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Appendix

APPENDIX A
DIVERSIONS

Appendix A

Diversions

A.1 List of Diversions

The following paragraphs list the diversions in the collection system and recommendations for improvements. The location, type and description of all diversions in the Gresham collection system are summarized in **Table A-1**.

Table A-1
Collection System Diversions

Location	ID	Type/Description	Overflow Pipe Dia (inches)	Status	Out-of-Basin Diversion (y/n)
Columbia Basin					
NE 201st, 950 ft south of Sandy Blvd	2750-1-017/018	Unknown: Gresham 30-inch & 42-inch interceptor	30	Open	No
Wilkes Basin					
NE 172nd at Multnomah Drive	2947-2-003	Elevated Relief Pipe: 10-inch trunk with 8-inch overflow	10	Open	No
Rockwood Basin					
NE Glisan St at 185th Pl	2949-3-005	Elevated Relief Pipe: Glisan 12-inch trunk	10	Open	Yes, Wilkes
201st St, 200 ft south of I-84	2850-3-020	Not Active: Cedar Lakes 36-inch & Gresham 24-inch interceptors	36	Open	Yes, Wilkes
Stark Street Basin					
SE Stark, 450 ft east of 202nd St	3051-5-007	Not Active: Stark 12-inch trunk & Gresham parallel 30-inch interceptor	12	Plug	No
North of Max Tracks, west of Birdsdale	3151-5-006	Stoplog Weir: Controls 30-inch trunk from Kelly Creek Basin	30	Open	No
Kelly Creek Basin					
NW Eastman, 600 ft south of Burnside	3252-6-016	Restrictor Plate[1]: North parallel trunk sewers	15	Open	No
N Main at NE 18th St	3253-6-006	Restrictor Plate[1]: North parallel trunk sewers	8	Open	No
NE Liberty at 18th St	3254-6-012/013	Restrictor Plate[1]: North parallel trunk sewers	15	Open	No

Location	ID	Type/Description	Overflow Pipe Dia (inches)	Status	Out-of-Basin Diversion (y/n)
NE Hogan at 18th St	3254-6-028	Restrictor Plate[1]: North parallel trunk sewers	10	Open	No
Gresham Golf Course	3255-6-003	Restrictor Plate[1]: North trunk and Kelly Creek trunk	15	Open	No
East Basin					
NE Kelly at 8th St	3353-7-092	Restrictor Plate[1]: East Basin 18-inch trunk	12	Open	No
NE Liberty at Powell Blvd	3354-7-042	Flow Split: Minor 8-inch diversion	8	Open	No
NE Cleveland, south of MAX tracks	3354-7-052	Not Active: East Basin 18-inch trunk	18	Open	No
SE Roberts at NE 4th St	3453-7-019	Fixed Weir: Roberts 12-inch to Johnson Creek 36-inch	12	Open	Yes, Johnson Creek
SE Roberts at NE 9th St	3454-7-042	Fixed Weir: Roberts 12-inch to Johnson Creek 30-inch	8	Open	Yes, Johnson Creek
SE Burnside Rd, 200 ft north of 3rd St	3455-7-064	Flow Split: East Bain parallel 18-inch trunks	18	Open	No

Note

1 Restrictor plates are bolted to the crown of the pipe inlet, generally above the spring line. Restrictor plates were not simulated in the hydraulic model.

A.1.1.1 Fixed weirs

Two diversions on Roberts Avenue have the potential to allow flow relief from East basin to Johnson Creek under surcharged conditions. The exact height of the weirs was not available so the weirs were simulated in the hydraulic model with a 1-foot height above the pipe invert. Under these conditions the diversions would not spill during the 5-year storm under current conditions. Note that monitoring did occur at one of these locations and no spilling was recorded.

Recommendations: Confirm weir elevation. If the heights of the weirs are significantly lower that one foot, they should be raised to prevent high flows from entering Johnson Creek basin.

A.1.1.2 Stop Log Weir

A stop log weir structure is located at the south end of the East Trunk. The structure was built prior to the construction of the West Trunk Sewer Project and was intended to balance flows between the east and west trunk. The actual height of the weir is unknown, but the weir was simulated as with 1.0-feet of stop logs. Under these assumptions the peak flow entering the structure during the 5-year design storm is currently estimated to be 28 cfs with 3.0 cfs spilling over the weir into the 30-inch pipe to the West Trunk. The model shows no flow deficiencies result from this setting, however more flow could be diverted to the west trunk.

Recommendations: Confirm the weir elevation. Inspect manholes between manholes 3151-5-006 and 3151-5-004 for evidence of surcharge. Lower weir if surcharge evidence is found.

A.1.1.3 Elevated Relief Pipes

These are manholes with one pipe entering and two exiting with one of the exiting pipes at a higher elevation. The higher elevation acts as a relief when water levels rise due to high flows.

Recommendation: No action is required.

A.1.1.4 Flow Split

These are manholes with one pipe entering and two exiting with no flow control.

Recommendation: No action is required.

A.1.1.5 Restrictor Plates

Several control manholes with restrictor plates are located in the Lower Kelly Basin (sub-basin 61). The restrictor plates are bolted to a pipe exiting the manhole in order to allow low flows through an exiting pipe and to force higher flows through another exiting pipe. These diversions were reviewed during design storm conditions, and it is not clear that these controls are required. It may be possible the same purpose is served during dry weather conditions but it is not apparent. It is possible that system improvements were made after the restrictor plates were installed which make these plates unnecessary. These plates were listed in the 2001 Wastewater Conveyance System Master Plan.

Recommendations: Review these locations with long-term maintenance and operations staff. Verify that the plates are installed and attempt to determine if they serve any purpose. Consider removing these restrictor plates based on this review.

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APPENDIX B
MODEL CALIBRATION TABLE AND PLOTS

Appendix B

Model Calibration Table and Plots

Table B-1
Dry and Wet Weather Calibration Details

Monitor	Basin	GWI Added (gpm)	DWF Calibration Date	Observed Peak (gpm)	Simulated Peak (gpm)	Error (%)	WWF Calibration Dates	24-hr Rainfall Depth (inch)	Storm Frequency (years)	Peak Simulated (gpm)	Peak Observed (gpm)	Error (%)	Calibration Notes
2850-2-005	Wilkes	0	7/16/2015	430	470	9%	11/24/2016 4/7/2018	1.8 2	<1.0 <1.0	1450 1480	1590 1480	-9% 0%	Calibration focused on latest (2018) storm.
2951-5-010	Stark	0	7/12/2012	868	672	-23%	11/22/2011 None	2	<1.0	650	1000	-35%	Much of the variation in flow in this monitor is related to industrial discharges that occur randomly. Industrial permits for this area indicate a steady increase in wastewater discharges over time since the monitoring period. Only wet period monitored was 11/2011.
3050-3-009	Rockwood	0	7/26/2012	542	644	19%	1/18/2012 11/19/2012	2.5 2.4	3.9 3.8	1210 1150	1060 1080	14% 6%	
3051-5-008	Stark	0	7/26/2012	290	290	0%	1/18/2012 11/22/2011	2.5 2	3.9 1.2	425 380	410 420	4% -10%	Although WWF appears to underestimate, during most of the storms it actually is predicting slightly higher flows than observed.
3051-5-018	Stark	0	8/25/2012	760	850	12%	1/18/2012 11/1/2011	2.5 2	3.9 <1.0	No WWF Observed No WWF Observed	No WWF Observed No WWF Observed		Wet industrial discharge pipe. Not much RDII observed during storms, but random high discharges.
3155-6-002	Kelly Creek	0	8/12/2010	132	132	0%	11/17/2010 None	1.7	<1.0	No WWF Observed 0	No WWF Observed 0		Very small area with short monitoring period.
3252-6-041	Kelly Creek	0	8/18/2016	1505	1440	-4%	3/15/2015 1/18/2015	2.5 2.1	3.9 3.3	3890 3023	3650 2972	7% 2%	2015 Stprms look very well calibrated. Simulated flows are higher compared to previous calibration storm.
3252-7-005	East	200	9/15/2011	1740	1640	-6%	1/15/2012 2/15/2014	2.5 1.3	3.9 <1.0	7140 4860	6870 4410	4% 10%	Slightly underpredicts peak for 12/2010 storm.
3352-7-006	East	0	8/23/2012	305	336	10%	2/28/2011 3/9/2011	2.5	4.0	1920 2060	2070 1920	-7% 7%	
3356-6-002	Kelly Creek	0	5/10/2018	610	585	-4%	4/7/2018 2/28/2011	2 2.5	<1.0 2.5	1493 1910	1397 2060	7% -7%	
3451-4-004	Johnson Creek	0	8/11/2011	330	302	-8%	12/9/2010 2/28/2011	2 2.5	3.2 3.99	1190 1160	1260 1080	-6% 7%	
3556-7-008	East	45	7/15/2010	375	334	-11%	1/18/2012 12/10/2010	2.5 2	3.9 3.2	1600 1530	3600 1230	-56% 24%	Backwater and surcharge conditions occur in pipe during WWF events.
WWTP Effluent	All	0	8/9/2018	8630	10000	16%	12/6/2015 2/3/2017	4.1 2.4	6.4 3.8	33910 20870	27520 22530	23% -7%	December 2015 storm is largest flow event in series.
185th PS*	Columbia	45	8/1/2016	122	120	-2%	2/1/2017 12/1/2015	2.4 4.1	3.8 6.4	212 263	247 265	-14% -1%	December 2015 storm is largest flow event in series.
Linneman PS*	Johnson Creek	0	8/1/2016	811	789	-3%	2/1/2017 12/1/2015	2.4 4.1	3.8 6.4	4600 7295	4870 6402	-6% 14%	December 2015 storm is largest flow event in series.

Table B-2
Monitoring Observation Periods and Data Review

Monitor Location	monitoring dates	Used in calibration
	Columbia	
185th PS	2014-2018	Yes
	East	
3252-7-005	1/18/10 to 1/18/13	Yes
	1/18/13 to 10/29/16	Yes
	1/3/18 to 8/2/18	No
3352-7-006	1/22/10 to 10/30/12	Yes
3556-7-008	2/5/10 to 2/25/13	Yes
3556-7-009	1/3/18 to 8/2/18	No
	Johnson Creek	
3451-4-004	1/22/10 to 11/1/11	Yes
3451-4-004	1/3/18 to 5/6/18	No
Linneman PS	12/1/08 to 2/1/18	Yes
3550-4-004	1/18/18 to 8/2/18	No
	Kelly Creek	
3155-6-002	2/22/10 to 8/24/11	Yes
3252-6-041	1/18/10 to 1/18/13	No
	1/18/13 to 1/18/16	Yes
	1/18/16 to 8/15/17	No
3356-6-002	2/3/10 to 5/24/10	Yes
	1/18/18 to 5/17/18	Yes
3356-6-006	1/18/18 to 8/2/18	No
	Rockwood	
3050-3-009	1/27/10 to 12/20/12	Yes
	Stark	
2951-5-010	10/26/11 to 9/5/12	Yes
3051-5-008	1/27/10 to 9/26/12	Yes
3051-5-018	10/26/11 to 8/30/12	Yes
	Wilkes	
2850-2-005	1/21/10 to 1/21/13	Yes
	1/21/13 to 1/21/16	No
	1/21/16 to 2/17/17	Yes
	1/3/18 to 8/2/18	Yes

