= Base construction cost+ Contingency+Administration cost +Engineering cost
 The 'Site Improvement Contingency' includes such things as headwalls, retaining wall or local channel improvements. It is assumed that all works would not extend more than 6 m beyond the limit of the culvert.
 Total Estimated Cost with Site improvement contingency= Total estimated cost+site improvement contingency

Assumptions for channel:

Assumed 4 m offset on the south side and 1 m offset on the north side of the proposed channel.
 Contingency = 35% of the cost of land acquisition, excavation and control structure
 Administration during construction= 10% of the cost of land acquisition, excavation and control structure
 Engineering = 15% of the cost of land acquisition, excavation and control structure

*** The channel feasibility and cost will need to be proven through further investigation to resolve alignment discrepancies between topography and legal boundaries**



APPENDIX C

CONSULTATION RECORDS

No.	Date	Name:	Address:	Phone:	Email:	No. of years in Greendale:	Property Use:	Basement or crawl space?	how much below ground level:	Sump pump?	discharge to?	past flooding experience?	how often?	nature of past problems?	local drainage worse over time?	explain:	Jan. 2009 property impact:	Explain:	Application to DFA with the PEP?	claim amount?	specific conditions observed during Jan. 2009 flood	Keep residents informed by:	Available for additional questions?	Additional comments:	Photos	
28	28-May-09	Cliff & Cindy McKay	41738 South Sumas Rd.	604-823-2454	ccc.mckay@shaw.ca	9	residential, hobby farm	Yes	crawl space	No	n/a	Yes		Frozen ground/snow/rain melting water up to floor boards in crawls, ditch over flowing & backfield.	Yes	Water table seems to be rising	Impact to home/outbuildings, yard/field flooding, impact to well, septic system & other.	Totally ruined house, still not living there.	Yes	Not required, insurance covered it.	My opinion/observation - is that if there was a culvert put in that went from the large corner field behind our property under Chadsey Rd. to the ditch across, it would help to drain the water away from all the properties on either side of us.					
29	28-May-09	Mike & Anne Feenstra	42476 Adams Rd.	604-823-0091	feenstra@shaw.ca	12	Residential	Yes	4 feet	Yes		Yes	3 to four times during 12 years.	The crawl space would then be covered with several inches & the lower part of the backyard (including many shrubs) always flooded, sometimes half a foot.		It's worse when the ditches aren't cleaned. We border McGillivray Creek on Adams Rd. & have seen the ditches get so clogged up with reeds & grass that slow down the flow.	Impact to home/outbuildings, yard/field flooding	Crawl space several inches, backyard flooded, 8" of water in shop.	No	n/a	Clogged up ditch in our area. Slow beginning to water removal.					
30	28-May-09	William Ade	42570 South Sumas Rd.	604-490-0013	billade@shaw.ca	1	Residential	Yes	2-3feet crawl space	No	n/a	No		new resident			yard/field flooding, impact to septic system.	Water depth: 4 - 4.5 feet, Prevented access to and from residence, water level was encroaching on septic systems, don't believe ground water run off sewer line is connected.	No	n/a	Water backed up through sewer lines onto my property. Water ran onto my property from neighbouring properties.	Website, Open House, E-mail	Yes			
31	28-May-09	Vie Ewert	42322 South Sumas Rd.	604-823-6931	vmewert@shaw.ca	64	Residential	Yes	2 feet	No	n/a	No			Yes		No impact		No	n/a				See lengthy additional notes (scanned)	Photos	
33	28-May-09	Daryl Wear & Anita Mosimann	43305 Adams Rd.	604-823-6095	lowbeddaryl@shaw.ca	4	Residential	Yes	crawl space - 1' above street	No	n/a	No			Yes	Slow to retreat.	Impact to home/outbuildings, yard/field flooding, impact to well, septic system & other.	My kensworth / low bed was under 3 feet of water for 3 weeks, along with our septic field (and other equipment)	No	n/a	Hopedale under Adams heading north, culverts too small! Where Hopedale bends, farmer has about 200 feet of culvert buried and half the amount of water coming out as trying to get in.	Website, E-mail	Yes		your "Road flood are recorded by staff" Map doesn't show Adams Rd. east of Hopedale or Hopedale flooded!	
34	28-May-09	Rudy Schellenberg	43233 Adams Rd.	604-823-6899	rudyschellenberga@shaw.ca	70	Agriculture (tree farm)	Yes	3 feet	No	n/a	Yes		To small culverts on Hopedale Rd. ditch	Yes		Impact to outbuildings, yard/field flooding	Outbuildings had 2 feet water	No	\$2,000		Mail-out, E-mail				
35	28-May-09					34	Residential	Yes	12"	No	n/a	Yes	last 5 years	Small amount of water in shop during heavy rains while ground is frozen.	Yes	Due to new homes built in area and requirements to fill so high. My shop was built on high spot. It is now 18" below neighbours driveway.	Outbuildings, yard/field flooding	Water depth: 12"	No	n/a	Catch basin at northeast corner backed up to about 4" above grade.	Website, Mail-out	No			
36	28-May-09	Greg & Candace English	43021 South Sumas Rd.	604-823-6412	genglish@shaw.ca	11	Residential	Yes	crawl space - 4 to 5 feet	No	n/a	No			Yes		Impact to outbuildings, yard flooding		No	n/a	It was starting to flood very early in the morning. Water seemed to start going over the ditches later, about 1pm & then within the hour it seemed to start to subside quickly. At the same time the lower areas received more. Husband, geotech, believes that the water we had had no where else to go but down into the lower lying areas, thus creating more water than greendale could handle. Drainage systems & culverts can not hold the change in recent years due to weather conditions.					Photos
37	28-May-09	R. David & Ruth Hall	47615 Hope River Rd.	604-792-6456	halida@shaw.ca	60	Residential	No	n/a	No	n/a	Yes	Jan. 2005	Frozen ground, unusual snow fall, sudden warming & torrential rain. Farmers in back of our property could not contain the melting & rain. Water moved onto our property and neighbours causing water 10" deep in our house & flooding garage & driving.	No		Impact to home/outbuildings, yard/field flooding, impact to well, impact to septic system.	Water depth approx 20" in yard. Well water tested (good). Septic tank requires pumping.	Yes	Applied for \$29,000, received \$13,600		Yes		We request funding from City of Chilliwack to offset cost. See sketch		
38	28-May-09	Donna Loughran & Wayne Henderson	41624 Keith Wilson Rd.	604-823-6385		5	Agricultural (Beef farm)	Yes	Above ground	No	n/a	Yes	Every spring & winter	Ditch on property (easement) floods very spring & winter	Yes	I get about 2 feet of water over driveway.	Impact to home/outbuildings, yard/field flooding, other: Home tenants house	Water depth 3.5 feet over land & driveway, flooding access to barn. Lot feed. Flooding lasted.	Yes	\$3,300 Residential only!		Mail-out, Open House	Yes		Put pump station on south side of Keith Wilson Rd. by Keith Wilson Bridge on property 41510 municipal land. Put culvert on south side of Keith Wilson Rd. including easement ditch. Will help stop flooding of land & using our land as a reservoir.	Photos
39	28-May-09	Bryan Stokes	42345 South Sumas Rd.	604-823-6325		30+	Residential/Agricultural (Hazelnuts)	Yes	2 feet	Yes	Ground surface	No		We have continual water in our field	Yes		Yard/field flooding, other: Home tenants house	Water depth 2.5 feet, tenants house uninhabitable	No	n/a		Mail-out, Open House	Yes		Photos	
41	28-May-09	Susan & Ernie Willms	42703 Janzen Rd.	604-823-6343		2	Residential	Yes	3 feet crawl space	Yes	Ground surface /municipal	No		Have not lived there long enough to know.		Unknown	Yard/field flooding	Water depth approx 1 foot. Ditches were full and over flowing onto driveways / property.	No	n/a	Ditches full and overflowing. Driveway flooded because of so much snow piled up on sides.					
42	28-May-09	G. Hilton	6480 Sumas Prairie Rd.	604-832-3694	ghilton@telus.net	18	Residential	Yes	3 feet crawl space	Yes	Municipal ditch	Yes		But not as severe.	Yes	City did not clean out our back ditch as they did on previous requests in prior years.	Impact to home	Furnace	Yes	Unknown	Crush service in parking lot not draining. Culver corner of 6480 Sumas Prairie Rd. & church parking lot not draining after cleared. System not draining on east side of Sumas Prairie Rd. at all.	Mail-out, Open House	Yes		Photos	
43	28-May-09	Chris Laidman	7500 Arnold Rd.	604-823-6083	ely@unserve.com	8	Residential	Yes	4'	Yes	Ground surface	No			No			More water in the surrounding fields.	No	n/a						
44	28-May-09	Don Hooge	45217 South Sumas Rd.	604-793-3064	dhooge@shaw.ca	20	Agricultural	Yes	3 feet crawl space	No	n/a	Yes	Every year	Field floods because of restriction at Adams Rd.	No		Impact to home/outbuildings, yard/field flooding	Water depth 4 feet	Yes	\$5,000	Hopedale & Adams water over flow on Hopedale as well as my property (20 acres) was 75% under water. Property at the end of South Sumas Rd. had water in barn. Water was 4' next to golf course.	Website, E-mail	Yes			
45	28-May-09	Marius Klop	41979 South Sumas Rd.	604-795-0562		14	Agricultural	Yes	4 feet	Yes	Ground surface	No					Yard/field flooding	Water depth 4 feet	Yes	Unknown		Mail-out	Yes			
47	28-May-09	Joanne Lester	41650 South Sumas Rd.	604-823-0040	lester1952@shaw.ca	11	Agricultural (house/plant growing)	Yes	2' crawl space	No	n/a	Yes	2 times in 11 years	Very minor 1 to 3 inches. Flow from farm south of me and go thru barn. About 2-3 inches. Always able to pump it out to field west of barn. This time was @ 4.5 inches by 11am Wed. and running past house.	Yes	Ditches are filling with black berries, grass, scrub trees.	Impact to home/outbuildings, yard/field flooding, impact to septic system	Water depth 2 feet	Yes	Received \$21,000	Culverts too small. Water backed up on east side of culvert @ 1pm on Wed. Was at top of crawl space by then. Raised another 3-4" by 10pm & another 8-12 by 5am Thurs. Drove by pumps on dyke @ 1pm Wed. Were not at full capacity. By 4pm Thurs. was up another 8 inches. Dropped about 2" by Fri. am. Out of home by Sun. morning. Out of outbuildings south of house by Tues.	Mail-out, Open house	Yes			

General comments noted:
Resident on Chadsey Rd. says that water from Miller Slough was flowing back south to South Sumas Rd. because McGillivray Slough & PS could not handle it.



