CITY OF KELSO

STORMWATER

MANAGEMENT PLAN

PHASE I

PREPARED BY:

GIBBS & OLSON, INC.
Longview, Washington

Project No. 0427.1013

July 2006

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CHAPTER 1

EXECUTIVE SUMMARY

The City of Kelso hired Gibbs & Olson, Inc. to delineate the stormwater basins within the city limits and to provide a Stormwater Management Plan (SWMP) for drainage within Phase 1 of the City of Kelso. This SWMP includes inventory of the existing structures and pipes, evaluation of the materials and function of the system, and recommendations for the improvement to the city's Phase 1 system. A map of the city basin delineations is included in Appendix A.

The SWMP identifies deficiencies and recommends improvements for the following three elements of the storm drainage system:

- Pipe capacities
- Pipe materials
- Structure access and connections

Development of the SWMP included the following steps:

- Prepare an inventory of the existing Stormwater collection system
- Model the existing collection system in Phase 1
- Identify areas of insufficiency
- Prepare a Capital Improvement Plan (CIP) for recommended improvements

Stormwater Collection System

Phase I is identified as the area bounded by Pacific Avenue to the west, Alder Street to the north, 8th Avenue to the east and Yew Street to the south. The Basin Plan in Appendix A shows the area of Phase I. The City of Kelso developed a numbering scheme for identifying the existing structures within Phase I based on the City's existing computer files. The city then located in the field each of these structures and documented the structure type, pipe or pipes type and measure down within the structure. Gibbs & Olson, Inc. then surveyed in the coordinate location (northing and easting), structure rim elevation, and inventorying them based on the structure

number documented in the field by City of Kelso personnel. An overall data file was created based on compilation of the data. Structure and pipe information was entered into StormCad (Haested Methods) to develop system flows utilizing the Rational Method and develop pipe capacities. The overall area for Phase I was divided into individual areas and applied to corresponding inlet structures, as shown on the Overall Phase I Plan in Appendix A. Due to limitations with the number of structures StormCad can process in a single file, Phase I was divided into 17 smaller systems, and output information from upstream systems added to downstream systems to determine overall system function and capacity.

System Deficiencies

Modeling for system deficiencies was conducted for Systems 1 through 17 of Phase I using a 25-year storm analysis. Individual system flows and capacities for Systems 1 through 17 can be found in Appendix B. Modeling identified capacities for the corresponding systems, together with individual pipe capacities and identified areas where existing system capacity was insufficient for modeled storm flows. In some locations, pipe material was more of an influence in capacity deficiency than pipe diameter.

A Capital Improvement Plan (CIP) was developed incorporating recommended improvements and associated cost estimates. Summary of the CIP is provided in Chapter 4 and at the end of each system analysis in Appendix B.

CHAPTER 2

INTRODUCTION

2.1 PURPOSE

In response to the 1987 Amendments to the Clean Water Act (CWA), the U.S. Environmental Protection Agency (EPA) developed Phase I of the NPDES Stormwater Program in 1990. The Phase I program addressed sources of stormwater runoff that had the greatest potential to negatively impact water quality. Under Phase I, EPA required NPDES permit coverage for stormwater discharges from medium and large municipalities (communities with populations greater than 100,000). Following the Phase I regulations, Phase II of the NPDES Stormwater Program was implemented which required communities with populations greater than 10,000 to comply with the NPDES regulations. With a population of approximately 11,950, the City of Kelso falls within these Phase II parameters and within the next few years will be required to comply with the NPDES regulations. To determine the level of work needed to meet these new requirements, the City chose a small area to analyze and develop procedures for the City's overall system.

2.2 SCOPE OF PLAN

This SWMP is intended to be the guiding document regarding the management of stormwater, quality and quantity, within the direct control of the City of Kelso. Best Management Practices (BMP's) will be identified in the SWMP as guiding principles for the City's activities in the stormwater arena.

2.3 GOALS AND OBJECTIVES

Goals

The goal of this plan is to:

1) Develop a continuous and comprehensive program for managing surface water and recognizing subsurface drainage contributions in Kelso that prevents property damage and meets or exceeds water quality standards, and;

2) Identify the existing Phase I system and its inadequacies and recommend improvements to the system.
3) Develop a procedure to inventory and analyze the remaining Phases within the City of Kelso city limits.

Objectives

The following objectives are designed to accomplish the above goals:

1) Develop stormwater basin boundaries within the City of Kelso city limits;
2) Develop a stormwater system inventory that provides a horizontal and vertical relationship together with pipe sizes for all known storm systems within Phase I;
3) Outline the current existing city conditions with respect to stormwater area characteristics, city policies and regulations, and how the system works;
4) Develop comprehensive maps of the City's Phase I drainage system;
5) Analyze the existing Phase I drainage system;
6) Develop a Capital Improvements Program;

CHAPTER 3

PHASE I SYSTEM ASSESSMENT

3.1 GENERAL

The current Phase I system is a combination of public and private systems. The City of Kelso owns and maintains the system in the public right-of-way together with some easements that cross private property.

Private systems were found in a few locations within Phase I, consisting mainly of catch basins and piping. These systems were identified on the City's overall stormwater map, but specific information for this study was not obtained due to the inability to access the structures on private property.

3.2 HYDROLOGY

A plan of the Phase I system of catch basins and manholes has been mapped and is included in the report in Appendix A. Field data for pipe size, invert elevations (IE), pipe materials, as well as lengths, have been recorded. This Phase has been divided into systems with basic flow modeling performed using StormCad by Haested Methods to determine where potential flow problems are likely to exist, and to aid in identifying capital improvement projects. StormCad calculates flow utilizing the Rational Method, Q=CIA. Each catch basin or system inlet was assigned an inlet area (in acres) and time of concentration based on the topography and existing features for the Basin I Area. The intensity was developed based on the formula $I = m/t^n$ where m= 7.74 and n=0.524 for the 25-year storm (*WSDOT Hydrology Manual, March 2005*). The Index to Rainfall Coefficients can be found in Table 9.4.1 in Appendix C (Hardbook of Hydrology, David Maidment, 1993). Individual runoff coefficients were selected for each area based on the existing area description. The coefficients for the types of drainage area are listed with a range and the median value was used. The majority of Basin I is comprised of single-family residential, listed in the table with a range from 0.3-0.5. A value of 0.4 was used in StormCad for the runoff calculations.

3.3 SYSTEM ISSUES

As stated previously, a system inventory of Phase I was conducted in a cooperative effort between the City of Kelso and Gibbs & Olson, Inc. The City of Kelso numbered the system structures and gathered the system information such as pipe sizes and types, along with measure down information for determining invert elevations. Gibbs & Olson, Inc. then surveyed in the coordinate locations of the numbered structures and gathered the structure rim elevation using the City of Kelso/Cowlitz County GIS datum. Using the structure rim elevation and the measure down data gathered by the City of Kelso, invert elevations were calculated and applied to the pipes entering or exiting a structure. During the analysis of the data, several issues became apparent with the system.

Slope: The first issue identified is that only one measure down per structure was provided, and therefore only one invert elevation for each pipe entering or exiting a structure was calculated. This may have impacts on the system function in the form of inaccurate slope calculations. It should be noted that identified undersized pipes may be found to be adequate if additional invert information is provided that change the existing pipe slope. For pipes identified to be upsized, a recommended first step would be to verify invert elevations and pipe slopes prior to replacing the pipe.

Pipe size: A second system issue identified is the presence of small diameter pipe, that is, pipe less than 12-inches in diameter. Approximately 60% of the system is comprised of pipe with a diameter less than 12-inches. Table 3A shows the pipe compilation by size and material. The small diameter pipe, in conjunction with the relatively flat pipe slopes, severely inhibits the capacity of the piping system due to the reduced flow capacity. A preliminary recommendation is to remove any trunk lines with piping less than 12-inches in diameter and replace with a minimum of 12-inch diameter pipe.

Pipe Size (inches)	Concrete (ft)	CMP (ft)	PVC (ft)	Terra-cotta (ft)	Ductile Iron (ft)	Cast Iron (ft)	Total (ft)	Percentage
6	1,753		350	20		26	2,149	10.11%
8	4,712		995			15	5,722	26.93%
10	3,458		188	1,345			4,991	23.49%
12	2,665		401	274	77		3,417	16.08%
15	262			905			1,167	5.49%
18	289						289	1.36%
21	204						204	0.96%
24	1,780		276				2,056	9.68%
30		1,115					1,115	5.25%
36	140						140	0.66%
Total (ft)	**15,263**	**1,115**	**2,210**	**2,544**	**77**	**41**	21,250	100%
Percentage	71.83%	5.25%	10.40%	11.97%	0.36%	0.19%	100%	

Table 3A Pipe Totals

Pipe Material: A third issue is the use of Corrugated Metal Pipe (CMP) for the 30-inch diameter pipes. This material reduces the capacity of the pipe by over 50% when compared to concrete or HPDE pipe. Virtually none of the piping found in the Phase I system was comprised of newer piping material, such as HDPE. Concrete was the prevalent material, accounting for almost 72% of the existing piping.

System Maintenance: The final contributing issue to the City of Kelso Phase I stormwater system is maintenance. During the inventory of structures and pipes, several notes were made in regards to cleaning a structure or pipe connection. It is recommended the system be cleaned to obtain further information on the system. Cleaning of the system might also improve calculated pipe slopes, if it were found the measure downs did not reach a pipe invert.

3.4 CONCLUSIONS

Reviewing Systems 1 through 17, the most prominent issue for the functioning of Phase I is the lack of pipe slope. Providing positive slope for those identified with negative slope is the first issue to be addressed. For those pipes with positive but relatively flat slopes, increasing the pipe size will provide additional capacity for the system. A notable issue to contend with is the lack of ground cover for the piping system. In some cases, providing increased slope and/or larger pipe sizes may not be feasible due to the lack of ground cover over the pipes. In these instances, it may be necessary to utilize a specialized pipe such as an arch pipe, or install two or more pipes of smaller diameter to provide the capacity needed.

CHAPTER 4

RECOMMENDATIONS

4.1 GENERAL:

With respect to stormwater, the City's current system complies with existing local and state requirements, with regular maintenance being the only ongoing expense. Note that stormwater is a new evolving field which is in its infancy. Driven by federally mandated changes, that are being governmentally implemented by the State of Washington Department of Ecology (DOE), the existing standards will be evolving and changing over the next decade.

This stormwater plan for Phase I, together with the following recommendations, represents a General Plan which will provide a proactive response for the citizens of Kelso, together with a comprehensive inventory of the City's existing stormwater infrastructure, to aid in a smooth and cost effective transition to the stormwater demands of 2010 and beyond.

4.2 SYSTEM UPGRADES

The Phase I inventory for stormwater piping and devices represents the best available information at this time. As ongoing piping and devices are expanded or upgraded into the system, the new installations need to be added to the existing inventory. Also, should pre-existing conditions be found that are not inventoried, these also need to be appended into the inventory.

Over 60% of the Phase I existing system is comprised of pipes with diameters less than 12-inches (see Chapter 3, Table 3.A). Many of these lines are single pipes connecting into a trunk line, and are not causing a significant problem to the system flow. However, it is recommended that any new pipe installed be a minimum of 12-inches in diameter. Overall, 15,106 linear feet of pipe were identified to be upgraded, and Table 4.A shows the breakdown of pipe per system and pipe size.

