Capital Regional District

Core Area Inflow & Infiltration Management Plan

2017 Update



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Capital Regional District
Core Area Liquid Waste Management Plan: 2017 Update

Core Area Inflow & Infiltration Management Plan

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CORE AREA INFLOW & INFILTRATION MANAGEMENT PLAN

EXECUTIVE SUMMARY

Purpose

The purpose of the plan is to guide the Capital Regional District (CRD) and its municipal partners towards Inflow and Infiltration (I&I) reduction in a responsible, cost effective, integrated and well-planned manner. The primary objective of the plan is to reduce overflows and I&I to less than four times average dry weather flow (4xADWF), based on a five year return period, at Clover Point and the Core Area Wastewater Treatment Plant at McLoughlin Point by 2031.

Background

The core area municipalities are actively managing inflow and infiltration (I&I), a term that describes rainwater and groundwater that mistakenly gets into the sanitary sewer system. Inflow refers to rainwater that enters the sewer through plumbing cross connections and infiltration refers to groundwater that seeps into the sewer through cracks, faulty joints, etc. A certain amount of I&I is unavoidable and is accounted for in routine sewer design. However, too much I&I results in excessive sewer flows which can lead to:

- leaking sewers and overflows that can contaminate the environment and create public health concerns;
- backing up of sewage into buildings and homes that can destroy belongings and require expensive restoration;
- increasing operation and maintenance costs to convey and treat the increased flows; and
- consuming sewer capacity which could require expensive premature upgrades to the system.

The content of the Core Area I&I Management Plan is organized in the following sections: 1) Overview; 2) Overflows; 3) Asset Management; 4) Climate Change; 5) Public Property I&I; 6) Private Property I&I; 7 to 17) Municipal Plans; and 18) Monitoring & Verification.

Regulatory Context

The core area wastewater system is governed by the Core Area Liquid Waste Management Plan (LWMP). This plan was first approved by the Ministry of Environment in 2003. Since that time, there have been a number of amendments to the plan, the most recent being Amendment No. 11 (approved in 2016).

Section 5 of the plan relates to I&I and overflows and includes the following commitments:

> *The CRD and the participating municipalities commit to the following actions to reduce I&I sufficiently to reduce maximum daily wet weather flows to less than four times the average dry weather flow by 2030:*
>
> 1. *Continue flow monitoring in each municipality to further refine priority areas for remediation.*
>
> 2. *Develop, by the end of 2011, and submit to the Ministry of Environment, comprehensive inflow and infiltration management plans for the core area that will:*
>   - *Identify and evaluate options and opportunities that promote the minimization of groundwater and rainwater I&I into municipal sanitary sewers, including I&I originating from service laterals (private and public sections of sewer connections)*
>   - *Identify needed changes to legislation and legal authority to enable options and strategies*
>   - *Identify opportunities for the inspection of private sewers connected to municipal sewers:*
>   i. *as part of the municipal process in evaluating and issuing renovation and building permits for serviced properties; and/or*

ii. *at the time of property transfer, and/or*
iii. *targeted inspections*

- *Require the repair or replacement of private sewers that have cross-connections between storm sewers and sanitary sewers or are identified as being in poor condition.*

3. *Update by the end of 2011, and enforce sewer use bylaws to prohibit the construction of rainwater and groundwater connections to sanitary sewers.*

4. *Implement the overflow reduction plans contained in the sanitary sewer overflow management plan, which was submitted to the Ministry of Environment in June 2008.*

Overflows

In 2014, the CRD submitted an updated core area overflow management plan to the Province. The plan documents the CRD's overflow related commitments and summarizes the significant work carried out related to overflows.

Asset Management

Asset management programs for sewer collection systems generally focus on the planned replacement of infrastructure based on remaining service life. Municipalities need to demonstrate that they are following the Asset Management BC Framework to qualify for federal gas tax funding.

Climate Change

Over the next five years, the CRD will carry out actions supporting a vulnerability assessment of CRD sewer infrastructure due to climate change. The actions include updating the core area sewer model, running the sewer model using climate change scenarios, and providing recommendations based on the results.

Public Property Inflow and Infiltration

I&I and overflow quantification helps municipalities to understand the condition and/or performance of their sewer systems. Quantified measurements can be compared to benchmarking standards and allow municipalities to track I&I performance. The most useful quantification methods are repeatable and follow a standardized approach. Examples of I&I quantification methods proposed in this plan include: statistical analysis of sewer flow data to calculate I&I rates, quantifying overflows based on given storm events, ranking structural integrity of sewer pipes based on closed circuit television (CCTV) inspections, counting cross-connections through smoke testing, documenting manhole condition and calibrating system performance using hydraulic models.

The public property I&I reduction plans are consistent with the systematic approach noted in the Infraguide for "Infiltration/Inflow Control/Reduction for Wastewater Collection Systems". Infraguide was a partnership between the Federation of Canadian Municipalities, the National Resource Council and Infrastructure Canada. It created best practice reports for municipal infrastructure. The guide proposes that I&I reduction programs be divided into the following three phases:

- Phase 1 - involves flow monitoring and data collection. The data is used to identify catchments that should be targeted for sewer investigation work.
- Phase 2 - involves sewer investigation work to identify specific sources of I&I. The data is used to create rehabilitation plans and to prioritize I&I rehab work.
- Phase 3 - involves sewer rehabilitation work. The rehabilitation work is based on investigation data from Phase 2. If investigation data is not yet available, then archetype I&I rehabilitation programs should be used.

Archetype I&I rehabilitation programs were developed to provide a framework under which any given sewer catchment can be evaluated and related to an actionable plan to move forward with I&I assessments and sewer rehabilitation. These programs are to be used as planning tools. They should be interpreted from a strategic planning level and are suitable for establishing long-range budgets and for steering the development of targeted I&I reduction programs.

Private Property Inflow and Infiltration

The I&I Management Plan (2012) contained a five-year plan for implementing a common private property I&I approach for the core area. The plan was to consult with stakeholders and the public from 2012 to 2014, recommend an approach in 2015 and implement that approach in 2016. Significant effort was made to come up with a common approach. By 2014, it was clear that a common approach wasn't appropriate as the core area municipalities have different I&I rates, different issues and require different solutions. Three of the core area municipalities have older sewers and elevated I&I and they would benefit from strong programs to reduce I&I. The other four municipalities have newer sewers and have low I&I. These municipalities would prefer to focus on I&I prevention activities. The I&I subcommittee agreed that each municipality should implement their own custom approach to suit their needs and should draw on the significant research and support that the CRD has provided.

In late 2014, the CRD Board directed that a sample model bylaw related to the inspection of private sewer laterals connected to municipal sewers be prepared. The sample bylaw was built using past I&I Subcommittee feedback and content from the Pinna Report (2014) which documented the best I&I related language from existing Canadian and American bylaws. It underwent legal review and I&I Subcommittee review for general acceptability. The sample model bylaw was presented to the Core Area Liquid Waste Management Committee on May 13, 2015. The Core Area Liquid Waste Management Committee recommended that the sample bylaw be discussed with the I&I Subcommittee to determine how best to move it forward. The I&I Subcommittee decided that it would be best to incorporate the powers from the sample model bylaw into the existing municipal sewer use bylaws. Subsequently, a gap analysis was carried out comparing the powers from existing municipal sewer bylaws to the draft sample model bylaw and presented to the member municipalities through the I&I Subcommittee.

The next steps for addressing private property I&I include:

- assisting municipalities with the further development of private property I&I reduction plans;
- supporting the implementation of the powers from the sample model bylaw for private property I&I into existing or new municipal sewer bylaws;
- developing common public education materials for use by key industry stakeholders (i.e. plumbers, realtors and home owners);
- updating the general education approach to focus on homeowner protection (i.e. basement flooding) and environmental protection and how I&I plays an integral role; and
- continued collaboration with Metro Vancouver and the National Water and Wastewater Benchmarking Initiative's I&I Task Force.

Municipal Inflow and Infiltration Plans

Each of the core area municipalities has participated in the development of their own individual municipal I&I plans. The municipal plans are organized into eight sections:

1. *Overview*
2. *Catchments* - A list and map of the long-term flow monitoring catchments that will form the basis for evaluation of I&I rates and I&I management planning
3. *Inflow & Infiltration Data* – Summary of historical data collected, current data collected, summary of I&I analyses results, and flow data analyses
4. *Sewer Infrastructure Maintenance & Capital Work* – summary of routine sewer work, notable work completed between 2012 and 2015, and notable work planned for 2016 to 2020

5. *Asset Management* – high level municipal tools, approaches, etc.
6. *Bylaws* – Contains a comparison of the key powers suggested by the CRD Private Property I&I Model Bylaw to those found in each of the municipality's existing sewer bylaws
7. *Budget* – Summary I&I budget related information
8. *Summary* - A high level summary and a graph showing projected peak wet-weather flow (PWWF) relative to 4xADWF for the entire municipality from 2011 to 2031

Monitoring and Verification

Monitoring and verification of I&I Management Plan objectives will be achieved by using the following metrics:

1. Comparison of peak wet weather flow (PWWF) with 4xADWF at Clover Point and the proposed wastewater treatment plant. This will include graphs comparing projected PWWF and ADWF verses actual rates recorded over time.
2. Flow monitoring of all catchments to track I&I rates paying extra attention to measuring flows before and after targeted I&I reduction work to verify results.
3. Tracking overflows by location, frequency, duration and receiving environment sensitivity rating to monitor trends and verify results.
4. Completion of detailed and specific I&I management strategies for each catchment to replace the archetype plans.
5. Reporting of efforts and costs applied towards I&I management on a regular basis.

The CRD will continue to provide annual reports on the I&I program to the Core Area Liquid Waste Management Committee. Every second year the I&I analyses results will be updated, as is the current practice, and an I&I benchmarking template will be filled out for each of the core municipalities. The benchmarking template is currently in development and will include a number of performance measure criteria to help gauge the level of effort each municipality is applying to I&I management.

Forecasted Inflow and Infiltration Reduction

Additional work will be needed to meet the LWMP commitment of reducing wet weather flows below 4xADWF at Clover Point and the McLoughlin Point Treatment Plant by 2031. However, the gap between 4xADWF and peak wet-weather flow (PWWF) is decreasing, which is significant as it takes a substantial investment of time and resources to reverse the natural trend of I&I increasing with sewer age.

Colwood, Langford, Saanich and View Royal already meet the 4xADWF performance target. This is largely due to having young sewers built with modern materials and good installation practices. These municipalities will need to focus on I&I prevention in order to continue to meet the performance target.

Esquimalt, Oak Bay, and Victoria have older sewers which tend to have elevated I&I rates. If we extrapolate out current I&I rates, it is evident that these municipalities will need to focus on I&I reduction to meet their commitments not to exceed the 4xADWF performance target. This will require increased focus and funding on I&I reduction to achieve their reduction targets. Financial support (i.e. grants) from senior government would help to accelerate the I&I reductions. It is worth noting that:

- Esquimalt rehabilitated all of its sewers and manholes that required structural repairs in the early 2000's. It has also separated almost all of its combined manholes. Esquimalt's next steps for addressing I&I will involve actions related to I&I from sewer laterals and stormwater sewer upgrades.
- Oak Bay's I&I reduction work focused on developing a plan for the separation of the combined sewers in the Uplands area. Oak Bay finalized the separation plan in 2017. This was Oak Bay's highest I&I related priority and was required as part of a LWMP commitment. Oak Bay also completed the significant task of collecting sewer flow data for each of its outstanding catchments using portable meters. Oak Bay's next steps for I&I reduction will be to implement the Uplands' separation project, to

complete the collection of sewer camera inspection data for the municipality and to update its sewer master plan based on the results of the camera inspections.

- Victoria has collected sewer flow data for its outstanding catchments, and has also performed camera inspections and smoke testing throughout the entire municipality. The data will be analyzed and actions put into Victoria's sewer master plan. Updating a sewer master plan is a substantial project. Victoria had to delay the update of its sewer master plan until the location of the core area treatment plant was finalized because some of the locations considered for the plant would have resulted in dramatic changes to the plan. Work on the sewer master plan commenced in late 2016 after the regional treatment plant location was finalized.

The CRD is committed to assisting individual municipalities in the development of suitable private property I&I initiatives. Such initiatives could accelerate a municipality towards meeting its performance targets as it is estimated that 50% of I&I enters the sewer system on private property. Currently, there are no significant private property I&I initiatives in the core area; however, the research needed to develop such commitments is complete.

In addition, it is anticipated that significant progress will be made through the continuation and further development of I&I related education, stakeholder engagement, regulatory mechanisms, permit requirements, time of home sale options and through targeted pilot programs.

Key Future Actions

The next steps for addressing private property I&I include:

- supporting the implementation of the powers from the sample model bylaw for private property I&I into existing sewer municipal bylaws or into a new bylaw;
- assisting municipalities with the development and implementation of municipality specific private property I&I reduction plans;
- developing common public education materials for use by key industry stakeholders (i.e. plumbers, realtors and home owners);
- updating the general education approach to focus on homeowner protection (i.e. basement flooding) and environmental protection and how I&I plays an integral role; and
- continued collaboration with Metro Vancouver and the National Water and Wastewater Benchmarking Initiative's I&I Task Force.

The next steps for addressing public property I&I include:

- identifying "semi-combined" sewers in the core area and developing plans to address them;
- taking leadership on I&I benchmarking and taking action to introduce nationally;
- updating the core area sewer model, running the sewer model using climate change scenarios, and providing recommendations based on the results; and
- ongoing I&I metering, analyses and program development.

Conclusion

The Ministry of Environment reviewed and approved Amendment No. 11 of the Core Area LWMP. The LWMP included four commitments related to I&I and overflow management which are fulfilled by the I&I Management Plan.

The plan is purposeful and guided by a number of federal, provincial, regional and municipal regulatory documents and best practices. It provides the framework for how I&I can be quantified and establishes priority programs and approaches for each municipality and the CRD to follow. A strategy has been developed for moving the issue of private property I&I forward and the whole program will be monitored, verified and reported out using standard metrics and templates.

All core area municipalities assisted in the preparation of the plan and the specific actions and programs were developed based on current CRD and municipal funding levels for I&I and sewer service budgets. Modelling the results of implementing this plan show that the goal of reducing I&I to 4xADWF at Clover Point and the wastewater treatment plant is achievable but will require additional effort.

1 INTRODUCTION

1.1 Purpose

This report is intended to fulfill on the Capital Regional District's (CRD) commitment to submit 5-year progress updates of the core area Inflow & Infiltration (I&I) Management Plan to the Ministry of Environment. The commitment comes from Section 5 of the LWMP which is entitled *Management of Infiltration and Inflow and the Control of Wastewater Overflows.* The original plan was submitted to the Province in 2012. The plan is used by the CRD and Core Area municipalities to carry out I&I reduction in a responsible, cost effective, integrated, and well planned manner. The next scheduled update will be in 2022.

1.2 Context

The Core Area of the Capital Regional District (CRD) is a partnership of seven local governments and two First Nation areas. These include: Colwood, Esquimalt, Langford, Oak Bay, Saanich, Victoria, View Royal, the Esquimalt Nation, and Songhees First Nation. The core area has a total land area of about 215 square kilometers and a population of approximately 320,000 people.

In the core area, municipal sewer flows are discharged into CRD trunk sewers which convey the flows to either the Clover Point or Macaulay Point pump stations, where the flows are screened and pumped out deep sea outfalls. A map of the core area sewers is located in Figure 1.1. A summary of sewer infrastructure in the core area is located in Table 1.1. Plans are in place to build a sewage treatment plant to treat core area sewer flows by 2020.

Figure 1.1: Map of the CRD Core Area

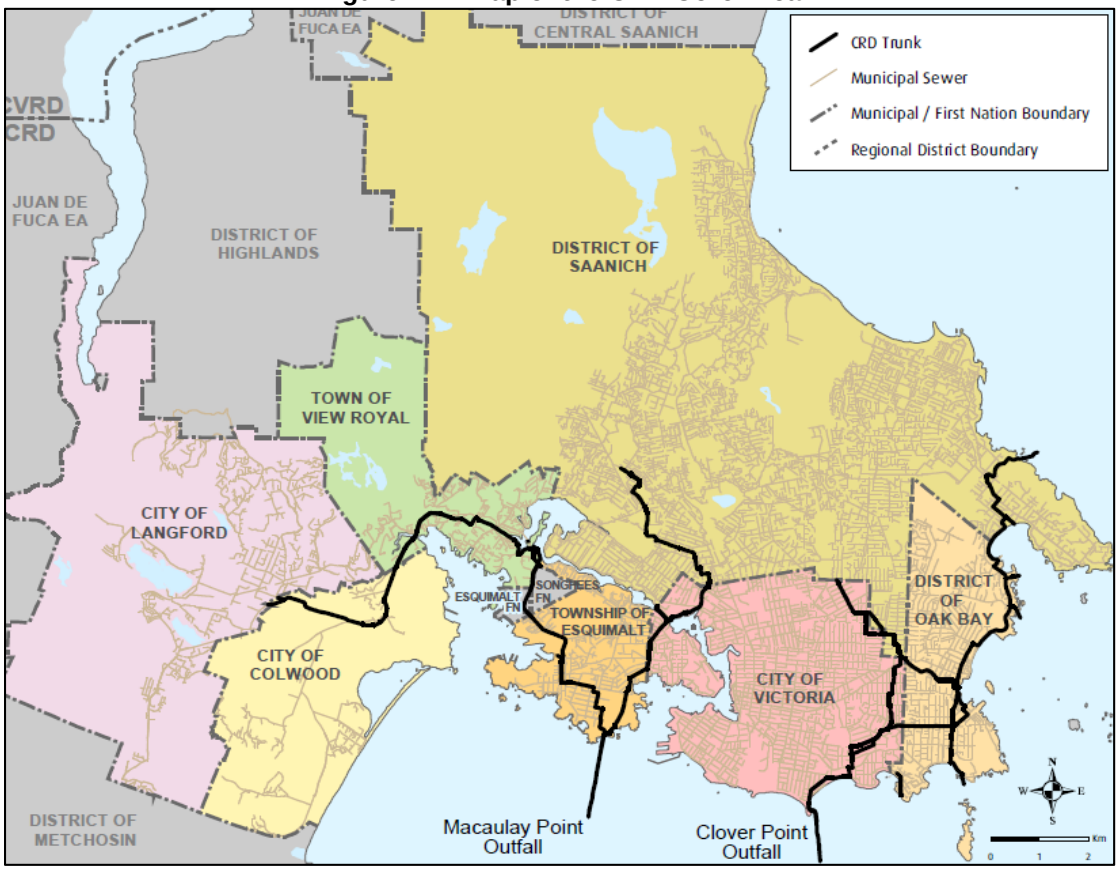


Table 1.1: Sewer Infrastructure in the Core Area

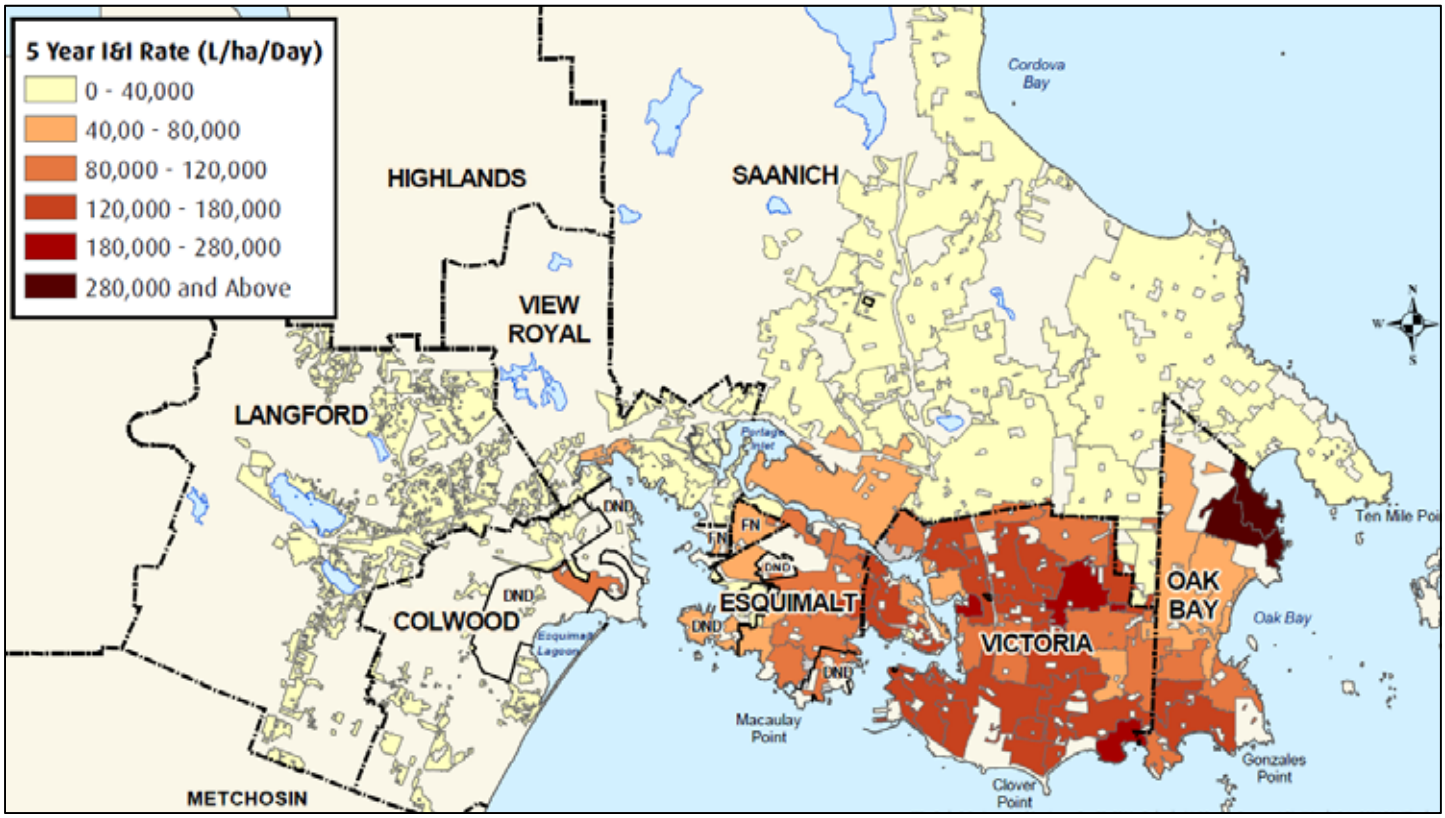
Jurisdiction		Gravity Sewers (km)	Force Mains (km)	Manholes	Pump Stations	Laterals**	Average Pipe Age *** (years)	% Developed Properties Connected to Sewer
Colwood	Municipal	35	7.3	510	9	1643	14	25%
	Private	5.2	3.7	120	12		15	
	Gov't of Canada	6.7	2.7	125	6		26	
Esquimalt	Municipal	54.8	3.9	820	12	4215	53	100%
	Private	0.2	0.0	4	0		81	
	Gov't of Canada	15.6	4.5	368	23		45	
Langford	Municipal	103.3	19.9	1512	14	6854	11	69%
	Private	9.0	0.9	144	8		10	
Oak Bay	Municipal	97.8	2.1	1280	7	6079	72	100%
	Private	2.3	0.0	32	2		56	
Saanich	Municipal	547.1	18.8	6173	43	29060	42	93%
	Private	11.7	1.4	181	0		13	
Victoria	Municipal	232.1	3.5	2754	11	17023	106	100%
View Royal	Municipal	43.0	6.5	765	23	3016	28	98%
	Private	1.4	0.2	21	1		13	
First Nations	Esquimalt	1.2	0.3	16	1	42	25	100%
	Songhees	N/A	N/A	N/A	N/A	233	N/A	100%
CRD Owned *		57.2	9.9	296	16	0	31	NA
Total		1222	85.8	15101	188	68165	51	91%

** Excludes Hartland Landfill site, but includes Hartland Leachate Line*
*** Some Estimated*
**** Includes both Gravity and Force Mains*

1.3 Existing Inflow and Infiltration Rates

For over 15 years, sewer flow data has been collected throughout the Core Area and has been used to calculate I&I rates. The rates are often higher in Esquimalt, Oak Bay, and Victoria, which have much older sewer infrastructure. The rates are generally lower in Colwood, Langford, Saanich and View Royal, which have comparatively young sewer infrastructure. In general, I&I rates are highest in older sewers due to deterioration, materials used, and installation practices of the day. Figure 1.2 illustrates the I&I rates on an area-weighted basis.

Figure 1.2: Overview of I&I Rates for the Core Area



1.4 Core Area I&I Subcommittee

The Core Area I&I sub-committee was established in the mid 1990's to work together to identify various methods of reducing and controlling I&I. The sub-committee is comprised of representatives from the CRD, Colwood, Esquimalt, Langford, Oak Bay, Saanich, Victoria, and View Royal and meets multiple times per year. One of the primary objectives of the group is to standardize procedures as much as possible, so that the Core Area municipalities (and their consultants) use the same approach when performing I&I investigations and analysis.

1.5 Drivers for I&I Reduction

In general, I&I related capital projects are carried out to support one or more of the following "drivers". Without a strong "driver", I&I reduction work is generally not considered cost effective or a good use of municipal resources. The drivers are as follows:

a) Regulatory Compliance / Commitments (see Section 1.7)
   - Reducing sanitary sewer overflows to Greater Victoria receiving waters and beaches.

b) Asset Management (see Section 3)
   - Maintaining sanitary sewer systems and replacing components at the end of their functional life or extending their service life.

c) Maintaining or Creating Sewer Capacity
   - Preventing or reducing overflows (Section 2)

- Providing capacity for Future Development / Densification
- Accommodating reasonable increases in I&I related to aging of younger sewers and climate change (Section 4)

1.6 Regulatory Context

The Core Area wastewater system is governed by the Core Area Liquid Waste Management Plan (LWMP). This plan was first approved by the Ministry of Environment (MOE), formerly the Ministry of Water, Land and Air Protection, in 2003. Since that time, there have been a number of amendments to the plan. Amendment No. 11 is the most recent amendment and was approved in 2016. This amendment builds on the previous amendment. Section 5 is devoted to I&I and overflows (Appendix A) and includes the following commitments:

> *The CRD and the participating municipalities commit to the following actions to reduce I&I sufficiently to reduce maximum daily wet weather flows to less than four times the average dry weather flow by 2030:*
>
> *5. Continue flow monitoring in each municipality to further refine priority areas for remediation.*
>
> *6. Develop, by the end of 2011, and submit to the Ministry of Environment, comprehensive inflow and infiltration management plans for the core area that will:*
>
> - *Identify and evaluate options and opportunities that promote the minimization of groundwater and rainwater I&I into municipal sanitary sewers, including I&I originating from service laterals (private and public sections of sewer connections)*
> - *Identify needed changes to legislation and legal authority to enable options and strategies*
> - *Identify opportunities for the inspection of private sewers connected to municipal sewers:*
>
> *iv. as part of the municipal process in evaluating and issuing renovation and building permits for serviced properties; and/or*
> *v. at the time of property transfer, and/or*
> *vi. targeted inspections*
>
> - *Require the repair or replacement of private sewers that have cross-connections between storm sewers and sanitary sewers or are identified as being in poor condition.*
>
> *7. Update by the end of 2011, and enforce sewer use bylaws to prohibit the construction of rainwater and groundwater connections to sanitary sewers.*
>
> 8. *Implement the overflow reduction plans contained in the sanitary sewer overflow management plan, which was submitted to the Ministry of Environment in June 2008*.

A list of additional related regulatory documents is listed in Table 1.2.

Table 1.2: Regulatory Documents Related to I&I

Level of Government	Regulatory Documents
Federal	CCME: Canada Wide Strategy for the Management of Municipal Wastewater Effluent
	National Guide to Sustainable Municipal Infrastructure: Innovations and Best Practices (InfraGuide)
Provincial	Municipal Sewer Regulation
	BC Building Code
Regional	*Core Area Liquid Waste Management Plan*
	CRD Sewer Use Bylaw
Municipal	
Colwood	Bylaw No. 1500 (2011): A Bylaw to Regulate the City Sewer Service
Esquimalt	Bylaws: No. 1867, 2332, and 2538, and Policy Sewer and Drain Blockages - Private Property NO. Plan – 28
Langford	Sewer Utility Bylaw No. 1600, 2016 (Consolidated to 20160516)
Oak Bay	Bylaw No. 3891: Public Sewer Bylaw, 1996
Saanich	Bylaws: No. 8627 Building and Plumbing Bylaw (2005) and No. 8792 Sanitary Sewer Bylaw
Victoria	Bylaw: Sanitary Sewer and Stormwater Utilities Bylaw No. 14-071
View Royal	Bylaw: No. 397 “A Bylaw to Regulate the Provision, Operation and Administration of View Royal’s Sewerage System and to Provide for the Imposition and Collection of Fees and Charges for its Use”

1.7 Public Property vs. Private Property I&I (PPI&I)

Public property sewers are owned and maintained by municipalities and regional districts. These sewers are routinely inspected and maintained.

Private property laterals are owned by property owners who generally only inspect or repair their laterals after a pipe failure or blockage has occurred. Proactive inspection, maintenance and repair is rare.

In general, I&I reduction work is most effective when it addresses the key sources of I&I from both public and private property.

1.8 Synergies with Other Programs

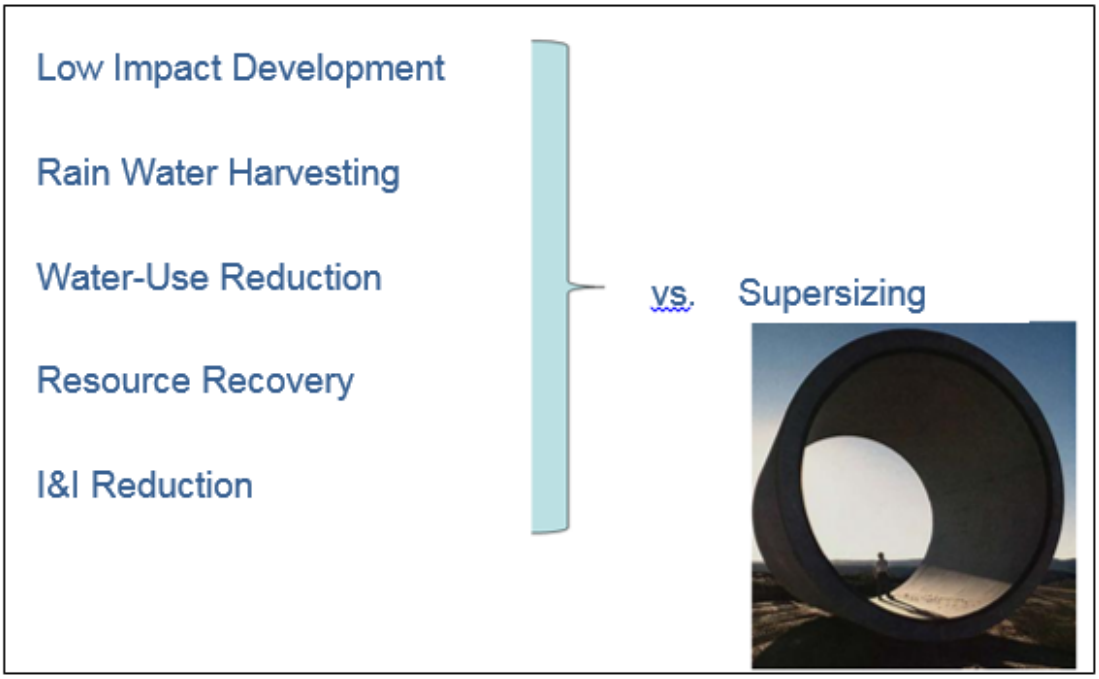
Municipalities look for synergies that can result in costs savings, reduced disruptions, increased municipal benefits, etc. For example, when municipalities replace sewer mains, there may be opportunities to replace adjacent underground utilities that need replacing. This collaborative planning process minimizes disruption to the community (by not digging up a street more than necessary), and minimizes cost (by combining restoration, economy of scale, etc.). Table 1.3 lists some of the different department/management areas that may be involved during the planning stages of I&I reduction work.

Table 1.3: Management Areas with Key Linkages to I&I Related Work

Management Area	Key linkage
Operations and Maintenance Departments	• Experts at the operation of the sewer, storm water system, etc. • Historical knowledge • CCTV (as required) • Manhole inspections • Spot repairs • SCADA
Capital Sewer Works Departments	• Design of new sewers and rehab programs • Construction / Inspection • I&I Programs • Investigation (CCTV, smoke testing, etc.)
Treatment Plant Design (CRD)	• Requires flow data for sizing • System alterations to reduce overflows
Source Control Programs	• Prevents large discharges of water to the sewer system • Prevents fats/oils/grease from entering the sewer which helps prevent blockages.
Environmental Protection	• Looks for opportunities to protect the environment by utilizing the approaches described in this Section. • Samples during some sewer overflow events. • Periodically samples to find the presence of leaking or cross connected sewers. • Created a map showing soil infiltration rates for the CRD. The infiltration rate categories were low, medium and high. The map was based on existing Provincial Soil maps. The map is important for I&I because areas with good drainage and a groundwater table well below the sewer system have a reduced risk of I&I. Conversely, areas with poor drainage and a groundwater table above the level of the sewer system have a higher risk of I&I. The map serves a number of users groups including I&I and low impact development.
Low Impact Development	• Supports development in the CRD with smaller environmental footprints • In 2016, the CRD started a project to create standardized design guidelines for LID. As part of that work a chapter was included showing the interrelationships and considerations related to LID and I&I.
Water Demand Management	• CRD staff work with business and residents on efforts to reduce water usage. • Water consumption is down by 10% in many parts of the CRD as a result of these initiatives (i.e. low flow fixtures, rebate programs) • Has a program to address “once-though cooling systems”, which continuously discharge clean potable water into the sewer system. These systems may be part of commercial ice making machines, air conditioners, etc. From 2007 to 2014, the CRD offered issued businesses over $260,000 in rebates to change out over 200 once through cooling units to air-cooled units. A CRD bylaw will ban once through cooling units in 2019.
Building Inspection	• Inspect new lateral connections to the sewer system.
Public Works	• Installs and/or inspects the municipal sewer system.

Synergies between programs help with sewer capacity related goals as illustrated in Figure 1.3.

Figure 1.3: Summary of Flow Reduction Options vs. Supersizing



1.9 Municipal I&I Management Plans

Each of the Core Area municipalities has participated in the development of this plan and has contributed to the individual municipal plans presented in Sections 7 - 17. The municipal plans are organized into seven sections:

- ***Overview*** - High level descriptions of the community, sewer system and approach for addressing I&I.
- ***Catchments*** - A list and map of the long-term flow monitoring catchments that will form the basis for evaluation of I&I rates and I&I management planning.
- ***Inflow & Infiltration Data*** – Summary of historical data collected, current data collected, summary of I&I analyses results, and flow data analyses.
- ***Sewer Infrastructure Maintenance & Capital Work*** – summary of routine sewer work, notable work completed between 2012 and 2015, and notable work planned for 2016 to 2020.
- ***Asset Management*** – high level municipal tools, approaches, etc.
- ***Bylaws*** – Contains a comparison of the key powers suggested by the CRD Private Property I&I Model Bylaw to those found in each of the municipality's existing sewer bylaws.
- ***Budget*** – Summary I&I budget related information
- ***Summary*** - A high level summary and a graph showing projected PWWF relative to 4xADWF for the entire municipality from 2011 to 2031.

The Core Area I&I Management Plan introduces a concept called "archetypes". The concept classifies sewer catchments based on average age and measured I&I rate then recommends an appropriate course of I&I investigation or rehabilitation action. Using this concept, a municipality can determine, for example, if the most appropriate course of action is to simply monitor the catchment or when the action should involve more aggressive I&I rehabilitation programs. The concept is discussed in detail in Section 5.

1.10 Plan Overview

The municipal I&I management plans contained in this report are based on an agreed upon methodology, documented in the original Core Area Inflow & Infiltration Plan (2012), and applies equally to each of the Core Area municipalities. In general, new sewers with low I&I require very little rehabilitation and older sewers with higher I&I require more extensive rehabilitation. The rehabilitation work is then prioritized and scheduled based on available municipal budgets. This report also contains a plan for addressing private property I&I.

The content of this document is presented in the following sections:

- Overflows (Section 2).
- Asset Management (Section 3)
- Climate Change (Section 4)
- Public Property I&I (Section 5).
- Private Property I&I (Section 6).
- Municipal I&I Management Plans (Sections 7-17).
- Monitoring & Verification (Section 18).

2 OVERFLOWS

2.1 Background

Sanitary sewer overflows are releases of raw sewage into storm drains and/or local waterways. The majority of sewer overflows occur during heavy rainfall events as a result of I&I overwhelming the capacity of the sewer system. Overflows may also occur as a result of sewer blockage (from debris, grease, roots), pipe failure and pump station failures.

Sewer overflows can expose people, pets, and the environment to harmful chemicals, infectious bacteria, viruses, parasites, etc. The risks associated with sewage releases are influenced by the following characteristics of the receiving environments:

- public use (e.g., shoreline access, kayaking, swimming, shellfish harvesting);
- habitat sensitivity (e.g., productive or endangered habitats such as shellfish areas, kelp beds and herring spawning sites); and
- flushing characteristics (e.g., exposed coast line or in-land waters).

In 2014, the CRD submitted an update to the Province on the status its commitments documented in the Core Area Overflow Management Plan (2008). A copy of the executive summary of the 2014 update is located in Appendix B. Key points from the 2014 update include the following:

- The CRD and core area municipalities are on track with their overflow management plans commitments. In late 2016, Oak Bay was in the process of formally updating its CALWMP commitment related to its Uplands sewer separation work.
- The CRD and municipalities have completed significant work to upgrade pump stations to reduce overflows, including: the addition of backup generators; real time computer monitoring; and mechanical upgrades.
- In 2008, the CRD commissioned the Trent pump station which virtually eliminated overflows into Bowker Creek.

2.2 Relation to I&I

A reduction in I&I will decrease the frequency, volume, and duration of sewer overflows. If, however, I&I is allowed to increase, the sewer capacity will be exceeded more often resulting in additional overflows. For this reason, I&I reduction and control programs are essential for preventing overflows now and into the future.

2.3 Beach Closures

In 2014, the CRD began testing water quality at selected public beaches. The testing was in response to a late summer intense storm event that resulted in an overflow into Cadboro Bay at a time when nearby beaches were in high use. Water quality testing after the overflow showed elevated bacteria levels in the ocean extending longer periods of time than would be expected for a typical sewer overflow event. Further investigation work was carried out through the winter and the results indicated that stormwater was a major source of the contamination. Prior to this time, water quality testing was not done in response to overflow events because most overflow events occur in the middle of winter when public use of beaches is low.

Following discussions with Island Health staff, the CRD undertook a four-month investigation in the winter of 2015-2016 and collected samples every two weeks for enterococci analysis at beaches with the potential for high winter public use. This sampling program showed that bacterial contamination levels exceeding recreational guidelines were found at most sites after rainfall events even when overflows did not occur. In the winter of 2016/2017, the CRD will complete the investigations and work with municipalities and Island

Health to further assess the shoreline areas of high public use and develop public education and notification strategies.

Based on the work carried out, the CRD and Island Health have developed a new notification and sampling protocol for overflow events. The public is notified of overflow related beach closures with signs on the beaches and notifications on Island Health's website, the CRD website and through CRD social media.

2.4 Overflow Locations

Most overflows in the Core Area occur at specific locations designed to overflow when sewer capacity is exceeded. Examples of these locations include:

- engineered relief points in manholes and sewer pipes;
- engineered relief points in pump station wetwells; and
- combined manholes, which can act as relief points if flows from the sanitary sewer spill into the storm sewer.

Table 2.1 summarizes the known potential overflow points in the CRD by the above categories. A map of the Core Area showing these overflow points is located in the executive summary of the Overflow Management Plan Update (2014) located in Appendix B. It must be emphasized that, even though there are a large number of known potential overflow locations, the majority of them are never used or infrequently used (such as the combined manholes or emergency pump station overflows).

Table 2.1: Number of Known Potential Overflow Points in the Core Area

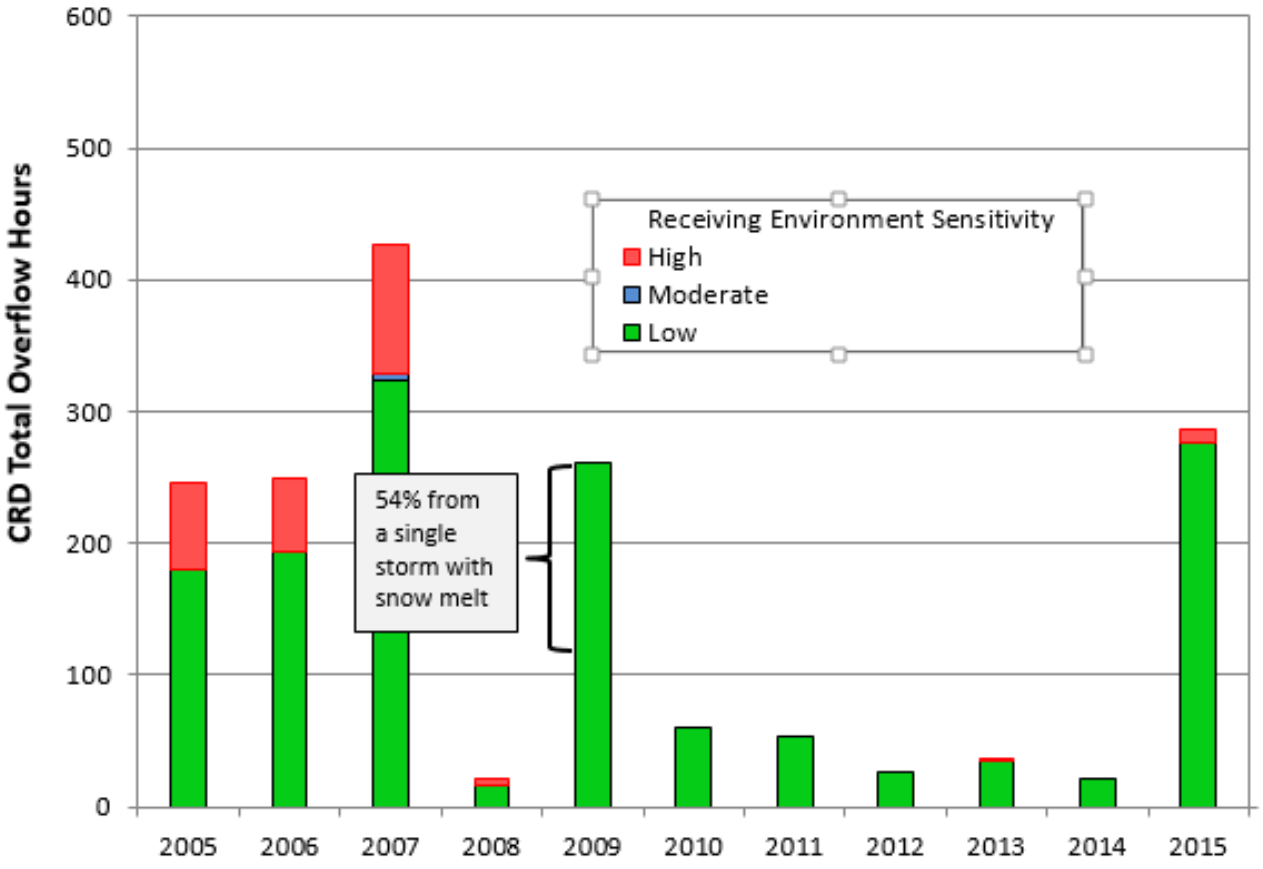
Jurisdiction	Pump Stations	Relief Points	Combined Manholes	Total
CRD	14	8	0	22
Colwood	0	0	0	0
Esquimalt	10	0	27	37
Langford	0	0	0	0
Oak Bay	4	2	Uplands is a combined collection system	6 plus Uplands
Saanich	28	0	0	28
Victoria	4	18	96	118
View Royal	9	5	0	14
Total	69	33	123	225

2.5 Reporting

The CRD continuously monitors most of the regional overflow points with overflow sensors. The Core Area municipalities monitor their pump stations for overflows. When overflows occur, they are investigated, documented and reported to the Emergency Management BC.

Figure 2.1 summarizes the overflows by year between 2005 and 2015. Note that discharges to high sensitivity receiving environments has decreased substantially over that time. Figures 2.2 to 2.5 summarize the specific overflow events for 2012 to 2015. Note that most overflow hours occur during very large storm events. In general, there were few large storm events from 2012 to 2014. However, in 2015, there were 6 storm events with return periods greater than 1 year resulting in a significant increase in overflow hours.

Figure 2.1: Graphical Comparison of Rainfall vs. Overflows



Note: The small number of overflow hours in 2008 and 2010 to 2014 is attributed to a reduced number of intense storm events when the ground was saturated, fewer back to back storm events, and to infrastructure improvements. The reduction in overflows to high sensitivity receiving environments is mainly the result of infrastructure improvements such as the Trent pump station, which was commissioned in 2008.

Figure 2.2: CRD Overflows in 2012

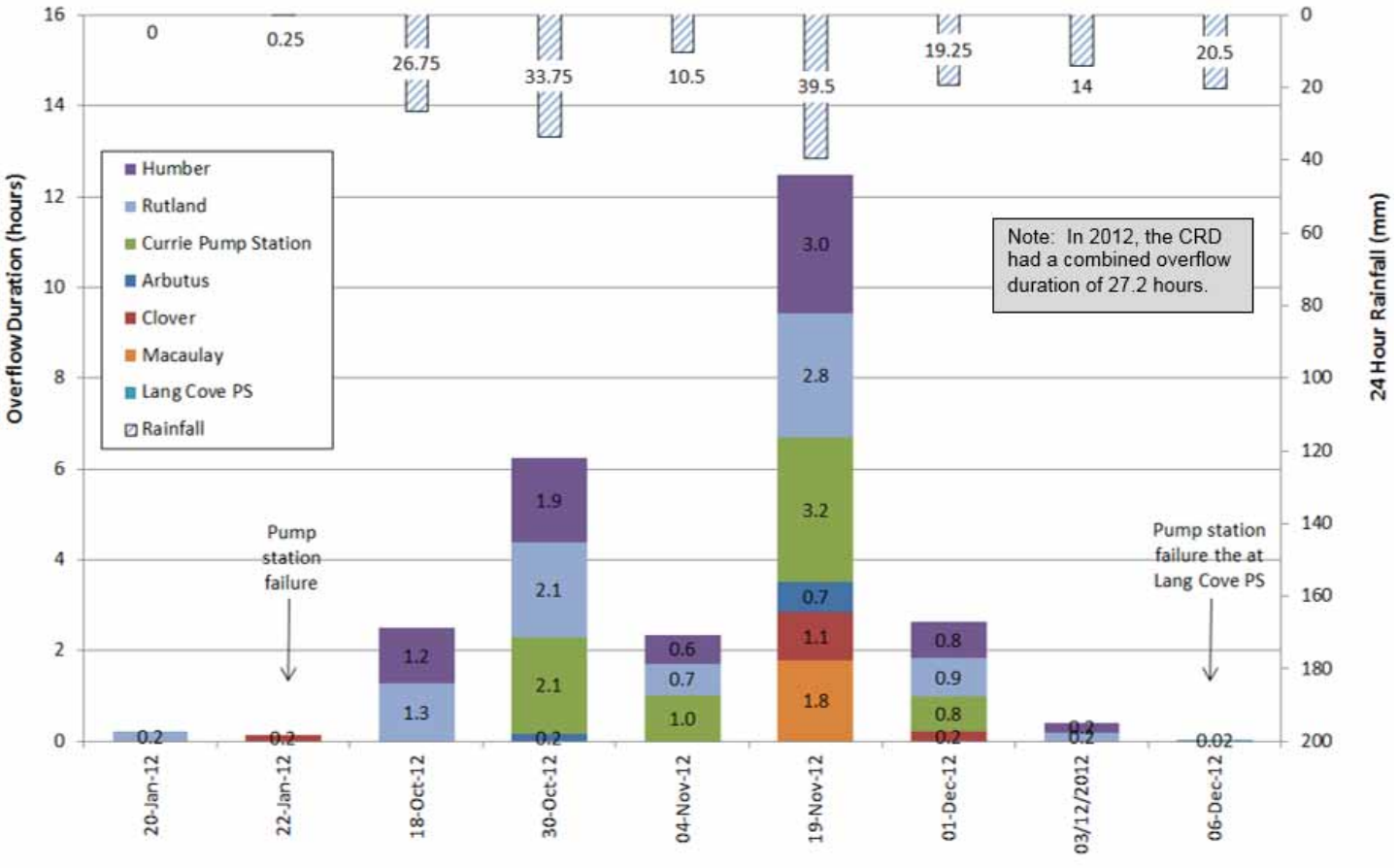


Figure 2.3: CRD Overflows in 2013

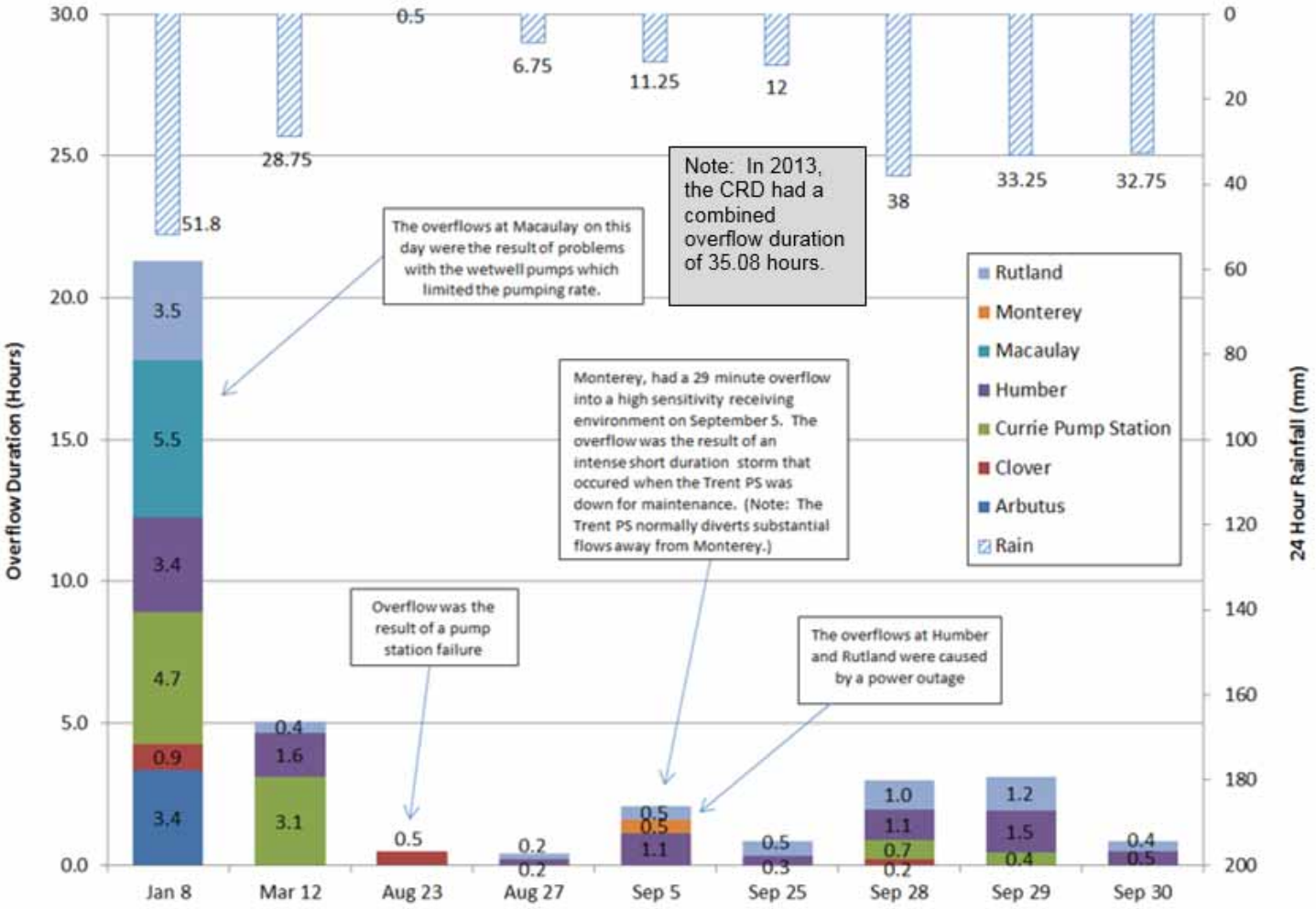


Figure 2.4: CRD Overflows in 2014

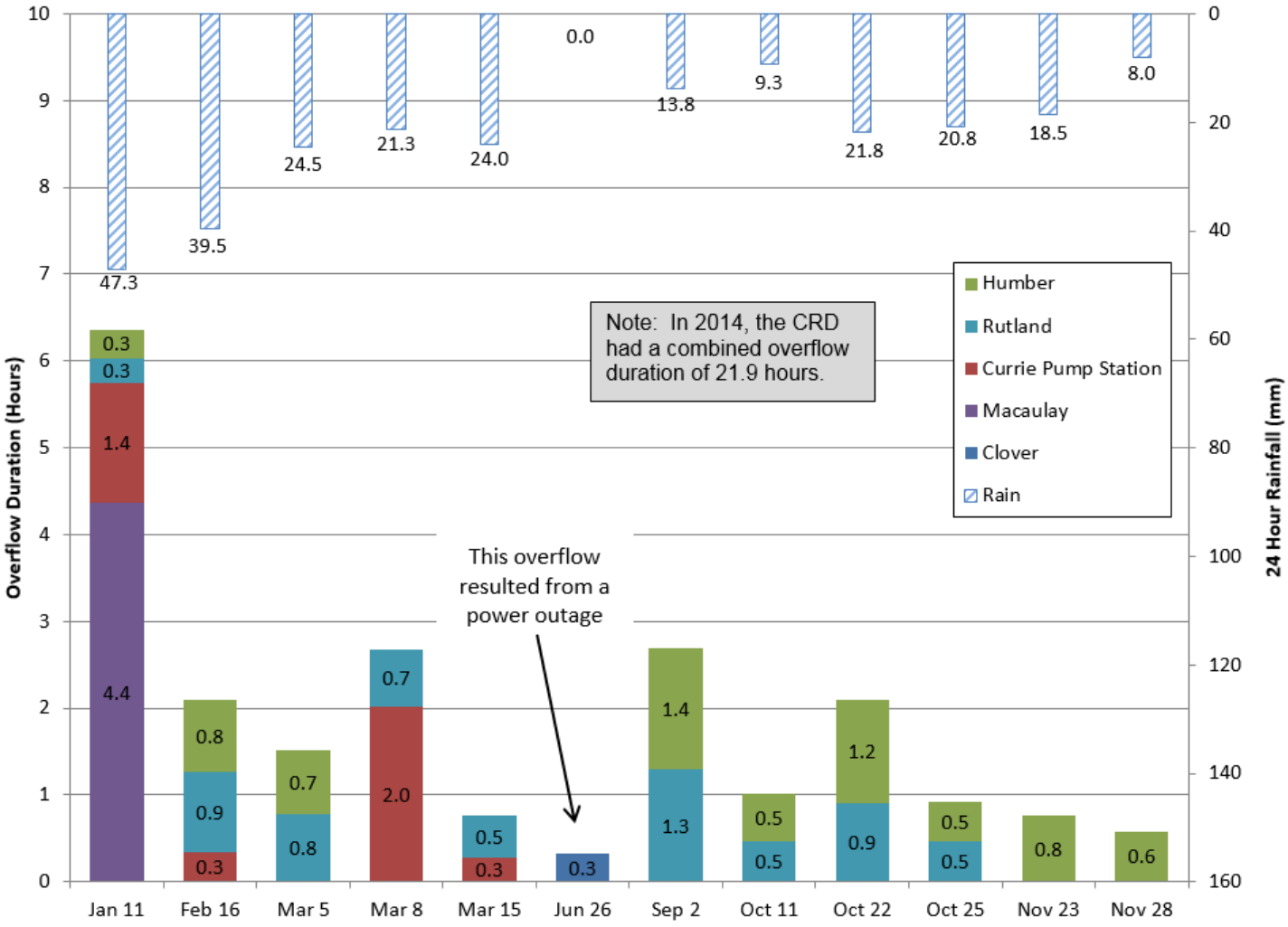
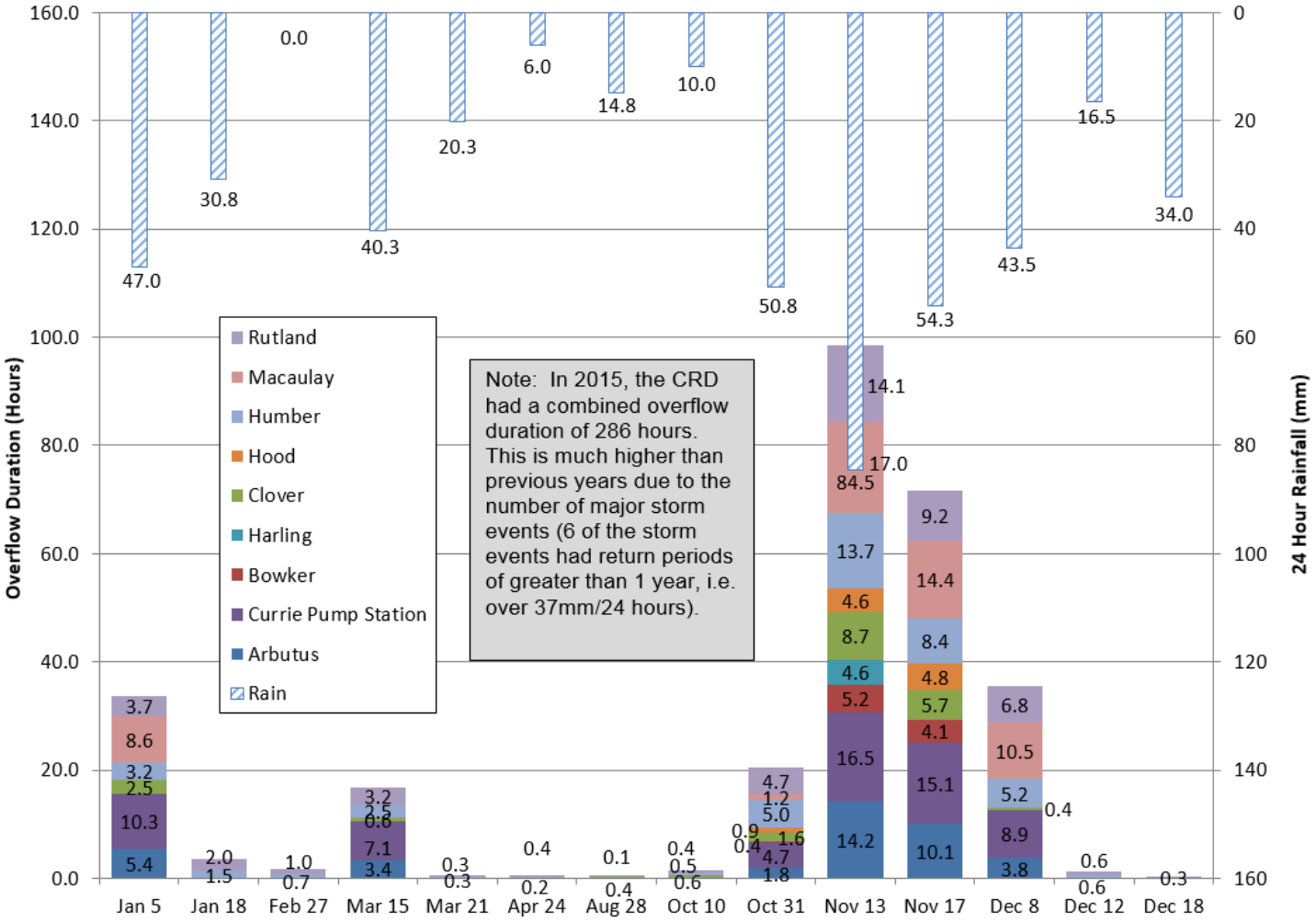


Figure 2.5: CRD Overflows in 2015



3 ASSET MANAGEMENT

3.1 Context

I&I relates to Asset Management (AM) in a number of ways:

- Replacement of aging infrastructure is an opportunity to reduce I&I in sewer collection systems;
- I&I in the CRD has been shown to have a correlation between sewer infrastructure age and I&I flow, due to a combination of past sewer design practices and the decay of sewer infrastructure (refer to Figure 5.2); and
- Twinning or upsizing sewer infrastructure to accommodate additional I&I flow will increase the burden on existing and future funding needs as these new assets will need replacement funding over time. This will impact the ability of municipalities to fund asset replacement and/or require increases in sewer rates.

AM programs for sewer collection systems are generally focused around planned replacement of infrastructure based on remaining service life (RSL), preferably determined by condition assessment, but often using asset age as a proxy in the absence of condition data. With Public Standard (PS) 3150 having been in place for seven years, most municipalities now have a reasonably good inventory of assets with book value and asset age determined. I&I should be an important consideration for all asset management programs for sewer collection systems.

The purpose of this section is to explain the role of asset management and how it is incorporated into the I&I Management Plan.

3.2 Asset Management Requirements

Public Sector Accounting Board (PSAB)

The Public Sector Accounting Board (PSAB) was created to serve the public interest by establishing accounting standards for the public sector. PSAB also provides guidance for financial and other performance information reported by the public sector. PS 3150 is a requirement for all public sector organizations to report the book value of their Tangible Capital Assets (TCAs) and record amortization of TCAs as a non-cash expense.

PS 3150 is an asset accounting practice, which is meant to record historic costs, but does not constitute asset management, which is more concerned with future costs. Further, amortization periods for underground infrastructure are generally shorter than the physical lifespan of assets. If amortization is fully-funded, it will not be sufficient to cover the future cost of replacing assets. Nonetheless, the requirement for municipalities to account for the value of TCAs has generally led to improvements in tracking asset inventories, which is beneficial to asset management programs, and by extension, I&I reduction programs.

Asset Management BC (AMBC) Framework for Sustainable Service Delivery

Asset Management for Sustainable Service Delivery: A BC Framework (the Framework) establishes a high-level, systematic approach that supports local governments in moving toward service, asset and financial sustainability through an asset management process. The Framework addresses:

- Why asset management is necessary
- What asset management is
- How it can be implemented

The Framework recognizes there are many components within the asset management process and provides a circular, continuous pathway to link all components of the process together. There are three main phases to the AMBC Framework:

- Assess – understand current asset management capacity and current state of assets;
- Plan – develop asset management policy, strategy, plans and long-term financial plans; and
- Implement – deploy asset management programs, monitor and report.

In general terms, BC municipalities should be working toward applying the AMBC Framework, and specific to sewerage infrastructure, should include I&I as a key component of asset management plans.

Infraguide Best Practices for Infrastructure Management

While several years old now, the seven Infraguide elements of asset management are nonetheless relevant to I&I management:

- What do you have?
- What is it worth?
- What condition is it in and what is the remaining service life?
- What service level is required and how is it performing?
- What needs to be done?
- How much will it cost, and how will it be paid for?
- When does it need to be done?

Being able to answer these questions would provide valuable insight for any asset management and I&I management program.

Asset Management Requirements for Federal Infrastructure Funding

As part of the most recent round of federal Gas Tax Fund applications, the Union of BC Municipalities (UBCM) included a questionnaire on the state of asset management programs for municipalities wishing to apply for funding. Municipalities need to demonstrate that they are following the AMBC Framework to qualify for funding.

3.3 Relationship between Asset Management and I&I

Asset management is inherently a business case-driven process, which would seek to determine the fundamental drivers for selecting I&I management practices. For example, the decision to fund I&I reduction versus expanding capacity should be made on the basis of lifecycle cost and meeting service levels. Since I&I reduction generally requires extensive work in the upstream collection system, meeting short-term targets for avoiding sewer overflows may not be a realistic approach for many municipalities. In other cases, for example in the City of Victoria where the collection system is very old, incorporating I&I reduction measures into sewer rehabilitation may yield improvements for a relatively small incremental cost. Another significant factor that will impact business cases will be the cost of wastewater treatment, and specifically how to deal with cost allocation for wet weather flow.

In terms of applying the AMBC and Infraguide frameworks to I&I, the following activities should be considered.

Assessment Phase

- Basic asset inventories should be complete to the point of being reliable, that is, having asset locations, size, age, material and other relevant physical data documented in a database, preferably GIS;

- If PS 3150 has been implemented, valuations for all assets should be complete. In addition to historical cost, the replacement value of all assets should be known for proper asset management;
- Condition assessments for I&I should include the following:

    - CCTV inspection completed within the past 10 years;
    - Flow monitoring of sub-catchments and derivation of I&I rates; and
    - Vapour and dye testing to identify sources of stormwater inflow (only necessary where flow monitoring indicates significant stormwater influence).

- Pipe and pumping hydraulic capacity under wet weather flow conditions should be known through modelling and/or water level monitoring;

Planning Phase

- Asset management strategies should include a plan for elimination of combined sewers;
- Capital plans that include renewal of existing infrastructure and any growth-related infrastructure upgrades, as required to meet the CALWMP service levels for sanitary sewer overflow frequency and volume;
- Financial plans and O&M plans that reflect the full cost of service delivery; and
- Funding mechanisms to finance lifecycle capital and O&M costs, which may include use of grant funding where available and appropriate.

Implementation Phase

- As I&I reduction programs are implemented, municipalities should plan to monitor pre- and post-rehabilitation I&I rates, then report these to the CRD.
- Benchmarking of cost versus effectiveness of I&I reduction measures will help to refine programs over time and assist municipalities to determine which specific approaches should be deployed in given situations. This information should be shared with other municipalities to inform the 'community of practice'.

Looking ahead to Section 5 where the I&I Archetypes are presented, asset management plays a critical role in establishing the "End of Life" threshold whereby the archetype for "Full basin Rehabilitation / Replacement" is established.

4 CLIMATE CHANGE

4.1 Overview

A changing climate brings much uncertainty. At a global scale, a changing climate has already resulted in a warmer atmosphere, warmer and more acidic oceans, reduced amounts of snow and ice, and higher sea levels. By the end of this century, even if we are able to take significant action to reduce emissions, it is likely that global temperatures will continue to rise by 1.5 degrees Celsius or more, and this is expected to result in continued ocean acidification, reduced glaciers and increased sea levels, and impacts on precipitation – generally becoming wetter in wet regions and drier in dry regions (IPCC, 2013).

Scientists project that the capital region will continue to experience (Plan2Adapt, 2012):

- hotter, drier summers;
- warmer, wetter winters;
- more intense and frequent rain and wind storms; and
- sea level rise.

As climate change impacts increase in frequency and severity, our region will feel direct consequences on infrastructure (e.g. water supply, sewer and storm water systems), social and economic systems (e.g. heat waves, disruptions to work, competitiveness), and natural systems (e.g. biodiversity and habitat loss, invasive species).

These changes will increasingly cause stress to the region's natural and built environments, social systems and economic systems. Without action, they will threaten a variety of regional and local government services, as well as overall community health and wellbeing.

4.2 Climate Action Commitments and Legislative Context

The CRD and local governments in the capital region are committed to taking action to help reduce the region's contribution to climate change (called "mitigation"), and to prepare our communities to be resilient in the face of a changing climate (called "adaptation"). Mitigating our collective impact on climate change requires us to find alternatives to burning fossil fuels for energy, and to preserve our forests and natural spaces. Adapting our communities for climate change requires us to understand the potential range of local impacts, and to prepare our social, economic, physical and natural infrastructure to handle the increasing stressors that are expected with climate change.

Local and regional governments are required to take action to reduce corporate and community greenhouse gas (GHG) emissions, and prepare for the impacts of climate change under the following provincial regulations and commitments:

- Local Government (Green Communities) Statutes Amendment Act (Bill 27) requires regional districts and municipalities to include targets, policies and actions for the reduction of GHG emissions in Regional Growth Strategies and Official Community Plans. The Act also provides powers to local governments to support mitigation and adaptation through development permit areas, development cost charges and parking and building code requirements.

- BC Climate Action Charter, of which all local governments in the capital region, including the CRD, became signatories by 2008, includes commitments to:
    - become carbon neutral in corporate operations starting in 2012;
    - measure and report on our community's GHG emissions profile; and
    - work to create compact, complete, more energy efficient rural and urban communities

- Carbon Tax Rebate Incentive Program (CARIP) includes commitments to report annually on corporate energy use, as well as corporate and community climate actions.

In addition, within the CRD:

- The draft Regional Climate Action Strategy (RCAS) is a companion strategy to the Regional Growth Strategy (RGS) and will guide CRD actions taken over the next five years to address climate change in the region and will set out a strategic approach with key goals, associated actions and resourcing requirements. Typically, municipalities refer to this document when working on their official community plans (OCP).

- In 2015, the CRD Board committed to accelerating corporate mitigation and adaptation activities, and providing a climate lens for Board decision-making. This lens extends to capital project decision-making, risk registers, and asset management planning to ensure that climate change is considered within the CRD's operational decision-making. To meet these objectives, the CRD has realigned resources to effectively deliver on Board directives relating to climate change and implement policy and practices to demonstrate leadership in operations. It has also ensured that resources are available for investment in current and future infrastructure, demonstrating efficiency and value for money and meeting regulatory and service requirements and to develop and implement asset management planning framework and tools to continue proactive and responsible management of assets.

- Climate mitigation and adaptation strategies and actions are included in many CRD service plans and master plans and will be included in the CRD Corporate Climate Action Strategy (CCAS), which is in development. The CCAS is a companion document to the RCAS and will outline the goals and targets and guide the organization's corporate actions over the next five years. In 2016, the CRD created a new Climate Action Analyst position to help support this work.

- Climate Change adaptation within the watershed is addressed in the *Climate Change Adaptation Strategy for the Greater Victoria Water Supply Area*. This strategy seeks to understand the effects of climate change on the forested watersheds of the greater Victoria water supply area, determine the potential vulnerabilities of the area to climate change, and identify adaptation measures to reduce or eliminate negative effects and assist with improving resiliency of the natural and built systems.

- CRD has conducted a Sea Level Rise Risk Assessment, which examines the potential future impacts of Sea Level Rise across the region. The CRD is currently working with the Pacific Climate Impacts Consortium (PCIC) to produce regionally downscaled future climate change projections. This work is anticipated in early 2017, and will inform the Corporate Adaptation Plan, which will be developed in 2018.

4.3 Relationship between Climate Change and I&I

Most climate change projections indicate that future rainfall events will be more extreme in size and intensity resulting in the potential for greater I&I. This relationship can now be predicted for 24-hour durations. Since I&I response to rainfall is highly correlated, once this number is established in 2017, it is possible to predict the impact of climate change on current I&I rates.

Rising sea levels could result in salt water intrusion within pump stations, and inside low-lying sewer infrastructure. Changes in the seasonality and intensity of storm events could impact the buffering capacity of the ecosystem. Regionally anticipated future climate impacts will be reviewed within the downscaled future climate change projections study, discussed above. Again, the predictions for sea level rise have been established, and the impacts of sea level on the CRD's sewer system hydraulics are well established. Once future impacts are documented, the impacts of climate change can be quantified using a calibrated model to predict how sewers will react to predicted future extreme storm events caused by climate change.

To support local governments undertaking this work, the Public Infrastructure Engineering Vulnerability Committee (PIEVC) has developed a protocol and procedure to guide a national engineering assessment of the vulnerability of Canadian public infrastructure to climate change.

4.4 Action Steps

Over the next five years, the CRD plans to start carrying out actions supporting the work on a vulnerability assessment of CRD sewer infrastructure due to climate change. The actions are as follows:

Vulnerability Assessment Scoping

- Determining which rainfall scenarios should be tested (i.e. peak 2, 12 and 24 hour storms based on projected 2050 and 2100 rainfall volumes)
- Determining which climate change impacts could be a threat to the region's sewer system

Collecting Data for the Sewer Model

- Consolidating sewer flow data and I&I rates
- Collecting rainfall data and current rainfall intensity, duration, and frequency (IDF) curve data
- Projecting changes in rainfall as a result of climate change; this work is scheduled to be completed in 2017 as part of the Downscaled Climate Projection Study which is being led by CRD on behalf of the region and carried out by the Pacific Climate Impacts Consortium (PCIC)

Update the Core Area Sewer Model.

- This action is anticipated for 2017.

Performing the Vulnerability Assessment of the Sewer System due to Climate Change

- Documenting the potential impacts on the sewer system from increased rainfall, sea level rise, and other projected future climate change impacts
- Providing recommendations for responding to impacts, including proactively sizing new sewers and choosing rehab options and for updating sewer master plans

Supporting the Core Area Municipalities

- Supporting municipal efforts to perform vulnerability assessments of sewer infrastructure due to climate change
- May include providing rainfall data, climate change data, sewer data, standardized assessment methodologies and/or other levels of support

5 PUBLIC PROPERTY I&I

5.1 General Approach

The public property I&I reduction plans are consistent with the systematic approach noted in the Infraguide for "Infiltration/Inflow Control/Reduction for Wastewater Collection Systems". This infraguide provides a proven framework for carrying out specific I&I reduction work in catchments (see Figure 5.1). The guide proposes that I&I reduction programs be divided into the following three phases:

Phase 1: Data Collection

- Create catchments with background data for each catchment
- Flow monitor catchments and analyze for I&I, etc.

Phase 2: Investigation

- May include manhole inspections, dye testing, smoke testing, camera inspections (CCTV) of mains and public laterals, drainage system assessment, subcatchment flow monitoring, etc.

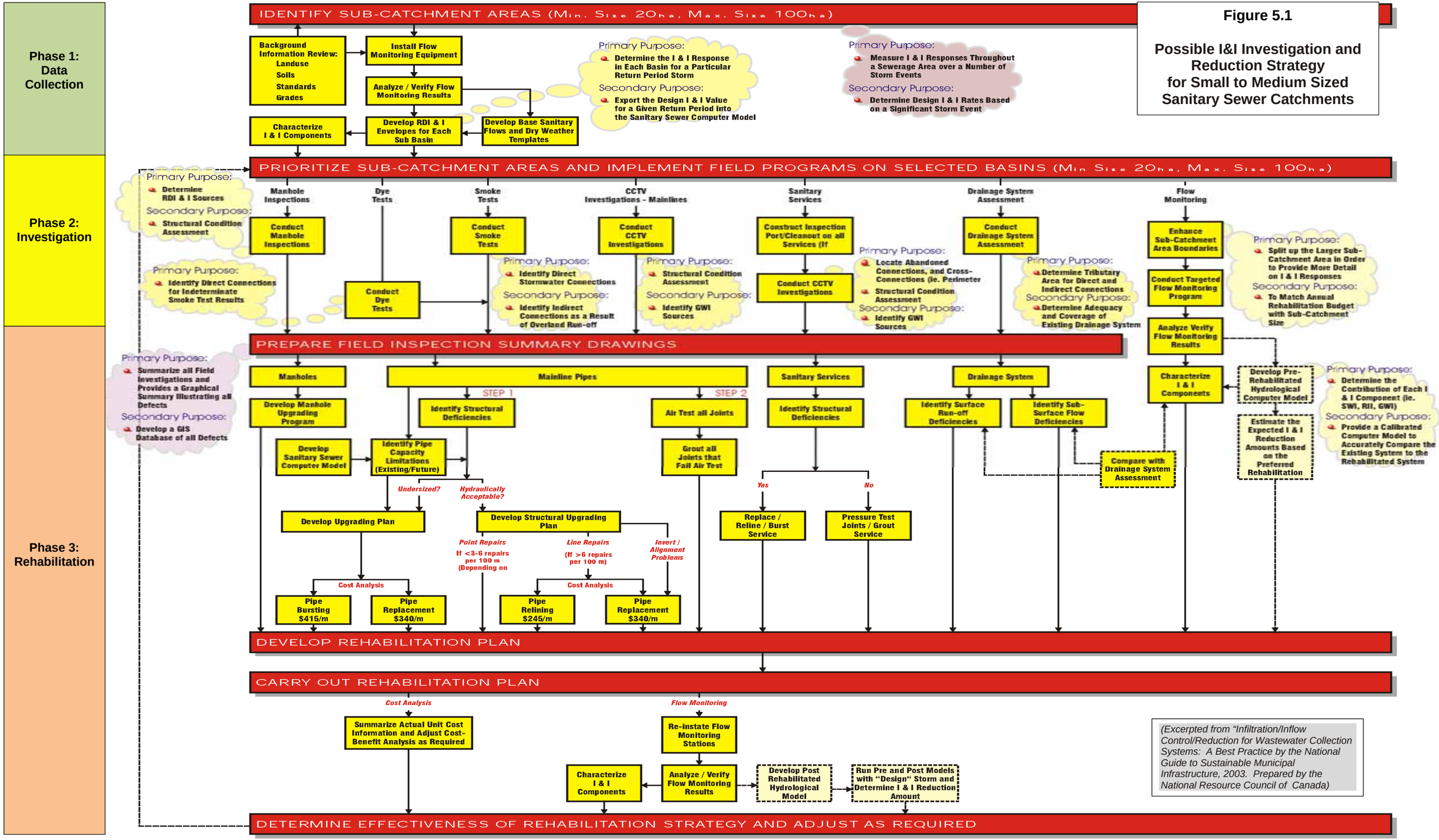
Phase 3: Rehabilitation

- Interpret investigation data and prepare summaries / summary drawings
- Develop rehabilitation plans
- Carry out rehabilitation
- Determine effectiveness of rehabilitation and adjust as required.

Phase 1 work applies to all of the long-term monitoring catchments; regardless of I&I rates. Phase 2 and 3 work will be discussed in more detail in Section 5.2.

Figure 5.1

Possible I&I Investigation and Reduction Strategy for Small to Medium Sized Sanitary Sewer Catchments



(Excerpted from "Infiltration/Inflow Control/Reduction for Wastewater Collection Systems: A Best Practice by the National Guide to Sustainable Municipal Infrastructure, 2003. Prepared by the National Resource Council of Canada)

5.2 Archetype Classification

The CRD's I&I Management Plan uses a concept known as the I&I Archetype Process. The process was adopted by the municipalities in the original 2012 I&I Management Plan. The archetype classification builds on the Infra-Guide Process in Section 5.1 and is designed to do the following:

- Determine which catchments should be investigated for I&I reduction work
- Provide high level budget and planning estimates in the absence of actual sewer investigation data and detailed rehabilitation plans

The archetype process is superseded when municipalities create actual rehabilitation plans based on investigation data. Of interest, once a catchment has been fully rehabilitated (including the services), **the catchments average age is reset to zero and the process begins again**.

The archetype classification methodology is documented in the I&I Management Plan (2012). Seven categories of archetypes were developed. Figure 5.2 shows a typical graph used to determine what archetype a catchment is in based on the catchments average sewer age (x-axis) and its 5-year 24 hour I&I rate (y-axis).

Average age is calculated by the following formula:

$$\text{Catchment Age} = \frac{(\text{sum of public sewer pipe age x length}) + (\text{sum of private lateral pipe age x length})}{\text{Sum of public sewer length + sum of private lateral length}}$$

The key to the I&I Archetype process is the "I&I versus Age" relationship line. This line is based on the monitoring of dozens and dozens of CRD and similar Lower Mainland sewer catchment areas and past rehabilitation efforts. It establishes if a catchment is "acting its age" or not. If a catchment plots on the line or below it, the catchment is acting its age and no significant I&I rehabilitation is recommended. If a catchment plots significantly above the line, it isn't acting its age, and it is highly likely that I&I investigation efforts will be successful. Conducting substantial I&I rehabilitation on catchments plotting below the line will likely yield high cost ($/L/ s) reduction costs based on experience from other municipalities. Further, if full basin rehabilitation is conducted prior to the "end of life" catchment age, the long term funding of the utilities asset management plan will be at risk.

Table 5.1 summarizes the characteristics of each archetype including a typical list of rehabilitation actions needed and a "per meter" budget number to complete the work. The rehabilitation % and costs referred to in Table 5.1 are based on actual catchments in the southwest BC and northwest Washington area where rehabilitation work was completed and a cost estimated provided. More detail on the Archetype approach can be found in the 2012 edition of the I&I Management Plan.

Figure 5.2: Graph Used to Classify Catchments into Archetypes

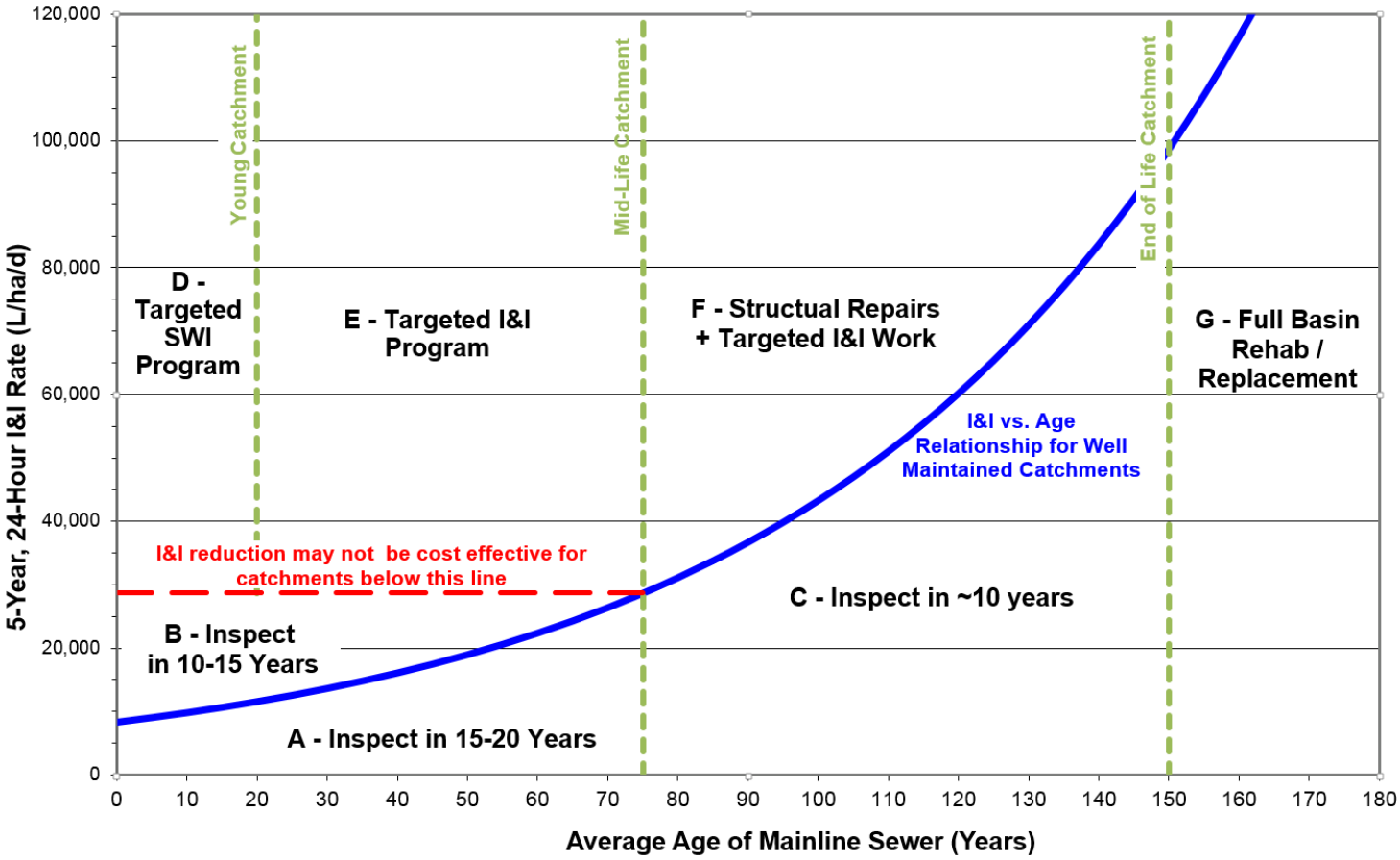


Table 5.1: Archetype Overview

Archetype	Phase 1: Data Collection	Phase 2: Investigation Work *(percent of catchment)*	Phase 3: Rehabilitation Work *(percent of catchment)*	Component Costs *Based on dollar values used in the 2012 I&I Management Plan ($/m)*
A	Flow Monitoring (ongoing)	CCTV Condition Assessment (15-20 years)	Point Repairs (0.1%)	$16 / meter *Plus $5000 for flow monitoring*
B	Flow Monitoring (ongoing)	CCTV Condition Assessment (10-15 years)	Point Repairs (0.1%)	$16 / meter *Plus $5000 for flow monitoring*
C	Flow Monitoring (ongoing)	CCTV Condition Assessment (~ 10 years)	Point Repairs (0.1%)	$16 / meter *Plus $5000 for flow monitoring*
D	Flow Monitoring (ongoing)	CCTV Program Development Smoke Testing Dye Testing (20%)	Point Repairs: 0.1% Manhole Rehab: 2%	$19 - $24 / meter *Plus $5000 for flow monitoring*
E	Flow Monitoring (ongoing)	CCTV: 100 Program Development Condition Assessment Smoke Testing: 100 Dye Testing: 20	Point Repairs: 0.1% Pipe Grouting: 100% Pipe Relining: 5% Pipe Replacement: 1% Lateral Relining: 40% Lateral Pipe Bursting: 20% Lateral Grouting: 100%	$300 – 540 / meter *Plus $5000 for flow monitoring*
F	Flow Monitoring (ongoing)	CCTV: 100 Condition Assessment Smoke Testing: 100 Dye Testing: 20	Pipe Relining: 20% Pipe Bursting: 5% Manhole Rehab: 10% Manhole Replacement: 5% Point Repairs: 0.5% Pipe Replacement: 1% Lateral Relining: 40% Lateral Pipe Bursting: 20% Lateral Grouting: 100% Storm Sewer Improvements: 5%	$1,300 – $1,500 / m *Plus $5000 for flow monitoring*
G	Flow Monitoring (ongoing)	---	Pipe Replacement: 10% Pipe Relining: 60 Pipe Bursting: 30 Manhole Rehab: 90 Manhole Replacement: 10 Lateral Relining: 50 Lateral Pipe Bursting: 50 Storm Sewer Improvements: 30%	$1,300 – $1,500 / m

5.3 Rehabilitation Plans

The implementation of the I&I Archetype Process can be described by the following steps:

1. Divide the municipality into sub-catchment areas
2. Conduct Flow Monitoring and CCTV inspections in each catchment
3. Use the *I&I Envelope Method* to derive 5-year, 24-hour I&I rates from the flow monitoring data
4. Calculate the average age of the catchment using the formula above
5. Plot the catchment on Figure 5.2 to determine the recommended next steps
6. Develop a plan for each catchment

For some catchments, particularly in younger sewerage areas, the course of action may be as simple as conducting some routine maintenance based on concern raised by CCTV inspection results. In older catchments, where the average age has not reached the “end of life” threshold (determined by an asset management plan), additional structural and targeted I&I programs will likely be required.

Each CRD municipality will then develop their own unique plans based on the above to suit their available budgets, and asset management plans. Looking ahead, Sections 7-17 provides a summary of the municipal plans that each municipality has developed.

5.4 Financial Commitment

Each municipality has identified its own funding level to monitor and maintain its sewer infrastructure in terms of system integrity and I&I reduction.

An effort has been made to identify budget amounts that include the following scope of work:

Capital costs for:

- Sanitary Sewer replacement
- Sanitary Sewer repair
- Manhole repair
- Cross connection repair
- Lateral rehabilitation/repair

Operations costs for:

- Flow monitoring
- Inspection work
- Condition assessments

Excluding the following project types:

- New sewer construction for extending a sewerage area
- Pump station renewal
- Drainage works (unless specifically aimed at I&I reduction)
- Operations costs unrelated to I&I reduction
- Capital works that do not impact I&I rates.

Prior to development of this I&I management plan, municipalities have not been accustomed to accounting specifically for I&I budgeting or expenditures. It is anticipated that budget amounts in future plans will be refined to accurately reflect I&I related work.

6 PRIVATE PROPERTY I&I

6.1 Background

Studies show that approximately half of all I&I originates on private property. The I&I is generally highest in areas with older sewers due to: general deterioration of sewer pipes; construction practices and materials used at the time of installation; and the fact that property owners rarely maintain their laterals.

In each of the core area municipalities, the property owner is responsible for their sewer lateral from their homes up to the property line. The exception to this is Oak Bay, where the property owner is responsible for the sewer lateral from their homes to the municipal sewer main.

Approximately 40% of the total length of the sewer system is composed of private property laterals. This is illustrated on Figure 6.1.

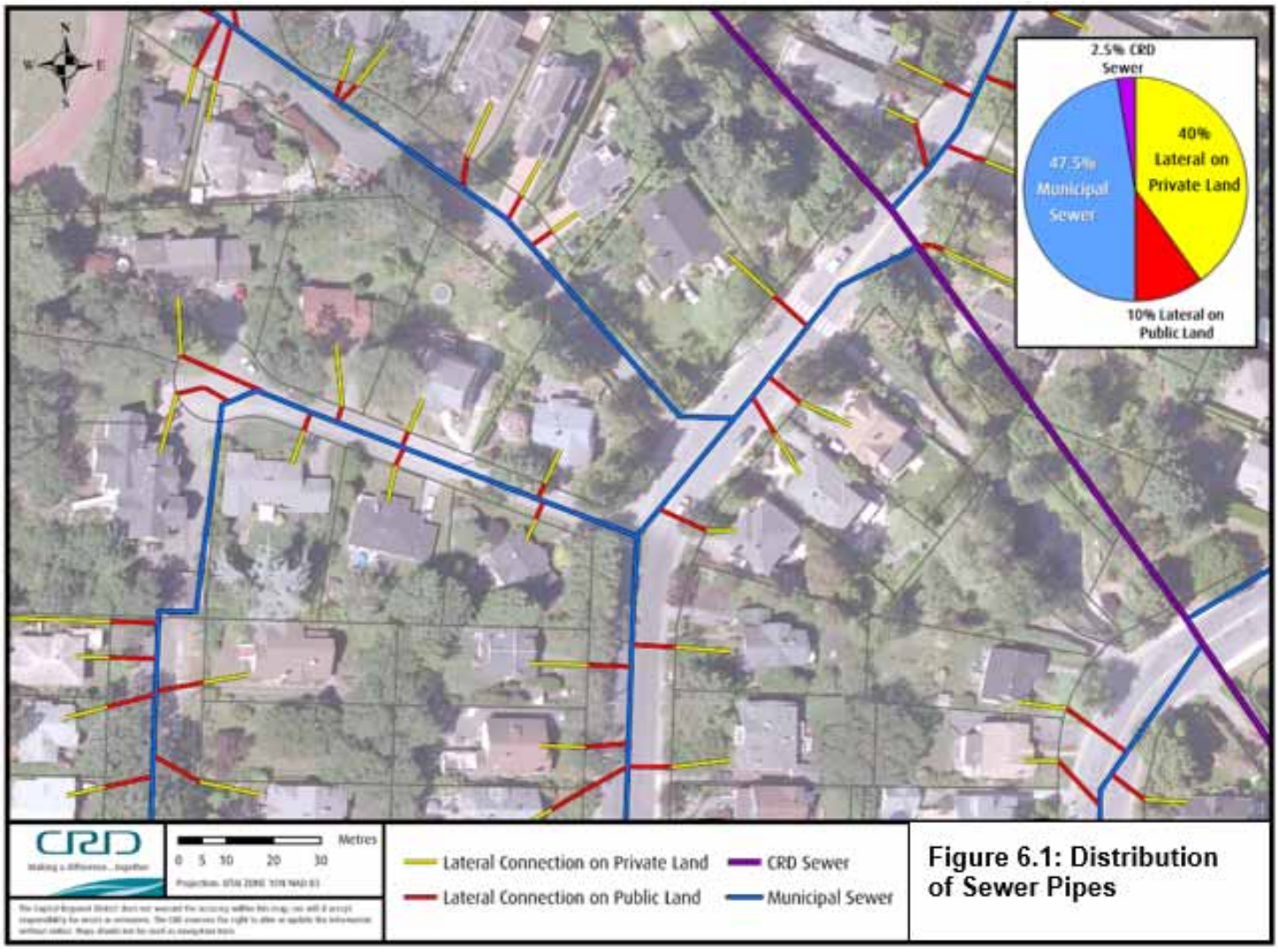


Figure 6.1: Distribution of Sewer Pipes

Property owners are generally aware of their responsibility to maintain their laterals and perimeter drains, however, they rarely think about their underground pipes, unless they have a problem. They are aware that plumbers can inspect their laterals but are put off by the cost (i.e. $250) and potentially massive repair cost (i.e. $1,200 to $20,000). Generally, property owners only camera inspect their pipes if they are dealing with an issue (i.e. poor drainage rates, damp basement, basement flooding).

Getting home owners to inspect and fix their sewer laterals is not just a matter of education. Expert stakeholder groups (i.e. plumbers, builders, and inspectors) often advise home owners regarding lateral issues. They note the costs to inspect the pipes, describe potential issues, provide estimated repair costs and recommend the most effective solutions for the homeowner. In some cases, the solution may address key pipe related problems without reducing I&I (i.e. cutting roots from inside pipe rather than replacing the pipe.) In other cases, the laterals may be leaky but in good working order and the stakeholders may advise the homeowner to do nothing as the fix is expensive with little benefit to the homeowner (i.e. clay lateral pipes in good condition but with substantial leakage at the joints). In both scenarios, the homeowner receives reliable information from experts which allows for a well thought out, diligent, decision in their own best interest, however, I&I is not reduced.

The CRD commissioned two reports summarizing the private property I&I programs from across Canada and the USA (2011 and 2015). Overall, the private property I&I programs that exist contain a hybrid of one or more of the following categories:

1. Education-based approaches:
    - Brochures and websites
    - Sewer lateral certificate programs
    - Real estate disclosure forms
2. Incentive-based approaches:
    - Grants or rebates for inspection, repair or replacement
    - Deferred payment program (low or no-interest loan)
    - Property tax exemption
3. Enforcement-based approaches:
    - Time of sale requirement to obtain a sewer lateral certificate before transfer of title
    - Fines on monthly utility bills for non-compliance
    - Termination of water or sewer service for non-compliance
4. Targeted inspection approaches:
    - Agency identifies problem connections through investigation work (i.e. smoke testing)
    - Agency may fund and/or undertake work to repair identified problems (i.e. with tax money)
    - Alternatively, agency may employ incentive or enforcement mechanisms to have property owners repair identified problems (home owner pays potentially with municipal incentive.)

Developing and broadly implementing effective private property I&I programs is expensive, complex, stakeholder intensive and highly political. Municipalities with elevated I&I may benefit greatly from the most effective approaches (i.e. enforcement based / time of sale requirements) but they must be willing to accept the associated financial and political costs. To date, these approaches are only used in American municipalities that are out of compliance with Environmental Protection Agency regulations regarding I&I related overflows. Canada has no such examples. In Canada, most municipalities inspect new lateral installations, a small number have I&I related education materials, and some have lateral related requirements when applying for building permits.

In addition to our member municipalities, the CRD is working with other jurisdictions regarding private property I&I approaches. For example, we share information and have meetings with Metro Vancouver. The CRD is also part of the National Water and Waste Water Benchmarking Initiatives I&I Task Force, whose members come from municipal engineering departments from across Canada including: Vancouver, Calgary, Regina, Toronto, and Halifax. The CRD has an active role on the I&I task force and has made presentations regarding private property I&I and has shared I&I video's and educational graphics.

The CALWMP contains commitments related to I&I as a whole (Section 6.2). How municipalities meet these commitments is up to them. For municipalities with elevated I&I, this may involve I&I reduction effort on public property, on private property or, more likely, on both public and private property. Municipalities with low I&I have no immediate need to lower their I&I but they understand the value in proactively

preventing future I&I from both public and private property. In the core area of the CRD, three of the municipalities have elevated I&I and four municipalities have low I&I.

Presently there is no region wide program for addressing private property I&I. On an individual basis, each municipality sets standards for new lateral installations and requires that laterals be tested prior to connection to municipal sewer mains. A few municipalities have carried out small pilot projects that included the repair or replacement of private sewer laterals. Two municipalities within the Core Area (Oak Bay and Esquimalt) require that laterals be inspected and fixed, if required, when applications are made for major building permits.

6.2 Commitments

In the Core Area Liquid Waste Management Plan (LWMP), the CRD and participating municipalities have committed to a number of I&I related actions. All of these commitments relate directly or indirectly to private property I&I. The commitments are noted in section 1.6 of this report.

6.3 Progress to Date

The I&I Management Plan (2012) contained a 5-year plan for implementing a common private property I&I approach for the core area. The plan was to consult with stakeholders and the public from 2012 to 2014, recommend an approach in 2015 and implement that approach in 2016. Significant effort was made to come up with a common approach. By 2014, it was clear that a common approach wasn't appropriate as the core area municipalities have different I&I rates, different issues and require different solutions. Three of the core area municipalities have older sewer and elevated I&I and they would benefit from strong programs to reduce I&I. Often these programs are expensive and/or require significant political will but the effort may be considered justifiable. The other four municipalizes have newer sewers and have low I&I. These municipalities would prefer to focus on I&I prevention activities. The I&I subcommittee agreed that each municipality should implement their own custom approach to suit their needs and draw on the significant research that the CRD has carried out to date as appropriate.

Table 6.1 documents private property I&I related actions carried out in the CRD.

Table 6.1: Private Property I&I Actions to Date

Timeline	Action

Ongoing	• CRD staff:
	  o Review case studies of jurisdictions taking steps to deal with private property I&I
	  o Meet with various experts and shared information
	  o Work with and share information with Metro Vancouver who is also working to establish programs to address private property I&I
	  o Are members of the National Water and Wastewater Benchmarking Initiatives I&I Task Force
	  o Provide I&I education to the public
	• Two municipalities within the Core Area (Oak Bay and Esquimalt) require that laterals be inspected and fixed, if required, when applications are made for major building permits.
	• Each of the Core Area municipalities have sewer bylaws or council policies that relate to private property I&I.

2010	• The CRD commissioned a report, completed by Stantec, showing potential management options for addressing private property I&I. The report included a summary of private property I&I programs used throughout North America, costs / effectiveness of these programs, and legal options for implementing programs in the CRD. A copy of this report is on the CRD I&I website. • A workshop was held with municipal and regional staff to initiate discussion about options for implementing private property I&I programs, objectives, and potential barriers. It was agreed that the key objectives for a private property I&I program would: protect the environment, create system capacity, minimize costs, increase ownership responsibility and awareness, and minimize liability issues. A summary of this workshop is located in the Stantec report.
2011	• The CRD provided an overview of the Stantec report to elected representatives and recommended a full workshop in 2012. • The CRD initiated an I&I related educational program that included new educational materials and education outreach events. The new educational materials included: an I&I brochure for residents, a comprehensive website, a survey used in 2012 to 2014, and educational videos. Public education regarding I&I will now be ongoing.
2012	• CRD prepared private property I&I specific education materials related to the program options noted in the Stantec report including: o Handouts summarizing each of the program option categories; o A detailed comparison table of the options; and o A reference guide covering frequently asked questions.

Timeline	Action
2012 continued	• In June 2012, the CRD hosted a workshop focused on private property I&I for elected representatives. The purpose of the meeting was to present background information, options for moving forward, and to open dialogue on the topic. New ideas were discussed and those who were present endorsed the implementation of the consultation portion of the private property I&I plan. • On November 30, 2012, the CRD put on a workshop for members of the Victoria Real Estate Board. The workshop was a collaborative effort between the CRD's I&I Program, Onsite Program (i.e. septic systems) and Cross Connection Program. The purpose of the workshop was to provide education and to promote the use of infrastructure inspection in the real estate industry.
2013	• CRD shortlisted PPI&I options and refined the options • The I&I subcommittee reviewed the shortlist and provided feedback on multiple occasions • Options were discussed with representatives from stakeholder groups (i.e. real estate, building association, building inspection, and insurance industry, etc.)

2014	• On May 22, 2014, the I&I Subcommittee unanimously recommended that each municipality be able to customize their approach for meeting agreed upon targets. This could involve a model bylaw that could be altered, as required, to meet the needs of individual municipalities. Overall, it was understood that municipalities with elevated I&I need different approach than municipalities with low I&I. • In 2014, the CRD commissioned a study by Pinna to prepare a memo entitled Update on Private Property I&I Programs (Appendix C). It contains supplementary research for the Stantec Report (2010). Notably it: o Summarizes effective "drivers" for private property I&I programs o Details private property I&I programs from across Canada by Province o Contains updates on private property I&I programs from the US o Documents potential problems related to implementing private property I&I programs and includes North American examples o Summarizes "good practices" that should apply to all private property I&I programs. For each "good practice" there is example bylaw language taken from existing Canadian sewer bylaws • In late 2014, the CALWMP Committee asked the I&I program to make a presentation to it in early 2015 and to include a working "draft" model bylaw in the presentation.
2015	• In late 2014, the CALWMP committee asked the CRD to prepare a sample model bylaw related to private property I&I. The sample bylaw was built using past I&I Subcommittee feedback and the best parts of existing bylaws from across Canada and the US as documented in the Pinna Report, 2014. The draft bylaw was reviewed by a lawyer and by the I&I Subcommittee for general acceptability. The sample model bylaw was prepared and presented to the CALWMP committee on May 13, 2015. The CALWMP committee recommended that the sample bylaw be discussed with the I&I subcommittee to determine how best to move it forward. The I&I Subcommittee decided that it would be best to incorporate the powers from the sample model bylaw into the existing municipal sewer use bylaws. One municipality (Esquimalt) may customize the sample model bylaw into a standalone bylaw suitable for Esquimalt. • A copy of the Sample Private Property I&I Model Bylaw is located in Appendix D.
Timeline	**Action**
2016	• In general, the I&I subcommittee agreed that the powers from the sample model bylaw should be incorporated into existing municipal sewer bylaws. To support this, the CRD retained Pinna to compare the powers in the sample model bylaw to the powers in each municipalities existing sewer bylaws and a gap analyses was completed. Based on the results, recommendations were made for updating each of the municipal sewer bylaws using language from the sample model bylaw. One municipality noted that they may include parts of the sample model bylaw as part of a new municipal bylaw. • On February 11, the CRD presented to the National Water and Wastewater Benchmarking Initiatives I&I Task Force on the topic of "Implementation of a Private Property I&I Management Program". The CRD is considered to be in front of most other Canadian municipalities regarding private property I&I efforts and we shared our experiences and our plans for moving forward. • The CRD commissioned Pinna to complete a detailed report documenting various aspects related to the CRD's private property I&I stakeholders.

6.4 Public Education

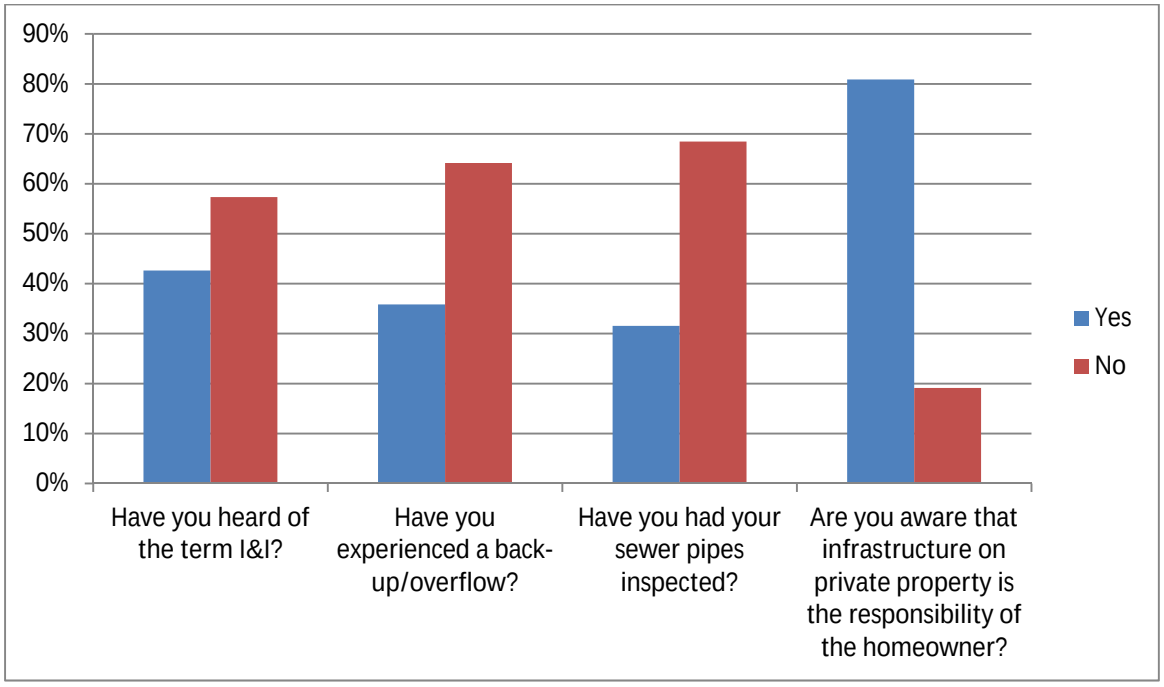
The CRD is taking steps to educate the public on the issue of I&I, where it comes from, and the problems it creates so that when funding is required and/or rehabilitation work is proposed in local neighbourhoods, the public will have a better understanding of why the work is required.

In 2010, the CRD in collaboration with the core area municipalities, created an I&I brochure, two sets of videos to help explain I&I, and an I&I website. This information is valuable when staff are providing notification to neighborhoods of upcoming video inspection, smoke testing, sewer rehabilitation or other work related to I&I management. The brochure and videos can be found on the CRD website at the following link: *http://www.crd.bc.ca/wastewater/ii/index.htm*

Starting in 2011, I&I information was added to CRD outreach events. In general, the materials are featured at 4 key events (i.e. home shows) and are available, but not featured, at an additional 10 events (i.e. municipal events). Currently, the campaign is one of general public awareness and basic information, and a way of establishing a baseline of public understanding to build upon. At the events, I&I materials are displayed along with education materials from other CRD programs.

From 2011 to 2014, the public was encouraged to fill out a four question, multiple choice survey to determine their understanding of I&I for a chance to win the year's $100 gift certificate. Over 2500 surveys were completed. The survey questions and results are summarized in Figure 6.2.

Figure 6.2: Summary of I&I Survey Results



Based on the response to date the following preliminary conclusions can be drawn:

- A significant proportion of residents surveyed had experienced a sewer back-up.
- Although there is growing awareness of responsibility for infrastructure on private property, relatively few property owners have had their sewer pipes inspected.
- Homeowners clearly recognize that infrastructure on private property is their responsibility.

From talking to CRD outreach staff, attending outreach events, and talking to stakeholder groups, it is clear that I&I knowledge is low with the general public. Most people have little interest in the topic and say that they'll deal with issues if they come up. As a result, in 2017, the CRD plans to refocus its general I&I education messaging to homeowner / homebuyer protection and preventing basement flooding. The reason for this is that homeowners directly relate to basement flooding but they don't relate to I&I and municipal overflows. The key message will still be the same; to promote sewer lateral camera inspections. The CRD will also explore creating targeted education related materials when appropriate (i.e. to support municipal efforts, camera inspections at time of real estate transactions).

6.5 Next Steps

Table 6.2: Anticipated Next Steps for Addressing Private Property I&I

Action	Description / Timeline
General Education Approach Update	The CRD plans to change the general education approach for outreach events from a focus on I&I, which the public limited interest in, to a focus homeowner / homebuyer protection. Overall, the goal is the same; to encourage property owners to maintain their sewer laterals but the approach will allow for easier public engagement. The approach will build upon messaging from a workshop with Metro Vancouver where the following simplified messaging was agreed on: "Avoid basement flooding; camera inspect your underground pipes and protect your home." (Ongoing)
Detailed Industry Stakeholder Engagement (2017 – 2019)	The issue of private property I&I is complex, often expensive to fix and involves a large number of stakeholders. Homeowners often get conflicting information from professionals which can lead to inaction. No matter what private property I&I program a municipality decides to use, it is important to have a unified message from stakeholders regarding sewer lateral related work. The goal of this project is to get stakeholder groups on the same page regarding private property laterals. The end product is a detailed brochure that can be used by each of the stakeholder groups to ensure a consistent message to the public. **Phase 1: Understanding the Industry Stakeholder Groups** (completed in 2016) • Pinna completed the study to better understand the related stakeholder groups and how they relate to perimeter drains and laterals. • The stakeholder groups include 19 local, provincial and national groups related to insurance, real estate, home inspection, plumbing, construction, and government. **Phase 2: Finding Consensus and Developing a Detailed Brochure** (2017 / 2018) • None of the industry stakeholder groups contacted in Phase 1 of the project have defined approaches for discussing lateral issues with homeowners. • The goal of Phase 2 is to develop a detailed brochure (i.e. 8-page) that addresses 95% of the typical detailed questions / concerns from the public and professionals (i.e. Plumbers, realtors). This version of the brochure is considered a starting point. It's anticipated that the document will be "strengthened" in the future as efforts are made to improve the consensus. **Phase 3: Develop Stakeholder Engagement Plans** (2017 / 2018) • Creating a detailed plan to engage stakeholder groups to support the unified messaging developed in Phase 2 (i.e. detailed brochure). • Determining how best to spread information, receive feedback, encourage technical discussions to improve the approach, etc. • Develop a plan for expanding approach other municipalities across BC / Canada. (The wider the buy-in for the approach amongst municipalities, the greater the chance of success.) • Accept feedback for continual improvement **Phase 4: Develop a Plan to "Strengthen" the Brochure / Consensus (2019 / 2020)**

Action	Description / Timeline
Use of Provincial / National Organizations (2017 – 2018)	Prepare a high level report assessing options for moving some private property I&I "tools, approaches, education materials" forward through broader entities such as the UBCM / CMHC / Province. The benefit of this is that most of the stakeholder groups operate broadly across the province or the country and may prefer to deal with organizations that represent municipalities from across the Province or country rather than individual municipalities. The report would help define the viability of this approach, options, pros and cons, etc. (2017 / 2018)
Review Time of Sale Options (2019 – 2020)	Determine potential options for incorporating sewer lateral education / actions into the real estate time of sale process. Include viability and pros and cons of the options. (2019 / 2021)
Assisting with Municipal Programs (2017 – Ongoing)	Assist the municipalities, upon request, with the following: • Incorporating the powers of the sample private property I&I model bylaw into their municipal bylaws, as appropriate. • Providing options for municipal specific private property I&I programs to help address their unique needs and circumstances. • Assisting with municipal specific private property I&I related educational materials (i.e. brochures to support municipal smoke testing or municipal installation of inspection chambers).
Collaborations / Leadership (2017 – Ongoing)	Continue working in collaboration with Metro Vancouver and the National Water and Wastewater Benchmarking Initiative's I&I Task Force to further private property I&I programs / options in Canada
Regional I&I Education Program (2018 – Ongoing)	Private property I&I education program deployment: • Homeowner / homebuyer protection • Outreach events • Website • Municipal displays.

7 COLWOOD

7.1 Colwood Overview

The City of Colwood is located in the Westshore area of the CRD. It was incorporated in 1985. It is approximately 1775 hectares in size and has a population of approximately 16,000 residents.

Colwood's first municipal sewers were installed in 1989, although the sanitary sewer system did not go into service until 1996. The average age of the sewer system is 14 years. The sewer system services approximately 25 % of the properties in Colwood. The rest of the properties are serviced by septic systems or onsite sewer systems. In total, there are approximately 35 kilometers of gravity sewer pipe in Colwood, of which almost 99% is PVC. There are also nine sewer pump stations and over 500 manholes.

Colwood has no overflow locations, combined manholes or combined sewers. It has had no I&I related sewer overflows. If a sewer overflow were to happen, Colwood would contain it and clean it up with its emergency response materials and a vactor truck, notify the Provincial Emergency Program if the volume released was large enough, document the incident and make any repairs to minimize the chance of a future occurrence.

Colwood's I&I rates are low due to the young age of its sewers. I&I in Colwood does not significantly impact Colwood's municipal sewers or the regional sewer system. Colwood focuses its I&I efforts on sound installation practices and preventative sewer maintenance. This includes CCTV sewer inspections and manhole inspections.

In Colwood, significant flows are generated by four private sewer systems; Royal Roads University, the Department of National Defence (DND)'s Belmont Park, DND operations located adjacent to the Juan de Fuca Recreation Centre on Esquimalt Harbor (F-Jetty) and the Juan de Fuca Recreation Centre (jointly owned by six municipalities). Belmont Park had significant sewer rehabilitation / replacement work done in the early 2000's when a number of sewer mains, manholes and laterals were replaced and a third pump was added to the pump station.

Starting in 2001, Colwood's sewer flow monitoring has consisted of short term flow monitoring at three pump stations, two gravity sewer locations, and continuous flow monitoring at two CRD cost-sharing locations. Around 2012, Colwood's SCADA system was programmed to generate ongoing continuous sewer flow data for each of Colwood's sanitary pump stations.

Colwood has nine pump stations. All of them are monitored using SCADA. Four pump stations have backup power and all have connections for portable generators. None of the stations have storage tanks, but pipes and wet wells have been designed for some storage. The pump stations and SCADA system are maintained by Colwood. There are no planned upgrades to the pump stations.

Colwood's stormwater drainage system consists mainly of underground pipes, seepage pits, ditches and stormwater management ponds. The system is maintained by Colwood Public Works. Colwood does not have any combined sewers.

Colwood has a sewer utility for sewer maintenance operation costs. Only properties connected to sewers pay into the utility. Maintenance costs are estimated annually. New sewer services and sewer main extensions on existing streets are paid for by the properties connecting to the sewer system. Colwood is not expected to require any sewer rehabilitation work within the next five years due to the young age of the system.

Colwood contributes to the Core Area I&I Subcommittee and its initiatives. These include: regional I&I reports for the Province such as Biennial I&I Reports and the Overflow Management Plan; annual/semiannual Core Area Inflow and Infiltration Program I&I Analyses Results Reports, and various region wide public education initiatives.

7.2 Catchments

Long-Term Monitoring Catchments

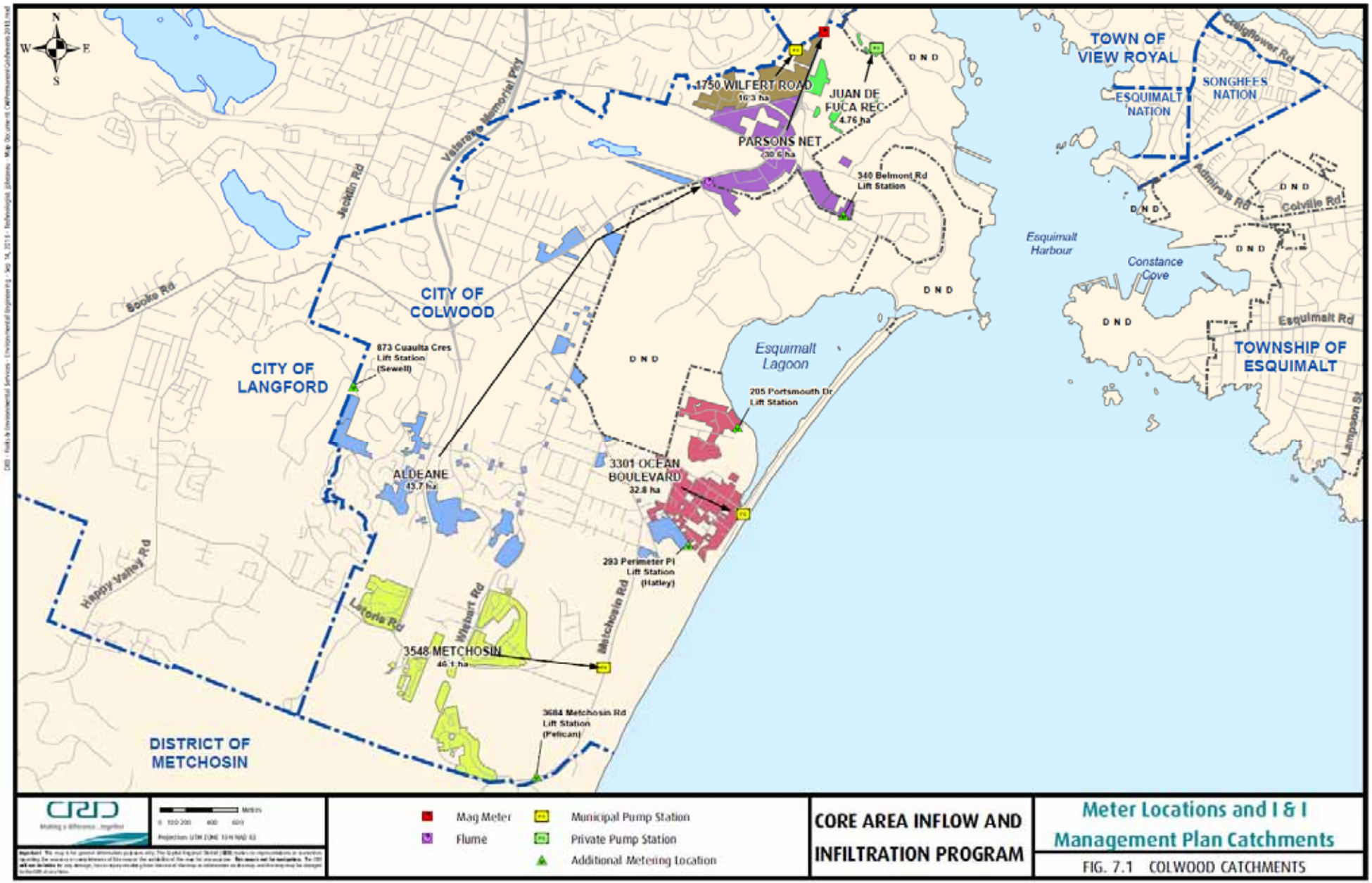
Colwood's sewer system is divided into 6 long-term flow monitoring catchments. The catchments were chosen based on existing pump stations and permanent flow monitoring stations which provide consistent reliable long-term flow data. All of Colwood's long-term monitoring catchments are appropriately sized based on the recommendations in the I&I Management Plan (2012). Each catchment has a unique site code that enables the tracking and comparison of I&I results for specific flow meter locations over time. The catchments are shown on a map in Figure 7.1 and listed in Table 7.1. It should be noted that the map is a little out of date as a number of as-built sewer drawings have not been imported to GIS yet.

Three of the Colwood's catchments are monitored at Colwood pump stations and are named after their respective pump stations. Two catchments are located at long-standing CRD cost sharing locations. The final catchment is for the Juan de Fuca Recreation Centre (jointly owned by 6 municipalities), which discharges directly into the CRD trunk sewer.

Colwood's sewer system is relatively new and only a small portion of Colwood's homes are connected. It's anticipated that additional properties will connect to the sewer system over time and the catchment sizes will increase. As a result, Colwood will need to re-evaluate these monitoring catchments at some point in the future.

Additional Catchments

Since 2012, an additional 7 catchments have been flow monitored and analyzed for I&I in Colwood. The catchments are listed in Table 7.1.


N
W
E
S
1750 WILFERT ROAD
16.3 ha
JUAN DE FUCA REC
4.76 ha
PARSONS NET
30.6 ha
340 Belmont Rd Lift Station
TOWN OF VIEW ROYAL
ESQUIMALT NATION
SONGHEES NATION
Craigflower Rd
Admirals Rd
Colville Rd
Esquimalt Harbour
Constance Cove
Esquimalt Rd
TOWNSHIP OF ESQUIMALT
Lampson St
Veterans Memorial Pkwy
Jacklin Rd
Sooke Rd
CITY OF COLWOOD
CITY OF LANGFORD
873 Cuaulta Cres Lift Station (Sewell)
ALDEANE
43.7 ha
Esquimalt Lagoon
205 Portsmouth Dr Lift Station
3301 OCEAN BOULEVARD
32.8 ha
293 Perimeter Pl Lift Station (Hatley)
Happy Valley Rd
Latoria Rd
Wishart Rd
Metchosin Rd
3548 METCHOSIN
46.1 ha
3684 Metchosin Rd Lift Station (Pelican)
DISTRICT OF METCHOSIN
D N D
Mag Meter
Flume
Municipal Pump Station
Private Pump Station
Additional Metering Location
CORE AREA INFLOW AND INFILTRATION PROGRAM
Meter Locations and I & I Management Plan Catchments
FIG. 7.1 COLWOOD CATCHMENTS

7.3 Inflow & Infiltration Data

Historical Data Collection

Prior to 2011, a significant amount of data was collected and consolidated for each of Colwood's long-term monitoring catchments. Much of this is summarized in the I&I Management Plan (2012) which includes:

- I&I data (5-year peak I&I rates; presence of overflows, average flows and peak wet weather flows)
- Catchment size, number of properties, and number of laterals.
- Percentage land use (single family, multi family, commercial, industrial, and institutional)
- Number of manholes and pump stations
- Sewer age and pipe materials.
- Type of flow meter.
- Detailed catchment maps with associated GIS information.
- Catchment "archetype" classifications for each of the municipality's long-term monitoring locations.
    - *For the I&I Management Plan, seven categories of archetypes were developed. The archetypes are delineated based on sewer age and I&I rates. Each archetype contains a typical list of rehabilitation actions needed and a "per meter" budget number to complete the work. The archetypes are designed to be used for high level budget and planning purposes. If investigation work is completed (i.e. CCTV and smoke testing), archetypes should be replaced with specific rehabilitation plans containing specific budgets.*

Current Data Collection

Significant catchment data was collected, analyzed, and/or updated between April 2010 and March 2016. This data is summarized in Table 7.1 and includes:

- Catchment sizes
- Average pipe ages
- Current peak 1-hour I&I rates
- If a catchment has "rapid I&I"
- If a catchment exceeds 4x average dry weather flow
- 5-year 24 hour I&I rate and projected rate at 2031 (based on current precipitation rates)
- Catchment archetype classification and budget estimates based on the current I&I analyses.
- I&I rates for "additional catchments" (i.e. different than the long term monitoring catchments) that have been analyzed since 2012.

Figure 7.2 shows how catchments were classified into archetypes based on average sewer age and I&I rates. This is the same system that was used in the Core Area I&I Management Plan (2012). An overview of the archetype methodology is located in Section 5.

Table 7.1: Summary of I&I in Colwood by Catchment

I&I Management Plan Catchments	General Info			Inflow & Infiltration							
	Site Code	Size (ha)	Pipe Ave. Age	Peak 1-hr I&I Rate *(l/ha/day)*	5-yr, 24-hr flows compared to ADWF	Rapid I&I? [1]	5-yr, 24-hr I&I Rate [2] (l/ha/day)				
							2010	2012	2014	2016	Archetype
Aldeane [3]	COL7A	37	16	14,729	~2.6x ADWF	no	9,966	8,104	8,104	10,253	A
Juan de Fuca Rec [4]	COL3	5	~18	n/a	5.3x ADWF	no	n/a	n/a	n/a	n/a	B
3548 Metchosin Rd	COL10	46	21	13,494	2.7x ADWF	no	9,966	9,966	9,541	9,132	A
3301 Ocean Blvd	COL11	33	~18	9,483	2.2x ADWF	no	9,966	9,966	3,296	4,604	A
Parson's [3]	COL8A	31	13	~15,000	n/a	no	11,724	11,724	9,539	~9,500	A
1750 Wilfert Rd	COL12	16	23	15,372	2.9x ADWF	no	9,966	9,966	9,539	11,350	A
Additional Catchments											
Aldeane *(Total Metered Area)*	COL7	123	n/a	14,729	2.6x ADWF	no	n/a	n/a	n/a	10,253	
Parson's *(Total Metered Area)*	COL8	944	n/a	~15,000	n/a	no	n/a	n/a	n/a	~9,500	
340 Belmont Rd	COL13	2	n/a	~10,000	2.7x ADWF	no	n/a	n/a	n/a	21,500	
873 Cuaulta Cr	COL17	2	n/a	~8600	2.2x ADWF	no	n/a	n/a	n/a	5,056	
3684 Metchosin Rd	COL15	11	n/a	15,316	3.4x ADWF	no	n/a	n/a	n/a	8,336	
293 Perimeter Pl	COL14	5	n/a	~6200	2.0x ADWF	no	n/a	n/a	n/a	3,600	
205 Portsmouth Dr	COL16	11	n/a	12,762	2.8x ADWF	no	n/a	n/a	n/a	7,982	

Footnotes:

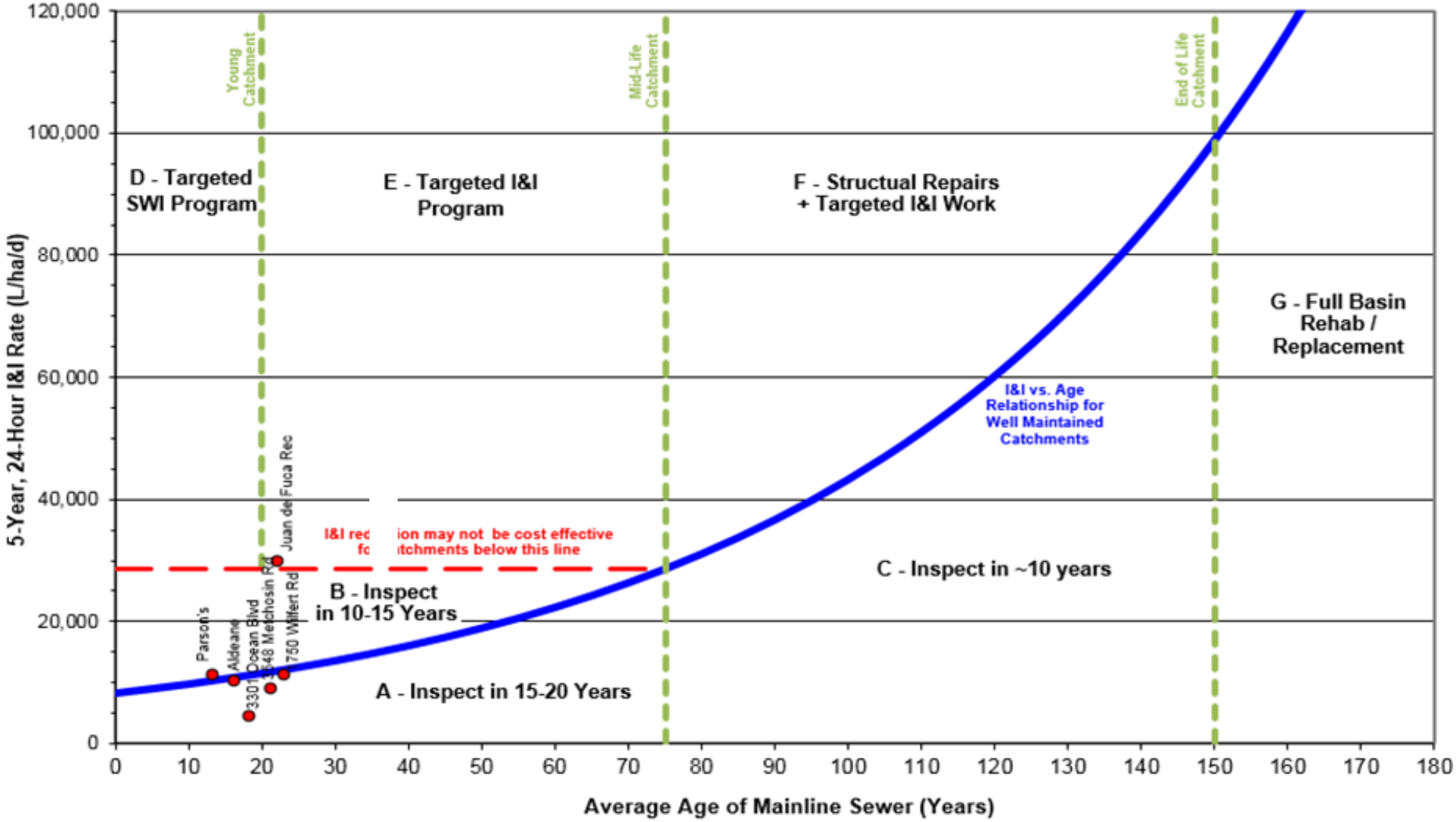
1 Catchments are considered to have some level of rapid I&I if flows more than doubled during one of two extremely intense 1 hour long dry weather storm events that occurred in 2014. This is documented in the Core Area Inflow & Infiltration Program Annual Report for 2014.

2 Rates up to 2014 were calculated based on the peak 1-hr I&I. The 2016 rate was calculated based on a stand-alone I&I analyses.

3 This catchment does not have its own sewer meter. Its data will always be derived mathematically using data from nearby catchments.

4 This is a private sewer catchment owned by multiple municipalities.

Figure 7.2: Classification of Colwood's Sewer Catchments in Archetypes



Flow Data Analyses

As shown in Table 7.1, five of Colwood's municipal catchments are classified in archetypes A. The Juan de Fuca Recreation Centre catchment is classified in archetype B. These catchments have low I&I and no flow related signs of structural issues.

Table 7.2 may be used for planning and budgetary purposes only. It shows typical recommended actions for each archetype and is divided into three phases.

- Phase 1 actions includes data collection. Colwood already has ongoing flow meter data for each of its long-term monitoring catchments. Data collection for this phase is considered routine and ongoing.
- Phase 2 actions include investigation work, which can be used to create catchment rehabilitation plans. As Colwood doesn't have elevated I&I, the work for this phase includes periodic sewer camera inspections.
- Phase 3 actions involve rehabilitation work. As Colwood's catchments have low I&I, specific I&I reduction work is not required. However, it's likely that point repairs and other minor maintenance work will be required over time, based on CCTV work and other inspections.

Table 7.2: Projected I&I Related Work Required Based on Catchment Archetype Classification

Archetype	Phase 1: Data Collection	Phase 2: Investigation Work *(percent of catchment)*	Phase 3: Rehabilitation Work *(percent of catchment)*	Component Costs *($/m)*
A	Flow Monitoring (ongoing)	CCTV Condition Assessment (15-20 years)	Point Repairs (0.1%)	$16 / meter *Plus $5000 for flow monitoring*
B	Flow Monitoring (ongoing)	CCTV Condition Assessment (10-15 years)	Point Repairs (0.1%)	$16 / meter *Plus $5000 for flow monitoring*

Please note that the archetypal methodology presents a plausible rehabilitation plan for catchments that don't have compete investigation data. It is to be used as a planning tool to guide budgeting and estimate I&I reduction effectiveness. It is intended that the archetype work programs for each catchment will be replaced by targeted I&I reduction programs based on investigative data for catchments with Archetypes D – G or an asset management program.

7.4 Sewer Infrastructure Maintenance & Capital Work

Routine Work

Colwood carries out a number of actions related to preventative maintenance and long term asset management of gravity sewers, manholes and appurtenances. Table 7.3 summarizes this work.

Table 7.3: Colwood's Preventative Sewer Maintenance Activities

Category	Performed By	Frequency	Notes
Sewer Cleaning (Flushing)	Colwood	Annually	
Manhole Inspections	Colwood	Annually	• Inspection is done visually • Inspection records are kept in field books.
Pump Station Maintenance	Colwood	Weekly to monthly	• Stations are inspected weekly • Wet wells are washed down monthly • Back-up generators are inspected monthly
SCADA Monitoring	Colwood	Continuously	
CCTV	Private contractors	n/a	• no current program for existing sewers • required for all new sewers • will be conducted if there is an issue with I&I • Testing of all new sewer mains
Relining			This has not been required.
Sewer replacement / upsizing			This has not been required and there are no plans for future replacement or upsizing.
Smoke Testing	Contractors	As required	Typically none.
Dye Testing	Contractors	As required	Typically none.
Sewer Services (laterals)	Contractors	As required	All new sewer services are installed with inspection chambers

Colwood takes efforts to prevent I&I resulting from new construction. All new systems are inspected during installation. Pipes are pressure tested, flushed and are inspected using CCTV cameras.

Records on inspection and maintenance are kept by Public Works staff in field books. Labour time and materials are entered into the applicable accounts of the finance software for the work completed. In the future, Colwood has plans to transfer records kept in field books into an asset management database.

Notable Work Completed (prior to 2017)

2012

- Added the following to its sewer system:
  - 1,440 meters of new gravity sewers
  - 57 new sewer services
  - 18 new manholes
  - 3 new sewer cleanouts
- Visual inspects of manholes and cleanouts.
- Flow monitoring

2013

- Added the following to its sewer system:
  - 576m of new gravity sewers
  - 73 new sewer services
  - 8 new manholes

    - 3 new cleanouts
    - New sewer master plan
- Colwood spent $37,517 on visual inspections of manholes and cleanouts and $9,488 on flow monitoring.

2014

- Added the following to its sewer system:
    - 269 meters of sewer mains.
    - 7 sewer services
    - 3 manholes.
    - 1 cleanout
- Visually inspected manholes and cleanouts at a cost of approximately $37,700.
- Carried out flow monitoring at a cost of approximately $8,500.

2015

- Added the following to its sewer system
    - 1 pump station
    - 71 sewer services
- Visually inspected manholes and cleanouts at a cost of approximately $50,000.
- Carried out flow monitoring at a cost of approximately $9,000.

Planned Special Projects (2016 – 2021)

- Protection of and a study on relocating the 3301 Ocean Boulevard pump station due to sea level rise.

7.5 Bylaws

The CRD and participating municipalities have committed in the Core Area Liquid Waste Management Plan (LWMP) to identify needed changes to legislation and legal authority to enable options and strategies with regard to inflow and infiltration.

The following table provides a comparison of the key powers located in the CRD Sample Private Property I&I Model Bylaw to those found in each of the municipality's existing sewer bylaws. The table demonstrate where existing powers appear to be equivalent between the municipal and model bylaw, and where there may be potential gaps. Suggestions or considerations for addressing the gaps are provided. This task was completed as a policy review, by Pinna, for consideration by municipalities when undertaking changes to their existing sewer use bylaws to assist with compliance with LWMP commitments. The municipal bylaw(s) being assessed in the analyses is Bylaw No. 1500 (2011): A Bylaw to Regulate the City Sewer Service

Table 7.4: Comparing Powers Municipal Bylaw to Sample PPI&I Bylaw

Key section(s) of the sample CRD PPI&I Model Bylaw	Is this section sufficiently addressed in current municipal bylaws and where?	Recommendations
Required maintenance standard (5-6)	Yes 2.2.2 – Owner is responsible for costs and maintenance of all private service pipes 2.2.4 – Maintain in proper order and free from leakage	
Unauthorized discharges or connections (7)	Yes 2.1.15 – No surface water, rainwater or groundwater to enter sewer system 2.1.16 – No person shall allow a private sewer pipe on their property to leak 2.1.17 – No person shall allow cross connections, inflow or infiltration on their property	
Entry and testing by city (8-11)	Partial 3.4.5 – If owner fails to perform work directed by City Engineer, City may enter property and perform work at owner's expense	Current bylaw does not explicitly state that "work" includes testing; to strengthen this, consider explicitly stating authority to perform tests *(see CRD PPII model bylaw 10)* or that it is an offence to prevent inspection *(see CRD PPII model bylaw 11)*
Required repair of defect (12-14)	Yes 3.4.4 – City Engineer may give notice and owner must do work within time specified – conduct tests, provide reports, and/or repair to prevent leakage, cross connections, inflow or infiltration	
Sewer lateral work – permit required (15-16)	No	Colwood bylaw 2.2.1 requires a permit for connecting to the sewer system, but does not explicitly require a permit for repairs (see *CRD PPII model bylaw 16*)
Financial assistance (17-21) and Monetary incentive for voluntary inspection and repairs (22-27)	No	These sections are optional in the sample model bylaw. Municipalities may opt to provide assistance and/or incentives to homeowners who voluntarily conduct inspections and repairs of private sewer laterals (for suggested language, see *CRD PPII model bylaw 17-27*). Also see *CRD PPII model bylaw 35* for no liability statement. To provide financial assistance, the municipality would need to comply with the notice requirements of the Community Charter, section 24. To provide a monetary incentive, the municipality may develop a Council-approved program as an alternative to including these sections in bylaw.

Key section(s) of the sample CRD PPI&I Model Bylaw	Is this section sufficiently addressed in current municipal bylaws and where?	Recommendations
Failure to comply – offence and penalties (28-35)	Yes 3.4.5 – If owner fails to perform work directed by City Engineer, City may enter property and perform work at owner's expense 3.4.6 – Costs of City doing work may be collected in same manner and with same remedies as property taxes 6.1 – Any contravention of bylaw may result in fine up to $10,000 per day	*CRD PPII model bylaw 33(a)* provides a penalty option to discontinue service of water supply to the property as an additional avenue for enforcement of the bylaw.

7.6 Private Property I&I

Along with its bylaw requirements, Colwood has the following mechanism related to private property I&I:

- Installation of inspection chambers on all services

The CRD also carries out private property I&I related work. In general, this work focusses on education, research, program options, bylaw wording, municipal coordination, reporting, stakeholder engagement (i.e. realtors, plumbers) and exchanging info and working with other jurisdictions (i.e. regional districts).

7.7 Budget

Colwood's I&I related sewer budget is summarized in Table 7.5.

Table 7.5: Summary of Colwood's Sewer Budget

Budget	Value
Total	
New Construction by Colwood to service existing properties previously serviced by on-site septic systems and by developers for new subdivisions	Varies
Annual Maintenance (sewer cleaning, manhole inspections and SCADA flow monitoring)	$60,000

Colwood anticipates that their sewers will have a design life of 75-100 years. In addition, Colwood budgets approximately 1% of total infrastructure value per year for a reserve fund for asset management.

In general, municipalities need to ensure that budgets are sufficient to maintain their sewer assets. For example, if a municipality expects its sewer assets to last 100 years then, on average, it should be setting funding equivalent to 1% of the replacement cost for the sewer system each year (i.e. 1 percent replacement cost / year x 100 years = 100%). Municipalities with younger sewers may decide that it's prudent to commit lower funding levels to sewer work as younger sewers generally require less rehabilitation work. Municipalities with older sewers may need to commit higher funding levels for sewer work, as their sewers reach the end of their service life.

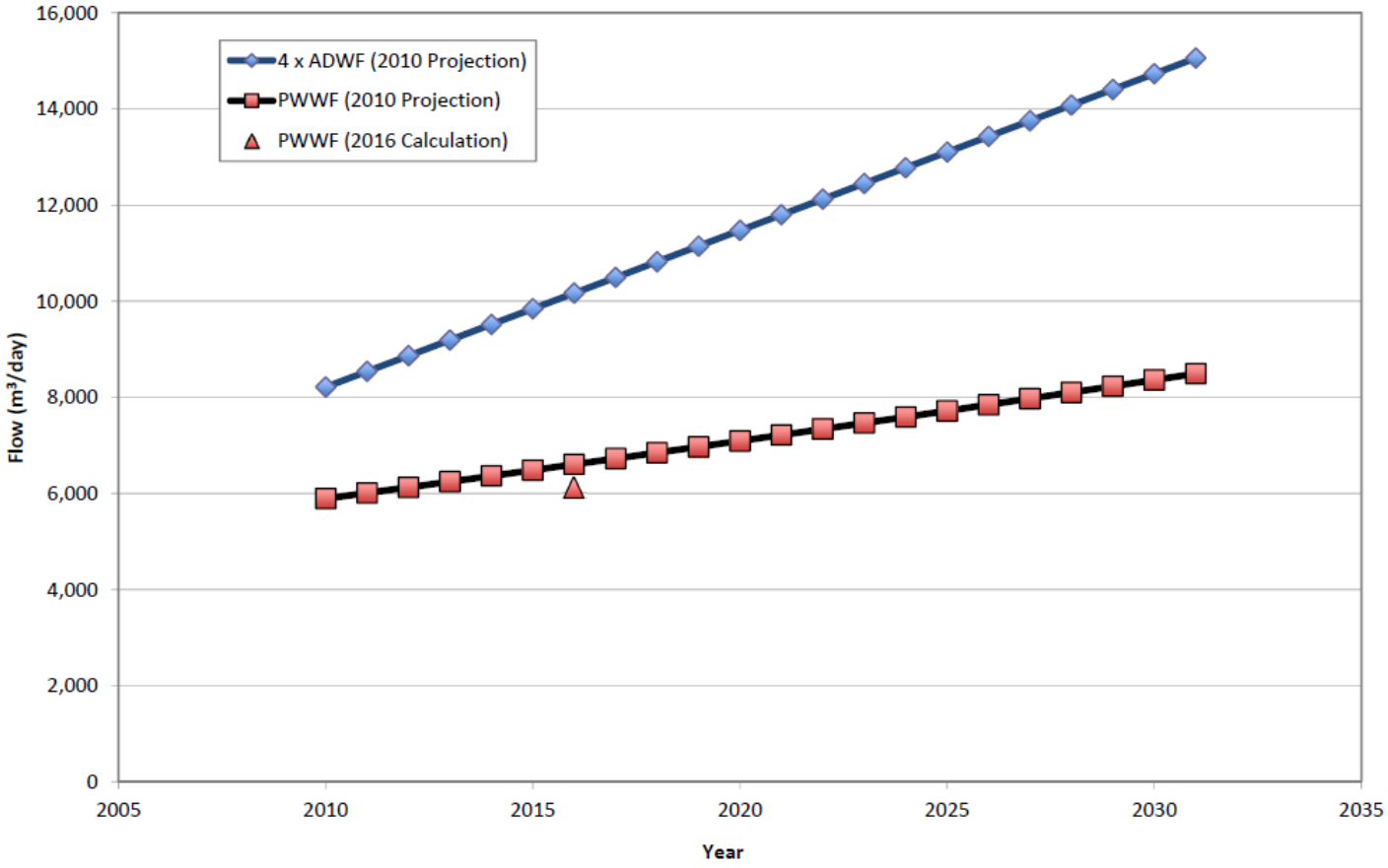
7.8 Colwood Summary

Colwood has been divided into 6 sewer catchments for this plan. Five of the catchments contain municipal sewers and one of the catchments is a completely private sewer catchment. In summary:

- None of Colwood's municipal catchments have elevated I&I.
- Peak Wet Weather Flow does not exceed 4x Average Dry Weather Flow in any of Colwood's catchments.
- The catchments will be periodically flow monitored and CCTV'd as part of the plan. Sources of new I&I will be addressed as required.
- The I&I budget for the municipality appears to be sufficient at present.

Figure 7.3 shows the anticipated PWWF and 4xADWF for 2012 to 2031 for Colwood as a whole. The blue line on the graph represents 4x ADWF. The 4x ADWF is a threshold which the Liquid Waste Management Plan has identified as a goal for the maximum flow to be conveyed and treated. This line generally increases over time due to population growth; the steeper the slope, the higher the projected growth. Various regional infrastructure including the waste water treatment plants have been sized to accommodate the projected 4x ADWF and this unit of measure is not influenced by wet weather flows. The red line on the graph represents PWWF. The PWWF includes normal sewer flows plus inflow and infiltration. It is the actual sewer flow generated during a peak rain storm event. In order to not exceed the capacity of the sewer system and to prevent overflows, the "red" PWWF line should remain under the "blue" 4x ADWF line. This is one of the primary goals noted in the Core Area Liquid Waste Management Plan.

Figure 7.3: Projected Peak Wet Weather Flow and 4xAverage Dry Weather Flow for Colwood



Minimal I&I reduction work is anticipated to be required to keep PWWF below the 4xADWF target until beyond 2031.

8 ESQUIMALT

8.1 Esquimalt Overview

The Township of Esquimalt is located in the Core Area of the CRD. It was incorporated in 1912. It is approximately 704 hectares in size and has a population of approximately 16,100 residents.

Esquimalt's first sewers were installed in 1929. The average age of the sewer system is over 100 years. The sewer system services all of the properties in Esquimalt. The municipal sewer system includes approximately 54.8 kilometers of sewer pipe, 11 sewer pump stations and 820 manholes. Pipe materials vary from vitrified clay, concrete and PVC. The majority of the pipes are vitrified clay.

Esquimalt has no combined sewers. The collection system does however contain combined manholes (storm and sanitary sewers located in the same manhole). In 2005 there was total of 153 combined manholes. 126 of these manholes have been separated with the program coming to a conclusion in 2015. The remaining combined manholes will be separated on a case by case basis dependent on need and budgetary considerations.

Esquimalt has 11 pump stations. All of the stations are equipped with SCADA to monitor flows and all are alarmed (including high water alarms). Each system has been equipped for a connection to a portable generator to provide a backup power potential. Nine of the eleven stations are located next to water bodies and are equipped with overflow pipes. For the two landlocked stations, no overflow/storage capacity is available. These stations are monitored for overflows but are not equipped with apparatus to measure overflow volumes. Esquimalt has not experienced any I&I related sewer overflows in the past several years. In order to minimize the possibility of overflows, each pump station is connected to SCADA. The SCADA is programmed to send all alarm information to Esquimalt's Public Works Department for investigation and action if required.

The procedure to deal with an overflow situation is as follows:

- All alarms are investigated by the Public Works Department
- If an overflow appears to be imminent, Public Works will bring in additional pumps, pumper trucks or other equipment as necessary to address the situation.
- If an overflow does occur, Public Works will strive to minimize the damage to structures and the environment.
- All activities are documented with any overflows being reported to the Emergency Management BC.

During storm events elevated flows can have an impact on the Regional sewer system but over the past several years this impact from Esquimalt has been minimal.

Since 2002, Esquimalt has had continuous sewer flow monitoring at nine CRD cost sharing locations. In addition, temporary metering was conducted at 11 temporary gravity sewer locations. There are future plans to generate sewer flow data from some of Esquimalt's pump stations.

Esquimalt's current focus for the reduction of I&I flows is focused on targeted I&I reduction. This work includes the separation of remaining combined manholes, dye testing to confirm possible cross connections and replacing failed sewer pipe.

The Department of National Defence (DND) has several significant properties that contribute flow to the Esquimalt collection system and to the downstream regional sewer system. The DND sewers are managed and regulated by DND and not by the Township of Esquimalt.

Between the years 2004 and 2010, Esquimalt undertook a program to carry out substantial rehabilitation work on the sanitary sewer collection system. This work included camera inspection and smoke testing of the entire sewer system, relining of approximately half the sewer system, separation of combined manholes

and a number of other actions. By carrying out this work, Esquimalt achieved significant strides in increasing the reliability and life span of the collection system. This work also had an effect on I&I rates. At various flow monitoring systems, there has been a decrease noted in flows as a result of I&I reduction. It is anticipated that I&I peaks during significant storms will continue to decrease with the separation of the combined manholes and upcoming programs.

Esquimalt contributes to the Core Area I&I Subcommittee and its initiatives. These include: regional I&I reports for the Province such as Biannual I&I Reports and the Overflow Management Plan; annual/semiannual Core Area Inflow and Infiltration Program I&I Analyses Results Reports, and various region wide public education initiatives.

8.2 Catchments

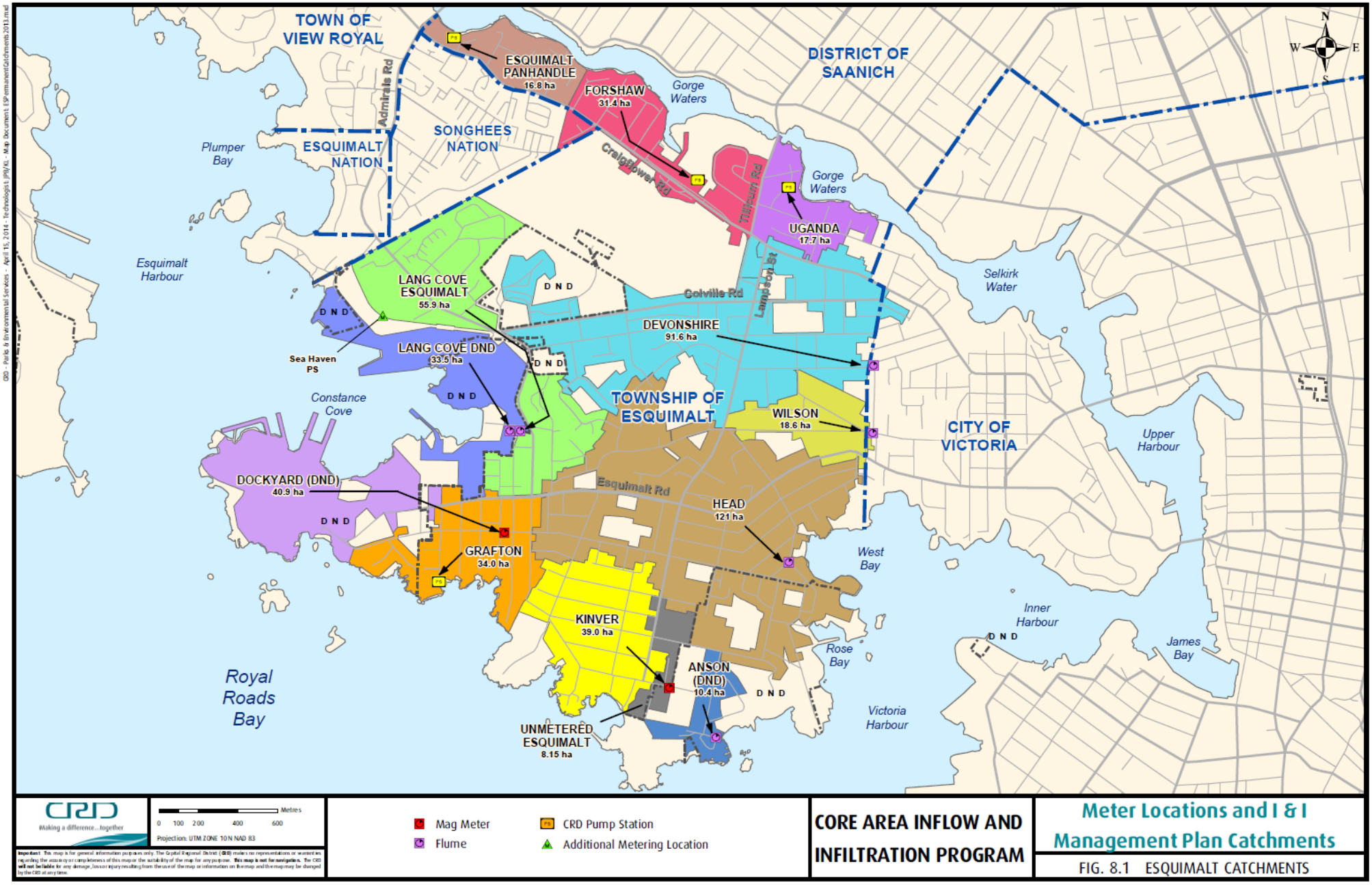
Long-Term Monitoring Catchments

Esquimalt's sewer system is divided into 12 long-term flow monitoring catchments. The catchments were chosen based on existing pump stations and permanent flow monitoring stations which provide consistent reliable long-term flow data. All of the catchments are monitored permanently using pump station data and flumes. The catchments are named based on the name of the pump station or meter that measures them. Often these names are based on the roads where they are located. Each catchment has a unique site code that enables the tracking and comparison of I&I results for specific flow meter locations over time. The catchments are shown on a map in Figure 8.1 and listed in Table 8.1.

Esquimalt's only catchment that is larger than the 30 – 100 hectare catchment size recommended in the I&I Management Plan (2012) is the Head catchment which is 120 hectares. This catchment already had significant I&I reduction work in the mid-2000's and has full CCTV and smoke testing data. As a result, subdividing this catchment in the future will not provide any additional value.

Additional Catchments

Since 2012, an additional 7 catchments have been flow monitored and analyzed for I&I in Esquimalt. The catchments are listed in Table 8.1.


TOWN OF VIEW ROYAL
DISTRICT OF SAANICH
ESQUIMALT PANHANDLE 16.8 ha
FORSHAW 31.4 ha
Gorge Waters
Admirals Rd
SONGHEES NATION
ESQUIMALT NATION
Plumper Bay
Craigflower Rd
Tillicum Rd
Gorge Waters
UGANDA 17.7 ha
Esquimalt Harbour
LANG COVE ESQUIMALT 55.9 ha
D N D
Colville Rd
Lampson St
Selkirk Water
DEVONSHIRE 91.6 ha
Sea Haven PS
LANG COVE DND 33.5 ha
TOWNSHIP OF ESQUIMALT
WILSON 18.6 ha
CITY OF VICTORIA
Constance Cove
Upper Harbour
DOCKYARD (DND) 40.9 ha
Esquimalt Rd
HEAD 121 ha
GRAFTON 34.0 ha
West Bay
KINVER 39.0 ha
Inner Harbour
Rose Bay
James Bay
ANSON (DND) 10.4 ha
Royal Roads Bay
UNMETERED ESQUIMALT 8.15 ha
Victoria Harbour
N
S
E
W
Making a difference...together
Metres
0 100 200 400 600
Projection: UTM ZONE 10N NAD 83
Mag Meter
Flume
CRD Pump Station
Additional Metering Location
CORE AREA INFLOW AND INFILTRATION PROGRAM
Meter Locations and I & I Management Plan Catchments
FIG. 8.1 ESQUIMALT CATCHMENTS

8.3 Inflow & Infiltration Data

Historical Data Collection

Prior to 2011, a significant amount of data was collected and consolidated for each of Esquimalt's long-term monitoring catchments. Much of this is summarized in the I&I Management Plan (2012) which includes:

- I&I data (5-year peak I&I rates; presence of overflows, average flows and peak wet weather flows)
- Catchment size, number of properties, and number of laterals.
- Percentage land use (single family, multi family, commercial, industrial, and institutional)
- Number of manholes and pump stations
- Sewer age and pipe materials.
- Type of flow meter.
- Detailed catchment maps with associated GIS information.
- Catchment "archetype" classifications for each of the municipality's long-term monitoring locations.
    - *For the I&I Management Plan, seven categories of archetypes were developed. The archetypes are delineated based on sewer age and I&I rates. Each archetype contains a typical list of rehabilitation actions needed and a "per meter" budget number to complete the work. The archetypes are designed to be used for high level budget and planning purposes. If investigation work is completed (i.e. CCTV and smoke testing), archetypes should be replaced with specific rehabilitation plans containing specific budgets.*

Current Data Collection

Significant catchment data was collected, analyzed, and/or updated between April 2010 and March 2016. This data is summarized in Table 8.1 and includes:

- Catchment sizes
- Average pipe ages
- Current peak 1-hour I&I rates
- If a catchment has "rapid I&I"
- If a catchment exceeds 4x average dry weather flow
- 5-year 24 hour I&I rate and projected rate at 2031 (based on current precipitation rates)
- Catchment archetype classification and budget estimates based on the current I&I analyses.
- I&I rates for "additional catchments" (i.e. different than the long term monitoring catchments) that have been analyzed since 2012.

Figure 8.2 shows how catchments were classified into archetypes based on average sewer age and I&I rates. This is the same system that was used in the Core Area I&I Management Plan (2012). An overview of the archetype methodology is located in Section 5

Table 8.1: Summary of I&I in Esquimalt by Catchment

I&I Management Plan Catchments	General Info			Inflow & Infiltration							
	Site Code	Size (ha)	Pipe Ave. Age	Peak 1-hr I&I Rate *(l/ha/day)*	5-yr, 24-hr flows compared to ADWF	Rapid I&I? [1]	5-yr, 24-hr I&I Rate [2] (l/ha/day)				
							2010	2012	2014	2016	Class [4]
Devonshire [3]	ES14A	90	74	111,744	5.1x ADWF	no	68,000	79,466	66,328	61,889	N/A
Esquimalt Panhandle	ES15	17	41	35,932	3.9x ADWF	no	23,461	23,461	22,146	21,765	
Forshaw	ES24	34	58	93,515	8.6x ADWF	no	68,000	50,027	48,937	59,794	
Grafton	ES25	34	83	105,865	9x ADWF	no	39,017	39,282	52,358	60,118	
Head	ES16	124	74	87,794	5.2x ADWF	no	45,283	45,246	45,305	47,565	
Kinver	ES17	39	72	84,185	5.5x ADWF	no	47,118	44,105	45,225	48,205	
Lang Cove Esquimalt	ES9	56	72	44,743	6.6x ADWF	no	26,662	27,372	25,881	31,375	
Uganda	ES26	18	80	115,200	6.1x ADWF	no	68,000	57,986	57,011	59,444	
Unmetered Esquimalt [3]	ES27	8	78	~85,000	5.5x ADWF	no	47,118	47,118	47,118	~48,000	
Wilson	ES20	19	75	127,326	6.3x ADWF	yes	99,227	94,662	51,440	62,000	
Additional Catchments											
Devonshire *(Total Metered Area)*	ES14	144	71	106,320	5.7x ADWF	no	n/a	n/a	n/a	60,229	
Dockyard	ES19	72	62	78,360	6x ADWF	yes	n/a	n/a	n/a	48,750	
Sea Haven	ES28	6	81	~14,500	1.9x ADWF	no	n/a	n/a	n/a	8,500	
Canteen	ES29	0.6	n/a	~318,000	38x ADWF	yes	n/a	n/a	n/a	186,667	
Constance	ES30	1.3	n/a	290,437	8.9x ADWF	no	n/a	n/a	n/a	170,000	
Garthland	ES31	6.6	n/a	68,073	5.8x ADWF	no	n/a	n/a	n/a	37,576	
Luscombe	ES32	2.6	n/a	~17,000	2.2x ADWF	no	n/a	n/a	n/a	10,385	

Footnotes:

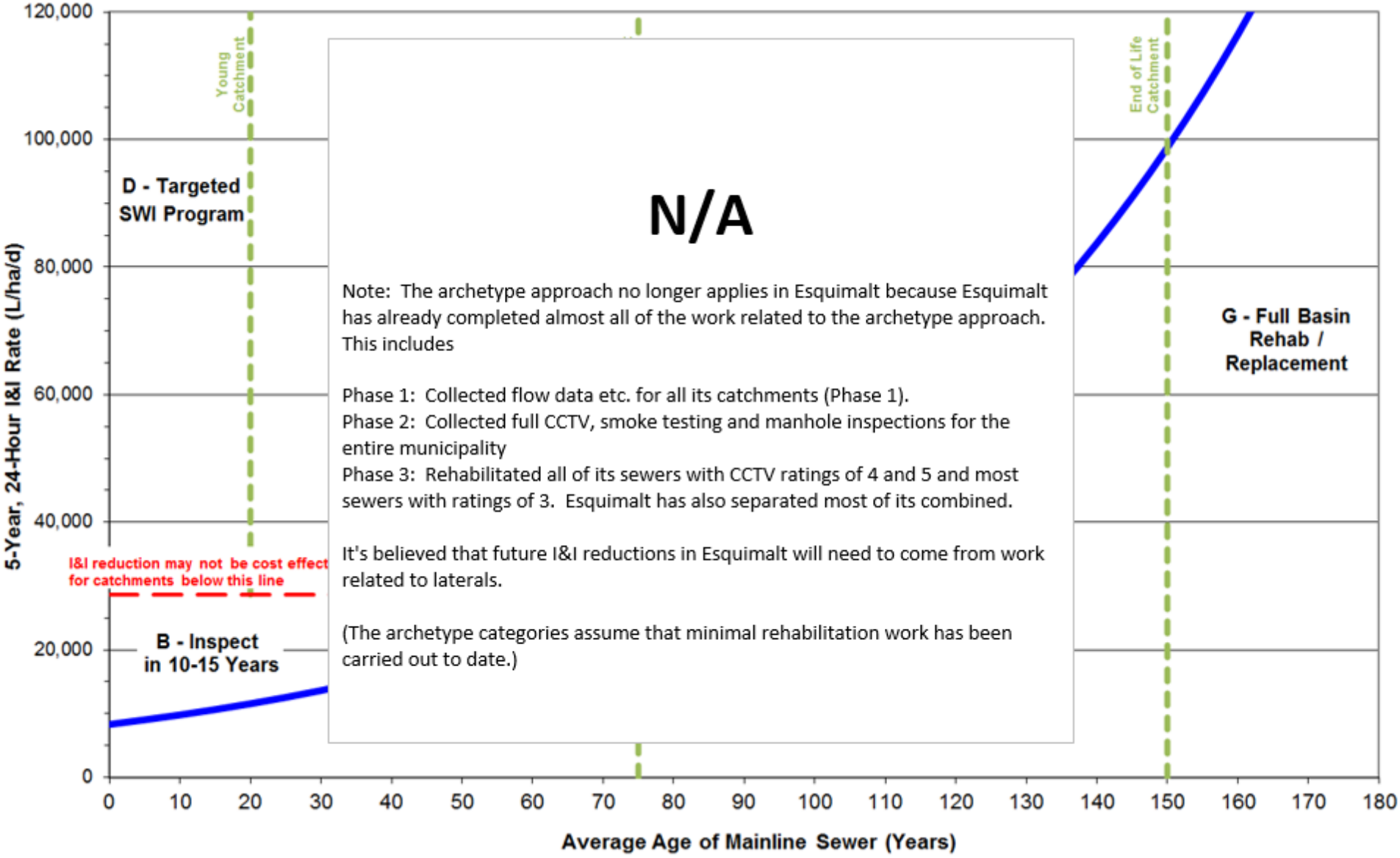
1 Catchments are considered to have some level of rapid I&I if flows more than doubled during one of two extremely intense 1 hour long dry weather storm events that occurred in 2014. This is documented in the Core Area Inflow & Infiltration Program Annual Report for 2014.

2 Rates up to 2014 were calculated based on the peak 1-hr I&I. The 2016 rate was calculated based on a stand-alone I&I analyses.

3 This catchment does not have its own sewer meter. Its data will always be derived mathematically using data from nearby catchments.

4 The current archetype approach is not applicable due to Esquimalt's extensively completed sewer rehab to date.

Figure 8.2: Classification of Esquimalt's Sewer Catchments in Archetypes



Flow Data Analyses

Esquimalt's catchments have already had considerable sewer rehabilitation work carried out in the 2000's. This included substantial mainline relining, manhole repairs and combined manhole separation (see Section 8.4). This resulted in a significant reduction in I&I. It is likely that future I&I reductions will require work on sewer laterals or improvements in the sanitary/storm water systems.

Half of Esquimalt's plan catchments have flows that exceed 4x average dry weather flow during major storm events. About a quarter of the catchments have some level of "rapid I&I". Along with catchment I&I rates, these metrics provide additional clues for determining potential I&I reduction efforts for specific catchments.

Many of the activities carried out by Esquimalt can be categorized into the 3 phases of the archetype process:

- Phase 1 - Data Collection: Esquimalt has real-time ongoing flow meter data collection for each of its long-term monitoring catchments. Data collection for is considered routine and ongoing.

- Phase 2 – Investigation: Esquimalt has an ongoing CCTV program and manhole inspection program.

- Phase 3 – Rehabilitation: Esquimalt's future I&I reduction efforts are intended to focus on service lateral or private property I&I reduction.

8.4 Sewer Infrastructure Maintenance & Capital Work

Routine Work

Esquimalt carries out a number of actions related to preventative maintenance and long term asset management of gravity sewers, manholes and appurtenances. Table 8.2 summarizes this work.

Table 8.2: Esquimalt's Preventative Sewer Maintenance Activities

Category	Performed By	Frequency	Notes
Rehab / Replacement			
Sewer Relining	Contractor	As required	This work carried out based on review of the system and the state of the collection system. Next project has not yet been determined.
Sewer replacement / upsizing	Municipal Staff	As required	Sewer replacement is carried out if a need for this work has been identified. The need for upsizing is determined by new development connecting to the system and past performance of the collection system
Manhole Rehabilitation	Municipal Staff	As required	As manholes are identified that require rehabilitation, the work will be carried out on priority basis and budget availability.
Manhole Replacement	Municipal Staff	As required	As manholes are identified that require replacement, the work will be carried out on a priority basis and budget availability
Separation of Combined Manholes	Municipal Staff	~1-2 / year	As manholes are identified based on priority and budget availability, the remaining combined manholes will be separated.
Pump Station related work	As required		The replacement of the pump station pumps is scheduled based on their estimated life spans and past performance.
Investigation Work			
CCTV	Contractor	10 to 15 year cycle	CCTV review and rating of the entire system happens on a long time frame and will be confirmed by the maintenance plan. CCTV will also be carried out for localized concerns and new construction.
Manhole Inspections	Municipal Staff	As required	This activity is currently carried out on an as-required basis. It will be incorporated into the maintenance plan.
Smoke Testing	Municipal Staff	10 to 15 year cycle	In 2009, Esquimalt smoke tested its entire sewer system. The results showed approximately 400 potential cross-connections. Future work will be carried out on a long time frame and will be confirmed by the maintenance plan. Smoke testing will also be carried out for localized concerns and new construction where warranted.

Table8.2: Continued

Category	Performed By	Frequency	Notes
Dye Testing	Municipal Staff	As required	Dye testing / investigation are being used to follow-up on the smoke testing results. At this time the program is a voluntary program and has experienced low participation. The Township will be exploring how to increase participation rates and investigations. To date all investigations have shown that there has been no cross connection. Dye testing will also be utilized on a localized basis to confirm or deny possible concerns.
Routine Maintenance			
Sewer Cleaning (Flushing)	Municipal Staff	As required	Sewer cleaning is carried out on a localized basis based on pipe performance or identified concerns.
Pump Station Maintenance	Municipal Staff/Contracted Forces	Annual	Pump stations have an annual inspection program to determine requirements for maintenance activities. Once these activities have been identified, they are prioritized and are corrected under operational budgets or specific capital programs. Activities that are outside of the expertise of the Public Works Department are contracted out.
SCADA Monitoring	Municipal Staff/Contracted Forces	Annual	The SCADA monitoring system is reviewed by municipal staff as well as the CRD. If it is determined that maintenance activities are required, the work will be contracted out. Timing of repairs will be based on severity and budget availability.

New construction in the Township is focused on infill housing projects and redevelopment of lots for higher density. As these projects are received, the Township ensures that the existing services are in good condition, not cross connected, meet the current plumbing code requirements, and properly direct storm water to the storm drain collection system. New service laterals are also CCTV'ed prior to acceptance. If a development requires an upgrade to either the sanitary or storm collection systems, main line work will be carried out to accommodate this work.

As repairs are carried out on the collection system or additions/modifications are made, as built information is annotated to current record drawings. New construction documentation is added to record drawings as this information is acquired.

Reactive maintenance also plays a role in the maintenance of the collection system. When a failure is corrected (either main line or service line), the Public Works crew will carry out a visual inspection of the pipe to determine the condition of the surrounding pipe. If this visual inspection determines that the adjacent pipe lengths are in poor condition, the Township will carry out CCTV work in order to determine the extent of the pipe distress. Based on the results of this investigation, the severity of the distress will be determined and the appropriate time for correction estimated.

The incorporation of Low Impact Development features will be explored in new developments and opportunities explored to utilize these types of features within the existing system.

Notable Work Completed (prior to 2017)

2004 to 2010 (Substantial Rehabilitation Work)

- Modeled collection system capacity prior to a relining program
- All structural category 5, 4, and 1/3 of 3-rated sewers were relined (approximately 50% of the system)
- 11 pump stations were upgraded and a SCADA system was installed
- A portable generator was purchased and modifications were carried out on pump stations to allow connection
- The entire system was smoked tested
- Locations that indicated a cross connection are being investigated by dye testing to confirm cross connections
- Combination manholes were separated. (The remaining combined manholes are scheduled to be separated by 2015)
- Possible cross connection of catch basins was investigated and where warranted separation occurred.

2012

Combined Manhole Separation Program

- 16 combined manholes separated at various locations

Sanitary Sewer Collection System

- 14 service laterals were installed/replaced at various locations to the property line
- 1 manhole was replaced
- 5 test and clear inspections were carried out at various locations to the property line

Pump Stations

- Reviewed and eliminated minor communication issues with SCADA system in conjunction with the CRD

Storm Drain Collection System

- 16 service laterals installed/replaced at various locations to the property line
- 1 manhole was replaced
- 2 catch basins were replaced
- 8 test and clear inspection were carried out at various locations to the property line
- Spot cleaning of collection system as required

Capital Projects

- 2 Stormceptor structures added to treat Craigflower Road storm water collection system

2013

Combined manhole separation program

- 14 manholes separated at various locations.

Sanitary Sewers

- 15 service laterals installed/replaced
- 2 test and clears carried out
- 13 manholes replaced

Pump Stations

- Replaced pumps (2) at Grafton Pump Station.

Storm Drains

- 11 service laterals installed/replaced
- 2 test and clears carried out
- 6 manholes replaced

- 9 catch basins replaced
- Fall and winter inspections and cleaning for catch basins completed

Capital Projects

- Added approximately 61 meters of new storm drain and 2 manholes to the collection system on Dunsmuir Road.

2014

Combined Manhole Separation Program

- 6 combined manholes separated at various locations

Sanitary Sewer Collection System

- 9 service laterals installed/replaced
- 8 test an clears carried out

Storm Drains

- 9 service laterals installed/replaced
- 5 test and clears carried out
- 6 manholes replaced
- 15 catch basins replaced
- Fall and winter inspections and cleaning for catch basins completed.

2015

Combined manhole separation program

- 7 manholes separated at various locations.

Sanitary Sewers

- 22 service laterals installed/replaced
- 4 test and clears carried out
- 2 manholes replaced

Pump Stations

- Annual maintenance program completed
- Kinver and Sea Haven internal piping systems were replaced

Storm Drains

- 19 service laterals installed/replaced
- 3 test and clears carried out
- 6 manholes replaced
- 26 catch basins replaced under replacement program.
- Fall and winter inspections and cleaning for catch basins completed

Capital Projects

- An Upgrade to the Admirals Road Corridor undertook:
    - Separation of 5 combined manholes (part of combined manhole separation total)
    - Installation of 3 Stormceptor oil/grit separators
    - Replacement of storm and sanitary mains as required
    - Replacement of storm and sanitary services as required (to property line). No cross connections were encountered.

Planned Special Projects (2016 – 2021)

2016

- Model the sanitary collection system
    - Confirm the flow volumes that occur in the system. This activity will assist the Township to determine expected the volume of flows that will require treatment and determine where the system is with respect to the 4xADWF limit.

- Adoption of Bylaw

  - The purpose of the activity is to provide a mechanism for the Township in order to deal with private services. Work will be focused on a review of the draft model bylaw from the CRD, cost for works and how the works will be carried out.
  - Determine a mechanism that will allow work to occur on private property and how the costs associated with these activities will allocated between the various stakeholders involved.

- Further review of 2009 smoke testing results
  - The purpose of the activity is to determine provide a scope of works for a number of future aspects of the management plan. These aspects include:
    - Where pipe extensions to the storm drain system is necessary in order to provide a drain to connect to (as per the Sewer Connection Bylaw, 2013, No. 2801).
    - Determine by which mechanism work will be carried out to pay for the drain extensions.
    - Where both sewer and drain mains are present, determine which properties are not meeting the requirements of Bylaw No. 2801.

2017

- Installation of inspection chambers on the suspected cross connection properties. Priority would be services connected to the sanitary main followed by services connected to storm drain.
- Once an inspection chamber was installed the service lateral (both public and private portions) would be videoed to confirm:
  - Is the lateral connected to the right collection system?
  - What condition is the lateral pipe in?
  - Cost estimate for replacement (i.e. no dig vs. dig)?
  - Mapping of lateral location for both home owner and Township information

- 2018
  - Camera and rating of sanitary mains not relined in early 2000's.
  - Installation of inspection chambers of laterals on these mains
  - Camera and rating of laterals
  - Inspection and rating of main manholes
  - Determine scope of work for repairs, upgrades as determined by inspection and model
- 2019
  - Repair mains based on condition ratings
  - Repair laterals based on condition rating (both public and private portions)
  - Repair manholes on mains not relined in 2000's
- 2020
  - Installation of inspection chambers on approximately half of the relined mains
  - Camera and rating of laterals
  - Inspections and rating of main manholes
  - Cost estimates proposed work

- 2021
    - Repair mains based on condition ratings
    - Repair laterals based on condition rating (both public and private portions)
    - Repair manholes on mains relined in 2000's
    - Installation of inspection chambers on approximately half of the relined mains
    - Camera and rating of laterals
    - Inspections and rating of main manholes
    - Cost estimates proposed work

From 2021 and beyond, similar work is to occur. It is anticipated that the project will be completed 2025. For the remaining combined manholes, individual projects will be identified and be undertaken as budget money and staff time becomes available.

8.5 Asset Management

Where possible, Esquimalt has adopted the triple bottom line philosophy (economic/social/environmental) for planning and decision making. This philosophy is also utilized in reactive maintenance activities to maximize efforts to maintain the collection system.

Starting in 2016 the Township is initiating a Corridor Infrastructure Management Program. The intent of the program will be an evaluation of transportation corridors to determine what activities are required on the various types of infrastructure (above/below ground). This program will also be utilizing information from the I/I Program (see 2017 to 2021 activities) and prior knowledge of the system to assist in determining the state of the underground infrastructure systems both on private and public lands. This information will then be translated into work plans/projects for implementation.

Funding for the work plans/projects will be reviewed with budget constraints either through the operational budget or capital budget. As well infrastructure replacement will be prioritized for replacement/upgrade/new construction.

Moving forward the Township is looking at expanding it capabilities to review SCADA data and determine locations for improvement in cross connections and I/I issues.

The I/I Program will see several main components developed in the next several years. They are:

- Modeling of the sanitary collection system
- Determining a bylaw for I/I issues on private property
- Review of smoke test results to assist in determine start point(s) for inspection chamber installation
- Videoing of mainline and service (public/private) lines
- Upgrade to manholes where required.

The I/I program will also look at development of time frames for (i.e. CCTV, system modeling) and formalizing the maintenance activities where required.

8.6 Bylaws

The CRD and participating municipalities have committed in the Core Area Liquid Waste Management Plan (LWMP) to identify needed changes to legislation and legal authority to enable options and strategies with regard to inflow and infiltration.

The following table provides a comparison of the key powers located in the CRD Sample Private Property I&I Model Bylaw to those found in each of the municipality's existing sewer bylaws. The table demonstrate where existing powers appear to be equivalent between the municipal and model bylaw, and where there may be potential gaps. Suggestions or considerations for addressing the gaps are provided. This task was completed as a policy review, by Pinna, for consideration by municipalities when undertaking changes to their existing sewer use bylaws to assist with compliance with LWMP commitments. The municipal bylaw(s) being assessed in the analyses are Bylaws: No. 1867, 2332, and 2538, and Policy Sewer and Drain Blockages - Private Property NO. Plan – 28

Table 8.3: Comparing Powers Municipal Bylaw to Sample PPI&I Bylaw

Key section(s) of the sample CRD PPI&I Model Bylaw	Is this section sufficiently addressed in current municipal bylaws and where?	Recommendations
Required maintenance standard (5-6)	No Policy – Owners are responsible for sewer and drain laterals on their (private) property and within private easements	See *CRD PPII model bylaw 5 and 6*
Unauthorized discharges or connections (7)	No	See *CRD PPII model bylaw 7*
Entry and testing by city (8-11)	No	Esquimalt Bylaw 1867 (1 and 2) allows entry by city to connect sanitary sewer or storm drain connections at owner's expense if owner fails to do so when ordered; however, it does not explicitly enable entry for testing (see *CRD PPII model bylaw 8-11*)
Required repair of defect (12-14)	No	See *CRD PPII model bylaw 12-14*
Sewer lateral work – permit required (15-16)	No	See *CRD PPII model bylaw 15 and 16*
Financial assistance (17-21) and Monetary incentive for voluntary inspection and repairs (22-27)	No	These sections are optional in the sample model bylaw. Municipalities may opt to provide assistance and/or incentives to homeowners who voluntarily conduct inspections and repairs of private sewer laterals (for suggested language, see *CRD PPII model bylaw 17-27*). Also see *CRD PPII model bylaw 35* for no liability statement. To provide financial assistance, the municipality would need to comply with the notice requirements of the Community Charter, section 24. To provide a monetary incentive, the municipality may develop a Council-approved program as an alternative to including these sections in bylaw.
Failure to comply – offence and penalties (28-35)	TBD	See *CRD PPII model bylaw 28-35.*

8.7 Private Property I&I

The Township is in the process of developing mechanisms for dealing with private property I&I. These mechanisms include:

- Development of a Bylaw that addresses private property I&I issues including a policy with respect to cost associated with private property I&I.
- Installation of inspection chambers on storm and sanitary services at property line
- As building permits are issued, the storm and sanitary services will be inspected. This will confirm if there are any cross connections and condition of the services.
- Determining stand-alone projects to address storm main line extension
- Determining stand-alone project to address remaining combination manholes

The CRD also carries out private property I&I related work. In general, this work focusses on education, research, program options, bylaw wording, municipal coordination, reporting, stakeholder engagement (i.e. realtors, plumbers) and exchanging info and working with other jurisdictions (i.e. regional districts).

8.8 Budget

Esquimalt's I&I related sewer budget is summarized in Table 8.4.

Table 8.4: Summary of Esquimalt's Sewer Budget

Budget	Value
Total [1]	
New Construction – determined on a case by case basis, none for 2016	
Sewer Reserve – gravity, maintenance	$150,000
Sewer Reserve – lift stations, maintenance	$125,000

1 2016 Financial Plan

In general, municipalities need to ensure that budgets are sufficient to maintain their sewer assets. For example, if a municipality expects its sewer assets to last 100 years then, on average, it should be setting funding equivalent to 1% of the replacement cost for the sewer system each year (i.e. 1 percent replacement cost / year x 100 years = 100%). Municipalities with younger sewers may decide that it's prudent to commit lower funding levels to sewer work as younger sewers generally require less rehabilitation work. Municipalities with older sewers may need to commit higher funding levels for sewer work, as their sewers reach the end of their service life.

Table 8.5: Comparison of Sewer System Value to Annual Budget

Category	Value
Anticipated Design Life of Sewer (years) • *Main line, manholes, lateral connections* • *Lift stations*	60 25
Estimated Sewer System Replacement Value ($)	45,600,000
Annual Budget / Replacement Value (%)	0.60

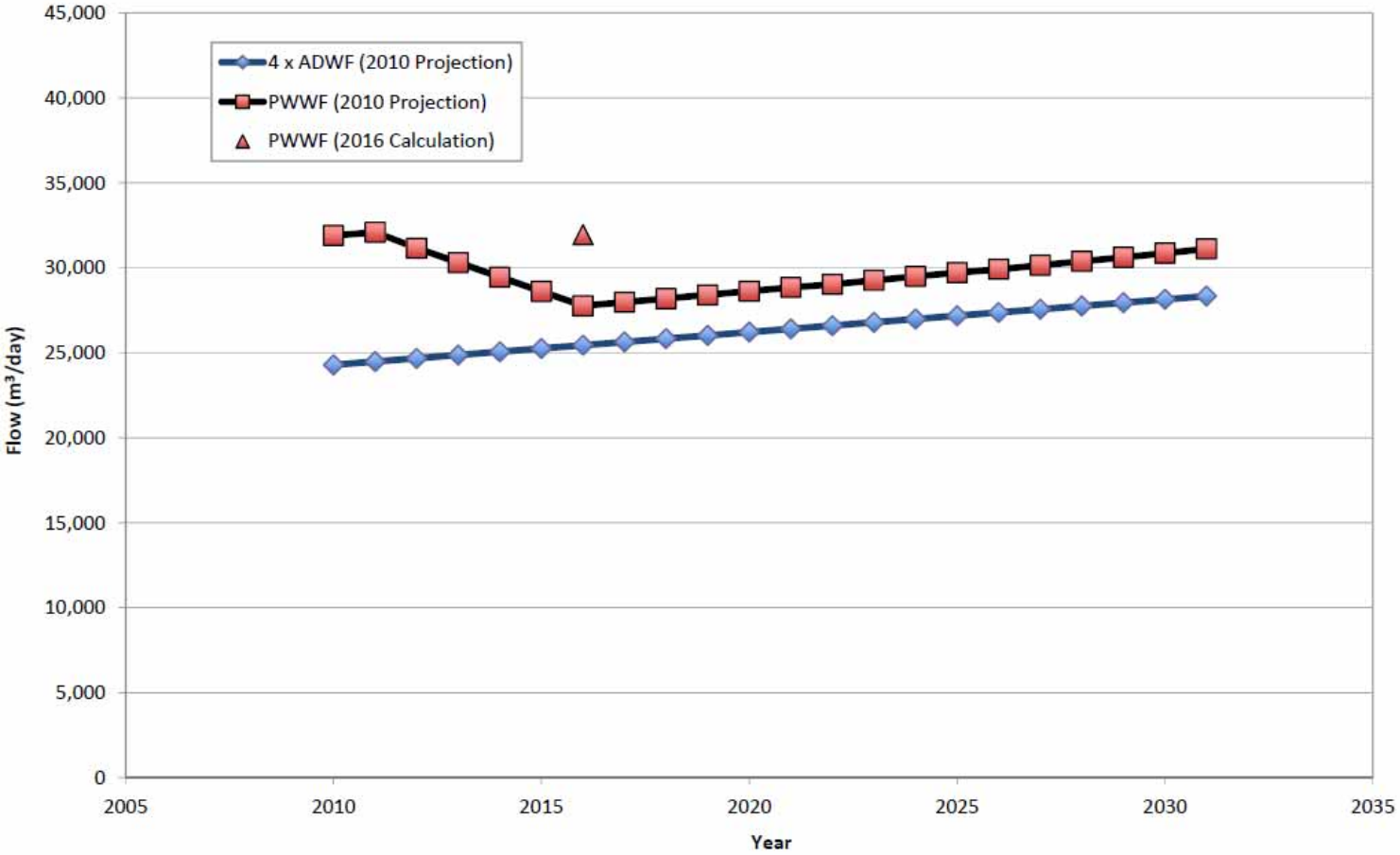
8.9 Esquimalt Summary

Esquimalt has been divided into 12 sewer catchments for this plan. In summary:

- 10 of the catchments have elevated I&I (Archetypes D-G).
- Two of these catchments are Department of National Defence flows catchments. Esquimalt does not have any maintenance responsibilities for these catchments.
- Esquimalt has already completed full sewer investigation work (CCTV and smoke testing) of all of its catchments. It has also rehabilitated approximately half of its gravity sewers.
- Esquimalt plans to separate its remaining combined manholes by 2016. It plans to deal with cross-connections and sewer infrastructure, as required, between 2017 and 2031.
- Peak Wet Weather Flow exceeds 4x Average Dry Weather Flow in many of Esquimalt's catchments.

Figure 8.3 shows the anticipated PWWF and 4xADWF for 2012 to 2031 for Esquimalt as a whole. The blue line on the graph represents 4x ADWF. The 4x ADWF is a threshold which the Liquid Waste Management Plan has identified as a goal for the maximum flow to be conveyed and treated. This line generally increases over time due to population growth; the steeper the slope, the higher the projected growth. Various regional infrastructure including the waste water treatment plants have been sized to accommodate the projected 4x ADWF and this unit of measure is not influenced by wet weather flows. The red line on the graph represents PWWF. The PWWF includes normal sewer flows plus inflow and infiltration. It is the actual sewer flow generated during a peak rain storm event. In order to not exceed the capacity of the sewer system and to prevent overflows, the "red" PWWF line should remain under the "blue" 4x ADWF line. This is one of the primary goals noted in the Core Area Liquid Waste Management Plan.

Figure 8.3: Projected Peak Wet Weather Flow and 4x Average Dry Weather Flow for Esquimalt



Esquimalt's PWWF reductions were projected to decrease to 2016 as a result of manhole separation. Additional efforts may be implemented after that time pending council approvals.

Esquimalt has identified a budget for maintaining sanitary sewer infrastructure of approximately 0.6% of asset value. Based on an analysis of plausible rehabilitation works significant I&I reduction is expected, however it is not anticipated that Peak Wet Weather Flow will be brought below 4x-Average Dry Weather Flow by 2031.

9 LANGFORD

9.1 Overview

The City of Langford is located in the Western Communities area of the CRD. It was incorporated in 1992. It is approximately 3,955 hectares in size and has a population of approximately 29,000 residents.

Langford's first sewers were installed in 1995. The average age of the sewer system is 11 years. The sewer system services approximately 69% of the estimated 8100 parcels in Langford. Approximately 3000 parcels are serviced by septic systems or on-site sewer systems of which an estimated 1000 could connect to the Langford sewer system.

In total, there are over 100 kilometers of gravity sewer pipe in Langford (of which about 97% is PVC), 19 kilometers of pressure main including low pressure sewer systems & siphons and approximately 6800 service laterals. There are also fourteen sewage pump stations and approximately 1500 manholes.

West Shore Environmental Services Inc. (WSES) a division of Corix Utilities signed a partnership agreement with the City of Langford in September 2004 to construct, own, operate and maintain extensions to the City of Langford's sewage collection system. This includes operating and maintaining the existing sewers as well as handling all customer inquiries and concerns. Langford's storm water drainage system is owned, operated and maintained by the City of Langford.

Langford has no known overflow locations, combined sewers or combined manholes. Langford has had no known I&I related sewer overflows. If a sewer overflow was to happen in Langford, WSES would immediately call Emergency Management BC (EMBC), obtain an incident number and implement an Emergency Response Plan; i.e. stop, contain and clean up the spill. Final documentation, information and reporting would be forwarded to EMBC and the City of Langford.

Langford's I&I rates are relatively low and do not significantly impact Langford's municipal sewers or the regional sewer system. Langford focuses its I&I efforts on preventative sewer maintenance and good installation practices. This includes CCTV sewer inspections, service chamber inspections & repairs, manhole inspections & repairs, and monitoring flow data.

Langford has fourteen pump stations. Of these, thirteen are monitored using SCADA and one is monitored by means of telephone dialup; eight have standby power generators; six have connections for a portable generator owned and operated by the maintenance contractor, and; twelve stations have storage tanks designed for either overflow or peak flow storage. The pump stations are maintained by WSES staff and contractors. Langford's pump station SCADA system is maintained by a SCADA consultant and monitored by local staff and an off-site contractor. The data is checked daily by WSES staff to identify potential I&I related issues. The data is also provided annually to the CRD for I&I analyses.

Langford contributes to the Core Area I&I Subcommittee and its initiatives. These include: regional I&I reports for the Province such as the I&I Management Plan, the Overflow Management Plan; annual Core Area Inflow and Infiltration Program I&I Analyses Results Reports, studies and various region wide public education initiatives.

9.2 Catchments

Long-Term Monitoring Catchments

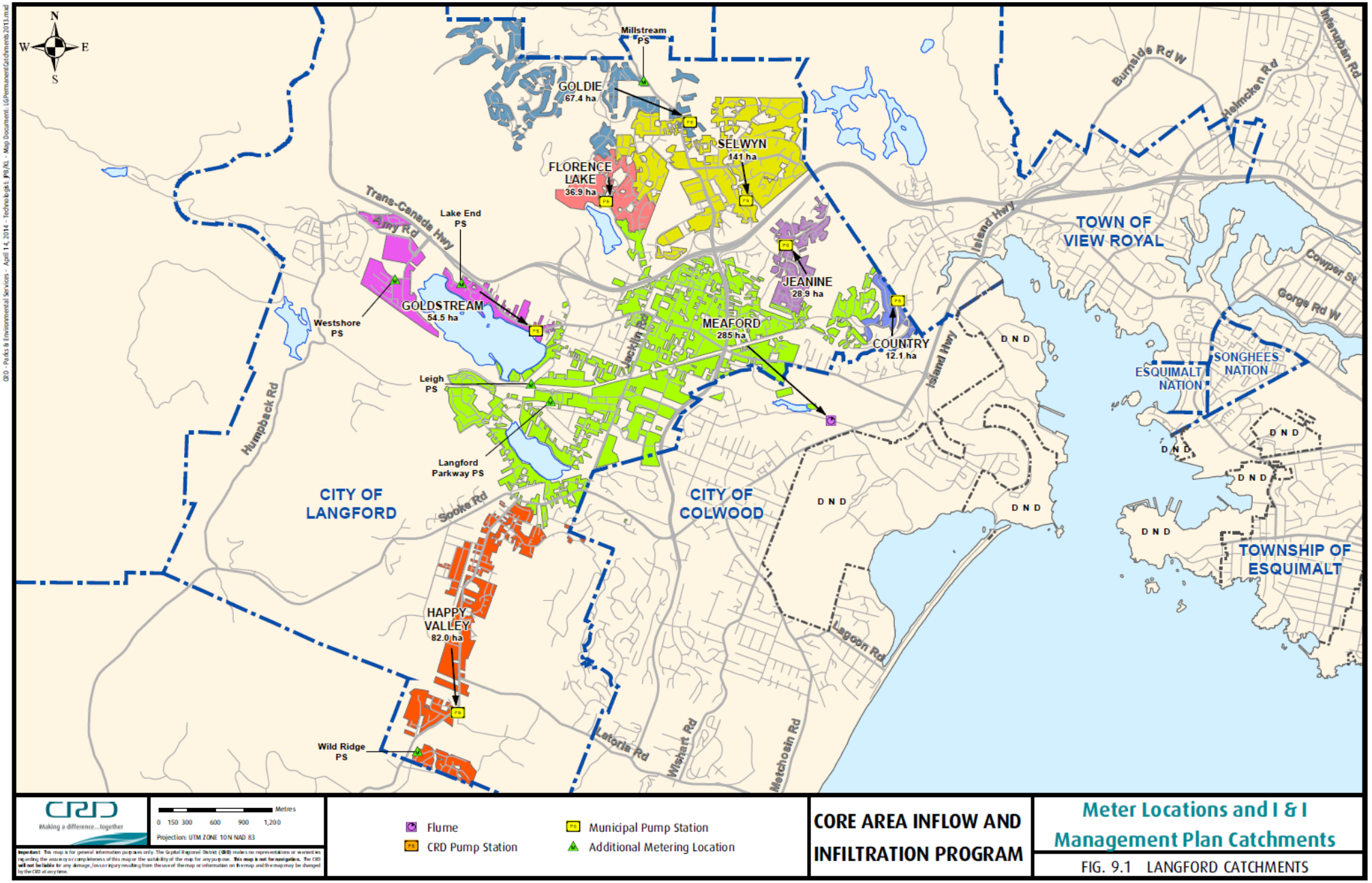
Langford's sewer system is divided into 8 long-term flow monitoring catchments. The catchments were chosen because they are appropriately sized and already had permanent flow metering. Seven of these catchments are monitored at municipal pump stations and share the same name as the pump stations. The eighth catchment is monitored at the CRD owned "Meaford" cost sharing location, which is located on

Aldeane Avenue. Each flow monitoring catchment has a unique site code that enables the tracking and comparison of I&I results for specific flow meter locations over time. The catchments are shown on a map in Figure 9.1 and listed in Table 9.1.

Two of Langford's long-term monitoring catchments are larger than the 30 – 100 hectare catchment size recommended in the I&I Management Plan (2012). However, these catchments have low I&I and can be subdivided in the future if warranted by increasing I&I rates.

Additional Catchments

Since 2012, an additional 10 catchments have been flow monitored an analyzed for I&I in Langford. The catchments are listed in Table 9.1.


N
W
E
S
Millstream PS
GOLDIE 67.4 ha
SELWYN 141 ha
FLORENCE LAKE 36.9 ha
Trans-Canada Hwy
Lake End PS
Army Rd
GOLDSTREAM 54.5 ha
Westshore PS
JEANINE 28.9 ha
MEAFORD 285 ha
COUNTRY 12.1 ha
Island Hwy
TOWN OF VIEW ROYAL
Burnside Rd W
Helmcken Rd
Interurban Rd
Cowper St
Gorge Rd W
SONGHEES NATION
ESQUIMALT NATION
Leigh PS
Langford Parkway PS
Humpback Rd
Jacklin Rd
CITY OF LANGFORD
CITY OF COLWOOD
Sooke Rd
D N D
TOWNSHIP OF ESQUIMALT
HAPPY VALLEY 82.0 ha
Wild Ridge PS
Lagoon Rd
Latoria Rd
Wishart Rd
Metchosin Rd
CRD
Making a difference...together
Metres
0 150 300 600 900 1,200
Projection: UTM ZONE 10N NAD 83
Flume
CRD Pump Station
Municipal Pump Station
Additional Metering Location
CORE AREA INFLOW AND INFILTRATION PROGRAM
Meter Locations and I & I Management Plan Catchments
FIG. 9.1 LANGFORD CATCHMENTS

9.3 Inflow & Infiltration Data

Historical Data Collection

Prior to 2011, a significant amount of data was collected and consolidated for each of the municipality's long-term monitoring catchments. Much of this is summarized in the I&I Management Plan (2012) which includes:

- I&I data (5-year peak I&I rates; presence of overflows, average flows and peak wet weather flows)
- Catchment size, number of properties, and number of laterals.
- Percentage land use (single family, multi family, commercial, industrial, and institutional)
- Number of manholes and pump stations
- Sewer age and pipe materials.
- Type of flow meter.
- Detailed catchment maps with associated GIS information.
- Catchment "archetype" classifications for each of the municipality's long-term monitoring locations.
    - *For the I&I Management Plan, seven categories of archetypes were developed. The archetypes are delineated based on sewer age and I&I rates. Each archetype contains a typical list of rehabilitation actions needed and a "per meter" budget number to complete the work. The archetypes are designed to be used for high level budget and planning purposes. If investigation work is completed (i.e. CCTV and smoke testing), archetypes should be replaced with specific rehabilitation plans containing specific budgets.*

Current Data Collection

Significant catchment data was collected, analyzed, and/or updated between April 2010 and March 2016. This data is summarized in Table 9.1 and includes:

- Catchment sizes
- Average pipe ages
- Current peak 1-hour I&I rates
- If a catchment has "rapid I&I"
- If a catchment exceeds 4x average dry weather flow
- 5-year 24 hour I&I rate and projected rate at 2031 (based on current precipitation rates)
- Catchment archetype classification and budget estimates based on the current I&I analyses.
- I&I rates for "additional catchments" (i.e. different than the long term monitoring catchments) that have been analyzed since 2012.

Figure 9.2 shows how catchments were classified into archetypes based on average sewer age and I&I rates. This is the same system that was used in the Core Area I&I Management Plan (2012). An overview of the archetype methodology is located in Section 5

Table 9.1: Summary of I&I in Langford by Catchment

I&I Management Plan Catchments	General Info			Inflow & Infiltration							
	Site Code	Size (ha)	Pipe Ave. Age	Peak 1-hr I&I Rate *(l/ha/day)*	5-yr, 24-hr flows compared to ADWF	Rapid I&I? [1]	5-yr, 24-hr I&I Rate [2] (l/ha/day)				
							2010	2012	2014	2016	Archetype
Country	LG4	12	16	18,907	2.7x ADWF	no	9,205	11,126	11,080	11,250	A
Florence Lake	LG12	37	10	7,816	2.8x ADWF	no	10,786	5,998	4,580	8,676	A
Goldie	LG5	67	12	16,176	2.9x ADWF	no	10,786	16,154	16,376	19,657	B
Goldstream	LG13	55	10	24,945	2.1x ADWF	no	5,111	5,111	5,111	2,618	A
Happy Valley	LG6	82	11	10,000	3.0x ADWF	no	19,538	4,924	9,479	11,488	B
Jeanine	LG7	29	13	12,800	2.5x ADWF	no	8,195	7,796	7,501	9,000	A
Meaford [3]	LGALL-A	259	15	11,400	2.7x ADWF	no	8,160	7,646	6,680	~8000	A
Selwyn [3]	LG8A	141	15	22,800	3.3x ADWF	no	14,547	14,589	13,361	14,475	B
Additional Catchments											
Lake End	LG14	11	8	10,000	1.6x ADWF	no	n/a	n/a	n/a	1,698	
Langford Parkway	LG15	18	6	10,000	2.6x ADWF	no	n/a	n/a	n/a	7,143	
Meaford *(Total Metered Area)*	LGALL	714	11	14,376	2.3x ADWF	no	n/a	n/a	n/a	9,703	
Millstream	LG17	8	9	10,000	2.0x ADWF	no	n/a	n/a	n/a	8,289	
Selwyn *(Total Metered Area)*	LG8	208	11	24,464	3.1x ADWF	no	n/a	n/a	n/a	16,113	
Westshore	LG18	37	7	10,000	2.5x ADWF	no	n/a	n/a	n/a	3,288	
Wild Ridge	LG9	20	9	10,000	1.8x ADWF	no	n/a	n/a	n/a	4,439	

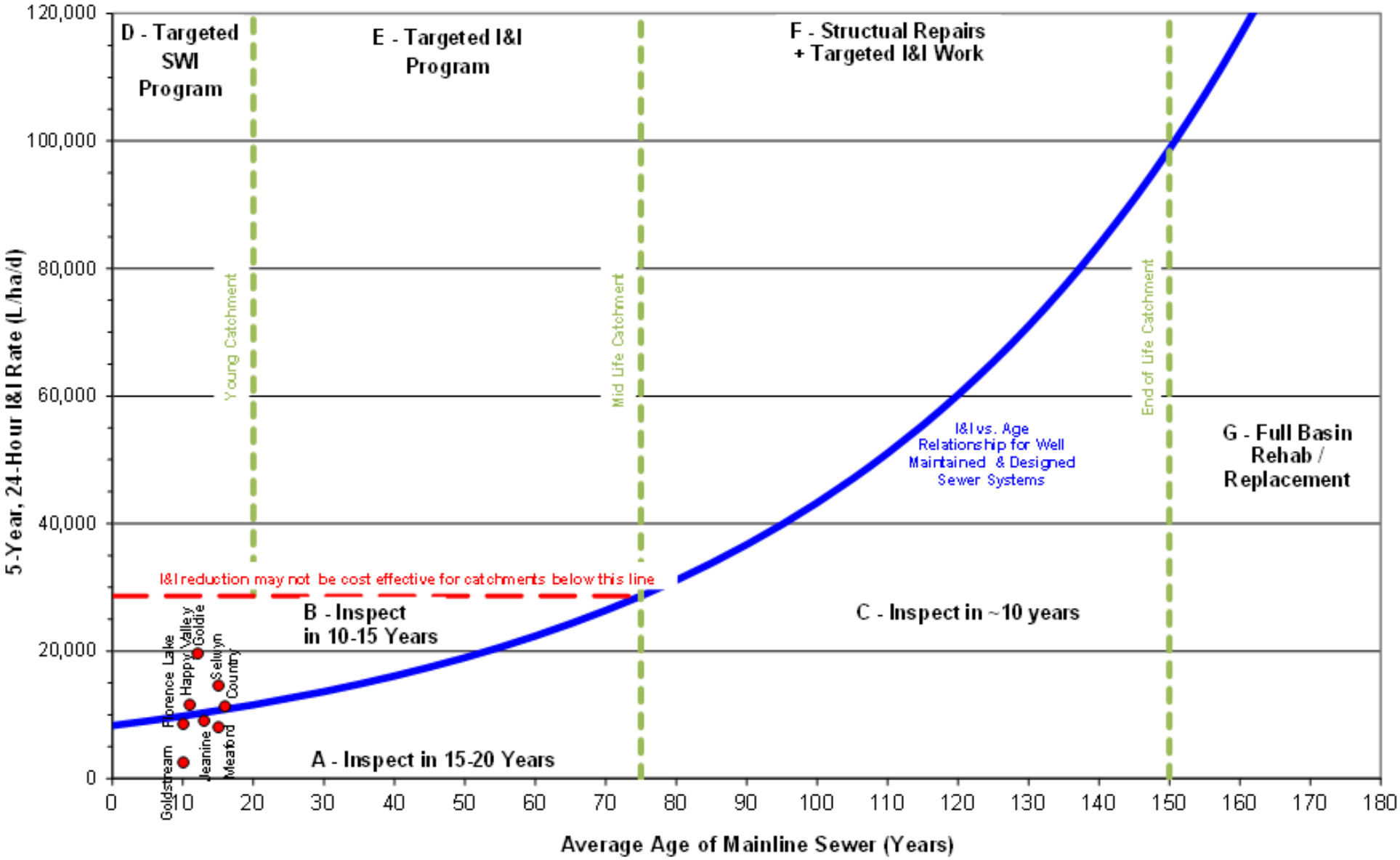
Footnotes:

1 Catchments are considered to have some level of rapid I&I if flows more than doubled during one of two extremely intense 1 hour long dry weather storm events that occurred in 2014. This is documented in the Core Area Inflow & Infiltration Program Annual Report for 2014.

2 Rates up to 2014 were calculated based on the peak 1-hr I&I. The 2016 rate was calculated based on a stand-alone I&I analyses.

3 This catchment does not have its own sewer meter. Its data will always be derived mathematically using data from nearby catchments.

Figure 9.2: Classification of Langford's Sewer Catchments in Archetypes



Analyses

As shown in Table 9.1, each of Langford's catchments is classified in archetype A or B. Table 9.2 summarizes the types of work and budget numbers expected for these archetype. Because of the young sewer age and low I&I rates, minimal additional rehabilitation work is anticipated.

Table 9.2 should be used for planning and budgetary purposes only. It shows typical recommended actions for each archetype divided into three phases.

- Phase 1 actions includes data collection. Langford has permanent ongoing flow meter data for each of its long-term monitoring catchments. Data collection for this phase is considered routine and ongoing.
- Phase 2 actions include investigation work, which can be used to create catchment rehabilitation plans. As Langford doesn't have elevated I&I, the work for this phase includes an ongoing CCTV program.
- Phase 3 actions involve rehabilitation work. As Langford's catchments have low I&I, specific I&I reduction work is not required. However, it's likely that point repairs and other minor maintenance work will be required over time, based on CCTV work and other inspections.

Table 9.2: Projected I&I Related Work Required Based on Catchment Archetype Classification

Archetype	Phase 1: Data Collection	Phase 2: Investigation Work *(percent of catchment)*	Phase 3: Rehabilitation Work *(percent of catchment)*	Component Costs *($/m)*
A	Flow Monitoring (ongoing)	CCTV (15-20 years)	Point Repairs (0.1%)	$16/meter *Plus $5000 for flow monitoring*
B	Flow Monitoring (ongoing)	CCTV (10-15 years)	Point Repairs (0.1%)	$16/meter *Plus $5000 for flow monitoring*

Please note that the archetypal methodology presents a plausible rehabilitation plan for catchments that don't have compete investigation data. It is to be used as a planning tool to guide budgeting and estimate I&I reduction effectiveness. It is intended that the archetype work programs for each catchment will be replaced by targeted I&I reduction programs based on investigative data for catchments with Archetypes D – G or an asset management program.

9.4 Sewer Infrastructure Maintenance & Capital Work

Routine Work

Langford carries out a number of actions related to preventative maintenance and long term asset management of gravity sewers, manholes and appurtenances. Table 9.3 summarizes this work.

Table 9.3: Langford's Preventative Sewer Maintenance Activities

Category	Performed By	Frequency	Notes
Sewer Cleaning (Flushing)	Contractors	Annually	Carried out after CCTV work to focus on areas that need to be cleaned
Manhole Inspections	Contractors	Annually	Inspections recorded and put on file
IC Inspections	Contractors	Annually	Inspections recorded and put on file
Pump Station Maintenance	Staff & Contractors	Weekly inspection	Monthly cleaning and annual maintenance including exercising valves and maintaining air valves
SCADA Monitoring	Staff & Contractors	24/7	Stations are Monitored 24/7 by contractor
CCTV	Contractors	Annually	• 6-7 km per year (of 90 km total) • Prioritized by suspected problem areas • Use WRc coding • CCTV work is done prior to flushing (to determine which areas require cleaning) • Developing a long-term CCTV program
Sewer Relining	Contractors	As required	
Sewer Replacement / Upsizing	Contractors	As required	
Smoke Testing	Contractors	As required	
Dye Testing	Staff & Contractors	As required	Dye testing to determine if property is connected
New Construction	Staff & Contractors		Significant new sewer construction is expected in the coming years

Inspection / Rehabilitation Work (prior to 2017)

Prior to 2012

- Remediation of sewers in the Phelps area was completed in 2005-2006 with the requirement to replace all asbestos cement (AC) sewer mains with poly vinyl chloride (PVC) pipe including replacement of all service laterals up to private property lines. Smoke testing of the general area was completed in 2006 identifying only a few minor issues.
- Rehabilitation of sewer manholes on Millstream south was completed in 2006 and in the Millstream north area in 2009.
- In 2006 rehabilitation of the Leigh Road pump station overflow & valve chambers was completed.
- Approximately 400 inspection chambers (IC's) have been inspected and repaired including installation of concrete boxes for protection. All new IC's are installed with boxes.
- Langford initiated and financed a multi-year sewer system project to improve water quality around all three lakes and other environmentally sensitive areas in the City of Langford to

initiate removal of septic fields. This project started with planning and design of sewer works within the watersheds including approximately 20 kilometers of sewers and four lift stations. This significant undertaking was divided into several discrete projects, and contracted local contractors to undertake the works. The uniqueness of this environmental improvement project lies in the integration between the design teams, City of Langford, contractors and WSES. Value Management workshops were held with the engineers and contractors to find ways to lower costs, improve service and evaluate potential savings through this program. Finally a representative of the Ministry of Environment completed his thesis on nitrogen isotope signatures in zooplankton as water quality indicators in small lakes. The research included the lakes in the City of Langford which showed a strong relationship between the nitrogen signature and the density of septic systems around the lakes.

2012

- Sewer System
  - Received approximately 543 new connections (SFE) to the Langford sewer system
  - Successfully continued with odor control program on Goldstream Avenue
  - 18 individual sewer services constructed
  - Installed approximately 100 m of mainline sewer in cooperation with local developers
  - Began construction of approximately 970 m of mainline sewer under the City's Leigh Road (Spencer) Interchange construction contract.
  - Repaired sewer service to 3364/68 Vision Way after damage by other contractor
  - Completed ROW clearing off Misty Way to Harrier Way to allow access for maintenance

- Inflow and Infiltration Program
  - 137 sewer manholes inspected; 2 sewer manholes repaired
  - Rehabilitated 104 sewer inspection chambers
  - 8.6 km of sewer main CCTV videoed; flushed and cleaned 300m
  - I&I repairs at Leigh Road pump station valve chamber

- Pump Station Upgrade and Maintenance
  - Replaced 5 backflow preventers
  - Replaced main check valve at Country Terrace pump station
  - Upgraded NI Lookout (pump station) SCADA program to V6.6 which runs on Windows 7

2013

- Sewer System
  - Received approximately 235 new connections (SFE) to the Langford sewer system.
  - 13 individual sewer services constructed.
  - Installed approximately 250 m of mainline sewer in cooperation with local developers.
  - Completed construction of approximately 970 m of mainline sewer under the City's Leigh Road (Spencer) Interchange construction contract.
  - Negotiated an agreement with the Latoria Sewer Enterprise Ltd development group and began construction of approximately 1.6 km of mainline sewer, to be completed early 2014.
  - Monitored repair of sewer service to 2317 Millstream after damage by site contractor.
  - Supervised relocation of the Leigh Road pump station sewer forcemain in order to accommodate future extension of the Leigh Road connector to Langford Parkway.
  - Responded to two sewage overflows, each event was handled well and brought under control promptly with no public or environmental risk.

- Inflow and Infiltration Program
  - 86 sewer manholes inspected; 3 sewer manholes repaired.
  - Rehabilitated 71 sewer inspection chambers.
  - 7.3 km of sewer main CCTV videoed; flushed and cleaned approximately 450 m.
  - Repaired cross connection at 1189 Natures Gate in cooperation with the City & original subdivision consultant & contractor.

- Pump Station Upgrade and Maintenance
  - Completed 6 pump rebuilds.
  - Replaced 1 backflow preventer.
  - Constructed new air valve chambers at Peatt Road and Strandlund servicing the Selwyn sewage forcemain.
  - Removed and replaced air valves at Crystalview Drive and Strandlund Road.
  - Removed and replaced faulty flow meter at Florence Lake pump station.
  - Installed new pump impellers at Millstream and Lake End pump stations.
  - Replaced main gate valve at Leigh Road pump station.
  - Installed new pump at Selwyn pump station; existing pump refurbished as spare.
  - Completed NI Lookout (pump station) SCADA program to run on MS Windows 7.

2014

- Sewer System
  - Received approximately 257 new connections (SFE) to the Langford sewer system.
  - Constructed 16 individual sewer services.
  - Continued working with the Latoria Sewer Enterprise Ltd. development group and completed construction of approximately 1.6 km of mainline sewer in April 2014.
  - Removed & replaced sewer service to 201 Flicker after numerous blockages due to improper grading.
  - Responded to one non-I&I related sewage overflow. The event was handled well and brought under control promptly with no public or environmental risk.

- Inflow and Infiltration Program
  - Inspected 42 sewer manholes
  - Repaired 8 sewer manholes
  - Rehabilitated 32 sewer inspection chambers
  - Camera inspected 6.1 km of sewer main
  - Flushed and cleaned approximately 1600 meters of sewer main
  - Constructed a drainage ditch at the Goldie siphon chamber to redirect overland drainage away from the chamber thereby reducing system I&I.

- Pump Station Upgrade and Maintenance
  - Completed 6 pump rebuilds.
  - Replaced 1 backflow preventer.
  - Upgraded the odor control system at Leigh road pump station.
  - Installed new pump impellers at the Goldie (x2) and Goldstream pump stations.
  - Replaced the main gate valve at Selwyn pump station.
  - Purchased a new spare pump for Selwyn pump station and refurbished the existing pumps
  - Began replacement of existing SCADA routers with high security SonicWALL routers at 14 WSES pump station sites. Security issues became apparent with the current residential type routers risking loss of security at pump stations and potential hacking of IP addresses and the SCADA system.

2015

- 420 new connections
- CCTV of 6.5 km of sewer mains
- Flushed 0.7 km of sewer mains
- Inspected 87 sanitary sewer manholes
- Repaired 1 manhole
- Repaired 80 SIC's
- Constructed 18 services
- Completed 1 km of mainline construction

Planned Special Projects (2017 to 2021)

- Leigh Road Pump Station: Corrosion of the wet well chamber is apparent and believed to be a result of the discharge from the SPL facility. WSES & VCMMC completed a condition survey of the internal concrete structure and mechanical components in February 2016 (remedial repairs are being considered this year). The valve chamber at Leigh Road is experiencing settlement and may need to be adjusted, it is currently being monitored. The overflow chamber at Leigh Road, while repaired as part of WSES's required "I and I Works" is once again leaking, it is currently being monitored.
- Goldie Pump Station: Pump upgrade including addition of a standby generator. Pending SMP update which is to consider Bear Mountain's anticipated down-zoning, etc. (Considered with next two years, 2017-2018).
- Selwyn Pump Station: Add piping for third pump. Third pump is currently in stock as a spare (piping upgrade considered this year, 2016). Control kiosk requires replacement when the third pump becomes operational (considered for 2017-2018).
- Country Terrace Pump Station: Replacement of tandem pump sets with single units. The Benshaw soft-starts are of concern and the control kiosk will most likely require replacement. Dependent on completion of the SMP update (considered for 2017-2018).
- Happy Valley Pump Station: Add the third pump as flows continue to increase with development (to be considered 2016-2017).
- The current SCADA system may not be compatible with new versions of the Windows operating system. Also, the Lookout program is no longer supported by National Instruments. WSES is considering upgrading to VTScada and a newer operating system on the SCADA server (planned for 2016-2017).

9.5 Asset Management

Municipal Approach

Langford practices integrated decision making and encourages work discussions between different program areas to find synergies prior to carrying out planned work. This includes triple bottom line (economic/social/environmental) analyses. Work is generally initiated for structural or operational reasons. In some cases, specific I&I reduction work is added to pre-planned work to take advantage of potential synergies (i.e. installing a sewer main when the road is slated for a water main replacement or prior to Langford re-paving a roadway).

WSES and Langford use the following to assist with sewer asset management:

- WSES maintains a GIS system and liaises with Langford staff bi-annually and CRD staff annually with updates and expansions to the system. Current records for customer inquiries, concerns or complaints as well as system repairs, callouts or maintenance orders, etc. are kept in a digital database which is to be added to the GIS in the near future.
- WSES is currently implementing the HACH JOB Cal program, a Computerized Maintenance Management system, in Langford to assist in assuring the pump station and collection system equipment is being properly maintained at the appropriate time. JOB Cal provides a solution for companies or utilities with assets that require scheduled maintenance, preventative maintenance, unscheduled repair, inspection or calibration as part of the life cycle. JOB Cal also provides a means to predefine maintenance intervals for assets as well as specific technicians, qualifications, tools, outside service providers and inventory required to complete the action.
- Langford maintains a Sewer Master Plan (SMP) which is currently being updated to reflect changes in the OCP and further expansion of the sewer system.

- The SMP provides analysis of the existing sewer network to determine the current state of the system, as well as an estimate of the full build-out system based on projected population and development growth. Development of the sewer model includes I&I evaluation, model calibration, future development analysis, evaluation of lift stations and preparation of a summary report which includes recommendations for lift station upgrades, gravity system upgrades and proposed attenuation storage locations and volumes to meet future demands on the system.

- The analysis methodology is reviewed and checked with recent flow monitoring data and the sanitary sewer pipe layout is updated to include new installations and new planning. Updates of proposed future sewer systems are incorporated into the overall sewer model based on discussions with the City of Langford planning staff including build-out population density, ultimate future land uses, and information on current and expected development activity.

- Analysis of gauged flows helps determine inflow and infiltration values which are used in the sewer system review and the updated sewer model. A hybrid of the SANSYS and HYDSYS programs is used to simulate sewage flows throughout Langford for existing and full build-out scenarios for the purposes of assessment and design.

9.6 Bylaws

The CRD and participating municipalities have committed in the Core Area Liquid Waste Management Plan (LWMP) to identify needed changes to legislation and legal authority to enable options and strategies with regard to inflow and infiltration.

The following table provides a comparison of the key powers located in the CRD Sample Private Property I&I Model Bylaw to those found in each of the municipality's existing sewer bylaws. The table demonstrate where existing powers appear to be equivalent between the municipal and model bylaw, and where there may be potential gaps. Suggestions or considerations for addressing the gaps are provided. This task was completed as a policy review, by Pinna, for consideration by municipalities when undertaking changes to their existing sewer use bylaws to assist with compliance with LWMP commitments. The municipal bylaw(s) being assessed in the analyses is Sewer Utility Bylaw No. 1600, 2016 (Consolidated to 20160516).

Table 9.4: Comparing Powers Municipal Bylaw to Sample PPI&I Bylaw

Key section(s) of the sample CRD PPI&I Model Bylaw	Is this section sufficiently addressed in current municipal bylaws and where?	Recommendations
Required maintenance standard (5-6)	Partial 33 – maintain Private Service Pipe in proper condition and free from leakage	The term "leakage" may only refer to contents exiting the pipe, as opposed to entering it; consider strengthening by explicitly being free of "inflow and infiltration", or see standard described in *CRD PPII model bylaw 5(a and b)*
Unauthorized discharges or connections (7)	Yes 34 – cannot connect drain or other works that do not carry sewage to a Private Service Pipe	
Entry and testing by city (8-11)	Yes 39 – Municipal Engineer and employees may enter on owner's land to determine whether the requirements of this Bylaw are being met and to monitor sewage metering equipment on the land	
Required repair of defect (12-14)	Yes 38 – Municipal Engineer may in writing require owner to maintain or repair their Private Service Pipe within the specified time	
Sewer lateral work – permit required (15-16)	Partial 6 – Installation of Private Sewer Pipes must be authorized by permit	Does not explicitly state a permit is required for repair, see *CRD PPII model bylaw 16*
Financial assistance (17-21) and Monetary incentive for voluntary inspection and repairs (22-27)	No	These sections are optional in the sample model bylaw. Municipalities may opt to provide assistance and/or incentives to homeowners who voluntarily conduct inspections and repairs of private sewer laterals (for suggested language, see *CRD PPII model bylaw 17-27*). Also see *CRD PPII model bylaw 35* for no liability statement. To provide financial assistance, the municipality would need to comply with the notice requirements of the Community Charter, section 24. To provide a monetary incentive, the municipality may develop a Council-approved program as an alternative to including these sections in bylaw.
Failure to comply – offence and penalties (28-35)	Yes 40 – Municipal Engineer may enter on the owner's land to perform the work at the cost of the owner 41 – No person shall obstruct an entry made under Section 38 or 39 of this bylaw 42, 43 – Fine up to $10,000; each day	*CRD PPII model bylaw 33(a)* provides a penalty option to discontinue service of water supply to the property as an additional avenue for enforcement of the bylaw.

9.7 Private Property I&I

Along with its bylaw requirements, Langford has the following mechanisms related to private property I&I:

- Requirements for new development (camera testing), including construction inspection and again one year after installation.
- Installation of inspection chambers at every property
- Storm sewer construction requirements

The CRD also carries out private property I&I related work. In general, this work focusses on education, research, program options, bylaw wording, municipal coordination, reporting, stakeholder engagement (i.e. realtors, plumbers) and exchanging info and working with other jurisdictions (i.e. regional districts).

9.8 Budget

Langford's I&I related sewer budget is summarized in Table 9.5.

Table 9.5: Summary of Langford's Sewer Budget

Budget	Value
Total	
Collection System Maintenance	200,000
Pump Station Maintenance	350,000
Annual Capital Works Program	800,000

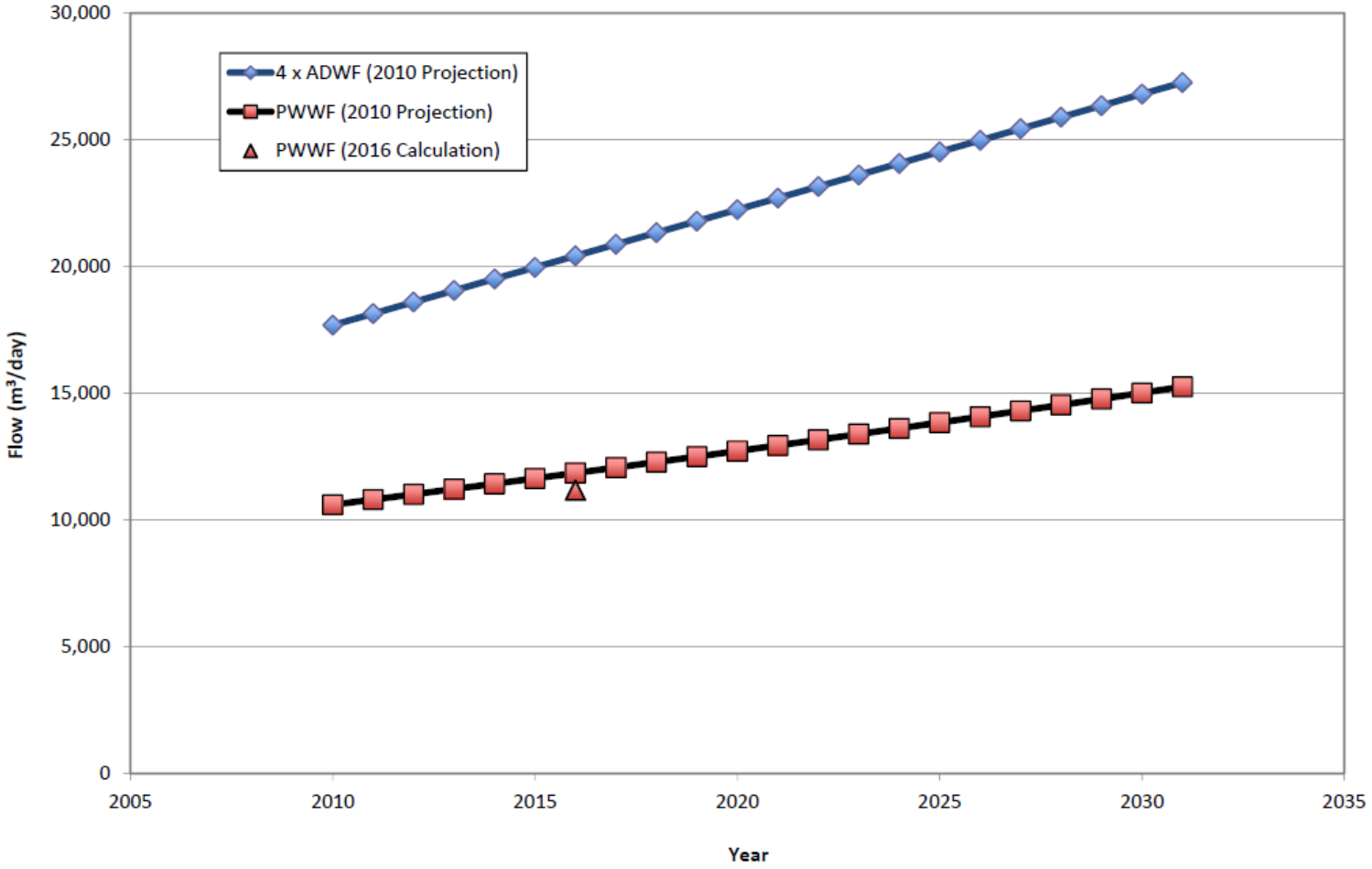
9.9 Langford Summary

Langford has been divided into 8 sewer catchments for this plan. In summary

- None of the catchments contain elevated I&I.
- Peak Wet Weather Flow does not exceed 4x Average Dry Weather Flow in any of Langford's catchments.
- The catchments will be flow monitored and CCTV videoed as part of the plan. Sources of new I&I will be addressed as required.
- The I&I budget for the municipality appears to be sufficient at present.

Figure 9.3 shows the anticipated PWWF and 4xADWF for 2012 to 2031 for Langford as a whole. The blue line on the graph represents 4x ADWF. The 4x ADWF is a threshold which the Liquid Waste Management Plan has identified as a goal for the maximum flow to be conveyed and treated. This line generally increases over time due to population growth; the steeper the slope, the higher the projected growth. Various regional infrastructure including the waste water treatment plants have been sized to accommodate the projected 4x ADWF and this unit of measure is not influenced by wet weather flows. The red line on the graph represents PWWF. The PWWF includes normal sewer flows plus inflow and infiltration. It is the actual sewer flow generated during a peak rain storm event. In order to not exceed the capacity of the sewer system and to prevent overflows, the "red" PWWF line should remain under the "blue" 4x ADWF line. This is one of the primary goals noted in the Core Area Liquid Waste Management Plan.

Figure 9.3: Projected Peak Wet Weather Flow and 4xAverage Dry Weather Flow for Langford



Minimal I&I reduction work is anticipated to be required to keep PWWF below the 4xADWF target until beyond 2031.

10 OAK BAY

10.1 Oak Bay Overview

The District of Oak Bay is a municipality first incorporated in 1906, with a current population of approximately 19,000 residents. It is 1,038 hectares in size and is located along the east coast in the Core Area of the CRD. Oak Bay's first sewers were installed in 1911, but the average age of the sewer system is 67 years. Oak Bay has approximately 98 kilometers of sewer pipe, 59% of which is vitrified clay and 28% asbestos-cement. These sewer pipes service all of the properties in Oak Bay. There are also seven sewer pump stations and 1,280 manholes.

Oak Bay has 7 known overflow locations. The overflows located at pump stations are monitored but the volume of the overflows is not measured. Each of these elevated flows during large storm events in turn overwhelm the Regional sewer system. Oak Bay's overflow procedure includes documenting the events and notifying the Provincial Emergency Program.

The Uplands portion of Oak Bay contains fully combined sewers/manholes. The municipality completed a series of public engagement activities in 2015 and early 2016, all with the aim of progressing on the Uplands Sewer Separation Project. Several of these key activities included open houses that allowed residents to view the 6 proposed options for sewer separation prepared by McElhanney, Oak Bay's engineering consultant. Municipal staff and consultants collected comments via letter and online survey. Other preliminary investigations related to Uplands Sewer separation were also completed in 2015, including a survey of all sewer main elevations and house main floor elevations in the Rutland and Humber catchment areas. As of January 2017, Oak Bay has selected a separation approach and the CRD is now in the process of obtaining approval for this from the Ministry via Amendment 12 to the CALWMP.

Continuous sewer flow monitoring has been conducted at five locations in Oak Bay since 2001. Most of the data is not suitable for I&I analysis because of the occurrence of upstream overflows. An additional 13 temporary metering locations at gravity sewer locations were also monitored in 2015.

Overflows into Bowker Creek have been eliminated for all but the largest storm events since the commissioning of the Trent Street pump station in late 2008. Upstream sewer flows have been diverted away from the Oak Bay portion of the North East Trunk, which results in additional capacity for Oak Bay.

Oak Bay has 7 pump stations. Of these, 5 are monitored using SCADA, 1 has a backup generator with an automatic transfer switch, and 4 have connections for portable generators. All stations have wet wells of various sizes that act as storage tanks. The pump stations and the SCADA system are maintained by municipal personnel. Potential upgrades to the pump stations include connecting the remaining stations to SCADA as funds become available. Oak Bay's storm water drainage system consists of 142 km of storm main which is maintained by Municipal Staff.

Oak Bay contributes to the Core Area I&I Subcommittee and its initiatives. These initiatives include regional I&I reports for the Province such as Biennial I&I Reports and the Overflow Management Plan; annual/semiannual Core Area Inflow and Infiltration Program I&I Analyses Results Reports, and various region wide public education initiatives.

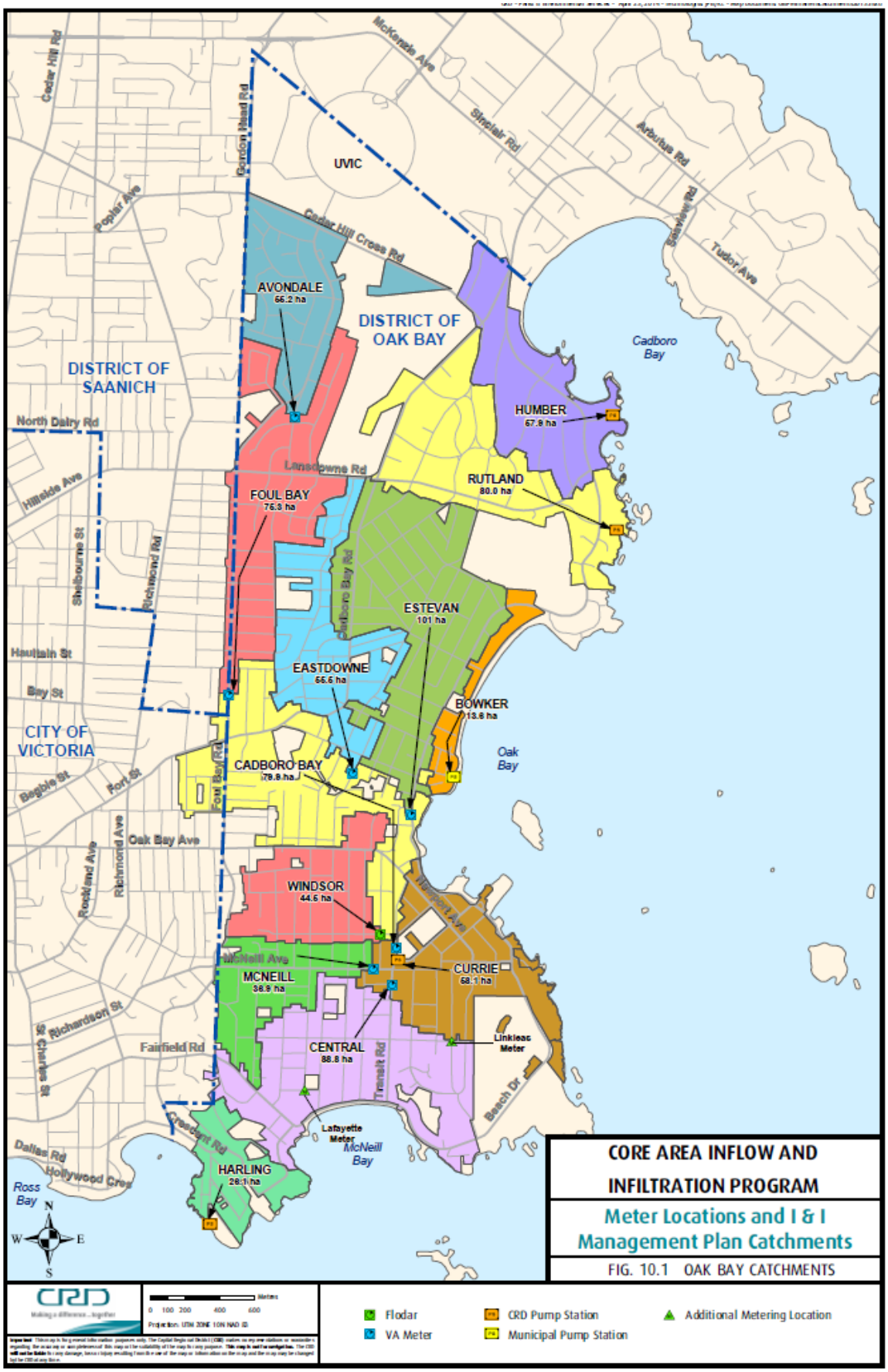
10.2 Catchments

Long-Term Monitoring Catchments

Oak Bay has divided the municipality into 13 long-term flow monitoring catchments. The catchments are all under the recommended 100 hectares in size except for one at 101 hectares. When suitable, existing pump stations were chosen for the metering as they provide consistent reliable long-term flow data at reasonable cost. The remaining locations are periodically monitored with temporary meters. Four of the catchments are monitored permanently using CRD cost sharing flow meters. The remaining catchments will be monitored, with CRD's assistance, using 4 flowmeters purchased by Oak Bay. These flow meters will be rotated, as appropriate, within the remaining 9 catchments. There will be a total of 8 flow meters in use at any one time. Each catchment has a unique site code that enables the tracking and comparison of I&I results for specific flow meter locations over time. The catchments are shown on a map in Figure 10.1 and listed in Table 10.1.

Additional Catchments

Since 2012, an additional 2 catchments have been flow monitored an analyzed for I&I in Oak Bay. The catchments are listed in Table 10.1.



CORE AREA INFLOW AND INFILTRATION PROGRAM

Meter Locations and I & I Management Plan Catchments

FIG. 10.1 OAK BAY CATCHMENTS

10.3 Inflow & Infiltration Data

Historical Data Collection

Prior to 2011, a significant amount of data was collected and consolidated for each of Oak Bay's long-term monitoring catchments. Much of this is summarized in the I&I Management Plan (2012) which includes:

- I&I data (5-year peak I&I rates; presence of overflows, average flows and peak wet weather flows)
- Catchment size, number of properties, and number of laterals.
- Percentage land use (single family, multi family, commercial, industrial, and institutional)
- Number of manholes and pump stations
- Sewer age and pipe materials.
- Type of flow meter.
- Detailed catchment maps with associated GIS information.
- Catchment "archetype" classifications for each of the municipality's long-term monitoring locations.
    - *For the I&I Management Plan, seven categories of archetypes were developed. The archetypes are delineated based on sewer age and I&I rates. Each archetype contains a typical list of rehabilitation actions needed and a "per meter" budget number to complete the work. The archetypes are designed to be used for high level budget and planning purposes. If investigation work is completed (i.e. CCTV and smoke testing), archetypes should be replaced with specific rehabilitation plans containing specific budgets.*

Current Data Collection

Significant catchment data was collected, analyzed, and/or updated between April 2010 and March 2016. This data is summarized in Table 10.1 and includes:

- Catchment sizes
- Average pipe ages
- Current peak 1-hour I&I rates
- If a catchment has "rapid I&I"
- If a catchment exceeds 4x average dry weather flow
- 5-year 24 hour I&I rate and projected rate at 2031 (based on current precipitation rates)
- Catchment archetype classification and budget estimates based on the current I&I analyses.
- I&I rates for "additional catchments" (i.e. different than the long term monitoring catchments) that have been analyzed since 2012.

Figure 10.2 shows how catchments were classified into archetypes based on average sewer age and I&I rates. This is the same system that was used in the Core Area I&I Management Plan (2012). An overview of the archetype methodology is located in Section 5

Table 10.1: Summary of I&I in Oak Bay by Catchment

I&I Management Plan Catchments	General Info			Inflow & Infiltration							
	Site Code	Size (ha)	Pipe Ave. Age	Peak 1-hr I&I Rate *(l/ha/day)*	5-yr, 24-hr flows compared to ADWF	Rapid I&I? [1]	5-yr, 24-hr I&I Rate [2] (l/ha/day)				
							2010	2012	2014	2016	Archetype
Avondale	OB23	55	57	13,824	2.6x ADWF	no	38,690	38,690	38,690	7,291	A
Bowker	OB16	13	48	126,276	12.6x ADWF	yes	48,069	48,069	48,069	64,076	E
Cadboro Bay [3]	OB25	80	70	78,136	~10x ADWF	n/a	28,724	28,724	28,724	56,949	E
Central	OB17	89	78	137,346	10.7x ADWF	yes	107,862	85,539	80,485	74,752	F
Currie [3]	OB18	58	89	118,143	9.9x ADWF	yes	107,862	107,862	98,163	60,278	F
Eastdowne	OB24	56	67	60,557	5.7x ADWF	n/a	28,724	28,724	28,724	44,625	E
Estevan	OB19	101	63	74,532	6.6x ADWF	yes	48,069	52,077	43,676	46,006	E
Foul Bay	OB22		52	102,349	15x ADWF	n/a	38,690	38,690	38,690	55,525	E
Harling	OB14	26	72	112,883	19x ADWF	yes	109,621	61,616	67,486	65,441	E
Humber [4]	OB20	58	82	~860,000	>20x ADWF	yes	504,138	504,138	504,138	~500,000	F
McNeill	OB3	37	91	169,909	12.2x ADWF	yes	107,862	104,857	99,567	90,732	F
Rutland [4]	OB21	80	84	~520,000	>20x ADWF	yes	304,828	304,828	304,828	~300,000	F
Windsor	OB4	45	88	105,377	9.9x ADWF	yes	109,621	64,493	61,751	70,697	F
Additional Catchments											
Windsor Flodar (CRD)	OB15	324	62	78,135.90	12x ADWF	yes	n/a	n/a	n/a	60,278	
Currie Minor PS	OB26	184	---	118,142.60	13.2x ADWF	yes	n/a	n/a	n/a	55,707	
Foul Bay	OB22	130		64,982.30	9.4x ADWF	n/a	n/a	n/a	n/a	35,165	
Sandowne	OB27	5.6	---	87,942	4.2x ADWF	n/a	n/a	n/a	n/a	41,429	

Footnotes:

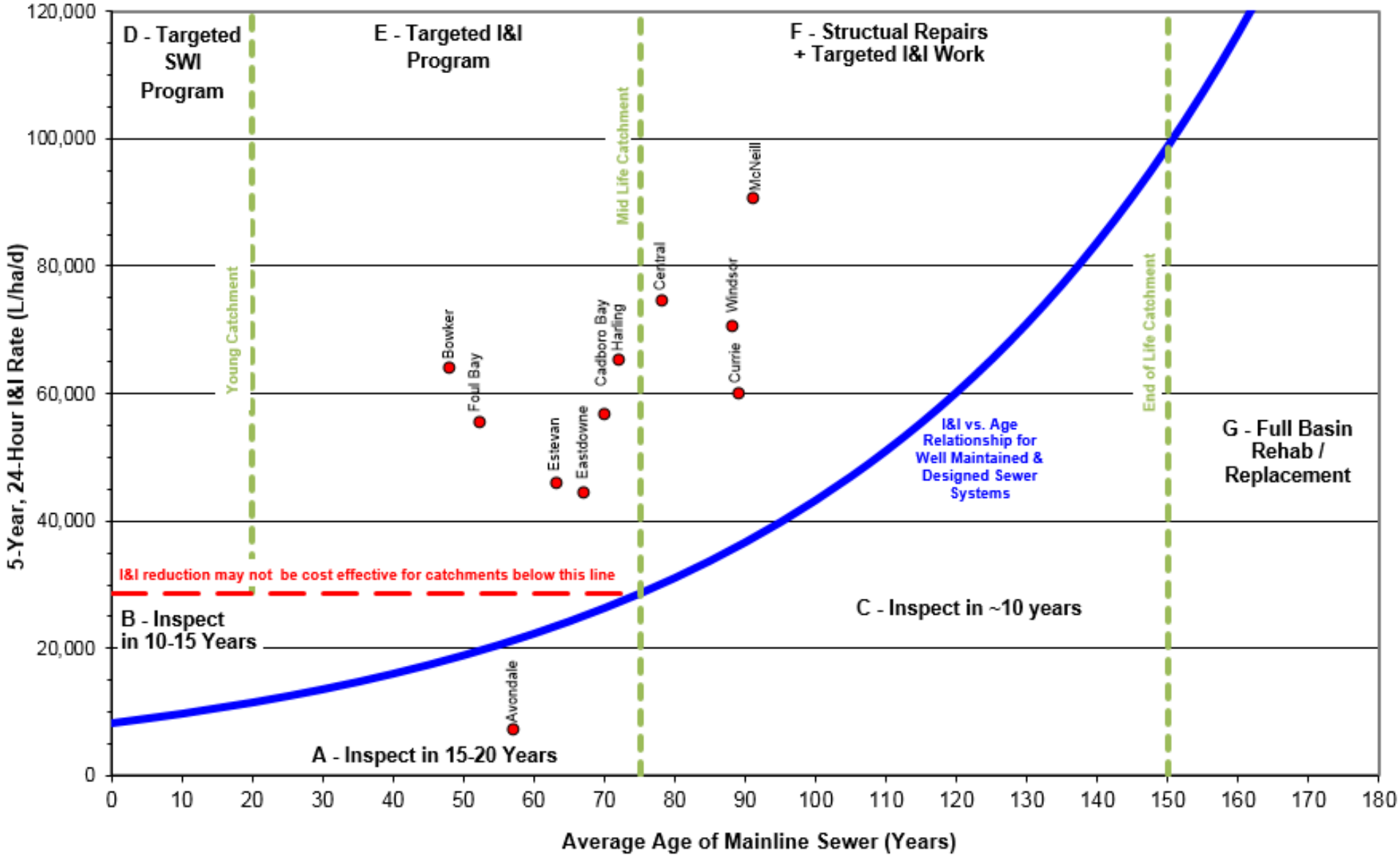
1 Catchments are considered to have some level of rapid I&I if flows more than doubled during one of two extremely intense 1 hour long dry weather storm events that occurred in 2014. This is documented in the Core Area Inflow & Infiltration Program Annual Report for 2014.

2 Rates up to 2014 were calculated based on the peak 1-hr I&I. The 2016 rate was calculated based on a stand-alone I&I analyses.

3 This catchment does not have its own sewer meter. Its data will always be derived mathematically using data from nearby catchments.

4 This catchment contains combined sewers.

Figure 10.2: Classification of Oak Bay's Sewer Catchments in Archetypes



Flow Data Analyses

Oak Bay has aging sewers and elevated I&I rates throughout the municipality. In 12 of 13 of the flow monitoring catchments, I&I rates exceed 4x average dry weather flows during large storm events. In addition, each of the 12 catchments have "rapid infiltration", where flows more than doubled during intense 1-hr long dry weather storm events). These metrics indicate that Oak Bay has significant I&I challenges throughout the municipality.

Oak Bay's biggest I&I related issue has to do with the fully combined sewers in the Humber and Rutland catchments in an area known as the Uplands. Over the last number of years, this is where Oak Bay has been focusing its I&I reduction resources.

As shown in Table 10.1, 12 of Oak Bay's 13 municipal catchments are classified in archetypes E or F. Table 10.2 describes these archetypes. The archetypes should be used for planning and budgetary purposes as they show typical recommended actions for each archetype divided into three phases.

- Phase 1 actions includes data collection. Oak Bay has already collected a first round of flow meter data for each of its long-term monitoring catchments. Some of the catchments use long-term ongoing data and the rest are based on data from temporary flow meters. Data collection for this phase is considered routine and ongoing.
- Phase 2 actions include investigation work, which can be used to create catchment rehabilitation plans. Oak Bay has significant investigation data for the Uplands separation work. Oak Bay has very little coded CCTV or smoke testing data for the rest of the municipality.
- Phase 3 actions involve rehabilitation work. Oak Bay is currently working on plans for separating sewers in the Uplands. As Oak Bay does not have significant I&I investigation data for the rest of the municipality, it does not have any significant I&I reduction plans for this area.

Table 10.2: Projected I&I Related Work Required Based on Catchment Archetype Classification

Archetype	Phase 1: Data Collection	Phase 2: Investigation Work *(percent of catchment)*	Phase 3: Rehabilitation Work *(percent of catchment)*	Component Costs *($/m)*
E	Flow Monitoring (ongoing)	CCTV: 100 Program Development Condition Assessment Smoke Testing: 100 Dye Testing: 20	Point Repairs: 0.1% Pipe Grouting: 100% Pipe Relining: 5% Pipe Replacement: 1% Lateral Relining: 40% Lateral Pipe Bursting: 20% Lateral Grouting: 100%	$300 – 540 / meter *Plus $5000 for flow monitoring*
F	Flow Monitoring (ongoing)	CCTV: 100 Condition Assessment Smoke Testing: 100 Dye Testing: 20	Pipe Relining: 20% Pipe Bursting: 5% Manhole Rehab: 10% Manhole Replacement: 5% Point Repairs: 0.5% Pipe Replacement: 1% Lateral Relining: 40% Lateral Pipe Bursting: 20% Lateral Grouting: 100% Storm Sewer Improvements: 5%	$1,300 – $1,500 / m

Please note that the archetypal methodology presents a plausible rehabilitation plan for catchments that don't have compete investigation data. It is to be used as a planning tool to guide budgeting and estimate I&I reduction effectiveness. It is intended that the archetype work programs for each catchment will be replaced by targeted I&I reduction programs based on investigative data for catchments with Archetypes D – G or an asset management program.

At its current rate, Oak Bay will not reduce its flows below 4x ADWF by 2031 and it's I&I rates will remain largely unchanged.

10.4 Sewer Infrastructure Maintenance & Capital Work

Routine Work

Oak Bay carries out a number of actions related to preventative maintenance and long term asset management of gravity sewers, manholes and appurtenances. Table 10.3 summarizes this work.

Table 10.3: Oak Bay's Preventative Sewer Maintenance Activities

Category	Performed By	Frequency	Notes (include routine work and planned)
Sewer Cleaning (Flushing)	Public Works	Ongoing	An annual flushing program is completed by Public Works.
Manhole Inspections	Public Works	Ongoing	New manholes are installed where access for other maintenance is required.
Pump Station Maintenance	Public Works	Ongoing	
SCADA Monitoring	Public Works	Ongoing	
CCTV	Engineering\ Public Works	Ongoing	Oak Bay routinely collects CCTV data for operational purposes but the videos are not coded. As of 2015, a CCTV program was implemented (5 year Sewer/10 year Storm). Data has been collected and reviewed by Oak Bay's consultant. Replacement/Rehabilitation of sewer pipes has been prioritized. Oak Bay will use this list to plan for future capital work projects
Sewer Relining	Contractors	Occasional	In 2016, Oak Bay implemented an annual sewer lining program similar to their CCTV program.
Sewer replacement / upsizing	Public Works	Occasional	Plans for sewer and storm modelling will assist in determining which existing pipes need to be upgraded, or which pipes need to be upgraded as a result of new large development/subdivisions.
Smoke Testing	Contractors	Occasional	
Dye Testing	Engineering\ Public Works	Ongoing	The number of dye tests completed has increased in recent years due, in part, to an increase in new construction (as old houses demolished), as well as major renovations and proactive municipal policies; no plumbing permits are issued until dye tests confirm appropriate connections. Coordinated efforts between the Municipality's building department, engineering services, and public works have had a positive impact.

Oak Bay carried out I&I investigation work, such as camera inspections (CCTV) and dye testing, to help prioritize Oak Bay's Capital Works Projects for future years. In addition, spot repairs are undertaken on sewer and storm mains when broken pipes identified during the camera inspections.

Oak Bay periodically installs new storm mains where no previous storm mains existed.

Many of Oak Bay sewer repair/replacement plans are based on CCTV inspections and municipal experience and knowledge of the areas. Sanitary Sewer improvements/renewal programs are based on structural failure. Drainage renewal is based on structural failure/condition and hydraulic capacity. New development master plans and/or proposed subdivisions tend to trigger the upsizing of pipes or extensions. Trenchless technology is preferred when rehabilitating sewer mains.

Public Works have a flushing and root cutting program in place. As lines are serviced a manual log is taken and provided to the Engineering department. Records are kept in the Public works yard. Public Works also has a program to increase the size of manhole covers through-out the municipality to improve access by maintenance crews.
Records on inspection and maintenance are kept by Public Works staff in field books. Labour time and materials are entered into the applicable accounts of the finance software for the work completed.

All new sewer systems are inspected during installation. Pipes are pressure tested, flushed and are inspected using CCTV cameras.

Notable Work Completed (prior to 2017)

2002 – 2011

- I&I reduction test areas in South Oak Bay.
- Lining the sanitary sewer and installation of a storm main under the recreation centre tennis bubble.
- Oak Bay Beach Hotel construction: For a large development, storm water is being treated and released to the ocean. All sewage from the hotel will be going into a designated pressure system which will eliminate infiltration. This design came about due to the limited capacity of the existing sewers in the vicinity.

2012

Sanitary Sewer

- Sewer Main Replacement : 135m
- Sewer Manholes Replacement: 4
- New Sewer Inspection Chambers: 29
- New/Replaced sewer laterals: 29
- South Oak Bay I & I Study ongoing: 13 Sewer laterals televised
- Combined systems separated into one sewer and one storm lateral: 7
- Combined systems separated into one sewer pipe and a storm management system: 3
- Sewer dye tests: 7
- TV Sewer inspections: 4226.8m
- SS Scada installation :1
- SS Pump Station upgrade: 1
- Various sewer main spot repairs –discovered while televising
- Sewer main Flushing: 54,985m

Storm Sewer

- New/Replaced Storm mains: 928m
- New Storm Manholes: 10
- New Storm Inspection Chambers: 21
- New/Replaced storm laterals: 21
- Storm Dye Tests: 40
- TV Storm Inspections: 3853.51m

- Various storm main spot repairs – discovered while televising
- Storm main flushing: 32 689m

2013

Sanitary Sewer

- Sewer Main Conventional Replacement: 118m
- Sewer Main Relining: 285.6m
- Sewer Manholes Replacement : 4 (Hewlett, Byng, Runnymede, Maquinna)
- Separated Combined manholes into Sewer Manholes:3 (Hewlett)
- New Sewer Inspection Chambers: 28
- New/Replaced sewer laterals: 28
- Combined systems separated into individual sewer and storm laterals: 10
- Combined systems separated into one sewer pipe and a storm management system: 3
- Sewer lateral dye tests: 2
- TV Sewer inspections: 3199 m
- Various sewer main spot repairs –Brighton easement, Henderson
- Sewer main Flushing: 41,574m
- Three combined sewer manholes were separated via a subdivision development.
- Oak Bay installed four flow meters in its I&I Management Plan catchments. Oak Bay's consulting engineers have been monitoring these meters and agree with the CRD that sufficient data has been collected from the current catchments.

Storm Sewer

- Storm main conventional replacement: 637.7m
- Storm main Relining: 138.2m
- New Storm Manholes:14 (Greatford, Dalhousie, Musgrave, Central, Newport, Larkdowne, Hall)
- New catch basins: 3
- Separated Combined manholes into Storm Manholes: 3
- New Storm Inspection Chambers:33
- New/Replaced storm laterals: 33
- Storm lateral Dye Tests: 56
- Storm Main dye tests:2
- Installation of a new pump and outfall at the St Patrick Storm station
- TV Storm Inspections: 2196.4m
- Various storm main spot repairs – Kings , Linkleas , Byng, Dalhousie
- Storm main flushing: 34,198m

2014

Sanitary Sewers

- 49 new sewer inspection chambers
- 3 new or replaced sewer laterals
- 41 replaced sewer laterals using PVC (in conjunction with replacing storm laterals in the same trench with PVC)
- 23 existing combined systems were separated into individual sewer and storm laterals each with new PVC pipe
- 1 combined system was separated into one sewer pipe and a storm management system (Nottingham)
- 214 meters of CCTV sewer inspections.
- 14.7 kilometers of sewer main flushing
- Oak Bay's existing sewer videos were sent to a consultant to add "pseudo defect coding." For years, Oak Bay staff has camera inspected Oak Bay's sewers for internal use.

However, the data wasn't coded and the videos weren't collected in accordance with common industry standards.

Storm Sewer

- 688 meters of storm main replacement
- Installation of new storm mains where no storm mains existed (19m of 150mm @Esplanade, 22m of 250mm pipe at Maquinna, 22.7m of 150mm on Dufferin land)
- 18 new stormwater manholes (Musgrave, Thompson, Hampshire, Esplanade, Dufferin and 5 as part of a Public Works Program).
- 62 new storm inspection chambers
- 8 new / replaced storm laterals
- 41 replaced storm laterals in PVC (in conjunction with replacing sewer laterals in the same trench with PVC)
- 23 existing combined systems separated into individual sewer and storm laterals each with new PVC pipe
- 78 storm lateral dye tests (discovered 26 cross connections, of which 17 were repaired)
- 2 storm main dye tests
- 1480 meters of storm sewer camera inspections.
- 6180 meters of storm main flushing
- 2 approvals of rain gardens with overflow into storm main (Clive apartments, Monterey)
- 1 approval of rain gardens with overflow into Bowker Creek (Oak Bay High School)

2015

Sanitary Sewer

- Used trenchless technology to line a total of 500m Sanitary Sewer main :
  - 56m of 200mm dia pipe @ Windsor /Goodwin
  - 96.5m of 200mm dia pipe @ easement between Brighton & Granite
  - 75m of 200mm pipe @ Dover (SS leaking into SD main)
  - 192m of 200mm pipe @ Henderson (storm was infiltrating into sewer main)
- As part of the preliminary investigation for Uplands Sewer separation
  - Survey of all sewer main elevations and house(main floor elevations) in the Rutland Catchment area completed
  - Survey of all sewer main elevations and house(main floor elevations) in the Humber Catchment area completed
- 59 new sewer inspection chambers
- 37 new sewer lateral installations
- 22 Existing combined/leaky sewer systems were separated and/or replaced with new 100mm pvc pipe for both sewer and storm laterals
- Implemented a 5 year Sewer and 10 year Storm televising program. Contractor completed approximately 19,272m of Sanitary sewer CCTV work
- Contractor cleaned approximately 19,272m of Sanitary sewer pipes
- Other televising (not CCTV) +/- 100m
- 14 kilometers of sewer main flushing
- A consultant completed Oak Bay's Sewer Flow Monitoring program in 2016. A report is expected summarizing their findings from the last several years of monitoring. Note: There was a total of 8 flow meters in use at any one time. Four permanent flow meters were located at Rutland, Humber, Harling, and Bowker. In 2014/2015, temporary meters were at Estevan Central, Windsor and McNeill. These rotated to Avondale, Foul Bay Road, Sandowne and Eastdowne in 2015/2016. The consultant will work with the CRD to determine if future monitoring will still be required.

Storm Sewer

- 187m of 200mm diameter storm main conventional replacement on Dufferin
- 256m of 200mm diameter storm main conventional replacement on Thompson
- 90m of 200mm diameter storm main through easement was replaced by the contractor as part of the Fair St subdivision
- Lined 40m of 200 diameter storm pipe using trenchless technology (was leaking into sanitary sewer main) on Inglewood Terrace
- Implemented a 5 year Sewer and 10 year Storm televising program. Contractor completed approximately 3416.2m of storm main CCTV work
- Contractor flushed/cleaned approximately 3416.2m of storm main
- Public Works flushed 6000m
- 133 storm lateral dye tests (32 cross connections confirmed)
- 13 new and/or replaced catch basins
- 69 new storm inspection chambers
- 87 replaced/new storm laterals
- 20 new/replaced storm manholes
- 3 storm management system were installed at 2120 Marne , 2773 Somass and 628 Transit (overflows were into ocean or the storm mains)
- Crews fixed a leaky storm drain that had water escaping and going down the retaining wall at 105 King George Terrace.
- Replaced section of leaky storm pipe on Dufferin Storm main (South side, from Musgrave to #2569 Dufferin)

Planned Special Projects (2016 – 2021)

- Implement Storm Water Modelling
- Implement Sanitary Sewer Modelling
- Continue Trenchless Technology Program started in 2016, continuing on an annual basis.
- Create Subdivision and DCC Bylaw in order to potentially fund sewer/storm main improvements and minimize I & I
- New stormwater management program may require developments/subdivision could require onsite stormwater flow mitigation measures
- Possible Storm Utilities considerations
- Boulevard Rain Gardens considerations
- Continue with CCTV 5 year Sewer and 10 year Storm CCTV program
- In fall of 2016, Oak Bay Municipal Council approved a plan for the separation of the combined sewers in the Uplands area. The plan will involve building a new storm sewer for the area.

10.5 Asset Management

Oak Bay uses the following tools and techniques to help with its asset management approach:

- GIS
- TV inspection camera/push camera
- Contract out CCTV for Sewer and Storm pipes
- Public Works field knowledge during the flushing/cleaning lines and flooding reports from homeowners
- Dye testing mains (check if storm mains leak into sewer mains and vice versa)

10.6 Bylaws

The CRD and participating municipalities have committed in the Core Area Liquid Waste Management Plan (LWMP) to identify needed changes to legislation and legal authority to enable options and strategies with regard to inflow and infiltration.

The following table provides a comparison of the key powers located in the CRD Sample Private Property I&I Model Bylaw to those found in each of the municipality's existing sewer bylaws. The table demonstrate where existing powers appear to be equivalent between the municipal and model bylaw, and where there may be potential gaps. Suggestions or considerations for addressing the gaps are provided. This task was completed as a policy review, by Pinna, for consideration by municipalities when undertaking changes to their existing sewer use bylaws to assist with compliance with LWMP commitments. The municipal bylaw(s) being assessed in the analyses is Bylaw No. 3891: Public Sewer Bylaw, 1996.

Table 10.4: Comparing Powers Municipal Bylaw to Sample PPI&I Bylaw

Key section(s) of the sample CRD PPI&I Model Bylaw	Is this section sufficiently addressed in current municipal bylaws and where?	Recommendations
Required maintenance standard (5-6)	No	Oak Bay Public Sewer Bylaw 7(1) – clarifies the owner is responsible for all costs of servicing the private sewer, but does not state the required maintenance standard; recommend strengthening (see *CRD PPII model bylaw 5-6*)
Unauthorized discharges or connections (7)	Yes 9 (1) – No storm water discharge into sanitary sewer 14 (4) – No connection of storm sewer lateral or combined lateral to sanitary sewer	
Entry and testing by city (8-11)	Yes 16 – Engineer may enter on any property that is subject to this Bylaw to ascertain compliance	
Required repair of defect (12-14)	No	See *CRD PPII model bylaw 12-14*
Sewer lateral work – permit required (15-16)	No	See *CRD PPII model bylaw 16*
Financial assistance (17-21) and Monetary incentive for voluntary inspection and repairs (22-27)	No	These sections are optional in the sample model bylaw. Municipalities may opt to provide assistance and/or incentives to homeowners who voluntarily conduct inspections and repairs of private sewer laterals (for suggested language, see *CRD PPII model bylaw 17-27*). Also see *CRD PPII model bylaw 35* for no liability statement. To provide financial assistance, the municipality would need to comply with the notice requirements of the Community Charter, section 24. To provide a monetary incentive, the municipality may develop a Council-approved program as an alternative to including these sections in bylaw.

Failure to comply – offence and penalties (28-35)	Yes 15 – If work must be done in default of it being done by the owner, costs may be recovered by Council 17 – Any contravention of bylaw is offence and may receive a fine between $200 and $2,000 per offence (each day) 18 (1) – Shall not hinder or prevent Engineer from entering premises to administer the bylaw	*CRD PPII model bylaw 33(a)* provides a penalty option to discontinue service of water supply to the property as an additional avenue for enforcement of the bylaw.

10.7 Private Property I&I

Along with its bylaw requirements, Oak Bay has the following mechanisms related to private property I&I:

- With demolition of an old house for new building construction, prior to the contractor capping the old sewer services at property line, Public Works will sonde the old sewer lateral and mark where the connection is at the main on the street. Homeowners are then given the option to reconnect a new PVC sewer lateral at the same location at the main or to relocate the sewer lateral. If the homeowner chooses to relocate the sewer then they are charged a capping fee and Public Works cap the old sewer connection at the main. This prevents ground water from infiltrating the old sewer lateral and entering into the main.

- Beginning in 2013, Oak Bay's Engineering Services & Building Departments implemented a dye testing program that will assist in eliminating combined systems. Typically, while most house files have information on a building's sewer location there are minimal records on the storm lateral location. When contractors apply for permits for storm or sewer work on private property, the municipality will undertake dye tests on properties where no storm drain information exists. These dye tests are conducted prior to the building department issuing the plumbing permits and come with no additional fees. With dye testing, contractors will provide better estimates to the homeowner thereby reducing unexpected costs to the homeowner if separation of the storm water from the sewer is deemed necessary.

- With new construction where a municipal sewer is located within a municipal easement, the developer must televise the sewer before and after construction and submit footage to Oak Bay for review. If the sewer is damaged as a result of the construction the developer is charged for the repairs by municipal crews.

- With new house construction, new development or subdivisions, the engineering department requests that developers incorporate into their design Rain Gardens or Storm Water Management systems with overflows into the municipal storm main. This would assist in mitigating storm flows during heavy rain events.

- All new sewer and storm service installations include Inspection chambers at the property line. This assists in cross connection investigations via dye testing because effluent is visible from the top of the chamber. In addition, this allows plumber and Public Works access for televising/investigating the laterals.

- When the building department receives applications for plumbing permits or plans showing additions or significant construction, dye tests are undertaken prior to permits issued to confirm

no cross connections/combined systems exist(with the exception of Uplands). If a cross connection has been determined, then owner/developer is required to replace both sewer and storm.

- With any new subdivisions, where only a sewer main is available, the developer is required to install a storm main as needed.

- Outside the Uplands, where only a sanitary sewer exists on the Municipal Right of way, residential houses on a combined system who are required to separate the sewer as a result of new construction or repairs to their sewer system, can install a storm water management system. This system must be designed by an engineer and all engineering parameters should be considered (i.e. soil imperviousness, lot size etc.)

- With any Sewer and Storm Capital Works projects, the engineering department reviews possible new storm main installations where none exist. As such, our bylaws allow the municipality to provide a free storm lateral to a property which is on a combined system. The homeowner is given a year to separate their storm system on their property and connect to this new lateral. This has not yet been enforced.

- During main replacements, Oak Bay encourages homeowners to replace their lateral to the new main with 50% reduction in the bylaw fee. Oak Bay also offers a discounted bylaw fee

- Cost savings to the homeowner if both sewer and storm lateral are in the same trench are replaced at the same time.

The CRD also carries out private property I&I related work. In general, this work focusses on education, research, program options, bylaw wording, municipal coordination, reporting, stakeholder engagement (i.e. realtors, plumbers) and exchanging info and working with other jurisdictions (i.e. regional districts).

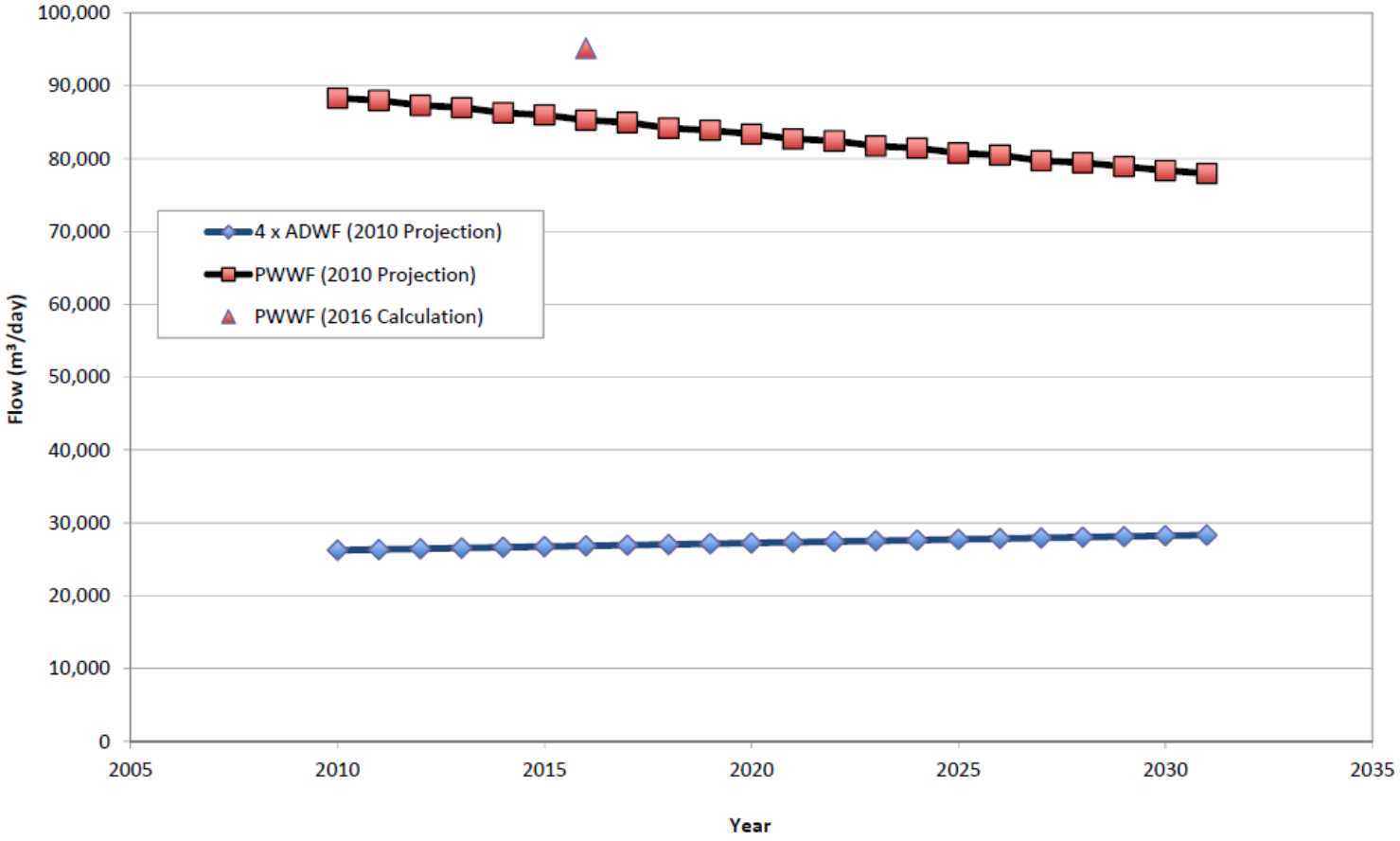
10.8 Oak Bay Summary

Oak Bay has been divided into 13 sewer catchments for this plan. In summary:

- Twelve of thirteen catchments have elevated I&I and are classified archetypes E or F.
- Peak Wet Weather Flow exceeds 4x Average Dry Weather Flow in 12 of Oak Bay's catchments that have flow data.
- The current trends indicate that the District is not likely to reduce its flows below 4xADWF by 2031. The District's current plans to implement I&I reduction projects have potential. However, without delivering on the combined sewer separation project in the Uplands and the planned increases in sewer rehabilitation projects, it is unlikely that Oak Bay's I&I rates will change significantly.

Figure 10.3 shows the anticipated PWWF and 4xADWF for 2012 to 2031 for Oak Bay as a whole. The blue line on the graph represents 4x ADWF. The 4x ADWF is a threshold which the Liquid Waste Management Plan has identified as a goal for the maximum flow to be conveyed and treated. This line generally increases over time due to population growth; the steeper the slope, the higher the projected growth. Various regional infrastructure including the waste water treatment plants have been sized to accommodate the projected 4x ADWF and this unit of measure is not influenced by wet weather flows. The red line on the graph represents PWWF. The PWWF includes normal sewer flows plus inflow and infiltration. It is the actual sewer flow generated during a peak rain storm event. In order to not exceed the capacity of the sewer system and to prevent overflows, the "red" PWWF line should remain under the "blue" 4x ADWF line. This is one of the primary goals noted in the Core Area Liquid Waste Management Plan.

Figure 10.3: Projected Peak Wet Weather Flow and 4x Average Dry Weather Flow for Oak Bay



Note: the majority of Oak Bay's PWWF reduction will result from combined sewer separation in Humber and Rutland.

11 SAANICH

11.1 Saanich Overview

The District of Saanich is located in the Core Area of the CRD and was incorporated in 1906. It is approximately 10,700 hectares in size and has a population of approximately 110,000 residents. Saanich is a combination of rural and urban areas. Many of the residents of the rural areas use on-site disposal systems for sewage disposal. The municipal sewer system services approximately 70% of all properties in Saanich and about 100% of the properties within the "urban containment boundary".
The first sewers in Saanich were installed in 1950, with most of the sewer system expansion taking place in the 1960's and 1970's. The average age of the sewer system is 42 years. In total, there are approximately 554 kilometers of sewer main and approximately 6200 manholes in Saanich. Of the total length of sewer in Saanich; about 56% is asbestos concrete and 35% is PVC. There are also 40 sewer pump stations.

Saanich has 28 pump station overflow locations, no combined manholes and no combined sewers. The pump stations are monitored for overflow events but the volumes of the overflows are not measured. Saanich doesn't currently have I&I related overflows. If overflows were to occur, Saanich crews would respond, document, and report the incident to Emergency Management BC through the Provincial Emergency Program.
Saanich has 40 pump stations. Each of the pump stations is monitored using SCADA, 24 have backup power, none of the pump stations have connections for portable generators, and none have storage tanks. The pump stations and SCADA system are maintained by Saanich crews. Saanich is planning to program the SCADA system to generate sewer flow data from the pump stations.
Saanich's stormwater drainage system consists of watercourses, drains, ditches, swales, ponds and rain gardens. In rural areas, an open drainage system of ditches and watercourses are used and promoted by policies in the Official Community Plan. In the urban areas, enclosed systems are used, although significant areas are still served by open ditch drainage systems. The drainage system is maintained by Saanich crews.
Saanich has adopted the general approach to I&I outlined in this plan. The first level of response is to monitor I&I rates to identify trends and problem areas that may be developing. Once a problem area is identified, Saanich would investigate the problem area in greater detail to identify the problem and the last stage would be to develop and implement a solution to the problem identified.
Since 2001, sewer flow monitoring has been carried out continuously at eight permanent locations and temporarily (for one to two seasons) at three Saanich pump stations and at 11 gravity sewer locations. Monitoring has shown that Saanich's I&I rate is low and does not impact Saanich's municipal sewers or the regional sewer system. In addition, Saanich does not have a large history of sewer overflows.

Saanich focuses its I&I related work on flow monitoring, preventative sewer maintenance and system renewal. This includes the periodic upgrading of pump stations, the repair or replacement of sewer mains, CCTV sewer inspections, "no-corrode" sewer service replacement, and manhole inspections. ("No-corrode" pipes is an inexpensive tar-coated cardboard pipe that was used in the initial post World War 2 era.) The work is carried out by public works staff within existing operational budgets.

Saanich's I&I related work is funded through its Capital Works and Operations Budgets. The Capital Works budgets are used to fund planned rehabilitation or replacements. The Operations budgets are used to fund maintenance and repairs. Operating capital for operations and maintenance work is also controlled by the engineering department.

The primary assessment tool is CCTV. Consideration is given to the criticality of system components and coordination of replacement with adjacent utilities or infrastructure.
Saanich contributes to the Core Area I&I Subcommittee and its initiatives. These include: regional I&I reports for the Province such as Biennial I&I Reports and the Overflow Management Plan; annual/semiannual Core Area Inflow and Infiltration Program I&I Analyses Results Reports, and various region wide public education initiatives.

11.2 Catchments

Long-Term Monitoring Catchments

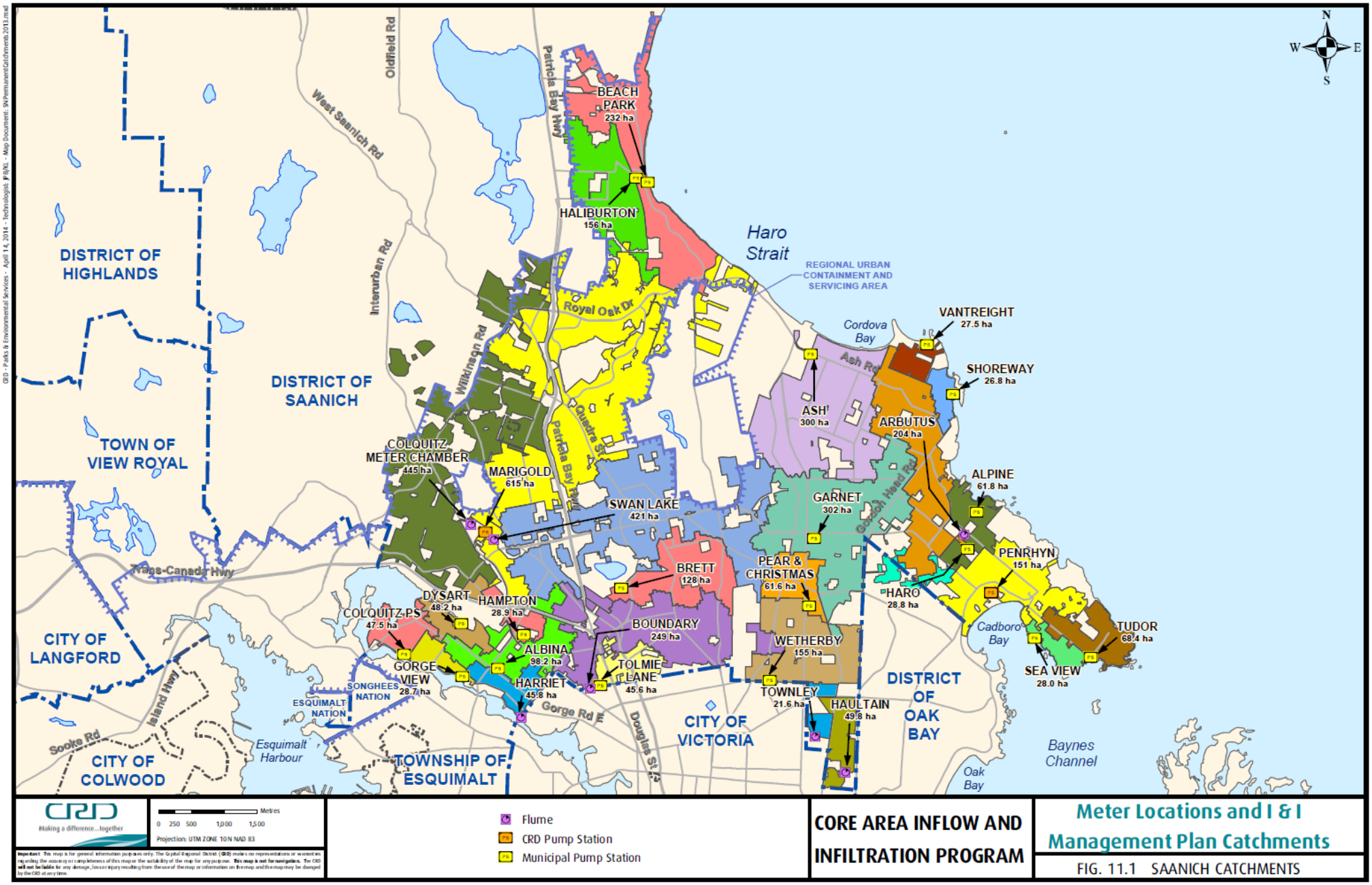
Saanich's sewer system is divided into 28 long-term flow monitoring catchments. The catchments were chosen based on existing pump stations and permanent flow monitoring stations. Each catchment has a unique site code that enables the tracking and comparison of I&I results for specific flow meter locations over time. The catchments are shown on a map in Figure 11.1 and listed in Table 11.1.