Figure B-1
Meter at 2850-2-005 (M6041) Dry Weather Calibration

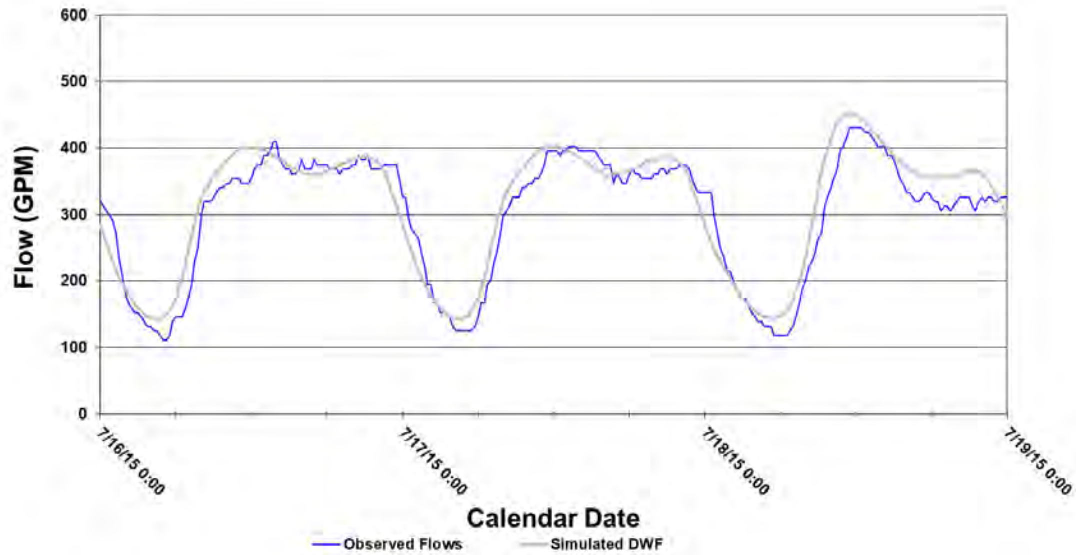


Figure B-2
Meter at 2951-5-010 (M6365) Dry Weather Calibration

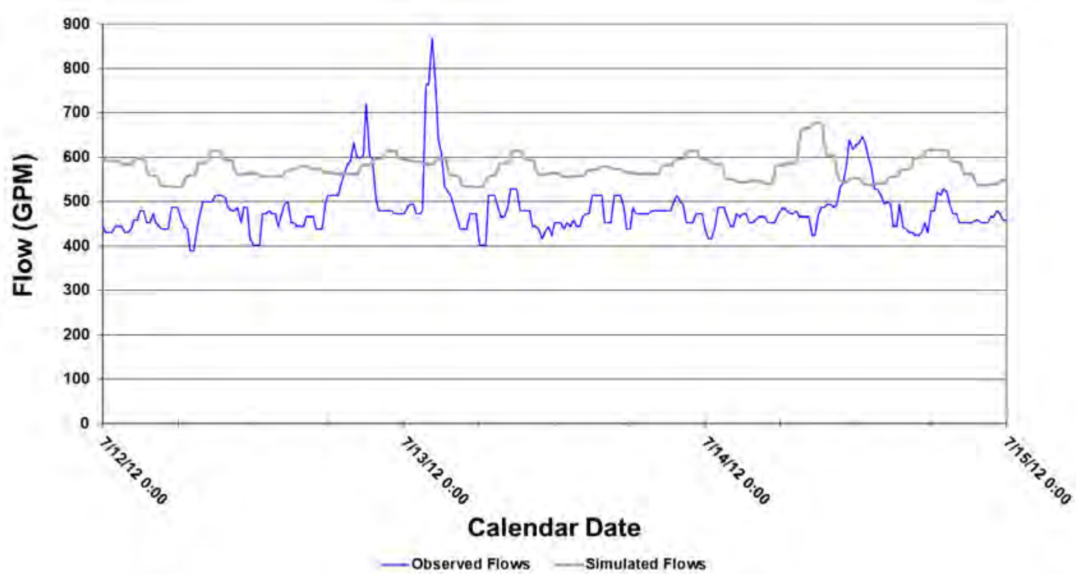


Figure B-3
Meter at 3050-3-009 (M6463) Dry Weather Calibration

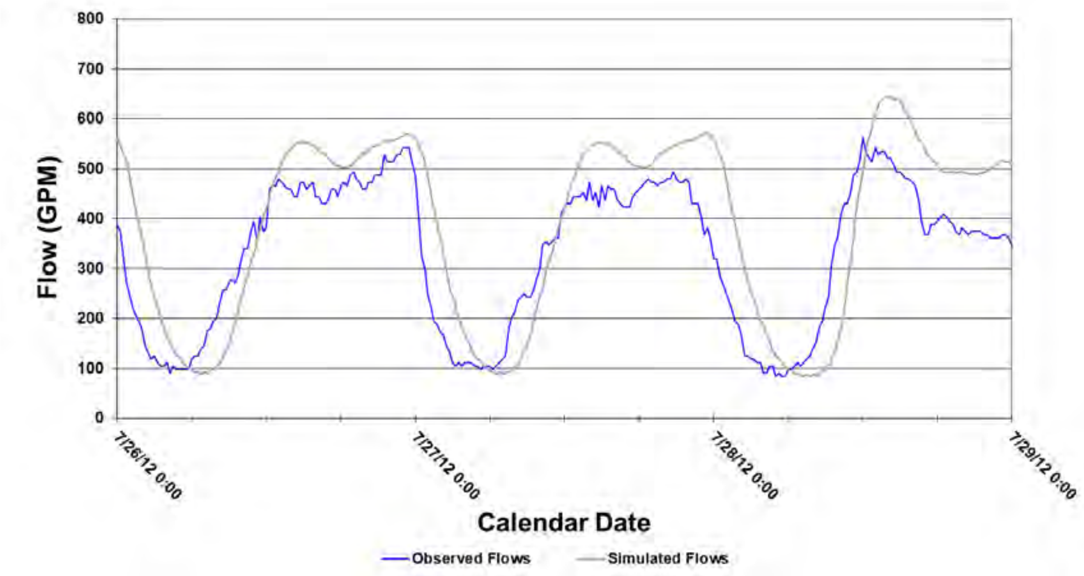


Figure B-4
Meter at 3051-5-008 (M6762) Dry Weather Calibration

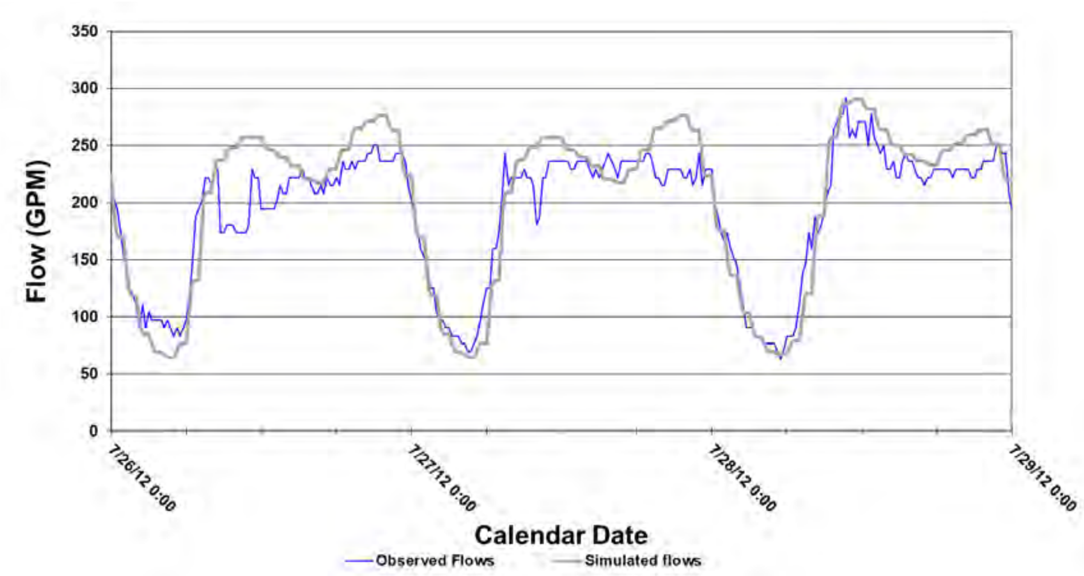


Figure B-5
Meter at 3051-5-018 (M6473) Dry Weather Calibration

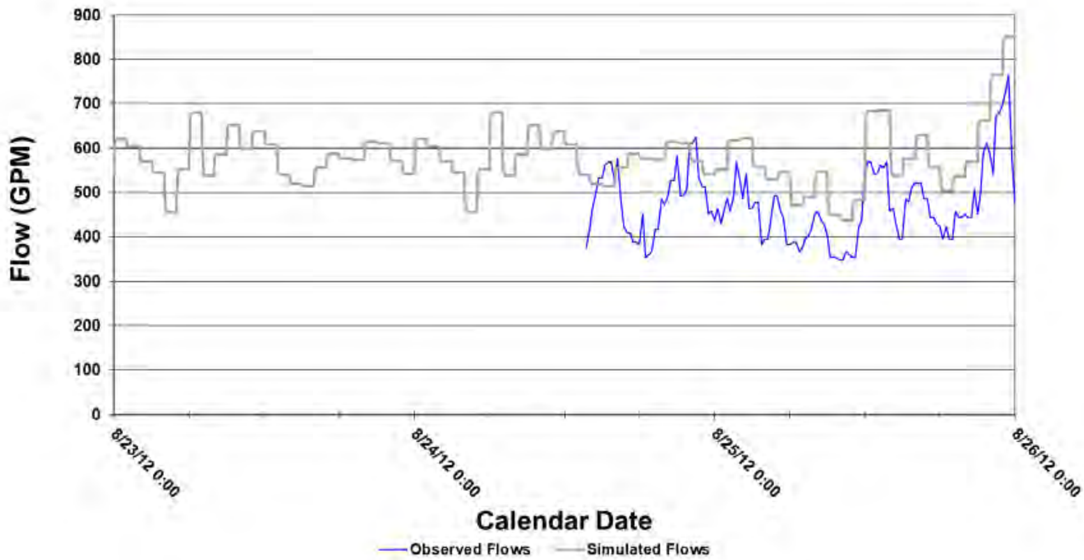


Figure B-6
Meter at 3155-6-002 (M6317) Dry Weather Calibration

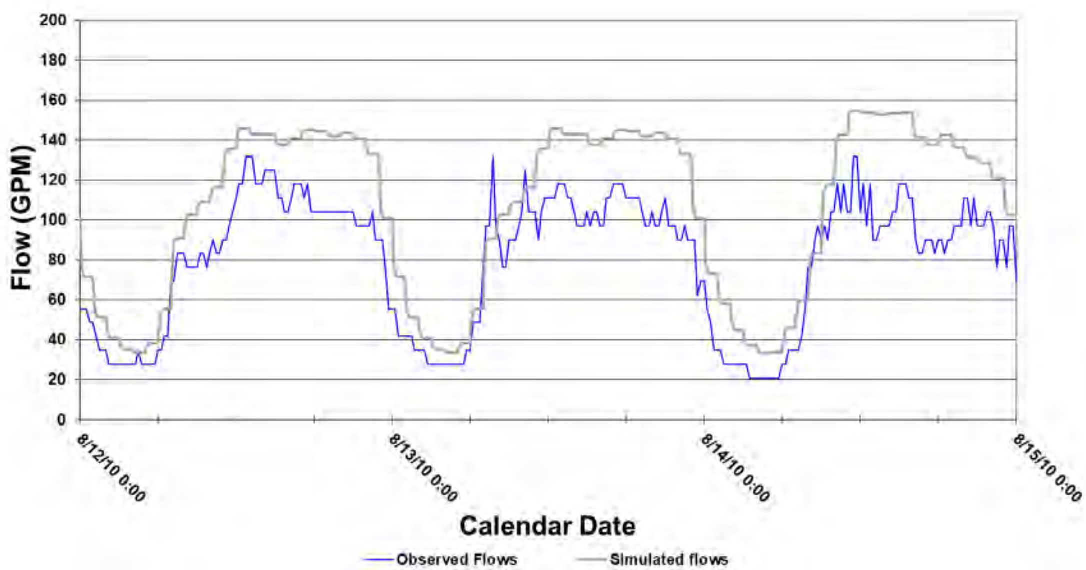


Figure B-7
Meter at 3252-6-041 (M11193) Dry Weather Calibration

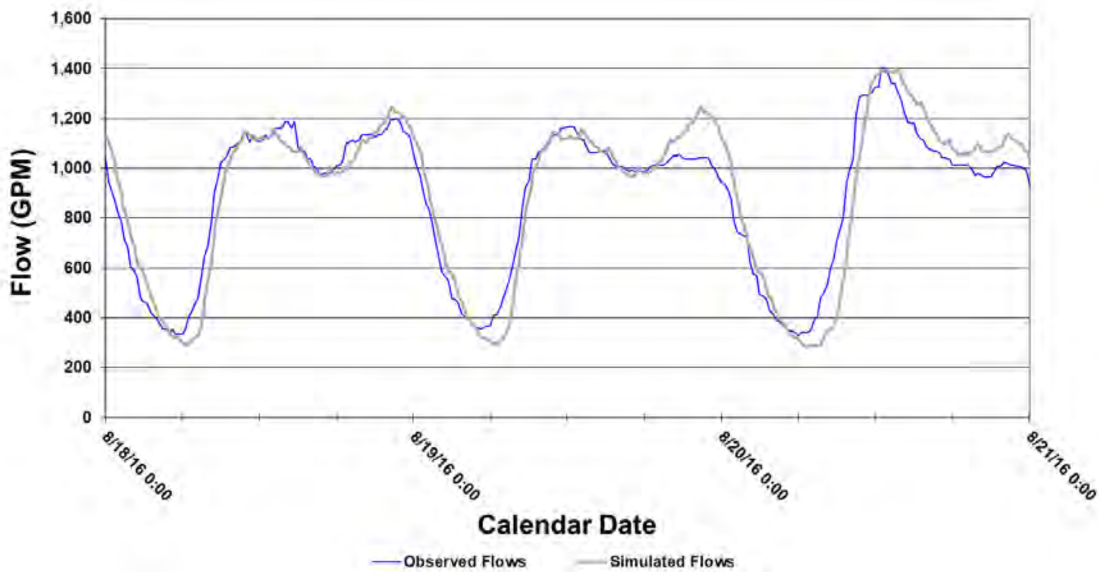


Figure B-8
Meter at 3252-7-005 (M6599) Dry Weather Calibration

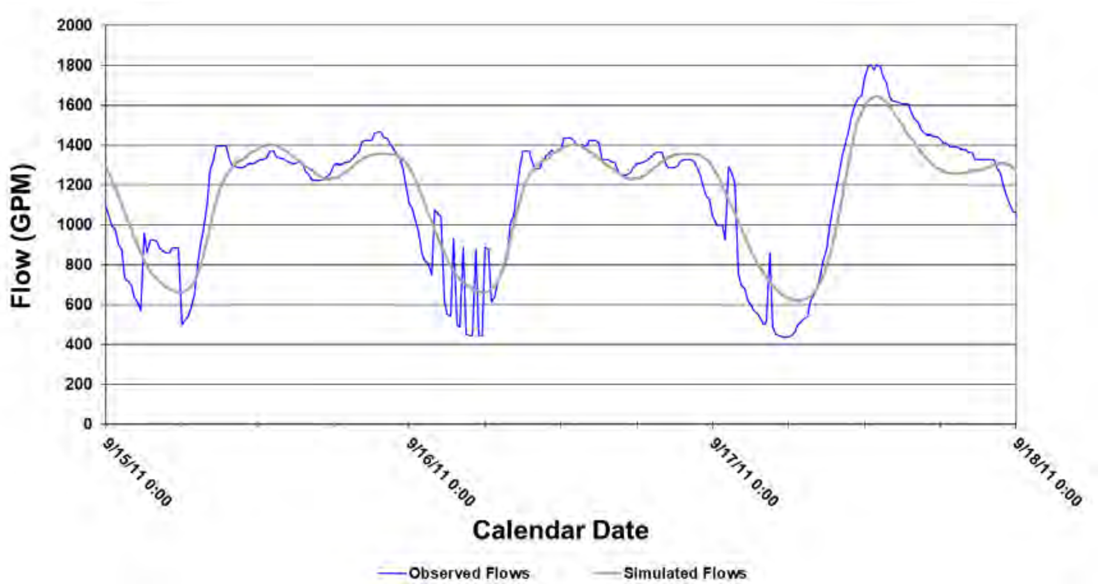


Figure B-9
Meter at 3352-7-006 (M6269) Dry Weather Calibration

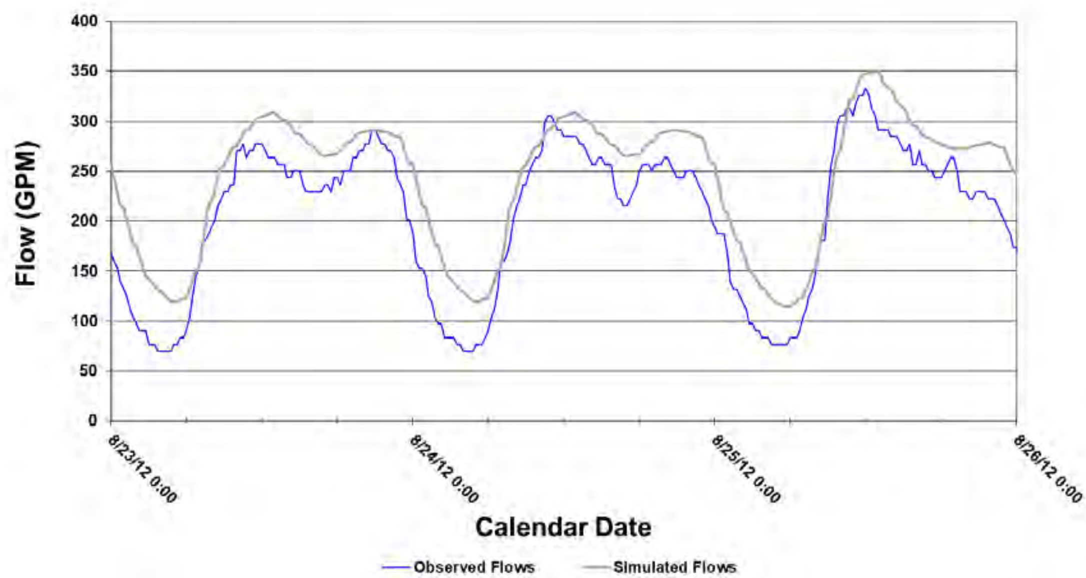


Figure B-10
Meter at 3356-6-002 (M6820) Dry Weather Calibration

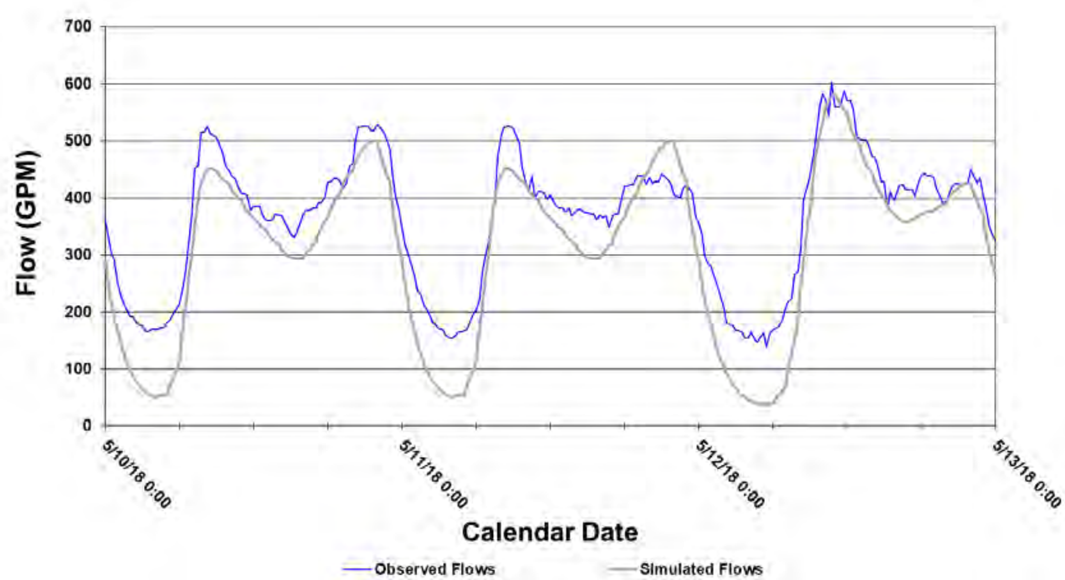


Figure B-11
Meter at 3451-4-004 (M6139) Dry Weather Calibration

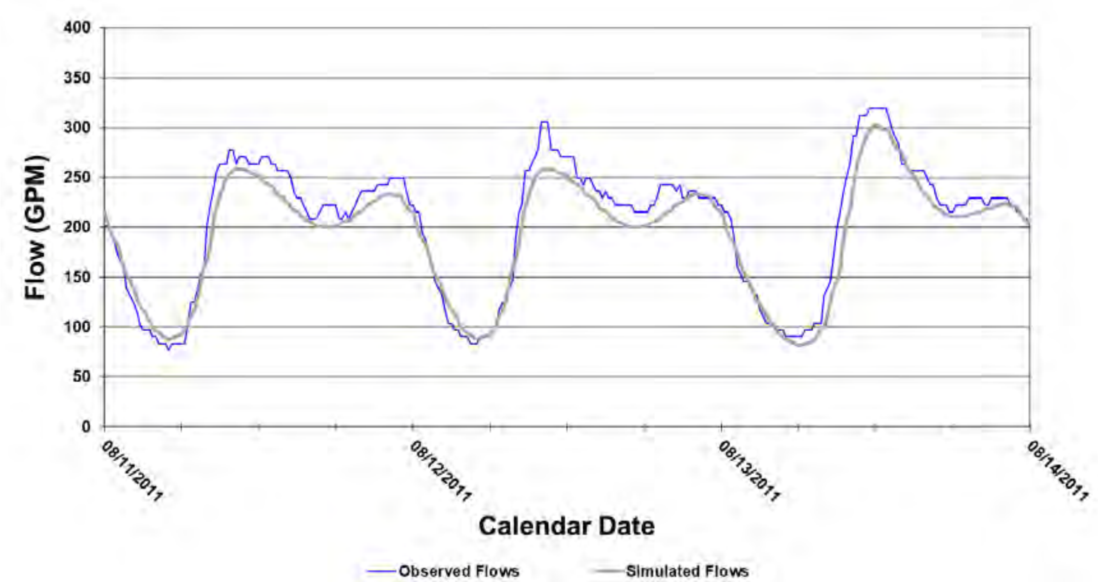


Figure B-12
Meter at 3556-7-008 (M5940) Dry Weather Calibration

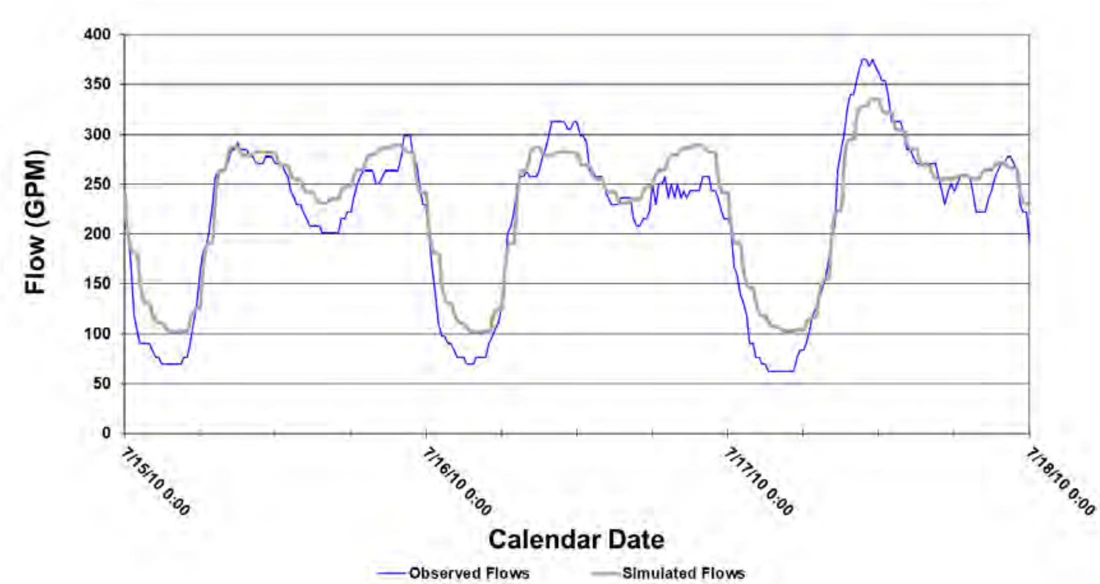


Figure B-13
WWTP Effluent (6914) Dry Weather Calibration

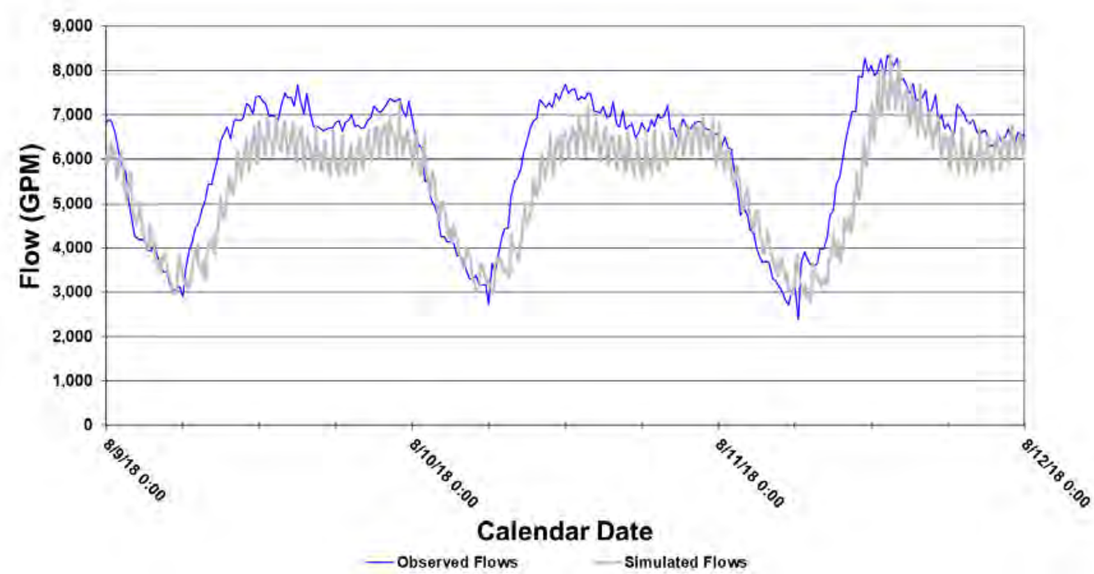


Figure B-14
185th Pump station (M10317 & M5915) Dry Weather Calibration

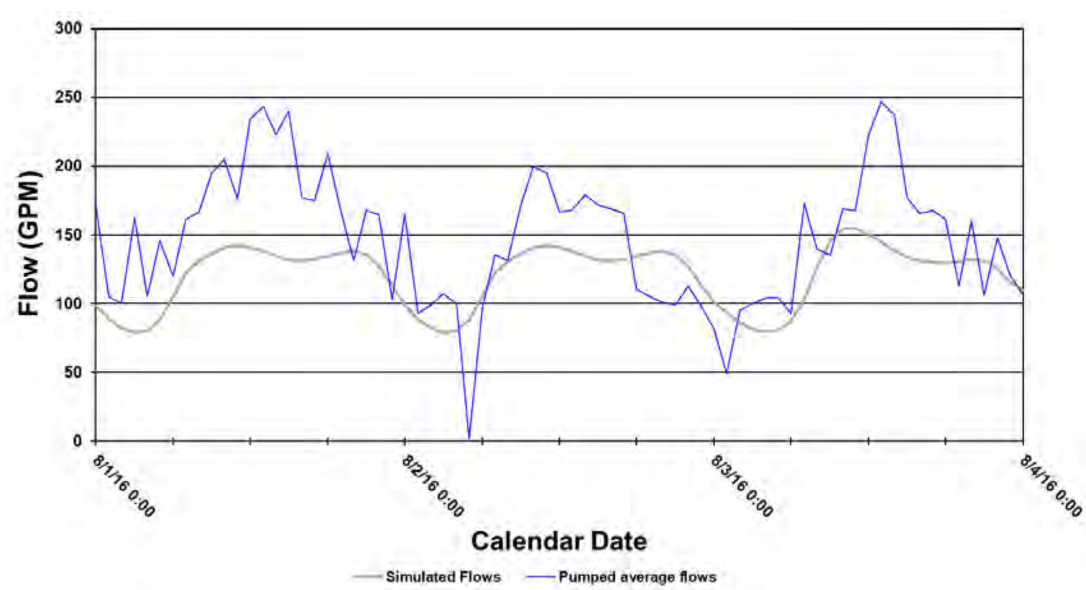


Figure B-15
Linneman Pump station (M12177) Dry Weather Calibration

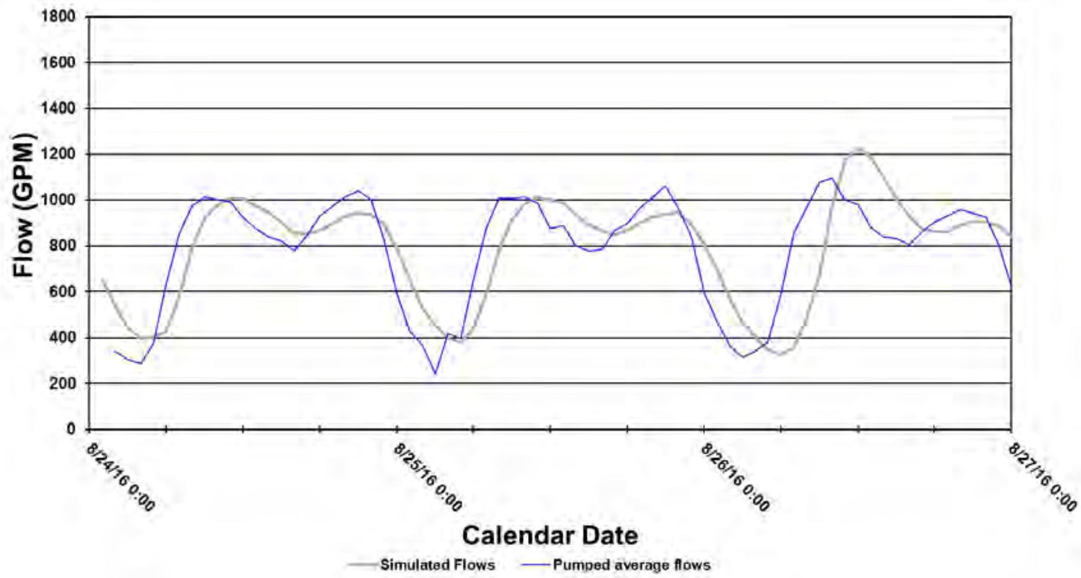


Figure B-16
Meter at 2850-2-005 (M6041) Wet Weather Calibration 12/7/10 to 12/31/10

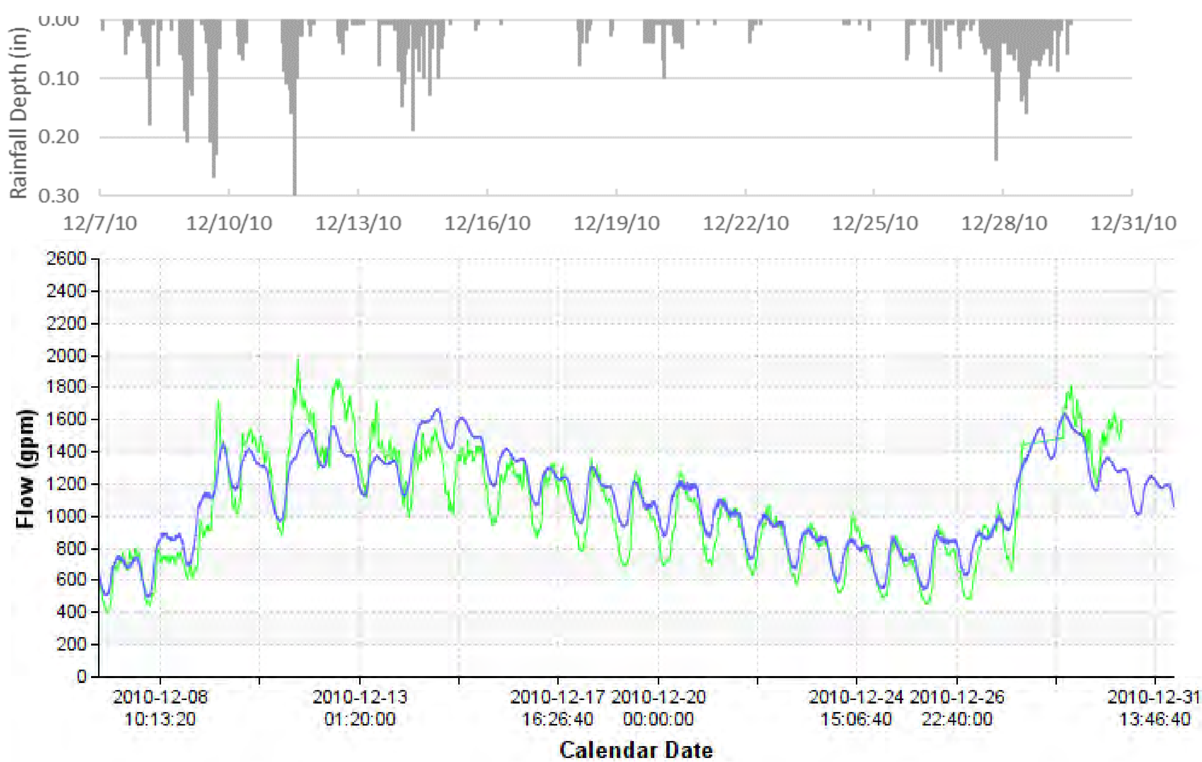


Figure B-17
Meter at 2850-2-005 (M6041) Wet Weather Calibration 11/17/2016 to 12/01/2016

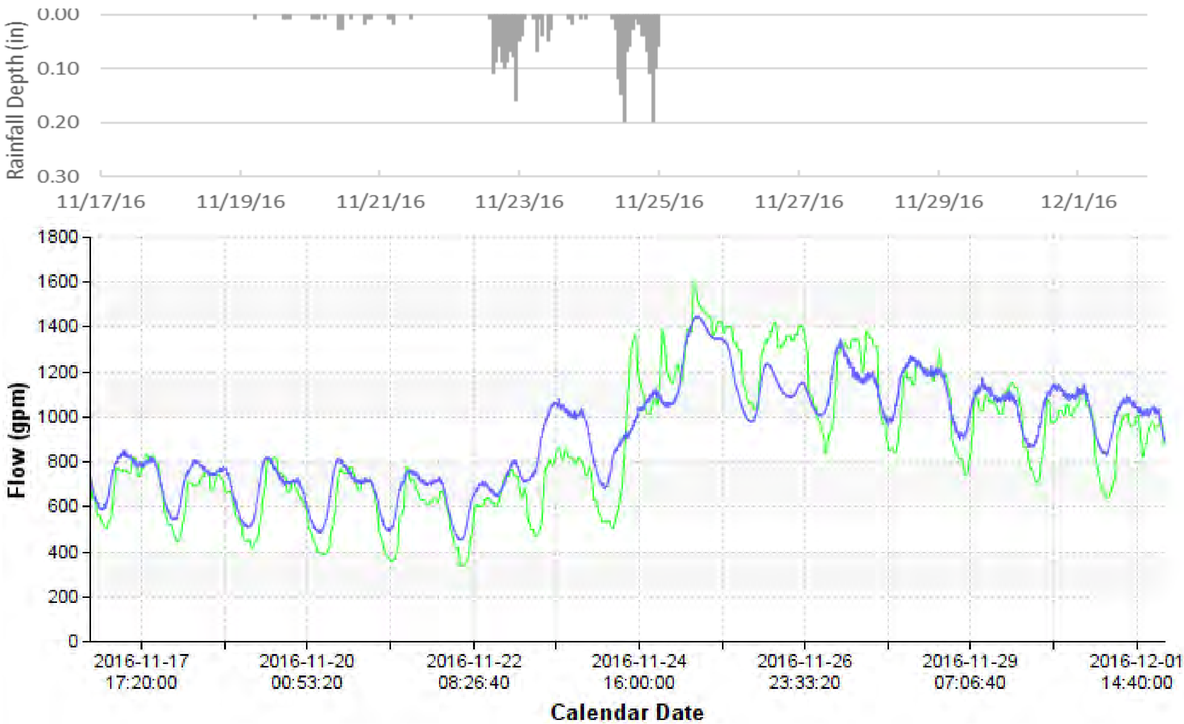


Figure B-18
Meter at 2850-2-005 (M6041) Wet Weather Calibration 3/28/18 to 4/25/18

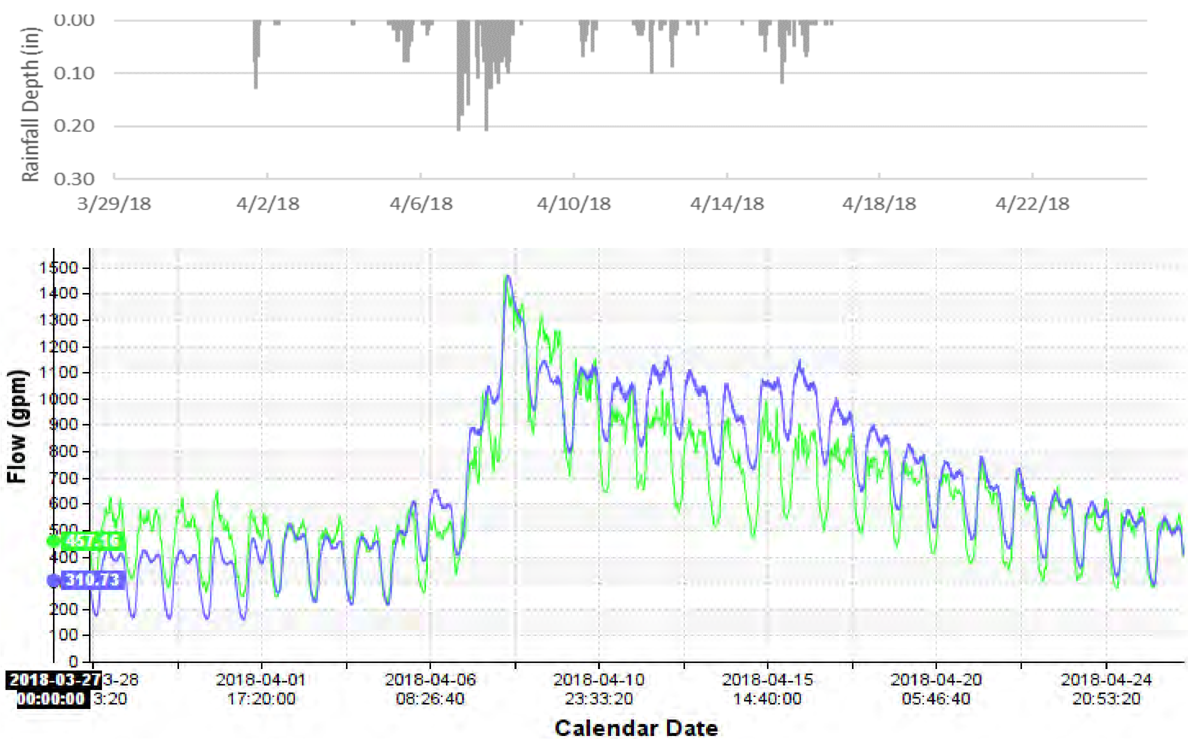


Figure B-19
Meter at 2951-5-010 (M6365) Wet Weather Calibration 11/15/11 to 11/29/11

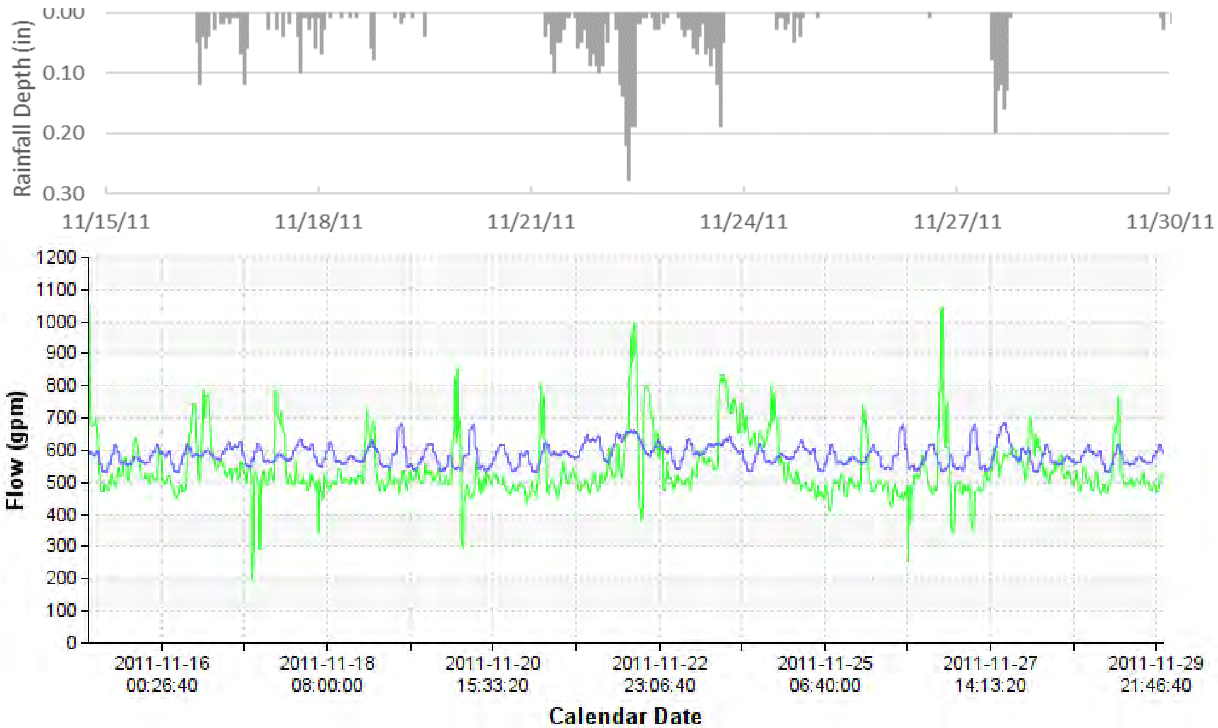


Figure B-20
Meter at 3050-3-009 (M6463) Wet Weather Calibration 1/11/12 to 1/25/12

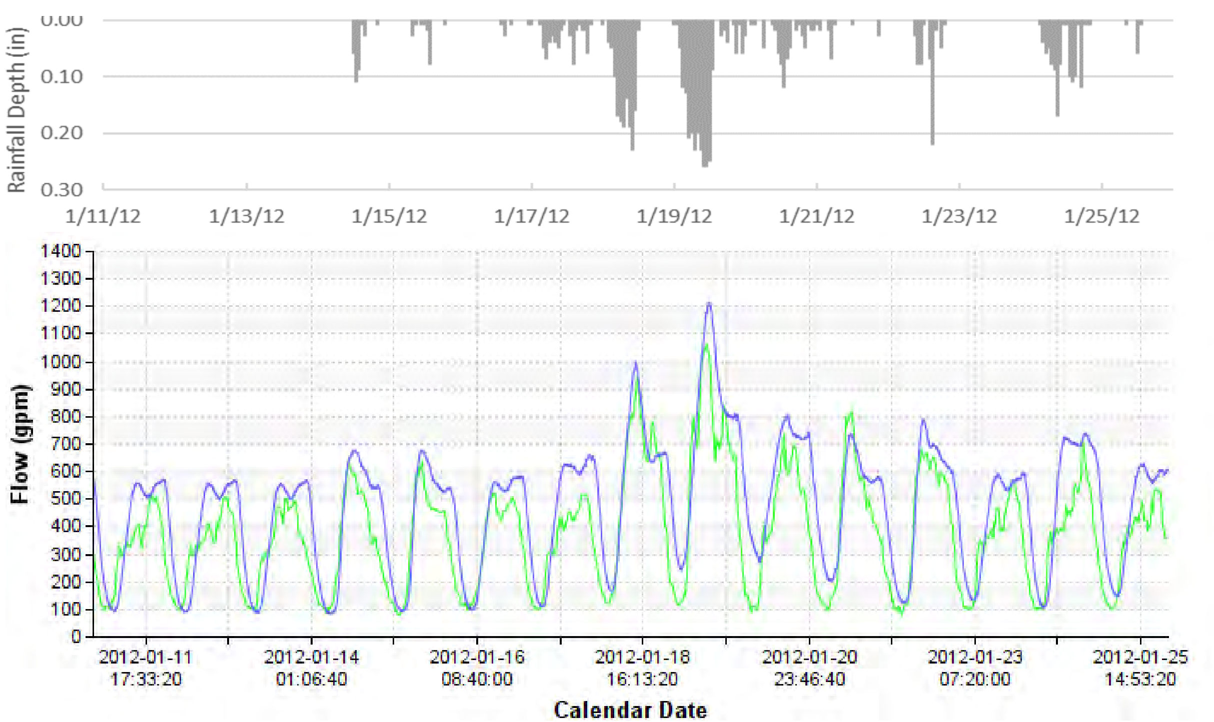


Figure B-21
Meter at 3050-3-009 (M6463) Wet Weather Calibration 11/12/12 to 11/26/12