System	12-inch	18-inch	24-inch	30-inch	36-inch	42-inch	48-inch	Total
1	234	0	730	0	0	0	0	**964 ft**
2	15	0	121	228	274	0	0	**638 ft**
3	141	0	1,049	67	0	0	0	**1,257 ft**
4	349	790	0	0	0	0	0	**1,139 ft**
5	429	361	0	0	247	0	0	**1,037 ft**
6	272	681	0	0	273	0	0	**1,226 ft**
7	198	453	0	0	0	245	0	**896 ft**
8	467	718	0	0	0	0	0	**1,185 ft**
9	236	0	685	0	0	276	0	**1,197 ft**
10	0	0	0	0	0	245	0	**245 ft**
11	157	473	0	0	0	0	0	**630 ft**
12	750	0	260	0	0	0	0	**1,010 ft**
13	139	293	0	0	0	0	0	**432 ft**
14	345	0	0	472	0	0	0	**817 ft**
15	26	532	204	0	0	0	0	**762 ft**
16	0	0	0	517	0	0	163	**680 ft**
17	0	0	0	0	0	0	991	**991 ft**
Total	**3,758 ft**	**4,301 ft**	**3,049 ft**	**1,284 ft**	**794 ft**	**766 ft**	**1,154 ft**	**15,106 ft**

Table 4.A Pipe Upgrades

The modeling results for the 25-year storm indicate the trunk line down Chestnut Street and the lines on the side streets connecting into Chestnut Street are undersized, and should be upsized according to the recommendations in the individual system assessments in Appendix B. However, it should be noted much of the system had hydraulic grade lines at or below the existing ground elevation, and while full, may not be creating a major flooding problem. Since the Phase I system outlets into another system, it is not known how the downstream system functions, which may be a contributing factor to stormwater problems the City has observed.

4.3 CAPITAL IMPROVEMENTS

Appendix B contains information on Systems 1 through 17 and recommended improvements. An estimated budget for completing all the pipe upgrades and repairing the surface to existing conditions was prepared and included in Table 4.B. Note that as this is a stormwater project, sales tax is not applied to the estimate. The total Preliminary Opinion of Probable Cost for the identified improvements is $1,910,190. This cost is based on contracting the work to be done by other than City of Kelso forces.

ITEM	DESCRIPTION	QTY	UNIT	PRICE	TOTAL
1	Mobilization	1	LS	$75,775	$75,775
2	Traffic Control	1	LS	$10,000	$10,000
3	Clearing & Grubbing	1	LS	$2,000	$2,000
4	Removal of Structures and Obstructions	1	LS	$5,000	$5,000
5	Removal of Existing Asphalt	6,700	SY	$45	$301,500
6	Construction Fabric	6,700	SY	$2	$13,400
7	Crushed Surfacing Base Course	3,400	Tons	$20	$68,000
8	Crushed Surfacing Top Course	1,150	Tons	$22	$25,300
9	Hot Mix Asphalt	1,250	Tons	$80	$100,000
10	12-inch HDPE Storm Pipe	3,758	LF	$25	$93,950
11	18-inch HDPE Storm Pipe	4,301	LF	$45	$193,545
12	24-inch HDPE Storm Pipe	3,049	LF	$60	$182,940
13	30-inch HDPE Storm Pipe	1,300	LF	$80	$104,000
14	36-inch HDPE Storm Pipe	794	LF	$95	$75,430
15	42-inch HDPE Storm Pipe	800	LF	$135	$108,000
16	48-inch HDPE Storm Pipe	1,160	LF	$170	$197,200
17	Import Trench Backfill	2,210	LF	$15	$33,150
18	Trench Safety Systems	1	LS	$2,000	$2,000
Subtotal					$1,591,190
Contingency @ 20%					$319,000
Total Construction Cost					**$1,910,190**

Table 4.B Preliminary Opinion of Probable Cost, Phase I

It is unlikely the City of Kelso will have the estimated budget to complete all the recommended upgrades to the system at the same time, as listed in this report. Therefore, a guideline for order of precedence for the CIP has been developed and is suggested as follows:

1. Clean catch basins and storm drain manholes to verify pipe inverts;
2. Clean and television storm drain pipes to determine if blockages are encountered;
3. Replace corrugated metal and terracotta pipes with HDPE pipe such as ADS N-12 or similar;
4. Upgrade storm drain pipes on Chestnut Street to sizes recommended to handle flow from side systems and to provide additional storage during larger storm events;
5. Upgrade storm drain pipes on side streets to sizes recommended, beginning at S. 8th Avenue and working to the west toward Pacific Avenue.

With the large pipes recommended for upgrading the system, it is recommended a more detailed engineering design of the proposed system be conducted, which takes into account the existing surrounding environment. The individual and overall system budget estimates have been developed based on the cost to remove and replace the pipes with the sizes as shown, and to repair the existing surface to its current condition. However, shallow cover and additional utilities within the City's right of way may require additional engineering solutions to those provided in this report, which could add additional unknown costs.

Appendix A

Legend

	Additional data needed; see comments
	Ground elevation interpolated from contour map
	Invert elevations interpolated from upstream and downstream nodes
-0.02	Negative slope based on data provided
MH	Manhole
CB	Catch Basin
J	Junction
O	Outlet
Conc.	Concrete
T-cotta	Terracotta
CI	Cast Iron
PVC	Polyvinyl Chloride
500-545	Additional nodes labeled based on storm layout
NDA	No Data Available

Kelso Stormwater Management Plan
Phase I
Stormwater Master Plan

7/13/2006

Pipe Label	Node								Length (ft)	Size (in.)	Material	Ground Elevations		Measure Downs		Invert Elevations		Slope (ft/ft)	Comments
	Upstream			Area		Downstream						Upstream	Downstream	Upstream	Downstream	Upstream	Downstream		
	No.	Type	Location	AC	SF	No.	Type	Location											
P-1	101	CB	SE Quad. of Pacific & Laurel	1.1706	50990	100	MH	Pacific Ave & Laurel St	47	8	Conc.	21.08	22.09	2.9	4.9	18.18	17.19	0.0211	~~Does 101 have two nodes?~~
P-2	100	MH	Pacific Ave & Laurel St	NA	NA	103	MH	Pacific Ave	146	8	Conc.	22.09	22.09	4.9	5.7	17.19	16.39	0.0055	~~Is 103 the junction between 102 & 104?~~
P-3	104	CB	Pacific Ave	0.2305	10042	103	MH	Pacific Ave	28	8	Conc.	21.60	22.09	3	5.7	18.60	16.39	0.0789	~~Is 104 crossed out?~~
P-4	102	CB	Pacific Ave	1.1621	50619	103	MH	Pacific Ave	14	8	Conc.	21.22	22.09	4.3	5.7	16.92	16.39	0.0379	
P-5	103	MH	Pacific Ave	NA	NA	107	MH	Pacific Ave	309	8	Conc.	22.09	22.03	5.7	6.8	16.39	15.23	0.0038	
P-6	106	CB	NE Quad. of Pacific & Elm	0.3619	15765	105	CB	SE Quad. of Pacific & Elm	26	8	Conc.	21.61	21.41	3	3	18.61	18.41	0.0077	
P-7	105	CB	SE Quad. of Pacific & Elm	2.3027	100306	107	MH	Pacific Ave	41	8	Conc.	21.41	22.03	3	6.8	18.41	15.23	0.0776	
P-8	107	MH	Pacific Ave	NA	NA	511	J	Pacific Ave N of Elm St	86	8	Conc.	22.03	21.20	6.8	N/A	15.23	14.77	0.0053	What type of junction is 511?
P-9	108	CB	W side of Pacific Ave	1.0948	47689	511	J	Pacific Ave N of Elm St	14	8	Conc.	20.95	21.20	3.5	N/A	17.45	14.77	0.1914	~~How many nodes does 108 have?~~
P-10	109	CB	E side of Pacific Ave	0.6101	26576	511	J	Pacific Ave N of Elm St	28	8	Conc.	21.15	21.20	4	N/A	17.15	14.77	0.0850	
P-11	511	J	Pacific Ave N of Elm St	NA	NA	512	J	Pacific Ave S end of Chestnut St	335	8	Conc.	21.20	22.40	N/A	N/A	14.77	12.99	0.0053	What type of junction is 512?
P-12	111	CB	W side of Pacific Ave	2.0109	87595	512	J	Pacific Ave S end of Chestnut St	14	8	Conc.	21.62	22.40	4.8	N/A	16.82	12.99	0.2736	
P-13	110	CB	E side of Pacific Ave	0.1027	4474	512	J	Pacific Ave S end of Chestnut St	28	8	Conc.	21.26	22.40	4	N/A	17.26	12.99	0.1525	
P-14	512	J	Pacific Ave S end of Chestnut St	NA	NA	114	MH	Pacific Ave	53	8	Conc.	22.40	22.51	N/A	9.8	12.99	12.71	0.0053	
P-15	133	CB	W side of Pacific Ave	2.8568	124443	500	J	Pacific Ave NW of Alder St	16	8	Conc.	23.38	23.31	2.3	N/A	21.08	18.59	0.1556	What type of junction is 500? No measure down.
P-16	134	CB	E side of Pacific Ave	0.4287	18675	500	J	Pacific Ave NW of Alder St	27	6	Conc.	23.24	23.31	1.5	N/A	21.74	18.59	0.1167	What type of junction is 500? No measure down.
P-17	500	J	Pacific Ave NW of Alder St	NA	NA	132	MH	Pacific Ave	96	8	Conc.	23.31	23.97	N/A	4.7	18.59	19.27	-0.0071	
P-18	131	CB	W side of Pacific Ave	0.7376	32129	132	MH	Pacific Ave	14	8	Conc.	23.16	23.97	3.3	4.7	19.86	19.27	0.0421	Is 131 crossed out?
P-19	130	CB	E side of Pacific Ave	0.5171	22527	132	MH	Pacific Ave	28	6	Conc.	23.44	23.97	1.3	~~4.7~~	22.14	19.27	0.1025	
P-20	132	MH	Pacific Ave	NA	NA	501	J	Pacific Ave NW of Cedar St	183	10	T-cotta	23.97	22.65	4.7	N/A	19.27	19.09	0.0010	What type of junction is 501?
P-21	128	CB	W side of Pacific Ave	0.5688	24775	501	J	Pacific Ave NW of Cedar St	15	8	Conc.	22.64	22.65	4	N/A	18.64	19.09	-0.0300	
P-22	129	CB	E side of Pacific Ave	0.2662	11595	501	J	Pacific Ave NW of Cedar St	27	6	Conc.	22.71	22.65	2.7	N/A	20.01	19.09	0.0341	
P-23	501	J	Pacific Ave NW of Cedar St	NA	NA	127	MH	Pacific Ave & Cedar St.	67	10	T-cotta	22.65	24.02	N/A	5	19.09	19.02	0.0010	
P-24	127	MH	Pacific Ave & Cedar St.	NA	NA	502	J	S end of Pacific Ave & Cedar St	46	10	T-cotta	24.02	23.00	5	N/A	19.02	18.77	0.0054	What type of junction is 502?
P-25	125	CB	W side of Pacific Ave	0.8112	35337	502	J	S end of Pacific Ave & Cedar St	15	8	Conc.	22.90	23.00	3.65	N/A	19.25	18.77	0.0320	
P-26	126	CB	E side of Pacific Ave	0.2285	9954	502	J	S end of Pacific Ave & Cedar St	28	8	Conc.	23.12	23.00	3.65	N/A	19.47	18.77	0.0250	List of questions from Kelso?
P-27	502	J	S end of Pacific Ave & Cedar St	NA	NA	503	J	Pacific Ave between Cedar & Cherry	179	10	T-cotta	23.00	22.60	N/A	N/A	18.77	17.80	0.0054	What type of junction is 503? Pipe may be TC or Conc.
P-28	124	CB	W side of Pacific Ave	1.1525	50203	503	J	Pacific Ave between Cedar & Cherry	15	8	Conc.	22.55	22.60	4.3	N/A	18.25	17.80	0.0300	
P-29	123	CB	E side of Pacific Ave	0.4494	19575	503	J	Pacific Ave between Cedar & Cherry	27	8	Conc.	22.70	22.60	3	N/A	19.70	17.80	0.0704	
P-30	503	J	Pacific Ave between Cedar & Cherry	NA	NA	504	J	Pacific Ave S of Cherry St	105	10	T-cotta	22.60	22.60	N/A	N/A	17.80	17.23	0.0054	What type of junction is 504? Pipe may be TC or Conc.
P-31	121	CB	W side of Pacific Ave	1.6073	70015	504	J	Pacific Ave S of Cherry St	15	8	Conc.	22.65	22.60	5	N/A	17.65	17.23	0.0280	
P-32	122	CB	E side of Pacific Ave	0.2428	10576	504	J	Pacific Ave S of Cherry St	27	8	Conc.	22.64	22.60	3.2	N/A	19.44	17.23	0.0819	
P-33	504	J	Pacific Ave S of Cherry St	NA	NA	505	J	Pacific Ave between Cherry & Mill	262	10	T-cotta	22.60	22.00	N/A	N/A	17.23	15.81	0.0054	What type of junction is 505? Pipe may be TC or Conc.
P-34	120	CB	E side of Pacific Ave	0.9332	40652	505	J	Pacific Ave between Cherry & Mill	15	8	CI	22.07	22.00	4	N/A	18.07	15.81	0.1507	
P-35	119	CB	W side of Pacific Ave	0.2814	12257	505	J	Pacific Ave between Cherry & Mill	28	8	Conc.	21.92	22.00	4.2	N/A	17.72	15.81	0.0682	
P-36	505	J	Pacific Ave between Cherry & Mill	NA	NA	506	J	Pacific Ave N end of Mill St	274	10	T-cotta	22.00	21.50	N/A	N/A	15.81	14.33	0.0054	What type of junction is 506? Pipe may be TC or Conc.
P-37	116	CB	NW Corner of Pacific & Mill St.	1.6106	70159	506	J	Pacific Ave N end of Mill St	15	6	Conc.	21.58	21.50	4.1	N/A	17.48	14.33	0.2100	
P-38	117	CB	NE Corner of Pacific & Mill St.	0.6567	28605	506	J	Pacific Ave N end of Mill St	30	6	Conc.	21.57	21.50	3.8	N/A	17.77	14.33	0.1147	
P-39	506	J	Pacific Ave N end of Mill St	NA	NA	509	J	Pacific Ave S end of Mill St	68	10	T-cotta	21.50	21.50	N/A	N/A	14.33	13.97	0.0053	What type of junction is 507? Pipe may be TC or Conc.
P-44	115	CB	SW Corner of Pacific & Mill St.	0.6853	29852	509	J	Pacific Ave S end of Mill St	15	6	PVC	21.60	21.50	3.1	N/A	18.50	13.97	0.3020	
P-45	118	CB	SE Corner of Pacific & Mill St.	0.5220	22738	509	J	Pacific Ave S end of Mill St	28	6	Conc.	21.40	21.50	3.8	N/A	17.60	13.97	0.1296	
P-46	509	J	Pacific Ave S end of Mill St	NA	NA	510	J	Pacific Ave between Mill & Chestnut	161	10	T-cotta	21.50	21.30	N/A	N/A	13.97	13.10	0.0054	What type of junction is 510? Pipe may be TC or Conc.
P-47	112	CB	W side of Pacific Ave	0.9014	39263	510	J	Pacific Ave between Mill & Chestnut	14	8	Conc.	21.56	21.30	3.4	N/A	18.16	13.10	0.3614	Does 112 have two nodes?
P-48	113	CB	E side of Pacific Ave	0.3142	13686	510	J	Pacific Ave between Mill & Chestnut	28	8	Conc.	21.46	21.30	3.2	N/A	18.26	13.10	0.1843	
P-49	510	J	Pacific Ave between Mill & Chestnut	NA	NA	114	MH	Pacific Ave	67	10	Conc.	21.30	22.51	N/A	9.8	13.10	12.71	0.0058	
P-50	147	CB	SW Corner of 3rd Ave & Elm St.	0.3506	15274	148	CB	NW Corner of 3rd Ave & Elm St.	22	6	Conc.	21.85	21.87	2.3	2.5	19.55	19.37	0.0082	
P-51	148	CB	NW Corner of 3rd Ave & Elm St.	1.2348	53786	149	CB	3rd Ave	32	6	Conc.	21.87	21.84	2.5	2.3	19.37	19.54	-0.0053	
P-52	149	CB	3th Ave	0.7120	31014	150	MH	3rd Ave	25	8	Conc.	21.84	22.02	2.3	4.6	19.54	17.42	0.0848	
P-53	150	MH	3rd Ave	NA	NA	150A	CB	3rd Ave	381	8	Conc.	22.02	21.17	4.6	1.7	17.42	12.41	0.0131	
P-54	151	CB	3rd Ave	0.5675	24722	150A	J	3rd Ave & Chestnut St	7	8	Conc.	21.17	21.00	1.7	N/A	19.47	12.41	1.0086	What type of junction is 516?
P-55	150A	J	3rd Ave & Chestnut St	NA	NA	516	J	3rd Ave & Chestnut St	16	8	Conc.	21.00	21.00	N/A	N/A	12.41	12.19	0.0138	