12 of Saanich's long-term monitoring catchments are larger than the 30 – 100 hectare catchment size recommended in the I&I Management Plan (2012). However, these catchments have low I&I and can be subdivided in the future if warranted by increasing I&I rates.

Flow data for Saanich's municipal pump stations are not currently available. Saanich plans to collect flow data from these pump stations in the near future using data collected on Saanich's SCADA system.

Additional Catchments

Since 2012, an additional 6 catchments have been flow monitored an analyzed for I&I in Saanich. The catchments are listed in Table 11.1.


DISTRICT OF HIGHLANDS
DISTRICT OF SAANICH
TOWN OF VIEW ROYAL
CITY OF LANGFORD
CITY OF COLWOOD
TOWNSHIP OF ESQUIMALT
CITY OF VICTORIA
DISTRICT OF OAK BAY
SONGHEES NATION
ESQUIMALT NATION
Haro Strait
Esquimalt Harbour
Cordova Bay
Cadboro Bay
Oak Bay
Baynes Channel
REGIONAL URBAN CONTAINMENT AND SERVICING AREA
West Saanich Rd
Oldfield Rd
Interurban Rd
Wildmgn Rd
Royal Oak Dr
Patricia Bay Hwy
Quadra St
Gordon Head Rd
Trans-Canada Hwy
Island Hwy
Sooke Rd
Gorge Rd E
Douglas St
BEACH PARK 232 ha
HALIBURTON 156 ha
COLQUITZ METER CHAMBER 445 ha
MARIGOLD 615 ha
SWAN LAKE 421 ha
DYSART 48.2 ha
HAMPTON 28.9 ha
COLQUITZ PS 47.5 ha
GORGE VIEW 28.7 ha
ALBINA 98.2 ha
HARRIET 45.8 ha
BRETT 128 ha
BOUNDARY 249 ha
TOLMIE LANE 45.6 ha
ASH 300 ha
VANTREIGHT 27.5 ha
SHOREWAY 26.8 ha
ARBUTUS 204 ha
ALPINE 61.8 ha
GARNET 302 ha
PEAR & CHRISTMAS 61.6 ha
WETHERBY 155 ha
TOWNLEY 21.6 ha
HAULTAIN 49.8 ha
HARO 28.8 ha
PENRHYN 151 ha
TUDOR 68.4 ha
SEA VIEW 28.0 ha
N
W
E
S
CRD
Making a difference...together
Metres
0 250 500 1,000 1,500
Projection: UTM ZONE 10N NAD 83
Flume
CRD Pump Station
Municipal Pump Station
CORE AREA INFLOW AND INFILTRATION PROGRAM
Meter Locations and I & I Management Plan Catchments
FIG. 11.1 SAANICH CATCHMENTS

11.3 Inflow & Infiltration Data

Historical Data Collection

Prior to 2011, a significant amount of data was collected and consolidated for each of Saanich's long-term monitoring catchments. Much of this is summarized in the I&I Management Plan (2012) which includes:

- I&I data (5-year peak I&I rates; presence of overflows, average flows and peak wet weather flows)
- Catchment size, number of properties, and number of laterals.
- Percentage land use (single family, multi family, commercial, industrial, and institutional)
- Number of manholes and pump stations
- Sewer age and pipe materials.
- Type of flow meter.
- Detailed catchment maps with associated GIS information.
- Catchment "archetype" classifications for each of the municipality's long-term monitoring locations.

    - *For the I&I Management Plan, seven categories of archetypes were developed. The archetypes are delineated based on sewer age and I&I rates. Each archetype contains a typical list of rehabilitation actions needed and a "per meter" budget number to complete the work. The archetypes are designed to be used for high level budget and planning purposes. If investigation work is completed (i.e. CCTV and smoke testing), archetypes should be replaced with specific rehabilitation plans containing specific budgets.*

Current Data Collection

Significant catchment data was collected, analyzed, and/or updated between April 2010 and March 2016. This data is summarized in Table 11.1 and includes:

- Catchment sizes
- Average pipe ages
- Current peak 1-hour I&I rates
- If a catchment has "rapid I&I"
- If a catchment exceeds 4x average dry weather flow
- 5-year 24 hour I&I rate and projected rate at 2031 (based on current precipitation rates)
- Catchment archetype classification and budget estimates based on the current I&I analyses.
- I&I rates for "additional catchments" (i.e. different than the long term monitoring catchments) that have been analyzed since 2012.

Figure 11.2 shows how catchments were classified into archetypes based on average sewer age and I&I rates. This is the same system that was used in the Core Area I&I Management Plan (2012). An overview of the archetype methodology is located in Section 5

Table 11.1: Summary of I&I in Saanich by Catchment

I&I Management Plan Catchments	General Info			Inflow & Infiltration							
	Site Code	Size (ha)	Pipe Ave. Age	Peak 1-hr I&I Rate *(l/ha/day)*	5-yr, 24-hr flows compared to ADWF	Rapid I&I? [1]	5-yr, 24-hr I&I Rate [2] (l/ha/day)				
							2010	2012	2014	2016	Archetype
Albina [3]	SA26A	98	59	---	---	no	24,798	24,798	24,798	24,798	B
Alpine [3]	SA28	62	54	---	---	no	17,586	17,586	17,586	17,586	A
Arbutus [3]	SA25	212	39	---	---	no	17,586	17,586	17,586	17,586	B
Ash	SA1	300	40	16867	---	no	9,888	9,884	9,884	9,884	A
Beach Park [3]	SA24	232	28	---	---	no	10,141	10,141	10,141	10,141	A
Boundary [3]	SA15A	247	57	---	---	no	16,414	16,414	16,414	16,414	A
Brett	SA12	128	53	22218	---	no	13,024	13,024	13,024	13,024	A
Colquitz Meter Chamber	SA4	439	32	40119	---	no	23,518	23,518	23,518	23,518	B
Colquitz PS [3]	SA30	48	62	---	---	no	32,828	32,828	32,828	26,337	B
Dysart	SA6	48	51	35501	---	no	20,811	20,811	20,811	20,811	B
Garnet	SA7A	302	46	25475	---	no	15,241	15,241	15,241	15,241	A
Gorge View [3]	SA13A	29	62	---	---	no	33,216	33,216	33,216	26,337	B
Haliburton [3]	SA8A	159	29	---	---	no	3,936	3,936	3,936	3,936	A
Hampton [3]	SA31	29	47	---	---	no	24,798	24,798	24,798	24,798	B
Haro	SA23	29	34	no visible I&I	1.4x ADWF	no	5,862	5,862	5,862	11,517	A
Harriet [3]	SA17A	46	60	---	---	no	24,621	24,621	24,621	24,621	B
Haultain	SA22	50	49	33178	4.2x ADWF	no	19,355	19,355	19,355	19,300	A
Marigold [3]	SA18A	609	34	---	n/a	no	10,141	10,141	10,141	10,141	A
Pear & Christmas [3]	SA29	62	49	---	---	no	17,586	17,586	17,586	17,586	A
Penrhyn [3]	SA19A	150	46	---	---	no	10,552	10,552	10,552	7943	A
Sea View [3]	SA32	28	26	---	---	no	10,145	10,145	10,145	7943	A
Shoreway [3]	SA33	27	36	---	---	no	17,586	17,586	17,586	17,586	B

I&I Management Plan Catchments	General Info			Inflow & Infiltration [1]							
	Site Code	Size (ha)	Pipe Ave. Age	Peak 1-hr I&I Rate *(l/ha/day)*	5-yr, 24-hr flows compared to ADWF	Rapid I&I? [2]	5-yr, 24-hr I&I Rate [3] (l/ha/day)				
							2010	2012	2014	2016	Archetype
Swan Lake	SA20	411	40	23881	3.3x ADWF	no	17,971	17,971	17,123	16,742	A
Tolmie Lane	SA14	45	53	36944	---	no	21,657	21,649	21,649	21,649	B
Townley	SA21	22	49	29062	5.2x ADWF	no	15,270	15,270	15,189	21,000	B
Tudor [3]	SA27	68	22	---	---	no	10,552	10,552	10,552	10,552	A
Vantreight [3]	SA34	27	42	---	---	no	17,586	17,586	17,586	17,586	B
Wetherby	SA11	155	55	34694	---	no	20,338	20,331	20,331	20,331	B
Additional Catchments											
Boundary *(Total Metered Area)*	SA15	575	51	26,560	3.8x ADWF	no	n/a	n/a	n/a	14,191	
Harriet *(Total Metered Area)*	SA17	297	54	42,518	4.9x ADWF	no	n/a	n/a	n/a	26,337	
Marigold *(Total Metered Area)*	SA18	1850	30	18,267	3.7x ADWF	no	n/a	n/a	n/a	14,456	
Penrhyn *(Total Metered Area)*	SA19	246	35	14,062	3.7x ADWF	no	n/a	n/a	n/a	7,943	
Sark	SA35	97.7	n/a	4,846	1.5x ADWF	no	n/a	n/a	n/a	2,272	
Behind 3400 Douglas St	SA36	36.3	n/a	46,651	3.2x ADWF	no	n/a	n/a	n/a	22,617	

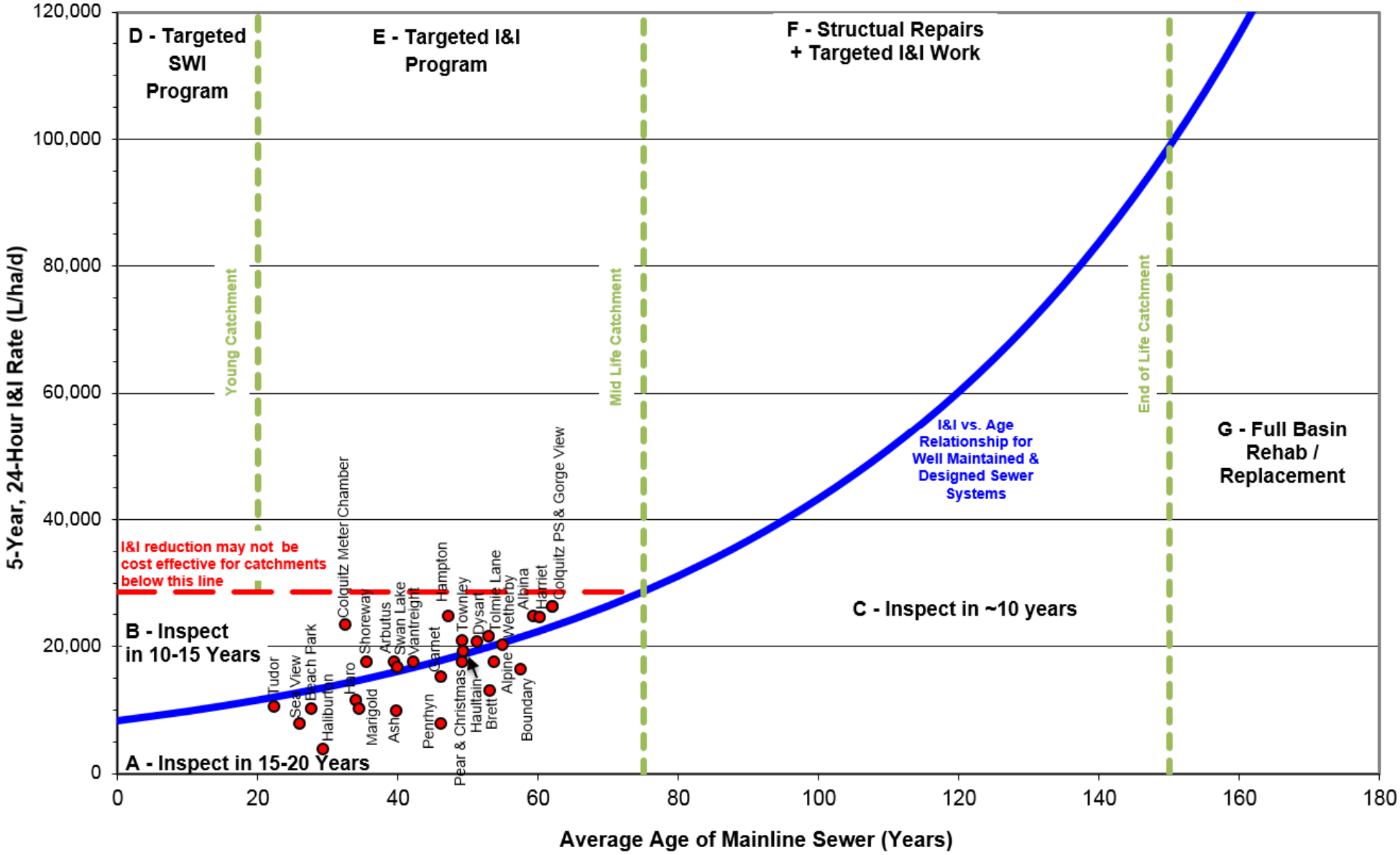
Footnotes:

1 Catchments are considered to have some level of rapid I&I if flows more than doubled during one of two extremely intense 1 hour long dry weather storm events that occurred in 2014. This is documented in the Core Area Inflow & Infiltration Program Annual Report for 2014.

2 Rates up to 2014 were calculated based on the peak 1-hr I&I. The 2016 rate was calculated based on a stand-alone I&I analyses.

3 This catchment does not have its own sewer meter. Its data will always be derived mathematically using data from nearby catchments.

Figure 11.2: Classification of Saanich's Sewer Catchments in Archetypes



Flow Data Analyses

As shown in Table 11.1, all Saanich's municipal catchments are classified in archetypes A or B. These catchments have low I&I and no flow related signs of structural issues.

Table 11.2 should be used for planning and budgetary purposes only. It shows typical recommended actions for each archetype divided into three phases.

- Phase 1 actions includes data collection. Saanich already has ongoing flow meter data for some of its long-term monitoring catchments. It's recommended that Saanich program its SCADA system to collect flow data from its sewer pump stations in order to generate ongoing I&I rates for its remaining long-term monitoring catchments. In general, data collection for this phase is ongoing.

- Phase 2 actions include investigation work, which can be used to create catchment rehabilitation plans. As Saanich doesn't have elevated I&I, the work for this phase includes periodic sewer camera inspections.

- Phase 3 actions involve rehabilitation work. As Saanich's catchments have low I&I, specific I&I reduction work is not required. However, it's likely that point repairs and other minor maintenance work will be required over time, based on CCTV work and other inspections. Saanich also routinely repairs and upgrades sewers for operational purposes such as increasing capacity which generally results in I&I reductions.

Table 11.2: Projected I&I Related Work Required Based on Catchment Archetype Classification

Archetype	**Phase 1: Data Collection**	**Phase 2: Investigation Work** *(percent of catchment)*	**Phase 3: Rehabilitation Work** *(percent of catchment)*	**Component Costs** *($/m)*
A	Flow Monitoring (ongoing)	CCTV Condition Assessment (15-20 years)	Point Repairs (0.1%)	$16 / meter *Plus $5000 for flow monitoring*
B	Flow Monitoring (ongoing)	CCTV Condition Assessment (10-15 years)	Point Repairs (0.1%)	$16 / meter *Plus $5000 for flow monitoring*

Please note that the archetypal methodology presents a plausible rehabilitation plan for catchments that don't have compete investigation data. It is to be used as a planning tool to guide budgeting and estimate I&I reduction effectiveness. It is intended that the archetype work programs for each catchment will be replaced by targeted I&I reduction programs based on investigative data for catchments with Archetypes D – G or an asset management program.

11.4 Sewer Infrastructure Maintenance & Capital Work

Routine Work

Saanich carries out a number of actions related to preventative maintenance and long term asset management of gravity sewers, manholes and appurtenances. Table 11.3 summarizes this work.

Table 11.3: Saanich's Preventative Sewer Maintenance Activities

Category	Performed By	Frequency	Notes
Rehab / Replacement			
Sewer Relining	Contractor	Annually	n/a
Sewer replacement / upsizing	Contractors/Saanich crews	Annually	n/a
Manhole Rehab	Contractors/Saanich crews	Annually	n/a
Manhole Replacement	Contractors/Saanich crews	Annually	n/a
Investigation Work			
CCTV	Contractors/Saanich crews	Varies with age of infrastructure or noted maintenance or hydraulic issues	• 16 critical sewer areas • Risk related areas: service required, ESA collectors • Attempting to CCTV 3 areas / year • Do not have a target of comprehensive coverage.
Manhole Inspections	Contractors/Saanich crews	As required	No formal program
Smoke Testing	Contractors/Saanich crews	As required	No formal program
Dye Testing	Contractors/Saanich crews	As required	No formal program
Routine Maintenance			
Sewer Cleaning (Flushing)	Contractors/Saanich crews	As required	Carried out after CCTV work to focus the work on areas that need to be cleaned.
Pump Station Maintenance	Saanich crews	ongoing	n/a
SCADA Monitoring	Saanich crews	ongoing	n/a

Saanich takes efforts to prevent I&I resulting from new construction by requiring CCTV, pressure testing and inspections.

Notable Work Completed (prior to 2017)

2012

- Replacement of no-corrode laterals up to the property line (approximately 60 – 80 per year).
- Replaced over 2200 meters of sanitary sewer main replaced via open cut and trench-less technology methods.
- Camera inspecting (CCTV) approximately 15 km of sanitary sewer main per year focusing on areas identified in a past "Critical Sewer assessment program".

2013

- In 2013, Saanich conducted a sanitary sewer CCTV investigation of approximately 16 km of sanitary sewer main in study areas based on a past Saanich "Critical Sewer assessment program" and other CCTV investigations of areas where specific problems were experienced during the year.
- Replaced over 2800m of sanitary sewer main and 217 sanitary sewer connections replaced via open cut and trench-less technology methods.
- Replaced 53 "No-Corrode" service connections and an additional 14 pre-1960 AC service connections.

2014

- Replaced approximately 80 no-corrode laterals up to the property line.
- Replaced 1800 meters of sanitary sewer main using open cut and trench-less technology methods.
- Camera inspected approximately 15 km of sanitary sewer main focusing on areas identified in its "Critical Sewer assessment program".

2015

- Replaced approximately 80 laterals (no-co or AC) up to the property line.
- Replaced approximately 2080 meters of sanitary sewer main using open cut and trench-less technology methods.
- Camera inspected approximately 16 km of sanitary sewer main focusing on areas identified in its "Critical Sewer assessment program".

Planned Special Projects (2016 – 2021)

- Plan on continuing replacing up to 80 laterals (no-co or AC) up to the property line.
- Replaced approximately 2100+/- meters of sanitary sewer main using open cut and trench-less technology methods per year.
- Camera inspected approximately 16 km of sanitary sewer main focusing on areas identified in its "Critical Sewer assessment program".
- Replace some pump station infrastructure to extend serviceability of system

11.5 Asset Management

Saanich practices integrated decision making and encourages work discussions between different program areas to find synergies prior to carrying out planned work. This includes triple bottom line (economic/social/environmental) analyses. Work is generally initiated for structural or operational reasons. In some cases, specific I&I reduction work is added to pre-planned work to take advantage of potential synergies (i.e. installing a sewer main when the road is slated for a water main replacement or prior to Saanich re-paving a roadway). Tools used to assist with asset management include GIS, a sewer master plan and CCTV of sewer mains.

11.6 Bylaws

The CRD and participating municipalities have committed in the Core Area Liquid Waste Management Plan (LWMP) to identify needed changes to legislation and legal authority to enable options and strategies with regard to inflow and infiltration.

The following table provides a comparison of the key powers located in the CRD Sample Private Property I&I Model Bylaw to those found in each of the municipality's existing sewer bylaws. The table demonstrate where existing powers appear to be equivalent between the municipal and model bylaw, and where there may be potential gaps. Suggestions or considerations for addressing the gaps are provided. This task was

completed as a policy review, by Pinna, for consideration by municipalities when undertaking changes to their existing sewer use bylaws to assist with compliance with LWMP commitments. The municipal bylaw(s) being assessed in the analyses are Bylaws No. 8627 Building and Plumbing Bylaw (2005) and No. 8792 Sanitary Sewer Bylaw.

Table 11.4: Comparing Powers Municipal Bylaw to Sample PPI&I Bylaw

Key section(s) of the sample CRD PPI&I Model Bylaw	Is this section sufficiently addressed in current municipal bylaws and where?	Recommendations
Required maintenance standard (5-6)	No	Saanich Sanitary Sewer Bylaw 11(a and c) – clarifies the owner is responsible for all costs of servicing the private sewer, but does not state the required maintenance; See *CRD PPII model bylaw 5-6*
Unauthorized discharges or connections (7)	Yes 12 (a) – No discharge of storm water, ground water, surface water, ice, snow or uncontaminated water into any sanitary sewer 13 (c) – No storm drain connection to sanitary sewer allowed	
Entry and testing by city (8-11)	Yes 15 – Director of Engineering may enter on property to ascertain whether bylaw requirements are being met	
Required repair of defect (12-14)	Yes 12 (b) – Director of Engineering determines storm water (etc.) is entering the sanitary sewer lateral, owner may be directed to carry out repairs to prevent inflow and infiltration failing which municipality may carry out work at owner's expense	
Sewer lateral work – permit required (15-16)	No	See *CRD PPII model bylaw 16*
Financial assistance (17-21) and Monetary incentive for voluntary inspection and repairs (22-27)	No	These sections are optional in the sample model bylaw. Municipalities may opt to provide assistance and/or incentives to homeowners who voluntarily conduct inspections and repairs of private sewer laterals (for suggested language, see *CRD PPII model bylaw 17-27*). Also see *CRD PPII model bylaw 35* for no liability statement. To provide financial assistance, the municipality would need to comply with the notice requirements of the Community Charter, section 24. To provide a monetary incentive, the municipality may develop a Council-approved

		program as an alternative to including these sections in bylaw.
Failure to comply – offence and penalties (28-35)	Yes 12(b) – municipality may carry out work at owner's expense 16 – Any contravention of bylaw is offence and may receive a fine between $200 and $2,000 per offence (each day) 17 (a) – Shall not hinder or prevent Engineer from entering premises to administer the bylaw	*CRD PPII model bylaw 33(a)* provides a penalty option to discontinue service of water supply to the property as an additional avenue for enforcement of the bylaw.
Municipal reporting and review (36)	No	Consider adding a statement to conduct an annual review and report to Council on effectiveness of private sewer maintenance *(see CRD PPII model bylaw 36)*

11.7 Budget

Saanich is 5-years into a 20 year plan to allocate an average annual budget of $6,008,000/year to sanitary sewers. This represents 1.05% of the estimated value of all laterals, manholes and gravity sewer.

Saanich's I&I related sewer budget is summarized in Table 11.5.

Table 11.5: Summary of Saanich's Sewer Budget

Budget	Value
2016	
Infrastructure Capital Replacement Program	5,985,000
Annual Maintenance	3,327,700

Note: values available from financial plan posted on Saanich's website: http://www.saanich.ca/EN/main/local-government/departments/finance-department/saanich-budget.html

Saanich's capital sewer projects are based on replacing infrastructure over time prior to failure. Contingency funding if available in event of unplanned works. With 64% of the sewer mains being asbestos cement (AC) pipe and requiring replacement and with lift stations' electrical, mechanical and structural components nearing their end of useful life, sustainable infrastructure replacement is a priority for the District. Annual funding for infrastructure replacement is increasing annually as per council policy and will reach sustainable levels by 2019.

In general, municipalities need to ensure that budgets are sufficient to maintain their sewer assets. For example, if a municipality expects its sewer assets to last 100 years then, on average, it should be setting funding equivalent to 1% of the replacement cost for the sewer system each year (i.e. 1 percent replacement cost / year x 100 years = 100%). Municipalities with younger sewers may decide that it's prudent to commit lower funding levels to sewer work as younger sewers generally require less rehabilitation work. Municipalities with older sewers may need to commit higher funding levels for sewer work, as their sewers reach the end of their service life.

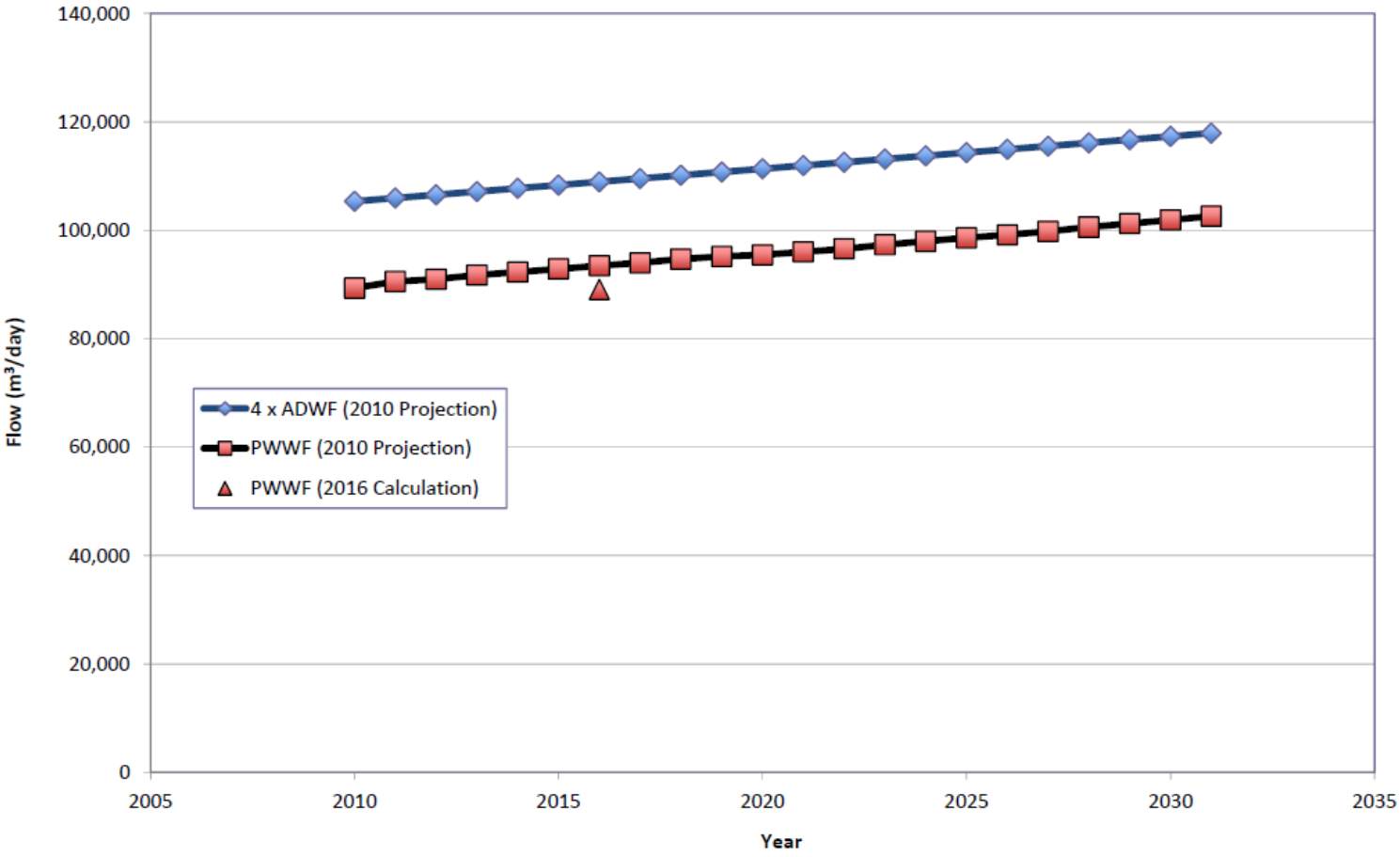
11.8 Saanich Summary

Saanich has been divided into 28 sewer catchments for this plan. In summary:

- None of Saanich's catchments have elevated I&I.
- Saanich needs to program its SCADA system to collect flow data from its sewer pump stations in order to generate ongoing I&I rates for its remaining long-term monitoring catchments. (Note that I&I is low throughout Saanich based on CRD cost sharing flow metering sites.)
- All catchments will be flow monitored and CCTV'ed as part of the plan. Sources of new I&I will be addressed as required.
- Peak Wet Weather Flow does not exceed 4x Average Dry Weather Flow in any of Saanich's catchments.
- The catchments will be periodically flow monitored and CCTV'ed as part of the plan. Sources of new I&I will be addressed as required.
- The I&I budget for the municipality appears to be sufficient at present.

Figure 11.3 shows the anticipated PWWF and 4xADWF for 2012 to 2031 for Saanich as a whole. The blue line on the graph represents 4x ADWF. The 4x ADWF is a threshold which the Liquid Waste Management Plan has identified as a goal for the maximum flow to be conveyed and treated. This line generally increases over time due to population growth; the steeper the slope, the higher the projected growth. Various regional infrastructure including the waste water treatment plants have been sized to accommodate the projected 4x ADWF and this unit of measure is not influenced by wet weather flows. The red line on the graph represents PWWF. The PWWF includes normal sewer flows plus inflow and infiltration. It is the actual sewer flow generated during a peak rain storm event. In order to not exceed the capacity of the sewer system and to prevent overflows, the "red" PWWF line should remain under the "blue" 4x ADWF line. This is one of the primary goals noted in the Core Area Liquid Waste Management Plan.

Figure 11.3: Projected Peak Wet Weather Flow and 4xAverage Dry Weather Flow for Muni Name



Minimal I&I reduction work is anticipated to be required to keep PWWF below the 4xADWF target until beyond 2031.

12 VICTORIA

12.1 Victoria Overview

The City of Victoria is located at the southern end of the Core Area of the CRD. It was incorporated in 1862. It is approximately 1,968 hectares in size and has a population of approximately 80,000 residents (based on 2011 census).

Sanitary Sewer System

Victoria's first sanitary sewers were installed around 1890. The average age of the system is approximately 83 years. The sanitary sewer system services all of the properties in Victoria. In total, there are approximately 232 kilometers of gravity sanitary sewer pipe in Victoria, mostly vitrified clay tile with some reinforced concrete, brick, and polyvinyl chloride mains, with approximately 3014 manhole structures. Mainline pipe diameters range from 150mm to 1200mm. Sanitary sewers constructed prior to 1950 were butt-jointed, whereas new construction is bell and spigot. Due to hilly topography and subsurface conditions 11 sanitary sewer pump stations serve approximately 20 percent of the system area, with over 2.6 kilometers of force mains. Two-thirds of the wastewater is conveyed to the Clover Point outfall, and one-third to the Macaulay Point outfall.

Victoria has 21 known sanitary sewer to storm drain overflow locations, 95 combined manholes (sanitary sewer and storm drain mains that flow through the same manhole, but have their own individual, separate channels) and no combined sewers. These overflow connections were built to prevent the sanitary sewer from flooding basements by allowing it to overflow into the storm drain. Changes in catchment area characteristics (larger roof areas on houses; paved driveways and roads) have resulted in the reverse; storm drainage inflowing into the sanitary sewer.

Of these 21 overflow locations, currently only the pump station overflows are monitored. None of the locations have meters to measure overflow volumes. Victoria has approximately 2-3 known I&I related sewer overflows per year. Increased rainfall-induced sewer flows within the City of Victoria do contribute to regional sewer overflows. If there is a sanitary sewer to storm drain overflow event within the City of Victoria, proper staff and agencies are notified and appropriate response plans are implemented: crews respond to the incident, overflow information is documented and sent to the Provincial Emergency Program.

Sewer flow monitoring in Victoria has generally been carried out using temporary flow meters installed in gravity sewers and using permanent metering at city pump stations and CRD cost sharing locations. Since 2001, over 50 locations have been flow monitored, however, the data has not always been suitable for I&I analyses.

Victoria has 11 sanitary sewer pump stations. All are monitored using SCADA, 9 have connections for portable generators, and 1 has a storage tank. There are transfer switches located at most pump stations for connecting a portable generator. Victoria electricians believe that the remaining two stations can be connected to, temporarily, if necessary. The pump stations and the SCADA systems are maintained by City Public Works staff.

Victoria currently focuses its primary I&I efforts on data collection and field investigations (Table 12.1). This is done to determine the potential scope of I&I within catchments and to identify and isolate potential sources. Victoria also carries out work related to sewer main rehabilitation / replacement (Table 12.2).

Table 12.1: I&I Related Data Collection/Investigation and Development Programs

Category	Description of Work
Sewer Mains Investigation Study	Mainline CCTV inspections and condition assessment of sanitary sewer & storm drains on public side.
	Service connection CCTV inspections and condition assessment of sanitary sewer & storm drains on public side.
	Smoke testing
	Groundwater monitoring
	Rain gauge monitoring
	National Benchmarking initiatives
Flow Monitoring	Flow monitoring of the gravity sanitary sewer system (permanent, semi-permanent and temporary locations).
	Flow monitoring of sanitary sewer pump stations using SCADA
Overflow Investigations	Overflow location identification, monitoring and reduction/elimination.
Program Development	Development of a Sewer Master Plan and model
	Continue to develop the I&I Program with the aid of consultants.
	Development of a Stormwater Master Plan and model

Table 12.2: I&I Rehab/Replacement Related Programs (in conjunction with Structural & Hydraulic Deficiencies)

Category	Description of Work
Sewer Main Rehabilitation	To rehab old, existing sanitary sewer mains that have been identified as being deficient. Typical projects would include repairs to various spots along the length of a main, or the trenchless rehab (i.e. relining) of the entire main.
Sewer Main Replacement	To replace old, existing sanitary sewer mains that have been identified as being deficient. Typical projects would include open-cut replacement of the entire section of main.

Victoria contributes to the Core Area I&I Subcommittee and its initiatives. These include: regional I&I reports for the Province such as Biennial I&I Reports and the Overflow Management Plan; annual/semiannual Core Area Inflow and Infiltration Program I&I Analyses Results Reports, and various region wide public education initiatives.

Storm Drainage System

The City of Victoria's stormwater drainage system consists of approximately 257 kilometers of storm drain pipe, mostly vitrified clay tile with some concrete, brick, and PVC. There are approximately 2984 manhole structures. The stormwater system has 4 pump stations and 66 outfalls that discharge into the Selkirk Waterway, Victoria Harbour and along the south coast. Only one pump station is used to drain a catchment area. The remaining three are used to reroute the storm drain to the sewer during low flows to reduce fecal coliforms at the discharge. The system is maintained by the City's Public Works underground crews.

In the early 1900s, the approach to storm drain development was to install drains initially in areas with poor surface drainage and later in areas to replace storm ditches. The design of the storm drain system included open joints, shallow depths, and short reaches to the nearest waterway. The shallow depth, boulevard location, and proximity to residential lots have resulted in severe root intrusion through the open joints causing pipe breaks and blockages. In many instances, the sanitary sewer and storm drain systems were constructed in a common trench and in some instances are now in poor physical condition. This allows for possible cross filtration between the two systems.

The drainage bylaw prior to 1950 required storm laterals (roof leaders and perimeter drains) to be connected to the storm sewer but allowed, by approval of the city engineer, connections to the sanitary

sewer if the storm connection could not be made by gravity (the cost of pumps at the time being extremely high). There are no records of which residences were permitted to connect storm drainage to the sanitary sewer. Since 1950, the bylaw has been amended to require all storm drainage to connect to either the storm drain or a rock pit (soak-away). Weeping tile flows must be pumped if the grade is not available. Surface flow is not considered a serious problem because of good surface drainage to the storm system and control of elevations on sanitary manholes.

In conjunction with its I&I initiatives, the City investigates point source fecal contamination in the stormwater system through its outfall sampling program. The sampling is performed on a regular basis and is carefully monitored for patterns to allow for further investigations. High priority outfalls (as defined by the CRD) continue to be up-stream sampled (individual manhole sampling) to narrow down potential sources. Once an area is identified as containing high levels of fecal contamination, dye testing, camera viewing and flood testing are undertaken. Additional investigatory tools include CCTV, smoke and flood testing of systems to check for right-of-way cross filtration situations.

Stormwater Quality Management Plan

In 2002, the City of Victoria completed a Stormwater Quality Management Plan (SQMP) which addresses environmental issues related to the City's storm drainage system. The strategies within this plan also have a major role in the I&I reduction program.

The SQMP had two main goals for stormwater outfalls to the receiving waters:

1. The reduction of fecal coliform concentrations
2. The reduction of chemical contaminants to meet parameters set out in the SQMP.

The goals would be achieved through structural measures, such as sewer rehabilitation, and by implementing policies, such as bylaws, source control and public education. The SQMP identifies four primary ways that fecal coliform that originate in the sanitary sewer system may end up in the storm drainage system:

1. Illegal sanitary sewer cross-connections to storm drain.
2. Pipe defects which cause cross-contamination where storm and sanitary sewer pipes are situated close together.
3. Combined manholes.
4. Emergency overflows between the sanitary sewer and storm drainage systems.

The structural measures to reduce or eliminate these sources of fecal coliform transfer into the stormwater system can be divided into two approaches:

1. Indirect reduction/elimination of fecal coliform transfer by reducing I&I to the sanitary sewer system (I&I causes overflows between the storm drainage system due to hydraulic overload of the sanitary sewer system)
2. Direct reduction/elimination of fecal coliform transfer by physical elimination of combined manholes, overflows and pipe defects.

12.2 Catchments

Long-Term Monitoring Catchments

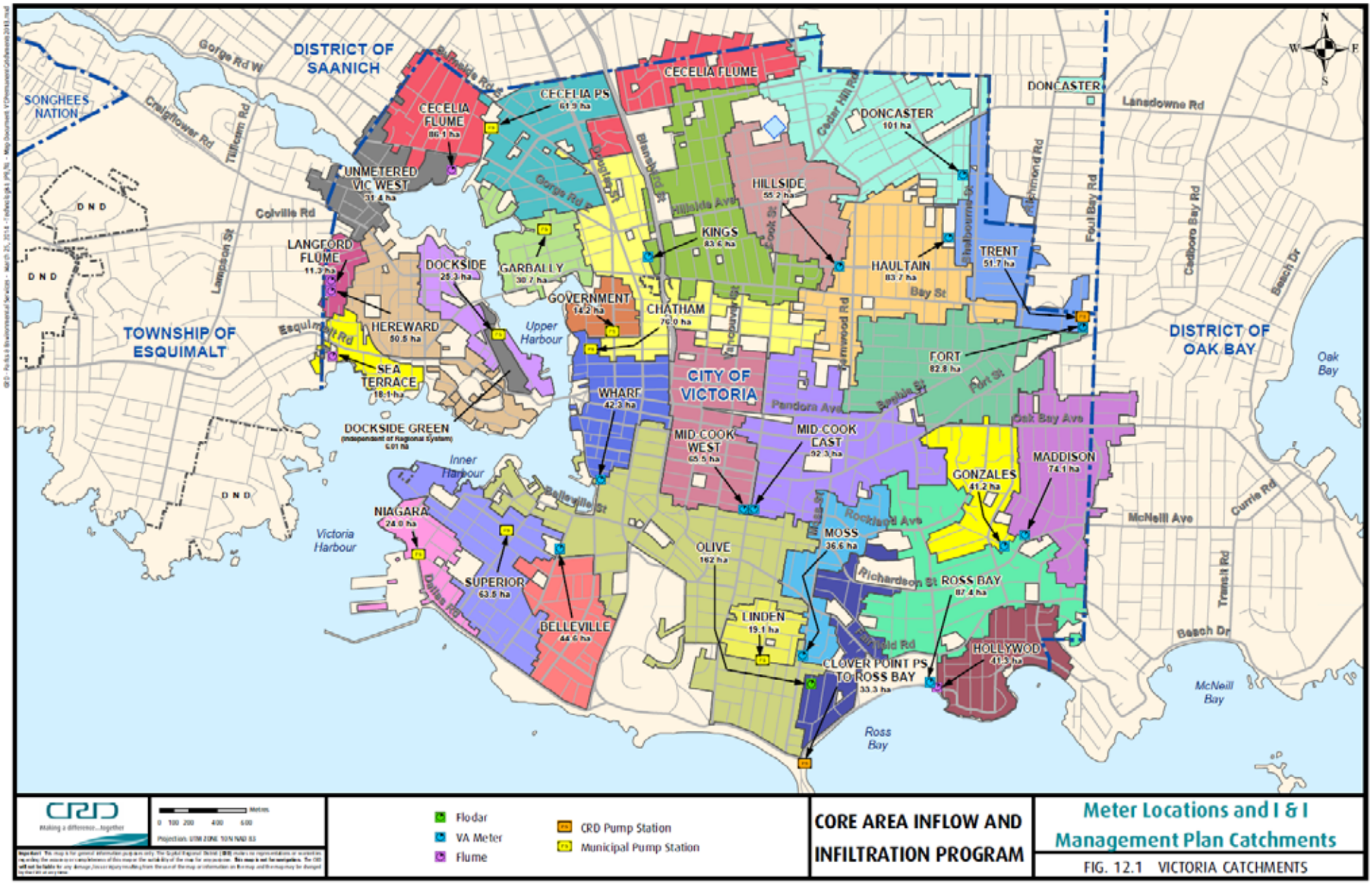
The City of Victoria's sanitary sewer collection system can be broken down into four main collection systems: Clover Point; East Coast Interceptor; North East Trunk; and the North West Trunk. These catchments are further broken down into 28 long-term flow monitoring catchments. The catchments were chosen using GIS to divide the municipality into suitably sized flow catchments. When practical, existing pump stations and permanent flow monitoring stations were chosen for the flow monitoring as they provide consistent reliable long-term flow data at reasonable costs. Sixteen of the catchments are monitored

permanently using pump stations and CRD cost sharing locations. These catchments were named based on their associated pump station or cost sharing location. The remaining 12 catchments require temporary meters. Each catchment has a unique site code that enables the tracking and comparison of I&I results for specific flow meter locations over time. The catchments are shown on a map in Figure 12.1 and listed in Table 12.3.

Victoria's only long-term monitoring catchment that is larger than the size recommended in the I&I Management Plan (2012) is the Olive Net catchment is 158.1 hectares in size. This catchment was not divided further because the sub-catchments are small, generally around 10 hectares in size which makes them technically difficult and expensive to monitor. If this catchment is found to have unusually high I&I in the future, efforts will be made to either subdivide the catchment to narrow down the source of the I&I or to carry out investigation work throughout the catchment.

Additional Catchments

Since 2012, an additional 8 catchments have been flow monitored an analyzed for I&I in Victoria. The catchments are listed in Table 12.3.


DISTRICT OF SAANICH
SONGHEES NATION
TOWNSHIP OF ESQUIMALT
CITY OF VICTORIA
DISTRICT OF OAK BAY
DONCASTER
CECELIA FLUME
CECELIA PS
UNMETERED VIC WEST
LANGFORD FLUME
DOCKSIDE
GARBALLY
KINGS
HILLSIDE
HAULTAIN
TRENT
GOVERNMENT
CHATHAM
HEREWARD
SEA TERRACE
DOCKSIDE GREEN
WHARF
FORT
MID-COOK WEST
MID-COOK EAST
GONZALES
MADDISON
NIAGARA
SUPERIOR
BELLEVILLE
OLIVE
MOSS
ROSS BAY
LINDEN
HOLLYWOOD
CLOVER POINT PS TO ROSS BAY
Upper Harbour
Inner Harbour
Victoria Harbour
Ross Bay
McNeill Bay
Oak Bay
Flodar
VA Meter
Flume
CRD Pump Station
Municipal Pump Station
CORE AREA INFLOW AND INFILTRATION PROGRAM
Meter Locations and I & I Management Plan Catchments
FIG. 12.1 VICTORIA CATCHMENTS

12.3 Inflow & Infiltration Data

Historical Data Collection

Prior to 2011, a significant amount of data was collected and consolidated for each of Victoria's long-term monitoring catchments. Much of this is summarized in the I&I Management Plan (2012) which includes:

- I&I data (5-year peak I&I rates; presence of overflows, average flows and peak wet weather flows)
- Catchment size, number of properties, and number of laterals.
- Percentage land use (single family, multi family, commercial, industrial, and institutional)
- Number of manholes and pump stations
- Sewer age and pipe materials.
- Type of flow meter.
- Detailed catchment maps with associated GIS information.
- Catchment "archetype" classifications for each of the municipality's long-term monitoring locations.
    - *For the I&I Management Plan, seven categories of archetypes were developed. The archetypes are delineated based on sewer age and I&I rates. Each archetype contains a typical list of rehabilitation actions needed and a "per meter" budget number to complete the work. The archetypes are designed to be used for high level budget and planning purposes. If investigation work is completed (i.e. CCTV and smoke testing), archetypes should be replaced with specific rehabilitation plans containing specific budgets.*

Current Data Collection

Significant catchment data was collected, analyzed, and/or updated between April 2010 and March 2016. This data is summarized in Table 12.3 and includes:

- Catchment sizes
- Average pipe ages
- Current peak 1-hour I&I rates
- If a catchment has "rapid I&I"
- If a catchment exceeds 4x average dry weather flow
- 5-year 24 hour I&I rate and projected rate at 2031 (based on current precipitation rates)
- Catchment archetype classification and budget estimates based on the current I&I analyses.
- I&I rates for "additional catchments" (i.e. different than the long term monitoring catchments) that have been analyzed since 2012.

Figure 12.2 shows how catchments were classified into archetypes based on average sewer age and I&I rates. This is the same system that was used in the Core Area I&I Management Plan (2012). An overview of the archetype methodology is located in Section 5

Table 12.3: Summary of I&I in Victoria by Catchment

I&I Management Plan Catchments	General Info			Inflow & Infiltration							
	Site Code	Size (ha)	Pipe Ave. Age	Peak 1-hr I&I Rate *(l/ha/day)*	5-yr, 24-hr flows compared to ADWF	Rapid I&I? [1]	5-yr, 24-hr I&I Rate [2] (l/ha/day)				
							2010	2012	2014	2016	Archetype
Belleville	VIC12	44.6	107	126,113	3.4x ADWF	---	99,655	99,655	74,114	63,677	F
Cecelia Flume [3]	VIC31A	86.4	100	104,900	8.0x ADWF	yes	55,884	54,784	61,471	56,400	F
Cecelia PS [3]	VIC35A	61.9	114	171,429	4.7x ADWF	yes	104,446	103,926	100,457	71,422	F
Chatham [3]	VIC36A	76	99	150,611	---	yes	82,655	82,655	88,258	88,258	F
Dockside	VIC42	25.3	82	77,384	5.5x ADWF	no	92,852	92,852	34,715	54,585	F
Doncaster	VIC49	101	96	95,553	4.1x ADWF	---	101,414	101,414	56,118	57,465	F
Fort	VIC51	82.8	106	107,270	5.8x ADWF	---	84,414	84,414	63,075	60,362	F
Garbally	VIC37	30.7	104	64,167	4.6x ADWF	no	47,765	45,915	43,881	34,528	C
Gonzales	VIC3	41.2	99	56,831	4.7x ADWF	---	109,621	109,621	32,981	38,180	C
Government	VIC38	14.2	105	200,180	3.7x ADWF	yes	138,644	140,319	141,908	62,887	F
Haultain	VIC50	83.7	101	222,555	6.9x ADWF	---	136,000	136,000	130,645	130,645	F
Hereward [3]	VIC32A	39.9	102	145,973	---	no	92,852	92,852	85,540	72,061	F
Hillside	VIC52	55.2	116	136,643	5.5x ADWF	---	84,414	84,414	80,070	87,355	F
Hollywood [3]	VIC55A	41.3	103	182,840	12.2x ADWF	yes	109,621	109,621	107,144	118,460	F
Kings	VIC41	83.6	110	137,041	6.5x ADWF	---	82,655	82,655	80,238	80,981	F
Langford Flume	VIC33	11.3	113	n/a	3.8x ADWF	yes	158,276	157,651	85,540	85,752	F
Linden	VIC43		105	n/a	---	yes	82,655	82,655	77,108	77,108	F
Maddison	VIC2	74.1	103	116,716	6.8x ADWF	---	164,773	164,773	68,145	69,015	F
Mid-Cook East	VIC44	92.3	114	154,453	5.4x ADWF	---	82,655	82,655	90,515	86,446	F
Mid-Cook West	VIC45	65.5	112	115,684	2.9x ADWF	---	82,655	82,655	67,788	62,809	F
Moss	VIC46	36.6	111	159,816	10.4x ADWF	---	82,655	82,655	93,368	107,131	F
Niagara	VIC39	24	94	122,040	6.9x ADWF	yes	87,931	62,029	62,029	64,458	F

I&I Management Plan Catchments	General Info			Inflow & Infiltration							
	Site Code	Size (ha)	Pipe Ave. Age	Peak 1-hr I&I Rate *(l/ha/day)*	5-yr, 24-hr flows compared to ADWF	Rapid I&I? [1]	5-yr, 24-hr I&I Rate [2] (l/ha/day)				
							2010	2012	2014	2016	Archetype
Olive [3]	VIC34A	162	107	131,583	---	---	82,655	82,655	77,108	77,108	F
Ross Bay [3]	VIC48A	86	97	141,405	---	yes	109,621	109,621	82,863	82,863	F
Sea Terrace	VIC54	18	91	145,973	--	---	48,069	48,069	85,540	72,061	F
Superior [3]	VIC40A	63.5	94	135,111	3.1x ADWF	no	165,398	116,002	105,458	86,929	F
Trent [3]	VIC11A	51.7	106	13,705	---	yes	84,814	84,414	66,631	66,631	F
Unmetered Vic West	VIC53	14	112	110,112	---	---	48,069	48,069	82,040	62,069	F
Wharf	VIC47	42.3	112	95,631	7.5x ADWF	---	82,655	82,655	286,371	66,938	F
Additional Catchments											
Cecelia Flume	VIC31	179	96	100,880	5.8x ADWF	yes	n/a	n/a	n/a	57,844	
Cecelia PS	VIC35	92.6	110	101,235	4.7x ADWF	yes	n/a	n/a	n/a	59,190	
Hereward	VIC32	75.7	98	131,940	4.5x ADWF	---	n/a	n/a	n/a	72,061	
Hollywood	VIC55	67.3		192,956	12.5x ADWF	yes	n/a	n/a	n/a	98,074	
Olive *(Total Metered Area)*	VIC34	723	102	Data not suitable for I&I analyses							
Superior	VIC40	87.5	90	131,525	3.4x ADWF	no	n/a	n/a	n/a	80,766	
Trent *(Total Metered Area)*	VIC11	446	91	130,007	6.9x ADWF	yes	n/a	n/a	n/a	72,886	
Cooperage	VIC56	2.5	n/a	n/a	1.1x ADWF	no	n/a	n/a	n/a	3,200	

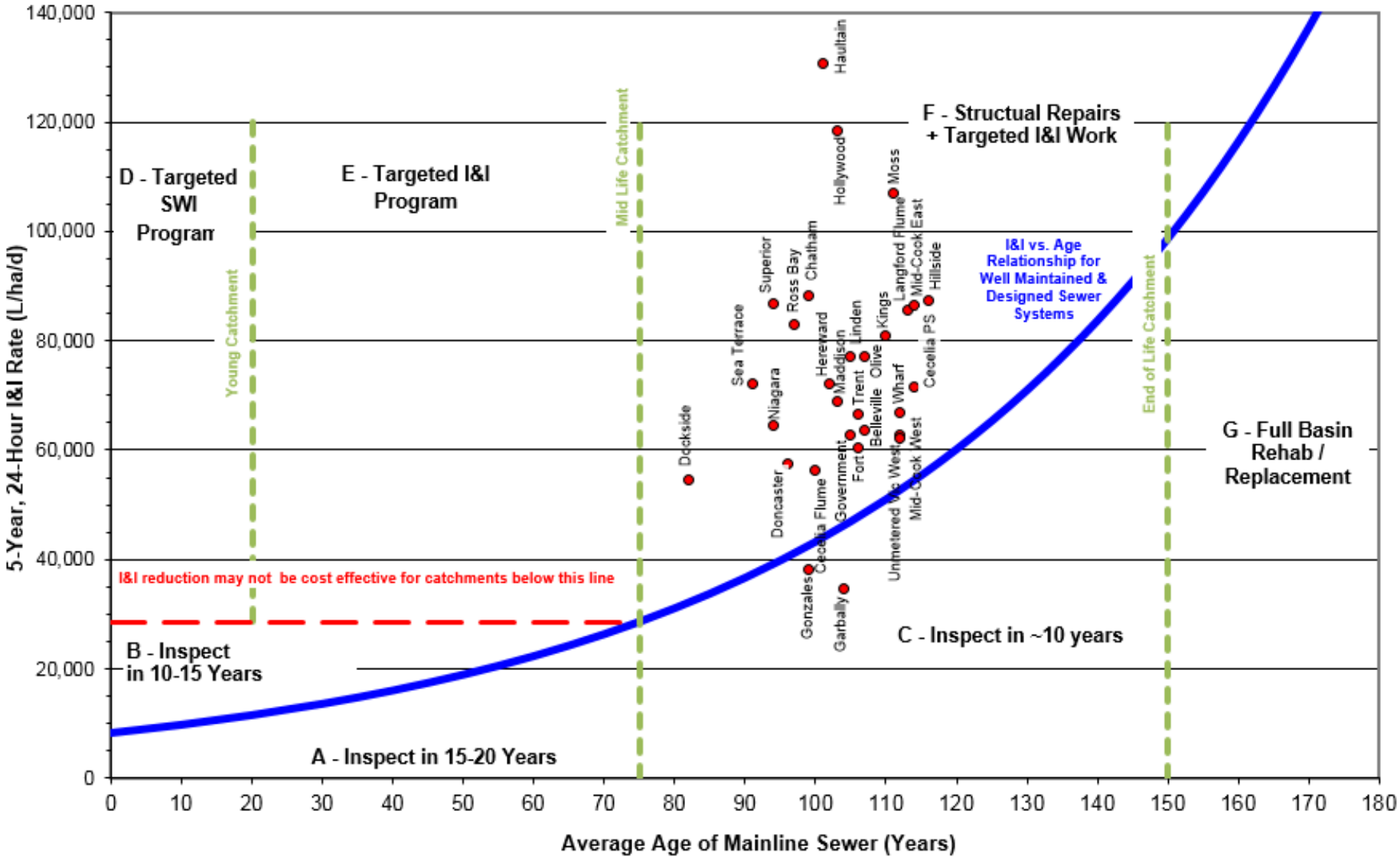
Footnotes:

10 Catchments are considered to have some level of rapid I&I if flows more than doubled during one of two extremely intense 1 hour long dry weather storm events that occurred in 2014. This is documented in the Core Area Inflow & Infiltration Program Annual Report for 2014.

11 Rates up to 2014 were calculated based on the peak 1-hr I&I. The 2016 rate was calculated based on a stand-alone I&I analyses.

12 This catchment does not have its own sewer meter. Its data will always be derived mathematically using data from nearby catchments.

Figure 12.2: Classification of Victoria's Sewer Catchments in Archetypes



Flow Data Analyses

All of Victoria's catchments have aging sewers and elevated I&I. In response to this Victoria has collected CCTV, smoke testing, and manhole inspection data for almost the entire municipality and will be creating prioritized sewer rehabilitation based on the results.

The activities carried out by Victoria can be categorized into the 3 phases of the archetype process:

- Phase 1 - Data Collection: Victoria has real-time ongoing flow meter data collection for many of its long-term monitoring catchments. It also has temporary meters that can be used to periodically collect flow data from the remainder of its catchments. Data collection for is considered routine and ongoing.

- Phase 2 – Investigation: Victoria has collected CCTV, smoke testing, and manhole inspection data for almost all of the City.

- Phase 3 – Rehabilitation: Victoria's long-term rehabilitation plan is in development.

12.4 Sewer Infrastructure Maintenance & Capital Work

Routine Work

Victoria carries out a number of actions related to preventative maintenance and long term asset management of gravity sewers, manholes and appurtenances. Table 12.4 summarizes this work.

Table 12.4: Victoria's Preventative Sewer Maintenance Activities

Category	Performed By	Frequency	Notes
Rehab / Replacement			
Sewer Relining	Contractors	As required	Based on structural grading from CCTV inspection results.
Sewer replacement / Upsizing	Contractors / City Staff	As required	Based on structural grading from CCTV inspection results and from hydraulic model. Will also be based on sanitary sewer master plan (upcoming) which incorporates population growth/development projections for future capacity.
Manhole Relining	Contractors	As required	Based on manhole inspection results.
Manhole Replacement	City Staff	As required	Based on manhole inspection results.
Investigation Work			
CCTV	Contractors / City Staff	As scheduled	A five year CCTV project to camera the entire SS & SD systems in the municipality is scheduled to be completed in the near future. Condition assessment review done by a consultant with results presented in a report, with GIS and database supporting documentation. Carries out some CCTV inspections of sewer and stormwater laterals from the main to the property line.

Manhole Inspections *(sanitary and storm)*	City Staff	As required	Inspections done by City staff, in conjunction with other projects. A pre-formatted form is filled out by staff and both a hardcopy and a scanned digital copy kept in a database. The manholes are given an overall rating based on several structural and maintenance related conditions.
Smoke Testing	Contractors	As required	A five year smoke testing program to smoke test the entire municipality is complete Results presented in a hardcopy report with supporting database in digital format.
Dye Testing	City Staff	As required	Performed either as part of development related work, or through City programs/investigations.
Rain Gauge/Groundwater Monitoring	City Staff	As required	Monitoring and collection of rain gauge and groundwater stations throughout the City. • The rain gauge monitoring is used to determine sub-catchment specific I&I responses to various storm events.
Routine Maintenance			
Sewer Cleaning (Flushing)	Contractors / City Staff	As required	Carried out as part of routine maintenance, CCTV inspections (see *investigation work*) or emergency related works.
Pump Station Maintenance	City Staff	Weekly / As required	Maintenance done on a regular basis by city staff to inspect pump and wet well conditions, or when flagged through SCADA system.
SCADA Monitoring (real time data acquisition)	City Staff	As required	Regular monitoring of City infrastructure that is connected to the SCADA system, including: 1. SS & SD pump stations • Generates flow data for wet and dry weather flows. 2. SS flow meters 3. Rain Gauges (assists in I&I investigations)
Temporary Flow Meters			The temporary installation & monitoring of flows in the gravity sanitary sewer system at various locations throughout the City. Provides flow data for I&I analyses.

Victoria also hires consultants to assist in formulating overall I&I and overflow reduction and rehab strategies.

Notable Work

2009-2010 – James Bay Pilot Project

In 2009-10, the City also embarked on an Inflow & Infiltration reduction pilot project, located within the James Bay sanitary sewer sub-catchment of the Clover Point catchment.

The City of Victoria's *James Bay Inflow & Infiltration Pilot Project* studied differing approaches to sanitary sewer I&I reduction and rehabilitation using a variety of trenchless technologies (such as lining, grouting, pipe bursting, epoxy wall coating and PVC liners), in four sub-catchments of similar size, age and infrastructure assets in the neighborhood of James Bay.

The project, totaling almost $3,618,000.00, included a detailed pre- and post-rehabilitation study of the sub-catchments over a two year period with the aim of developing a systematic model for identifying the best reduction and rehabilitation strategy for I&I in the sanitary sewers of Victoria. To help pay for this project, the City was able to secure a grant in the amount of $3,000,000, which was funded through the Innovations Fund Grant from the Canada-British Columbia-UBCM Agreement on the Transfer of Federal Gas Tax Revenues

2012

- In a multiyear program to camera inspect and smoke test its entire sewer system by 2016.
- Procured and installed 12 temporary flow meters (one for each of its *I&I Management Plan* catchments that don't have permanent meters).
- Characterized and investigated storm drain to sanitary sewer cross connections identified from the previous years' smoke testing program
- CCTV'ed approximately 36 kilometers of sanitary sewer main
- CCTV'ed approximately 300 sanitary sewer laterals
- Developed a pilot project to identify and quantify the benefit of sanitary sewer lateral and interface sealing strategies
- Trenchless lining (CIPP) of 965 meters of sanitary sewer. As part of the work, when abandoned lateral connections were identified, their flows were prevented from entering the sewer by simply not cutting the CIPP liner at the connection point with the abandoned lateral.
- Trenchless lining (CIPP) of 22 storm sewer laterals up to the property line.

2013

- Monitoring flows in 12 sanitary sewer catchments with elevated I&I for targeted I&I reduction program
- Characterization and investigation of storm drain to sanitary sewer cross connections identified from previous years' smoke testing program
- Carried out a dye testing program
- Cured in place pipe (CIPP) lining of approximately 1km of sanitary sewer mains, only cutting active services
- Repaired, CIPP lined 49 SS laterals
- Camera inspected approximately 36 km of sanitary sewer main
- Camera inspected approximately 350 sanitary sewer laterals

2014

- Collected sewer flow data from 12 catchments to establish baseline flows for use in post rehabilitation effectiveness confirmation
- Relined 1250 meters of sanitary sewer mains
- Camera inspected 22.5 km of sanitary sewer mains
- Prepared tender / RFP documents for smoke testing, relining, and separating Victoria's few combined manholes.

2015

- Developing the citywide predictive sanitary sewer model only,
- Continuing by collecting flow monitoring data in 12 sewer catchments,
- Inspecting by CCTV approximately 17 kilometers of sanitary sewer mains,
- Reviewing by CCTV approximately 252 sanitary sewer laterals,
- Constructing CIPP lining of approximately 3,254 meters of sanitary sewer mains, and
- Smoke testing 45 kilometers of sanitary sewer mains

Planned Special Projects (2016 – 2021)

From 2016 to 2021, the City of Victoria plans to carry out the following I&I related work:

- Development of a new sanitary sewer master plan
    - Victoria plans to hire a consultant to produce/update its sewer master plan for the City in the near future. The Sanitary sewer Master Plan Request for Proposal is expected to be advertised by the end of January 2017 and the City is anticipating in completing the Sewer Master Plan by year end.
- Completion of a citywide predictive sanitary sewer hydraulic model
- Installation and maintenance of three temporary Flo-Dar flow monitors in specific location to help calibrate our new sanitary model, and to review Victoria's I&I criteria, and
- Condition assessment of the Victoria sewer pump stations to help determine long term plans for upgrades.
- Reviewing and assessing the City's sewer camera inspection data and smoke testing data. The results of this will be a prioritized list of rehab projects which will be incorporated into Victoria's sewer master plan.
    - Presently, the City has camera inspected approximately 95% of its sanitary sewers (remaining 5% could not be inspected due to access issues.). This data has been collected since 2009 as part of the City's assessment program and is focused on the condition of the sewer mains.
    - The amount of sewer investigation data is substantial and it will take significant effort to evaluate and prioritize. The results would be incorporated into Victoria's sewer master plan.
- Camera inspections of sewer laterals
    - Via Lamping ® Technology City is planning to inspect laterals from the main to the property line recording date, their condition as well as they are active or abandoned.
    - During the inspection the location of the laterals will be marked on the surface and these points later picked up by the survey crews to be inserted in the City's GIS mapping.
    - This will initially be a pilot project contained within a designated catchment area located in James Bay. From that the scope maybe expanded based on the availability of funds and equipment.
- Existing scheduled upgrades / repairs. This typically included:
    - Citywide annual Lining programs,
    - Planned sanitary main repair/upgrades, and
    - Emergency sewer main repairs.

It's expected that this emergency and general maintenance work will continue until the sewer master plan is updated. Once the CRD's sewage treatment plants are established, the City will commence on major strategic works.

12.5 Asset Management

Integrated Approach

Victoria uses an integrated decision making approach that attempts to increase the benefits of any planned rehab work. This includes discussions between different program and departmental areas to find synergies, using triple bottom line (economic/social/environmental) considerations in the decision making process. The rehabilitation strategy for any facility, ranging from individual pipeline needs to the complete collection system program approach, involves consideration of the all the City's infrastructure and each collection system's structural, service & hydraulic conditions and performance (whether sanitary sewer, storm drain or water). This leads to a long-term planning approach that encompasses the overall needs of the City's entire infrastructure, and takes into consideration limited budgets within each area.

I&I Prevention

Given the high capital costs to substantially reduce I&I in existing systems, Victoria has recognised that preventative measures during new construction can be the most cost-effective I&I management strategy.

Some approaches already in place in Victoria, and other possible recommendations to reduce I&I from new construction include:

Table 12.5: Methods of Reducing I&I from New Construction

Scope	Recommendations
Design Procedures	• Design locations of joints carefully • Design transition between flexible and non-flexible pipe adequately. • Applying the Master Municipal Construction Documents (MMCD), Platinum Edition, printed 2009 and City of Victoria Subdivision and Development Servicing Bylaw No. 12-042.
Inspection of Municipal Installations	• Video inspect sewers after construction (and maybe after 1 year of operation) • Require developer's engineer to certify installation in accordance with municipal standards. • Reviewing bylaws requiring air or hydraulic testing of new laterals and connections to the municipal system after backfilling of the private lateral is completed
Inspection of Private Developments	• Standards to be equivalent to public facilities.
Bylaws	• Existing Sanitary Sewer and Stormwater Bylaws, in conjunction with Storm Drain Master Plan. • Plumbing Inspections Division to notify the homeowner to disconnect inappropriate connections.

Multifaceted Thinking

The overall goal of the I&I Management Plan is to reduce I&I to levels that minimize total conveyance, treatment and disposal costs, coincident with reduction of I&I induced overflows to acceptable levels. Safety, hydraulic and environmental issues are outstanding from the economic considerations and need to factor into any reduction program. As a result, the City of Victoria believes that through timely and appropriate maintenance, I&I can be managed at levels acceptable for the age of the system.

The development of an area priority list and the identification of the critical sub-catchment require the consideration of six main aspects:

Environmental
The main environmental objective in the implementation of an I&I reduction program, as per the Municipal Sewage Regulation (MSR) and the LWMP, is to improve the stormwater quality that is being discharged to the receiving environment. (see Section 5.6.6 for more information regarding the City's SQMP)

Inventory
Sewer systems have critical components, the failure of which would have significant impact on the surrounding environment, and would cause disproportionate repair costs due to their specific attributes. Adequate sewer system management is supposed to account for the higher priority of such components. A selective planned/reactive management approach is generally considered the best policy approach in terms of balancing the need to make cost effective system expenditures on rehabilitation and repair with the requirement to maintain public safety and other critical performance objectives. The identification of this *critical sewer network* is important in implementing any successful I&I reduction plan.

Structural
In order to establish priorities for areas according to their sewer structural condition, it is necessary to examine existing structural condition reports for the components that make up any sewer system, namely the mains/trunks, manholes and laterals. These reports may be available as hardcopy CCTV reports, digital files or as pre-formatted forms, etc. The available data should be reviewed for major defects which would account for structural performance grades that promote I&I.

Hydraulic
In 2017, the City will be hiring a consultant to develop a Sanitary Sewer Master Plan, along with an updated hydraulic model. The identification of hydraulic deficiencies within the sanitary sewer system is an important step for the process of setting priorities. Pipe sections with hydraulic bottlenecks are either undersized for the design sewage flows (due to overdevelopment in the catchment) or are subject to high I&I rates.

Socio-Economic
Sewer sections that are sufficiently sized for today's sewage flows may not be any more if the socio-economic structure of an area is going to change. Expected population growth and planned land developments must be reviewed in discussions with the Planning Department to identify areas with potential increase in sewage flows.

Internal (Public/Political Pressure)
The City of Victoria has considerable exposure to international publicity as the capital of B.C., and matters of prestige and image can play a major role for capital work programs. Reports of contaminated shorelines, inferior water quality or sewage flooding do not suit the image of Victoria. Therefore, consideration should be given during the process of setting priorities to areas of the City where such problems must be avoided.

Tools

Presently, the City uses the following tools:

- Asset Management – Cartegraph,
- Municipal sewer modelling – InfoSWMM,
- CCTV data review– Granite XP. In 2018 Granite NET will replace Granite XP,
- Website map information – VicMap,
- Geographic Information System Data storage – ArcGIS, and
- As-Constructed drawing data integration with ArcGIS – Civil 3D.

12.6 Bylaws

The CRD and participating municipalities have committed in the Core Area Liquid Waste Management Plan (LWMP) to identify needed changes to legislation and legal authority to enable options and strategies with regard to inflow and infiltration.

The following table provides a comparison of the key powers located in the CRD Sample Private Property I&I Model Bylaw to those found in each of the municipality's existing sewer bylaws. The table demonstrate where existing powers appear to be equivalent between the municipal and model bylaw, and where there may be potential gaps. Suggestions or considerations for addressing the gaps are provided. This task was completed as a policy review, by Pinna, for consideration by municipalities when undertaking changes to their existing sewer use bylaws to assist with compliance with LWMP commitments. The municipal bylaw(s) being assessed in the analyses is Bylaw SANITARY SEWER AND STORMWATER UTILITIES BYLAW NO. 14-071.

Table 12.6: Comparing Powers Municipal Bylaw to Sample PPI&I Bylaw

Key section(s) of the sample CRD PPI&I Model Bylaw	Is this section sufficiently addressed in current municipal bylaws and where?	Recommendations
Required maintenance standard (5-6)	Partial 21 – refers to CRD Sewer Use Bylaw 5 which does not allow stormwater 25 (1) – owner must maintain in state of good repair	Clarify "good repair" *(see CRD PPII model bylaw 5 (a) – clear of obstructions; (b) – free of structural defects)*
Unauthorized discharges or connections (7)	Yes 21 – does not allow anything that contravenes CRD Sewer Use Bylaw 5, 2001 – which does not allow stormwater	
Entry and testing by city (8-11)	Yes 34 (1) – NOTE: 15- requires inspection chamber to be installed within 0.3m	To strengthen this, recommend explicitly stating authority to perform tests *(see RD PPII model bylaw 10}*
Required repair of defect (12-14)	Partial 13- requires repair at time of building permit 25 (2)- owner must clear a stoppage on private side	Section 34 enables inspection, however, recommend a clear section that requires the repair of defects found
Sewer lateral work – permit required (15-16)	No	Recommend updating to require repair upon notice of defect, in addition to current requirement to remove a stoppage *(see CRD PPII model bylaw 15)* Consider adding a statement that a permit is required for this work *(see CRD PPII model bylaw 16)*
Financial assistance (17-21) and Monetary incentive for voluntary inspection and repairs (22-27)	No	These sections are optional in the sample model bylaw. Municipalities may opt to provide assistance and/or incentives to homeowners who voluntarily conduct inspections and repairs of private sewer laterals (for suggested language, see *CRD PPII model bylaw 17-27*). Also see *CRD PPII model bylaw 35* for no liability statement.
Failure to comply – offence and penalties (28-35)	Partial 36 – fine of up to $10,000, each day is considered a separate offence	See *CRD PPII model bylaw 33(c)* allows the City to perform work and recover costs where the owner has failed to come into compliance with the bylaw.

12.6 Private Property I&I

Along with its bylaw requirements, Victoria has the following mechanisms related to private property I&I:

- Requirements for new development (camera testing, etc).
  - With new developments, the City of Victoria (City) is responsible in constructing and maintaining the City's service connections. If the City discovered a cross-connection in the City's property and statutory right-of-way, the City will correct this issue at City's cost. However, if the cross connection is in private property, it is the responsibility of the owner(s) of the property to correct this problem at his or her cost. Under the City's on-going implementation and enforcement of the Stormwater Codes of Practice the City is working with property owners and businesses on proper implementation and ongoing maintenance of their storm facilities. The City will only use CCTV on City's property and right-of-way.

- Requirements at time of major renovation.
  - Through the City of Victoria, the private owner is required to confirm their connection to the City's Storm Drain system. In the event that such connection is non-existence, they required to either install a new rock pit or apply for a new lateral and have it installed as part of the overall City's permit review. If a certified Geotechnical Engineering firm confirms in a written report that the rock pit is not suitable because of their existing ground condition and there is no storm main fronting their property, plus they have previously had a cross-connection to the sewer main, the private owner may continue to connect until the City extends the storm main fronting their properties. Once the City constructs this new storm main extension, the private owner will need to apply for a new storm service connection.

- Installation of new inspection chambers.
  - All new installations have Inspections chambers installed as per Master Municipal Construction Document (MMCD).
  - To prevent cross-connecting the storm and sanitary services are tagged with a 40 cm x 90 cm post marked with depth post and plug being coloured "RED" for the sanitary sewer service connection as addressed in the MMCD drawing S7. While the post and plug being coloured "GREEN for the storm drain service connection, as addressed in the MMCD drawing S8.

- Verification of existing service connections
  - The City continues to perform smoke testing to all services in the City. When there is a discrepancy, the City will follow through by conducting a dye test on private property with only private owner's written permission.

- Bylaws
  - Should a cross connection be found and traced to exist on private side, the private owner is informed by a letter from the City of Victoria the deficiency.

The CRD also carries out private property I&I related work. In general, this work focusses on education, research, program options, bylaw wording, municipal coordination, reporting, stakeholder engagement (i.e. realtors, plumbers) and exchanging info and working with other jurisdictions (i.e. regional districts).

12.7 Budget

Victoria's I&I related sewer budget is summarized in Table 12.7 and 12.8.

Victoria's I&I related work is funded through its Capital, Operations, and I&I budgets. The Capital works budget is used to fund rehabilitation and replacement related projects. The Operations budget is used to fund maintenance related works for the existing infrastructure. Table 4 shows Victoria's proposed capital budgets over the next five years. Table 12.8 shows Victoria's sewer budget for 2016.

Table 12.7: Summary of Victoria's Sewer Budget

Budget	Value
Total [1]	
New Construction – capital budget 2016	$2,949,000
Annual Maintenance - operating budget 2016 for public works underground operations and utilities underground section.	$7,874,200
System planning and System assessment	$620,000

1 Source documents – 2016 COV Financial Plan

Table 12.8: Proposed Five Year Capital Plan Budgets 2016 - 2020

Capital Program	2016	2017	2018	2019	2020
Rehabilitation	$475,000	$500,000	$500,000	$500,000	$500,000
Replacement	$1,062,000	$1,010,000	$2,000,000	$2,100,000	$2,205,000
Inflow & Infiltration	$1,412,000	$613,000	$668,000	$727,000	$788,000

Table 12.9: Comparison of Sewer System Value to Annual Budget

Category	Value
Anticipated Design Life of Sewer • *Consistent with asset management accounting value (i.e. PSAB)*	
Estimated Sewer System Replacement Value ($)	$345,000,000
Annual Budget / Replacement Value (%)	$2,867,000

In general, municipalities need to ensure that budgets are sufficient to maintain their sewer assets. For example, if a municipality expects its sewer assets to last 100 years then, on average, it should be setting funding equivalent to 1% of the replacement cost for the sewer system each year (i.e. 1 percent replacement cost / year x 100 years = 100%). Municipalities with younger sewers may decide that it's prudent to commit lower funding levels to sewer work as younger sewers generally require less rehabilitation work. Municipalities with older sewers may need to commit higher funding levels for sewer work, as their sewers reach the end of their service life.

12.8 Victoria Summary

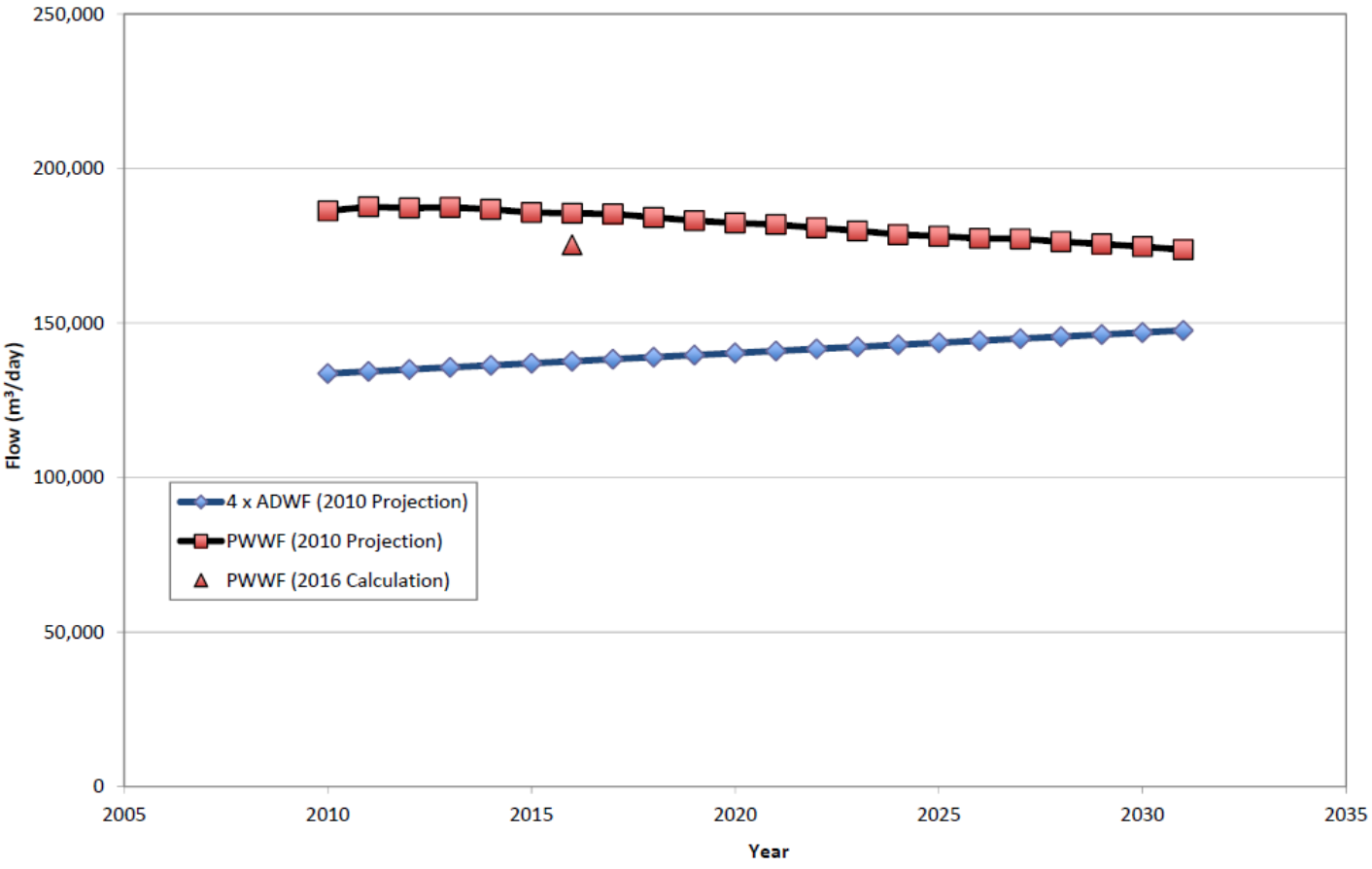
Victoria has been divided into 29 sewer catchments for this plan. In summary:

- All of the catchments contain elevated I&I and are in archetypes E or F.
- Victoria is in the process of camera inspecting and smoke testing all of their sewers.
- Victoria has updated its hydraulic model.
- Victoria will be developing a Sanitary Sewer Master Plan

- Victoria will be identifying its critical sewer network.
- Significant I&I reduction work is anticipated over the timeline of this plan.
- Peak Wet Weather Flow exceeds 4x Average Dry Weather Flow in many Victoria's catchments.

Figure 12.3 shows the anticipated PWWF and 4xADWF for 2012 to 2031 for Victoria as a whole. The blue line on the graph represents 4x ADWF. The 4x ADWF is a threshold which the Liquid Waste Management Plan has identified as a goal for the maximum flow to be conveyed and treated. This line generally increases over time due to population growth; the steeper the slope, the higher the projected growth. Various regional infrastructure including the waste water treatment plants have been sized to accommodate the projected 4x ADWF and this unit of measure is not influenced by wet weather flows. The red line on the graph represents PWWF. The PWWF includes normal sewer flows plus inflow and infiltration. It is the actual sewer flow generated during a peak rain storm event. In order to not exceed the capacity of the sewer system and to prevent overflows, the "red" PWWF line should remain under the "blue" 4x ADWF line. This is one of the primary goals noted in the Core Area Liquid Waste Management Plan.

Figure 12.3: Projected Peak Wet Weather Flow and 4x Average Dry Weather Flow for Victoria



Significant I&I reduction work is required to be reduce Victoria's PWWF below the 4xADWF target. It is not anticipated that this will be complete prior to 2031. However, I&I reduction is expected, and based on the projected level of funding it is estimated that the target will be reached.

13 VIEW ROYAL

13.1 View Royal Overview

The Town of View Royal is located in the Core Area of the CRD. It was incorporated in 1988. It is approximately 1,448 hectares in size and has a population of approximately 9400 residents.

View Royal's first sewers were installed in 1971. The average age of the sewer system is 28 years. The sewer system services approximately 98% of the properties in View Royal. The rest of the properties are serviced by septic systems or onsite sewer systems. In total, there are approximately 43 kilometers of sewer pipe in View Royal, of which 94% PVC. There are also approximately 765 manholes.
View Royal has 14 overflow locations, no combined manholes and no combined sewers. View Royal's pump stations are monitored for overflows but the overflow volumes are not measured. View Royal has not had an I&I related sewer overflow in well over five years. If overflows were to occur, the event would be documented, reported to PEP, and mitigated / cleaned up by an on-call contractor.

Since 2004, sewer flow monitoring has been continuously carried out at each of View Royal's pump stations. The data from 10 of these pump station is suitable for I&I analyses. In addition, one temporary gravity sewer location was monitored for a few seasons. The flow meter data indicates that View Royal's I&I generally does not significantly impact View Royal's municipal sewers or the regional sewer system.
View Royal focuses its I&I efforts on preventative sewer maintenance and system renewal. This includes the periodic upgrading of pump stations, the repair or replacement of sewer pipe, CCTV sewer inspections, and manhole inspections.

View Royal has 17 pump stations. Each of the pump stations is are monitored using SCADA, 9 have backup power, 8 have connections for portable generators, and none have storage tanks. The pump stations are maintained by Esquimalt crews and the SCADA system is maintained by View Royal staff. Currently, the SCADA system is used to generate sewer flow data from the pump stations.

View Royal takes efforts to prevent I&I resulting from new construction by requiring CCTV, pressure testing and inspections.

View Royal's stormwater drainage system consists of ditches, which are maintained by private contractors.

View Royal contributes to the Core Area I&I Subcommittee and its initiatives. These include: regional I&I reports for the Province such as Biennial I&I Reports and the Overflow Management Plan; annual/semiannual Core Area Inflow and Infiltration Program I&I Analyses Results Reports, and various region wide public education initiatives.

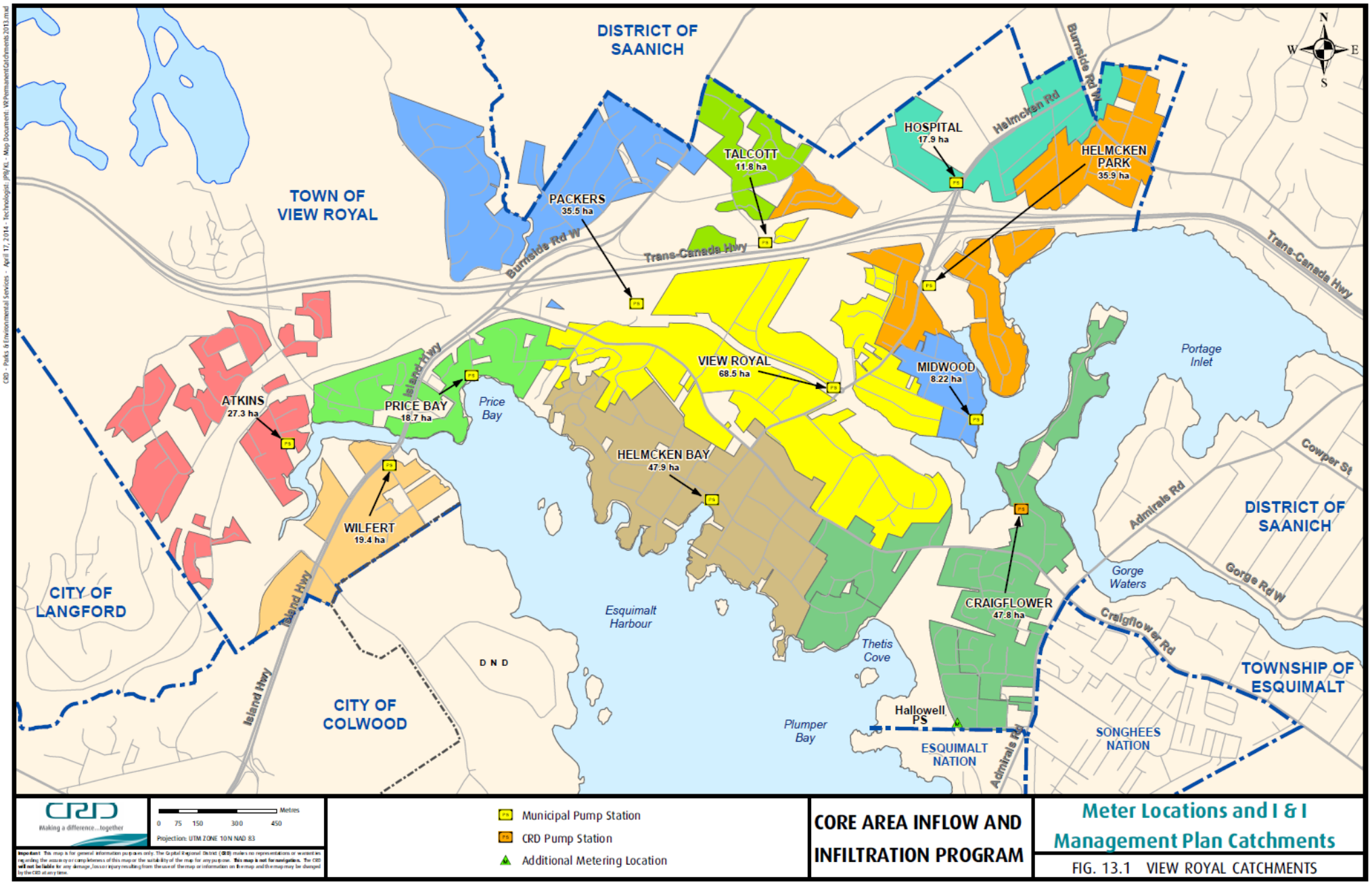
13.2 Catchments

Long-Term Monitoring Catchments

View Royal's sewer system is divided into 11 long-term flow monitoring catchments. The catchments were chosen based on existing pump stations and permanent flow monitoring stations which provide consistent reliable long-term flow data. All of View Royal's long-term monitoring catchments are appropriately sized based on the recommendations in the I&I Management Plan (2012). The catchment names are the same as their associated pump station names. Each catchment has a unique site code that enables the tracking and comparison of I&I results for specific flow meter locations over time. The catchments are shown on a map in Figure 13.1 and listed in Table 13.1.

Additional Catchments

Since 2012, an additional 3 catchments have been flow monitored an analyzed for I&I in View Royal. The catchments are listed in Table 13.1.


DISTRICT OF SAANICH
TOWN OF VIEW ROYAL
CITY OF LANGFORD
CITY OF COLWOOD
DISTRICT OF SAANICH
TOWNSHIP OF ESQUIMALT
SONGHEES NATION
ESQUIMALT NATION
D N D
PACKERS 35.5 ha
TALCOTT 11.8 ha
HOSPITAL 17.9 ha
HELMCKEN PARK 35.9 ha
VIEW ROYAL 68.5 ha
MIDWOOD 8.22 ha
ATKINS 27.3 ha
PRICE BAY 18.7 ha
HELMCKEN BAY 47.9 ha
WILFERT 19.4 ha
CRAIGFLOWER 47.8 ha
Hallowell PS
Trans-Canada Hwy
Burnside Rd W
Helmcken Rd
Island Hwy
Price Bay
Portage Inlet
Esquimalt Harbour
Thetis Cove
Plumper Bay
Gorge Waters
Admirals Rd
Cowper St
Gorge Rd W
Craigflower Rd
N
S
E
W
Municipal Pump Station
CRD Pump Station
Additional Metering Location
Metres
0 75 150 300 450
Projection: UTM ZONE 10N NAD 83
Making a difference...together
CORE AREA INFLOW AND INFILTRATION PROGRAM
Meter Locations and I & I Management Plan Catchments
FIG. 13.1 VIEW ROYAL CATCHMENTS

13.3 Inflow & Infiltration Data

Historical Data Collection

Prior to 2011, a significant amount of data was collected and consolidated for each of View Royal's long-term monitoring catchments. Much of this is summarized in the I&I Management Plan (2012) which includes:

- I&I data (5-year peak I&I rates; presence of overflows, average flows and peak wet weather flows)
- Catchment size, number of properties, and number of laterals.
- Percentage land use (single family, multi family, commercial, industrial, and institutional)
- Number of manholes and pump stations
- Sewer age and pipe materials.
- Type of flow meter.
- Detailed catchment maps with associated GIS information.
- Catchment "archetype" classifications for each of the municipality's long-term monitoring locations.
    - *For the I&I Management Plan, seven categories of archetypes were developed. The archetypes are delineated based on sewer age and I&I rates. Each archetype contains a typical list of rehabilitation actions needed and a "per meter" budget number to complete the work. The archetypes are designed to be used for high level budget and planning purposes. If investigation work is completed (i.e. CCTV and smoke testing), archetypes should be replaced with specific rehabilitation plans containing specific budgets.*

Current Data Collection

Significant catchment data was collected, analyzed, and/or updated between April 2010 and March 2016. This data is summarized in Table 13.1 and includes:

- Catchment sizes
- Average pipe ages
- Current peak 1-hour I&I rates
- If a catchment has "rapid I&I"
- If a catchment exceeds 4x average dry weather flow
- 5-year 24 hour I&I rate and projected rate at 2031 (based on current precipitation rates)
- Catchment archetype classification and budget estimates based on the current I&I analyses.
- I&I rates for "additional catchments" (i.e. different than the long term monitoring catchments) that have been analyzed since 2012.

Figure 13.2 shows how catchments were classified into archetypes based on average sewer age and I&I rates. This is the same system that was used in the Core Area I&I Management Plan (2012). An overview of the archetype methodology is located in Section 5

Table 13.1: Summary of I&I in View Royal by Catchment

I&I Management Plan Catchments	General Info			Inflow & Infiltration							
	Site Code	Size (ha)	Pipe Ave. Age	Peak 1-hr I&I Rate *(l/ha/day)*	5-yr, 24-hr flows compared to ADWF	Rapid I&I? [1]	5-yr, 24-hr I&I Rate [2] (l/ha/day)				
							2010	2012	2014	2016	Archetype
Atkins	VR11	27.3	13	38,295	3.3x ADWF	no	25,879	23,380	22,441	23,150	B
Craigflower [3]	VR7A	37.3	30	~23,000	~5.4x ADWF	no	9,672	9,672	9,672	13,313	A
Helmcken Bay	VR9	47.9	31	18,939	5.4x ADWF	no	7,758	8,116	11,099	13,319	A
Helmcken Park	VR10	35.9	32	22,864	3.2x ADWF	no	17,676	16,381	13,398	15,292	A
Hospital	VR14	17.9	34	n/a	1.7x ADWF	no	5,862	5,862	5,862	23,296	B
Midwood	VR16	8.2	32	17,807	2.9x ADWF	no	8,269	10,524	10,281	7,390	A
Packers	VR3	35.5	23	22,148	2.9x ADWF	no	17,701	12,100	12,978	12,563	B
Price Bay	VR12	18.7	31	47,127	4.0x ADWF	no	1,672	17,040	27,617	35,187	E
Talcott	VR15	11.8	12	18,085	3.5x ADWF	no	12,765	11,175	13,689	12,034	B
View Royal [3]	VR8A	67.3	31	17,393	~3.5x ADWF	no	9,672	9,672	10,192	8,863	A
Wilfert	VR17	19.4	13	~10,000	3.1x ADWF	no	16,729	16,729	16,729	6,031	A
Additional Catchments											
Glenarlie	VR18	1.3	n/a	~24,500	2.6x ADWF	no	n/a	n/a	n/a	14,385	
Hallowell	VR2	5.9	9	~31,500	2.0x ADWF	no	n/a	n/a	n/a	18,475	
View Royal (Total Metered Area)	VR8	183.8	24	17,392.82	3.5x ADWF	no	n/a	n/a	n/a	8,863	
Heddle	VR19	6.1	n/a	~9500	2.7x ADWF	no	n/a	n/a	n/a	5,557	
Stewart	VR20	4.3	n/a	28,733.02	10.2x ADWF	no	n/a	n/a	n/a	23,070	
Norquay	VR21	1.3	n/a	~10,500	2.9x ADWF	no	n/a	n/a	n/a	6,154	

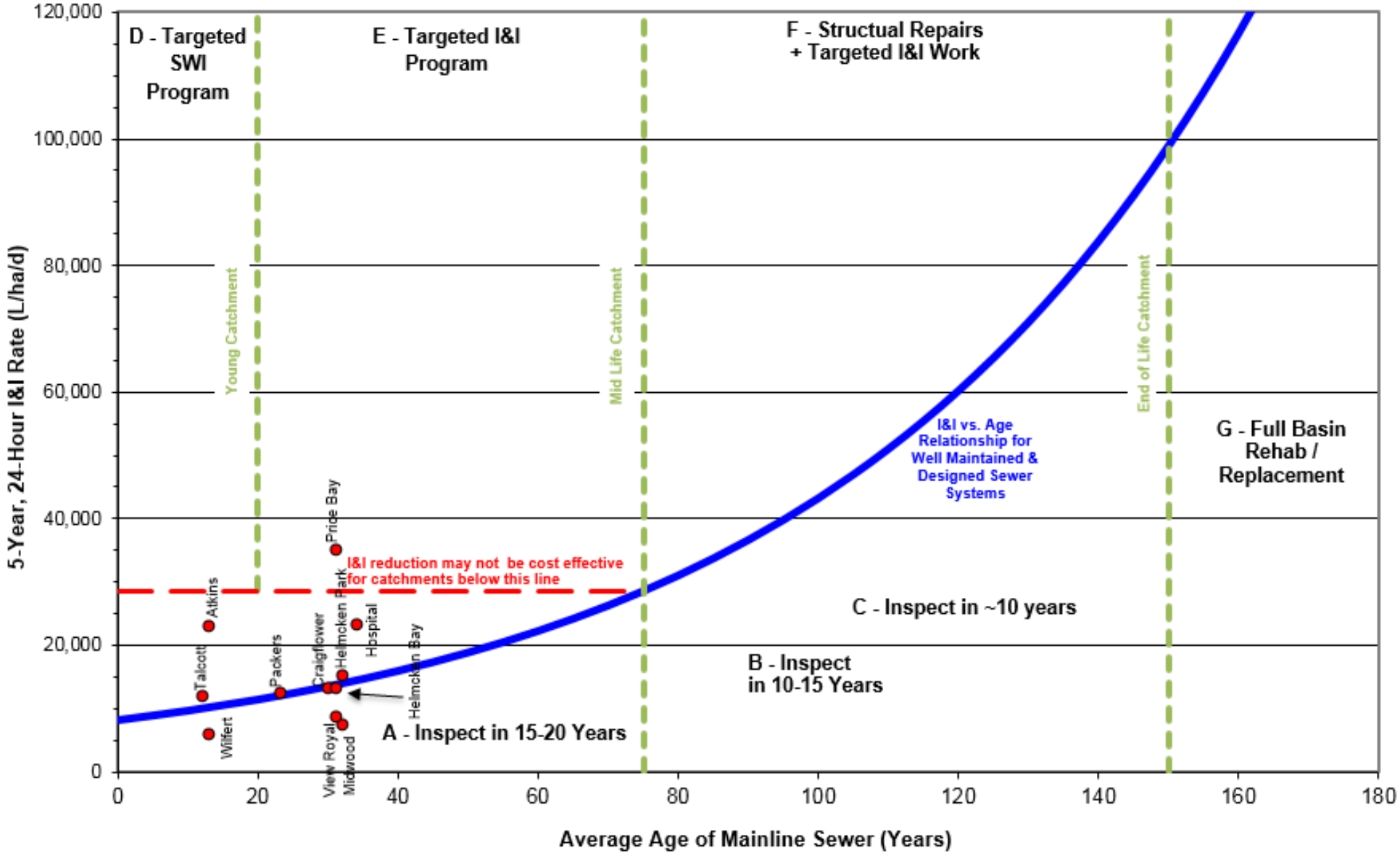
Footnotes:

5 Catchments are considered to have some level of rapid I&I if flows more than doubled during one of two extremely intense 1 hour long dry weather storm events that occurred in 2014. This is documented in the Core Area Inflow & Infiltration Program Annual Report for 2014.

6 Rates up to 2014 were calculated based on the peak 1-hr I&I. The 2016 rate was calculated based on a stand-alone I&I analyses.

7 This catchment does not have its own sewer meter. Its data will always be derived mathematically using data from nearby catchments.

Figure 13.2: Classification of View Royal's Sewer Catchments in Archetypes



Flow Data Analyses

As shown in Table 13.1, ten out of eleven of View Royal's municipal catchments are classified in archetypes A and B. These catchments have low I&I and no flow related signs of structural issues.

Table 13.2 should be used for planning and budgetary purposes only. It shows typical recommended actions for each archetype divided into three phases.

- Phase 1 actions includes data collection. View Royal has permanent ongoing flow meter data for each of its long-term monitoring catchments. Data collection for this phase is considered routine and ongoing.
- Phase 2 actions include investigation work, which can be used to create catchment rehabilitation plans. As View Royal doesn't have elevated I&I, the work for this phase includes View Royal's sewer camera inspection program.
- Phase 3 actions involve rehabilitation work. As View Royal's catchments have low I&I, specific I&I reduction work is not required. However, it's likely that point repairs and other minor maintenance work will be required over time, based on CCTV work and other inspections.

Table 13.2: Projected I&I Related Work Required Based on Catchment Archetype Classification

Archetype	Phase 1: Data Collection	Phase 2: Investigation Work *(percent of catchment)*	Phase 3: Rehabilitation Work *(percent of catchment)*	Component Costs *($/m)*
A	Flow Monitoring (ongoing)	CCTV Condition Assessment (15-20 years)	Point Repairs (0.1%)	$16 / meter *Plus $5000 for flow monitoring*
B	Flow Monitoring (ongoing)	CCTV Condition Assessment (10-15 years)	Point Repairs (0.1%)	$16 / meter *Plus $5000 for flow monitoring*

Please note that the archetypal methodology presents a plausible rehabilitation plan for catchments that don't have compete investigation data. It is to be used as a planning tool to guide budgeting and estimate I&I reduction effectiveness. It is intended that the archetype work programs for each catchment will be replaced by targeted I&I reduction programs based on investigative data for catchments with Archetypes D – G or an asset management program.

13.4 Sewer Infrastructure Maintenance & Capital Work

Routine Work

View Royal carries out a number of actions related to preventative maintenance and long term asset management of gravity sewers, manholes and appurtenances. Table 13.3 summarizes this work.

Table 13.3: View Royal's Preventative Sewer Maintenance Activities

Category	Performed By	Frequency	Notes
Rehab / Replacement			
Sewer Relining	Contractor	As Required	n/a
Sewer replacement / upsizing	Contractor	As Required	n/a
Manhole Rehab	Contractor	As Required	n/a
Manhole Replacement	Contractor	As Required	n/a
Investigation Work			
CCTV	Contractor	Varies with age of infrastructure or noted maintenance or hydraulic issues	• Required for all new construction. • Prioritized by suspected problem areas. • Attempting to CCTV 1/5th of View Royal per year on an ongoing basis. • Do not have a target of comprehensive coverage.
Manhole Inspections	View Royal staff	As required	No formal program
Smoke Testing	Contractor	As required	No formal program
Dye Testing	Contractor/View Royal staff	As required	No formal program
Routine Maintenance			
Sewer Cleaning (Flushing)	Contractor	As required	Carried out after CCTV work to focus the work on areas that need to be cleaned.
Pump Station Maintenance	Esquimalt crews	ongoing	n/a
SCADA Monitoring	View Royal staff	ongoing	New SCADA system to be installed in 2012.

Notable Work Completed

Prior to 2012

- Creation of a long-term CCTV program. (The current round of CCTV info is being collected as part of a 5-year project.)
- A SCADA system upgrade including new software, a new server, and a new terminal.
- Reviewing bylaws.
- Creating a hydraulic sewer model

2012

- In the process of collecting camera inspection data (CCTV) for the entire municipality

- Carried out upgrades on the Stewart pump station.

2013

- Completed the upgrade of the Stewart Pump Station including installing a flow meter, new dry well, new pumps, new kiosk and emergency generator.
- Spent $25,000 on CCTV and flushing of sanitary sewer mains.
- Inspected sewer manholes for I&I in the area that the CCTV work was done.
- Continued routine maintenance of its sanitary sewer system.

2014

- Upgraded the Heddle Pump Station, complete with flow meter, dry well, control kiosk, new Flygt pumps and emergency generator.
- Inspected sanitary sewer manholes for evidence of infiltration.
- In 2014, new regulations required that municipalities get confirmation from Fortis BC that there are no gas lines improperly running through the sewers prior to municipalities doing sewer cleaning or CCTV work. View Royal was unable to get this confirmation until the end of the 2014. As a result, no camera inspections were carried out in 2014.

2015

- CCTV of Midwood Siphon
- Completed 2 pump replacement at Heddle Pump Station

2016

- CCTV 20% of municipality
- Six manhole repairs
- Two pump replacements – Helmeken Park and Stoneridge Pump Stations
- Price Bay Pump Station upgrade

Planned Special Projects (2017 – 2021)

- CCTV 20% of municipality
- Price Bay Pump Station upgrade completion
- Two manhole repairs and four main interface repairs that are I&I related
- Thetis Cove Pump Station upgrade
- Complete 100% of CCTV

13.5 Asset Management

View Royal encourages discussions between different program areas prior to starting any new works. Effort is made to find synergies to help maximize triple bottom line considerations in the decision making process.

13.6 Bylaws

The CRD and participating municipalities have committed in the Core Area Liquid Waste Management Plan (LWMP) to identify needed changes to legislation and legal authority to enable options and strategies with regard to inflow and infiltration.

The following table provides a comparison of the key powers located in the CRD Sample Private Property I&I Model Bylaw to those found in each of the municipality's existing sewer bylaws. The table demonstrate where existing powers appear to be equivalent between the municipal and model bylaw, and where there may be potential gaps. Suggestions or considerations for addressing the gaps are provided. This task was

completed as a policy review, by Pinna, for consideration by municipalities when undertaking changes to their existing sewer use bylaws to assist with compliance with LWMP commitments. The municipal bylaw(s) being assessed in the analyses is Bylaw No. 397 "A Bylaw to Regulate the Provision, Operation and Administration of View Royal's Sewerage System and to Provide for the Imposition and Collection of Fees and Charges for its Use".

Table 13.4: Comparing Powers Municipal Bylaw to Sample PPI&I Bylaw

Key section(s) of the sample CRD PPI&I Model Bylaw	Is this section sufficiently addressed in current municipal bylaws and where?	Recommendations
Required maintenance standard (5-6)	No	See *CRD PPII model bylaw 5-6*
Unauthorized discharges or connections (7)	Partial 9 – prohibits roof drain or storm water drain from connecting to sewer system	Consider strengthening by prohibiting anything other than sanitary waste in the sewer (see *CRD PPII model bylaw 7*)
Entry and testing by city (8-11)	Yes 27 – Town may enter on property to ascertain whether bylaw is being observed	To strengthen this, recommend explicitly stating authority to perform tests *(see CRD PPII model bylaw 10)* or that it is an offence to prevent inspection *(see CRD PPII model bylaw 11)*
Required repair of defect (12-14)	No	See *CRD PPII model bylaw 12-14*
Sewer lateral work – permit required (15-16)	Partial 17 – Must obtain a permit prior to connection	Consider adding a statement that a permit is required for repair or replacement work *(see CRD PPII model bylaw 16)*
Financial assistance (17-21) and Monetary incentive for voluntary inspection and repairs (22-27)	No	These sections are optional in the sample model bylaw. Municipalities may opt to provide assistance and/or incentives to homeowners who voluntarily conduct inspections and repairs of private sewer laterals (for suggested language, see *CRD PPII model bylaw 17-27*). Also see *CRD PPII model bylaw 35* for no liability statement. To provide financial assistance, the municipality would need to comply with the notice requirements of the Community Charter, section 24. To provide a monetary incentive, the municipality may develop a Council-approved program as an alternative to including these sections in bylaw.
Failure to comply – offence and penalties (28-35)	Yes 28 – Allows Council to undertake action at expense of owner and recover expense 29 – Penalty may be $100 to $1,000 (first offense) or $200 to $2,000 (subsequent) per day	*CRD PPII model bylaw 33(a)* provides a penalty option to discontinue service of water supply to the property as an additional avenue for enforcement of the bylaw.

13.7 Budget

View Royal's budgets are set out in 5-year plans that get adjusted annually. The budgets consist of routine / ongoing work and special projects. The routine / ongoing budgets increase each year in line with inflation. The special projects budgets require council approval each year.

View Royal's I&I related sewer budget is summarized in Table 13.5.

Table 13.5: Summary of View Royal's Sewer Budget

Budget	Value
Total for 2016	
Capital Budget	$413,400
Annual Maintenance (Ppump station and pipe repairs, maintenance)	$311,500

In general, municipalities need to ensure that budgets are sufficient to maintain their sewer assets. For example, if a municipality expects its sewer assets to last 100 years then, on average, it should be setting funding equivalent to 1% of the replacement cost for the sewer system each year (i.e. 1 percent replacement cost / year x 100 years = 100%). Municipalities with younger sewers may decide that it's prudent to commit lower funding levels to sewer work as younger sewers generally require less rehabilitation work. Municipalities with older sewers may need to commit higher funding levels for sewer work, as their sewers reach the end of their service life.

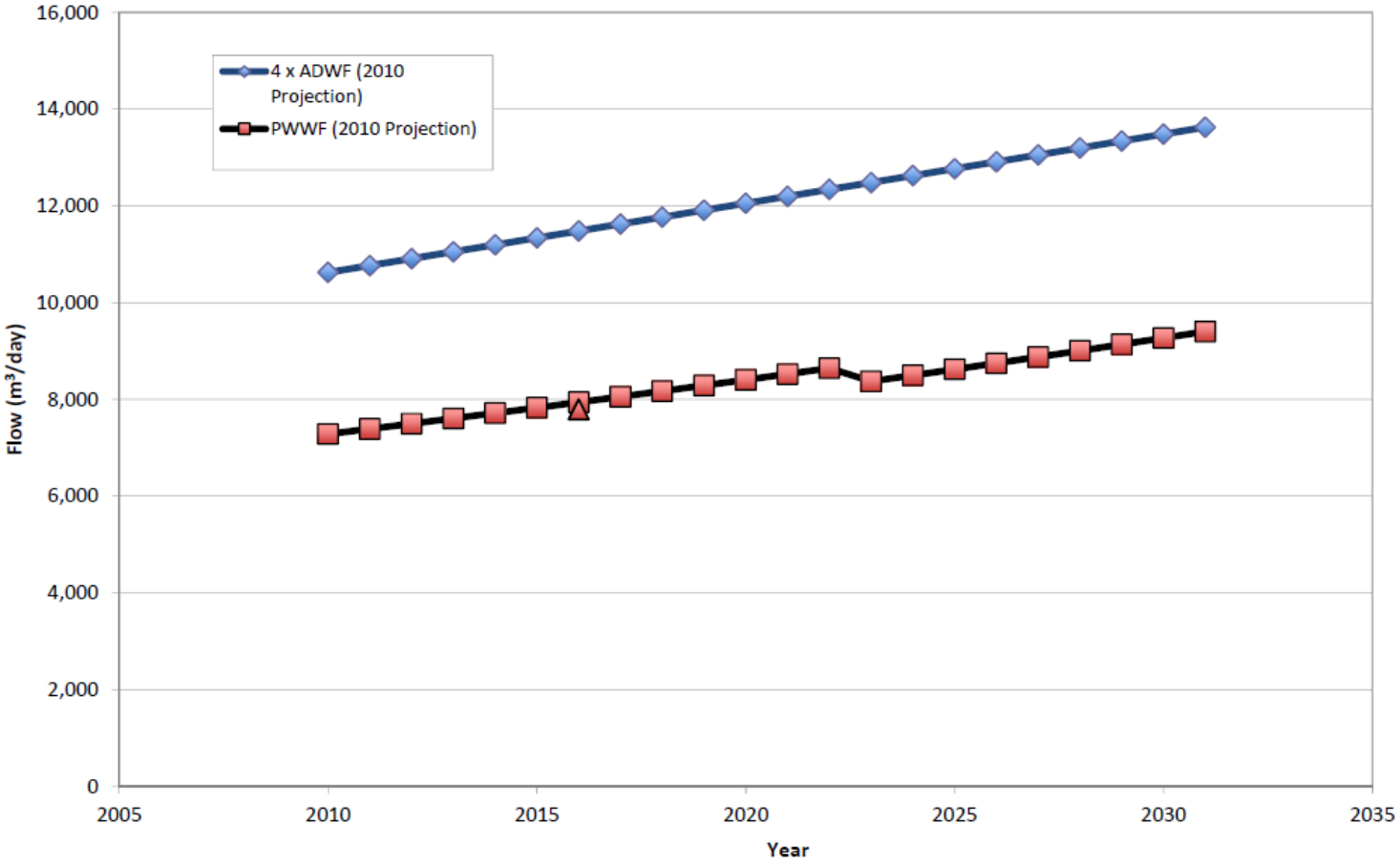
13.8 View Royal Summary

View Royal has been divided into 11 sewer catchments for this plan. In summary:

- One of View Royal's municipal catchments currently has elevated I&I.
- Peak Wet Weather Flow exceeds 4x Average Dry Weather Flow in three of eleven catchments.
- The catchments will be periodically flow monitored and CCTV'ed as part of the plan. Sources of new I&I will be addressed as required.
- The I&I budget for the municipality appears to be sufficient at present.

Figure 13.3 shows the anticipated PWWF and 4xADWF for 2012 to 2031 for View Royal as a whole. The blue line on the graph represents 4x ADWF. The 4x ADWF is a threshold which the Liquid Waste Management Plan has identified as a goal for the maximum flow to be conveyed and treated. This line generally increases over time due to population growth; the steeper the slope, the higher the projected growth. Various regional infrastructure including the waste water treatment plants have been sized to accommodate the projected 4x ADWF and this unit of measure is not influenced by wet weather flows. The red line on the graph represents PWWF. The PWWF includes normal sewer flows plus inflow and infiltration. It is the actual sewer flow generated during a peak rain storm event. In order to not exceed the capacity of the sewer system and to prevent overflows, the "red" PWWF line should remain under the "blue" 4x ADWF line. This is one of the primary goals noted in the Core Area Liquid Waste Management Plan.

Figure 13.3: Projected Peak Wet Weather Flow and 4x Average Dry Weather Flow for View Royal



Minimal I&I reduction work is anticipated to be required to keep PWWF below the 4xADWF target until beyond 2031. It is anticipated that Peak Wet Weather Flow for the Town as a whole will remain below 4x-Average Dry Weather Flow to beyond 2031.

14 ESQUIMALT NATION

The Esquimalt Nation is located on the southern tip of Vancouver Island, within the Capital Regional District (CRD). It is located adjacent to the Songhees Nation and the municipalities of Esquimalt and View Royal.

The Esquimalt Nation Reserve is approximately 20 hectares in size. The property contains residential housing, green space, and a leased area containing a cement mixing plant.

Each of the buildings on the Reserve, except for the cement mixing plant, is believed to be connected to the Nation's sanitary sewer system. The Esquimalt Nation owns and operates its own sanitary sewer system, which includes:

- 1230 meters of gravity sewers;
- 344 meters of force main sewers;
- 17 manholes;
- 4 sewer cleanouts;
- approximately 35 sewer laterals; and a
- sewage pumping station.

The Nation's sewer flows are discharged directly into the CRD sewer system. Figure 14.1 contains a map showing the Esquimalt Nation's sewer system and a catchment evaluation table.

The Esquimalt Nation had a meter installed in the pump station kiosk in October 2010. The meter recorded pump "start and stop" data which was converted into flow data. As of 2011, however, the meter is no longer operational or collecting data.

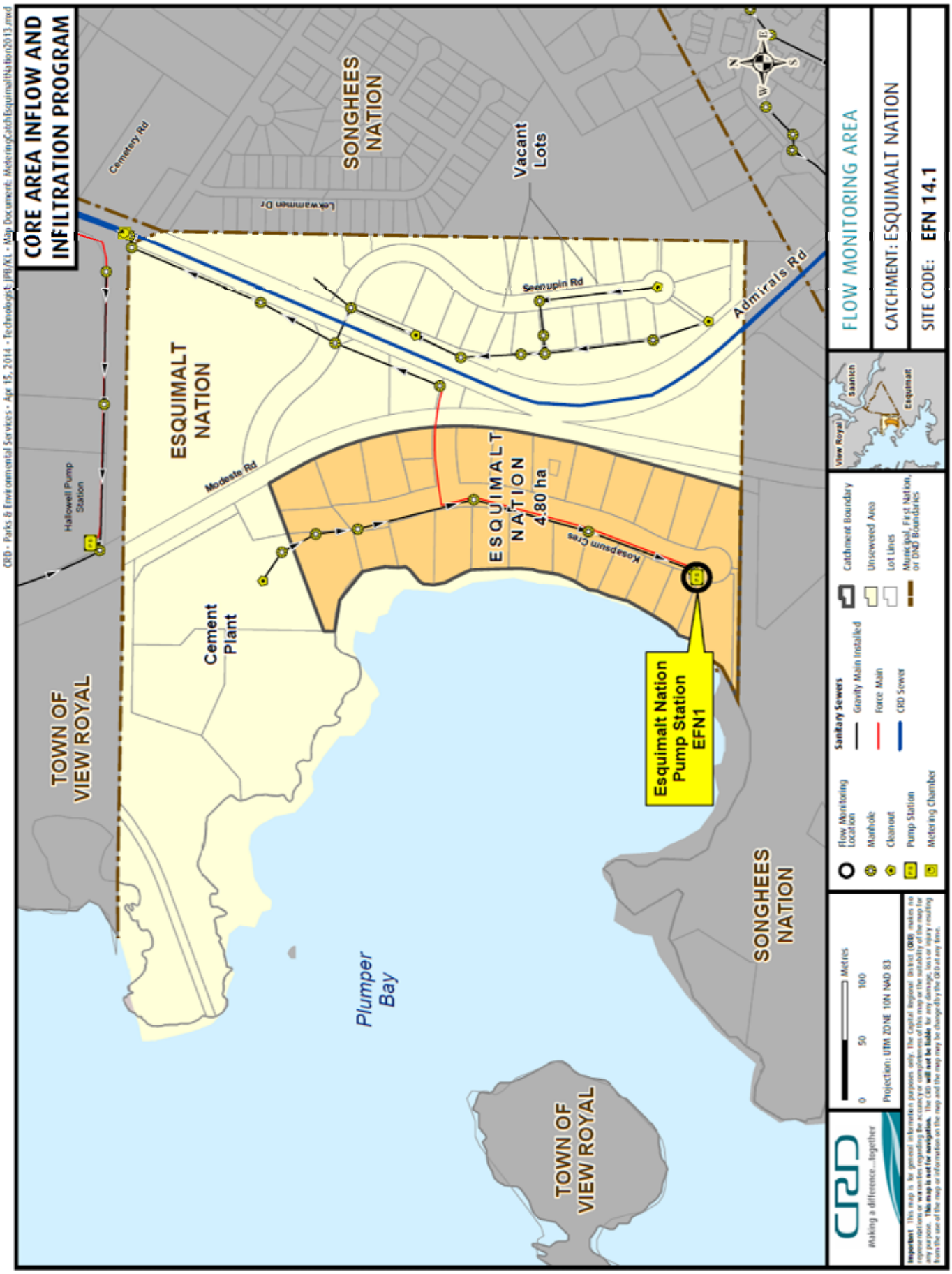
(The pump station is located on the south end of Kosapsum Crescent and only receives sewer flows from the portion of the Reserve located west of Admirals Road. Sewer flows from the portion of the reserve located east of Admirals Road have not been monitored.)

The most recent 24-hour I&I rate based on the pump station sewer meter is 44,300 l/ha/day.

In early 2009, the CRD was asked to provide a preliminary assessment of the Esquimalt Nation's gravity sewers and pump station. The Nation asked for the assessment to better understand if rainwater is taking up their valuable sewer capacity. The CRD conducted the assessment which included the following:

- collecting GPS coordinates for the sewer manholes, determining the direction of sewer flow, inputting the information into GIS, and generating approximate maps.
- an assessment of sewer flows;
- closed circuit television (CCTV) inspections of the gravity sewers;
- smoke testing of the gravity sewers;
- sanitary sewer manholes inspections; and
- a visual assessment of the pump station electrical kiosk and wetwell.

Upon completion of the assessment, the results were summarized into a report which included a list of potential future actions. The CRD recommended that an independent expert review the report, make recommendations and, if required, help prepare a grant application to the Department of Indian and Northern Affairs to fund the work.


CORE AREA INFLOW AND INFILTRATION PROGRAM
SONGHEES NATION
Vacant Lots
Cemetery Rd
Lekwammen Dr
Seenupin Rd
Admirals Rd
ESQUIMALT NATION
Modeste Rd
Hallowell Pump Station
ESQUIMALT NATION 4.80 ha
Kosapsum Cres
Cement Plant
Esquimalt Nation Pump Station EFN1
TOWN OF VIEW ROYAL
Plumper Bay
SONGHEES NATION
TOWN OF VIEW ROYAL
FLOW MONITORING AREA
CATCHMENT: ESQUIMALT NATION
SITE CODE: EFN 14.1
View Royal
Saanich
Esquimalt
Catchment Boundary
Unsewered Area
Lot Lines
Municipal, First Nation, or DND Boundaries
Sanitary Sewers
Gravity Main Installed
Force Main
CRD Sewer
Flow Monitoring Location
Manhole
Cleanout
Pump Station
Metering Chamber
Metres
0
50
100
Projection: UTM ZONE 10N NAD 83
CRD
Making a difference...together
Important: This map is for general information purposes only. The Capital Regional District (CRD) makes no representations or warranties regarding the accuracy or completeness of this map or the suitability of the map for any purpose. This map is not for navigation. The CRD will not be liable for any damage, loss or injury resulting from the use of the map or information on the map and the map may be changed by the CRD at any time.
CRD - Parks & Environmental Services - Apr 15, 2014 - Technologist: JPB/KL - Map Document: Metering/CatchEsquimaltNation2013.mxd

15 SONGHEES NATION

The Songhees First Nation is located on the southern tip of Vancouver Island, within the Capital Regional District (CRD). It is located adjacent to the Esquimalt Nation and the municipalities of Esquimalt and View Royal.

The Songhees First Nation Reserve is approximately 68.7 hectares in size and consists of two separate catchments; one near Admirals Road and Craigflower Road and the other near Admirals Road and Maplebank Road.

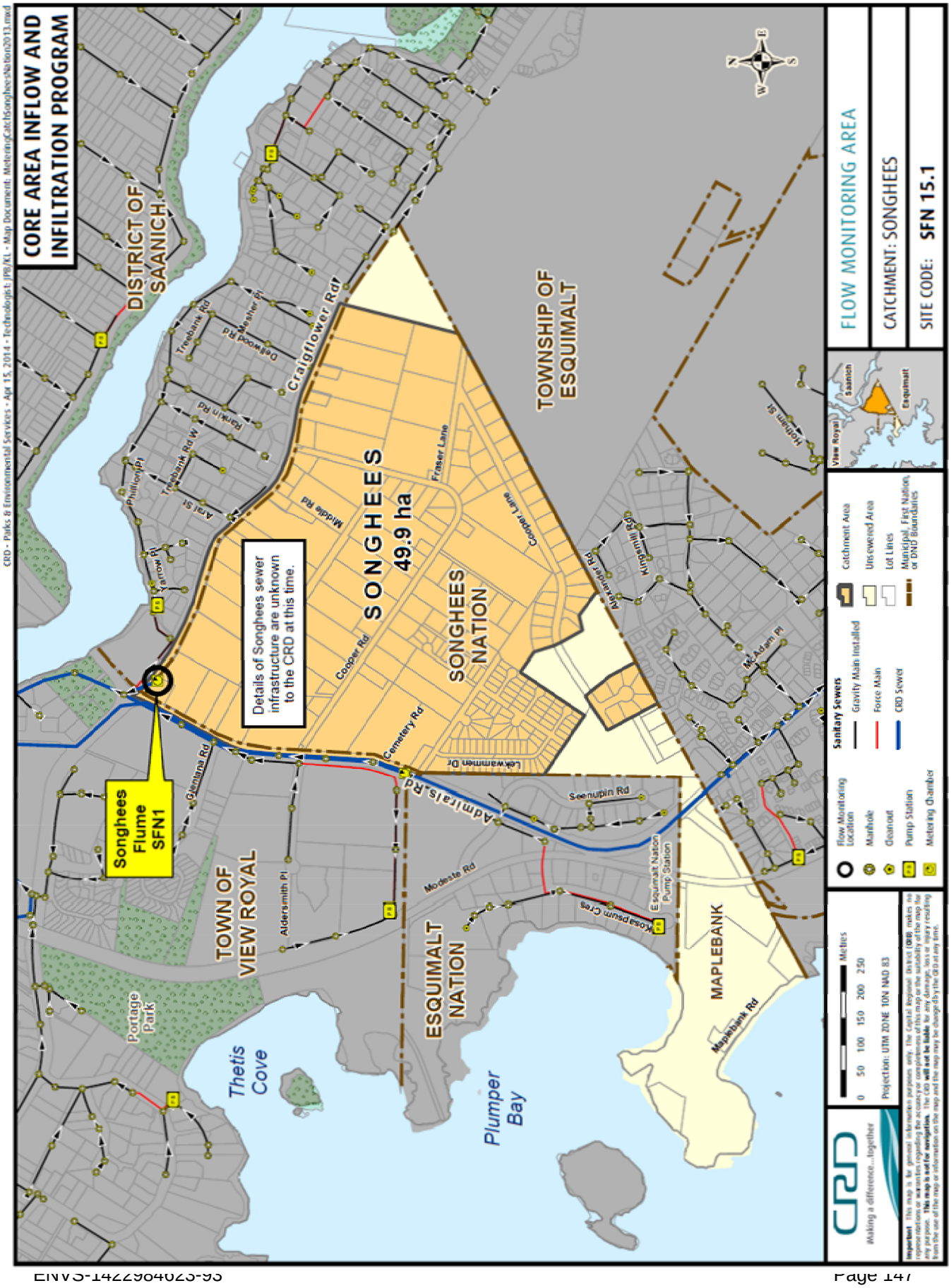
The catchment east of Admirals Road is approximately 56.7 hectares in size of which 49.9 hectares is sewered (note: parks / undeveloped land are considered unsewered) The property consists of residential housing and some commercial property including a gas station. Each of the buildings in this catchment are connected to the Nation's sanitary sewer system. The sewer system is owned and operated by the Nation and includes gravity sewers, manholes, and sewer cleanouts. Flows from the property are measured by the CRD SCADA system using a flume prior to discharge into the regional sewer system.

The catchment west of Admirals Road (near Maplebank Road) is approximately 12 hectares in size. The property is still largely undeveloped but it has a few buildings a pump station and sewers. Flows from the pump station are measured with a mag meter and discharge into the regional sewer system at Admirals Road and Maplebank.

The most recent 5-year 24-hour I&I rate based on the Songhees flume is 41,600 l/ha/day.

Figure 15.1 contains a map showing the Songhees First Nation's property.

Recently, the Songhees First Nation had a consultant do investigative work on its sewers and drinking water pipes. The CRD expects to receive a summary of the work at some point in the future once the work is completed and the report is approved for distribution.


CORE AREA INFLOW AND INFILTRATION PROGRAM
FLOW MONITORING AREA
CATCHMENT: SONGHEES
SITE CODE: SFN 15.1
DISTRICT OF SAANICH
TOWNSHIP OF ESQUIMALT
SONGHEES
49.9 ha
SONGHEES NATION
Details of Songhees sewer infrastructure are unknown to the CRD at this time.
Songhees Flume SFN1
TOWN OF VIEW ROYAL
ESQUIMALT NATION
MAPLEBANK
Thetis Cove
Plumper Bay
Portage Park
Craigflower Rd
Admirals Rd
Cooper Rd
Cemetery Rd
Middle Rd
Fraser Lane
Cooper Lane
Lekwammen Dr
Seenupin Rd
Modeste Rd
Kosapsum Cres
Esquimalt Nation Pump Station
Glentana Rd
Aldersmith Pl
Treebank Rd
Treebank Rd W
Rankin Rd
Deltwood Rd
Mesher Pl
Phillion Pl
Aral St
Yarrow Pl
Alexander Rd
Kingsmill Rd
McAdam Pl
Hotham St
Maplebank Rd
Sanitary Sewers
Gravity Main Installed
Force Main
CRD Sewer
Catchment Area
Unsewered Area
Lot Lines
Municipal, First Nation, or DND Boundaries
Flow Monitoring Location
Manhole
Cleanout
Pump Station
Metering Chamber
Metres
0 50 100 150 200 250
Projection: UTM ZONE 10N NAD 83
Making a difference...together
View Royal
Saanich
Esquimalt

16 DEPARTMENT OF NATIONAL DEFENCE

The Department of National Defence has multiple properties located in the Core Area of the CRD. Figure 16.1 shows the locations of these properties. Table 16.1 summarizes the data from this figure.

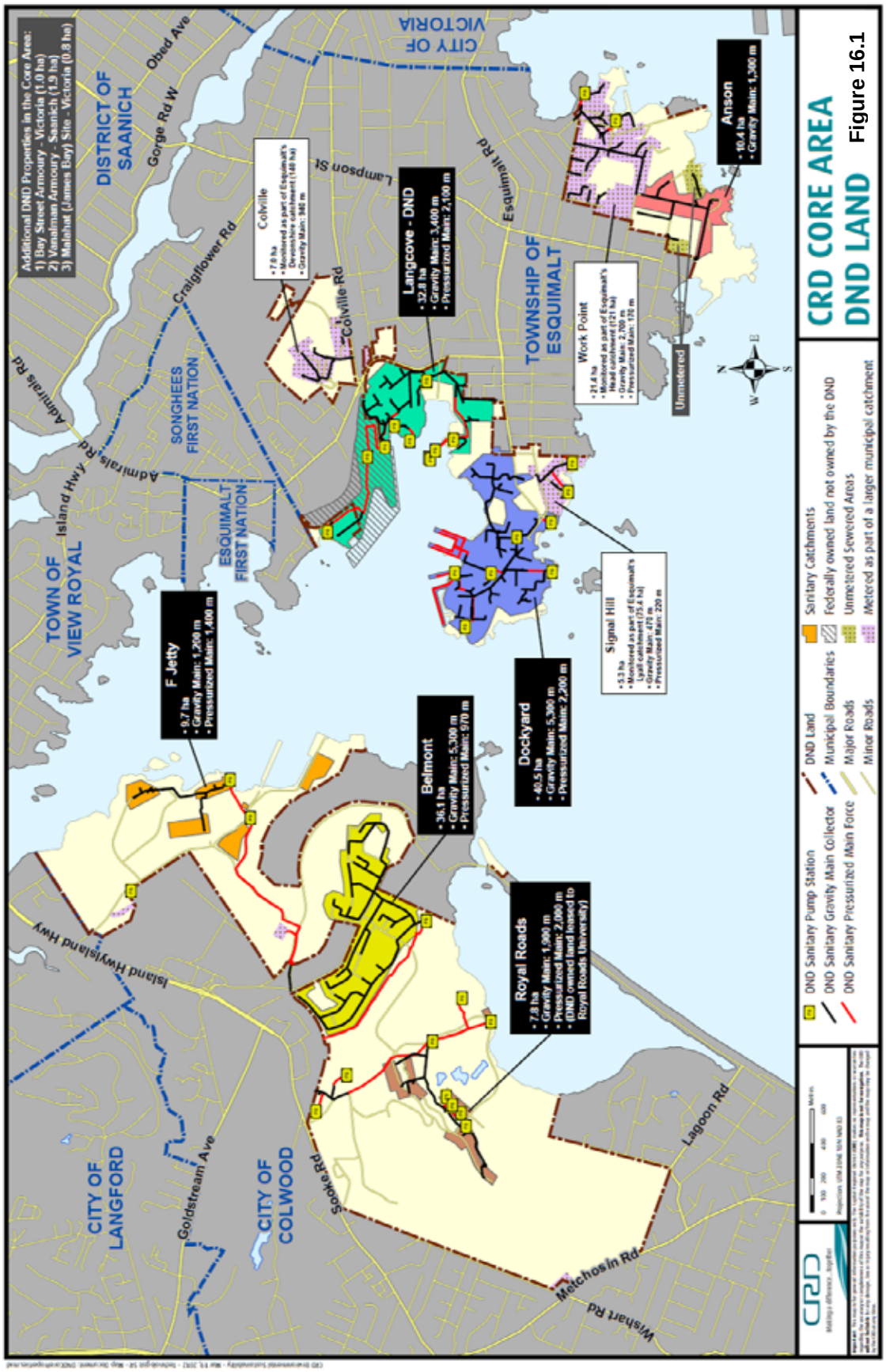
Table 16.1: Overview of DND Catchments

Name of Catchment	Sewer Catchment (ha)	5-year, 24 Hour-Peak I&I Rate	Municipality	Site Code
Anson (DND)	10.4	52,000	Esquimalt	ES13
Bay Street Armoury	1.0	88,000 [1]	Victoria	Flows are measured as part of Victoria's Chatham Catchment (VIC36A) which has a size of 76 hectares.
Belmont (DND)	36.1	56,000	Colwood	COL1
Colville	7	62,000 [1]	Esquimalt	Flows are measured as part of Esquimalt's Devonshire Catchment (ES14A) which has a size of 91.3 hectares
Dockyard (DND)	40.4	40,700	Esquimalt	ES19A
F-Jetty (DND)	9.7	n/a [2]	Colwood	COL2
Lang Cove DND	32.8	34,000	Esquimalt	ES18
Malahat (James Bay)	0.8	87,000 [1]	Victoria	Flows are measured as part of Victoria's Superior Catchment (VIC40A) which has a size of 59.1 hectares.
Royal Roads	7.8	15,000	Colwood	COL4
Vanalman Armoury	1.9	24,000 [1]	Saanich	Flows are measured as part of Saanich's Colquitz catchment (SA4) which has a size of 444 hectares.

[1] The I&I rate is for the larger municipal catchment. DND property makes up a very small percentage of the land and sewer flows for this catchment.

2 F-Jetty's flows consist predominately of periodic discharges from ships to the sewer system. The flows are not suitable for I&I analyses.

DND has agreements individual municipalities to accept its sewage. Like all large dischargers into municipal sewer systems (i.e. hospitals, universities, etc.), DND is encouraged to maintain its sewer infrastructure and address catchments that are found to have elevated I&I. DND is known to have upgraded substantial sewer infrastructure and removed a number of overflows over the last number of years.


CRD CORE AREA
DND LAND
Figure 16.1
Additional DND Properties in the Core Area:
1) Bay Street Armoury - Victoria (1.0 ha)
2) Vanalman Armoury - Saanich (1.9 ha)
3) Malahat (James Bay) Site - Victoria (0.8 ha)
DISTRICT OF SAANICH
CITY OF VICTORIA
TOWN OF VIEW ROYAL
SONGHEES FIRST NATION
ESQUIMALT FIRST NATION
TOWNSHIP OF ESQUIMALT
CITY OF LANGFORD
CITY OF COLWOOD
Obed Ave
Gorge Rd W
Craigflower Rd
Admirals Rd
Island Hwy
Lampson St
Colville Rd
Esquimalt Rd
Goldstream Ave
Sooke Rd
Lagoon Rd
Metchosin Rd
Wishart Rd
Colville
• 7.9 ha
• Monitored as part of Esquimalt's Devonshire catchment (149 ha)
• Gravity Main: 940 m
Langcove - DND
• 32.8 ha
• Gravity Main: 3,400 m
• Pressurized Main: 2,100 m
Work Point
• 21.4 ha
• Monitored as part of Esquimalt's Head catchment (121 ha)
• Gravity Main: 2,700 m
• Pressurized Main: 175 m
Unmetered
Anson
• 10.4 ha
• Gravity Main: 1,300 m
Signal Hill
• 5.3 ha
• Monitored as part of Esquimalt's Lyall catchment (75.4 ha)
• Gravity Main: 470 m
• Pressurized Main: 220 m
Dockyard
• 40.5 ha
• Gravity Main: 5,300 m
• Pressurized Main: 2,200 m
Belmont
• 36.1 ha
• Gravity Main: 5,300 m
• Pressurized Main: 970 m
F Jetty
• 9.7 ha
• Gravity Main: 1,200 m
• Pressurized Main: 1,400 m
Royal Roads
• 7.8 ha
• Gravity Main: 1,300 m
• Pressurized Main: 2,000 m
• (DND owned land leased to Royal Roads University)
DND Land
Municipal Boundaries
Major Roads
Minor Roads
Sanitary Catchments
Federally owned land not owned by the DND
Unmetered Sewered Areas
Metered as part of a larger municipal catchment
DND Sanitary Pump Station
DND Sanitary Gravity Main Collector
DND Sanitary Pressurized Main Force
N
S
E
W

17 CRD

17.1 CRD Overview

The Core Area of the CRD includes the municipalities of Colwood, Esquimalt, Langford, Oak Bay, Saanich, Victoria, View Royal, the Esquimalt Nation and the Songhees First Nation. The CRD was established in 1966. The Core Area of the CRD had a population of approximately 292,000 residents in 2011.

The Core Area regional sewer system is composed of approximately 58 km sewer pipe, 15 pump stations and approximately 291 manholes. The sewers are larger, deeper, and convey more flow than typical upstream municipal sewers. As a result, regional sewers also tend to be much more expensive to repair in the event of pipe failures. Regional sewers are managed with very low risk tolerance to minimize the possibility of failure. This includes frequent inspection and repairs as required.

It is generally not possible to quantify I&I directly entering the regional sewer system because:

- Virtually all base sanitary flow enters the regional sewer system through municipal sewers;
- Almost all the I&I in the regional sewers come from municipal sewers and private property. This is assumed based on the following:
    - Regional sewers make up only 2.5% of the total sewer length in the Core Area
    - Regional sewers have less than 0.2% of the regions sewer connections. (There are 115 municipal connections to the regional sewer system compared to over 60,000 lateral connections to Core Area municipal sewers.)
    - The entire regional sewer system is routinely inspected and fixed as required.
- Even the most accurate flow meters are not accurate enough to reliably quantify regional sewer I&I. (Flow meter accuracy about 1% for full pipe flow (magmeters) and 5 – 15% for open channel sewer flow.

The CRD has 38 flow monitoring locations. Each of these are monitored using the CRD's Core Area SCADA system. The meters include magmeters, flumes, and Flodars. The data is used for sewer cost allocation purposes. Many of the meters are also used to monitor catchments for the municipal I&I management plans.

There are 22 overflow locations in the Core Area regional sewers system. There are no combined manholes or combined sewers. It must be emphasized that even though there are a large number of known overflow locations, a majority of them are inactive. The overflow locations that are more frequently activated utilize preliminary screening prior to discharge. All CRD overflow locations are monitored using SCADA. When overflows occur, the CRD notifies the Provincial Emergency Program and documents the incident.

The CRD has a large storage tank at the Marigold pump station that is used to temporarily store sewer flows during large storm to reduce downstream overflows.

In 2008, the CRD commissioned the Trent pump station and forcemain. Since being commissioned, there have been only two overflows to Bowker Creek for storm events from rainfall events with return periods under five years. One of these events occurred when the Trent PS was down for maintenance. The other was during an unusual storm event. Prior to commissioning, overflows to Bowker Creek were numerous.

The CRD oversees and facilitates the Core Area I&I Subcommittee and its initiatives. A few key initiatives include:

- Preparing regional I&I reports for the Province (i.e. Biennial I&I Reports);
- Monitoring the status of the Overflow Management Plan;
- Reporting on annual/biennial I&I analyses results for catchments in the Core Area;
- Providing region wide public education initiatives.

17.2 Catchments

There are no CRD long-term regional sewer catchments because flow meters cannot quantify I&I directly entering the regional sewer system. The CRD uses its flow meter network to assist in monitoring flows from municipal catchments.

17.3 Inflow & Infiltration Data

This section is not applicable as the CRD has no long-term regional sewer catchments for reasons mentioned in section 5.10.2. In addition, the CRD has an aggressive preventative maintenance program in lieu of an archetypal program.

17.4 Sewer Infrastructure Maintenance & Capital Work

Routine Work

The CRD carries out a number of actions related to preventative maintenance and long term asset management of gravity sewers, manholes and appurtenances. Table 17.1 summarizes this work.

Table 17.1: CRD's Preventative Sewer Maintenance Activities

Category	Performed By	Frequency	Notes
Rehab / Replacement			
Sewer Relining	Contractors	As required	Based on analyses of CCTV data, rehab method selection and need.
Sewer replacement / upsizing	Contractors	As required	Based on analyses of CCTV data, rehab method selection and need.
Manhole Rehabilitation	Contractors	As required	Based on manhole inspections, rehab method selection and need.
Manhole Replacement	Contractors	As required	Based on manhole inspections, rehab method selection and need.
Investigation Work			
CCTV	Contractors	5–15 years	Based on WRc classification
Manhole Inspections	CRD staff	As Required	No formal program
Smoke Testing	CRD staff or contractors	As required	No formal program.
Dye Testing	n/a	As required	No formal program.
Routine Maintenance			
Sewer Cleaning (Flushing)	Contractors	As required	Based on need as identified with CCTV inspections.
Pump Station Maintenance	CRD Staff	As required	Regularly
SCADA Monitoring	CRD staff	Weekly	Data is reviewed to identify issues with the sewer system and with the flow data.

The Core Area Regional Sewer system has 15 pump stations. All are monitored using the CRD SCADA system. Each of the pump stations has backup power or connections for portable generators. The pump stations and SCADA system are maintained by the CRD.

Notable Work Completed (prior to 2017)

The CRD works with the core area municipalities to collect, analyze and report on I&I related data. The work includes preparing annual reports, preparing I&I and overflow management plans, and providing I&I related education. It also includes assisting the municipalities on issues related to sewer flows and I&I.

The CRD also carries out notable work on its own sewer system. Two highlights are the building and commissioning of the Marigold storage tank (2003) and the Trent pump station (2008), which collectively eliminated overflows to downstream high sensitivity receiving environments.

It should be noted that CRD sewer work was reduced in 2012 to 2016 due to the uncertainty related to the location and timing of the treatment plant project. Significant tasks completed during these years include:

2012

- Completed the original Core Area I&I Management Plan
- CCTV work
- Installed a permanent flow meter at Currie Minor pump station.

2013

- Installed two new permanent flow meters

2014

- Completed the Core Area Overflow Management Plan Update
- Completed phase 1 of the North West Trunk Meter Station's rehabilitation project
- Completed phase 1 of a comprehensive strategic asset management plan for the core area

2015

- Commissioned the new Craigflower pump station.

Planned Special Projects (2016 – 2021)

- Projects relate to the treatment plant project.
- Creating a new sewer model

17.5 Summary

The CRD owns and operates a number of trunk sewers in the Core Area. Is is not possible to assign I&I rates to trunk sewers so the CRD's I&I reduction efforts are focused on preventative maintenance.

18 PLAN MONITORING, VERIFICATION, AND REPORTING

18.1 The Goal of the CRD I&I Management Plan

The CRD and the member municipalities are currently undertaking a significant wastewater capital program to construct and operate a wastewater treatment plant in the core area. In the CRD Core Area Liquid Waste Management Plan (LWMP), the CRD and member municipalities have committed to limit I&I to less than 4x average dry weather flow through the development and execution of the I&I Management Plan. Sizing of the proposed wastewater treatment plant and related conveyance infrastructure are based on this performance commitment. Going forward, it will be important to measure, monitor and compare I&I performance of each regional catchment such that the targets can be realized by the regional municipalities.

The purpose of this Section is to summarize the recommended reporting content and schedule.

18.2 Forecasted I&I Reductions

Currently, it is projected that the Core Area I&I Management Plan will not meet its key performance target; to reduce wet weather flows below 4x average dry weather flow at Clover Point and the McLaughlin Point Treatment Plant by 2031. However, the gap between 4x average dry weather flow and peak wet-weather flow is decreasing. This is shown graphically in Figure 18.1 which is based on sewer modeling and data from the I&I Management Plans documented in Sections 7-17. This is significant as it takes a substantial investment of time and resources to reverse the natural trend of I&I increasing with sewer age. It should be noted that:

- The younger core area municipalities (Colwood, Langford, Saanich and View Royal) already meet the 4x average dry weather flow performance target. This is largely due to having younger sewers that tend to have lower I&I. These municipalities will need to focus on I&I prevention in order to continue to meet the performance target.

- The older core area municipalities (Esquimalt, Oak Bay and Victoria) currently exceed the 4x average dry weather flow performance target. This is largely due to having older sewers that tend to have elevated I&I. These municipalities will need to focus on I&I reduction in order to meet the performance target. It should be recognized that these municipalities may require a longer time period to achieve their reduction targets. Financial support (i.e. grants) from senior government would help to accelerate the I&I reductions.

- Although regional members are developing tools and working towards private property I&I initiatives, there are currently no significant private property I&I initiatives in the core area. Such initiatives could accelerate a municipality towards meeting its performance targets as it is estimated that 50% of I&I enters the sewer system on private property.

- The CRD is committed to assisting individual municipalities to develop suitable private property I&I initiatives. We anticipate significant progress will be made through the continuation and further development of I&I related education, stakeholder engagement, regulatory mechanisms, permitting requirements, time of home sale options and through targeted pilot programs.

- It is envisioned that partnerships with senior governments will also help municipalities achieve their performance targets. A past example of a senior government partnership is the James Bay I&I Reduction Pilot Project. This project was very successful in lowering I&I in that neighborhood. Further partnerships and I&I reduction projects will be essential to the success of this I&I Management Plan.

18.3 Metrics

The principle objective of the I&I Management Plan is to ensure that peak wet weather flow does not exceed four times average dry weather flow. This can be estimated by analyzing flow monitoring records. I&I rates are an essential component of the analysis, and provide a benchmark for inter-catchment comparison, evaluating I&I reduction effectiveness relative to program costs and methods, and determining I&I management plan priorities.

The following performance metrics will be used to monitor and track the progress of the individual regional member's private property I&I reductions.

- Comparison of peak wet weather flow with 4xADWF at Clover Point and the proposed wastewater treatment plant(s). This will include the graphs comparing projected PWWF and ADWF verses actual rates recorded over time (similar to Figure 18.1).
- Flow monitoring of all catchments to track I&I rates paying extra attention to measuring flows before and after targeted I&I reduction work to verify results.
- Tracking overflows by location, frequency, duration and receiving environment sensitivity rating to monitor trends and verify results.
- Completion of detailed and specific I&I management strategies for each catchment to replace the archetype plans.
- Reporting of efforts and costs applied towards I&I management on a regular basis.

The CRD will continue to use standard methods of analysis to derive I&I rates, average dry weather flows and peak wet weather flows from flow monitoring data for the core municipalities. These methods were approved by the Core Area I&I sub-committee, which includes representatives from the CRD and core municipalities.

Core Area municipalities will be responsible for undertaking flow monitoring programs and making flow data available to the CRD for analysis.

18.4 Reporting

Annual Report

The CRD has and will continue to provide annual reports on the I&I program to the Core Area Liquid Waste Management Plan Committee and summary reports to the Ministry of Environment. These reports document I&I related progress and metrics.

Biennial Report

In addition to the items notes in the annual reports, the biennial reports will also include:

- Updated I&I analysis results, as has been done since development of the Core Area Liquid Waste Management Program in 2000;

- An I&I benchmarking template for use by the core municipalities. The template will be developed by the CRD in consultation with the core area municipalities. It will include a number of benchmarks and performance measure criteria to help gauge the level of effort each municipality is applying to I&I management and is expected to cover I&I rates, investigation work, capital work, etc. The municipalities will then be expected to report their progress using this reporting template.

5-Year I&I Management Plan Update

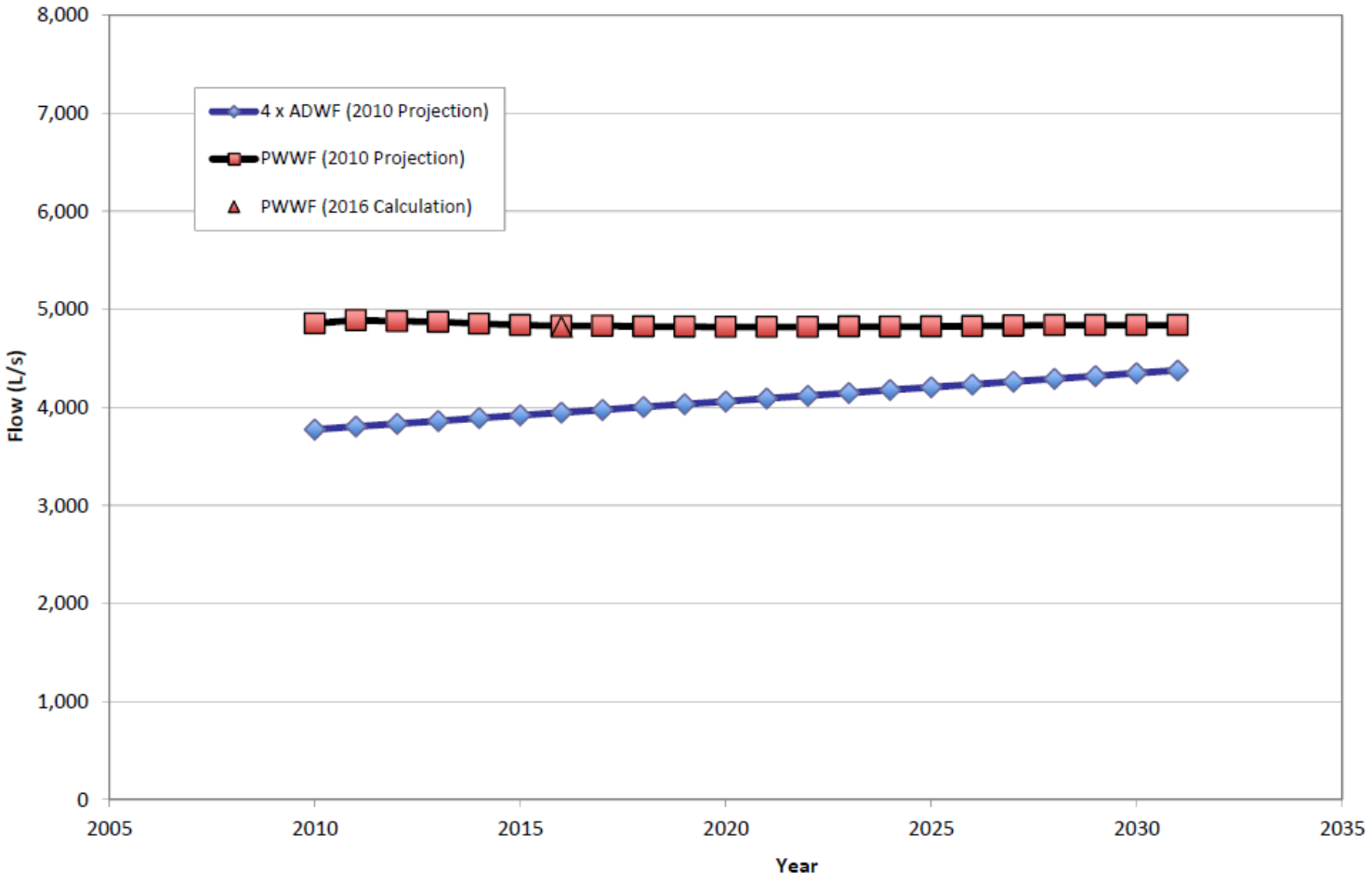
In addition to the items noted in the Biennial Report, the 5-year I&I Management Plan Update will:

- Track progress against the LWMP commitments
- Include the tracking and trending of each municipality against their respective 4 x ADWF target
- Contain an updated plan for the next 5-years
- Be prepared for submission to the Province.

18.5 Plan Updates and Submission to the Province

As the current interval for updating the Core Area Liquid Waste Management Plan is 5 years, it is proposed that the I&I Management plans be revised on the same time scale. Depending on the results of the work completed and as technology improves, the plan will be adjusted to seek the most cost-effective and beneficial opportunities to manage and reduce I&I. The next 5-year update will be submitted to the Province in 2022.

Figure 18.1: Projected Peak Wet Weather Flow and 4x Average Dry Weather Flow for the CRD Core Area



Note: The data used to make up this graph is a consolidation of data for the entire Core Area. Flows and I&I rates are based on the existing infrastructure and service area (which does not include western community expansion) and are projected based on the rehabilitation work documented in this I&I management plan.

Appendix A:
LWMP Commitments Related to I&I

CAPITAL REGIONAL DISTRICT
CORE AREA LIQUID WASTE MANAGEMENT PLAN
(Consolidated Version incorporating all applicable amendments, February 2015)

SECTION 5
MANAGEMENT OF INFILTRATION AND INFLOW AND CONTROL OF WASTEWATER OVERFLOWS

GOAL

Condition 17(1)(a) of Schedule 1 of the Municipal Sewage Regulation (MSR) requires that if infiltration and inflow (I&I) causes daily flows to be greater than 2 times the average dry weather flow (ADWF), the discharger must address "how I&I can be reduced as part of a Liquid Waste Management Plan" and condition 17(2) outlines the treatment and discharge requirements for such flows.

The goal of the I&I program is therefore to comply with this requirement of the MSR by developing and implementing a strategy aimed at reducing the amount of rainwater and groundwater entering the core area's sanitary sewer system from both the publicly owned and privately owned parts of the system in order to reduce and eventually eliminate overflows from the system.

How the Capital Regional District (CRD) proposes to substantially meet the requirements of Condition 17(2) is addressed in Sections 4 and 6 and in the draft operational certificate in Section 12.

COMMITMENTS

The CRD and the participating municipalities commit to the following actions to reduce I&I sufficiently to reduce maximum daily wet weather flows to less than four times the average dry weather flow by 2030:

1. Continue flow monitoring in each municipality to further refine priority areas for remediation.

2. Develop, by the end of 2011, and submit to the Ministry of Environment, comprehensive inflow and infiltration management plans for the core area that will:
   a) Identify and evaluate options and opportunities that promote the minimization of groundwater and rainwater I&I into municipal sanitary sewer systems, including I&I originating from service laterals (private and public sections of sewer connections).
   b) Identify needed changes to legislation and legal authority to enable options and strategies.
   c) Identify opportunities for the inspection of private sewers connected to municipal sewers:
      (i) as part of the municipal process in evaluating and issuing renovation and building permits for serviced properties; and/or
      (ii) at the time of property transfer; and/or
      (iii) targeted inspections.
   d) Require the repair or replacement of private sewers that have cross-connections between storm sewers and sanitary sewer or are identified as being in poor condition.

3. Update, by the end of 2011, and enforce sewer use bylaws to prohibit the construction of rainwater and groundwater connections to sanitary sewers.

4. Implement the overflow reduction plans contained in the sanitary sewer overflow management plan, which was submitted to the Ministry of Environment in June 2008. These plans are summarized as follows:

Table 5.1
Prioritized Order of CRD Overflow Reduction Plan
(Updated based on current information)

Priority No.	O/F Name	Action Plan	Estimated Year of Completion	Estimated Cost ($2008) to Complete
1.	Monterey Avenue MH0130	Complete and commission Trent pump station	2008 (Complete)	$500,000
2.	Macaulay Point Pump Station	Complete installation of standby power	2008 (Complete)	$800,000
3.	Harling Pump Station	Install a screen on the overflow pipe	2008 (Complete)	$10,000
4.	Shoreline Drive MH0340	Commence with capacity deficiency study and identify upgrade options	2010	$50,000
5.	Penrhyn Lift Station	Investigate pump and genset capacity	2010	$600,000
6.	Humber Combined Sewers	Oak Bay plans to separate the sewers in the Uplands area	2015	To be determined (Oak Bay cost)
7.	Rutland Combined Sewers	Oak Bay plans to separate the sewers in the Uplands area	2015	To be determined (Oak Bay cost)
8.	Head Street MH0040	Twin the NWT from Macaulay Point to MH0055	2015	$20,000,000
9.	Sea Terrace MH0055	Twin the NWT from Macaulay Point to MH0055	2015	as above
10.	Broom Road	Extend Trent forcemain down to Clover Point	2017	as above

Table 5.2
Prioritized Order of Colwood Overflow Reduction Plan

Item No.	Work Name	Description	Estimated Year of Completion	Estimated Cost ($2008) to Complete
1.	SCADA Upgrade	Upgrade the SCADA system to collect flow data from all pump stations.	2008 (Complete)	$10,000
2.	CCTV Inspection	Continue to inspect all new sewers that are installed to ensure they are well constructed	Annually	$15,000
3.	Sewer System Maintenance	Continue to clean all mains and manholes, and repair as necessary.	Annually	$50,000
4.	Lift Station Maintenance	Continue to maintain all lift station components to ensure that they run efficiently.	Annually	$72,500

Table 5.3
Prioritized Order of Esquimalt Overflow Reduction Plan

Item No.	Work Name	Description	Estimated Year of Completion	Estimated Cost ($2008) to Complete
1.	Sewer Relining	Relining and repairs to sewer mains rated poor and poorest	Completed	n/a
2.	Combination Manhole Separation	• 148 manholes remain to be separated • 29 manholes to be separated in 2008 • Five manholes separated per year from 2009 to 2025	2025	$950,000
3.	Grafton Pump Station Upgrade	New electrical power supply, kiosk and controls	2008 (Complete)	$38,000
4.	Grafton Pump Station Upgrade	Pump replacement	2012	$40,000
5.	Sewer Main Replacement	Replacement of undersize sewer main on Craigflower Road between Tillicum Road and Lampson Street	2009 (Complete)	$250,000
6.	Municipal Wide Smoke and Dye Testing	Smoke and dye testing underway to identify cross connections in attempts to reduce I&I in the future. The full scope of the project has not yet been determined.	2010	unknown

Table 5.4
Prioritized Order of Langford Overflow Reduction Plan

Item No.	Work Name	Description	Estimated Year of Completion	Estimated Cost ($2008) to Complete
1.	Sewer Master Plan Upgrades	Continue with infrastructure upgrades as identified in the Sewer Master Plan.	Ongoing	$0.2-0.5 Million
2.	CCTV Inspection	Continue to video inspect all new sewers that are installed to ensure that they are well constructed.	Annually	$15,000
3.	Manhole Inspection	Continue to visually inspect manholes to ensure that they do not leak.	Annually	$15,000
4.	Pump Station Maintenance	Continue to maintain all pump station components to ensure that they run efficiently.	Annually	$200,000
5.	Sewer System Maintenance	Continue to keep the sewers clean and free from defects.	Annually	$25,000

Table 5.5
Prioritized Order of Oak Bay Overflow Reduction Plan

Item No.	Work Name	Description	Estimated Year of Completion	Estimated Cost ($2008) to Complete
1.	Uplands Sewer Separation	Complete the separation of combined sewers in Uplands.	2015	$12,000,000 (est.)
2.	South Oak Bay I&I Rehab Project	Continue with the phased rehabilitation project in the Windsor catchment area.	2010	$1,000,000 (est.)
3.	Hydraulic Model	Continue to complete a hydraulic model of the entire collection system.	2014	$90,000 (est.)
4.	CCTV Inspection	Continue to video inspect sewer mains.	Annually	$25,000
5.	Pump Station Maintenance	Continue to maintain all pump station components to ensure that they run efficiently.	Annually	$30,000
6.	SCADA Upgrade	Upgrade the SCADA system to collect flow data from all pump stations. Typically one station per year is added to the Oak Bay SCADA system.	2016	$180,000 (est.)
7.	Sewer System Maintenance	Continue to keep the sewers clean and free from defects.	Annually	$237,000
8.	Manhole Inspection	Continue to visually inspect manholes to ensure that they do not leak.	Annually	$15,000

Table 5.6
Prioritized Order of Saanich Overflow Reduction Plan

Item No.	Work Name	Description	Estimated Year of Completion	Estimated Cost ($2008) to Complete
1.	Dysart Pump Station	Complete construction of the new Dysart pump station.	2008 (Complete)	$2,500,000 (est.)
2.	The following pump stations will be upgraded: Vantreight Lift Station Murray #1 Pump Station Murray #2 Pump Station Arundel Pump Station Glenwood Pump Station Ashley Pump Station Dunkirk Pump Station Colquitz Pump Station Gorge Pump Station	Rebuild pump station and add a new standby generator.	2009-2015	$500,000 Annually

Table 5.7
Prioritized Order of Victoria Overflow Reduction Plan

Item No.	Work Name	Description	Estimated Year of Completion	Estimated Cost ($2008) to Complete
1.	James Bay I&I Pilot Project	Commence with the rehabilitation of sewer mains, laterals and manholes in James Bay.	2010	$3,000,000
2.	Hydraulic Model	Continue to complete a hydraulic model of the City's entire sanitary sewer collection system.	2009	$100,000
3.	Overflow Elimination	Investigate, monitor and abandon, if possible, existing known overflow locations.	2010	$100,000
4.	Combined Manhole Separation	Investigate, monitor and initiate a program to separate combined manholes.	2015	$400,000

Table 5.8
Prioritized Order of View Royal Overflow Reduction Plan

Item No.	Work Name	Description	Estimated Year of Completion	Estimated Cost ($2008) to Complete
1.	Upgrade Pump Stations	Upgrade pump stations where required to improve pump performance, provide standby power and collect better data.	2017	$140,000
2.	CCTV Inspection	Continue to video inspect all new sewers that are installed to ensure that they are well constructed.	Annually	$20,000
3.	Manhole Inspection	Continue to visually inspect manholes to ensure that they do not leak.	Annually	$5,000
4.	Pump Station Maintenance	Continue to maintain all pump station components to ensure that they run efficiently.	Annually	$120,000
5.	Sewer System Maintenance	Continue to keep the sewers clean and free from defects.	Annually	$40,000

APPENDIX C

Excerpt from the Capital Regional District Core Area Liquid Waste Management Plan – Sanitary Sewer Overflow Management Plan, June 2008.

Appendix B:

EXCEUTIVE SUMMARY: SANITARY SEWER OVERFLOW MANAGEMENT PLAN: 2014 UPDATE

CAPITAL REGIONAL DISTRICT
CORE AREA LIQUID WASTE MANAGEMENT PLAN

SANITARY SEWER OVERFLOW MANAGEMENT PLAN: 2014 UPDATE

EXECUTIVE SUMMARY

On July 3, 2014, the Minister of Environment approved the Capital Regional District's Amendment No. 9 to the Core Area Liquid Waste Management Plan (LWMP) subject to four conditions being met by December 31, 2014. Condition No. 2 to the Minister's approval requires that the CRD submit a *Wet Weather Flow Management progress report that includes an update on the progress made to date in achieving the LWMP commitment to eliminate sanitary and combined sewer overflows*. This progress report was written to satisfy that requirement.

Section 5 of the LWMP entitled "*Management of Infiltration and Inflow and the Control of Wastewater Overflows"* includes the individual overflow reduction plans for the CRD and each of the core area municipalities.

Background

Rainwater and groundwater that mistakenly enters the sanitary sewer system is referred to as inflow and infiltration (I&I). Inflow refers to rainwater that enters the sewer system through improper plumbing connections such as cross-connections with storm drains. Infiltration refers to groundwater that seeps into the sanitary sewer through cracks or joints in the sewer pipe. A certain amount of I&I is unavoidable and is accounted for in routine sewer design. However, when I&I exceeds design allowances, sewer capacity is consumed, and may result in overflows, risks to health, damage to the environment, and increased conveyance costs.

In the core area, the overall length of the sewer system can be broken down as follows: 45% municipal sewers; 40% private property laterals; 10% public property laterals; 5% regional sewers. Municipalities and regional districts tend to proactively inspect and fix their sewers. Conversely, private property owners rarely inspect or perform maintenance on their sewer laterals unless they are adversely impacted by a problem.

Since 2001, the CRD has collected valuable sewer flow monitoring data for the core area. Initially, the monitoring was done with a small number of portable flow meters. The monitoring has since expanded to include over 90 permanent meters and 20 portable meters with the CRD analyzing the data collected. The results are documented in I&I analyses reports which are submitted to the Core Area Liquid Waste Management committee annually. In addition, the CRD has prepared a number of reports for the Province as required by the LWMP including: biennial update reports (2005, 2007, and 2009), the Overflow Management Plan (2008) and the I&I Management Plan (2012).

The *Core Area Sanitary Sewer Overflow Management Plan* (2008) was developed by the CRD in collaboration with representatives from the core area municipalities engineering departments. The document includes the mapping of the known sewer overflow locations in the core area (including pump stations, combined manholes and sewer relief points), rating core area shorelines based their sensitivity to sewer overflows, summarizing overflows from 2000 to 2007, and documenting prioritized overflow management plans for the CRD and each of the core area municipalities.

The *Core Area Inflow and Infiltration Management Plan* documents an approach for addressing I&I in the core area to the year 2031. The plan was developed by the CRD in collaboration with representatives from the core area municipalities engineering departments. In the plan, the core area is divided into 108 long-term monitoring catchment areas. Each catchment area is flow monitored and the data is analyzed for I&I. Catchments that exceed the agreed upon I&I rate are investigated (i.e., camera inspections / smoke testing) and the data collected is used to determine what work needs to be completed. Finally, the rehabilitation

work is prioritized and carried out based on available budget. The I&I Management Plan also contains a sub-plan for developing and implementing an approach to address private property I&I starting in 2016.

As of 2014:

- I&I rates have been collected for all 108 I&I Management Plan catchments.
- All of the catchments in Colwood, Langford, Saanich, or View Royal have relatively low I&I.
- Most catchments in Esquimalt, Oak Bay, and Victoria's catchments have elevated I&I. Many of these catchments have been or will be investigated. From 2005 to 2010, Esquimalt inspected its entire sewer system and repaired all of the sewers and manholes that were in poor condition.
- Work is still being carried out to implement a private property I&I approach by 2016.

Between 2008 and 2013, the following significant I&I related work items have taken place in the core area:

- Esquimalt completed a $6.75 million upgrade of the sanitary collection system which included the relining of over 30% of Esquimalt's gravity sewers and separation of combined manholes.
- Victoria completed the James Bay I&I Reduction Pilot Study.
- The *Core Area Inflow and Infiltration Management Plan* was completed in 2012
- Methods were developed to generate sewer flow data from data already collected at municipal pump stations. This results in consistent, relatively inexpensive long-term flow monitoring data.
- I&I has been included at over 17 CRD outreach events per year since 2011. At these events the public was encouraged to complete a 4-question I&I related survey. I&I education material includes a brochure, two sets of videos to help explain I&I, and an I&I website.

Overflows (2008 – 2013)

The CRD and core area municipalities have identified all of their known sewer overflow locations, which are summarized in Table ES-1 and Figure ES-1. It must be emphasized that, even though there are a large number of known overflow locations, the majority of them are never used or are infrequently used.

Table ES-1: Number of Known Potential Overflow Points

Jurisdiction	Pump Stations [1]	Relief Points [2]	Combined Manholes [3]	Total
CRD	14	8	0	22
Colwood	0	0	0	0
Esquimalt	11	0	~48	59
Langford	0	0	0	0
Oak Bay	6	0	Uplands is a combined collection system	6 plus Uplands
Saanich	28	0	0	28
Victoria	7	16	98	121
View Royal	12	0	0	12
Total	78	24	146	248

1. Sanitary pump station overflows are those that have a designed overflow point included within or just upstream of the pump station.
2. Relief point overflows include overflow pipes designed into the collection system that spill into storm drains or nearby waterways.
3. Combined manhole overflows are those where both sanitary and storm pipes are located within the same manhole but are separated by a concrete dividing wall. All of these manholes were installed as a cost-saving measure in the 1960-70s, as it was cheaper to install one manhole instead of two.

Most I&I related overflows take place in the regional sewer system during large storm events when operators monitoring the sewer flows selectively allow overflows to deep sea outfalls with low sensitivity receiving environments. This is done to preserve sewer capacity for areas that would otherwise overflow into high sensitivity receiving environments (creeks, basement flooding, etc.). The I&I that causes these overflows comes from the upstream municipal sewers and private property laterals. Table ES-2, summarizes the sewer overflows in the core area from 2008 to 2013.

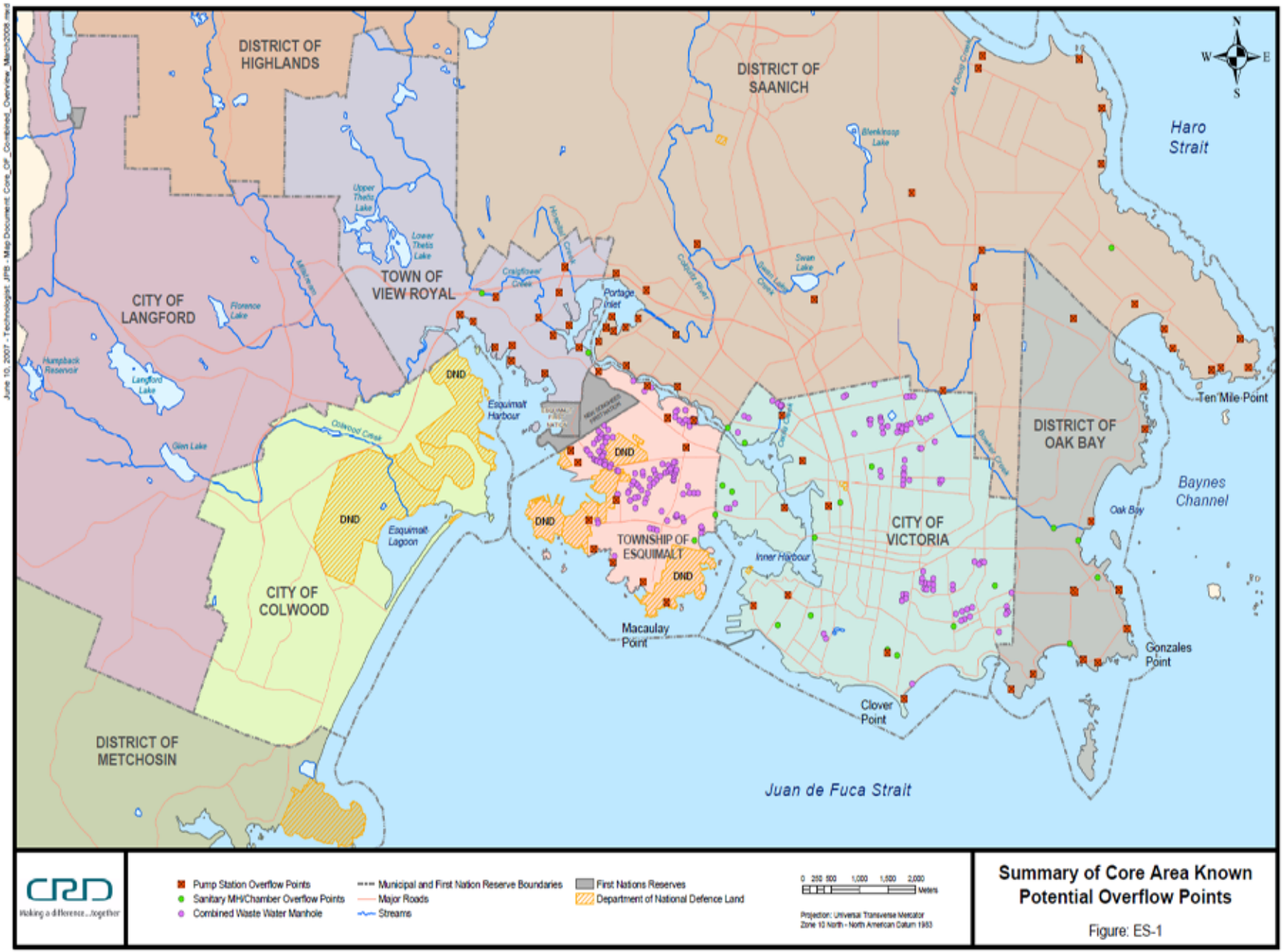

DISTRICT OF HIGHLANDS
DISTRICT OF SAANICH
TOWN OF VIEW ROYAL
CITY OF LANGFORD
CITY OF COLWOOD
DISTRICT OF METCHOSIN
TOWNSHIP OF ESQUIMALT
CITY OF VICTORIA
DISTRICT OF OAK BAY
DND
Haro Strait
Juan de Fuca Strait
Baynes Channel
Esquimalt Harbour
Esquimalt Lagoon
Inner Harbour
Portage Inlet
Colwood Creek
Craigflower Creek
Gorge Waterway
Bowker Creek
Oak Bay
Macaulay Point
Clover Point
Gonzales Point
Ten Mile Point
Upper Thetis Lake
Lower Thetis Lake
Florence Lake
Langford Lake
Glen Lake
Humpback Reservoir
Blenkinsop Lake
Swan Lake
Pump Station Overflow Points
Sanitary MH/Chamber Overflow Points
Combined Waste Water Manhole
Municipal and First Nation Reserve Boundaries
Major Roads
Streams
First Nations Reserves
Department of National Defence Land
Meters
Projection: Universal Transverse Mercator
Zone 10 North - North American Datum 1983
Summary of Core Area Known Potential Overflow Points
Figure: ES-1

Table ES-2: Frequency of Overflows Classified by Cause and Receiving Environment Sensitivity

Jurisdiction/Cause of Overflow		2008			2009			2010			2011			2012			2013		
Total Annual Rainfall (mm)		619			662.5			814			865			876			741		
		Receiving Environment Sensitivity of where Overflows were Discharged [1]																	
		Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High
Capital Regional District																			
Cause	1. Power outage				2						2						2		
	2. Pump station failure	1		1	1			7			3						1		
	3. Blocked pipe																		
	4. Storm event <5-yr.	7		2	32			17			16						8		1
	5. Storm event >5-yr.							7		1									
	6. Upland combined sewers	4			15			13			11						14		
	TOTAL	15			50			45			32						26		
Colwood																			
Cause	1. Power outage																		
	2. Pump station failure																		
	3. Blocked pipe																		
	4. Storm event <5-yr.																		
	5. Storm event >5-yr.																		
	TOTAL	0			0			0			0			0			0		
Esquimalt																			
Cause	1. Power outage																		
	2. Pump station failure																		
	3. Blocked pipe																		
	4. Storm event <5-yr.																		
	5. Storm event >5-yr.																		
	TOTAL	0			0			0			0			0			0		
Langford																			
Cause	1. Power outage																		
	2. Pump station failure																		
	3. Blocked pipe										1						2		
	4. Storm event <5-yr.																		
	5. Storm event >5-yr.																		
	TOTAL										1						2		
Oak Bay																			
Cause	1. Power outage				3														
	2. Pump station failure																		
	3. Blocked pipe																		
	4. Storm event <5-yr.																		
	5. Storm event >5-yr.																		
	TOTAL	0			3			0			0			0			0		
Saanich																			
Cause	1. Power outage																		
	2. Pump station failure																		
	3. Blocked pipe																		
	4. Storm event <5-yr.																		
	5. Storm event >5-yr.																		
	TOTAL	0			0			0			0			0			0		
Victoria																			
Cause	1. Power outage																		
	2. Pump station failure																		
	3. Blocked pipe																1		
	4. Storm event <5-yr.																		
	5. Storm event >5-yr.																		
	TOTAL	0			0			0			0			0			1		
View Royal																			
Cause	1. Power outage																		
	2. Pump station failure																		
	3. Blocked pipe																		
	4. Storm event <5-yr.																		
	5. Storm event >5-yr.																		
	TOTAL	0			0			0			0			0			0		

Note: Low, Moderate, and High ratings of receiving environment sensitivity were determined by Seaconsult Marine Research Ltd.

Wet Weather Flow Management Progress Update

The CRD and core area municipalities are on track with their overflow management plans with the following highlights.

The CRD commissioned the Trent pump station in 2008 which eliminated overflows to Bowker Creek Prior to commissioning, there were ~10 overflows per year into Bowker Creek.

Colwood programmed its Supervisory Control and Data Acquisition (SCADA) system to generate sewer flow data from its pump stations.

Esquimalt separated approximately 100 combined manholes (of 148), relined all poor and poorest condition sewer mains, and smoke tested the entire municipal sewer system.

Langford ensured that each of its pump station either has a backup generator or can be powered with Langford's portable standby generator.

Oak Bay added 7 of its 9 pump stations to SCADA and implemented policies that require the upgrade or replacement of sewer / stormwater laterals, when homeowners apply for major building permits, etc. or when cross connections are identified by the municipality. In the LWMP, Oak Bay has a commitment to separate its combined sewers by 2015. The timeline below describes Oak Bay's status and plan going forward.

- **Up to 2010**: Oak Bay had a plan in place that would have resulted in the Uplands combined sewers being separated by 2015. The approach was estimated to cost approximately $7.5M (excluding private property works) and Oak Bay had successfully secured a $5 million dollar grant toward this work. The work was anticipated to be complete by the end of 2015. However, many Uplands residents resisted this plan on account of each house needing to install a sewer sump pump to convey its sewage into the municipal low pressure sewer main. As a result, in 2010, Oak Bay council decided to have staff investigate other alternative approaches for sewer separation in the Uplands.

    - **2010 to 2014**: Oak Bay collected detailed data (municipal records, etc.) on the Uplands sewers and hired a land surveyor to collect additional information.

    - **2014 to 2016:** Oak Bay plans to:

        1. Retain a consultant to prepare detailed plan options.
        2. Consult with the public on the options.
        3. Select a preferred option.
        4. Tender construction contracts to start the separation of the sewers.

Saanich upgraded 5 pump stations and is in the process upgrading 5 more.

Victoria completed the James Bay I&I Reduction Pilot Project, which compared the effectiveness between various types of sewer rehab for reducing I&I and is in the process of camera inspecting and smoke testing the entire municipality by the end of 2016.

View Royal has been upgrading one pump station every two years including the addition of backup generators and is in the process of camera inspecting the municipalities' sewers.

Conclusions

On July 3, 2014, the Minister of Environment approved the Capital Regional District's Amendment No. 9 to the Core Area Liquid Waste Management Plan subject to four conditions being met by December 31, 2014. Condition No. 2 to the Minister's approval requires that the CRD submit a *Wet Weather Flow Management progress report that includes an update on the progress made to date in achieving the LWMP commitment*

to eliminate sanitary and combined sewer overflows. This progress report was written to satisfy that requirement.

During the period from 2008 to 2013, the municipal sewer collection systems experienced a total of seven overflows. These included three overflows resulting from pump station failures and four overflows attributed to blockages in sewer pipes related to new construction. The municipal sewer systems were able to convey all peak flows, including infiltration and inflows from storm events, into the regional trunk sewer system for discharge to the marine environment via deep sea outfalls.

During the same time period, CRD regional trunk sewers experienced a total of 193 sewer overflows, of which 100 were caused by I&I flows received from municipal sewers and another 70 overflows were directly attributed to combined sewer flows coming from the Oak Bay Uplands combined sewer systems during significant storm events. The remaining 23 overflows were the result of power outages, pump station failures, or pump station upgrades in the regional system.

All but one of the CRD regional system overflows were discharged through deep sea outfalls to marine environments of low sensitivity. The only overflow to a medium or high sensitivity receiving environment occurred during a summer storm when the Trent pump station was shut down for maintenance.

The LWMP (2010) Section 5 contains the overflow reduction plan commitments for the CRD and each of the core area municipalities. These individual plans identify specific infrastructure work items including inspections, studies and upgrades to regional and municipal pump stations and sewer systems.

The CRD and the participating municipalities have completed or initiated many of the overflow reduction tasks committed to in the LWMP. I&I must be further reduced by completing all tasks to limit maximum daily wet weather flows to less than four times the average dry weather flow by 2030.

Oak Bay's commitment to separate its combined sewers in the Uplands, which collect and convey both sewage and storm water to the CRD regional pump stations at Humber and Rutland, remains outstanding.

The CRD will continue to monitor the status of the overflow reduction plans for CRD and the participating municipalities of Colwood, Esquimalt, Langford, Oak Bay, Saanich, Victoria, and View Royal. These plans will be evaluated and updated as required.

The core area treatment plant project includes infrastructure upgrades that should further reduce the frequency I&I related overflows in the core area.

Appendix C:
Update on Private Property I&I Programs from Around North America (2014)

2014 Update on Private Property I&I Programs

Supplementary research for the 2011 report entitled Private Property Inflow & Infiltration (I&I) Management Options for the ***CRD Core Area***

April 24, 2015



Pinna
Sustainability

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1 Scope and Purpose of this Memo

In 2010-2011, the Capital Regional District commissioned a report from Stantec Consulting to identify *Private Property Inflow & Infiltration (I&I) Management Options for the CRD Core Area* ("2011 Report"). The 2011 Report included a review of the approaches employed by other jurisdictions in the management of private property I&I (PPI&I), and a review of the legal authority and considerations for adopting these approaches in the CRD context. Since this report was authored, a number of municipalities across Canada and the US have continued to address private property I&I through various means. This memo serves to supplement the 2011 Report by providing an update that summarizes:

- The key drivers for municipalities that have implemented private property I&I programs.
- Of the programs originally reviewed, the programs that are most relevant to the CRD context, and their key drivers.
- The current state of private property I&I programs in Canada, and in particular, a province-by-province summary of activity.
- A high-level review of the prevalence, type and key drivers for private property I&I programs in the United States (US), and in particular, a summary of activity in Washington State.
- A list of good practices being employed in other jurisdictions for managing private property I&I.
- Specific examples of sewer bylaws in Canada that address good practices for managing private property I&I.
- An understanding of how CRD compares relative to other jurisdictions with comparable contexts.

This updated information in intended to support the CRD as it embarks on further discussions among staff and elected officials in determining which approach is most suitable to its context. Appendix A provides an updated version of the table included in Appendix A of the 2011 Report (Survey of I&I Programs in Other Jurisdictions).

2 Private Property I&I Program Drivers

As identified in the 2011 Report, BC municipalities have the legal authority to implement numerous types of programs to address inflow and infiltration from private property. To assist with identifying the most appropriate approach(es) for CRD member municipalities, this report seeks to clarify the reasons programs are being implemented in other regions (what is driving those regions to take action) in relation to the types of approaches that are being employed.

Sewer systems in the CRD are "separated" – that is, the sewage is conveyed in a separate network of pipes than the storm water. The only exception to this is the "combined" sewers in the Uplands area of Oak Bay where the same pipes convey both sewage and storm water.

Communities with combined systems have a different set of priorities and drivers, and tend to focus on ways to divert rainwater from the system altogether (e.g. by disconnecting downspouts from the collection system), or ways to minimize damage (e.g. by installing backflow prevention valves). These combined programs are generally not very applicable to the CRD context, so this research focuses on programs that are targeted at separated systems.

Based on the research conducted, it is estimated that less than 5% (and likely closer to 1%) of US municipalities with separated sewers have I&I programs specifically for addressing private property. In Canada there are very few such programs.

The primary drivers for PPI&I programs focused on areas with separated sewers typically fall into one or more of the following:

1. **Senior government requirements**: In numerous municipalities throughout the US, the EPA and/or State authorities have ordered sewer agencies to take action to reduce sewer overflows into fresh water in order to bring them into compliance with the *Clean Water Act*. In many locations, these orders specifically require action to be taken on private as well as public property. This is also the case in a selection of Canadian municipalities that have been ordered to comply with Federal *Fisheries Act* requirements.
2. **Basement backups or flooding**: Many communities across Canada and the US have identified the need to reduce basement backups and flooding that cause damage and health concerns for private property. Primarily these programs relate to municipalities with combined sewers and focus on disconnecting downspouts from the sanitary sewer system, and/or removing illegal cross connections (when a storm water pipe is connected to a sanitary sewer).
3. **System capacity**: Other communities are experiencing system capacity issues, where urban densification and/or new development puts strain on an existing sewer system. This can result in sewage overflows at specific locations during rainfall events. In some places, regional sewer authorities set capacity limits or costs for exceeding certain flow allotments, and this drives municipalities to develop PPI&I programs.
4. **Infrastructure maintenance and treatment costs**: A few municipalities cited that they developed their programs in a proactive manner, as part of long-term maintenance planning and/or to reduce treatment costs. More typically, this driver is a secondary reason or benefit for implementing a program.

Implementing private property I&I programs can be resource intensive and politically challenging, particularly when significant costs and/or burden are borne by property owners to fix a problem they were not even aware of. The first three drivers listed above are strong enough to support significant PPI&I programs. The fourth driver is weaker and by itself generally is not strong enough to maintain the political support needed for a significant I&I program targeting private property.

The following table illustrates examples of programs in relation to the primary drivers identified.

Program driver	Examples of programs implemented
1 – Senior government requirements	An ordinance requiring a lateral be inspected and fixed at the point of sale of a property is highly effective, while also placing significant onus on the property owner at a time when they would not normally be undertaking that type of work. Of the over 20 point of sale programs identified across the US, all but two communities are under an order or decree with the EPA to take action to reduce sewage overflows. Other communities under federal orders decided to have the agency undertake the repairs, rather than requiring the property owner to do the work (e.g. Westlake OH and Fort Erie ON), or have insurance programs requiring all property owners participate.
2 – Basement backups or flooding	Many programs driven by a desire to reduce basement backups or flooding have insurance programs in place where an annual fee is added to utility bills and claims are made if a backup occurs. Other regions undertake testing then serve notice to property owners to fix problems identified (e.g. Halifax NS, Kingston ON). Numerous regions provide voluntary incentive programs to install backflow valves or disconnect downspouts to alleviate this flooding. One point of sale program was found that was driven by the need to reduce basement backs or flooding (Rock River IL).
3 – System capacity	There are a number of communities in the US that are not under agreements with the EPA, but are facing limits on system capacity. Programs in these areas include one point of sale program (Golden Valley MN), and several with an ordinance requiring inspection and repair of laterals at the time of major renovations (e.g. Lakeport CA, Santa Barbara CA and Ukiah CA). This approach is less onerous for the property owner because they are already engaging in a significant renovation project. One point of sale program was also found that was driven by limitations for new development (Golden Valley MN). At a regional scale where there are system capacity concerns, some regional agencies have set targets for each member municipality, then monitor wet weather flows to see if the targets are being met. If not, communities must respond by creating I&I management plans, increasing spending on I&I reduction efforts, or face surcharges. The result has been municipal programs that include grants for private sewer lateral replacements, targeted inspections followed by orders to do work where needed, and/or point of sale programs (Metropolitan Council of Environmental Services MN, Metropolitan Sewerage District WI).
4 – Infrastructure maintenance and treatment costs	Where the programs are in place in a more proactive manner, the typical form of program is a voluntary approach providing education, rebates, and in some cases, a requirement to inspect and repair laterals during major renovations. Examples include Tacoma WA (requiring education at time of sale), Costa Mesa CA and Brantford ON (incentives for repairs), and District of North Vancouver BC (requiring inspection and repair at time of renovation).

3 Private Property I&I Programs – Canada

3.1 Drivers for Programs in Canada

Two Canadian municipal private property I&I programs were identified in the 2011 Report: the Town of Fort Erie Extraneous Flow Program, and the City of Thunder Bay Downspout Program. Each of these programs was formed in response to drivers that are not directly applicable to the CRD context. In Fort Erie, the program developed in response to a *Remedial Action Plan* created by Environment Canada and the Province of Ontario that was put into place to protect the Great Lakes from sewer overflows (driver #1 – senior government requirements). Some financial support for the program was also provided by Environment Canada. In Thunder Bay, the PPI&I program focuses on separating combined sewers by disconnecting downspouts.

Additional research was conducted to ascertain how many other communities in Canada have programs or approaches for addressing private property I&I. The research indicates that most of these programs are aimed at reducing basement flooding. The following table summarizes the findings, including a summary of the drivers for the programs, and whether the program focuses on inflow sources (cross connections or combined sewers), or infiltration (leaky laterals).

Province	Program summary and drivers
Newfoundland	None identified.
Prince Edward Island	One program (Charlottetown) focuses on inflow removal in a combined system.
Nova Scotia	One program (Halifax Water) targets removal of improper rainwater connections into the separated system. Focus is on ensuring downspouts connect to the storm water system, and removing cross-connections.
New Brunswick	One program (Moncton) provides rebates for installing backwater valves to prevent basement flooding.
Quebec	One pilot project to disconnect downspouts (Quebec City) from a combined sewer system.
Ontario	Over a dozen programs, and almost all are driven by reducing basement flooding predominately in areas with combined sewers. Some are related to federal requirements to improve Great Lakes water quality. One community cites long-term infrastructure maintenance as the driver (Brantford) and one cites reducing costs for homeowners to do repairs as the driver (Windsor). Several provide rebates for disconnecting downspouts, or for redirecting storm water out of the sewer system. Two provide rebates for fixing sewer laterals (Brantford and Windsor). One provides financing for sewer lateral repairs (Cornwall). One regional I&I reduction strategy that identifies the need to improve private property sewer maintenance, and a commitment to identify an appropriate approach (York).
Manitoba	Provincial grant program currently provides funding to 22 municipalities to provide rebates for installing backwater valves to prevent basement flooding. Winnipeg still has 30% combined sewers.
Saskatchewan	Two programs (Saskatoon and Humboldt) provide rebates for installing backwater valves to prevent flooding. Separated systems in Saskatoon and Regina.

Province	Program summary and drivers
Alberta	One program (Edmonton) for flood prevention on a largely combined system. Also a private insurance program for basement backups. No program for Calgary, which has a separated system.
British Columbia	Two bylaws requiring lateral inspections / repair during major renovations or re-development (North Vancouver and Surrey). On a very small scale, municipalities have completed targeted I&I removal projects to remove cross-connections and repair laterals on private property. Metro Vancouver and CRD have identified policy and legal options for managing private property I&I.

3.2 Summary of Program Activity by Province

The following provides more detail about the programs identified that address private property inflow or infiltration in some form, organized by province. Where programs have elements that may be of interest to the CRD were identified, these were incorporated into the table in Appendix A (and are marked with an asterisk * below).

Newfoundland & Labrador: The Province undertook a study in 2012 to identify location and frequency of CSOs, SSOs and potential solutions, province-wide, in response to the proposed WSER (legislation for Municipal Wastewater Effluent, under the Federal *Fisheries Act*, enacted 2012). No community was identified that had any reference to a private inflow and/or infiltration program (though Mount Pearl has a successful cross connection control project).

Prince Edward Island: The City of Charlottetown was the only community identified with private property program, and it focuses on the removal of inflow sources.

- Charlottetown: Inflow reduction education campaign. The primary purpose is to reduce the numerous illegal connections of inflow identified. Concurrently, the City is working to separate their sewer system.

Nova Scotia: The Province is developing a wastewater standard to address the objectives of the WSER, including an approach to overflows. At a community scale, Halifax has been working to reduce inflow and infiltration since 1999. The utility Halifax Water formed in 2007 and has had a private side program for I&I reduction since 2008. No other communities were identified that have a private property inflow and/or infiltration program in Nova Scotia.

- Halifax Water*: Stormwater Inflow Reduction (SIR) program in place several years with an exclusive focus on private property I&I. The program includes: targeted inspection of private I&I sources through smoke, dye, and CCTV testing; notices to owners where repairs are needed; and follow up notices if work is not completed. A bylaw is in place to enable various forms of enforcement (shutting off water service, issuing tickets, placing property liens). The program previously included CCTV inspections of laterals from the inside of the dwelling, though this was onerous to conduct. The focus of the program is currently only on inflow sources.

New Brunswick: All municipalities are required to develop long-term plans to reduce combined sewer overflows and reduce overflows from infiltration by January 1, 2016. One existing private property program was identified in Moncton.

- Moncton: Backwater valve incentive program ($500 towards installation) to reduce basement flooding. City has both separated and combined sewers.

Quebec: One program was identified in Quebec with respect to private property inflow and infiltration (note: web searches were conducted in English only). This program focused on the reduction of basement flooding.

- Quebec City: Required downspout disconnections for one neighbourhood, funded by the City (launched 2005). Program results: 25% uptake on first round; 60% of remaining on second round; five more rounds, including warnings of $300 fine for not complying, and reached 100% compliance by early 2008. City has primarily combined sewers.

Ontario: Numerous programs were identified in municipalities and/or regions across Ontario, and four of these have been added to the table in Appendix A (as indicated by an asterisk*). Over a dozen programs were identified that addressed private property I&I in some form, and some of these are regional and cover numerous municipalities. Generally the programs are focused on reduction of inflow, and cite the reduction of basement flooding as the primary driver for having a program. The most comprehensive strategy identified for managing I&I was the York region.

- York Region* (Newmarket, Richmond Hill, Vaughan, Markham, and 5 others): Comprehensive I&I strategy addresses public and private sources. Planned and tendered a pilot project to conduct inspections and repairs for 3,000 private laterals to determine most cost effective method of reducing I&I. After tendering, the Region changed the scope of the project to only focus on the public portion of the lateral due to uncertainties about the legal implications should any damage to private property occur during the project. The strategy also identifies the need to address private property I&I through one or more of the following: increased education, incorporating lateral information into GIS, developing region-wide standards for private side inspections, and investigating long-term program options (including time-of-sale certification of laterals and subsidy programs) – though these have not been implemented to date.
- Brantford*: Grants to replace ageing sewer laterals (50% up to $1,500) started in 2014. City also took back ownership of lateral from property to main effective 2014.
- Windsor*: Grants to replace ageing sewer laterals (up to $2,000 once every 20 years).
- Kingston*: Grant program to reduce basement flooding, and stronger bylaw language adopted in 2012, including enforcement measures if private sewer laterals are not properly maintained.
- Cornwall: Sewer Lateral Replacement Financing Program.
- Niagara Falls: Grants for disconnecting foundation drains (100%), and a free service to inspect the condition of a private lateral upon request. Driven by Federal and Provincial requirements in relation to protection of the Great Lakes basin.
- Port Colbourne: New *Sewer Use Bylaw* supporting an Extraneous Flow Reduction Program enabling the City to undertake inspections of private laterals to identify need for repairs,

and to provide grants for some or all of the repair work. Driven by Federal and Provincial requirements in relation to protection of the Great Lakes basin. Combined system.

- Hamilton: Proposed insurance program where residents voluntarily pay a monthly fee for sewer lateral insurance. Generally considered a reactive approach as laterals are fixed after a backup or problem becomes evident.
- Region of Waterloo: Storm sewer inspection program using video to identify areas that require rehabilitation. All storm sewers to be inspected and flushed over five years.
- Several other municipalities: Downspout and foundation drain disconnection programs, including grants to assist with the costs of disconnecting, are quite common across Ontario. Other municipalities include with these programs include Toronto, Ottawa, Halton Region, Region of Peel, Brantford, London, Durham Region, Greater Sudbury, St. Catharines, Vaughan, Welland and Cornwall.

Manitoba: Grant program that provides funding for installation of backwater valves and sump pits is provided to 22 municipalities across Manitoba, and is jointly funded by the two levels of government. Significant focus province-wide is on reducing flooding risks.

- Winnipeg: The City is an early adopter of a bylaw requiring backwater valve installation (1979). City also has a grant program to reduce basement flooding, including backwater valve and sump pit installation rebates. 30% of the city still has combined sewers.

Saskatchewan: Two programs were identified in Saskatchewan, and they focus on reducing inflow. A program was previously available for Prince Albert but no current reference found for this. The focus of these programs is reducing flooding risks.

- Saskatoon: Grant program to reduce basement flooding for backflow preventer installation, foundation drain disconnection, and sump pump installation. Program had general public resistance and slow uptake. All homes built 1965 to 2004 have foundation drains connected to the sanitary system.
- Humboldt: Storm Water Rebate Program is similar to the Saskatoon program and focuses on flood prevention.

Alberta: One private property inflow reduction program was found in Edmonton. In 2011, EPCOR Utilities announced a joint marketing agreement for service line warranties with HomeServe. This is a voluntary insurance program.

- Edmonton: Grant program to reduce basement flooding in place since 1991. City has combined sewers.

British Columbia: Two municipalities in BC require the rehabilitation or replacement of sewer laterals at the time of major renovations and re-developments (e.g. City of Surrey and District of North Vancouver) and some municipalities have "rodding lists" (e.g. City of Vancouver and District of North Vancouver) to perform regular clearing of laterals on the public side.

- District of North Vancouver: all building permits of value greater than $150,000 with connections over 30 years old must demonstrate the lateral meets MMCD or equivalent standards. Also, since the 2011 Report, the District of North Vancouver undertook a project to reduce I&I from private properties in Lynn Creek. Metro Vancouver undertook a

study of how to implement a private sewer lateral certification program at the time of property sale, but have not yet taken steps to implement this.

- City of Surrey: all applications for a service connection with a building permit of value greater than $100,000 or where a parcel is being redeveloped must demonstrate their lateral is in good condition (if under 30 years old), or replace it (if over 30 years old). All no-corrode, asbestos cement or clay service pipes of any age or condition must be replaced.
- Metro Vancouver and CRD: both regional districts have reports (including the 2011 Report) that identify the policy options and legal authority for municipalities to develop and implement programs to address private property I&I. Metro Vancouver also has a Sample Bylaw for private sewer laterals.
- Some municipalities have undertaken work on private property laterals to get them into better condition as part of targeted I&I reduction projects (e.g. James Bay in Victoria, Lynn Creek in North Vancouver)

In summary, the vast majority of communities in Canada with private property programs are driven by the need to reduce basement flooding, and a couple of programs are in relation to senior government requirements. The more proactive programs identified that apply to separated sewer systems were in Brantford Ontario – a rebate program for repairing a private lateral, and in North Vancouver and Surrey – bylaw requirements to inspect and/or fix private laterals at the time of renovation or re-development.

4 Private Property I&I Programs – US

4.1 Drivers for Programs in the US

Twelve programs from the US were reviewed in the 2011 Report. This memo clarifies what were the key driving forces for developing the programs (see updates for each program in Appendix A, including a new column "Primary drivers for the program"). The majority of the examples presented in the 2011 Report were driven by senior government requirements (driver #1) because the EPA had issued administrative orders or consent decrees due to violations of the Federal *Clean Water Act*. The others were related to capacity concerns (driver #3) as follows:

- **Senior government requirements** (EPA): McMinnville OR, Berkeley CA, Brentwood and Glendale MO, Austin TX, Miami-Dade FL
- **Capacity** (reduction of sanitary sewer overflows): Santa Barbara CA, Westlake OH, Costa Mesa CA, Naperville IL
- **Regional surcharges** to municipalities for wet weather flows: Eagan and Golden Valley MN (note – these regional surcharges are driven by desire to reduce spills and increase capacity)

This list highlights the primary drivers, although in most cases communities cite numerous drivers for taking action. There are, however, useful examples from communities that are not facing US EPA orders (e.g. Costa Mesa CA, Santa Barbara CA, Metropolitan Council MN communities). Note that all US examples in the 2011 Report have fully separated sewer systems, or where there are combined systems, the focus of the private property program has been on areas with separated systems.

4.2 Summary of Program Types and Drivers by State

A high-level scan of programs in place across the US identified upwards of 100 communities with some form of private property I&I program. Without a more in-depth study a more precise estimate is not possible, however the overall number is likely in the hundreds of programs, and not likely to be as high as thousands of programs. For context, that is less than 5% of municipalities, and more likely close to 1%.

PPI&I programs were found in 21 states. California municipalities appear to have the most number and types of programs (e.g. required education, renovation ordinance, point of sale ordinance, agency undertaking the work on private property, rebate programs, loan programs). Very little activity was found in the Pacific Northwest other than a required education program in Tacoma, a number of pilot studies in King County, and loan programs for low-income households.

The results of the scan are summarized by state with a brief indication of the type and driver for the programs:

Alabama: 1 EPA order found – agency fixes laterals in examples found

California: Several EPA orders – most have point of sale programs
Non-EPA cities – some have ordinance requirements for renovations (but not for point of sale), rebates, "required education" (information is provided during real estate transactions on property reports)

Colorado: Basement backup prevention

Florida: EPA order for Miami-Dade – program required property owners to fix problems identified

Illinois: Mostly downspout/foundation drain disconnection programs
Some programs where City does the work to fix laterals on private property

Indiana: Mostly downspout/foundation drain disconnection programs
2 insurance programs (where property owner pays monthly fee, then insurance covers repair/replacement costs if problem found)

Kansas: 1 rebate program
Some downspout/foundation drain disconnection programs

Kentucky: 1 rebate program
1 downspout/foundation drain disconnection program
1 program where the agency fixes private laterals

Michigan: Several programs where the agency fixes private laterals

Minnesota: EPA orders with point of sale ordinances
MCES also has regional requirements related to capacity – 1 city in MCES has a point of sale program due to capacity
1 agency requires property owners to undertake fixes, but agency pays 50%

Missouri: EPA order for St Louis County
Numerous insurance programs

Ohio: EPA orders – 1 agency fixes the private laterals; 1 has a point of sale ordinance
Non-EPA cities have downspout disconnect programs

Oregon: EPA order for McMinnville and city requires property owners to fix problems identified

Pennsylvania: EPA orders – several have point of sale ordinances and/or city inspects and requires property owners to fix laterals

South Carolina: 1 rebate program
1 city that fixes private laterals

Tennessee: 1 city that fixes private laterals

Texas: EPA order for Austin – city requires property owners to fix problems
Dallas also requires property owners fix problems, no EPA order found
2 low income programs
Backflow preventer program

Virginia: 1 Region with municipal flow commitments
1 downspout disconnection program

Washington: Loan and low income programs
King County pilot studies (where County fixed laterals to assess cost effectiveness
Tacoma has a required education ordinance for point of sale, but no requirement to inspect or do work

Wisconsin: Education and loan programs

Wyoming: 1 insurance program

4.3 Washington State Approaches

Of particular interest to CRD are the approaches undertaken by their neighbours in the Pacific Northwest.

King County in Washington State has undertaken a large multi-year methodical I&I reduction program targeting both public and private infrastructure. To date, the program has been entirely agency-led and has not put any onus on property owners, other than to obtain their permission to complete the rehabilitation projects. All work and costs were borne by the County. I&I reduction projects involve the rehabilitation of public and private sewers in select basins where expected reductions are deemed to be cost effective (because they will avoid the cost of future storage and diversion needs).

No programs were found for the City of Seattle, or other municipalities in King County.

The City of Tacoma attempted to proactively implement a time of sale program without a strong driver such as an EPA order. The program lost political support just prior to implementation. Further details are provided in Section 5.2, which highlights some problems communities have faced when implementing these programs.

The result was that effective 2010, Tacoma realtors are required to provide the City's information package on sewer laterals to both buyers and sellers prior to closing of a property. The City also provides the package to any property owners who request a building permit. The package recommends conducting a sewer lateral inspection prior to completing the purchase or renovation on any home more than 25 years old. The City has levied a few fines against realtors who did not hand out the package, and the homes later encountered sewer problems. Anecdotal information from City staff suggests that there has been an increase in the number of sewer lateral inspections being conducted during real estate transactions. The City has also made information about the condition of sewer laterals available on their property search website, along with all other permit information, and includes age and condition of the lateral where available. City staff continues to review options to further develop programs for I&I removal from private property.

5 Example Problems Related to PPI&I Approaches

5.1 Inadequacy of Education Alone

It has been found that education alone is not effective for reducing PPI&I. Some communities that originally opted to pursue purely educational approaches are now finding that it is time to re-evaluate options for further addressing private property I&I.

For example, a 2014 staff report from Laguna Beach City in California states that the City's 10-year awareness program has been ineffective, and it is now seeking to update the program. The program involved educating owners about lateral inspection and maintenance, and encouraging voluntary action. The municipality has decided that it needs to expand on the education approach and will do public consultation in 2015 as the first step towards defining that program.

5.2 Loss of Political Support

The City of Tacoma proactively updated their Municipal code to directly address private property sewer laterals (called "side sewers" in Tacoma). This program was originally designed to be more prescriptive by requiring a "Certification of Inspection" be obtained from the City prior to completing a home sale. The intent of the original program was to ensure prospective homeowners understood the current state of the sewer lateral prior to completing the purchase. The City developed the original program based on two years of consultation with the real estate industry and other stakeholders. However, shortly before the ordinance was to come into effect Council directed municipal staff to significantly reduce the requirements of the adopted PPI&I ordinance in response to pressure from real estate agents.

5.3 Liability Fears Related to Working on Private Property

The Regional Municipality of York engaged a consultant to conduct a condition assessment, detailed design, contract administration and site inspection services for about 3,000 private property sewer laterals throughout the region (for a value of 1.06 million dollars) in the fall of 2013. However, during early project planning, the regional municipality's legal department became concerned about the potential liabilities associated with working on private property. The project scope was then changed to only include the inspection and rehabilitation of the service lateral (from the main to the property line). The region is currently considering other avenues for evaluating and rehabilitating private sewer laterals, as these have been identified as an important part of their comprehensive I&I reduction strategy.

6 Good Practices for Addressing PP I&I

This section outlines a collection of good practices for addressing PPI&I. It is based on the research conducted for the previous sections of this report and a review of best practice research conducted in other regions.

6.1 Bylaws Pertaining to Private Sewer Laterals

A good practice identified by numerous agencies is to first conduct a review and update of existing bylaws to ensure they are explicit about several important aspects of sewer lateral maintenance. The 2011 Report outlines the options available to municipalities in CRD for managing private sewer laterals, and also provides a sample bylaw that was developed for Metro Vancouver municipalities (attached as an appendix to the 2011 Report).

Appendix B contains sections from Canadian municipal bylaws relating to PPI&I. It demonstrates how PPI&I approaches can be implemented through bylaws and is organized by the following key elements:

- **Responsibility of owner** – to clearly state property owner responsibilities in maintaining laterals
- **Cleanouts required** – to assist with future testing and access, some municipalities require cleanouts be added under certain trigger conditions
- **Entry and testing** – to state the legal authority for the municipality to enter private property to conduct testing, and to undertake work; this section usually identifies part or all of the process to be followed (e.g. type of communication, amount of advance warning provided)
- **Require fix of defects** – to state the legal authority for the municipality to require property owners to fix defects; this section usually identifies the circumstances that will trigger this requirement
- **Require inspection for renovation or new construction** – a special condition currently found in two bylaws stating laterals must be tested and/or fixed when undertaking major renovation or new construction

- **Fees, recovering costs** – to state the authority for municipality to do the work then recover the costs from the property owner
- **Financial assistance, monetary incentive** – to identify the purpose and authority to provide financial assistance for fixing laterals; note that many grant programs don't explicitly identify this in their bylaws
- **Enforcements, penalties** – to clearly state the enforcement approach and penalties that may ensue for non-compliance

This summary of key elements of a sewer lateral bylaw is not exhaustive (see the 2011 Report for a more extensive list and description). It does highlight the need for clearly stating the municipal authority to enter onto property, test, inspect, require fixes, charge fees and enforce penalties for non-compliance.

6.2 Testing Private Property I&I

With respect to entry and testing, no Canadian bylaws reviewed provided details of the method of testing or inspection that would be conducted (though this is present in several US ordinances reviewed). Several municipalities in Canada do have testing programs primarily employing smoke testing to ascertain whether inflow sources are illegally connected to the sanitary sewer system. Municipalities that have undertaken smoke testing for this purpose have outlined their testing policies and procedures on their website. These procedures include providing notice to property owners with dates and times of upcoming smoke testing, providing notice to emergency services (fire, police) of the location, dates and times of smoke testing, and providing answers to Frequently Asked Questions with the notice and on their websites.

Examples of the notices and/or procedures for conducting smoke testing programs include (for links to these examples, see Appendix C):

- London ON: Report from staff to Council Committee outlining the procedures to be followed and an example public notice to be provided to property owners
- Markham ON: Website provides overview of purpose, links to sewer bylaw and requirements being tested, maps of program areas to be checked, links to Council Minutes relating to the program, other educational information, and a rebate program to assist with disconnecting downspouts and/or installing rain barrels
- Halifax NS: Written notice of smoke testing is provided to properties in advance of testing, police and fire is notified each day prior to testing
- Regional District of Nanaimo BC: RDN notice of smoke testing listing specific times and dates that testing will be conducted in specified locations for the purpose of identifying cross connections

6.3 Standards, Guidelines and Policies

In addition to reviewing and updating bylaws, many communities also review and produce or update standards for construction of private sewers, guidelines for executing private property rehabilitation, and policies that ensure standards and guidelines are applied consistently.

The region of King County developed a comprehensive set of Standards, Guidelines, Procedures and Policies for use in long-term I&I control (2004). The document addresses both public and private infrastructure, and is based on the first five years of experience in I&I control projects. The 15 policies are designed to support the application of standards and guidelines in I&I control projects, and address the issues of: funding, public education, access to private property, inspection, permitting, liability, and storm water drainage. The County plans to review and update the document as needed following the completion of larger scale projects, which have just come to completion.

The Region of York is developing region-wide standard procedures for private side inspections, including notification materials and consent/ waivers. They plan to use a standard ROE (Right of Entry) form across the region, to be signed by the property owner.

For agencies that issue a sewer lateral certificate of compliance, more recent programs are distinguishing between watertight laterals (which receive a 25-year certificate) and laterals in good condition (which receive a 10-year certificate). To receive a 25-year certificate, laterals must pass a hydrostatic pressure test. 10-year certificates are issued to laterals that pass a CCTV inspection.

6.4 Communications and Education

Education alone will not result in noticeable changes in I&I; however, all agencies agree it is essential to have a strong focus on this when implementing any program. Effective campaigns in Canadian communities have occurred in conjunction with targeted programs that have strong regulatory backing cited in the communications material.

In Halifax, the utility (Halifax Water) contacts property owners requiring them to take action on their improperly connected downspouts or cross-connections when smoke testing reveals problems. The program initially had an uptake rate of approximately 40% of property owners that responded to Halifax Water's communications. This rate increased to 90% uptake last year after improvements were made in the communications methods, including:

- Improvements in customer care, including longer hours of availability (to 8pm) and email communication,
- Increased staff, and
- Addition of door-to-door knocking when staff is already out in a neighbourhood.

Other communities such as Tacoma have taken advantage of natural times to communicate with property owners and provide education about I&I – at the time of property transfer (through realtors) and at the time of major renovation (through the City building permit department).

Lateral certificates are another tool used to educate the public on their responsibility to maintain their private property laterals. In general, lateral certificates certify compliance for a period of

time (e.g. 10 or 20 years). The City of Lakeport CA has a voluntary certification program for this purpose.

6.5 Checkpoints for Long-term Maintenance

Communities under EPA orders to reduce inflow and infiltration are typically required to put into place ordinances that ensure private laterals will be inspected and rehabilitated at regular checkpoints on an ongoing basis, in addition to taking immediate actions to reduce sewer overflows. This demonstrates a good practice for long-term maintenance, which is also being implemented by some communities more proactively. Checkpoints (or triggers) for inspection are typically one or more of the following:

- When a property is re-developed
- When obtaining a building or plumbing permit exceeding a particular value
- At a particular age of lateral (e.g. laterals 25 years old)
- When a property changes use (e.g. from residential to commercial)
- Time of sale of property, name change on municipal / utility account (not common in proactive programs)

These are typically designed to try to align with commitments to regular inspection on the public infrastructure. The use of the age of lateral checkpoint is more common with commercial properties. York Region, Halifax Water and Metro Vancouver are investigating options to put a longer-term checkpoint into place. Both Halifax Water and Metro Vancouver have had preliminary discussions with the real estate industry regarding the option to include the condition of the sewer lateral on property disclosure statements.

6.6 Data Collection and Management

Communities are tracking information about the condition of private laterals and incorporating the data into broader sewer information systems. For example:

- The City of Kingston used a GIS overlay of the location of flooding complaints to target their program efforts towards those catchments.
- The City of Tacoma publishes known information about private sewer laterals along with permit information for all properties in the city, publicly accessible through a web-based interface.
- The Region of York plans to develop an inventory through a review of historic plumbing records, combined with all new inspections conducted to better understand the state of the private system.
- Many communities are monitoring I&I rates before and after rehabilitation work.

These good practices are being demonstrated in various programs throughout Canada and the US. To date, no region in Canada has put in place a comprehensive program that incorporates all of these elements.

Appendix A – Survey of I&I Programs in Other Jurisdictions – Updated 2014

Jurisdiction	Program Approach	Program Description	Primary Driver(s) for Program	Program Impacts	Program Costs and Source of Funding	References
CANADA						
Town of Fort Erie, ON **Population 30,000** Program for separated system	Incentive Approach	**Grants to Property owners** for the costs of repairs made to reduce extraneous flow. 100% reimbursement to a maximum of: o $100 for the removal of roof leaders from the sanitary sewer o $500 for the removal of existing sump pump connections from the sanitary sewer o $2,500 for the removal of foundation drains connections from the sanitary sewer o $1,500 for the repair or replacement of a leaking sanitary lateral o $1,000 for the installation of an approved backflow prevention device	History of overflows to environment: in 1987 the Niagara River was designated an Area of Concern in the Great Lakes Basin by the International Joint Commission. In response, Remedial Action Plan created by Environment Canada and Province of Ontario. Snowmelt events have led to loading and trucking sewage out of overloaded pump stations.	90% inspections now complete. Residential: 24% infrastructure failures found in inspections Public: < 5% infrastructure failures Over 3 years the Town reduced extraneous flow from about 60% to about 40%. Now working to reduce from 40% to 20%.	Costs: 1. Crescent Park: Overall cost $211,743 to date. Approx $850/lateral, includes public side inspections. 2. Outside of Ward 3: Overall cost: 221,516 to date. Approx $990/lateral, includes public side inspections. Funding: o Annual budget deliberations o Federal funding (2007 $130,000; 2008 $80,000) o Regional funding	By-Law 68-06 Being a By-Law to Regulate the Management of a System of Sewer Works and Drainage Works (3.8.5)
	Targeted Inspection Approach	**Inspection Requirements from Municipality** to customers to arrange for in-home inspections to complete a video of all private side sanitary sewer laterals. Program targets inspections to most flood-prone areas.				
	Regulatory Approach	**Sewer Bylaw** specifies: o Owner must allow access to building or premises for inspection, maintenance, repair o If problem identified, owner is notified to fix. Owner will pay costs incurred directly, or it will be added to the tax roll for the property. If a lateral is found to be non-compliant, the Town may terminate water service or perform the necessary repairs if the owner does not after sufficient notice. The Town may then recover the full cost of the work from the owner through municipal taxes.				
City of Thunder Bay, ON **Population 30,000** Program for combined system	Incentive Approach	**Downspout Program:** o Targets areas that experienced sewage-flooded basements during heavy rainfall events, particularly in older residential/commercial neighbourhoods where downspout connections to the sanitary sewer (instead of storm sewers) were most common. o The City contracted with a private not-for-profit organization, EcoSuperior Environmental Programs, to aid property owners in disconnecting their downspouts. o Rain Barrel Program was introduced as one alternative to redirect downspouts. The City offered 45-gallon rain barrels at a discount price of $40, available only to city residents with a water account.	Alleviating basement flooding: reduce inflow and infiltration with significant focus on reducing inflow sources. Prior to the program, 70-100 basements would flood several times per year.	In total, 786 properties were identified, 64% of which complied and disconnected their downspouts from the sanitary sewer. Those properties not able to disconnect (for various reasons), are being dealt with as road/ infrastructure upgrades occur. Estimated savings of $980,000 from reduction of inflow and infiltration from 2000 to 2006.	Property owner pays. Estimated savings of $17,000/year which would have historically been paid out in overtime to deal with rainstorm events (based on 2 events per year). Estimated cost savings from reduced insurance claims is approximately $60,000/year.	
City of Brantford, ON **Population 93,650** Separated system	Incentive Approach	**Private Sanitary Sewer Lateral Replacement Grant Program**: In 2014 the City began offering a grant of 50% up to $1,500 to replace an ageing sewer lateral. The intention is to proactively prevent backups and to benefit overall I&I reduction. Note that the City also took back ownership of the laterals from the property line to the main effective 2014. This is the only grant program for laterals in Canada found that applies where the property owner is only responsible for the lateral to the property line.	Proactive program to prevent sewer backups into homes, and to benefit the overall I&I reduction goals of the City.		New program – funding for 2014 set at $200,000.	Staff report "Private Sewer Lateral Replacement Grant Program"
City of Kingston, ON **Population 123,000**	Incentive Approach (inflow) Regulatory Approach (laterals)	**Grant program** (Preventative Plumbing Program) to reduce basement flooding: provide a grant to disconnect downspouts, sumps, weeping tiles. o Grant program does not cover lateral repairs, but will cover a video inspection of lateral. o Program manager actively identifies catchments with high flooding, sends letters to property owners, then goes door-to-door. Where external visual inspection is not enough, a CCTV is offered to determine if any illegal connections. **Bylaw** for maintenance of laterals: o Updated bylaw in 2012 to include enforcement option for City to disconnect water for not repairing structural defects within 30 days of written notice. o As of 2014, City has new enforcement tool to issue tickets ($200) for non-compliance.	Reduce risk of sewage backup to homes and secondary driver is reducing strain on whole system, particularly by eliminating illegal connections.	Not currently measuring program impacts, but have had significantly fewer reports of flooding since prior to the program starting.		Bylaw 2008-192 Rob Bowen 613-546-2242

Jurisdiction	Program Approach	Program Description	Primary Driver(s) for Program	Program Impacts	Program Costs and Source of Funding	References
City of Windsor, ON **Population 211,000** Separated and Combined system	Incentive Approach	Grant program for replacement of old sewer laterals. o Grants to replace sewer laterals that are over 20 years old and in disrepair (up to $2,000). o City created a pre-qualified list of private drain connection contractors that are eligible for the grant. o City also has an "Eeling program" where the City conducts clean-outs up to 3 times in a 24-month period for free, as long as the clean-out is for City tree roots.	Property owner is responsible for the sewer lateral up to the main. This program assists owners with rehabilitation costs, and with free eeling related to City tree roots.	Approximately 50 to 60 properties per year replace the sewer lateral and obtain the grant. Approximately 1,600 to 1,900 properties per year participate in the Eeling program to remove tree roots from laterals.		Bylaw 4921 for Servicing of Private Sewer Connections
Halifax Water, NS **Population 385,500** Separated, except in some older parts (program applies to separated)	Regulatory Approach: Mandatory Inspection Program	**Private Property Inspection Program**: The Stormwater Inflow Reduction (SIR) program includes smoke, dye and CCTV testing of private laterals to identify sources of inflow, or significant infiltration if found. o Where repairs needed, notices given to owners to fix; follow up notices given if work not completed. o Bylaw in place that enables various forms of enforcement: may shut off water, issue tickets, or put liens on properties (where funds are owing). o Program targets both residential and ICI; tends to focus more heavily on ICI. Target properties chosen each year by evaluating multiple criteria in a matrix. o Future plans: investigating options for point-of-sale requirements or other trigger (e.g. age of home/lateral); have had early discussions with realtor association regarding property disclosure forms.	Reducing overflows, system capacity and, later, in response to WSER (legislation for Municipal Wastewater Effluent, under the Federal Fisheries Act, enacted 2012).	Example uptake from last year: 142 houses targeted, 90% of homes agreed to allow entry. Uptake significantly increased over the years, likely due to improvements in customer service and communication. Employed enforcement measure of shutting off water once (for a cross-connection, and only after years of discussion). Incident received a lot of media, and has likely led to increased uptake, particularly with ICI customers.	Funding: Utility operating budget	Halifax Regional Municipality Charter, sections 13, 61, 64, 79 Patricia Isnor 902-483-8187
Regional Municipality of York, ON **Population 1.03 million** Separated system	Comprehensive I&I Strategy and Pilot Projects	o Approach: First will conduct pilot studies to test effectiveness of specific rehabilitation techniques and methods, then will determine best management approaches moving forward. o Municipal programs: some local programs funded by developers in exchange for allocation of new units of development.	Province approved construction of new tunneled sanitary trunk sewer and attached conditions, including a requirement to develop an I&I Strategy and program for the service area; other drivers include capacity and treatment plant loads, basement flooding and SSOs		Budget: Estimated private side remediation program budget of $10 million for Phase 2 (inspecting and re-lining ~3,000 private sewer laterals)	York Region Inflow and Infiltration Reduction Strategy
USA						
City of Lakeport, CA **Population 4,700** Separated system	Regulatory Approach: Inspection with Permits and Certificate Program	**Requirement for Certificate with Permit**: Ordinance requires private laterals be cleaned, inspected and tested for I&I by the owner at predetermined events – including when applying for a building or plumbing permit. 25-year certificate for watertight laterals, 10-year certificate for CCTV tested. Option to fine a noncompliance fee.	Reducing overflows to fresh water lake. No EPA order.			Ordinance 872 (2008)
City of Glendale, MO **Population 6,000** Separated system	Targeted Approach	**Refuse Bill (insurance program)** – added $7 to quarterly bill and saved in a separate fund for a Sewer Lateral Repair Program (1997). o Assistance for residents who have to pay for sanitary sewer lateral repairs between its connection with the sewer main and the house connection. o The program does not pay for the cost of sewer cleaning to remove tree roots or buildups, rather that is the responsibility of the property owner/resident. o The program pays for point-of-break repairs, which means that the portion of the pipe that is defective is repaired. o Residents will be reimbursed up to $3000/year. If a problem is found, the CCTV video inspection will be paid for by the program.	Regional: St Louis City began a sewer lateral insurance program in 1989. Most municipalities in the County followed, including Glendale in 1997. Note: The EPA issued orders to the regional sewer agency in 1994 due to CSOs and in 2007 due to continued overflows and basement backups; though it's unclear the level of contribution from Glendale.		Funding: Refuse bill every three months Property owner's annual contribution is $50/year that is billed quarterly in increments on the City's sanitation bill ($12.50/quarter). $112,500 is collected annually as part of this program.	Tom White - 314-965-3600
City of Brentwood, MO **Population 8,000**	Incentive Approach	**Reimbursement to 100% (insurance program)** – when a blockage or sinkhole is noticed by the property owner, the owner must call the Sewer Hotline, the City sends a company out to check the problem and if there is a problem, the City will pay to have it fixed. Residents are reimbursed up to 100%.	US EPA issued a CSO control policy in 1994 (applies to combined areas only – includes St Louis City). St Louis City began a sewer lateral insurance program in 1989. Most		Funding: $120,000 is collected annually as part of this program. Property owner's annual contribution is $28/year. In 2010, voters agreed to raise this to $50/year.	Mark Nahmensen 314-963-8643

Jurisdiction	Program Approach	Program Description	Primary Driver(s) for Program	Program Impacts	Program Costs and Source of Funding	References
Combined & separated systems			municipalities in the County followed, including Brentwood in 1997. In 2007, EPA issued MSD (the regional sewer agency) an Administrative Order due to continued overflows and basement backups.			
City of Golden Valley, MN **Population 20,000** Program for separated system	Incentive Approach	**Grant Program:** o 2008 - Grants for lesser of $1,000 or 50% of the actual cost for separation. o 2009 - Grant for lesser of $2,000 or 50% of the actual repair cost. o Both programs ended May 2009 (no more funds).	Regional surcharges from MCES (see MCES entry below) if the City does not reduce peak flows to the regional collection system. MCES driver is maintaining sufficient capacity for growing population – current treatment site for Golden Valley cannot be expanded significantly.	21.4% properties have reached compliance (1,715 inspections, 11.7% in compliance after first inspection). 570/year (approx) repaired / replaced. Flow monitors are used in the system to monitor the flows. Data is received; however it has been unusually dry the last couple of years.	Costs: 2008 – 6 residents received a total of $2,982.75 from the foundation drain separation program. 2009 – 56 residents received a total of $82,745.38 from the service lateral grant program. Funding: Incentive funds from regional authority (MCES) grant program. Property owners pay required inspection fees: $250 residential, $750 non-residential.	City Code Chapter 3, Section 3.31
	Regulatory Approach	**Point-of-Sale Program (Jan 2007):** o Requires all properties to pass a sanitary sewer inspection and obtain a certificate before selling, advertising for sale, or transferring title. o Failure to comply may result in monthly utility bill charges ($500-$1,000) and possible loss of water service.				
	Targeted Approach	**Private Property Inspections** o Property owners agree to inspection.				
City of McMinnville, OR **Population 32,400** Program for separated system	Incentive Approach	**Monetary Incentive**: part of the private sewer lateral replacement program. o Reimbursed 10% of their construction cost up to a maximum of $250. o To be eligible, property owners must construct an acceptable lateral replacement within the 90-day grace period. **Interest Program**: property owners who may have trouble finding financial assistance through banks or other lending agencies. o Interest shall accrue on the balance due at the prime interest rate plus 3.5%. It is important to note that this is not a "low interest" loan.	US EPA: City has been directed by EPA and the Oregon Department of Environmental Quality (DEQ) to control the overflow of untreated sewage into the Yamhill River, which occurs frequently during the rainy season.	25% of total laterals have been inspected in 8 years (775). Only 6 have not complied. 60 to 70% of those inspected were repaired. Others passed.	Property owner pays to replace defective private sewer laterals.	
	Regulatory Approach	**Repair Enforcement with Financial Penalty** o Problem laterals are identified by the City and property owners informed of responsibilities by letter. 90 days to repair/replace lateral or fine of $50/month. o Non-compliance accumulates and lien is placed on the property. o Properties will not be randomly selected for evaluation. The properties evaluated will usually be part of a comprehensive pipeline repair project where City pipes are repaired first.				
City of Westlake, OH **Population 34,000** Program for separated system	Targeted Approach	**Rehabilitation Program** undertaken in 8 basins. o Started in 1992 by only public side rehab, but still had flooding. Decided private side must also be rehabilitated. o 2014: completed 8 basins in total since 1992.	Flooding of streets and yards during intense rainfall events and surcharging of sanitary sewers within basements. Westlake has joint treatment with City of Rocky River, which received an Administrative Order from the EPA in 2009; unclear level of contribution from Westlake.	1992 – inspected, re-grouted and fixed as needed private laterals where dye in sewer. 2001 – re-lined private laterals. I&I was 80% reduced in the area. 2004 – re-lined private laterals, as well as manhole sealing and tight seal at mainline/ lateral interface. I&I was 95% reduced in area. Complaints reduced or non-existent. 2007 – similar to above. Complaints reduced, no flow data yet available. 2014 – 816 homes inspected; 417 repaired.	Costs: 1992 – $338,000 and only $5,000 under property owner responsibility. Funding: 1992 - property owners paid private portion. 2001-2007 - City decided to fund all private property costs in future projects because the private portion was estimated to be approx 1.5% of the project cost. Total Costs (up to 2014): $2.3 million (3.3 million "total")	
City of Eagan, MN **Population**	Incentive Approach	**Inspection Program:** o City pays 50% of required repairs. o Property owner may elect to have all or part of their portion levied as a special	Regional surcharges from MCES if peak flows are not reduced (see MCES below). Focus is on	Estimate of 2,500 residential inspections this year. 2014 update: completed over 19,000	The City pays for inspections done by the company the City contracted with. If a homeowner chooses to have a	City Code Section 3.40 to add

Jurisdiction	Program Approach	Program Description	Primary Driver(s) for Program	Program Impacts	Program Costs and Source of Funding	References
67,448 Program for separated system		assessment against the property over 5 years at 4% interest. o Utility staff inspect for I&I sources when installing a water meter.	disconnecting improperly connected sump pumps and drainage systems.	inspections 2010 to 2014; over 850 repairs made.	plumber of their choice do the inspection they are responsible for the cost of the inspection.	Subdivision 10
	Regulatory Approach	**Monthly Fines on Utility Bills:** o Fines for non-compliance. o City inspects properties in identified neighbourhoods. o Required inspections followed by Corrective Work Order / Compliance Certificate.				
	Education	**Public I&I Education Program:** o Education program before starting the private inspections. o Included newsletter articles, public meetings and spots on ETV (Eagan's TV stations).				
City of Berkeley, CA **Population 103,000** Program for separated system	Regulatory Approach	**Sewer Lateral Certificate** - prior to selling a property or obtaining a permit for certain major remodeling projects. There are three events that trigger compliance: o 1. The sale of property; or o 2. A remodeling project that costs more than $100,000 or costs more than $50,000 and involves replacing or relocating two or more plumbing fixtures; or o 3. The City discovers an illegal connection from the City's lower sewer lateral to the private sewer lateral (owner's responsibility). *In 2007, 250 properties had closed escrow without obtaining a Sewer Lateral Certificate (SLC). Subsequently, the property owners were issued a Notice of Violation and corrective action is required to fulfill the requirements of BMC 17.24. By end of 2007, 53% of these complied. Enforcement proceeding with remainder.*	US EPA order to East Bay MUD. It is estimated that half of the water that enters the City's sewer during wet weather comes from private property sewer lines, downspouts and yard area drains. Bylaw is for protecting the water quality of creeks, watersheds and the San Francisco Bay.	First year (Oct 2006 – Oct 2007): 1,251 applicants. 84% of properties issued certificates upon submittal and remaining issued deficiency notices. o 65% property transfer trigger o 14% major renovation trigger o 21% voluntary or unidentified After 1st year 80% of laterals were out of compliance. At current rate, will take 30 years to complete all work.	Application fee of $150 required for all applications that require CCTV review. Property owner cost also for having CCTV reviewed (Engineer had to review 35% of applications)	Berkeley Municipal Code, Chapter 17.24
City of Costa Mesa, CA **Population 116,479** Program for separated system	Incentive Approach	**Sewer Lateral Assistance Program (2007)** Rebate 50% up to $1,250 for inspection, repair or replacement of lateral. *Recommendations* o Public Outreach Program was successful o Public readily gave permission for entry o Lateral renewal program was cost effective o Proposed to expand program to all 500 critical basins with excessive RDII 2014: SLAP program is still in place	Proactive: To prevent sewer backups and spills. "Sewer spills cause very expensive damage to the interior of a house and the environment, particularly the beaches."	315 in 2.5 years (approx 120/year) out of 35,000 connections (~0.4% per year).	$150,000 per year in grants; $50,000 per year for staff costs	Resolution No. 2007-742
City of Naperville, IL **Population 145,000** Program for separated system	Targeted Approach	**Targeted Program:** o Private lateral rehabilitation in high priority sewer basins (10 targeted areas). o Areas are selected by the following criteria: 1. Customer service calls; 2. Rain events; 3. Flow monitoring; and 4. Maintenance schedule.	Capacity: Flood situations force lids off of manholes leading to the combining of storm and sanitary flows, and to treatment plant being over capacity.		$2 million for sewer rehabilitation $4 million for the entire program Capital Budget	
City of Tacoma, WA **Population 200,000** Separated system	Regulatory Requirement for Education	**Required Education Program** Starting in 2010, real estate professionals are required to provide a side sewer educational flyer to buyers and sellers they are representing prior to the closing of a property. The City also provides the flyer to all permit applicants. The flyer recommends property owners locate and determine the condition of a side sewer.	Proactive program to complement public side efforts to reduce I&I.	No formal tracking of program impacts. Anecdotal information indicates more buyers are conducting sewer lateral inspections prior to buying properties.	Minimal	Tacoma Municipal Code Chapter 12.08.720
City of Santa Barbara, CA **Population 420,000** Program for separated system	Incentive Approach	**Grant Program:** o $150 for inspection; Up to $2,000 or 50% for repair; permit fees waived o Low-interest loans for those needing financial assistance.	Spill prevention / reduction of sewage spills into storm drains *(no reference to EPA order found)*. Recent (2012) settlement with Channel keepers re: Clean Water Act will require the City to spend an additional $4.5 million over the next 5 years to improve its sewage system, reduce sewage spills; with a focus on	Inspections: 1306 (residential), 313 (commercial), 29 (condo) from Jan 2007 to Feb 2010 o 930 residential laterals repaired over same period o 983 certificates issued over same period Over 95% have reach compliance	Far more expensive than anticipated (> $600K in first year – 3 times more than estimated). Since January 2007, total program cost of $2,470,000: o < 1% ($7,600) for lateral inspections only o 73% ($1,800,000) for lateral repair incentives	Municipal Code Chapter 14.46
	Regulatory Approach	**Enforcement Program:** o City identifies problem laterals & provides notices requiring repair. o City notifies property owner & required to fix or $150 penalty & referral to attorney's office for enforcement. o Commercial properties required to inspect every 10 years.				

Jurisdiction	Program Approach	Program Description	Primary Driver(s) for Program	Program Impacts	Program Costs and Source of Funding	References
	Education	**Certificate Program:** o Zoning Information Report (ZIR) at time of sale indicates if Certificate obtained & advises buyer of responsibility.	those with highest risk of leaking into storm drains.		o 11% ($270,000) for waived permit fees charged to our section. Does not include any additional costs of resources, marketing or legal fees. Capital Program Funding.	
City of Austin, TX **Population 757,688** Program for separated system	Incentive Approach & Regulatory Approach	**Financing (loan) Program** available up to $3,000. o Utility buys down interest rate on the loan. o A grant program for low income people is being developed. **Fines for Non-Compliance:** o City identifies with inspection and sends letter requiring fix within 120 days. Fine up to $500 per offense (each day non-compliant is a separate offence).	US EPA Administrative Order requiring City to take measures to prevent sewage overflows (1999). Also cite desire to reduce costs.	No definite tracking system for number of laterals repaired. Many are replaced following initial trouble call and don't enter enforcement program. No change in I&I has been attributed to the private lateral program, yet.	Costs for the program are not tracked separately from other utility costs. Funding for the grant and loan program is from utility's CIP budget. Staff resources are funded through the utility's O&M program.	Ordinance No. 20070125-007
Milwaukee Metropolitan Sewerage District (MMSD), WI **Population 1.1 million** Primarily separated system (~5% combined)	Regional Targets and Required Compliance Plans Approach	**Regional I&I Targets (Limits)** and Community Compliance Requirements: o Made long-term peak wet weather management plan that sets standards for expected flows at each "metershed", then identifies if standard is exceeded, and requires offending municipality to create a plan that will bring it into compliance. Within 1.5 years, 8 municipalities had been notified of non-compliance and were creating flow reduction plans. o In 1998 MMSD adopted rules that municipalities must develop and implement an I&I management plan; and must enforce prohibited connection ordinances. o Region created a Policy Document for I&I funds clearly establishing the rational for private property I&I work, and what is eligible for funding. o Region has also aggressively pursued education program with respect to basement backups, including website and video.	Historically has had settlement with EPA/DNR for SSOs (early 2000s). Created a 2010 Facility Plan, then later a 2020 Facility Plan to reduce SSOs. Federal grant provided for private property efforts.		10-year $60million program for private property I&I split proportionately to each community. Region provides guidance documents and processes for communities (e.g. community cannot spend more than 20% of allocated funds on investigation).	MMSD 2020 Facilities Plan Private Property I&I Policy Documents and Work Plan
King County, WA **Population 1.5 million** Separated systems except in some parts of Seattle	Agency led Inspection and Rehabilitation Projects	**Rehabilitation Projects where Cost Effective**: Started Regional I&I Control Program in 2000 – now in place 15 years. o Completed several pilot projects and assessed cost effectiveness o Evaluate projects on a case-by-case basis to determine cost effectiveness o Developed standards, guidelines and policies for lateral inspection and remediation o Found that basins with I&I less than 3 gallons per minute per property were not good candidates (too many properties would have to be rehabilitated to achieve target reductions	King County and City of Seattle agreement to upgrade combined sewers under settlement with US EPA in 2013.	Data collected indicates large percentage of I&I originates from private property. Recently completed larger scale I&I control project (Skyway) that tested assumptions from the smaller pilot projects. Found the I&I reductions were much lower than predicted, but still significant.	6-year control study of 10 pilot projects cost $41 million. Combined funding from King County and local agencies.	Executive's Recommended Regional I&I Control Program (2005)
Miami-Dade County, FL **Population 2.4 million** Program for separated system	Regulatory Approach & Targeted Approach	**Enforcement Program:** o Identified private property defects through smoke testing and property owners were required to make repairs to their laterals as required by Miami Dade County Ordinance. o The County simply the property owners and they made repairs to the system. o Subsequent re-smokes of the area verified if the repairs were completed. *Insurance Issues: minor property damages usually the result of testing and or repair crew equipment that have inadvertently encroached on private property and damaged easement and ROW areas.* **Comprehensive Lateral Pilot Program (began in 2004)**: $13 million dollar project designed to determine if a private lateral testing and inspection program was a viable solution to the reduction of peak flow.	Series of US EPA Consent Decrees (1994/5 and 2013) in relation to sewer spills. 2013 Consent Decree requires substantial repair of 3 WTPs and sewer system at an estimated cost of $1.6 billion (Miami-Dade County Clean Water Act Settlement).	Enforcement Program was 85% effective. Average of over 700 lateral replacements per year. Average daily flow: 116 MGD's in total reduction (over a 14 year period). CLIP: Inspected 6,749 laterals. 85% effective in repairing laterals (repaired / replaced over 1200 laterals). Estimated cost to pump and treat $8,645/GPM. Estimated cost for mainline inspection/repair $362/GPM (23 times more cost-effective than pump and treat). Estimated cost for lateral inspection/repair $2,308/GPM (about 3.7 times more cost effective than pump and treat). Total Program $1,011/GPM removed.	Both programs funded by combination of: Bond Funds, Capital Revenue Funds, and O&M Funds. Overall cost of the enforcement program is now over $400 million dollars. Cost of the 43 basin CLIP program approx. $13 million: o $4m - mainline inspection/ repair o $4m - lateral inspection o $4.5m - lateral repair o $0.5m - admin costs NOTE: lateral inspection / repair includes public side upper lateral Funding: $1 million dollar grant for the implementation of the CLIP program.	
Metropolitan Council of	Regional Targets and	**Regional Surcharge**: MCES continuously monitors volumes of wastewater from municipal systems, and requires the municipalities to reduce peak flows to the regional	History of working to improve water quality in the Mississippi has led to		I&I reduction is funded by communities with amounts equivalent or exceeding	Water Resources

Jurisdiction	Program Approach	Program Description	Primary Driver(s) for Program	Program Impacts	Program Costs and Source of Funding	References
Environmental Services (MCES), MN (Twin Cities) **Population 2.7 million** Program for separated system	Surcharge Approach	collection system, or charges them. o 1993 – 2003 MCES provided grants to communities to reduce I&I, but not sufficient o In 2006 instituted surcharge for clear water; communities that have I&I reduction plans can opt out of the surcharge in order to make investments in I&I reduction (must match or exceed surcharge) o Starting in 2015, demand charge for communities not meeting I&I goals; also MCES will have the ability to limit future increases in service where communities have not met I&I goals o Created a "toolbox" for member communities to solve I&I problems	implementation of more proactive approaches. Capacity concerns in certain locations (e.g. Golden Valley). Also SSOs, private property spills, using up capacity for future growth.		avoided surcharges. 2013 received $1,000,000 in grants for local I&I reduction programs.	Management Policy Plan

Appendix B – Bylaw Examples (Canadian)

Responsibility of Owner

Sample Bylaw, Metro Vancouver (2011 Report, Appendix H):

PART 2 – (6) to (9) – Required Maintenance Standard

Town of Fort Erie Bylaw 68-06:

3.8.2 Every owner shall maintain their private sewer lateral or private sewage collection system and private drainage lateral or private drainage or storm water management systems, including appurtenances connected thereto, in good working order and condition, and adequately protected from blockage and freezing. Private sewer laterals and private sewage collection systems shall be maintained free from drainage and storm water inflow and infiltration.

Halifax Water Rules and Regulations for Water, Wastewater and Stormwater Services:

64.(1) The Commission may from time to time undertake testing or inspections to identify and locate connections that convey stormwater into a wastewater facility.
(2) No person shall, without the prior written approval of the Commission connect, cause to be connected, or allow to remain connected to a wastewater facility or plumbing installation, any piping fixtures, sump pumps, downspouts, fittings appliances or like equipment or device in a manner which allows or may allow stormwater to ingress or flow into a wastewater facility.
(3) The Commission may direct a person to discharge stormwater to a stormwater system, a surface area or watercourse.
(6) The Commission may determine, in its discretion, that this Section does not apply to existing premises connected to an existing combined sewer system or to new premises intended to be connected to a combined sewer system, provided that those premises are not serviced or able to be serviced by a separate stormwater system.

Cleanouts Required

Sample Bylaw, Metro Vancouver (2011 Report, Appendix H):

PART 2 – (10) to (12) – Cleanouts Required [optional]

Town of Fort Erie Bylaw 68-06:

3.8.4 Inspection tees shall be installed in all private sewer laterals at the expense of the Owner as specified in Appendix "1" attached hereto, and shall be maintained in good order and accessible at all times, and free from drainage water inflow and ground water infiltration.

Entry and Testing

Sample Bylaw, Metro Vancouver (2011 Report, Appendix H):

PART 2 – (14) to (17) – Entry and Testing by City

City of Kingston Sewer bylaw 2008-192:

14.1 Inspection powers

The Operating Authority or any person designated by it as inspector for purposes of this by-law may, at reasonable times enter onto any land on which the City supplies sewer services for the following purposes:

a) to inspect, repair, alter, or disconnect the sewer lateral or storm sewer lateral, machinery, equipment and other works used to supply sewer services to the building or land;

b) to inspect, install, repair, replace or alter any related metering equipment;

c) to inspect the discharge of any matter into the sewage system of the City or into any other sewage system the contents of which ultimately empty into the municipal sewage system and may conduct tests, measure flow and take samples for this purpose; or

d) to investigate or determine if this by-law, an order, or condition to any permit or agreement is being complied with.

14.4 Entry on land – notice requirements

Whenever an inspector exercises a power of entry pursuant to this By-law, the inspector shall:

a) provide reasonable notice of the proposed entry to the occupier of the land by personal service or prepaid mail or by posting the notice on the land in a conspicuous place for three consecutive days prior to entry;

b) where the proposed entry is an inspection to determine compliance with this By-law the inspector must provide reasonable notice by means of personal service only;

c) in so far as is practicable, restore the land to its original condition where any damage is caused by the inspection; and

d) provide compensation for any damage caused and not remedied.

Halifax Water Rules and Regulations for Water, Wastewater and Stormwater Services:

61.(3) The Commission may require a wastewater or stormwater service connection to be inspected and brought into compliance with these regulations.

64.(1) The Commission may from time to time undertake testing or inspections to identify and locate connections that convey stormwater into a wastewater facility.

Town of Fort Erie Bylaw 68-06:

3.8.7 Every Owner shall, at all reasonable times and upon reasonable notice given and request made, allow and provide access to their building or premises to the Engineer for the purpose of conducting a compliance inspection and taking corrective action, and/or to carry out work, all as permitted under this Schedule, the Ontario Building Code, or the Municipal Act 2001.

3.9.1 The Engineer and/or Chief Building Official or any person duly authorized by the Corporation shall be allowed access to a building or premises, at all reasonable times, and upon reasonable notice given and request made to the Owner, Operator or Customer, for the purpose of inspecting, maintaining, repairing, disconnecting or reinstalling a sewer

service connection or drainage service connection as permitted by this Schedule or by the Ontario Building Code or by the Municipal Act 2001.

City of Brantford Sewer System Regulation – Use:

ARTICLE 11 POWER OF ENTRY AND INSPECTION

11.1 The City may enter upon any part of a property at any reasonable time, to inspect the discharge of any substance into the sewage works or storm sewers and may conduct tests and take samples of the discharge.

11.2 The City's power of entry described in subsection 11.1 may be exercised by an employee, officer or agent of the City, including a municipal by-law enforcement officer.

11.5 When entering a property in accordance with articles 11 and 12 of this by-law the person exercising the power of entry shall provide identification to any person requesting identification during the course of the inspection and,

a) may be accompanied by a person or persons under his or her direction; and

b) shall not enter or remain in any room or place actually used as a dwelling unless one of the conditions set out in section 437 of the Municipal Act, 2001 are met.

11.6 When entering a property in accordance with articles 11 and 12 of this by-law the exercise of such powers shall be limited to reasonable times, unless an emergency situation requires otherwise.

11.7 For the purposes of an inspection to determine compliance with this by-law or any order issued under this by-law or to otherwise enforce this by-law a municipal by-law enforcement officer may,

a) access any drain pipe, interceptor, maintenance access hole, catch-basin or other discharge point connecting, directly or indirectly, to the sewage works or storm sewers, including by making or requiring necessary excavations;

b) make and record observations, such as by taking photographs, notes, video recordings and sound recordings;

c) require the production for inspection of documents or things relevant to the inspection;

d) require information from any person concerning a matter related to the inspection;

e) alone or in conjunction with a person possessing special or expert knowledge make examinations or take tests, samples or photographs necessary for the purposes of the inspection.

f) inspect and remove documents or things relevant to the inspection for the purpose of making copies or extracts; and

g) do such other things that are reasonably necessary for an enforcement officer to effectively carry out the inspection.

11.8 A demand by a municipal by-law enforcement officer to respond to reasonable inquiries under subsection 11.7 (e) or to produce documents under subsection 11.7 (f) may be made by telephone, letter or e-mail and such demand shall be deemed to be made in the course of an inspection.

11.9 No person shall refuse or neglect to give, produce or deliver any access, information, document or other thing that is requested by a municipal by-law enforcement officer carrying out an inspection.

11.10 No person shall hinder or obstruct or attempt to hinder or obstruct the City, its municipal by-law enforcement officers, employees or agents from carrying out any powers or duties under this by-law.

Require Fix of Defect

Sample Bylaw, Metro Vancouver (2011 Report, Appendix H):

PART 3 – (18) to (20) – Certificate Required – Identified Defect

City of Kingston Sewer bylaw 2008-192:

3.2 Maintenance of sewer lateral – Owner

Every Owner of a property to which sewer service is provided shall be responsible for the maintenance, repair, and replacement of the sewer lateral from the building to the property line. Any and all structural defects of a sewer lateral shall be repaired by the Owner of the property being serviced. Should the City become aware of any such structural defect, and upon written notification to the Owner, the said structural defect is not repaired within thirty (30) days of the date of the notification or within such time as the Operating Authority may deem necessary, then the City may turn off the municipal water supply to the property. If the City is ordered to restore the water supply, then the City may repair the structural defect in the sewer lateral pipe at the Owners expense. In so doing the City of Kingston shall only reinstate the property to a safe condition and all final restoration shall be the Owners responsibility. The City of Kingston shall not be held responsible for any damages to the Owners property arising from such work such as damage to root systems or other landscaping features located along the sewer lateral. If flushing or rodding of a sewer lateral is required to remove an obstruction located anywhere between the building and the sewer lateral stub, the Owner or occupier shall be solely responsible for the cost of removing the obstruction.

Town of Fort Erie Bylaw 68-06:

3.8.5 Should a leakage occur from a private sewer lateral or private sewage collection system, or from a sewage holding tank, or from a septic tank system or any other private sewage treatment system; the Owner shall be bound to take corrective action and to complete the repairs of the said leakage, at the Owner's expense, within seven (7) calendar days after being duly notified by the Corporation of such leak detected. In the event of non-compliance with this provision by the Owner, the Corporation may at its sole discretion exercised by the Engineer, discontinue the supply of water from the Water Works until the Owner has made the necessary repairs. All repairs are to be inspected and approved by the Chief Building Official prior to backfill.

City of Brantford Sewer System Regulation – Use:

ARTICLE 12 ORDERS

12.1 Where the General Manager has reason to believe that a contravention of this by-law has occurred, the General Manager may issue and serve an order requiring the person who has contravened the by-law or who has caused or permitted the contravention or the owner or occupier of the property on which contravention of the by-law occurred to discontinue the contravening activity.

12.2 Where the General Manager has reason to believe that a contravention of this by-law has occurred, the General Manager may make an order requiring the person who has contravened the by-law or who has caused or permitted the contravention or the owner or occupier of the property on which contravention of the by-law occurred to do work to correct the contravention.

12.3 Where a person is issued an order described under sections 12.1 and 12.2 and in the opinion of the City fails to do a matter or thing required by the order by the date specified in the order, the City may cause the matter or thing set out in the order to be done at the person's expense.

12.4 For the purpose of doing any matter or thing under section 12.3, employees of the City and any contractor, consultant or other person authorized by the City may enter upon the property referred to in the order at any reasonable time.

Require Inspection for Construction, Renovation or New Connection

Sample Bylaw, Metro Vancouver (2011 Report, Appendix H):

PART 3 – (21) to (23) – Certificate Required – Construction, Renovation or New Construction

District of North Vancouver bylaw 6656:

14. Re-Use of Existing Sewer Connections

All building permits of value greater than $150,000 will require a new sewer (sanitary) connection unless:

(a) the existing connection(s) is less than 30 years old;

(b) a current video inspection meeting MMCD or equivalent standards is undertaken by a qualified inspector and provided to the District; and

(c) the video inspection establishes to the satisfaction of the Director that the connection(s) is in good condition with no defects.

City of Surrey bylaw 16611, 2008:

39. When an application for a service connection accompanies a building permit with the construction value greater than $100,000 or where a parcel is being redeveloped, the following shall apply to the service connection and the building sanitary sewer:

(a) if the service connection and building sanitary sewer is less than 30 years old, the owner must provide a video inspection and recommendation for the City to review. The owner shall repair or replace the connection if the City determines that the connection is not adequate for service or has excessive damage;

(b) if either the service connection or the building sanitary sewer is 30 years old or older, a replacement or new service is required;

(c) all no-corrode, asbestos cement or clay service pipes of any age or condition shall be replaced;

(d) any shared service connections and building sanitary sewer shall be replaced; and

(e) all costs associated with the above are the responsibility of the owner.

The General Manager, Engineering may waive part of the above requirements if the General Manager, Engineering deems the cost of the replacement excessive.

Fees, Recovering Costs

Sample Bylaw, Metro Vancouver (2011 Report, Appendix H):

PART 5 – (51) – Fees

Town of Fort Erie Bylaw 68-06:

3.9 Compliance Inspections and Corrective Actions

3.9.2 Any costs incurred by the Corporation in conducting inspections and subsequent reporting or in effecting any corrective action, shall be payable to the Corporation by such Owner, Operator or Customer; and if not paid, the costs shall be added to the tax roll for the property and collected in the same manner and with the same priority as municipal taxes.

Financial Assistance, Monetary Incentive

Sample Bylaw, Metro Vancouver (2011 Report, Appendix H):

PART 5 – (52) to (63) – Financial Assistance and/or Monetary Incentive for Voluntary Inspection and Repairs

City of Brantford Program (not in the bylaw – text from website):

Private Sanitary Sewer Lateral Replacement Grant Program

This is a financial assistance program for homeowners to help offset costs for the replacement of old sanitary sewer laterals on private property. This incentive program is being offered in the interest of helping homeowners prevent or reduce the occurrence of sewer blockages.

City of Windsor bylaw 4921 (n.b. the owner is responsible for the lateral to the main):

PART B – SEWER CONNECTION REPLACEMENT POLICY

1.REPLACEMENT

The City will provide a sewer replacement rebate for a complete sewer replacement calculated as follows:

1. Where there is a fronting Public Sewer that can be used in a complete sewer replacement, the City will provide a rebate being the lesser of the following:

(i) The amount set out in the City's Schedule of Fees, as amended from time to time. It is the intention of this provision that the City's Schedule of Fees will be the relevant rate,

(ii) Fifty Per Cent (50%) of the total cost of the complete replacement,

(iii) The unit cost (being the total cost divided by the total length) multiplied by the length of the replacement on the public highway.

Enforcement, Penalties

Sample Bylaw, Metro Vancouver (2011 Report, Appendix H):

PART 6 – (64) to (74) – Failure to Comply – Offence and Penalties

Halifax Water Rules and Regulations for Water, Wastewater and Stormwater Services:

Offences

79. Where the Commission believes that a person has contravened any provision of these regulations, it may commence proceedings by issuing a Summary Offence Ticket in accordance with the Nova Scotia Summary Proceedings Act.

Suspension or Refusal of Service

13.(3) In the event of a violation of these Regulations by a person or Customer, including liabilities and obligations owed to the Commission by any Customer under a private contract for services entered into between the Commission and such Customer, the Commission may refuse or immediately suspend service to such Customer, and may continue such refusal or suspension until the violation has been cured.

Town of Fort Erie Bylaw 68-06:

3.9 Compliance Inspections and Corrective Actions

3.9.3 Should any Owner or Operator or Customer of a service connection refuse entry to any authorized officer, inspector, employee or Agent of the Corporation for the purposes of any compliance inspection, maintenance, repair, disconnection or reinstallation and/or other corrective action, under the provisions of this Schedule or the Ontario Building Code, or the Municipal Act, 2001; the Corporation may, at its sole discretion exercised by the Engineer, on the provision of seven (7) calendar days notice, discontinue the supply of water to the Owner or Operator or Customer of the service connection until such required inspection and corrective action or required work has been completed to the satisfaction of the Corporation.

Appendix C – References and Links

Examples of smoke testing notices and procedures for Canadian municipalities:

London ON:
http://council.london.ca/meetings/Archives/Agendas/Environment%20and%20Transportation%20Committee%20Agendas/ETC%20Agendas%202009/2009-07-20%20Agenda/Item%2020.pdf

Markham ON:
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Appendix D:
Sample Private Property I&I Model Bylaw

PREFACE:

In 2008, an example bylaw "For the maintenance and repair of private sewer laterals" was developed to provide a reference for Metro Vancouver municipalities that demonstrates their legal authority for management of private sewer laterals. The example bylaw was developed by a BC lawyer (with West Coast Environmental Law) for the BC context, ensuring the provisions are within the authority of municipalities under the Community Charter. The key concepts for the bylaw were drawn from examples found in other jurisdictions, both in Canada and the US. Now (2015): Two example bylaws have been created for CRD municipalities that are modeled on the Metro Vancouver example.

The first bylaw ('Basic elements') contains the elements that are recommended be addressed in all municipalities. These elements provide clarity for the required maintenance standards expected of property owners, clarity about the authority of municipalities to inspect and require action to bring private laterals into compliance, and clarity about the penalties that may be imposed if they are not brought into compliance. These are important to clarify before embarking on programs that involve inspection of private laterals, such as smoke testing programs. Several municipalities in Canada have been updating their sewer bylaws in recent years to address these elements.

Here are the key elements of bylaw #1:

- *Required maintenance standards*
- *Authority for entry and testing by City*
- *Authority to require repair of a defect*
- *Requirement to get a permit for work*
- *Financial assistance and Monetary incentive (Note: Recommend removing these items in Part 5 from 'Basic Elements' bylaw)*
- *Offence and penalties for failure to comply*

Sample Bylaw on Private Sewer Laterals for CRD – 'Basic Elements'

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CITY OF _____

BYLAW NO. ____, 20__

FOR THE MAINTENANCE AND REPAIR OF PRIVATE SEWER LATERALS

WHEREAS the Council of ____ is authorized to provide laws and services for the benefit of the community, and to provide for responsible stewardship and management of the public assets of the community;

AND WHEREAS Council has regulatory authority over sewers and drains and deems it in the public interest to regulate the maintenance, operation and function of private sewer laterals within the sanitary sewer system;

AND WHEREAS such regulation supports and advances regional objectives to improve the integrity and efficient operation and function of the sewer system, and to reduce and prevent sewage overflows caused by inflow and infiltration,

NOW THEREFORE, the Council of ___, in open meeting assembled, enacts as follows:

PART 1

SHORT TITLE

1. This bylaw may be cited for all purposes as the Private Sewer Lateral Maintenance Bylaw No. ____, 20__.

DEFINITIONS

2. The following definitions apply for the purposes of the bylaw:

"Bylaw Enforcement Officer" means a person appointed by the Council as a Bylaw Enforcement Officer.

"Chief Building Inspector" means the Chief Building Inspector for the City and his/her authorized designate(s).

"Combined Sewer" means a sewer or portion thereof designed to function simultaneously as a storm sewer and as a sanitary sewer and its appurtenances.

"Council" means the Council of the _____ of _____.

"Director of Engineering" means the Director of Engineering for the _____ and any successor in title to that position and his/her authorized designate(s).

"Infiltration" means Non-Sanitary Water Flow that enters a sanitary sewer system from such means as, but not limited to, defective, cracked or faulty pipes, pipe joints, connections or manhole walls. Infiltration does not include, and is distinguished from, Inflow.

"Inflow" means Non-Sanitary Water Flow that enters a sanitary sewer system from connections that include, but are not limited to, roof leaders, surface, foundation or other drains, manhole covers, and cross connections with storm or combined sewers.

"Licensed Plumber" means a plumber who has received accreditation in that trade pursuant to the Interprovincial Standards (Red Seal) Program.

"Owner" means the registered owner of a real property estate in fee simple.

"Non-Sanitary Water Flow" means a flow of water that has not been polluted by Sanitary Waste, and includes but is not limited to rainwater, stormwater, groundwater, roof and parking lot runoff.

"Plumbing Fixture" means any toilet, urinal, wash basin, sink, bath tub, shower, or other plumbing apparatus on private property that connects to the Sanitary Sewer Main via a Private Sewer Lateral or Sewer Service Pipe.

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"Private Sewer Lateral" means the underground pipe or any works on private property connecting an existing building or proposed building on private property to the Sewer Service Pipe at the property line.

"Sanitary Sewer Main" means publicly owned sewer pipe that is located on public property and to which a Private Sewer Lateral is directly connected or connected via a Sewer Service Pipe.

"Sanitary Waste" means waste and waste water from plumbing fixtures on residential and non-residential property.

"Sewer Service Pipe" means publicly owned pipe and fittings connecting a property, at or near the private property line, to the Sanitary Sewer Main.

APPLICATION

3. This bylaw applies to all properties that receive water or wastewater service from the _____of _____.

NOTICE

4. For the purposes of this bylaw, any notice delivered to an Owner by mail is deemed to be received on the same day of the week, in the calendar week following mailing, as the day of the week on which the document was mailed or, if that day is a Saturday or holiday, on the next day that is not a Saturday or holiday.

PART 2

REQUIRED MAINTENANCE STANDARD

5. An Owner of real property containing a Private Sewer Lateral shall at the Owner's expense maintain the Private Sewer Lateral to the following required maintenance standard:

   (a) the Private Sewer Lateral shall be clear of all obstructions (including roots, grease deposits, debris and other solids) which may impede the flow or obstruct the transmission of waste;

   (b) the Private Sewer Lateral shall be free of any structural defects (including cracks, breaks, openings, rodent holes or missing portions), which may allow the introduction of extraneous flow or debris into the sanitary sewer system or allow the discharge of sewage onto the property, and the lateral shall be uniform and without sags; and

   (c) the Private Sewer Lateral shall not be connected to any source of Non-Sanitary Water Flow and shall not discharge Non-Sanitary Water Flows into a Sanitary Sewer Main.

6. The City is responsible for maintaining the Sewer Service Pipe at the City's expense. If flushing or rodding of a Private Sewer Lateral is required to remove an obstruction caused solely by a structural defect in the Sewer Service Pipe, the City shall be solely responsible for the cost of removing the obstruction.

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UNAUTHORIZED DISCHARGES OR CONNECTIONS

7. No person shall discharge or permit to be discharged anything other than Sanitary Waste into the public sewer.

ENTRY AND TESTING BY CITY

8. The Director of Engineering, Chief Building Inspector or a Bylaw Enforcement Officer may at reasonable times and on giving reasonable notice to the Owner, enter upon any property or premises for the purposes of ascertaining whether the regulations of this bylaw are being observed.

9. The Director of Engineering is directed, where any dwelling is occupied, to obtain the consent of the occupant or provide written notice 24 hours in advance of entry upon the occupied dwelling pursuant to section 8.

10. The Director of Engineering may periodically perform tests or inspections of a Private Sewer Lateral to confirm the integrity and proper function of the sanitary sewer system or whether the Private Sewer Later is being maintained to the required maintenance standard set out in section 5 of this Bylaw. Testing and inspection methodology may include smoke testing, dyed water testing, air testing, hydraulic testing, closed circuit television inspection, and other testing or inspection techniques approved by the Director of Engineering.

11. It is an offence under this bylaw to hinder or obstruct entry, tests or inspections by the Director of Engineering.

PART 3

REQUIRED REPAIR OF DEFECT

12. The Director of Engineering may provide the Owner with written notice of a defect identified in a Private Sewer Lateral as a result of testing or inspection conducted by the City.

13. Subject to section 14, an Owner in receipt of a written notice of a defect shall within 120 days of receipt of the notice repair the defect as necessary to meet the required maintenance standard described in Part 2.

14. If the identified defect is such that sewage is exposed on the property or there is a potential health hazard, an Owner must:

    (a) Stop the discharge immediately;

    (b) Remediate the site not later than 24 hours after the Owner has notice of the exposed sewage; and

    (c) Within 14 days of receipt of the notice repair the defect as necessary to meet the required maintenance standard described in Part 2.

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PART 4

SEWER LATERAL WORK – PERMIT REQUIREMENT

15. If a notice of defect delivered by the Director of Engineering reveals a defect in a Private Sewer Lateral, an Owner shall at his/her own expense repair or replace the Private Sewer Lateral as necessary to meet the required maintenance standard described in Part 2.

16. An Owner shall first obtain from the City Engineering or Building Department a permit to conduct the repair or replacement work.

PART 5

FINANCIAL ASSISTANCE [***N.B. to provide this kind of assistance (lending money) the municipality would need to comply with the notice requirements of the Community Charter, section 24*]

*[** optional – council may opt to include a financial assistance component in this bylaw]*

17. The City is hereby authorized to establish a Private Sewer Lateral financial assistance program in the nature of a no-interest loan program, to assist Owners with the costs of repairing or replacing a defective Private Sewer Lateral.

18. Loans will not be granted unless the Owner signs an agreement that includes the Owner's agreement:

    (a) To repay the loan plus the lien registration costs in full, by way of five equal annual installments collected as property taxes;

    (b) That the loan principal will be secured by a lien registered against the property's title in the Land Title Office;

    (c) That upon any Change in Ownership of the property, the full balance of the loan will become immediately due and payable to the City and if unpaid, due and collectable as property taxes in arrears.

19. An Owner may apply for assistance from the program by filing an application with the Director of Engineering in the form prescribed by the Director of Engineering.

20. Eligibility for financial assistance will be determined by the Director of Engineering on the basis of financial inability to pay for required repairs.

21. If an Owner complies with the application requirements, the __Director of Engineering may authorize the Owner to receive financial assistance under the program.

MONETARY INCENTIVE FOR VOLUNTARY INSPECTION AND REPAIRS

*[** optional – council may opt to include a rebate component in this bylaw]*

22. The City is authorized to offer to Owners a monetary incentive as provided in this Part to encourage eligible Owners to voluntarily comply with the required maintenance standard for Private Sewer

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Laterals, and to help to offset the cost of inspection and repairs ("Monetary Incentive"). The Monetary Incentive is not available in respect of work performed after ____, 20__.

23. The City is not required to offer or continue the Monetary Incentive, except as authorized by Council. This incentive is subject to the budgetary limitations as may be established by Council from time to time.

24. Council may grant a Monetary Incentive under this Part only in respect of properties that meet all of the following criteria:

    (a) The Private Sewer Lateral was installed more than 20 years prior to the date of the application for the Monetary Incentive;

    (b) The property is not subject to any of the requirements set out in Parts 3 and 4 of this bylaw;

    (c) The property is a residential use property and contains three or fewer residential units.

    (d) The Owner has voluntarily repaired a defective Private Sewer Lateral not more than 60 days before the date of the application.

25. Monetary Incentives granted to reimburse Owners under this Part will be limited to a maximum amount of $____ Canadian or __ per cent of the Eligible Repair Costs, whichever is less.

26. Eligible Repair Costs are defined for the purposes of this Part as:

    (a) the costs of Private Sewer Lateral inspection and testing,

    (b) costs for pipe or other pipe repair material, and/or

    (c) costs of excavation or burial of pipe in the soil.

    (d) All other costs, including but not limited to landscape repairs, sidewalk repairs, driveway repairs, the cost of the Owner's own labour or other incidental costs are ineligible.

27. An Owner must apply for a Monetary Incentive within 60 days of completing the repairs on the defective Private Sewer Lateral. To apply, an Owner must submit to the Director of Engineering:

    (a) an application in the form prescribed by the Director of Engineering;

    (b) a copy of a Licenced Plumber's invoice, detailing the work performed on the property and listing the cost of the work; and

    (c) a copy of the permit from the City Engineering or Building Department for the repair or replacement work.

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PART 6

FAILURE TO COMPLY – OFFENCE AND PENALTIES

28. The Director of Engineering, the Chief Building Inspector, and Bylaw Enforcement Officers are authorized to enforce the provisions of this bylaw.

29. On becoming aware of an Owner's non-compliance with this bylaw, an authorized enforcement officer may deliver a Notice of Non-Compliance to the Owner advising him/her of the failure to comply and the obligation to comply with the bylaw.

30. An Owner shall comply with the bylaw within 30 days of issuance of a Notice of Non-Compliance, or be liable to enforcement action.

31. A person who violates or contravenes a provision of this bylaw or who consents, allows or permits any act or thing that violates or contravenes a provision of this bylaw, or who neglects or refrains from doing anything required to be done by this bylaw, commits an offence and is liable to a fine not exceeding $10,000 or imprisonment for 6 months, or both

32. Each day that a violation occurs or continues constitutes a separate offence.

33. Nothing in this bylaw shall limit the City from pursuing any and all bylaw enforcement or remedial authority available to it pursuant to the *Local Government Act* or *Community Charter*. Without limiting that authority, such authority includes the right of the City to pursue any or all of the following enforcement or remedial measures:

    (a) Following non-compliance with the bylaw and on providing the Owner with 30 days written notice, the City may discontinue the service of water supply to the property [***N.B. The municipality would need to modify the terms of its water service to include the need to comply with this bylaw – see section 18 of the Community Charter]*;

    (b) A civil proceeding in the BC Supreme Court;

    (c) Reimbursement for the costs of municipal action pursuant to section 17 of the *Community Charter*. Costs incurred by the City to effect repairs required to bring a defaulting Owner's Private Sewer Lateral into compliance with the bylaw will be a debt of the Owner owed to the City [***optional** and will bear interest at the prime rate of the Bank of Canada plus 2 per cent*]. This debt will be due and payable 30 days after the date on which the expenses were incurred and if unpaid on the due date will be deemed taxes in arrears and may be so entered on the tax roll by the collector. Debts due may be recovered as a lien against the property.

34. Nothing in this bylaw shall be interpreted as relieving a person discharging waste from complying with federal, provincial and local government enactments governing the discharge of waste into sewers.

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35. Any financial assistance or monetary incentive provided to an Owner by the City, or any repair and/or replacement of a defaulting Owner's Private Sewer Lateral by the City pursuant to section 17 of the *Community Charter,* are at the sole risk and cost of the Owner only. The City assumes no liability for providing financial assistance or a monetary incentive, or for effecting repair or replacement work and shall be immune from any claim by the Owner or any other person that as a result of providing the financial assistance or monetary incentive or effecting the repair or replacement, the City:

    (a) holds any interest in the Private Sewer Lateral,

    (b) bears any liability whatsoever in respect of the Private Sewer Lateral or arising from the work that was effected or financially assisted by the City, or

    (c) has any continuing duty to effect or finance maintenance or repairs to the Private Sewer Lateral.

PART 7

MUNICIPAL REPORTING AND REVIEW

36. The Director of Engineering shall gather data and deliver to Council an annual report summarizing the actions that have resulted from the adoption of the bylaw, assessing the effectiveness of those actions, and making recommendations on any other priority actions needed to address Private Sewer Lateral maintenance.

SEVERABILITY

37. In the event any provision, or part thereof, of this bylaw is found by a court of competent jurisdiction to be invalid, such provision or part thereof shall be determined to be severed and such decision shall not affect the validity of the remaining provisions of this bylaw, which shall remain in full force and effect.

READ A FIRST TIME this __ day of _____, 20__.

READ A SECOND TIME this __ day of _____, 20__.

READ A THIRD TIME this ___ day of _____, 20 .

ADOPTED by the Council this __ day of _____, 20__.

_____

MAYOR

_____

CITY CLERK

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Appendix E
Measurement Methodologies

1.0 Introduction

Flow monitoring programs are rarely undertaken on a comprehensive, municipal-wide basis, due to budget constraints. Generally, they are completed over a period of years. To complicate matters, no two rainfall events are the same, and it is unlikely that a 'perfect' storm event, which matches the desired return period, will occur during most flow monitoring programs. Therefore, the analysis methods used must allow direct comparison of the I&I response in any two basins, regardless of the year or magnitude of the storms recorded. This enables "apples to apples" comparisons between basins.

The I&I analysis methodologies used by the CRD are based on statistical method of correlating measured sewer flows with rainfall histories. The processes involve collecting data from flow meters and rain gauges, separating the I&I components from the flow hydrographs and correlating I&I volumes with rainfall histories.

This document contains the following sections:

1.0 Introduction
2.0 Definitions related to I&I
3.0 Rainfall Dependent Inflow & Infiltration Analysis Method
4.0 I&I Management Plan Data: 5-year 24 Hour I&I Rate; Archetypes; and Phases
5.0 Rainfall: Intensity-Duration-Frequency Curves; and Return Period Analysis

2.0 Definitions

Table 1 below lists the commonly accepted I&I analysis terms. Figure 1 shows a schematic of extraneous water in sewers. Figure 2 illustrates these components on a hydrograph.

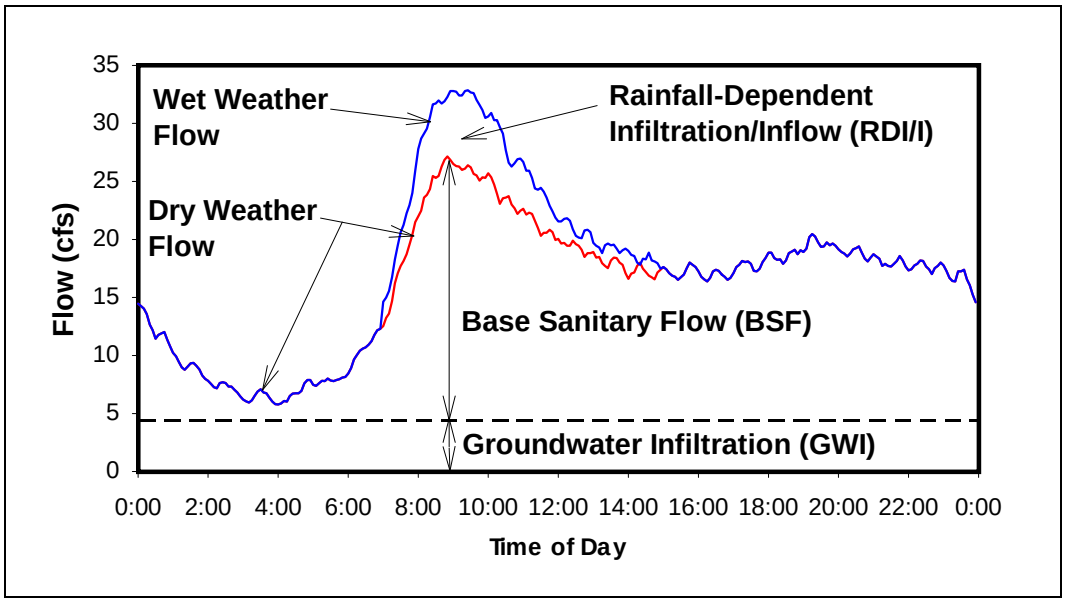
Table 1: Inflow and Infiltration Analysis Terms

Component	Acronym	Calculated As	Definition / Explanation
Inflow:			
Stormwater Inflow	SWI_{RP}		Rainwater that enters the sewer through direct (non-soil) connections to the runoff surface.
Snowmelt Inflow	SMI		Snowmelt that runs overland and enters the sewer through direct (non-soil) connections to the surface.
Infiltration:			
Groundwater Infiltration	GWI	The minimum GWI is generally taken as 85% of the minimum hour dry weather flow for small to medium-sized basins.	Extraneous flow from the ambient long-term water table, not influenced by individual rainfall events. Seasonal fluctuations in GWI depend on the groundwater table and soil type. During I&I analyses, the dry weather flow pattern may be shifted up or down, when needed, by adjusting the GWI rate. The shifting is done in circumstances when the DWF does not match the flows on the days surrounding the targeted storm event. The BSF component of DWF is never changed as it is assumed to remain constant.
Rainfall-induced Infiltration	RII_{RP} $RII_{RP\text{-}slow}$ $RII_{RP\text{-}fast}$		Rainfall that follows a path to the sewer through the soil and/or from short-term, rainfall-based increases in water table elevation. Often occurs in two discernible components, slow and fast.
Snowmelt-induced Infiltration	SII		Snowmelt that follows a path to the sewer through the soil.
Inflow and Infiltration:			
Rainfall-dependent Inflow and Infiltration	$RDI\&I_{RP}$	$SWI_{RP} + RII_{RP}$	Total peak rainfall-sourced extraneous flow, averaged over short-terms ranging from five minutes to 24 hours depending on catchment characteristics.
Snowmelt-dependent Inflow and Infiltration	$SDI\&I_{RP}$	SMI + SII	Total peak snowmelt-sourced extraneous flow, averaged over short-terms ranging from five minutes to 24 hours depending on catchment characteristics.
Other I&I Terms:			
Base Sanitary Flow	BSF	ADWF – GWI	Sewage from serviced buildings, i.e., domestic wastewater flow. Excludes all extraneous flow such as groundwater and rainwater.
Average Dry Weather Flow	ADWF	BSF + GWI	The average daily flow rate during dry-weather periods when rainfall-induced infiltration is minimized. The DWF pattern is selected from a segment of the "total flow" data. It is selected from a dry period of time during the same season as the storm event being analyzed.

