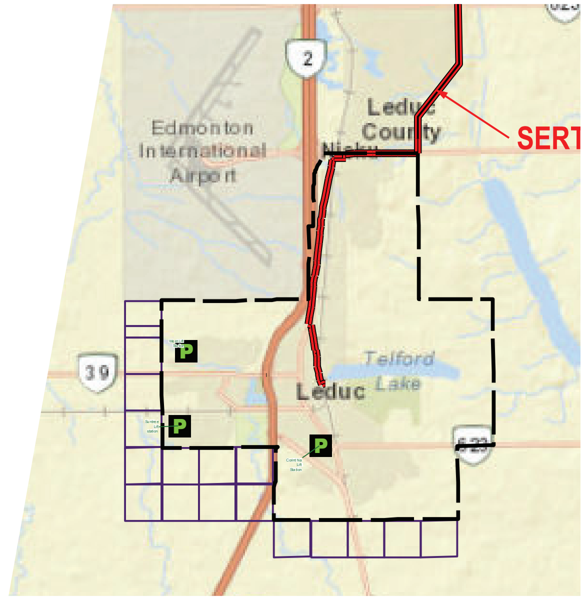

JANUARY 6, 2014

Sanitary Sewer Master Plan

- FINAL REPORT -

Prepared for:

CITY OF Leduc

City of Leduc
#1 Alexandra Park
Leduc, Alberta T9E 4C4

Prepared by:

XCG Environmental Engineers & Scientists

XCG Consultants Ltd.
300 - 2620 Bristol Circle
Oakville, Ontario L6H 6Z7

XCG CONSULTANTS LTD.
T 905 829 8880 F 905 829 8890 | toronto@xcg.com
2620 Bristol Circle, Suite 300, Oakville, Ontario, Canada L6H 6Z7

XCG File No.: 3-2945-02-01
January 6, 2014

SANITARY SEWER MASTER PLAN

Prepared for:

CITY OF LEDUC
#1 Alexandra Park
Leduc, AB
T9E 4C4

Prepared by:

XCG CONSULTANTS LTD.
300 - 2620 Bristol Circle
Oakville, Ontario
L6H 6Z7

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1. INTRODUCTION

1.1 Background

The City of Leduc (City) is expecting continued growth over the next 20 years. This growth is identified in both the 2012 Municipal Development Plan and the Downtown Master Plan. Growth, at a regional scale, is also identified in the 2011 Intermunicipal Development Plan that addresses future land use related to neighbouring communities within the County of Leduc. Furthermore, the Capital Region Growth Plan identified the City as a Priority Growth Area projecting 1.6% average annual population increase to 2044 and a 1.8% increase in average annual employment over the same period.

The City, through the 2012 Municipal Development Plan, defined a 2035 vision where the City of Leduc will be a vibrant community where growth is balanced and sustainable. One component of this vision is to provide wastewater servicing to support growth over this period.

For the City to continue to provide reliable sanitary service and to meet wastewater servicing demands they have initiated this Sanitary Servicing Study to identify existing capacity constraints and develop servicing strategies to meet future sanitary servicing needs of the City. The City retained XCG Consultants Ltd. (XCG) to prepare this Sanitary Servicing Study that includes updating the exiting 2006 sanitary system hydraulic model, an evaluation of existing wastewater services, and preparation of a sanitary servicing strategy to address future growth.

The City prepared a sanitary system model in 2006 to assist with their wastewater infrastructure planning and assessment. The City recognized their existing 2006 system sanitary system model required updating to provide the support for expanding existing wastewater services to meet current and future needs. The updated sanitary system model, as an engineering tool, is to be used to support the City in planning their sanitary servicing to meet existing and future capacity needs. To start this work the City initiated the collection of flow monitoring data starting in December 2011 with additional flow monitoring in the summer 2012 to characterize both dry and weather flows. This new information, and an updated sanitary system model, is used to assess current wastewater servicing levels and identify servicing alternatives for future growth areas.

Through the City's planning efforts, future development is generally identified in the south and west of the City documented in the Municipal Develop Plan (MDP). Furthermore, there are plans for a Northeast Sanitary Trunk Sewer as part of the City's and Regional servicing strategy. The sanitary servicing study takes into consideration the proposed servicing strategies and provides more detailed information with respect to staging of needed infrastructure and sizing.

The goal of this project is to prepare a Sanitary Servicing Study for the City that will address current wastewater issues and future servicing needs. To accomplish this goal, there are a number of key project objectives:

- Update, verify and calibrate the existing 2006 system model.
- Identify current sanitary servicing capacity restrictions.
- Identify sanitary servicing capacity needs within growth areas generally to the south and west of Leduc.
- Identify alternative servicing strategies for the future growth areas.

1.2 Study Area

Figure 1.1 shows the City of Leduc and surrounding area. Wastewater servicing is provided through approximately 125.5 km of sanitary sewer pipes. There are three pump stations in the service area: Suntree; West; and, Corinthia. All local wastewater is conveyed to a Regional wastewater trunk sewer owned and operated by the Alberta Capital Regional Wastewater Commission (ACRWC) that starts just south of 50th Avenue and extends north parallel to the railway tracks to Airport Road (10th Avenue) where it again heads north on Range Road 250. The ACRWC Southeast Regional Trunk Sewer (SERTS) conveys Leduc's wastewater flows ultimately to the City of Edmonton's Gold Bar Wastewater Treatment Plant.

The City of Leduc's current population is approximately 24,000 and it is projected to grow to over 50,000 by approximately 2032 with a projected ultimate population of over 85,000. In addition to residential growth, the City has identified growth in the industrial and employment lands over the same time period. Edmonton International Airport also contributes wastewater flows into the local City system with expansion planned on the airport lands with additional wastewater contributions.

1.3 Problem/Opportunity Statement

The Sanitary Servicing Study has been carried out to establish a long term servicing strategy with the following requirements:

1. Supports growth in the City.
2. Maximizes existing infrastructure, including optimized use of the existing trunk sewer system.
3. Recognizes I/I contributions and considers I/I reduction programs.

The servicing study objectives need to be addressed within the context of City initiatives and programs. These include:

- City programs that promote efficiency of water use by residential, commercial and institutional customers.
- Ongoing City efforts to reduce wet weather I/I.
- Capacity assessment of the existing systems.
- Recognition of existing municipal plan development plan policy areas and approved statutory plans (February 2012).
- City wastewater design standards review.
- ACRWC Level of Service (LOS) requirements.
- The review of City design standards.
- Updated growth projections and service area boundaries.

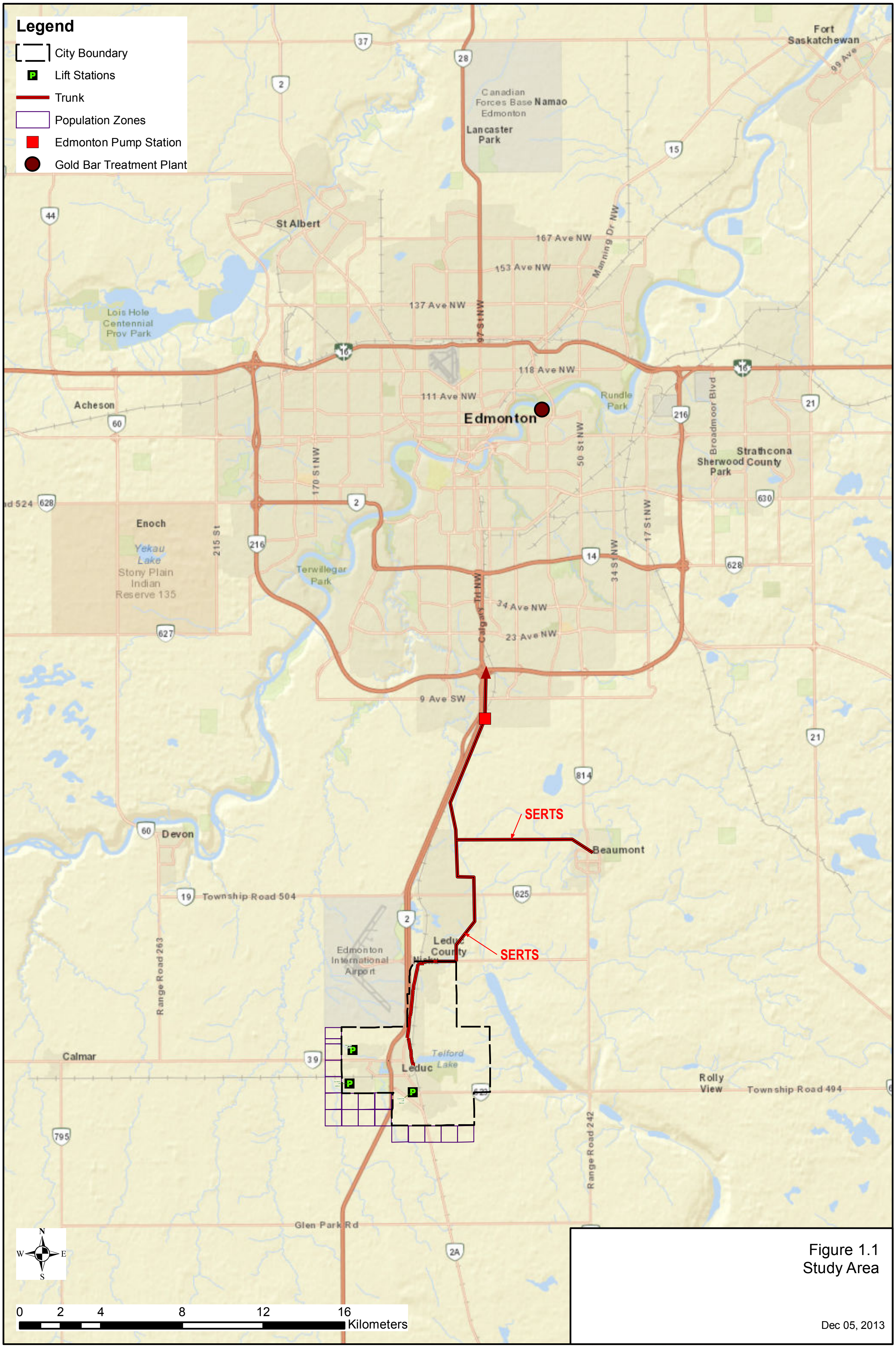

Figure 1.1
Study Area

Dec 05, 2013

1.4 Scope of Work

This project proceeded on the basis of a Terms of Reference dated July 6, 2012 developed by the City. The Terms of Reference describes the required scope of work, which is summarized below.

1. Background information and data collection and interpretation.
2. Analysis of sewer flow monitoring data.
3. Review of existing sanitary servicing standards and design flow.
4. Preparation and calibration of a PCSWMM model (or equivalent).
5. Existing system capacity assessment.
6. Assessment of the capacity of the existing infrastructure to service projected future development.
7. Development of a long-term servicing strategy to support future developments.
8. Identification of sanitary system improvements and estimated capital costs.

1.5 Report Organization

This report documents the project methods and results, leading to the recommended Sanitary Master Servicing Plan for the City.

The main report is supported by a set of Appendices that provide details on the methods and results of various information gathering and technical analyses carried out during the course of the project.

Section 1 ***Introduction***
- Project Background, Objectives, and Scope.

Section 2 ***Sanitary Collection System***
- Overview of existing systems.

Section 3 ***Design Standard Review***
- Review of existing City of Leduc design standards and recommended changes.

Section 4 ***Land Use and Future Growth***
- A summary of projected growth and land use.

Section 5 ***Sanitary System Model Development***
- Summary of flow monitoring data analysis.
- Model development and calibration.

Section 6 ***Sanitary System Capacity Assessment***
- Performance of existing sanitary system for a range of flow scenarios (Actual and Design).
- 2012 Baseline Capacity Assessment.
- Assessment of flow contributions to the Regional system.

Section 7 ***Sanitary Servicing Strategy Development***
- Development of sanitary servicing strategies for the growth scenarios.
- Staging, sizing and implications of future servicing.

Section 8 ***Recommendations***
- Recommendation resulting from the servicing studies addressing future model development, ACWRC LOS, and other City programs.

2. SANITARY COLLECTION SYSTEM

2.1 Sanitary System Overview

Figure 2.1 depicts the existing sanitary collection system that serves the City. There is approximately 125.5 km of sanitary sewer pipe owned and operated by the City. The majority of the sanitary system (82%) is 300 mm in diameter or less. The largest sanitary sewer is 750 mm, sanitary flow from the City discharges into the ACRWC Southeast Regional Trunk Sewer (SERTS) which conveys Leduc's wastewater ultimately to the City of Edmonton's Gold Bar Wastewater Treatment Plant.

Table 2.1 summarizes the age of the sanitary collection systems.

Table 2.1 Sanitary System Age

Constructed	% of Sanitary Pipe
1952 - 1970	11%
1971 - 1980	35%
1981 - 1990	10%
1991 - 2000	8%
2001 - 2010	36%

A large majority of the sanitary system has been installed over the past 20 years where 44% of the system was installed. The 1970's were also a period where a significant amount of the sanitary system was installed. Figure 2.2 shows the distribution of sanitary sewer pipe age.

Table 2.2 presents a summary of pipe material. Concrete and PVC pipes are used primarily now by the City. Historically, VCT was used primarily for local sanitary sewers in Leduc.

Table 2.2 Sanitary System Pipe Material

Code	Pipe Material	% of Sanitary Pipe	Date Used
AC	Asbestos Cement	4.5%	1952 -1990
CONC	Concrete	12.0%	1952 - Present
HDPE	High Density Polyethylene	>1%	1991 - Present
PVC	Polyvinyl Chloride	54.0%	1971 - Present
Steel	Steel	>1%	1971 - 1990
VCT	Vitrified Clay Pipe	23.0%	1952 - 1990
UNK	Unknown	6.0%	-

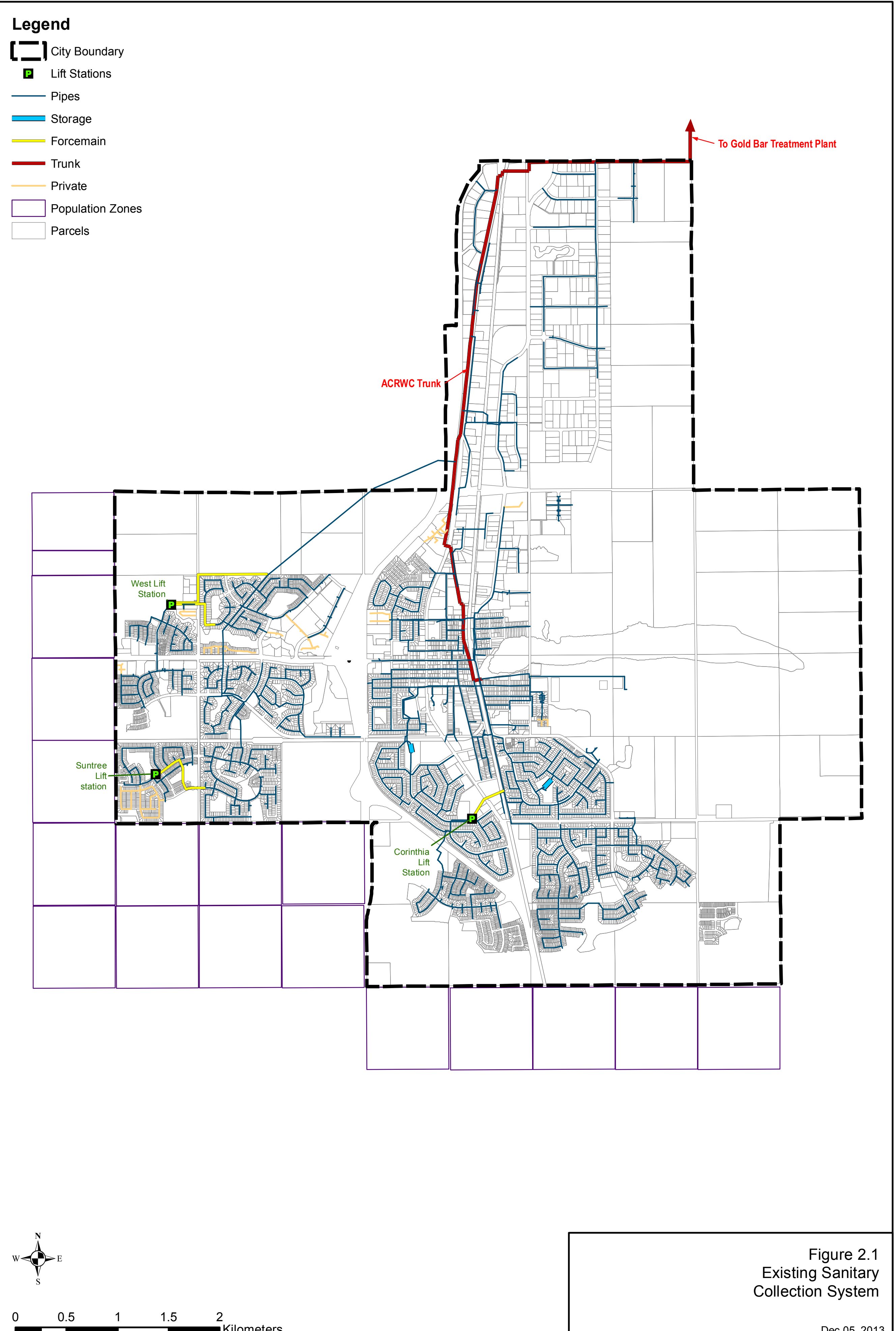

Figure 2.1
Existing Sanitary
Collection System

Dec 05, 2013

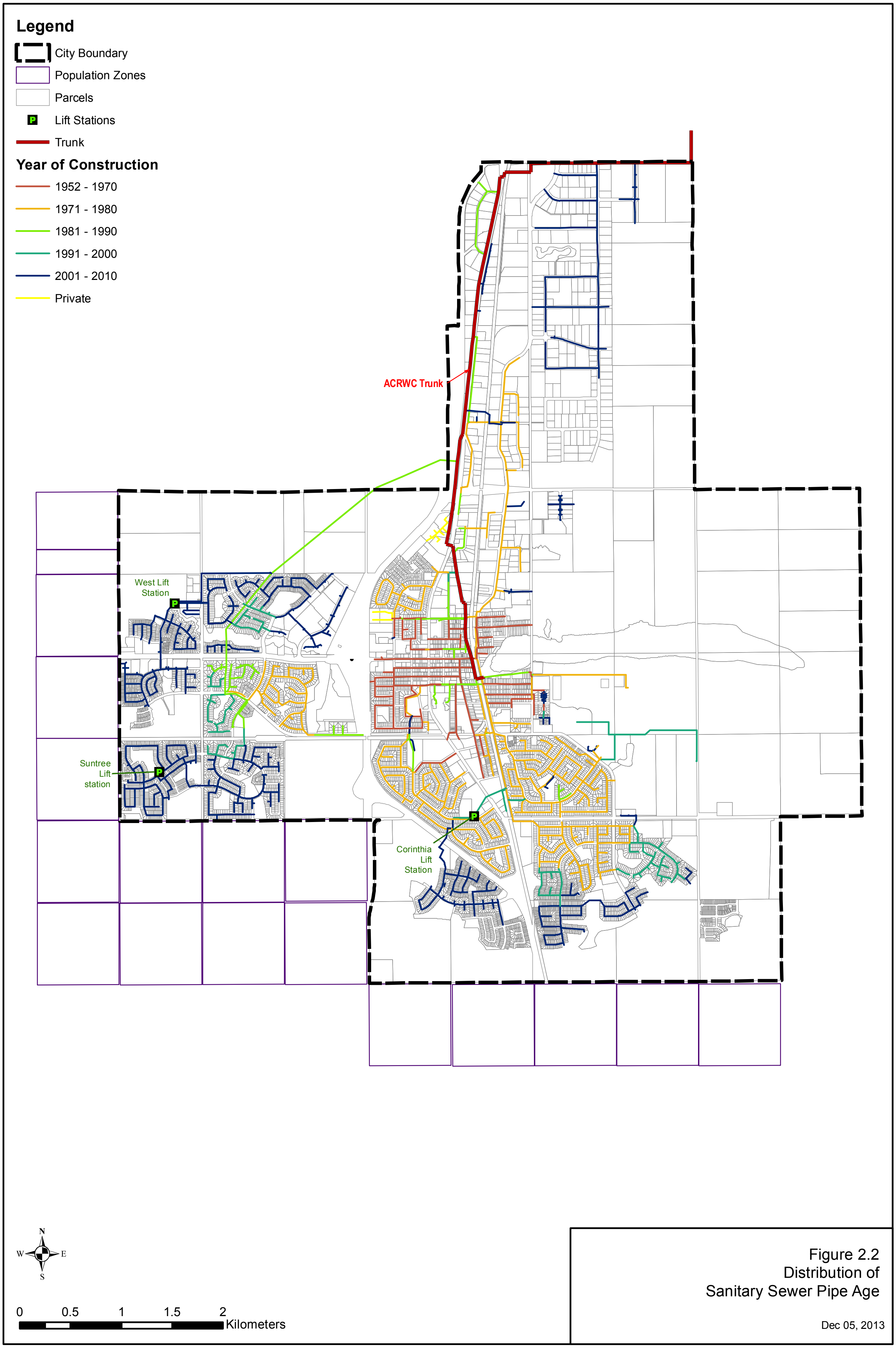

Figure 2.2
Distribution of
Sanitary Sewer Pipe Age

Dec 05, 2013

There are two wastewater storage facilities in the system. The first is located Kinsmen Park south of Black Gold Drive adjacent to Camelot Avenue. The storage is in the form of an oversized inline pipe where excess flow is diverted to storage with a controlled outlet back into the main sanitary line.

The second facility passes through Notre Dame Park. A parallel storage pipe is located in the park for excess flows. The storage pipe is gravity fed and outlets back to the main system by gravity.

In 2000, the Corinthia Park sanitary sewer relief project established a diversion structure where sanitary flow from Bella Coola Drive was split. This diversion structure maintained dry weather flow and allowed a portion of wet weather flow to continue to flow northwest on Corinthia Drive. Under wet weather conditions excess flow would overflow to the north towards the new Corinthia Pump Station (PS).

In 2013 this structure was modified (weir plate removed) to allow more flow to the Corinthia PS as the lack of pump station use was creating maintenance issues with the station. Now where the flow is split at the intersection of Corinthia Drive and Bella Coola Drive, there is approximately a 50% flow split directing dry weather to the Corinthia PS as well as increasing the portion of wet weather flow to the station.

2.2 Local Pumping Stations

Table 2.3 identifies the three local wastewater pump stations owned and operated by the City.

Table 2.3 Wastewater Pump Stations

Name	Firm Pumping Capacity
Suntree PS	135 L/s
West PS	85 L/s
Corinthia PS	123 L/s

Notes:
1. Firm Capacity is based on the largest pump being out of service.
2. Firm Capacity is based on available information.
3. West PS future upgrade to 198 L/s associated with growth.

The current firm capacity for each station is identified in Table 2.3. The West PS is identified to be upgraded in the future to 198 L/s to support growth in the service area.

2.3 Capital Regional System

The City does not have a wastewater treatment plant. All wastewater from the City discharges into the Alberta Capital Region Wastewater Commission (ACRWC) SERTS. The SERTS starts just south of 50th Avenue and extends north parallel to the railway tracks to Airport Road (10th Avenue) where it again heads north on Range Road 250 out of the community. In the City the SERTS is approximately 7.2 km long ranging in size from 750 mm to a maximum of 1050 mm. Wastewater is conveyed ultimately to the City of Edmonton's Gold Bar Wastewater Treatment Plant.

There is an agreement between ACRWC and the member communities, including the City, that establishes a level of service criteria ACRWC will provide with respect to the transmission of wastewater and providing treatment.

3. DESIGN STANDARDS REVIEW

3.1 Overview

The City is considering revising their Engineering Design Standards for sanitary sewage system. The City Minimum Design Standards, April 2006 Section 8.1, 8.2 and 8.3 were reviewed (Appendix B contains a copy of Section 8.1, 8.2 and 8.3 as reference). These sections outline the current methodology and design criteria that apply to the design of sanitary sewer systems in the City.

The City's sanitary sewer design standards were compared with other municipalities of the same sizes (Fort Saskatchewan, Spruce Grove, and Lloydminster), as well as several leading municipalities in Alberta, Manitoba and Ontario, such as City of Edmonton, City of Winnipeg, City of Toronto, and others as a comparison against industry standards and trends.

3.2 Design Standard Comparison

Table 3.1 summarizes the design standards for the City and each community including wastewater unit rates for residential and Industrial-Commercial-Institutional (ICI) wastewater flow, peaking factor, Inflow/Infiltration allowance, additional inflow allowance at manholes in sag locations, and Manning's "n" for pipe materials. All of the design parameters affect the sizing of sanitary sewers.

In general, residential wastewater generation rates range from 265 Lpcd to 450 Lpcd with a majority of jurisdictions using approximately 360 Lpcd, which is comparable to the City. Based on this comparison, the City's current sanitary sewer design standard, with respect to unit rates for per capita wastewater flow, is similar to other jurisdictions. The City's residential peaking factor, ICI wastewater generation rate, I/I allowance, and Manning's "n" are also comparable with other municipalities.

Despite the similarity in sanitary unit rates, jurisdictions are considering adjusting sanitary design standards to reduce the sanitary unit rate to recognize industry changes in water consumption rates. With the advent of water conservation measures supported by updated building codes features such as low flush toilets, low flow shower heads, as well as the adoption of high efficiency washers, etc., there has been a corresponding reduction in water consumption and therefore wastewater generation rates.

Evidence of wastewater flow reduction is captured in a 2008 unit rate assessment for the Region of York, Ontario. As part of the Region of York's 2009 Water and Wastewater Master Plan it was concluded that water consumption rates, over the past decade, have reduced by 10 to 35% depending on the area. Also, the review of flow data collected at York Region's permanent monitoring sites suggested that the unit wastewater generation rate in 2007 has been declining from the original rate of 368 Lpcd to 265 Lpcd, which reflects the current Regional standard.

Table 3.1 Design Standard Comparison

	Leduc	Edmonton	Fort Saskatchewan	Spruce Grove	Lloydminster	Winnipeg	Toronto	York Region	Markham	Vaughan	Richmond Hill	Halton Region
Population (approx.)	25,000	817,000	20,000	26,000	28,000	664,000	2,600,000	1,100,000	302,000	288,000	186,000	502,000
Residential Wastewater Generation for New Development	360 Lpcd	300 Lpcd	360 Lpcd	364 Lpcd	360 Lpcd	270 Lpcd	450 Lpcd or 240 Lpcd (1)	265 Lpcd	365 Lpcd	450 Lpcd	365 Lpcd	275 Lpcd
Peaking Factor (Residential)	Larger of 1.5 or $2.6P_{pf}^{-0.1}$	Larger of 1.5 or $2.6P_{pf}^{-0.1}$	Larger of 1.5 or $2.6P_{pf}^{-0.1}$	Harmon PF	Harmon PF, Max 3.8	Harmon PF	Harmon PF	Harmon PF	Harmon PF	Harmon PF	Harmon PF	Modified Harmon PF
Non-residential Wastewater Generation	0.2 L/s/ha	0.2 L/s/ha	0.2 L/s/ha	364 Lpcd (Equivalent Pop.)	0.2 L/s/ha	0.2 L/s/ha (commercial) 0.26 L/s/ha (light industrial) 0.39 L/s/ha (wet industrial)	2.1 L/s/ha (including peak flow)	160 Lpcd	214 Lpcd	Ind. - 0.5 L/s/ha Com. -0.4 L/s/ha Inst. - 0.26 L/s/ha	2.08 L/s/ha (including peak flow)	Ind. - 410 Lpcd Com. - 260 Lpcd Inst. - 135 Lpcd
Peaking Factor (Non-Residential)	Q_{AVG} x 3	$10\ Q_{AVG}^{-0.45}$ (Min. 2.5; Max. 25	$10\ Q_{AVG}^{-0.45}$ (Min. 2.5; Max. 25	Harmon PF	Harmon PF, Max 3.8	1.6 for commercial and light industrial 1.34 for wet industrial	-	Harmon PF	Harmon PF	Harmon PF	-	Modified Harmon PF
I/I allowance	0.2 L/s/ha in residential areas 0.05 L/s/ha in ICI areas	0.28 L/s/ha	0.28 L/s/ha	0.28 L/s/ha	0.28 L/s/ha	0.35 L/s/ha (residential) 0.23 L/s/ha (ICI)	0.26 L/s/ha	Based on 1:25 yr storm event from Region's model	0.26 L/s/ha	0.23 L/s/ha	0.26 L/s/ha	0.286 L/s/ha
Inflow allowance (Manhole in sag locations)	0.4 L/s/MH	Additional 0.4 L/s/MH	Additional 0.4 L/s/MH	Not allowed	Not allowed	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manning's N	0.013	0.013	0.013	PVC - 0.011 Concrete - 0.013	0.013	0.013	0.013	0.013	0.013	PVC/Concrete - 0.013 Corrugated metal - 0.024	0.013	-

Notes:
P_{pf} = design contributing population in 1,000's
Harmon PF = $1+14/(4+P^{0.5})$, P = population in 1,000's
1. Average wastewater flows in fully separated sanitary sewer areas where no downspout and foundation drains are connected to the sanitary sewer.

Flow monitoring carried out by the City in 2011 and 2012 reflect actual flow conditions in the sanitary systems. Appendix A contains Technical Memorandum #1 which presents the flow data analysis where the average residential sanitary unit rate is approximately 205 Lpcd. In the southwest and southeast areas of the City the average sanitary unit rate is approximately 175 Lpcd. These areas of the City represent newer development areas in the City of Leduc.

It is therefore reasonable for the City to consider lowering the wastewater Unit Rate for residential areas to less than the current 360 Lcpd. The trend in water consumption records, and recent in-sewer flow monitoring in newer areas of the City, support a reduction in the sanitary unit rate for residential developments.

The residential extraneous flow allowance of 0.20 L/s/Ha is consistent with other jurisdictions which tend to be slightly higher at 0.28 L/s/Ha. The additional extraneous flow allowance for manholes located in sag locations (0.40 L/s/MH) appears common practice in Alberta. Some municipalities such as Spruce Grove and Lloydminster do not allow new manholes located in sags, while others do not recognize this as extraneous flow sources.

For ICI flow generation there is a wider range of unit rates used to determine design flows for ICI lands. Some jurisdictions use a per area rate while others use an equivalent population approach. The City of Leduc uses a unit rate of 0.20 L/s/Ha (17,280 L/d/Ha), plus a Peaking Factor of 3.0, plus an I/I allowance of 0.05 L/s/Ha. In comparison, the ACRWC standard is 0.071 L/s/Ha (6,170 L/d/Ha), plus a Peaking Factor of 3.0 inclusive of extraneous flow allowance. The City's ICI design flow rates are approximately three times greater than the ACRWC standard. The City of Edmonton ICI standard for planning purposes is similar to the City of Leduc using 0.20 L/s/Ha, however the minimum Peaking Factor is 2.5, but the maximum is 25.

2011 and 2012 flow data collected by the City includes ICI lands in the northeast area where the average dry weather flow measured was approximately 2.3 L/s, or 0.03 L/s/Ha based on the service area with an observed peaking factor of approximately 1.26. The actual ICI flows are a factor of 10 lower than the design standard and the Peaking Factor is half of the standard.

3.3 Proposed Design Standard Revisions

Only two revisions to the current City of Leduc Engineering Design Standards for sanitary sewage system are recommended, namely:

- Reduction of the residential wastewater unit rate down from 360 Lpcd to 300 Lpcd. There is sufficient evidence to support reducing the wastewater unit rate for residential land use to 300 Lpcd based on local information and industry standards.
- Eliminate the extraneous flow allowance for manholes in sag locations of 0.4 L/s/MH. This recommended revision is contingent on not allowing manholes to be located at sag locations.

A revision considered, but ultimately not proposed, is a reduction in the ICI wastewater unit rate of 0.20 L/s/Ha with a peaking factor of 3 and extraneous flow allowance of 0.05 L/s/Ha. The ICI rate in the City's design standards is approximately three times greater than the ACRWC standard for Level of Service. There is always uncertainty regarding the types of ICI developments and their wastewater servicing requirements. For this reason the higher unit rates result in a conservative design that will be able to accommodate demands associated with changing ICI demands in the future.

3.4 Design Standards for Sanitary Servicing Study

The following sanitary sewer design criteria are used for the Sanitary Serving Study:

Residential Contributions:

- 300 litres per person per day.
- Peak dry weather flow rates for each contributing area calculated as average flow multiplied by the following peaking factor:
  - Peaking Factor shall be the larger of either 1.5 or PF = $2.6P^{-0.1}$.
    Where P = population in 1000's.
- Extraneous flow allowance of 0.20 litres per second per hectare.

Commercial, Industrial and Institutional Contribution:

- Minimum average contribution of 0.20 litres per second per hectare.
- Peak dry weather flow rates for each contributing area calculated as average flow multiplied by a peaking factor of 3.0.
- Extraneous flow allowance of 0.05 litres per second per hectare.

The total design peak flow for sanitary sewers is the sum of the peak dry weather flow plus all extraneous flows.

3.5 ACRWC Level of Service Criteria

In addition to local design standards, the ACRWC has a defined Level of Service (LOS) criterion. ACRWC is committed to provide wastewater capacity based on the following criteria.

Residential Areas:

- Sewage generation rate of 320 litres/capita/day.
- Peaking Factor of $2.6*(Population/1000)^{-0.1}$.
- Inflow and infiltration allowance of 0.28 litres/second/hectare.

Commercial and Industrial Areas:

- Sewage generation rate of 6,170 litres/hectare/day.
- Peaking Factor of 3.
- Inflow and infiltration allowance included in sewage generation rate and peaking factor.

Neighbourhood Commercial and Institutional Areas:

- Sewage generation rate of 6,170 litres/hectare/day.
- Peaking Factor of 3.
- Inflow and infiltration allowance of 0.28 litres/second/hectare.

In addition to the level of service criteria, ACRWC has defined procedures for system planning. The following procedures are used by ACRWC and member communities for system planning and capital upgrades:

- System planning is based on joint monitoring and modelling of members' and ACRWC systems.
- Sanitary sewer system modelling is based on the ACWRC LOS criteria. This is compared to the member's contributory flows associated with actual dry weather flow plus applying a 1:25 year, 24-hour rainfall event on the existing developed areas. The modelled LOS flows and modelled contributory flows are compared.
- System planning is based on reasonable population and development projections.

The ACRWC uses this approach to integrate systems to optimize from a technical and financial perspective.

4. LAND USE AND FUTURE GROWTH

The City, through their transportation master planning process has established population growth projections. The growth projects provided by the City identify growth areas within and outside the current urban boundary, the timing of growth, and the type of growth as either residential or employment.

The growth projections form the basis of wastewater flow generation that are used in the development of sanitary servicing strategies.

4.1 Planning Horizon and Projected Growth

The City provided residential and employment land growth projections for a short, medium and long term planning horizon, as well as an ultimate condition. The growth information was generated through the City's Transportation Master Plan and is distributed according to traffic zones.

The baseline population and land use information provided is considered to represent 2012 conditions. This aligns with the 2011/2012 flow monitoring data collected and system infrastructure to represent 2012 as the existing baseline conditions.

4.1.1 Service Boundaries

Figure 4.1 shows the current City urban service boundary. Growth in the City of Leduc area will require expansion of the current City service area boundary. For the purpose of this sanitary servicing plan, the future ultimate servicing boundary is shown on Figure 4.1.

4.1.2 Growth Projections

Table 4.1 summarizes the growth projections for the short, medium, long and ultimate planning horizons.

Table 4.1 Growth Projections

Year	Residential Population (people)	Residential Outside Existing Urban Boundary (People)	Total Residential (People)	Ind/Com/Inst Lands (Ha)
Current 2012	24,241	0	24,130	598
Short	30,507	1,520	32,027	959
Medium	33,798	3,640	37,438	1292
Long	40,911	10,050	50,961	1575
Ultimate	41,902	44,850	86,752	1624

Figure 4.1 present the growth projections showing growth areas and land use type.

The population and employment projections presented in Table 4.1 are planning-level estimates supplied by the City of Leduc in September 2012 as generated through the Transportation Master Plan. These numbers can only be considered as estimates. Actual future increases may change as specific development applications are received and approved.

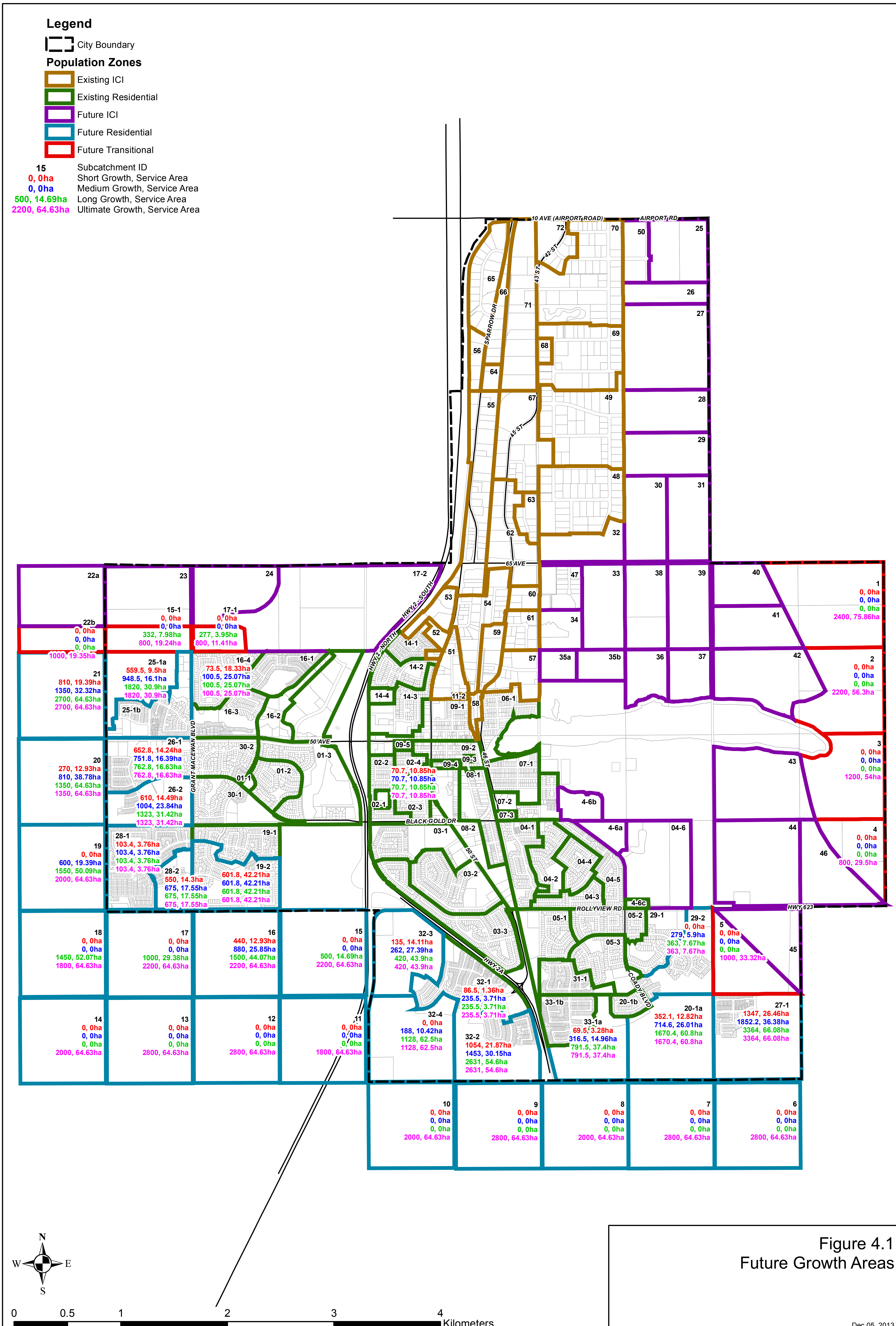

Figure 4.1
Future Growth Areas

4.2 Future Flow Projections

Figure 4.2 presents a summary of peak design flows associated with the short, medium, long and ultimate planning horizons. The design flows are based on a modified design standard that used 300 Lpcd for residential areas versus the current 360 Lpcd unit generation rate. All other design flow parameters (peaking factor, inflow/infiltration allowance) are the same as the current City design standard.

The growth related flows are used in the assessment of the existing sanitary system to accommodate the growth as part of approved servicing areas, as well as to prepare a servicing strategy for future growth areas.

Appendix C presents the growth and flow projections for the short, medium, long and ultimate planning horizons

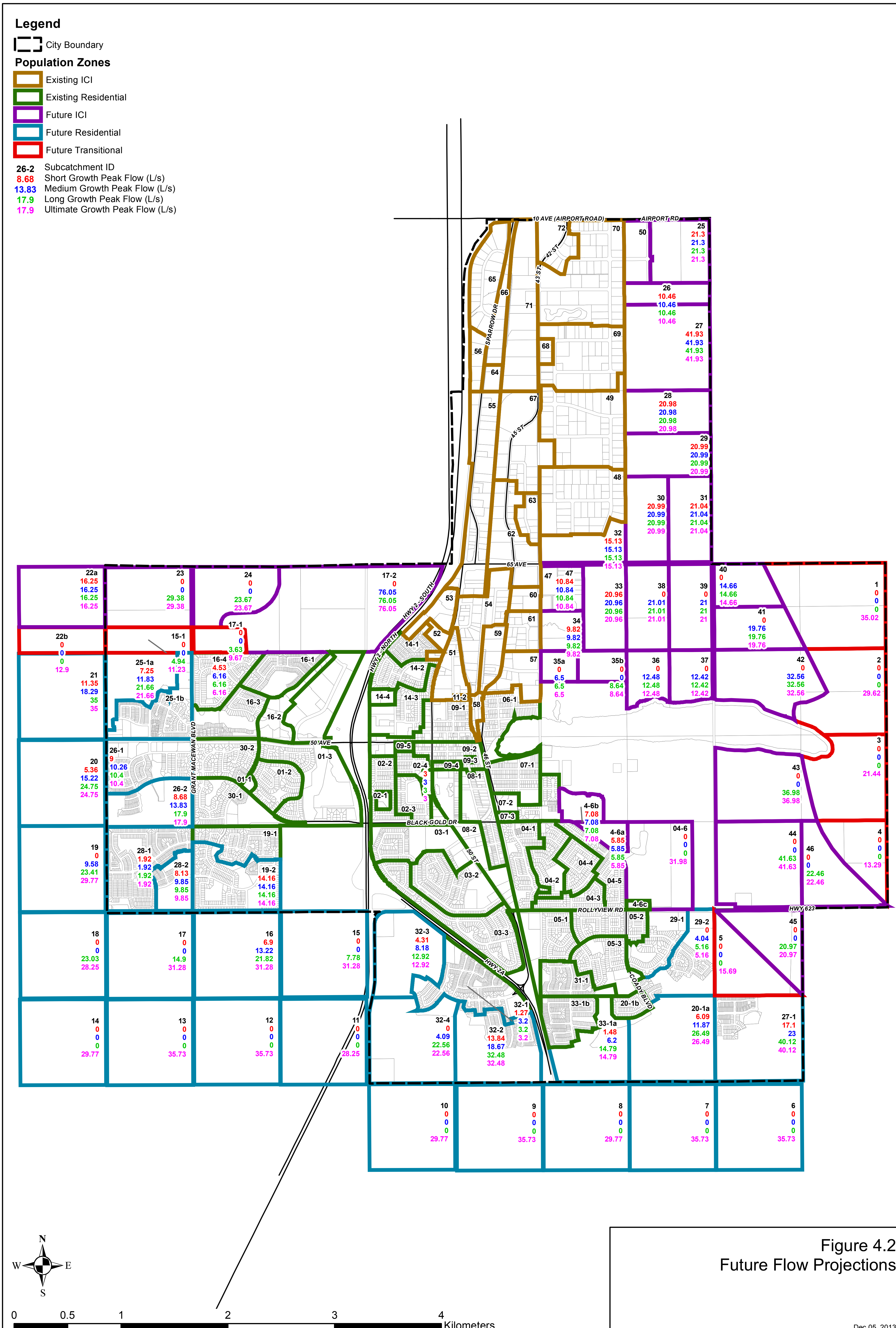

Figure 4.2
Future Flow Projections

Dec 05, 2013

5. SANITARY SYSTEM MODEL DEVELOPMENT

To assess the capacity of the existing sanitary collections system, to look at the impact of growth on existing infrastructure, and to define future needs, a sanitary system hydraulic model was developed. The following section provides an overview of the sanitary system model development and calibration.

5.1 Existing Sanitary System Model

The City provided a previously developed sanitary system hydraulic model (2006). The model was developed using PCSWMM which is based on EPA's SWMM 5. The model was reviewed and the following was identified:

- The model reflected the sanitary collections physical network. Not all pipes were included in the model, only the main collectors and ACRWC trunk sewer.
- The network did not extent into new development areas.
- Suntree PS was not included.
- There was no wet weather flow generation set up in the model.
- There was no sanitary flow diurnal pattern of inflow defined.
- The only flow in the model was the model initial conduit flow.
- Flow was introduced using an external file "ver2.txt" (not provided).
- Node and conduit names did not reflect GIS asset Ids.
- Model had used dummy storage at nodes throughout the model, most likely for model stability.
- There were some discrepancy between some manhole and pipe inverts and diameters.
- There was no dry or wet weather flow calibration.

The existing model was not sufficient to characterize flow in the sanitary collection system needed to undertake a capacity assessment, or to identify servicing needs associated with growth and future servicing.

5.2 Updating Sanitary System Model

The updated sanitary system model continues to use PCSWMM as the model interface. The underlying model is based on EPA's SWMM 5.0 analytical engine. SWMM 5.0 is widely used for the analysis of sanitary, storm and combined systems. SWMM 5.0 is a fully dynamic model capable of complex hydraulics analysis required for wet weather simulation and capacity assessments. The PCSWMM interface provides superior data management and visualization tools with a link to GIS tools and production modelling tools.

5.2.1 Network

The existing model was used as a starting point. The current model extents were compared to the existing infrastructure and where future growth was expected.

The physical network was extended accordingly to provide a reasonable representation of existing systems and suitable inflow locations for future growth inside and outside of the current urban boundary.

The City provided background information and data regarding the sanitary collection systems. Much of the physical network information is maintained in the City's GIS which was used as the primary source of system data. This data was reviewed and where necessary additional information was sought from drawings and other City records for clarification. City staff also inspected select locations to verify flow directions and flow conditions.

System data was reviewed and compiled only for the sanitary collection system that would be part of the hydraulic model. Not all sanitary systems are included in the model.

Figure 5.1 shows the extent of the updated sanitary system model. As part of the model updating process, manhole names were updated to reflect asset names found in the City's GIS. For the purpose of modelling, there are times additional dummy nodes are required. Any dummy node is identified as follows - "XX-####". Conduit names are a combination of the upstream node and downstream node name connected by a hyphen.

Pump station information was updated (Section 2.1.1) with the firm capacity of each pump station based on available records. Firm capacity recognizes the largest pump is out of service. The pump stations were simply represented in the model with on/off levels.

5.2.2 Catchment Delineation

The previous model did not have defined service areas. Flow was introduced at load points in the model (manholes) with no supporting service area map.

Recognizing the modelling objectives, the delineation of catchments, or service areas, was required. In large part, the sanitary service area catchments were premised on the Regional Transportation Zones (RTZ). They were based on this delineation to facilitate the distribution of population projections. Within the RTZ catchments further subdivisions were made based on the configuration of the local collection system. The resulting subcatchments provide the basis for flow generation based on contributing population and service area. Figure 5.1 presents the sub-catchment boundaries for the existing system.

5.2.3 Flow Generation

In order to use the model to assess system capacity and for system planning the introduction of flows was changed from a text inflow file. Dry weather flows are introduced as inflows at select manholes in the model with average dry weather flow values and a diurnal pattern. This information is derived from the flow monitoring program (Section 5.3).

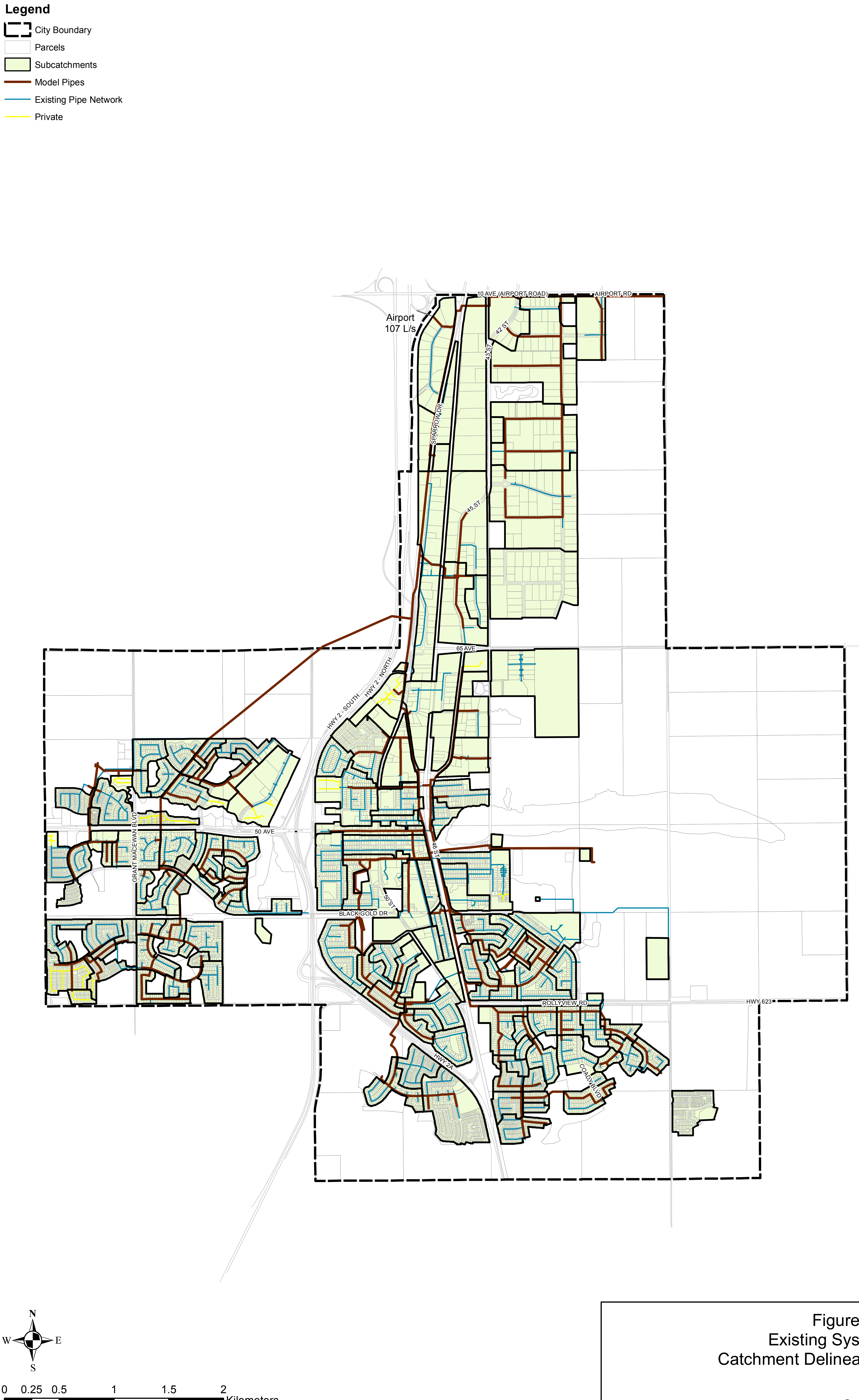

Figure 5.1
Existing System
Catchment Delineation

Dec 05, 2013

Wet weather flow is characterized as inflow/infiltration and is introduced using a unit hydrograph method known as R-T-K. The RTK method generates a response hydrograph based on precipitation data, catchment area and RTK parameters that define a unit response. There are three unit hydrographs that together make up the overall response. The three triangular unit hydrographs represent the following:

- Rapid inflow - An immediate response in sewer flow associated with precipitation, which is associated with direct inflow.
- Moderate infiltration - A medium-term response related to less direct inflow and more significant infiltration sources. Can represent foundation drains as well as deficiencies in the system.
- Slow Infiltration - A Long-term response associated with infiltration.

The following three parameters are used to describe the shape and volume of runoff that enters the sanitary sewer:

- "R" is the fraction of precipitation that becomes inflow/infiltration.
- "T" is the time to peak of the hydrograph.
- "K" is the ratio of the recession time to time to peak.

The parameters are initially derived from the analysis of flow monitoring data characterizing the wet weather response in the sanitary system. The RTK values are then adjusted through the model calibration process.

Model datasets representing different flow scenarios have been prepared to address the capacity assessment and future growth scenarios.

5.3 Flow Monitoring Data Analysis

Appendix A presents Technical Memorandum #1, Flow Monitoring Data Review, which summarizes the flow data monitoring program completed by InsituCan Services Ltd. and presents the data analysis completed through this assignment.

5.3.1 Flow and Rainfall Monitoring Program

Monitoring was completed in the fall of 2011 and summer of 2012 by InsituCan Services Ltd. on behalf of the City. Figure 5.2 shows the flow monitoring locations and rain gauge, while Table 5.1 provides a description of each monitoring location and summarizes data observations from reviewing the datasets. Flow data was collected at 15 minute intervals and the rainfall in five minute increments.

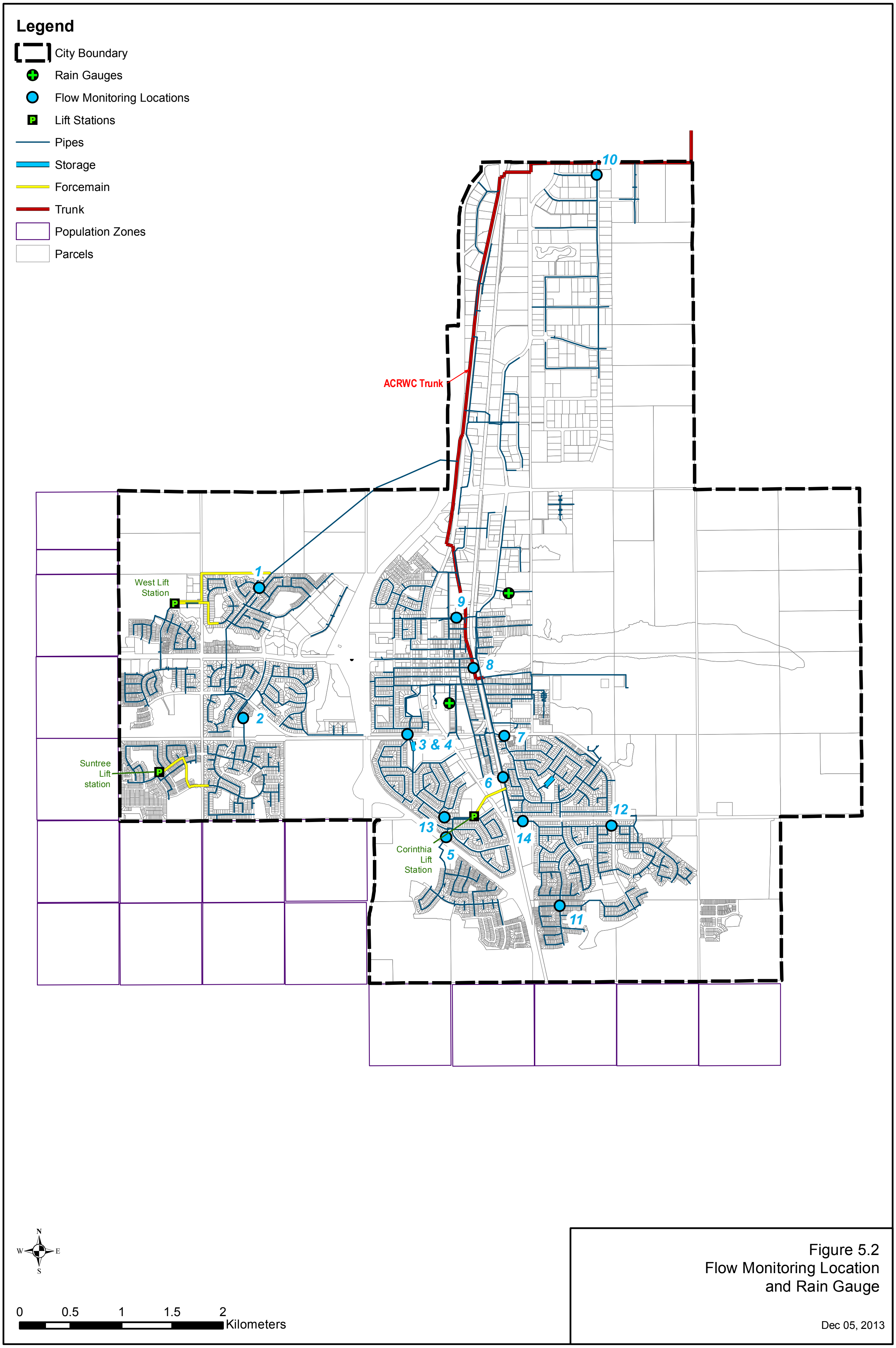

Figure 5.2
Flow Monitoring Location
and Rain Gauge

Dec 05, 2013

Table 5.1 Flow and Rainfall Monitoring Data Observations

Site	Manhole ID	Pipe Diam. (mm)	Data Review Comments / Observations	
			Winter 2011/2012 Data	**Summer 2012 Data**
1	1019	750	• Data generally good.	• Data generally good. • Flows higher in 2012. • Velocity spikes observed in dataset. • Response to wet weather evident.
2	159	600	• Effect of pump station upstream observed. • Periods of high velocity and flow.	• Effect of pump station upstream observed. • Periods of high velocity and flow makes for noise data. • Flow lower than 2011 data. • Low flow dropout of velocity during night time. • Response to wet weather evident.
3	1285	250	• Data not used directly. • Change in service area at Corinthia pump station between when 2011 data collected and 2012 data.	• Poor data from June 17 to July 7, 2012. • Data generally good beyond July 7, 2012. • Response to wet weather evident, very direct.
5	1148	525	• Velocity data inconsistent. • Varies from low to extremely high (spikes) throughout monitoring period.	• Velocity data very poor until July 15, 2012. • Velocity spikes throughout dataset. • Level data inconsistent as well. • Better dataset after August 29, 2012 but no wet weather events. • Limited reliable wet weather data. • Response to wet weather evident.
6	569	525	• Data not used directly. • Change in service area at Corinthia pump station between when 2011 data collected and 2012 data.	• Influence of upstream pump station evident. • Velocity spikes in dataset. • Data generally good. • Response to wet weather evident.
7	1669	375	• Data generally good. • There is the occasional spike in depth and velocity observed.	• Data generally good. • There is the occasional spike in depth and velocity observed. • Response to wet weather evident, very direct.
8	1571	750	• Random spikes in velocity and flow. • Velocity trending down. • No velocity data from December 1, 2011 to end of program.	• Data generally good until July 26, 2012, data generally poor afterwards. • Response to wet weather evident, very direct.
9	524	450	• Random spikes in velocity and flow. • Velocity unsteady. • Data unusable after December 12, 2011 no velocity data. Level data usable.	• Periods with no velocity measurements, level is generally good. • Short periods of usable data. • Response to wet weather evident, very direct.

Table 5.1 Flow and Rainfall Monitoring Data Observations

Site	Manhole ID	Pipe Diam. (mm)	Data Review Comments / Observations	
			Winter 2011/2012 Data	Summer 2012 Data
10	1124	525	• Industrial area. • Does not follow typical diurnal flow pattern. • December 2011 data more consistent.	• Industrial area. • Does not follow typical diurnal flow pattern. • Very low weekend flows during summer. • Limited response to wet weather evident.
11	1136	375	• No data collected in 2011.	• Data generally good. • Response to wet weather evident.
12	932	375	• No data collected in 2011.	• Data generally good. • Response to wet weather evident, very direct.
13	357	250	• No data collected in 2011.	• Poor data until August 4, 2012, data generally good afterwards. • Response to wet weather minimal. • Increase in flow every seven days (weekly) industrial process.
14	747	525	• No data collected in 2011.	• Low flow conditions, velocity night time dropout. Velocity inconsistent. • Level data consistent • Response to wet weather evident, very direct.

Rainfall was collected at the Leduc Civic Centre and the Leduc Operations Building. The Civic Centre rain gauge data set was more completed and was used for all wet weather analysis.

5.3.2 Dry Weather Flow Analysis

The objectives of the dry weather flow analysis included:

- Determination of the average, peak and minimum dry weather flows;
- Quantification of groundwater infiltration flows; and,
- Generation of typical dry weather 24-hour diurnal flow plots for each monitoring site.

The flow data analysis involved the definition of dry weather flow periods, calculation of average dry weather flows, and calculation of groundwater infiltration flows. All datasets were used to characterize dry weather flow.

Table 5.2 presents a summary of the dry weather flow data analysis results by monitored site.

Table 5.2 Dry Weather Flow Characteristics

Site	Service Area (Ha)	Avg. DWF (L/s)	Peak DWF (L/s)	Min. DWF (L/s)	GWI(1) (L/s/ha)	Sanitary Flow(2) (L/s)	2011 Population	Per Capita DWF(3) (Lpcd)	Total Per Capita Flow(4) (Lpcd)	Peaking Factor(5)
1	465.8	11.5	13.0	4.8	0.009	7.4	10,144	63	98	1.34
2	121.8	6.0	8.9	1.2	0.008	5.0	2,737	157	189	1.48
3	67.6	11.1	13.5	6.7	0.084	5.4	2,009	232	477	1.22
5	48.2	5.0	7.8	1.8	0.032	3.5	1,402	214	308	1.56
6	150.3	12.8	22.4	7.6	0.043	6.3	5,615	98	197	1.75
7	93.4	11.9	14.7	7.0	0.064	6.0	2,185	235	471	1.24
8	506.9	36.8	46.2	18.6	0.031	21.0	13,687	133	232	1.26
9	39.2	13.4	16.0	10.6	0.230	4.4	830	457	1,395	1.19
10	87.8	2.3	2.9	1.9	0.018	0.7	- (6)	-	-	1.26
11	27.4	3.6	5.9	0.5	0.016	3.2	1,105	248	281	1.64
12	32.1	3.2	4.1	1.2	0.032	2.2	952	198	290	1.28
13	70.3	2.4	3.7	0.6	0.007	1.9	643	254	322	1.54
14	132.2	7.1	16.7	0.4	0.003	6.8	3,946	148	155	2.35

Notes:
1. GWI = (0.85* Minimum DWF)/Area
2. Average Sanitary Flow = Average DWF – (0.85)*Minimum DWF
3. Per Capita Sanitary Flow = Average Sanitary Flow/ Population
4. Total Per Capita Flow = Average DWF / Population
5. Peaking Factor = Peak DWF/Average DWF
6. Industrial Area - no population data.

Technical Memorandum #1 in Appendix A, presents the typical 24-hour dry weather flow graphs for each sanitary sewer monitoring location. The diurnal flow values and patterns area used to define average dry weather flow in the model and define a typical 24-hour diurnal pattern.

5.3.3 Wet Weather Flow Analysis

The objective of the wet weather flow analysis is to characterize extraneous flows response in the sanitary system to a range of wet weather events.

To complete this analysis, the previously developed dry weather diurnal flow time series is subtracted from the total measured flow to isolate the wet weather response as an infiltration/inflow (I/I) hydrograph. From this, the volume of wet weather for each event is determined for the contributing area. To evaluate the amount of wet weather a volumetric runoff coefficient is calculated. The volumetric runoff coefficient (%Cv) is the volume of wet weather divided by the total rainfall volume over the contributing service area. The greater the %Cv, the greater the amount of I/I. In addition to the %Cv, the peak and average event I/I rate is determined on an areas basis.

Table 5.3 presents a summary of the wet weather flow analysis. The %Cv and I/I rates presented in Table 5.3 represent the average of all the events analyzed at each monitoring site. Appendix B in Technical Memorandum #1 provides detailed summary tables for each individual event analyzed as well as the event flow hydrographs.

Table 5.3 Wet Weather Flow Analysis Summary

Site	Peak I/I Rate (L/s/ha)	Average I/I Rate (L/s/ha)	Volumetric Runoff Coefficient %Cv
1	0.02	0.004	0.40 %
2	0.94	0.03	2.31 %
3	0.52	0.05	4.62 %
5	1.38	0.09	5.73 %
6	0.69	0.05	8.65 %
7	0.65	0.04	4.38 %
8	0.34	0.02	1.85 %
9	4.63	0.14	11.32 %
10	0.11	0.01	0.74 %
11	0.37	0.02	2.59 %
12	1.94	0.06	4.36 %
13	0.09	0.01	1.24 %
14	0.63	0.02	1.36 %

Notes:
1. I/I rates and % Cv values represent average values over a number of events. TM#1 Appendix B provides specific event analysis results.

5.3.4 Flow Monitoring Data Summary

The City's flow monitoring program was intended to characterize dry and wet weather flows and to support the hydrologic/hydraulic model development of the City wastewater collection system.

The flow and rainfall monitoring program was carried out in two phases. Phase 1 was over a three month period between November 2011 and January 2012 while Phase 2 was over a four month period between June 2012 and September 2012. Phase 1 was primarily used for dry weather flow analysis and Phase 2 was used for both dry weather flow and wet weather flow analysis. The data collected throughout the program was sufficient to characterize dry and wet weather conditions although there were periods of poor data quality associated largely with velocity measurements.

The flow data analysis provided the following information:

- Dry weather flow analysis characterized 24-hour diurnal flow patterns used in the development of the sanitary system model.
- Site 10 serves an industrial area. The diurnal flow pattern is irregular when compared to residential areas.
- The older sections of the City (Sites 3, 5, 6, 7, 8, 9 and 12) tend to have higher groundwater infiltration (GWI) rates. These sites have GWI rates greater than 0.030 L/s/ha. Newer areas (sites 1, 2, 13, 14) have GWI rates of less than 0.010 L/s/ha.
- Per capita sanitary flows in the study area ranged from 63 Lpcd to 457 Lpcd.
- The per capita flow rates of less than 100 Lpcd at Sites 1 and 6 are considered unreasonably low. The rate may be distorted if the contributing population actually less than current population information.
- At Site 13 there is a weekly increase in dry weather flow. The source of this flow increase is unknown at this time.
- Sites 1, 2 and 10 have a slight response to rainfall relative to Sites 5, 11 and 13 which display a moderate response. Sites 3, 6, 7, 8, 9, 12, and 14 display the most direct response to rainfall events. Site 9 displays the greatest response to wet weather flow.
- Peak I/I observed at all sites (except Sites 1, 10 and 13) were shown to exceed the I/I allowance of 0.20 L/s/ha.
- There is sufficient number of wet weather events and data to support the development and calibration of the sanitary system model.

The outcome of the dry and wet weather flow data analysis characterizes existing flows in the sanitary system at specific locations under a range of conditions. The information collected is used directly in the preparation of a sanitary system model to support the sanitary servicing study and to develop and evaluate servicing alternatives associated with planned growth.

5.4 Model Calibration

The updated SWMM model was calibrated to the flow monitoring data collected and analyzed.

5.4.1 Dry Weather Calibration

Dry weather flow in the model was populated using the flow data collected and characterized. The objective of the dry weather calibration is to have modelled dry weather flow at each flow monitoring station to match the flow data collected.

For areas with no flow monitoring data, the dry weather average flow is selected from a flow meter location with similar system characteristics with respect to development and system age. In the future this can be updated if new data becomes available.

Appendix D contains a summary of dry weather flow graphs comparing the modelled flows and measured flows under dry weather conditions.

Overall there is good agreement at most locations. Sites 1, 2, 3, 5, 7, 9, 10, 11, 12 are all within 10% of measured average dry weather flow. For sites 6, 8, 13 and 14 the difference is greater than 10%. In looking at the modelled versus observed flow graphs for these locations, the difference for Site 13 and 14 is related to poor low flow data. For Sites 6 it is the influence of the Corinthia PS that creates the difference, while for Site 8 the flow data is not stable. For all sites, the dry weather flow in the model is considered representative of existing conditions and suitable for modelling and undertaking capacity assessments.

5.4.2 Wet Weather Calibration

Overall, wet weather calibration provided a reasonable fit between observed flows and modelled flows over a range of events where data was available. Table 5.4 summarizes comments and observations made regarding the wet weather calibration. Appendix D presents the wet weather calibration curves and summarizes the volume and peak flow comparison.

The model is calibrated for wet weather events that range from 10 mm to up approximately 45 mm. The flow monitoring data available was found to have issues at some locations. However, overall there was sufficient data to reasonably characterize wet weather response in the system. Through the calibration process it was identified at Site 3 there was a build-up of debris (field verified) that affected the flow monitoring data and the calibration. This condition was taken into account during the calibration, and then the model was adjusted to reflect the clean condition since the debris was addressed by the City.

Table 5.5 presents the final RTK parameters used in the model. These RTK parameters are used for the wet weather flow analysis and generate the inflow and infiltration flow components.

Table 5.4 Calibration Observations

Site	Primary Calibration Event	Overall Calibration Quality (1)	Comments
1	August 4, 2012	3	• 2 events with data for calibration. • Volume and peak flow within 25%. • Event (c) does not show a large response in the data even though the model does - this appears to be an issue with the monitored data.
2	July 14, 2012	3	• 3 events for calibration. • Volume within 5% and peak flow 25%. • Model is overestimating for event (d) and underestimating for event (c) and (e).
3	August 14, 2012	4	• 3 events for calibration. • Volume within 10% and peak flow 20%. • Sites 3 and 13 were calibrated as together due to poor data at site 13 (and high flows seen at Site 3). • All flow was assumed to be routed to the west at the two splits south of monitoring location 3. Field investigations identified blockages in the system that routed the flows through the one pipe and past Site 3. • Seeing surcharging for events (c) and (d) through the corridor - not significant amounts to cause flooding or damage (hydraulic grade line shows flow is still being pushed through).
5	August 14, 2012	3	• 3 events for calibration. • Volume within 20% and peak flow 25%. • Model is underestimating for events (c) and (f) and over estimating for event (d). • Monitored flow data is very peaky which is not reflected in the model, but does affect the volume and peak flow evaluation.
6	July 23, 2012	3	• 3 events for calibration. • Volume within 45% and peak flow 25%. • Data is peaky due to location directly downstream of Corinthia PS. • Model is over predicting; however there is no contributing area and the upstream calibrations are good as is the downstream calibration at Site 8. • Shape and magnitude of response is consistent.
7	July 23, 2012	4	• 3 events for calibration. • Volume within 10% and peak flow 10%. • Event (e) does not match well as the monitored flow data appears to be off.
8	July 23, 2012	4	• 3 events for calibration. • Volume within 25% and peak flow 15%. • Event (b) does not have good monitored flow data and the model over estimates the flow - there is no response from the observed data for this event. • Has a similar RTK value to 3 and 13 which is expected due to similar age and location within Leduc.

Table 5.4 Calibration Observations

Site	Primary Calibration Event	Overall Calibration Quality (1)	Comments
9	August 21, 2012	3	• 3 events for calibration. • Volume within 20% and peak flow 15%. • Data quality issues at this location. • Note that the end node was modelled as a storage unit due to modelling flooding issues while loading the system - this has been sized at 18.1 x 5.5 to represent approximately 3250 m of pipe which would essentially act as storage upstream of the system. • The RTK values for this site are high (15%), this is not unexpected as seen in the WWF analysis where the Cv values ranged from ~7-16%.
10	July 3, 2012	4	• 2 events for calibration. • Volume within 15% and peak flow 15%. • Event (a) peak flow was not a good match. • Industrial area land use.
11	July 23, 2012	1	• 3 events for calibration. • Volume within 15% and peak flow 40%. • Data quality is generally poor. • RTK values are less than 1%, which is low even considering the area is newer. • But downstream at Site 12 - calibration results are good.
12	July 23, 2012	5	• 3 events for calibration. • Volume within 10% and peak flow 10%. • Event (f) peak flow over estimated, but very good calibration for events (c) and (d).
13	August 14, 2012	1	• 2 events for calibration. • Volume within 25% and peak flow 25%. • Poor flow monitoring data at this locations.
14	July 23, 2012	4	• 3 events for calibration. • Volume within 20% and peak flow 40%. • Model matches very well for event (d) and underestimates (c) and over estimates (f). • There are periods of poor flow data where flow drops out. • RTK values within reason and similar to Site 12.

Note:
1. 1-Poor
   5-Excellent

Table 5.5 Wet Weather Flow Analysis Summary

RTK Id	Short-Term			Medium-Term			Long-Term		
	R_1	T_1	K_1	R_2	T_2	K_2	R_3	T_3	K_3
WWF1	0.0008	0.070	4.50	0.0035	0.200	2.00	0.0020	0.300	1.00
WWF2	0.0083	0.070	4.50	0.0049	0.380	5.00	0.0030	1.500	2.00
WWF3	0.0275	0.100	1.00	0.0100	2.000	3.00	0.0100	4.000	6.00
WWF5	0.0035	0.005	5.00	0.0015	0.100	10.00	0.0500	0.500	75.00
WWF7	0.0090	0.750	0.10	0.0100	1.000	2.00	0.0280	3.000	11.00
WWF8	0.0175	0.100	1.00	0.0025	2.000	2.00	0.0025	4.000	4.00
WWF9	0.1050	0.050	1.00	0.0200	1.000	2.00	0.0250	3.000	3.00
WWF10	0.0150	0.010	2.00	0.0025	1.000	10.00	0.0000	0.000	0.00
WWF11	0.0015	1.100	1.00	0.0015	3.000	1.00	0.0025	3.000	1.00
WWF12	0.0235	0.030	15.00	0.0250	0.480	10.00	0.0200	4.000	10.00
WWF13	0.0275	0.100	1.00	0.0100	2.000	3.00	0.0100	4.000	6.00
WWF14	0.0020	0.010	1.00	0.0100	1.000	1.00	0.0075	2.000	1.75

5.5 Model Scenario Datasets

The sanitary system model is set up for a number of scenarios for system evaluation and planning. The model has been prepared for system planning and is not suitable for detailed design at the local level. The following briefly describes the model datasets developed and used.

Existing System Model:

The existing system model represents the 2012 wastewater system. The dry weather flow is based on measured flows characterized in the model. The existing system model is used to evaluate system capacity under dry weather flow conditions characterized with diurnal flow. Wet weather capacity assessments apply a design storm event such as the 2, 5, and 25-year design storms. Although sanitary sewers are not designed with a design storm return period, applying such storms are used to evaluate system capacity recognizing there is an inflow and infiltration contribution.

Design Model:

The design model is similar to the existing model with respect to the physical network. However, all flows are generated using the City of Leduc design standards for sanitary systems. The population and service area are used to generate peak design flows. Wet weather is represented as an inflow and infiltration allowance.

Growth Model:

There are two types of growth models. The first is based on the design model where new growth is added using design values to define flow.

The second growth model is based on the existing system model where actual flows are used. Dry and wet weather and design flows are used to define future growth flows.

ACWRC LOS Model:

There are two ACWRC models. The first model is similar to the design model, but uses the ACWRC LOS design standards to generate flows. A second ACWRC model is based on the existing system model and applies a 25-year, 24 hour wet weather events. The modelling results are compared against the each other to define the LOS and needs in the ACWRC system.

5.6 Summary

The sanitary collection system model for the City is updated and represents 2012 conditions. The model has been set up for a number of modelling conditions required to evaluate service capacity and support future growth. The calibrated model was adjusted to recognize network changes made to represent the system configuration at the time flow data was collected.

The current model does not include all local pipes and is a planning level model. Using the model for detail design requires additional detail be added to the model and further flow monitoring be undertaken in any area of interest. The system planning model does provide a basis for more detailed modelling and system analysis.

The model is limited to the quality and amount of flow monitoring data collected. The wet weather calibration is also limited by the magnitude of wet weather events observed and used during model calibration.

6. *SANITARY SYSTEM CAPACITY ASSESSMENT*

This section provides an assessment of the existing wastewater collection system serving the City. The capacity assessment is undertaken using an updated and calibrated hydrologic/hydraulic model of the main sanitary collection systems. A range of flow scenarios are included in the capacity assessment including future growth flows.

This section contains a number of Figures which are located at the end of the section for convenience.

6.1 *Sanitary System Capacity Criteria*

To assess if a sanitary system has sufficient capacity, the following criteria have been used.

For existing systems, the capacity assessment is focused more on the protection of existing customers and to protect against sanitary sewer backup. To assess the risk of sanitary sewer backup, the criteria used is based on the maximum hydraulic grade line (HGL). If the maximum HGL in a sanitary sewer is within 2.0 m of the surface there is a risk of sanitary sewer backup. The assumption is the sanitary service lateral and floor drain is approximately 2.0 m below the ground (basement), therefore is prone to backup if the maximum HGL is within 2.0 m of the ground elevation. The criteria is used to assess the system capacity for actual dry and wet weather flow conditions.

Under design flow conditions, a sanitary sewer is considered overcapacity if the pipe is greater than 86% full. This criterion is used as a guideline and may not be applied specifically to all pipes as minor changes in pipe slopes that are represented in the model may result in an exceedance when the system, as a whole, does provide sufficient capacity. It should be recognized that using a model will produce different results than traditional sanitary design sheets.

Thematic maps are used to illustrate capacity conditions under the various criteria associated with the different flow scenarios.

6.2 *2012 Baseline Assessment*

The baseline assessment uses the Existing system model representing current conditions. A dry weather capacity assessment, representing actual peak dry weather flow conditions, is followed by a wet weather capacity assessment that used a 2, 5 and 25-year design storm.

Appendix E includes a summary table of all conduits and manholes in the model and their %Capacity status for the various baseline capacity assessment scenarios. The table shows three levels %full, less than 50% (green), between 50% and 86% (yellow) and greater than 85% (red).

6.2.1 *Dry Weather Capacity Assessment*

Figure 6.1 shows the baseline capacity assessment for existing dry weather flow conditions. Figure 6.1 shows there are no capacity issues in the existing sanitary system and the system is operating at less than 50% full throughout. There are also no capacity issues in the ACWRC system.

6.2.2 Wet Weather Capacity Assessment

Figures 6.2, 6.3 and 6.4 show the percent full for the 2, 5 and 25-year design storm events using the existing dry weather flow characterization. The design storms are based on a 4-hour Chicago distribution.

In reviewing these figures the following is observed:

- West of Highway 2, the sanitary collection system in this area has sufficient capacity under the 2, 5 and 25-year design events. Inflow and infiltration in this area is less than other areas of the City. As a newer area, this is not an unexpected result. There is one location, flows into the Suntree PS, which are surcharged under the 25-year event. Otherwise, the system is largely less than 50% full, and the main sanitary sewer is 50% to 86% full. In this area the maximum HGL is greater than 2.0 m below the surface, representing a low risk of sewer backup.
- The older sections of the City, generally east of Highway 2, between 65th Avenue and Rollyview Road, showed capacity issues starting with the 2-year event and getting progressively worse for the 5 and 25-year events.
- The main sanitary sewer going north on Corinthia Drive becomes surcharged with a maximum HGL within 2 m of the surface for the 5 and 25-year design storm events. This indicates a higher risk for sanitary sewer backup.
- In the area of 50th Avenue to 57th Avenue, west of 50th Street, there is a greater risk of sewer backup for the 25-year event.
- The ACWRC sanitary trunk shows minor surcharging for the 5-year event. For 25-year event the top end (50th Avenue to 46a Street) is surcharged, and downstream of this the trunk sewer is greater than 86% full.
- South of Rollyview Road and Highway 2A these communities are generally less than 50% full with some minor surcharging for the 25-year event. The maximum HGL in these areas is greater than 2 m from the surface indicating a low risk of sewer backup.
- In the northeast industrial areas there the wet weather assessment shows some surcharge starting with the 5-year design event. The maximum HGL is greater than 2 m below the surface indicating a low risk of sewer backup.

6.2.3 Design Flow Capacity Assessment

For the design flow capacity assessment the actual measured flows and wet weather response is replaced with design standard flows generated using unit rates, peaking factors and inflow/infiltration allowances appropriate to the land use.

Figure 6.5 shows the capacity assessment results under design flow conditions for the existing development. Under design flow conditions the sanitary system in the City operates less than 50% full. There are some segments that are greater than 50% full, but no segment is greater than 86% full.

The ACWRC also operates well with all segment less than 86% full.

6.2.4 Baseline Capacity Assessment Summary

Figure 6.6 highlights where sanitary capacity problem were identified in the City. Capacity issues are identified in the older parts of the City where systems were constructed before 1980.

The following conclusions are made from the baseline sanitary sewer capacity assessment:

- The sanitary system operates well under existing dry weather conditions as well as under design flow conditions.
- Inflow and infiltration rates exceed the design allowance based on the flow monitoring data collected for peak I/I rates. As a consequence, under wet weather conditions there are capacity issues in the sanitary system.
- In the newer development areas the sanitary system has low inflow/infiltration rates and this is reflected in no capacity issues for the 2, 5 and 25-year design events.
- There is a risk of sanitary sewer backup in the older areas of the City. The risk increases for wet weather events greater than the 5-year design event.

Based on the baseline capacity assessment, a combination of system improvements (capacity) or I/I programs (source control) will be required to improve system capacity to reduce the risk of sewer backup in the existing system.

6.3 ACRWC LOS Capacity Assessment

The ACRWC has outlined a system planning process previously described in Section 3.5. For system planning, the Leduc sanitary system is modelled with existing dry weather flow and a 25-Year, 24-Hour distribution event (ACWRC Planning). A similar model is run using ACRWC design Level of Service (LOS) unit rates and flow generation procedures. Figure 6.7 and 6.8 show the capacity assessment for each flow scenario, respectively.

The peak flows at each ACRWC connection point are compared for the two scenarios to identify if ACRWC is providing an appropriate Level of Service (LOS). Figure 6.8 shows the connection points and Table 6.1 is a summary of connection points and peak flows for both models. Table 6.1 shows the ACRWC planning criteria peak flows in comparison to the ACWRC design peak flows at each location where the local City of Leduc system connects into the regional ACWRC system. The City of Leduc is contributing approximately 1.3 to 23 times more peak flow than the ACWRC LOS.

From a community perspective, the maximum flow from the City is approximately 1000 L/s under the 25-year design storm. Using ACWRC design standards, the peak flow is 770 L/s. Therefore, the City is contributing approximately 30% more flow to the ACWRC than defined by the LOS. At individual connection points the local contributions associated with the existing system with a 25-year, 24-hour event shows a significant discrepancy at the majority of connection points with the LOS of service criteria. The differences are the greatest where older areas of City of Leduc connect into the Regional system. The difference is largely associated with wet weather I/I contributions.

To address this discrepancy will require the City to reduce their I/I, provide system storage, and/or maintain very low I/I rates for new development areas. Most likely a combination of measures will be required to manage existing I/I to meets ACRWC's LOS.

Table 6.1 ACWRC LOS Assessment

ACWRC Manhole Ids	ACWRC Planning Criteria Existing System with 25-Year, 24-Hour Peak Flow (m^3/s)	ACWRC Design LOS Design Peak Flow (m^3/s)	Difference in Peak Flow at Connection Points to Regional System	Magnitude Greater Than LOS
1606 (NTS045)	0.078	0.005	0.073	15.6
1116 (NTS043A)	0.279	0.033	0.246	8.5
1601 (NTS035)	0.150	0.115	0.035	1.3
1595 (NTS031)	0.102	0.007	0.095	14.6
1588 (NTS024)	0.419	0.041	0.378	10.2
1585 (NTS018)	0.316	0.200	0.116	1.6
526 (NTS015)	0.068	0.004	0.064	17.0
1617 (NTS011)	0.180	0.021	0.159	8.6
1566 (NTS007)	0.387	0.017	0.370	22.8
1572 (NTS004)	0.005	0.000	0.005	0.0
1570 (NTS002)	0.255	0.082	0.173	3.1
1610 (NTS00)	0.830	0.219	0.611	3.8
ACWRC Outlet	0.999	0.770	0.229	1.3

Notes:
1. At NTS035 Edmonton International Airport flow is fixed at 107 L/s (0.107 m^3/s) for both simulations.

6.4 Future Growth Scenarios and Servicing

The City has identified growth for short, medium, long and ultimate planning horizons. In Section 4.2 the design flows were defined for the growth areas. A portion of the growth is within existing urban boundaries while the substantial proportion is outside the current urban boundary.

Previously, the City has considered servicing plans for the external areas as highlighted in the 2012 Municipal Development Plan. The basis for future servicing builds on the presented future sanitary sewer plans with a Westside and Eastside collector sewer and corresponding pump stations.

To evaluate future servicing capacity, design flows are used for both future and existing systems.

6.4.1 Future Capacity Assessment

Figures 6.9, 6.10, 6.11 and 6.12 present the hydraulic analysis for the short, medium, long and ultimate planning horizon design flow scenarios. Under each growth scenario, the necessary sanitary collector infrastructure is added. In reviewing the figures the following is observed:

- There is sufficient capacity in the existing system for the short to ultimate growth conditions within the existing urban boundaries.

- Growth outside the existing boundaries will require additional capacity in the ACWRC Region trunk within the medium planning horizon.
- The entire ACWRC Regional trunk capacity would need to be approximately doubled to support the long and ultimate planning horizons.
- The estimated ultimate firm capacity of a new Westside PS is approximately 505 L/s.
- The estimated ultimate firm capacity of the new Eastside PS is approximately 170 L/s assuming the most southeast area is conveyed to the top end of the ACWRC Regional trunk. If the southeast area is conveyed to Eastside sanitary trunk the Eastside PS ultimate firm capacity increases to approximately 450 L/s.

It is evident through the future capacity assessment the current ACWRC Regional trunk will not provide sufficient capacity for the planned growth. The capacity of the Regional system will be exceeded within the medium planning horizon based on the planned growth.

Within the short term growth scenario there will be a need for a new Westside PS. A new Eastside PS is required within the medium term growth scenario.

Servicing strategies to support future growth are discussed in greater detail in Section 7.

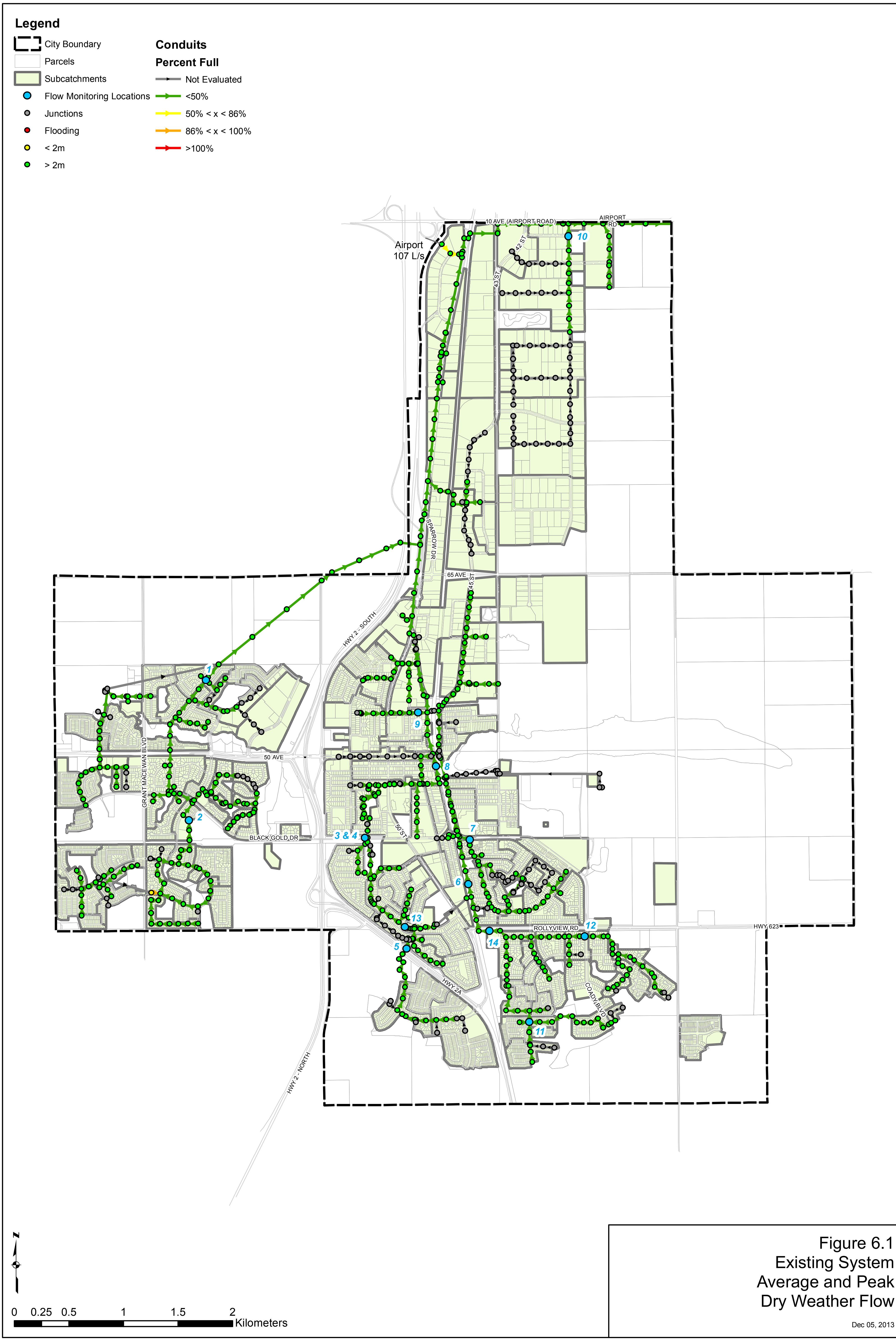

Figure 6.1
Existing System
Average and Peak
Dry Weather Flow

Figure 6.2
Existing System
2 Year 4 Hour
Chicago Storm

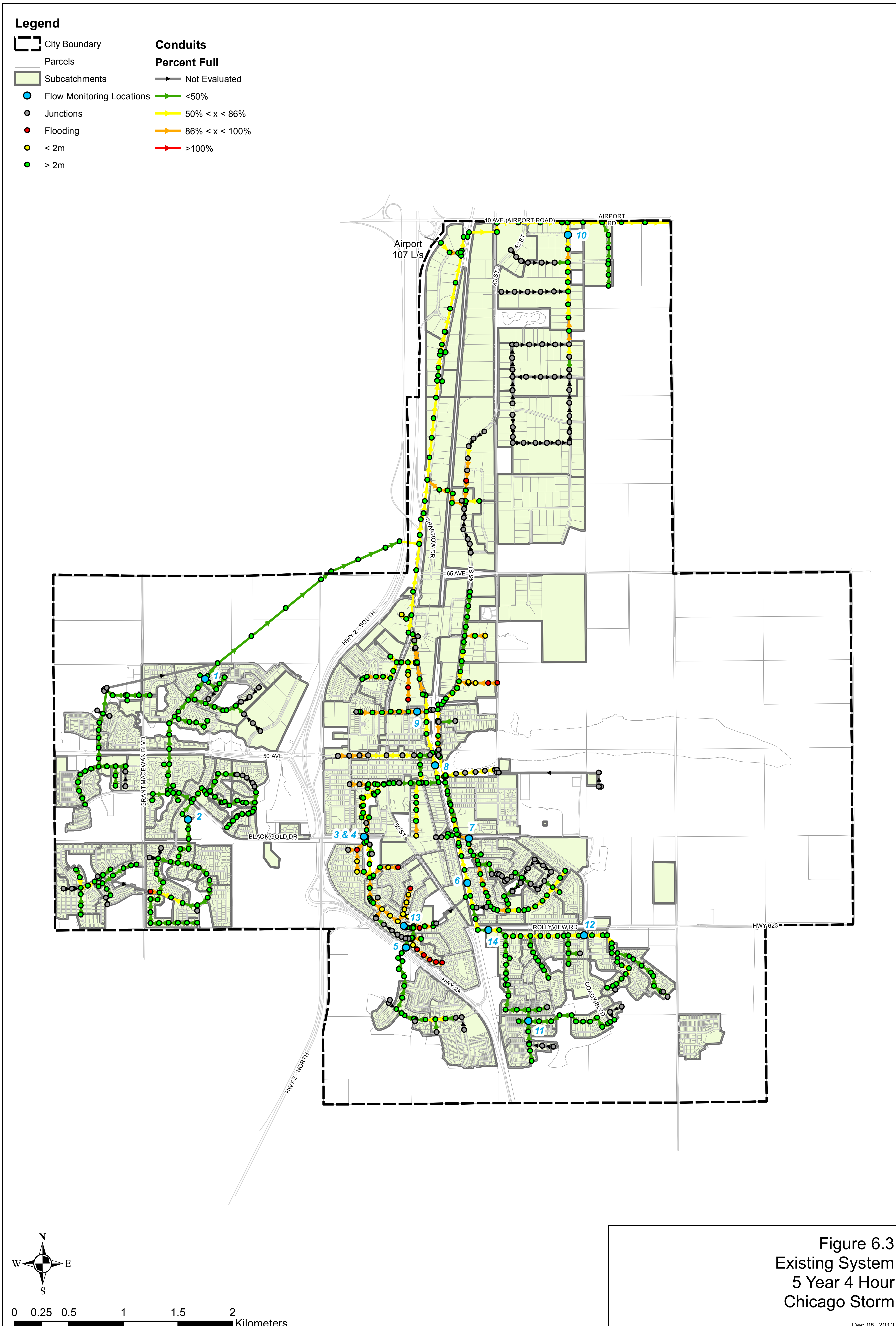

Figure 6.3
Existing System
5 Year 4 Hour
Chicago Storm

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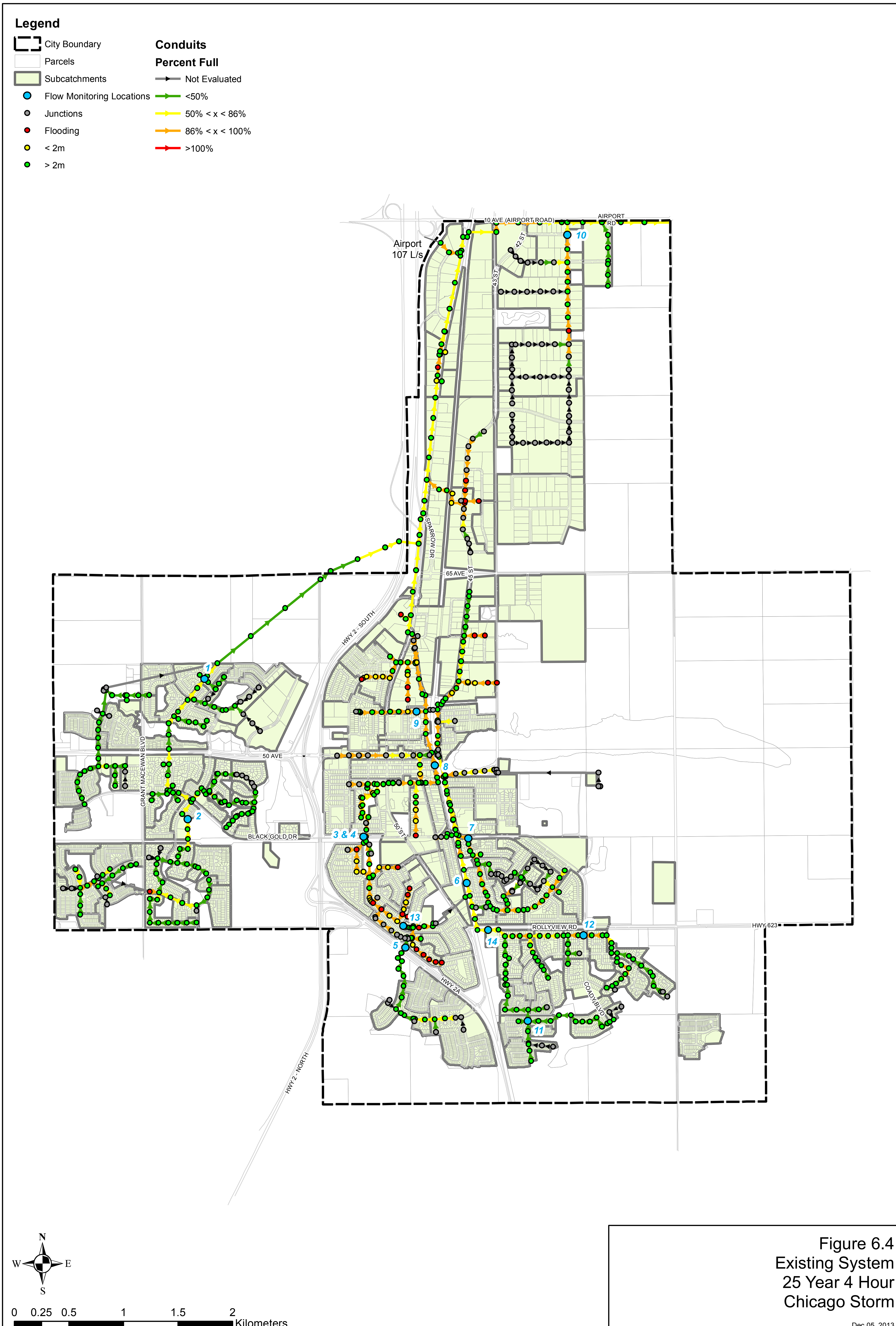

Figure 6.4
Existing System
25 Year 4 Hour
Chicago Storm

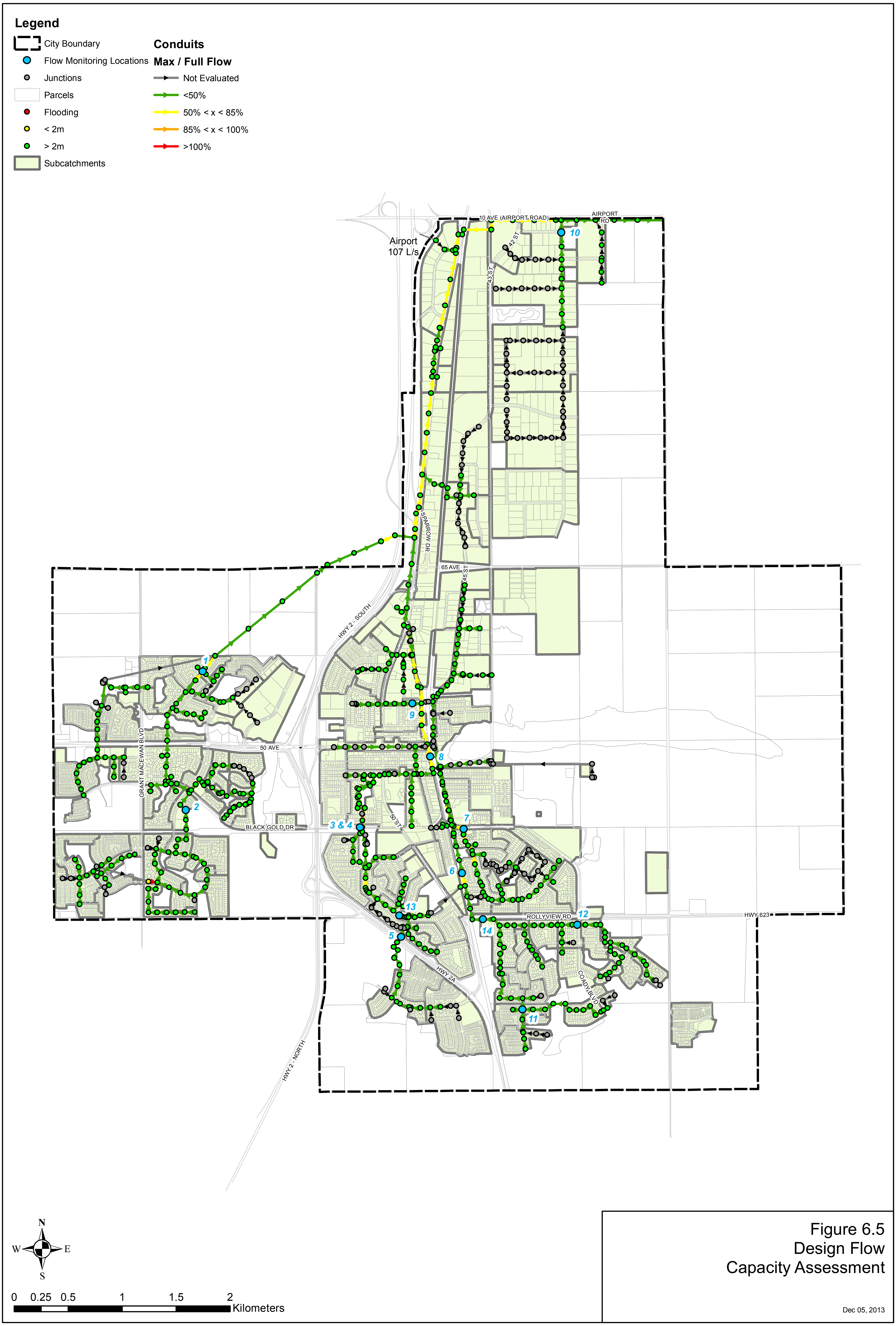

Figure 6.5
Design Flow
Capacity Assessment

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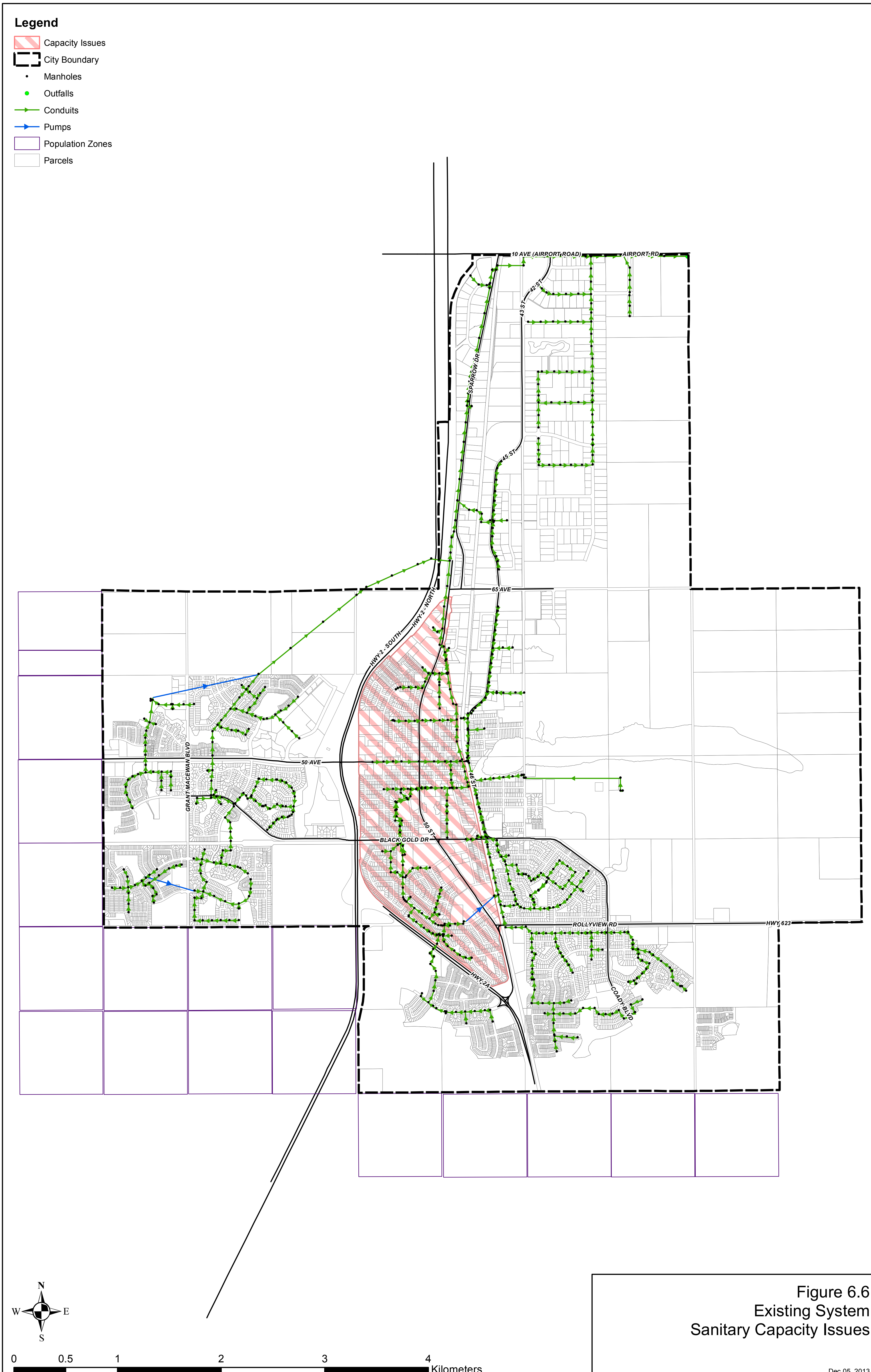