APPENDIX D

OPTIONS COMPARISON OF WATER LEVELS

Option 1 - Comparison of Water Level to Baseline Conditions

Culvert ID	Branch ID	Culvert Location Changeage	Existing Equivalent Culvert Diameter (m)	Proposed Equivalent Culvert Diameter (m)	Culvert Upgrade Ratio	10y			25y			100y			January Event		
						Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)
840	1	999	0.60	0.60	1.00	8.468	8.468	0	8.872	8.872	0.000	9.051	9.051	0.000	8.753	8.753	0.000
8003	1	1820.54	1.20	1.20	1.00	6.188	6.149	-0.039	6.866	6.707	-0.159	7.183	7.005	-0.178	6.753	6.822	-0.069
1177	1	2227.46	1.60	1.60	1.00	6.052	5.943	-0.109	6.777	6.47	-0.307	7.044	6.859	-0.185	7.182	6.882	-0.500
1178	1	2468.6	0.90	1.27	1.41	5.95	5.691	-0.269	6.625	6.228	-0.397	6.922	6.581	-0.341	6.976	6.407	-0.569
841	1	3012.01	1.00	1.00	1.00	4.741	4.759	0.018	5.356	5.552	0.196	5.784	6.003	0.219	5.986	5.913	-0.073
842	1	3012.01	1.00	1.00	1.00	4.741	4.759	0.018	5.356	5.552	0.196	5.784	6.003	0.219	5.986	5.913	-0.073
1161	1	3108.54	1.20	1.20	1.00	4.583	4.595	0.012	5.077	5.131	0.054	5.441	5.403	-0.038	5.663	5.466	-0.197
1162	1	3108.54	1.48	1.48	1.00	4.583	4.595	0.012	5.077	5.131	0.054	5.441	5.403	-0.038	5.663	5.466	-0.197
1163	1	3341.18	1.48	1.48	1.00	4.339	4.35	0.011	4.948	4.906	-0.042	5.347	5.242	-0.105	5.59	5.339	-0.251
1164	1	3341.18	1.48	1.48	1.00	4.339	4.35	0.011	4.948	4.906	-0.042	5.347	5.242	-0.105	5.59	5.339	-0.251
1165	1	3452.38	1.48	1.48	1.00	4.175	4.186	0.011	4.895	4.784	-0.111	5.307	5.17	-0.137	5.557	5.279	-0.278
1166	1	3452.38	1.48	1.48	1.00	4.175	4.186	0.011	4.895	4.784	-0.111	5.307	5.17	-0.137	5.557	5.279	-0.278
1167	1	3701.9	1.48	1.48	1.00	3.947	3.954	0.007	4.832	4.606	-0.226	5.252	5.059	-0.193	5.517	5.192	-0.325
1168	1	3701.9	1.48	1.48	1.00	3.947	3.954	0.007	4.832	4.606	-0.226	5.252	5.059	-0.193	5.517	5.192	-0.325
1169	1	3866.86	1.48	1.48	1.00	3.863	3.866	0.003	4.793	4.508	-0.285	5.209	4.975	-0.234	5.483	5.122	-0.361
1170	1	3866.86	1.48	1.48	1.00	3.863	3.866	0.003	4.793	4.508	-0.285	5.209	4.975	-0.234	5.483	5.122	-0.361
1171	1	4024.26	1.48	1.48	1.00	3.766	3.757	-0.009	4.756	4.414	-0.342	5.165	4.888	-0.277	5.448	5.051	-0.397
1172	1	4024.26	1.48	1.48	1.00	3.766	3.757	-0.009	4.756	4.414	-0.342	5.165	4.888	-0.277	5.448	5.051	-0.397
847	1	4251.84	1.80	1.80	1.00	3.614	3.531	-0.083	4.703	4.281	-0.422	5.105	4.768	-0.337	5.402	4.958	-0.444
8005	1	4388.97	2.26	2.26	1.00	3.534	3.36	-0.174	4.625	4.124	-0.501	5.01	4.573	-0.437	5.323	4.822	-0.501
1173	1	4487.49	1.83	1.83	1.00	3.518	3.325	-0.193	4.605	4.087	-0.518	4.984	4.531	-0.453	5.299	4.785	-0.514
1174	1	4487.49	1.83	1.83	1.00	3.518	3.325	-0.193	4.605	4.087	-0.518	4.984	4.531	-0.453	5.299	4.785	-0.514
1175	1	4629.45	1.83	1.83	1.00	3.496	3.272	-0.224	4.586	4.052	-0.534	4.968	4.501	-0.467	5.286	4.761	-0.525
1176	1	4629.45	1.83	2.59	1.00	3.496	3.272	-0.224	4.586	4.052	-0.534	4.968	4.501	-0.467	5.286	4.761	-0.525
1207	1	4653.71	1.20	2.60	2.17	3.485	3.215	-0.27	4.57	4.021	-0.549	4.955	4.471	-0.484	5.274	4.735	-0.539
8006	1	4878.97	2.23	2.23	1.00	3.09	3.105	0.015	3.965	3.963	-0.002	4.236	4.422	0.186	4.66	4.696	0.036
1155	1	5438.45	1.53	1.53	1.00	3.157	3.167	0.01	3.944	3.957	0.013	4.226	4.412	0.186	4.658	4.704	0.046
1156	1	5634.5	1.53	1.53	1.00	3.203	3.216	0.013	3.951	3.982	0.031	4.231	4.423	0.192	4.665	4.725	0.060
1157	1	6005.19	1.53	1.53	1.00	3.252	3.267	0.015	3.959	4.009	0.050	4.235	4.434	0.199	4.673	4.748	0.075
1158	1	6093.92	1.53	1.53	1.00	3.262	3.277	0.015	3.965	4.028	0.063	4.24	4.444	0.204	4.68	4.771	0.091
1160	1	6166.66	1.53	1.53	1.00	3.281	3.297	0.016	3.971	4.046	0.075	4.243	4.454	0.211	4.687	4.792	0.105
1159	1	6183.35	1.53	1.53	1.00	3.296	3.312	0.016	3.977	4.061	0.084	4.247	4.464	0.217	4.695	4.812	0.117
1145	4	1	1.50	1.50	1.00	6.239	6.123	-0.116	6.907	6.639	-0.268	7.175	6.859	-0.316	7.157	6.836	-0.321
1217	4	687.86	0.90	1.20	1.33	5.973	5.768	-0.205	6.766	6.344	-0.422	7.042	6.564	-0.478	7.029	6.537	-0.492
1215	4	1429.54	1.50	1.50	1.00	5.038	4.958	-0.08	5.419	5.396	-0.023	5.635	5.784	0.149	5.8	5.852	0.052
1216	4	1429.54	1.50	1.50	1.00	5.038	4.958	-0.08	5.419	5.396	-0.023	5.635	5.784	0.149	5.8	5.852	0.052
1214	4	1691.15	1.50	1.50	1.00	4.742	4.634	-0.108	5.233	5.207	-0.026	5.535	5.704	0.169	5.743	5.794	0.051
8013	4	2150.92	1.40	1.40	1.00	4.322	4.211	-0.111	4.997	4.966	-0.031	5.376	5.532	0.156	5.612	5.645	0.033
1240	4	2228.53	1.20	1.20	1.00	4.286	4.186	-0.1	4.913	4.887	-0.026	5.258	5.386	0.128	5.499	5.516	0.017
486	6	6.88	0.90	1.50	1.67	13.109	13.096	-0.013	13.173	13.156	-0.017	13.206	13.18	-0.026	13.188	13.167	-0.021
1204	6	190.06	0.90	1.50	1.67	12.579	12.563	-0.016	12.679	12.646	-0.033	12.749	12.706	-0.043	12.716	12.684	-0.032
1203	6	456.46	0.90	0.90	1.00	11.396	11.396	0	11.529	11.529	0.000	11.619	11.612	0.001	11.547	11.547	0.000
843	6	498.19	1.53	1.53	1.00	11.34	11.34	0	11.454	11.454	0.000	11.535	11.535	0.000	11.467	11.467	0.000
1200	6	876.97	1.20	1.20	1.00	10.299	10.299	0	10.734	10.704	-0.030	11.036	10.932	-0.104	10.838	10.599	-0.039
1201	6	1087.47	1.20	1.20	1.00	10.041	10.041	0	10.587	10.499	-0.088	10.927	10.759	-0.168	10.504	10.387	-0.117
1202	6	1154.39	1.20	1.20	1.00	9.977	9.977	0	10.51	10.373	-0.137	10.825	10.629	-0.196	10.44	10.276	-0.164
1199	6	1329.8	1.20	1.20	1.00	9.685	9.546	-0.139	10.444	10.18	-0.264	10.728	10.502	-0.226	10.384	10.105	-0.279
1234	6	1575.14	1.20	1.70	1.41	9.639	9.447	-0.192	10.204	9.852	-0.352	10.369	9.987	-0.382	10.16	9.816	-0.344
1198	6	2072.65	1.53	1.53	1.00	8.429	8.443	0.014	8.852	8.886	0.034	8.967	9.059	0.092	8.815	8.842	0.027
1233	6	2318.74	2.00	2.83	1.41	7.998	7.789	-0.209	8.41	8.098	-0.312	8.508	8.225	-0.283	8.377	8.075	-0.302
1195	6	3407.19	1.83	2.59	1.41	6.737	6.545	-0.192	7.468	7.087	-0.381	7.725	7.32	-0.405	7.608	7.26	-0.348
1196	6	3510.22	1.83	2.59	1.41	6.552	6.377	-0.175	7.313	6.984	-0.329	7.572	7.23	-0.342	7.477	7.159	-0.318
1197	6	3604.94	1.83	2.59	1.41	6.404	6.247	-0.157	7.117	6.819	-0.298	7.372	7.054	-0.318	7.304	7.001	-0.303
1232	6	3894.69	1.83	2.59	1.41	6.212	6.1	-0.112	6.882	6.615	-0.267	7.155	6.839	-0.316	7.141	6.817	-0.324
1230	6	4210.09	1.50	1.50	1.00	6.008	5.91	-0.098	6.617	6.385	-0.232	6.838	6.597	-0.241	6.88	6.621	-0.259
1231	6	4210.09	1.50	1.50	1.00	6.008	5.91	-0.098	6.617	6.385	-0.232	6.838	6.597	-0.241	6.88	6.621	-0.259
1143	6	4272.07	1.50	1.50	1.00	5.991	5.897	-0.094	6.55	6.342	-0.208	6.733	6.532	-0.201	6.767	6.552	-0.215
1144	6	4272.07	1.50	1.50	1.00	5.991	5.897	-0.094	6.55	6.342	-0.208	6.733	6.532	-0.201	6.767	6.552	-0.215
1141	6	5040.07	1.50	1.83	1.00	5.696	5.601	-0.095	6.23	5.918	-0.312	6.242	6.044	-0.198	6.268	6.061	-0.207
1142	6	5040.07	1.50	1.83	1.00	5.696	5.601	-0.095	6.23	5.918	-0.312	6.242	6.044	-0.198	6.268	6.061	-0.207
1350	6	5119.52	1.53	1.53	1.00	5.481	5.415	-0.066	6.142	5.702	-0.440	5.746	5.598	-0.148	5.857	5.63	-0.227
1351	6	5119.52	1.53	1.53	1.00	5.481	5.415	-0.066	6.142	5.702	-0.440	5.746	5.598	-0.148	5.857	5.63	-0.227
1352	6	5174.86	2.15	2.15	1.00	4.685	4.685	0	4.72	4.719	-0.001	5.62	5.588	-0.032	5.733	5.502	-0.231
1220	6	5220	2.50	2.50	1.00	4.685	4.685	0	4.72	4.718	-0.002	5.422	5.398	-0.024	5.659	5.453	-0.206
9006	10	562.13	0.90	0.90	1.00	4.9	4.894	-0.006	5.31	5.422	0.112	5.724	5.619	0.095	6.041	5.971	0.070
1191	13	766.85	2.00	2.00	1.00	13.703	13.703	0	13.886	13.886	0.000	14.032	14.032	0.000	14.143	14.143	0.000
1190	13	906.79	1.80	1.80	1.00	13.686	13.687	0.001	13.855	13.855	0.000	13.987	13.987	0.000	14.085	14.085	0.000
1189	13	11															

Option 1B : Comparison of Water Level to Baseline Conditions

Culvert ID	Branch ID	Culvert Location Chainage	Existing Equivalent Culvert Diameter (m)	Proposed Equivalent Culvert Diameter (m)	Culvert Upgrade Ratio	10y			25y			100y			January Event		
						Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)
840	1	999	0.60	0.60	1.00	8.468	8.469	0.001	8.872	8.872	0.000	9.051	9.051	0.000	8.753	8.753	0.000
8003	1	1920.54	1.20	1.20	1.00	6.188	6.143	-0.045	6.866	6.866	-0.180	7.183	6.975	-0.208	7.153	6.773	-0.380
1177	1	2227.46	1.60	1.60	1.00	6.052	5.916	-0.136	6.777	6.396	-0.374	7.044	6.606	-0.438	7.182	6.502	-0.680
1178	1	2468.6	0.90	1.27	1.41	5.96	5.688	-0.272	6.625	5.953	-0.672	6.922	6.065	-0.857	6.976	6.006	-0.970
841	1	3012.01	1.00	1.00	1.00	4.741	4.868	0.127	5.356	5.311	-0.045	5.784	5.583	-0.201	5.986	5.551	-0.435
842	1	3012.01	1.00	1.00	1.00	4.741	4.868	0.127	5.356	5.311	-0.045	5.784	5.583	-0.201	5.986	5.551	-0.435
1161	1	3108.54	1.20	1.20	1.00	4.583	4.687	0.104	5.077	5.201	0.124	5.441	5.527	0.086	5.663	5.509	-0.154
1162	1	3108.54	1.48	1.48	1.00	4.583	4.687	0.104	5.077	5.201	0.124	5.441	5.527	0.086	5.663	5.509	-0.154
1163	1	3341.18	1.48	1.48	1.00	4.339	4.427	0.088	4.948	4.823	-0.125	5.347	4.993	-0.354	5.59	5.173	-0.417
1164	1	3341.18	1.48	1.48	1.00	4.339	4.427	0.088	4.948	4.823	-0.125	5.347	4.993	-0.354	5.59	5.173	-0.417
1165	1	3452.38	1.48	1.48	1.00	4.175	4.092	-0.083	4.895	4.573	-0.322	5.307	4.859	-0.448	5.557	5.11	-0.447
1166	1	3452.38	1.48	1.48	1.00	4.175	4.092	-0.083	4.895	4.573	-0.322	5.307	4.859	-0.448	5.557	5.11	-0.447
1167	1	3701.9	1.48	1.48	1.00	3.947	3.939	-0.008	4.832	4.433	-0.399	5.252	4.796	-0.456	5.517	5.065	-0.452
1168	1	3701.9	1.48	1.48	1.00	3.947	3.939	-0.008	4.832	4.433	-0.399	5.252	4.796	-0.456	5.517	5.065	-0.452
1169	1	3866.86	1.48	1.48	1.00	3.863	3.84	-0.023	4.793	4.338	-0.455	5.209	4.745	-0.464	5.483	5.023	-0.460
1170	1	3866.86	1.48	1.48	1.00	3.863	3.84	-0.023	4.793	4.338	-0.455	5.209	4.745	-0.464	5.483	5.023	-0.460
1171	1	4024.26	1.48	1.48	1.00	3.766	3.771	0.005	4.756	4.26	-0.496	5.165	4.697	-0.468	5.448	4.982	-0.466
1172	1	4024.26	1.48	1.48	1.00	3.766	3.771	0.005	4.756	4.26	-0.496	5.165	4.697	-0.468	5.448	4.982	-0.466
847	1	4251.84	1.80	1.80	1.00	3.614	3.567	-0.047	4.703	4.448	-0.255	5.105	4.631	-0.474	5.402	4.93	-0.472
8005	1	4388.97	2.26	2.26	1.00	3.534	3.403	-0.131	4.625	4.05	-0.575	5.01	4.54	-0.470	5.323	4.853	-0.470
1173	1	4487.49	1.83	1.83	1.00	3.518	3.329	-0.189	4.605	4.025	-0.580	4.984	4.53	-0.454	5.299	4.848	-0.451
1174	1	4487.49	1.83	1.83	1.00	3.518	3.329	-0.189	4.605	4.025	-0.580	4.984	4.53	-0.454	5.299	4.848	-0.451
1175	1	4629.45	1.83	1.83	1.00	3.496	3.281	-0.215	4.586	3.983	-0.603	4.968	4.495	-0.473	5.286	4.815	-0.471
1176	1	4629.45	1.83	2.59	1.00	3.496	3.281	-0.215	4.586	3.983	-0.603	4.968	4.495	-0.473	5.286	4.815	-0.471
1207	1	4653.71	1.20	2.60	2.17	3.485	3.194	-0.291	4.57	3.944	-0.626	4.955	4.473	-0.482	5.274	4.796	-0.478
8006	1	4878.97	2.23	2.23	1.00	3.09	3.15	0.06	3.965	3.913	-0.052	4.236	4.448	0.212	4.66	4.773	0.113
1155	1	5438.45	1.53	1.53	1.00	3.157	3.065	-0.092	3.944	3.876	-0.068	4.226	4.433	0.207	4.658	4.762	0.104
1156	1	5634.5	1.53	1.53	1.00	3.203	3.171	-0.032	3.951	3.899	-0.052	4.231	4.443	0.212	4.665	4.776	0.111
1157	1	6005.19	1.53	1.53	1.00	3.252	3.238	-0.014	3.959	3.928	-0.031	4.235	4.456	0.221	4.673	4.793	0.120
1158	1	6093.92	1.53	1.53	1.00	3.262	3.246	-0.016	3.965	3.929	-0.036	4.24	4.456	0.216	4.68	4.793	0.113
1160	1	6166.66	1.53	1.53	1.00	3.281	3.252	-0.029	3.971	3.931	-0.040	4.243	4.457	0.214	4.687	4.794	0.107
1159	1	6183.35	1.53	1.53	1.00	3.296	3.274	-0.022	3.977	3.95	-0.027	4.247	4.47	0.223	4.695	4.812	0.117
1145	4	1	1.50	1.50	1.00	6.239	6.124	-0.115	6.907	6.638	-0.269	7.175	6.862	-0.313	7.157	6.837	-0.320
1217	4	687.86	0.90	1.20	1.33	5.973	5.768	-0.205	6.766	6.344	-0.422	7.042	6.566	-0.476	7.029	6.538	-0.491
1215	4	1429.54	1.50	1.50	1.00	5.038	4.959	-0.079	5.419	5.387	-0.032	5.635	5.7	0.065	5.8	5.77	-0.030
1216	4	1429.54	1.50	1.50	1.00	5.038	4.959	-0.079	5.419	5.387	-0.032	5.635	5.7	0.065	5.8	5.77	-0.030
1214	4	1691.15	1.50	1.50	1.00	4.742	4.634	-0.108	5.233	5.183	-0.050	5.535	5.596	0.061	5.743	5.698	-0.045
8013	4	2150.92	1.40	1.40	1.00	4.322	4.212	-0.11	4.997	4.9	-0.097	5.376	5.409	0.033	5.612	5.545	-0.067
1240	4	2228.53	1.20	1.20	1.00	4.286	4.187	-0.099	4.913	4.821	-0.092	5.258	5.264	0.006	5.499	5.414	-0.085
486	6	6.88	0.90	1.50	1.67	13.109	13.096	-0.013	13.173	13.156	-0.017	13.206	13.18	-0.026	13.188	13.167	-0.021
1204	6	190.06	0.90	1.50	1.67	12.579	12.563	-0.016	12.679	12.646	-0.033	12.749	12.706	-0.043	12.716	12.684	-0.032
1203	6	456.46	0.90	0.90	1.00	11.396	11.396	0	11.529	11.53	0.001	11.619	11.62	0.001	11.547	11.547	0.000
843	6	498.19	1.53	1.53	1.00	11.34	11.34	0	11.454	11.455	0.001	11.535	11.535	0.000	11.467	11.467	0.000
1200	6	876.97	1.20	1.20	1.00	10.299	10.299	0	10.734	10.704	-0.030	11.036	10.932	-0.104	10.638	10.599	-0.039
1201	6	1087.47	1.20	1.20	1.00	10.041	10.041	0	10.587	10.499	-0.088	10.927	10.759	-0.168	10.504	10.387	-0.117
1202	6	1154.39	1.20	1.20	1.00	9.977	9.977	0	10.51	10.373	-0.137	10.825	10.629	-0.196	10.44	10.276	-0.164
1199	6	1329.8	1.20	1.20	1.00	9.685	9.547	-0.138	10.444	10.18	-0.264	10.728	10.502	-0.226	10.384	10.105	-0.279
1234	6	1575.14	1.20	1.70	1.41	9.639	9.448	-0.191	10.204	9.852	-0.352	10.369	9.987	-0.382	10.16	9.816	-0.344
1198	6	2072.65	1.53	1.53	1.00	8.429	8.444	0.015	8.852	8.887	0.035	8.967	9.059	0.092	8.815	8.842	0.027
1233	6	2318.74	2.00	2.83	1.41	7.998	7.79	-0.208	8.41	8.098	-0.312	8.508	8.225	-0.283	8.377	8.075	-0.302
1195	6	3407.19	1.83	2.59	1.41	6.737	6.546	-0.191	7.468	7.088	-0.380	7.725	7.325	-0.400	7.608	7.26	-0.348
1196	6	3510.22	1.83	1.83	1.00	6.552	6.378	-0.174	7.313	6.984	-0.329	7.572	7.233	-0.339	7.477	7.159	-0.318
1197	6	3604.94	1.83	1.83	1.00	6.404	6.248	-0.156	7.117	6.819	-0.298	7.372	7.057	-0.315	7.304	7.001	-0.303
1232	6	3894.69	1.83	1.83	1.00	6.212	6.101	-0.111	6.882	6.615	-0.267	7.155	6.842	-0.313	7.141	6.818	-0.323
1230	6	4210.09	1.50	1.50	1.00	6.008	5.911	-0.097	6.617	6.382	-0.235	6.838	6.599	-0.239	6.88	6.621	-0.259
1231	6	4210.09	1.50	1.50	1.00	6.008	5.911	-0.097	6.617	6.382	-0.235	6.838	6.599	-0.239	6.88	6.621	-0.259
1143	6	4272.07	1.50	1.50	1.00	5.991	5.898	-0.093	6.55	6.346	-0.204	6.733	6.534	-0.199	6.767	6.552	-0.215
1144	6	4272.07	1.50	1.50	1.00	5.991	5.898	-0.093	6.55	6.346	-0.204	6.733	6.534	-0.199	6.767	6.552	-0.215
1141	6	5040.07	1.50	1.83	1.00	5.696	5.602	-0.094	6.23	5.92	-0.310	6.242	6.045	-0.197	6.268	6.061	-0.207
1142	6	5040.07	1.50	1.83	1.00	5.696	5.602	-0.094	6.23	5.92	-0.310	6.242	6.045	-0.197	6.268	6.061	-0.207
1350	6	5119.52	1.53	1.53	1.00	5.481	5.416	-0.065	6.142	5.498	-0.644	5.746	5.599	-0.147	5.857	5.632	-0.225
1351	6	5119.52	1.53	1.53	1.00	5.481	5.416	-0.065	6.142	5.498	-0.644	5.746	5.599	-0.147	5.857	5.632	-0.225
1352	6	5174.86	2.15	2.15	1.00	4.688	4.688	0.000	4.72	4.625	-0.095	5.62	5.469	-0.151	5.733	5.504	-0.229
1220	6	6220	2.50	2.50	1.00	4.685	4.688	0.003	4.72	4.517	-0.203	5.317	5.135	-0.182	5.659	5.454	-0.205
9006	10	562.13	0.90	0.90	1.00	4.9	4.894	-0.006	5.31	5.408	0.098	5.724	5.58	-0.144	6.041	5.844	-0.197
1191	13	766.85	2.00	2.00	1.00	13.703	13.703	0	13.886	13.886	0.000	14.032	14.032	0.000	14.143	14.143	0.000
1190	13	906.79	1.80	1.80	1.00	13.686	13.687	0.001	13.855	13.855	0.000	13.987	13.987	0.000	14.085	14.085	0.000
1189	13																