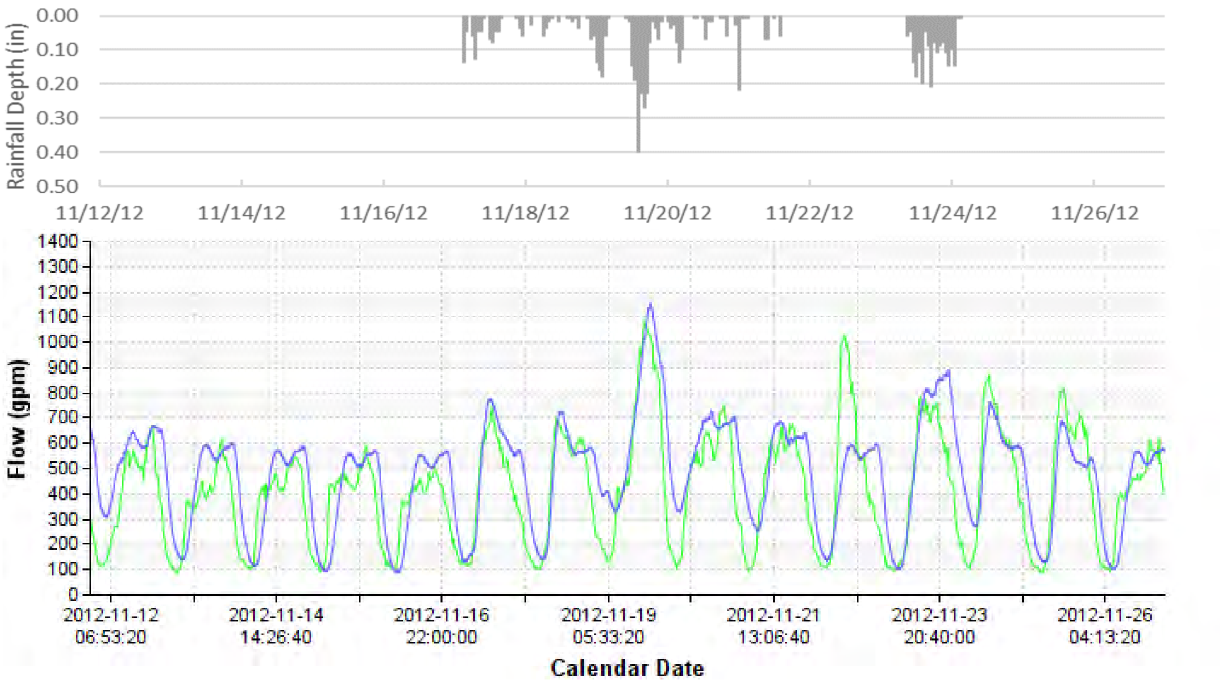


Figure B-22
Meter at 3051-5-008 (M6762) Wet Weather Calibration 1/12/12 to 1/27/12

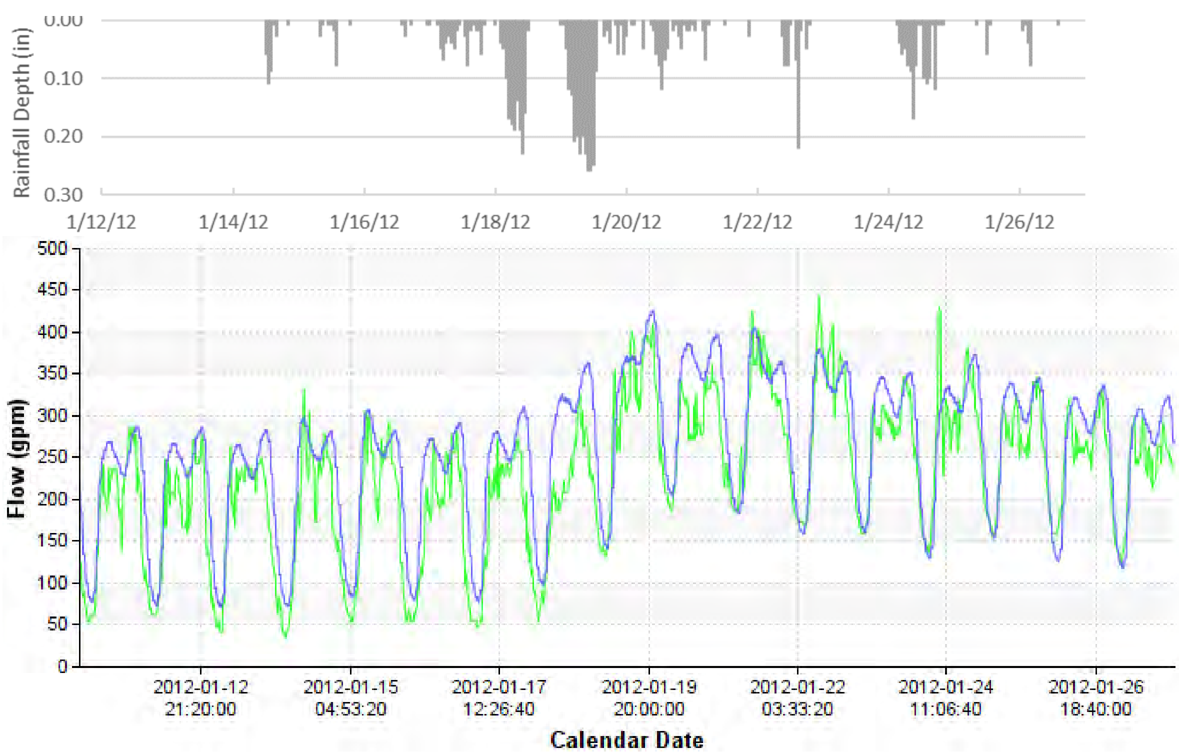


Figure B-23
Meter at 3051-5-008 (M6762) Wet Weather Calibration 11/16/2011 to 12/01/2011

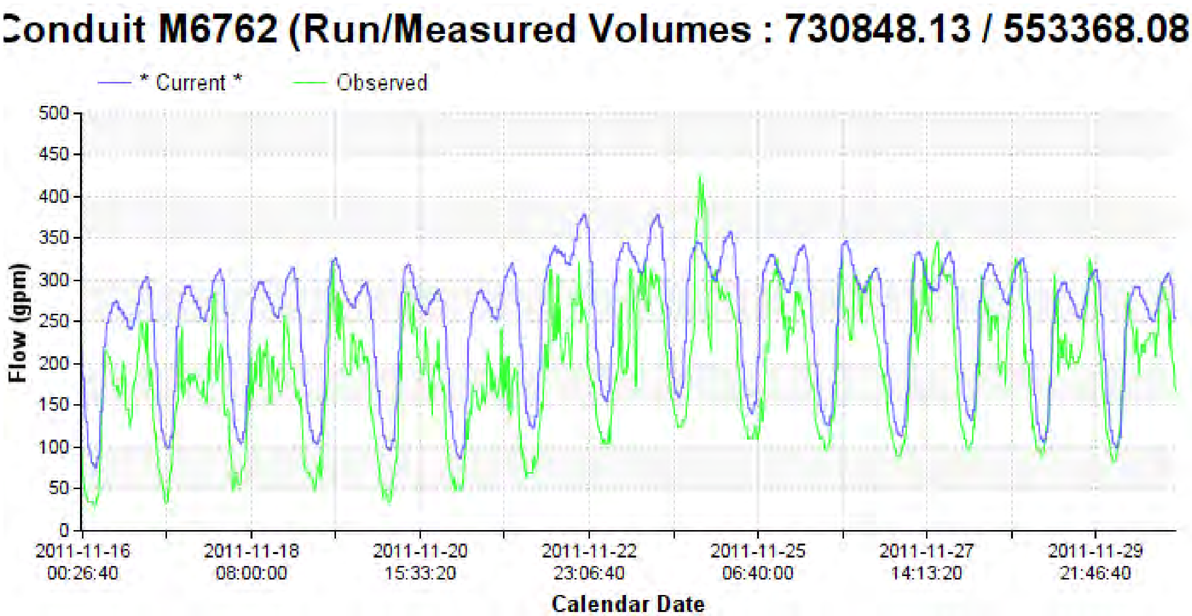


Figure B-24
Meter at 3051-5-018 (M6473) Wet Weather Calibration 1/12/12 to 1/27/12

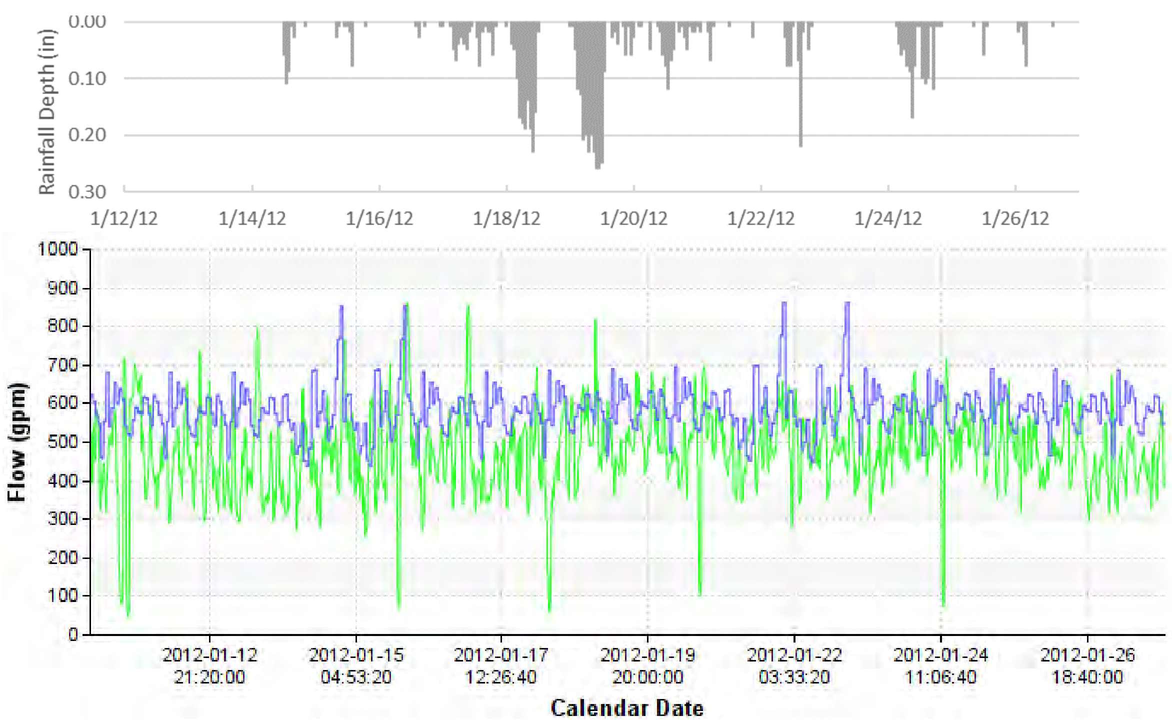


Figure B-25
Meter at 3051-5-018 (M6473) Wet Weather Calibration 11/7/11 to 11/22/11

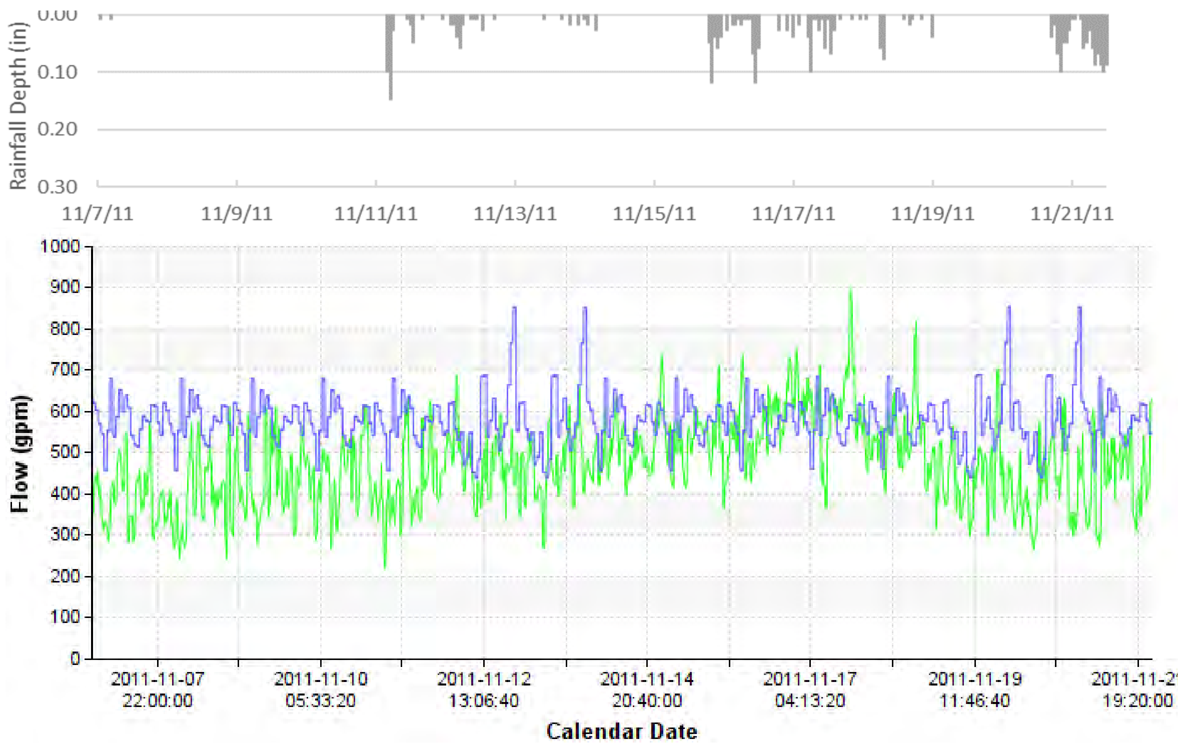


Figure B-26
Meter at 3155-6-002 (M6317) Wet Weather Calibration 11/10/10 to 11/26/10

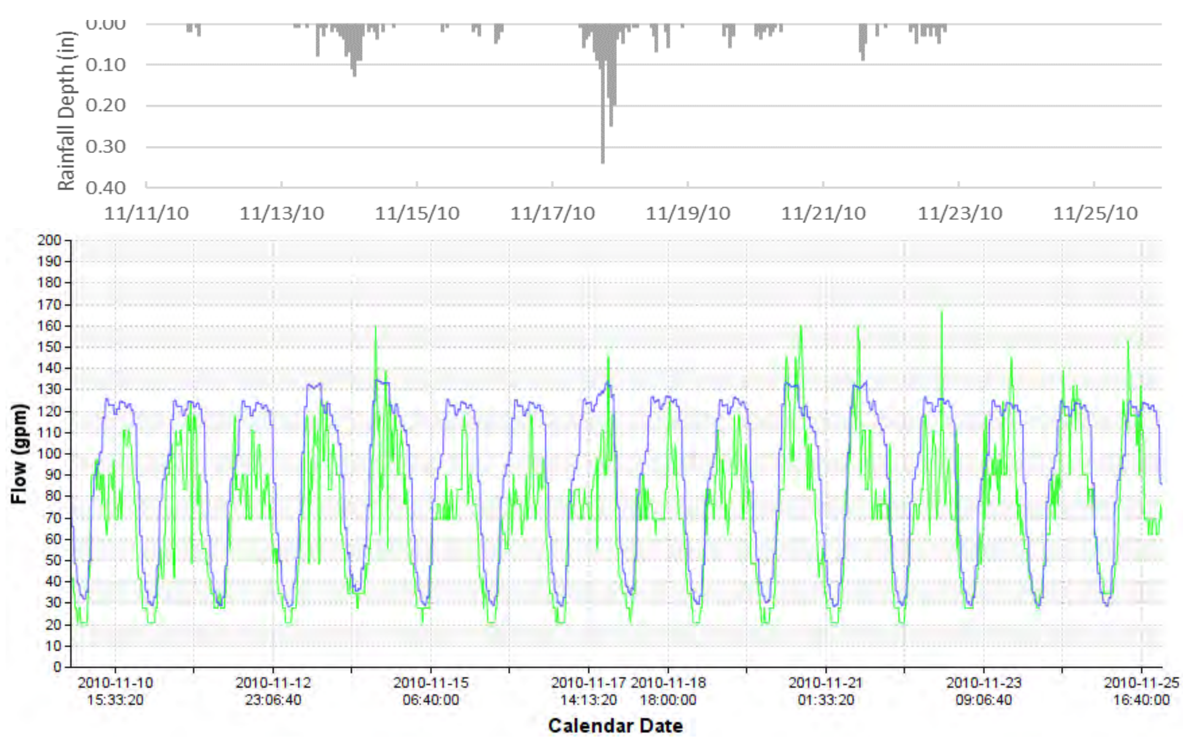


Figure B-27
Meter at 3252-6-041 (M11193) Wet Weather Calibration 12/7/10 to 12/19/10

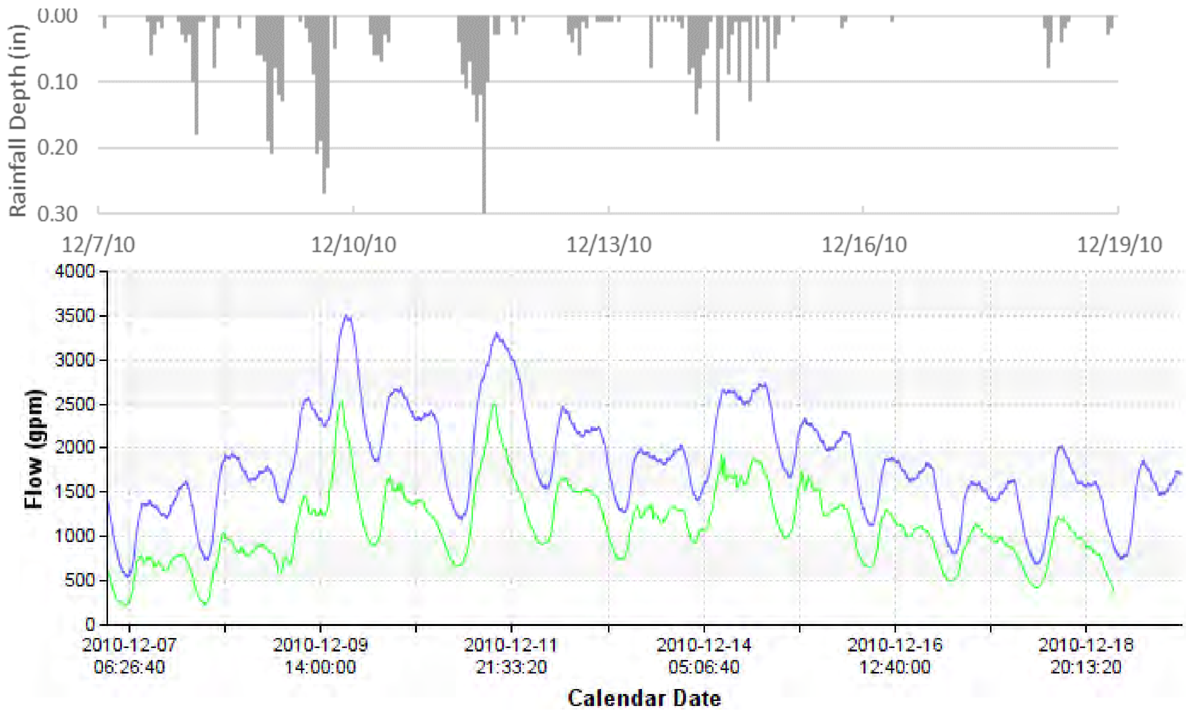


Figure B-28
Meter at 3252-6-041 (M11193) Wet Weather Calibration 1/10/2015 to 1/28/2015

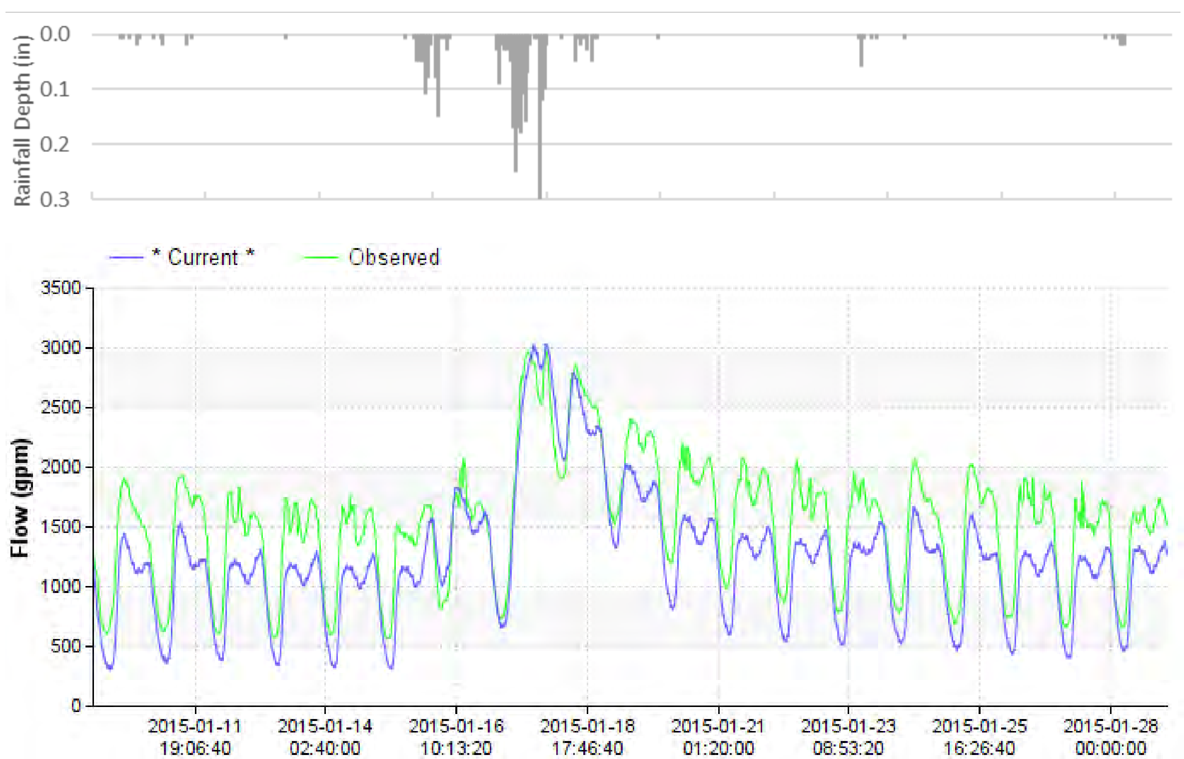


Figure B-29
Meter at 3252-6-041 (M11193) Wet Weather Calibration 3/10/15 to 3/24/15

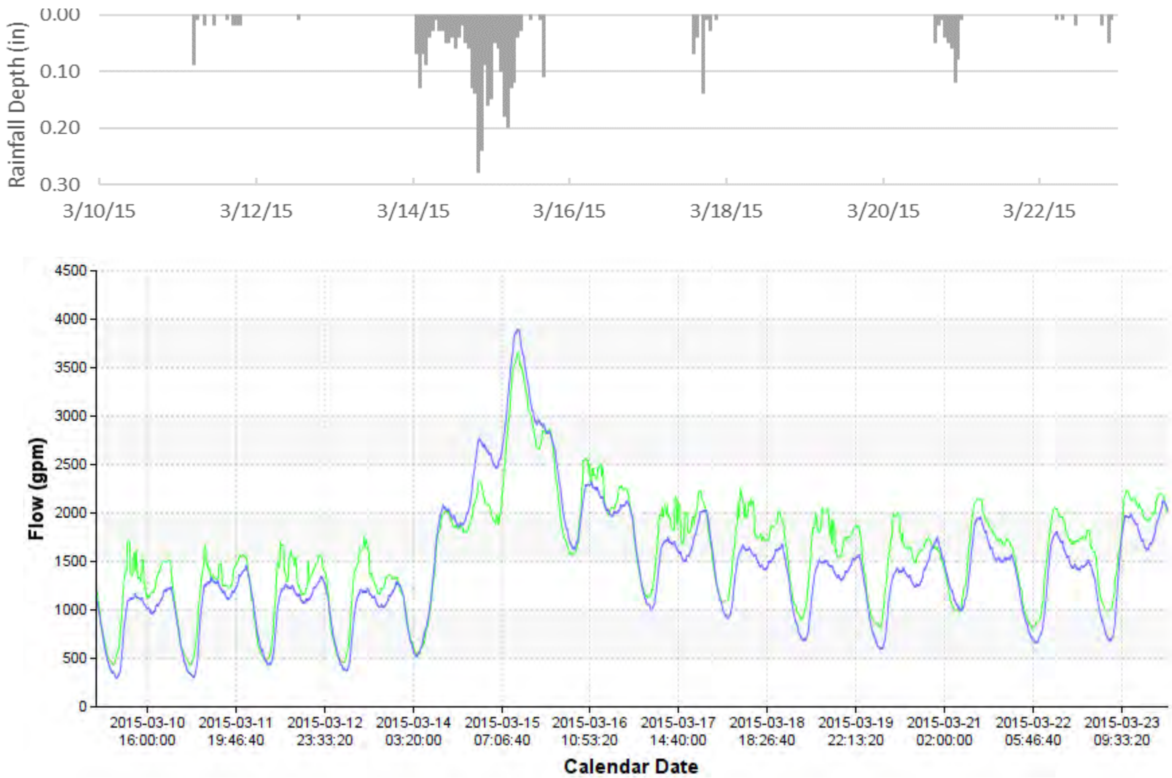


Figure B-30
Meter at 3252-7-005 (M6599) Wet Weather Calibration 12/7/10 to 12/31/10

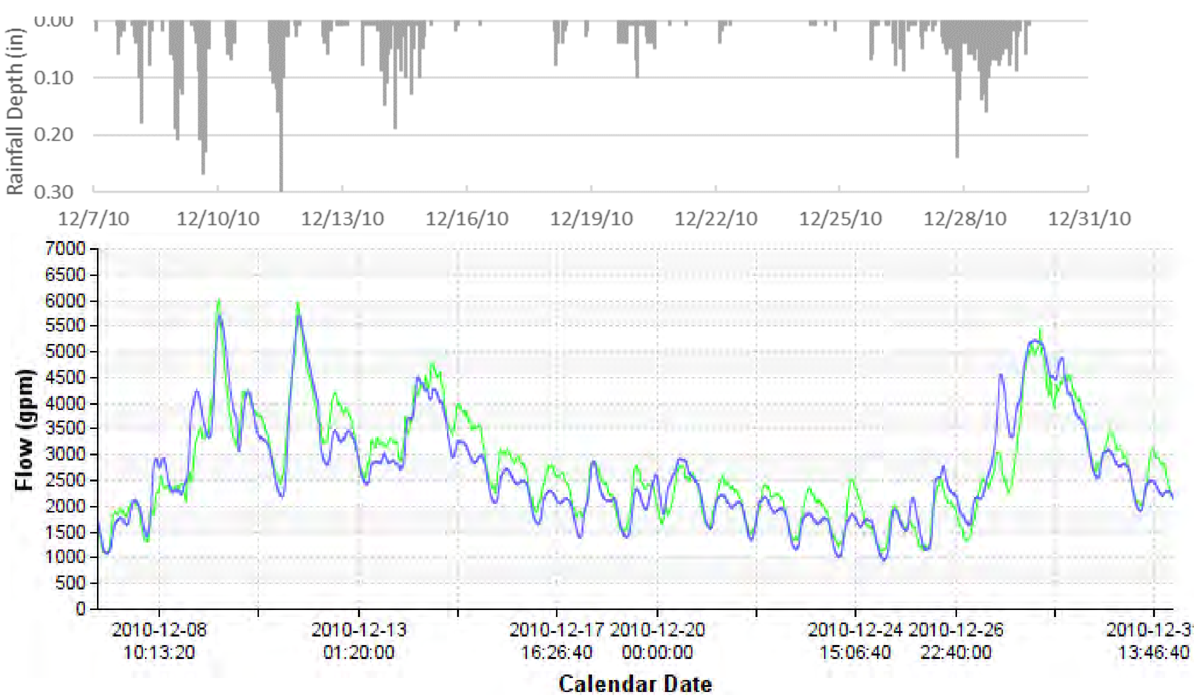


Figure B-31
Meter at 3252-7-005 (M6599) Wet Weather Calibration 1/11/12 to 1/26/12

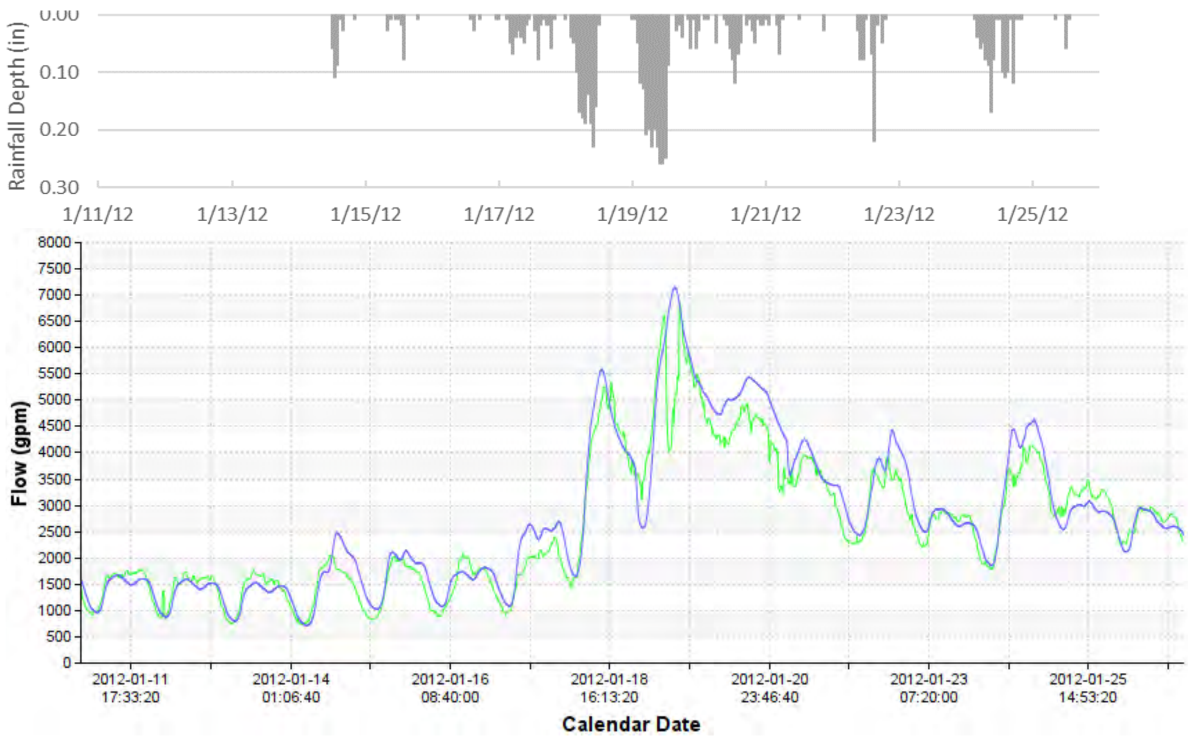


Figure B-32
Meter at 3252-7-005 (M6599) Wet Weather Calibration 2/10/14 to 2/27/14