Figure 6.6
Existing System
Sanitary Capacity Issues

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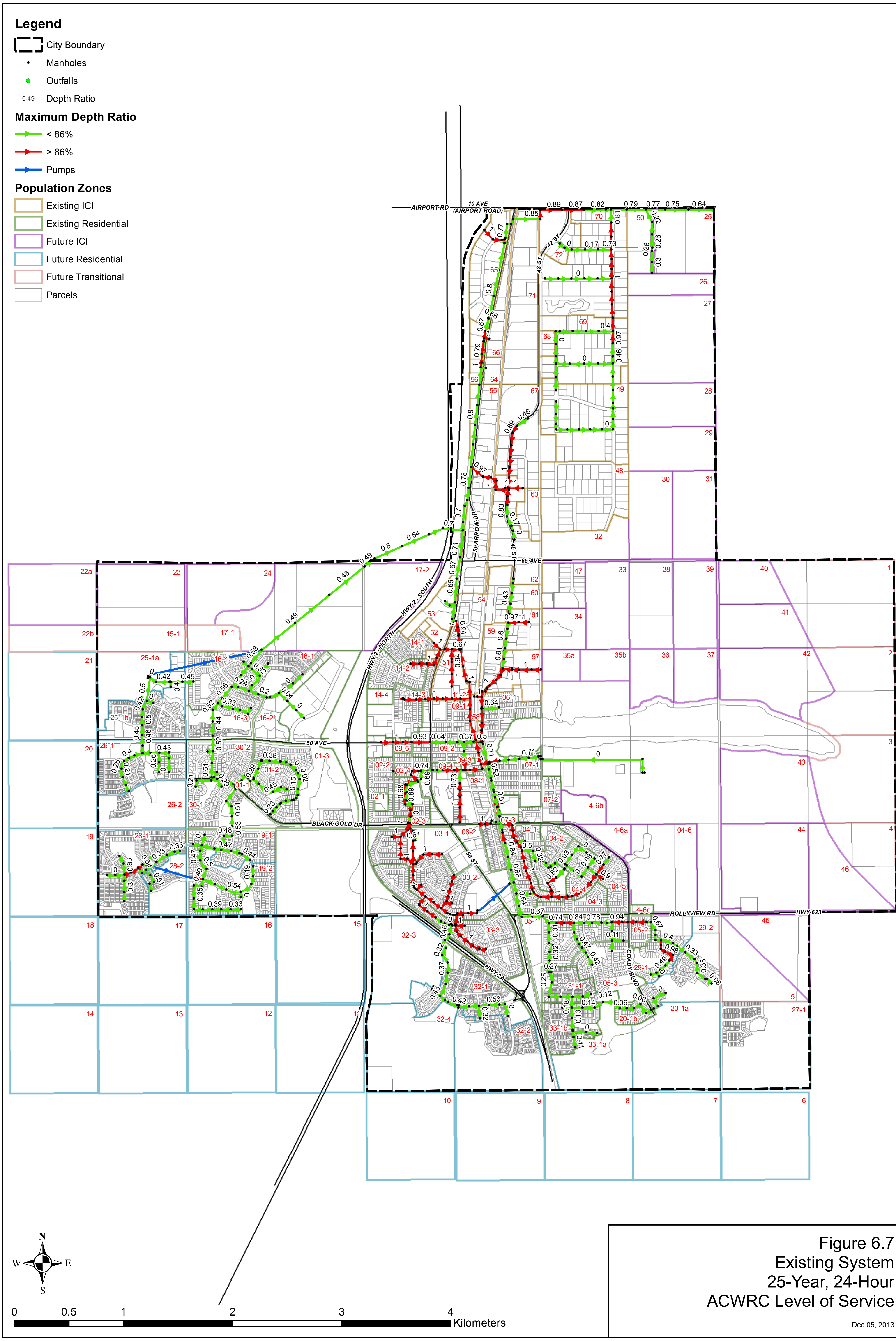

Figure 6.7
Existing System
25-Year, 24-Hour
ACWRC Level of Service

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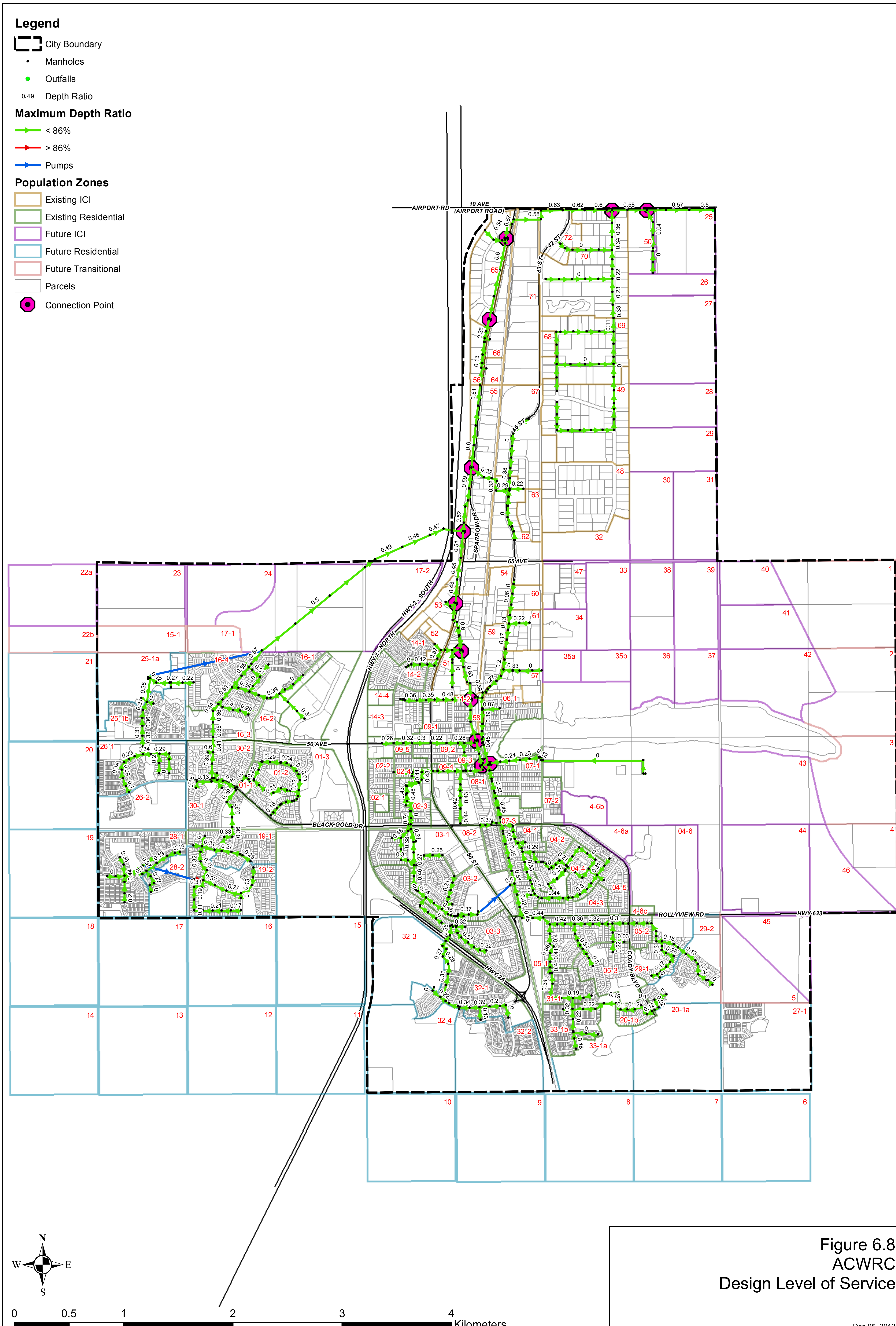


Figure 6.8
ACWRC
Design Level of Service

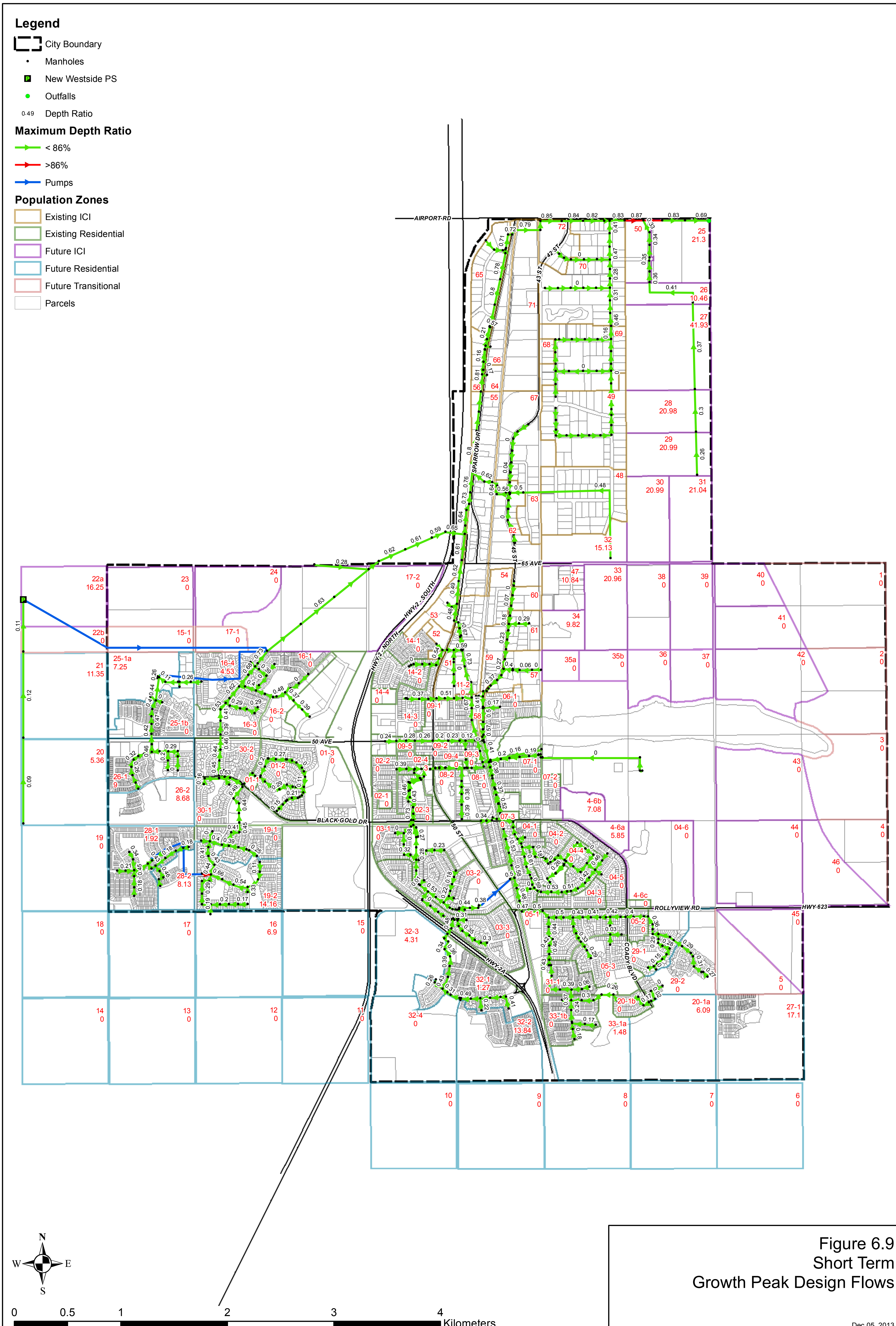


Figure 6.9
Short Term
Growth Peak Design Flows

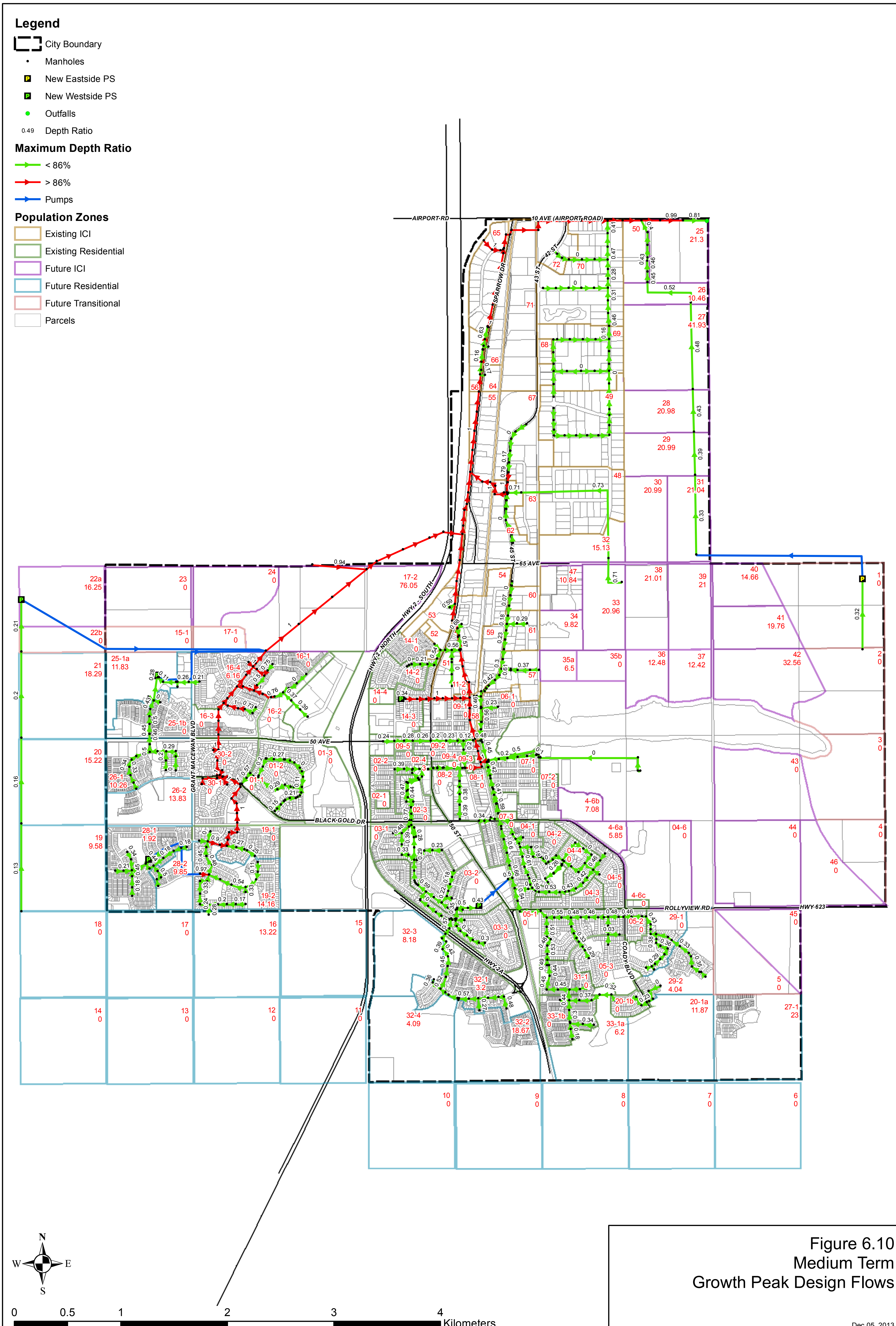


Figure 6.10
Medium Term
Growth Peak Design Flows

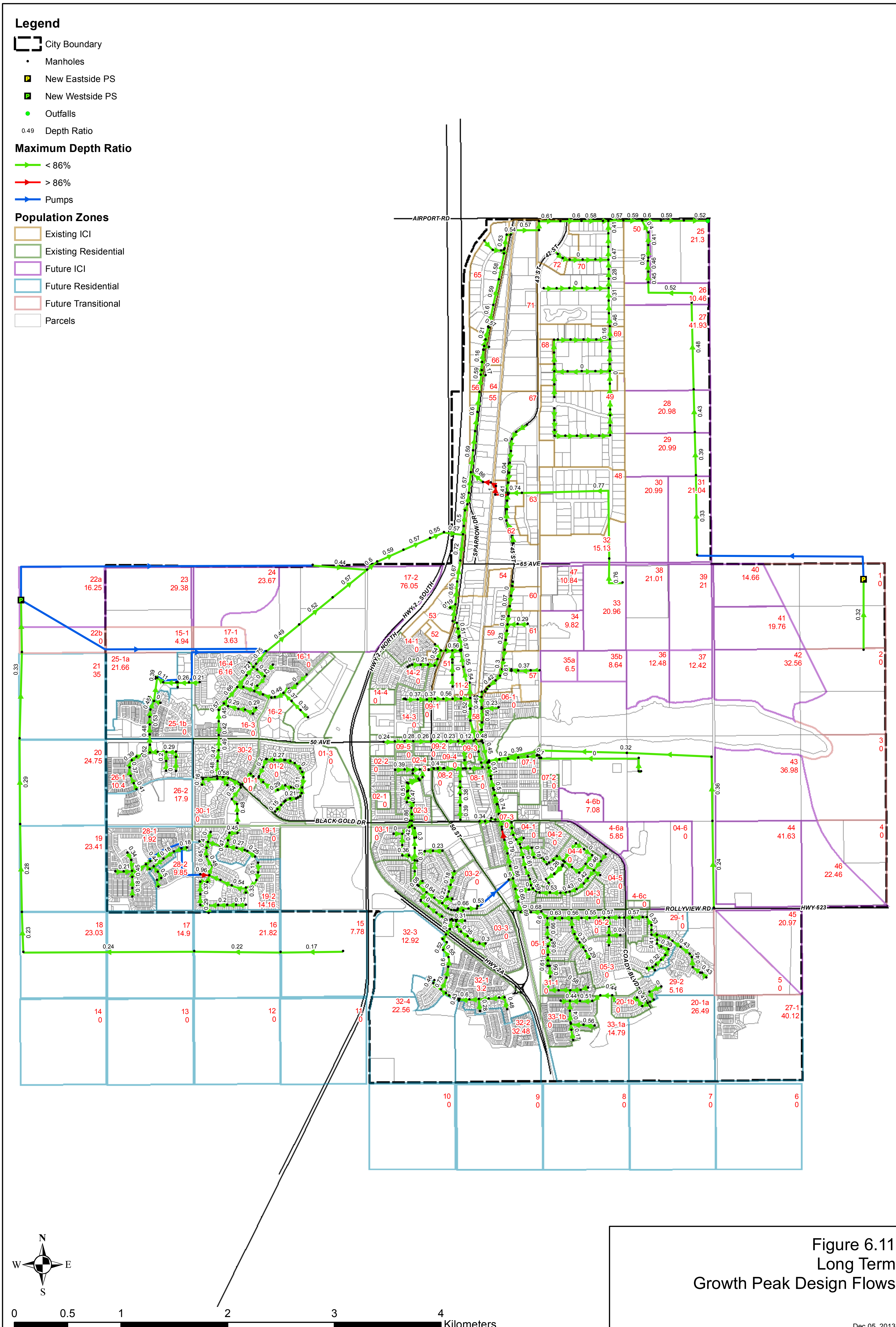


Figure 6.11
Long Term
Growth Peak Design Flows

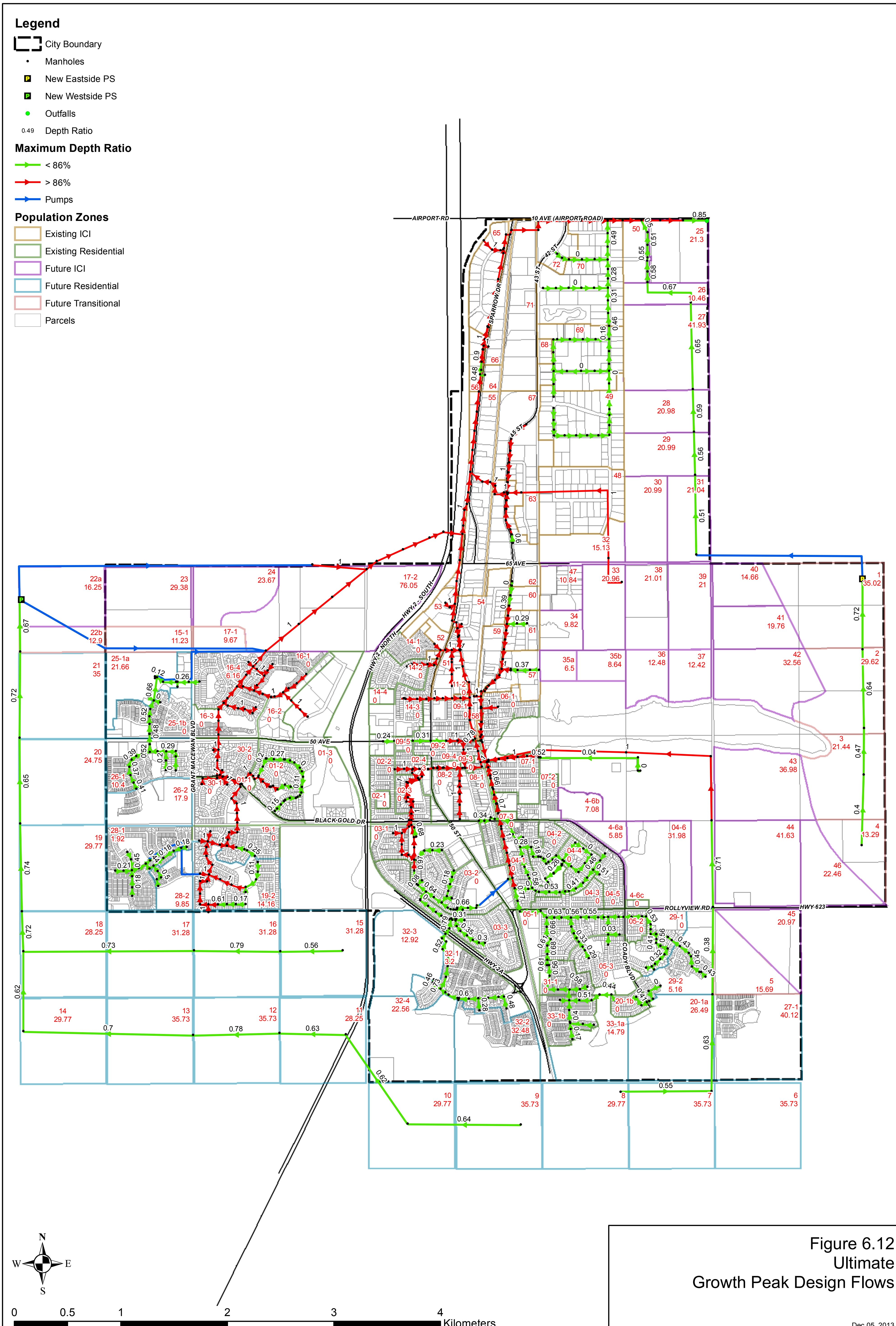


Figure 6.12
Ultimate
Growth Peak Design Flows

Dec 05, 2013

7. SANITARY SERVICING STRATEGY DEVELOPMENT

The following section identifies improvements to the existing sanitary system as well as future servicing needs. All Figures and Table associated with this section are located at the end of the section.

7.1 Existing System Improvements

7.1.1 Capacity Assessment

The capacity assessment showed no capacity issues under existing peak dry weather flow conditions or under design flow conditions. Capacity constraints were identified only under wet weather flow conditions.

Although capacity constraints were identified as surcharged pipes, not all constraints are considered critical. A critical capacity issue is associated with a condition where a pipe is surcharged and the maximum HGL is within 2.0 m of the surface. If a HGL is within 2.0 m there is a risk for sanitary sewer backup.

Within the context of sanitary servicing, the expectation is the sanitary system will provide sufficient capacity (no more than 86% pipe full) under actual dry weather flow conditions as well as design flow conditions. Under actual operating conditions, capacity expectation change to recognize the influence of wet weather on flows in a sanitary system. Under this condition, the capacity expectation is to minimize any surcharge and to control the maximum HGL to greater than 2.0 m below the ground surface.

The need for capacity improvements is therefore based on controlling the maximum HGL to greater than 2.0 m from the surface for the 25-year design storm event. The 25-year design storm event is based on a 4-hour Chicago distribution. Where there is surcharging and the maximum HGL is within 2.0 m of the surface system, improvements are considered. The system improvements are sized to accommodate the peak flow without surcharging.

7.1.2 Existing System Capacity Improvements

For the existing system and the 25-year design storm event, system capacity improvements are required east of Highway 2 in the older part of the City. Figure 7.1 identifies the modelled pipes that are surcharged with a maximum HGL within 2.0 m of the surface.

Two improvement scenarios were considered. The first relies solely on improving capacity by replacing existing sanitary sewers with larger diameter pipes. In total, there are 12 areas of improvements representing approximately 6.6 km of sanitary sewer replacement with larger diameter pipes.

The second improvement scenario looked at a combination of storage and flow diversions. For this alternative the flow from south of Bella Coola Drive and Corinthia Drive is directed entirely to the Corinthia PS. Under existing conditions the Corinthia PS is sufficiently sized to manage flow, but with any future development there will be a need to add storage at the pump station. Given there is active development in the South Forks area, storage of approximately 500 m^3 is required at the Corinthia PS. This volume would service existing and future needs. Pipe improvements on Corinthia Drive are still be necessary, but would be smaller diameter because of the diversion of South Fork flows. Other system improvements included optimizing the existing storage in Kinsmen Park by diverting all flow at Corinthia

Drive and Capri Road north. This diversion reduces the system improvements associated with Capri Street. For the remaining capacity issues the most effective solution still remains to be pipe replacement.

Table 7.1 summarizes capital level construction costs for the initial pipe replacement scenario. Table 1 itemizes each pipe identified for improvement. The estimated capital construction cost of improvement is $9,000,000.

Appendix G presents the unit costs used for capital cost estimates.

The infrastructure improvements will reduce the risk of sanitary sewer backup. Before proceeding with any improvements, it is recommended the City undertake further flow monitoring and expand the current system model to include more of the local systems. Flow monitoring is required to quantify I/I values associated with local systems and expanding the model to include more local infrastructure. Expanding the model network will reduce the possibility the capacity issues identified are modelling artifacts associated with concentrating the hydraulic load at one location versus spreading it out among a number of junctions. Both the flow monitoring and model expansion may lead to additional local improvements once a detailed assessment is completed of the contributing local systems.

7.1.3 I/I Programs

The capacity improvements are driven by rainfall derived I/I. Development and implementation of an I/I program can reduce the cost of capacity improvements. Addressing I/I sources, in particular more direct inflow sources, will reduce the scope of capacity improvements.

I/I is evident in sanitary systems in the older sections of the City as demonstrated through the flow monitoring wet weather flow analysis. To address I/I the challenge is to identify the sources of I/I and to determine if they can be cost effectively eliminated or controlled. I/I source identification involves a number of investigative techniques. The following techniques are typically employed:

1. **Flow Monitoring:** Flow monitoring can identify areas with high I/I. The best opportunities for I/I reduction are in areas with high I/I rates. Flow monitoring can be used to identify target locations for further investigations
2. **CCTV:** CCTV inspection provides information on the condition of a pipe. Pipes with cracks, poor joints, calcium buildup indicate I/I potential. An effective CCTV technique is to CCTV pipes lines during or shortly after a wet weather event. Inspecting a pipe during a wet weather event will identify I/I in service laterals and around joints.
3. **Smoke and Dye Test:** Smoke testing is an effective way to identify direct connections to the sanitary sewer. If roof leaders or catchbasins are connected to the sanitary sewer smoke will be observed confirming the connection. Dye testing can also be used to identify any cross connections between a storm and sanitary system.
4. **Manhole Inspections:** Manholes represent a potential I/I source typically around the top rings. Inspecting manholes provide information on the manhole condition and I/I as well as providing some indication of pipe condition.

I/I corrective actions will depend on the sources. The success of any I/I program will also depend on the sources and the willingness of each community to address both public and private side I/I. If the majority of I/I is found to come from service laterals the ability of a municipality to address this can be limited.

I/I reduction through pipe lining and rehabilitation, removal of cross connections, roof leader disconnection are effective in reducing the response to wet weather flow in a sanitary system.

Within the context of the City's sanitary servicing strategy it is recommended the City consider a pilot I/I program. The objective of the pilot program is to identify one or two candidate locations (i.e. service area contributing to flow monitoring Site 9, or in the Corinthia Drive service area) for more detailed investigations to identify the primary sources of I/I.

Once the sources of I/I are identified, then evaluate alternative I/I control measures and costs, and compare this to system capacity improvements.

7.1.4 Operations and Maintenance

As part of the servicing strategy there was identified some issues with deposition and debris build up in the existing sanitary system. In particular, this was evident in the vicinity of Capri Drive and Corinthia Drive. The build-up of deposits in the collection system can cause unexpected capacity constraints. More frequent inspection and sewer flushing is recommended in known problem locations and where there are flow control locations (diversions). This is in addition to existing routine sewer and manhole inspection and flushing programs.

7.2 Future Servicing Strategies

The following servicing strategies are presented to accommodate growth associated with approved plans and growth beyond the current urban boundary. Section 6.4 presented the future peak design flow capacity assessment for the short, medium, long and and ultimate planning horizons. The following analysis is based on City of Leduc design flow conditions for existing and future development.

The following section provides more detailed information on servicing growth flows and sequencing. Capital cost estimates are provided for the infrastructure needs for each servicing strategy. Unit costs information is based on unit capital cost sheet that recognizes sewer costs associated with new construction, replacements of existing systems and depth of the system all adjusted to limited local tender information. Appendix F present the thematic maps showing the hydraulic performance associated with each servicing strategy.

The future strategies identify necessary capacity improvements in the ACWRC system associated with City growth based on peak design flows. The future strategies do not include additional system requirements associated with managing City flow contribution into the ACWRC system based on ACRWC Planning LOS.

7.2.1 Short Term Servicing Strategy

Figure 7.2 shows the short term servicing strategy. This strategy is premised on new infrastructure to service growth beyond the current urban boundary. As well, this servicing strategy takes advantage of some excess sanitary system capacity in the Windrose development (southwest) to take in additional flow from the south.

The available capacity in the Windrose sanitary sewer can accommodate growth from the southern quarter panel up to and including the medium term flow projection of 21.8 L/s. Beyond this flow, the quarter section will need to be serviced to the west to the new Westside trunk and pump station. The Westside PS is initially to be sized to provide a firm capacity of 60 L/s, which will provide sufficient service capacity for growth beyond the medium term, but will need to be upgraded to meet the long term and ultimate flow conditions. The Westside PS would initially discharge through a 300 mm forcemain. A second forcemain (525 mm) will be required when the station is upgraded.

Table 7.2 lists the infrastructure requirements and estimated capital costs.

7.2.2 Medium Term Servicing Strategy

Figure 7.3 shows the medium term servicing strategy. This strategy is premised on the expansion of new infrastructure to service growth beyond the current urban boundary. This servicing strategy takes advantage of excess sanitary system capacity in the Windrose development (southwest) to take in 21.8 L/s. Beyond this flow, the quarter section will need to be serviced to the west to the new Westside trunk and pump station. The Eastside PS is required within the medium term growth horizon. The Eastside PS is sized with a firm capacity of 70 L/s which is sufficient for the long term needs, but will need to be upgraded for ultimate flow conditions. The Eastside PS forcemain is 300 mm.

As observed in Figure 6.10, the ACWRC trunk does not have sufficient capacity to service the medium term growth flows and results in the Regional trunk backwatering local networks. To address this condition the Regional trunk capacity would need to be increased to accommodate the planned growth. The Region trunk capacity would effectively need to be doubled to service the medium term growth, which would service the ultimate capacity needs design flow condition.

Within the medium term growth horizon, the northern portion of the Regional trunk from 65th Avenue north would require improvement. The current diameter is 1050 mm and this pipe would need to upgrade to a 1500 mm diameter pipe to serve design growth flows up tothe ultimate conditions. Alternatively, a twin pipe could be used to provide the additional capacity.

This assessment does not extend beyond the City of Leduc and downstream SERTS improvements.

Table 7.3 lists the infrastructure requirements and estimated capital costs. The infrastructure needs and costs are based on replacing existing infrastructure versus twinning.

7.2.3 Long Term Servicing Strategy

Figure 7.4 shows the long term servicing strategy. The long term servicing strategy builds on the medium term infrastructure expanding to the growth areas outside of the current urban boundary. Within the long term planning horizon the sanitary flows generated in the current urban boundary reach their peak contribution.

Expansion of the existing West PS to a firm capacity of 198 L/s will be required. As well, the new Westside PS will require expansion to 505 L/s and the installation of a second 525 mm forcemain. The proposed alignment of the second forcemain is north to 65th Avenue then heading east to the sanitary collector system.

The Region trunk capacity south of 65th Avenue to the start of the Regional trunk at 50th Avenue would effectively need to be doubled to service the long term design growth flows also supporting the ultimate capacity condition. The current diameter is 750 mm and this pipe would need to be upgrade to a 1050 mm diameter pipe to support both long term and ultimate design flow conditions. This is in addition to the capacity expansion for the northern part of the Regional trunk required to meet the medium term growth flows.

Table 7.4 lists the infrastructure requirements and estimated costs. The infrastructure needs and costs are based on replacing existing infrastructure versus twinning.

7.2.4 Ultimate Servicing Strategy

Figure 7.5 shows the ultimate servicing strategy. The ultimate servicing strategy builds on the long term infrastructure needs expanding to the growth areas outside of the current urban boundary.

Under ultimate conditions the Eastside PS will require expansion to a firm capacity of 170 L/s. The previous expansion of the Regional Trunk provides sufficient capacity for the ultimate condition.

Table 7.5 lists the infrastructure requirements and estimated costs. The infrastructure needs and costs are based on replacing existing infrastructure versus twinning.

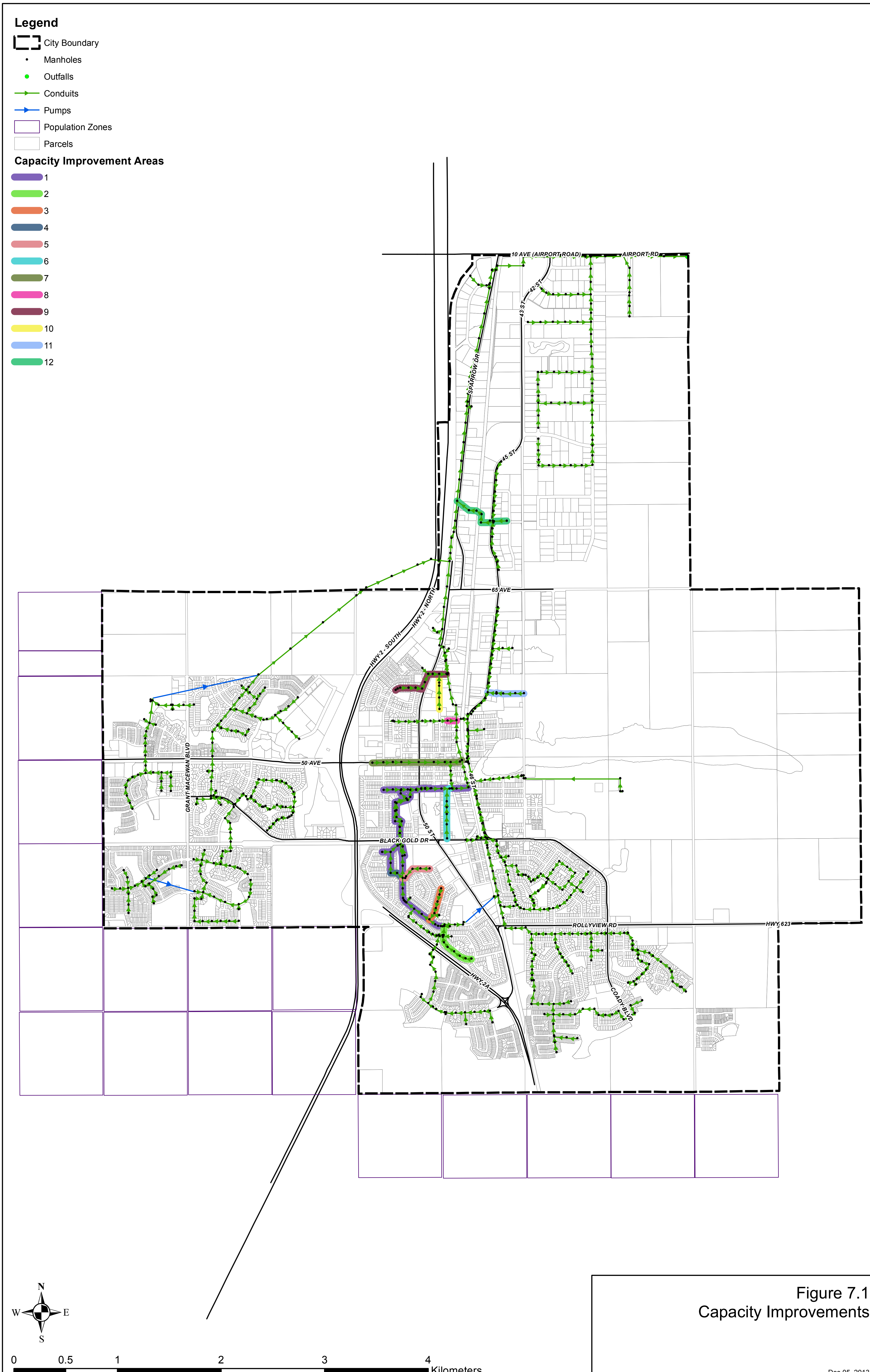


Figure 7.1
Capacity Improvements

Dec 05, 2013

Table 7.1 Estimated Planning Level Capital Cost of Improvements

Index	Name	Inlet Node	Outlet Node	Up Asset Id	Dwn Asset Id	Tag	Sub-sections	Dia. (mm)	Avg. Depth (m)	Length (m)	Unit Cost in Road - $	Total Cost per Section $
1	COR001	COR001	LIN001	1281	90	imp-1	1	450	8.92	76.2	1,481	112,852
2	COR004	COR004	COR003	302	1284	imp-1	2	250	8.51	89.9	1,135	102,059
3	COR008A	COR008	COR035	99	83	imp-1	3	450	7.39	121.9	1,481	180,564
4	COR009	COR009	COR008	100	99	imp-1	4	450	7.37	74.7	1,481	110,601
5	COR010	COR010	COR009	101	100	imp-1	5	450	7.16	91.4	1,481	135,423
6	COR011	COR011	COR010	102	101	imp-1	6	450	6.95	21.3	1,481	31,605
7	COR012	COR012	COR011	103	102	imp-1	7	450	6.76	17.4	1,481	25,725
8	COR013	COR012	COR013	103	338	imp-1	8	450	6.64	19.8	1,481	29,339
9	COR014	COR014	COR013	419	338	imp-1	9	450	6.65	96.0	1,481	142,191
10	COR015	COR015	COR014	358	419	imp-1	10	450	6.78	93.0	1,481	137,674
11	COR016	COR016	COR015	384	358	imp-1	11	450	6.54	90.2	1,481	133,616
12	COR017	COR017	COR016	357	384	imp-1	12	450	6.40	70.1	1,481	103,818
13	COR018	COR018	COR017	359	357	imp-1	13	450	6.47	29.0	1,481	42,890
14	COR019	COR019	COR018	549	359	imp-1	14	450	6.62	29.0	1,481	42,890
15	COR019A	COR019A	COR019	676	549	imp-1	15	450	6.51	15.2	1,481	22,570
16	COR032	COR033	COR001	1283	1281	imp-1	16	450	9.11	43.9	1,481	64,986
17	COR034	COR034	COR033	84	1283	imp-1	17	450	10.53	121.9	1,481	180,564
18	COR035	COR035	COR034	83	84	imp-1	18	450	8.63	94.5	1,481	139,940
19	COR060	COR060	COR019A	1100	676	imp-1	19	450	6.64	8.5	1,481	12,589
20	LIN001	LIN001	LIN002	90	91	imp-1	20	450	7.74	61.3	1,481	90,726
21	LIN002	LIN002	LIN003	91	1287	imp-1	21	450	7.64	61.0	1,481	90,282
22	LIN003	LIN003	LIN004	1287	95	imp-1	22	450	7.75	67.1	1,481	99,316
23	LIN004	LIN004	LIN005	95	86	imp-1	23	450	7.42	99.1	1,481	146,708
24	LIN005	LIN005	LIN006	86	96	imp-1	24	450	7.16	82.3	1,481	121,886
25	LIN006	LIN006	LIN007	96	337	imp-1	25	450	7.03	115.8	1,481	171,529

Table 7.1 Estimated Planning Level Capital Cost of Improvements

Index	Name	Inlet Node	Outlet Node	Up Asset Id	Dwn Asset Id	Tag	Sub-sections	Dia. (mm)	Avg. Depth (m)	Length (m)	Unit Cost in Road - $	Total Cost per Section $
26	LIN007	LIN007	LIN008	337	65	imp-1	26	450	7.13	73.2	1,481	108,335
27	LIN008	LIN008	LIN009	65	XX-LIN009	imp-1	27	450	7.38	30.5	1,481	45,141
28	LIN009	LIN009	LIN010	XX-LIN009	97	imp-1	28	450	7.73	10.7	1,481	15,802
29	LIN010	LIN010	LIN013	97	1660	imp-1	29	450	7.80	89.6	1,481	132,712
30	LIN013	LIN013	LIN014	1660	1659	imp-1	30	450	7.72	52.4	1,481	77,649
31	LIN014	LIN014	LIN015	1659	353	imp-1	31	450	8.09	54.9	1,481	81,248
32	LIN015	LIN015	LIN016	353	355	imp-1	32	450	7.85	85.3	1,481	126,389
33	LIN016	LIN016	CBD007	355	342	imp-1	33	450	7.78	10.3	1,481	15,254
34	C31	506	MH17	506	507	imp-2	1	350	7.23	60.7	1,261	76,483
35	C33	508	COR030	508	541	imp-2	2	350	6.81	81.3	1,261	102,534
36	699	560	506	560	506	imp-2	3	350	7.04	57.2	1,261	72,070
37	C4	COR028	MH2	540	1150	imp-2	4	350	6.25	9.8	1,261	12,373
38	COR029	COR029	COR028	542	540	imp-2	5	350	6.50	58.2	1,261	73,415
39	COR030	COR030	COR029	541	542	imp-2	6	350	6.61	54.9	1,261	69,178
40	C32	MH17	508	507	508	imp-2	7	350	7.17	67.8	1,261	85,538
41	629	7	390	7	390	imp-3	1	350	5.47	71.5	1,177	84,184
42	625	382	COR027	382	383	imp-3	2	350	6.14	48.6	1,261	61,240
43	627	390	382	390	382	imp-3	3	350	6.15	64.6	1,261	81,419
44	85	522	7	522	7	imp-3	4	350	4.43	60.5	1,082	65,438
45	COR027	COR027	COR016	383	384	imp-3	5	350	6.26	80.8	1,261	101,851
46	COR008	COR008	COR007	99	300	imp-4	1	250	7.75	73.8	1,135	83,718
47	639	389	429	389	429	imp-5	1	350	5.46	89.9	1,177	105,849
48	324	429	COR024	429	422	imp-5	2	350	6.29	77.7	1,261	97,993
49	COR022	COR022	COR008	299	99	imp-5	3	350	7.42	22.6	1,261	28,448
50	COR023	COR023	COR022	339	299	imp-5	4	350	7.26	22.3	1,261	28,057

Table 7.1 Estimated Planning Level Capital Cost of Improvements

Index	Name	Inlet Node	Outlet Node	Up Asset Id	Dwn Asset Id	Tag	Sub-sections	Dia. (mm)	Avg. Depth (m)	Length (m)	Unit Cost in Road - $	Total Cost per Section $
51	COR024	COR024	COR023	422	339	imp-5	5	350	7.07	93.9	1,261	118,383
52	295	516	517	516	517	imp-6	1	350	6.16	63.4	1,261	79,911
53	294	517	518	517	518	imp-6	2	350	6.29	57.4	1,261	72,350
54	1725	518	CBD005	518	1634	imp-6	3	350	6.44	130.7	1,261	164,802
55	722	MH11	MH12	529	515	imp-6	4	350	8.99	253.4	1,261	319,481
56	C14	MH12	516	515	516	imp-6	5	350	6.86	100.0	1,261	126,100
57	249	24	304	24	304	imp-7	1	300	2.17	107.3	987	105,860
58	1333	61	424	61	424	imp-7	2	300	2.27	169.0	987	166,759
59	646	304	1093	304	1093	imp-7	3	300	2.68	90.6	987	89,448
60	91	363	531	363	531	imp-7	4	300	4.66	105.9	1,177	124,609
61	328	424	363	424	363	imp-7	5	300	2.14	145.4	987	143,523
62	737	531	530	531	530	imp-7	6	300	5.74	56.4	1,177	66,373
63	694	1093	61	1093	61	imp-7	7	300	3.27	81.2	1,082	87,909
64	WIP001	WIP001	NTS007	524	1566	imp-8	1	600	12.40	84.6	1,757	148,642
65	WIP002	WIP002	WIP001	1291	524	imp-8	2	600	11.79	79.3	1,757	139,330
66	533	80	82	80	82	imp-9	1	300	4.64	25.9	1,177	30,501
67	532	81	80	81	80	imp-9	2	300	4.31	24.6	1,082	26,567
68	139	82	403	82	403	imp-9	3	300	5.08	81.7	1,177	96,138
69	318	403	406	403	406	imp-9	4	300	5.68	66.8	1,177	78,577
70	1728	406	1661	406	1661	imp-9	5	300	5.74	65.1	1,177	76,598
71	1729	1661	WIP013	1661	1662	imp-9	6	300	6.29	69.8	1,261	88,063
72	WIP011	WIP011	WIP009	1663	1296	imp-9	7	300	8.62	18.3	1,261	23,064
73	WIP012	WIP012	WIP011	1664	1663	imp-9	8	300	9.06	89.6	1,261	112,998
74	WIP013	WIP013	WIP012	1662	1664	imp-9	9	300	7.93	86.9	1,261	109,543
75	WIP006	WIP006	WIP005	1294	1295	imp-10	1	300	7.28	121.5	1,261	153,212

Table 7.1 Estimated Planning Level Capital Cost of Improvements

Index	Name	Inlet Node	Outlet Node	Up Asset Id	Dwn Asset Id	Tag	Sub-sections	Dia. (mm)	Avg. Depth (m)	Length (m)	Unit Cost in Road - $	Total Cost per Section $
76	WIP007	WIP007	WIP006	1293	1294	imp-10	2	300	6.63	122.0	1,261	153,842
77	WIP008	WIP008	WIP007	1292	1293	imp-10	3	300	6.20	77.5	1,261	97,728
78	1858	1696	EIP019	1696	1694	imp-11	1	350	4.99	10.5	1,177	12,382
79	1840	1698	1699	1698	1699	imp-11	2	350	6.32	83.7	1,261	105,539
80	1839	1699	1700	1699	1700	imp-11	3	350	5.41	117.6	1,177	138,361
81	1843	1700	1696	1700	1696	imp-11	4	350	5.37	65.0	1,177	76,514
82	EIP019	EIP019	EIP008	1694	590	imp-11	5	350	5.45	86.0	1,177	101,163
83	416	610	NEI008	610	611	imp-12	1	450	7.99	91.5	1,481	135,566
84	NEI001	NEI001	NEI015	614	1270	imp-12	2	450	10.16	9.5	1,481	14,070
85	NEI008	NEI008	NEI001	611	614	imp-12	3	450	9.14	93.9	1,481	139,036
86	NEI010	NEI010	NTS024	1265	1588	imp-12	4	600	11.10	121.2	1,757	212,878
87	NEI011	NEI011	NEI010	1266	1265	imp-12	5	600	11.18	71.3	1,757	125,344
88	NEI012	NEI012	NEI011	1267	1266	imp-12	6	600	11.19	58.6	1,757	102,925
89	NEI013	NEI013	NEI012	1268	1267	imp-12	7	600	11.33	83.4	1,757	146,534
90	NEI014	NEI014	NEI013	1269	1268	imp-12	8	600	11.81	121.4	1,757	213,265
91	NEI015	NEI015	NEI014	1270	1269	imp-12	9	600	11.16	16.1	1,757	28,323
										6597		8,900,000

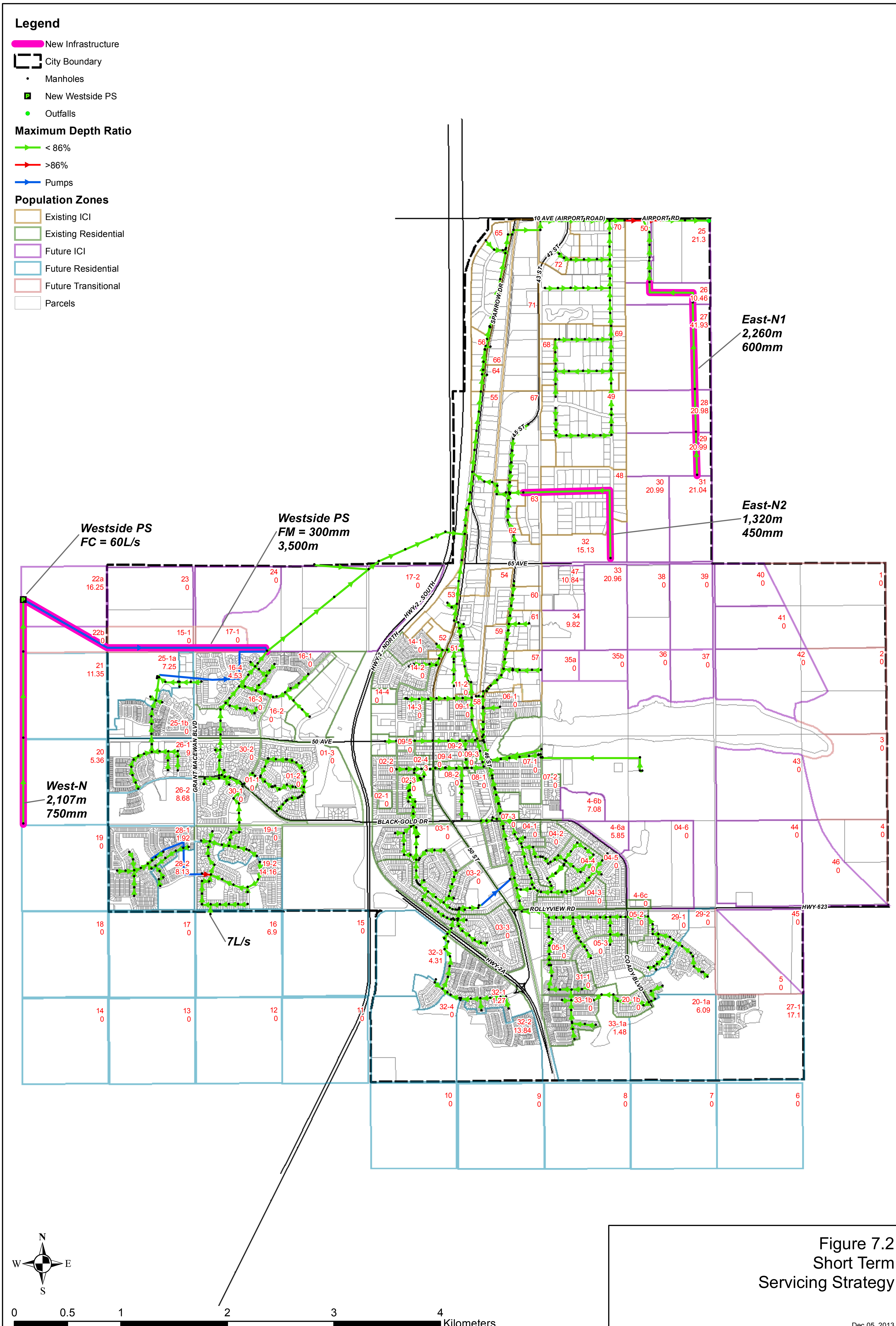


Figure 7.2
Short Term
Servicing Strategy

Dec 05, 2013

Table 7.2 Short Term Infrastructure Needs

	Conduit Id	Up	Down	Length (m)	Dia (mm)	Slope (m/m)	Max Flow (m^3/s)	Max Velocity (m/s)	Average Depth (m)	Unit Cost for New $	Capital Cost $
WESTSIDE											
West-N1											
	C50	SW-MH27	SW-MH28	802.8	750	0.0030	0.436	1.44	7	1,443	1,158,440
	C51	SW-MH28	SW-MH29	810.0	750	0.0029	0.471	1.39	7	1,443	1,168,787
	C52	SW-MH29	SW-PS1	494.6	750	0.0028	0.5	1.58	6	1,443	713,722
EASTSIDE											
East-N1											
	C54	E-MH20	E-MH19	430.0	600	0.0035	0.208	1.28	4	1,085	466,550
	C55	E-MH19	E-MH18	430.0	600	0.0035	0.229	1.31	5	1,182	508,260
	C56	E-MH18	E-MH17	800.0	600	0.0035	0.25	1.29	8	1,268	1,014,400
	C57	E-MH17	1542	600.0	600	0.0035	0.292	1.44	8	1,268	760,800
East-N2											
	C59	E1-MH22	NEI016	1320.0	450	0.0030	0.146	1.02	8	1,077	1,421,640
PUMP STATIONS											
Westside PS		**Firm Capacity**			**Unit Cost ($/m)**						
		60	L/s								2,100,000
	FM-1	300	mm	3500	380.0						1,330,000
Short Term Horizon **TOTAL**											**10,643,000**

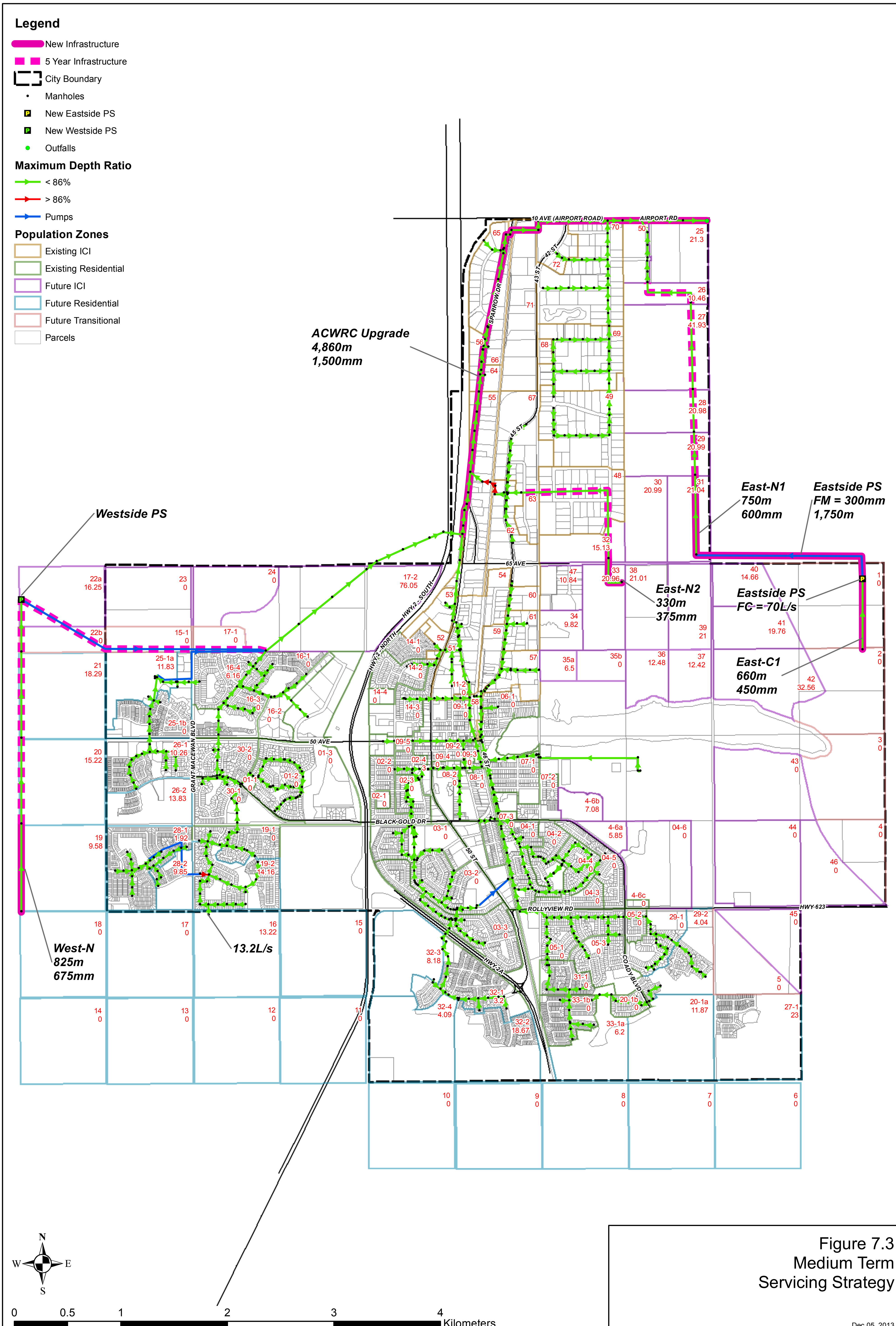


Figure 7.3
Medium Term
Servicing Strategy

Table 7.3 Medium Term Infrastructure Needs

	Conduit Id	Up	Down	Length (m)	Dia (mm)	Slope (m/m)	Max Flow (m3/s)	Max Velocity (m/s)	Average Depth (m)	Unit Cost for New - $	Capital Cost $
WESTSIDE											
West-N1											
	C49	SW-MH26	SW-MH27	824.4	675	0.0029	0.411	1.46	4	1,169	963,712
EASTSIDE											
East-N1											
	C53	E-MH21	E-MH20	750.0	600	0.0035	0.166	1.15	4	1,085	813,750
East-N2											
	C58	E1-MH23	E1-MH22	330.0	375	0.0030	0.076	0.81	5	926	305,580
East-C1											
	C63	E2-MH19	E2-PS	661.5	450	0.0048	0.132	1.35	6	1,077	712,446
ACWRC Upgrades											
	NTS018	NTS018	NTS020	100.0	1500	0.0010	1.754	1.46	8.5	1,911	191,100
	NTS020	NTS020	NTS021	121.0	1500	0.0011	1.754	1.49	8.5	1,911	231,231
	NTS021	NTS021	NTS022	50.0	1500	0.0010	1.754	1.43	8.5	1,911	95,550
	NTS022	NTS022	NTS023	122.0	1500	0.0010	1.754	1.34	8.5	1,911	233,142
	NTS023	NTS023	NTS024	197.0	1500	0.0010	1.754	1.3	8.5	1,911	376,467
	NTS024	NTS024	NTS025	204.0	1500	0.0010	1.974	1.42	8.5	1,911	389,825
	NTS025	NTS025	NTS026	185.0	1500	0.0010	1.974	1.42	8.5	1,911	353,535
	NTS026	NTS026	NTS027	185.0	1500	0.0010	1.974	1.42	8.5	1,911	353,535
	NTS027	NTS027	NTS028	184.8	1500	0.0010	2	1.43	8.5	1,911	353,134
	NTS028	NTS028	NTS029	200.0	1500	0.0010	2	1.44	8.5	1,911	382,200
	NTS029	NTS029	NTS030	196.0	1500	0.0010	2	1.44	8.5	1,911	374,556

Table 7.3 Medium Term Infrastructure Needs

	Conduit Id	Up	Down	Length (m)	Dia (mm)	Slope (m/m)	Max Flow (m3/s)	Max Velocity (m/s)	Average Depth (m)	Unit Cost for New - $	Capital Cost $
	NTS030	NTS030	NTS031	212.0	1500	0.0010	2	1.44	8.5	1,911	405,132
	NTS031	NTS031	NTS032	213.3	1500	0.0010	2.012	1.45	8.5	1,911	407,616
	NTS032	NTS032	NTS033	246.0	1500	0.0010	2.012	1.47	8.5	1,911	470,106
	NTS033	NTS033	NTS034	246.5	1500	0.0010	2.012	1.52	8.5	1,911	471,062
	NTS034	NTS034	NTS035	50.0	1500	0.0010	2.012	1.57	8.5	1,911	95,550
	NTS035	NTS035	NTS036	134.2	1500	0.0010	2.027	1.66	8.5	1,911	256,456
	NTS036	NTS036	NTS037	38.3	1500	0.0013	2.027	1.64	8.5	1,911	73,191
	NTS037	NTS037	NTS038	46.0	1500	0.0011	2.027	1.56	8.5	1,911	87,906
	NTS038	NTS038	NTS039	256.3	1500	0.0010	2.027	1.53	8.5	1,911	489,789
	NTS039	NTS039	NTS040	87.8	1500	0.0010	2.053	1.52	8.5	1,911	167,709
	NTS040	NTS040	NTS041	200.0	1500	0.0010	2.053	1.47	8.5	1,911	382,200
	NTS041	NTS041	NTS042	200.0	1500	0.0010	2.053	1.49	8.5	1,911	382,200
	NTS042	NTS042	NTS043	200.0	1500	0.0010	2.053	1.55	8.5	1,911	382,200
	NTS043	NTS043	NTS043A	50.0	1500	0.0014	2.053	1.59	8.5	1,911	95,550
	NTS043A	NTS043A	NTS044	142.2	1500	0.0014	2.115	1.61	8.5	1,911	271,763
	NTS044	NTS044	NTS045	175.0	1500	0.0014	2.115	1.54	8.5	1,911	334,425
	NTS045	NTS045	NTS046	175.0	1500	0.0014	2.442	1.76	8.5	1,911	334,425
	NTS046	NTS046	NTS047	214.4	1500	0.0015	2.442	1.83	8.5	1,911	409,776
	NTS047	NTS047	NTS048	224.4	1500	0.0017	2.442	2.14	8.5	1,911	428,886

Table 7.3 Medium Term Infrastructure Needs

	Conduit Id	Up	Down	Length (m)	Dia (mm)	Slope (m/m)	Max Flow (m3/s)	Max Velocity (m/s)	Average Depth (m)	Unit Cost for New - $	Capital Cost $
PUMP STATIONS											
Eastside PS		**Firm Capacity**			**Unit Cost ($/m)**						
		70	L/s								1,120,000
	FM-1	300	mm	1750	380.0						665,000
Medium Term Horizon TOTAL											**13,861,000**

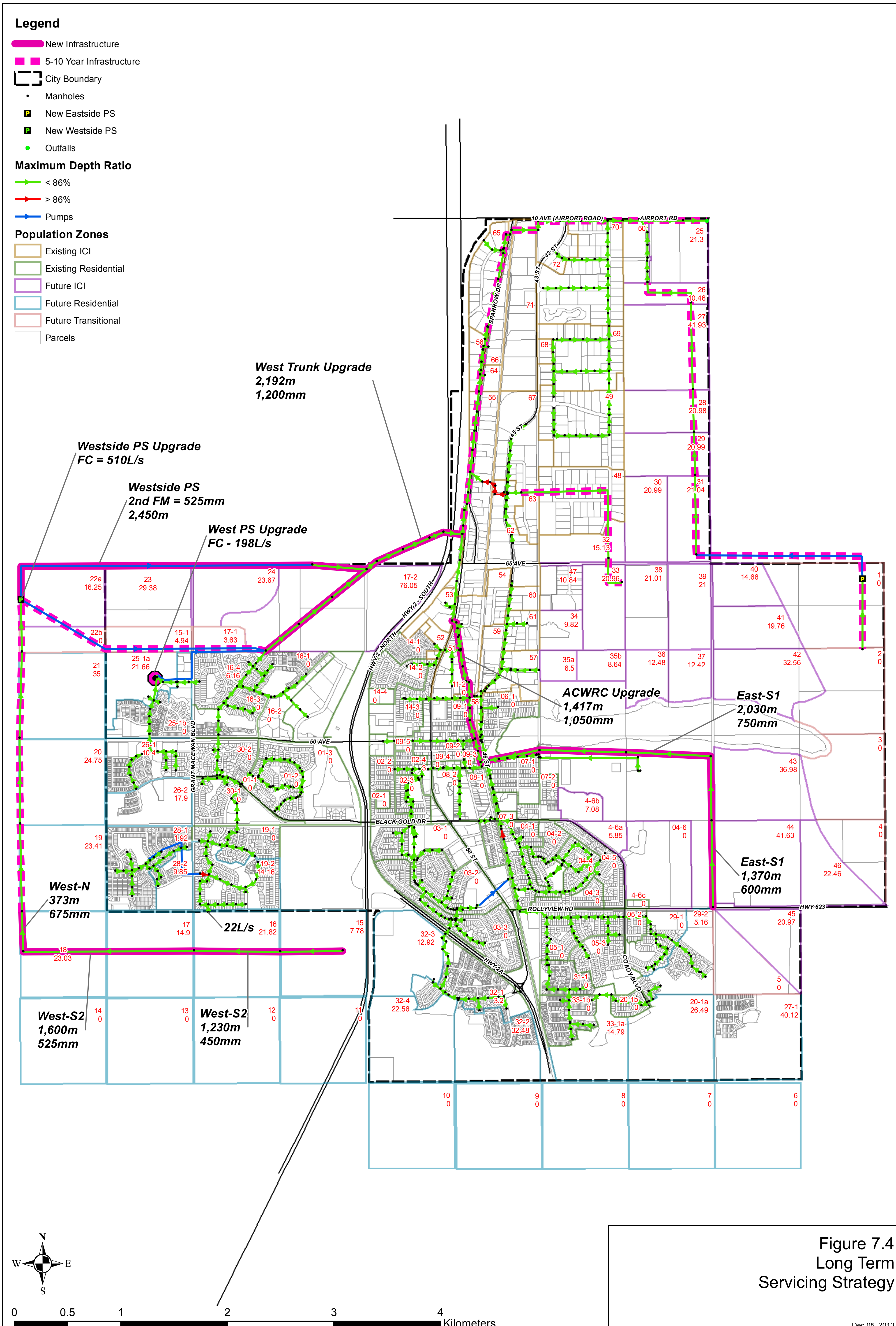


Figure 7.4
Long Term
Servicing Strategy

Table 7.4 Long Term Infrastructure Needs

	Conduit Id	Up	Down	Length (m)	Dia (mm)	Slope (m/m)	Max Flow (m^3/s)	Max Velocity (m/s)	Average Depth (m)	Unit Cost for New $	Capital Cost $
WESTSIDE											
West-S2											
	C38	SW-MH18	SW-MH19	430.0	450	0.0040	0.031	0.43	4	913	392,590
	C39	SW-MH19	SW-MH20	800.0	450	0.0040	0.126	1.18	8	1,077	861,600
	C40	SW-MH20	SW-MH21	1600.8	525	0.0028	0.158	0.94	4	1,003	1,605,602
Wset-N1											
	C41	SW-MH21	SW-MH26	373.0	675	0.0035	0.382	1.39	4	1,169	436,025
West Trunk Upgrade											
	WTS008	WTS008	WTS008A	400.0	1200	0.0005	0.426	0.77	9	1,911	764,400
	WTS008A	WTS008A	WTS008B	400.0	1200	0.0005	0.426	0.73	9	1,911	764,400
	WTS008B	WTS008B	WTS009	417.0	1200	0.0005	0.427	0.64	7	1,911	796,887
	WTS009	WTS009	WTS010	120.4	1200	0.0006	0.952	0.96	6.5	1,911	230,084
	WTS010	WTS010	WTS011	271.6	1200	0.0004	0.952	0.98	7	1,911	519,028
	WTS011	WTS011	WTS012	272.0	1200	0.0006	0.952	1.02	9	1,911	519,792
	WTS012	WTS012	WTS013	140.0	1200	0.0004	0.952	1.08	8	1,911	267,540
	WTS013	WTS013	NTS018	171.6	1200	0.0012	0.952	1.07	7.5	1,911	327,947
EASTSIDE											
East-S1											
	C67	E3-MH21	E3-MH22	800.0	600	0.0040	0.138	1.01	10	1,268	1,014,400
	C68	E3-MH22	E3-MH23	570.0	600	0.0039	0.234	1.36	7.5	1,268	722,760
	C69	E3-MH23	E3-MH24	800.0	750	0.0026	0.271	1.27	4	1,245	996,000
	C70	E3-MH24	E3-MH25	800.0	750	0.0026	0.271	1.27	7.5	1,443	1,154,400
	C71	E3-MH25	NTS001	430.0	750	0.0026	0.271	1.19	6	1,443	620,490

Table 7.4 Long Term Infrastructure Needs

	Conduit Id	Up	Down	Length (m)	Dia (mm)	Slope (m/m)	Max Flow (m^3/s)	Max Velocity (m/s)	Average Depth (m)	Unit Cost for New $	Capital Cost $
ACWRC Upgrades											
	NTS002	NTS002	NTS003	111.9	1050	0.0014	0.751	1.3	8.5	1,765	197,556
	NTS003	NTS003	NTS004	140.0	1050	0.0014	0.741	1.29	8.5	1,765	247,100
	NTS004	NTS004	NTS005	158.9	1050	0.0014	0.74	1.3	8.5	1,765	280,511
	NTS005	NTS005	NTS006	108.6	1050	0.0015	0.74	1.32	8.5	1,765	191,750
	NTS006	NTS006	NTS007	95.7	1050	0.0014	0.74	1.37	8.5	1,765	168,840
	NTS007	NTS007	NTS008	149.8	1050	0.0015	0.757	1.44	8.5	1,765	264,397
	NTS008	NTS008	NTS009	30.4	1050	0.0017	0.757	1.43	8.5	1,765	53,638
	NTS009	NTS009	NTS010	143.4	1050	0.0015	0.757	1.33	8.5	1,765	253,172
	NTS010	NTS010	NTS011	151.9	1050	0.0015	0.757	1.32	8.5	1,765	268,174
	NTS011	NTS011	NTS012	113.5	1050	0.0016	0.795	1.38	8.5	1,765	200,275
	NTS012	NTS012	NTS013	150.0	1050	0.0016	0.795	1.52	8.5	1,765	264,750
	NTS013	NTS013	NTS014	63.3	1050	0.0018	0.795	1.71	8.5	1,765	111,795
PUMP STATIONS											
Westside PS		**Firm Capacity**			**Unit Cost ($/m)**						**Capital Cost Estimate**
		510	L/s								1,000,000
	FM-2	525	mm	2450	625.0						1,531,250
West PS Upgrade		**Firm Capacity**			**Unit Cost ($/m)**						**Capital Cost Estimate**
		198	L/s								250,000
Long Term Horizon TOTAL											**17,277,000**

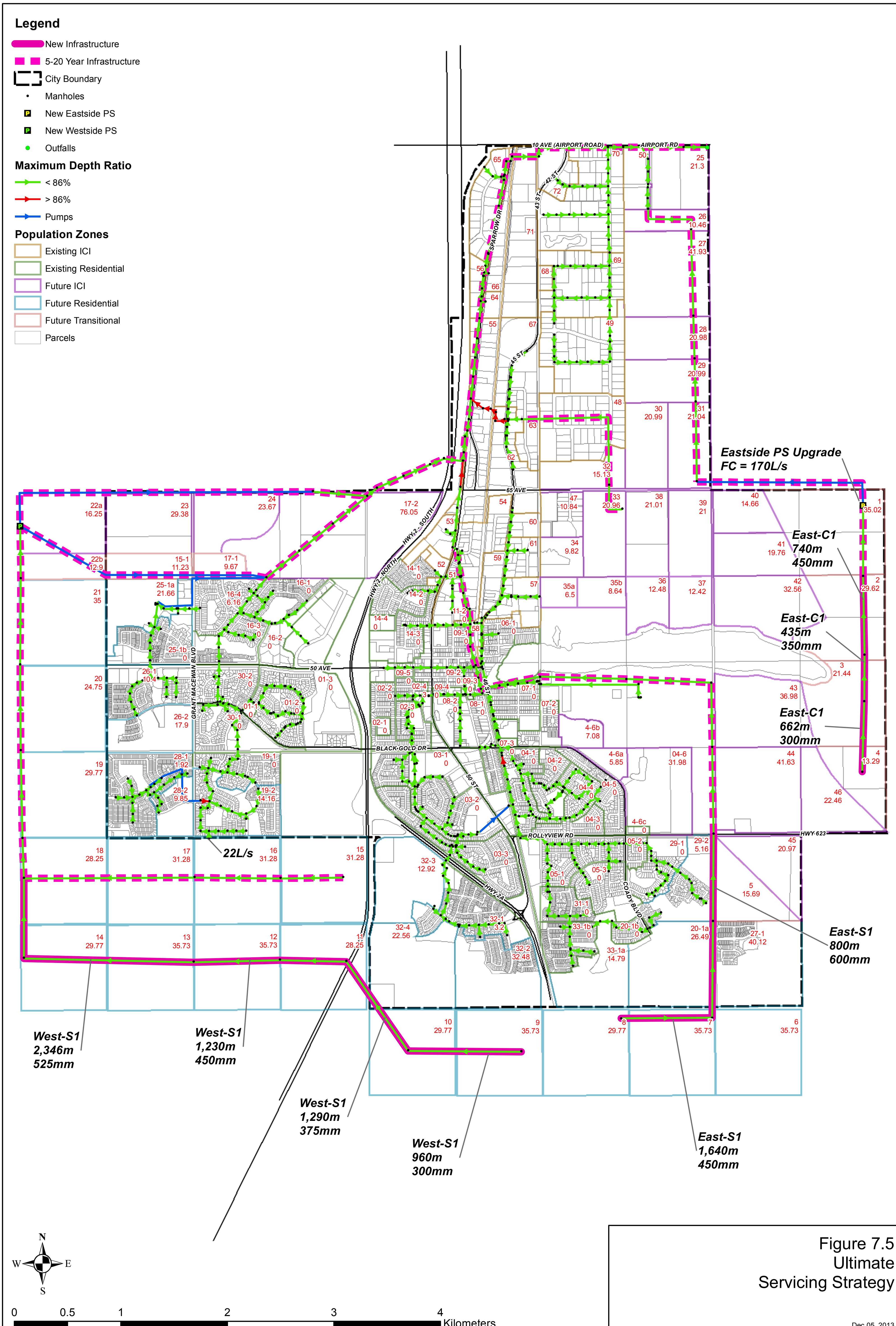


Figure 7.5
Ultimate
Servicing Strategy

Table 7.5 Ultimate Infrastructure Needs

	Conduit Id	Up	Down	Length (m)	Dia (mm)	Slope (m/m)	Max Flow (m3/s)	Max Velocity (m/s)	Average Depth (m)	Unit Cost for New $	Capital Cost $
WESTSIDE											
South 1											
	C42	SW-MH31	SW-MH32	960.0	300	0.0035	0.036	0.74	4	709	680,640
	C43	SW-MH32	SW-MH22	1290.0	375	0.0036	0.066	0.91	4	839	1,082,310
	C45	SW-MH22	SW-MH23	430.0	450	0.0030	0.094	0.89	7	1,077	463,110
	C46	SW-MH23	SW-MH24	800.0	450	0.0030	0.129	0.99	5	998	798,400
	C47	SW-MH24	SW-MH25	1594.0	525	0.0021	0.167	1.04	8	1,174	1,871,379
	C48	SW-MH25	SW-MH21	752.6	525	0.0038	0.196	1.39	6	1,174	883,541
EASTSIDE											
East-C1											
	C60	E2-MH22	E2-MH21	661.7	300	0.0030	0.013	0.5	4	709	469,174
	C61	E2-MH21	E2-MH20	435.1	350	0.0052	0.035	0.78	6	885	385,081
	C62	E2-MH20	E2-MH19	739.5	450	0.0043	0.064	0.76	5	998	737,991
East-S1											
	C64	E3-MH18	E3-MH19	815.0	450	0.0026	0.03	0.42	5	998	813,370
	C65	E3-MH19	E3-MH20	825.0	450	0.0037	0.101	1.21	8	1,077	888,525
	C66	E3-MH20	E3-MH21	800.0	600	0.0040	0.101	1.03	9	1,268	1,014,400
PUMP STATIONS											
Eastside PS		**Firm Capacity**			**Unit Cost ($/m)**	**Capital Cost Estimate $**					
		170	L/s			500,000					500,000
Ultimate Term Horizon TOTAL											**10,588,000**

8. RECOMMENDATIONS

The sanitary servicing study involved the following activities:

- Background information and data collection and interpretation.
- Analysis of sewer flow monitoring data.
- Review of existing sanitary servicing standards and design flow.
- Preparation and calibration of a PCSWMM model (or equivalent).
- Existing system capacity assessment.
- Assessment of the capacity of the existing infrastructure to service projected future development.
- Development of a long-term servicing strategy to support future developments.
- Identification of sanitary system improvements and estimated capital costs.

The following section presents recommendations resulting from the above activities.

8.1 Design Standards

The City's design standards were found to be comparable to other jurisdictions in Alberta and Ontario. In reviewing current standards it was concluded the current 360 Lpcd sanitary flow generation rate could be reasonably lowered to 300 Lpcd. Lowering this rate is in line with industry standards as the effectiveness of water conservation measures (low flow toilets, high efficiency washers, public education, etc.) are realized in wastewater flow rates. Other jurisdictions have already lowered or are contemplating reducing their residential rate to less than 300 Lpcd.

It is recommended that the City lower their residential sanitary rate to 300 Lpcd. In addition, it is recommended that the City eliminate the inflow allowance for sanitary manhole covers in sag locations of 0.4 L/s/MH. The elimination of this inflow allowance should only proceed if the City includes a provision in their standards not allowing sanitary manholes at low points or sag locations.

Although, changes to the ICI rate were considered, no change is recommended. The ICI rate in the City's design standards is approximately three times greater than the ACRWC standard for Level of Service. There is always uncertainty regarding the types of ICI developments and their wastewater servicing requirements. For this reason the higher unit rates result in a conservative design that will be able to accommodate demands associated with changing ICI demands in the future.

Periodic monitoring of ICI flows is recommended to track actual flows relative to design flows. The difference between actual flows and the ACRWC LOS may reduce the need for other measures, such as storage, to manage flows to meet the ACRWC LOS requirements.

8.2 Existing System

8.2.1 Capacity Assessment

A capacity assessment was undertaken for various flow conditions. Table 8.1 presents a summary of the existing system capacity assessment.

Table 8.1 Existing System Capacity Assessment Summary

Flow Conditions	Comments
Actual Dry Weather Flow	• Operating at 50% full. • No capacity issues observed.
Actual Dry Weather Flow and 2-Year Design Storm	• Majority of system operates less than 86% full. • Surcharged sections in older areas of the City. • The maximum hydraulic grade line (water surface elevation) is greater than 2.0 m from the surface. • Low risk of sanitary sewer backup.
Actual Dry Weather Flow and 5-Year Design Storm	• Majority of system operates less than 86% full. • More extensive surcharged sections in older areas of the City. • The maximum HGL is within 2.0 m of the surface in the southern section of the City in the vicinity of Corinthia Drive. • Moderate risk of sanitary sewer backup in the Corinthia Drive area.
Actual Dry Weather Flow and 25-Year Design Storm	• System generally operates less than 86% full. • More extensive surcharged sections in older areas of the City. • There are sections in the west side of the City that are greater than 86% full. • The maximum HGL is within 2.0 m of the surface in the southern section of the City in the vicinity of Corinthia Drive as well as north up to 65th Avenue. • Higher risk of sanitary sewer backup in older areas of the City area.
Design Standard	• Operating at less than 86% full. • No capacity issues observed.
ACRWC - Design	• Operating at less than 86% full. • No capacity issues observed.
ACRWC Design and 25-Year, 24 hour Design Storm	• Flow at connection points exceeds the ACRWC design values at all locations. • The City is contributing more flow than the ACRWC LOS.

The existing sanitary system in the City of Leduc, under most operating conditions, provides a reasonable level of service that meets the original design standards. Inflow and infiltration, as a result of rainfall, can create capacity issues in the collection system around the 5-year rainfall event. Larger wet weather events increase the risk of sanitary sewer backup in the older sections of the City where I/I rates were found to be higher than in newer areas of the City.

Capacity improvements have been identified in the form of replacement sanitary sewers to address capacity issues. The sizing of new sanitary sewers to resolve capacity constraints is based on existing dry weather flow conditions and the 25-year design storm event. In total there were 12 areas, or sanitary sewer runs that were identified for improvement totaling approximately $9.0 million in capital cost. Other measures, such as storage, in combination with local capacity improvements have not been considered.

The identified sanitary system improvements are based on the current model which has been prepared as a system planning level model. Prior to implementing any system improvements, it is recommended the hydraulic model be expanded to include more of the contributing systems to the problem area. This will provide better resolution of the capacity issue in the model.

Furthermore it is recommended that additional monitoring be completed to support model refinement to verify the current findings and to support consideration of other types of capacity improvements that may include flow diversion and storage.

8.3 I/I Program

It is recommended the City of Leduc undertake a pilot I/I program. The goal of the pilot program is to identify the primary sources of I/I and to determine if they can cost effectively be removed. Any I/I reduction will benefit the existing system by providing system capacity during wet weather periods. A pilot program would entail identification of one or two neighbourhood areas and conducting CCTV inspections, manhole inspections, and smoke and dye tests. This work should include flow monitoring as well to quantify I/I contributions. The outcome of the investigative work is to identify sources of I/I and develop a rehabilitation plan to determine if system rehabilitation will be effective in I/I reduction.

The success of I/I programs depend largely on the source of I/I and agency commitment to remove sources.

Based on the flow monitoring data analysis and sanitary modelling results, it is recommended the City consider more intense I/I investigations in the older sections of the City in the vicinity of Corinthia Drive. Capacity issues along Corinthia Drive stem from the I/I contributions from local services areas.

8.4 Future Servicing Strategy

Servicing strategies for short, medium, long and ultimate planning horizons involve new infrastructure to the west and east of the City. The servicing strategy outlined is similar to the servicing presented in the 2012 Municipal Development Plan with one exception. On the eastside the long term servicing takes flows from south of the existing urban boundary around Highway 2A to the top end of the ACRWC at 50th Avenue instead of to the proposed Eastside PS. Taking this development flow into Regional system at this location reduces the pumping requirements at the Eastside PS.

The servicing strategy also recognizes some existing capacity in the Windrose development. There is approximately 22 L/s of capacity through the existing Windrose system that can service the quarter section immediately south. Other capacity opportunities were investigated to allow some portion of development flow from outside the existing urban boundary to be connected to existing systems. No other opportunities were identified.

A new Westside PS is required in the short term planning horizon that will require expansion in the future. Similarly a new Eastside PS is required, which will be expanded in the future. The existing West PS will require expansion based on the long term planning horizon. The service area for the West PS was altered to include areas north of 65th Avenue and east of the current urban boundary.

As part of future servicing, the capacity expansion of the ACRWC Regional trunk was identified. The first capacity expansion is required in the medium term. Given this need, it is recommended the City engage the ACRWC early in the process to evaluate options and costs. The ACRWC capacity assessment showed the City is contributing more flow than the ACRWC LOS. As such, it is expected ACRWC may require the City control their future discharges especially during wet weather flow. To do this the City will need to consider storage elements.

At this time, the servicing strategy has not considered system storage and flow management to manage flow contributions into the ACRWC system to the committed ACRWC LOS. The outcome of the pilot I/I program will provide additional insight on the feasibility and practicality of I/I control. If an effective I/I program is successful, then the need for storage will be minimized. Otherwise it is expected storage will be required to address the current and future ACRWC contributions. In-system storage, if required, should be considered as part of any capacity upgrade, or as part of future servicing strategy as it is easier to build in storage and controls at that time versus retrofitting existing systems.

8.5 Future Model Development and Analysis

The current model represents the main sanitary drainage system and does not include all local systems. As a consequence, the model does display higher than expected HGL elevations typically where flows are loaded into the model. The load point represent larger service areas, therefore the inflow at these locations can result in overestimation. As well, model calibration is based flow monitoring data collected at select locations. This information is used to characterize the wet weather flow response at other locations and given the nature of I/I may not represent the local condition.

Where capacity improvements are identified it is important to do some additional work to verify the modelling results to ensure the improvement is required and sized appropriately.

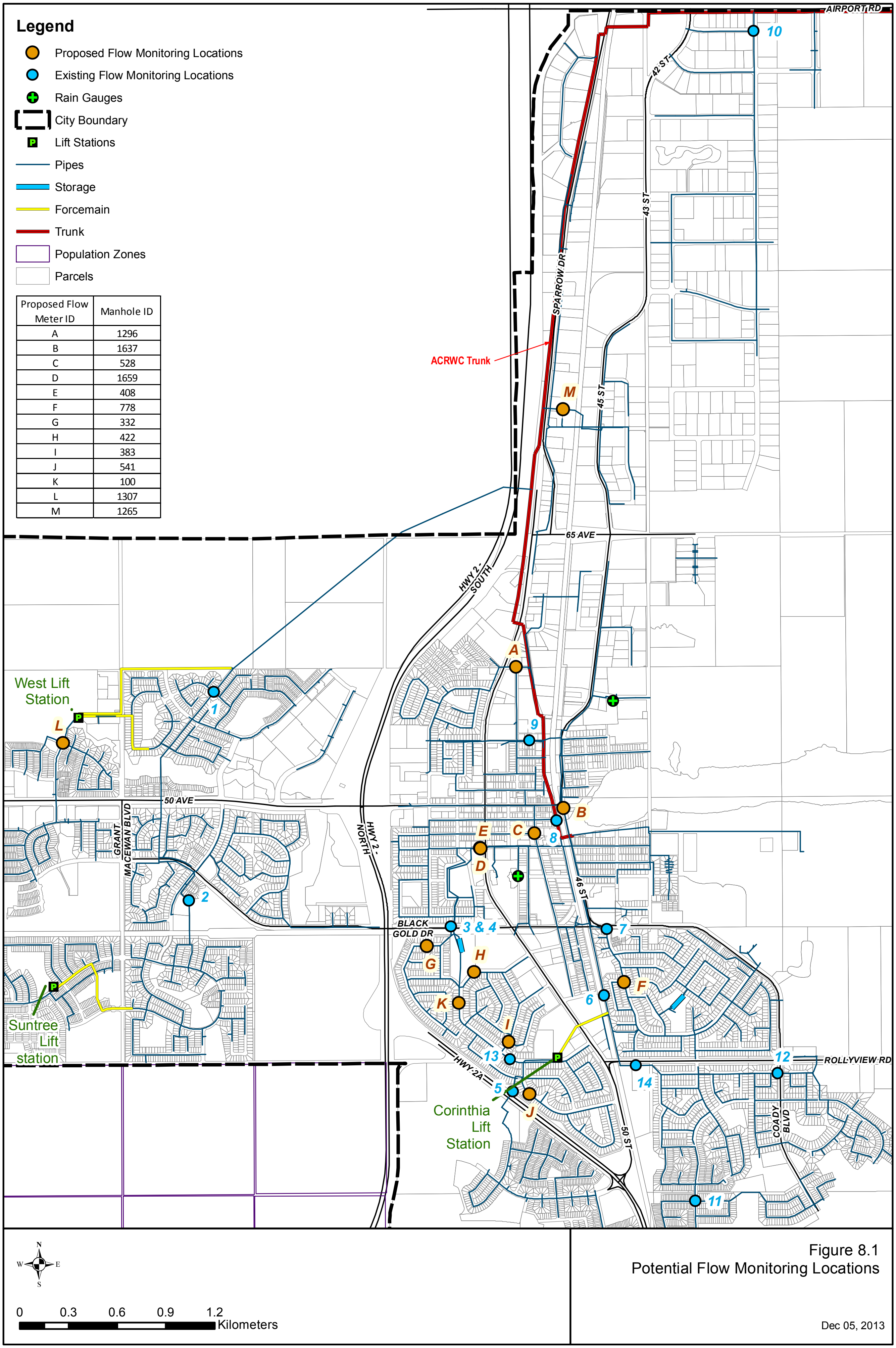
Flow monitoring is recommended before any capacity improvements are made to characterize actual dry and wet weather flow at the local level. A 3-4 month flow monitoring program would typically capture sufficient wet weather events to confirm the model current parameterization to make informed adjustments to the existing parameters. The second recommended step is to add additional detail to the model. The additional detail will distribute the load points to better represent actual loads to the system. This will eliminate modelling artifacts that occur when using larger lumped catchments.

Figure 8.1 identifies potential flow monitoring locations to support further I/I investigations and capacity analysis primarily in the Corinthia Drive service area. Other sites are identified for future flow monitoring programs to track flow trends as development continues.

The sanitary servicing model can be used to investigate additional servicing strategies associated with ACRWC LOS, storage and flow control.

Future model improvements should focus on expanding the model with more local detail where required to ultimately establish an "all-pipes" model. Further refinement of catchments and population information will provide better flow estimates. It is recommended the model be reviewed every 6-months to determine the need for updating. Model development should also include establishing a formal methodology for updating the model flows. This includes taking population information, distributing it to catchments and identifying appropriate load points.

The updated model is suitable for system planning and can be further improved to support more detailed design.



Proposed Flow Meter ID	Manhole ID
A	1296
B	1637
C	528
D	1659
E	408
F	778
G	332
H	422
I	383
J	541
K	100
L	1307
M	1265

Figure 8.1
Potential Flow Monitoring Locations

Dec 05, 2013

APPENDIX A
TECHNICAL MEMORANDUM #1 - FLOW MONITORING DATA REVIEW

XCG CONSULTANTS LTD.
T 905 829 8880 F 905 829 8890 | toronto@xcg.com
2620 Bristol Circle, Suite 300, Oakville, Ontario, Canada L6H 6Z7

XCG File No.: 3-2945-02-01
July 23, 2013

CITY OF LEDUC
SANITARY SEWER MODELING AND SERVICING STUDY
TECHNICAL MEMORANDUM NO.1
FLOW MONITORING DATA REVIEW

Prepared for:

CITY OF LEDUC
#1 Alexandra Park
Leduc, Alberta
T9E 4C4

Prepared by:

XCG CONSULTANTS LTD.
2620 Bristol Circle
Suite 300
Oakville, Ontario
L6H 6Z7

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1. INTRODUCTION

The City of Leduc (City) is located in Leduc County, approximately 25 kilometers south of the City of Edmonton. All wastewater from the City discharges into the Alberta Capital Region Wastewater Commission (ACRWC) system and treated at the City of Edmonton Gold Bar Wastewater Treatment Plant (WWTP).

In 2012, the City initiated the City of Leduc Sanitary Sewer Modeling Servicing Study to develop short and long term wastewater servicing strategies taking into account sustainability for long term growth and financial responsibility.

In preparation for the servicing study the City commissioned the collection of sanitary flow data and rainfall data in the fall of 2011 and summer of 2012. The objectives of the City flow monitoring program included:

- Characterization of dry and wet weather flow in the sanitary sewer system; and,
- Collection of flow data to support the development of a sanitary system model suitable for evaluating existing and future servicing strategies.

This Technical Memorandum presents the results of flow and rainfall data analysis completed as part of this servicing study using the 2011 and 2012 data collected by the City. The data analysis characterizes existing dry and wet weather flow conditions in the sanitary system to be used in the development and calibration of a system model of the Leduc wastewater collection system to support the servicing study.

2. DATA REVIEW AND ANALYSIS

2.1 Flow and Rainfall Monitoring Program

Monitoring was completed in the fall of 2011 and summer of 2012 by InsituCan Services Ltd. on behalf of the City of Leduc. Figure 2.1 shows the flow monitoring locations and rain gauge, while Table 2.2 provides a description of each monitoring location. Table 2.3 summarizes data observations from reviewing the datasets. Flow data was collected at 15 minute intervals and the rainfall in 5 minute increments.

2.2 Flow Data Analysis

The data analysis was undertaken to characterize dry and wet weather flow conditions. The data considered most representative at each site from 2011 and 2012 was used in the analysis.

Figure 2.1
Flow Monitoring and Rain Gauge Locations

Nov 14, 2012

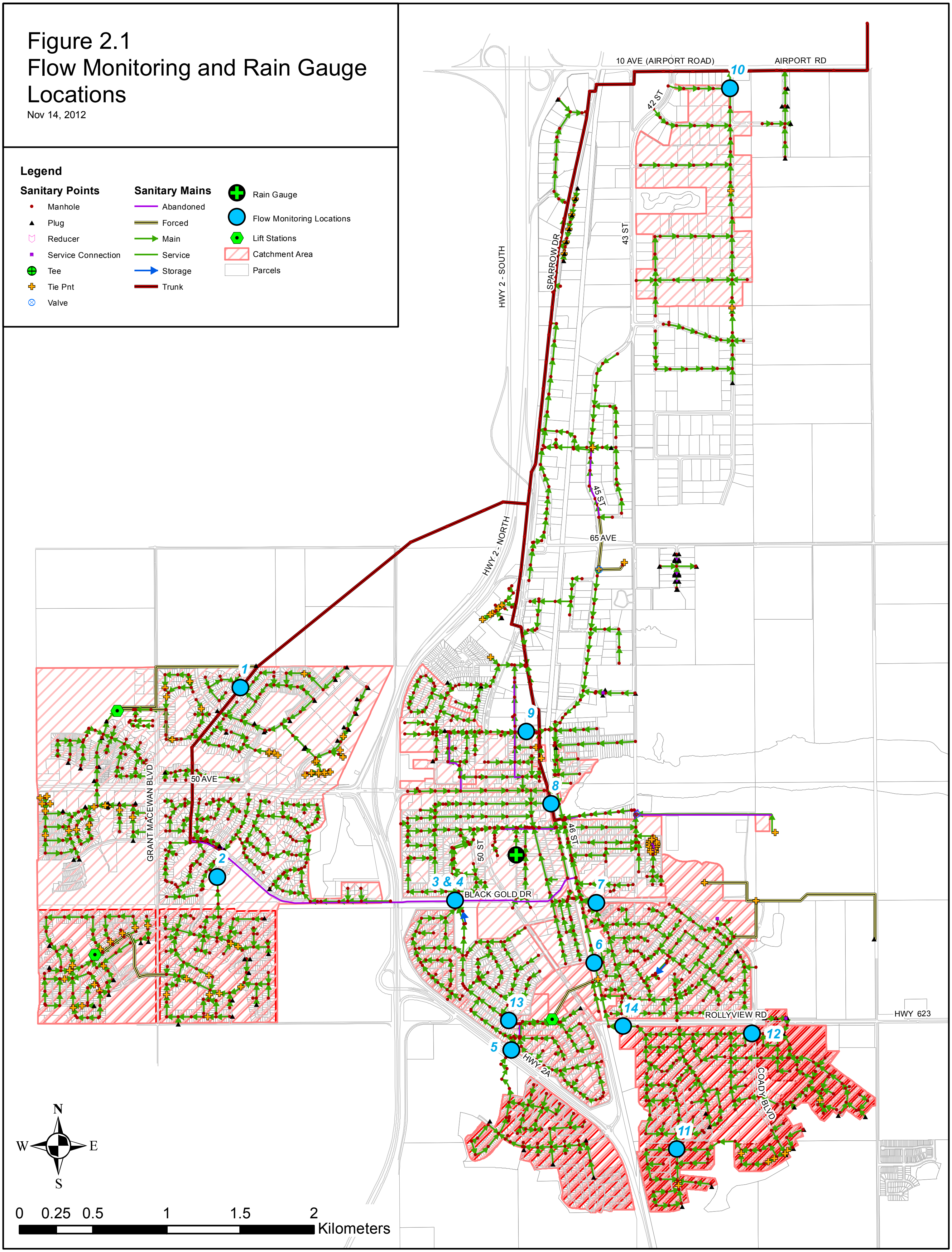


Table 2.1 Flow and Rainfall Monitoring Locations

Site	Manhole ID	Pipe Diameter (mm)	Location Description
1	1019	750	• On walking path located between Bridgeport Court and Birchwood Close.
2	159	600	• Behind St. Benedict School.
3	1285	250	• Black Gold Drive, east of Highway 2 and adjacent to Leduc Composite High School.
5	1148	525	• Grass south of the intersection of Nootka Road and Bella Coola Drive, behind homes in the area.
6	569	525	• Path located behind the City of Leduc Fire Services building on 50 Street, east of the rail road tracks.
7	1669	375	• Intersection of Black Gold Drive and South Park Drive.
8	1571	750	• Intersection of 47 Street and 49 Avenue.
9	524	450	• 54 Avenue between 49 Street and 47 Street.
10	1124	525	• Intersection of 84 Avenue and 37 Street.
11	1136	375	• Intersection of Douglas Lane and Caledonia Drive.
12	932	375	• Coady Boulevard, south of the intersection of Rollyview Road and Coady Boulevard.
13	357	250	• Corinthia Drive, just east of the intersection of Corinthia Drive and Athapaskan Drive.
14	747	525	• Rollyview Road adjacent to Leduc Fellowship Church.
Rain Gauge	Tipping Bucket		• Leduc Civic Centre.
Rain Gauge	Tipping Bucket		• Leduc Operations Building.

Table 2.2 Flow and Rainfall Monitoring Data Observations

Site	Manhole ID	Data Review Comments / Observations	
		Winter 2011/2012 Data	Summer 2012 Data
1	1019	• Data generally good.	• Data generally good. • Flows higher in 2012. • Velocity spikes observed in dataset. • Response to wet weather evident.
2	159	• Effect of pump station upstream observed. • Periods of high velocity and flow.	• Effect of pump station upstream observed. • Periods of high velocity and flow makes for noise data. • Flow lower than 2011 data. • Low flow dropout of velocity during night time. • Response to wet weather evident.
3	1285	• Data not used directly. • Change in service area at Corinthia pump station between when 2011 data collected and 2012 data.	• Poor data from June 17 to July 7, 2012. • Data generally good beyond July 7, 2012. • Response to wet weather evident, very direct.

Table 2.2 Flow and Rainfall Monitoring Data Observations

Site	Manhole ID	Data Review Comments / Observations	
		Winter 2011/2012 Data	Summer 2012 Data
5	1148	• Velocity data inconsistent. • Varies from low to extremely high (spikes) throughout monitoring period.	• Velocity data very poor until July 15, 2012. • Velocity spikes throughout dataset. • Level data inconsistent as well. • Better dataset after August 29, 2012 but no wet weather events. • Limited reliable wet weather data. • Response to wet weather evident.
6	569	• Data not used directly. • Change in service area at Corinthia pump station between when 2011 data collected and 2012 data.	• Influence of upstream pump station evident. • Velocity spikes in dataset. • Data generally good. • Response to wet weather evident.
7	1669	• Data generally good. • There is the occasional spike in depth and velocity observed.	• Data generally good. • There is the occasional spike in depth and velocity observed. • Response to wet weather evident, very direct.
8	1571	• Random spikes in velocity and flow. • Velocity trending down. • No velocity data from December 1, 2011 to end of program.	• Data generally good until July 26, 2012, data generally poor afterwards. • Response to wet weather evident, very direct.
9	524	• Random spikes in velocity and flow. • Velocity unsteady. • Data unusable after December 12, 2011 no velocity data. Level data usable.	• Periods with no velocity measurements, level is generally good. • Short periods of usable data. • Response to wet weather evident, very direct.
10	1124	• Industrial area. • Does not follow typical diurnal flow pattern. • December 2011 data more consistent.	• Industrial area. • Does not follow typical diurnal flow pattern. • Very low weekend flows during summer. • Limited response to wet weather evident.
11	1136	• No data collected in 2011.	• Data generally good. • Response to wet weather evident.
12	932	• No data collected in 2011.	• Data generally good. • Response to wet weather evident, very direct
13	357	• No data collected in 2011.	• Poor data until August 4, 2012, data generally good afterwards. • Response to wet weather minimal. • Increase in flow every 7-days (weekly) industrial process?
14	747	• No data collected in 2011.	• Low flow conditions, velocity night time dropout. Velocity inconsistent. • Level data consistent • Response to wet weather evident, very direct.

2.2.1 Rainfall Analysis

The objective of the rainfall analysis is to identify rainfall events that will be used for the wet weather flow data analysis. Data from the two rain gauges were reviewed and the Civic Centre Rain Gauge was chosen to use primarily because the dataset was more complete. A comparison of the two rain gauges can be seen in Appendix B. The analysis is also used to identify wet weather events that will be used in the subsequent calibration of the sanitary system model.

Table 2.3 summarizes a total of seven rainfall events greater than 10 mm that occurred over the course of the 2012 monitoring program. Rainfall event volumes ranged from 10.4 mm on Aug 4, 2012 to 45.8 mm during the July 14, 2012 rainfall event. The specific rainfall events which will be used to calibrate the model will be chosen during the model calibration process.

Table 2.3 Rainfall Analysis Summary

Event Id	Begin	End	Duration (hours)	Total Rainfall Volume (mm)(1)
a	July 1, 2012 8:00	July 2, 2012 2:30	17.5	16.6
b	July 3, 2012 17:00	July 4, 2012 14:30	21.5	17.4
c	July 14, 2012 22:00	July 16, 2012 7:00	33	45.8
d	July 23, 2012 8:00	July 23, 2012 19:00	8	27.4
e	Aug 4, 2012 20:00	Aug 6, 2012 1:00	29	10.4
f	Aug 14, 2012 5:30	Aug 16, 2012 18:30	13	20.6
g	Aug 21, 2012 21:00	Aug 23, 2012 18:00	33	24.6

Note:
1. Rainfall data was recorded every 5 minutes from the Civic Centre rain gauge

2.2.2 *Dry Weather Flow Analysis*

The objectives of the dry weather flow analysis included:

- Determination of the average, peak and minimum dry weather flows;
- Quantification of groundwater infiltration flows; and,
- Generation of typical dry weather 24-hour diurnal flow plots for each monitoring site.

The flow data analysis involved the definition of dry weather flow periods, calculation of average dry weather flows, and calculation of groundwater infiltration flows. All datasets were used to characterize dry weather flow. The methodology consists of the following steps:

1. Rainfall data recorded at the rain gauges and flow data at each flow monitoring location were reviewed to identify dry weather periods. Periods were defined as dry if no rainfall was recorded within the previous 48 hours.
2. Average dry weather flows were calculated for each flow monitoring location using the flows recorded during the defined dry weather periods.
3. The average groundwater infiltration was estimated as 85% of the lowest recorded flow on the average dry weather day. Where a flow of zero was recorded, 85% of the minimum non-zero flow recorded was used to calculate the

average groundwater infiltration flows. The average groundwater infiltration flow was normalized using tributary area to determine an aerial groundwater infiltration rate at each monitoring location.

4. An average dry weather flow peak factor was calculated from the flow time series of average dry weather flow at each monitoring location.

Table 2.4 presents a summary of the dry weather flow data analysis results by monitored site.

Appendix A presents typical 24-hour dry weather flow graphs for each sanitary sewer monitoring location. The diurnal flow values and patterns will be used in the system model development.