Component	Acronym	Calculated As	Definition / Explanation
Peak Dry-weather Flow	PDWF	PSF + GWI	Daily total peak flow during dry-weather periods.
Peaking Factor	PF	PSF / BSF	The relationship between daily peak flow and daily average flow.
Peak Sanitary Flow	PSF	PF * BSF	Daily peak flow from serviced buildings, excludes all extraneous flow.
Peak Wet-weather Flow	$PWWF_{RP}$	PDWF + $RDI\&I_{RP}$ + $SDI\&I_{RP}$	The daily peak wastewater flow during a rainfall event of the specified return period. Averaged over short terms ranging from five minutes to one hour, depending on catchment characteristics.
Average Wet-weather Flow	$AWWF_{RP}$	ADWF + Avg. $RDI\&I_{RP}$ + Avg. $SDI\&I_{RP}$	The daily average wastewater flow on a day where a rainfall event of specified return period occurs.
Total Flow		As measured using flow meters	Examples of flow meters include velocity/area (VA) meters, weirs, flumes, magmeters, and data derived from pump stations.

Notes:
- ADWF is defined in the 1999 BC Municipal Sewage Regulation.
- RP is return period of the wet weather event.

Figure 2 - Hydrograph Illustrating Flow Components



3.0 Rainfall Dependent Inflow & Infiltration Analysis Method

3.1 Overview

The I&I analysis methodology used by the CRD, to establish I&I rates, is the "rainfall dependent inflow and infiltration" (RDI&I) envelope method. This methodology develops a relationship for RDI&I as a function of rainfall return period using measured data from previously recorded storms.

The RDI&I method was first developed as part of the *Esquimalt Trunk – Western Communities Feasibility Study* (KWL, 1993) for the CRD. Variations have also been used on:

- *Northwest Trunk Sanitary Sewer System Summary Report on Design Flows and Hydraulic Analysis* (KWL, November 1999)
- *Development of East Coast Interceptor/Northeast Trunk Designs Flows at Clover Point* (KWL, October 2000)
- *Craigflower Pump Station Upgrade Study* (KWL, February 2003)
- Core Area Inflow and Infiltration Program I&I Analyses Results, 2001 – 2004 Flow Monitoring Sites, 2005
- Core Area Inflow and Infiltration Program I&I Analyses Results, 2004 – 2005 Flow Monitoring Sites, 2006.
- Core Area Inflow and Infiltration Program I&I Analyses Results, 2005 – 2006 Flow Monitoring Sites, 2007.
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In addition, an updated version of the RDI&I method was developed for use in the *GVRD Sewer Condition Reporting Template Standard,* which is used by several municipalities in the Greater Vancouver Regional District.

3.2 Methodology

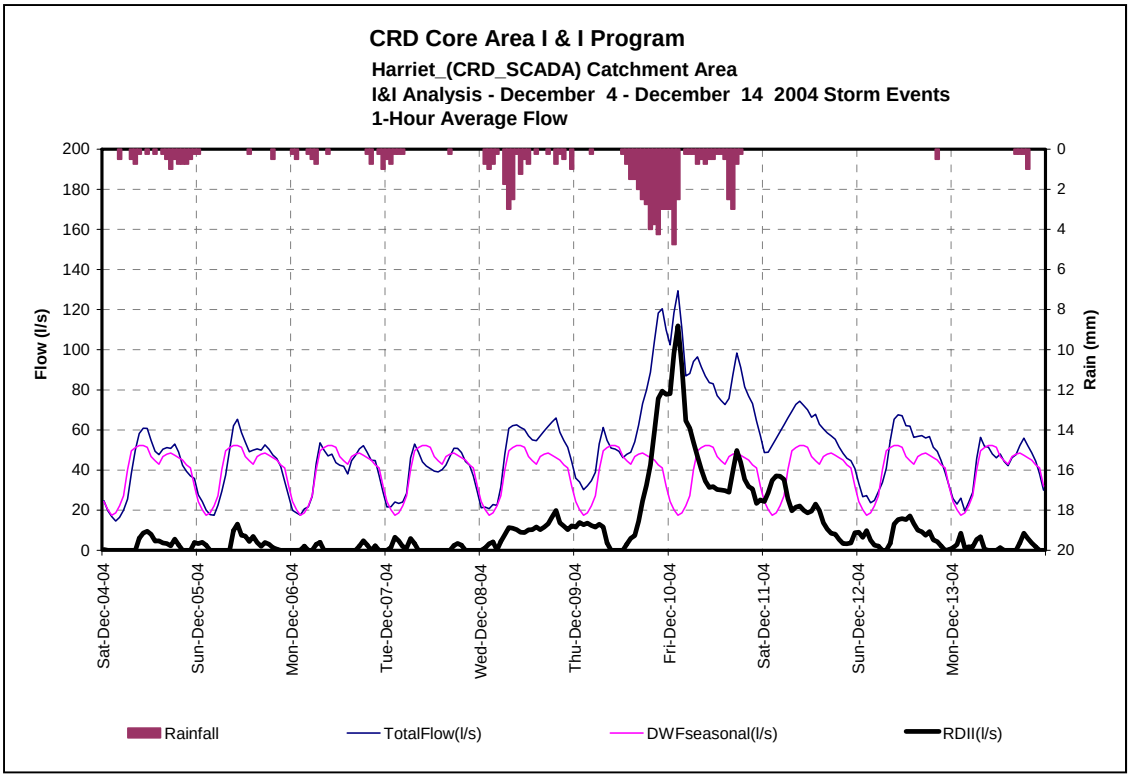
The RDI&I methodology requires two types of data; sewer flow data and rainfall data.

The methodology can be divided into three steps. The first step is to create storm event hydrographs (Figure 3). The second step is to take the peak I&I rates from the hydrographs and plot them on an RDI&I chart (Figure 4). The third step is to take the derived data from the RDI&I charts, along with the catchment size for the flow monitored area, and calculate total I&I rates as a function of area, for example l/ha/day (Table 2). Details of the method are as follows:

<u>Step 1: Create Storm Event Hydrographs</u>

- Using sewer flow data and rainfall data, flow charts for each storm event are plotted on graphs. A dry-weather flow template is selected from the prior records and subtracted from the storm event flow signal, resulting in an RDI&I flow signal.
- The *peak* 15-minute to 1-hour average RDI&I for each storm is determined from the resulting RDI&I flow signal.

Figure 3: Typical Hydrograph used in the RDI&I Method



Step 2: Plot the Peak I&I Rates onto RDI&I Charts

- The peak RDI&I values from the hydrographs are plotted against rainfall totals for various storm event durations and a linear line is fitted through each set of data points. To determine the most sensitive rainfall duration for a given catchment, the best R-squared value from the fitted lines is chosen.

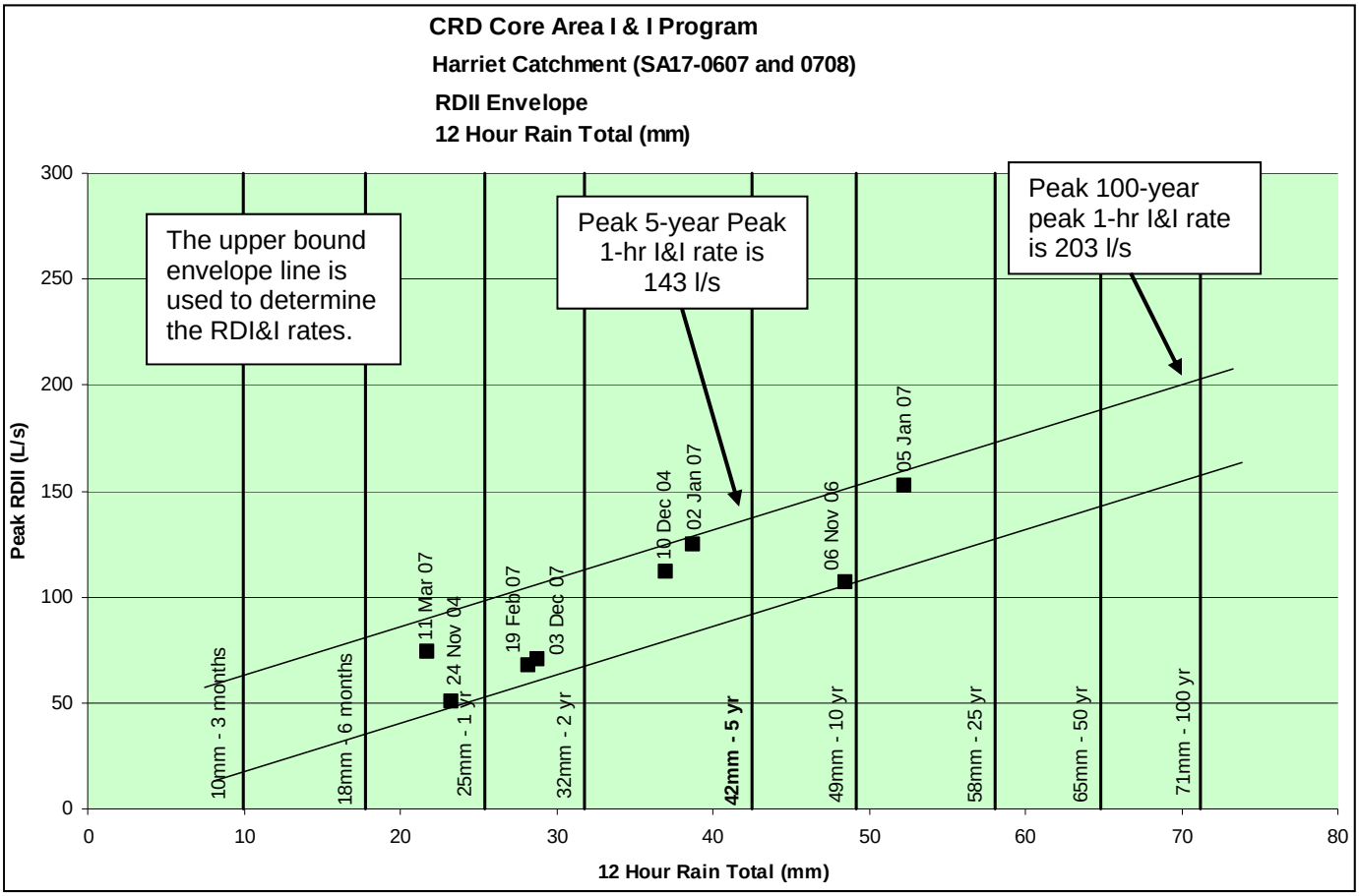
- Using the catchment's most sensitive rainfall duration determined from the previous step, a final chart of peak RDI&I against rainfall totals is plotted. The entire linear relationship is shifted upwards to intersect the largest RDI&I storm events when necessary.

- By shifting the line through the data points, upper and lower boundaries are drawn on the graph to illustrate the effect of antecedent soil moisture on the RDI&I response. The upper bound line provides an estimate of the maximum expected RDI&I for a particular rainfall event following a prolonged wet period. The lower bound line provides an estimate of the SWI component. The separated region between the upper and lower bound lines mainly represents varying antecedent soil moisture conditions, with some spatial rainfall anomalies.

- The point of intersection between the upper diagonal RDI&I line and the vertical rainfall return period lines represent the maximum expected RDI&I rates, during saturated conditions, for different storm events.

- Note: return-period rainfall depths are calculated from the nearest rainfall gauging station using statistically derived intensity-duration-frequency (IDF) curves (see Section 2.4.4 and 3.4).

Figure 4: Typical RDI&I Chart



Step 3: Summary Tables and Total I&I Rates

Data for each municipality's flow monitoring locations are summarized in I&I rate summary tables. These tables include the catchment names, areas, peak RDI&I rates for different rainfall return periods, and ground water infiltration rates. Using these values, the total I&I rates for the catchments are calculated and added to the tables. Table 2 contains an example of an I&I summary table.

Table 2: Example I&I Summary Table

Catchment	General Information			Most Recent I&I Analyses							
	Site Code	Size	Average Sewer Age	Year	GWI (l/s)	Peak RDI&I (l/s)		Total I&I (l/s)		Total I&I (l/ha/day)	
		(ha)	(years)			5yr	100yr	5yr	100yr	5yr	100yr
Harriet	SA17	297	54	2012	14	143	203	157	217	45,673	63,127

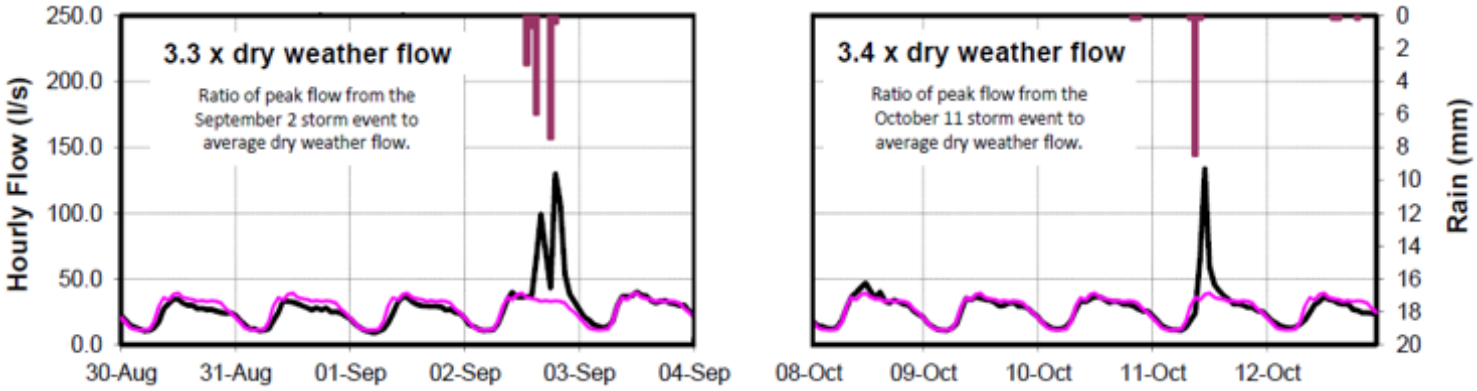
Notes:

- *To accurately define the RDI&I envelope, at least one storm event should preferably be at least the size of a 2-year return period with the remaining data points being greater than a 6-month return period.*
- *The typical I&I design allowance for new sewers is 11,200 l/ha/day.*

4.0 Rapid I&I Calculation

The “inflow analyses” involved measuring the peak sewer flows during two extremely intense 1-hour rainfall events that occurred on September 2 and October 11, 2014 when conditions are typically dry and unsaturated. It was hypothesized that any increases in peak sewer flows during these storm events can be attributed to inflow (direct pipe connections) without the influence of infiltration (leaks in pipe). There was virtually no rainfall for six days prior to each storm. The storms were short in duration and amongst the most intense 1-hr rainfall events recorded over the last 15 years, regardless of time of year. Figure 2 shows an example graph that includes measured sewer flows (black line), typical dry weather flow (pink line), rainfall intensity (red bars at the top) and a written statement noting how much the flows increased as a result of the short intense storm events. Flow data from 101 metered catchments within the core area was analyzed. The results are summarized, by municipality, in Sections 2.2 to 2.9. The graphs for the analyses are located in Appendix B.

Figure 2: Example of an Inflow Analyses Graph



5.0 Rainfall Intensity-Duration-Frequency Curves and Return Period Analysis

5.1 Overview

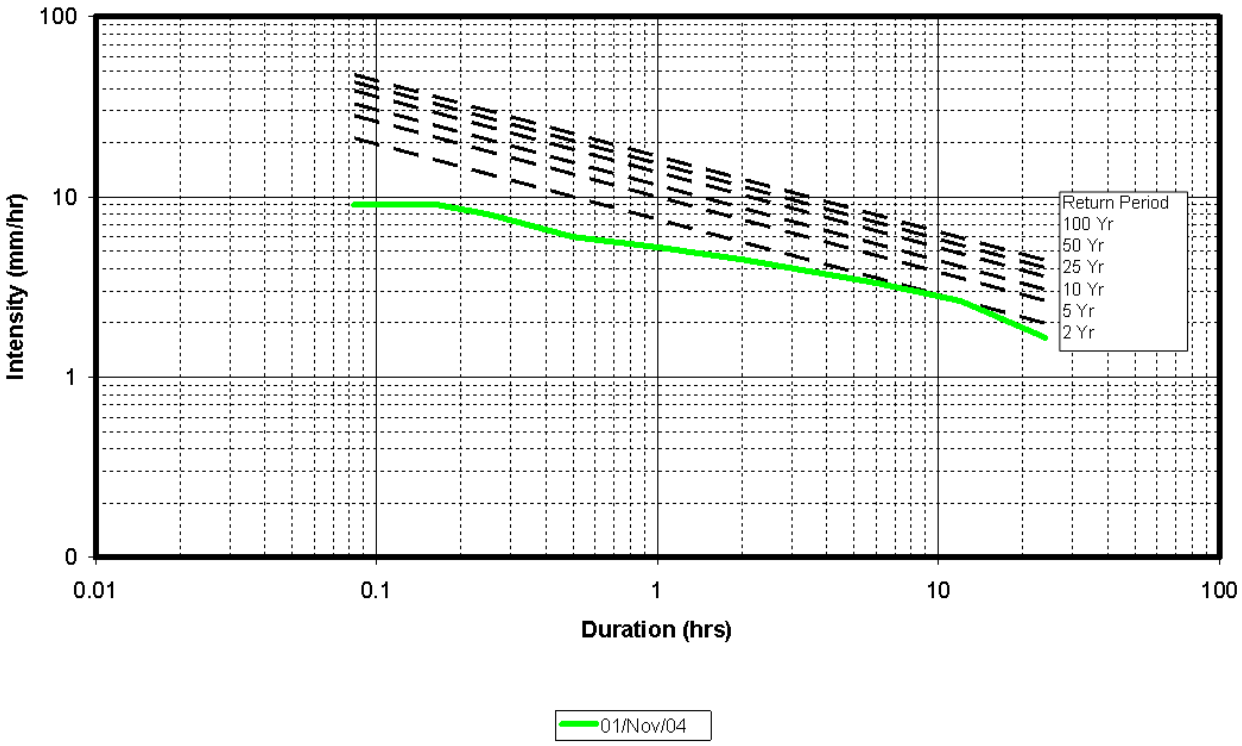
Intensity-duration-frequency (IDF) curves summarize historical rainfall information into three components:

- intensity of the rainfall (mm/hour)
- duration of the storm (hours)
- frequency of the storm (return period measured in years)

Figure 6 shows a typical storm event from the Craigflower rainfall gauge in comparison with the Gonzales station IDF curve. The storm event shown, November 1, 2004, indicates a 2-year return storm event at a 10-hour storm duration. IDF curves for major storm events for each of the rain gauges is located in Appendix D.

Figure 6: Example IDF Chart

Comparison with Gonzales IDF



5.2 Published IDF Curves

The accuracy of IDF curves is correlated to the duration of the data used to create the curve. The longer the period of data collection used to create the curve, the higher the accuracy of the curve. Table 4 shows the period of data used to generate the published IDF's for the Core Area of the CRD

Table 4: Published IDF Curves for the Core Area of the CRD

Rain gauge	Owner	Duration of Data Used in the IDF
Camosun	Environment Canada	1964 – 1975
Gonzales	Environment Canada	1925 – 1988
UVic	Environment Canada	1965 – 1988
Victoria Airport	Environment Canada	1965 – 2005
Victoria Marine	Environment Canada	1967 – 1991

The CRD and the Province also have rain gauges in the Core Area but none of the gauges has a published IDF curve. In addition, the maximum period of data collection for these gauges is 14 years. The gauges located in the western communities have a significantly shorter duration of data collection.

The CRD is not aware of any other reliable IDF's for the Core Area. It is worth noting that the IDF's used for I&I analyses must be based on data that is collected at a minimum at one hour increments.

3.5.3 Selection of IDF Curves for Analyses

Down Town Municipalities IDF

The Gonzales IDF curve was used to determine the storm return periods for the rain gauges located in Esquimalt, Oak Bay, Saanich, and Victoria. The Gonzales IDF curve was selected because:

- It is built on using 63 years of data, the longest by far of the available IDF's;
- None of the other CRD or Province rain gauges in the area has enough data for its own IDF; and
- The rainfall in these municipalities is consistent with the data from the Gonzales IDF.

Western Communities IDF's

In late 2007, new CRD and municipal rain gauges were installed in the Western Communities. The rainfall recorded from these gauges is significantly greater than that of the rain gauges located in the downtown portion of the Core Area. Research confirmed that there were no nearby IDF's for the Western Communities. For the purpose of the I&I analyses in this report, synthetic IDF's were generated for these rain gauges. The following notes describe the process:

- Storm event rainfall amounts, for both 12 and 24 durations, were compared between the CRD's Craigflower rain gauge and selected Western Community rain gauges for rainfall events of over 13 mm that occurred between late 2007 and the summer of 2010 (~30 storm events). The data was plotted on different axis'. Best fit lines and R^2 values were added to the graphs (see Appendix D).

There was a linear relationship between the rain gauges. In general, the R^2 values were around 0.9 or greater, which indicates a strong correlation. The formulas for the best fit lines were:

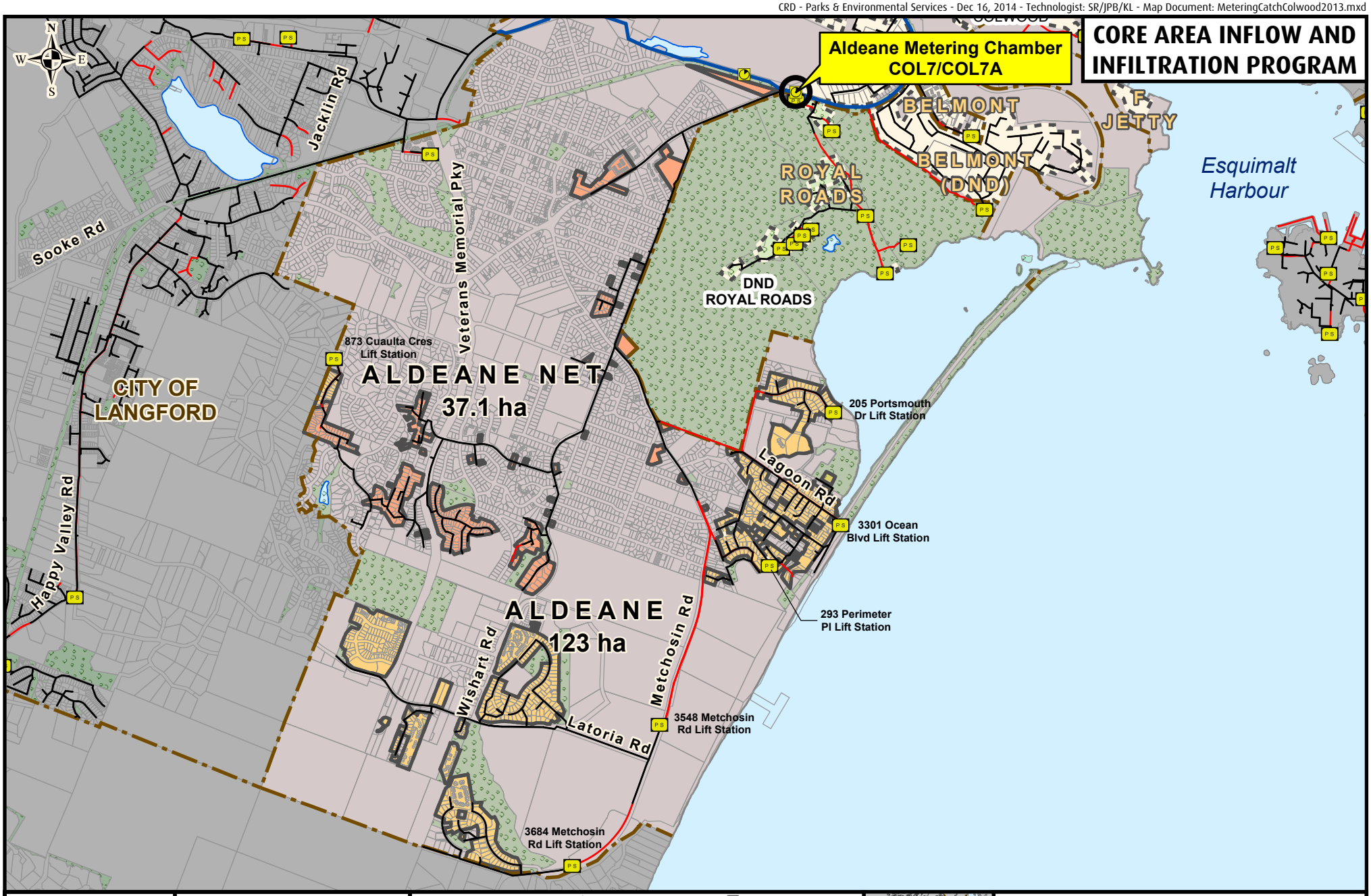
  - Applied to the data from the Gonzales IDF to create "synthetic" IDF's for each of the Western Community rain gauges.
  - Applied to the Craigflower rain gauge data collected prior to mid-2007 so it could be used in the new "synthetic" IDF's for the Western Communities rain gauges.

- The "synthetic" IDF's for the Western Communities:

  - Appear reliable (when compared to the downtown rain gauges/IDF's);
  - Seamlessly incorporate the historical rainfall data collected using the Craigflower rain gauge. (Mathematically, this is because the data from the Craigflower rain gauge and the Gonzales IDF were both adjusted using the same formula.)

Appendix F
Flow Data Analyses

CORE AREA INFLOW AND INFILTRATION PROGRAM



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- Flow Monitoring Location
- Manhole
- Cleanout
- Pump Station
- Metering Chamber

Sanitary Sewers

- Gravity Main Installed After 1930
- Gravity Main Installed Before 1930
- Force Main
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- CRD Sewer

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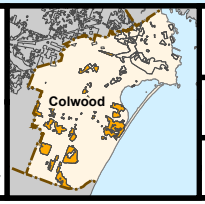
- Non-Sewered Area
- Lot Lines
- Parks
- Sewered Park Areas
- Catchment Boundary Municipal, First Nation, or DND Boundaries

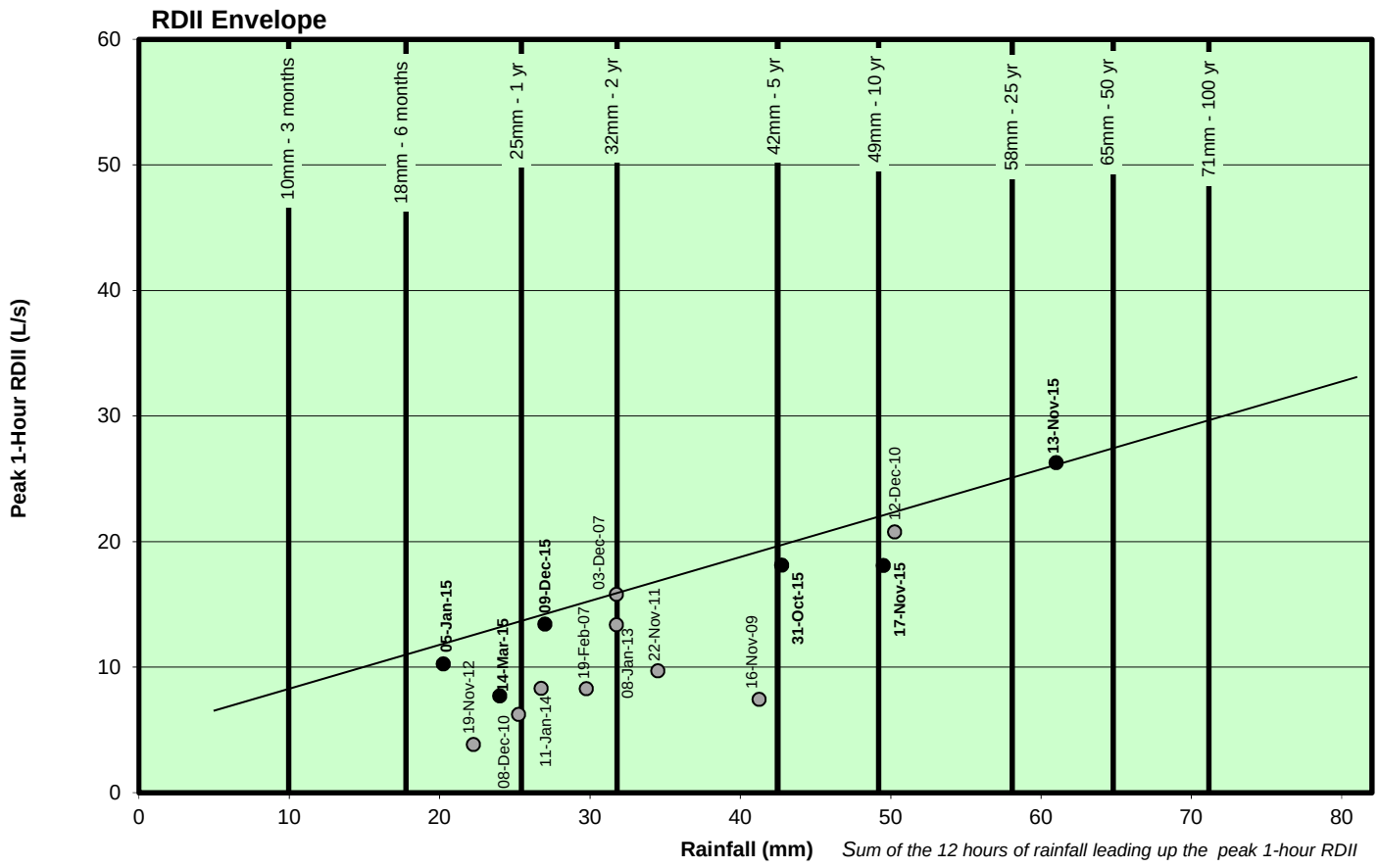


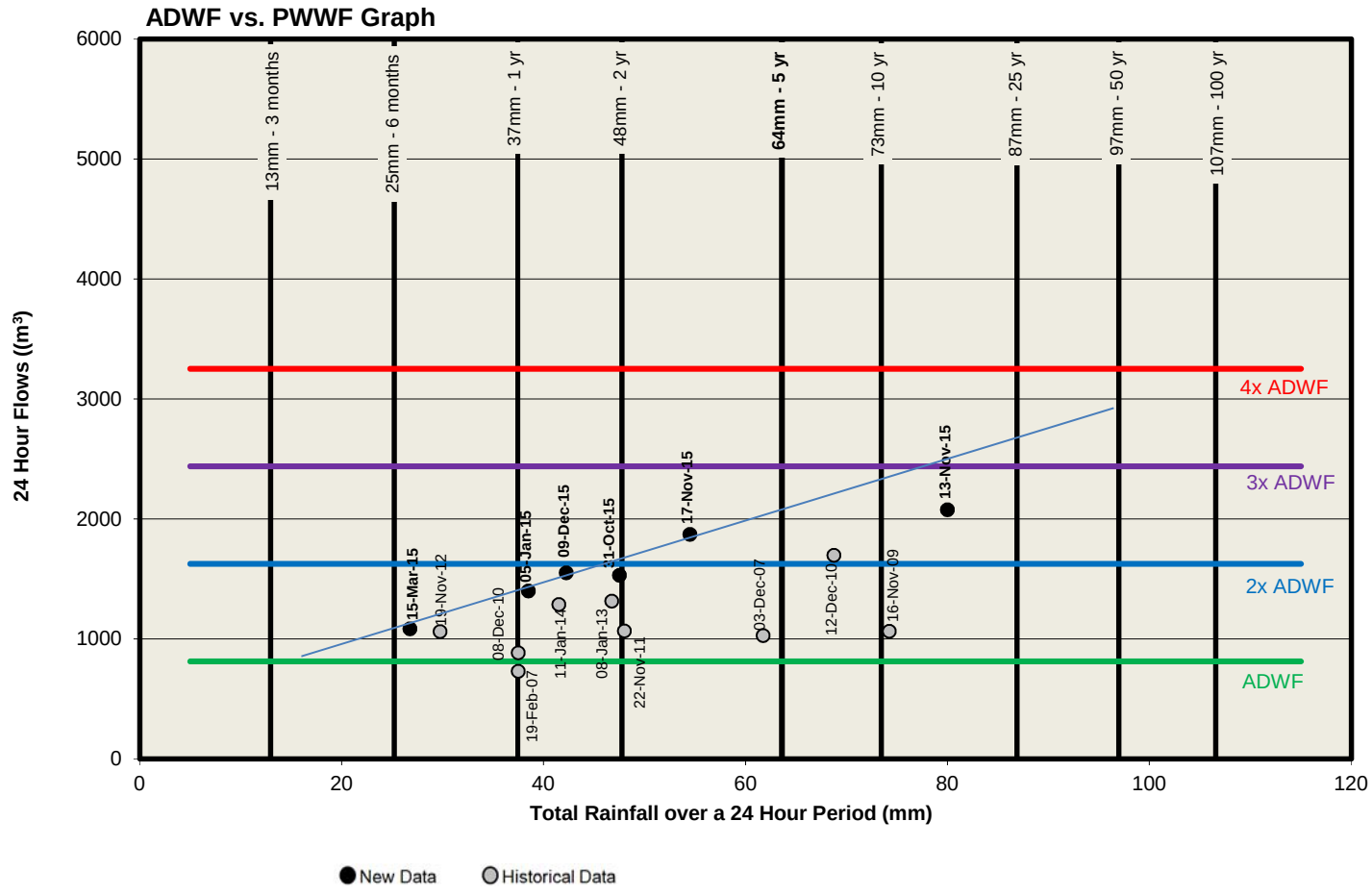
FLOW MONITORING AREA

CATCHMENT: ALDEANE FLUME & ALDEANE

SITE CODE: **COL7 / COL7A**

Aldeane (COL7)





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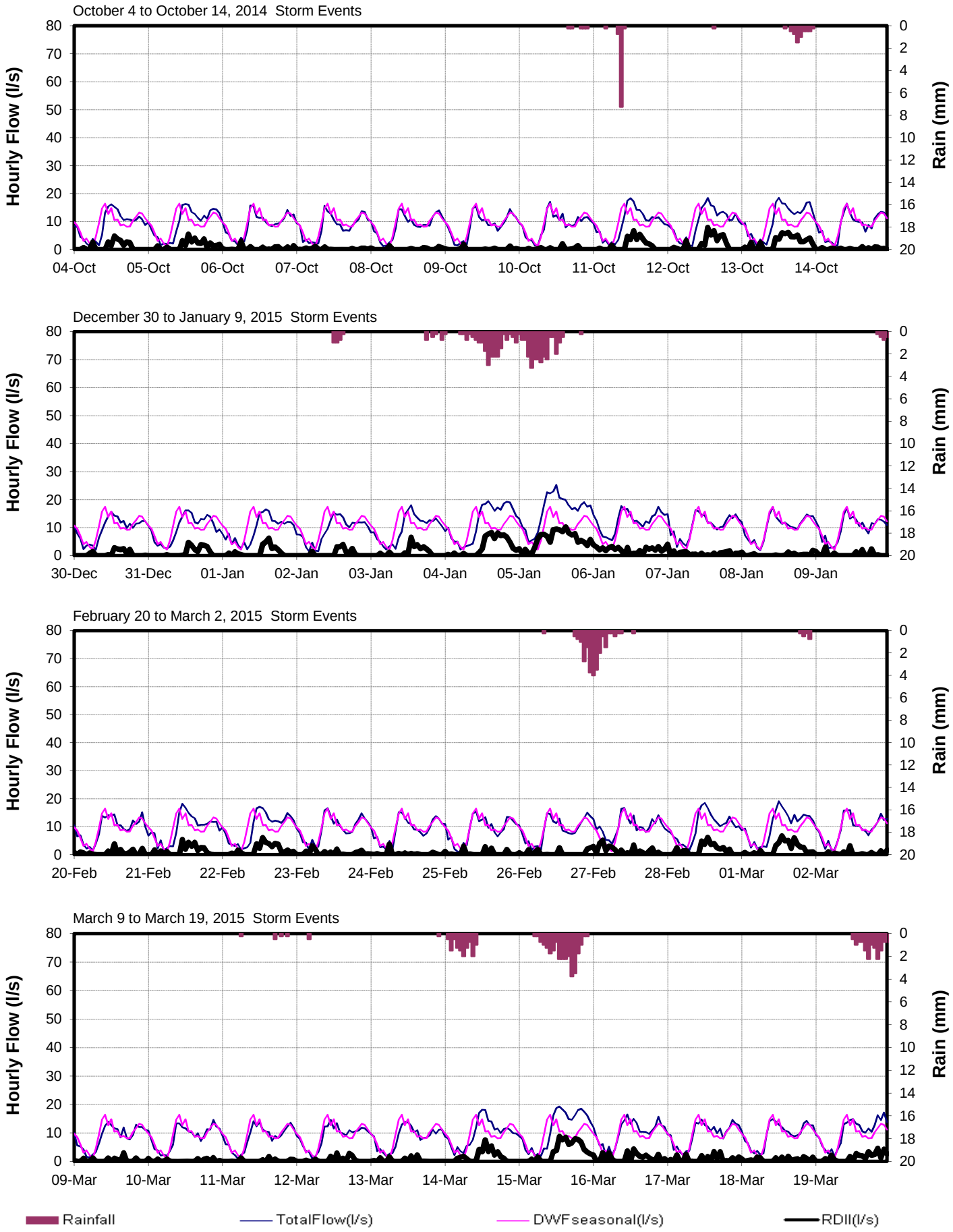

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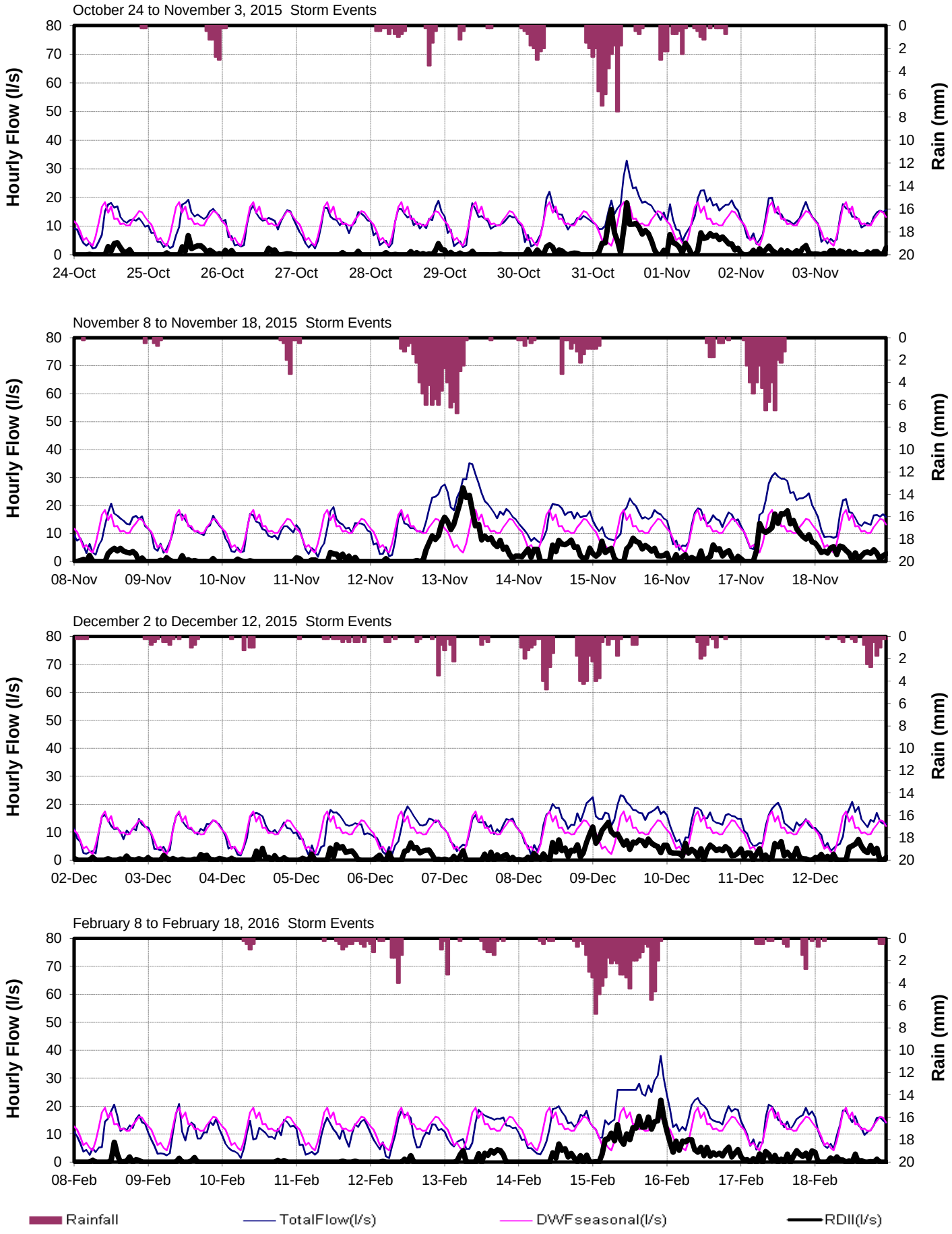

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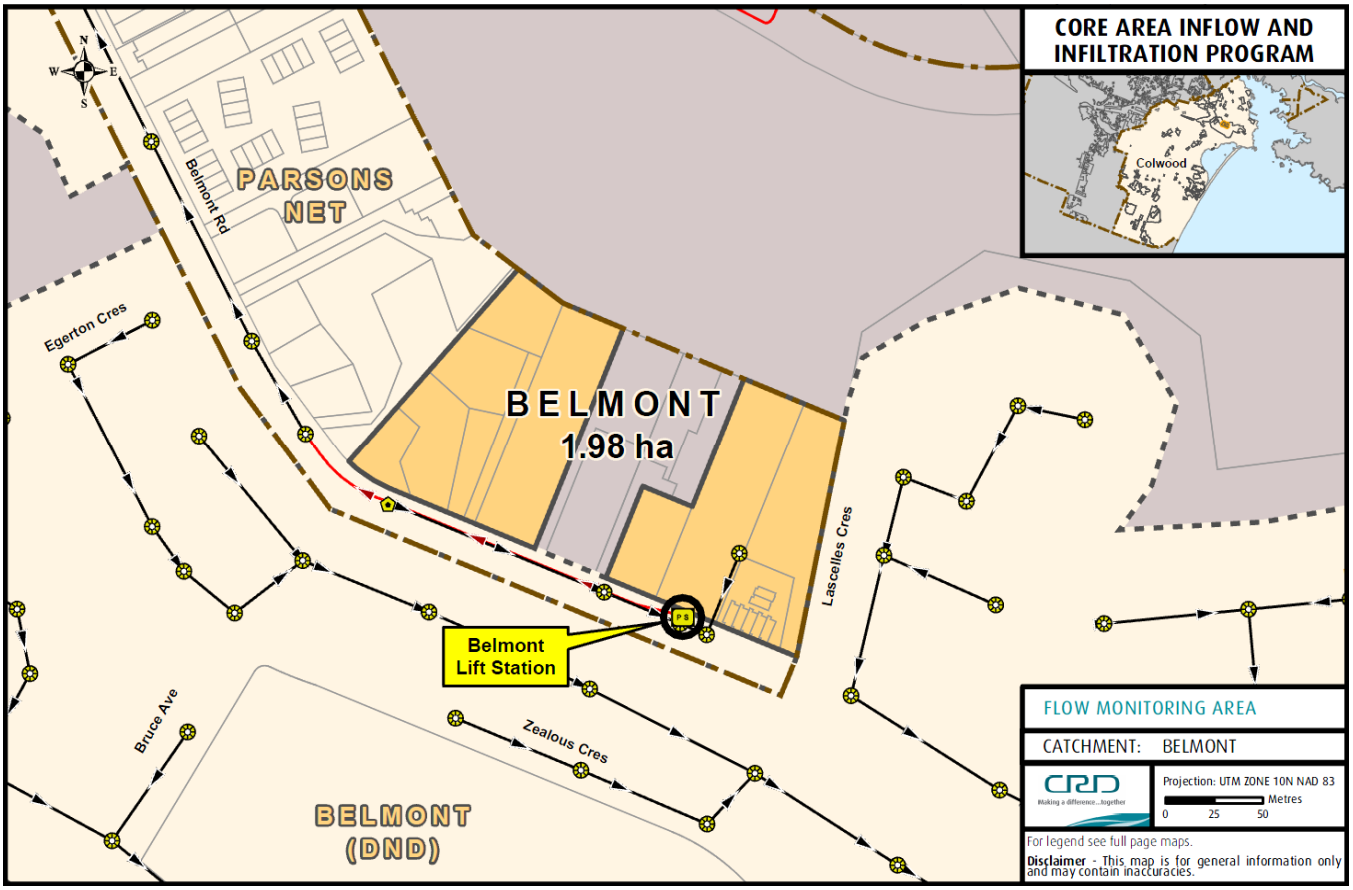

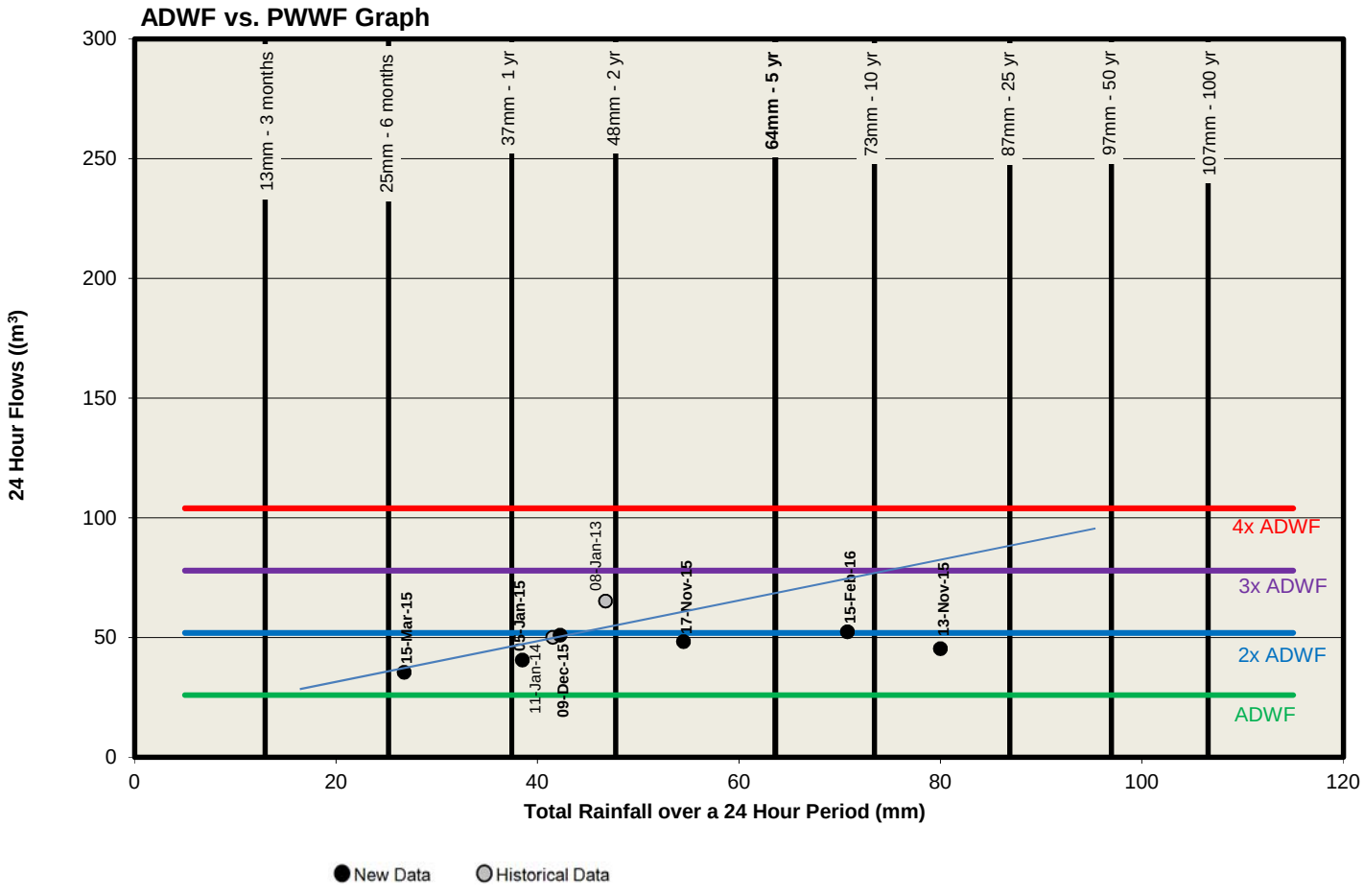

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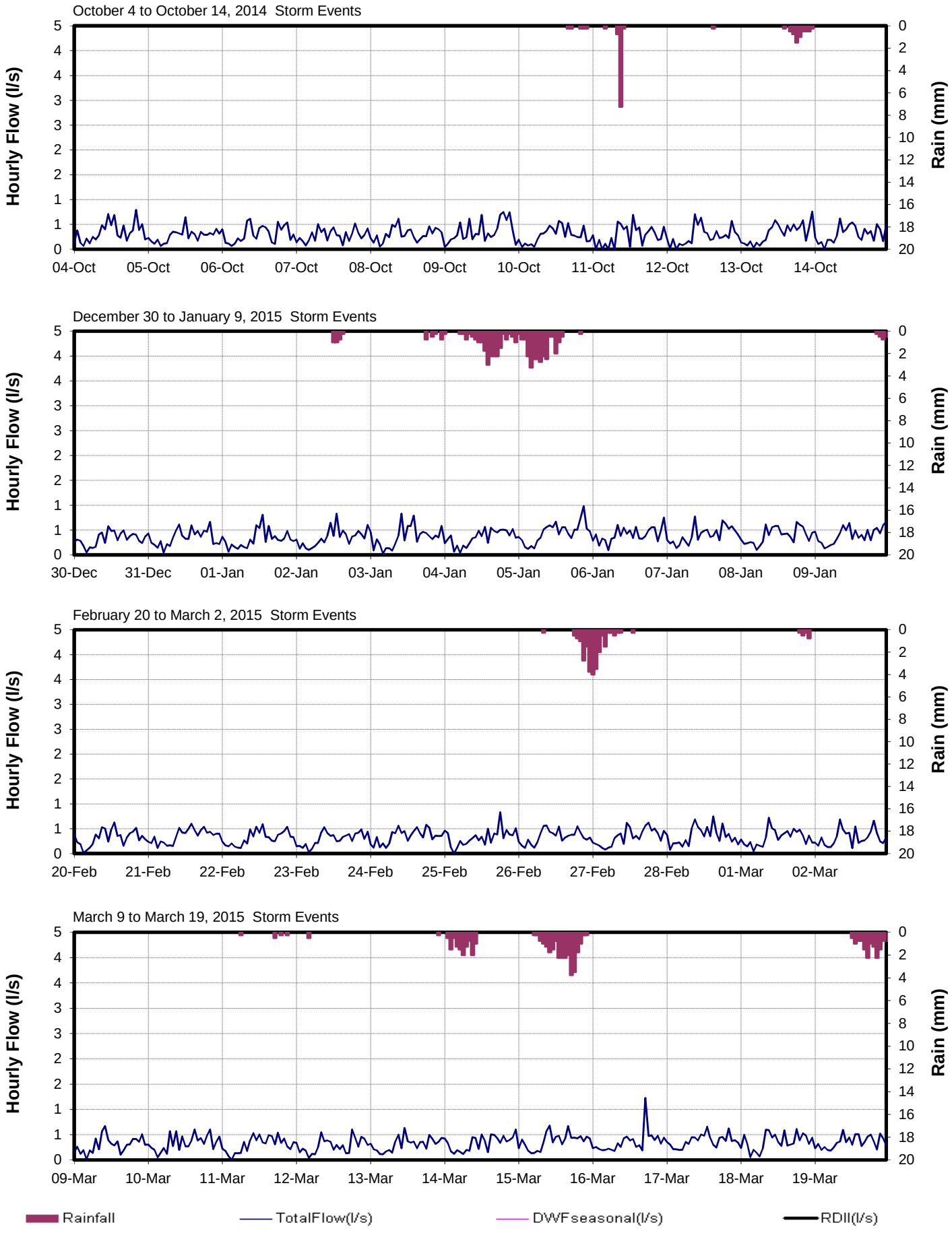

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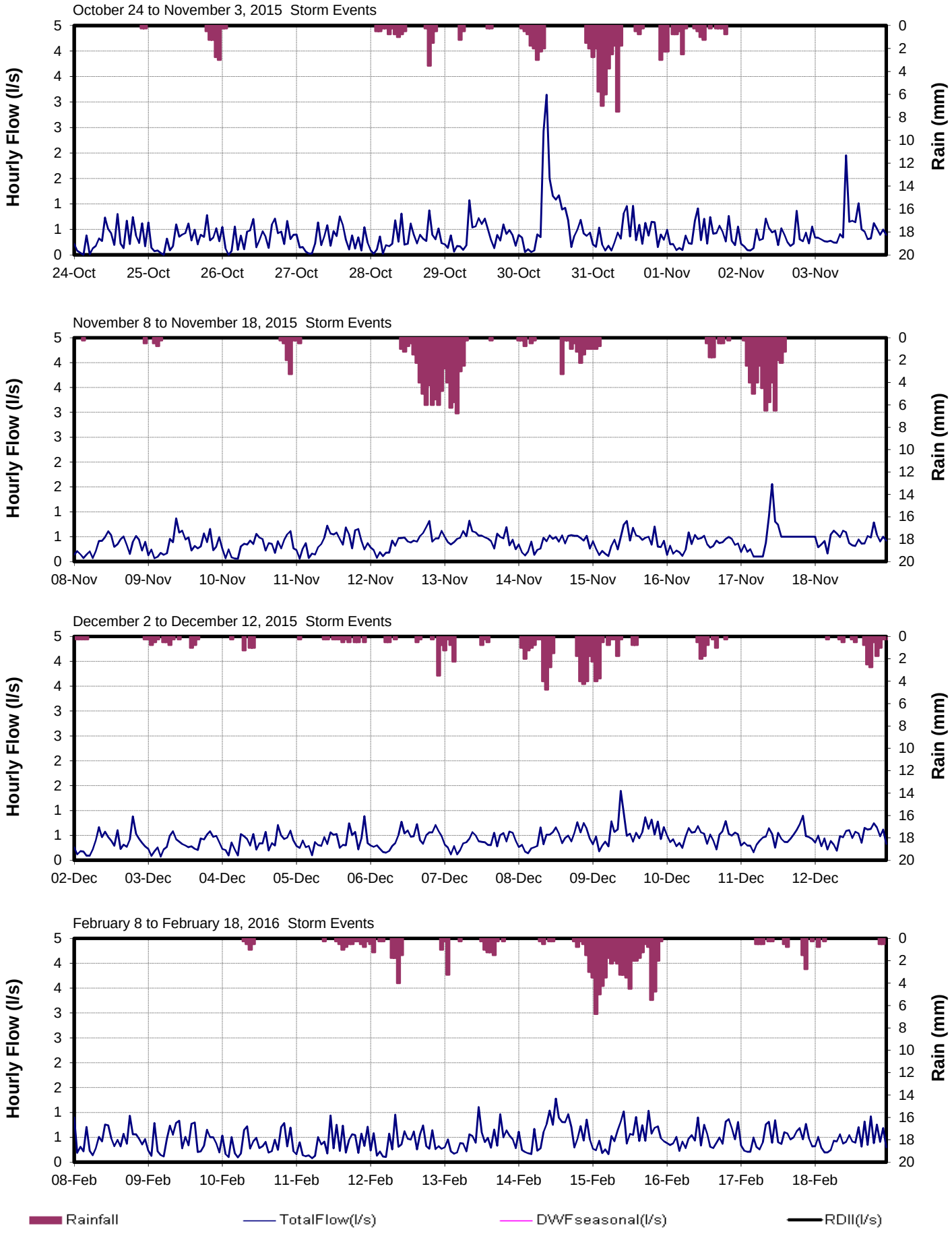

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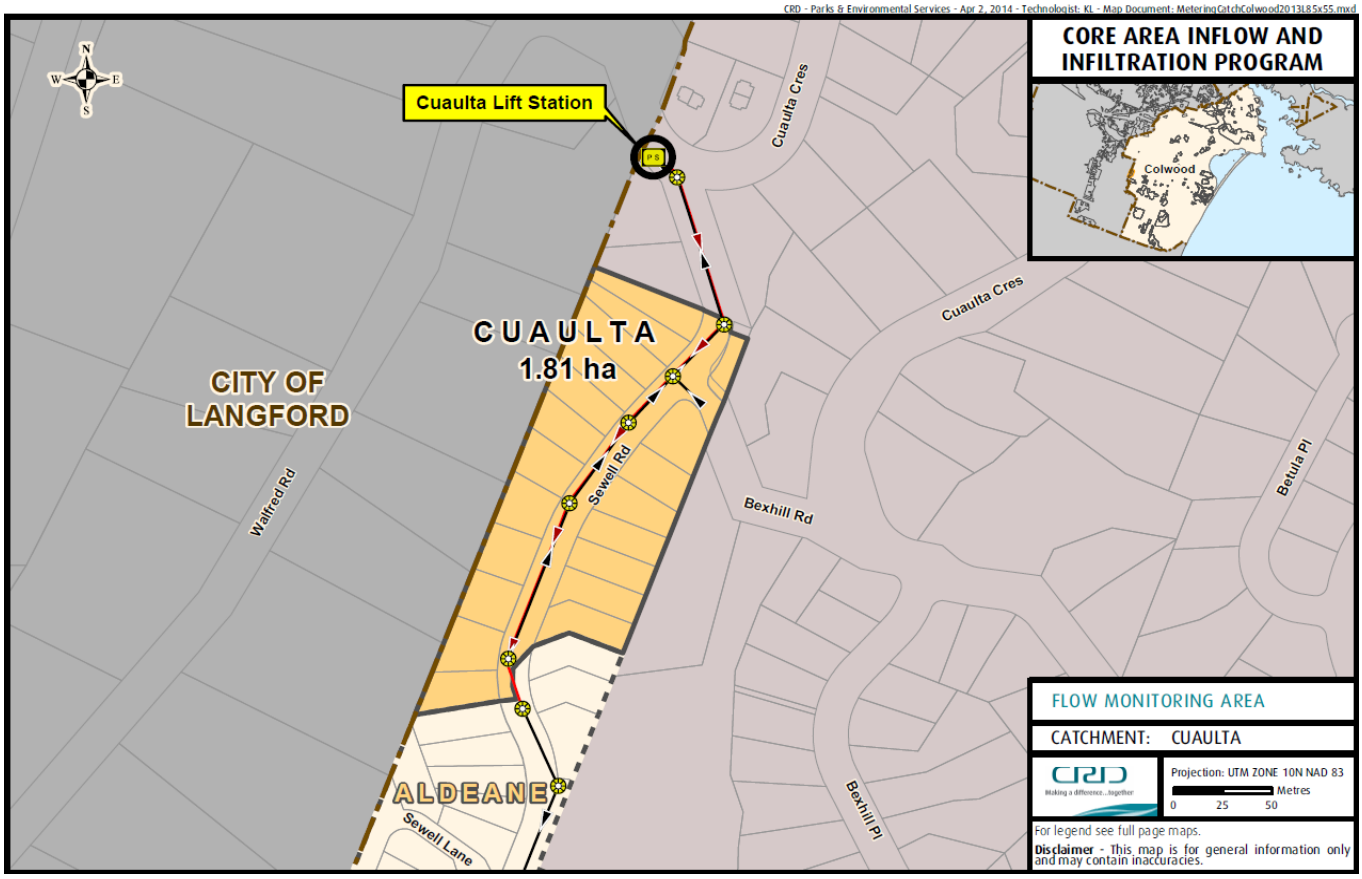

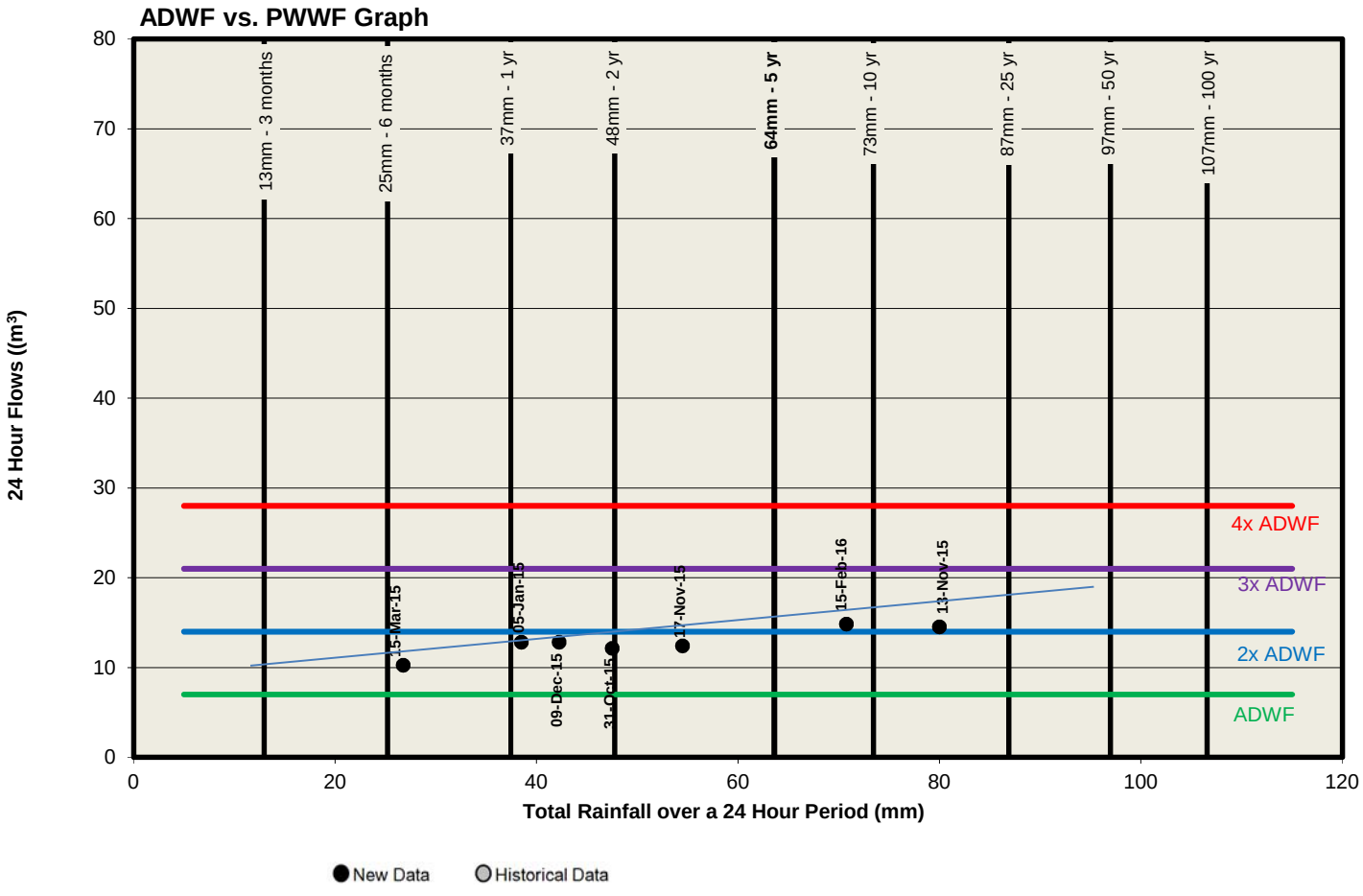

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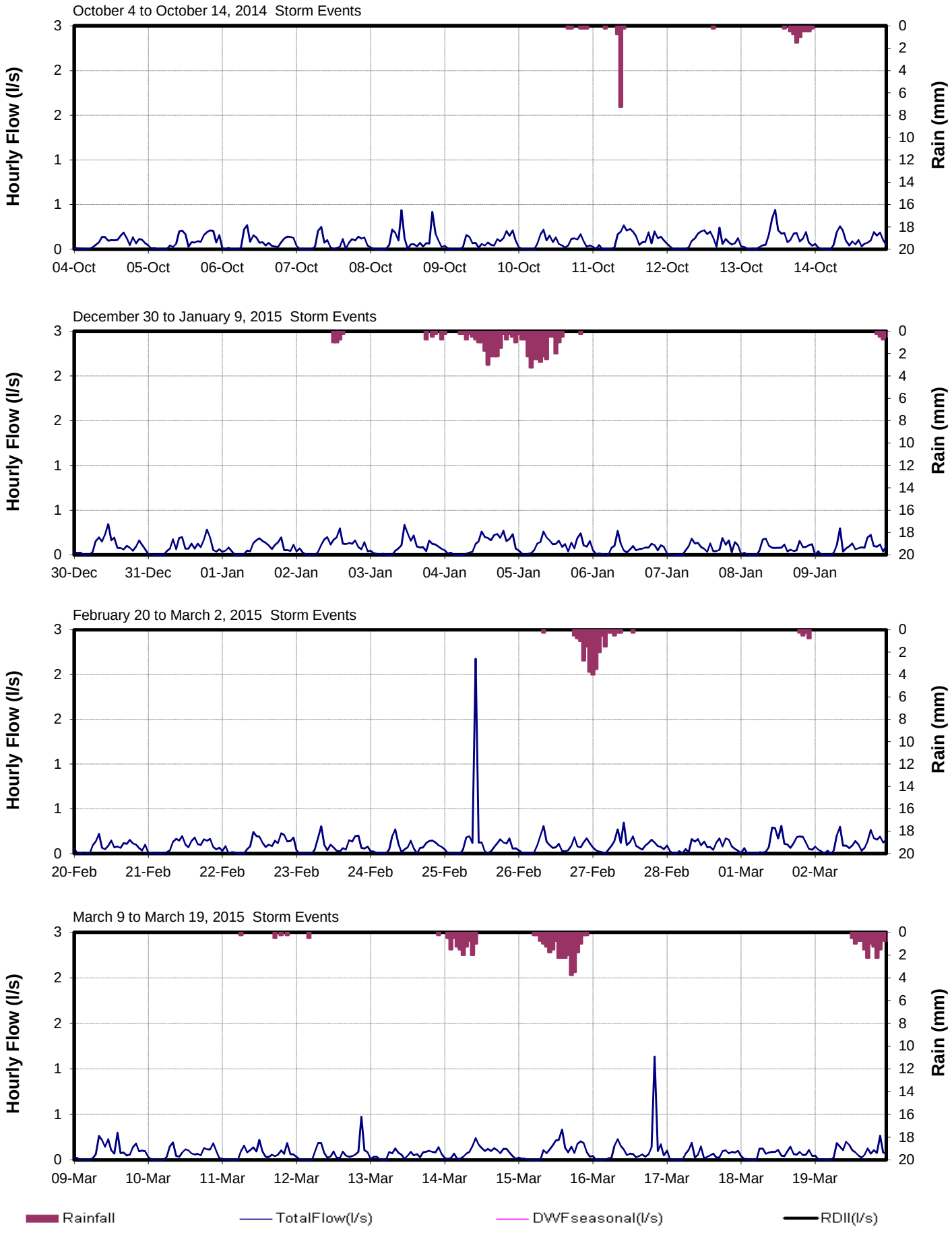

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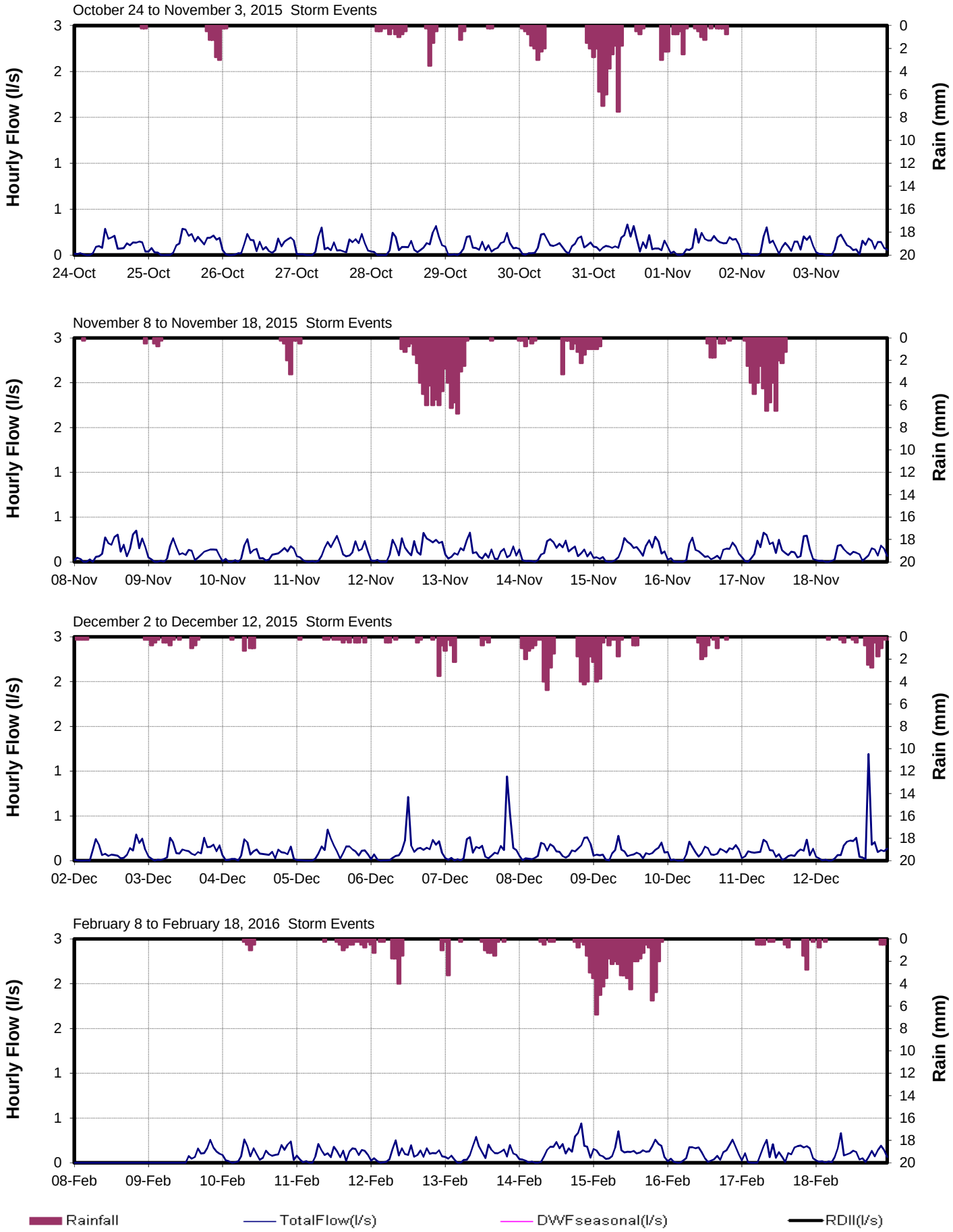
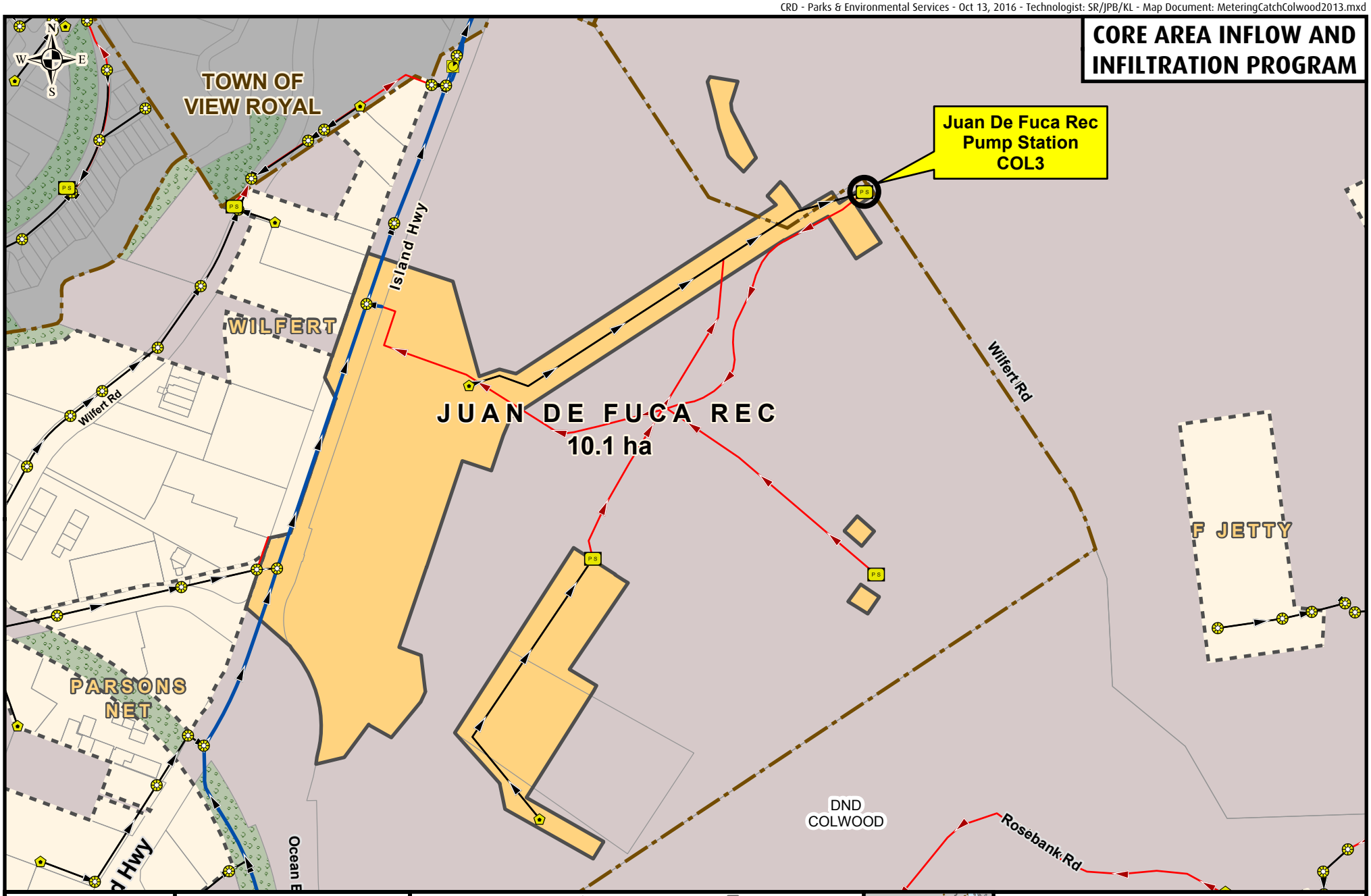


CORE AREA INFLOW AND INFILTRATION PROGRAM



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- Metering Chamber

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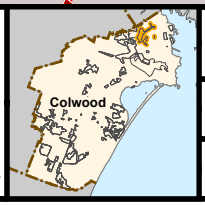


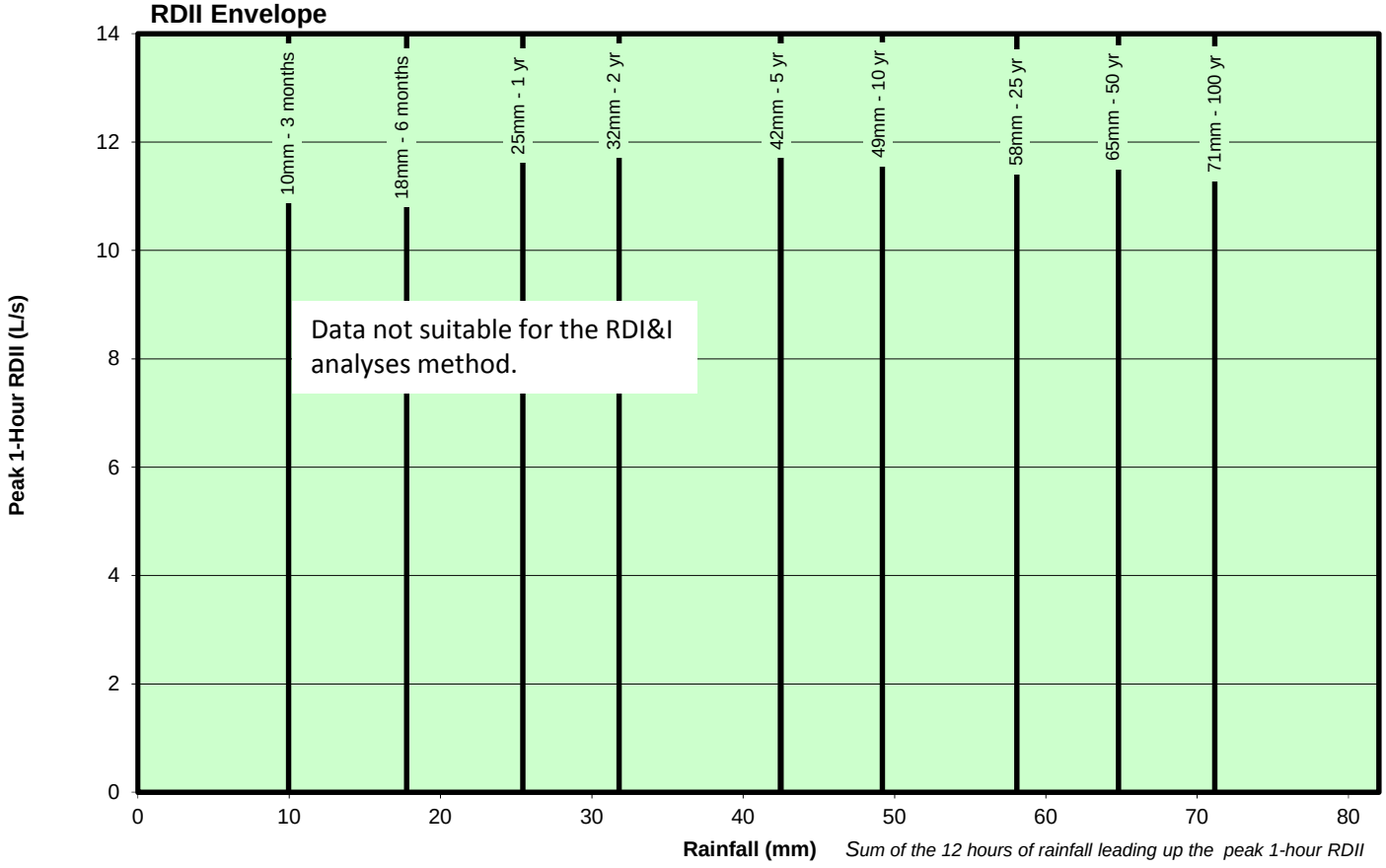
FLOW MONITORING AREA

CATCHMENT: JUAN DE FUCA REC

SITE CODE: **COL3**

Juan de Fuca Rec (COL3)

RDII Envelope



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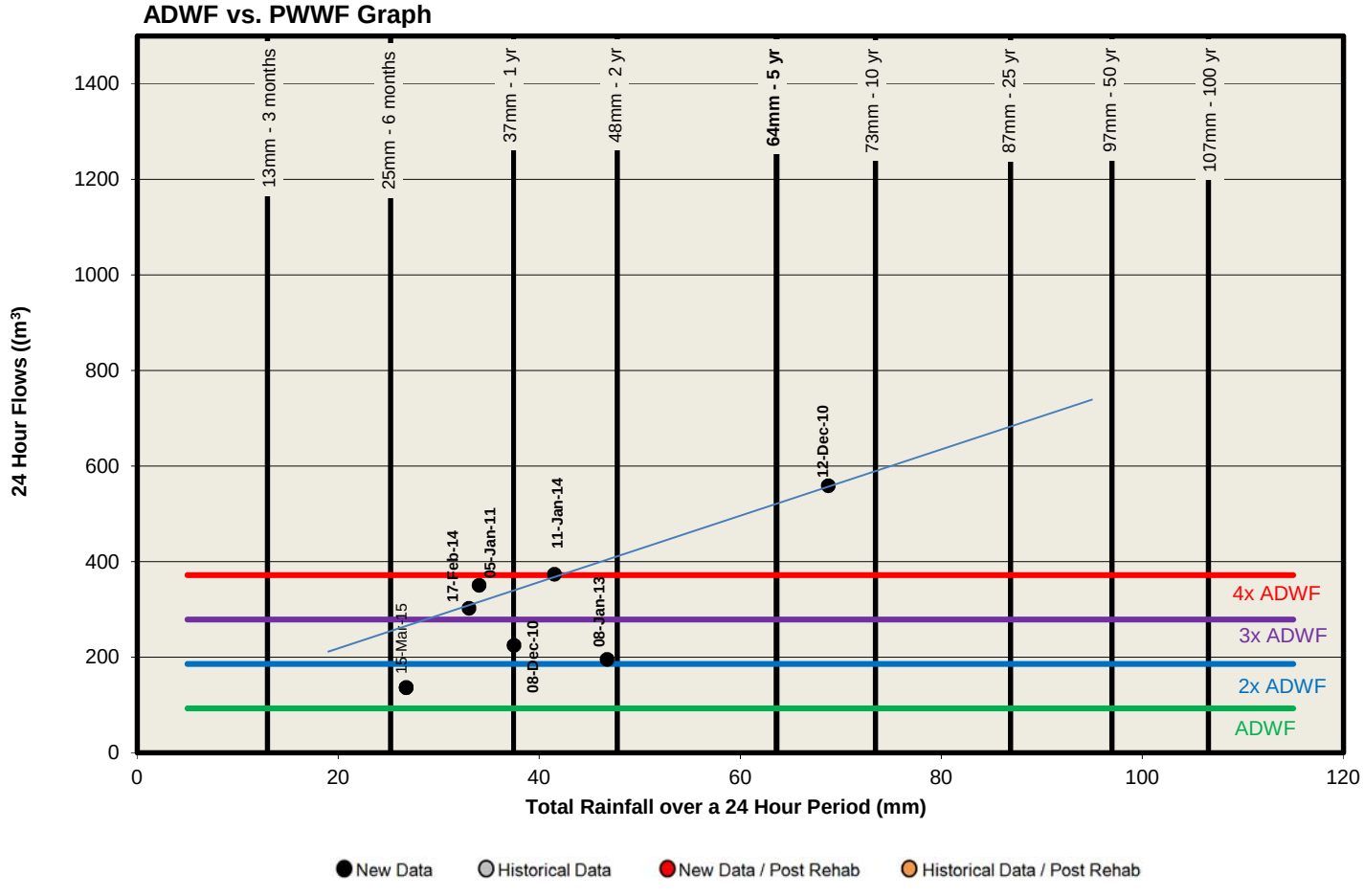
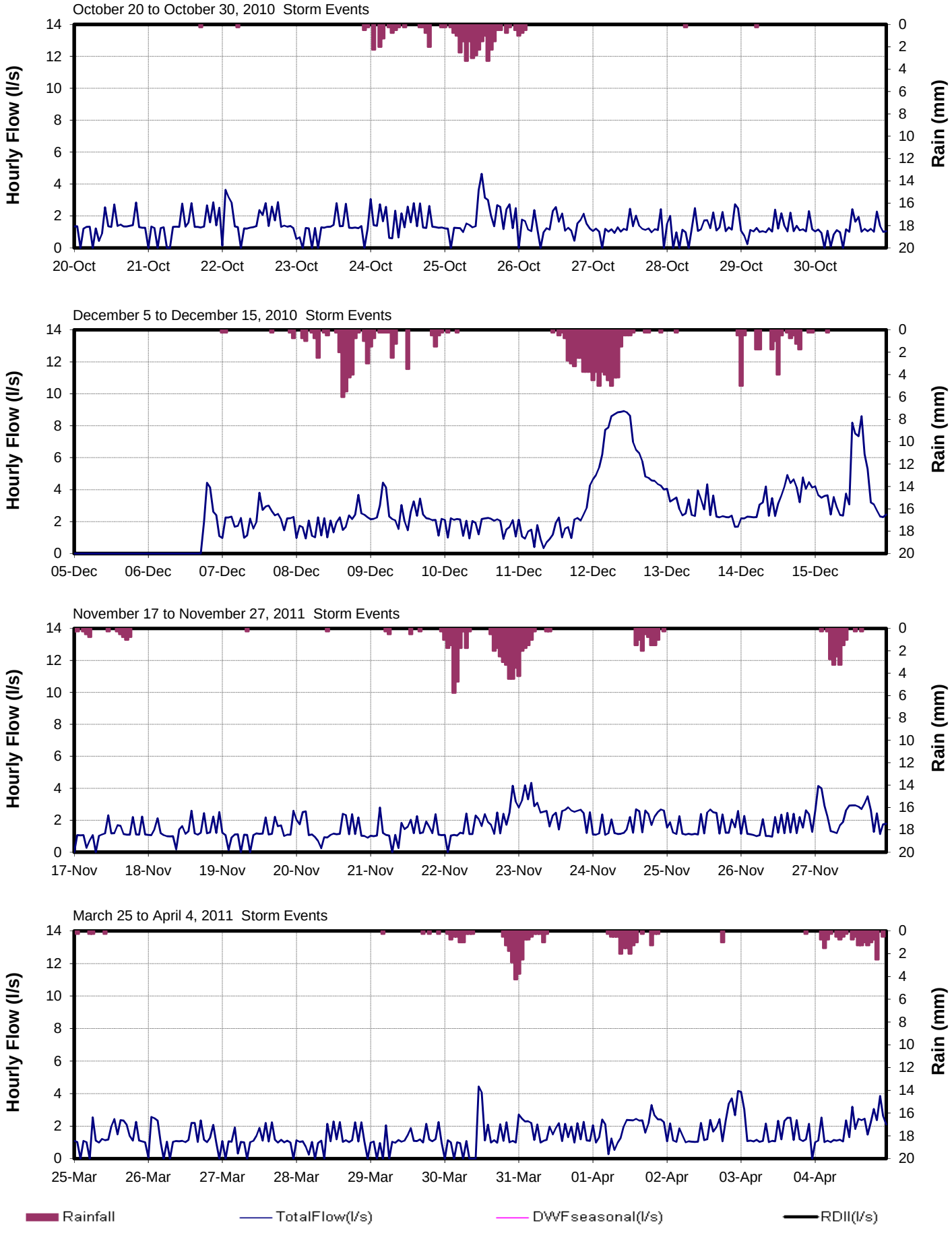


Juan de Fuca Rec (COL3)



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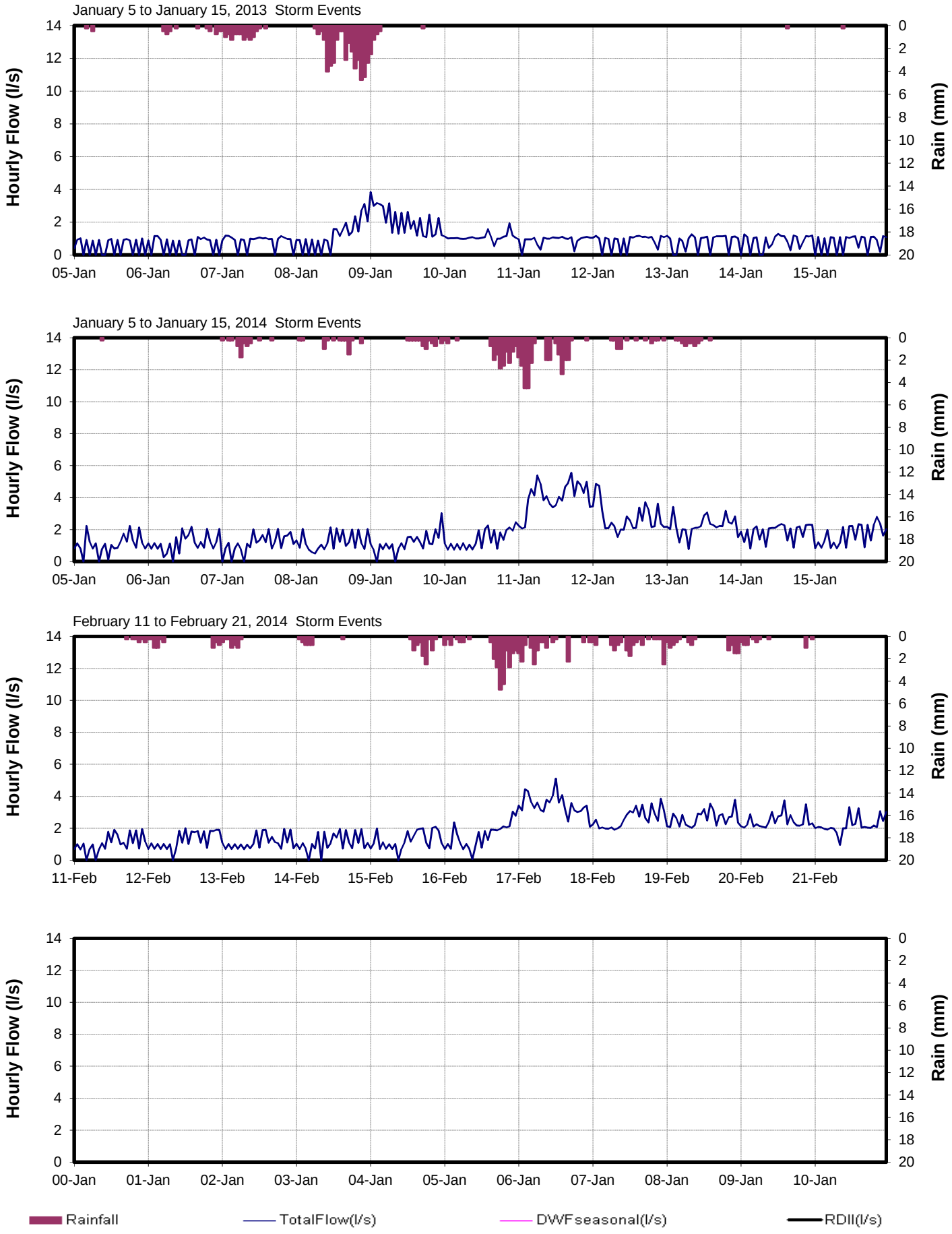
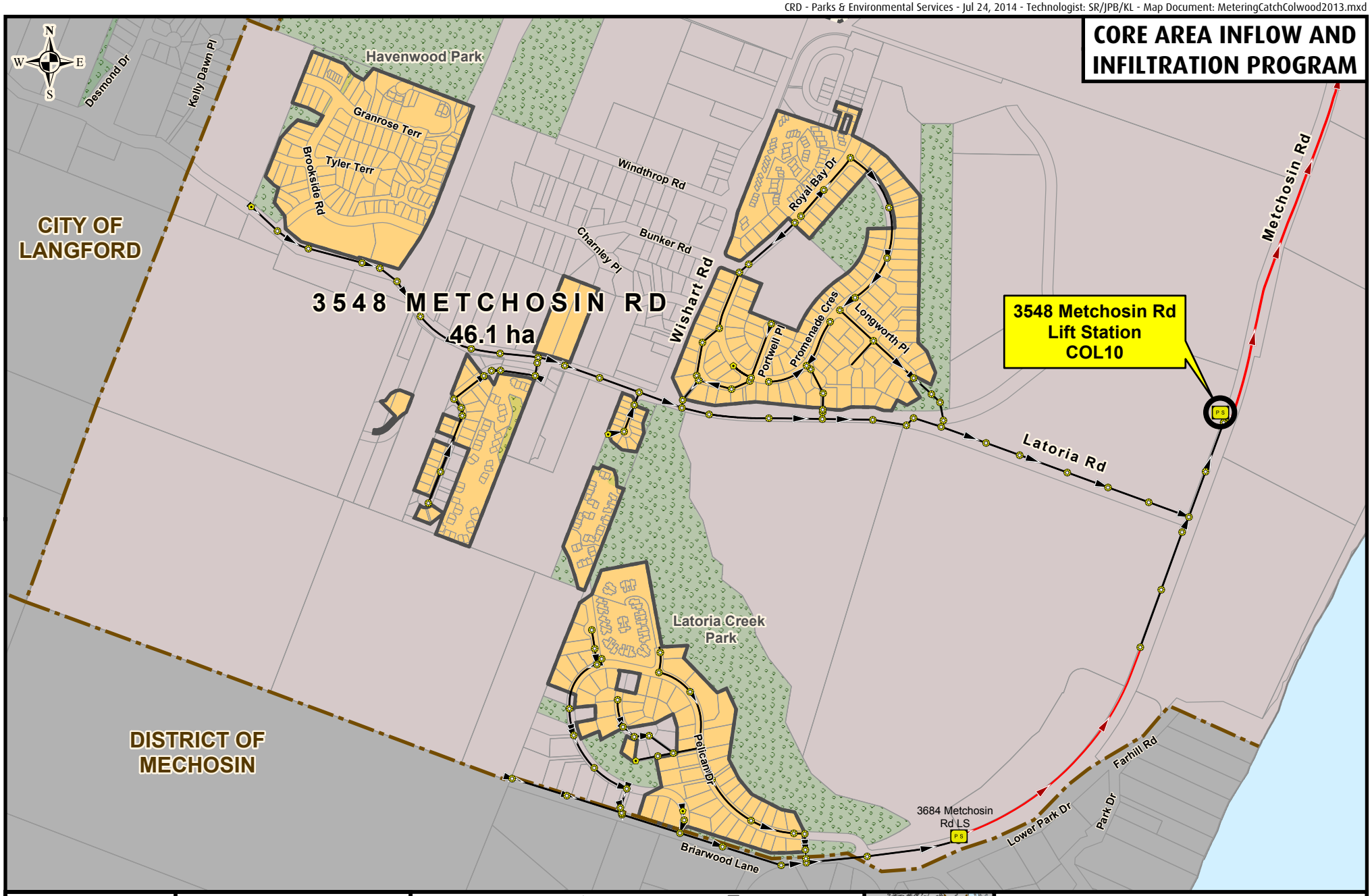


CORE AREA INFLOW AND INFILTRATION PROGRAM



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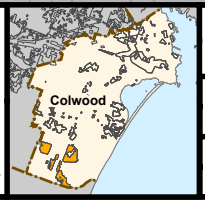

FLOW MONITORING AREA

CATCHMENT: 3548 METCHOSIN RD

SITE CODE: **COL10**

3548 Metchosin Rd (COL10)

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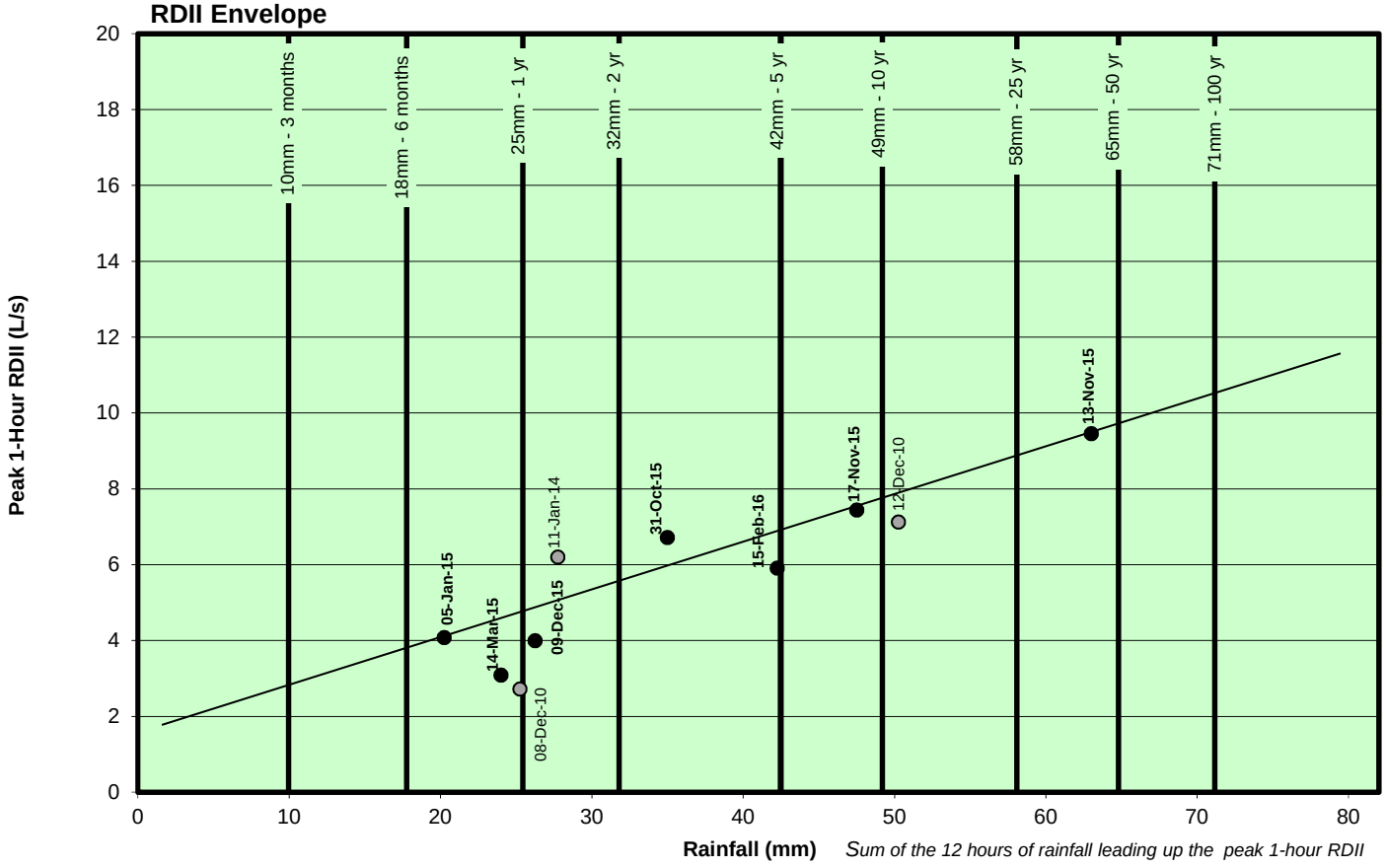
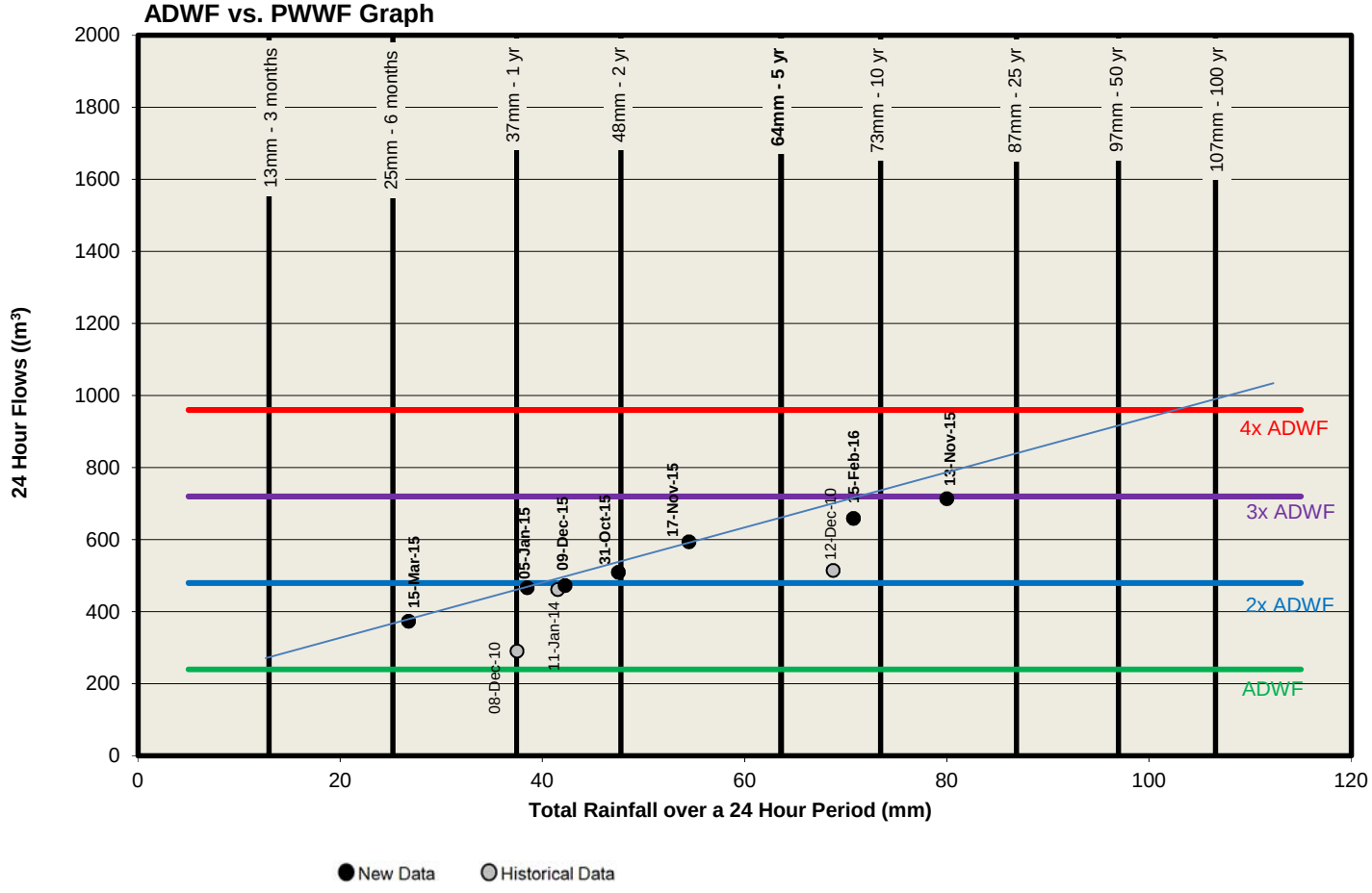
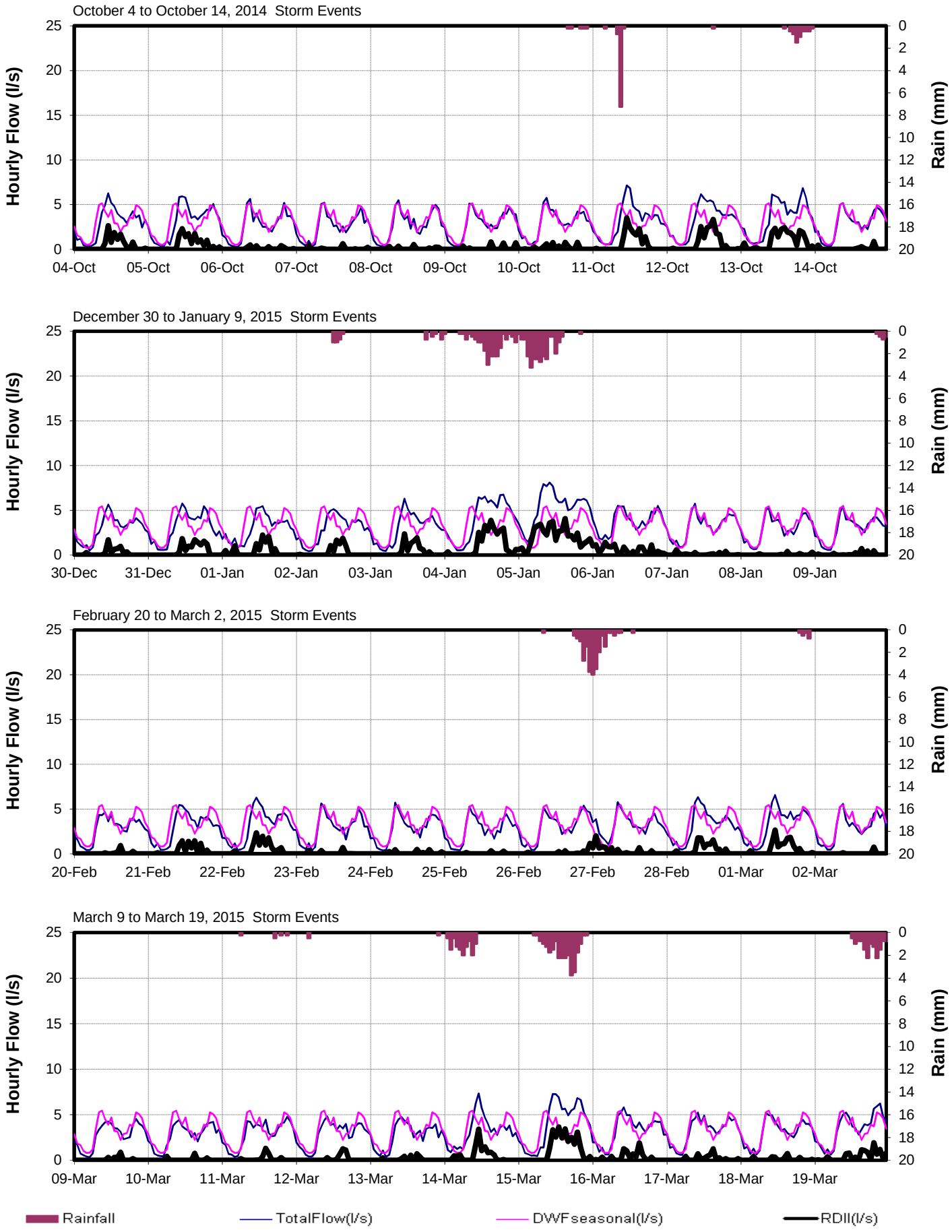


ADWF vs. PWWF Graph

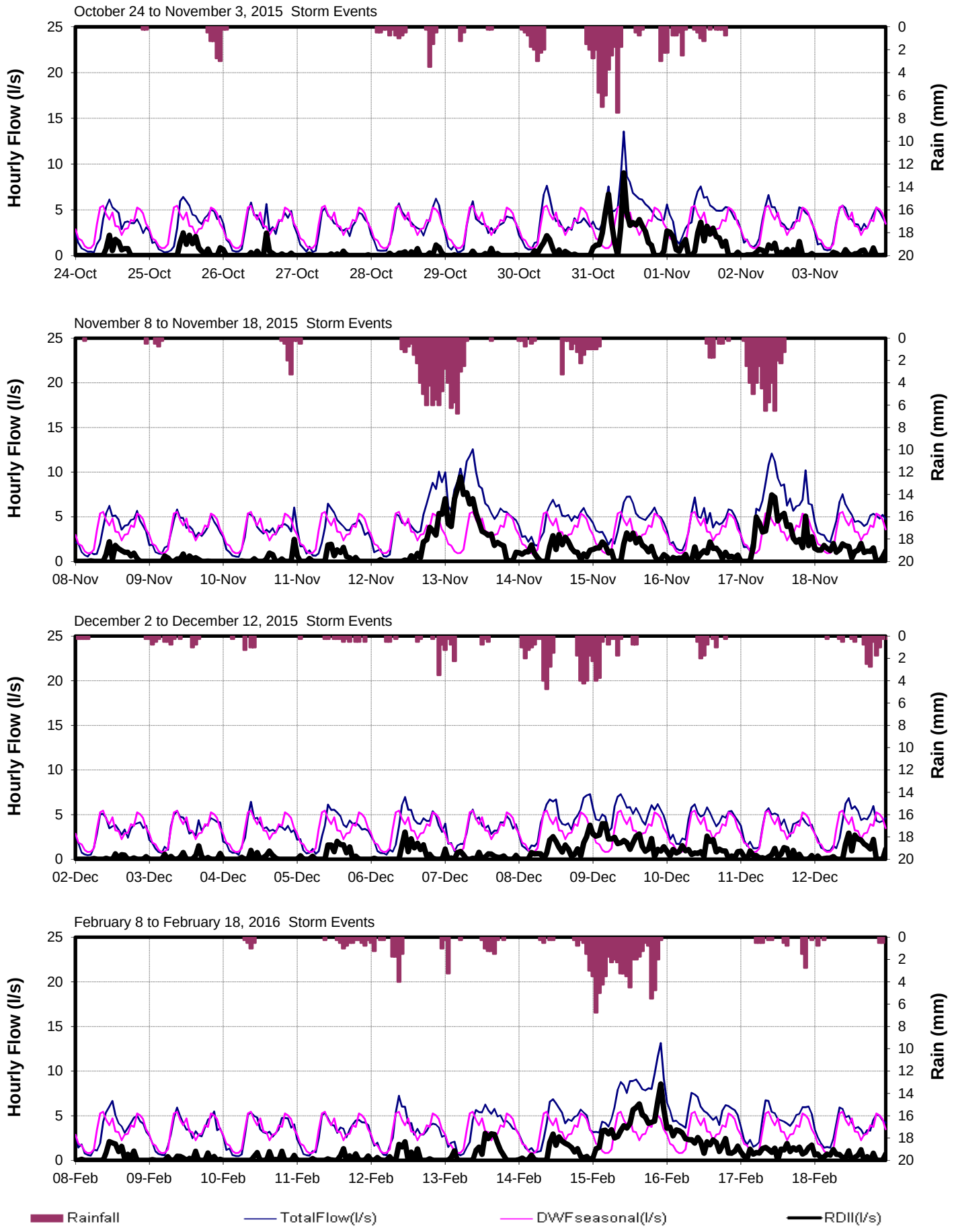


3548 Metchosin Rd (COL10)

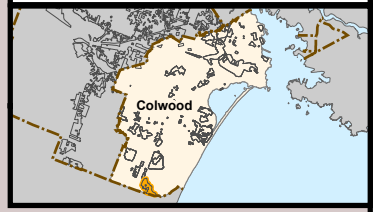


CRD Core Area I Program

3548 Metchosin Rd (COL10)



CORE AREA INFLOW AND INFILTRATION PROGRAM



FLOW MONITORING AREA

CATCHMENT: 3684 METCHOSIN RD

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Metres

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For legend see full page maps.

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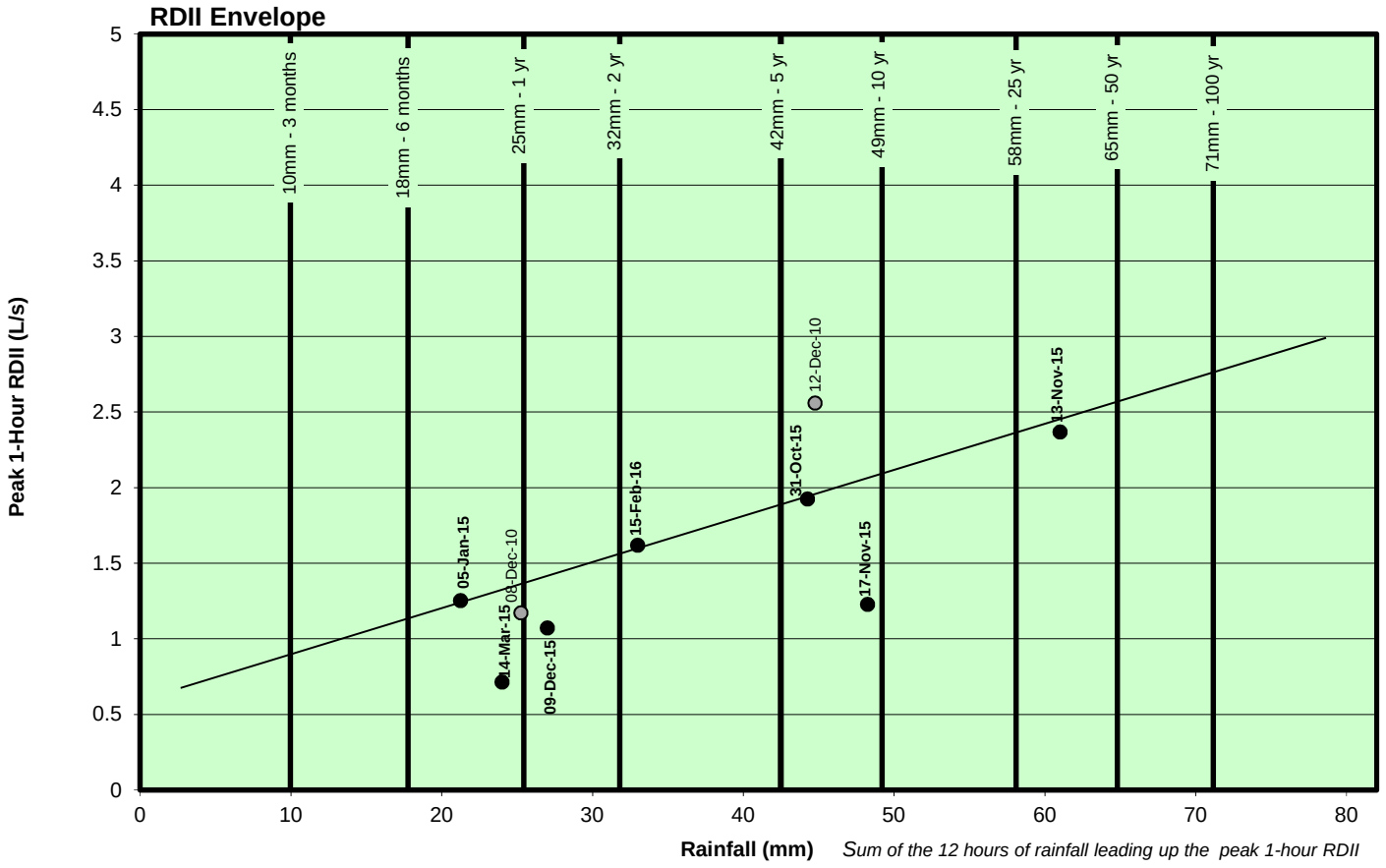
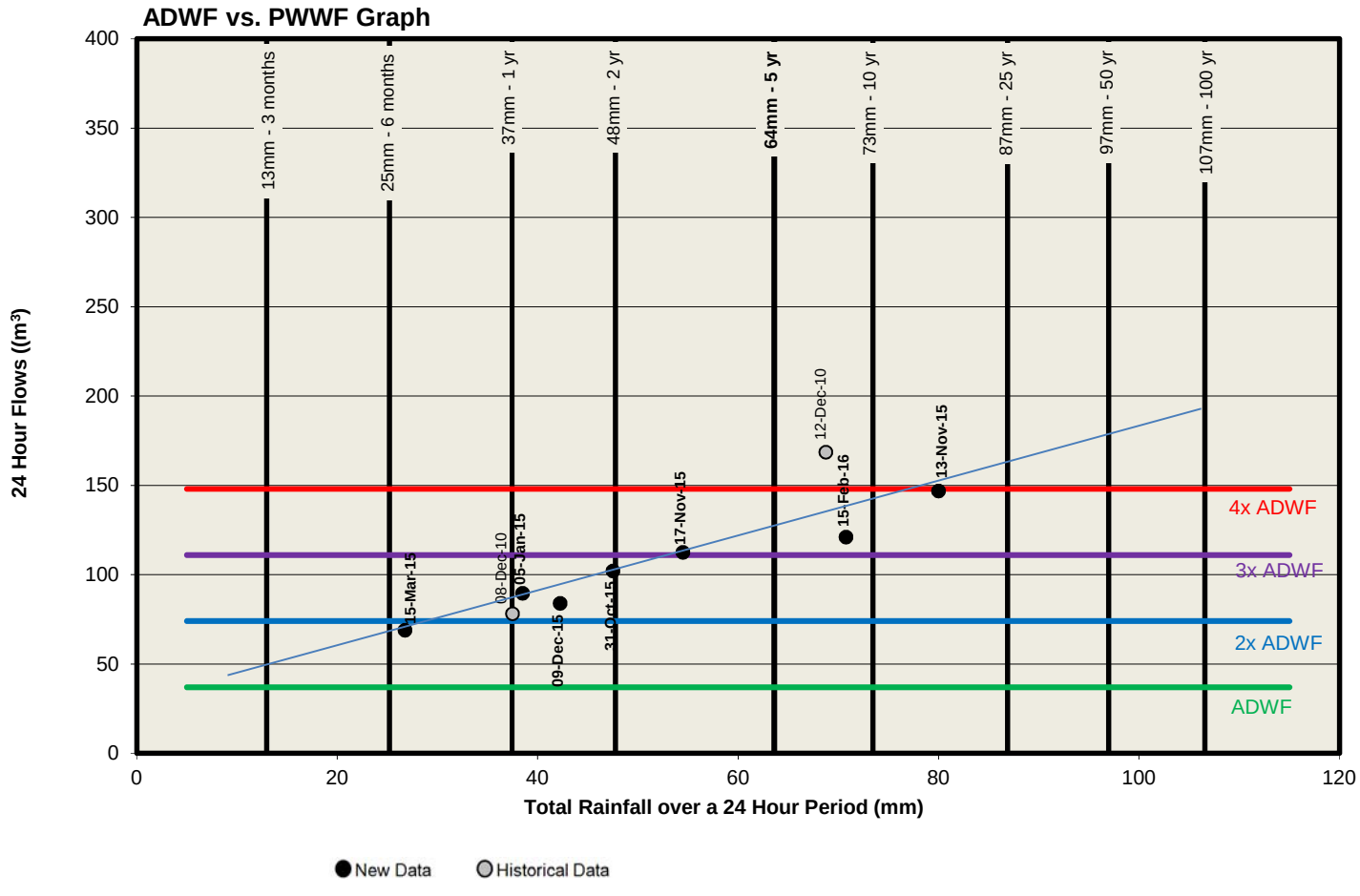
3684 Metchosin Rd (COL15)





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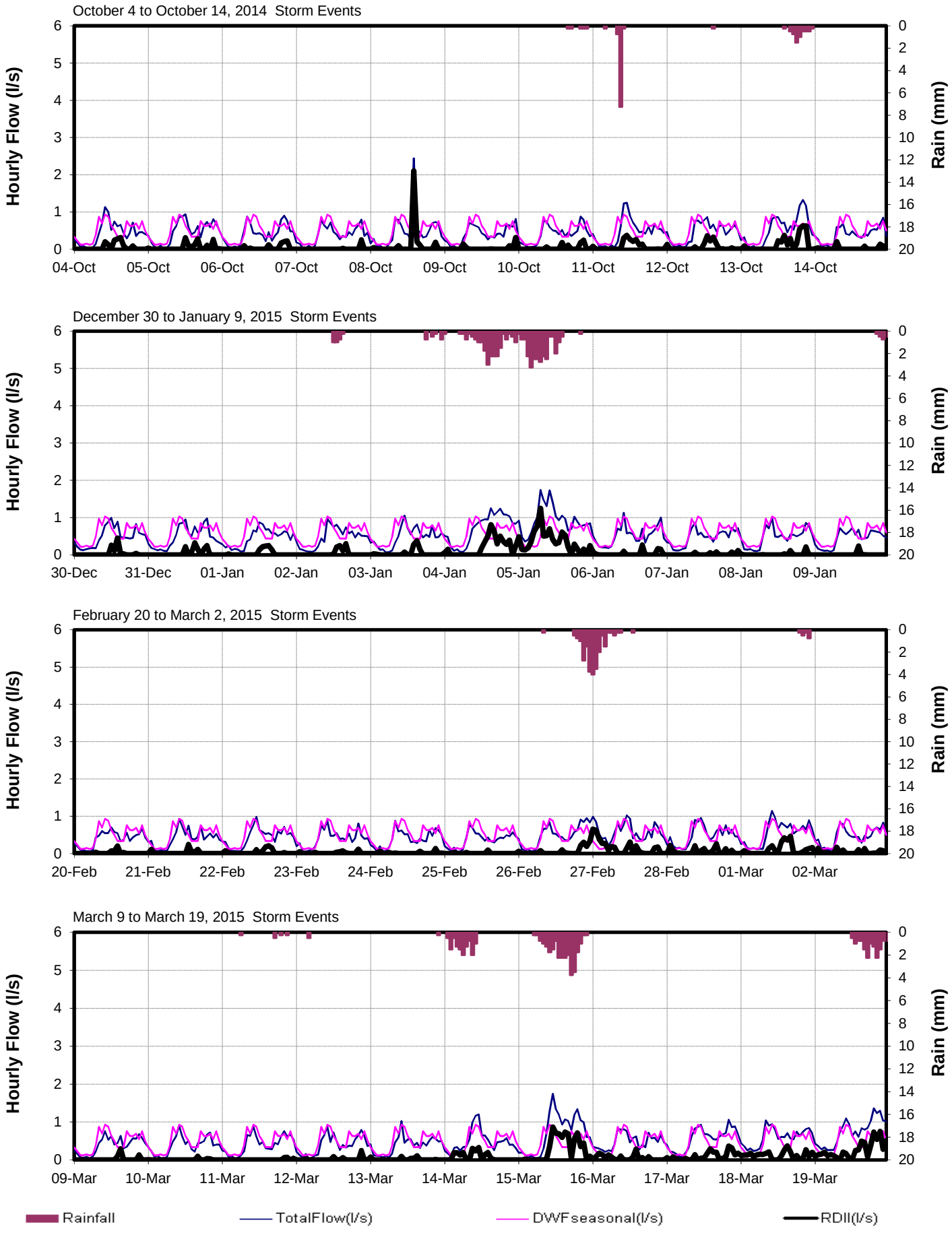
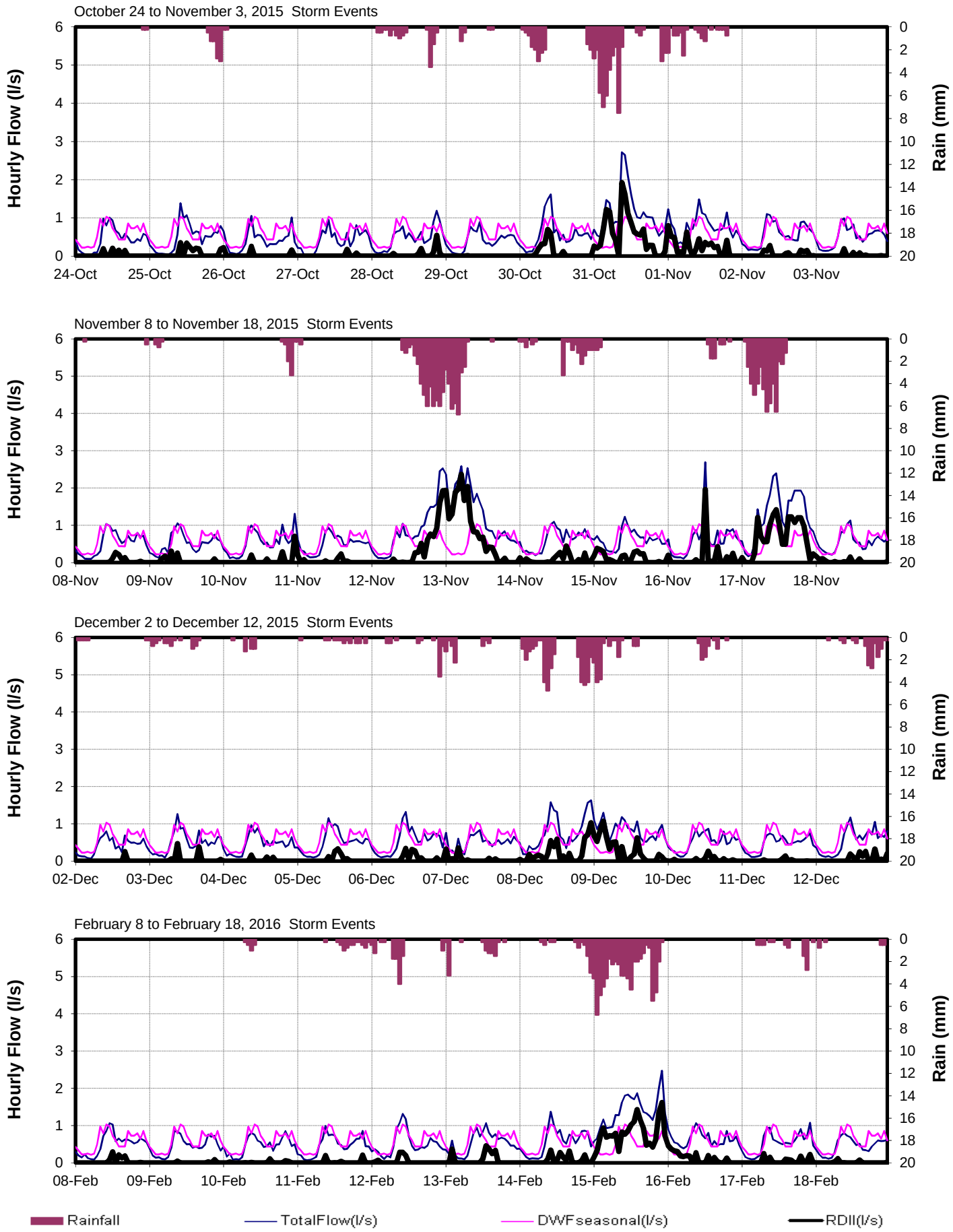
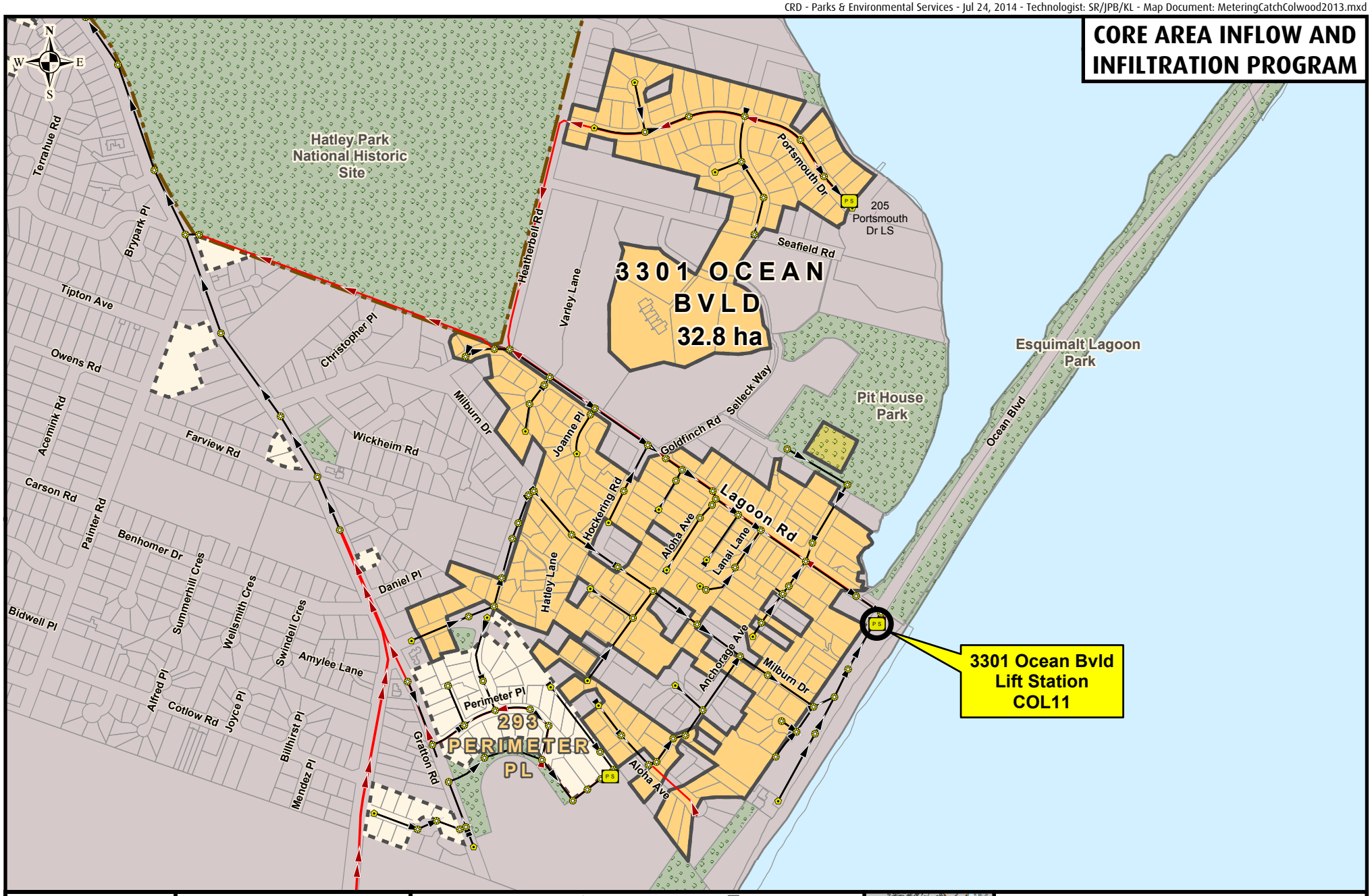


3684 Metchosin Rd (COL15)



CRD - Parks & Environmental Services - Jul 24, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchColwood2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



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Metres
0 50 100 150 200 250
Projection: UTM ZONE 10N NAD 83

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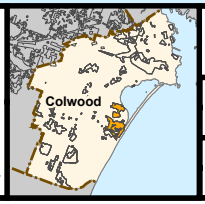
- CRD Sewer

- Catchment Area
- Non-Sewered Area
- Lot Lines
- Parks
- Sewered Park Areas
- Catchment Boundary Municipal, First Nation, or DND Boundaries

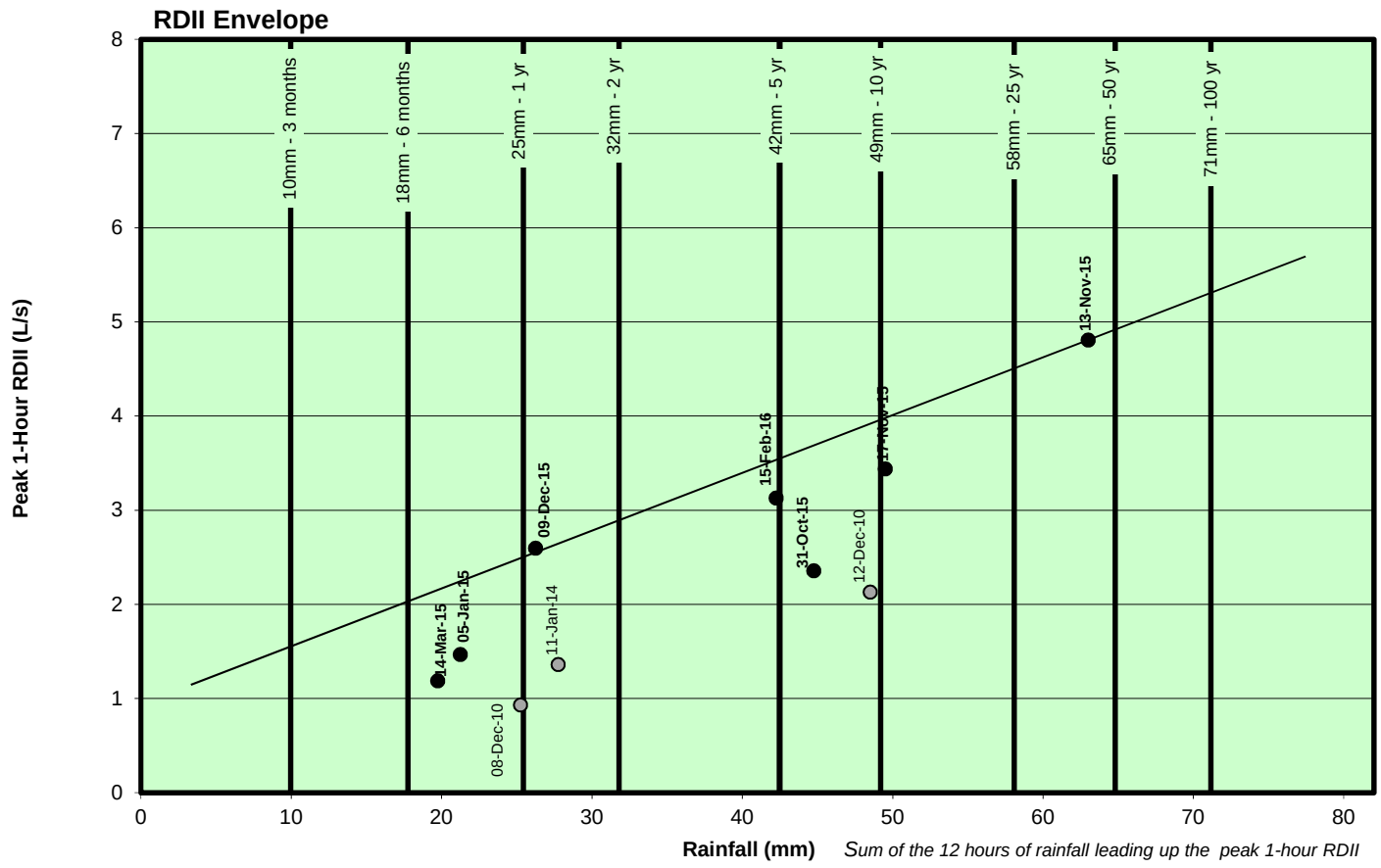


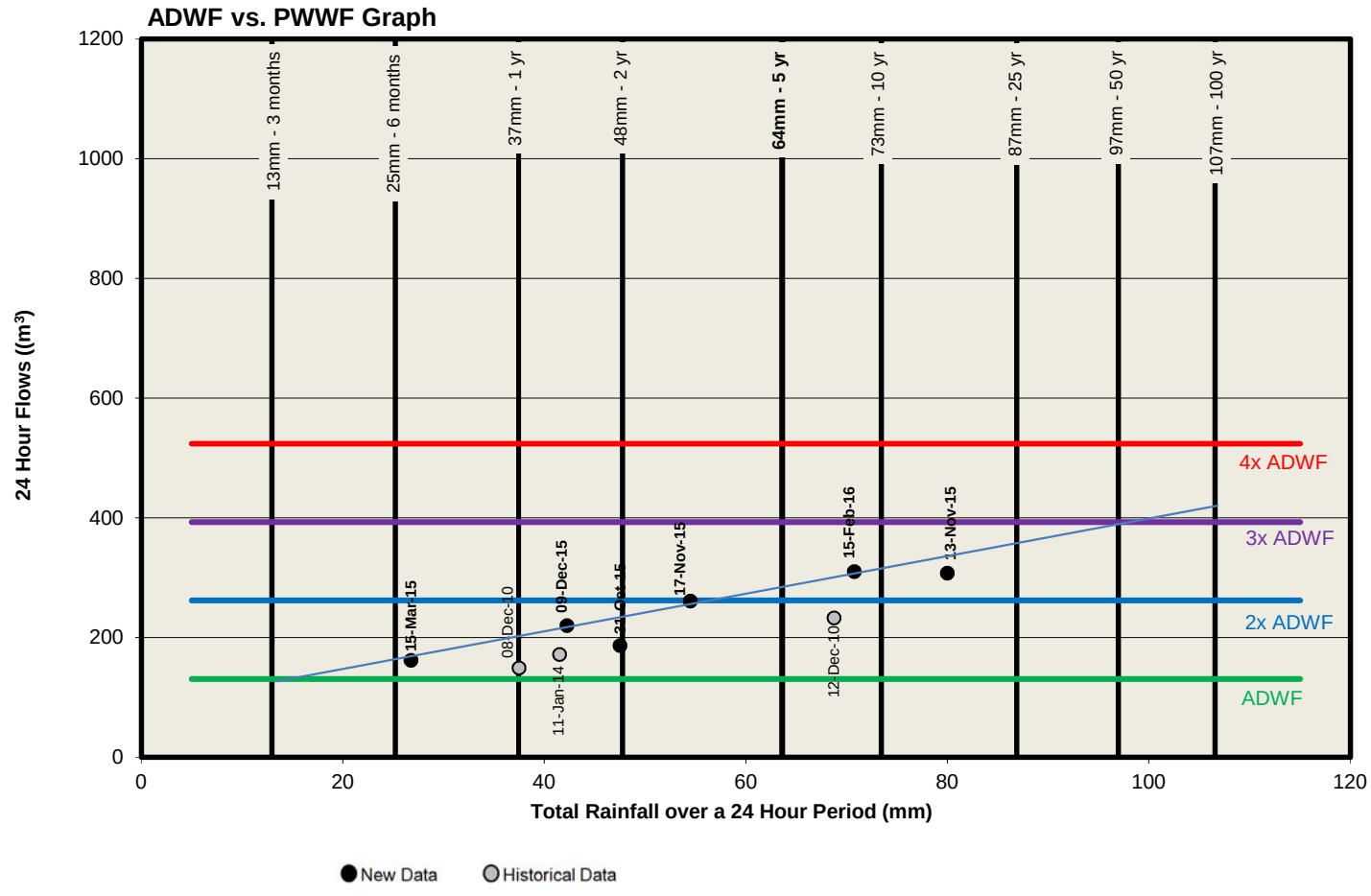
FLOW MONITORING AREA

CATCHMENT: 3301 OCEAN BVLD

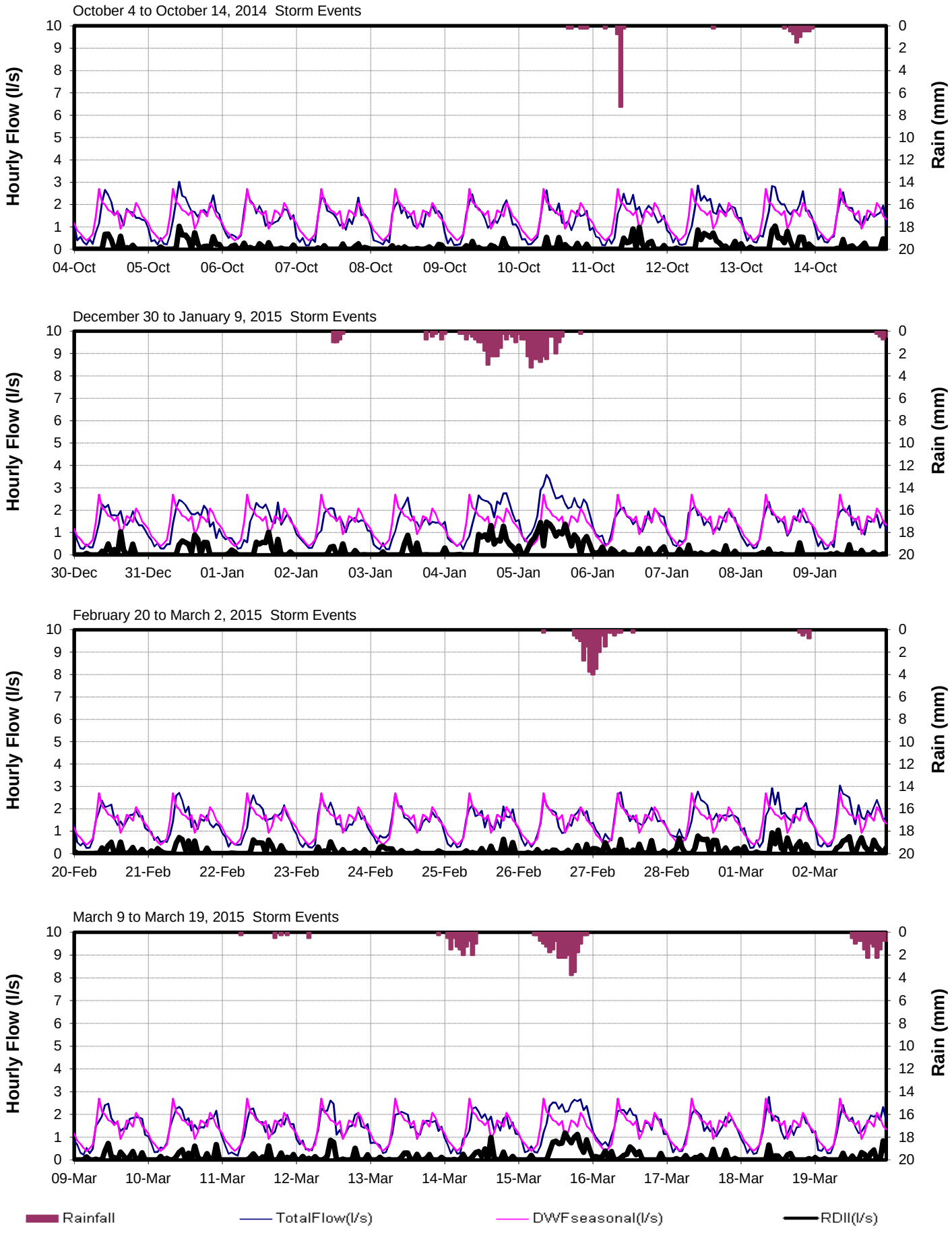
SITE CODE: **COL11**

3301 Ocean Boulevard (COL11)

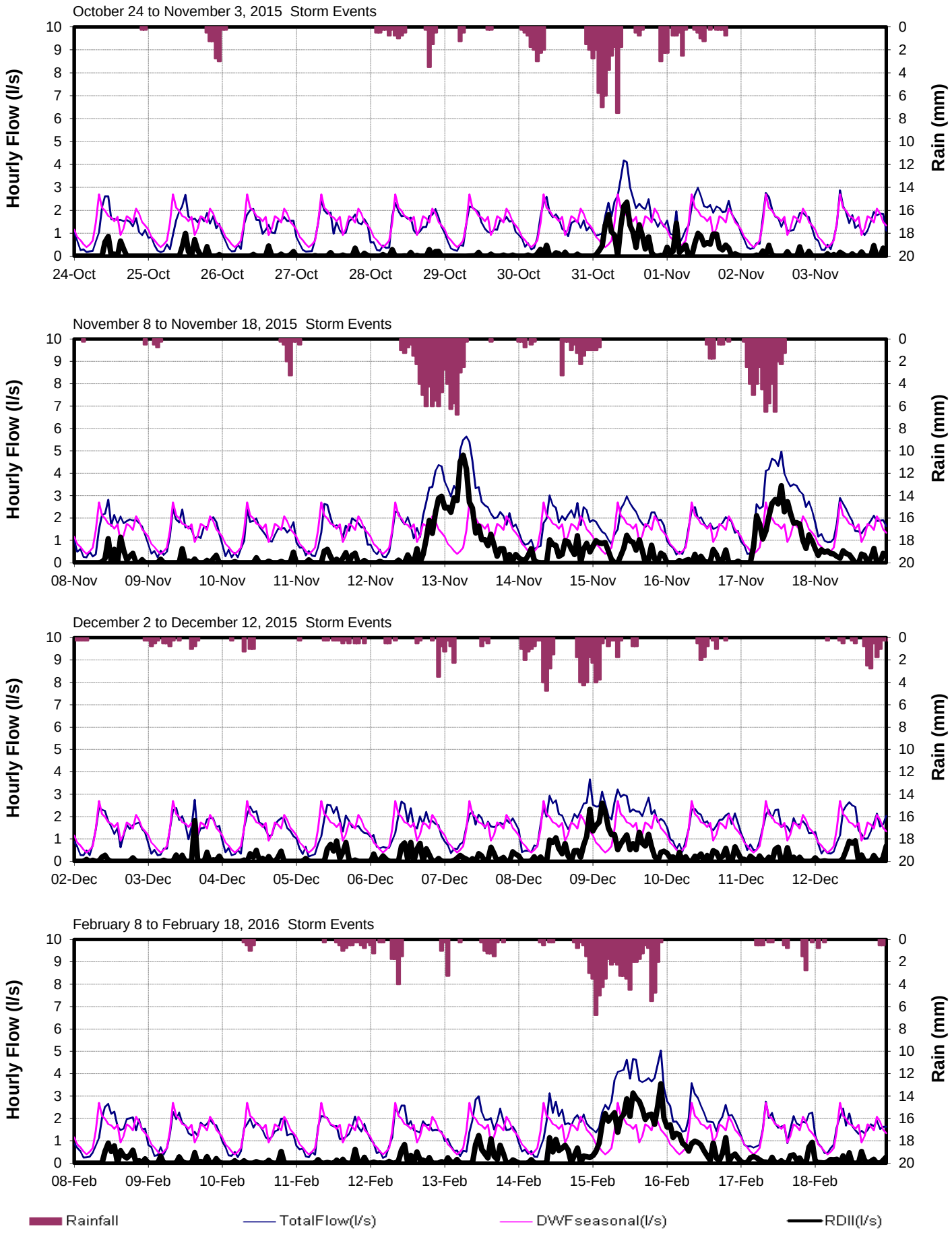




3301 Ocean Boulevard (COL11)

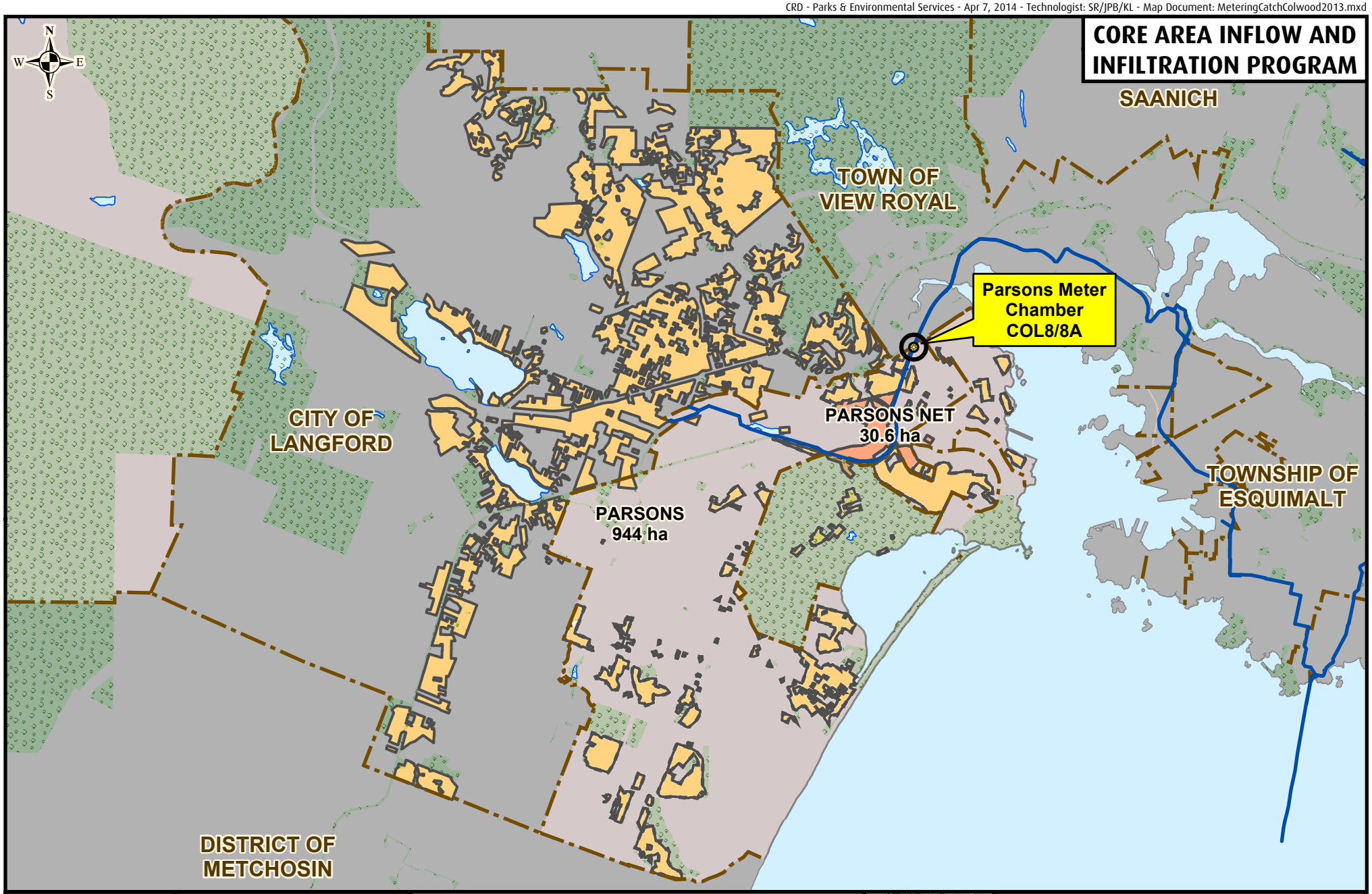


3301 Ocean Boulevard (COL11)



CRD - Parks & Environmental Services - Apr 7, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchColwood2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



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Metres

0 500 1,000 1,500

Projection: UTM ZONE 10N NAD 83

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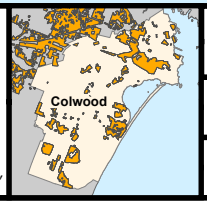
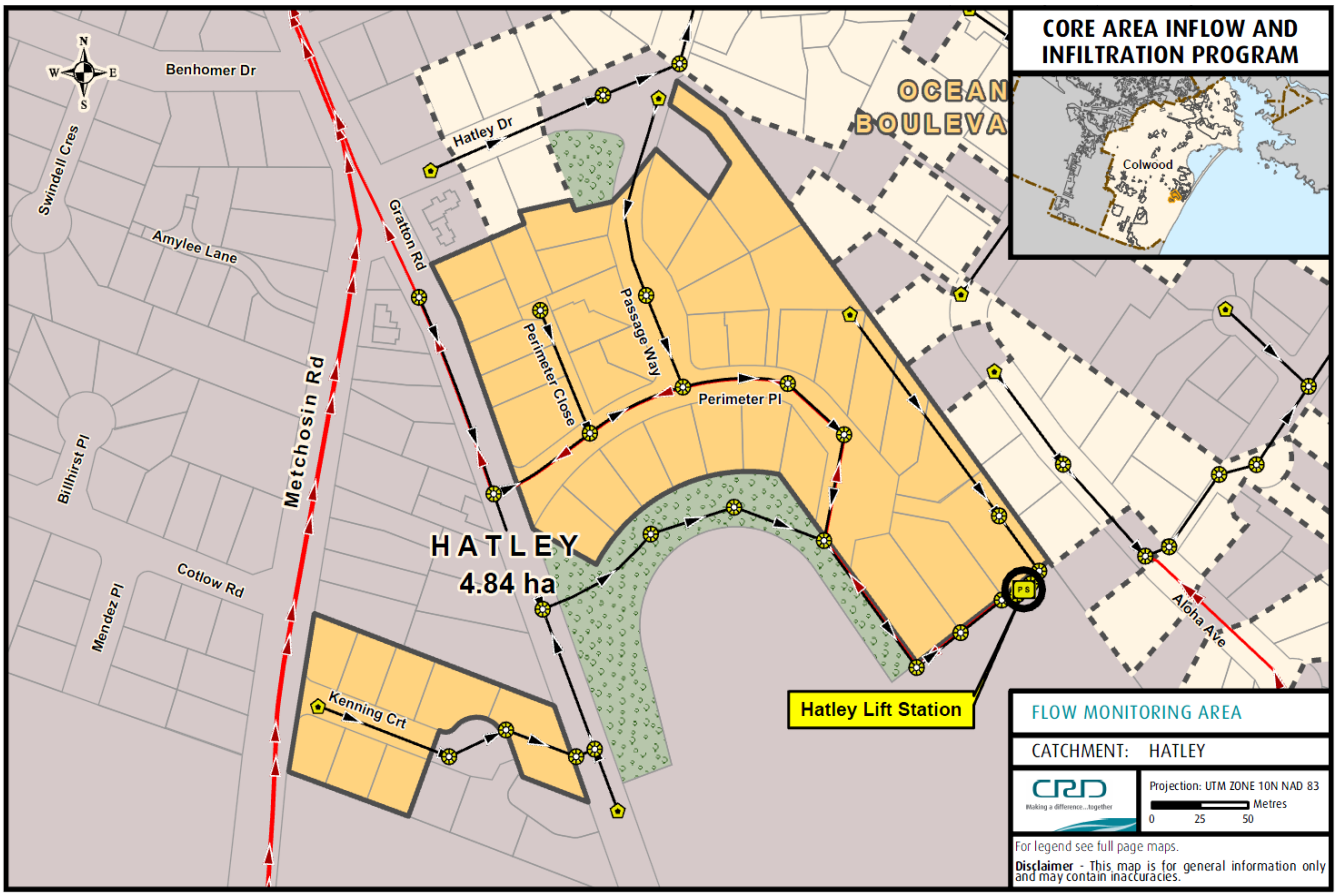


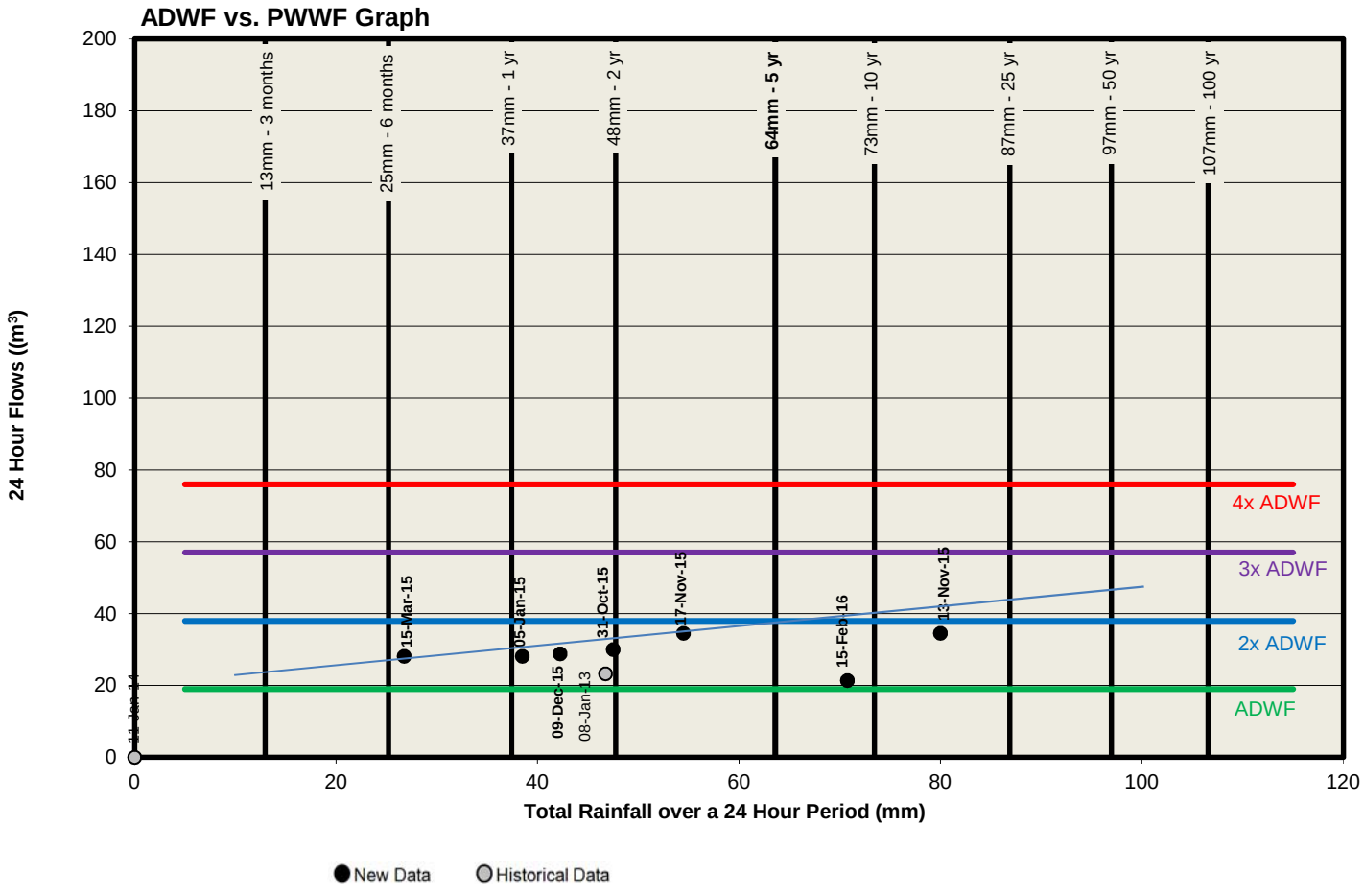
FLOW MONITORING AREA

CATCHMENT: PARSONS & PARSONS NET

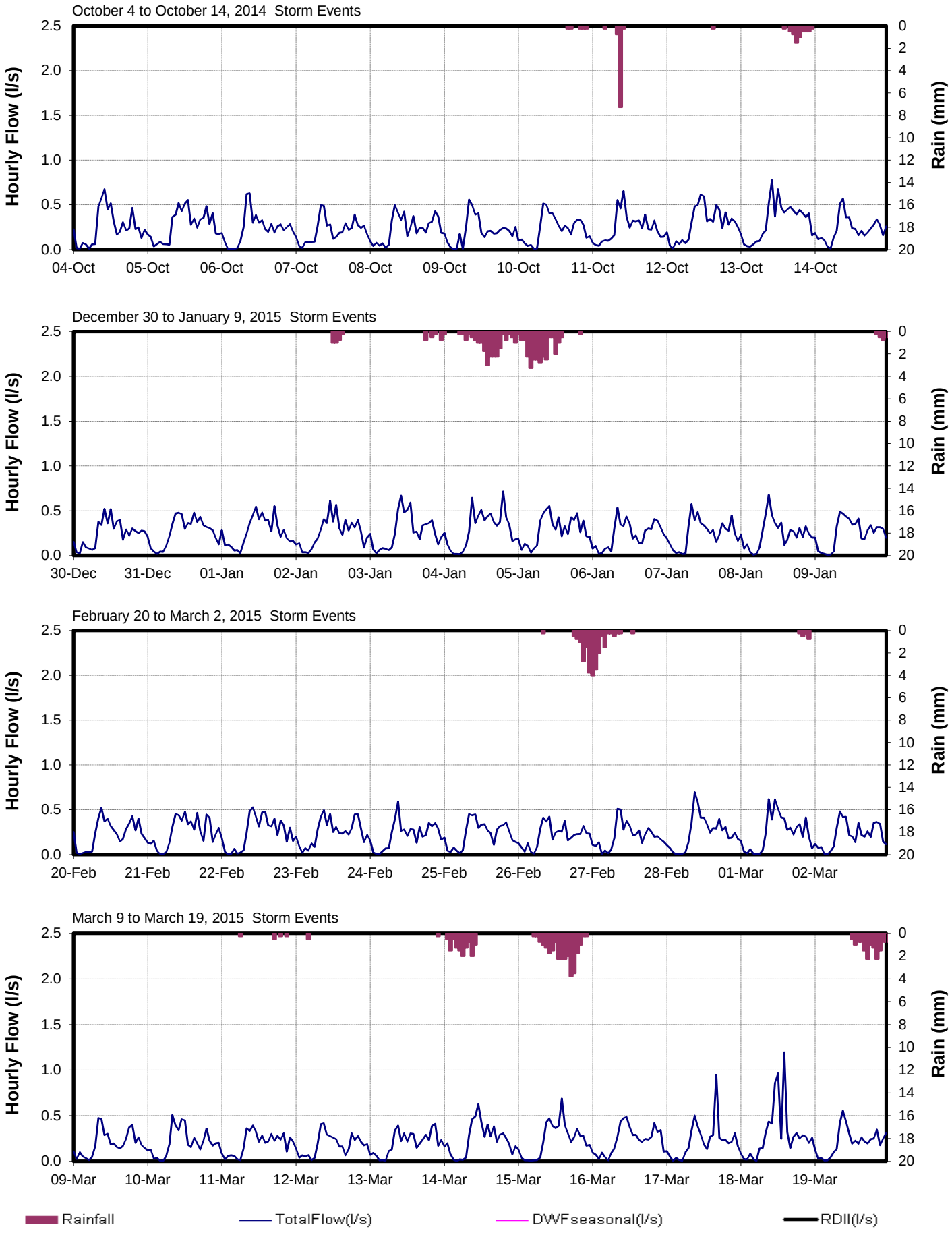
SITE CODE: **COL8 / COL8A**

293 Perimeter Pl (COL14)

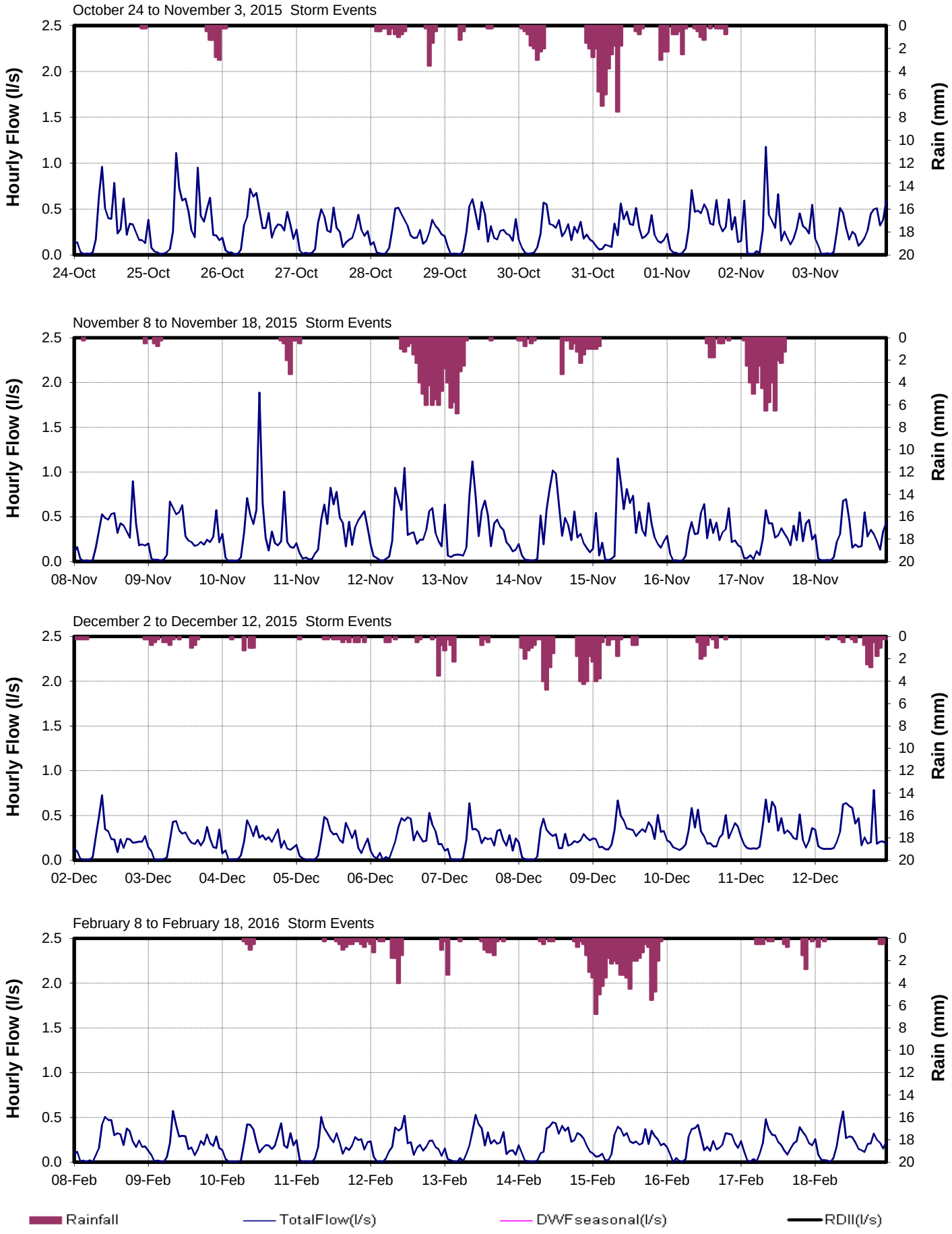




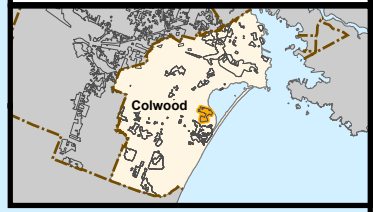
293 Perimeter Pl (COL14)



293 Perimeter Pl (COL14)



CORE AREA INFLOW AND INFILTRATION PROGRAM



FLOW MONITORING AREA

CATCHMENT: 205 PORTSMOUTH DR

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Projection: UTM ZONE 10N NAD 83

Metres

0 25 50 75

For legend see full page maps.

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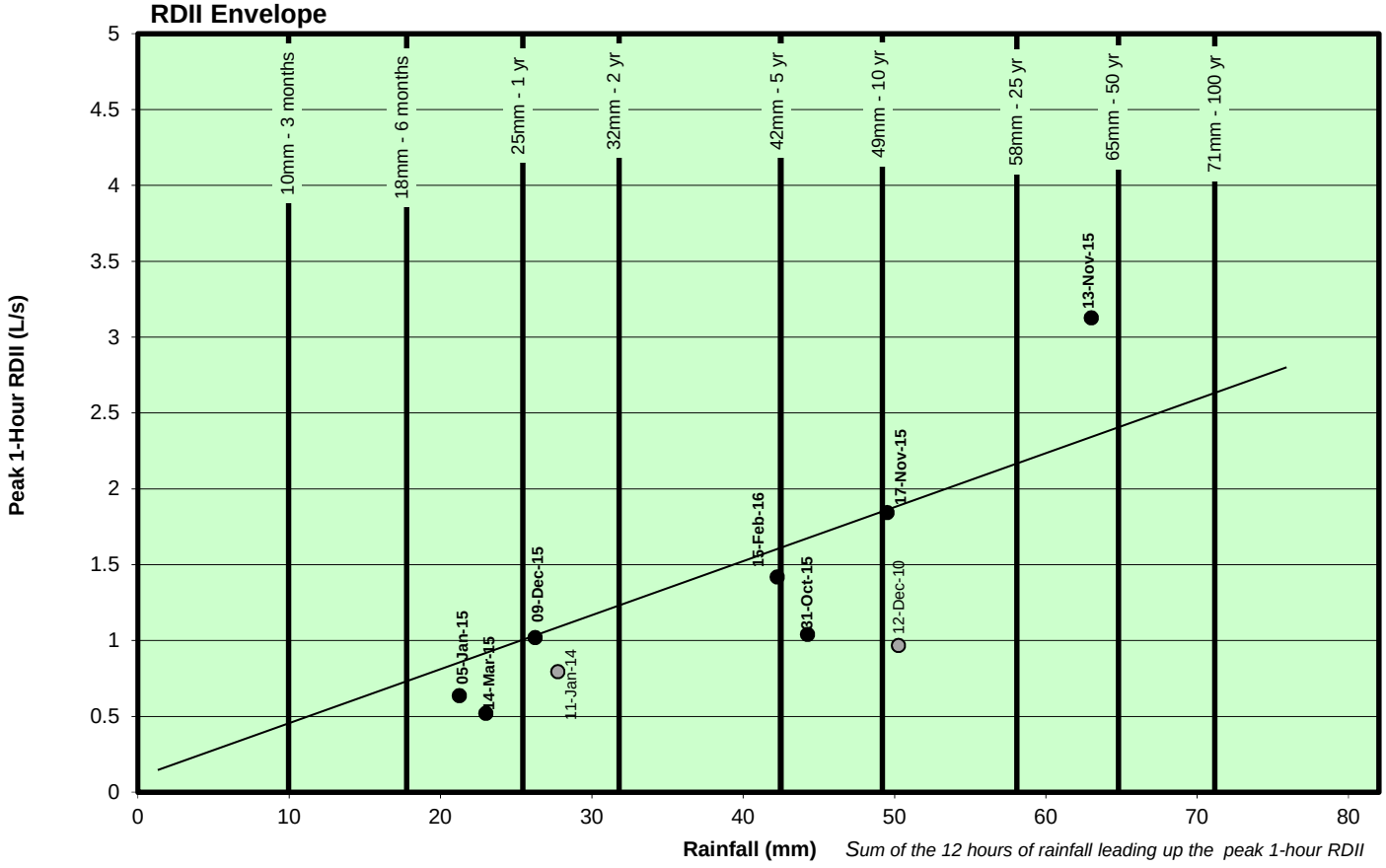
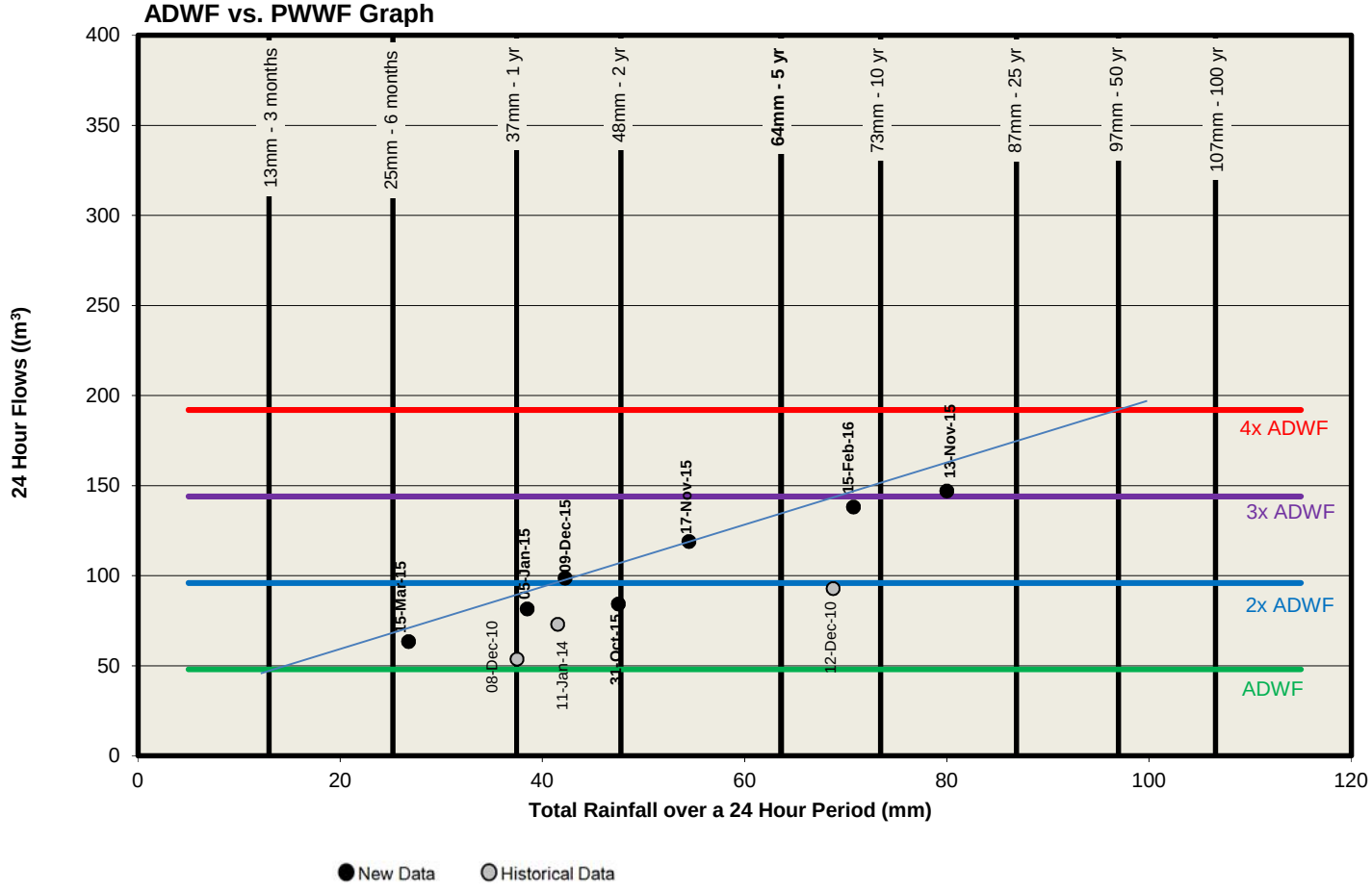
205 Portsmouth Drive

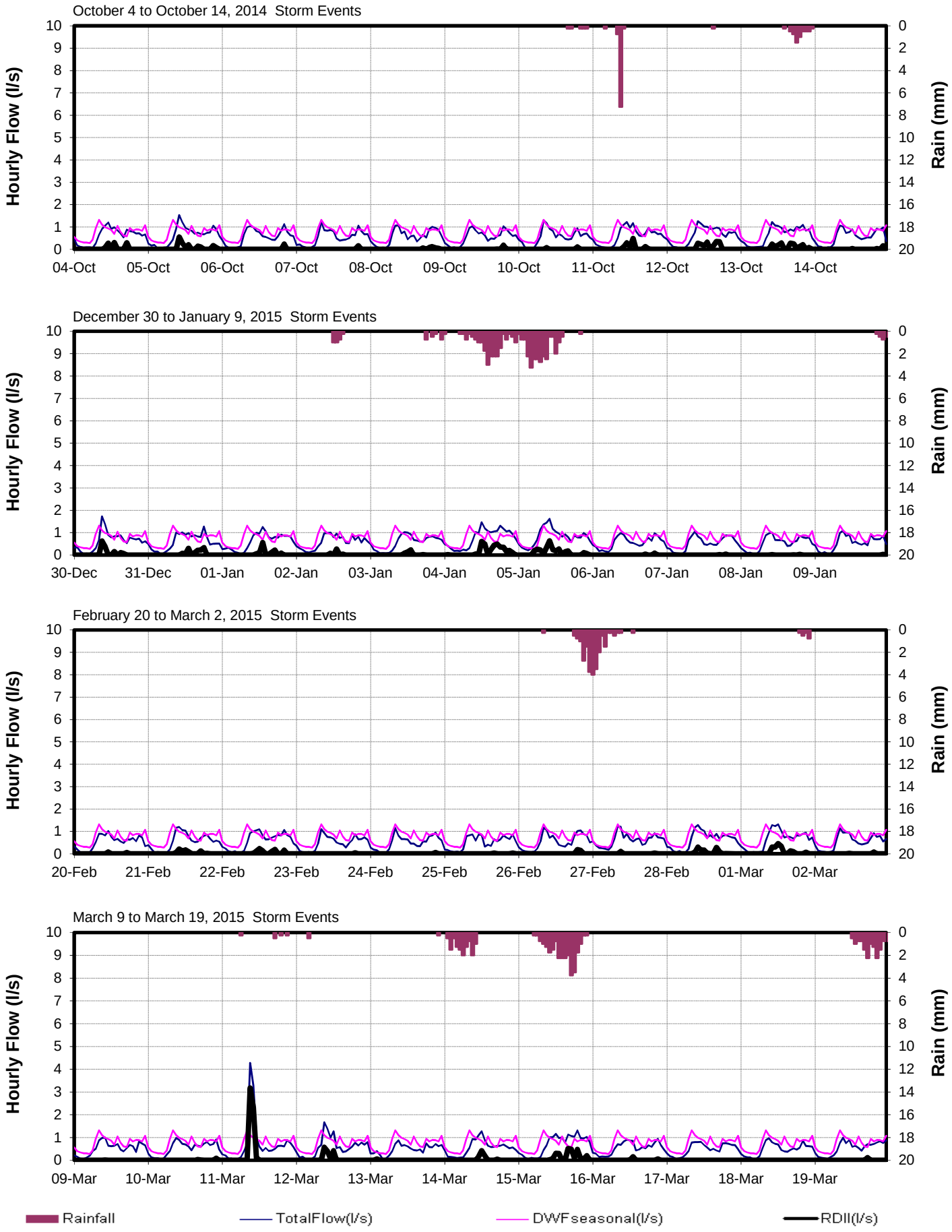
RDII Envelope



ADWF vs. PWWF Graph



205 Portsmouth Drive



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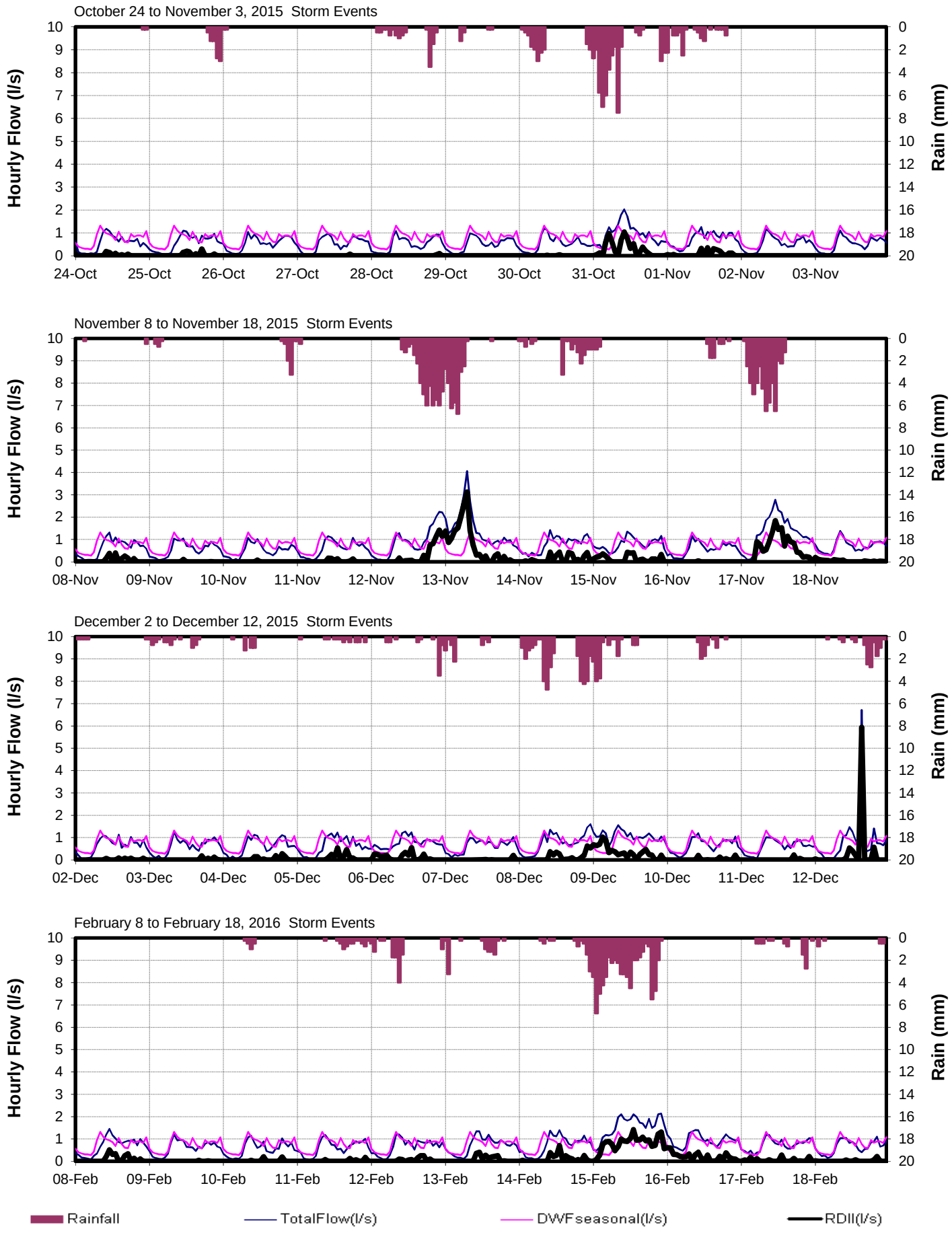
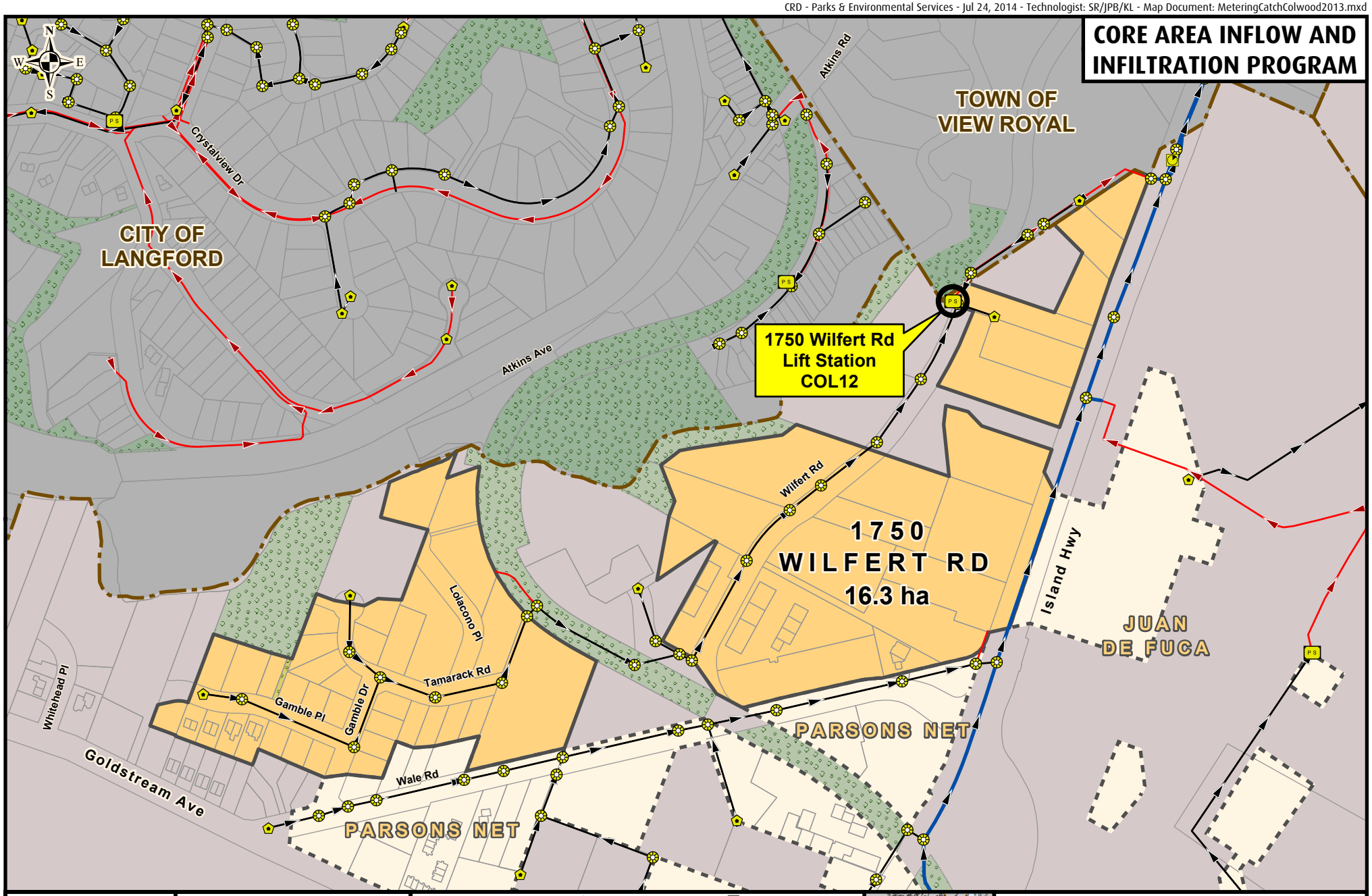


CRD - Parks & Environmental Services - Jul 24, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchColwood2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



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Metres
0 50 100 150

Projection: UTM ZONE 10N NAD 83

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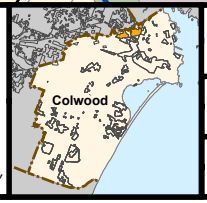
- Sewered Park Areas
- Catchment Boundary Municipal, First Nation, or DND Boundaries



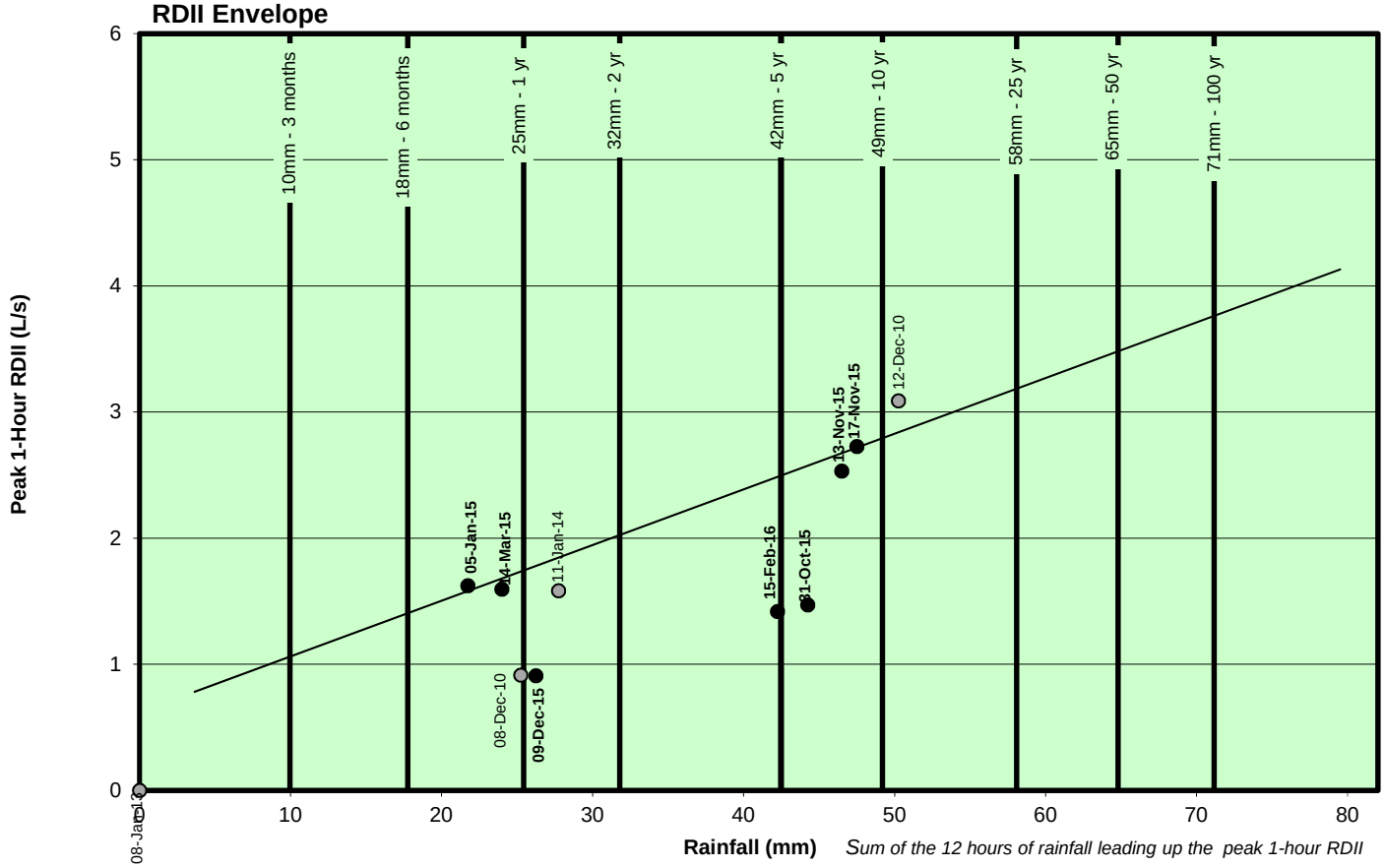
FLOW MONITORING AREA

CATCHMENT: 1750 WILFERT RD

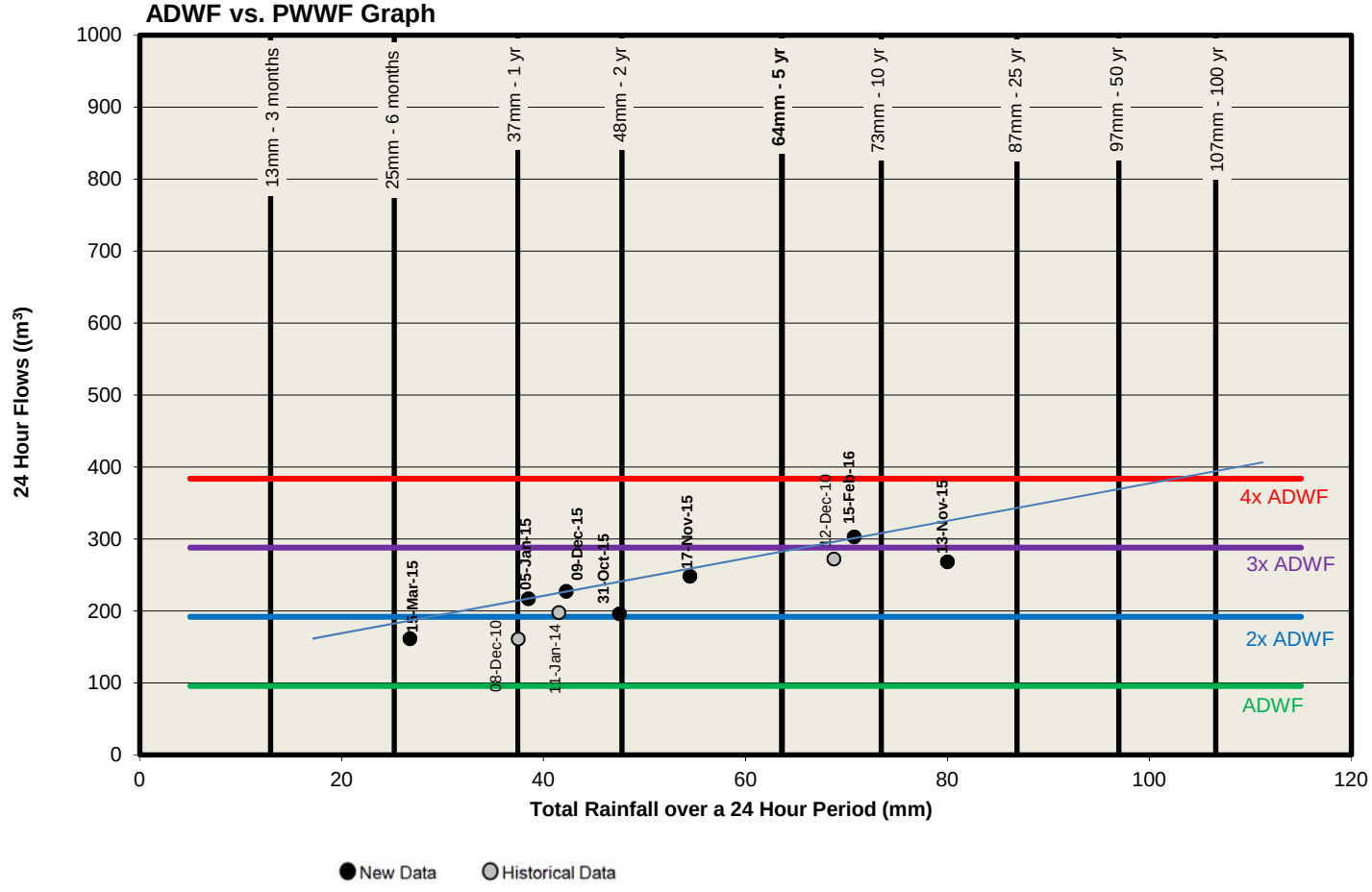
SITE CODE: **COL12**

1750 Wilfert Rd (COL12)

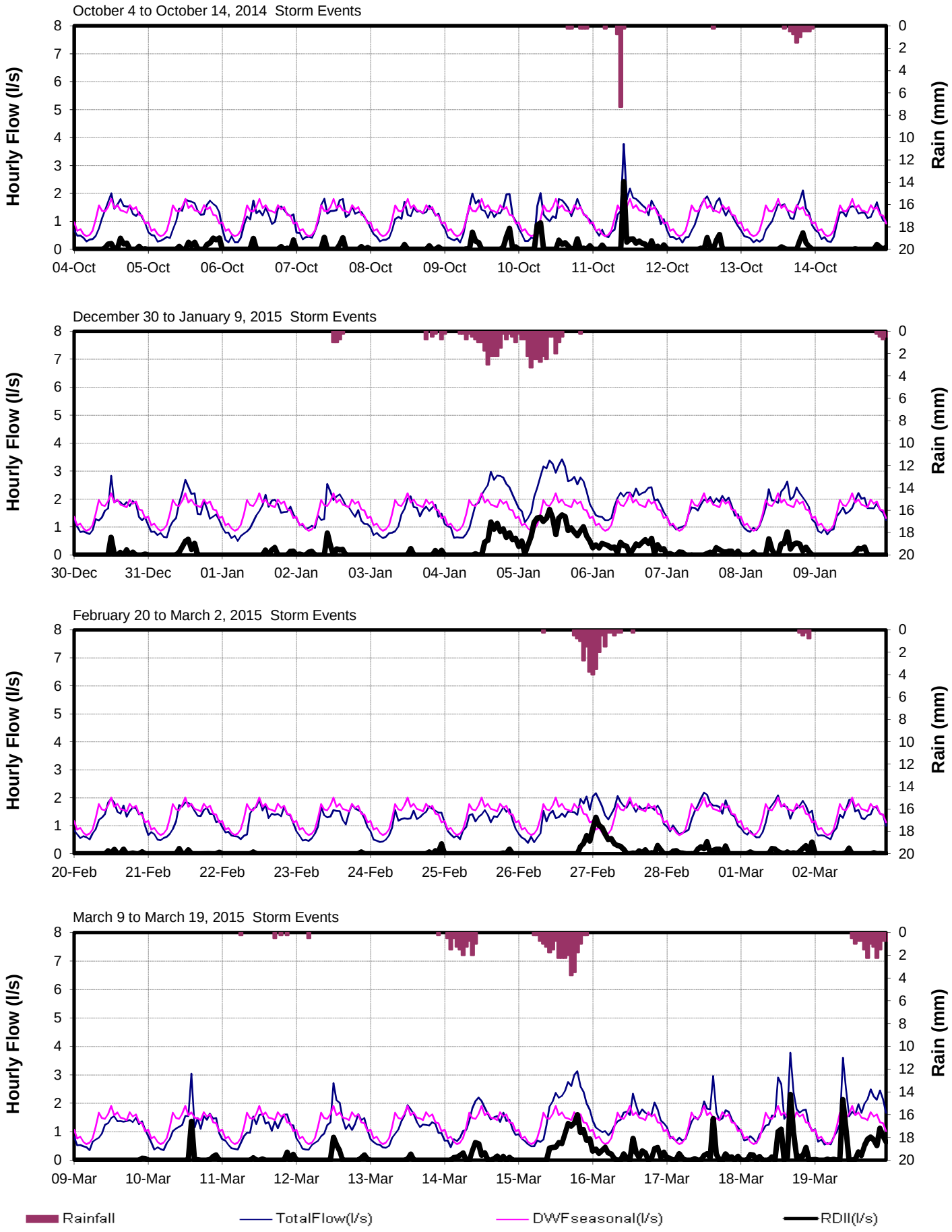
RDII Envelope



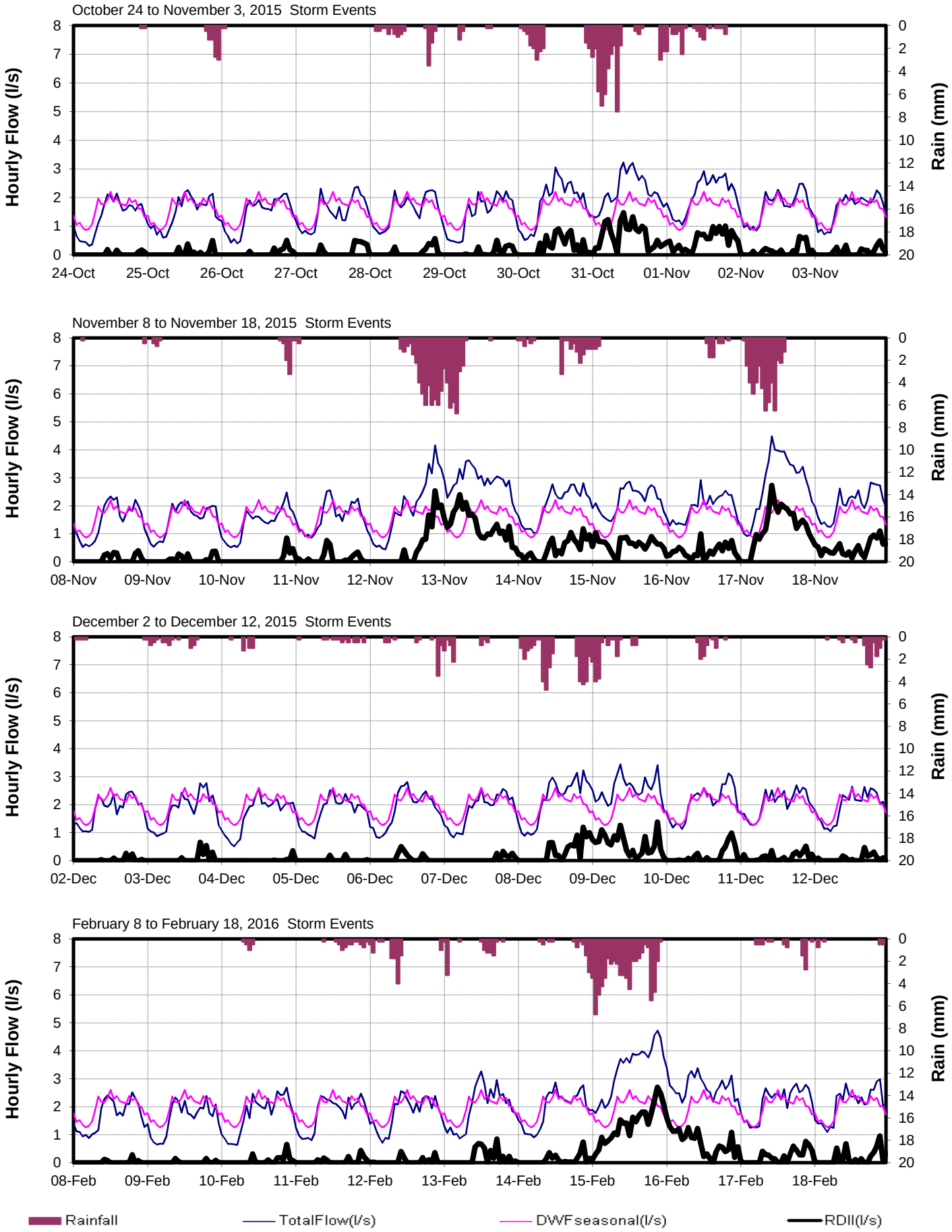
ADWF vs. PWWF Graph



1750 Wilfert Rd (COL12)

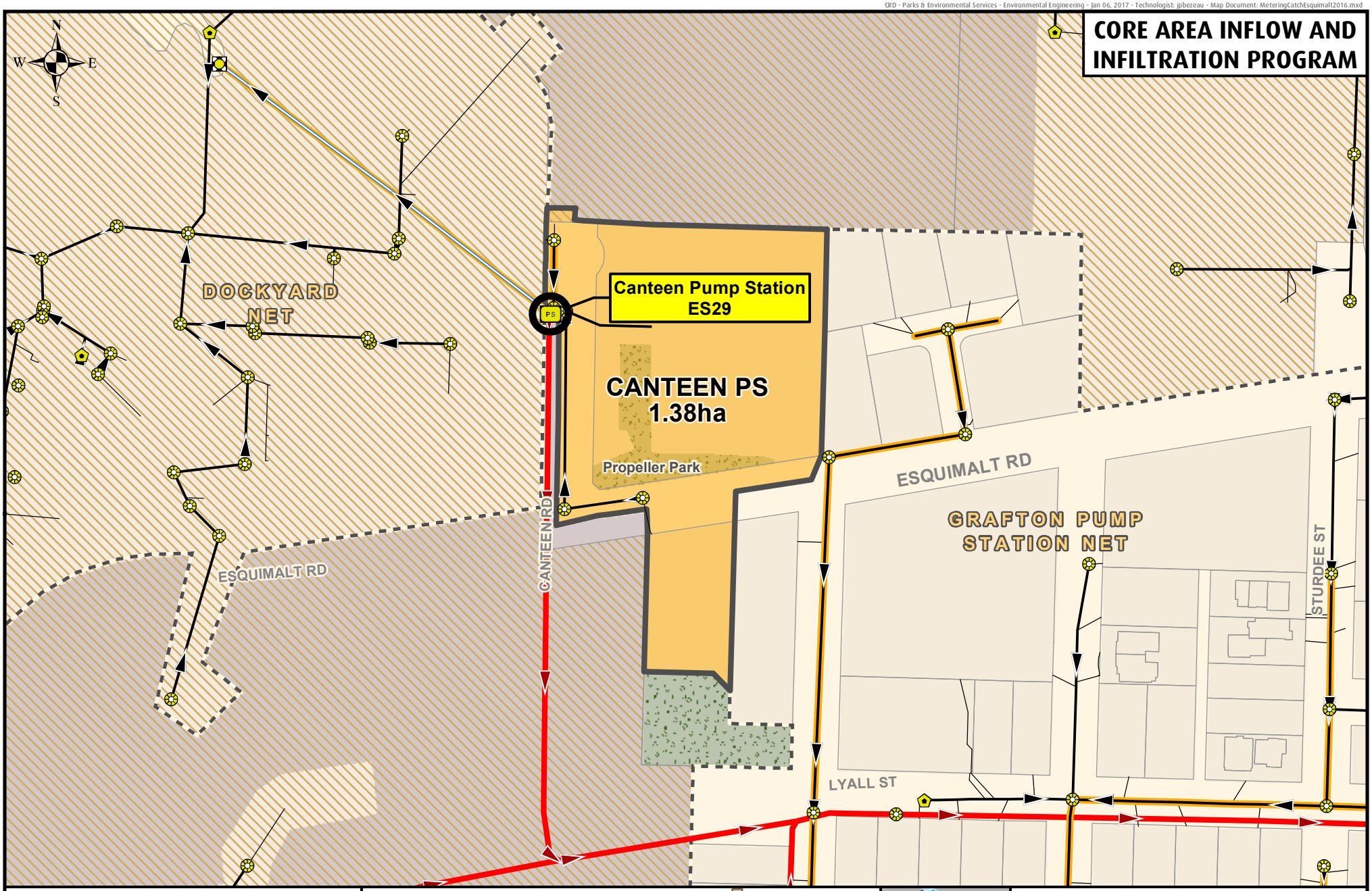


1750 Wilfert Rd (COL12)



CRD - Parks & Environmental Services - Environmental Engineering - Jan 06, 2017 - Technologist: jpbezeau - Map Document: MeteringCatchEsquimalt2016.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Metres
0 50 100

Projection: UTM ZONE 10N, NAD83

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- Flow Monitoring Location
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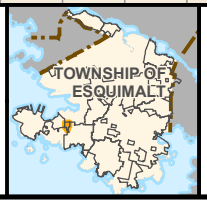

FLOW MONITORING AREA
Catchment: Canteen Pump Station
Site Code: ES29

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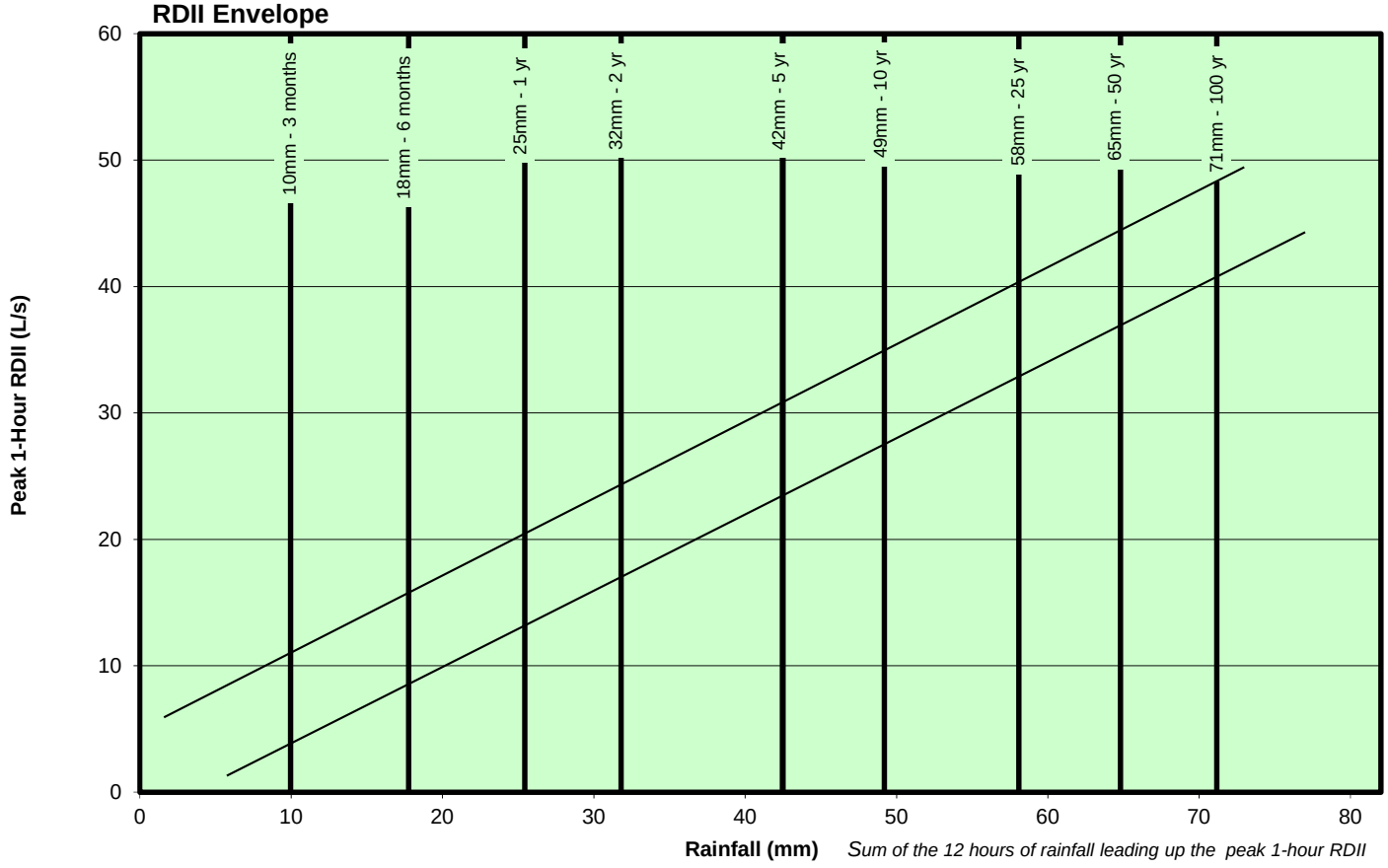
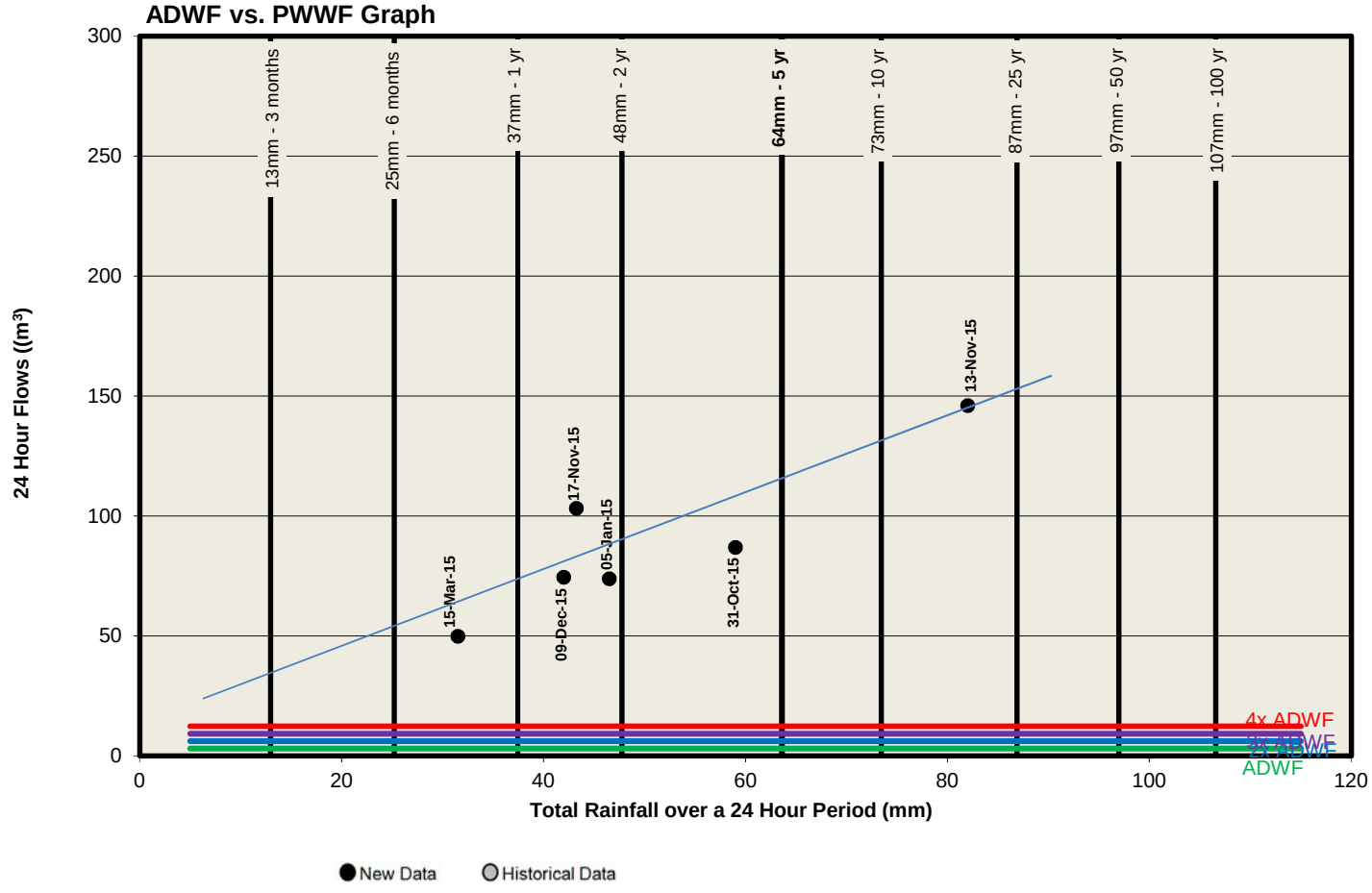
Canteen (ES29)

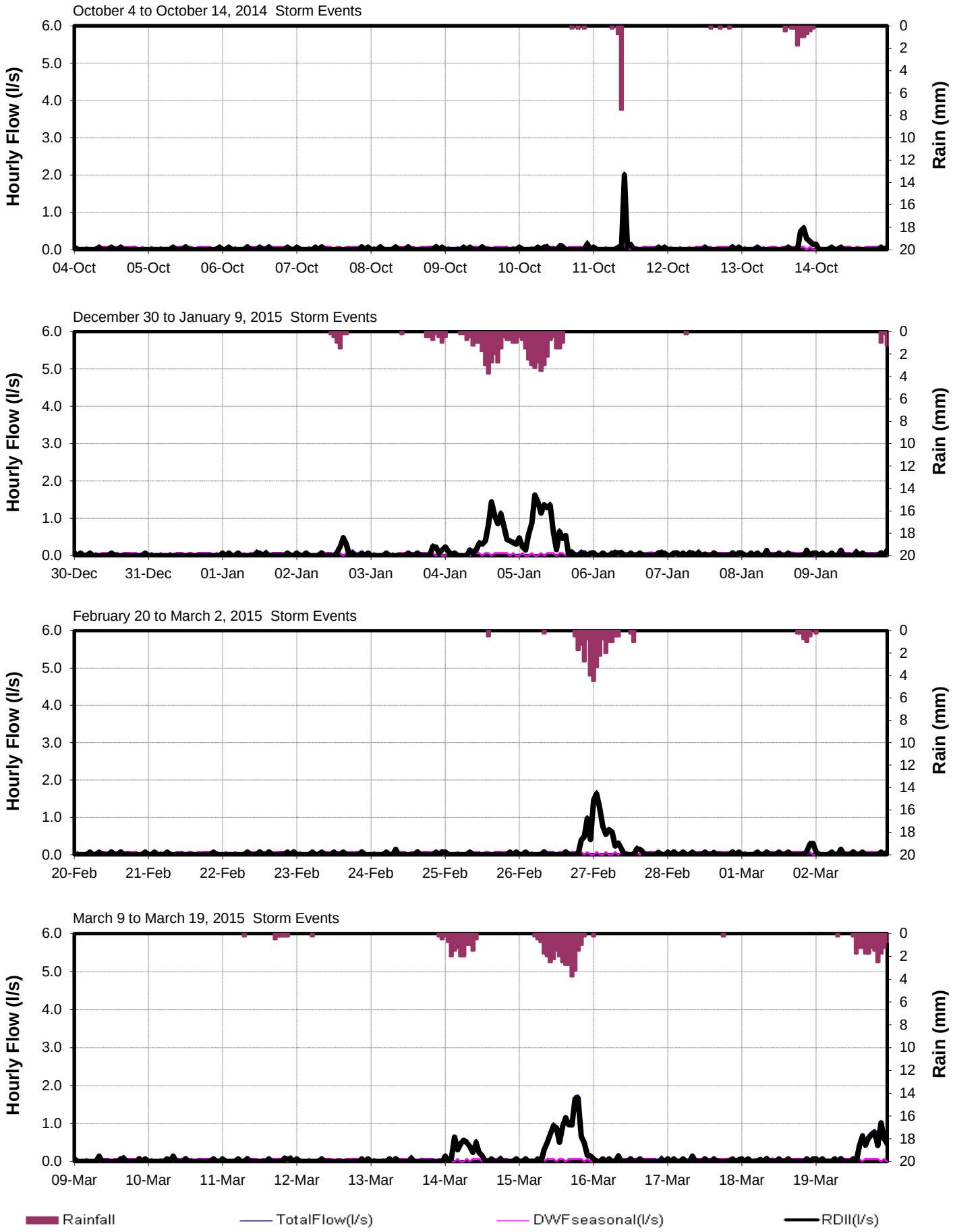
RDII Envelope



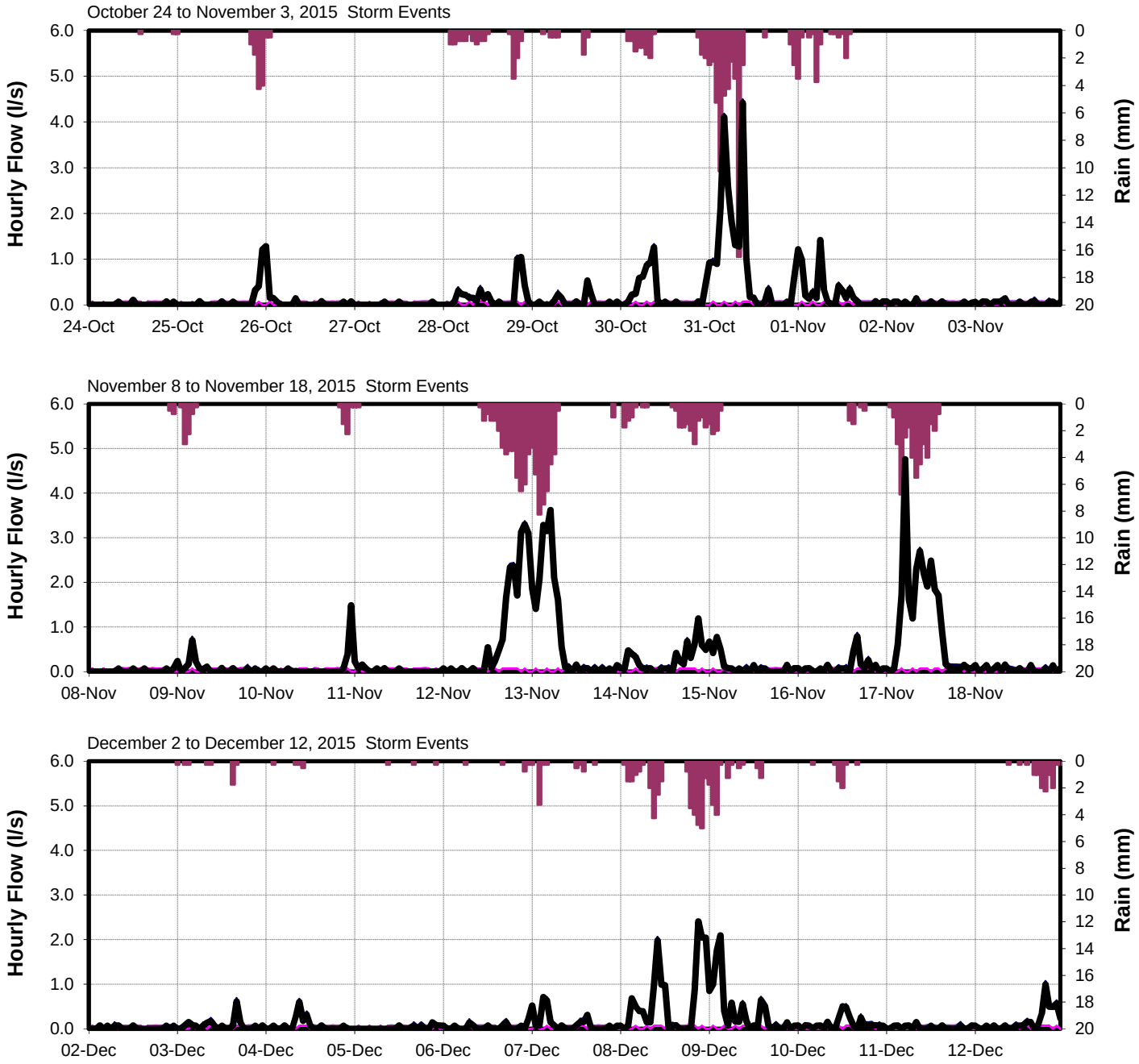
ADWF vs. PWWF Graph



Canteen (ES29)

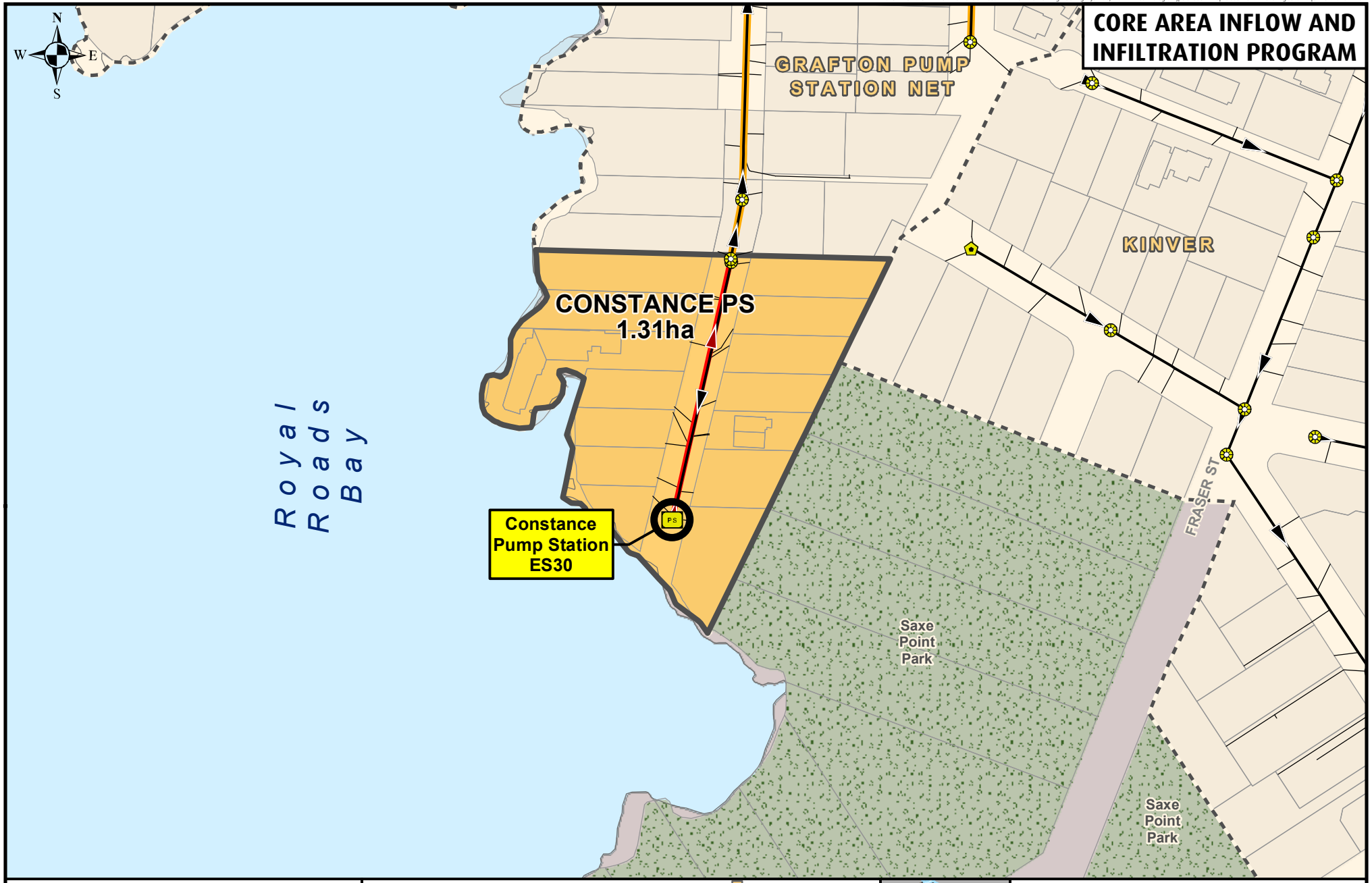


Canteen (ES29)



CRD - Parks & Environmental Services - Environmental Engineering - Jan 06, 2017 - Technologist: jpbezeau - Map Document: MeteringCatchEsquimalt2016.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Metres
0 50 100

Projection: UTM ZONE 10N, NAD83

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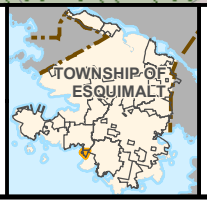

FLOW MONITORING AREA
Catchment: Constance Pump Station
Site Code: ES30

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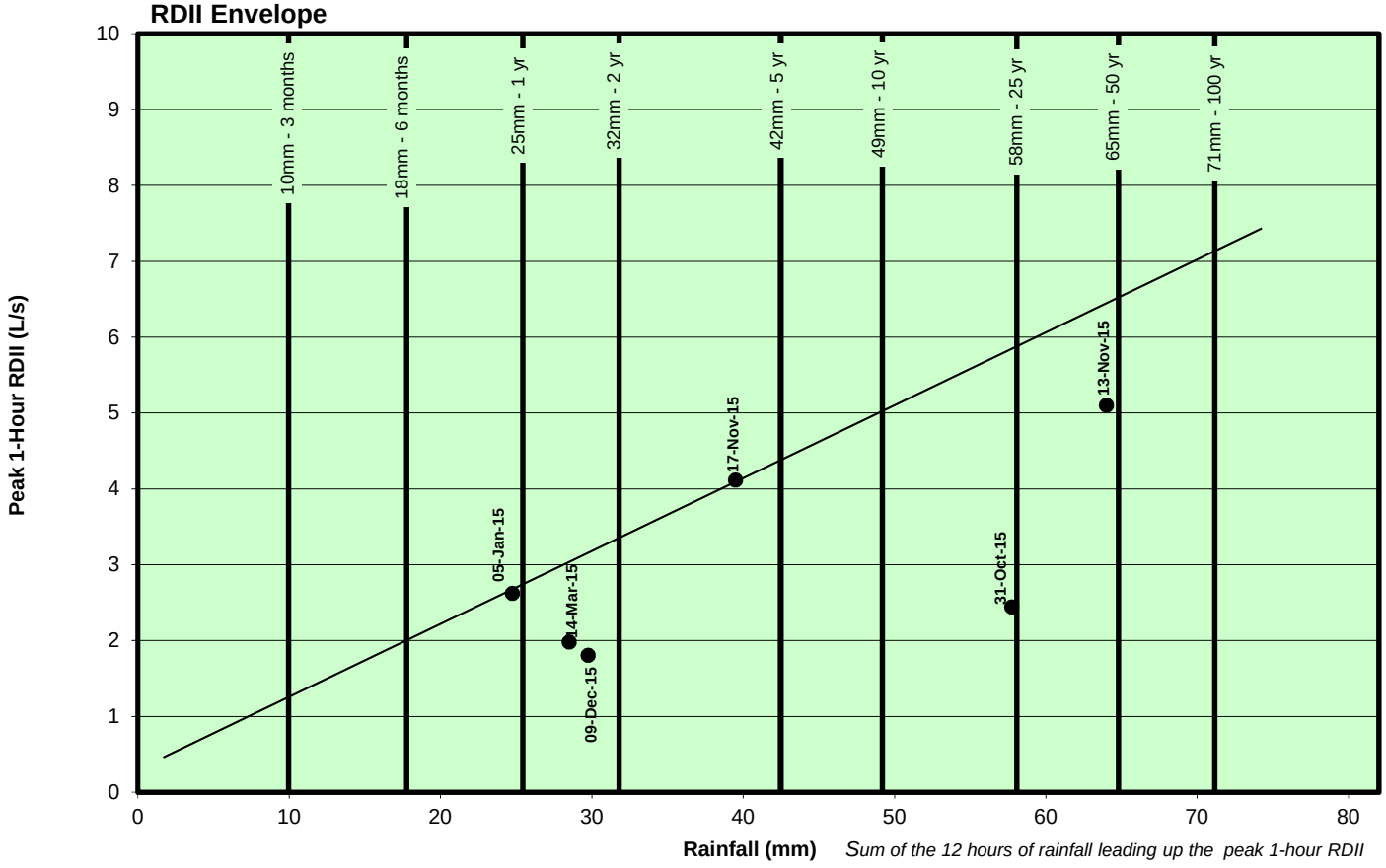
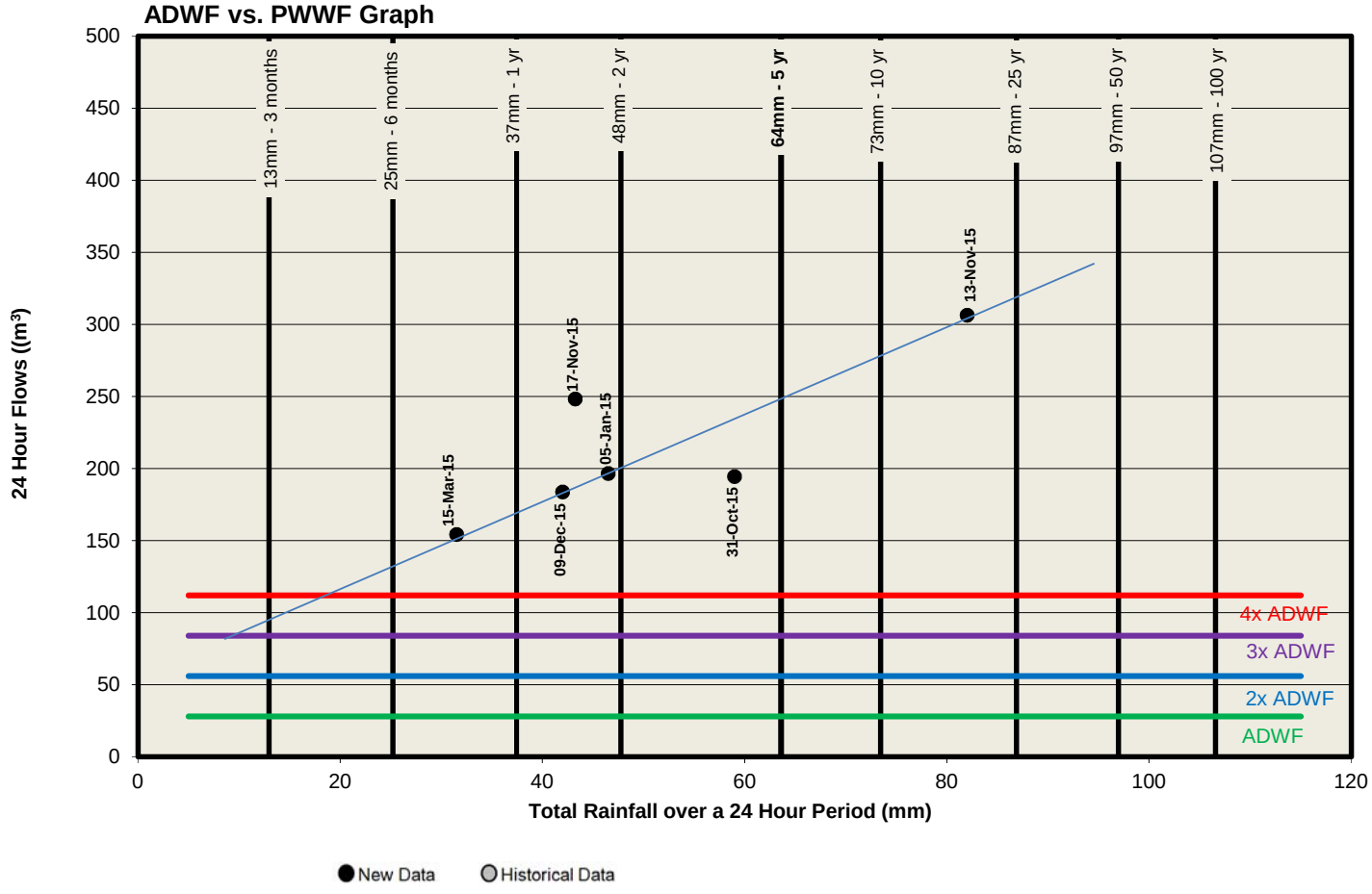
Constance (ES30)

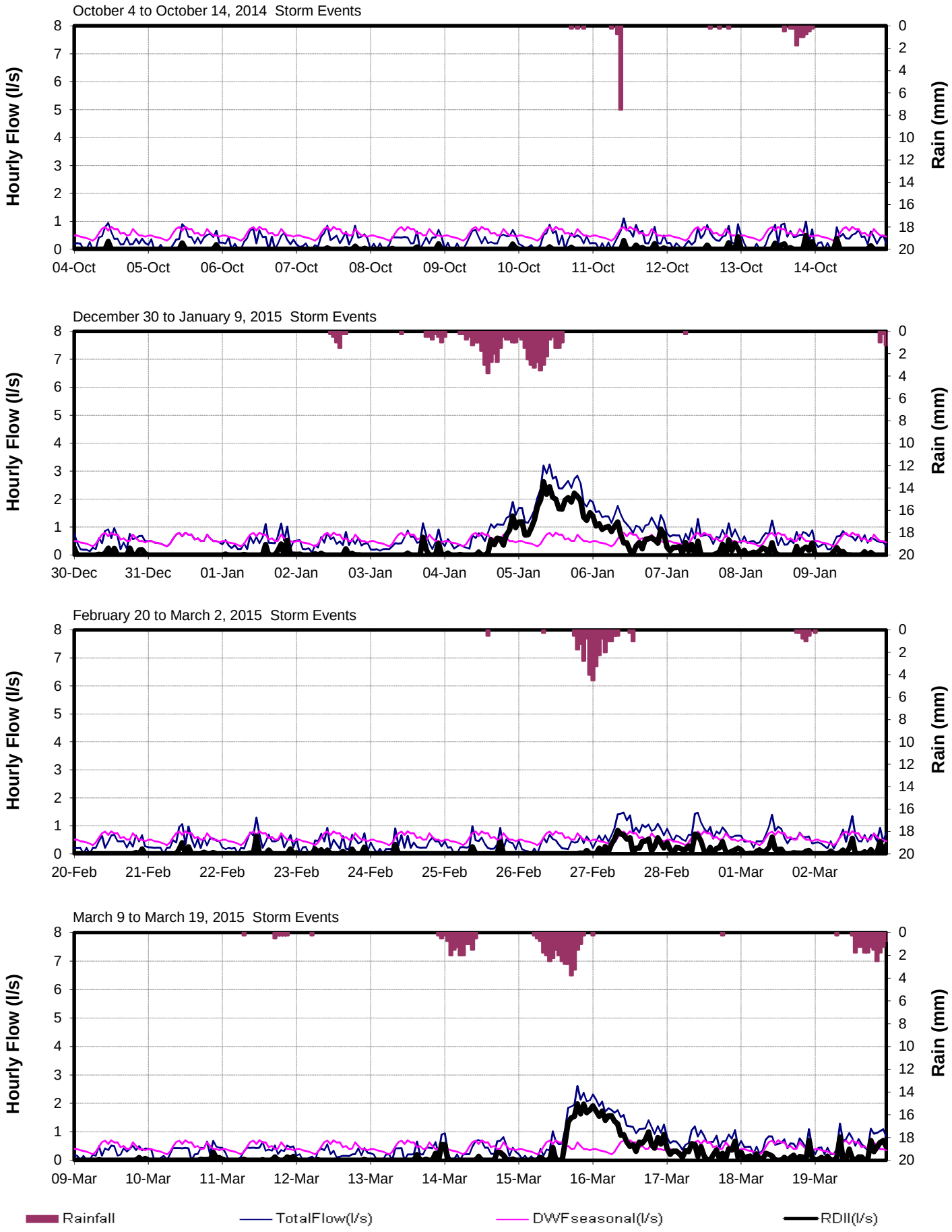
RDII Envelope



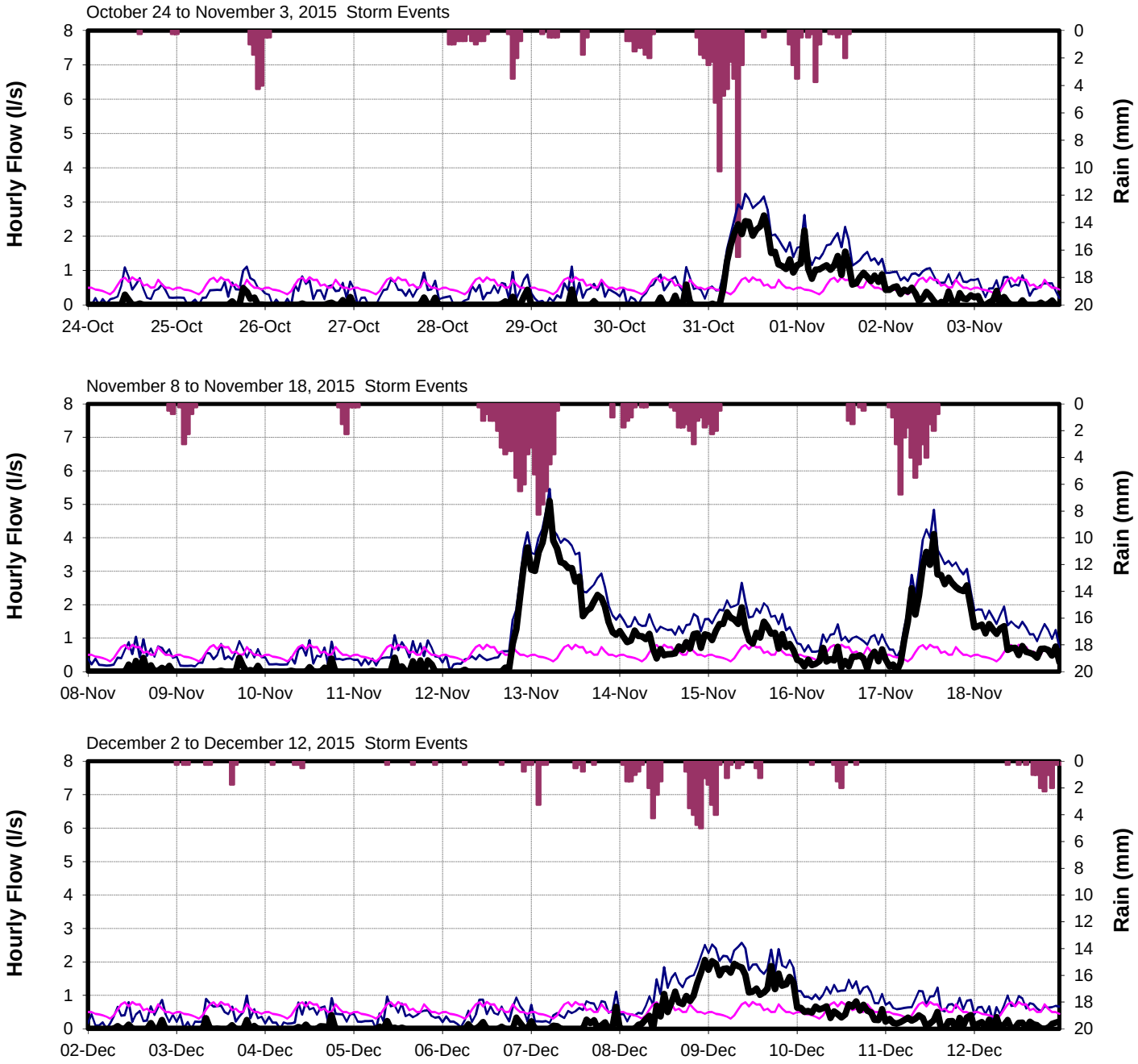
ADWF vs. PWWF Graph



Constance (ES30)

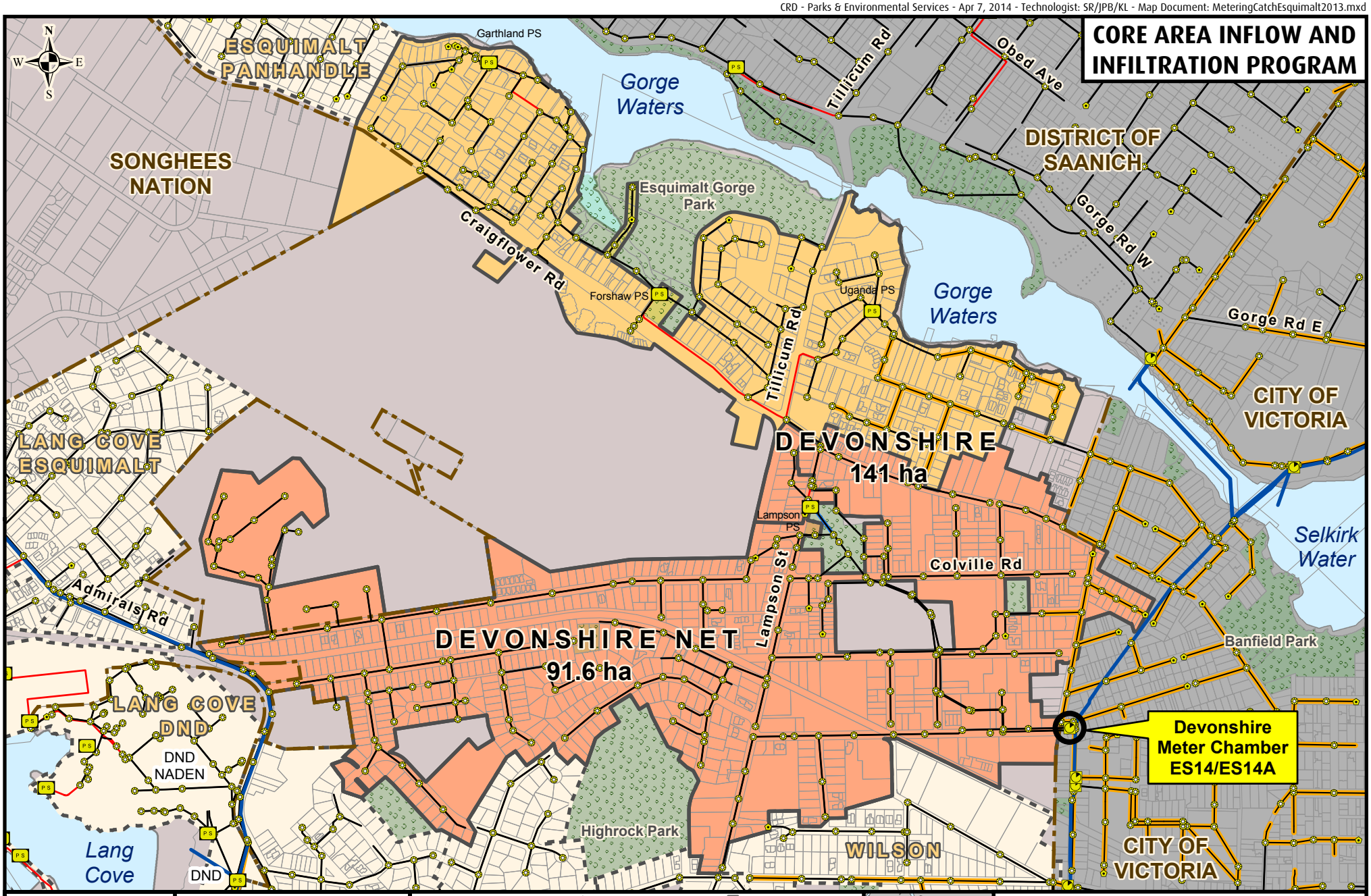


Constance (ES30)



CRD - Parks & Environmental Services - Apr 7, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchEsquimalt2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



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Metres
0 100 200 300

Projection: UTM ZONE 10N NAD 83

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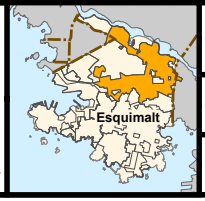


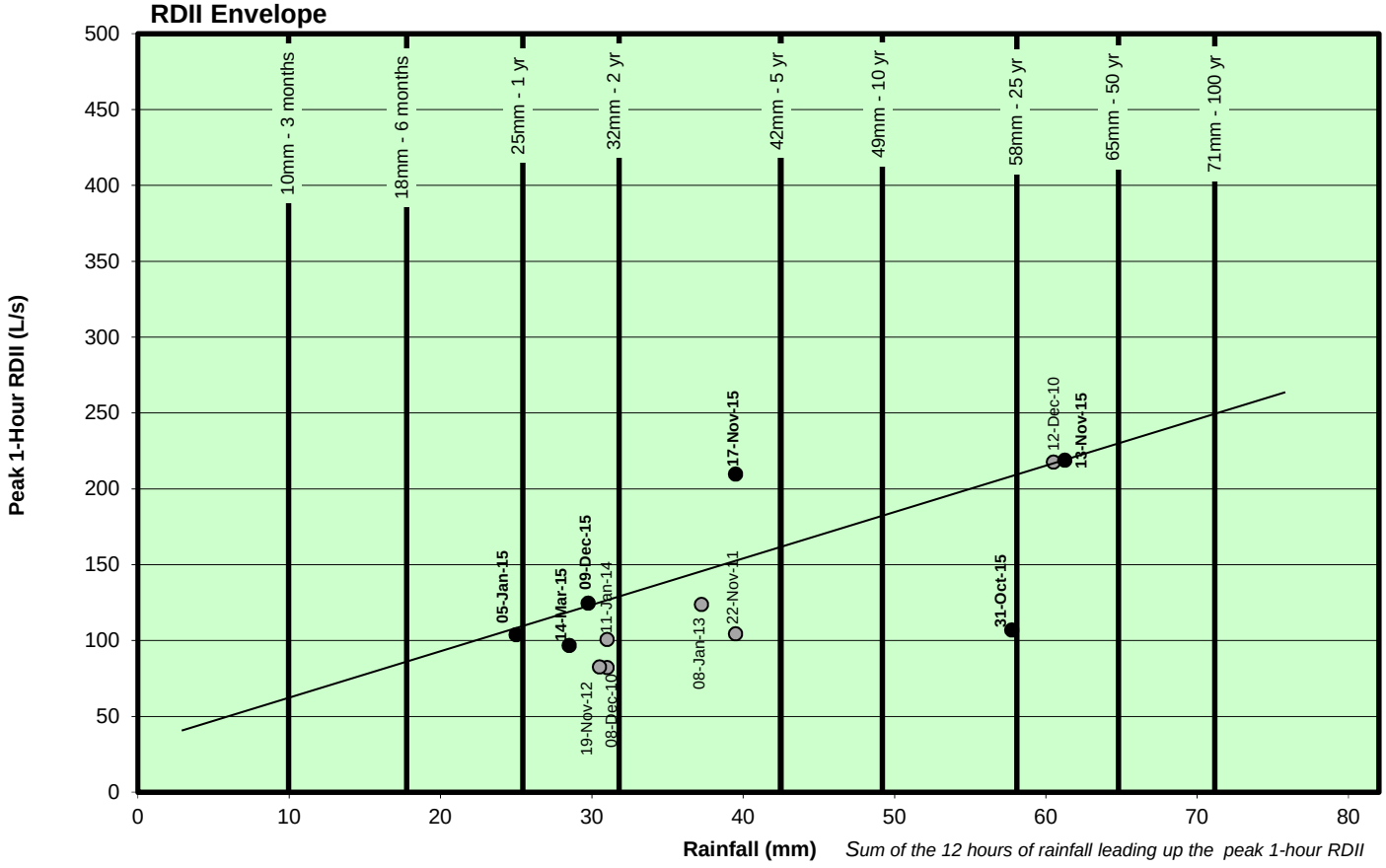
FLOW MONITORING AREA

CATCHMENT: DEVONSHIRE/DEVONSHIRE NET

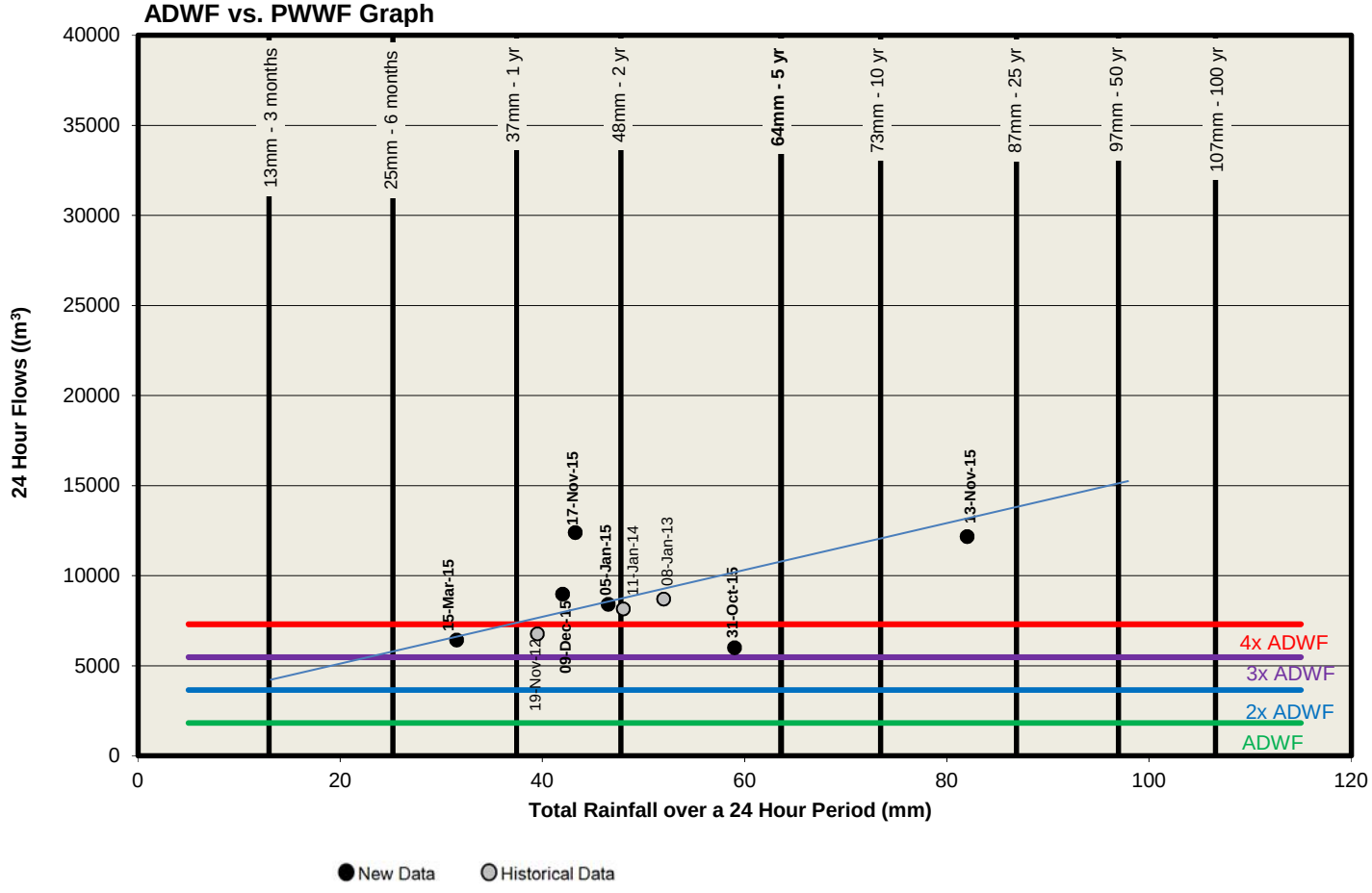
SITE CODE: **ES14/ES14A**

Devonshire (ES14)

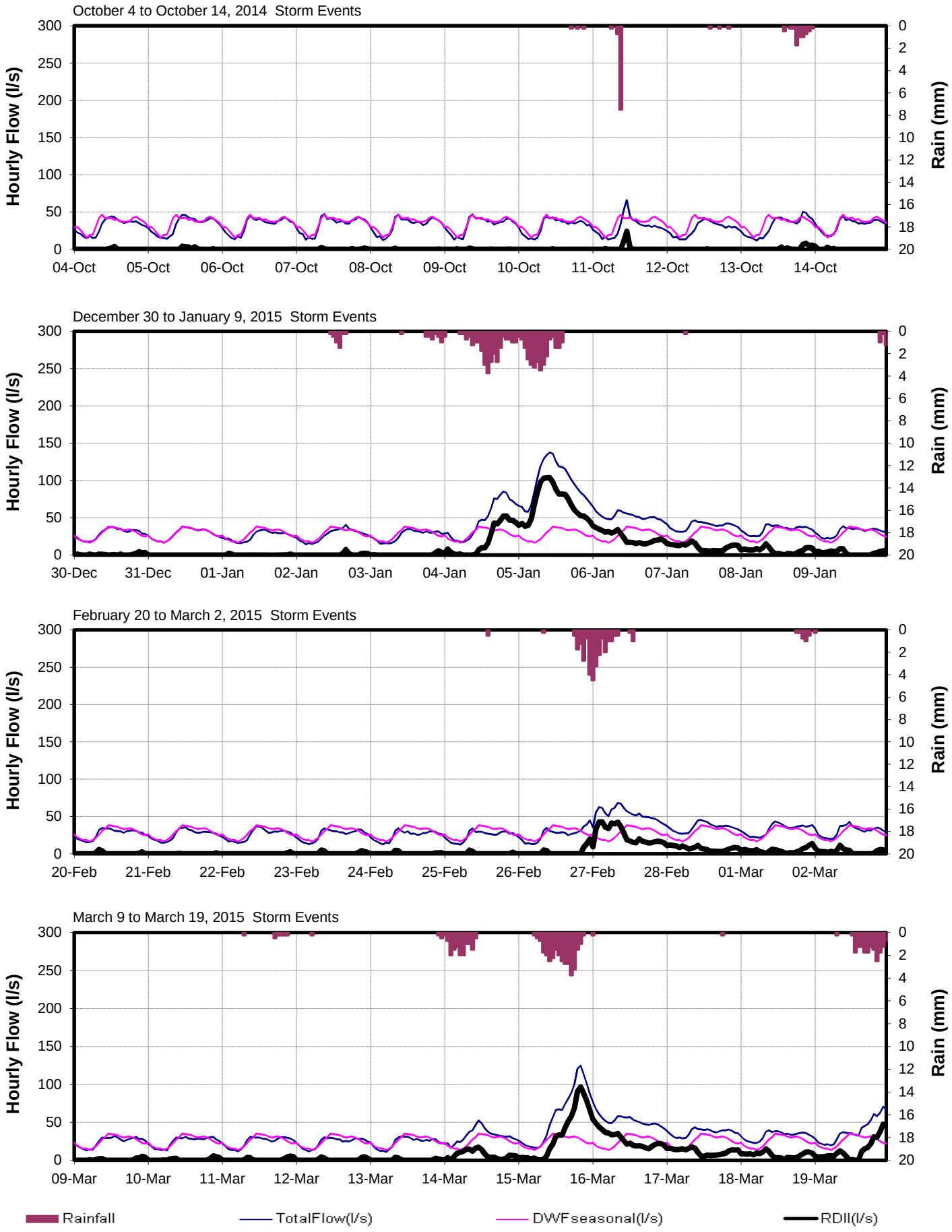
RDII Envelope



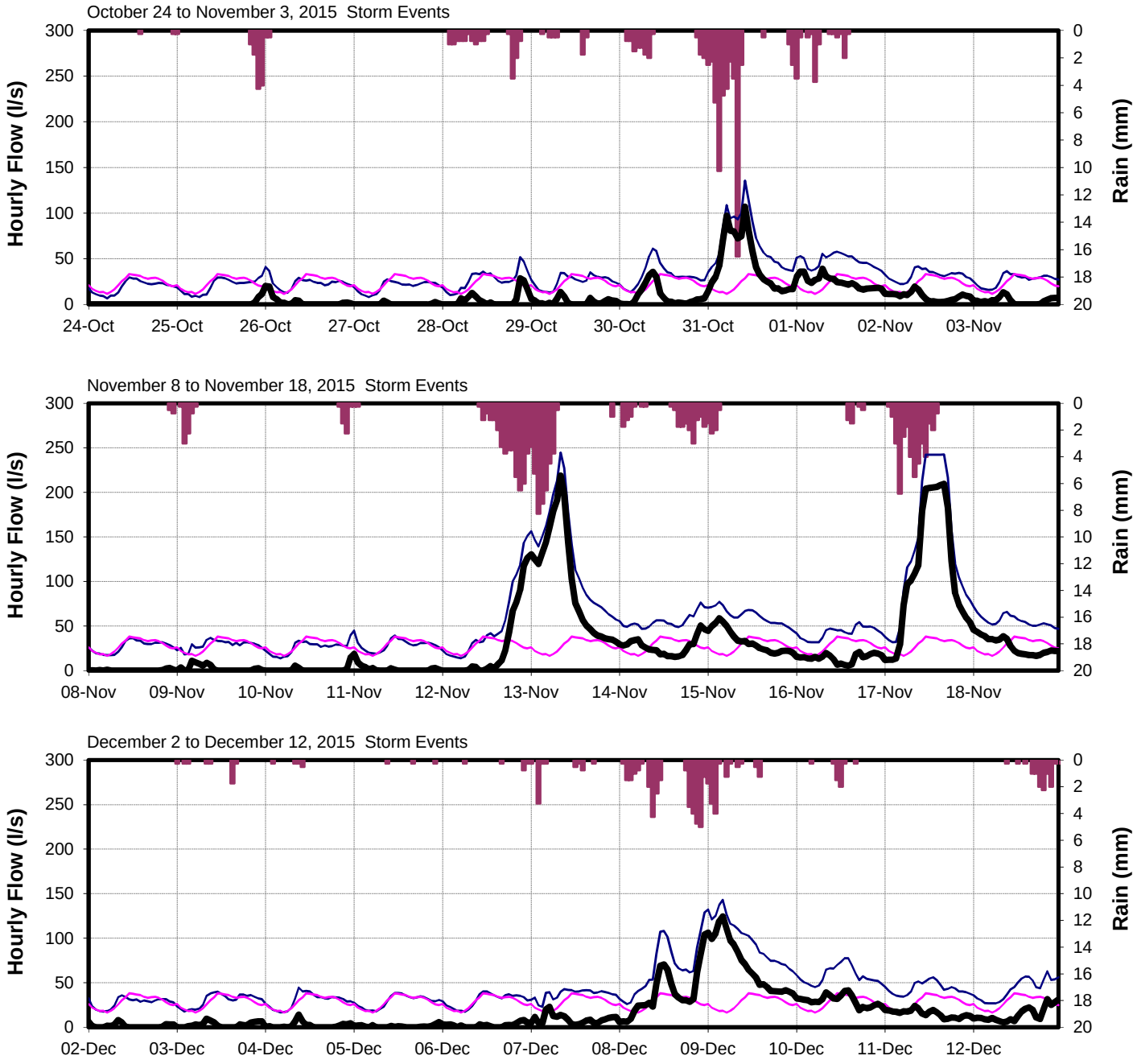
ADWF vs. PWWF Graph



Devonshire (ES14)

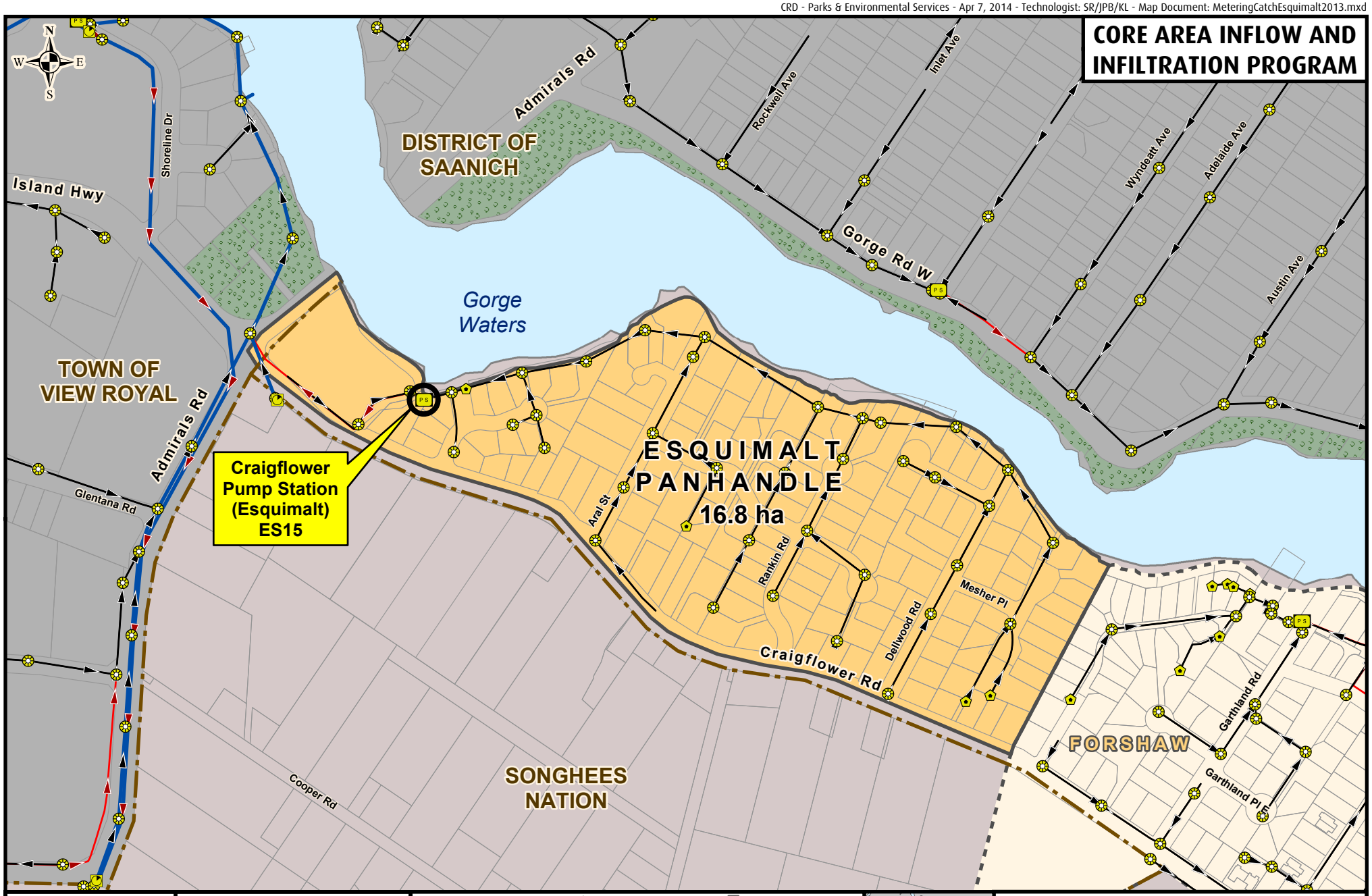


Devonshire (ES14)



CRD - Parks & Environmental Services - Apr 7, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchEsquimalt2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100 150

Projection: UTM ZONE 10N NAD 83

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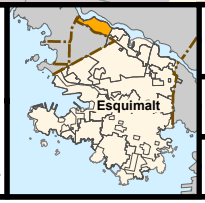
- Sewered Park Areas
- Catchment Boundary Municipal, First Nation, or DND Boundaries

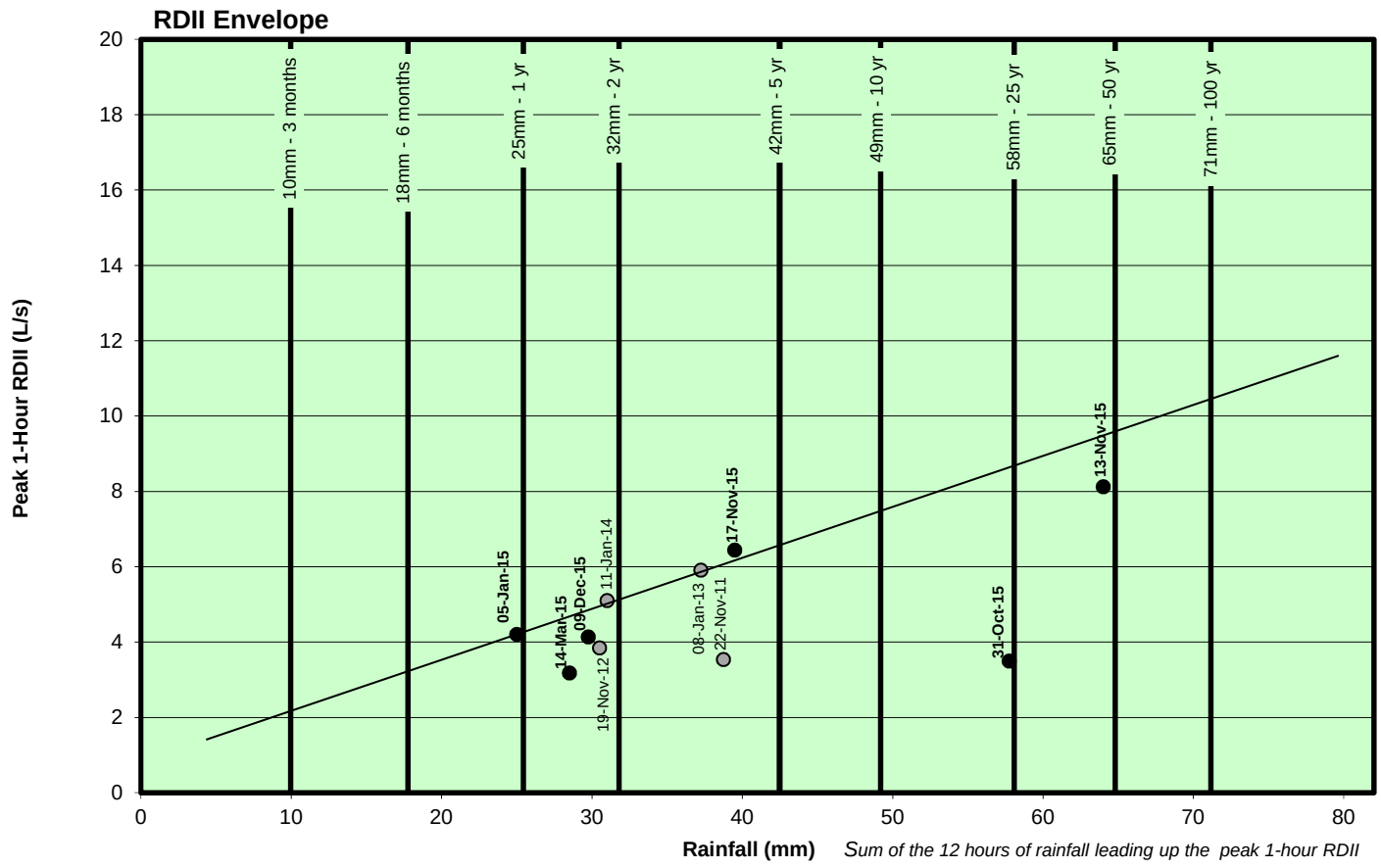


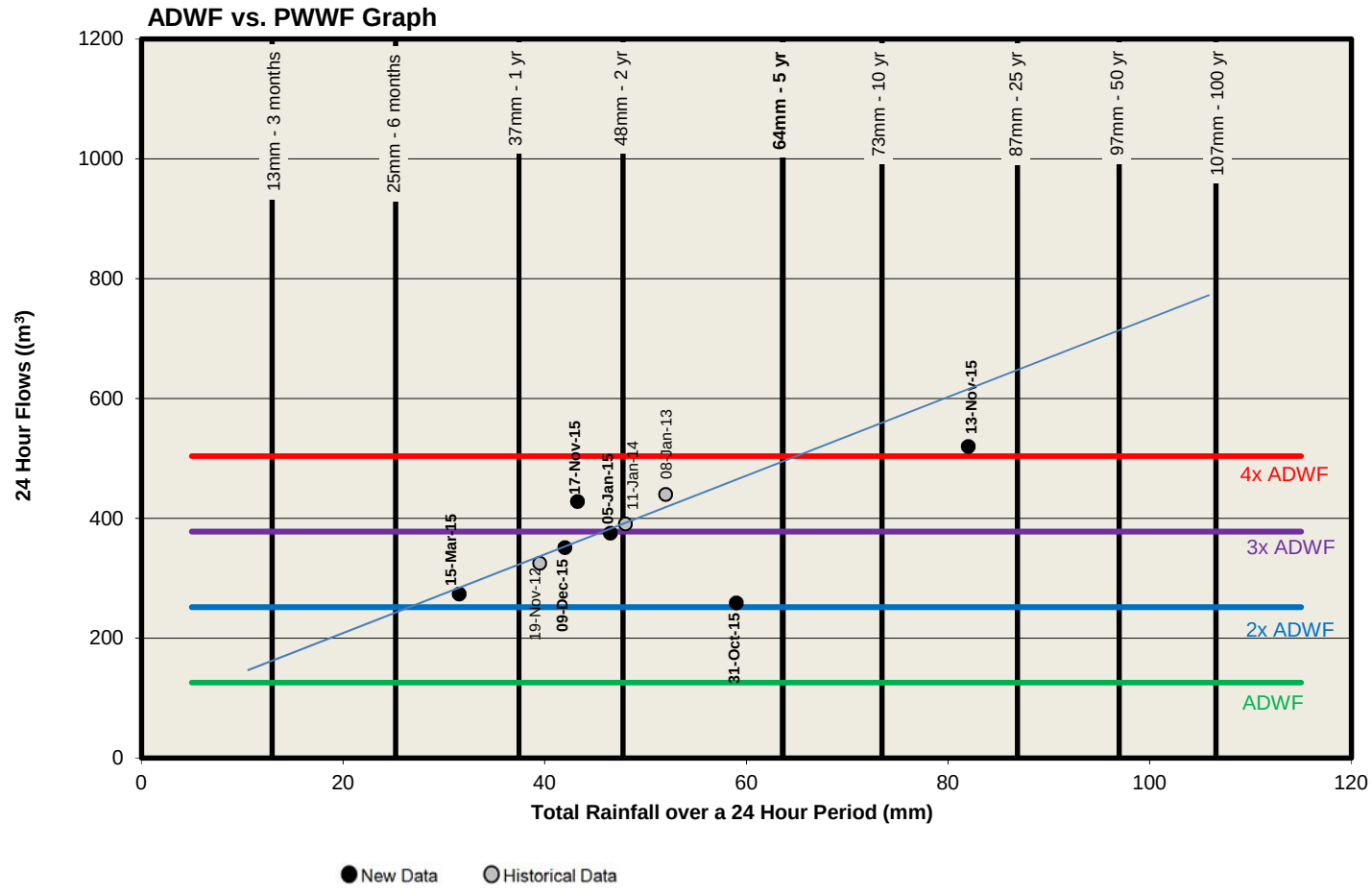
FLOW MONITORING AREA

CATCHMENT: ESQUIMALT PANHANDLE

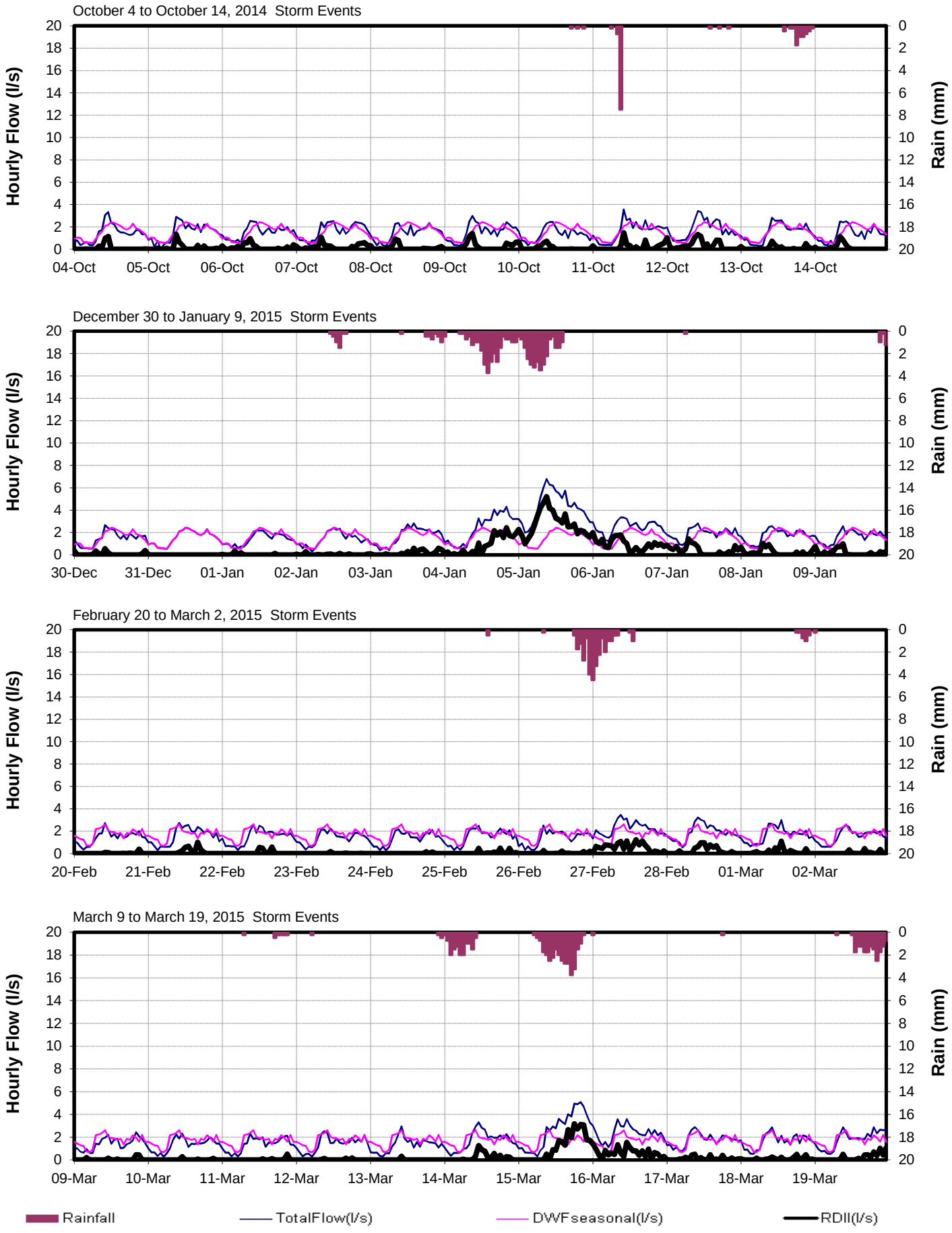
SITE CODE: **ES15**

Esquimalt Panhandle (ES15)