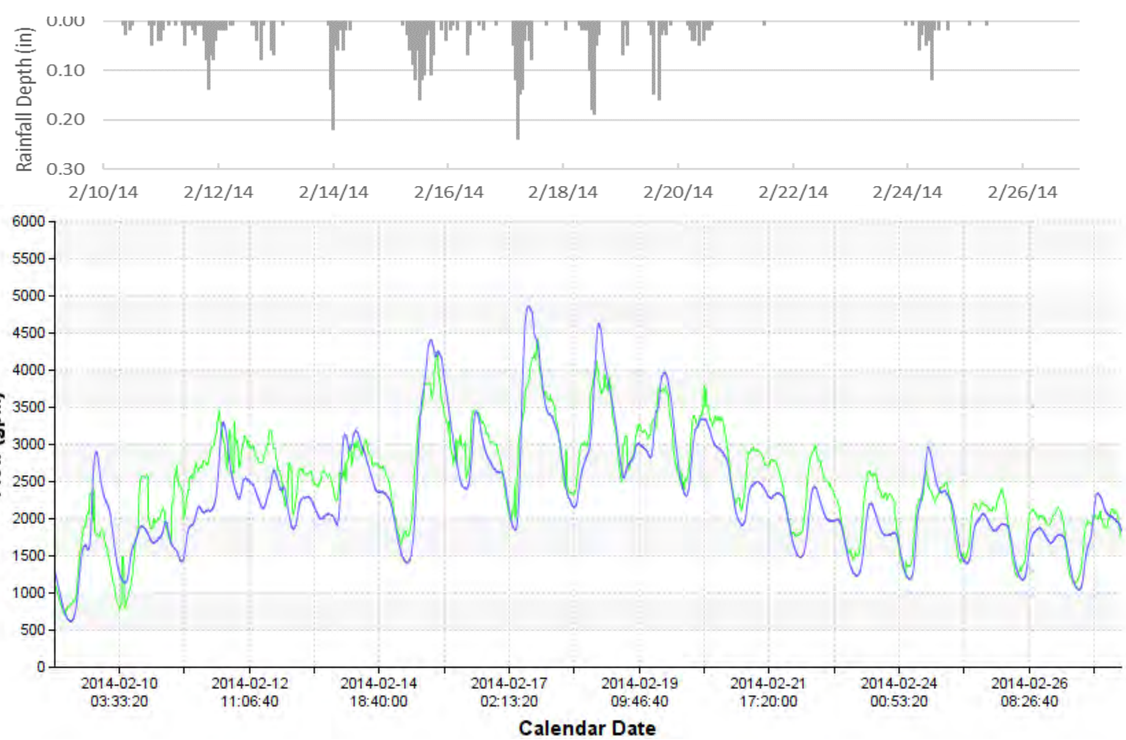


Figure B-33
Meter at 3352-7-006 (M6269) Wet Weather Calibration 12/7/10 to 12/31/10

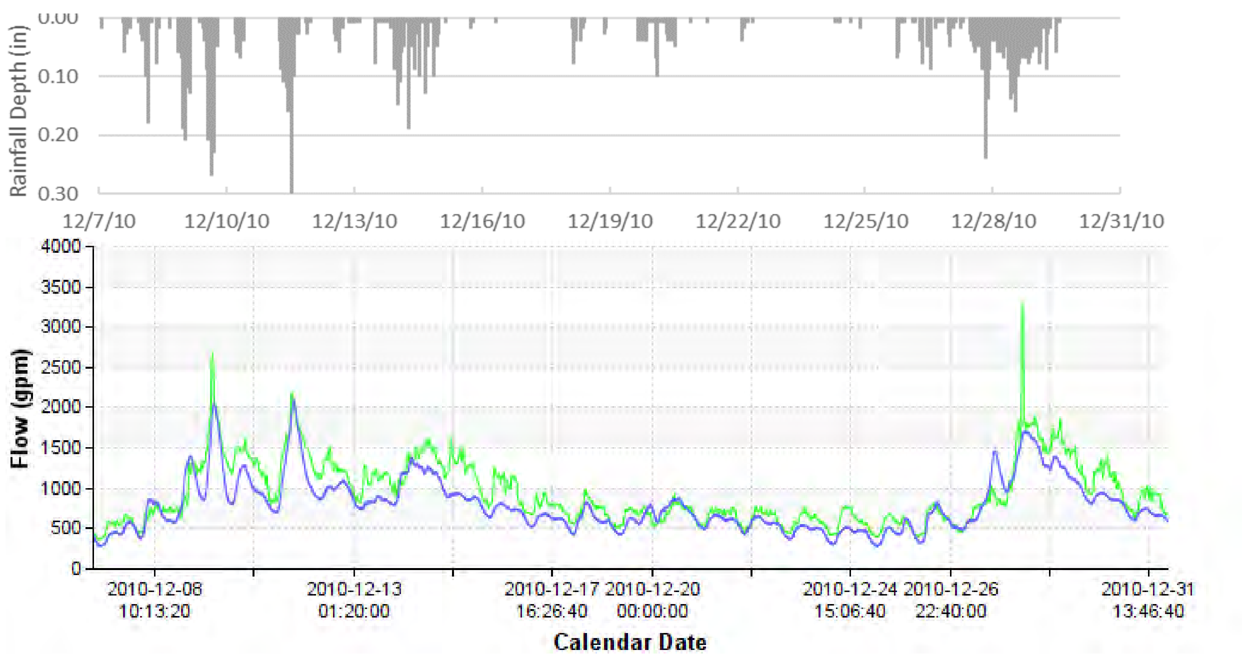


Figure B-34
Meter at 3352-7-006 (M6269) Wet Weather Calibration 2/21/11 to 3/7/11

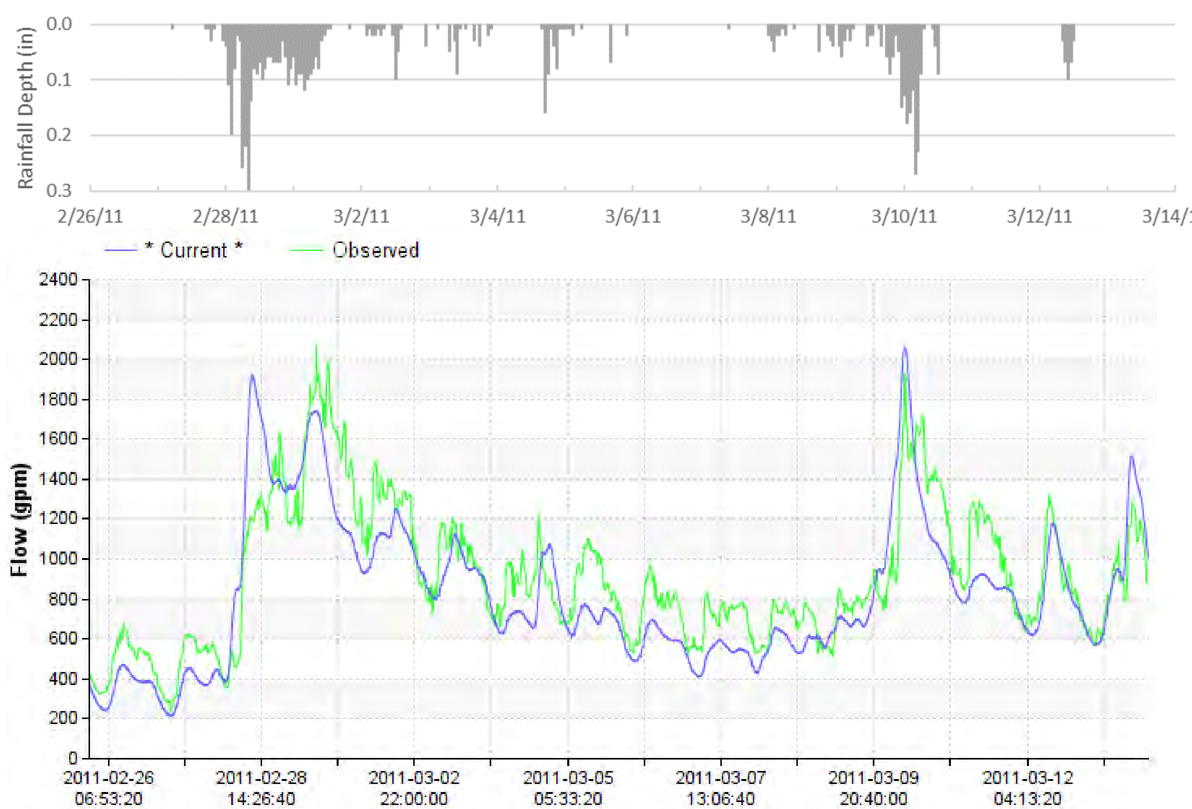


Figure B-35
Meter at 3356-6-002 (M6820) Wet Weather Calibration 3/28/18 to 4/25/18

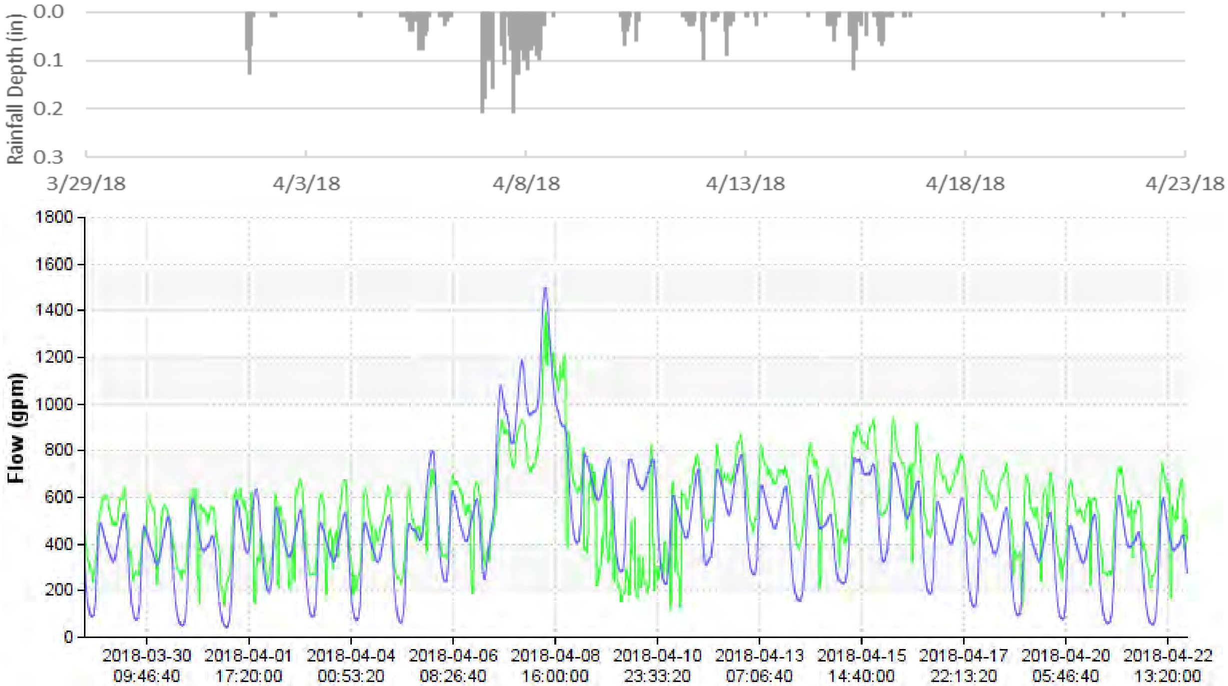


Figure B-36
Meter at 3356-6-002 (M6820) Wet Weather Calibration 3/20/10 to 4/6/10

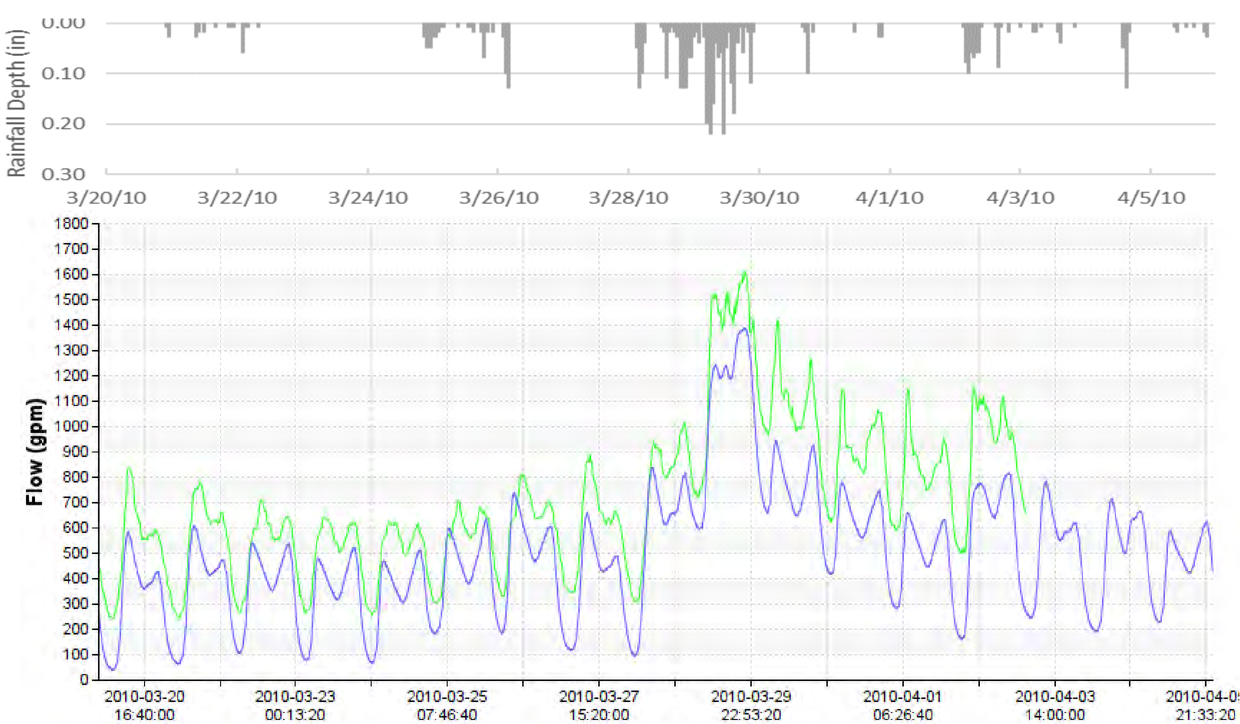


Figure B-37
Meter at 3451-4-004 (M6139) Wet Weather Calibration 12/2/10 to 12/19/10

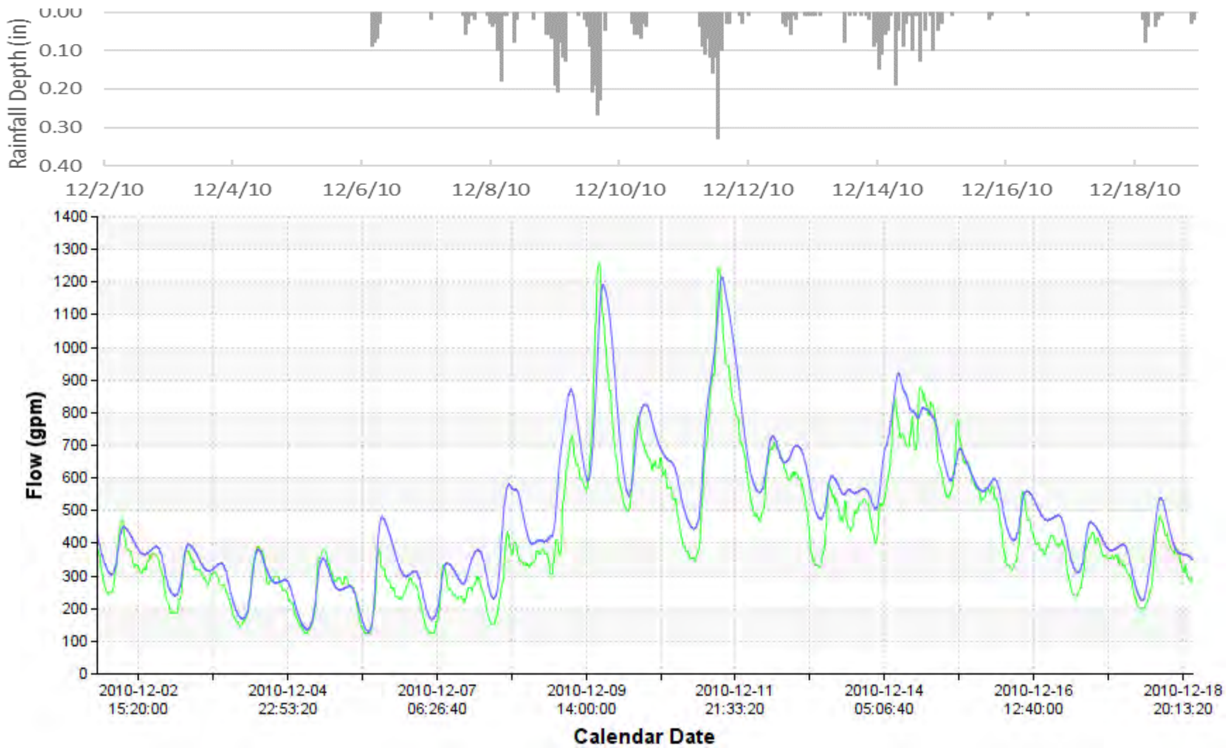


Figure B-38
Meter at 3451-4-004 (M6139) Wet Weather Calibration 2/21/11 to 3/10/11

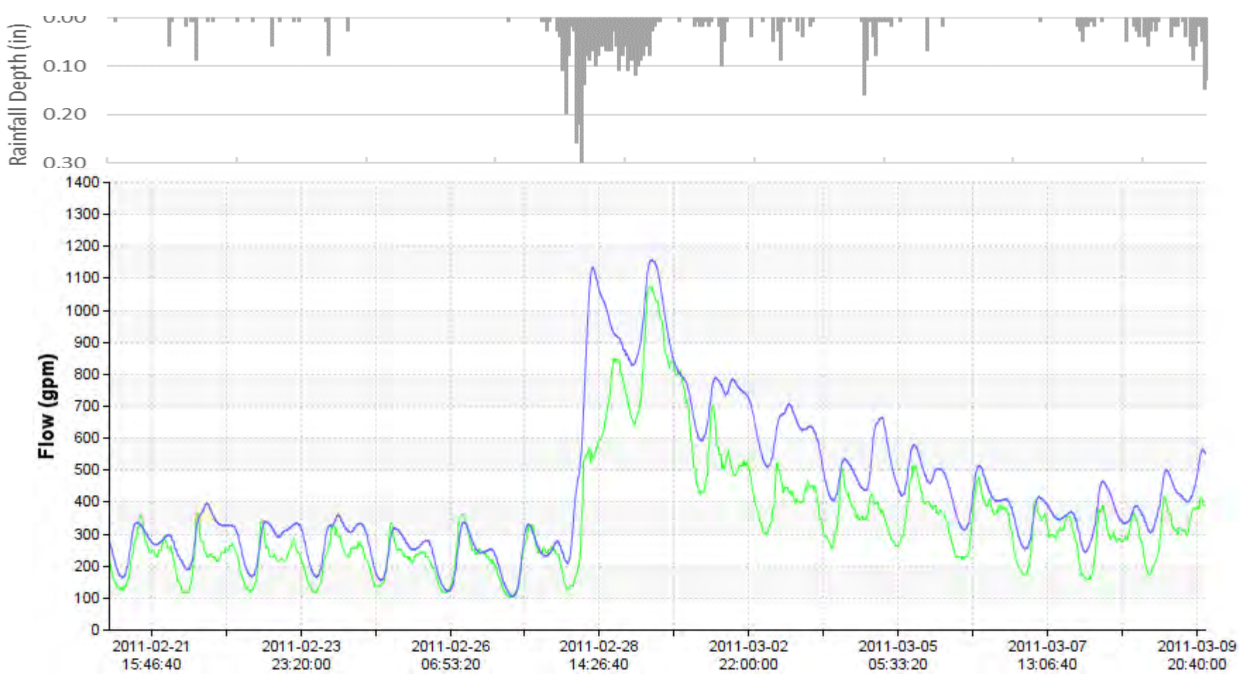


Figure B-39
Meter at 3556-7-008 (M5940) Wet Weather Calibration 1/12/12 to 2/27/12

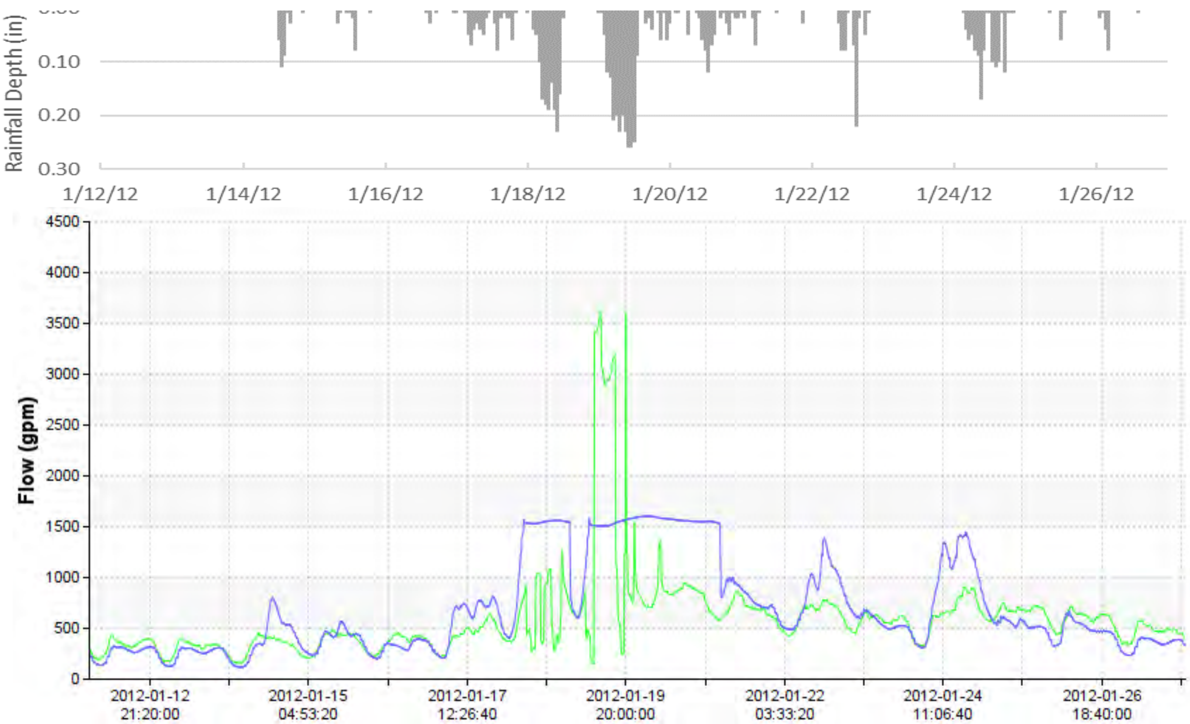


Figure B-40
Meter at 3556-7-008 (M5940) Wet Weather Calibration 12/3/10 to 12/19/10