Option 2 : Comparison of Water Level to Baseline Conditions

Culvert ID	Branch ID	Culvert Location Chainage	Existing Equivalent Culvert Diameter (m)	Proposed Equivalent Culvert Diameter (m)	Culvert Upgrade Ratio	10y			25y			100y			January Event		
						Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)
840	1	999	0.60	1.70	2.83	8.468	8.322	-0.146	8.872	8.524	-0.348	9.051	8.596	-0.455	8.753	8.453	-0.300
8003	1	1929.54	1.20	2.12	1.77	6.188	6.079	-0.109	6.865	6.401	-0.464	7.183	6.548	-0.635	7.153	6.557	-0.596
1177	1	2227.46	1.60	2.12	1.33	6.052	5.87	-0.182	6.77	6.295	-0.475	7.044	6.48	-0.564	7.192	6.39	-0.792
1178	1	2468.6	0.90	2.12	2.36	5.96	5.629	-0.331	6.625	6.059	-0.566	6.922	6.237	-0.685	6.976	6.152	-0.824
841	1	3012.01	1.00	2.08	1.47	4.741	4.656	-0.085	5.356	5.242	-0.114	5.784	5.641	-0.143	5.986	5.526	-0.460
842	1	3012.01	1.00														
1161	1	3108.54	1.20														
1162	1	3108.54	1.48	2.56	1.35	4.583	4.577	-0.006	5.077	5.106	0.029	5.441	5.449	0.008	5.663	5.402	-0.261
1163	1	3341.18	1.48	1.48	1.00	4.339	4.351	0.012	4.948	4.95	0.002	5.347	5.337	-0.010	5.59	5.334	-0.256
1164	1	3341.18	1.48	1.48	1.00	4.339	4.351	0.012	4.948	4.95	0.002	5.347	5.337	-0.010	5.59	5.334	-0.256
1165	1	3452.38	1.48	1.48	1.00	4.175	4.186	0.011	4.895	4.805	-0.090	5.307	5.196	-0.111	5.557	5.259	-0.298
1166	1	3452.38	1.48	1.48	1.00	4.175	4.186	0.011	4.895	4.805	-0.090	5.307	5.196	-0.111	5.557	5.259	-0.298
1167	1	3701.9	1.48	1.48	1.00	3.947	3.952	0.005	4.832	4.595	-0.237	5.252	5.018	-0.234	5.517	5.145	-0.372
1168	1	3701.9	1.48	1.48	1.00	3.947	3.952	0.005	4.832	4.595	-0.237	5.252	5.018	-0.234	5.517	5.145	-0.372
1169	1	3866.86	1.48	1.48	1.00	3.863	3.86	-0.003	4.793	4.474	-0.319	5.209	4.912	-0.297	5.483	5.052	-0.431
1170	1	3866.86	1.48	1.48	1.00	3.863	3.86	-0.003	4.793	4.474	-0.319	5.209	4.912	-0.297	5.483	5.052	-0.431
1171	1	4024.26	1.48	1.48	1.00	3.766	3.745	-0.021	4.756	4.357	-0.399	5.165	4.807	-0.358	5.448	4.958	-0.490
1172	1	4024.26	1.48	1.48	1.00	3.766	3.745	-0.021	4.756	4.357	-0.399	5.165	4.807	-0.358	5.448	4.958	-0.490
847	1	4251.84	1.80	2.55	1.41	3.614	3.461	-0.153	4.703	4.165	-0.538	5.105	4.665	-0.440	5.402	4.833	-0.569
8005	1	4388.97	2.26	2.26	1.00	3.534	3.369	-0.165	4.625	4.107	-0.518	5.01	4.607	-0.403	5.323	4.785	-0.538
1173	1	4487.49	1.83	1.83	1.00	3.518	3.335	-0.183	4.605	4.063	-0.542	4.984	4.546	-0.438	5.299	4.731	-0.568
1174	1	4487.49	1.83	1.83	1.00	3.518	3.335	-0.183	4.605	4.063	-0.542	4.984	4.546	-0.438	5.299	4.731	-0.568
1175	1	4629.45	1.83	1.83	1.00	3.496	3.285	-0.211	4.586	4.021	-0.565	4.968	4.504	-0.464	5.286	4.697	-0.589
1176	1	4629.45	1.83	1.83	1.00	3.496	3.285	-0.211	4.586	4.021	-0.565	4.968	4.504	-0.464	5.286	4.697	-0.589
1207	1	4653.71	1.20	2.60	2.17	3.485	3.236	-0.249	4.57	3.984	-0.586	4.955	4.464	-0.491	5.274	4.66	-0.614
8006	1	4878.97	2.23	2.23	1.00	3.09	3.142	0.052	3.965	3.913	-0.052	4.236	4.396	0.160	4.66	4.604	-0.056
1155	1	5438.45	1.53	1.53	1.00	3.157	3.181	0.024	3.944	3.91	-0.034	4.226	4.377	0.151	4.658	4.598	-0.060
1156	1	5634.5	1.53	1.53	1.00	3.203	3.224	0.021	3.951	3.945	-0.006	4.231	4.386	0.155	4.665	4.613	-0.052
1157	1	6005.19	1.53	1.53	1.00	3.252	3.271	0.019	3.959	3.983	0.024	4.235	4.397	0.162	4.673	4.629	-0.044
1158	1	6093.92	1.53	1.53	1.00	3.262	3.281	0.019	3.965	4.01	0.045	4.24	4.406	0.166	4.68	4.645	-0.035
1160	1	6166.66	1.53	1.53	1.00	3.281	3.299	0.018	3.971	4.034	0.063	4.243	4.415	0.172	4.687	4.66	-0.027
1159	1	6183.35	1.53	1.53	1.00	3.296	3.314	0.018	3.977	4.055	0.078	4.247	4.424	0.177	4.695	4.675	-0.020
1145	4	1	1.50	1.50	1.00	6.239	6.065	-0.174	6.907	6.555	-0.352	7.175	6.775	-0.400	7.157	6.742	-0.415
1217	4	687.86	0.90	1.70	1.89	5.973	5.596	-0.377	6.766	6.046	-0.720	7.042	6.263	-0.779	7.029	6.233	-0.796
1215	4	1429.54	1.50	1.50	1.00	5.038	4.923	-0.115	5.419	5.353	-0.066	5.635	5.756	0.121	5.8	5.791	-0.009
1216	4	1429.54	1.50	1.50	1.00	5.038	4.923	-0.115	5.419	5.353	-0.066	5.635	5.756	0.121	5.8	5.791	-0.009
1214	4	1691.15	1.50	1.50	1.00	4.742	4.587	-0.155	5.233	5.152	-0.081	5.535	5.669	0.134	5.743	5.724	-0.019
8013	4	2150.92	1.40	1.40	1.00	4.322	4.163	-0.159	4.997	4.903	-0.094	5.376	5.494	0.118	5.612	5.574	-0.038
1240	4	2228.53	1.20	1.20	1.00	4.286	4.142	-0.144	4.913	4.827	-0.086	5.258	5.348	0.090	5.499	5.445	-0.054
486	6	6.88	0.90	1.50	1.67	13.109	13.096	-0.013	13.173	13.156	-0.017	13.206	13.18	-0.026	13.188	13.167	-0.021
1204	6	190.06	0.90	2.12	2.36	12.579	12.537	-0.042	12.679	12.595	-0.084	12.749	12.626	-0.123	12.716	12.612	-0.104
1203	6	456.46	0.90	0.90	1.00	11.396	11.396	0	11.529	11.53	0.001	11.619	11.621	0.002	11.547	11.548	0.001
843	6	498.19	1.20	1.83	1.39	11.34	11.302	-0.038	11.454	11.374	-0.080	11.535	11.431	-0.104	11.467	11.385	-0.082
1200	6	876.97	1.20	1.83	1.53	10.299	10.247	-0.052	10.747	10.657	-0.090	11.036	10.768	-0.268	10.838	10.508	-0.330
1201	6	1087.47	1.20	1.20	1.00	10.041	10.015	-0.026	10.587	10.436	-0.151	10.927	10.623	-0.304	10.504	10.335	-0.169
1202	6	1154.39	1.20	1.83	1.53	9.977	9.926	-0.051	10.51	10.252	-0.258	10.825	10.39	-0.435	10.44	10.176	-0.264
1199	6	1329.8	1.20	1.70	1.41	9.685	9.525	-0.16	10.444	9.961	-0.483	10.728	10.175	-0.553	10.384	9.913	-0.471
1234	6	1575.14	1.20	2.58	2.15	9.639	9.465	-0.174	10.204	9.81	-0.394	10.369	9.943	-0.426	10.16	9.774	-0.386
1198	6	2072.65	1.53	1.53	1.00	8.429	8.443	0.014	8.852	8.895	0.043	8.967	9.132	0.165	8.815	8.85	0.035
1233	6	2318.74	2.00	2.83	1.41	7.998	7.789	-0.209	8.41	8.102	-0.308	8.508	8.261	-0.247	8.377	8.077	-0.300
1195	6	3407.19	1.83	2.59	1.41	6.737	6.534	-0.203	7.468	6.957	-0.511	7.725	7.159	-0.566	7.608	7.085	-0.523
1196	6	3510.22	1.83	2.59	1.41	6.552	6.244	-0.308	7.313	6.746	-0.567	7.572	6.961	-0.611	7.477	6.905	-0.572
1197	6	3604.94	1.83	2.59	1.41	6.404	6.131	-0.273	7.117	6.639	-0.478	7.372	6.859	-0.513	7.304	6.814	-0.490
1232	6	3894.69	1.83	2.59	1.41	6.212	6.024	-0.188	6.882	6.517	-0.365	7.155	6.744	-0.411	7.141	6.719	-0.422
1230	6	4210.09	1.50	2.12	1.00	6.008	5.942	-0.066	6.617	6.428	-0.189	6.838	6.657	-0.181	6.88	6.653	-0.227
1231	6	4210.09	1.50	2.12	1.00	6.008	5.942	-0.066	6.617	6.428	-0.189	6.838	6.657	-0.181	6.88	6.653	-0.227
1143	6	4272.07	1.50	2.12	1.00	5.991	5.926	-0.065	6.55	6.379	-0.171	6.733	6.579	-0.154	6.767	6.576	-0.191
1144	6	4272.07	1.50	2.12	1.00	5.991	5.926	-0.065	6.55	6.379	-0.171	6.733	6.579	-0.154	6.767	6.576	-0.191
1141	6	5040.07	1.50	2.12	1.00	5.696	5.516	-0.18	6.23	5.872	-0.358	6.242	5.997	-0.245	6.268	5.998	-0.270
1142	6	5040.07	1.50	2.12	1.00	5.696	5.516	-0.18	6.23	5.872	-0.358	6.242	5.997	-0.245	6.268	5.998	-0.270
1350	6	5119.52	1.53	1.53	1.00	5.481	5.439	-0.042	6.142	5.742	-0.400	5.746	5.632	-0.114	5.857	5.648	-0.209
1351	6	5119.52	1.53	1.53	1.00	5.481	5.439	-0.042	6.142	5.742	-0.400	5.746	5.632	-0.114	5.857	5.648	-0.209
1352	6	5174.86	2.15	2.15	1.00	4.685	4.685	0	4.72	4.719	-0.001	5.62	5.504	-0.116	5.733	5.52	-0.213
1220	6	5220	2.50	2.50	1.00	4.685	4.685	0	4.72	4.718	-0.002	5.62	5.558	-0.062	5.688	5.468	-0.220
9006	10	562.13	0.90	0.90	1.00	4.9	4.895	-0.005	5.31	5.439	0.129	5.724	5.65	0.074	6.041	5.586	-0.455
1191	13	766.85	2.00	2.00	1.00	13.703	13.703	0	13.886	13.886	0.000	14.032	14.032	0.000	14.143	14.143	0.000
1190	13	906.79	1.80	1.80	1.00	13.686	13.687	0.001	13.855	13.855	0.000	13.987	13.987	0.000	14.085	14.085	0.000
1189	13	1123.2	1.80	1.80	1.00	12.687	12.687	0	12.861	12.861	0.000	12.994	12.994	0.000	13.087	13.087	