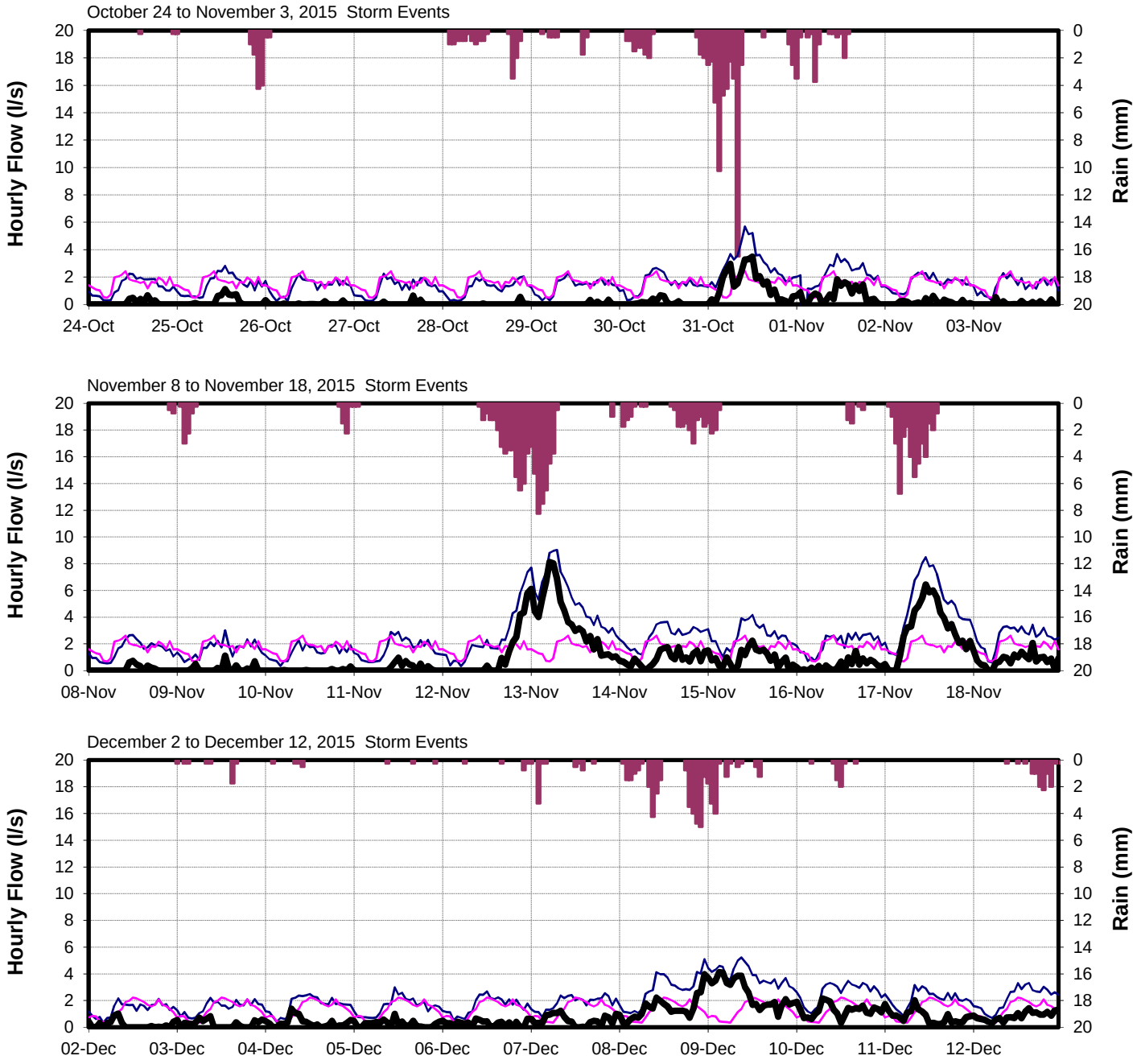




Esquimalt Panhandle (ES15)

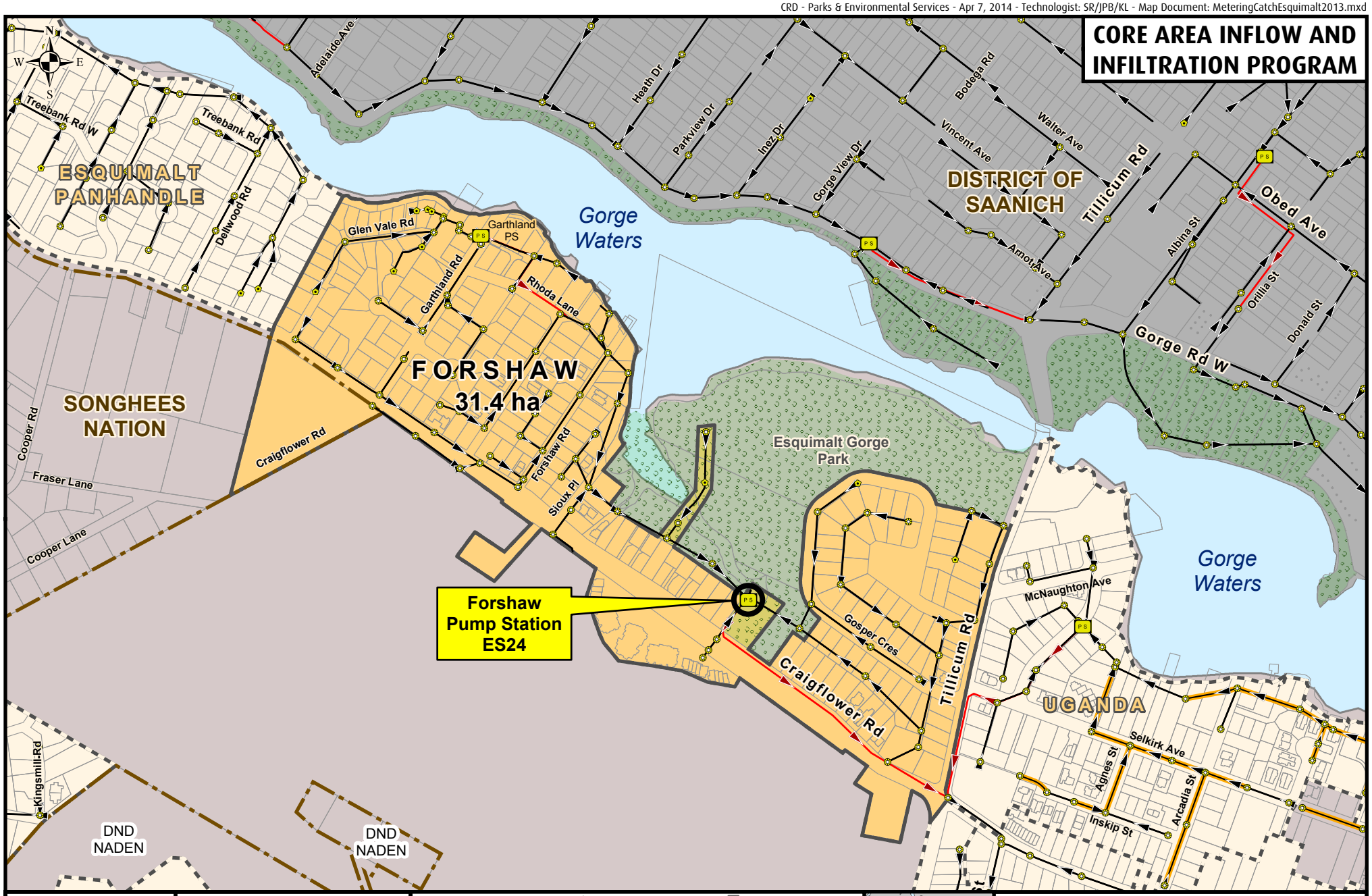


Esquimalt Panhandle (ES15)



CRD - Parks & Environmental Services - Apr 7, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchEsquimalt2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100 150 200

Projection: UTM ZONE 10N NAD 83

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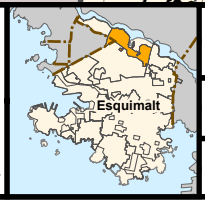


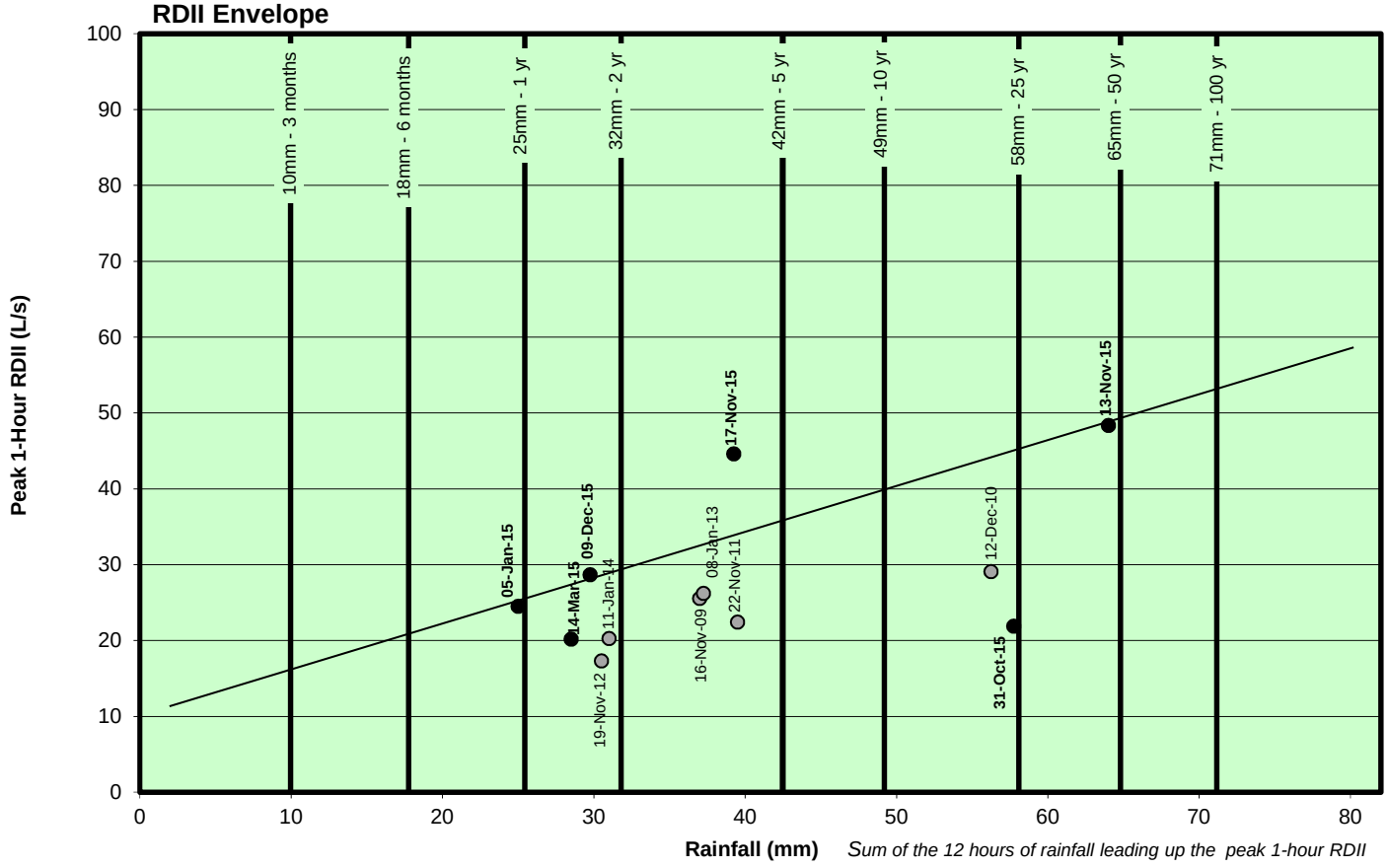
FLOW MONITORING AREA

CATCHMENT: FORSHAW

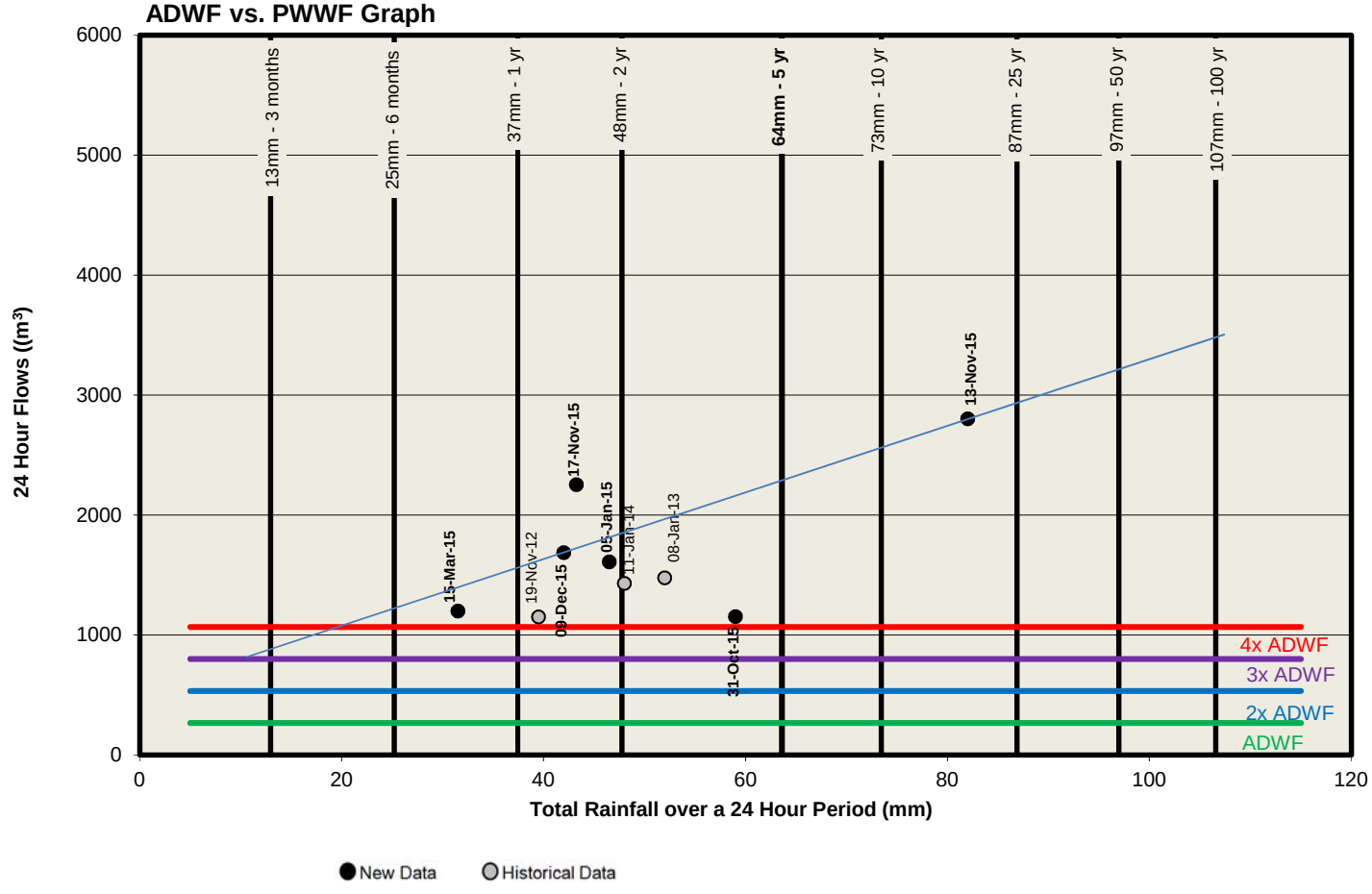
SITE CODE: **ES24**

Foreshaw (ES24)

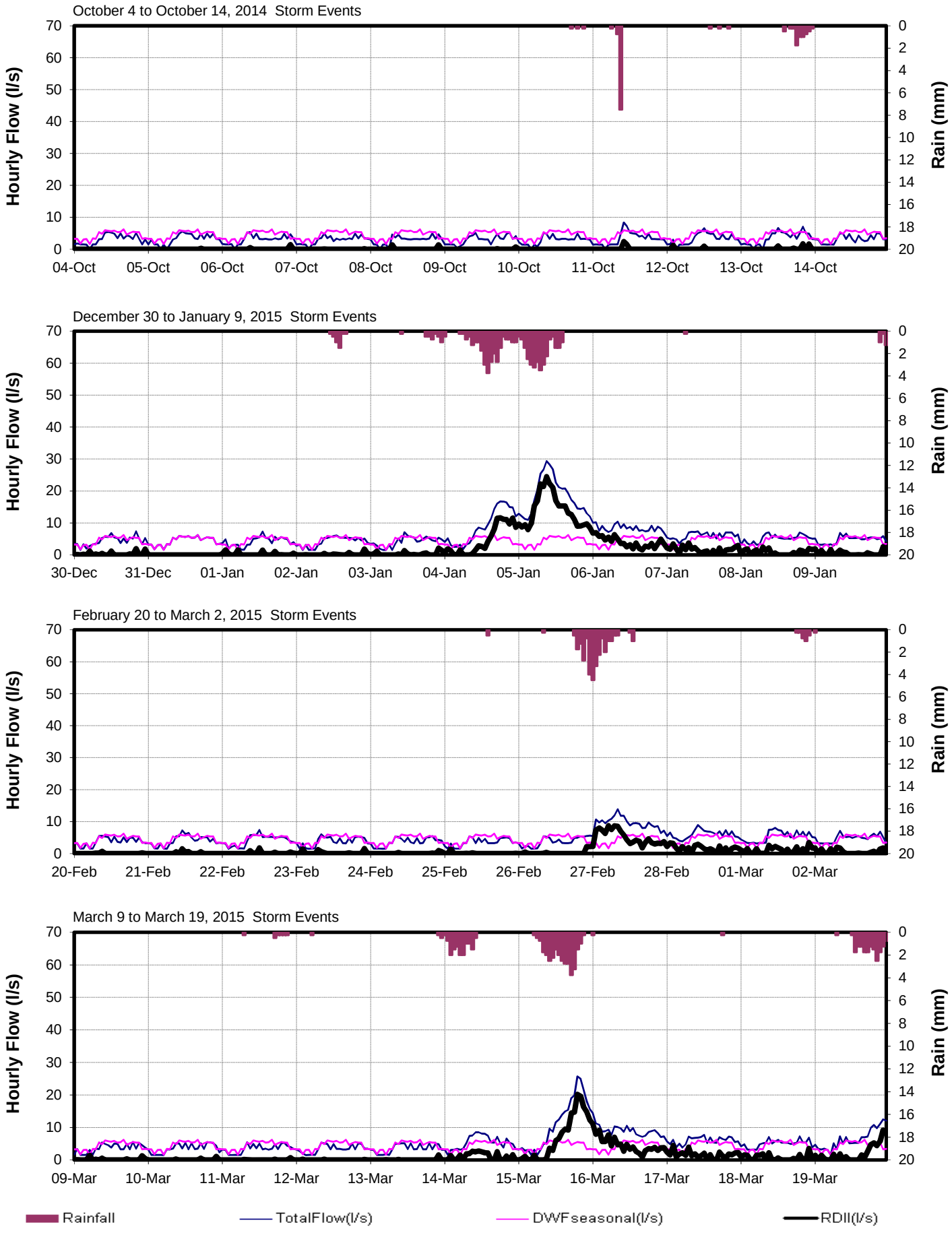
RDII Envelope



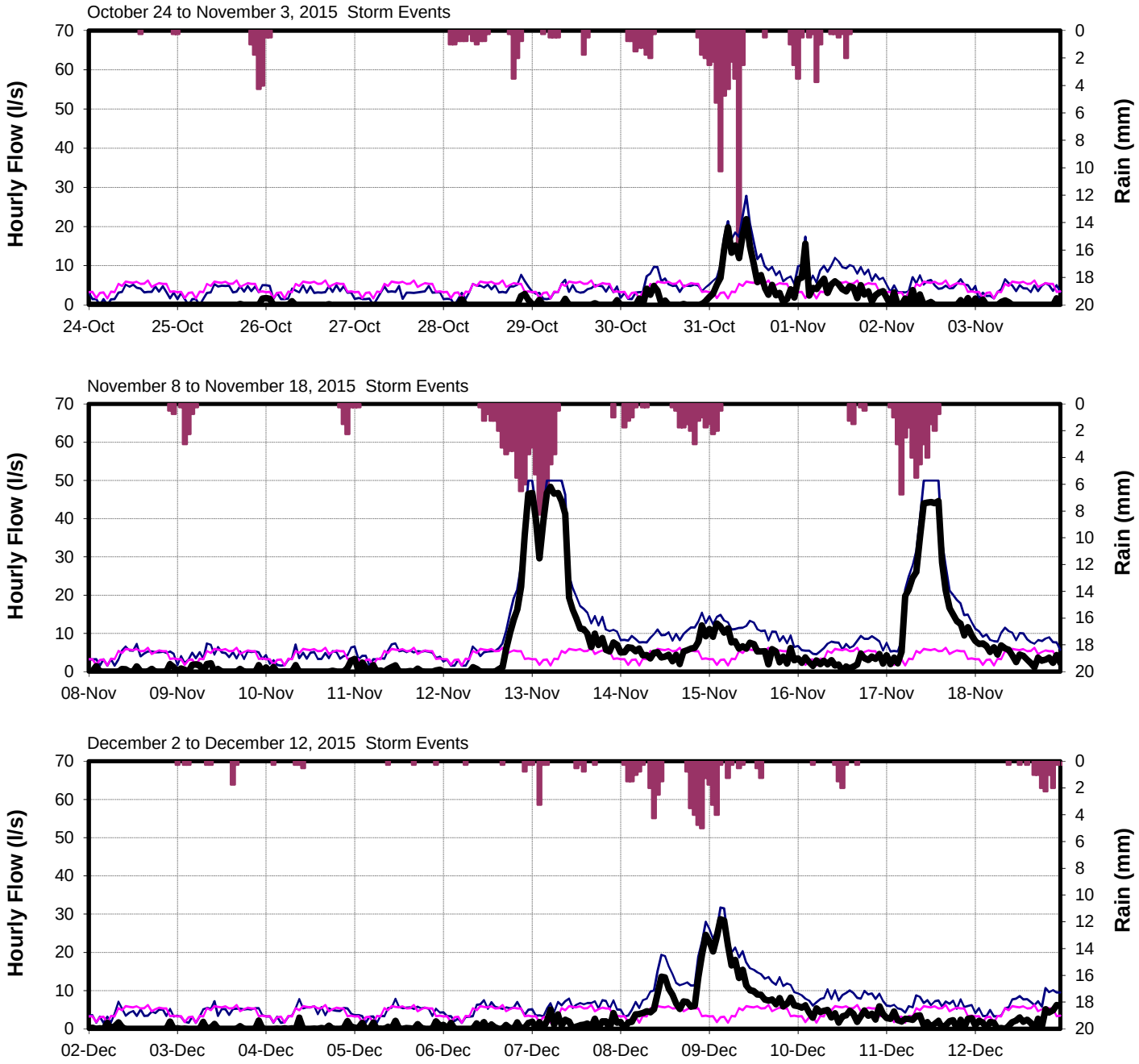
ADWF vs. PWWF Graph



Foreshaw (ES24)

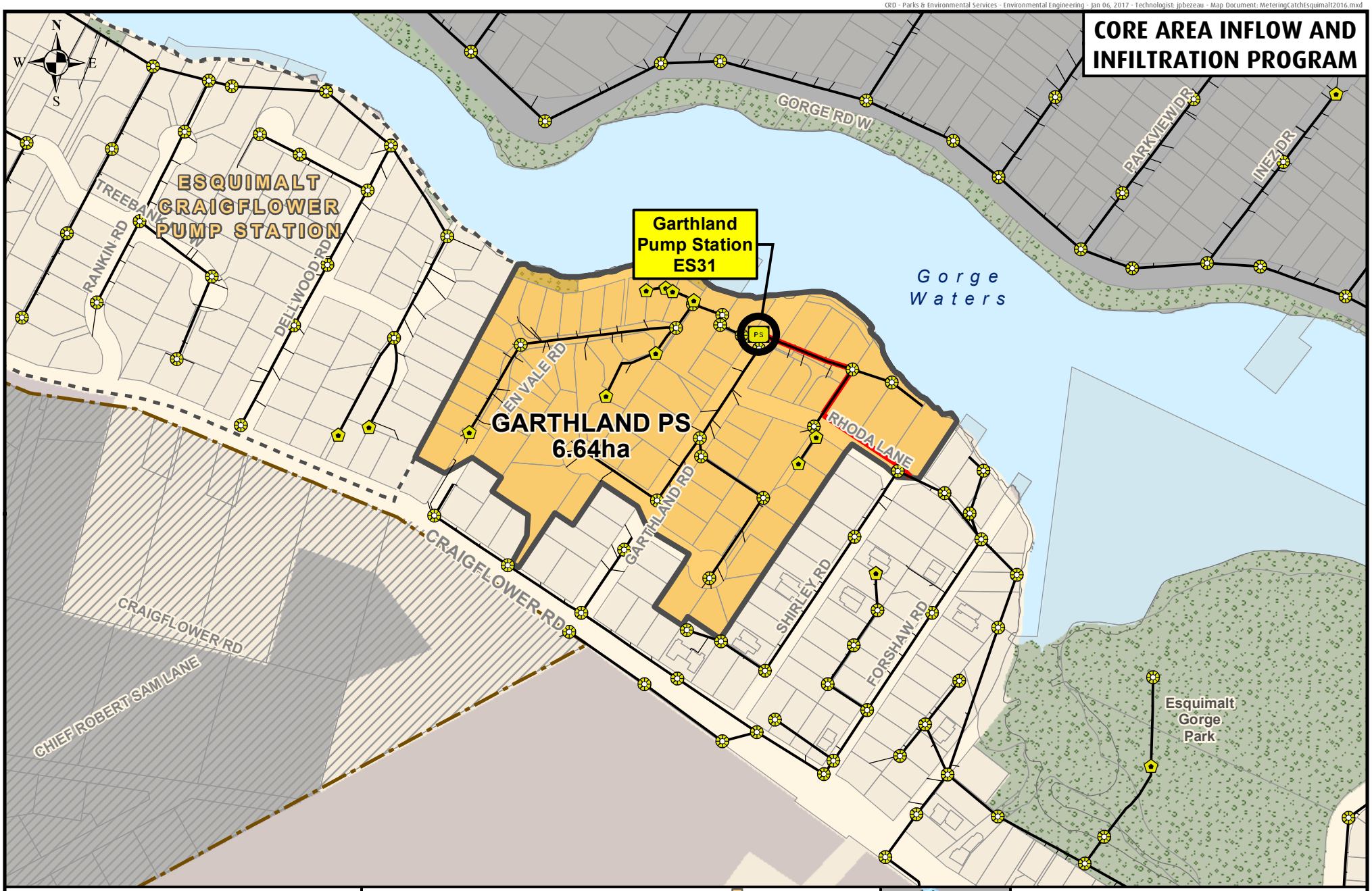


Foreshaw (ES24)



CRD - Parks & Environmental Services - Environmental Engineering - Jan 06, 2017 - Technologist: jpbezeau - Map Document: MeteringCatchEsquimalt2016.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Metres
0 50 100

Projection: UTM ZONE 10N, NAD83

Disclaimer
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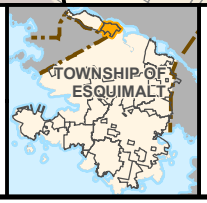

FLOW MONITORING AREA
Catchment: Garthland Pump Station
Site Code: ES31

CRD
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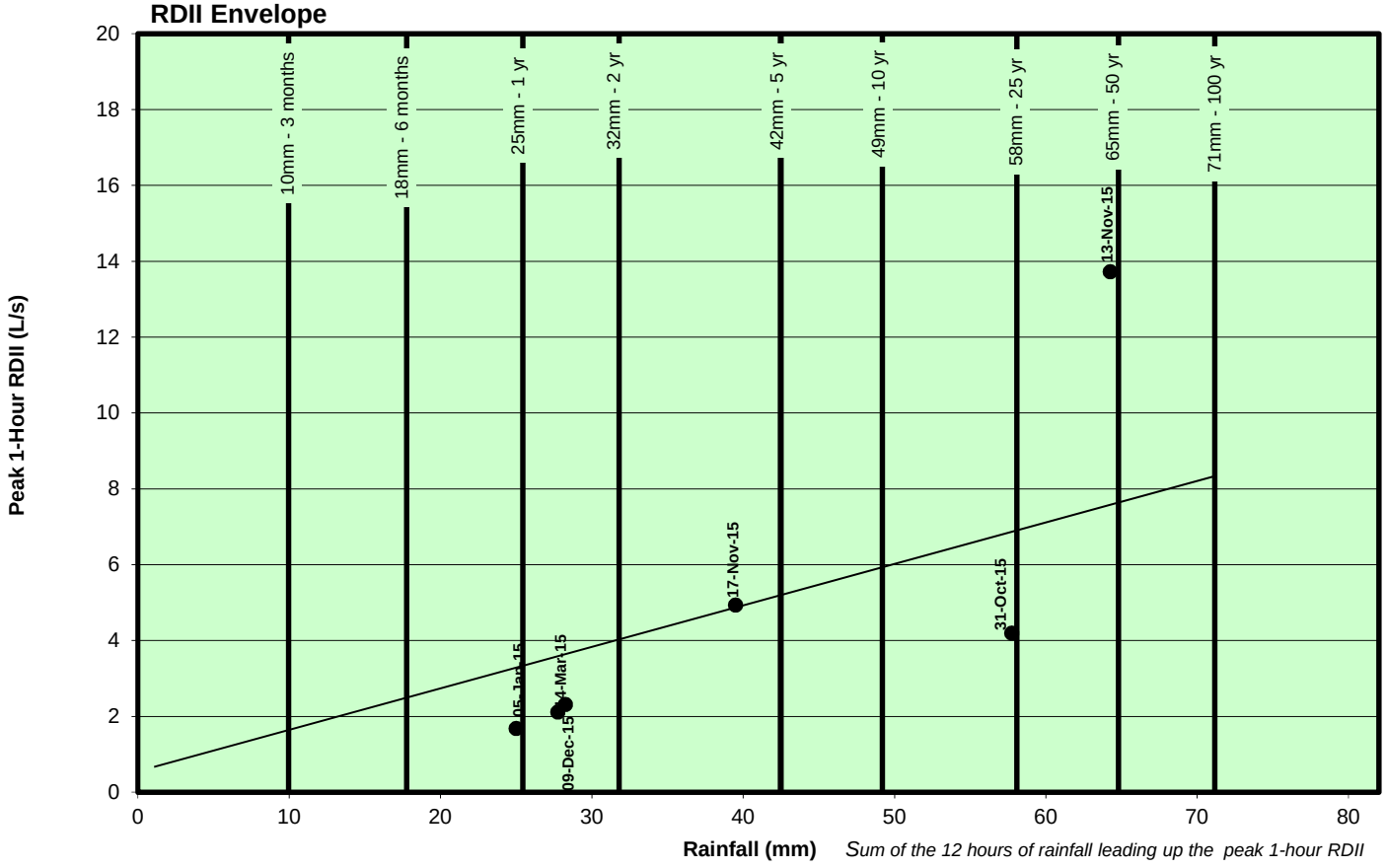
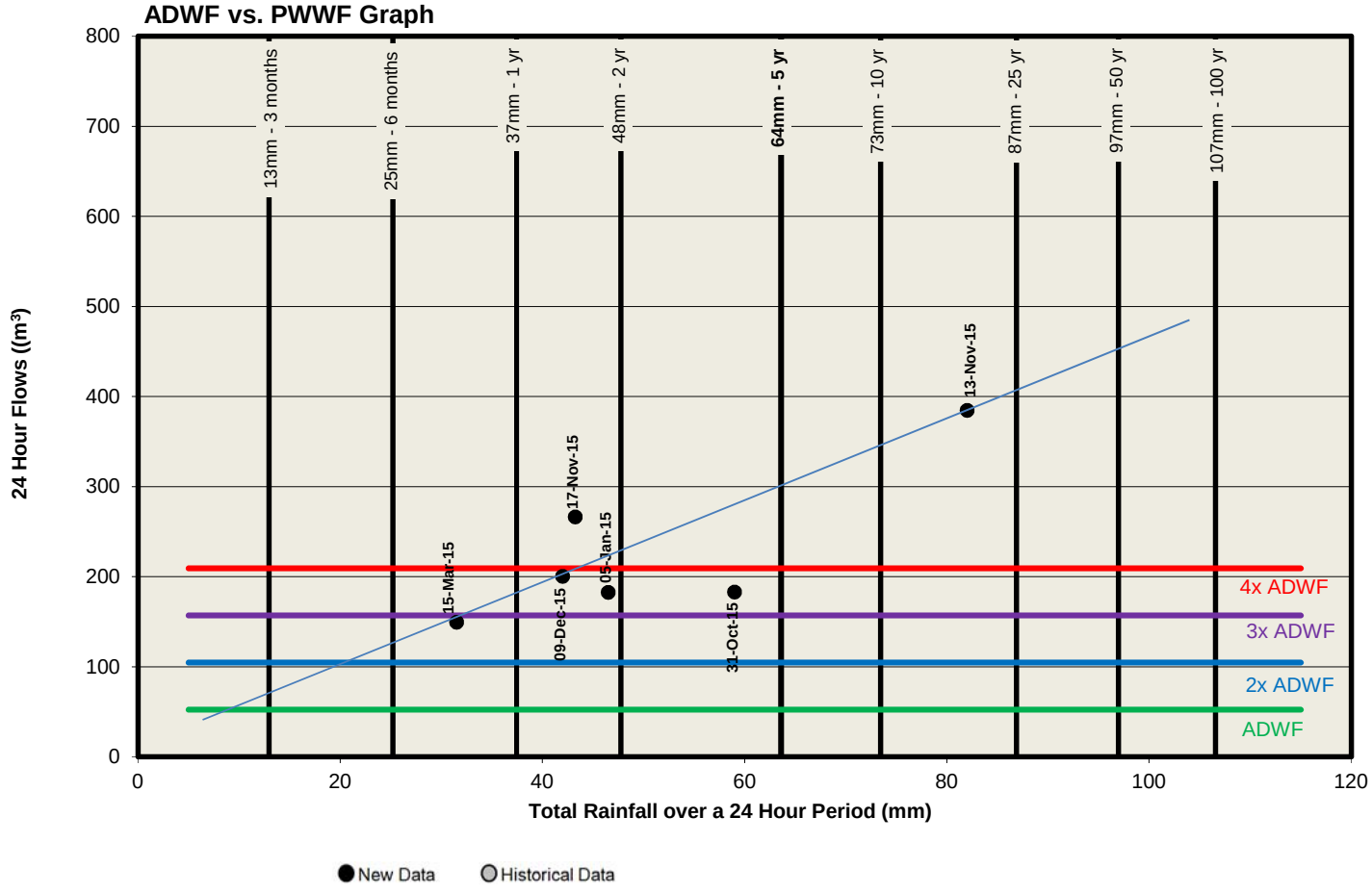
Garthland (ES31)

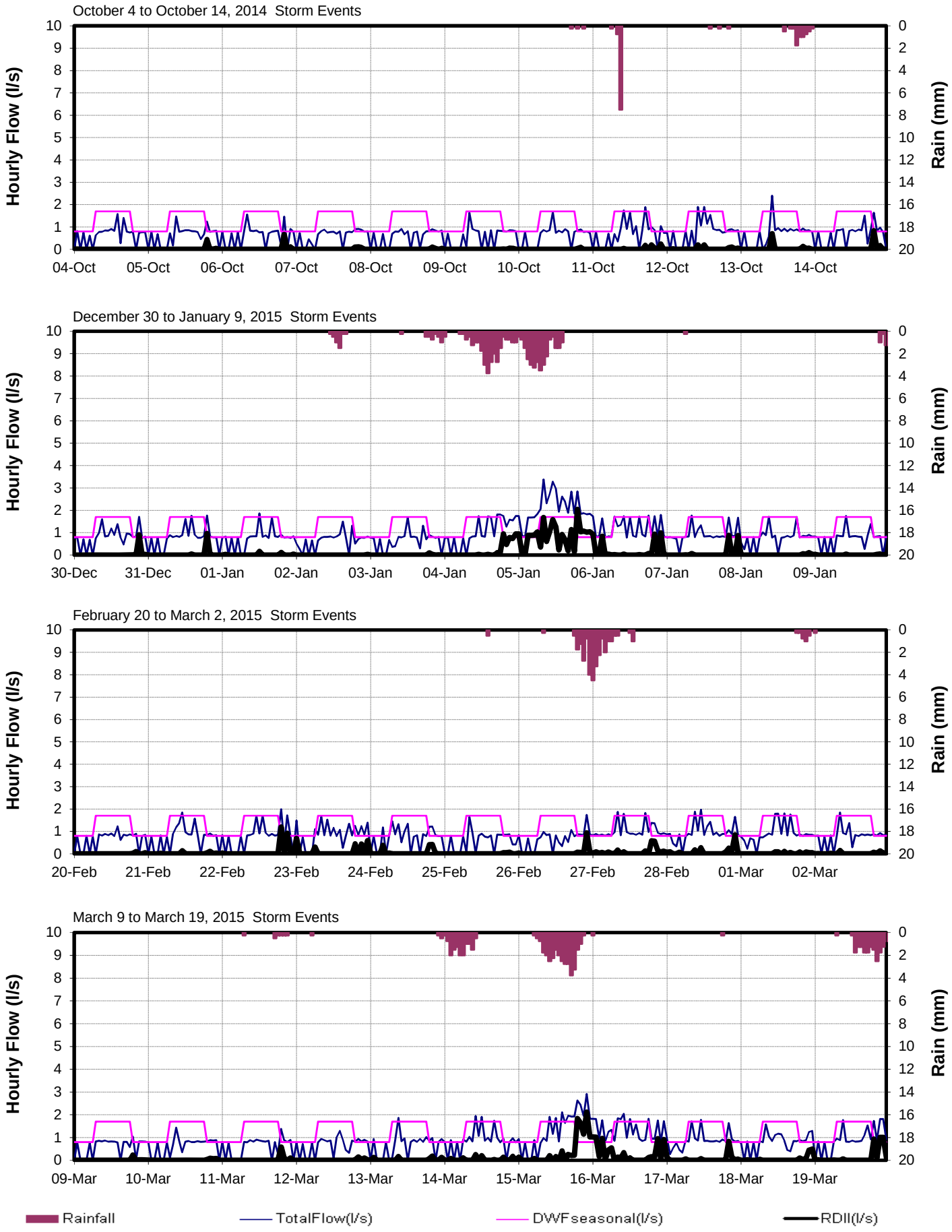
RDII Envelope



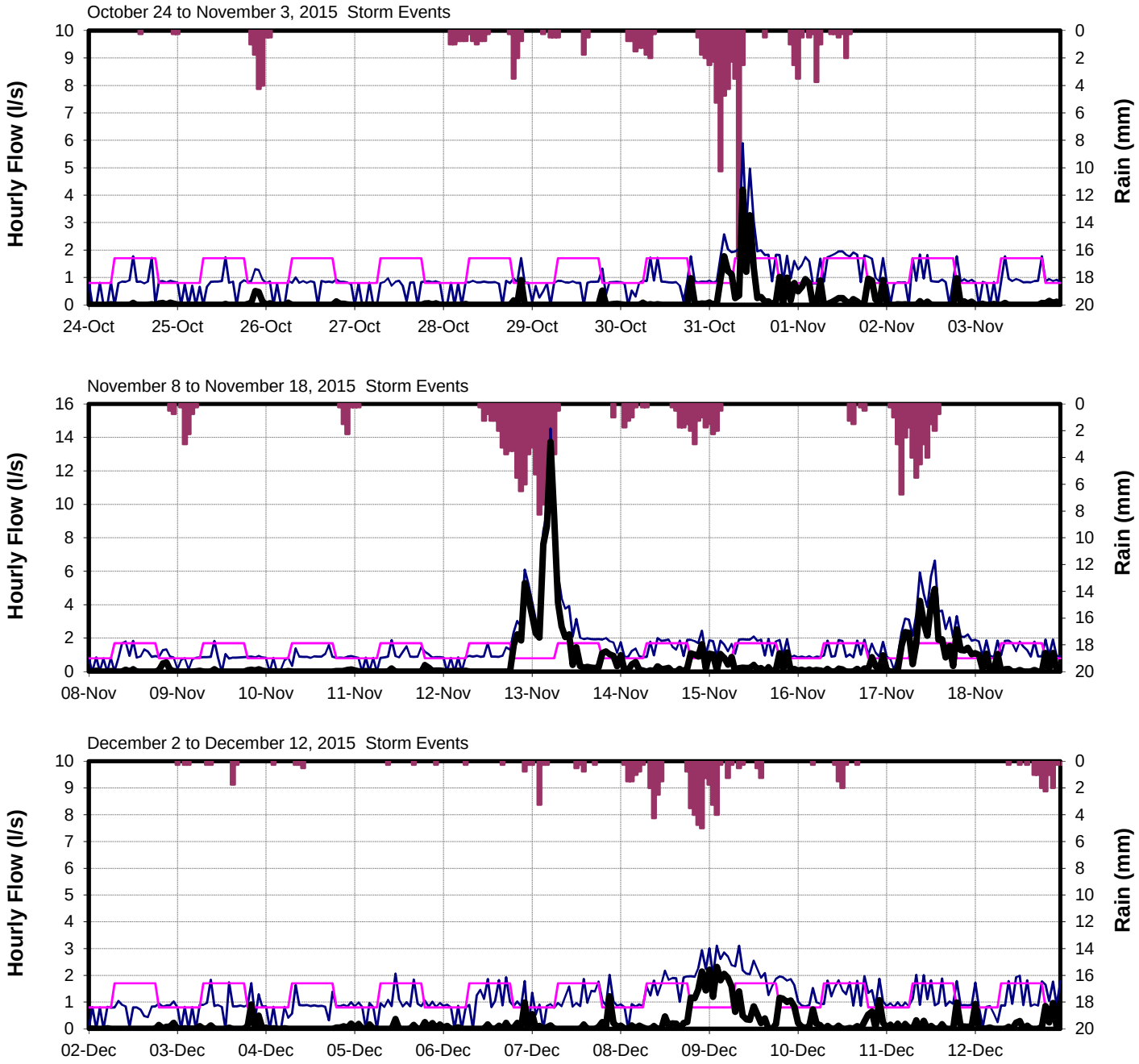
ADWF vs. PWWF Graph



Garthland (ES31)



Garthland (ES31)



CRD - Parks & Environmental Services - Apr 7, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchEsquimalt2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



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Metres
0 50 100 150

Projection: UTM ZONE 10N NAD 83

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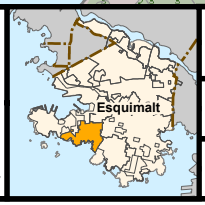


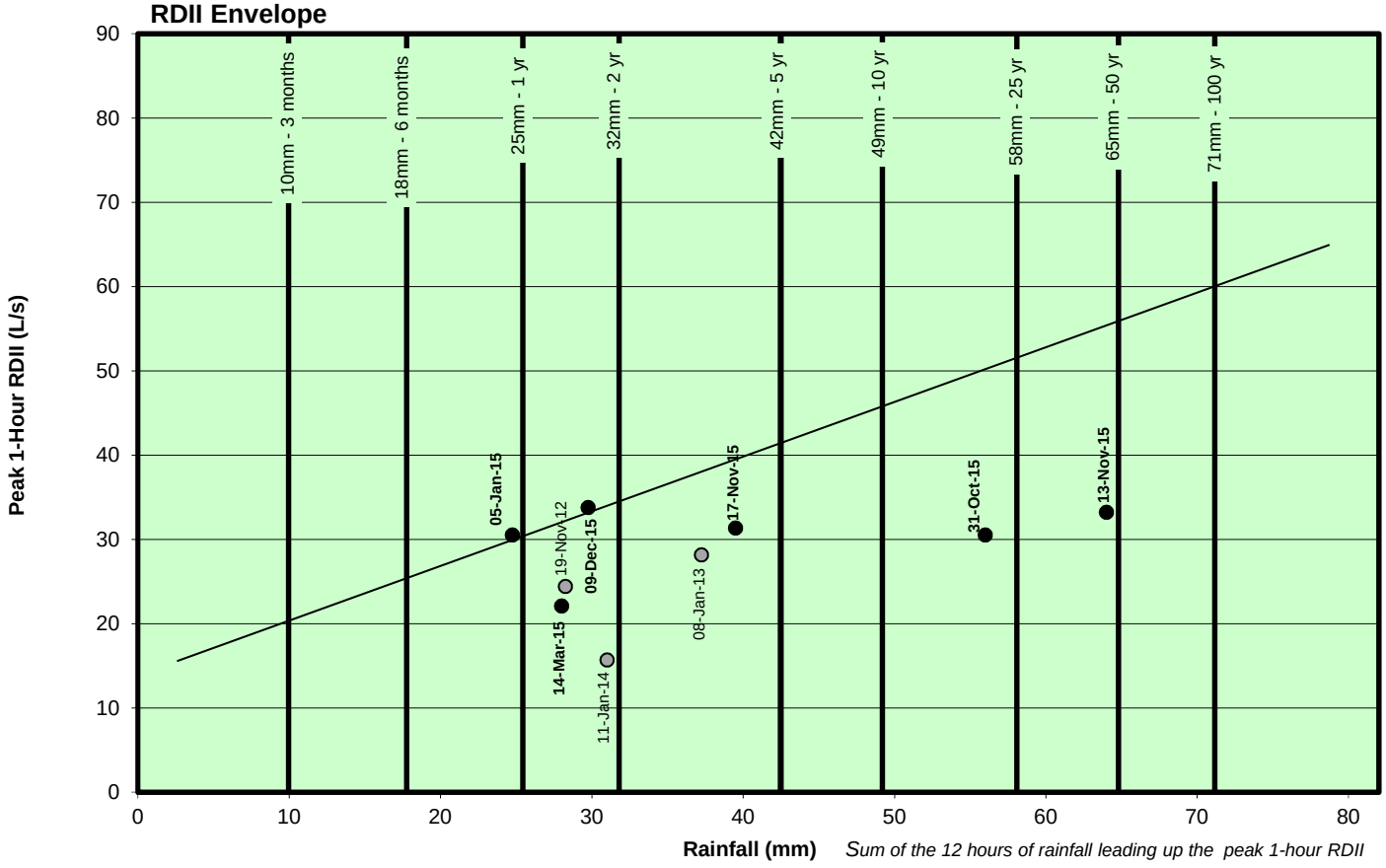
FLOW MONITORING AREA

CATCHMENT: GRAFTON

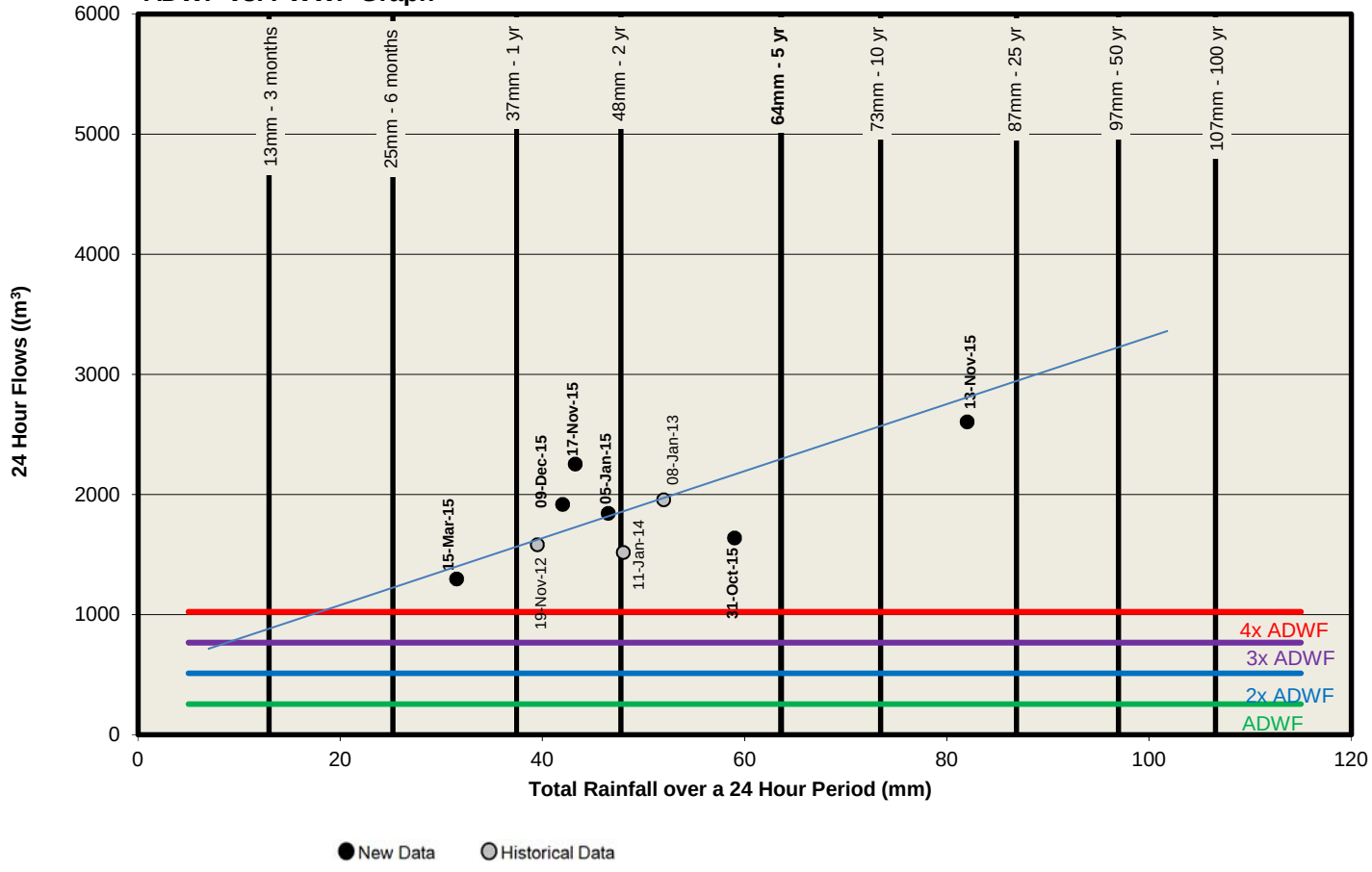
SITE CODE: **ES25**

Grafton (ES25)

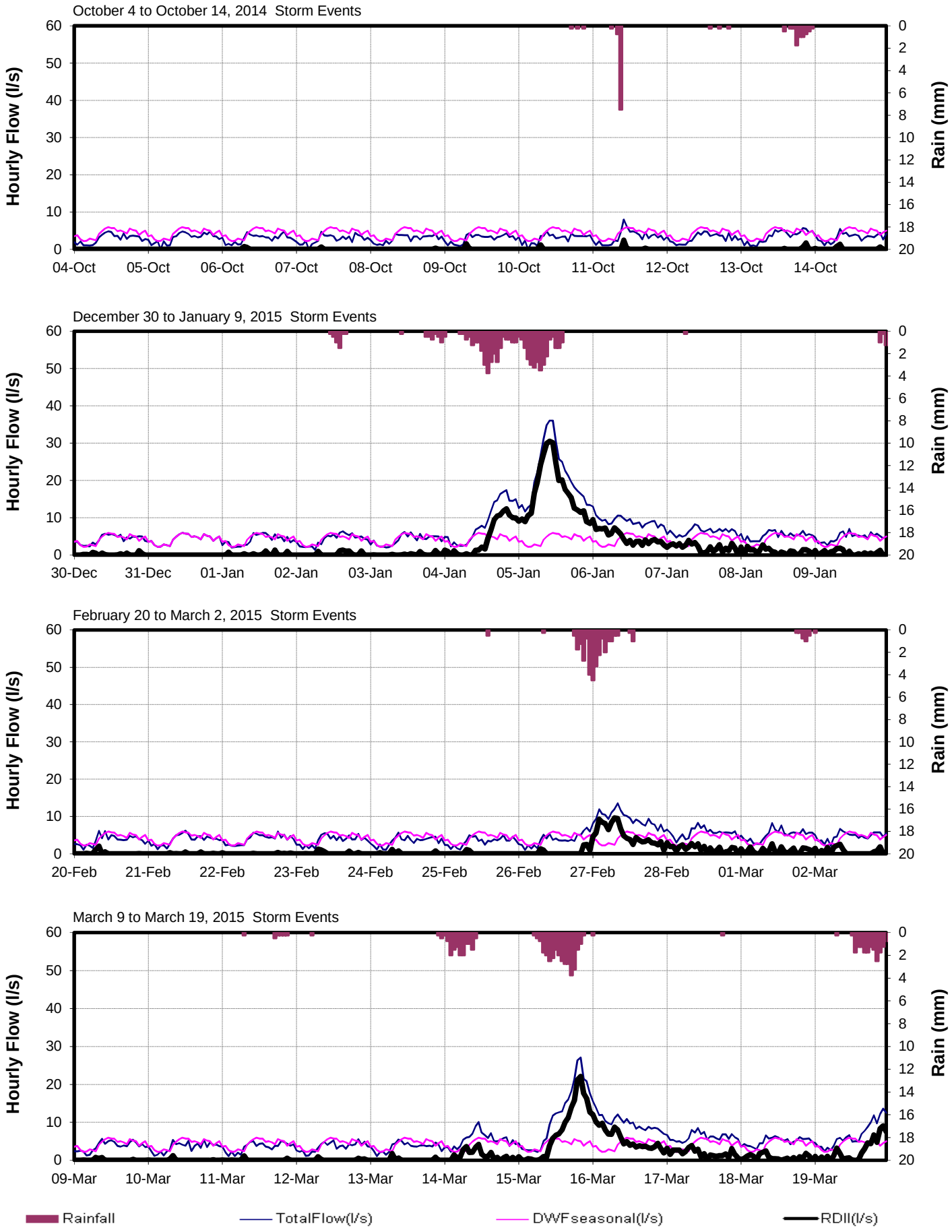
RDII Envelope



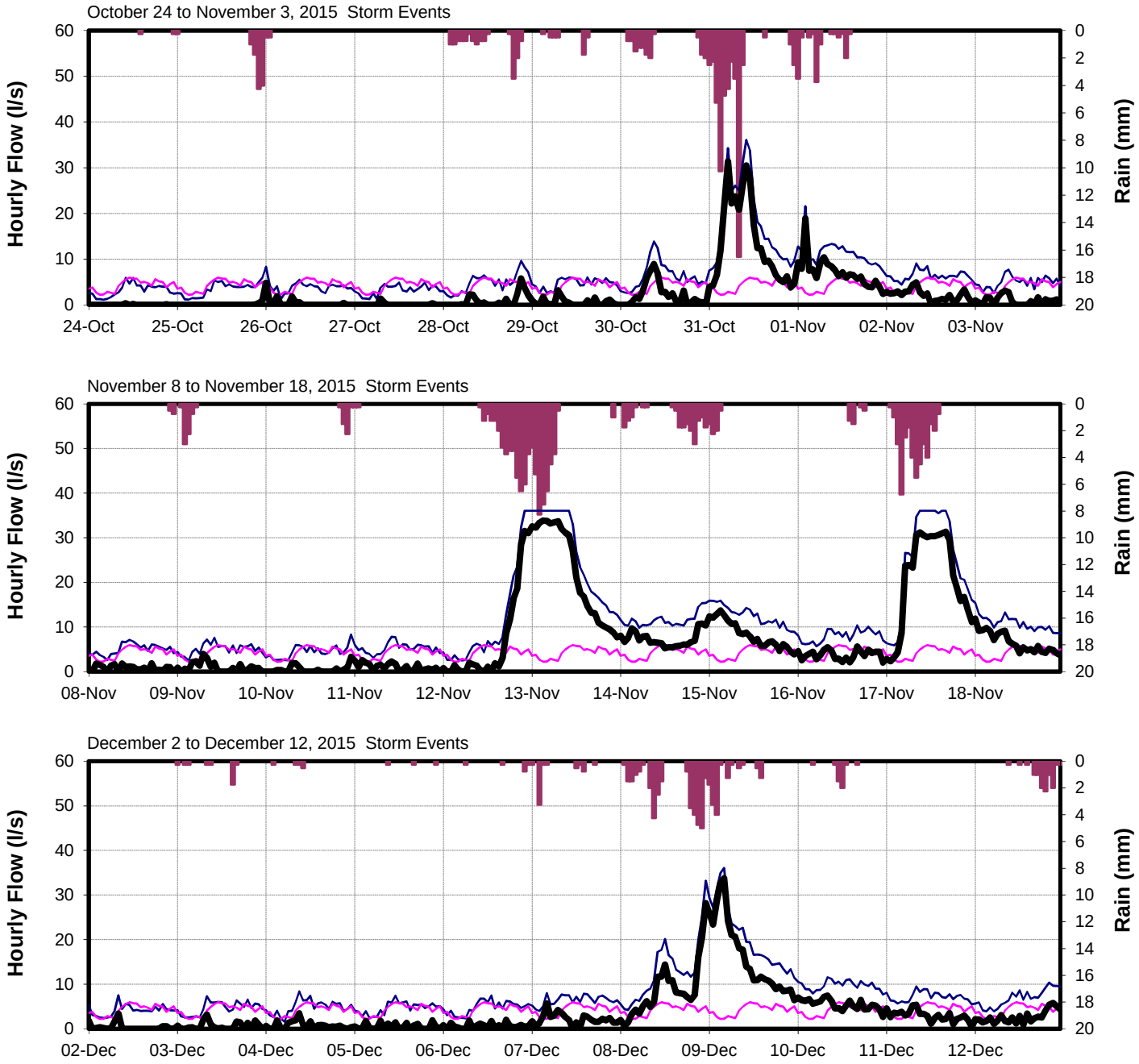
ADWF vs. PWWF Graph



Grafton (ES25)

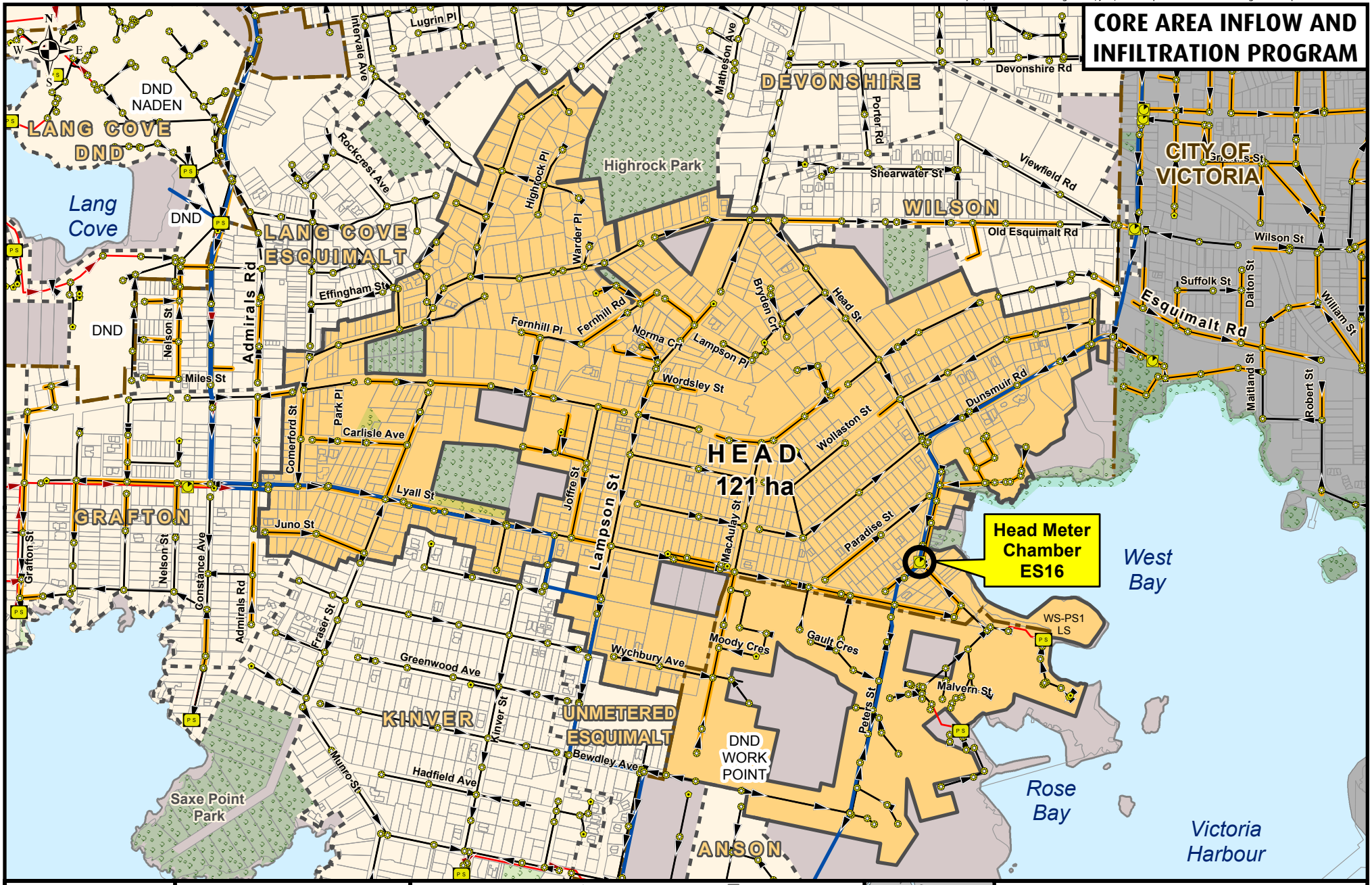


Grafton (ES25)



CRD - Parks & Environmental Services - Apr 7, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchEsquimalt2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 100 200 300

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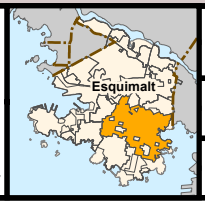


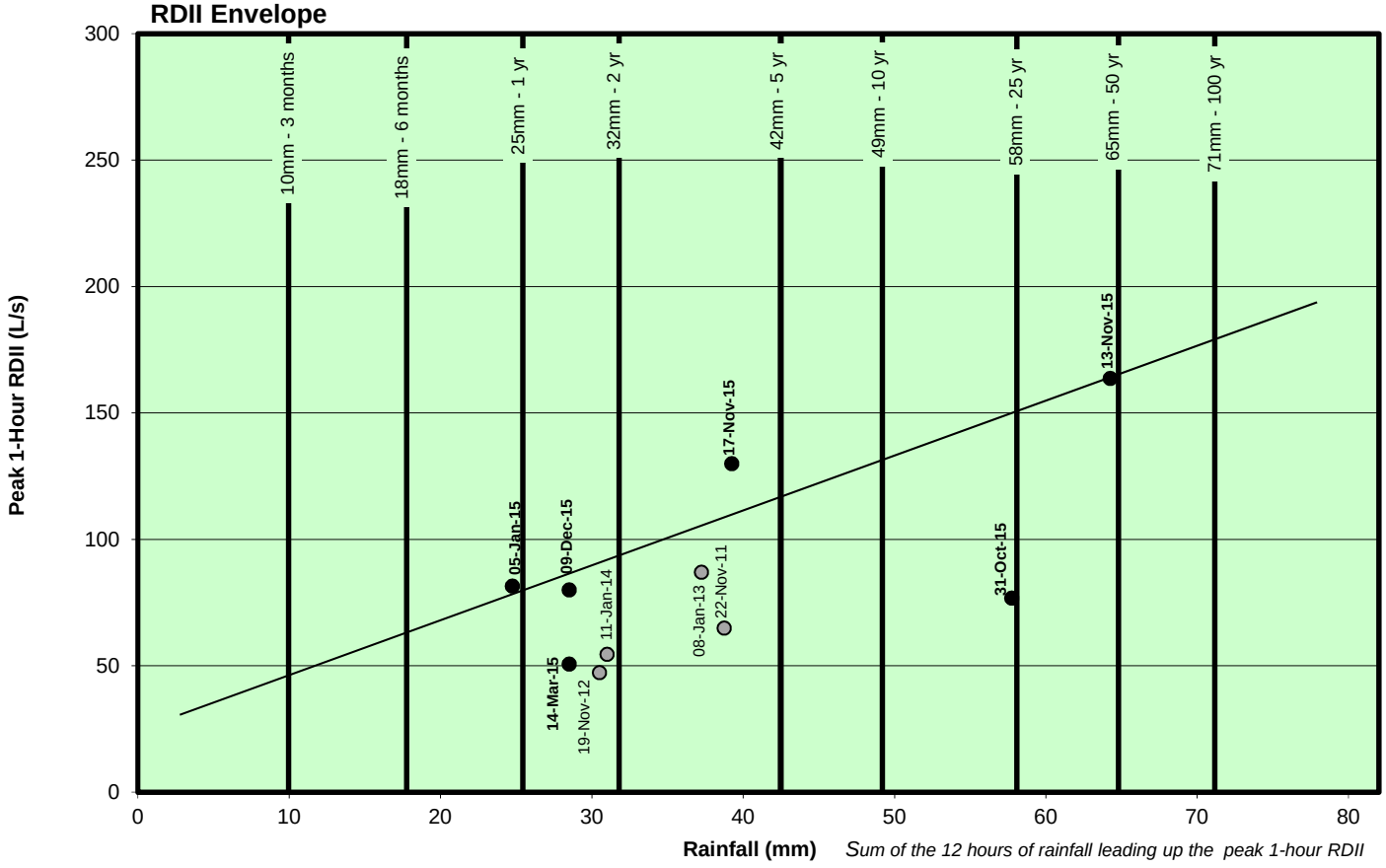
FLOW MONITORING AREA

CATCHMENT: HEAD

SITE CODE: **ES16**

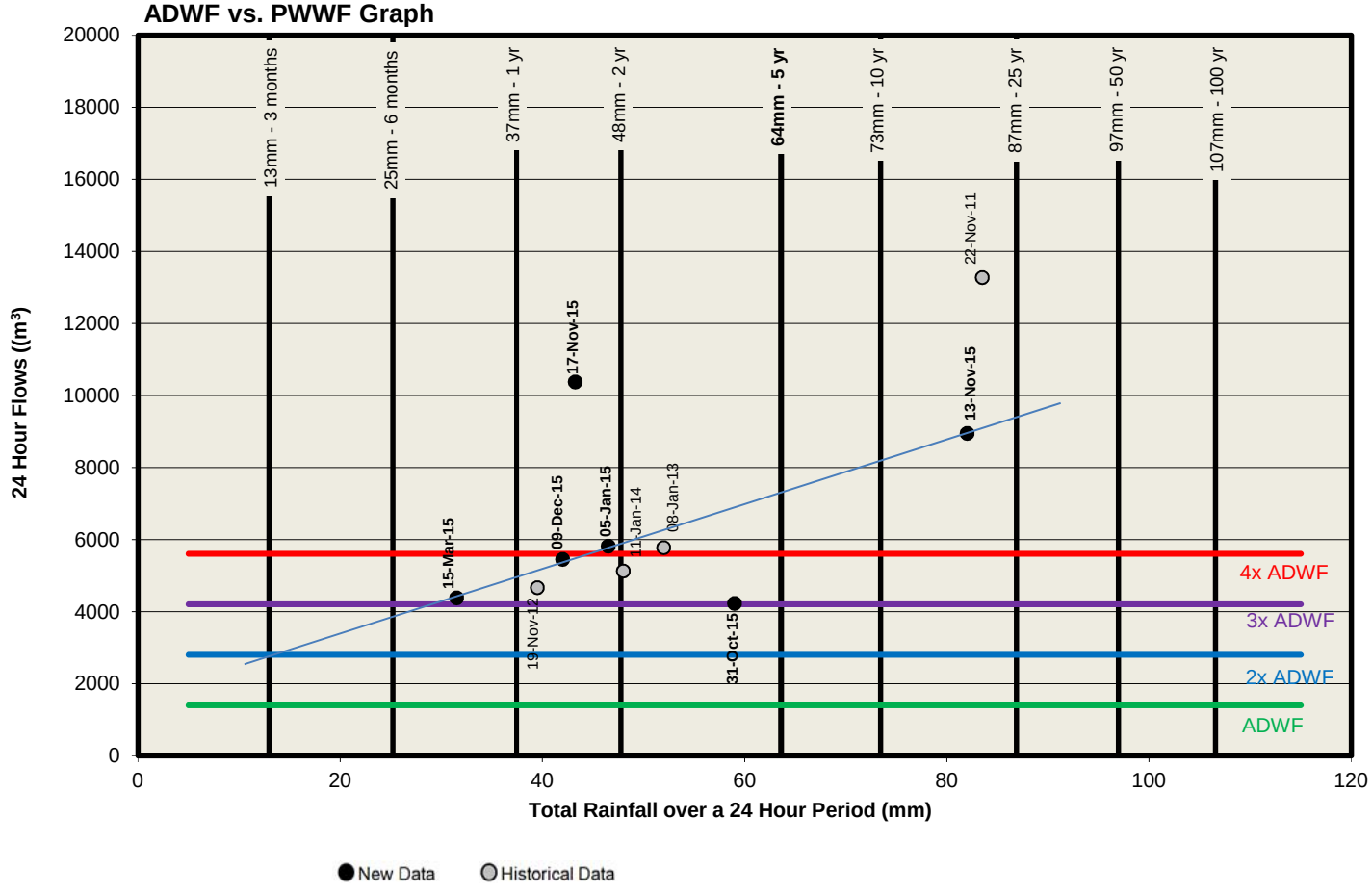
Head (ES16)

RDII Envelope

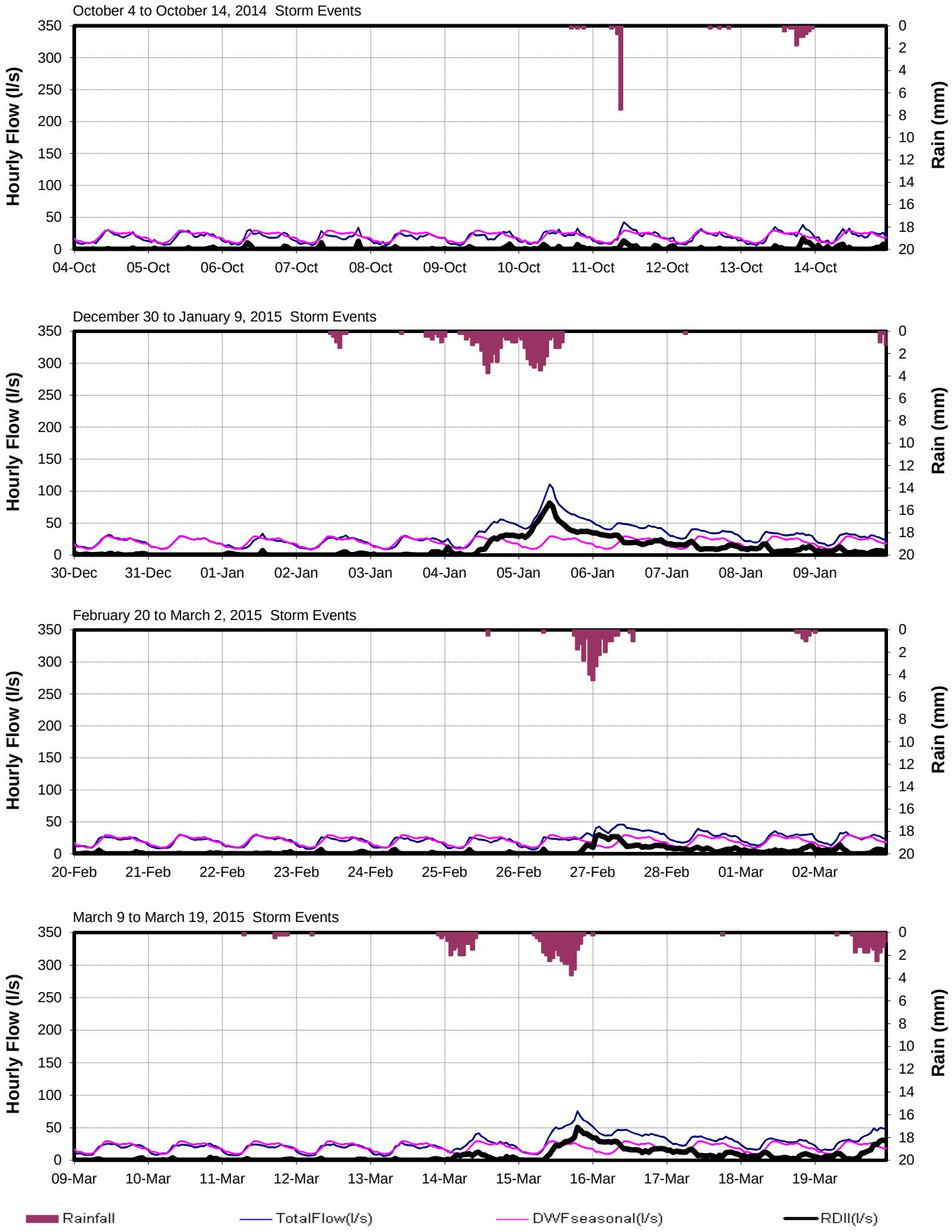


Sum of the 12 hours of rainfall leading up the peak 1-hour RDII

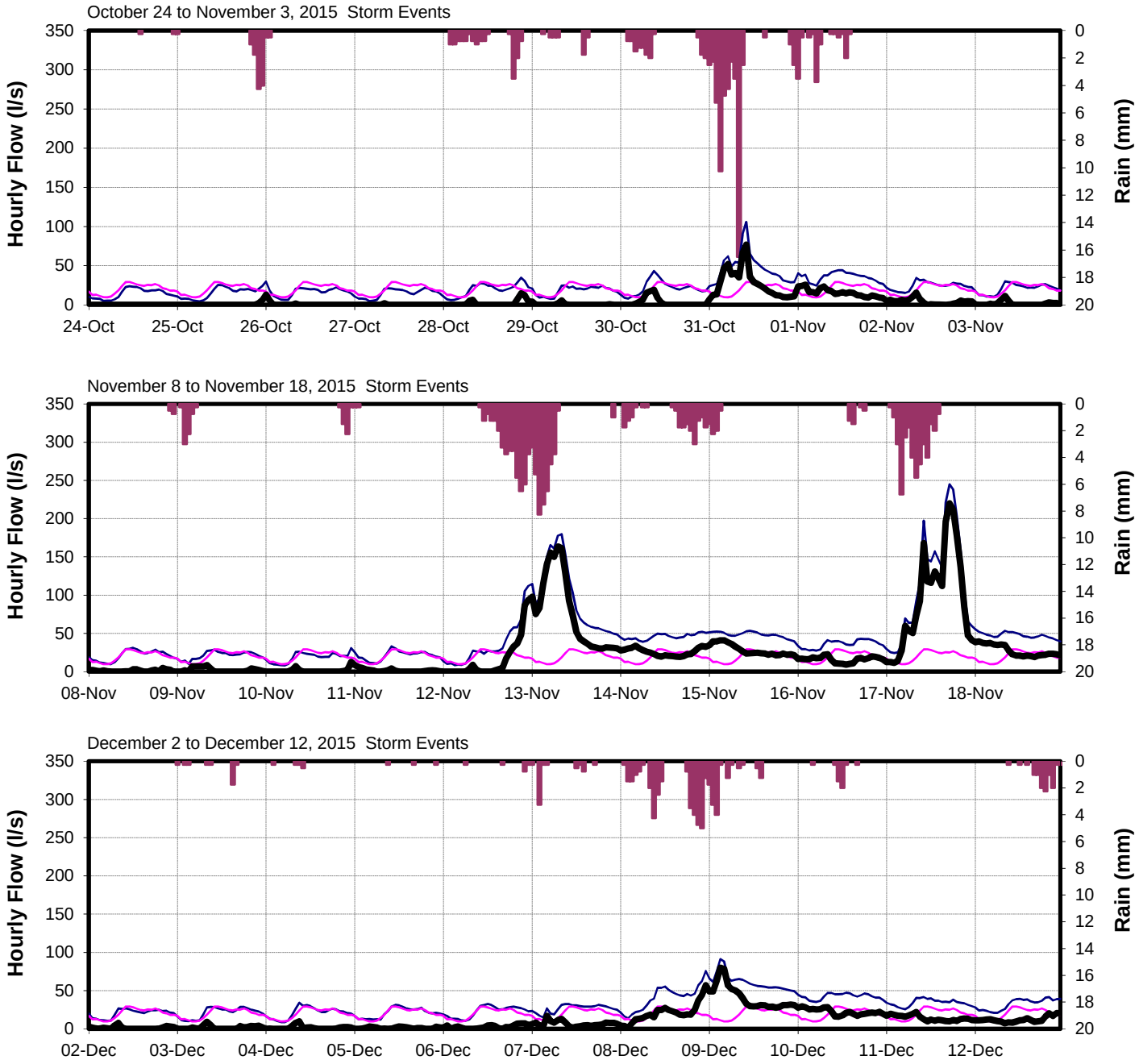
ADWF vs. PWWF Graph



Head (ES16)

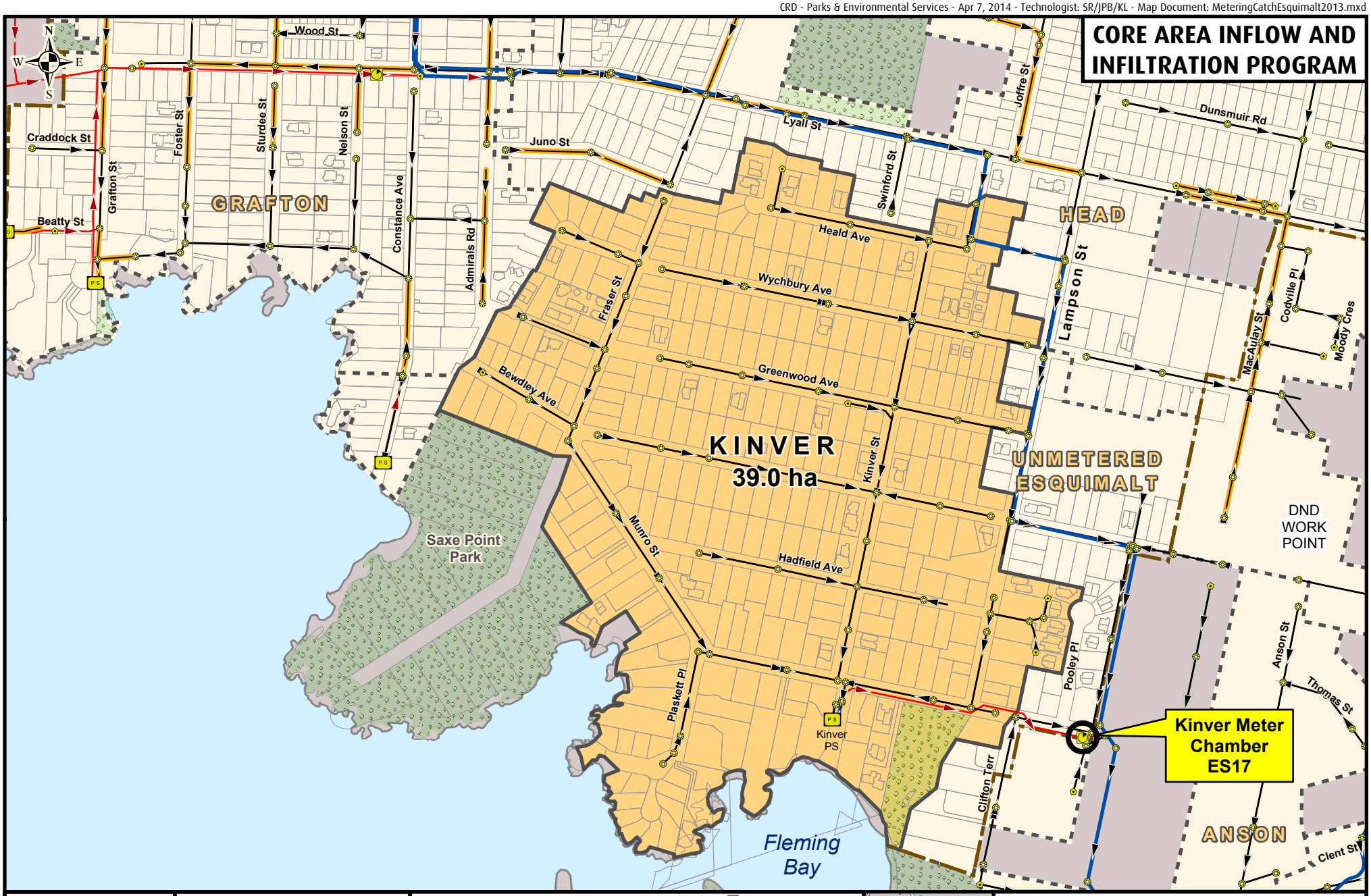

October 4 to October 14, 2014 Storm Events
December 30 to January 9, 2015 Storm Events
February 20 to March 2, 2015 Storm Events
March 9 to March 19, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
0
50
100
150
200
250
300
350
0
2
4
6
8
10
12
14
16
18
20
04-Oct
05-Oct
06-Oct
07-Oct
08-Oct
09-Oct
10-Oct
11-Oct
12-Oct
13-Oct
14-Oct
30-Dec
31-Dec
01-Jan
02-Jan
03-Jan
04-Jan
05-Jan
06-Jan
07-Jan
08-Jan
09-Jan
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
26-Feb
27-Feb
28-Feb
01-Mar
02-Mar
09-Mar
10-Mar
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
19-Mar
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

Head (ES16)


October 24 to November 3, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
0
50
100
150
200
250
300
350
0
2
4
6
8
10
12
14
16
18
20
24-Oct
25-Oct
26-Oct
27-Oct
28-Oct
29-Oct
30-Oct
31-Oct
01-Nov
02-Nov
03-Nov
November 8 to November 18, 2015 Storm Events
08-Nov
09-Nov
10-Nov
11-Nov
12-Nov
13-Nov
14-Nov
15-Nov
16-Nov
17-Nov
18-Nov
December 2 to December 12, 2015 Storm Events
02-Dec
03-Dec
04-Dec
05-Dec
06-Dec
07-Dec
08-Dec
09-Dec
10-Dec
11-Dec
12-Dec
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

CRD - Parks & Environmental Services - Apr 7, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchEsquimalt2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100 150

Projection: UTM ZONE 10N NAD 83

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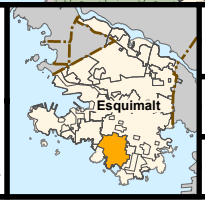


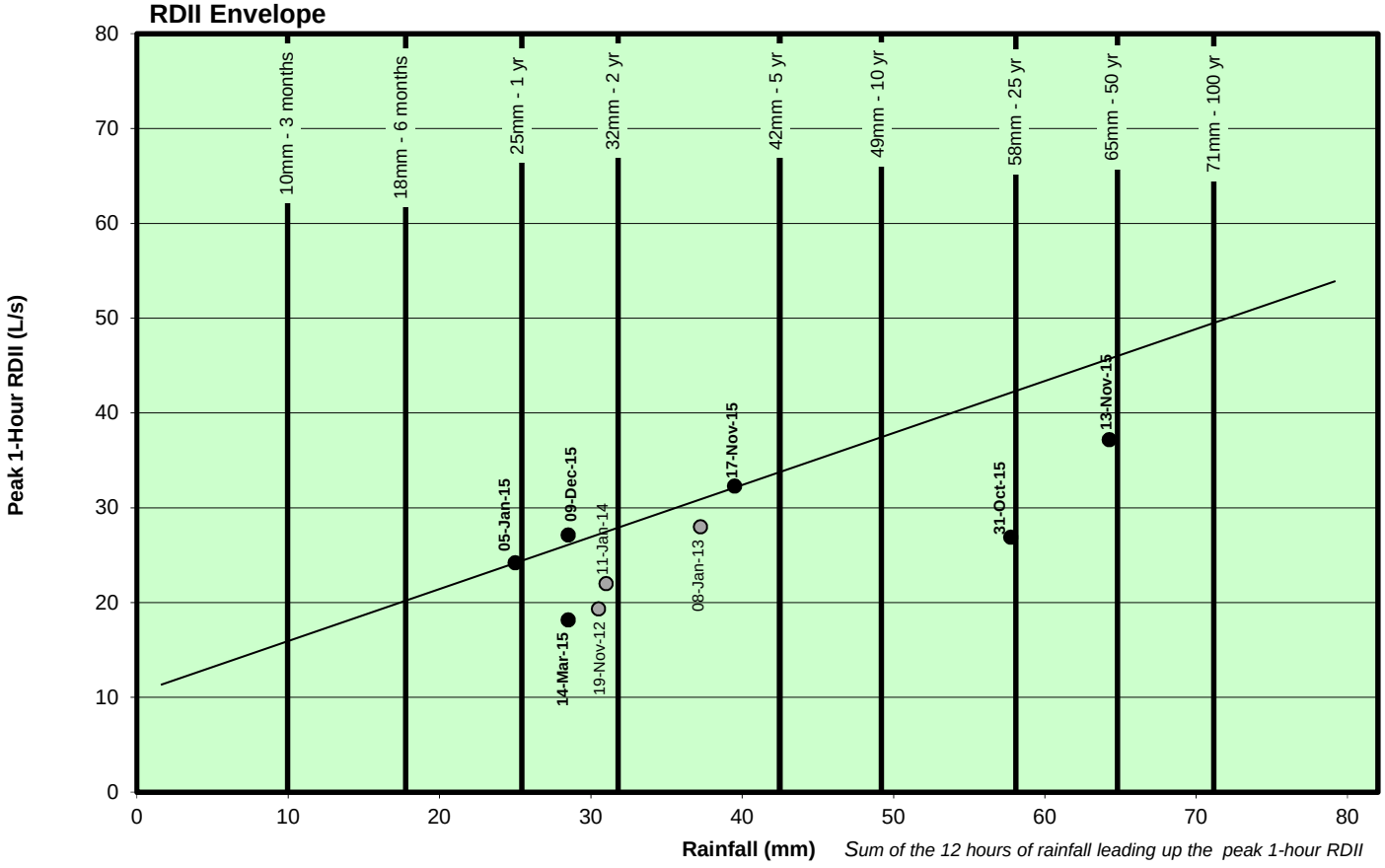
FLOW MONITORING AREA

CATCHMENT: KINVER

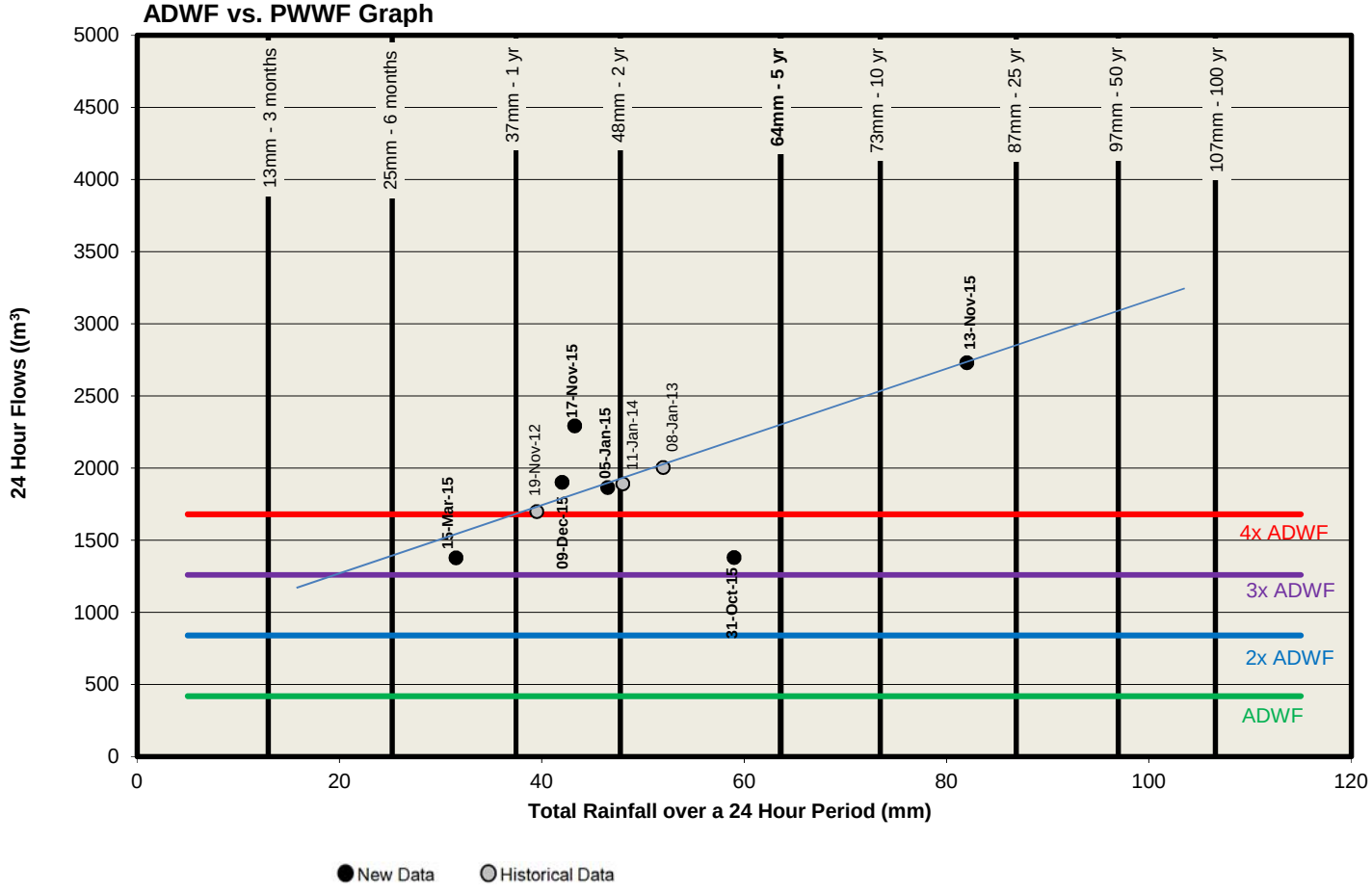
SITE CODE: **ES17**

Kinver (ES17)

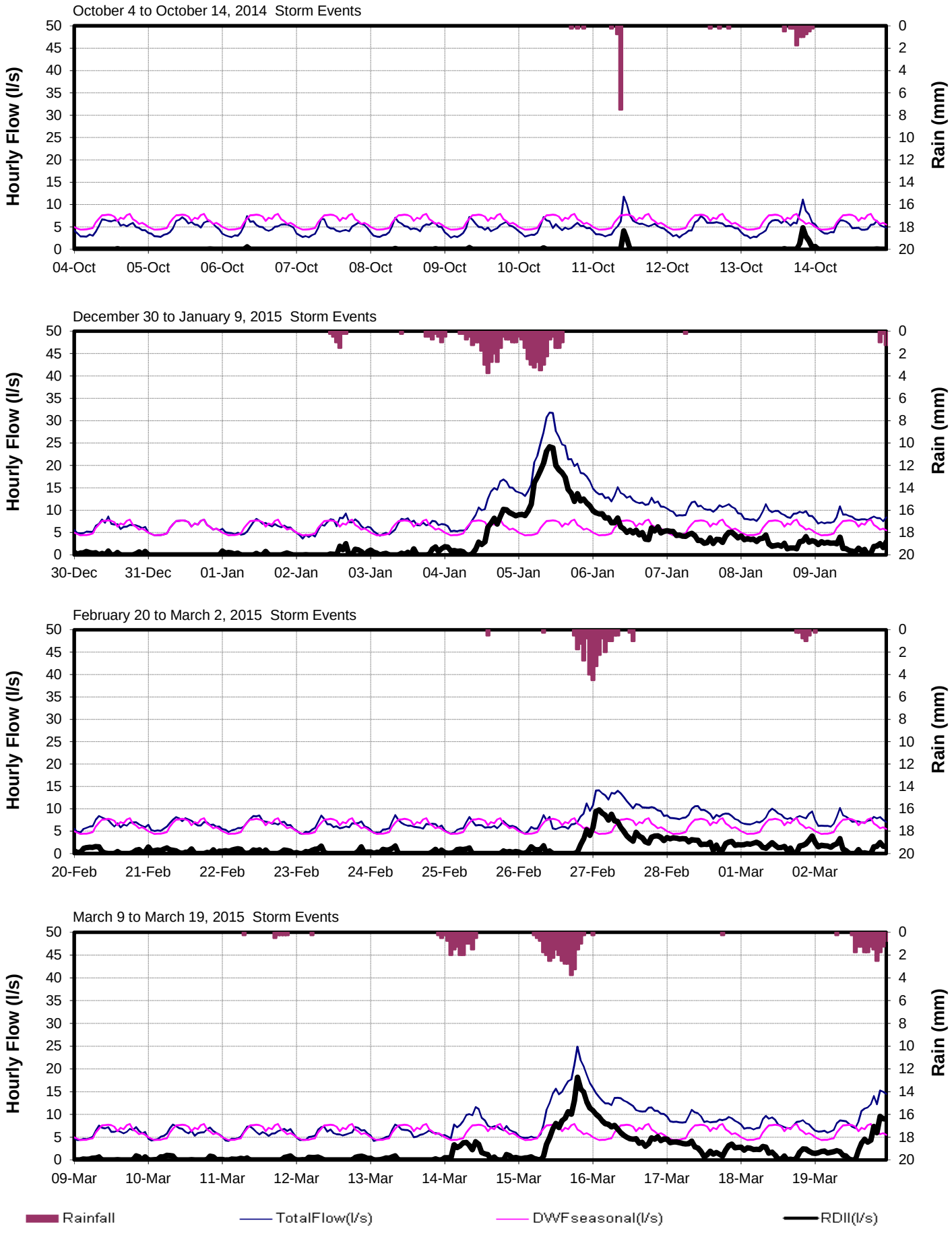
RDII Envelope



ADWF vs. PWWF Graph



Kinver (ES17)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Hourly Flow (l/s)
Rain (mm)
0
5
10
15
20
25
30
35
40
45
50
0
2
4
6
8
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04-Oct
05-Oct
06-Oct
07-Oct
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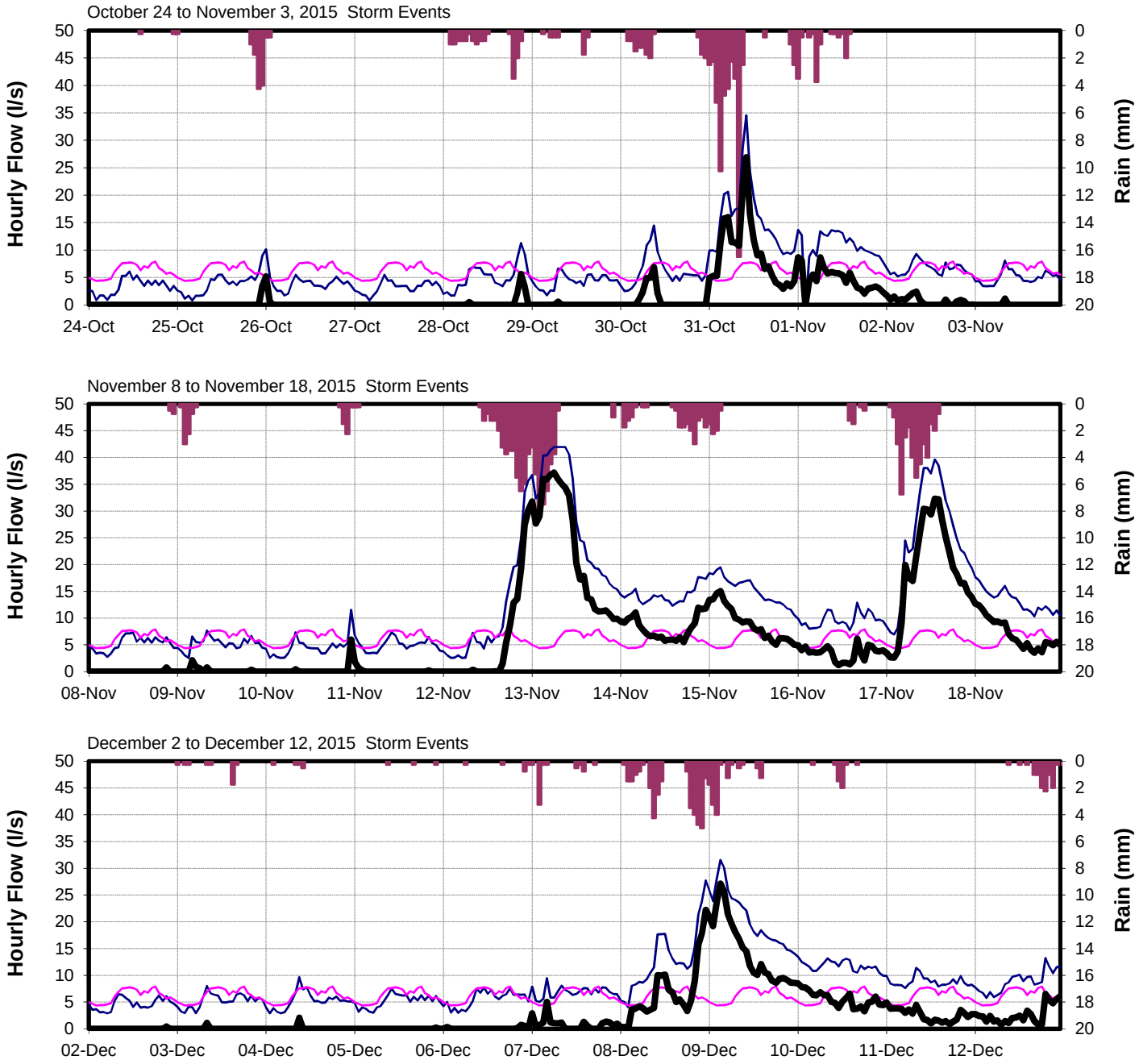
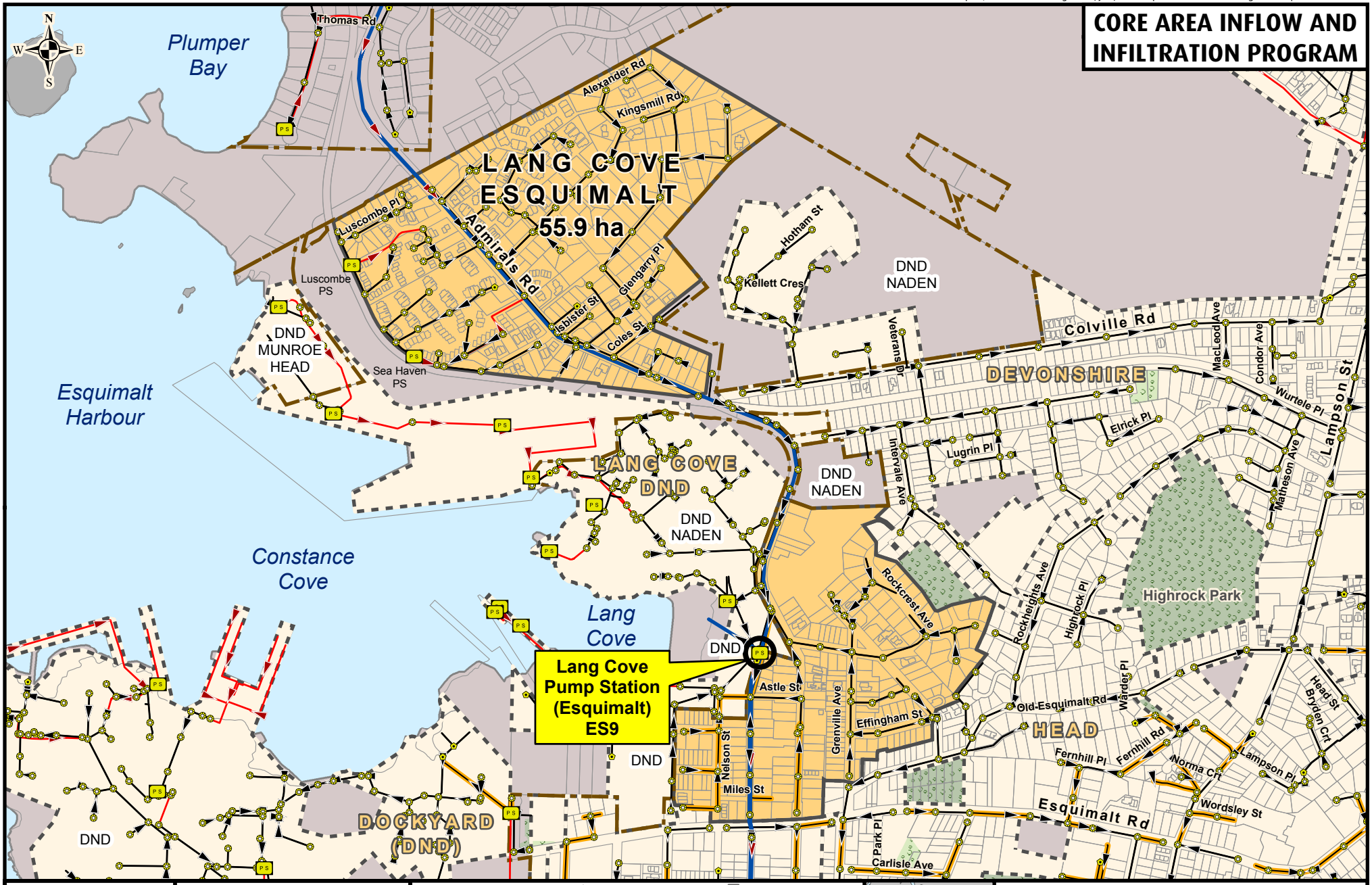
16-Mar
17-Mar
18-Mar
19-Mar
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

Kinver (ES17)


October 24 to November 3, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
0 5 10 15 20 25 30 35 40 45 50
0 2 4 6 8 10 12 14 16 18 20
24-Oct 25-Oct 26-Oct 27-Oct 28-Oct 29-Oct 30-Oct 31-Oct 01-Nov 02-Nov 03-Nov
November 8 to November 18, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
0 5 10 15 20 25 30 35 40 45 50
0 2 4 6 8 10 12 14 16 18 20
08-Nov 09-Nov 10-Nov 11-Nov 12-Nov 13-Nov 14-Nov 15-Nov 16-Nov 17-Nov 18-Nov
December 2 to December 12, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
0 5 10 15 20 25 30 35 40 45 50
0 2 4 6 8 10 12 14 16 18 20
02-Dec 03-Dec 04-Dec 05-Dec 06-Dec 07-Dec 08-Dec 09-Dec 10-Dec 11-Dec 12-Dec
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 100 200

Projection: UTM ZONE 10N NAD 83

Important This map is for general information purposes only. The Capital Regional District (**CRD**) makes no representations or warranties regarding the accuracy or completeness of this map or the suitability of the map for any purpose. **This map is not for navigation.** The CRD **will not be liable** for any damage, loss or injury resulting from the use of the map or information on the map and the map may be changed by the CRD at any time.

- Flow Monitoring Location
- Manhole
- Cleanout
- Pump Station
- Metering Chamber

Sanitary Sewers

- Gravity Main Installed After 1930
- Gravity Main Installed Before 1930
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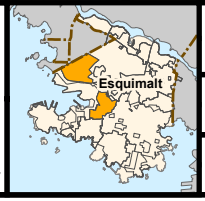
- CRD Sewer

- Catchment Area
- Non-Sewered Area
- Lot Lines
- Parks
- Sewered Park Areas
- Catchment Boundary Municipal, First Nation, or DND Boundaries



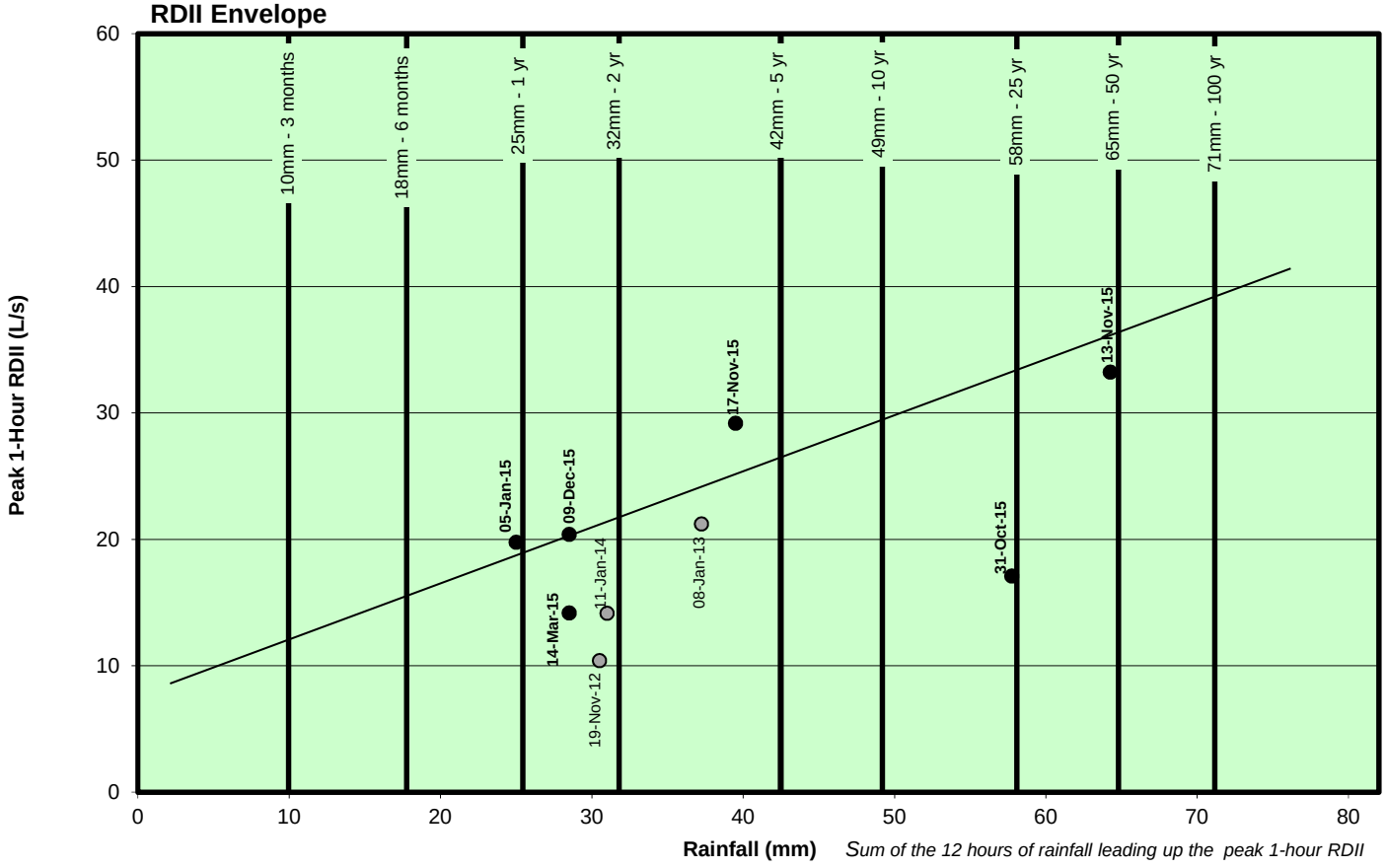
FLOW MONITORING AREA

CATCHMENT: LANG COVE ESQUIMALT

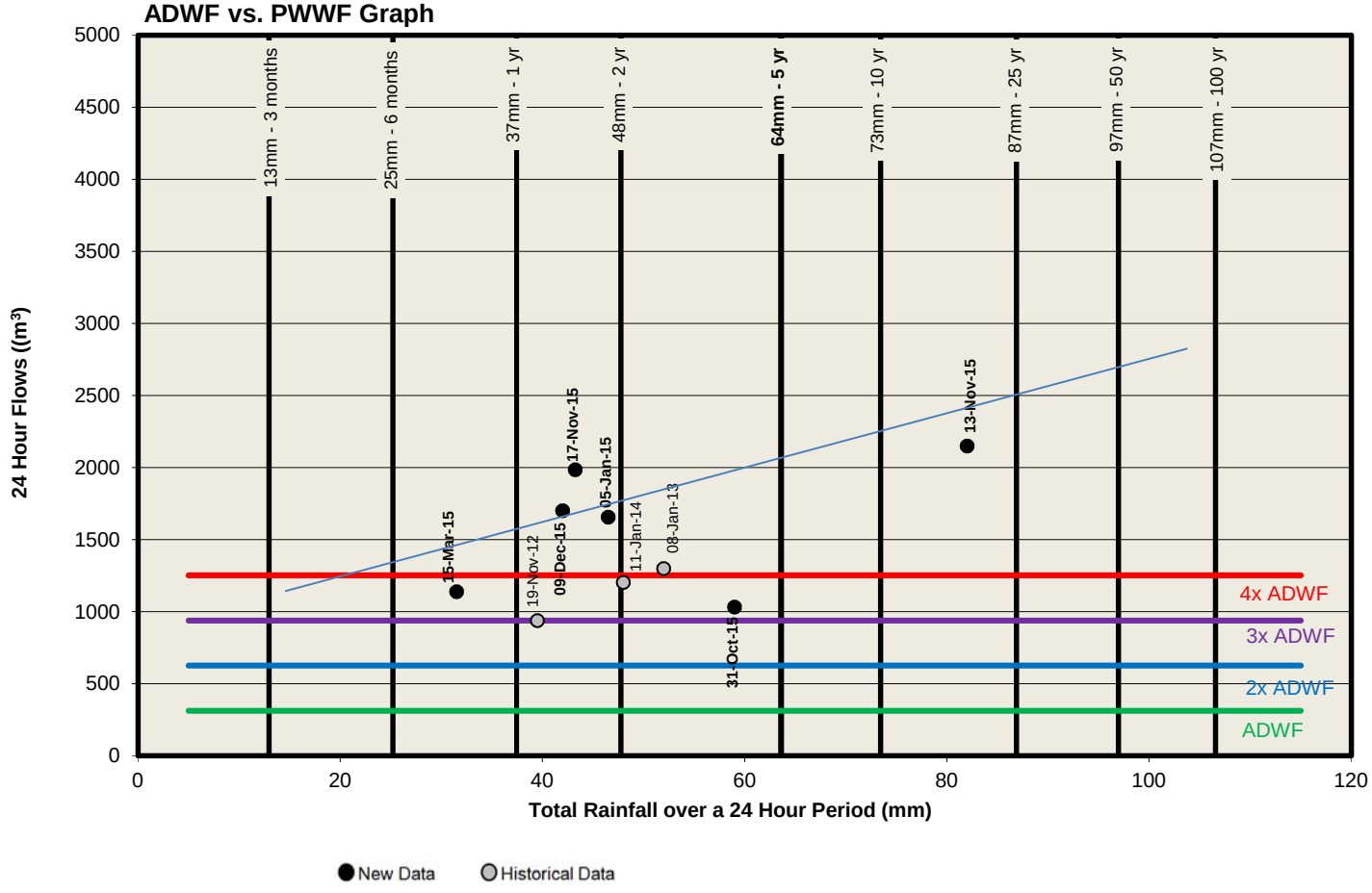
SITE CODE: **ES9**

Lang Cove Esquimalt (ES9)

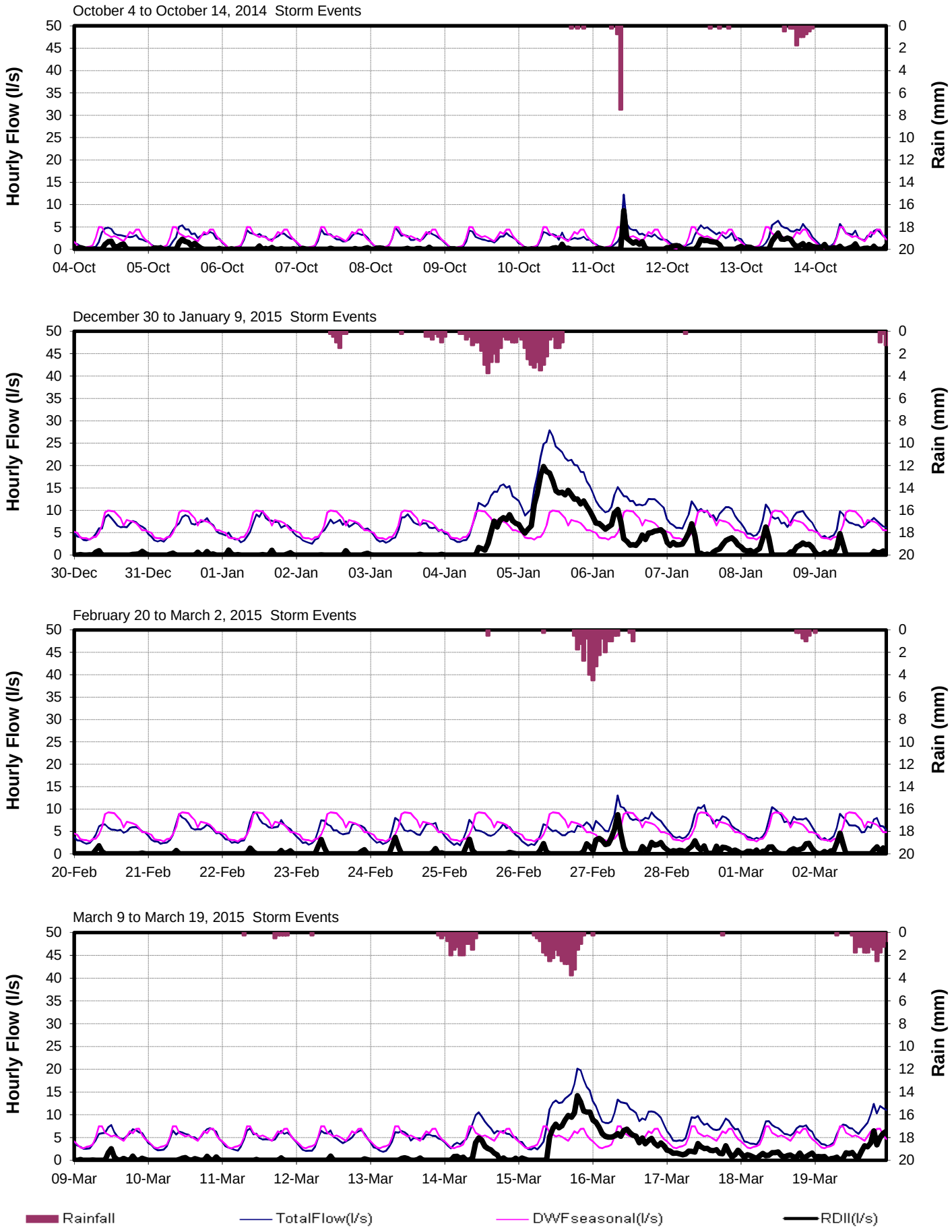
RDII Envelope



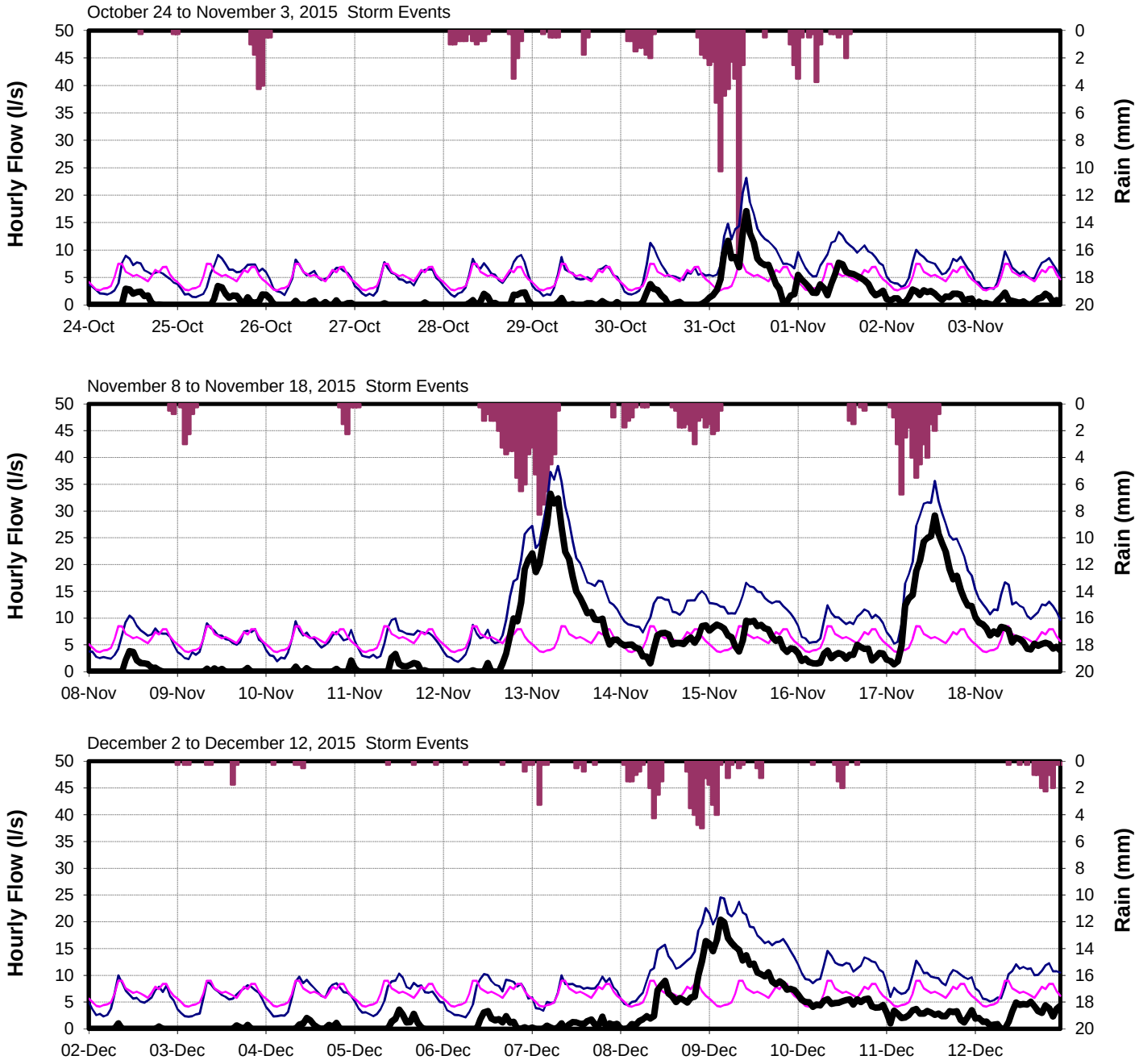
ADWF vs. PWWF Graph



Lang Cove Esquimalt (ES9)

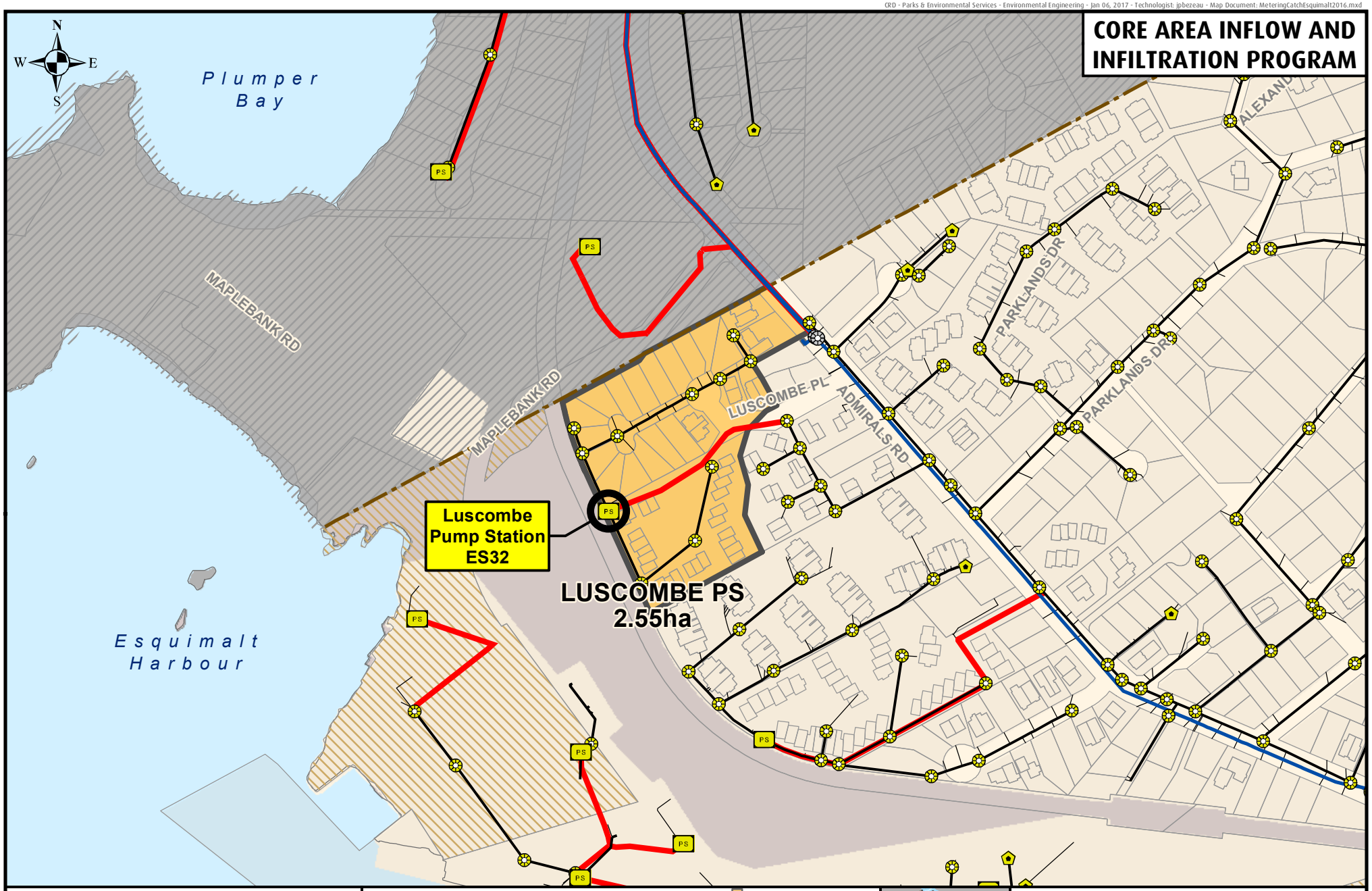


Lang Cove Esquimalt (ES9)



CRD - Parks & Environmental Services - Environmental Engineering - Jan 06, 2017 - Technologist: jpbezeau - Map Document: MeteringCatchEsquimalt2016.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Metres
0 50 100

Projection: UTM ZONE 10N, NAD83

Disclaimer
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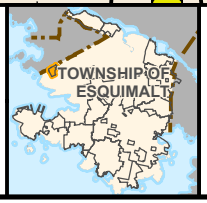
- Catchment Boundary
- Municipal, First Nation, or DND Boundaries

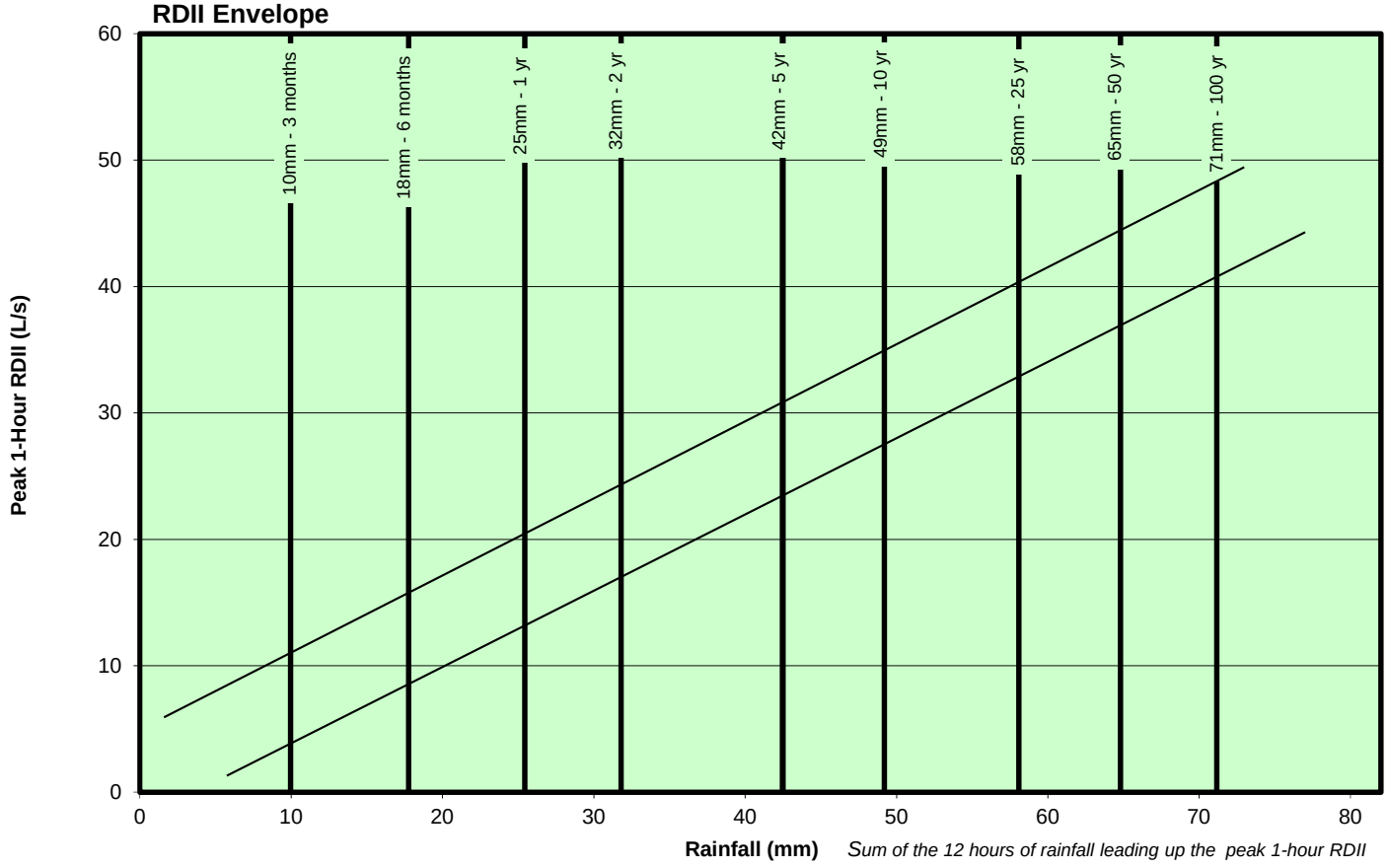


FLOW MONITORING AREA
Catchment: Luscombe Pump Station
Site Code: ES32

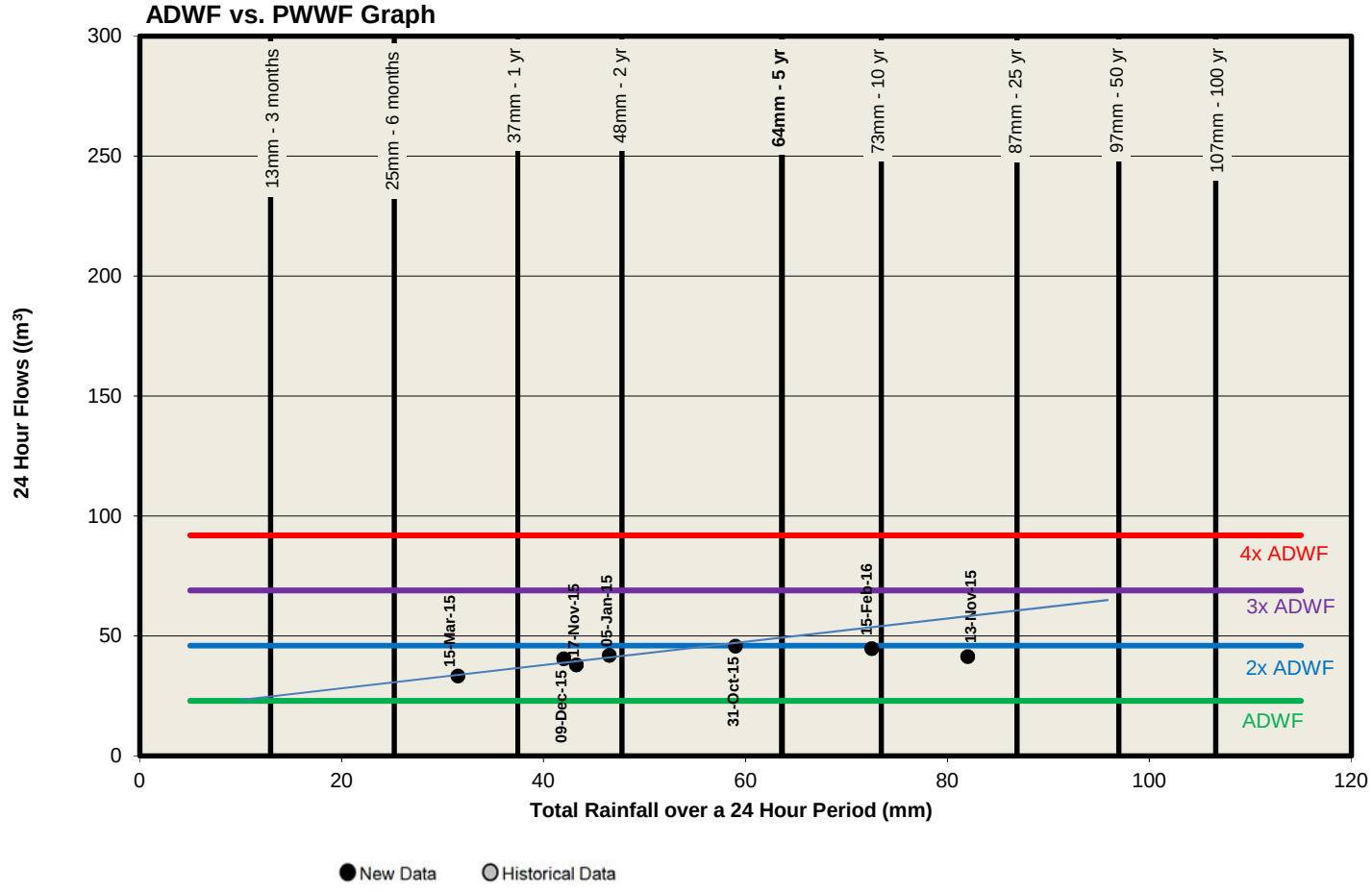
CRD
Making a difference...together

Luscombe (ES31)

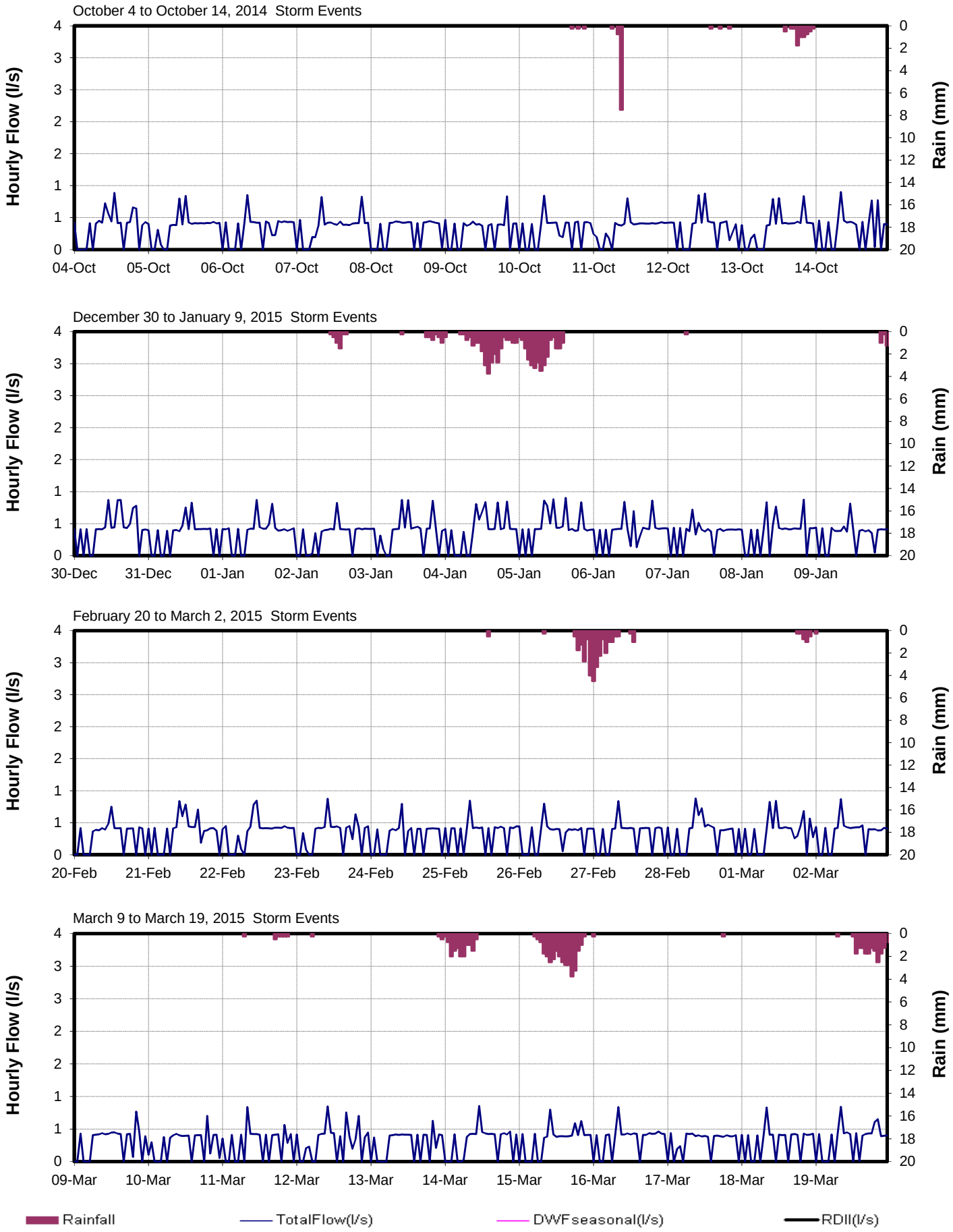
RDII Envelope



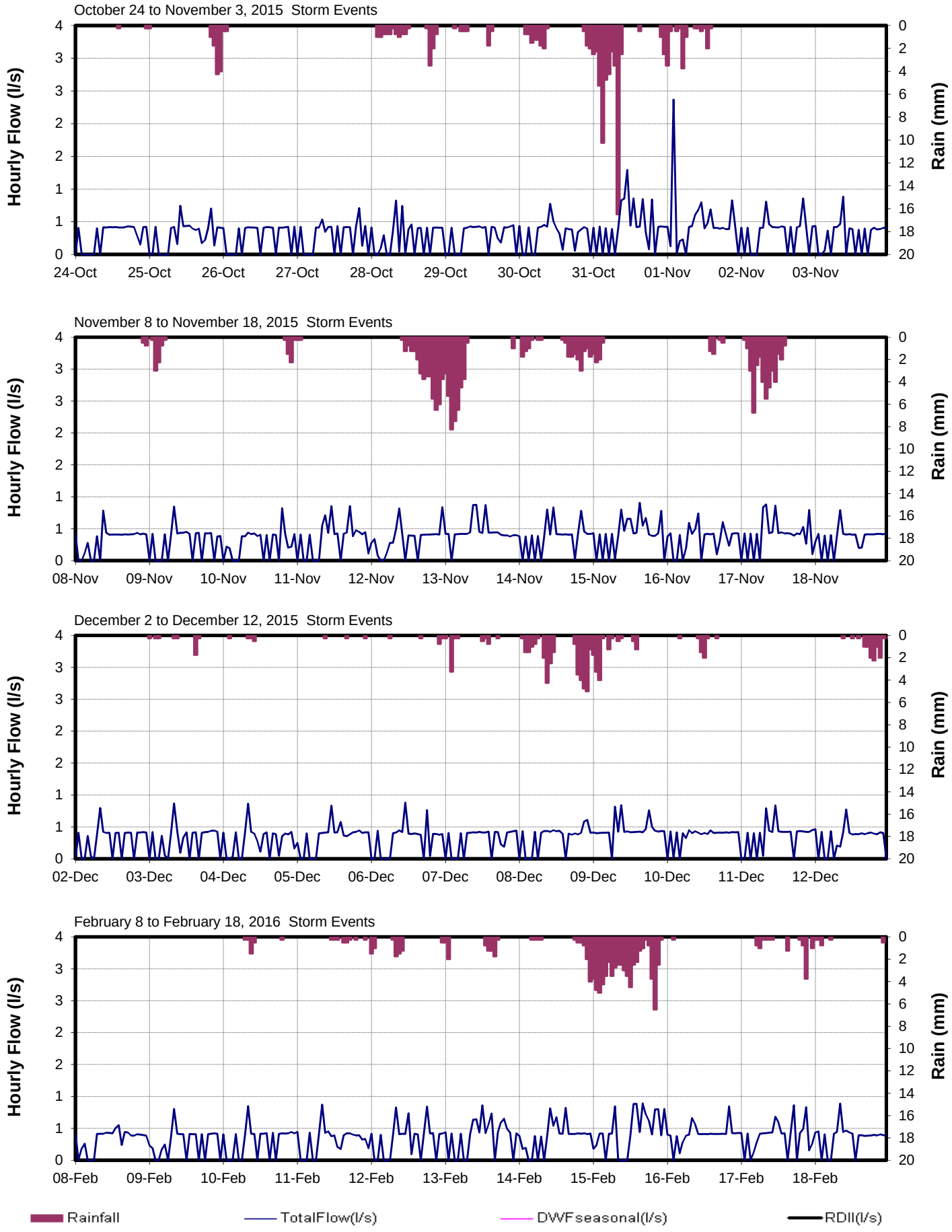
ADWF vs. PWWF Graph



Luscombe (ES31)

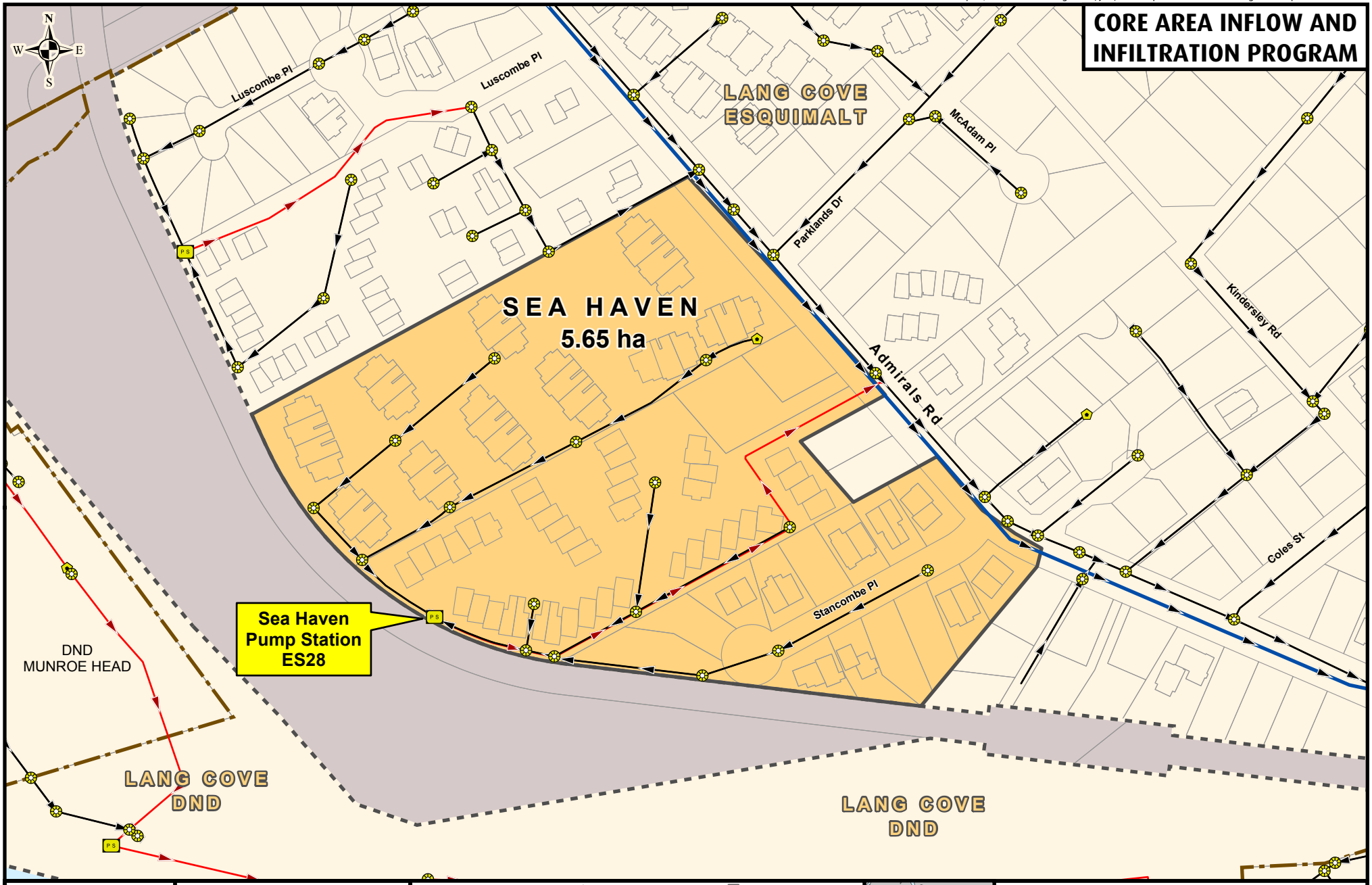


Luscombe (ES31)



CRD - Parks & Environmental Services - Apr 7, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchEsquimalt2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



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Metres
0 20 40 60 80

Projection: UTM ZONE 10N NAD 83

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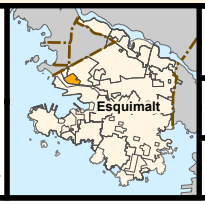
- Catchment Boundary
- Municipal, First Nation, or DND Boundaries



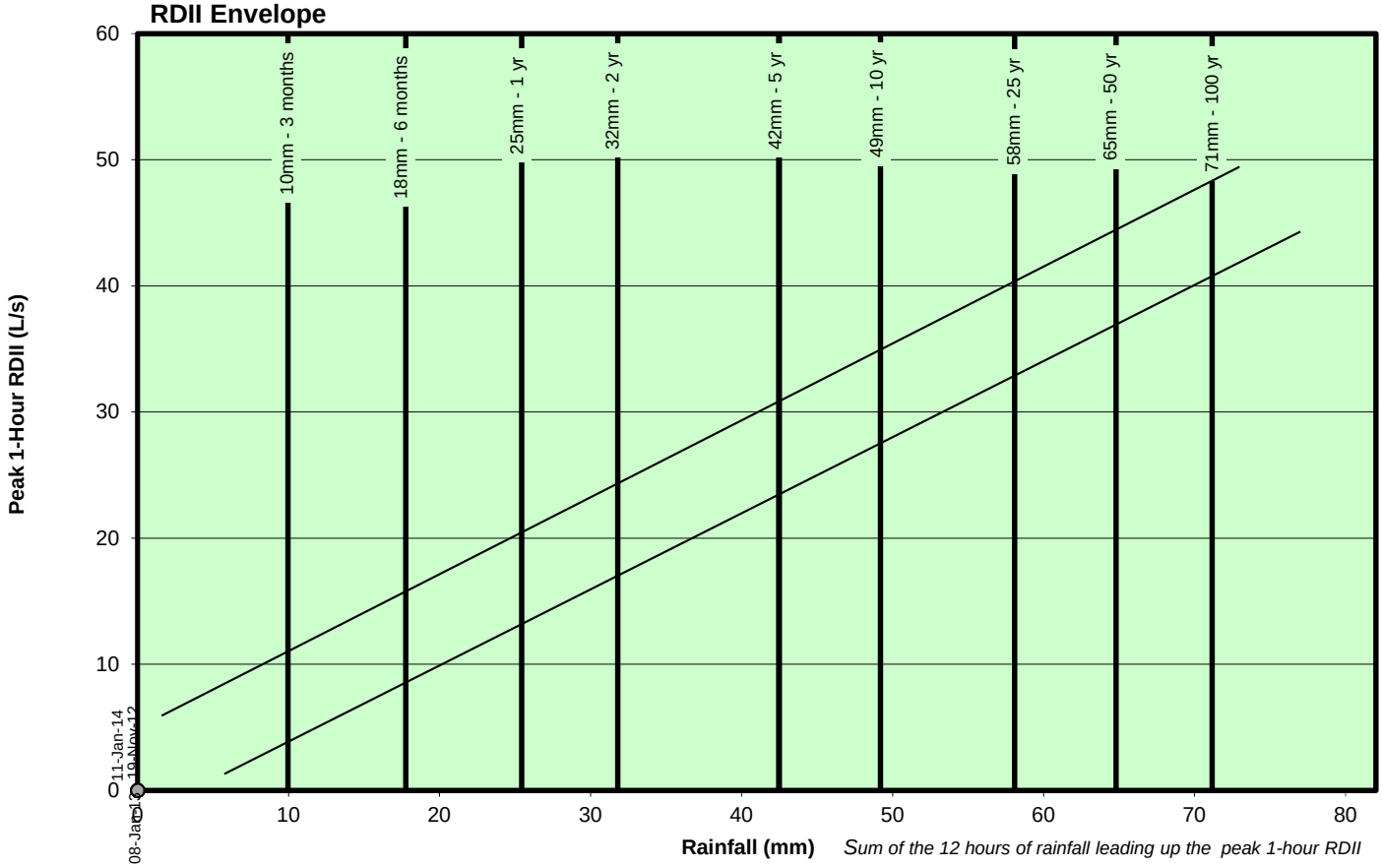
FLOW MONITORING AREA

CATCHMENT: SEA HAVEN

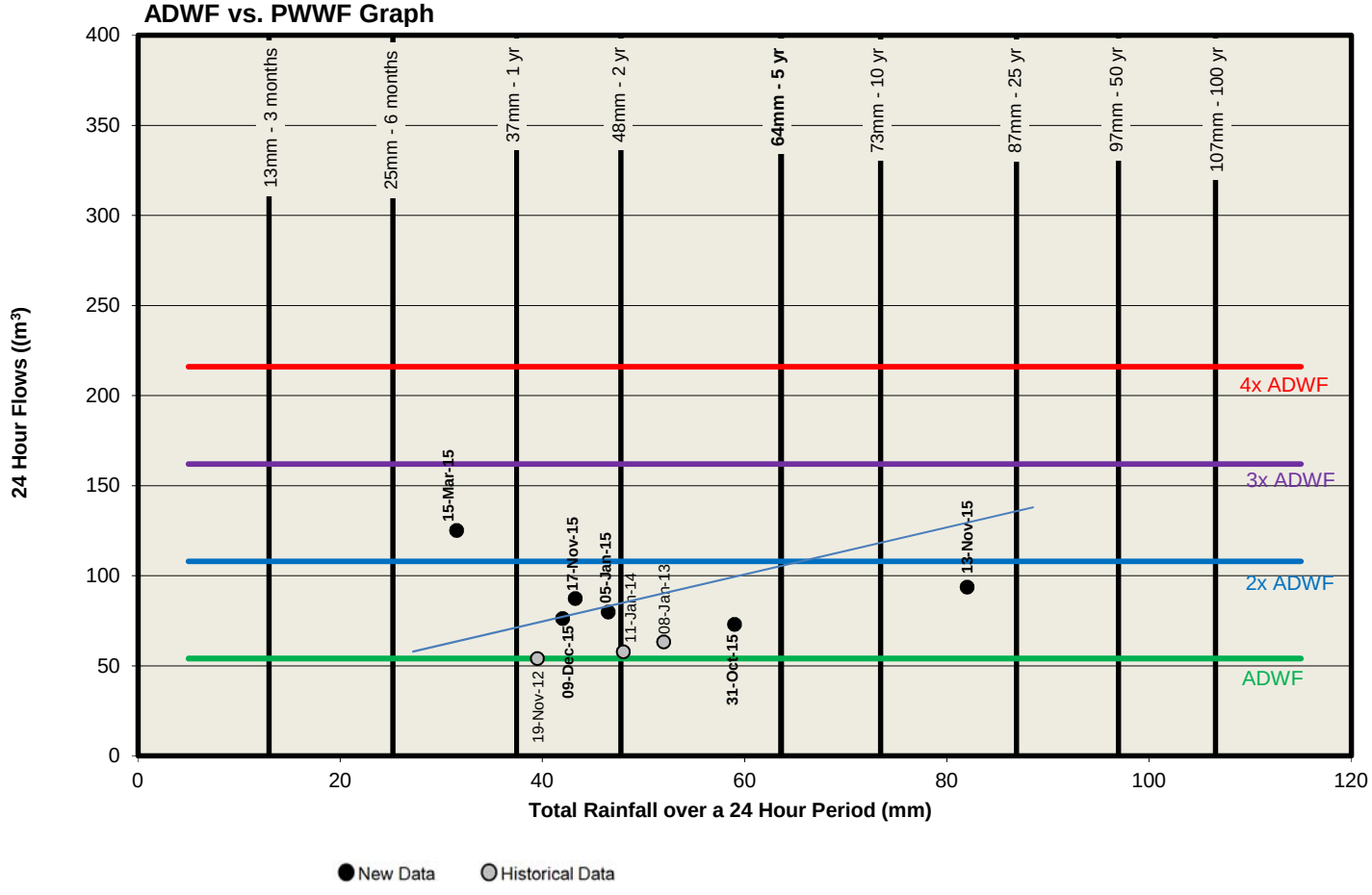
SITE CODE: **ES28**

Sea Haven (ES28)

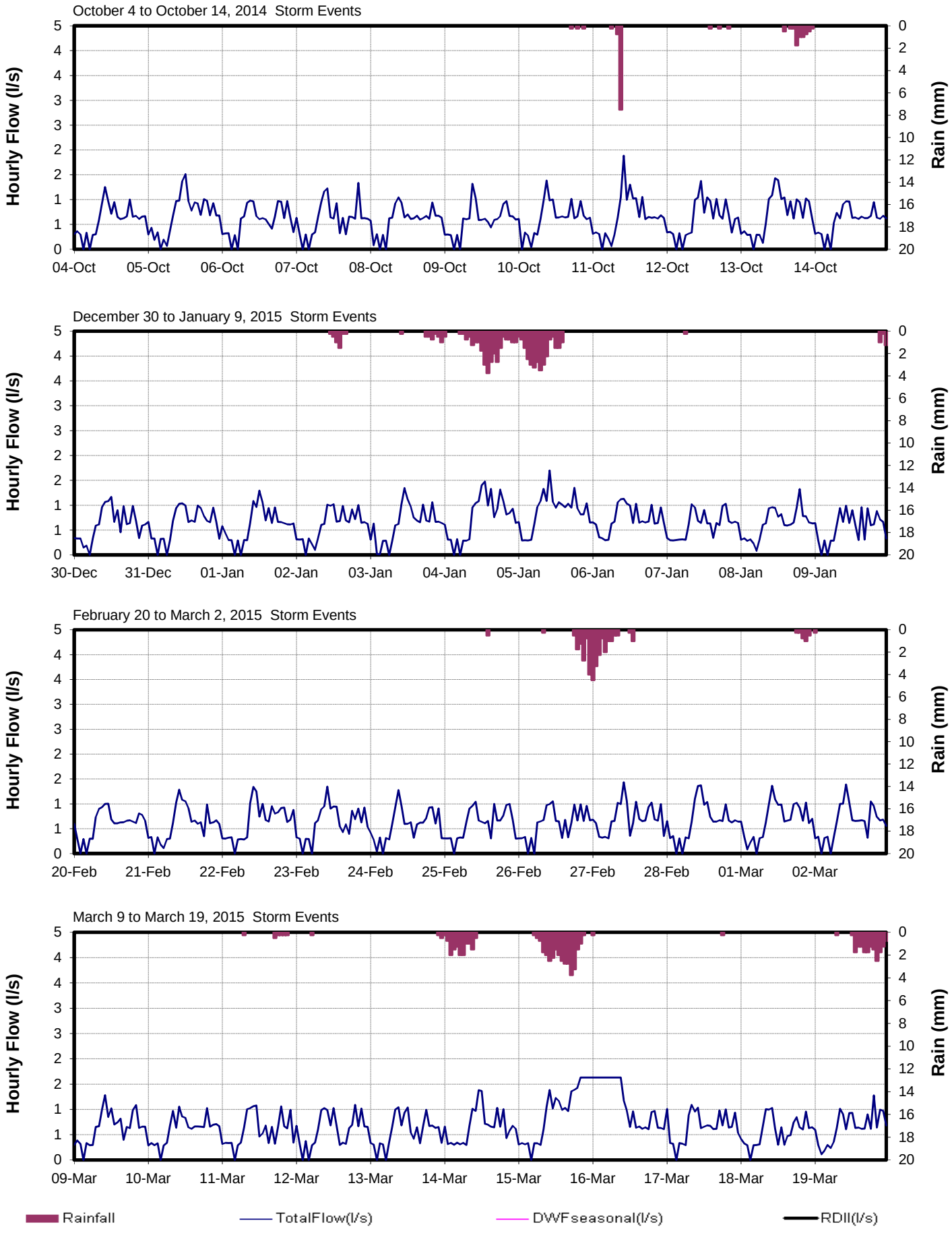
RDII Envelope



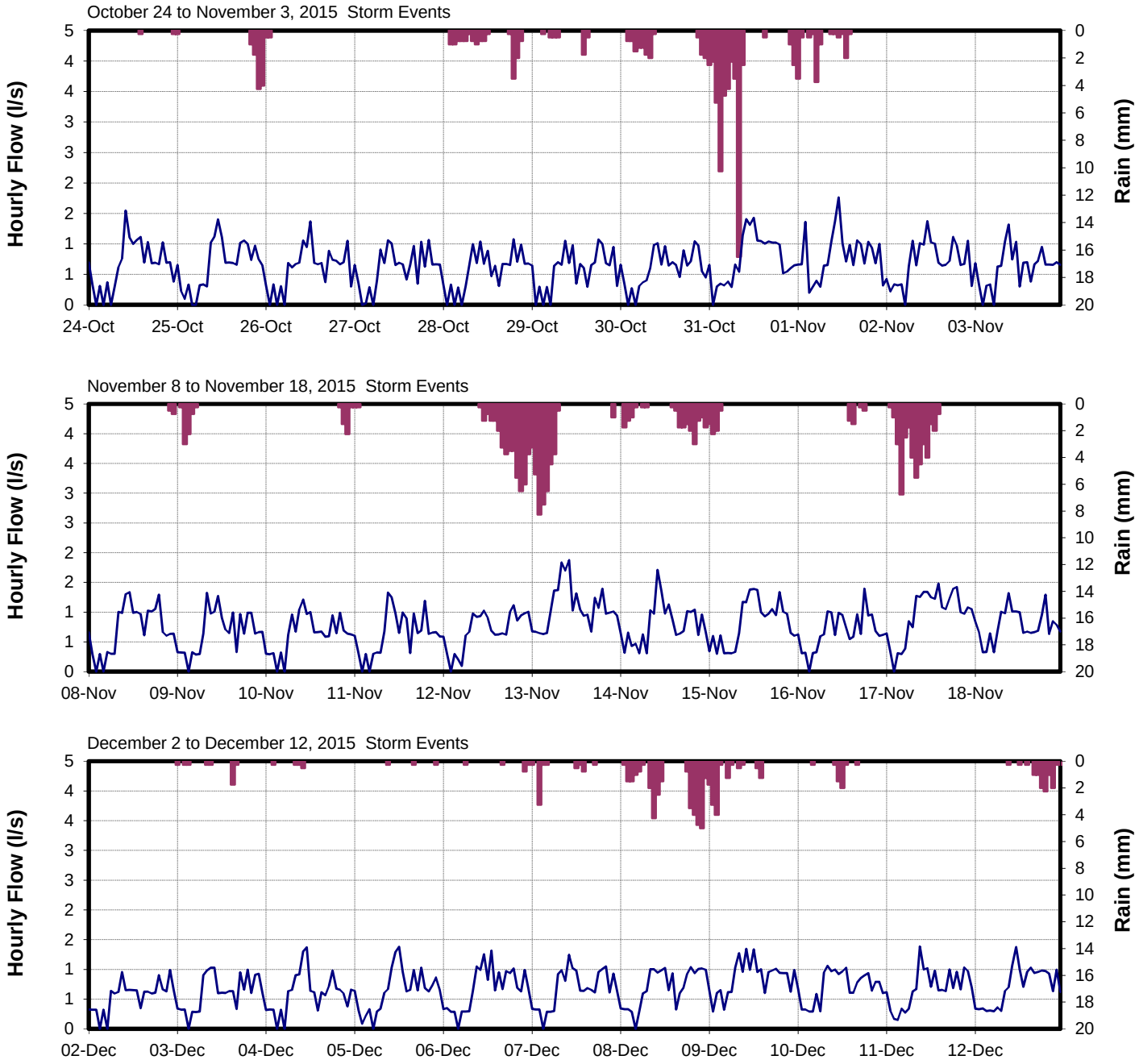
ADWF vs. PWWF Graph



Sea Haven (ES28)

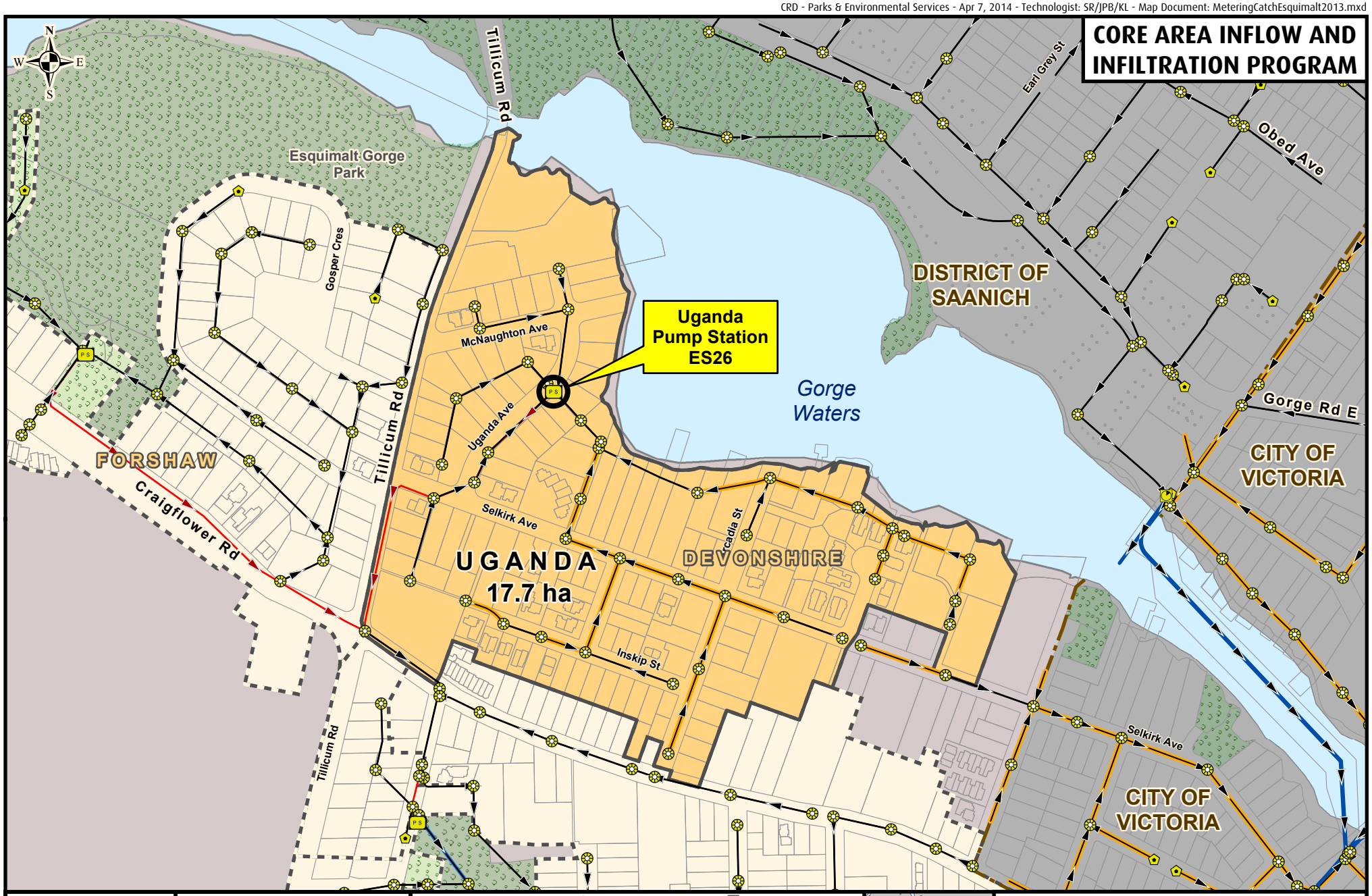


Sea Haven (ES28)



CRD - Parks & Environmental Services - Apr 7, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchEsquimalt2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100 150

Projection: UTM ZONE 10N NAD 83

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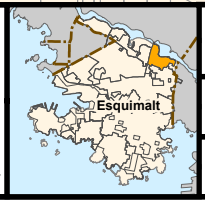
- Catchment Boundary Municipal, First Nation, or DND Boundaries

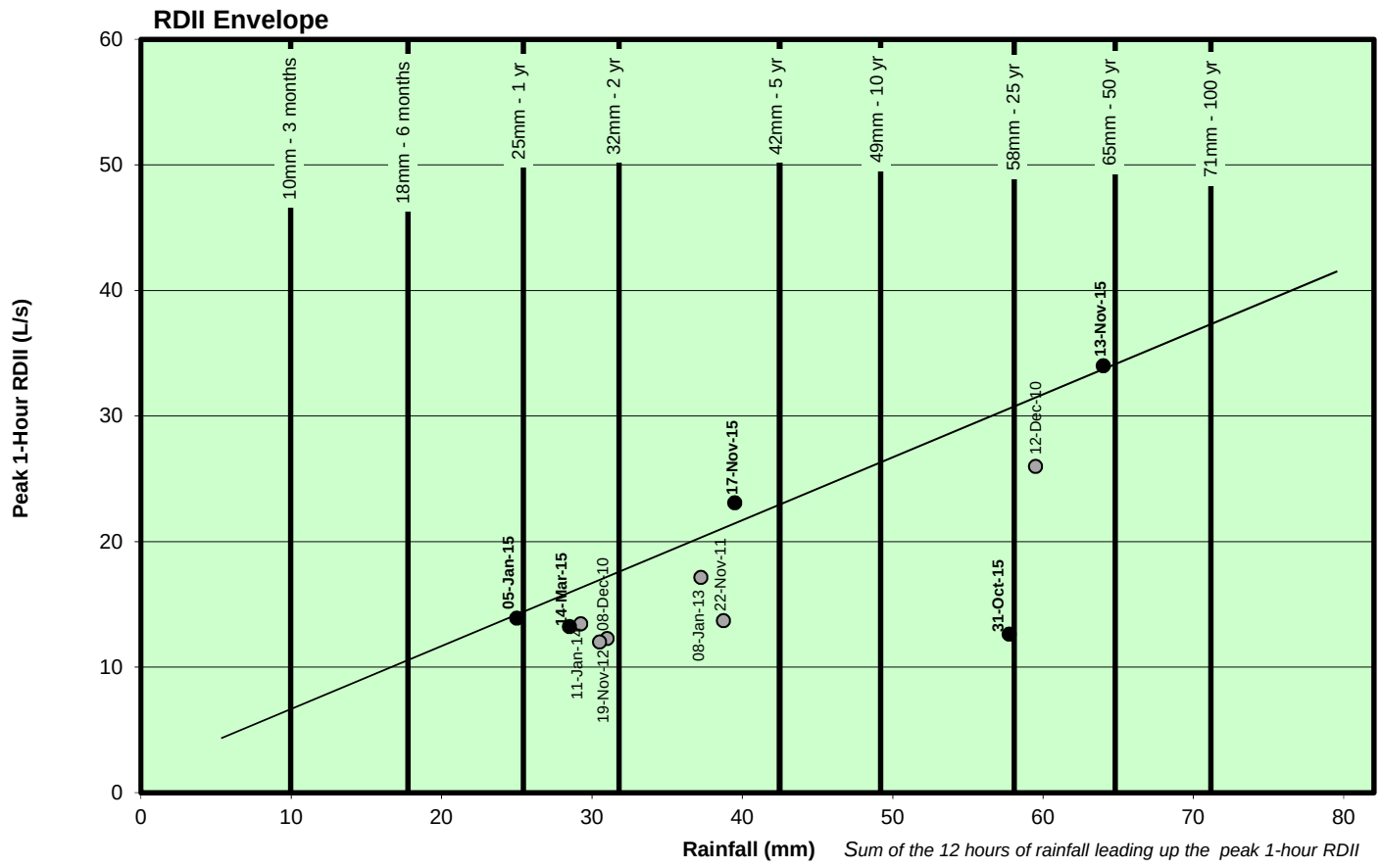


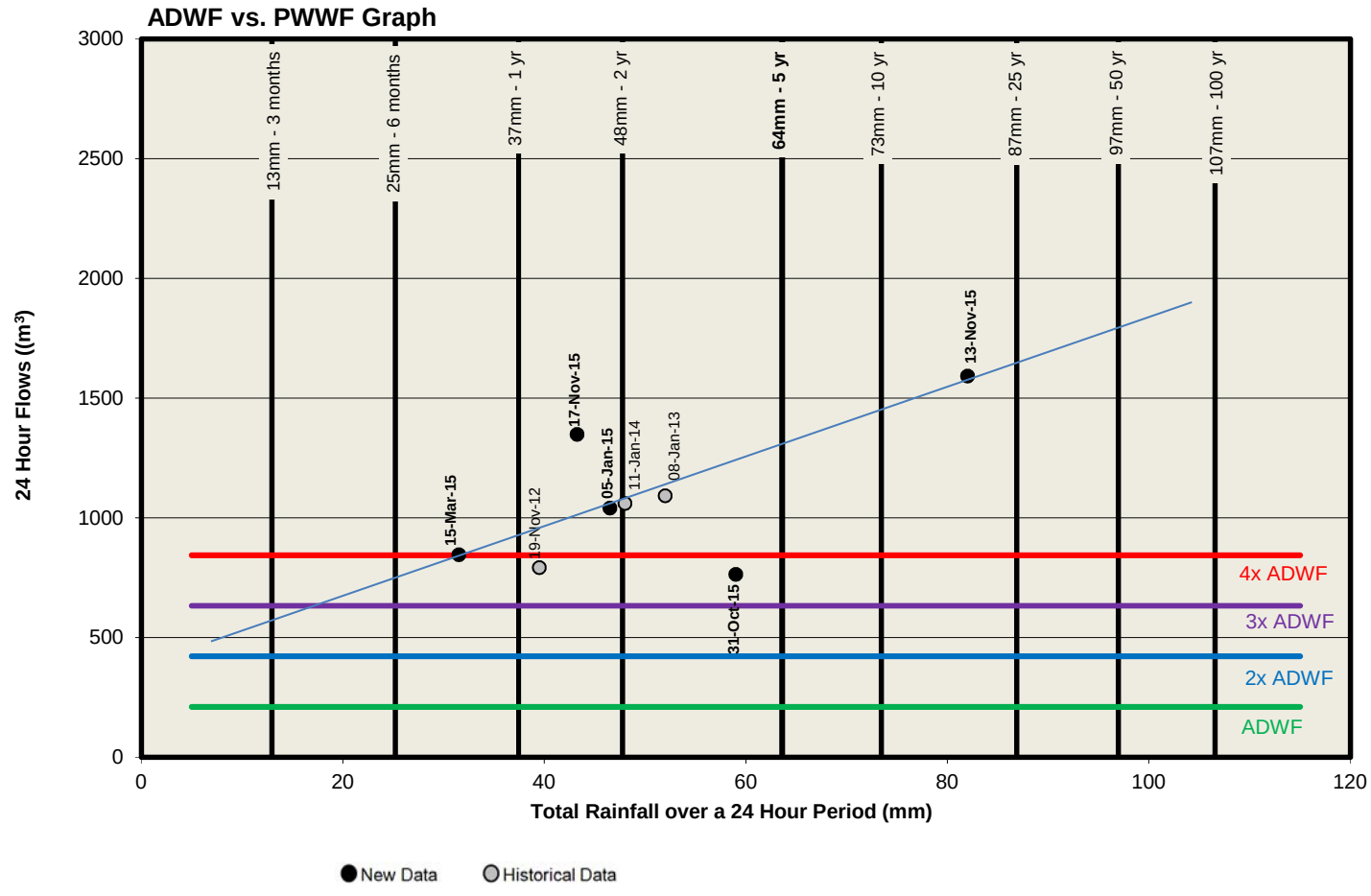
FLOW MONITORING AREA

CATCHMENT: UGANDA

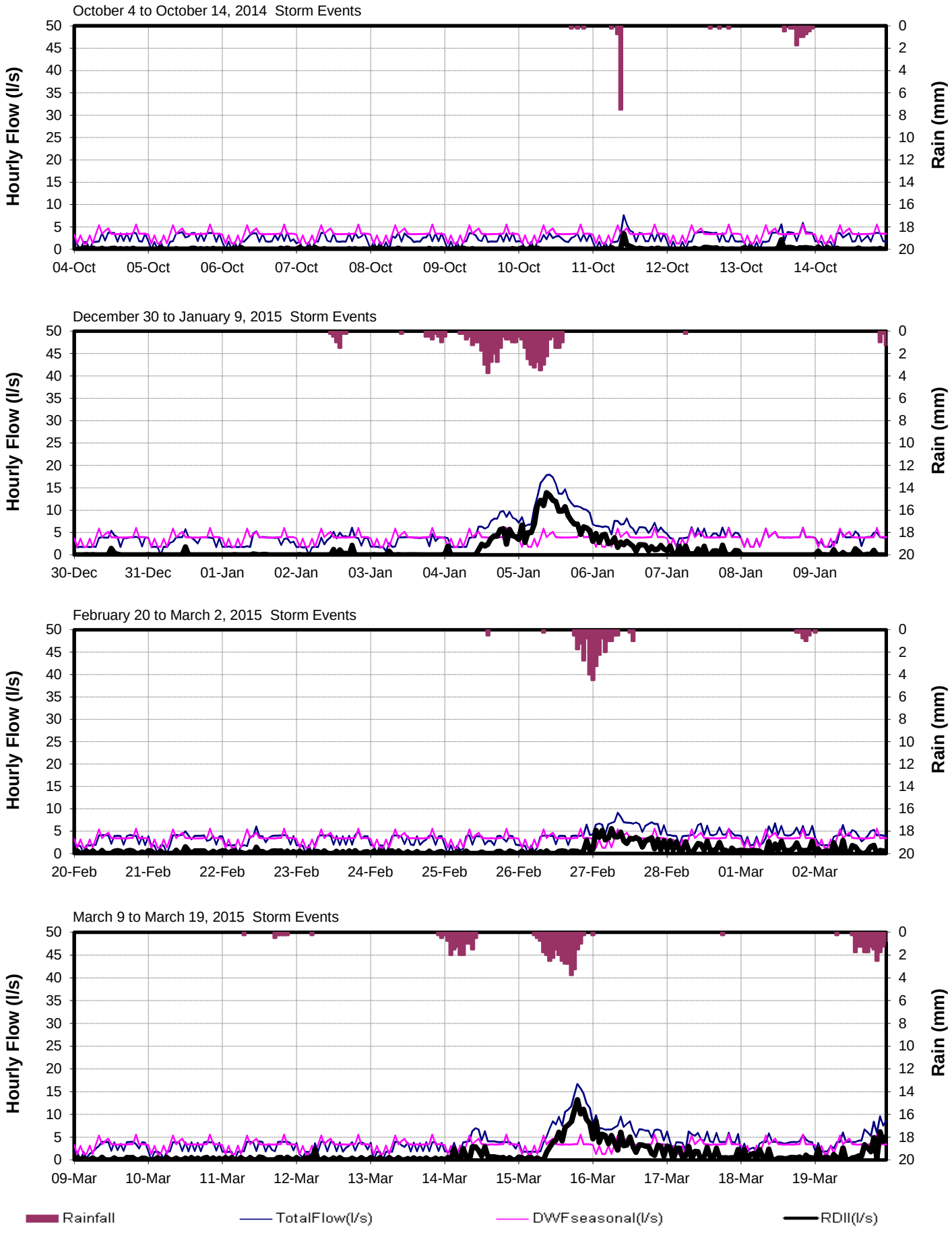
SITE CODE: **ES26**

Uganda (ES26)

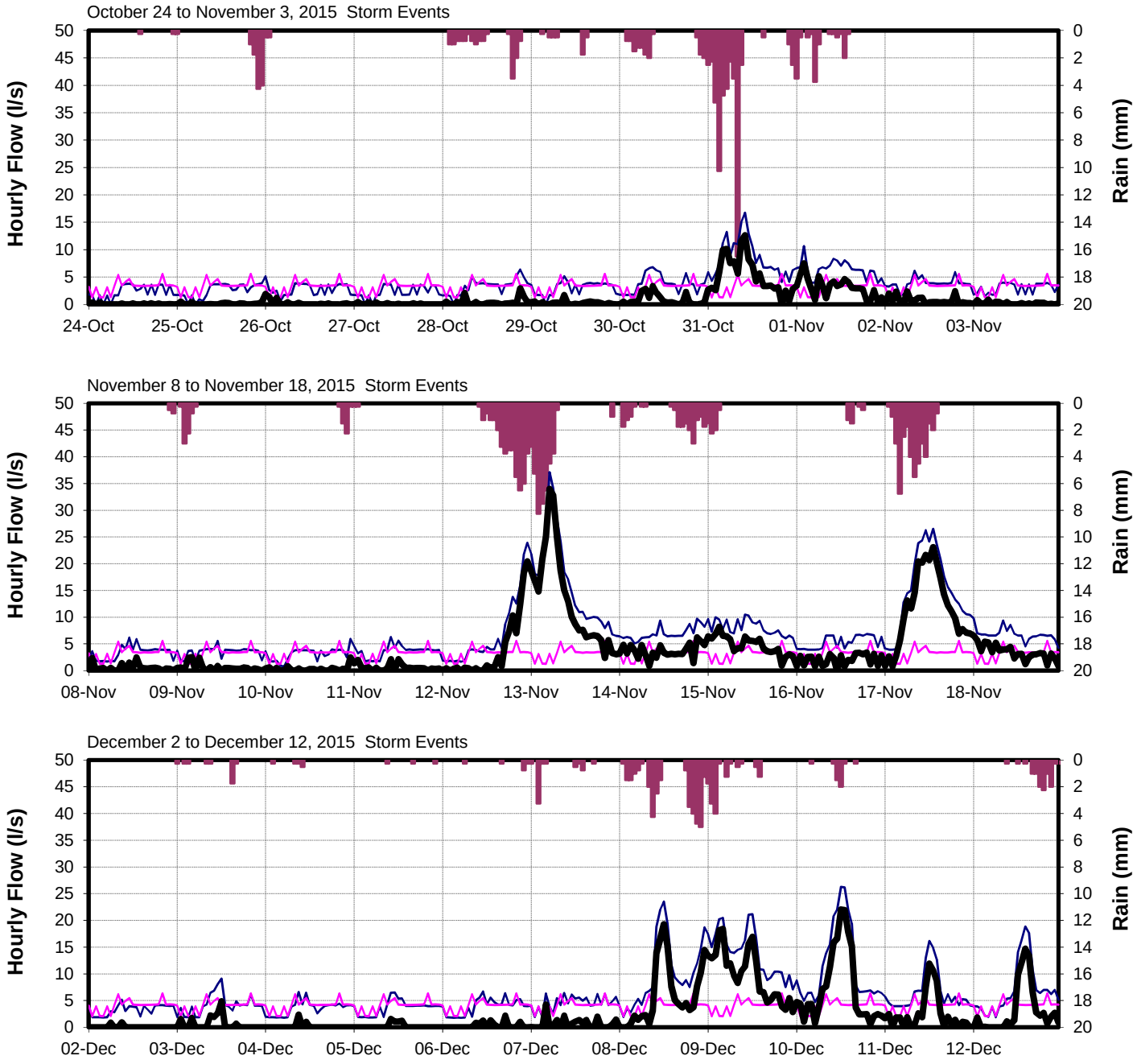

RDII Envelope
Peak 1-Hour RDII (L/s)
Rainfall (mm)
Sum of the 12 hours of rainfall leading up the peak 1-hour RDII
10mm - 3 months
18mm - 6 months
25mm - 1 yr
32mm - 2 yr
42mm - 5 yr
49mm - 10 yr
58mm - 25 yr
65mm - 50 yr
71mm - 100 yr
05-Jan-15
14-Mar-15
11-Jan-14
08-Dec-10
19-Nov-12
17-Nov-15
08-Jan-13
22-Nov-11
31-Oct-15
12-Dec-10
13-Nov-15


ADWF vs. PWWF Graph
24 Hour Flows ((m³)
Total Rainfall over a 24 Hour Period (mm)
13mm - 3 months
25mm - 6 months
37mm - 1 yr
48mm - 2 yr
64mm - 5 yr
73mm - 10 yr
87mm - 25 yr
97mm - 50 yr
107mm - 100 yr
15-Mar-15
19-Nov-12
17-Nov-15
05-Jan-15
11-Jan-14
08-Jan-13
31-Oct-15
13-Nov-15
4x ADWF
3x ADWF
2x ADWF
ADWF
New Data
Historical Data

Uganda (ES26)

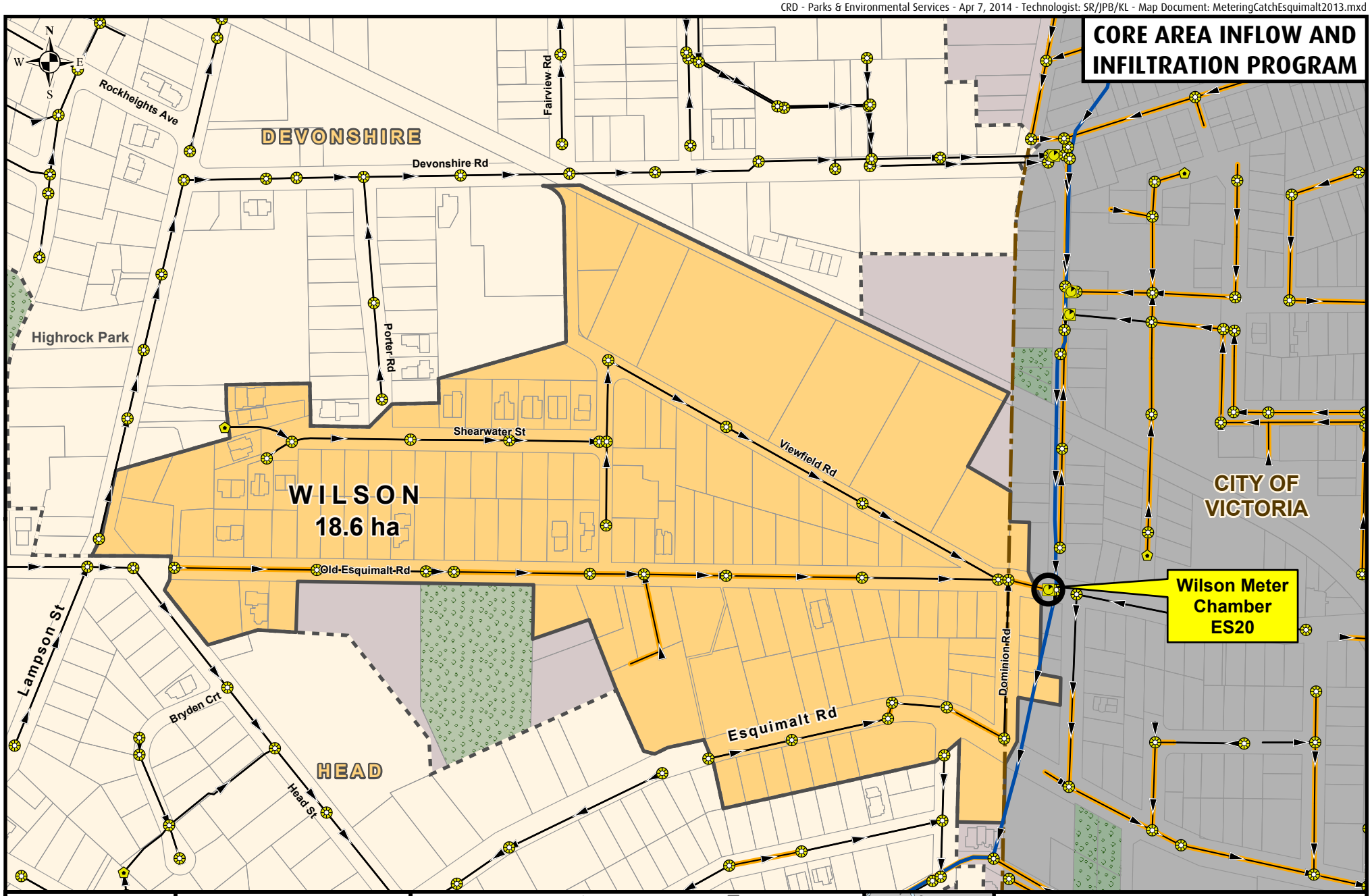

October 4 to October 14, 2014 Storm Events
Hourly Flow (l/s)
Rain (mm)
04-Oct
05-Oct
06-Oct
07-Oct
08-Oct
09-Oct
10-Oct
11-Oct
12-Oct
13-Oct
14-Oct
December 30 to January 9, 2015 Storm Events
30-Dec
31-Dec
01-Jan
02-Jan
03-Jan
04-Jan
05-Jan
06-Jan
07-Jan
08-Jan
09-Jan
February 20 to March 2, 2015 Storm Events
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
26-Feb
27-Feb
28-Feb
01-Mar
02-Mar
March 9 to March 19, 2015 Storm Events
09-Mar
10-Mar
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
19-Mar
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

Uganda (ES26)


October 24 to November 3, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
24-Oct
25-Oct
26-Oct
27-Oct
28-Oct
29-Oct
30-Oct
31-Oct
01-Nov
02-Nov
03-Nov
November 8 to November 18, 2015 Storm Events
08-Nov
09-Nov
10-Nov
11-Nov
12-Nov
13-Nov
14-Nov
15-Nov
16-Nov
17-Nov
18-Nov
December 2 to December 12, 2015 Storm Events
02-Dec
03-Dec
04-Dec
05-Dec
06-Dec
07-Dec
08-Dec
09-Dec
10-Dec
11-Dec
12-Dec
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

CRD - Parks & Environmental Services - Apr 7, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchEsquimalt2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100

Projection: UTM ZONE 10N NAD 83

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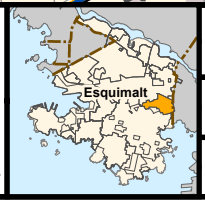
- Parks
- Sewered Park Areas
- Catchment Boundary
- Municipal, First Nation, or DND Boundaries



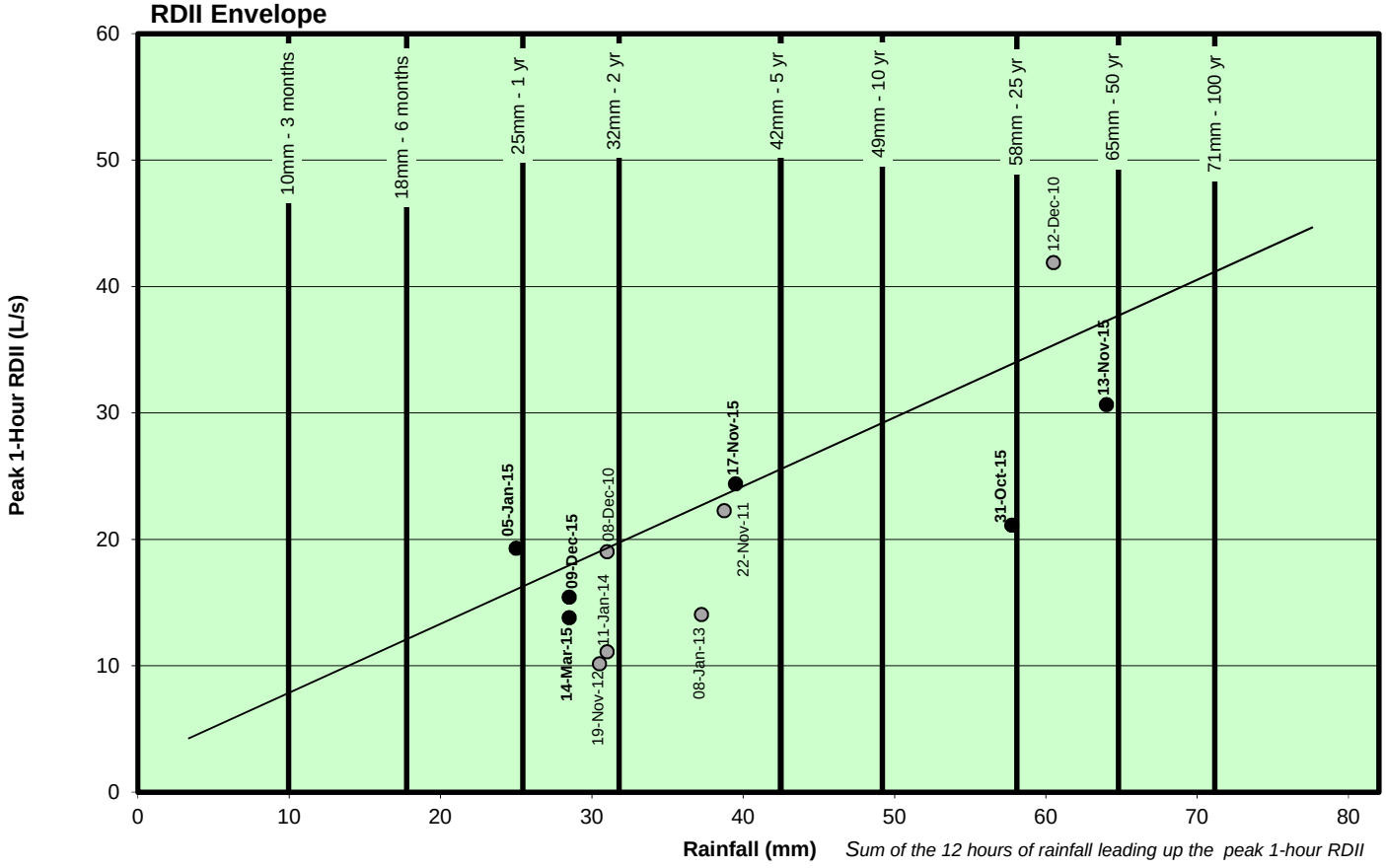
FLOW MONITORING AREA

CATCHMENT: WILSON

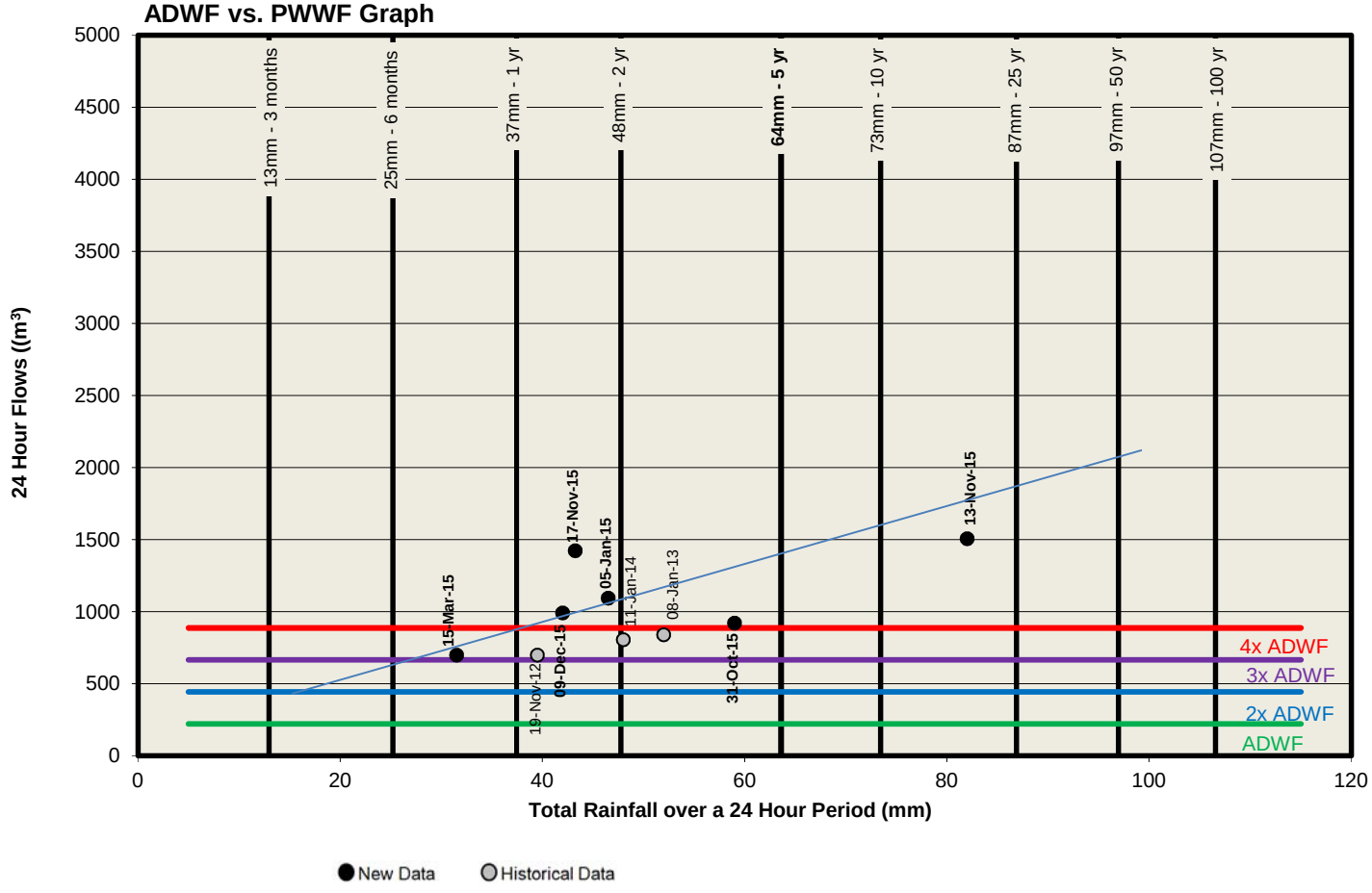
SITE CODE: **ES20**

Wilson (ES20)

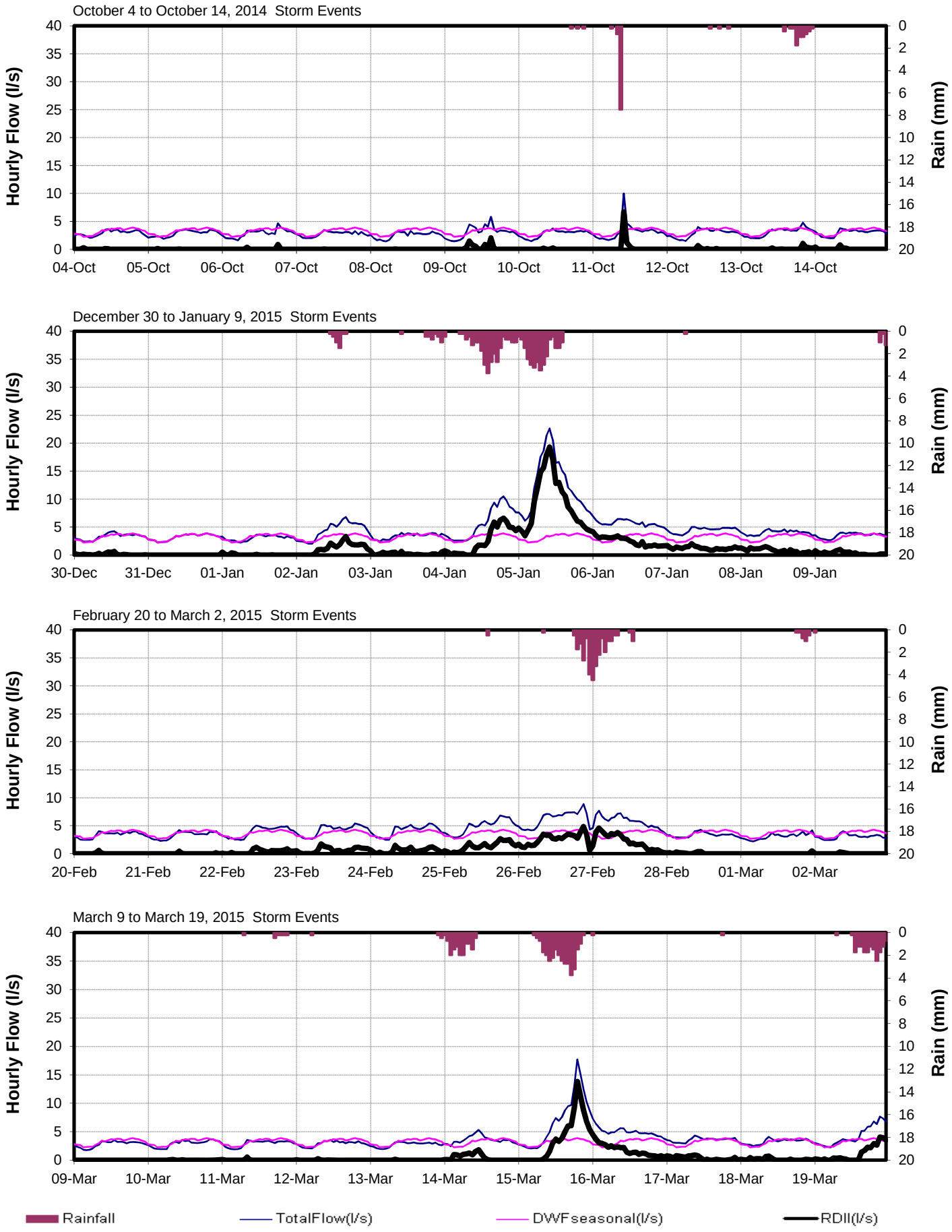
RDII Envelope



ADWF vs. PWWF Graph



Wilson (ES20)


October 4 to October 14, 2014 Storm Events
Hourly Flow (l/s)
Rain (mm)
04-Oct
05-Oct
06-Oct
07-Oct
08-Oct
09-Oct
10-Oct
11-Oct
12-Oct
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20-Feb
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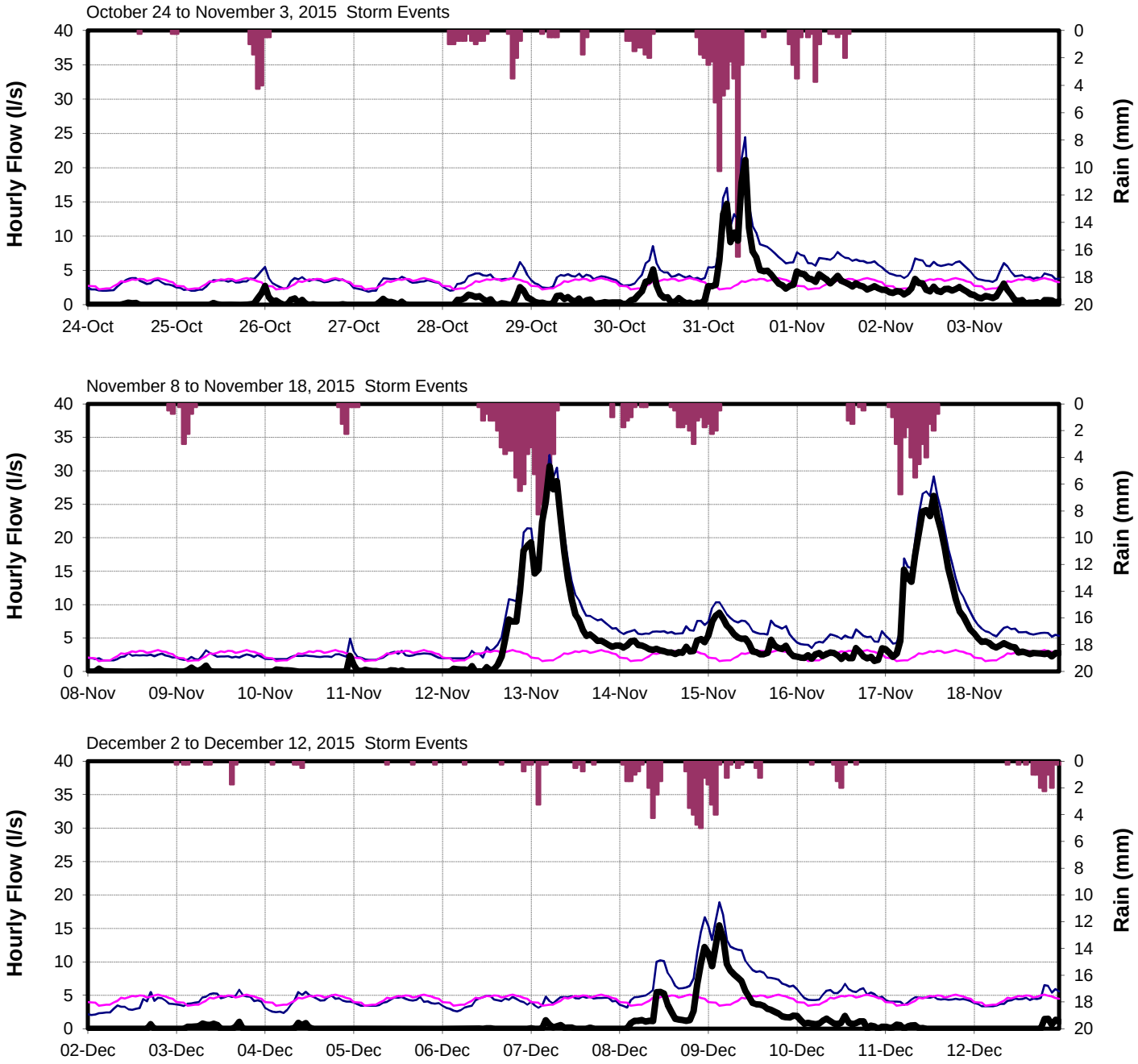
22-Feb
23-Feb
24-Feb
25-Feb
26-Feb
27-Feb
28-Feb
01-Mar
02-Mar
March 9 to March 19, 2015 Storm Events
09-Mar
10-Mar
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
19-Mar
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

Wilson (ES20)


October 24 to November 3, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
0
5
10
15
20
25
30
35
40
0
2
4
6
8
10
12
14
16
18
20
24-Oct
25-Oct
26-Oct
27-Oct
28-Oct
29-Oct
30-Oct
31-Oct
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02-Nov
03-Nov
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Hourly Flow (l/s)
Rain (mm)
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09-Nov
10-Nov
11-Nov
12-Nov
13-Nov
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15-Nov
16-Nov
17-Nov
18-Nov
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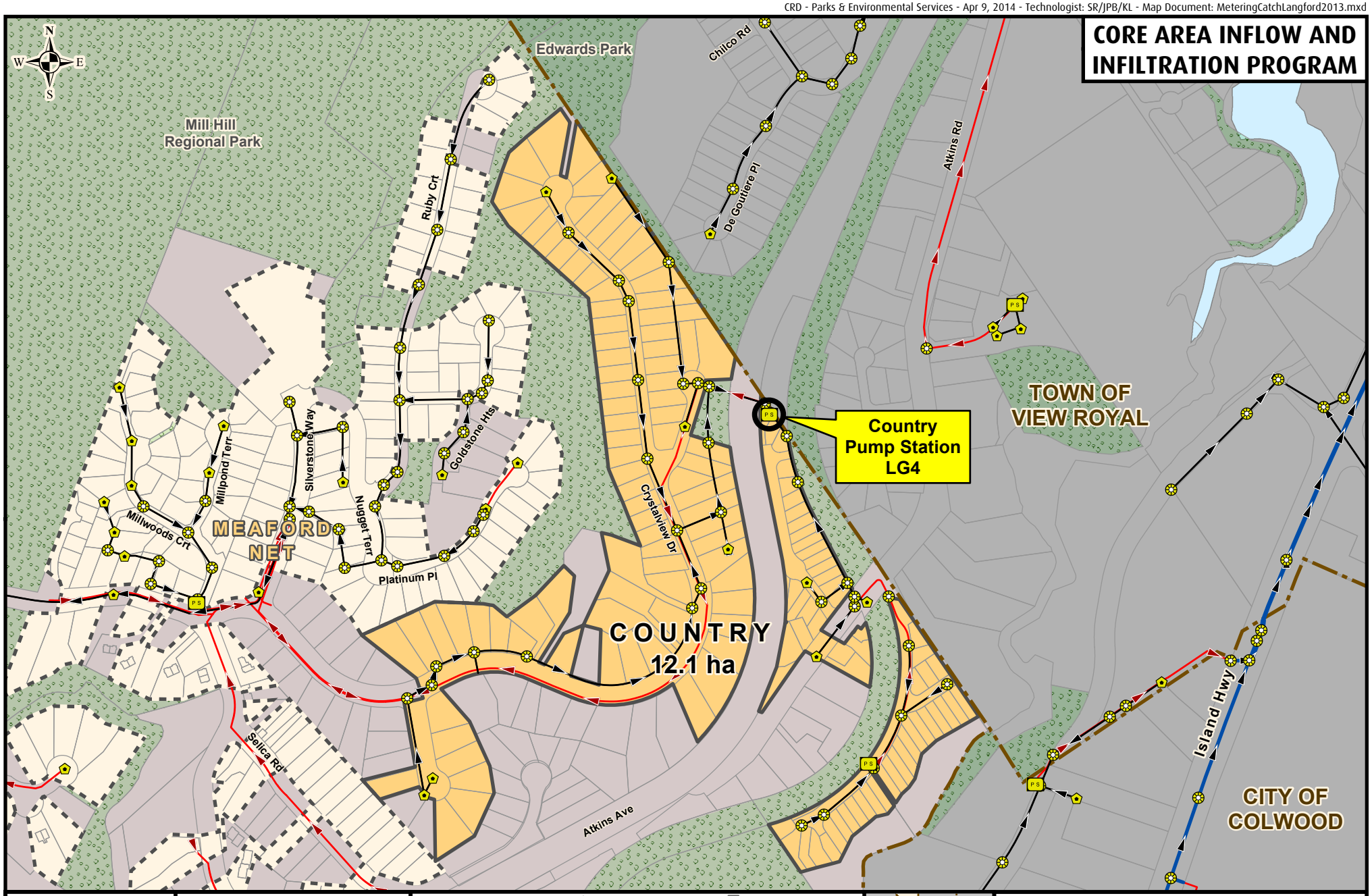
Hourly Flow (l/s)
Rain (mm)
02-Dec
03-Dec
04-Dec
05-Dec
06-Dec
07-Dec
08-Dec
09-Dec
10-Dec
11-Dec
12-Dec
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

CRD - Parks & Environmental Services - Apr 9, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchLangford2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100 150

Projection: UTM ZONE 10N NAD 83

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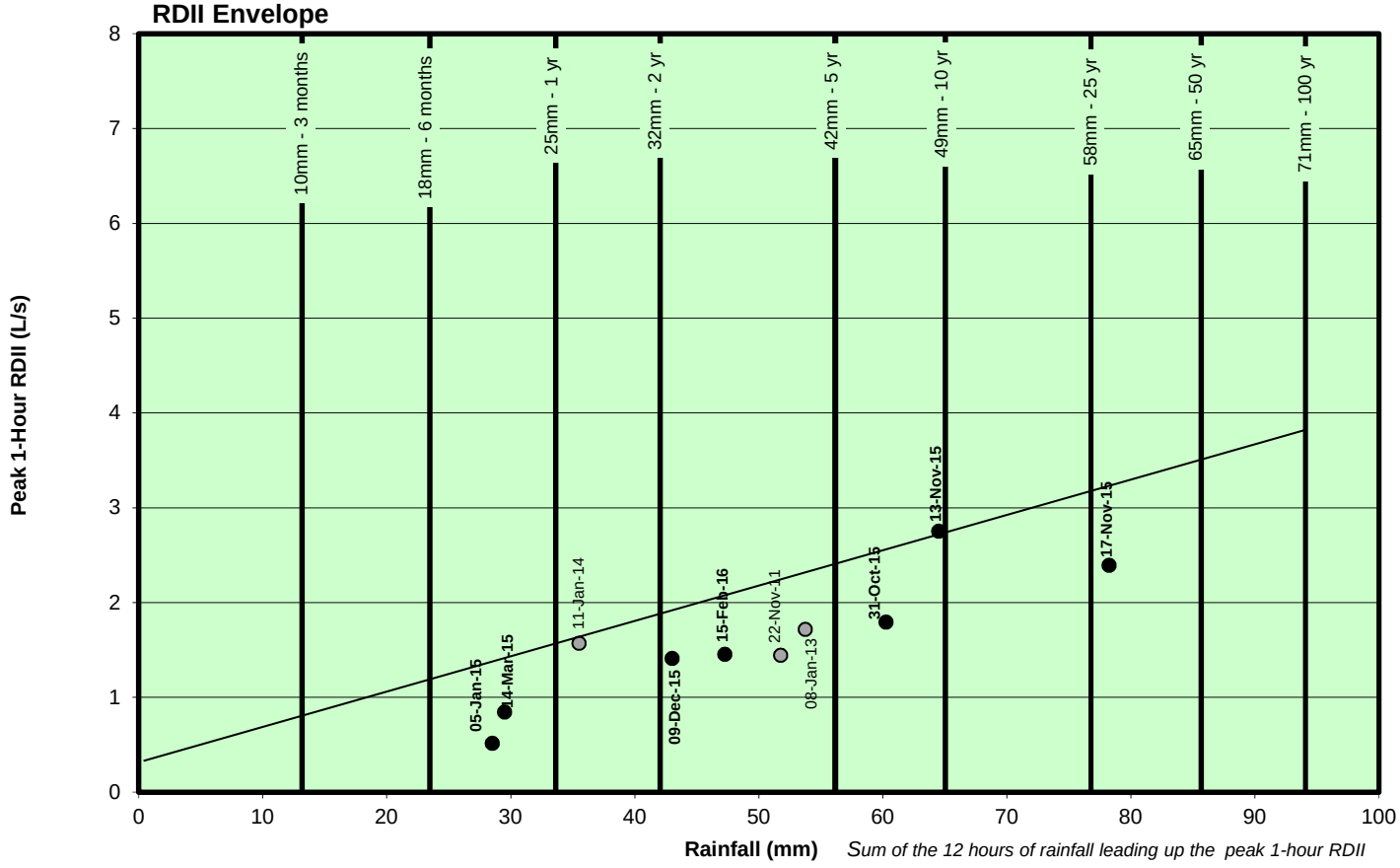
FLOW MONITORING AREA

CATCHMENT: COUNTRY

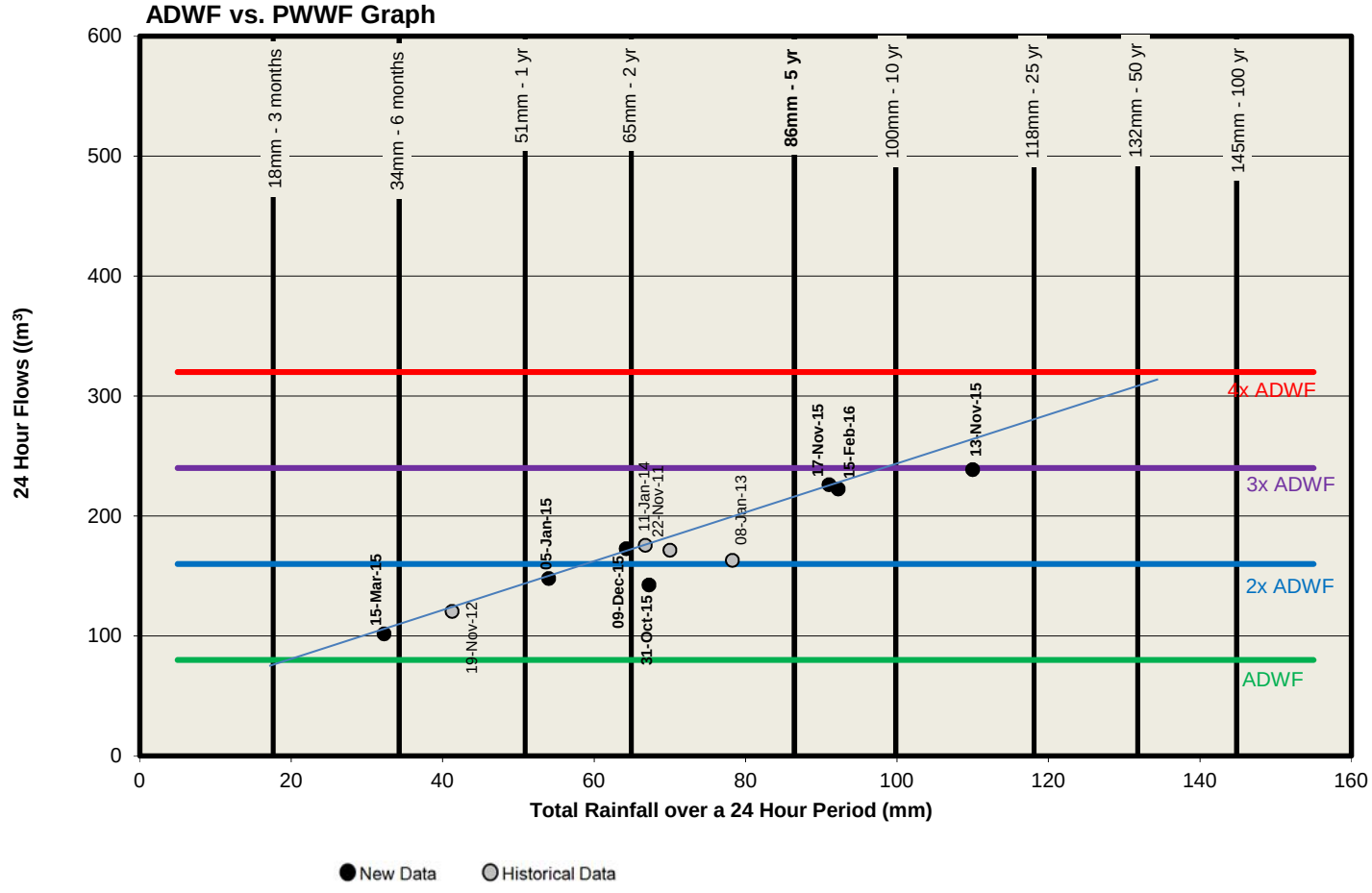
SITE CODE: **LG4**

Country (LG4)

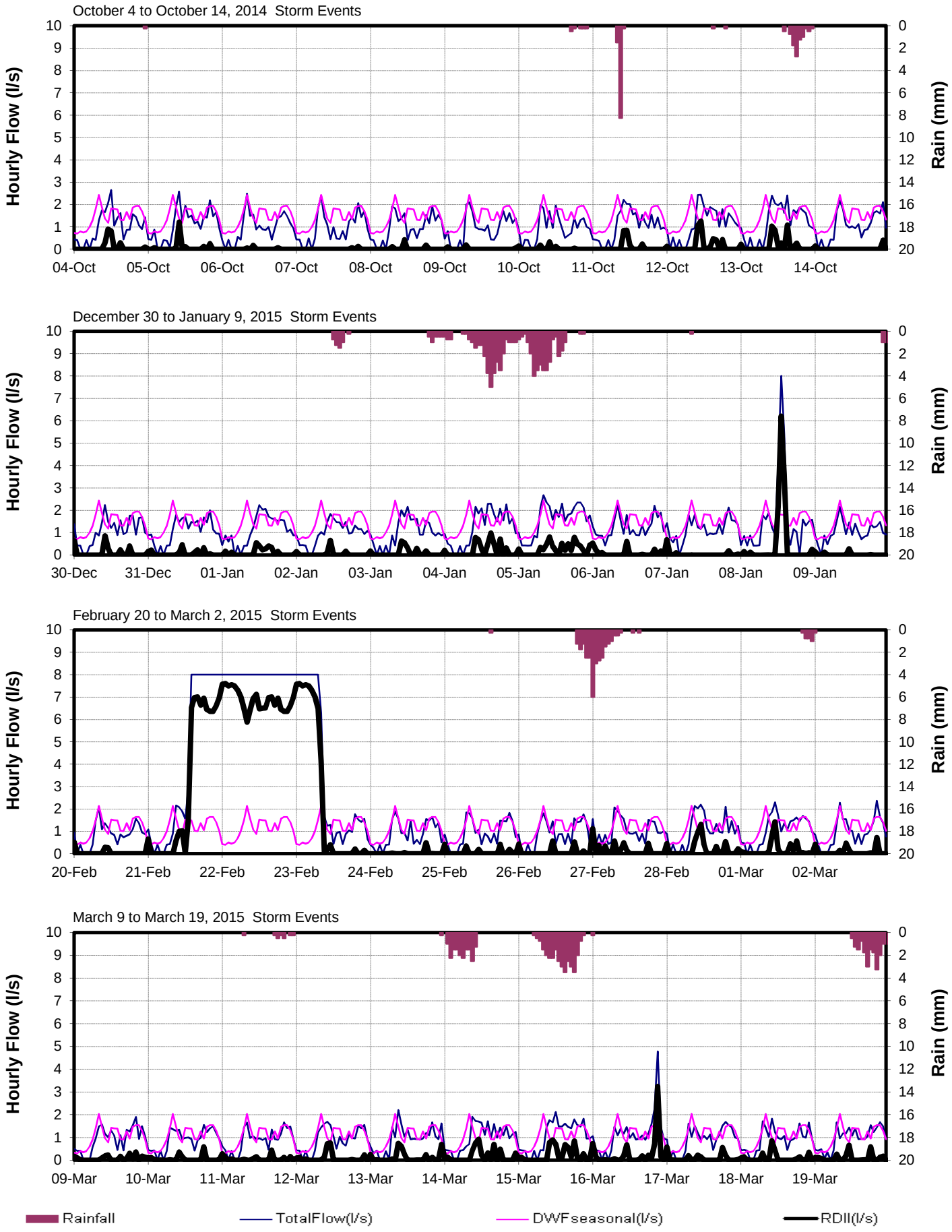
RDII Envelope



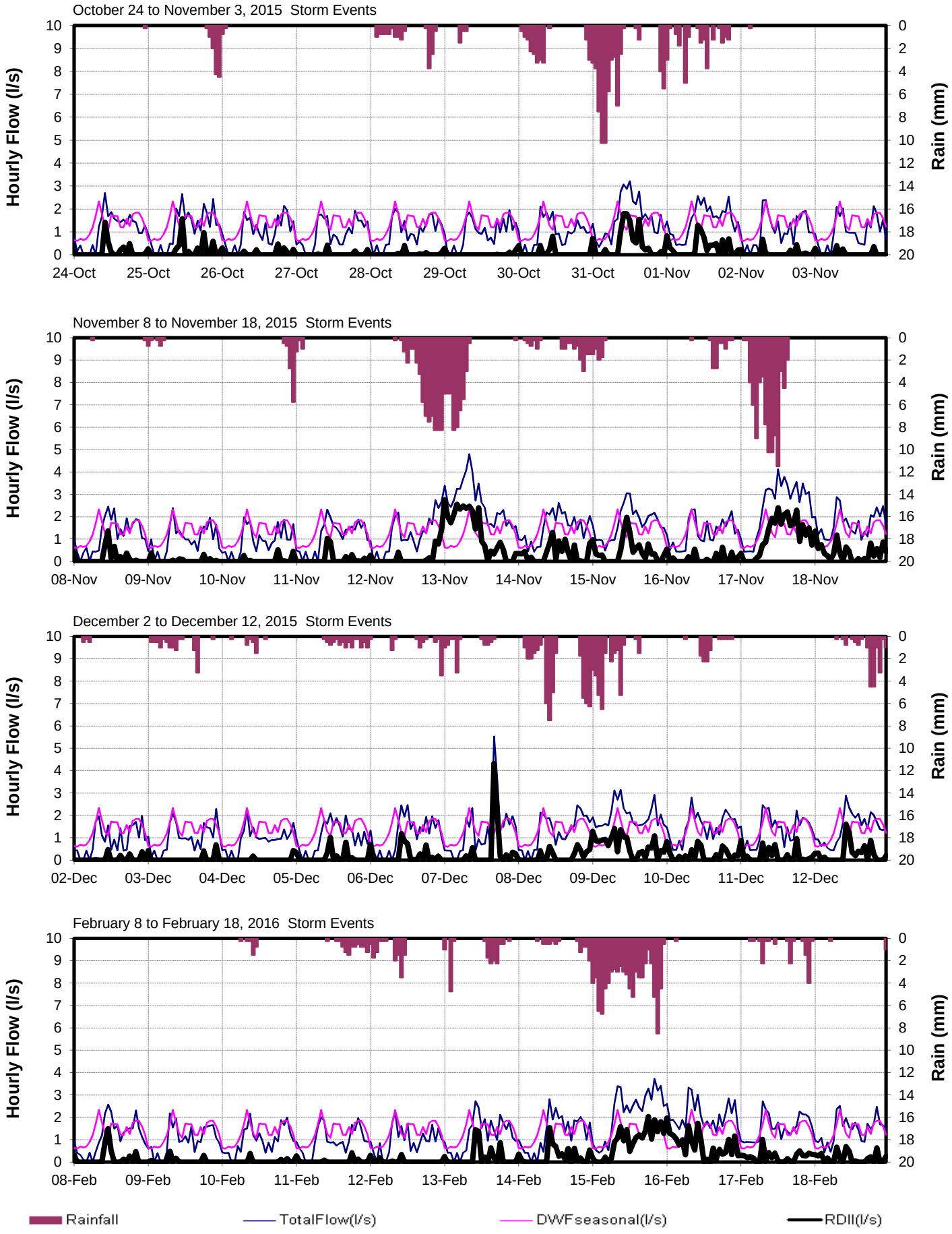
ADWF vs. PWWF Graph



Country (LG4)

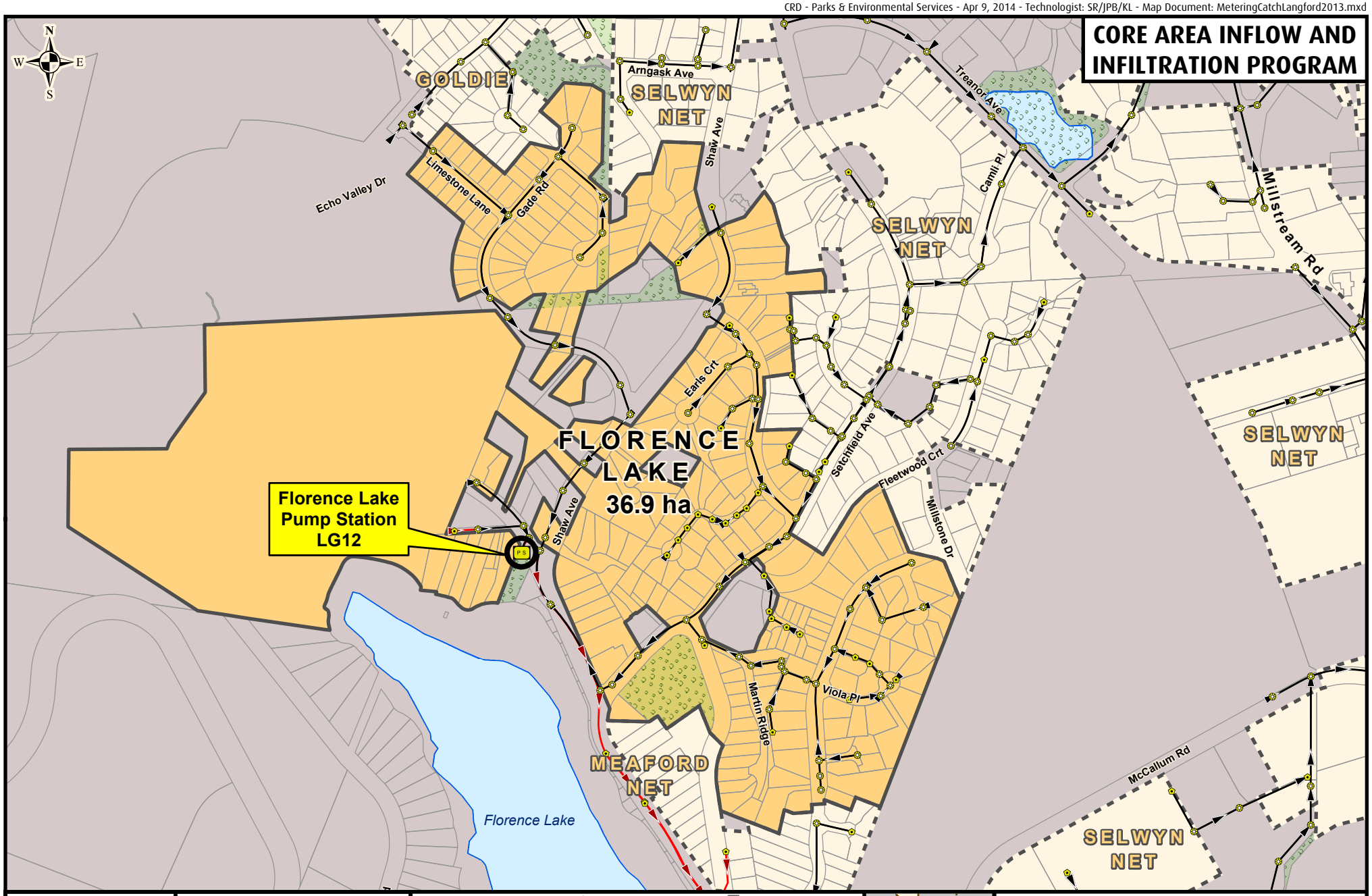

October 4 to October 14, 2014 Storm Events
Hourly Flow (l/s)
Rain (mm)
04-Oct
05-Oct
06-Oct
07-Oct
08-Oct
09-Oct
10-Oct
11-Oct
12-Oct
13-Oct
14-Oct
December 30 to January 9, 2015 Storm Events
30-Dec
31-Dec
01-Jan
02-Jan
03-Jan
04-Jan
05-Jan
06-Jan
07-Jan
08-Jan
09-Jan
February 20 to March 2, 2015 Storm Events
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
26-Feb
27-Feb
28-Feb
01-Mar
02-Mar
March 9 to March 19, 2015 Storm Events
09-Mar
10-Mar
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
19-Mar
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

Country (LG4)


October 24 to November 3, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
24-Oct
25-Oct
26-Oct
27-Oct
28-Oct
29-Oct
30-Oct
31-Oct
01-Nov
02-Nov
03-Nov
November 8 to November 18, 2015 Storm Events
08-Nov
09-Nov
10-Nov
11-Nov
12-Nov
13-Nov
14-Nov
15-Nov
16-Nov
17-Nov
18-Nov
December 2 to December 12, 2015 Storm Events
02-Dec
03-Dec
04-Dec
05-Dec
06-Dec
07-Dec
08-Dec
09-Dec
10-Dec
11-Dec
12-Dec
February 8 to February 18, 2016 Storm Events
08-Feb
09-Feb
10-Feb
11-Feb
12-Feb
13-Feb
14-Feb
15-Feb
16-Feb
17-Feb
18-Feb
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

CRD - Parks & Environmental Services - Apr 9, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchLangford2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100 150

Projection: UTM ZONE 10N NAD 83

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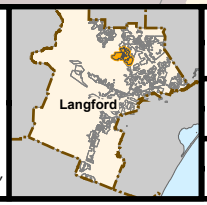
- Catchment Boundary
- Municipal, First Nation, or DND Boundaries



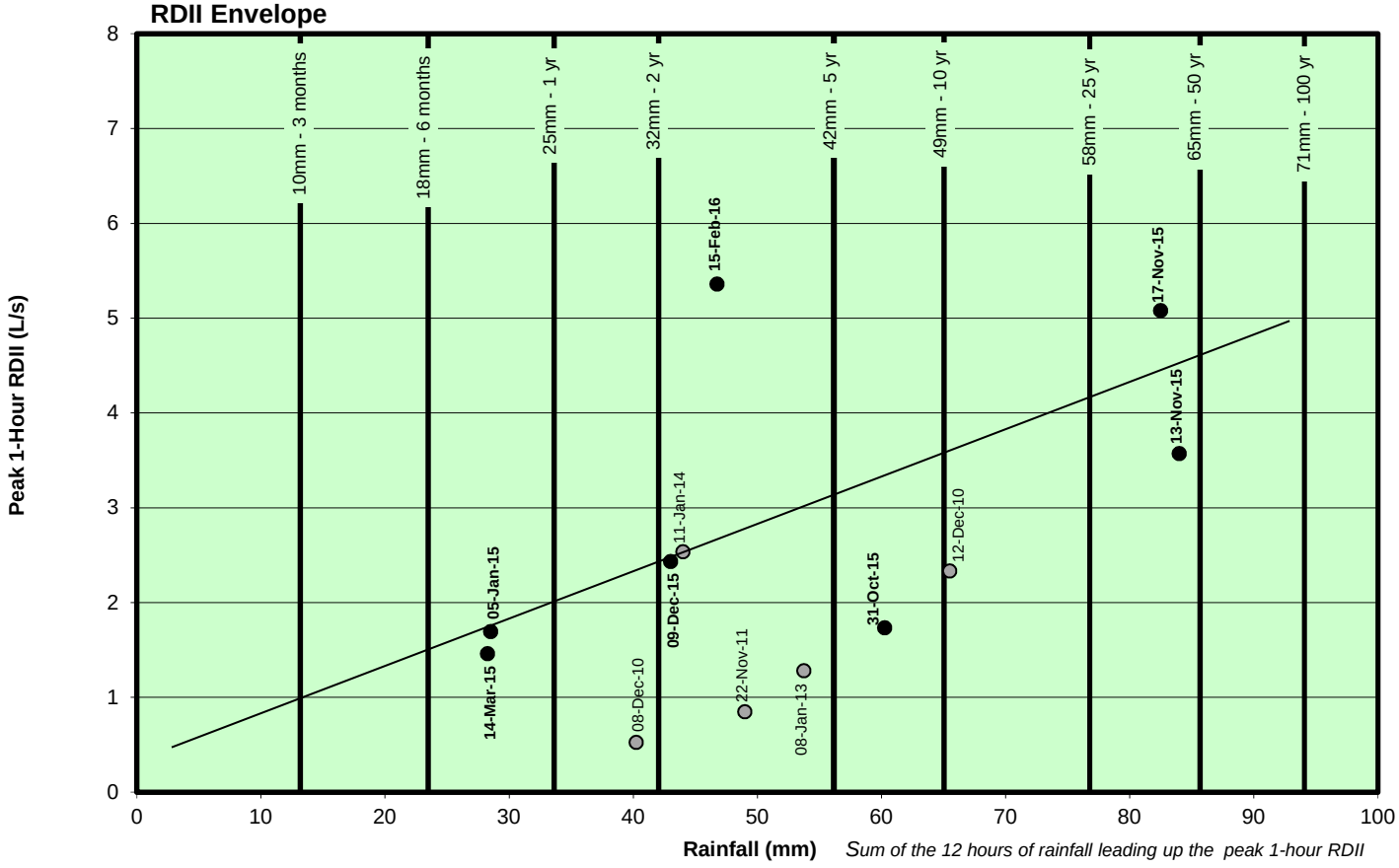
FLOW MONITORING AREA

CATCHMENT: FLORENCE LAKE

SITE CODE: **LG12**

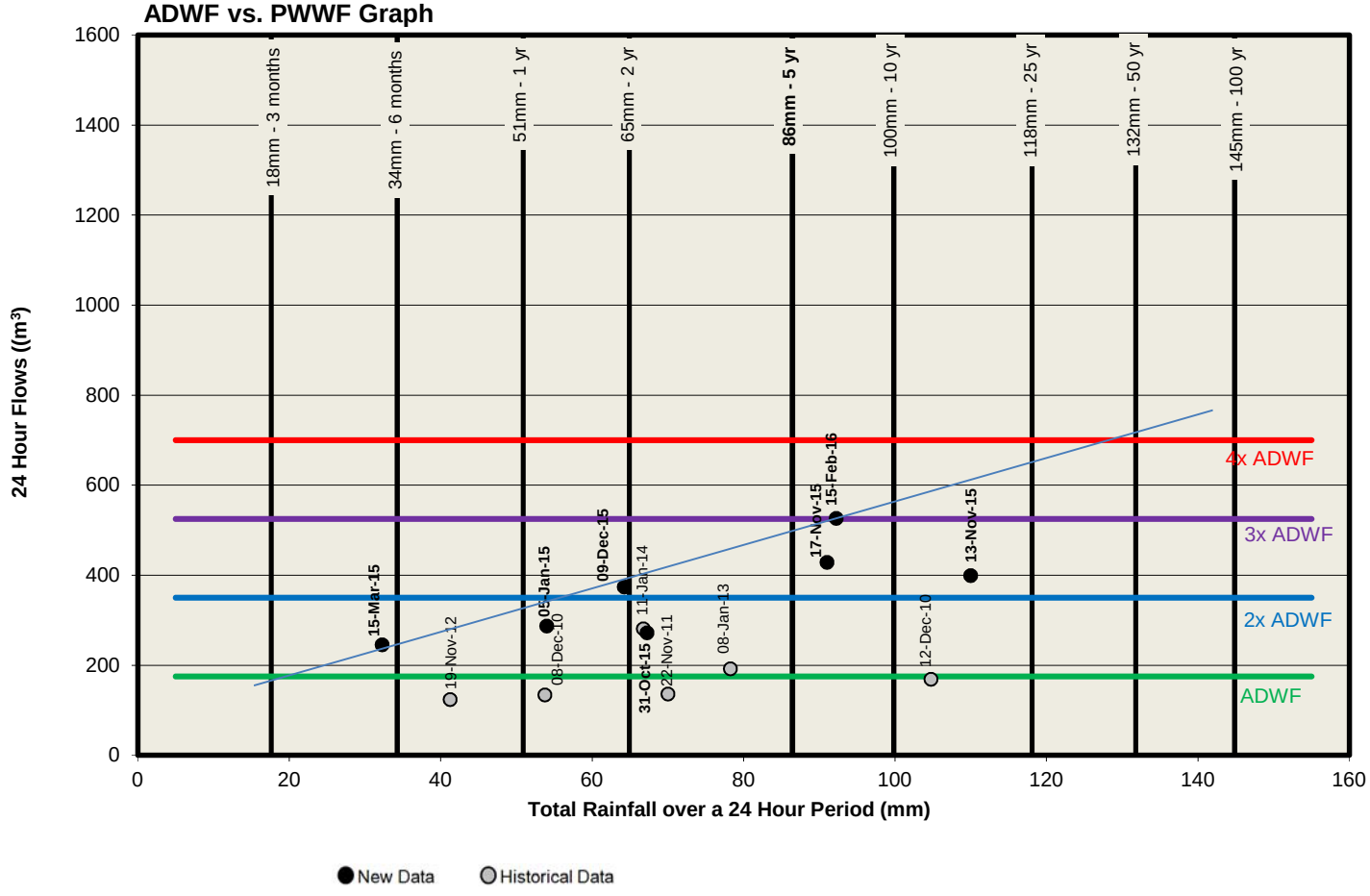
Florence (LG12)

RDII Envelope

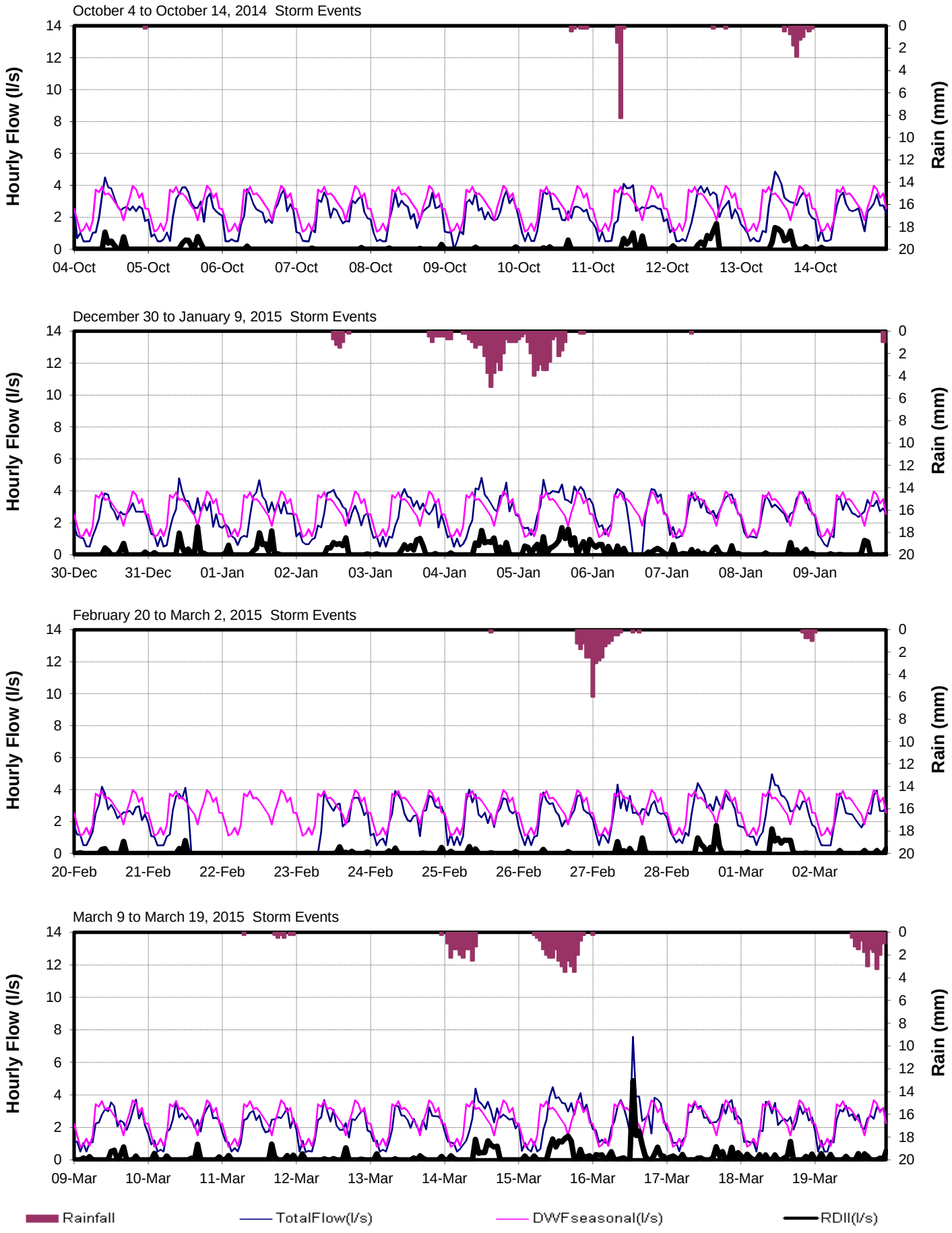


Sum of the 12 hours of rainfall leading up the peak 1-hour RDII

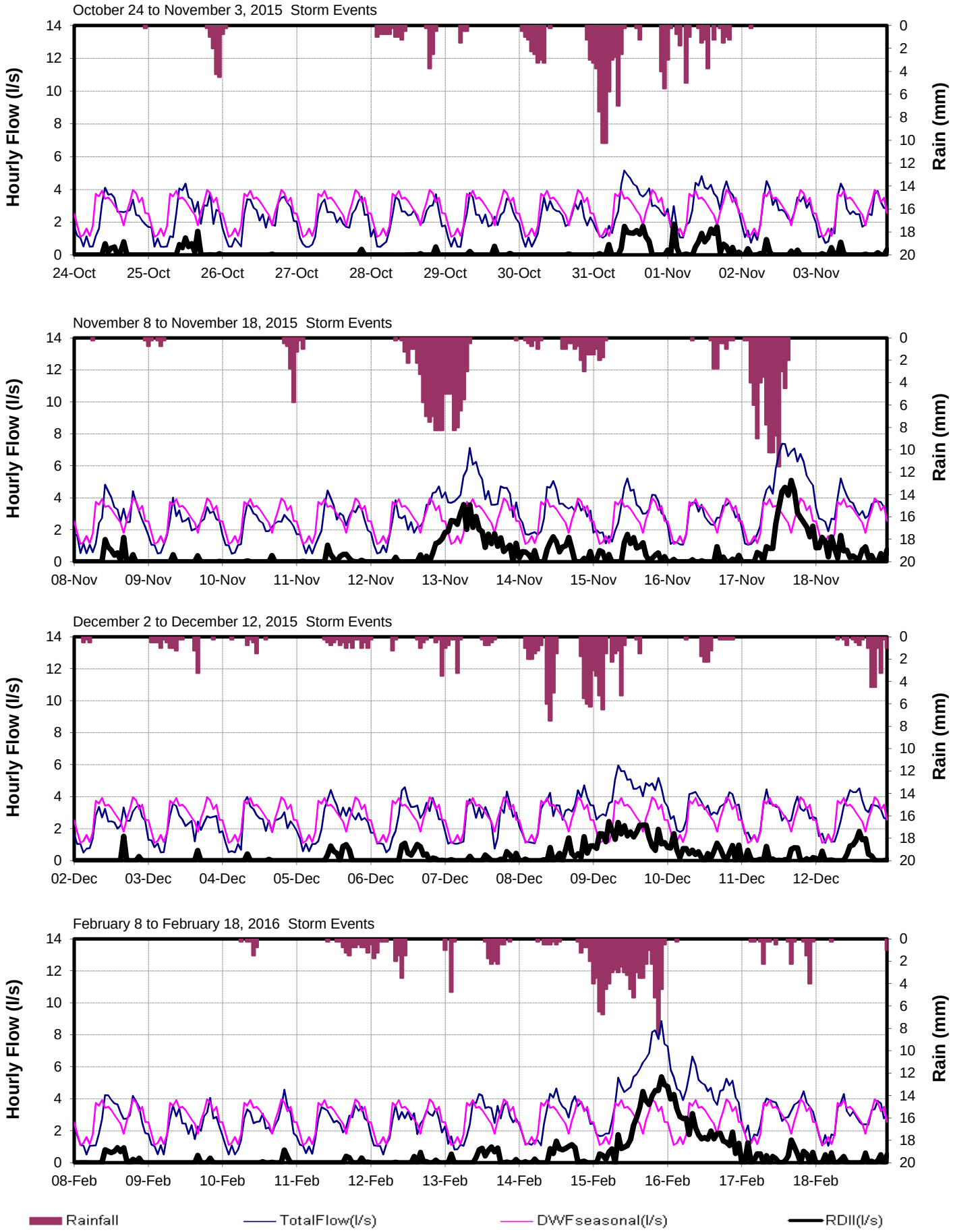
ADWF vs. PWWF Graph



Florence (LG12)



Florence (LG12)



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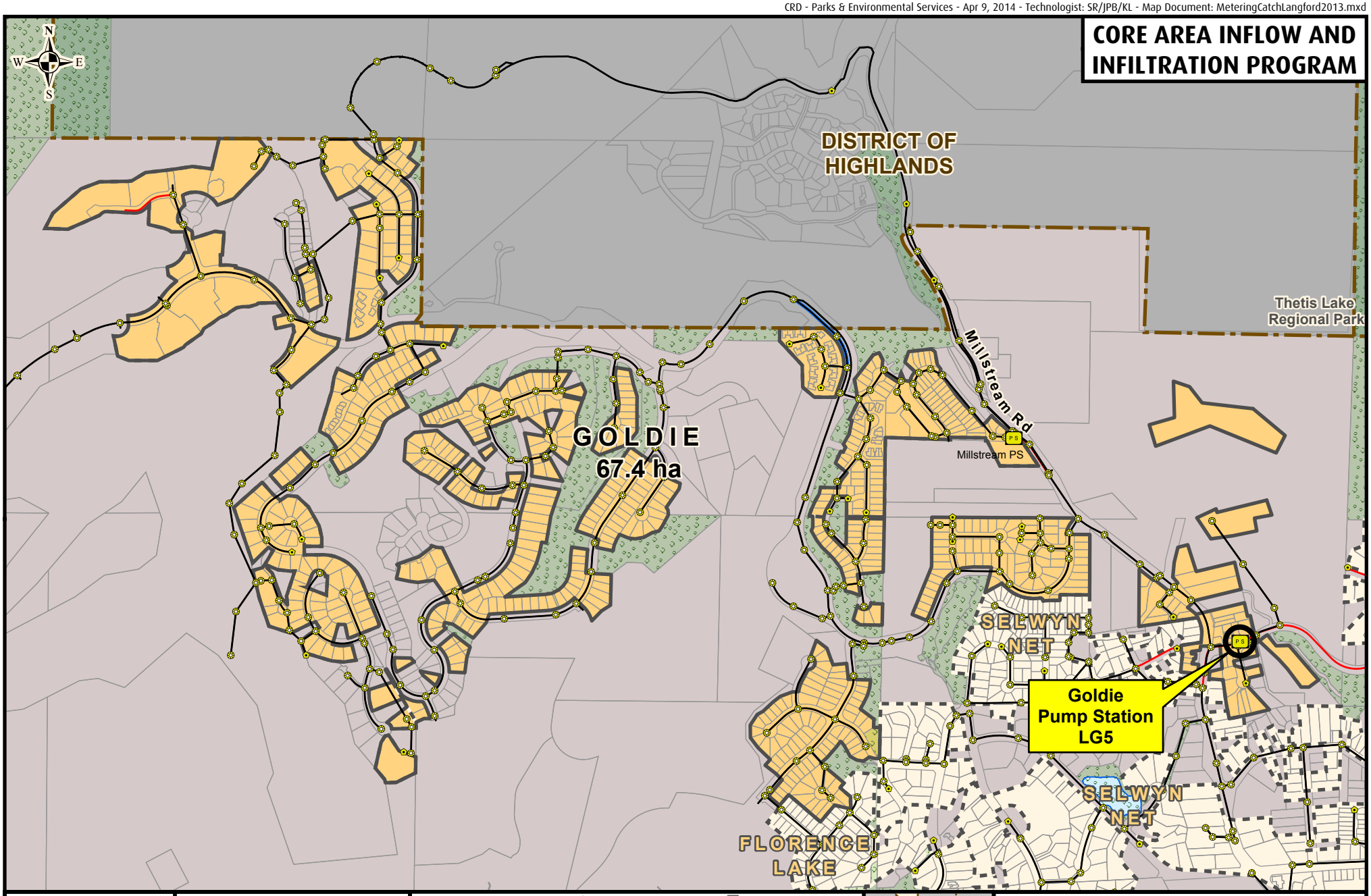
CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 100 200 300

Projection: UTM ZONE 10N NAD 83

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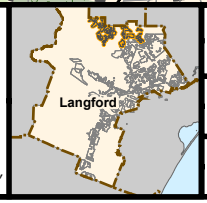


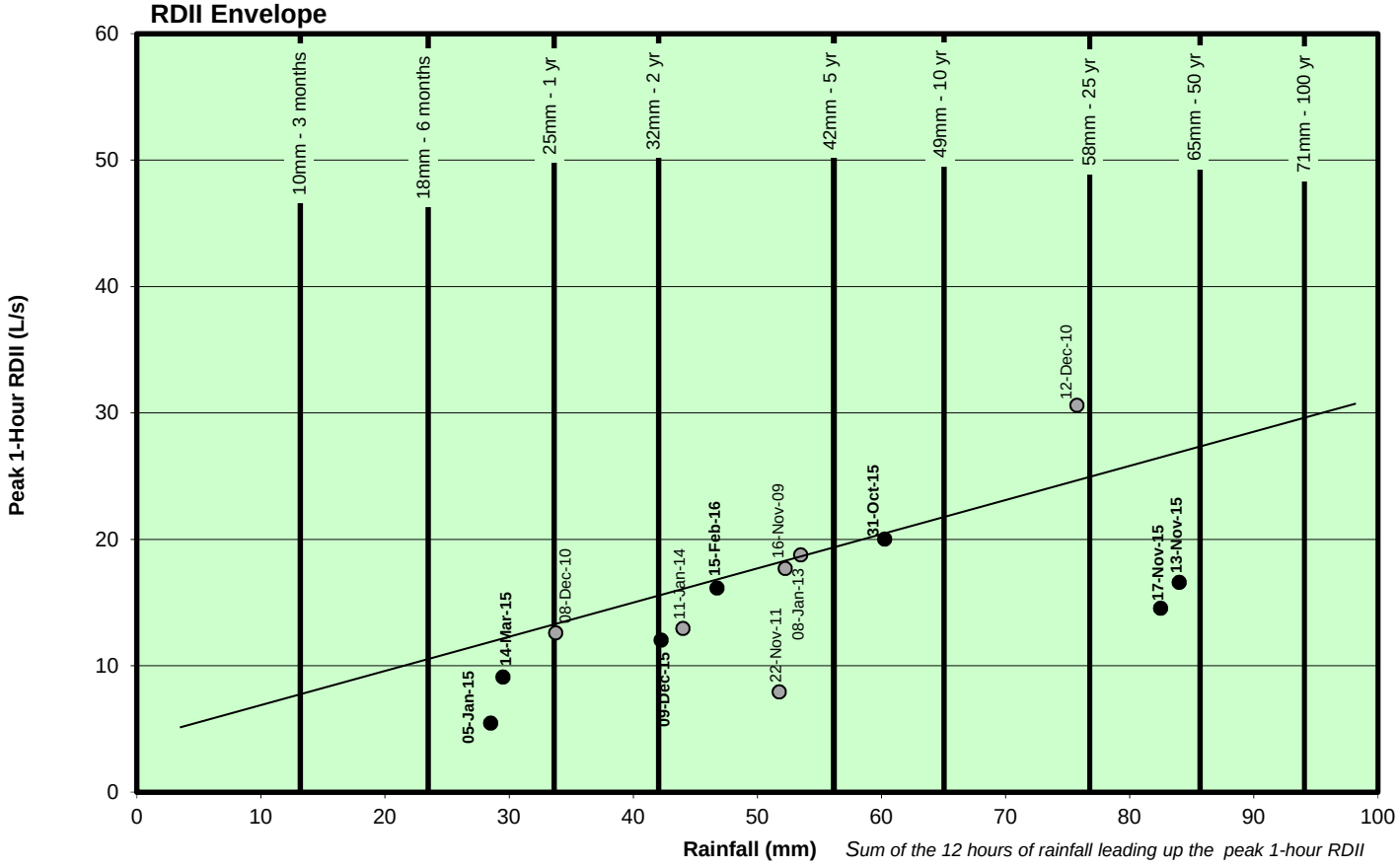
FLOW MONITORING AREA

CATCHMENT: GOLDIE

SITE CODE: **LG5**

Goldie (LG5)

RDII Envelope



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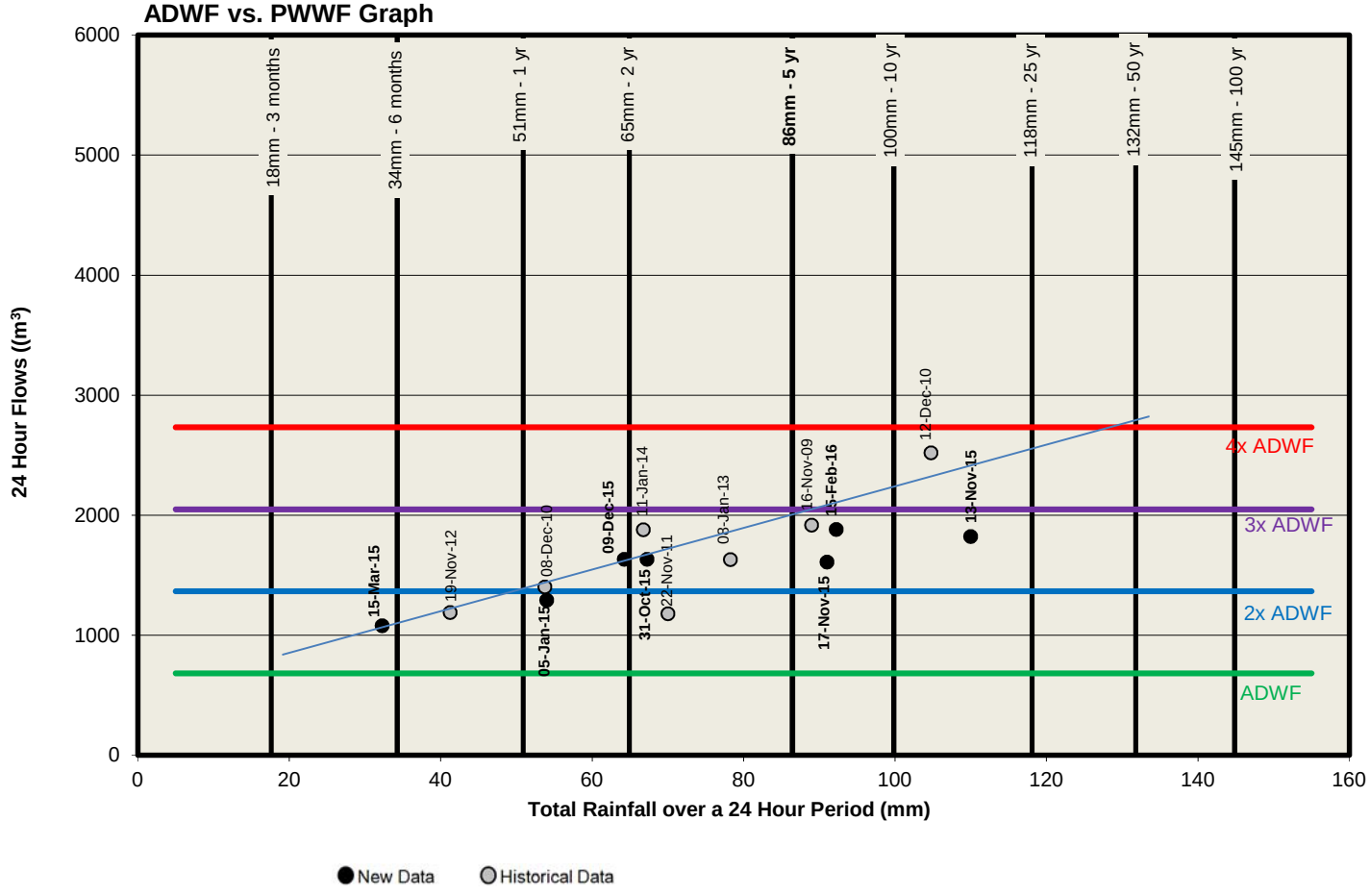
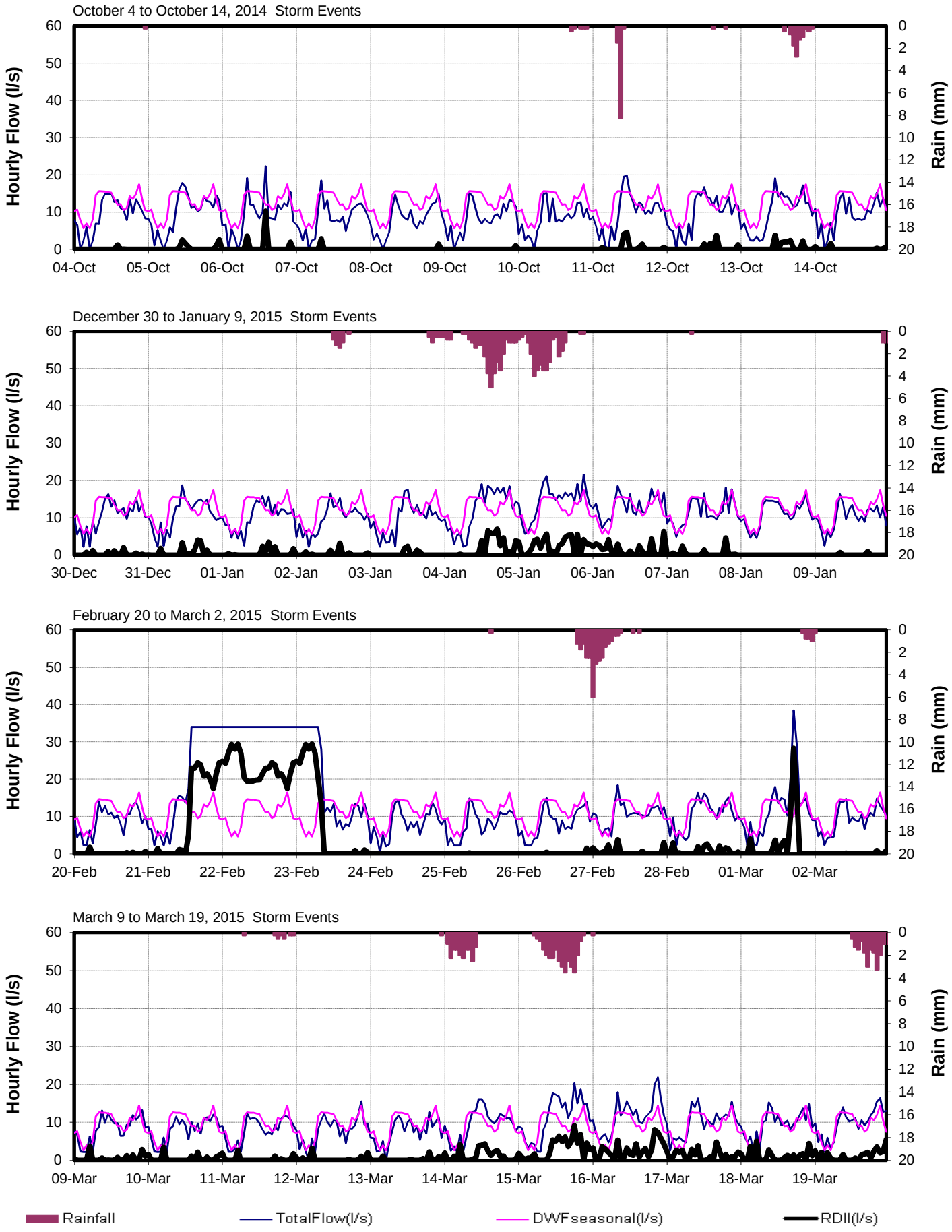


Goldie (LG5)


October 4 to October 14, 2014 Storm Events
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Hourly Flow (l/s)
Rain (mm)
0
10
20
30
40
50
60
0
2
4
6
8
10
12
14
16
18
20
04-Oct
05-Oct
06-Oct
07-Oct
08-Oct
09-Oct
10-Oct
11-Oct
12-Oct
13-Oct
14-Oct
30-Dec
31-Dec
01-Jan
02-Jan
03-Jan
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07-Jan
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25-Feb
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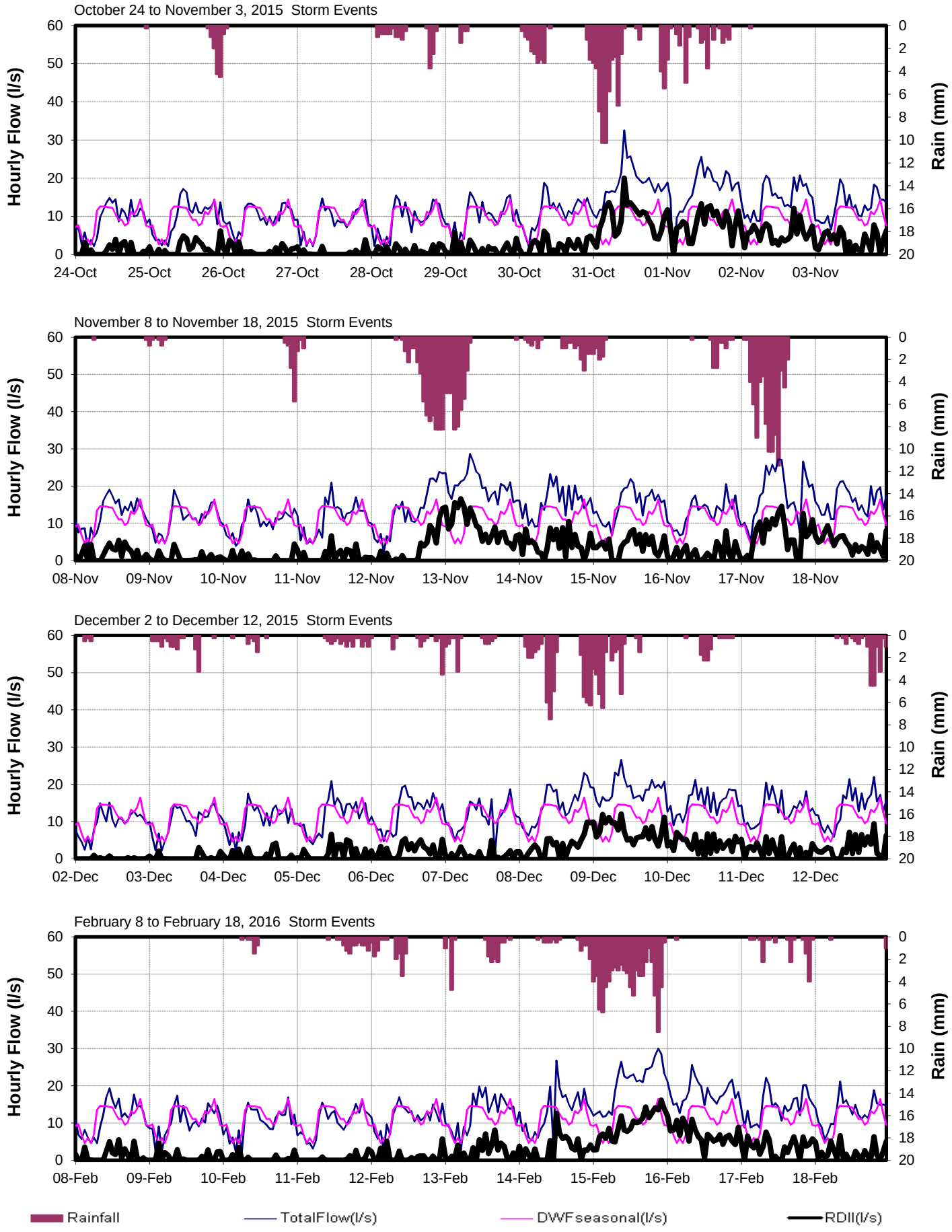
18-Mar
19-Mar
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

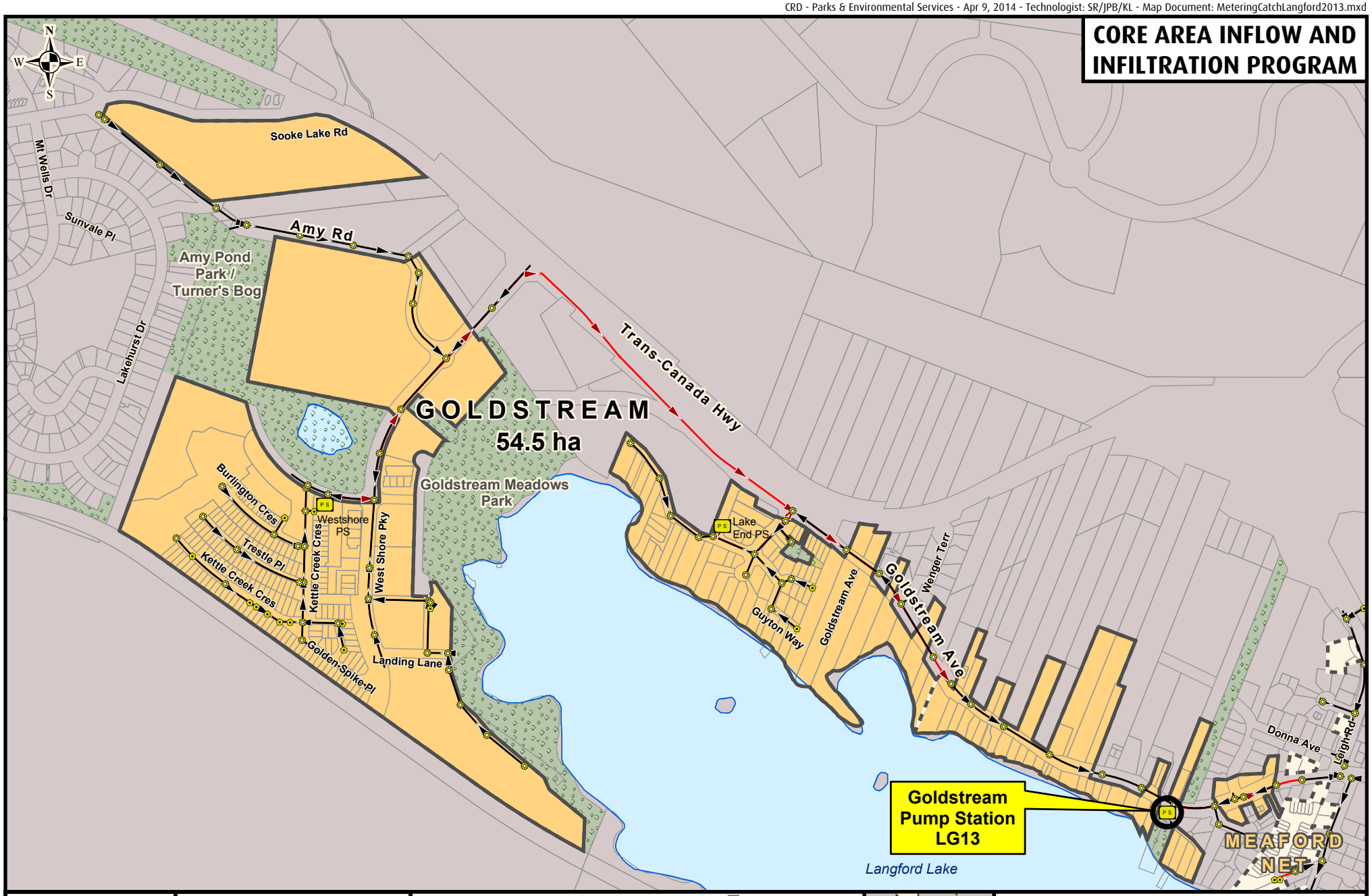
Goldie (LG5)



CRD Core Area I Program

CRD - Parks & Environmental Services - Apr 9, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchLangford2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100 150 200 250

Projection: UTM ZONE 10N NAD 83

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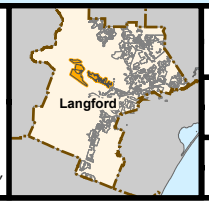


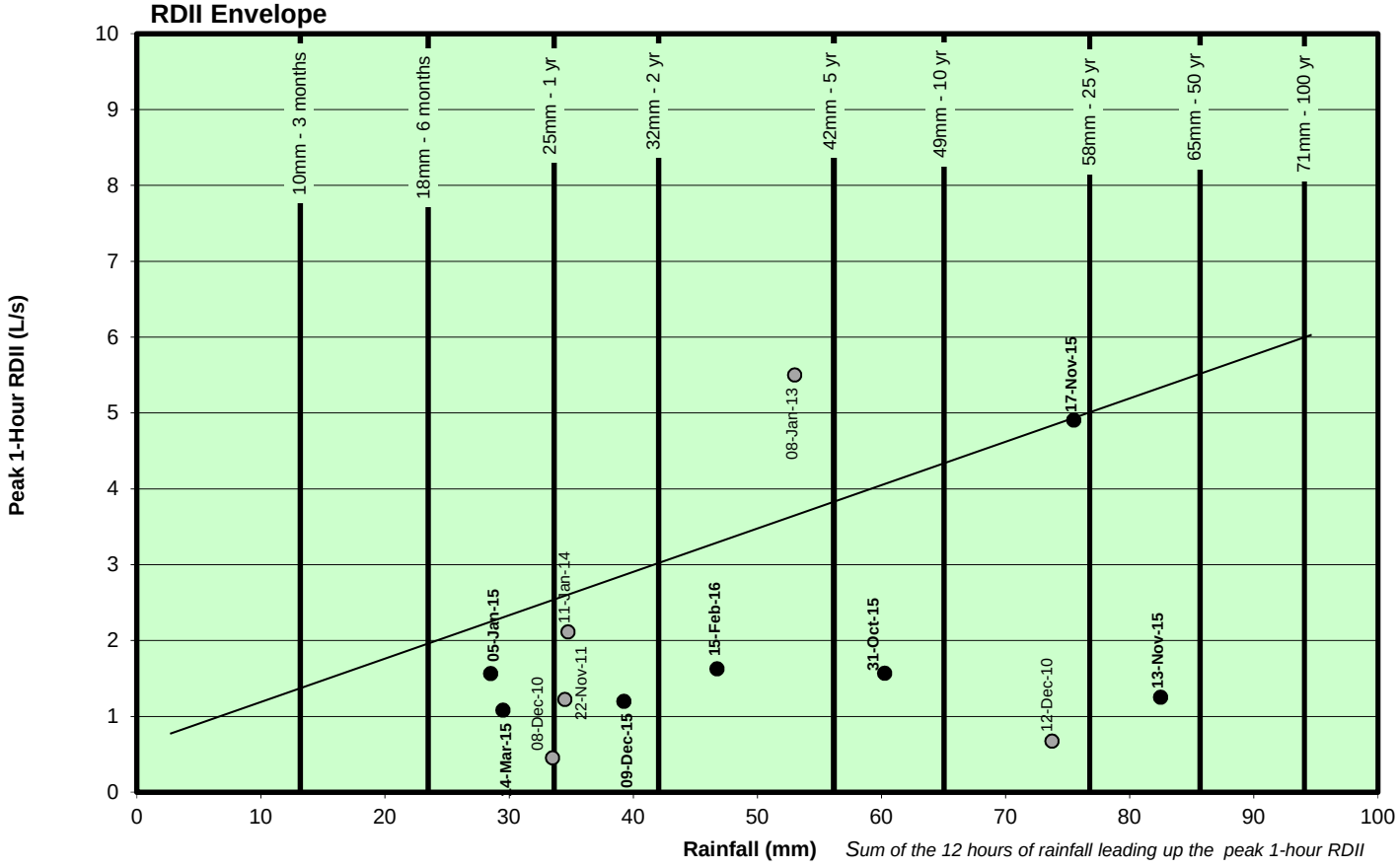
FLOW MONITORING AREA

CATCHMENT: GOLDSTREAM

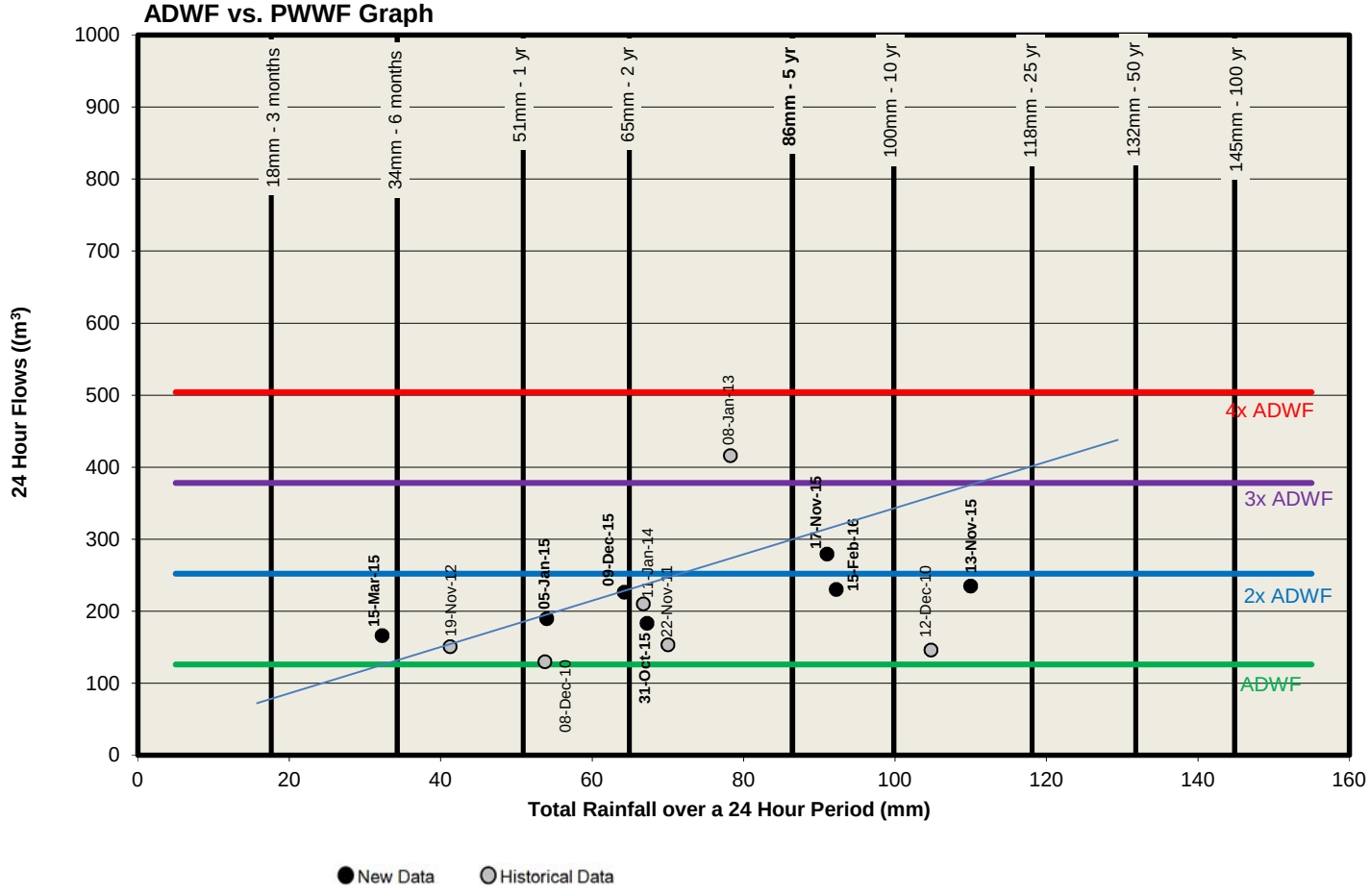
SITE CODE: **LG13**

Goldstream (LG13)