Table 2.4 Dry Weather Flow Characteristics

Site	Service Area (Ha)	Avg. DWF (L/s)	Peak DWF (L/s)	Min. DWF (L/s)	GWI(1) (L/s/ha)	Sanitary Flow(2) (L/s)	2011 Population	Per Capita DWF(3) (Lpcd)	Total Per Capita Flow(4) (Lpcd)	Peaking Factor(5)
1	465.8	11.5	13.0	4.8	0.009	7.4	10,144	63	98	1.34
2	121.8	6.0	8.9	1.2	0.008	5.0	2,737	157	189	1.48
3	67.6	11.1	13.5	6.7	0.084	5.4	2,009	232	477	1.22
5	48.2	5.0	7.8	1.8	0.032	3.5	1,402	214	308	1.56
6	150.3	12.8	22.4	7.6	0.043	6.3	5,615	98	197	1.75
7	93.4	11.9	14.7	7.0	0.064	6.0	2,185	235	471	1.24
8	506.9	36.8	46.2	18.6	0.031	21.0	13,687	133	232	1.26
9	39.2	13.4	16.0	10.6	0.230	4.4	830	457	1,395	1.19
10	87.8	2.3	2.9	1.9	0.018	0.7	- (6)	-	-	1.26
11	27.4	3.6	5.9	0.5	0.016	3.2	1,105	248	281	1.64
12	32.1	3.2	4.1	1.2	0.032	2.2	952	198	290	1.28
13	70.3	2.4	3.7	0.6	0.007	1.9	643	254	322	1.54
14	132.2	7.1	16.7	0.4	0.003	6.8	3,946	148	155	2.35

Notes:

1. GWI = (0.85* Minimum DWF)/Area.
2. Average Sanitary Flow = Average DWF – (0.85)*Minimum DWF.
3. Per Capita Sanitary Flow = Average Sanitary Flow/ Population.
4. Total Per Capita Flow = Average DWF / Population.
5. Peaking Factor = Peak DWF/Average DWF.
6. Industrial Area - no population data.

The following observations are made from the dry weather flow data summary analysis presented in Table 2.4:

- There is continuity between the flow monitoring stations with respect to average dry weather flow.
- Site 10 serves an industrial area, the diurnal flow pattern is irregular when compared to residential areas.
- Site 9 has the greatest base flow and exceeds the City's criteria of 0.20 L/s/ha for inflow/infiltration.
- The older section of the City (Sites 3, 5, 6, 7, 8, 9, 11 and 12) tend to have higher GWI rates. These sites have GWI rates greater than 0.030 L/s/ha. Newer areas (sites 1, 2, 13, 14) have GWI rates of less than 0.010 L/s/ha.
- Peaking factors in the study area range from 1.2 to 2.4.
- Per capita sanitary flows in the study area ranged from 63 Lpcd to 457 Lpcd.
- The per capita flow at Site 1 of 63 Lpcd and 98 Lpcd at Site 6 are considered very low sanitary flow rates. The rate may be distorted if the contributing population is actually less than current population information. This will be checked as part of preparing the system model.
- At Site 13 there is a weekly increase in dry weather flow. The source of this flow increase is unknown at this time.

2.2.3 Wet Weather Flow Analysis

The objective of the wet weather flow analysis is to characterize extraneous flows response in the sanitary system to wet weather events. Wet weather analyses are typically completed for a range of rainfall events. This approach recognizes that the variability of rainfall can have a significant impact on results. In addition, the approach tends to negate the impact of the spatial variability of rainfall on analysis results.

To complete this analysis, the previously developed dry weather diurnal flow time series is subtracted from the total measured flow to isolate the wet weather response as a infiltration/inflow (I/I) hydrograph. From this, the volume of wet weather for each event is determined. To evaluate the amount of wet weather a volumetric runoff coefficient is calculated. The volumetric runoff coefficient (%Cv) is the volume of wet weather divided by the total rainfall volume over the contributing service area. The greater the %Cv the greater the amount of I/I. In addition to the %Cv, the peak and average event I/I rate is determined on an areas basis. The I/I rates are compared to the City's infiltration allowance of 0.20 L/s/ha for the design of new sanitary sewers.

The wet weather analysis was completed using the data from June, 2012 to September, 2012. The seven rainfall events summarized previously in Table 2.3 represent the wet weather periods reviewed. Not all flow monitoring sites had usable data for all events.

Table 2.5 presents a summary results of the wet weather flow analysis. The %Cv and I/I rates presented in Table 2.5 represent the average of all the events analyzed at each monitoring site. Appendix B provides detailed summary tables for each individual event analyzed as well as the event flow hydrographs.

Table 2.5 Wet Weather Flow Analysis Summary

Site	Peak I/I Rate (L/s/ha)	Average I/I Rate (L/s/ha)	Volumetric Runoff Coefficient %Cv
1	0.02	0.004	0.40 %
2	0.94	0.03	2.31 %
3	0.52	0.05	4.62 %
5	1.38	0.09	5.73 %
6	0.69	0.05	8.65 %
7	0.65	0.04	4.38 %
8	0.34	0.02	1.85 %
9	4.63	0.14	11.32 %
10	0.11	0.01	0.74 %
11	0.37	0.02	2.59 %
12	1.94	0.06	4.36 %
13	0.09	0.01	1.24 %
14	0.63	0.02	1.36 %

Notes:
I/I rates and %Cv values represent average values over a number of events. Appendix B provides specific event analysis results.

Reviewing Table 2.5 and Appendix B hydrographs and detailed wet weather event results reveal the following:

- Site 9 displays the greatest amount of wet weather I/I. There is a very direct response to rainfall in the system as demonstrated by the greatest peak I/I rate and the overall 11% volumetric runoff coefficient.
- Sites 1, 2 and 10 have a slight response to rainfall relative to Sites 5, 11 and 13 which display a moderate response. Sites 3, 6, 7, 8, 9, 12, and 14 display the most direct response to rainfall events.
- In reviewing the wet weather hydrographs there is clear evidence of more direct inflow at Site 3, 6, 7, 8, 9, 12, and 14 as the system responds immediately to wet weather events. Direct inflow may be a result of stormwater cross connections, roof downspouts, foundation drains and sump pump connections to the sanitary system.

3. CONCLUSION

The City's flow monitoring program was intended to characterize dry and wet weather flows and to support the hydrologic/hydraulic model development of the City of Leduc wastewater collection system.

The flow and rainfall monitoring program was carried out in two phases. Phase 1 was over a three month period between November 2011 and January 2012 while Phase 2 was over a four month period between June 2012 and September 2012. Phase 1 was primarily used for dry weather flow analysis and Phase 2 was used for both dry weather flow and wet weather flow analysis. The data collected throughout the program was sufficient to characterize dry and wet weather conditions although there were periods of poor data quality associated largely with velocity measurements.

The flow data analysis provided the following information:

- Dry weather flow analysis characterized 24-hour diurnal flow patterns that will be used in the development of the sanitary system model.
- Site 10 serves an industrial area the diurnal flow pattern is irregular when compared to residential areas.
- The older section of the City (Sites 3, 5, 6, 7, 8, 9 and 12) tend to have higher GWI rates. These sites have GWI rates greater than 0.030 L/s/ha. Newer areas (sites 1, 2, 13, 14) have GWI rates of less than 0.010 L/s/ha.
- Per capita sanitary flows in the study area ranged from 63 Lpcd to 457 Lpcd.
- The per capita flow rates of less than 100 Lpcd at Sites 1 and 6 are considered unreasonably low. The rate may be distorted if the contributing population actually less than current population information. This will be checked as part of preparing the system model through the model calibration process where flow depth will be considered along with flow.
- At Site 13 there is a weekly increase in dry weather flow. The source of this flow increase is unknown at this time.
- Sites 1, 2 and 10 have a slight response to rainfall relative to Sites 5, 11 and 13 which display a moderate response. Sites 3, 6, 7, 8, 9, 12, and 14 display the most direct response to rainfall events.
- Site 9 displays the most direct response to wet weather flow.
- Peak I/I observed at all sites (except Sites 1, 10 and 13) were shown to exceed the I/I allowance of 0.20 L/s/ha.
- There is sufficient number of wet weather events and data to support the development and calibration of the sanitary system model.

The outcome of the dry and wet weather flow data analysis characterizes existing flows in the sanitary system at specific locations under a range of conditions. The information collected will be used directly in the preparation of a sanitary system model to support the sanitary servicing study and to develop and evaluate servicing alternatives associated with planned growth. The data analysis results will be used in the model development process to best characterize existing conditions under typical conditions.

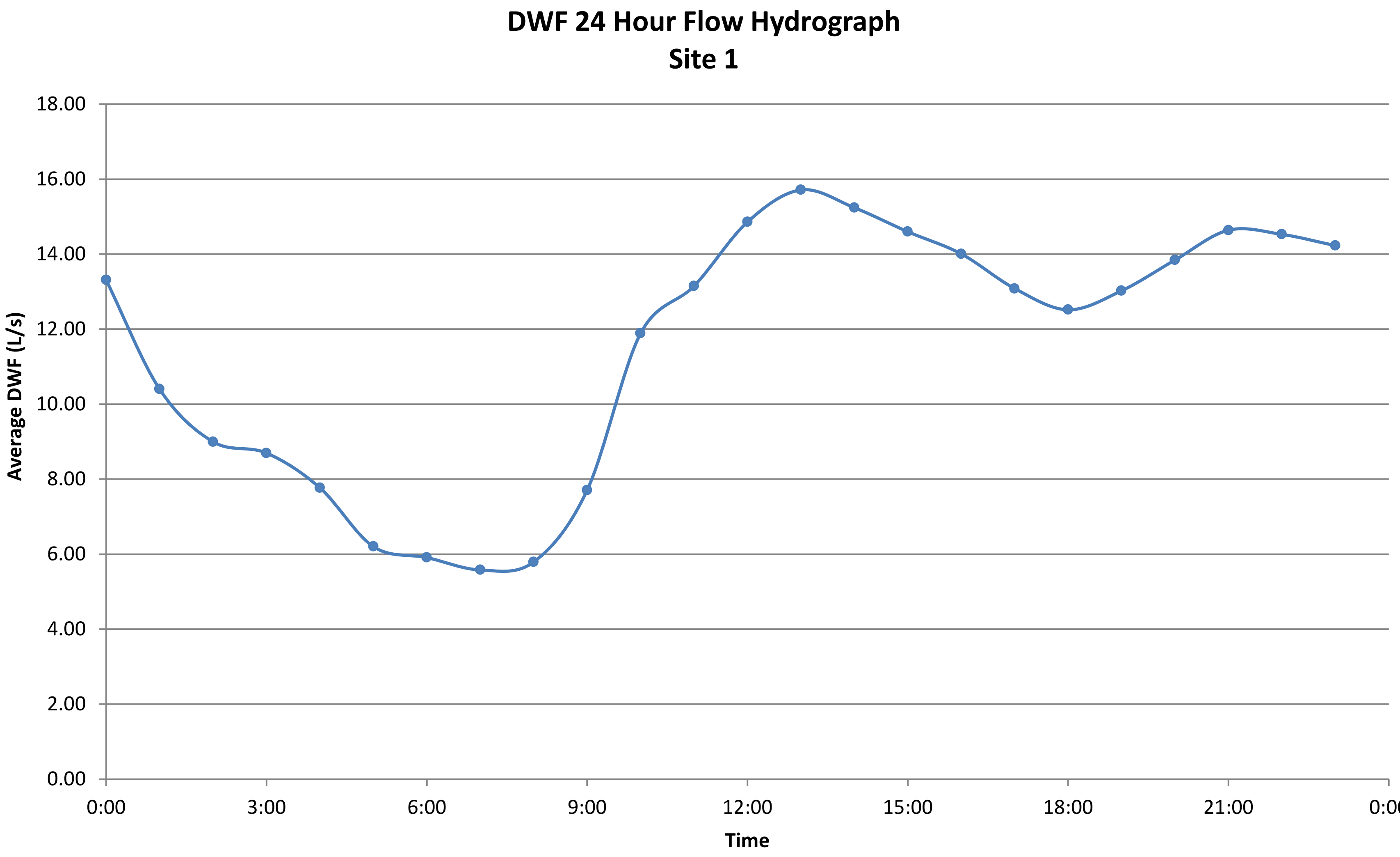
4. REFERENCES

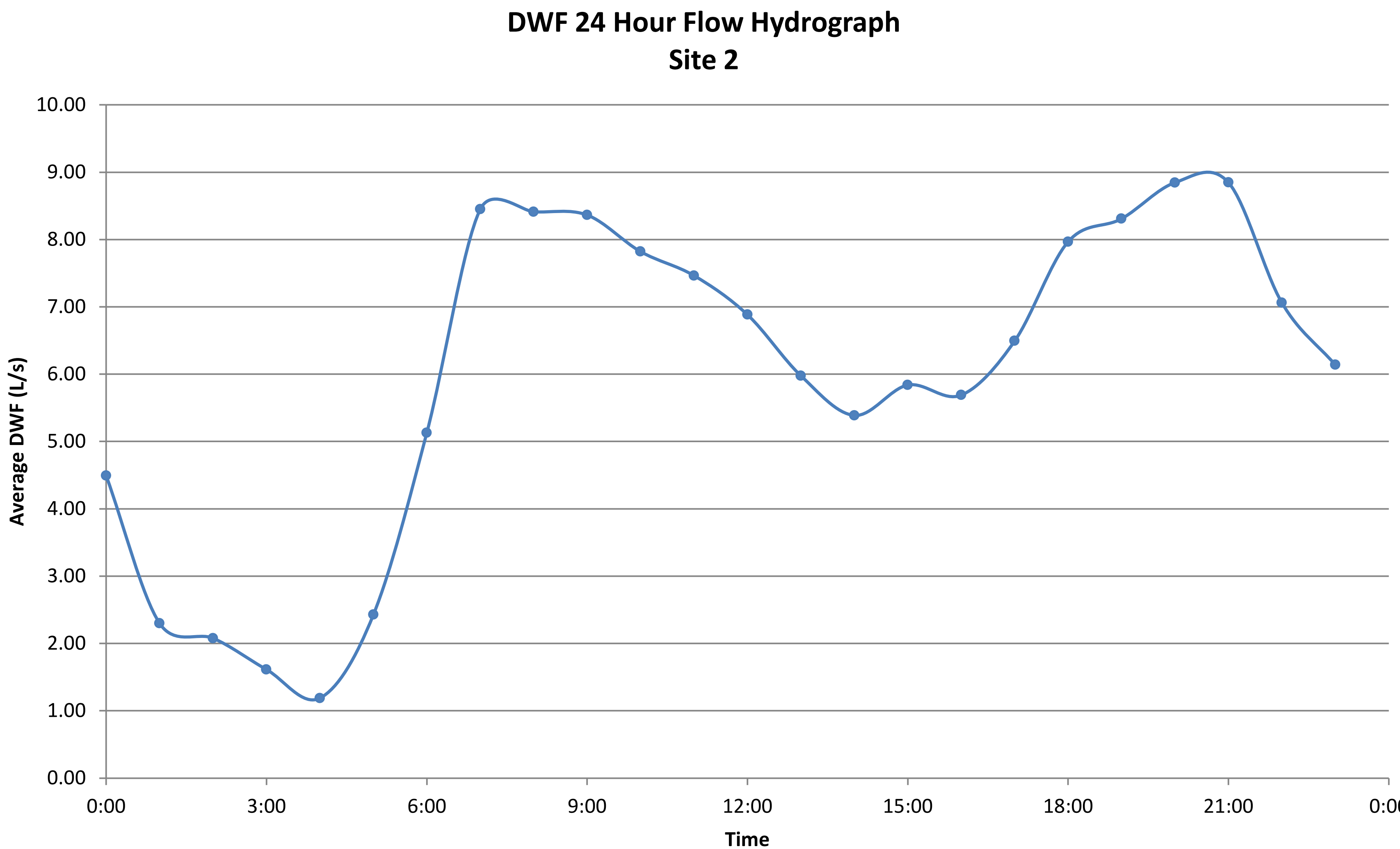
The City of Leduc, Minimum Engineering Design Standards, April 2006.

InsituCan Services Ltd., Sewer Flow Monitoring (Phase 1), Draft Report, January 20, 2012.

InsituCan Services Ltd., Sewer Flow Monitoring (Phase 2), Draft Report, October 1, 2012.

APPENDIX A
DRY WEATHER FLOW DATA HYDROGRAPH


DWF 24 Hour Flow Hydrograph
Site 1
Average DWF (L/s)
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time


DWF 24 Hour Flow Hydrograph
Site 2
Average DWF (L/s)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
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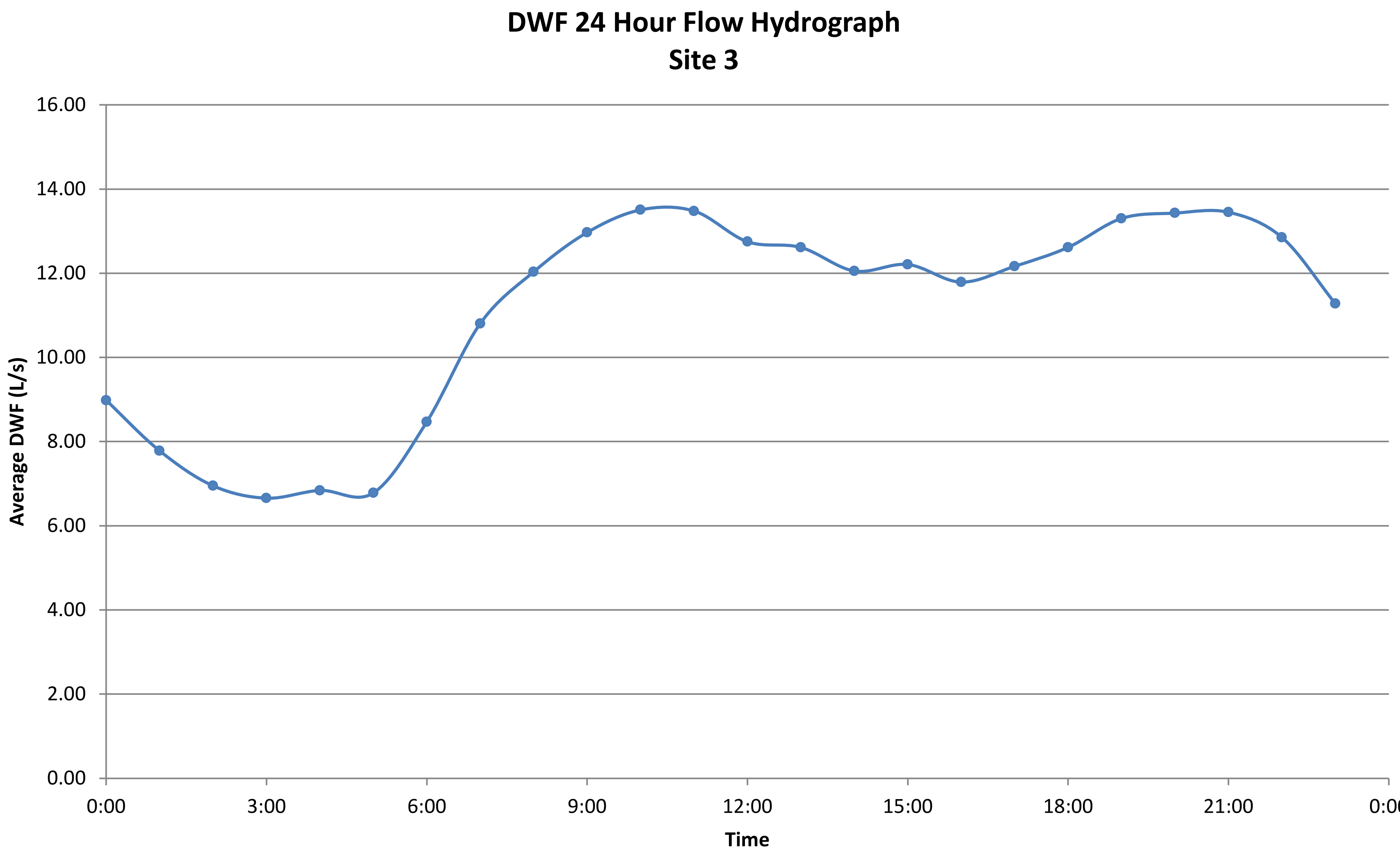
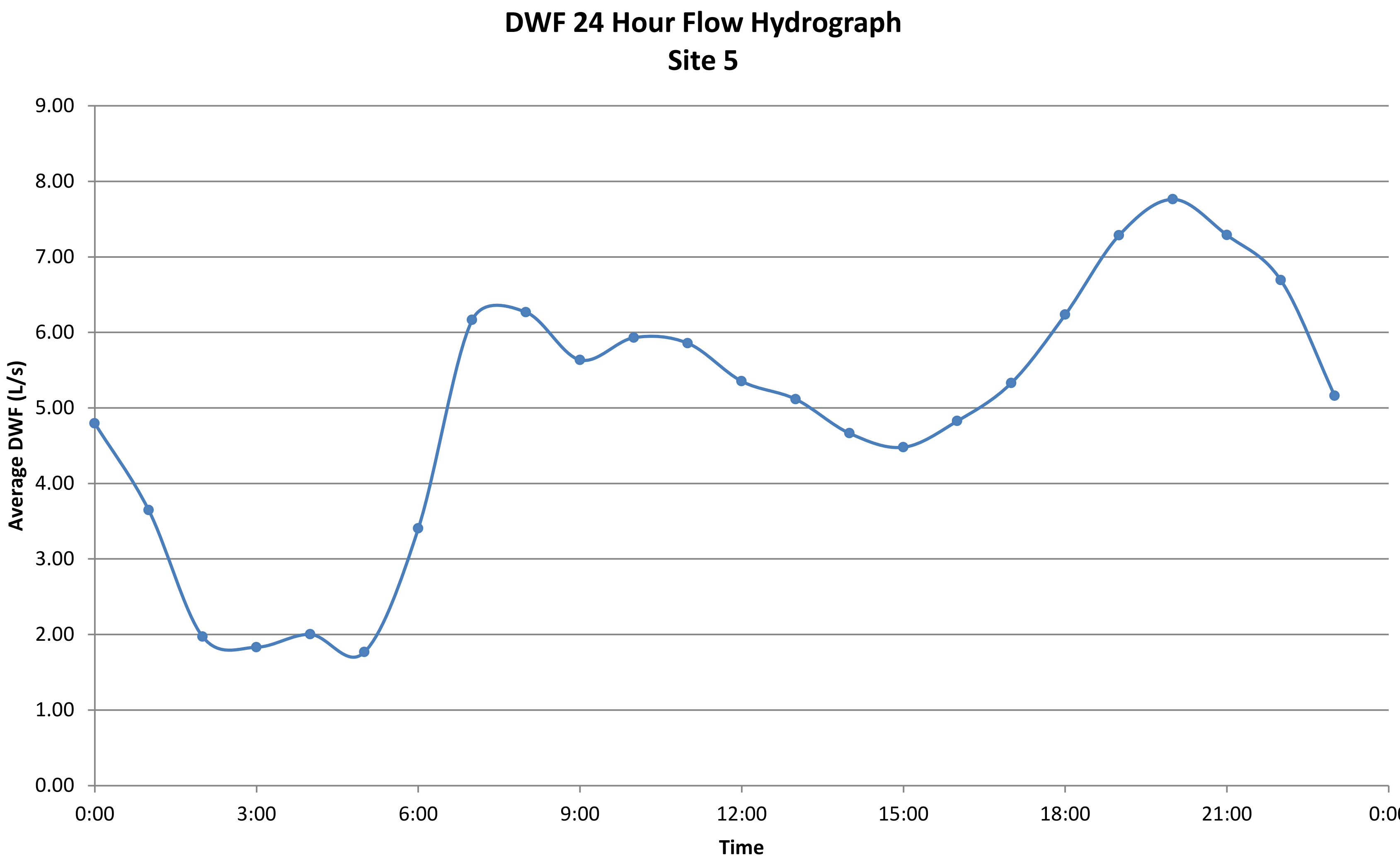
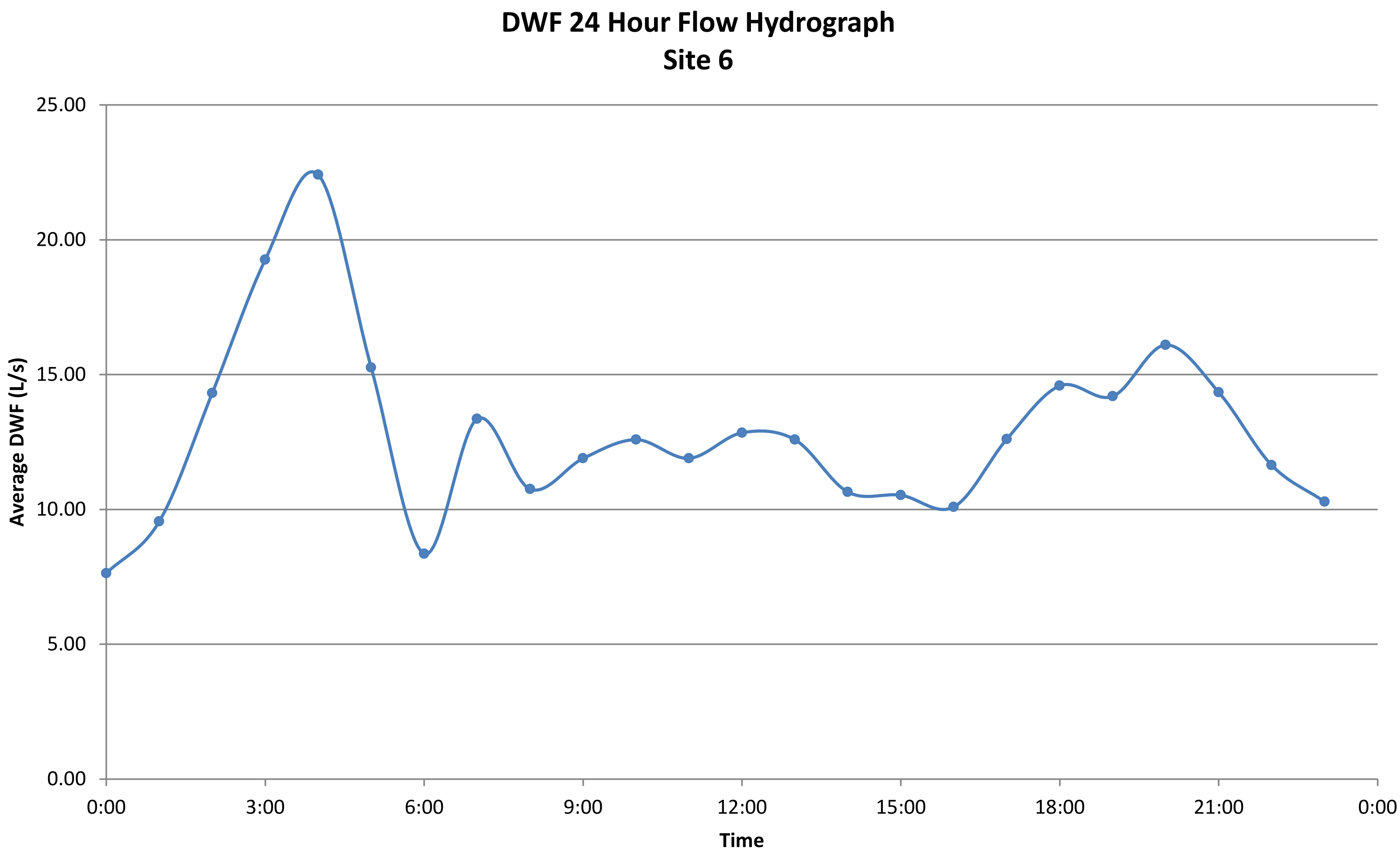
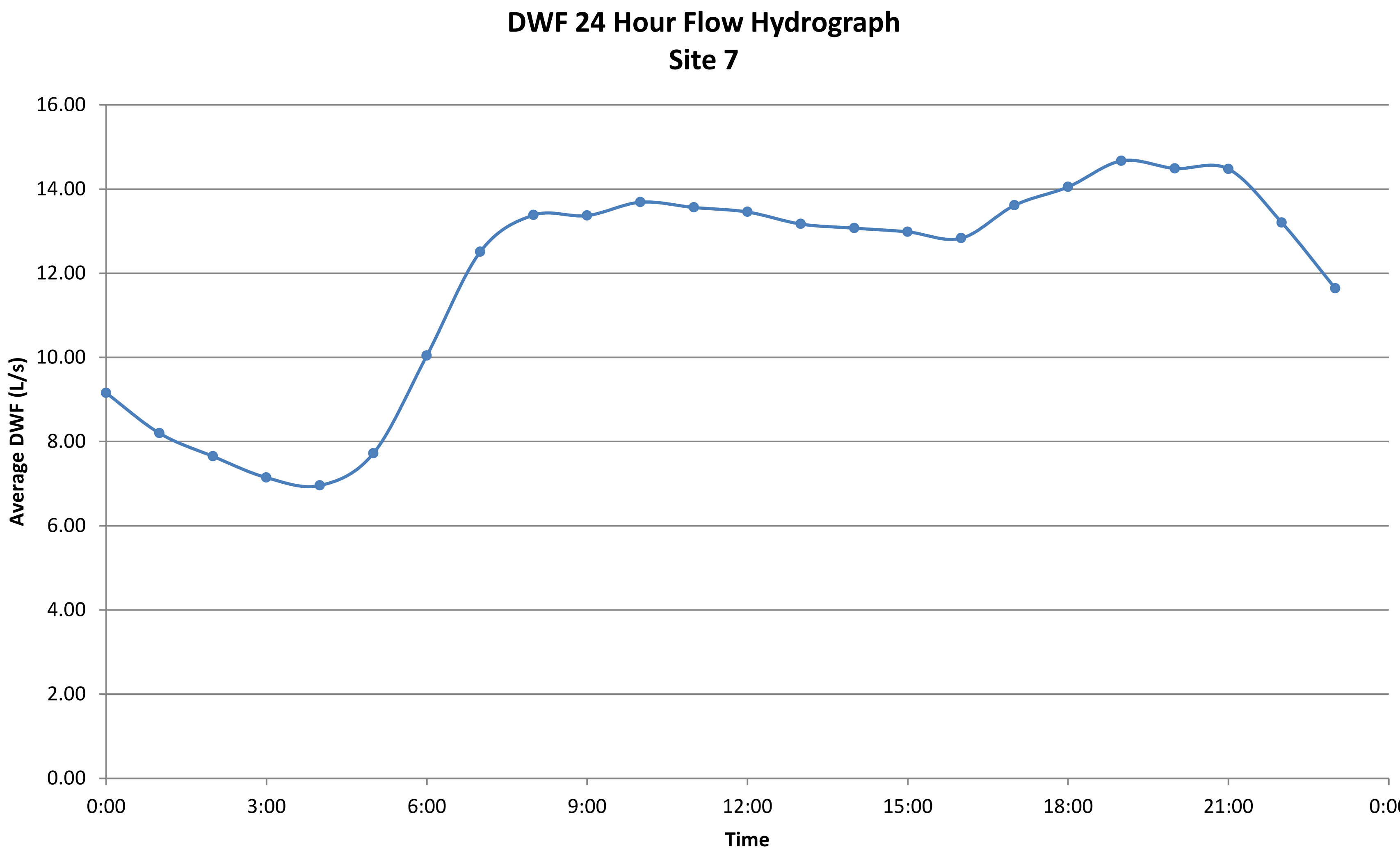
Time


DWF 24 Hour Flow Hydrograph
Site 3
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Average DWF (L/s)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time

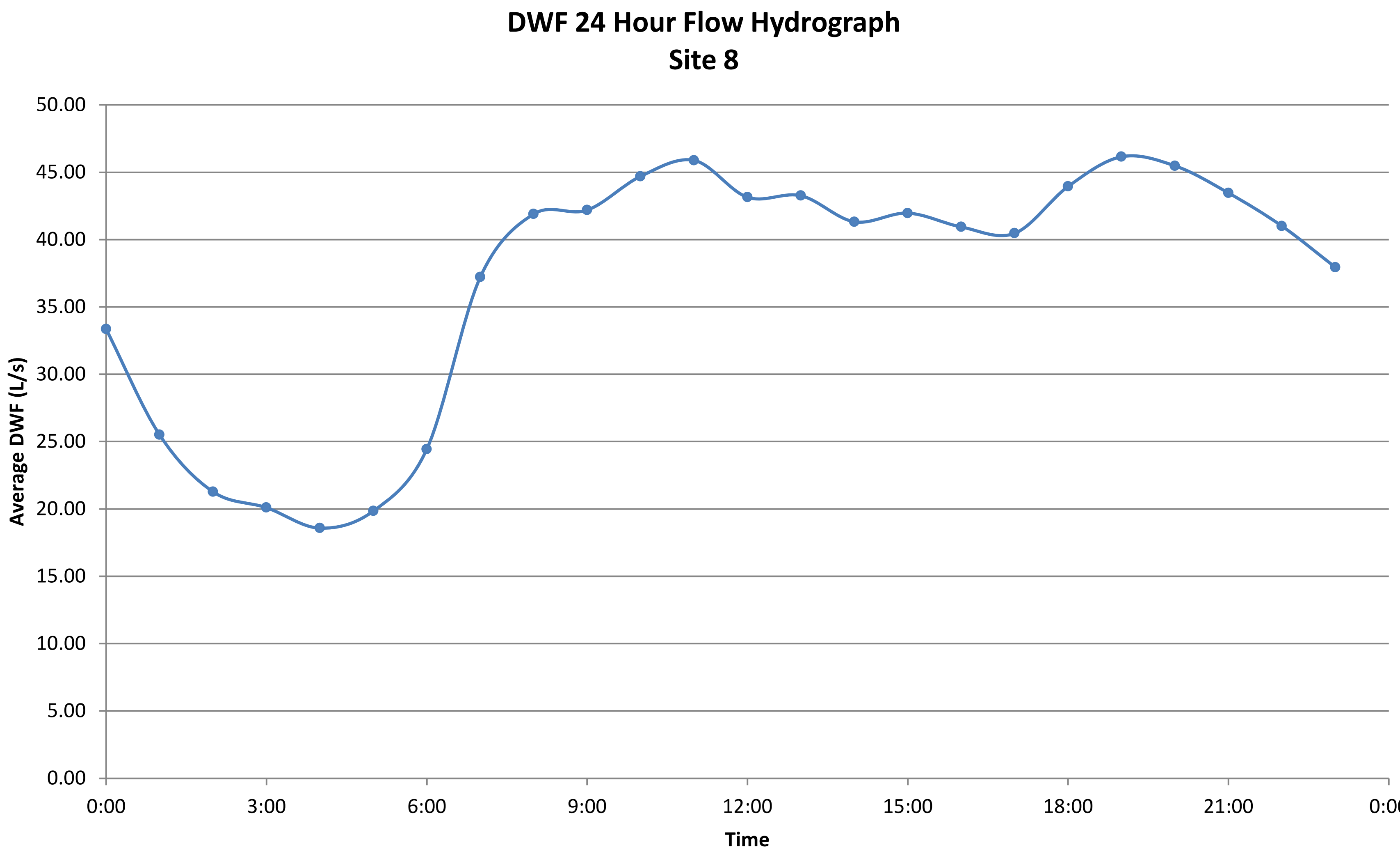


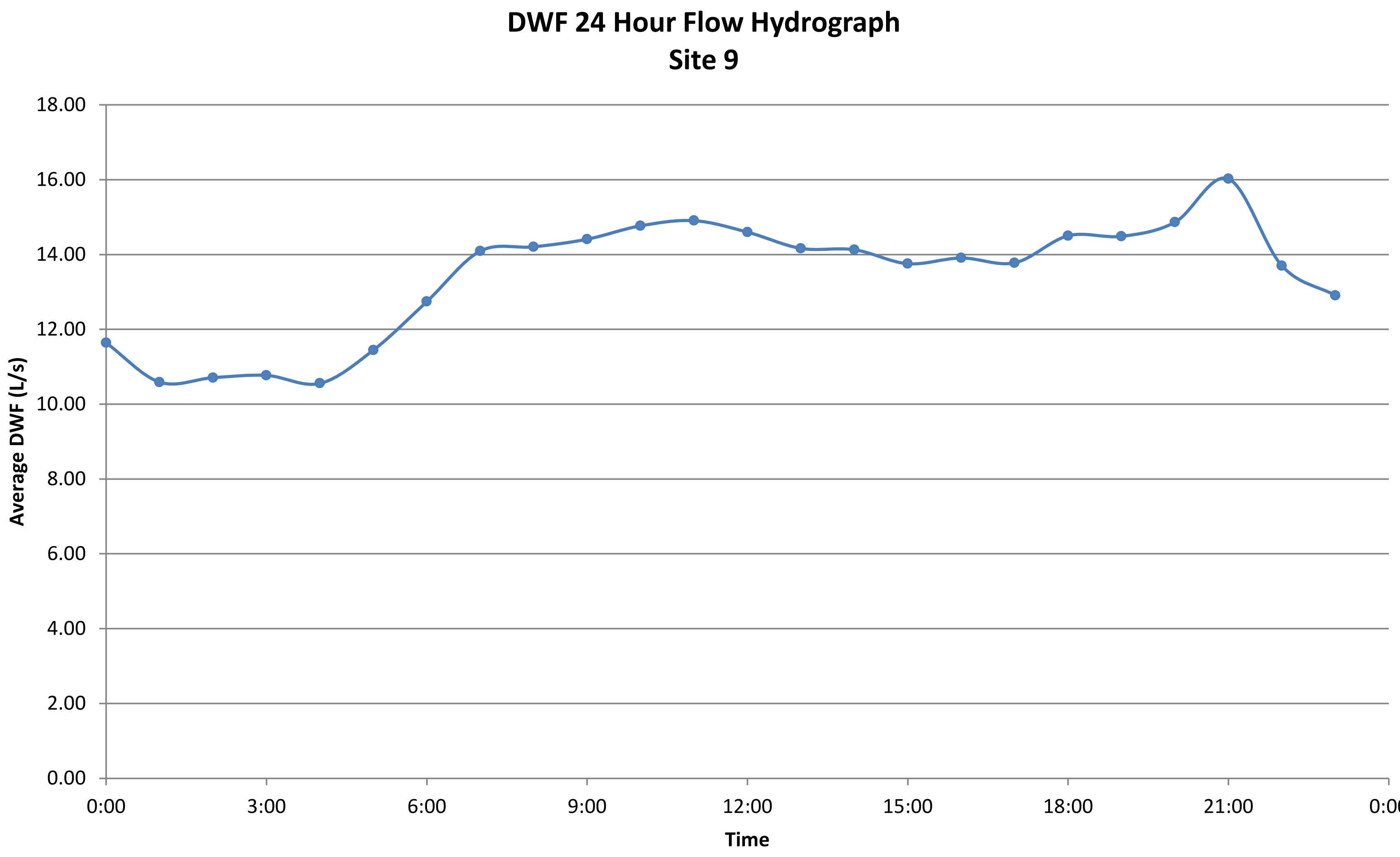
DWF 24 Hour Flow Hydrograph
Site 5
Average DWF (L/s)
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time

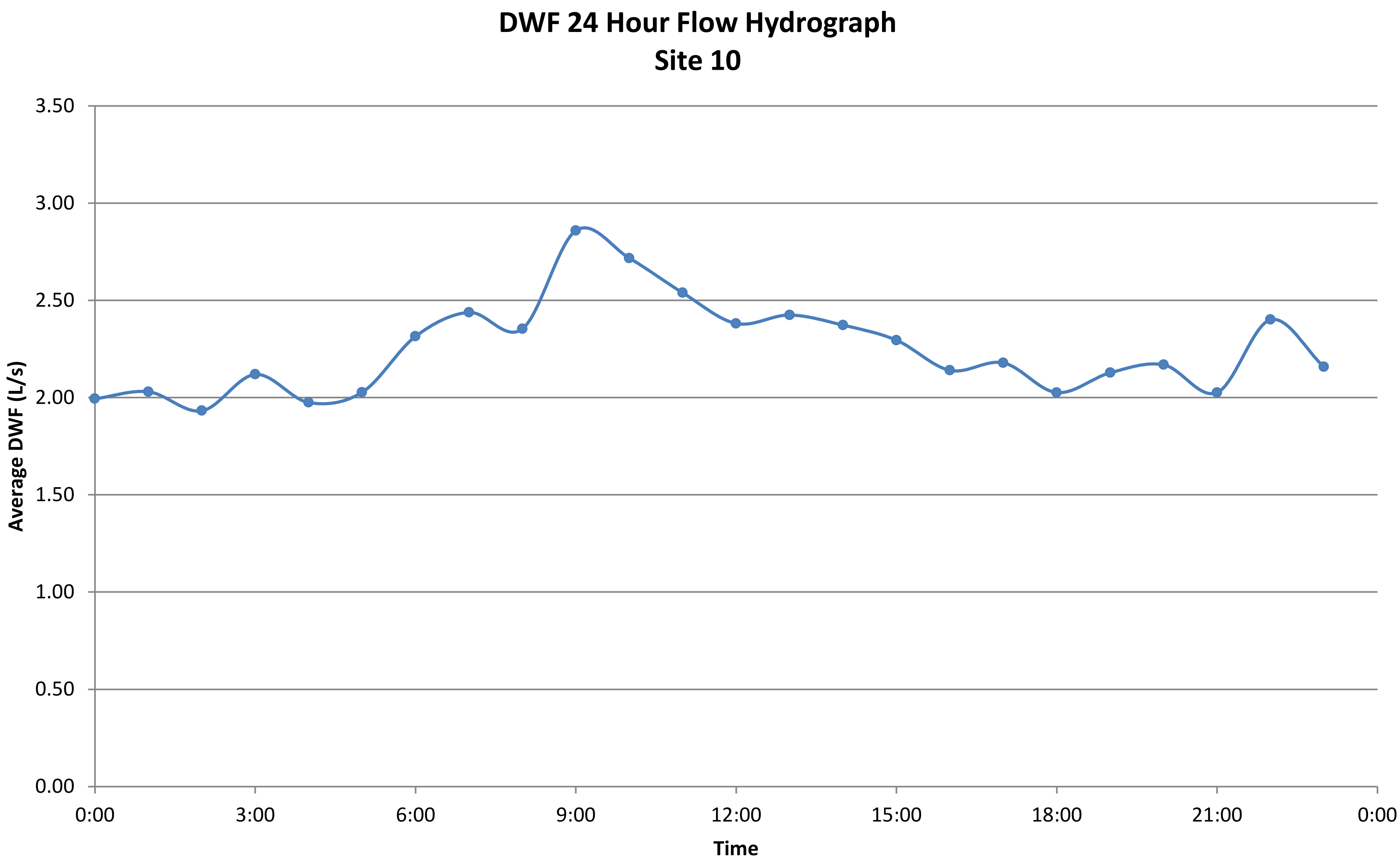

DWF 24 Hour Flow Hydrograph
Site 6
Average DWF (L/s)
25.00
20.00
15.00
10.00
5.00
0.00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time

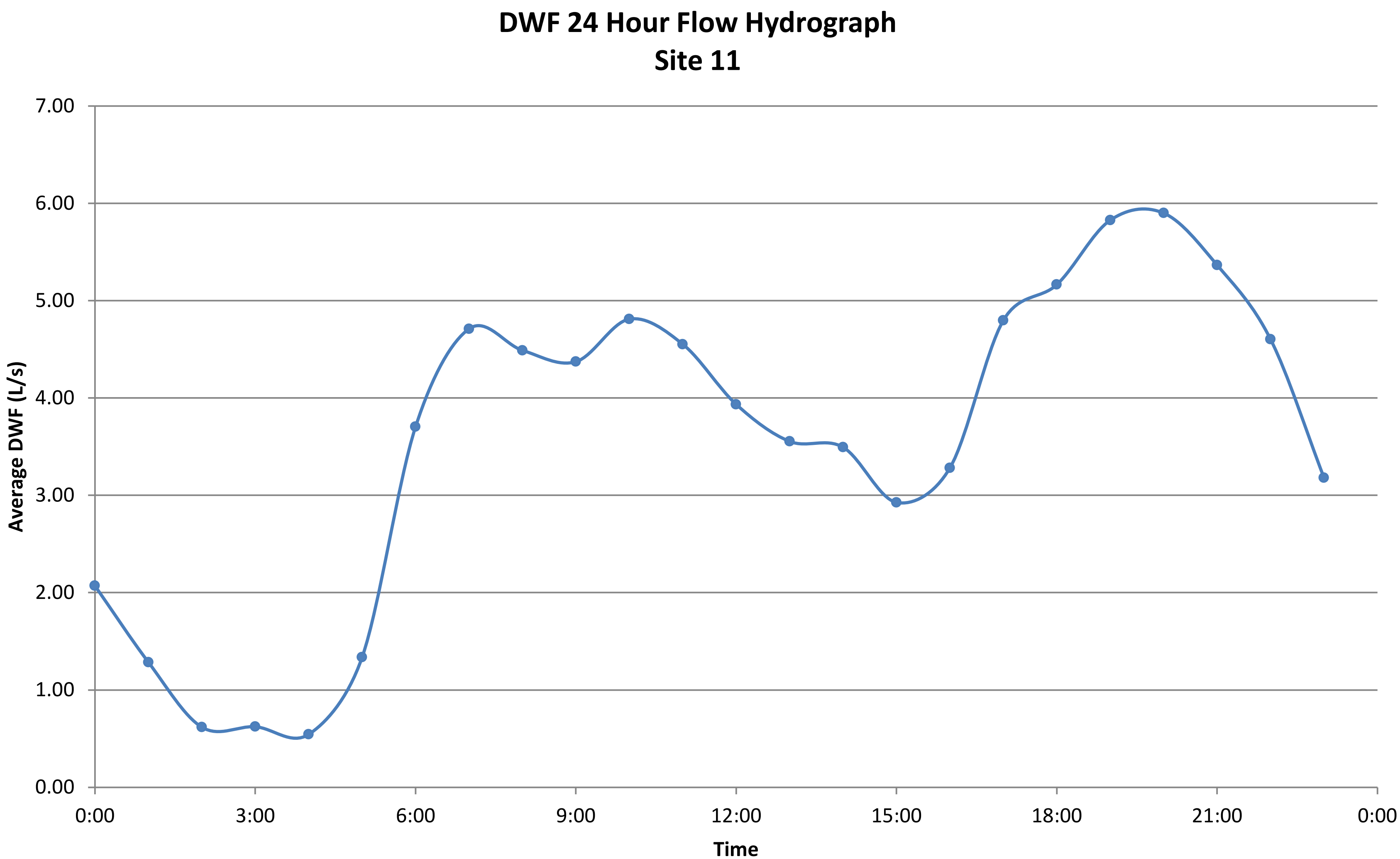


DWF 24 Hour Flow Hydrograph
Site 7
Average DWF (L/s)
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time

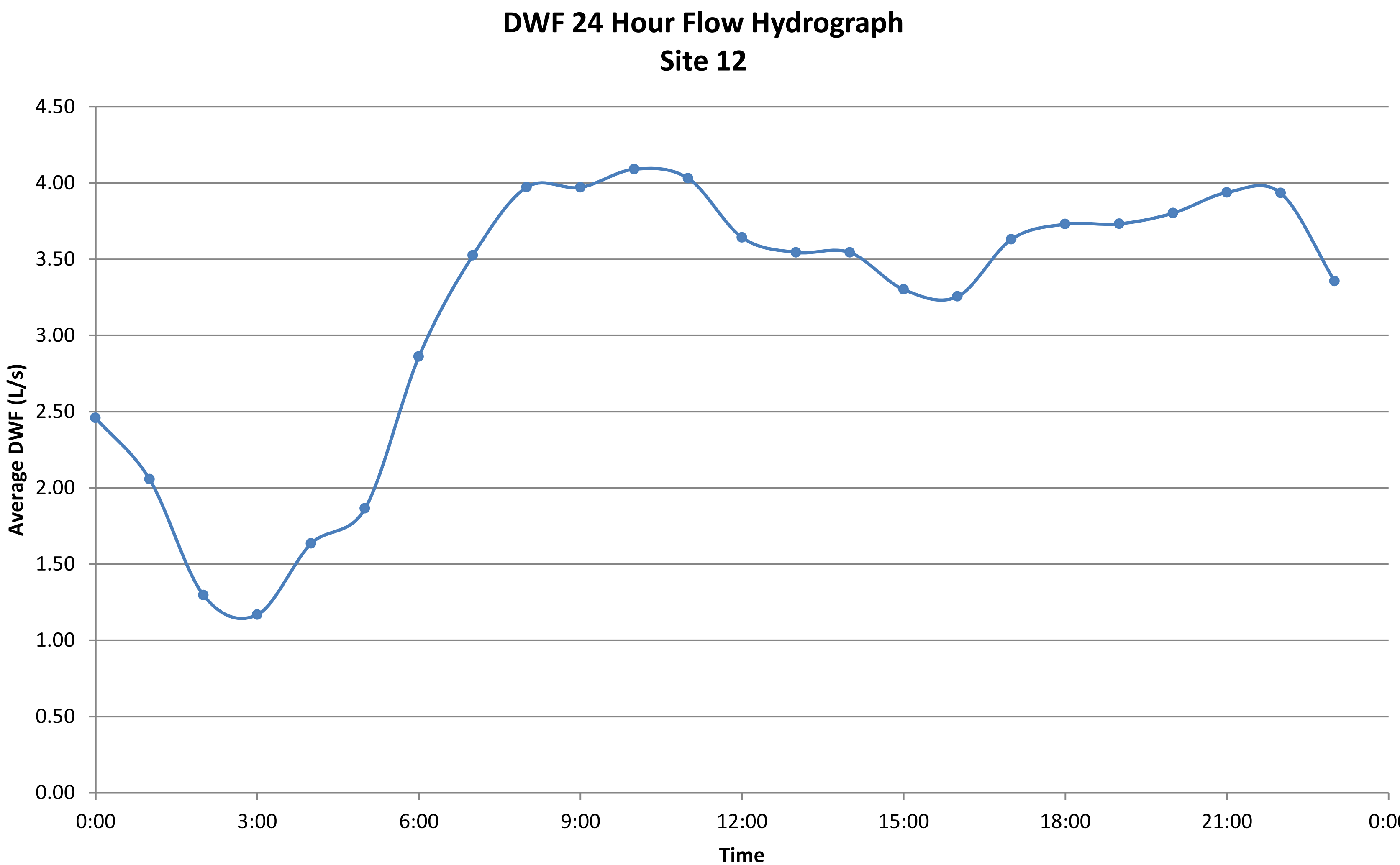

DWF 24 Hour Flow Hydrograph
Site 8
Average DWF (L/s)
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time

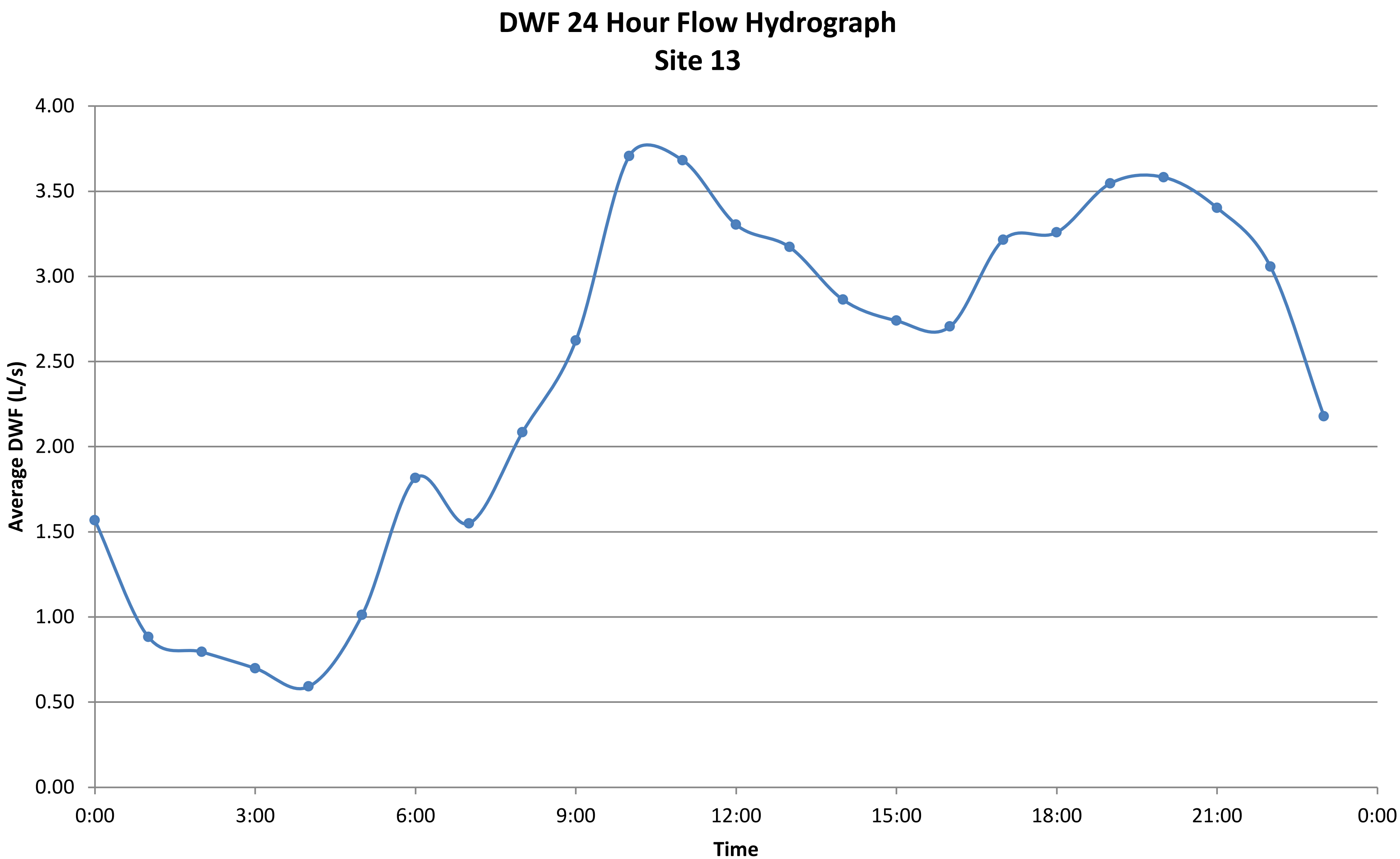

DWF 24 Hour Flow Hydrograph
Site 9
Average DWF (L/s)
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time


DWF 24 Hour Flow Hydrograph
Site 10
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Average DWF (L/s)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time

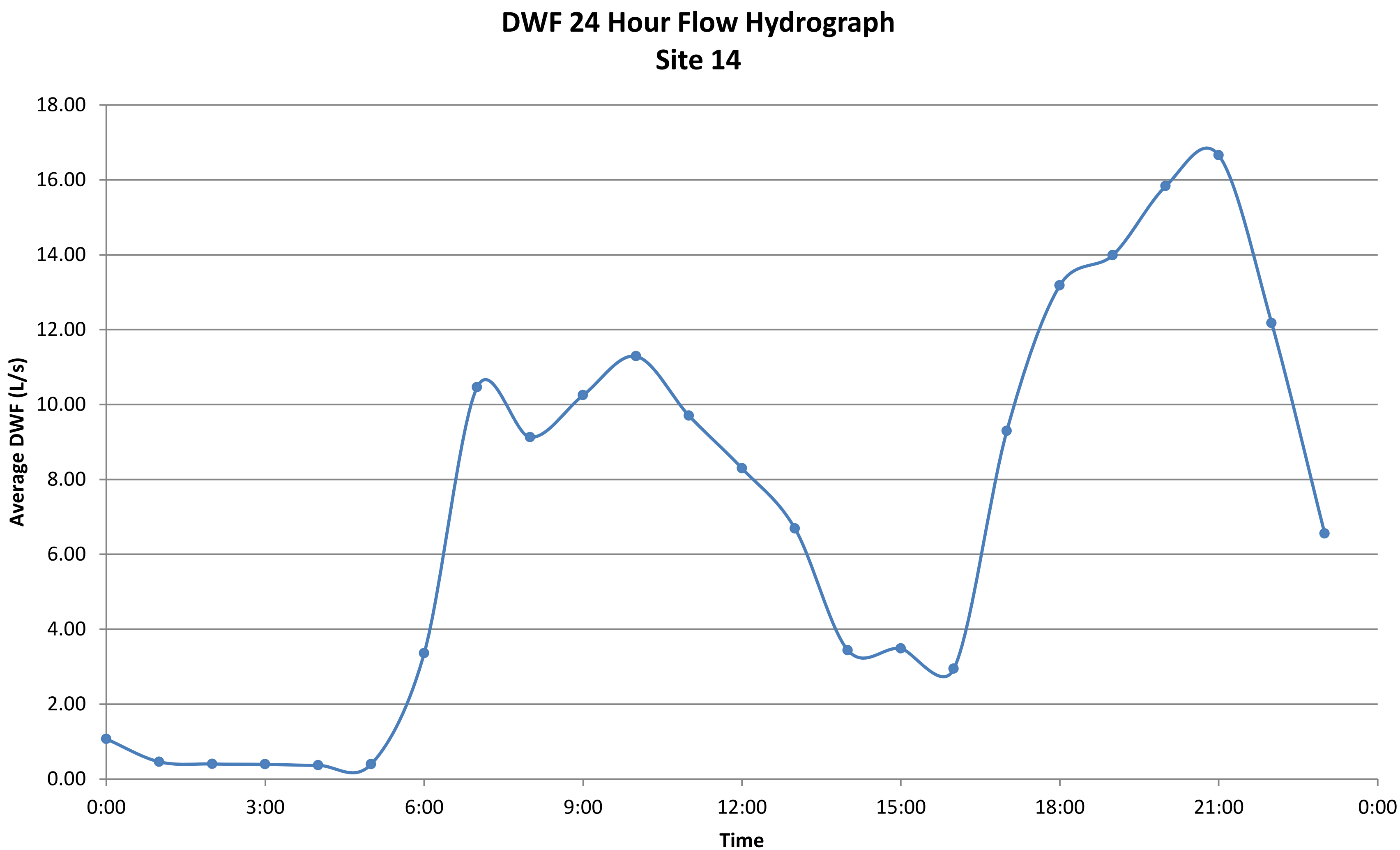


DWF 24 Hour Flow Hydrograph
Site 11
Average DWF (L/s)
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time


DWF 24 Hour Flow Hydrograph
Site 12
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Average DWF (L/s)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time



DWF 24 Hour Flow Hydrograph
Site 13
Average DWF (L/s)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time


DWF 24 Hour Flow Hydrograph
Site 14
Average DWF (L/s)
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time

APPENDIX B
WET WEATHER FLOW DATA HYDROGRAPH

Table B-1 Wet Weather Analysis Events

Site	a Jul 1 16. 6mm	b Jul 3 17.4mm	c Jul 14 45.8mm	d Jul 23 27.4mm	e Aug 4 10.4mm	f Aug 14 45.8mm	g Aug 21 24.6mm
1			X		X		
2			X				X
3			X		X	X	
5			X	X		X	
6			X	X		X	
7			X	X	X	X	
8		X	X	X			
9				X		X	X
10	X	X					
11	X	X	X	X		X	
12	X	X	X	X		X	
13					X	X	X
14			X	X		X	

Table B-2 Site 1

Event #	Date	Begin Analysis	End Analysis	Area (ha)	Average I/I (L/s)	Peak I/I (L/s)	Average I/I Rate (L/s/ha)	Peak I/I Rate (L/s/ha)	Total Volume (m^3)	Total Rain Depth (mm)	Volumetric Runoff Coefficient, Cv
1c	July 14, 2012	July 14, 2012	July 17, 2012	465.8	1.51	9.69	0.003	0.021	403	45.8	0.19%
1e	August 4, 2012	August 4, 2012	August 6, 2012	465.8	2.07	10.8	0.004	0.023	290	10.4	0.60%
					Average		**0.004**	**0.022**			**0.39%**

Table B-3 Site 2

Event #	Date	Begin Analysis	End Analysis	Area (ha)	Average I/I (L/s)	Peak I/I (L/s)	Average I/I Rate (L/s/ha)	Peak I/I Rate (L/s/ha)	Total Volume (m^3)	Total Rain Depth (mm)	Volumetric Runoff Coefficient, Cv
2c	July 14, 2012	July 14, 2012	July 17, 2012	121.8	4.90	114.1	0.04	0.937	989	45.8	1.77%
2g	August 21, 2012	August 21, 2012	August 25, 2012	121.8	2.41	28.7	0.02	0.235	869	25.0	2.85%
					Average		**0.03**	**0.586**			**2.31%**

Table B-4 Site 3

Event #	Date	Begin Analysis	End Analysis	Area (ha)	Average I/I (L/s)	Peak I/I (L/s)	Average I/I Rate (L/s/ha)	Peak I/I Rate (L/s/ha)	Total Volume (m^3)	Total Rain Depth (mm)	Volumetric Runoff Coefficient, Cv
3c	July 14, 2012	July 14, 2012	July 17, 2012	67.6	6.12	35.2	0.09	0.521	1631	45.8	5.27%
3e	August 4, 2012	August 4, 2012	August 7, 2012	67.6	1.05	21.5	0.02	0.318	361	10.4	5.13%
3f	August 14, 2012	August 14, 2012	August 16, 2012	67.6	2.71	22.0	0.04	0.325	481	20.6	3.45%
					Average		**0.05**	**0.388**			**4.62%**

Table B-5 Site 5

Event #	Date	Begin Analysis	End Analysis	Area (ha)	Average I/I (L/s)	Peak I/I (L/s)	Average I/I Rate (L/s/ha)	Peak I/I Rate (L/s/ha)	Total Volume (m^3)	Total Rain Depth (mm)	Volumetric Runoff Coefficient, Cv
5c	July 14, 2012	July 14, 2012	July 16, 2012	48.2	7.55	66.3	0.16	1.375	1359	45.8	6.16%
5d	July 23, 2012	July 23, 2012	July 26, 2012	48.2	2.36	16.2	0.05	0.336	606	28.0	4.49%
5f	August 14, 2012	August 14, 2012	August 16, 2012	48.2	2.61	16.1	0.05	0.334	649	20.6	6.54%
					Average		**0.09**	**0.682**			**5.73%**

Table B-6 Site 6

Event #	Date	Begin Analysis	End Analysis	Area (ha)	Average I/I (L/s)	Peak I/I (L/s)	Average I/I Rate (L/s/ha)	Peak I/I Rate (L/s/ha)	Total Volume (m^3)	Total Rain Depth (mm)	Volumetric Runoff Coefficient, Cv
6c	July 14, 2012	July 14, 2012	July 17, 2012	150.3	9.82	70.6	0.07	0.470	2616	9.8	17.76%
6d	July 23, 2012	July 23, 2012	July 27, 2012	150.3	5.58	104.4	0.04	0.694	1869	28.0	4.44%
6f	August 14, 2012	August 14, 2012	August 15, 2012	150.3	7.15	57.2	0.05	0.381	1158	20.6	3.74%
					Average		**0.05**	**0.515**			**8.65%**

Table B-7 Site 7

Event #	Date	Begin Analysis	End Analysis	Area (ha)	Average I/I (L/s)	Peak I/I (L/s)	Average I/I Rate (L/s/ha)	Peak I/I Rate (L/s/ha)	Total Volume (m^3)	Total Rain Depth (mm)	Volumetric Runoff Coefficient, Cv
7c	July 14, 2012	July 14, 2012	July 17, 2012	93.4	6.18	39.2	0.07	0.420	1645	45.8	3.85%
7d	July 23, 2012	July 23, 2012	July 27, 2012	93.4	3.17	60.7	0.03	0.650	1100	28.0	4.21%
7e	August 4, 2012	August 4, 2012	August 7, 2012	93.4	2.29	23.9	0.02	0.255	666	10.4	6.86%
7f	August 14, 2012	August 14, 2012	August 16, 2012	93.4	2.89	24.6	0.03	0.263	503	20.6	2.61%
					Average		**0.04**	**0.397**			**4.38%**

Table B-8 Site 8

Event #	Date	Begin Analysis	End Analysis	Area (ha)	Average I/I (L/s)	Peak I/I (L/s)	Average I/I Rate (L/s/ha)	Peak I/I Rate (L/s/ha)	Total Volume (m^3)	Total Rain Depth (mm)	Volumetric Runoff Coefficient, Cv
8ab	July 3, 2012	July 3, 2012	July 6, 2012	506.9	5.27	32.8	0.01	0.065	1538	20.2	1.50%
8c	July 14, 2012	July 14, 2012	July 17, 2012	506.9	17.74	142.4	0.04	0.281	4727	45.8	2.04%
8d	July 23, 2012	July 23, 2012	July 26, 2012	506.9	8.48	241.9	0.02	0.477	2839	28.0	2.00%
					Average		**0.02**	**0.274**			**1.85%**

Table B-9 Site 9

Event #	Date	Begin Analysis	End Analysis	Area (ha)	Average I/I (L/s)	Peak I/I (L/s)	Average I/I Rate (L/s/ha)	Peak I/I Rate (L/s/ha)	Total Volume (m^3)	Total Rain Depth (mm)	Volumetric Runoff Coefficient, Cv
9d	July 23, 2012	July 23, 2012	July 25, 2012	39.1	8.49	181.1	0.22	4.632	1712	26.6	16.46%
9f	August 14, 2012	August 14, 2012	August 16, 2012	39.1	3.92	35.7	0.10	0.913	790	20.0	10.10%
9g	August 21, 2012	August 21, 2012	August 23, 2012	39.1	3.80	30.4	0.10	0.777	712	24.6	7.41%
					Average		**0.14**	**2.107**			**11.32%**

Table B-10 Site 10

Event #	Date	Begin Analysis	End Analysis	Area (ha)	Average I/I (L/s)	Peak I/I (L/s)	Average I/I Rate (L/s/ha)	Peak I/I Rate (L/s/ha)	Total Volume (m^3)	Total Rain Depth (mm)	Volumetric Runoff Coefficient, Cv
10a	July 1, 2012	July 1, 2012	July 1, 2012	87.8	1.15	9.8	0.01	0.112	100	16.6	0.69%
10b	July 3, 2012	July 3, 2012	July 5, 2012	87.8	0.81	4.5	0.01	0.051	120	17.4	0.79%
					Average		**0.01**	**0.082**			**0.74%**

Table B-11 Site 11

Event #	Date	Begin Analysis	End Analysis	Area (ha)	Average I/I (L/s)	Peak I/I (L/s)	Average I/I Rate (L/s/ha)	Peak I/I Rate (L/s/ha)	Total Volume (m³)	Total Rain Depth (mm)	Volumetric Runoff Coefficient, Cv
11ab	July 1, 2012	July 1, 2012	July 7, 2012	27.4	0.92	8.1	0.03	0.297	458	36.8	4.54%
11c	July 14, 2012	July 14, 2012	July 21, 2012	27.4	0.64	10.0	0.02	0.366	390	55.2	2.58%
11d	July 23, 2012	July 23, 2012	July 26, 2012	27.4	0.44	8.6	0.02	0.315	117	28.0	1.52%
11f	August 14, 2012	August 14, 2012	August 16, 2012	27.4	0.56	5.1	0.02	0.185	97	20.6	1.71%
					Average		**0.02**	**0.291**			**2.59%**

Table B-12 Site 12

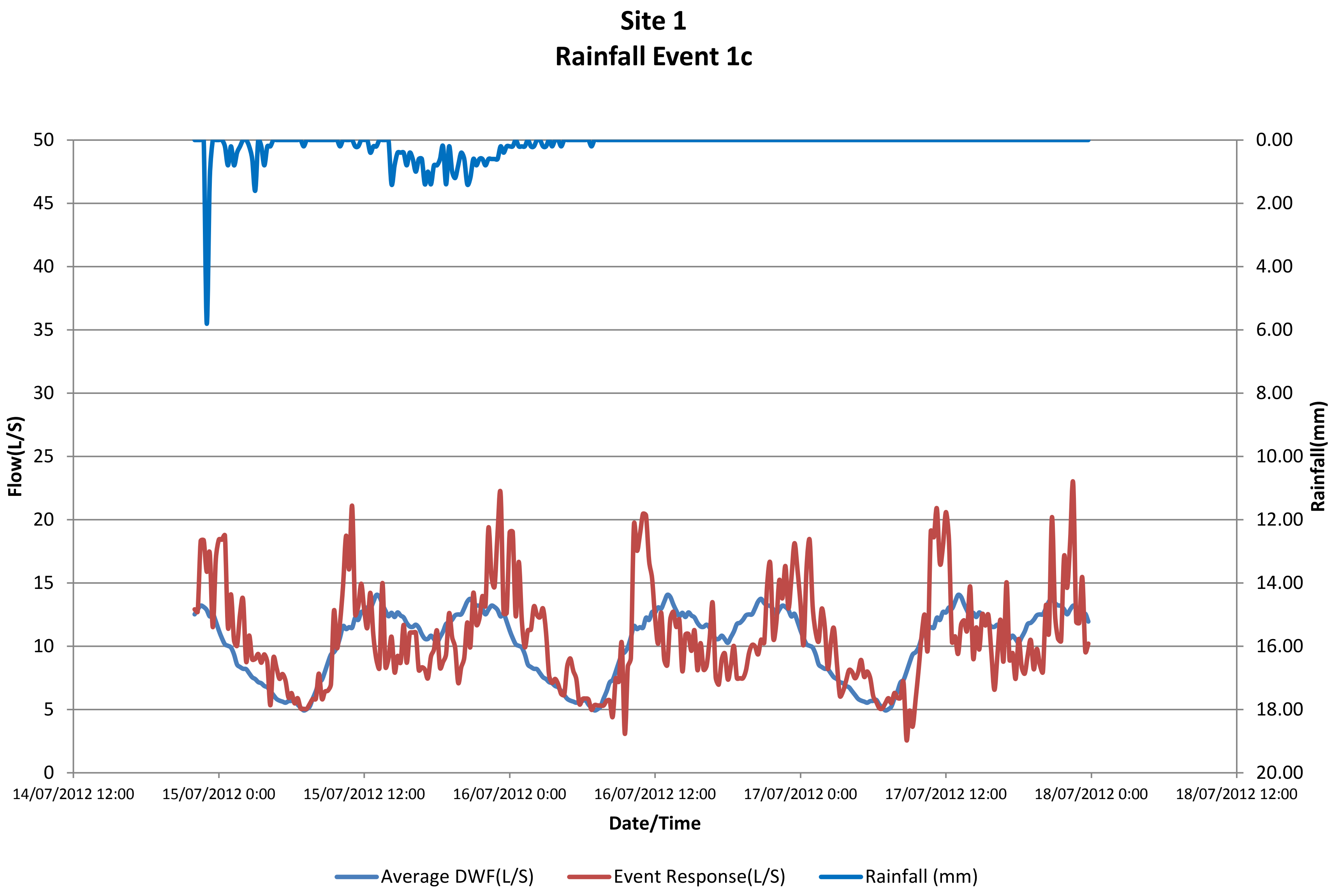
Event #	Date	Begin Analysis	End Analysis	Area (ha)	Average I/I (L/s)	Peak I/I (L/s)	Average I/I Rate (L/s/ha)	Peak I/I Rate (L/s/ha)	Total Volume (m³)	Total Rain Depth (mm)	Volumetric Runoff Coefficient, Cv
12ab	July 1, 2012	July 1, 2012	July 6, 2012	32.1	0.57	3.6	0.02	0.113	278	36.8	2.35%
12c	July 14, 2012	July 14, 2012	July 17, 2012	32.1	3.20	17.1	0.10	0.531	614	45.8	4.17%
12d	July 23, 2012	July 23, 2012	July 27, 2012	32.1	1.88	62.1	0.06	1.935	653	28.0	7.26%
12f	August 14, 2012	August 14, 2012	August 16, 2012	32.1	1.39	11.3	0.04	0.351	241	20.6	3.64%
					Average		**0.06**	**0.732**			**4.36%**

Table B-13 Site 13

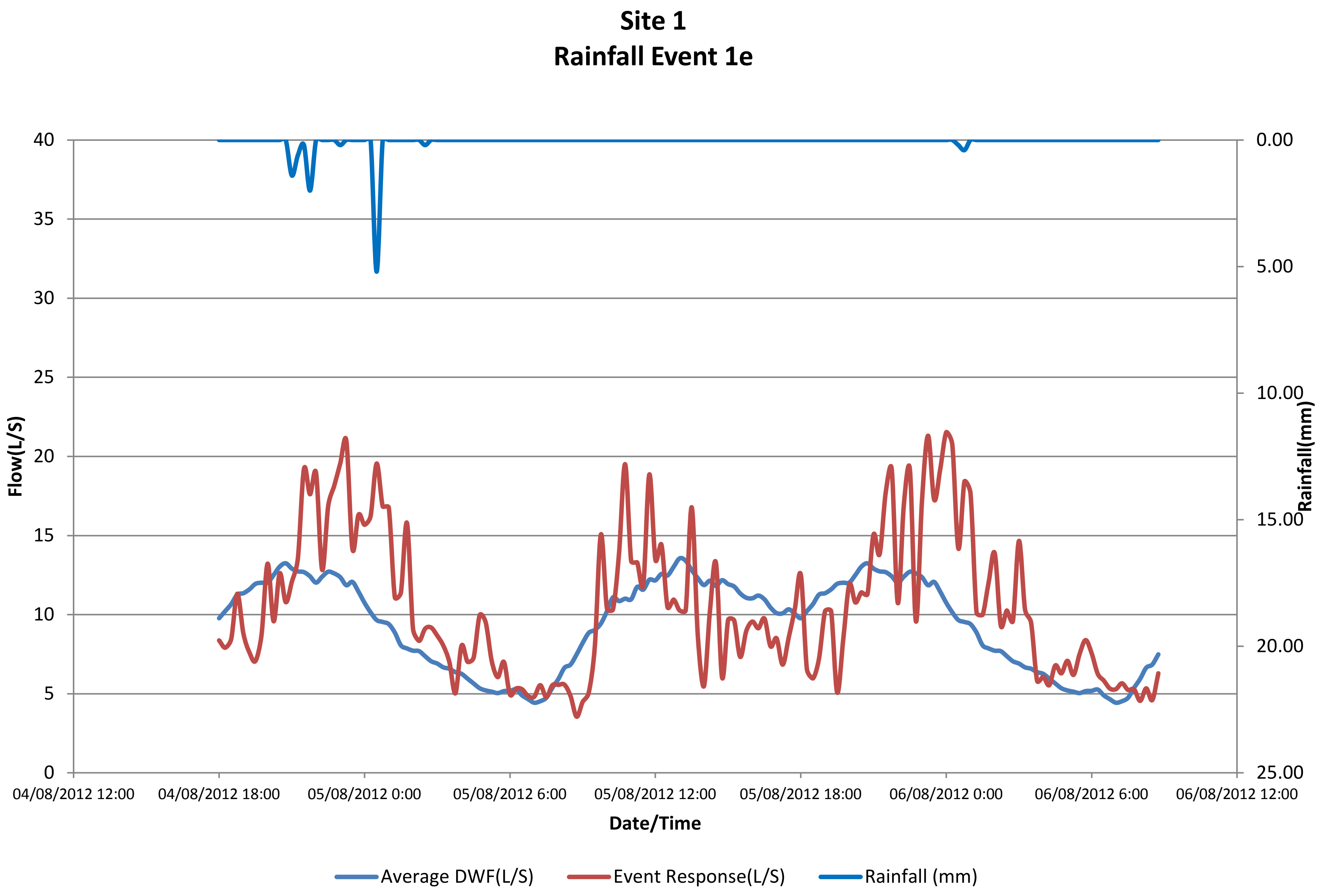
Event #	Date	Begin Analysis	End Analysis	Area (ha)	Average I/I (L/s)	Peak I/I (L/s)	Average I/I Rate (L/s/ha)	Peak I/I Rate (L/s/ha)	Total Volume (m^3)	Total Rain Depth (mm)	Volumetric Runoff Coefficient, Cv
13e	August 4, 2012	August 4, 2012	August 6, 2012	70.3	0.96	3.5	0.01	0.050	124	10.4	1.70%
13f	August 14, 2012	August 14, 2012	August 15, 2012	70.3	1.20	6.1	0.02	0.086	159	20.6	1.10%
13g	August 21, 2012	August 21, 2012	August 24, 2012	70.3	0.59	3.9	0.01	0.055	162	24.8	0.93%
					Average		**0.01**	**0.064**			**1.24%**

Table B-14 Site 14

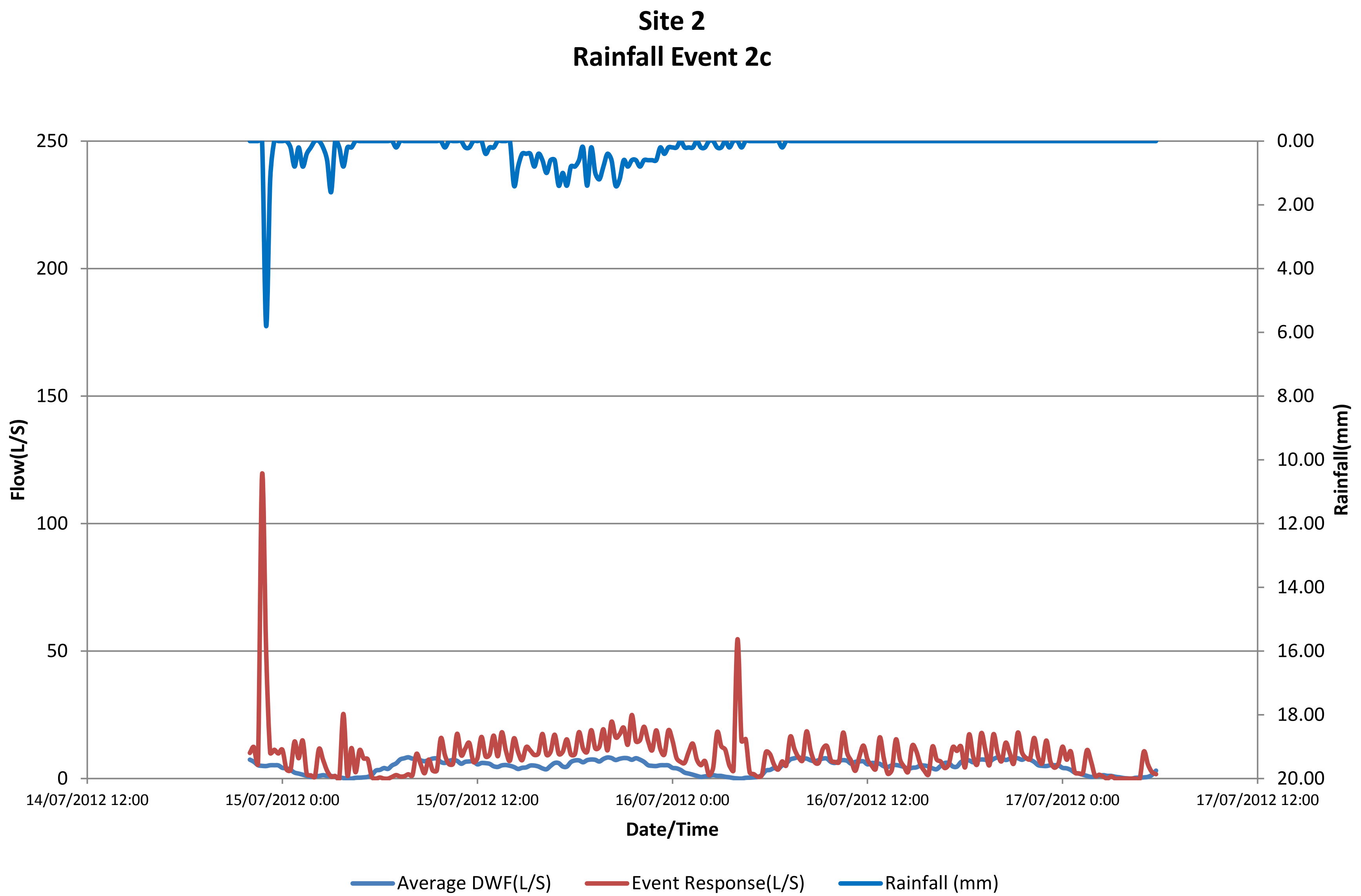
Event #	Date	Begin Analysis	End Analysis	Area (ha)	Average I/I (L/s)	Peak I/I (L/s)	Average I/I Rate (L/s/ha)	Peak I/I Rate (L/s/ha)	Total Volume (m^3)	Total Rain Depth (mm)	Volumetric Runoff Coefficient, Cv
14c	July 14, 2012	July 14, 2012	July 20, 2012	132.2	4.57	53.5	0.03	0.405	2079	53.8	2.92%
14d	July 23, 2012	July 23, 2012	July 26, 2012	132.2	2.49	83.6	0.02	0.632	648	28.0	1.75%
14f	August 14, 2012	August 14, 2012	August 16, 2012	132.2	1.51	25.9	0.01	0.196	266	20.6	0.98%
					Average		**0.02**	**0.41**			**1.36%**



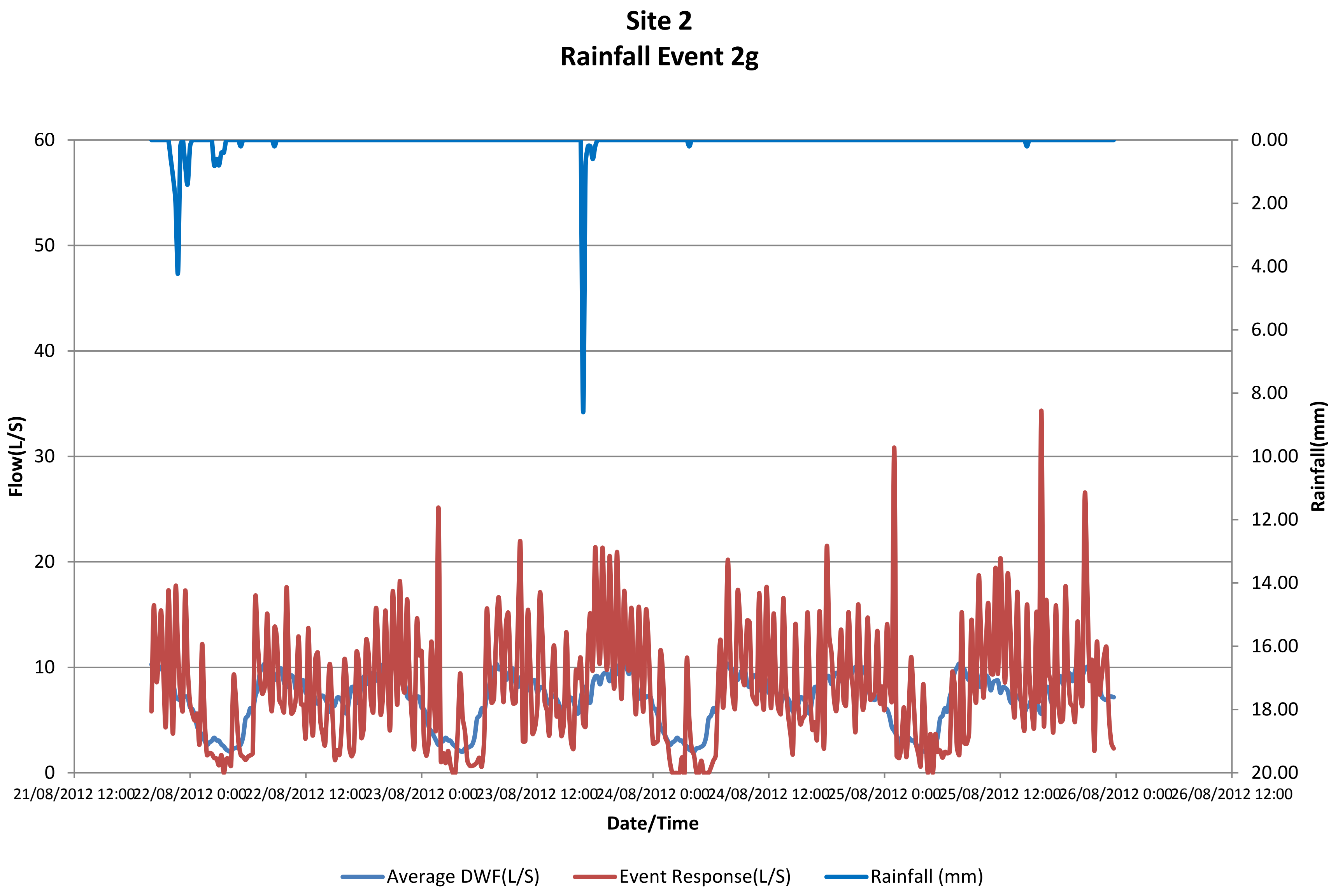
Site 1
Rainfall Event 1c
Flow(L/S)
Rainfall(mm)
50
45
40
35
30
25
20
15
10
5
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
14/07/2012 12:00
15/07/2012 0:00
15/07/2012 12:00
16/07/2012 0:00
16/07/2012 12:00
17/07/2012 0:00
17/07/2012 12:00
18/07/2012 0:00
18/07/2012 12:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)



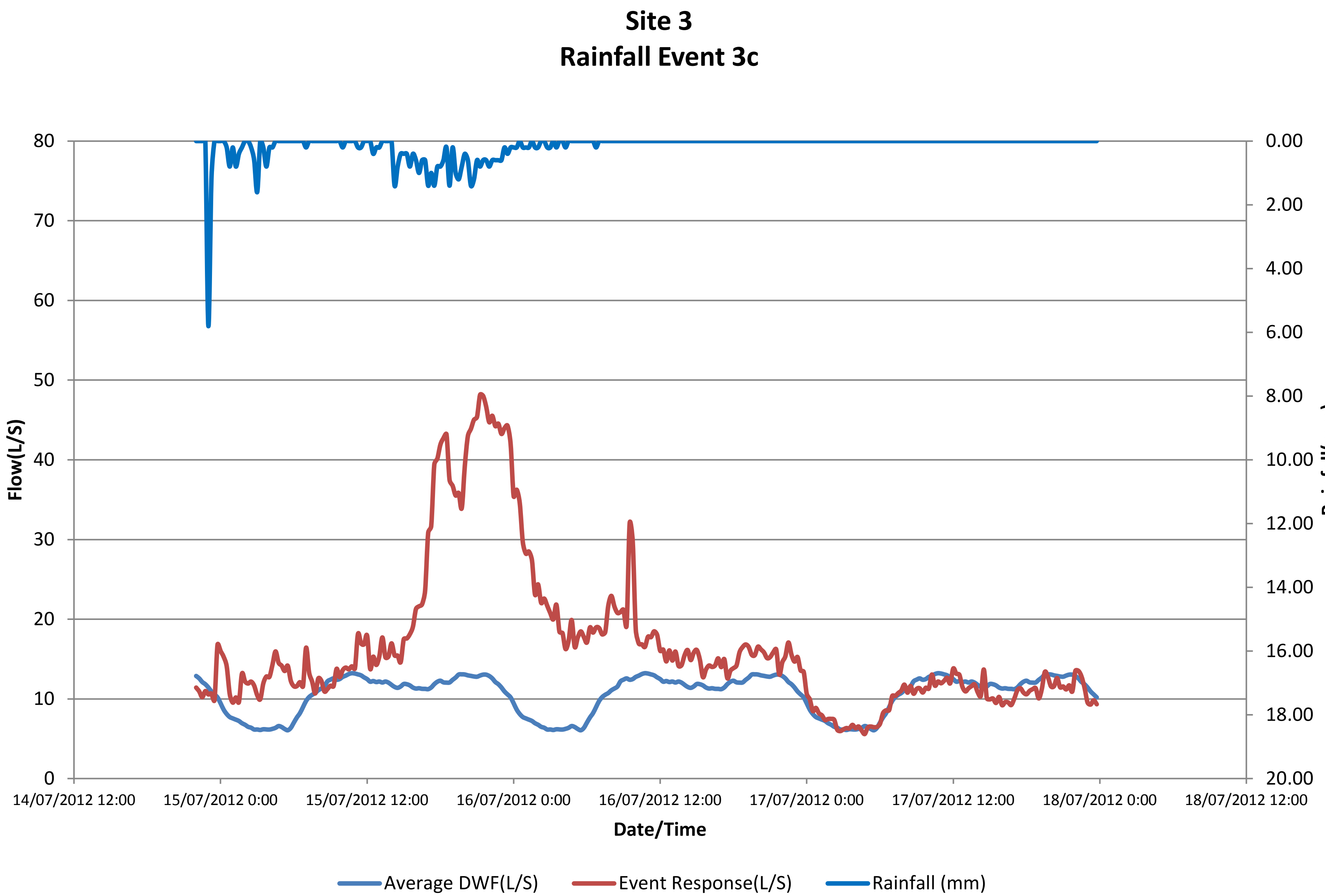
Site 1
Rainfall Event 1e
Flow(L/S)
Rainfall(mm)
40
35
30
25
20
15
10
5
0
0.00
5.00
10.00
15.00
20.00
25.00
04/08/2012 12:00
04/08/2012 18:00
05/08/2012 0:00
05/08/2012 6:00
05/08/2012 12:00
05/08/2012 18:00
06/08/2012 0:00
06/08/2012 6:00
06/08/2012 12:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)



Site 2
Rainfall Event 2c
250
200
150
100
50
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Flow(L/S)
Rainfall(mm)
14/07/2012 12:00
15/07/2012 0:00
15/07/2012 12:00
16/07/2012 0:00
16/07/2012 12:00
17/07/2012 0:00
17/07/2012 12:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

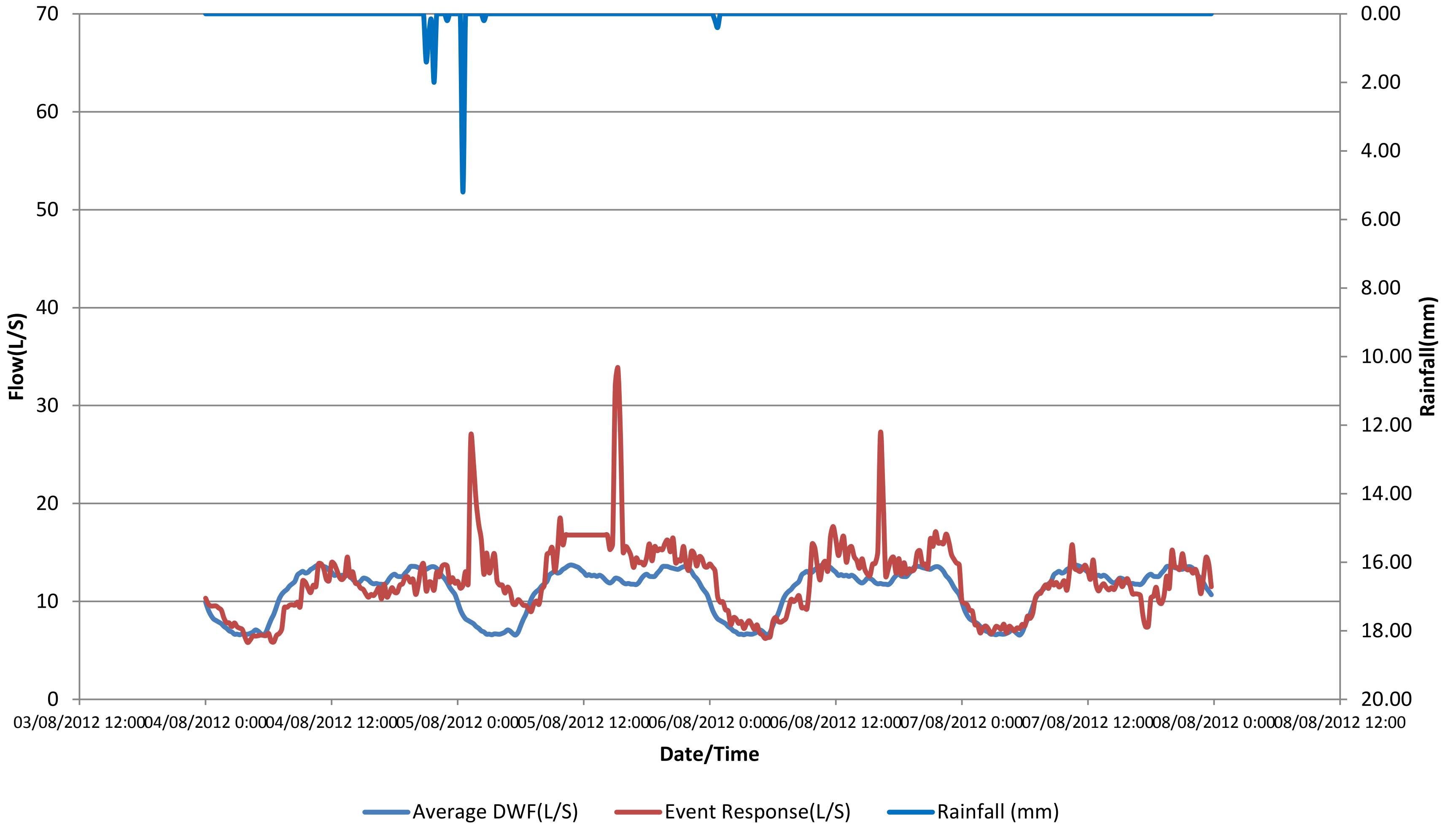


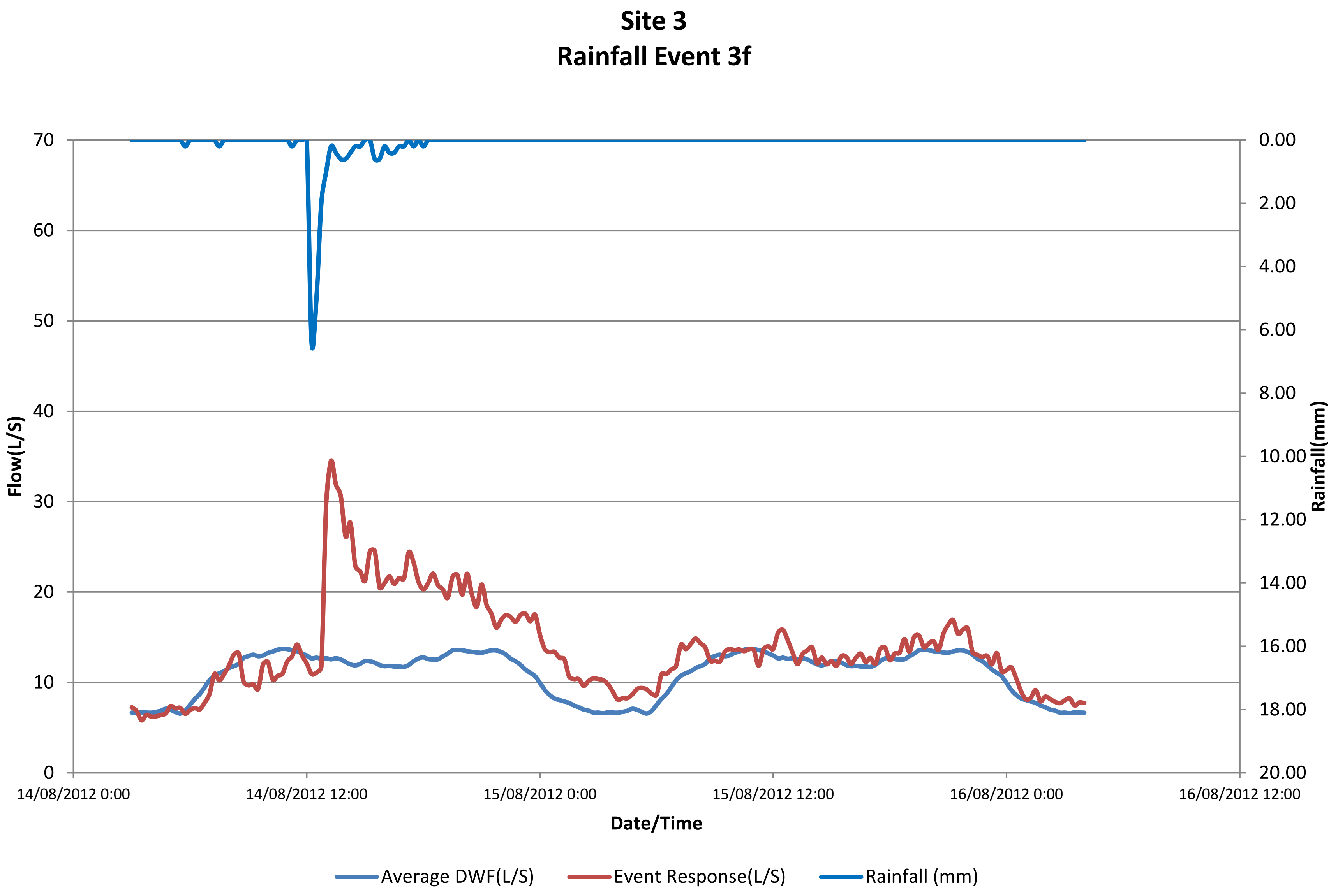
Site 2
Rainfall Event 2g
Flow(L/S)
Rainfall(mm)
60
50
40
30
20
10
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
21/08/2012 12:00
22/08/2012 0:00
22/08/2012 12:00
23/08/2012 0:00
23/08/2012 12:00
24/08/2012 0:00
24/08/2012 12:00
25/08/2012 0:00
25/08/2012 12:00
26/08/2012 0:00
26/08/2012 12:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

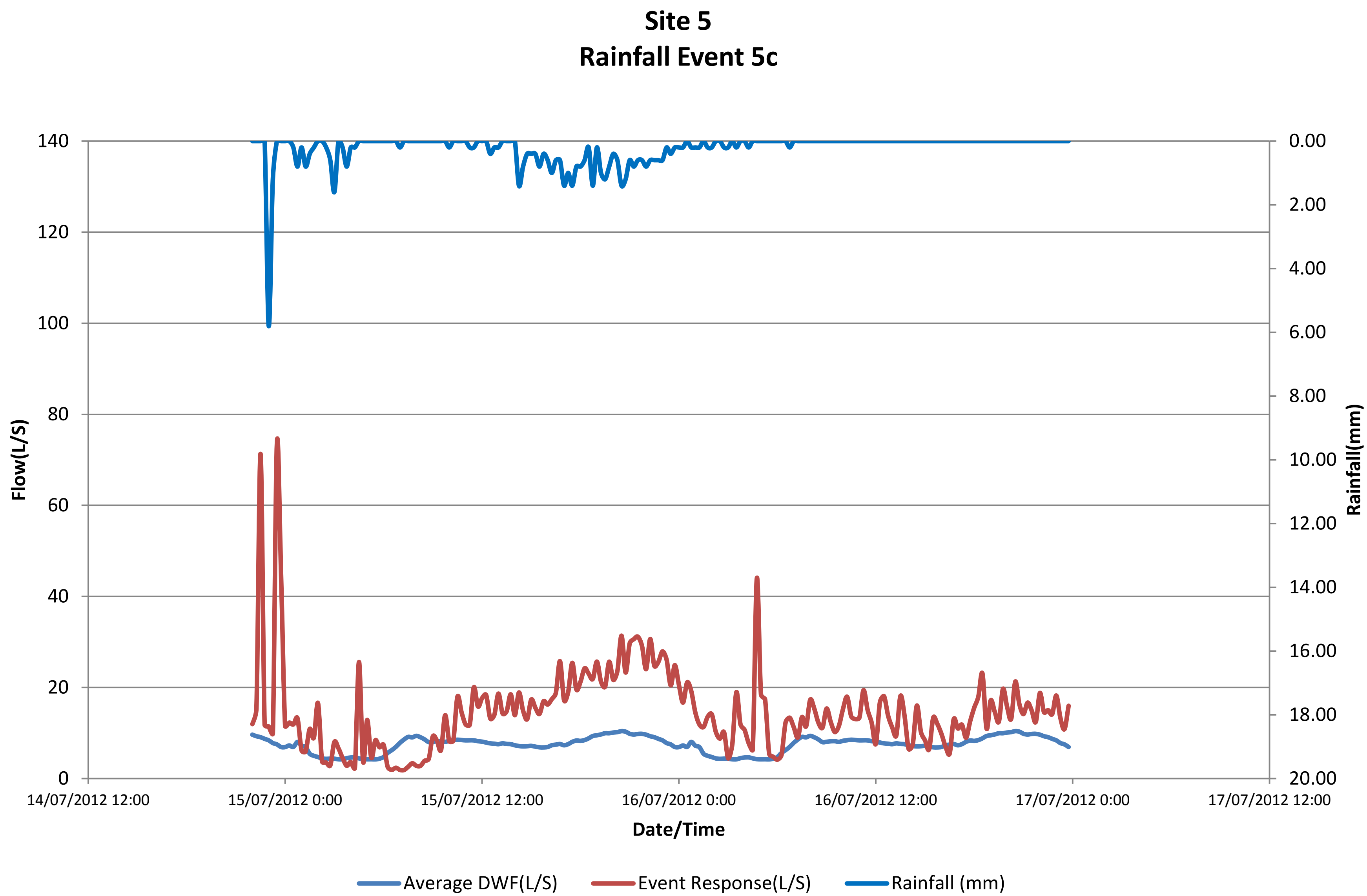


Site 3
Rainfall Event 3c
80
70
60
50
40
30
20
10
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Flow(L/S)
Rainfall(mm)
14/07/2012 12:00
15/07/2012 0:00
15/07/2012 12:00
16/07/2012 0:00
16/07/2012 12:00
17/07/2012 0:00
17/07/2012 12:00
18/07/2012 0:00
18/07/2012 12:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