Option 3 : Comparison of Water Level to Baseline Conditions

Culvert ID	Branch ID	Culvert Location Chainage	Existing Equivalent Culvert Diameter (m)	Proposed Equivalent Culvert Diameter (m)	Culvert Upgrade Ratio	10y			25y			100y			January Event		
						Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)
840	1	999	0.60	1.70	2.83	8.468	8.322	-0.146	8.872	8.524	-0.348	9.051	8.583	-0.468	8.753	8.453	-0.300
8003	1	1929.54	1.20	2.12	1.77	6.188	6.079	-0.109	6.865	6.491	-0.375	7.183	6.639	-0.544	7.153	6.557	-0.596
1177	1	2227.46	1.60	2.12	1.33	6.052	5.87	-0.182	6.77	6.295	-0.475	7.044	6.47	-0.574	7.182	6.39	-0.792
1178	1	2468.6	0.90	2.12	2.36	5.96	5.628	-0.332	6.625	6.059	-0.566	6.922	6.222	-0.700	6.976	6.152	-0.824
841	1	3012.01	1.00	2.08	1.47	4.741	4.656	-0.085	5.356	5.242	-0.114	5.784	5.579	-0.205	5.986	5.441	-0.545
842	1	3012.01	1.00														
1161	1	3108.54	1.20														
1162	1	3108.54	1.48	2.56	1.35	4.583	4.577	-0.006	5.077	5.106	0.029	5.441	5.392	-0.049	5.663	5.284	-0.379
1163	1	3341.18	1.48	1.48	1.00	4.339	4.351	0.012	4.948	4.95	0.002	5.347	5.277	-0.070	5.59	5.188	-0.402
1164	1	3341.18	1.48	1.48	1.00	4.339	4.351	0.012	4.948	4.95	0.002	5.347	5.277	-0.070	5.59	5.188	-0.402
1165	1	3452.38	1.48	1.48	1.00	4.175	4.186	0.011	4.895	4.805	-0.090	5.307	5.137	-0.170	5.557	5.101	-0.456
1166	1	3452.38	1.48	1.48	1.00	4.175	4.186	0.011	4.895	4.805	-0.090	5.307	5.137	-0.170	5.557	5.101	-0.456
1167	1	3701.9	1.48	1.48	1.00	3.947	3.951	0.004	4.832	4.595	-0.237	5.252	4.936	-0.316	5.517	4.952	-0.565
1168	1	3701.9	1.48	1.48	1.00	3.947	3.951	0.004	4.832	4.595	-0.237	5.252	4.936	-0.316	5.517	4.952	-0.565
1169	1	3866.86	1.48	1.48	1.00	3.863	3.86	-0.003	4.793	4.474	-0.319	5.209	4.788	-0.421	5.483	4.838	-0.645
1170	1	3866.86	1.48	1.48	1.00	3.863	3.86	-0.003	4.793	4.474	-0.319	5.209	4.788	-0.421	5.483	4.838	-0.645
1171	1	4024.26	1.48	1.48	1.00	3.766	3.745	-0.021	4.756	4.358	-0.398	5.165	4.638	-0.527	5.448	4.722	-0.726
1172	1	4024.26	1.48	1.48	1.00	3.766	3.745	-0.021	4.756	4.358	-0.398	5.165	4.638	-0.527	5.448	4.722	-0.726
847	1	4251.84	1.80	2.55	1.41	3.614	3.461	-0.153	4.703	4.14	-0.563	5.105	4.425	-0.680	5.402	4.553	-0.849
8005	1	4388.97	2.26	2.26	1.00	3.534	3.368	-0.166	4.625	4.056	-0.569	5.01	4.343	-0.667	5.323	4.479	-0.844
1173	1	4487.49	1.83	1.83	1.00	3.518	3.335	-0.183	4.605	3.996	-0.609	4.984	4.267	-0.717	5.299	4.405	-0.894
1174	1	4487.49	1.83	1.83	1.00	3.518	3.335	-0.183	4.605	3.996	-0.609	4.984	4.267	-0.717	5.299	4.405	-0.894
1175	1	4629.45	1.83	1.83	1.00	3.496	3.284	-0.212	4.586	3.933	-0.653	4.968	4.206	-0.762	5.286	4.348	-0.938
1176	1	4629.45	1.83	1.83	1.00	3.496	3.284	-0.212	4.586	3.933	-0.653	4.968	4.206	-0.762	5.286	4.348	-0.938
1207	1	4653.71	1.20	2.60	2.17	3.485	3.236	-0.249	4.57	3.879	-0.691	4.955	4.153	-0.802	5.274	4.299	-0.975
8006	1	4878.97	2.23	2.23	1.00	3.09	3.142	0.052	3.965	3.756	-0.209	4.236	4.037	-0.199	4.66	4.2	-0.460
1155	1	5438.45	1.53	1.53	1.00	3.157	3.181	0.024	3.944	3.766	-0.178	4.226	4.02	-0.206	4.658	4.198	-0.460
1156	1	5634.5	1.53	1.53	1.00	3.203	3.224	0.021	3.951	3.835	-0.116	4.231	4.067	-0.164	4.665	4.246	-0.419
1157	1	6005.19	1.53	1.53	1.00	3.252	3.271	0.019	3.959	3.905	-0.054	4.235	4.116	-0.119	4.673	4.298	-0.375
1158	1	6093.92	1.53	1.53	1.00	3.262	3.281	0.019	3.965	3.949	-0.016	4.24	4.154	-0.086	4.68	4.341	-0.339
1160	1	6166.66	1.53	1.53	1.00	3.281	3.299	0.018	3.971	3.99	0.019	4.243	4.186	-0.057	4.687	4.373	-0.314
1159	1	6183.35	1.53	1.53	1.00	3.296	3.314	0.018	3.977	4.025	0.048	4.247	4.214	-0.033	4.695	4.401	-0.294
1145	4	1	1.50	1.50	1.00	6.239	6.065	-0.174	6.907	6.555	-0.352	7.175	6.747	-0.428	7.157	6.742	-0.415
1217	4	687.86	0.90	1.70	1.89	5.973	5.596	-0.377	6.766	6.046	-0.720	7.042	6.229	-0.813	7.029	6.226	-0.803
1215	4	1429.54	1.50	1.50	1.00	5.038	4.923	-0.115	5.419	5.353	-0.066	5.635	5.669	0.034	5.8	5.734	-0.066
1216	4	1429.54	1.50	1.50	1.00	5.038	4.923	-0.115	5.419	5.353	-0.066	5.635	5.669	0.034	5.8	5.734	-0.066
1214	4	1691.15	1.50	1.50	1.00	4.742	4.587	-0.155	5.233	5.152	-0.081	5.535	5.565	0.030	5.743	5.653	-0.090
8013	4	2150.92	1.40	1.40	1.00	4.322	4.163	-0.159	4.997	4.903	-0.094	5.376	5.391	0.015	5.612	5.497	-0.115
1240	4	2228.53	1.20	1.20	1.00	4.286	4.142	-0.144	4.913	4.827	-0.086	5.258	5.259	0.001	5.499	5.367	-0.132
486	6	6.88	0.90	1.50	1.67	13.109	13.096	-0.013	13.173	13.156	-0.017	13.206	13.185	-0.021	13.188	13.167	-0.021
1204	6	190.06	0.90	2.12	2.36	12.579	12.537	-0.042	12.679	12.595	-0.084	12.749	12.622	-0.127	12.716	12.612	-0.104
1203	6	456.46	0.90	0.90	1.00	11.396	11.396	0	11.529	11.53	0.001	11.619	11.596	-0.023	11.547	11.548	0.001
843	6	498.19	1.20	1.83	1.39	11.34	11.302	-0.038	11.454	11.374	-0.080	11.535	11.421	-0.114	11.467	11.385	-0.082
1200	6	876.97	1.20	1.83	1.53	10.299	10.247	-0.052	10.734	10.597	-0.137	11.036	10.73	-0.306	10.638	10.508	-0.130
1201	6	1087.47	1.20	1.20	1.00	10.041	10.015	-0.026	10.587	10.436	-0.151	10.927	10.581	-0.346	10.504	10.335	-0.169
1202	6	1154.39	1.20	1.83	1.53	9.977	9.926	-0.051	10.51	10.252	-0.258	10.825	10.36	-0.465	10.44	10.176	-0.264
1199	6	1329.8	1.20	1.70	1.41	9.685	9.525	-0.16	10.444	9.961	-0.483	10.728	10.109	-0.619	10.384	9.913	-0.471
1234	6	1575.14	1.20	2.58	2.15	9.639	9.466	-0.173	10.204	9.81	-0.394	10.369	9.913	-0.456	10.16	9.774	-0.386
1198	6	2072.65	1.53	1.53	1.00	8.429	8.444	0.015	8.852	8.895	0.043	8.967	8.952	0.085	8.815	8.85	0.035
1233	6	2318.74	2.00	2.83	1.41	7.998	7.79	-0.208	8.41	8.102	-0.308	8.508	8.218	-0.290	8.377	8.077	-0.300
1195	6	3407.19	1.83	2.59	1.41	6.737	6.534	-0.203	7.468	6.957	-0.511	7.725	7.118	-0.607	7.608	7.085	-0.523
1196	6	3510.22	1.83	2.59	1.41	6.552	6.245	-0.307	7.313	6.746	-0.567	7.572	6.928	-0.644	7.477	6.905	-0.572
1197	6	3604.94	1.83	2.59	1.41	6.404	6.131	-0.273	7.117	6.639	-0.478	7.372	6.828	-0.544	7.304	6.814	-0.490
1232	6	3894.69	1.83	2.59	1.41	6.212	6.024	-0.188	6.882	6.517	-0.365	7.155	6.715	-0.440	7.141	6.719	-0.422
1230	6	4210.09	1.50	2.12	1.00	6.008	5.942	-0.066	6.617	6.428	-0.189	6.838	6.63	-0.208	6.88	6.653	-0.227
1231	6	4210.09	1.50	2.12	1.00	6.008	5.942	-0.066	6.617	6.428	-0.189	6.838	6.63	-0.208	6.88	6.653	-0.227
1143	6	4272.07	1.50	2.12	1.00	5.991	5.926	-0.065	6.55	6.379	-0.171	6.733	6.557	-0.176	6.767	6.576	-0.191
1144	6	4272.07	1.50	2.12	1.00	5.991	5.926	-0.065	6.55	6.379	-0.171	6.733	6.557	-0.176	6.767	6.576	-0.191
1141	6	5040.07	1.50														
1142	6	5040.07	1.50	2.12	1.00	5.696	5.516	-0.18	6.23	5.872	-0.358	6.242	5.981	-0.261	6.268	5.998	-0.270
1350	6	5119.52	1.53	1.53	1.00	5.481	5.439	-0.042	6.142	5.742	-0.400	5.746	5.619	-0.127	5.857	5.646	-0.211
1351	6	5119.52	1.53	1.53	1.00	5.481	5.439	-0.042	6.142	5.742	-0.400	5.746	5.619	-0.127	5.857	5.646	-0.211
1352	6	5174.86	2.15	2.15	1.00	4.685	4.685	0	4.72	4.719	-0.001	5.62	5.491	-0.129	5.733	5.518	-0.215
1220	6	5220	2.50	2.50	1.00	4.685	4.685	0	4.72	4.718	-0.002	5.558	5.443	-0.115	5.659	5.467	-0.192
9006	10	562.13	0.90	0.90	1.00	4.9	4.895	-0.005	5.31	5.439	0.129	5.724	5.567	-0.157	6.041	5.541	-0.500
1191	13	766.85	2.00	2.00	1.00	13.703	13.703	0	13.886	13.886	0.000	14.032	14.01	-0.022	14.143	14.143	0.000
1190	13	906.79	1.80	1.80	1.00	13.686	13.686	0	13.855	13.855	0.000	13.987	13.967	-0.020	14.085	14.085	0.000
1189	13	1123.2	1.80	1.80	1.00	12.687	12.687	0	12.861	12.861	0.000	12.994	12.974	-0.020	13.087	13.088	0.001
1188	13	1252.7	1.75	1.75	1.00	12.03											