Pipe Label	Node								Length (ft)	Size (in.)	Material	Ground Elevations		Measure Downs		Invert Elevations		Slope (ft/ft)	Comments
	Upstream			Area		Downstream						Upstream	Downstream	Upstream	Downstream	Upstream	Downstream		
	No.	Type	Location	AC	SF	No.	Type	Location											
P-56	152	CB	W side of 3rd Ave & Chestnut St	0.9502	41389	516	J	3rd Ave & Chestnut St	22	8	Conc.	21.02	21.00	2	N/A	19.02	12.19	0.3105	
P-57	516	J	3rd Ave & Chestnut St	NA	NA	153	MH	W side of 3rd Ave & Chestnut St	8	8	Conc.	21.00	21.59	N/A	9.5	12.19	12.09	0.0125	
P-58	177	CB	SE corner of 3rd & Alder	0.4404	19184	176	CB	3rd Ave & Alder St.	19	6	Cast Iron	21.72	22.06	2	6.3	19.72	15.76	0.2084	
P-59	175	CB	SW corner of 3rd & Alder	0.3311	14424	176	CB	3rd Ave & Alder St.	4	6	Cast Iron	21.61	22.06	2	6.3	19.61	15.76	0.9625	~~Verify layout of 175, 176, 177.~~
P-60	176	CB	3rd Ave & Alder St.	NA	NA	173	CB	E side of Cedar St	231	8	Conc.	22.06	22.04	6.3	4.3	15.76	17.74	-0.0086	~~Does 173 connect with 176?~~
P-61	172	CB	W side of Cedar St	0.3286	14314	173	CB	E side of Cedar St	22	6	Conc.	21.99	22.04	1.8	4.3	20.19	17.74	0.1114	~~What type and size pipe? Unknown measure down~~
P-62	170	CB	SW side of Cedar St	0.3263	14214	171	CB	NW side of Cedar St	22	6	Conc.	21.81	22.18	1.4	1	20.41	21.18	-0.0350	
P-63	171	CB	NW side of Cedar St	0.2644	11519	172	CB	W side of Cedar St	29	6	Conc.	22.18	21.99	1	1.8	21.18	20.19	0.0341	What is going on around 174?
P-65	173	CB	E side of Cedar St	0.4175	18185	169	CB	SE corner of 3rd & Cedar	66	10	Conc.	22.04	21.89	4.3	4.1	17.74	17.79	-0.0008	
P-66	168	CB	SW corner of 3rd & Cedar	0.2454	10690	169	CB	SE corner of 3rd & Cedar	22	8	Conc.	22.09	21.89	2	4.1	20.09	17.79	0.1045	
P-67	169	CB	SE corner of 3rd & Cedar	0.4318	18809	167	CB	W side of 3rd Ave	234	10	Conc.	21.89	21.68	4.1	4	17.79	17.68	0.0005	
P-68	165	CB	N side of Cherry St	0.2512	10942	166	CB	W side of 3rd Ave	29	6	Conc.	21.60	21.40	1	1.7	20.60	19.70	0.0310	
P-69	166	CB	W side of 3rd Ave	0.2850	12414	167	CB	W side of 3rd Ave	22	8	Conc.	21.40	21.68	1.7	4	19.70	17.68	0.0918	
P-70	167	CB	W side of 3rd Ave	0.4241	18474	163	CB	E side of 3rd Ave	67	10	Conc.	21.68	21.49	4	4.2	17.68	17.29	0.0058	
P-71	164	CB	S side of Cherry St	0.3246	14139	162	CB	W side of 3rd Ave	30	6	Conc.	21.44	21.50	8	2	13.44	19.50	-0.2020	
P-72	162	CB	W side of 3rd Ave	0.5272	22966	163	CB	E side of 3rd Ave	23	8	Conc.	21.50	21.49	2	4.2	19.50	17.29	0.0961	
P-73	163	CB	E side of 3rd Ave	0.5410	23565	161	CB	E side of 3rd Ave	236	10	Conc.	21.49	21.36	4.2	3.7	17.29	17.66	-0.0016	
P-74	160	CB	W side of 3rd Ave	0.6640	28923	161	CB	E side of 3rd Ave	23	8	Conc.	21.25	21.36	1.8	3.7	19.45	17.66	0.0778	
P-75	161	CB	E side of 3rd Ave	0.9723	42355	513	J	3rd Ave & Mill St	253	10	Conc.	21.36	21.50	3.7	N/A	17.66	15.34	0.0092	What type of junction is 513?
P-76	159	CB	3rd Ave & Mill Street	0.4861	21175	513	J	3rd Ave & Mill St	23	8	Conc.	21.28	21.50	1.8	N/A	19.48	15.34	0.1800	
P-77	513	J	3rd Ave & Mill St	NA	NA	513A	CB	5th Ave	69	10	Conc.	21.50	21.10	N/A	N/A	15.34	14.70	0.0093	
P-78	158	CB	3rd Ave	0.4900	21345	513A	CB	5th Ave	21	8	Conc.	21.14	21.10	2.9	N/A	18.24	14.70	0.1686	
P-79	157	CB	3th Ave	0.6564	28591	513A	J	3rd Ave S. of Mill St.	3	6	Cast Iron	21.10	21.10	5.4	N/A	15.70	14.70	0.3333	What type of junction if 514?
P-80	513A	J	3rd Ave S. of Mill St.	NA	NA	153	MH	W side of 3rd Ave & Chestnut St	284	10	Conc.	21.10	21.59	N/A	9.5	14.70	12.09	0.0092	
P-81	155	CB	3th Ave	0.2327	10138	154	MH	5th Ave & Chestnut St (in grass)	19	8	Conc.	20.92	21.94	2	7.5	18.92	14.44	0.2358	~~Verify layout of pipes at 3rd & Chestnut.~~
P-82	154	MH	3th Ave & Chestnut St (in grass)	NA	NA	153	MH	W side of 3rd Ave & Chestnut St	26	8	Conc.	21.94	21.59	7.5	9.5	14.44	12.09	0.0904	Which junction does 154 connect to?
P-83	156	CB	3rd Ave & Chestnut St	0.4690	20431	154	MH	3rd Ave & Chestnut St	29	8	Conc.	21.12	21.94	2.5	7.5	18.62	14.44	0.1441	
P-84	179	CB	W side 4th, S of Laurel (culv inlet)	0.7020	30580	517	J	Laurel St & 4th Ave	115	8	Conc.	18.49	19.50	0.67	N/A	17.82	16.42	0.0122	Is 517 just an elbow? Underground junction?
P-85	517	J	Laurel St & 4th Ave	NA	NA	182	CB	SW corner of 4th Ave & Laurel St	11	8	PVC	19.50	19.46	N/A	3.6	16.42	15.86	0.0509	
P-86	182	CB	SW corner of 4th Ave & Laurel St	0.2207	9614	183	CB	NW corner of 4th Ave & Laurel St	33	8	Conc.	19.46	19.80	3.6	3.2	15.86	16.60	-0.0224	
P-87	183	CB	NW corner of 4th Ave & Laurel St	0.8862	38601	184	MH	4th Ave & Laurel St	26	8	Conc.	19.80	20.86	3.2	4.1	16.60	16.76	-0.0062	
P-88	184	MH	4th Ave & Laurel St	NA	NA	518	J	4th Ave between Laurel & Elm	213	8	Conc.	20.86	20.00	4.1	N/A	16.76	15.52	0.0058	What type of junction is 518?
P-89	188	CB	W side of 4th Ave	0.3963	17262	518	J	4th Ave between Laurel & Elm	9	8	Conc.	20.27	20.00	2.7	N/A	17.57	15.52	0.2278	
P-90	187	CB	E side of 4th Ave	0.5924	25807	518	J	4th Ave between Laurel & Elm	20	8	Conc.	20.18	20.00	2.5	N/A	17.68	15.52	0.1080	
P-91	518	J	4th Ave between Laurel & Elm	NA	NA	193	MH	Center of 4th & Elm	221	8	Conc.	20.00	20.83	N/A	6.6	15.52	14.23	0.0058	
P-92	189	CB	SE side of 4th & Elm	0.1658	7221	193	MH	Center of 4th & Elm	34	8	Conc.	20.39	20.83	2.2	6.6	18.19	14.23	0.1165	
P-93	190	CB	SW side of 4th & Elm	0.3497	15233	193	MH	Center of 4th & Elm	30	8	Conc.	20.23	20.83	2.3	6.6	17.93	14.23	0.1233	
P-94	191	CB	SW side of Elm St	0.6954	30290	193	MH	Center of 4th & Elm	28	8	Conc.	20.25	20.83	1.6	6.6	18.65	14.23	0.1579	
P-95	192	CB	NW side of Elm St	0.7956	34657	193	MH	Center of 4th & Elm	31	8	Conc.	20.18	20.83	2	6.6	18.18	14.23	0.1274	
P-96	193	MH	Center of 4th & Elm	NA	NA	519	J	4th Ave between Elm & Chestnut	230	10	Conc.	20.83	19.85	6.6	N/A	14.23	13.00	0.0053	What type of junction is 519?
P-97	194	CB	4th Ave between Elm & Chestnut	0.1389	6052	519	J	4th Ave between Elm & Chestnut	20	8	Conc.	19.80	19.85	2	N/A	17.80	13.00	0.2399	
P-98	195	CB	4th Ave between Elm & Chestnut	0.5994	26108	519	J	4th Ave between Elm & Chestnut	8	8	Conc.	19.88	19.85	4.9	N/A	14.98	13.00	0.2479	
P-99	519	J	4th Ave between Elm & Chestnut	NA	NA	202	MH	Center of 4th & Chestnut	230	10	Conc.	19.85	19.98	N/A	8.2	13.00	11.78	0.0053	
P-100	196	CB	SE corner of 4th & Chestnut St	0.3564	15523	202	MH	Center of 4th & Chestnut	34	8	Conc.	19.68	19.98	2	8.2	17.68	11.78	0.1735	
P-101	197	CB	SW corner of 4th & Chestnut St	0.6486	28254	202	MH	Center of 4th & Chestnut	30	8	Conc.	19.50	19.98	2	8.2	17.50	11.78	0.1907	
P-102	198	CB	SW side of Chestnut & 4th	0.1188	5176	202	MH	Center of 4th & Chestnut	29	8	Conc.	19.61	19.98	2	8.2	17.61	11.78	0.2010	
P-103	199	CB	NW side of Chestnut & 4th	0.3888	16936	202	MH	Center of 4th & Chestnut	32	8	Conc.	19.66	19.98	2.1	8.2	17.56	11.78	0.1806	
P-104	200	CB	NW corner of 4th & Chestnut	0.2670	11629	202	MH	Center of 4th & Chestnut	38	8	Conc.	19.41	19.98	2.1	8.2	17.31	11.78	0.1455	
P-105	201	CB	NE corner of 4th & Chestnut	0.6192	26973	202	MH	Center of 4th & Chestnut	41	8	Conc.	19.53	19.98	2.1	8.2	17.43	11.78	0.1378	
P-106	210	CB	W side of 5th Ave	0.8425	36699	211	CB	SW Corner of 5th & Elm St	98	8	30/34	18.15	18.11	2	2	16.15	16.11	0.0005	~~What is 210 connected to?~~
P-107	211	CB	SW Corner of 5th & Elm St	0.2234	9731	217	MH	Center of 5th & Elm St	43	8	Conc.	18.11	18.79	2	3	16.11	15.79	0.0073	~~Is 217 CB or MH? Listed two ways on data sheet~~