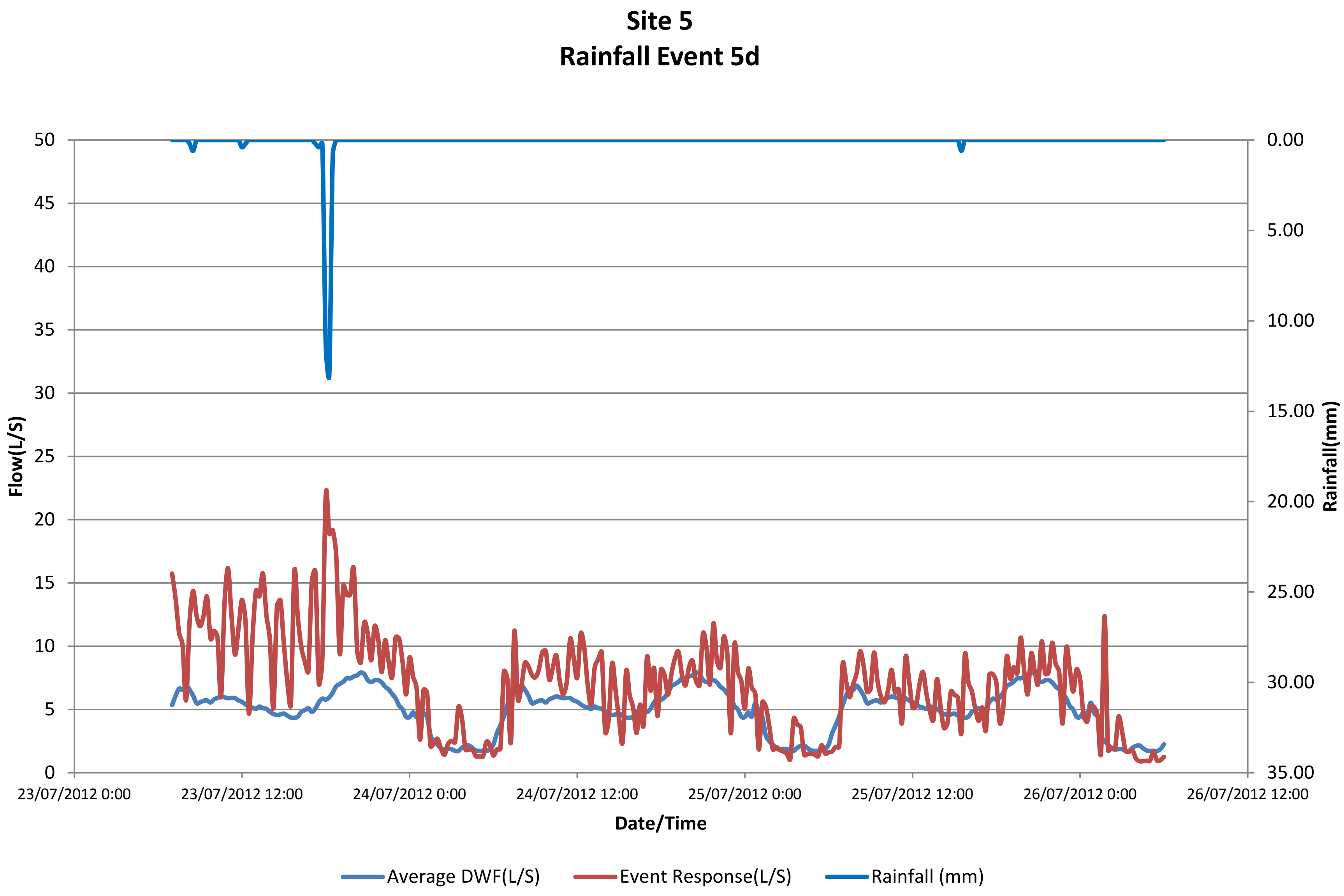
Site 3
Rainfall Event 3e

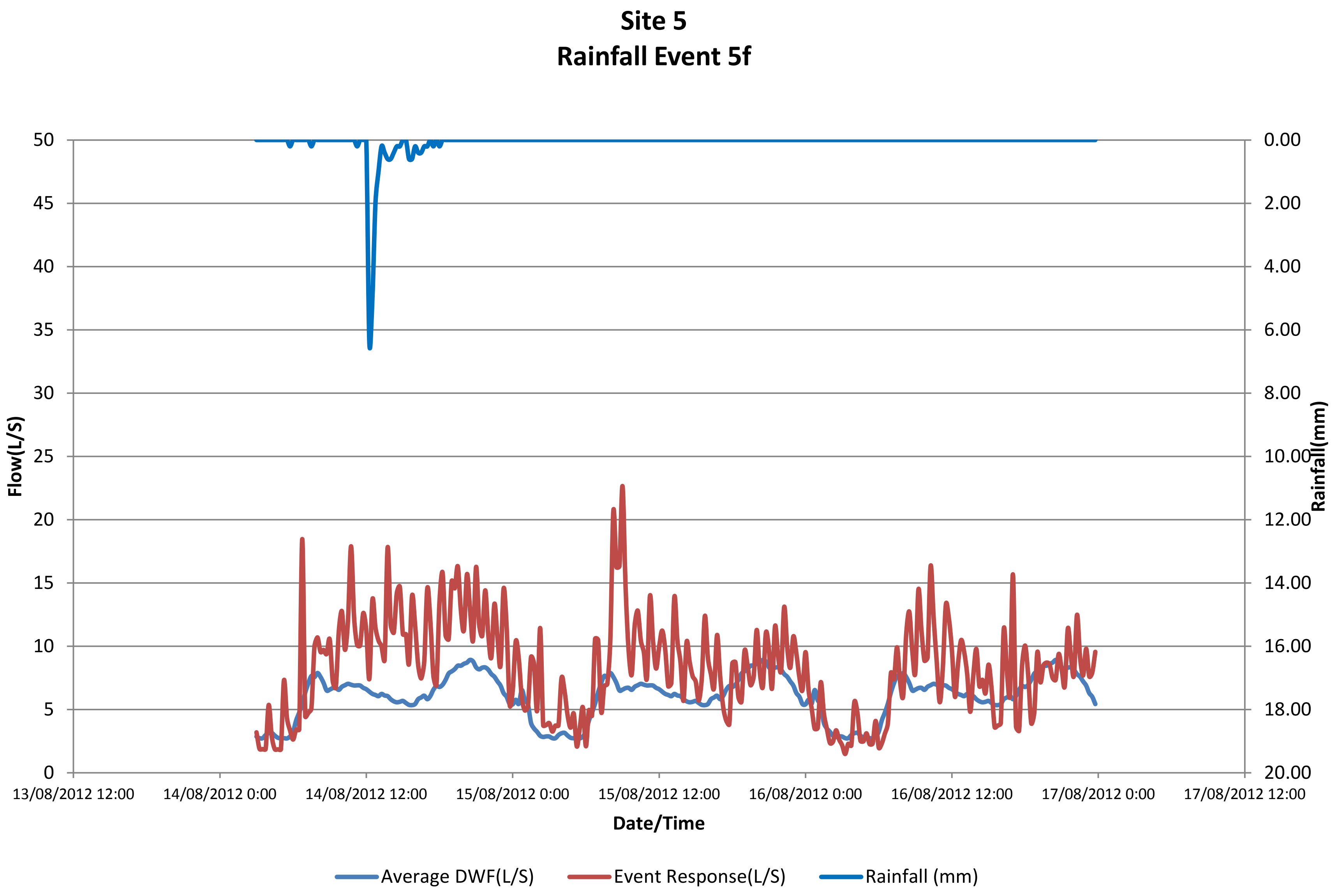



Site 3
Rainfall Event 3f
70
60
50
40
30
20
10
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Flow(L/S)
Rainfall(mm)
14/08/2012 0:00
14/08/2012 12:00
15/08/2012 0:00
15/08/2012 12:00
16/08/2012 0:00
16/08/2012 12:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

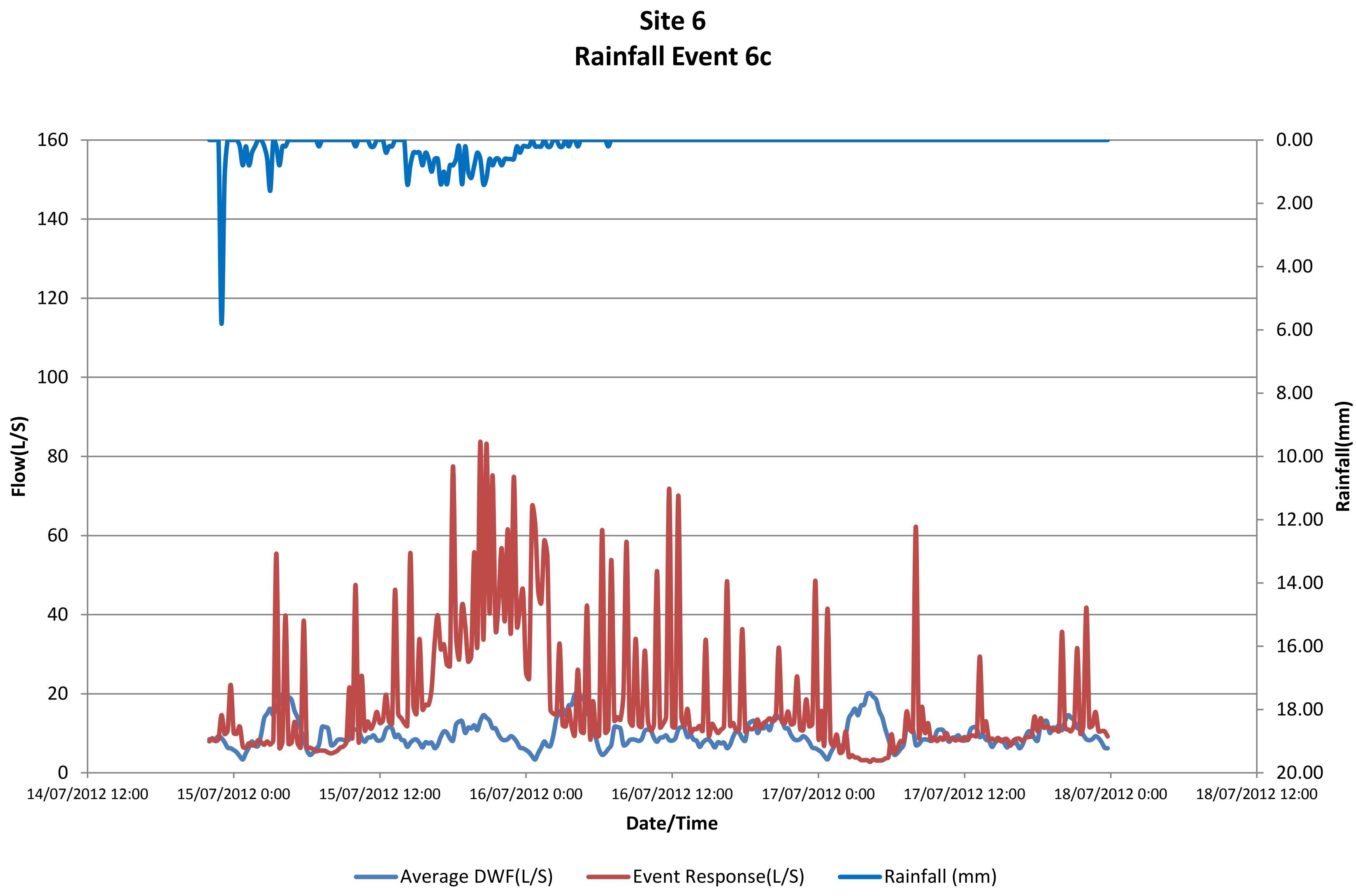


Site 5
Rainfall Event 5c
140
120
100
80
60
40
20
0
Flow(L/S)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Rainfall(mm)
14/07/2012 12:00
15/07/2012 0:00
15/07/2012 12:00
16/07/2012 0:00
16/07/2012 12:00
17/07/2012 0:00
17/07/2012 12:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

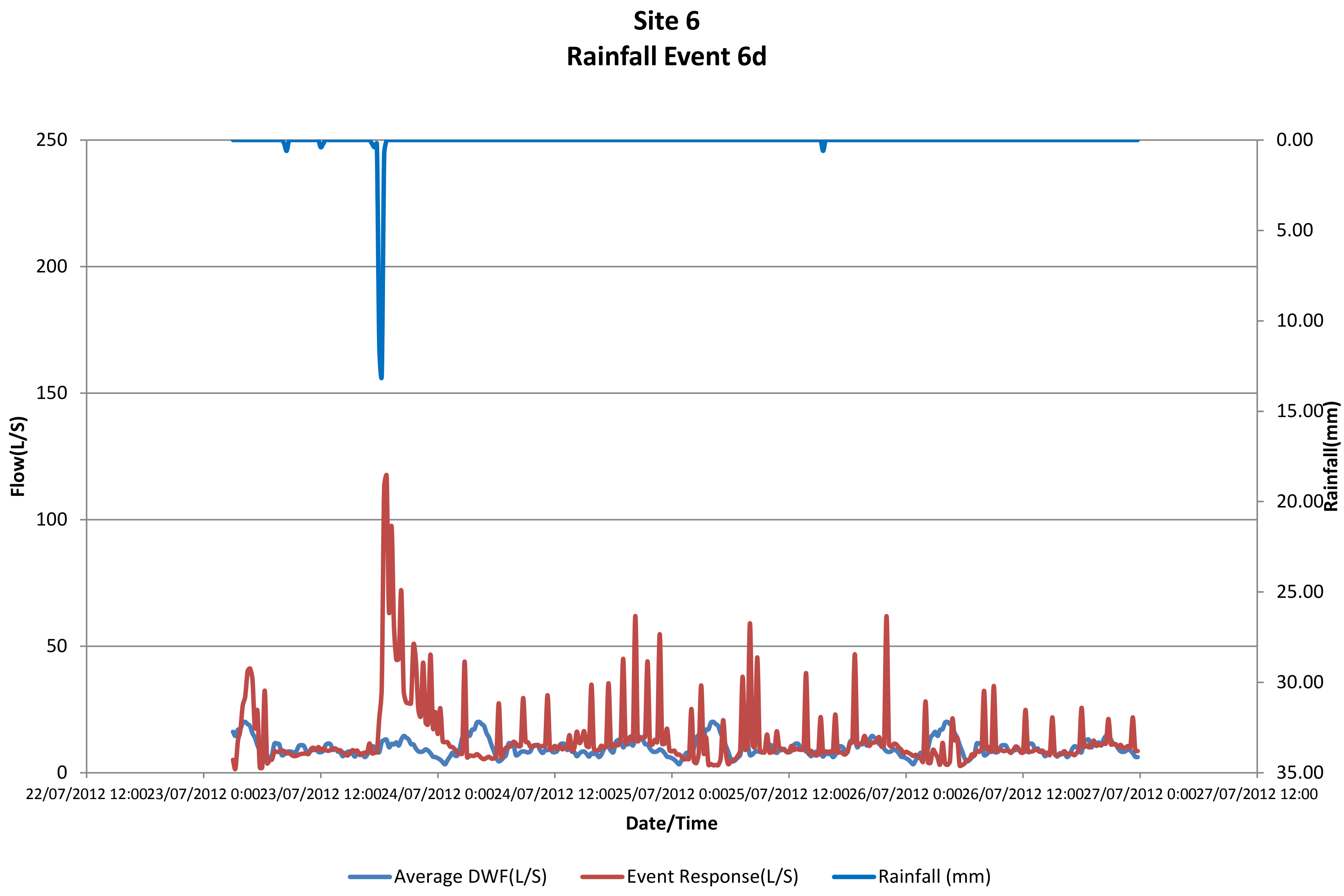

Site 5
Rainfall Event 5d
Flow(L/S)
50
45
40
35
30
25
20
15
10
5
0
Rainfall(mm)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
23/07/2012 0:00
23/07/2012 12:00
24/07/2012 0:00
24/07/2012 12:00
25/07/2012 0:00
25/07/2012 12:00
26/07/2012 0:00
26/07/2012 12:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)



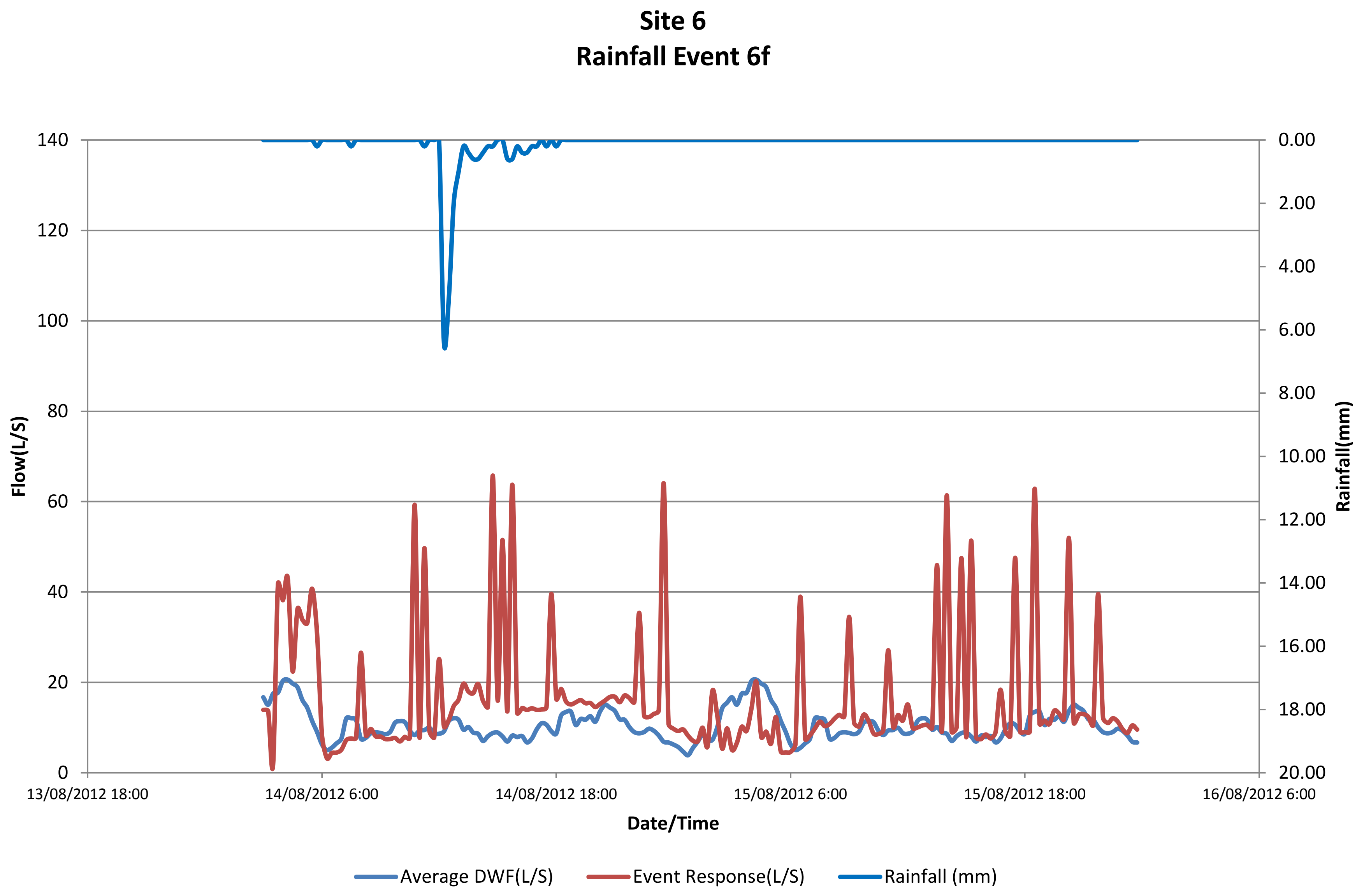
Site 5
Rainfall Event 5f
Flow(L/S)
Rainfall(mm)
50
45
40
35
30
25
20
15
10
5
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
13/08/2012 12:00
14/08/2012 0:00
14/08/2012 12:00
15/08/2012 0:00
15/08/2012 12:00
16/08/2012 0:00
16/08/2012 12:00
17/08/2012 0:00
17/08/2012 12:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)



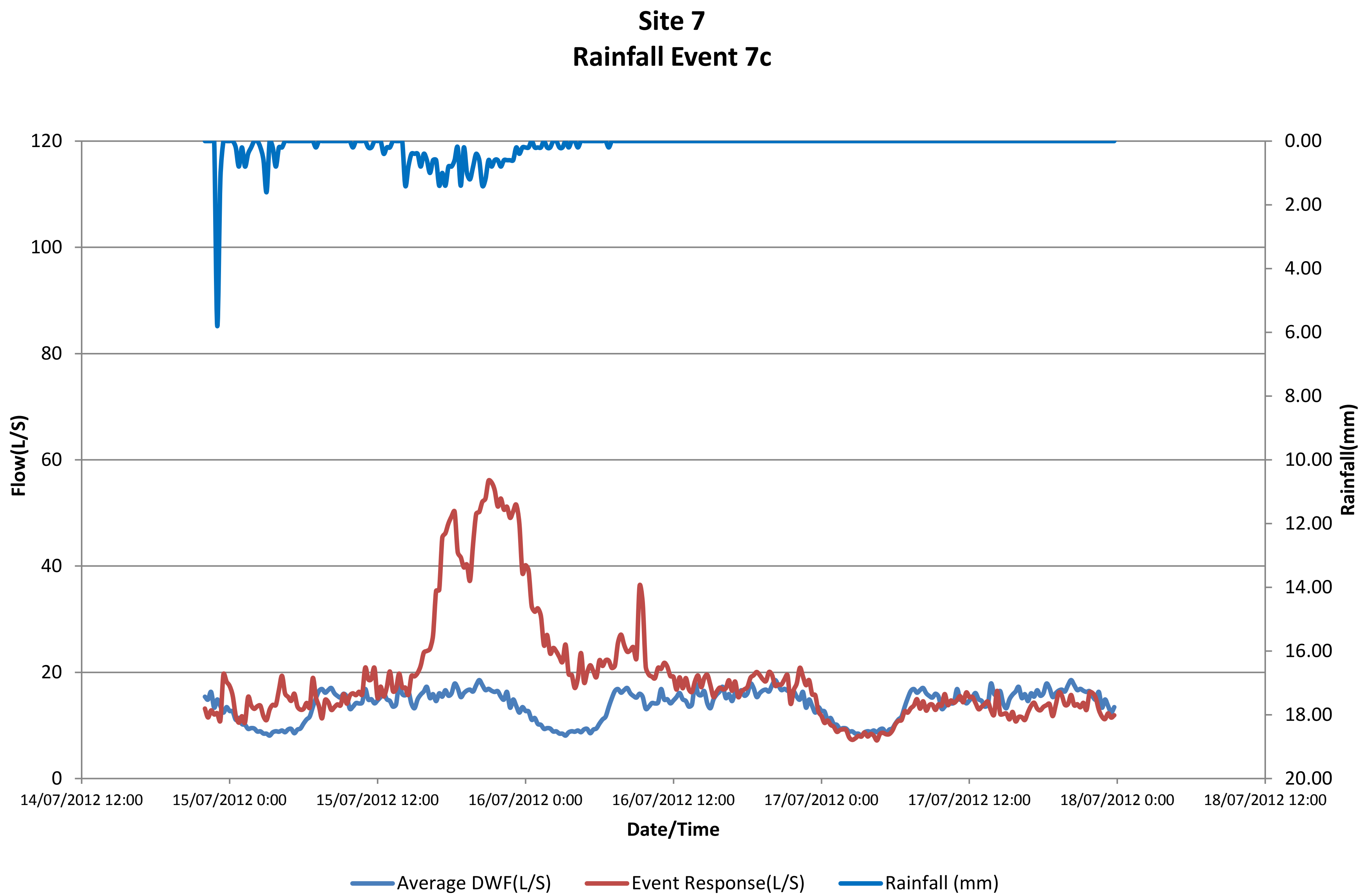
Site 6
Rainfall Event 6c
Flow(L/S)
Rainfall(mm)
160
140
120
100
80
60
40
20
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
14/07/2012 12:00
15/07/2012 0:00
15/07/2012 12:00
16/07/2012 0:00
16/07/2012 12:00
17/07/2012 0:00
17/07/2012 12:00
18/07/2012 0:00
18/07/2012 12:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

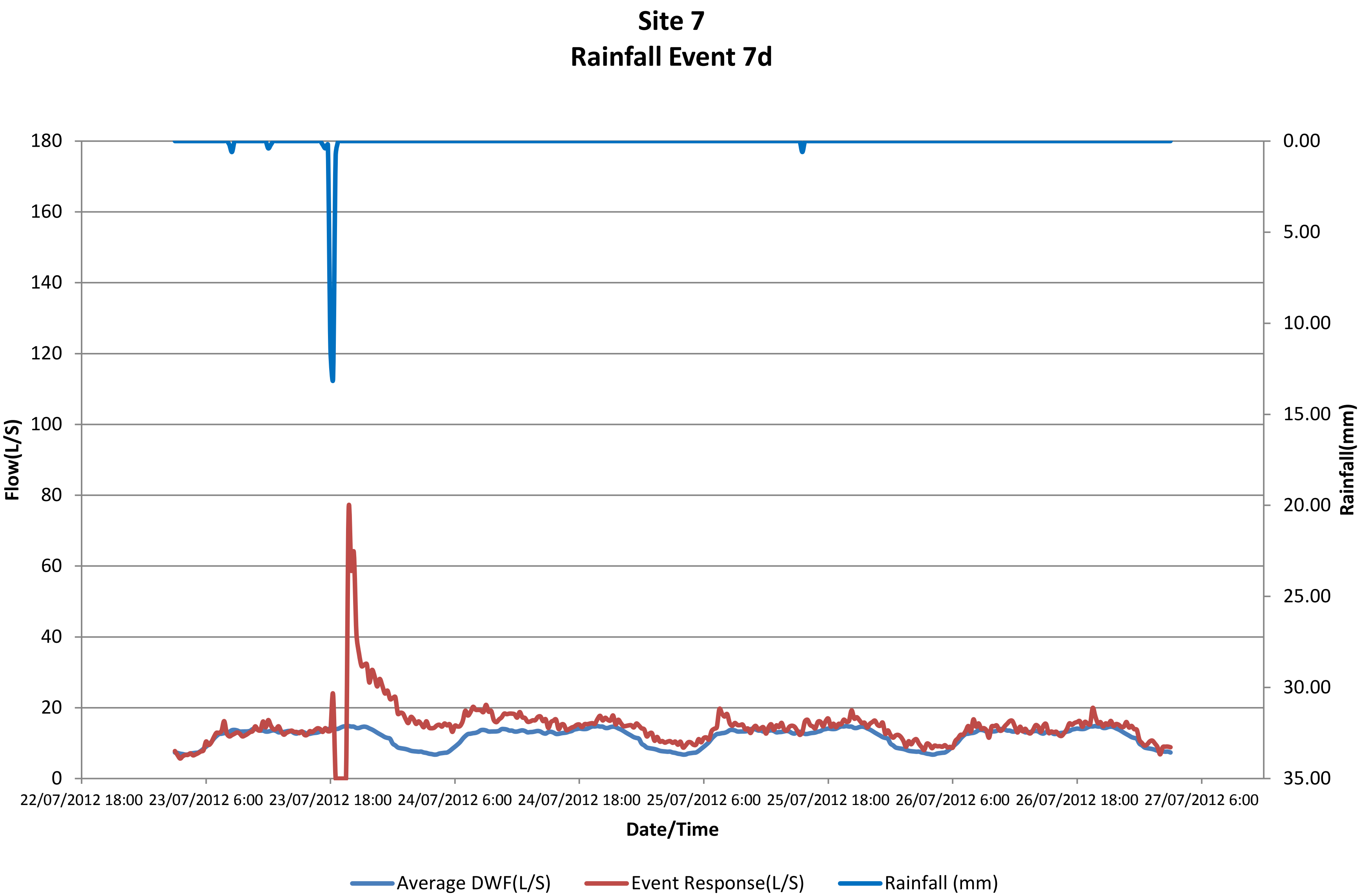


Site 6
Rainfall Event 6d
250
200
150
100
50
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
Flow(L/S)
Rainfall(mm)
22/07/2012 12:00
23/07/2012 0:00
23/07/2012 12:00
24/07/2012 0:00
24/07/2012 12:00
25/07/2012 0:00
25/07/2012 12:00
26/07/2012 0:00
26/07/2012 12:00
27/07/2012 0:00
27/07/2012 12:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

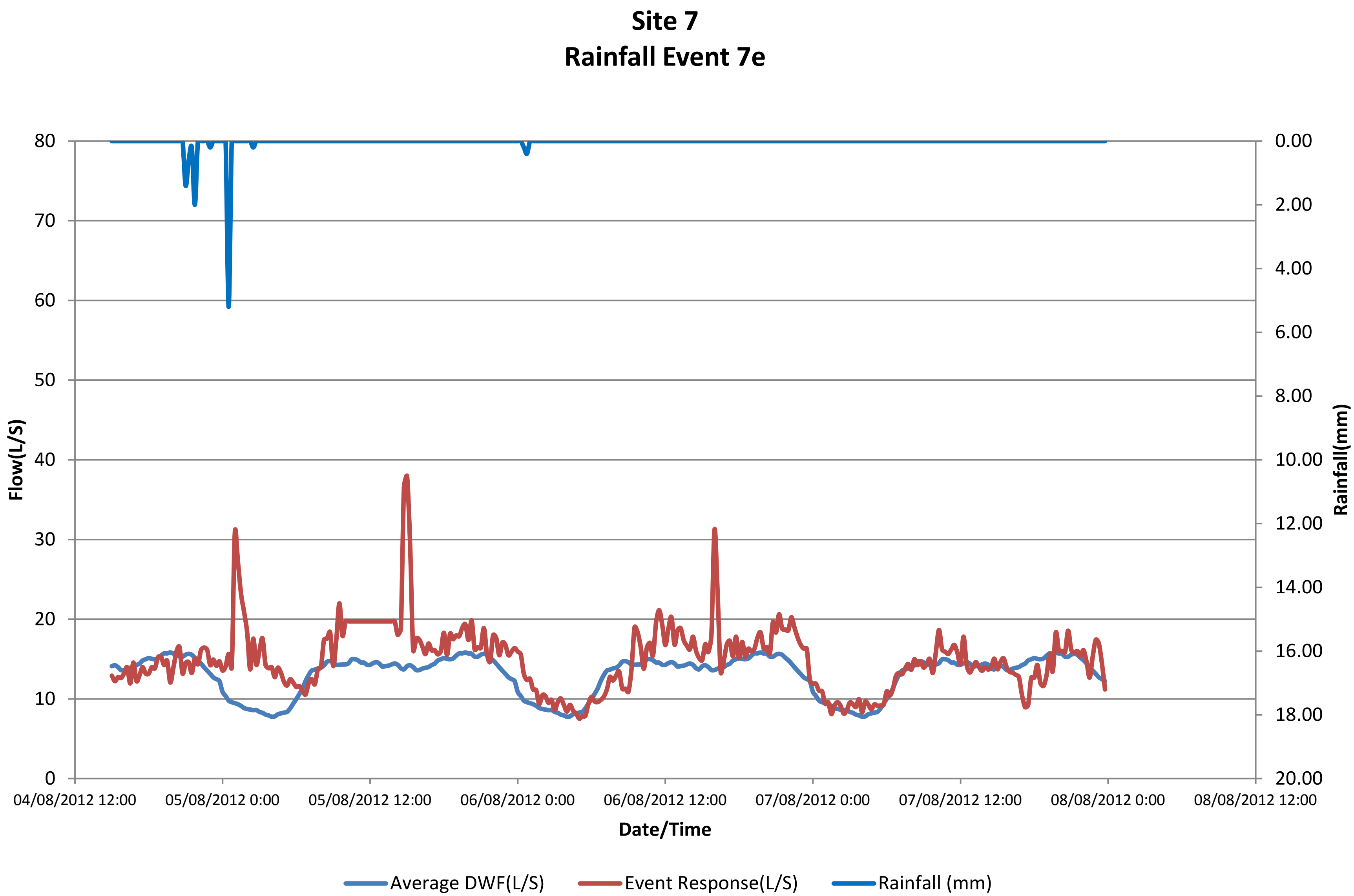


Site 6
Rainfall Event 6f
140
120
100
80
60
40
20
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Flow(L/S)
Rainfall(mm)
13/08/2012 18:00
14/08/2012 6:00
14/08/2012 18:00
15/08/2012 6:00
15/08/2012 18:00
16/08/2012 6:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

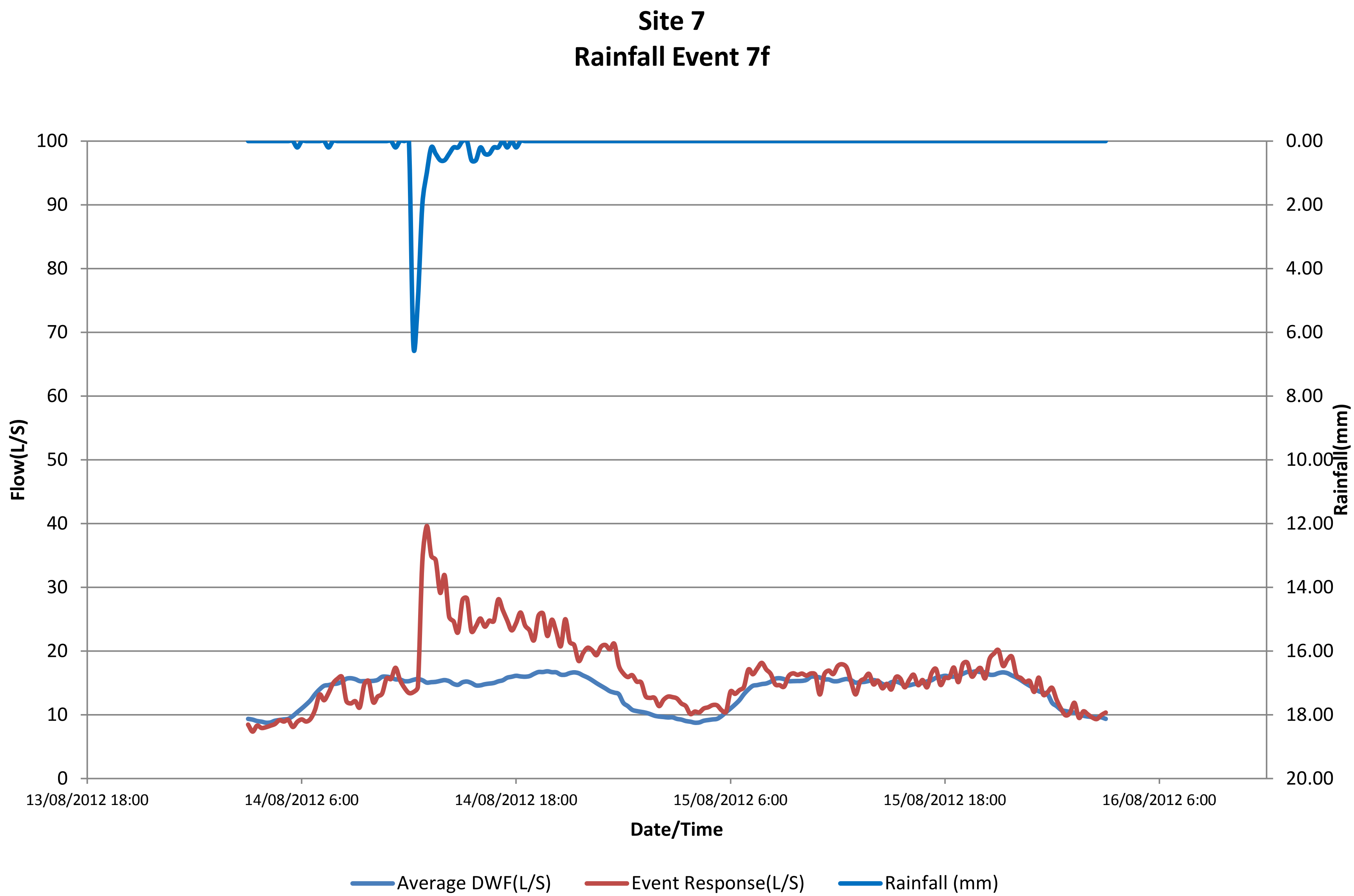

Site 7
Rainfall Event 7c
Flow(L/S)
Rainfall(mm)
120
100
80
60
40
20
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
14/07/2012 12:00
15/07/2012 0:00
15/07/2012 12:00
16/07/2012 0:00
16/07/2012 12:00
17/07/2012 0:00
17/07/2012 12:00
18/07/2012 0:00
18/07/2012 12:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)



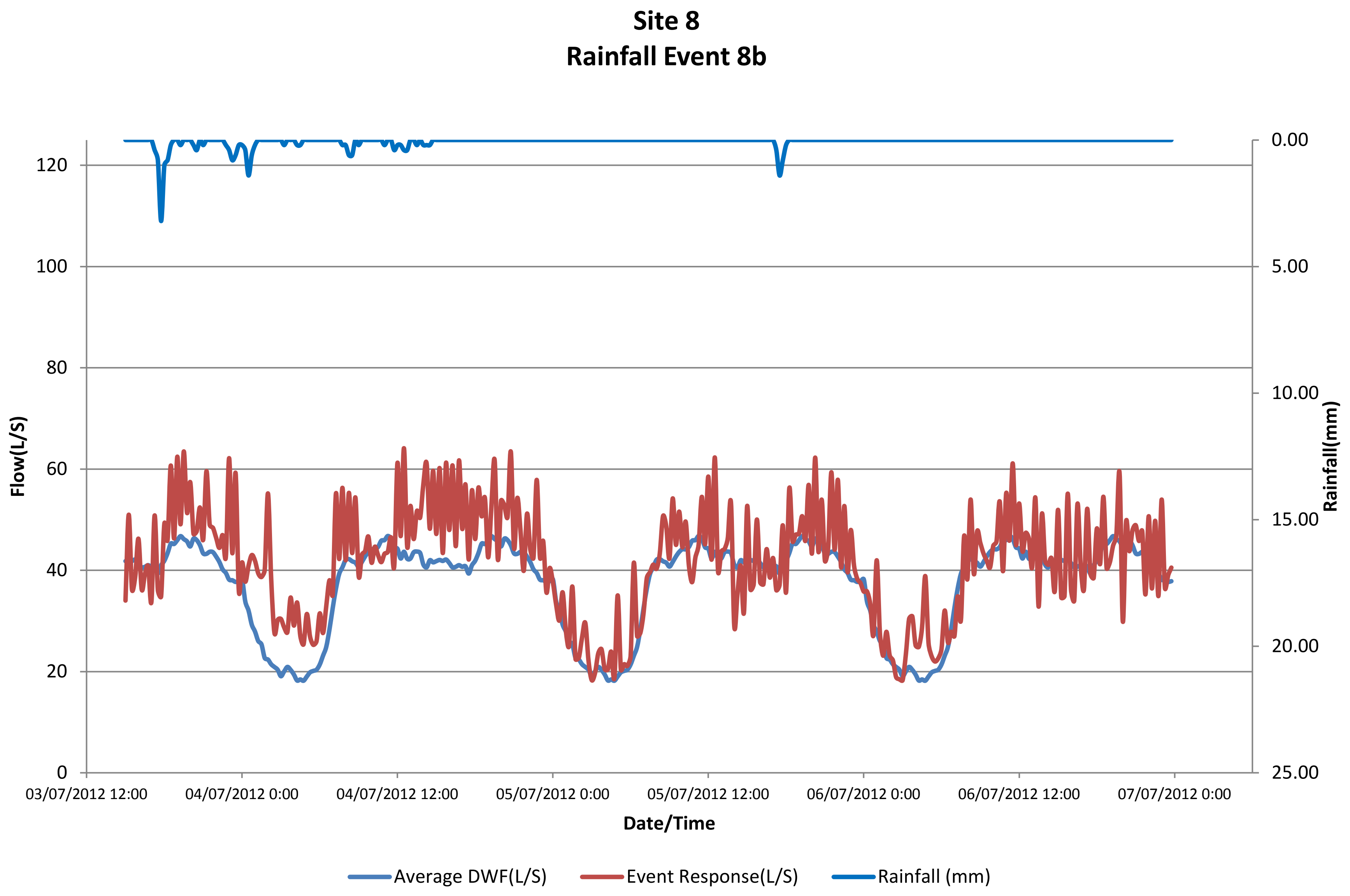
Site 7
Rainfall Event 7d
180
160
140
120
100
80
60
40
20
0
Flow(L/S)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
Rainfall(mm)
22/07/2012 18:00
23/07/2012 6:00
23/07/2012 18:00
24/07/2012 6:00
24/07/2012 18:00
25/07/2012 6:00
25/07/2012 18:00
26/07/2012 6:00
26/07/2012 18:00
27/07/2012 6:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)



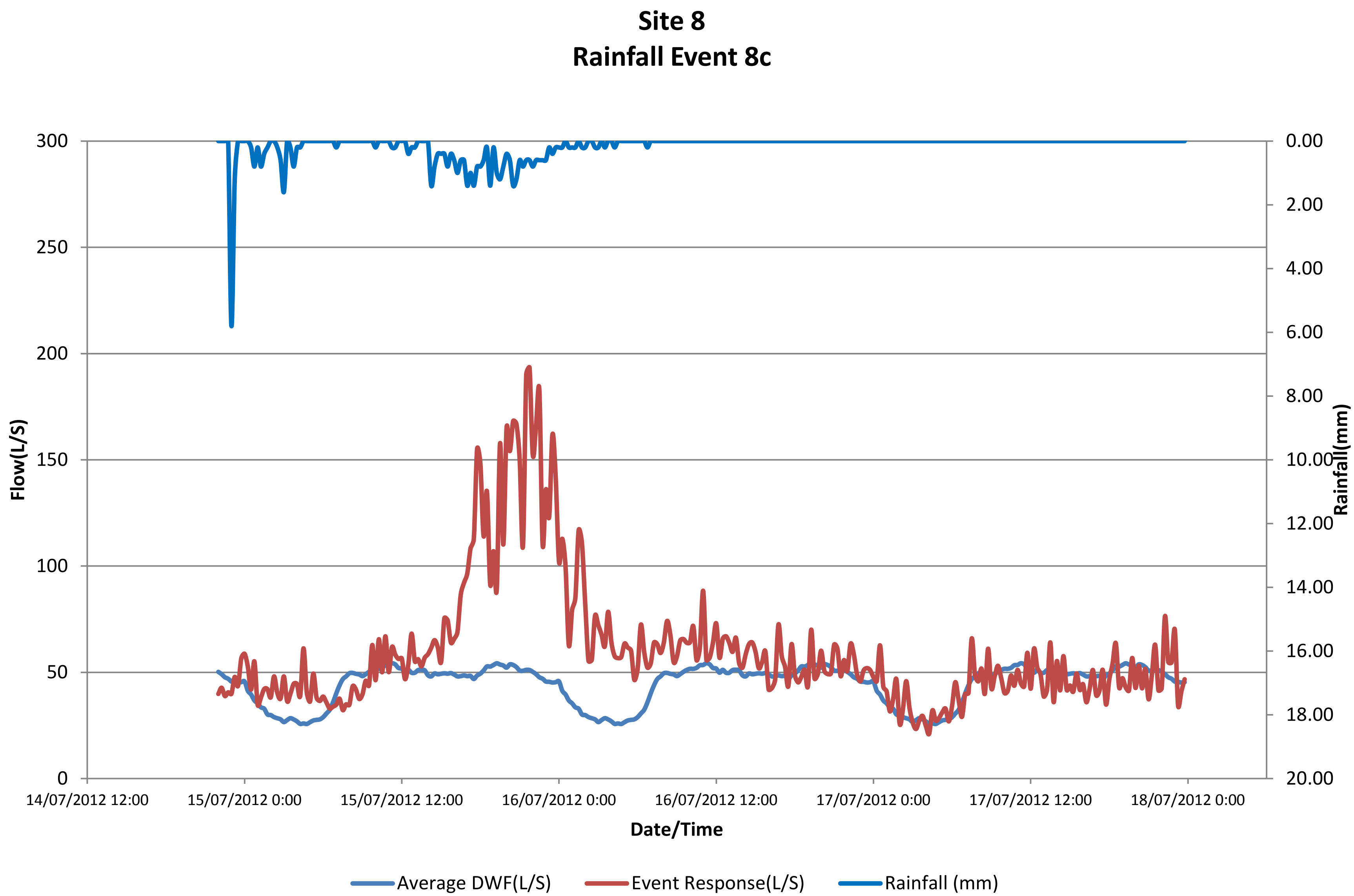
Site 7
Rainfall Event 7e
80
70
60
50
40
30
20
10
0
Flow(L/S)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Rainfall(mm)
04/08/2012 12:00
05/08/2012 0:00
05/08/2012 12:00
06/08/2012 0:00
06/08/2012 12:00
07/08/2012 0:00
07/08/2012 12:00
08/08/2012 0:00
08/08/2012 12:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

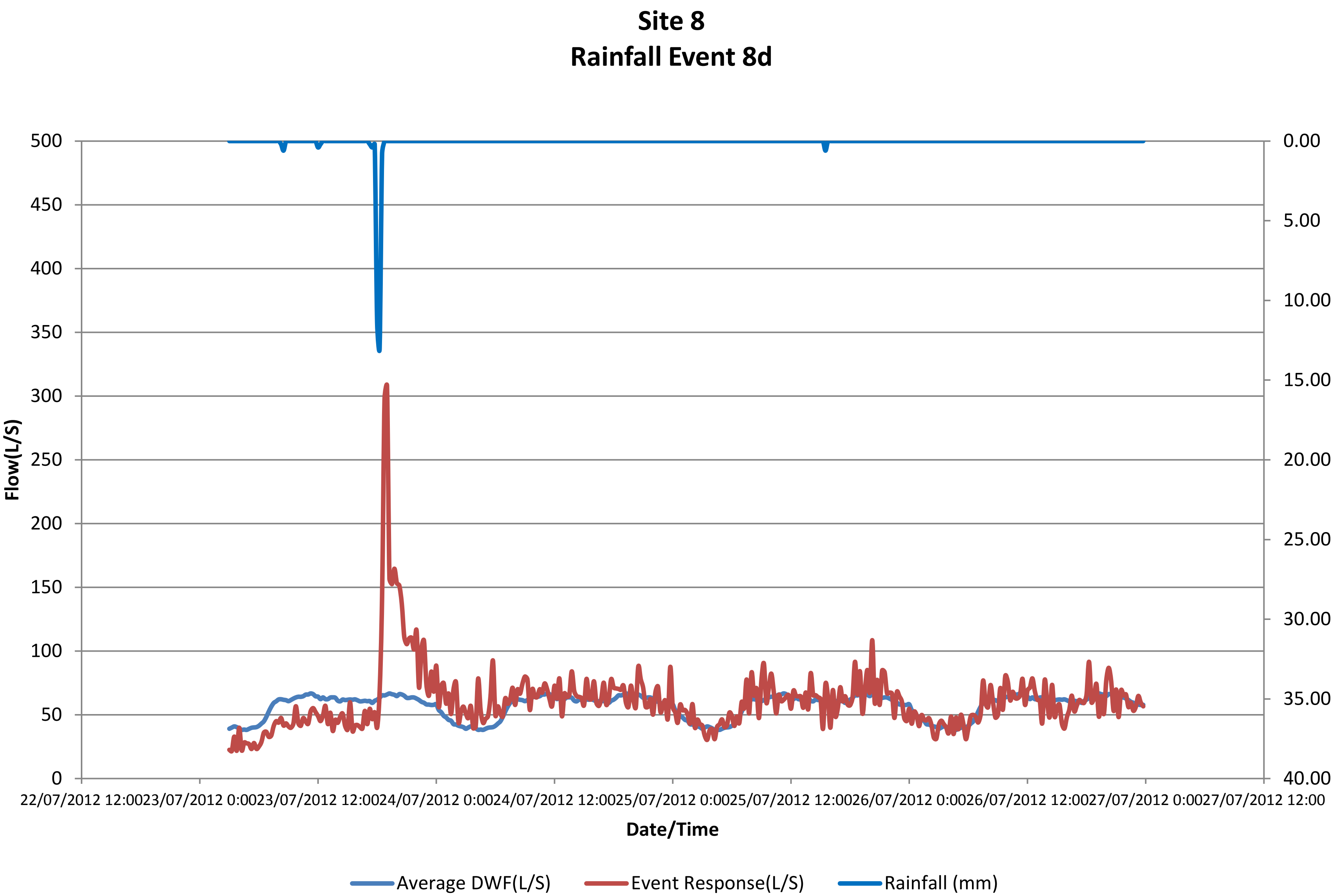


Site 7
Rainfall Event 7f
Flow(L/S)
Rainfall(mm)
100
90
80
70
60
50
40
30
20
10
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
13/08/2012 18:00
14/08/2012 6:00
14/08/2012 18:00
15/08/2012 6:00
15/08/2012 18:00
16/08/2012 6:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

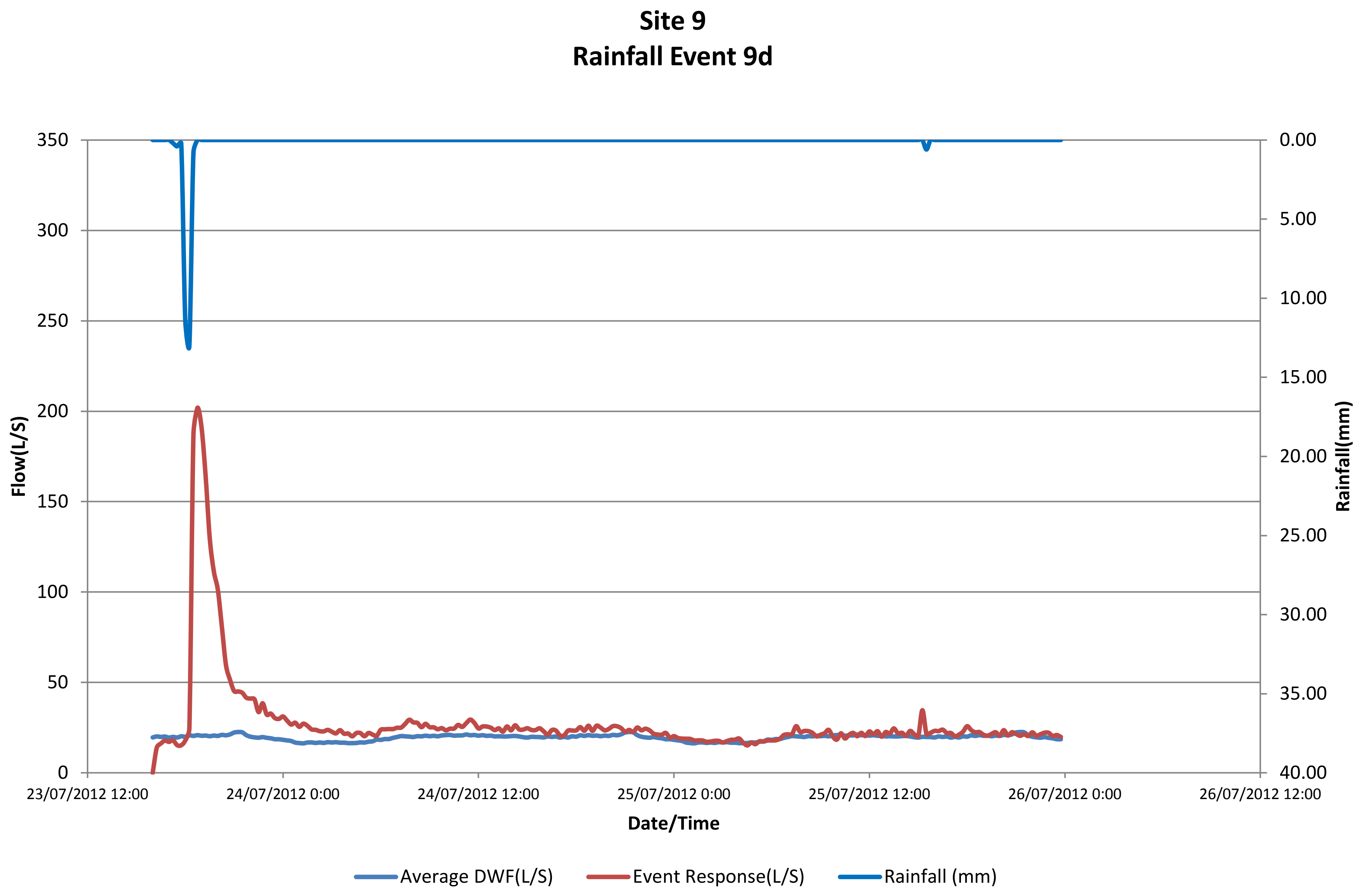


Site 8
Rainfall Event 8b
Flow(L/S)
Rainfall(mm)
120
100
80
60
40
20
0
0.00
5.00
10.00
15.00
20.00
25.00
03/07/2012 12:00
04/07/2012 0:00
04/07/2012 12:00
05/07/2012 0:00
05/07/2012 12:00
06/07/2012 0:00
06/07/2012 12:00
07/07/2012 0:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

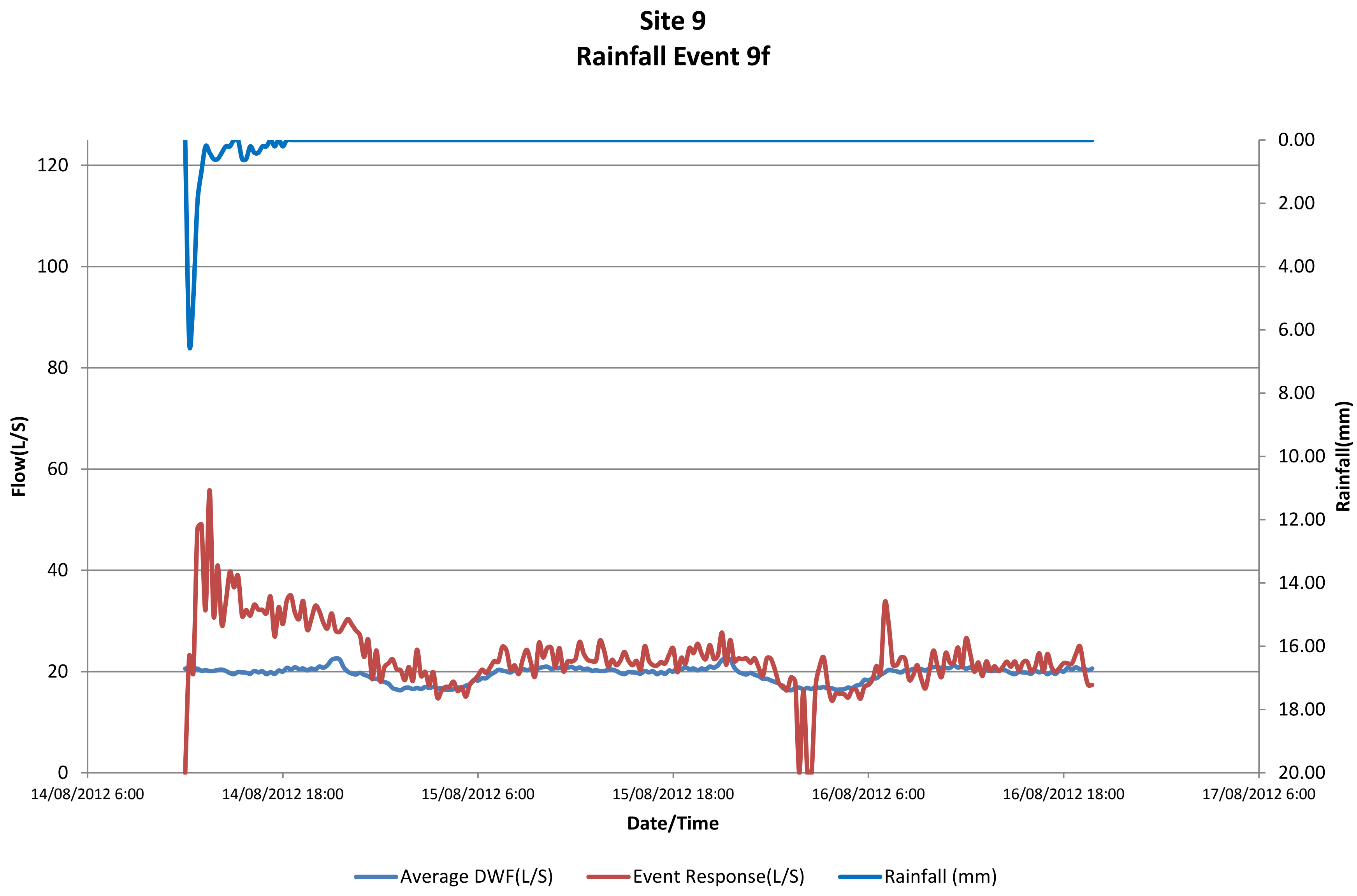

Site 8
Rainfall Event 8c
Flow(L/S)
Rainfall(mm)
300
250
200
150
100
50
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
14/07/2012 12:00
15/07/2012 0:00
15/07/2012 12:00
16/07/2012 0:00
16/07/2012 12:00
17/07/2012 0:00
17/07/2012 12:00
18/07/2012 0:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)



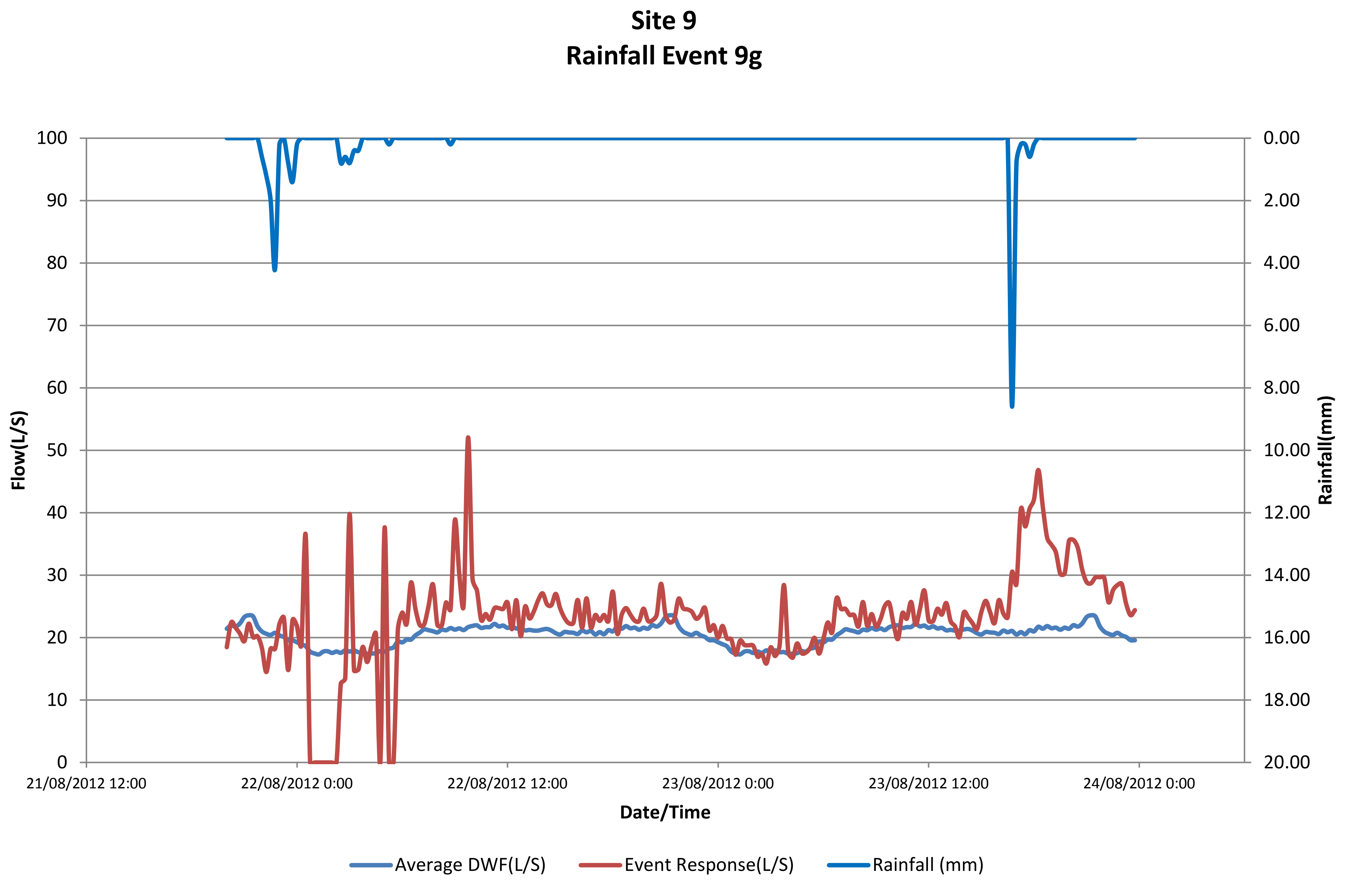
Site 8
Rainfall Event 8d
500
450
400
350
300
250
200
150
100
50
0
Flow(L/S)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
Rainfall(mm)
22/07/2012 12:00
23/07/2012 0:00
23/07/2012 12:00
24/07/2012 0:00
24/07/2012 12:00
25/07/2012 0:00
25/07/2012 12:00
26/07/2012 0:00
26/07/2012 12:00
27/07/2012 0:00
27/07/2012 12:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)



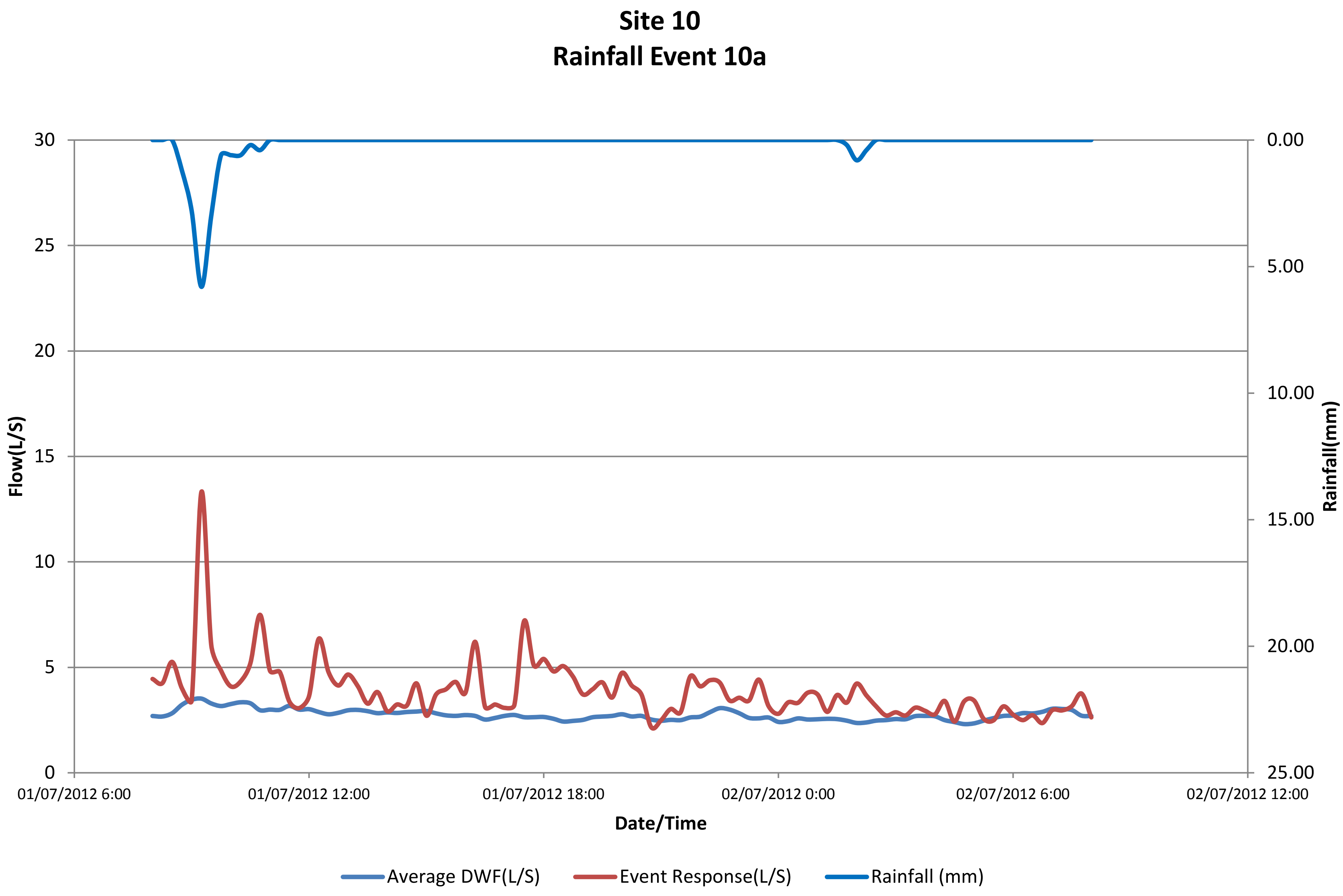
Site 9
Rainfall Event 9d
350
300
250
200
150
100
50
0
Flow(L/S)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
Rainfall(mm)
23/07/2012 12:00
24/07/2012 0:00
24/07/2012 12:00
25/07/2012 0:00
25/07/2012 12:00
26/07/2012 0:00
26/07/2012 12:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)



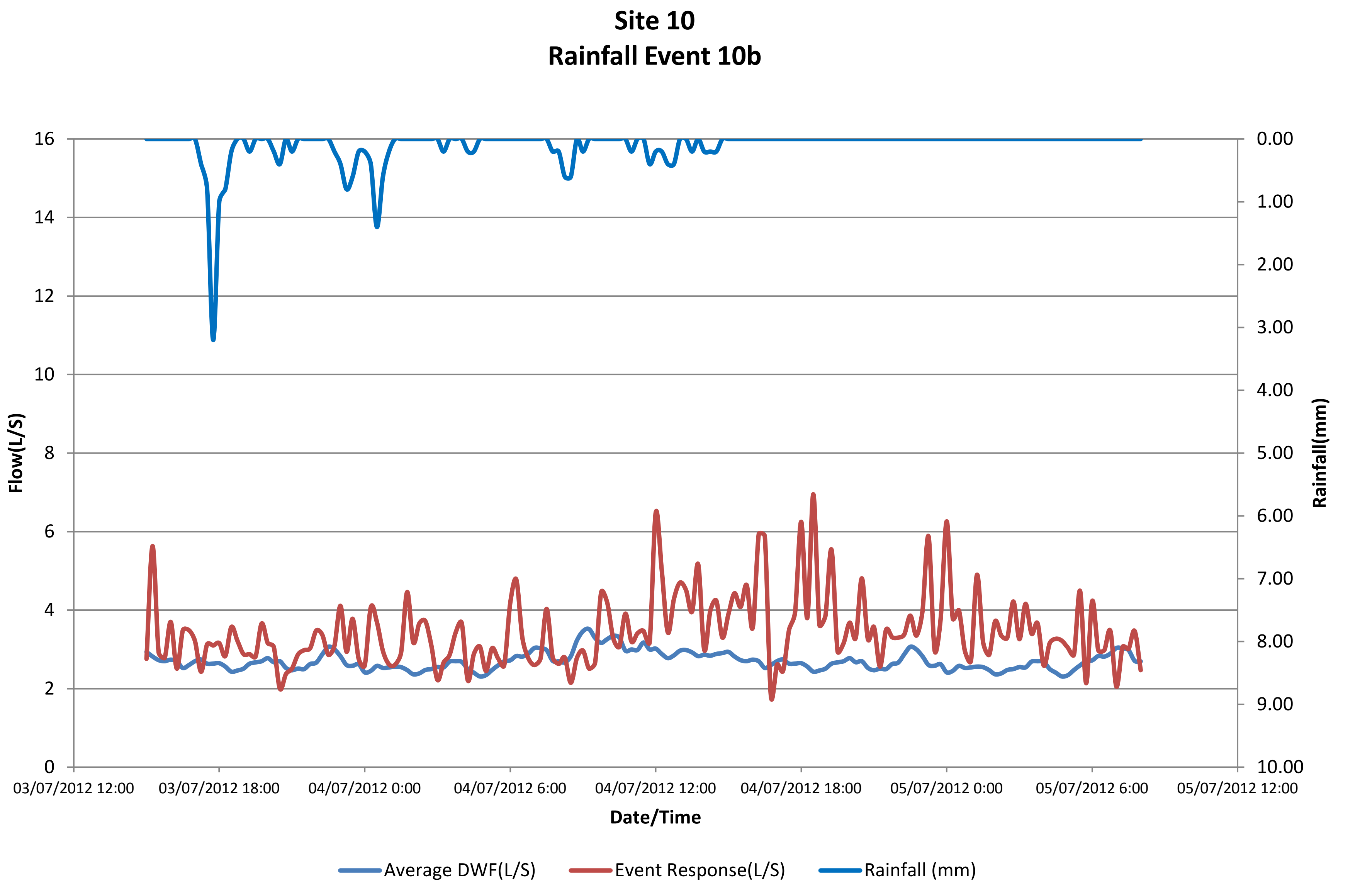
Site 9
Rainfall Event 9f
Flow(L/S)
0
20
40
60
80
100
120
Rainfall(mm)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
14/08/2012 6:00
14/08/2012 18:00
15/08/2012 6:00
15/08/2012 18:00
16/08/2012 6:00
16/08/2012 18:00
17/08/2012 6:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)



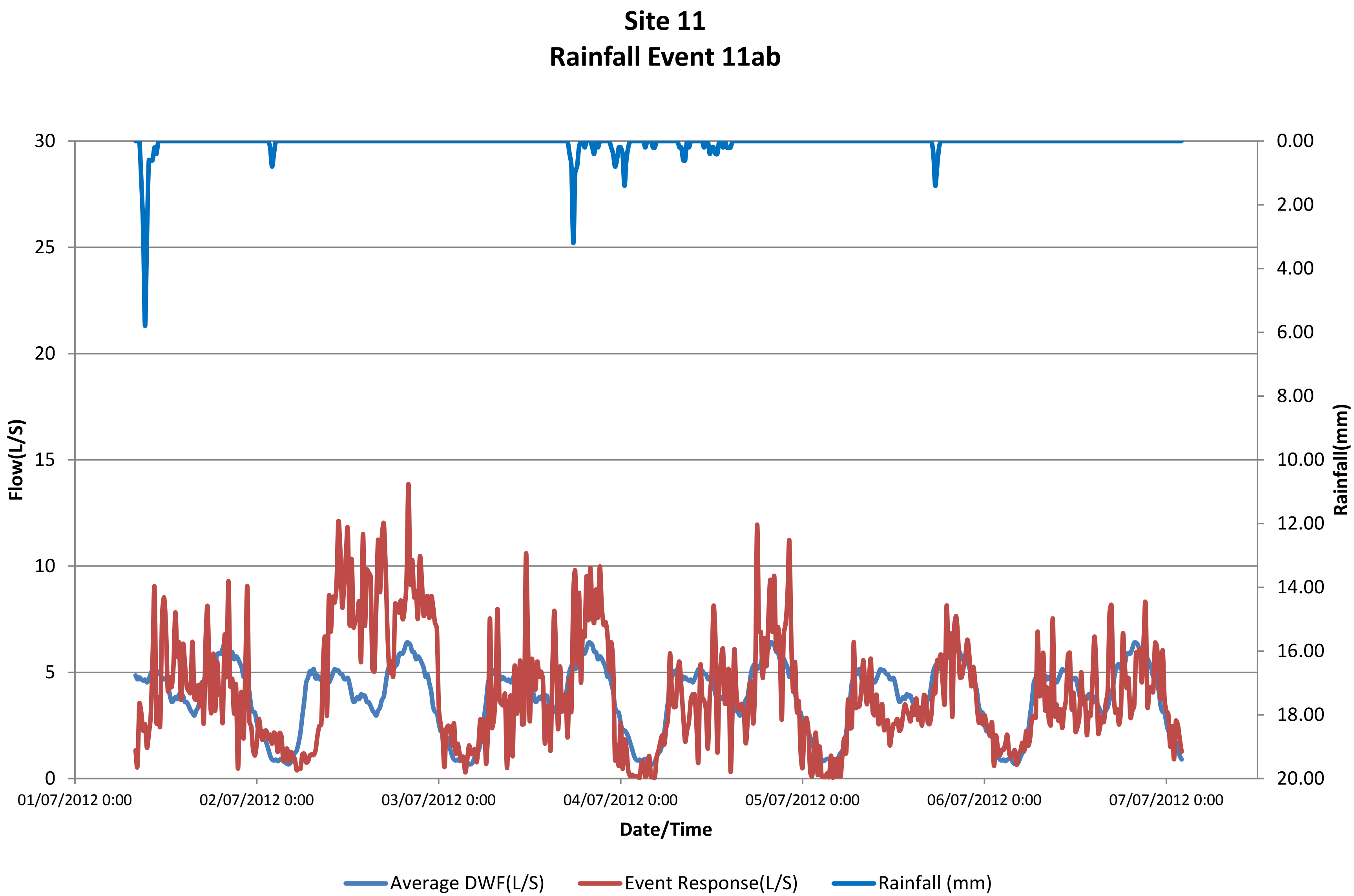
Site 9
Rainfall Event 9g
Flow(L/S)
Rainfall(mm)
100
90
80
70
60
50
40
30
20
10
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
21/08/2012 12:00
22/08/2012 0:00
22/08/2012 12:00
23/08/2012 0:00
23/08/2012 12:00
24/08/2012 0:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)



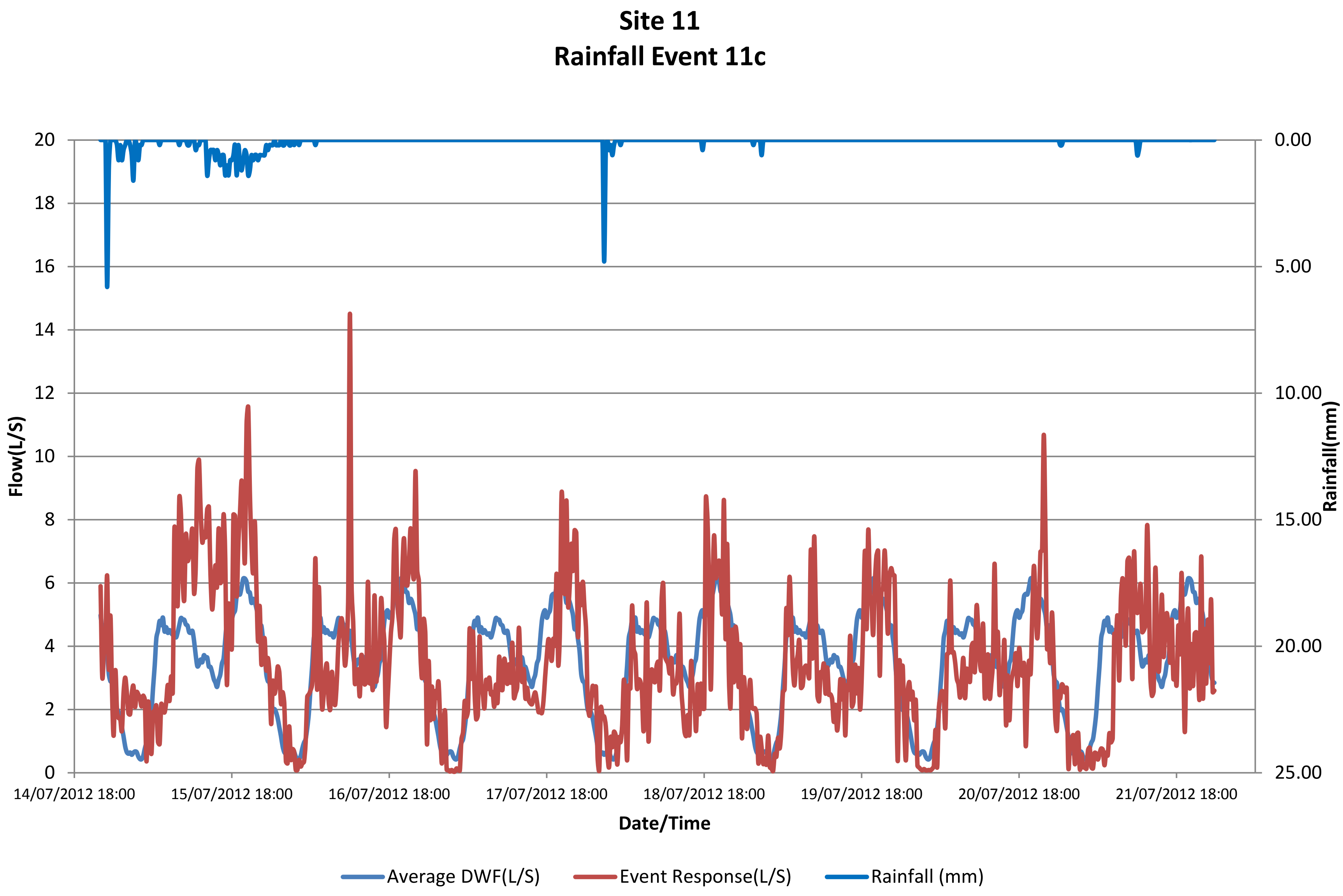
Site 10
Rainfall Event 10a
30
25
20
15
10
5
0
Flow(L/S)
0.00
5.00
10.00
15.00
20.00
25.00
Rainfall(mm)
01/07/2012 6:00
01/07/2012 12:00
01/07/2012 18:00
02/07/2012 0:00
02/07/2012 6:00
02/07/2012 12:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

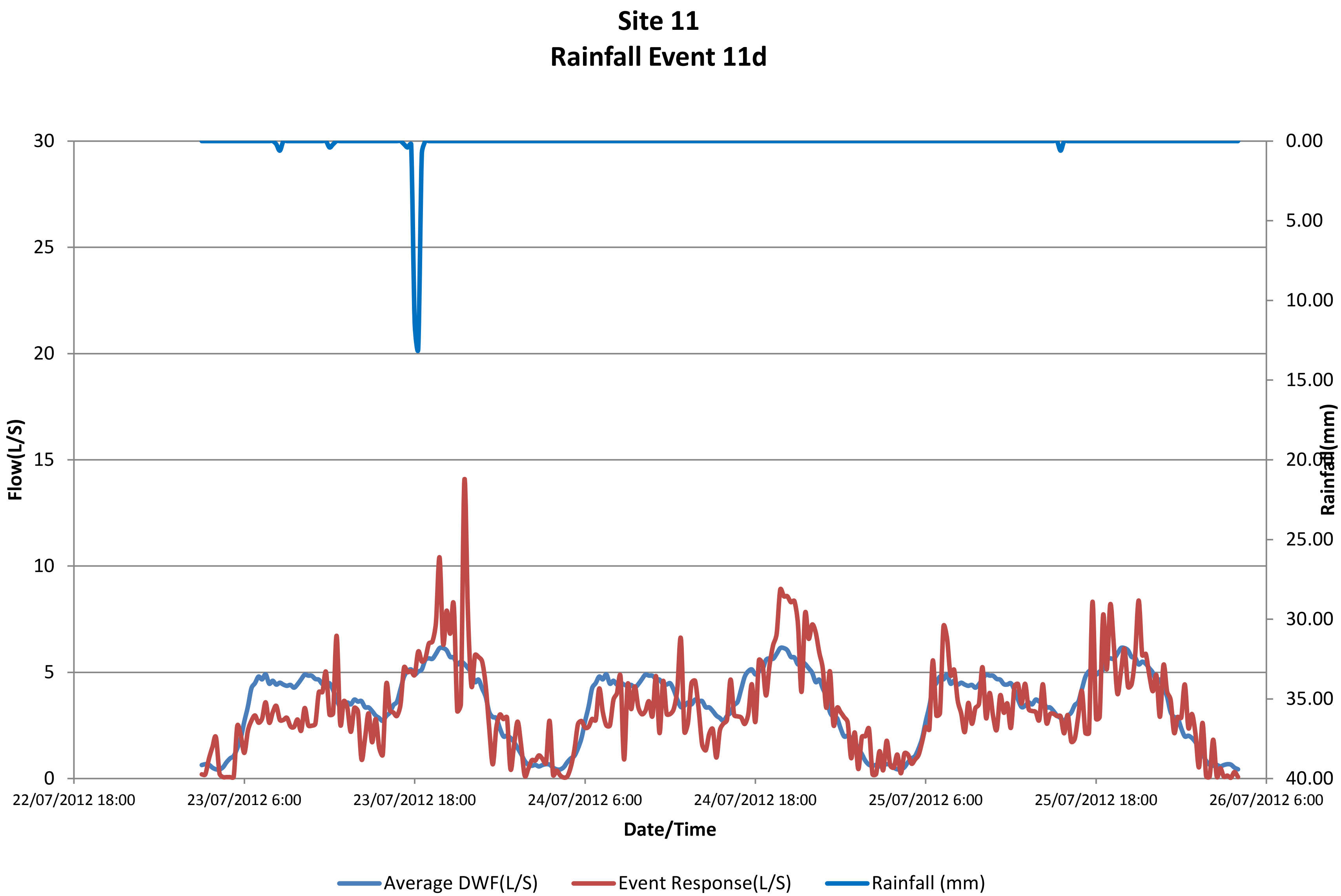


Site 10
Rainfall Event 10b
Flow(L/S)
Rainfall(mm)
16
14
12
10
8
6
4
2
0
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
03/07/2012 12:00
03/07/2012 18:00
04/07/2012 0:00
04/07/2012 6:00
04/07/2012 12:00
04/07/2012 18:00
05/07/2012 0:00
05/07/2012 6:00
05/07/2012 12:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

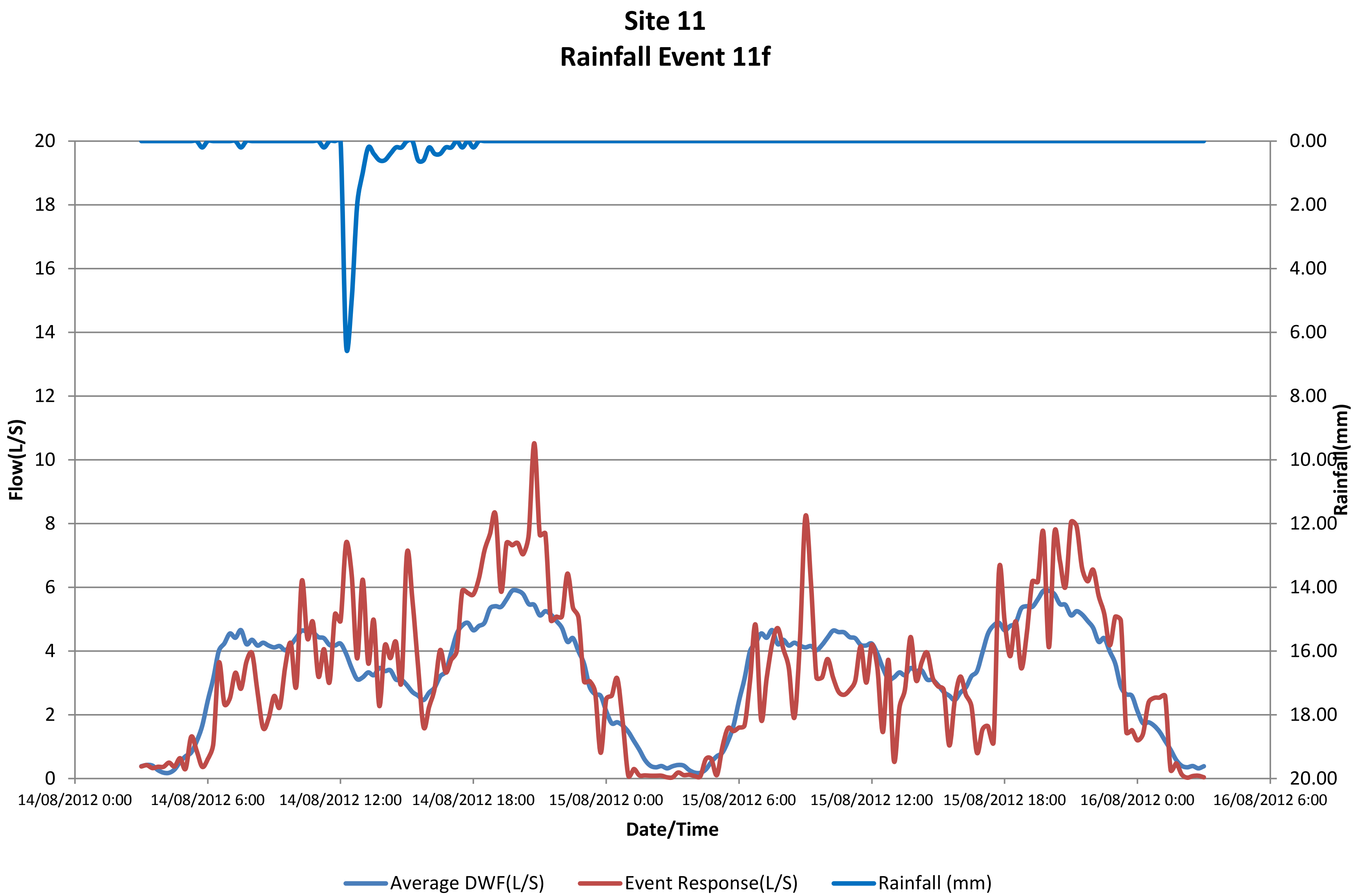


Site 11
Rainfall Event 11ab
30
25
20
15
10
5
0
Flow(L/S)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Rainfall(mm)
01/07/2012 0:00
02/07/2012 0:00
03/07/2012 0:00
04/07/2012 0:00
05/07/2012 0:00
06/07/2012 0:00
07/07/2012 0:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

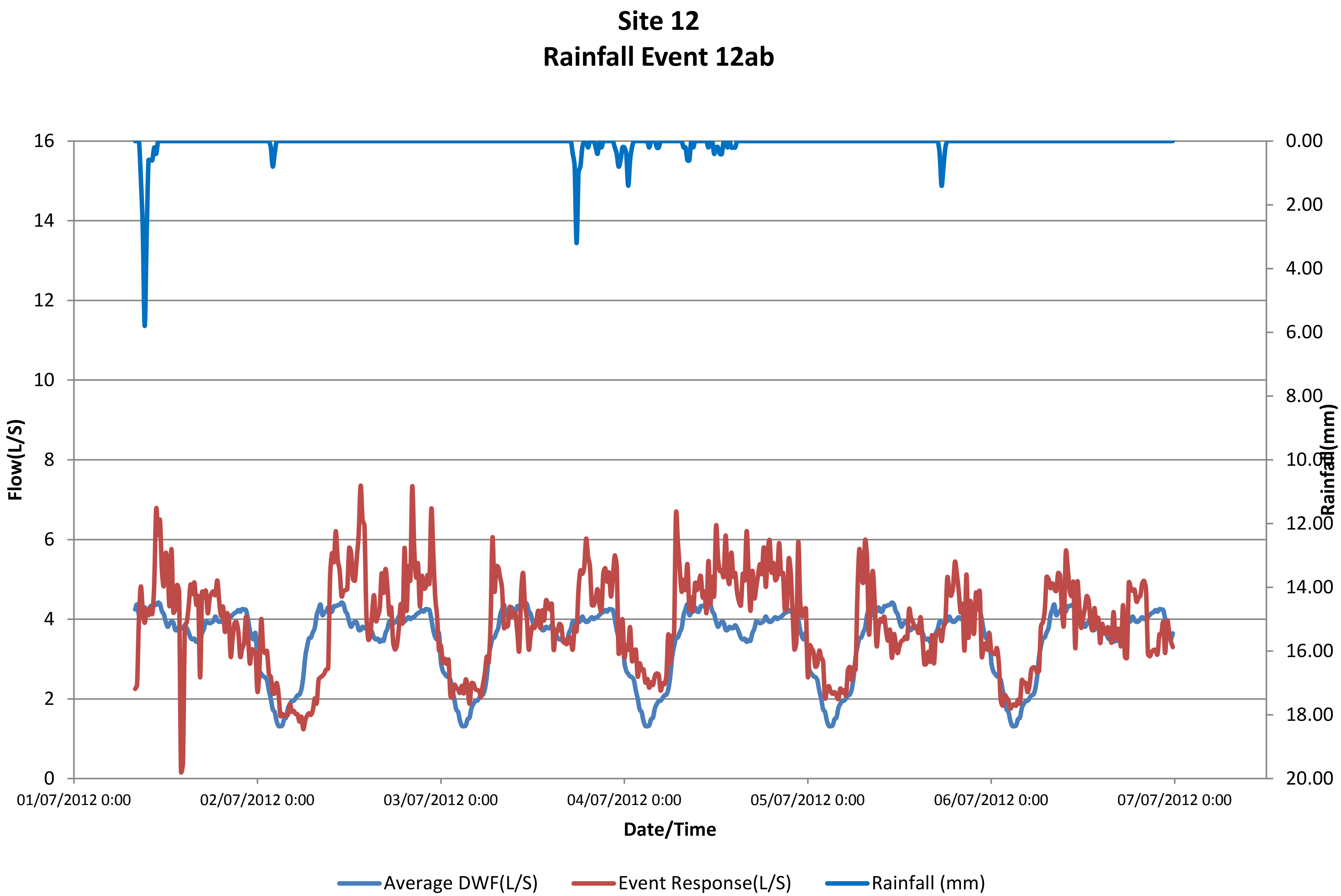

Site 11
Rainfall Event 11c
Flow(L/S)
Rainfall(mm)
20
18
16
14
12
10
8
6
4
2
0
0.00
5.00
10.00
15.00
20.00
25.00
14/07/2012 18:00
15/07/2012 18:00
16/07/2012 18:00
17/07/2012 18:00
18/07/2012 18:00
19/07/2012 18:00
20/07/2012 18:00
21/07/2012 18:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

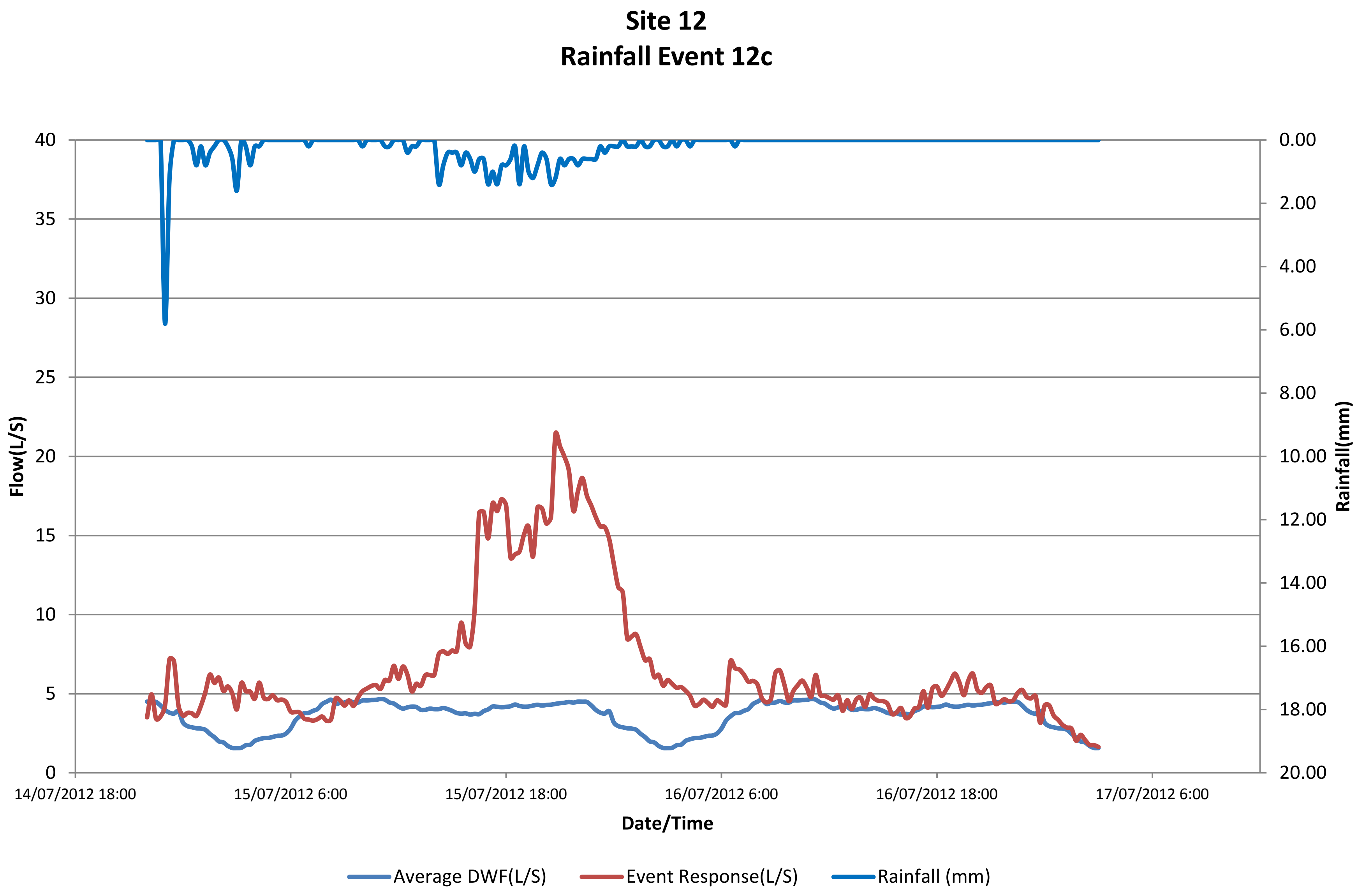


Site 11
Rainfall Event 11d
Flow(L/S)
Rainfall(mm)
30
25
20
15
10
5
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
22/07/2012 18:00
23/07/2012 6:00
23/07/2012 18:00
24/07/2012 6:00
24/07/2012 18:00
25/07/2012 6:00
25/07/2012 18:00
26/07/2012 6:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

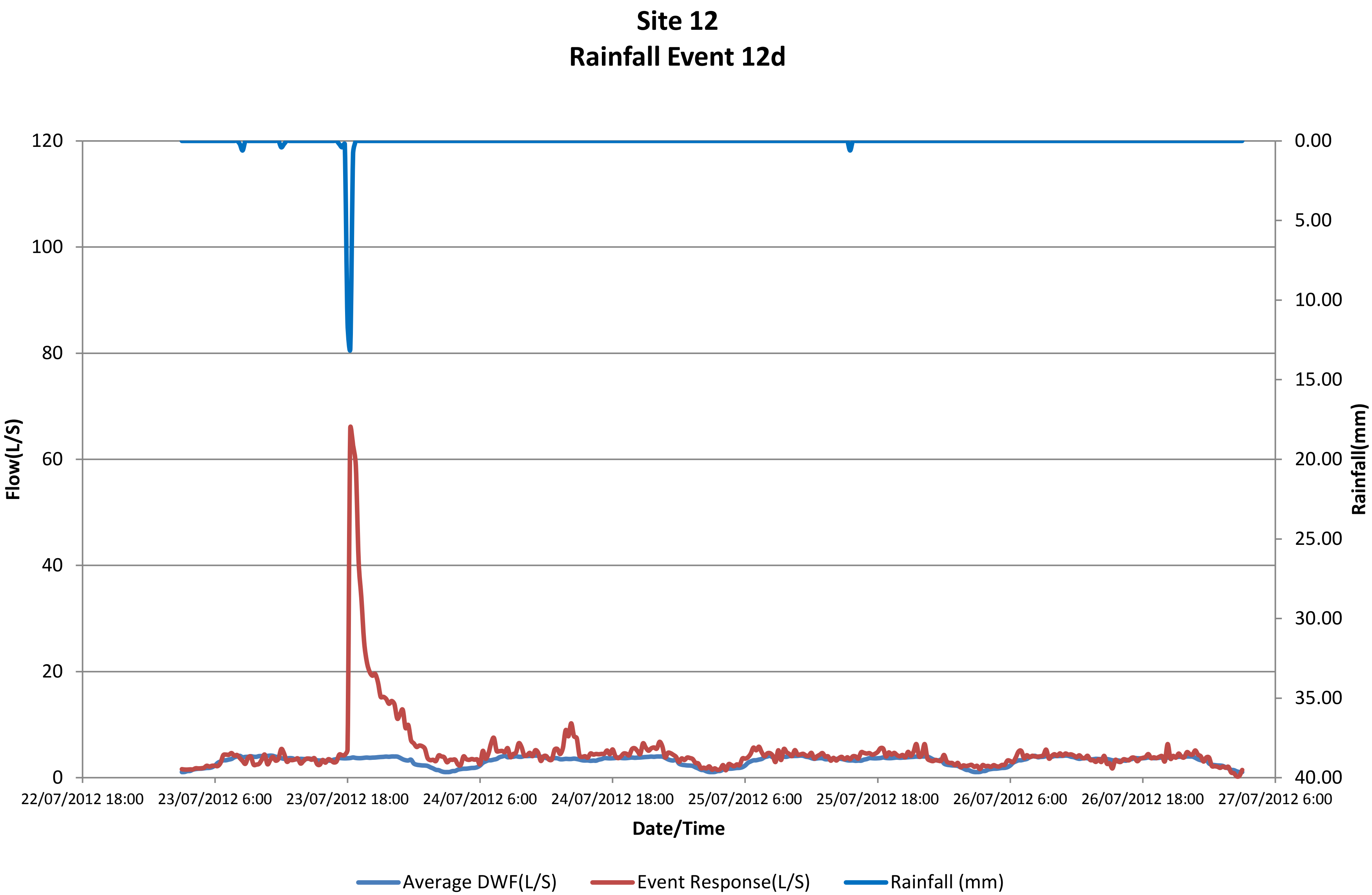


Site 11
Rainfall Event 11f
Flow(L/S)
Rainfall(mm)
20
18
16
14
12
10
8
6
4
2
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
14/08/2012 0:00
14/08/2012 6:00
14/08/2012 12:00
14/08/2012 18:00
15/08/2012 0:00
15/08/2012 6:00
15/08/2012 12:00
15/08/2012 18:00
16/08/2012 0:00
16/08/2012 6:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

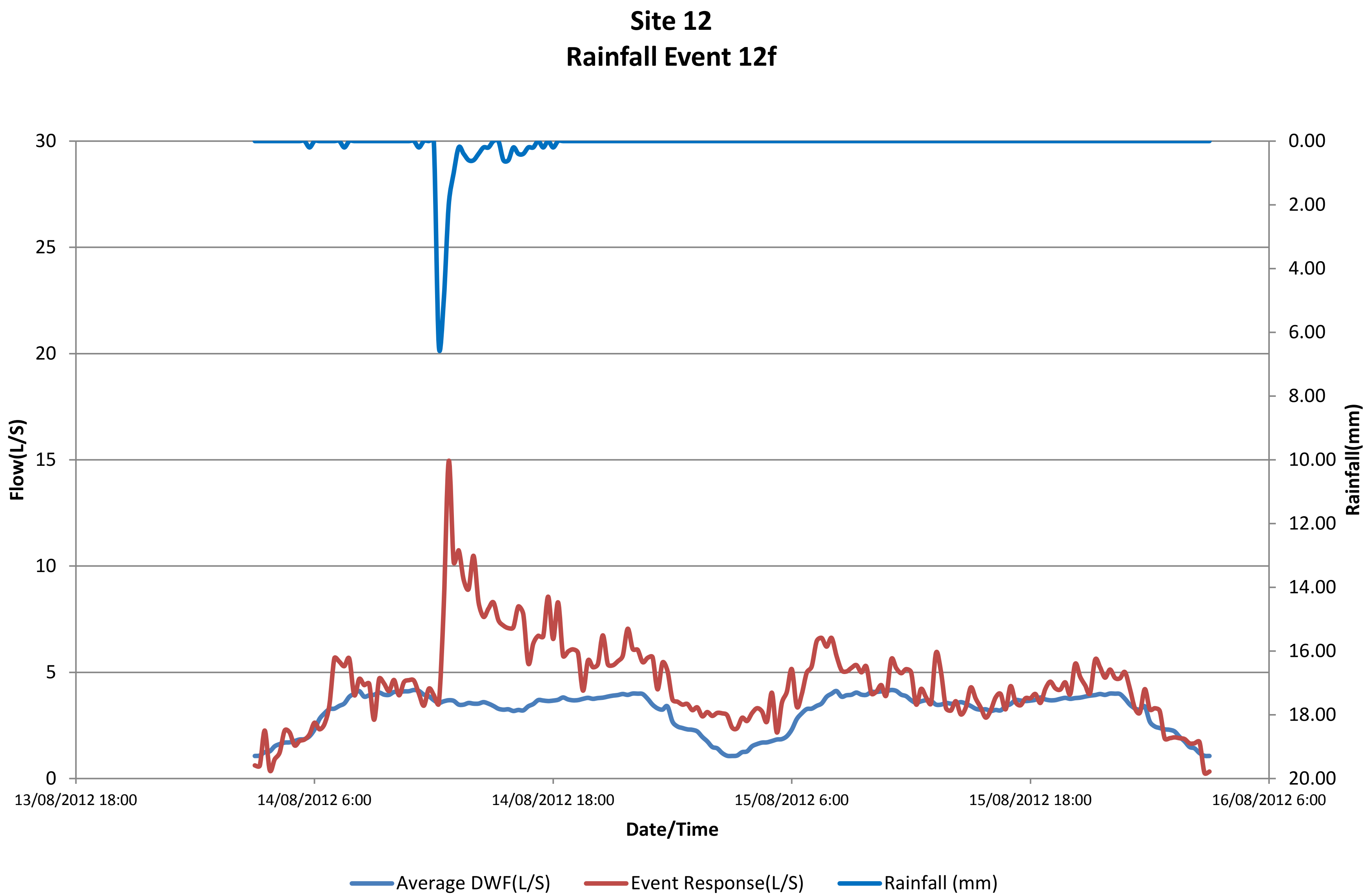

Site 12
Rainfall Event 12ab
Flow(L/S)
Rainfall(mm)
16
14
12
10
8
6
4
2
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
01/07/2012 0:00
02/07/2012 0:00
03/07/2012 0:00
04/07/2012 0:00
05/07/2012 0:00
06/07/2012 0:00
07/07/2012 0:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)



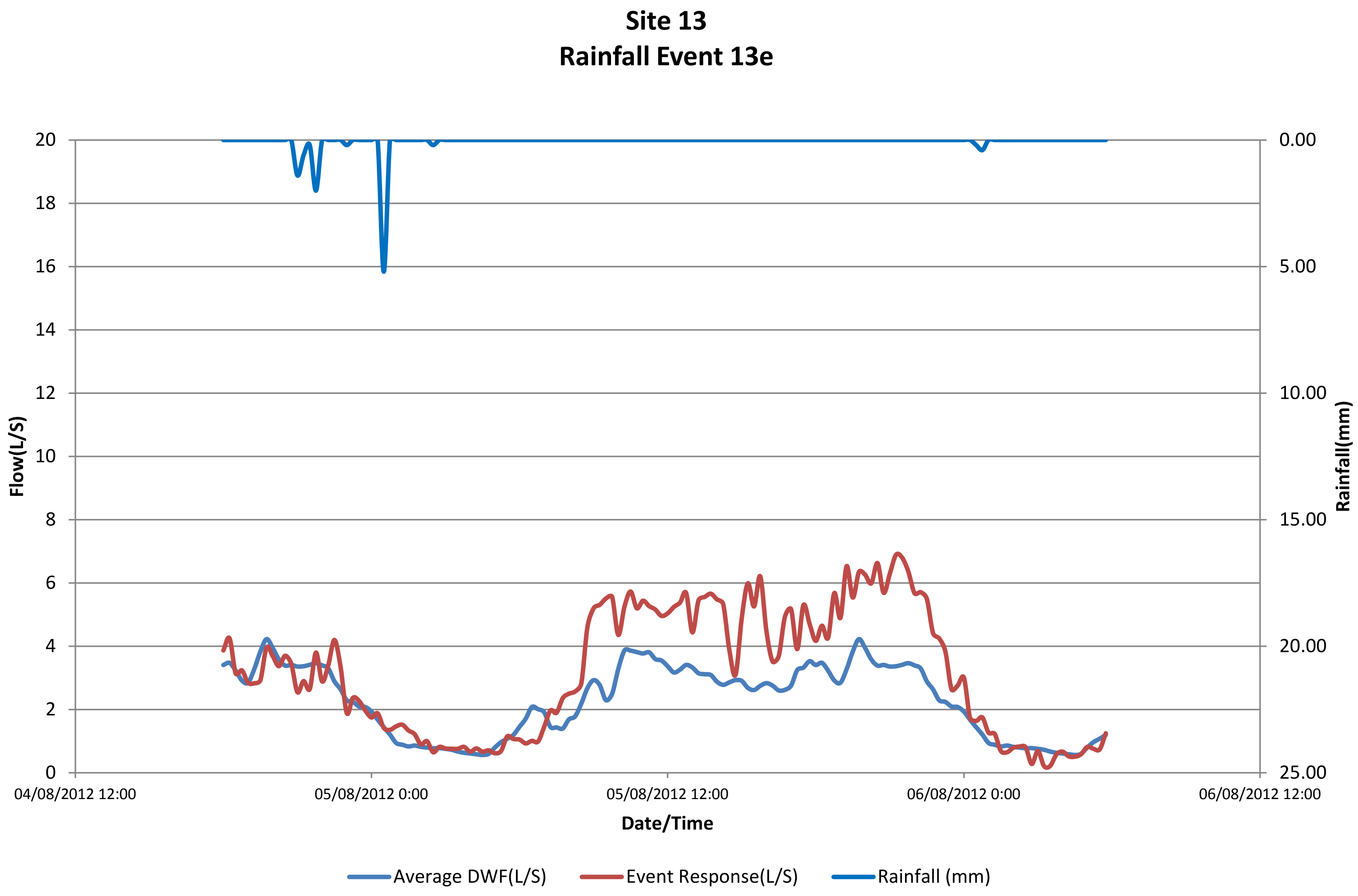
Site 12
Rainfall Event 12c
Flow(L/S)
40
35
30
25
20
15
10
5
0
Rainfall(mm)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
14/07/2012 18:00
15/07/2012 6:00
15/07/2012 18:00
16/07/2012 6:00
16/07/2012 18:00
17/07/2012 6:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