Option 3B : Comparison of Water Level to Baseline Conditions

Culvert ID	Branch ID	Culvert Location Chainage	Existing Equivalent Culvert Diameter (m)	Proposed Equivalent Culvert Diameter (m)	Culvert Upgrade Ratio	10y			25y			100y			January Event		
						Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)
840	1	999	0.60	1.70	2.83	8.468	8.322	-0.146	8.872	8.524	-0.348	9.051	8.596	-0.455	8.753	8.453	-0.300
8003	1	1929.54	1.20	2.12	1.77	6.188	6.071	-0.117	6.865	6.447	-0.418	7.183	6.643	-0.540	7.153	6.519	-0.634
1177	1	2227.46	1.60	2.12	1.33	6.052	5.828	-0.224	6.777	6.216	-0.561	7.044	6.378	-0.666	7.182	6.286	-0.896
1178	1	2468.6	0.90	2.12	2.36	5.96	5.68	-0.28	6.625	5.951	-0.674	6.922	6.059	-0.863	6.976	6.001	-0.975
841	1	3012.01	1.00	2.08	1.47	4.741	4.858	0.117	5.356	5.252	-0.104	5.784	5.43	-0.354	5.986	5.337	-0.649
842	1	3012.01	1.00														
1161	1	3108.54	1.20														
1162	1	3108.54	1.48	2.56	1.35	4.583	4.595	0.012	5.077	5.037	-0.040	5.441	5.269	-0.172	5.663	5.149	-0.514
1163	1	3341.18	1.48	1.48	1.00	4.339	4.433	0.094	4.948	4.849	-0.099	5.347	5.064	-0.283	5.59	4.974	-0.616
1164	1	3341.18	1.48	1.48	1.00	4.339	4.433	0.094	4.948	4.849	-0.099	5.347	5.064	-0.283	5.59	4.974	-0.616
1165	1	3452.38	1.48	1.48	1.00	4.175	4.098	-0.077	4.895	4.593	-0.302	5.307	4.846	-0.461	5.557	4.811	-0.746
1166	1	3452.38	1.48	1.48	1.00	4.175	4.098	-0.077	4.895	4.593	-0.302	5.307	4.846	-0.461	5.557	4.811	-0.746
1167	1	3701.9	1.48	1.48	1.00	3.947	3.944	-0.003	4.832	4.442	-0.390	5.252	4.703	-0.549	5.517	4.715	-0.802
1168	1	3701.9	1.48	1.48	1.00	3.947	3.944	-0.003	4.832	4.442	-0.390	5.252	4.703	-0.549	5.517	4.715	-0.802
1169	1	3866.86	1.48	1.48	1.00	3.863	3.843	-0.02	4.793	4.336	-0.457	5.209	4.597	-0.612	5.483	4.641	-0.842
1170	1	3866.86	1.48	1.48	1.00	3.863	3.843	-0.02	4.793	4.336	-0.457	5.209	4.597	-0.612	5.483	4.641	-0.842
1171	1	4024.26	1.48	1.48	1.00	3.766	3.773	0.007	4.756	4.247	-0.509	5.165	4.496	-0.669	5.448	4.57	-0.878
1172	1	4024.26	1.48	1.48	1.00	3.766	3.773	0.007	4.756	4.247	-0.509	5.165	4.496	-0.669	5.448	4.57	-0.878
847	1	4251.84	1.80	2.55	1.41	3.614	3.55	-0.064	4.703	4.082	-0.621	5.105	4.377	-0.728	5.402	4.472	-0.930
8005	1	4388.97	2.26	2.26	1.00	3.534	3.411	-0.123	4.625	4.009	-0.616	5.01	4.332	-0.678	5.323	4.433	-0.890
1173	1	4487.49	1.83	1.83	1.00	3.518	3.34	-0.178	4.605	3.964	-0.641	4.984	4.305	-0.679	5.299	4.412	-0.887
1174	1	4487.49	1.83	1.83	1.00	3.518	3.34	-0.178	4.605	3.964	-0.641	4.984	4.305	-0.679	5.299	4.412	-0.887
1175	1	4629.45	1.83	1.83	1.00	3.496	3.295	-0.201	4.586	3.895	-0.691	4.968	4.238	-0.730	5.286	4.349	-0.937
1176	1	4629.45	1.83	1.83	1.00	3.496	3.295	-0.201	4.586	3.895	-0.691	4.968	4.238	-0.730	5.286	4.349	-0.937
1207	1	4653.71	1.20	2.60	2.17	3.485	3.217	-0.268	4.57	3.824	-0.746	4.955	4.187	-0.768	5.274	4.305	-0.969
8006	1	4878.97	2.23	2.23	1.00	3.09	3.179	0.089	3.965	3.768	-0.197	4.236	4.132	-0.104	4.66	4.256	-0.404
1155	1	5438.45	1.53	1.53	1.00	3.157	3.104	-0.053	3.944	3.685	-0.259	4.226	4.082	-0.144	4.658	4.22	-0.438
1156	1	5634.55	1.53	1.53	1.00	3.203	3.183	-0.02	3.951	3.763	-0.188	4.231	4.12	-0.111	4.665	4.254	-0.411
1157	1	6005.19	1.53	1.53	1.00	3.252	3.244	-0.008	3.959	3.847	-0.112	4.235	4.166	-0.069	4.673	4.296	-0.377
1158	1	6093.92	1.53	1.53	1.00	3.262	3.251	-0.011	3.965	3.851	-0.114	4.24	4.168	-0.072	4.68	4.297	-0.383
1160	1	6166.66	1.53	1.53	1.00	3.281	3.256	-0.025	3.971	3.856	-0.115	4.243	4.17	-0.073	4.687	4.298	-0.389
1159	1	6183.35	1.53	1.53	1.00	3.296	3.277	-0.019	3.977	3.905	-0.072	4.247	4.207	-0.040	4.695	4.335	-0.360
1145	4	1	1.50	1.50	1.00	6.239	6.066	-0.173	6.907	6.553	-0.354	7.175	6.775	-0.400	7.157	6.742	-0.415
1217	4	687.86	0.90	1.70	1.89	5.973	5.596	-0.377	6.766	6.044	-0.722	7.042	6.256	-0.786	7.029	6.219	-0.810
1215	4	1429.54	1.50	1.50	1.00	5.038	4.924	-0.114	5.419	5.345	-0.074	5.635	5.674	0.039	5.8	5.657	-0.143
1216	4	1429.54	1.50	1.50	1.00	5.038	4.924	-0.114	5.419	5.345	-0.074	5.635	5.674	0.039	5.8	5.657	-0.143
1214	4	1691.15	1.50	1.50	1.00	4.742	4.588	-0.154	5.233	5.13	-0.103	5.535	5.558	0.023	5.743	5.551	-0.192
8013	4	2150.92	1.40	1.40	1.00	4.322	4.163	-0.159	4.997	4.841	-0.156	5.376	5.357	-0.019	5.612	5.374	-0.238
1240	4	2228.53	1.20	1.20	1.00	4.286	4.143	-0.143	4.913	4.772	-0.141	5.258	5.209	-0.049	5.499	5.24	-0.259
486	6	6.88	0.90	1.50	1.67	13.109	13.096	-0.013	13.173	13.156	-0.017	13.206	13.18	-0.026	13.188	13.167	-0.021
1204	6	190.06	0.90	2.12	2.36	12.579	12.537	-0.042	12.679	12.595	-0.084	12.749	12.626	-0.123	12.716	12.612	-0.104
1203	6	456.46	0.90	0.90	1.00	11.396	11.396	0	11.529	11.53	0.001	11.619	11.621	0.002	11.547	11.548	0.001
843	6	498.19	1.20	1.83	1.39	11.34	11.302	-0.038	11.454	11.374	-0.080	11.535	11.431	-0.104	11.467	11.385	-0.082
1200	6	876.97	1.20	1.83	1.53	10.299	10.247	-0.052	10.734	10.597	-0.137	11.036	10.768	-0.268	10.808	10.508	-0.300
1201	6	1087.47	1.20	1.20	1.00	10.041	10.015	-0.026	10.587	10.436	-0.151	10.927	10.623	-0.304	10.504	10.335	-0.169
1202	6	1154.39	1.20	1.83	1.53	9.977	9.926	-0.051	10.51	10.252	-0.258	10.825	10.39	-0.435	10.44	10.175	-0.265
1199	6	1329.8	1.20	1.70	1.41	9.685	9.525	-0.16	10.444	9.961	-0.483	10.728	10.175	-0.553	10.384	9.913	-0.471
1234	6	1575.14	1.20	2.58	2.15	9.639	9.466	-0.173	10.204	9.81	-0.394	10.369	9.943	-0.426	10.16	9.774	-0.386
1198	6	2072.65	1.53	1.53	1.00	8.429	8.444	0.015	8.852	8.896	0.044	8.967	9.132	0.165	8.815	8.85	0.035
1233	6	2318.74	2.00	2.83	1.41	7.998	7.79	-0.208	8.41	8.102	-0.308	8.508	8.261	-0.247	8.377	8.077	-0.300
1195	6	3407.19	1.83	2.59	1.41	6.737	6.534	-0.203	7.468	6.957	-0.511	7.725	7.159	-0.566	7.608	7.085	-0.523
1196	6	3510.22	1.83	2.59	1.41	6.552	6.245	-0.307	7.313	6.745	-0.568	7.572	6.961	-0.611	7.477	6.905	-0.572
1197	6	3604.94	1.83	2.59	1.41	6.404	6.131	-0.273	7.117	6.637	-0.480	7.372	6.859	-0.513	7.304	6.814	-0.490
1232	6	3894.69	1.83	2.59	1.41	6.212	6.024	-0.188	6.882	6.514	-0.368	7.155	6.743	-0.412	7.141	6.719	-0.422
1230	6	4210.09	1.50	2.12	1.00	6.008	5.942	-0.066	6.617	6.424	-0.193	6.838	6.657	-0.181	6.88	6.653	-0.227
1231	6	4210.09	1.50	2.12	1.00	6.008	5.942	-0.066	6.617	6.424	-0.193	6.838	6.657	-0.181	6.88	6.653	-0.227
1143	6	4272.07	1.50	2.12	1.00	5.991	5.926	-0.065	6.55	6.382	-0.168	6.733	6.579	-0.154	6.767	6.576	-0.191
1144	6	4272.07	1.50	2.12	1.00	5.991	5.926	-0.065	6.55	6.382	-0.168	6.733	6.579	-0.154	6.767	6.576	-0.191
1141	6	5040.07	1.50	2.12	1.00	5.696	5.516	-0.18	6.23	5.875	-0.355	6.242	5.997	-0.245	6.268	5.998	-0.270
1142	6	5040.07	1.50	2.12	1.00	5.696	5.516	-0.18	6.23	5.875	-0.355	6.242	5.997	-0.245	6.268	5.998	-0.270
1350	6	5119.52	1.53	1.53	1.00	5.481	5.439	-0.042	6.142	5.744	-0.398	5.746	5.632	-0.114	5.857	5.646	-0.211
1351	6	5119.52	1.53	1.53	1.00	5.481	5.439	-0.042	6.142	5.744	-0.398	5.746	5.632	-0.114	5.857	5.646	-0.211
1352	6	5174.86	2.15	2.15	1.00	4.685	4.688	0.003	4.72	4.719	-0.001	5.62	5.504	-0.116	5.733	5.518	-0.215
1220	6	6220	2.50	2.50	1.00	4.685	4.688	0.003	4.72	4.718	-0.002	5.658	5.558	-0.100	5.659	5.467	-0.192
9006	10	562.13	0.90	0.90	1.00	4.9	4.893	-0.007	5.31	5.421	0.111	5.724	5.612	-0.112	6.041	5.412	-0.629
1191	13	766.85	2.00	2.00	1.00	13.703	13.703	0	13.886	13.886	0.000	14.032	14.032	0.000	14.143	14.143	0.000
1190	13	906.79	1.80	1.80	1.00	13.686	13.687	0.001	13.855	13.855	0.000	13.987	13.987	0.000	14.085	14.085	0.000
1189	13	1123.2	1.80	1.80	1.00	12.687	12.687	0	12.861	12.861	0.000	12.994	12.994	0.000	13.087		