Pipe Label	Node								Length (ft)	Size (in.)	Material	Ground Elevations		Measure Downs		Invert Elevations		Slope (ft/ft)	Comments
	Upstream			Area		Downstream						Upstream	Downstream	Upstream	Downstream	Upstream	Downstream		
	No.	Type	Location	AC	SF	No.	Type	Location											
P-108	212	CB	SE corner of 5th & Elm	0.5310	23131	217	MH	Center of 5th & Elm St	36	8	Conc.	18.01	18.79	1.9	3	16.11	15.79	0.0089	
P-109	213	CB	SW side of Elm St	0.3089	13457	217	MH	Center of 5th & Elm St	43	8	Conc.	18.26	18.79	1.3	3	16.96	15.79	0.0272	
P-110	214	CB	NW side of Elm St	0.6460	28140	217	MH	Center of 5th & Elm St	41	8	Conc.	18.43	18.79	1.9	3	16.53	15.79	0.0180	
P-111	215	CB	NW corner of 5th & Elm St	1.3361	58202	217	MH	Center of 5th & Elm St	36	8	Conc.	17.90	18.79	1	3	16.90	15.79	0.0308	
P-112	216	CB	NE corner of 5th & Elm St	0.6454	28112	217	MH	Center of 5th & Elm St	30	8	Conc.	17.96	18.79	1	3	16.96	15.79	0.0390	
P-113	217	CB	Center of 5th & Elm St	0.3296	14358	220	MH	Center of 5th & Chestnut	453	12	Conc.	18.79	20.61	3	10	15.79	10.61	0.0114	
P-114	218	CB	SW side of 5th & Chestnut	0.3219	14023	220	MH	Center of 5th & Chestnut	41	8	Conc.	18.76	20.61	2	10	16.76	10.61	0.1500	
P-115	219	CB	NW side of 5th & Chestnut	0.6617	28824	220	MH	Center of 5th & Chestnut	43	8	Conc.	18.80	20.61	2.2	10	16.60	10.61	0.1393	
P-116	225	CB	SE corner of 5th & Mill St	0.1841	8018	520	J	5th Ave S of Mill St	13	8	Conc.	18.48	18.50	2	N/A	16.48	16.72	-0.0185	~~Is 520 a MH?~~
P-117	224	CB	SW side of 5th & Mill St	0.2192	9550	223	CB	SW corner of 5th & Mill St	30	8	Conc.	18.53	18.62	1.8	1.9	16.73	16.72	0.0003	
P-118	223	CB	SW corner of 5th & Mill St	0.3678	16023	520	J	5th Ave S of Mill St	14	8	Conc.	18.62	18.50	1.9	N/A	16.72	16.72	0.0000	
P-119	520	J	5th Ave S of Mill St	NA	NA	521	J	5th Ave between Chestnut & Mill	186	12	Conc.	18.50	19.45	N/A	N/A	16.72	14.01	0.0146	What type of junction is 521?
P-120	221	CB	W side of 5th Ave	0.7204	31381	521	J	5th Ave between Chestnut & Mill	18	6	Conc.	18.97	19.45	2.6	N/A	16.37	14.01	0.1311	
P-121	222	CB	E side of 5th Ave	0.1952	8503	521	J	5th Ave between Chestnut & Mill	5	6	Conc.	19.15	19.45	2.4	N/A	16.75	14.01	0.5480	
P-122	521	J	5th Ave between Chestnut & Mill	NA	NA	220	MH	Center of 5th & Chestnut	234	12	Conc.	19.45	20.61	N/A	10	14.01	10.61	0.0145	
P-123	204	CB	W side of Yew & 5th	0.6616	28821	203	CB	E side of Yew & 5th	29	6	PVC	18.42	18.16	2.2	2.3	16.22	15.86	0.0124	
P-124	203	CB	E side of Yew & 5th	0.5005	21803	206	CB	E side of 5th Ave	188	10	PVC	18.16	19.15	2.3	3.7	15.86	15.45	0.0022	
P-125	205	CB	W side of 5th Ave	0.7018	30571	206	CB	E side of 5th Ave	24	6	PVC	19.13	19.15	2.2	3.7	16.93	15.45	0.0617	~~What type and size Pipe?~~
P-126	206	CB	E side of 5th Ave	0.3122	13599	208	MH	5th & Laurel	251	8	PVC	19.15	19.94	3.7	5.3	15.45	14.64	0.0032	
P-127	207	CB	SE 5th & Laurel	0.4312	18783	208	MH	5th & Laurel	18	6	PVC	19.03	19.94	2.3	5.3	16.73	14.64	0.1161	~~Does 207 connect to 208?~~
P-128	209	CB	NE 5th & Laurel	0.9897	43112	208	MH	5th & Laurel	18	6	PVC	18.91	19.94	2.3	5.3	16.61	14.64	0.1094	
P-129	208	MH	5th & Laurel	NA	NA	232	MH	Laurel St & 6th St	242	8	PVC	19.94	18.96	5.3	4.9	14.64	14.06	0.0024	What type of junction is 525?
P-130	230	CB	Needs Cleaned - can't tell	0.3315	14438	231	MH	Laurel St W of 6th St	22	6	Conc.	18.46	18.49	2.3	2.4	16.16	16.09	0.0032	~~What type and size Pipe?~~
P-131	231	MH	Laurel St W of 6th St	0.5061	22044	232	MH	Laurel St & 6th St	26	6	Conc.	18.49	18.96	2.4	4.9	16.09	14.06	0.0781	What type of junction is 526?
~~P-132~~	~~522~~	~~J~~	~~6th Ave N or Yew St~~	0.7912	34463	~~523~~	~~J~~	~~6th Ave between Yew & Laurel~~	~~182~~	~~8~~	~~Conc.~~	N/A	~~19.00~~	~~N/A~~	~~N/A~~	~~N/A~~	~~13.96~~	#VALUE!	~~Where is 522? What type of junction is 523?~~
P-133	226	CB	Needs Cleaned - can't tell	0.4991	21742	523	J	6th Ave between Yew & Laurel	18	8	Conc.	19.03	19.00	1.2	N/A	17.83	13.96	0.2150	~~What type and size Pipe?~~
P-134	227	CB	Needs Cleaned - can't tell	0.9146	39842	523	J	6th Ave between Yew & Laurel	9	8	Conc.	19.04	19.00	1.8	N/A	17.24	13.96	0.3644	~~What type and size Pipe?~~
P-135	523	J	6th Ave between Yew & Laurel	NA	NA	232	MH	Laurel St & 6th St	228	8	Conc.	19.00	18.96	N/A	5	13.96	13.96	0.0000	What type of junction is 524?
P-136	229	CB	SE corner of 6th & Laurel	0.3723	16217	228	J	6th Ave S end of Laurel St	23	8	Conc.	18.57	18.47	1.9	2.4	16.67	16.07	0.0260	
P-137	228	CB	SW corner of 6th & Laurel	0.2230	9712	232	MH	Laurel St & 6th St	39	8	Conc.	18.47	18.96	2.4	4.9	16.07	14.06	0.0516	~~Where does 228 connect to?~~
P-138	232	MH	Laurel St & 6th St	NA	NA	527	J	6th Ave between Laurel & Elm	225	10	Conc.	18.96	19.00	4.9	N/A	14.06	12.92	0.0051	What type of junction is 527?
P-139	233	CB	Needs Cleaned - can't tell	0.3818	16630	527	J	6th Ave between Laurel & Elm	4	8	Conc.	17.93	19.00	2	N/A	15.93	12.92	0.7520	
P-140	234	CB	E side of 6th Ave	0.3603	15696	527	J	6th Ave between Laurel & Elm	18	8	Conc.	18.03	19.00	1.3	N/A	16.73	12.92	0.2117	
P-141	527	J	6th Ave between Laurel & Elm	NA	NA	240	MH	6th Ave S end of Elm St	241	10	Conc.	19.00	17.80	N/A	5.7	12.92	12.10	0.0034	What type of junction is 527?
P-142	236	CB	SE corner of 6th & Elm	0.3972	17302	240	MH	Center of 6th & Elm	47	8	Conc.	17.47	17.80	2.5	5.7	14.97	12.10	0.0611	
P-143	235	CB	SW corner of 6th & Elm	0.2673	11642	240	MH	Center of 6th & Elm	43	8	Conc.	17.51	17.80	2.5	5.7	15.01	12.10	0.0677	~~Where does 235 connect to?~~
P-144	237	CB	SW side of Elm & 6th	0.2480	10804	240	MH	Center of 6th & Elm	34	8	Conc.	17.52	17.80	2.3	5.7	15.22	12.10	0.0918	
P-145	238	CB	NW side of Elm & 6th	0.2657	11576	240	MH	Center of 6th & Elm	25	8	Conc.	17.49	17.80	2.6	5.7	14.89	12.10	0.1116	
P-146	239	CB	NW corner of 6th & Elm	0.3732	16255	240	MH	Center of 6th & Elm	21	8	Conc.	17.48	17.80	2	5.7	15.48	12.10	0.1610	~~Where does 239 connect to?~~
P-147	248	CB	7th & Elm St	0.8857	38579	247	CB	NW side of 7th & Elm St	23	8	Conc.	16.52	16.49	1.3	2.3	15.22	14.19	0.0448	
P-148	247	CB	NW side of 7th & Elm St	1.4625	63706	241	CB	E side of 6th & Elm	197	10	Conc.	16.49	17.47	2.3	4.5	14.19	12.97	0.0062	
P-149	241	CB	E side of 6th & Elm	0.5669	24694	240	MH	Center of 6th & Elm	39	10	Conc.	17.47	17.80	4.5	5.7	12.97	12.10	0.0223	
P-150	240	MH	Center of 6th & Elm	NA	NA	529	J	6th Ave between Elm & Chestnut	224	12	Conc.	17.80	17.75	5.7	N/A	12.10	10.87	0.0055	What type of junction is 529?
P-150a	529	J	6th Ave between Elm & Chestnut	NA	NA	244	CB	6th Ave between Elm & Chestnut	220	12	Conc.	17.70	18.85	N/A	9.2	10.87	9.65	0.0055	
P-151	243	CB	W side of 6th Ave	0.6755	29424	529	J	6th Ave between Elm & Chestnut	19	8	Conc.	17.69	17.70	1.3	N/A	16.39	10.87	0.2905	~~What type and size of pipe?~~
P-152	242	CB	W side of 6th Ave	0.9006	39230	529	J	6th Ave between Elm & Chestnut	7	8	Conc.	17.75	17.70	1.8	N/A	15.95	10.87	0.7257	
P-153	246	CB	NE side of 6th & Chestnut	0.4711	20519	245	CB	NW side of 6th & Chestnut	32	6	30/34	17.94	17.46	1.5	2.3	16.44	15.16	0.0400	
P-154	245	CB	NW side of 6th & Chestnut	1.1300	49222	244	MH	Center of 6th & Chestnut	28	8	Conc.	17.46	18.85	2.3	9.2	15.16	9.65	0.1968	
P-155	114	MH	Pacific Ave	NA	NA	153	MH	W side of 3rd Ave & Chestnut St	274	12	T-cotta	22.51	21.59	9.8	9.5	12.71	12.09	0.0023	
P-156	153	MH	W side of 3rd Ave & Chestnut St	NA	NA	202	MH	Center of 4th & Chestnut	247	15	T-cotta	21.59	19.98	9.5	8.2	12.09	11.78	0.0013	
P-157	202	MH	Center of 4th & Chestnut	NA	NA	220	MH	Center of 5th & Chestnut	273	15	T-cotta	19.98	20.61	8.2	10	11.78	10.61	0.0043	