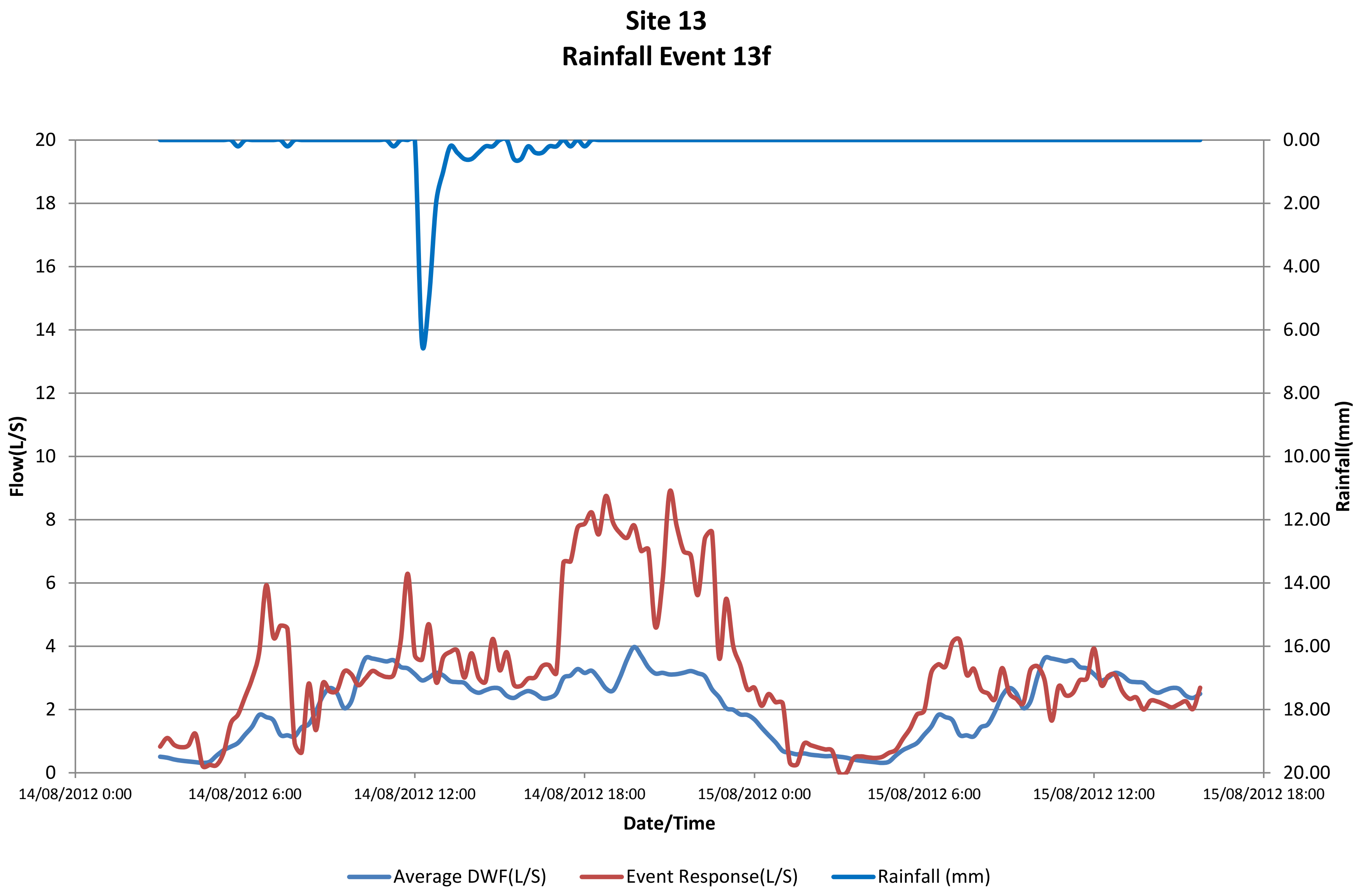


Site 12
Rainfall Event 12d
120
100
80
60
40
20
0
Flow(L/S)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
Rainfall(mm)
22/07/2012 18:00
23/07/2012 6:00
23/07/2012 18:00
24/07/2012 6:00
24/07/2012 18:00
25/07/2012 6:00
25/07/2012 18:00
26/07/2012 6:00
26/07/2012 18:00
27/07/2012 6:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

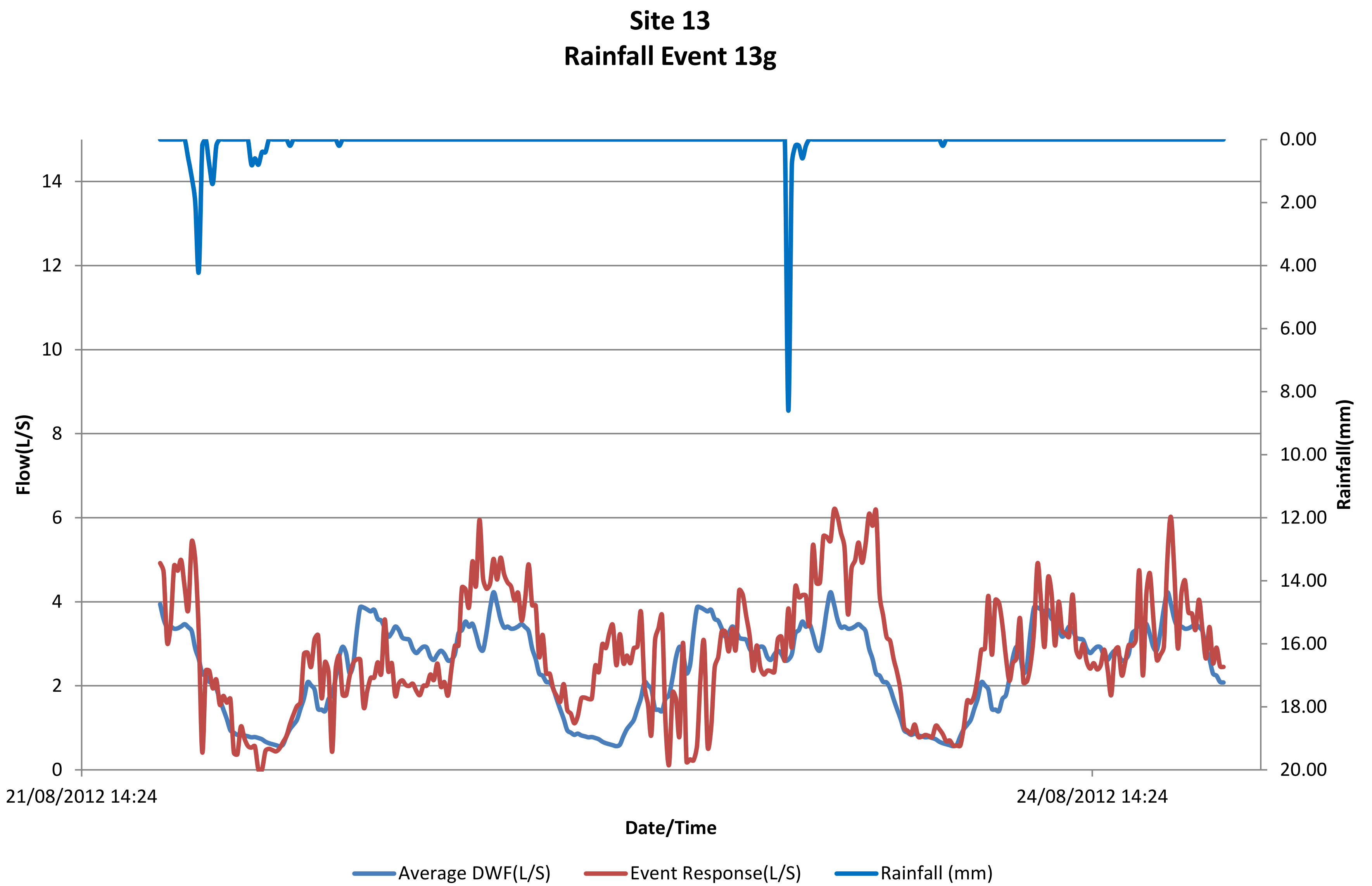


Site 12
Rainfall Event 12f
Flow(L/S)
Rainfall(mm)
30
25
20
15
10
5
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
13/08/2012 18:00
14/08/2012 6:00
14/08/2012 18:00
15/08/2012 6:00
15/08/2012 18:00
16/08/2012 6:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

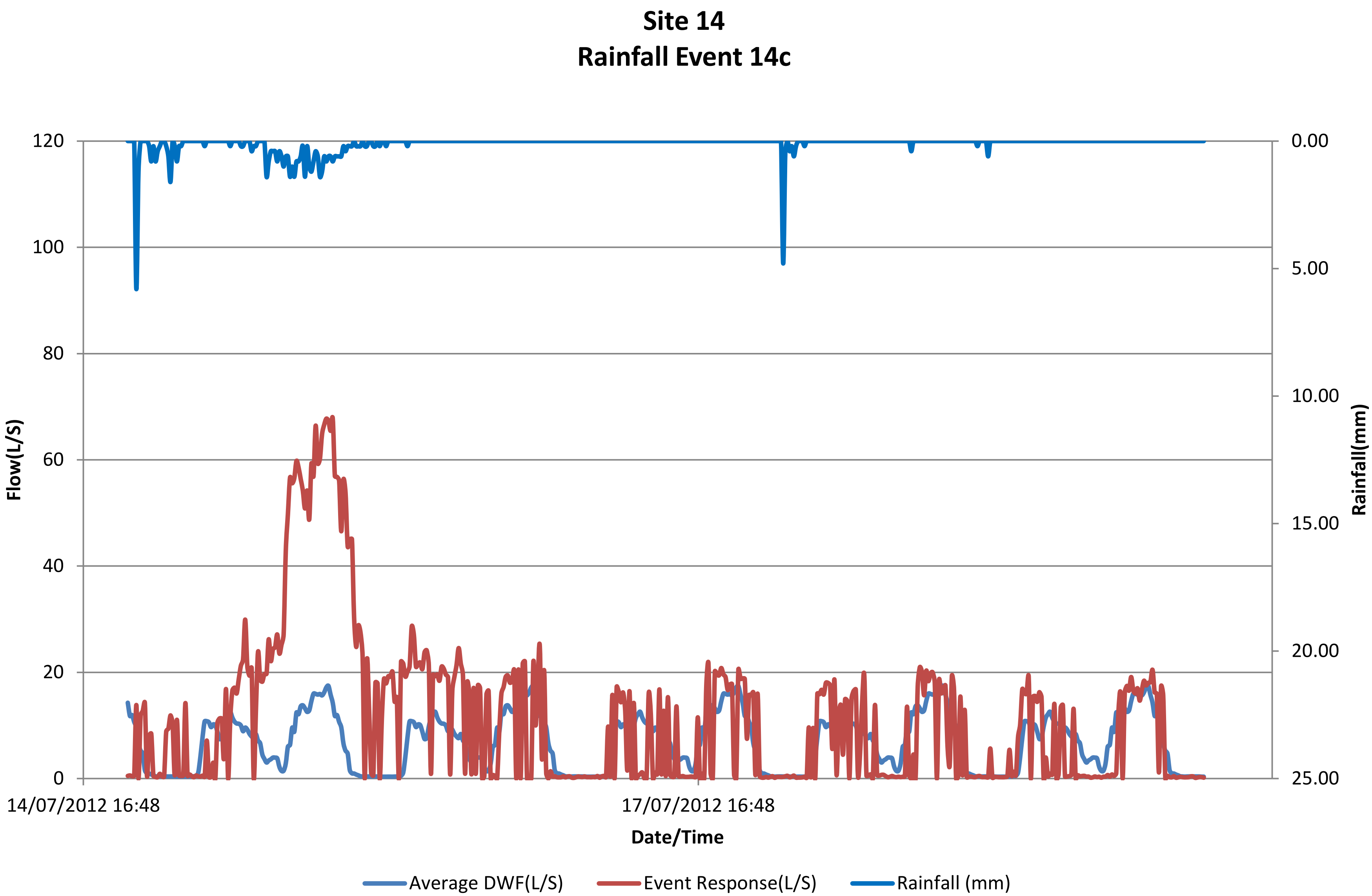

Site 13
Rainfall Event 13e
Flow(L/S)
Rainfall(mm)
20
18
16
14
12
10
8
6
4
2
0
0.00
5.00
10.00
15.00
20.00
25.00
04/08/2012 12:00
05/08/2012 0:00
05/08/2012 12:00
06/08/2012 0:00
06/08/2012 12:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)



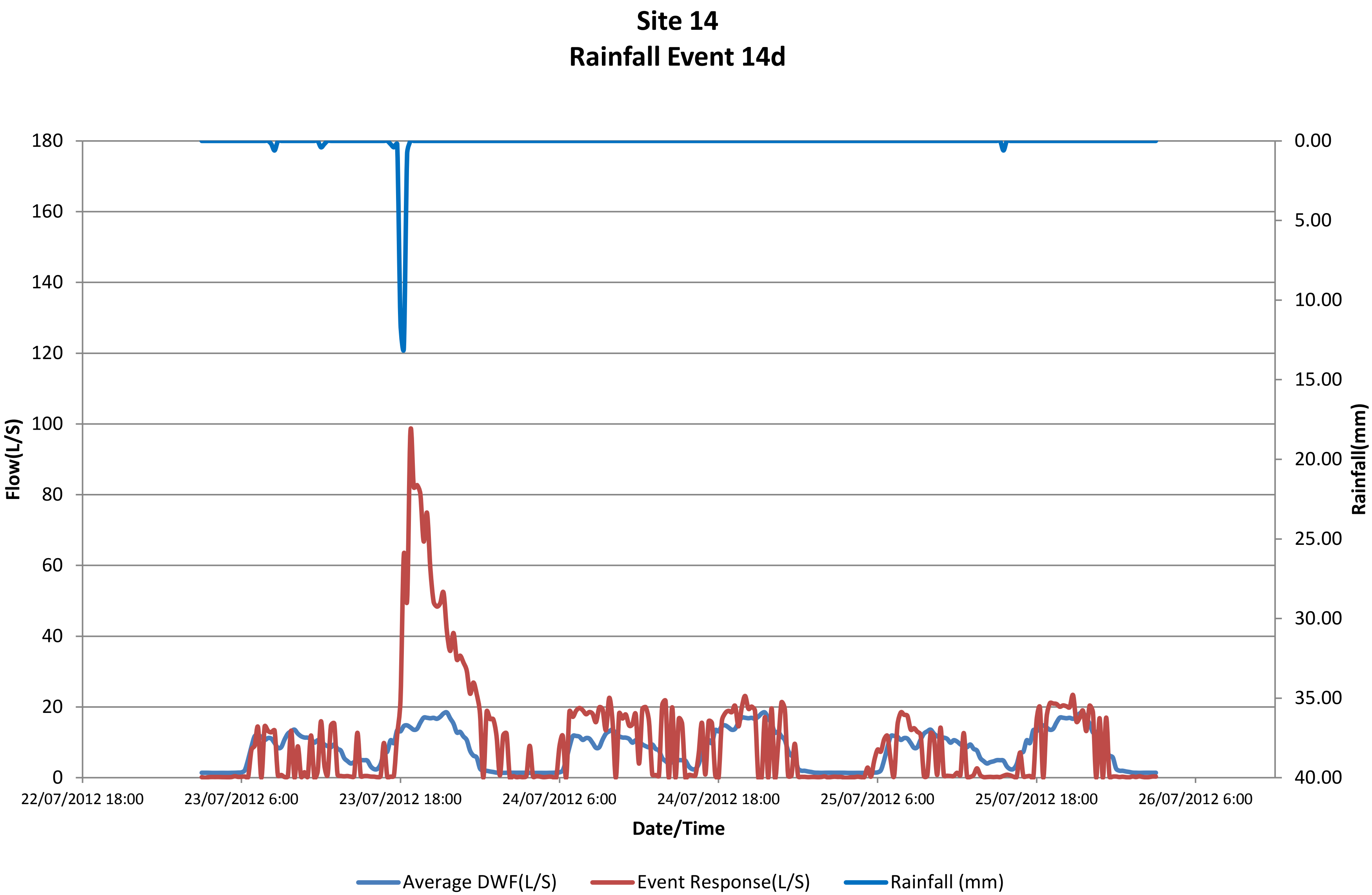
Site 13
Rainfall Event 13f
Flow(L/S)
Rainfall(mm)
20
18
16
14
12
10
8
6
4
2
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
14/08/2012 0:00
14/08/2012 6:00
14/08/2012 12:00
14/08/2012 18:00
15/08/2012 0:00
15/08/2012 6:00
15/08/2012 12:00
15/08/2012 18:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)



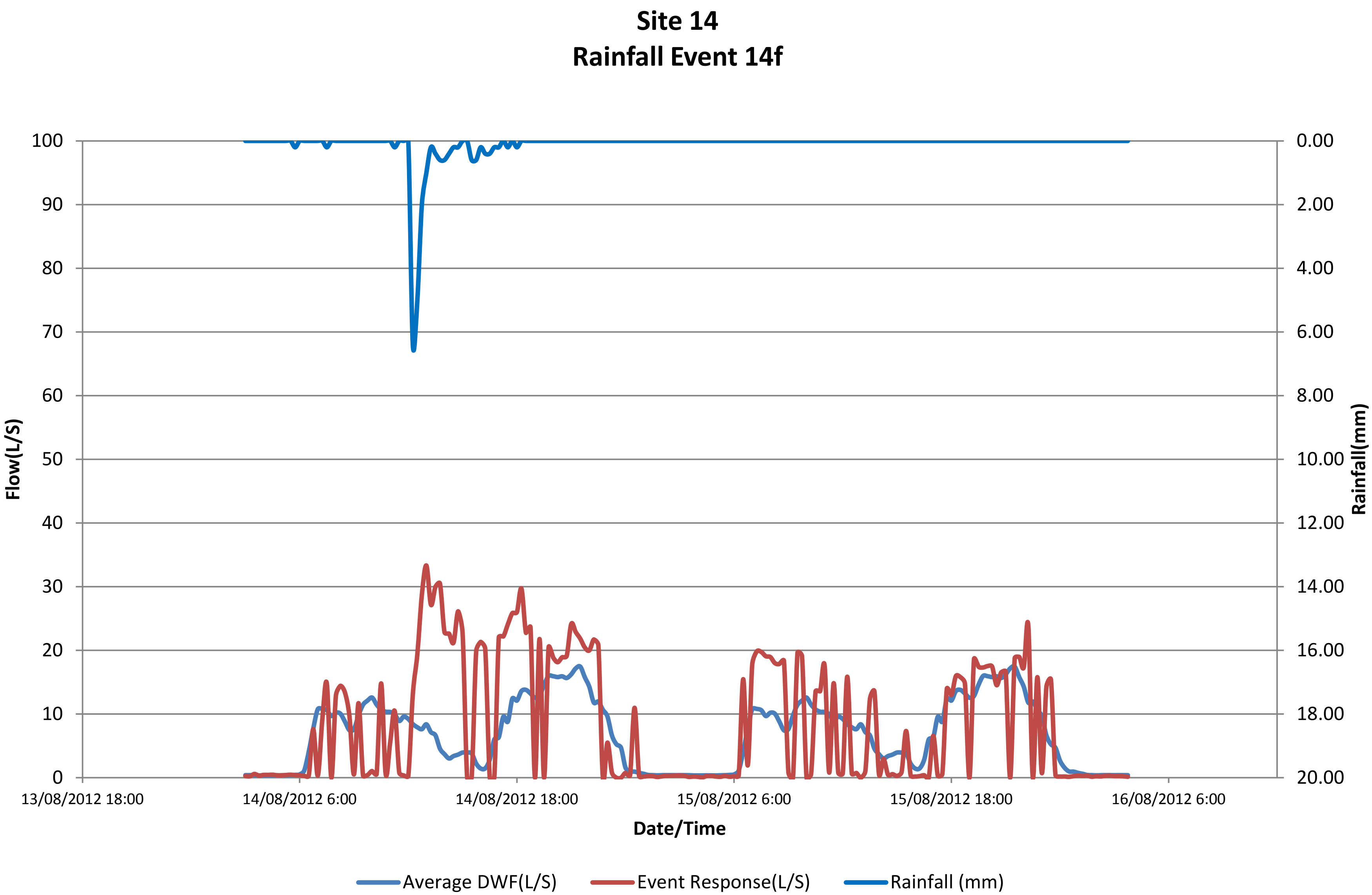
Site 13
Rainfall Event 13g
Flow(L/S)
14
12
10
8
6
4
2
0
Rainfall(mm)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
21/08/2012 14:24
24/08/2012 14:24
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)



Site 14
Rainfall Event 14c
Flow(L/S)
120
100
80
60
40
20
0
Rainfall(mm)
0.00
5.00
10.00
15.00
20.00
25.00
14/07/2012 16:48
17/07/2012 16:48
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

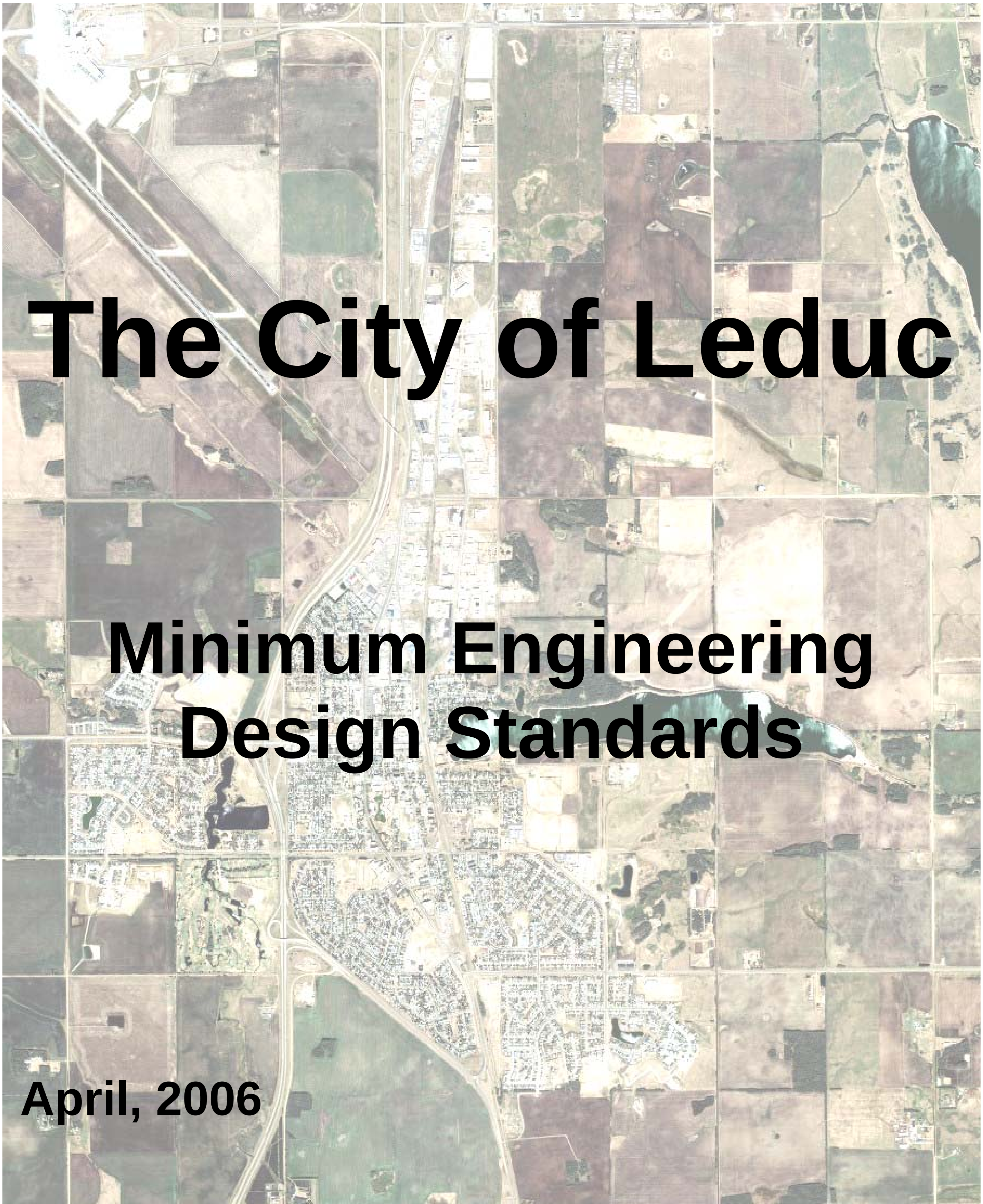


Site 14
Rainfall Event 14d
180
160
140
120
100
80
60
40
20
0
Flow(L/S)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
Rainfall(mm)
22/07/2012 18:00
23/07/2012 6:00
23/07/2012 18:00
24/07/2012 6:00
24/07/2012 18:00
25/07/2012 6:00
25/07/2012 18:00
26/07/2012 6:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)



Site 14
Rainfall Event 14f
100
90
80
70
60
50
40
30
20
10
0
Flow(L/S)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Rainfall(mm)
13/08/2012 18:00
14/08/2012 6:00
14/08/2012 18:00
15/08/2012 6:00
15/08/2012 18:00
16/08/2012 6:00
Date/Time
Average DWF(L/S)
Event Response(L/S)
Rainfall (mm)

APPENDIX B
CITY OF LEDUC DESIGN STANDARDS - SECTION 8.1, 8.2 AND 8.3



The City of Leduc

Minimum Engineering Design Standards

April, 2006

8.0 SANITARY SEWAGE SYSTEM

8.1 GENERAL

8.1.1 The sanitary sewer system shall have sufficient capacity to convey the peak dry weather flow plus extraneous flows plus sanitary flow from all future contributing areas. This section outlines the methodology and design criteria that apply to the design of the sanitary sewer system.

8.2 DESIGN FLOW

8.2.1 Population estimates used for residential sanitary sewer flow calculations shall be based on the greater of:

.1 Subdivision design population density

.2 40 persons per hectare

8.2.2 Residential Contributions

.1 Minimum average contribution of 360 litres per person per day.

.2 Peak dry weather flow rates for each contributing area calculated as average flow multiplied by the following peaking factor:

Peaking Factor shall be the larger of either 1.5 or $PF = 2.6\ P^{-0.1}$

Where P = population in 1000’s

8.2.3 Commercial, Industrial, and Institutional Contribution

.1 Minimum average contribution of 0.2 litres per second per hectare (17,280 litres per hectare per day). The Developer should account for higher average flows if high water use facilities are being planned within the development (Food processing plant, large hotel, hospital, etc.)

.2 Peak dry weather flow rate for each contributing area calculated as average flow multiplied by a peaking factor of 3.0.

8.2.4 Extraneous Flow Allowance

.1 A general allowance of 0.20 litres per second per hectare shall be applied to all residential areas to account for wet weather inflow to manholes not located in street sags and for infiltration into pipes and manholes.

.2 A general allowance of 0.05 litres per second per hectare shall be applied to all commercial, industrial, and institutional areas to account for wet weather inflow to manholes not located in street sags and for infiltration into pipes and manholes.

.3 A separate allowance of 0.4 litres per second per manhole shall be applied for inflows at manholes located within roadway sags or other low areas that may be flooded during major storm events. An effort should be made during the design stage to locate sanitary manholes away from sag locations. For planning purposes and downstream system design, the Developer shall make a conservative estimate of the number of sag manholes that may be located in the future contributing area.

.4 Subsequent to June 1991, connection of foundation drains (weeping tile) to sanitary sewers is no longer permitted. Therefore, for new development areas, a specific allowance for foundation drains flow to the sanitary sewer system is not required. However, the Developer is required to account for foundation drain flow when computing sanitary design flow from previously developed areas where such connections may be present.

8.2.5 Total Design Peak Flow for Sanitary Sewers

The total design peak flow for the sanitary sewer is the sum of the peak dry weather flow plus all extraneous flows plus sanitary flow from all future contributing areas.

8.3 SIZING OF SANITARY SEWERS

.1 All sanitary sewers shall be sized using the Manning's equation and an "n" value of 0.013 for all smooth walled pipes of approved material.

.2 Application of a depth variable friction factor at a flow depth of 80% of the sewer diameter results in a flow rate of approximately 86% of the sewer's full flow capacity. Therefore, the required flow capacity for sizing of the sewer shall be computed using the following relationship:

$$\text{Required Full Sewer Flow Capacity} = \frac{\text{Estimated Total Design Peak Flow Rate}}{0.86}$$

.3 The minimum size for sanitary sewers in residential areas is 200 mm for the first two sewer pipes in the upstream reach. Downstream of these locations, the minimum sewer size is 250 mm.

.4 The minimum size for sanitary sewers for commercial, industrial and institutional areas is 250 mm.

.5 The preferred slope on sanitary sewers is 0.40% or greater. The Developer should optimize the use of available elevation differences to provide this preferred slope throughout the entire development where feasible. If it is not feasible to provide a 0.40% slope throughout the entire development, the steeper slopes should be provided in the upper reaches of the sanitary system where design flows are minimal.

.6 Sanitary sewers shall be designed to provide a minimum full flow velocity of 0.60 metres per second for pipes 375 mm or greater. For pipes 300 mm or smaller, the minimum full flow velocity is about 0.65 metres per second. No sanitary sewer shall have a slope of less than 0.10%.

The following lists minimum slopes for various sewer sizes for both straight and curved alignments:

Sewer Size	Straight Alignment Minimum Slope	Curved Alignment Minimum Slope
200 mm	0.40%	0.60%
250 mm	0.28%	0.42%
300 mm	0.22%	0.33%
375 mm	0.15%	0.22%
450 mm	0.12%	0.18%
525 mm	0.10%	0.14%
600 mm	0.10%	0.12%
675 mm and larger	0.10%	0.10%

.7 Sanitary sewers shall be designed to limit the maximum full flow velocity to 3.0 metres per second.

.8 The minimum slope for the most upstream reach of any sanitary sewer system shall be 0.60% from the terminal manhole to the second manhole downstream from the terminal manhole. From this second manhole to the point where the design flow exceeds 10 litres per second, the minimum slope shall be 0.40%. Where depth constraints make this slope requirement not feasible, the City may approve an exemption for these design criteria. If an exemption is granted, the requirements listed in 8.3.7 shall apply.

8.4 PIPE ELEVATION CONSIDERATIONS AT MANHOLES

.1 Pipe inverts shall have a minimum drop through the manhole of 10 mm for a bend in the pipe alignment of between 0 degrees and 10 degrees.

.2 Pipe inverts shall have a minimum drop through the manhole of 30 mm for a bend in the pipe alignment of between 10 degrees and 45 degrees.

.3 Pipe inverts shall have a minimum drop through the manhole of 50 mm for a bend in the pipe alignment of between 45 degrees and 90 degrees.

.4 Bends of more than 90 degrees in the pipe alignment through a manhole are not recommended. The City may approve an exemption to these criteria if suitable justification is provided by the Developer.

.5 The obvert elevation of a sanitary sewer entering a manhole shall not be lower than the obvert elevation of the outlet sewer.

.6 Large differences in invert elevations at manholes shall be avoided. A drop manhole shall be installed at all locations where the invert elevations of the inlet and outlet sewer differ by more than 1.0 m.

APPENDIX C
GROWTH AND FLOW PROJECTIONS

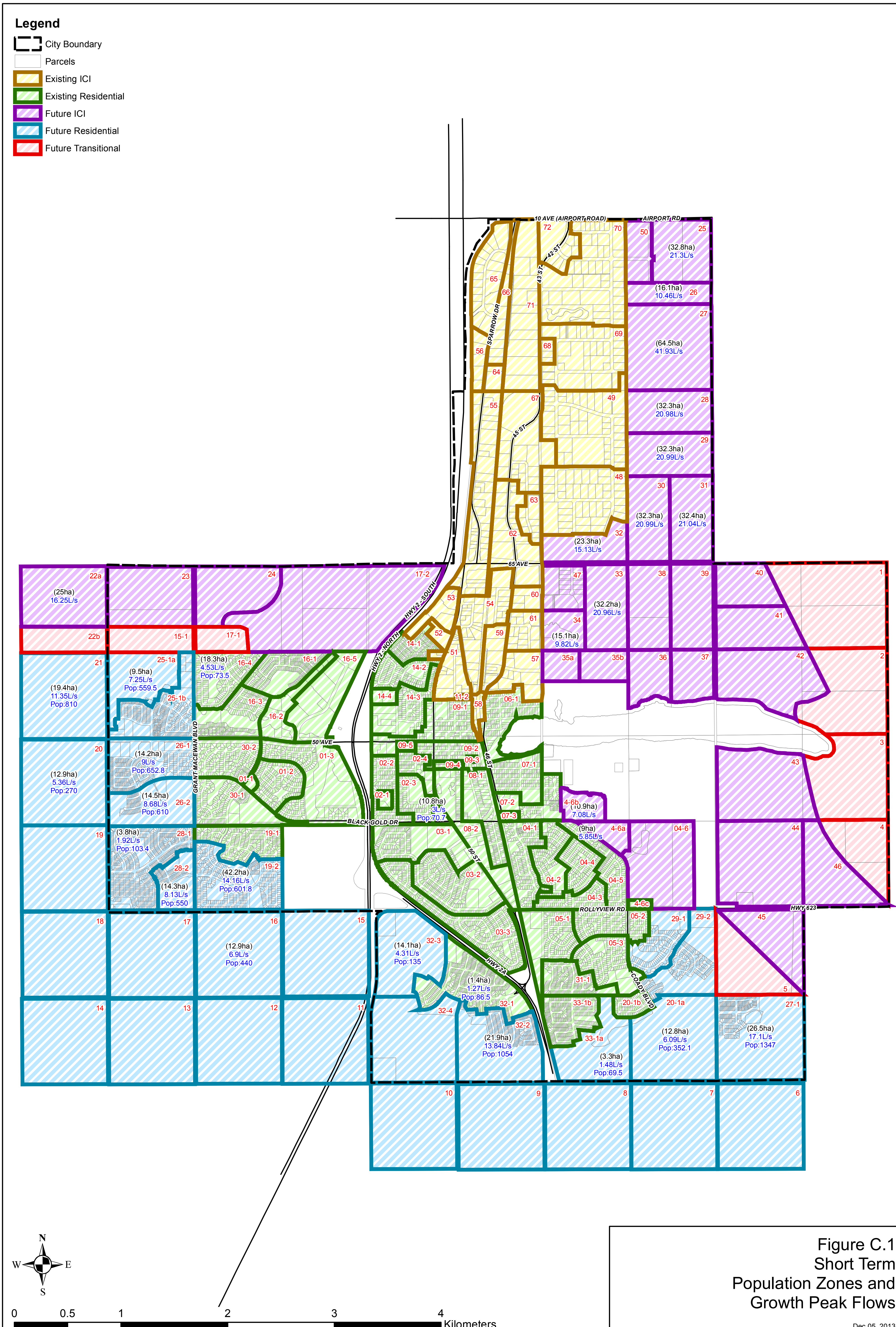


Figure C.1
Short Term
Population Zones and
Growth Peak Flows

Dec 05, 2013

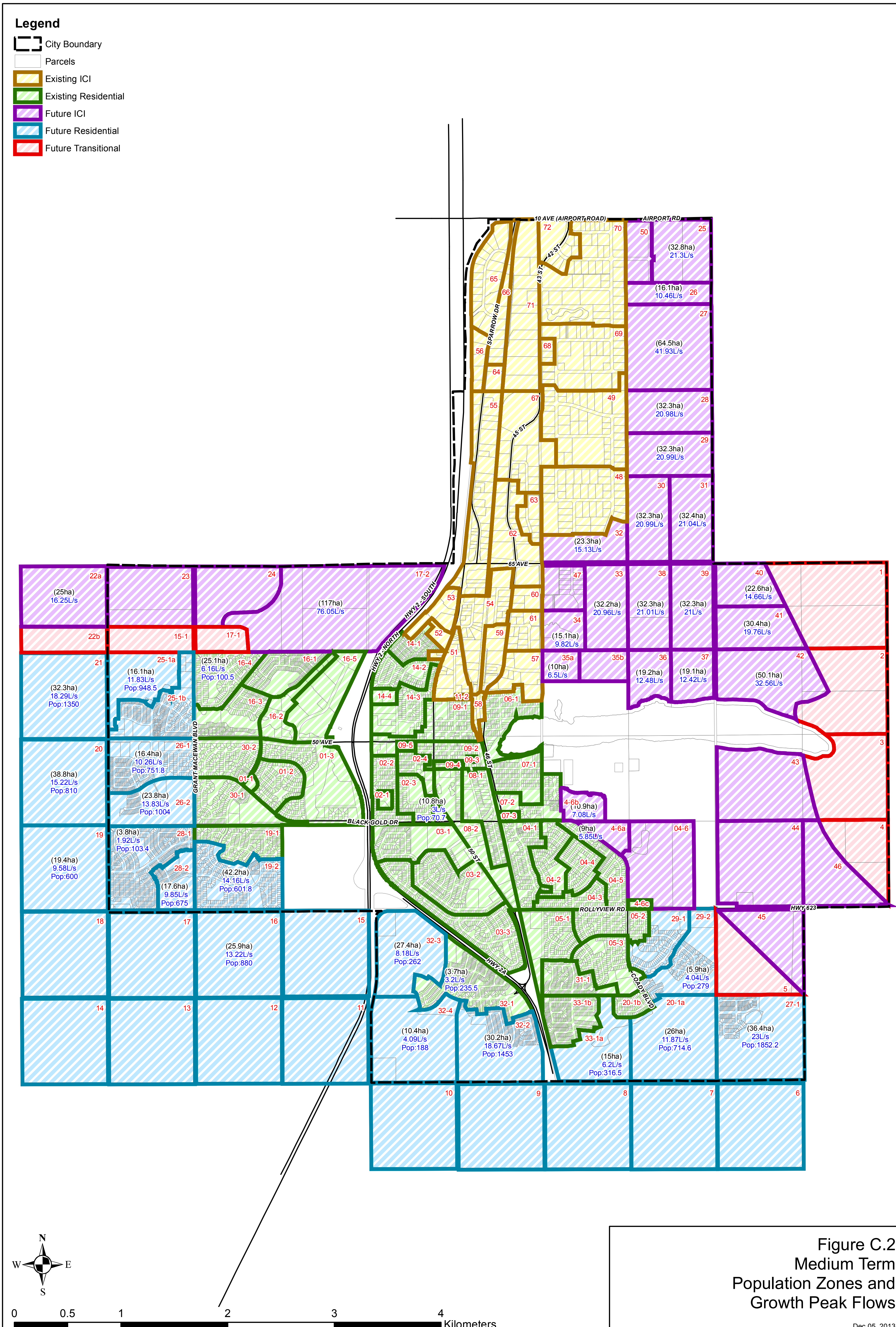


Figure C.2
Medium Term
Population Zones and
Growth Peak Flows

Dec 05, 2013

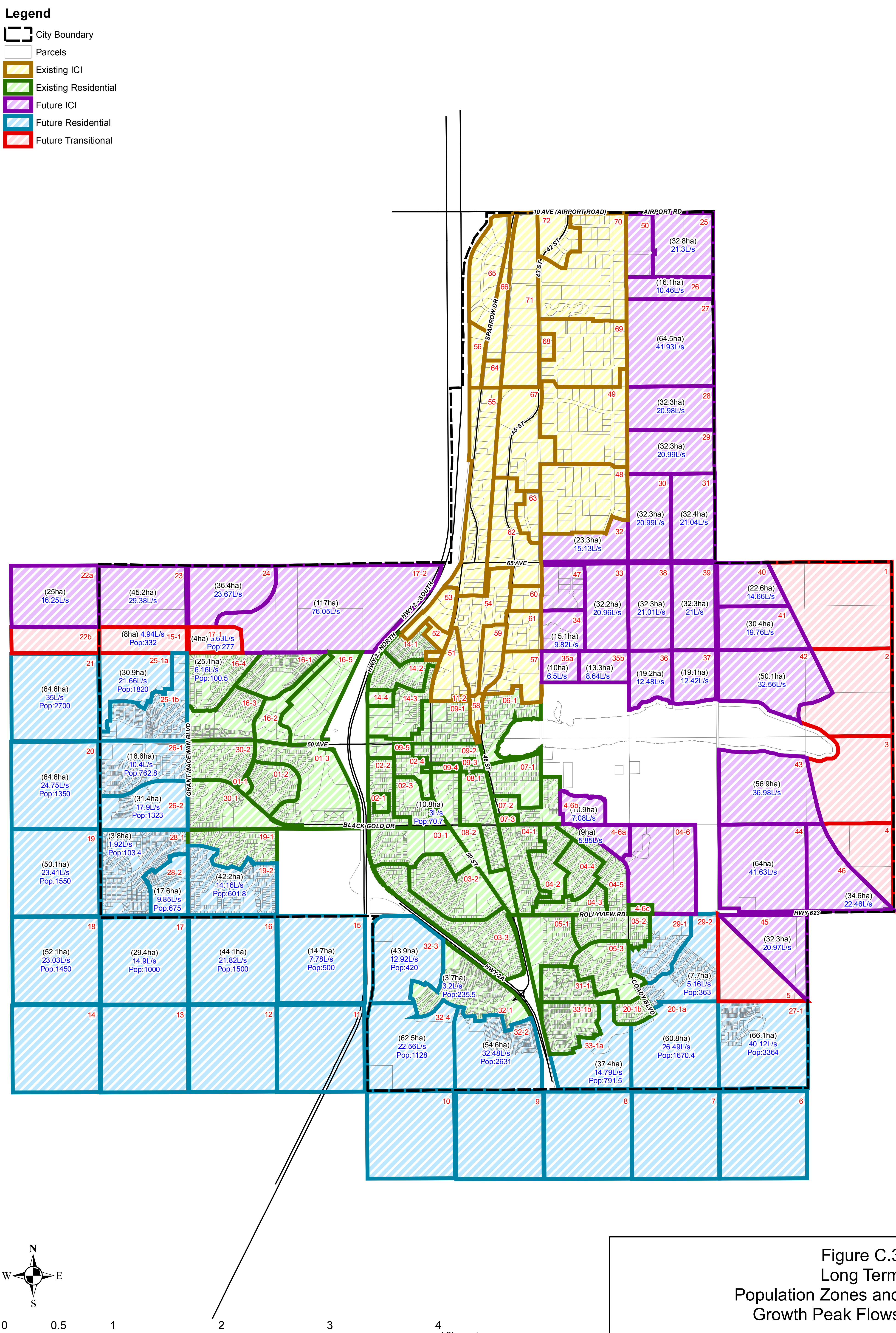


Figure C.3
Long Term
Population Zones and
Growth Peak Flows

Dec 05, 2013

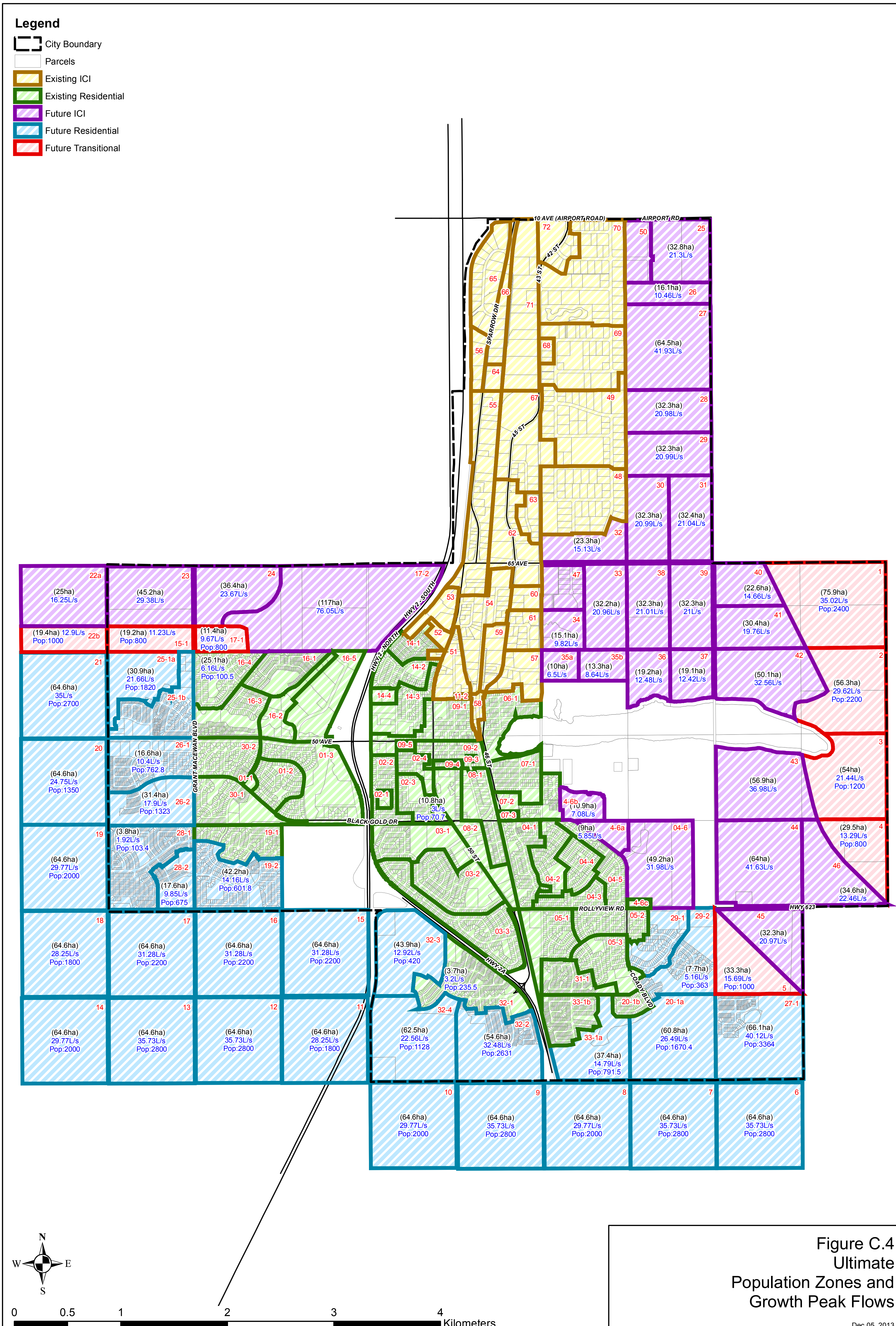


Figure C.4
Ultimate
Population Zones and
Growth Peak Flows

Dec 05, 2013

APPENDIX D
MODEL CALIBRATION CURVES

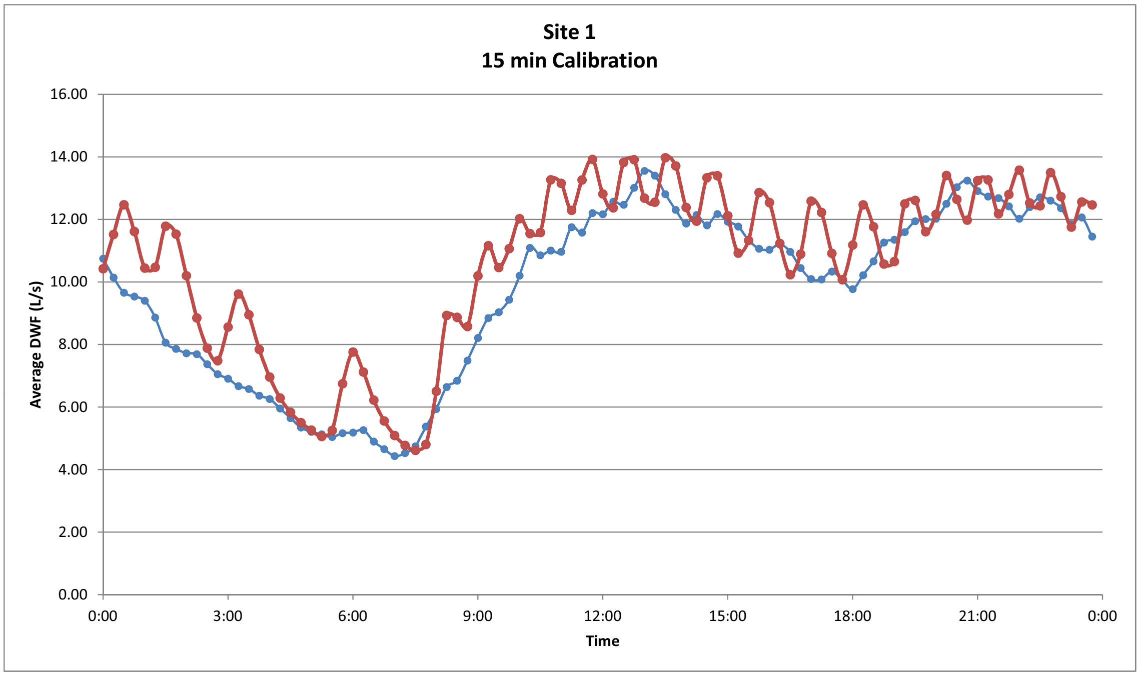
Dry Weather Flow Calibration Summary

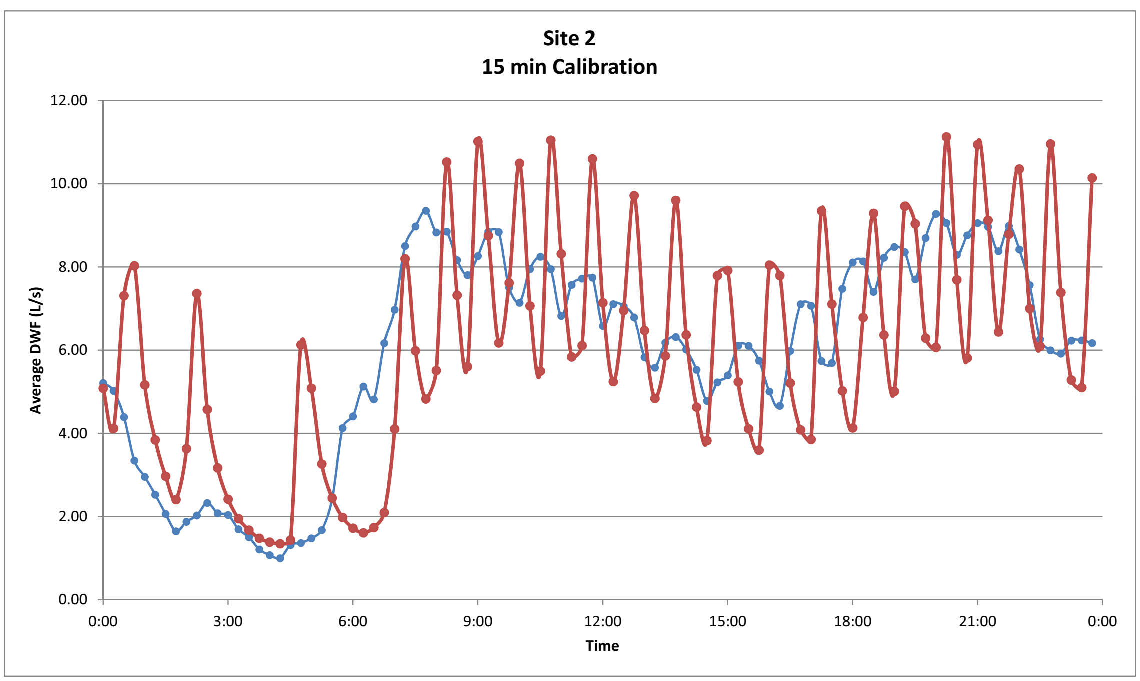
Site	Average Flow (L/s)			Peak Flow (L/s)			Volume (m^3)		
	Monitored	Model	% Diff	Monitored	Model	% Diff	Monitored	Model	% Diff
1	9.73	10.64	9.30%	13.56	13.98	3.11%	840.69	918.88	9.30%
2	5.97	6.05	1.37%	9.35	11.13	19.00%	515.41	522.48	1.37%
3	9.57	9.61	0.42%	12.22	11.03	-9.77%	827.14	830.63	0.42%
5	4.98	5.11	2.66%	7.92	7.91	-0.18%	430.05	441.51	2.66%
6	12.82	18.16	41.62%	23.11	40.18	73.83%	1107.82	1568.88	41.62%
7	11.88	12.05	1.43%	14.83	14.82	-0.02%	1026.10	1040.77	1.43%
8	36.83	56.17	52.50%	46.78	94.91	102.87%	3182.50	4495.32	41.25%
9	13.40	13.90	3.75%	16.58	16.54	-0.27%	1157.95	1201.39	3.75%
10	2.25	2.42	7.59%	3.02	3.00	-0.48%	194.42	209.17	7.59%
11	3.55	3.76	5.88%	6.14	6.14	-0.10%	306.56	324.60	5.88%
12	3.18	3.25	2.32%	4.17	4.17	0.02%	274.83	281.22	2.32%
13	2.42	2.79	15.39%	4.23	3.78	-10.59%	208.89	241.05	15.39%
14	7.07	11.81	66.96%	17.44	17.23	-1.20%	611.27	1020.59	66.96%

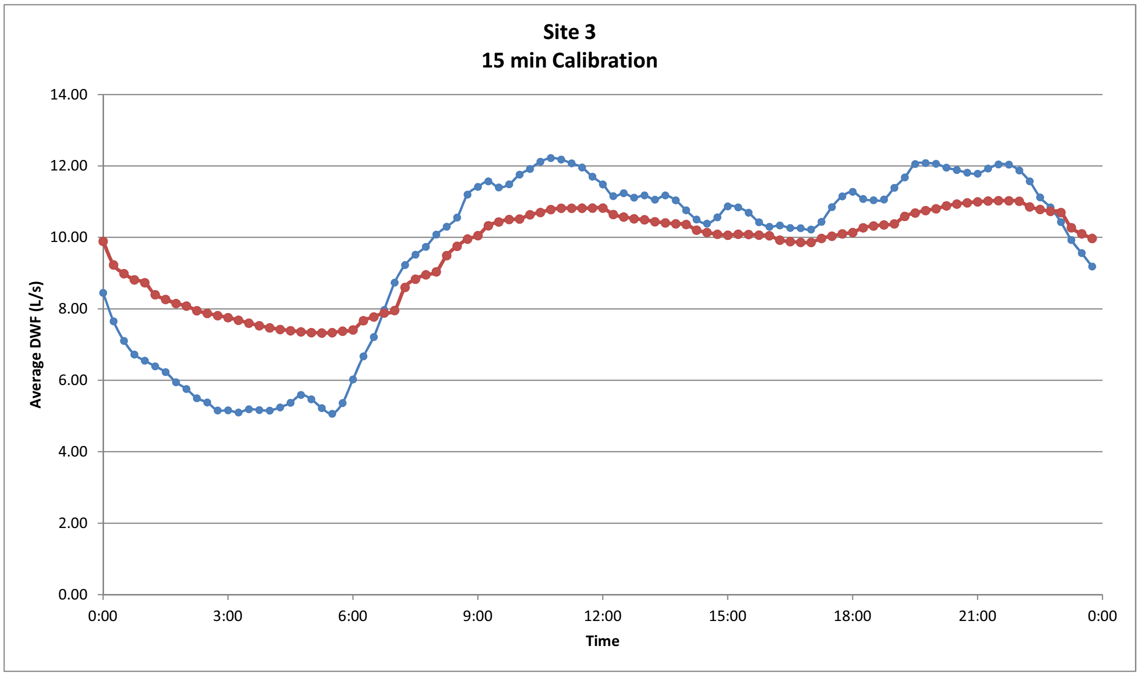
LEGEND

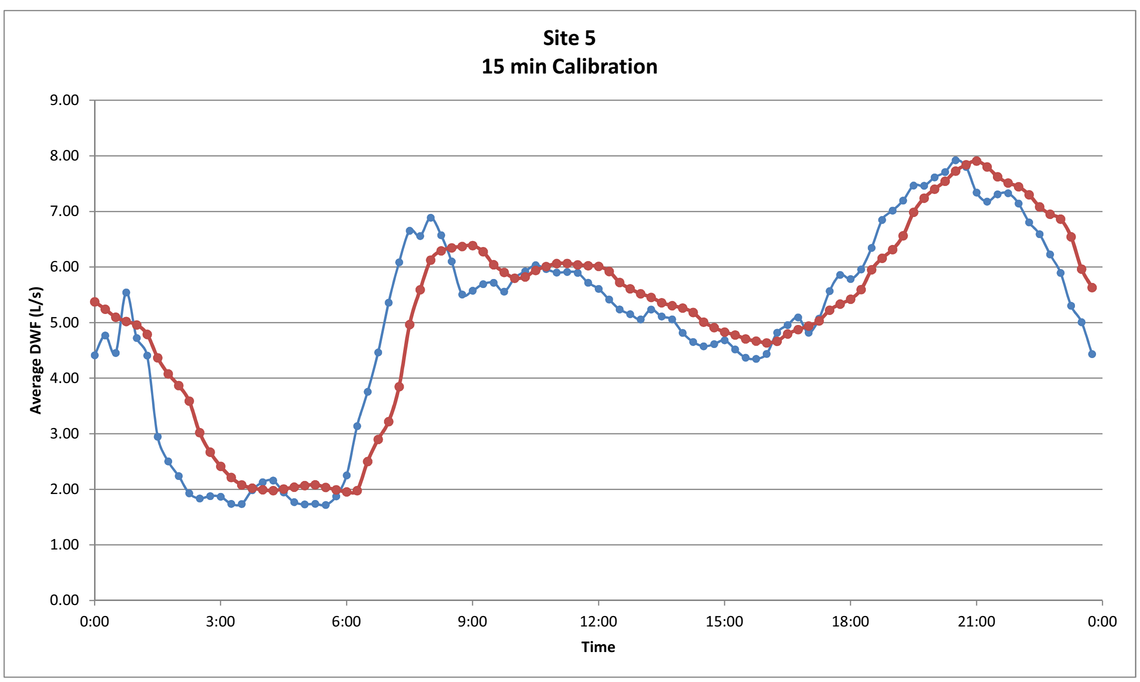
Model

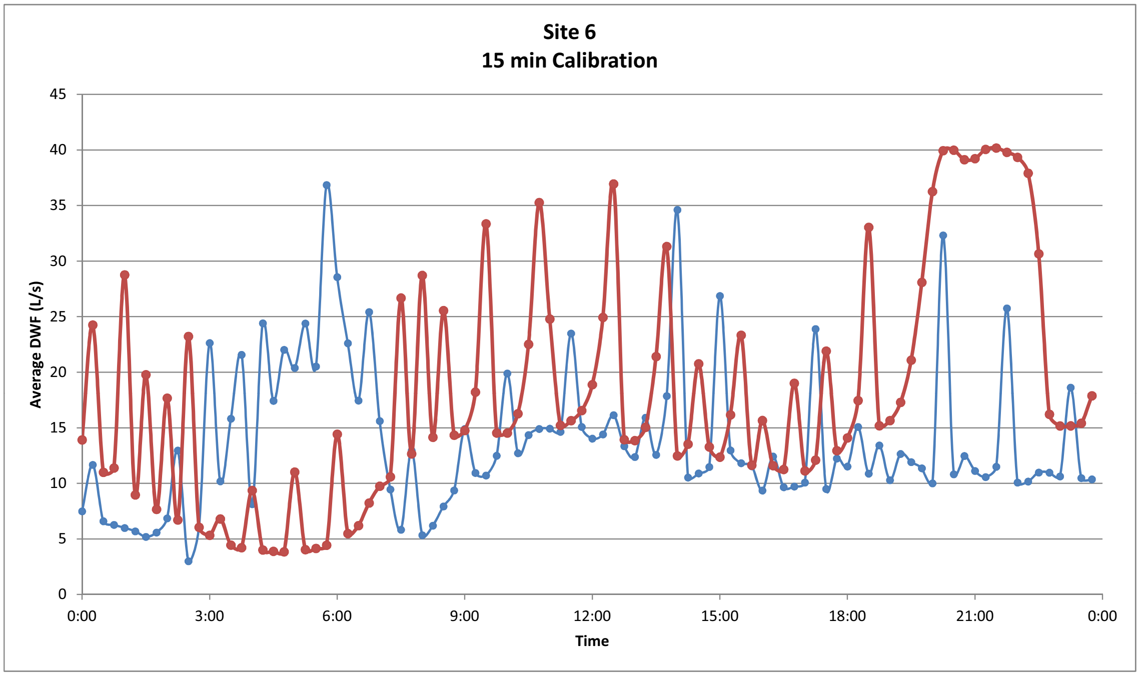
Monitored


Site 1
15 min Calibration
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Average DWF (L/s)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time

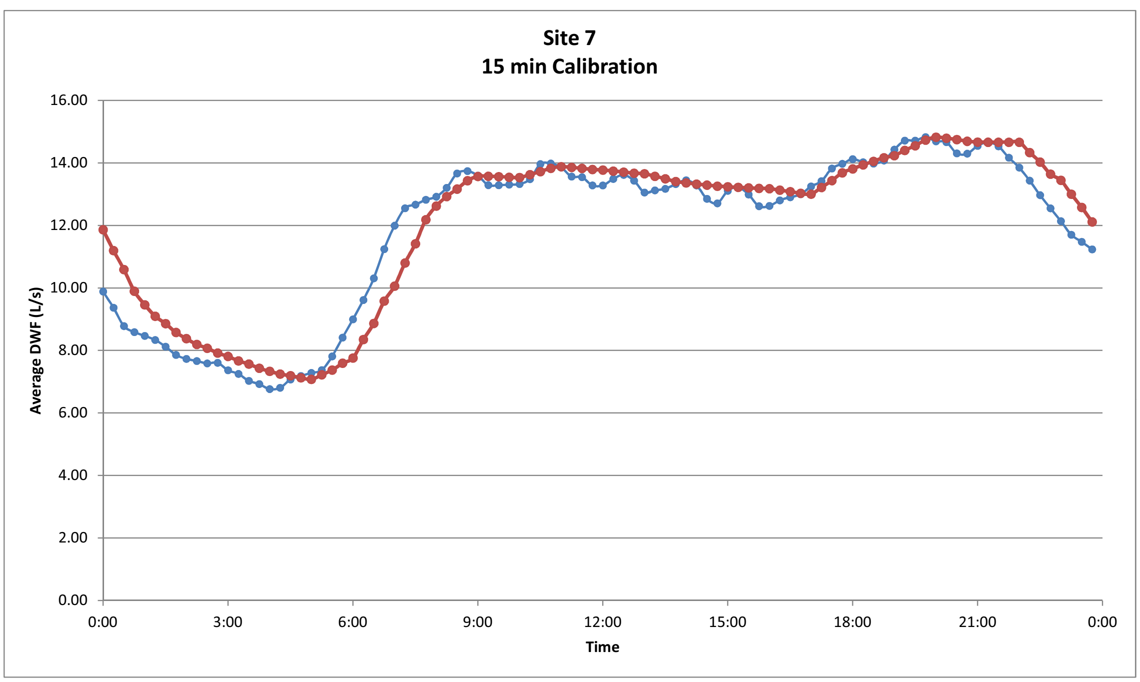

Site 2
15 min Calibration
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Average DWF (L/s)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time


Site 3
15 min Calibration
Average DWF (L/s)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time

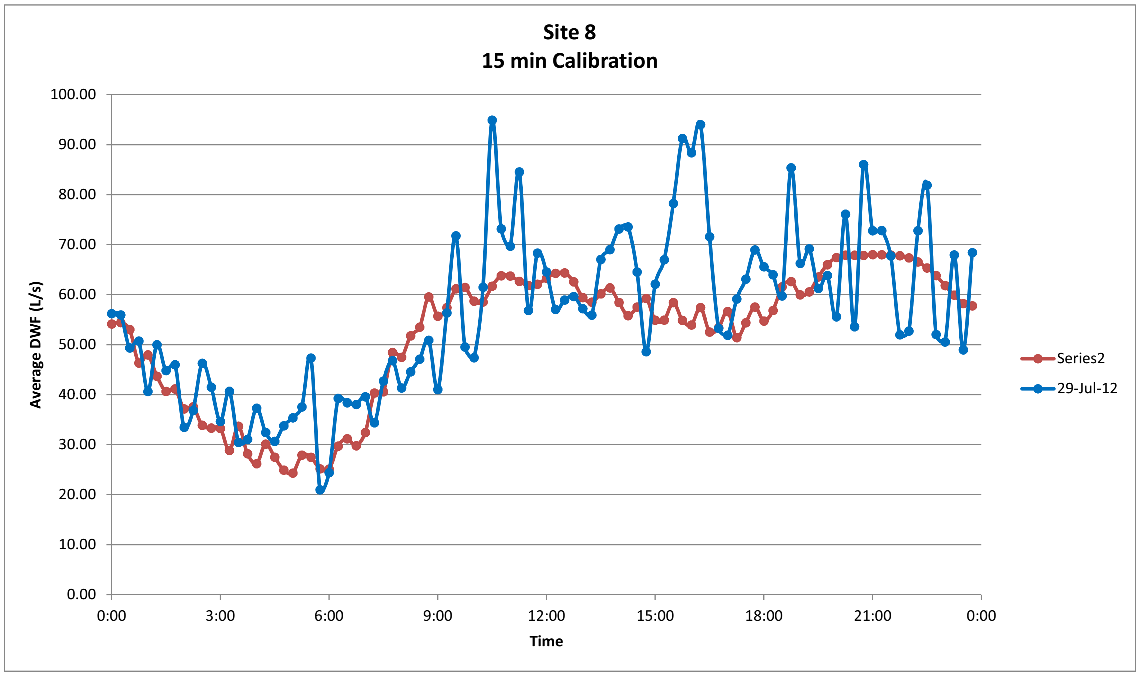

Site 5
15 min Calibration
Average DWF (L/s)
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time

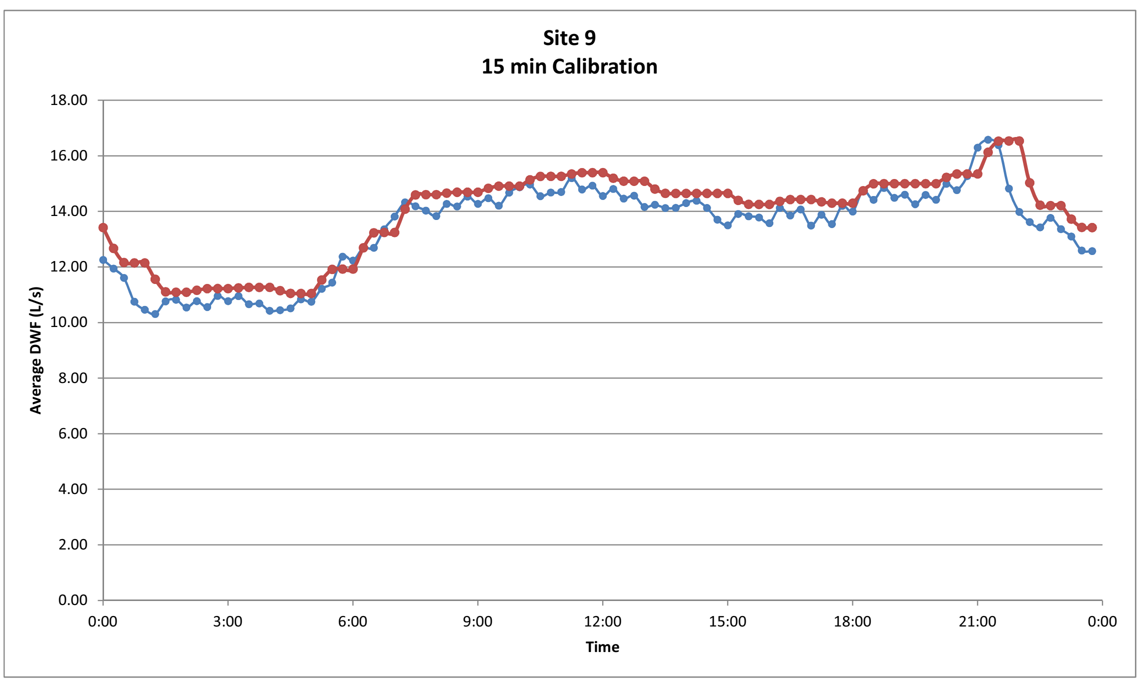


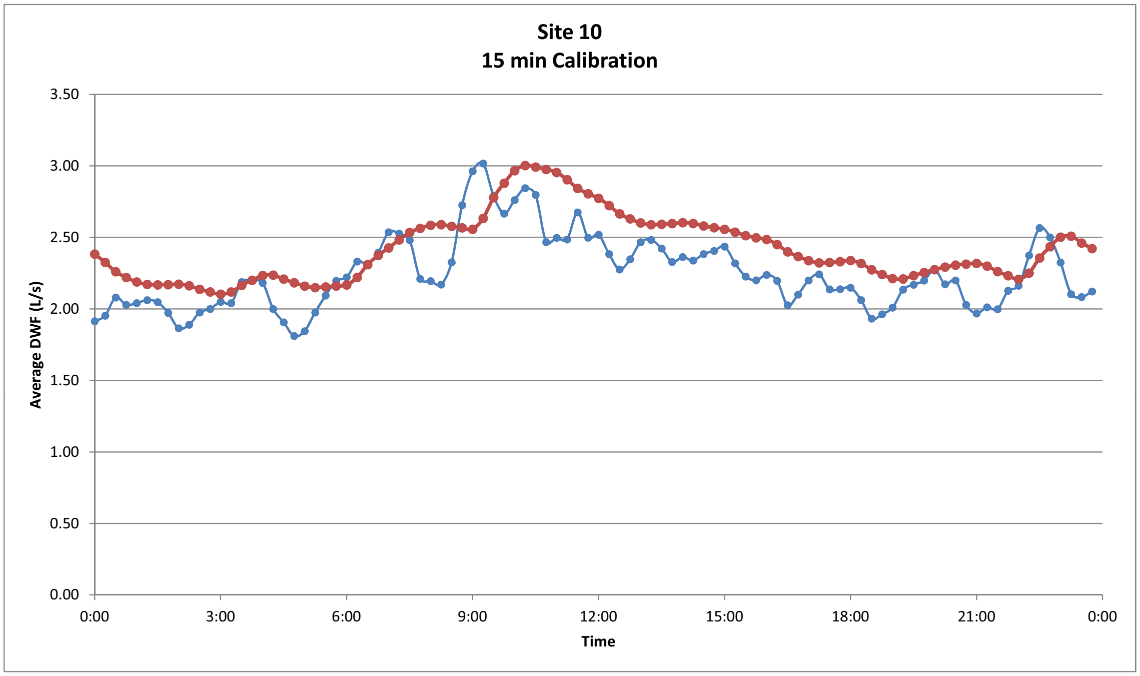
Site 6
15 min Calibration
45
40
35
30
25
20
15
10
5
0
Average DWF (L/s)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time

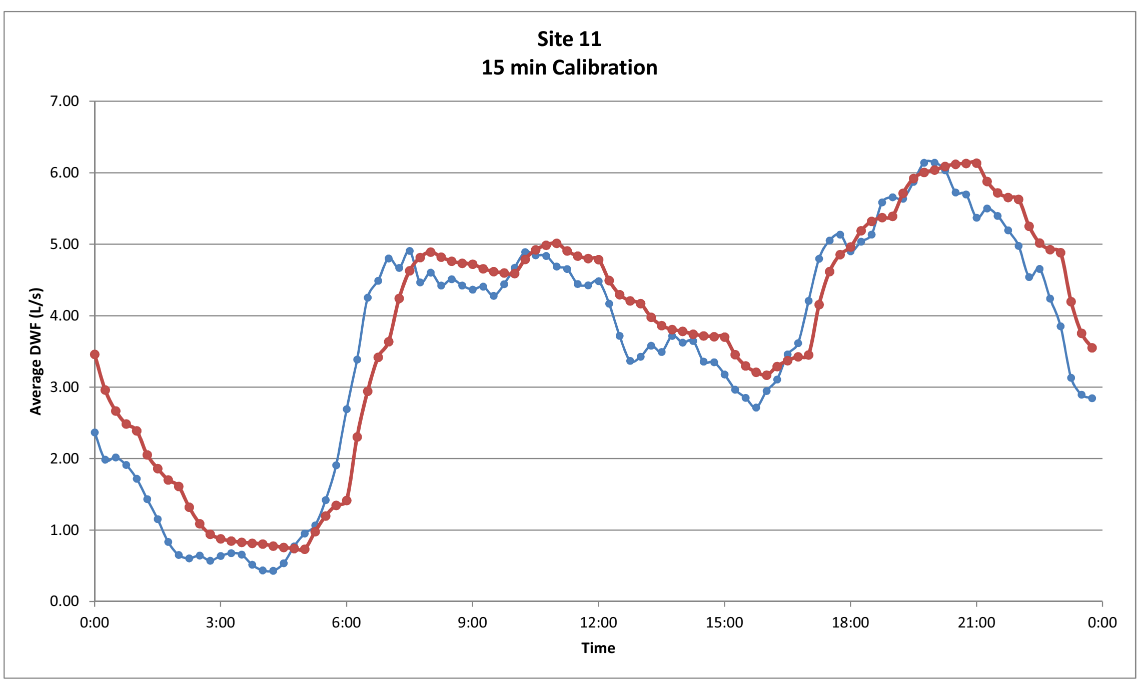


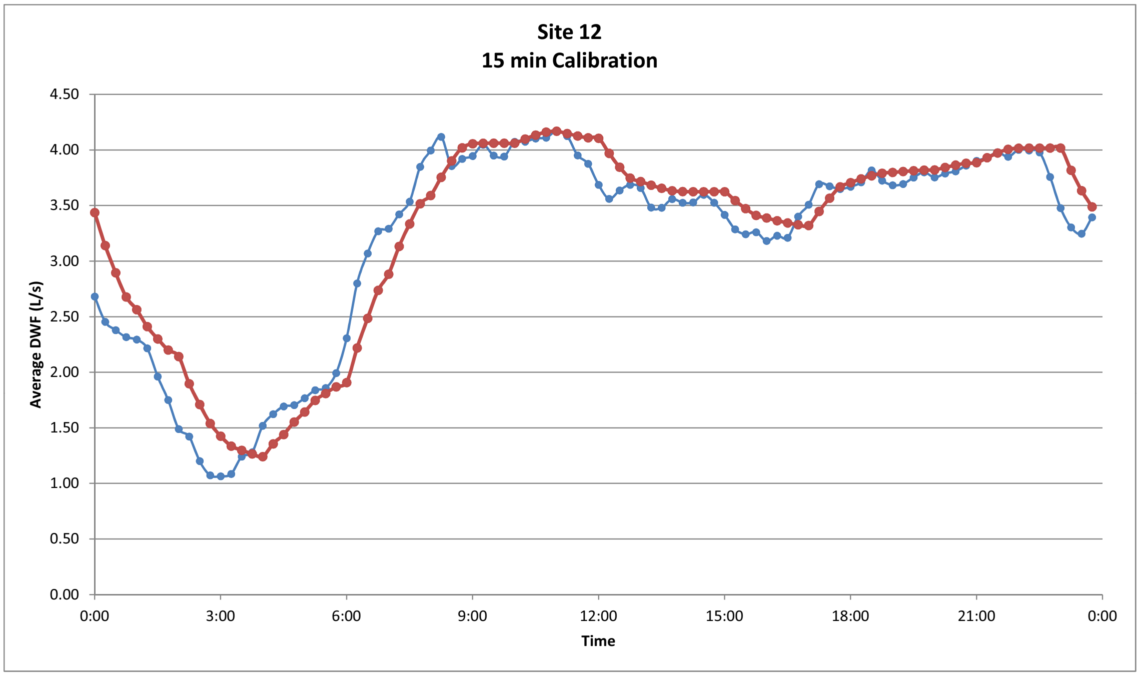
Site 7
15 min Calibration
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Average DWF (L/s)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time

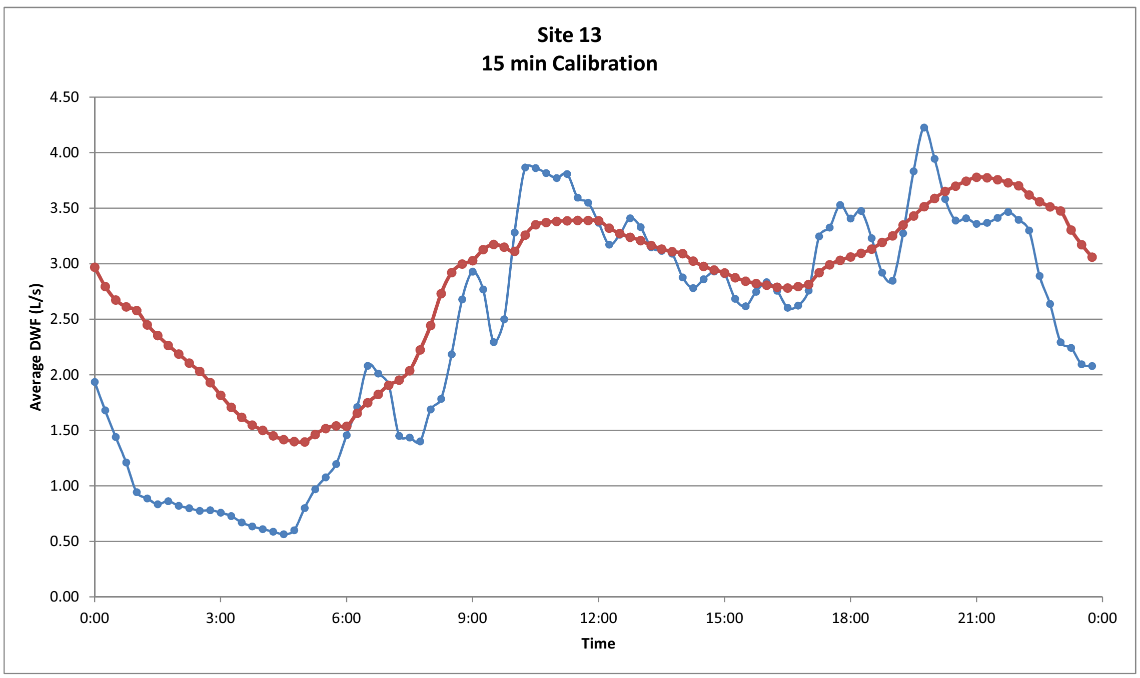

Site 8
15 min Calibration
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Average DWF (L/s)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time
Series2
29-Jul-12

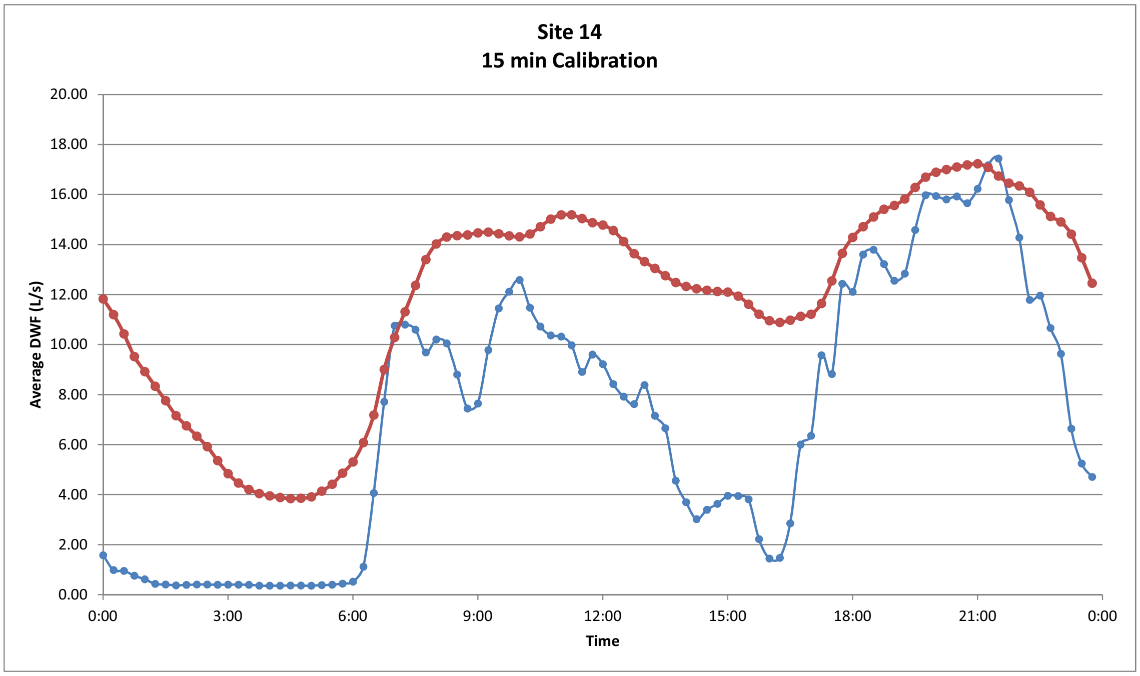

Site 9
15 min Calibration
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Average DWF (L/s)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time


Site 10
15 min Calibration
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Average DWF (L/s)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time


Site 11
15 min Calibration
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Average DWF (L/s)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time


Site 12
15 min Calibration
Average DWF (L/s)
Time
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00


Site 13
15 min Calibration
Average DWF (L/s)
Time
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00


Site 14
15 min Calibration
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Average DWF (L/s)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time

Site 1

	R	T	K
Short	0.00083	0.07	4.5
Medium	0.0035	0.2	2
Long	0.002	0.3	1

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
1c	2856087	3565051	-24.8%	22.9	28.7	-25.5%
1e	601281	727953	-21.1%	21.0	21.5	-2.5%

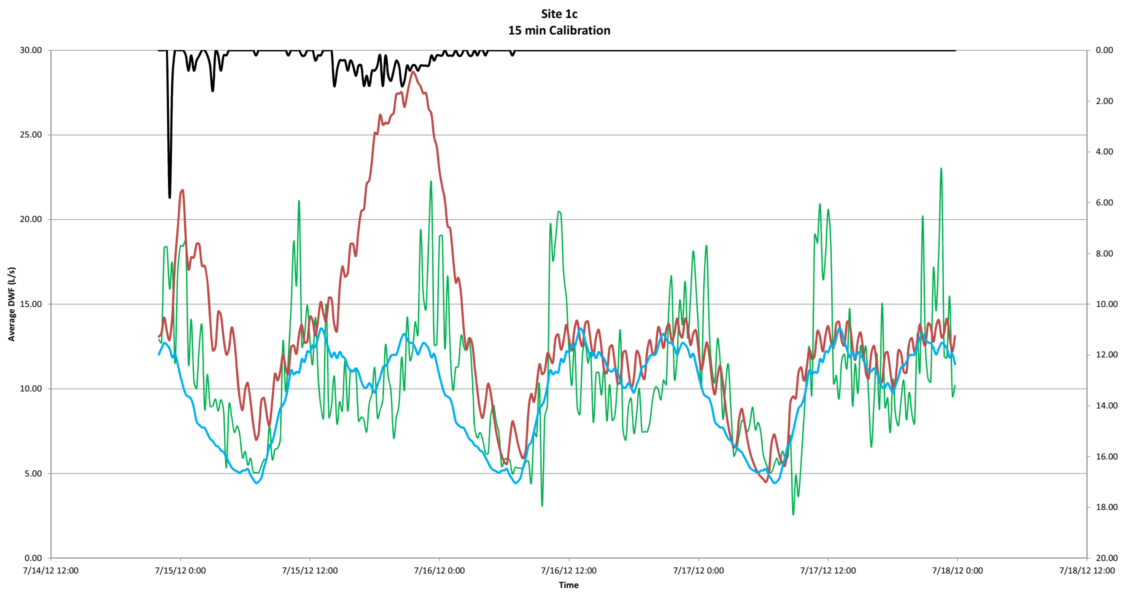
LEGEND

Model

Monitored

DWF

Rainfall


Site 1c
15 min Calibration
Average DWF (L/s)
Time
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
7/14/12 12:00
7/15/12 0:00
7/15/12 12:00
7/16/12 0:00
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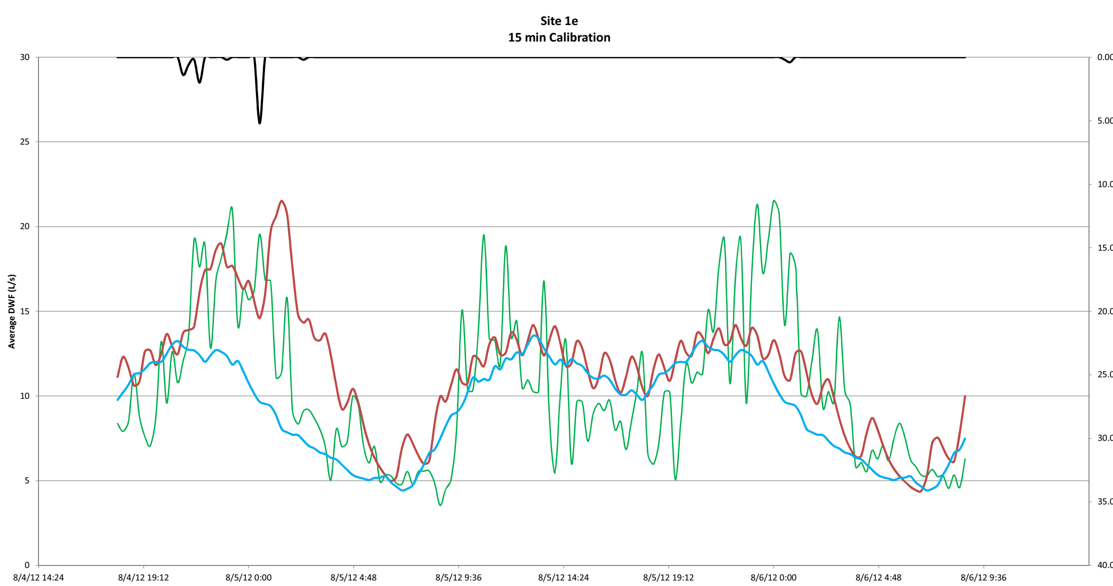
7/17/12 0:00
7/17/12 12:00
7/18/12 0:00
7/18/12 12:00


Site 1e
15 min Calibration
Average DWF (L/s)
Time
30
25
20
15
10
5
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
8/4/12 14:24
8/4/12 19:12
8/5/12 0:00
8/5/12 4:48
8/5/12 9:36
8/5/12 14:24
8/5/12 19:12
8/6/12 0:00
8/6/12 4:48
8/6/12 9:36

Site 2

	R	T	K
Short	0.0083	0.07	4.5
Medium	0.0049	0.38	5
Long	0.003	1.5	2

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
2c	792297	765669	3.4%	24.9	18.4	26.4%
2d	1250730	1192593	4.6%	27.4	34.6	-26.3%
2g	1011474	822082	18.7%	21.3	16.5	22.6%

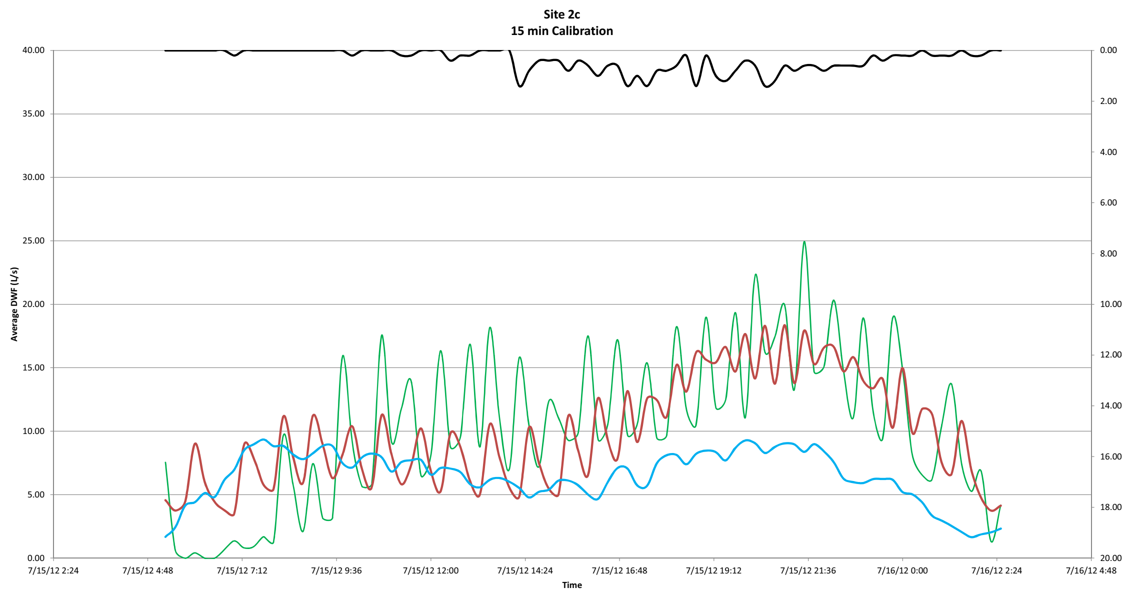
LEGEND

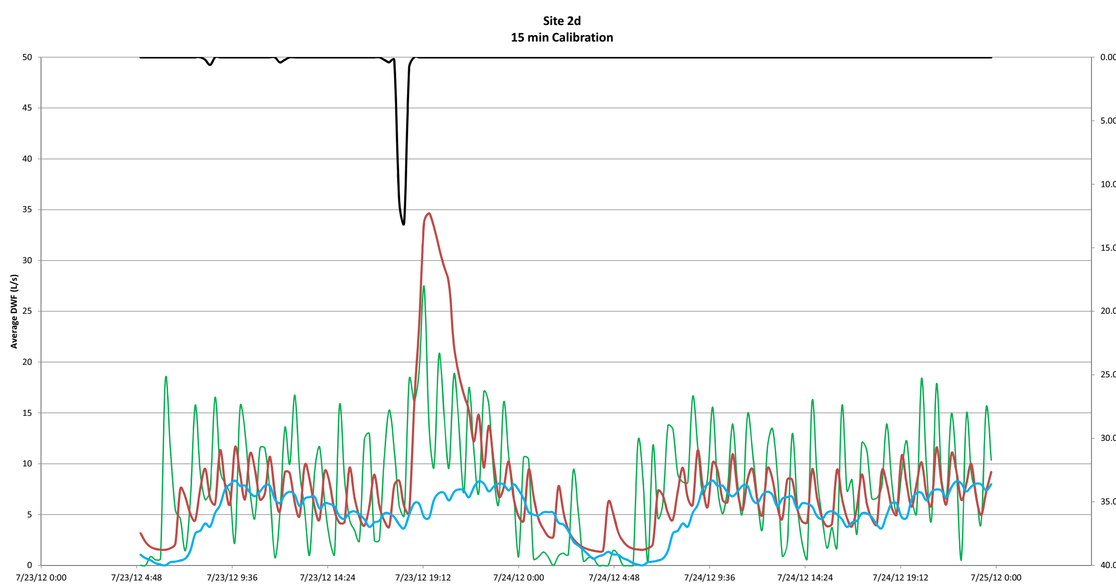
Model

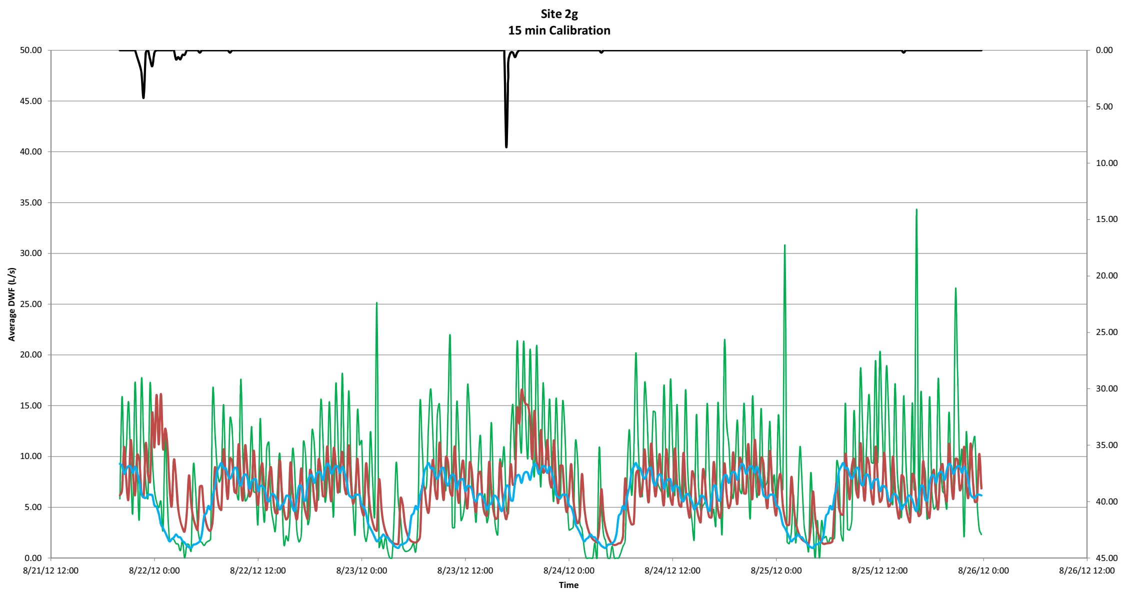
Monitored

DWF

Rainfall


Site 2c
15 min Calibration
Average DWF (L/s)
Time
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
7/15/12 2:24
7/15/12 4:48
7/15/12 7:12
7/15/12 9:36
7/15/12 12:00
7/15/12 14:24
7/15/12 16:48
7/15/12 19:12
7/15/12 21:36
7/16/12 0:00
7/16/12 2:24
7/16/12 4:48
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00


Site 2d
15 min Calibration
Average DWF (L/s)
Time
50
45
40
35
30
25
20
15
10
5
0
7/23/12 0:00
7/23/12 4:48
7/23/12 9:36
7/23/12 14:24
7/23/12 19:12
7/24/12 0:00
7/24/12 4:48
7/24/12 9:36
7/24/12 14:24
7/24/12 19:12
7/25/12 0:00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00


Site 2g
15 min Calibration
Average DWF (L/s)
Time
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
8/21/12 12:00
8/22/12 0:00
8/22/12 12:00
8/23/12 0:00
8/23/12 12:00
8/24/12 0:00
8/24/12 12:00
8/25/12 0:00
8/25/12 12:00
8/26/12 0:00
8/26/12 12:00

Site 3

	R	T	K
Short	0.0275	0.1	1
Medium	0.01	2	3
Long	0.01	4	6

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
3c	4445289	4128900	7.1%	48.2	38.8	19.4%
3d	4023378	4283107	-6.5%	53	54.2	-2.1%
3f	2390238	2338269	2.2%	34.5	27.1	21.5%

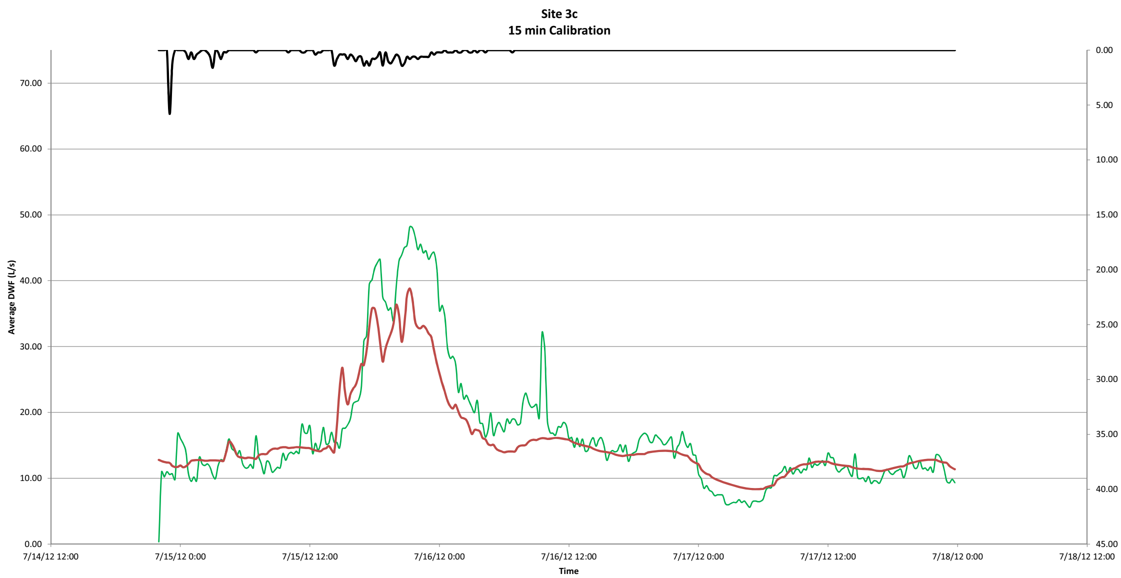
LEGEND

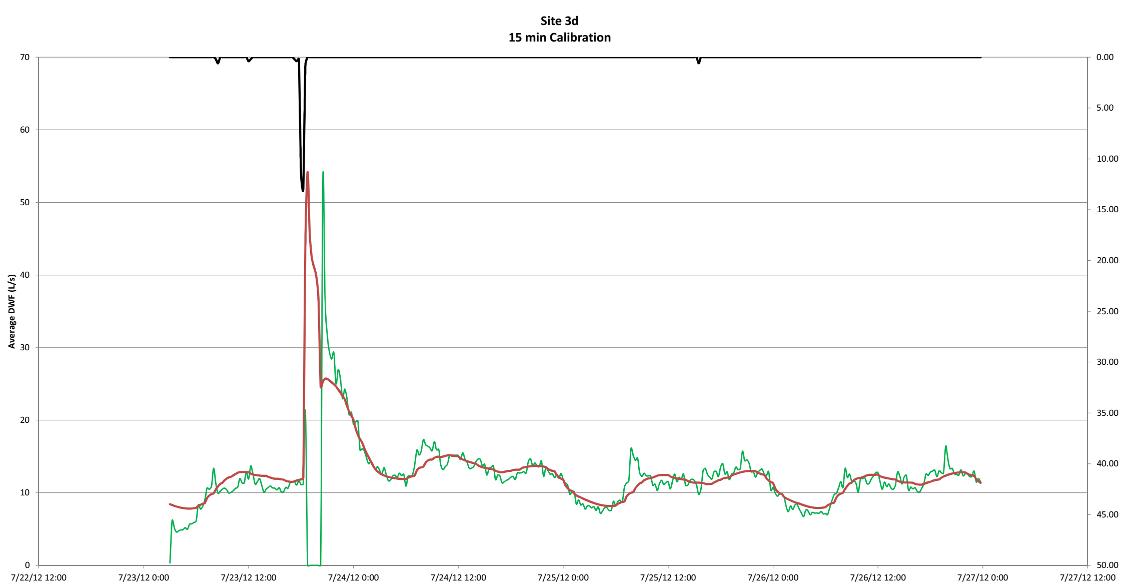
Model

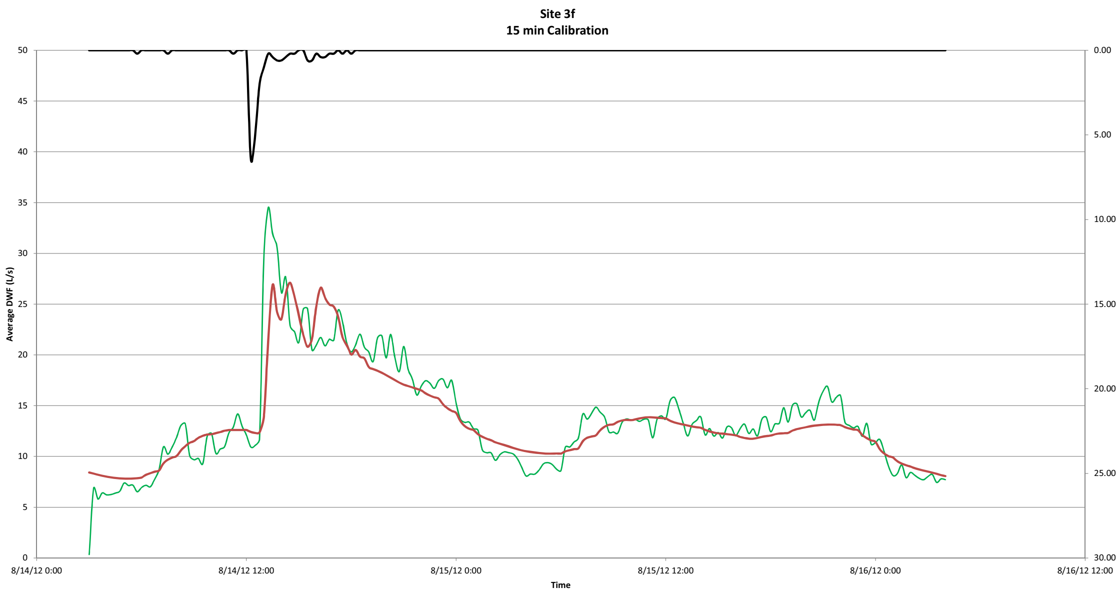
Monitored

DWF

Rainfall


Site 3c
15 min Calibration
Average DWF (L/s)
Time
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
7/14/12 12:00
7/15/12 0:00
7/15/12 12:00
7/16/12 0:00
7/16/12 12:00
7/17/12 0:00
7/17/12 12:00
7/18/12 0:00
7/18/12 12:00


Site 3d
15 min Calibration
Average DWF (L/s)
Time
0
10
20
30
40
50
60
70
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
7/22/12 12:00
7/23/12 0:00
7/23/12 12:00
7/24/12 0:00
7/24/12 12:00
7/25/12 0:00
7/25/12 12:00
7/26/12 0:00
7/26/12 12:00
7/27/12 0:00
7/27/12 12:00



Site 3f
15 min Calibration
Average DWF (L/s)
Time
50
45
40
35
30
25
20
15
10
5
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
8/14/12 0:00
8/14/12 12:00
8/15/12 0:00
8/15/12 12:00
8/16/12 0:00
8/16/12 12:00

Site 5

	R	T	K
Short	0.0035	0.005	5
Medium	0.0015	0.1	10
Long	0.05	0.5	75

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
5c	1742760	1442580	17.2%	31.4	19.8	37.0%
5d	1348182	1748612	-29.7%	22.0	27.8	-26.3%
5f	1269045	1295987	-2.1%	17.8	13.9	22.0%