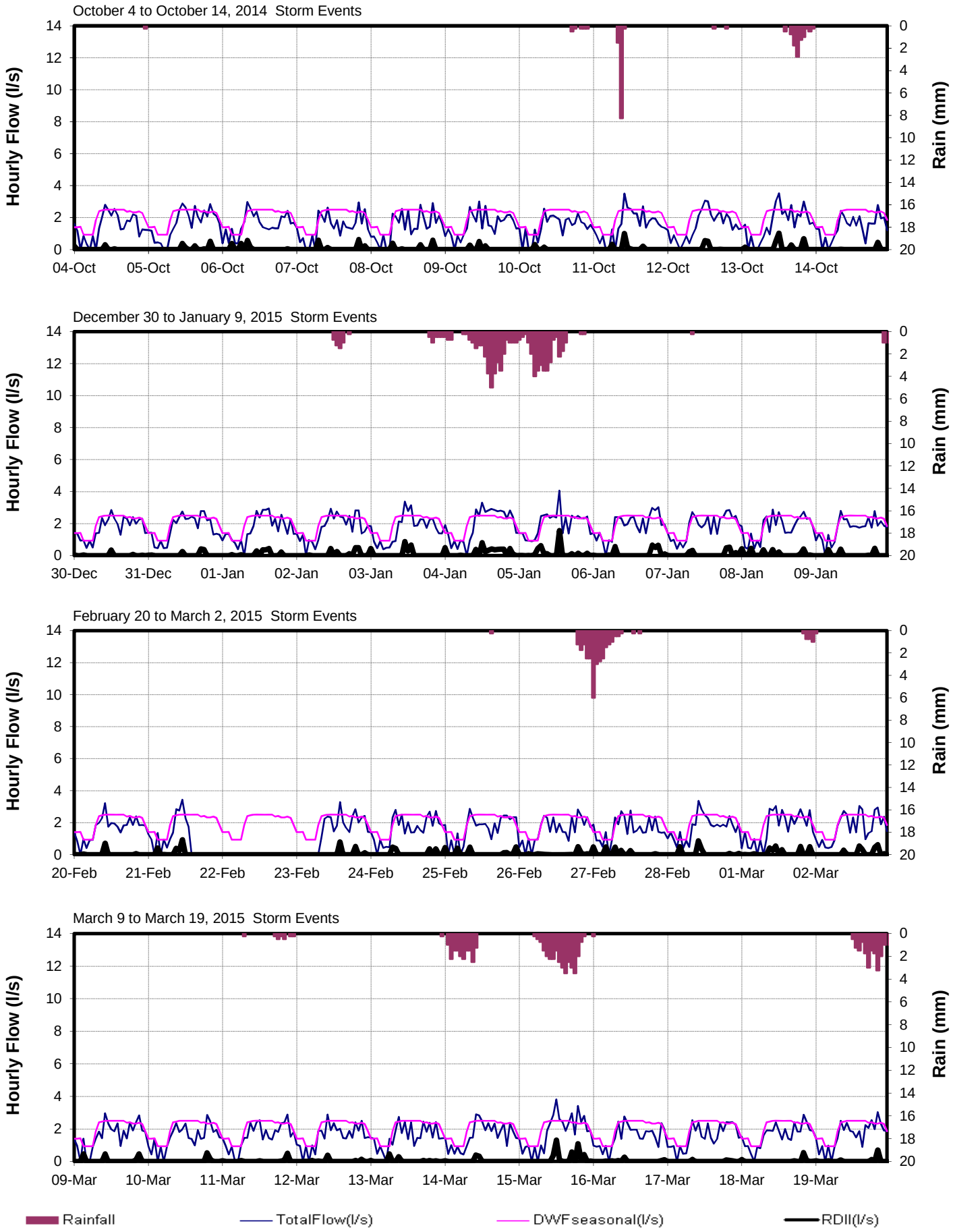
RDII Envelope



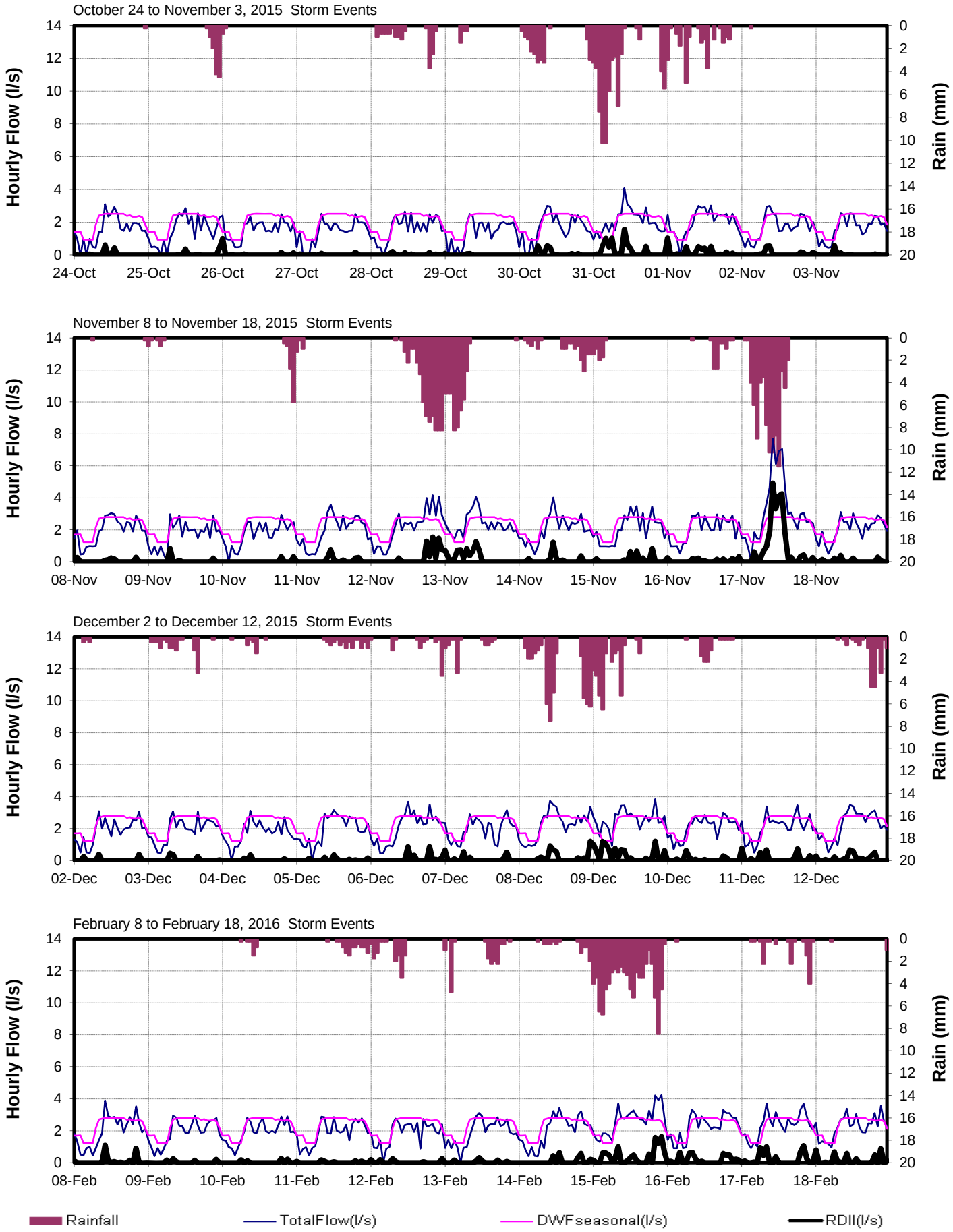
ADWF vs. PWWF Graph



Goldstream (LG13)



Goldstream (LG13)



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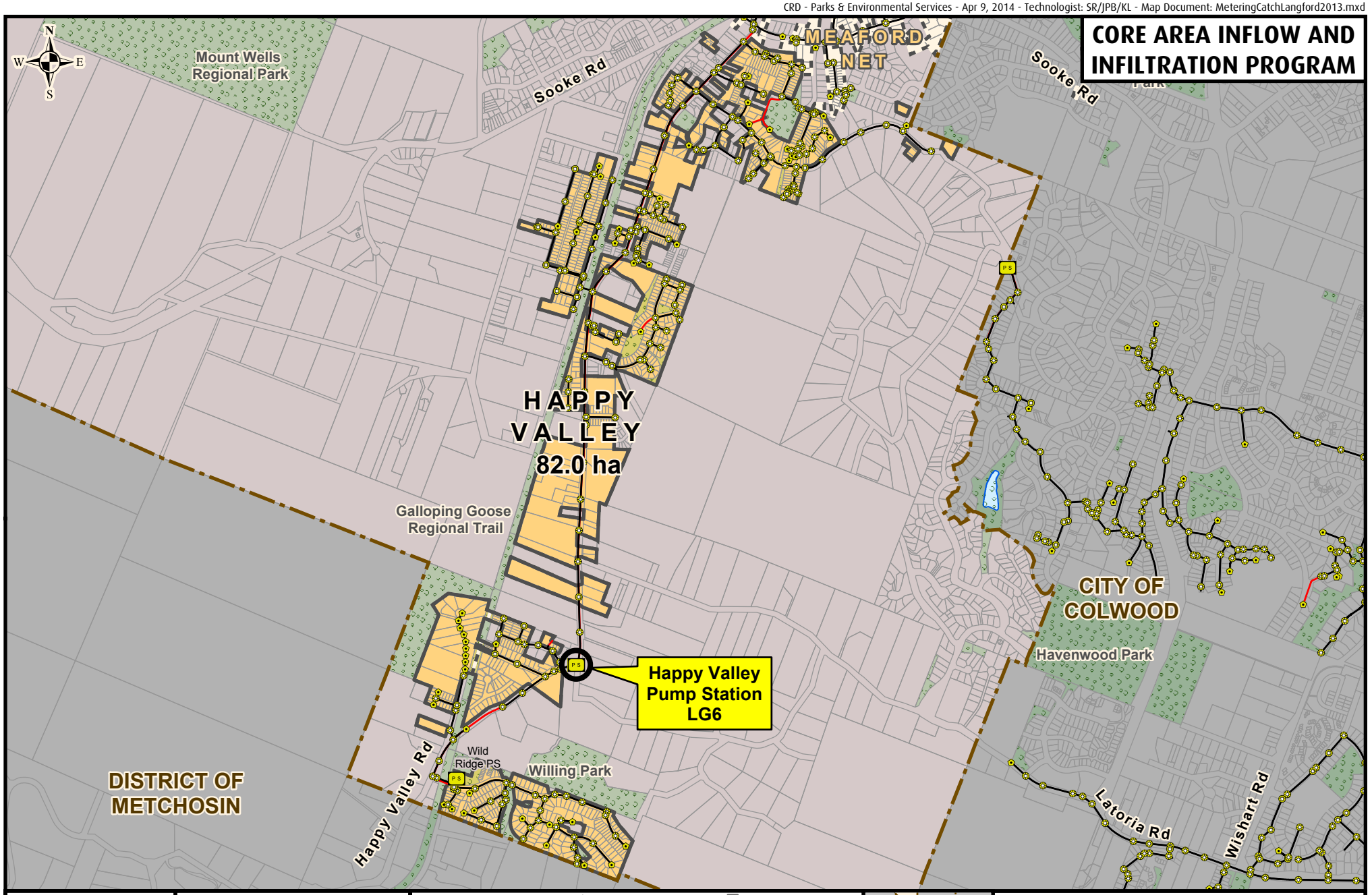
CORE AREA INFLOW AND INFILTRATION PROGRAM



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Metres
0 100 200 300 400 500

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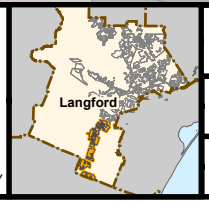


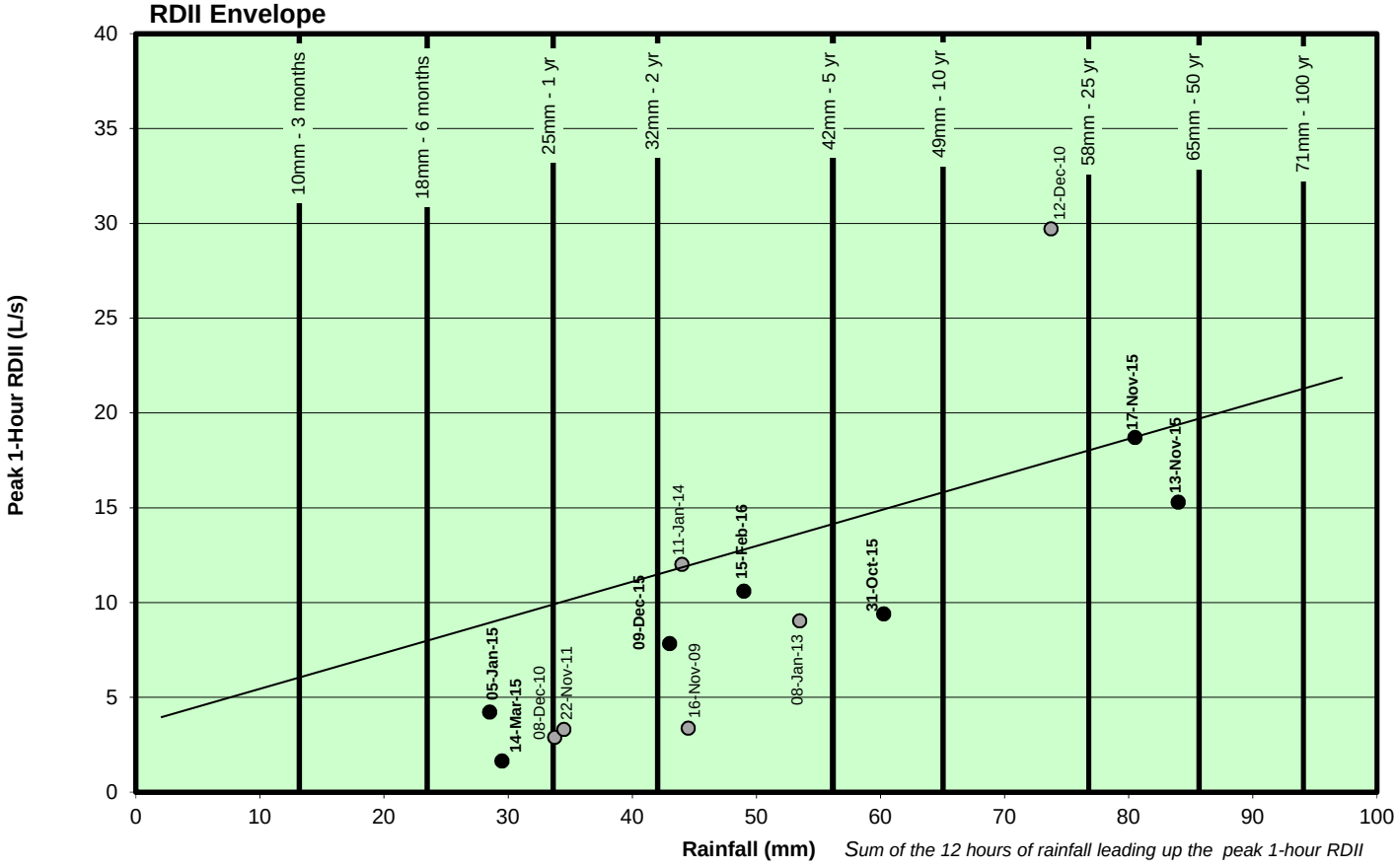
FLOW MONITORING AREA

CATCHMENT: HAPPY VALLEY

SITE CODE: **LG6**

Happy Valley (LG6)

RDII Envelope



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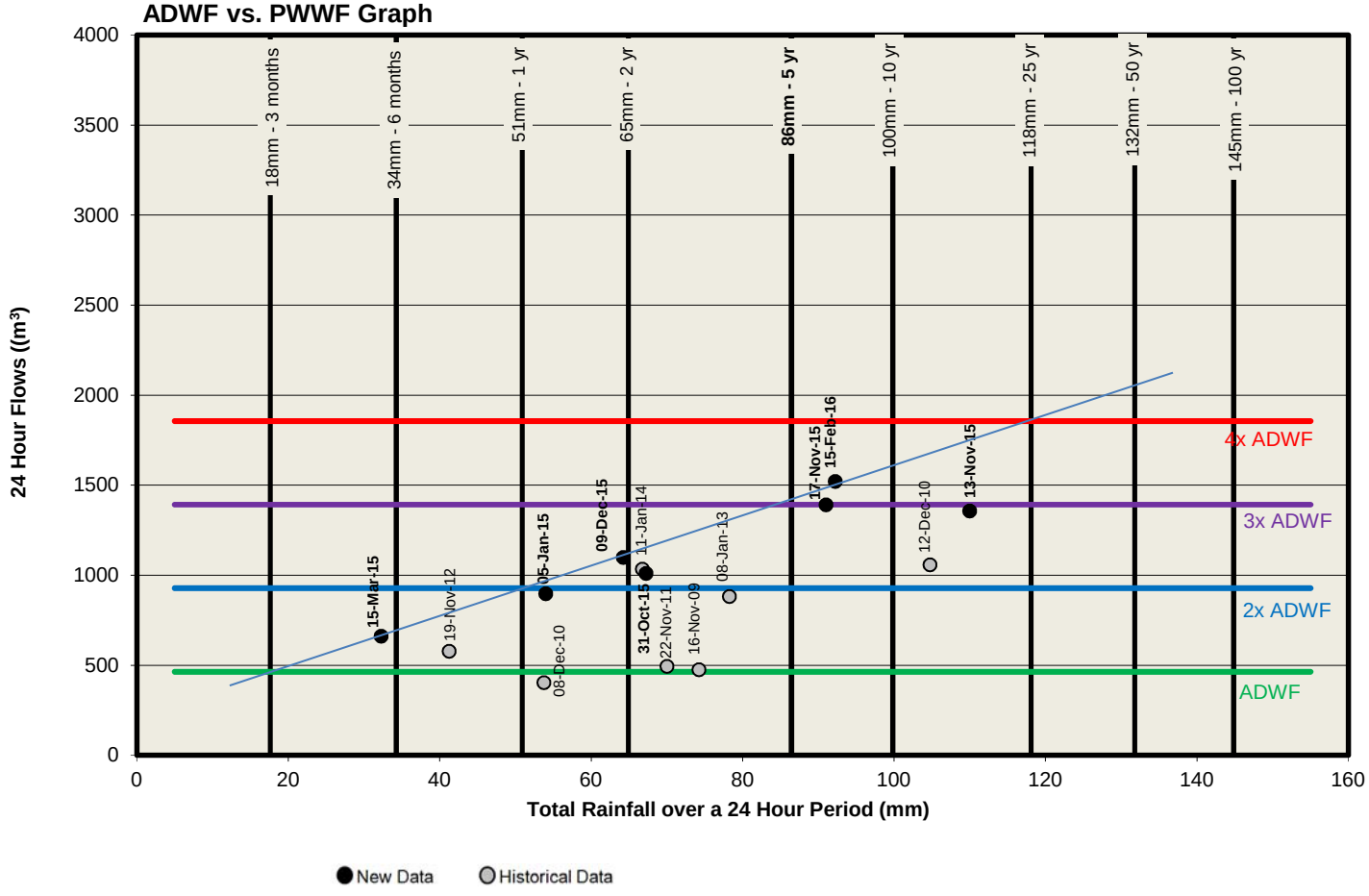
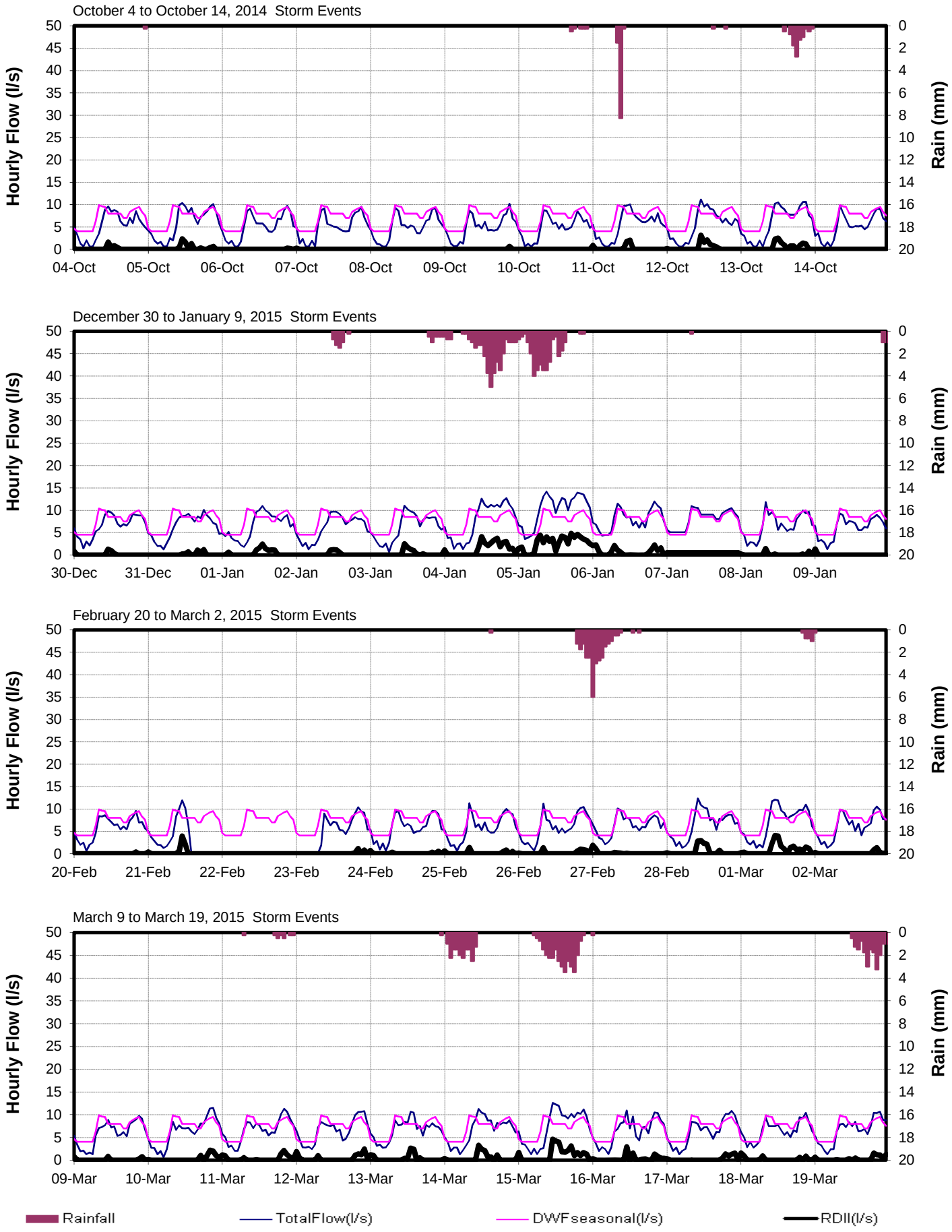
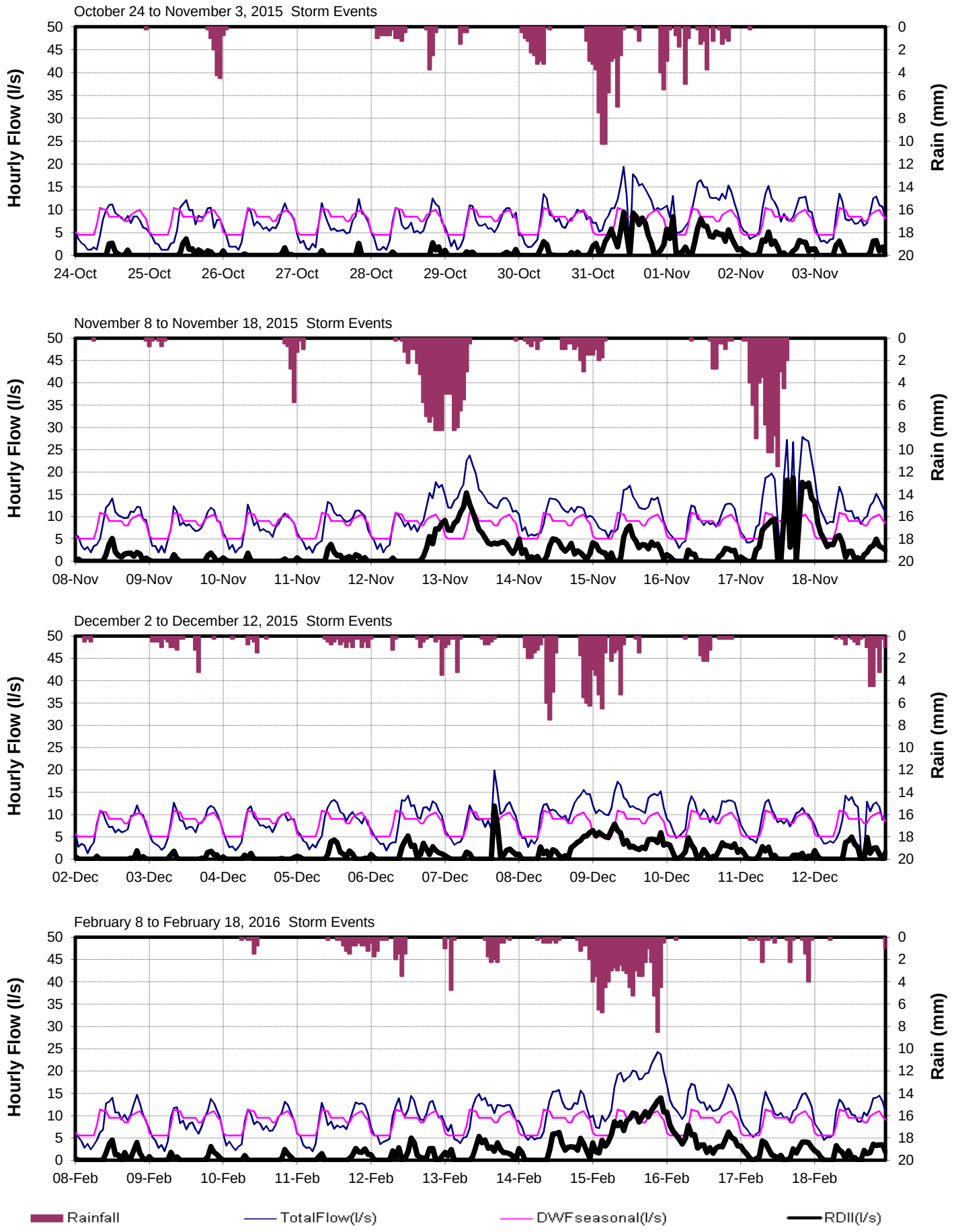


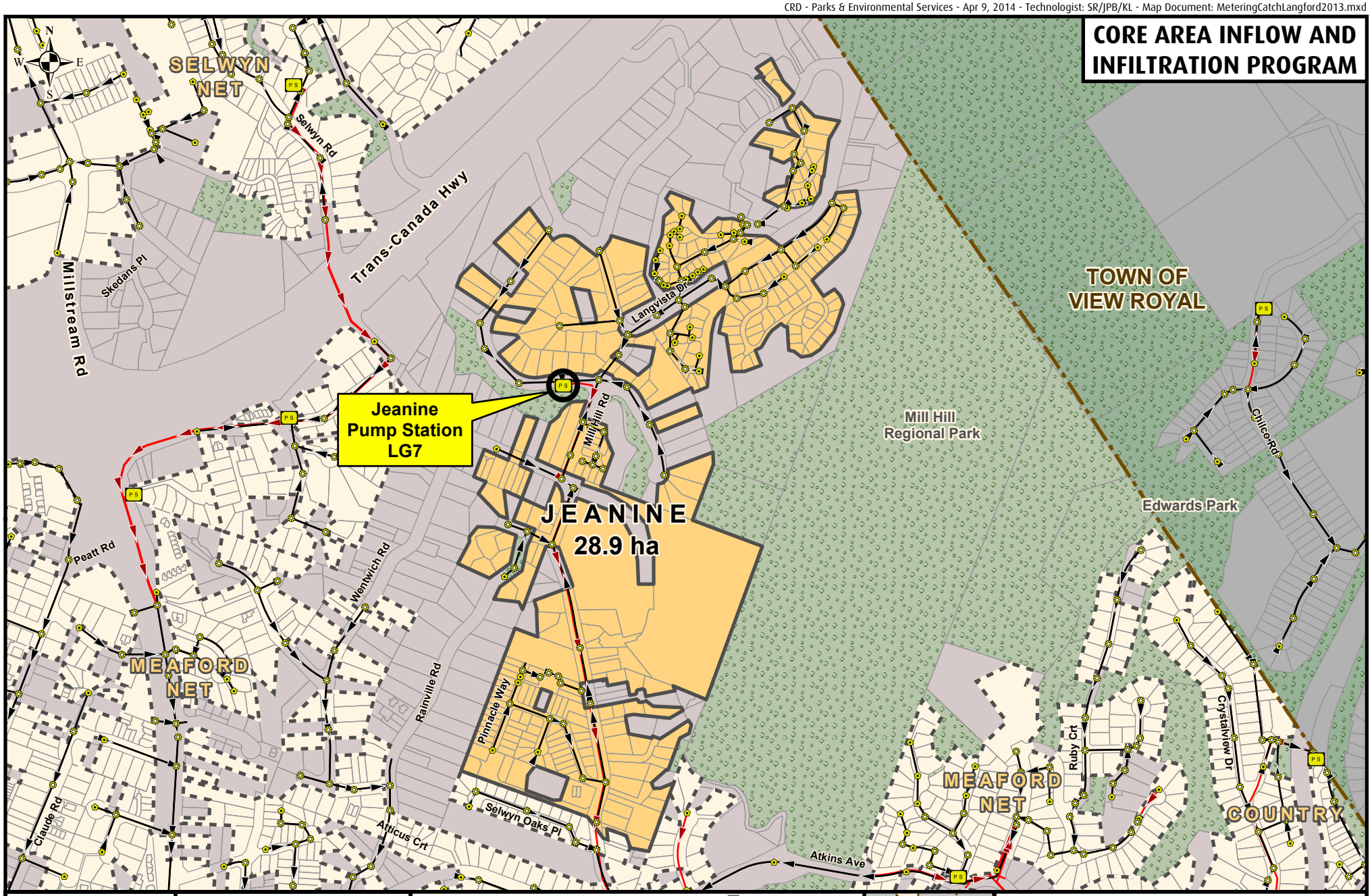
Happy Valley (LG6)



Happy Valley (LG6)



CORE AREA INFLOW AND INFILTRATION PROGRAM



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Metres
0 50 100 150 200

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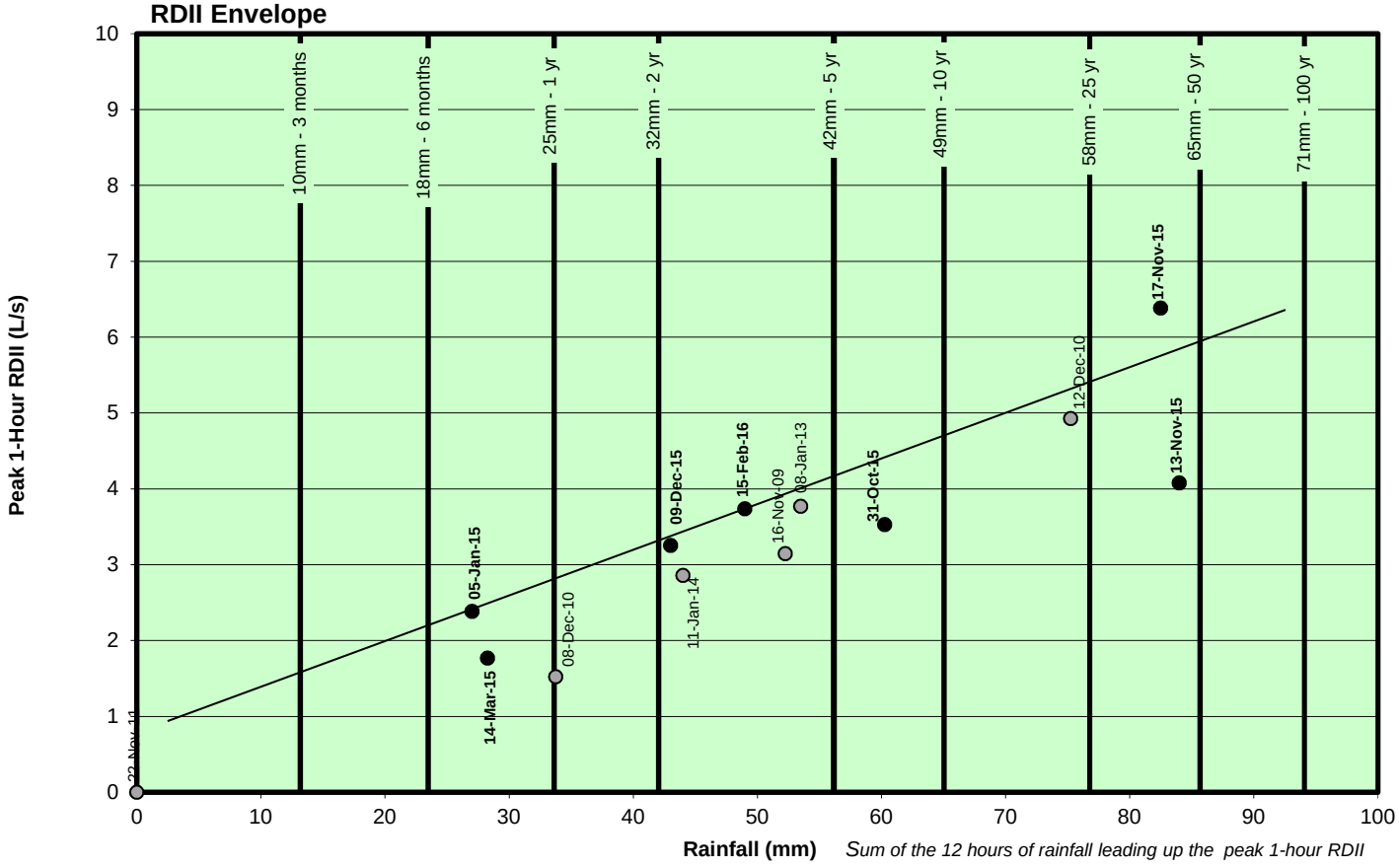
FLOW MONITORING AREA

CATCHMENT: JEANINE

SITE CODE: **LG7**

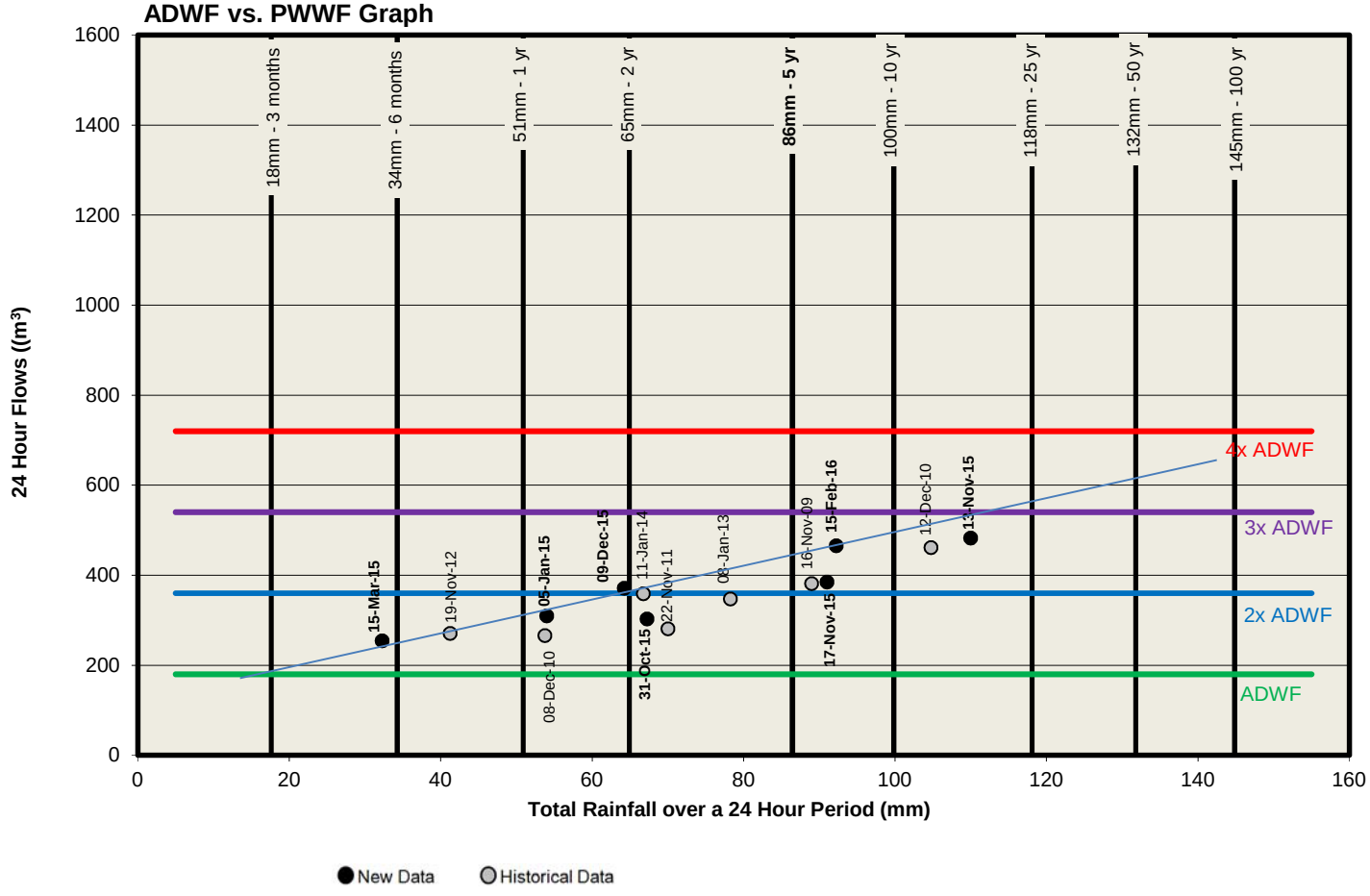
Jeanne (LG7)

RDII Envelope



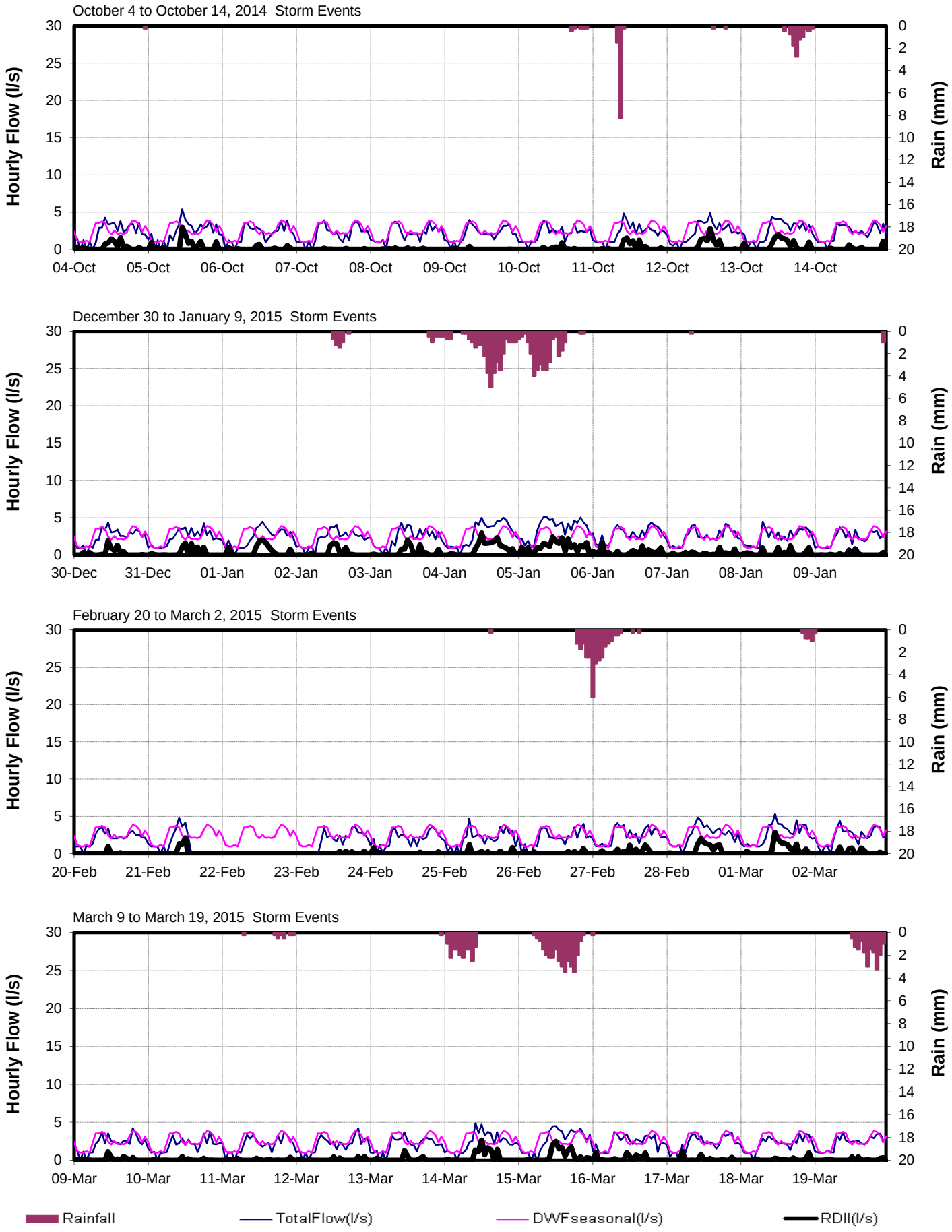
Sum of the 12 hours of rainfall leading up the peak 1-hour RDII

ADWF vs. PWWF Graph



New Data Historical Data

Jeanne (LG7)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17-Mar
18-Mar
19-Mar
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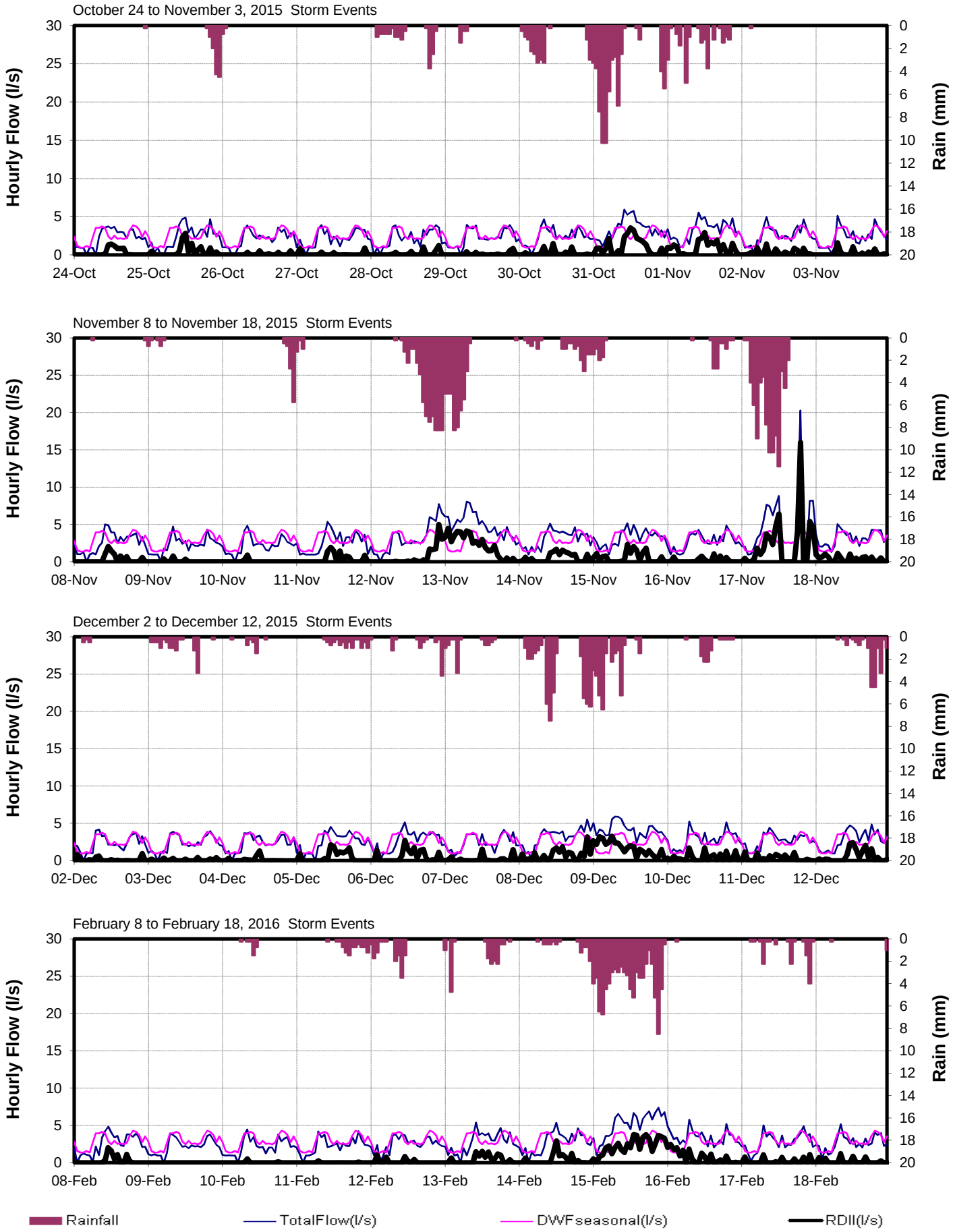
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

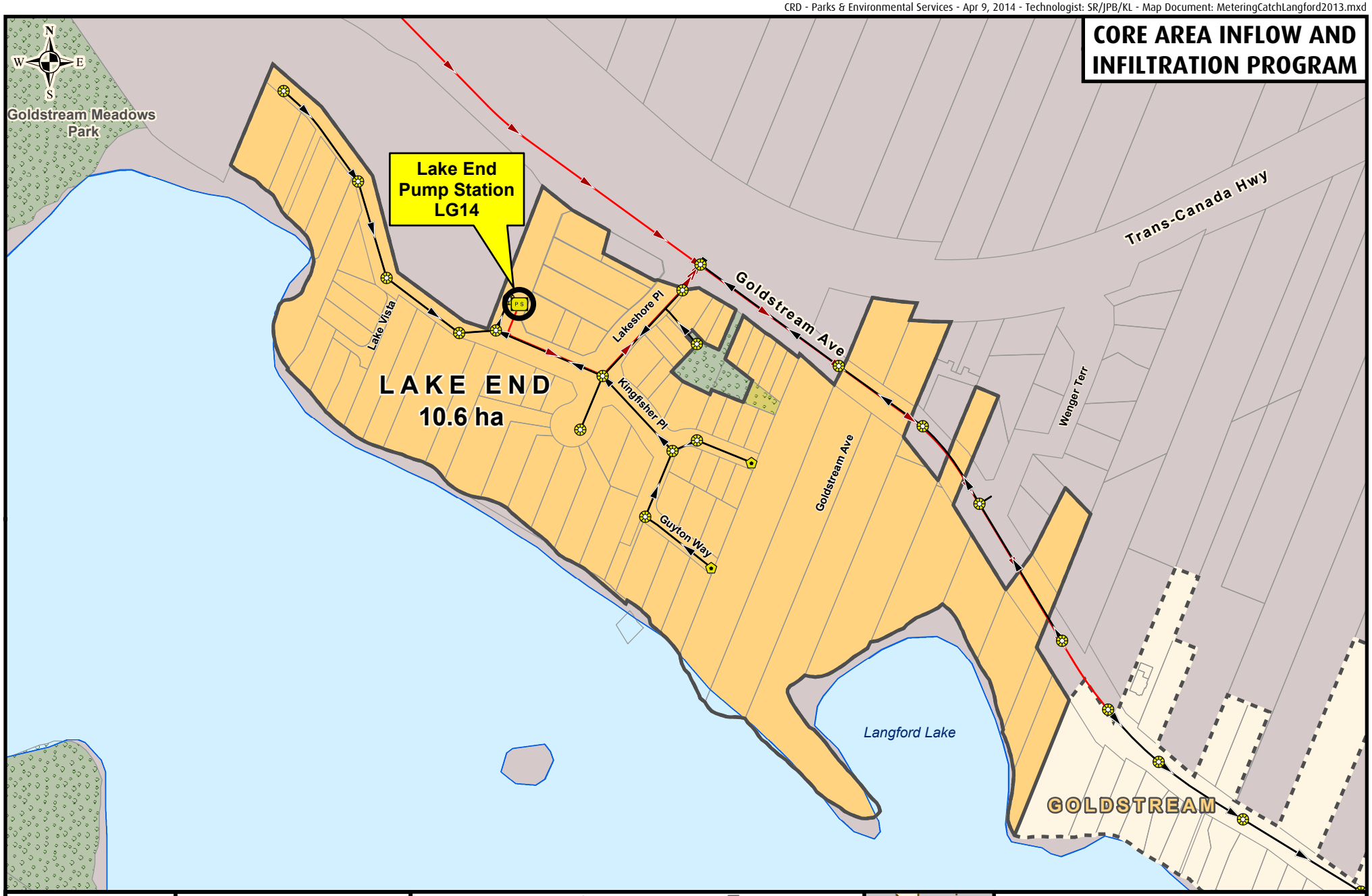
Jeanne (LG7)



CRD Core Area I Program

CRD - Parks & Environmental Services - Apr 9, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchLangford2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100

Projection: UTM ZONE 10N NAD 83

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- Cleanout
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- CRD Sewer

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- Non-Sewered Area
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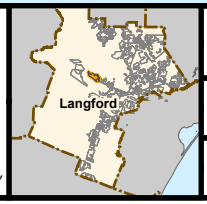
- Parks
- Sewered Park Areas
- Catchment Boundary
- Municipal, First Nation, or DND Boundaries



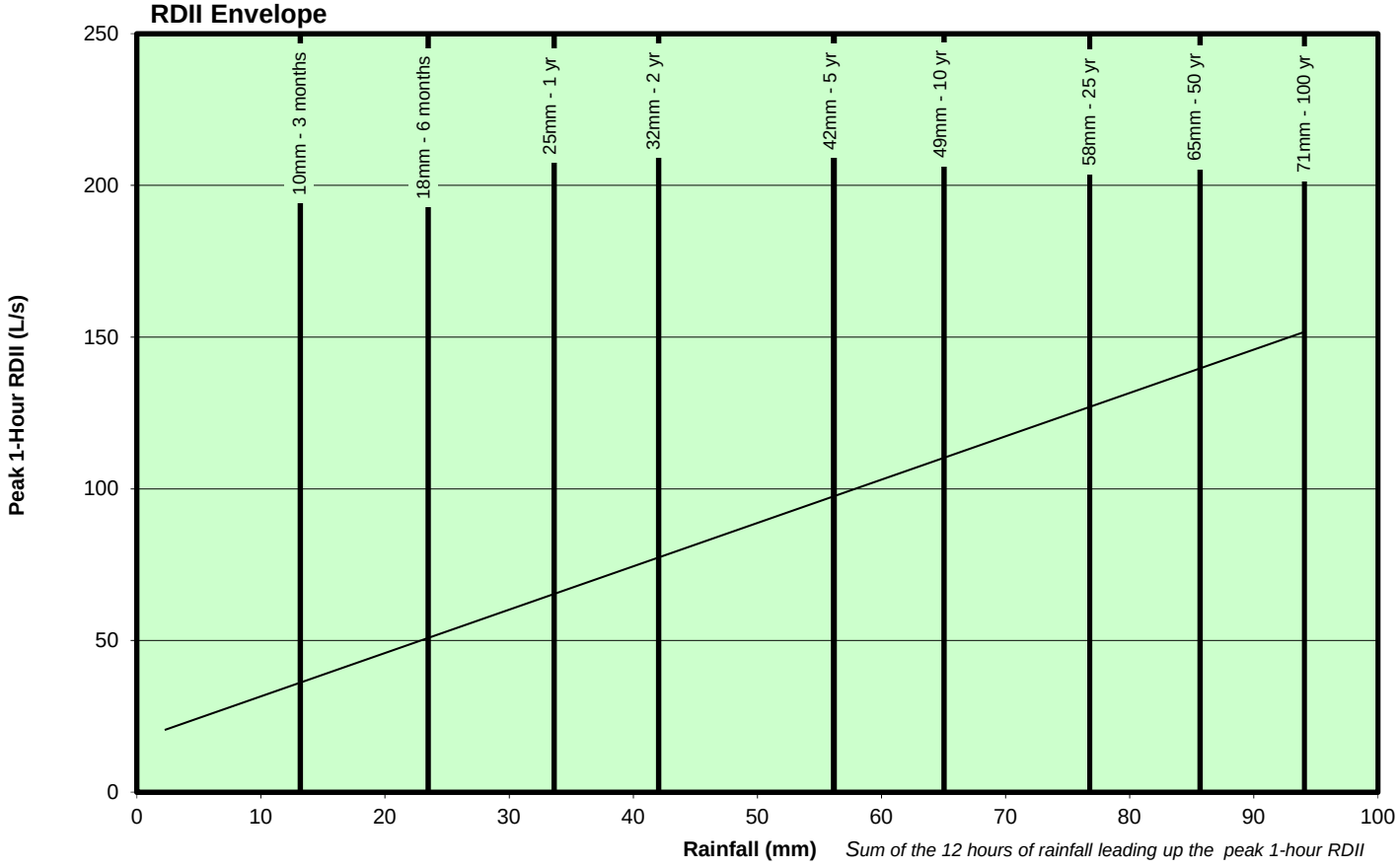
FLOW MONITORING AREA

CATCHMENT: LAKE END

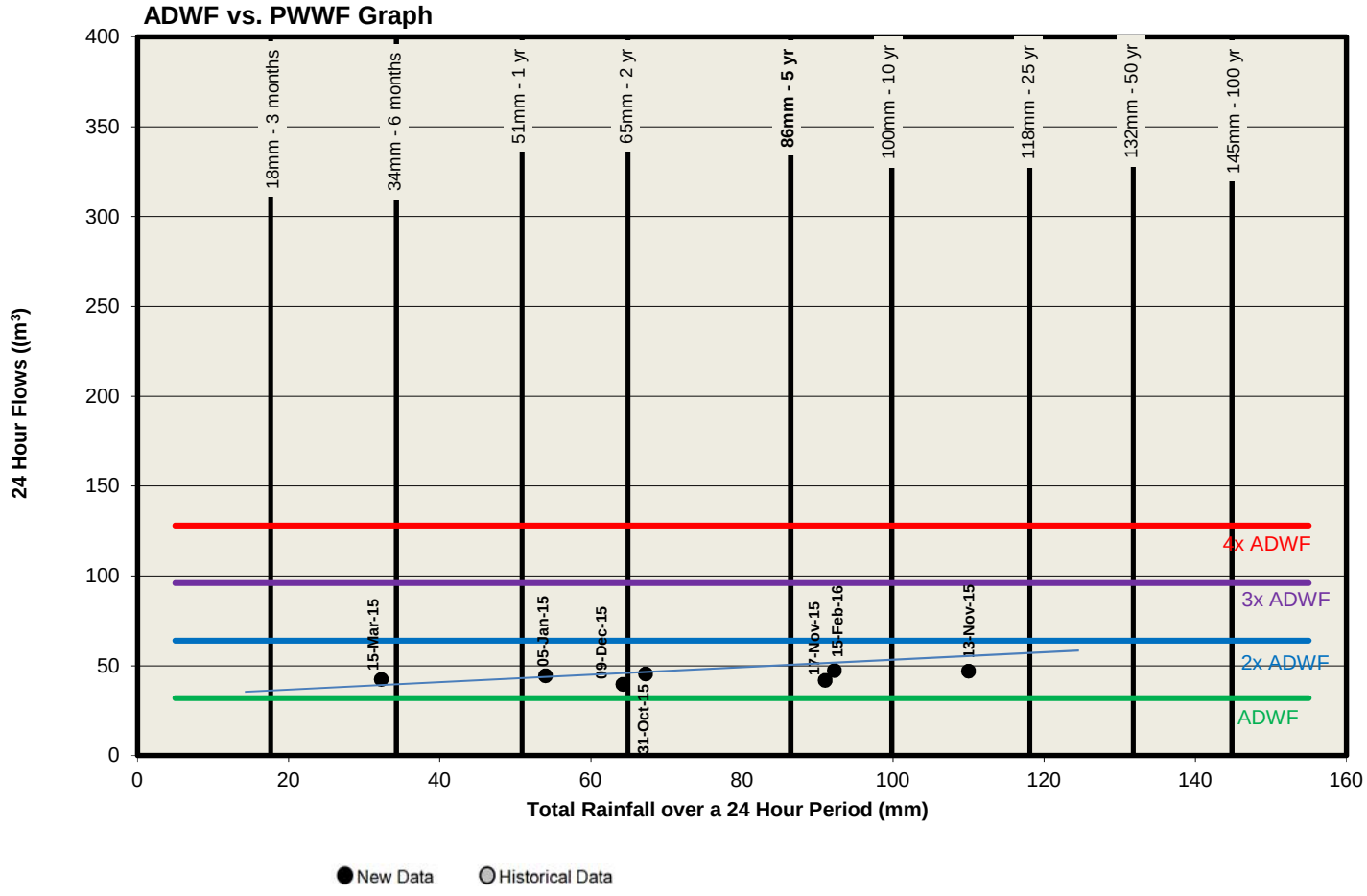
SITE CODE: **LG14**

Lake End (LG14)

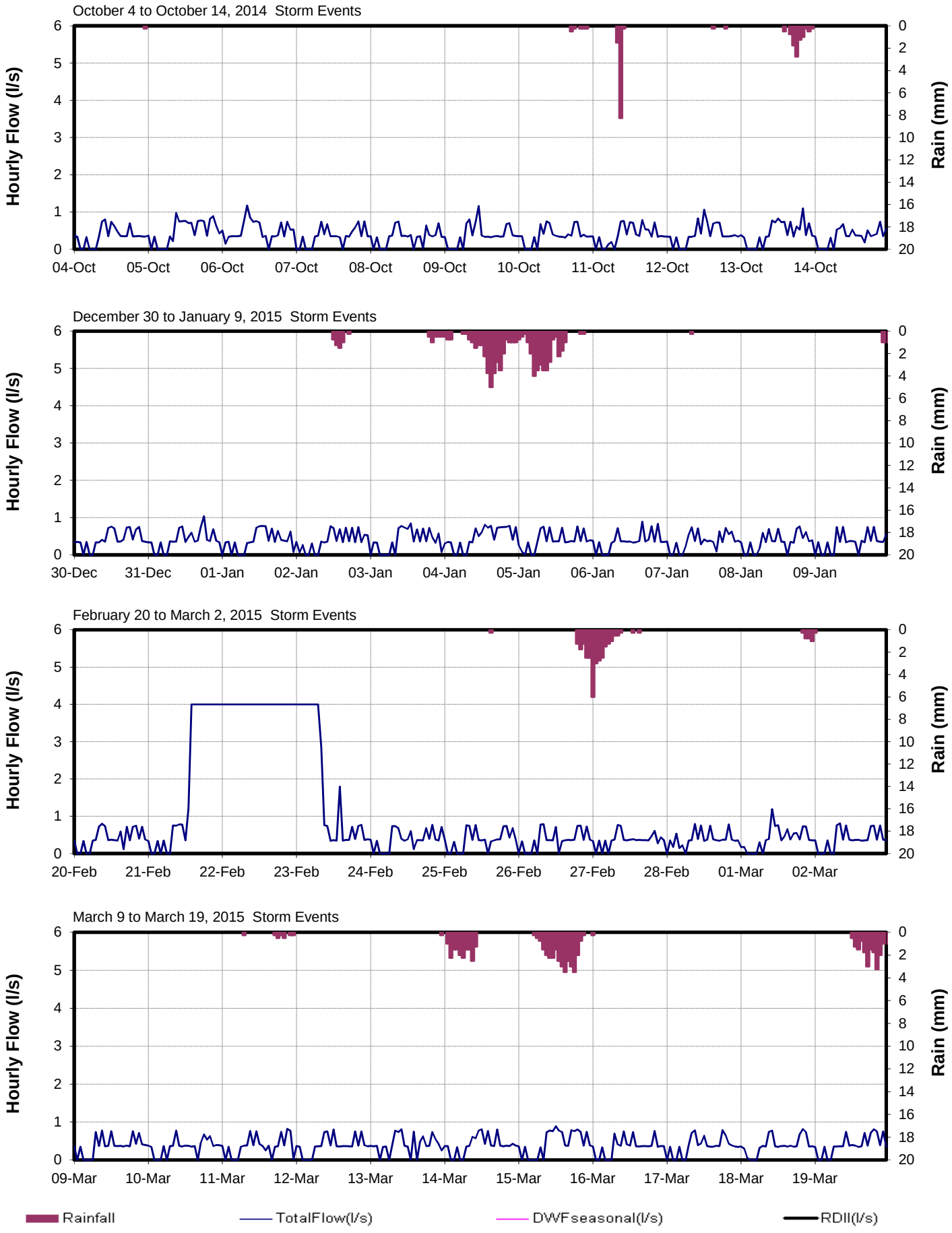
RDII Envelope



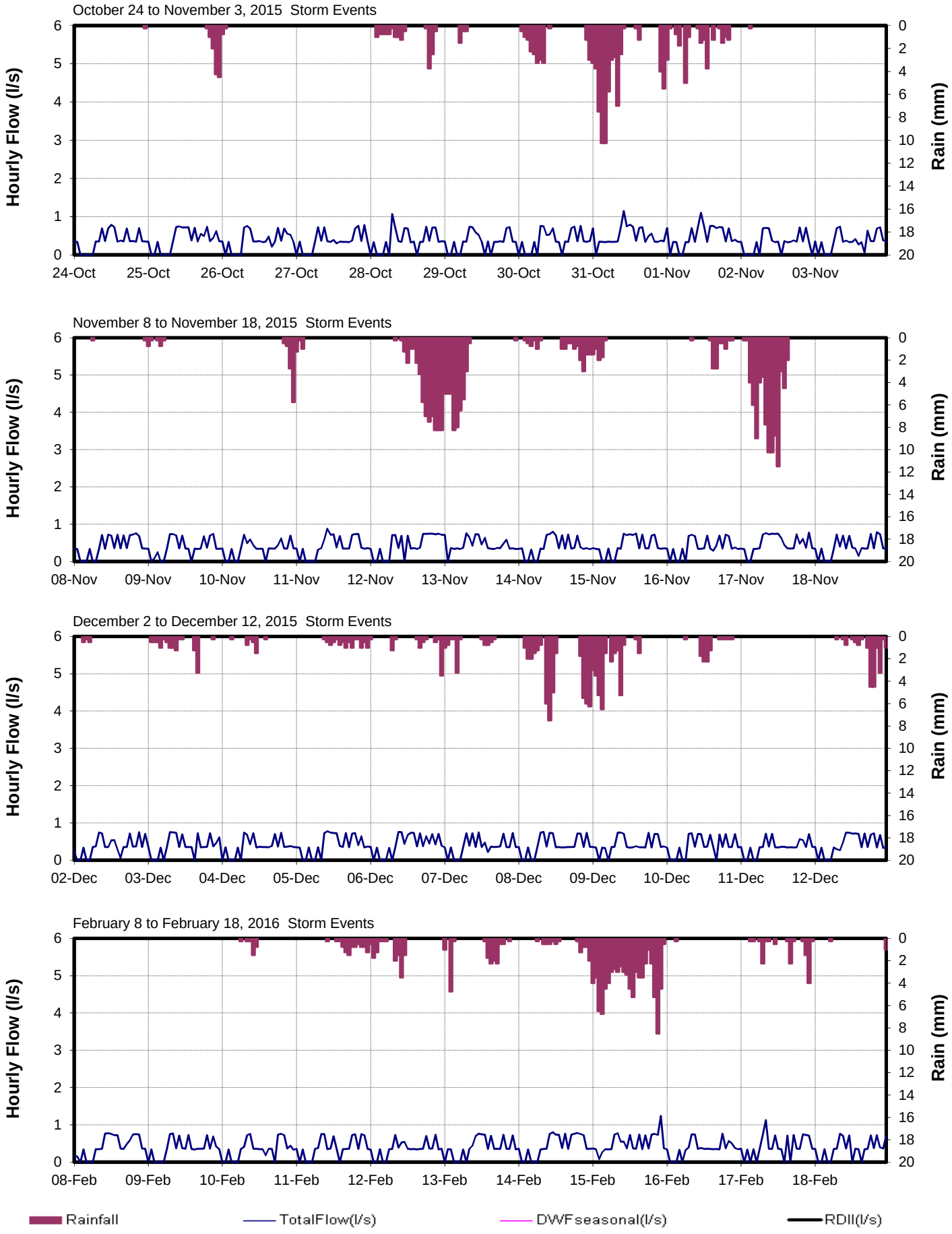
ADWF vs. PWWF Graph



Lake End (LG14)

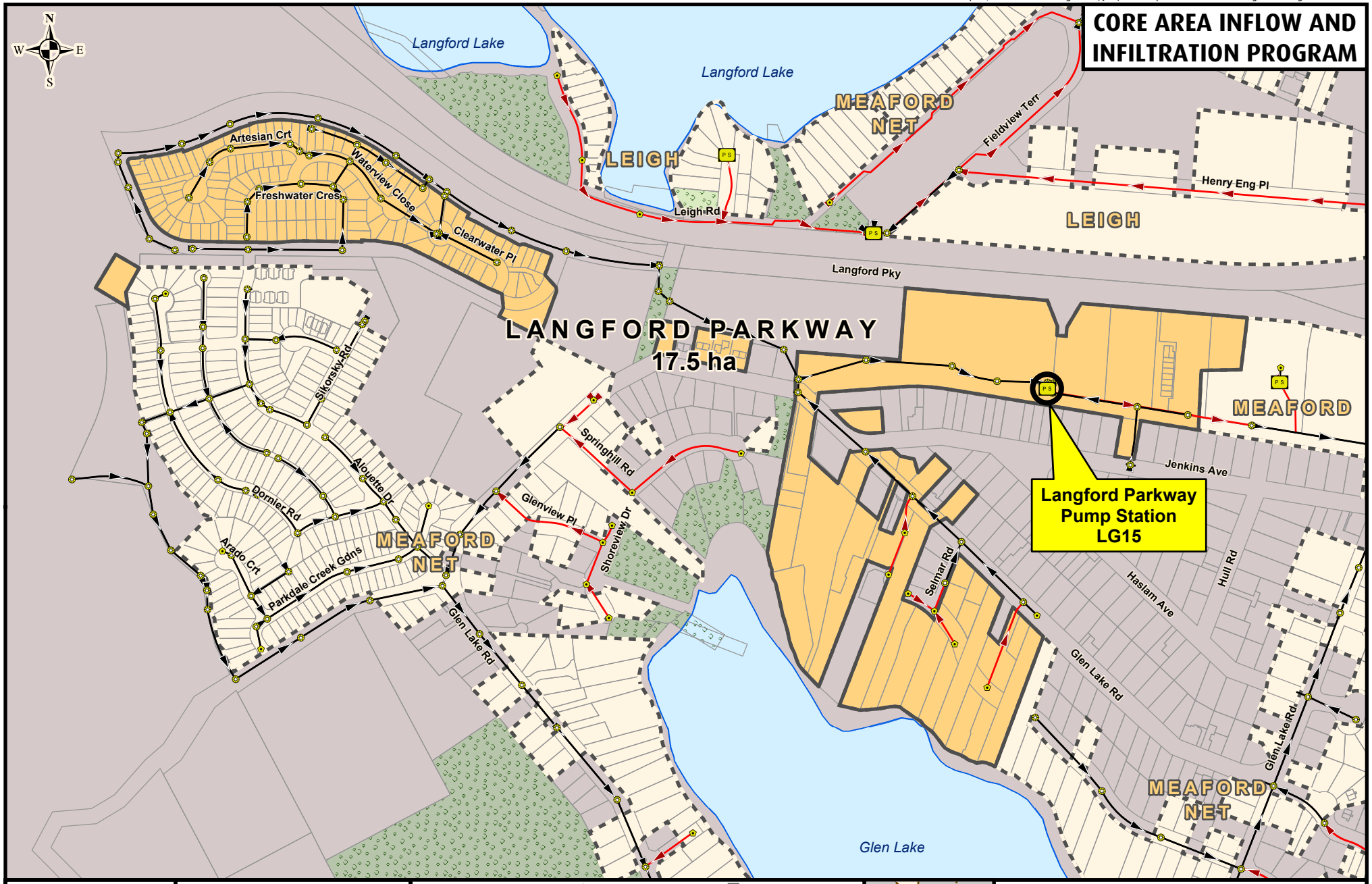


Lake End (LG14)



CRD - Parks & Environmental Services - Apr 9, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchLangford2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100 150

Projection: UTM ZONE 10N NAD 83

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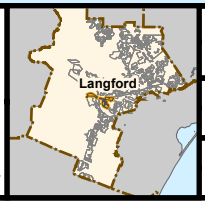


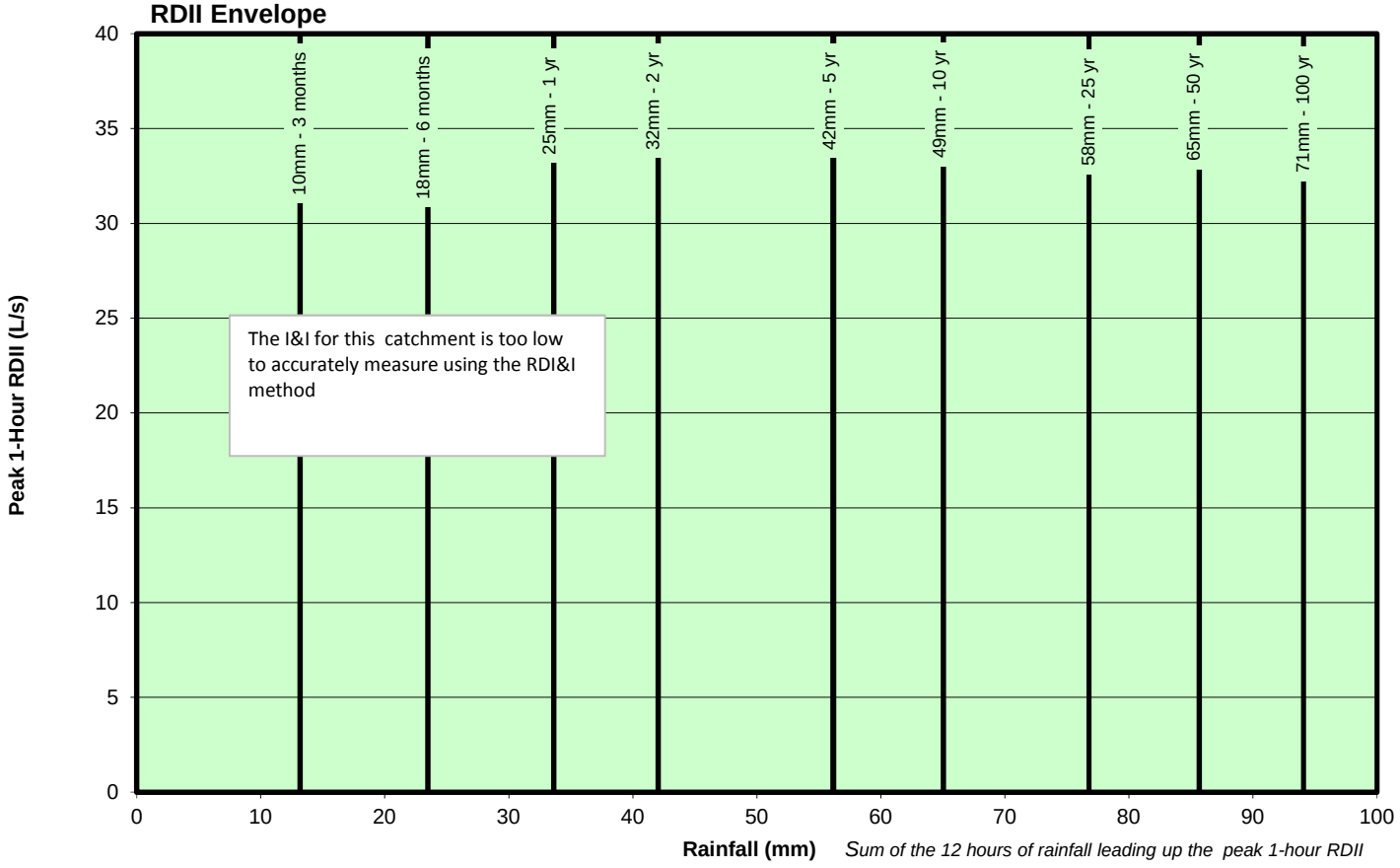
FLOW MONITORING AREA

CATCHMENT: LANGFORD PARKWAY

SITE CODE: **LG15**

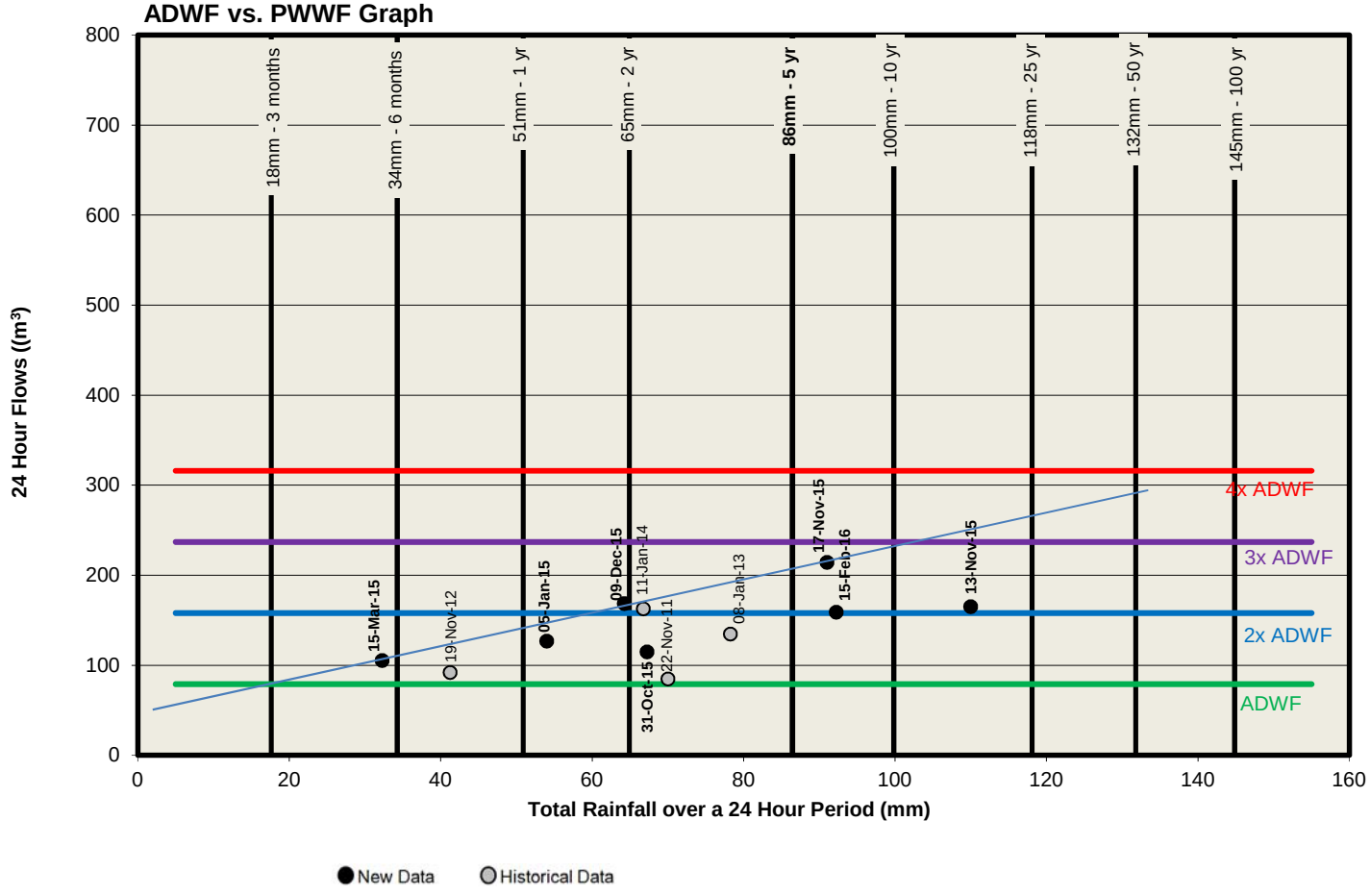
Langford Parkway (LG)

RDII Envelope

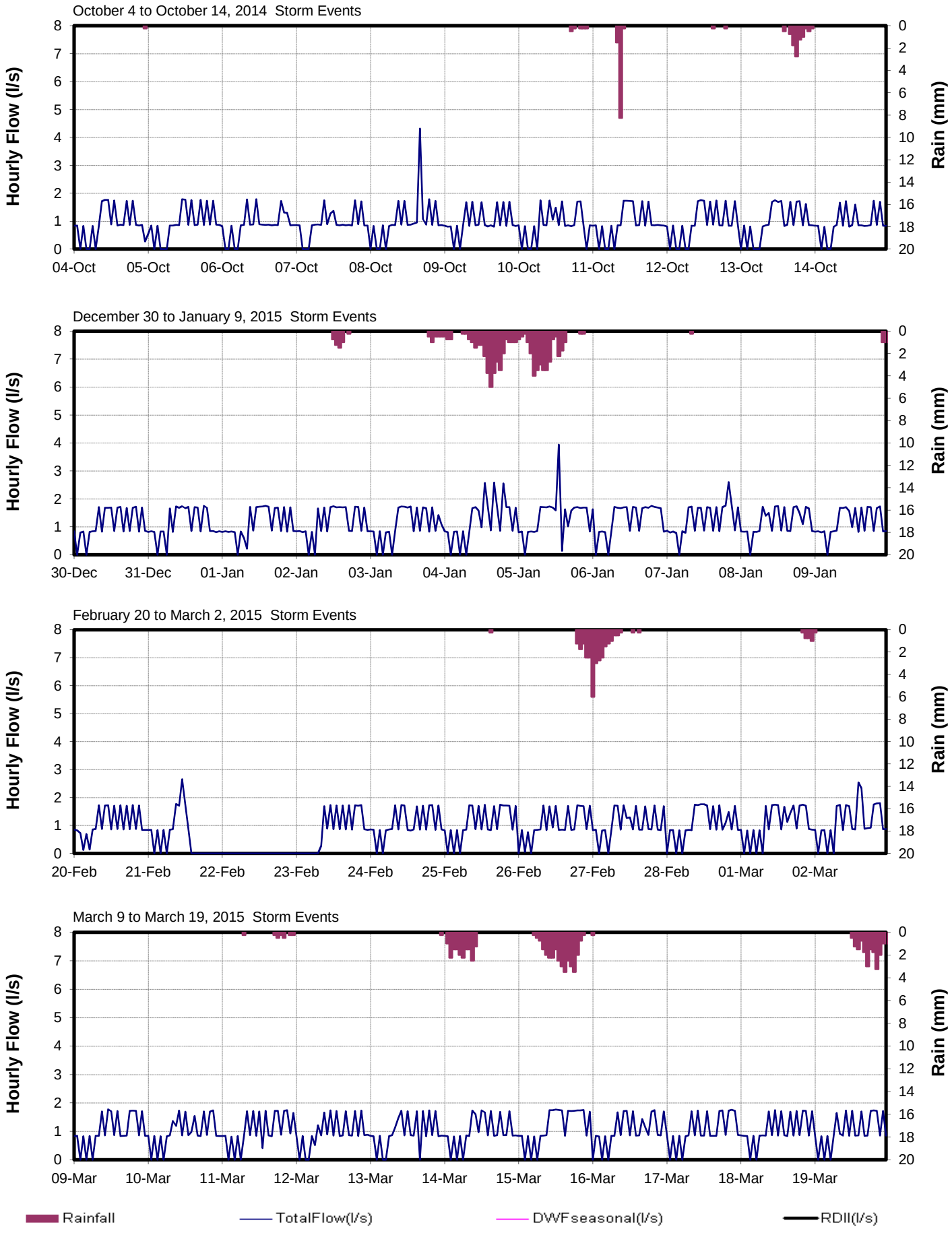


Sum of the 12 hours of rainfall leading up the peak 1-hour RDII

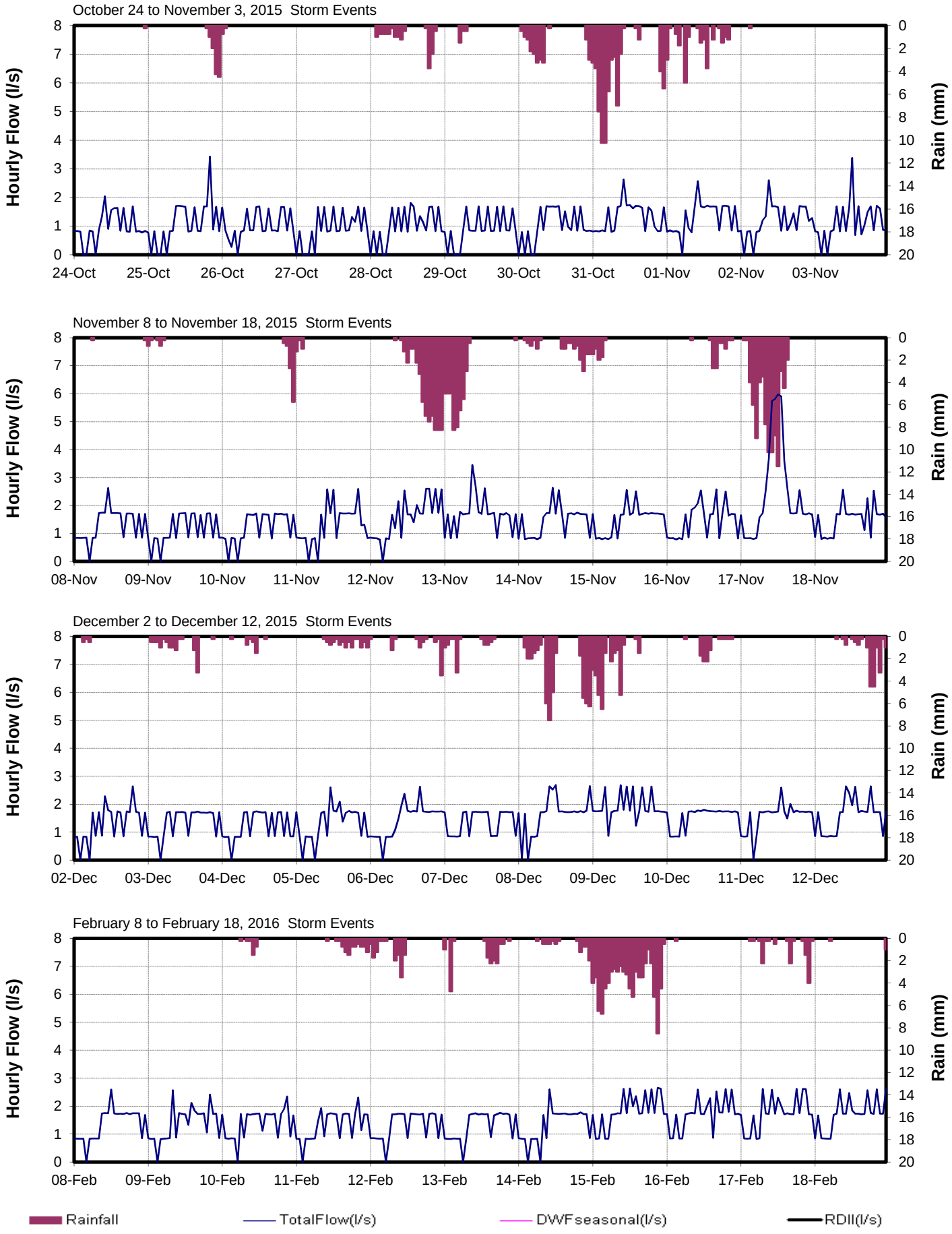
ADWF vs. PWWF Graph



Langford Parkway (LG)

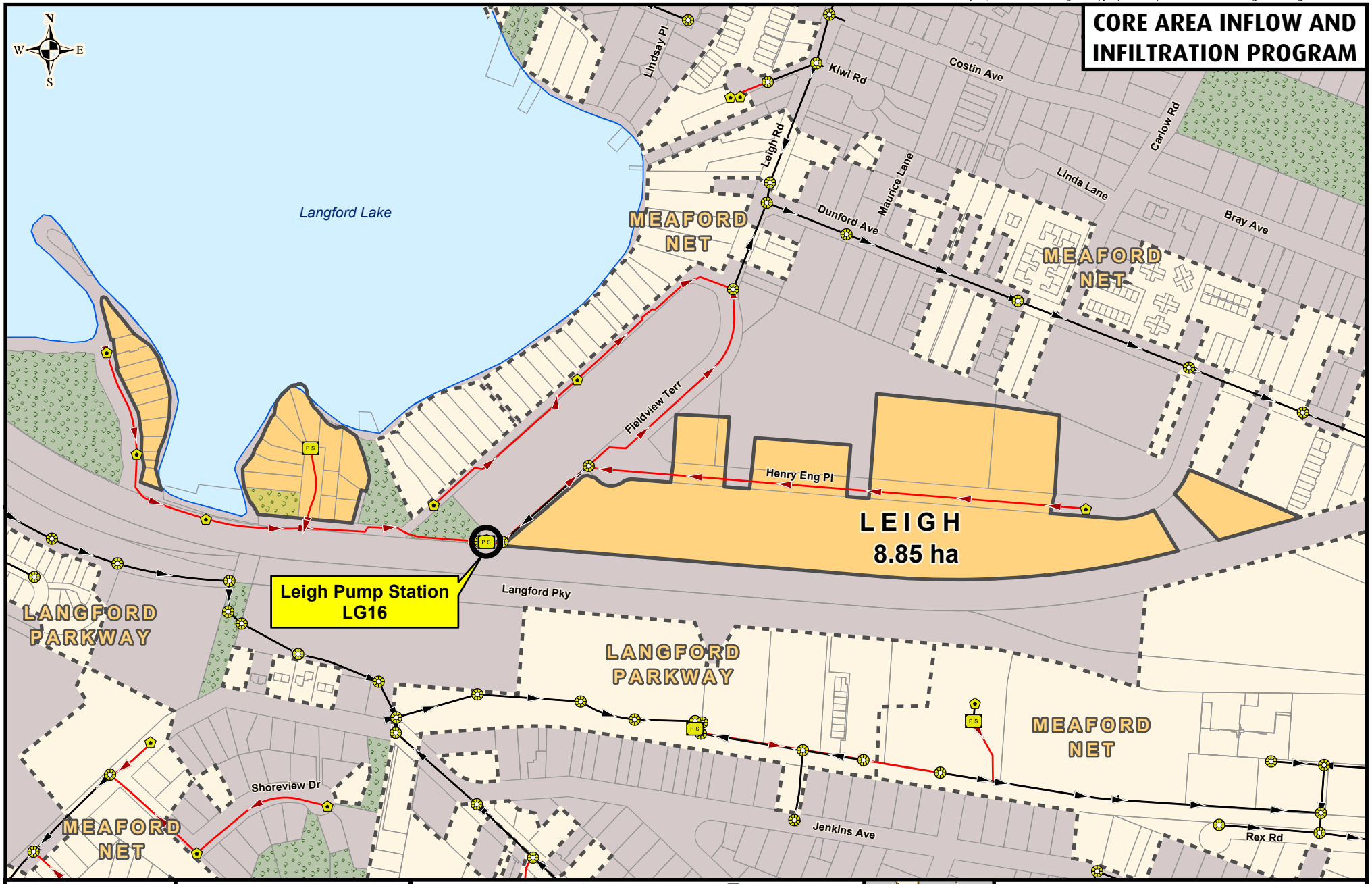


Langford Parkway (LG)



CRD - Parks & Environmental Services - Apr 9, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchLangford2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100 150

Projection: UTM ZONE 10N NAD 83

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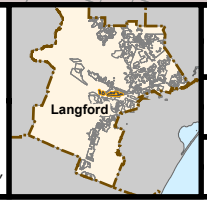
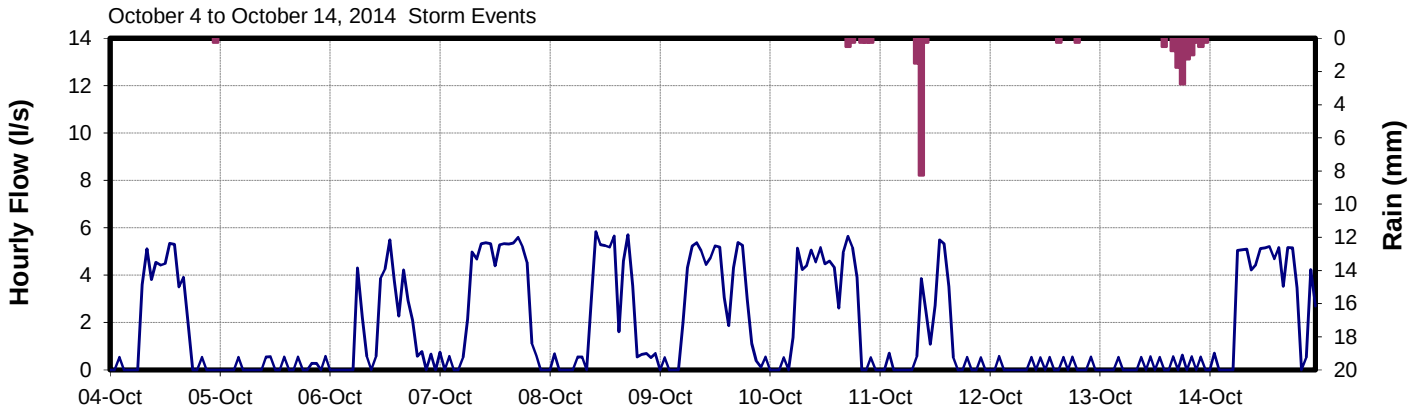


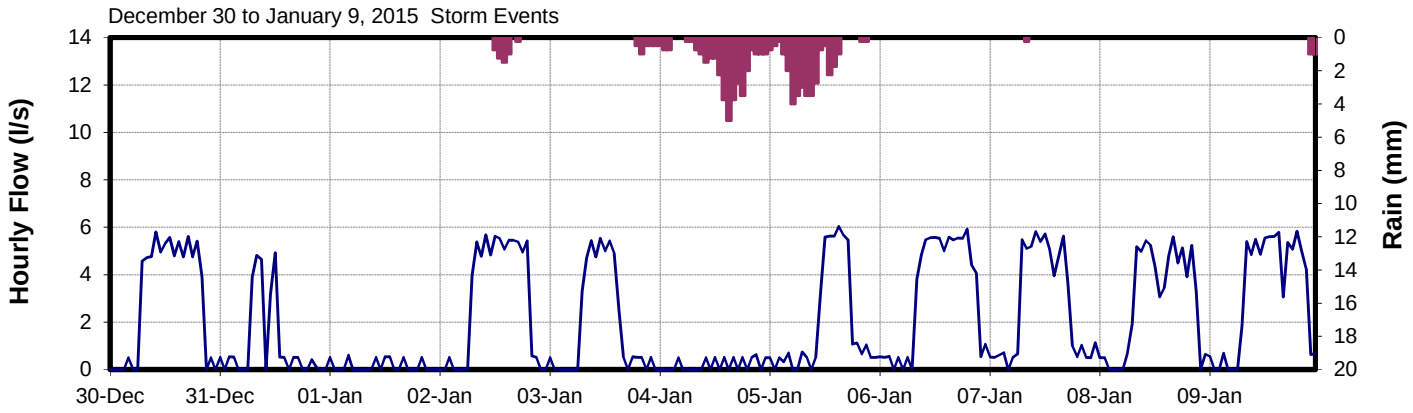
FLOW MONITORING AREA

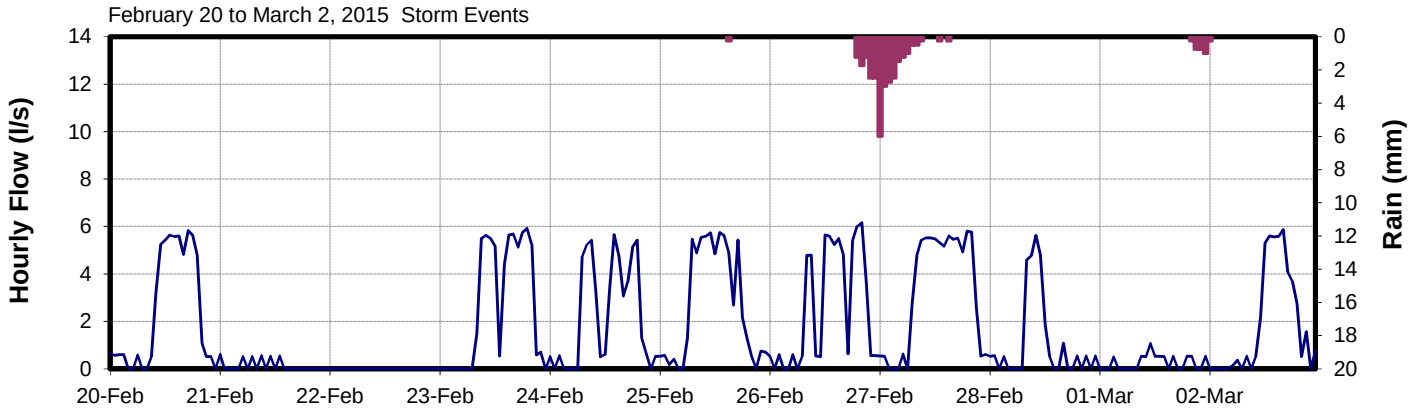
CATCHMENT: LEIGH

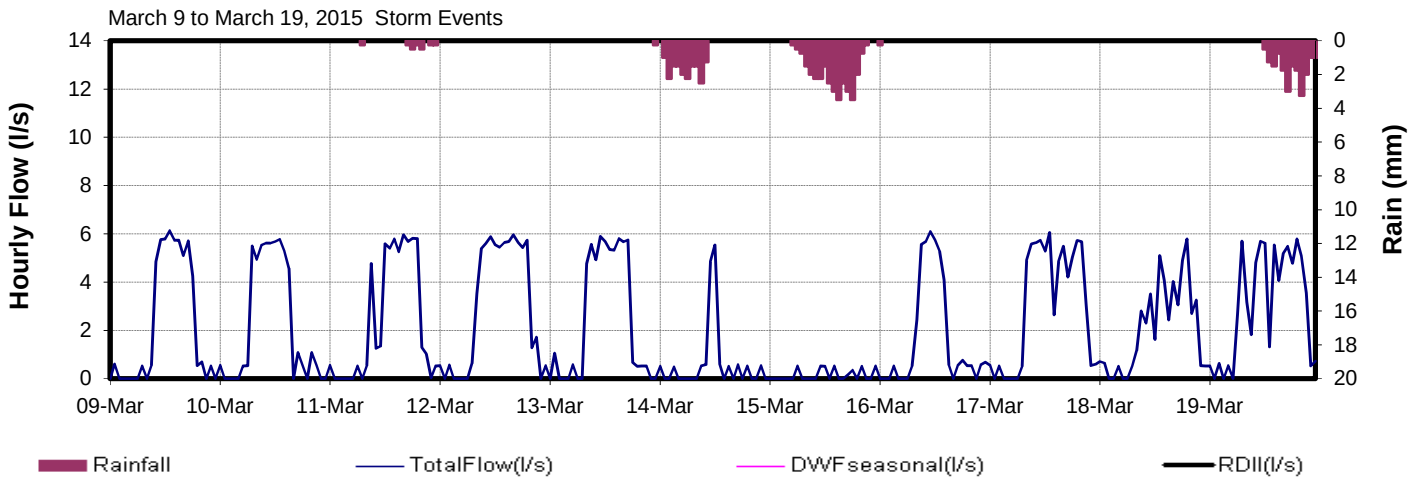
SITE CODE: **LG16**

Leigh (LG16)

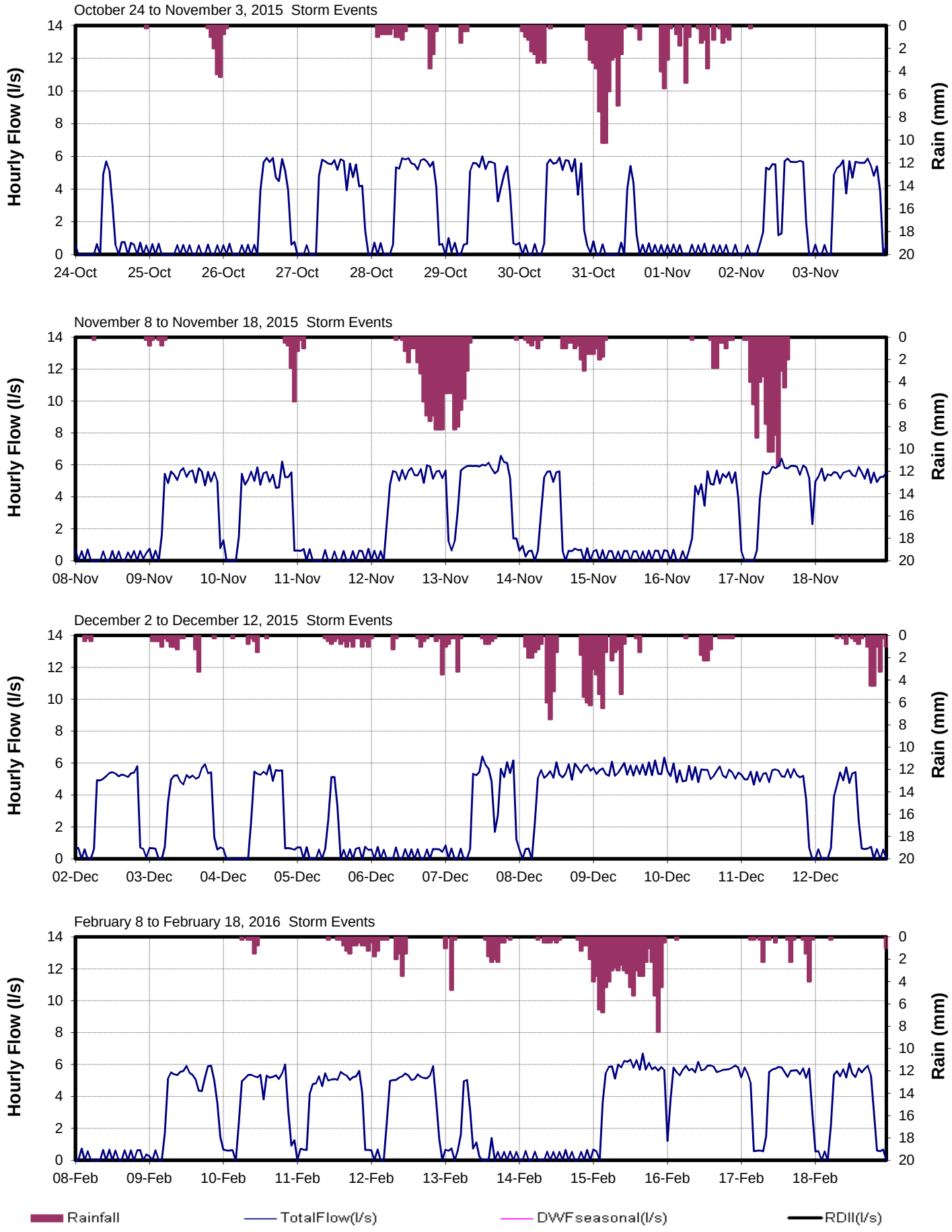

October 4 to October 14, 2014 Storm Events
Hourly Flow (l/s)
Rain (mm)
0
2
4
6
8
10
12
14
16
18
20
04-Oct
05-Oct
06-Oct
07-Oct
08-Oct
09-Oct
10-Oct
11-Oct
12-Oct
13-Oct
14-Oct


December 30 to January 9, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
0
2
4
6
8
10
12
14
16
18
20
30-Dec
31-Dec
01-Jan
02-Jan
03-Jan
04-Jan
05-Jan
06-Jan
07-Jan
08-Jan
09-Jan


February 20 to March 2, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
0
2
4
6
8
10
12
14
16
18
20
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
26-Feb
27-Feb
28-Feb
01-Mar
02-Mar

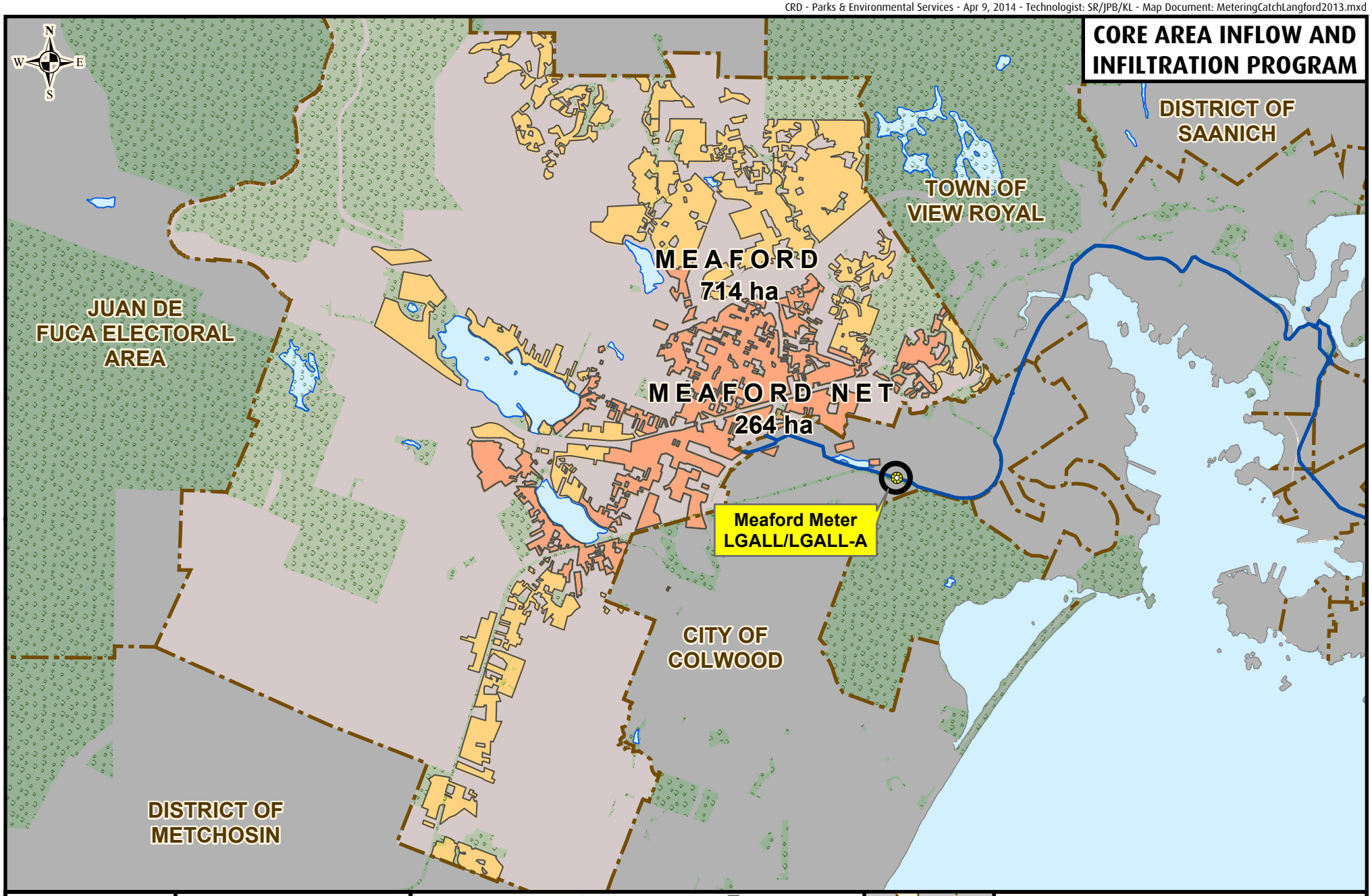

March 9 to March 19, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
0
2
4
6
8
10
12
14
16
18
20
09-Mar
10-Mar
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
19-Mar
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

Leigh (LG16)


October 24 to November 3, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
24-Oct
25-Oct
26-Oct
27-Oct
28-Oct
29-Oct
30-Oct
31-Oct
01-Nov
02-Nov
03-Nov
November 8 to November 18, 2015 Storm Events
08-Nov
09-Nov
10-Nov
11-Nov
12-Nov
13-Nov
14-Nov
15-Nov
16-Nov
17-Nov
18-Nov
December 2 to December 12, 2015 Storm Events
02-Dec
03-Dec
04-Dec
05-Dec
06-Dec
07-Dec
08-Dec
09-Dec
10-Dec
11-Dec
12-Dec
February 8 to February 18, 2016 Storm Events
08-Feb
09-Feb
10-Feb
11-Feb
12-Feb
13-Feb
14-Feb
15-Feb
16-Feb
17-Feb
18-Feb
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

CRD - Parks & Environmental Services - Apr 9, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchLangford2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 500 1,000 1,500

Projection: UTM ZONE 10N NAD 83

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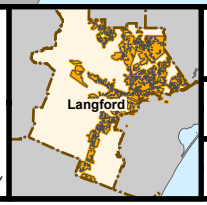
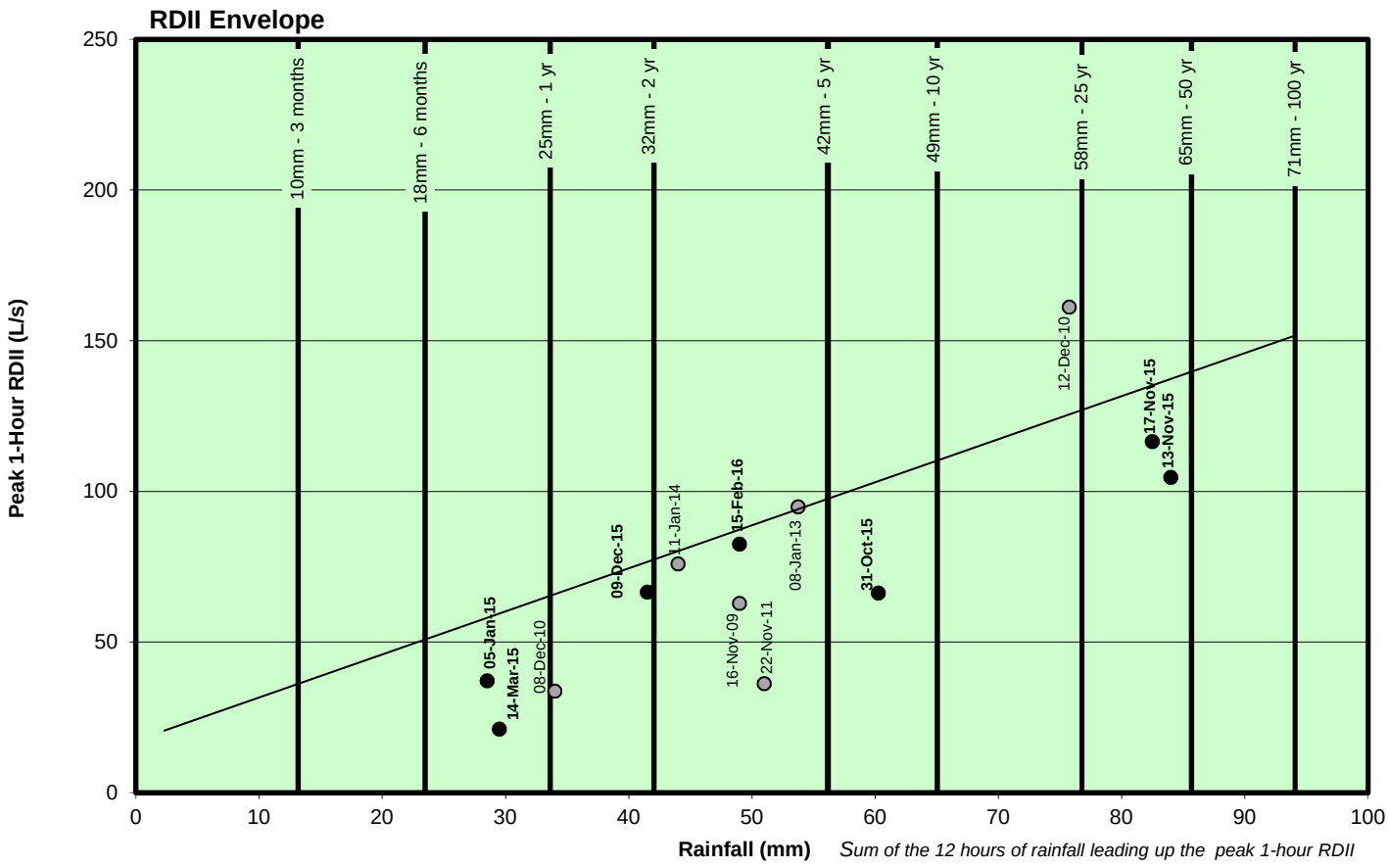


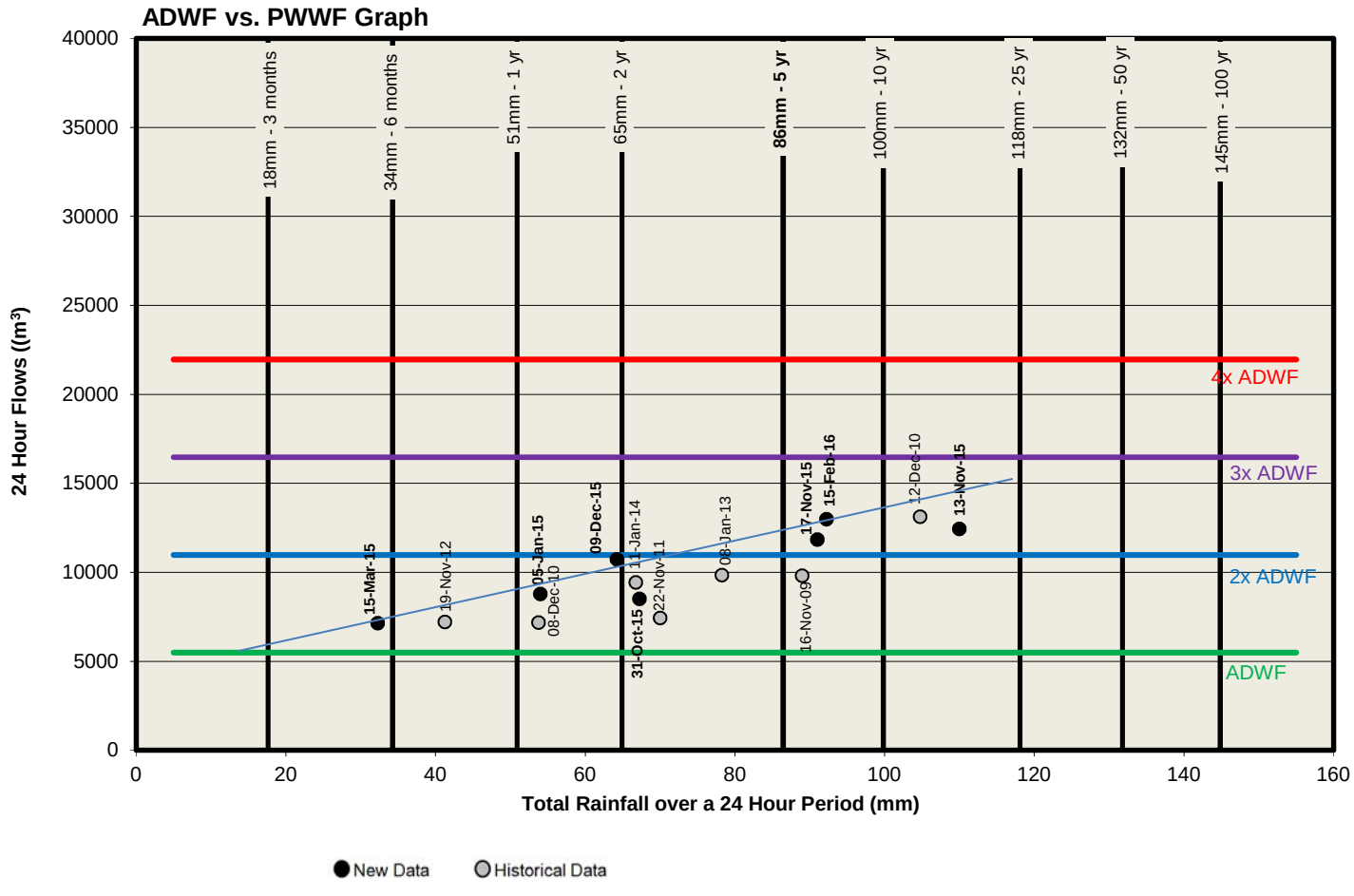
FLOW MONITORING AREA

CATCHMENT: MEAFORD/MEAFORD NET

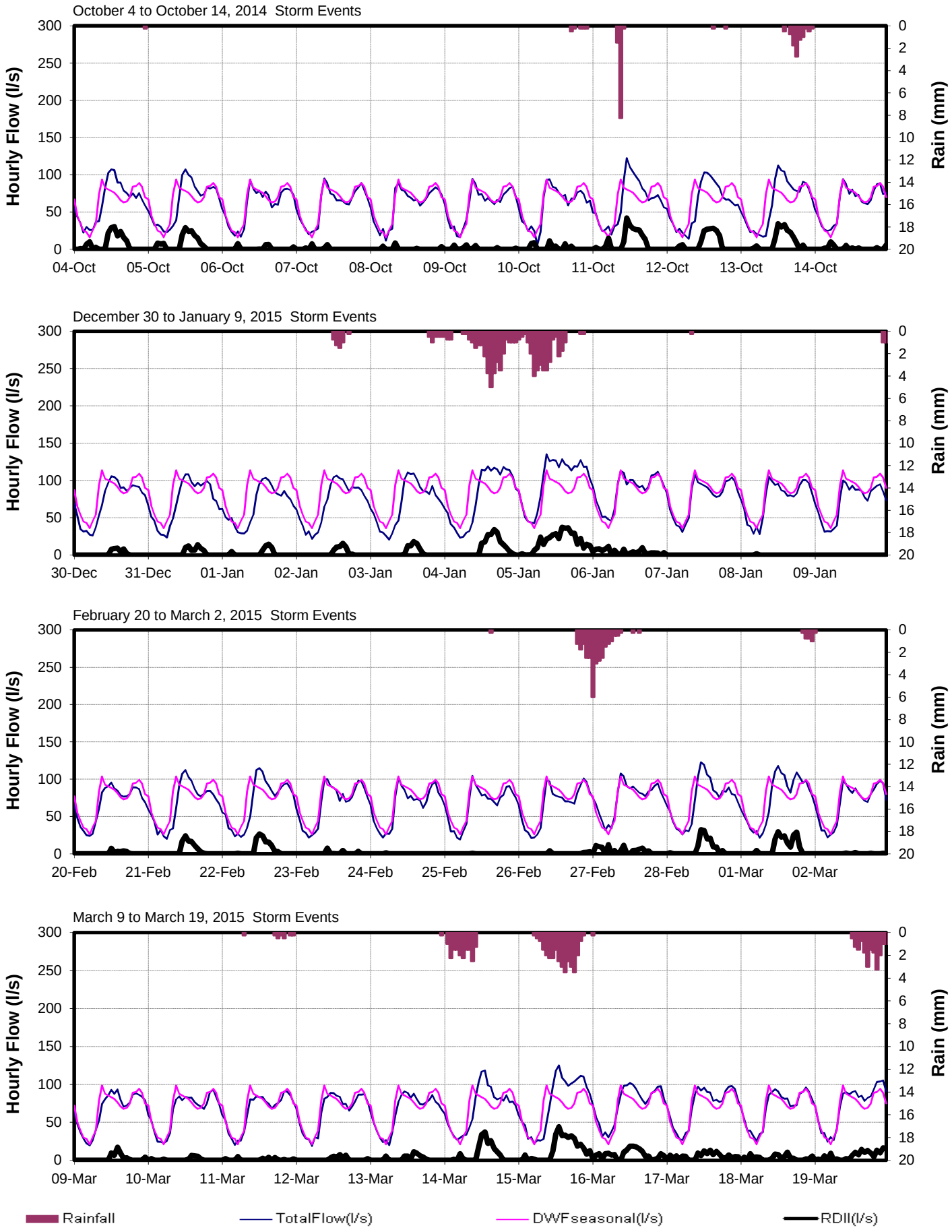
SITE CODE: **LGALL/LGALL-A**

Meaford (LGALL)

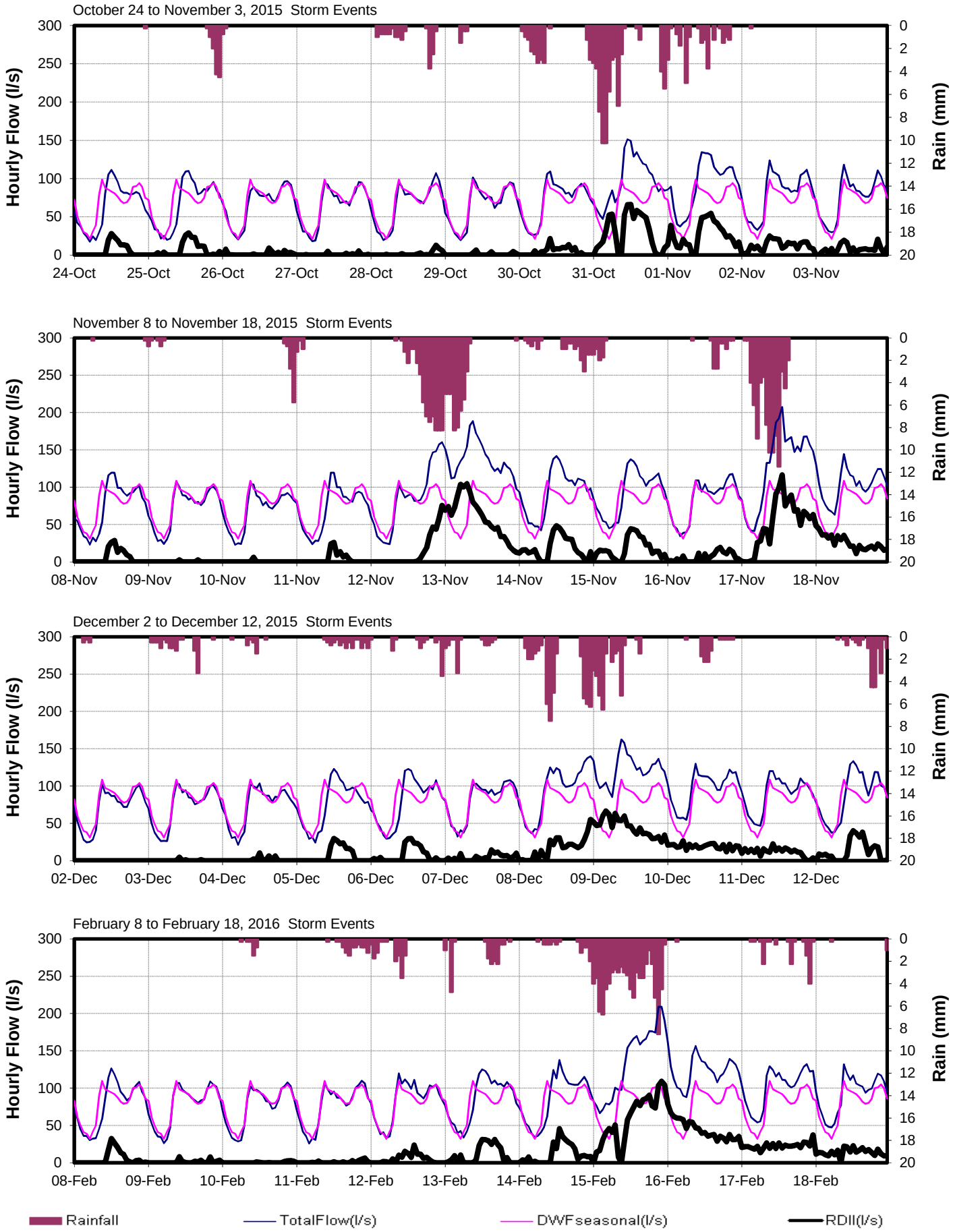




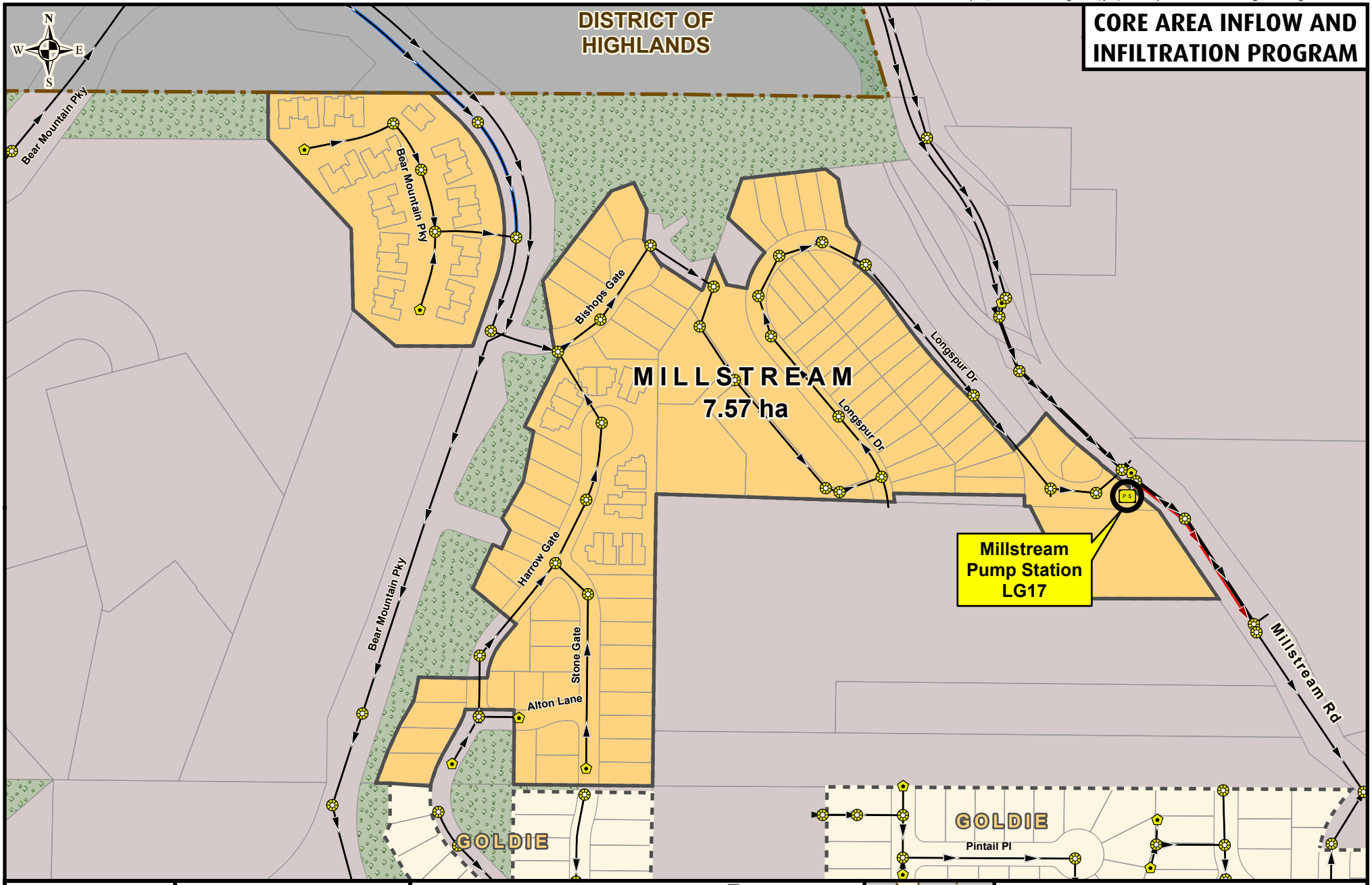
Meaford (LGALL)



Meaford (LGALL)



CORE AREA INFLOW AND INFILTRATION PROGRAM



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Metres
0 50 100

Projection: UTM ZONE 10N NAD 83

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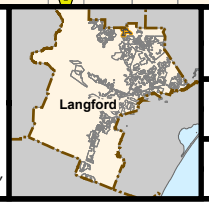


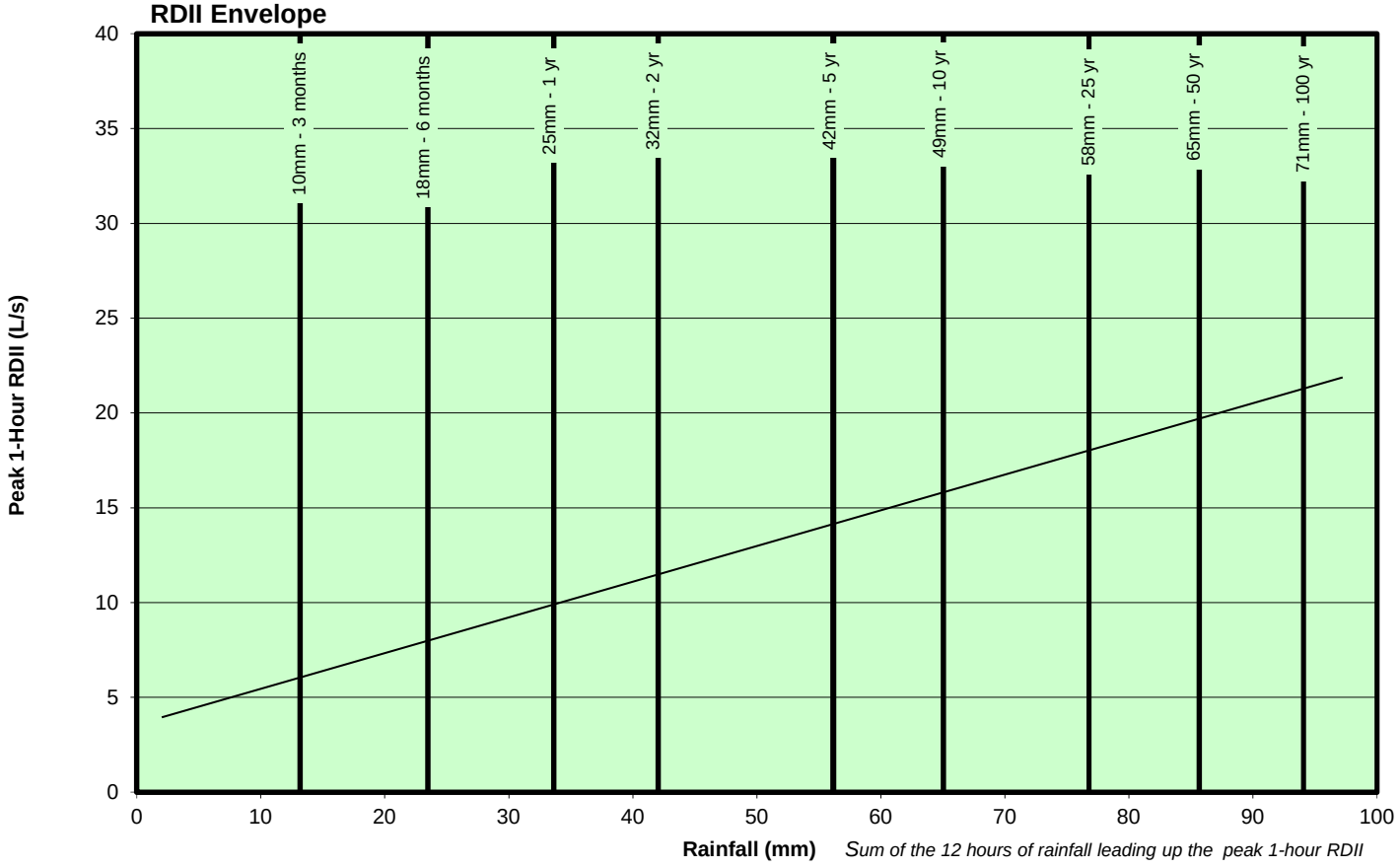
FLOW MONITORING AREA

CATCHMENT: MILLSTREAM

SITE CODE: **LG17**

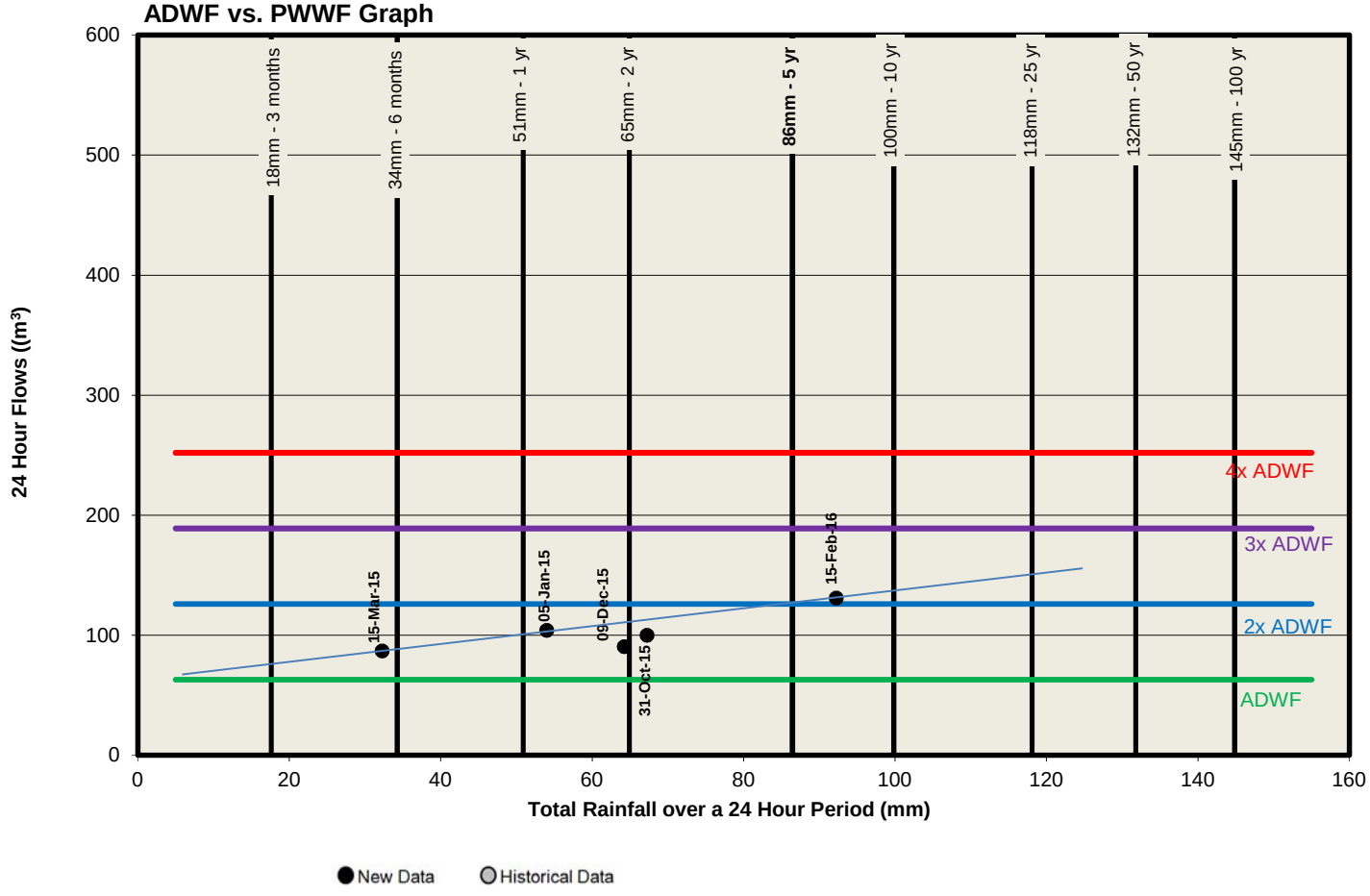
Millstream (LG17)

RDII Envelope

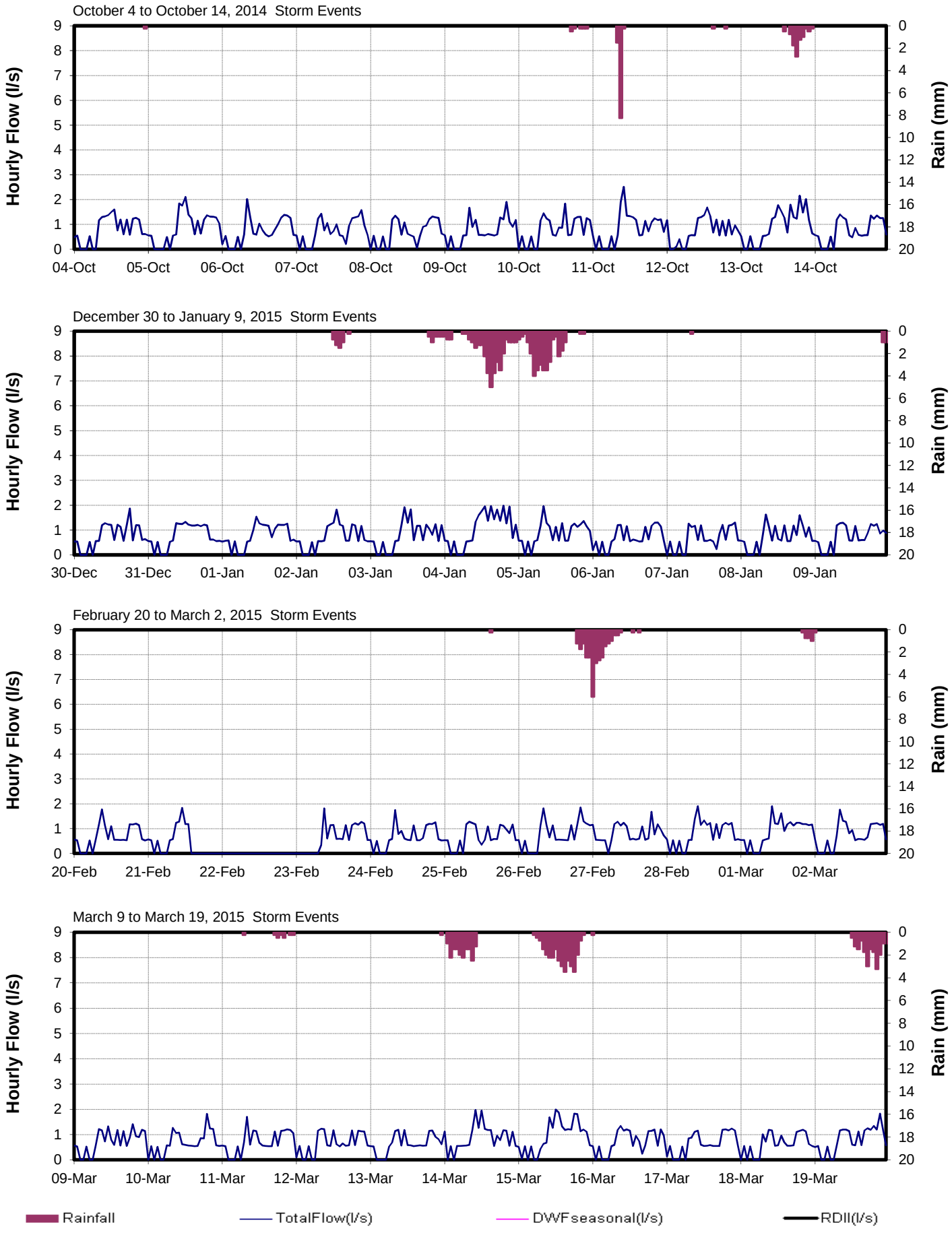


Sum of the 12 hours of rainfall leading up the peak 1-hour RDII

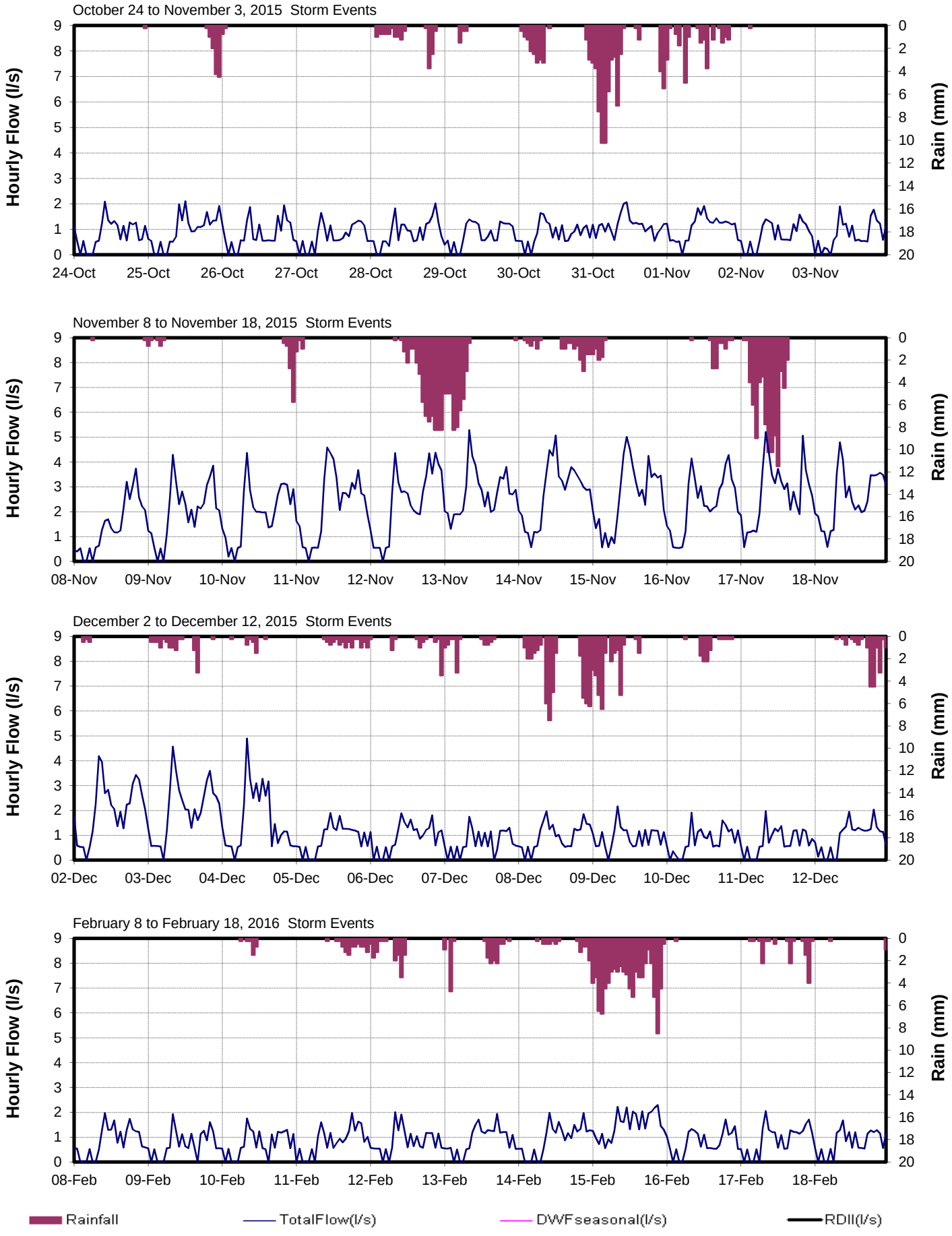
ADWF vs. PWWF Graph



Millstream (LG17)



Millstream (LG17)



CRD Core Area I Program

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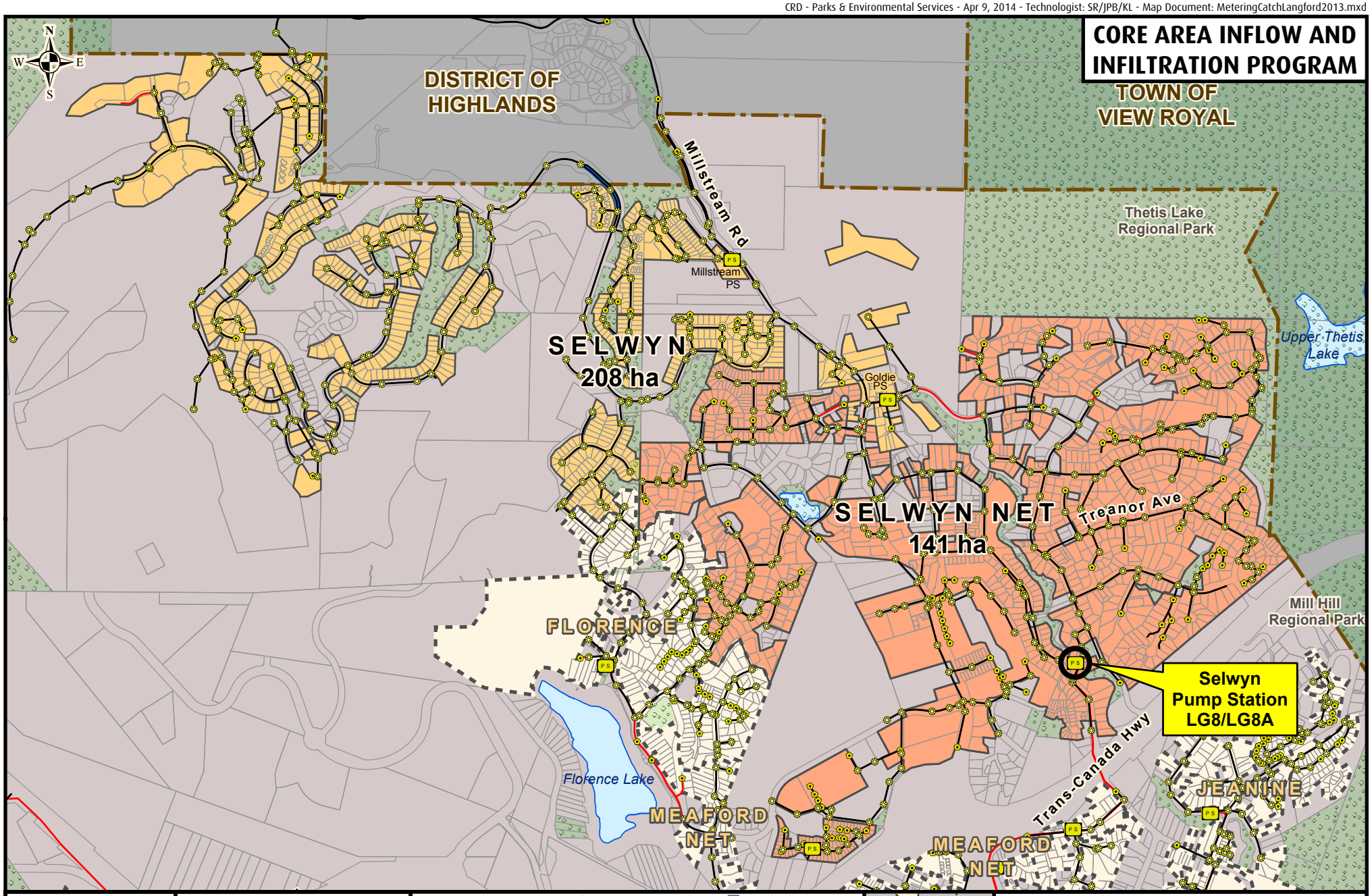

Making a difference...together

Metres
0 100 200 300 400 500

Projection: UTM ZONE 10N NAD 83

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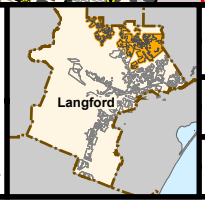


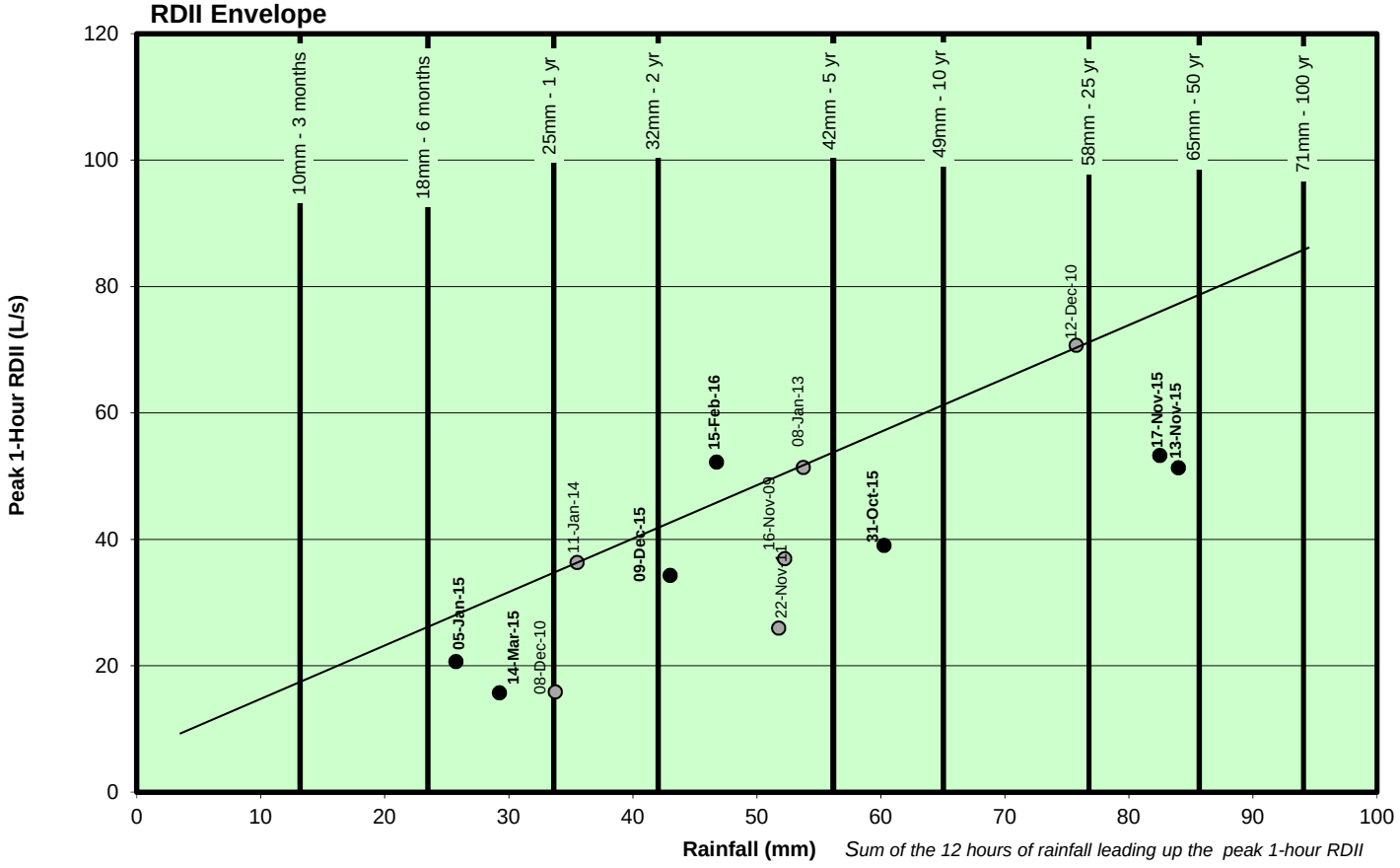
FLOW MONITORING AREA

CATCHMENT: SELWYN/SELWYN NET

SITE CODE: **LG8/LG8A**

Selwyn (LG8)

RDII Envelope



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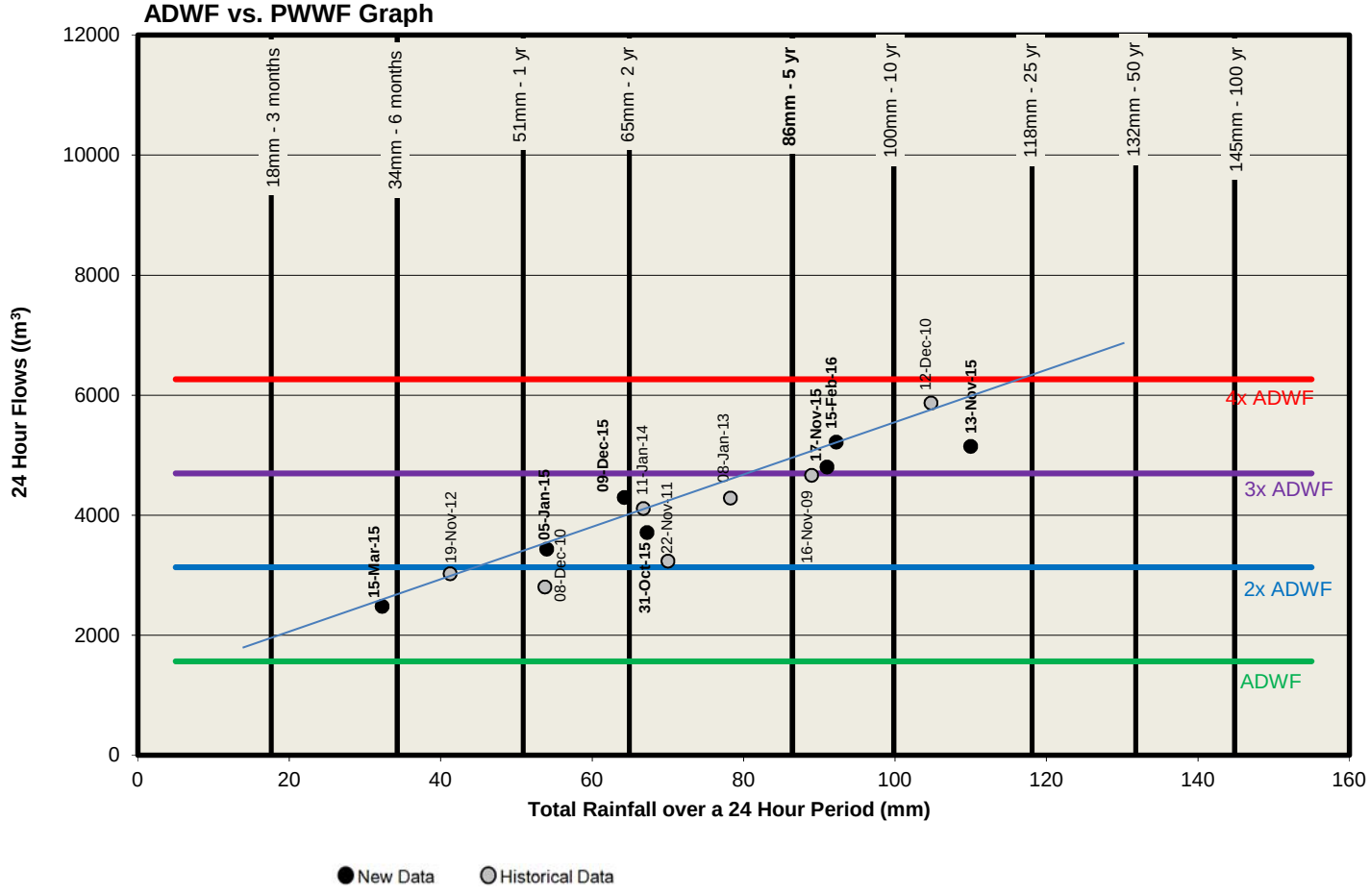
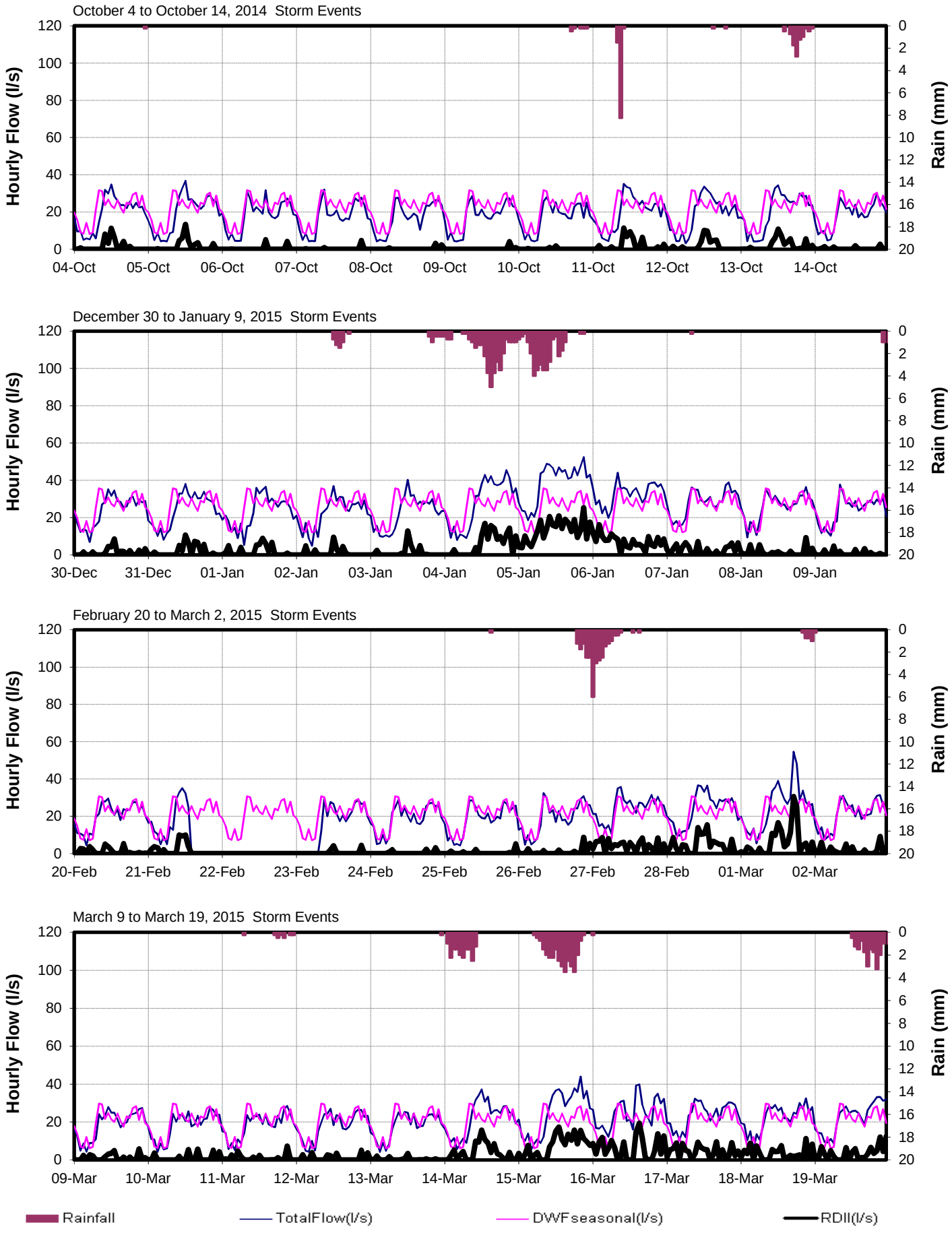
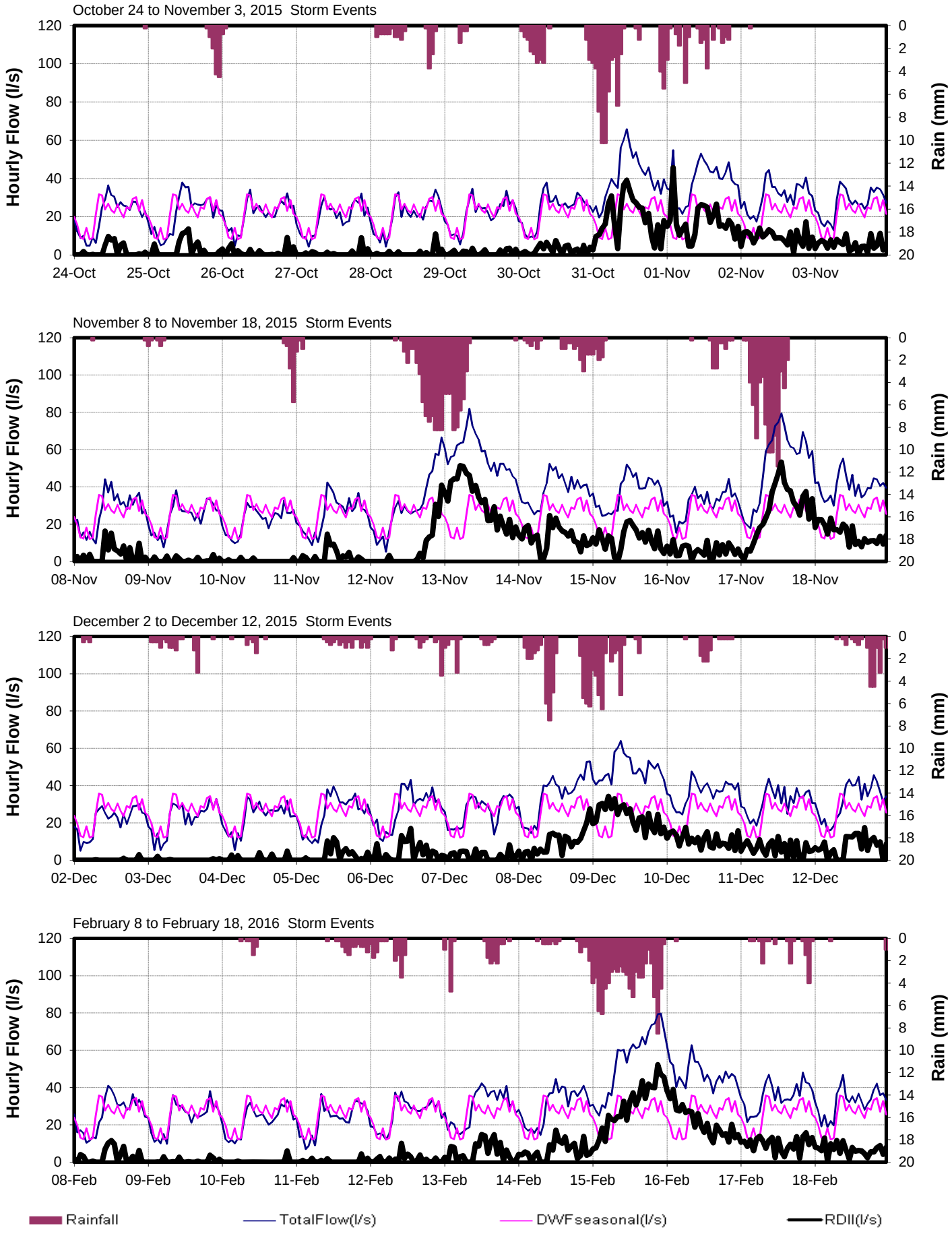


Selwyn (LG8)


October 4 to October 14, 2014 Storm Events
Hourly Flow (l/s)
Rain (mm)
04-Oct
05-Oct
06-Oct
07-Oct
08-Oct
09-Oct
10-Oct
11-Oct
12-Oct
13-Oct
14-Oct
December 30 to January 9, 2015 Storm Events
30-Dec
31-Dec
01-Jan
02-Jan
03-Jan
04-Jan
05-Jan
06-Jan
07-Jan
08-Jan
09-Jan
February 20 to March 2, 2015 Storm Events
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
26-Feb
27-Feb
28-Feb
01-Mar
02-Mar
March 9 to March 19, 2015 Storm Events
09-Mar
10-Mar
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
19-Mar
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

Selwyn (LG8)


October 24 to November 3, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
24-Oct
25-Oct
26-Oct
27-Oct
28-Oct
29-Oct
30-Oct
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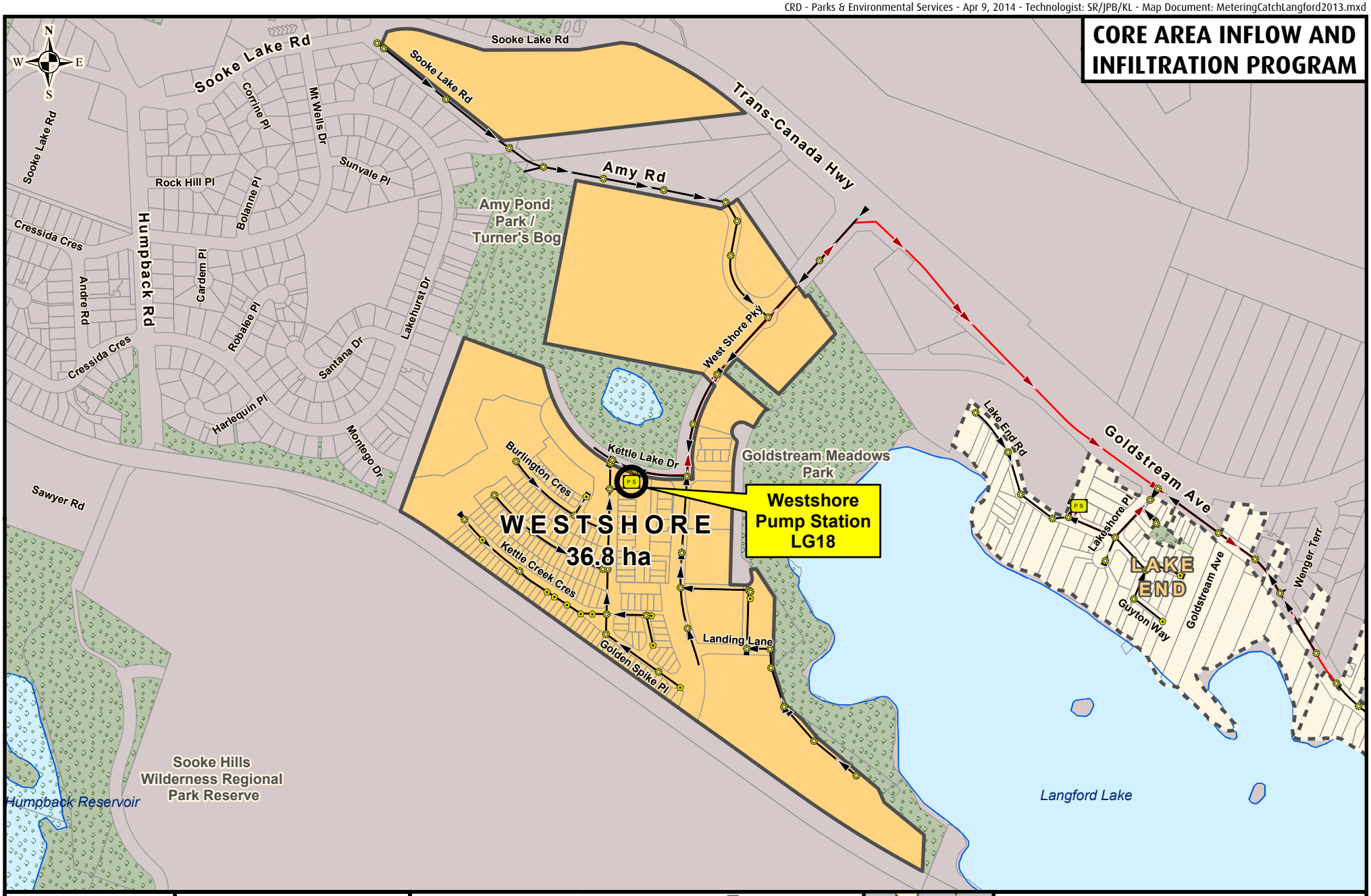
02-Nov
03-Nov
November 8 to November 18, 2015 Storm Events
08-Nov
09-Nov
10-Nov
11-Nov
12-Nov
13-Nov
14-Nov
15-Nov
16-Nov
17-Nov
18-Nov
December 2 to December 12, 2015 Storm Events
02-Dec
03-Dec
04-Dec
05-Dec
06-Dec
07-Dec
08-Dec
09-Dec
10-Dec
11-Dec
12-Dec
February 8 to February 18, 2016 Storm Events
08-Feb
09-Feb
10-Feb
11-Feb
12-Feb
13-Feb
14-Feb
15-Feb
16-Feb
17-Feb
18-Feb
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

CRD - Parks & Environmental Services - Apr 9, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchLangford2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100 150 200

Projection: UTM ZONE 10N NAD 83

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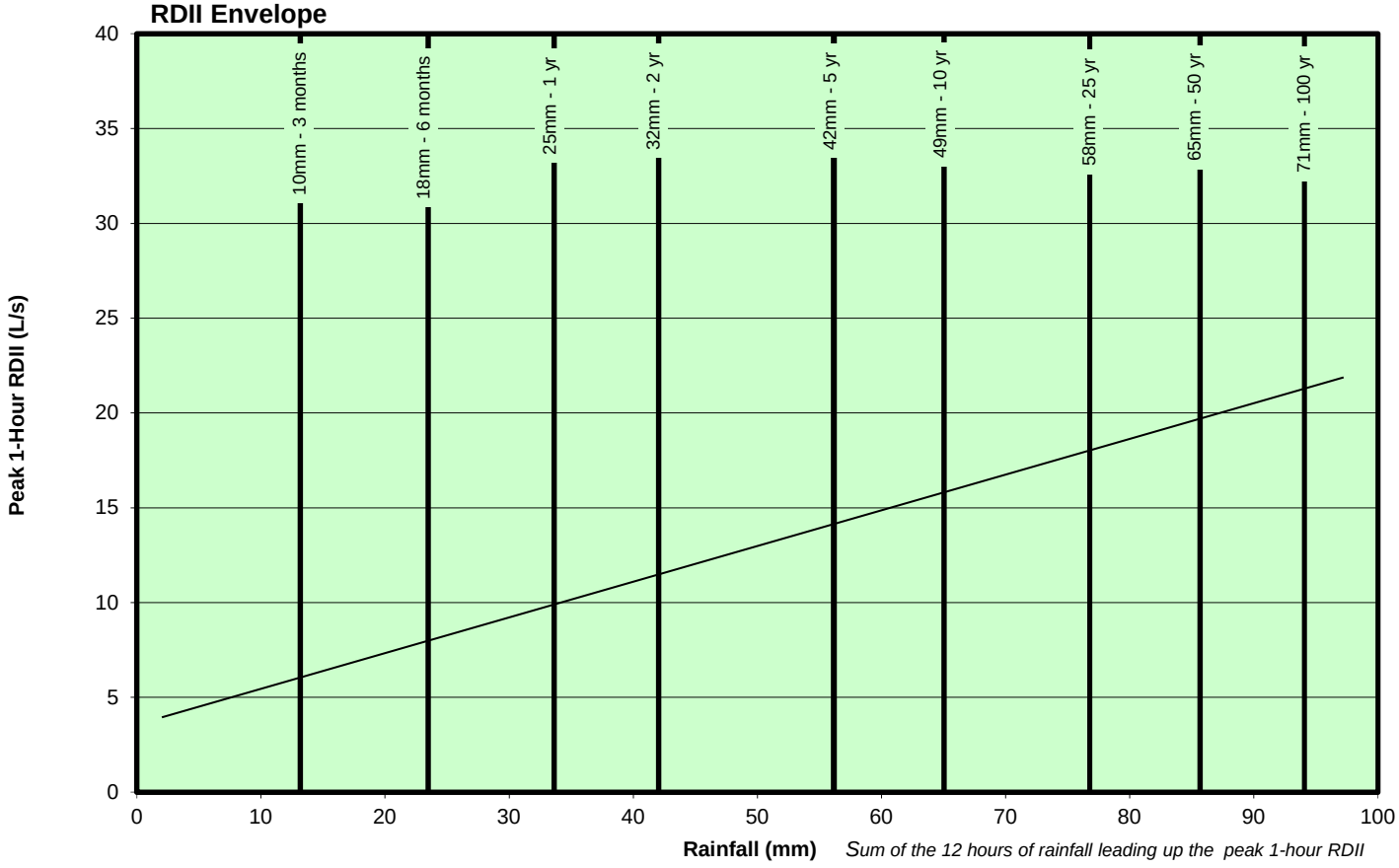
FLOW MONITORING AREA

CATCHMENT: WESTSHORE

SITE CODE: **LG18**

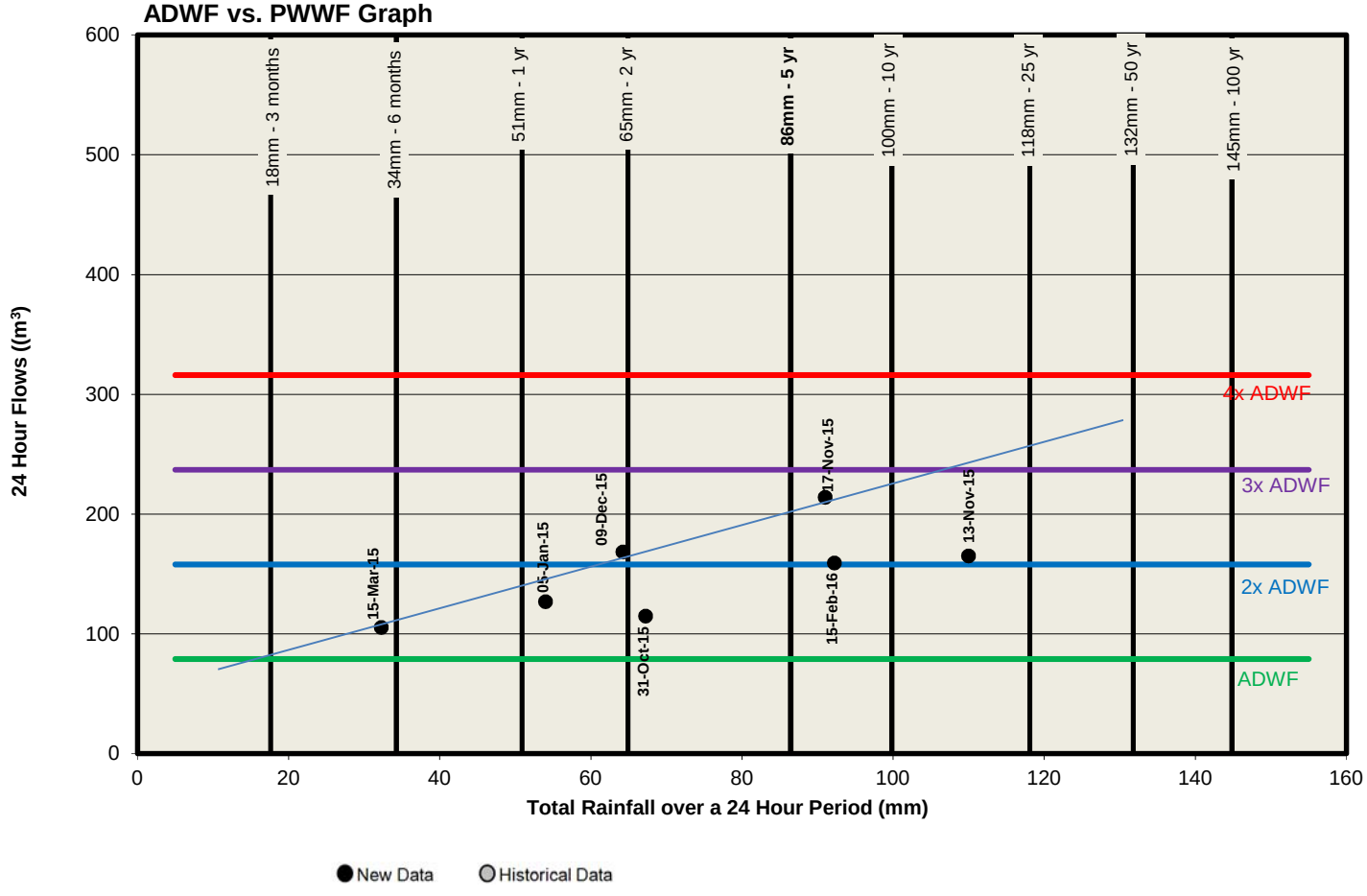
Westshore Parkway (LG18)

RDII Envelope

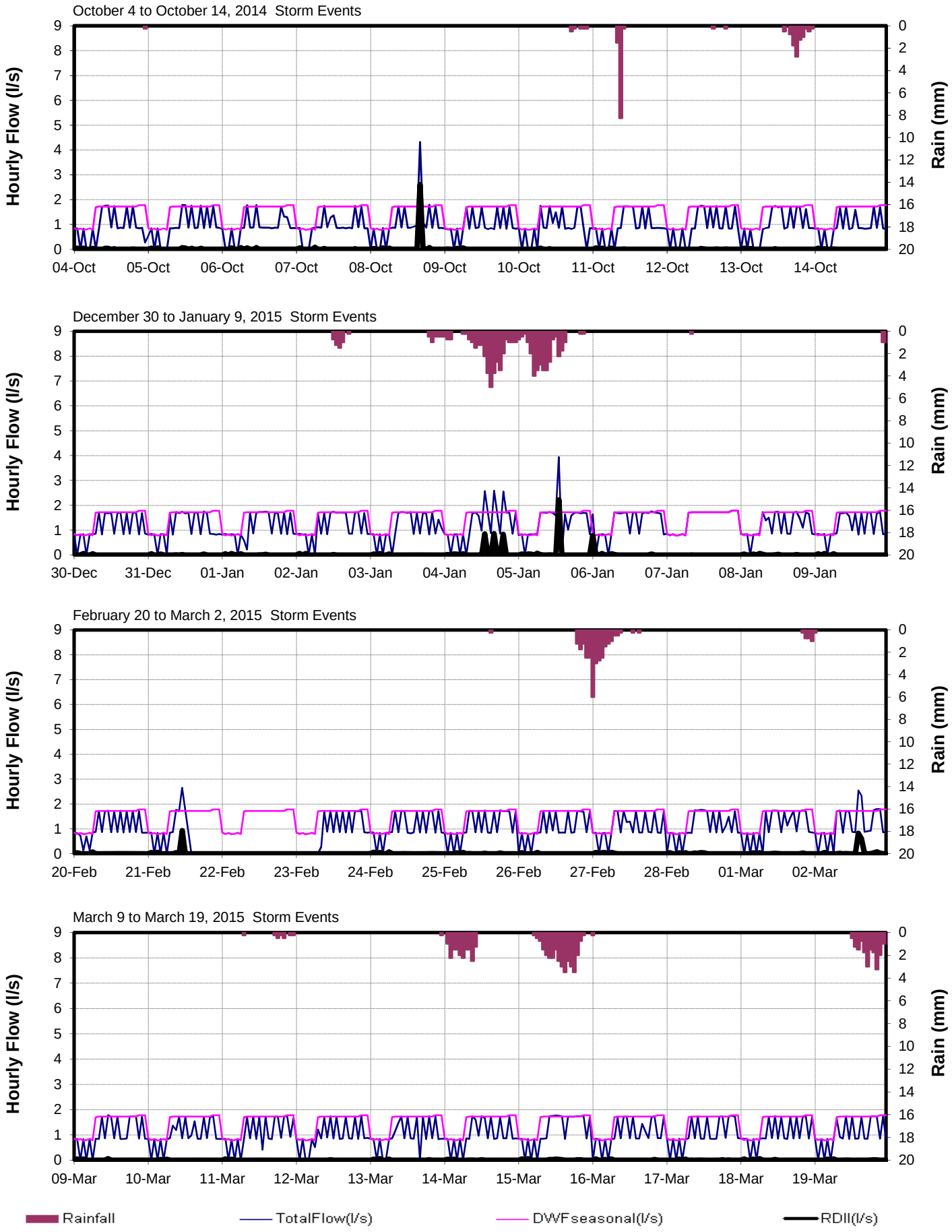


Sum of the 12 hours of rainfall leading up the peak 1-hour RDII

ADWF vs. PWWF Graph



Westshore Parkway (LG18)



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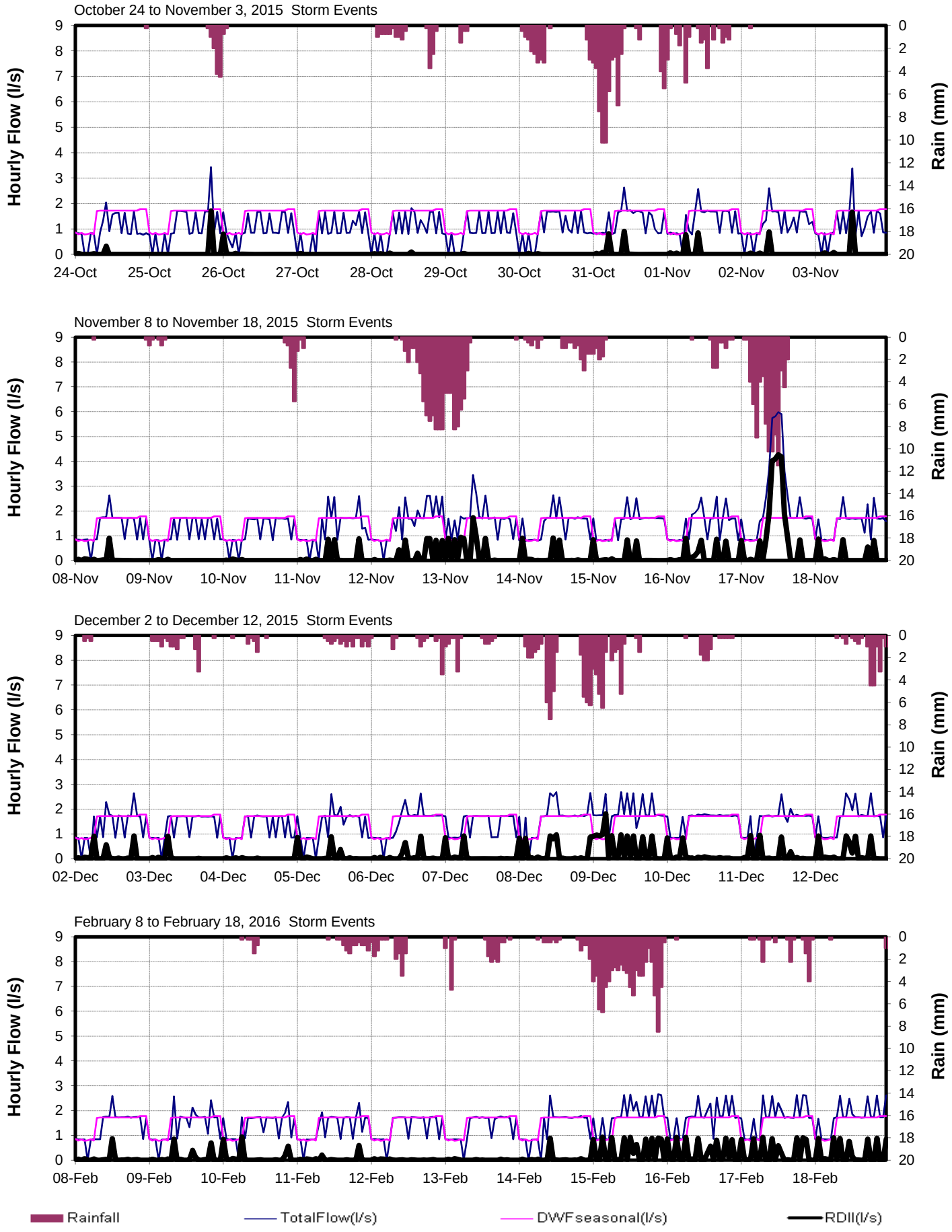
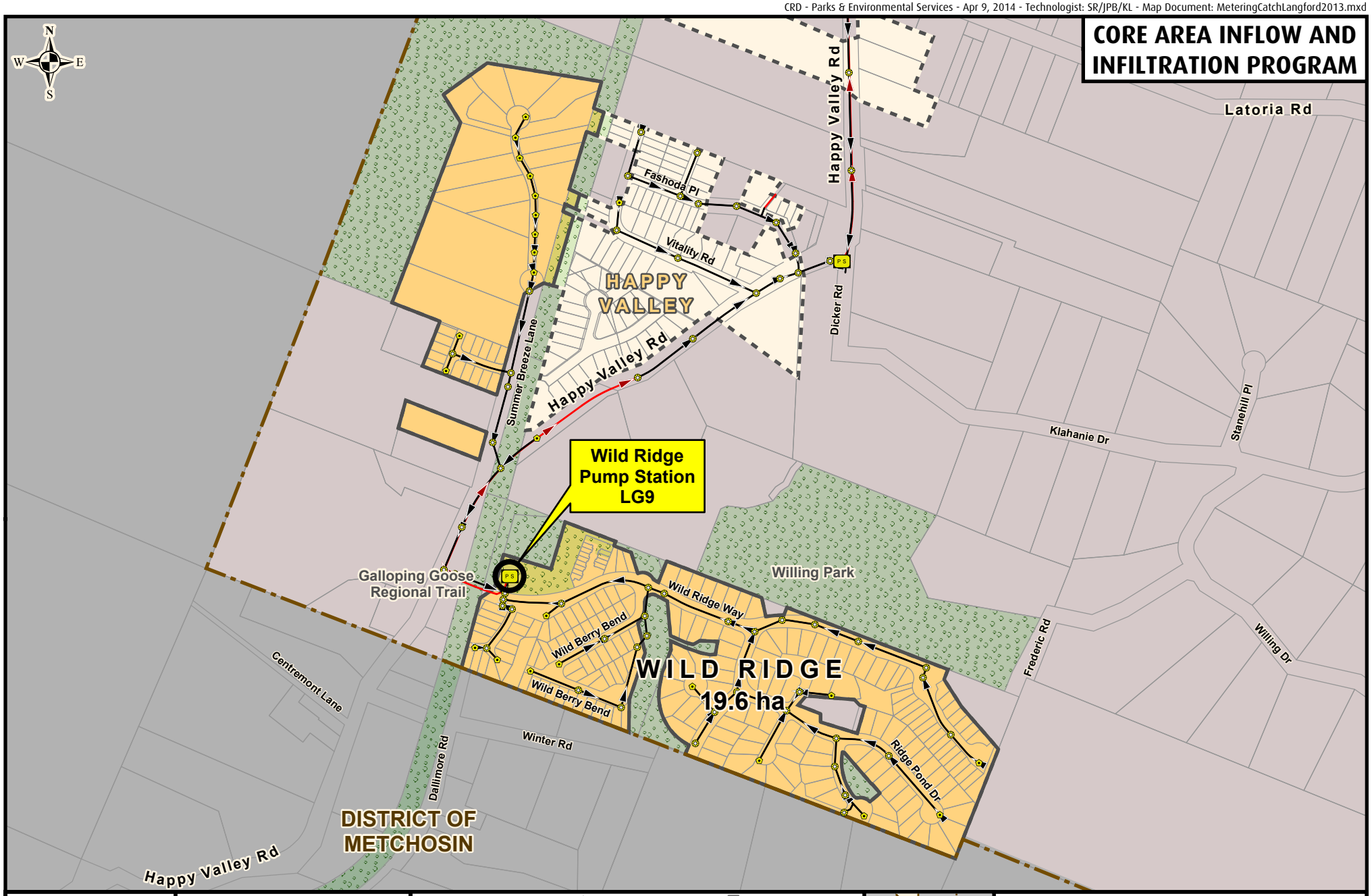


CRD - Parks & Environmental Services - Apr 9, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchLangford2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100 150

Projection: UTM ZONE 10N NAD 83

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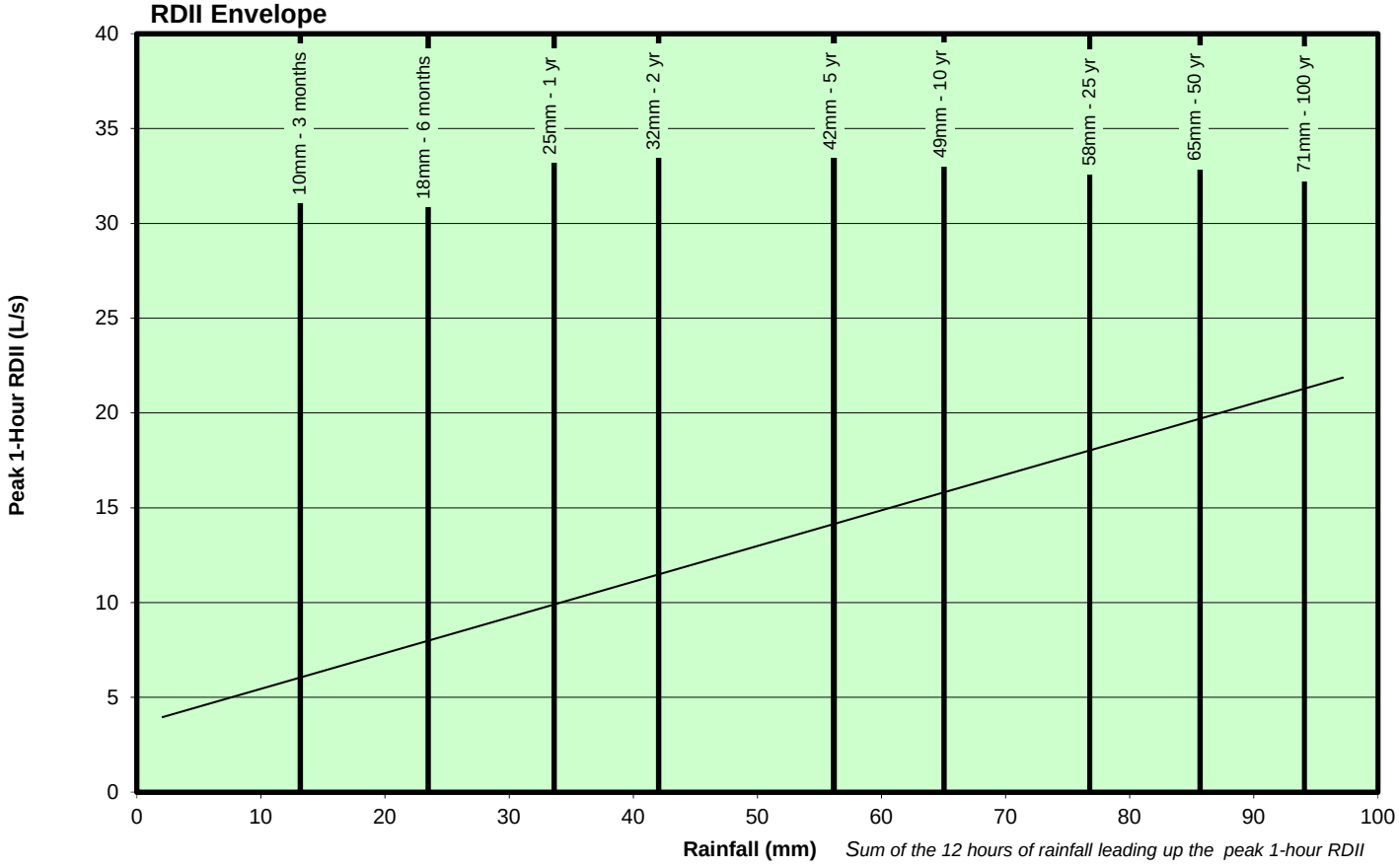
FLOW MONITORING AREA

CATCHMENT: WILD RIDGE

SITE CODE: **LG9**

Wild Ridge (LG9)

RDII Envelope



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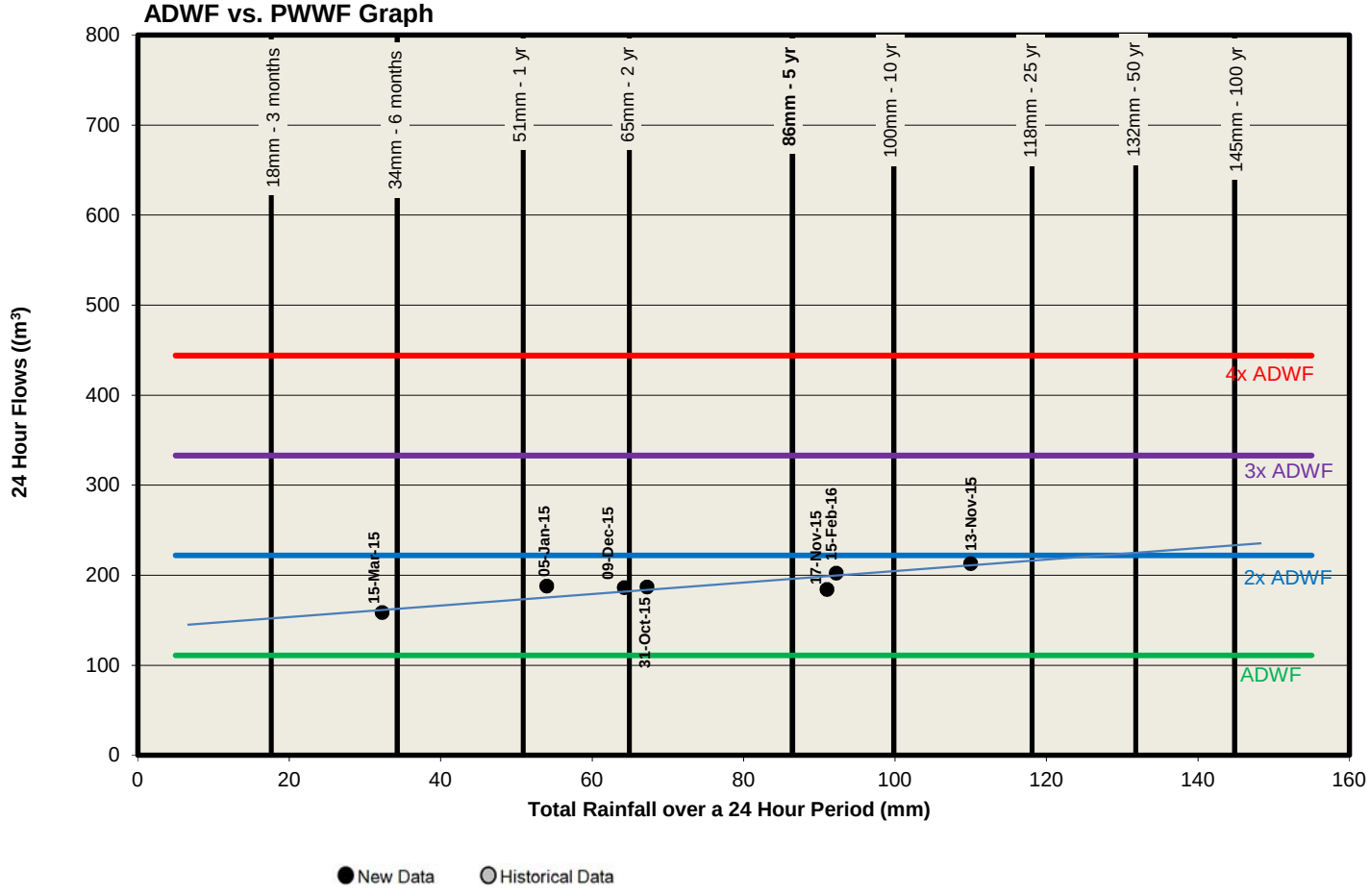
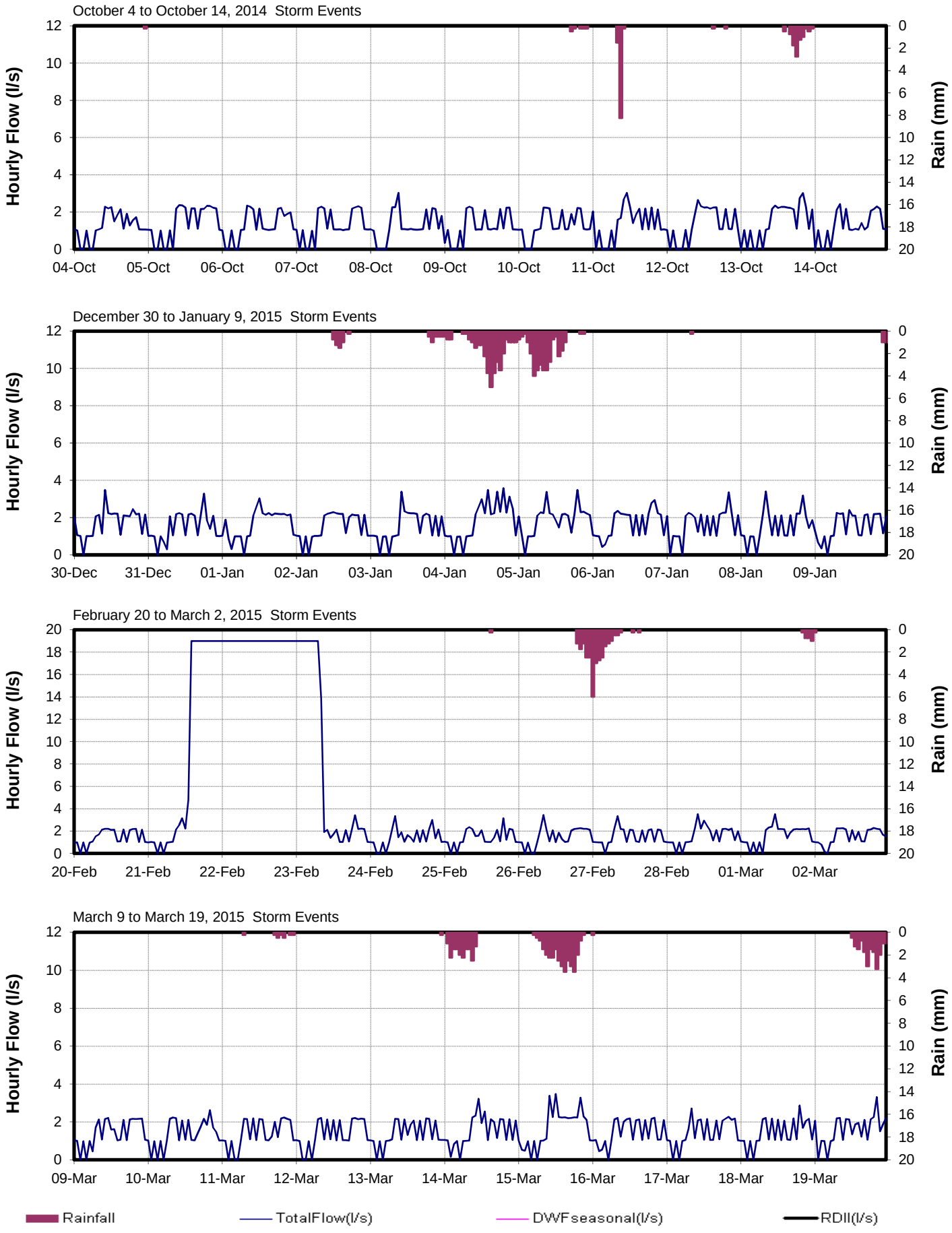


Wild Ridge (LG9)



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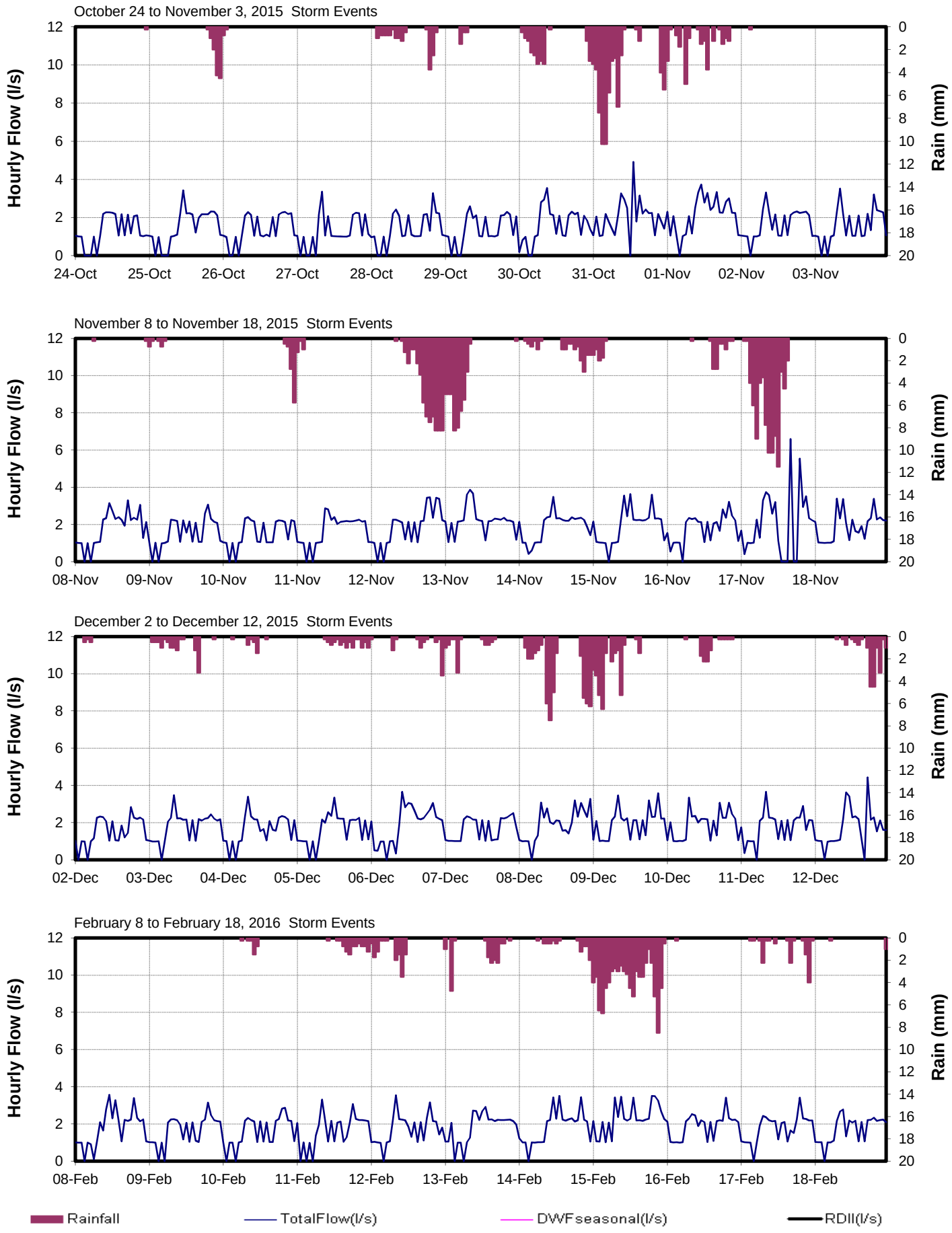
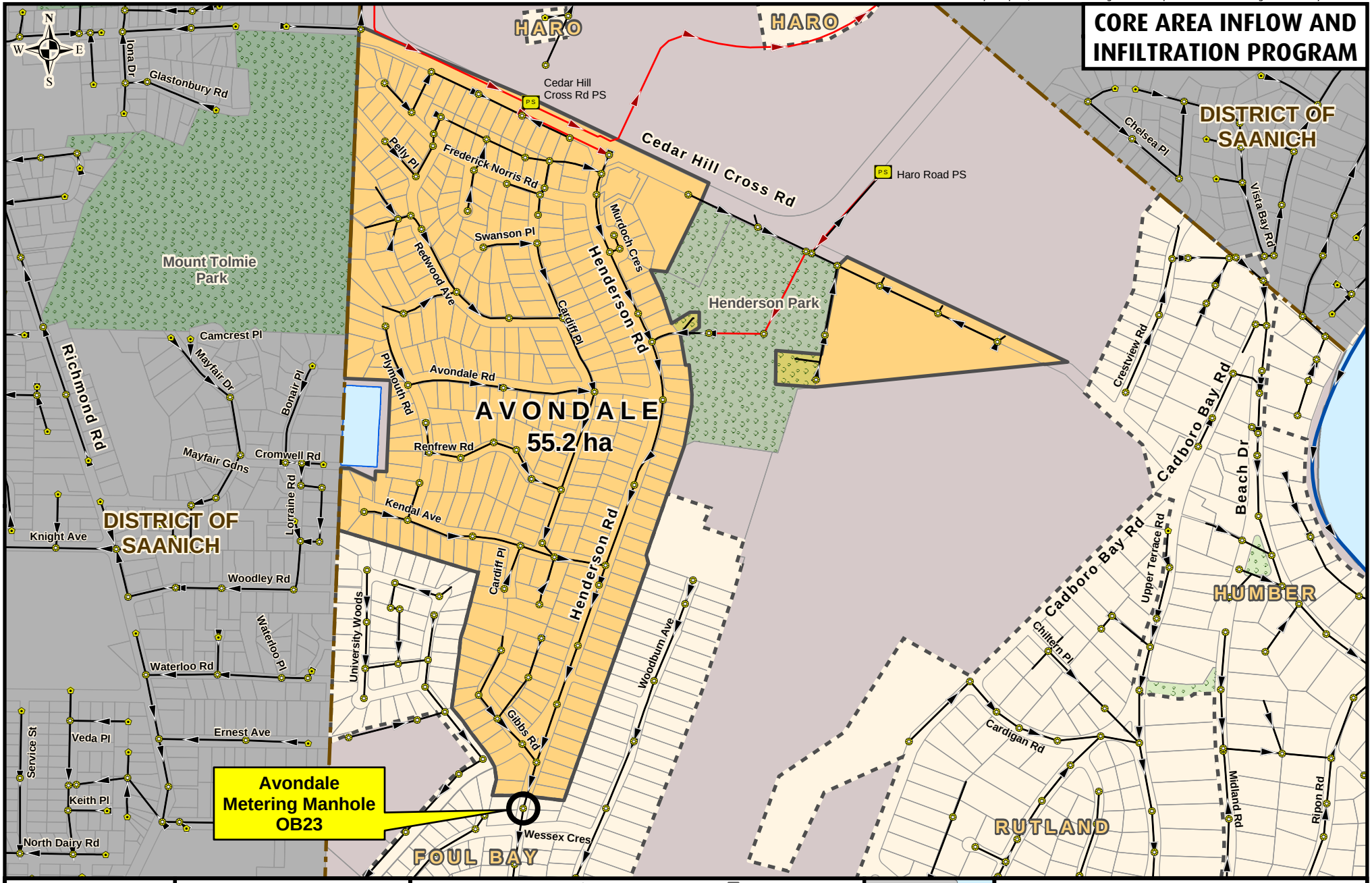


CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 100 200 300

Projection: UTM ZONE 10N NAD 83

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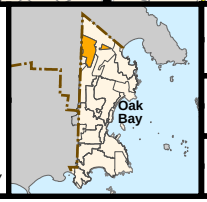


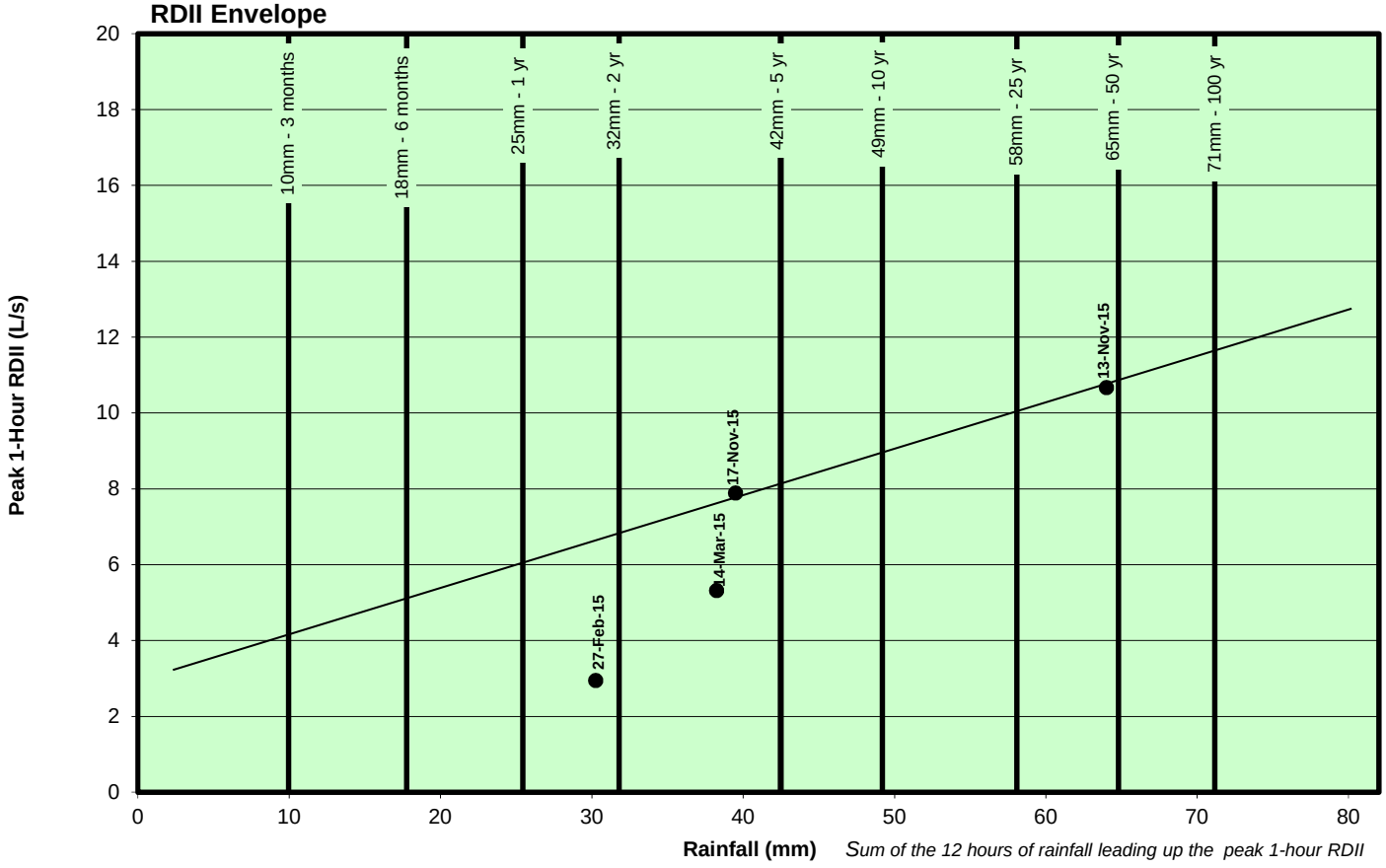
FLOW MONITORING AREA

CATCHMENT: AVONDALE

SITE CODE: **OB23**

Avondale (OB23)

RDII Envelope



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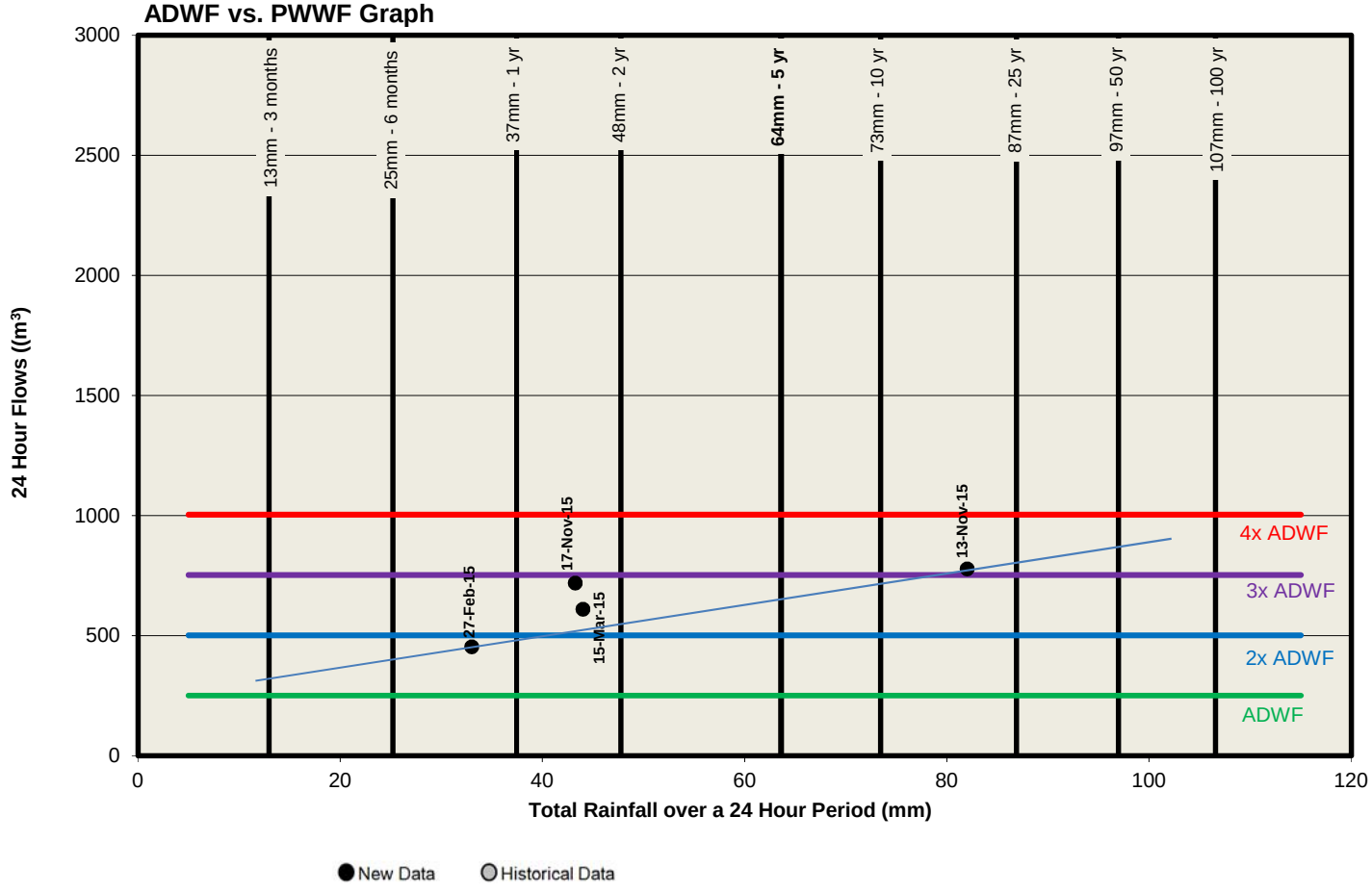
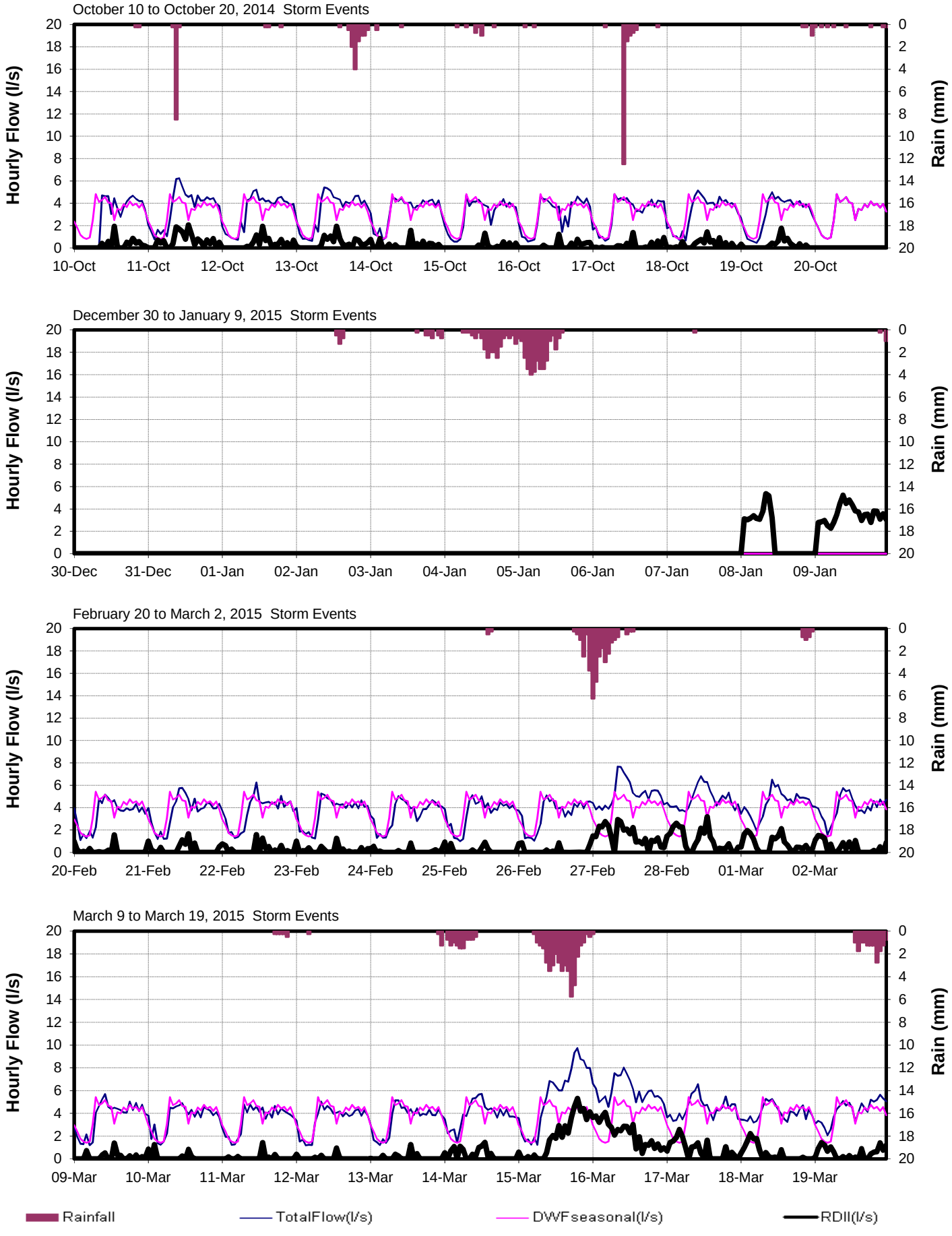
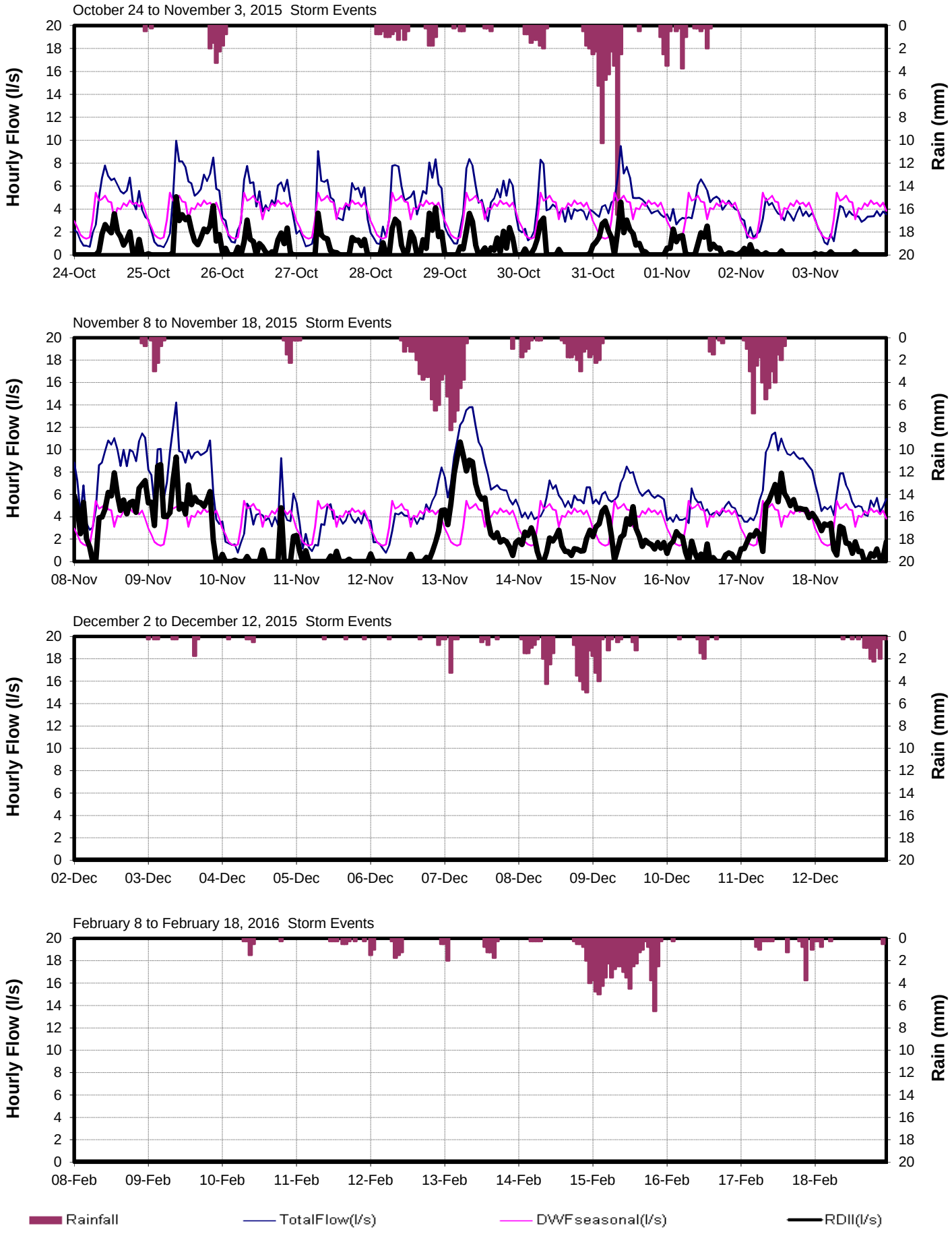


Avondale (OB23)

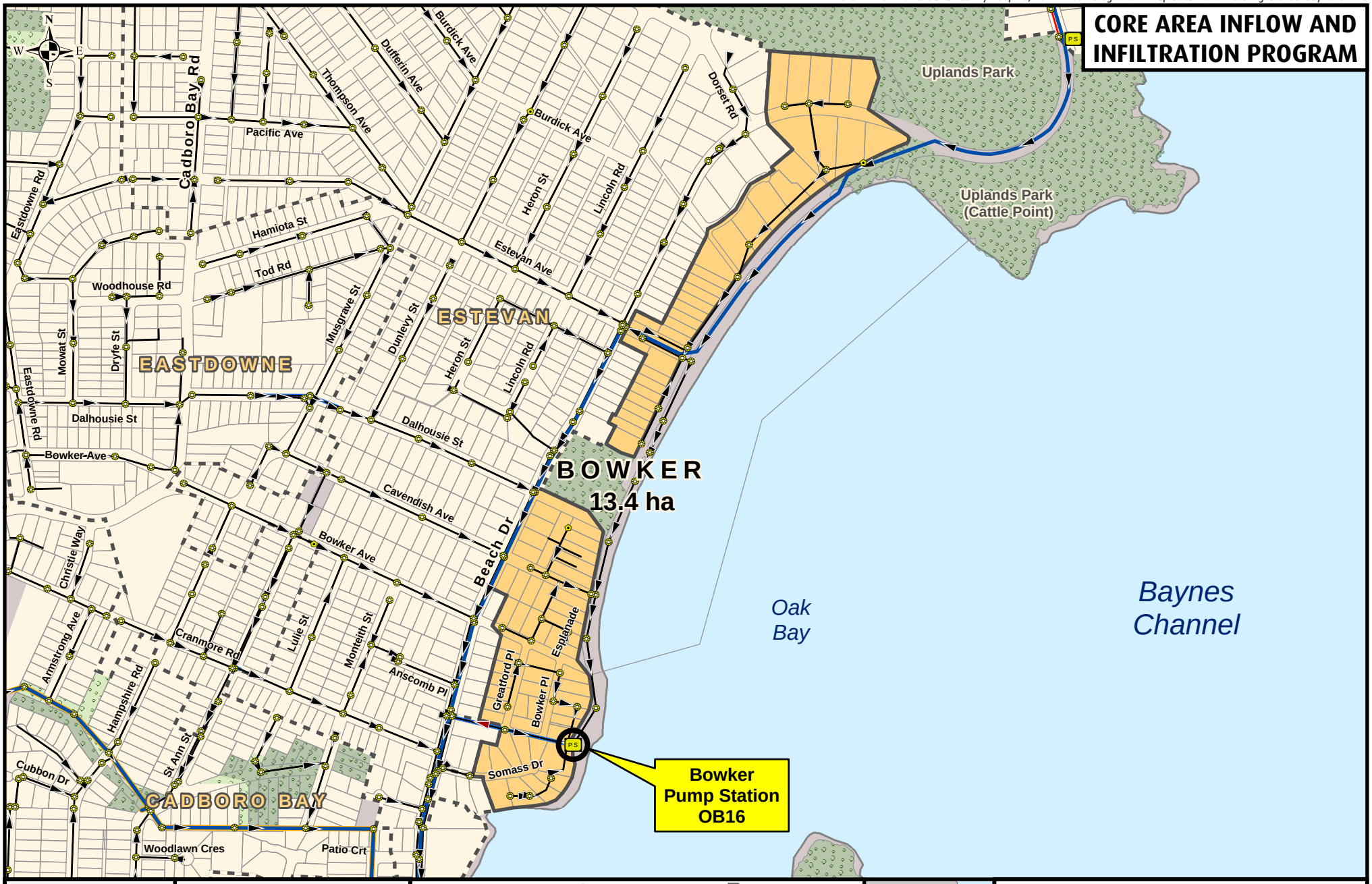


Avondale (OB23)



CRD Environmental Sustainability - Sep 20, 2011 - Technologist: SR - Map Document: MeteringCatchOakBay2010.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 100 200

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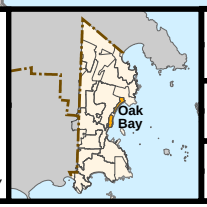


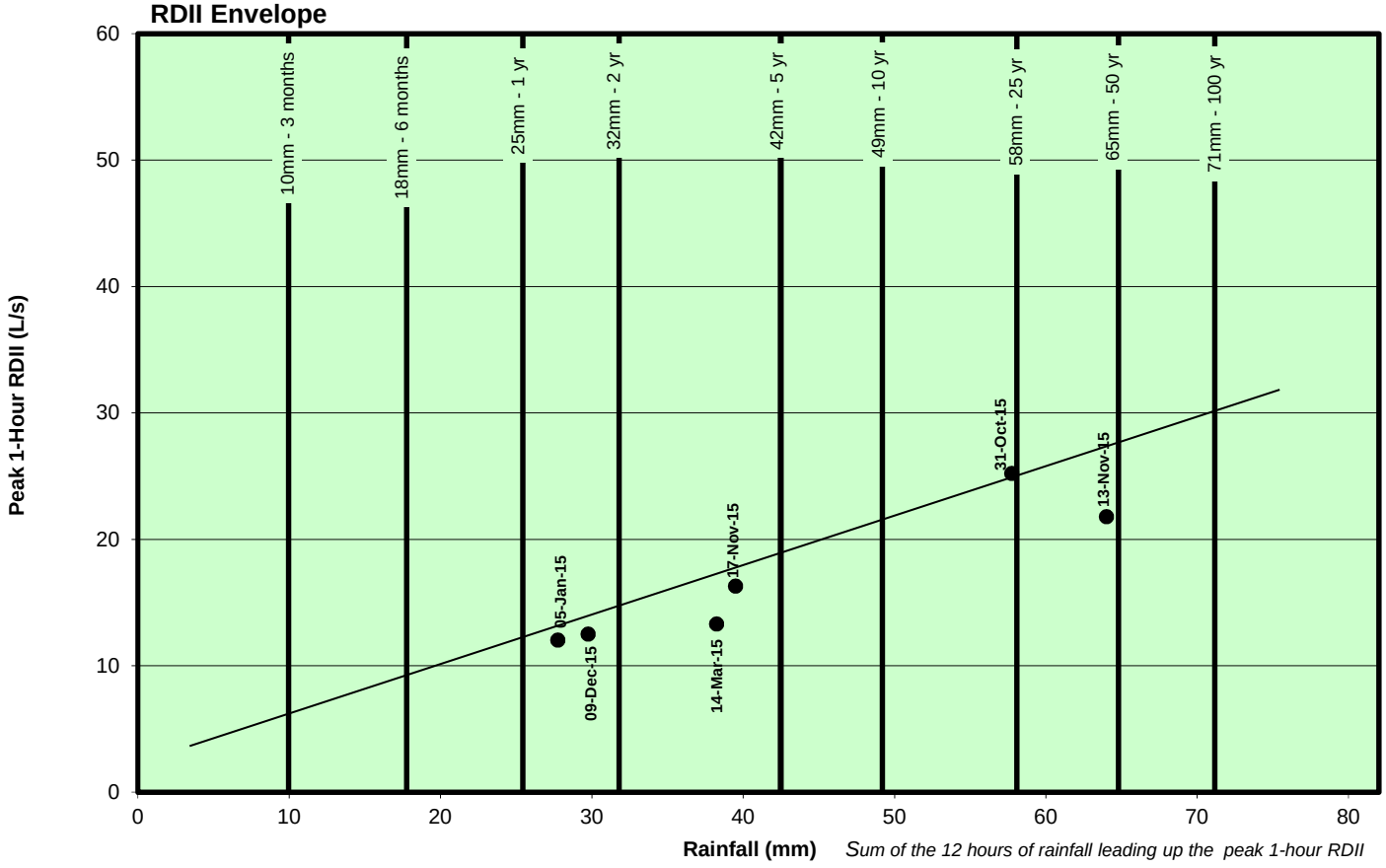
FLOW MONITORING AREA

CATCHMENT: BOWKER

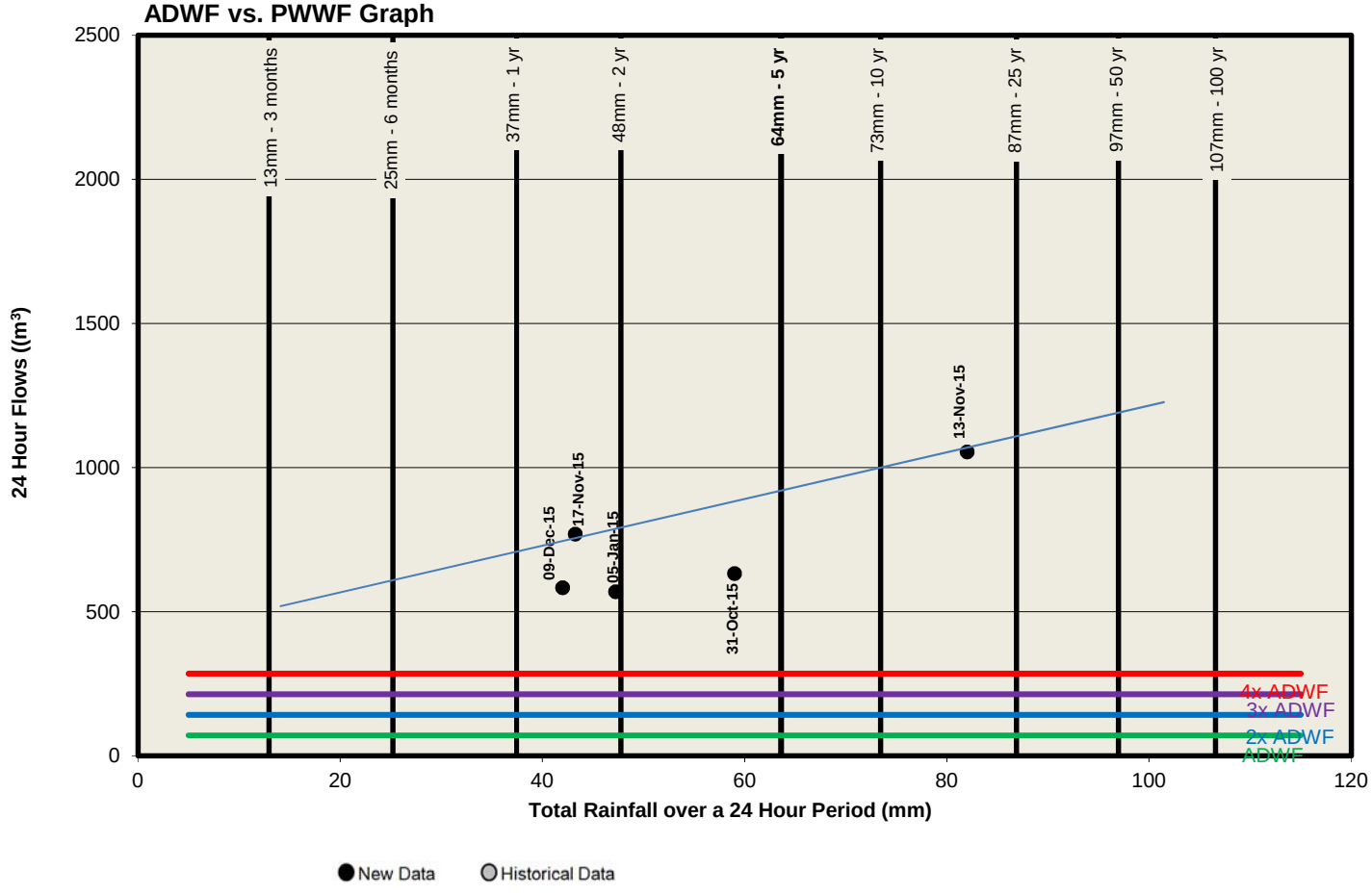
SITE CODE: **OB16**

Bowker (OB16)

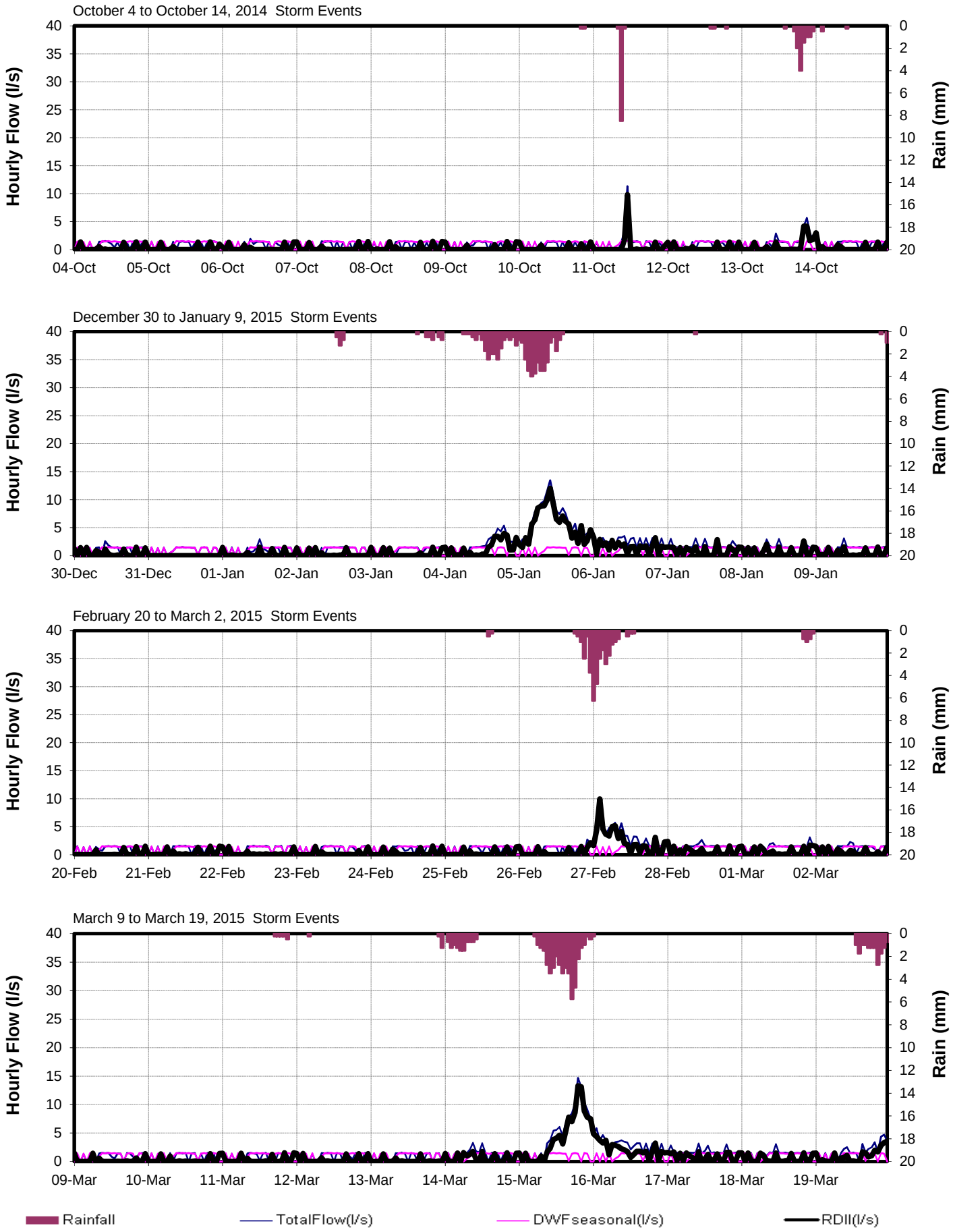
RDII Envelope



ADWF vs. PWWF Graph



Bowker (OB16)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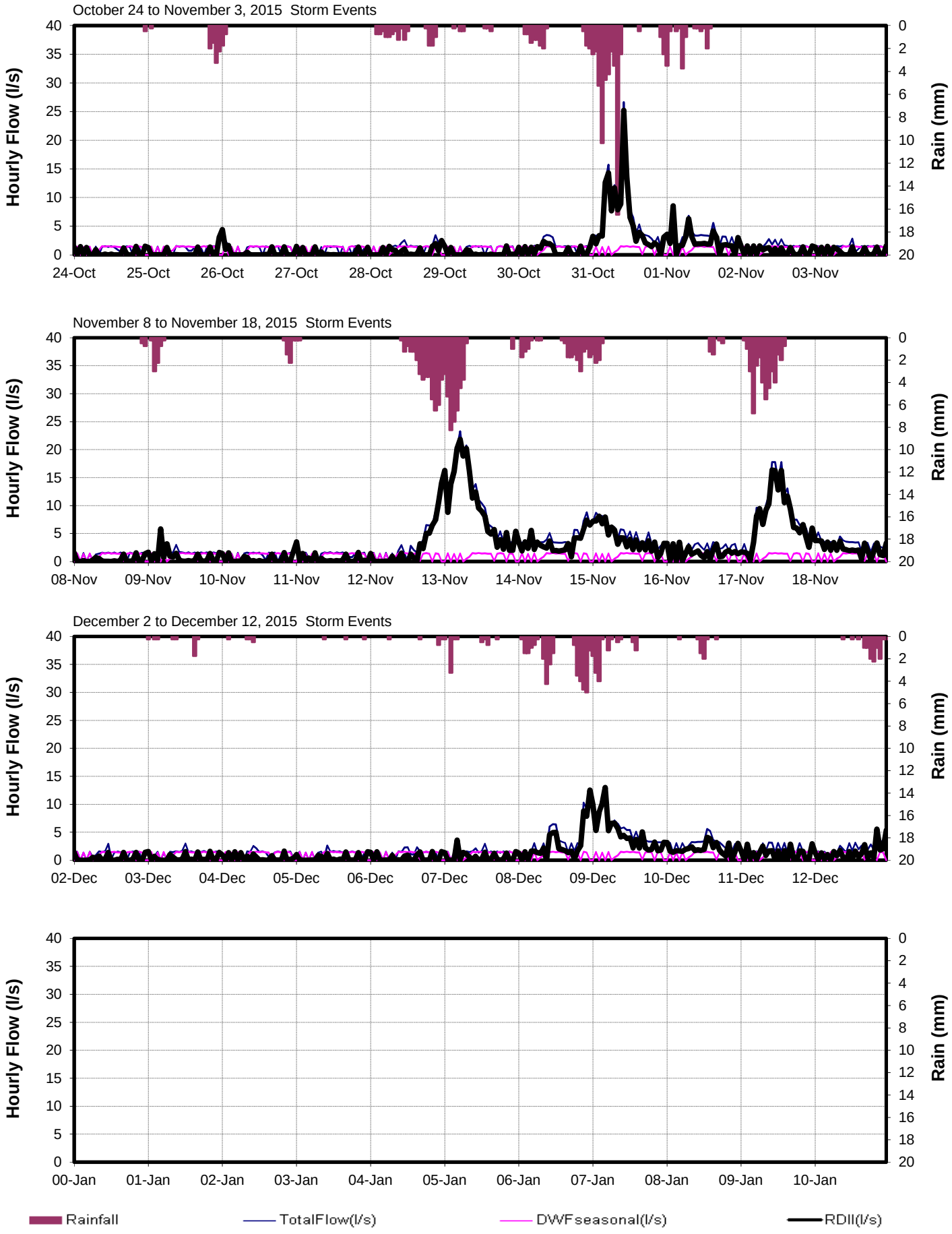
18-Mar
19-Mar
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

Bowker (OB16)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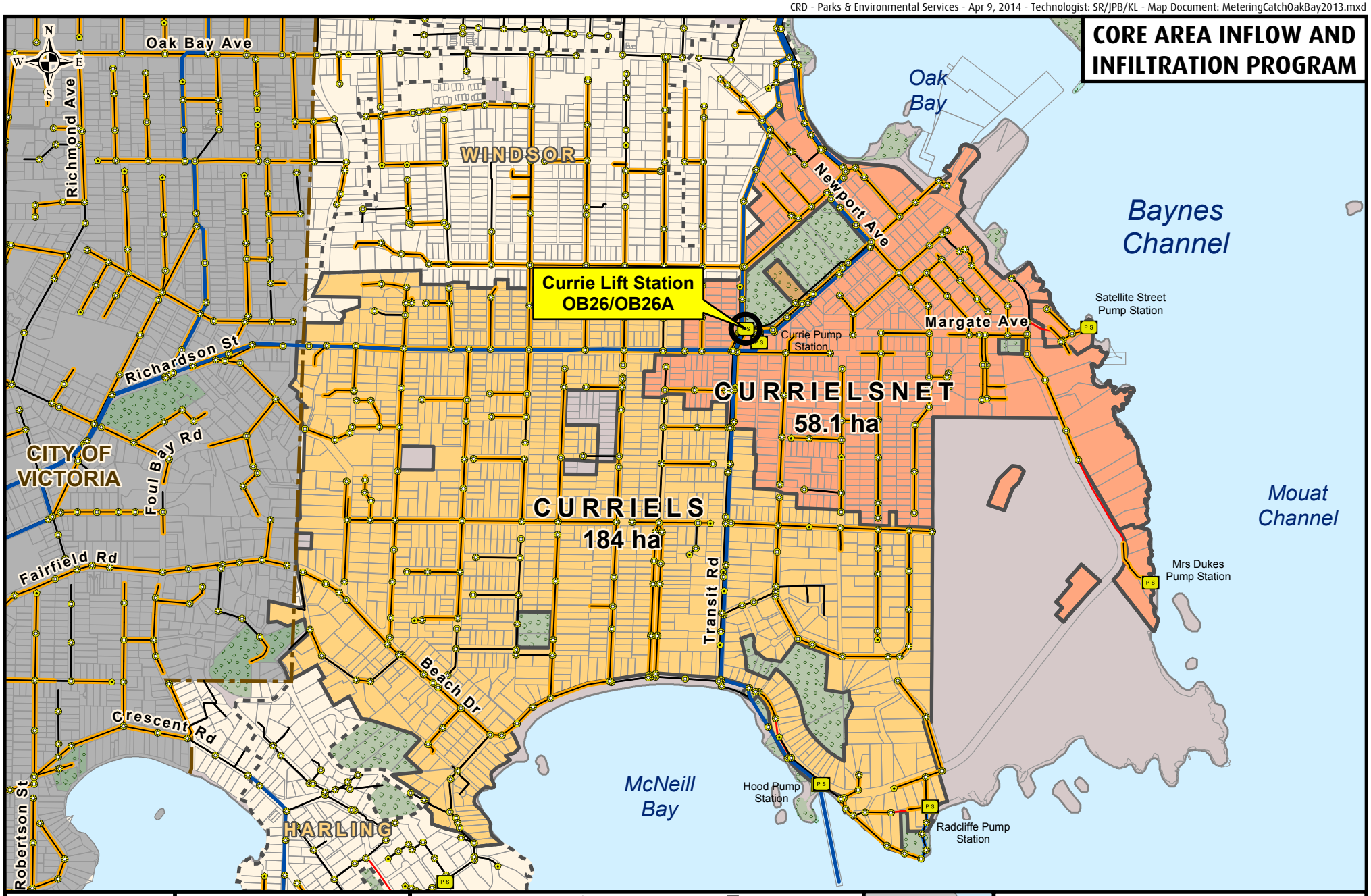
CRD - Parks & Environmental Services - Apr 9, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchOakBay2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 100 200 300

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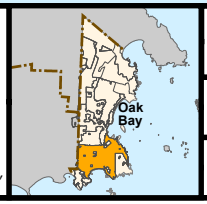


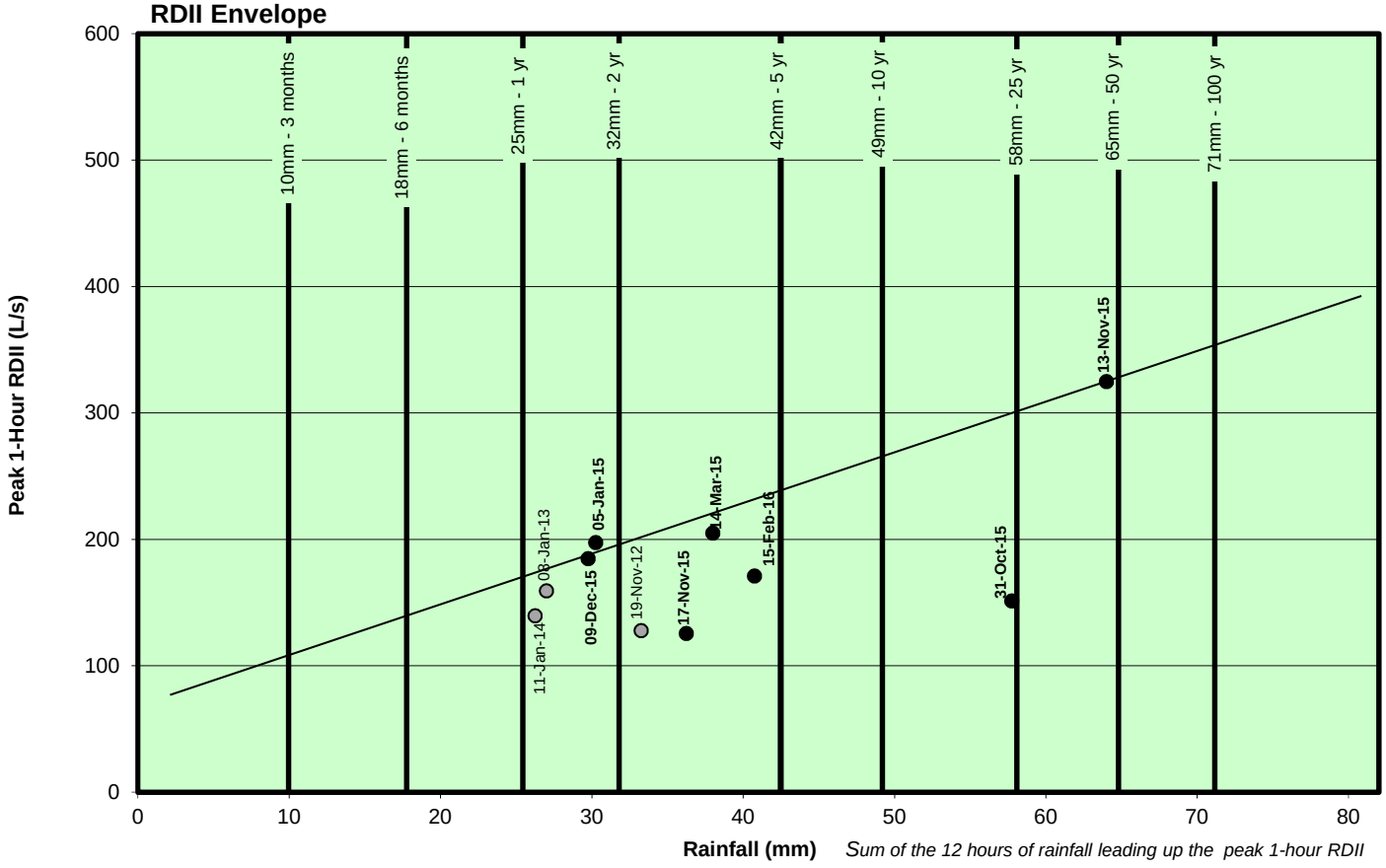
FLOW MONITORING AREA

CATCHMENT: CURRIELS/CURRIELSNET

SITE CODE: **OB26/OB26A**

Currie Minor (OB26)

RDII Envelope



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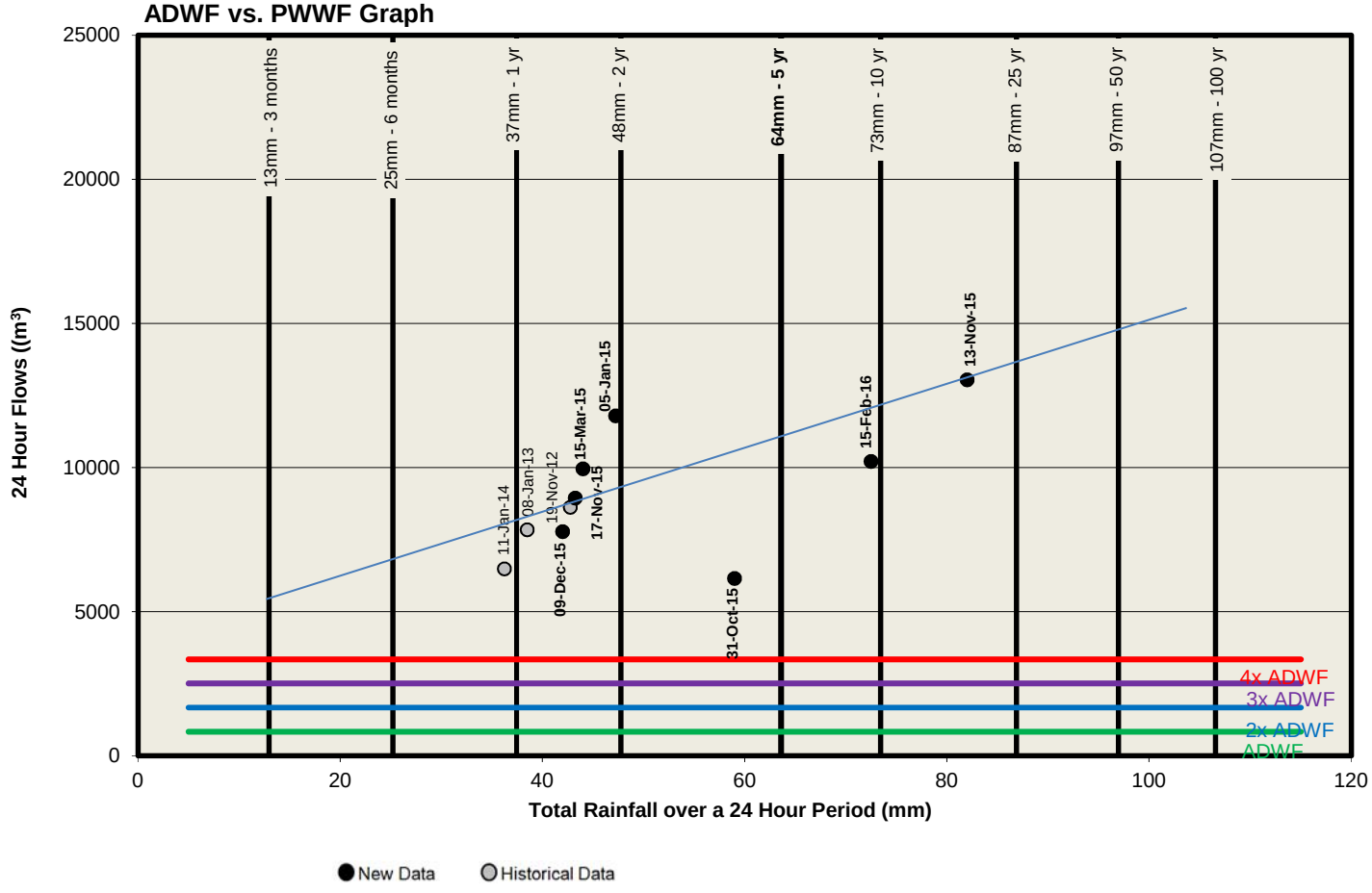
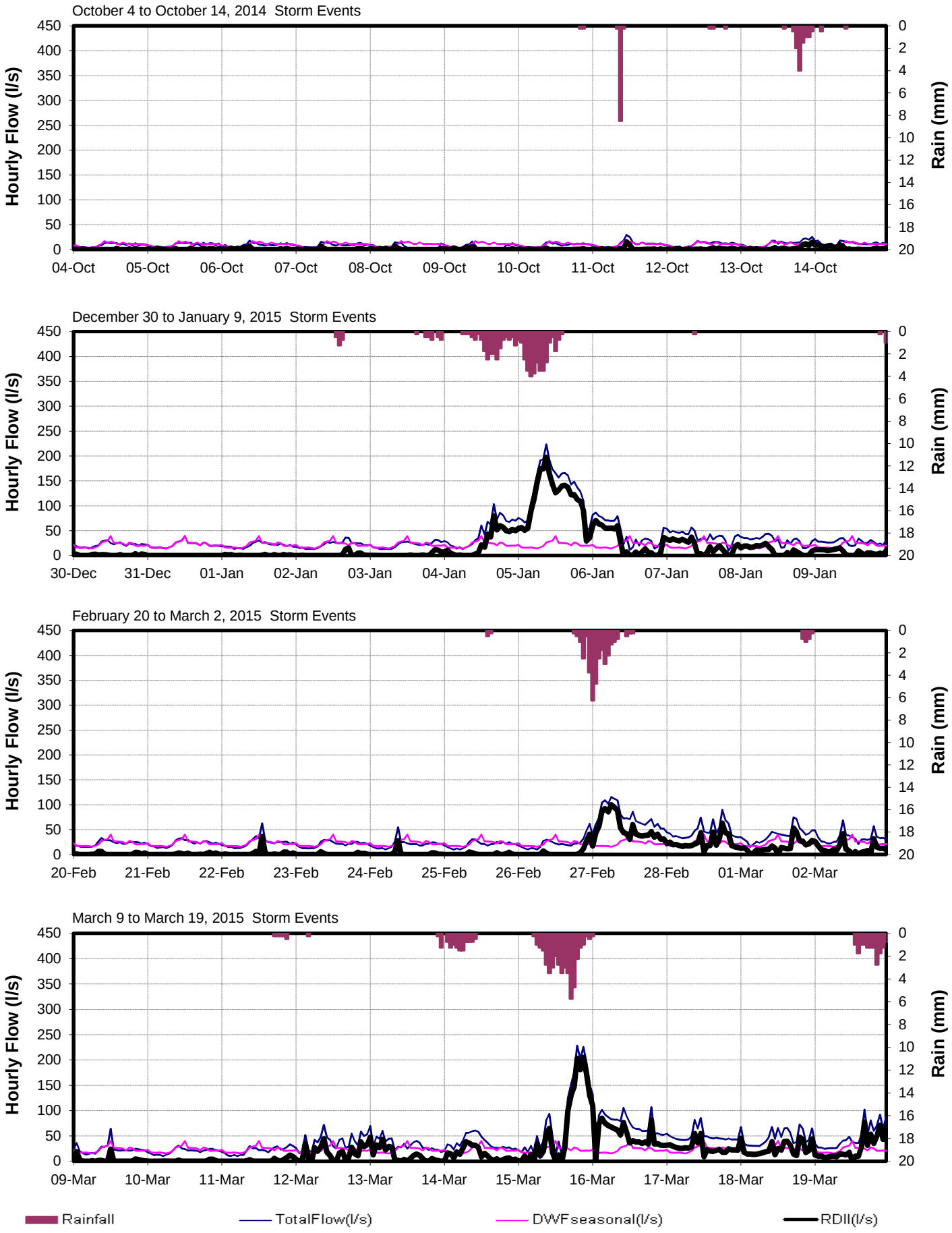
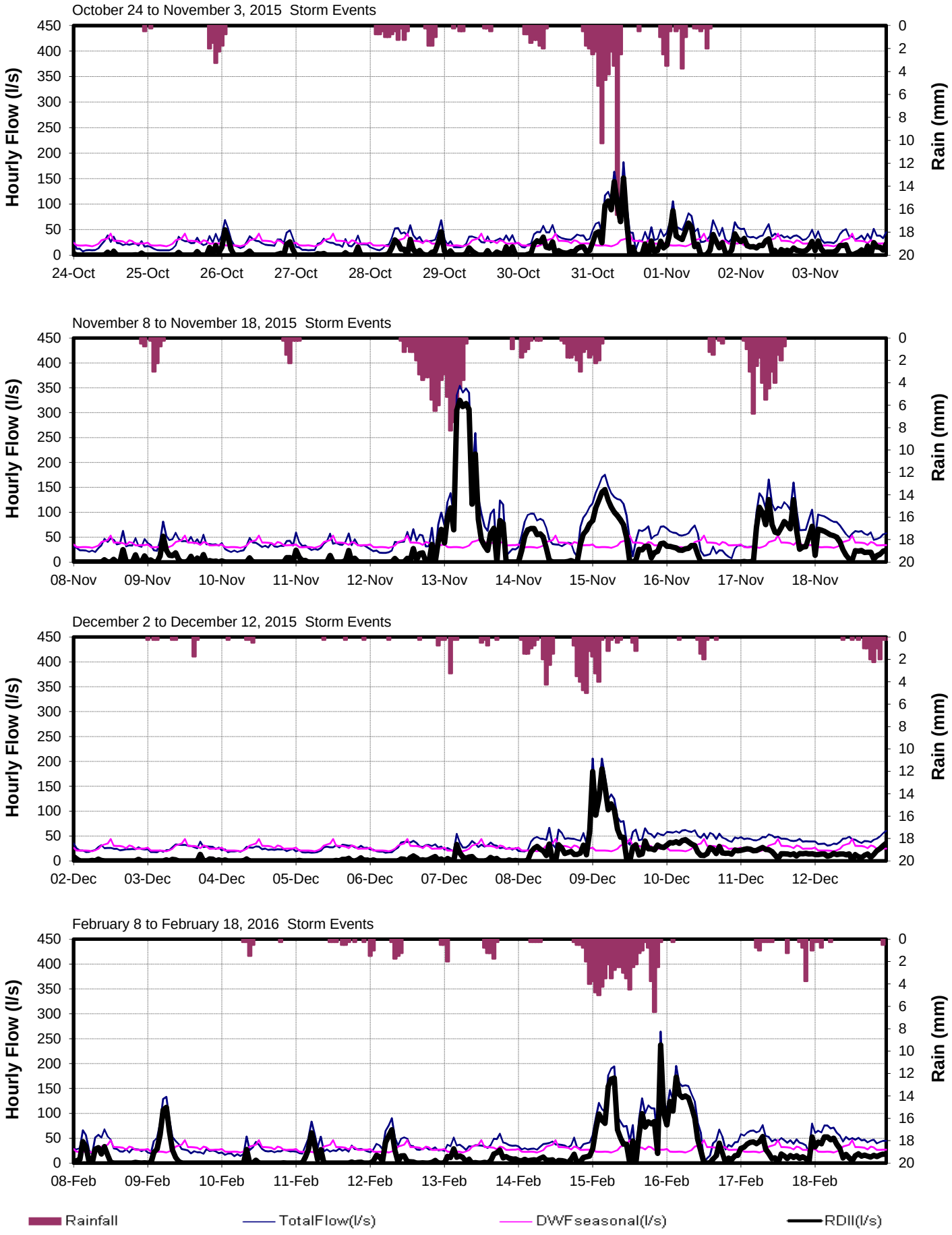


Currie Minor (OB26)



Currie Minor (OB26)



CRD Environmental Sustainability - Sep 20, 2011 - Technologist: SR - Map Document: MeteringCatchOakBay2010.mxd

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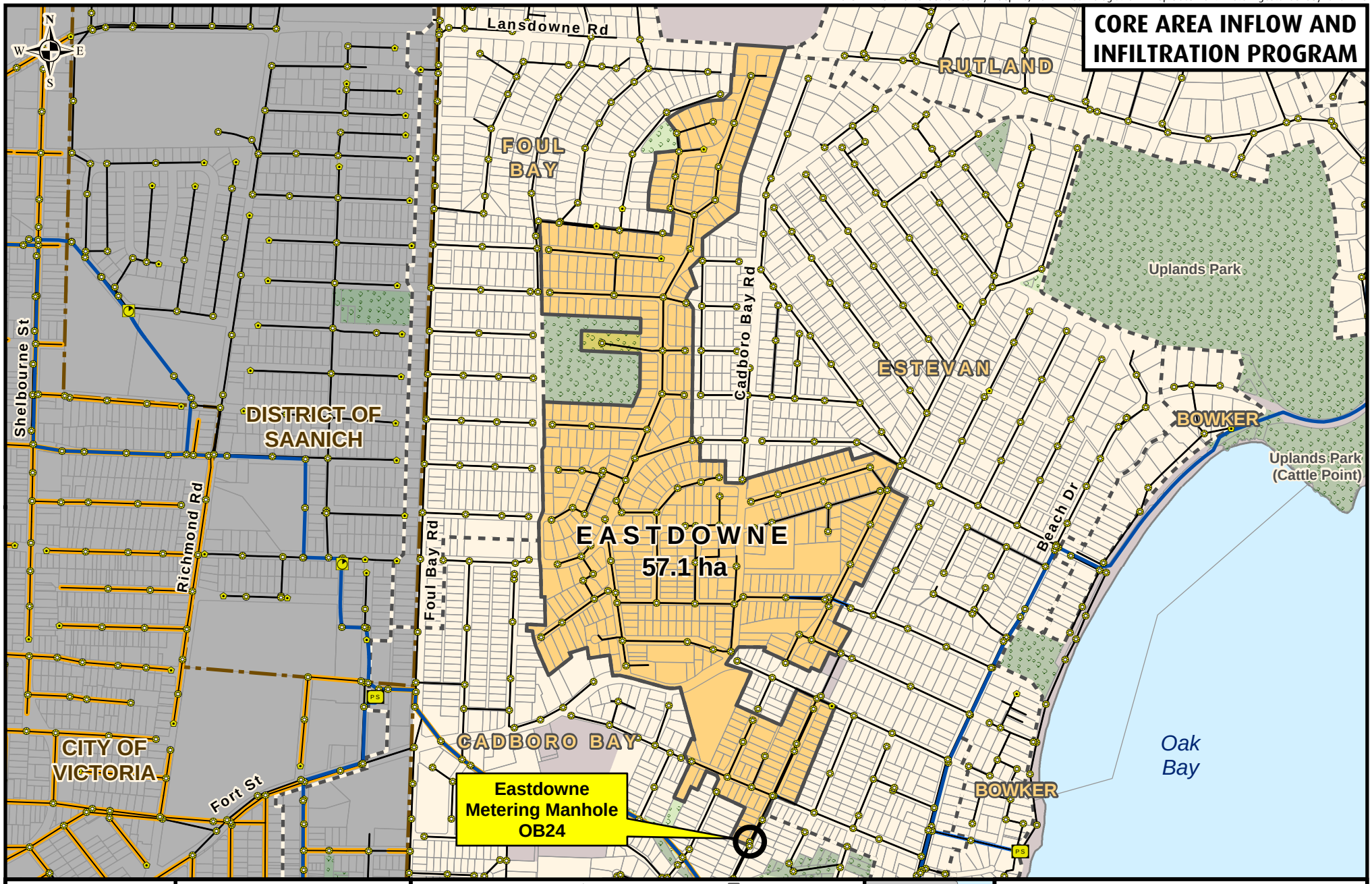

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Metres

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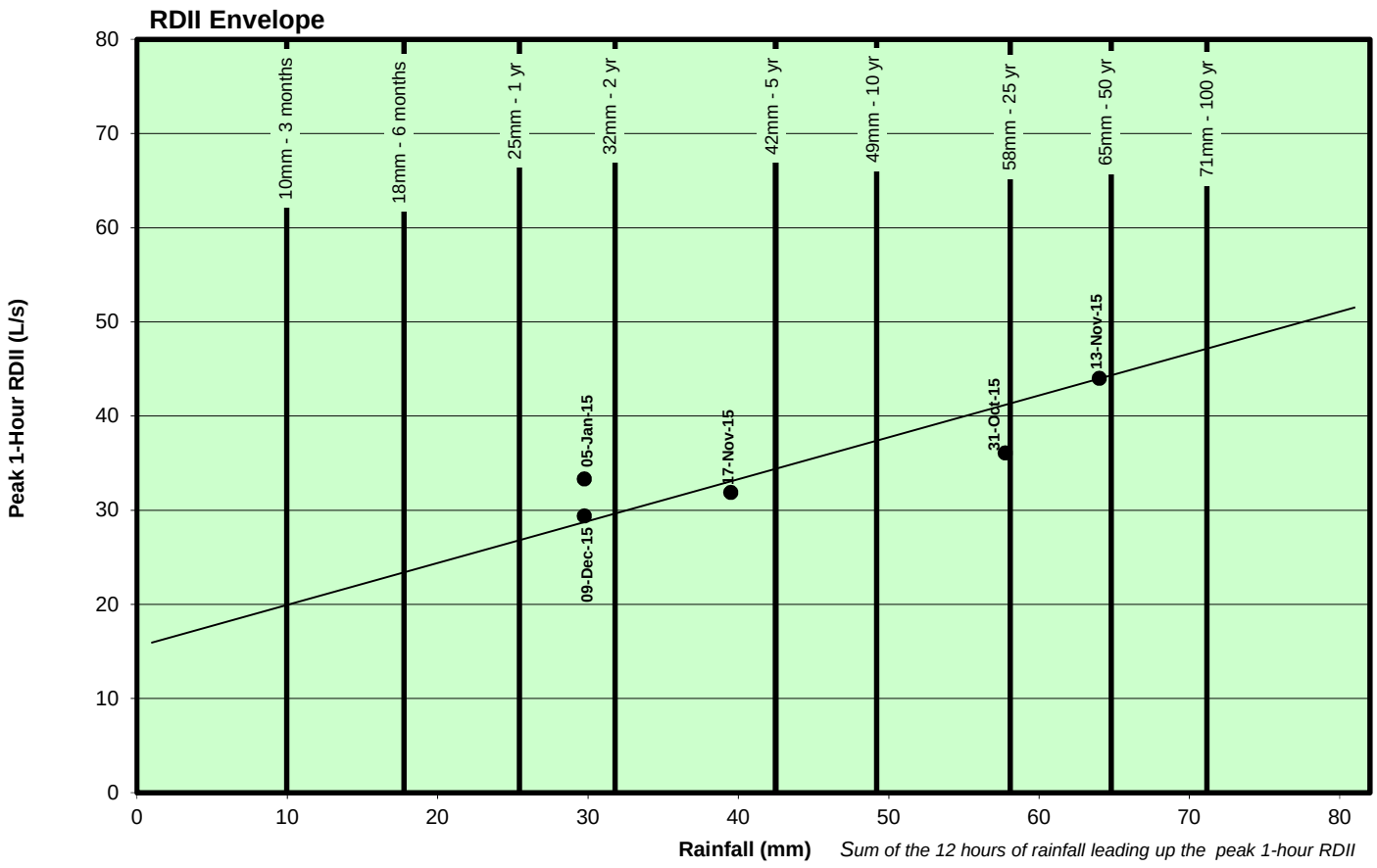
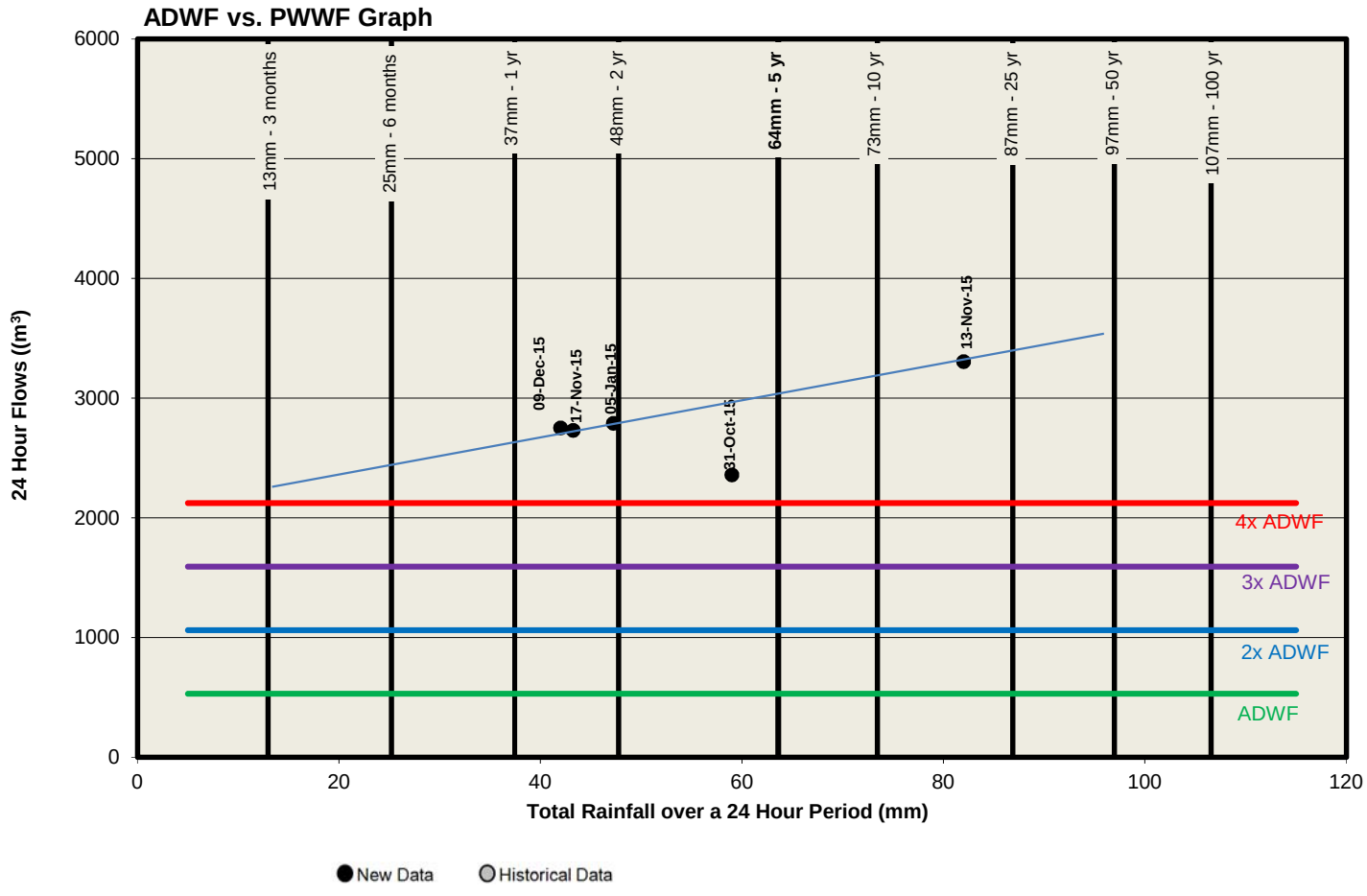
FLOW MONITORING AREA