Pipe Label	Node								Length (ft)	Size (in.)	Material	Ground Elevations		Measure Downs		Invert Elevations		Slope (ft/ft)	Comments
	Upstream			Area		Downstream						Upstream	Downstream	Upstream	Downstream	Upstream	Downstream		
	No.	Type	Location	AC	SF	No.	Type	Location											
P-158	220	MH	Center of 5th & Chestnut	NA	NA	244	MH	Center of 6th & Chestnut	245	24	Conc.	20.61	18.85	10	9.2	10.61	9.65	0.0039	
P-159	244	MH	Center of 6th & Chestnut	NA	NA	303	MH	Center of 7th Ave & Chestnut St	276	24	PVC	18.85	18.28	9.2	9.6	9.65	8.68	0.0035	
P-160	262	CB	SW corner of Cedar & 4th Ave	0.2084	9079	266	MH	Center of 4th & Cedar	30	6	Conc.	20.83	21.33	1.6	4.5	19.23	16.83	0.0800	
P-161	263	CB	NW corner of Cedar & 4th Ave	0.3027	13185	266	MH	Center of 4th & Cedar	27	6	Conc.	20.87	21.33	2.1	4.5	18.77	16.83	0.0719	
P-162	264	CB	NW corner of 4th & Cedar	0.4702	20482	266	MH	Center of 4th & Cedar	31	6	Conc.	20.67	21.33	2.1	4.5	18.57	16.83	0.0561	
P-163	265	CB	NE corner of 4th & Cedar	0.2602	11334	266	MH	Center of 4th & Cedar	38	6	Conc.	20.64	21.33	1.4	4.5	19.24	16.83	0.0634	
P-164	266	MH	Center of 4th & Cedar	NA	NA	546	CB	Center of 4th Ave	166	10	Conc.	21.33	20.50	4.5	N/A	16.83	15.18	0.0099	
P-165	261	CB	Center of 4th Ave	0.2680	11673	546	MH	Center of 4th & Cherry	8	10	Conc.	20.92	20.50	1.8	N/A	19.12	15.18	0.4925	
P-166	546	J	Center of 4th Ave	NA	NA	260	MH	Center of 4th & Cherry	134	8	Conc.	20.50	21.35	N/A	7.5	15.18	13.85	0.0099	~~What type and size of pipe?~~
P-167	256	CB	SW corner of Cherry & 4th	0.1723	7505	260	MH	Center of 4th & Cherry	30	6	Conc.	20.91	21.35	2.1	7.5	18.81	13.85	0.1653	
P-168	257	CB	NW corner of Cherry & 4th	0.2144	9338	260	MH	Center of 4th & Cherry	28	6	Conc.	20.95	21.35	2.1	7.5	18.85	13.85	0.1786	
P-169	258	CB	NW corner of 4th & Cherry	0.2232	9721	260	MH	Center of 4th & Cherry	30	6	Conc.	20.76	21.35	2.1	7.5	18.66	13.85	0.1603	
P-170	259	CB	NE corner of 4th & Cherry	0.1802	7848	260	MH	Center of 4th & Cherry	35	6	Conc.	20.70	21.35	2.1	7.5	18.60	13.85	0.1357	
P-171	249	CB	SW corner of Mill St & 4th Ave	0.5941	25880	250	CB	NW corner of Mill St & 4th Ave	23	6	Conc.	20.20	20.35	1.6	2	18.60	18.35	0.0109	~~What type and size of pipe?~~
P-172	250	CB	NW corner of Mill St & 4th Ave	0.3010	13110	253	MH	4th Ave	53	8	Conc.	20.35	20.67	2	4.6	18.35	16.07	0.0430	~~What type and size of pipe?~~
P-173	251	CB	NW corner of 4th & Mill St	0.3950	17207	253	MH	4th Ave	20	8	Conc.	20.25	20.67	2.6	4.6	17.65	16.07	0.0790	~~What type and size of pipe?~~
P-174	252	CB	NE corner of 4th & Mill St	0.2615	11390	253	MH	4th Ave	22	6	Conc.	20.13	20.67	2.6	4.6	17.53	16.07	0.0664	
P-175	253	MH	4th Ave	NA	NA	541	J	4th Ave between Mill & Cherry	223	12	Conc.	20.67	20.50	4.6	N/A	16.07	14.93	0.0051	What type of junction is 541?
P-176	254	CB	W side of 4th Ave	0.6018	26213	541	J	4th Ave between Mill & Cherry	8	6	Conc.	20.56	20.50	2.6	N/A	17.96	14.93	0.3788	~~What type and size of pipe?~~
P-177	255	CB	E side of 4th Ave	0.3526	15360	541	J	4th Ave between Mill & Cherry	19	6	Conc.	20.43	20.50	2.6	N/A	17.83	14.93	0.1526	~~What type and size of pipe?~~
P-178	541	J	4th Ave between Mill & Cherry	NA	NA	260	MH	Center of 4th & Cherry	211	10	Conc.	20.50	21.35	N/A	7.5	14.93	13.85	0.0051	
P-179	274	CB	SW corner of Cedar & 5th Ave	1.0766	46895	276	MH	Center of 5th & Cedar St	32	6	Conc.	19.63	20.01	1.6	3.1	18.03	16.91	0.0350	
P-180	275	CB	(needs cleaned)	0.4021	17516	276	MH	Center of 5th & Cedar St	30	6	Conc.	19.54	20.01	3	3.1	16.54	16.91	-0.0123	~~Measure down not listed (needs to be cleaned)~~
P-181	277	CB	NW corner of 5th & Cedar St	0.4756	20715	276	MH	Center of 5th & Cedar St	30	6	Conc.	19.52	20.01	1.4	3.1	18.12	16.91	0.0403	
P-182	278	CB	NE corner of 5th & Cedar St	0.2954	12867	276	MH	Center of 5th & Cedar St	33	6	Conc.	19.37	20.01	1.4	3.1	17.97	16.91	0.0321	
P-183	276	MH	Center of 5th & Cedar St	NA	NA	271	MH	Center of 5th Ave & Cherry St	300	10	Conc.	20.01	20.21	3.1	7.3	16.91	12.91	0.0133	
P-184	269	CB	SW corner of Cherry & 5th Ave	0.6254	27242	271	MH	Center of 5th Ave & Cherry St	32	6	Conc.	19.66	20.21	2.5	7.3	17.16	12.91	0.1328	
P-185	270	CB	NW corner of Cherry & 5th Ave	0.1674	7294	271	MH	Center of 5th Ave & Cherry St	30	6	Conc.	19.64	20.21	2.2	7.3	17.44	12.91	0.1510	
P-186	272	CB	NW corner of 5th & Cherry St	0.3695	16094	271	MH	Center of 5th Ave & Cherry St	31	6	Conc.	19.32	20.21	2	7.3	17.32	12.91	0.1423	
P-187	273	CB	NE corner of 5th & Cherry St	0.4456	19409	271	MH	Center of 5th Ave & Cherry St	32	6	Conc.	19.23	20.21	2.3	7.3	16.93	12.91	0.1256	
P-188	267	CB	NW corner of Mill St & 5th Ave	0.4661	20305	268	CB	NW corner of 5th Ave & Mill St	35	6	Conc.	18.64	18.81	1.3	2.3	17.34	16.51	0.0237	
P-189	268	CB	NW corner of 5th Ave & Mill St	0.9420	41035	271	MH	5th Ave N of Mill St	388	6	Conc.	18.81	20.21	2.3	7.3	16.51	12.91	0.0093	What type of junction is 532?
P-190	287	CB	SW corner of 6th & Alder St	0.4236	18454	291	MH	Center of 6th & Alder St	15	8	Conc.	17.17	17.80	2	2.6	15.17	15.20	-0.0020	
P-191	288	CB	NW corner of 6th & Alder St	0.5001	21784	291	MH	Center of 6th & Alder St	20	6	T-cotta	17.28	17.80	2	2.6	15.28	15.20	0.0040	
P-192	289	CB	NE corner of 6th & Alder St	0.2685	11696	291	MH	Center of 6th & Alder St	27	6	Conc.	17.17	17.80	2.8	2.6	14.37	15.20	-0.0307	
P-193	290	CB	SE corner of 6th & Alder St	0.1815	7906	291	MH	Center of 6th & Alder St	23	6	Conc.	17.08	17.80	2.7	2.6	14.38	15.20	-0.0357	
P-194	291	MH	Center of 6th & Alder St	NA	NA	286	MH	Center of 6th & Cedar St	300	12	Conc.	17.80	17.86	2.6	4.3	15.20	13.56	0.0055	
P-195	282	CB	SW corner of 6th & Cedar St	0.7473	32552	286	MH	Center of 6th & Cedar St	16	6	Conc.	17.23	17.86	2.1	4.3	15.13	13.56	0.0981	
P-196	283	CB	NW corner of 6th & Cedar St	0.8422	36686	286	MH	Center of 6th & Cedar St	20	6	Conc.	17.28	17.86	1.6	4.3	15.68	13.56	0.1060	
P-197	284	CB	NE corner of 6th & Cedar St	0.1757	7655	286	MH	Center of 6th & Cedar St	27	6	Conc.	17.23	17.86	1.6	4.3	15.63	13.56	0.0767	
P-198	285	CB	SE corner of 6th & Cedar St	0.2851	12417	286	MH	Center of 6th & Cedar St	24	6	Conc.	17.33	17.86	2.5	4.3	14.83	13.56	0.0529	
P-199	286	MH	Center of 6th & Cedar St	NA	NA	281	MH	6th Ave N of Cherry	293	12	Conc.	17.86	18.94	4.3	7	13.56	11.94	0.0055	What type of junction is 533?
P-200	280	CB	NW corner of 6th & Cherry	1.3031	56763	279	CB	6th Ave N of Cherry	22	6	Conc.	17.89	17.71	2.4	3.1	15.49	14.61	0.0400	
P-201	279	CB	NE corner of 6th & Cherry St	0.7115	30991	281	MH	Center of 6th Ave & Cherry St	32	6	Conc.	17.71	18.94	3.1	7	14.61	11.94	0.0834	
P-202	298	CB	SW corner of Cedar & 7th	0.7429	32360	297	MH	Center of 7th Ave & Cherry St	23	8	PVC	14.71	15.37	2.6	5.1	12.11	10.27	0.0798	Does this connect?
P-203	299	CB	NW corner of Cedar & 7th	0.7244	31556	297	MH	Center of 7th Ave & Cherry St	22	8	PVC	14.72	15.37	2.5	5.1	12.22	10.27	0.0884	Does this connect?
P-204	300	CB	NE corner of Cedar & 7th	0.0550	2397	297	MH	Center of 7th Ave & Cherry St	20	8	PVC	14.57	15.37	2.5	5.1	12.07	10.27	0.0898	Does this connect?
P-205	301	CB	SE corner of Cedar & 7th	0.1258	5482	297	MH	Center of 7th Ave & Cherry St	21	8	PVC	14.62	15.37	2.5	5.1	12.12	10.27	0.0879	Does this connect?
P-206	297	MH	Center of 7th Ave & Cherry St	NA	NA	296	MH	Center of 7th Ave & Cherry St	296	12	PVC	15.37	17.27	5.1	6.8	10.27	10.47	-0.0007	What type and size of pipe?
P-207	292	CB	SW corner of Cherry St & 7th Ave	0.3863	16828	296	MH	Center of 7th Ave & Cherry St	26	8	PVC	16.50	17.27	2.9	6.8	13.60	10.47	0.1204	
P-208	293	CB	NW corner of Cherry St & 7th Ave	0.3570	15550	296	MH	Center of 7th Ave & Cherry St	21	8	PVC	16.53	17.27	2.8	6.8	13.73	10.47	0.1552	