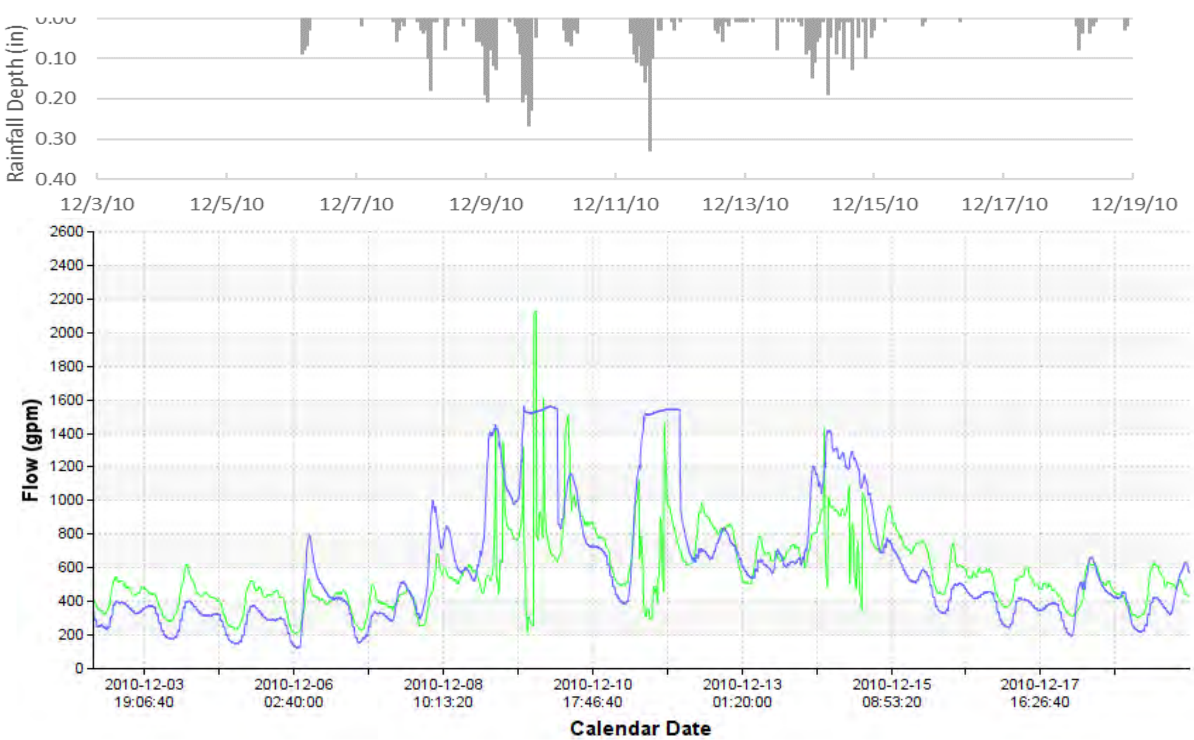


Figure B-41
WWTP Effluent (M6194) Wet Weather Calibration 11/30/15 to 12/15/15

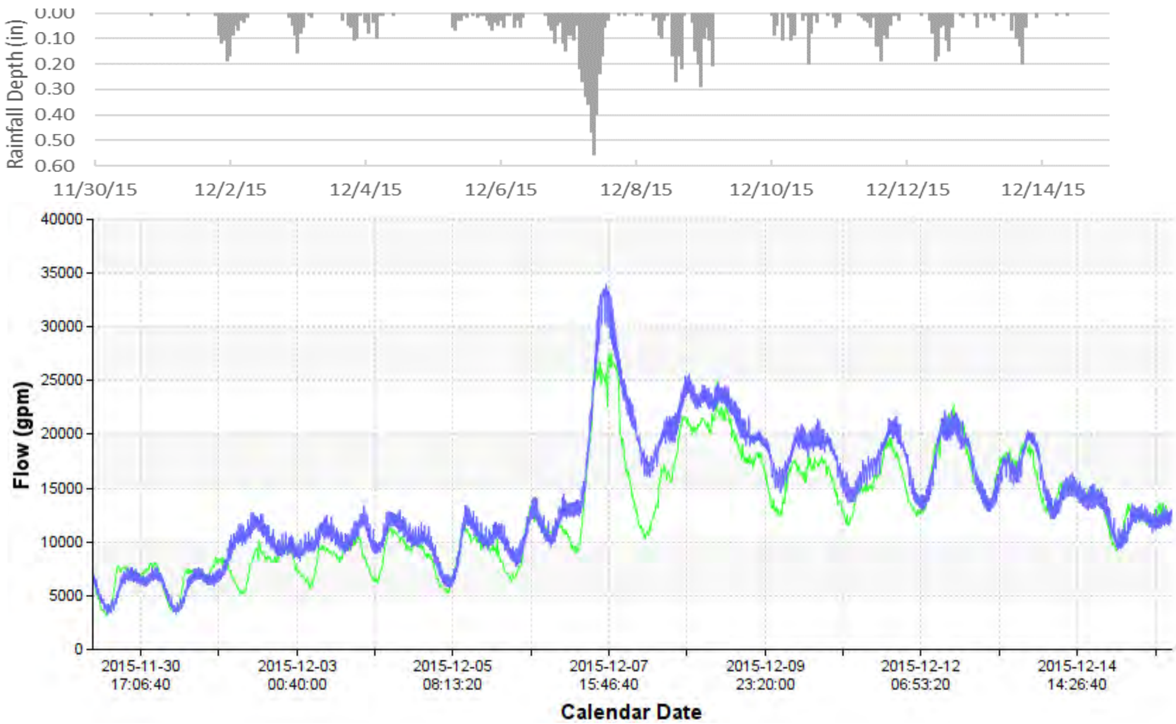


Figure B-42
WWTP Effluent (M6194) Wet Weather Calibration 1/27/17 to 2/13/17

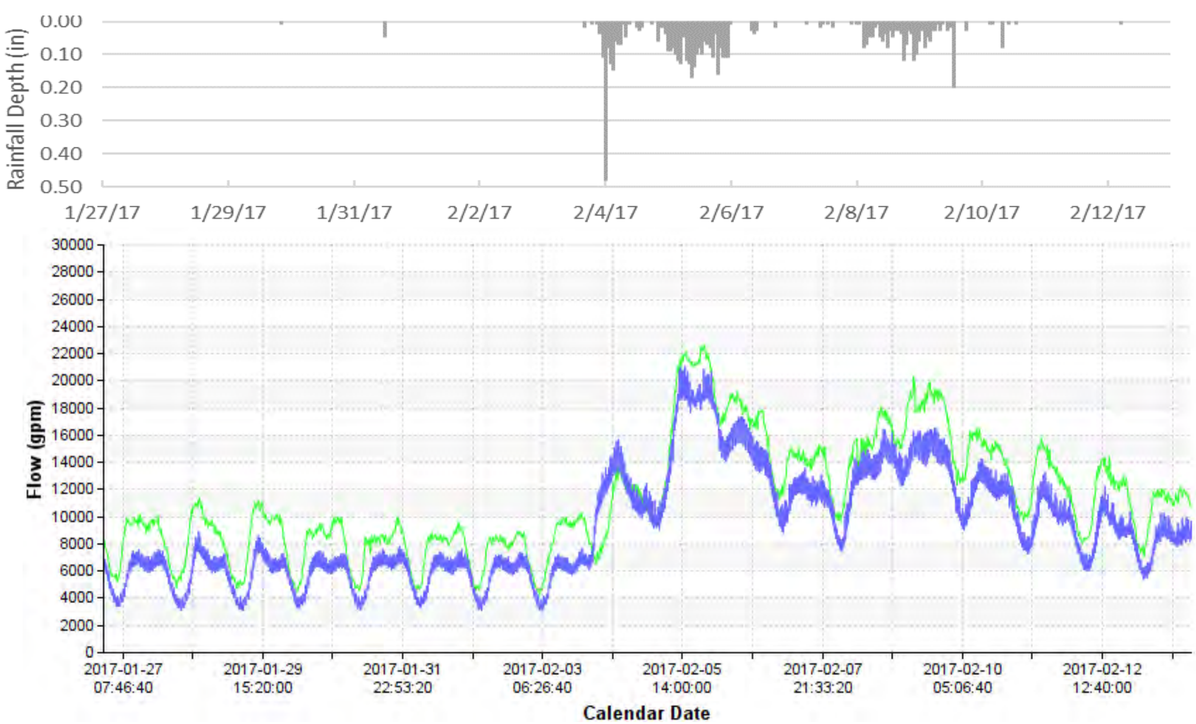


Figure B-43
185th PS Wet Weather Calibration 2/1/17 to 2/21/17

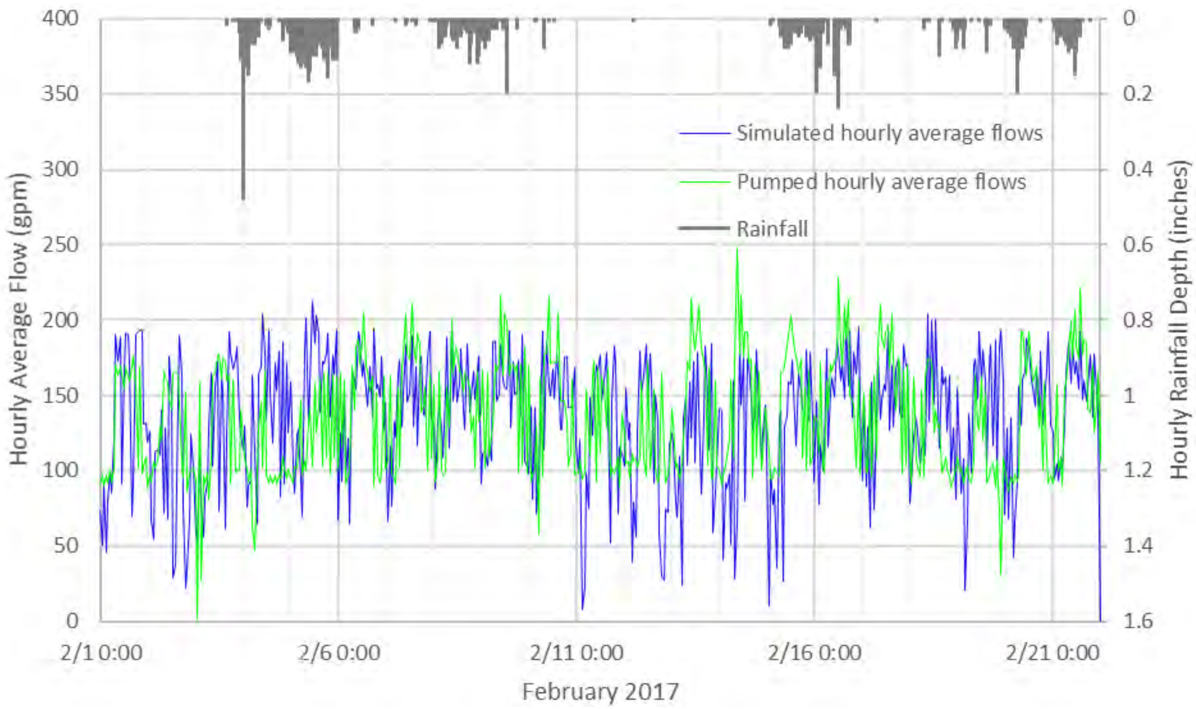


Figure B-44
185th PS Wet Weather Calibration 12/1/15 to 12/23/15

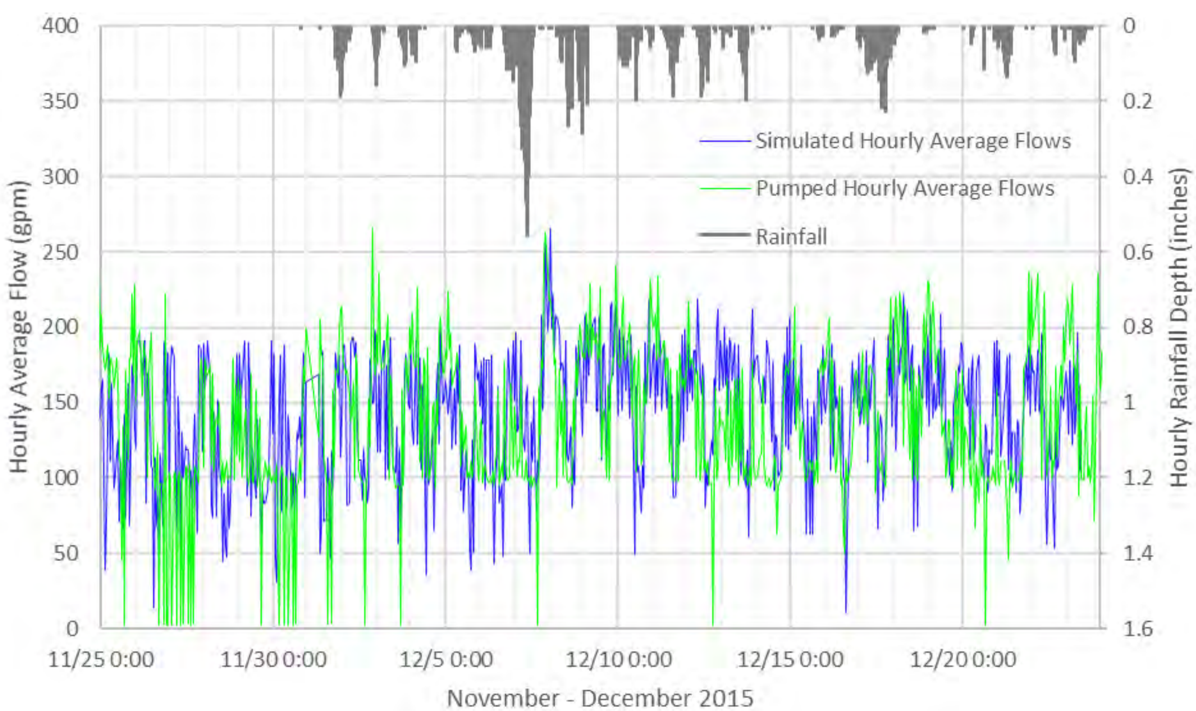


Figure B-45
Linneman PS Wet Weather Calibration 2/1/17

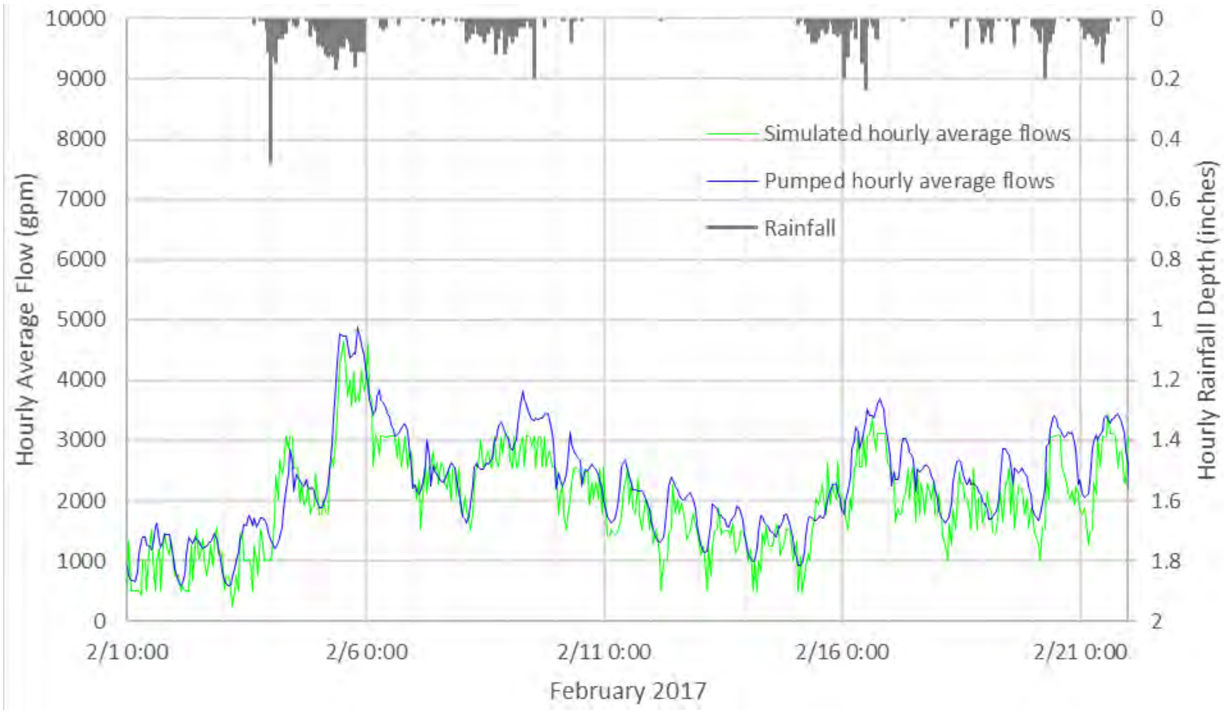


Figure B-46
Linneman PS Wet Weather Calibration 12/1/15 – 12/25/15

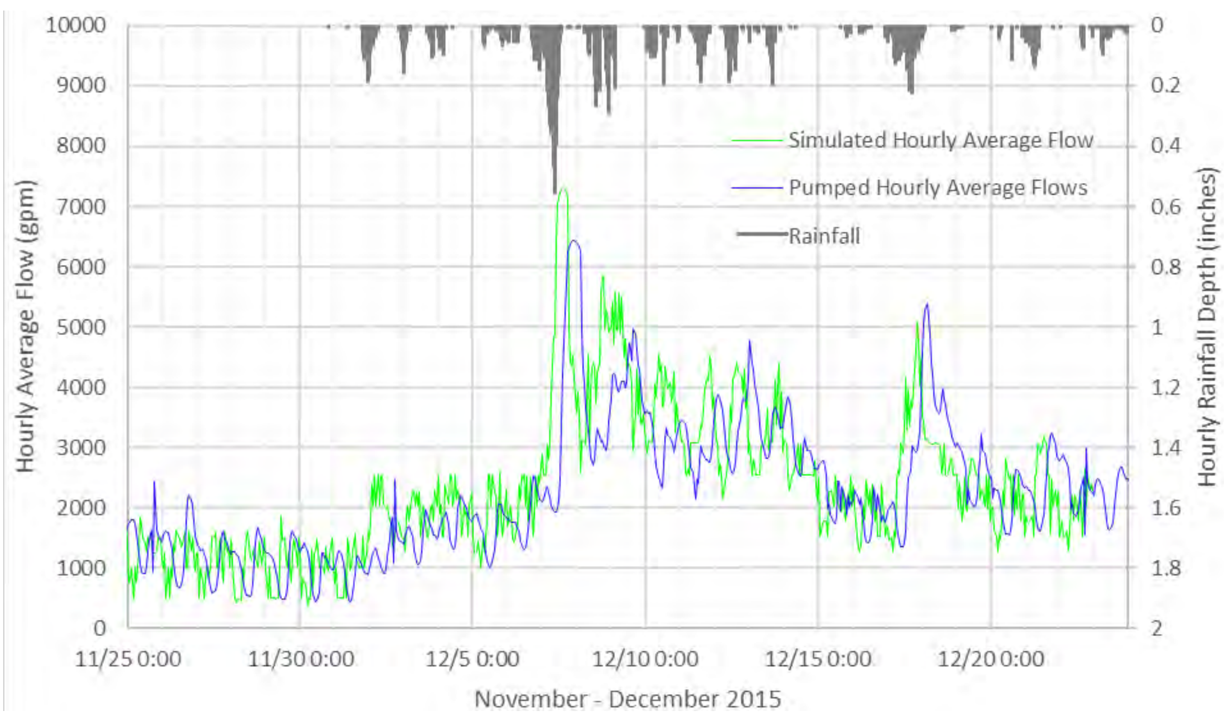
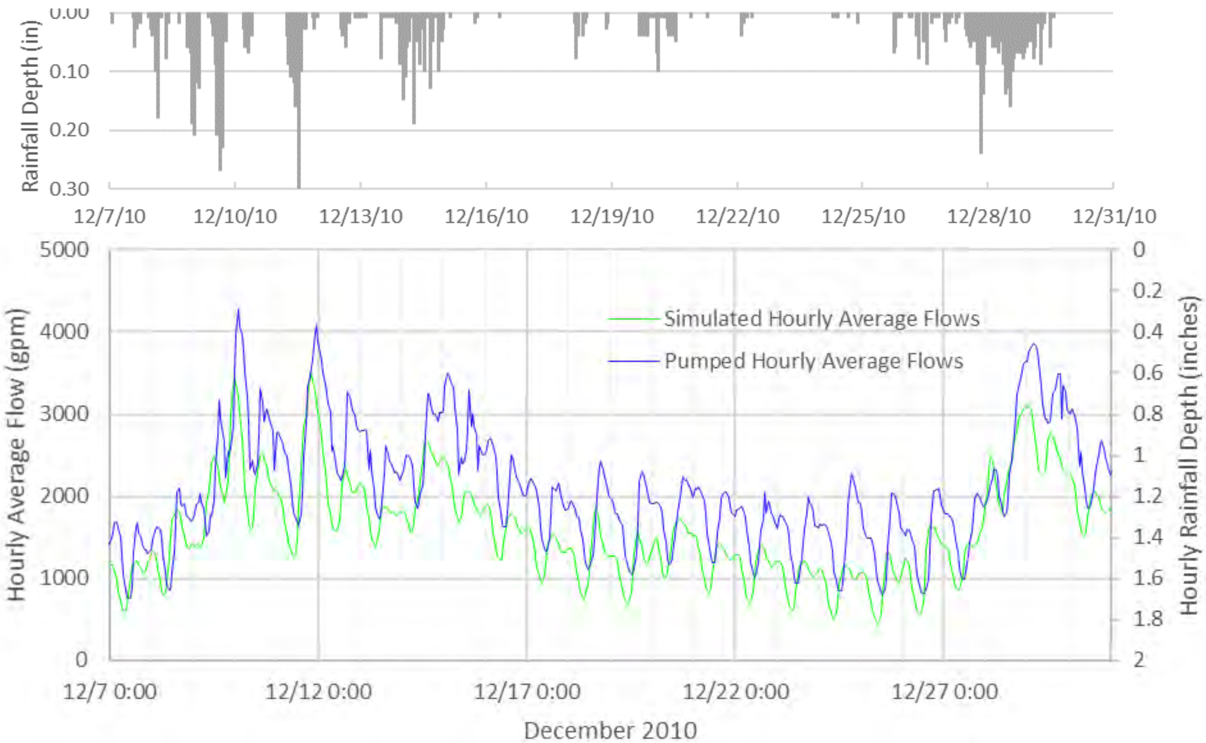


Figure B-47
Linneman PS Wet Weather 12/7/10 to 12/31/10



APPENDIX C
BASIS OF OPINION OF COST

Appendix C

Basis of Opinion of Cost

Introduction

This section summarizes the approach used in development of unit costs and project costs used in the Capital Improvement Program (CIP).

All project descriptions and cost estimates in this document represent a Class 5 budget estimate, as established by the American Association of Cost Engineers. This preliminary estimate class is used for conceptual screening and assumes project definition maturity level below two percent. The expected accuracy range is -20 to -50 percent on the low end, and +30 to +100 percent on the high end, meaning the actual cost should fall in the range of 50-percent below the estimate to 100-percent above the estimate.

Cost estimates are intended to be used as guidance in establishing funding requirements based on information available at the time of the estimate. The procedure used to generate cost information presented herein is consistent with the definition of “rough cost estimates” under OAR 660-011-0005(2) and OAR 660-011-035. The final cost of individual projects will depend on actual labor and material costs, site topography, existing utility installations within the limits of work, competitive market conditions, regulatory requirements, project schedule, contractor bidding strategies and other factors. All cost estimates are in 2019 dollars.

Due to the project definition maturity level at this phase in system planning, the following considerations are excluded from the opinion of costs.

- Land or Right-of-Way Acquisition[1];
- Studies, planning or modeling of the Transportation System, Sanitary System, Water System, or Stormwater System;
- Borrowing or finance charges during the planning, design, or construction of assets;
- Improvements to distribution, conveyance, pumping, storage, or treatment facilities in response to changes in regulatory standards or rules;
- Remediation or fines associated with system violations.

[1] Land acquisition is not included in this estimate but will be included when the project is built.

Project Cost Development

Project costs were developed through a progression of steps, starting with development of construction costs. Construction costs consist of the sum of materials, labor and equipment of easily identifiable features of a project such as piping, manholes, trench work, and road work. The estimated costs for each improvement are based on averages from the *RS Means Heavy Construction Cost Data* (Reed Construction Data, 2018), supplemented with quotes from local suppliers, City input and construction costs for similar projects near the City of Gresham. Information from RS Means is derived from a national average of construction cost indexes from over 700 cities. To correlate these costs to local market conditions, a Portland market location factor was applied to both materials (100.2) and labor (100.4). The historical cost index for the date of publication is 222.9 with a projected 2019 cost index of 227.3 (January 2018).

Component Unit Costs

Unit costs are applied to The unit costs are applied to improvement pipe lengths for varied depths and assumed manhole spacing at approximately 400 feet. The unit costs account for the materials, labor, and equipment necessary to complete the improvements. Unit costs for wastewater collection system improvements are shown in Tables B-1 through B-6. These costs include considerations for:

- Trench saw cutting, excavation and hauling of waste;
- Importing and placement of pipe zone bedding;
- Trench backfill and compaction of native soils;
- Pipe material and installation labor;
- Trench safety systems (temporary shoring or trench box);
- Testing and video inspection;
- Surface restoration of unpaved streets, or paved local versus arterial roads;
- Dewatering;
- Bypass pumping on pipe replacement projects.
- Subcontractor's markup for profit and overhead

The CIP presents projects are grouped into three categories; existing system capacity upgrades, seismic resiliency improvements, and new infrastructure for future development. The unit costs were applied differently depending on the category of project, as summarized below.

- Cost estimates for projects specifying replacement or upsizing of existing pipes for condition utilize the unit costs specified in Table C-1, Table C-2, and Table C-3.

- Cost estimates for projects to improve seismic resiliency and capacity improvements are based on the unit costs specified in Table C-1, Table C-4 and Table C-7.

- Cost estimates for projects with new pipe trunk lines utilize the unit costs specified Table C-1, Table C-5 and Table C-6.

Table C-1
Unit Costs for Surface Restoration of Pipelines (2019 dollars)

Pipe Diameter (inch)	Average Cost (per linear foot) Roadway Category		
	Unpaved	Local	Arterial
10 to 15	$7	$49	$63
18	$7	$50	$63
21 to 27	$7	$50	$64
30	$7	$51	$65
36	$7	$51	$66
42	$8	$52	$66
48	$8	$53	$67

Table C-2
Unit Costs for Replacement of Existing Gravity Mains (2019 dollars)

Pipe Diameter (inch)	Material Cost (per linear foot)	Installation and Equipment Cost with Depth Category			
		<10 ft	10-15 ft	15-20 ft	20-25 ft
10	$3.75	$77	$135	$251	$426
12	$6.74	$78	$136	$252	$427
15	$11.65	$81	$140	$256	$430
18	$13.28	$87	$145	$261	$436
21	$13.28	$89	$147	$263	$438
24	$15.43	$95	$153	$269	$444
27	$15.43	$103	$162	$278	$452
30	$15.68	$111	$169	$285	$460
36	$21.97	$173	$231	$347	$521
42	$28.10	$187	$245	$361	$535
48	$47.00	$219	$278	$394	$568

Table C-3
Unit Costs for Repair of Existing Manholes (2019 dollars)

Manhole Diameter (inch)	Manhole Cost per Depth Category (each)			
	<10 ft	10-15 ft	15-20 ft	20-25 ft
48	$1,634	$1,634	$1,634	$1,634
60	$1,936	$1,936	$1,936	$1,936
72	$2,325	$2,325	$2,325	$2,325

Table C-4
Unit Costs for Replacement of Existing Gravity Pipelines with HDPE (2019 dollars)

Pipe Diameter (inch)	Material Cost (per linear foot)	Installation and Equipment Cost with Depth Category			
		<10 ft	10-15 ft	15-20 ft	20-25 ft
10	$24.86	$80	$138	$254	$429
12	$29.96	$83	$141	$257	$432
15	$39.14	$86	$144	$261	$435
18	$49.54	$93	$151	$267	$441
21	$61.16	$94	$152	$269	$443
24	$74.00	$103	$161	$277	$451
27	$88.06	$111	$169	$285	$460
30	$103.34	$121	$179	$295	$469
36	$111.60	$181	$239	$356	$530
42	$137.60	$196	$254	$370	$545
48	$198.14	$233	$291	$407	$582

Table C-5
Unit Costs for New Gravity Pipelines (2019 dollars)

Pipe Diameter (inch)	Material Cost (per linear foot)	Installation and Equipment Cost with Depth Category			
		<10 ft	10-15 ft	15-20 ft	20-25 ft
10	$11.65	$68	$121	$226	$383
12	$13.28	$68	$121	$226	$383
15	$13.28	$71	$124	$229	$386
18	$15.43	$75	$129	$234	$390
21	$15.43	$77	$130	$235	$392
24	$15.68	$82	$135	$240	$397
27	$21.97	$89	$142	$247	$404
30	$28.10	$94	$147	$252	$409
36	$47.00	$138	$191	$296	$453
42	$61.82	$148	$201	$306	$463
48	$88.38	$171	$224	$329	$486

Table C-6
Unit Costs for New Manholes (2019 dollars)

Manhole Diameter (inch)	Manhole Cost per Depth Category (each)			
	<10 ft	10-15 ft	15-20 ft	20-25 ft
48	$7,593	$11,624	$15,893	$20,871
60	$10,047	$18,160	$25,020	$32,927
72	$12,731	$22,600	$31,438	$41,521

Unit Cost Notes Applicable to Tables C-1 through C-7

1) Unit costs exclude lateral tie-ins.

2) Unit costs exclude utility relocation associated with potential conflicts.

3) Road resurfacing assumes:

   a) Local = 4-inch AC + 8-inch base course + 2-inch leveling course
   b) Arterial = 6-inch AC + 10-inch base course + 4-inch leveling course
   c) Unpaved = 4-inch base course.

4) The pipe material for gravity sewer was assumed to be PVC (ASTM D-3034, SDR 35) for 15-inch diameter pipe and smaller, and Class III (ASTM C-76) reinforced concrete for pipe with a diameter greater than 15 inches.

5) Pipe material for replacement of gravity mains for seismic resiliency and increased capacity is assumed to be fusible HDPE.

6) Trenchless installation of new pipes is assumed for anything deeper than 25 feet to the pipe invert elevation.

7) Manhole installation assumes that surface restoration effort is covered under the surface restoration cost associated with the pipeline trenching (Table C-1).

8) The bypass pumping for replacement and upsizing of existing gravity lines is for above grade application (no trenchwork) and includes the cost of the piping, installation and removal.

Trenchless Construction Methods

Trenchless construction methods are assumed for some specific situations. For new pipes, trenchless methods are assumed when crossing a waterway, highway or when pipe depth exceeds 25 feet. Unit cost for trenchless installation of new pipe is $1,500 per linear foot, including materials and installation.

Where existing pipes are recommended to be replaced with new larger pipes, upsizing within two pipe diameters of the original pipe size is assumed to be a candidate for pipe bursting. Understanding site specific geotechnical conditions precludes this construction practice and if unfavorable, can make the practice impractical. The City has a history of successfully using the pipe bursting technique throughout the wastewater collection system. This trenchless approach is typically less expensive than open trench construction. Pipe bursting costs are highly variable and rely upon site specific influences such as soil type, installation depth, length of construction, and ability to excavate departure and receiving pits.

The unit costs presented in **Table C-7** were used to estimate costs of capacity improvements within the range attainable with pipe bursting. The unit costs include manhole restoration and assume favorable site conditions for pipe bursting. Additional study of the site conditions will need to be conducted in order to proceed with using pipe bursting methods on any individual pipe.

Table C-7
Unit Costs for Trenchless Replacement of Gravity Mains (2019 dollars)

Pipe Diameter (inch)	Increase One Pipe Diameter (per linear foot)	Increase Two Pipe Diameters (per linear foot)
8	$72	$117
10	$86	$143
12	$111	$161
15	$126	$178
18	$156	$241
21	$189	$268
24	$217	$313
27	$253	$387

Project Cost Allowances

The project cost is the sum of construction component unit costs with additional cost allowances for contingency, engineering, permitting, legal and administration fees. **Table C-8** below summarizes the cost allowances for each additional project cost. These project cost allowances are factored on top of the total construction cost, according to **Equation C-1**, not the individual unit costs. Each category is described in more detail below.

Equation C-1

$$\begin{aligned} \mathit{Total\ Project\ Cost} &= \left(\sum \mathit{Unit\ Project\ Construction\ Costs}\right) \\ &\times \left(1 + \sum \mathit{General\ Construction\ Allowance\ Factors}\right) \\ &\times (1 + \mathit{Contingency\ Factor}) \times \left(1 + \sum \mathit{Indirect\ Poject\ Cost\ Factors}\right) \end{aligned}$$

Table C-8
Project Cost Allowances

Description	Factor
General Construction Factors	26 percent
Contingency	25 percent
Indirect Project Costs	30 percent

Construction Cost Allowances

Costs for commonly occurring general work elements in wastewater collection projects were factored into the construction costs through the use of assumed allowances. Table B-8 presents a summary of these allowances, and when they are combined with the unit costs and multiplied by the improvement lengths, create an estimated "bid price" for the work. Detailed information justifying the assumed allowance values is provided below.

Traffic Control

Traffic control will be required for all projects that occur in roadways. The traffic control mark-up is intended to account for such costs as signage, flagging and temporary barriers, pavement markings, lane delineators and lighting at flagging locations.

Erosion Control

The erosion control mark-up accounts for materials and practices to protect adjacent property, stormwater conveyance systems, and surface water in accordance with regulatory requirements. Obtaining Erosion Control Permit compliance will require construction site runoff control for activities that result in a land disturbance exceeding 500 square feet. More complex projects may require the development of a stormwater pollution prevention plan, 1200-C permit application and reporting, installation of erosion control best management practices (BMPs), and routine maintenance, testing and inspection of all installed BMPs.

General Contractors Overhead

Overhead costs associated with the General Contractor's day-to-day operations such as staff salary, taxes, benefits, insurance, marketing, and proposal preparation are an inherent cost of running their business. Contractors will typically markup their subcontractor's costs as a management expense as a way to keep their business running.

General Contractors Profit

In addition to the overhead costs, contractors will typically markup their subcontractors to realize a profit for their effort. This is one of the most highly variable parts of a budget and depends upon the type of project, its size, the amount of risk involved, how much money the contractor wants to make, the general market conditions, and bidding strategies.