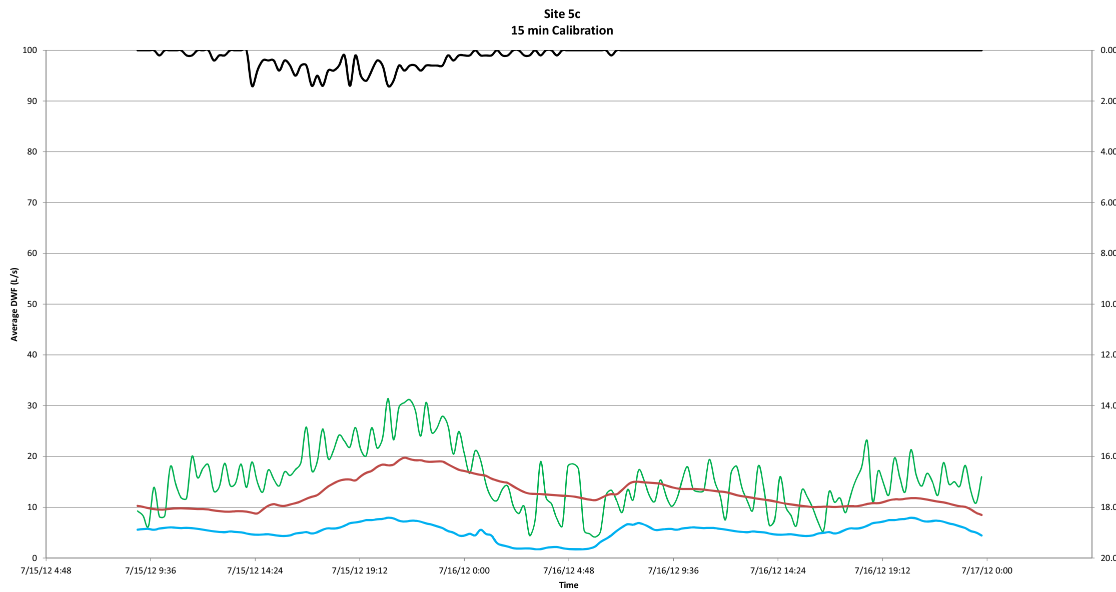
LEGEND

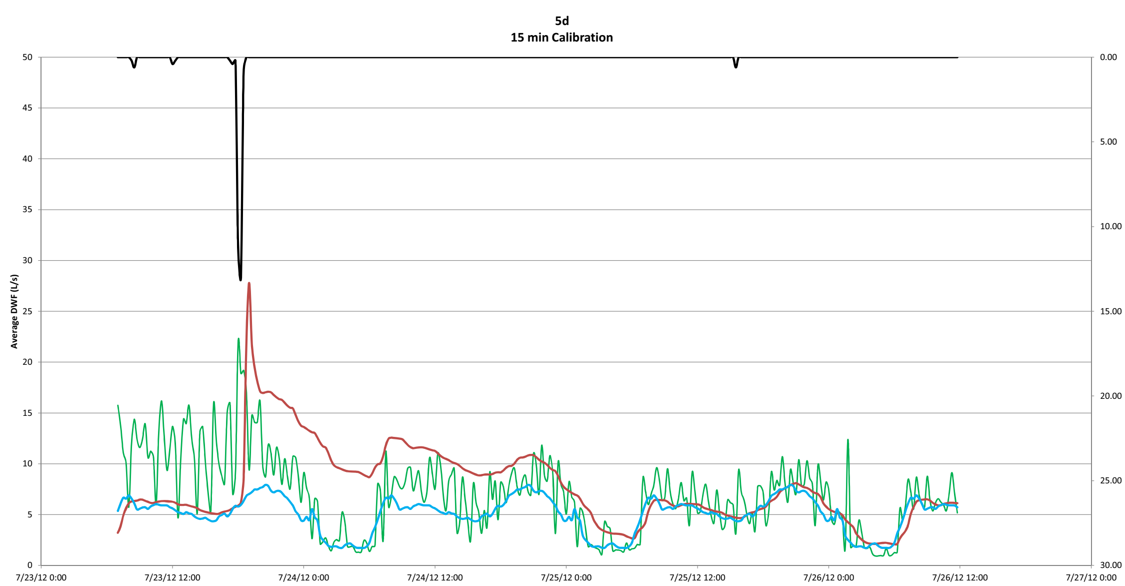
Model

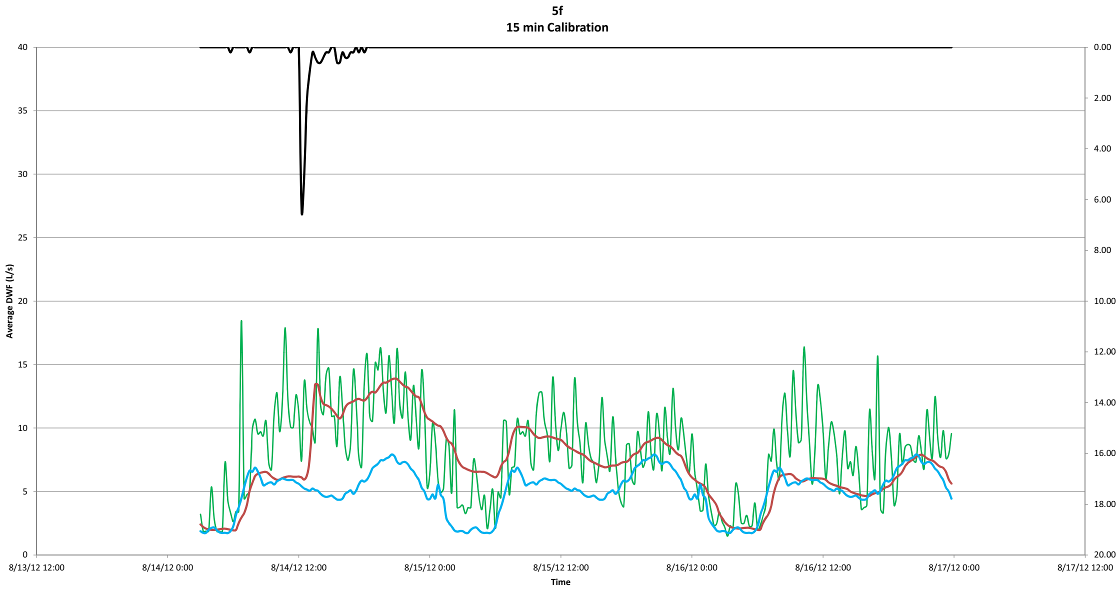
Monitored

DWF

Rainfall


Site 5c
15 min Calibration
Average DWF (L/s)
Time
100
90
80
70
60
50
40
30
20
10
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
7/15/12 4:48
7/15/12 9:36
7/15/12 14:24
7/15/12 19:12
7/16/12 0:00
7/16/12 4:48
7/16/12 9:36
7/16/12 14:24
7/16/12 19:12
7/17/12 0:00


5d
15 min Calibration
Average DWF (L/s)
Time
50
45
40
35
30
25
20
15
10
5
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
7/23/12 0:00
7/23/12 12:00
7/24/12 0:00
7/24/12 12:00
7/25/12 0:00
7/25/12 12:00
7/26/12 0:00
7/26/12 12:00
7/27/12 0:00


5f
15 min Calibration
Average DWF (L/s)
Time
40
35
30
25
20
15
10
5
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
8/13/12 12:00
8/14/12 0:00
8/14/12 12:00
8/15/12 0:00
8/15/12 12:00
8/16/12 0:00
8/16/12 12:00
8/17/12 0:00
8/17/12 12:00

Site 6

**No additional loads for this location*

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
6c	4868559	7149617	-46.9%	83.7	79.7	4.8%
6d	2768976	4337808	-56.7%	117.4	154.3	-31.5%
6f	2676987	3923599	-46.6%	65.8	79.7	-21.2%

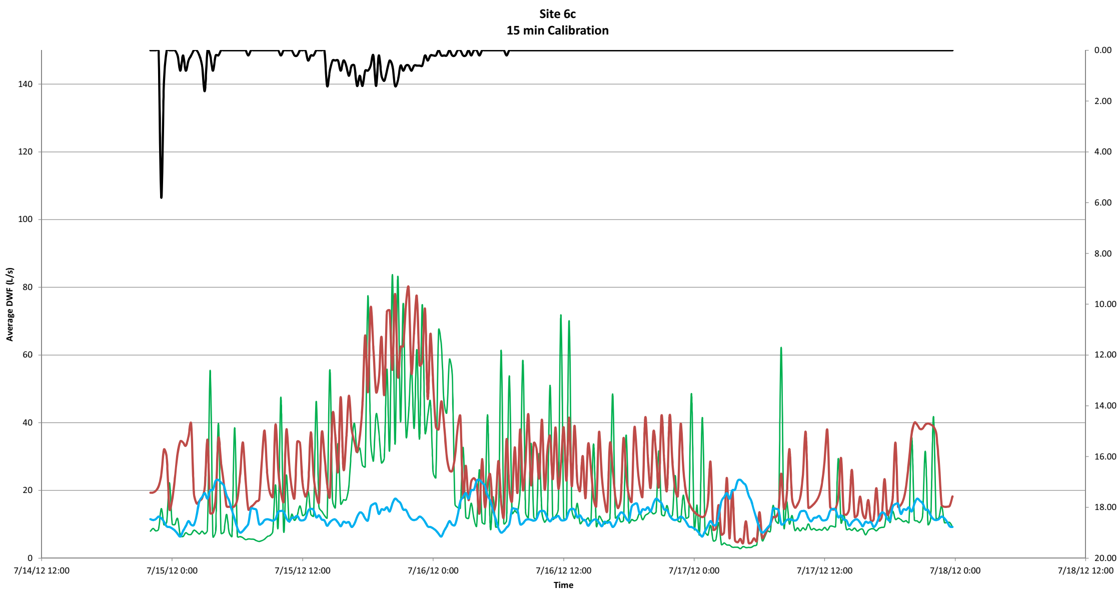
LEGEND

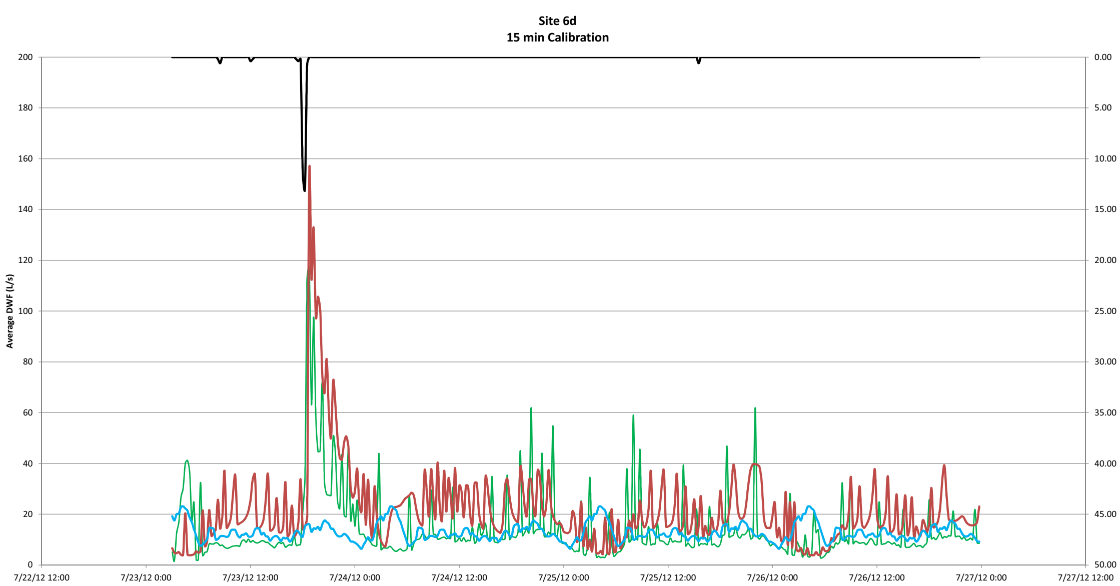
Model

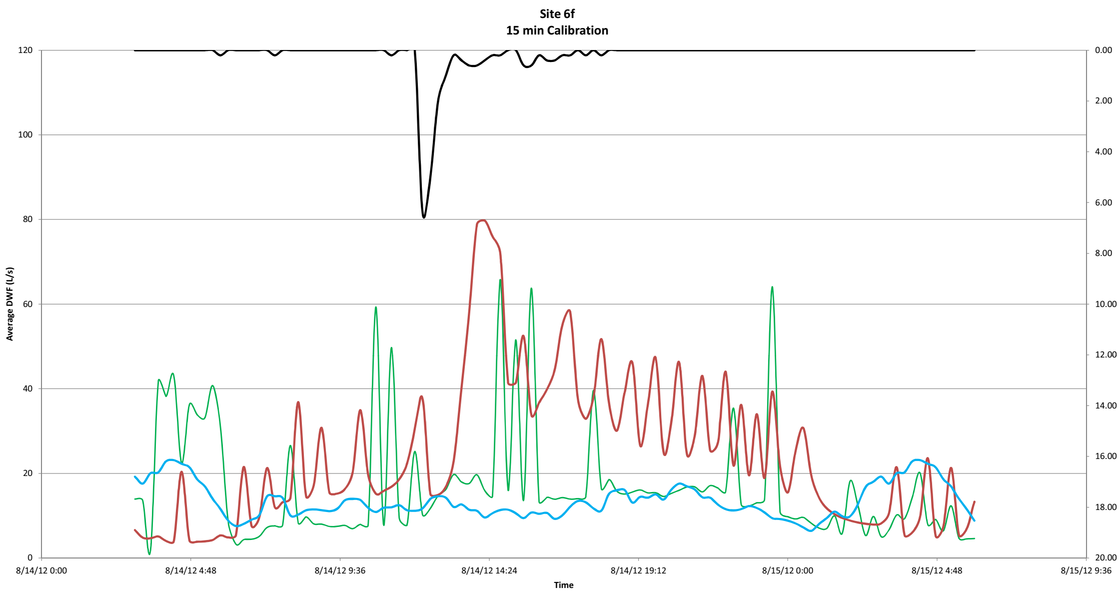
Monitored

DWF

Rainfall


Site 6c
15 min Calibration
Average DWF (L/s)
Time
0
20
40
60
80
100
120
140
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
7/14/12 12:00
7/15/12 0:00
7/15/12 12:00
7/16/12 0:00
7/16/12 12:00
7/17/12 0:00
7/17/12 12:00
7/18/12 0:00
7/18/12 12:00


Site 6d
15 min Calibration
Average DWF (L/s)
Time
0
20
40
60
80
100
120
140
160
180
200
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
7/22/12 12:00
7/23/12 0:00
7/23/12 12:00
7/24/12 0:00
7/24/12 12:00
7/25/12 0:00
7/25/12 12:00
7/26/12 0:00
7/26/12 12:00
7/27/12 0:00
7/27/12 12:00


Site 6f
15 min Calibration
Average DWF (L/s)
Time
0
20
40
60
80
100
120
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
8/14/12 0:00
8/14/12 4:48
8/14/12 9:36
8/14/12 14:24
8/14/12 19:12
8/15/12 0:00
8/15/12 4:48
8/15/12 9:36

Site 7

	R	T	K
Short	0.009	0.75	0.1
Medium	0.01	1	2
Long	0.028	3	11

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	**Model (L/s)**	**% Diff**	**Monitored (L/s)**	**Model (L/s)**	**% Diff**
7d	3275433	3454686	-5.5%	75.5	78.2	-3.6%
7e	2272077	2086336	8.2%	38.0	18.8	50.6%
7f	2842587	2831245	0.4%	39.6	40.5	-2.2%

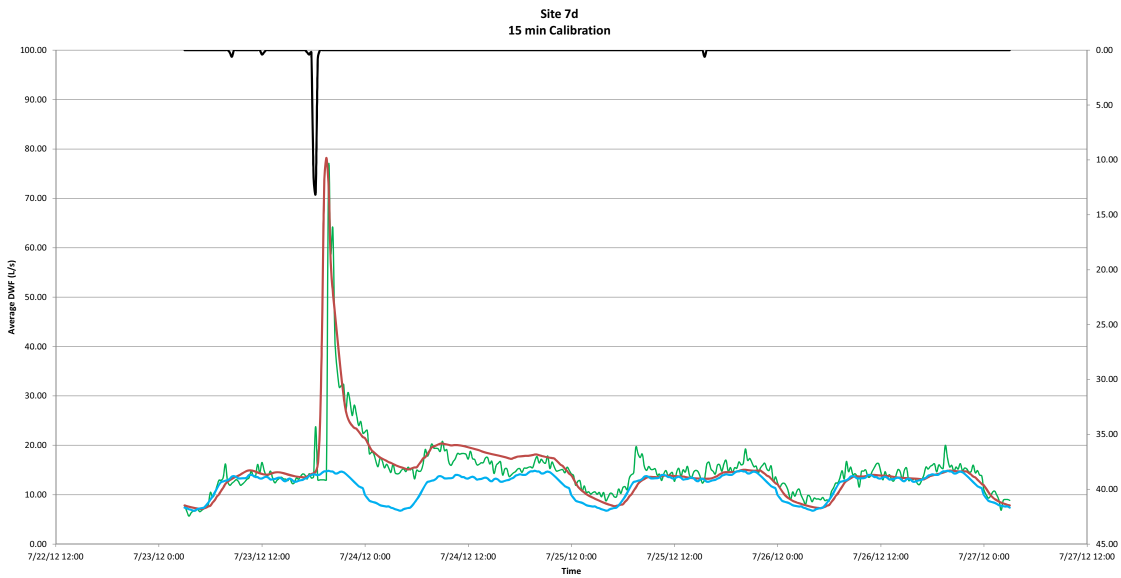
LEGEND

Model

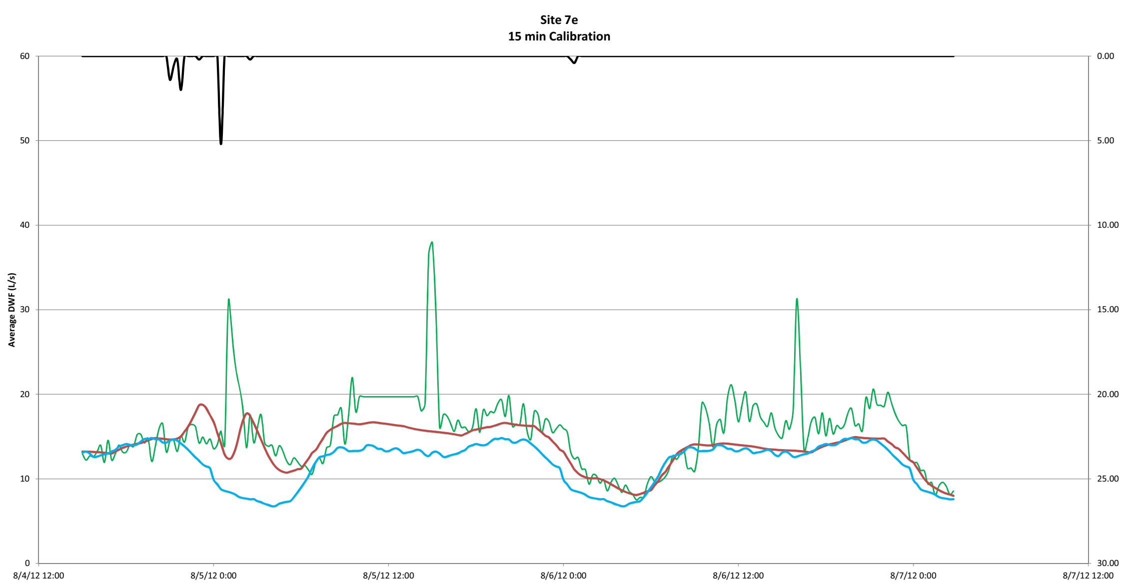
Monitored

DWF

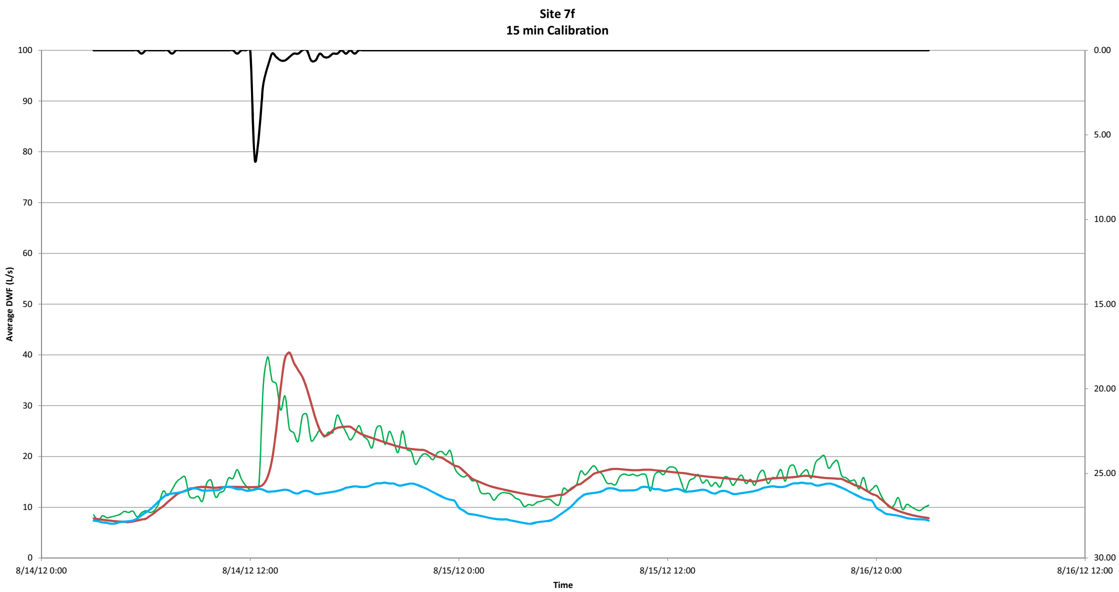
Rainfall



Site 7d
15 min Calibration
Average DWF (L/s)
Time
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
7/22/12 12:00
7/23/12 0:00
7/23/12 12:00
7/24/12 0:00
7/24/12 12:00
7/25/12 0:00
7/25/12 12:00
7/26/12 0:00
7/26/12 12:00
7/27/12 0:00
7/27/12 12:00



Site 7e
15 min Calibration
Average DWF (L/s)
Time
60
50
40
30
20
10
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
8/4/12 12:00
8/5/12 0:00
8/5/12 12:00
8/6/12 0:00
8/6/12 12:00
8/7/12 0:00
8/7/12 12:00


Site 7f
15 min Calibration
100
90
80
70
60
50
40
30
20
10
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Average DWF (L/s)
8/14/12 0:00
8/14/12 12:00
8/15/12 0:00
8/15/12 12:00
8/16/12 0:00
8/16/12 12:00
Time

Site 8

	R	T	K
Short	0.0175	0.1	1
Medium	0.0025	2	2
Long	0.0025	4	4

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
8b	12173103	17756909	-45.9%	64.1	95.8	-49.4%
8c	9210735	12256250	-33.1%	193.5	197.1	-1.9%
8d	20445129	21367122	-4.5%	307.9	309.8	-0.6%

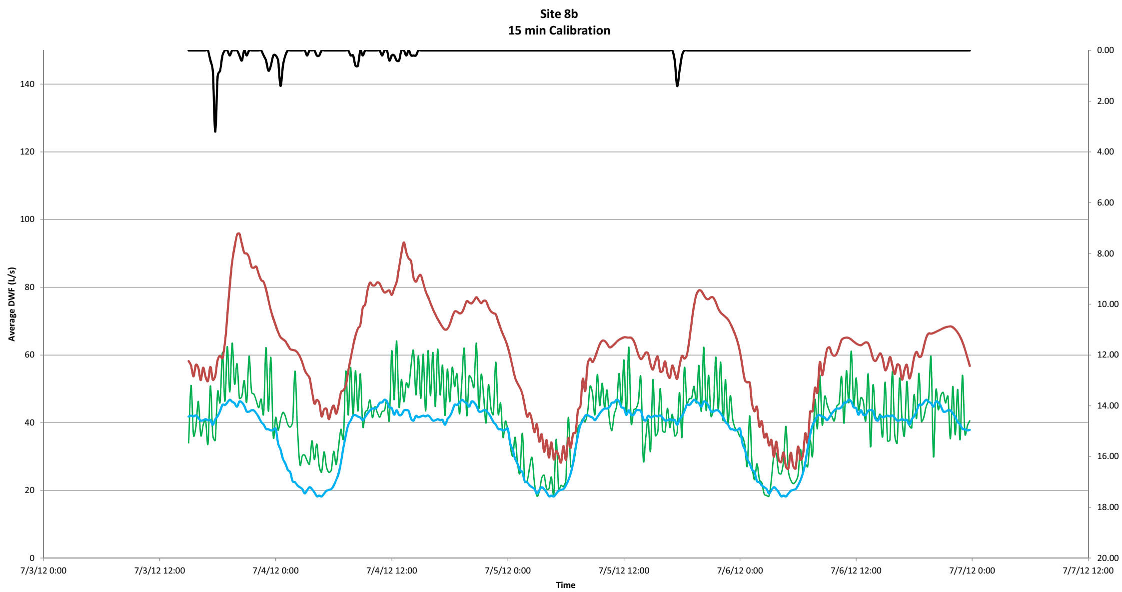
LEGEND

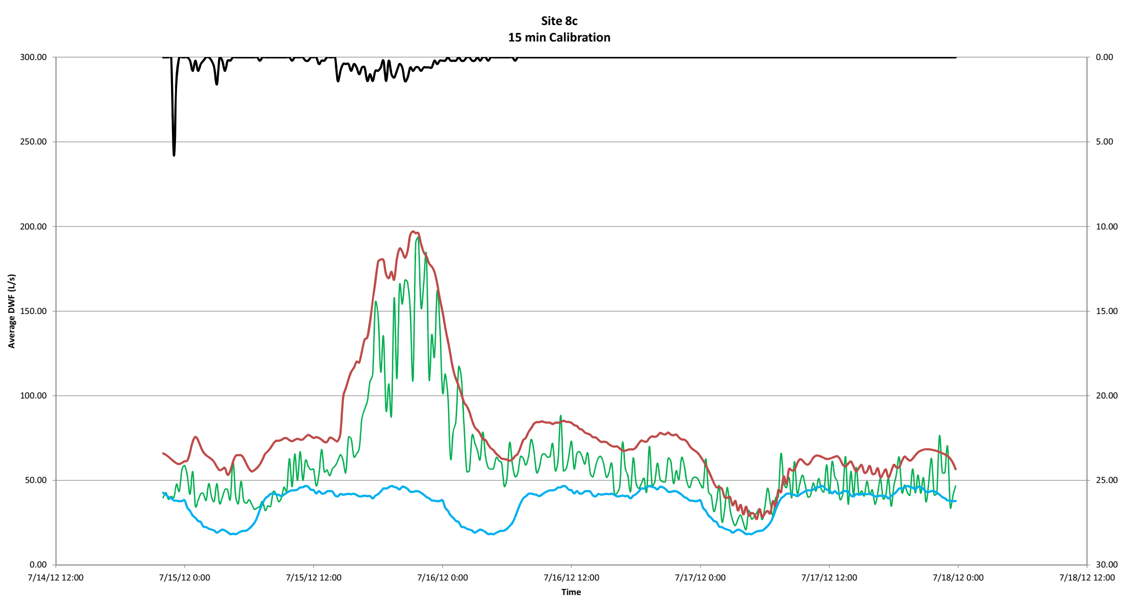
Model

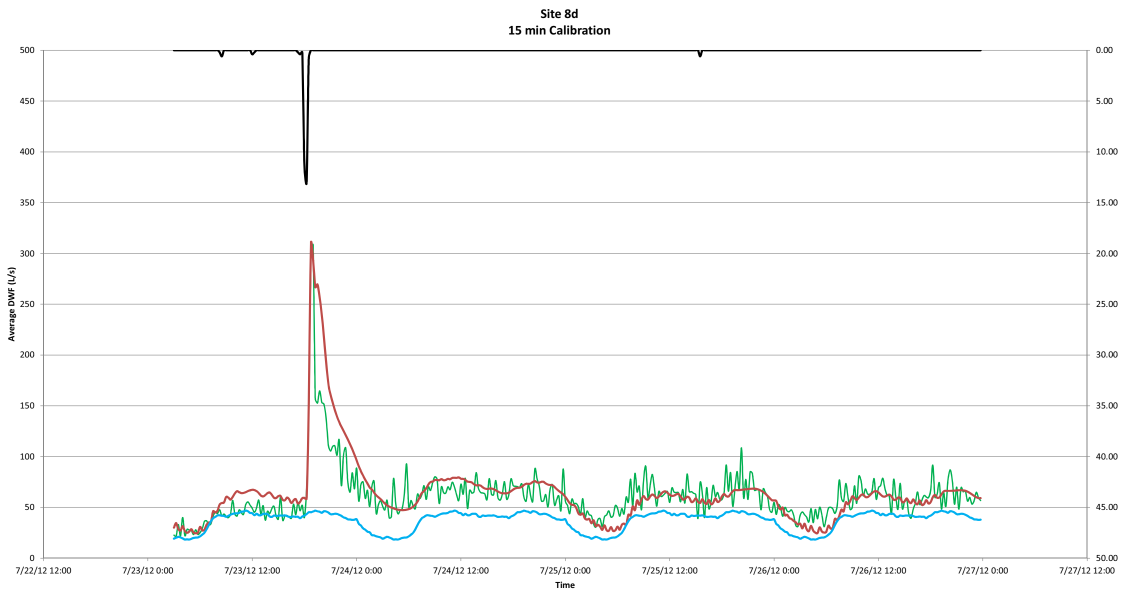
Monitored

DWF

Rainfall


Site 8b
15 min Calibration
Average DWF (L/s)
Time
0
20
40
60
80
100
120
140
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
7/3/12 0:00
7/3/12 12:00
7/4/12 0:00
7/4/12 12:00
7/5/12 0:00
7/5/12 12:00
7/6/12 0:00
7/6/12 12:00
7/7/12 0:00
7/7/12 12:00


Site 8c
15 min Calibration
Average DWF (L/s)
Time
0.00
50.00
100.00
150.00
200.00
250.00
300.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
7/14/12 12:00
7/15/12 0:00
7/15/12 12:00
7/16/12 0:00
7/16/12 12:00
7/17/12 0:00
7/17/12 12:00
7/18/12 0:00
7/18/12 12:00


Site 8d
15 min Calibration
Average DWF (L/s)
Time
500
450
400
350
300
250
200
150
100
50
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
7/22/12 12:00
7/23/12 0:00
7/23/12 12:00
7/24/12 0:00
7/24/12 12:00
7/25/12 0:00
7/25/12 12:00
7/26/12 0:00
7/26/12 12:00
7/27/12 0:00
7/27/12 12:00

Site 9

	R	T	K
Short	0.105	0.05	1
Medium	0.02	1	2
Long	0.025	3	3

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
9d	3368736	2975840	11.7%	195.9	204.8	-4.5%
9f	2453157	2525215	-2.9%	49.8	52.5	-5.4%
9g	1345640	1058009	21.4%	40.8	31.4	23.0%

**Not good data*

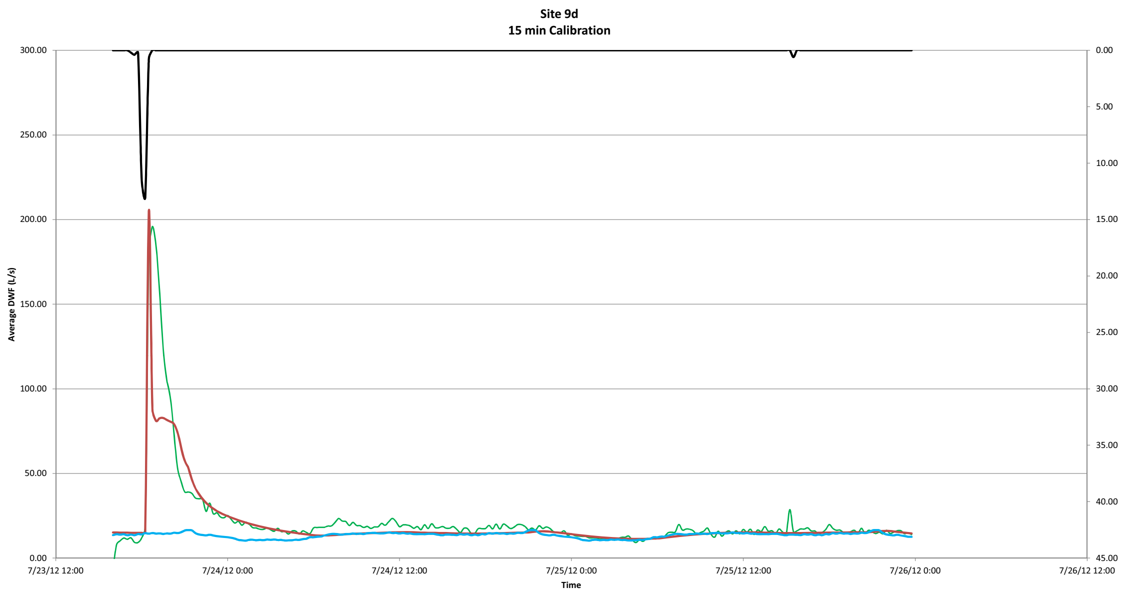
LEGEND

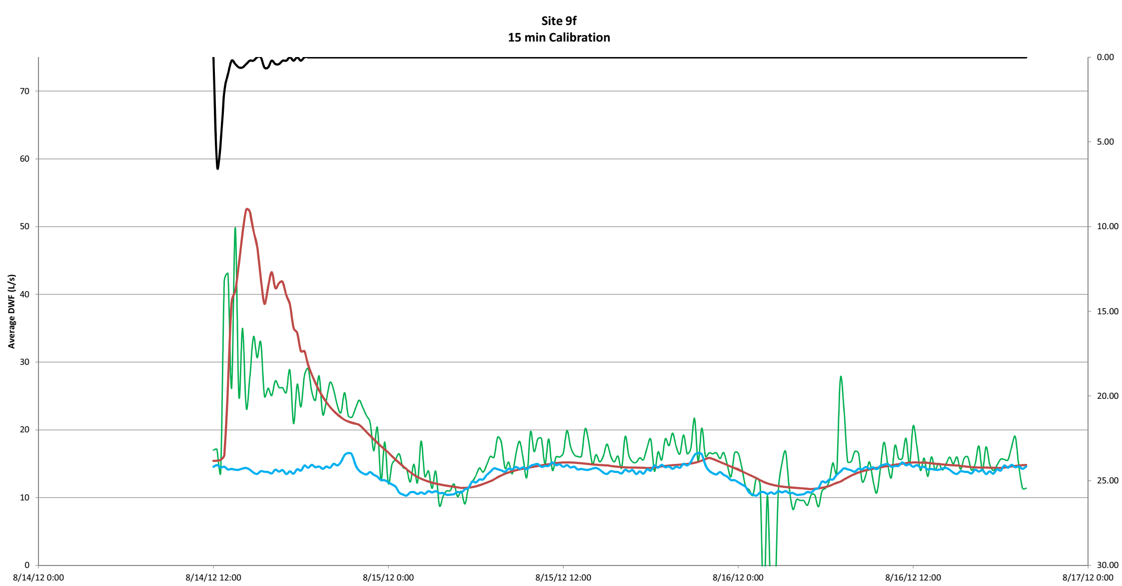
Model

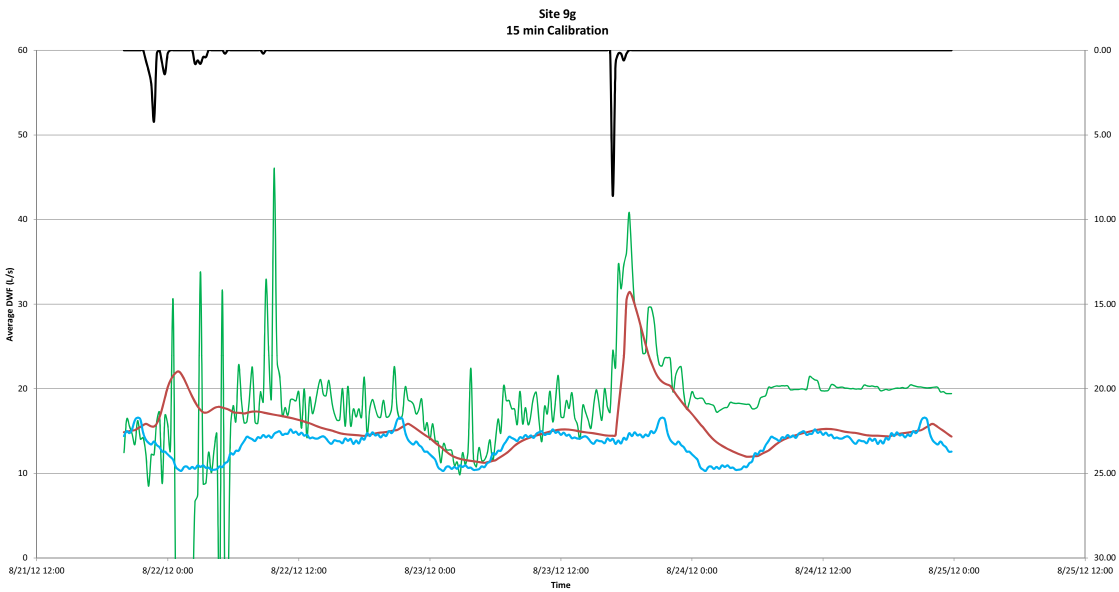
Monitored

DWF

Rainfall


Site 9d
15 min Calibration
Average DWF (L/s)
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
7/23/12 12:00
7/24/12 0:00
7/24/12 12:00
7/25/12 0:00
7/25/12 12:00
7/26/12 0:00
7/26/12 12:00
Time


Site 9f
15 min Calibration
Average DWF (L/s)
70
60
50
40
30
20
10
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
8/14/12 0:00
8/14/12 12:00
8/15/12 0:00
8/15/12 12:00
8/16/12 0:00
8/16/12 12:00
8/17/12 0:00
Time



Site 9g
15 min Calibration
Average DWF (L/s)
Time
60
50
40
30
20
10
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
8/21/12 12:00
8/22/12 0:00
8/22/12 12:00
8/23/12 0:00
8/23/12 12:00
8/24/12 0:00
8/24/12 12:00
8/25/12 0:00
8/25/12 12:00

Site 10

	R	T	K
Short	0.015	0.01	2
Medium	0.0025	1	10
Long	0	0	0

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
10a	338814	291635	13.9%	13.3	13.4	-0.8%
10b	287820	280527	2.5%	6.5	7.4	-14.0%

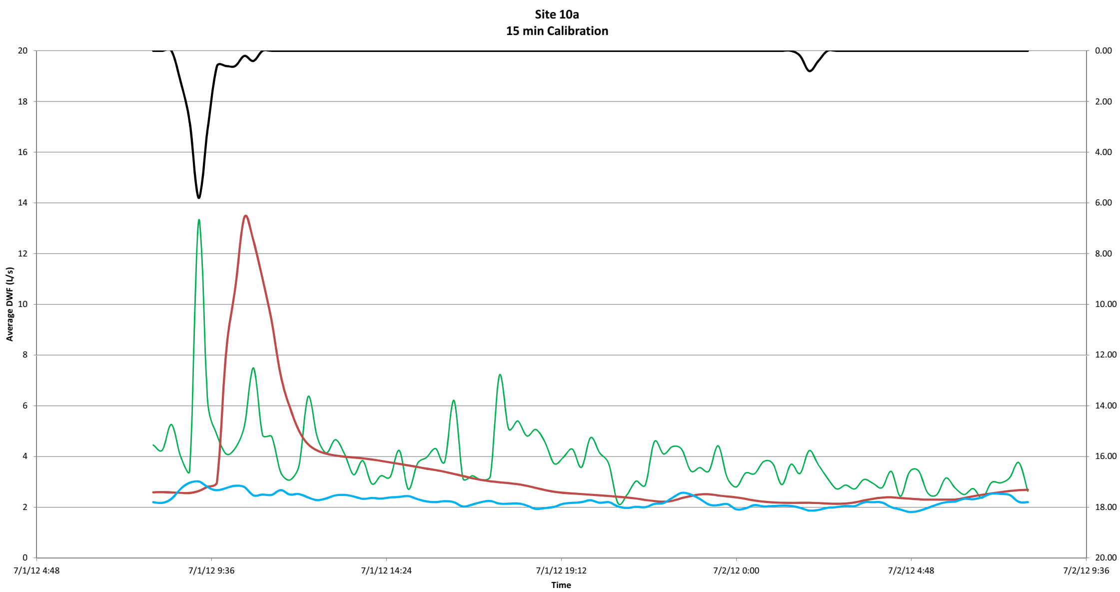
LEGEND

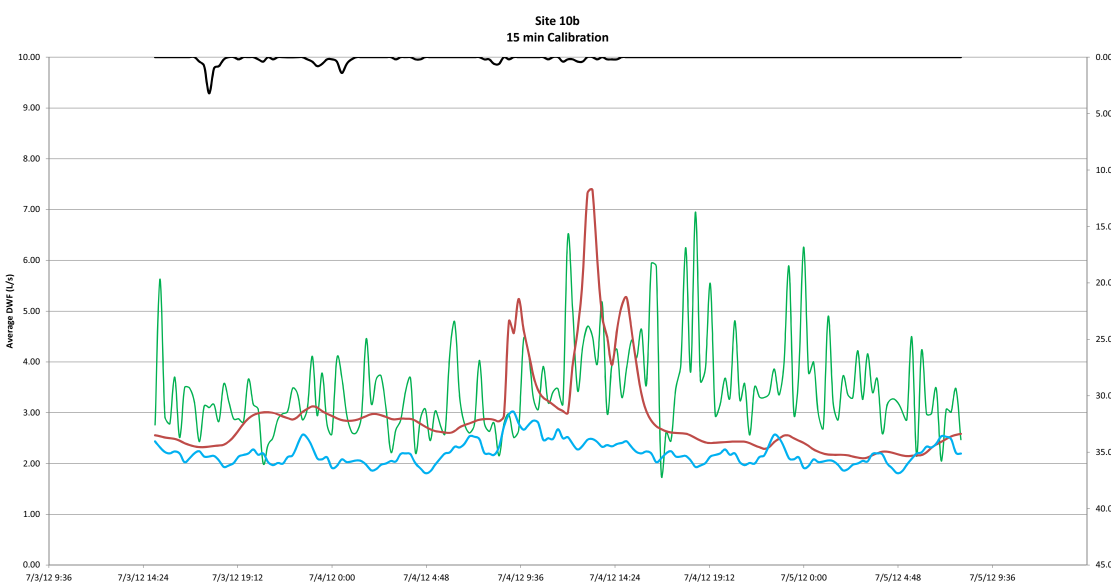
Model

Monitored

DWF

Rainfall


Site 10a
15 min Calibration
Average DWF (L/s)
Time
7/1/12 4:48
7/1/12 9:36
7/1/12 14:24
7/1/12 19:12
7/2/12 0:00
7/2/12 4:48
7/2/12 9:36


Site 10b
15 min Calibration
Average DWF (L/s)
Time
7/3/12 9:36
7/3/12 14:24
7/3/12 19:12
7/4/12 0:00
7/4/12 4:48
7/4/12 9:36
7/4/12 14:24
7/4/12 19:12
7/5/12 0:00
7/5/12 4:48
7/5/12 9:36

Site 11

	R	T	K
Short	0.0015	1.1	1
Medium	0.0015	3	1
Long	0.0025	3	1

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
11c	562590	550359	2.2%	11.6	7.7	33.6%
11d	192951	225373	-16.8%	14.0	8.5	39.3%
11f	227133	229185	-0.9%	10.5	6.3	40.0%

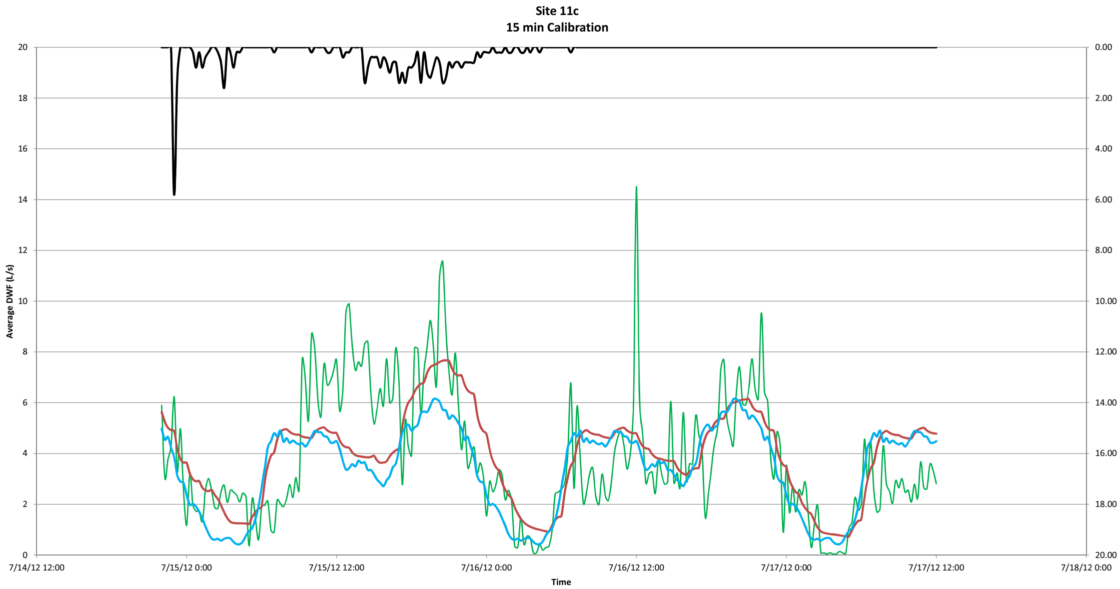
LEGEND

Model

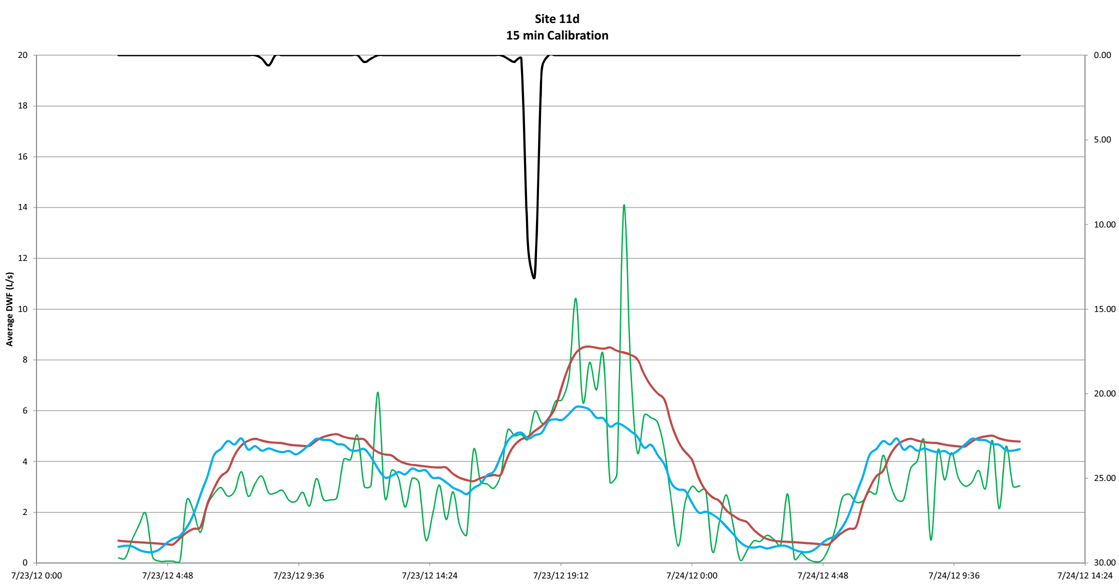
Monitored

DWF

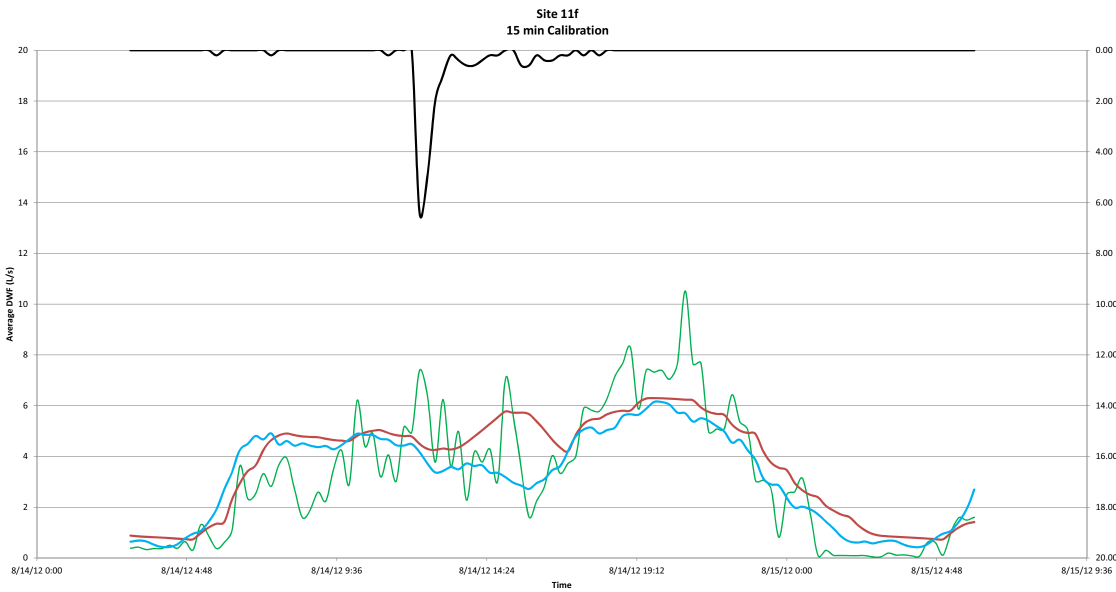
Rainfall



Site 11c
15 min Calibration
Average DWF (L/s)
Time
20
18
16
14
12
10
8
6
4
2
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
7/14/12 12:00
7/15/12 0:00
7/15/12 12:00
7/16/12 0:00
7/16/12 12:00
7/17/12 0:00
7/17/12 12:00
7/18/12 0:00



Site 11d
15 min Calibration
Average DWF (L/s)
Time
20
18
16
14
12
10
8
6
4
2
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
7/23/12 0:00
7/23/12 4:48
7/23/12 9:36
7/23/12 14:24
7/23/12 19:12
7/24/12 0:00
7/24/12 4:48
7/24/12 9:36
7/24/12 14:24



Site 11f
15 min Calibration
Average DWF (L/s)
Time
20
18
16
14
12
10
8
6
4
2
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
8/14/12 0:00
8/14/12 4:48
8/14/12 9:36
8/14/12 14:24
8/14/12 19:12
8/15/12 0:00
8/15/12 4:48
8/15/12 9:36

Site 12

	R	T	K
Short	0.0235	0.03	15
Medium	0.025	0.48	10
Long	0.02	4	10

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
12c	1265886	1317262	-4.1%	21.4	19.9	7.0%
12d	1397646	1252255	10.4%	65.8	65.8	0.1%
12f	780912	855699	-9.6%	14.9	17.6	-17.8%

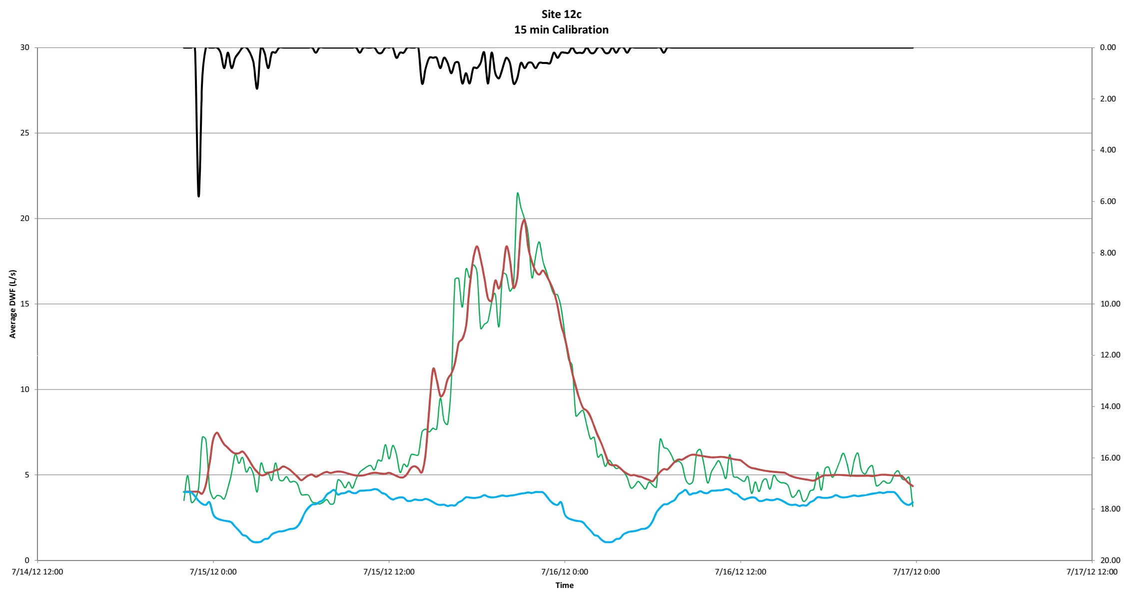
LEGEND

Model

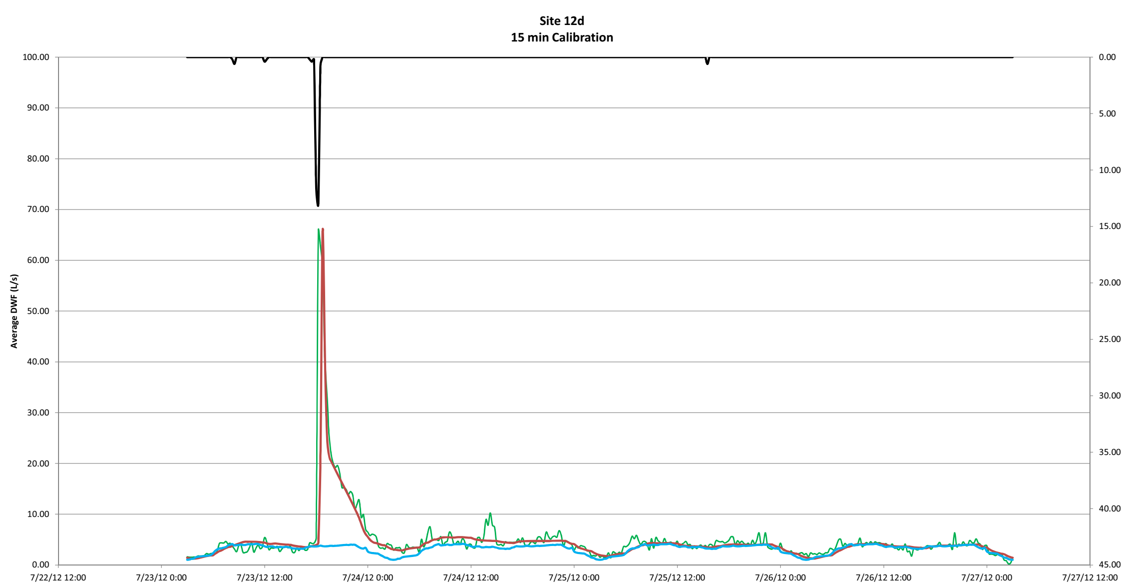
Monitored

DWF

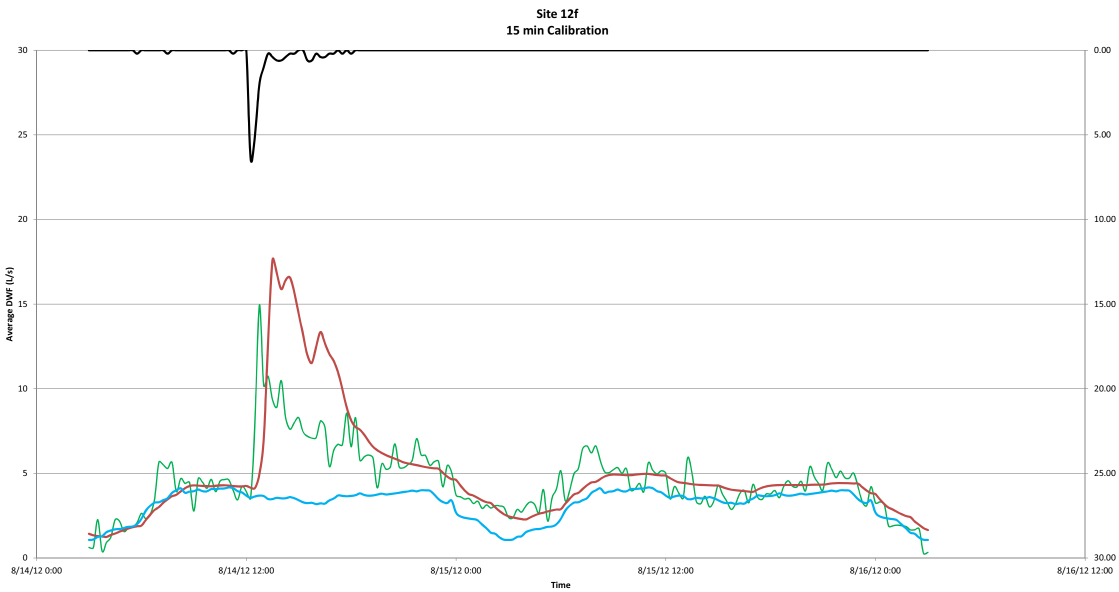
Rainfall



Site 12c
15 min Calibration
Average DWF (L/s)
Time
30
25
20
15
10
5
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
7/14/12 12:00
7/15/12 0:00
7/15/12 12:00
7/16/12 0:00
7/16/12 12:00
7/17/12 0:00
7/17/12 12:00



Site 12d
15 min Calibration
Average DWF (L/s)
Time
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
7/22/12 12:00
7/23/12 0:00
7/23/12 12:00
7/24/12 0:00
7/24/12 12:00
7/25/12 0:00
7/25/12 12:00
7/26/12 0:00
7/26/12 12:00
7/27/12 0:00
7/27/12 12:00



Site 12f
15 min Calibration
Average DWF (L/s)
Time
30
25
20
15
10
5
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
8/14/12 0:00
8/14/12 12:00
8/15/12 0:00
8/15/12 12:00
8/16/12 0:00
8/16/12 12:00

Site 13

	R	T	K
Short	0.03	0.1	1
Medium	0.015	2	3
Long	0.01	4	6

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
13f	346302	443044	-27.9%	8.9	6.5	26.8%
13g	409014	459776	-12.4%	6.2	5.0	19.6%

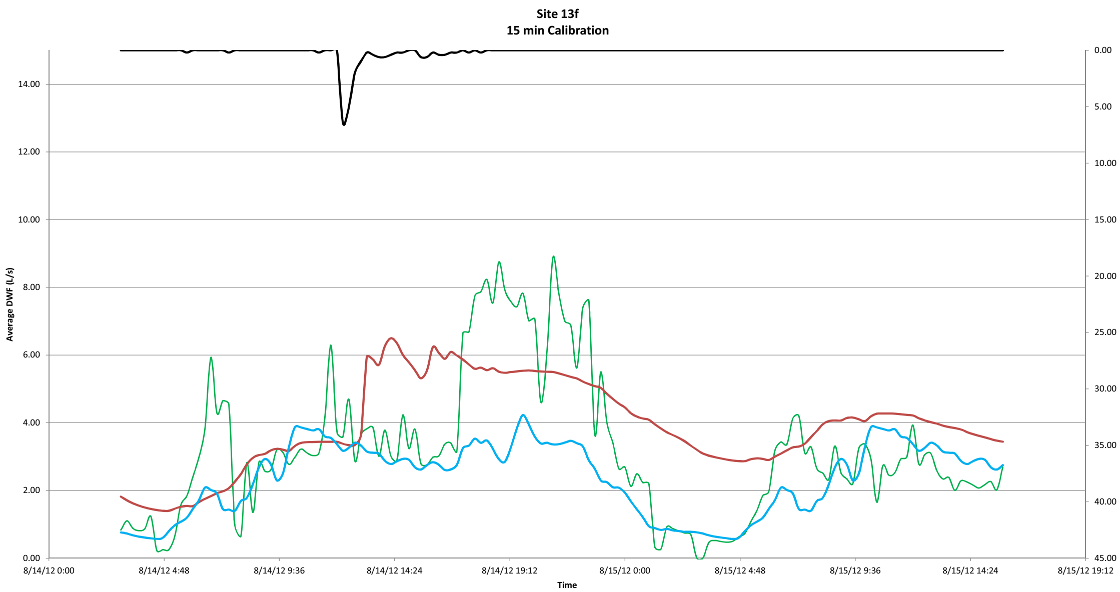
LEGEND

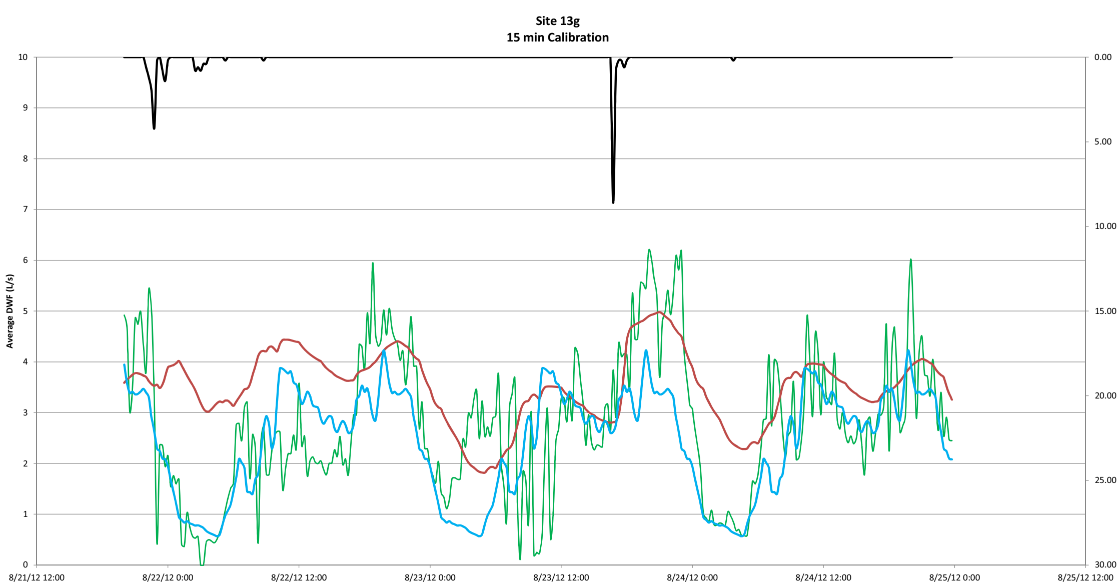
Model

Monitored

DWF

Rainfall


Site 13f
15 min Calibration
Average DWF (L/s)
Time
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
8/14/12 0:00
8/14/12 4:48
8/14/12 9:36
8/14/12 14:24
8/14/12 19:12
8/15/12 0:00
8/15/12 4:48
8/15/12 9:36
8/15/12 14:24
8/15/12 19:12


Site 13g
15 min Calibration
Average DWF (L/s)
Time
0
1
2
3
4
5
6
7
8
9
10
0.00
5.00
10.00
15.00
20.00
25.00
30.00
8/21/12 12:00
8/22/12 0:00
8/22/12 12:00
8/23/12 0:00
8/23/12 12:00
8/24/12 0:00
8/24/12 12:00
8/25/12 0:00
8/25/12 12:00

Site 14

	R	T	K
Short	0.002	0.01	1
Medium	0.01	1	1
Long	0.0075	2	1.75

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
14c	3520188	3467566	1.5%	67.8	44.9	33.7%
14d	1728936	2074159	-20.0%	97.8	4.2	95.7%
14f	1493352	2606488	-74.5%	33.3	48.9	-46.6%

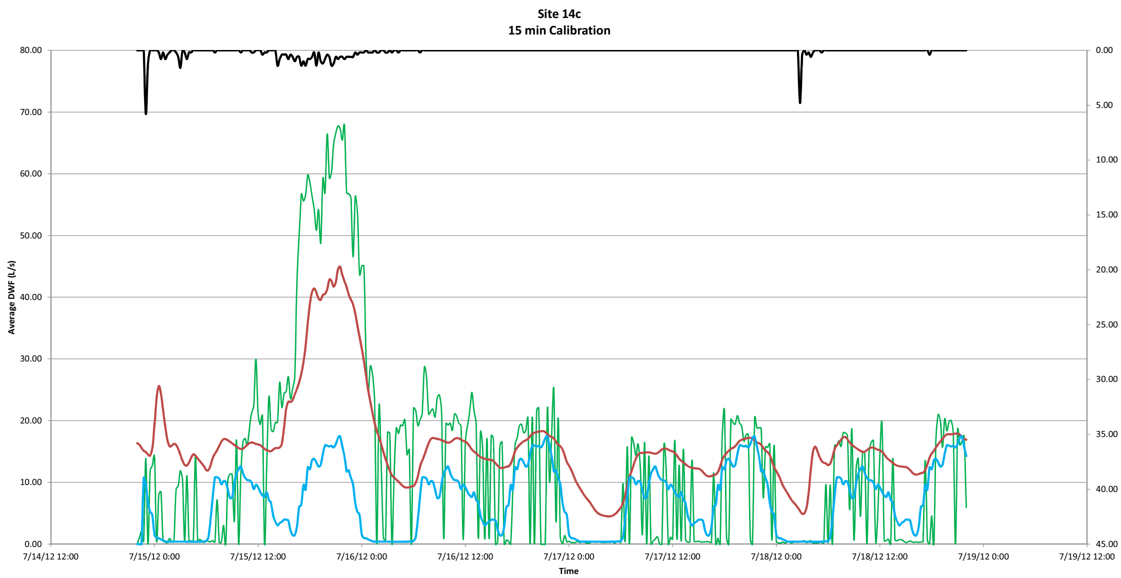
LEGEND

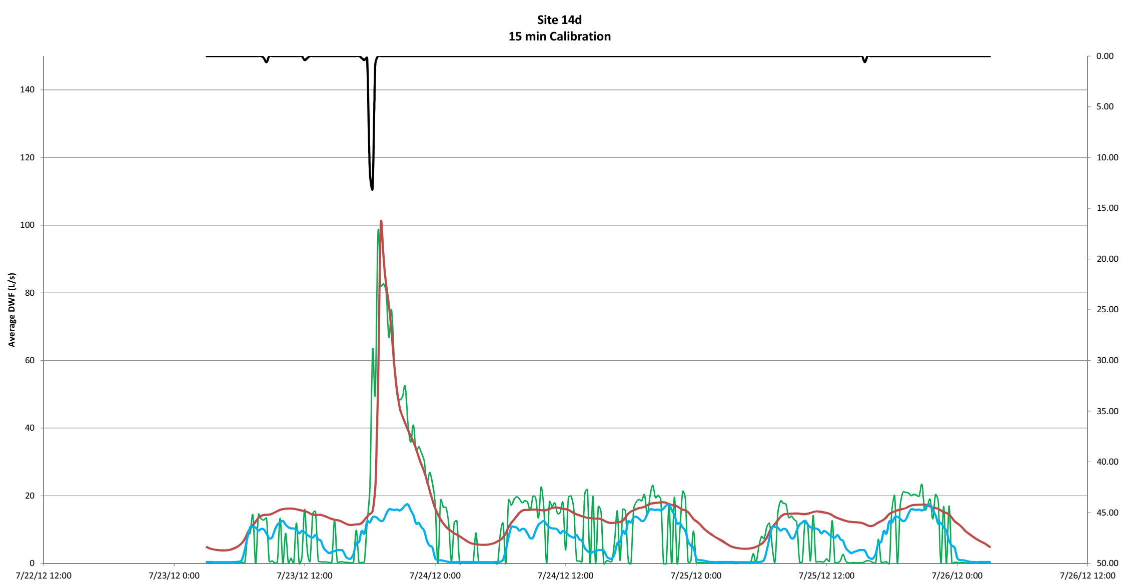
Model

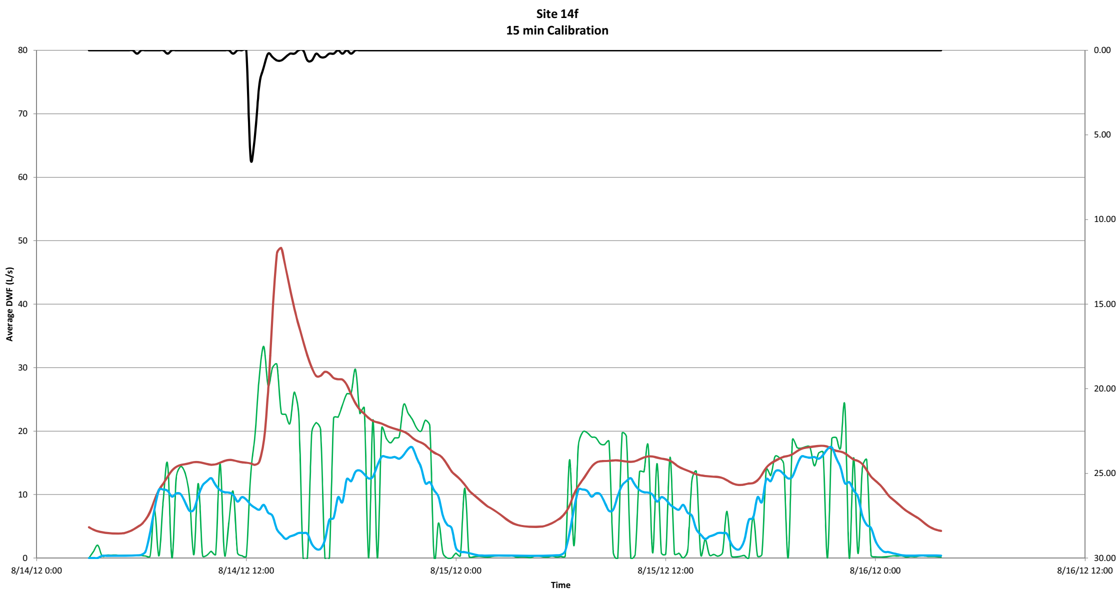
Monitored

DWF

Rainfall


Site 14c
15 min Calibration
Average DWF (L/s)
Time
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
7/14/12 12:00
7/15/12 0:00
7/15/12 12:00
7/16/12 0:00
7/16/12 12:00
7/17/12 0:00
7/17/12 12:00
7/18/12 0:00
7/18/12 12:00
7/19/12 0:00
7/19/12 12:00


Site 14d
15 min Calibration
Average DWF (L/s)
Time
140
120
100
80
60
40
20
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
7/22/12 12:00
7/23/12 0:00
7/23/12 12:00
7/24/12 0:00
7/24/12 12:00
7/25/12 0:00
7/25/12 12:00
7/26/12 0:00
7/26/12 12:00



Site 14f
15 min Calibration
80
70
60
50
40
30
20
10
0
Average DWF (L/s)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
8/14/12 0:00
8/14/12 12:00
8/15/12 0:00
8/15/12 12:00
8/16/12 0:00
8/16/12 12:00
Time

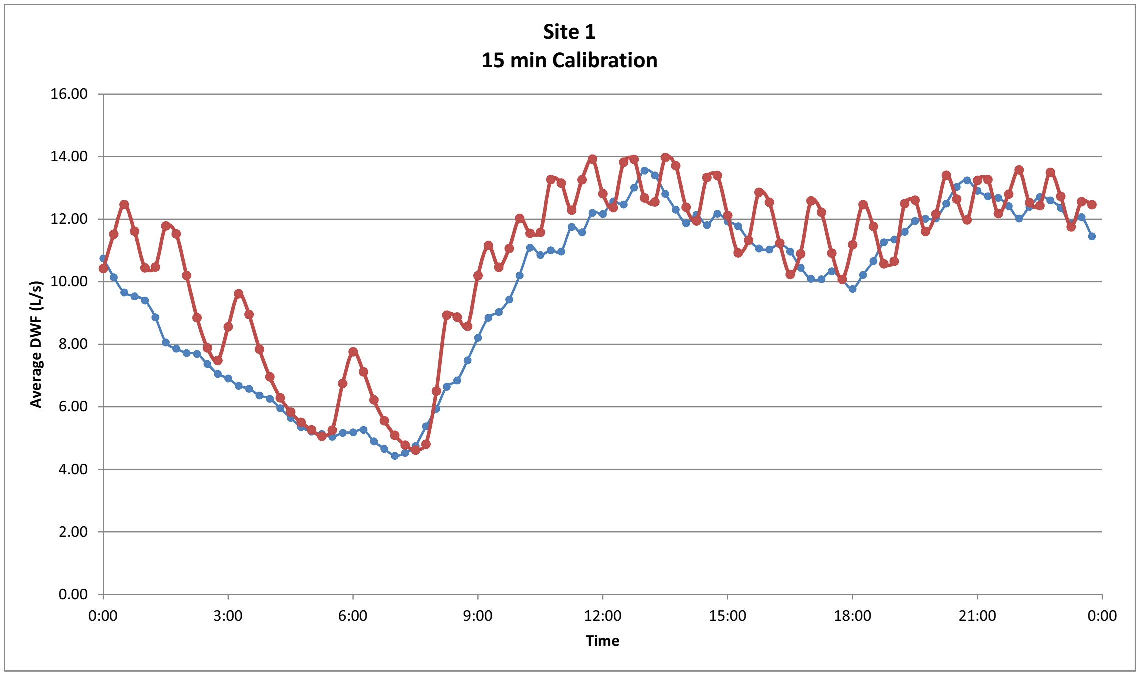
Dry Weather Flow Calibration Summary

Site	Average Flow (L/s)			Peak Flow (L/s)			Volume (m^3)		
	Monitored	**Model**	**% Diff**	**Monitored**	**Model**	**% Diff**	**Monitored**	**Model**	**% Diff**
1	9.73	10.64	9.30%	13.56	13.98	3.11%	840.69	918.88	9.30%
2	5.97	6.05	1.37%	9.35	11.13	19.00%	515.41	522.48	1.37%
3	9.57	9.61	0.42%	12.22	11.03	-9.77%	827.14	830.63	0.42%
5	4.98	5.11	2.66%	7.92	7.91	-0.18%	430.05	441.51	2.66%
6	12.82	18.16	41.62%	23.11	40.18	73.83%	1107.82	1568.88	41.62%
7	11.88	12.05	1.43%	14.83	14.82	-0.02%	1026.10	1040.77	1.43%
8	36.83	56.17	52.50%	46.78	94.91	102.87%	3182.50	4495.32	41.25%
9	13.40	13.90	3.75%	16.58	16.54	-0.27%	1157.95	1201.39	3.75%
10	2.25	2.42	7.59%	3.02	3.00	-0.48%	194.42	209.17	7.59%
11	3.55	3.76	5.88%	6.14	6.14	-0.10%	306.56	324.60	5.88%
12	3.18	3.25	2.32%	4.17	4.17	0.02%	274.83	281.22	2.32%
13	2.42	2.79	15.39%	4.23	3.78	-10.59%	208.89	241.05	15.39%
14	7.07	11.81	66.96%	17.44	17.23	-1.20%	611.27	1020.59	66.96%

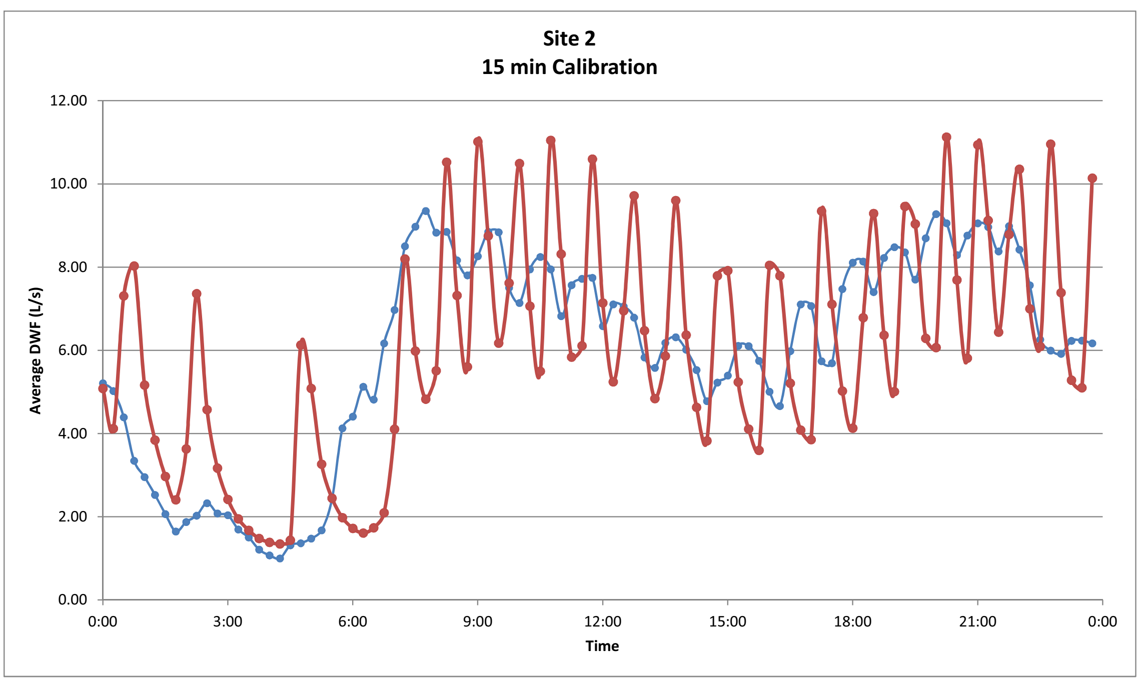
LEGEND

Model

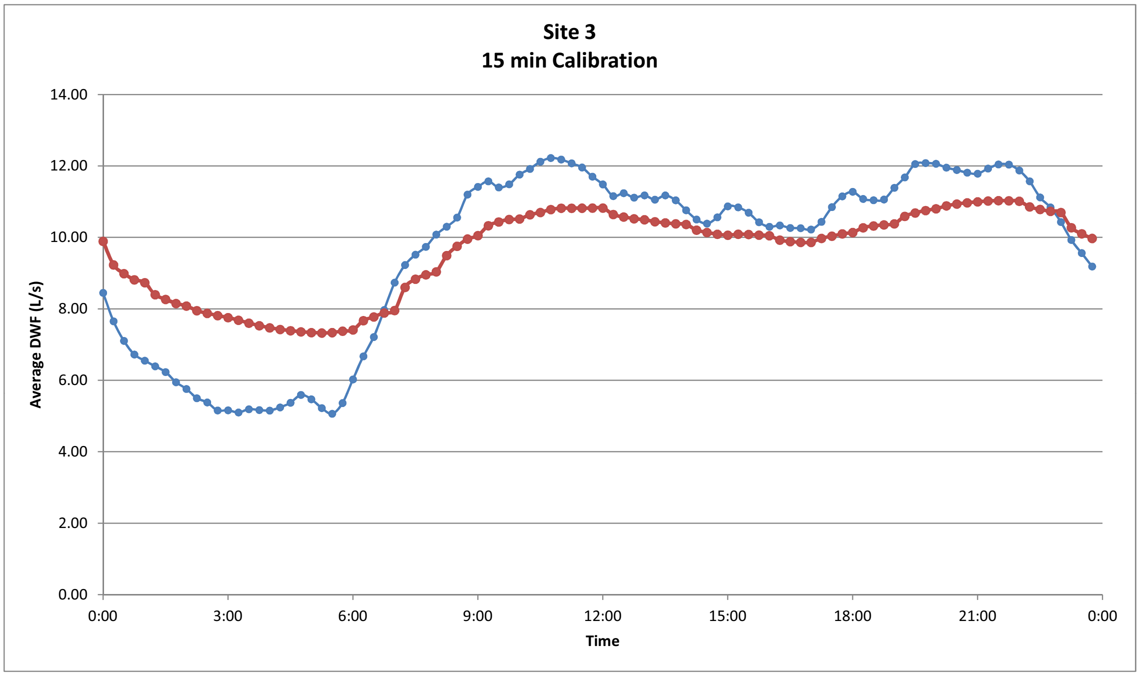
Monitored

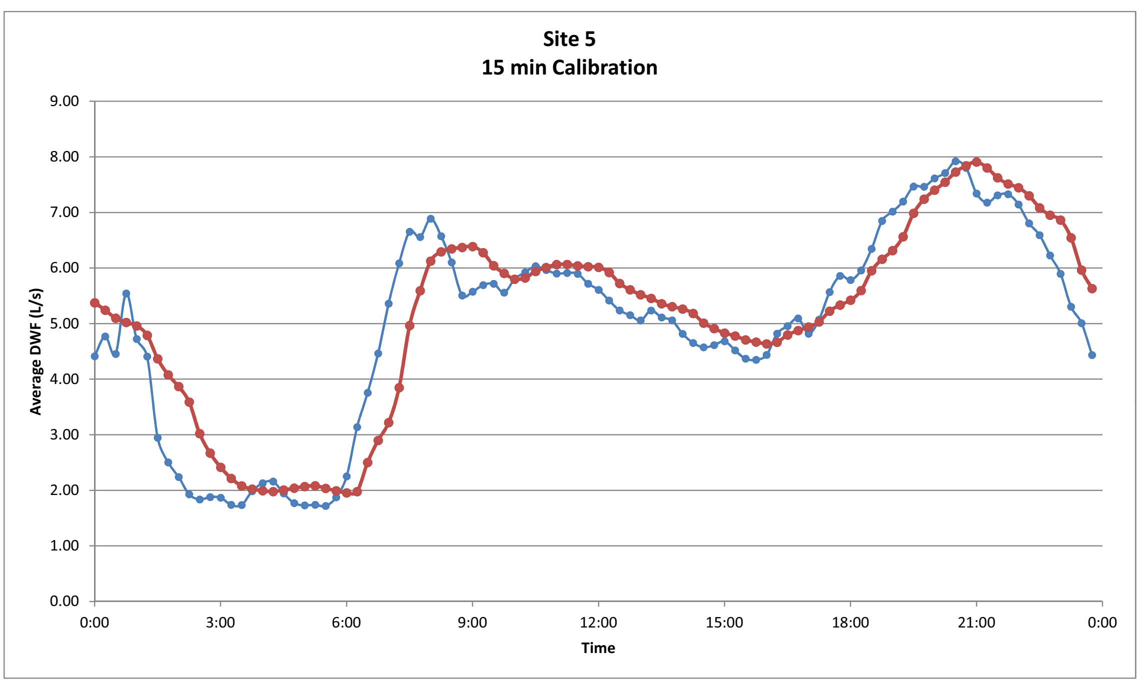


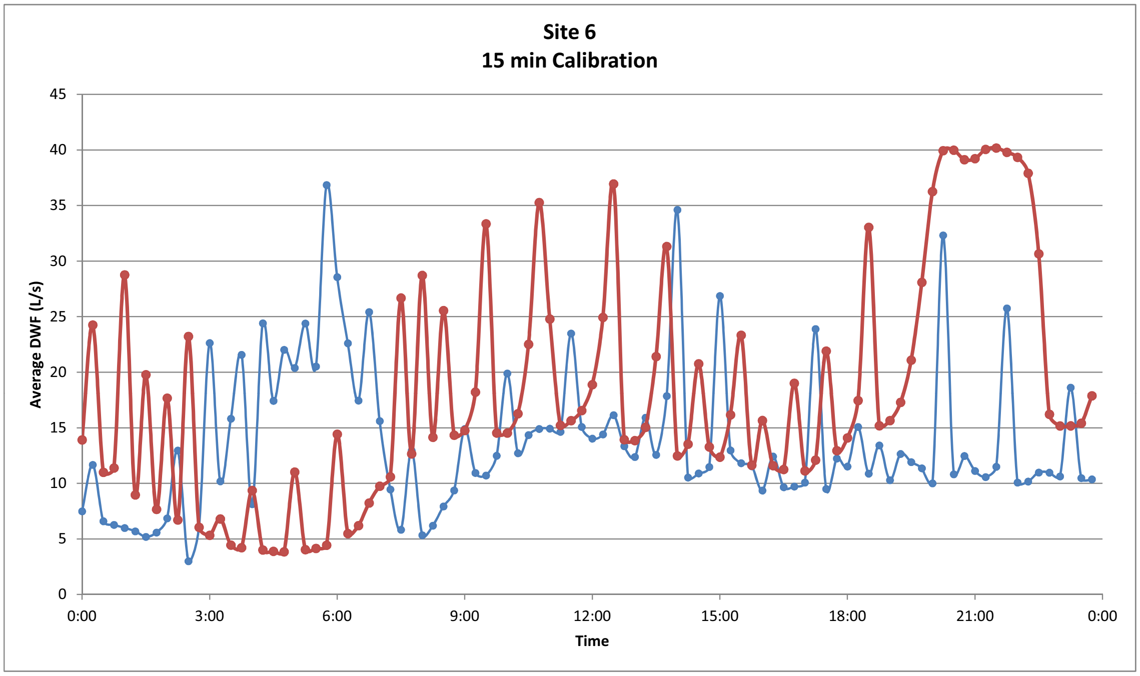
8/1/2013 Appendix D

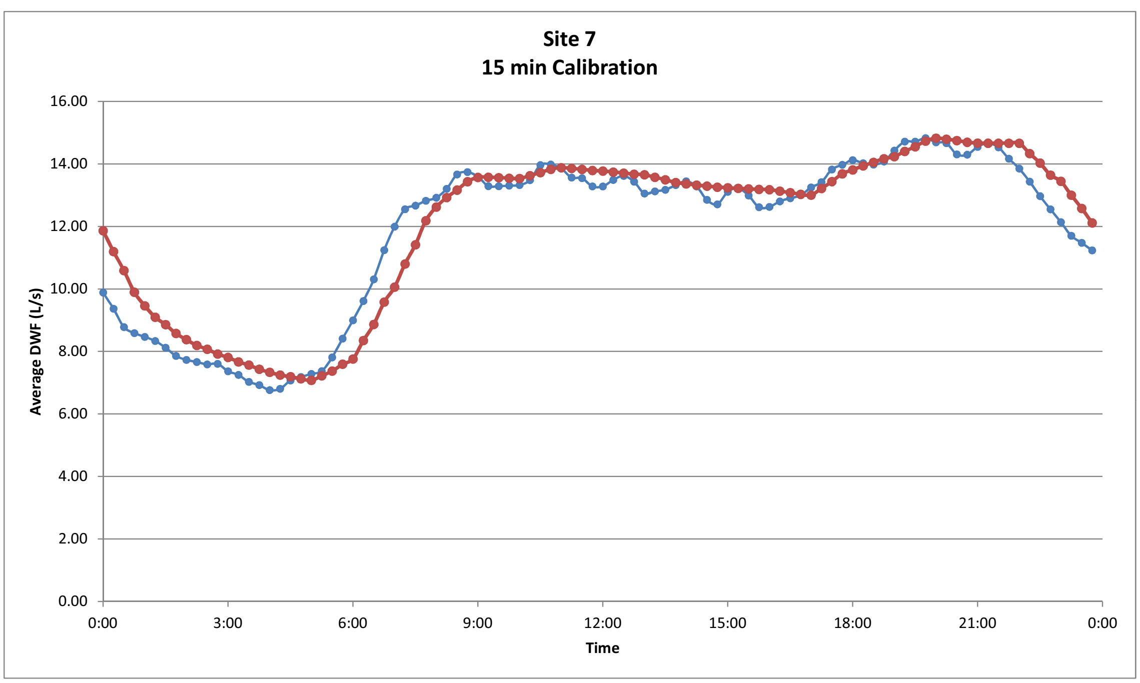


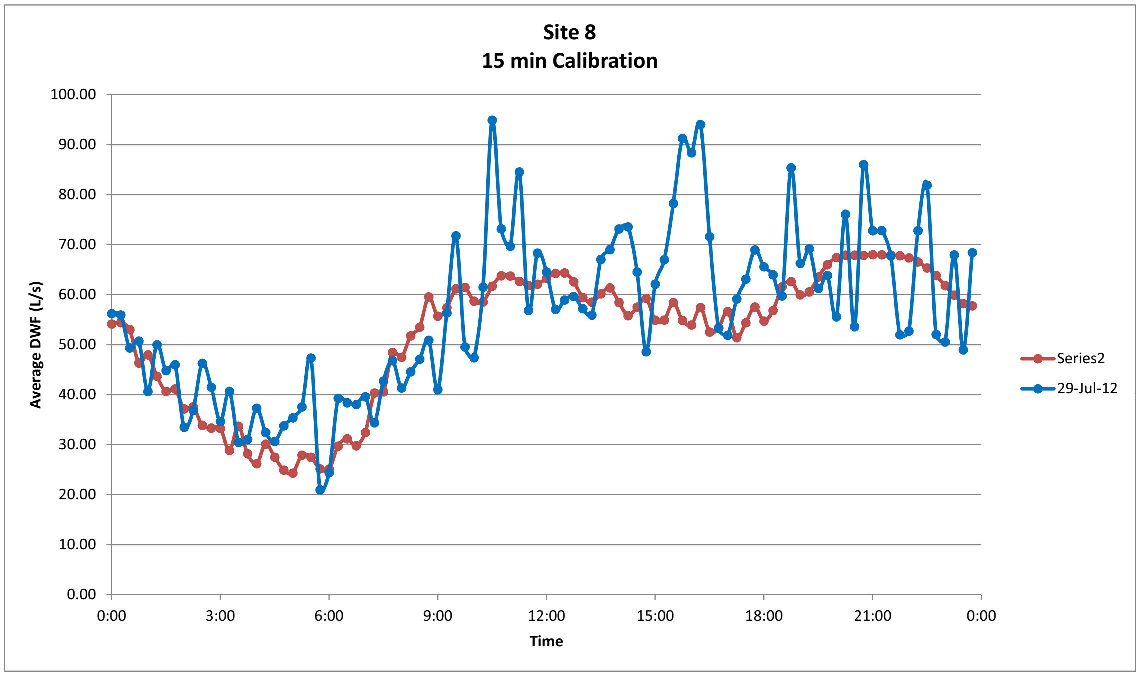
8/1/2013 Appendix D


Site 3
15 min Calibration
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Average DWF (L/s)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time

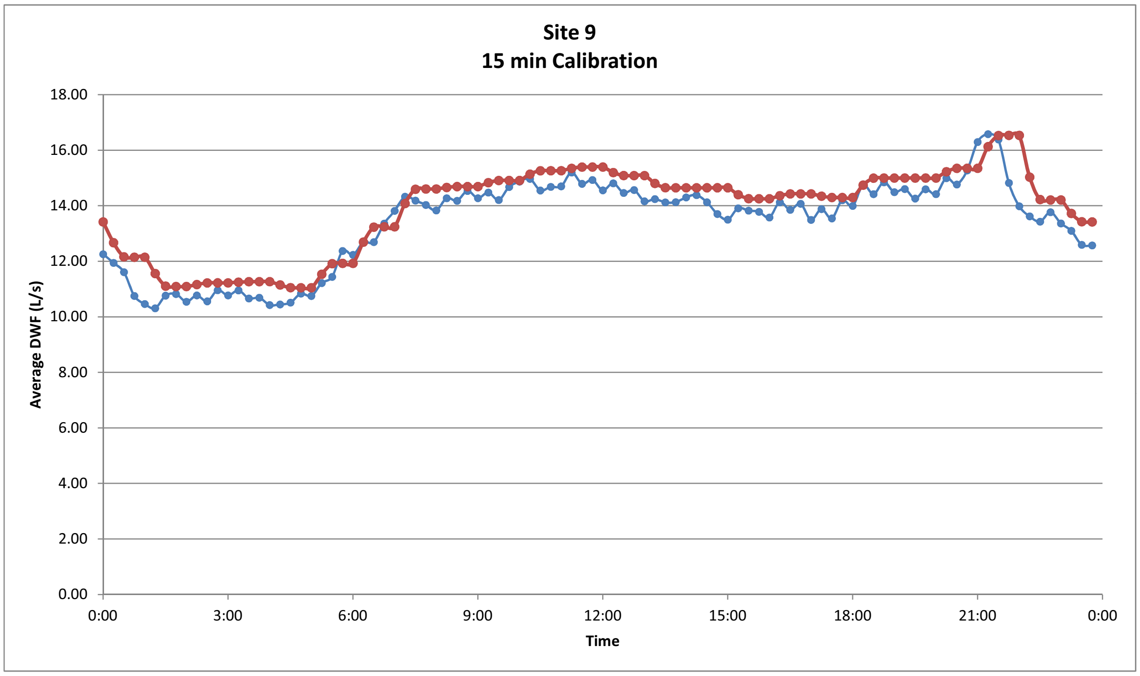

Site 5
15 min Calibration
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Average DWF (L/s)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time


Site 6
15 min Calibration
45
40
35
30
25
20
15
10
5
0
Average DWF (L/s)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time

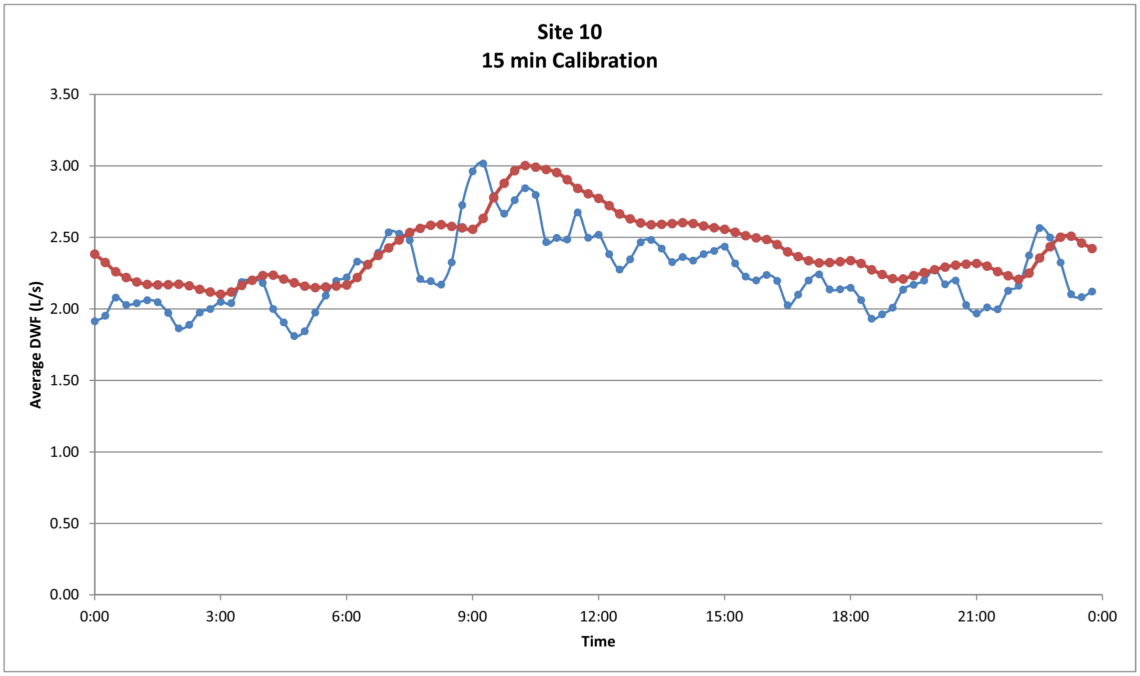

Site 7
15 min Calibration
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Average DWF (L/s)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time

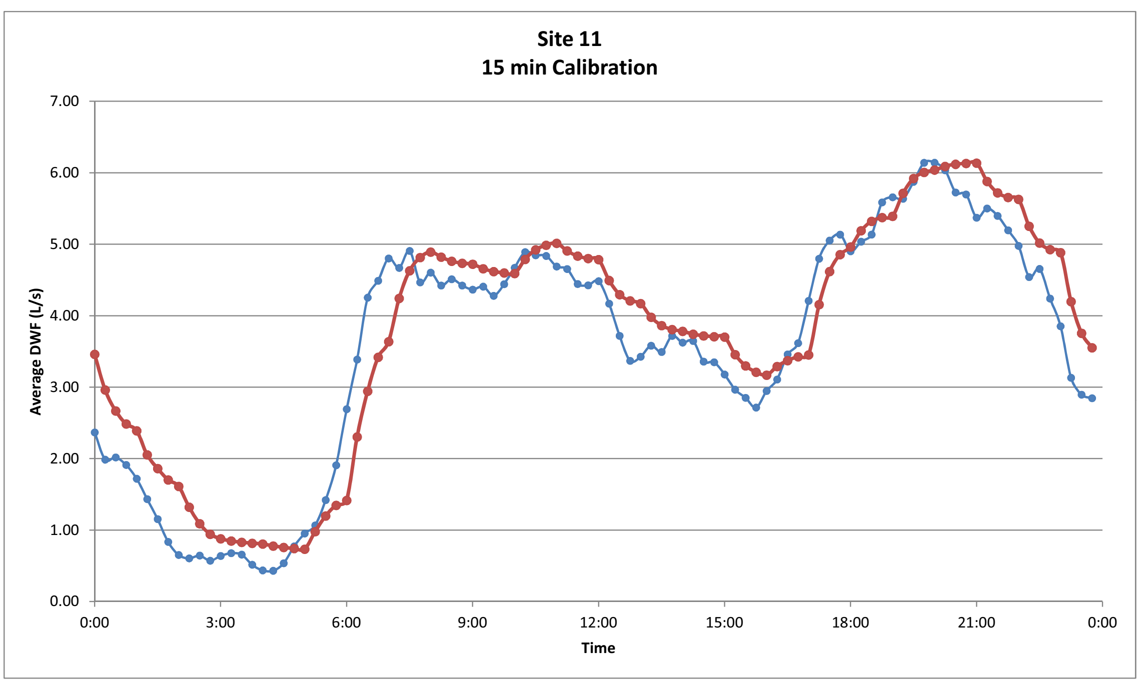


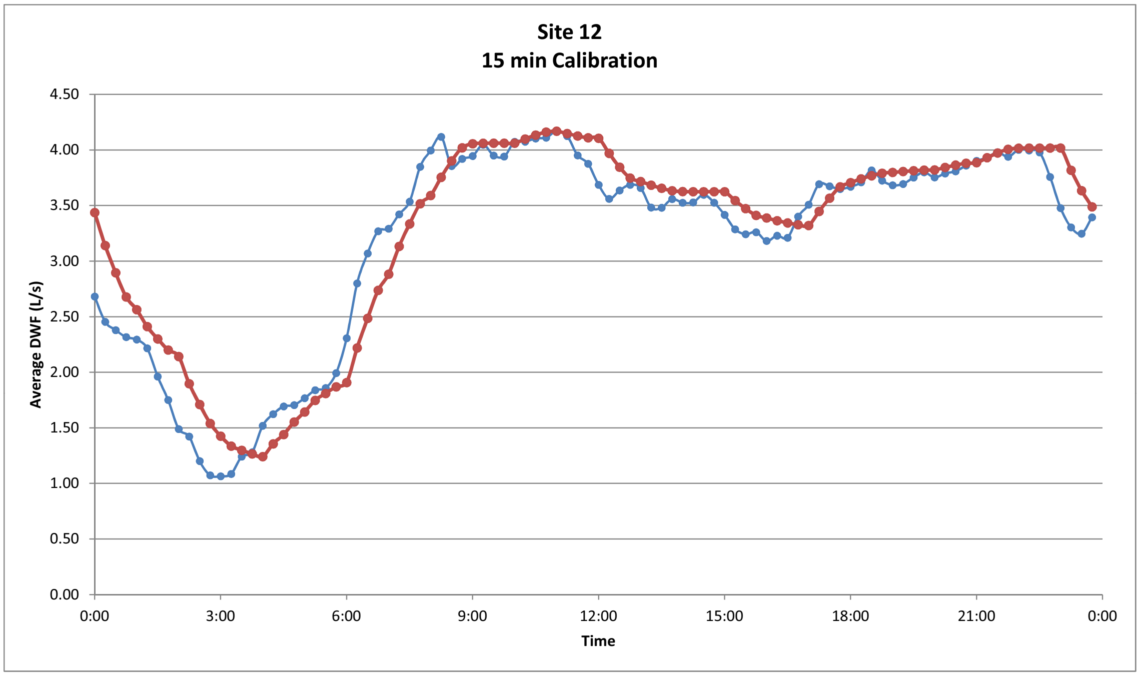
8/1/2013 Appendix D

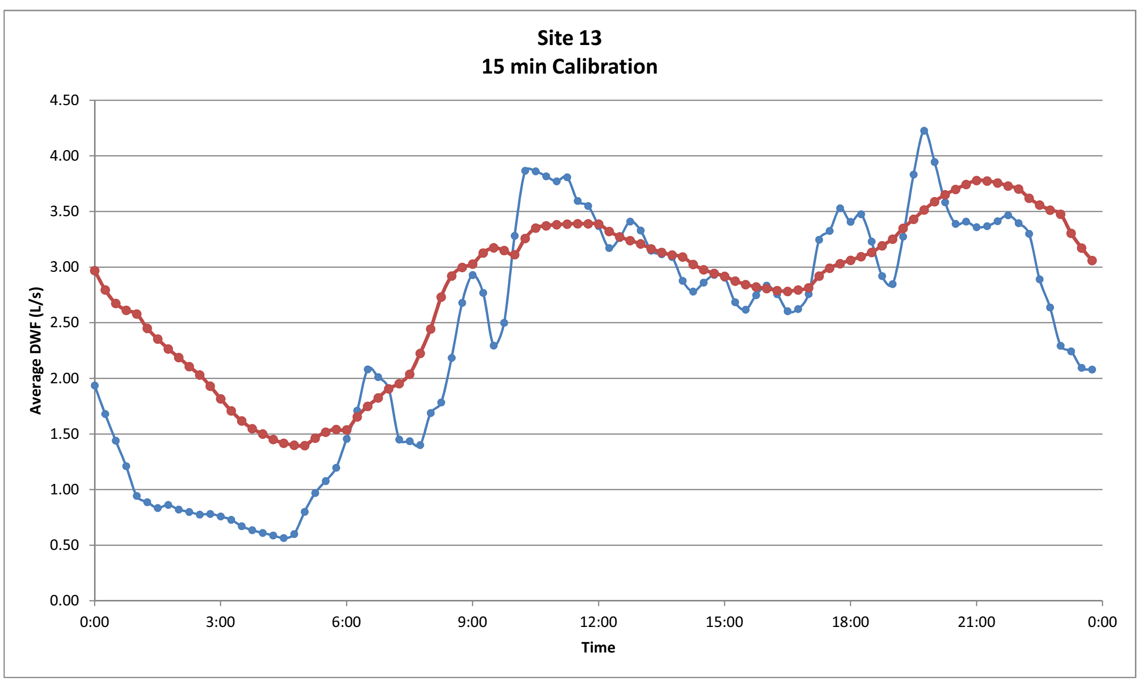


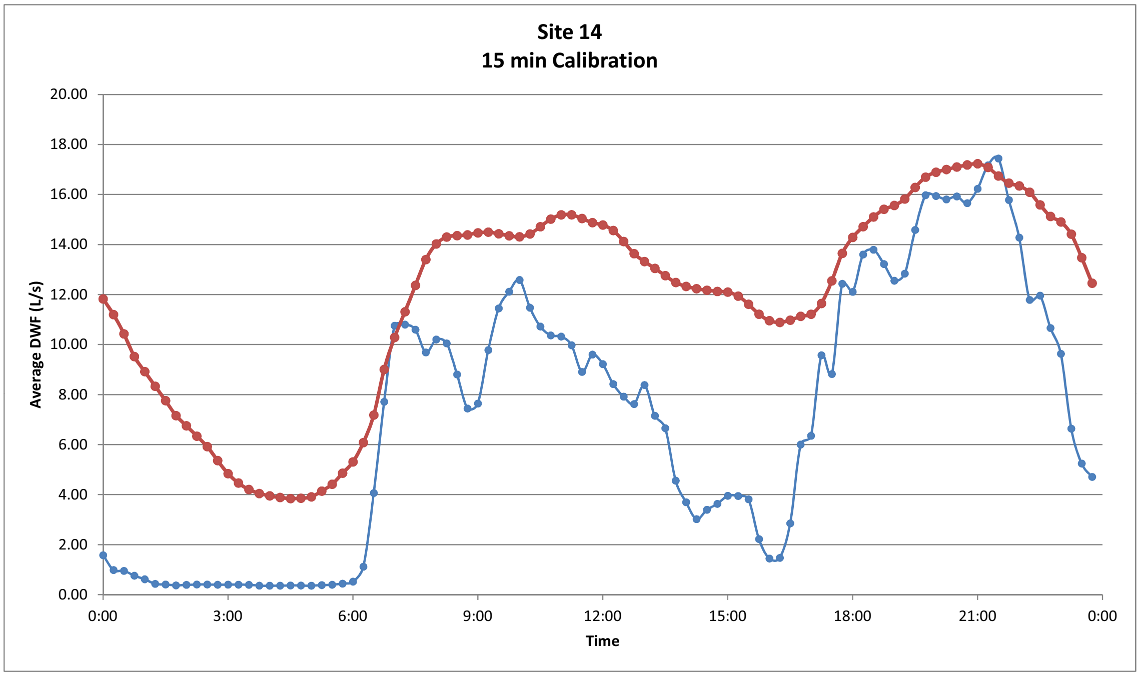
8/1/2013 Appendix D


Site 10
15 min Calibration
Average DWF (L/s)
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time


Site 11
15 min Calibration
Average DWF (L/s)
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time


Site 12
15 min Calibration
Average DWF (L/s)
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time


Site 13
15 min Calibration
Average DWF (L/s)
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time


Site 14
15 min Calibration
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Average DWF (L/s)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time

Site 1

	R	T	K
Short	0.00083	0.07	4.5
Medium	0.0035	0.2	2
Long	0.002	0.3	1

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
1c	2856087	3565051	-24.8%	22.9	28.7	-25.5%
1e	601281	727953	-21.1%	21.0	21.5	-2.5%