Pipe Label	Node								Length (ft)	Size (in.)	Material	Ground Elevations		Measure Downs		Invert Elevations		Slope (ft/ft)	Comments
	Upstream			Area		Downstream						Upstream	Downstream	Upstream	Downstream	Upstream	Downstream		
	No.	Type	Location	AC	SF	No.	Type	Location											
P-209	294	CB	NE corner of Cherry St & 7th Ave	0.0702	3060	296	MH	Center of 7th Ave & Cherry St	25	8	PVC	16.48	17.27	2.9	6.8	13.58	10.47	0.1244	
P-210	295	CB	SE corner of Cherry St & 7th Ave	0.1757	7652	296	MH	Center of 7th Ave & Cherry St	30	8	PVC	16.64	17.27	2.9	6.8	13.74	10.47	0.1090	
P-211	322	CB	Needs Cleaned - can't tell	0.6877	29956	324	MH	Center of 8th Ave & Cherry St	27	NDA	NDA	12.27	13.40	NDA	3.7	#VALUE!	9.70	#VALUE!	Does this connect? What type and size of pipe? (cleanout?)
P-212	323	CB	NW corner of Cherry St & 8th Ave	0.7775	33869	324	MH	Center of 8th Ave & Cherry St	22	6	Conc.	12.33	13.40	1.9	3.7	10.43	9.70	0.0330	
P-213	325	CB	8th Ave near Cherry St	0.1344	5856	324	MH	Center of 8th Ave & Cherry St	82	8	PVC	11.73	13.40	1.9	3.7	9.83	9.70	0.0015	Does this connect?
P-214	260	MH	Center of 4th & Cherry	NA	NA	271	MH	Center of 5th Ave & Cherry St	262	15	Conc.	21.35	20.21	7.5	7.3	13.85	12.91	0.0036	
P-215	271	MH	Center of 5th Ave & Cherry St	NA	NA	281	MH	Center of 6th Ave & Cherry St	260	18	Conc.	20.21	18.94	7.3	7	12.91	11.94	0.0037	
P-216	281	MH	Center of 6th Ave & Cherry St	NA	NA	296	MH	Center of 7th Ave & Cherry St	262	24	Conc.	18.94	17.27	7	6.8	11.94	10.47	0.0056	
P-217	296	MH	Center of 7th Ave & Cherry St	NA	NA	324	MH	Center of 8th Ave & Cherry St	253	24	Conc.	17.27	13.40	6.8	3.7	10.47	9.70	0.0030	
P-218	324	MH	Center of 8th Ave & Cherry St	NA	NA	320	MH	Center of 8th Ave & Mill St	219	24	Conc.	13.40	16.26	3.7	7	9.70	9.26	0.0020	
P-219	312	CB	SW corner of Mill & 6th	1.7608	76702	311	CB	NW corner of Mill & 6th	39	10	Conc.	18.07	17.94	3.2	4.3	14.87	13.64	0.0315	
P-220	311	CB	NW corner of Mill & 6th	1.5489	67472	310	MH	Center of 6th & Mill St	26	10	Conc.	17.94	18.64	4.3	5.5	13.64	13.14	0.0192	
P-221	310	MH	Center of 6th & Mill St	NA	NA	534	J	Mill St W of 7th Ave	240	12	Conc.	18.64	17.20	5.5	N/A	13.14	10.85	0.0095	What type of junction is 534?
P-222	308	CB	SW corner of Mill St & 7th Ave	1.2210	53188	534	J	Mill St W of 7th Ave	28	10	Conc.	17.29	17.20	4.5	N/A	12.79	10.85	0.0693	
P-223	309	CB	NW corner of Mill St & 7th Ave	1.1304	49241	534	J	Mill St W of 7th Ave	11	8	Conc.	17.11	17.20	4.7	N/A	12.41	10.85	0.1418	How does this connect?
P-224	534	J	Mill St W end of 7th Ave	NA	NA	320	MH	Center of 8th Ave & Mill St	292	12	Conc.	17.20	16.26	N/A	7	10.85	9.26	0.0054	
P-225	535	CB	Mill St E of 8th Ave	0.7708	33576	320	MH	Center of 8th Ave & Mill St	204	21	Conc.	14.00	16.26	N/A	7	NDA	9.26	#VALUE!	Is there a junction for 535? What type and size of pipe?
P-226	321	CB	N side of Mill St near 8th Ave	0.2035	8865	320	MH	Center of 8th Ave & Mill St	24	8	Conc.	15.62	16.26	3.7	7	11.92	9.26	0.1108	
P-227	319	CB	S side of Mill Street near 8th Ave	1.3801	60115	320	MH	Center of 8th Ave & Mill St	43	8	PVC	15.45	16.26	4	7	11.45	9.26	0.0509	~~What type and size of pipe? Not listed on data sheet~~
P-228	320	MH	Center of 8th Ave & Mill St	NA	NA	318	MH	9th Ave	140	36	Conc.	16.26	15.90	7	7	9.26	8.90	0.0026	~~What type and size of pipe?~~
P-229	318	MH	9th Ave	NA	NA	317	MH	8th Ave. N of Elizabeth St.	194	24	Conc.	15.90	16.18	7	7.25	8.90	8.93	-0.0002	~~What type and size of pipe? Not listed on data sheet~~
P-230	317	CB	8th Ave. N of Elizabeth St.	0.8699	37894	316	MH	8th Ave. & Elizabeth St.	72	24	Conc.	16.18	17.47	7	8.6	9.18	8.87	0.0043	~~Does this connect? Measure down not listed on data sheet~~
P-231	307	CB	W side of 7th Ave	0.3435	14963	306	MH	7th Ave	44	6	Conc.	16.87	17.12	2.7	4	14.17	13.12	0.0239	
P-232	306	MH	7th Ave	NA	NA	530	J	7th Ave & Elizabeth St	21	8	Conc.	17.12	16.50	4	N/A	13.12	12.81	0.0148	What type of junction is 530?
P-233	305	CB	NE corner of 7th & Elizabeth St	0.2444	10646	530	J	7th Ave & Elizabeth St	9	6	Conc.	16.63	16.50	2.1	N/A	14.53	12.81	0.1911	
P-234	530	J	7th Ave & Elizabeth St	NA	NA	531	J	7th Ave & Elizabeth St	37	8	Conc.	16.50	17.00	N/A	N/A	12.81	12.27	0.0148	What type of junction is 531?
P-235	304	CB	SE corner of 7th & Elizabeth St	1.4194	61830	531	J	7th Ave & Elizabeth St	9	6	Conc.	17.14	17.00	2.5	N/A	14.64	12.27	0.2633	
P-236	531	J	7th Ave & Elizabeth St	NA	NA	303	MH	Center of 7th Ave & Chestnut St	242	10	Conc.	17.00	18.28	N/A	9.6	12.27	8.68	0.0148	
P-237	303	MH	Center of 7th Ave & Chestnut St	NA	NA	313	MH	Center of 8th Ave & Cherry St	245	24	Conc.	18.28	17.48	9.6	10.2	8.68	7.28	0.0057	
P-237a	313a	I	NW corner of 8th & Chestnut	NA	NA	313	MH	Center of 8th Ave & Cherry St	19	8	Conc.	NDA	NDA	NDA	NDA	NDA	NDA		Buried, unable to locate, area added to 314
P-237b	313b	I	SW corner of 8th & Chestnut	NA	NA	313	MH	Center of 8th Ave & Cherry St	25	8	Conc.	NDA	NDA	NDA	NDA	NDA	NDA		Buried, unable to locate, area added to 314
P-238	316	MH	Center of 8th Ave & Elizabeth St	NA	NA	313	MH	Center of 8th Ave & Cherry St	251	24	Conc.	17.47	17.48	8.6	10.2	8.87	7.28	0.0063	
P-239	313	MH	Center of 8th Ave & Cherry St	NA	NA	315	CB	S side of Cherry St	39	24	Conc.	17.48	15.19	10.2	6.6	7.28	8.59	-0.0336	What size of pipe? Measure down not listed on data sheet
P-240	315	CB	S side of Cherry St	0.0345	1504	326	CB	Chestnut St. E of S 8th Ave.	124	30	CMP	15.19	11.74	6.6	3.5	8.59	8.24	0.0028	What type and size of pipe?
P-241	326	CB	Chestnut St. E of 8th Ave.	0.5376	23419	537	J	Chestnut St. E of S 8th Ave.	185	30	CMP	11.74	11.50	3.5	N/A	8.24	7.51	0.0039	What type of junction is 537?
P-242	536	J	Private Dr. N of Chestnut	1.7770	77405	537	J	Chestnut St. E of S 8th Ave.	105	30	CMP		11.50	N/A	N/A				Does 536 exist?
P-243	537	J	Chestnut St. E of S 8th Ave.	NA	NA	327	CB	Chestnut St. N of S 10th Ave.	105	30	CMP	11.50	11.19	N/A	4.1	7.51	7.09	0.0040	What type and size of pipe?
P-244	327	CB	Chestnut St. N of S 10th Ave.	1.6749	72960	328	CB	Chestnut St. N of S 11th Ave.	320	30	CMP	11.19	9.93	4.1	3.9	7.09	6.03	0.0033	What type and size of pipe?
P-245	328	CB	Chestnut St. N of S 11th Ave.	0.1383	6025	331	CB	Chestnut St. mid btw 11th & 12th	135	30	CMP	9.93	9.39	3.9	3.5	6.03	5.89	0.0010	What type and size of pipe?
P-246	331	CB	Chestnut St. mid btw 11th & 12th	0.2711	11809	332	CB/O	Chestnut St. N. of 12th Ave.	141	30	CMP	9.39	8.44	3.5	3.7	5.89	4.74	0.0082	What type and size of pipe?
				~~0.5938~~	~~25867~~	~~333~~	~~CB~~												
~~P-248~~	~~333~~	~~CB~~		~~0.9145~~	~~39835~~	~~334~~	~~MH/O~~		~~34~~	~~30~~	~~CMP~~	~~7.12~~	~~9.51~~	~~N/A~~	~~5.3~~	~~#VALUE!~~	~~4.21~~	~~#VALUE!~~	~~Entered as outfall for this drainage system~~
P-250	185	CB	Drains to school system	0.3911	17036					6	Conc.	20.23		2.8		17.43		#DIV/0!	Drains to school grounds
P-251	302	CB	Not listed on 2nd Map	1.2988	56576	303	MH		48	6	Conc.	17.26	18.28	2.8	9.6	14.46	8.68	0.1204	Where does 302 connect to?
P-254	314	CB	SE corner of 8th & Cherry St	1.0050	43779	315	CB	S side of Cherry St	26	12	Surelock	16.83	15.19	4.1	6.6	12.73	8.59	0.1592	Does this connect?
P-255	135	MH	Cedar St & 1st Ave	NA	NA	127	MH	Pacific Ave & Cedar St.	212	15	T-cotta	23.95	24.02	4.5	5	19.45	19.02	0.0020	~~How is 135 connected?~~
P-256	136	CB	1st Ave	0.1842	8024	137	CB	N side of Cedar St	38	6	PVC	24.18	24.24	1.3	2.7	22.88	21.54	0.0353	~~How is 136 connected?~~
P-257	137	CB	N side of Cedar St	0.0433	1884	135	MH	Cedar St & 1st Ave	34	12	PVC	24.24	23.95	3.6	3.35	20.64	20.60	0.0012	~~How is 137 connected? Is 138 connected to 137?~~
P-258	138	CB	N side of Cedar St	0.0569	2478	137	CB	N side of Cedar St	80	8	PVC	24.17	24.24	2.9	3.5	21.27	20.74	0.0066	~~How is 138 connected?~~
P-259	138a	CB	N of Cedar, in WTP yard	0.0358	1560	138	CB	N side of Cedar St	38	6	PVC	23.47	24.17	1.76	2.1	21.71	22.07	-0.0095	Roof drain connects into 138a, 6" pvc
P-259a	138b	RD	Roof drain from WTP	0.0493	2149	138a	YD	N of Cedar, in WTP yard	26	6	PVC	NDA	NDA	NDA	NDA				Roof drain, data inaccessible