Mobilization

Before construction of a project may begin, setup and preparatory activities are necessary to become ready to perform the work. Mobilization is a general term that used to capture many variables but typically relates to:

- Moving staff, equipment, supplies, and incidentals to the project site

- Establishing site trailers or offices or other facilities necessary for the project
- Incurring costs as necessary before beginning work on the project. This may include expenses associated with acquisition of bonds and insurance.

Contingency

A contingency was included in each project's cost to account for the uncertainties inherent within the preliminary level of the estimate. Contingency is a term used in estimating that refers to costs that will probably occur based on past experience, but with some uncertainty regarding the amount. This factor was applied to all estimated project costs except for the City Internal Overhead. The contingency is provided to account for factors such as:

- Unanticipated utilities;
- Relocation and connection to existing infrastructure;
- Minor elements of work not addressed in component unit cost development;
- Details of construction;
- Changes in site conditions;
- Variability in construction bid climate.

The contingency excludes:

- Major scope changes such as end product specification, capacities and location of project;
- Extraordinary events such as strikes or natural disasters;
- Management reserves;
- Escalation and currency effects.

Indirect Project Cost Allowances

Engineering, Legal, Permitting and Construction Services

This category is intended to capture the costs needed for development of all the upfront project related documentation to make a project bid ready. Construction drawings, specifications and permit applications are both time and resource intensive, often requiring months of preparatory work before a project may be bid. Additional services typically provided by the engineering team during construction include site inspections, assisting the contractor in interpretation of the contract documents and preparation of record drawings.

Costs for engineering, legal, permitting and construction services can vary widely based on the unique scope of work for each project. A cost factor approach is an appropriate assumption for most projects of the size and character within the CIP, however the cost factor is not well suited for projects with construction costs below $300,000. For these smaller projects, the engineering, legal, permitting and construction services costs should be evaluated by the City on a case-by-case basis for project budgeting.

Administrative Costs

The City of Gresham has an assortment of departments and personnel that are involved in the realization of a construction project. This cost allowance is intended to capture the effort needed on the part of the City related to project management, plan review, permit processing, code compliance, construction inspections and financial management.

Project Cost Multiplier

For simplicity in estimating overall project costs, a multiplier can be applied against the construction costs determined from unit pricing. This multiplier accounts for the allowances for both construction costs and project costs into one easily used factor. An example calculation showing how this multiplier was developed is provided in below.

Table C-9
Project Cost Multiplier

Cost Allowance	Allowance Factor	Cost
Example Construction Cost Total	-	**$1,000,000**
Traffic Control	3%	$30,000
Erosion Control	1%	$10,000
General Contractor Overhead	8%	$80,000
General Contractor Profit	7%	$70,000
Mobilization	7%	$70,000
Subtotal Direct Construction Costs	**26%**	**$260,000**
Contingency	30%	$326,880
Construction Administration	10%	$157,500
Engineering	12%	$189,000
Permitting	5%	$78,750
Legal and Administrative	3%	$47,250
Subtotal Indirect Project Costs	**30%**	**$472,500**
Project Total Cost		**$2,047,500**
Total Project Cost		$2,047,500
÷ Sum of Unit Construction Costs		$1,000,000
= Cost Multiplier		**2.05**

APPENDIX D
PROJECT MAPS AND SUMMARIES

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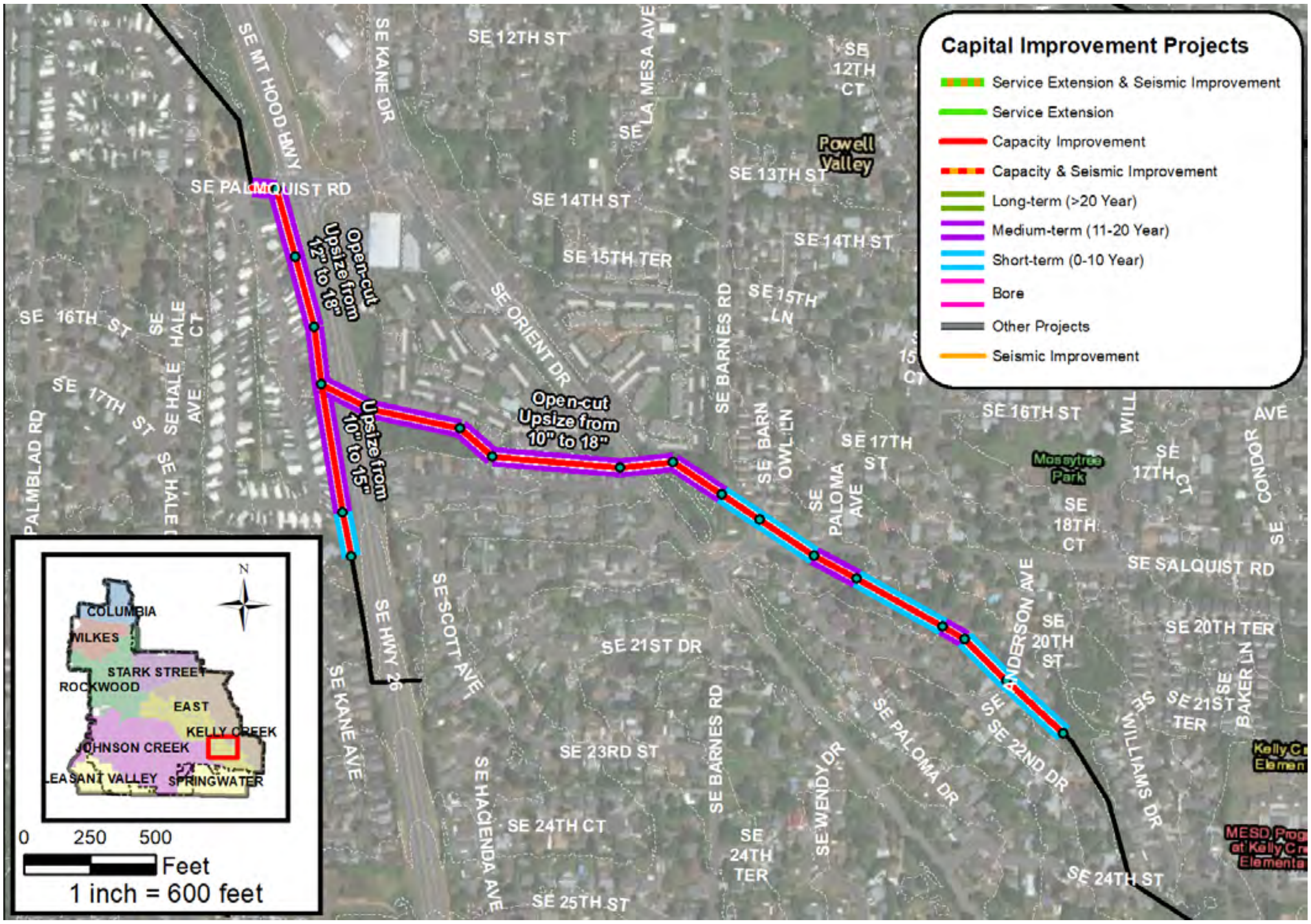

Project Name: EAST BASIN TRUNK IMPROVEMENT

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
E1	East	Burst	15	2,493	$1,112,575
			18	861	$435,356
		Sub-total			$1,547,931
E1	East	Open-cut	18	1,414	$654,545
		Sub-total			$654,545
Project totals				**4,768**	**$2,202,476**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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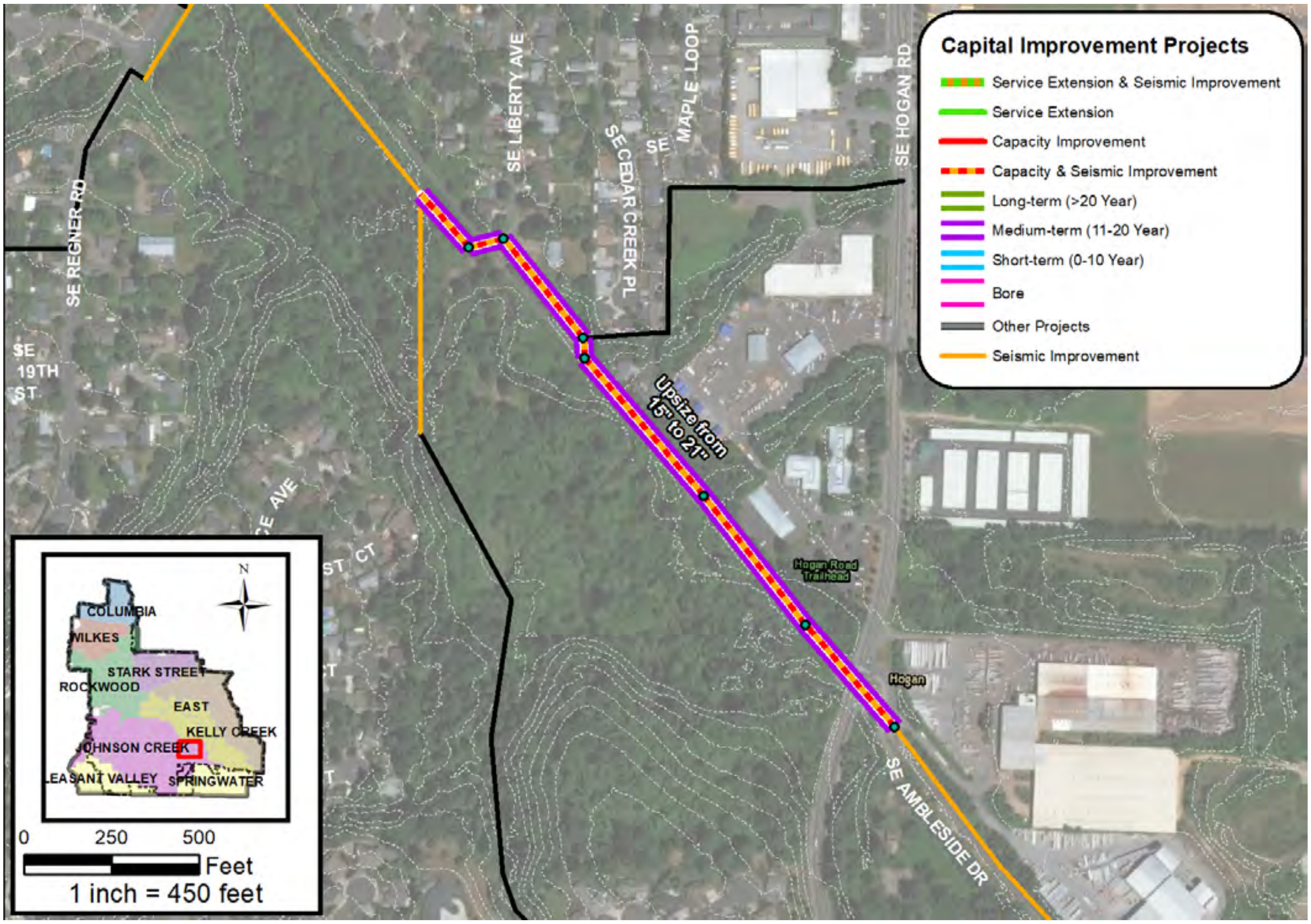

Project Name: LOWER JOHNSON CREEK TRUNK IMPROVEMENT

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
JC1	Johnson Creek	Burst	21	2,109	$1,160,938
		Sub-total			$1,160,938
Project totals				**2,109**	**$1,160,938**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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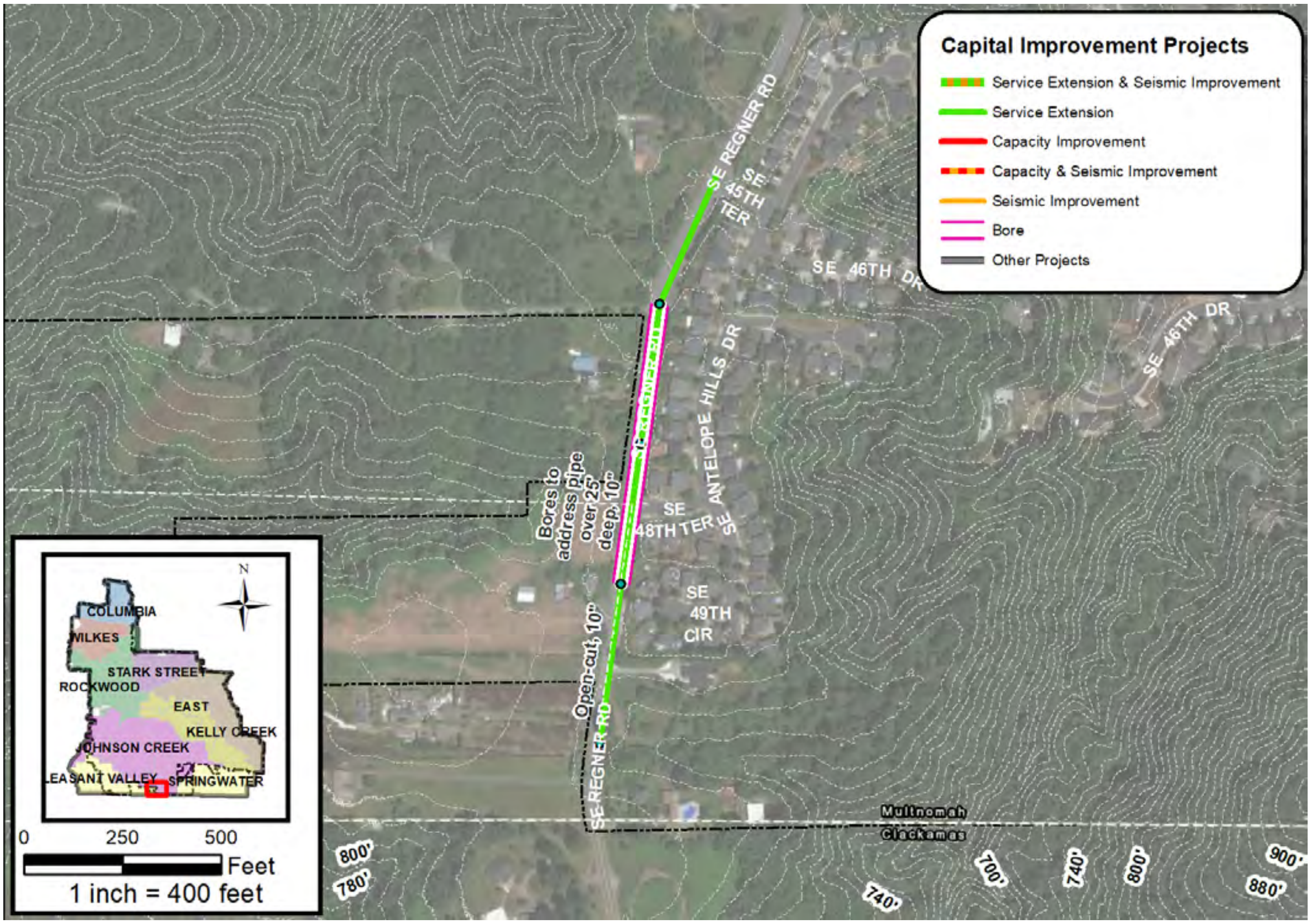

Project Name: UPPER REGNER ROAD TRUNK

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
JC3	Johnson Creek	Bore	10	720	$2,055,240
		Sub-total			$2,055,240
JC3	Johnson Creek	Open-cut	10	762	$480,698
		Sub-total			$480,698
Project totals				**1,482**	**$2,535,938**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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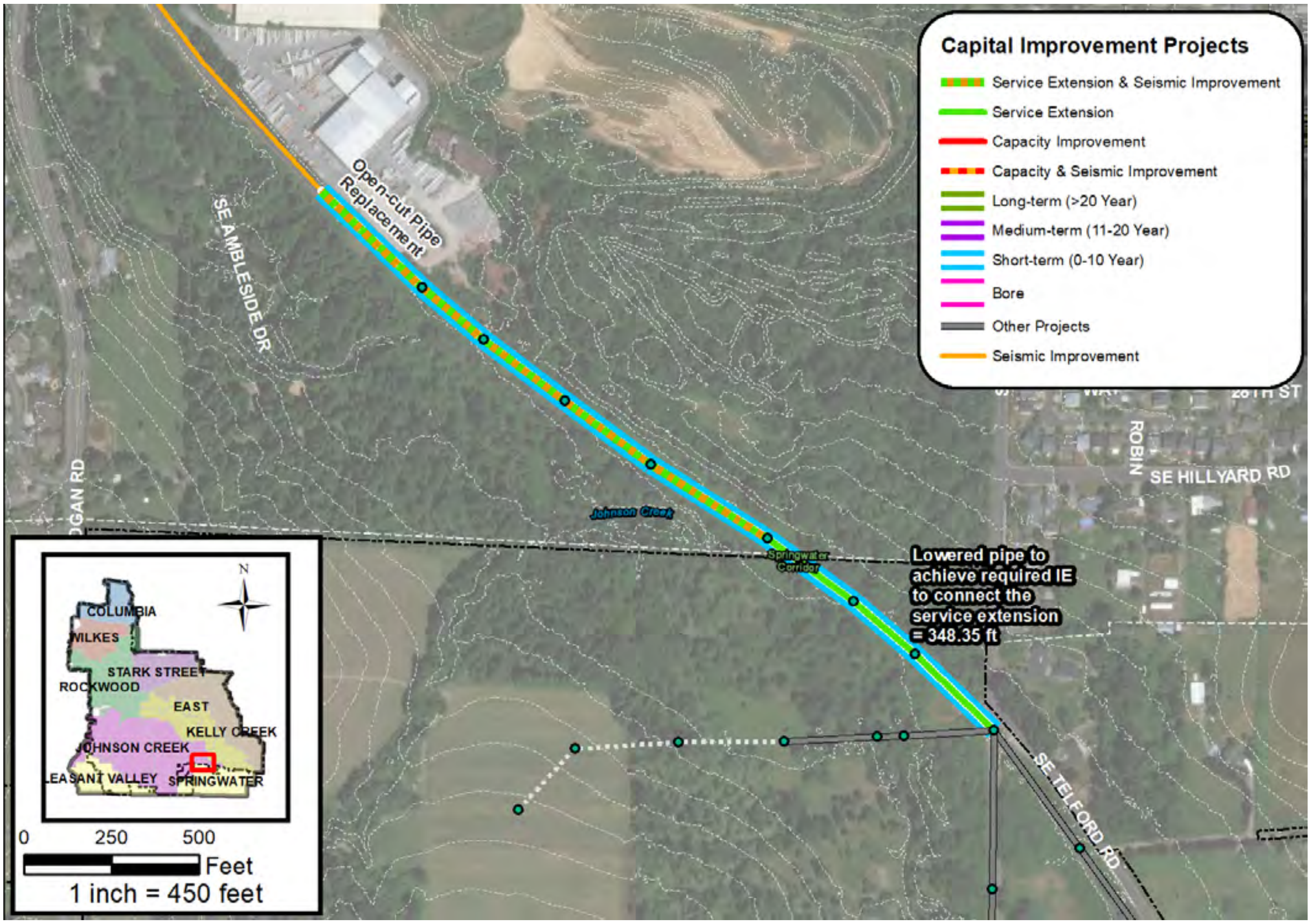

Project Name: UPPER JOHNSON CREEK TRUNK IMPROVEMENT

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
JC4	Johnson Creek	Open-cut	21	2,471	$2,726,325
		Sub-total			$2,726,325
Project totals				**2,471**	**$2,726,325**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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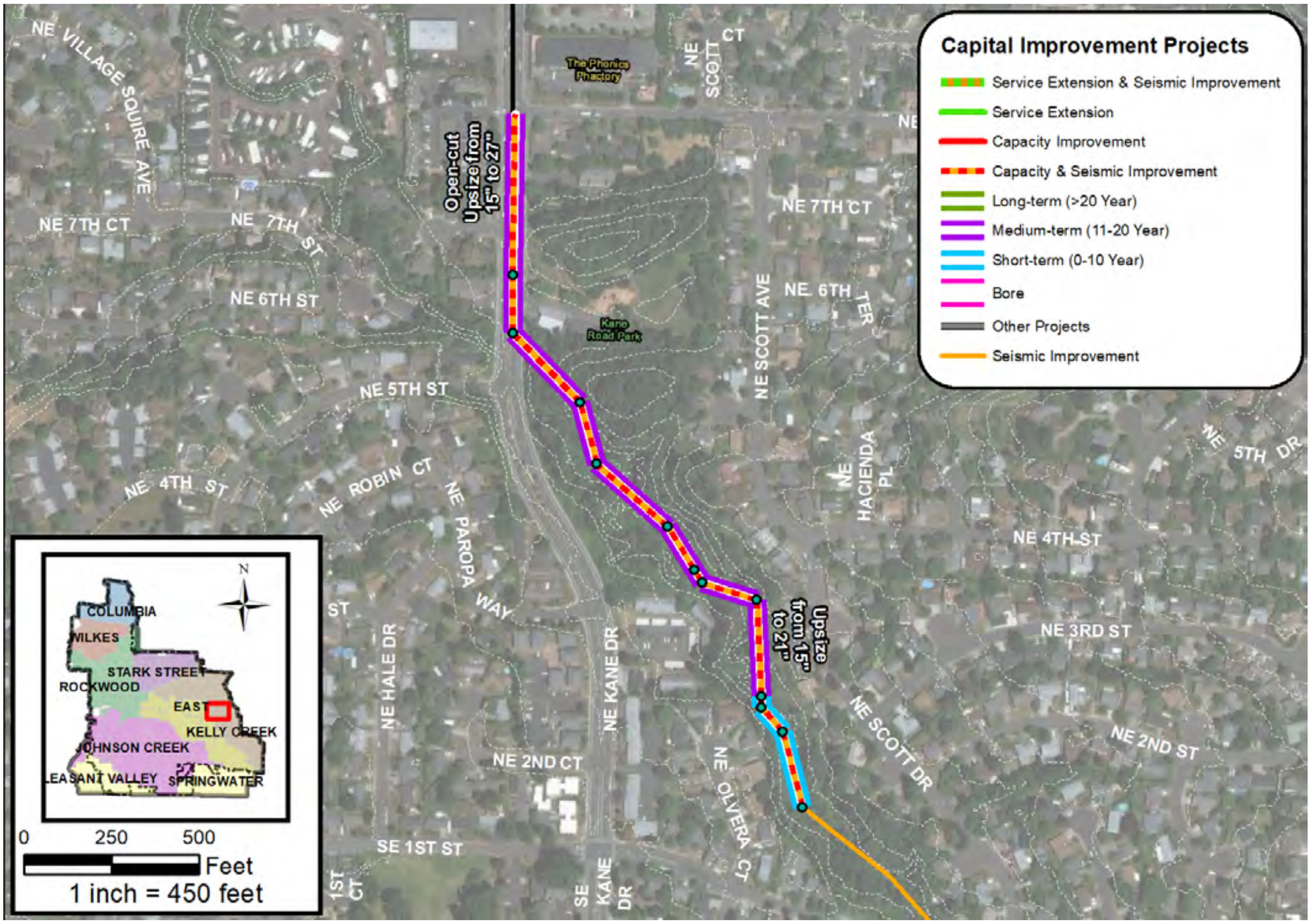

Project Name: UPPER KELLY CREEK BASIN TRUNK IMPROVEMENT

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
KC1	Kelly Creek	Burst	21	832	$499,533
		Sub-total			$499,533
KC1	Kelly Creek	Fused-HDPE	27	1,505	$1,243,579
		Sub-total			$1,243,579
Project totals				**2,337**	**$1,743,112**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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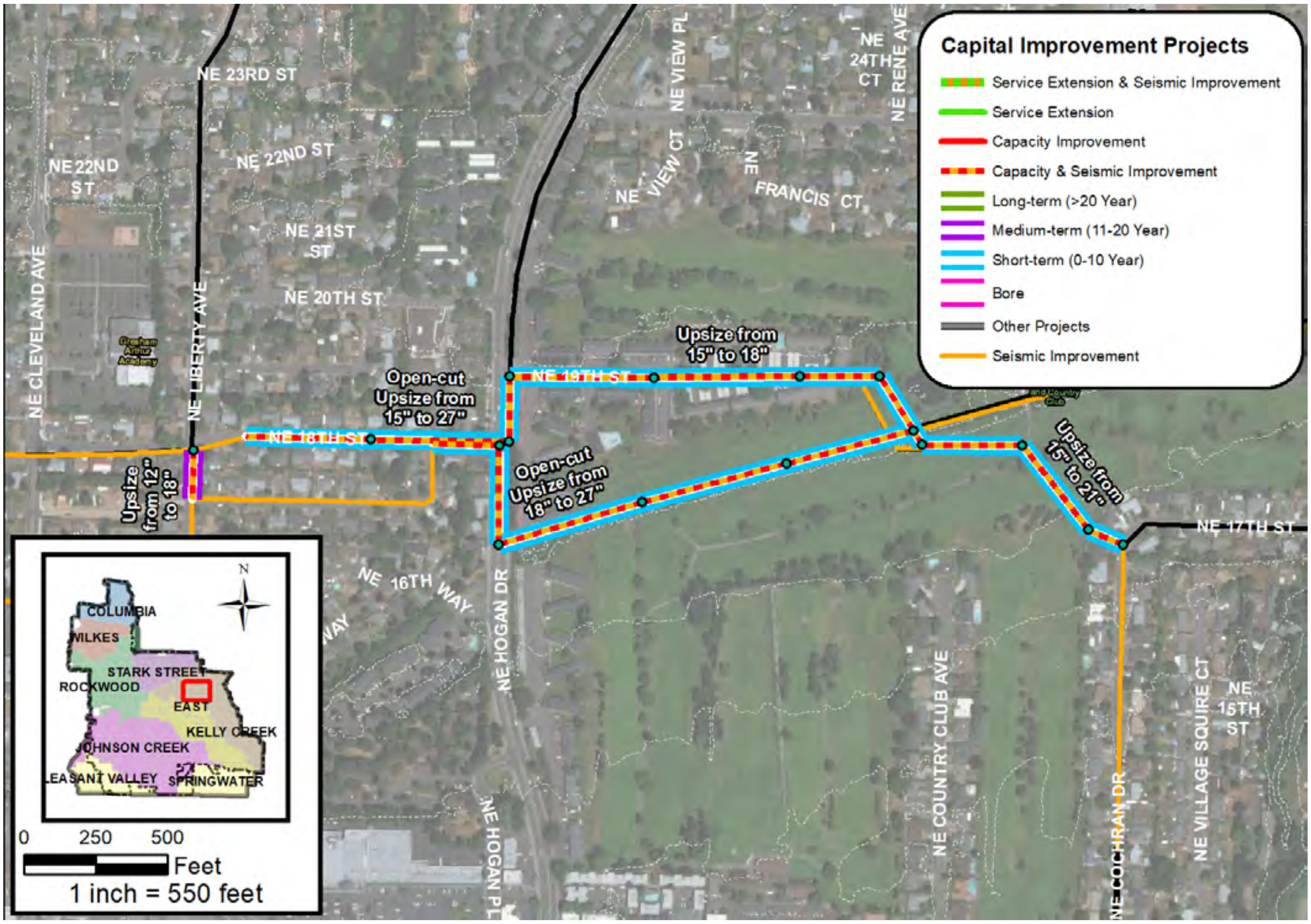