Option 4 : Comparison of Water Level to Baseline Conditions

Culvert ID	Branch ID	Culvert Location Changeage	Existing Equivalent Culvert Diameter (m)	Proposed Equivalent Culvert Diameter (m)	Culvert Upgrade Ratio	10y			25y			100y			January Event		
						Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)
840	1	999	0.60	1.70	2.83	8.468	8.292	-0.176	8.872	8.545	-0.327	9.051	8.93	-0.121	8.753	8.732	-0.021
8003	1	1829.54	1.20	2.12	1.77	6.188	6.091	-0.097	6.865	6.525	-0.341	7.183	6.614	-0.569	7.153	6.503	-0.650
1177	1	2227.46	1.60	2.12	1.33	6.052	5.928	-0.124	6.777	6.341	-0.429	7.044	6.441	-0.604	7.182	6.36	-0.822
1178	1	2468.6	0.90	2.12	2.36	5.96	5.787	-0.173	6.625	6.183	-0.442	6.922	6.283	-0.639	6.976	6.206	-0.770
841	1	3012.01	1.00	2.08	1.47	4.741	4.884	0.143	5.356	5.347	-0.009	5.784	5.502	-0.282	5.986	5.404	-0.582
842	1	3012.01	1.00														
1161	1	3108.54	1.20														
1162	1	3108.54	1.48	2.56	1.35	4.583	4.622	0.039	5.077	5.162	0.085	5.441	5.364	-0.077	5.663	5.266	-0.397
1163	1	3341.18	1.48	1.48	1.00	4.339	4.457	0.118	4.948	4.969	0.021	5.347	5.148	-0.199	5.59	5.108	-0.482
1164	1	3341.18	1.48	1.48	1.00	4.339	4.457	0.118	4.948	4.969	0.021	5.347	5.148	-0.199	5.59	5.108	-0.482
1165	1	3452.38	1.48	1.48	1.00	4.175	4.155	-0.02	4.895	4.73	-0.165	5.307	4.949	-0.358	5.557	4.971	-0.586
1166	1	3452.38	1.48	1.48	1.00	4.175	4.155	-0.02	4.895	4.73	-0.165	5.307	4.949	-0.358	5.557	4.971	-0.586
1167	1	3701.9	1.48	1.48	1.00	3.947	3.997	0.05	4.832	4.567	-0.265	5.252	4.793	-0.459	5.517	4.868	-0.649
1168	1	3701.9	1.48	1.48	1.00	3.947	3.997	0.05	4.832	4.567	-0.265	5.252	4.793	-0.459	5.517	4.868	-0.649
1169	1	3866.86	1.48	1.48	1.00	3.863	3.893	0.03	4.793	4.445	-0.348	5.209	4.679	-0.530	5.483	4.778	-0.705
1170	1	3866.86	1.48	1.48	1.00	3.863	3.893	0.03	4.793	4.445	-0.348	5.209	4.679	-0.530	5.483	4.778	-0.705
1171	1	4024.26	1.48	1.48	1.00	3.766	3.819	0.053	4.756	4.335	-0.421	5.165	4.574	-0.591	5.448	4.689	-0.759
1172	1	4024.26	1.48	1.48	1.00	3.766	3.819	0.053	4.756	4.335	-0.421	5.165	4.574	-0.591	5.448	4.689	-0.759
847	1	4251.84	1.80	2.55	1.41	3.614	3.583	-0.031	4.703	4.19	-0.513	5.105	4.424	-0.681	5.402	4.568	-0.834
8005	1	4388.97	2.26	2.26	1.00	3.534	3.408	-0.126	4.625	4.135	-0.490	5.01	4.361	-0.649	5.323	4.519	-0.804
1173	1	4487.49	1.83	1.83	1.00	3.518	3.332	-0.186	4.605	4.107	-0.498	4.984	4.332	-0.652	5.299	4.499	-0.800
1174	1	4487.49	1.83	1.83	1.00	3.518	3.332	-0.186	4.605	4.107	-0.498	4.984	4.332	-0.652	5.299	4.499	-0.800
1175	1	4629.45	1.83	1.83	1.00	3.496	3.284	-0.212	4.586	4.06	-0.526	4.968	4.255	-0.713	5.286	4.328	-0.958
1176	1	4629.45	1.83	1.83	1.00	3.496	3.284	-0.212	4.586	4.06	-0.526	4.968	4.255	-0.713	5.286	4.328	-0.958
1207	1	4653.71	1.20	2.60	2.17	3.485	3.195	-0.29	4.57	4.015	-0.555	4.955	4.197	-0.758	5.274	4.484	-0.790
8006	1	4878.97	2.23	2.23	1.00	3.09	3.15	0.06	3.965	3.984	0.019	4.236	4.145	-0.091	4.66	4.34	-0.320
1155	1	5438.45	1.53	1.53	1.00	3.157	3.062	-0.095	3.944	3.936	-0.008	4.226	4.08	-0.146	4.658	4.299	-0.359
1156	1	5634.5	1.53	1.53	1.00	3.203	3.179	-0.024	3.951	3.96	0.009	4.231	4.078	-0.153	4.665	4.303	-0.362
1157	1	6005.19	1.53	1.53	1.00	3.252	3.236	-0.016	3.959	3.984	0.025	4.235	4.076	-0.159	4.673	4.308	-0.365
1158	1	6093.92	1.53	1.53	1.00	3.262	3.238	-0.024	3.965	3.984	0.019	4.24	4.076	-0.164	4.68	4.308	-0.372
1160	1	6166.66	1.53	1.53	1.00	3.281	3.269	-0.012	3.971	4.019	0.048	4.243	4.073	-0.170	4.687	4.316	-0.371
1159	1	6183.35	1.53	1.53	1.00	3.296	3.271	-0.025	3.977	4.02	0.043	4.247	4.071	-0.176	4.695	4.316	-0.379
1145	4	1	1.50	1.50	1.00	6.239	6.099	-0.14	6.907	6.72	-0.187	7.175	5.61	-1.565	7.157	5.586	-1.571
1217	4	687.86	0.90	1.70	1.89	5.973	5.623	-0.35	6.766	6.183	-0.583	7.042	5.519	-1.523	7.029	5.494	-1.535
1215	4	1429.54	1.50	1.50	1.00	5.038	4.946	-0.092	5.419	5.487	0.068	5.635	4.936	-0.699	5.8	4.938	-0.862
1216	4	1429.54	1.50	1.50	1.00	5.038	4.946	-0.092	5.419	5.487	0.068	5.635	4.936	-0.699	5.8	4.938	-0.862
1214	4	1691.15	1.50	1.50	1.00	4.742	4.618	-0.124	5.233	5.296	0.063	5.535	4.61	-0.925	5.743	4.613	-1.130
8013	4	2150.92	1.40	1.40	1.00	4.322	4.194	-0.128	4.997	4.992	-0.005	5.376	4.253	-1.123	5.612	4.432	-1.180
1240	4	2228.53	1.20	1.20	1.00	4.286	4.171	-0.115	4.913	4.88	-0.033	5.258	4.243	-1.015	5.499	4.423	-1.076
486	6	6.88	0.90	1.50	1.67	13.109	13.096	-0.013	13.173	13.156	-0.017	13.206	13.18	-0.026	13.188	13.167	-0.021
1204	6	190.06	0.90	2.12	2.36	12.579	12.537	-0.042	12.679	12.595	-0.084	12.749	12.626	-0.123	12.716	12.612	-0.104
1203	6	456.46	0.90	0.90	1.00	11.396	11.397	0.001	11.529	11.53	0.001	11.619	11.621	0.002	11.547	11.548	0.001
843	6	498.19	1.20	1.83	1.39	11.34	11.302	-0.038	11.454	11.376	-0.078	11.535	11.356	-0.179	11.467	11.385	-0.082
1200	6	876.97	1.20	1.83	1.53	10.299	10.248	-0.051	10.734	10.598	-0.136	11.038	10.768	-0.268	10.838	10.509	-0.329
1201	6	1087.47	1.20	1.20	1.00	10.041	10.015	-0.026	10.587	10.436	-0.151	10.927	10.624	-0.303	10.504	10.336	-0.168
1202	6	1154.39	1.20	1.83	1.53	9.977	9.926	-0.051	10.51	10.253	-0.257	10.825	10.39	-0.435	10.44	10.176	-0.264
1199	6	1329.8	1.20	1.70	1.41	9.685	9.525	-0.16	10.444	9.961	-0.483	10.728	10.175	-0.553	10.384	9.914	-0.470
1234	6	1575.14	1.20	2.58	2.15	9.639	9.466	-0.173	10.204	9.81	-0.394	10.369	9.944	-0.425	10.16	9.775	-0.385
1198	6	2072.65	1.53	1.53	1.00	8.429	8.066	-0.363	8.852	8.626	-0.226	8.967	8.844	-0.123	8.815	8.572	-0.243
1233	6	2318.74	2.00	2.83	1.41	7.998	7.794	-0.204	8.41	8.08	-0.330	8.508	8.464	-0.044	8.377	8.199	-0.178
1195	6	3407.19	1.83	2.59	1.41	6.737	6.539	-0.198	7.468	7.162	-0.306	7.725	8.124	0.399	7.608	7.828	0.220
1196	6	3510.22	1.83	2.59	1.41	6.552	6.355	-0.197	7.313	7.022	-0.291	7.572	8.035	0.463	7.477	7.774	0.297
1197	6	3604.94	1.83	2.59	1.41	6.404	6.299	-0.105	7.117	6.955	-0.162	7.372	8.02	0.648	7.304	7.762	0.458
1232	6	3894.69	1.83	2.59	1.41	6.212	6.091	-0.121	6.882	6.712	-0.170	7.155	7.778	0.623	7.141	7.629	0.488
1230	6	4210.09	1.50	2.12	1.00	6.008	5.832	-0.176	6.617	6.481	-0.136	6.838	7.414	0.576	6.88	7.459	0.479
1231	6	4210.09	1.50	2.12	1.00	6.008	5.832	-0.176	6.617	6.481	-0.136	6.838	7.414	0.576	6.88	7.459	0.479
1143	6	4272.07	1.50	2.12	1.00	5.991	5.83	-0.161	6.55	6.479	-0.071	6.733	7.076	0.343	6.767	7.037	0.270
1144	6	4272.07	1.50	2.12	1.00	5.991	5.83	-0.161	6.55	6.479	-0.071	6.733	7.076	0.343	6.767	7.037	0.270
1141	6	5040.07	1.50														
1142	6	5040.07	1.50	2.12	1.00	5.696	5.653	-0.043	6.23	6.159	-0.071	6.242	6.506	0.264	6.268	6.48	0.212
1350	6	5119.52	1.53	1.53	1.00	5.481	5.541	0.06	6.142	6.006	-0.136	5.746	6.033	0.287	6.042	6.042	0.000
1351	6	5119.52	1.53	1.53	1.00	5.481	5.541	0.06	6.142	6.006	-0.136	5.746	6.033	0.287	6.042	6.042	0.000
1352	6	5174.86	2.15	2.15	1.00	4.685	4.537	-0.148	4.72	5	0.280	5.62	5.908	0.288	5.733	5.912	0.179
1220	6	5220	2.50	2.50	1.00	4.685	4.689	0.004	4.72	4.72	0.000	5.284	5.558	0.274	5.659	5.815	0.156
9006	10	562.13	0.90	0.90	1.00	4.9	4.89	-0.01	5.31	5.42	0.110	5.724	5.186	-0.538	6.041	5.1	-0.941
1191	13	766.85	2.00	2.00	1.00	13.703	13.703	0	13.886	13.886	0.000	14.032	14.032	0.000	14.143	14.143	0.000
1190	13	906.79	1.80	1.80	1.00	13.686	13.687	0.001	13.855	13.855	0.000	13.987	13.987	0.000	14.085	14.085	0.000
1189	13	1123.2	1.80	1.80	1.00	12.687	12.687	0	12.861	12.861	0.000	12.994	12.994	0.000	13.087	13.088	0.001
1188	13	1252.7	1.75	1.75	1.00	12.03	12.031										

Option 5 : Comparison of Water Level to Baseline Conditions

Culvert ID	Branch ID	Culvert Location Changeage	Existing Equivalent Culvert Diameter (m)	Proposed Equivalent Culvert Diameter (m)	Culvert Upgrade Ratio	10y			25y			100y			January Event		
						Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)
840	1	999	0.60	1.70	2.83	8.468	8.292	-0.176	8.872	8.545	-0.327	9.051	8.93	-0.121	8.753	8.731	-0.022
8003	1	1829.54	1.20	2.12	1.77	6.188	6.091	-0.097	6.865	6.525	-0.341	7.183	6.415	-0.768	7.153	6.503	-0.650
1177	1	2227.46	1.60	2.12	1.33	6.052	5.928	-0.124	6.77	6.342	-0.428	7.044	6.443	-0.601	7.182	6.362	-0.820
1178	1	2468.6	0.90	2.12	2.36	5.95	5.787	-0.173	6.625	6.184	-0.441	6.922	6.289	-0.633	6.976	6.209	-0.767
841	1	3012.01	1.00	2.08	1.47	4.741	4.885	0.144	5.356	5.382	0.026	5.784	5.613	-0.171	5.986	5.458	-0.528
842	1	3012.01	1.00														
1161	1	3108.54	1.20														
1162	1	3108.54	1.48	2.56	1.35	4.583	4.623	0.04	5.077	5.206	0.129	5.441	5.505	0.064	5.663	5.31	-0.353
1163	1	3341.18	1.48	1.48	1.00	4.339	4.458	0.119	4.948	5.008	0.060	5.347	5.266	-0.081	5.59	5.116	-0.474
1164	1	3341.18	1.48	1.48	1.00	4.339	4.458	0.119	4.948	5.008	0.060	5.347	5.266	-0.081	5.59	5.116	-0.474
1165	1	3452.38	1.48	1.48	1.00	4.175	4.157	-0.018	4.895	4.772	-0.123	5.307	5.086	-0.221	5.557	4.962	-0.595
1166	1	3452.38	1.48	1.48	1.00	4.175	4.157	-0.018	4.895	4.772	-0.123	5.307	5.086	-0.221	5.557	4.962	-0.595
1167	1	3701.9	1.48	1.48	1.00	3.947	3.998	0.051	4.832	4.608	-0.224	5.252	4.915	-0.337	5.517	4.836	-0.681
1168	1	3701.9	1.48	1.48	1.00	3.947	3.998	0.051	4.832	4.608	-0.224	5.252	4.915	-0.337	5.517	4.836	-0.681
1169	1	3866.86	1.48	1.48	1.00	3.863	3.894	0.031	4.793	4.489	-0.304	5.209	4.772	-0.437	5.483	4.728	-0.755
1170	1	3866.86	1.48	1.48	1.00	3.863	3.894	0.031	4.793	4.489	-0.304	5.209	4.772	-0.437	5.483	4.728	-0.755
1171	1	4024.26	1.48	1.48	1.00	3.766	3.82	0.054	4.756	4.378	-0.378	5.165	4.629	-0.536	5.448	4.617	-0.831
1172	1	4024.26	1.48	1.48	1.00	3.766	3.82	0.054	4.756	4.378	-0.378	5.165	4.629	-0.536	5.448	4.617	-0.831
847	1	4251.84	1.80	2.55	1.41	3.614	3.585	-0.029	4.703	4.173	-0.530	5.105	4.42	-0.685	5.402	4.452	-0.950
8005	1	4388.97	2.26	2.26	1.00	3.534	3.415	-0.119	4.625	4.081	-0.544	5.01	4.34	-0.670	5.323	4.376	-0.947
1173	1	4487.49	1.83	1.83	1.00	3.518	3.344	-0.174	4.605	4.028	-0.577	4.984	4.299	-0.685	5.299	4.339	-0.960
1174	1	4487.49	1.83	1.83	1.00	3.518	3.344	-0.174	4.605	4.028	-0.577	4.984	4.299	-0.685	5.299	4.339	-0.960
1175	1	4629.45	1.83	1.83	1.00	3.495	3.297	-0.199	4.586	3.948	-0.638	4.968	4.196	-0.772	5.286	4.239	-1.047
1176	1	4629.45	1.83	1.83	1.00	3.495	3.297	-0.199	4.586	3.948	-0.638	4.968	4.196	-0.772	5.286	4.239	-1.047
1207	1	4653.71	1.20	2.60	2.17	3.485	3.219	-0.266	4.57	3.859	-0.711	4.955	4.114	-0.841	5.274	4.163	-1.111
8006	1	4878.97	2.23	2.23	1.00	3.09	3.18	0.09	3.965	3.801	-0.164	4.236	4.043	-0.193	4.66	4.093	-0.567
1155	1	5438.45	1.53	1.53	1.00	3.157	3.106	-0.051	3.944	3.681	-0.263	4.226	3.93	-0.296	4.658	3.99	-0.668
1156	1	5634.5	1.53	1.53	1.00	3.203	3.202	-0.001	3.951	3.776	-0.175	4.231	3.944	-0.287	4.665	4.013	-0.652
1157	1	6005.19	1.53	1.53	1.00	3.252	3.257	0.005	3.959	3.855	-0.104	4.235	3.959	-0.276	4.673	4.037	-0.636
1158	1	6093.92	1.53	1.53	1.00	3.262	3.259	-0.003	3.965	3.857	-0.108	4.24	3.959	-0.281	4.68	4.038	-0.642
1160	1	6166.66	1.53	1.53	1.00	3.281	3.29	0.009	3.971	3.952	-0.019	4.243	3.979	-0.264	4.687	4.069	-0.618
1159	1	6183.35	1.53	1.53	1.00	3.296	3.292	-0.004	3.977	3.954	-0.023	4.247	3.979	-0.268	4.695	4.07	-0.625
1145	4	1	1.50	1.50	1.00	6.239	6.038	-0.201	6.907	6.589	-0.318	7.175	5.706	-1.469	7.157	5.7	-1.457
1217	4	687.86	0.90	1.70	1.89	5.973	5.571	-0.402	6.766	6.072	-0.694	7.042	5.519	-1.523	7.029	5.494	-1.535
1215	4	1429.54	1.50	1.50	1.00	5.038	4.907	-0.131	5.419	5.371	-0.048	5.635	4.936	-0.699	5.8	4.938	-0.862
1216	4	1429.54	1.50	1.50	1.00	5.038	4.907	-0.131	5.419	5.371	-0.048	5.635	4.936	-0.699	5.8	4.938	-0.862
1214	4	1691.15	1.50	1.50	1.00	4.742	4.562	-0.18	5.233	5.166	-0.067	5.535	4.61	-0.925	5.743	4.612	-1.131
8013	4	2150.92	1.40	1.40	1.00	4.322	4.141	-0.181	4.997	4.904	-0.093	5.376	4.245	-1.131	5.612	4.363	-1.249
1240	4	2228.53	1.20	1.20	1.00	4.286	4.122	-0.164	4.913	4.834	-0.079	5.258	4.234	-1.024	5.499	4.353	-1.146
486	6	6.88	0.90	1.50	1.67	13.109	13.096	-0.013	13.173	13.156	-0.017	13.206	13.18	-0.026	13.188	13.167	-0.021
1204	6	190.06	0.90	2.12	2.36	12.579	12.537	-0.042	12.679	12.595	-0.084	12.749	12.626	-0.123	12.716	12.612	-0.104
1203	6	456.46	0.90	0.90	1.00	11.396	11.397	0.001	11.529	11.53	0.001	11.619	11.621	0.002	11.547	11.548	0.001
843	6	498.19	1.20	1.83	1.39	11.34	11.302	-0.038	11.454	11.376	-0.078	11.535	11.396	-0.099	11.467	11.385	-0.082
1200	6	876.97	1.20	1.83	1.53	10.299	10.248	-0.051	10.734	10.598	-0.136	11.036	10.768	-0.268	10.838	10.509	-0.329
1201	6	1087.47	1.20	1.20	1.00	10.041	10.015	-0.026	10.587	10.436	-0.151	10.927	10.624	-0.303	10.504	10.336	-0.168
1202	6	1154.39	1.20	1.83	1.53	9.977	9.926	-0.051	10.51	10.253	-0.257	10.825	10.39	-0.435	10.44	10.176	-0.264
1199	6	1329.8	1.20	1.70	1.41	9.685	9.525	-0.16	10.444	9.961	-0.483	10.728	10.175	-0.553	10.384	9.914	-0.470
1234	6	1575.14	1.20	2.58	2.15	9.639	9.466	-0.173	10.204	9.81	-0.394	10.369	9.944	-0.425	10.16	9.775	-0.385
1198	6	2072.65	1.53	1.53	1.00	8.429	8.066	-0.363	8.852	8.626	-0.226	8.967	8.844	-0.123	8.815	8.572	-0.243
1233	6	2318.74	2.00	2.83	1.41	7.998	7.794	-0.204	8.41	8.08	-0.330	8.508	8.464	-0.044	8.377	8.198	-0.179
1195	6	3407.19	1.83	2.59	1.41	6.737	6.534	-0.203	7.468	7.076	-0.392	7.725	8.124	0.399	7.608	7.828	0.220
1196	6	3510.22	1.83	2.59	1.41	6.552	6.279	-0.273	7.313	6.869	-0.444	7.572	8.035	0.463	7.477	7.774	0.297
1197	6	3604.94	1.83	2.59	1.41	6.404	6.229	-0.175	7.117	6.802	-0.315	7.372	8.02	0.648	7.304	7.762	0.458
1232	6	3894.69	1.83	2.59	1.41	6.212	6.031	-0.181	6.882	6.582	-0.300	7.155	7.778	0.623	7.141	7.628	0.487
1230	6	4210.09	1.50	2.12	1.00	6.008	5.776	-0.232	6.617	6.352	-0.265	6.838	7.414	0.576	6.88	7.356	0.476
1231	6	4210.09	1.50	2.12	1.00	6.008	5.776	-0.232	6.617	6.352	-0.265	6.838	7.414	0.576	6.88	7.356	0.476
1143	6	4272.07	1.50	2.12	1.00	5.991	5.774	-0.217	6.55	6.35	-0.200	6.733	7.076	0.343	6.767	7.035	0.268
1144	6	4272.07	1.50	2.12	1.00	5.991	5.774	-0.217	6.55	6.35	-0.200	6.733	7.076	0.343	6.767	7.035	0.268
1141	6	5040.07	1.50														
1142	6	5040.07	1.50	2.12	1.00	5.696	5.607	-0.089	6.23	6.057	-0.173	6.242	6.507	0.265	6.268	6.479	0.211
1350	6	5119.52	1.53	1.53	1.00	5.481	5.505	0.024	6.142	5.903	-0.239	5.746	6.033	0.287	5.857	6.038	0.181
1351	6	5119.52	1.53	1.53	1.00	5.481	5.505	0.024	6.142	5.903	-0.239	5.746	6.033	0.287	5.857	6.038	0.181
1352	6	5174.86	2.15	2.15	1.00	4.685	5.301	0.616	4.72	5.897	1.177	5.62	5.908	0.288	5.733	5.907	0.174
1220	6	5220	2.50	2.50	1.00	4.685	4.689	0.004	4.72	4.599	-0.121	5.219	5.812	0.593	5.812	5.812	0.000
9006	10	562.13	0.90	0.90	1.00	4.5	4.891	-0.009	5.31	5.427	0.117	5.724	5.187	-0.537	6.041	5.1	-0.941
1191	13	766.85	2.00	2.00	1.00	13.703	13.703	0	13.886	13.886	0.000	14.032	14.032	0.000	14.143	14.143	0.000
1190	13	906.79	1.80	1.80	1.00	13.686	13.687	0.001	13.855	13.855	0.000	13.987	13.987	0.000	14.085	14.085	0.000
1189	13	1123.2	1.80	1.80	1.00	12.687	12.687	0	12.861	12.861	0.000	12.994	12.994	0.000	13.087	13.087	0.000
1188	13	1252.7	1.75	1.75	1.00	1											