Pipe Label	Node								Length (ft)	Size (in.)	Material	Ground Elevations		Measure Downs		Invert Elevations		Slope (ft/ft)	Comments
	Upstream			Area		Downstream						Upstream	Downstream	Upstream	Downstream	Upstream	Downstream		
	No.	Type	Location	AC	SF	No.	Type	Location											
P-260	139	CB	E side of 1st Ave	0.1938	8441	137	CB	N side of Cedar St	77	12	DI	25.43	24.24	3.45	2.55	21.98	21.69	0.0038	~~How is 139 connected?~~
P-260a	139a	RD	E side of 1st Ave	0.0282	1230	139	CB	E side of 1st Ave	11	6	PVC	25.50	25.43	NDA	3.35	NDA	22.08		Roof drain, data inaccessible
P-261	140	MH	E side of 1st Ave	NA	NA	135	MH	Cedar St & 1st Ave	173	15	T-cotta	25.47	23.95	5.45	4.4	20.02	19.55	0.0027	~~Is 139 on line of 140 to 135 or own branch?~~
P-261a	140a	I	E side of 1st Ave, N of 140	NA	NA	140	MH	E side of 1st Ave	45	12	PVC	NDA	25.47	3.5	5.3		20.17		Ground shot not obtained
P-262	141	MH	E side of 1st Ave	NA	NA	140	MH	E side of 1st Ave	29	18	Conc.	25.10	25.47	4.9	5.3	20.20	20.17	0.0010	~~Which direction does this go? Downstream connection?~~
P-263	142	CB	E side of 1st Ave	0.4771	20783	141	MH	E side of 1st Ave	24	6	Conc.	24.85	25.10	2.10	3.25	22.75	21.85	0.0375	~~How is 142 connected? Not on 2nd map?~~
P-264	135a	CB	W side of 1st Ave, S of 136	0.2274	9907	135	MH	Cedar St & 1st Ave	18	6	PVC	23.05	23.95	1.60	2.8	21.45	21.15		
P-265	135b	CB	E side of 1st Ave, S of 135	0.1306	5687	135	MH	Cedar St & 1st Ave	83	6	PVC	23.15	23.95	1.45	4.44	21.70	19.51		
	540	J	4th Ave between Yew & Laurel	0.9478	41285	180	CB	Culvert, W side 4th, S of Laurel		8	Conc.	19.61		3.6	N/A	16.01	#VALUE!	#VALUE!	Culvert system not connected to main system
	178	CB	Culvert, E side 4th, S of Laurel	0.5095	22194	540	J	4th Ave between Yew & Laurel		6	PVC	18.14		1.55	N/A	18.14		#DIV/0!	
	181	CB	E side of 4th Ave	0.1726	7520	540	J	4th Ave between Yew & Laurel		8	PVC	19.61		3.6	N/A	16.01		#DIV/0!	What type of junction is 540?
	186	CB	not listed	0.3042	13252							20.05		2.25	2.75			#DIV/0!	Drains to school grounds
	~~329~~	~~CB~~		~~NA~~	~~NA~~	~~330~~	~~CB~~			~~12~~	~~Sureloek~~	~~11.24~~		~~4.1~~	~~4.2~~	~~7.14~~	~~4.20~~	~~#DIV/0!~~	~~Does this connect?~~
	~~330~~	~~CB~~		~~NA~~	~~NA~~	~~334~~	~~CB~~					~~10.46~~		~~3.3~~	~~3.4~~	~~7.16~~	~~3.40~~	~~#DIV/0!~~	~~Does this connect?~~
	~~334~~			~~NA~~	~~NA~~							~~9.51~~		~~5.3~~	~~5.4~~	~~4.21~~	~~5.40~~	~~#DIV/0!~~	~~Does this connect?~~
	~~344~~			~~NA~~	~~NA~~							~~10.63~~				~~10.63~~		~~#DIV/0!~~	~~Does this connect?~~
	345			1.0050	43779							12.11				12.11		#DIV/0!	Does this connect?
	542	J	Lot SE of Cedar St & 8th Ave			543	J											#DIV/0!	Does this connect?
	543	J	Lot SE of Cedar St & 8th Ave			325	CB											#DIV/0!	Does this connect?
	544	J	Lot SE of Cedar St & 8th Ave			545	J											#DIV/0!	Does this connect?
	545	J	Lot SE of Cedar St & 8th Ave			325	CB											#DIV/0!	Does this connect?