CATCHMENT: EASTDOWNE

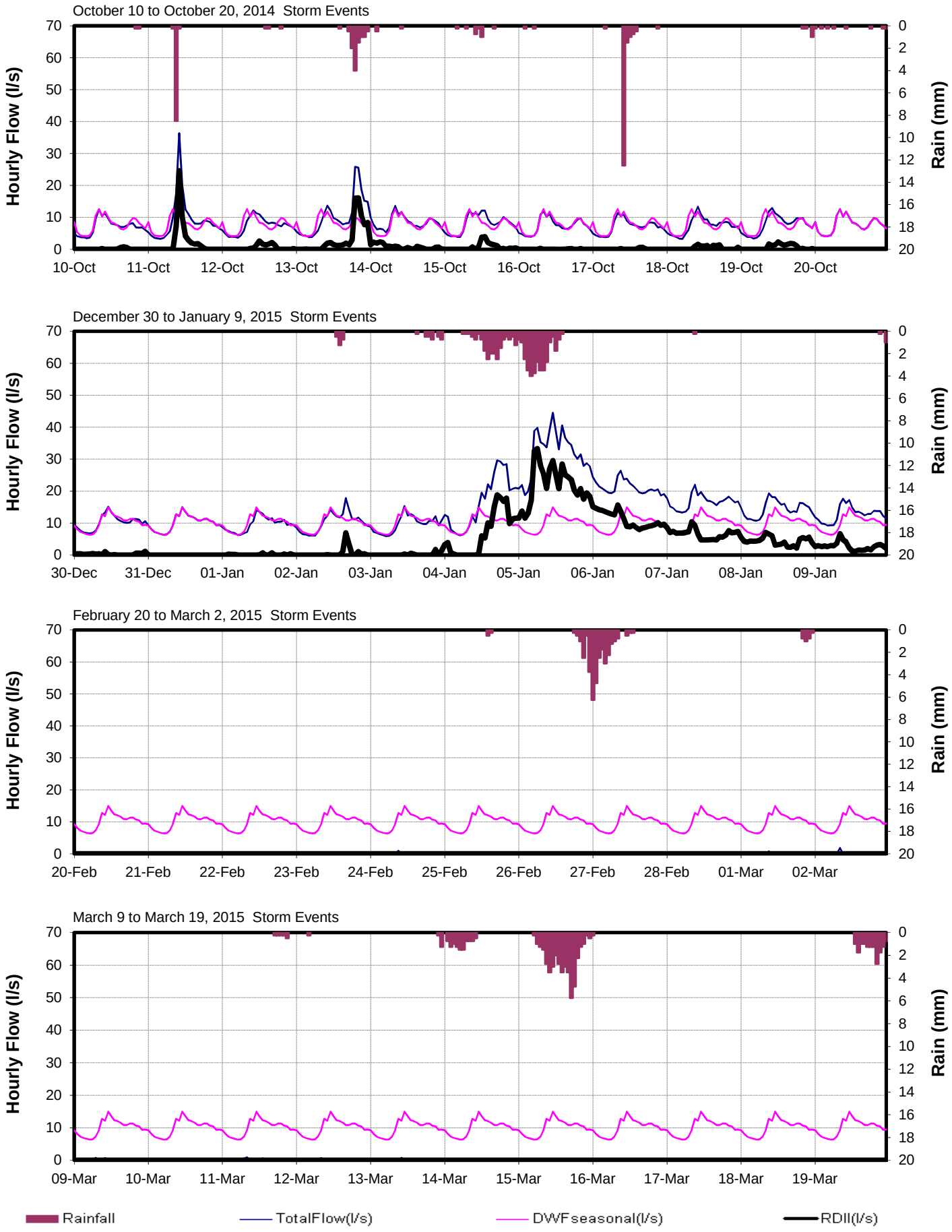
SITE CODE: **OB24**

Eastdowne (OB24)

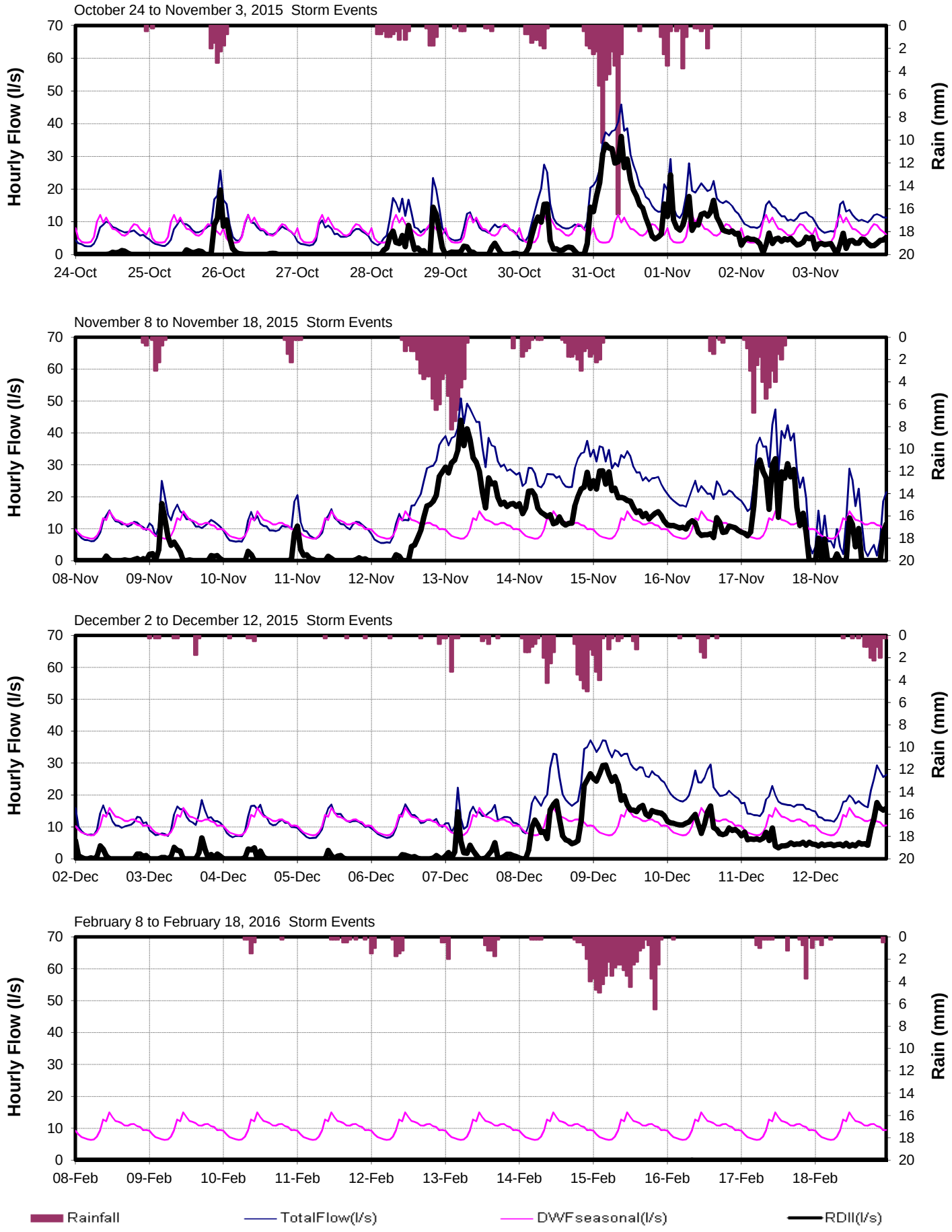




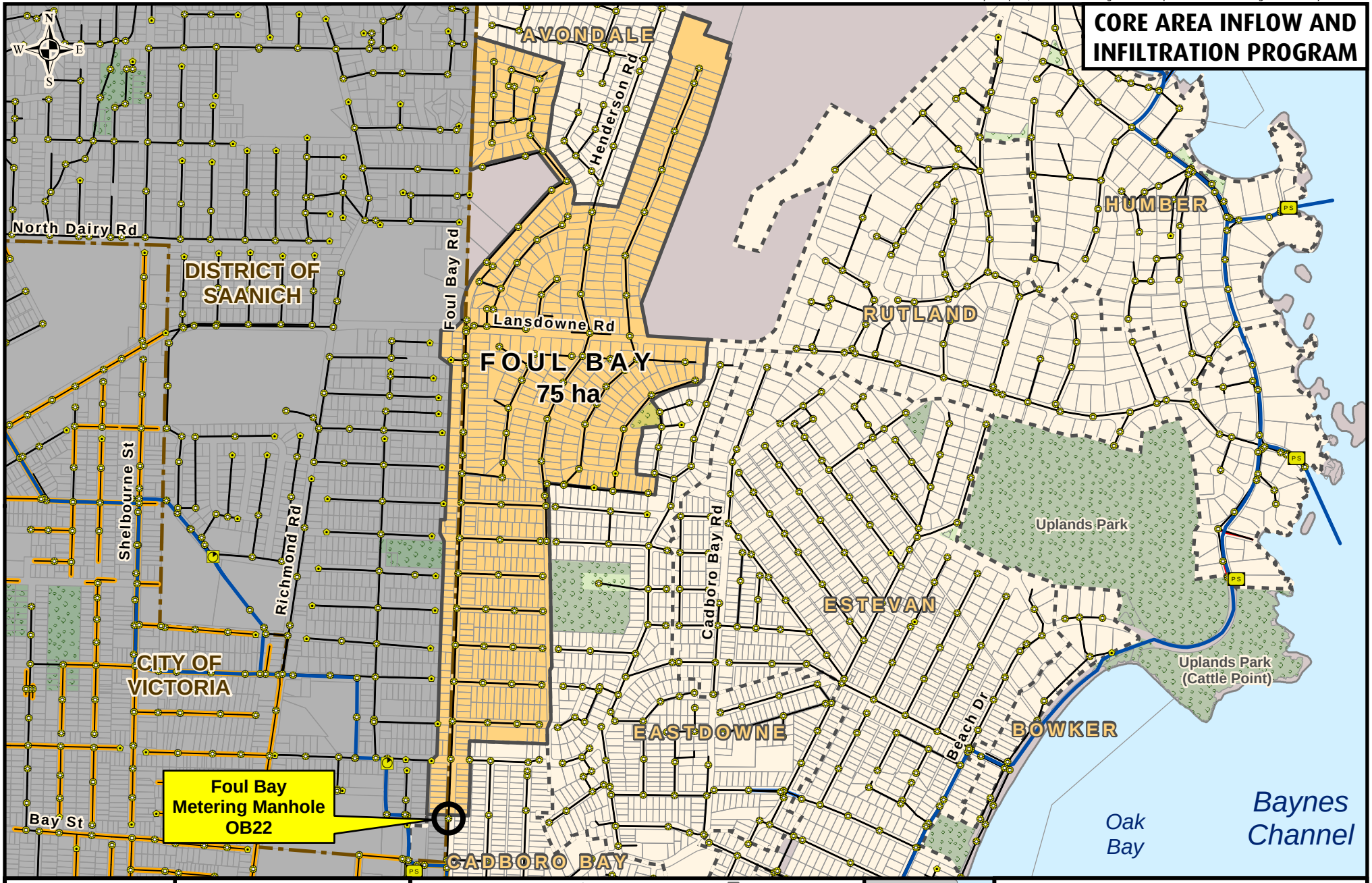
Eastdowne (OB24)



Eastdowne (OB24)



CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres

0 100 200 300 400

Projection: UTM ZONE 10N NAD 83

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- Pump Station
- Metering Chamber

Sanitary Sewers

- Gravity Main Installed After 1930
- Gravity Main Installed Before 1930
- Force Main
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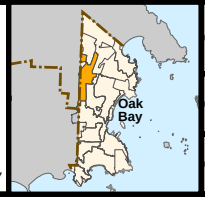
- CRD Sewer

- Catchment Area
- Non-Sewered Area
- Lot Lines
- Parks
- Sewered Park Areas
- Catchment Boundary
- Municipal, First Nation, or DND Boundaries



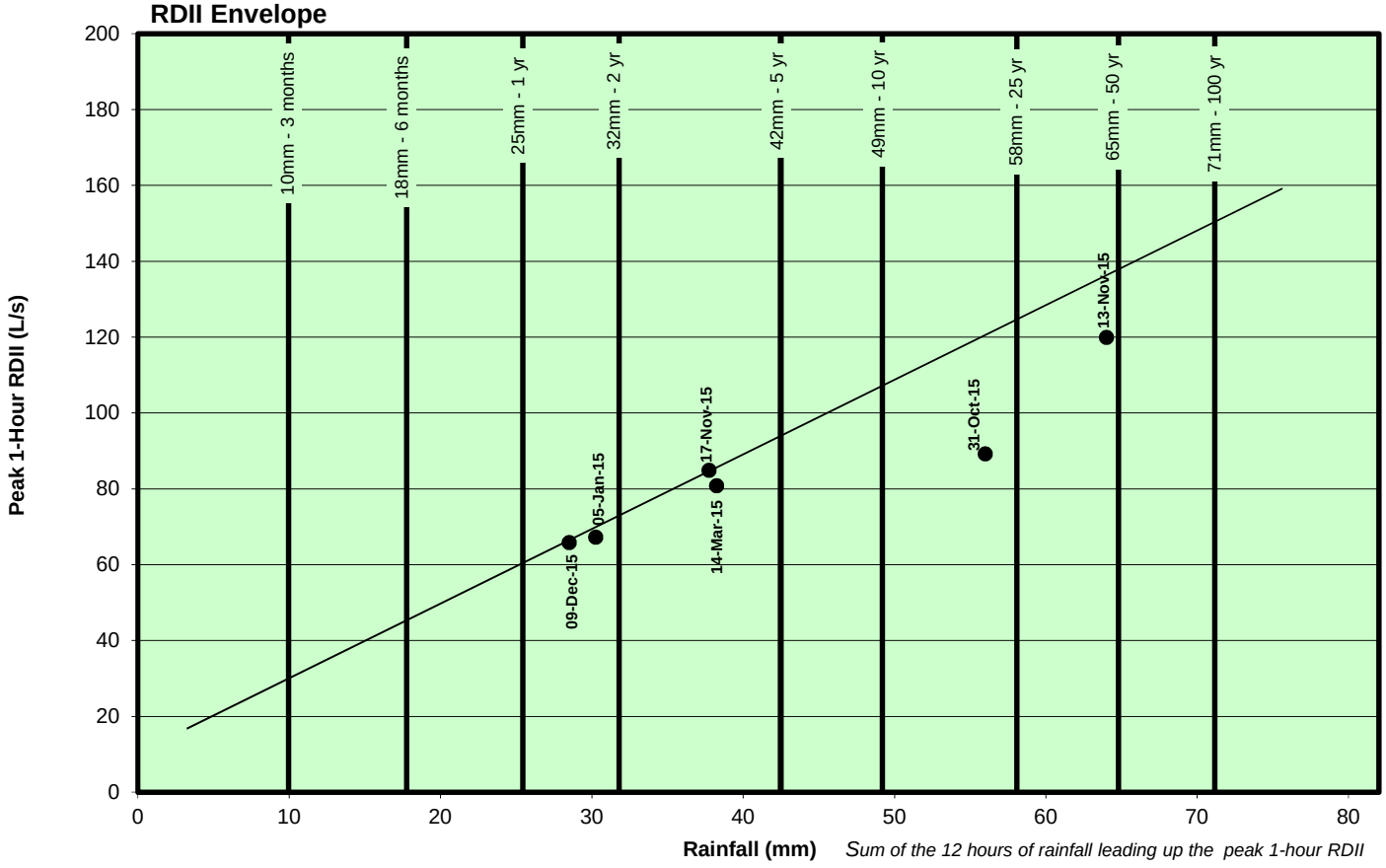
FLOW MONITORING AREA

CATCHMENT: FOUL BAY

SITE CODE: **OB22**

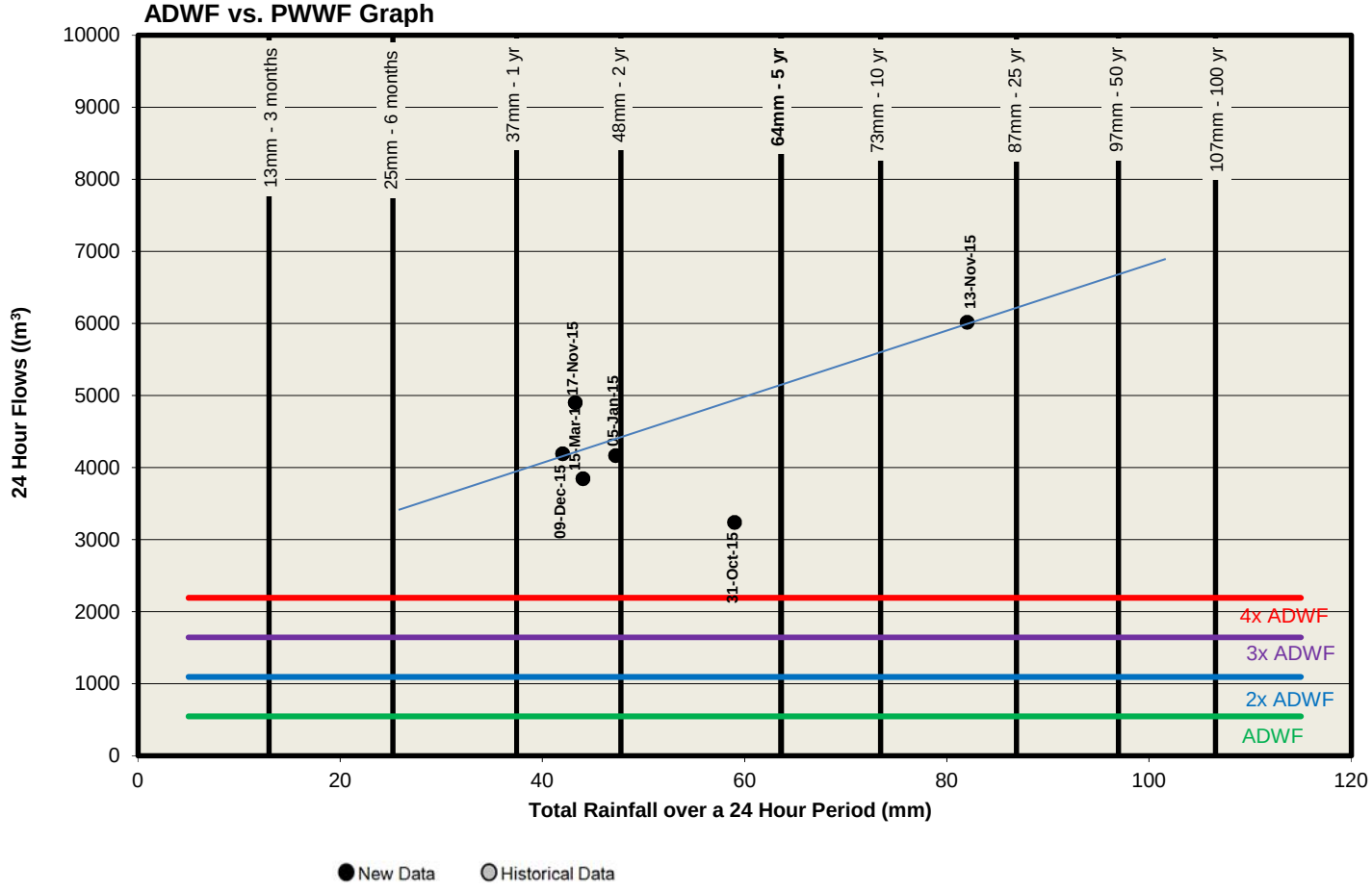
Foul Bay (OB22)

RDII Envelope

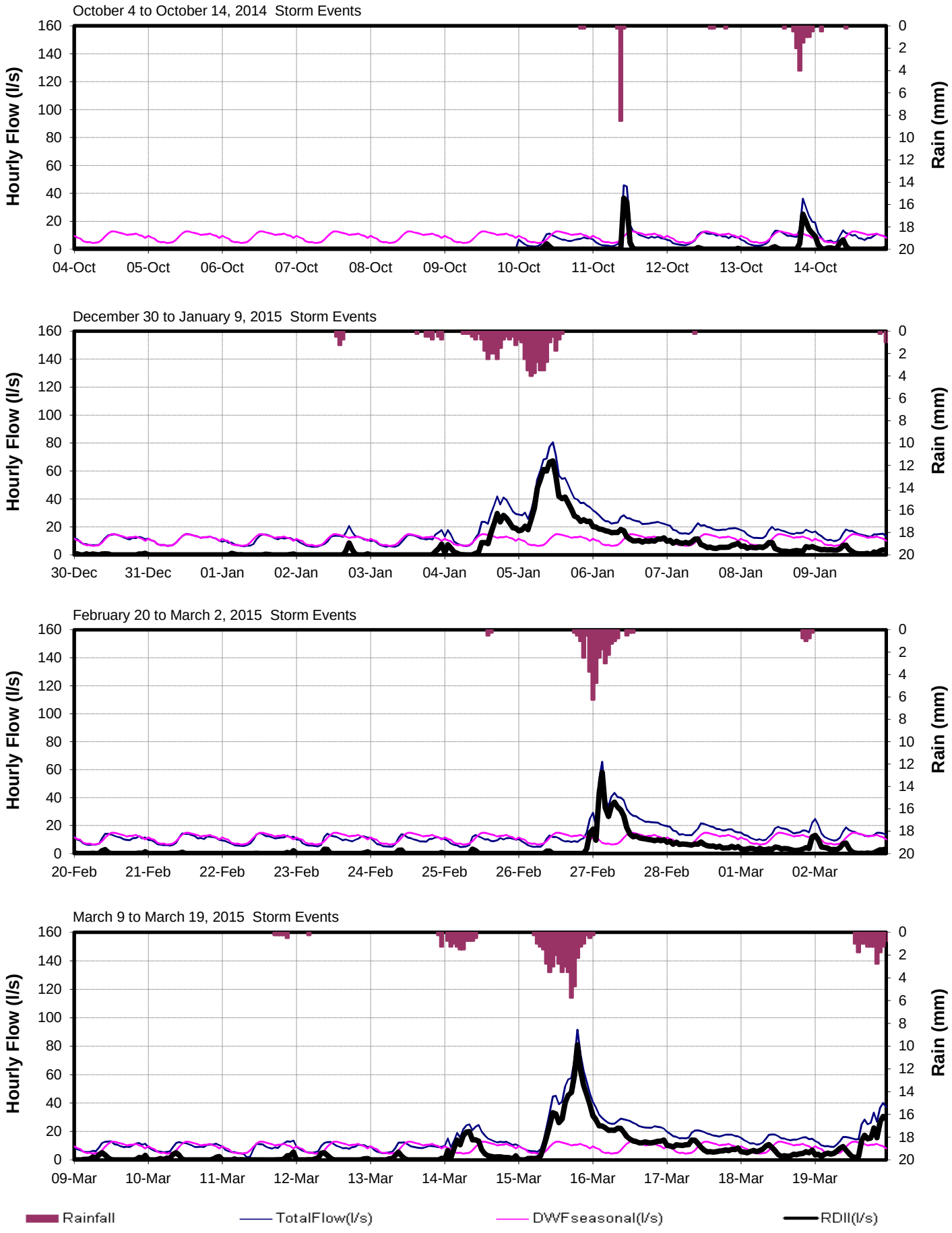


Sum of the 12 hours of rainfall leading up the peak 1-hour RDII

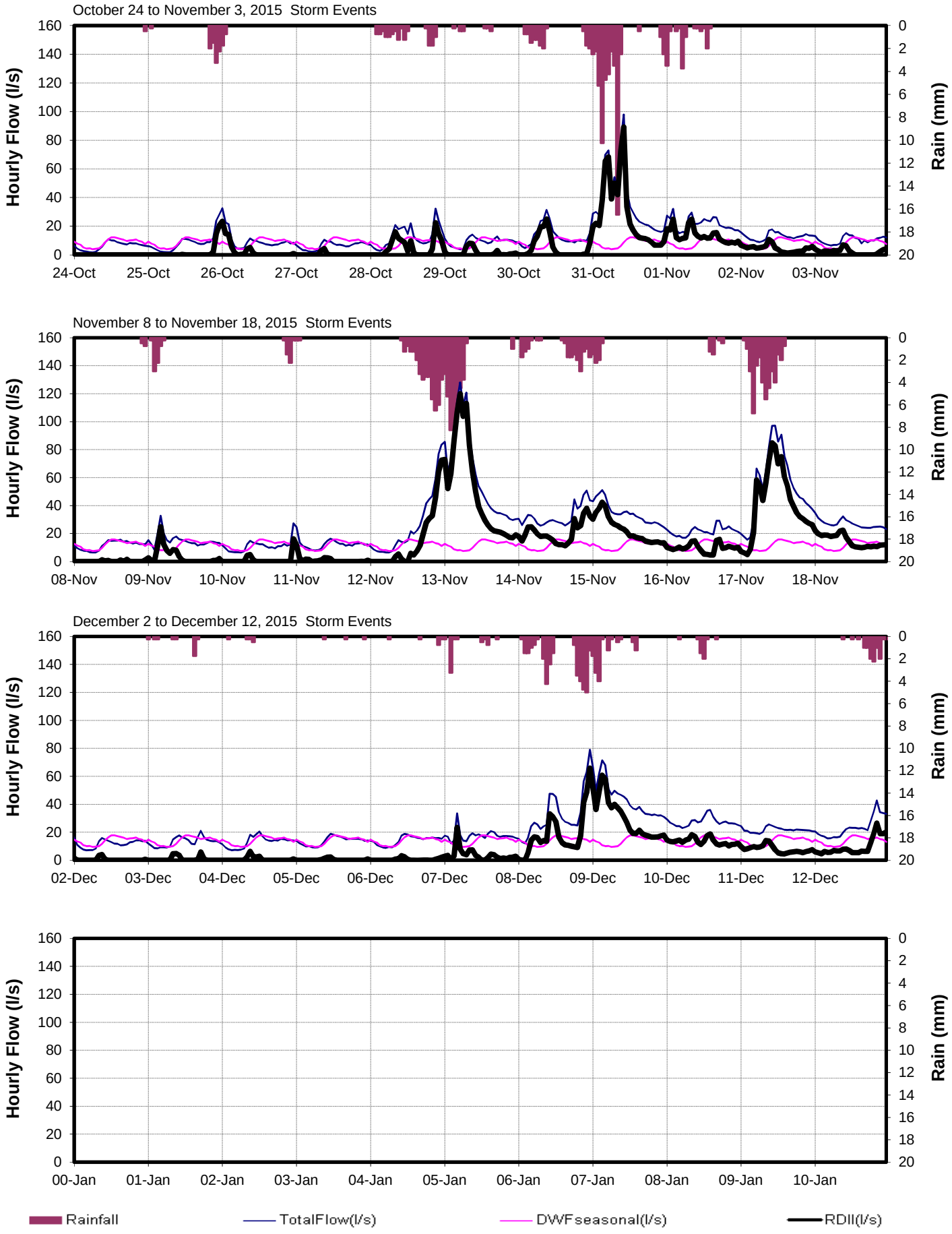
ADWF vs. PWWF Graph



Foul Bay (OB22)

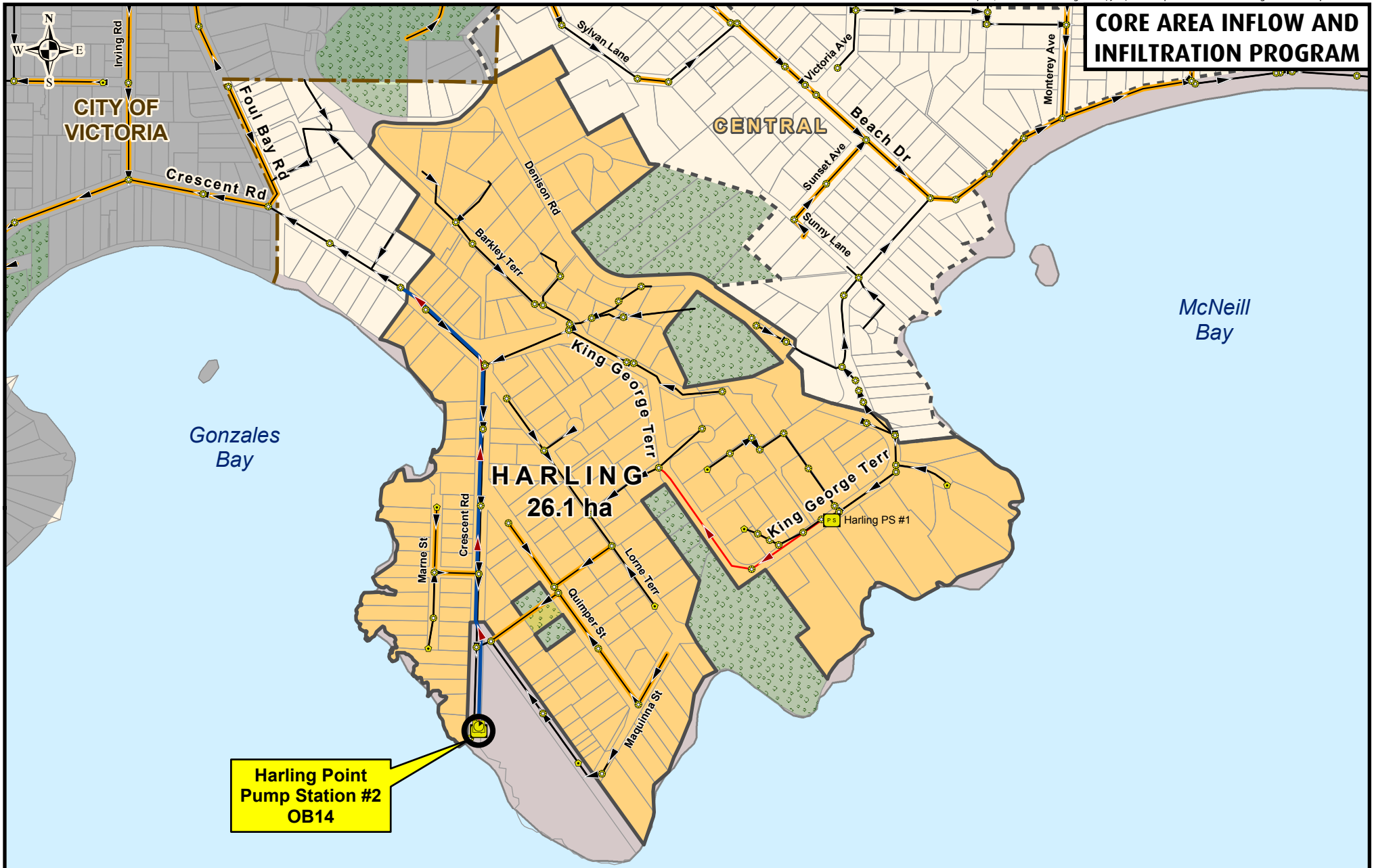


Foul Bay (OB22)



CRD - Parks & Environmental Services - Apr 9, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchOakBay2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100 150

Projection: UTM ZONE 10N NAD 83

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- Catchment Area
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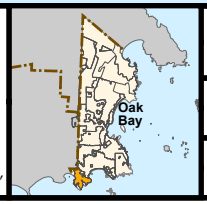
- Lot Lines
- Parks
- Sewered Park Areas
- Catchment Boundary Municipal, First Nation, or DND Boundaries



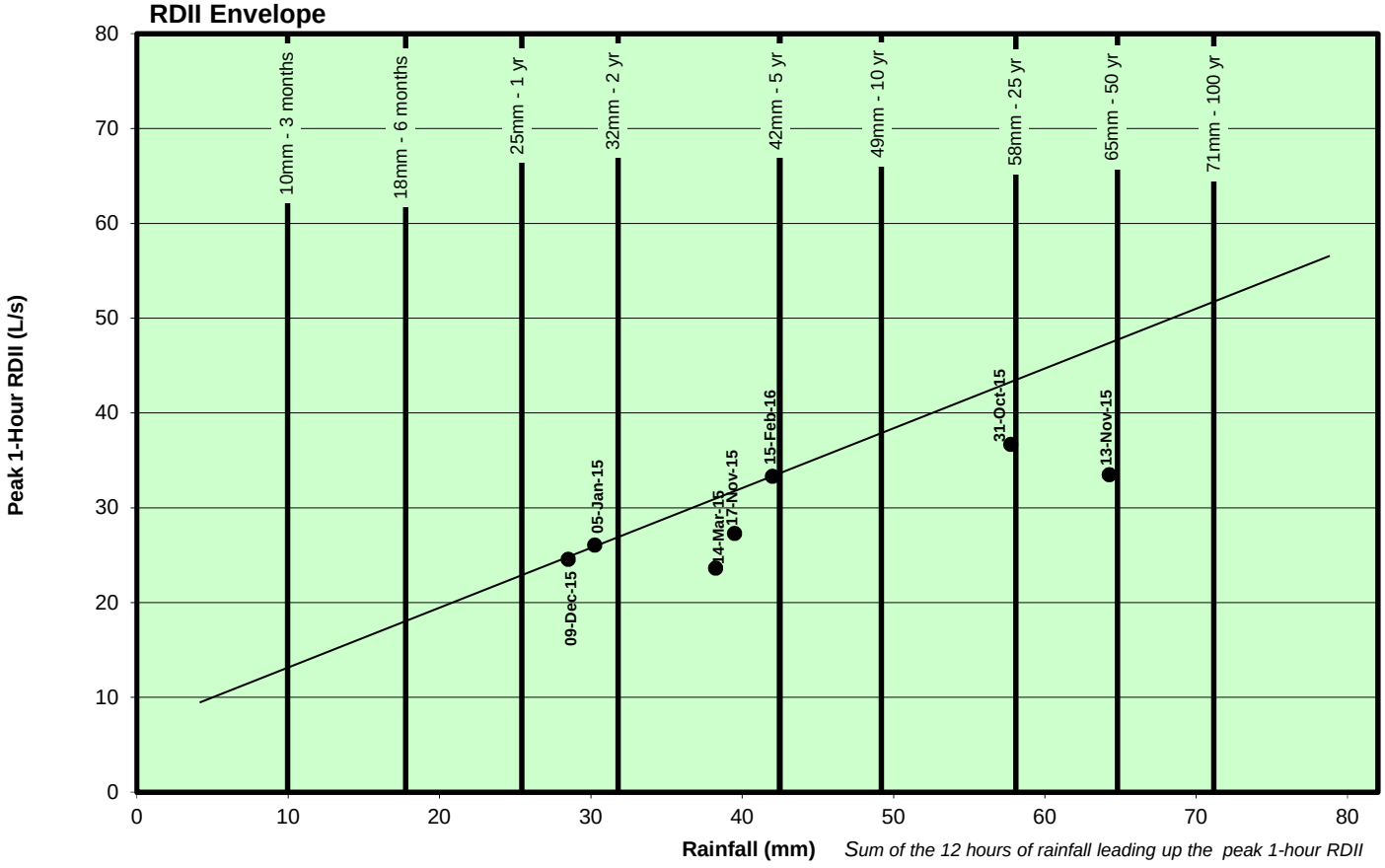
FLOW MONITORING AREA

CATCHMENT: HARLING

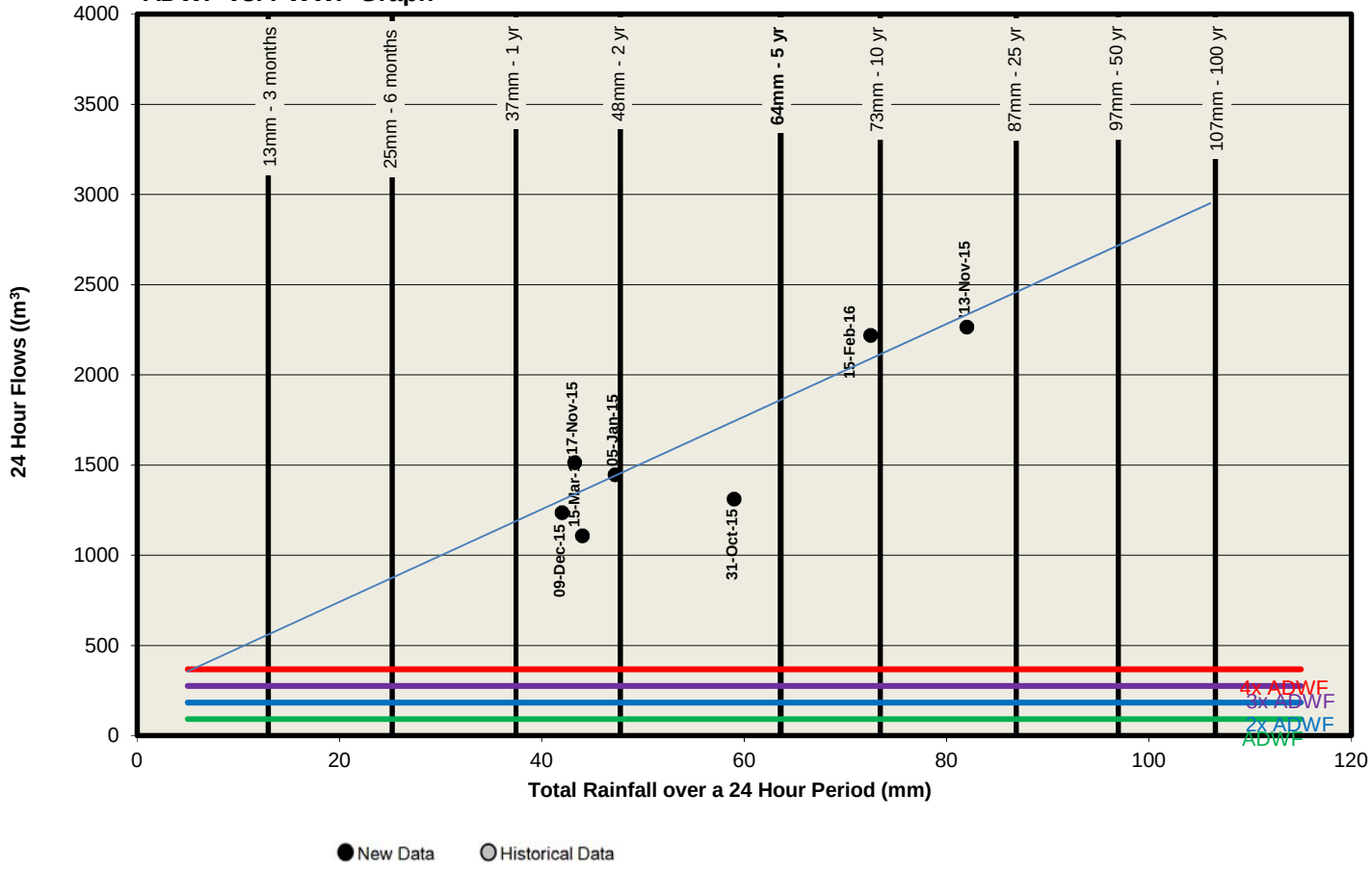
SITE CODE: **OB14**

Harling (OB14)

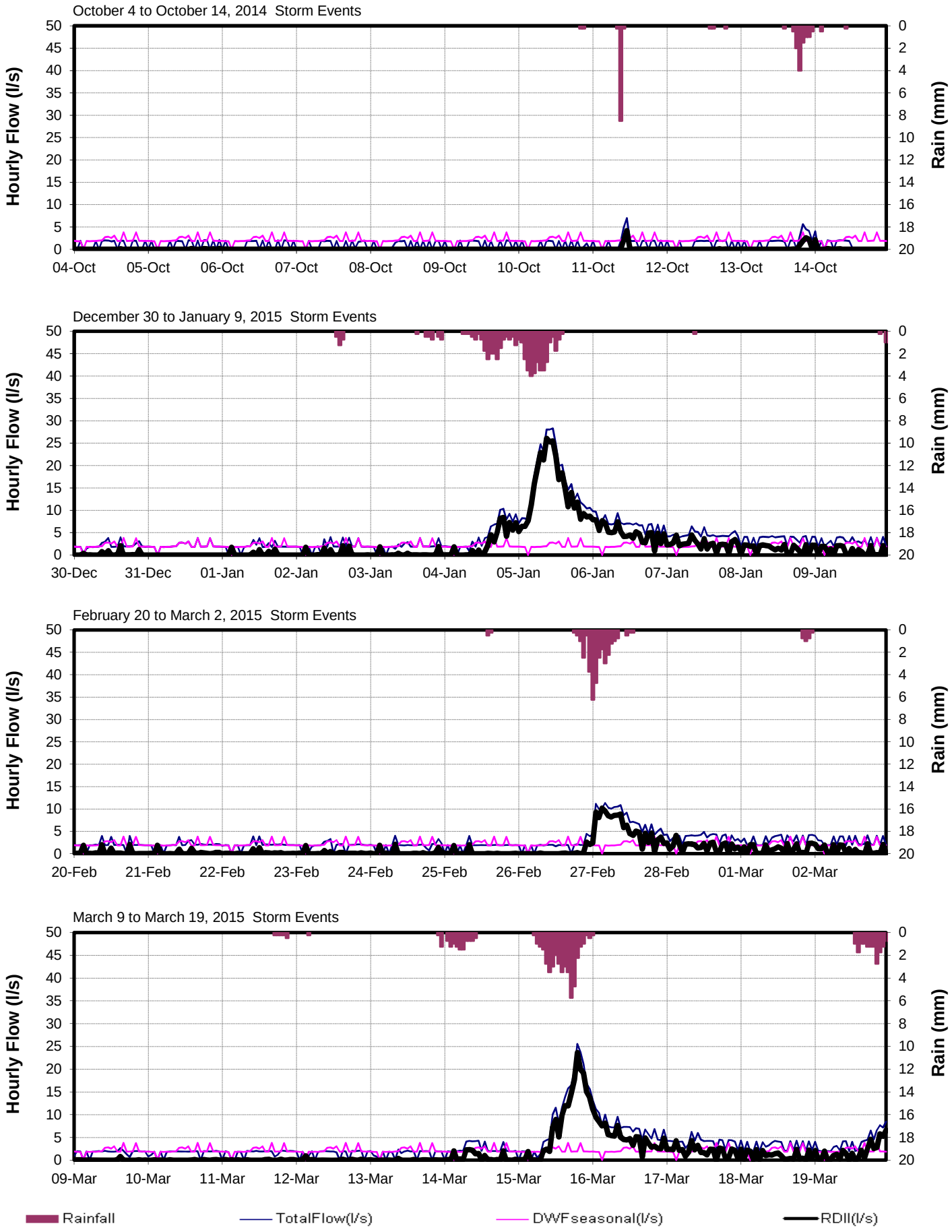
RDII Envelope



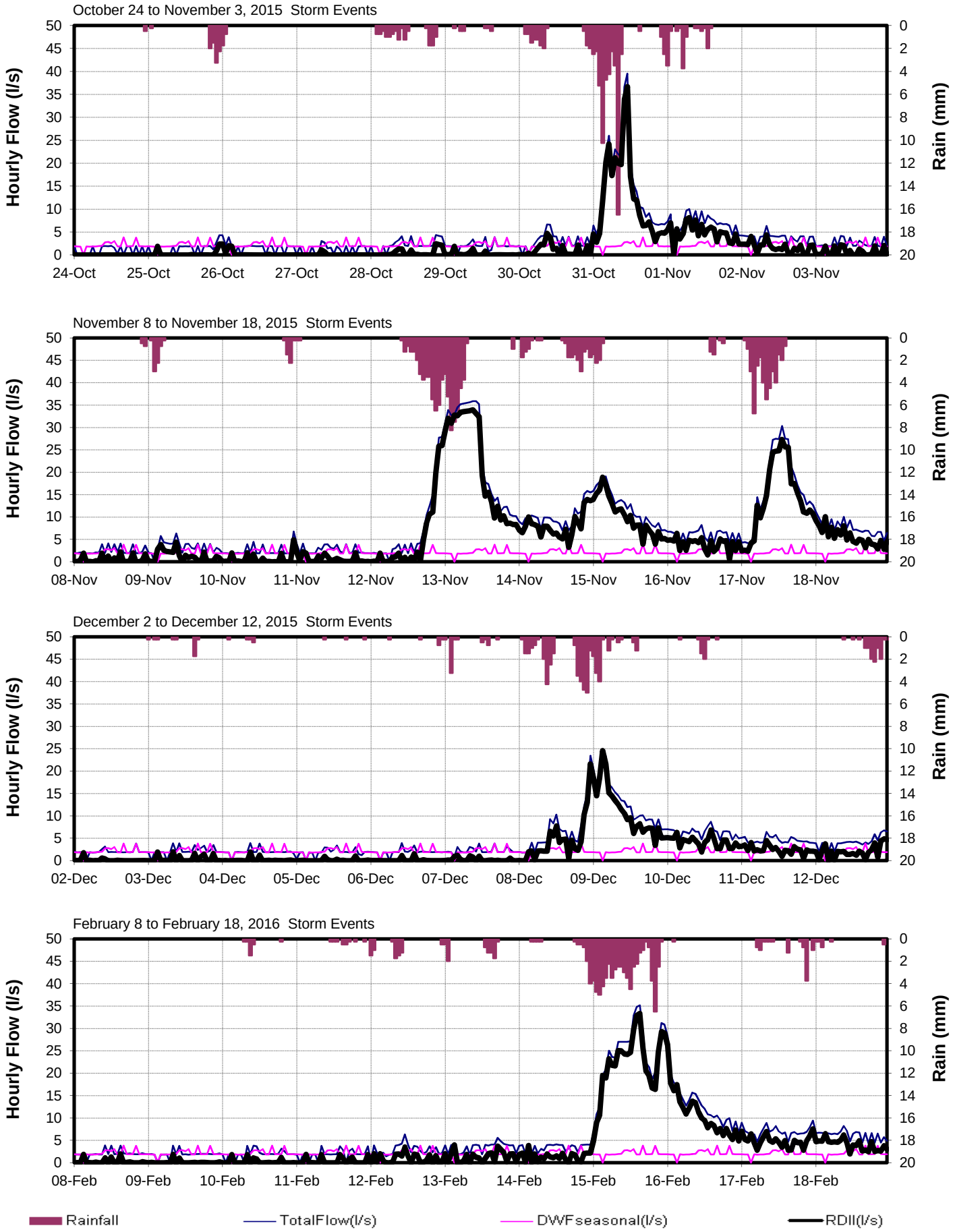
ADWF vs. PWWF Graph



Harling (OB14)

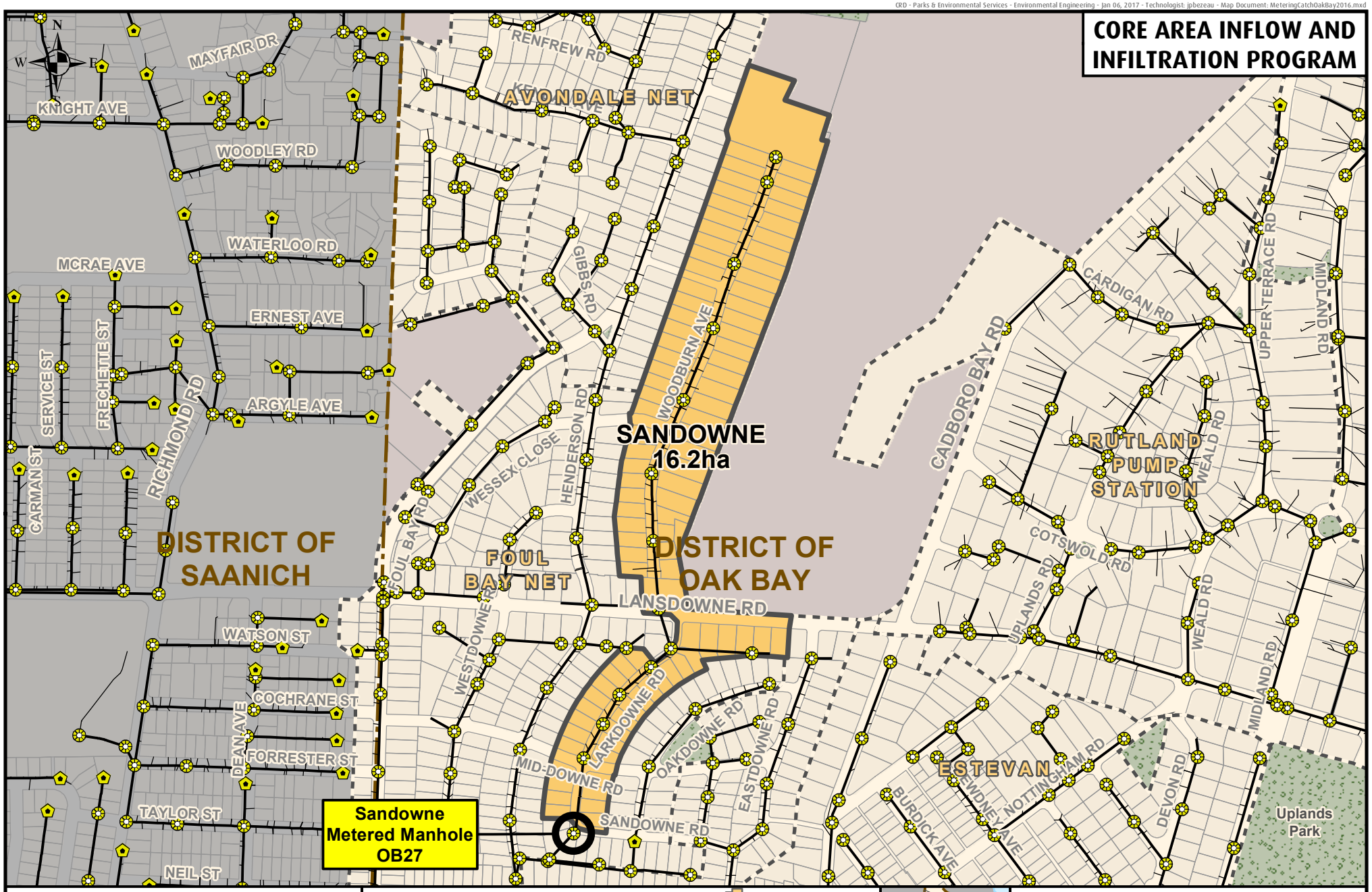


Harling (OB14)



CRD - Parks & Environmental Services - Environmental Engineering - Jan 06, 2017 - Technologist: jpbezeau - Map Document: MeteringCatchOakBay2016.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Metres
0 200 400

Projection: UTM ZONE 10N, NAD83

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- Flow Monitoring Location
- Manhole
- Cleanout
- Pump Station
- Metering Chamber

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- Lot Lines
- Parks
- Sewered Park Areas
- Catchment Boundary
- Municipal, First Nation, or DND Boundaries

FLOW MONITORING AREA

Catchment: Sandowne Temporary Meter
Site Code: OB27

CRD
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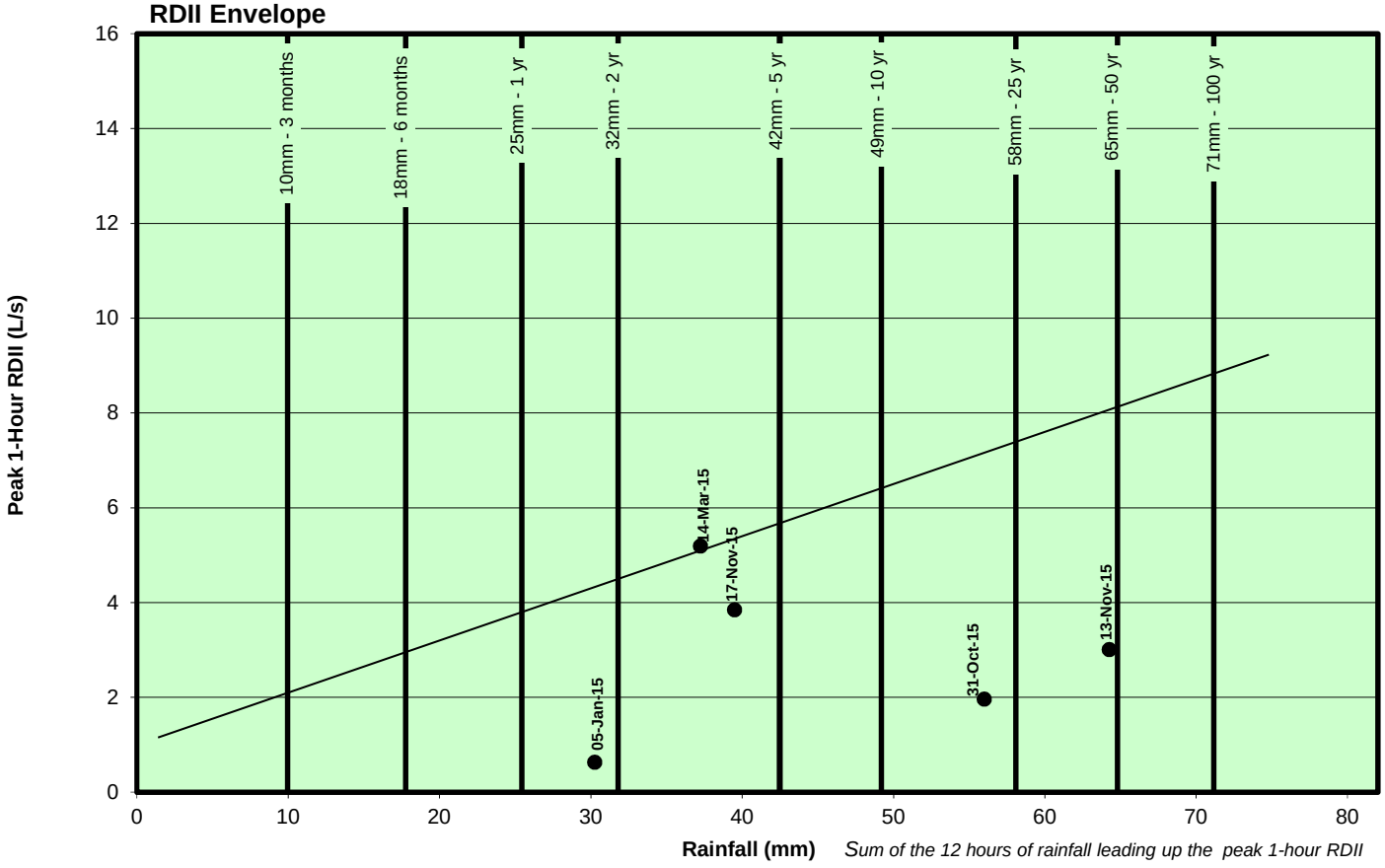
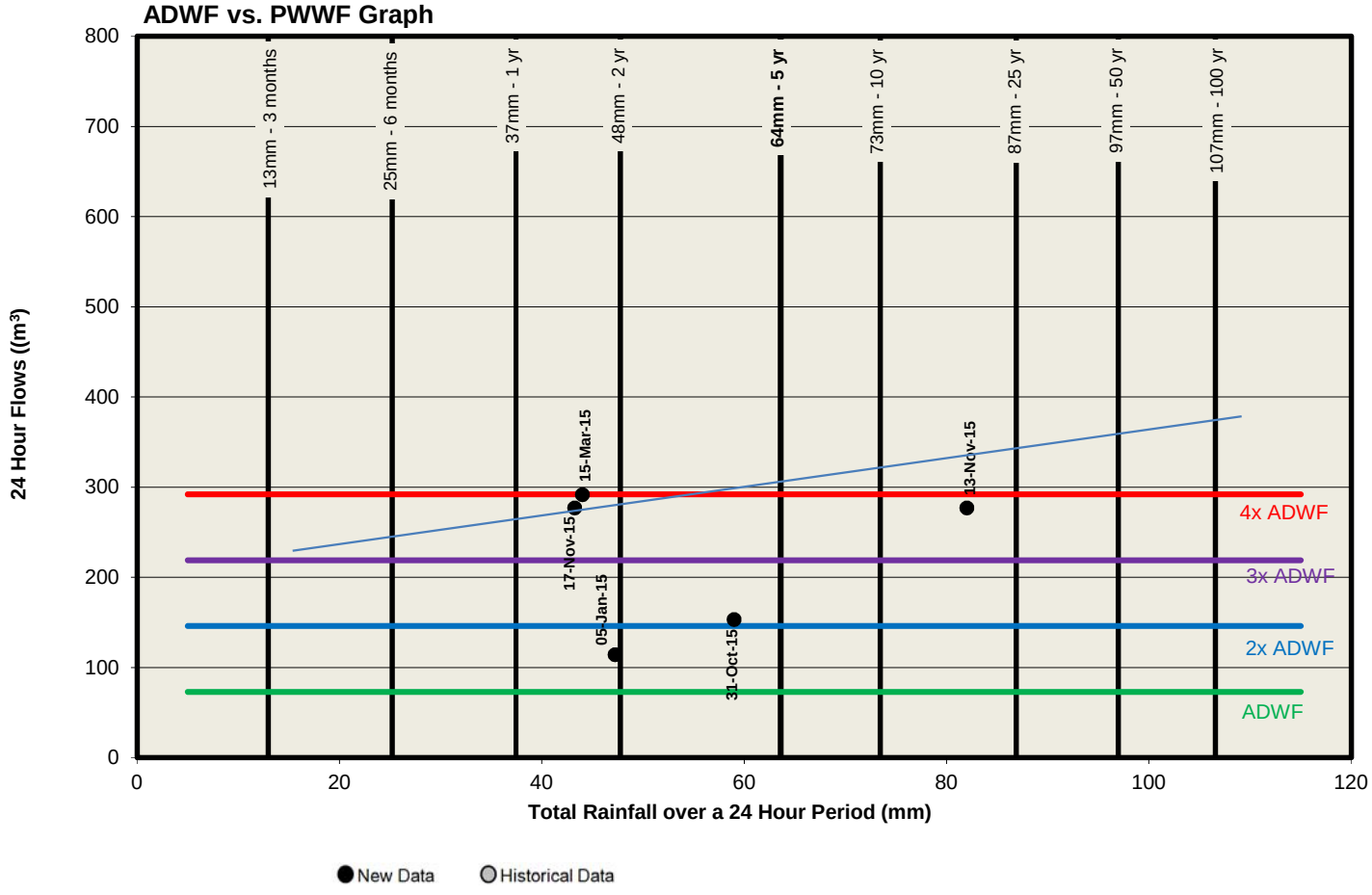
Sandowne (OB27)

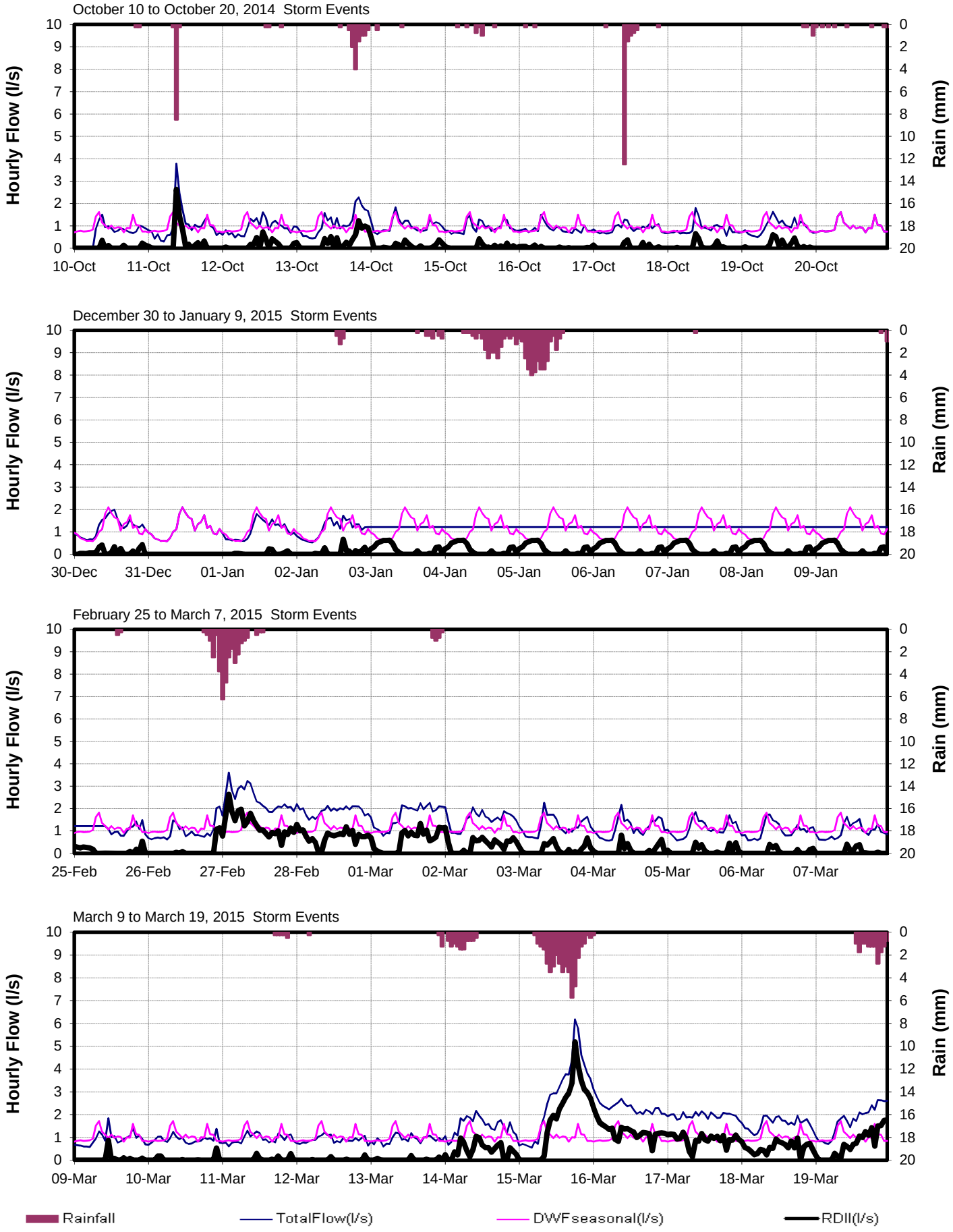
RDII Envelope



ADWF vs. PWWF Graph

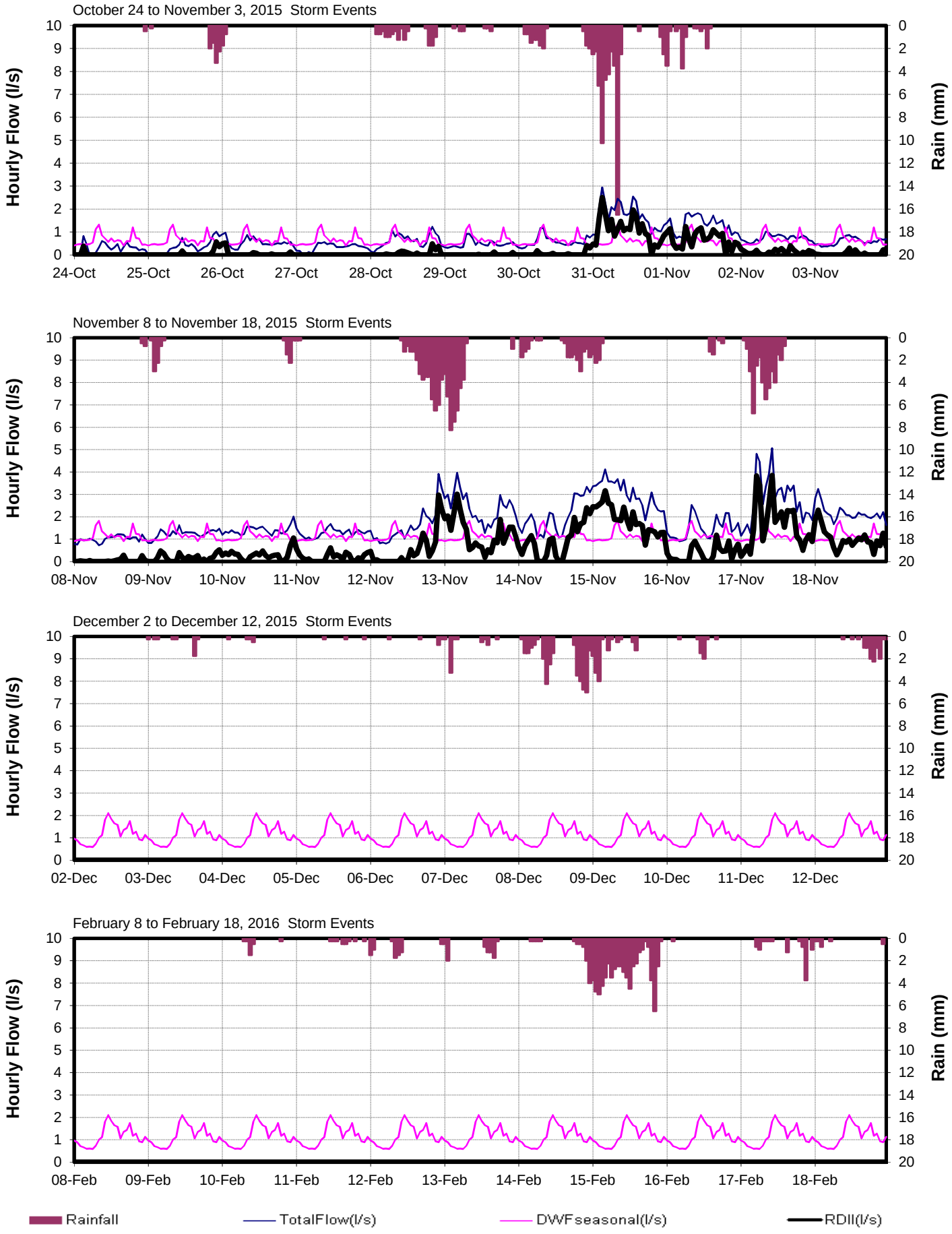


Sandowne (OB27)



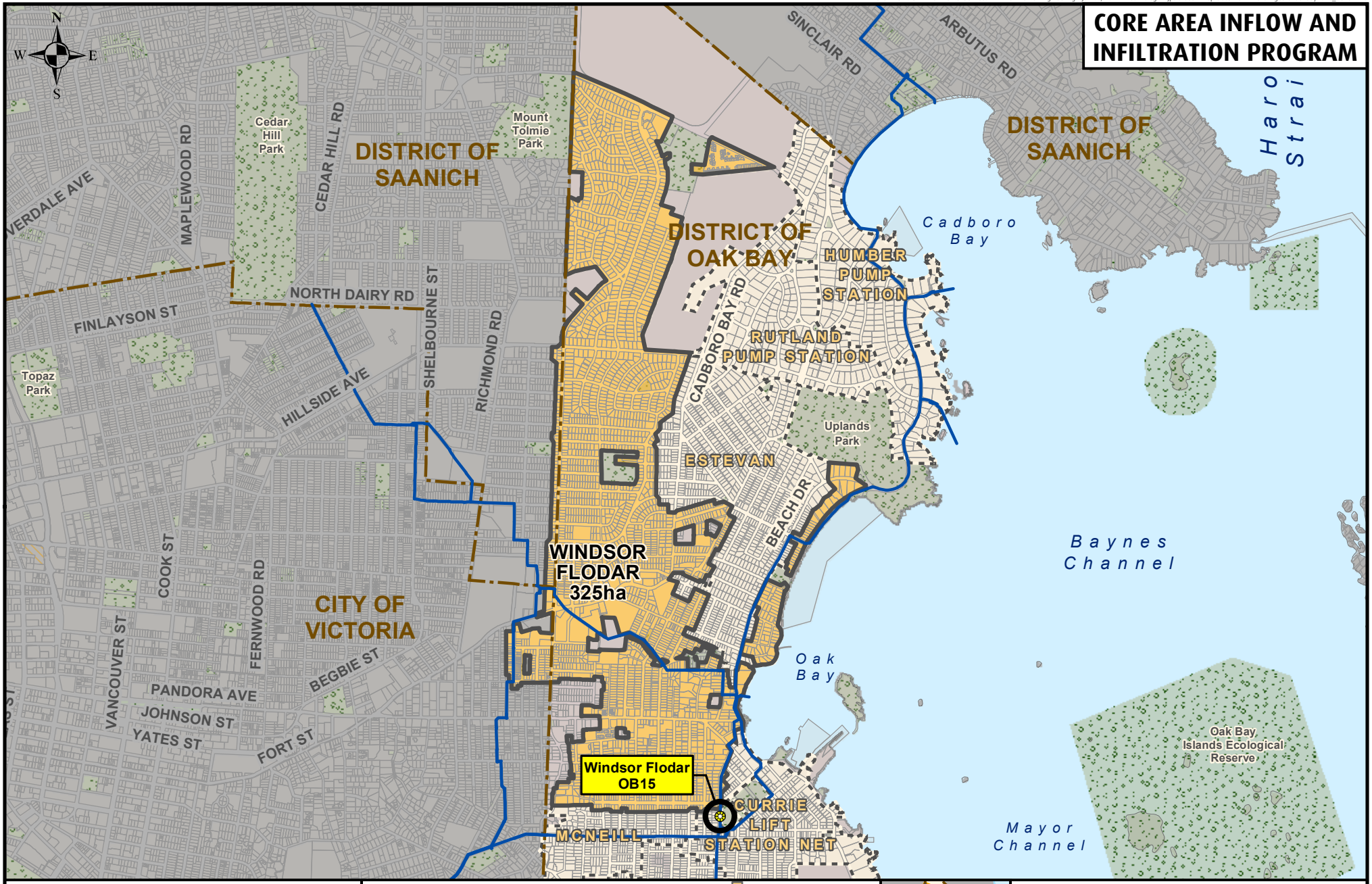
CRD Core Area I Program

Sandowne (OB27)



CRD - Parks & Environmental Services - Environmental Engineering - Jan 06, 2017 - Technologist: jpbezeau - Map Document: MeteringCatchOakBay2016_OB15.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Metres
0 750 1,500

Projection: UTM ZONE 10N, NAD83

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- Flow Monitoring Location
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- Municipal, First Nation, or DND Boundaries

FLOW MONITORING AREA
Catchment: Windsor Flume
Site Code: OB15

CRD
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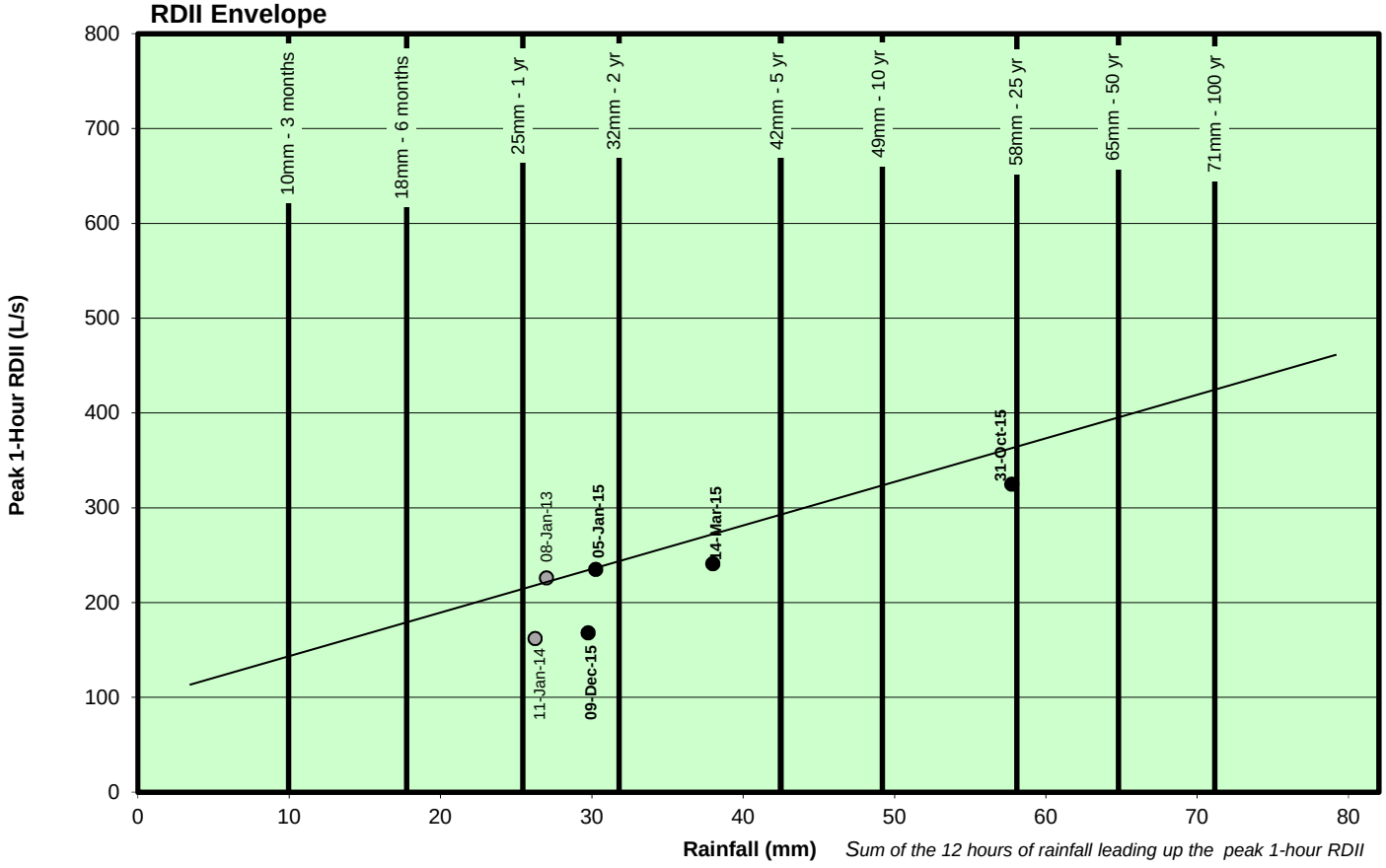
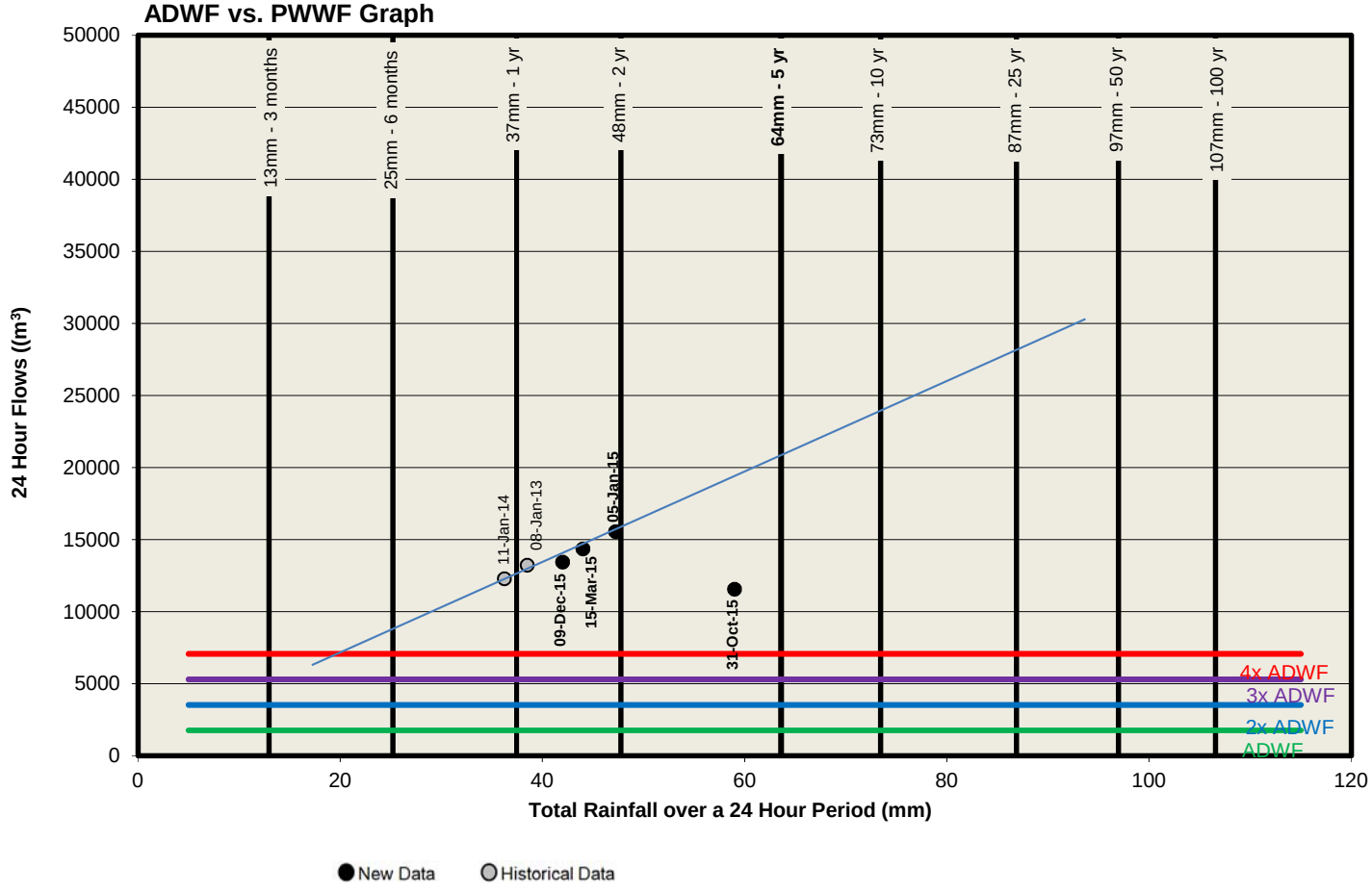
Windsor Flodar (OB15)

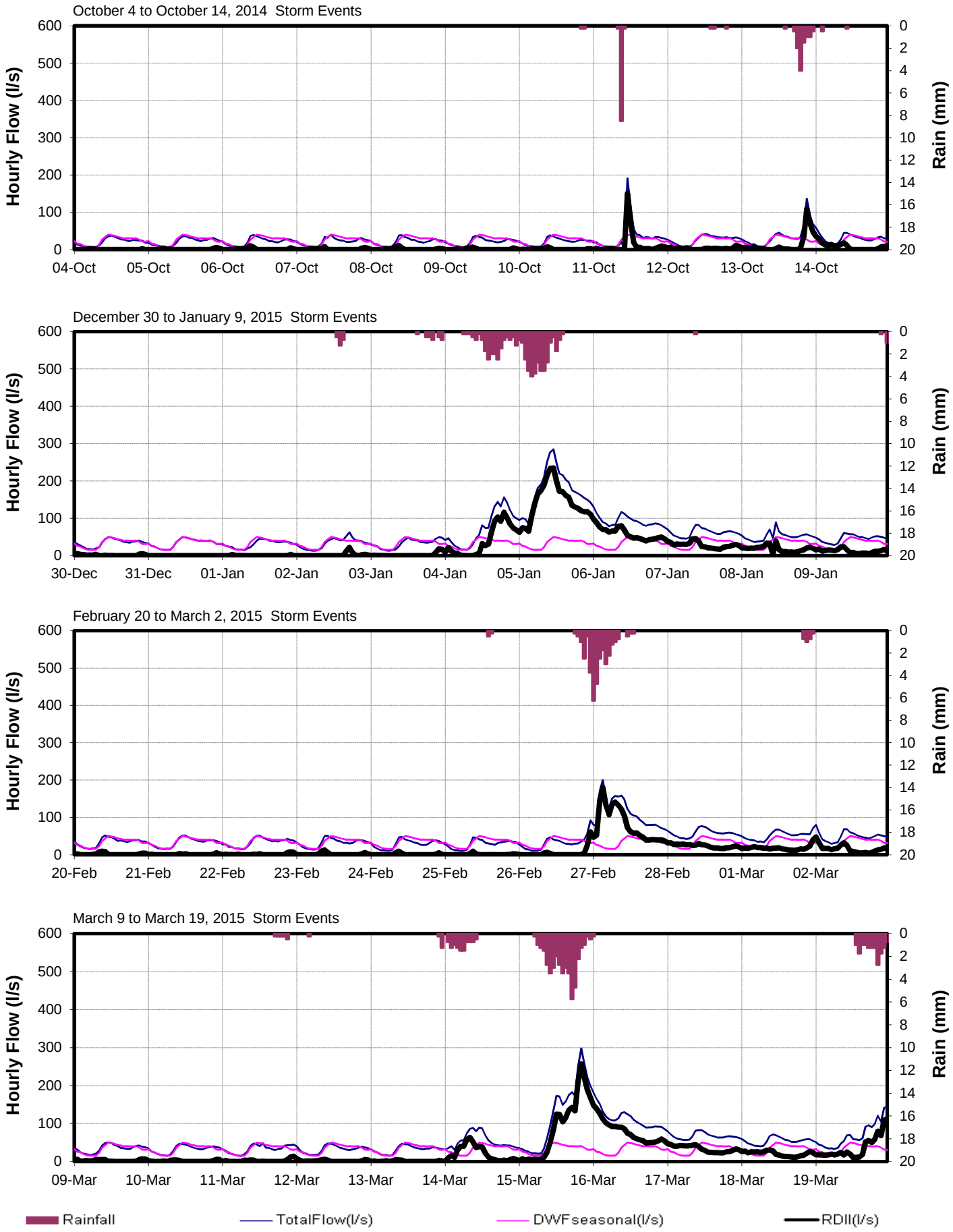
RDII Envelope



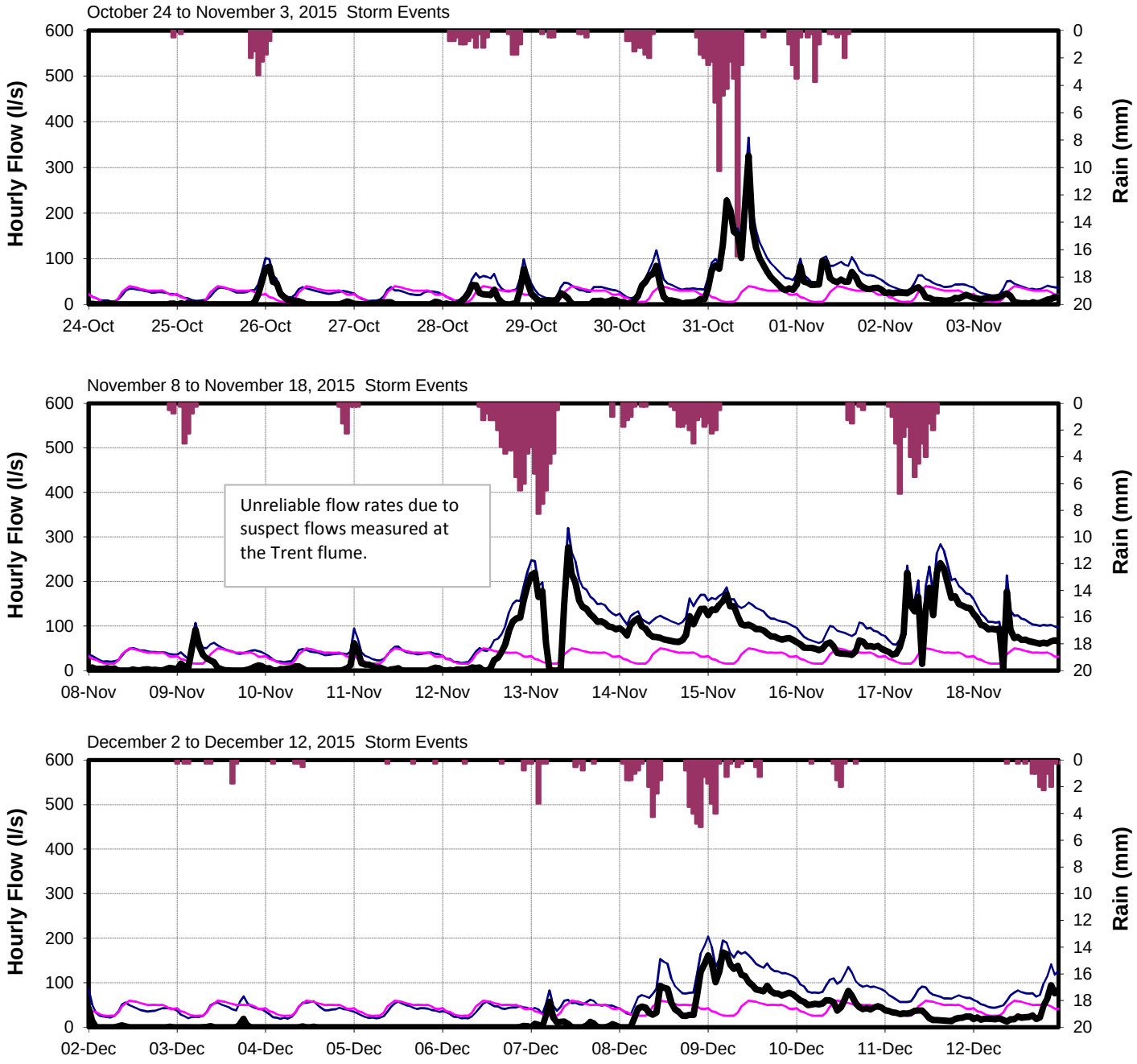
ADWF vs. PWWF Graph



Windsor Flodar (OB15)

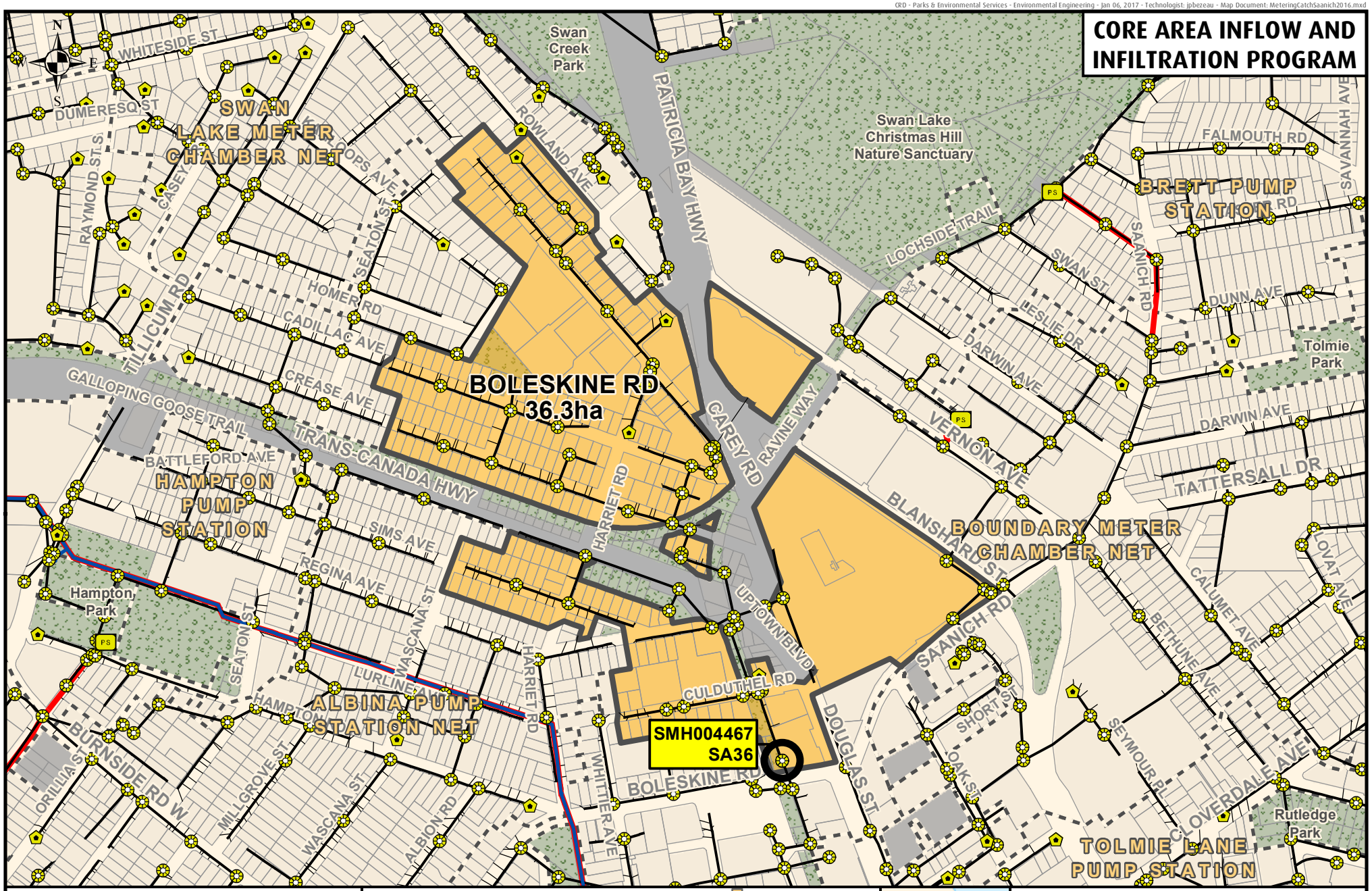


Windsor Flodar (OB15)



CRD - Parks & Environmental Services - Environmental Engineering - Jan 06, 2017 - Technologist: jpbezeau - Map Document: MeteringCatchSaanich2016.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Metres
0 200 400

Projection: UTM ZONE 10N, NAD83

Disclaimer
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FLOW MONITORING AREA

Catchment: Behind 3400 Douglas
Site Code: SA36

CRD
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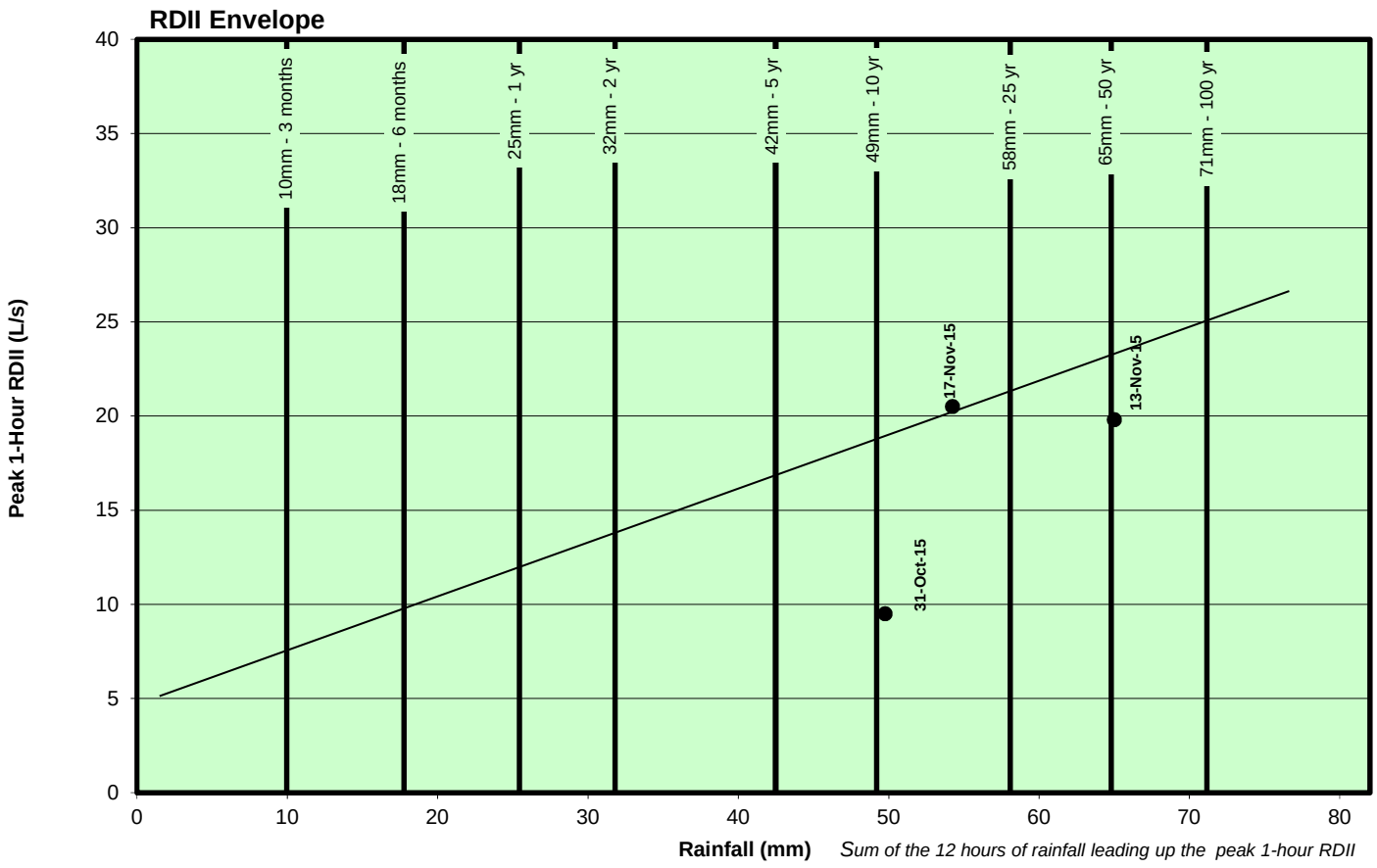
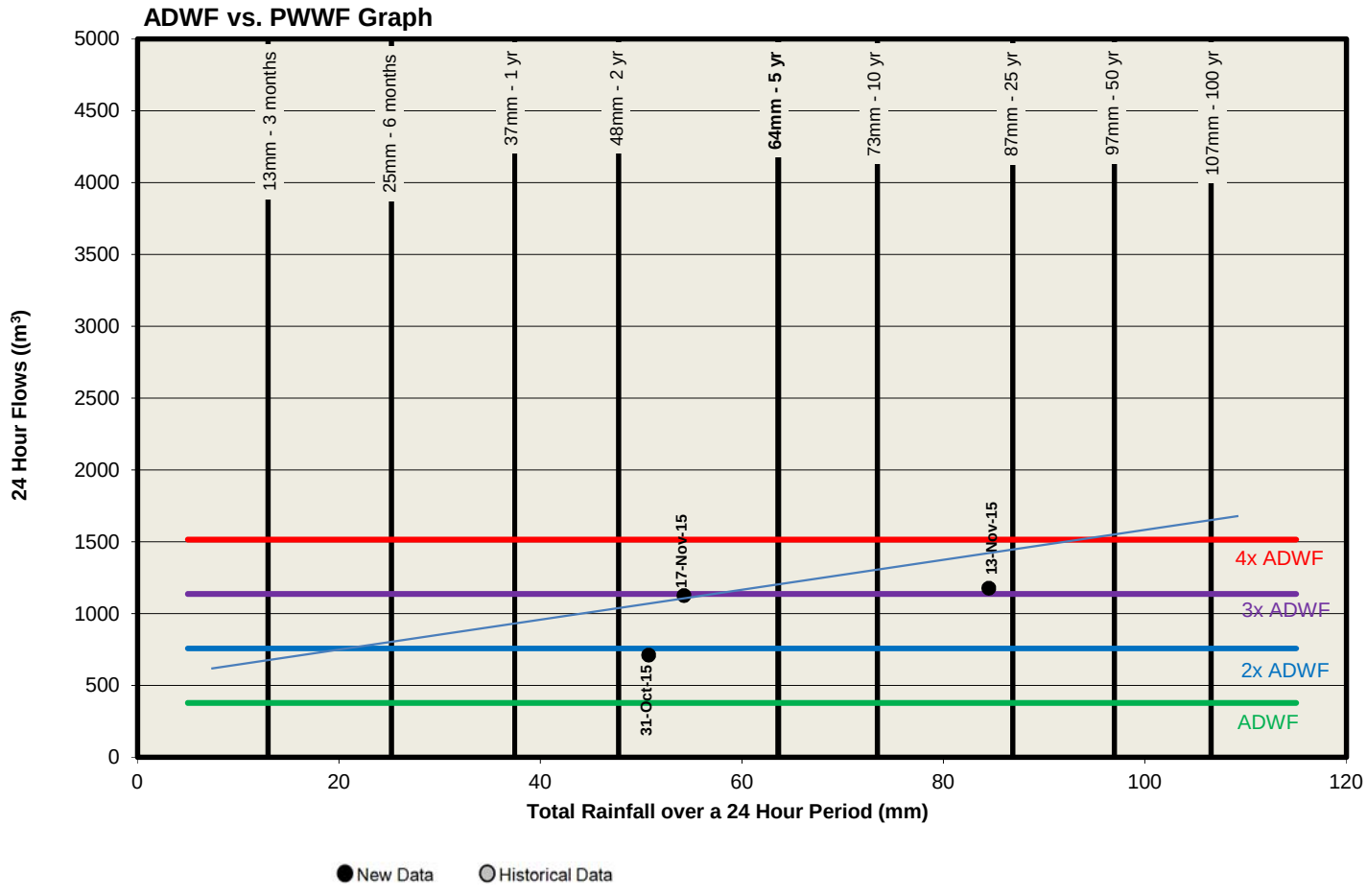
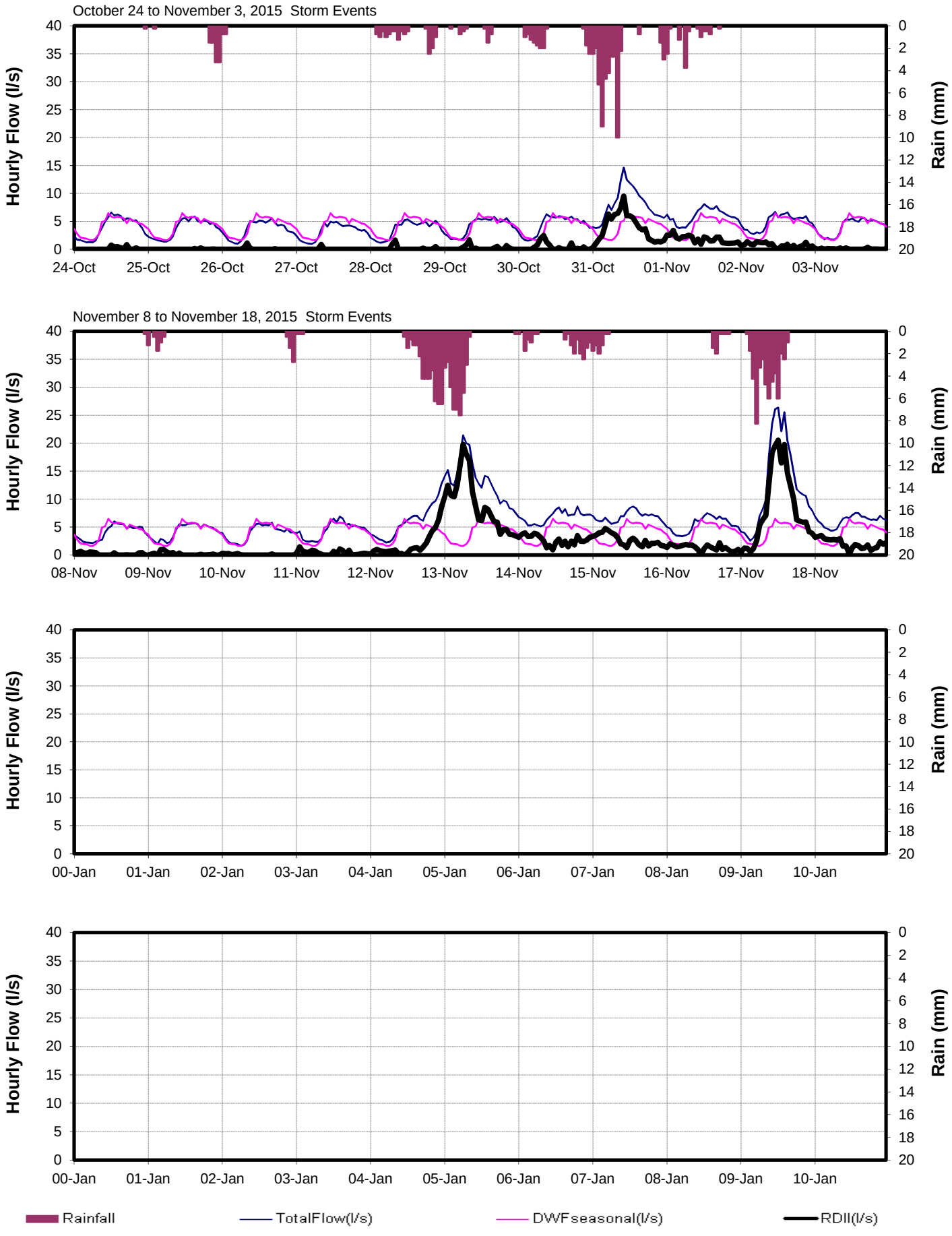
Behind 3400 Douglas Street (SA36)

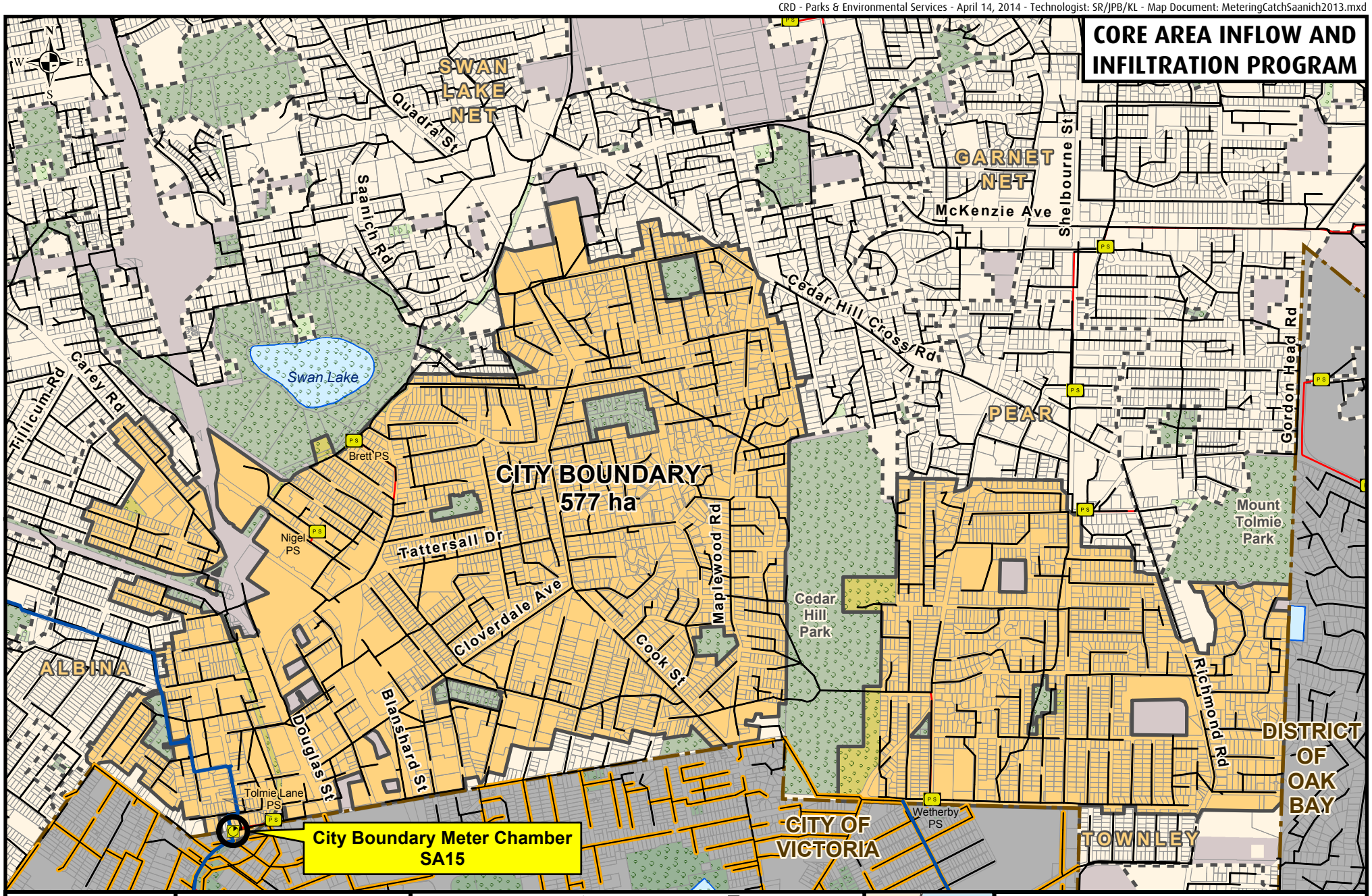




Behind 3400 Douglas Street (SA36)



CORE AREA INFLOW AND INFILTRATION PROGRAM



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Metres
0 200 400 600

Projection: UTM ZONE 10N NAD 83

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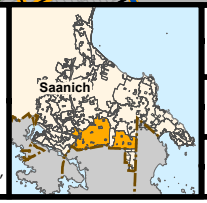


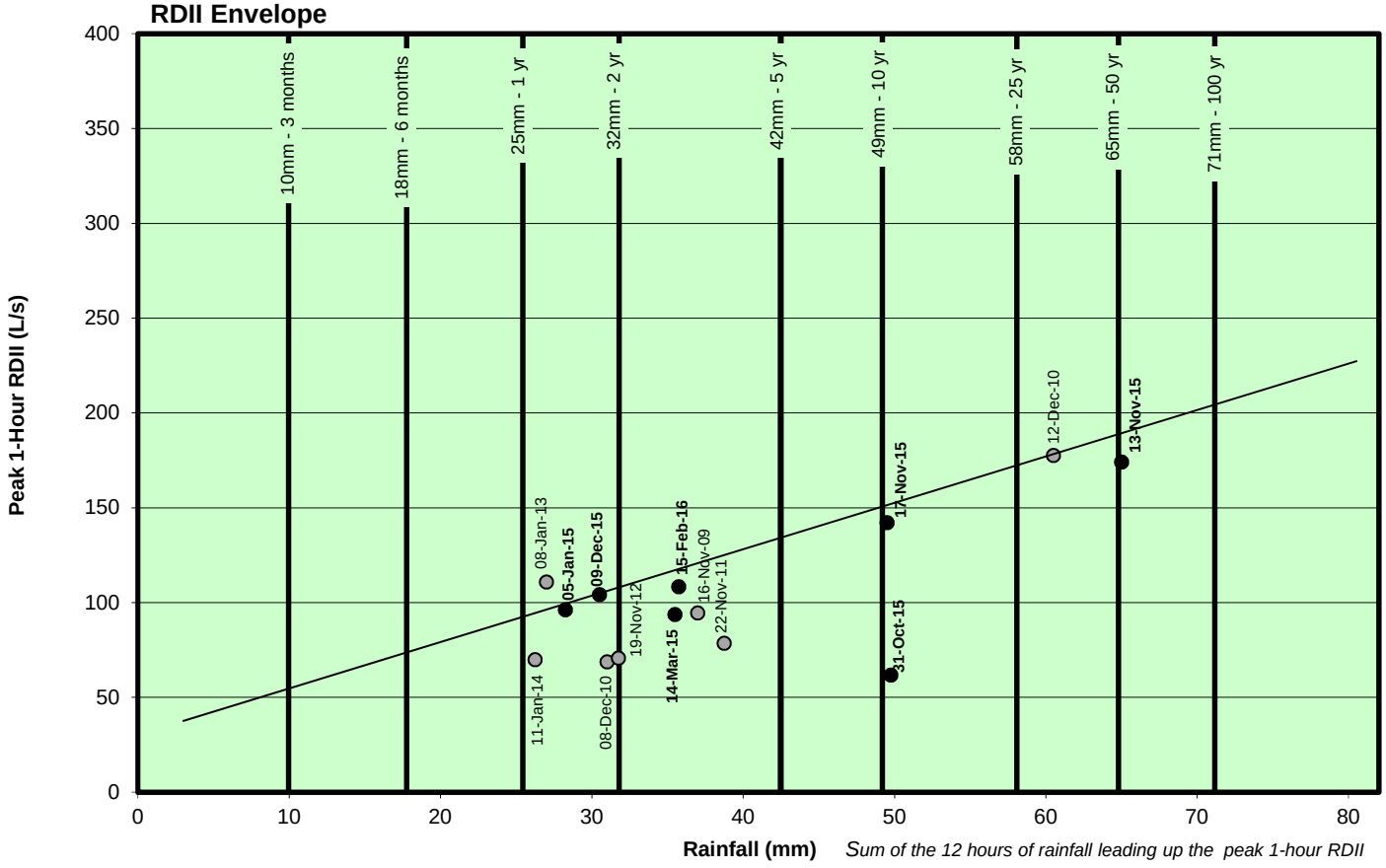
FLOW MONITORING AREA

CATCHMENT: CITY BOUNDARY

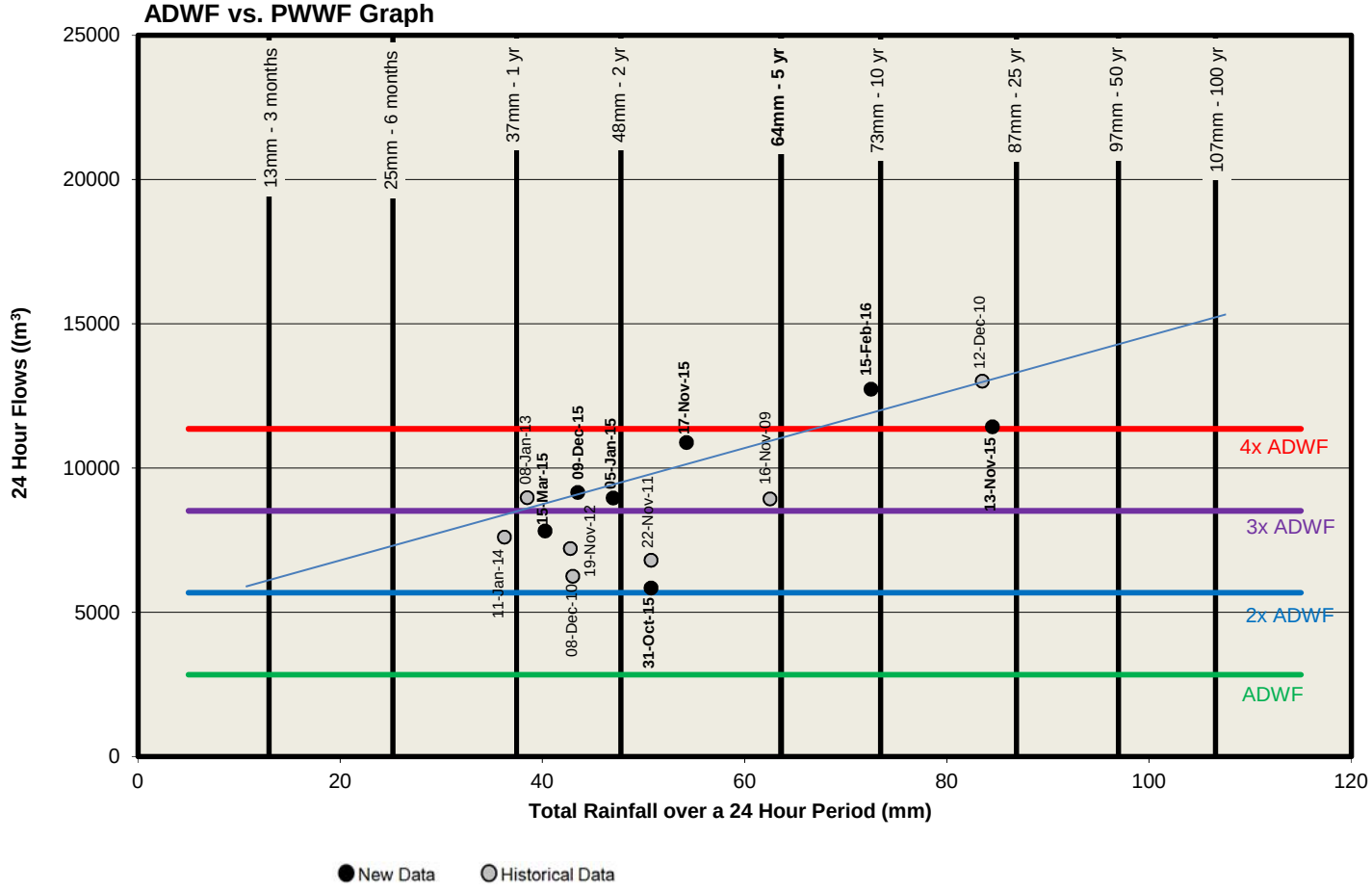
SITE CODE: **SA15**

Boundary (SA15)

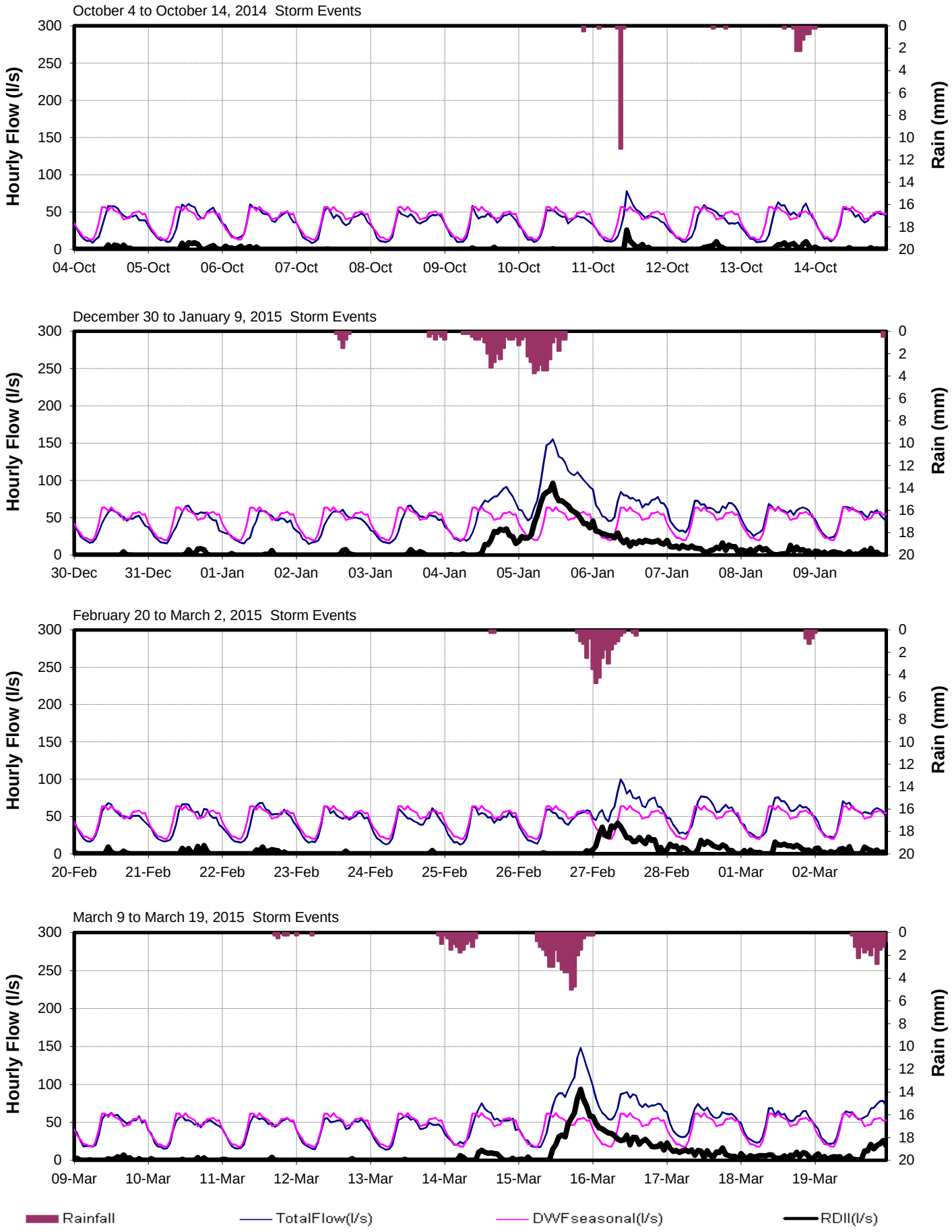
RDII Envelope



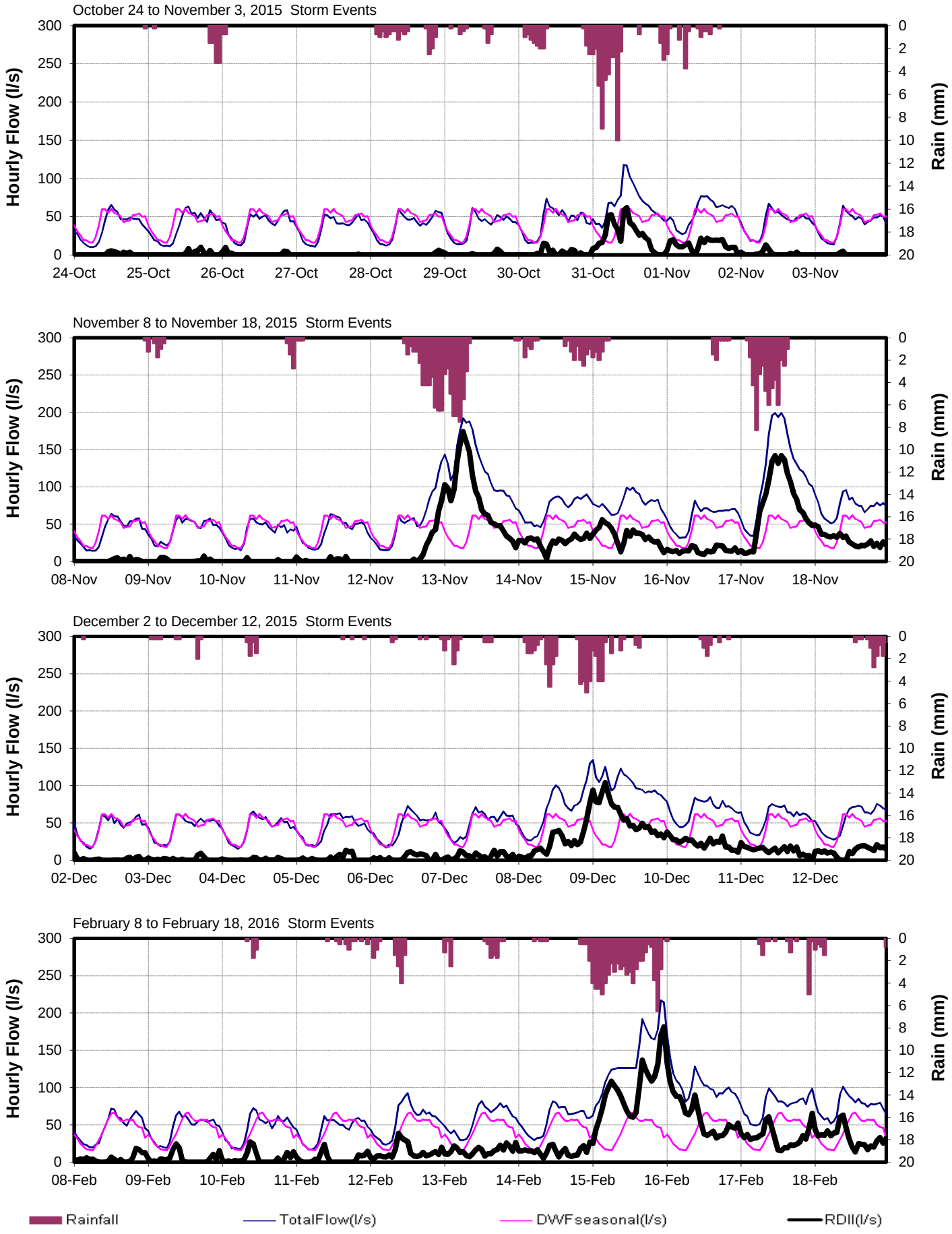
ADWF vs. PWWF Graph



Boundary (SA15)

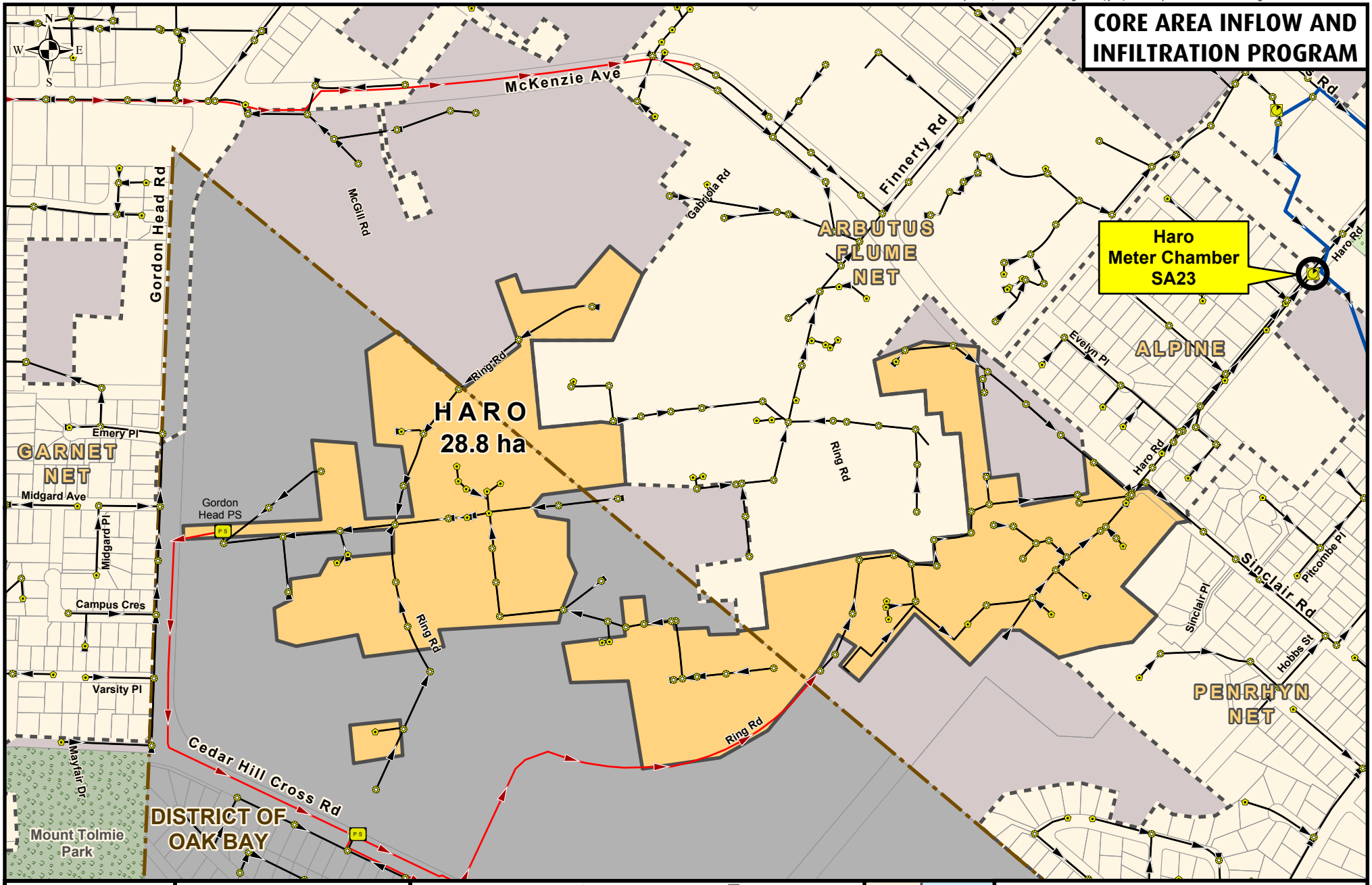


Boundary (SA15)



CRD - Parks & Environmental Services - April 14, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchSaanich2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 100 200

Projection: UTM ZONE 10N NAD 83

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- Catchment Boundary
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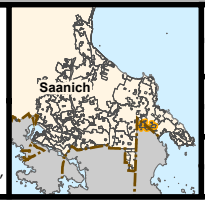
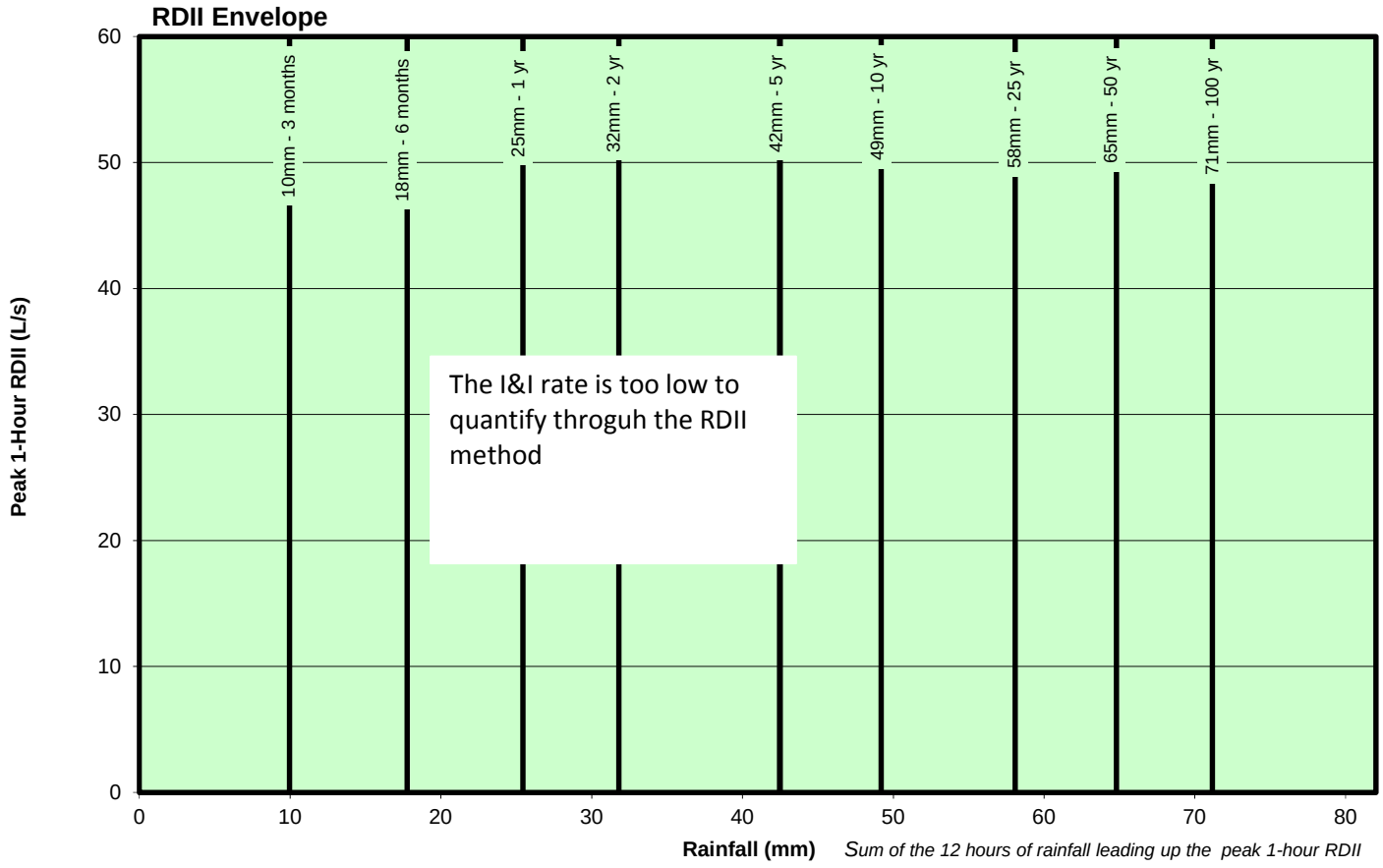


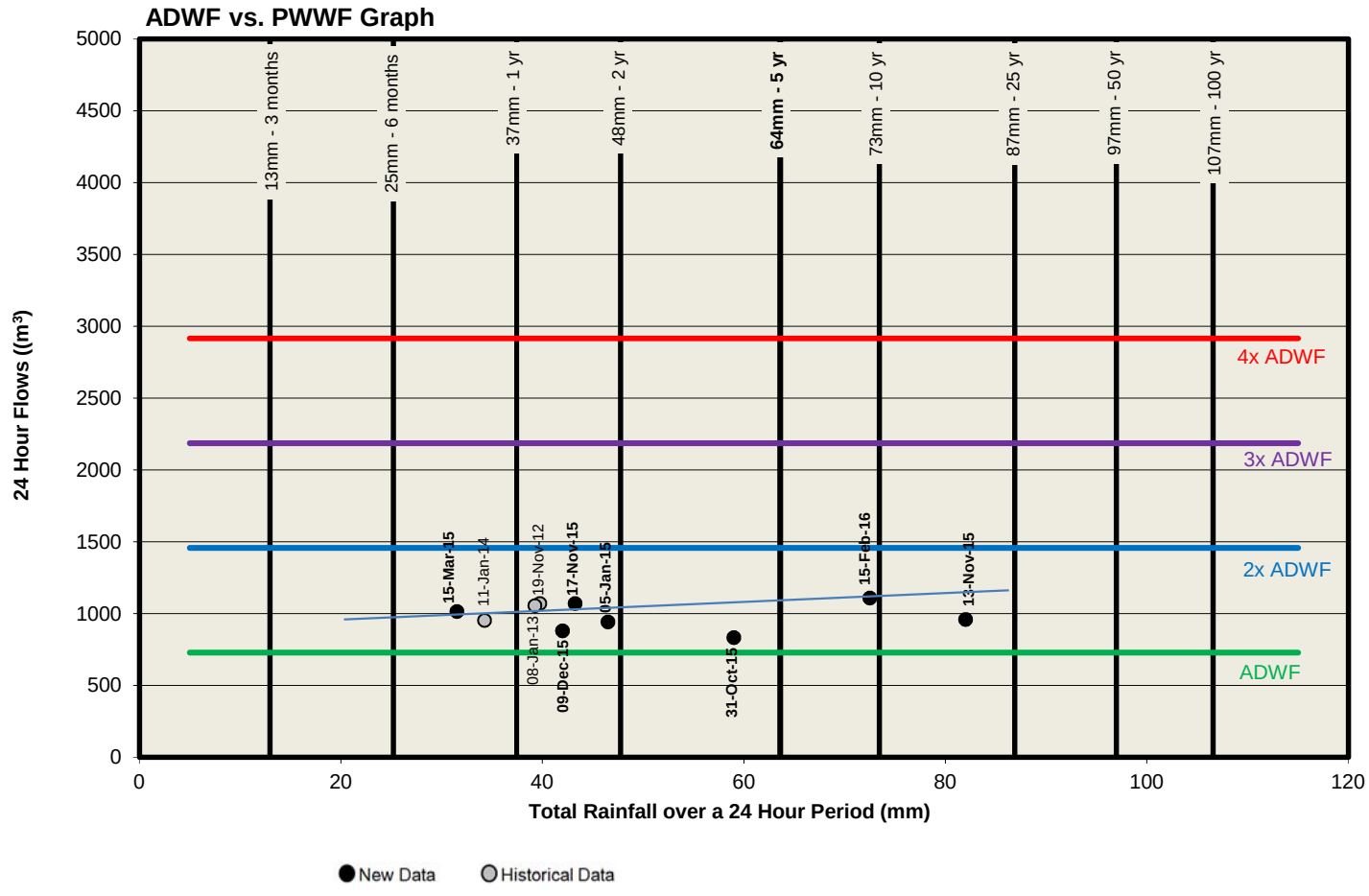
FLOW MONITORING AREA

CATCHMENT: HARO

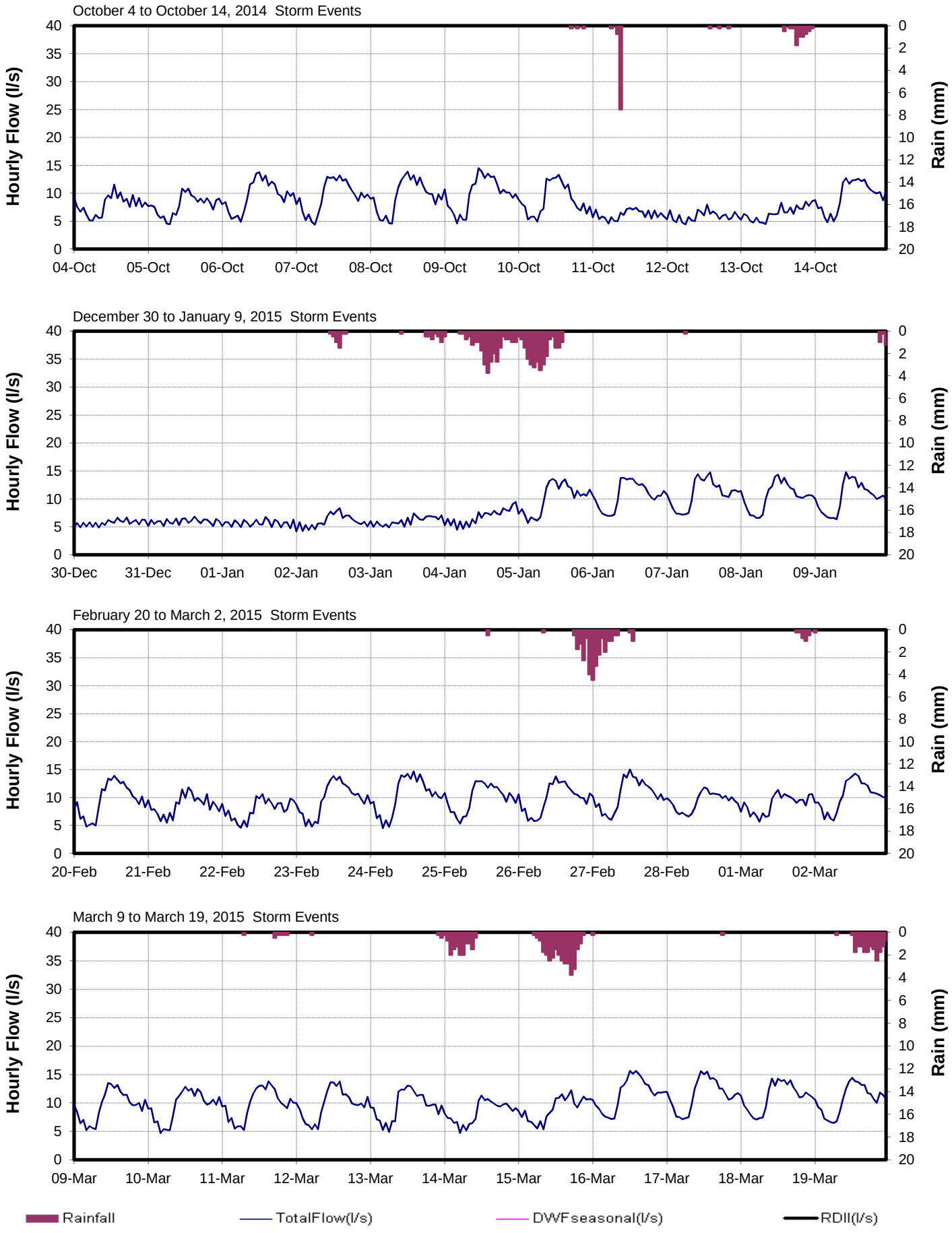
SITE CODE: **SA23**

Haro (SA23)

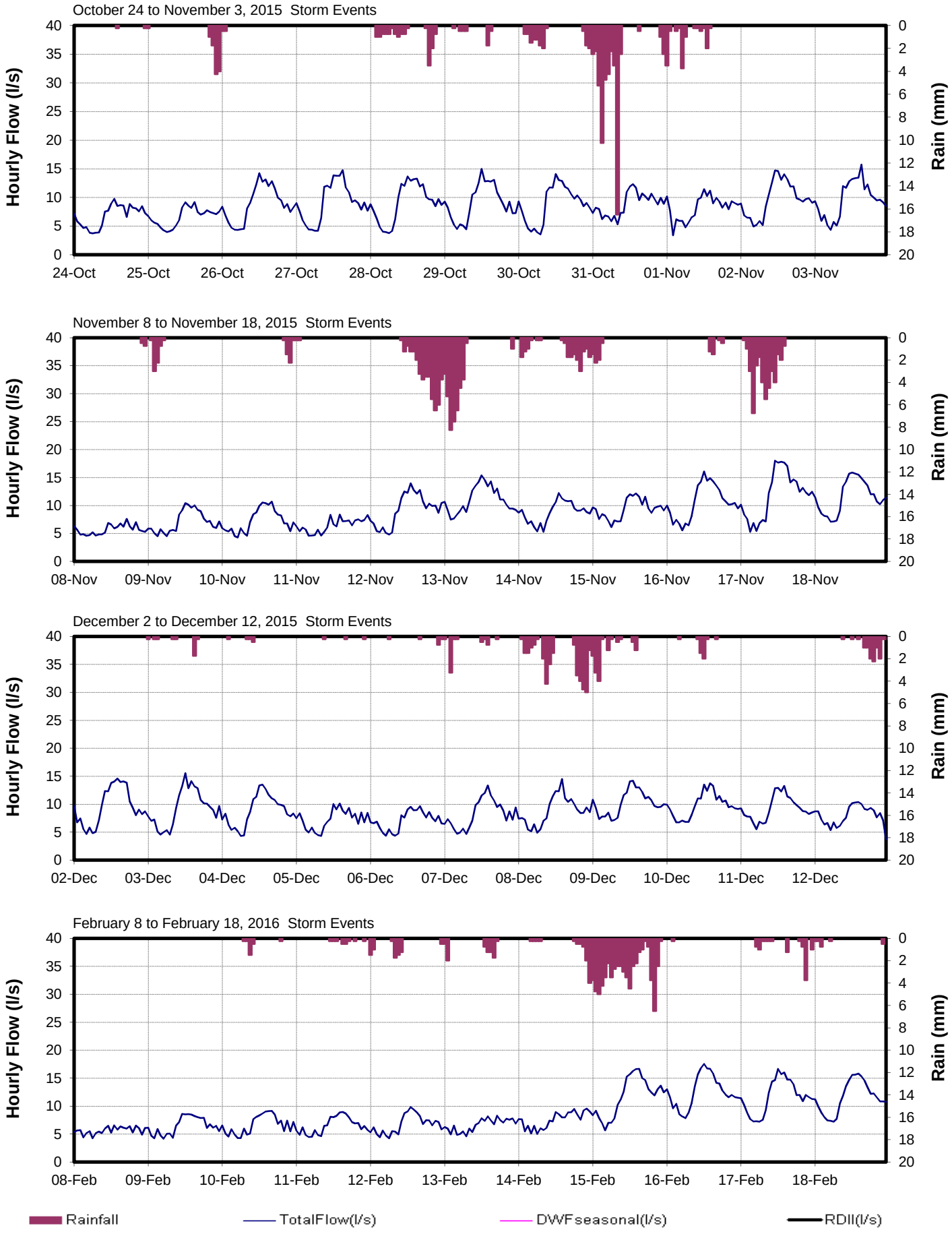

RDII Envelope
Peak 1-Hour RDII (L/s)
Rainfall (mm)
Sum of the 12 hours of rainfall leading up the peak 1-hour RDII
10mm - 3 months
18mm - 6 months
25mm - 1 yr
32mm - 2 yr
42mm - 5 yr
49mm - 10 yr
58mm - 25 yr
65mm - 50 yr
71mm - 100 yr
The I&I rate is too low to quantify throguh the RDII method


ADWF vs. PWWF Graph
24 Hour Flows ((m³)
Total Rainfall over a 24 Hour Period (mm)
13mm - 3 months
25mm - 6 months
37mm - 1 yr
48mm - 2 yr
64mm - 5 yr
73mm - 10 yr
87mm - 25 yr
97mm - 50 yr
107mm - 100 yr
4x ADWF
3x ADWF
2x ADWF
ADWF
15-Mar-15
11-Jan-14
19-Nov-12
08-Jan-13
17-Nov-15
09-Dec-15
05-Jan-15
31-Oct-15
15-Feb-16
13-Nov-15
New Data
Historical Data

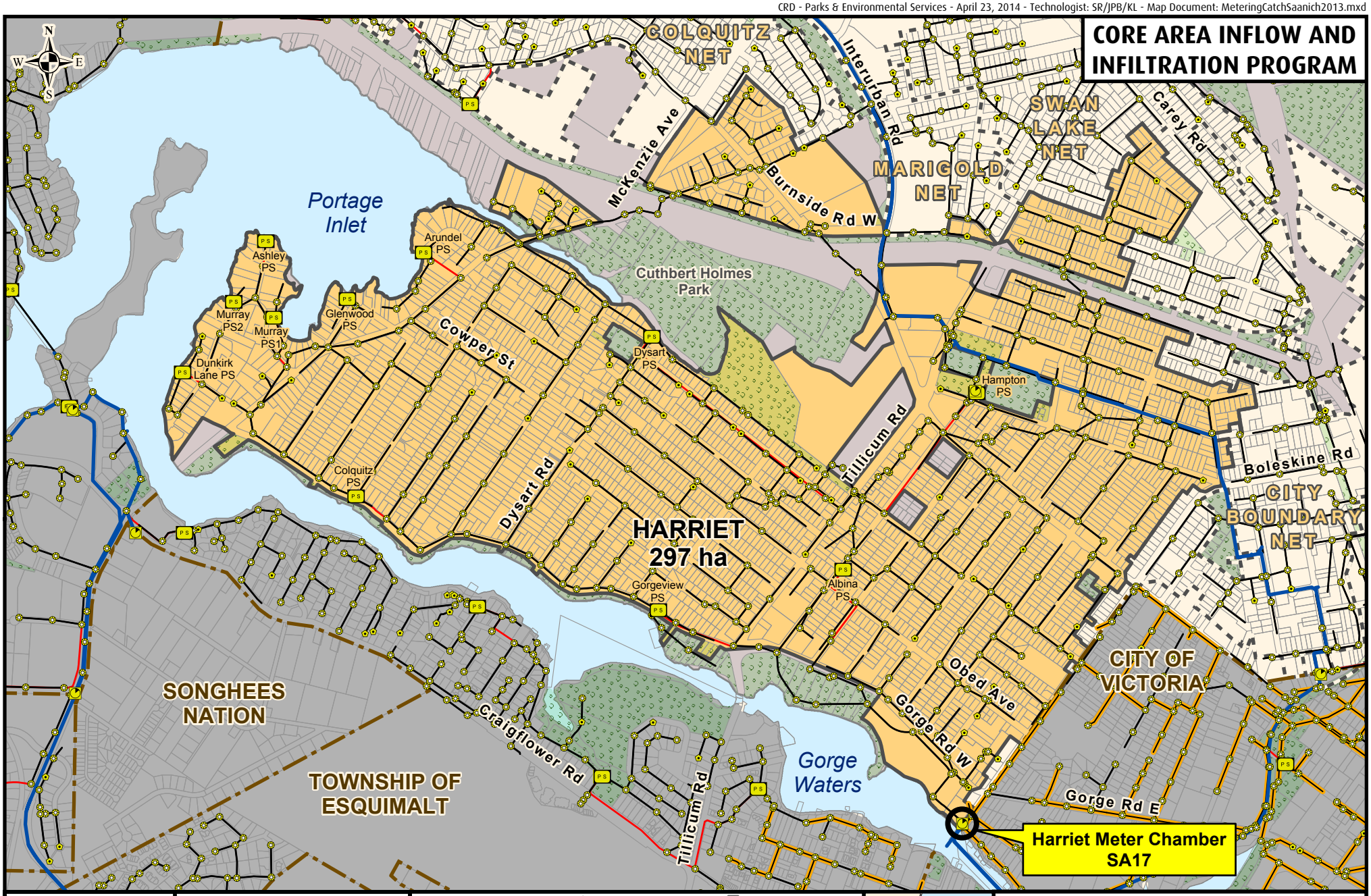
Haro (SA23)


October 4 to October 14, 2014 Storm Events
December 30 to January 9, 2015 Storm Events
February 20 to March 2, 2015 Storm Events
March 9 to March 19, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
0
5
10
15
20
25
30
35
40
0
2
4
6
8
10
12
14
16
18
20
04-Oct
05-Oct
06-Oct
07-Oct
08-Oct
09-Oct
10-Oct
11-Oct
12-Oct
13-Oct
14-Oct
30-Dec
31-Dec
01-Jan
02-Jan
03-Jan
04-Jan
05-Jan
06-Jan
07-Jan
08-Jan
09-Jan
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
26-Feb
27-Feb
28-Feb
01-Mar
02-Mar
09-Mar
10-Mar
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
19-Mar
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

Haro (SA23)


October 24 to November 3, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
24-Oct
25-Oct
26-Oct
27-Oct
28-Oct
29-Oct
30-Oct
31-Oct
01-Nov
02-Nov
03-Nov
November 8 to November 18, 2015 Storm Events
08-Nov
09-Nov
10-Nov
11-Nov
12-Nov
13-Nov
14-Nov
15-Nov
16-Nov
17-Nov
18-Nov
December 2 to December 12, 2015 Storm Events
02-Dec
03-Dec
04-Dec
05-Dec
06-Dec
07-Dec
08-Dec
09-Dec
10-Dec
11-Dec
12-Dec
February 8 to February 18, 2016 Storm Events
08-Feb
09-Feb
10-Feb
11-Feb
12-Feb
13-Feb
14-Feb
15-Feb
16-Feb
17-Feb
18-Feb
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 100 200 300 400

Projection: UTM ZONE 10N NAD 83

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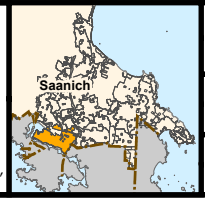
- Flow Monitoring Location
- Manhole
- Cleanout
- Pump Station
- Metering Chamber

Sanitary Sewers
- Gravity Main Installed After 1930
- Gravity Main Installed Before 1930
- Force Main
- Relief, Outfall, Overflow Sewer
- CRD Sewer

- Catchment Area
- Non-Sewered Area
- Lot Lines
- Parks
- Sewered Park Areas
- Catchment Boundary
- Municipal, First Nation, or DND Boundaries



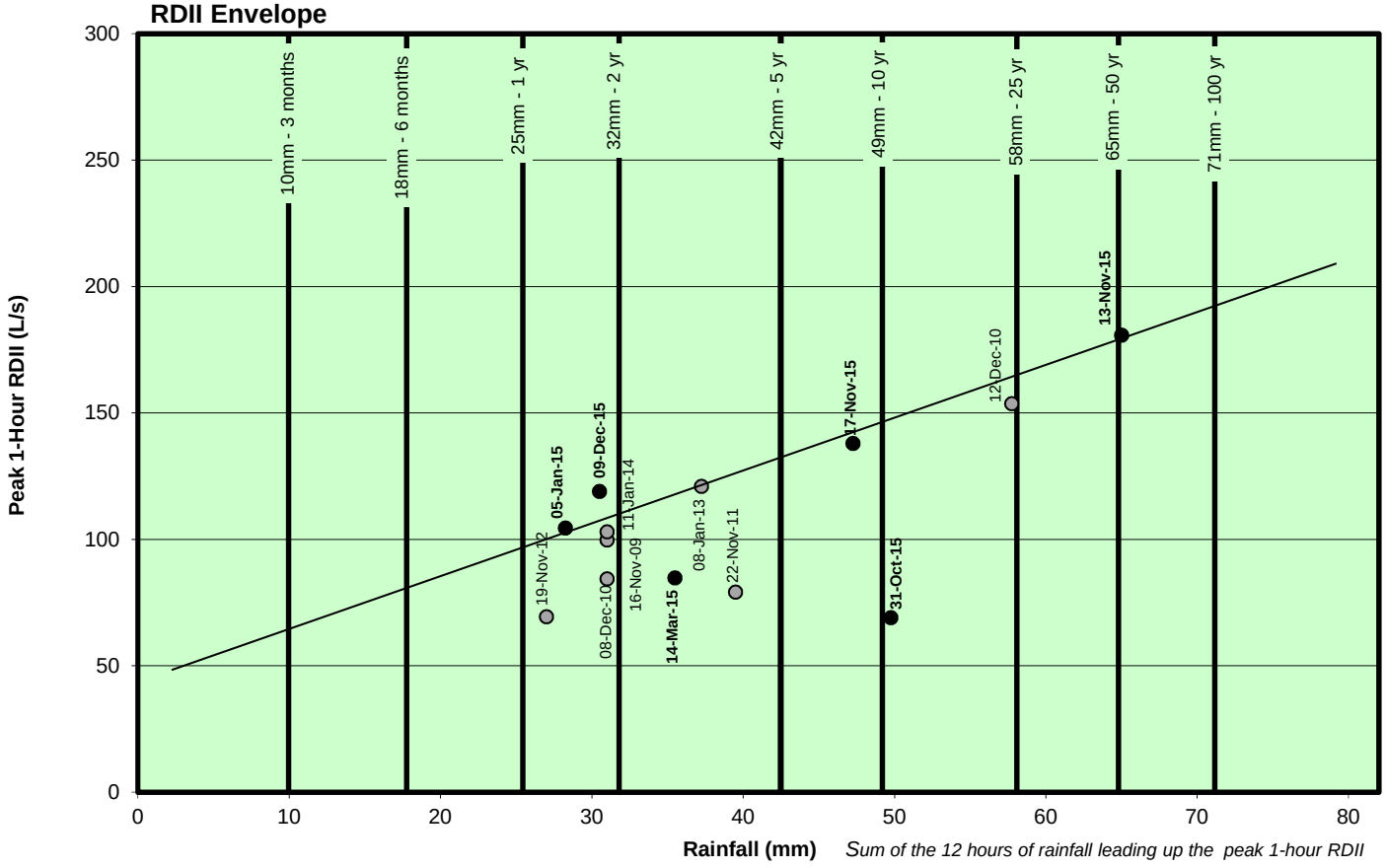
FLOW MONITORING AREA

CATCHMENT: HARRIET

SITE CODE: **SA17**

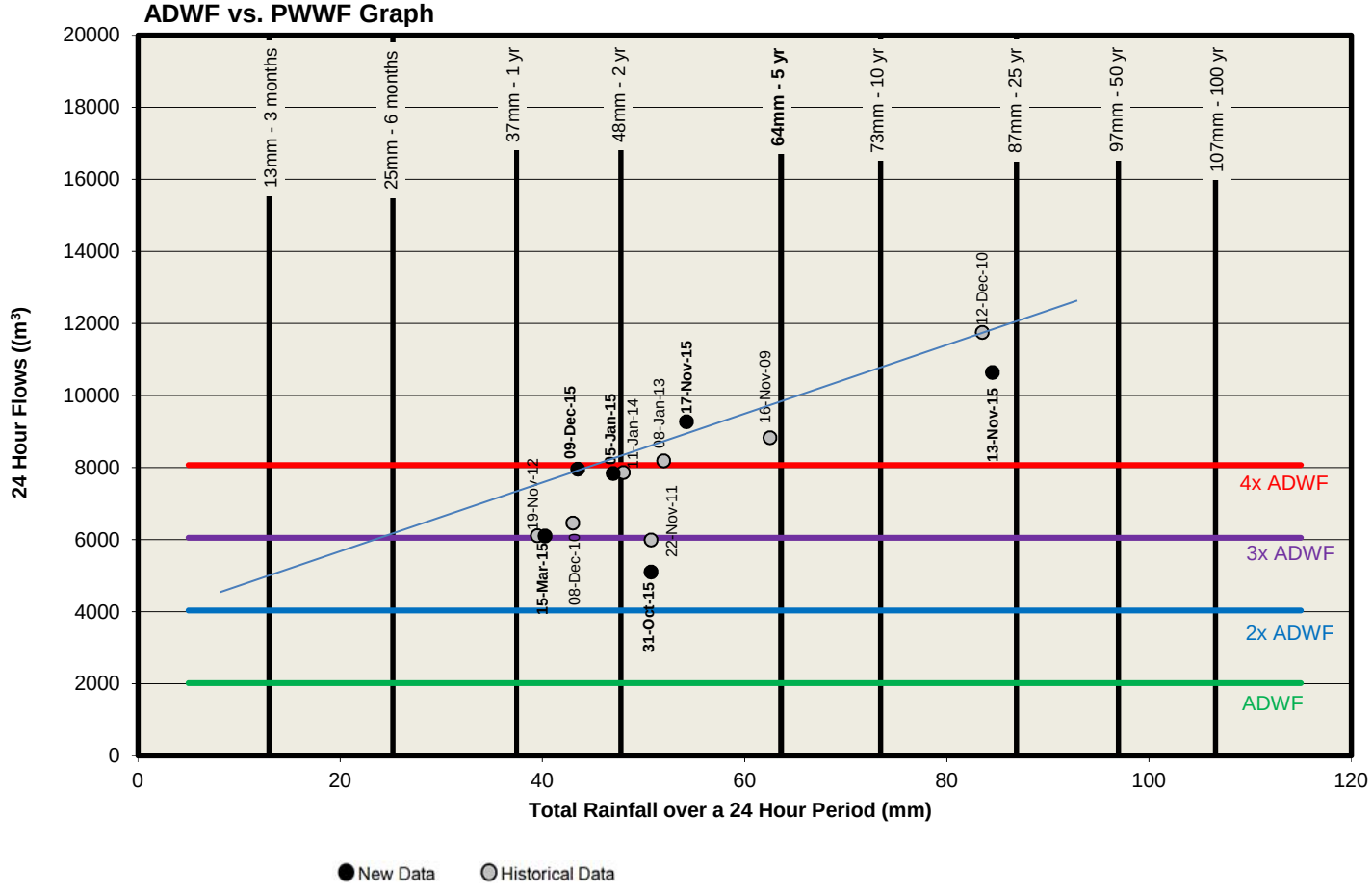
Harriet (SA17)

RDII Envelope

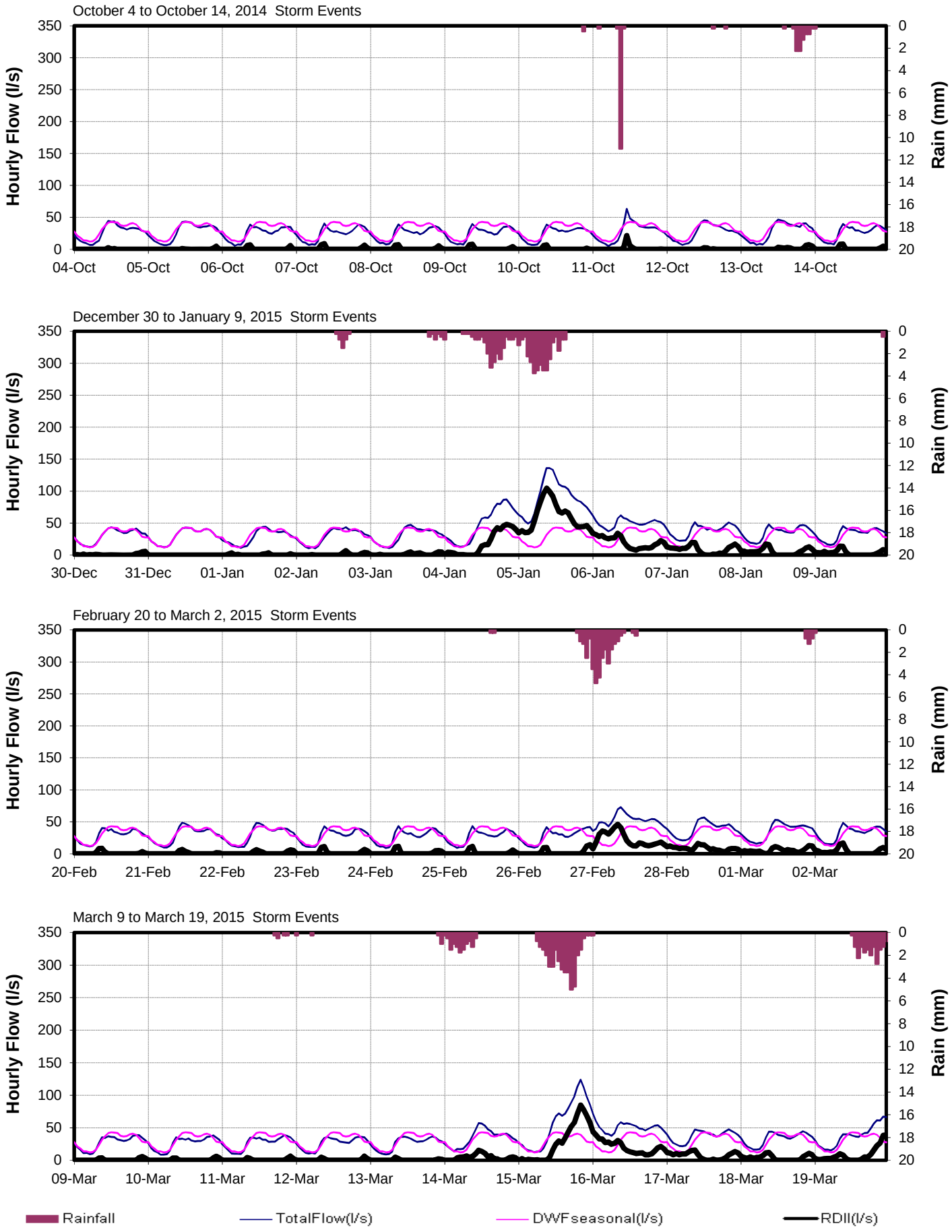


Sum of the 12 hours of rainfall leading up the peak 1-hour RDII

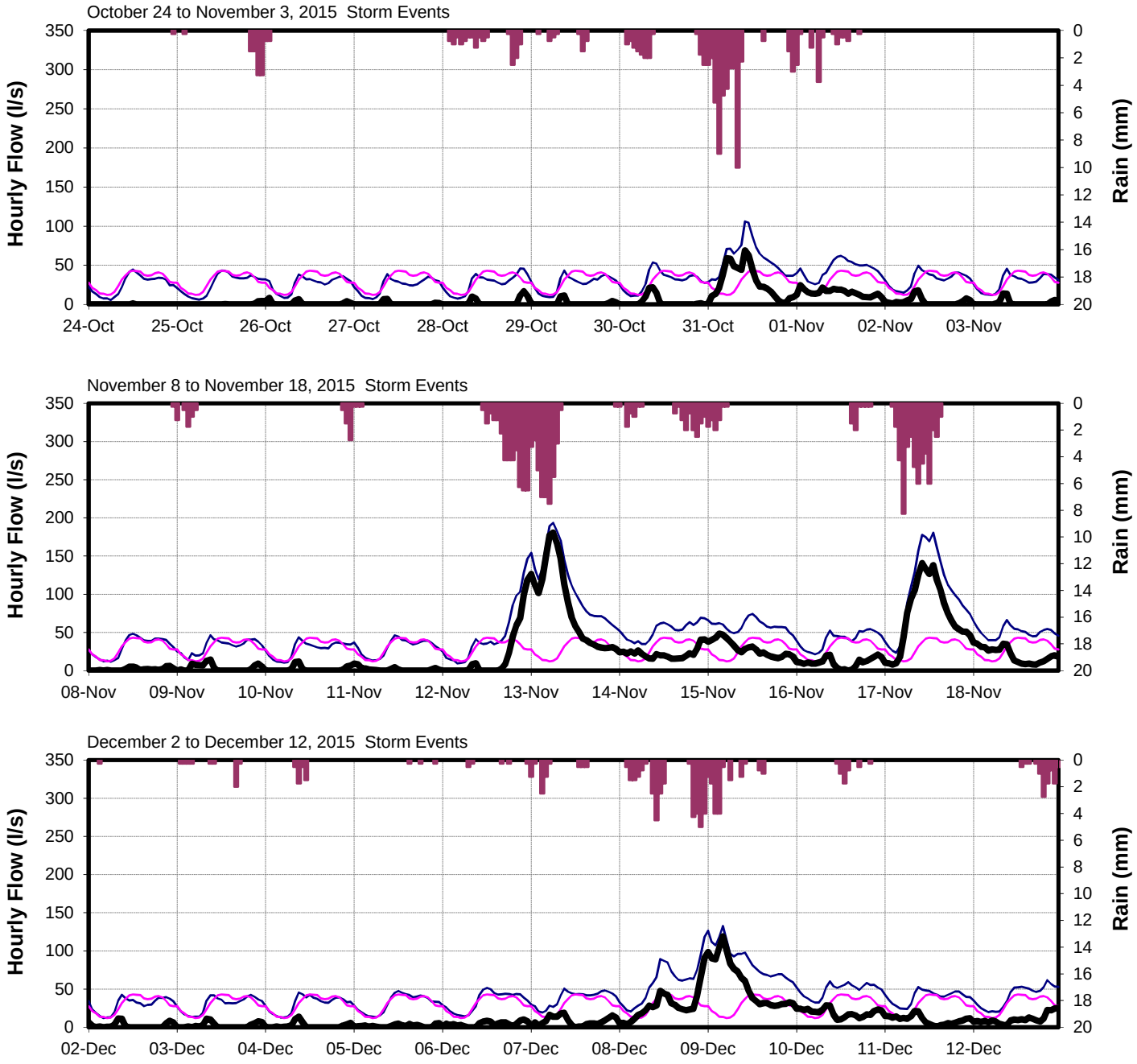
ADWF vs. PWWF Graph



Harriet (SA17)

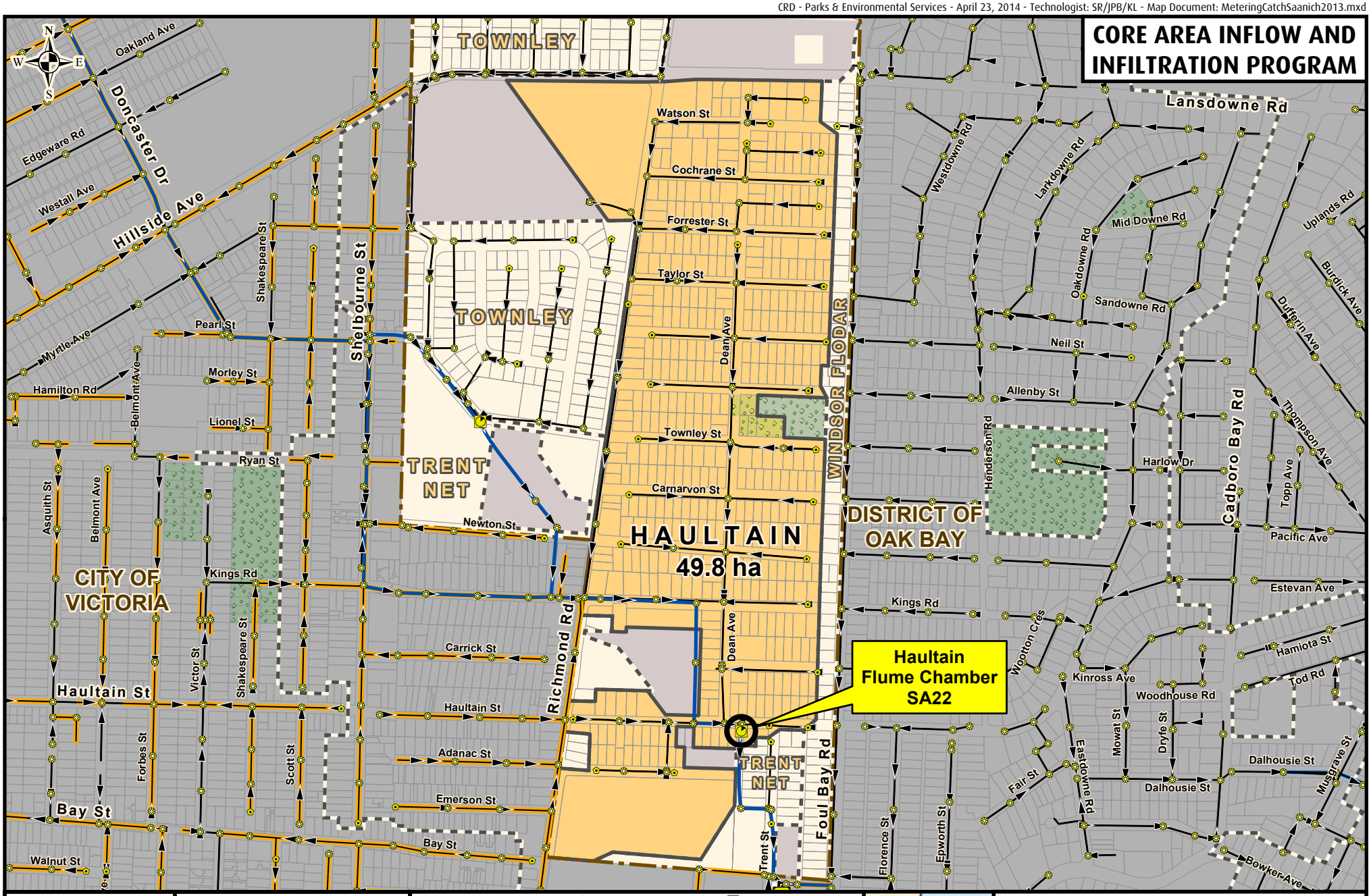


Harriet (SA17)



CRD - Parks & Environmental Services - April 23, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchSaanich2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 100 200

Projection: UTM ZONE 10N NAD 83

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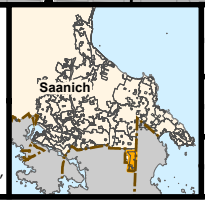


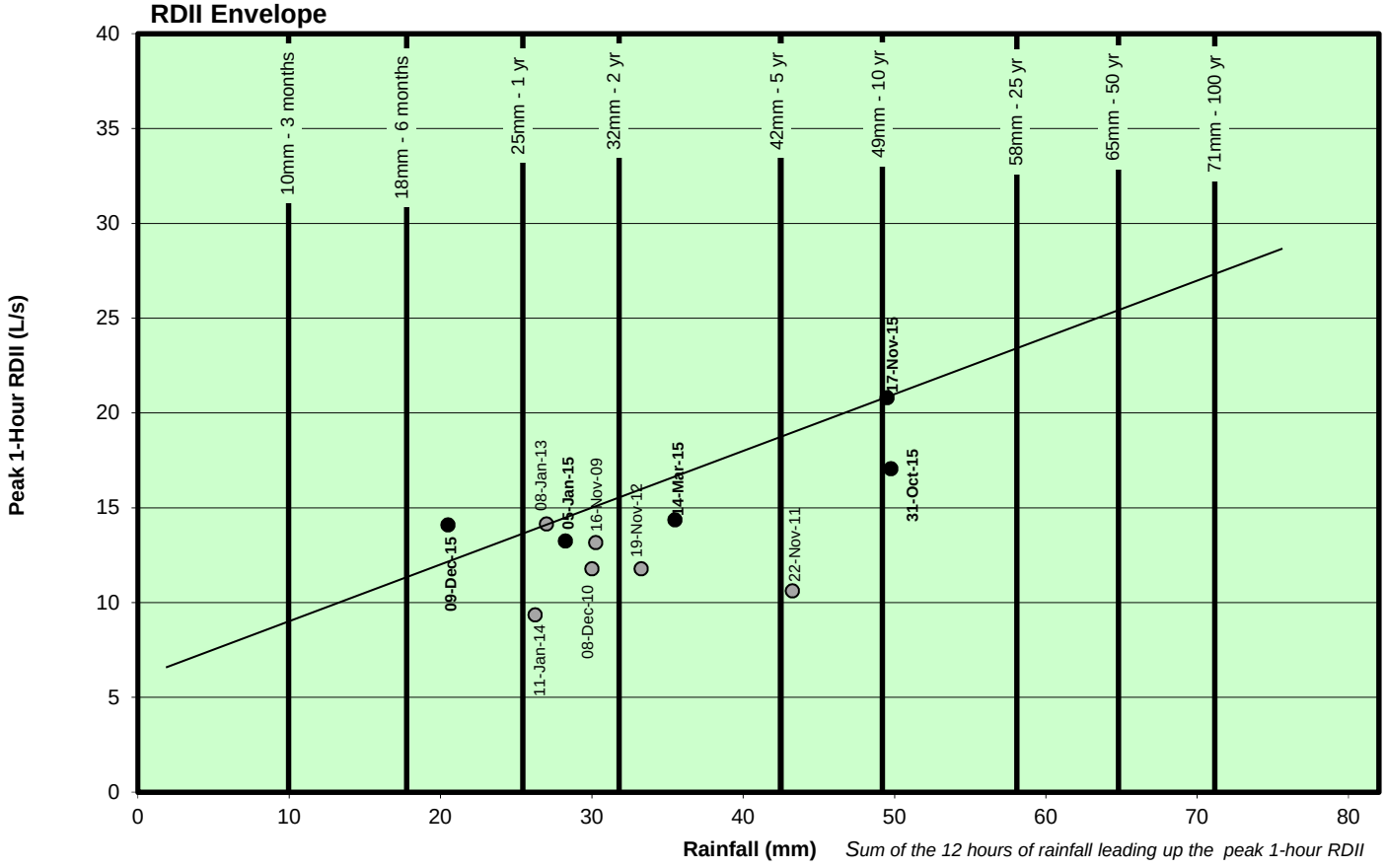
FLOW MONITORING AREA

CATCHMENT: HAULTAIN

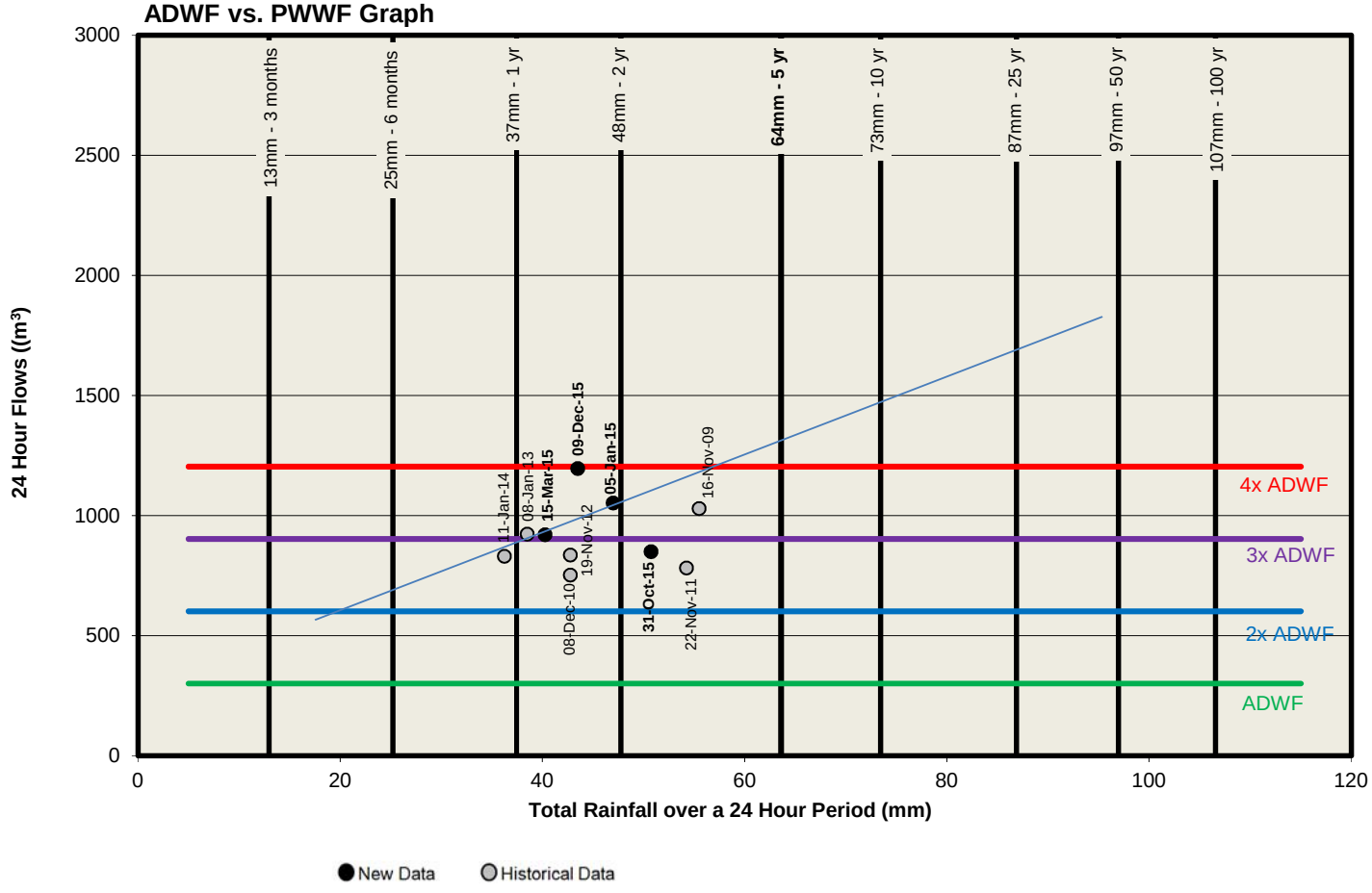
SITE CODE: **SA22**

Haultain (SA22)

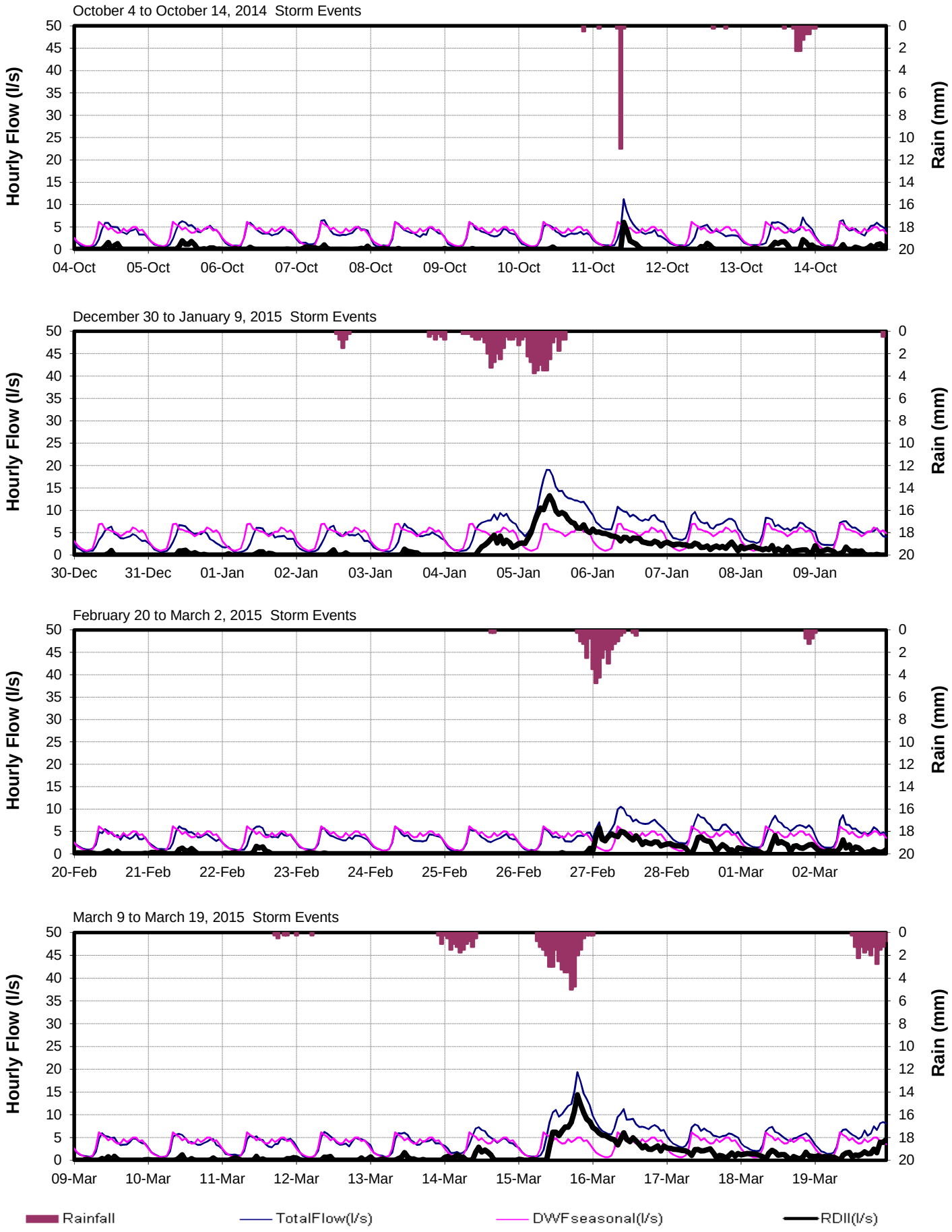
RDII Envelope



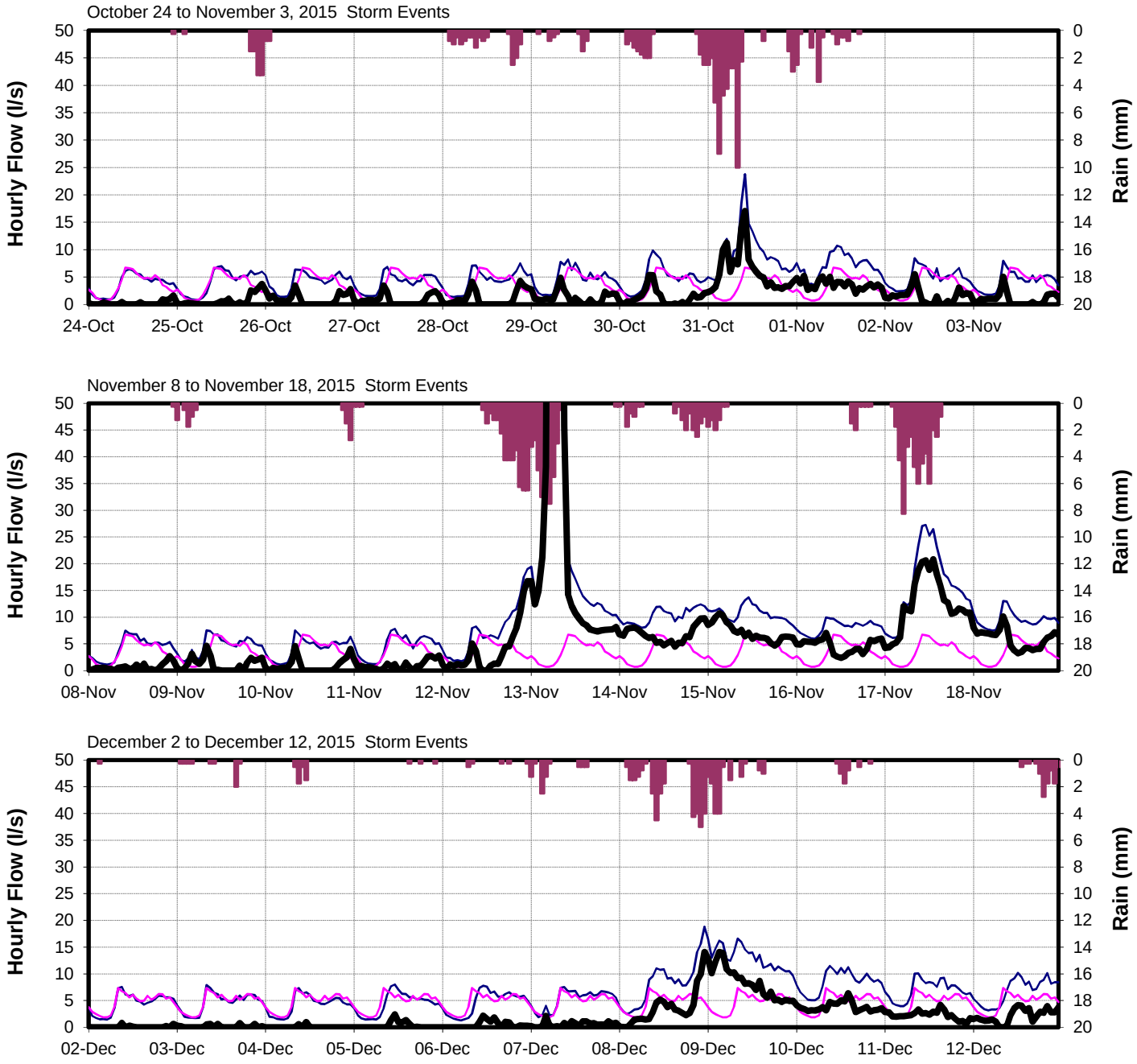
ADWF vs. PWWF Graph



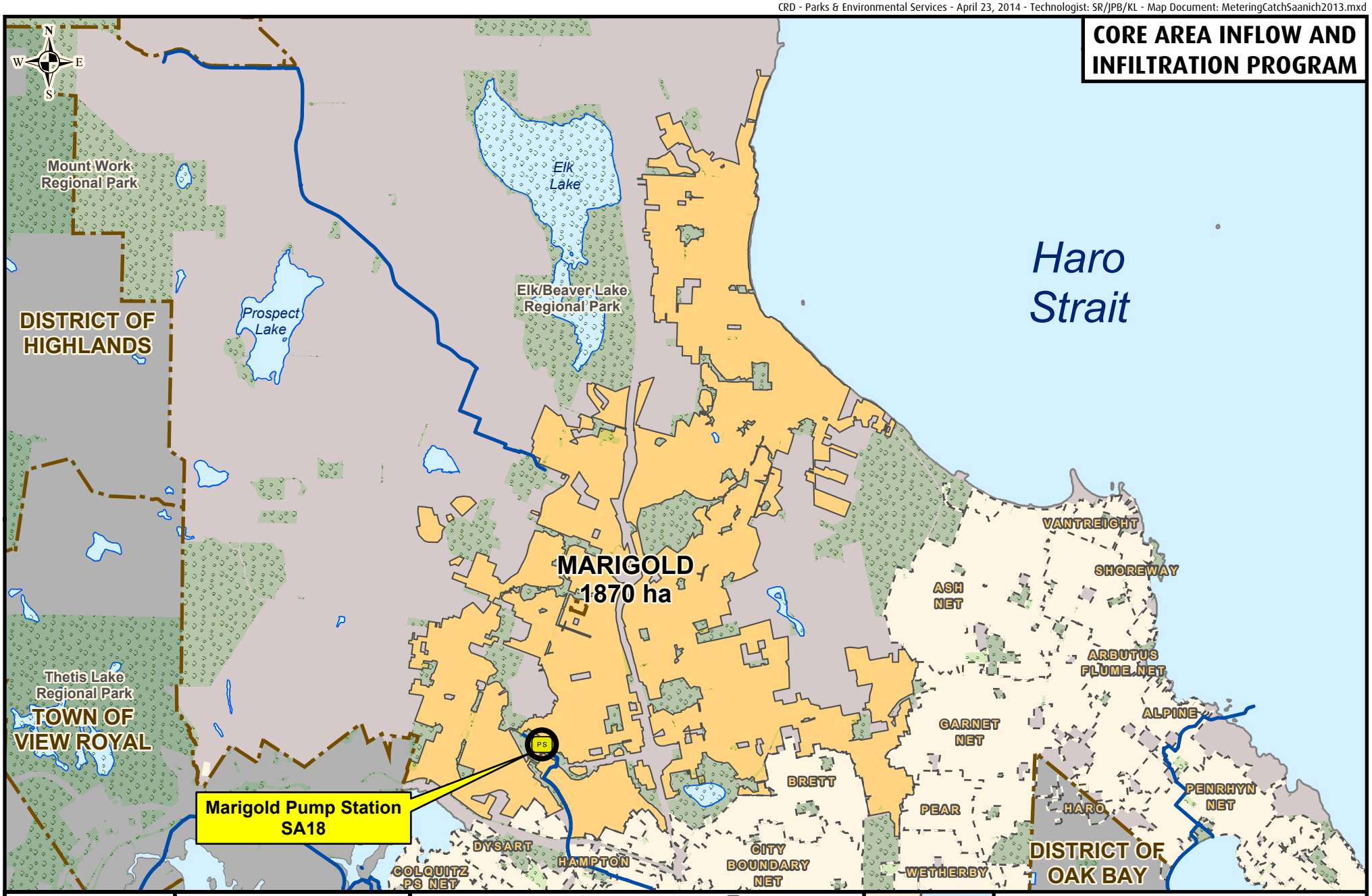
Haultain (SA22)



Haultain (SA22)



CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 500 1,000 1,500 2,000

Projection: UTM ZONE 10N NAD 83

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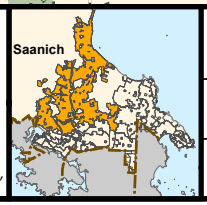


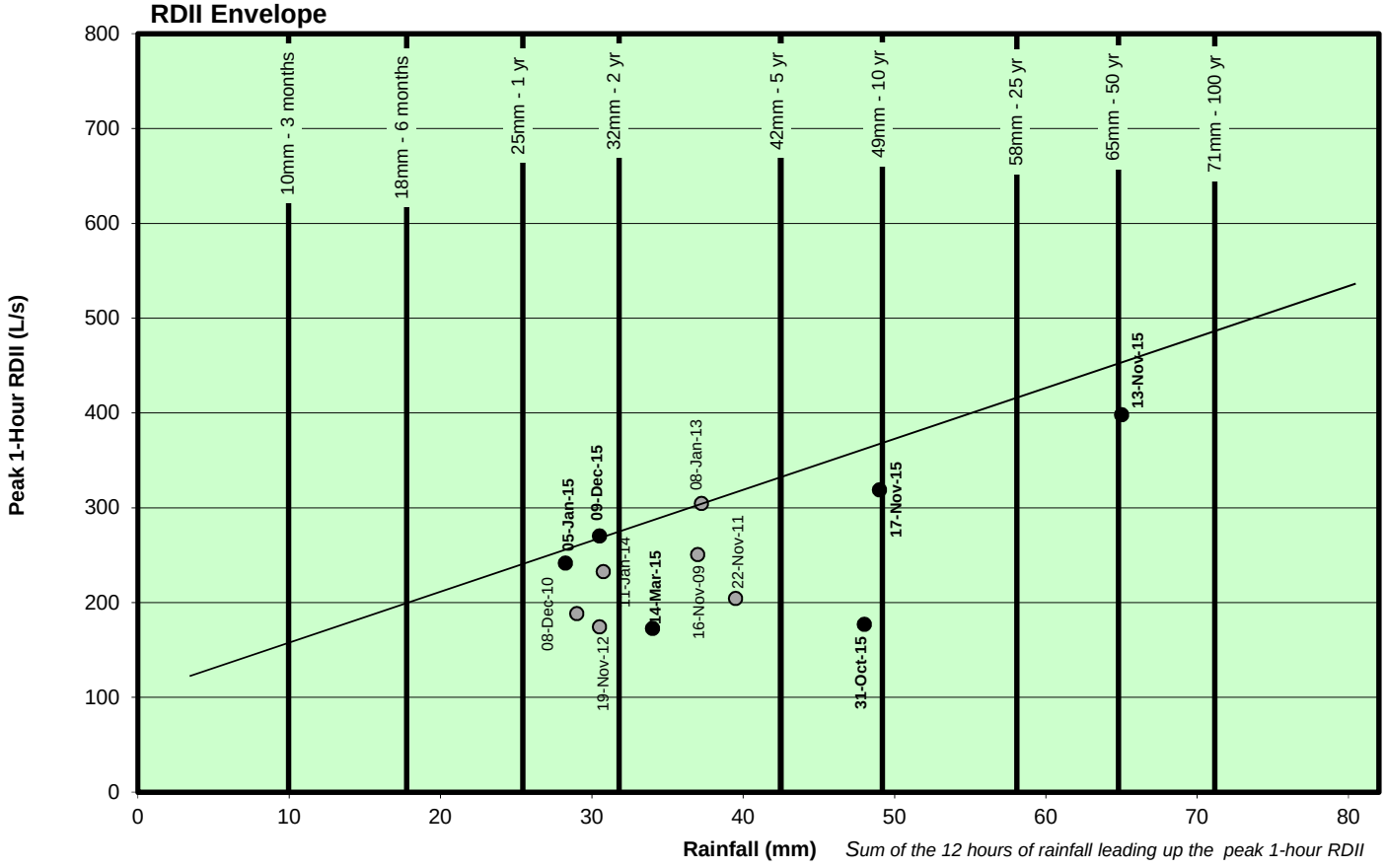
FLOW MONITORING AREA

CATCHMENT: MARIGOLD

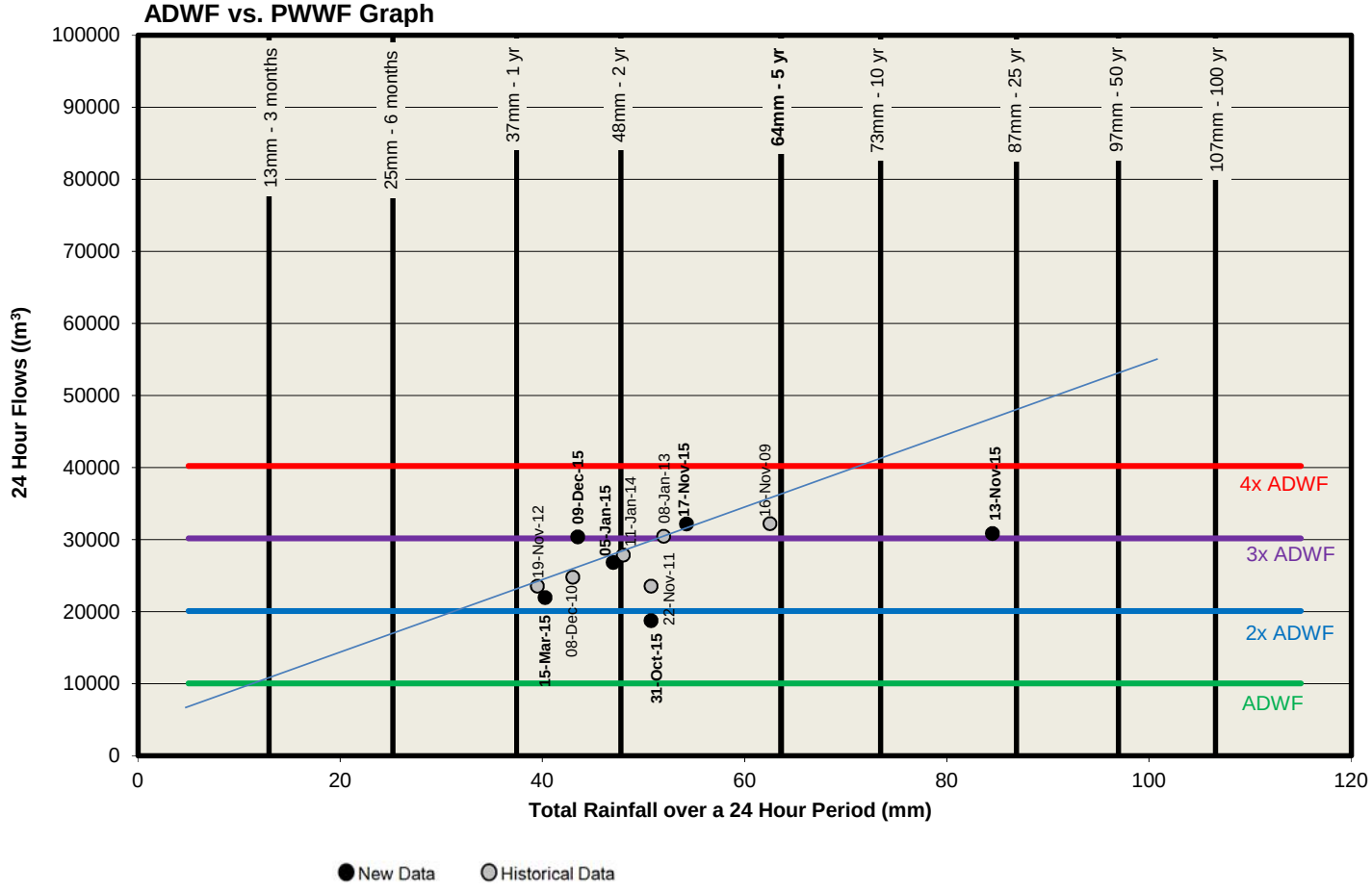
SITE CODE: **SA18**

Marigold (SA18)

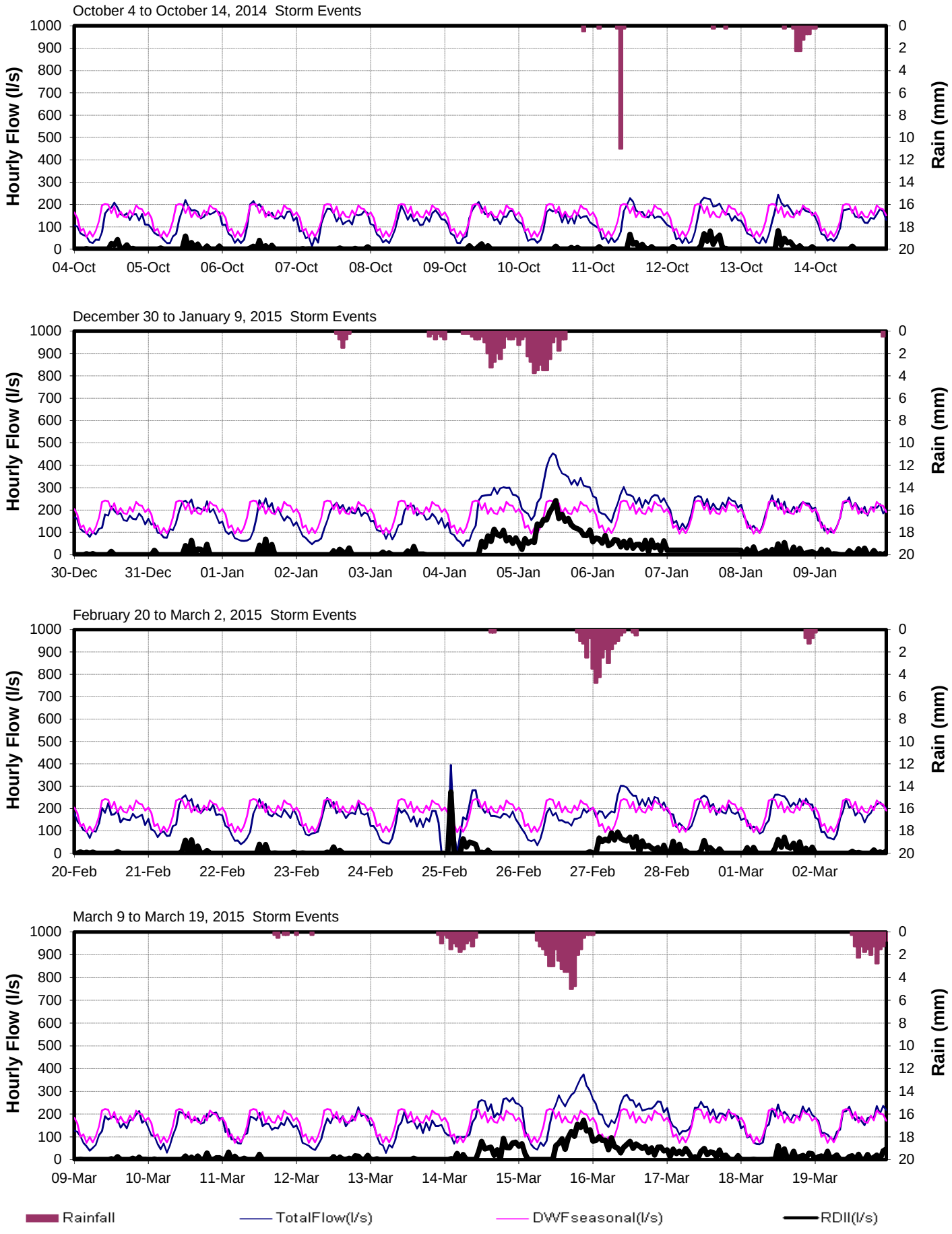
RDII Envelope



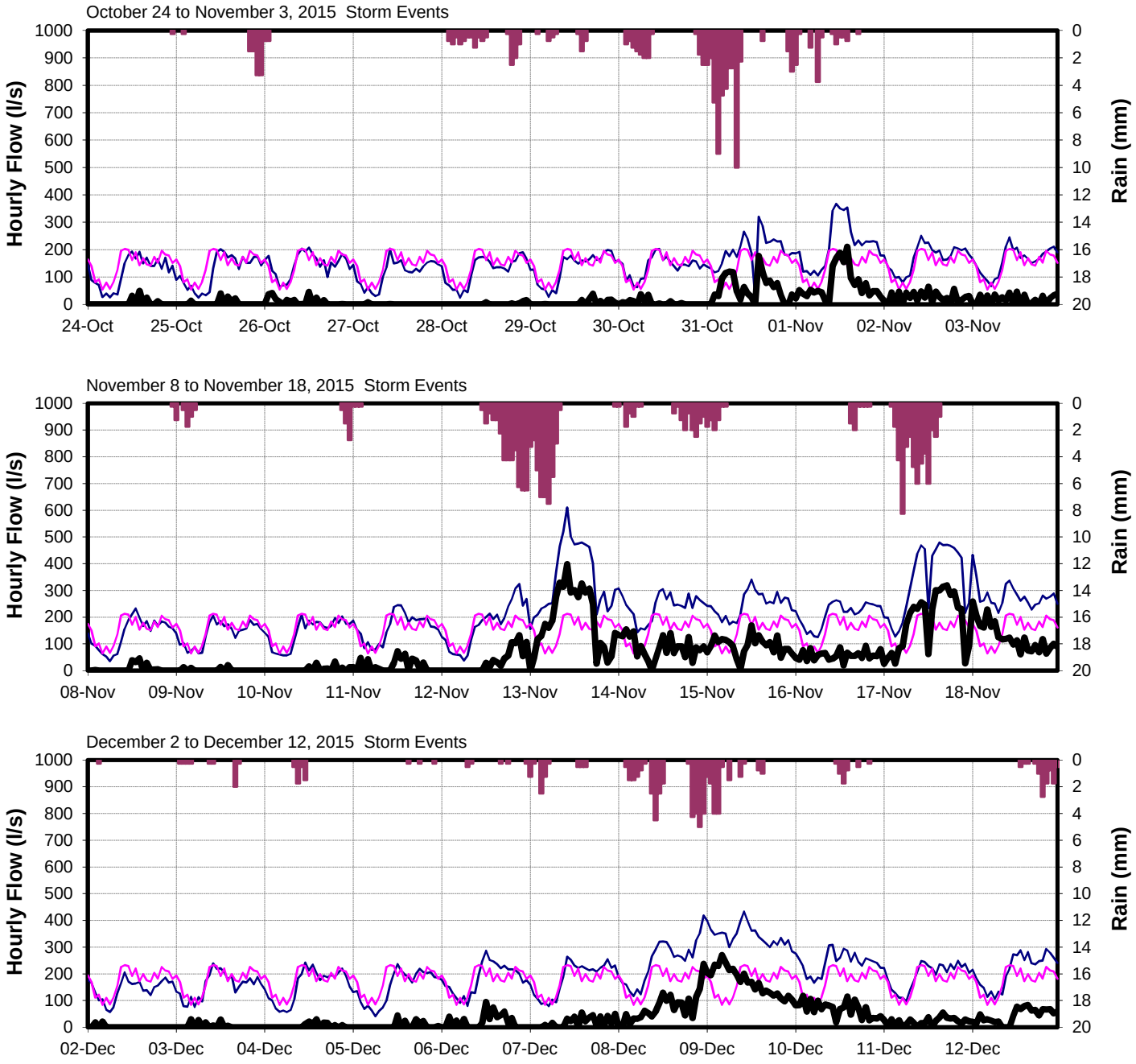
ADWF vs. PWWF Graph



Marigold (SA18)

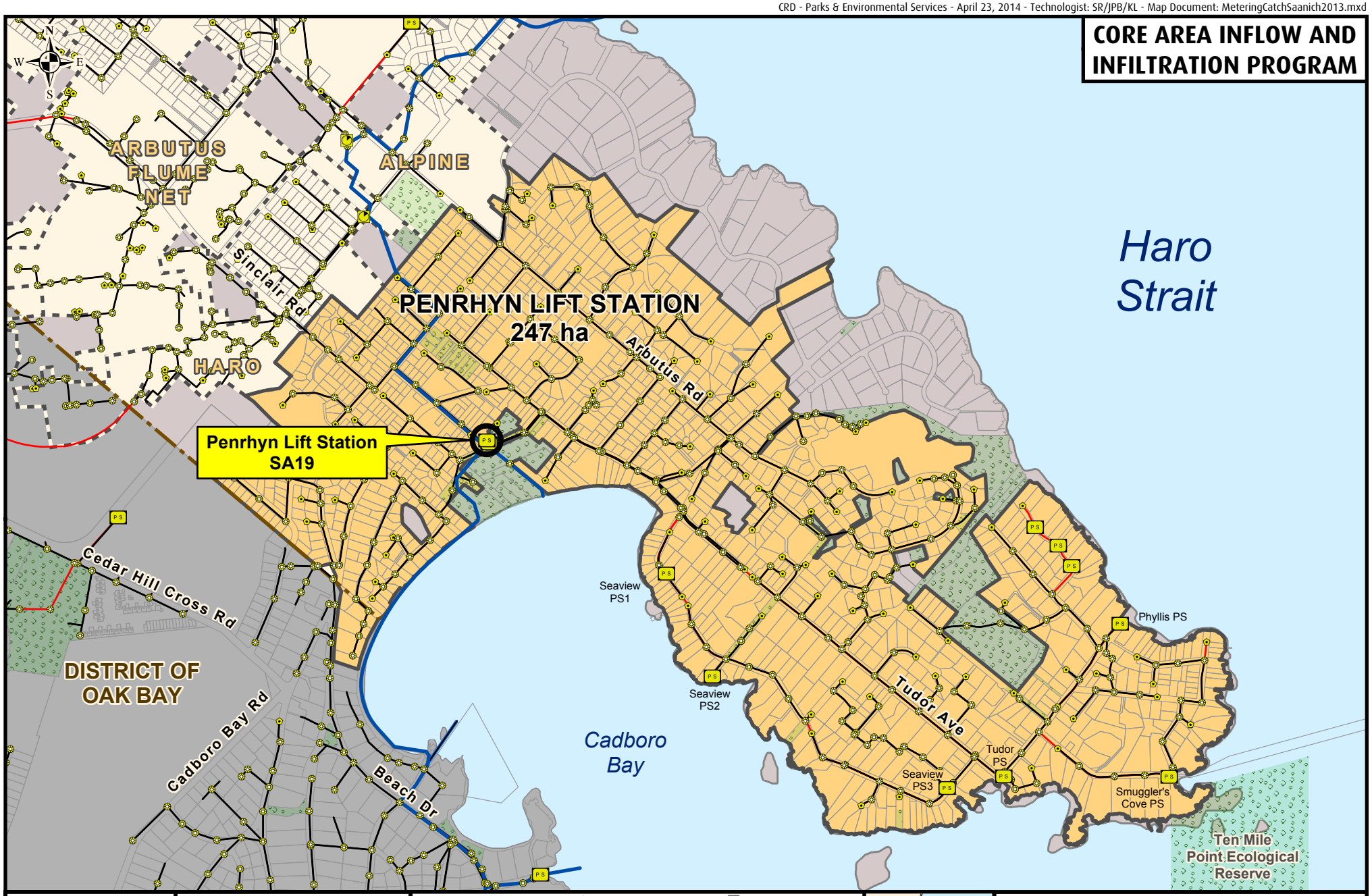


Marigold (SA18)



CRD - Parks & Environmental Services - April 23, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchSaanich2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 100 200 300 400

Projection: UTM ZONE 10N NAD 83

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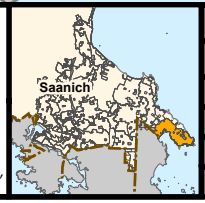
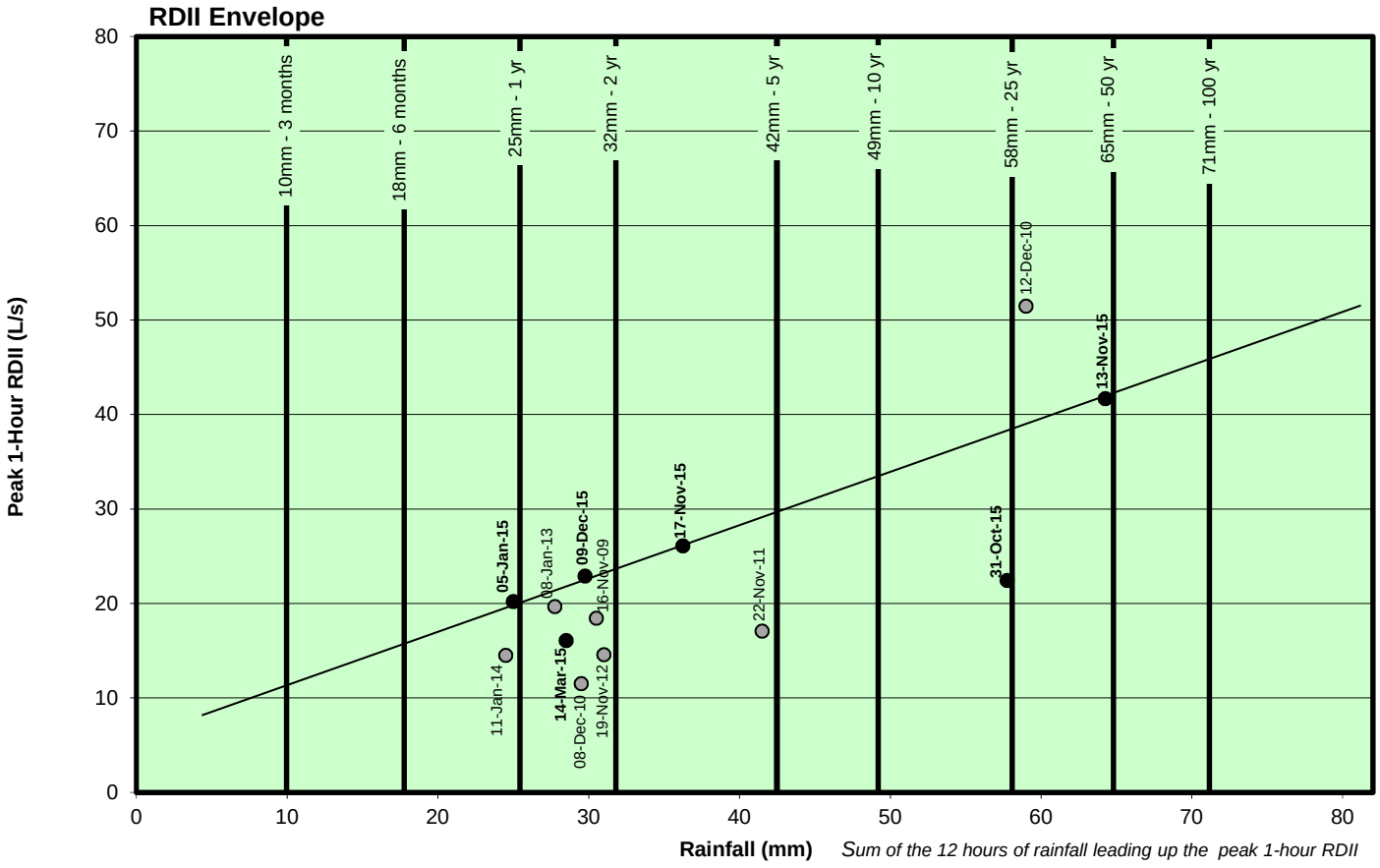


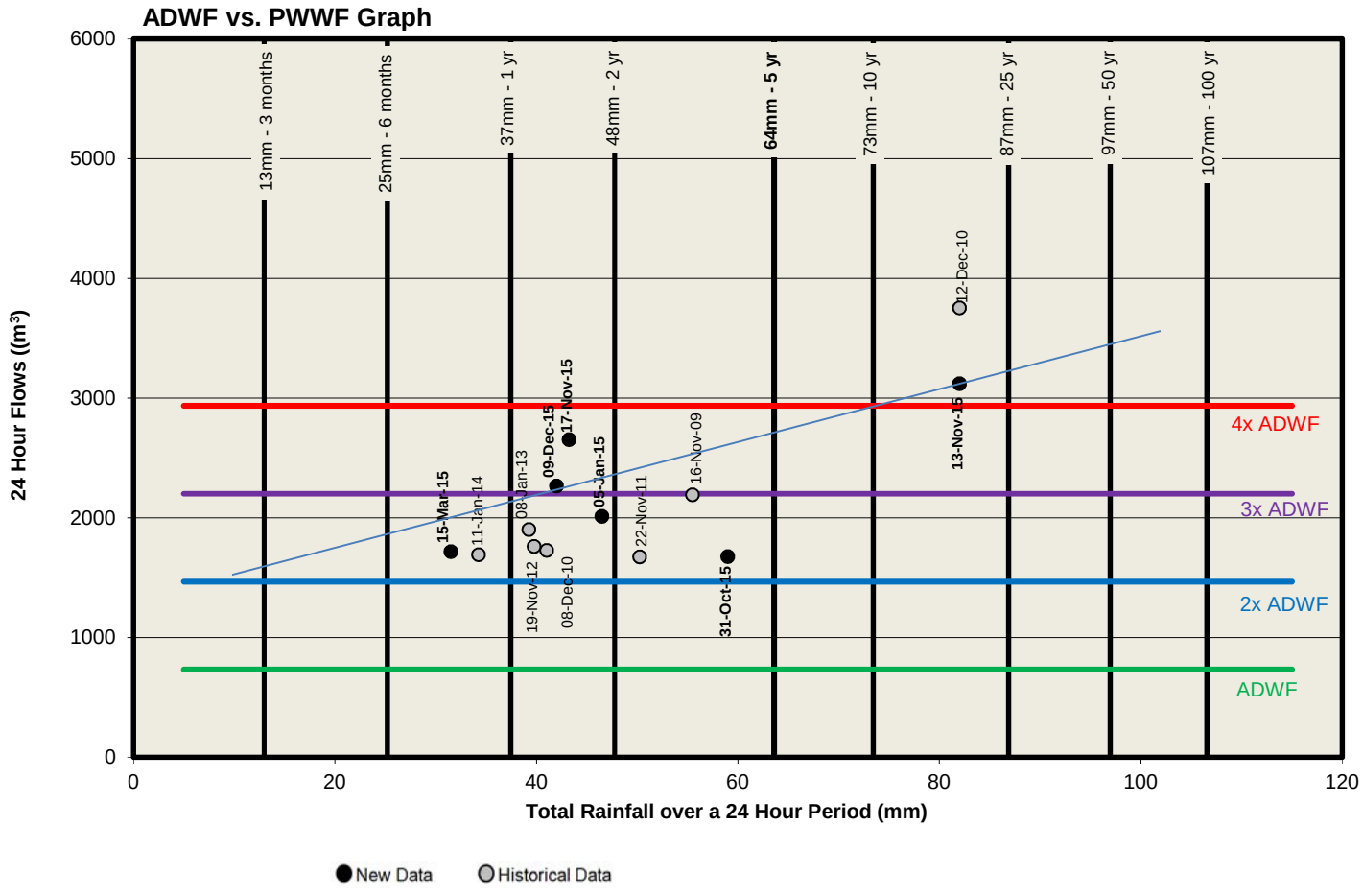
FLOW MONITORING AREA

CATCHMENT: PENRHYN

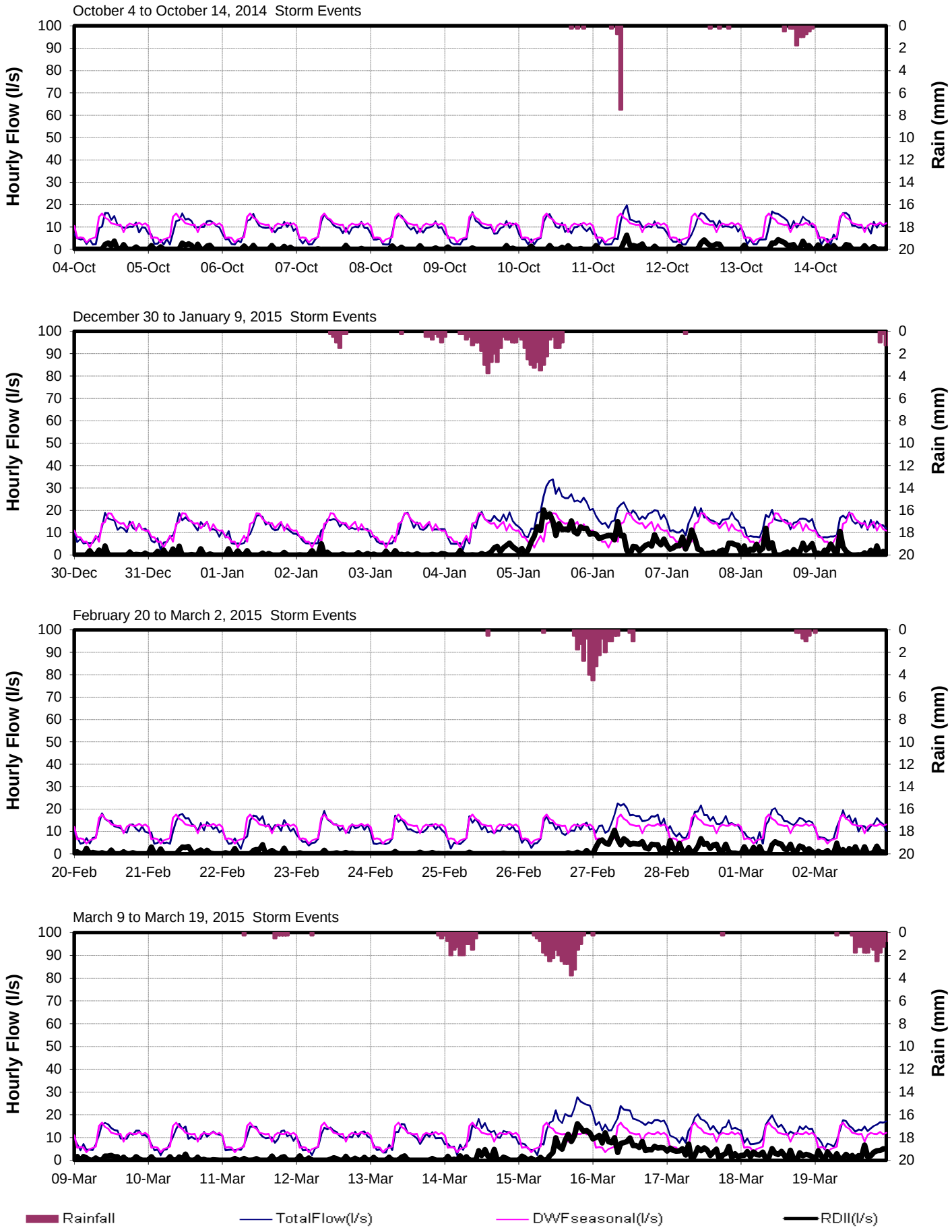
SITE CODE: **SA19**

Penrhyn (SA19)

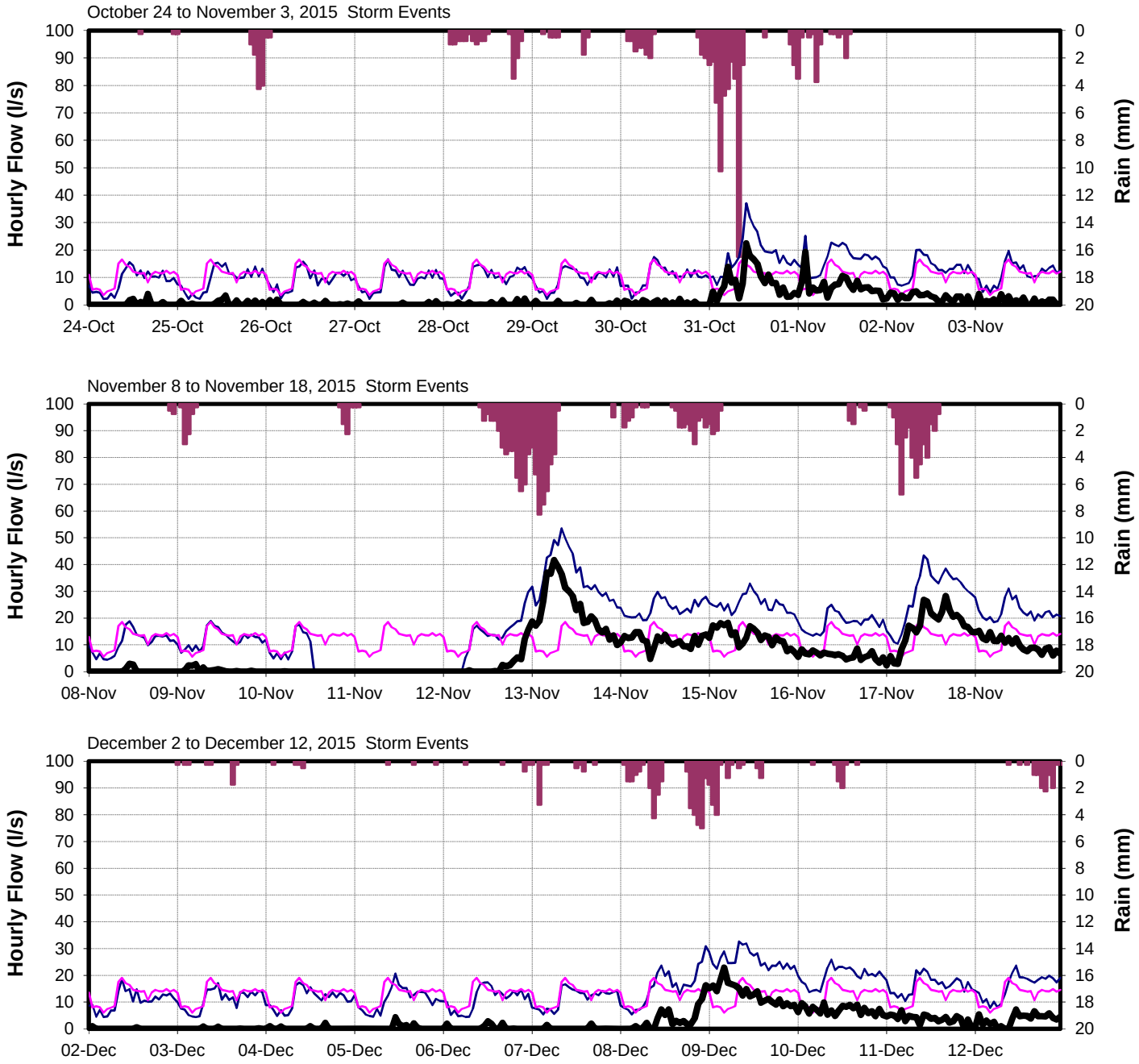




Penrhyn (SA19)

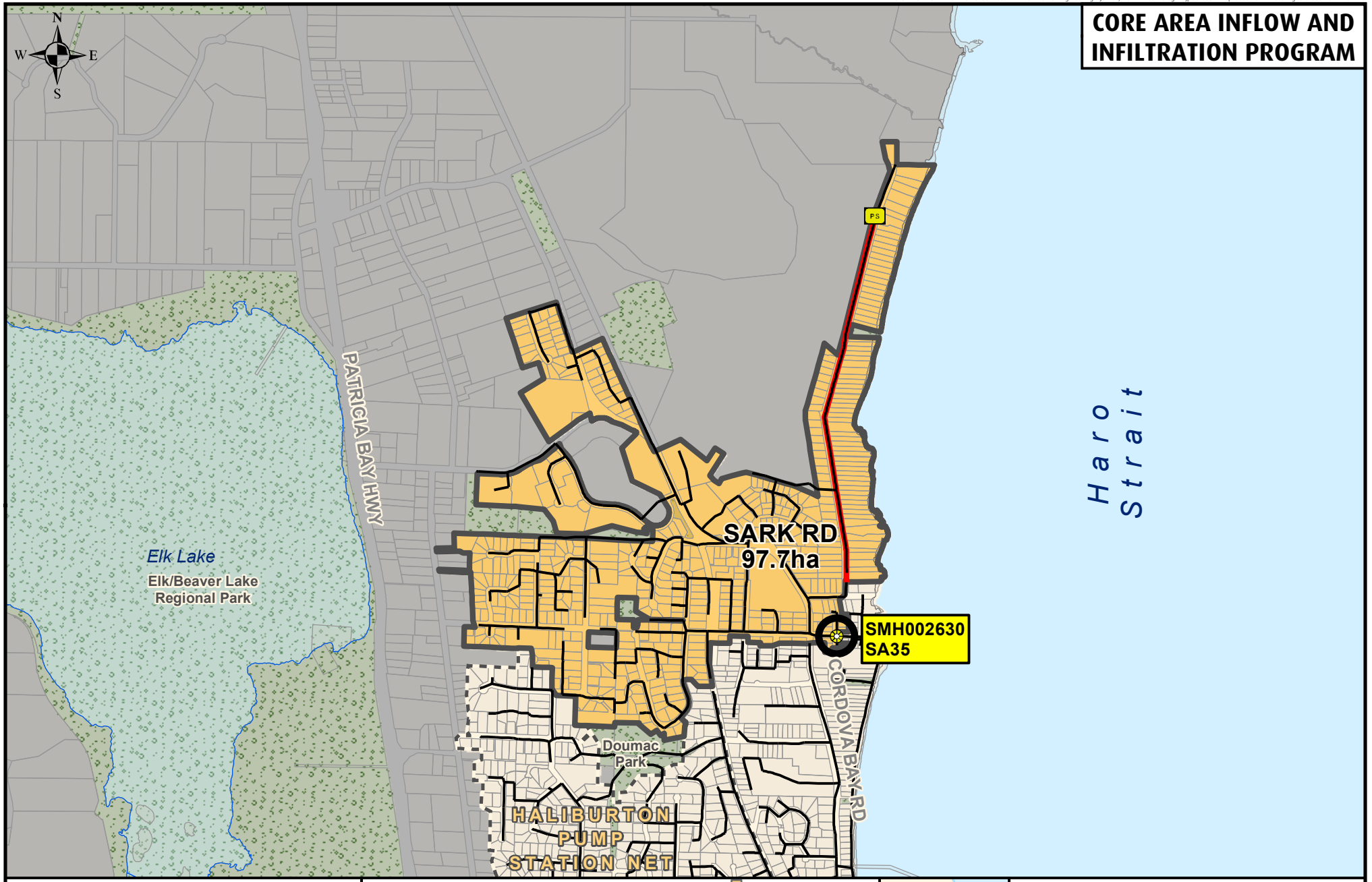


Penrhyn (SA19)



CRD - Parks & Environmental Services - Environmental Engineering - Jan 06, 2017 - Technologist: jpbezeau - Map Document: MeteringCatchSaanich2016.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Metres
0 200 400

Projection: UTM ZONE 10N, NAD83

Disclaimer
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- Flow Monitoring Location
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Sanitary Sewers
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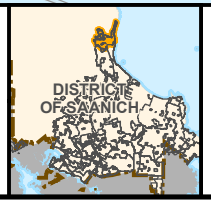
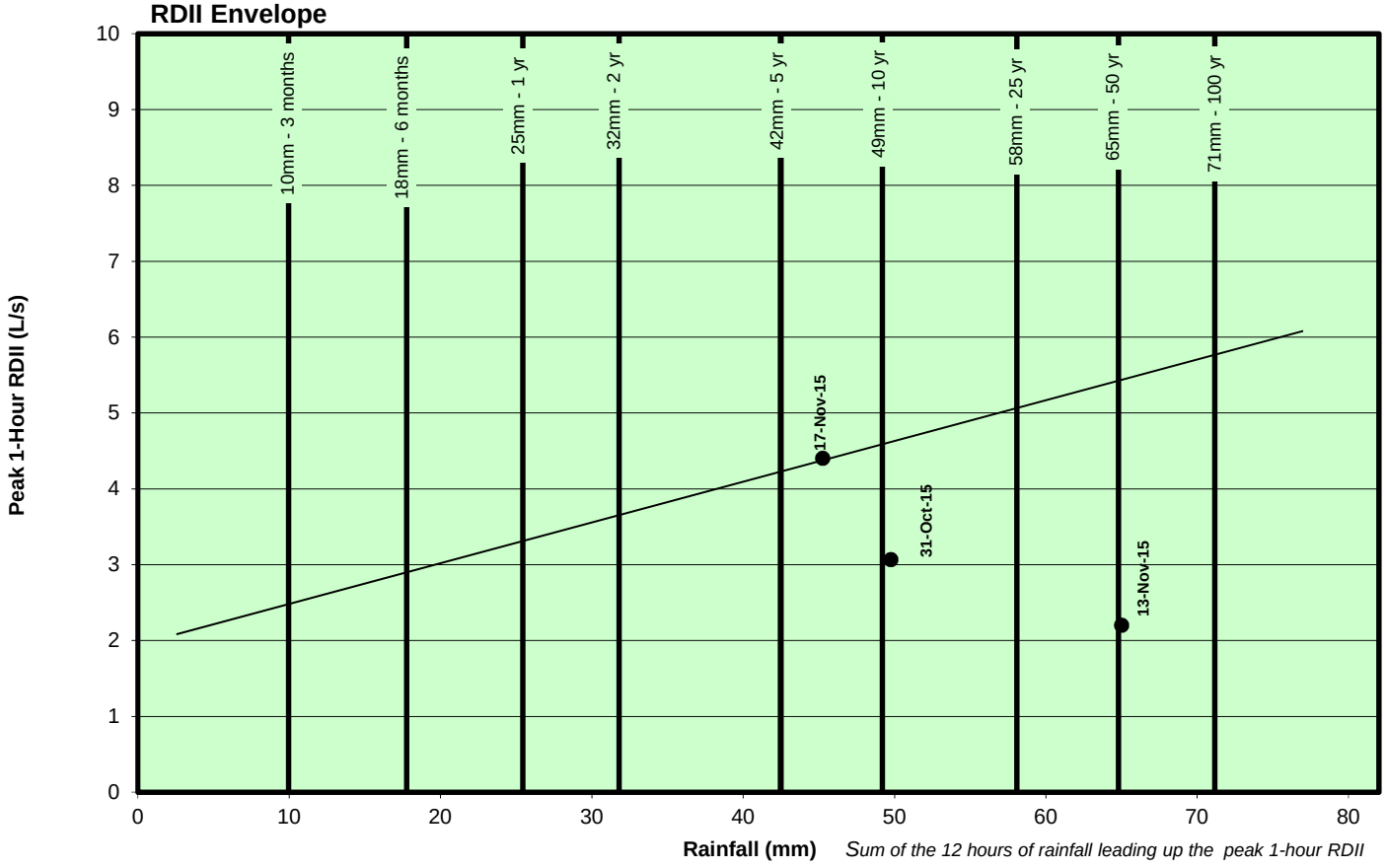


FLOW MONITORING AREA
Catchment: Sark Rd
Site Code: SA35

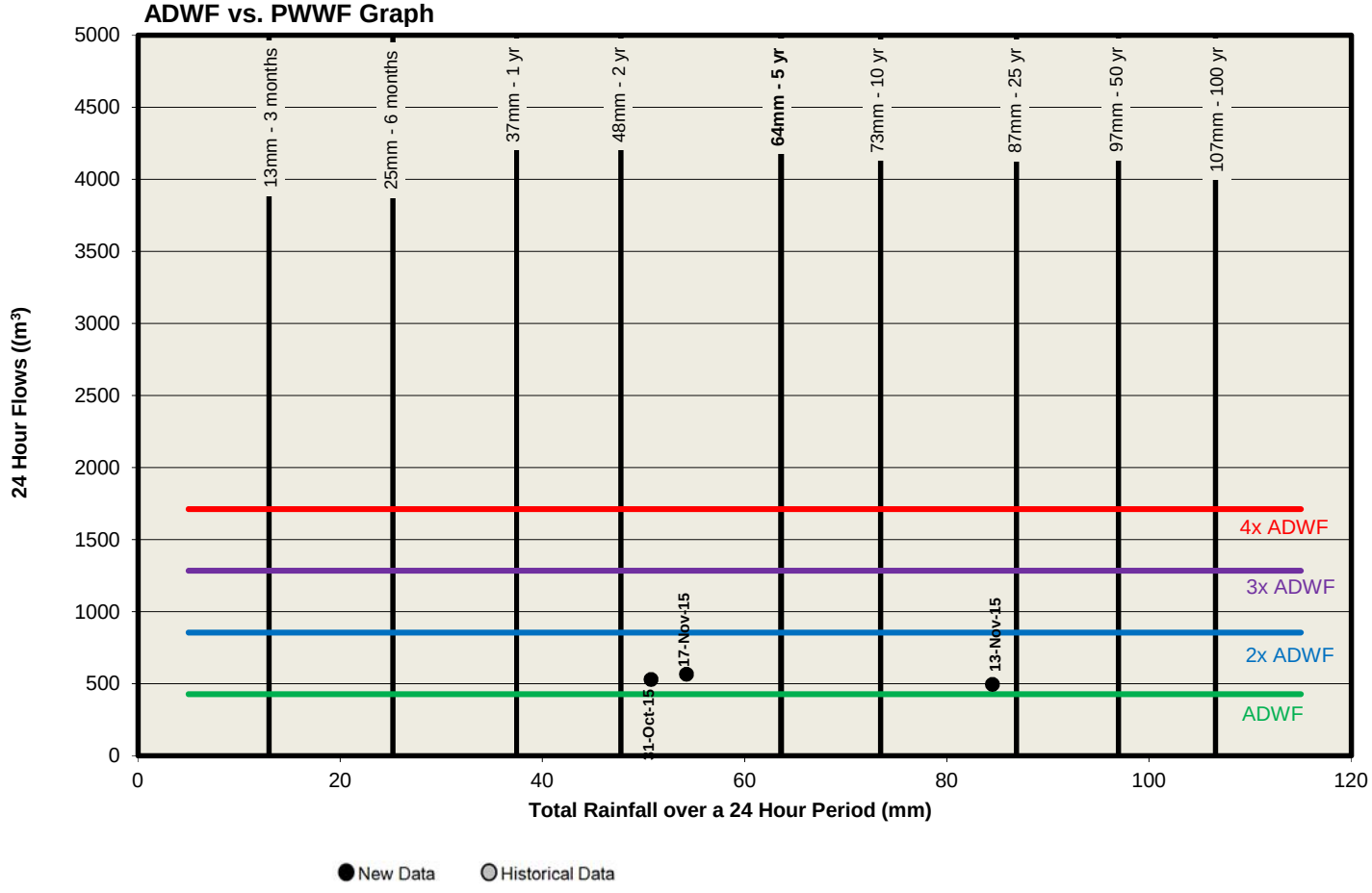
CRD
Making a difference...together

Sark Road (SA35)

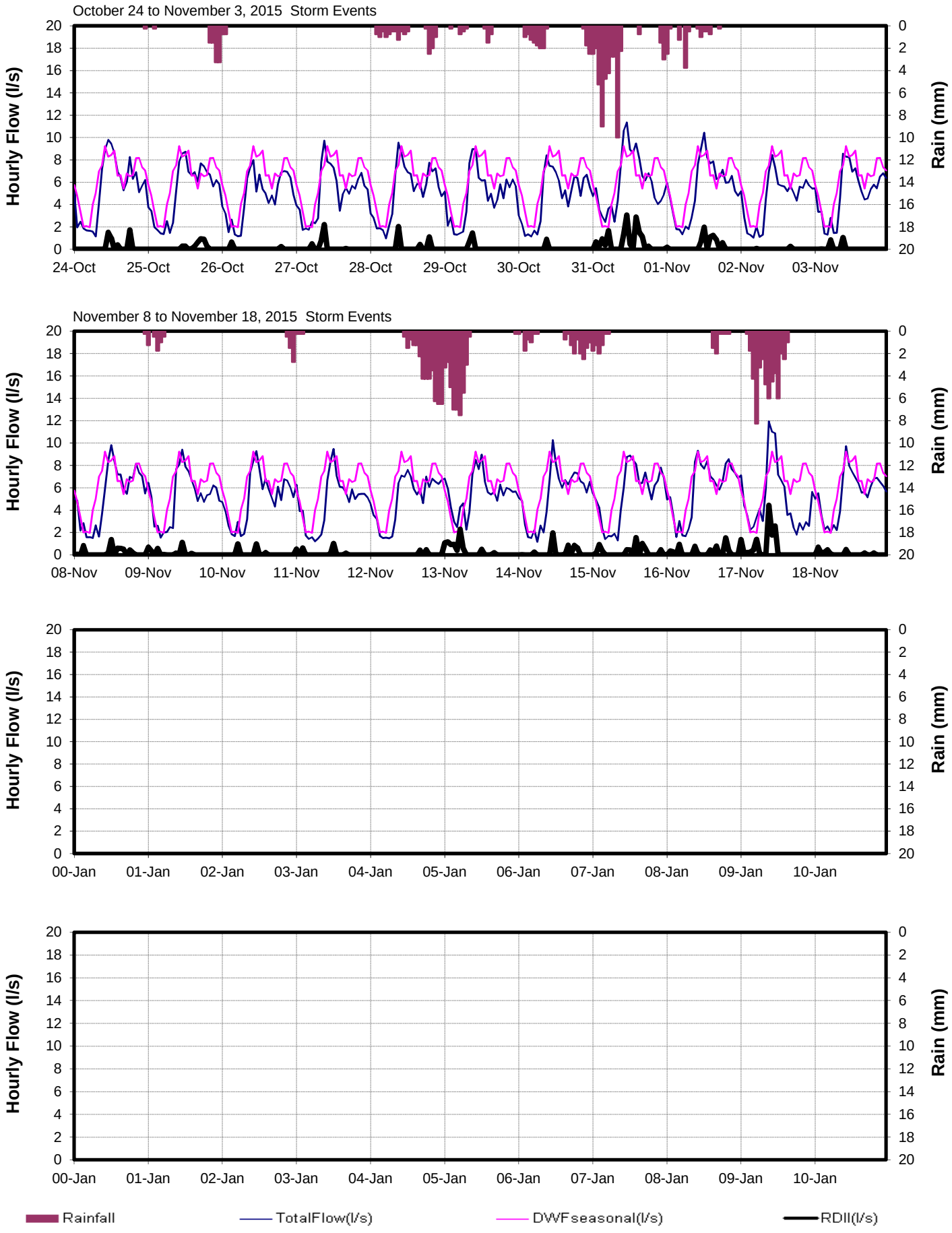
RDII Envelope



ADWF vs. PWWF Graph

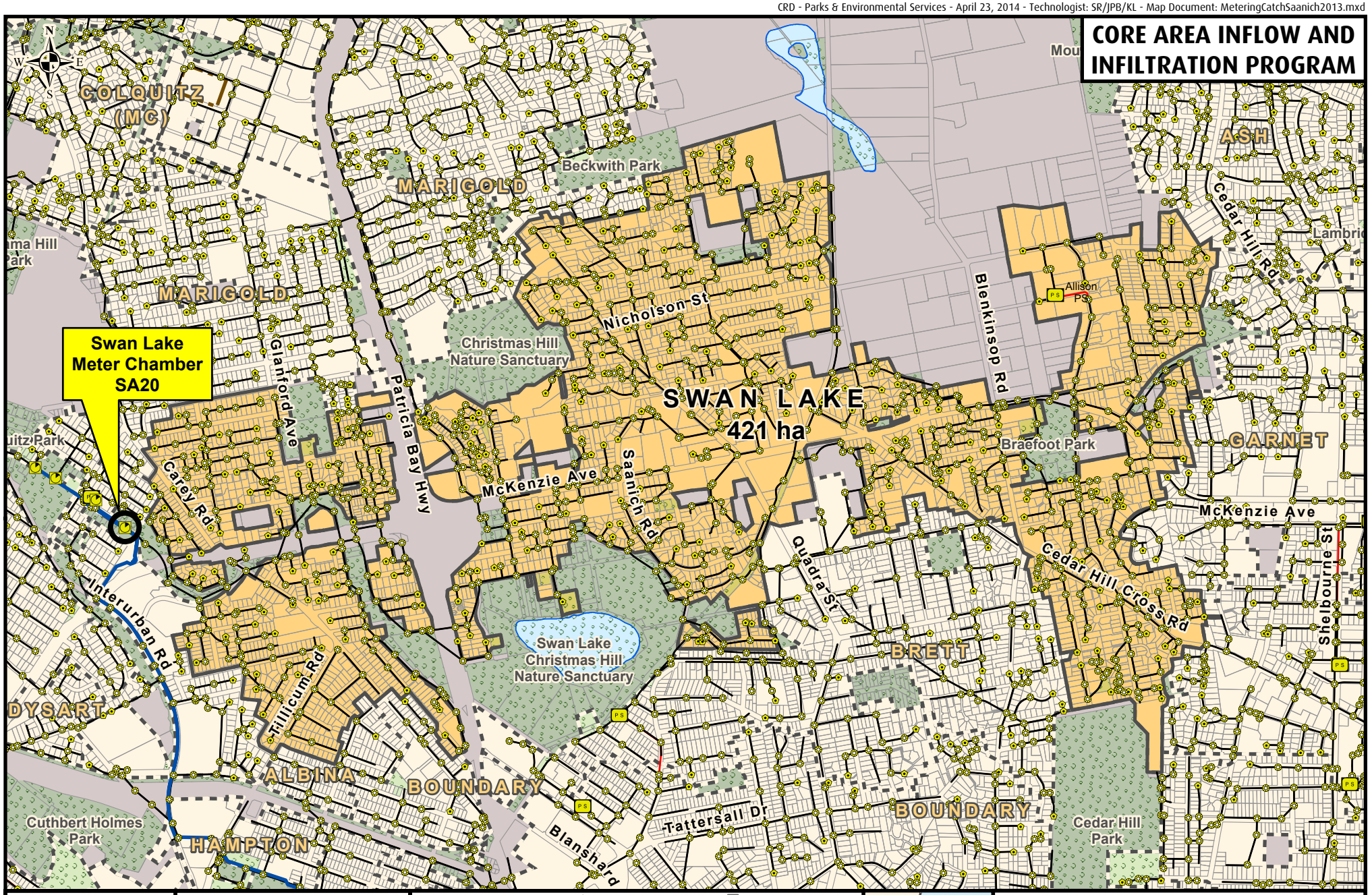


Sark Road (SA35)



CRD - Parks & Environmental Services - April 23, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchSaanich2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



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Metres
0 200 400 600

Projection: UTM ZONE 10N NAD 83

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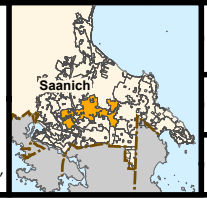


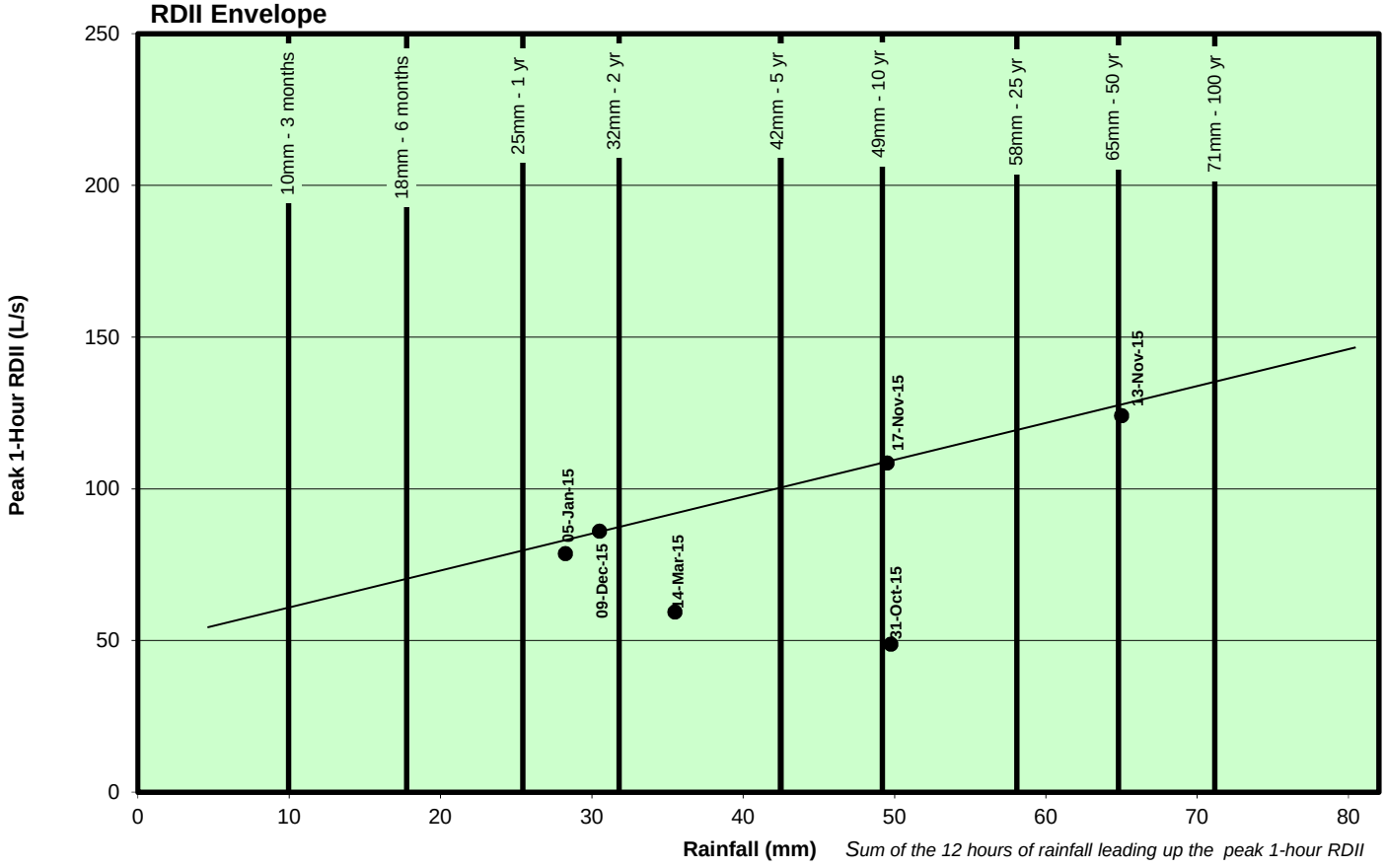
FLOW MONITORING AREA

CATCHMENT: SWAN LAKE

SITE CODE: **SA20**

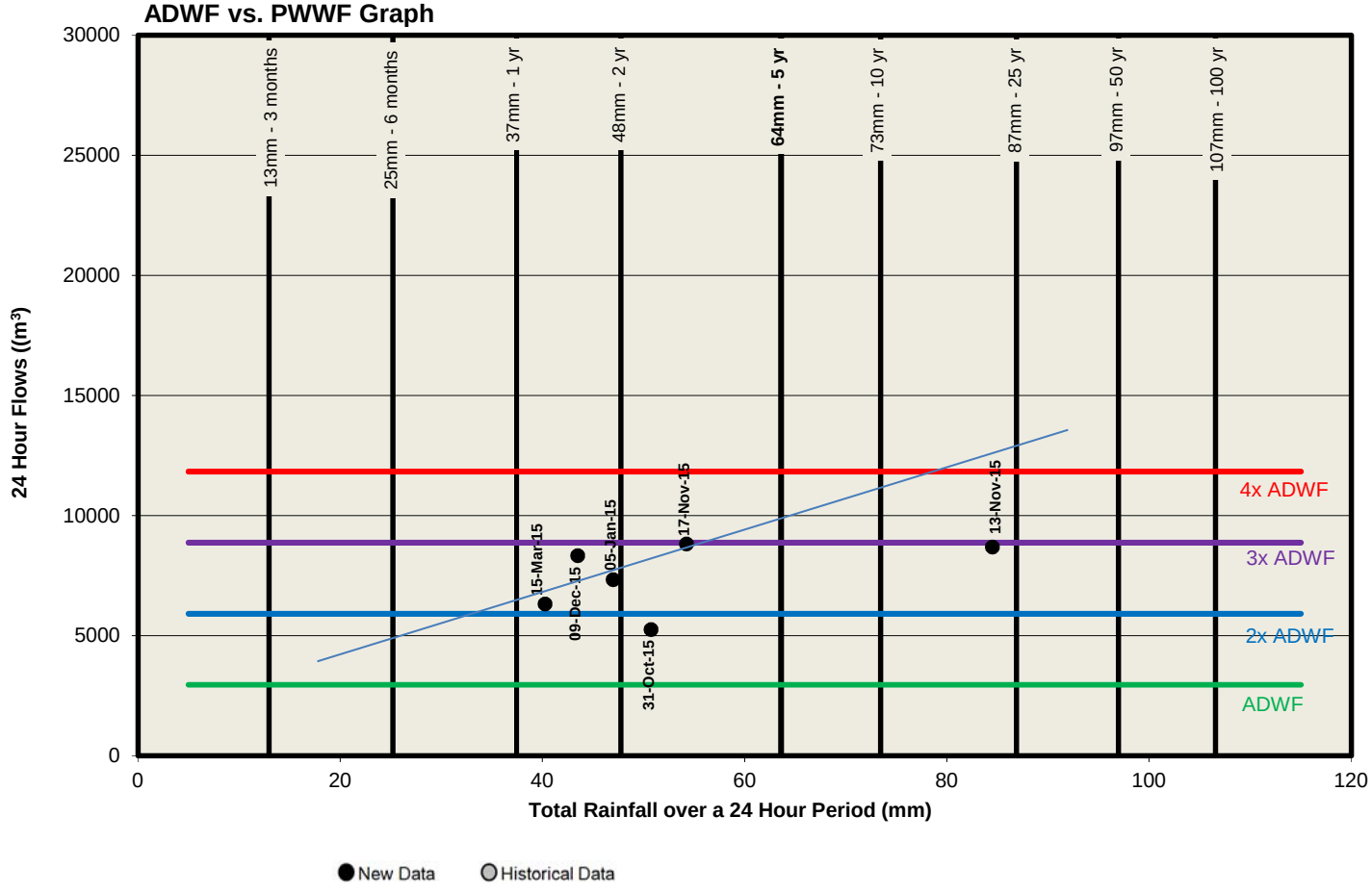
Swan Lake (SA20)

RDII Envelope

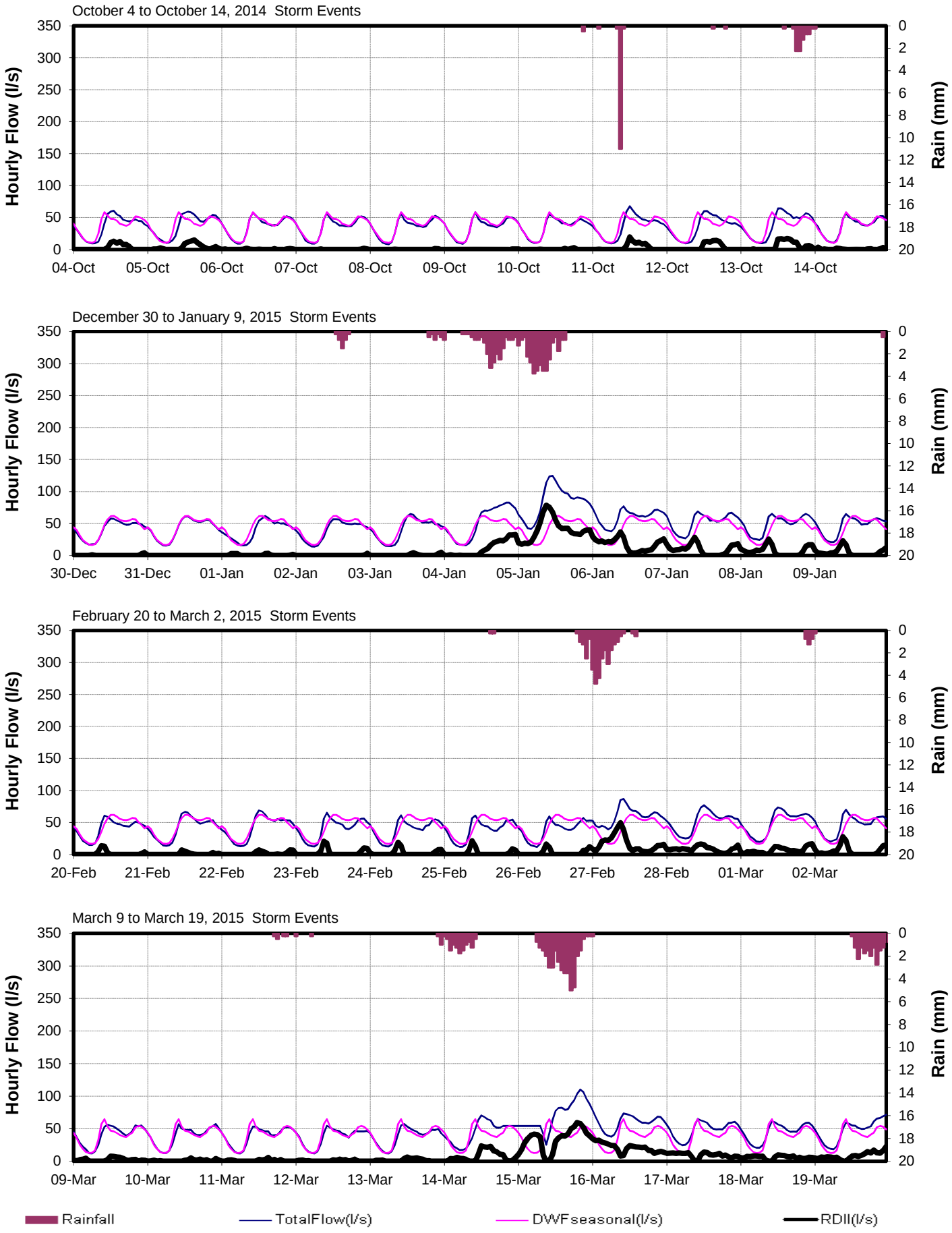


Sum of the 12 hours of rainfall leading up the peak 1-hour RDII

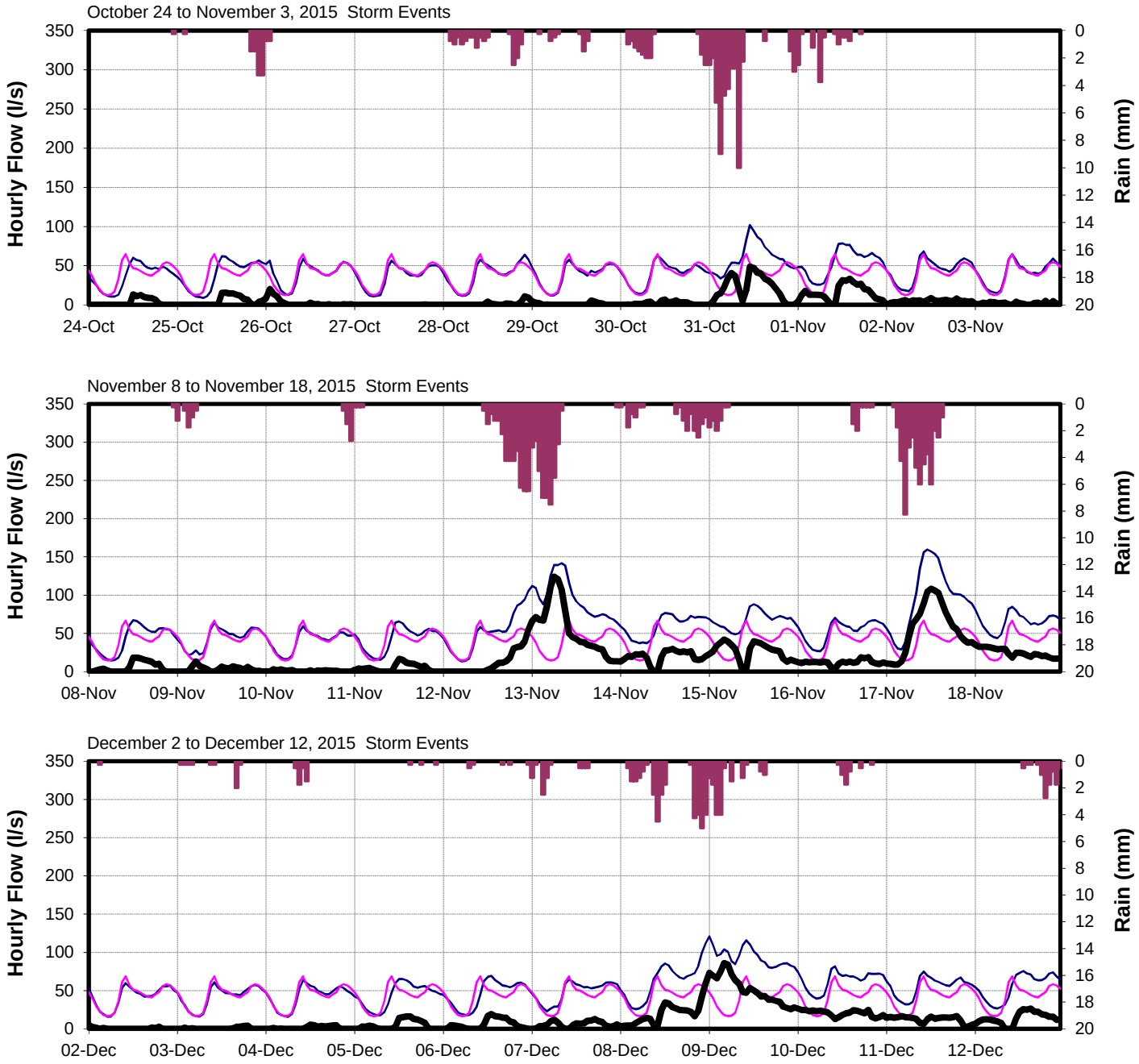
ADWF vs. PWWF Graph



Swan Lake (SA20)

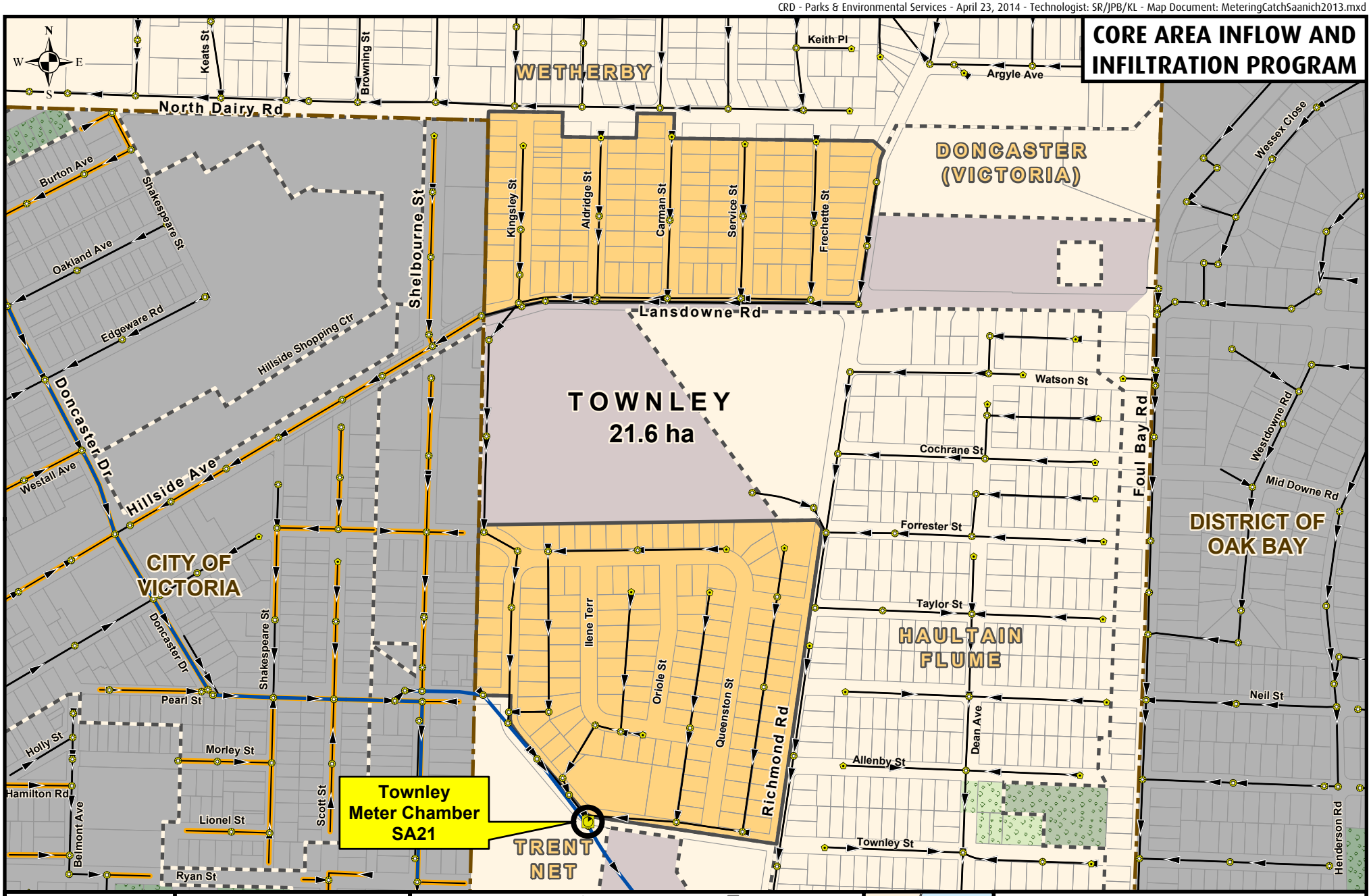


Swan Lake (SA20)



CRD - Parks & Environmental Services - April 23, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchSaanich2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100 150 200

Projection: UTM ZONE 10N NAD 83

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- Flow Monitoring Location
- Manhole
- Cleanout
- Pump Station
- Metering Chamber

Sanitary Sewers

- Gravity Main Installed After 1930
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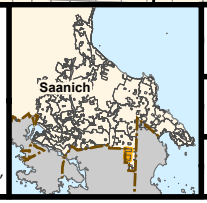
- Force Main
- Relief, Outfall, Overflow Sewer
- CRD Sewer

- Catchment Area
- Non-Sewered Area
- Lot Lines
- Parks
- Sewered Park Areas
- Catchment Boundary
- Municipal, First Nation, or DND Boundaries



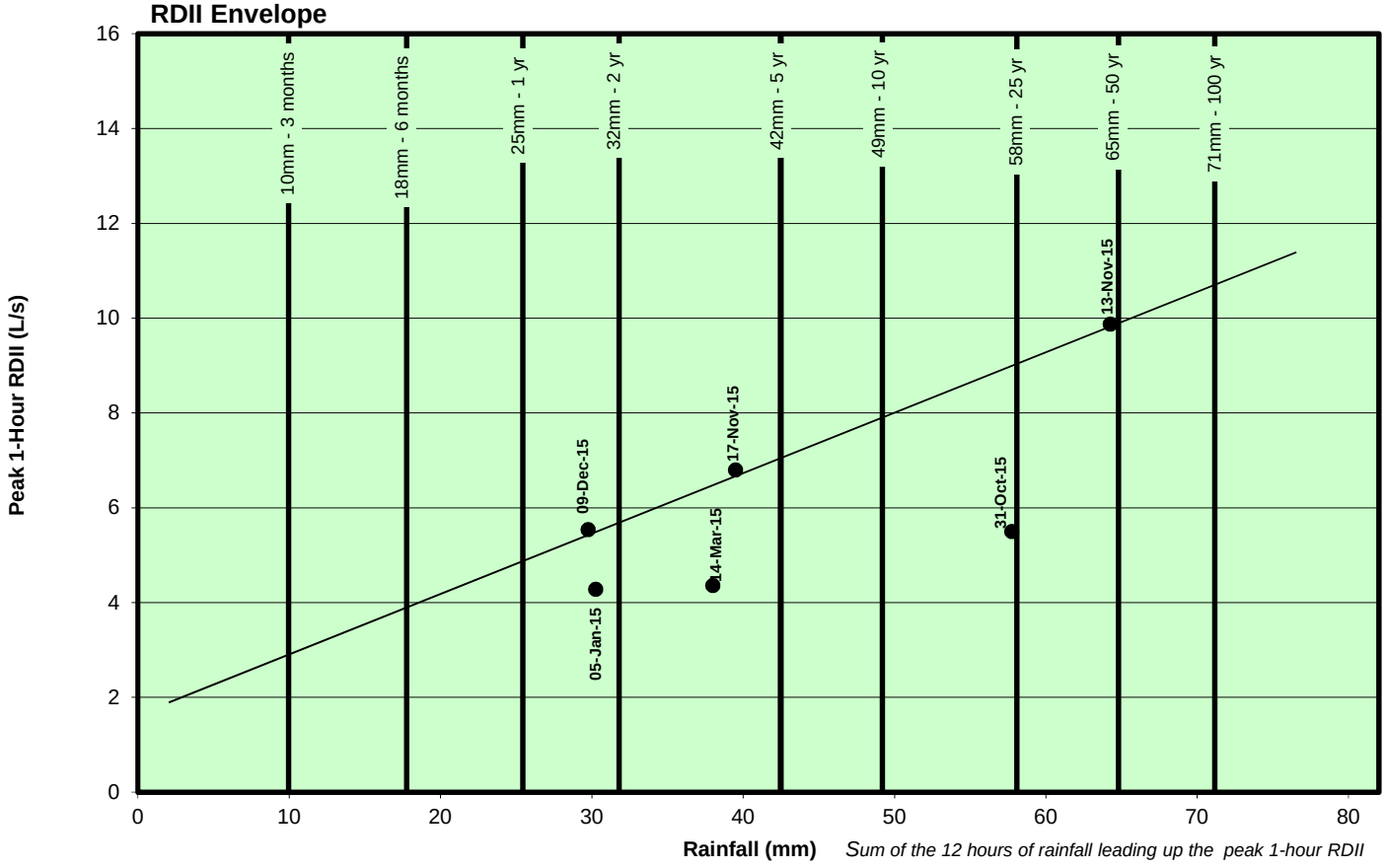
FLOW MONITORING AREA

CATCHMENT: TOWNLEY

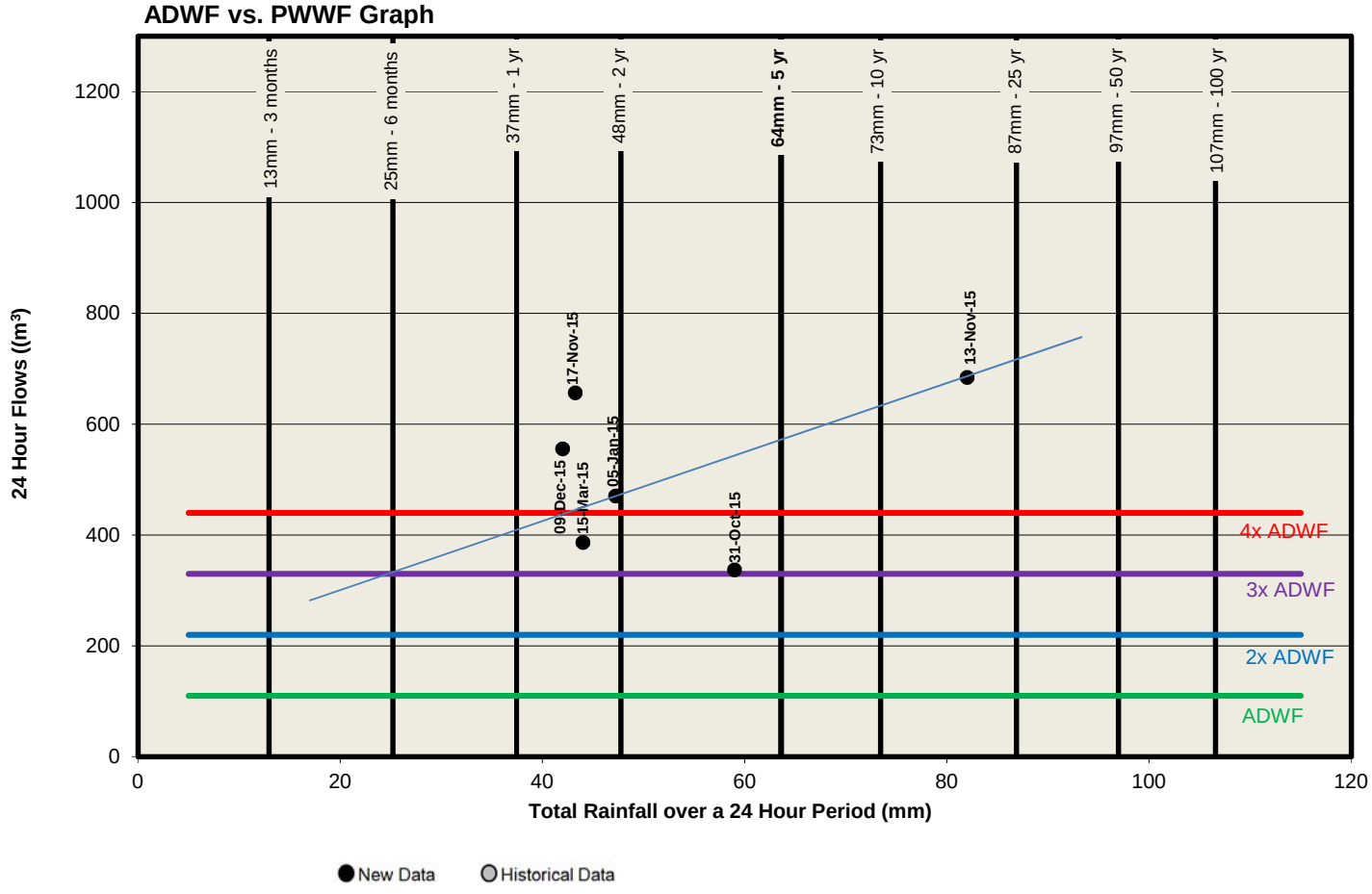
SITE CODE: **SA21**

Townley (SA21)