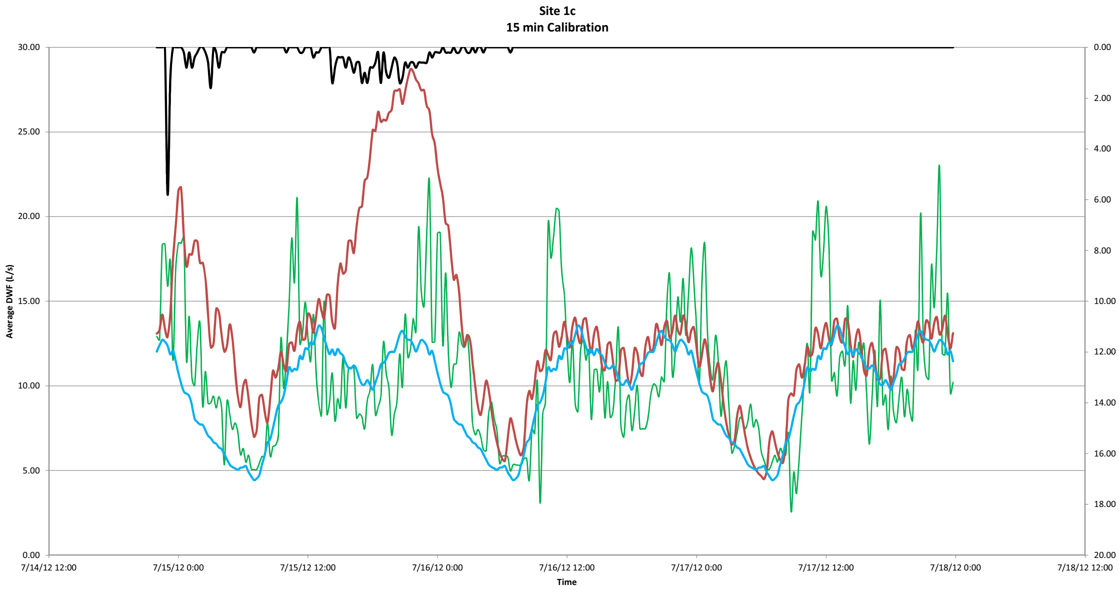
LEGEND

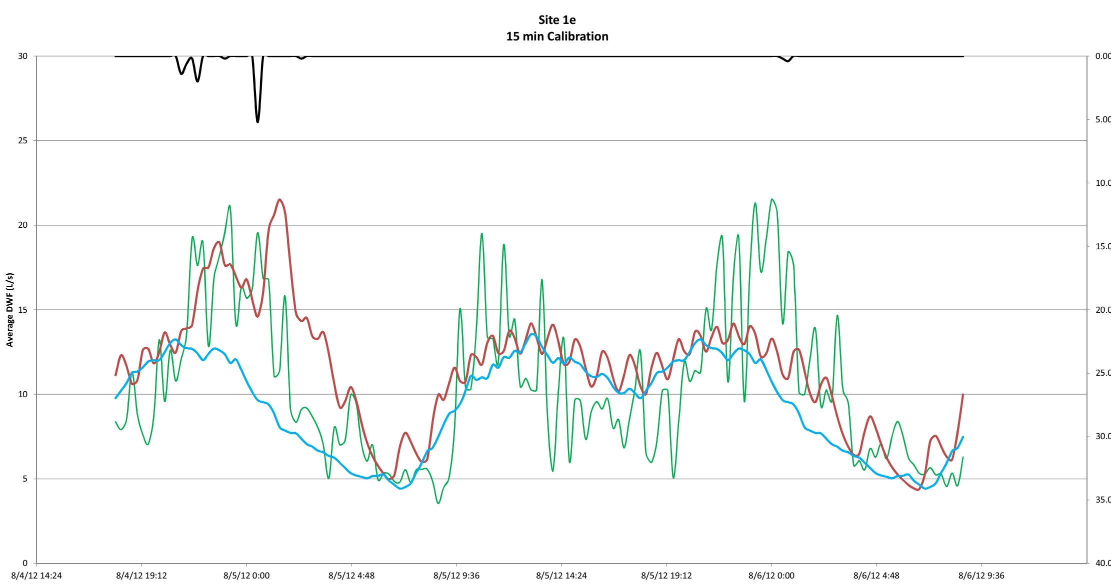
Model

Monitored

DWF

Rainfall


Site 1c
15 min Calibration
Average DWF (L/s)
Time
30.00
25.00
20.00
15.00
10.00
5.00
0.00
7/14/12 12:00
7/15/12 0:00
7/15/12 12:00
7/16/12 0:00
7/16/12 12:00
7/17/12 0:00
7/17/12 12:00
7/18/12 0:00
7/18/12 12:00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00


Site 1e
15 min Calibration
Average DWF (L/s)
Time
30
25
20
15
10
5
0
8/4/12 14:24
8/4/12 19:12
8/5/12 0:00
8/5/12 4:48
8/5/12 9:36
8/5/12 14:24
8/5/12 19:12
8/6/12 0:00
8/6/12 4:48
8/6/12 9:36
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00

Site 2

	R	T	K
Short	0.0083	0.07	4.5
Medium	0.0049	0.38	5
Long	0.003	1.5	2

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	**Model (L/s)**	**% Diff**	**Monitored (L/s)**	**Model (L/s)**	**% Diff**
2c	792297	765669	3.4%	24.9	18.4	26.4%
2d	1250730	1192593	4.6%	27.4	34.6	-26.3%
2g	1011474	822082	18.7%	21.3	16.5	22.6%

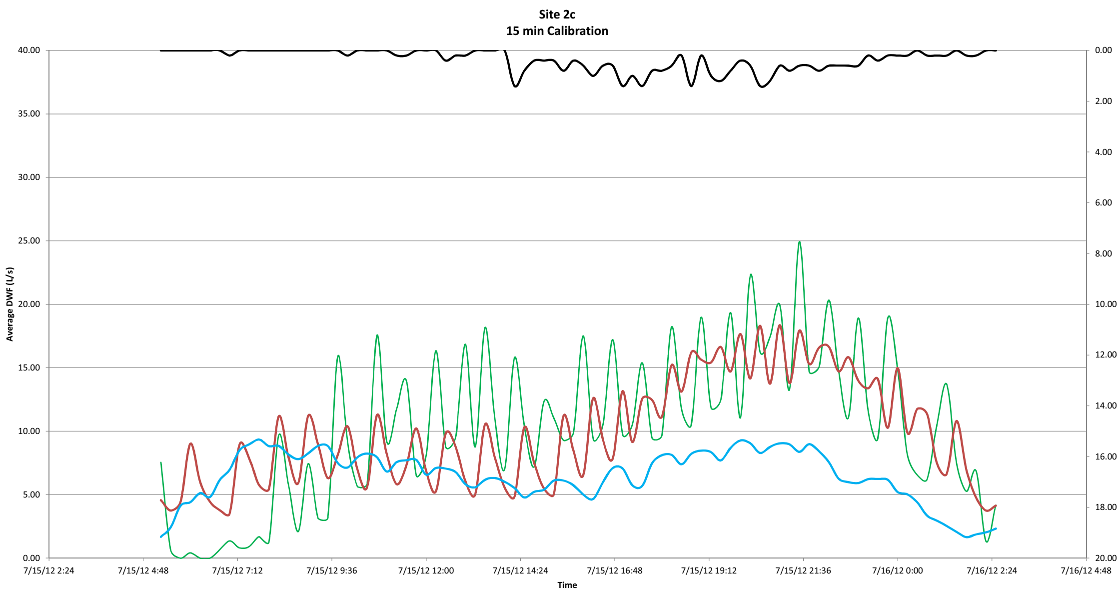
LEGEND

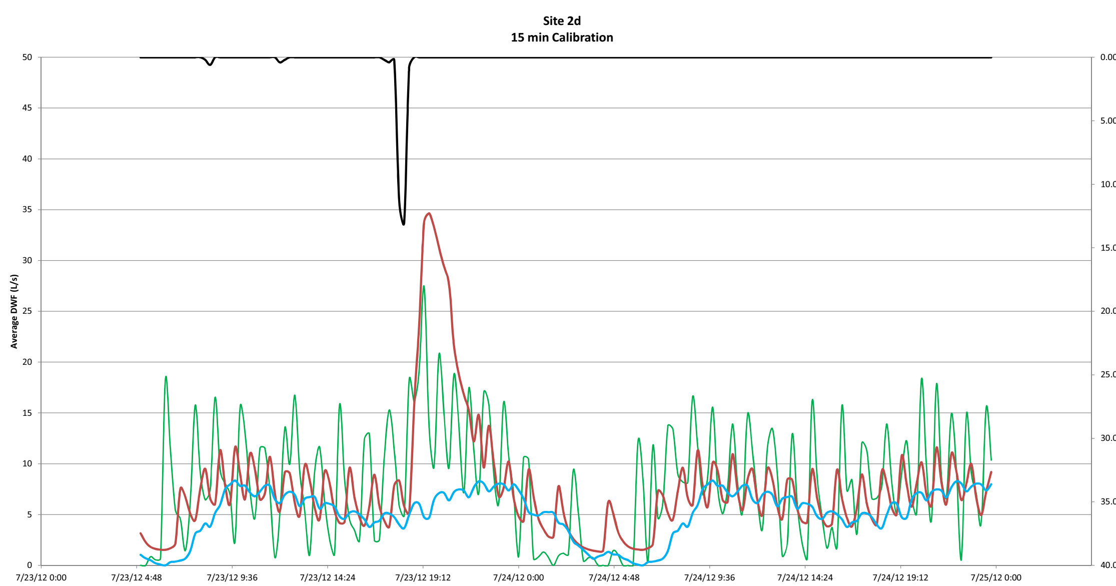
Model

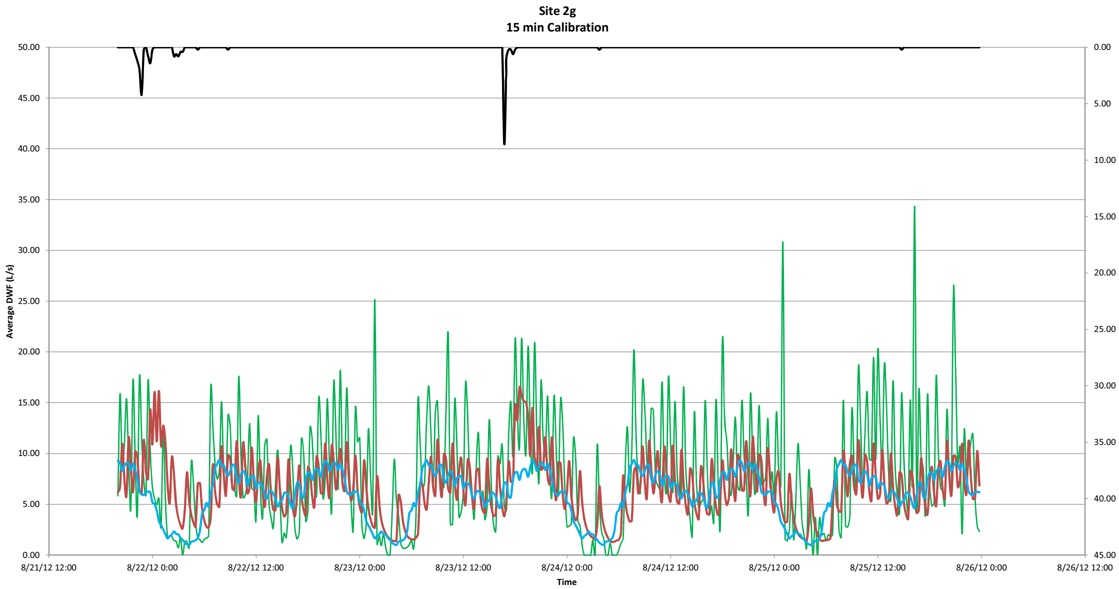
Monitored

DWF

Rainfall


Site 2c
15 min Calibration
Average DWF (L/s)
Time


Site 2d
15 min Calibration
Average DWF (L/s)
Time



Site 2g
15 min Calibration
Average DWF (L/s)
Time
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
8/21/12 12:00
8/22/12 0:00
8/22/12 12:00
8/23/12 0:00
8/23/12 12:00
8/24/12 0:00
8/24/12 12:00
8/25/12 0:00
8/25/12 12:00
8/26/12 0:00
8/26/12 12:00

Site 3

	R	T	K
Short	0.0275	0.1	1
Medium	0.01	2	3
Long	0.01	4	6

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
3c	4445289	4128900	7.1%	48.2	38.8	19.4%
3d	4023378	4283107	-6.5%	53	54.2	-2.1%
3f	2390238	2338269	2.2%	34.5	27.1	21.5%

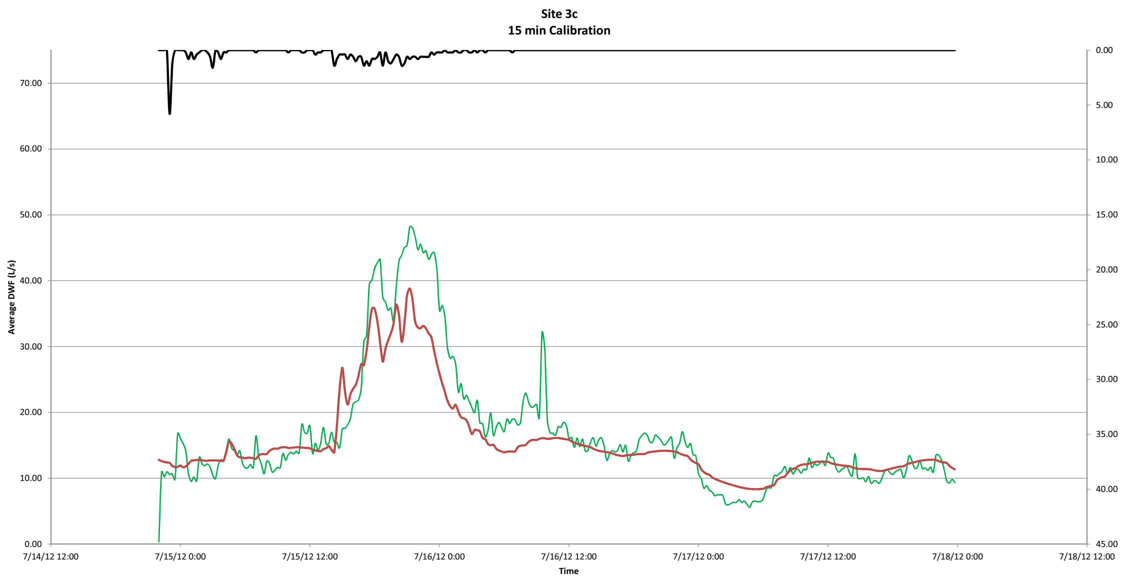
LEGEND

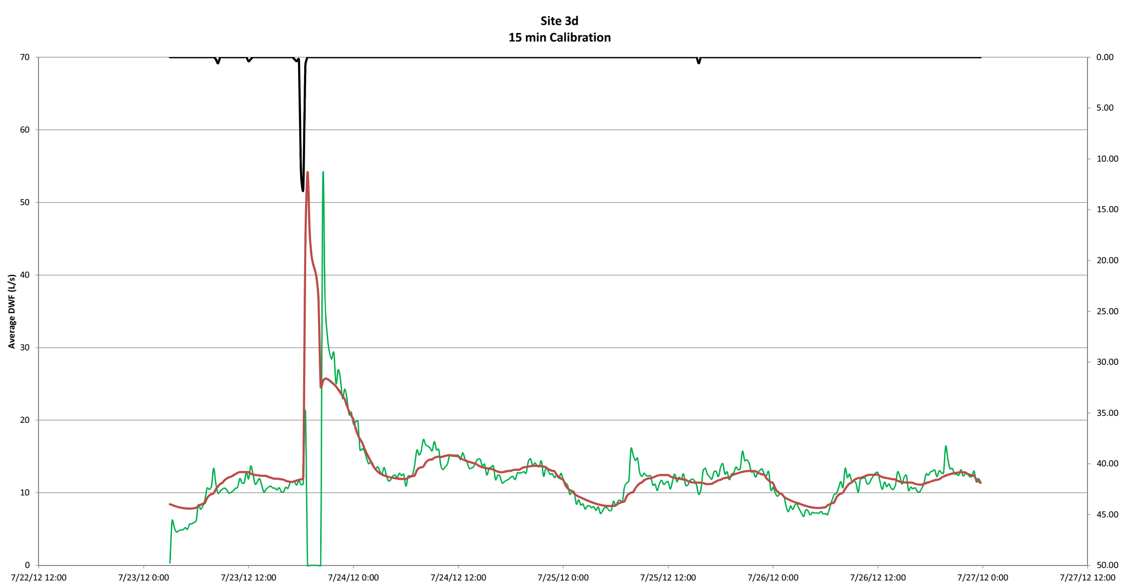
Model

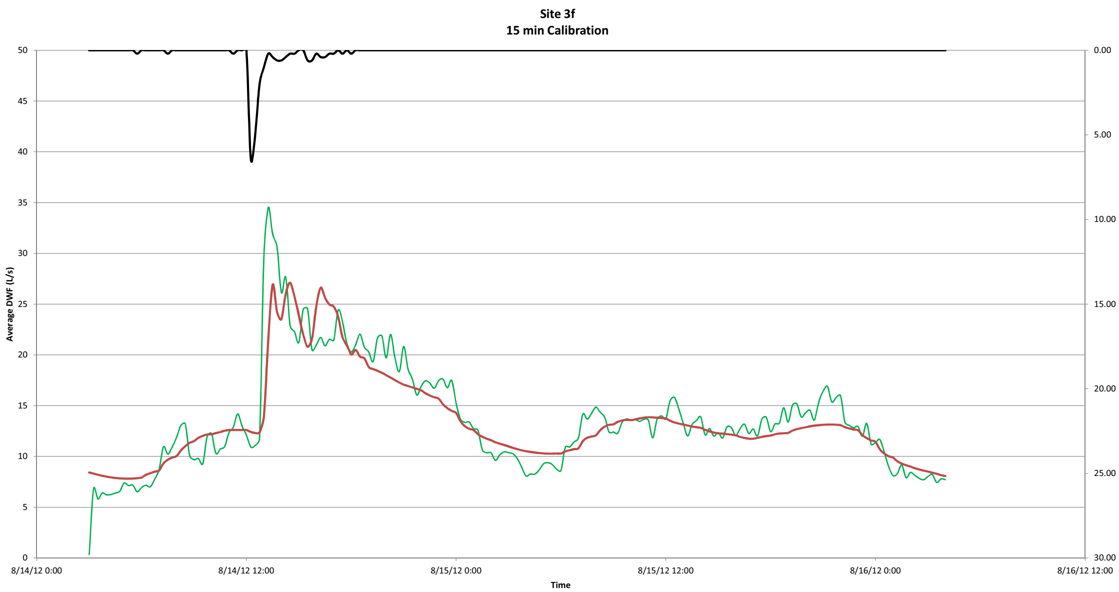
Monitored

DWF

Rainfall


Site 3c
15 min Calibration
Average DWF (L/s)
Time
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
7/14/12 12:00
7/15/12 0:00
7/15/12 12:00
7/16/12 0:00
7/16/12 12:00
7/17/12 0:00
7/17/12 12:00
7/18/12 0:00
7/18/12 12:00


Site 3d
15 min Calibration
Average DWF (L/s)
Time
0
10
20
30
40
50
60
70
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
7/22/12 12:00
7/23/12 0:00
7/23/12 12:00
7/24/12 0:00
7/24/12 12:00
7/25/12 0:00
7/25/12 12:00
7/26/12 0:00
7/26/12 12:00
7/27/12 0:00
7/27/12 12:00



Site 3f
15 min Calibration
Average DWF (L/s)
Time
50
45
40
35
30
25
20
15
10
5
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
8/14/12 0:00
8/14/12 12:00
8/15/12 0:00
8/15/12 12:00
8/16/12 0:00
8/16/12 12:00

Site 5

	R	T	K
Short	0.0035	0.005	5
Medium	0.0015	0.1	10
Long	0.05	0.5	75

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
5c	1742760	1442580	17.2%	31.4	19.8	37.0%
5d	1348182	1748612	-29.7%	22.0	27.8	-26.3%
5f	1269045	1295987	-2.1%	17.8	13.9	22.0%

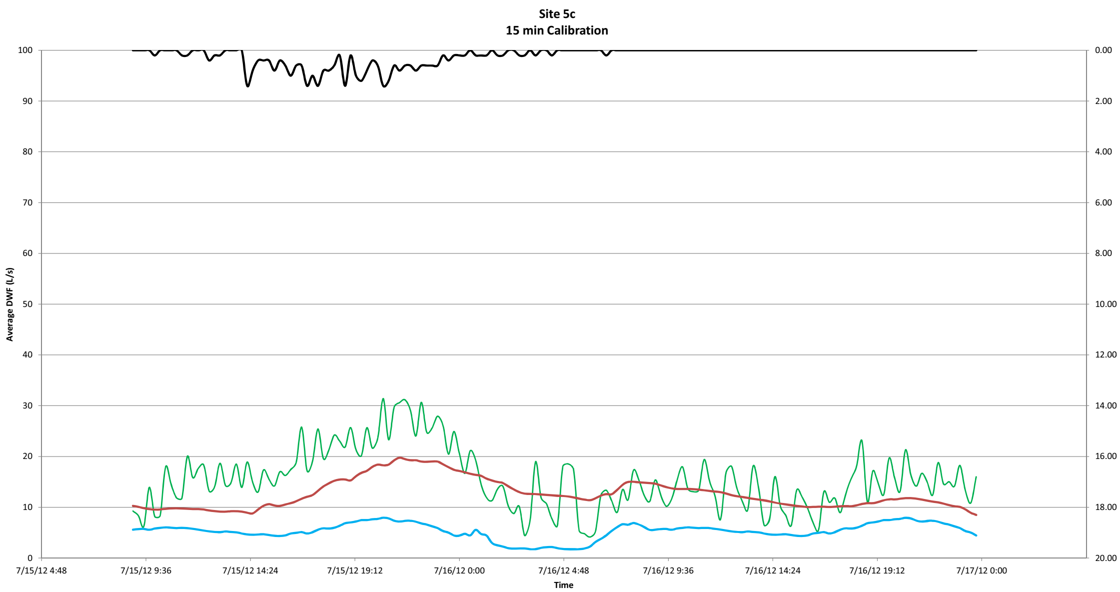
LEGEND

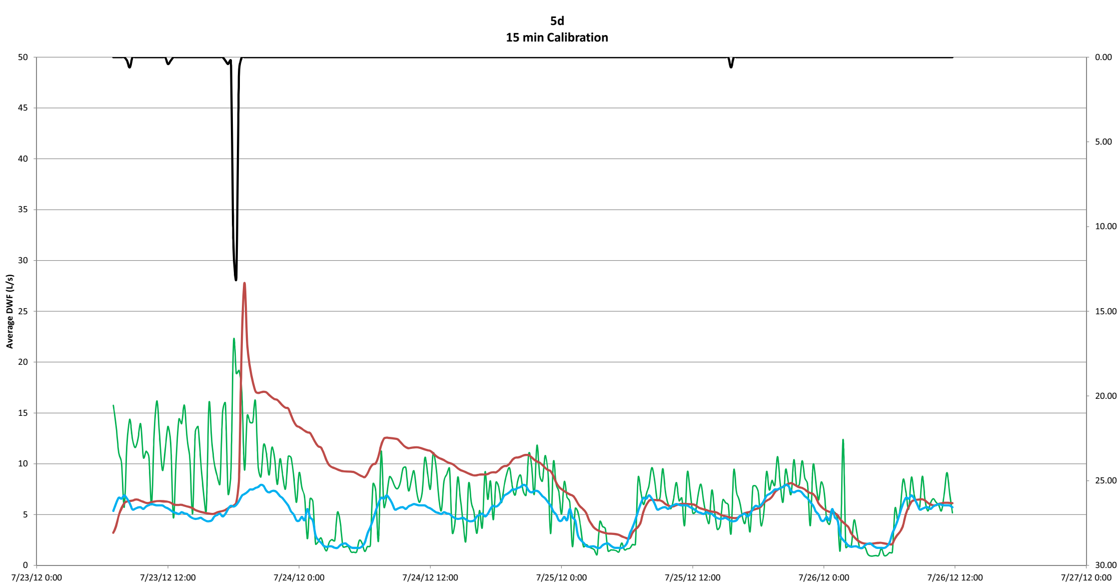
Model

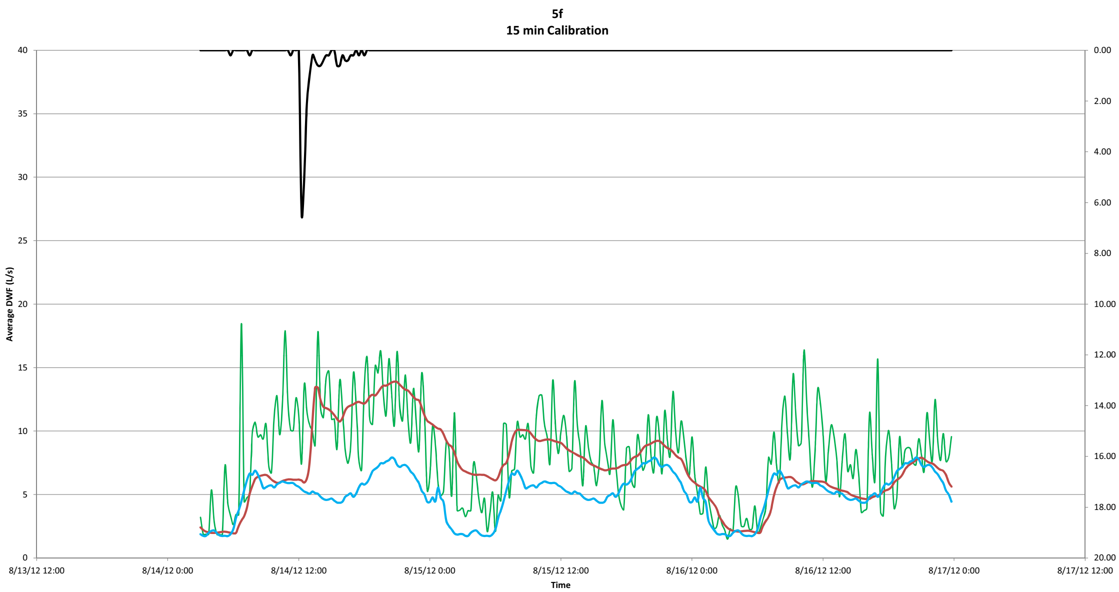
Monitored

DWF

Rainfall


Site 5c
15 min Calibration
Average DWF (L/s)
Time
100
90
80
70
60
50
40
30
20
10
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
7/15/12 4:48
7/15/12 9:36
7/15/12 14:24
7/15/12 19:12
7/16/12 0:00
7/16/12 4:48
7/16/12 9:36
7/16/12 14:24
7/16/12 19:12
7/17/12 0:00


5d
15 min Calibration
Average DWF (L/s)
Time
50
45
40
35
30
25
20
15
10
5
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
7/23/12 0:00
7/23/12 12:00
7/24/12 0:00
7/24/12 12:00
7/25/12 0:00
7/25/12 12:00
7/26/12 0:00
7/26/12 12:00
7/27/12 0:00


5f
15 min Calibration
Average DWF (L/s)
Time
0
5
10
15
20
25
30
35
40
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
8/13/12 12:00
8/14/12 0:00
8/14/12 12:00
8/15/12 0:00
8/15/12 12:00
8/16/12 0:00
8/16/12 12:00
8/17/12 0:00
8/17/12 12:00

<u>Site 6</u>

**No additional loads for this location*

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitore d (L/s)	Model (L/s)	% Diff
6c	4868559	7149617	-46.9%	83.7	79.7	4.8%
6d	2768976	4337808	-56.7%	117.4	154.3	-31.5%
6f	2676987	3923599	-46.6%	65.8	79.7	-21.2%

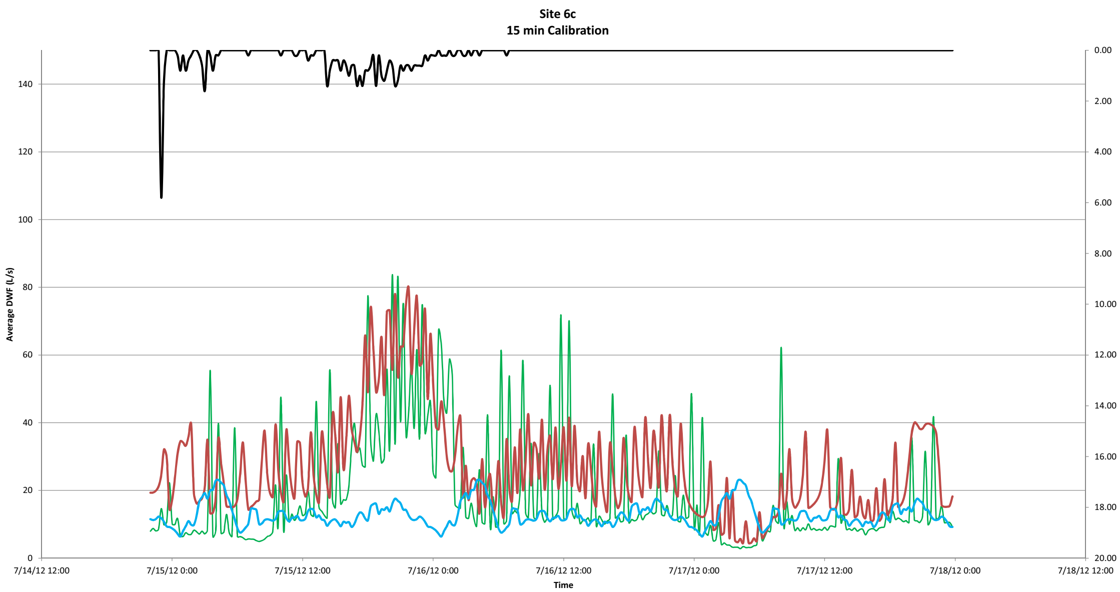
LEGEND

Model

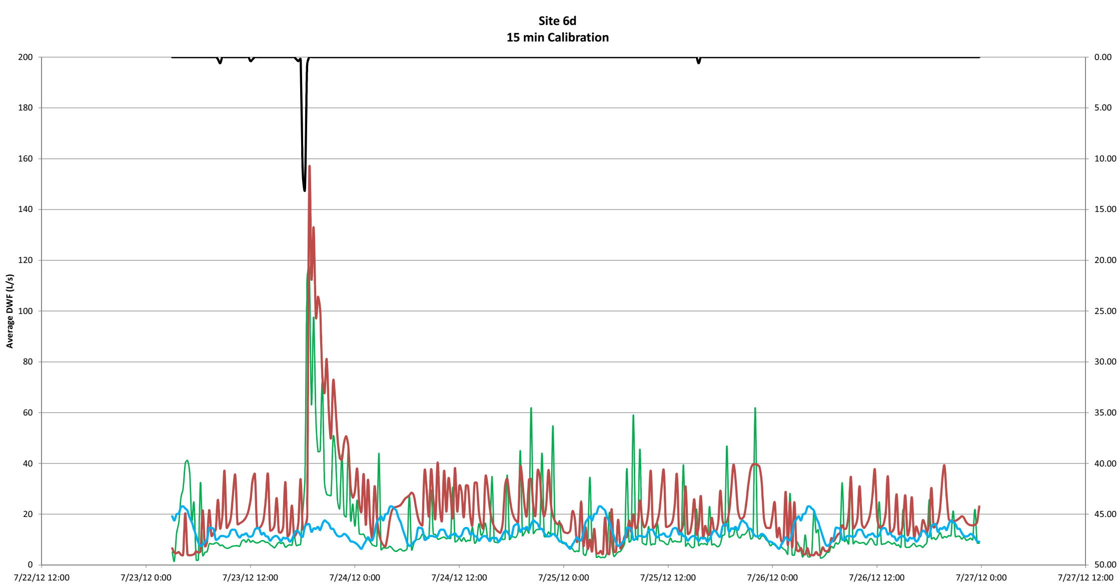
Monitored

DWF

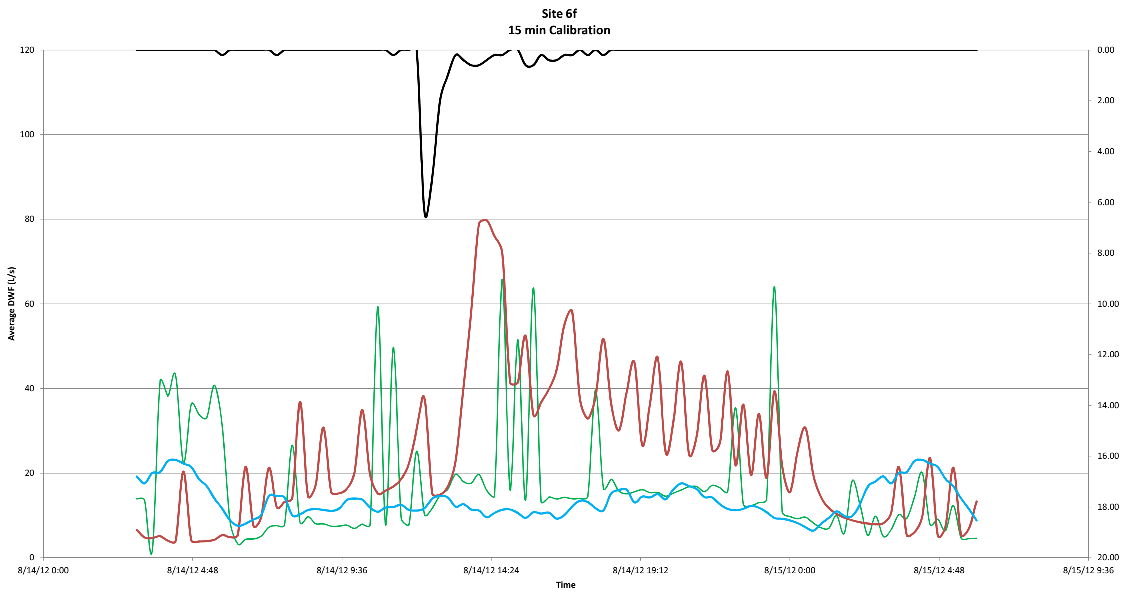
Rainfall



Site 6c
15 min Calibration
Average DWF (L/s)
Time
0
20
40
60
80
100
120
140
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
7/14/12 12:00
7/15/12 0:00
7/15/12 12:00
7/16/12 0:00
7/16/12 12:00
7/17/12 0:00
7/17/12 12:00
7/18/12 0:00
7/18/12 12:00



Site 6d
15 min Calibration
Average DWF (L/s)
Time
0
20
40
60
80
100
120
140
160
180
200
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
7/22/12 12:00
7/23/12 0:00
7/23/12 12:00
7/24/12 0:00
7/24/12 12:00
7/25/12 0:00
7/25/12 12:00
7/26/12 0:00
7/26/12 12:00
7/27/12 0:00
7/27/12 12:00



Site 6f
15 min Calibration
Average DWF (L/s)
Time
120
100
80
60
40
20
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
8/14/12 0:00
8/14/12 4:48
8/14/12 9:36
8/14/12 14:24
8/14/12 19:12
8/15/12 0:00
8/15/12 4:48
8/15/12 9:36

Site 7

	R	T	K
Short	0.009	0.75	0.1
Medium	0.01	1	2
Long	0.028	3	11

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
7d	3275433	3454686	-5.5%	75.5	78.2	-3.6%
7e	2272077	2086336	8.2%	38.0	18.8	50.6%
7f	2842587	2831245	0.4%	39.6	40.5	-2.2%

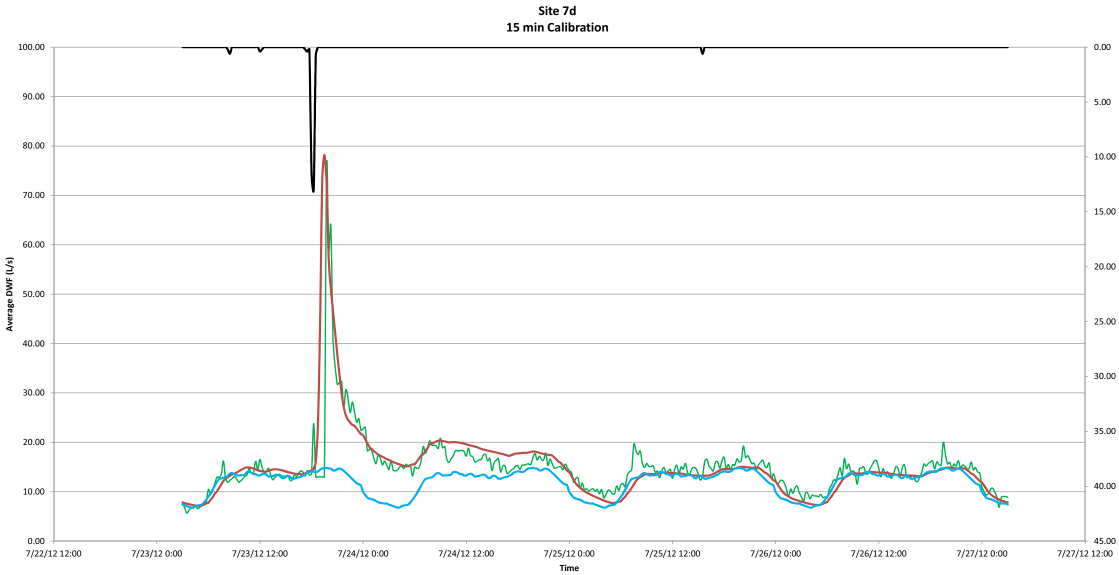
LEGEND

Model

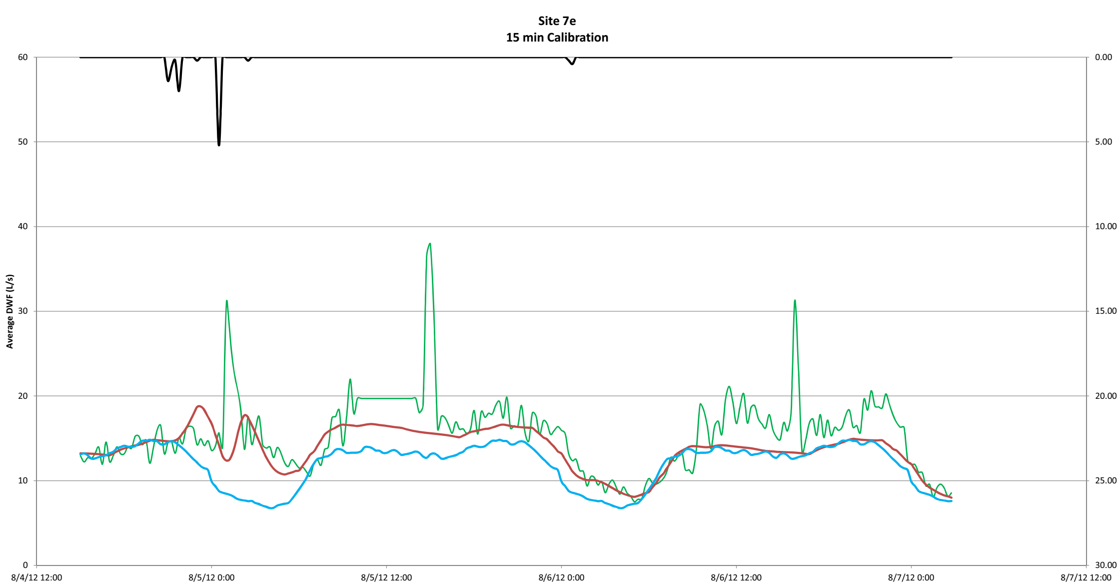
Monitored

DWF

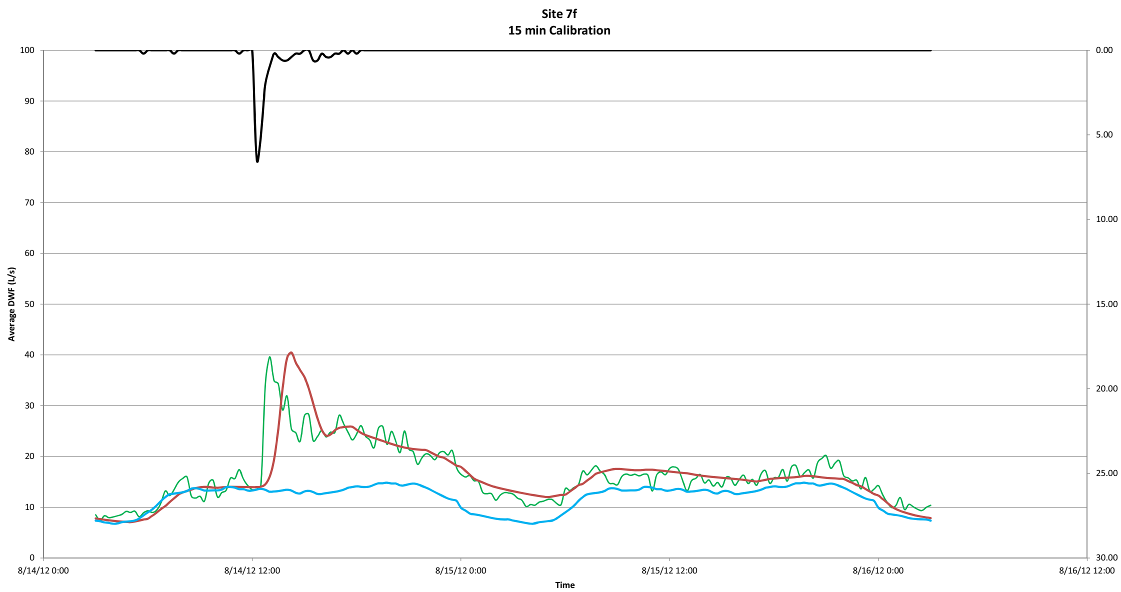
Rainfall



Site 7d
15 min Calibration
Average DWF (L/s)
Time
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
7/22/12 12:00
7/23/12 0:00
7/23/12 12:00
7/24/12 0:00
7/24/12 12:00
7/25/12 0:00
7/25/12 12:00
7/26/12 0:00
7/26/12 12:00
7/27/12 0:00
7/27/12 12:00



Site 7e
15 min Calibration
Average DWF (L/s)
Time
60
50
40
30
20
10
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
8/4/12 12:00
8/5/12 0:00
8/5/12 12:00
8/6/12 0:00
8/6/12 12:00
8/7/12 0:00
8/7/12 12:00


Site 7f
15 min Calibration
Average DWF (L/s)
Time
100
90
80
70
60
50
40
30
20
10
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
8/14/12 0:00
8/14/12 12:00
8/15/12 0:00
8/15/12 12:00
8/16/12 0:00
8/16/12 12:00

Site 8

	R	T	K
Short	0.0175	0.1	1
Medium	0.0025	2	2
Long	0.0025	4	4

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
8b	12173103	17756909	-45.9%	64.1	95.8	-49.4%
8c	9210735	12256250	-33.1%	193.5	197.1	-1.9%
8d	20445129	21367122	-4.5%	307.9	309.8	-0.6%

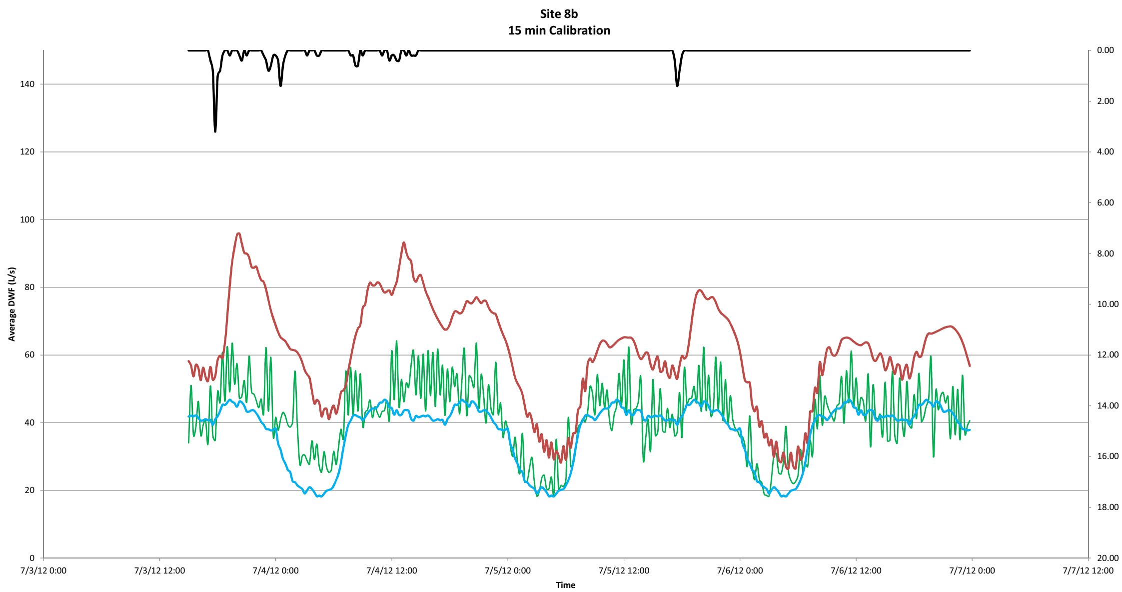
LEGEND

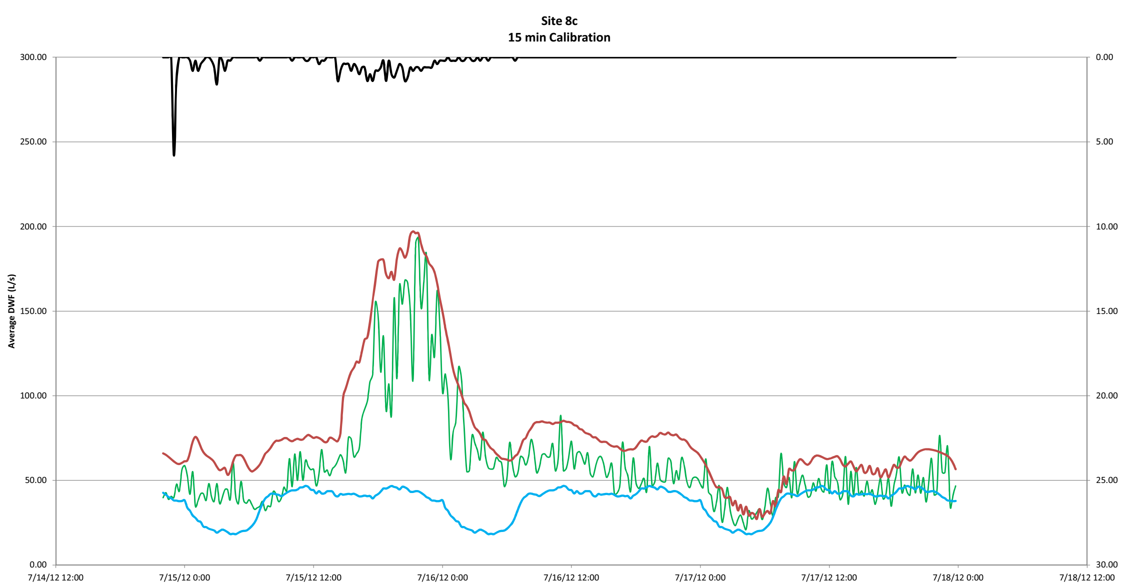
Model

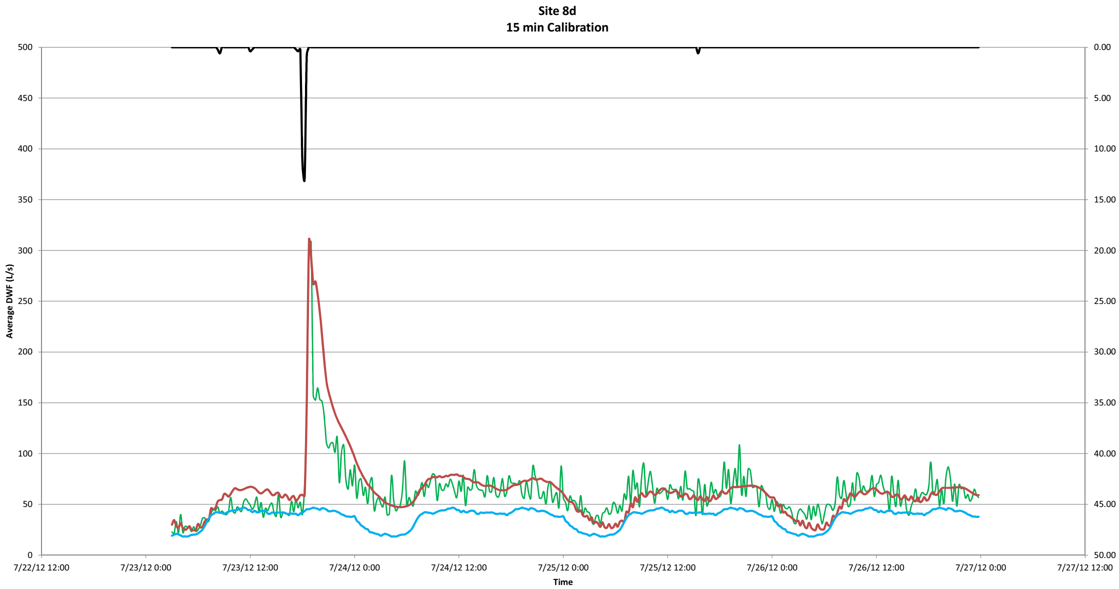
Monitored

DWF

Rainfall


Site 8b
15 min Calibration
Average DWF (L/s)
Time
0
20
40
60
80
100
120
140
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
7/3/12 0:00
7/3/12 12:00
7/4/12 0:00
7/4/12 12:00
7/5/12 0:00
7/5/12 12:00
7/6/12 0:00
7/6/12 12:00
7/7/12 0:00
7/7/12 12:00


Site 8c
15 min Calibration
Average DWF (L/s)
Time
0.00
50.00
100.00
150.00
200.00
250.00
300.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
7/14/12 12:00
7/15/12 0:00
7/15/12 12:00
7/16/12 0:00
7/16/12 12:00
7/17/12 0:00
7/17/12 12:00
7/18/12 0:00
7/18/12 12:00


Site 8d
15 min Calibration
Average DWF (L/s)
Time
500
450
400
350
300
250
200
150
100
50
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
7/22/12 12:00
7/23/12 0:00
7/23/12 12:00
7/24/12 0:00
7/24/12 12:00
7/25/12 0:00
7/25/12 12:00
7/26/12 0:00
7/26/12 12:00
7/27/12 0:00
7/27/12 12:00

Site 9

	R	T	K
Short	0.105	0.05	1
Medium	0.02	1	2
Long	0.025	3	3

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
9d	3368736	2975840	11.7%	195.9	204.8	-4.5%
9f	2453157	2525215	-2.9%	49.8	52.5	-5.4%
9g	1345640	1058009	21.4%	40.8	31.4	23.0%

**Not good data*

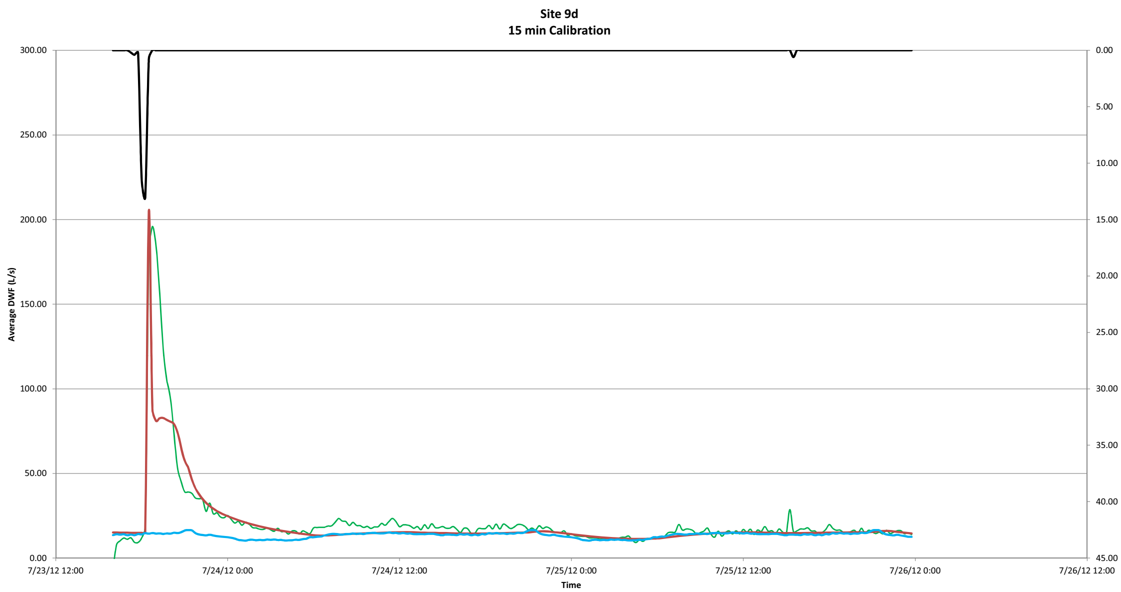
LEGEND

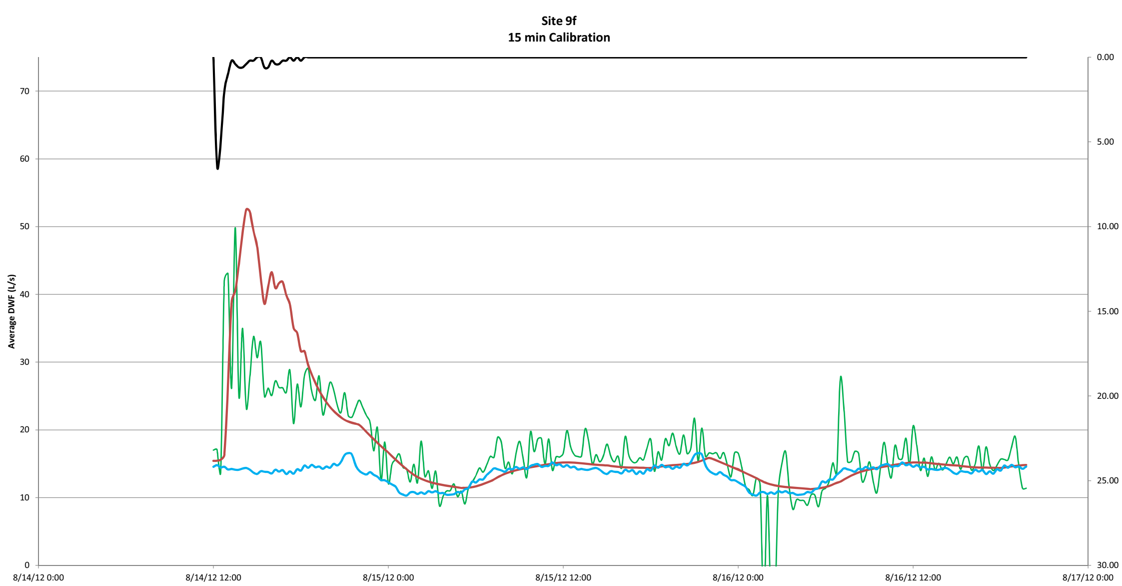
Model

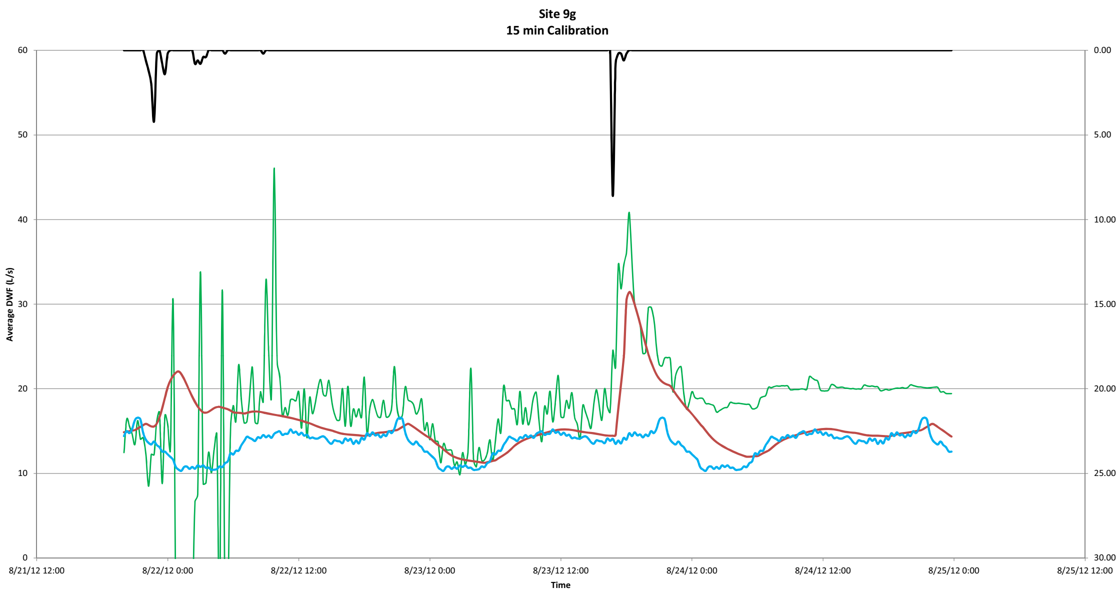
Monitored

DWF

Rainfall


Site 9d
15 min Calibration
Average DWF (L/s)
Time
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
7/23/12 12:00
7/24/12 0:00
7/24/12 12:00
7/25/12 0:00
7/25/12 12:00
7/26/12 0:00
7/26/12 12:00


Site 9f
15 min Calibration
Average DWF (L/s)
Time
70
60
50
40
30
20
10
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
8/14/12 0:00
8/14/12 12:00
8/15/12 0:00
8/15/12 12:00
8/16/12 0:00
8/16/12 12:00
8/17/12 0:00


Site 9g
15 min Calibration
60
50
40
30
20
10
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Average DWF (L/s)
8/21/12 12:00
8/22/12 0:00
8/22/12 12:00
8/23/12 0:00
8/23/12 12:00
8/24/12 0:00
8/24/12 12:00
8/25/12 0:00
8/25/12 12:00
Time

Site 10

	R	T	K
Short	0.015	0.01	2
Medium	0.0025	1	10
Long	0	0	0

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
10a	338814	291635	13.9%	13.3	13.4	-0.8%
10b	287820	280527	2.5%	6.5	7.4	-14.0%

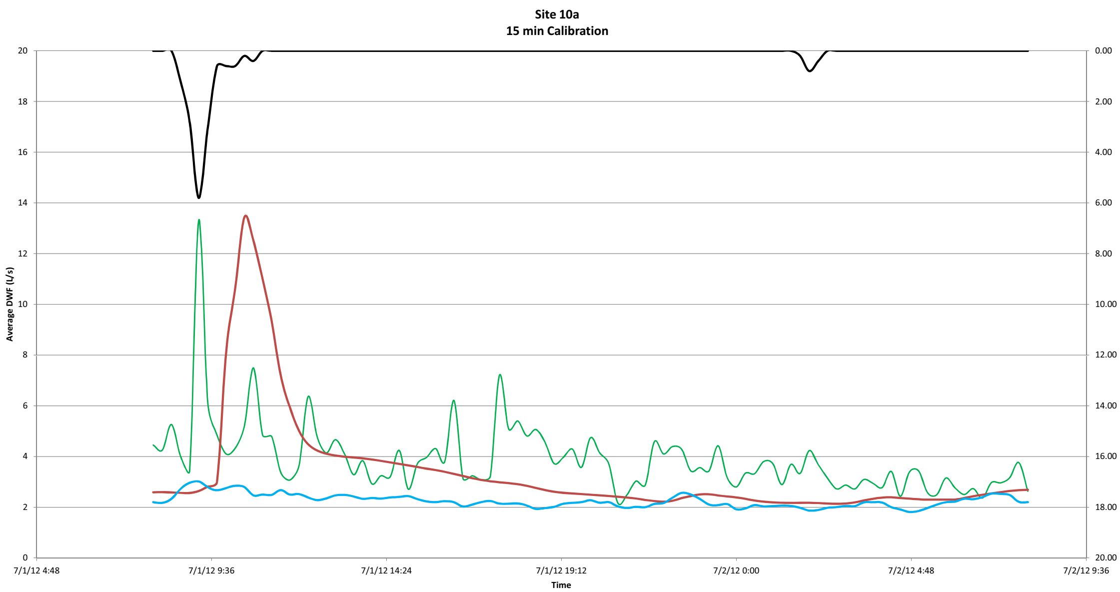
LEGEND

Model

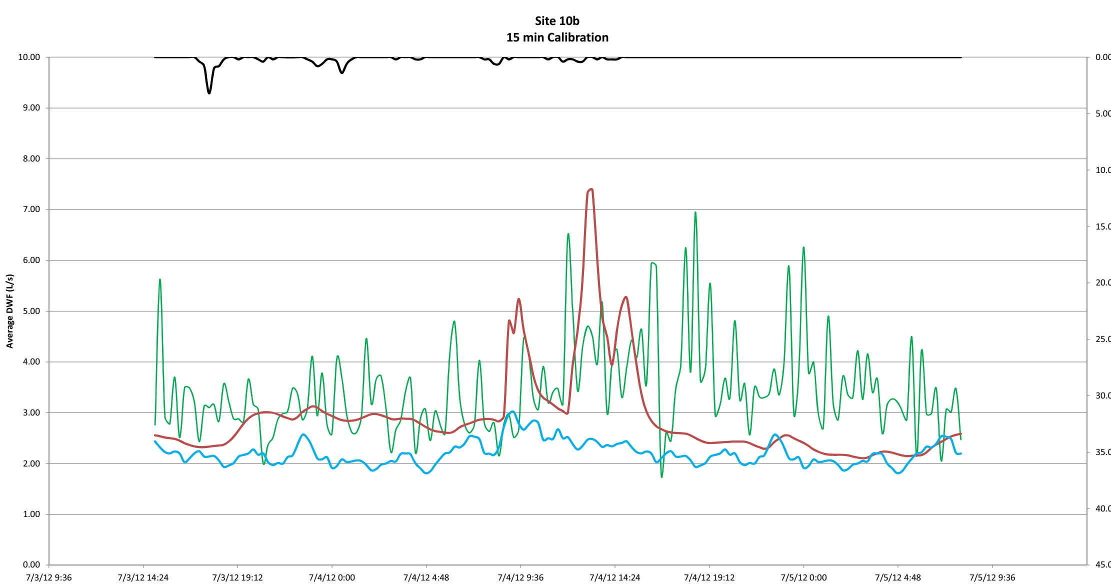
Monitored

DWF

Rainfall



Site 10a
15 min Calibration
Average DWF (L/s)
Time
0
2
4
6
8
10
12
14
16
18
20
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
7/1/12 4:48
7/1/12 9:36
7/1/12 14:24
7/1/12 19:12
7/2/12 0:00
7/2/12 4:48
7/2/12 9:36



Site 10b
15 min Calibration
Average DWF (L/s)
Time
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
7/3/12 9:36
7/3/12 14:24
7/3/12 19:12
7/4/12 0:00
7/4/12 4:48
7/4/12 9:36
7/4/12 14:24
7/4/12 19:12
7/5/12 0:00
7/5/12 4:48
7/5/12 9:36

Site 11

	R	T	K
Short	0.0015	1.1	1
Medium	0.0015	3	1
Long	0.0025	3	1

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
11c	562590	550359	2.2%	11.6	7.7	33.6%
11d	192951	225373	-16.8%	14.0	8.5	39.3%
11f	227133	229185	-0.9%	10.5	6.3	40.0%

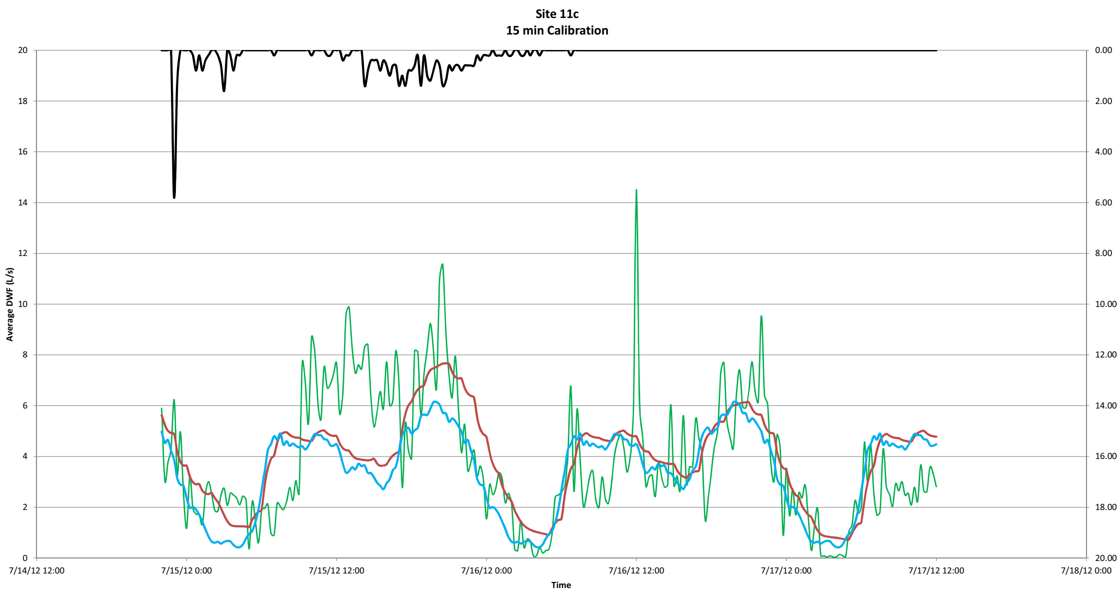
LEGEND

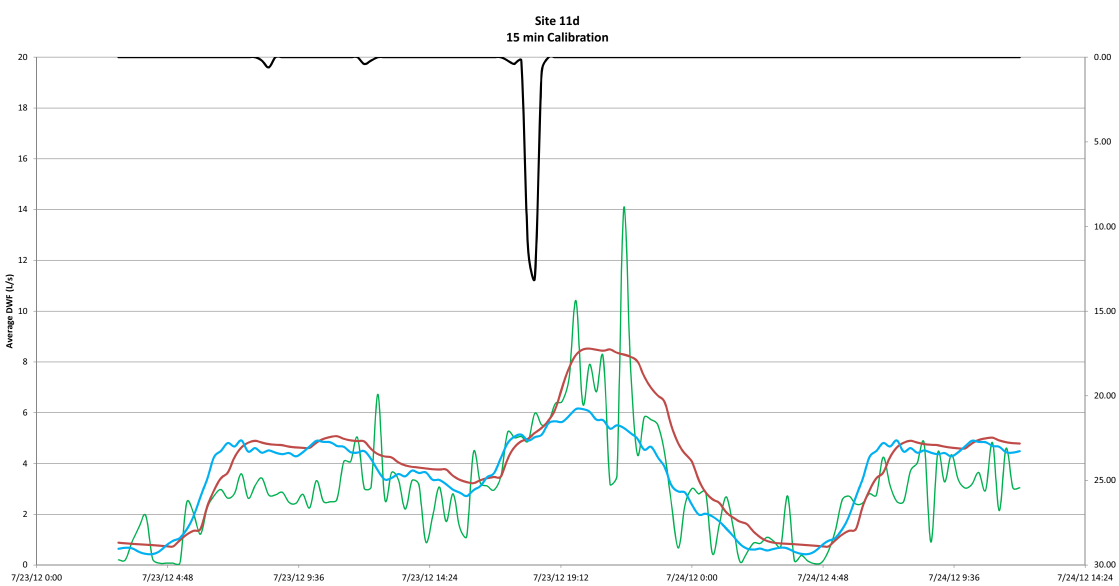
Model

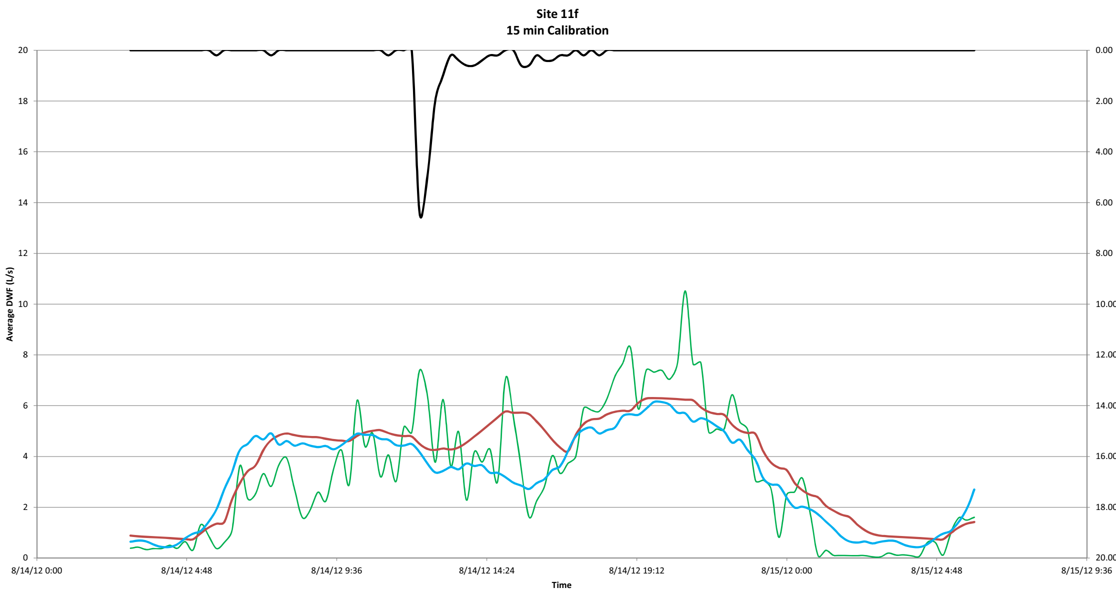
Monitored

DWF

Rainfall


Site 11c
15 min Calibration
Average DWF (L/s)
Time
20
18
16
14
12
10
8
6
4
2
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
7/14/12 12:00
7/15/12 0:00
7/15/12 12:00
7/16/12 0:00
7/16/12 12:00
7/17/12 0:00
7/17/12 12:00
7/18/12 0:00


Site 11d
15 min Calibration
Average DWF (L/s)
Time
20
18
16
14
12
10
8
6
4
2
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
7/23/12 0:00
7/23/12 4:48
7/23/12 9:36
7/23/12 14:24
7/23/12 19:12
7/24/12 0:00
7/24/12 4:48
7/24/12 9:36
7/24/12 14:24


Site 11f
15 min Calibration
Average DWF (L/s)
Time
20
18
16
14
12
10
8
6
4
2
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
8/14/12 0:00
8/14/12 4:48
8/14/12 9:36
8/14/12 14:24
8/14/12 19:12
8/15/12 0:00
8/15/12 4:48
8/15/12 9:36

Site 12

	R	T	K
Short	0.0235	0.03	15
Medium	0.025	0.48	10
Long	0.02	4	10

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
12c	1265886	1317262	-4.1%	21.4	19.9	7.0%
12d	1397646	1252255	10.4%	65.8	65.8	0.1%
12f	780912	855699	-9.6%	14.9	17.6	-17.8%

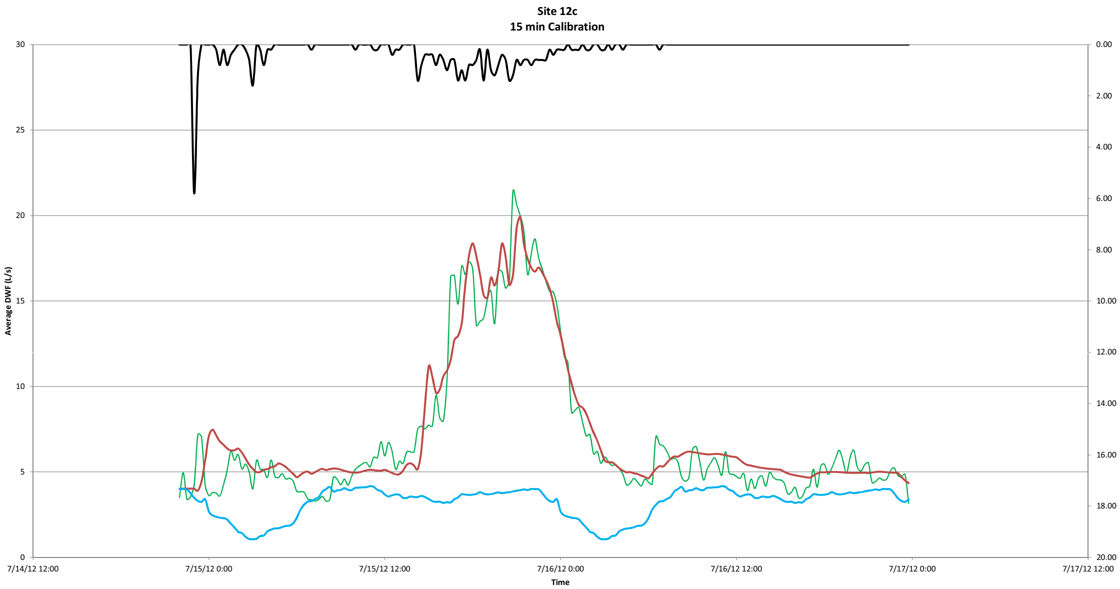
LEGEND

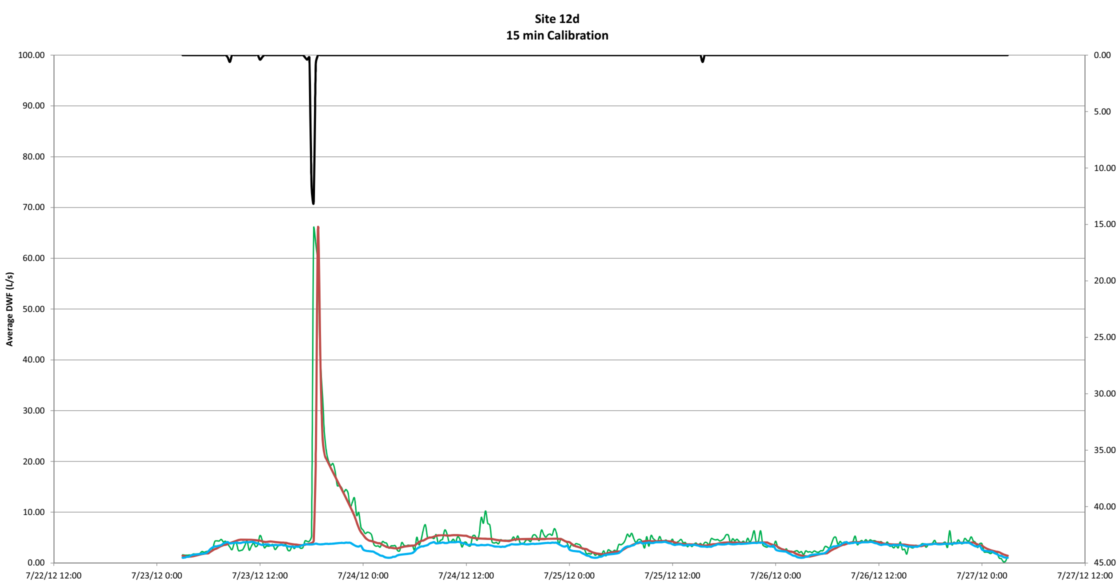
Model

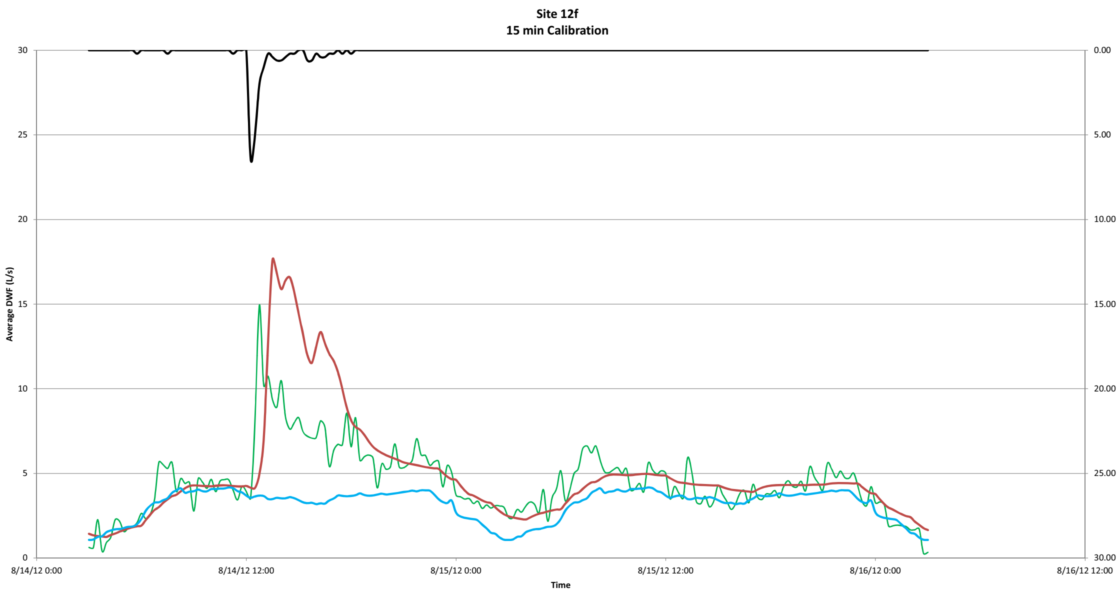
Monitored

DWF

Rainfall


Site 12c
15 min Calibration
Average DWF (L/s)
Time
30
25
20
15
10
5
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
7/14/12 12:00
7/15/12 0:00
7/15/12 12:00
7/16/12 0:00
7/16/12 12:00
7/17/12 0:00
7/17/12 12:00


Site 12d
15 min Calibration
Average DWF (L/s)
Time
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
7/22/12 12:00
7/23/12 0:00
7/23/12 12:00
7/24/12 0:00
7/24/12 12:00
7/25/12 0:00
7/25/12 12:00
7/26/12 0:00
7/26/12 12:00
7/27/12 0:00
7/27/12 12:00


Site 12f
15 min Calibration
30
25
20
15
10
5
0
Average DWF (L/s)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
8/14/12 0:00
8/14/12 12:00
8/15/12 0:00
8/15/12 12:00
8/16/12 0:00
8/16/12 12:00
Time

Site 13

	R	T	K
Short	0.03	0.1	1
Medium	0.015	2	3
Long	0.01	4	6

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
13f	346302	443044	-27.9%	8.9	6.5	26.8%
13g	409014	459776	-12.4%	6.2	5.0	19.6%

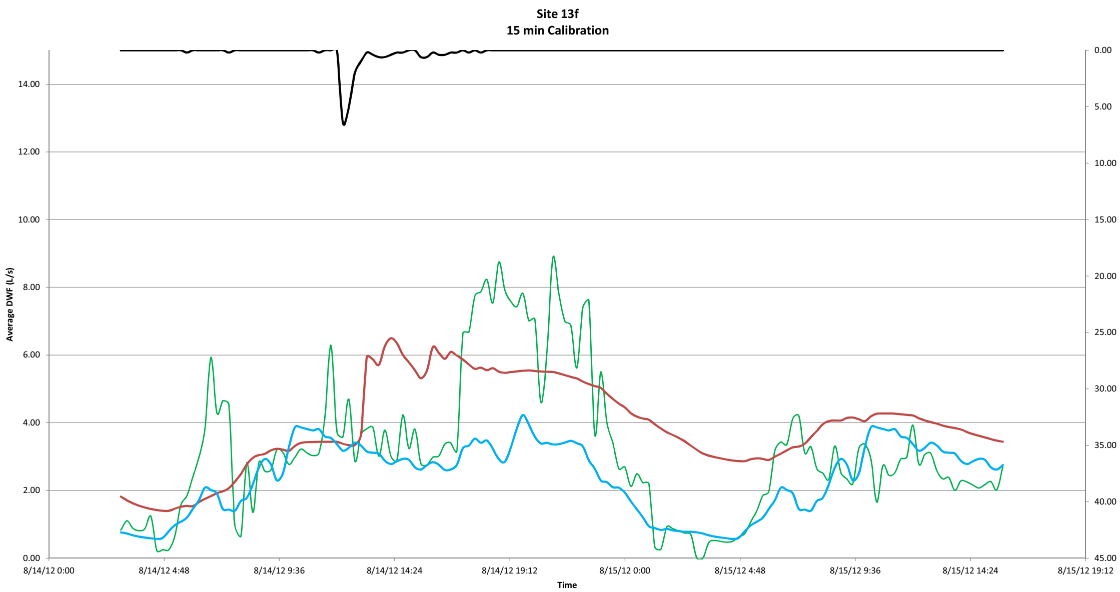
LEGEND

Model

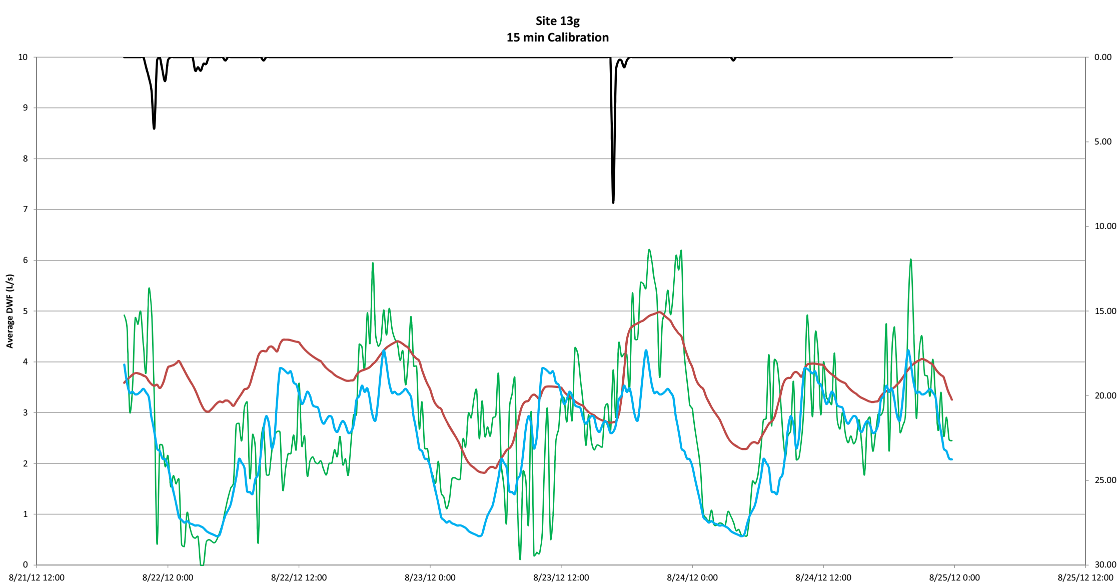
Monitored

DWF

Rainfall



Site 13f
15 min Calibration
Average DWF (L/s)
Time
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
8/14/12 0:00
8/14/12 4:48
8/14/12 9:36
8/14/12 14:24
8/14/12 19:12
8/15/12 0:00
8/15/12 4:48
8/15/12 9:36
8/15/12 14:24
8/15/12 19:12



Site 13g
15 min Calibration
Average DWF (L/s)
Time
0
1
2
3
4
5
6
7
8
9
10
30.00
25.00
20.00
15.00
10.00
5.00
0.00
8/21/12 12:00
8/22/12 0:00
8/22/12 12:00
8/23/12 0:00
8/23/12 12:00
8/24/12 0:00
8/24/12 12:00
8/25/12 0:00
8/25/12 12:00

Site 14

	R	T	K
Short	0.002	0.01	1
Medium	0.01	1	1
Long	0.0075	2	1.75

Initial Abstract Depth

	Dmax	Drec	Do
Short	12.5	5	1.25
Medium	0	0	0
Long	0	0	0

	Volume			Peak		
	Monitored (L/s)	Model (L/s)	% Diff	Monitored (L/s)	Model (L/s)	% Diff
14c	3520188	3467566	1.5%	67.8	44.9	33.7%
14d	1728936	2074159	-20.0%	97.8	4.2	95.7%
14f	1493352	2606488	-74.5%	33.3	48.9	-46.6%

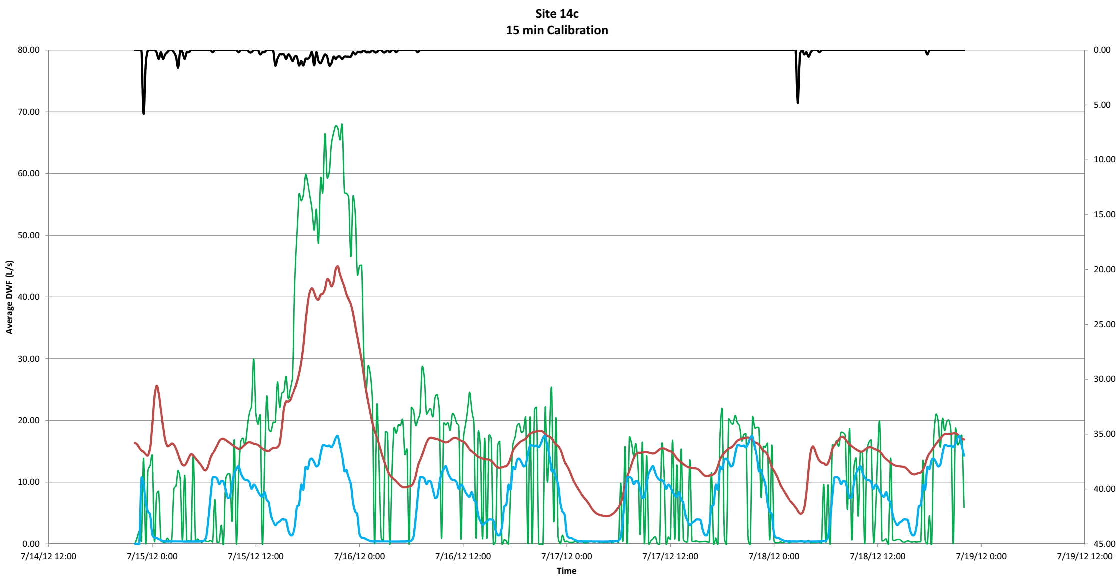
LEGEND

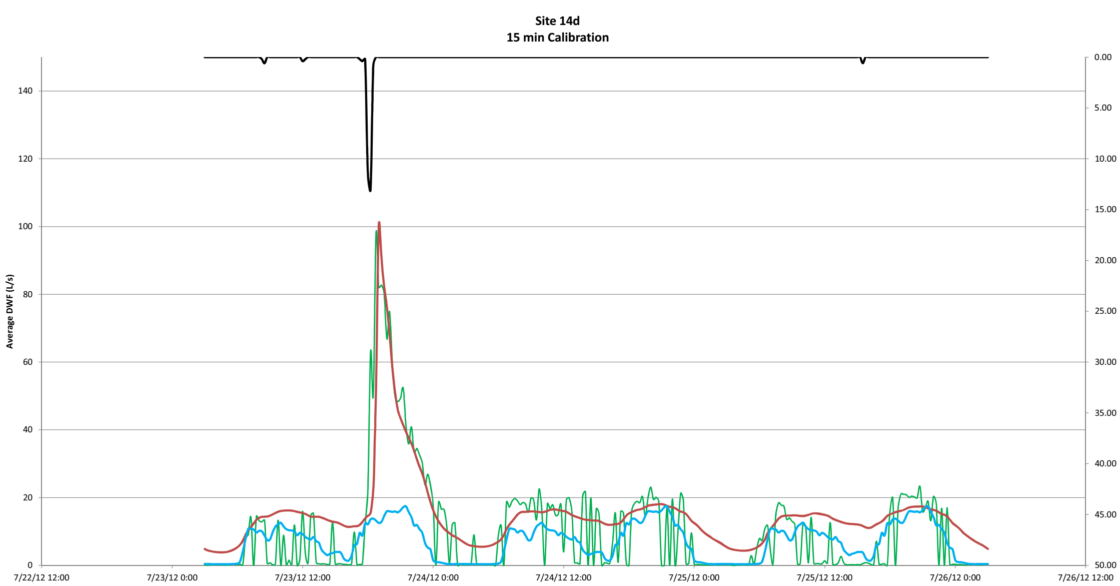
Model

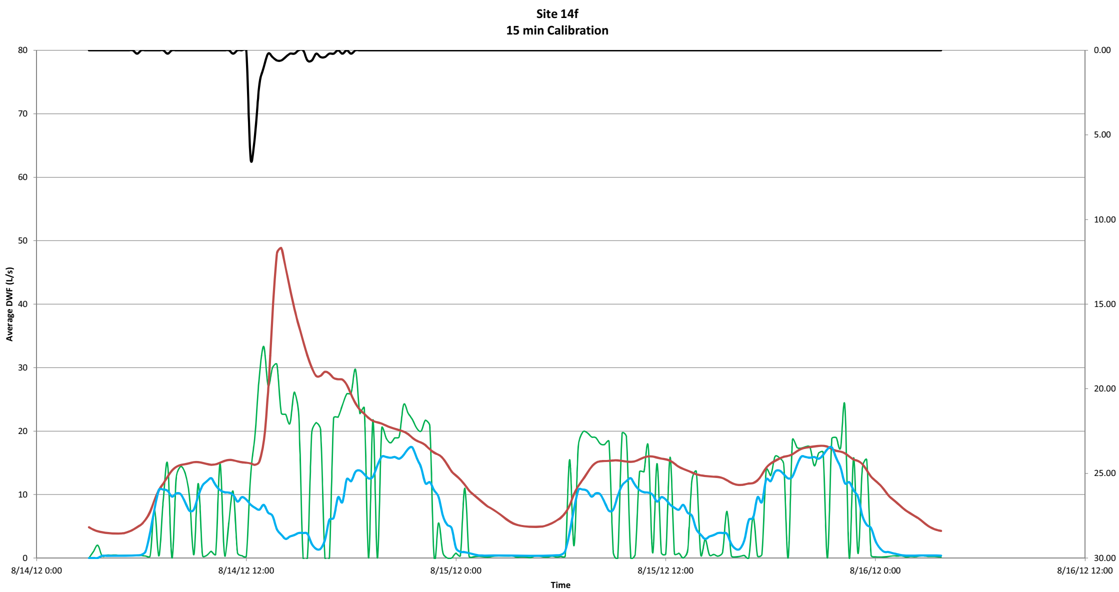
Monitored

DWF

Rainfall


Site 14c
15 min Calibration
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Average DWF (L/s)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
7/14/12 12:00
7/15/12 0:00
7/15/12 12:00
7/16/12 0:00
7/16/12 12:00
7/17/12 0:00
7/17/12 12:00
7/18/12 0:00
7/18/12 12:00
7/19/12 0:00
7/19/12 12:00
Time


Site 14d
15 min Calibration
140
120
100
80
60
40
20
0
Average DWF (L/s)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
7/22/12 12:00
7/23/12 0:00
7/23/12 12:00
7/24/12 0:00
7/24/12 12:00
7/25/12 0:00
7/25/12 12:00
7/26/12 0:00
7/26/12 12:00
Time


Site 14f
15 min Calibration
Average DWF (L/s)
Time
80
70
60
50
40
30
20
10
0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
8/14/12 0:00
8/14/12 12:00
8/15/12 0:00
8/15/12 12:00
8/16/12 0:00
8/16/12 12:00

APPENDIX E
CAPACITY ASSESSMENT TABLES

Baseline Capacity Assessment - Pipe Capacity Ratio, Percent Full

Conduit Performance

	Conduit	UP Node	DWN Node	UP Asset ID	DWN Asset ID	Dia (m)	Length (m)	Inlet Elev (m)	Outlet Elev (m)	MaxFlow/FullFlow				
										Avg-Peak DWF	Design Flow	Chicago 2Y4H	Chicago 5Y4H	Chicago 25Y4H
1	WTS013	WTS013	NTS018	372	1585	0.9	171.61	716.38	716.18	0.03	0.29	0.12	0.19	0.31
2	WTS012	WTS012	WTS013	407	372	0.9	140.00	716.43	716.38	0.06	0.52	0.21	0.34	0.55
3	WTS011	WTS011	WTS012	85	407	0.9	272.00	716.59	716.43	0.05	0.41	0.16	0.27	0.42
4	WTS010	WTS010	WTS011	31	85	0.9	271.60	716.71	716.59	0.06	0.47	0.19	0.31	0.49
5	WTS009	WTS009	WTS010	32	31	0.9	120.40	716.78	716.71	0.05	0.41	0.16	0.27	0.43
6	WTS008B	WTS008B	WTS009	XX-WTS008B	32	0.9	417.00	716.98	716.78	0.05	0.45	0.18	0.30	0.49
7	WTS008A	WTS008A	WTS008B	XX-WTS008A	XX-WTS008B	0.9	400.00	717.18	716.98	0.05	0.44	0.18	0.30	0.49
8	WTS008	WTS008	WTS008A	236	XX-WTS008A	0.9	400.00	717.38	717.18	0.05	0.44	0.18	0.31	0.50
9	WTS007	WTS007	WTS008	256	236	0.75	147.09	717.47	717.39	0.06	0.51	0.22	0.38	0.63
10	WTS005	WTS005	WTS006	182	181	0.75	140.00	717.62	717.54	0.05	0.44	0.20	0.37	0.60
11	WTS004	WTS004	WTS005	220	182	0.75	140.00	717.70	717.62	0.05	0.40	0.20	0.36	0.59
12	WTS003A	WTS003A	WTS004	204	220	0.75	43.82	717.74	717.70	0.04	0.32	0.16	0.29	0.47
13	WTS003	WTS003	WTS003A	202	204	0.75	98.31	717.82	717.74	0.04	0.30	0.16	0.30	0.49
14	WTS002	WTS002	WTS003	195	202	0.75	101.00	718.07	717.82	0.02	0.17	0.09	0.17	0.28
15	WTS001	WTS001	WTS002	196	195	0.75	131.77	718.15	718.07	0.04	0.34	0.19	0.35	0.57
16	WIP013	WIP013	WIP012	1662	1664	0.2	86.87	721.93	721.52	0.15	0.31	0.60	0.99	1.45
17	WIP012	WIP012	WIP011	1664	1663	0.25	89.61	721.50	721.31	0.12	0.28	0.51	0.84	1.29
18	WIP011	WIP011	WIP009	1663	1296	0.25	18.29	721.31	721.19	0.07	0.16	0.29	0.47	0.76
19	WIP009	WIP009	1618	1296	1618	0.3	868.85	721.18	720.78	0.18	0.36	0.62	0.99	1.77
20	WIP008	WIP008	WIP007	1292	1293	0.2	77.50	723.30	723.00	0.02	0.00	1.69	2.48	2.52
21	WIP007	WIP007	WIP006	1293	1294	0.2	122.00	723.00	722.45	0.02	0.00	1.58	2.30	2.34
22	WIP006	WIP006	WIP005	1294	1295	0.2	121.50	722.45	721.92	0.02	0.00	0.87	2.01	2.02
23	WIP005	WIP005	WIP009	1295	1296	0.25	86.00	721.80	721.45	0.01	0.00	0.46	0.97	1.05
24	WIP004	WIP004	WIP003	351	352	0.3	78.50	719.80	719.54	0.23	0.25	1.06	1.28	1.40
25	WIP003	WIP003	WIP002	352	1291	0.3	87.20	719.54	719.45	0.41	0.46	1.90	2.30	2.51
26	WIP002	WIP002	WIP001	1291	524	0.45	79.30	719.45	719.40	0.22	0.24	1.11	3.15	4.64
27	WIP001	WIP001	NTS007	524	1566	0.45	84.60	719.40	719.38	0.32	0.36	1.61	4.60	6.83
28	WIN008	WIN008	WIN006	123	124	0.25	97.70	721.92	721.58	0.00	0.00	0.00	0.00	0.00
29	WIN007	WIN007	WIN006	125	124	0.2	79.83	721.62	720.97	0.00	0.00	0.00	0.00	0.00
30	WIN006	WIN006	WIN005	124	164	0.6	119.30	720.38	720.23	0.06	0.22	0.17	0.31	0.48
31	WIN005	WIN005	WIN004	164	998	0.6	65.37	720.21	720.11	0.05	0.19	0.15	0.27	0.43
32	WIN004	WIN004	WIN003	998	165	0.6	59.22	720.07	720.00	0.07	0.28	0.20	0.37	0.57
33	WIN003	WIN003	WIN002	165	163	0.6	71.96	719.99	719.87	0.05	0.23	0.17	0.30	0.47
34	WIN002	WIN002	WIN001	163	162	0.6	75.05	719.81	719.73	0.06	0.29	0.21	0.38	0.60
35	WIN001	WIN001	LKD013	162	161	0.6	90.39	719.69	719.55	0.05	0.24	0.17	0.31	0.49
36	WIL006	WIL006	WIL005	WIL006	74	0.3	21.80	721.95	721.89	0.25	0.28	1.16	1.70	1.74
37	WIL005	WIL005	WIL004	74	67	0.3	11.00	721.89	721.83	0.18	0.20	0.83	1.24	1.30
38	WIL004	WIL004	WIL003	67	66	0.3	10.50	721.83	721.72	0.13	0.14	0.58	0.83	0.84
39	WIL003	WIL003	WIL002	66	68	0.3	108.70	720.48	720.18	0.25	0.28	1.16	1.40	1.54
40	WIL002	WIL002	WIL001	68	399	0.3	86.40	720.18	719.98	0.28	0.30	1.27	1.53	1.68
41	WIL001	WIL001	WIP004	399	351	0.3	78.00	719.98	719.80	0.28	0.31	1.27	1.53	1.68
42	STS017	STS017	NTS001	1611	1610	0.6	14.60	723.12	723.03	0.06	0.17	0.15	0.24	0.41
43	STS016	STS016	STS017	1614	1611	0.6	14.60	723.45	723.12	0.05	0.17	0.15	0.24	0.41
44	STS015	STS015	STS016	1613	1614	0.6	15.00	723.85	723.45	0.05	0.18	0.16	0.25	0.43
45	STS014	STS014	STS015	657	1613	0.6	131.37	724.89	723.98	0.06	0.22	0.17	0.31	0.53
46	STS013	STS013	STS014	656	657	0.6	132.13	725.95	724.89	0.05	0.20	0.16	0.29	0.49
47	STS012	STS012	STS013	655	656	0.6	136.25	726.94	725.95	0.06	0.22	0.17	0.30	0.52
48	STS011	STS011	STS012	685	655	0.525	97.38	727.39	727.00	0.11	0.42	0.32	0.58	1.00
49	STS009	STS009	STS010	567	568	0.525	27.58	727.95	727.88	0.14	0.50	0.40	0.72	1.25
50	STS008	STS008	STS009	570	567	0.525	98.21	728.27	727.95	0.13	0.44	0.36	0.64	1.10
51	STS007	STS007	STS008	571	570	0.525	131.06	728.92	728.27	0.12	0.37	0.30	0.52	0.90
52	STS006	STS006	STS007	569	571	0.525	121.31	729.43	728.92	0.15	0.42	0.35	0.57	0.98
53	STS005	STS005	STS006	573	569	0.525	122.53	729.87	729.43	0.23	0.53	0.46	0.67	1.07
54	STS004	STS004	STS005	572	573	0.525	101.19	730.25	729.87	0.06	0.28	0.24	0.39	0.58
55	STS003	STS003	STS004	574	572	0.525	115.52	730.46	730.25	0.09	0.40	0.34	0.57	0.85
56	STS002	STS002	STS003	432	574	0.525	102.72	730.72	730.46	0.08	0.34	0.29	0.48	0.72
57	STS001	STS001	STS002	747	432	0.525	97.84	731.01	730.82	0.09	0.39	0.33	0.55	0.82
58	STF013	STF013	STF012	708	746	0.375	89.30	724.28	723.66	0.00	0.08	0.30	0.56	0.84
59	STF012	STF012	STF011	746	578	0.375	88.30	723.66	723.12	0.00	0.09	0.31	0.59	0.88
60	STF011	STF011	STF010	578	564	0.375	97.00	723.12	722.58	0.00	0.09	0.32	0.62	0.92
61	STF010	STF010	STF009	564	688	0.375	81.30	722.58	722.10	0.00	0.09	0.31	0.59	0.88
62	STF009	STF009	NTS001	688	1610	0.375	98.55	722.10	721.50	0.00	0.08	0.27	0.56	0.83
63	STF008	STF008	STS015	1612	1613	0.6	14.60	724.23	723.85	0.01	0.03	0.04	0.07	0.13
64	STF007	STF007	STF008	646	1612	0.6	50.00	724.53	724.23	0.03	0.12	0.14	0.25	0.38
65	STF006	STF006	STF007	648	646	0.375	103.94	726.46	724.53	0.06	0.21	0.25	0.35	0.49
66	STF005	STF005	STF006	659	648	0.375	89.61	728.24	726.46	0.06	0.18	0.23	0.32	0.38
67	STF004	STF004	STF005	1076	659	0.375	66.45	728.34	728.24	0.22	0.66	0.82	1.15	1.36
68	STF003	STF003	STF004	658	1076	0.375	91.44	728.48	728.34	0.22	0.65	0.82	1.14	1.35
69	STF002	STF002	STF003	686	658	0.375	91.44	728.62	728.48	0.22	0.65	0.82	1.14	1.35
70	STF001	STF001	STF002	1668	686	0.375	60.96	728.73	728.62	0.20	0.60	0.75	1.05	1.25
71	SPK066	SPK066	SPK036	696	840	0.2	50.30	731.68	731.48	0.00	0.00	0.00	0.00	0.00
72	SPK065	SPK065	SPK066	729	696	0.2	48.80	731.92	731.68	0.00	0.00	0.00	0.00	0.00
73	SPK064	SPK064	SPK065	730	729	0.2	24.40	732.02	731.92	0.00	0.00	0.00	0.00	0.00
74	SPK063	SPK063	SPK064	728	730	0.2	50.60	732.24	732.02	0.00	0.00	0.00	0.00	0.00
75	SPK062	SPK062	SPK063	727	728	0.2	31.40	732.32	732.24	0.00	0.00	0.00	0.00	0.00
76	SPK061A	SPK061	SPK060	726	719	0.2	50.30	732.58	732.31	0.00	0.00	0.00	0.00	0.00
77	SPK061	SPK061	SPK062	726	727	0.2	20.70	732.43	732.32	0.00	0.00	0.00	0.00	0.00
78	SPK060	SPK060	SPK028	719	772	0.2	92.70	732.31	731.73	0.00	0.00	0.00	0.00	0.00
79	SPK054	SPK054	SPK051	894	793	0.2	104.55	731.96	731.54	0.00	0.00	0.00	0.00	0.00
80	SPK053	SPK053	SPK054	791	894	0.2	93.57	732.38	732.04	0.00	0.00	0.00	0.00	0.00
81	SPK052A	SPK052	SPK053	807	791	0.2	93.57	732.80	732.38	0.00	0.00	0.00	0.00	0.00
82	SPK052	SPK052	SPK037	807	790	0.2	101.19	732.34	731.86	0.00	0.00	0.00	0.00	0.00
83	SPK051	SPK051	SPK022	793	895	0.2	97.54	731.50	731.01	0.00	0.00	0.00	0.00	0.12
84	SPK050A	SPK050	SPK051	792	793	0.2	97.84	732.12	731.57	0.00	0.00	0.00	0.00	0.00
85	SPK050	SPK050	SPK038	792	808	0.2	85.65	731.96	731.56	0.00	0.00	0.00	0.00	0.00
86	SPK041	SPK041	STS004	1625	572	0.3	26.60	730.57	730.55	0.00	0.00	0.00	0.00	0.17
87	SPK040	SPK040	SPK041	1623	1625	0.3	114.60	730.82	730.57	0.00	0.00	0.00	0.00	0.10
88	SPK039	SPK039	SPK022	911	895	0.2	73.21	731.46	731.01	0.06	0.19	0.25	0.39	0.57
89	SPK038	SPK038	SPK034	808	841	0.2	82.91	731.56	731.23	0.00	0.00	0.00	0.00	0.00
90	SPK037	SPK037	SPK035	790	842	0.2	101.19	731.86	731.32	0.00	0.00	0.00	0.00	0.00
91	SPK036	SPK036	SPK035	840	842	0.3	73.15	731.37	731.24	0.03	0.10	0.14	0.22	0.32
92	SPK035	SPK035	SPK034	842	841	0.3	18.29	731.24	731.16	0.02	0.06	0.09	0.14	0.20
93	SPK034	SPK034	SPK033	841	843	0.3	35.05	731.13	731.10	0.07	0.22	0.31	0.49	0.70
94	SPK033	SPK033	SPK032	843	694	0.3	109.21	731.10	730.86	0.04	0.15	0.19	0.30	0.44
95	SPK032	SPK032	SPK031	694	733	0.3	98.51	730.86	730.65	0.04	0.14	0.18	0.30	0.48

Baseline Capacity Assessment - Pipe Capacity Ratio, Percent Full
Conduit Performance