Project Name: LOWER KELLY CREEK BASIN TRUNK IMPROVEMENT

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
KC2	Kelly Creek	Burst	18	1,683	$680,078
			21	505	$302,424
		Sub-total			$982,502
KC2	Kelly Creek	Fused-HDPE	27	3,636	$3,128,053
		Sub-total			$3,128,053
Project totals				**5,825**	**$4,110,555**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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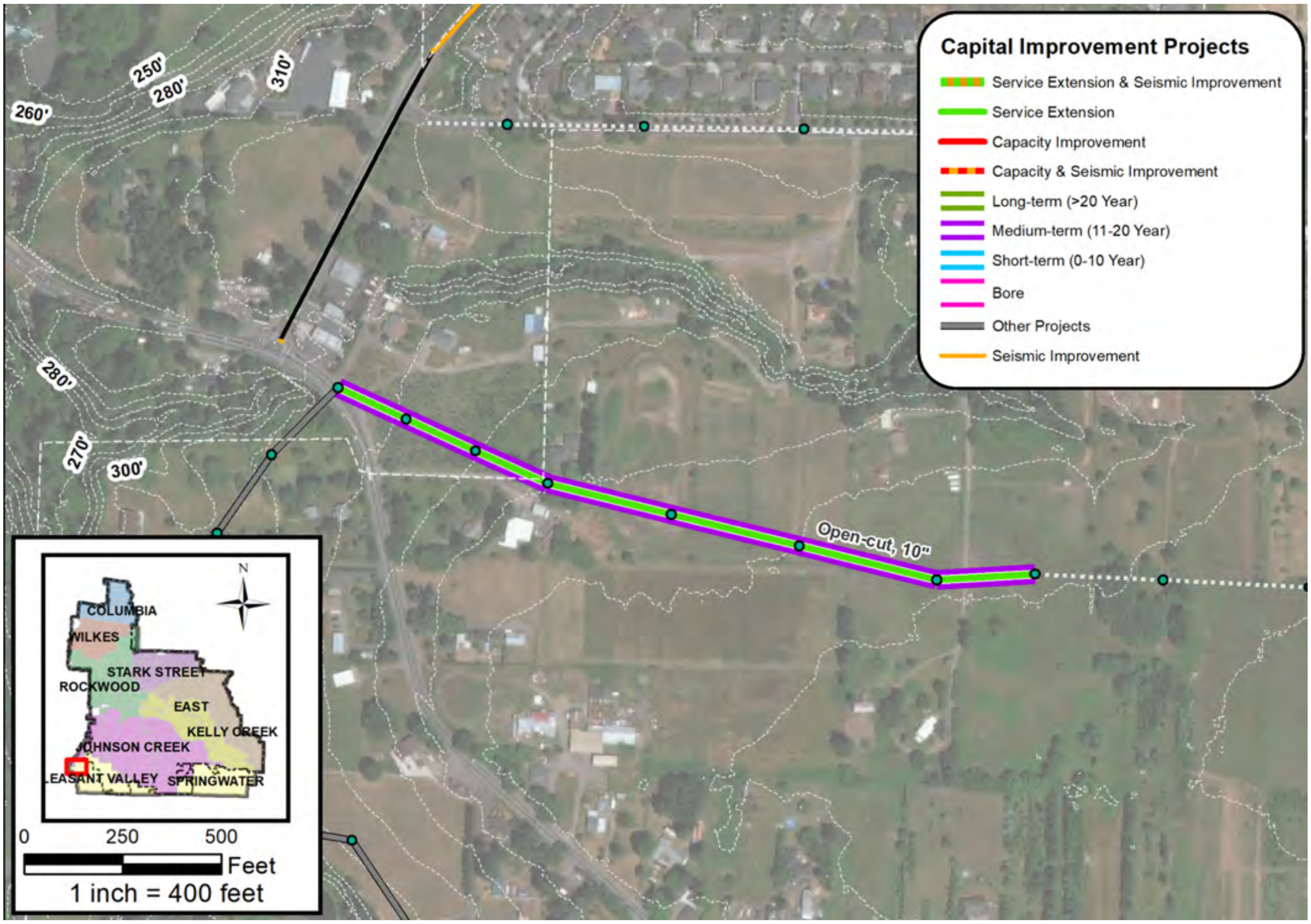

Project Name: LOWER GIESE ROAD TRUNK

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
PV3	Pleasant Valley	Open-cut	10	1,853	$634,026
		Sub-total			$634,026
Project totals				**1,853**	**$634,026**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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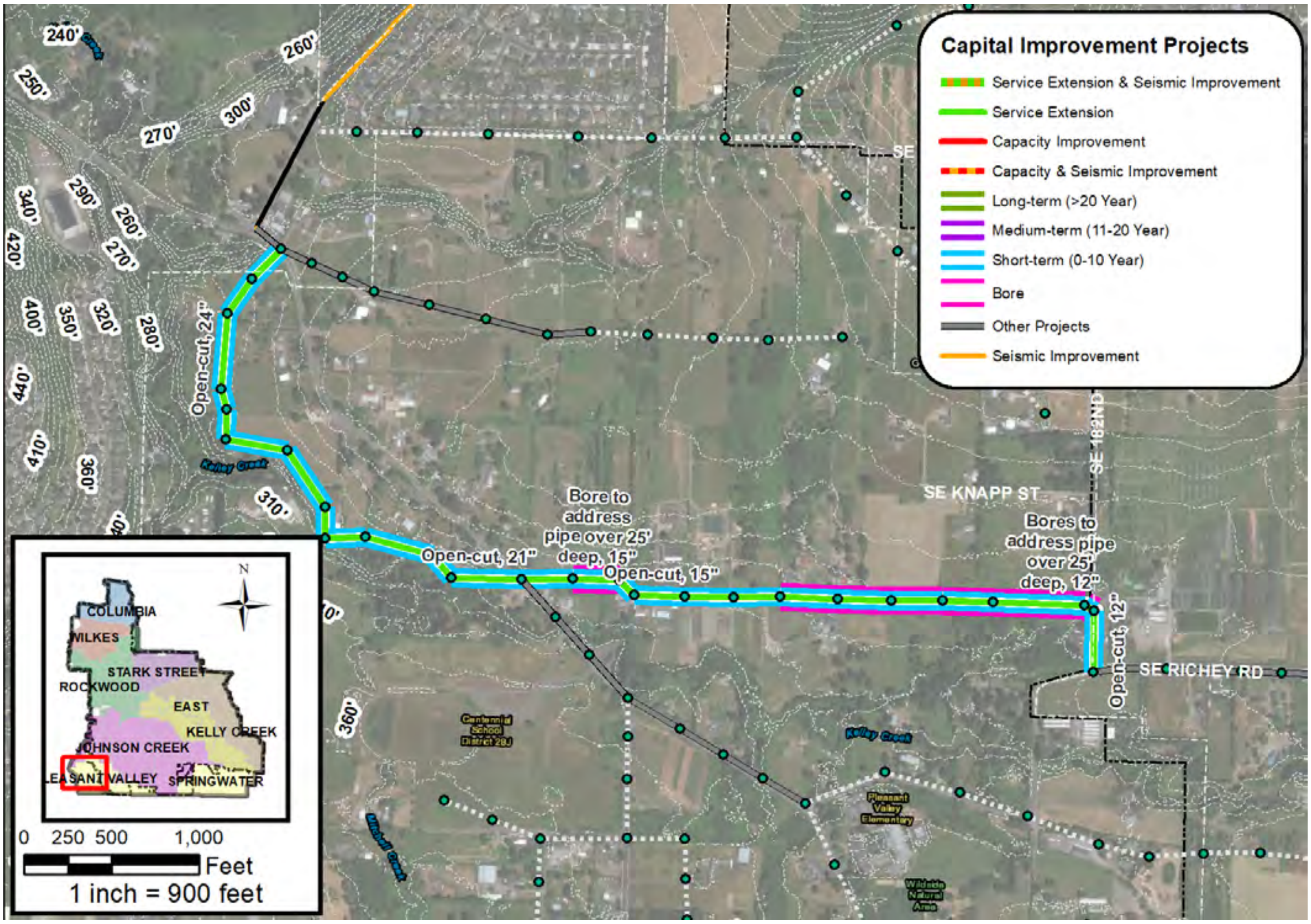

Project Name: PV LOWER KELLEY CREEK TRUNK

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
PV4	Pleasant Valley	Bore	12	1,792	$4,399,274
			15	172	$422,241
		Sub-total			$4,821,515
PV4	Pleasant Valley	Open-cut	12	903	$626,988
			15	793	$594,324
			21	1,194	$376,033
			24	2,139	$700,282
		Sub-total			$2,297,627
Project totals				**6,993**	**$7,119,142**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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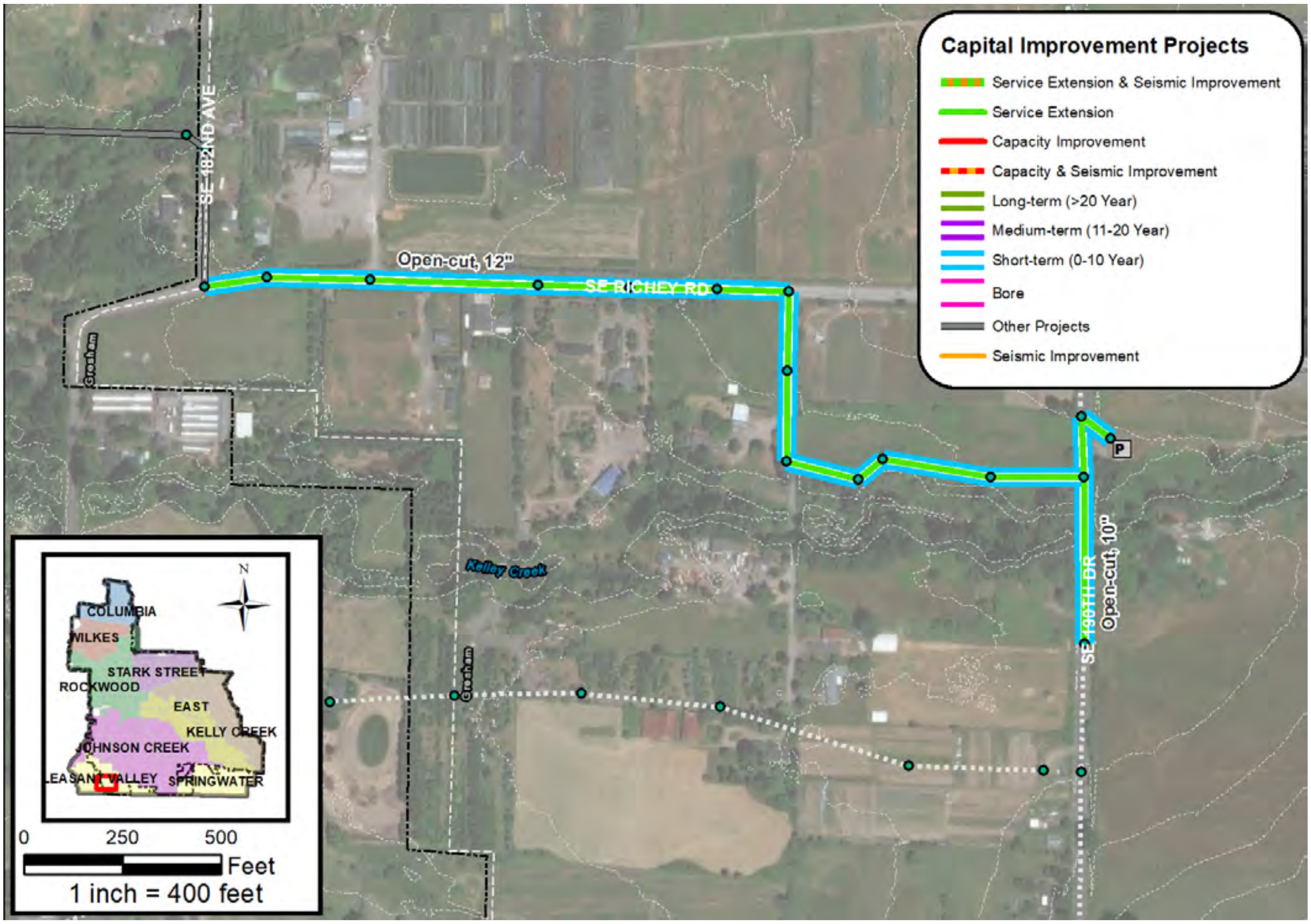

Project Name: PV UPPER KELLEY CREEK TRUNK

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
PV6	Pleasant Valley	Open-cut	10	2,072	$1,158,814
			12	1,487	$990,705
		Sub-total			$2,149,519
Project totals				**3,559**	**$2,149,519**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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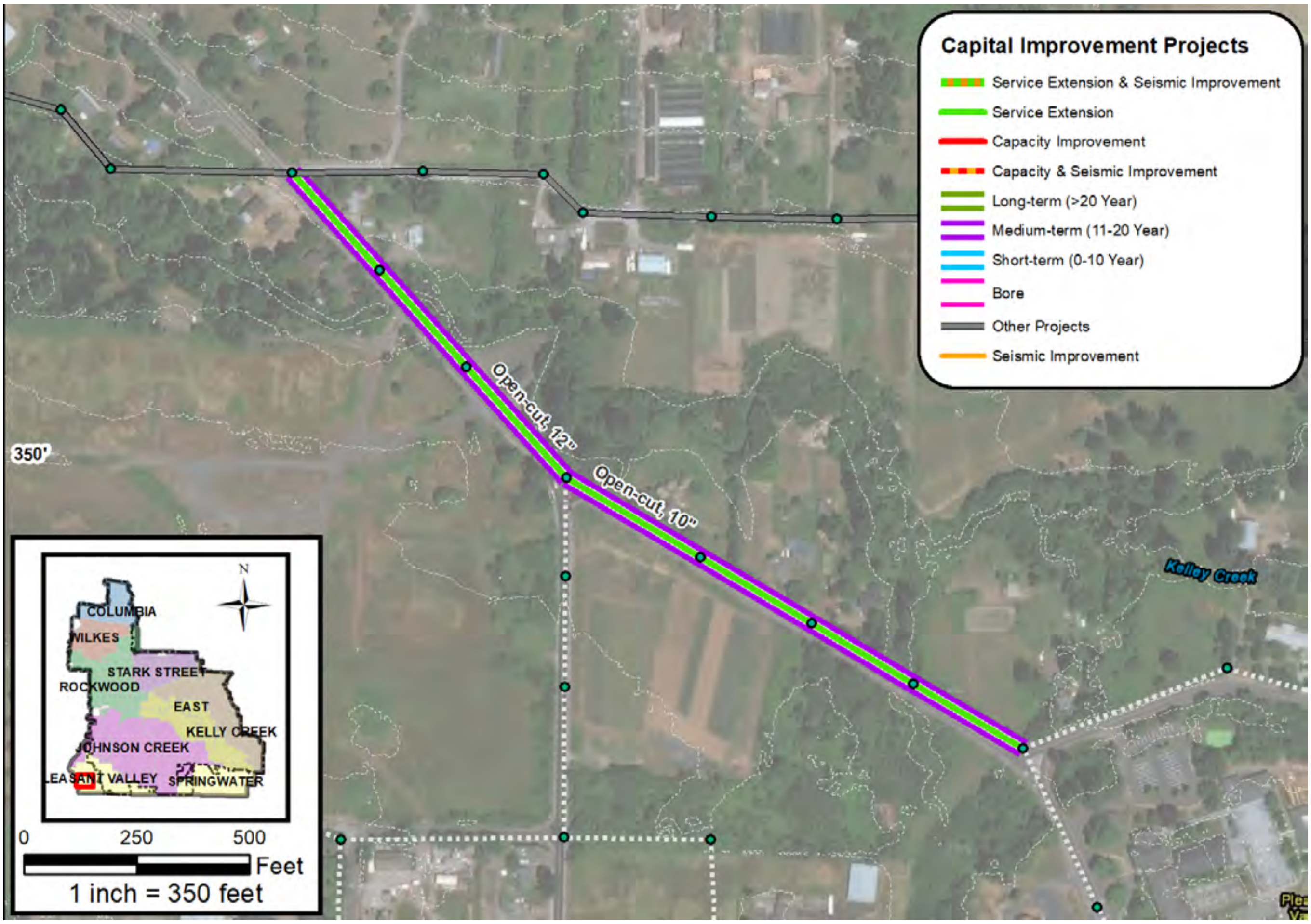

Project Name: FOSTER ROAD TRUNK

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
PV7	Pleasant Valley	Open-cut	10	1,180	$381,130
			12	914	$370,978
		Sub-total			$752,108
Project totals				**2,094**	**$752,108**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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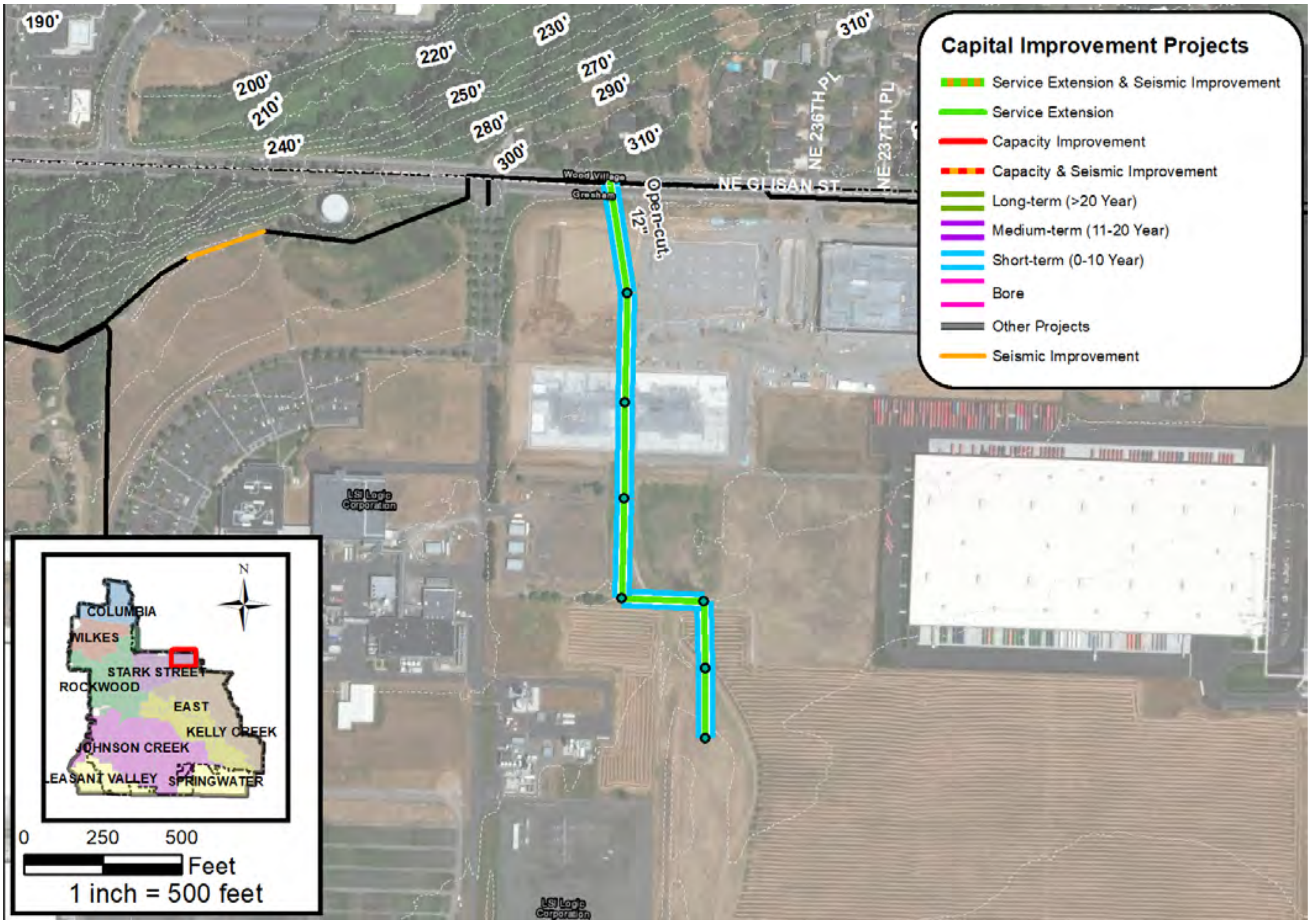

Project Name: STARK BASIN IMPROVEMENT

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
SB1	Stark	Open-cut	12	2,023	$694,196
		Sub-total			$694,196
Project totals				**2,023**	**$694,196**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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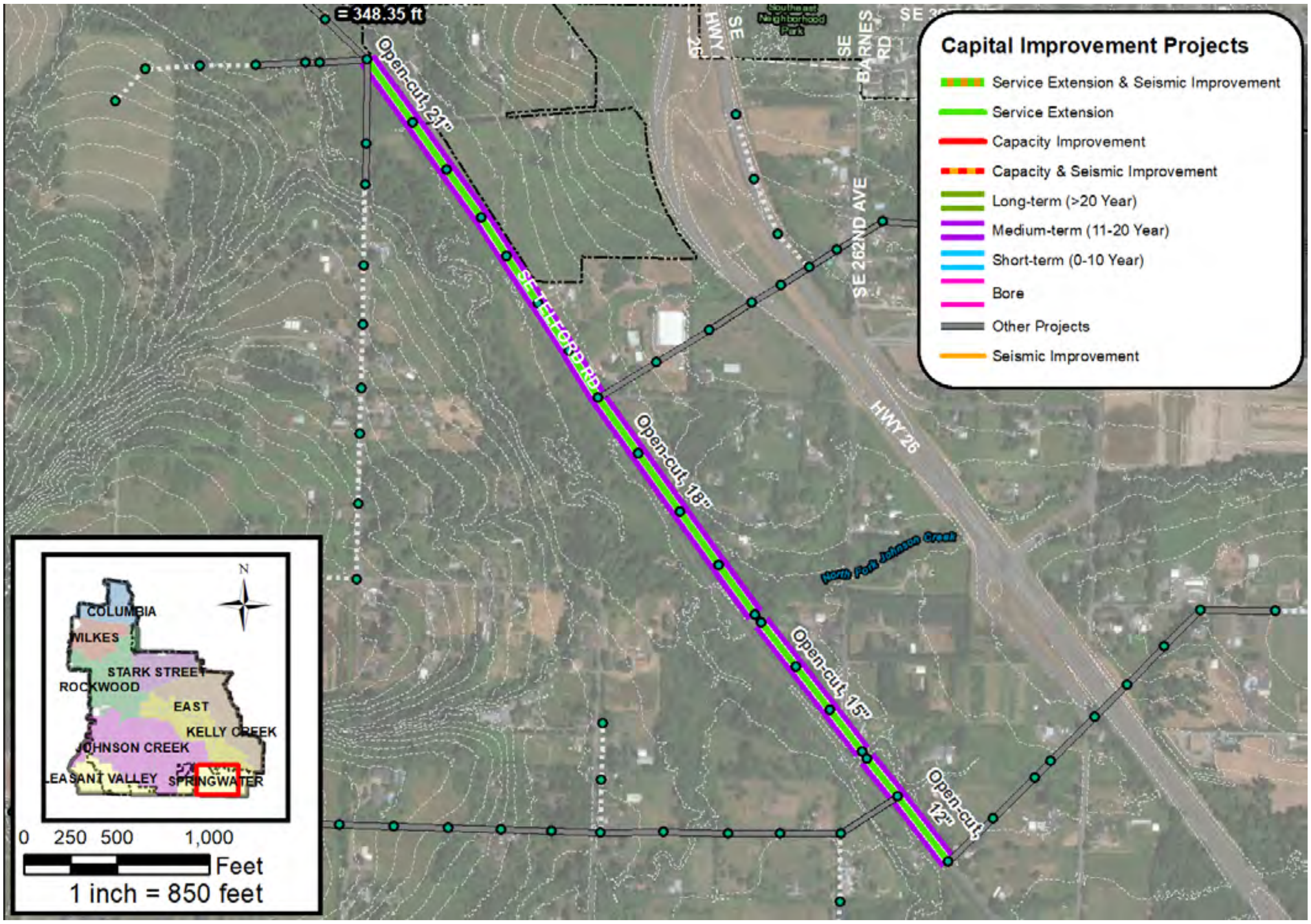

Project Name: TELFORD ROAD TRUNK

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
SW1	Springwater	Open-cut	12	445	$139,608
			15	1,151	$397,698
			18	2,927	$1,077,370
			21	736	$333,406
		Sub-total			$1,948,082
Project totals				**5,259**	**$1,948,082**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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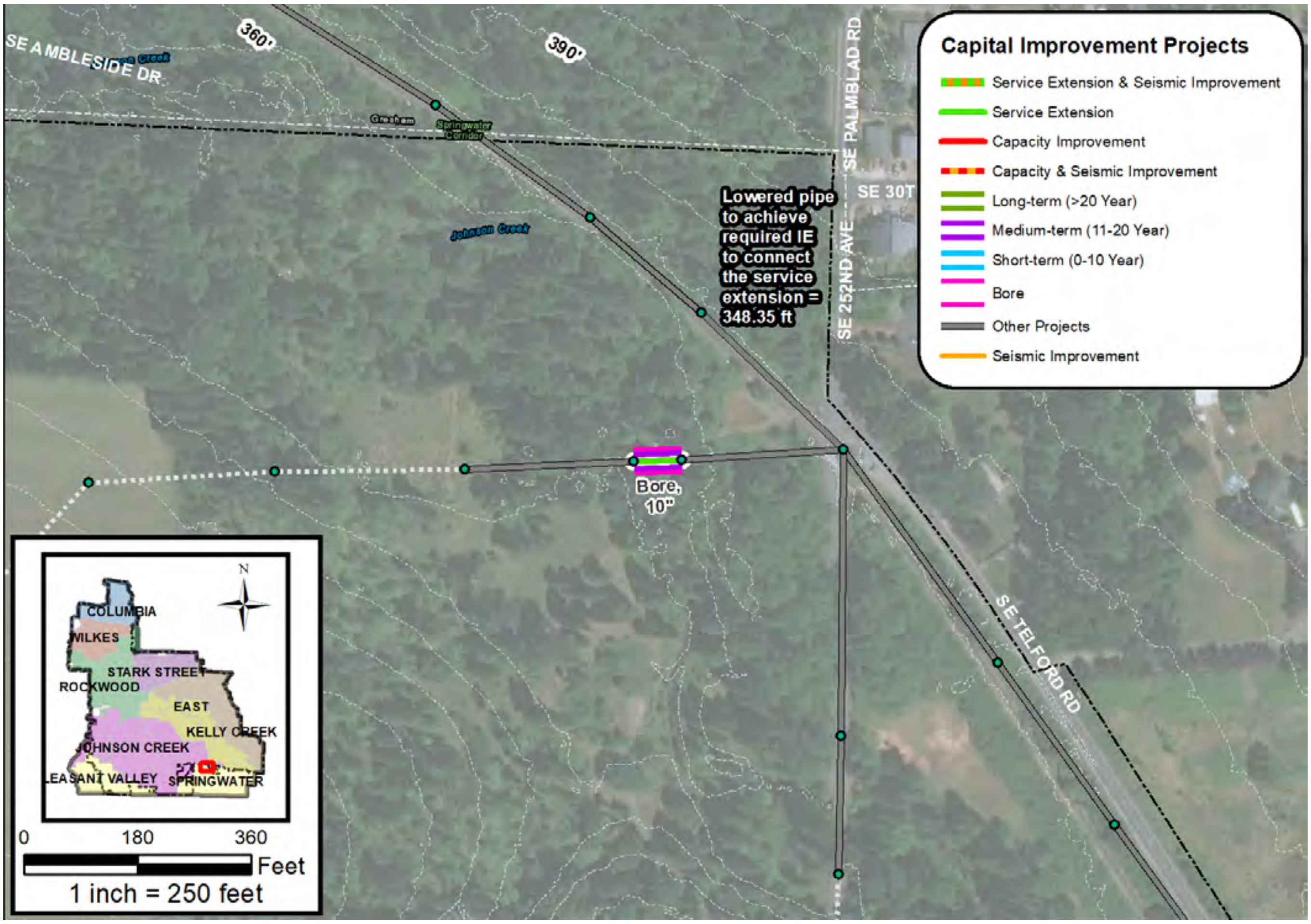

Project Name: VILLAGE CENTER TRUNK NORTH CREEK CROSSING

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
SW11	Springwater	Bore	10	77	$254,500
		Sub-total			$254,500
Project totals				**77**	**$254,500**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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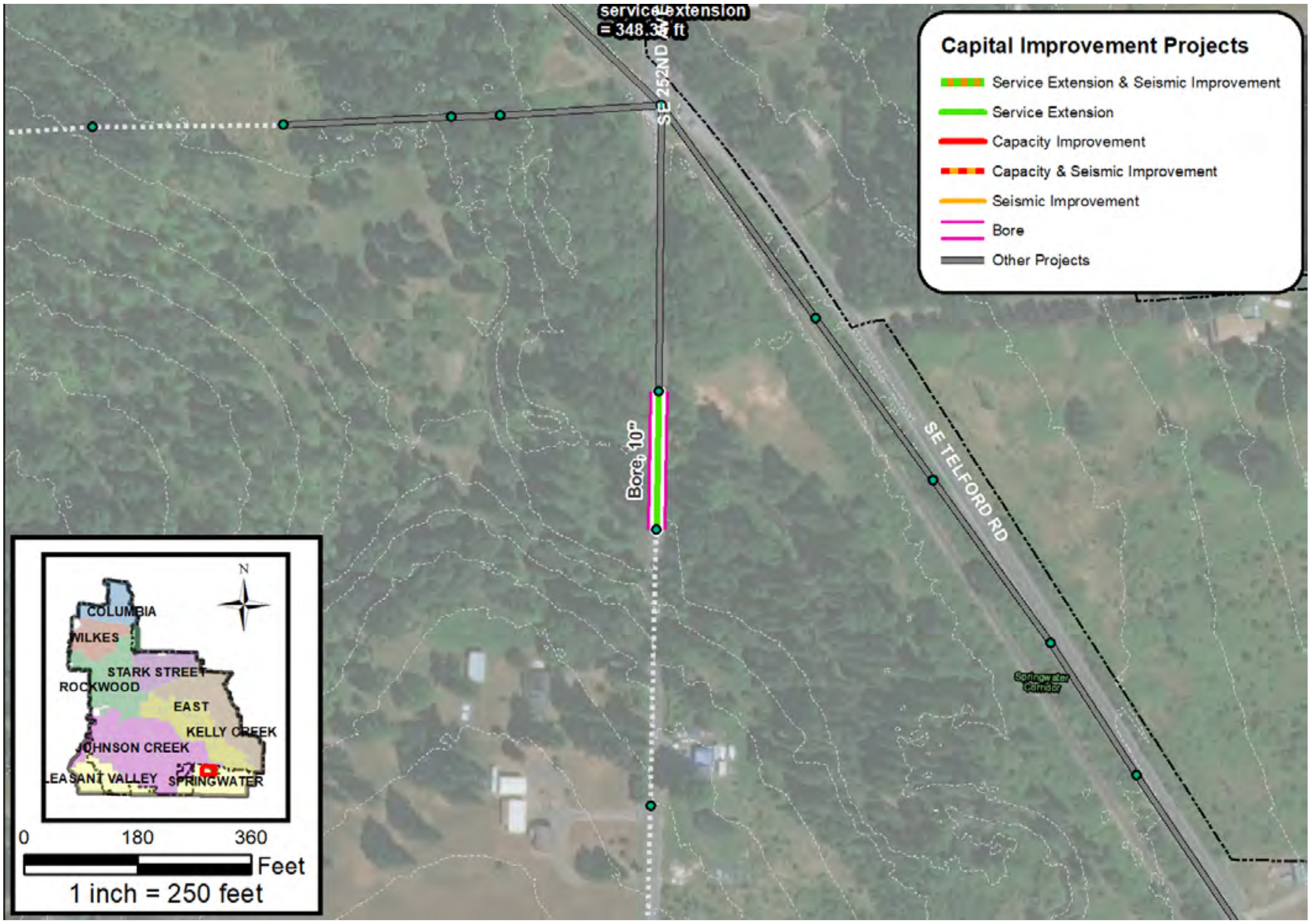