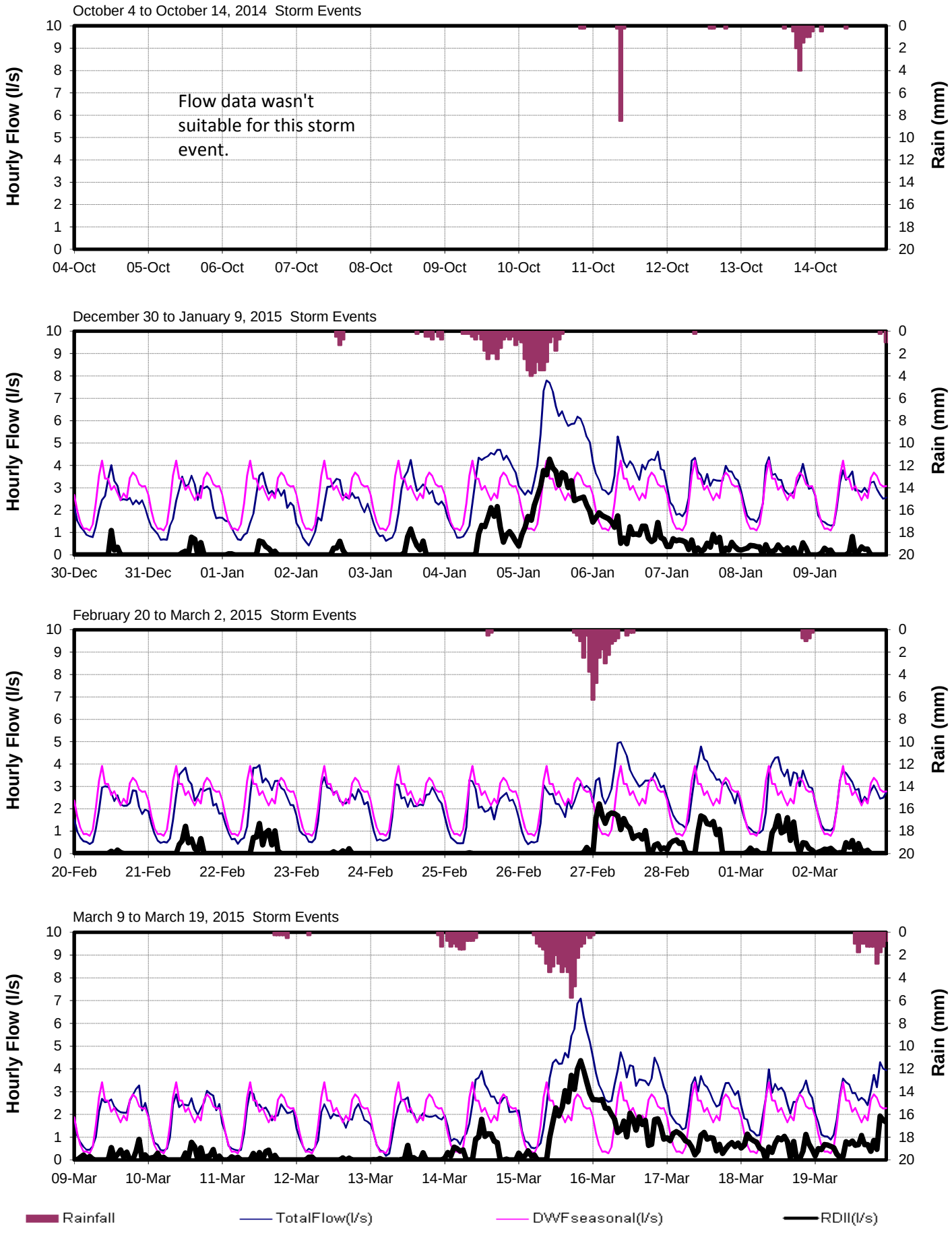
RDII Envelope



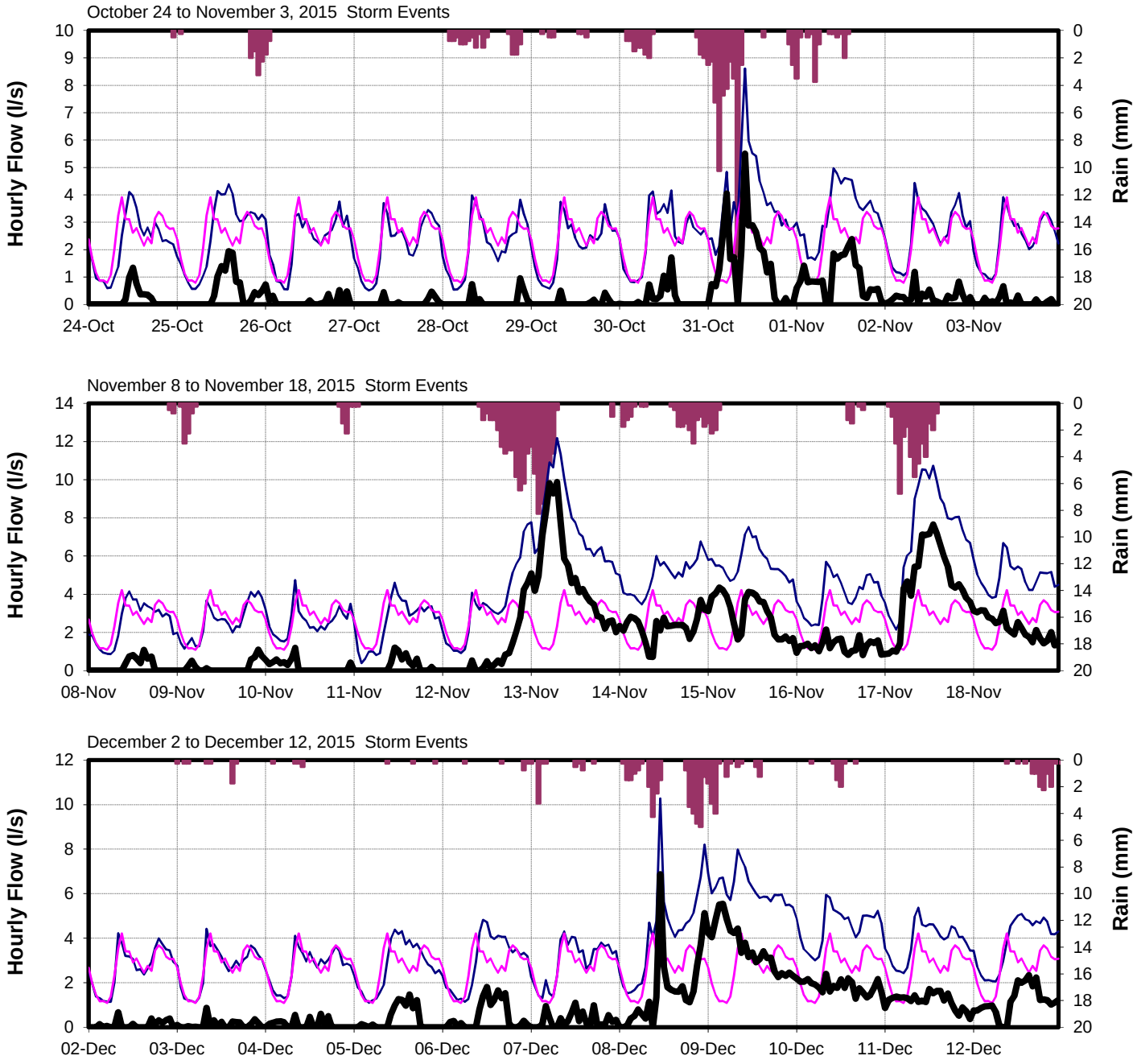
ADWF vs. PWWF Graph



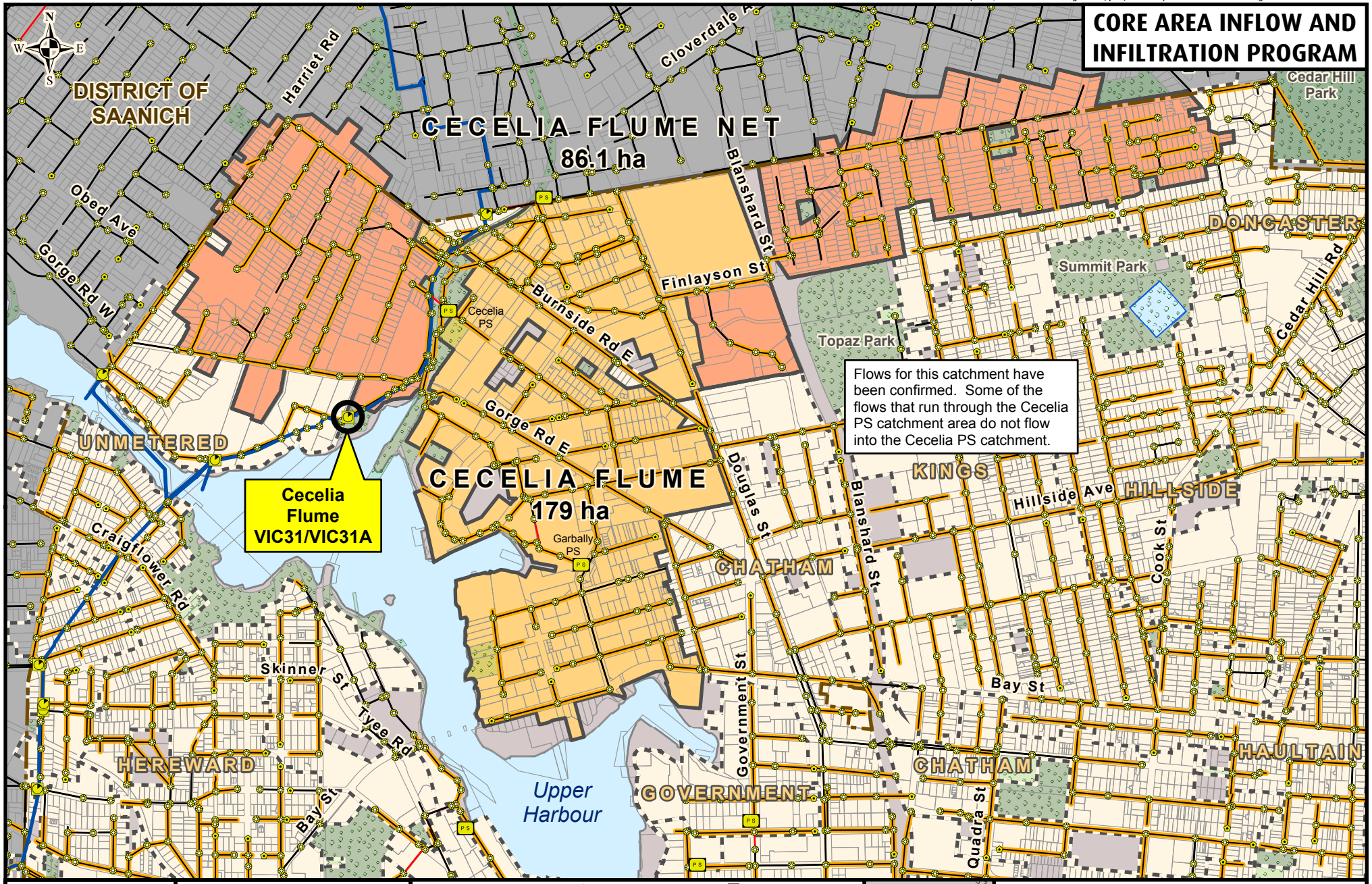
Townley (SA21)



Townley (SA21)



CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres

0 100 200 300 400

Projection: UTM ZONE 10N NAD 83

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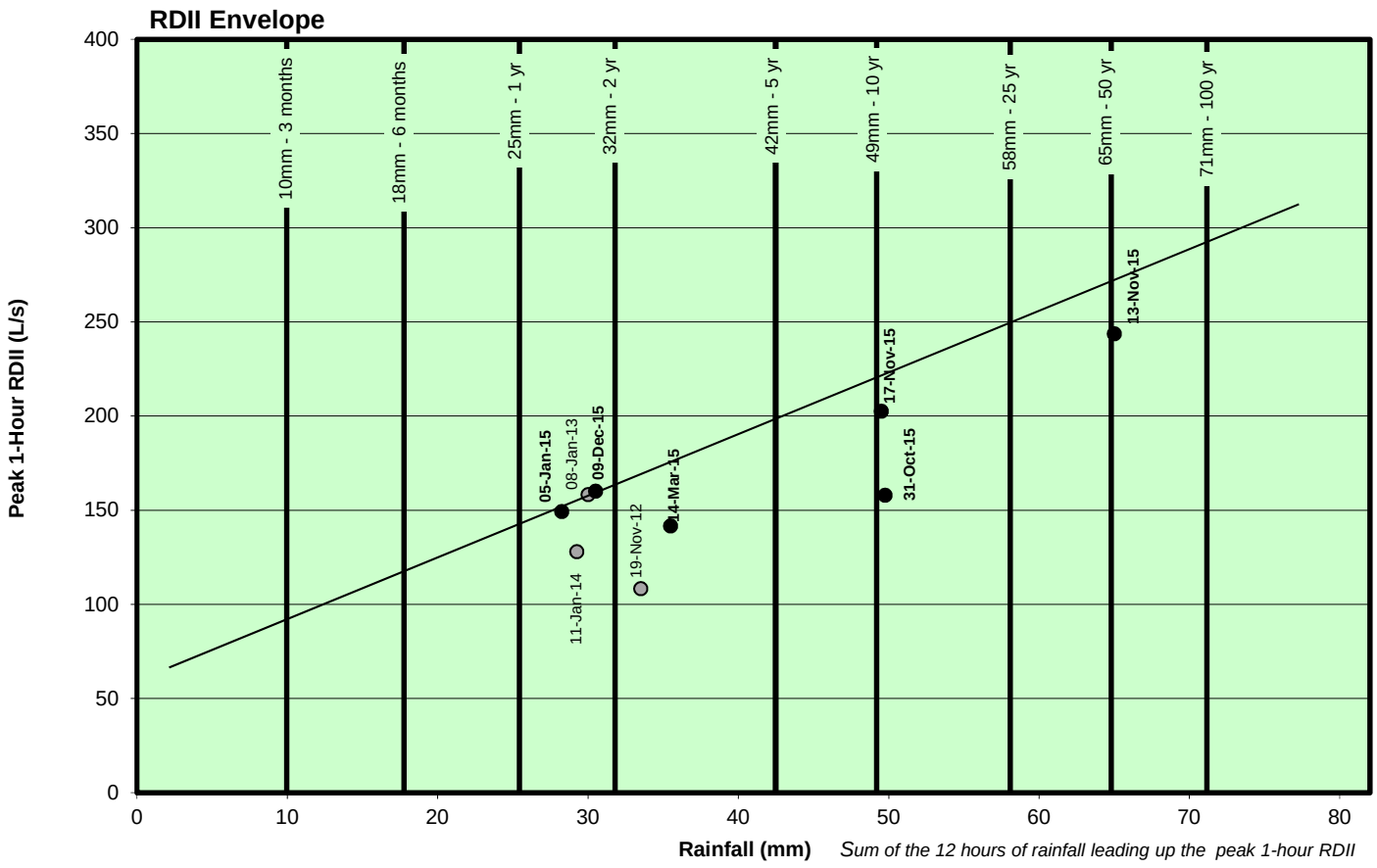
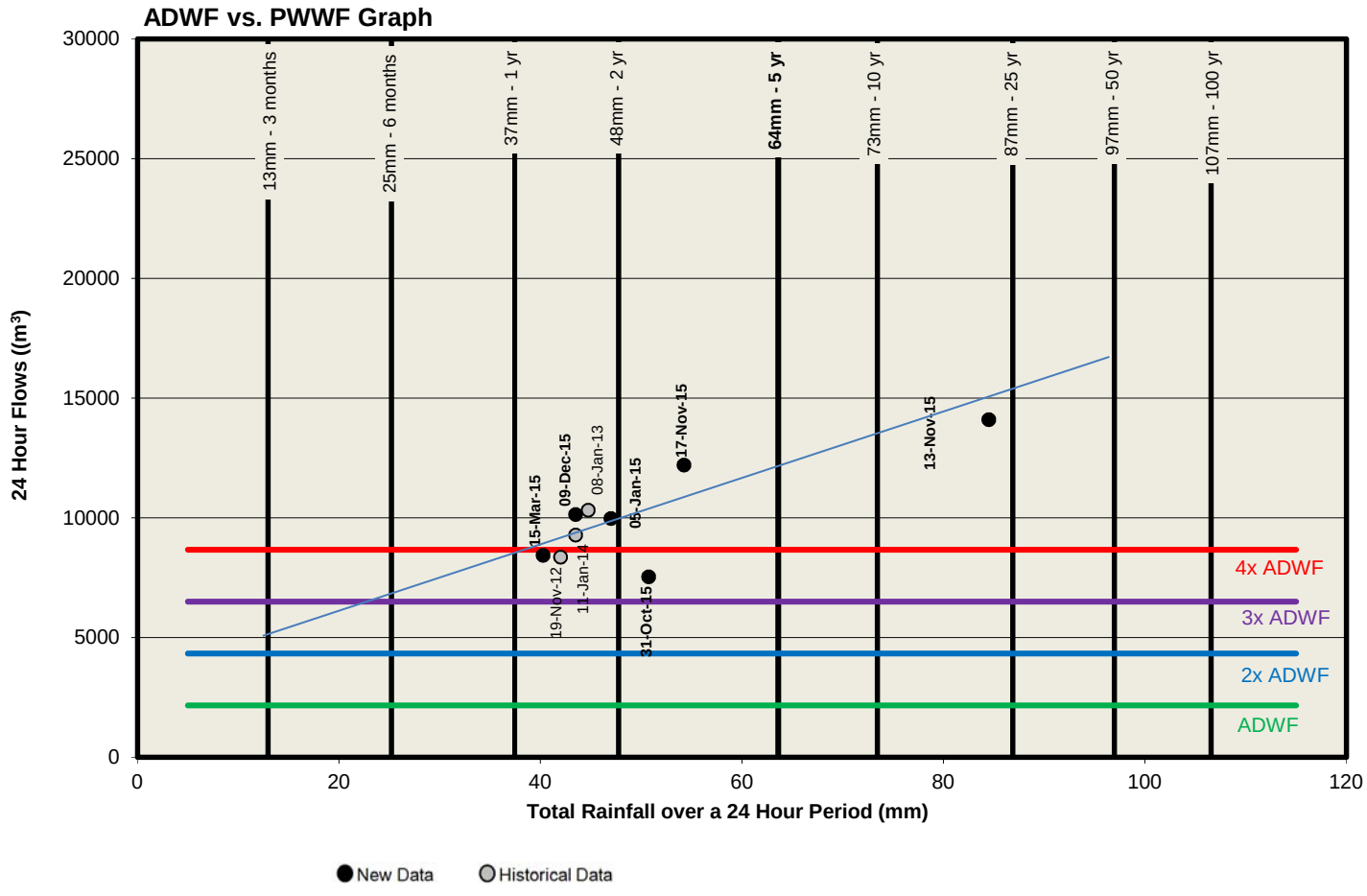
FLOW MONITORING AREA

CATCHMENT: CECELIA FLUME

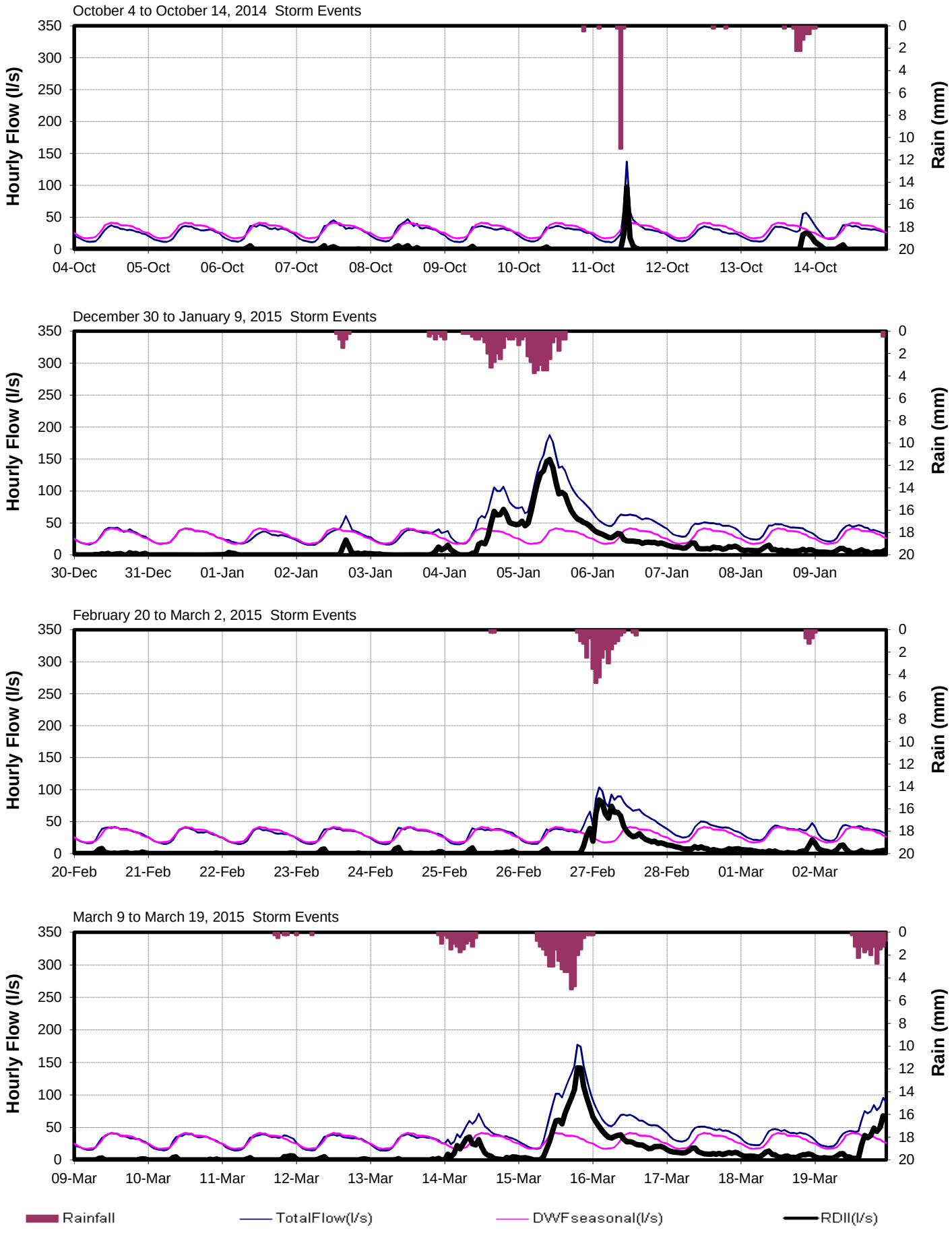
SITE CODE: **VIC31/VIC31A**

Cecelia Flume (VIC31)

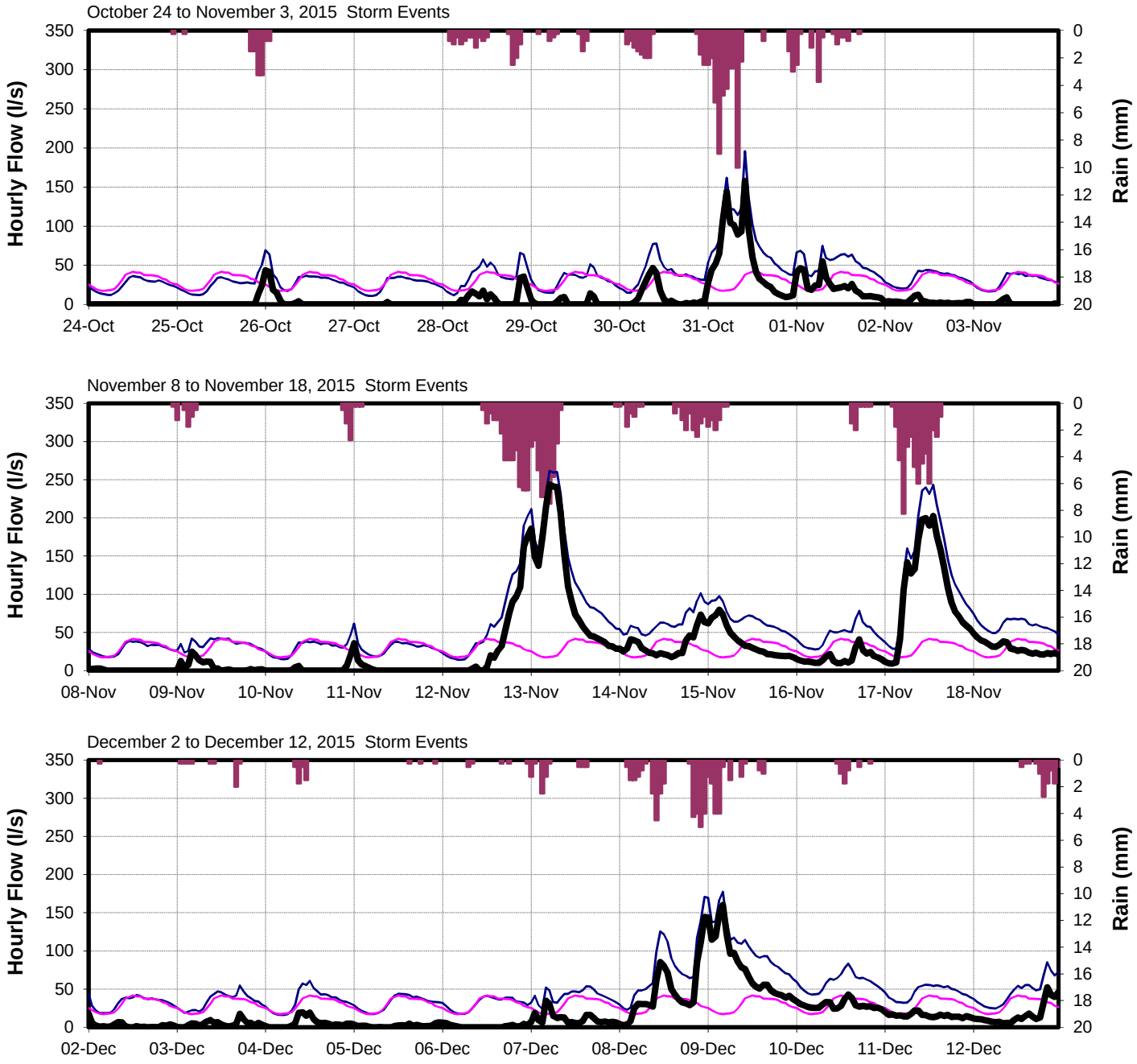




Cecelia Flume (VIC31)

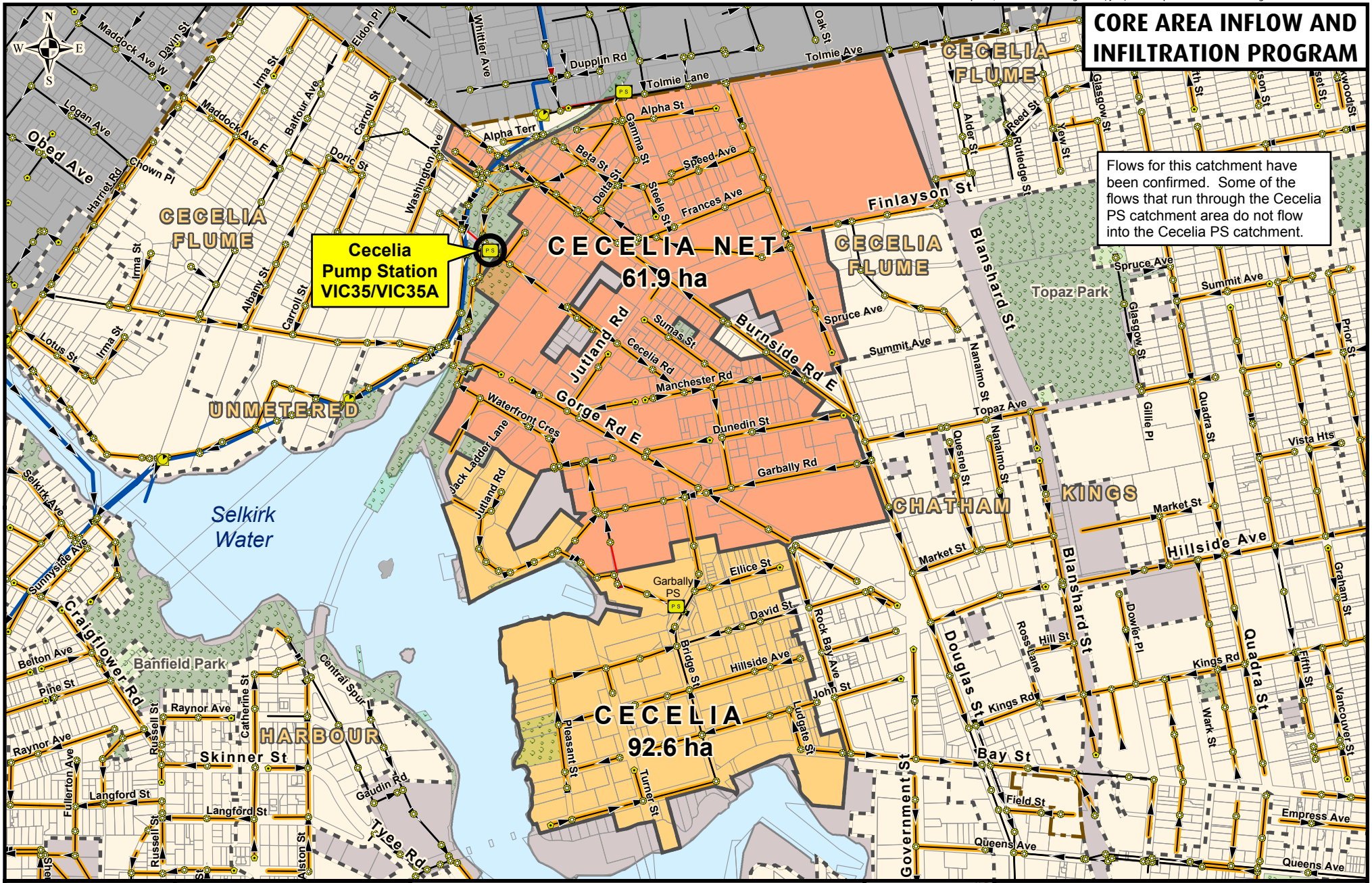


Cecelia Flume (VIC31)



CRD - Parks & Environmental Services - Apr 14, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchVictoria2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 100 200 300

Projection: UTM ZONE 10N NAD 83

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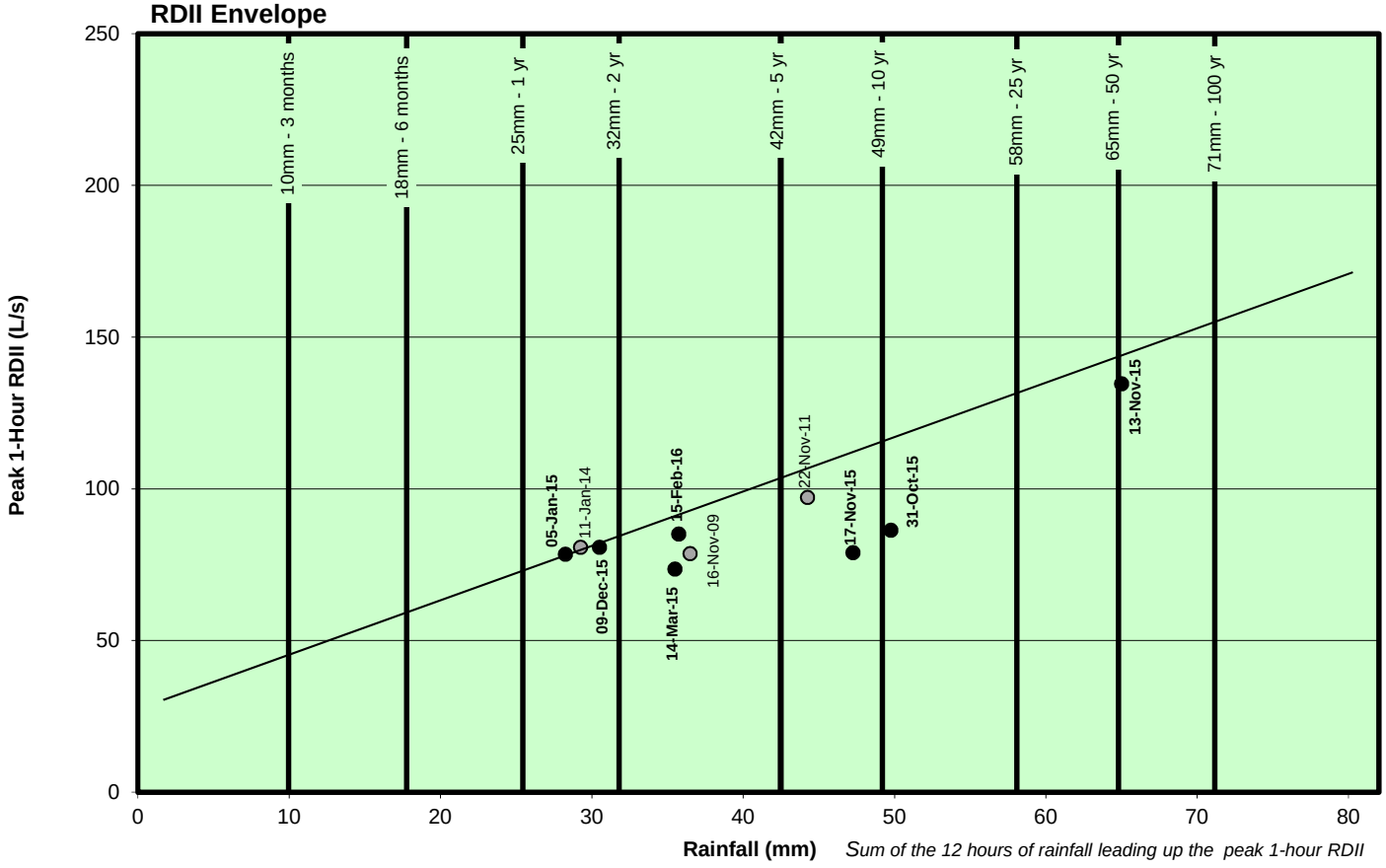
FLOW MONITORING AREA

CATCHMENT: CECELIA

SITE CODE: **VIC35/VIC35A**

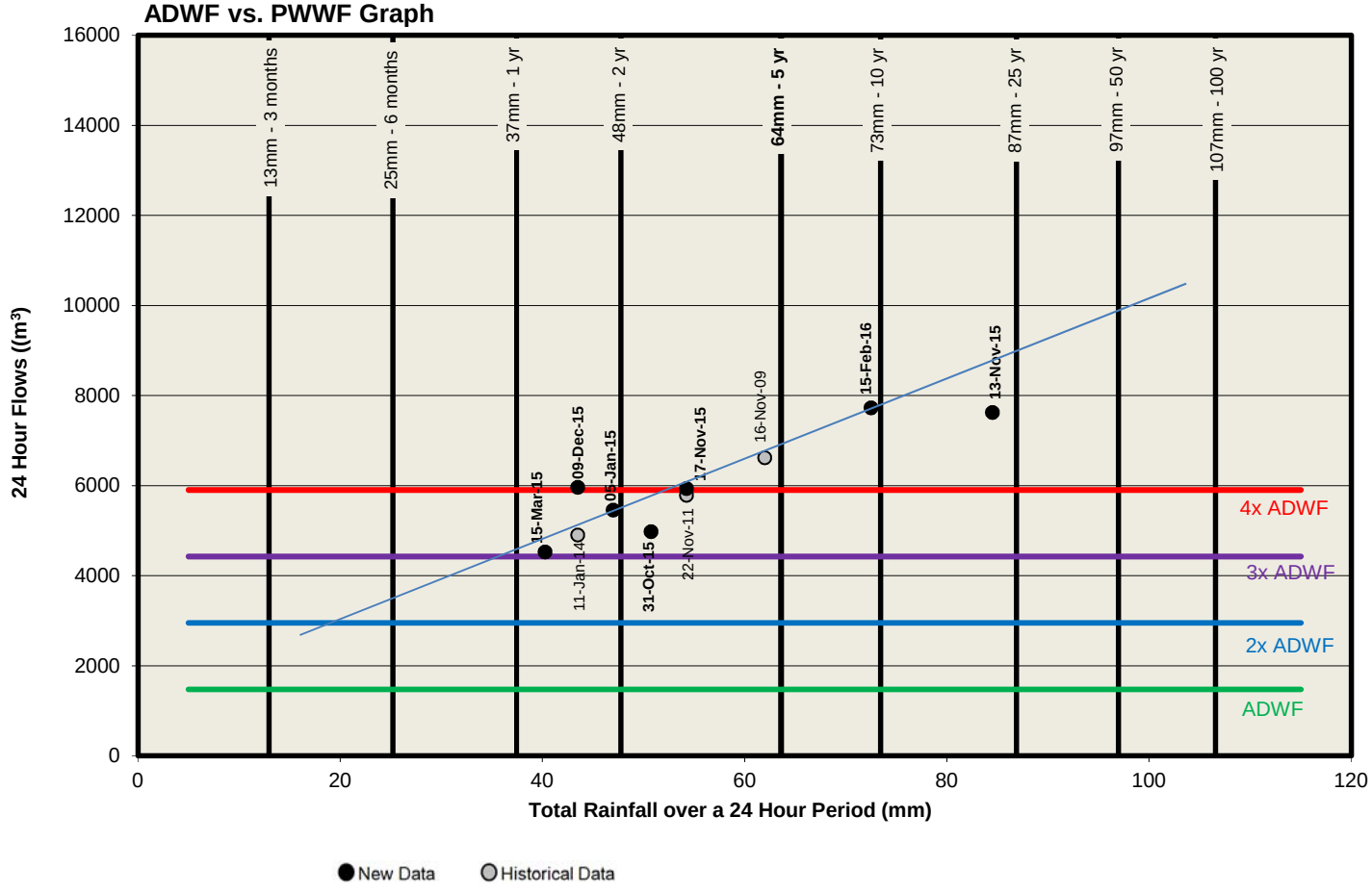
Cecelia PS (VIC35)

RDII Envelope

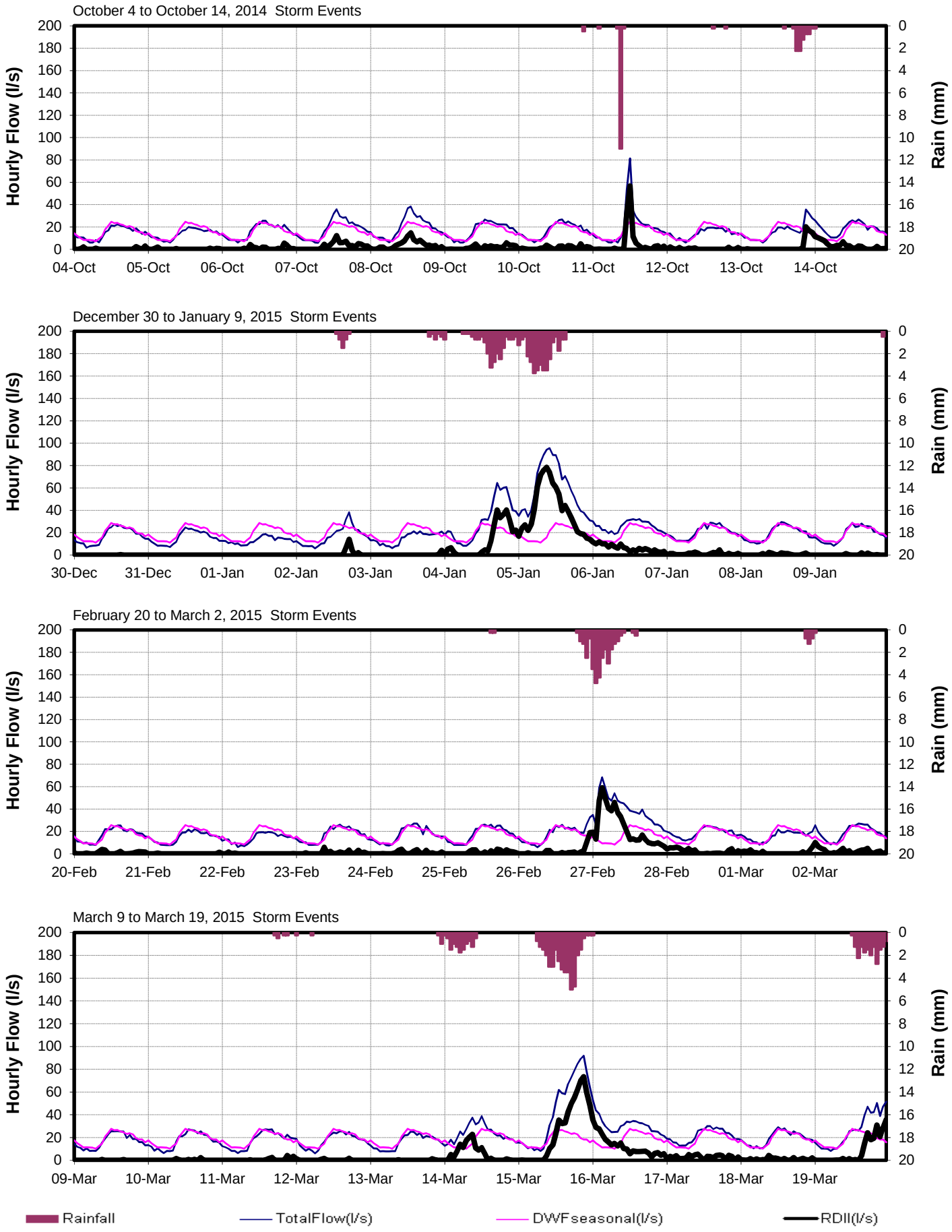


Sum of the 12 hours of rainfall leading up the peak 1-hour RDII

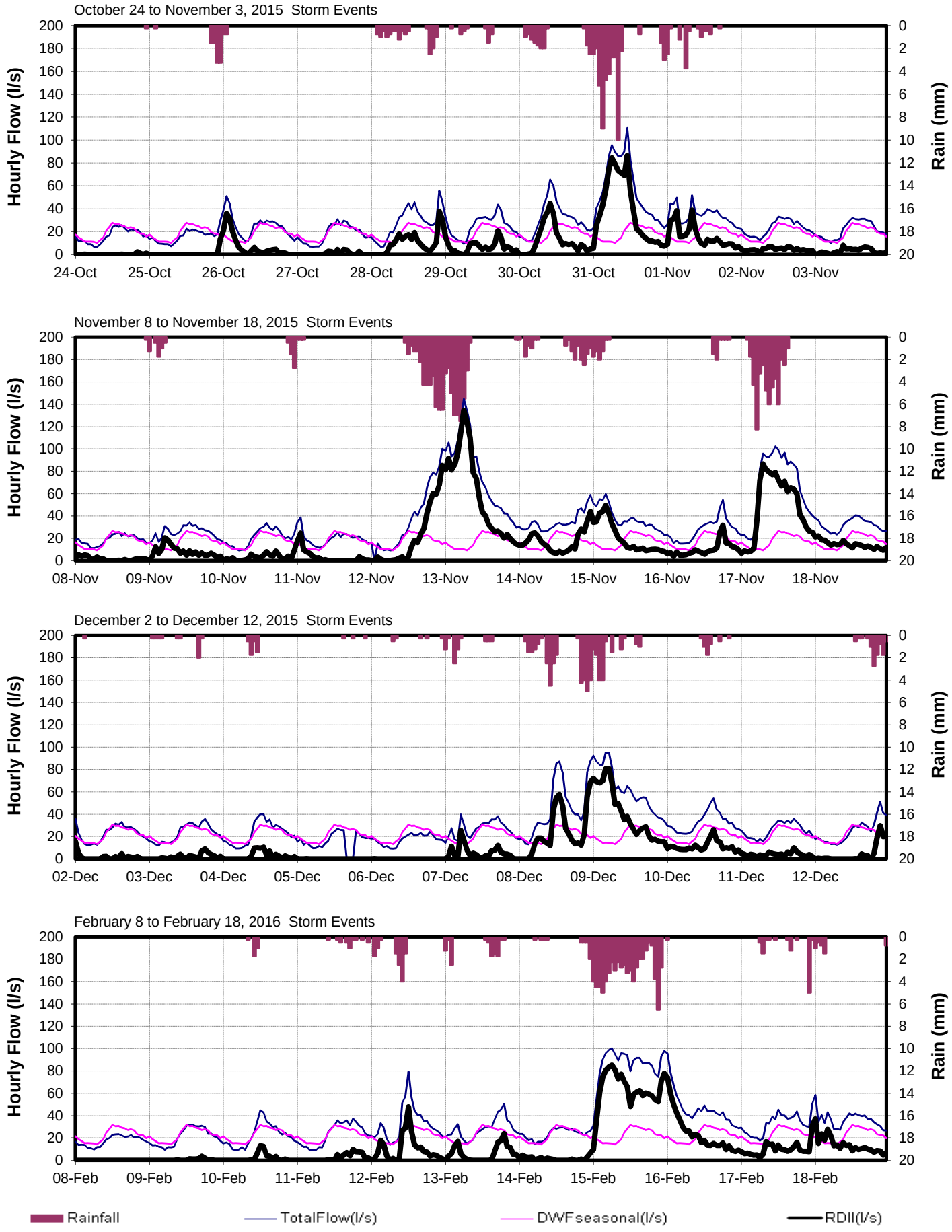
ADWF vs. PWWF Graph



Cecelia PS (VIC35)

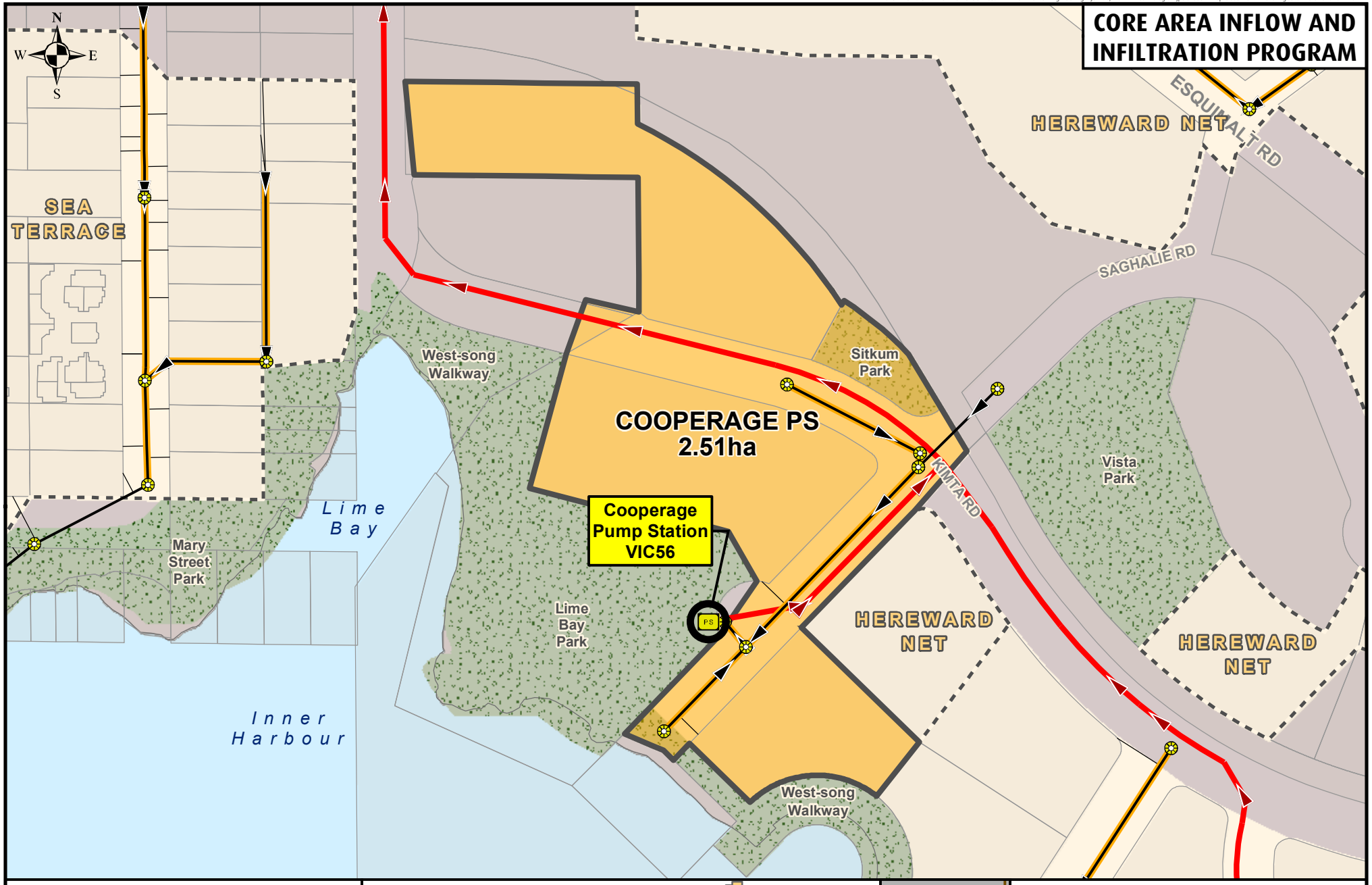


Cecelia PS (VIC35)



CRD - Parks & Environmental Services - Environmental Engineering - Jan 06, 2017 - Technologist: jpbezeau - Map Document: MeteringCatchVictoria2016.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Metres
0 50 100

Projection: UTM ZONE 10N, NAD83

Disclaimer
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- Cleanout
- Pump Station
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FLOW MONITORING AREA
Catchment: Cooperage Pump Station
Site Code: VIC56

CRD
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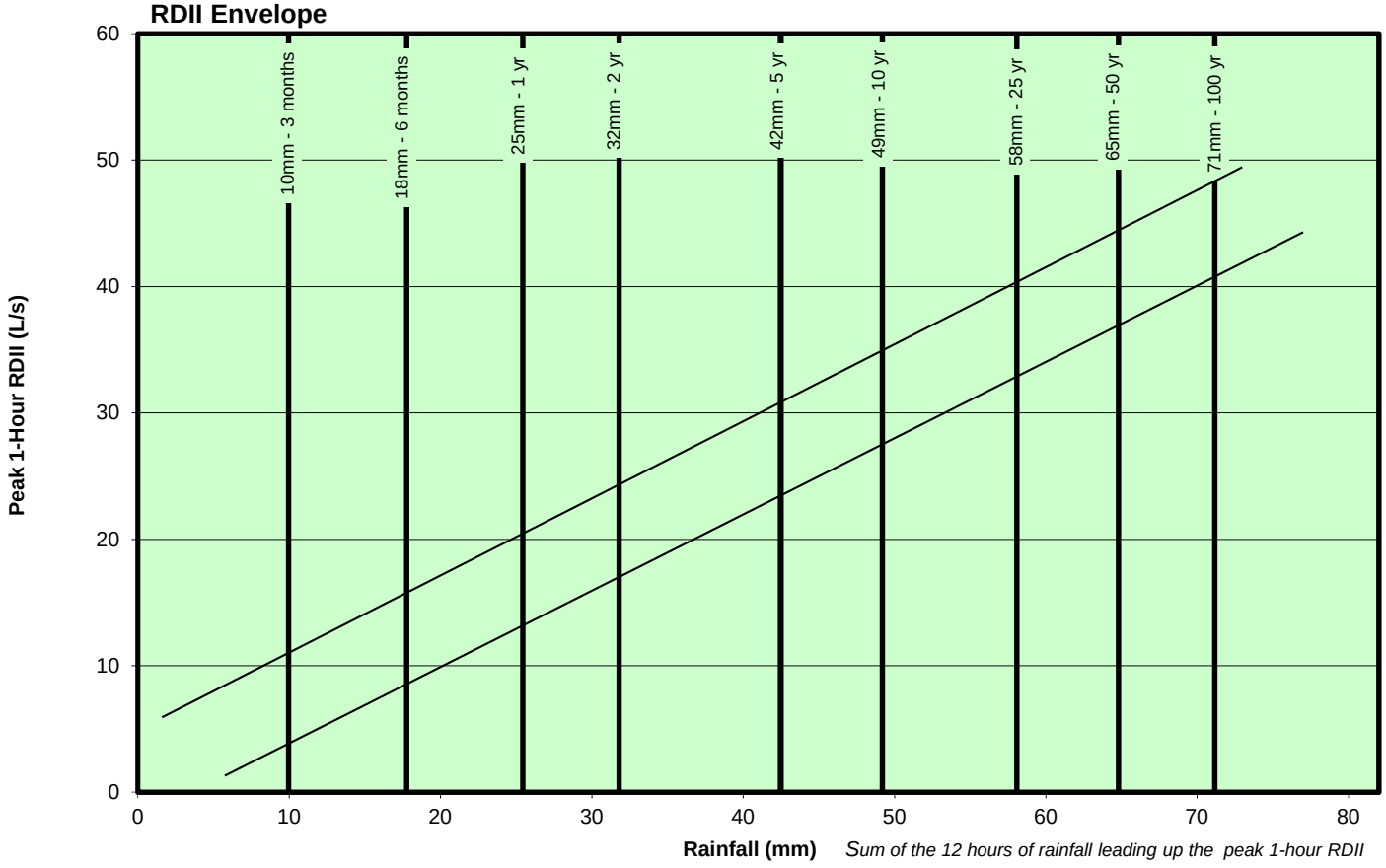
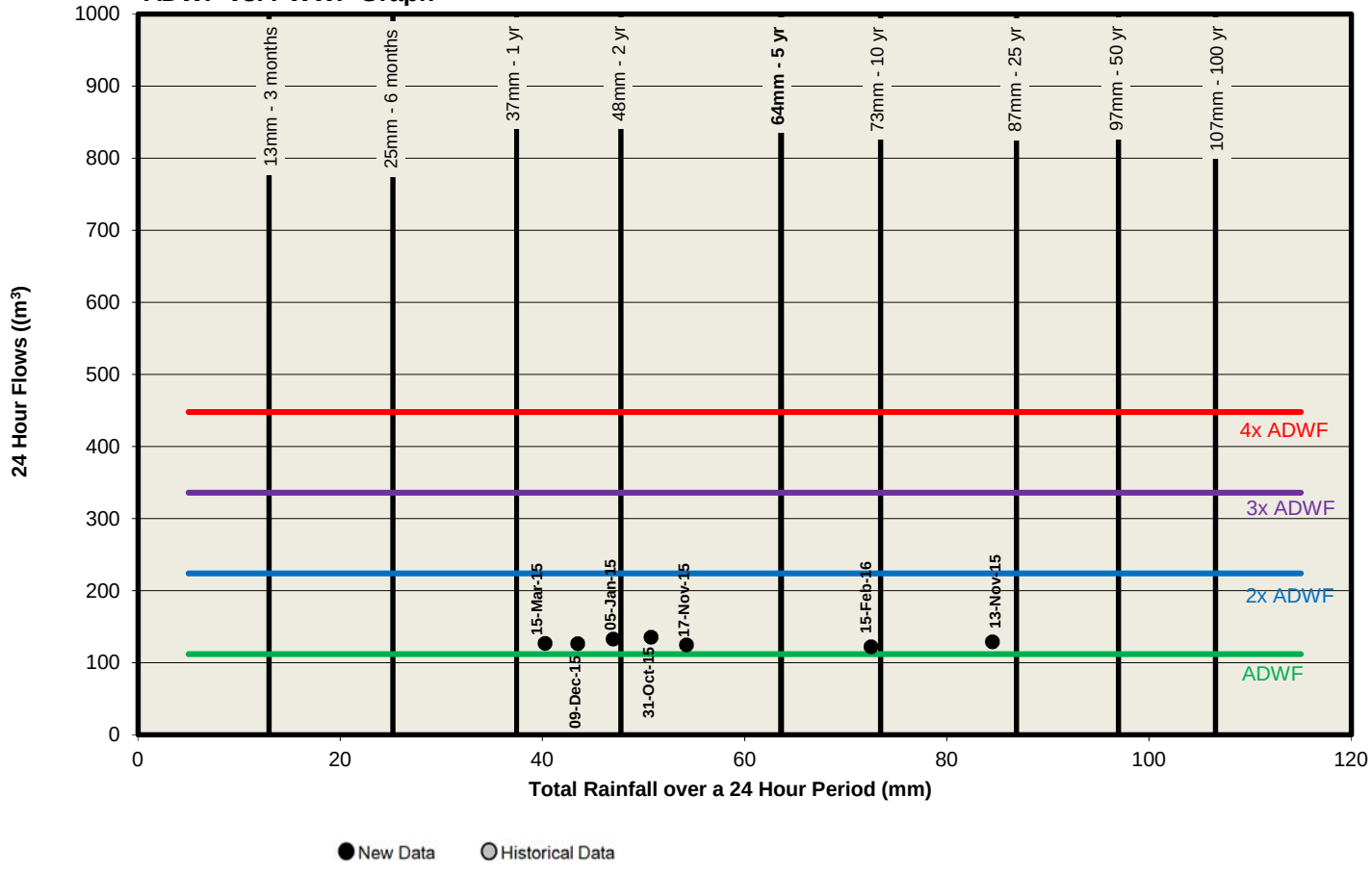
Cooperage

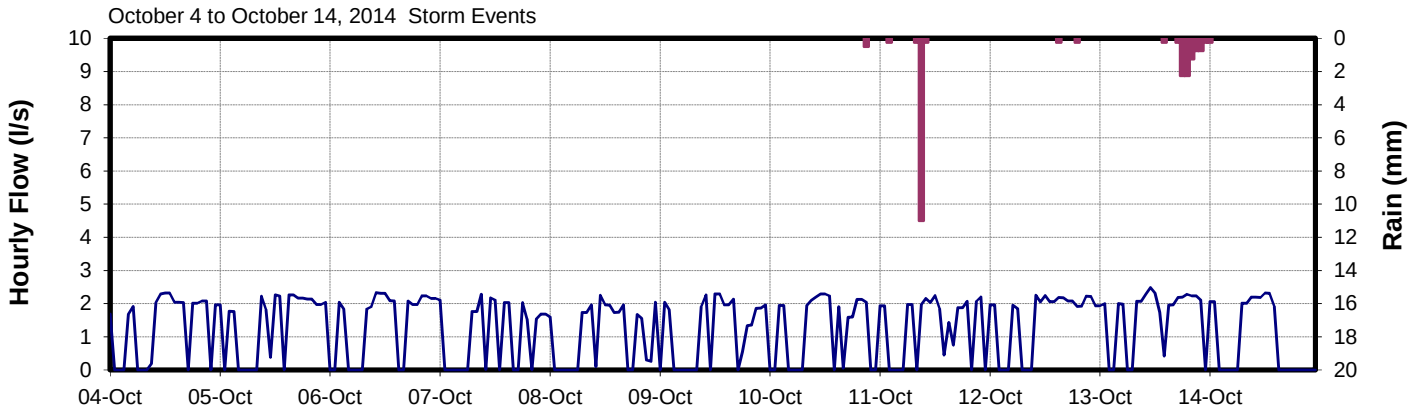
RDII Envelope

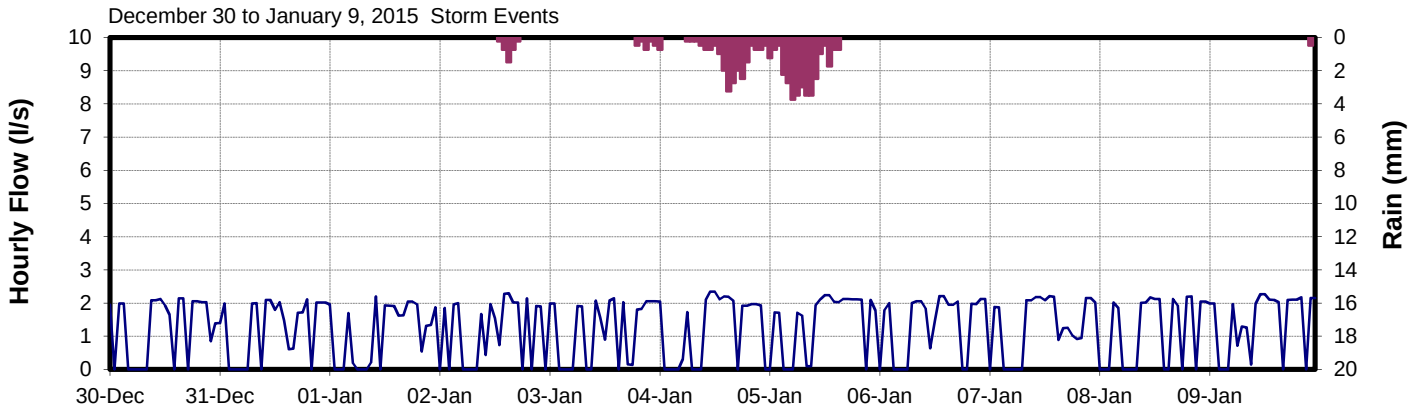


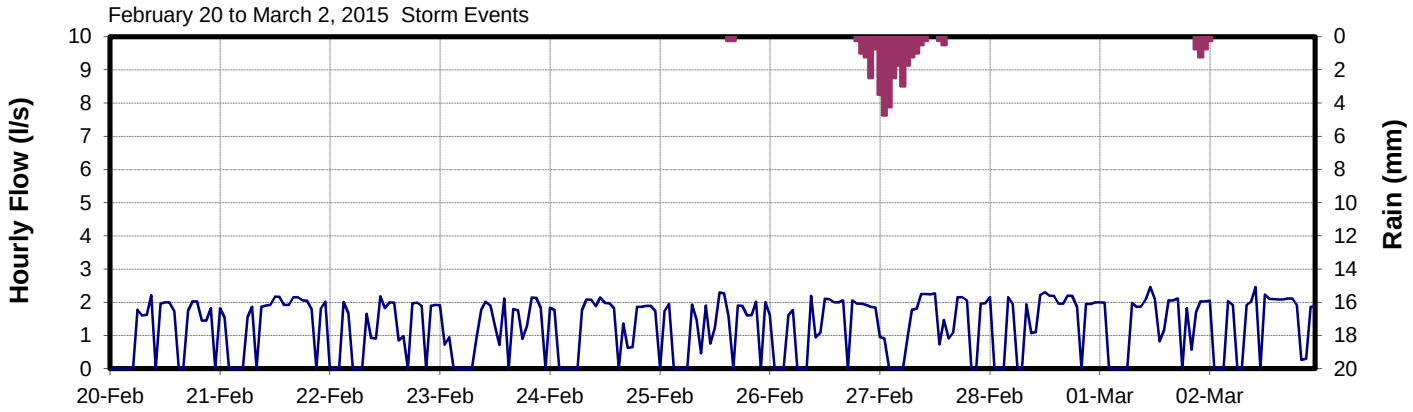
ADWF vs. PWWF Graph

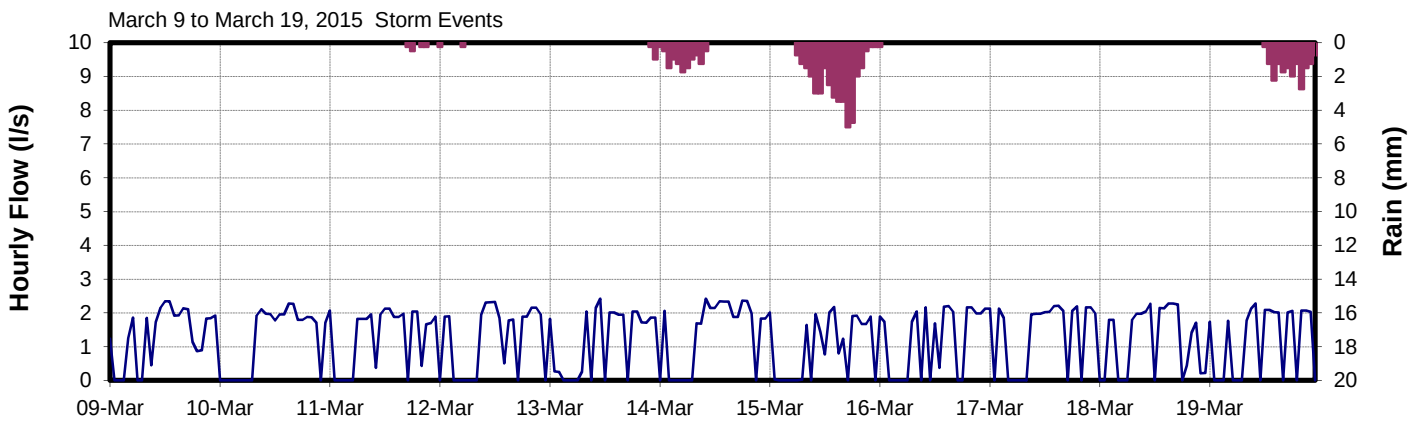


Cooperage

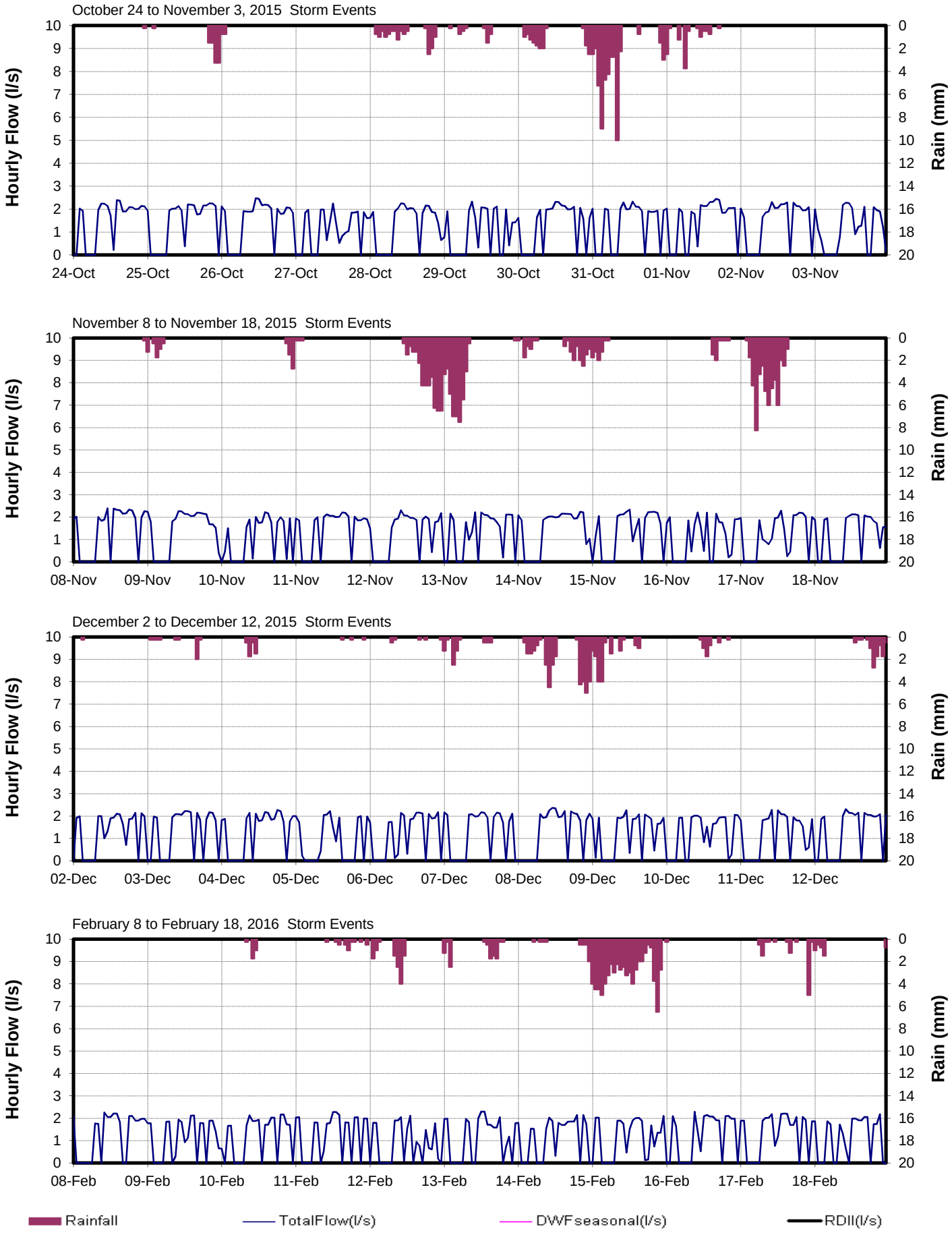

October 4 to October 14, 2014 Storm Events
Hourly Flow (l/s)
Rain (mm)
04-Oct
05-Oct
06-Oct
07-Oct
08-Oct
09-Oct
10-Oct
11-Oct
12-Oct
13-Oct
14-Oct


December 30 to January 9, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
30-Dec
31-Dec
01-Jan
02-Jan
03-Jan
04-Jan
05-Jan
06-Jan
07-Jan
08-Jan
09-Jan


February 20 to March 2, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
26-Feb
27-Feb
28-Feb
01-Mar
02-Mar

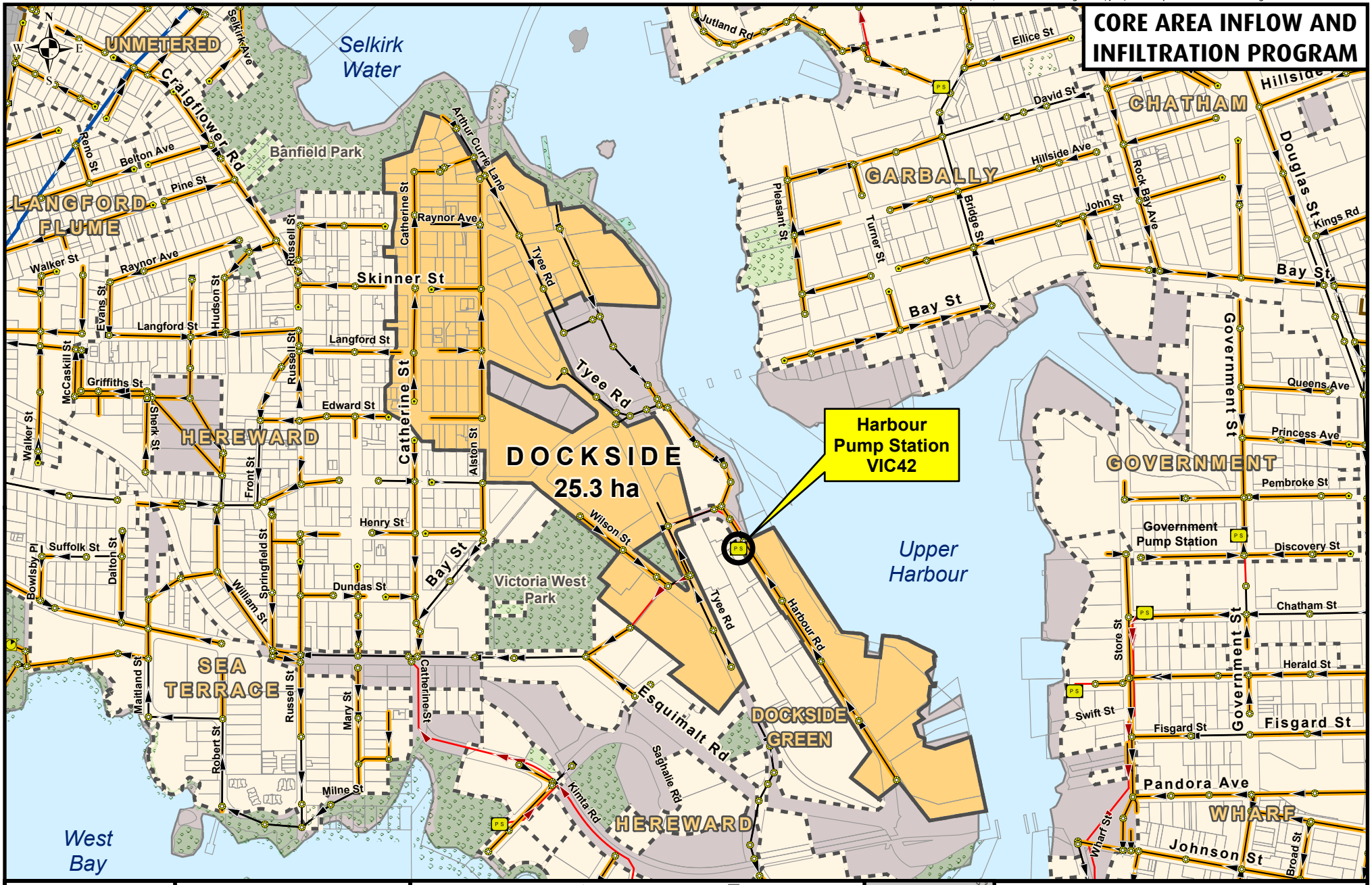

March 9 to March 19, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
09-Mar
10-Mar
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
19-Mar
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

Cooperage


October 24 to November 3, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
24-Oct
25-Oct
26-Oct
27-Oct
28-Oct
29-Oct
30-Oct
31-Oct
01-Nov
02-Nov
03-Nov
November 8 to November 18, 2015 Storm Events
08-Nov
09-Nov
10-Nov
11-Nov
12-Nov
13-Nov
14-Nov
15-Nov
16-Nov
17-Nov
18-Nov
December 2 to December 12, 2015 Storm Events
02-Dec
03-Dec
04-Dec
05-Dec
06-Dec
07-Dec
08-Dec
09-Dec
10-Dec
11-Dec
12-Dec
February 8 to February 18, 2016 Storm Events
08-Feb
09-Feb
10-Feb
11-Feb
12-Feb
13-Feb
14-Feb
15-Feb
16-Feb
17-Feb
18-Feb
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

CRD - Parks & Environmental Services - Apr 14, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchVictoria2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 100 200

Projection: UTM ZONE 10N NAD 83

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- Catchment Boundary
- Municipal, First Nation, or DND Boundaries

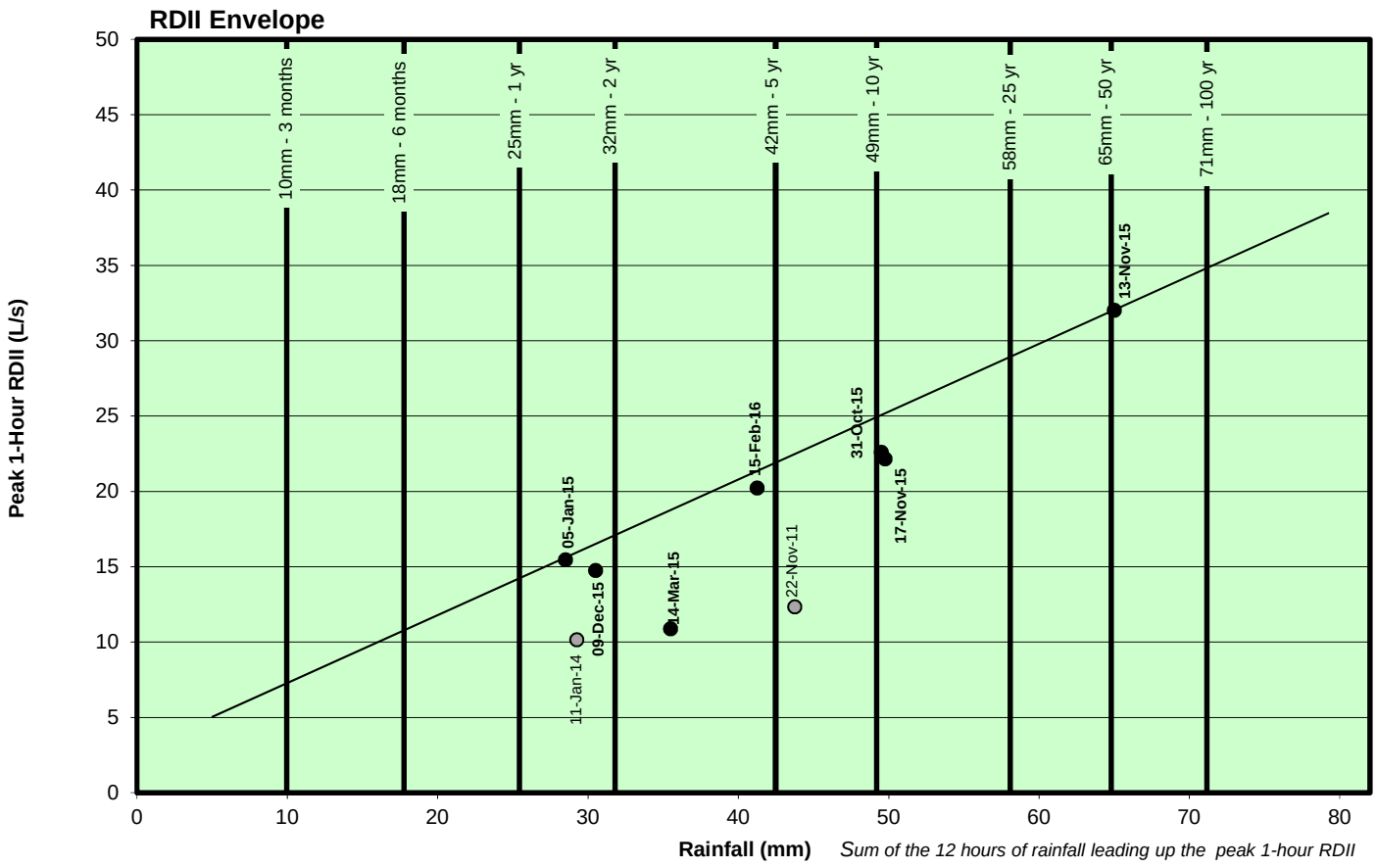


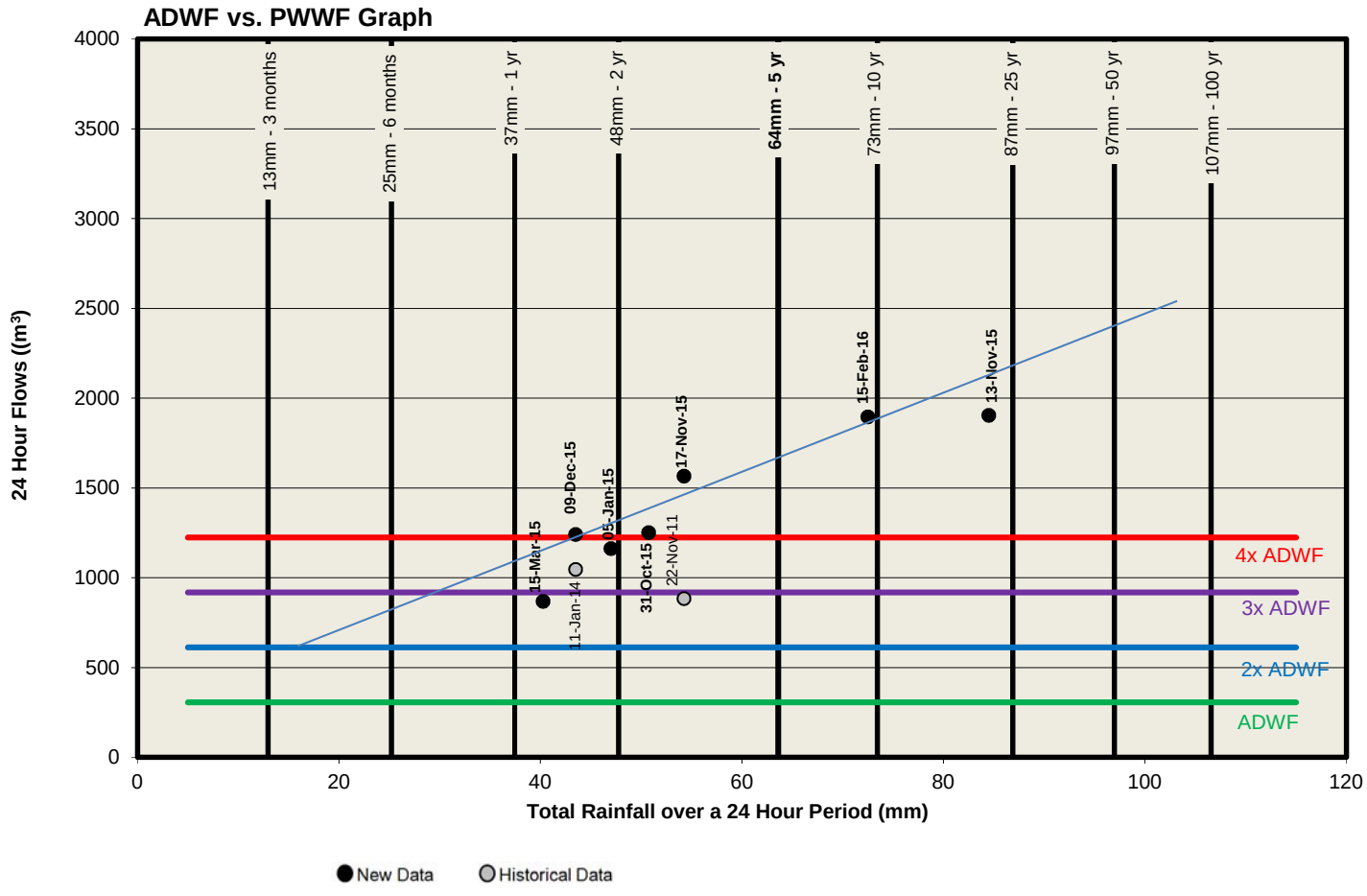
FLOW MONITORING AREA

CATCHMENT: DOCKSIDE

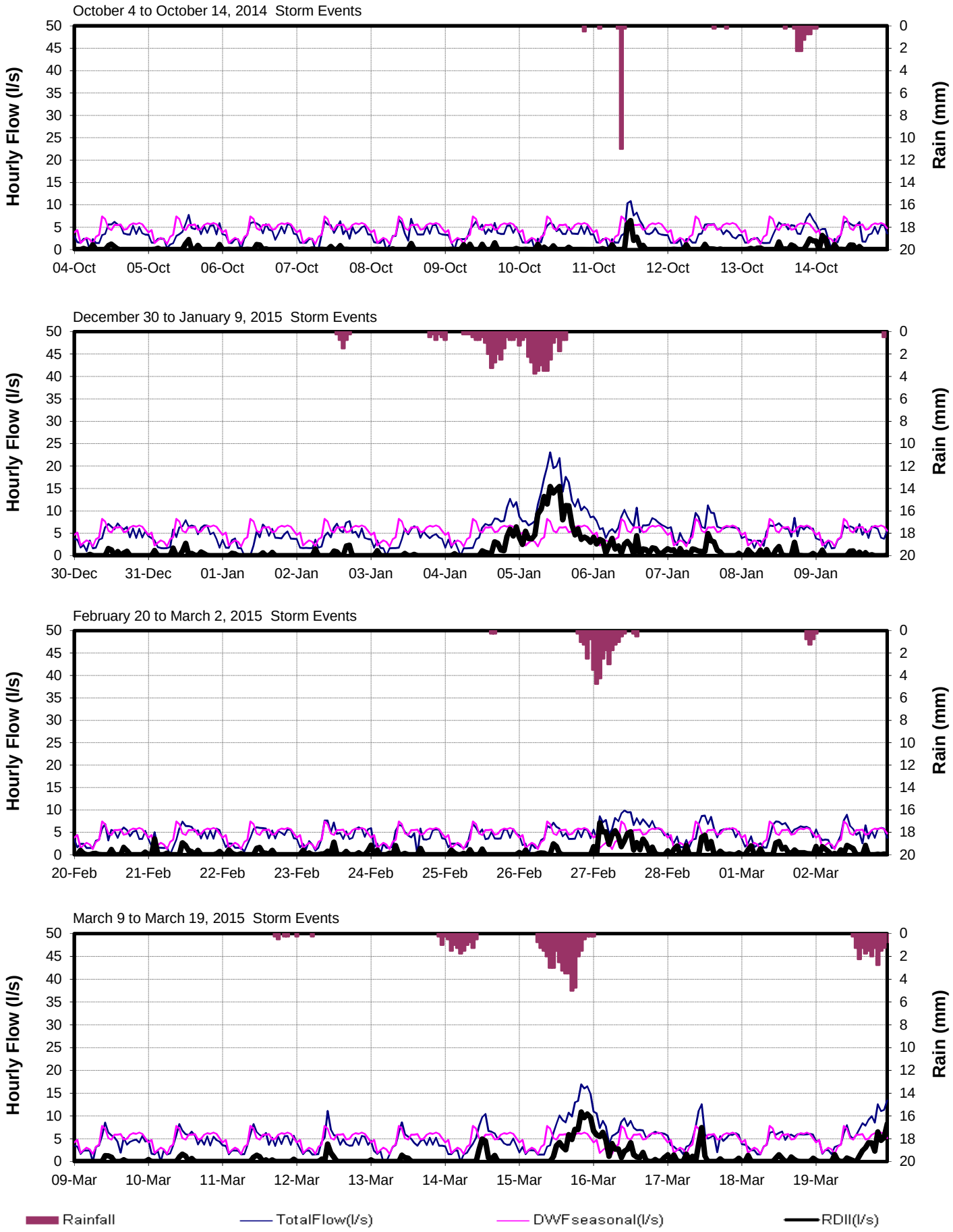
SITE CODE: **VIC42**

Dockside (VIC42)

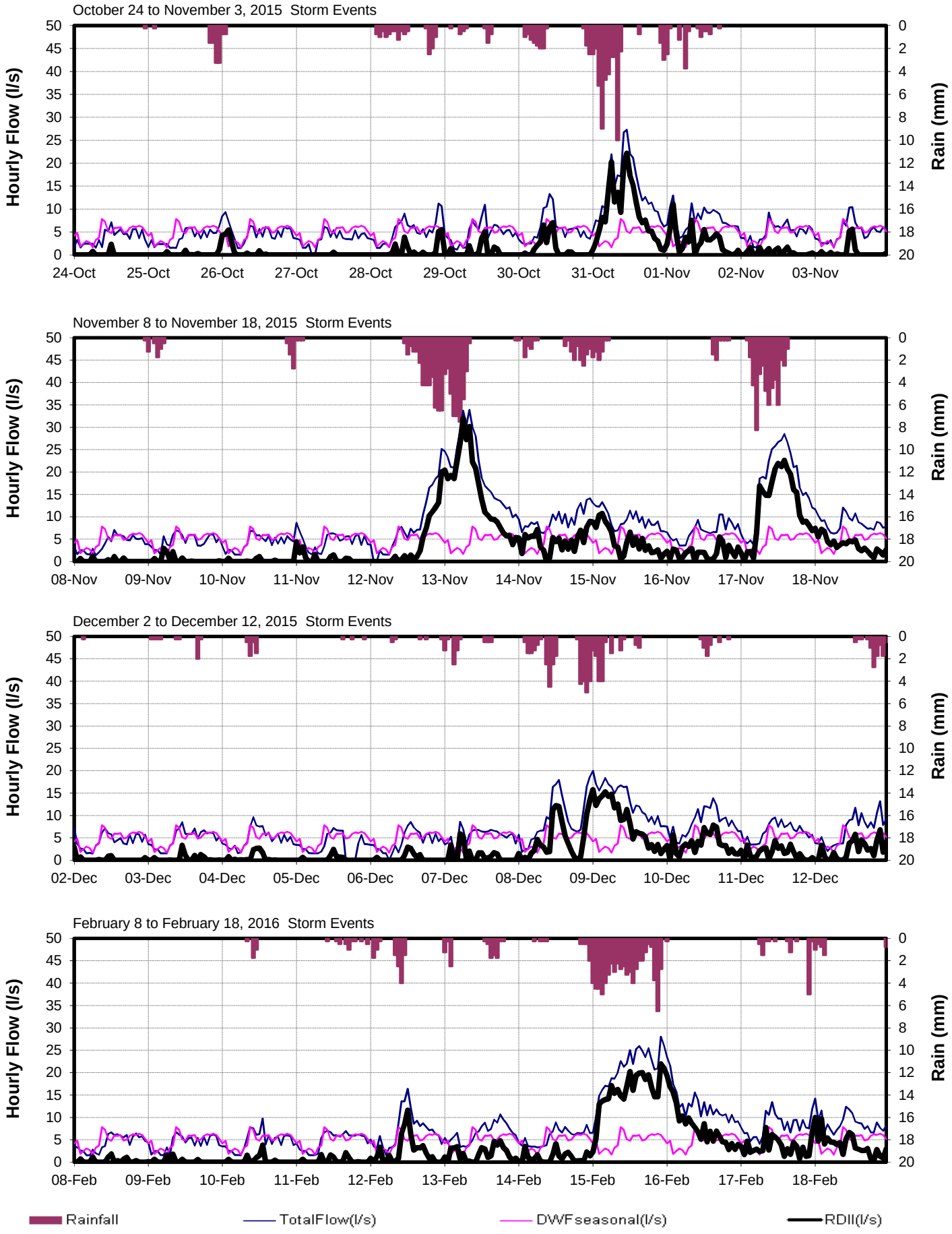




Dockside (VIC42)

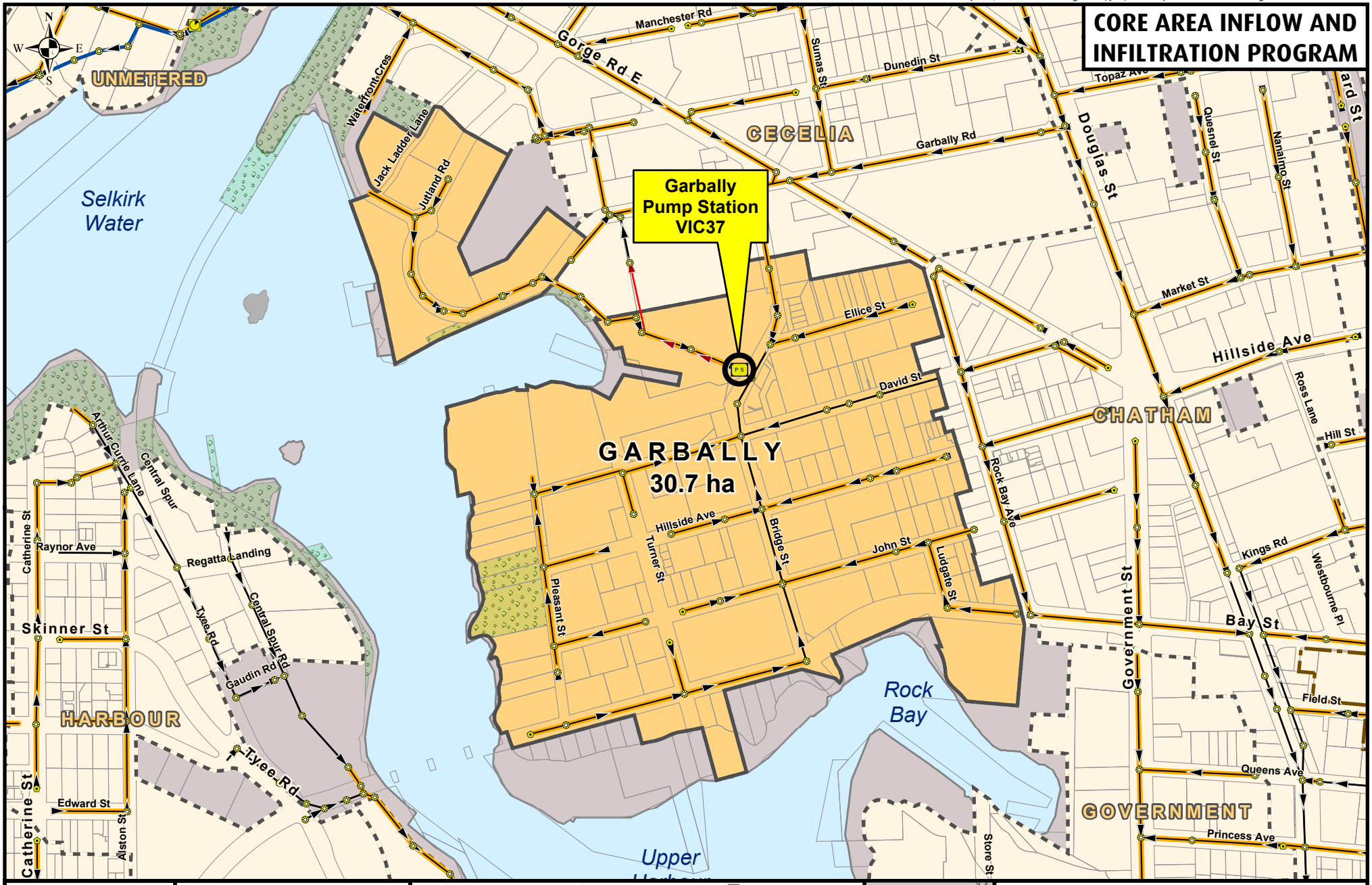


Dockside (VIC42)



CRD - Parks & Environmental Services - Apr 14, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchVictoria2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100 150

Projection: UTM ZONE 10N NAD 83

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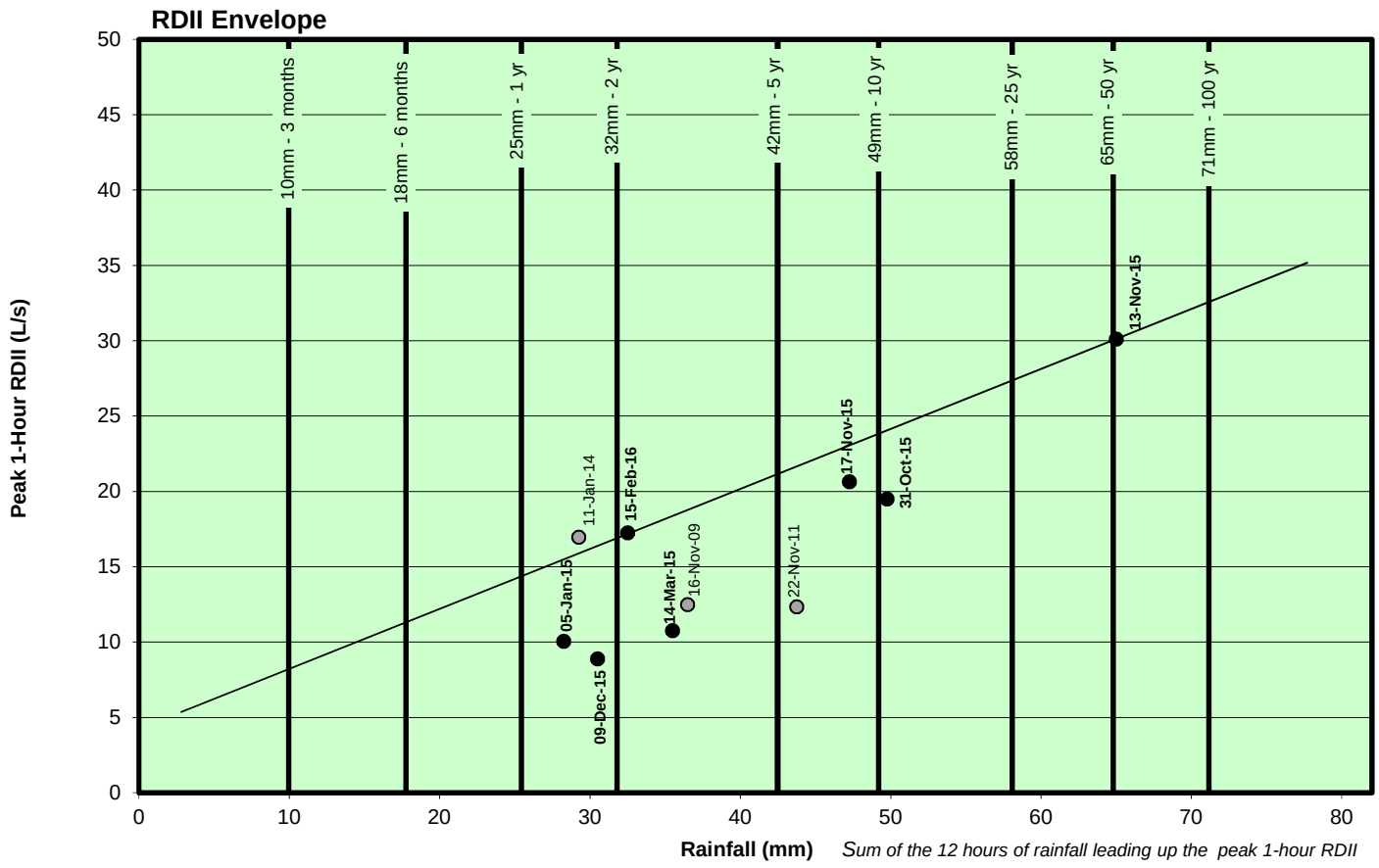
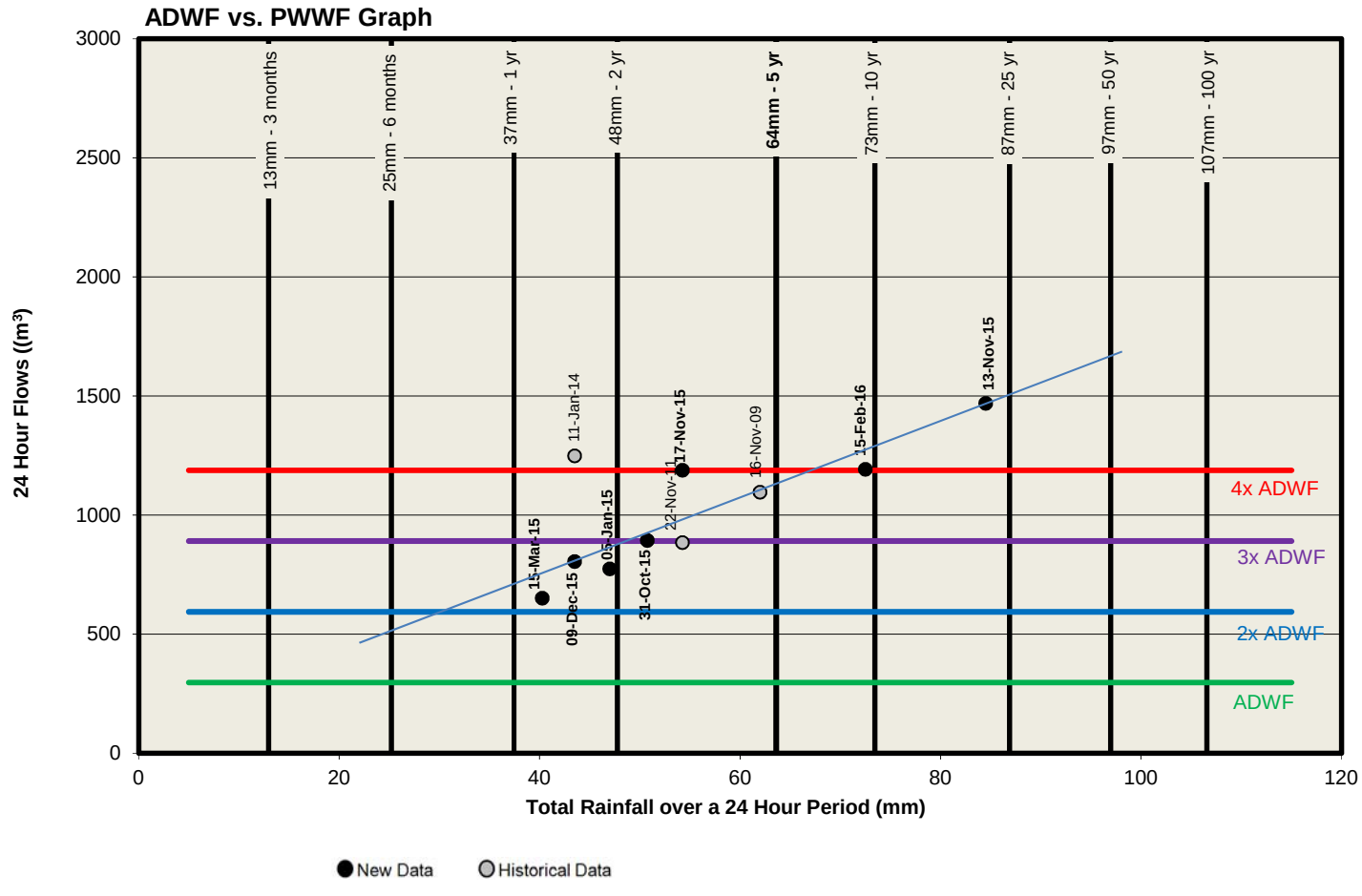
FLOW MONITORING AREA

CATCHMENT: GARBALLY

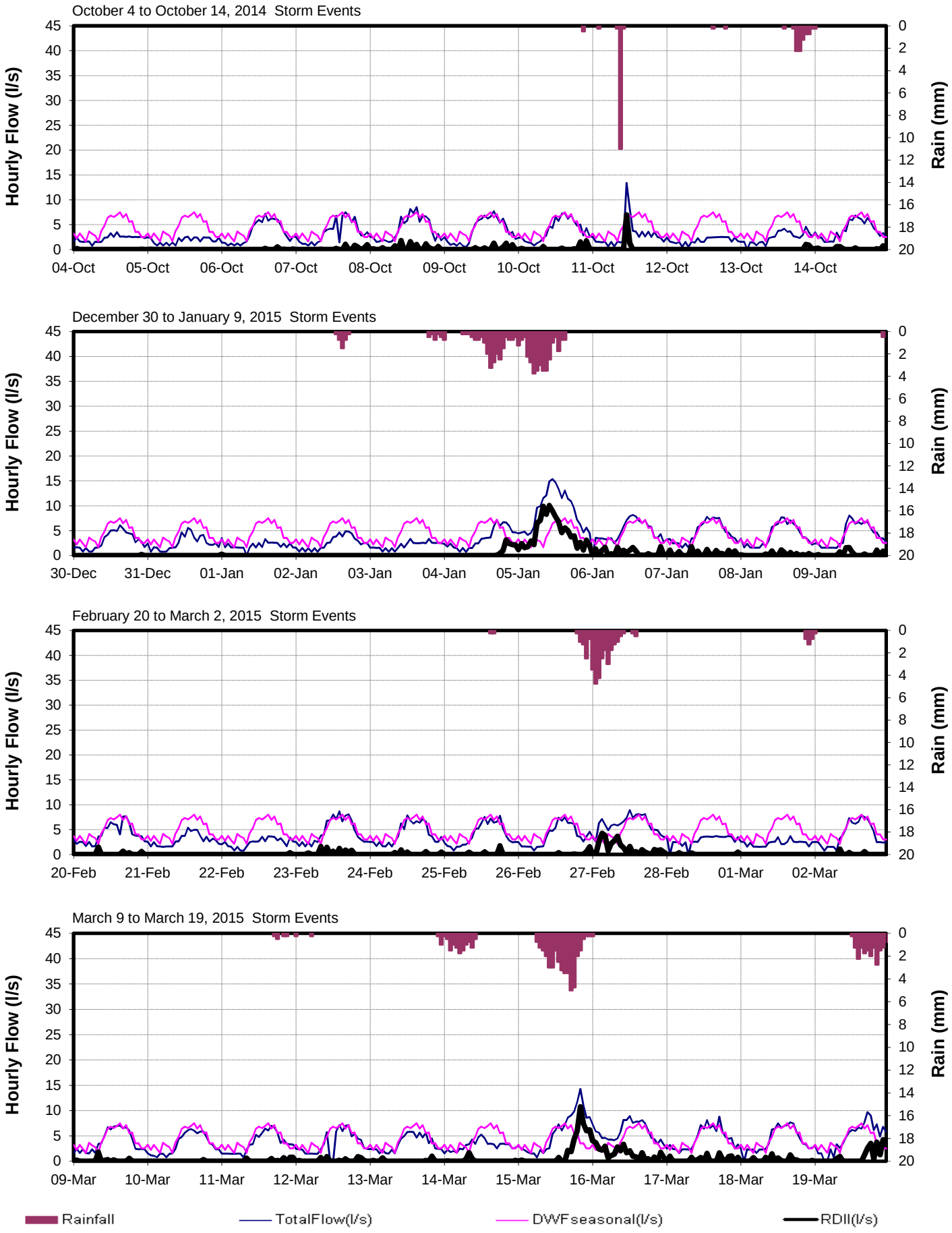
SITE CODE: **VIC37**

Garbally (VIC37)

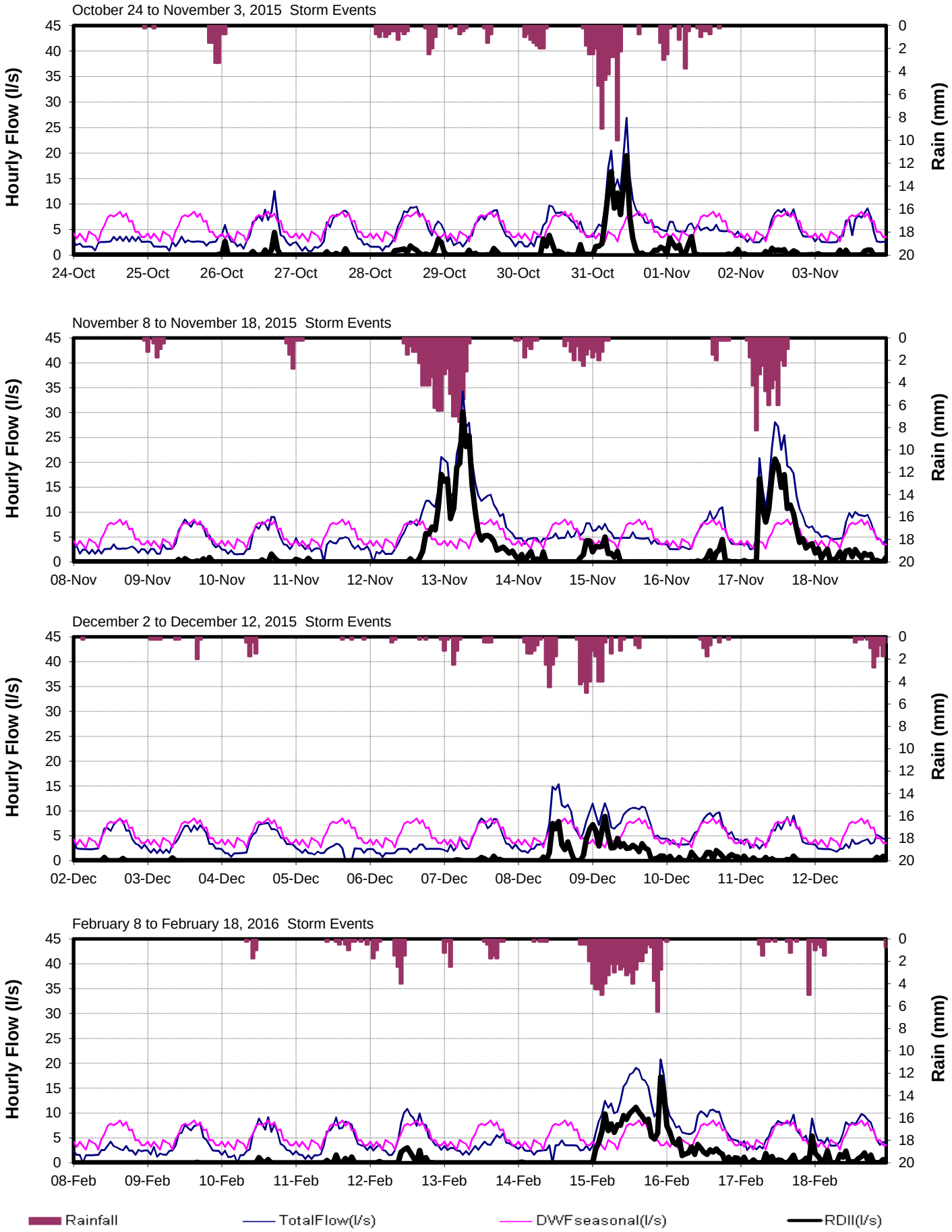




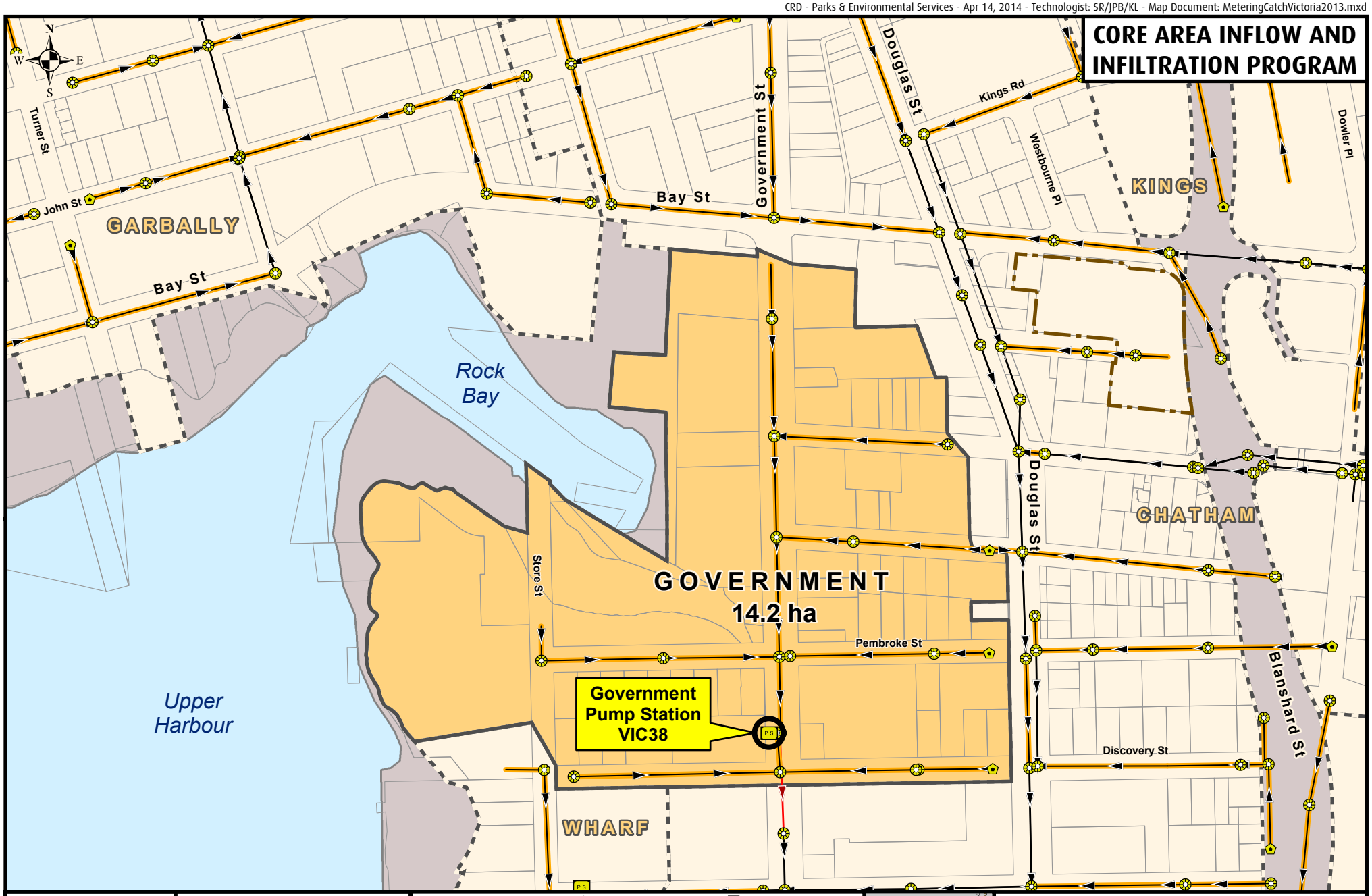
Garbally (VIC37)



Garbally (VIC37)



CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100

Projection: UTM ZONE 10N NAD 83

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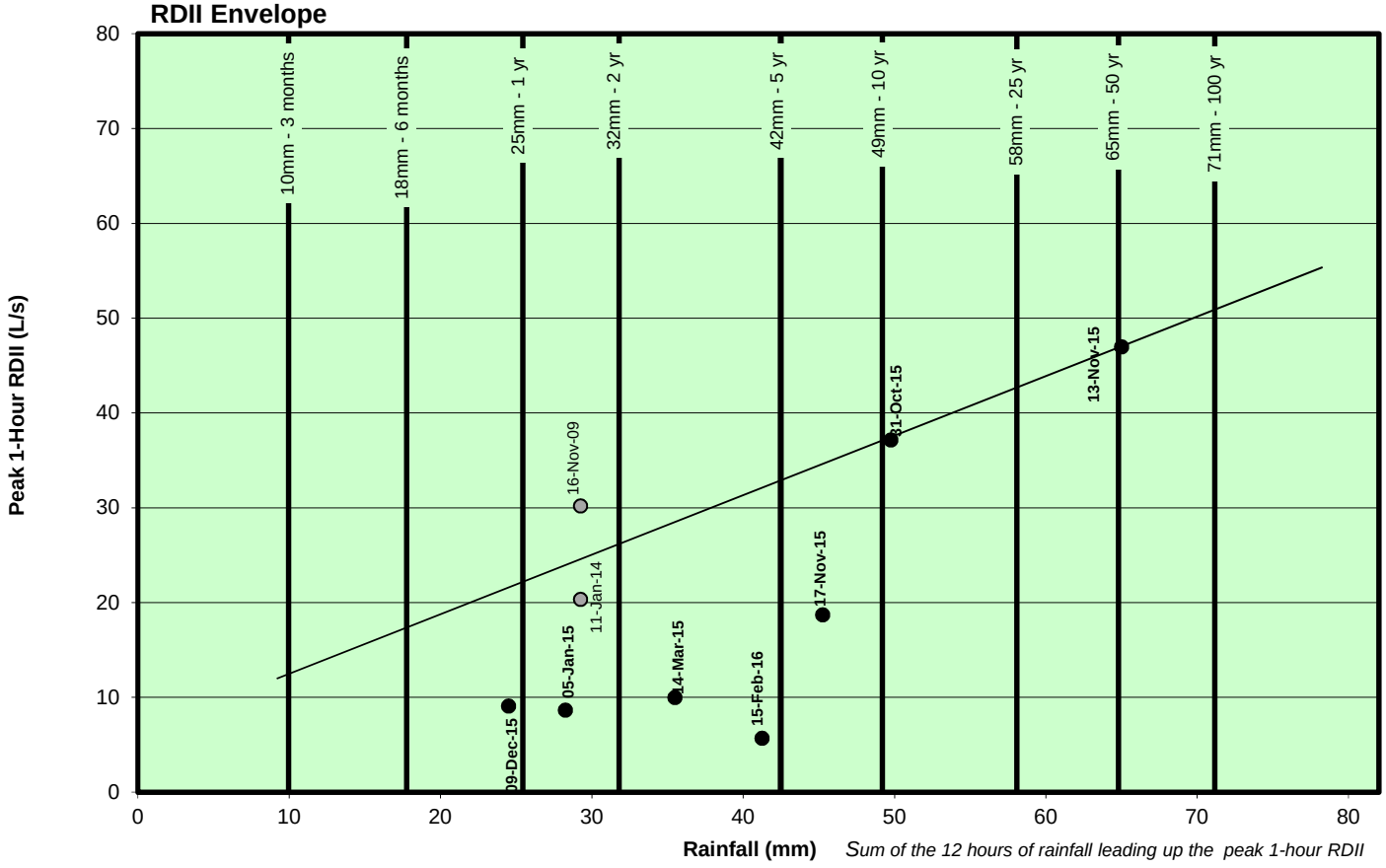
FLOW MONITORING AREA

CATCHMENT: GOVERNMENT

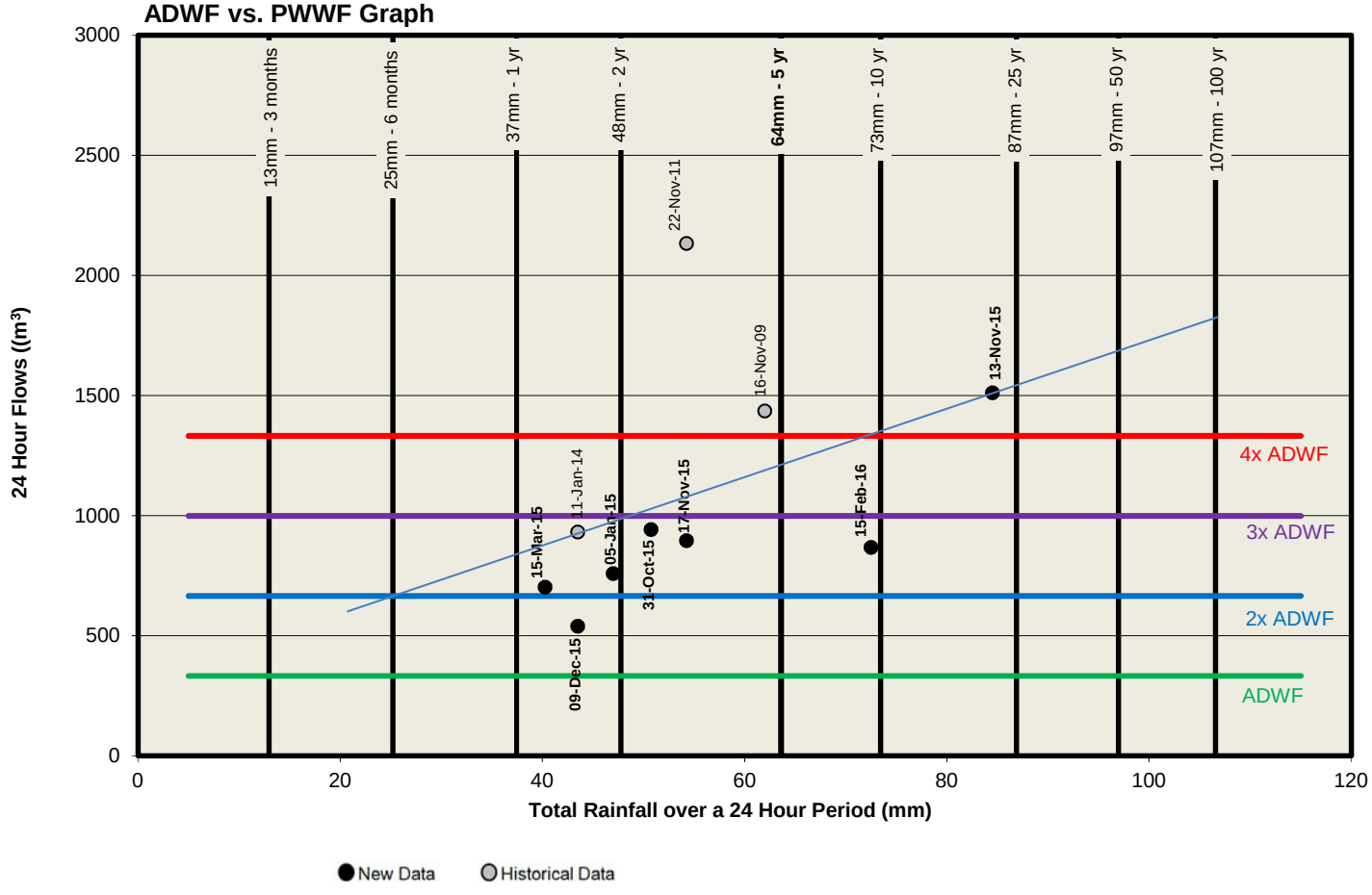
SITE CODE: **VIC38**

Government (VIC38)

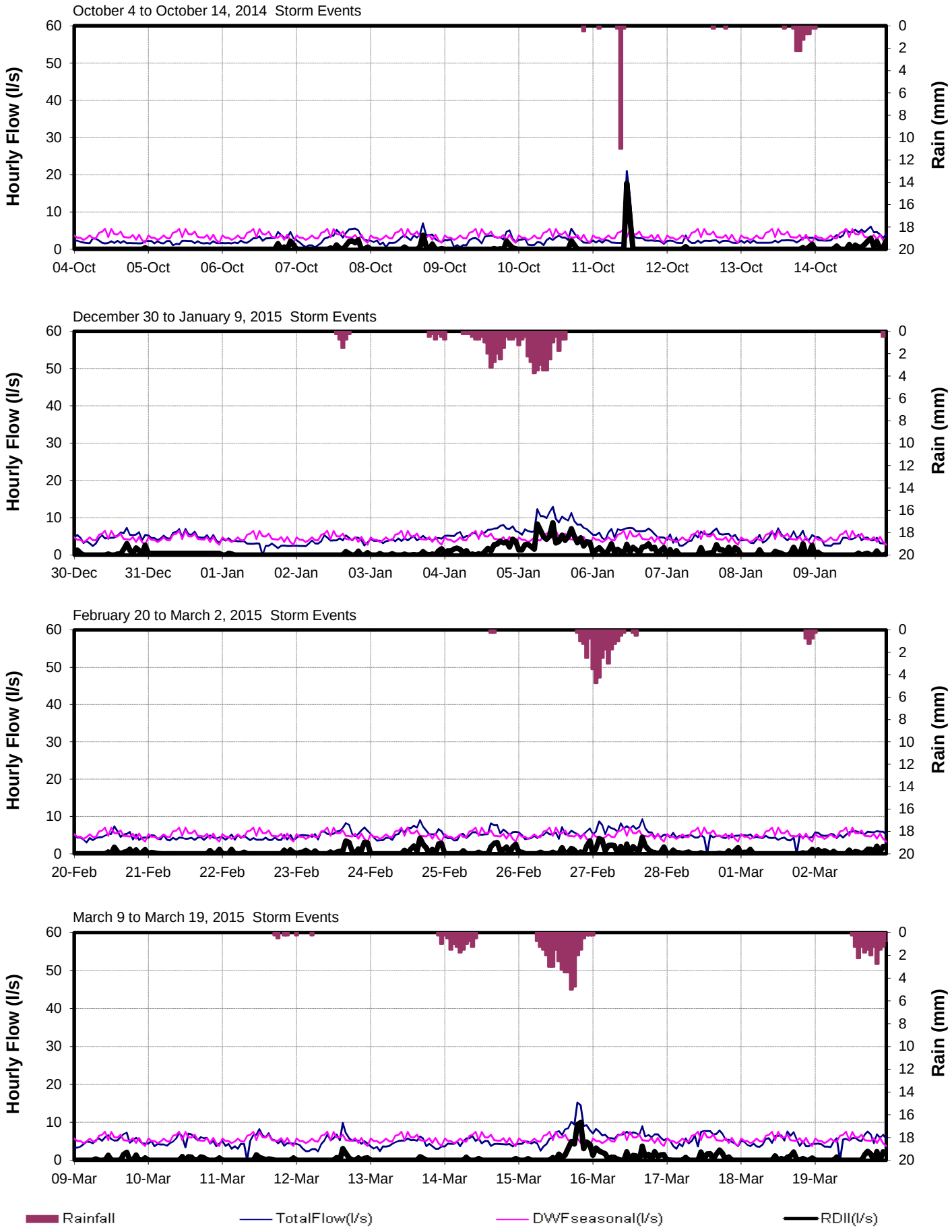
RDII Envelope



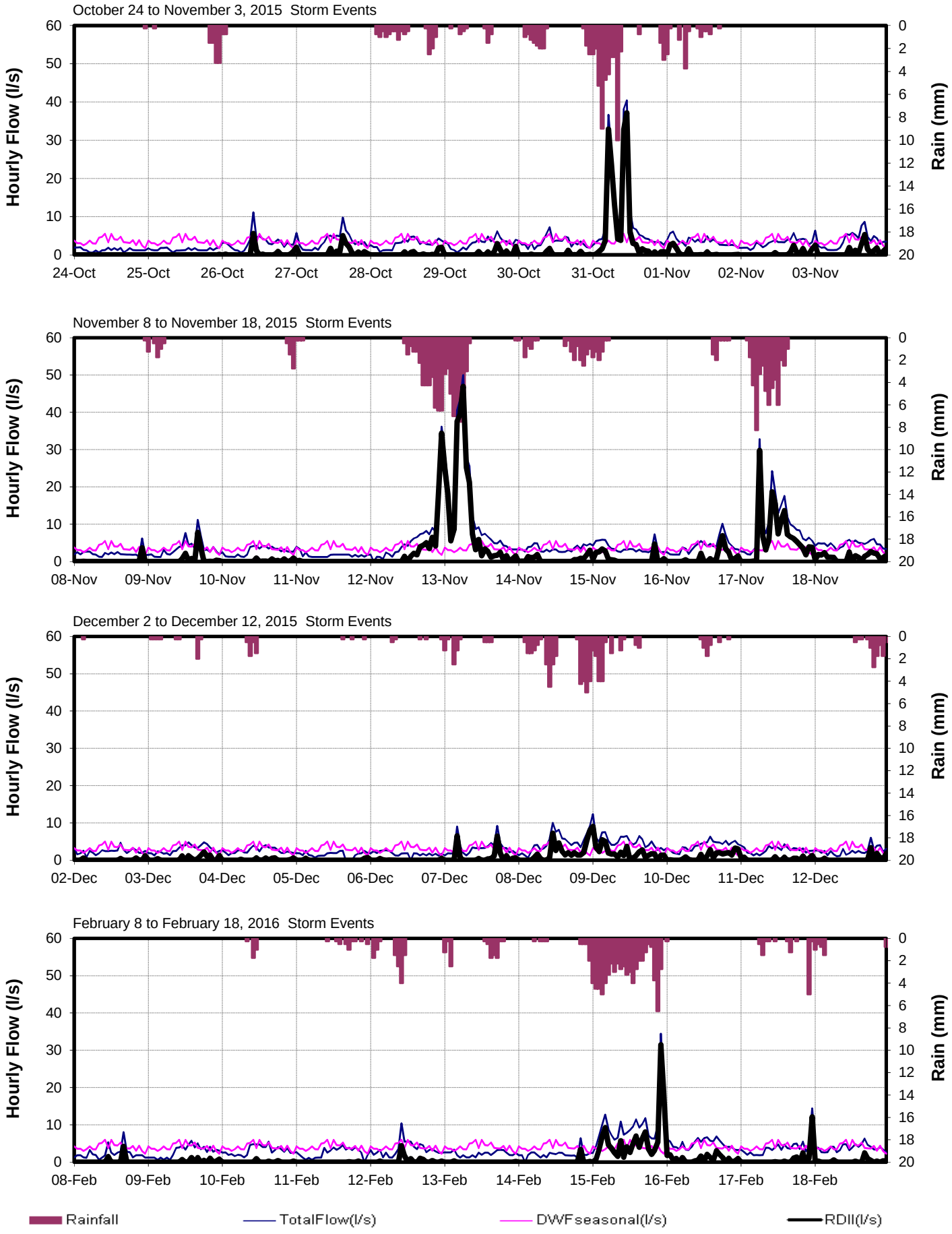
ADWF vs. PWWF Graph



Government (VIC38)

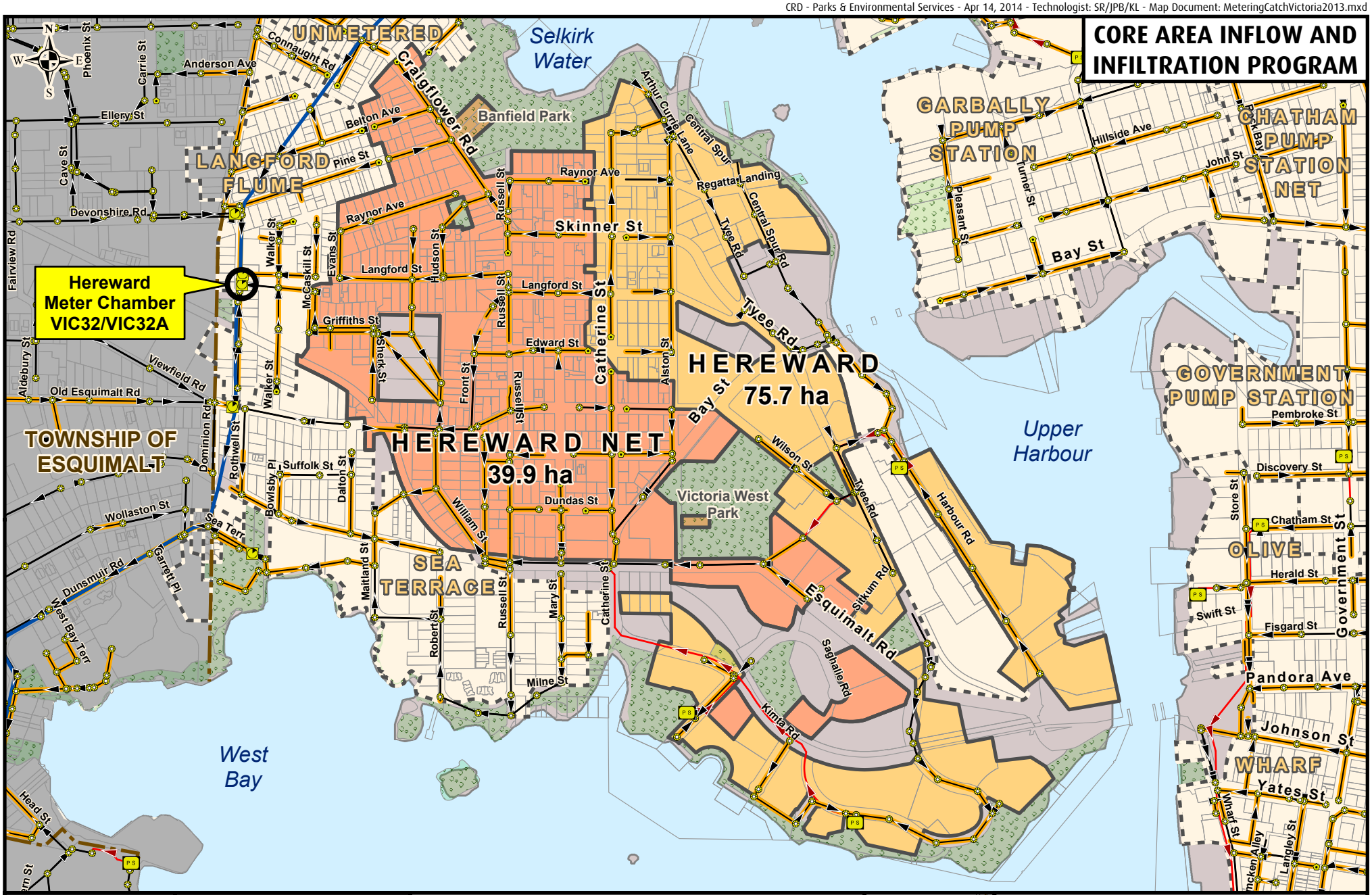


Government (VIC38)



CRD - Parks & Environmental Services - Apr 14, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchVictoria2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

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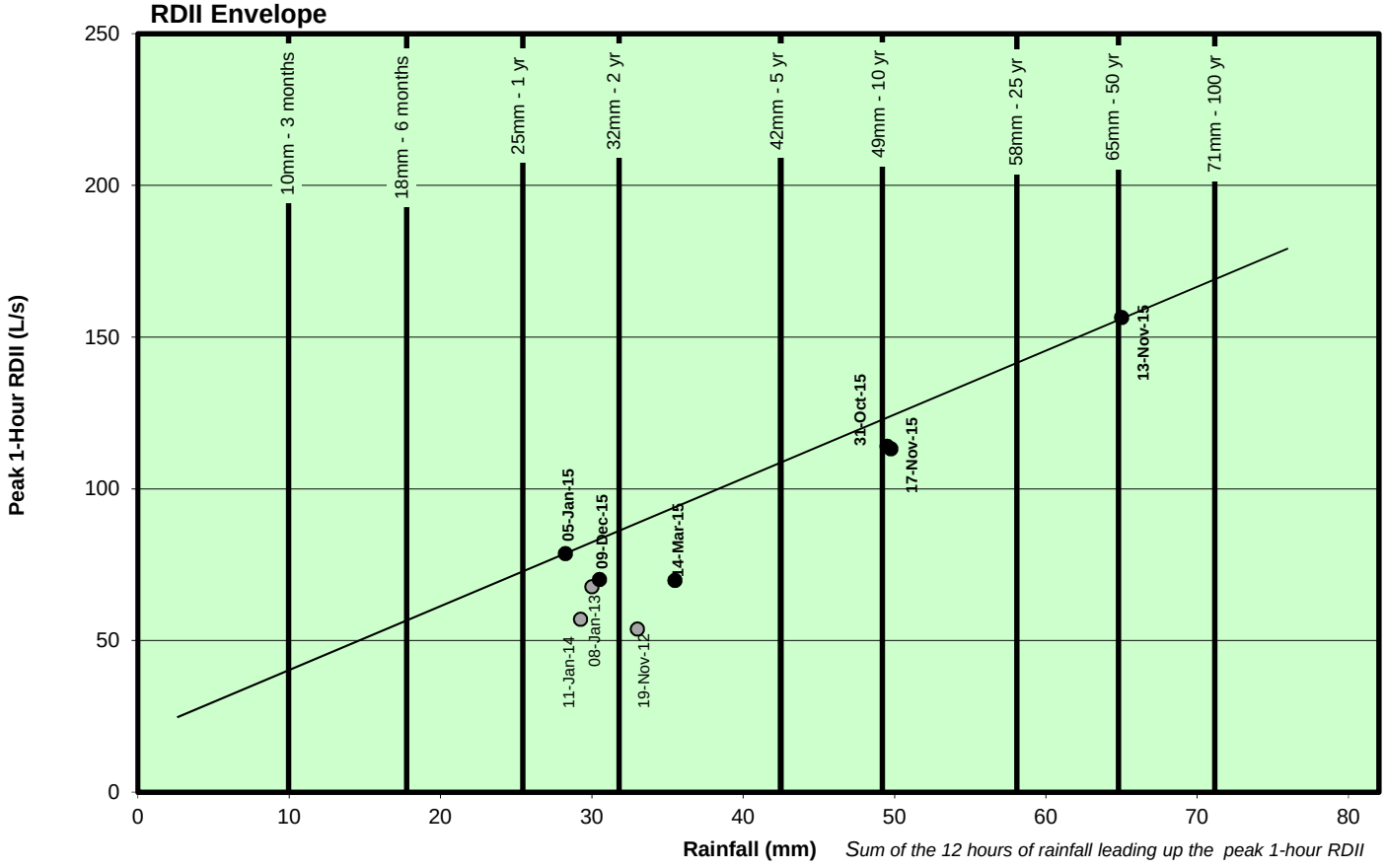
FLOW MONITORING AREA

CATCHMENT: HEREWARD/HEREWARDNET

SITE CODE: **VIC32/VIC32A**

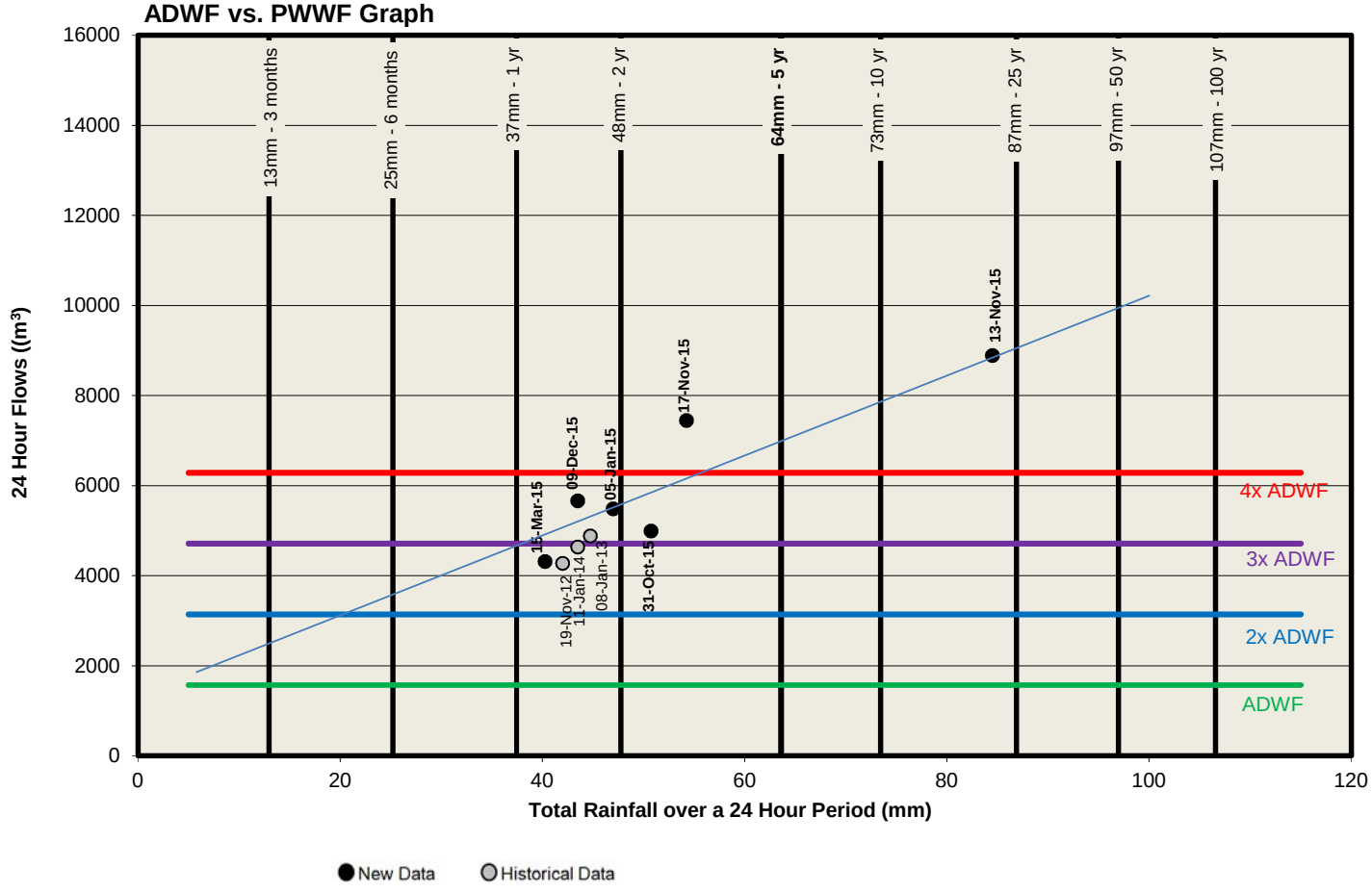
Hereward (VIC32)

RDII Envelope

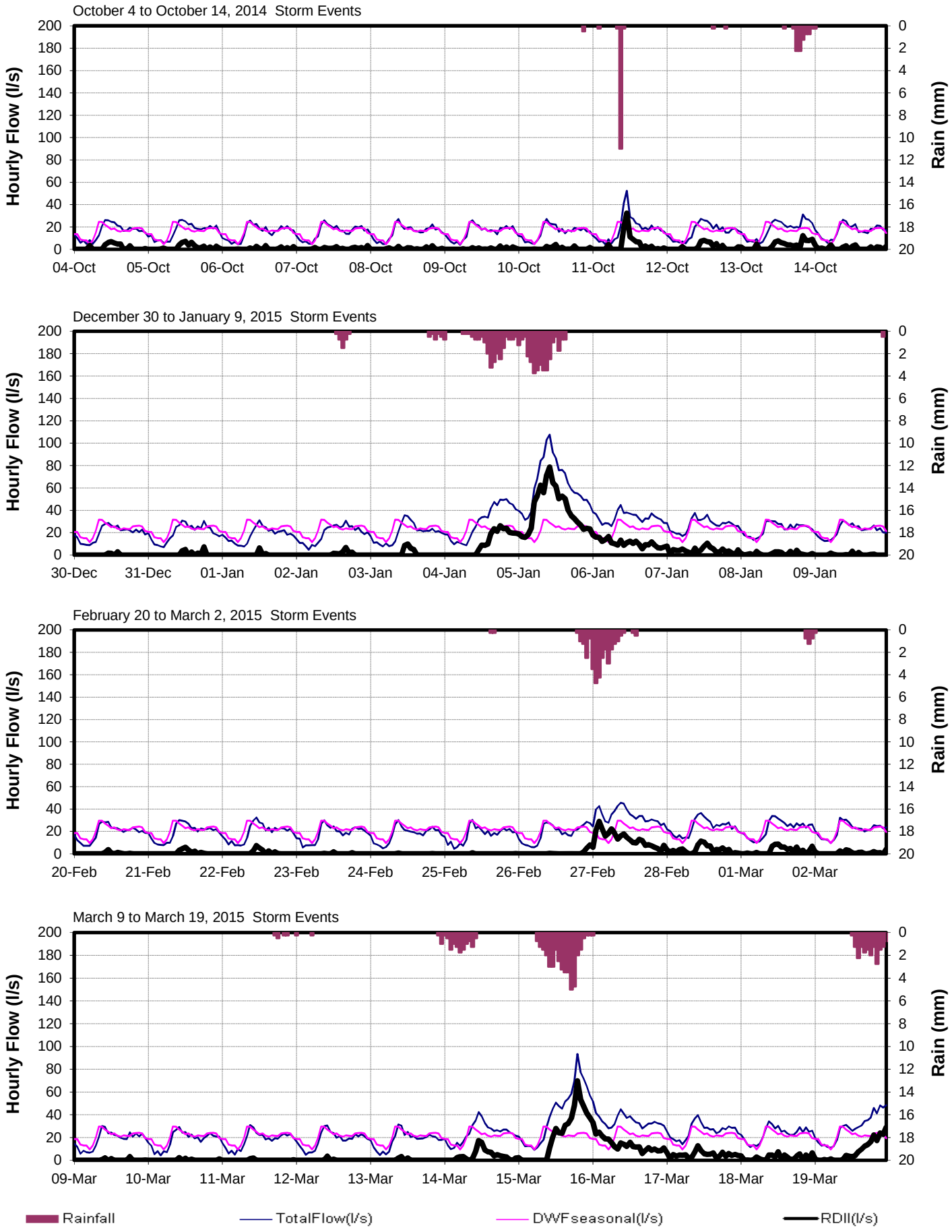


Sum of the 12 hours of rainfall leading up the peak 1-hour RDII

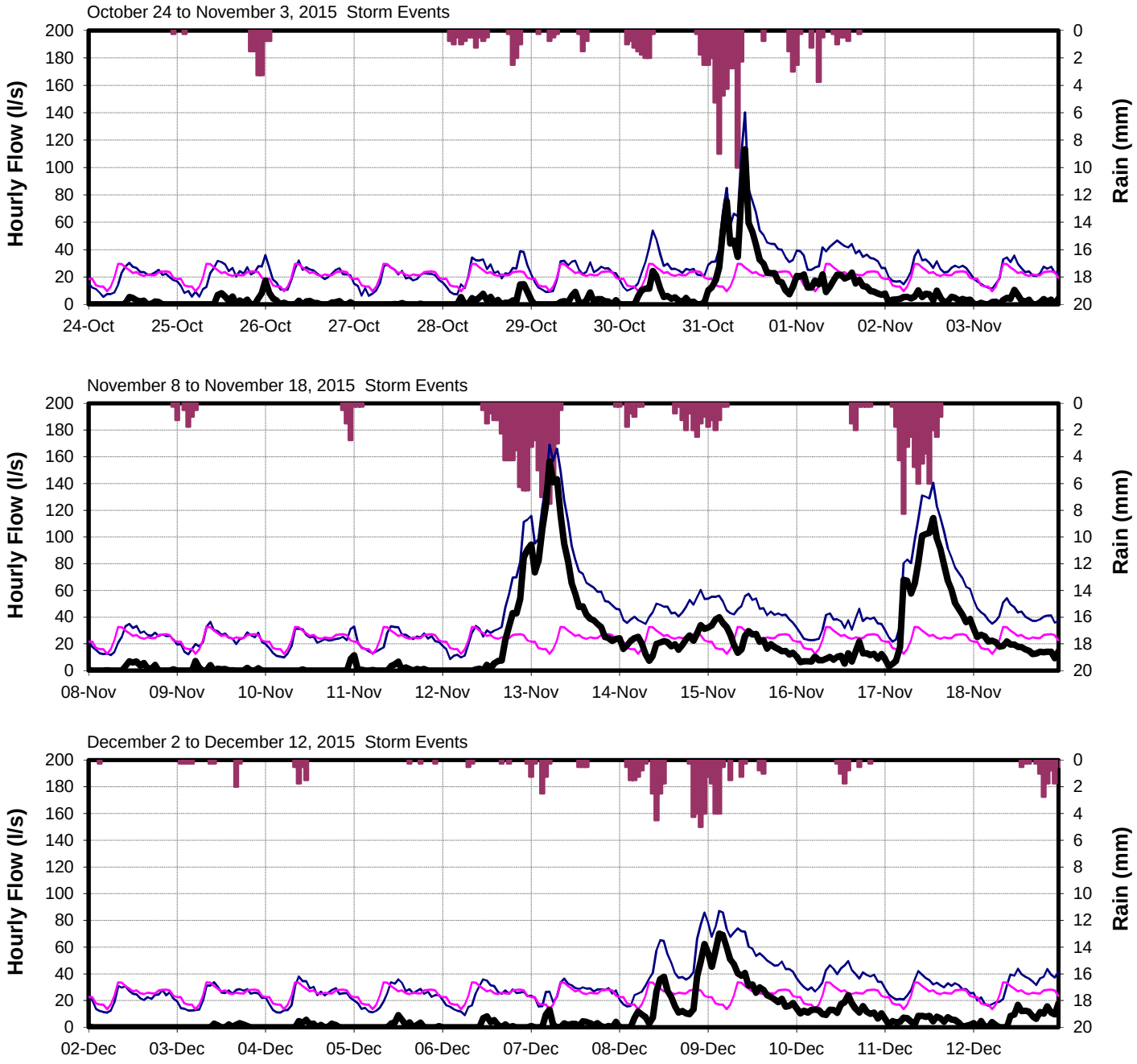
ADWF vs. PWWF Graph



Hereward (VIC32)

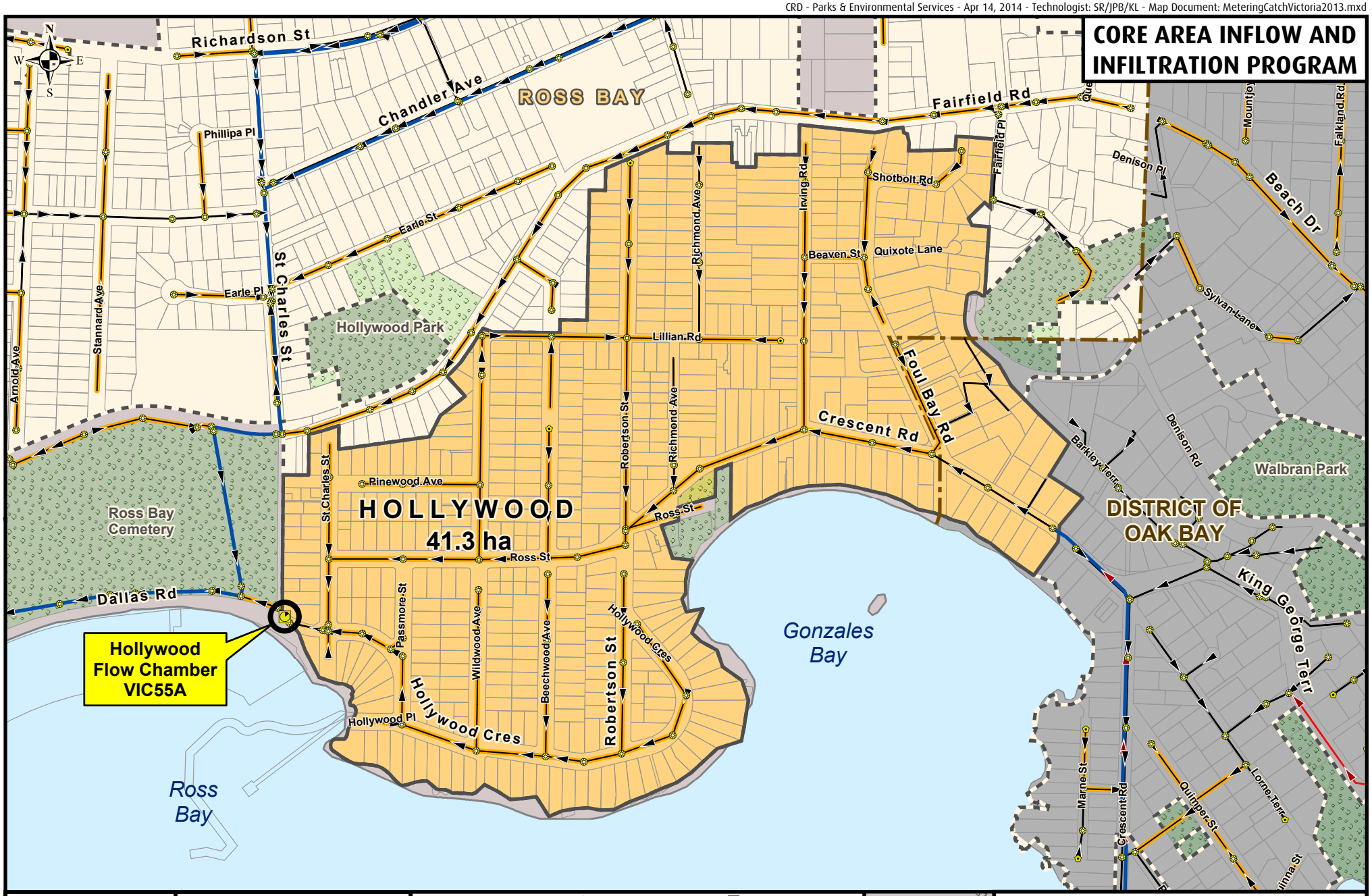


Hereward (VIC32)



CRD - Parks & Environmental Services - Apr 14, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchVictoria2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100 150 200

Projection: UTM ZONE 10N NAD 83

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- Pump Station
- Metering Chamber

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- Gravity Main Installed Before 1930
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- CRD Sewer

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- Lot Lines
- Parks
- Sewered Park Areas
- Catchment Boundary
- Municipal, First Nation, or DND Boundaries



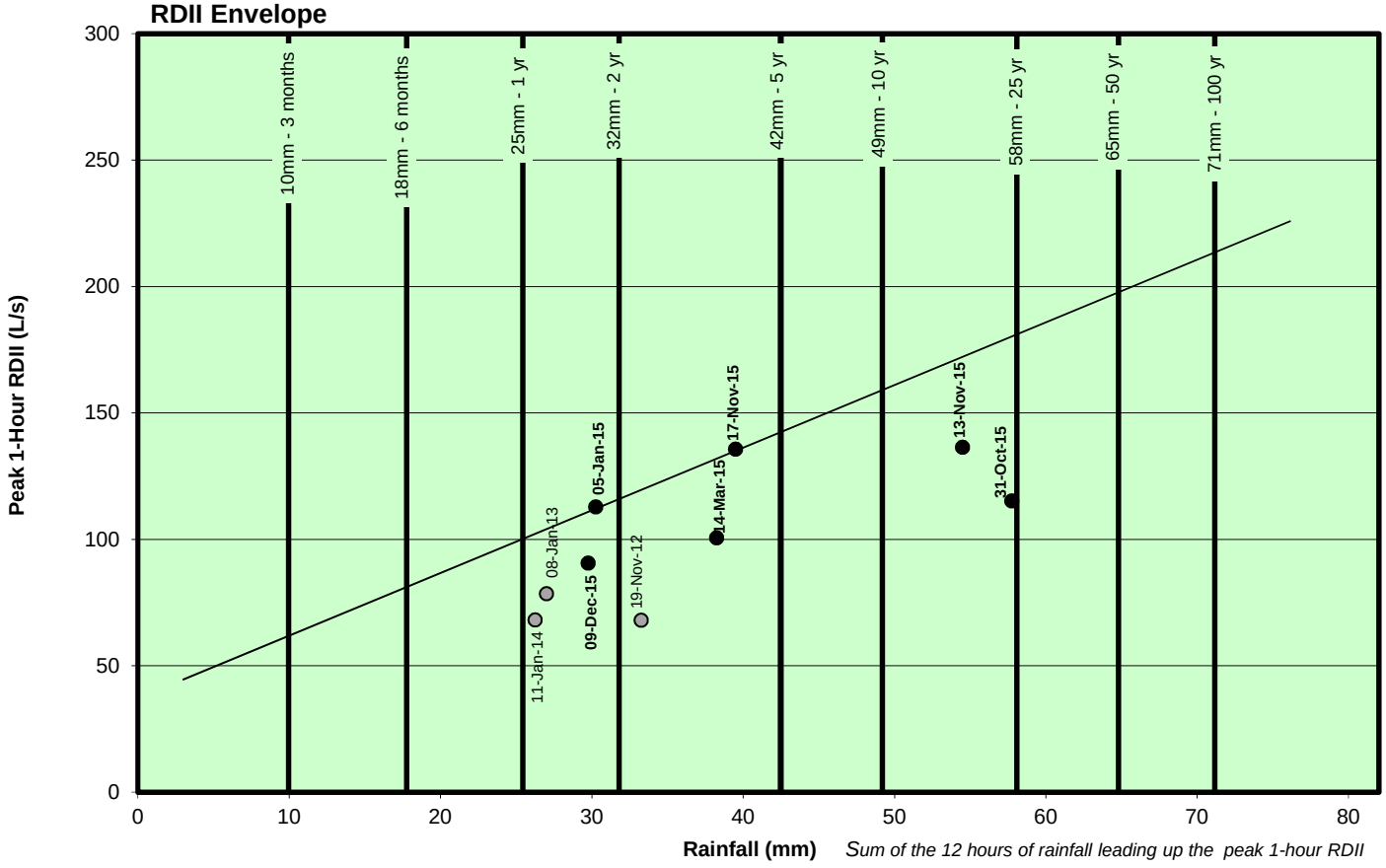
FLOW MONITORING AREA

CATCHMENT: HOLLYWOOD

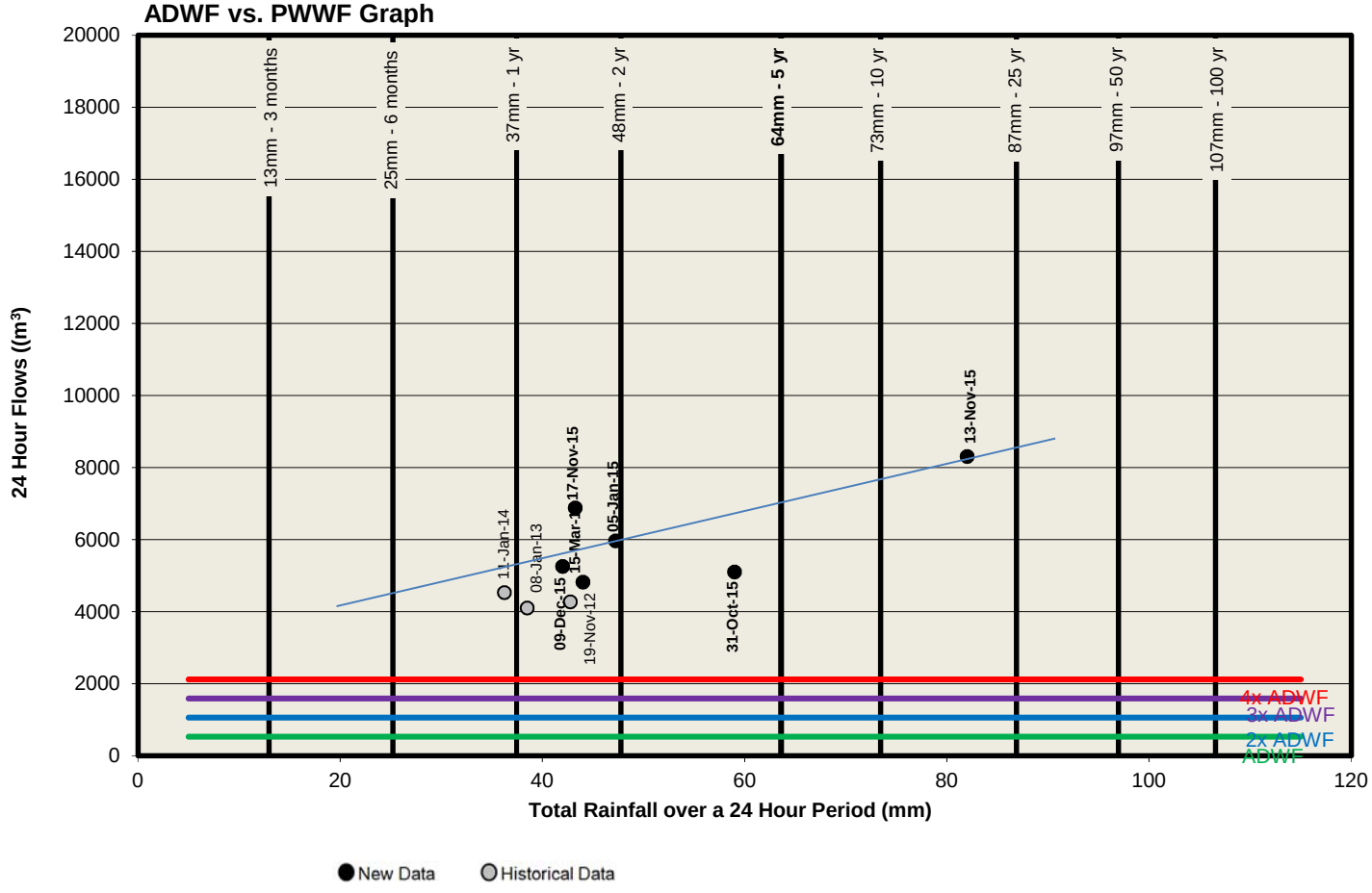
SITE CODE: **VIC55A**

Hollywood (VIC55)

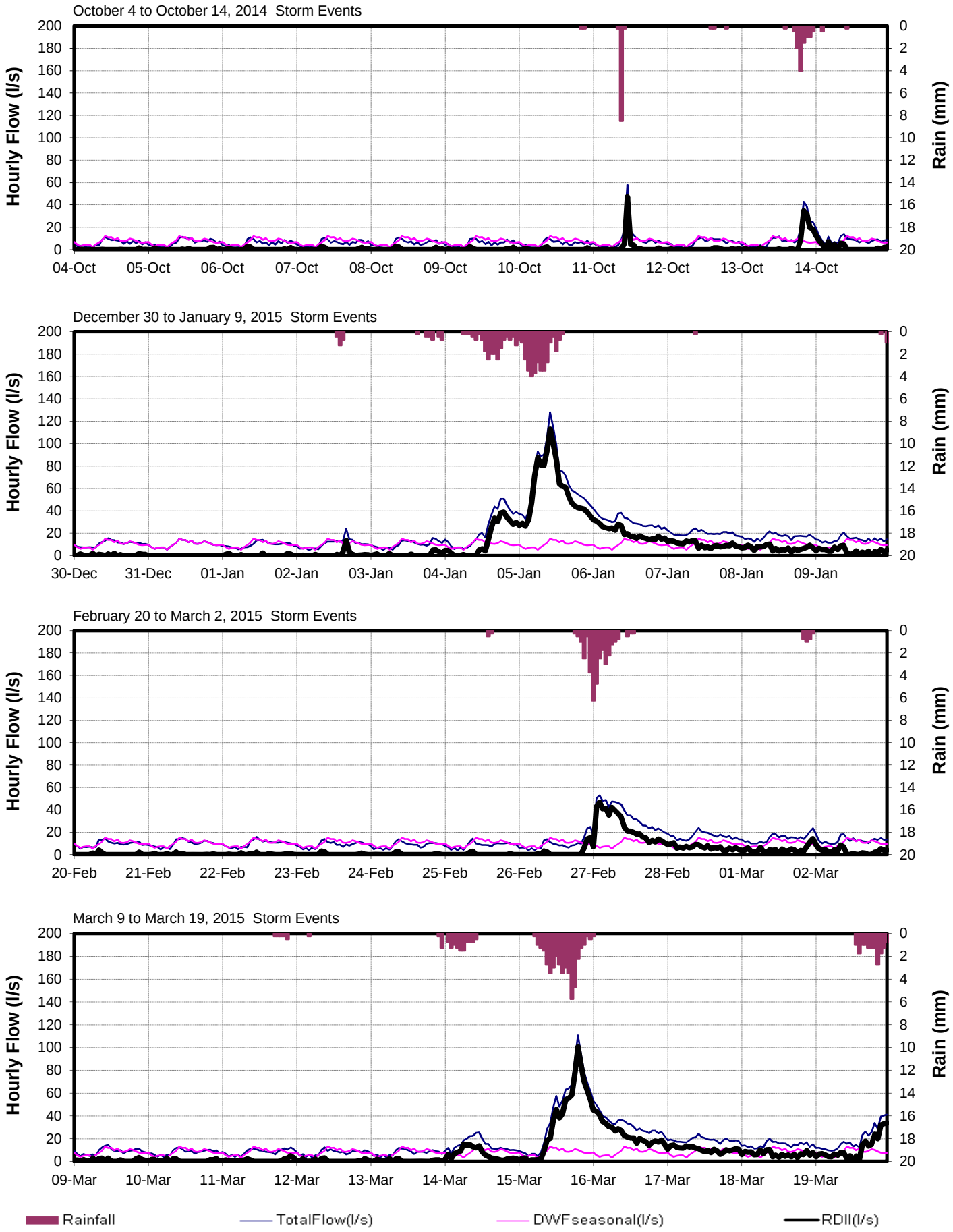
RDII Envelope



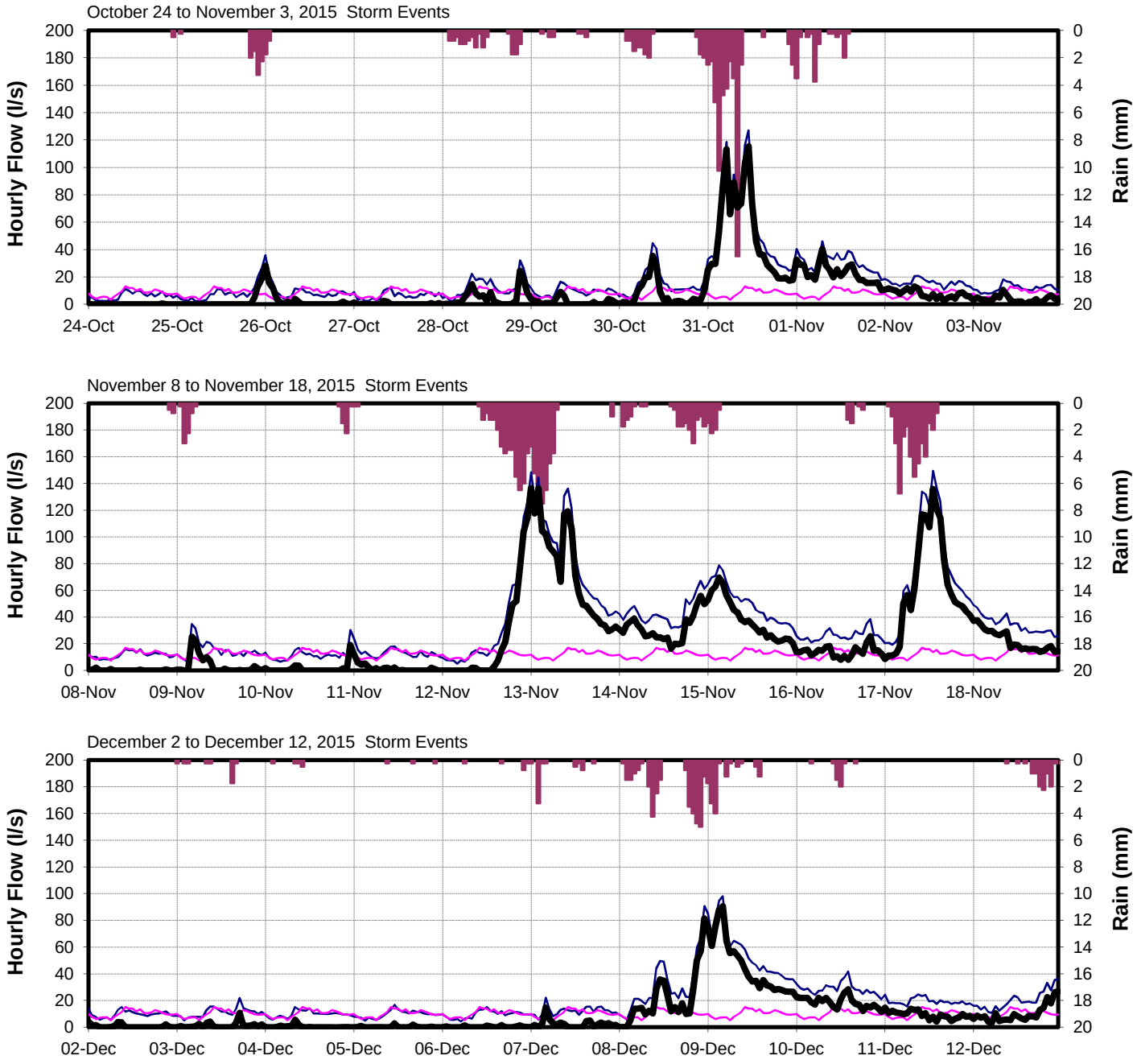
ADWF vs. PWWF Graph



Hollywood (VIC55)

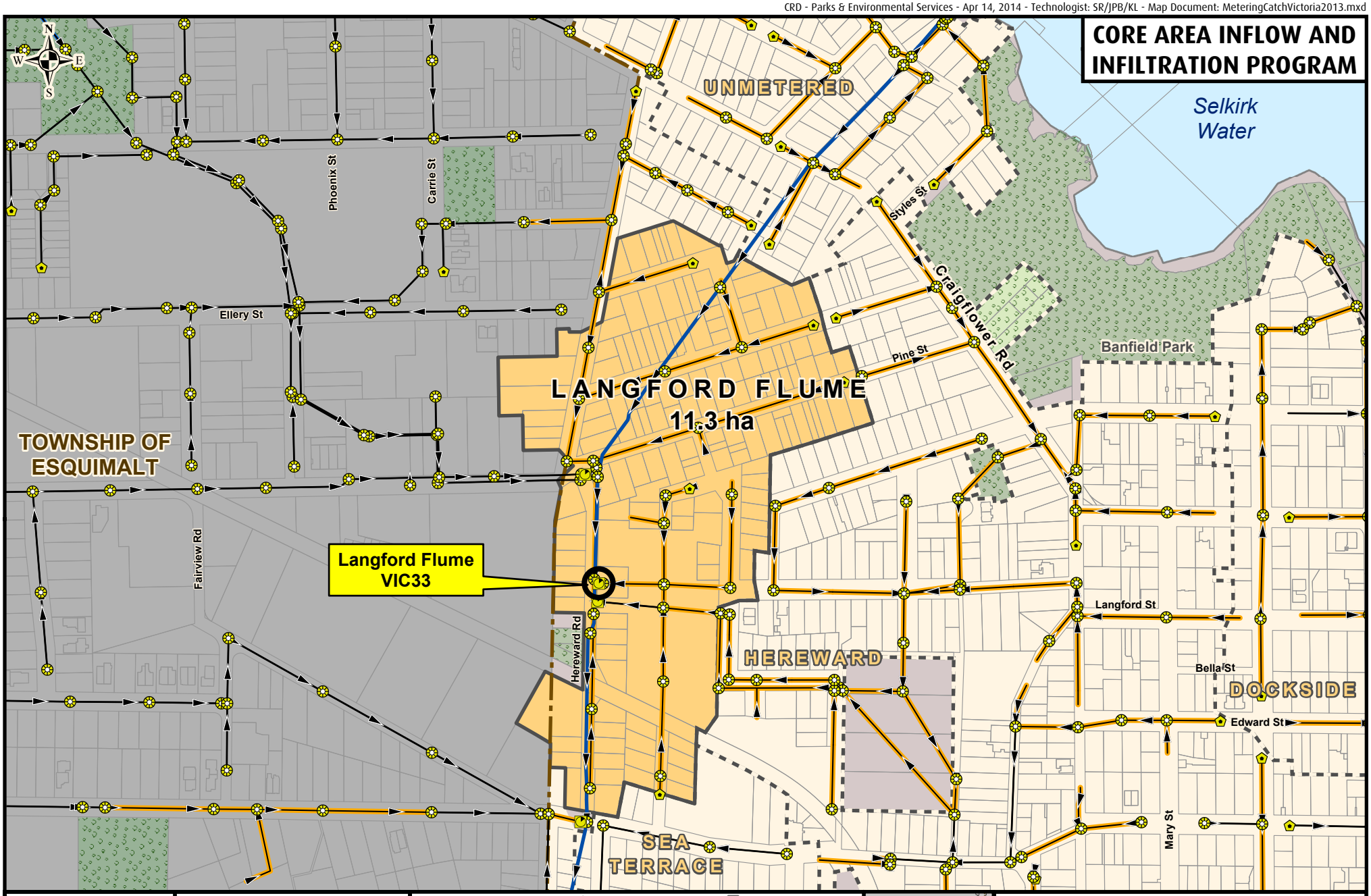


Hollywood (VIC55)



CRD - Parks & Environmental Services - Apr 14, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchVictoria2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



CRD
Making a difference...together

Metres
0 50 100 150

Projection: UTM ZONE 10N NAD 83

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- Municipal, First Nation, or DND Boundaries



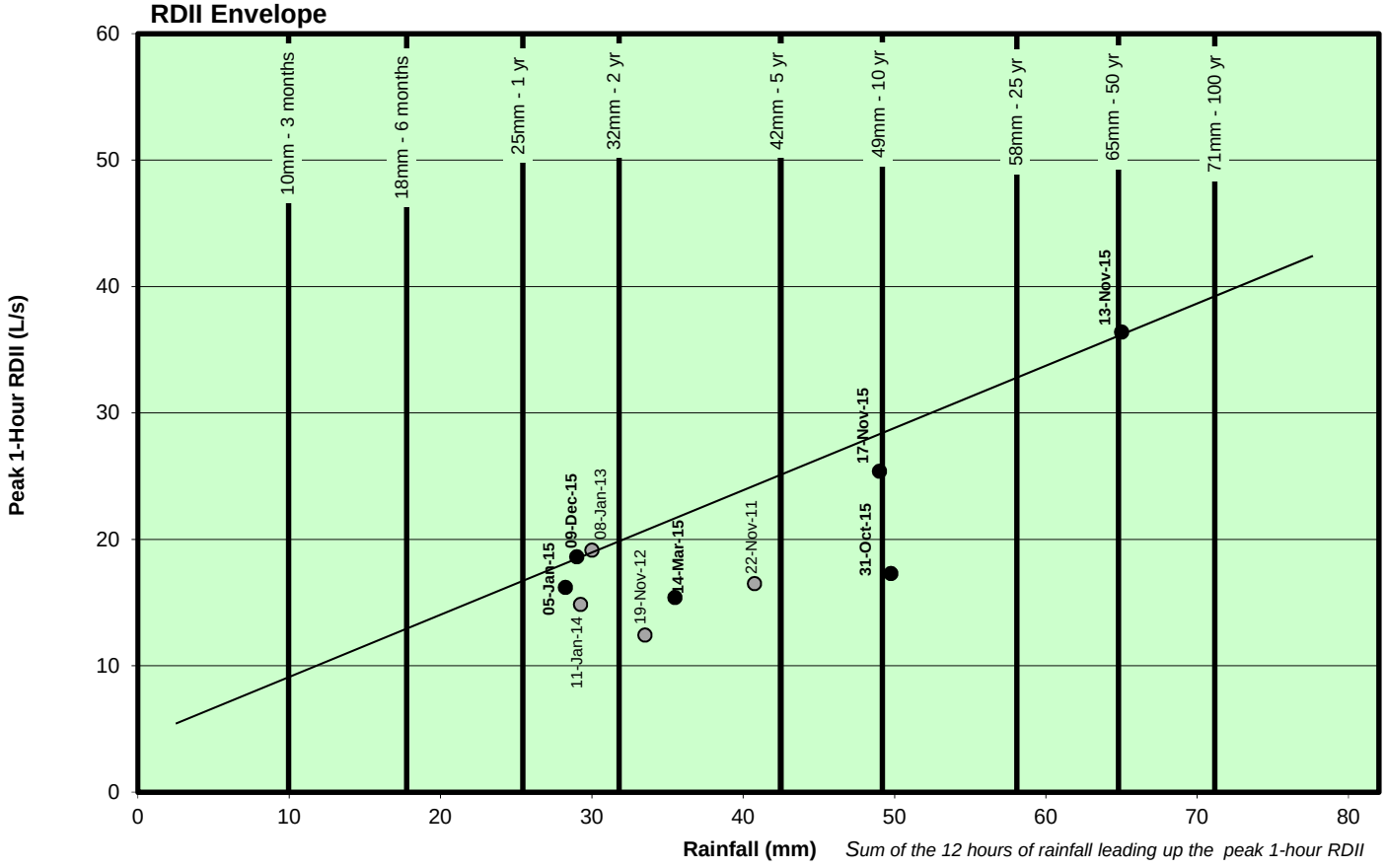
FLOW MONITORING AREA

CATCHMENT: LANGFORD FLUME

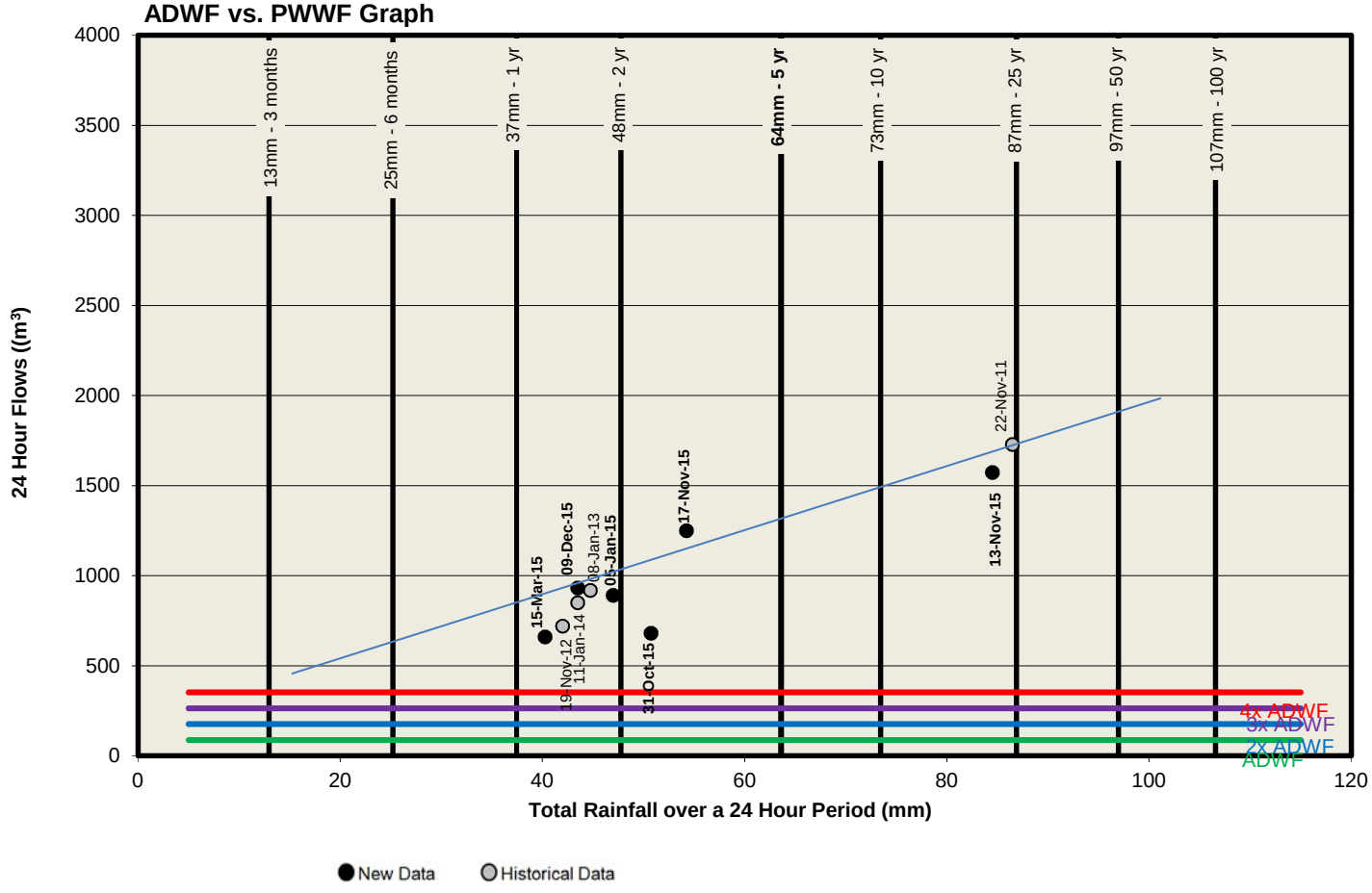
SITE CODE: **VIC33**

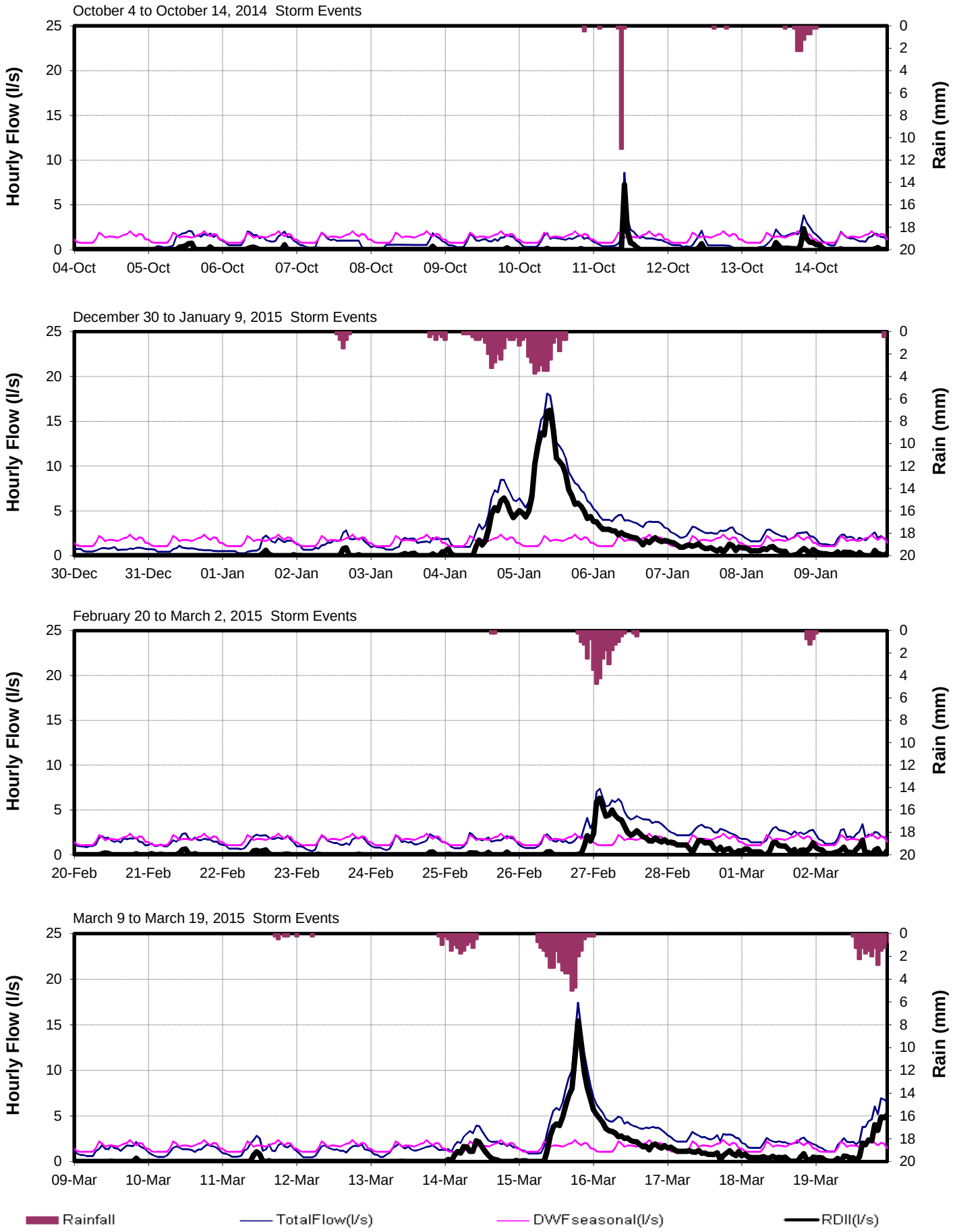
Langford Flume (VIC33)

RDII Envelope

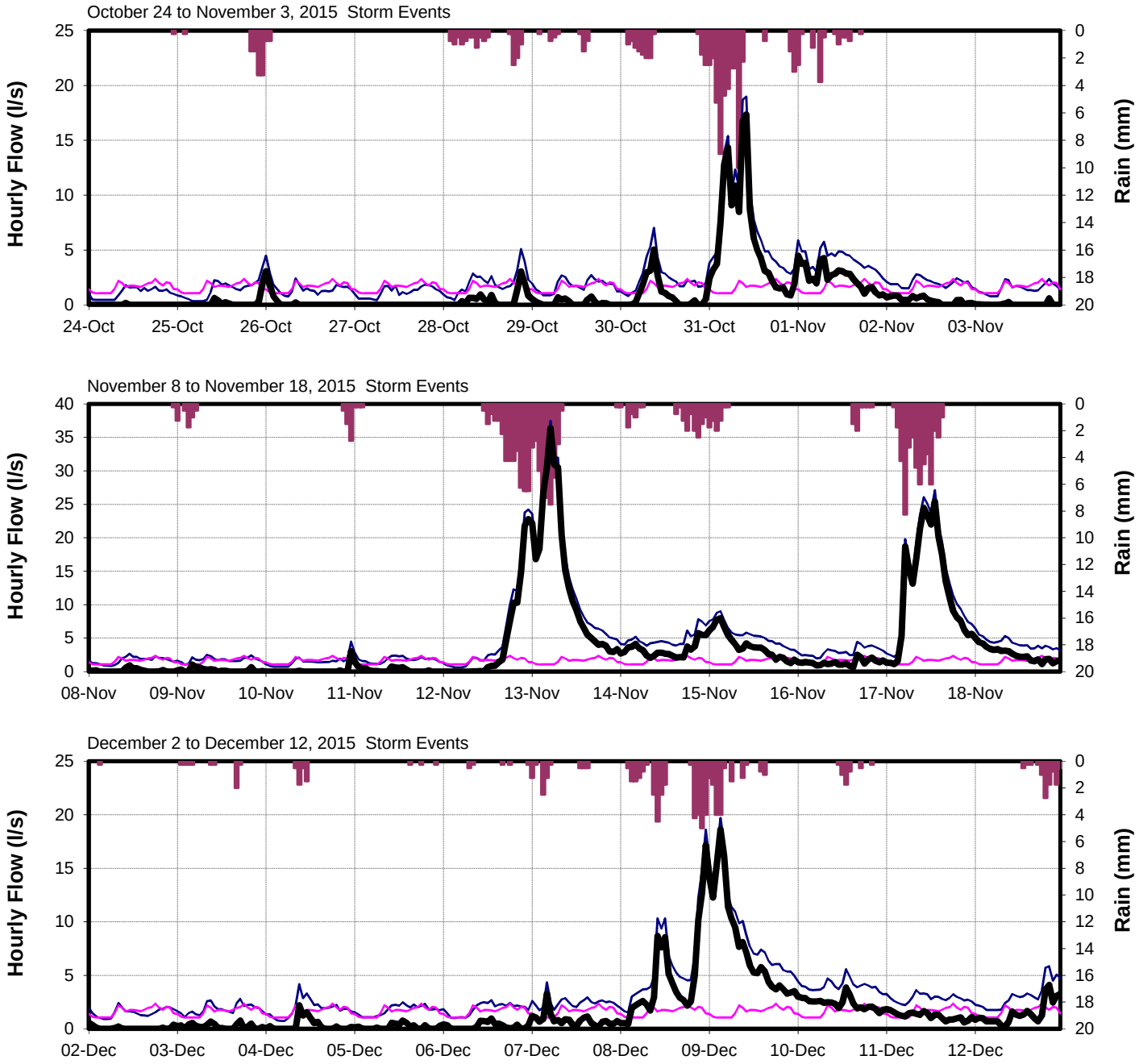


ADWF vs. PWWF Graph



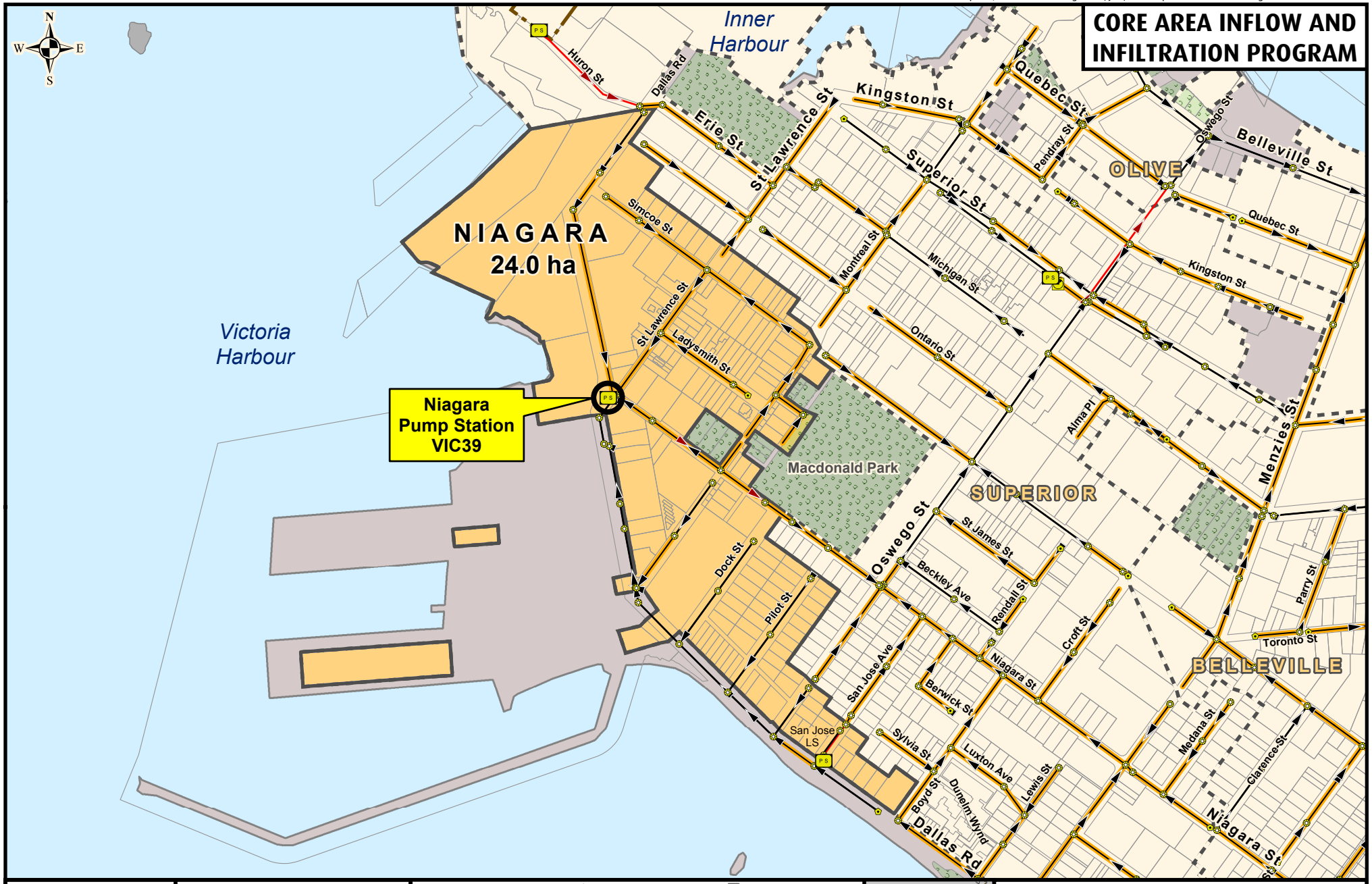

October 4 to October 14, 2014 Storm Events
Hourly Flow (l/s)
Rain (mm)
04-Oct
05-Oct
06-Oct
07-Oct
08-Oct
09-Oct
10-Oct
11-Oct
12-Oct
13-Oct
14-Oct
December 30 to January 9, 2015 Storm Events
30-Dec
31-Dec
01-Jan
02-Jan
03-Jan
04-Jan
05-Jan
06-Jan
07-Jan
08-Jan
09-Jan
February 20 to March 2, 2015 Storm Events
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
26-Feb
27-Feb
28-Feb
01-Mar
02-Mar
March 9 to March 19, 2015 Storm Events
09-Mar
10-Mar
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
19-Mar
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

Langford Flume (VIC33)



CRD - Parks & Environmental Services - Apr 14, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchVictoria2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



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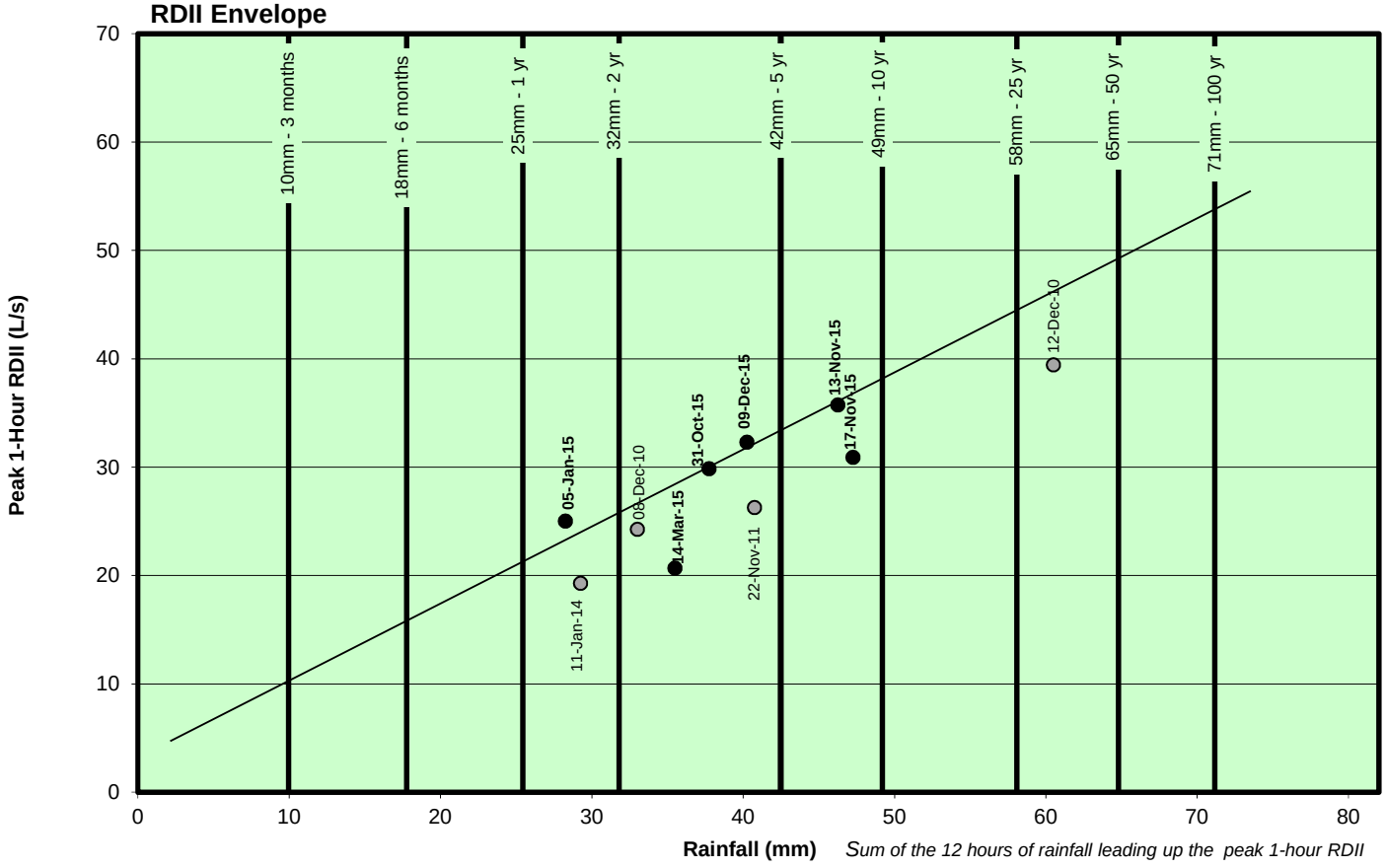
FLOW MONITORING AREA

CATCHMENT: NIAGARA

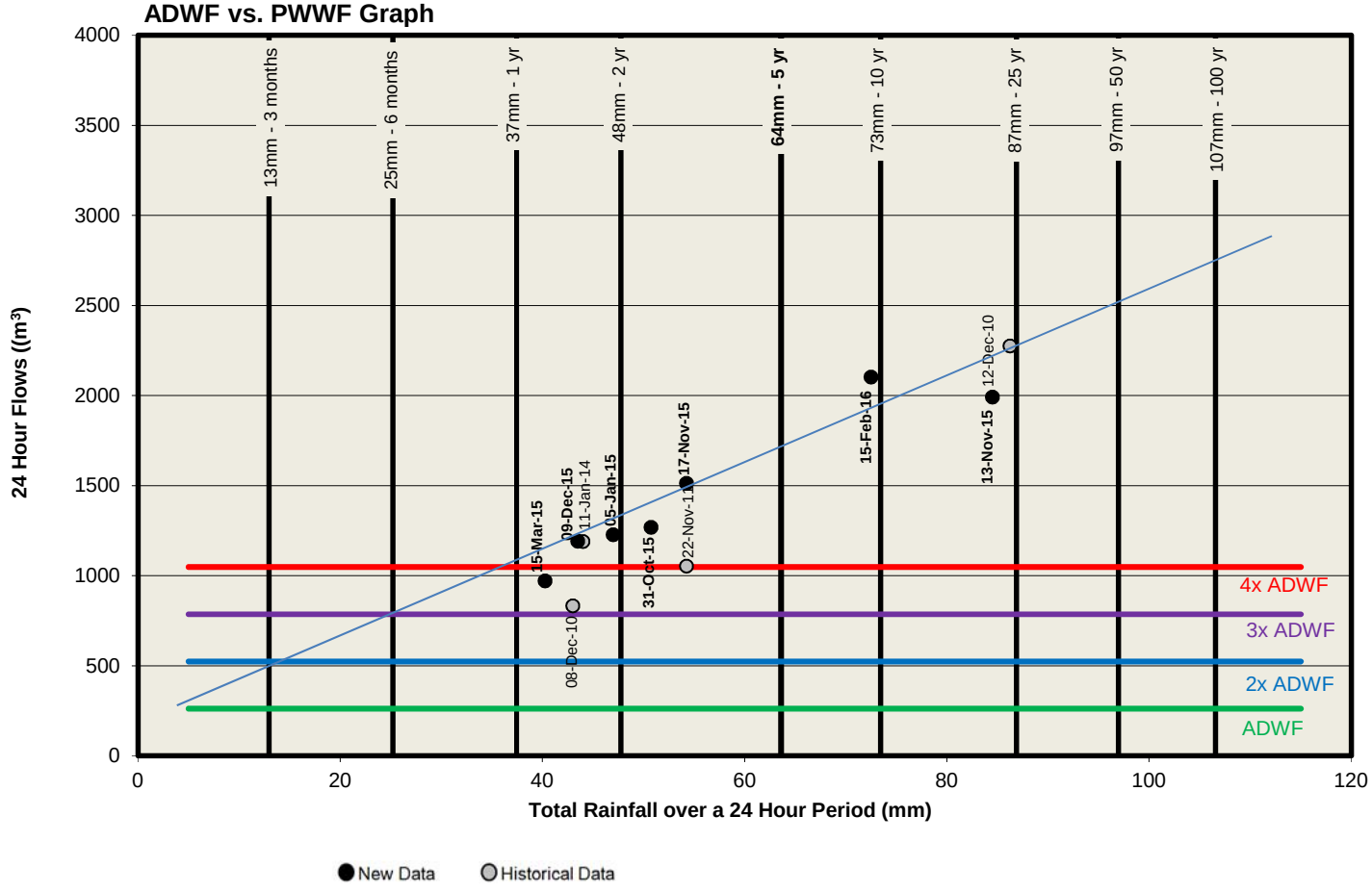
SITE CODE: **VIC39**

Niagara (VIC39)

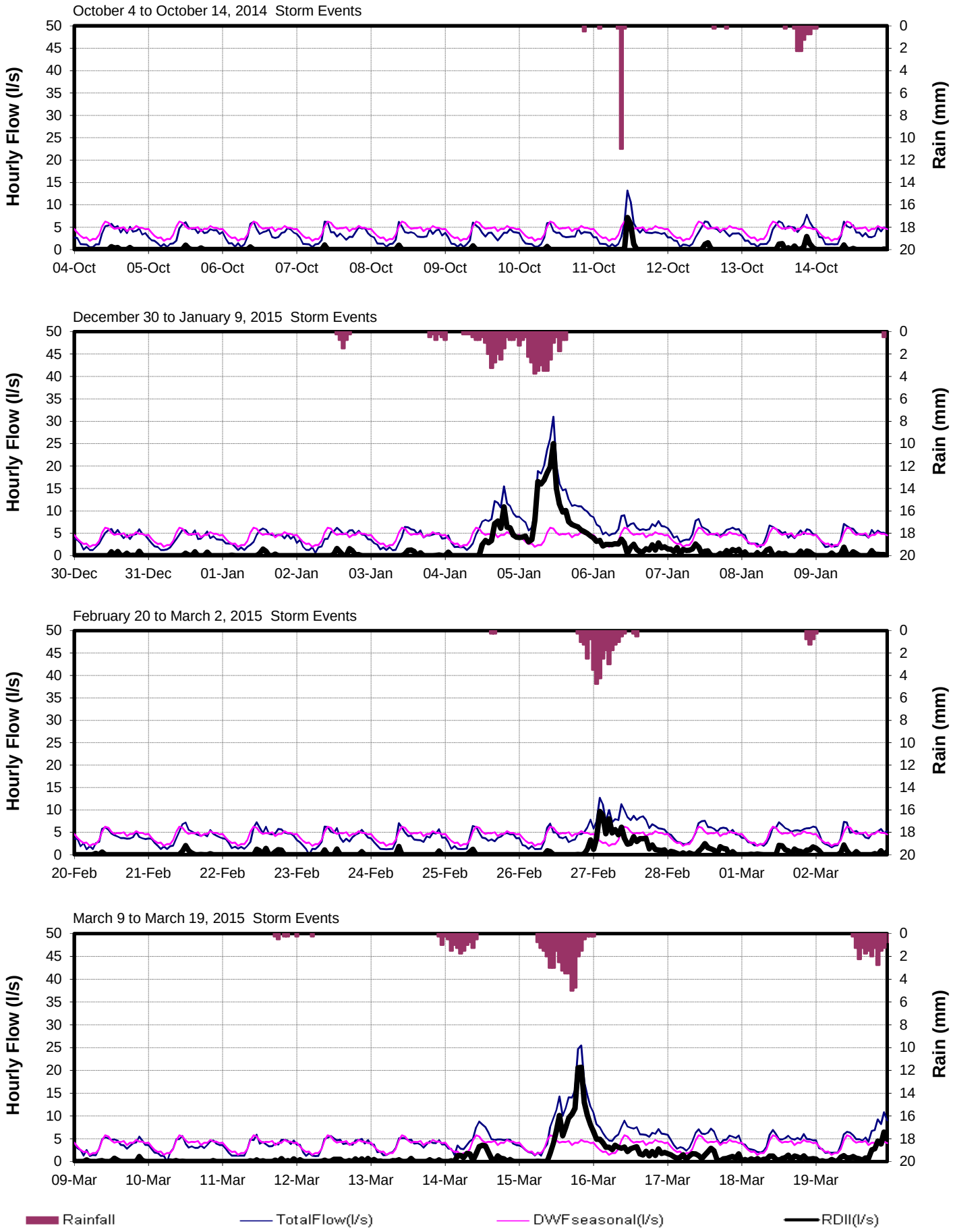
RDII Envelope



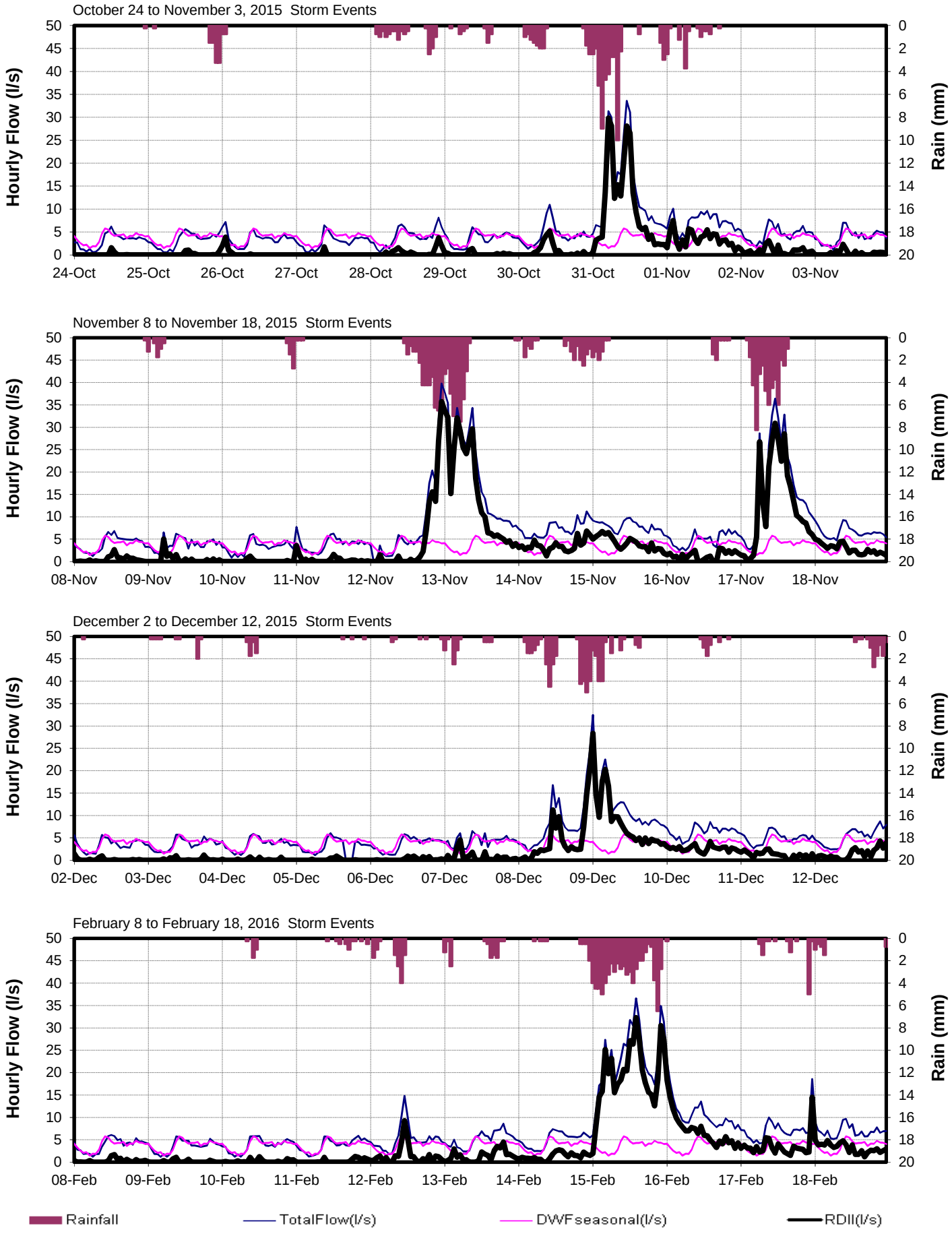
ADWF vs. PWWF Graph



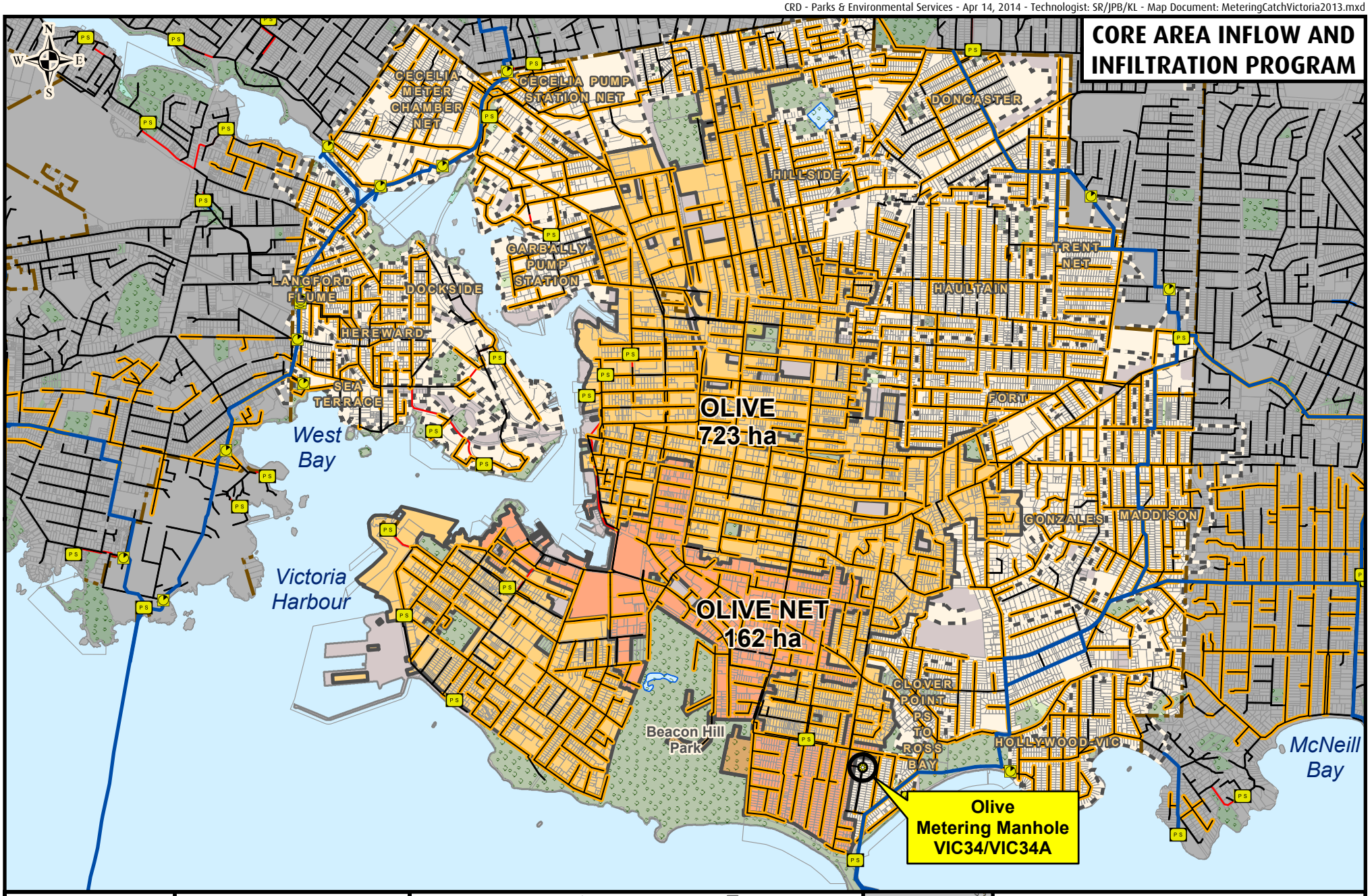
Niagara (VIC39)



Niagara (VIC39)



CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 250 500 750

Projection: UTM ZONE 10N NAD 83

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- Parks
- Sewered Park Areas
- Catchment Boundary
- Municipal, First Nation, or DND Boundaries

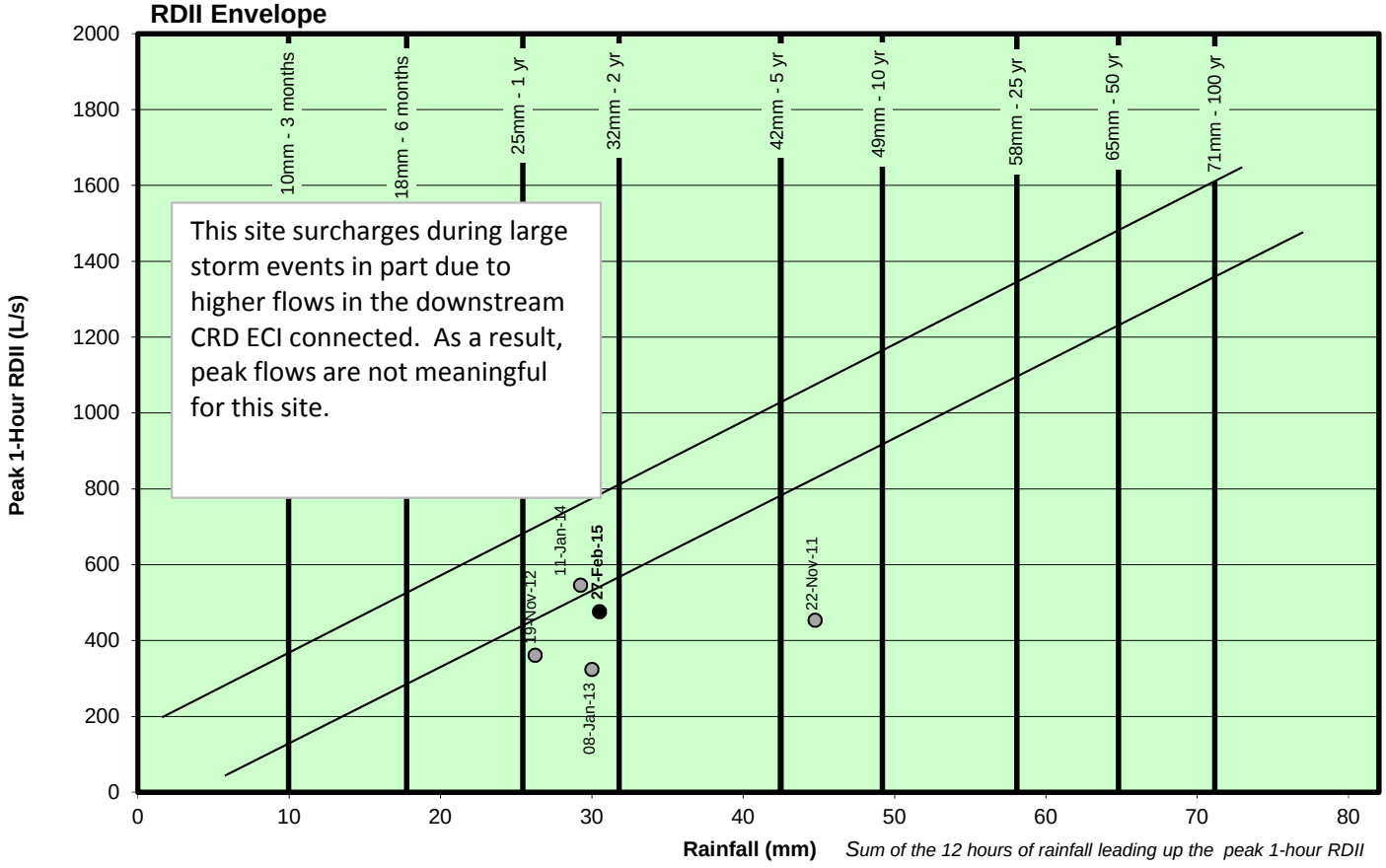
FLOW MONITORING AREA

CATCHMENT: OLIVE/OLIVENET

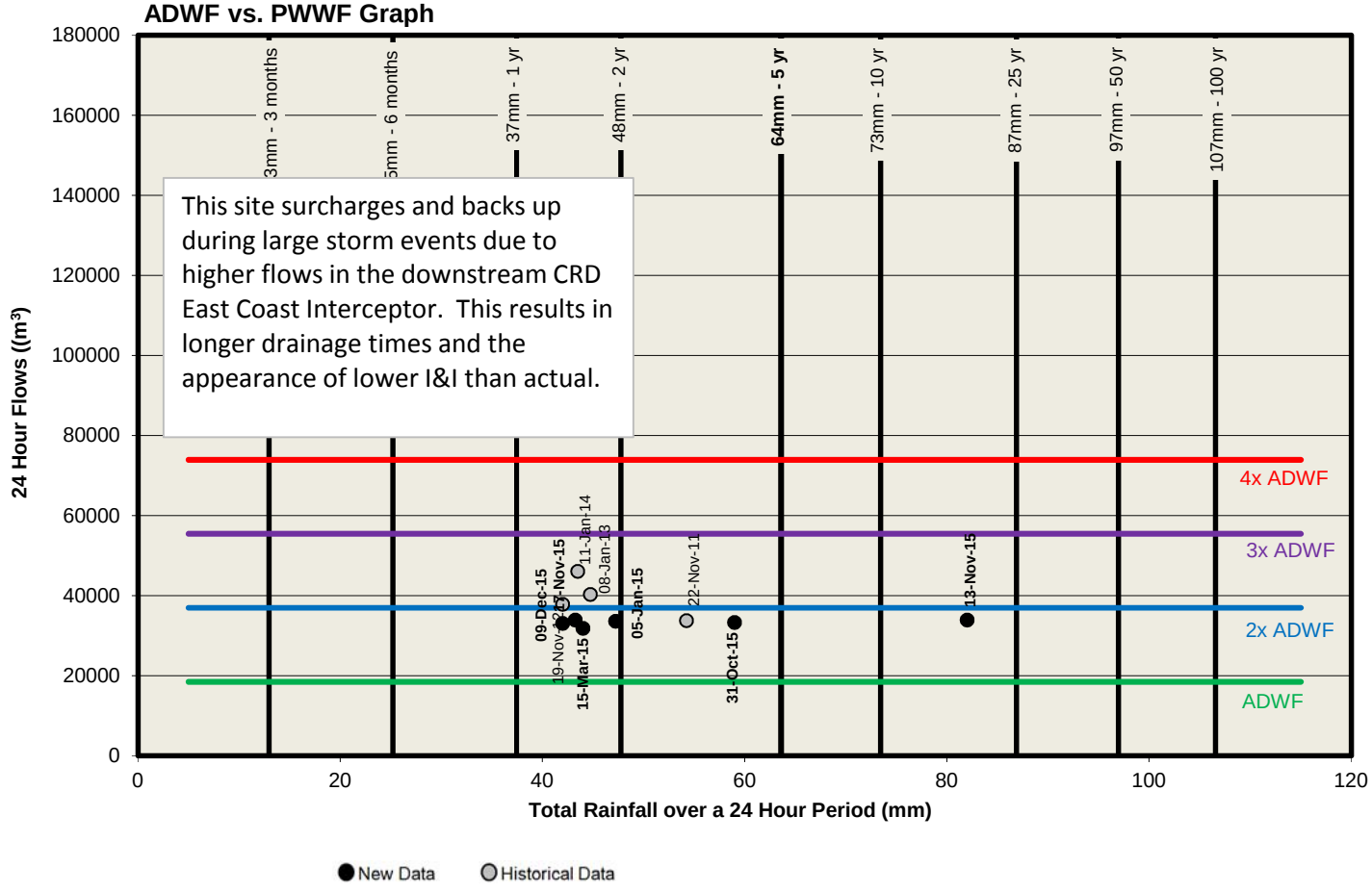
SITE CODE: **VIC34/VIC34A**

Olive (VIC34)

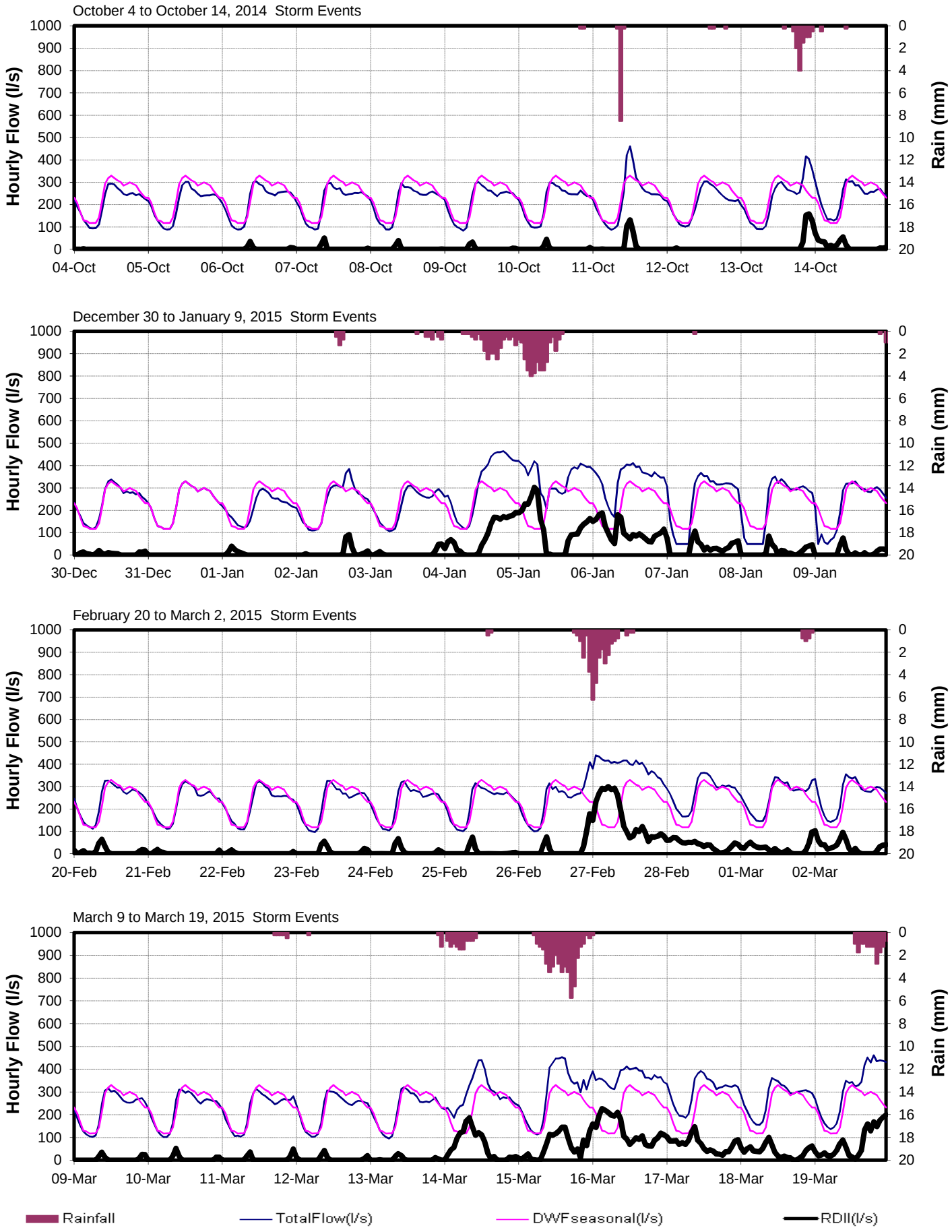
RDII Envelope



ADWF vs. PWWF Graph



Olive (VIC34)


October 4 to October 14, 2014 Storm Events
Hourly Flow (l/s)
Rain (mm)
04-Oct
05-Oct
06-Oct
07-Oct
08-Oct
09-Oct
10-Oct
11-Oct
12-Oct
13-Oct
14-Oct
December 30 to January 9, 2015 Storm Events
30-Dec
31-Dec
01-Jan
02-Jan
03-Jan
04-Jan
05-Jan
06-Jan
07-Jan
08-Jan
09-Jan
February 20 to March 2, 2015 Storm Events
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
26-Feb
27-Feb
28-Feb
01-Mar
02-Mar
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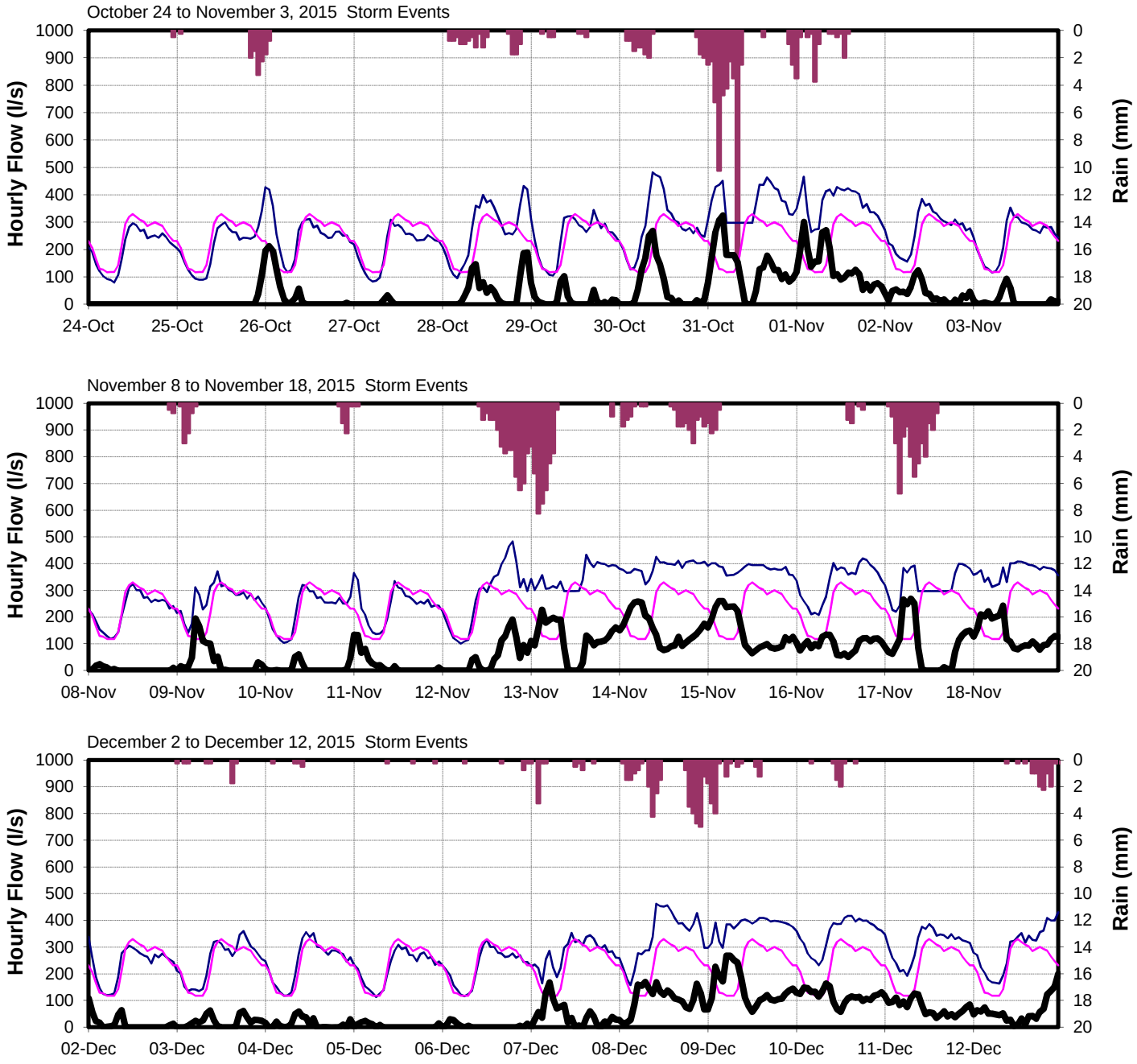
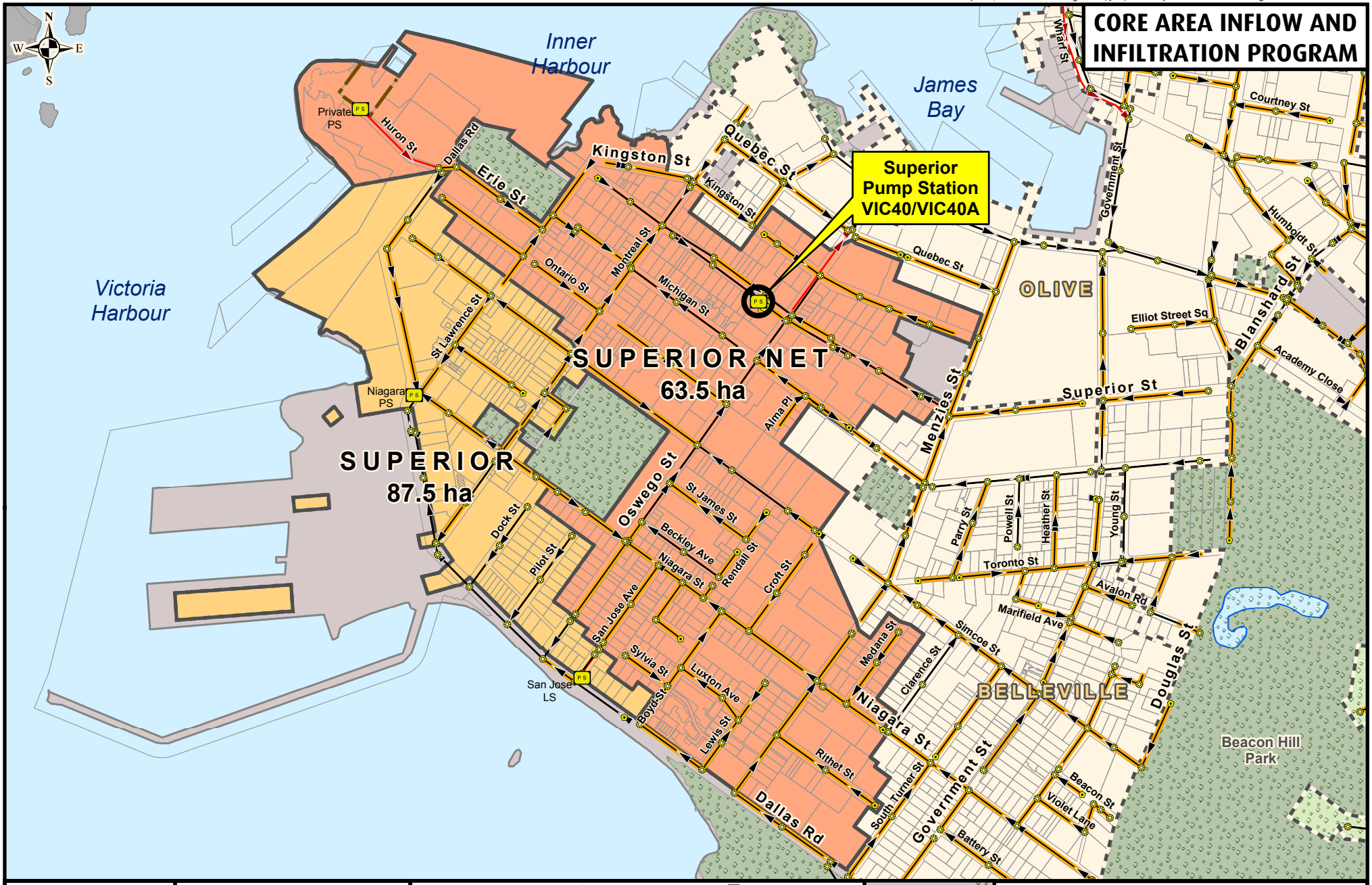
09-Mar
10-Mar
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
19-Mar
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

Olive (VIC34)


October 24 to November 3, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
1000
900
800
700
600
500
400
300
200
100
0
0
2
4
6
8
10
12
14
16
18
20
24-Oct
25-Oct
26-Oct
27-Oct
28-Oct
29-Oct
30-Oct
31-Oct
01-Nov
02-Nov
03-Nov
November 8 to November 18, 2015 Storm Events
08-Nov
09-Nov
10-Nov
11-Nov
12-Nov
13-Nov
14-Nov
15-Nov
16-Nov
17-Nov
18-Nov
December 2 to December 12, 2015 Storm Events
02-Dec
03-Dec
04-Dec
05-Dec
06-Dec
07-Dec
08-Dec
09-Dec
10-Dec
11-Dec
12-Dec
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

CRD - Parks & Environmental Services - Apr 14, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchVictoria2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100 150 200 250

Projection: UTM ZONE 10N NAD 83

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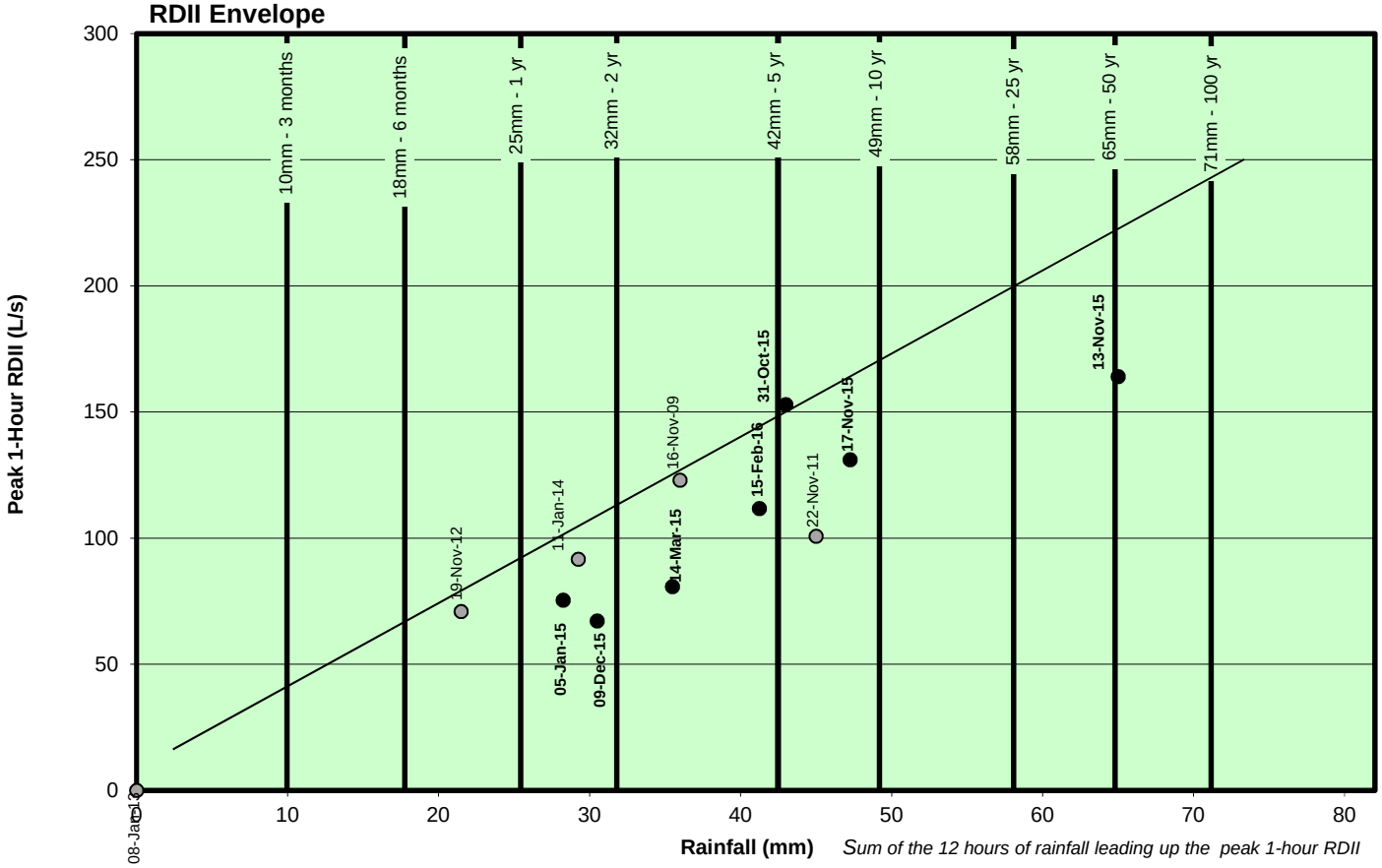
FLOW MONITORING AREA

CATCHMENT: SUPERIOR/SUPERIOR NET

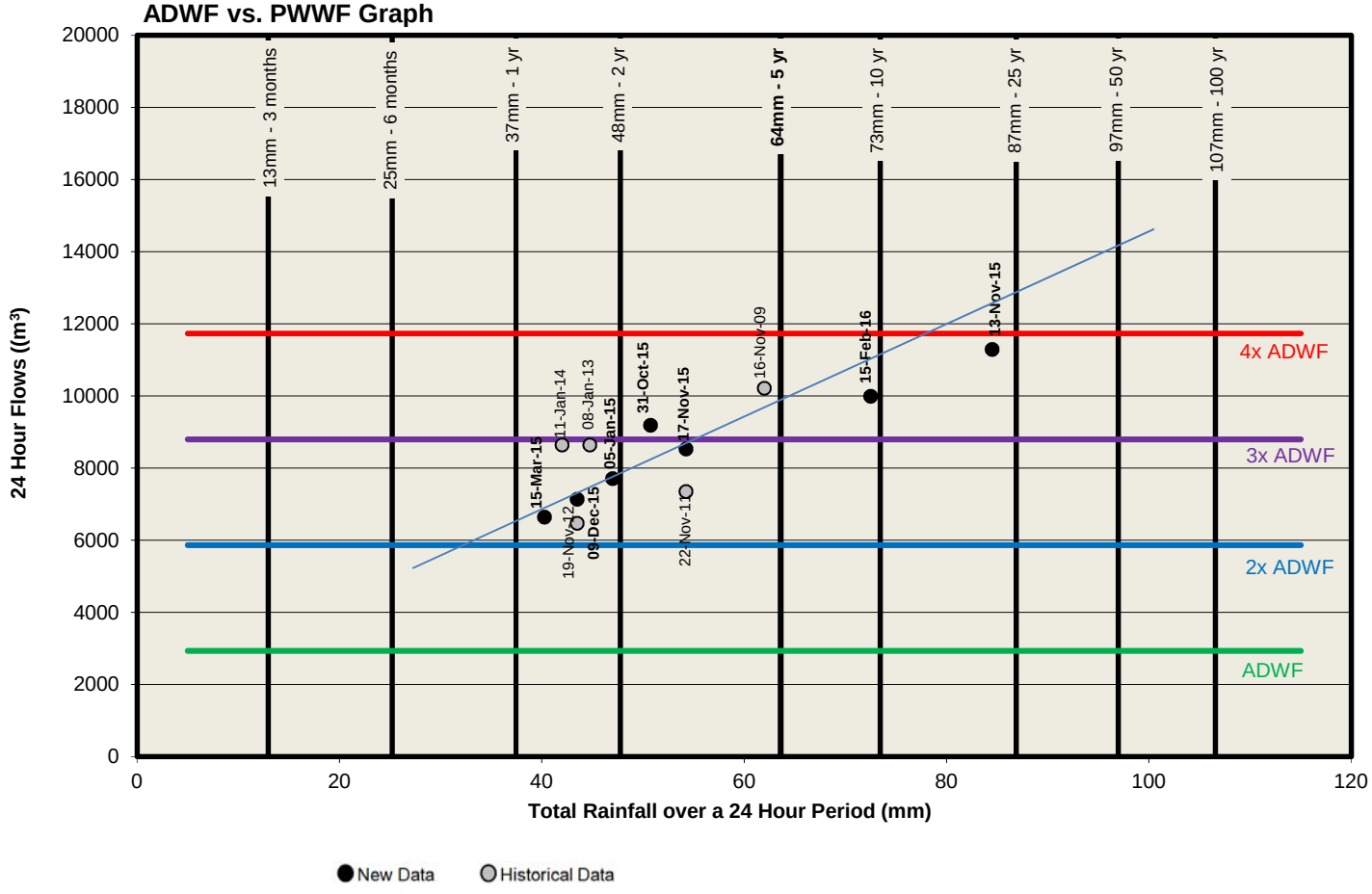
SITE CODE: **VIC40/VIC40A**

Superior (VIC40)

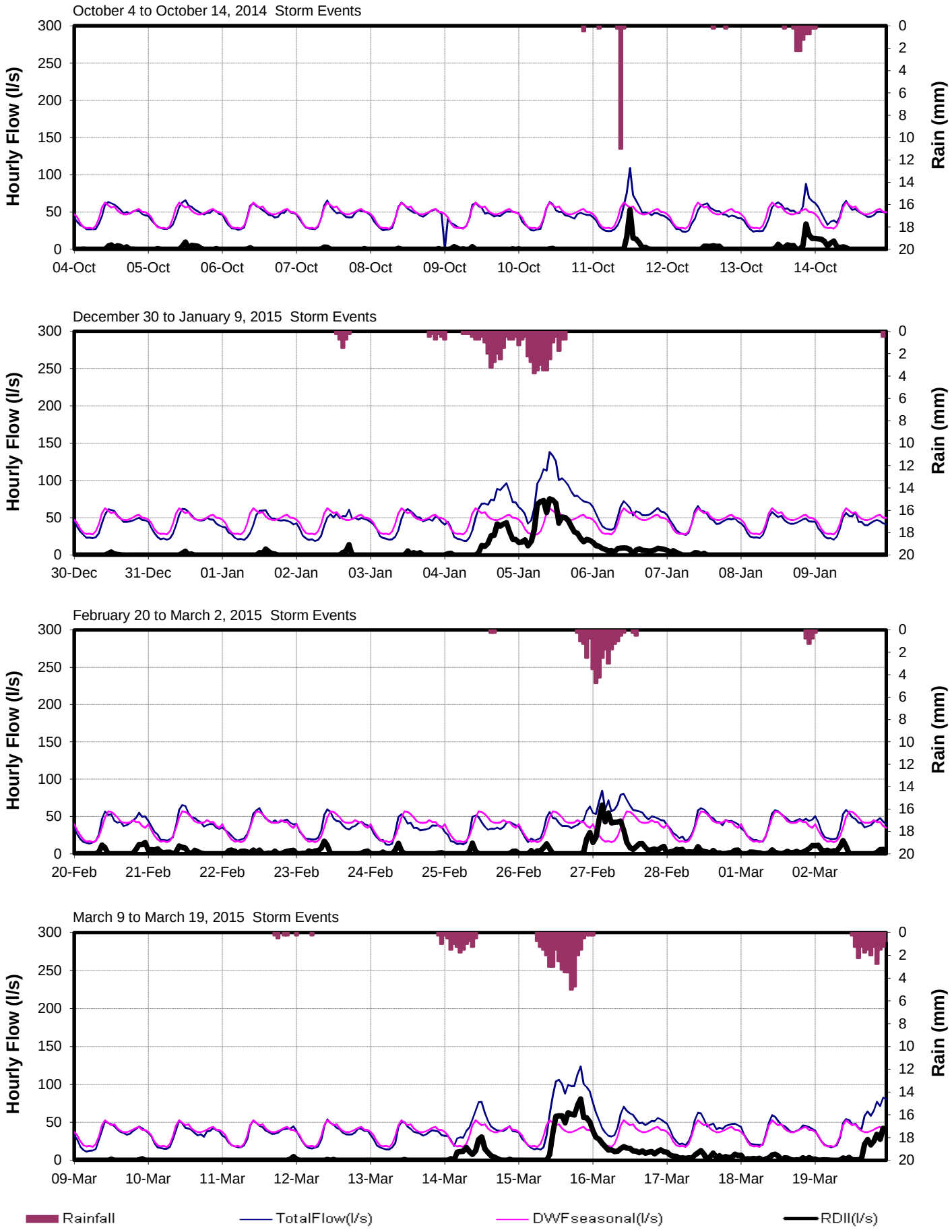
RDII Envelope



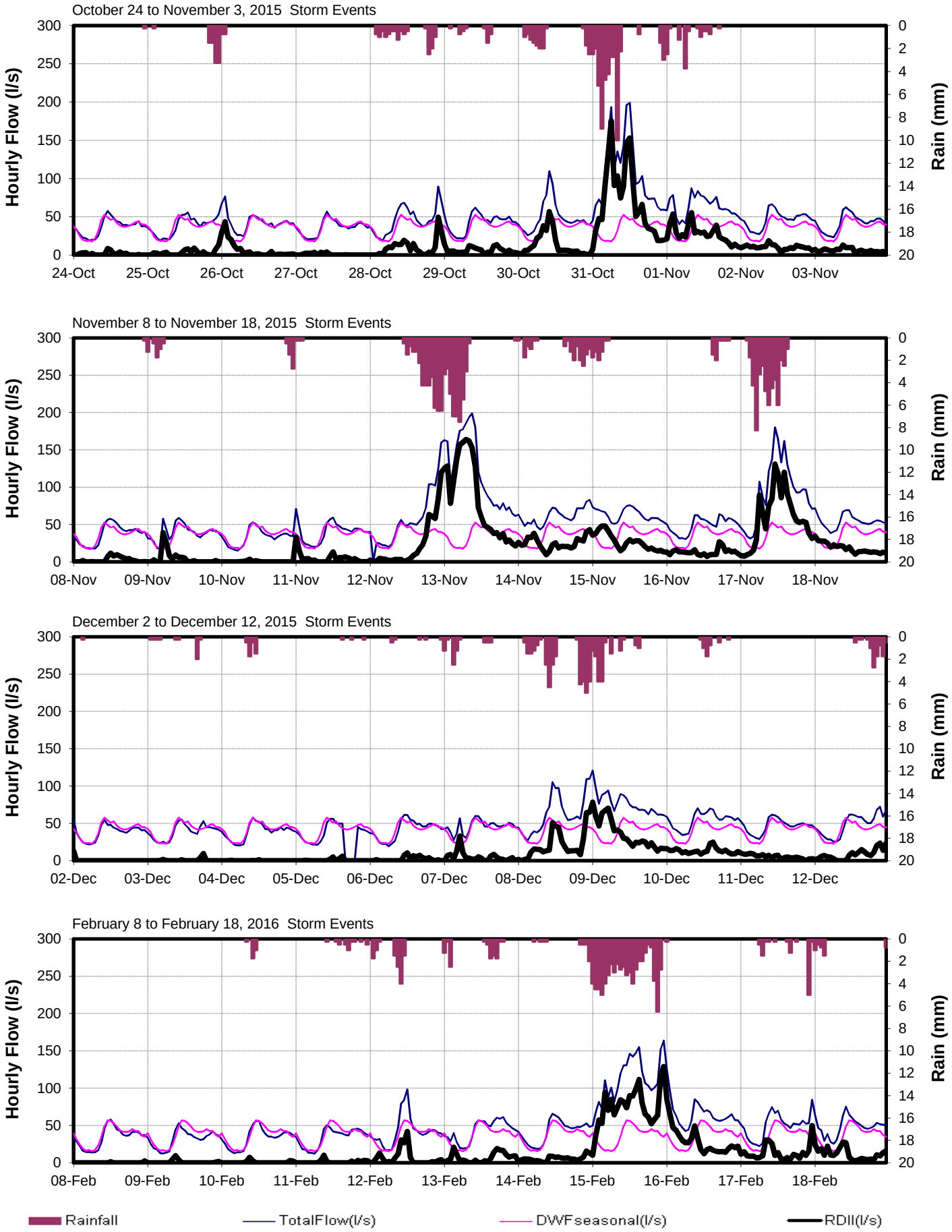
ADWF vs. PWWF Graph



Superior (VIC40)

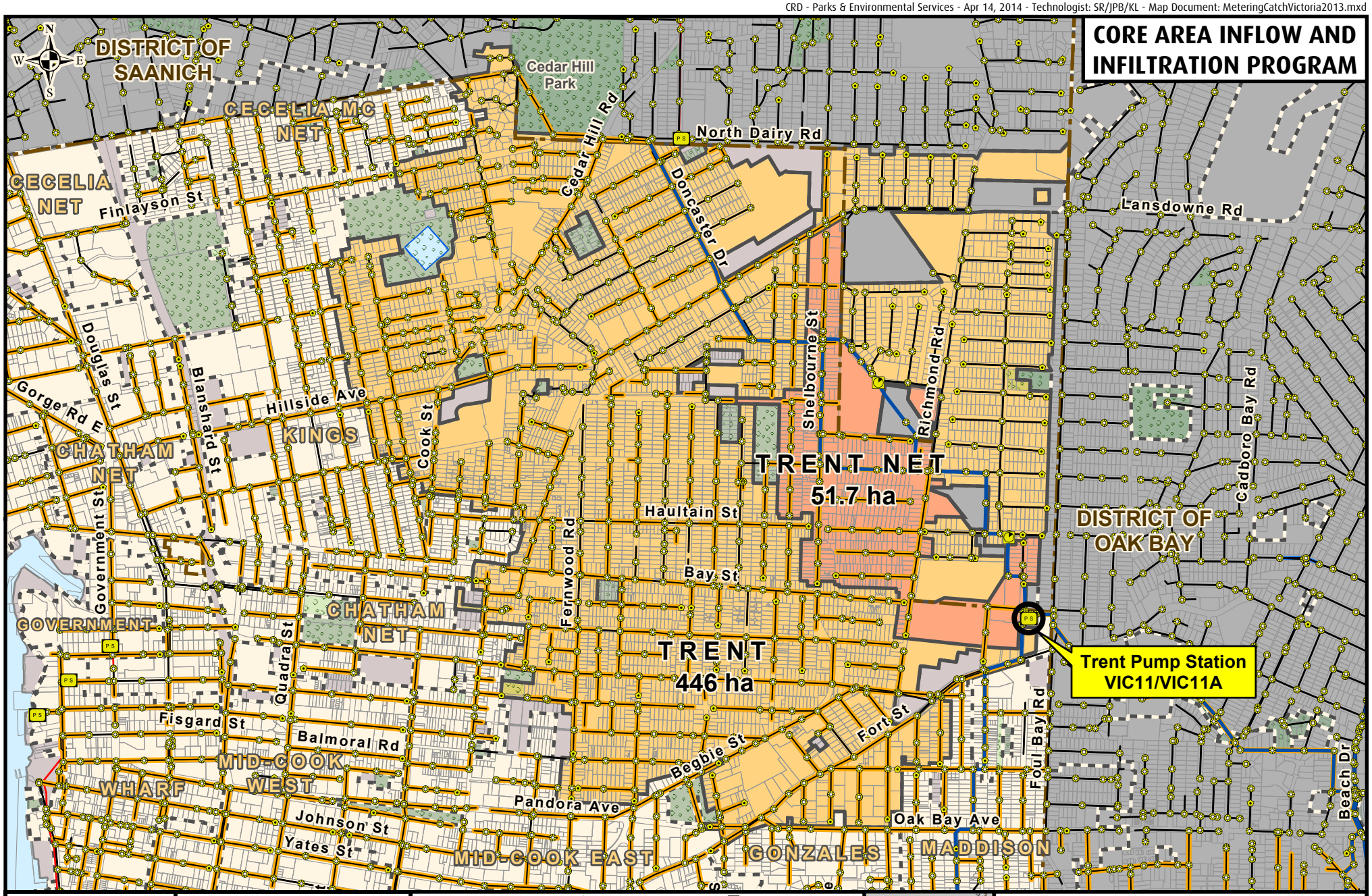


Superior (VIC40)



CRD - Parks & Environmental Services - Apr 14, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchVictoria2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 100 200 300 400 500

Projection: UTM ZONE 10N NAD 83

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- Catchment Boundary
- Municipal, First Nation, or DND Boundaries

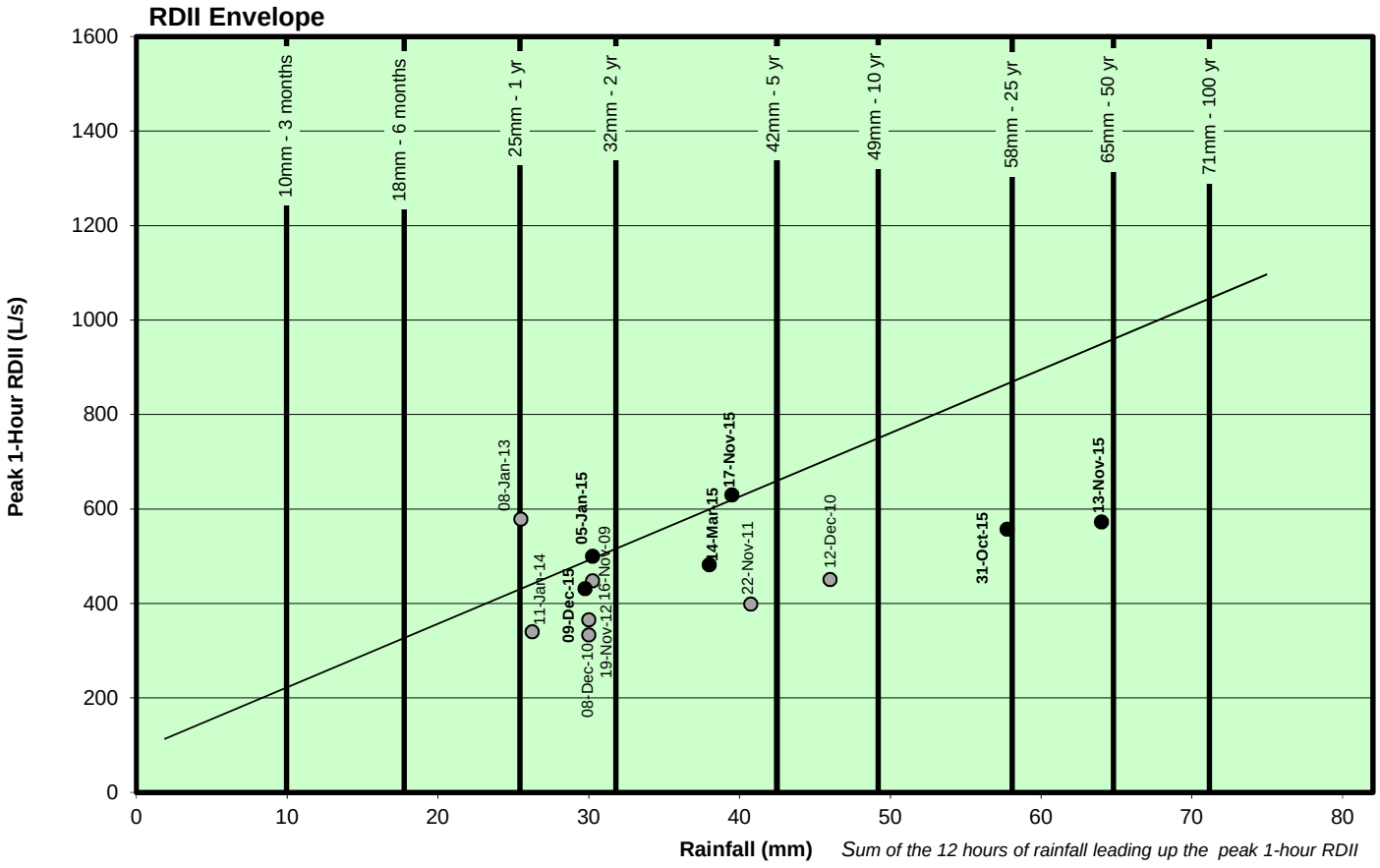


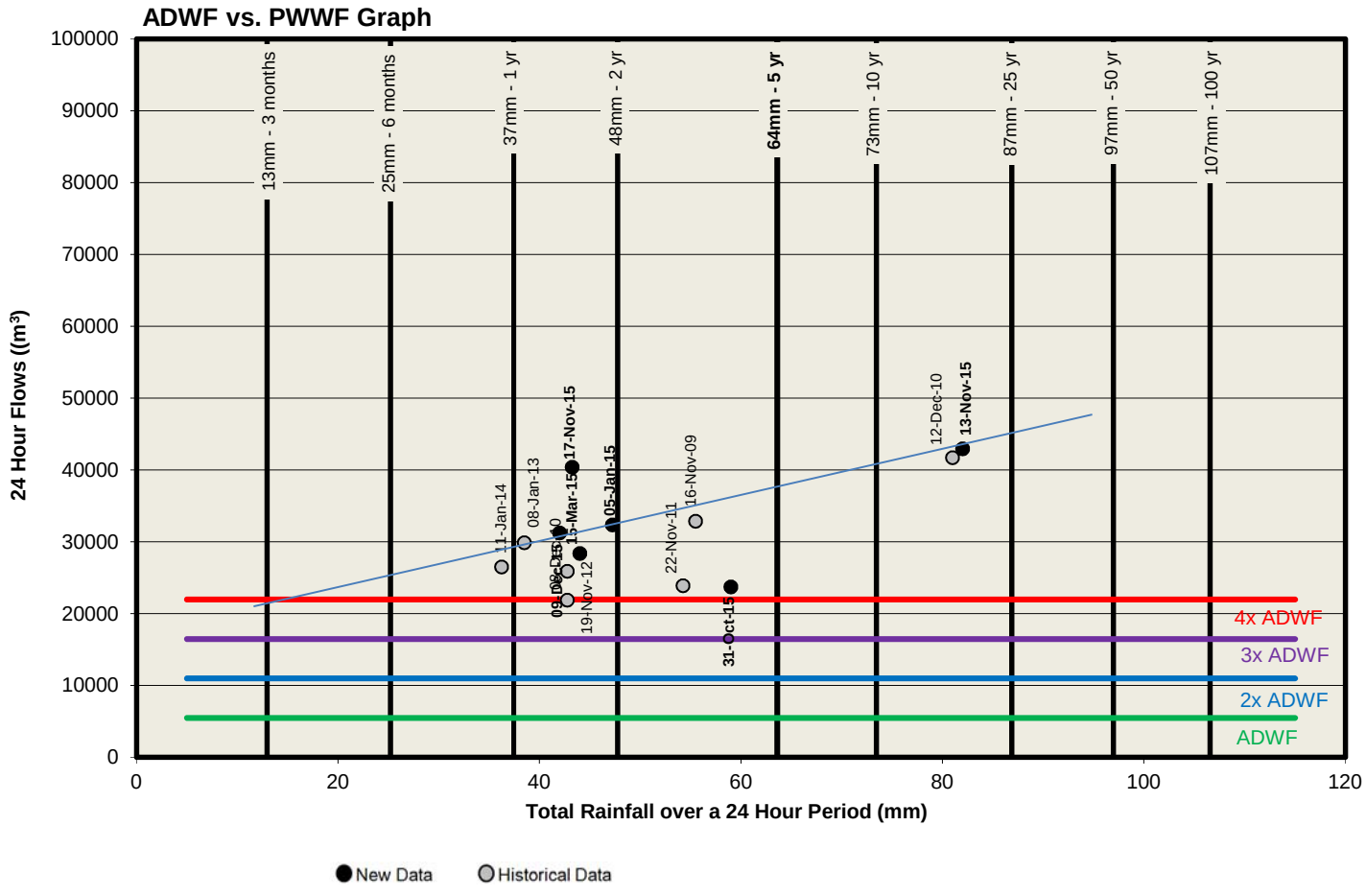
FLOW MONITORING AREA

CATCHMENT: TRENT/TRENT NET

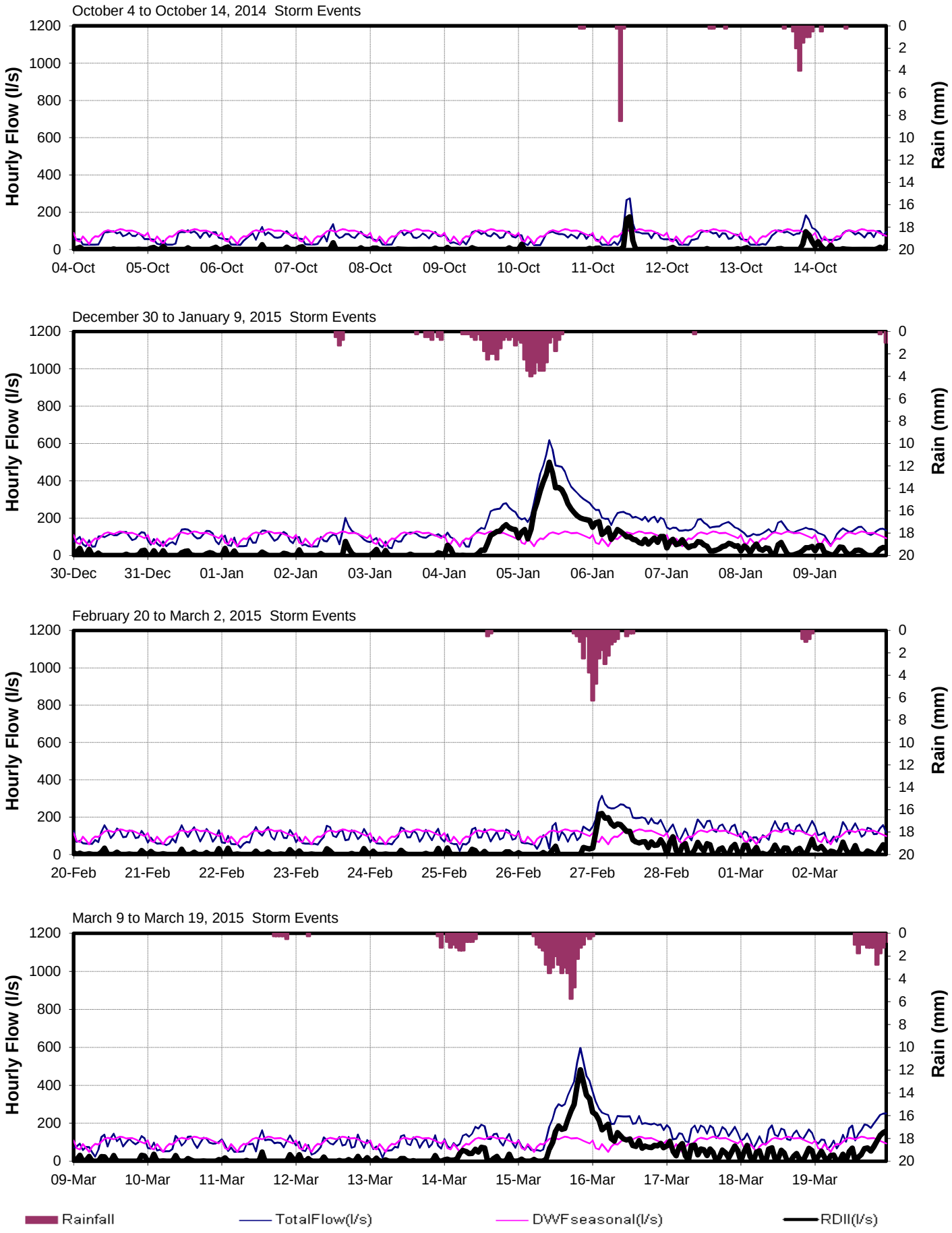
SITE CODE: **VIC11/VIC11A**

Trent (VIC11)

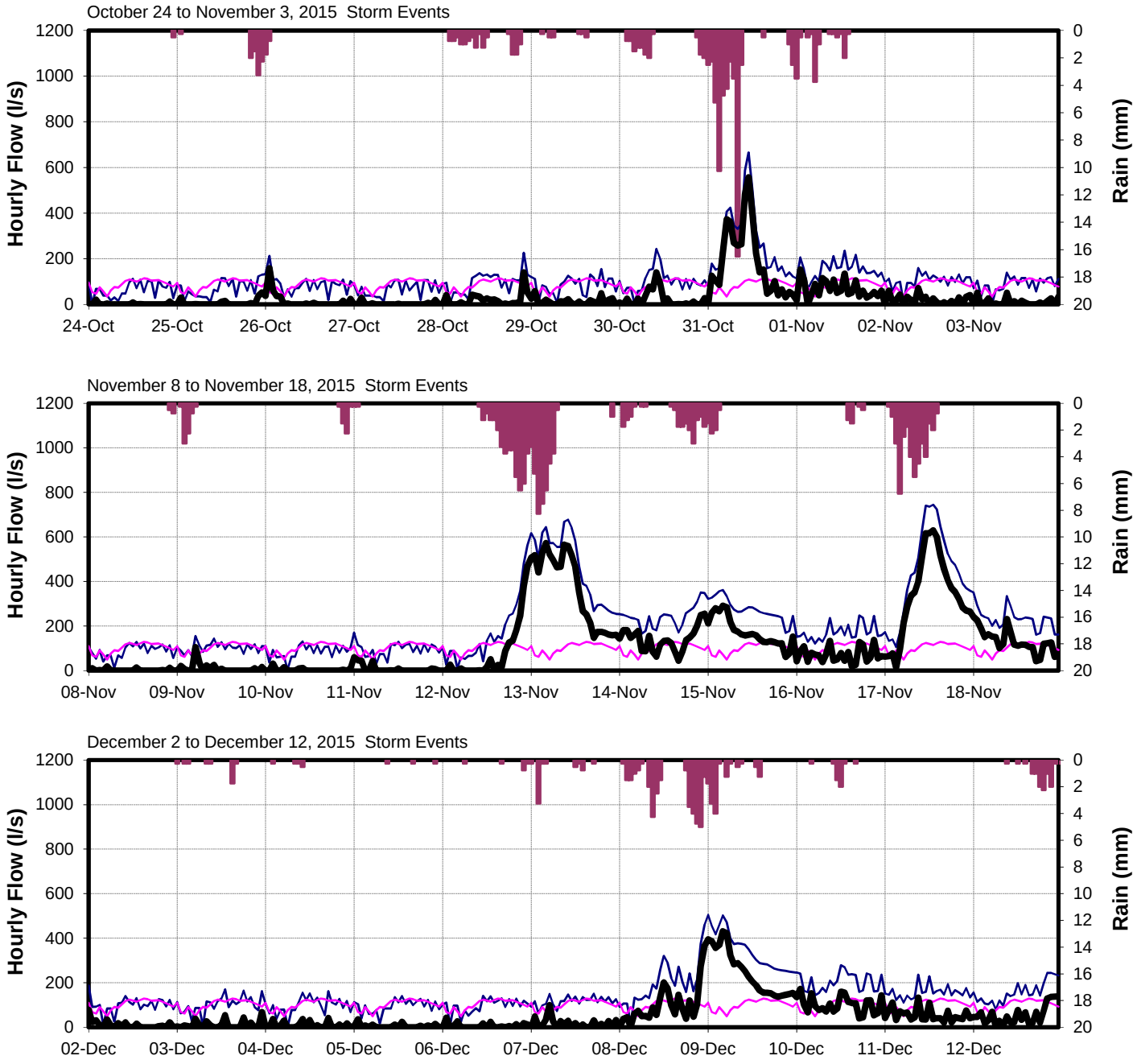

RDII Envelope
Peak 1-Hour RDII (L/s)
Rainfall (mm)
Sum of the 12 hours of rainfall leading up the peak 1-hour RDII
10mm - 3 months
18mm - 6 months
25mm - 1 yr
32mm - 2 yr
42mm - 5 yr
49mm - 10 yr
58mm - 25 yr
65mm - 50 yr
71mm - 100 yr
08-Jan-13
11-Jan-14
09-Dec-15
05-Jan-15
08-Dec-10
19-Nov-12
16-Nov-09
14-Mar-15
17-Nov-15
22-Nov-11
12-Dec-10
31-Oct-15
13-Nov-15


ADWF vs. PWWF Graph
24 Hour Flows ((m³)
Total Rainfall over a 24 Hour Period (mm)
13mm - 3 months
25mm - 6 months
37mm - 1 yr
48mm - 2 yr
64mm - 5 yr
73mm - 10 yr
87mm - 25 yr
97mm - 50 yr
107mm - 100 yr
11-Jan-14
08-Jan-13
09-Dec-15
17-Nov-15
14-Mar-15
05-Jan-15
08-Dec-10
19-Nov-12
16-Nov-09
22-Nov-11
31-Oct-15
12-Dec-10
13-Nov-15
4x ADWF
3x ADWF
2x ADWF
ADWF
New Data
Historical Data

Trent (VIC11)

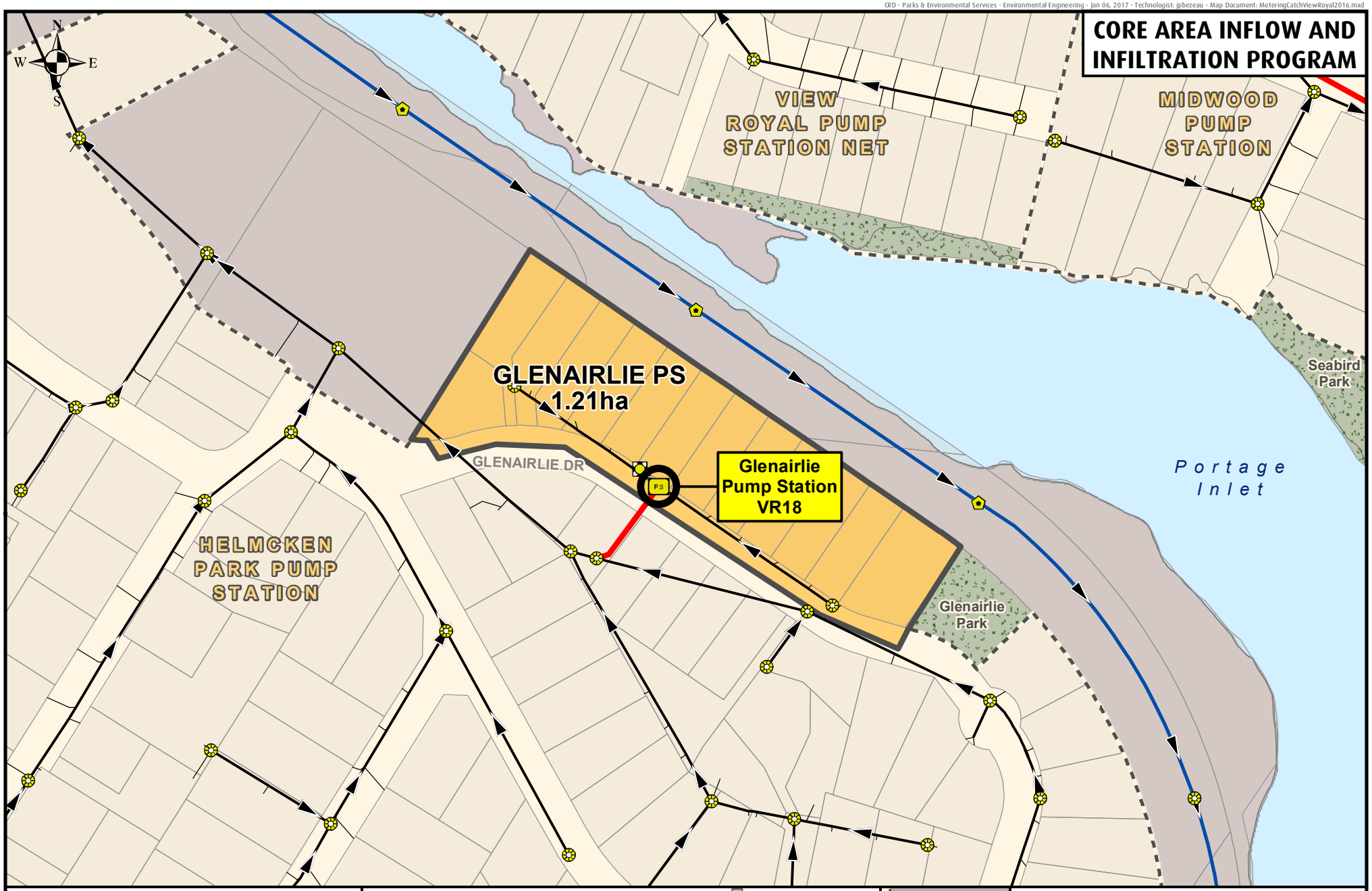

October 4 to October 14, 2014 Storm Events
Hourly Flow (l/s)
Rain (mm)
1200
1000
800
600
400
200
0
0
2
4
6
8
10
12
14
16
18
20
04-Oct
05-Oct
06-Oct
07-Oct
08-Oct
09-Oct
10-Oct
11-Oct
12-Oct
13-Oct
14-Oct
December 30 to January 9, 2015 Storm Events
30-Dec
31-Dec
01-Jan
02-Jan
03-Jan
04-Jan
05-Jan
06-Jan
07-Jan
08-Jan
09-Jan
February 20 to March 2, 2015 Storm Events
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
26-Feb
27-Feb
28-Feb
01-Mar
02-Mar
March 9 to March 19, 2015 Storm Events
09-Mar
10-Mar
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
19-Mar
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

Trent (VIC11)


October 24 to November 3, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
1200
1000
800
600
400
200
0
0
2
4
6
8
10
12
14
16
18
20
24-Oct
25-Oct
26-Oct
27-Oct
28-Oct
29-Oct
30-Oct
31-Oct
01-Nov
02-Nov
03-Nov
November 8 to November 18, 2015 Storm Events
08-Nov
09-Nov
10-Nov
11-Nov
12-Nov
13-Nov
14-Nov
15-Nov
16-Nov
17-Nov
18-Nov
December 2 to December 12, 2015 Storm Events
02-Dec
03-Dec
04-Dec
05-Dec
06-Dec
07-Dec
08-Dec
09-Dec
10-Dec
11-Dec
12-Dec
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

CRD - Parks & Environmental Services - Environmental Engineering - Jan 06, 2017 - Technologist: jpbezeau - Map Document: MeteringCatchViewRoyal2016.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



0 50 100 Metres

Projection: UTM ZONE 10N, NAD83

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- Flow Monitoring Location
- Manhole
- Cleanout
- Pump Station
- Metering Chamber

Sanitary Sewers
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- Gravity Main Installed Before 1930
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- CRD Sewer

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- Sewered Park Areas
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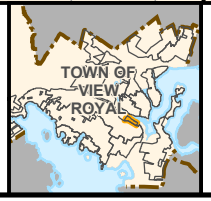
- Municipal, First Nation, or DND Boundaries