	Conduit	UP Node	DWN Node	UP Asset ID	DWN Asset ID	Dia (m)	Length (m)	Inlet Elev (m)	Outlet Elev (m)	MaxFlow/FullFlow				
										Avg-Peak DWF	Design Flow	Chicago 2Y4H	Chicago 5Y4H	Chicago 25Y4H
96	SPK031	SPK031	SPK030	733	735	0.3	40.23	730.55	730.54	0.13	0.40	0.52	0.88	1.17
97	SPK030	SPK030	SPK029	735	734	0.3	38.10	730.54	730.43	0.04	0.12	0.15	0.26	0.32
98	SPK029	SPK029	SPK015	734	738	0.3	59.44	730.43	730.27	0.04	0.12	0.16	0.26	0.33
99	SPK028	SPK028	SPK006	772	431	0.2	101.80	731.73	731.58	0.06	0.18	0.23	0.39	0.57
100	SPK027	SPK027	SPK004	771	636	0.2	76.20	731.23	730.93	0.07	0.22	0.29	0.45	0.65
101	SPK024	SPK024	SPK023	858	871	0.3	123.44	731.71	731.34	0.05	0.15	0.35	0.55	0.80
102	SPK023	SPK023	SPK022	871	895	0.3	109.12	731.34	731.02	0.05	0.14	0.34	0.55	0.80
103	SPK022	SPK022	SPK021	895	114	0.375	93.27	731.01	730.84	0.05	0.16	0.31	0.52	0.74
104	SPK021	SPK021	SPK020	114	796	0.375	63.70	730.84	730.74	0.06	0.17	0.33	0.55	0.76
105	SPK020	SPK020	SPK019	796	795	0.375	82.30	730.74	730.62	0.06	0.18	0.34	0.57	0.74
106	SPK019	SPK019	SPK018	795	794	0.375	71.02	730.62	730.47	0.05	0.15	0.28	0.47	0.54
107	SPK018	SPK018	SPK017	794	854	0.375	36.27	730.47	730.40	0.10	0.29	0.45	0.77	0.93
108	SPK017	SPK017	SPK016	854	835	0.375	50.90	730.40	730.34	0.12	0.35	0.53	0.92	1.08
109	SPK016	SPK016	SPK015	835	738	0.375	99.06	730.34	730.19	0.11	0.32	0.48	0.82	0.94
110	SPK015	SPK015	SPK014	738	737	0.375	97.54	730.17	730.04	0.16	0.49	0.70	1.16	1.33
111	SPK014	SPK014	SPK013	737	721	0.375	36.88	730.04	729.97	0.14	0.41	0.58	0.95	1.07
112	SPK013	SPK013	SPK012	721	1624	0.375	38.10	729.97	729.91	0.15	0.46	0.66	1.07	1.19
113	SPK012A	SPK012	SPK040	1624	1623	0.3	25.20	730.91	730.82	0.00	0.00	0.00	0.00	0.08
114	SPK012	SPK012	SPK011	1624	779	0.375	33.83	729.91	729.87	0.16	0.49	0.70	1.13	1.23
115	SPK011	SPK011	SPK010	779	780	0.375	64.62	729.87	729.77	0.15	0.45	0.64	1.03	1.10
116	SPK010	SPK010	SPK009	780	782	0.375	32.00	729.77	729.72	0.15	0.45	0.64	1.01	1.05
117	SPK009	SPK009	SPK008	782	781	0.375	81.08	729.72	729.60	0.15	0.46	0.66	1.02	1.03
118	SPK008	SPK008	SPK007	781	778	0.375	93.27	729.60	729.46	0.15	0.46	0.65	0.96	1.01
119	SPK007	SPK007	SPK006	778	431	0.375	92.35	729.46	729.32	0.18	0.55	0.73	1.05	1.27
120	SPK006	SPK006	SPK005	431	433	0.375	37.49	729.32	729.26	0.19	0.57	0.75	1.08	1.22
121	SPK005	SPK005	SPK004	433	636	0.375	69.80	729.26	729.16	0.20	0.60	0.79	1.13	1.28
122	SPK004	SPK004	SPK003	636	635	0.375	35.66	729.16	729.11	0.23	0.68	0.86	1.22	1.42
123	SPK003	SPK003	SPK002	635	634	0.375	64.31	729.11	729.01	0.21	0.65	0.82	1.16	1.35
124	SPK002	SPK002	SPK001	634	1669	0.375	52.73	729.01	728.94	0.23	0.70	0.88	1.25	1.45
125	SPK001	SPK001	STF001	1669	1668	0.375	96.01	728.94	728.73	0.18	0.54	0.69	0.96	1.13
126	NTS047	NTS047	NTS048	1608	1609	1.05	224.43	710.76	710.37	0.20	0.45	0.47	0.65	0.88
127	NTS046	NTS046	NTS047	1607	1608	1.05	214.43	711.09	710.76	0.21	0.47	0.49	0.69	0.93
128	NTS045	NTS045	NTS046	1606	1607	1.05	175.00	711.33	711.09	0.22	0.50	0.52	0.73	0.99
129	NTS044	NTS044	NTS045	1114	1606	1.05	175.00	711.58	711.33	0.22	0.49	0.51	0.72	0.96
130	NTS043A	NTS043A	NTS044	116	1114	1.05	142.21	711.78	711.58	0.22	0.49	0.52	0.72	0.97
131	NTS043	NTS043	NTS043A	1113	116	1.05	50.00	711.85	711.78	0.22	0.49	0.51	0.70	0.95
132	NTS042	NTS042	NTS043	1111	1113	1.05	200.00	712.05	711.85	0.26	0.58	0.60	0.83	1.12
133	NTS041	NTS041	NTS042	1112	1111	1.05	200.00	712.25	712.05	0.26	0.58	0.60	0.83	1.12
134	NTS040	NTS040	NTS041	1605	1112	1.05	200.00	712.45	712.25	0.26	0.58	0.60	0.83	1.12
135	NTS039	NTS039	NTS040	1604	1605	1.05	87.76	712.59	712.50	0.25	0.57	0.59	0.82	1.11
136	NTS038	NTS038	NTS039	1603	1604	1.05	256.30	712.90	712.64	0.25	0.57	0.60	0.82	1.10
137	NTS037	NTS037	NTS038	577	1603	1.05	46.00	713.00	712.95	0.25	0.55	0.58	0.79	1.07
138	NTS036	NTS036	NTS037	1599	577	1.05	38.30	713.10	713.05	0.22	0.50	0.53	0.72	0.97
139	NTS035	NTS035	NTS036	1601	1599	1.05	134.20	713.29	713.15	0.25	0.56	0.59	0.81	1.09
140	NTS034	NTS034	NTS035	1602	1601	1.05	50.00	713.34	713.29	0.13	0.57	0.48	0.70	0.98
141	NTS033	NTS033	NTS034	1598	1602	1.05	246.50	713.59	713.34	0.13	0.57	0.47	0.69	0.97
142	NTS032	NTS032	NTS033	1597	1598	1.05	246.00	713.84	713.59	0.13	0.56	0.47	0.69	0.97
143	NTS031	NTS031	NTS032	1595	1597	1.05	213.30	714.05	713.84	0.13	0.57	0.48	0.70	0.99
144	NTS030	NTS030	NTS031	1594	1595	1.05	212.00	714.27	714.05	0.13	0.55	0.47	0.68	0.96
145	NTS029	NTS029	NTS030	1593	1594	1.05	196.00	714.47	714.27	0.13	0.56	0.47	0.69	0.97
146	NTS028	NTS028	NTS029	1592	1593	1.05	200.00	714.67	714.47	0.13	0.57	0.47	0.69	0.98
147	NTS027	NTS027	NTS028	1591	1592	1.05	184.79	714.85	714.67	0.13	0.57	0.48	0.70	1.00
148	NTS026	NTS026	NTS027	1590	1591	1.05	185.00	715.04	714.85	0.13	0.56	0.46	0.68	0.96
149	NTS025	NTS025	NTS026	1589	1590	1.05	185.00	715.22	715.04	0.13	0.57	0.48	0.69	0.99
150	NTS024	NTS024	NTS025	1588	1589	1.05	203.99	715.43	715.22	0.13	0.55	0.46	0.68	0.96
151	NTS023	NTS023	NTS024	1587	1588	1.05	197.00	715.63	715.43	0.13	0.55	0.45	0.65	0.93
152	NTS022	NTS022	NTS023	1586	1587	1.05	122.00	715.75	715.63	0.13	0.56	0.45	0.66	0.94
153	NTS021	NTS021	NTS022	1583	1586	1.05	50.00	715.85	715.80	0.13	0.55	0.45	0.66	0.94
154	NTS020	NTS020	NTS021	1584	1583	1.05	121.00	716.03	715.90	0.12	0.53	0.43	0.63	0.90
155	NTS018	NTS018	NTS020	1585	1584	1.05	100.00	716.13	716.03	0.13	0.57	0.46	0.67	0.96
156	NTS017	NTS017	NTS018	1582	1585	1.05	224.00	716.35	716.13	0.10	0.34	0.38	0.57	0.77
157	NTS016	NTS016	NTS017	1578	1582	1.05	225.16	716.58	716.35	0.10	0.34	0.38	0.57	0.77
158	NTS015	NTS015	NTS016	526	1578	1.05	224.00	716.81	716.58	0.10	0.34	0.38	0.57	0.77
159	NTS014	NTS014	NTS015	1615	526	1.05	150.95	716.96	716.81	0.10	0.35	0.38	0.58	0.78
160	NTS013	NTS013	NTS014	1577	1615	0.75	63.34	717.76	717.65	0.19	0.63	0.69	1.05	1.42
161	NTS012	NTS012	NTS013	1576	1577	0.75	150.00	718.05	717.81	0.20	0.67	0.74	1.11	1.51
162	NTS011	NTS011	NTS012	1617	1576	0.75	113.47	718.23	718.05	0.20	0.67	0.74	1.12	1.52
163	NTS010	NTS010	NTS011	157	1617	0.75	151.94	718.46	718.23	0.19	0.66	0.72	1.08	1.46
164	NTS009	NTS009	NTS010	1574	157	0.75	143.44	718.68	718.46	0.19	0.66	0.72	1.08	1.45
165	NTS008	NTS008	NTS009	448	1574	0.75	30.39	718.77	718.72	0.19	0.63	0.69	1.05	1.40
166	NTS007	NTS007	NTS008	1566	448	0.75	149.80	719.04	718.82	0.20	0.66	0.72	1.10	1.46
167	NTS006	NTS006	NTS007	1573	1566	0.75	95.66	719.21	719.08	0.16	0.64	0.56	0.89	1.27
168	NTS005	NTS005	NTS006	1567	1573	0.75	108.64	719.37	719.21	0.16	0.63	0.55	0.87	1.24
169	NTS004	NTS004	NTS005	1572	1567	0.75	158.93	719.59	719.37	0.17	0.65	0.56	0.91	1.30
170	NTS003	NTS003	NTS004	1571	1572	0.75	140.00	719.79	719.59	0.16	0.64	0.56	0.93	1.49
171	NTS002	NTS002	NTS003	1570	1571	0.75	111.93	719.95	719.79	0.17	0.64	0.56	0.96	1.50
172	NTS001	NTS001	NTS002	1610	1570	0.75	74.50	720.76	719.95	0.04	0.17	0.14	0.23	0.41
173	NTF007	NTF007	NTF006	442	1665	0.375	14.63	725.21	725.09	0.02	0.02	0.19	0.35	0.44
174	NTF006	NTF006	NTF005	1665	465	0.35	128.63	724.89	724.70	0.05	0.16	0.59	1.13	1.53
175	NTF005	NTF005	NTF004	465	1279	0.35	70.10	724.70	724.58	0.05	0.15	0.54	0.96	1.37
176	NTF004	NTF004	NTF003	1279	466	0.35	70.71	724.58	724.46	0.05	0.15	0.53	0.94	1.39
177	NTF003	NTF003	NTF002	466	471	0.35	115.00	724.46	724.40	0.09	0.26	0.95	1.70	2.51
178	NTF002	NTF002	NTF001	471	1637	0.35	24.83	724.40	724.34	0.04	0.16	0.46	0.82	1.46
179	NTF001	NTF001	STF008	1637	1612	0.35	76.20	724.34	724.23	0.05	0.20	0.59	1.06	1.88
180	NEI016	NEI016	NEI015	1271	1270	0.45	125.20	721.02	720.56	0.01	0.01	0.74	1.11	1.92
181	NEI015	NEI015	NEI014	1270	1269	0.45	16.12	719.56	719.37	0.01	0.03	0.81	1.17	1.52
182	NEI014	NEI014	NEI013	1269	1268	0.469	121.38	718.65	718.10	0.01	0.04	1.07	1.36	1.94
183	NEI013	NEI013	NEI012	1268	1267	0.469	83.40	718.04	717.80	0.02	0.05	1.21	1.71	2.43
184	NEI012	NEI012	NEI011	1267	1266	0.469	58.58	717.78	717.60	0.02	0.05	1.11	1.65	2.35
185	NEI011	NEI011	NEI010	1266	1265	0.45	71.34	717.57	717.31	0.02	0.05	1.05	1.69	2.41
186	NEI010	NEI010	NTS024	1265	1588	0.45	121.16	717.25	716.79	0.02	0.05	0.92	1.57	2.37
187	NEI009	NEI009	NEI001	615	614	0.3	28.96	719.87	719.81	0.00	0.00	0.00	0.54	1.23
188	NEI008	NEI008	NEI001	611	614	0.3	93.88	720.10	719.81	0.01	0.03	0.96	1.89	2.32
189	NEI007	NEI007	NEI006	619	618	0.2	85.34	724.05	723.10	0.00	0.00	0.00	0.00	0.00
190	NEI006	NEI006	NEI005	618	617	0.2	50.29	723.01	722.68	0.00	0.00	0.00	0.00	0.00

Baseline Capacity Assessment - Pipe Capacity Ratio, Percent Full
Conduit Performance

	Conduit	UP Node	DWN Node	UP Asset ID	DWN Asset ID	Dia (m)	Length (m)	Inlet Elev (m)	Outlet Elev (m)	MaxFlow/FullFlow				
										Avg-Peak DWF	Design Flow	Chicago 2Y4H	Chicago 5Y4H	Chicago 25Y4H
191	NEI005	NEI005	NEI004	617	616	0.25	84.73	722.60	722.39	0.00	0.00	0.00	0.00	0.00
192	NEI004	NEI004	NEI003	616	613	0.25	111.86	722.30	721.82	0.00	0.00	0.00	0.00	1.59
193	NEI003	NEI003	NEI002	613	612	0.25	82.30	721.80	721.53	0.00	0.00	0.00	0.00	2.64
194	NEI002	NEI002	NEI001	612	614	0.25	73.76	721.52	721.32	0.00	0.00	0.00	0.00	4.16
195	NEI001	NEI001	NEI015	614	1270	0.3	9.50	719.69	719.60	0.01	0.02	0.59	1.30	1.63
196	MEA016	MEA016	MEA015	1038	1029	0.375	60.62	738.23	738.03	0.00	0.00	0.00	0.00	0.00
197	MEA015	MEA015	MEA014	1029	1028	0.375	16.39	738.03	737.96	0.00	0.00	0.00	0.01	0.02
198	MEA014	MEA014	MEA013	1028	1027	0.375	87.98	737.96	737.66	0.01	0.04	0.09	0.17	0.27
199	MEA013	MEA013	MEA012	1027	960	0.375	90.94	737.65	737.36	0.01	0.04	0.09	0.18	0.28
200	MEA012	MEA012	MEA011	960	961	0.375	35.86	737.36	737.19	0.01	0.04	0.08	0.15	0.23
201	MEA011	MEA011	MEA010	961	948	0.375	105.48	737.18	736.74	0.01	0.04	0.08	0.16	0.24
202	MEA010	MEA010	MEA009	948	950	0.375	95.10	736.74	736.28	0.01	0.03	0.07	0.14	0.22
203	MEA009	MEA009	MEA008	950	938	0.375	50.72	736.28	736.01	0.01	0.03	0.07	0.14	0.21
204	MEA008	MEA008	MEA007	938	956	0.375	106.63	736.01	735.39	0.01	0.05	0.11	0.21	0.34
205	MEA007	MEA007	MEA006	956	928	0.375	52.20	735.27	735.10	0.03	0.12	0.29	0.56	0.85
206	MEA006	MEA006	MEA005	928	929	0.375	47.50	734.99	734.84	0.03	0.13	0.30	0.57	0.87
207	MEA005	MEA005	MEA004	929	927	0.375	44.63	734.80	734.67	0.03	0.13	0.31	0.59	0.90
208	MEA004	MEA004	MEA003	927	921	0.375	85.51	734.61	734.36	0.03	0.13	0.31	0.59	0.89
209	MEA003	MEA003	MEA002	921	920	0.375	39.62	734.25	734.10	0.03	0.13	0.29	0.55	0.84
210	MEA002	MEA002	MEA001	920	937	0.375	97.54	734.10	733.83	0.04	0.15	0.33	0.64	0.98
211	MEA001	MEA001	CAL012	937	932	0.375	76.20	733.80	733.59	0.04	0.19	0.42	0.81	1.22
212	LKD013	LKD013	LKD012	161	160	0.6	88.13	719.55	719.46	0.06	0.30	0.21	0.39	0.61
213	LKD012	LKD012	LKD011	160	159	0.6	91.39	719.46	719.38	0.06	0.30	0.22	0.40	0.63
214	LKD011	LKD011	LKD008	159	962	0.6	69.59	719.37	719.23	0.04	0.21	0.15	0.28	0.43
215	LKD010	LKD010	LKD006	193	178	0.25	17.00	720.33	720.28	0.04	0.59	0.39	0.61	0.94
216	LKD009	LKD009	LKD001	155	227	0.2	50.00	719.26	718.23	0.00	0.08	0.08	0.13	0.18
217	LKD008	LKD008	LKD007	962	175	0.525	144.20	719.18	718.92	0.06	0.31	0.22	0.41	0.64
218	LKD007	LKD007	LKD006	175	178	0.525	17.00	718.92	718.89	0.06	0.31	0.22	0.40	0.64
219	LKD006	LKD006	LKD005	178	205	0.6	134.50	718.83	718.67	0.06	0.37	0.23	0.43	0.70
220	LKD004	LKD004	LKD003	1075	122	0.6	22.85	718.54	718.51	0.05	0.37	0.22	0.41	0.67
221	LKD003	LKD003	LKD002	122	121	0.75	136.00	718.37	718.31	0.05	0.37	0.22	0.41	0.67
222	LKD002	LKD002	LKD001	121	227	0.75	80.07	718.31	718.23	0.03	0.25	0.14	0.27	0.44
223	LKD001	LKD001	WTS001	227	196	0.75	120.10	718.23	718.15	0.04	0.32	0.18	0.33	0.54
224	LIN025	LIN025	CBD007	354	342	0.3	9.80	723.10	722.20	0.05	0.06	0.11	0.12	0.14
225	LIN024	LIN024	LIN025	349	354	0.3	81.99	723.28	723.10	0.31	0.40	0.72	0.81	0.89
226	LIN023	LIN023	LIN024	408	349	0.3	54.86	723.40	723.28	0.31	0.40	0.72	0.81	0.90
227	LIN022	LIN022	LIN023	409	408	0.3	57.91	723.53	723.40	0.31	0.39	0.72	0.80	0.88
228	LIN021	LIN021	LIN022	398	409	0.3	63.15	723.70	723.56	0.31	0.39	0.72	0.80	0.89
229	LIN020	LIN020	LIN021	53	398	0.3	44.29	723.83	723.73	0.24	0.39	0.69	0.78	0.86
230	LIN019	LIN019	LIN020	89	53	0.3	110.69	724.07	723.83	0.24	0.40	0.71	0.79	0.88
231	LIN018	LIN018	LIN019	88	89	0.3	68.58	724.25	724.10	0.19	0.40	0.68	0.77	0.86
232	LIN017	LIN017	LIN018	87	88	0.3	68.45	724.40	724.25	0.19	0.40	0.68	0.77	0.86
233	LIN016	LIN016	CBD007	355	342	0.3	10.30	722.24	722.07	0.04	0.14	0.18	0.37	0.60
234	LIN015	LIN015	LIN016	353	355	0.3	85.34	722.46	722.27	0.12	0.46	0.58	1.20	1.93
235	LIN014	LIN014	LIN015	1659	353	0.3	54.86	722.63	722.49	0.11	0.43	0.60	1.22	1.80
236	LIN013	LIN013	LIN014	1660	1659	0.3	52.43	722.79	722.66	0.11	0.43	0.63	1.25	1.82
237	LIN012	LIN012	LIN011	318	98	0.25	86.26	723.85	723.62	0.00	0.36	1.06	2.16	3.15
238	LIN011	LIN011	LIN010	98	97	0.25	86.26	723.59	723.09	0.00	0.25	0.69	1.44	2.14
239	LIN010	LIN010	LIN013	97	1660	0.3	89.61	723.06	722.82	0.09	0.42	0.62	1.23	1.74
240	LIN009	LIN009	LIN010	XX-LIN009	97	0.25	10.67	723.24	723.21	0.15	0.32	0.55	0.62	1.14
241	LIN008	LIN008	LIN009	65	XX-LIN009	0.25	30.48	723.33	723.24	0.14	0.30	0.52	0.58	1.05
242	LIN007	LIN007	LIN008	337	65	0.25	73.15	723.55	723.33	0.14	0.30	0.51	0.58	1.00
243	LIN006	LIN006	LIN007	96	337	0.25	115.82	723.92	723.58	0.14	0.30	0.52	0.58	0.95
244	LIN005	LIN005	LIN006	86	96	0.25	82.30	724.20	723.95	0.13	0.30	0.51	0.57	1.00
245	LIN004	LIN004	LIN005	95	86	0.25	99.06	724.50	724.20	0.14	0.30	0.51	0.57	0.91
246	LIN003A	LIN003	LIN017	1287	87	0.3	70.59	724.61	724.43	0.18	0.37	0.63	0.71	0.79
247	LIN003	LIN003	LIN004	1287	95	0.25	67.06	724.61	724.53	0.22	0.47	0.81	0.91	1.02
248	LIN002	LIN002	LIN003	91	1287	0.25	60.96	724.95	724.64	0.30	0.65	1.12	1.26	1.40
249	LIN001	LIN001	LIN002	90	91	0.25	61.26	725.13	724.95	0.40	0.86	1.47	1.66	1.85
250	LIN000	LIN000	LIN003	1288	1287	0.3	62.00	725.78	724.61	0.00	0.00	0.00	0.00	0.00
251	LED008	LED008	LED005	261	262	0.25	60.50	721.40	721.28	0.02	0.29	0.24	0.37	0.56
252	LED007	LED007	LED006	264	263	0.25	94.50	722.69	721.54	0.01	0.10	0.08	0.12	0.18
253	LED006	LED006	LED005	263	262	0.25	13.40	721.41	721.31	0.01	0.13	0.11	0.16	0.24
254	LED005	LED005	LED004	262	259	0.25	39.10	721.19	721.13	0.04	0.60	0.44	0.69	1.07
255	LED004	LED004	LED003	259	260	0.25	32.90	721.06	721.01	0.05	0.72	0.50	0.78	1.21
256	LED003	LED003	LED002	260	117	0.25	38.00	721.01	720.83	0.03	0.41	0.28	0.44	0.68
257	LED002	LED002	LED001	117	194	0.25	61.50	720.83	720.70	0.05	0.71	0.47	0.73	1.14
258	LED001	LED001	LKD010	194	193	0.25	67.10	720.70	720.37	0.03	0.46	0.31	0.48	0.75
259	LBP003	LBP003	LBP002	1122	1123	0.525	123.85	714.98	714.86	0.02	0.04	0.74	1.30	1.95
260	LBP002	LBP002	LBP001	1123	1124	0.525	127.90	714.86	714.73	0.02	0.03	0.56	1.12	1.85
261	LBP001	LBP001	NTS043A	1124	116	0.525	118.50	714.73	714.62	0.02	0.04	0.53	1.10	1.70
262	EIP019	EIP019	EIP008	1694	590	0.2	85.95	727.58	727.20	0.02	0.11	0.82	2.00	2.02
263	EIP018	EIP018	EIP017	601	602	0.3	39.62	728.18	728.07	0.00	0.00	0.20	0.30	0.44
264	EIP017	EIP017	EIP016	602	600	0.3	91.74	728.07	727.71	0.00	0.00	0.16	0.24	0.37
265	EIP016	EIP016	EIP015	600	599	0.3	91.14	727.71	727.49	0.00	0.00	0.13	0.27	0.42
266	EIP015	EIP015	EIP014	599	598	0.3	92.35	727.49	727.19	0.00	0.00	0.10	0.21	0.33
267	EIP014	EIP014	EIP013	598	596	0.3	95.10	727.19	726.93	0.03	0.00	0.10	0.20	0.32
268	EIP013	EIP013	EIP012	596	594	0.375	54.86	726.91	726.76	0.02	0.01	0.29	0.48	0.68
269	EIP012	EIP012	EIP011	594	593	0.375	92.05	726.76	726.55	0.02	0.01	0.28	0.50	0.71
270	EIP011	EIP011	EIP010	593	592	0.375	88.70	726.55	726.36	0.02	0.01	0.26	0.48	0.67
271	EIP010	EIP010	EIP009	592	591	0.375	95.10	726.36	726.22	0.03	0.01	0.27	0.55	0.77
272	EIP009	EIP009	EIP008	591	590	0.375	91.14	726.22	726.02	0.02	0.01	0.20	0.42	0.60
273	EIP008	EIP008	EIP007	590	566	0.375	64.31	726.02	725.87	0.03	0.04	0.34	0.64	0.81
274	EIP007	EIP007	EIP006	566	653	0.375	62.18	725.87	725.75	0.03	0.04	0.37	0.70	0.83
275	EIP006	EIP006	EIP005	653	654	0.375	78.03	725.75	725.57	0.03	0.04	0.38	0.70	1.12
276	EIP005	EIP005	EIP004	654	436	0.375	33.22	725.57	725.51	0.04	0.05	0.42	0.78	1.19
277	EIP004	EIP004	EIP003	436	558	0.375	34.44	725.51	725.44	0.04	0.05	0.40	0.73	1.08
278	EIP003	EIP003	EIP002	558	455	0.375	31.09	725.44	725.36	0.03	0.04	0.35	0.65	0.92
279	EIP002	EIP002	EIP001	455	474	0.375	47.24	725.36	725.28	0.04	0.05	0.42	0.77	1.06
280	EIP001	EIP001	NTF007	474	442	0.375	99.36	725.26	725.21	0.07	0.09	0.76	1.41	1.94
281	DVY007	DVY007	DVY006	1004	1343	0.375	68.68	714.25	713.98	0.05	0.23	0.14	0.29	0.46
282	DVY006	DVY006	DVY005	1343	1344	0.375	89.95	713.95	713.47	0.04	0.20	0.12	0.25	0.40
283	DVY005	DVY005	DVY004	1344	1345	0.375	100.22	713.44	713.16	0.06	0.30	0.17	0.35	0.55
284	DVY004	DVY004	DVY003	1345	1346	0.375	108.07	713.07	712.74	0.05	0.29	0.16	0.33	0.52
285	DVY003	DVY003	DVY002	1346	1307	0.375	118.13	712.69	711.98	0.04	0.21	0.11	0.23	0.37

Baseline Capacity Assessment - Pipe Capacity Ratio, Percent Full
Conduit Performance

	Conduit	UP Node	DWN Node	UP Asset ID	DWN Asset ID	Dia (m)	Length (m)	Inlet Elev (m)	Outlet Elev (m)	MaxFlow/FullFlow				
										Avg-Peak DWF	Design Flow	Chicago 2Y4H	Chicago 5Y4H	Chicago 25Y4H
286	DVY002	DVY002	DVY001	1307	XX-DVY001	0.45	88.66	711.94	711.51	0.04	0.21	0.12	0.22	0.37
287	DVY001B	DVY001B	DVY001	XX-DVY001B	XX-DVY001	0.45	10.00	711.55	711.53	0.00	0.00	0.00	0.01	0.01
288	DVY001A	DVY001A	DVY001	XX-DVY001A	XX-DVY001	0.25	9.46	713.50	711.96	0.00	0.00	0.00	0.00	0.00
289	DVY001	DVY001	DVY000	XX-DVY001	DVY000	0.525	14.00	711.46	711.41	0.03	0.18	0.11	0.21	0.37
290	COR065	COR065	COR066	1104	COR066	0.45	11.18	728.73	728.72	0.08	0.33	0.46	1.83	1.88
291	COR064	COR064	COR065	1103	1104	0.45	18.46	728.79	728.76	0.07	0.28	0.39	1.57	1.59
292	COR063	COR063	COR064	1102	1103	0.45	78.50	728.92	728.82	0.08	0.31	0.45	1.72	1.81
293	COR062	COR062	COR063	1101	1102	0.45	99.30	729.08	728.95	0.07	0.27	0.39	1.53	1.62
294	COR061	COR060	COR062	1100	1101	0.45	17.76	729.47	729.11	0.02	0.08	0.12	0.45	0.47
295	COR060	COR060	COR019A	1100	676	0.2	8.50	729.45	729.42	0.19	0.47	0.64	2.51	3.48
296	COR050	COR050	STS005	576	573	0.525	20.00	730.50	730.47	0.67	0.68	0.68	0.68	0.68
297	COR035	COR035	COR034	83	84	0.35	94.49	726.70	726.29	0.06	0.14	0.36	0.83	1.46
298	COR034	COR034	COR033	84	1283	0.35	121.92	726.29	725.77	0.06	0.14	0.35	0.77	0.88
299	COR032	COR033	COR001	1283	1281	0.35	43.88	725.77	725.46	0.07	0.15	0.29	0.32	0.36
300	COR031	COR031	COR028	556	540	0.2	67.06	730.40	729.94	0.02	0.08	0.38	0.78	1.06
301	COR030	COR030	COR029	541	542	0.2	54.86	730.61	730.28	0.08	0.30	1.25	2.31	2.47
302	COR029	COR029	COR028	542	540	0.2	58.22	730.28	729.94	0.08	0.30	1.07	2.34	2.51
303	COR028	MH3	COR060	1151	1100	0.525	89.69	729.66	729.45	0.05	0.17	0.18	0.38	0.55
304	COR027	COR027	COR016	383	384	0.2	80.77	729.22	728.90	0.07	0.14	0.96	2.23	2.24
305	COR026	COR026	COR014	421	419	0.2	91.44	729.31	728.94	0.00	0.00	0.00	1.06	1.68
306	COR025	COR025	COR013	412	338	0.2	65.53	728.69	728.17	0.00	0.00	0.00	0.40	0.42
307	COR024	COR024	COR023	422	339	0.2	93.88	728.05	727.68	0.06	0.12	0.95	1.96	2.08
308	COR023	COR023	COR022	339	299	0.2	22.25	727.68	727.62	0.07	0.14	1.05	2.33	2.38
309	COR022	COR022	COR008	299	99	0.2	22.56	727.53	727.39	0.05	0.09	0.70	1.57	1.58
310	COR021	COR021	COR004	332	302	0.2	81.38	726.94	726.58	0.00	0.00	0.00	1.02	1.30
311	COR020	COR020	COR060	548	1100	0.2	64.65	729.74	729.46	0.06	0.25	1.77	3.12	3.70
312	COR019A	COR019A	COR019	676	549	0.2	15.24	729.42	729.39	0.25	0.63	0.83	3.35	4.65
313	COR019	COR019	COR018	549	359	0.25	28.96	729.26	729.17	0.11	0.28	0.36	1.47	2.03
314	COR018	COR018	COR017	359	357	0.25	28.96	729.17	729.08	0.11	0.28	0.36	1.46	2.03
315	COR017	COR017	COR016	357	384	0.25	70.10	729.08	728.87	0.12	0.30	0.48	1.35	1.86
316	COR016	COR016	COR015	384	358	0.25	90.22	728.87	728.62	0.21	0.49	1.36	1.83	1.81
317	COR015	COR015	COR014	358	419	0.25	92.96	728.62	728.30	0.19	0.44	1.12	1.63	1.61
318	COR014	COR014	COR013	419	338	0.25	96.01	728.30	728.03	0.21	0.49	1.07	1.22	1.32
319	COR013	COR013	COR012	338	103	0.25	19.81	728.03	727.97	0.24	0.54	1.22	2.05	2.30
320	COR012	COR012	COR011	103	102	0.25	17.37	727.97	727.91	0.22	0.50	1.13	1.84	2.10
321	COR011	COR011	COR010	102	101	0.25	21.34	727.91	727.84	0.23	0.52	1.16	1.93	2.19
322	COR010	COR010	COR009	101	100	0.25	91.44	727.84	727.57	0.24	0.55	1.22	2.05	2.34
323	COR009	COR009	COR008	100	99	0.25	74.68	727.57	727.16	0.18	0.40	0.88	1.49	1.71
324	COR008A	COR008	COR035	99	83	0.35	121.92	727.22	726.70	0.07	0.15	0.40	1.06	1.72
325	COR008	COR008	COR007	99	300	0.25	73.76	727.16	726.95	0.10	0.23	0.60	1.07	1.35
326	COR007	COR007	COR006	300	301	0.25	63.09	726.92	726.73	0.09	0.21	0.55	0.76	1.24
327	COR006	COR006	COR005	301	113	0.25	96.01	726.70	726.42	0.09	0.21	0.56	0.72	1.26
328	COR005	COR005	COR004	113	302	0.25	107.29	726.42	726.09	0.09	0.21	0.53	0.70	1.23
329	COR004	COR004	COR003	302	1284	0.25	89.92	726.06	725.79	0.22	0.47	1.34	2.94	3.55
330	COR003A	COR003	COR033	1284	1283	0.25	24.99	725.90	725.77	0.09	0.23	0.85	2.83	3.35
331	COR003	COR003	COR002	1284	1285	0.25	56.08	725.81	725.61	0.14	0.28	0.73	0.96	1.23
332	COR002	COR002	COR001	1285	1281	0.25	17.68	725.58	725.52	0.14	0.28	0.71	0.94	1.20
333	COR001A	COR001	LIN000	1281	1288	0.3	128.00	727.26	725.85	0.00	0.00	0.00	0.00	0.00
334	COR001	COR001	LIN001	1281	90	0.25	76.20	725.46	725.13	0.33	0.71	1.21	1.36	1.52
335	CBD009	CBD009	CBD003	528	1635	0.3	40.00	725.13	725.05	0.01	0.41	0.66	1.37	2.16
336	CBD008	CBD008	CBD007	350	342	0.375	94.49	724.03	723.84	0.00	0.00	0.00	0.00	0.00
337	CBD007	CBD007	CBD006	342	523	0.525	98.40	722.01	721.34	0.05	0.14	0.17	0.38	0.66
338	CBD006	CBD006	CBD005	523	1634	0.525	77.10	721.34	721.01	0.07	0.18	0.22	0.46	0.83
339	CBD005	CBD005	CBD004	1634	553	0.525	65.70	721.01	720.66	0.07	0.17	0.21	0.41	0.68
340	CBD004	CBD004	CBD003	553	1635	0.525	13.60	720.66	720.65	0.09	0.23	0.28	0.57	0.93
341	CBD003	CBD003	CBD002	1635	443	0.525	110.90	720.65	720.36	0.10	0.32	0.37	0.78	1.36
342	CBD002	CBD002	CBD001	443	1357	0.675	15.40	720.36	720.28	0.02	0.07	0.08	0.18	0.46
343	CBD001	CBD001	NTS002	1357	1570	0.675	51.70	720.28	720.16	0.05	0.18	0.20	0.44	0.70
344	CAL042	CAL042	CAL041	1067	1068	0.375	36.78	735.35	735.22	0.00	0.00	0.00	0.00	0.00
345	CAL041	CAL041	CAL040	1068	1070	0.375	68.16	735.22	734.95	0.01	0.03	0.02	0.03	0.04
346	CAL040	CAL040	CAL039	1070	1060	0.375	34.90	734.92	734.80	0.07	0.23	0.07	0.07	0.09
347	CAL039	CAL039	CAL038	1060	697	0.375	73.87	734.80	734.51	0.07	0.25	0.07	0.09	0.13
348	CAL038	CAL038	CAL037	697	698	0.375	131.12	734.48	734.02	0.07	0.26	0.07	0.09	0.14
349	CAL037	CAL037	CAL036	698	700	0.375	98.11	734.00	733.66	0.07	0.26	0.07	0.09	0.14
350	CAL036	CAL036	CAL035	700	699	0.375	21.65	733.60	733.51	0.07	0.26	0.07	0.11	0.16
351	CAL035	CAL035	CAL025	699	739	0.375	54.69	733.48	733.35	0.10	0.35	0.10	0.14	0.22
352	CAL030	CAL030	CAL028	915	885	0.2	106.68	734.56	734.09	0.00	0.00	0.00	0.00	0.00
353	CAL029	CAL029	CAL028	890	885	0.3	94.49	734.26	734.04	0.02	0.10	0.12	0.17	0.26
354	CAL028	CAL028	CAL027	885	884	0.3	84.12	734.04	733.77	0.02	0.09	0.10	0.14	0.21
355	CAL027	CAL027	CAL010	884	883	0.3	82.60	733.77	733.56	0.03	0.16	0.17	0.25	0.37
356	CAL026	CAL026	CAL005	816	828	0.2	86.26	733.03	732.53	0.06	0.31	0.28	0.40	0.58
357	CAL025	CAL025	CAL024	739	740	0.375	50.60	733.24	733.10	0.09	0.33	0.09	0.14	0.20
358	CAL024	CAL024	CAL023	740	741	0.375	79.55	733.10	732.88	0.09	0.33	0.09	0.14	0.20
359	CAL023	CAL023	CAL022	741	742	0.375	67.36	732.88	732.70	0.09	0.33	0.10	0.14	0.21
360	CAL022	CAL022	CAL021	742	743	0.375	43.89	732.63	732.50	0.09	0.32	0.09	0.13	0.20
361	CAL021	CAL021	CAL020	743	744	0.375	93.57	732.44	732.16	0.09	0.31	0.09	0.13	0.20
362	CAL020	CAL020	CAL002	744	745	0.375	85.95	732.16	731.90	0.09	0.31	0.09	0.13	0.19
363	CAL012	CAL012	CAL011	932	880	0.375	46.33	733.54	733.43	0.05	0.21	0.46	0.90	1.33
364	CAL011	CAL011	CAL010	880	883	0.375	97.54	733.40	733.11	0.04	0.19	0.41	0.78	1.17
365	CAL010	CAL010	CAL009	883	878	0.375	43.89	733.10	732.93	0.05	0.24	0.41	0.75	1.11
366	CAL009	CAL009	CAL008	878	904	0.45	55.78	732.90	732.78	0.04	0.19	0.34	0.62	0.92
367	CAL008	CAL008	CAL007	904	905	0.45	84.89	732.78	732.57	0.04	0.18	0.31	0.58	0.86
368	CAL007	CAL007	CAL006	905	827	0.45	75.44	732.57	732.46	0.05	0.24	0.41	0.75	1.11
369	CAL006	CAL006	CAL005	827	828	0.45	92.05	732.46	732.19	0.04	0.19	0.30	0.55	0.81
370	CAL005	CAL005	CAL004	828	852	0.45	91.90	732.19	732.04	0.07	0.32	0.45	0.79	1.17
371	CAL004	CAL004	CAL003	852	695	0.45	66.75	732.04	731.91	0.06	0.30	0.41	0.72	1.07
372	CAL003	CAL003	CAL002	695	745	0.45	70.87	731.91	731.82	0.08	0.38	0.52	0.90	1.35
373	CAL002	CAL002	CAL001	745	701	0.45	80.16	731.76	731.36	0.08	0.34	0.29	0.49	0.72
374	CAL001	CAL001	STS001	701	747	0.525	97.54	731.26	731.01	0.08	0.34	0.29	0.48	0.71
375	C9	MH6	MH7	1454	1453	0.25	33.89	718.57	718.40	0.00	0.00	0.00	0.00	0.00
376	C8	MH5	MH6	1455	1454	0.25	119.98	719.02	718.60	0.00	0.00	0.00	0.00	0.00
377	C7	MH4	MH5	1443	1455	0.25	109.97	719.31	719.02	0.00	0.00	0.00	0.00	0.00
378	C6	1442	MH4	1442	1443	0.25	67.51	719.51	719.35	0.00	0.00	0.00	0.00	0.00
379	C5	MH2	MH3	1150	1151	0.525	8.49	729.72	729.67	0.03	0.12	0.13	0.27	0.35
380	C4	COR028	MH2	540	1150	0.2	9.81	729.94	729.88	0.10	0.38	1.45	3.06	3.64

Baseline Capacity Assessment - Pipe Capacity Ratio, Percent Full
Conduit Performance

	Conduit	UP Node	DWN Node	UP Asset ID	DWN Asset ID	Dia (m)	Length (m)	Inlet Elev (m)	Outlet Elev (m)	MaxFlow/FullFlow				
										Avg-Peak DWF	Design Flow	Chicago 2Y4H	Chicago 5Y4H	Chicago 25Y4H
381	C37	430	COR027	430	383	0.2	51.65	729.46	729.22	0.03	0.07	0.64	1.20	1.72
382	C36	464	NTF002	464	471	0.2	6.70	726.38	724.40	0.00	0.00	0.00	0.00	0.01
383	C35	367	NTS015	367	526	0.2	42.07	720.67	717.85	0.00	0.01	0.33	0.50	0.74
384	C34	1596	NTS031	1596	1595	0.25	4.58	715.16	714.05	0.00	0.01	0.12	0.19	0.26
385	C33	508	COR030	508	541	0.2	81.31	730.93	730.61	0.06	0.24	1.04	1.79	1.69
386	C32	MH17	508	507	508	0.2	67.83	731.20	730.98	0.07	0.26	1.30	2.16	1.87
387	C31	506	MH17	506	507	0.2	60.65	731.54	731.20	0.05	0.21	1.07	1.63	1.34
388	C30	709	STF013	709	708	0.375	3.37	724.48	724.28	0.00	0.00	0.00	0.00	0.03
389	C3	MH1	MH2	1149	1150	0.525	400.00	729.76	729.72	0.17	0.57	0.32	0.50	0.97
390	C29	446	NTF006	446	1665	0.35	12.97	725.00	724.89	0.00	0.00	0.03	0.10	0.15
391	C28	1376	WIP012	1376	1664	0.25	75.61	721.70	721.50	0.00	0.03	0.35	0.52	0.78
392	C27	1380	MH16	1380	1019	0.25	54.12	718.19	717.98	0.01	0.12	0.09	0.13	0.19
393	C26	967	BRD007	967	966	0.2	51.59	720.26	719.08	0.00	0.00	0.00	0.00	0.00
394	C25	1018	MH16	1018	1019	0.25	42.73	719.47	717.98	0.01	0.10	0.05	0.07	0.11
395	C24	1023	1018	1023	1018	0.25	94.97	719.87	719.51	0.02	0.23	0.11	0.17	0.24
396	C23	MH16	WTS007	1019	256	0.75	35.45	717.50	717.47	0.04	0.41	0.17	0.30	0.50
397	C22	WTS006	MH16	181	1019	0.75	104.55	717.54	717.50	0.06	0.54	0.25	0.44	0.72
398	C21	MH15	LKD003	217	122	0.375	24.87	718.81	718.49	0.00	0.02	0.02	0.03	0.04
399	C20	MH14	MH15	221	217	0.25	50.25	719.21	718.91	0.01	0.09	0.09	0.13	0.19
400	C2	565	STS011	565	685	0.525	42.33	727.56	727.39	0.12	0.42	0.32	0.59	1.00
401	C19	1352	LKD004	1352	1075	0.25	7.25	718.96	718.54	0.00	0.01	0.01	0.02	0.02
402	C18	210	MH13	210	211	0.25	81.81	719.18	718.95	0.01	0.11	0.09	0.13	0.20
403	C17	MH13	LKD004	211	1075	0.6	50.73	718.62	718.58	0.07	0.47	0.29	0.54	0.87
404	C16	LKD005	MH13	205	211	0.6	52.84	718.66	718.62	0.07	0.46	0.29	0.54	0.87
405	C15	1156	1160	1156	1160	0.25	90.13	715.39	715.11	0.02	0.15	0.11	0.22	0.33
406	C14	MH12	516	515	516	0.2	100.00	724.44	724.36	0.16	0.36	0.59	2.14	3.18
407	C13	MH10	1449	1450	1449	0.25	127.00	717.27	716.85	0.00	0.00	0.00	0.00	0.00
408	C12	MH9	MH10	1451	1450	0.25	119.96	717.75	717.27	0.00	0.00	0.00	0.00	0.00
409	C11	MH8	MH9	1452	1451	0.25	119.99	718.00	717.76	0.00	0.00	0.00	0.00	0.00
410	C10	MH7	MH8	1453	1452	0.25	119.95	718.35	718.00	0.00	0.00	0.00	0.00	0.00
411	C1	STS010	565	568	565	0.525	77.75	727.88	727.56	0.11	0.39	0.31	0.56	0.98
412	BRD009	BRD009	BRD008	969	968	0.3	82.93	720.12	719.58	0.01	0.08	0.04	0.06	0.09
413	BRD008	BRD008	BRD007	968	966	0.3	89.54	719.58	719.03	0.01	0.08	0.04	0.06	0.09
414	BRD007	BRD007	BRD006	966	964	0.3	107.97	719.02	718.33	0.01	0.10	0.06	0.09	0.13
415	BRD006	BRD006	WTS005	964	182	0.3	43.79	718.32	718.07	0.01	0.12	0.07	0.11	0.15
416	BRD005	BRD005	BRD004	254	253	0.25	60.03	720.68	720.42	0.02	0.20	0.12	0.17	0.25
417	BRD004	BRD004	BRD003	253	174	0.25	82.24	720.37	720.00	0.02	0.19	0.11	0.17	0.25
418	BRD003	BRD003	BRD002	174	168	0.25	72.73	719.98	719.55	0.02	0.17	0.10	0.15	0.21
419	BRD002	BRD002	BRD001	168	203	0.25	95.16	719.53	719.11	0.02	0.20	0.11	0.17	0.24
420	BRD001	BRD001	WTS003A	203	204	0.25	43.36	719.09	718.20	0.01	0.09	0.05	0.08	0.11
421	999	1035	DVY001	1035	XX-DVY001	0.25	9.46	712.85	711.87	0.00	0.03	0.04	0.09	0.13
422	998	1057	1910	1057	1910	0.25	120.00	715.23	714.38	0.01	0.09	0.13	0.26	0.40
423	997	1055	1057	1055	1057	0.25	100.00	715.96	715.26	0.01	0.09	0.13	0.27	0.41
424	985	976	975	976	975	0.25	25.35	722.59	722.46	0.03	0.17	0.16	0.33	0.50
425	968	949	958	949	958	0.25	73.56	736.12	735.92	0.04	0.19	0.48	0.91	1.40
426	967	957	949	957	949	0.25	61.46	736.27	736.16	0.01	0.07	0.20	0.38	0.76
427	965	954	MEA007	954	956	0.25	47.61	735.44	735.30	0.04	0.18	0.46	0.87	1.28
428	964	955	954	955	954	0.25	35.22	735.54	735.44	0.04	0.18	0.47	0.89	1.30
429	963	958	955	958	955	0.25	49.15	735.85	735.61	0.03	0.14	0.36	0.68	1.00
430	962	953	957	953	957	0.25	59.42	736.42	736.27	0.01	0.06	0.17	0.32	0.51
431	960	856	953	856	953	0.25	67.59	736.64	736.42	0.01	0.05	0.15	0.29	0.45
432	929	919	918	919	918	0.25	54.96	737.33	736.91	0.01	0.03	0.10	0.19	0.30
433	928	1032	918	1032	918	0.2	40.44	738.09	737.93	0.00	0.00	0.00	0.00	0.00
434	91	363	531	363	531	0.25	105.87	726.38	726.08	0.00	0.09	0.29	0.56	0.71
435	85	522	7	522	7	0.2	60.48	730.20	729.93	0.04	0.07	0.69	0.99	1.44
436	81	274	289	274	289	0.2	70.39	724.93	724.66	0.00	0.00	0.00	0.00	0.00
437	801	650	649	650	649	0.2	39.00	728.78	728.61	0.05	0.30	0.46	0.89	1.38
438	797	1681	650	1681	650	0.2	29.30	728.93	728.81	0.05	0.31	0.48	0.93	1.42
439	790	1255	1257	1255	1257	0.375	95.98	737.26	737.12	0.01	0.03	0.01	0.01	0.01
440	79	278	293	278	293	0.25	77.09	722.65	722.46	0.01	0.20	0.20	0.31	0.47
441	789	1252	1255	1252	1255	0.375	60.27	737.37	737.26	0.01	0.03	0.01	0.01	0.01
442	788	1257	1258	1257	1258	0.375	72.92	737.06	736.95	0.01	0.03	0.01	0.01	0.01
443	78	2	277	2	277	0.2	26.42	723.12	723.03	0.01	0.26	0.28	0.42	0.63
444	75	288	228	288	228	0.2	51.28	724.30	724.04	0.00	0.00	0.00	0.00	0.00
445	74	289	288	289	288	0.2	44.30	724.65	724.31	0.00	0.00	0.00	0.00	0.00
446	737	531	530	531	530	0.25	56.39	726.08	725.94	0.00	0.15	0.35	0.68	1.39
447	735	530	527	530	527	0.3	87.47	725.94	725.68	0.01	0.08	0.20	0.38	0.67
448	734	527	CBD009	527	528	0.3	87.02	725.68	725.42	0.01	0.08	0.18	0.37	0.61
449	722	MH11	MH12	529	515	0.2	253.36	724.66	724.44	0.15	0.38	0.73	2.04	3.04
450	721	440	441	440	441	0.25	24.86	726.23	725.54	0.00	0.00	0.00	0.00	0.14
451	710	470	464	470	464	0.2	50.70	726.69	726.38	0.00	0.00	0.00	0.00	0.00
452	699	560	506	560	506	0.2	57.15	731.91	731.54	0.05	0.20	1.04	1.50	2.16
453	698	1137	1136	1137	1136	0.375	97.00	735.93	735.79	0.02	0.09	0.02	0.03	0.03
454	694	1093	61	1093	61	0.2	81.25	727.50	727.32	0.00	0.19	0.85	1.84	1.84
455	692	492	672	492	672	0.45	116.71	714.70	714.29	0.66	0.00	0.66	0.66	0.89
456	686	691	446	691	446	0.2	152.93	725.85	725.00	0.00	0.00	0.00	0.00	0.28
457	682	463	1681	463	1681	0.2	52.21	729.17	728.96	0.00	0.32	0.47	0.93	1.41
458	674	769	606	769	606	0.2	119.80	723.18	722.60	0.00	0.00	0.00	0.00	0.00
459	671	757	595	757	595	0.2	95.06	730.41	729.02	0.01	0.01	0.78	1.13	1.68
460	663	420	COR026	420	421	0.2	10.64	729.38	729.32	0.00	0.00	0.00	0.23	1.42
461	662	418	420	418	420	0.2	92.85	729.75	729.38	0.00	0.00	0.00	0.00	1.41
462	66	250	249	250	249	0.2	6.70	723.27	723.24	0.01	0.16	0.13	0.20	0.29
463	658	368	367	368	367	0.2	58.30	720.98	720.67	0.01	0.02	1.19	1.77	2.65
464	65	238	250	238	250	0.2	70.86	723.56	723.27	0.01	0.17	0.14	0.21	0.31
465	646	304	1093	304	1093	0.2	90.63	727.67	727.50	0.00	0.20	1.06	2.21	2.29
466	639	389	429	389	429	0.2	89.93	728.71	728.36	0.06	0.12	1.07	1.96	2.24
467	63	235	238	235	238	0.2	92.93	724.00	723.56	0.01	0.16	0.13	0.20	0.29
468	629	7	390	7	390	0.2	71.52	729.93	729.67	0.04	0.08	0.76	1.09	0.90
469	627	390	382	390	382	0.2	64.57	729.67	729.41	0.04	0.07	0.71	1.00	0.89
470	625	382	COR027	382	383	0.2	48.57	729.41	729.22	0.04	0.07	0.57	1.20	0.94
471	619	386	387	386	387	0.2	62.12	730.30	730.11	0.00	0.00	0.00	0.00	1.10
472	618	385	386	385	386	0.2	39.71	730.52	730.36	0.00	0.00	0.00	0.00	0.00
473	617	341	385	341	385	0.2	41.24	730.69	730.52	0.00	0.00	0.00	0.00	0.00
474	616	8	341	8	341	0.2	30.28	731.07	730.70	0.00	0.00	0.00	0.00	0.00
475	59	247	246	247	246	0.25	22.19	721.84	721.74	0.01	0.15	0.14	0.22	0.33

Baseline Capacity Assessment - Pipe Capacity Ratio, Percent Full
Conduit Performance

	Conduit	UP Node	DWN Node	UP Asset ID	DWN Asset ID	Dia (m)	Length (m)	Inlet Elev (m)	Outlet Elev (m)	MaxFlow/FullFlow				
										Avg-Peak DWF	Design Flow	Chicago 2Y4H	Chicago 5Y4H	Chicago 25Y4H
476	580	1138	1137	1138	1137	0.375	111.30	736.10	735.93	0.02	0.09	0.02	0.03	0.03
477	58	246	245	246	245	0.25	12.25	721.72	721.66	0.01	0.15	0.14	0.21	0.32
478	579	1243	1136	1243	1136	0.375	93.32	735.84	735.73	0.04	0.12	0.04	0.04	0.04
479	573	918	856	918	856	0.25	36.90	736.91	736.64	0.01	0.03	0.10	0.19	0.30
480	57	248	247	248	247	0.25	53.10	721.91	721.85	0.02	0.30	0.28	0.44	0.67
481	56	240	233	240	233	0.2	44.31	723.81	723.65	0.01	0.10	0.09	0.14	0.21
482	55	239	240	239	240	0.2	51.27	725.04	723.82	0.00	0.04	0.04	0.05	0.08
483	54	241	239	241	239	0.2	33.25	725.76	725.04	0.00	0.04	0.04	0.06	0.08
484	533	80	82	80	82	0.2	25.91	723.24	723.17	0.20	0.00	0.84	1.31	1.91
485	532	81	80	81	80	0.2	24.55	723.44	723.27	0.12	0.00	0.52	0.82	1.19
486	519	1074	1136	1074	1136	0.25	87.31	736.22	735.97	0.05	0.14	0.05	0.05	0.05
487	50	228	235	228	235	0.2	8.33	724.04	724.00	0.00	0.01	0.00	0.01	0.02
488	497	672	620	672	620	0.45	79.87	714.29	714.05	0.69	0.01	1.09	1.32	1.63
489	490	649	565	649	565	0.2	44.94	728.61	728.11	0.04	0.19	0.28	0.55	0.85
490	49	230	248	230	248	0.25	84.88	722.19	721.99	0.01	0.21	0.20	0.31	0.46
491	48	233	229	233	229	0.2	14.27	723.65	723.60	0.01	0.11	0.09	0.14	0.21
492	475	462	463	462	463	0.2	51.40	729.53	729.18	0.00	0.24	0.38	0.72	1.08
493	442	975	973	975	973	0.25	80.14	722.43	721.96	0.03	0.16	0.15	0.31	0.47
494	434	990	991	990	991	0.3	107.98	720.98	720.59	0.00	0.00	0.00	0.00	0.00
495	431	989	990	989	990	0.3	117.24	721.34	721.00	0.00	0.00	0.00	0.00	0.00
496	420	606	607	606	607	0.25	79.45	722.59	722.30	0.00	0.00	0.00	0.00	1.38
497	419	607	608	607	608	0.25	112.30	722.15	721.75	0.00	0.00	0.00	1.02	1.74
498	418	608	609	608	609	0.25	110.08	721.69	720.89	0.00	0.00	0.00	0.94	1.64
499	417	609	610	609	610	0.25	94.41	720.83	720.58	0.00	0.00	1.00	1.97	3.30
500	416	610	NEI008	610	611	0.25	91.54	720.45	720.15	0.02	0.05	2.18	2.97	3.64
501	404	595	EIP013	595	596	0.2	94.82	729.02	727.95	0.01	0.02	0.80	1.29	1.59
502	39	1080	WIN006	1080	124	0.6	56.42	720.60	720.53	0.06	0.23	0.18	0.33	0.51
503	366	817	CAL026	817	816	0.2	71.74	733.44	733.03	0.05	0.23	0.21	0.30	0.44
504	362	818	817	818	817	0.2	51.28	733.69	733.44	0.05	0.25	0.22	0.32	0.47
505	361	820	818	820	818	0.2	38.90	733.94	733.69	0.04	0.22	0.20	0.28	0.41
506	359	819	820	819	820	0.2	58.89	734.30	733.94	0.03	0.17	0.15	0.22	0.32
507	358	830	819	830	819	0.2	41.13	734.54	734.30	0.03	0.18	0.16	0.23	0.34
508	35	292	230	292	230	0.25	56.78	722.34	722.19	0.01	0.20	0.19	0.30	0.45
509	34	293	292	293	292	0.25	29.98	722.44	722.35	0.01	0.19	0.18	0.28	0.42
510	33	291	2	291	2	0.2	18.25	723.18	723.12	0.01	0.11	0.09	0.14	0.23
511	328	424	363	424	363	0.25	145.41	726.81	726.38	0.00	0.09	0.32	0.58	0.77
512	324	429	COR024	429	422	0.2	77.71	728.36	728.04	0.06	0.11	1.00	1.91	2.18
513	32	290	291	290	291	0.2	57.06	723.42	723.18	0.01	0.09	0.08	0.13	0.19
514	319	387	418	387	418	0.2	91.46	730.11	729.75	0.00	0.00	0.00	0.00	1.13
515	318	403	406	403	406	0.2	66.76	722.81	722.55	0.16	0.00	0.68	1.09	1.59
516	31	229	290	229	290	0.2	46.89	723.60	723.43	0.01	0.10	0.09	0.14	0.20
517	296	516	516	516	516	0.2	100.00	724.44	724.36	0.00	0.00	0.00	0.00	0.00
518	295	516	517	516	517	0.2	63.37	724.36	724.30	0.14	0.32	0.48	0.92	2.96
519	294	517	518	517	518	0.2	57.38	724.30	724.25	0.15	0.36	0.49	0.94	3.10
520	287	494	495	494	495	0.25	118.68	718.48	718.00	0.00	0.02	0.15	0.34	0.84
521	263	441	EIP001	441	474	0.25	41.49	725.54	725.31	0.00	0.00	0.00	0.02	0.71
522	249	24	304	24	304	0.2	107.25	728.09	727.70	0.00	0.14	0.87	1.58	1.80
523	23	274	275	274	275	0.2	37.50	724.95	724.73	0.00	0.00	0.00	0.00	0.00
524	22	275	279	275	279	0.2	54.02	724.72	724.46	0.00	0.00	0.00	0.00	0.00
525	21	279	278	279	278	0.2	94.56	724.44	722.88	0.00	0.03	0.02	0.03	0.05
526	204	973	WIN004	973	998	0.25	90.19	721.96	721.43	0.03	0.16	0.15	0.29	0.45
527	2031	1951	1950	1951	1950	0.25	92.24	725.12	724.53	0.00	0.03	0.03	0.05	0.08
528	2030	1950	1949	1950	1949	0.25	71.66	724.53	724.20	0.00	0.03	0.03	0.06	0.10
529	2028	1949	1791	1949	1791	0.25	124.28	724.18	723.27	0.01	0.10	0.11	0.22	0.34
530	2012	1922	1237	1922	1237	0.2	63.54	716.00	715.72	0.01	0.10	0.19	0.38	0.58
531	2011	1921	1922	1921	1922	0.2	69.52	716.36	716.02	0.01	0.09	0.18	0.36	0.55
532	2010	1920	1921	1920	1921	0.2	46.68	716.59	716.39	0.00	0.00	0.00	0.00	0.00
533	2009	1918	1920	1918	1920	0.2	63.76	716.83	716.62	0.00	0.00	0.00	0.00	0.00
534	2000	1910	1058	1910	1058	0.25	65.56	714.41	713.56	0.01	0.08	0.12	0.24	0.37
535	20	276	278	276	278	0.2	56.09	722.85	722.65	0.01	0.25	0.27	0.41	0.61
536	1998	1904	1910	1904	1910	0.2	46.24	714.87	714.41	0.00	0.02	0.05	0.11	0.17
537	1984	1887	1888	1887	1888	0.3	74.26	715.99	715.84	0.00	0.02	0.04	0.09	0.14
538	1979	1888	1501	1888	1501	0.3	80.98	715.79	715.49	0.00	0.01	0.03	0.07	0.11
539	1969	1886	1887	1886	1887	0.3	62.07	716.17	716.04	0.00	0.02	0.05	0.09	0.15
540	1924	1839	1838	1839	1838	2.4	85.16	726.03	725.94	0.00	0.00	0.00	0.01	0.01
541	1923	COR034	1839	84	1839	0.45	12.16	726.61	726.58	0.00	0.00	0.00	0.00	0.45
542	1921	1838	COR033	1838	1283	0.45	46.50	725.93	725.77	0.00	0.00	0.06	0.39	0.83
543	1901	1821	1820	1821	1820	0.2	78.23	717.39	717.04	0.00	0.00	0.00	0.00	0.00
544	1900	1820	1216	1820	1216	0.2	80.54	717.03	716.78	0.00	0.00	0.00	0.00	0.00
545	19	277	276	277	276	0.2	28.85	723.03	722.87	0.01	0.20	0.22	0.33	0.49
546	1898	1818	1819	1818	1819	0.2	78.09	716.20	715.92	0.05	0.27	0.27	0.54	0.82
547	1869	1787	1644	1787	1644	0.25	86.00	722.82	722.44	0.01	0.09	0.10	0.21	0.32
548	1868	1786	1787	1786	1787	0.25	91.90	723.65	722.83	0.01	0.06	0.07	0.15	0.23
549	1866	1790	1791	1790	1791	0.25	49.80	722.95	722.45	0.00	0.00	0.00	0.00	0.00
550	1863	1791	1649	1791	1649	0.25	136.24	722.27	721.91	0.02	0.16	0.17	0.35	0.57
551	1860	1712	1193	1712	1193	0.2	93.78	732.17	731.31	0.00	0.00	0.00	0.00	0.00
552	1858	1696	EIP019	1696	1694	0.2	10.52	727.63	727.58	0.02	0.11	0.93	2.07	2.10
553	1853	1713	1712	1713	1712	0.2	28.35	732.54	732.31	0.00	0.00	0.00	0.00	0.00
554	1843	1700	1696	1700	1696	0.2	65.01	727.91	727.63	0.02	0.12	0.98	2.23	2.23
555	1840	1698	1699	1698	1699	0.2	83.69	728.87	728.43	0.02	0.00	1.37	2.06	3.06
556	1839	1699	1700	1699	1700	0.2	117.55	728.42	727.97	0.02	0.00	1.05	2.43	2.63
557	1837	589	EIP019	589	1694	0.2	5.04	727.57	727.58	0.01	0.04	0.07	0.41	0.42
558	1834	1741	1747	1741	1747	0.375	93.97	736.43	736.23	0.03	0.08	0.03	0.03	0.03
559	1833	1747	1244	1747	1244	0.375	55.67	736.20	736.12	0.03	0.10	0.03	0.03	0.04
560	183	129	1352	129	1352	0.25	135.54	719.49	718.96	0.00	0.05	0.04	0.06	0.09
561	1825	1739	1191	1739	1191	0.375	20.35	731.85	731.82	0.00	0.00	0.00	0.00	0.00
562	182	147	129	147	129	0.25	59.70	719.69	719.50	0.00	0.06	0.05	0.07	0.11
563	1803	1748	1244	1748	1244	0.2	120.02	736.86	736.26	0.00	0.00	0.00	0.00	0.00
564	1802	1749	1748	1749	1748	0.2	104.27	737.43	736.89	0.00	0.00	0.00	0.00	0.00
565	1801	1191	1717	1191	1717	0.45	13.95	731.29	731.28	0.04	0.14	0.16	0.27	0.39
566	1800	1192	1715	1192	1715	0.45	36.14	731.19	731.15	0.03	0.12	0.14	0.22	0.32
567	1774	1691	1254	1691	1254	0.375	41.77	737.51	737.42	0.01	0.02	0.01	0.01	0.01
568	1773	1689	1691	1689	1691	0.375	80.09	737.74	737.54	0.00	0.00	0.00	0.00	0.00
569	1772	1688	1689	1688	1689	0.375	122.47	737.99	737.78	0.00	0.00	0.00	0.00	0.00
570	1752	1673	1674	1673	1674	0.375	16.26	724.70	724.66	0.00	0.00	0.00	0.00	0.00

Baseline Capacity Assessment - Pipe Capacity Ratio, Percent Full
Conduit Performance

	Conduit	UP Node	DWN Node	UP Asset ID	DWN Asset ID	Dia (m)	Length (m)	Inlet Elev (m)	Outlet Elev (m)	MaxFlow/FullFlow				
										Avg-Peak DWF	Design Flow	Chicago 2Y4H	Chicago 5Y4H	Chicago 25Y4H
571	1750	1677	1678	1677	1678	0.6	125.00	731.36	726.95	0.00	0.00	0.00	0.00	0.00
572	1749	1678	1676	1678	1676	0.6	916.95	726.95	724.70	0.00	0.00	0.00	0.00	0.00
573	1743	1676	1673	1676	1673	0.6	0.71	726.95	726.03	0.00	0.00	0.00	0.00	0.00
574	1742	1675	1677	1675	1677	0.6	20.00	732.07	731.36	0.00	0.00	0.00	0.00	0.00
575	1741	1674	1671	1674	1671	0.375	26.72	724.66	724.59	0.00	0.00	0.00	0.00	0.00
576	1740	1671	709	1671	709	0.375	16.87	724.59	724.51	0.00	0.00	0.00	0.00	0.00
577	1729	1661	WIP013	1661	1662	0.2	69.84	722.26	721.93	0.15	0.30	0.61	0.98	1.44
578	1728	406	1661	406	1661	0.2	65.08	722.52	722.28	0.17	0.34	0.69	1.11	1.63
579	1725	518	CBD005	518	1634	0.2	130.69	724.25	724.14	0.15	0.32	0.42	0.81	1.19
580	1700	1649	1648	1649	1648	0.25	117.35	721.85	721.62	0.04	0.27	0.28	0.59	0.94
581	1699	1648	1301	1648	1301	0.25	116.22	721.61	721.44	0.04	0.31	0.29	0.60	0.98
582	1697	1646	1301	1646	1301	0.3	83.75	721.91	721.37	1.88	1.88	1.89	1.88	1.89
583	1695	1644	1643	1644	1643	0.25	82.98	722.44	722.12	0.01	0.09	0.10	0.22	0.33
584	1694	1643	1641	1643	1641	0.25	88.37	722.10	721.85	0.02	0.11	0.12	0.24	0.38
585	1692	1641	1640	1641	1640	0.525	79.63	721.58	721.47	0.00	0.02	0.02	0.05	0.07
586	1691	1640	1639	1640	1639	0.525	100.59	721.42	721.35	0.00	0.03	0.03	0.06	0.12
587	1690	1639	1170	1639	1170	0.6	119.31	721.29	721.20	0.00	0.03	0.02	0.07	0.15
588	1676	1620	1618	1620	1618	0.2	13.78	721.70	721.27	0.01	0.02	1.21	1.78	2.74
589	1662	1622	1620	1622	1620	0.2	132.13	722.23	721.70	0.00	0.06	0.01	0.88	1.56
590	1661	536	1621	536	1621	0.2	54.31	722.71	722.50	0.00	0.07	0.00	0.00	1.03
591	1660	1621	1622	1621	1622	0.2	68.59	722.50	722.23	0.00	0.07	0.00	0.00	1.20
592	1658	1619	NTS011	1619	1617	0.3	9.68	720.69	718.23	0.01	0.02	0.10	0.15	0.26
593	1657	1618	1619	1618	1619	0.3	7.49	720.70	720.69	0.13	0.34	1.50	2.18	3.79
594	1620	1600	NTS035	1600	1601	0.45	12.28	713.90	713.87	0.76	0.01	1.19	1.45	1.81
595	1619	620	1600	620	1600	0.45	24.96	713.99	713.90	0.63	0.01	0.98	1.19	1.50
596	1613	559	1596	559	1596	0.25	121.61	717.62	715.16	0.01	0.04	0.41	0.67	0.96
597	1586	NTS004	1568	1572	1568	0.25	18.36	726.37	726.21	0.00	0.00	0.00	0.00	0.00
598	1585	1568	530	1568	530	0.25	91.11	726.21	725.94	0.00	0.00	0.00	0.00	0.00
599	1577	1058	1035	1058	1035	0.25	51.44	713.56	712.89	0.01	0.08	0.12	0.24	0.37
600	1561	1542	1541	1542	1541	0.675	100.20	716.36	716.04	0.00	0.00	0.08	0.13	0.20
601	1559	1541	1540	1541	1540	0.675	101.02	716.03	715.71	0.00	0.00	0.08	0.13	0.20
602	1558	1540	1536	1540	1536	0.675	28.16	715.73	715.62	0.00	0.00	0.06	0.11	0.17
603	1554	1534	NTS045	1534	1606	0.675	119.73	714.42	713.67	0.00	0.00	0.03	0.07	0.11
604	1553	1535	1534	1535	1534	0.675	120.00	715.09	714.41	0.00	0.00	0.04	0.08	0.13
605	1552	1536	1535	1536	1535	0.675	119.02	715.61	715.12	0.00	0.00	0.05	0.10	0.15
606	1535	1517	976	1517	976	0.25	91.90	723.35	722.62	0.02	0.14	0.13	0.26	0.40
607	1518	1501	1500	1501	1500	0.3	73.70	715.41	715.11	0.00	0.01	0.03	0.06	0.10
608	1517	1500	1499	1500	1499	0.375	54.85	715.06	714.94	0.03	0.15	0.08	0.17	0.26
609	1516	1499	1497	1499	1497	0.375	57.79	714.89	714.81	0.04	0.18	0.10	0.21	0.33
610	1514	1497	1166	1497	1166	0.375	75.02	714.75	714.69	0.07	0.36	0.19	0.40	0.62
611	1511	1489	1154	1489	1154	0.25	130.10	716.03	715.62	0.00	0.00	0.00	0.00	0.00
612	1510	1492	1160	1492	1160	0.2	87.01	716.23	715.70	0.02	0.09	0.05	0.10	0.15
613	1506	1163	1166	1163	1166	0.25	75.13	714.83	714.64	0.04	0.26	0.21	0.45	0.71
614	1504	1491	1492	1491	1492	0.2	92.17	717.65	716.29	0.01	0.06	0.03	0.06	0.10
615	1493	1480	989	1480	989	0.3	99.26	721.65	721.38	0.00	0.00	0.00	0.00	0.00
616	1476	1436	1438	1436	1438	0.375	119.93	717.36	717.13	0.00	0.00	0.00	0.00	0.00
617	1475	1423	1424	1423	1424	0.25	91.45	720.60	720.33	0.00	0.00	0.00	0.00	0.00
618	1462	1448	1449	1448	1449	0.375	113.00	716.61	716.36	0.00	0.00	0.00	0.23	0.86
619	1461	1449	1167	1449	1167	0.375	123.99	716.36	716.03	0.00	0.00	0.14	0.84	1.40
620	1460	1447	1448	1447	1448	0.375	119.83	716.88	716.64	0.00	0.00	0.00	0.00	0.15
621	1459	1438	1447	1438	1447	0.375	64.63	717.10	716.94	0.00	0.00	0.00	0.00	0.00
622	1457	1445	1444	1445	1444	0.2	121.46	721.11	719.94	0.00	0.00	0.00	0.00	0.00
623	1456	1444	1442	1444	1442	0.25	121.07	719.89	719.52	0.00	0.00	0.00	0.00	0.00
624	1454	1441	1442	1441	1442	0.25	125.67	719.96	719.56	0.00	0.00	0.00	0.00	0.00
625	1453	1440	1441	1440	1441	0.25	132.68	720.98	719.99	0.00	0.00	0.00	0.00	0.00
626	1452	1440	1439	1440	1439	0.2	127.85	721.29	720.00	0.00	0.00	0.00	0.00	0.00
627	1451	1439	1438	1439	1438	0.2	134.99	719.98	718.55	0.00	0.00	0.00	0.00	0.00
628	1450	1435	1436	1435	1436	0.375	119.90	717.64	717.38	0.00	0.00	0.00	0.00	0.00
629	1448	1434	1435	1434	1435	0.375	120.01	717.92	717.64	0.00	0.00	0.00	0.00	0.00
630	1447	1433	1434	1433	1434	0.375	53.84	718.05	717.92	0.00	0.00	0.00	0.00	0.00
631	1446	1432	1433	1432	1433	0.375	94.55	718.36	718.05	0.00	0.00	0.00	0.00	0.00
632	1445	1429	1432	1429	1432	0.375	94.37	718.53	718.36	0.00	0.00	0.00	0.00	0.00
633	1443	1428	1430	1428	1430	0.25	104.37	719.29	719.03	0.00	0.00	0.00	0.00	0.00
634	1442	1430	1429	1430	1429	0.25	104.38	718.98	718.67	0.00	0.00	0.00	0.00	0.00
635	1441	1427	1428	1427	1428	0.25	104.39	719.59	719.33	0.00	0.00	0.00	0.00	0.00
636	1440	1426	1427	1426	1427	0.25	108.78	719.84	719.63	0.00	0.00	0.00	0.00	0.00
637	1439	1425	1426	1425	1426	0.25	99.98	720.09	719.89	0.00	0.00	0.00	0.00	0.00
638	1438	1424	1425	1424	1425	0.25	52.80	720.28	720.11	0.00	0.00	0.00	0.00	0.00
639	1437	1422	1423	1422	1423	0.25	112.48	721.30	720.65	0.00	0.00	0.00	0.00	0.00
640	1422	1388	1389	1388	1389	0.25	46.61	719.15	719.00	0.00	0.02	0.28	0.43	0.71
641	1421	1389	494	1389	494	0.25	120.70	718.93	718.48	0.00	0.02	0.23	0.39	0.87
642	1420	1395	1396	1395	1396	0.25	46.63	718.26	717.88	0.00	0.03	0.42	0.79	1.01
643	142	910	830	910	830	0.2	82.91	734.94	734.54	0.04	0.20	0.18	0.26	0.38
644	1406	495	1396	495	1396	0.25	33.09	718.00	717.86	0.00	0.02	0.27	0.62	1.11
645	1405	1396	559	1396	559	0.25	62.94	717.86	717.62	0.02	0.10	0.97	1.85	2.56
646	14	249	LED007	249	264	0.25	77.08	723.03	722.71	0.01	0.09	0.08	0.11	0.17
647	139	82	403	82	403	0.2	81.68	723.14	722.83	0.16	0.00	0.71	1.10	1.61
648	1356	1233	1235	1233	1235	0.2	75.26	719.67	719.14	0.01	0.06	0.07	0.14	0.22
649	1355	1219	1220	1219	1220	0.25	50.50	714.93	714.64	0.07	0.44	0.44	0.89	1.28
650	1333	61	424	61	424	0.2	168.96	727.32	726.81	0.00	0.16	0.63	1.36	1.40
651	1322	1326	DVY002	1326	1307	0.3	61.22	713.01	712.70	0.00	0.00	0.00	0.00	0.00
652	1311	1349	1262	1349	1262	0.375	71.92	736.63	736.53	0.02	0.09	0.02	0.03	0.03
653	1298	1166	DVY007	1166	1004	0.375	105.07	714.58	714.25	0.05	0.26	0.16	0.33	0.52
654	1268	1310	DVY002	1310	1307	0.25	60.72	713.81	713.25	0.00	0.00	0.00	0.00	0.00
655	1248	SPK033	1297	843	1297	0.45	12.34	731.40	731.25	0.00	0.00	0.00	0.00	0.00
656	1246	1298	SPK032	1298	694	0.45	20.15	731.14	731.09	0.00	0.00	0.00	0.00	0.06
657	1244	1105	1301	1105	1301	0.6	66.56	721.12	721.09	0.16	0.30	0.29	0.35	0.41
658	1242	1301	1084	1301	1084	0.6	99.21	721.09	721.05	0.20	0.47	0.39	0.65	0.92
659	1235	1297	1298	1297	1298	2.4	110.00	731.25	731.14	0.00	0.00	0.00	0.00	0.00
660	12	245	LED008	245	261	0.25	80.32	721.66	721.40	0.01	0.18	0.17	0.26	0.39
661	1194	1170	1105	1170	1105	0.6	68.87	721.19	721.13	0.03	0.13	0.10	0.17	0.23
662	1192	1258	1260	1258	1260	0.375	64.75	736.89	736.79	0.01	0.03	0.01	0.01	0.01
663	1191	1260	1349	1260	1349	0.375	64.80	736.79	736.69	0.01	0.03	0.01	0.01	0.01
664	1189	1262	1139	1262	1139	0.375	110.00	736.47	736.30	0.02	0.09	0.02	0.03	0.03
665	1183	1244	1242	1244	1242	0.375	11.38	736.08	736.06	0.03	0.09	0.03	0.03	0.03

Baseline Capacity Assessment - Pipe Capacity Ratio, Percent Full
Conduit Performance

	Conduit	UP Node	DWN Node	UP Asset ID	DWN Asset ID	Dia (m)	Length (m)	Inlet Elev (m)	Outlet Elev (m)	MaxFlow/FullFlow				
										Avg-Peak DWF	Design Flow	Chicago 2Y4H	Chicago 5Y4H	Chicago 25Y4H
666	1180	1254	1252	1254	1252	0.375	24.41	737.42	737.37	0.01	0.03	0.01	0.01	0.01
667	1175	1242	1243	1242	1243	0.375	110.16	735.99	735.88	0.04	0.11	0.04	0.04	0.04
668	1169	1218	1219	1218	1219	0.25	75.49	715.19	714.98	0.08	0.45	0.43	0.88	1.20
669	1168	1222	1221	1222	1221	0.2	86.00	716.78	716.10	0.03	0.18	0.18	0.35	0.54
670	1166	1239	1219	1239	1219	0.25	58.54	715.27	714.98	0.02	0.13	0.16	0.33	0.51
671	1162	1220	1225	1220	1225	0.25	19.80	714.46	714.00	0.04	0.28	0.27	0.55	0.80
672	1160	1237	1239	1237	1239	0.2	46.50	715.72	715.30	0.02	0.18	0.21	0.44	0.68
673	1158	1235	1236	1235	1236	0.2	118.39	718.49	717.94	0.01	0.08	0.08	0.17	0.26
674	1156	1231	1233	1231	1233	0.2	51.28	719.92	719.70	0.01	0.08	0.09	0.18	0.28
675	1148	1221	1220	1221	1220	0.2	46.50	714.70	714.51	0.04	0.24	0.24	0.48	0.73
676	1147	1216	1218	1216	1218	0.25	67.77	715.39	715.19	0.07	0.44	0.43	0.86	1.17
677	1146	1236	1237	1236	1237	0.2	117.80	717.92	715.73	0.01	0.04	0.04	0.08	0.13
678	1142	1203	1202	1203	1202	0.2	83.49	718.06	717.73	0.01	0.09	0.09	0.17	0.26
679	1139	1202	1201	1202	1201	0.2	102.20	717.72	717.11	0.01	0.08	0.06	0.13	0.20
680	1138	1201	1216	1201	1216	0.2	57.96	717.09	716.78	0.01	0.08	0.07	0.14	0.21
681	1137	1819	1216	1819	1216	0.2	100.27	715.89	715.40	0.04	0.23	0.23	0.45	0.70
682	1136	1177	1180	1177	1180	0.3	96.39	732.23	732.05	0.00	0.00	0.00	0.03	0.13
683	1135	1180	1183	1180	1183	0.3	93.14	732.05	731.86	0.08	0.28	0.48	0.71	0.98
684	1134	1174	1177	1174	1177	0.25	51.81	732.52	732.31	0.00	0.00	0.00	0.00	0.00
685	1131	1175	1174	1175	1174	0.25	116.78	733.30	732.84	0.00	0.00	0.00	0.00	0.00
686	1129	1194	1195	1194	1195	0.45	105.37	730.84	730.71	0.05	0.19	0.16	0.25	0.38
687	1128	1193	1194	1193	1194	0.45	120.55	730.99	730.84	0.05	0.18	0.16	0.26	0.37
688	1127	1183	1190	1183	1190	0.3	90.30	731.86	731.65	0.07	0.27	0.35	0.58	0.81
689	1126	1190	1191	1190	1191	0.3	91.81	731.65	731.41	0.07	0.25	0.29	0.48	0.69
690	1125	1717	1192	1717	1192	0.45	89.81	731.28	731.19	0.04	0.14	0.16	0.26	0.37
691	1124	1715	1193	1715	1193	0.45	58.97	731.15	731.07	0.03	0.12	0.13	0.21	0.31
692	1119	1196	1197	1196	1197	0.525	85.26	730.59	730.50	0.06	0.18	0.13	0.20	0.29
693	1117	1184	1183	1184	1183	0.25	116.86	732.42	731.91	0.00	0.00	0.00	0.00	0.00
694	1112	1195	1196	1195	1196	0.525	92.94	730.69	730.59	0.05	0.18	0.12	0.20	0.29
695	1111	1197	1198	1197	1198	0.525	78.43	730.45	730.37	0.06	0.19	0.13	0.21	0.31
696	1110	1198	1199	1198	1199	0.525	48.42	730.31	730.26	0.06	0.19	0.13	0.20	0.30
697	1109	1199	1147	1199	1147	0.525	54.34	730.21	730.08	0.04	0.12	0.08	0.13	0.19
698	1107	1167	1134	1167	1134	0.375	120.20	715.99	715.79	0.02	0.03	1.39	2.68	3.38
699	1106	1134	1118	1134	1118	0.525	119.90	715.77	715.69	0.01	0.02	0.60	1.08	1.63
700	1102	1160	1163	1160	1163	0.25	79.45	715.11	714.87	0.04	0.20	0.14	0.29	0.43
701	1097	1154	1156	1154	1156	0.25	52.47	715.59	715.41	0.00	0.00	0.00	0.00	0.00
702	1091	1148	MH1	1148	1149	0.525	95.88	729.95	729.80	0.05	0.15	0.10	0.16	0.24
703	1090	1147	1148	1147	1148	0.525	63.10	730.05	730.00	0.06	0.20	0.13	0.21	0.32
704	1083	1136	CAL040	1136	1070	0.375	104.77	735.60	735.36	0.07	0.24	0.07	0.07	0.08
705	1082	1133	1135	1133	1135	0.25	119.97	716.12	715.79	0.00	0.00	0.00	0.00	0.00
706	1081	1139	1138	1139	1138	0.375	94.19	736.24	736.10	0.02	0.09	0.02	0.03	0.03
707	1080	1132	1133	1132	1133	0.25	122.73	716.62	716.15	0.00	0.00	0.00	0.00	0.00
708	1079	1131	1132	1131	1132	0.25	67.89	717.00	716.66	0.00	0.00	0.00	0.00	0.00
709	1078	1130	1131	1130	1131	0.25	58.90	717.36	717.05	0.00	0.00	0.00	0.00	0.00
710	1077	1129	1130	1129	1130	0.2	75.83	718.27	717.41	0.00	0.00	0.00	0.00	0.00
711	1076	1106	1107	1106	1107	0.2	122.63	720.50	719.30	0.00	0.00	0.00	0.00	0.00
712	1075	1107	1108	1107	1108	0.25	118.68	719.25	718.90	0.00	0.00	0.00	0.00	0.00
713	1074	1108	1109	1108	1109	0.25	119.97	718.90	718.55	0.00	0.00	0.00	0.00	0.00
714	1073	1109	1110	1109	1110	0.25	119.97	718.55	718.13	0.00	0.00	0.00	0.00	0.00
715	1072	1110	1119	1110	1119	0.25	129.24	718.13	717.58	0.00	0.00	0.00	0.00	0.00
716	1070	1118	1119	1118	1119	0.525	119.97	715.57	715.38	0.01	0.01	0.40	0.68	0.86
717	1069	1119	1120	1119	1120	0.525	86.12	715.38	715.30	0.01	0.02	0.45	0.81	1.18
718	1068	1120	1121	1120	1121	0.525	89.98	715.30	715.10	0.01	0.01	0.28	0.55	0.76
719	1067	1121	LBP003	1121	1122	0.525	90.60	715.10	714.98	0.01	0.01	0.34	0.70	0.97
720	1066	1135	LBP003	1135	1122	0.25	121.87	715.76	715.39	0.00	0.00	0.00	0.00	0.59
721	1042	1084	1081	1084	1081	0.6	101.88	720.86	720.72	0.09	0.25	0.20	0.34	0.52
722	1040	1081	1080	1081	1080	0.6	86.03	720.72	720.62	0.07	0.24	0.19	0.34	0.53
723	1012	1016	1017	1016	1017	0.25	75.58	720.39	720.13	0.02	0.24	0.12	0.18	0.26
724	1011	1017	1023	1017	1023	0.25	58.84	720.11	719.93	0.03	0.25	0.13	0.19	0.27
725	1010	1023	967	1023	967	0.2	114.41	721.01	720.26	0.00	0.00	0.00	0.00	0.00
726	1009	1011	991	1011	991	0.25	61.95	720.89	720.64	0.00	0.00	0.00	0.00	0.00
727	1008	1012	1011	1012	1011	0.25	91.82	721.33	720.93	0.00	0.00	0.00	0.00	0.00
728	1007	1013	1012	1013	1012	0.25	123.00	721.70	721.36	0.00	0.00	0.00	0.00	0.00
729	1003	988	BRD009	988	969	0.3	31.56	720.24	720.17	0.01	0.13	0.07	0.11	0.16
730	1002	991	988	991	988	0.3	93.69	720.54	720.25	0.01	0.11	0.06	0.09	0.14

APPENDIX F
FUTURE SERVICING CAPACITY ASSESSMENT

Legend

- City Boundary
- Manholes
- New Westside PS
- Outfalls
- 0.49 Depth Ratio

Maximum Depth Ratio

- < 86%
- >86%
- Pumps

Population Zones

- Existing ICI
- Existing Residential
- Future ICI
- Future Residential
- Future Transitional
- Parcels

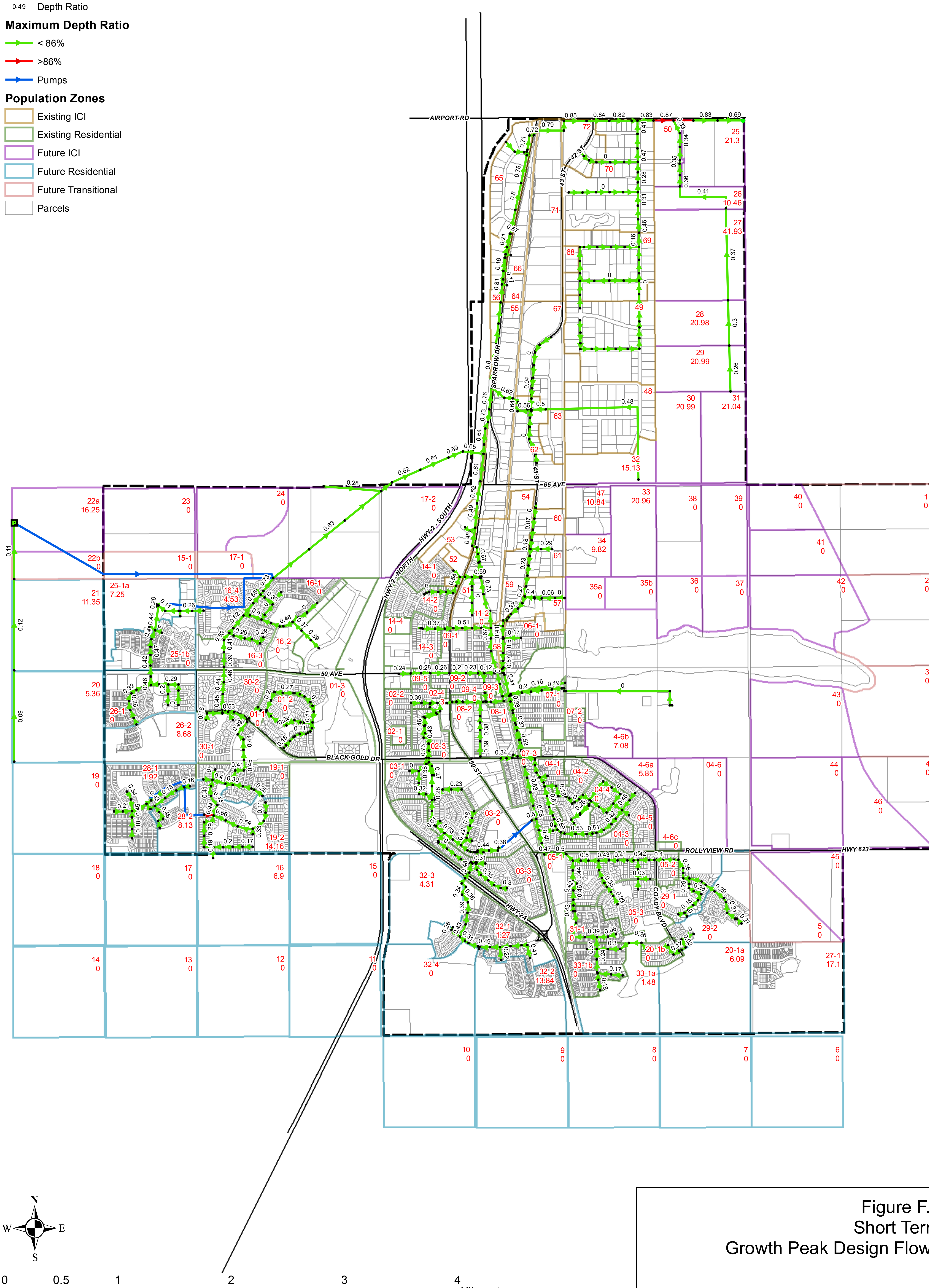


Figure F.1
Short Term
Growth Peak Design Flows

Dec 05, 2013

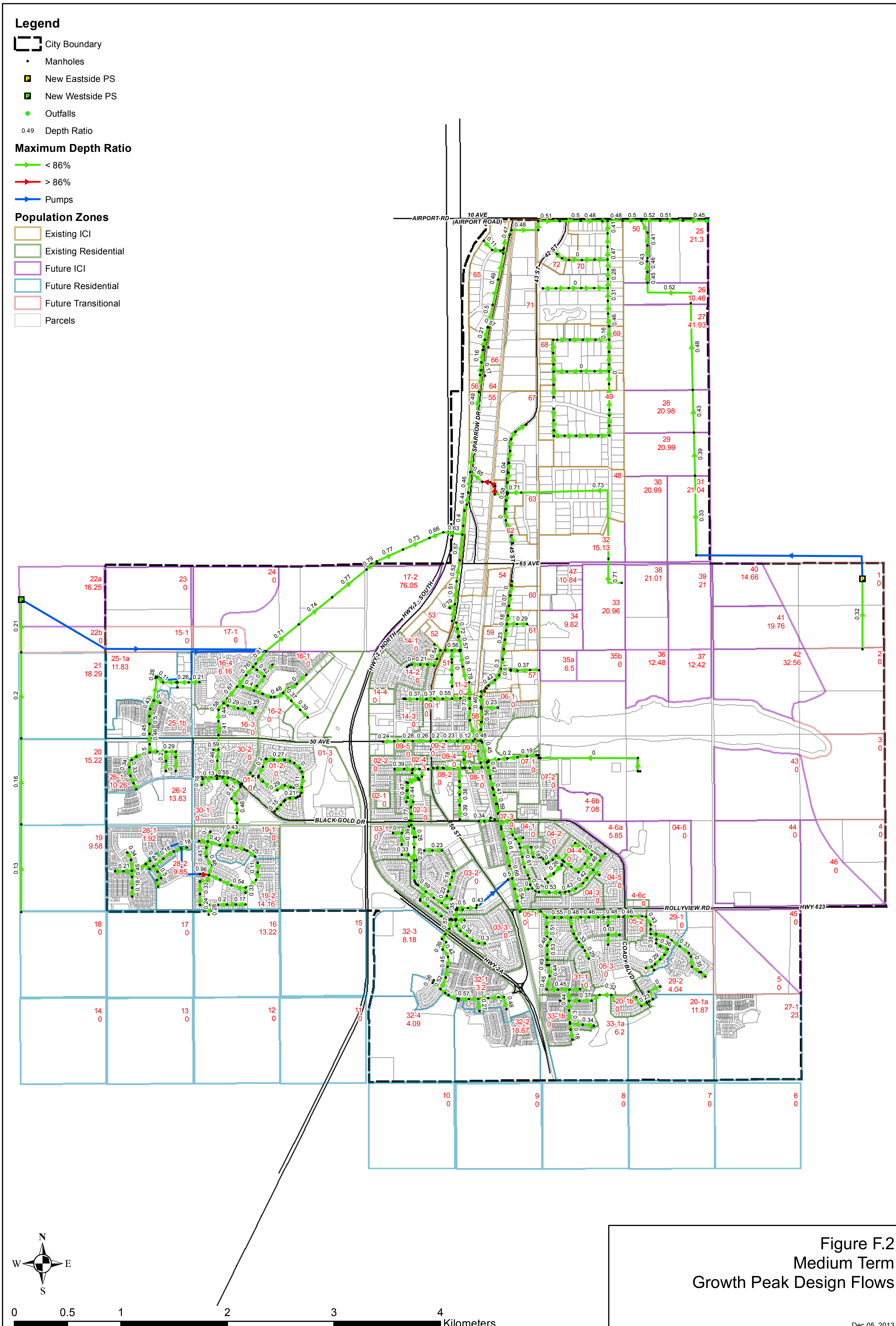


Figure F.2
Medium Term
Growth Peak Design Flows

Dec 05, 2013

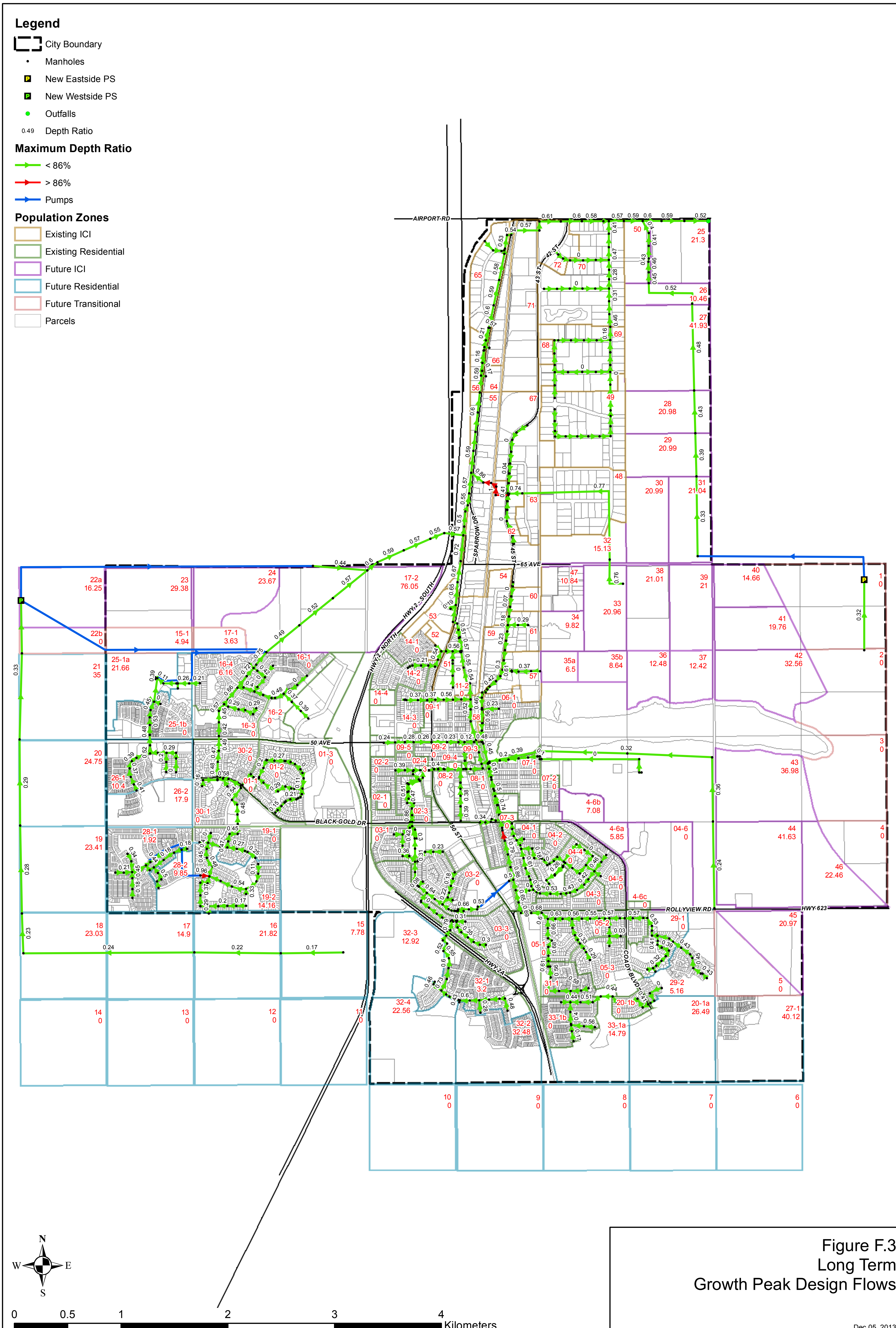


Figure F.3
Long Term
Growth Peak Design Flows

Dec 05, 2013

Legend

- City Boundary
- Manholes
- New Eastside PS
- New Westside PS
- Outfalls
- 0.49 Depth Ratio

Maximum Depth Ratio

- < 86%
- > 86%
- Pumps

Population Zones

- Existing ICI
- Existing Residential
- Future ICI
- Future Residential
- Future Transitional
- Parcels

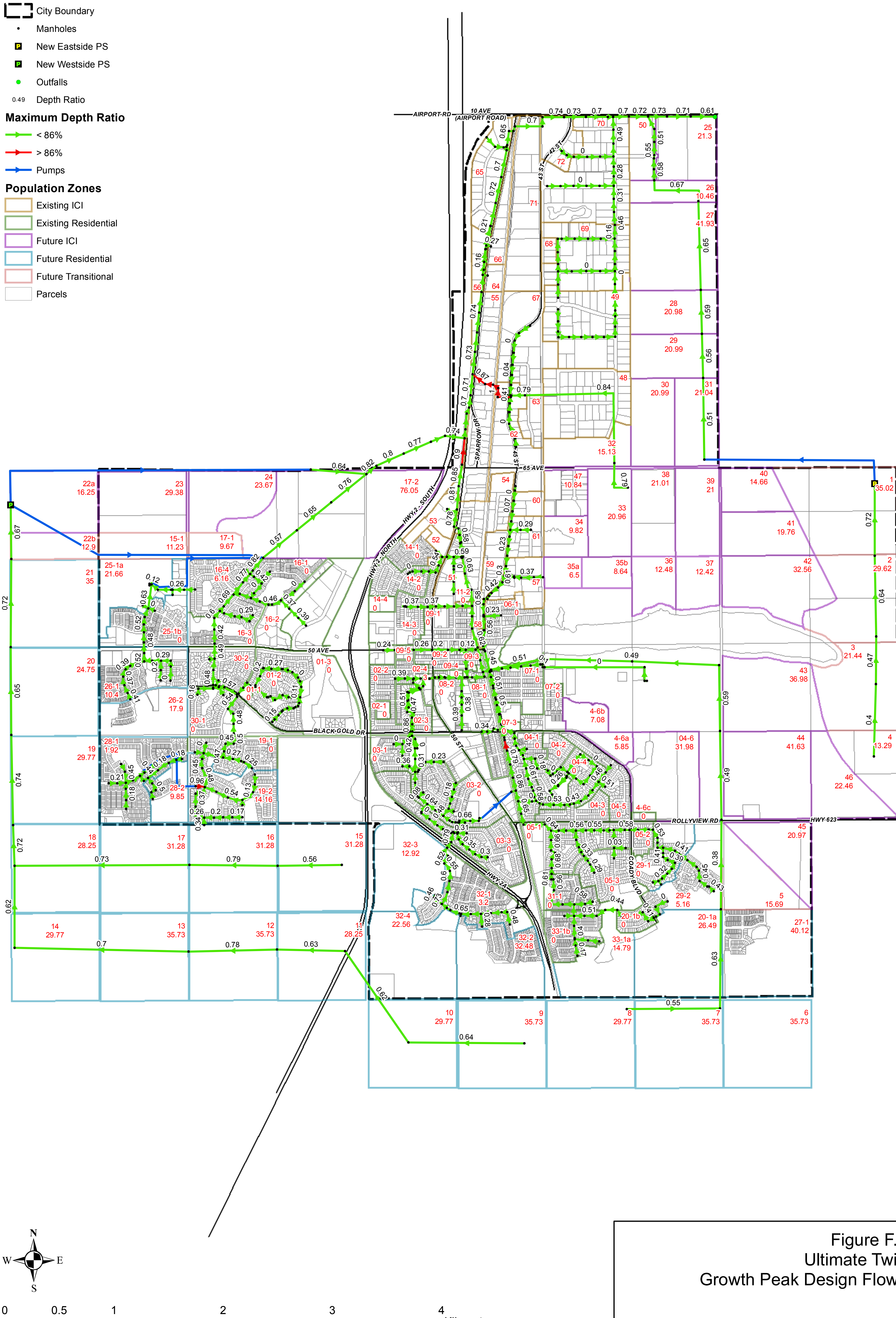


Figure F.4
Ultimate Twin
Growth Peak Design Flows

Dec 05, 2013

APPENDIX G
UNIT CAPITAL COSTS

2013 BUDGET LEVEL ESTIMATE
City of Leduc Unit Costs for Sanitary Sewer Construction
In Road

Depth	Sanitary Sewer Pipe Size (mm)													
	200	250	300	375	450	525	600	675	750	825	900	975	1050	1200
Less than 3 m	$764	$878	$987	$1,130	$1,166	$1,286	$1,401	$1,509	$1,614	$1,714	$1,815	$1,911	$2,005	$2,182
3 to 4.5 m	$844	$966	$1,082	$1,238	$1,281	$1,407	$1,483	$1,645	$1,764	$1,869	$1,977	$2,077	$2,177	$2,370
4.5 to 6 m	$926	$1,056	$1,177	$1,345	$1,386	$1,522	$1,649	$1,777	$1,892	$2,008	$2,122	$2,228	$2,337	$2,540
6 to 10 m	$1,002	$1,135	$1,261	$1,435	$1,481	$1,622	$1,757	$1,882	$2,008	$2,128	$2,243	$2,360	$2,468	$2,685
10 m or greater	$1,203	$1,345	$1,484	$1,676	$1,736	$1,890	$2,046	$2,162	$2,318	$2,448	$2,566	$2,709	$2,818	$3,071

Unit Costs include manholes every 100m.

2013 BUDGET LEVEL ESTIMATE
City of Leduc Unit Costs for Sanitary Sewer Construction
New Construction

Depth	Sanitary Sewer Pipe Size (mm)													
	200	250	300	375	450	525	600	675	750	825	900	975	1050	1200
Less than 3 m	$560	$588	$639	$762	$826	$910	$990	$1,066	$1,135	$1,209	$1,278	$1,340	$1,411	$1,534
3 to 4.5 m	$606	$675	$709	$839	$913	$1,003	$1,085	$1,169	$1,245	$1,325	$1,394	$1,468	$1,537	$1,672
4.5 to 6 m	$704	$731	$816	$926	$998	$1,094	$1,182	$1,271	$1,350	$1,432	$1,509	$1,585	$1,657	$1,803
6 to 10 m	$770	$796	$885	$1,002	$1,077	$1,174	$1,268	$1,360	$1,443	$1,530	$1,611	$1,686	$1,765	$1,911
10 m or greater	$946	$972	$1,069	$1,203	$1,287	$1,389	$1,496	$1,596	$1,693	$1,793	$1,882	$1,957	$2,054	$2,200

Unit Costs include manholes every 100m.