Project Name: VILLAGE CENTER TRUNK SOUTH CREEK CROSSING

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
SW12	Springwater	Bore	10	219	$690,204
		Sub-total			$690,204
Project totals				**219**	**$690,204**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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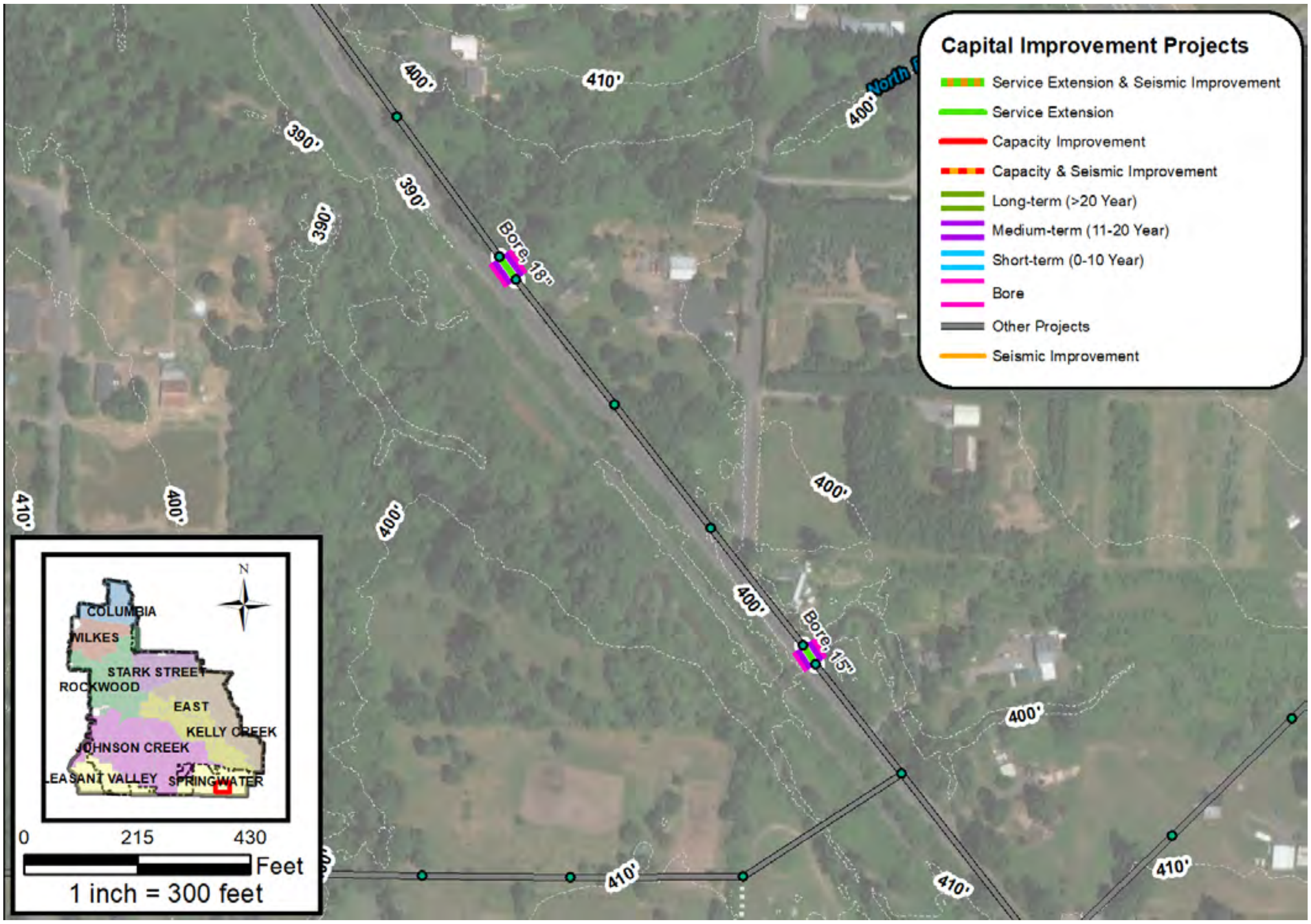

Project Name: TELFORD ROAD TRUNK CREEK CROSSINGS

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
SW13	Springwater	Bore	15	44	$138,448
			18	55	$173,060
		Sub-total			$311,508
Project totals				**99**	**$311,508**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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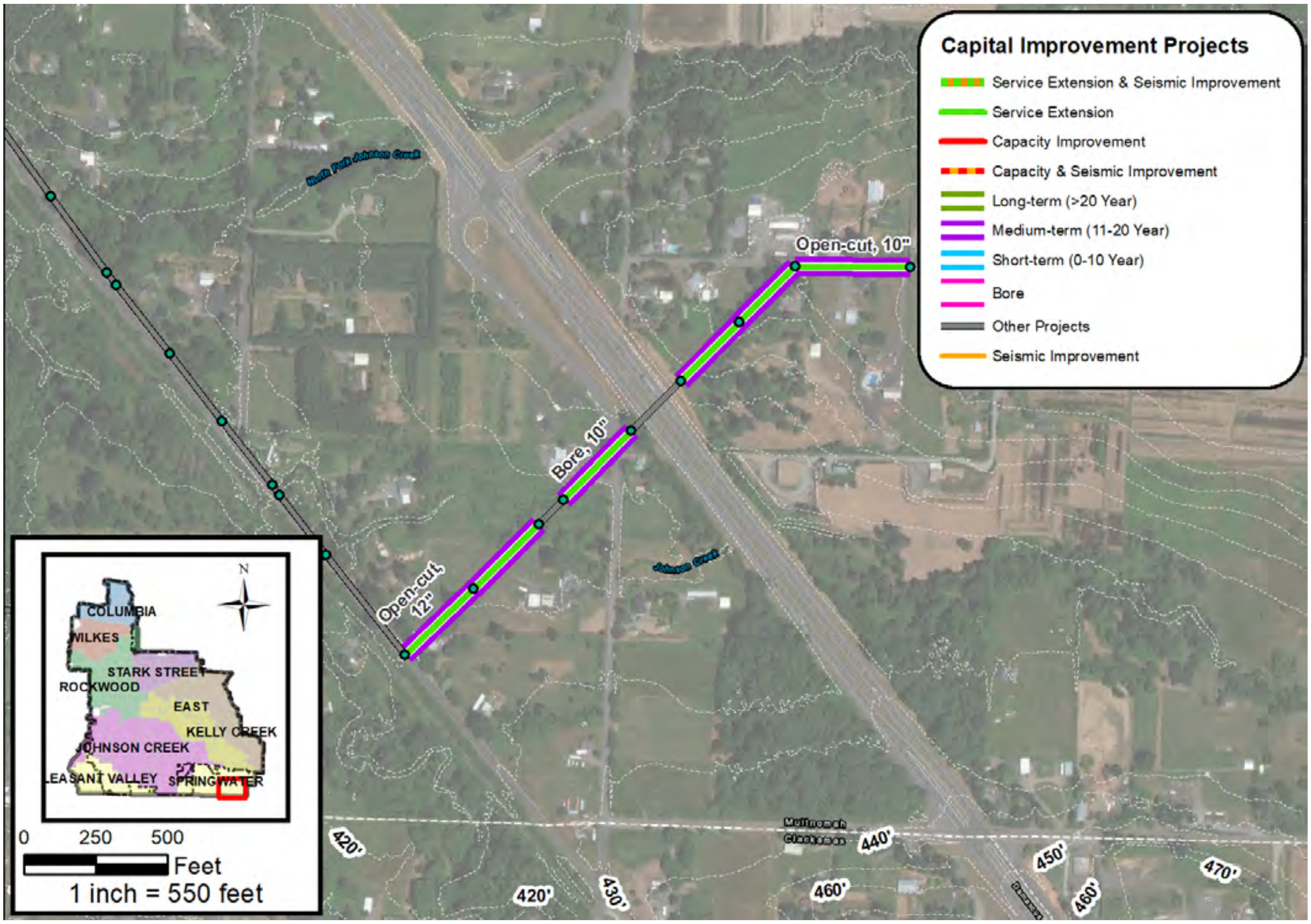

Project Name: JEANETTE ROAD TRUNK

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
SW2	Springwater	Open-cut	10	1,433	$325,443
			12	784	$227,053
		Sub-total			$552,496
Project totals				**2,217**	**$552,496**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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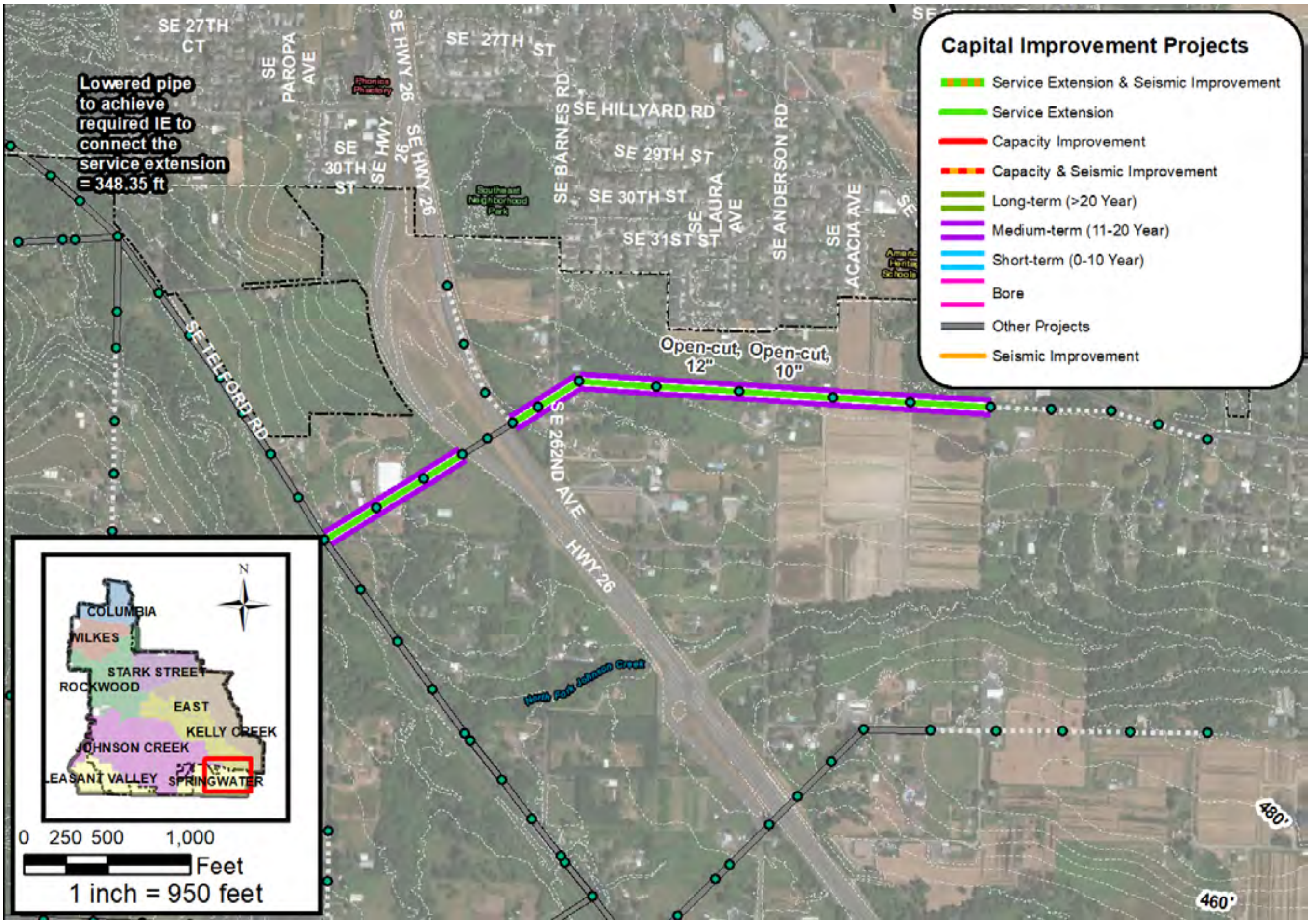

Project Name: ORIENT TRUNK

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
SW3	Springwater	Open-cut	10	1,519	$671,821
			12	2,496	$994,190
		Sub-total			$1,666,011
Project totals				**4,015**	**$1,666,011**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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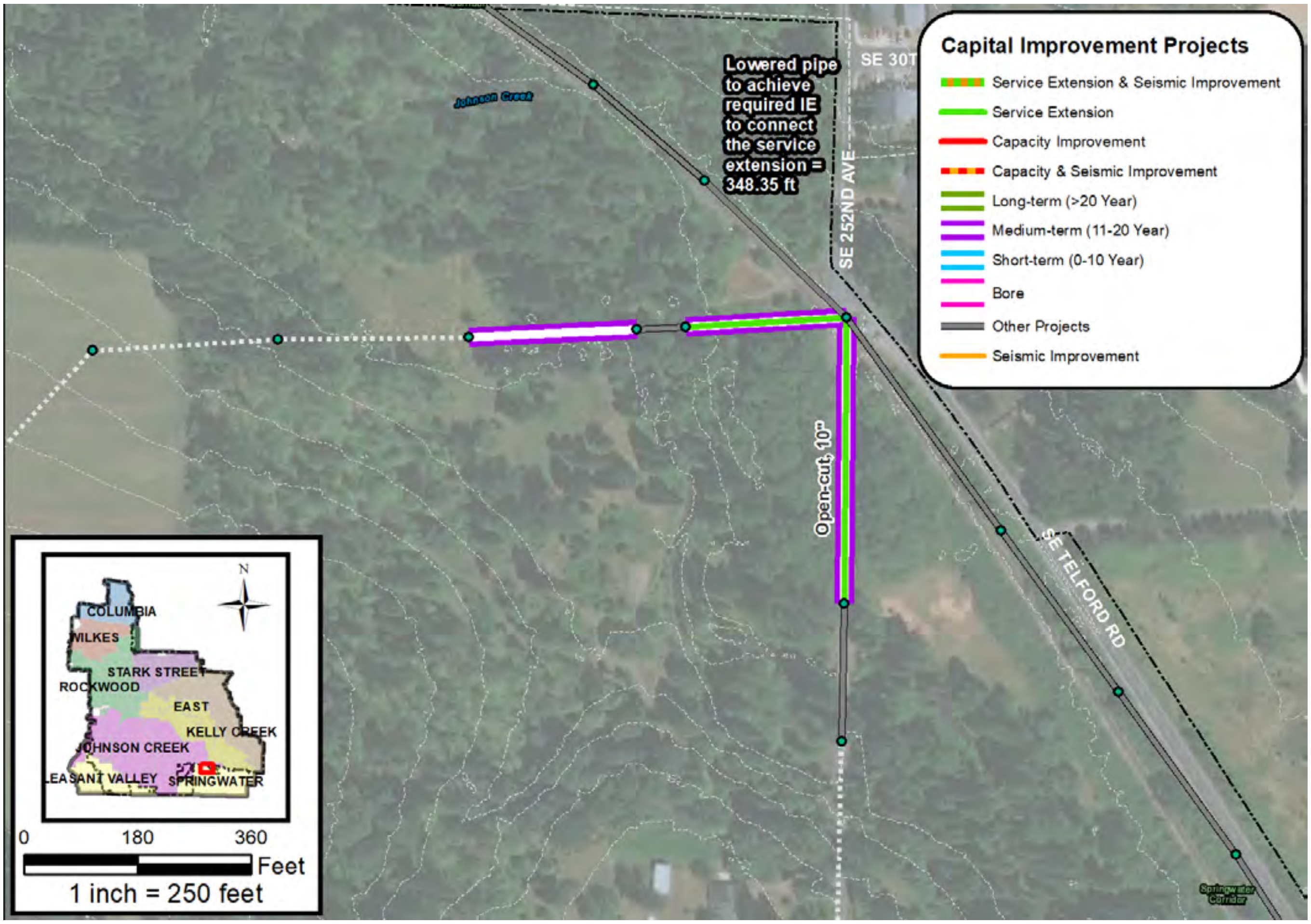

Project Name: VILLAGE CENTER TRUNK

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
SW4	Springwater	Open-cut	10	712	$361,377
		Sub-total			$361,377
Project totals				**712**	**$361,377**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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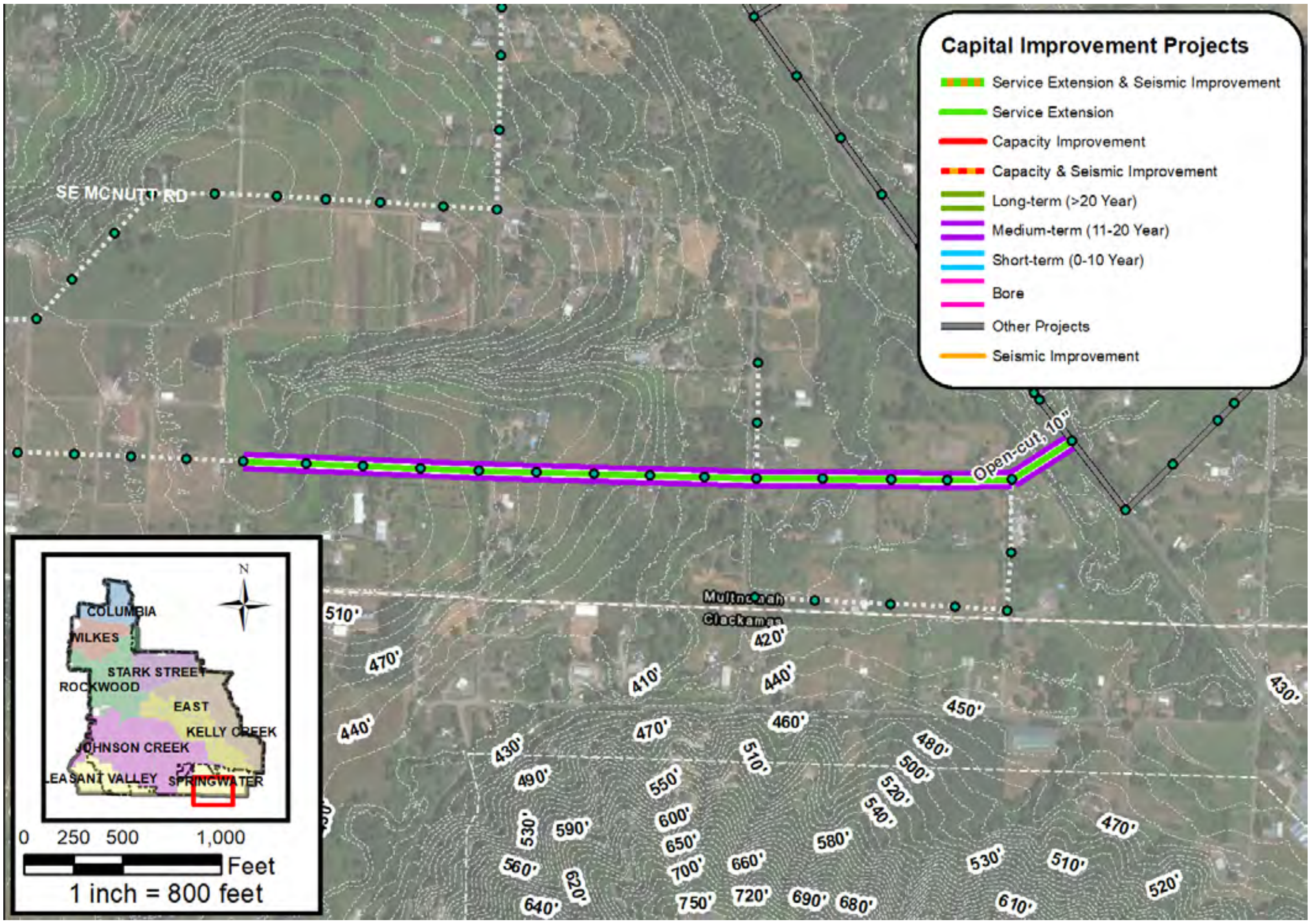

Project Name: RUGG ROAD TRUNK

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
SW6	Springwater	Open-cut	10	4,266	$1,534,353
		Sub-total			$1,534,353
Project totals				**4,266**	**$1,534,353**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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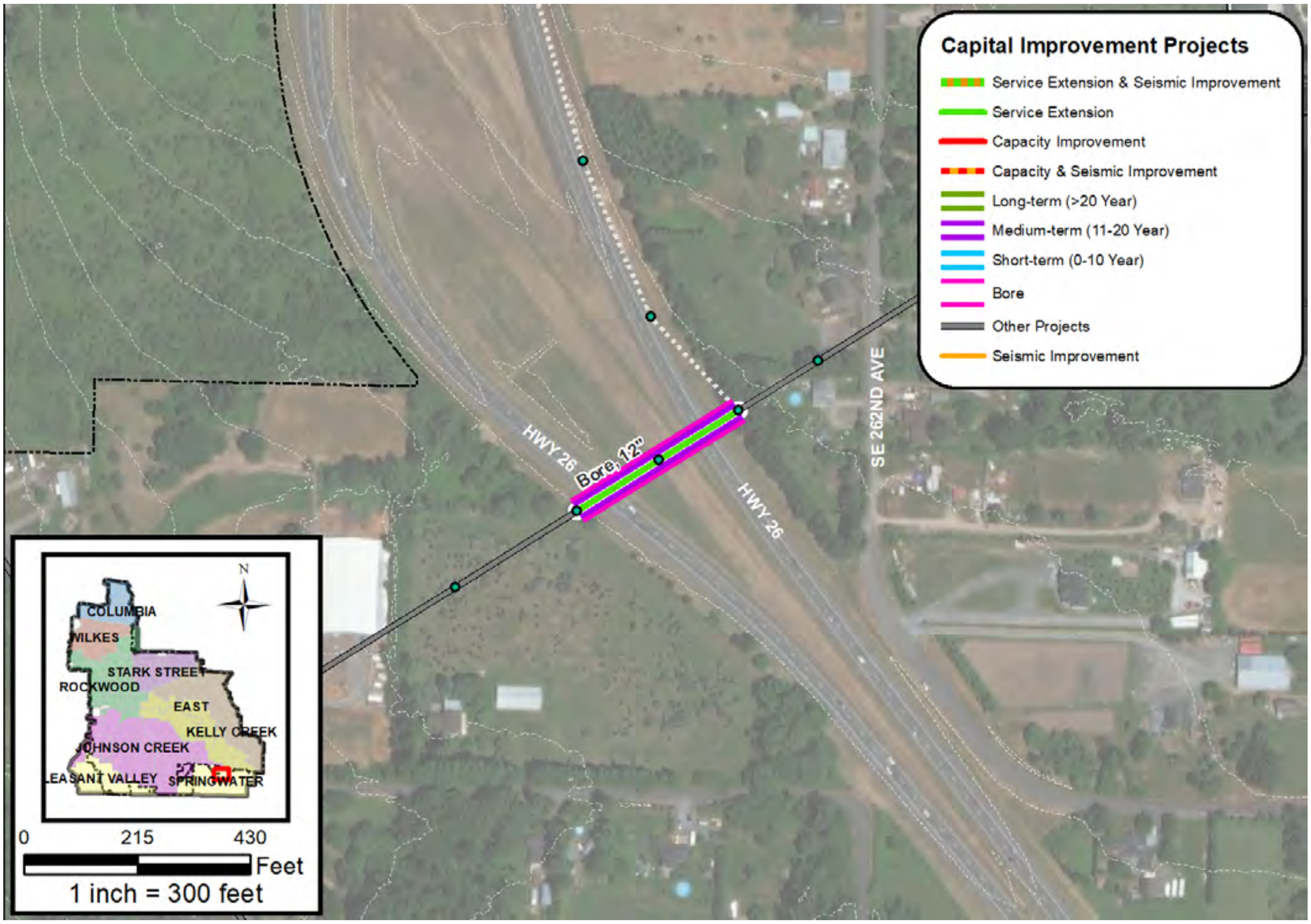

Project Name: ORIENT TRUNK BORE

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
SW8	Springwater	Bore	12	363	$1,140,160
		Sub-total			$1,140,160
Project totals				**363**	**$1,140,160**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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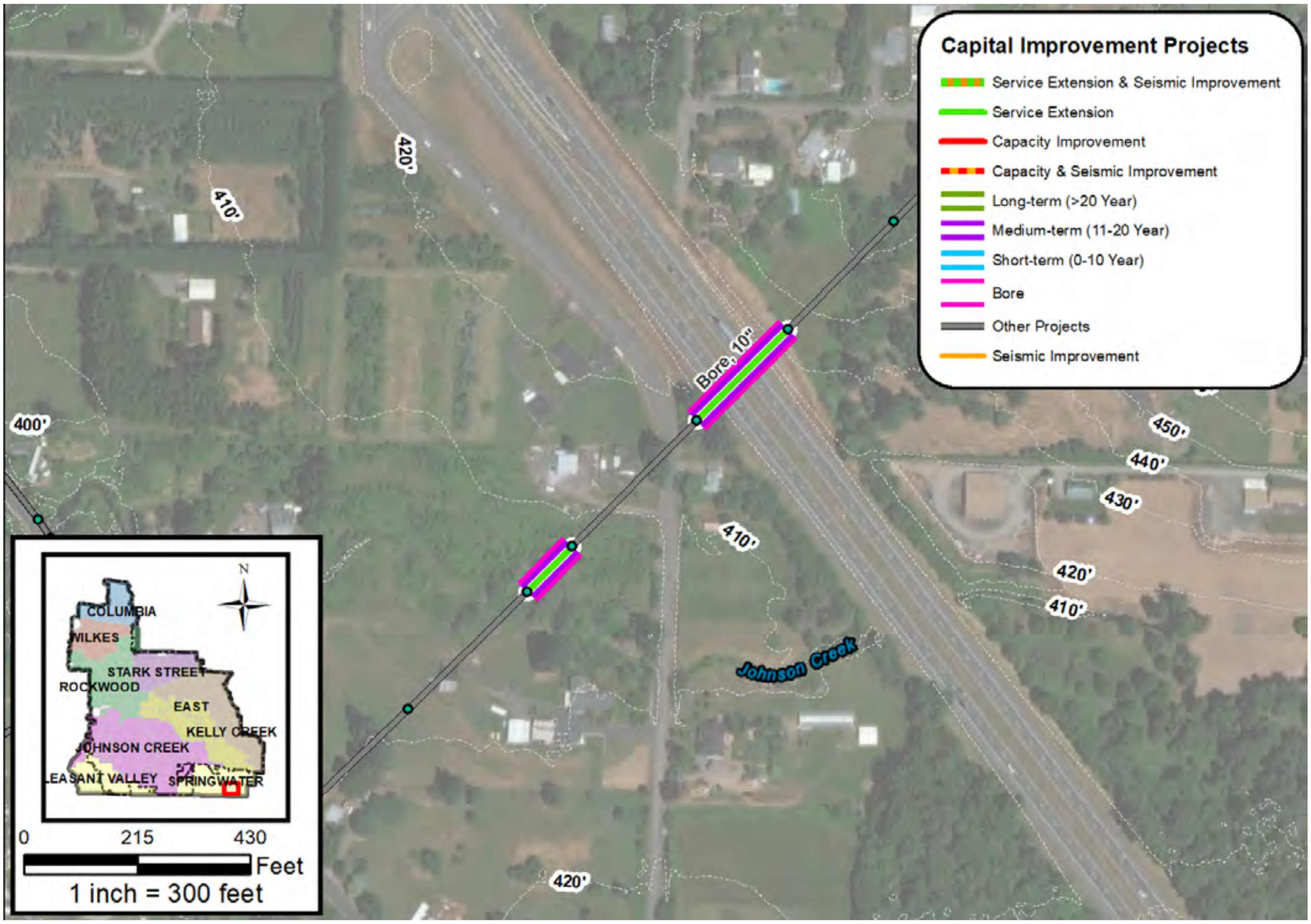

Project Name: JEANETTE ROAD TRUNK BORES

Project ID	Basin	Method	Diameter (in)	Total Length (ft)	Total Cost
SW9	Springwater	Bore	10	368	$1,155,430
		Sub-total			$1,155,430
Project totals				**368**	**$1,155,430**

Cost estimates include a markup of 26% of General Construction Allowances, 25% of Contingency, and 30% of Indirect Project Costs.

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