FLOW MONITORING AREA
Catchment: Glenairlie Pump Station
Site Code: VR18

CRD
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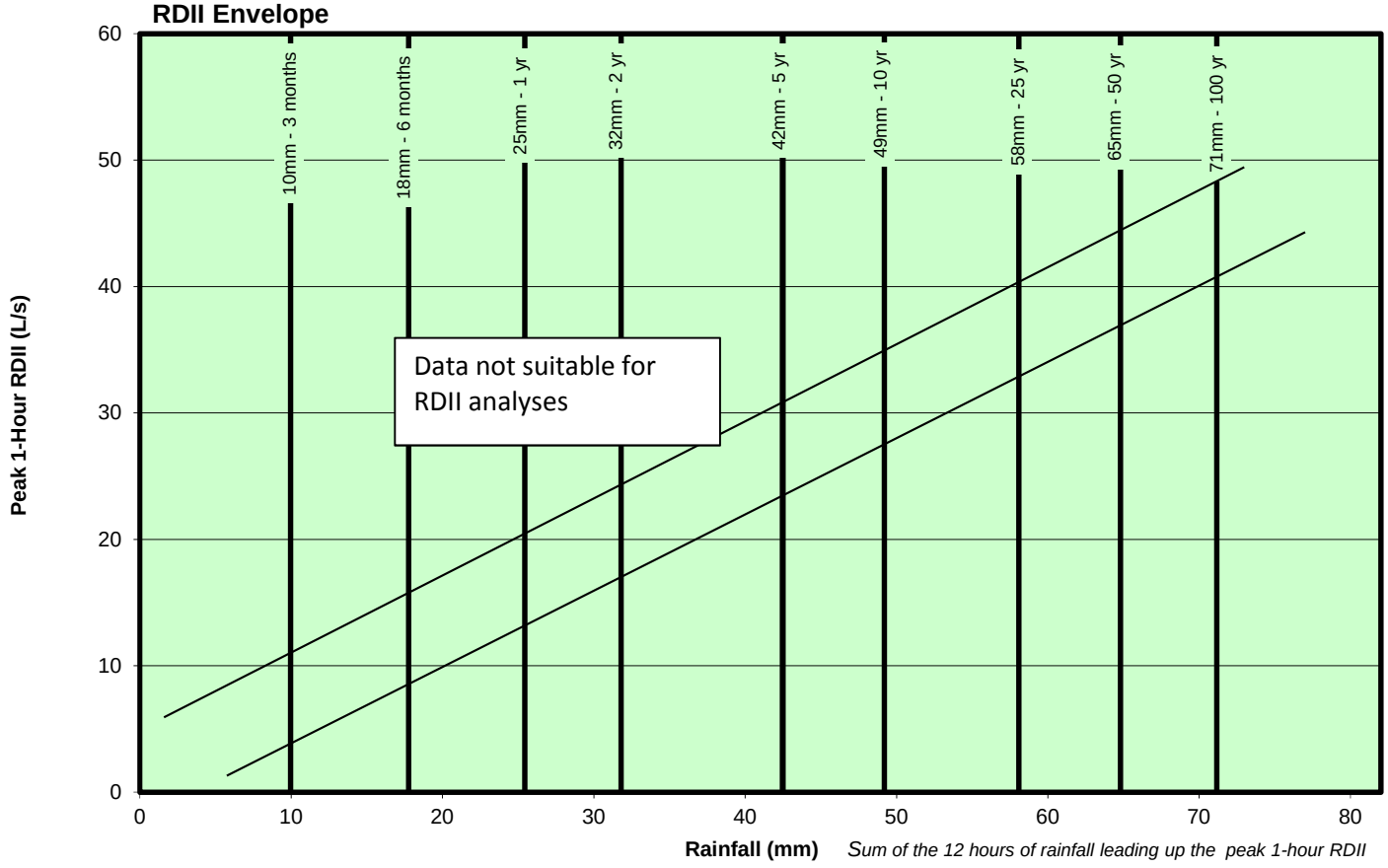
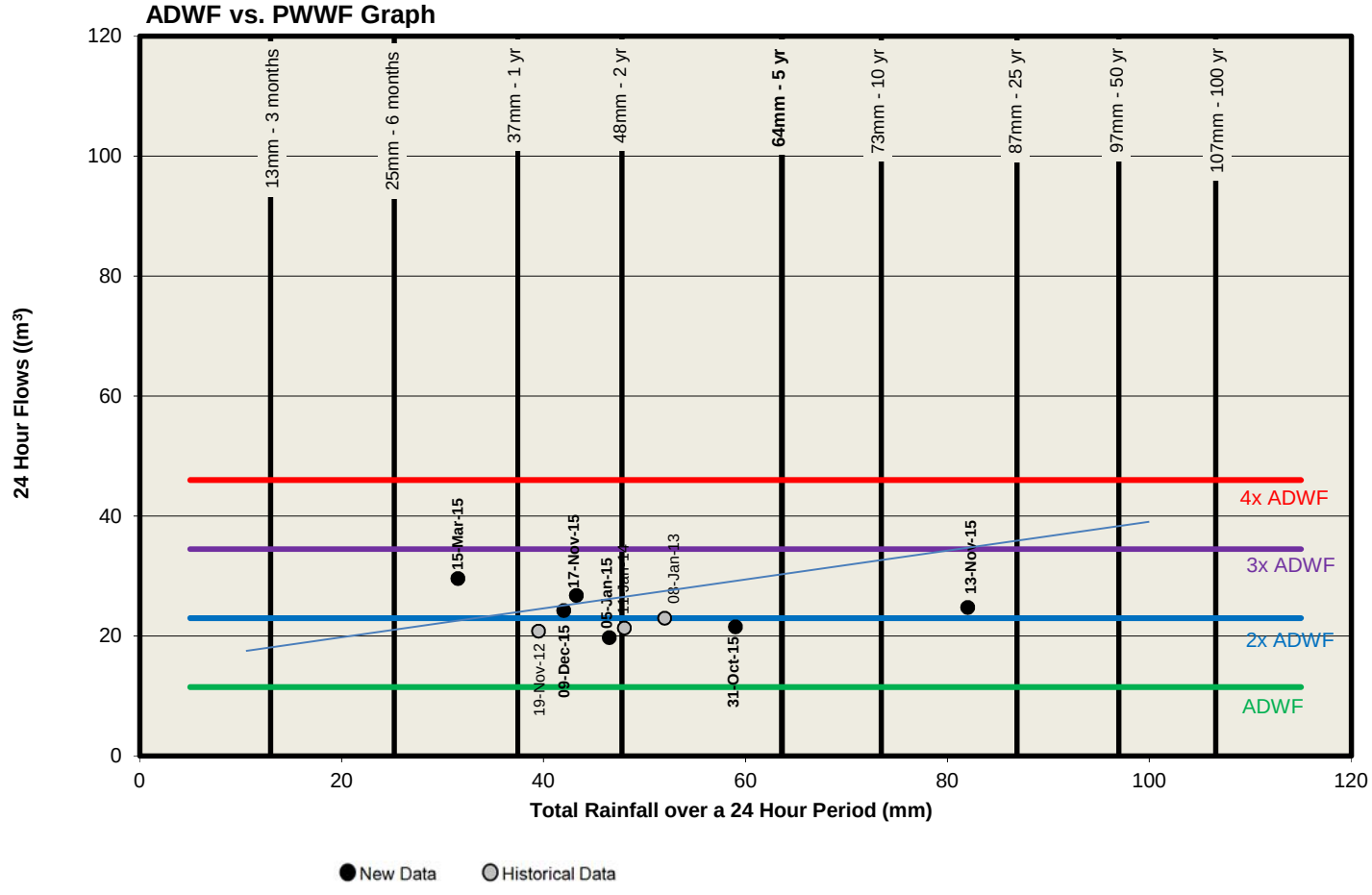
Glenairlie (VR18)

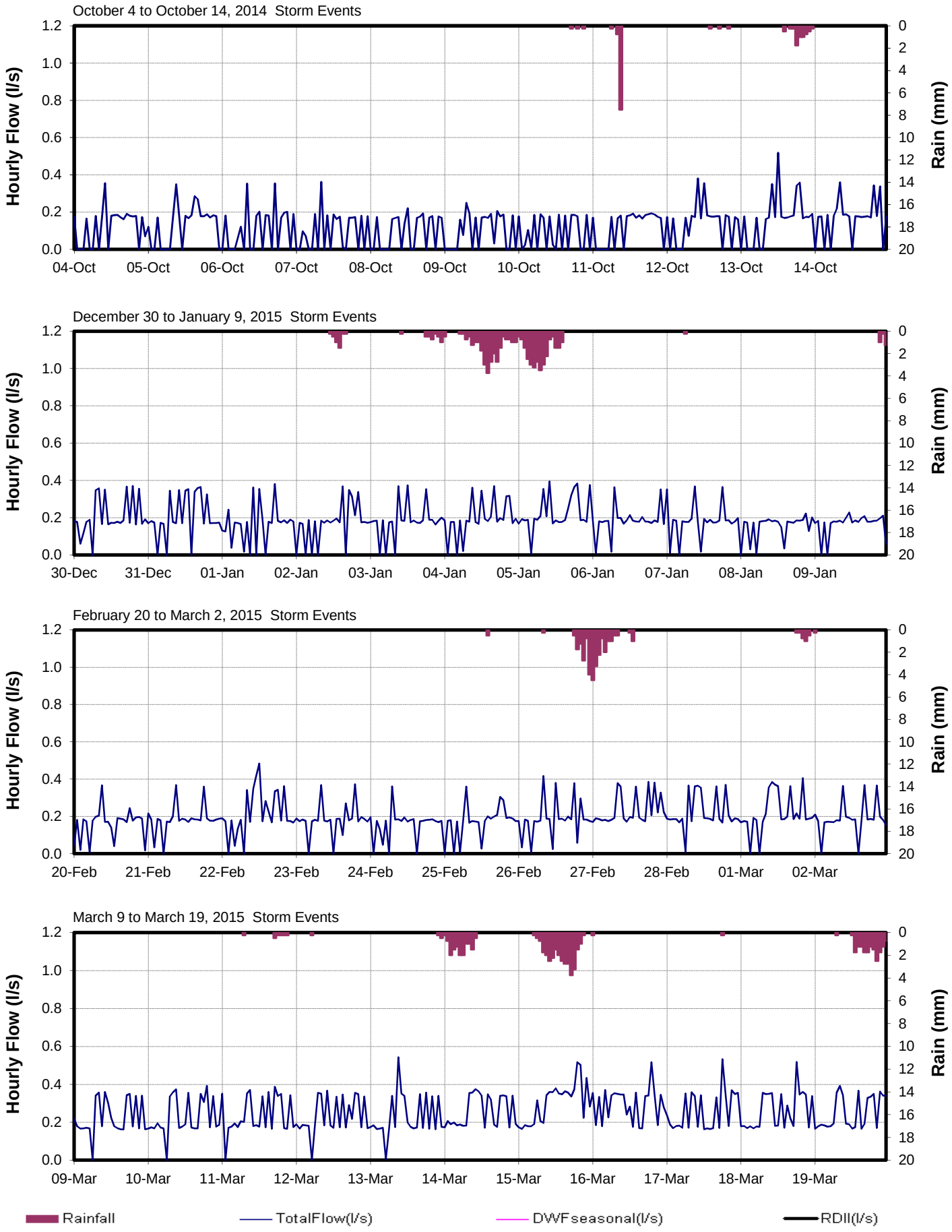
RDII Envelope



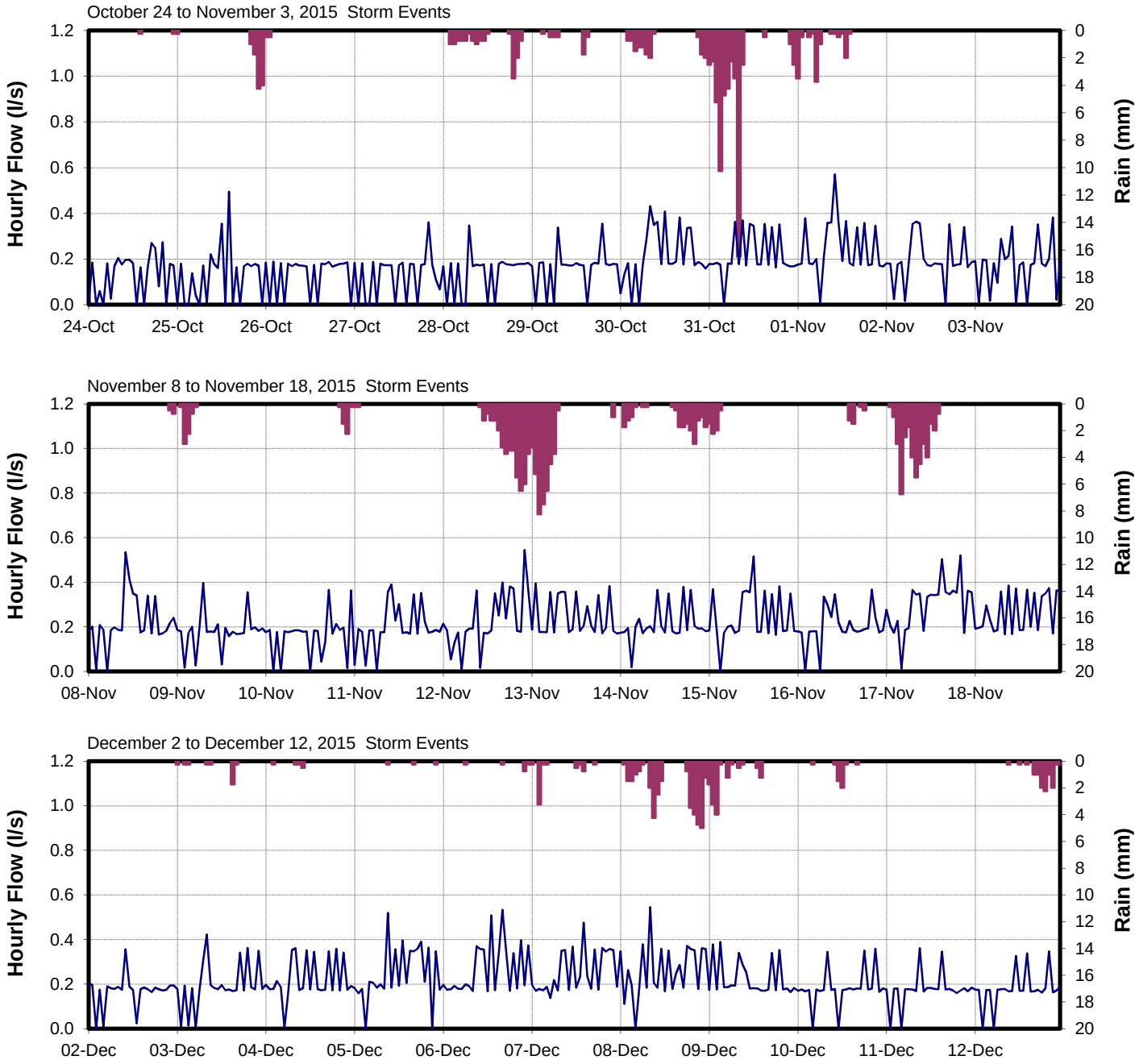
ADWF vs. PWWF Graph



Glenairlie (VR18)



Glenairlie (VR18)



CRD - Parks & Environmental Services - Apr 9, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchViewRoyal2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



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Metres
0 25 50 75

Projection: UTM ZONE 10N NAD 83

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Sanitary Sewers

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- CRD Sewer

- Catchment Area
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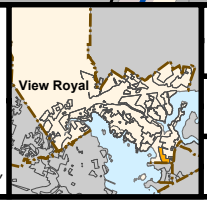
- Catchment Boundary
- Municipal, First Nation, or DND Boundaries



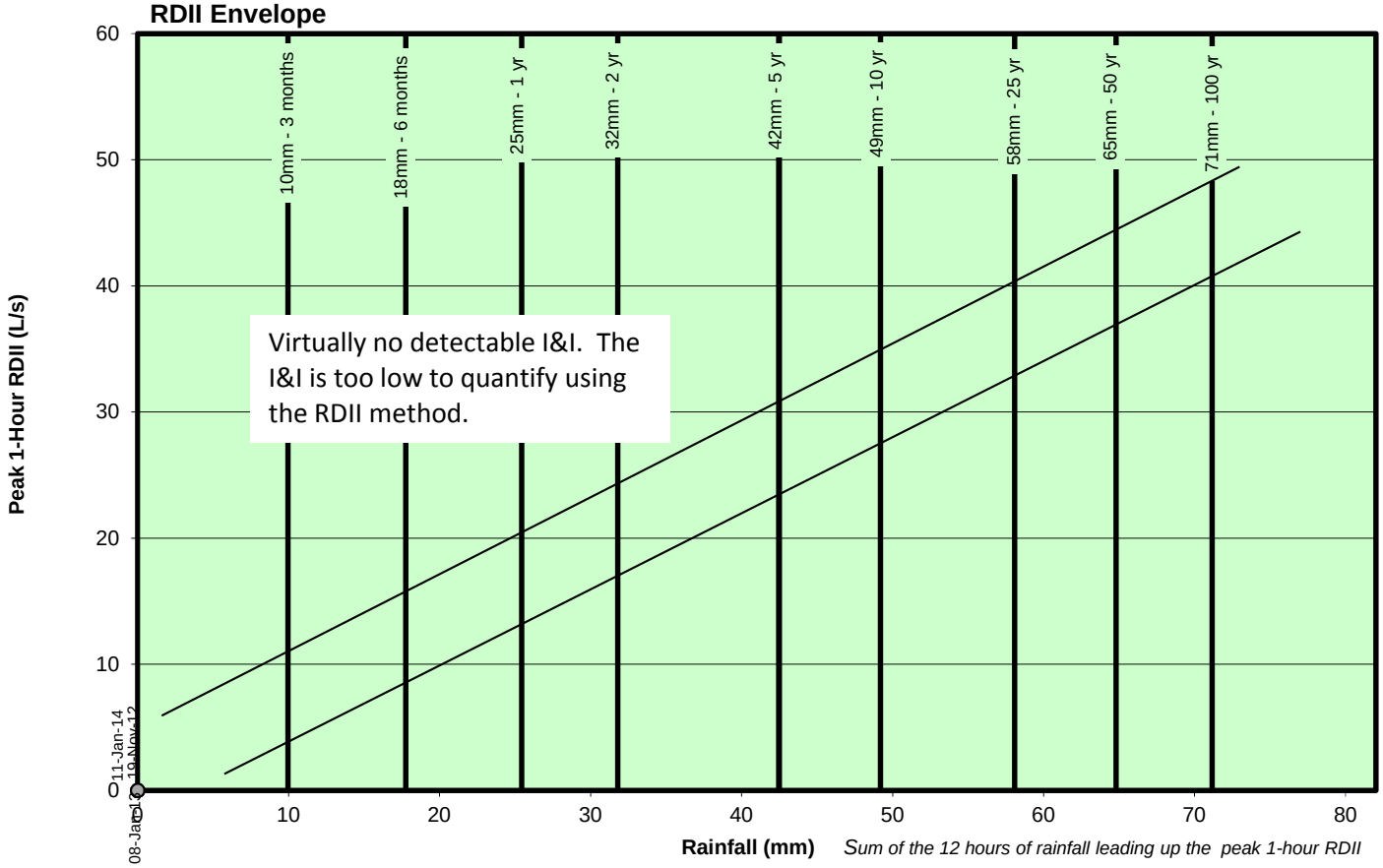
FLOW MONITORING AREA

CATCHMENT: HALLOWELL

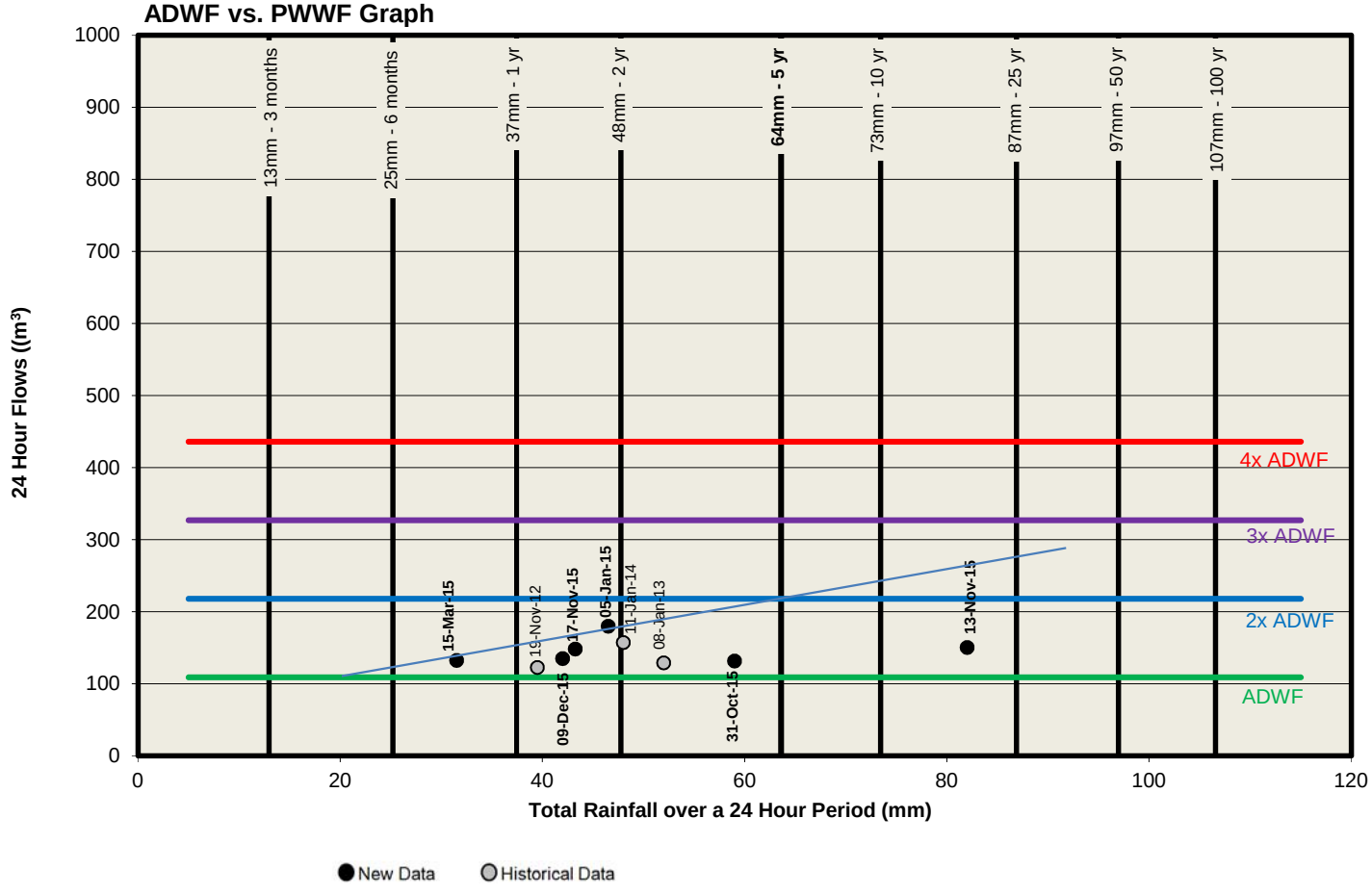
SITE CODE: **VR2**

Hallowell (VR2)

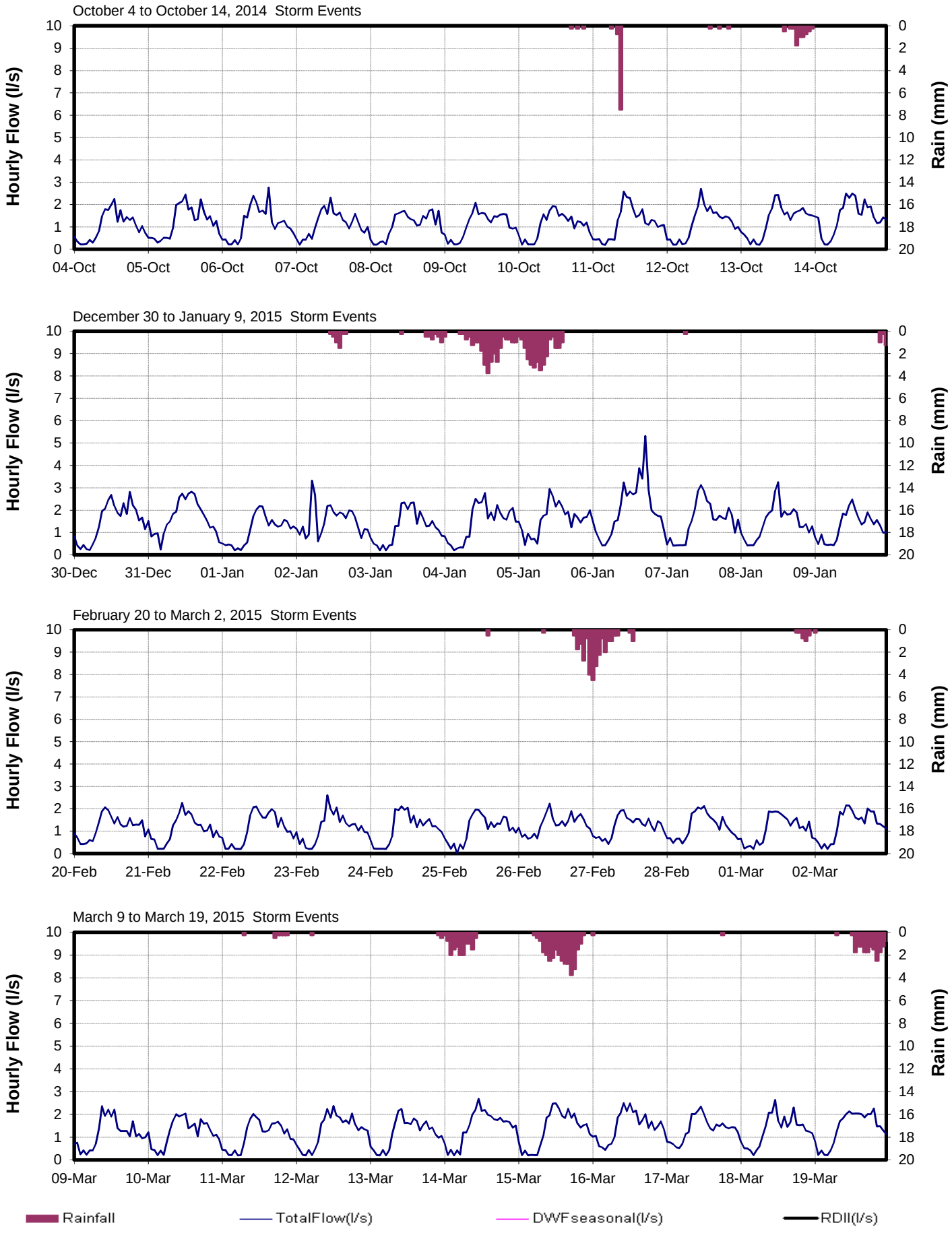
RDII Envelope



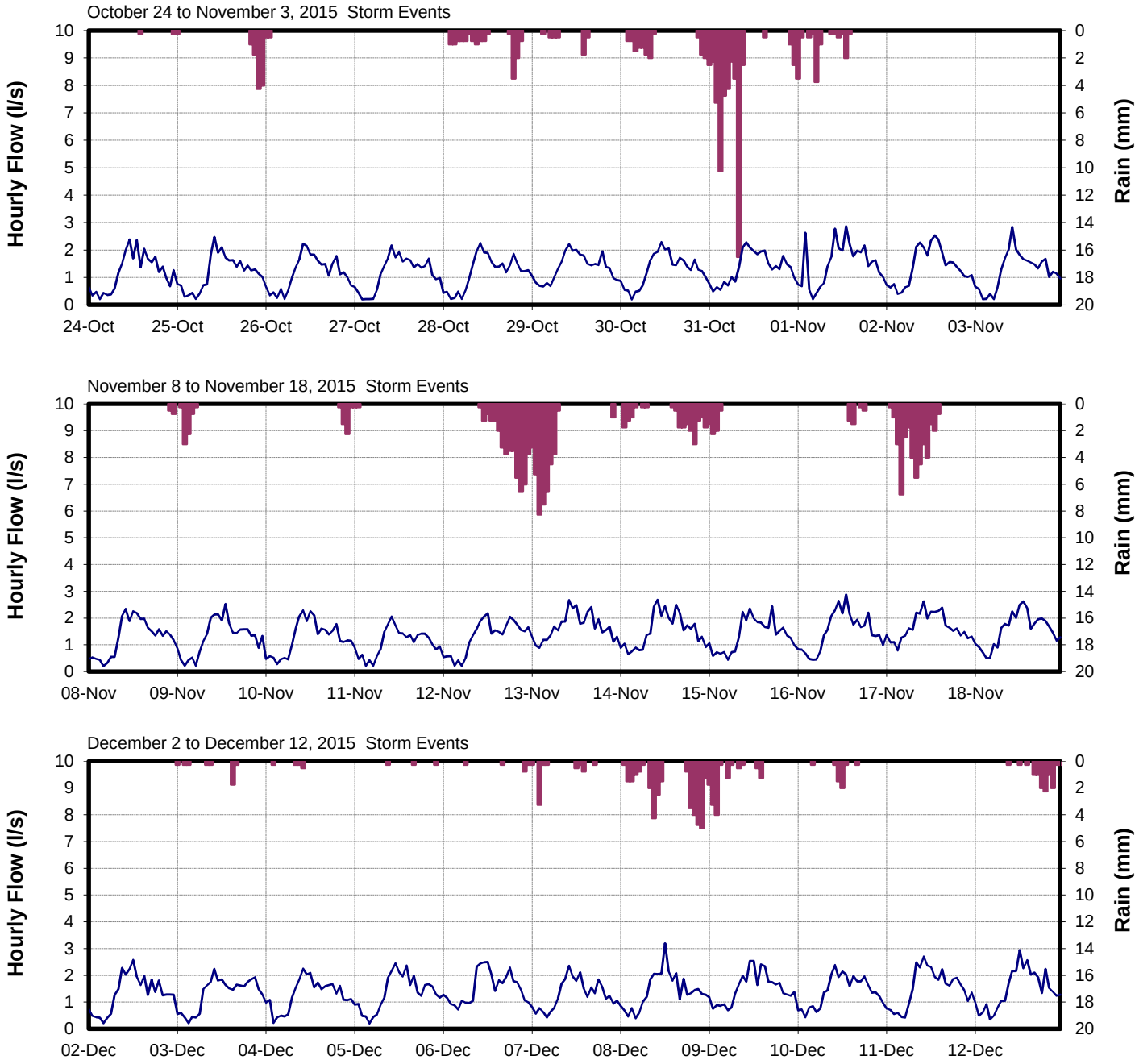
ADWF vs. PWWF Graph



Hallowell (VR2)

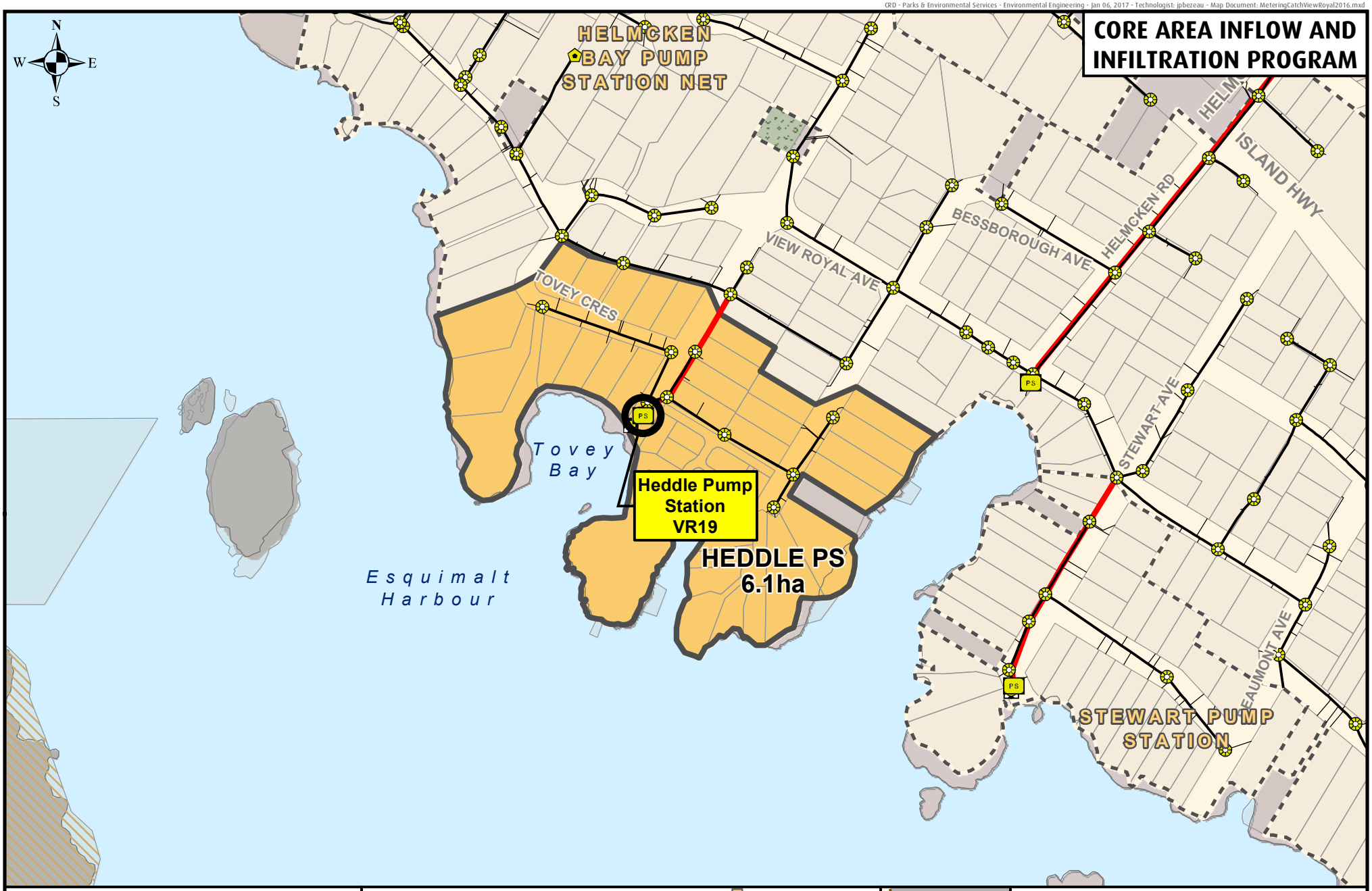


Hallowell (VR2)



CRD - Parks & Environmental Services - Environmental Engineering - Jan 06, 2017 - Technologist: jpbezeau - Map Document: MeteringCatchViewRoyal2016.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Metres
0 50 100

Projection: UTM ZONE 10N, NAD83

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- Flow Monitoring Location
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- Cleanout
- Pump Station
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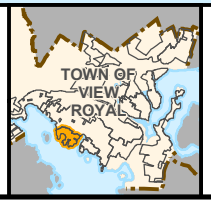
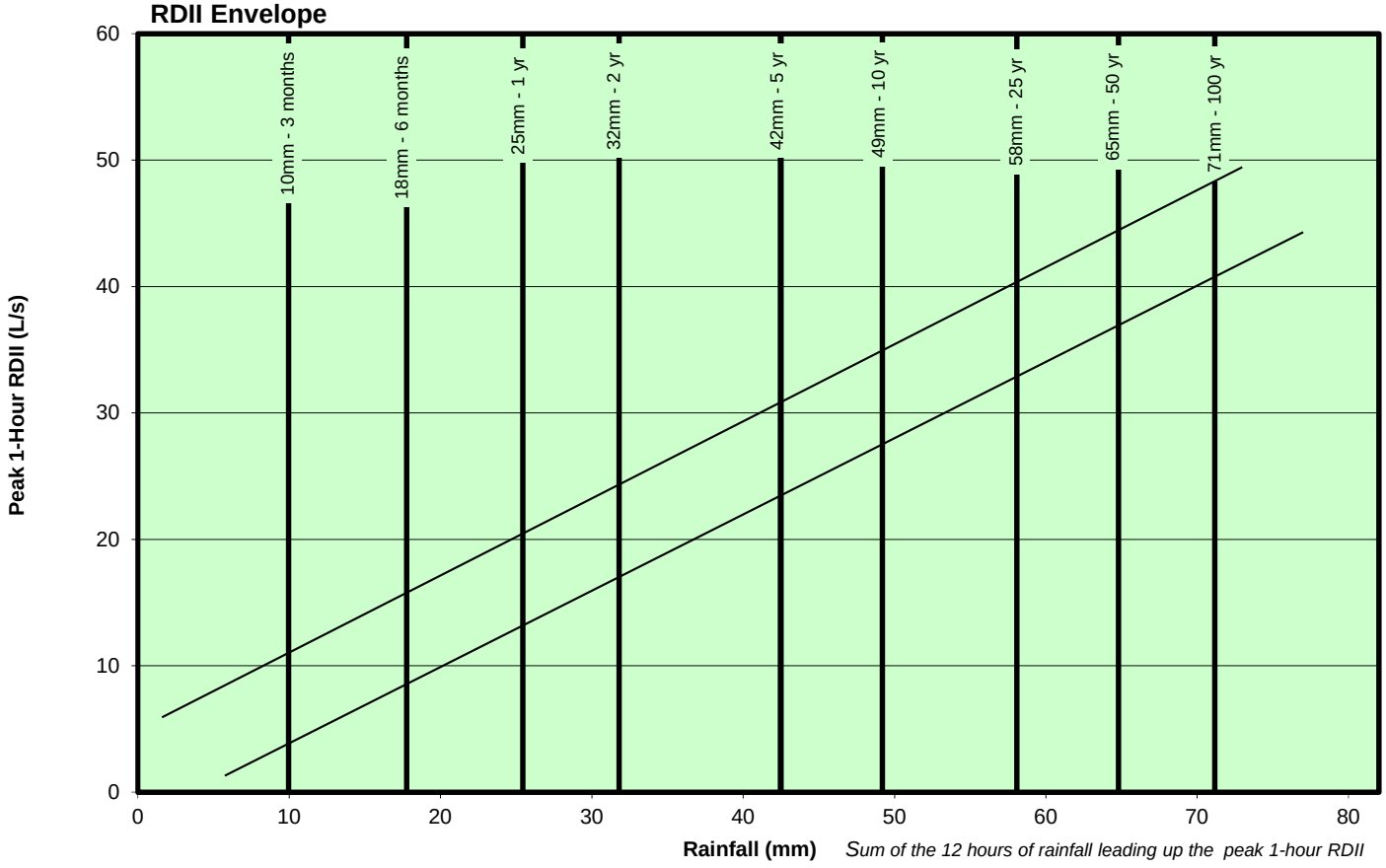


FLOW MONITORING AREA
Catchment: Heddle Pump Station
Site Code: VR19

CRD
Making a difference...together

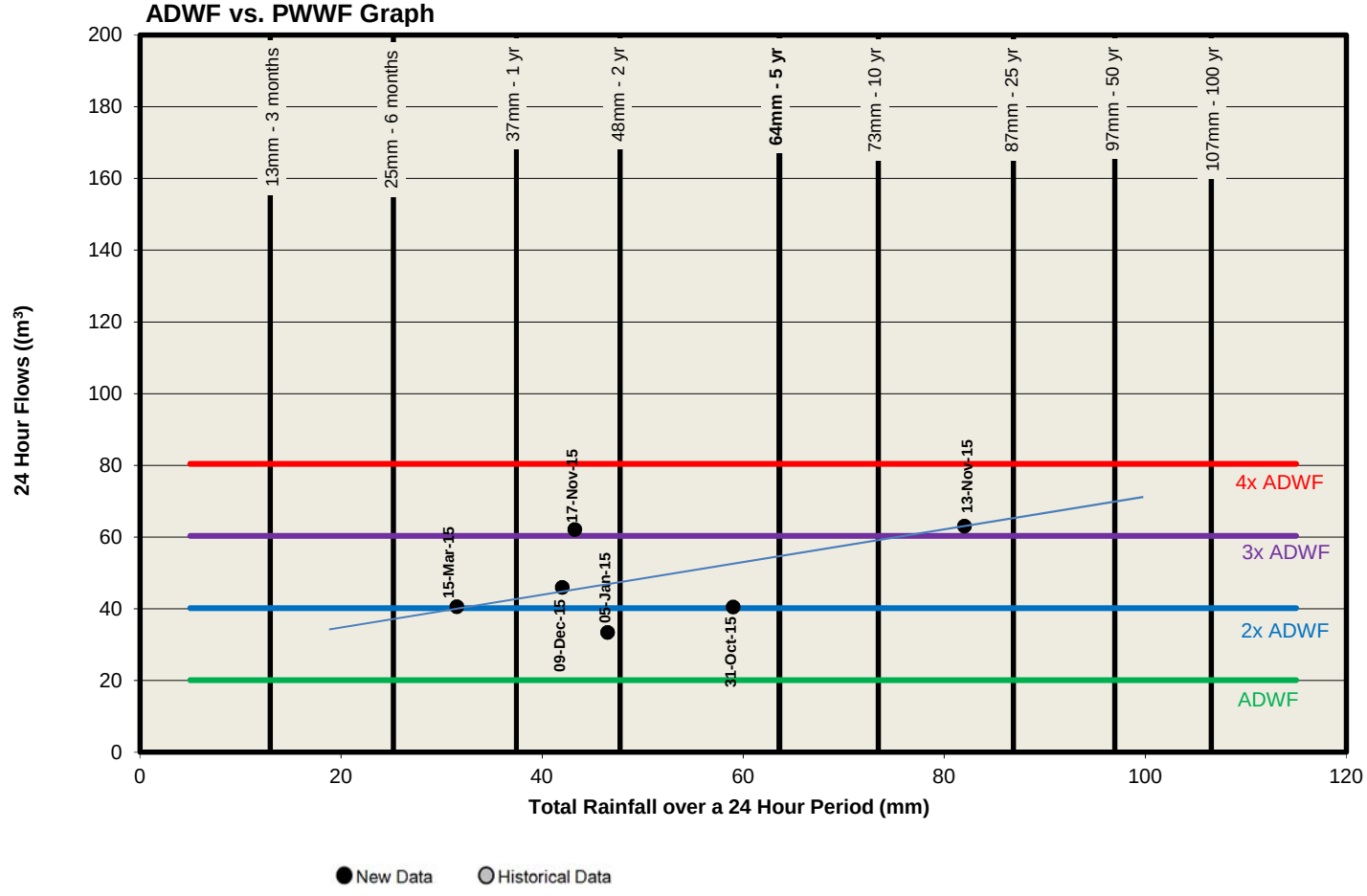
Heddle (VR19)

RDII Envelope

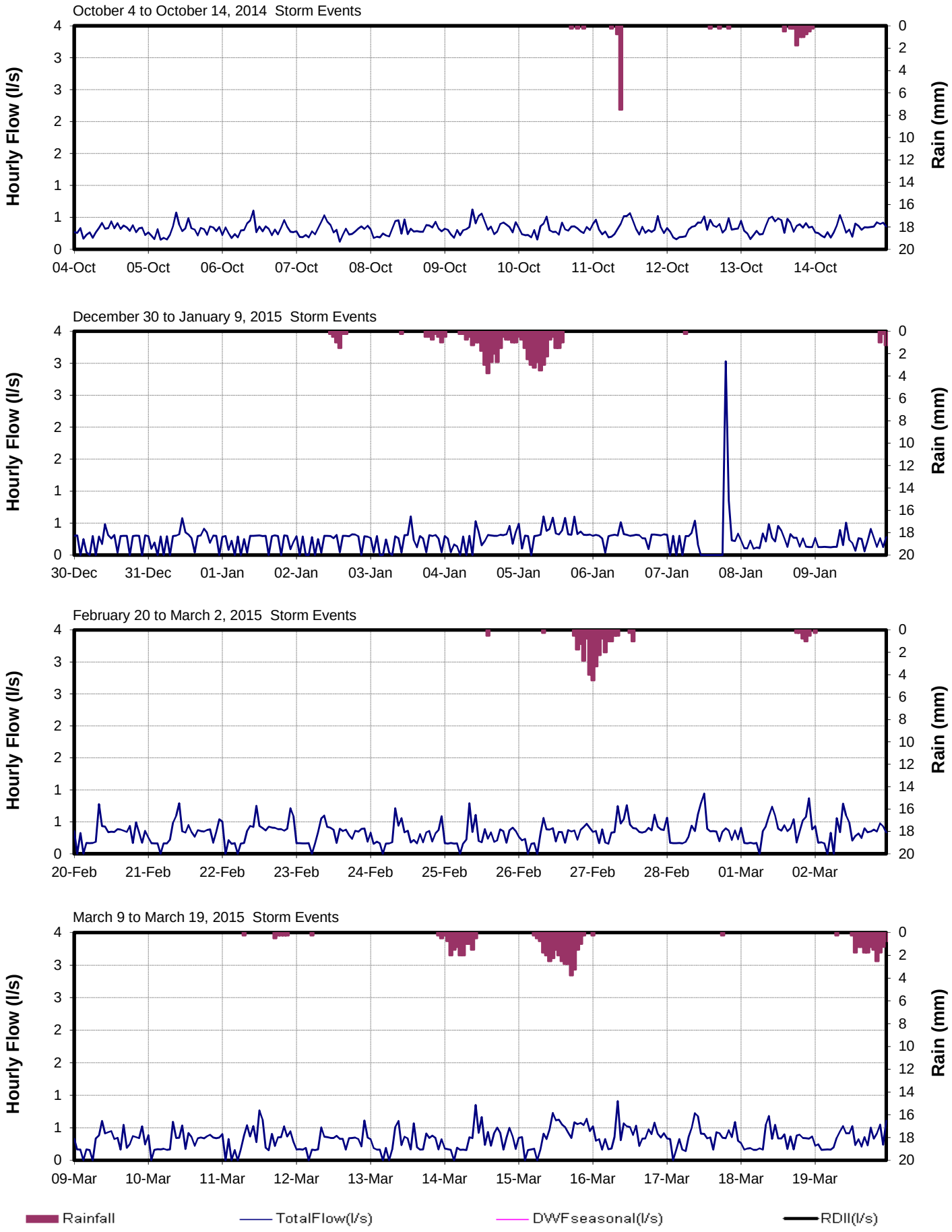


Sum of the 12 hours of rainfall leading up the peak 1-hour RDII

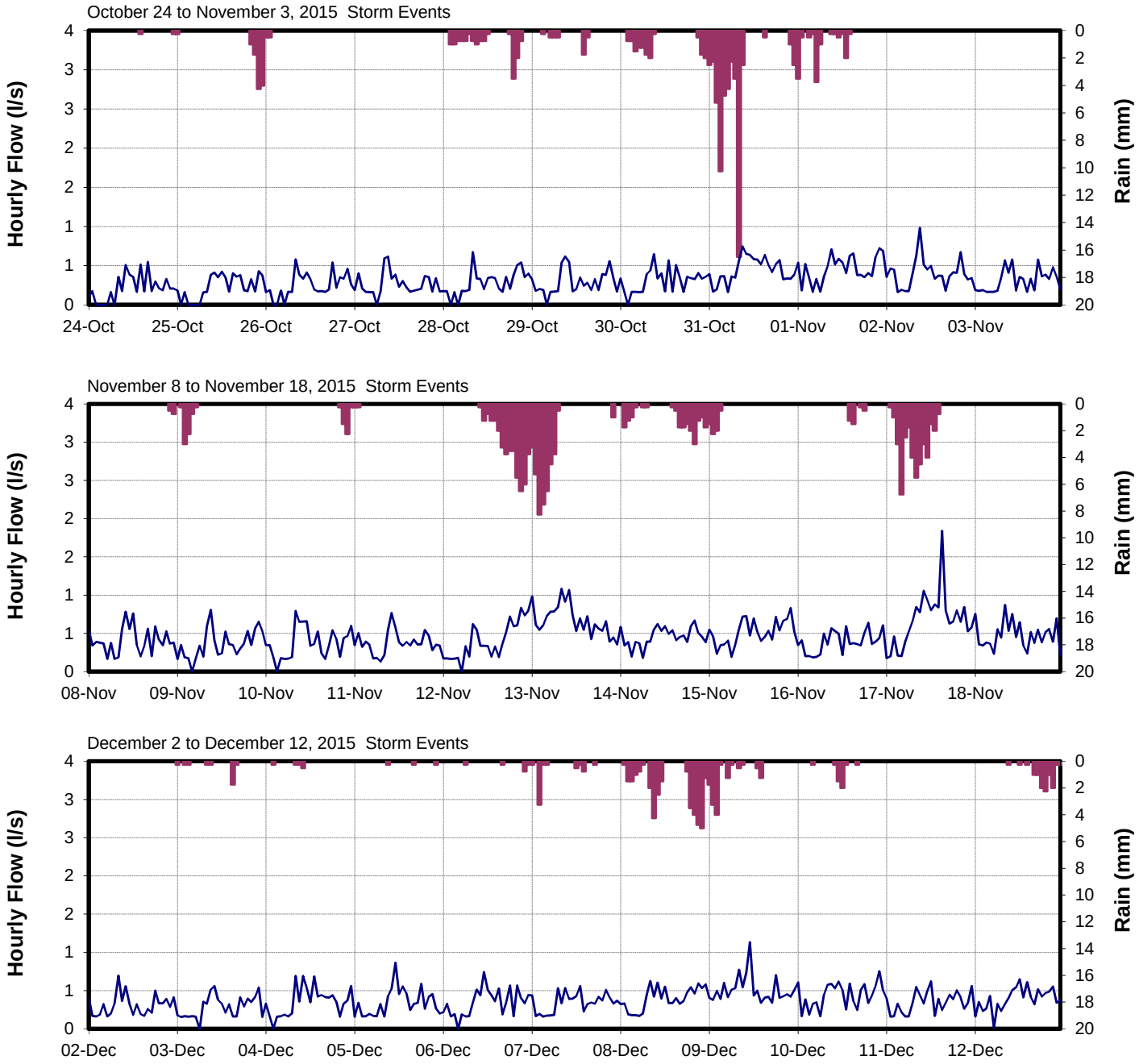
ADWF vs. PWWF Graph



Heddle (VR19)

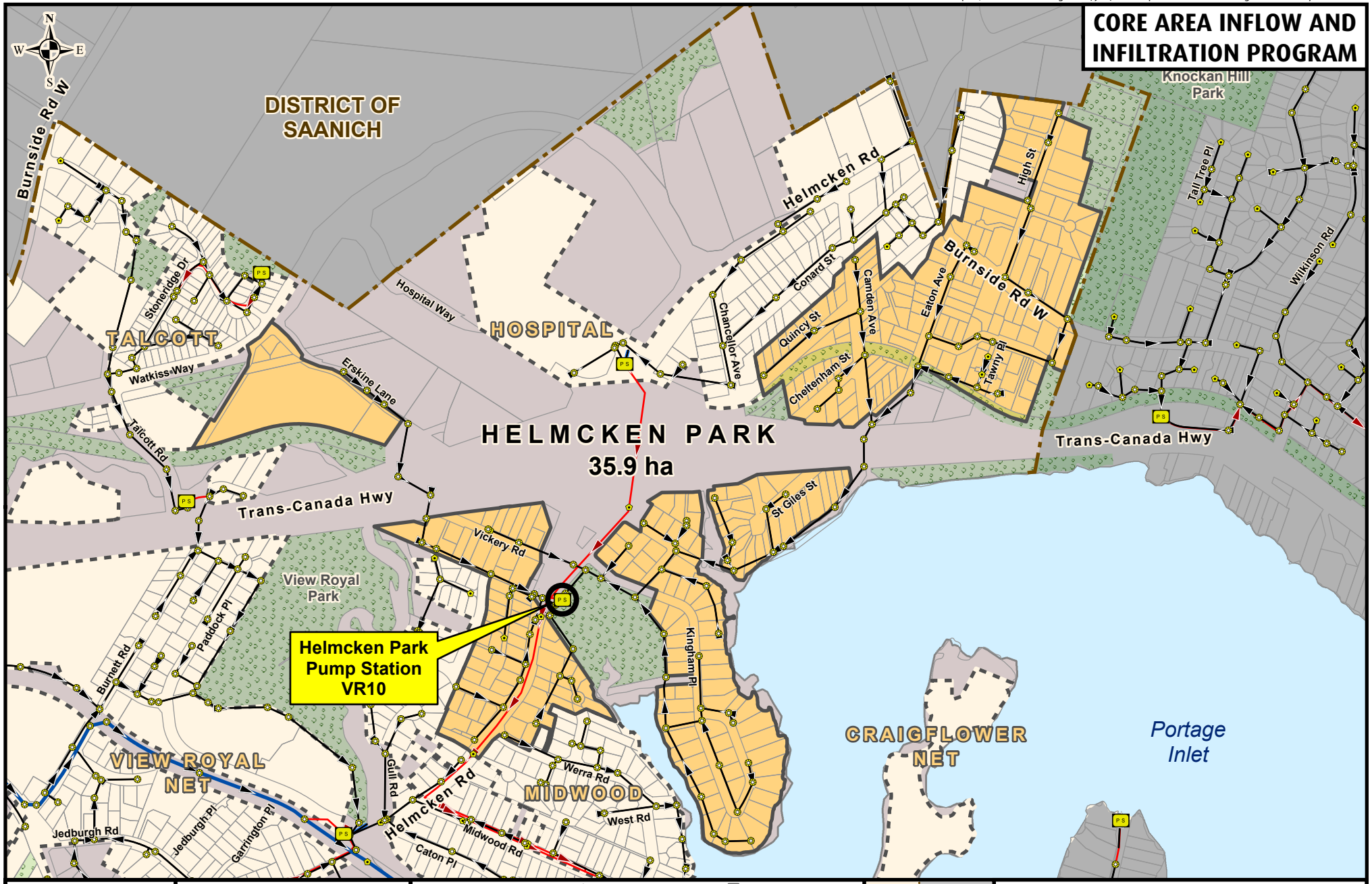

October 4 to October 14, 2014 Storm Events
Hourly Flow (l/s)
Rain (mm)
04-Oct
05-Oct
06-Oct
07-Oct
08-Oct
09-Oct
10-Oct
11-Oct
12-Oct
13-Oct
14-Oct
December 30 to January 9, 2015 Storm Events
30-Dec
31-Dec
01-Jan
02-Jan
03-Jan
04-Jan
05-Jan
06-Jan
07-Jan
08-Jan
09-Jan
February 20 to March 2, 2015 Storm Events
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
26-Feb
27-Feb
28-Feb
01-Mar
02-Mar
March 9 to March 19, 2015 Storm Events
09-Mar
10-Mar
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
19-Mar
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

Heddle (VR19)


October 24 to November 3, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
24-Oct
25-Oct
26-Oct
27-Oct
28-Oct
29-Oct
30-Oct
31-Oct
01-Nov
02-Nov
03-Nov
November 8 to November 18, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
08-Nov
09-Nov
10-Nov
11-Nov
12-Nov
13-Nov
14-Nov
15-Nov
16-Nov
17-Nov
18-Nov
December 2 to December 12, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
02-Dec
03-Dec
04-Dec
05-Dec
06-Dec
07-Dec
08-Dec
09-Dec
10-Dec
11-Dec
12-Dec
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

CRD - Parks & Environmental Services - Apr 9, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchViewRoyal2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



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Metres
0 100 200

Projection: UTM ZONE 10N NAD 83

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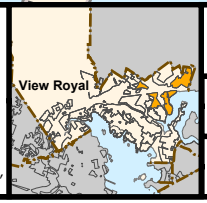


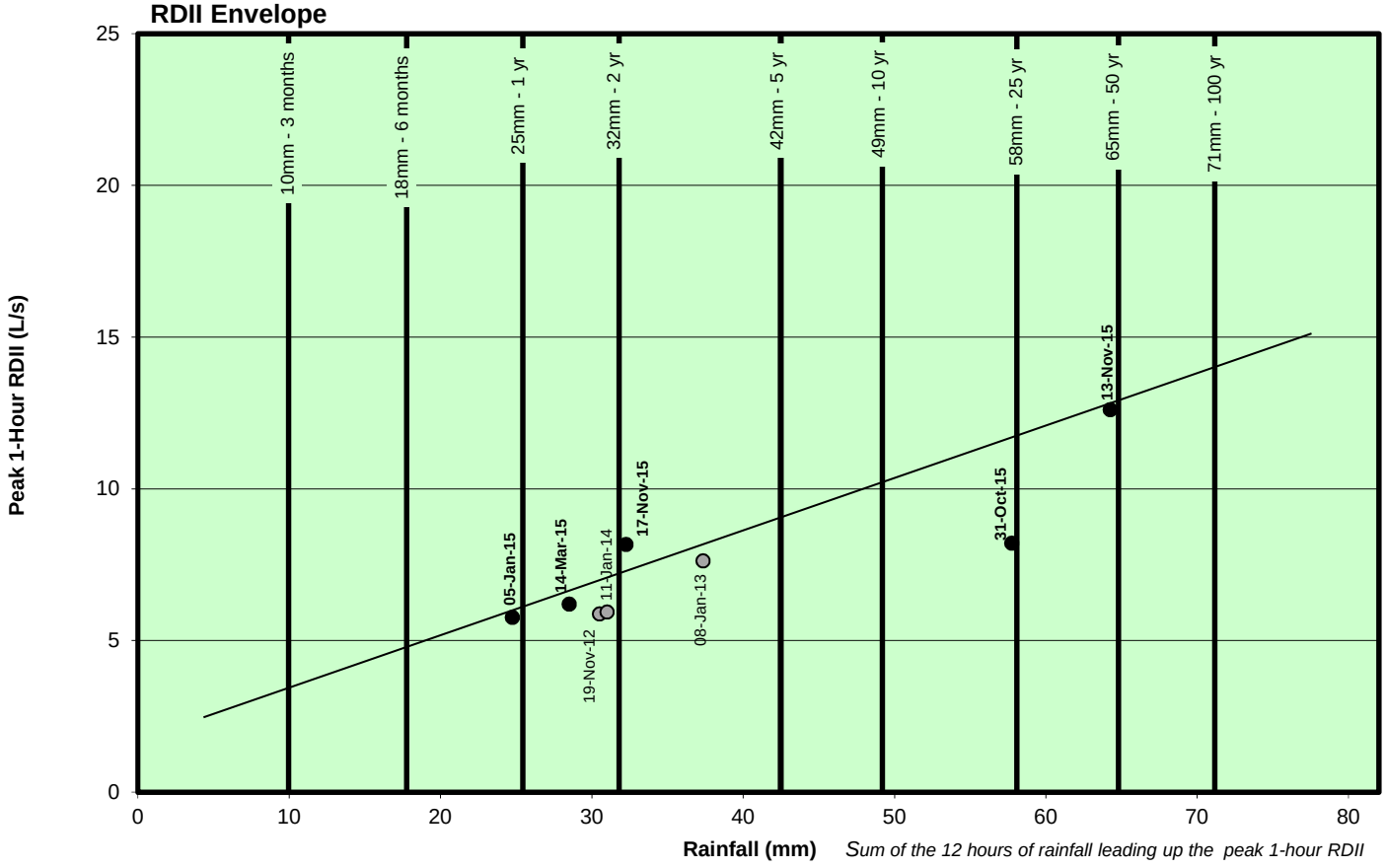
FLOW MONITORING AREA

CATCHMENT: HELMCKEN PARK

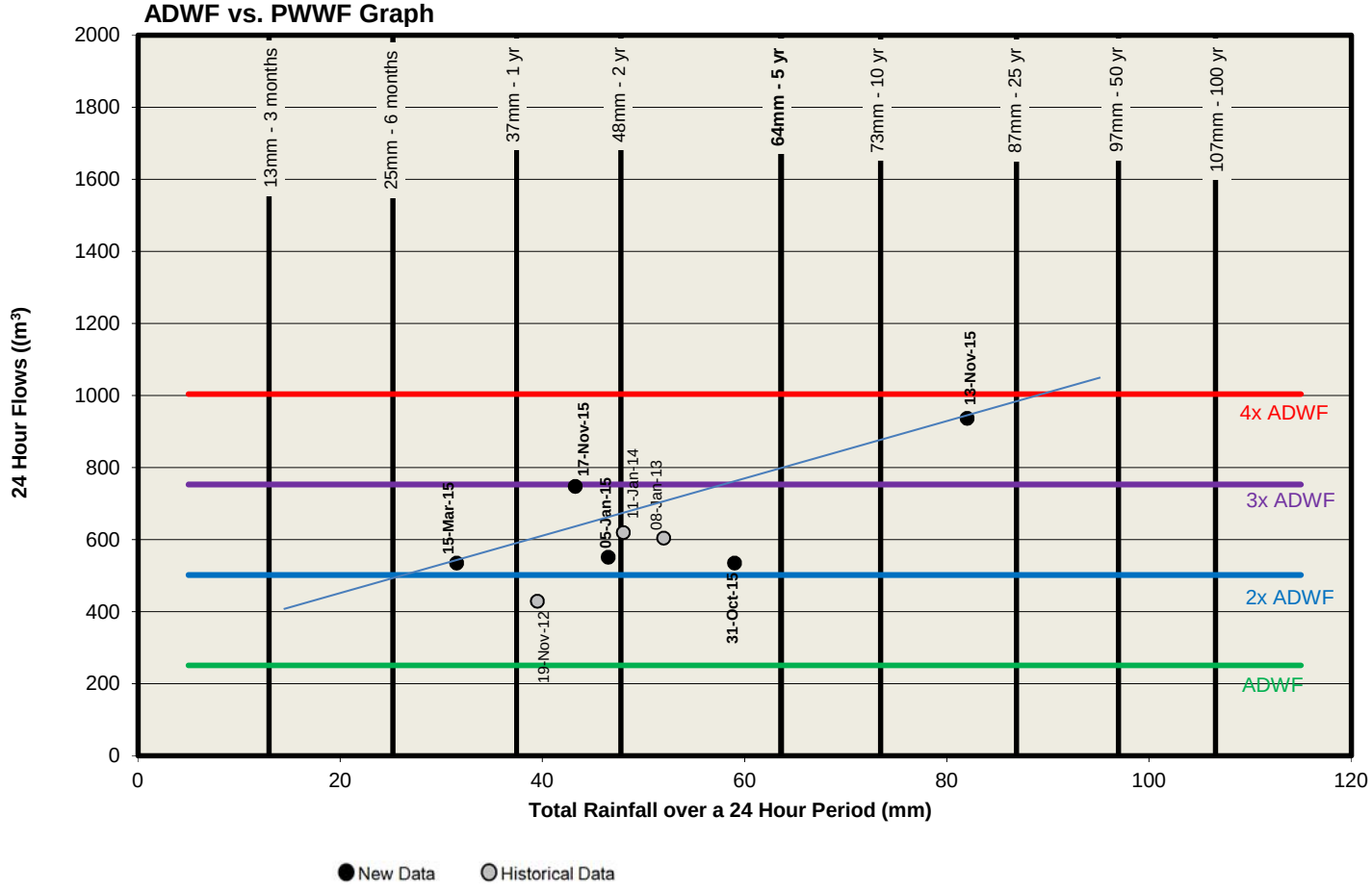
SITE CODE: **VR10**

Helmcken Park (VR10)

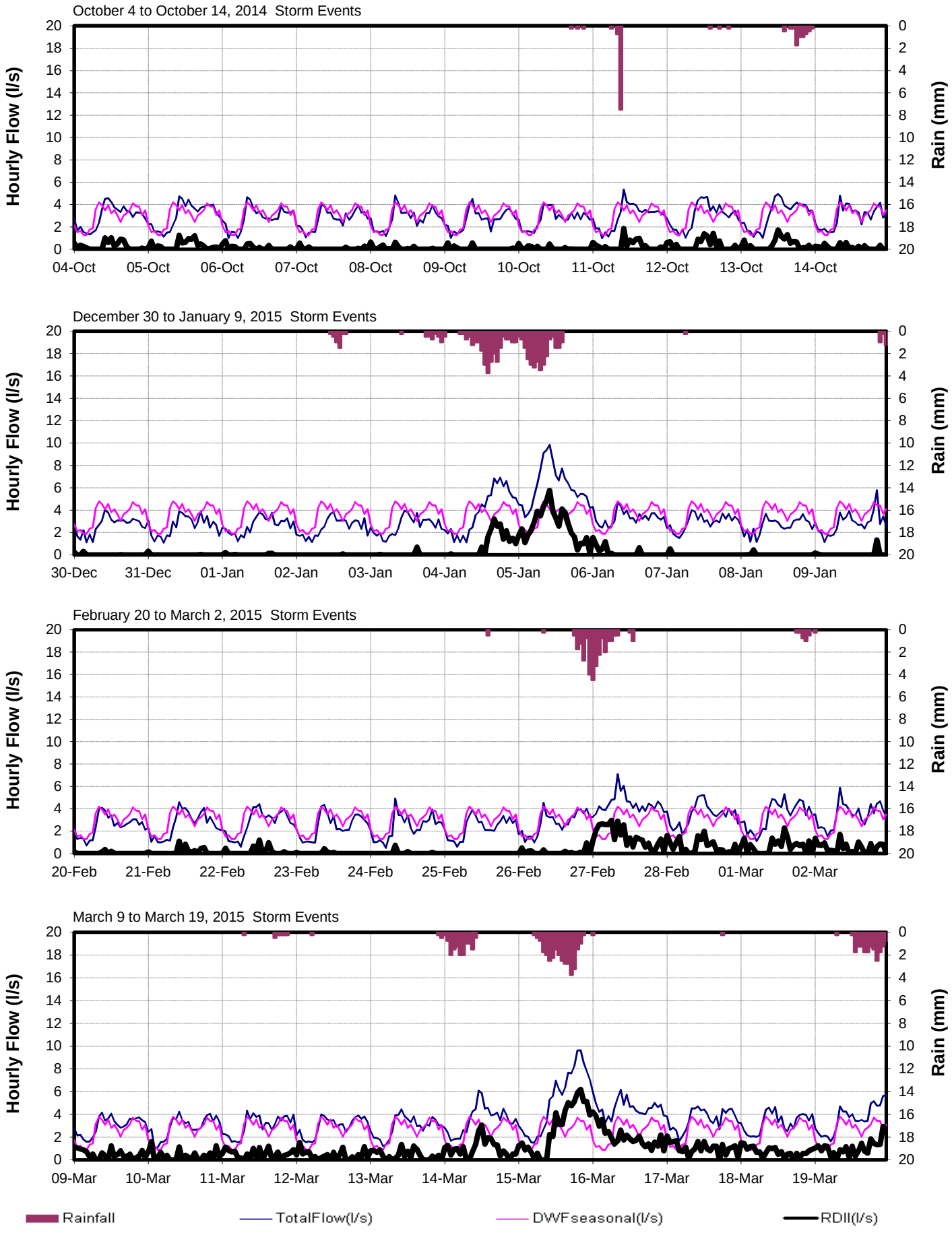
RDII Envelope



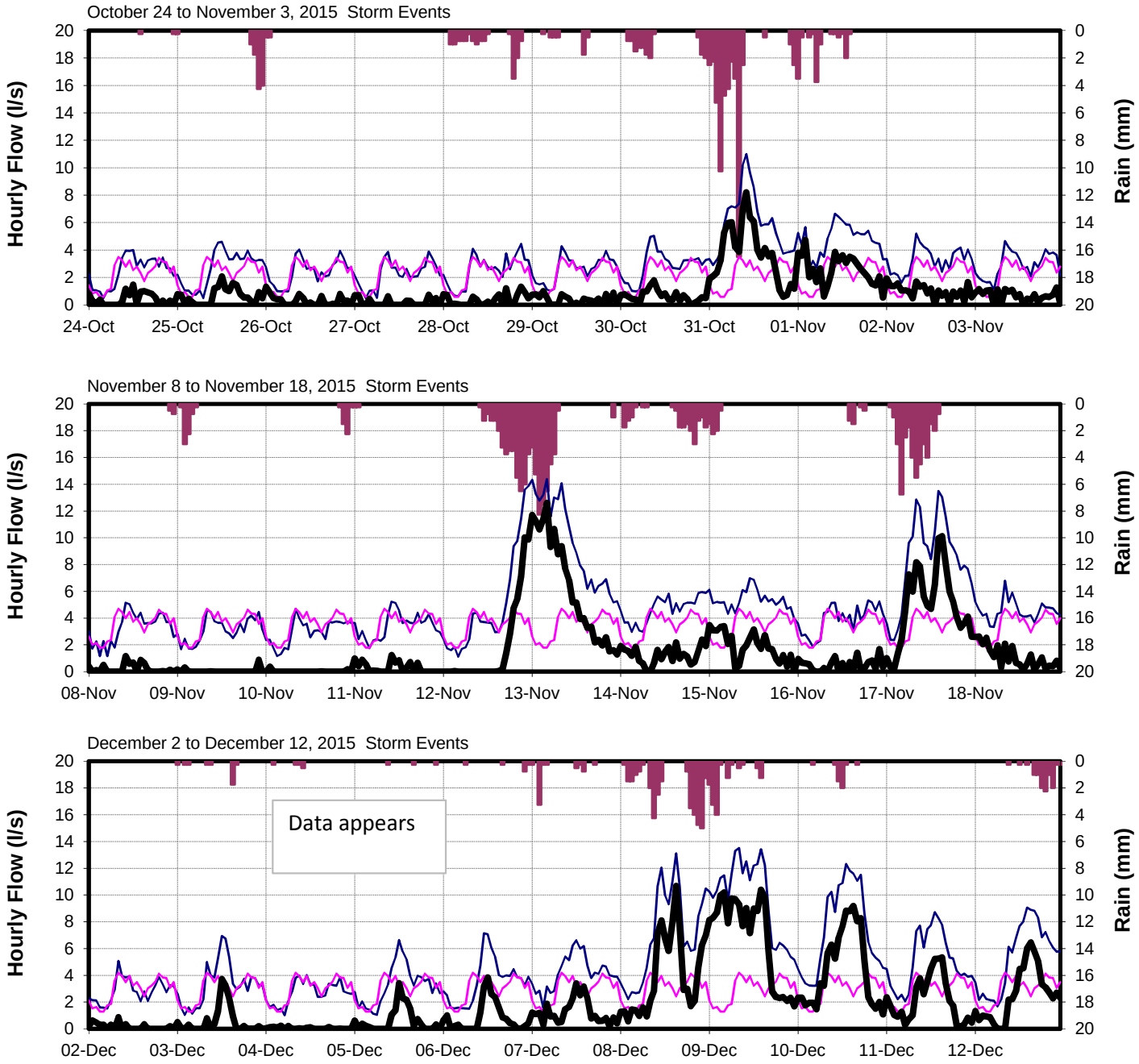
ADWF vs. PWWF Graph



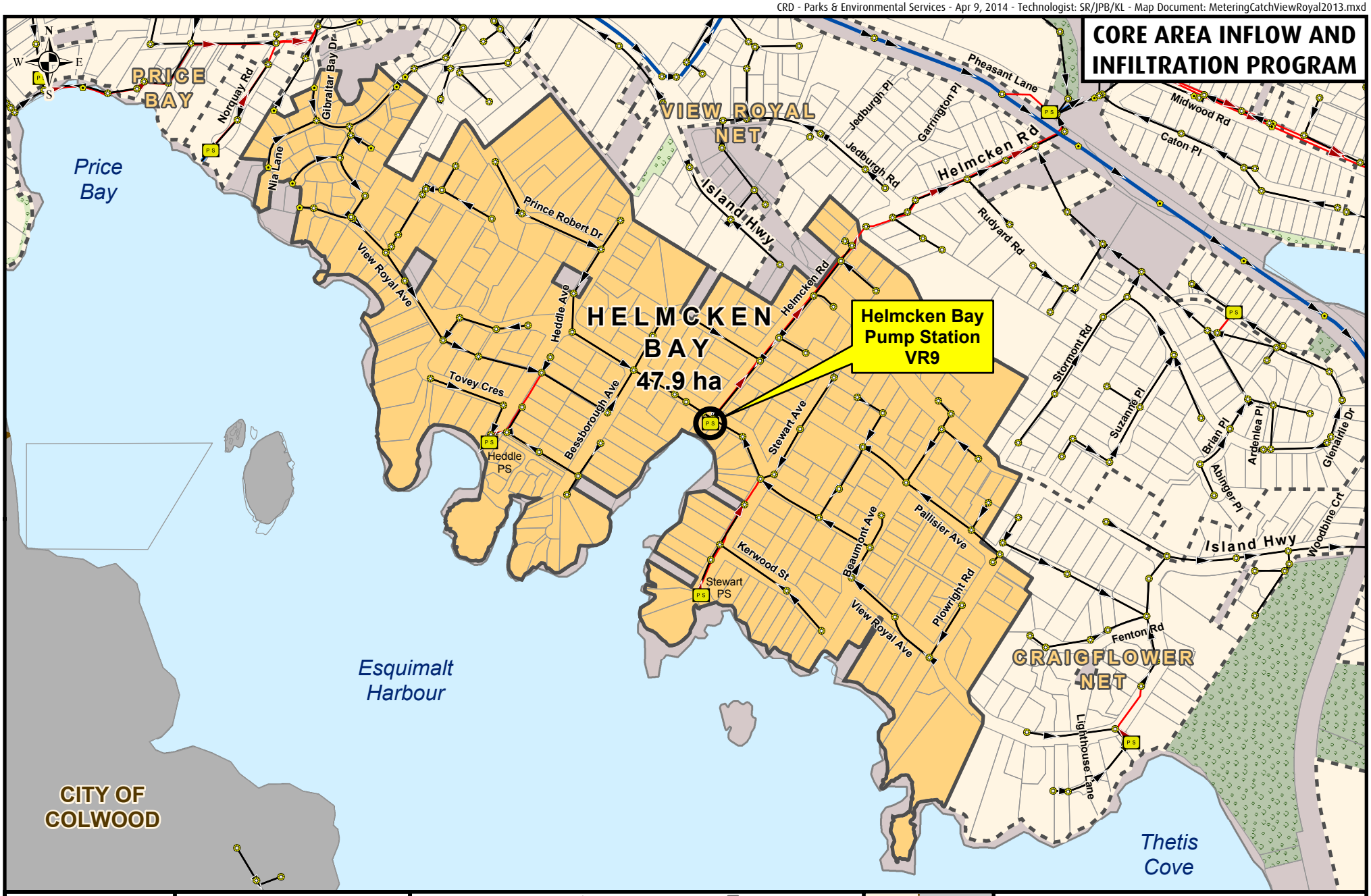
Helmcken Park (VR10)



Helmcken Park (VR10)



CORE AREA INFLOW AND INFILTRATION PROGRAM



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Metres
0 50 100 150 200

Projection: UTM ZONE 10N NAD 83

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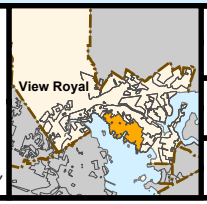


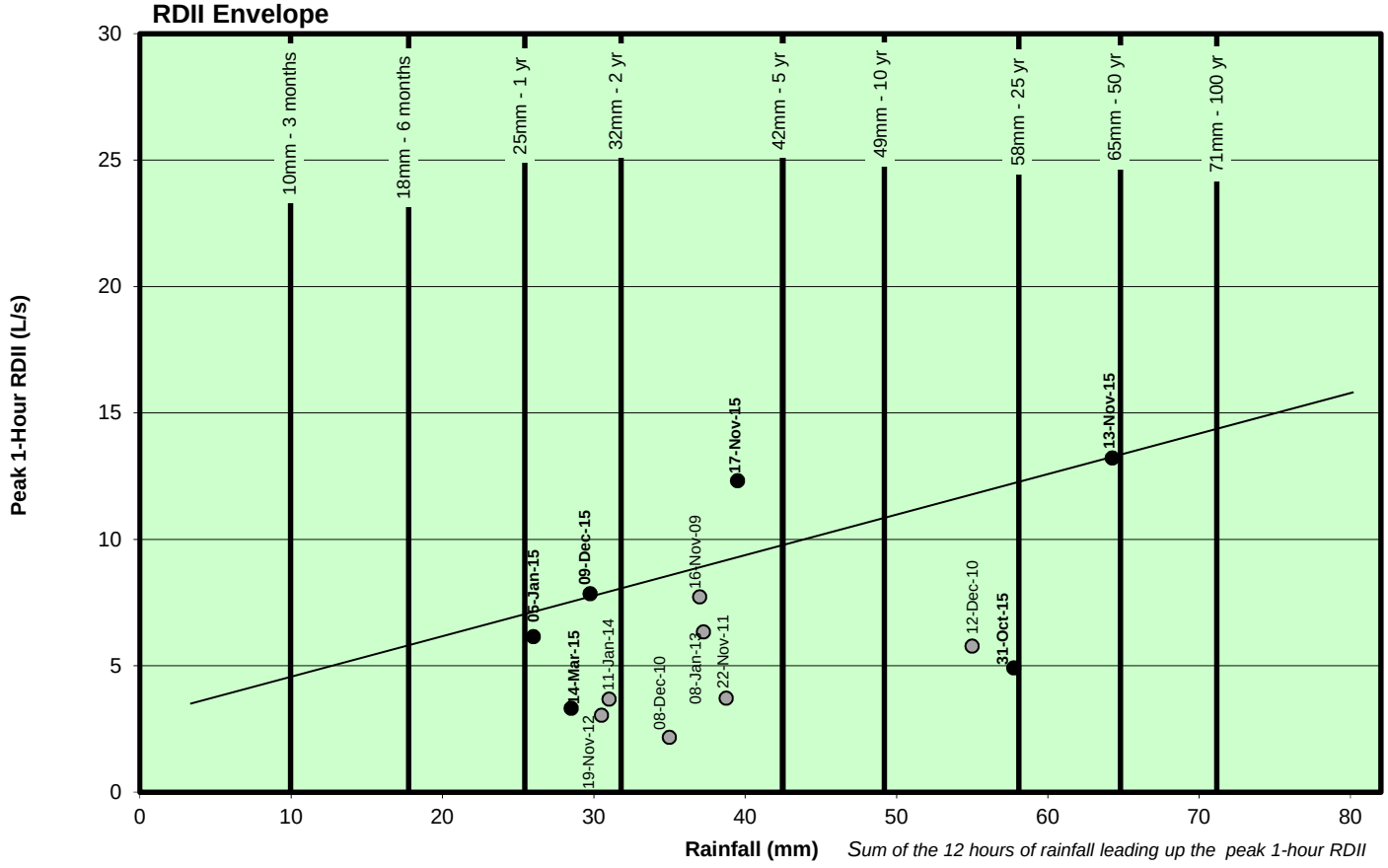
FLOW MONITORING AREA

CATCHMENT: HELMCKEN BAY

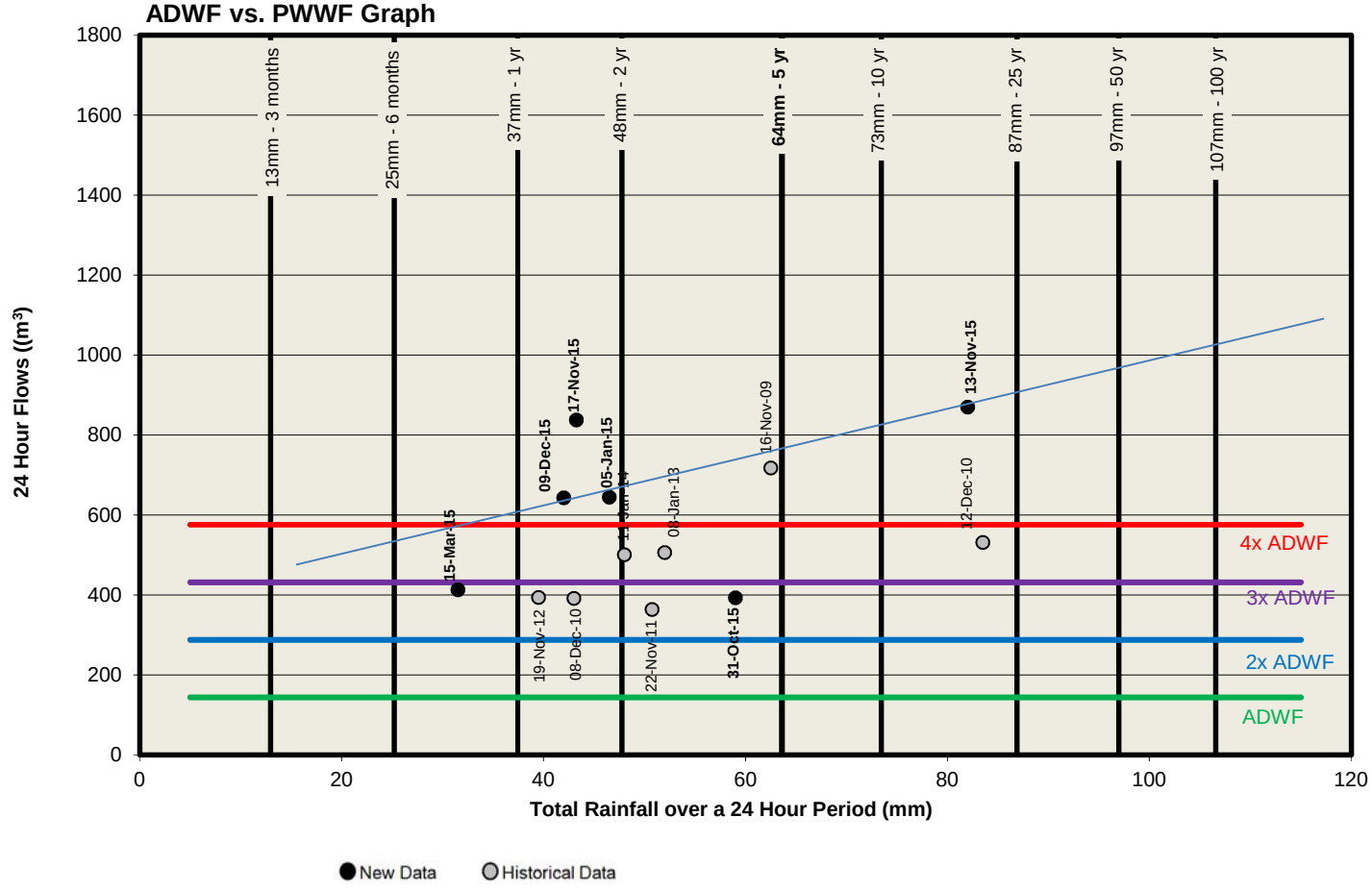
SITE CODE: **VR9**

Helmcken Bay (VR9)

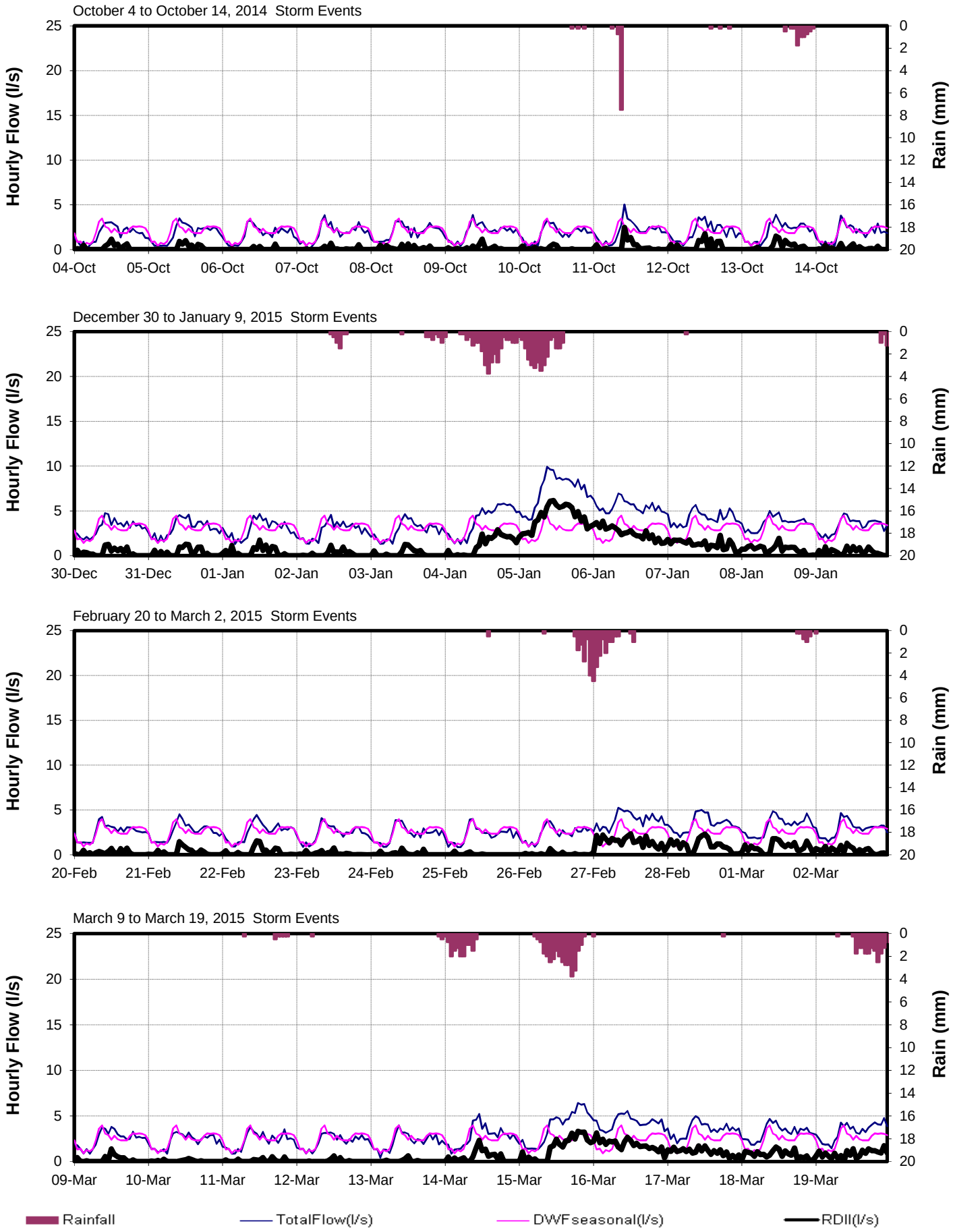
RDII Envelope



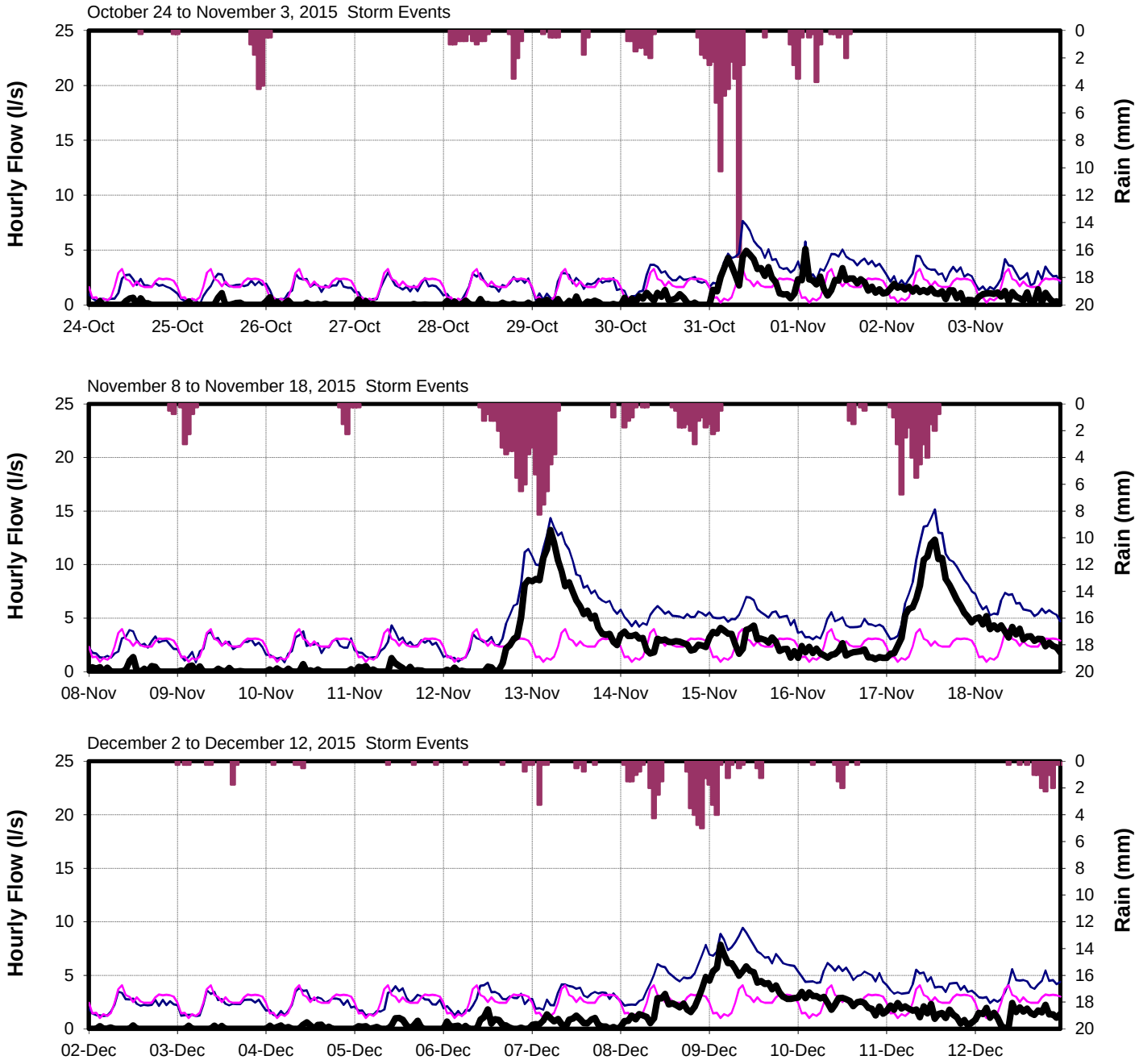
ADWF vs. PWWF Graph



Helmcken Bay (VR9)

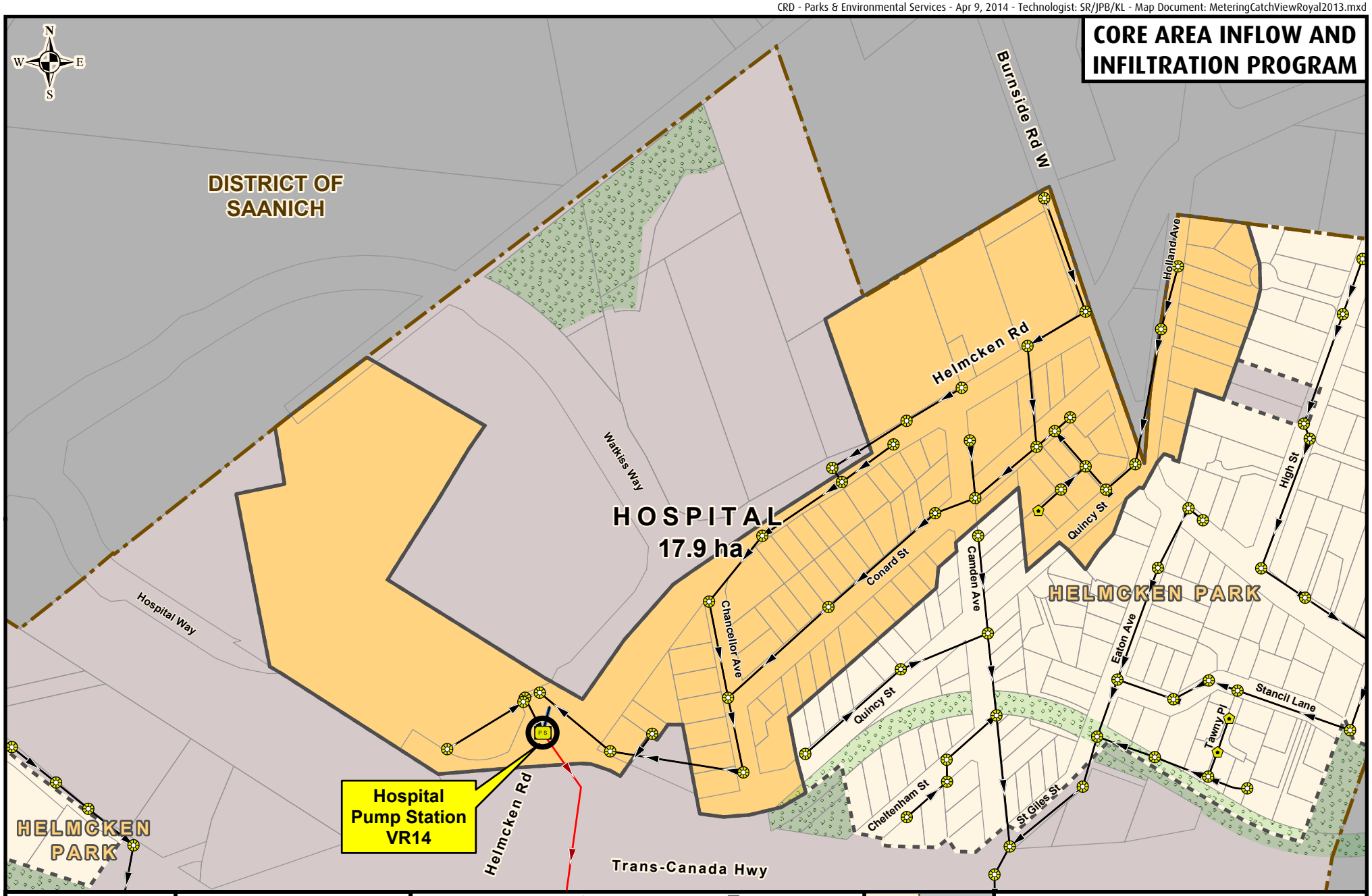


Helmcken Bay (VR9)



CRD - Parks & Environmental Services - Apr 9, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchViewRoyal2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100 150

Projection: UTM ZONE 10N NAD 83

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- Flow Monitoring Location
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Sanitary Sewers

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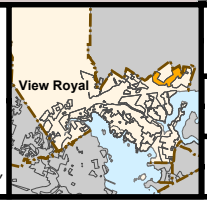
- Municipal, First Nation, or DND Boundaries

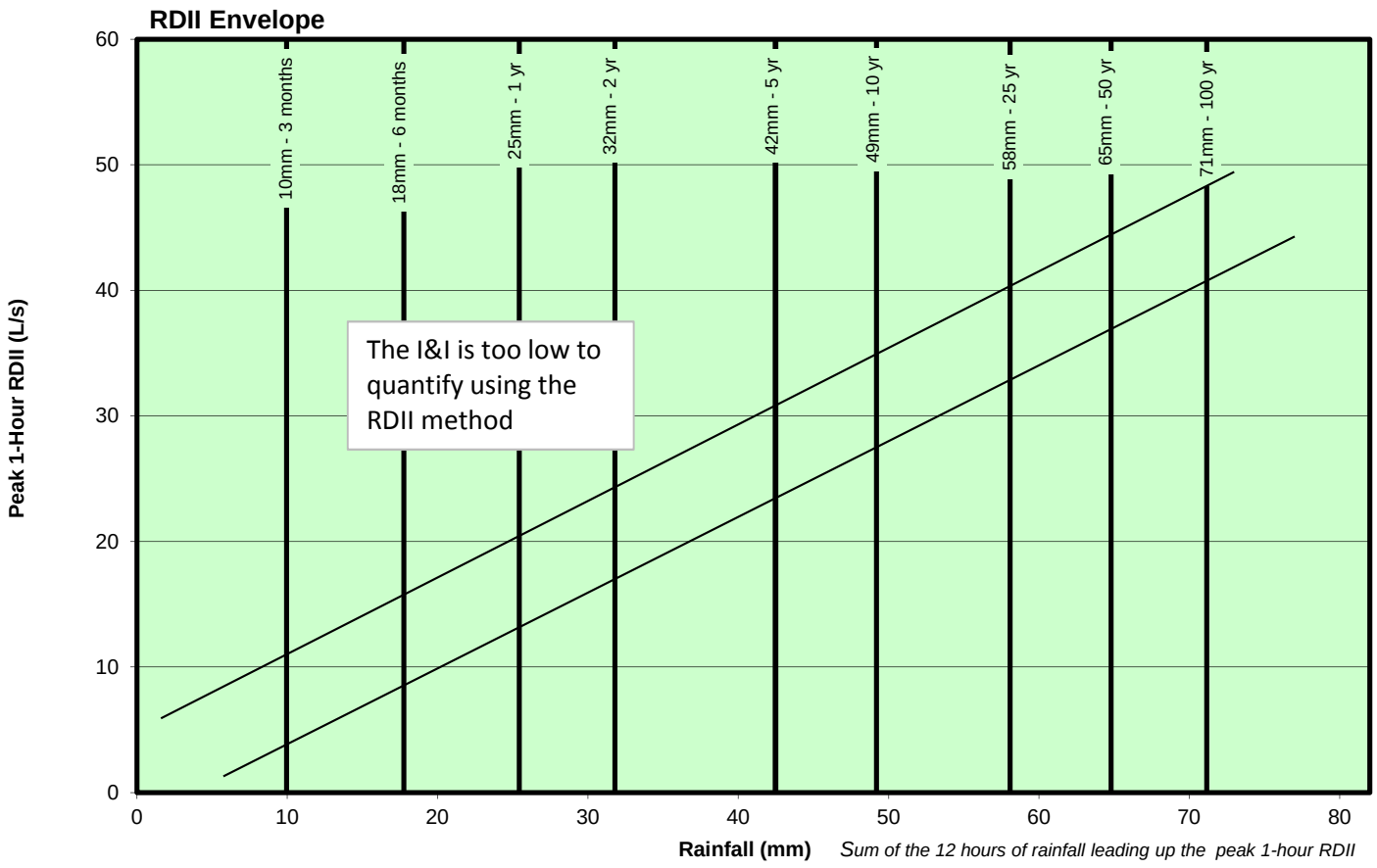


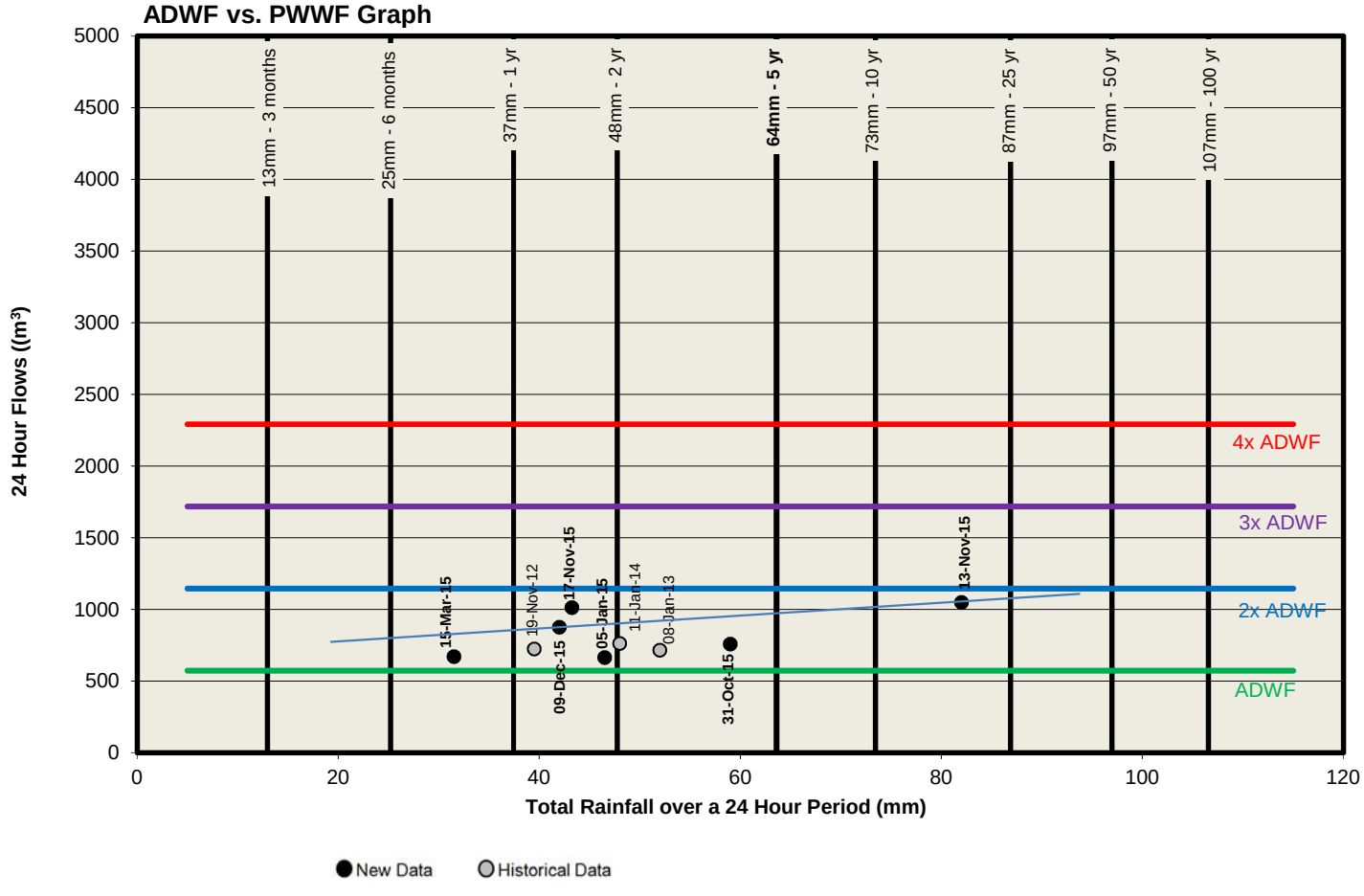
FLOW MONITORING AREA

CATCHMENT: HOSPITAL

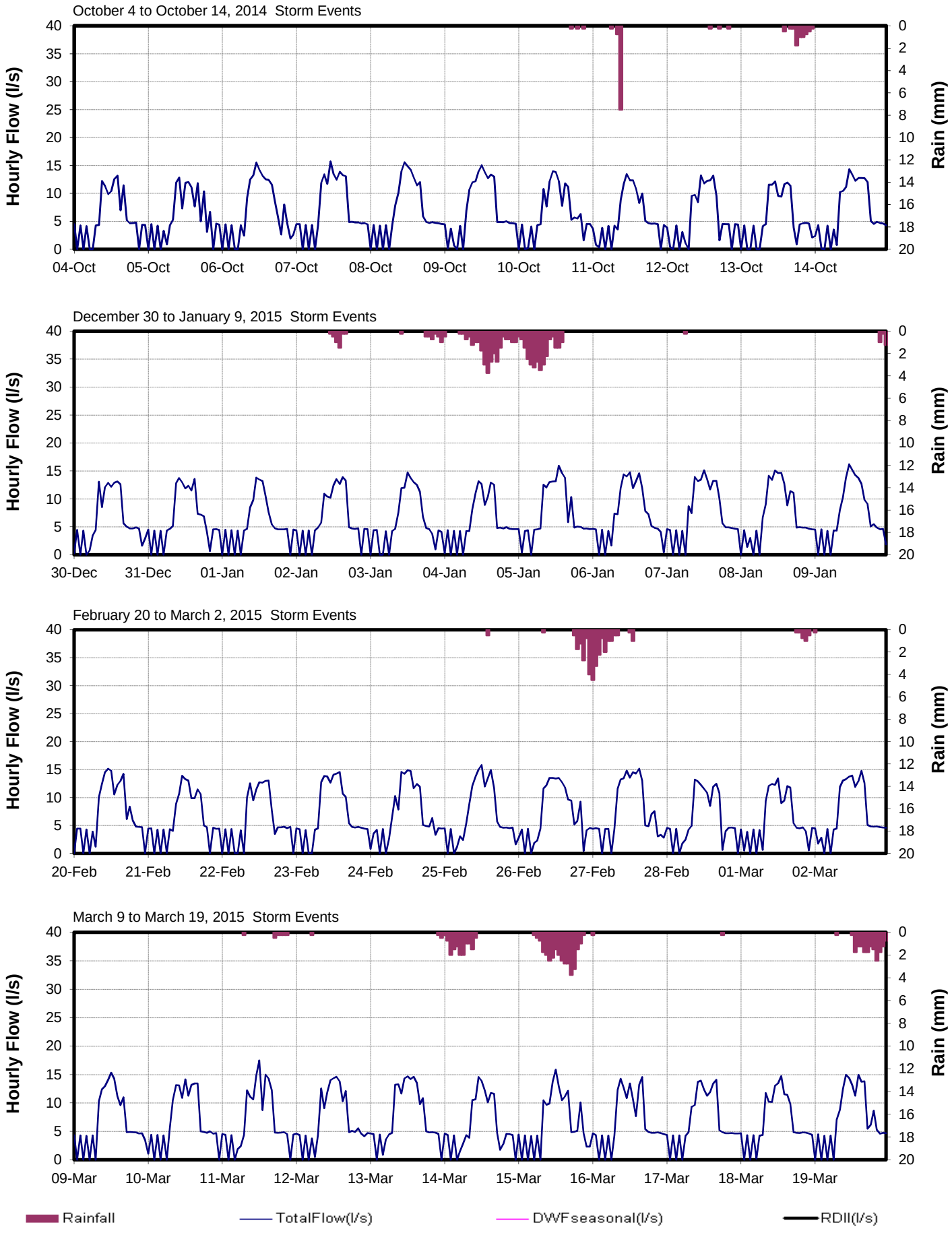
SITE CODE: **VR14**

Hospital (VR14)

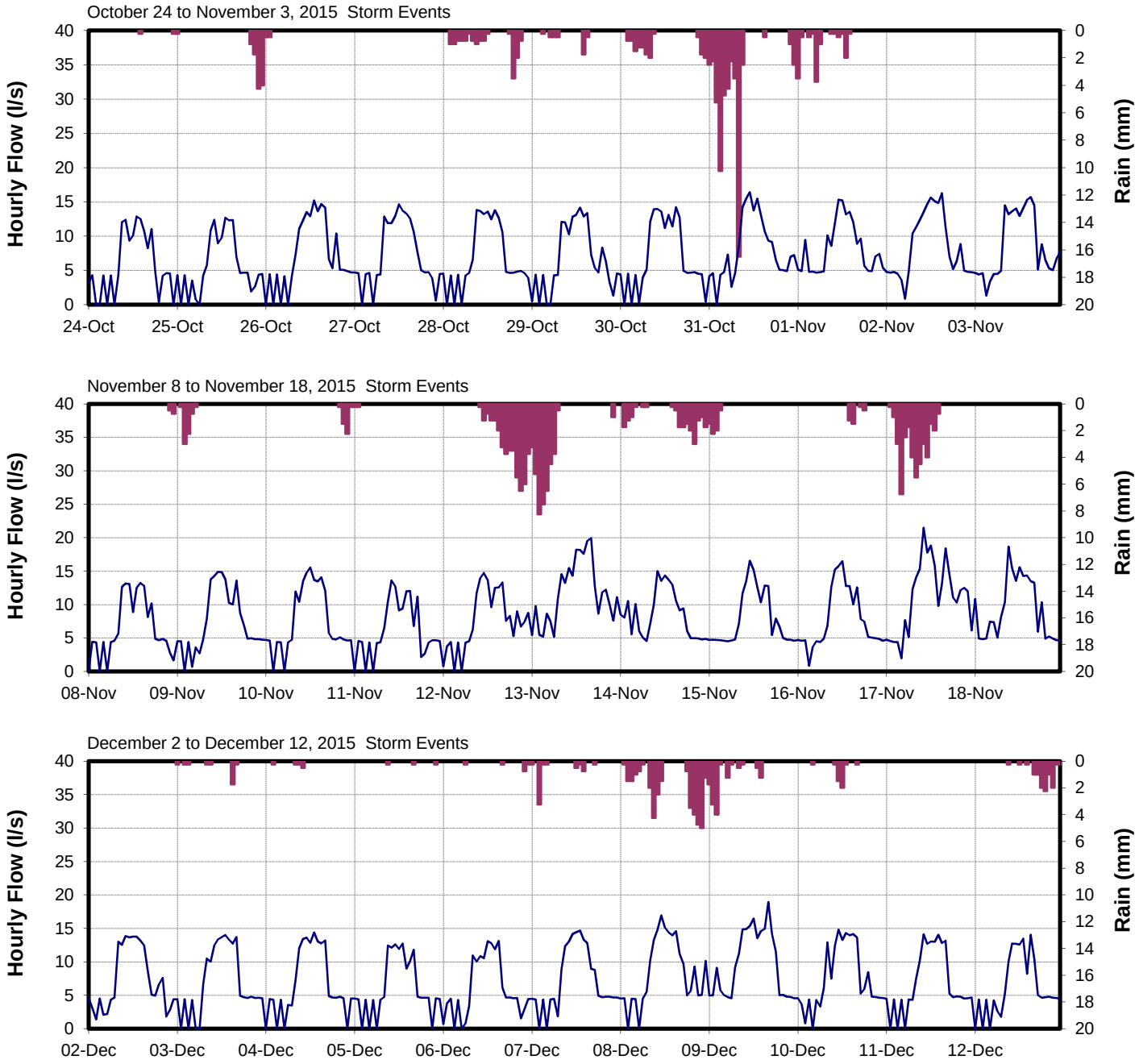




Hospital (VR14)



Hospital (VR14)



Rainfall TotalFlow(l/s) DWFseasonal(l/s) RDII(l/s)

CRD - Parks & Environmental Services - Apr 9, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchViewRoyal2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100

Projection: UTM ZONE 10N NAD 83

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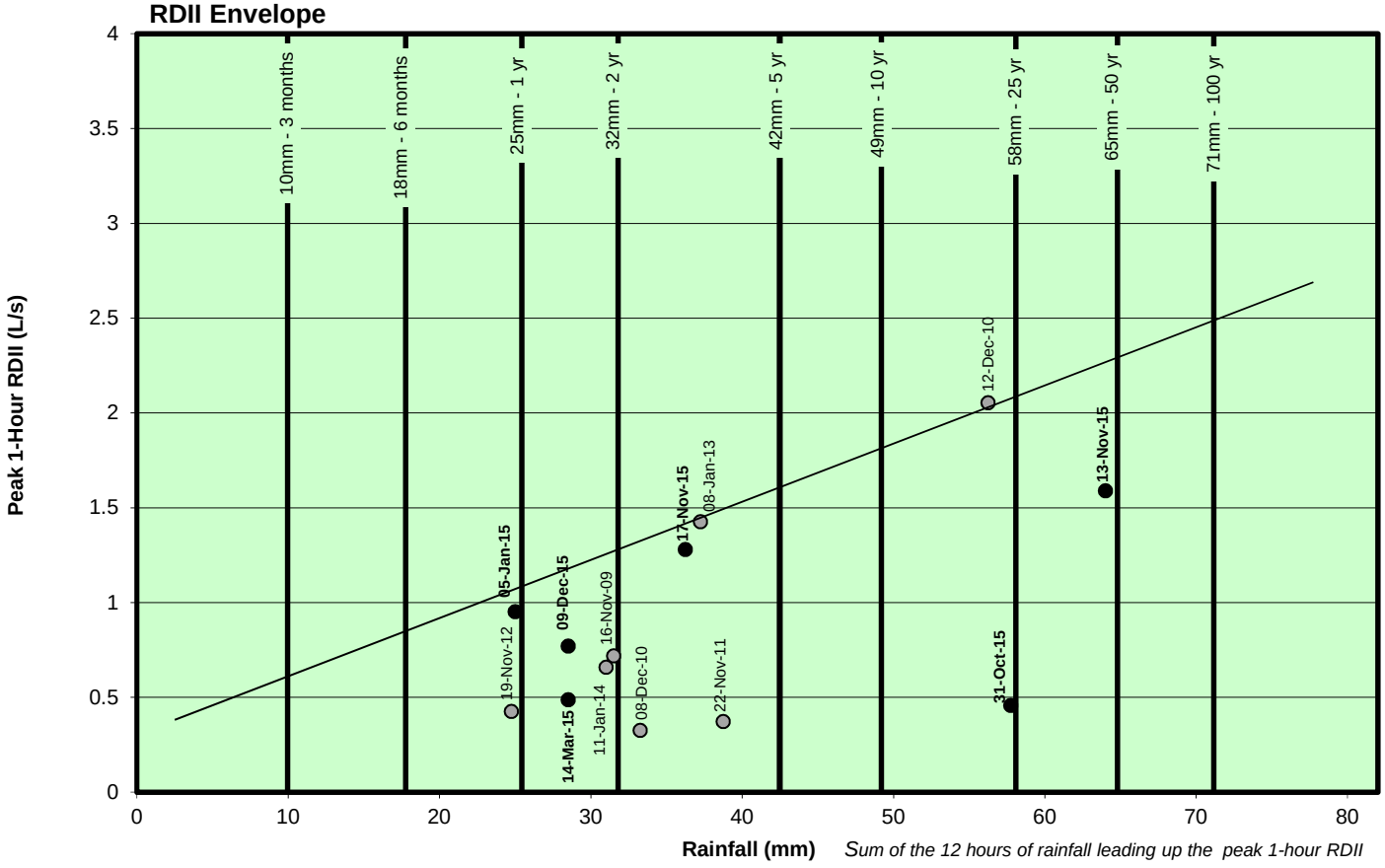
FLOW MONITORING AREA

CATCHMENT: MIDWOOD

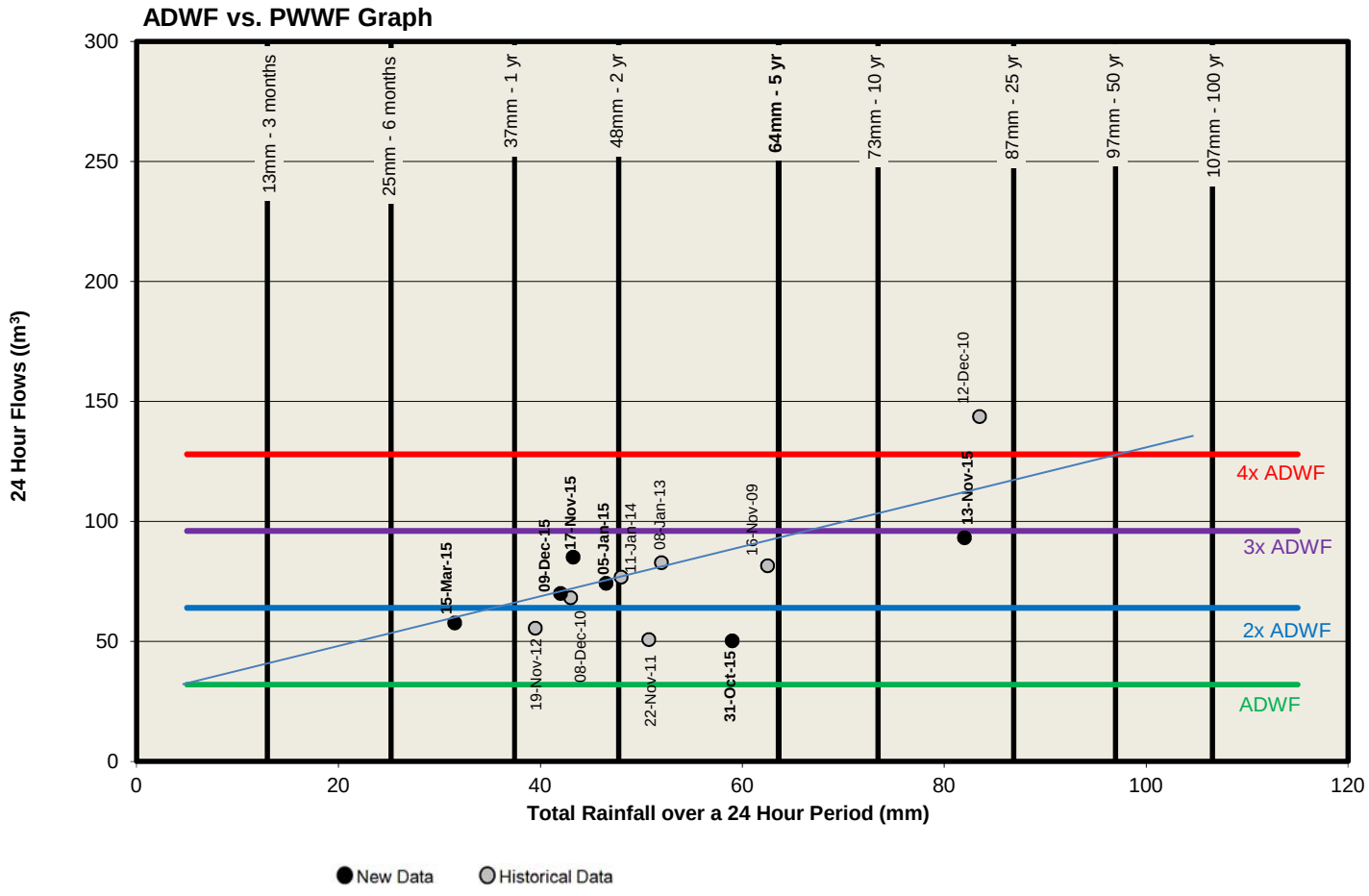
SITE CODE: **VR16**

Midwood (VR16)

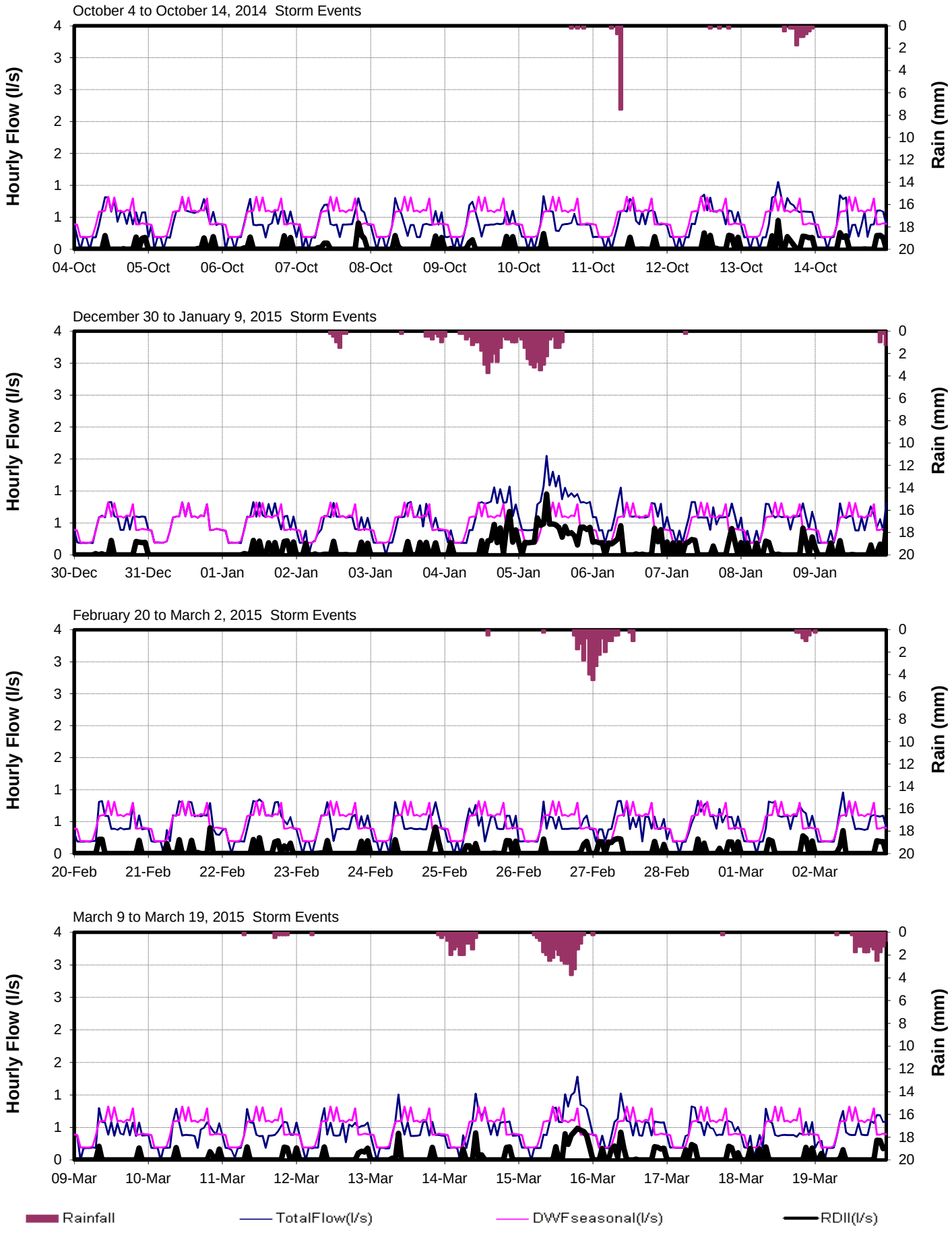
RDII Envelope



ADWF vs. PWWF Graph

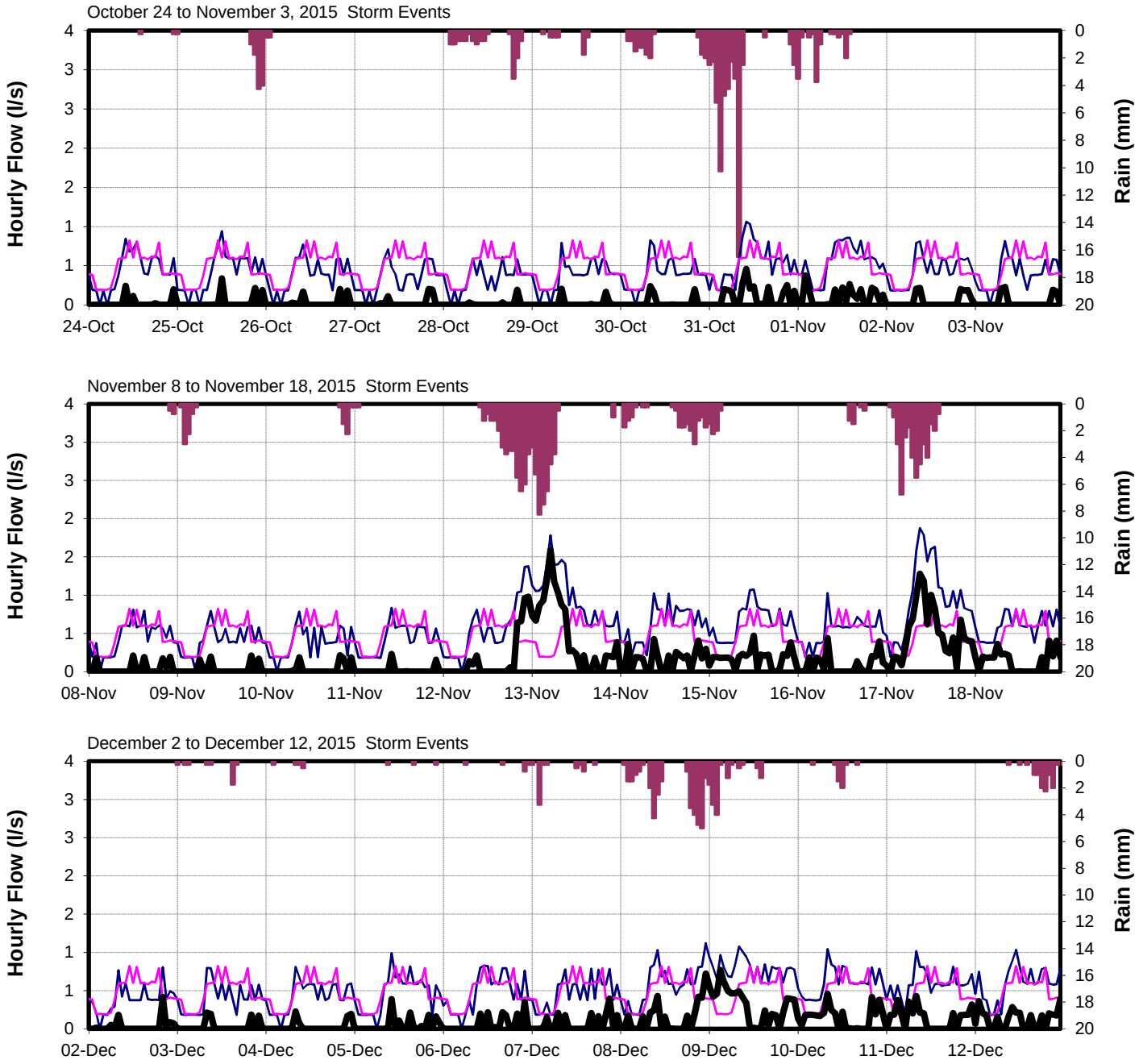


Midwood (VR16)



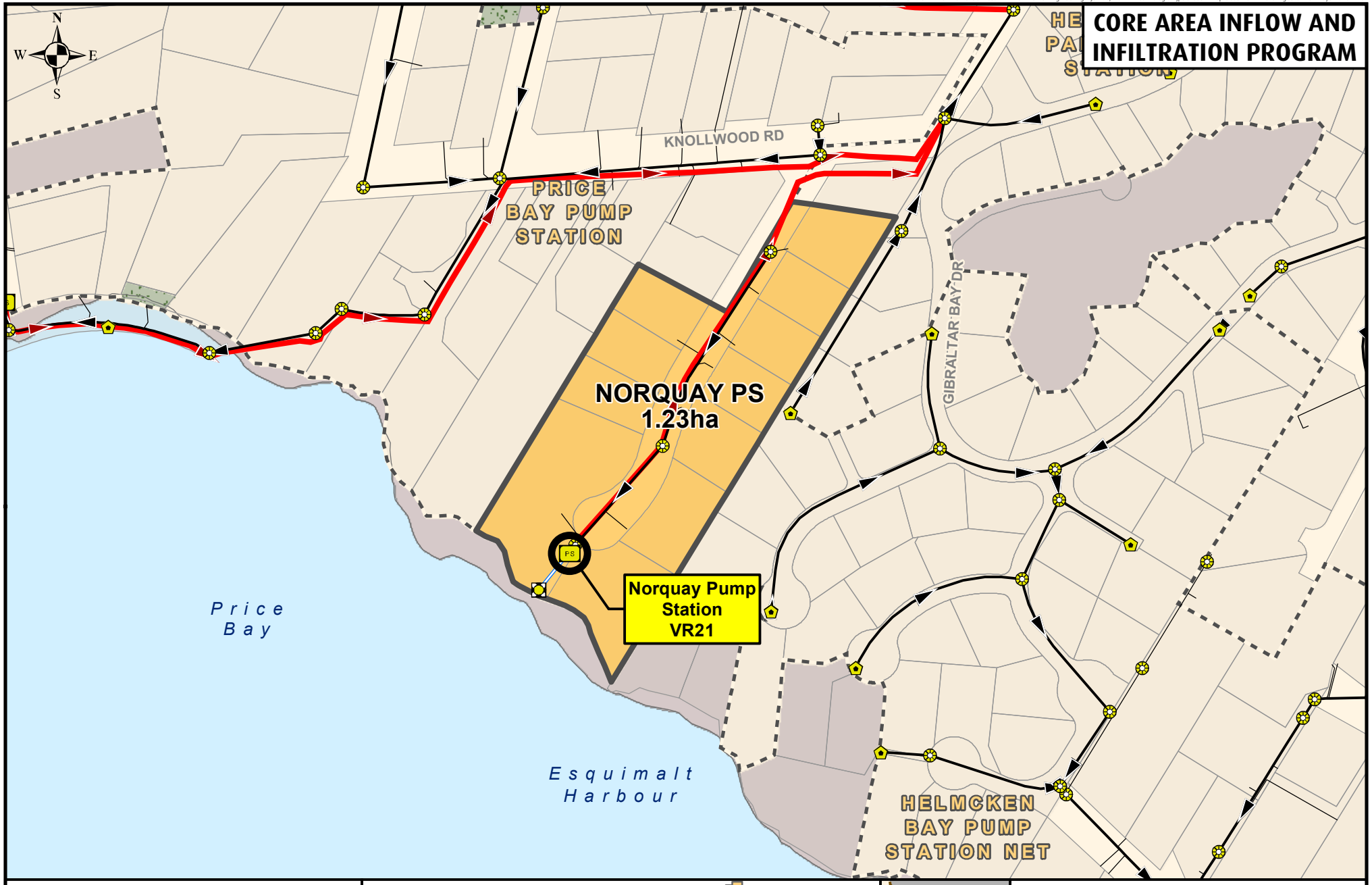
CRD Core Area I Program

Midwood (VR16)



CRD - Parks & Environmental Services - Environmental Engineering - Jan 06, 2017 - Technologist: jpbezeau - Map Document: MeteringCatchViewRoyal2016.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Metres
0 50 100

Projection: UTM ZONE 10N, NAD83

Disclaimer
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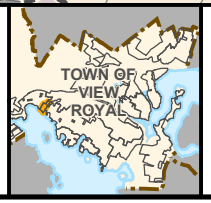

FLOW MONITORING AREA
Catchment: Norquay Pump Station
Site Code: VR21

CRD
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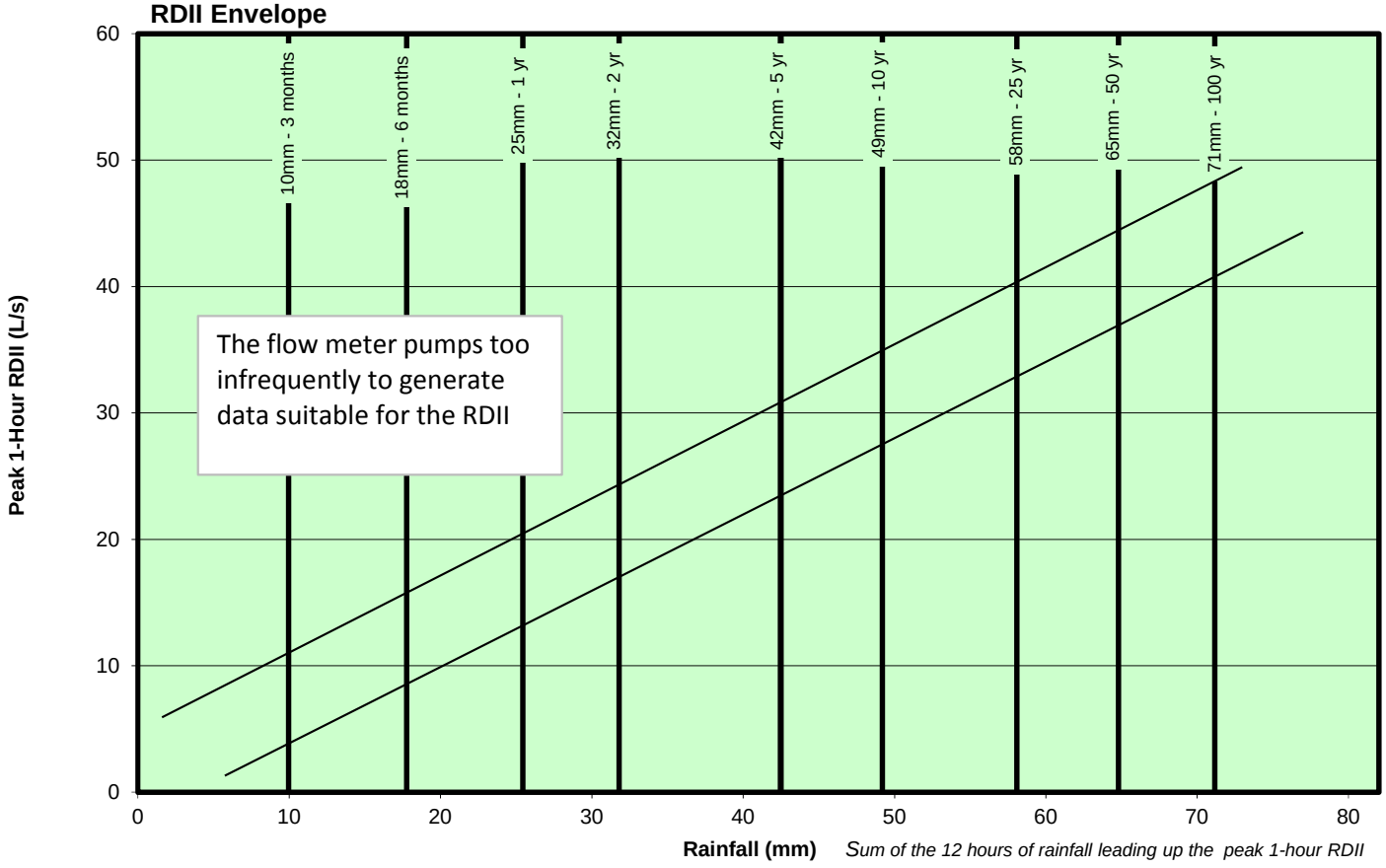
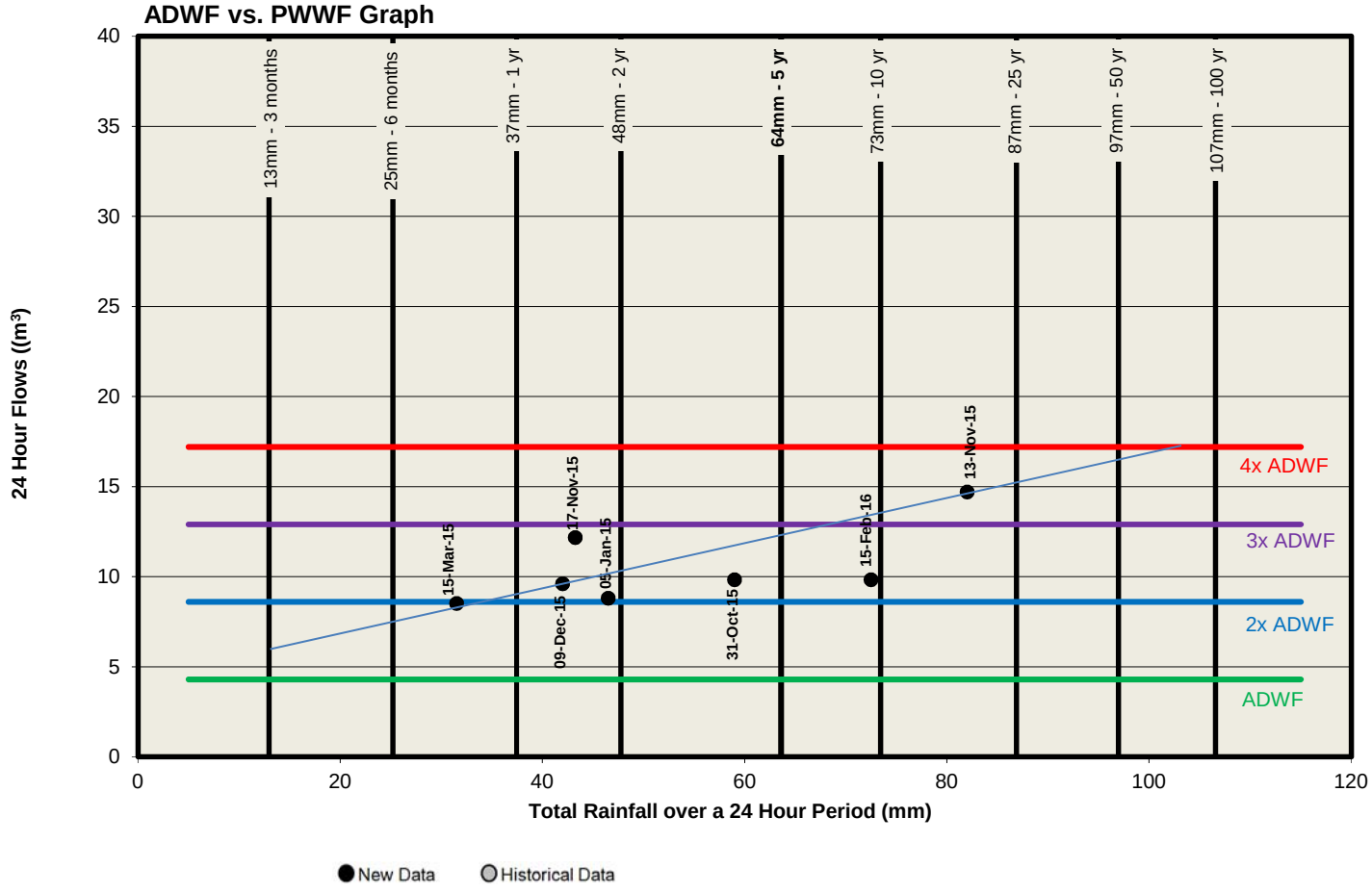
Norquay (VR21)

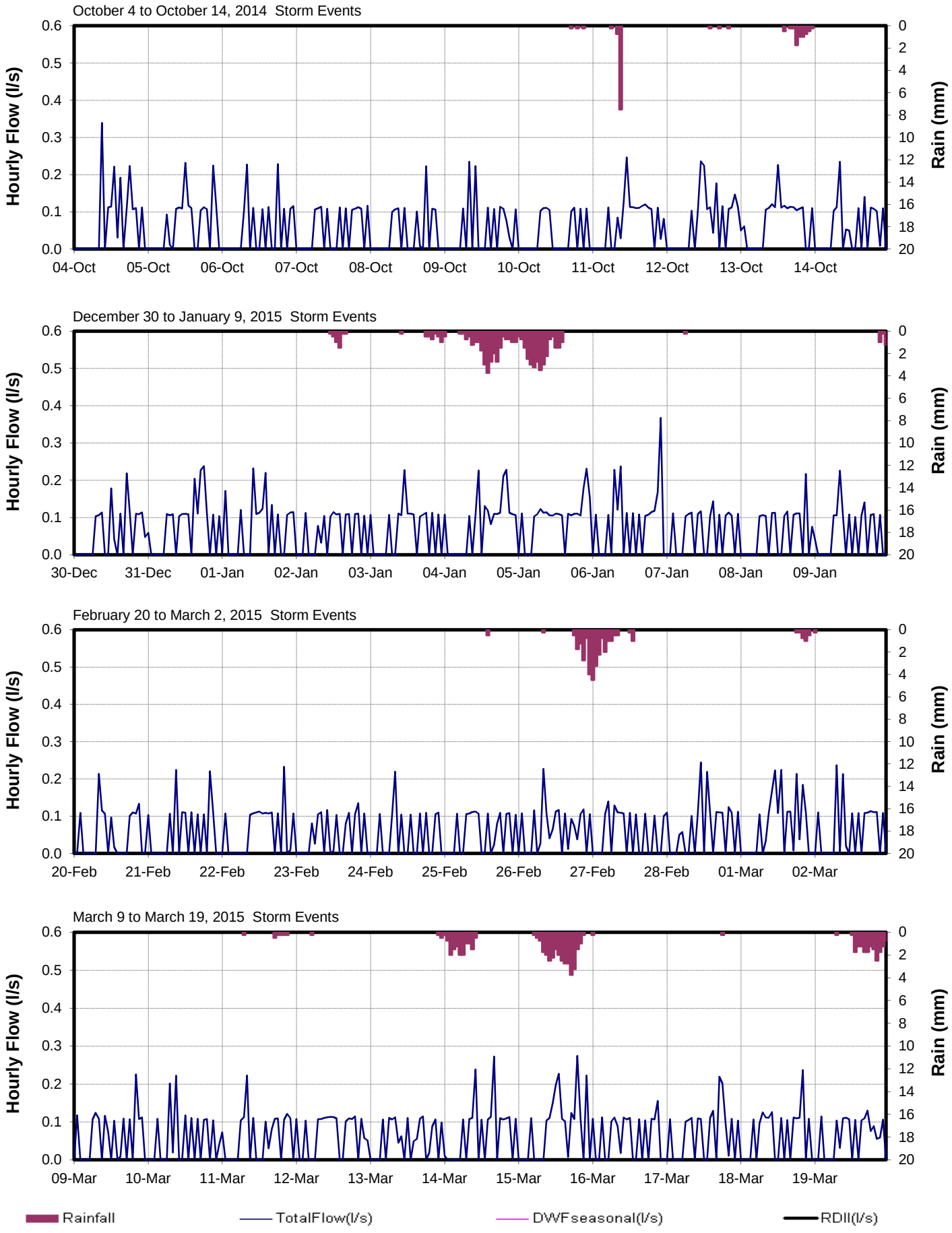
RDII Envelope



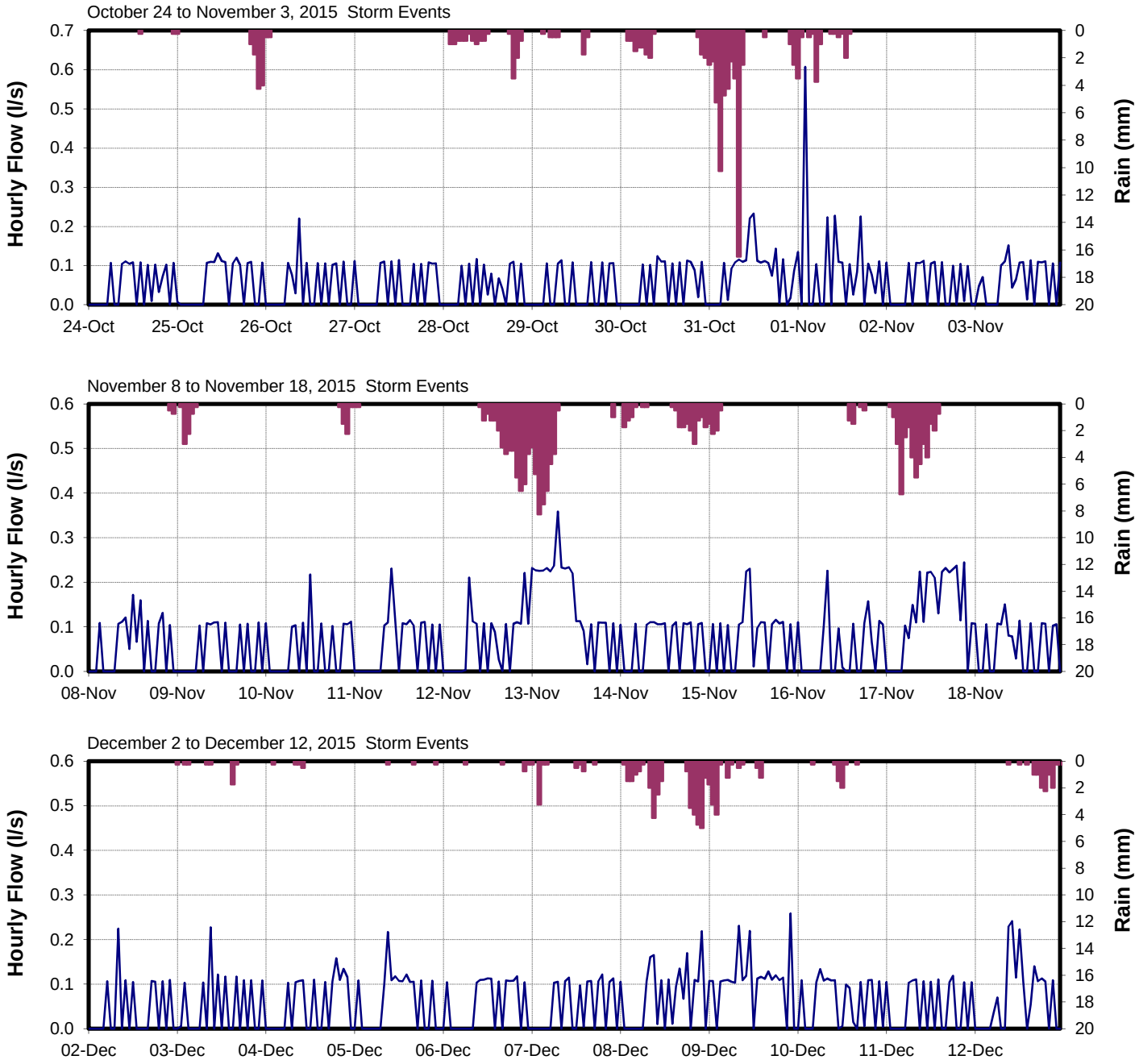
ADWF vs. PWWF Graph



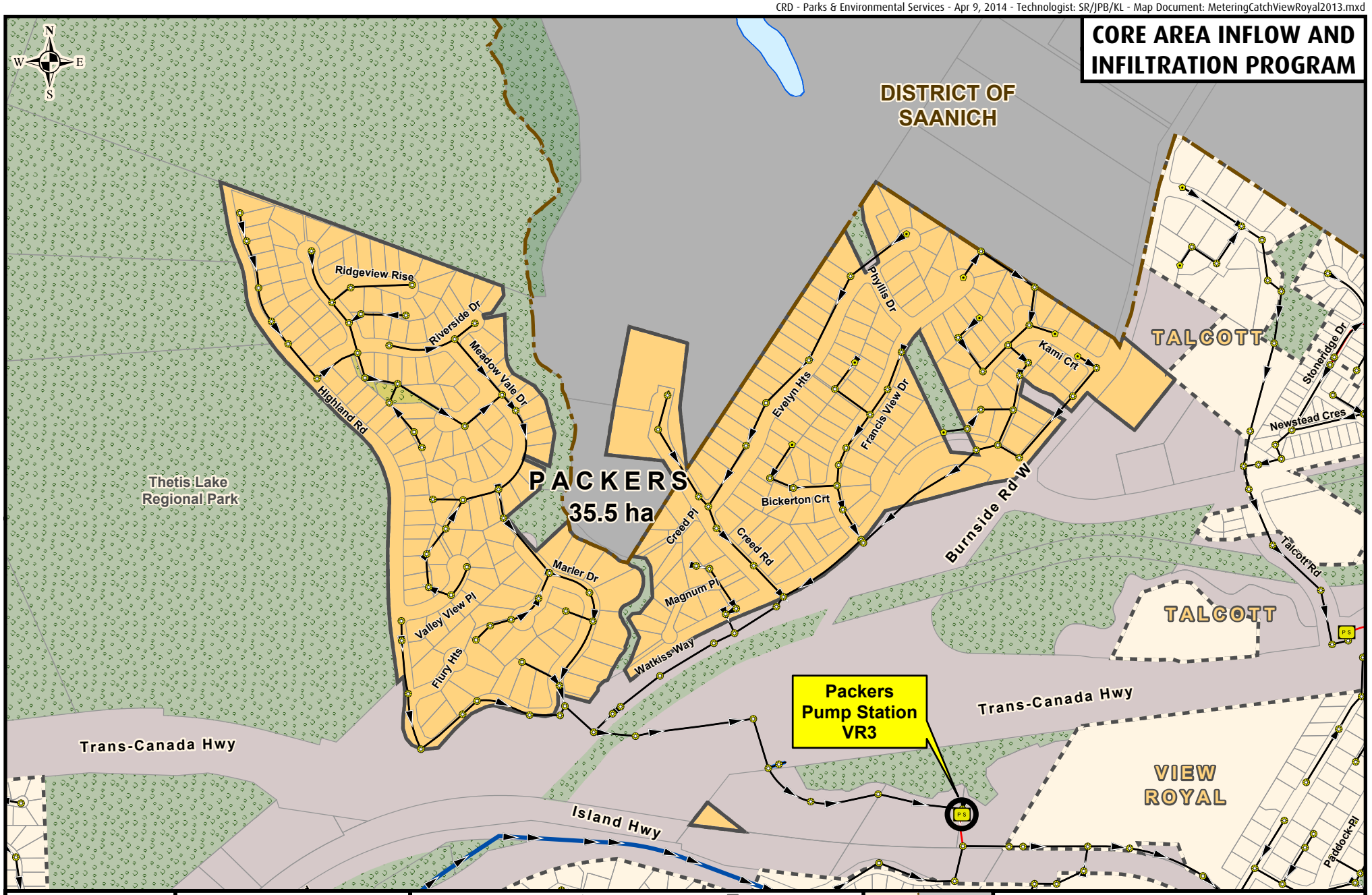
Norquay (VR21)



Norquay (VR21)



CORE AREA INFLOW AND INFILTRATION PROGRAM



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Metres
0 50 100 150 200

Projection: UTM ZONE 10N NAD 83

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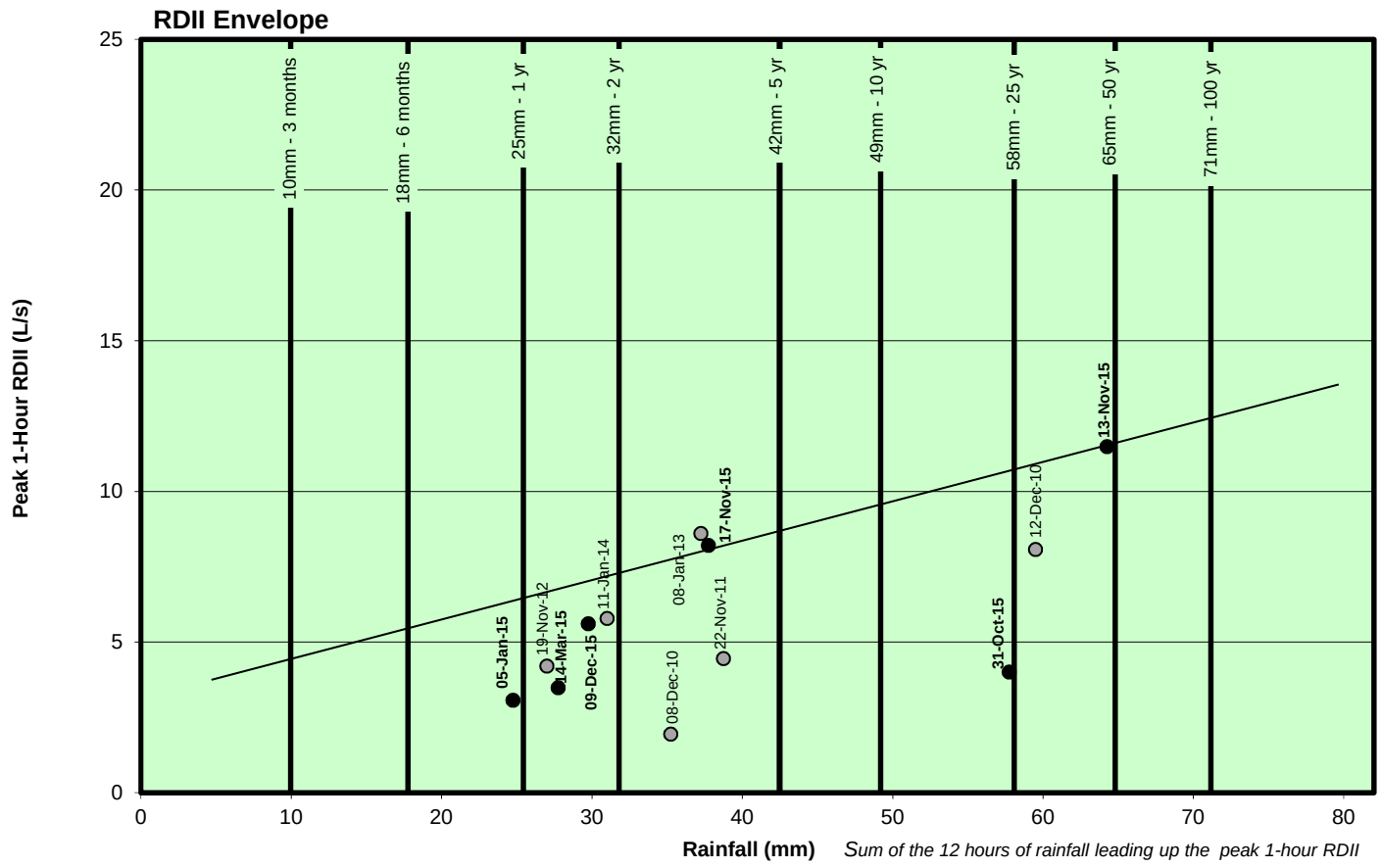
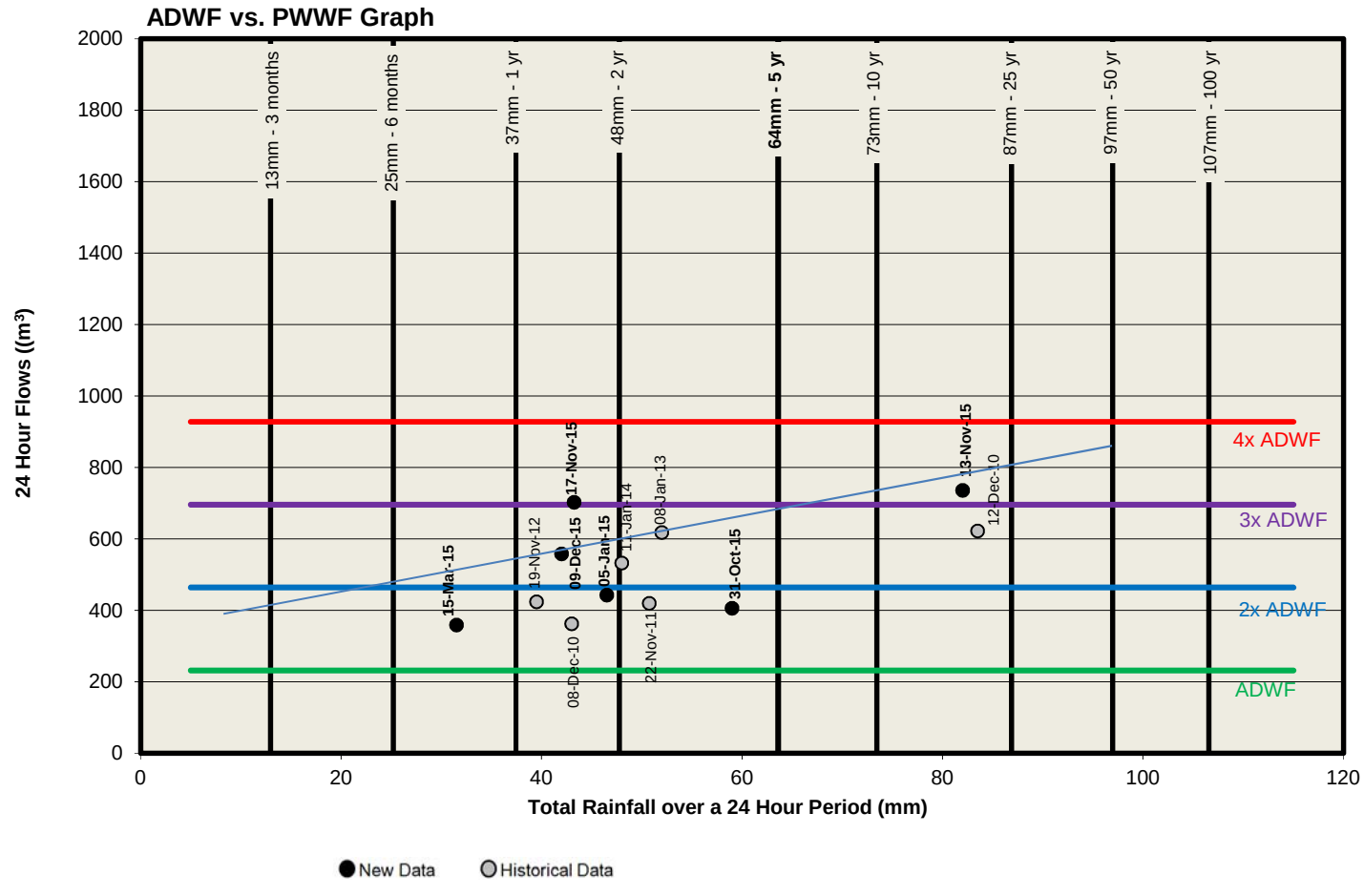
FLOW MONITORING AREA

CATCHMENT: PACKERS

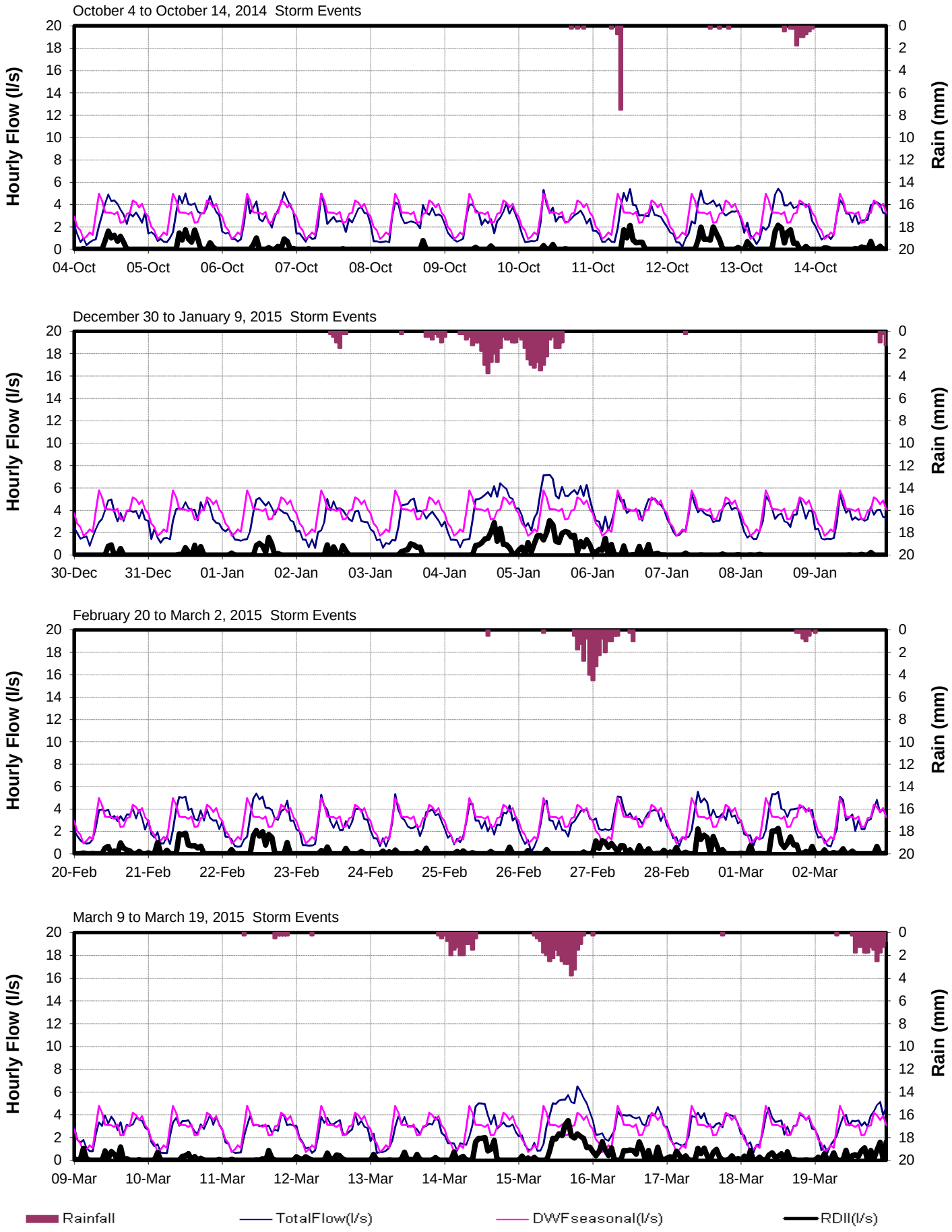
SITE CODE: **VR3**

Packers (VR3)

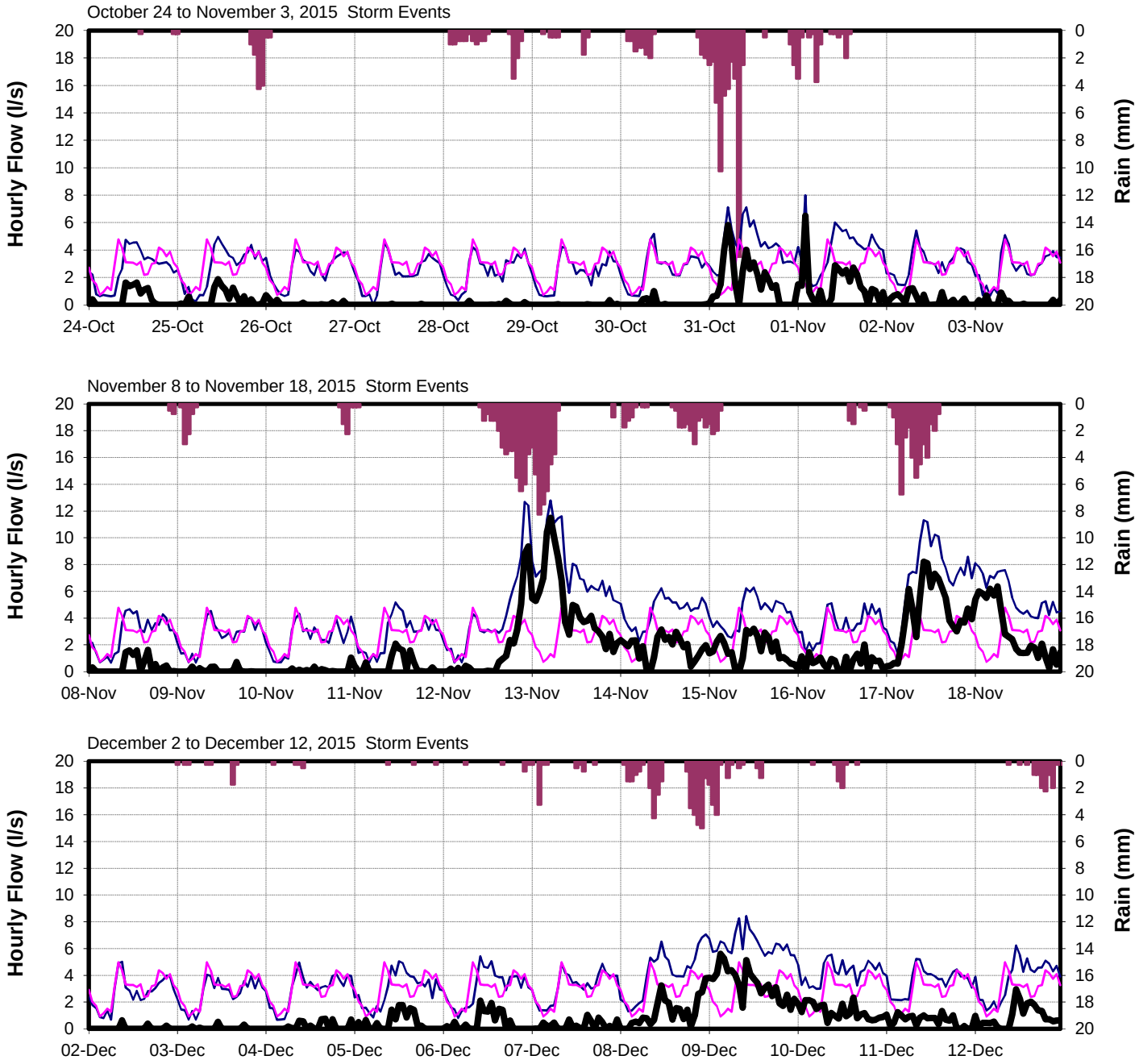

RDII Envelope
Peak 1-Hour RDII (L/s)
Rainfall (mm)
Sum of the 12 hours of rainfall leading up the peak 1-hour RDII
10mm - 3 months
18mm - 6 months
25mm - 1 yr
32mm - 2 yr
42mm - 5 yr
49mm - 10 yr
58mm - 25 yr
65mm - 50 yr
71mm - 100 yr
05-Jan-15
19-Nov-12
14-Mar-15
09-Dec-15
11-Jan-14
08-Jan-13
17-Nov-15
22-Nov-11
08-Dec-10
31-Oct-15
12-Dec-10
13-Nov-15


ADWF vs. PWWF Graph
24 Hour Flows ((m³)
Total Rainfall over a 24 Hour Period (mm)
13mm - 3 months
25mm - 6 months
37mm - 1 yr
48mm - 2 yr
64mm - 5 yr
73mm - 10 yr
87mm - 25 yr
97mm - 50 yr
107mm - 100 yr
4x ADWF
3x ADWF
2x ADWF
ADWF
15-Mar-15
19-Nov-12
09-Dec-15
17-Nov-15
05-Jan-15
11-Jan-14
08-Jan-13
31-Oct-15
13-Nov-15
12-Dec-10
08-Dec-10
22-Nov-11
New Data
Historical Data

Packers (VR3)

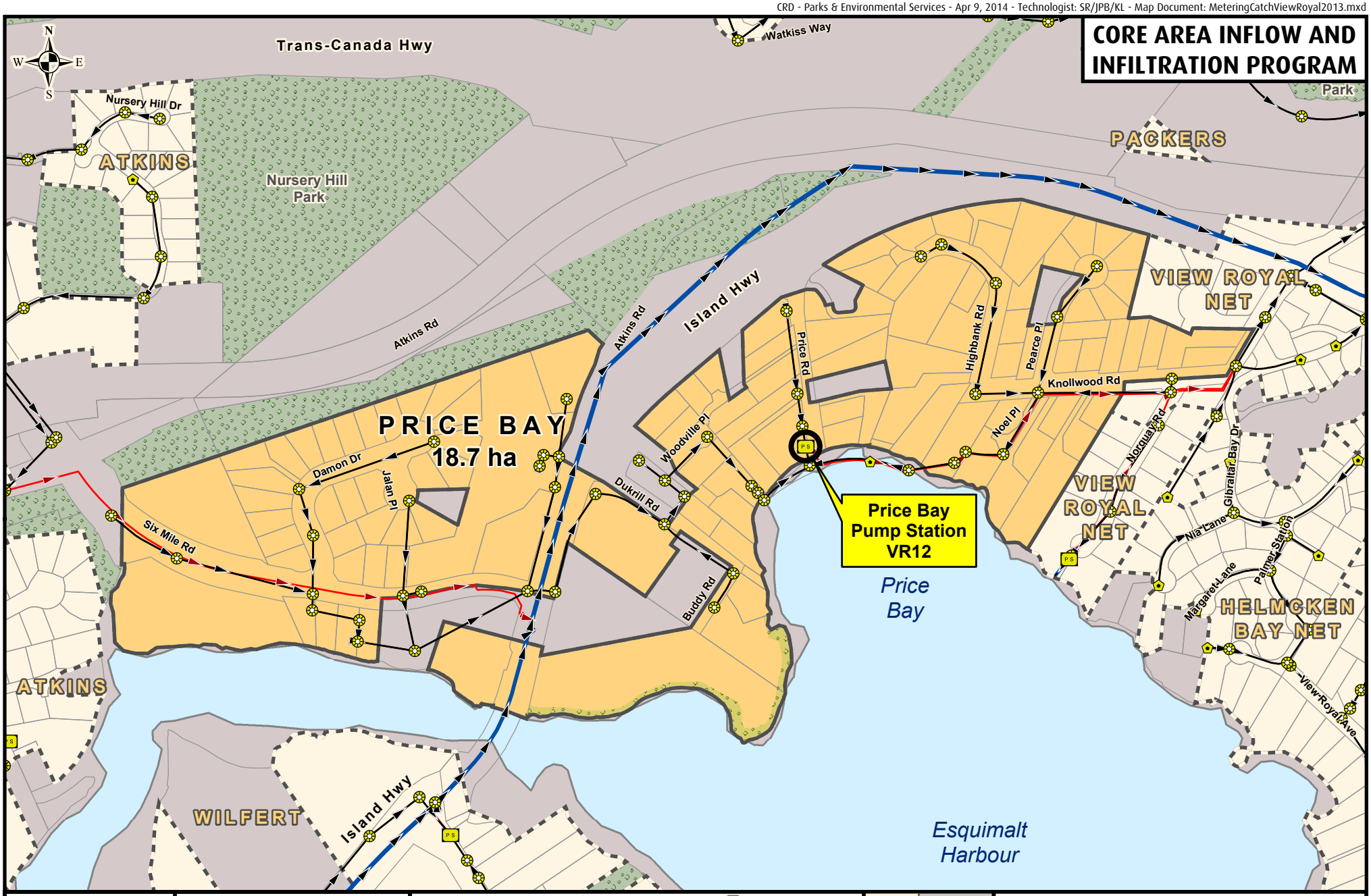

October 4 to October 14, 2014 Storm Events
December 30 to January 9, 2015 Storm Events
February 20 to March 2, 2015 Storm Events
March 9 to March 19, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
0
2
4
6
8
10
12
14
16
18
20
04-Oct
05-Oct
06-Oct
07-Oct
08-Oct
09-Oct
10-Oct
11-Oct
12-Oct
13-Oct
14-Oct
30-Dec
31-Dec
01-Jan
02-Jan
03-Jan
04-Jan
05-Jan
06-Jan
07-Jan
08-Jan
09-Jan
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
26-Feb
27-Feb
28-Feb
01-Mar
02-Mar
09-Mar
10-Mar
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
19-Mar
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

Packers (VR3)


October 24 to November 3, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
0
2
4
6
8
10
12
14
16
18
20
24-Oct
25-Oct
26-Oct
27-Oct
28-Oct
29-Oct
30-Oct
31-Oct
01-Nov
02-Nov
03-Nov
November 8 to November 18, 2015 Storm Events
08-Nov
09-Nov
10-Nov
11-Nov
12-Nov
13-Nov
14-Nov
15-Nov
16-Nov
17-Nov
18-Nov
December 2 to December 12, 2015 Storm Events
02-Dec
03-Dec
04-Dec
05-Dec
06-Dec
07-Dec
08-Dec
09-Dec
10-Dec
11-Dec
12-Dec
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

CRD - Parks & Environmental Services - Apr 9, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchViewRoyal2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100 150

Projection: UTM ZONE 10N NAD 83

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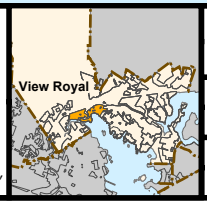


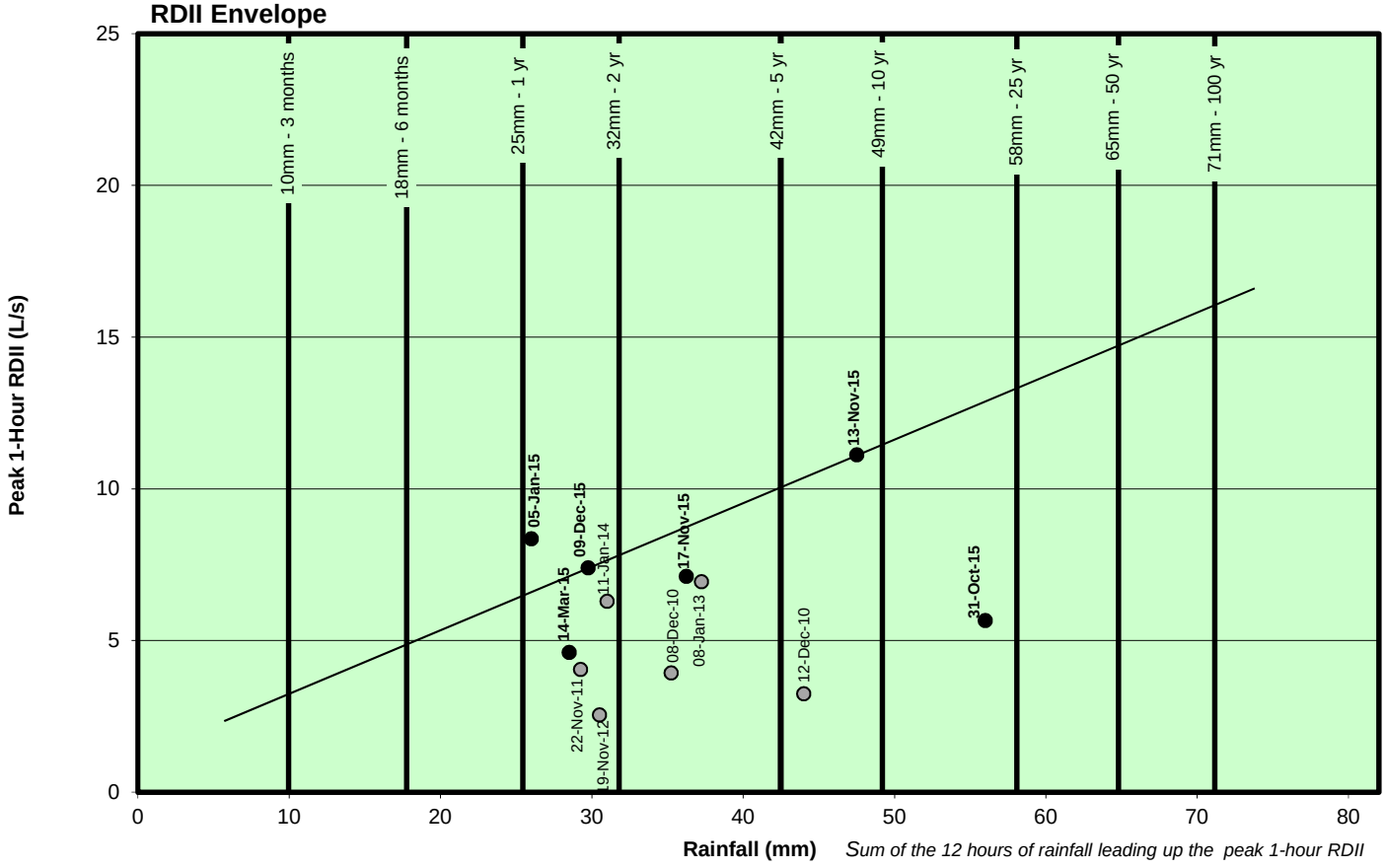
FLOW MONITORING AREA

CATCHMENT: PRICE BAY

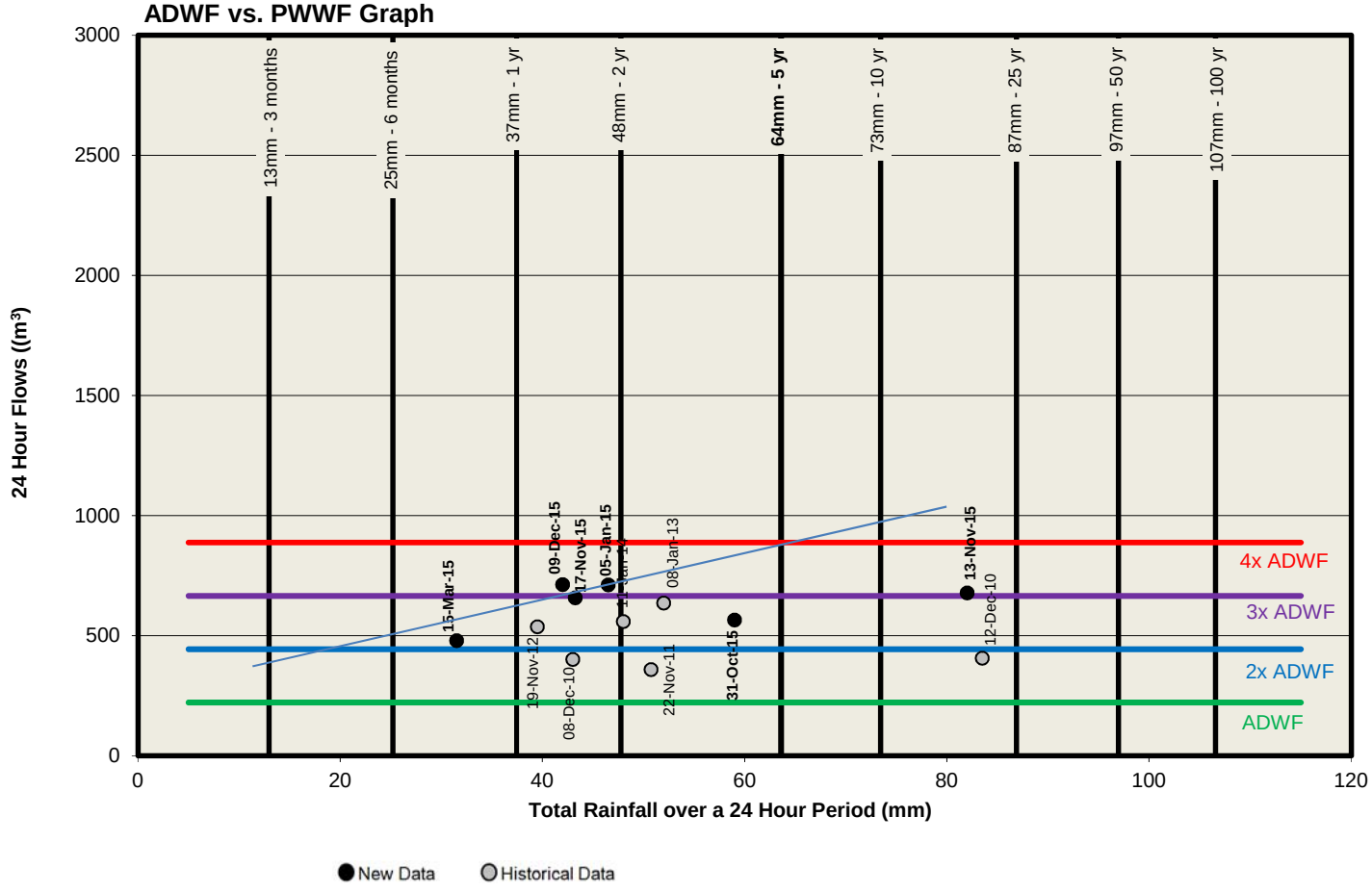
SITE CODE: **VR12**

Price Bay (VR12)

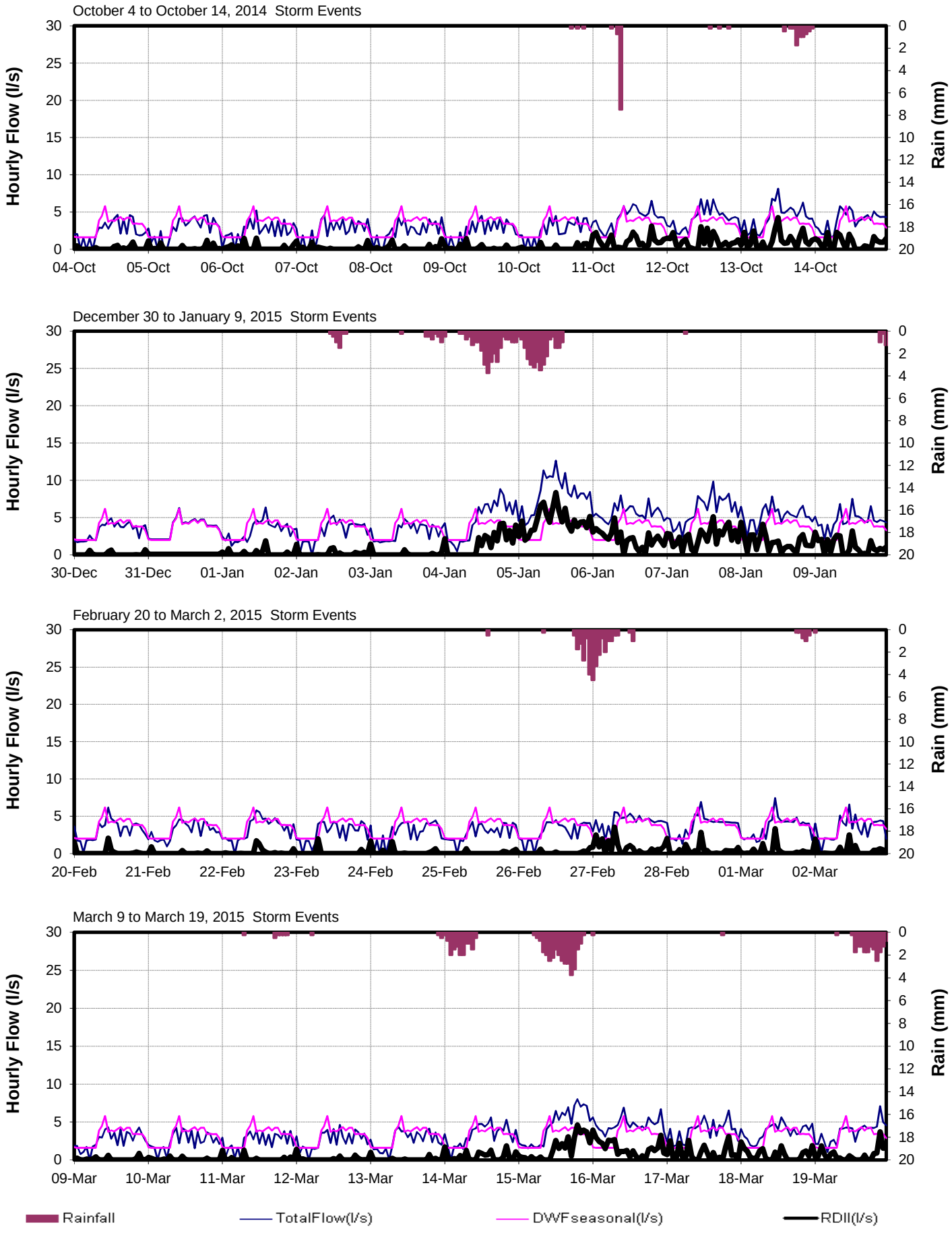
RDII Envelope



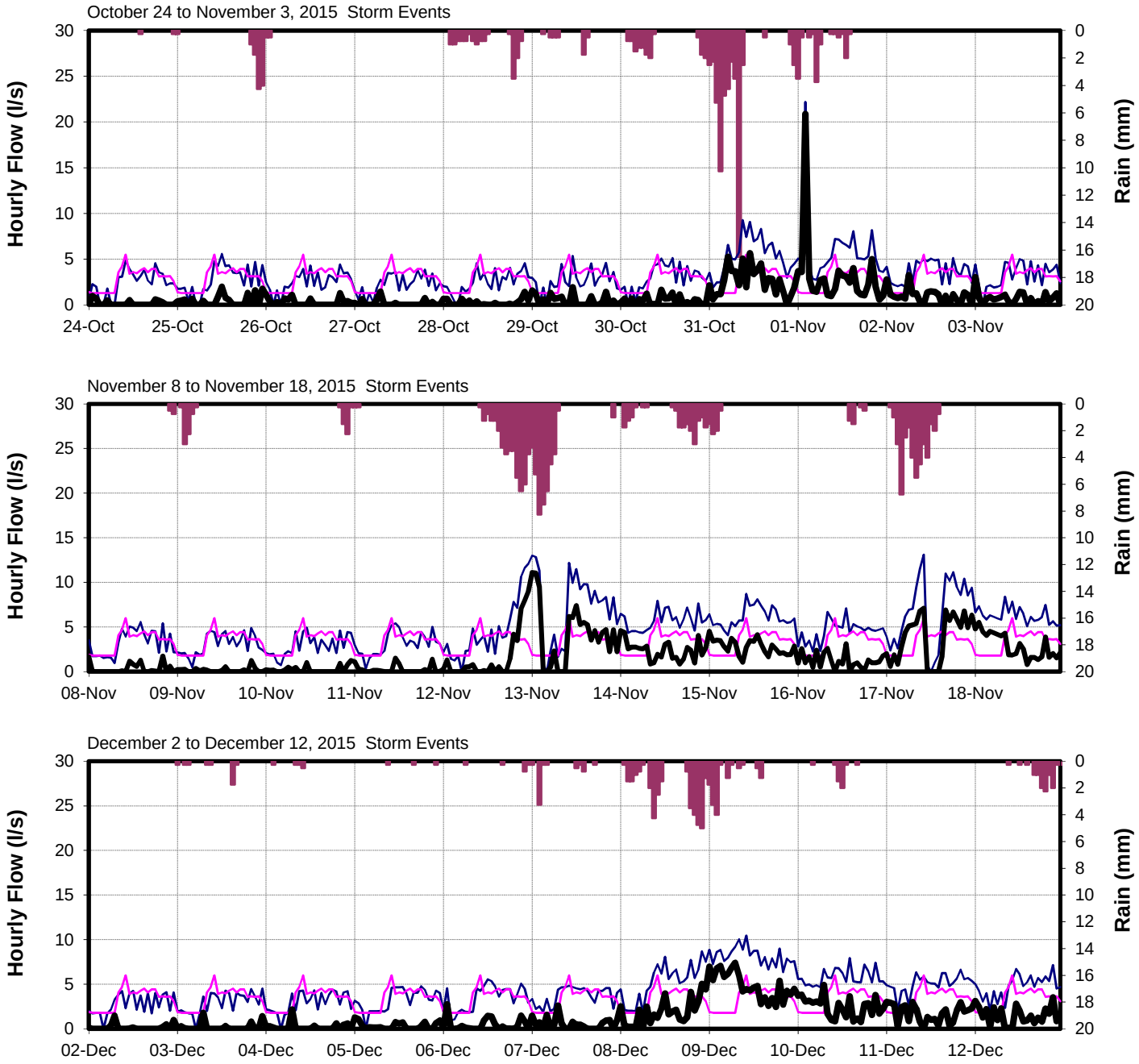
ADWF vs. PWWF Graph



Price Bay (VR12)

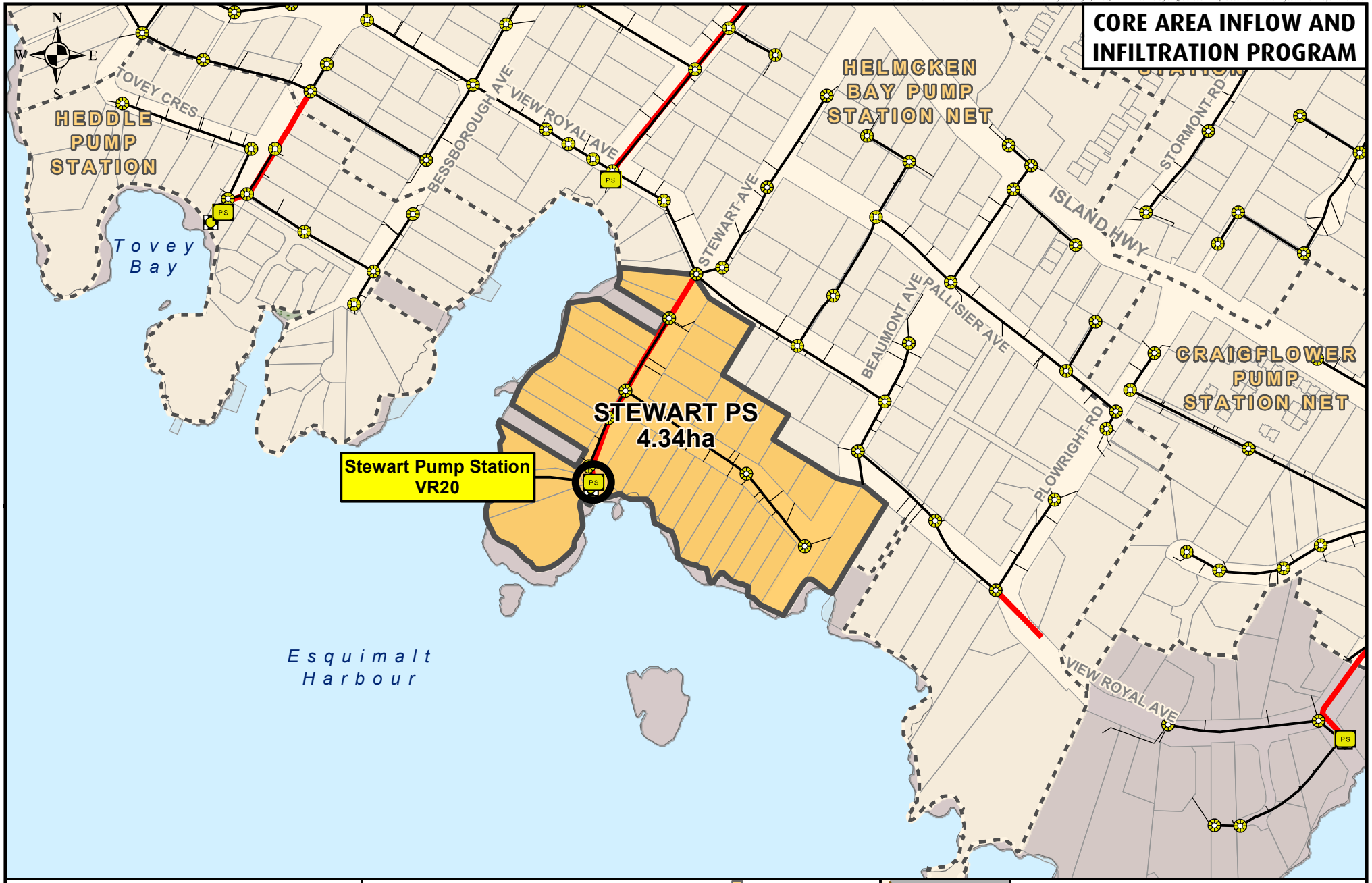


Price Bay (VR12)



CRD - Parks & Environmental Services - Environmental Engineering - Jan 06, 2017 - Technologist: jpbezeau - Map Document: MeteringCatchViewRoyal2016.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Metres
0 50 100

Projection: UTM ZONE 10N, NAD83

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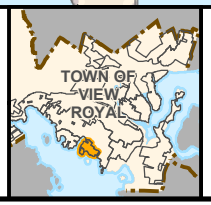

FLOW MONITORING AREA
Catchment: Stewart Pump Station
Site Code: VR20

CRD
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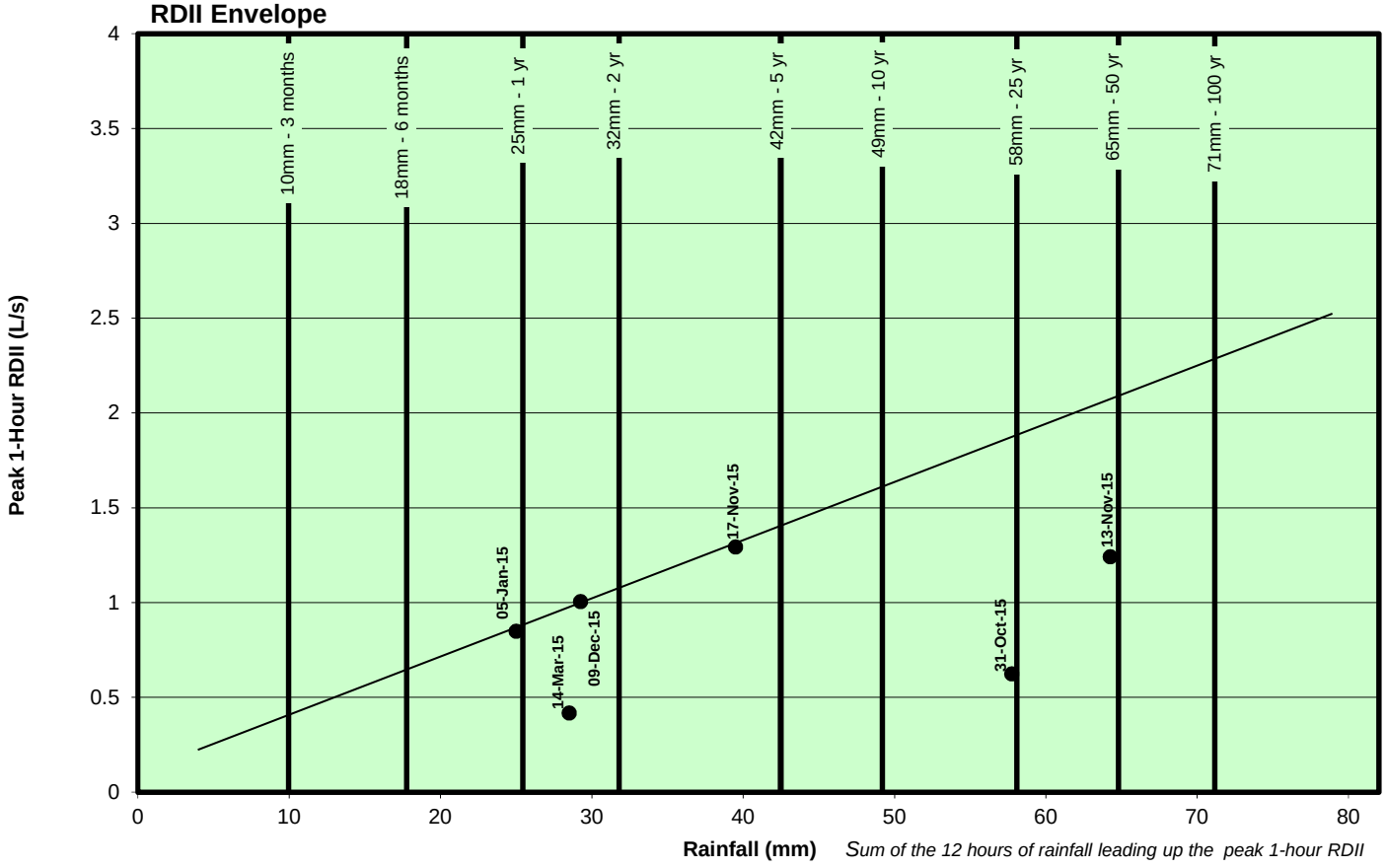
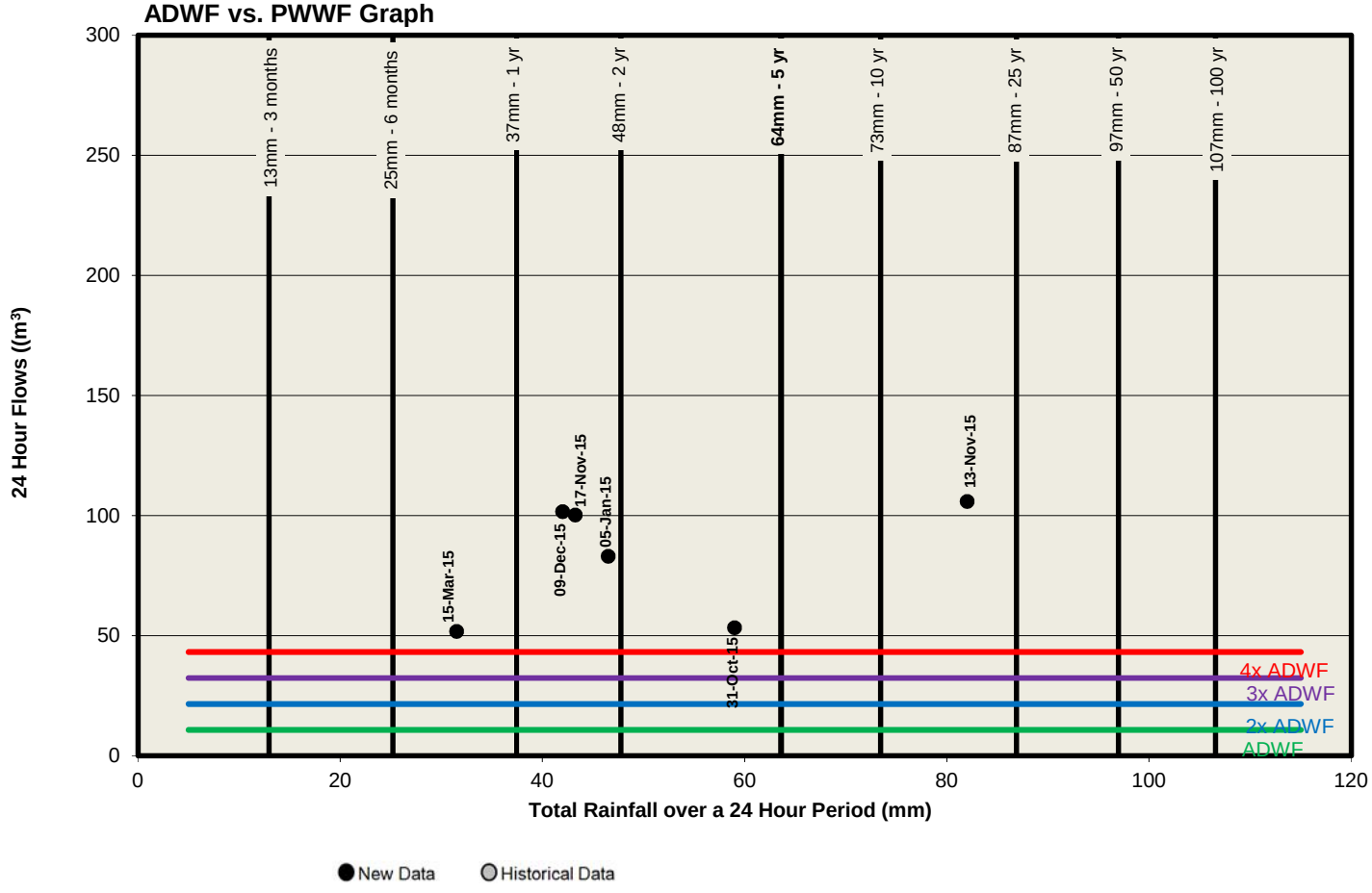
Stewart (VR20)

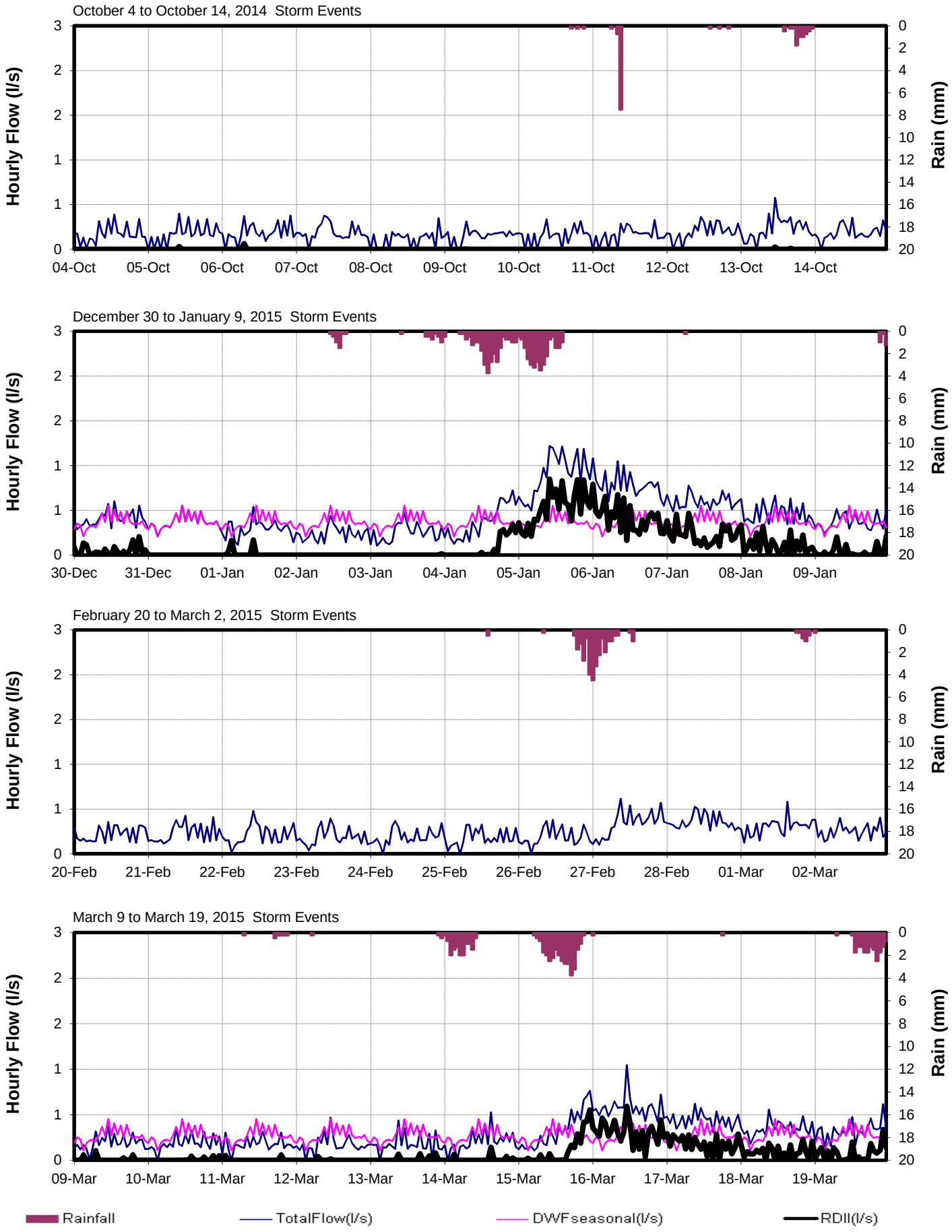
RDII Envelope



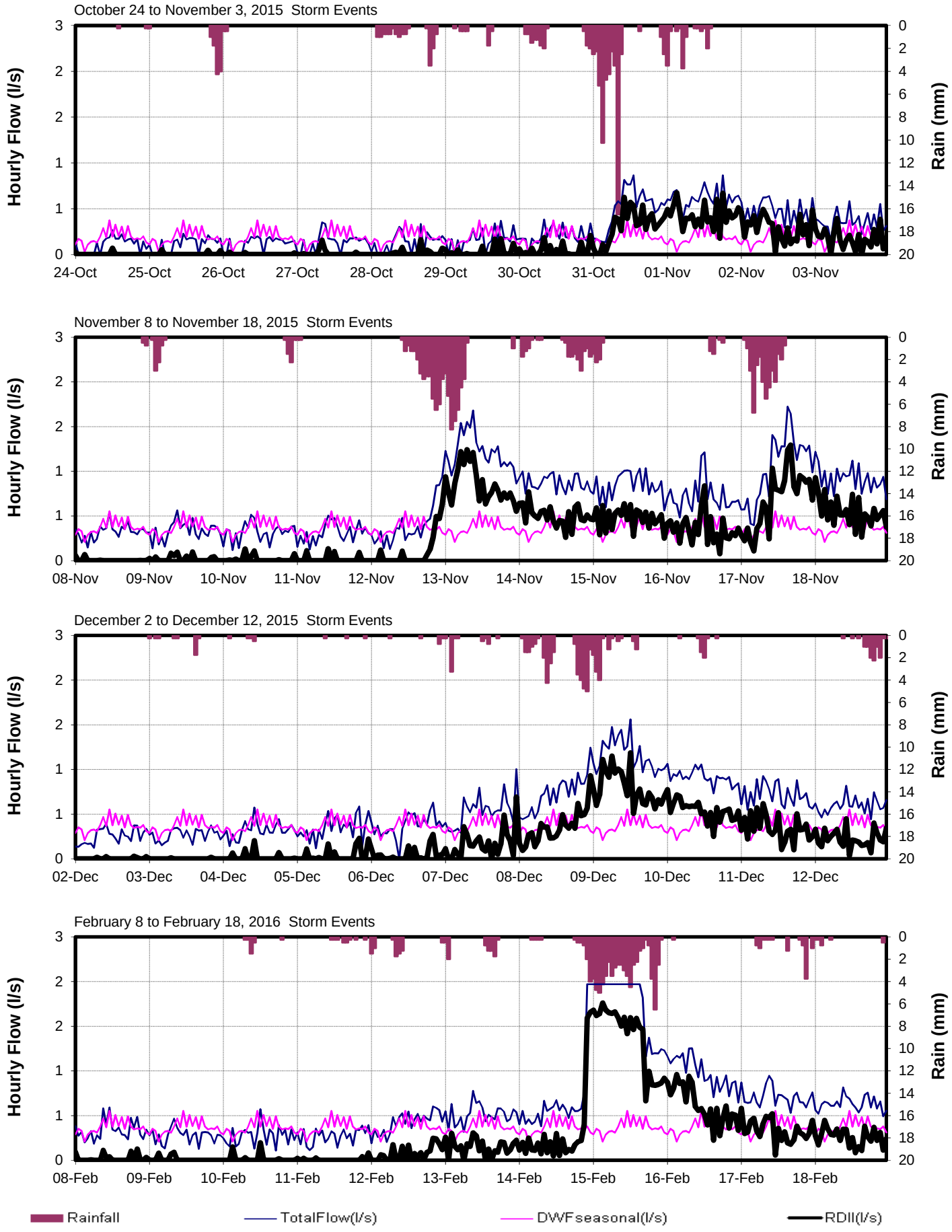
ADWF vs. PWWF Graph



Stewart (VR20)

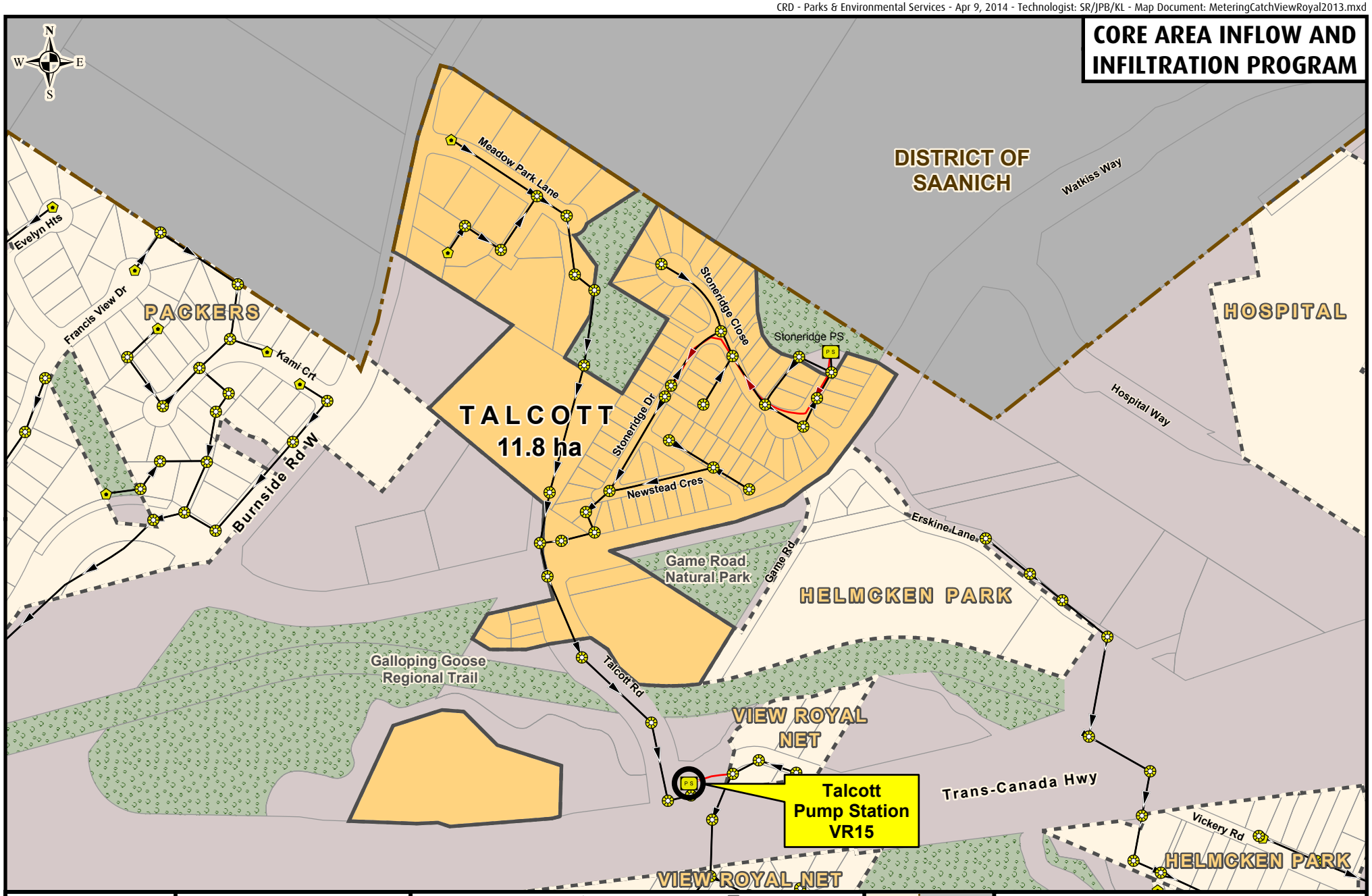


Stewart (VR20)



CRD - Parks & Environmental Services - Apr 9, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchViewRoyal2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



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Metres
0 50 100 150

Projection: UTM ZONE 10N NAD 83

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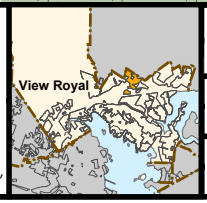


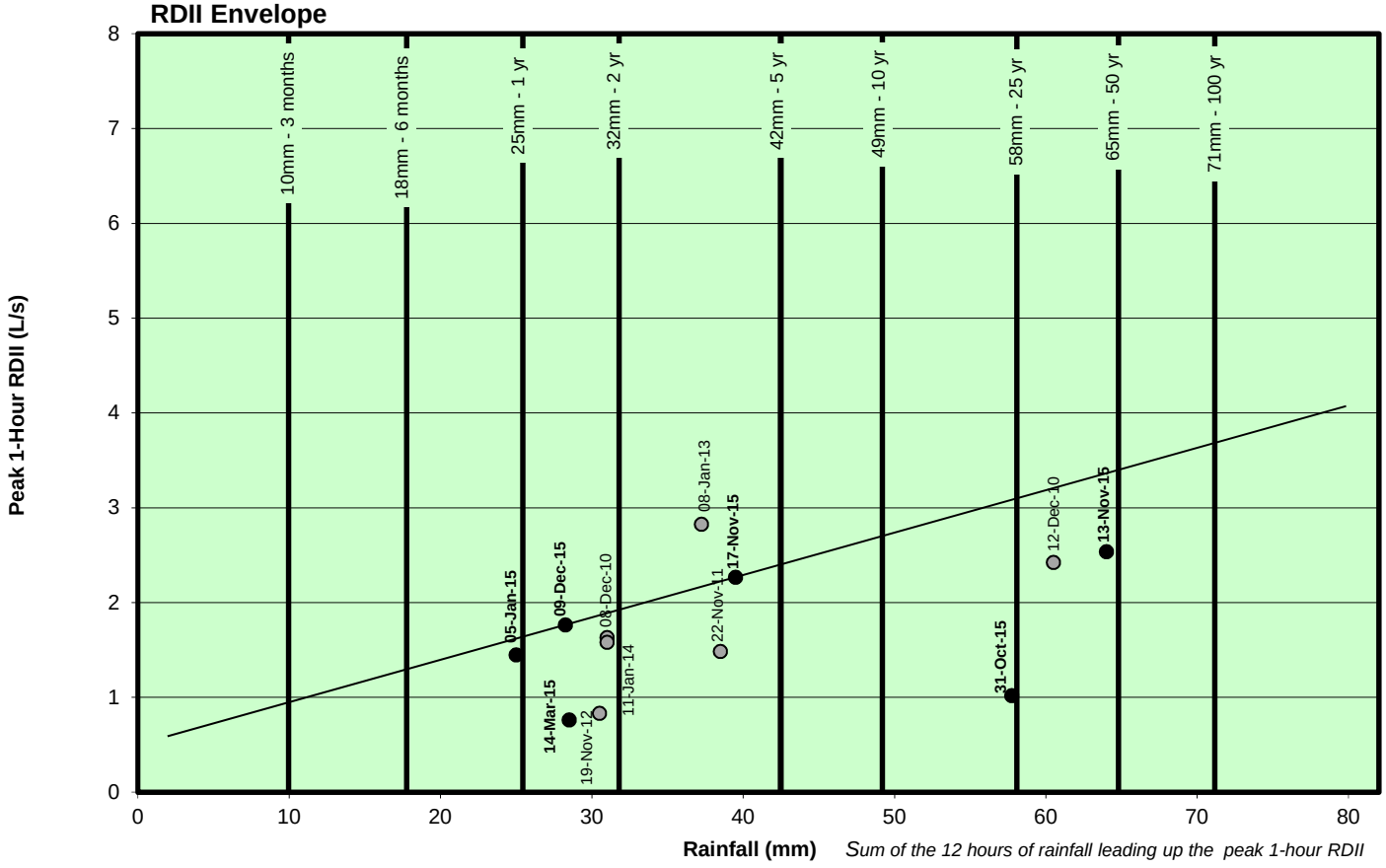
FLOW MONITORING AREA

CATCHMENT: TALCOTT

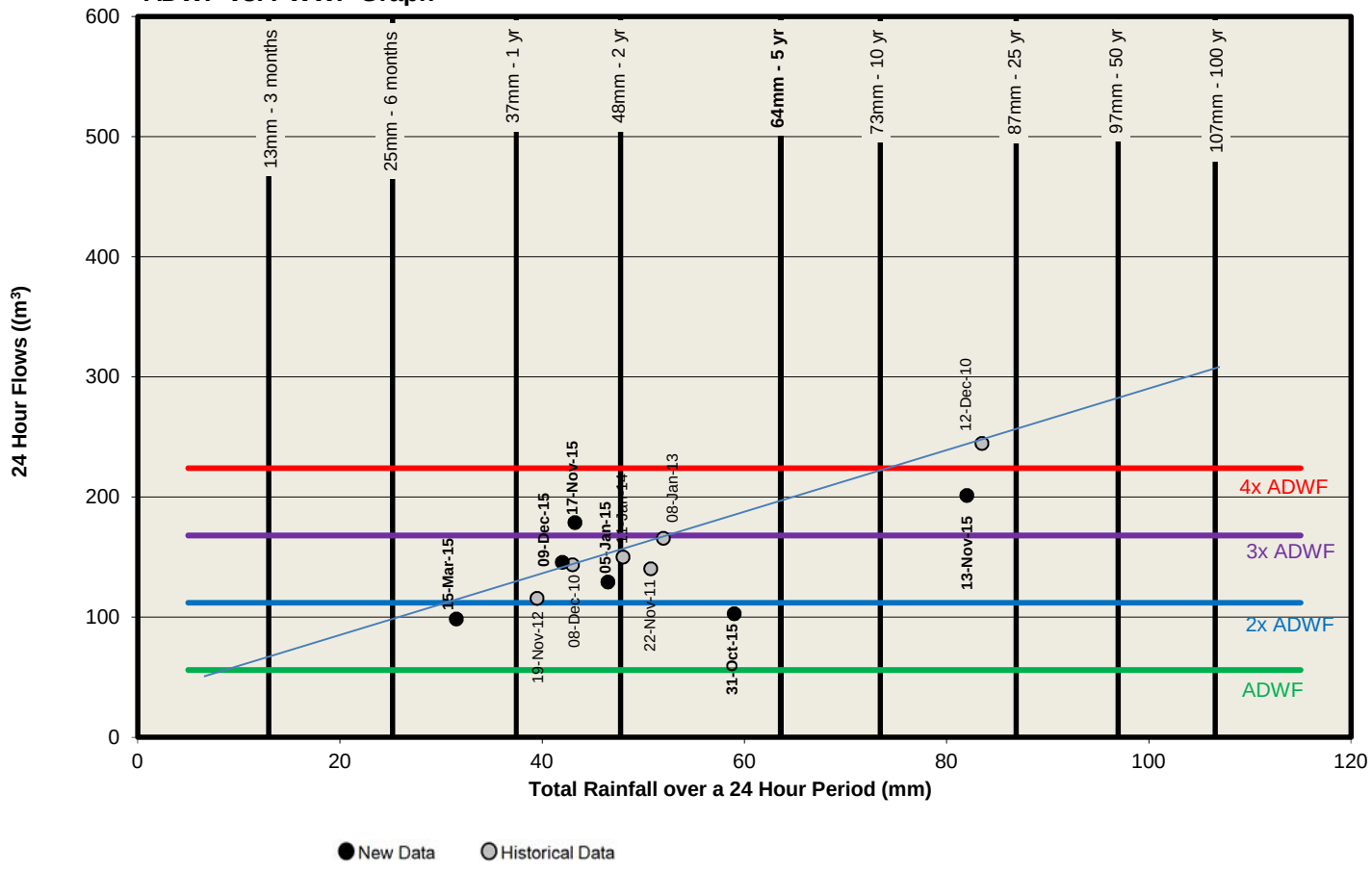
SITE CODE: **VR15**

Talcott (VR15)

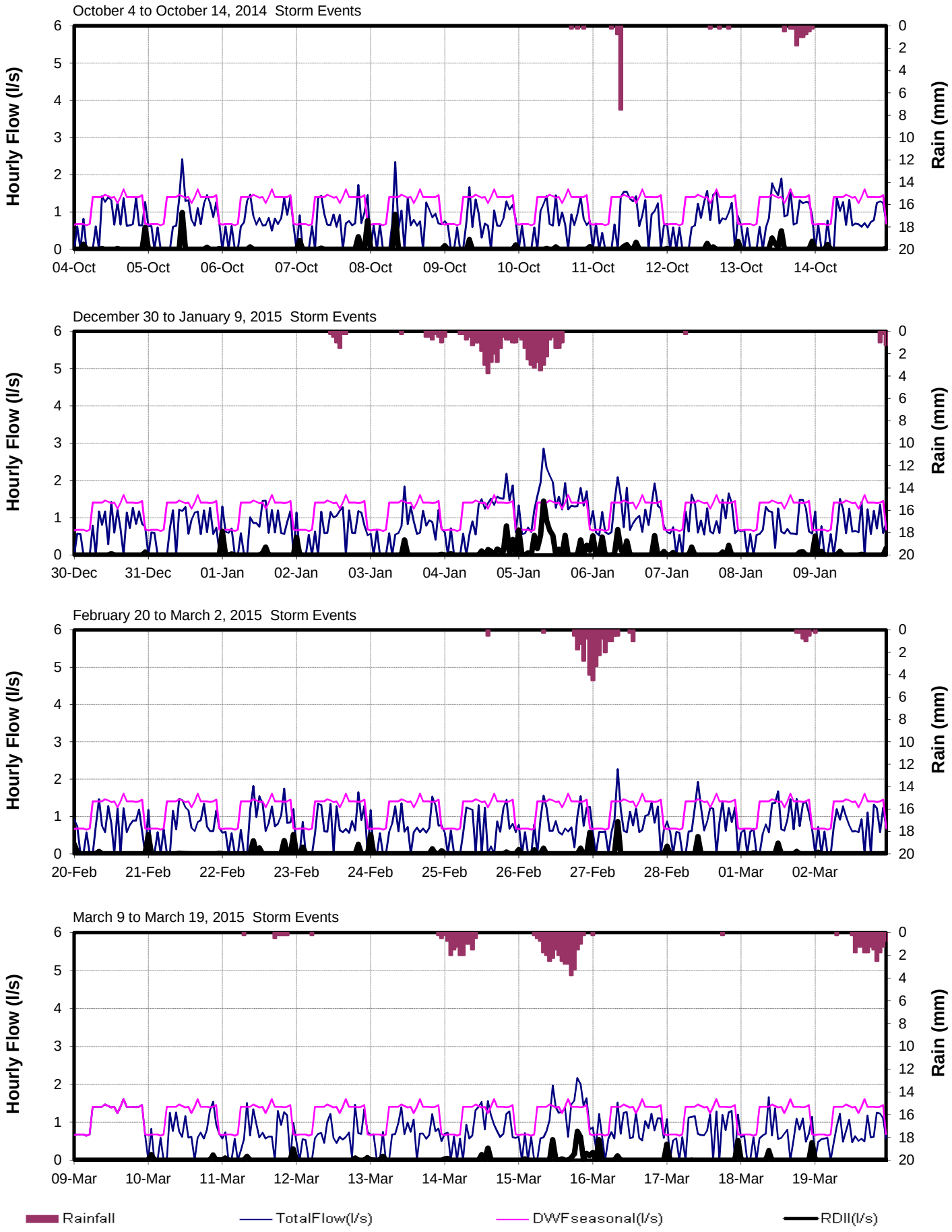
RDII Envelope



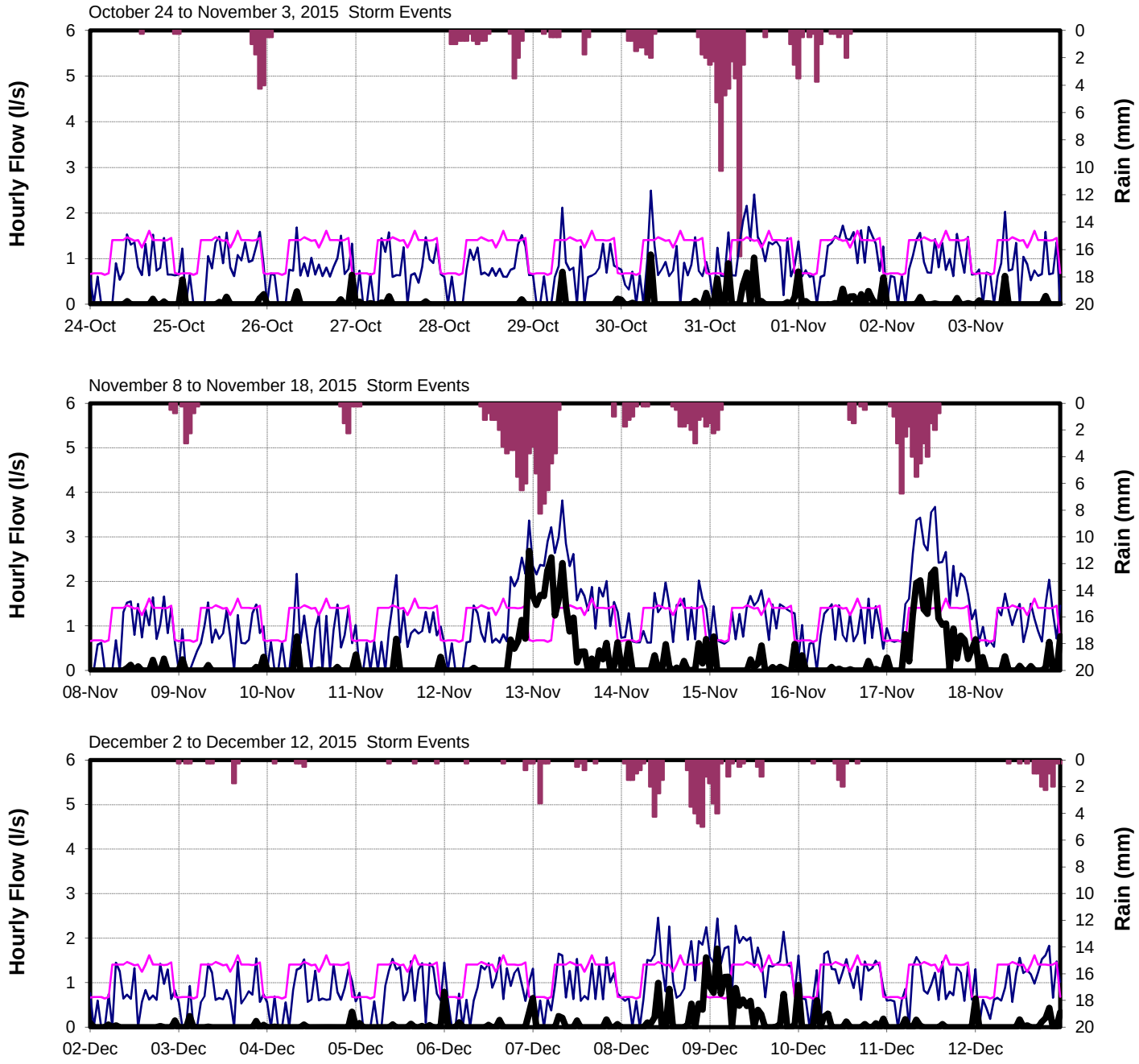
ADWF vs. PWWF Graph



Talcott (VR15)

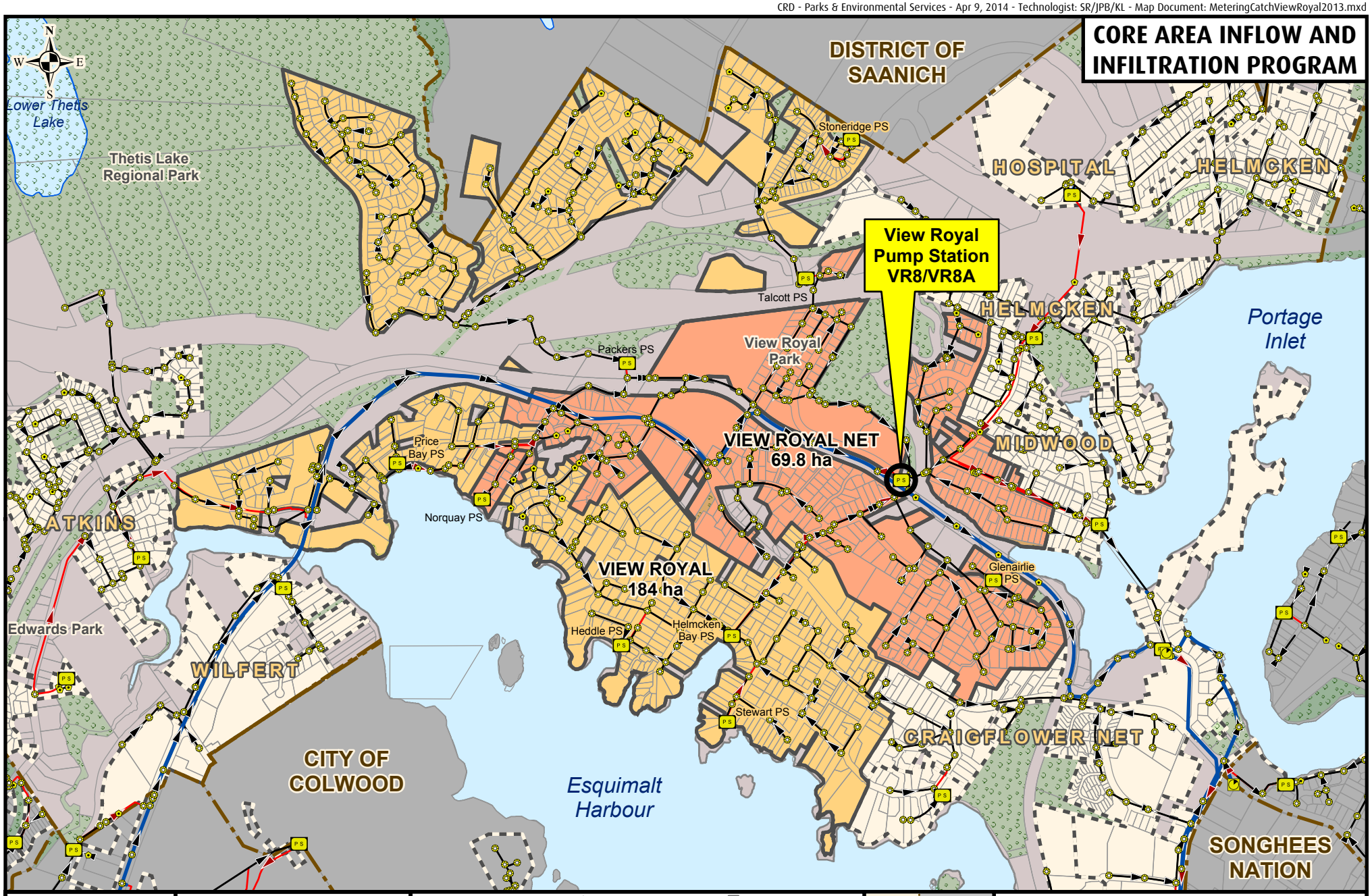


Talcott (VR15)



CRD - Parks & Environmental Services - Apr 9, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchViewRoyal2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 100 200 300 400

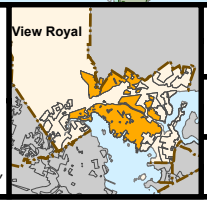
Projection: UTM ZONE 10N NAD 83

Important This map is for general information purposes only. The Capital Regional District (**CRD**) makes no representations or warranties regarding the accuracy or completeness of this map or the suitability of the map for any purpose. **This map is not for navigation.** The CRD **will not be liable** for any damage, loss or injury resulting from the use of the map or information on the map and the map may be changed by the CRD at any time.

- Flow Monitoring Location
- Manhole
- Cleanout
- Pump Station
- Metering Chamber

Sanitary Sewers
- Gravity Main Installed After 1930
- Gravity Main Installed Before 1930
- Force Main
- Relief, Outfall, Overflow Sewer
- CRD Sewer

- Catchment Area
- Non-Sewered Area
- Lot Lines
- Parks
- Sewered Park Areas
- Catchment Boundary
- Municipal, First Nation, or DND Boundaries



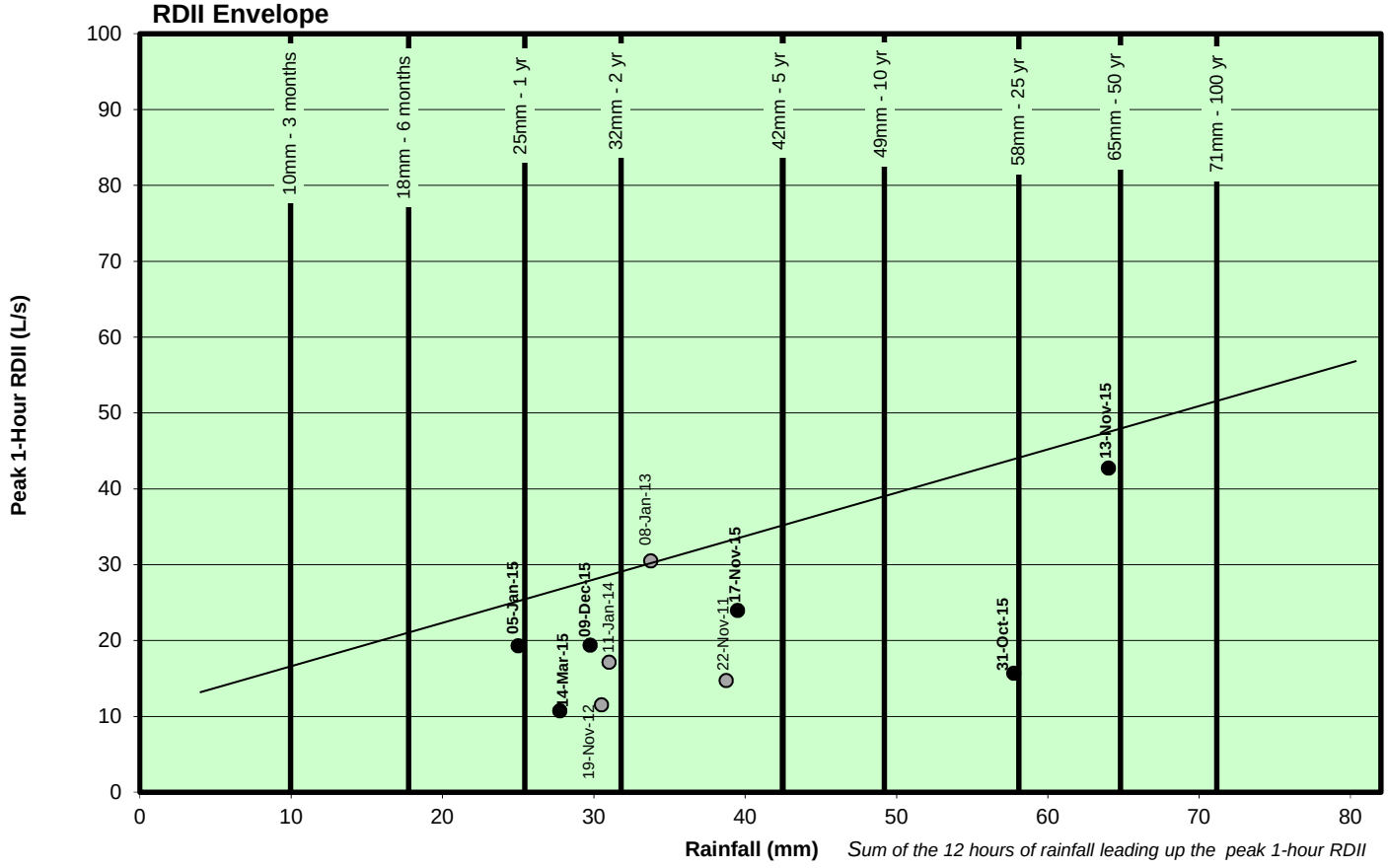
FLOW MONITORING AREA

CATCHMENT: VIEW ROYAL

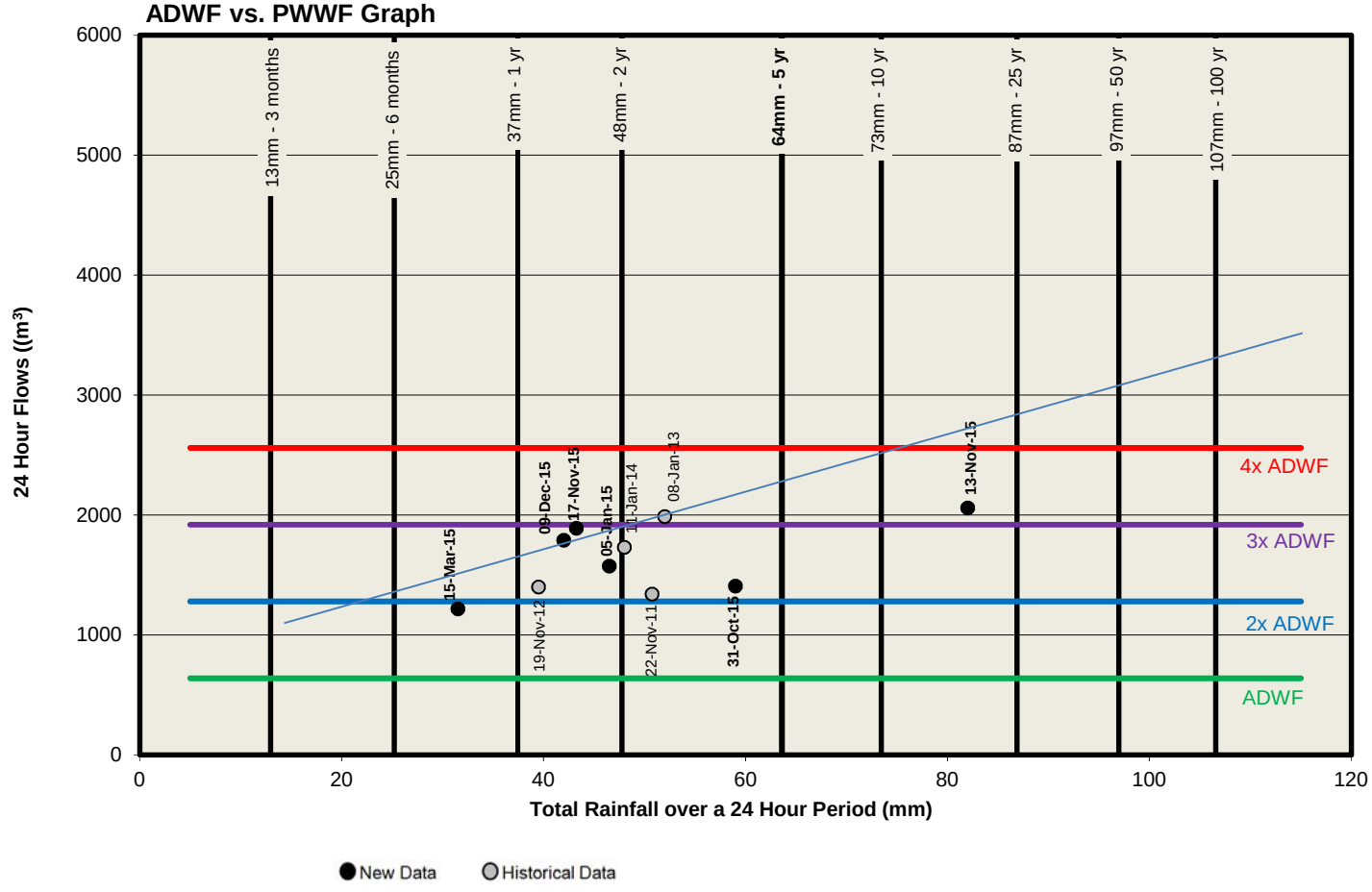
SITE CODE: **VR8/VR8A**

View Royal PS (VR8)

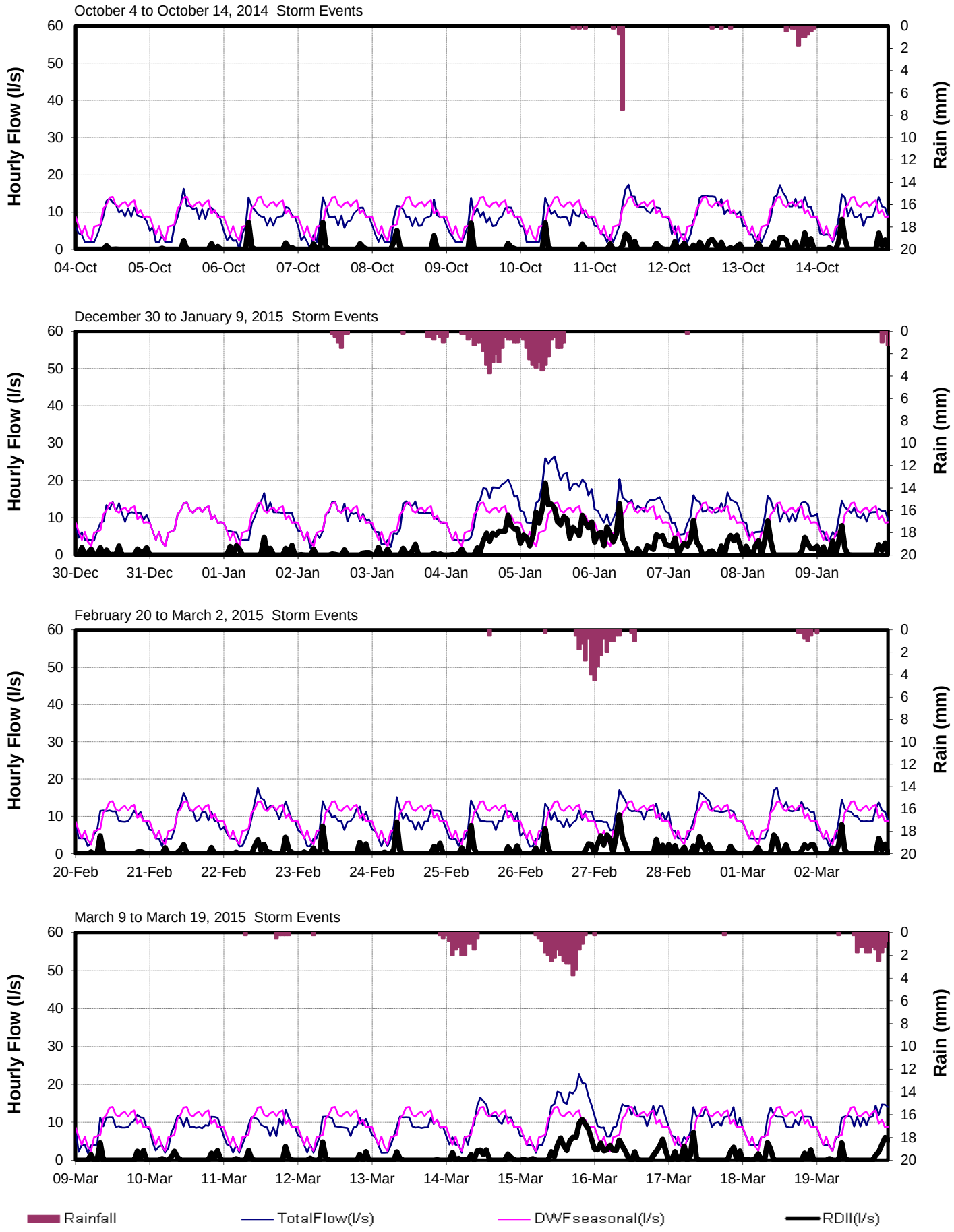
RDII Envelope



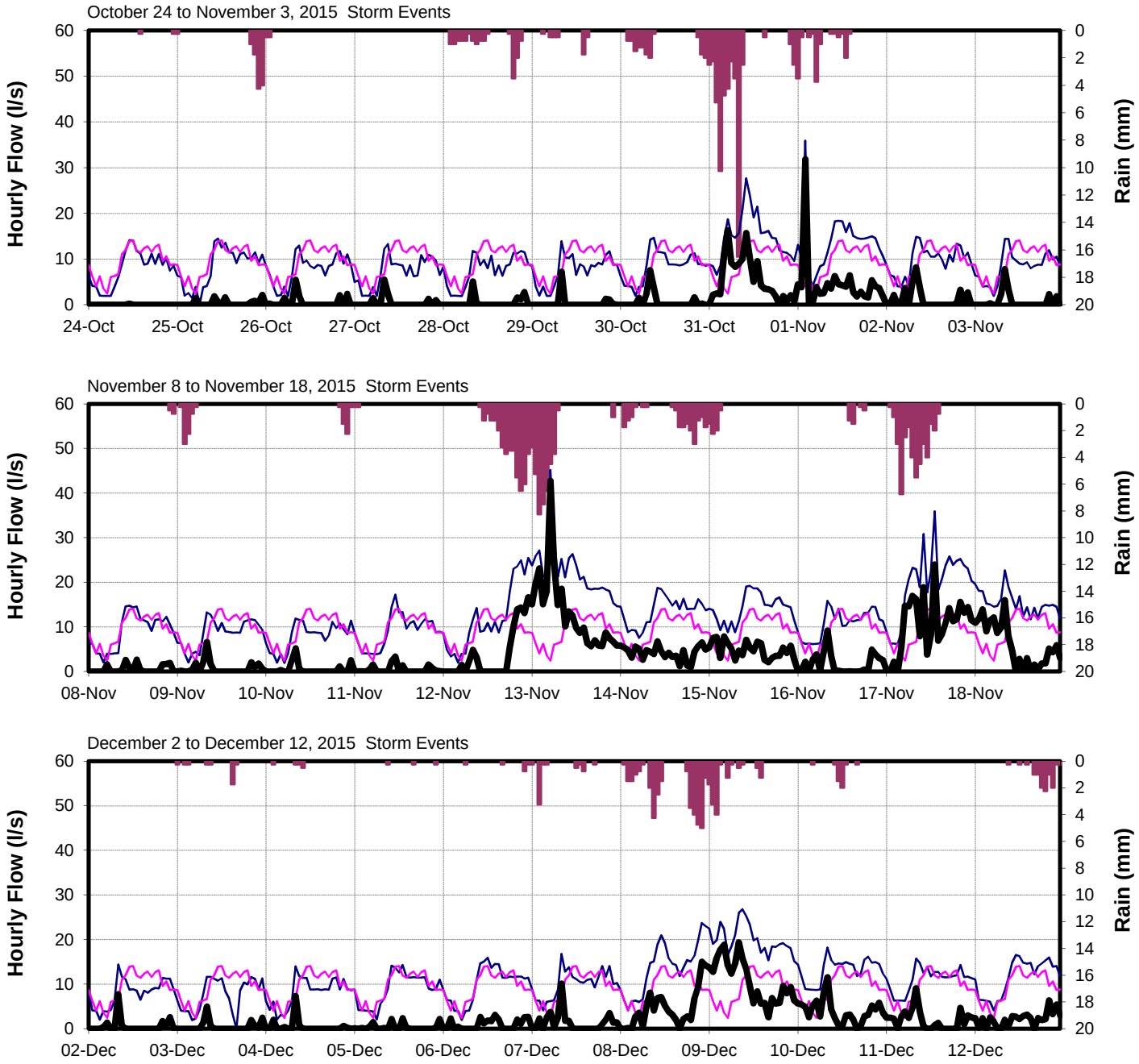
ADWF vs. PWWF Graph



View Royal PS (VR8)

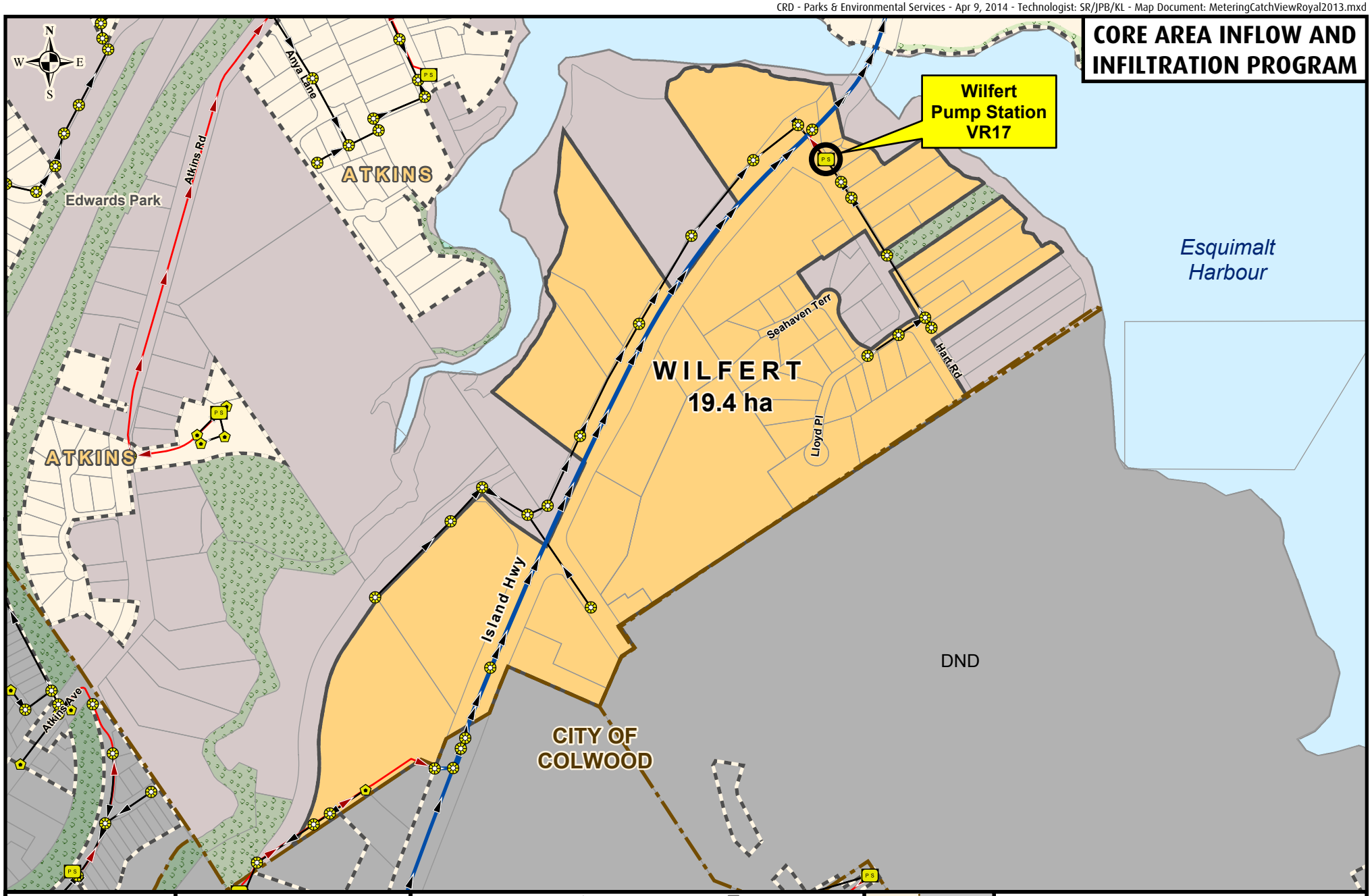


View Royal PS (VR8)



CRD - Parks & Environmental Services - Apr 9, 2014 - Technologist: SR/JPB/KL - Map Document: MeteringCatchViewRoyal2013.mxd

CORE AREA INFLOW AND INFILTRATION PROGRAM



Making a difference...together

Metres
0 50 100 150

Projection: UTM ZONE 10N NAD 83

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Sanitary Sewers

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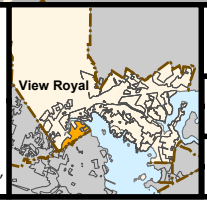
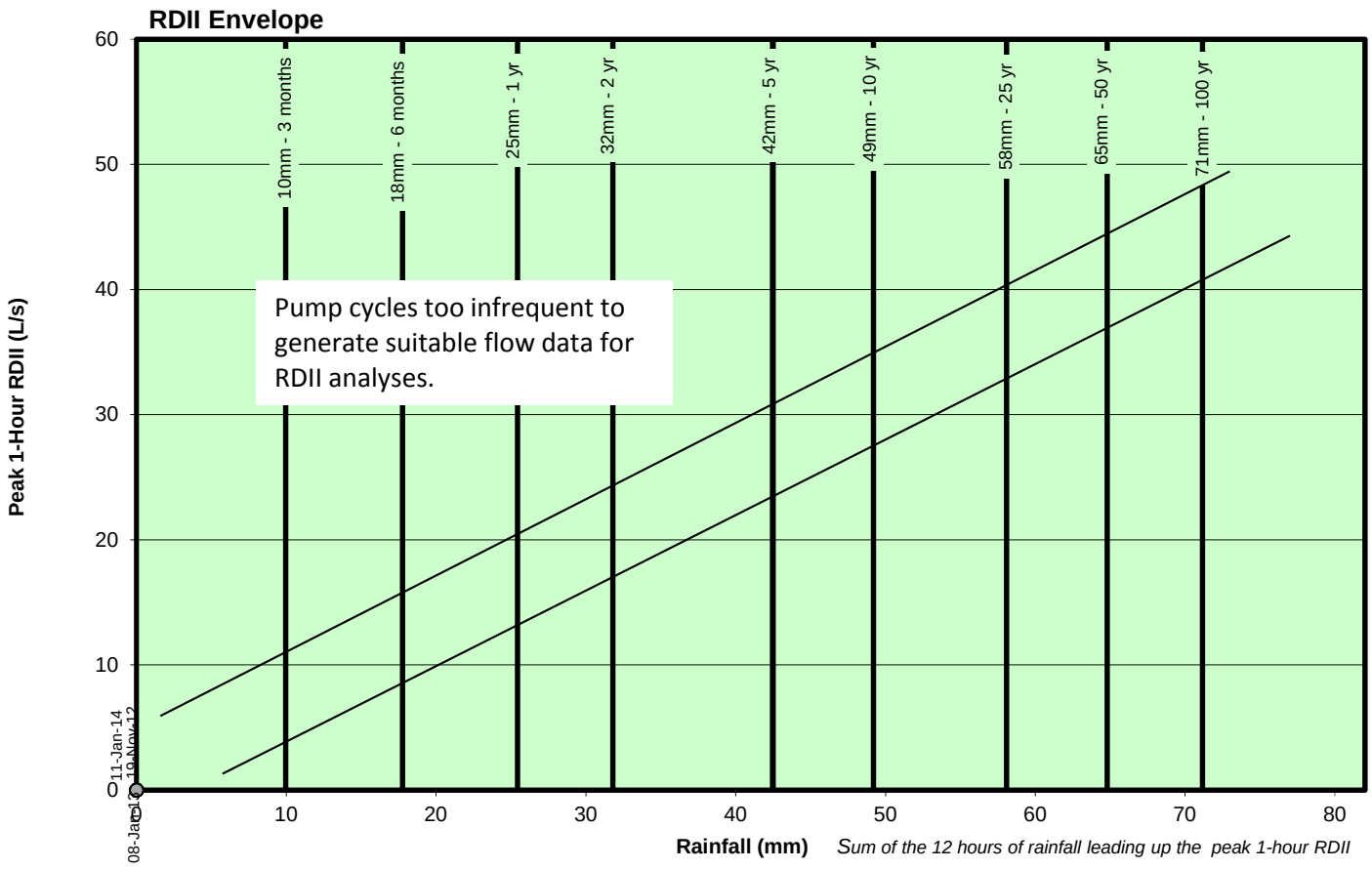


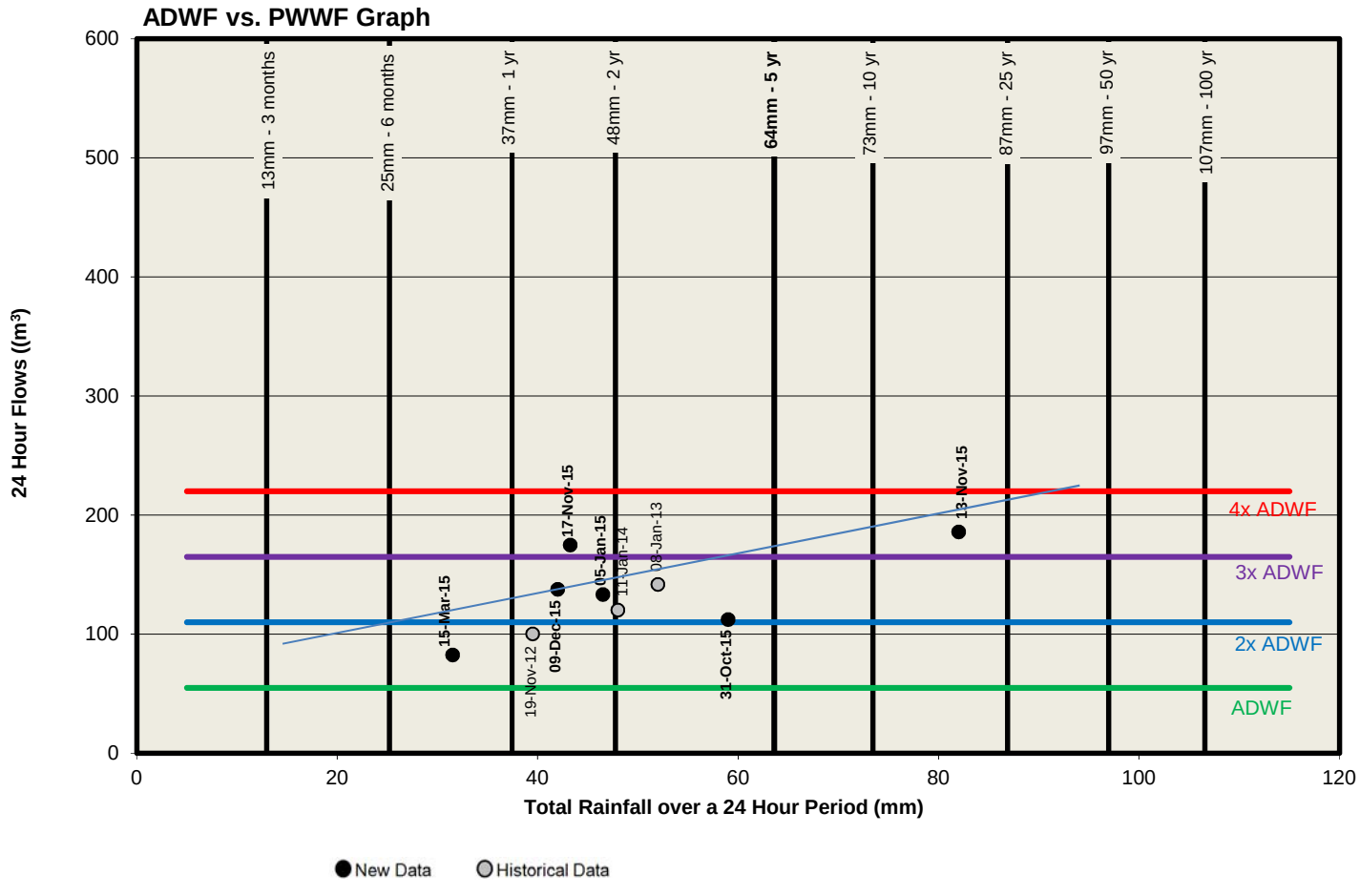
FLOW MONITORING AREA

CATCHMENT: WILFERT

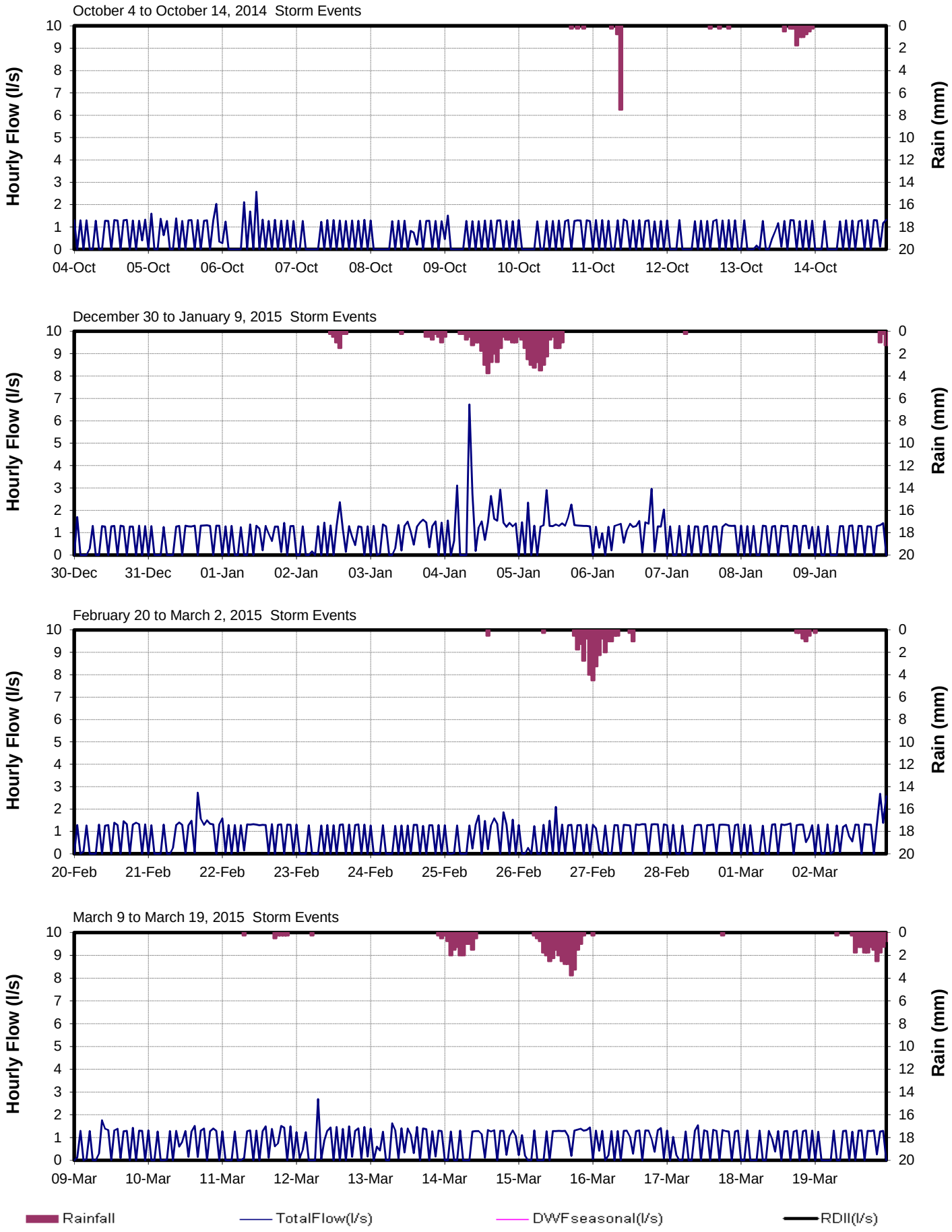
SITE CODE: **VR17**

Wilfert (VR8)

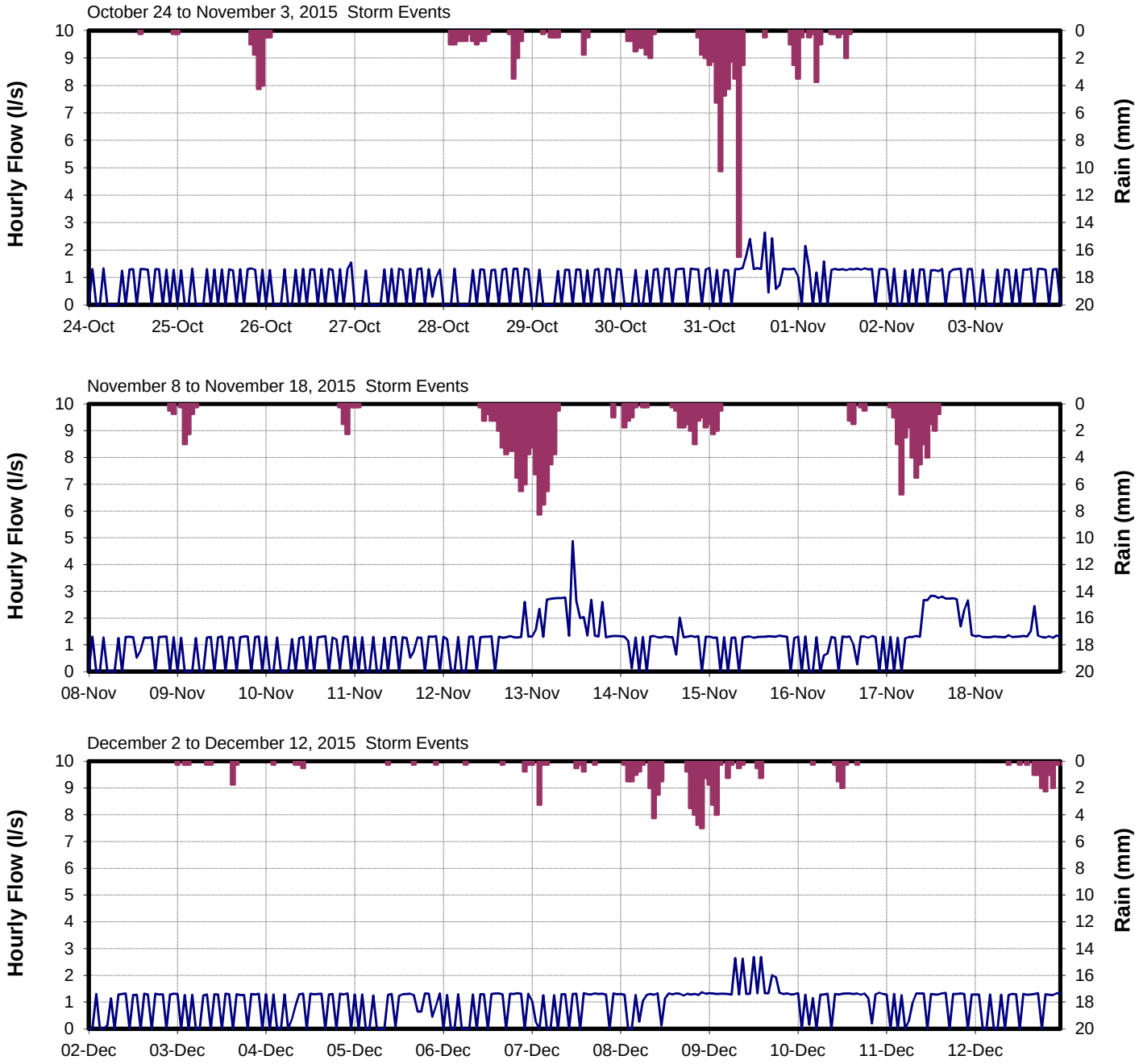

RDII Envelope
Peak 1-Hour RDII (L/s)
Rainfall (mm)
Sum of the 12 hours of rainfall leading up the peak 1-hour RDII
10mm - 3 months
18mm - 6 months
25mm - 1 yr
32mm - 2 yr
42mm - 5 yr
49mm - 10 yr
58mm - 25 yr
65mm - 50 yr
71mm - 100 yr
Pump cycles too infrequent to generate suitable flow data for RDII analyses.
08-Jan-13
11-Jan-14
19-Nov-12


ADWF vs. PWWF Graph
24 Hour Flows ((m³)
Total Rainfall over a 24 Hour Period (mm)
13mm - 3 months
25mm - 6 months
37mm - 1 yr
48mm - 2 yr
64mm - 5 yr
73mm - 10 yr
87mm - 25 yr
97mm - 50 yr
107mm - 100 yr
4x ADWF
3x ADWF
2x ADWF
ADWF
15-Mar-15
09-Dec-15
17-Nov-15
05-Jan-15
31-Oct-15
13-Nov-15
19-Nov-12
11-Jan-14
08-Jan-13
New Data
Historical Data

Wilfert (VR8)

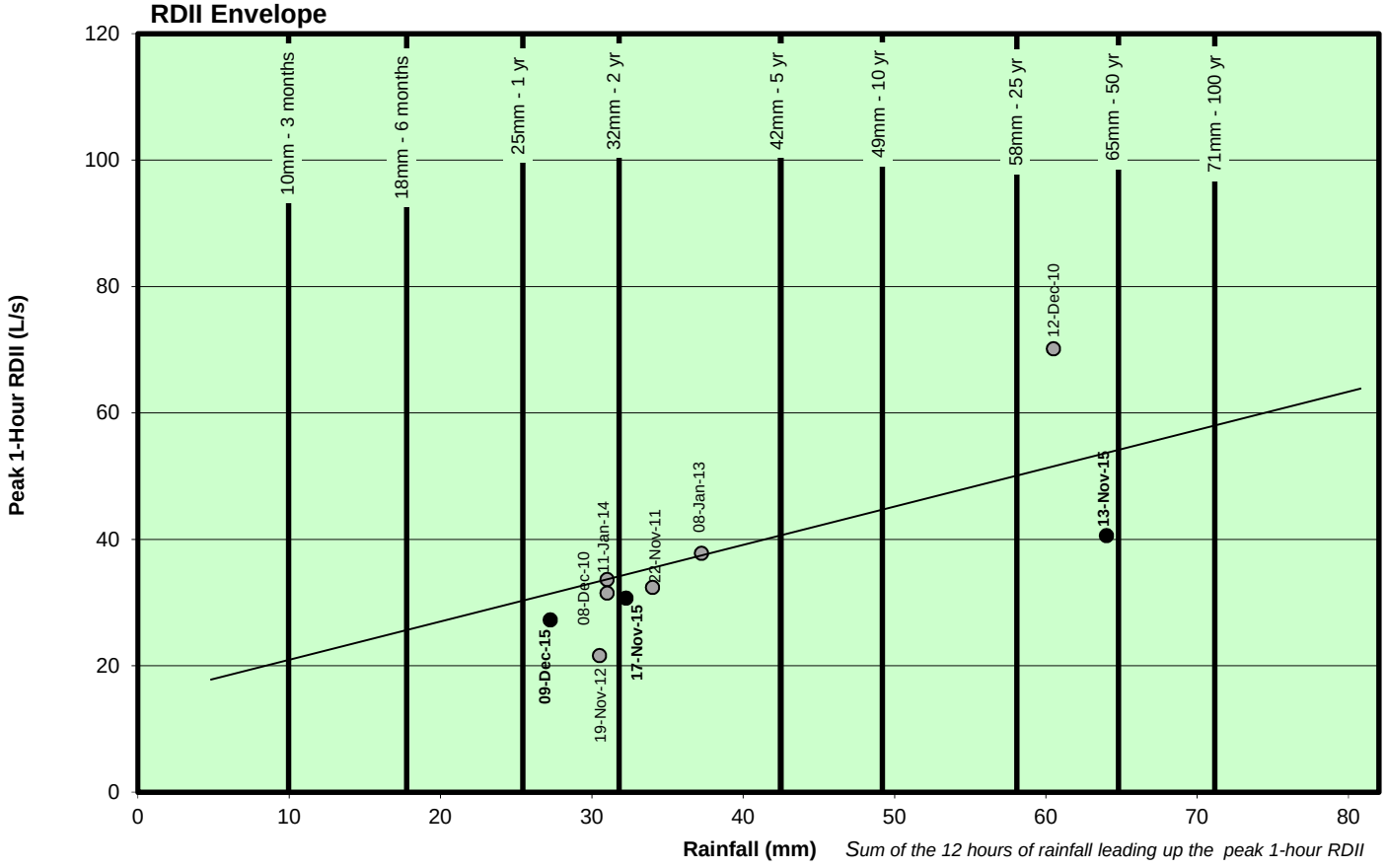

October 4 to October 14, 2014 Storm Events
Hourly Flow (l/s)
Rain (mm)
04-Oct
05-Oct
06-Oct
07-Oct
08-Oct
09-Oct
10-Oct
11-Oct
12-Oct
13-Oct
14-Oct
December 30 to January 9, 2015 Storm Events
30-Dec
31-Dec
01-Jan
02-Jan
03-Jan
04-Jan
05-Jan
06-Jan
07-Jan
08-Jan
09-Jan
February 20 to March 2, 2015 Storm Events
20-Feb
21-Feb
22-Feb
23-Feb
24-Feb
25-Feb
26-Feb
27-Feb
28-Feb
01-Mar
02-Mar
March 9 to March 19, 2015 Storm Events
09-Mar
10-Mar
11-Mar
12-Mar
13-Mar
14-Mar
15-Mar
16-Mar
17-Mar
18-Mar
19-Mar
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

Wilfert (VR8)

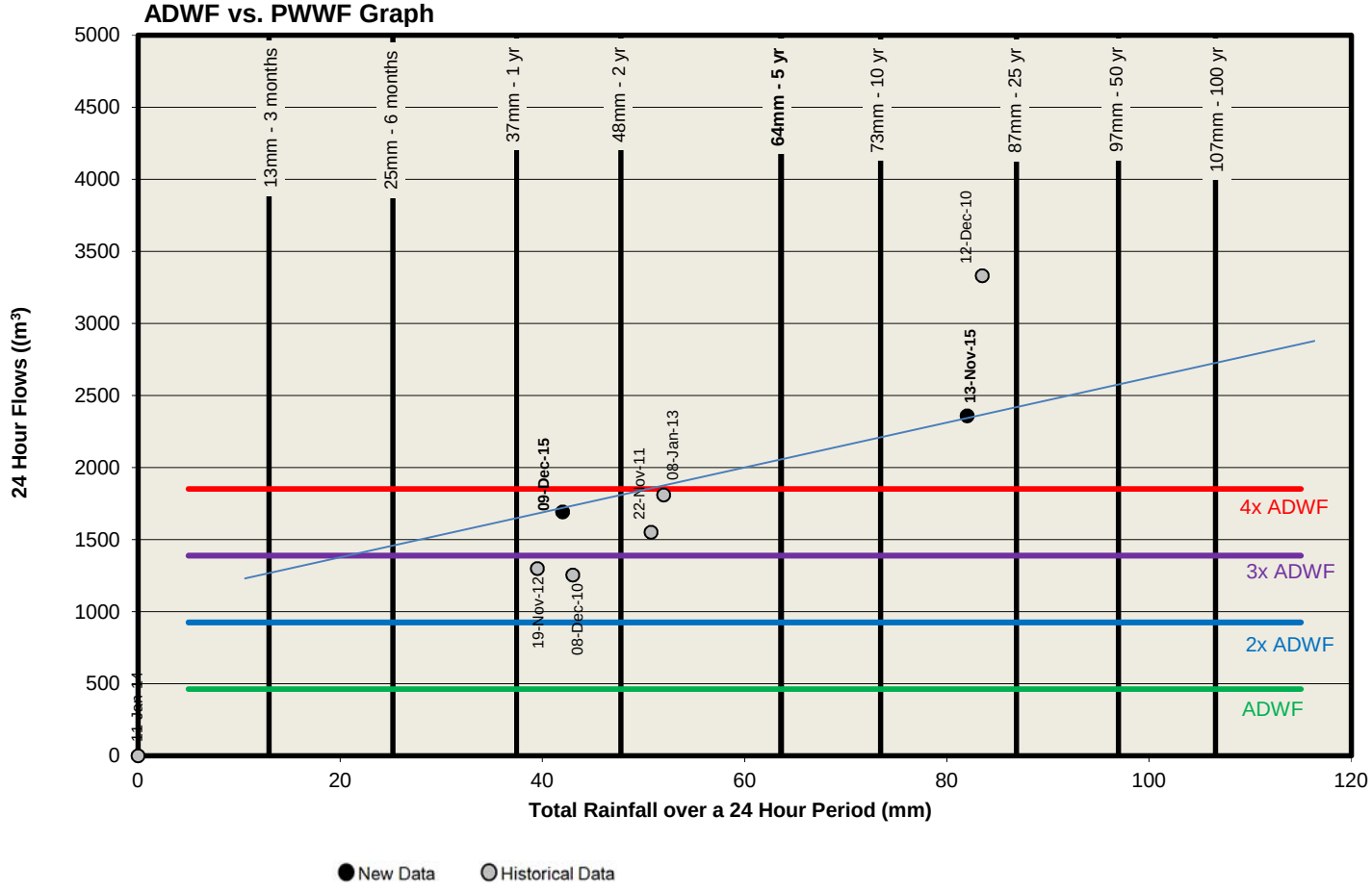

October 24 to November 3, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
24-Oct
25-Oct
26-Oct
27-Oct
28-Oct
29-Oct
30-Oct
31-Oct
01-Nov
02-Nov
03-Nov
November 8 to November 18, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
08-Nov
09-Nov
10-Nov
11-Nov
12-Nov
13-Nov
14-Nov
15-Nov
16-Nov
17-Nov
18-Nov
December 2 to December 12, 2015 Storm Events
Hourly Flow (l/s)
Rain (mm)
02-Dec
03-Dec
04-Dec
05-Dec
06-Dec
07-Dec
08-Dec
09-Dec
10-Dec
11-Dec
12-Dec
Rainfall
TotalFlow(l/s)
DWFseasonal(l/s)
RDII(l/s)

Songhees (SFN1)

RDII Envelope



ADWF vs. PWWF Graph



Songhees (SFN1)