Option 6: Comparison of Water Level to Baseline Conditions

Culvert ID	Branch ID	Culvert Location Chainage	Existing Equivalent Culvert Diameter (m)	Proposed Equivalent Culvert Diameter (m)	Culvert Upgrade Ratio	10y			25y			100y			January Event		
						Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)
840	1	999	0.60	0.60	1.00	8.468	8.469	0.001	8.872	8.872	0.000	9.051	9.051	0.000	8.753	8.753	0.000
8003	1	1929.54	1.20	1.20	1.00	6.188	6.143	-0.045	6.866	6.866	-0.180	7.183	6.975	-0.208	7.153	6.773	-0.380
1177	1	2227.46	1.60	1.60	1.00	6.052	5.916	-0.136	6.777	6.396	-0.374	7.044	6.604	-0.440	7.182	6.477	-0.712
1178	1	2468.6	0.90	1.27	1.41	5.956	5.688	-0.272	6.625	5.953	-0.672	6.922	6.074	-0.848	6.976	6.006	-0.970
841	1	3012.01	1.00	1.00	1.00	4.741	4.868	0.127	5.356	5.315	-0.041	5.784	5.594	-0.190	5.986	5.467	-0.519
842	1	3012.01	1.00	1.00	1.00	4.741	4.868	0.127	5.356	5.315	-0.041	5.784	5.594	-0.190	5.986	5.467	-0.519
1161	1	3108.54	1.20	1.20	1.00	4.583	4.686	0.103	5.077	5.207	0.130	5.441	5.54	0.099	5.663	5.406	-0.257
1162	1	3108.54	1.48	1.48	1.00	4.583	4.686	0.103	5.077	5.207	0.130	5.441	5.54	0.099	5.663	5.406	-0.257
1163	1	3341.18	1.48	1.48	1.00	4.339	4.427	0.088	4.948	4.835	-0.113	5.347	5.021	-0.326	5.59	5.046	-0.544
1164	1	3341.18	1.48	1.48	1.00	4.339	4.427	0.088	4.948	4.835	-0.113	5.347	5.021	-0.326	5.59	5.046	-0.544
1165	1	3452.38	1.48	1.48	1.00	4.175	4.123	-0.052	4.895	4.612	-0.283	5.307	4.883	-0.424	5.557	4.948	-0.609
1166	1	3452.38	1.48	1.48	1.00	4.175	4.123	-0.052	4.895	4.612	-0.283	5.307	4.883	-0.424	5.557	4.948	-0.609
1167	1	3701.9	1.48	1.48	1.00	3.947	3.968	0.021	4.832	4.47	-0.362	5.252	4.804	-0.448	5.517	4.876	-0.641
1168	1	3701.9	1.48	1.48	1.00	3.947	3.968	0.021	4.832	4.47	-0.362	5.252	4.804	-0.448	5.517	4.876	-0.641
1169	1	3866.86	1.48	1.48	1.00	3.863	3.867	0.004	4.793	4.373	-0.420	5.209	4.739	-0.470	5.483	4.812	-0.671
1170	1	3866.86	1.48	1.48	1.00	3.863	3.867	0.004	4.793	4.373	-0.420	5.209	4.739	-0.470	5.483	4.812	-0.671
1171	1	4024.26	1.48	1.48	1.00	3.766	3.797	0.031	4.756	4.293	-0.463	5.165	4.677	-0.488	5.448	4.749	-0.699
1172	1	4024.26	1.48	1.48	1.00	3.766	3.797	0.031	4.756	4.293	-0.463	5.165	4.677	-0.488	5.448	4.749	-0.699
847	1	4251.84	1.80	1.80	1.00	3.614	3.592	-0.022	4.703	4.173	-0.530	5.105	4.59	-0.515	5.402	4.662	-0.740
8005	1	4888.97	2.26	2.26	1.00	3.534	3.419	-0.115	4.625	4.05	-0.575	5.01	4.46	-0.550	5.323	4.531	-0.792
1173	1	4887.49	1.83	1.83	1.00	3.518	3.341	-0.177	4.605	4.019	-0.586	4.984	4.444	-0.540	5.299	4.517	-0.782
1174	1	4887.49	1.83	1.83	1.00	3.518	3.341	-0.177	4.605	4.019	-0.586	4.984	4.444	-0.540	5.299	4.517	-0.782
1175	1	4629.45	1.83	1.83	1.00	3.496	3.289	-0.207	4.586	3.966	-0.620	4.968	4.39	-0.578	5.286	4.46	-0.826
1176	1	4629.45	1.83	2.59	1.00	3.496	3.289	-0.207	4.586	3.966	-0.620	4.968	4.39	-0.578	5.286	4.46	-0.826
1207	1	4653.71	1.20	2.60	2.17	3.485	3.187	-0.298	4.57	3.916	-0.654	4.955	4.353	-0.602	5.274	4.424	-0.850
8006	1	4878.97	2.23	2.23	1.00	3.09	3.135	0.045	3.965	3.876	-0.089	4.236	4.312	0.076	4.66	4.382	-0.278
1155	1	5438.45	1.53	1.53	1.00	3.157	2.996	-0.161	3.944	3.811	-0.133	4.226	4.274	0.048	4.658	4.348	-0.310
1156	1	5634.55	1.53	1.53	1.00	3.203	3.008	-0.195	3.951	3.809	-0.142	4.231	4.272	0.041	4.665	4.346	-0.319
1157	1	6005.19	1.53	1.53	1.00	3.252	3.023	-0.229	3.959	3.756	-0.203	4.235	4.157	-0.078	4.673	4.23	-0.443
1158	1	6093.92	1.53	1.53	1.00	3.262	3.026	-0.236	3.965	3.754	-0.211	4.24	4.155	-0.085	4.68	4.228	-0.452
1160	1	6166.66	1.53	1.53	1.00	3.281	3.027	-0.254	3.971	3.749	-0.222	4.243	4.151	-0.092	4.687	4.225	-0.462
1159	1	6183.35	1.53	1.53	1.00	3.296	3.034	-0.262	3.977	3.748	-0.229	4.247	4.149	-0.098	4.695	4.223	-0.472
1145	4	1	1.50	1.50	1.00	6.239	6.124	-0.115	6.907	6.638	-0.269	7.175	6.86	-0.315	7.157	6.837	-0.320
1217	4	687.86	0.90	1.20	1.33	5.973	5.768	-0.205	6.766	6.344	-0.422	7.042	6.565	-0.477	7.029	6.538	-0.491
1215	4	1429.54	1.50	1.50	1.00	5.038	4.959	-0.079	5.419	5.386	-0.033	5.635	5.674	0.039	5.8	5.619	-0.181
1216	4	1429.54	1.50	1.50	1.00	5.038	4.959	-0.079	5.419	5.386	-0.033	5.635	5.674	0.039	5.8	5.619	-0.181
1214	4	1691.15	1.50	1.50	1.00	4.742	4.634	-0.108	5.233	5.18	-0.053	5.535	5.555	0.020	5.743	5.493	-0.250
8013	4	2150.92	1.40	1.40	1.00	4.322	4.212	-0.11	4.997	4.89	-0.107	5.376	5.346	-0.030	5.612	5.29	-0.322
1240	4	2228.53	1.20	1.20	1.00	4.286	4.187	-0.099	4.913	4.81	-0.103	5.258	5.191	-0.067	5.499	5.151	-0.348
486	6	6.88	0.90	1.50	1.67	13.109	13.096	-0.013	13.173	13.156	-0.017	13.206	13.18	-0.026	13.188	13.167	-0.021
1204	6	190.06	0.90	1.50	1.67	12.579	12.563	-0.016	12.679	12.646	-0.033	12.749	12.706	-0.043	12.716	12.684	-0.032
1203	6	456.46	0.90	0.90	1.00	11.396	11.396	0	11.529	11.529	0.000	11.619	11.612	0.001	11.547	11.547	0.000
843	6	498.19	1.53	1.53	1.00	11.34	11.34	0	11.454	11.455	0.001	11.535	11.535	0.000	11.467	11.467	0.000
1200	6	876.97	1.20	1.20	1.00	10.299	10.299	0	10.734	10.704	-0.030	11.036	10.932	-0.104	10.638	10.599	-0.039
1201	6	1087.47	1.20	1.20	1.00	10.041	10.041	0	10.587	10.499	-0.088	10.927	10.759	-0.168	10.504	10.387	-0.117
1202	6	1154.39	1.20	1.20	1.00	9.977	9.977	0	10.51	10.373	-0.137	10.825	10.629	-0.196	10.44	10.276	-0.164
1199	6	1329.8	1.20	1.20	1.00	9.685	9.547	-0.138	10.444	10.18	-0.264	10.728	10.502	-0.226	10.384	10.105	-0.279
1234	6	1575.14	1.20	1.70	1.41	9.639	9.448	-0.191	10.204	9.852	-0.352	10.369	9.987	-0.382	10.16	9.816	-0.344
1198	6	2072.65	1.53	1.53	1.00	8.429	8.444	0.015	8.852	8.887	0.035	8.967	9.059	0.092	8.815	8.842	0.027
1233	6	2318.74	2.00	2.83	1.41	7.998	7.79	-0.208	8.41	8.098	-0.312	8.508	8.225	-0.283	8.377	8.075	-0.302
1195	6	3407.19	1.83	2.59	1.41	6.737	6.546	-0.191	7.468	7.088	-0.380	7.725	7.32	-0.405	7.608	7.261	-0.347
1196	6	3510.22	1.83	1.83	1.00	6.552	6.378	-0.174	7.313	6.984	-0.329	7.572	7.23	-0.342	7.477	7.159	-0.318
1197	6	3604.94	1.83	1.83	1.00	6.404	6.248	-0.156	7.117	6.819	-0.298	7.372	7.054	-0.318	7.304	7.001	-0.303
1232	6	3894.69	1.83	1.83	1.00	6.212	6.101	-0.111	6.882	6.615	-0.267	7.155	6.84	-0.315	7.141	6.818	-0.323
1230	6	4210.09	1.50	1.50	1.00	6.008	5.911	-0.097	6.617	6.382	-0.235	6.838	6.598	-0.240	6.88	6.621	-0.259
1231	6	4210.09	1.50	1.50	1.00	6.008	5.911	-0.097	6.617	6.382	-0.235	6.838	6.598	-0.240	6.88	6.621	-0.259
1143	6	4272.07	1.50	1.50	1.00	5.991	5.898	-0.093	6.55	6.346	-0.204	6.733	6.533	-0.200	6.767	6.552	-0.215
1144	6	4272.07	1.50	1.50	1.00	5.991	5.898	-0.093	6.55	6.346	-0.204	6.733	6.533	-0.200	6.767	6.552	-0.215
1141	6	5040.07	1.50	1.83	1.00	5.696	5.602	-0.094	6.23	5.92	-0.310	6.242	6.045	-0.197	6.268	6.061	-0.207
1142	6	5040.07	1.50	1.83	1.00	5.696	5.602	-0.094	6.23	5.92	-0.310	6.242	6.045	-0.197	6.268	6.061	-0.207
1350	6	5119.52	1.53	1.53	1.00	5.481	5.416	-0.065	6.142	5.705	-0.437	5.746	5.599	-0.147	5.857	5.623	-0.234
1351	6	5119.52	1.53	1.53	1.00	5.481	5.416	-0.065	6.142	5.705	-0.437	5.746	5.599	-0.147	5.857	5.623	-0.234
1352	6	5174.86	2.15	2.15	1.00	4.688	4.688	0.000	4.72	4.719	-0.001	5.62	5.469	-0.151	5.733	5.495	-0.238
1220	6	5220	2.50	2.50	1.00	4.685	4.688	0.003	4.72	4.719	-0.001	5.62	5.469	-0.151	5.733	5.495	-0.238
9006	10	562.13	0.90	0.90	1.00	4.9	4.894	-0.006	5.31	5.408	0.098	5.724	5.58	-0.144	6.041	5.346	-0.695
1191	13	766.85	2.00	2.00	1.00	13.703	13.703	0	13.886	13.886	0.000	14.032	14.032	0.000	14.143	14.142	-0.001
1190	13	906.79	1.80	1.80	1.00	13.686	13.687	0.001	13.855	13.855	0.000	13.987	13.987	0.000	14.085	14.085	0.000
1189																	

Option 68 : Comparison of Water Level to Baseline Conditions

Culvert ID	Branch ID	Culvert Location Chainage	Existing Equivalent Culvert Diameter (m)	Proposed Equivalent Culvert Diameter (m)	Culvert Upgrade Ratio	10y			25y			100y			January Event		
						Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)	Existing Condition Upstream Water Elevation (m)	Future Condition Upstream Water Elevation (m)	Change In Max Water Level (m)
840	1	999	0.60	1.70	2.83	8.468	8.322	-0.146	8.872	8.525	-0.347	9.051	8.596	-0.455	8.753	8.453	-0.300
8003	1	1929.54	1.20	2.12	1.77	6.188	6.071	-0.117	6.365	6.147	-0.218	6.383	6.143	-0.240	6.543	6.316	-0.227
1177	1	2227.46	1.60	2.12	1.33	6.052	5.828	-0.224	6.777	6.218	-0.559	7.044	6.378	-0.666	7.182	6.284	-0.898
1178	1	2468.6	0.90	2.12	2.36	5.96	5.68	-0.28	6.625	5.951	-0.674	6.922	6.059	-0.863	6.976	5.999	-0.977
841	1	3012.01	1.00	2.08	1.47	4.741	4.858	0.117	5.356	5.256	-0.100	5.784	5.44	-0.344	5.986	5.353	-0.633
842	1	3012.01	1.00														
1161	1	3108.54	1.20														
1162	1	3108.54	1.48	2.56	1.35	4.583	4.595	0.012	5.077	5.047	-0.030	5.441	5.289	-0.152	5.663	5.226	-0.437
1163	1	3341.18	1.48	1.48	1.00	4.339	4.433	0.094	4.948	4.865	-0.083	5.347	5.094	-0.253	5.59	5.1	-0.490
1164	1	3341.18	1.48	1.48	1.00	4.339	4.433	0.094	4.948	4.865	-0.083	5.347	5.094	-0.253	5.59	5.1	-0.490
1165	1	3452.38	1.48	1.48	1.00	4.175	4.129	-0.046	4.895	4.633	-0.262	5.307	4.903	-0.404	5.557	5	-0.557
1166	1	3452.38	1.48	1.48	1.00	4.175	4.129	-0.046	4.895	4.633	-0.262	5.307	4.903	-0.404	5.557	5	-0.557
1167	1	3701.9	1.48	1.48	1.00	3.947	3.973	0.026	4.832	4.477	-0.355	5.252	4.821	-0.431	5.517	4.919	-0.598
1168	1	3701.9	1.48	1.48	1.00	3.947	3.973	0.026	4.832	4.477	-0.355	5.252	4.821	-0.431	5.517	4.919	-0.598
1169	1	3866.86	1.48	1.48	1.00	3.863	3.871	0.008	4.793	4.368	-0.425	5.209	4.754	-0.455	5.483	4.847	-0.636
1170	1	3866.86	1.48	1.48	1.00	3.863	3.871	0.008	4.793	4.368	-0.425	5.209	4.754	-0.455	5.483	4.847	-0.636
1171	1	4024.26	1.48	1.48	1.00	3.766	3.798	0.032	4.756	4.274	-0.482	5.165	4.689	-0.476	5.448	4.776	-0.672
1172	1	4024.26	1.48	1.48	1.00	3.766	3.798	0.032	4.756	4.274	-0.482	5.165	4.689	-0.476	5.448	4.776	-0.672
847	1	4251.84	1.80	2.55	1.41	3.614	3.571	-0.043	4.703	4.144	-0.559	5.105	4.601	-0.504	5.402	4.68	-0.722
8005	1	4388.97	2.26	2.26	1.00	3.534	3.424	-0.11	4.625	4.093	-0.532	5.01	4.564	-0.446	5.323	4.641	-0.682
1173	1	4487.49	1.83	1.83	1.00	3.518	3.348	-0.17	4.605	4.062	-0.543	4.984	4.548	-0.436	5.299	4.627	-0.672
1174	1	4487.49	1.83	1.83	1.00	3.518	3.348	-0.17	4.605	4.062	-0.543	4.984	4.548	-0.436	5.299	4.627	-0.672
1175	1	4629.45	1.83	1.83	1.00	3.496	3.298	-0.198	4.586	4.006	-0.580	4.968	4.485	-0.483	5.286	4.562	-0.724
1176	1	4629.45	1.83	1.83	1.00	3.496	3.298	-0.198	4.586	4.006	-0.580	4.968	4.485	-0.483	5.286	4.562	-0.724
1207	1	4653.71	1.20	2.60	2.17	3.485	3.205	-0.28	4.57	3.956	-0.614	4.955	4.445	-0.510	5.274	4.523	-0.751
8006	1	4878.97	2.23	2.23	1.00	3.09	3.157	0.067	3.965	3.914	-0.051	4.236	4.398	0.162	4.66	4.475	-0.185
1155	1	5438.45	1.53	1.53	1.00	3.157	3.035	-0.122	3.944	3.847	-0.097	4.226	4.36	0.134	4.658	4.441	-0.217
1156	1	5634.5	1.53	1.53	1.00	3.203	3.04	-0.163	3.951	3.845	-0.106	4.231	4.358	0.127	4.665	4.439	-0.226
1157	1	6005.19	1.53	1.53	1.00	3.252	3.045	-0.207	3.959	3.786	-0.173	4.235	4.227	-0.008	4.673	4.304	-0.369
1158	1	6093.92	1.53	1.53	1.00	3.262	3.045	-0.217	3.965	3.783	-0.182	4.24	4.225	-0.015	4.68	4.302	-0.378
1160	1	6166.66	1.53	1.53	1.00	3.281	3.045	-0.236	3.971	3.778	-0.193	4.243	4.221	-0.022	4.687	4.298	-0.389
1159	1	6183.35	1.53	1.53	1.00	3.296	3.048	-0.248	3.977	3.777	-0.200	4.247	4.219	-0.028	4.695	4.297	-0.398
1145	4	1	1.50	1.50	1.00	6.239	6.066	-0.173	6.907	6.553	-0.354	7.175	6.775	-0.400	7.157	6.742	-0.415
1217	4	687.86	0.90	1.70	1.89	5.973	5.596	-0.377	6.766	6.044	-0.722	7.042	6.256	-0.786	7.029	6.215	-0.814
1215	4	1429.54	1.50	1.50	1.00	5.038	4.924	-0.114	5.419	5.344	-0.075	5.635	5.661	0.026	5.8	5.603	-0.197
1216	4	1429.54	1.50	1.50	1.00	5.038	4.924	-0.114	5.419	5.344	-0.075	5.635	5.661	0.026	5.8	5.603	-0.197
1214	4	1691.15	1.50	1.50	1.00	4.742	4.588	-0.154	5.233	5.128	-0.105	5.535	5.537	0.002	5.743	5.47	-0.273
8013	4	2150.92	1.40	1.40	1.00	4.322	4.163	-0.159	4.997	4.829	-0.168	5.376	5.322	-0.054	5.612	5.257	-0.355
1240	4	2228.53	1.20	1.20	1.00	4.286	4.143	-0.143	4.913	4.759	-0.154	5.258	5.167	-0.091	5.499	5.12	-0.379
486	6	6.88	0.90	1.50	1.67	13.109	13.096	-0.013	13.173	13.155	-0.018	13.206	13.18	-0.026	13.188	13.167	-0.021
1204	6	190.06	0.90	2.12	2.36	12.579	12.537	-0.042	12.679	12.595	-0.084	12.749	12.626	-0.123	12.716	12.612	-0.104
1203	6	456.46	0.90	0.90	1.00	11.396	11.396	0	11.529	11.53	0.001	11.619	11.621	0.002	11.547	11.548	0.001
843	6	498.19	1.20	1.83	1.39	11.34	11.302	-0.038	11.454	11.374	-0.080	11.535	11.431	-0.104	11.467	11.385	-0.082
1200	6	876.97	1.20	1.83	1.53	10.299	10.247	-0.052	10.734	10.597	-0.137	11.036	10.768	-0.268	10.838	10.508	-0.330
1201	6	1087.47	1.20	1.20	1.00	10.041	10.015	-0.026	10.587	10.436	-0.151	10.927	10.623	-0.304	10.504	10.335	-0.169
1202	6	1154.39	1.20	1.83	1.53	9.977	9.926	-0.051	10.51	10.252	-0.258	10.825	10.39	-0.435	10.44	10.176	-0.264
1199	6	1329.8	1.20	1.70	1.41	9.685	9.525	-0.16	10.444	9.961	-0.483	10.728	10.175	-0.553	10.384	9.913	-0.471
1234	6	1575.14	1.20	2.58	2.15	9.639	9.466	-0.173	10.204	9.81	-0.394	10.369	9.943	-0.426	10.16	9.774	-0.386
1198	6	2072.65	1.53	1.53	1.00	8.429	8.444	0.015	8.852	8.895	0.043	8.967	9.132	0.165	8.815	8.85	0.035
1233	6	2318.74	2.00	2.83	1.41	7.998	7.79	-0.208	8.41	8.102	-0.308	8.508	8.261	-0.247	8.377	8.077	-0.300
1195	6	3407.19	1.83	2.59	1.41	6.737	6.534	-0.203	7.468	6.957	-0.511	7.725	7.159	-0.566	7.608	7.085	-0.523
1196	6	3510.22	1.83	2.59	1.41	6.552	6.245	-0.307	7.313	6.745	-0.568	7.572	6.961	-0.611	7.477	6.905	-0.572
1197	6	3604.94	1.83	2.59	1.41	6.404	6.131	-0.273	7.117	6.637	-0.480	7.372	6.859	-0.513	7.304	6.814	-0.490
1232	6	3894.69	1.83	2.59	1.41	6.212	6.024	-0.188	6.882	6.514	-0.368	7.155	6.744	-0.411	7.141	6.719	-0.422
1230	6	4210.09	1.50	2.12	1.00	6.008	5.942	-0.066	6.617	6.424	-0.193	6.838	6.657	-0.181	6.88	6.653	-0.227
1231	6	4210.09	1.50	2.12	1.00	6.008	5.942	-0.066	6.617	6.424	-0.193	6.838	6.657	-0.181	6.88	6.653	-0.227
1143	6	4272.07	1.50	2.12	1.00	5.991	5.926	-0.065	6.55	6.382	-0.168	6.733	6.579	-0.154	6.767	6.576	-0.191
1144	6	4272.07	1.50	2.12	1.00	5.991	5.926	-0.065	6.55	6.382	-0.168	6.733	6.579	-0.154	6.767	6.576	-0.191
1141	6	5040.07	1.50														
1142	6	5040.07	1.50	2.12	1.00	5.696	5.516	-0.18	6.23	5.875	-0.355	6.242	5.997	-0.245	6.268	5.998	-0.270
1350	6	5119.52	1.53	1.53	1.00	5.481	5.439	-0.042	6.142	5.744	-0.398	5.746	5.632	-0.114	5.857	5.645	-0.212
1351	6	5119.52	1.53	1.53	1.00	5.481	5.439	-0.042	6.142	5.744	-0.398	5.746	5.632	-0.114	5.857	5.645	-0.212
1352	6	5174.86	2.15	2.15	1.00	4.688	4.688	0.003	4.72	4.719	-0.001	5.62	5.505	-0.115	5.733	5.517	-0.216
1220	6	5220	2.50	2.50	1.00	4.685	4.688	0.003	4.72	4.718	-0.002	5.62	5.505	-0.115	5.669	5.466	-0.203
9006	10	562.13	0.90	0.90	1.00	4.9	4.893	-0.007	5.31	5.42	0.110	5.724	5.613	-0.111	6.041	5.93	-0.111
1191	13	766.85	2.00	2.00	1.00	13.703	13.703	0	13.886	13.886	0.000	14.032	14.032	0.000	14.143	14.143	0.000
1190	13	906.79	1.80	1.80	1.00	13.686	13.687	0.001	13.855	13.855	0.000	13.987	13.987	0.000	14.085	14.085	0.000
1189	13	1123.2	1.80	1.80	1.00	12.687	12.687	0	12.861	12.861	0.000	12.994	12.994	0.000	13.087	13.087	0.000
1188	13	1252.7	1.75	1.75	1.00	12.03											