NORTH

0 150 300 600

Scale (in Feet)

BASIN 1

BASIN 10

BASIN 11

BASIN 12

BASIN 12

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City of Kelso
Stormwater Management Plan
Phase 1
Basin Plan

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City of Kelso
Stormwater Management Plan
Phase 1 Plan
Overall System with Aerial Photo

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LEGEND

- AIRPORT INDUSTRIAL
- COMMERCIAL NEIGHBORHOOD
- COUNTY PARCELS
- GENERAL MANUFACTURING
- HIGHLIGHTS
- KELSO CITY LIMITS
- LIGHT INDUSTRIAL AREA
- MAJOR RETAIL AREA
- OPEN SPACE
- RESIDENTIAL MULTI-FAMILY
- RESIDENTIAL SINGLE FAMILY
- SPECIAL RETAIL DISTRICT
- STRUCTURE DRAINAGE AREA BOUNDARY
- TOWN CENTER COMMUNITY
- WEST KELSO COMMUNITY

NORTH

0 150 300 600

Scale (in Feet)

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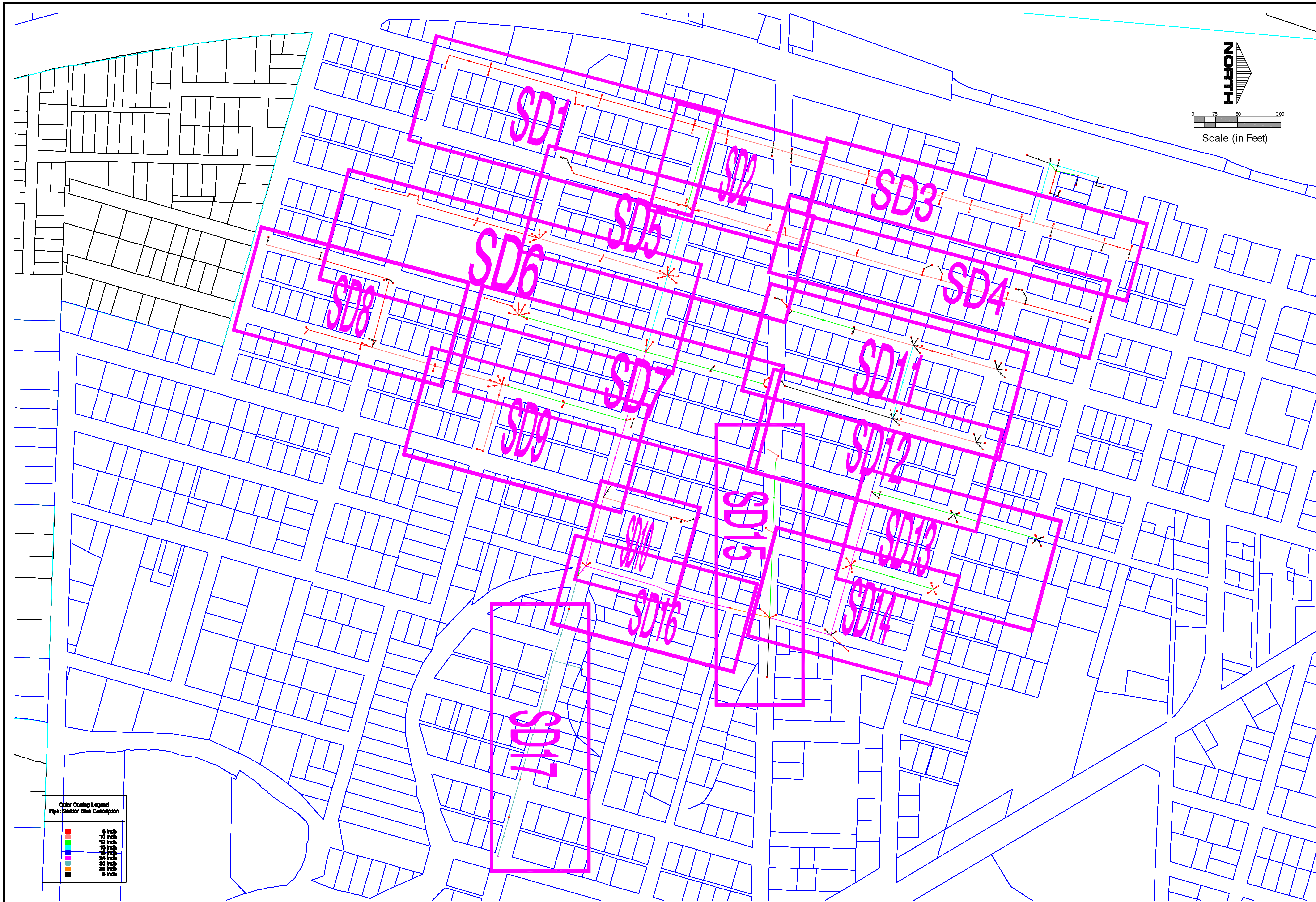
City of Kelso
Stormwater Management Plan
Phase 1 Drainage Areas
Systems 1 - 17

Appendix B

Kelso Stormwater Management Plan
Phase 1
System Flows

System	In					In					Out				
	From System	Node	CA (acres)	t_c	Flow (cfs)	From System	Node	CA (acres)	t_c	Flow (cfs)	To System	Node	CA (acres)	t_c	Flow (cfs)
1											2	512	3.51	7.14	9.79
2	1	512	3.51	7.14	9.79	3	506	6.34	12.78	13.01	5	153	13.15	12.94	26.82
3											2	506	6.34	12.78	13.01
4											5	513	2.78	7.45	7.58
5	2	153	13.15	12.94	26.82	4	513	2.78	7.45	7.58	6	202	18.38	12.94	37.49
6	5	202	18.38	12.94	37.49						7	220	21.57	12.94	43.99
7	6	220	21.57	12.94	43.99						9	244	24.59	12.94	50.15
8											9	527	2.57	7.12	7.17
9	7	244	24.59	12.94	50.15	8	527	2.57	7.12	7.17	10	303	30.52	12.94	62.25
10	9	303	30.52	12.94	62.25						16	313	31.32	12.94	63.88
11											12	271	2.04	7.36	5.60
12	11	271	2.04	7.36	5.60						13	281	4.61	7.36	11.39
13	12	281	4.61	7.36	11.39						14	296	6.79	8.55	17.20
14	13	296	6.79	8.55	17.20						15	320	8.49	9.22	20.69
15	14	320	8.49	9.22	20.69						16	318	11.73	13.74	23.19
16	10	313	31.32	12.94	63.88	15	318	11.73	13.74	23.19	17	326	43.81	14.93	82.91
17	16	326	43.81	14.93	82.91						**Outfall**	332	45.62	15.65	84.23



Layout Phase 1

City of Kelso
Stormwater Management Plan - Phase 1
Kelso, Washington

H.Scale: 1"=150'
V.Scale:
Datum:
Survey Books:
Project Directory: 04271013.act
AutoCAD File: Project.dwg

Designed
Drawn
Checked
Approved
Date

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Job Number
04271013
Bid Schedule
Drawing Number
Sheet Number
1 of 1

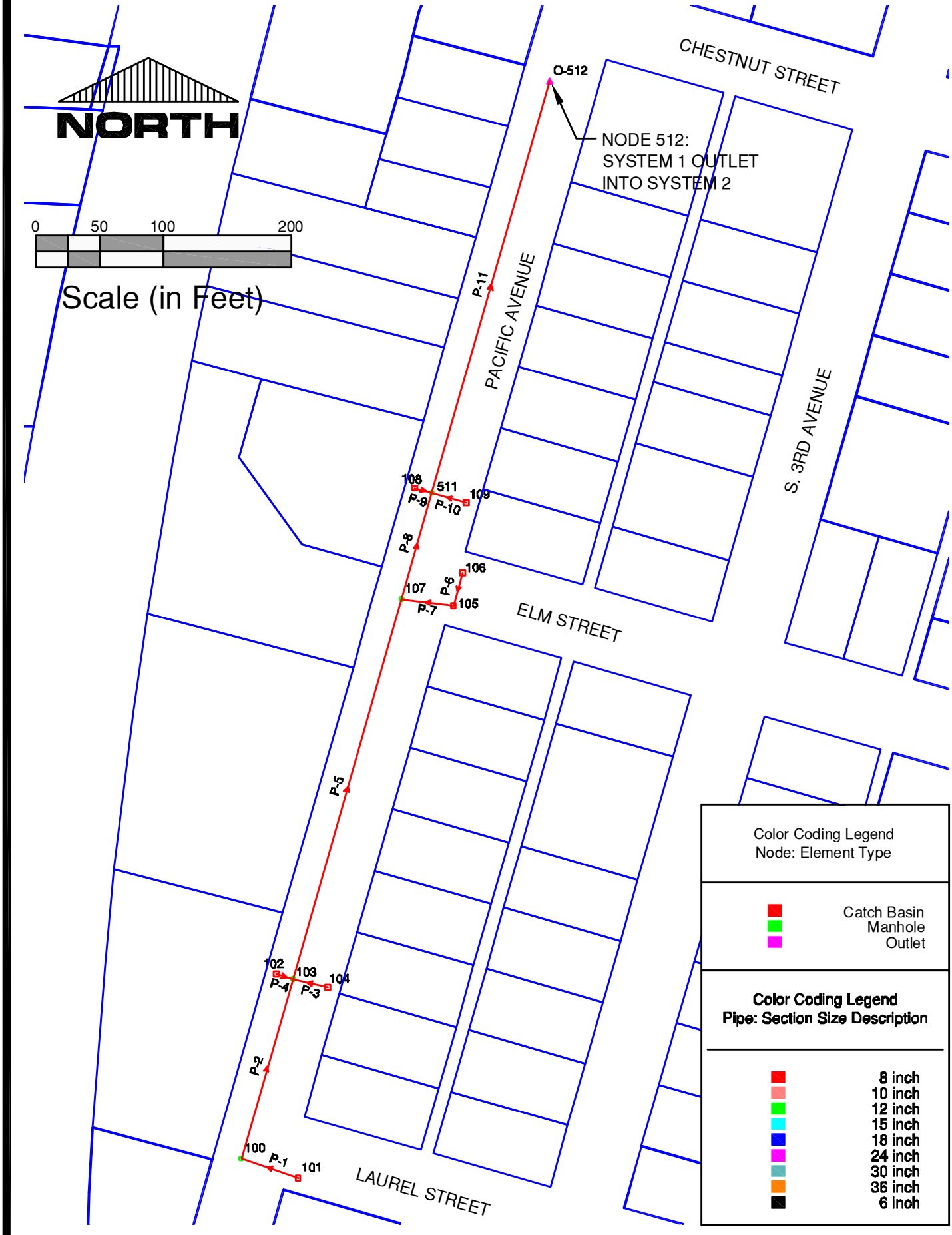
System 1

Modeling results: System 1 consists of the structures along Pacific Avenue, from Laurel Street to Chestnut Street. It drains an area between the bank of the rail road on the west and the alley way to the east (between Pacific Avenue and 3rd Avenue), from Laurel Street to Chestnut Street. It contains 12 structures, the majority on Pacific Avenue, and outlets into System 2 at node 512. The total drainage area for System 1 is 6.94 acres and the land use is approximately 50% residential and 50% commercial with an average runoff coefficient of 0.51.

Table 1.1 lists the structure information and connections, along with total flows and capacities. Figure 1 shows a schematic of the structure locations and piping layout. As seen in Table 1.1, pipes P-1, P-2, P-5, P-7, P-8 and P-11 are under capacity. Utilizing the current slopes, pipes P-1, P-2 and P-7 will gain capacity by upsizing to 12-inch pipe. Pipes P-5, P-8 and P-11 have very flat slopes and will require an increased pipe slope of 2% or greater, an increase in pipe diameter of 24-inches or greater, or a combination of the two.

With an increase in pipe size and slope, the capacity of the system will be greater and function better.

Recommendations: It is recommended at a minimum that 876 LF of 8-inch pipe under Pacific Avenue be upsized to 12-inch pipe to allow for increased pipe capacity and to act as storage for the system should down stream back up occur. The estimated budget to upgrade from 8 to 12-inch pipe is approximately $49,650 as shown in Table 1.2.



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City of Kelso
Stormwater Management Plan
Phase 1
System 1

Kelso Stormwater Management Plan
Phase 1
System 1

Pipe Label	Upstream Node	Downstream Node	Upstream Inlet Area (acres)	Upstream Inlet Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	System Flow Time (min)	System Intensity (in/hr)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Material	Manning's n	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-1	101	100	1.17	0.69	0.81	0.81	5.00	3.33	2.73	47	0.0211	8 inch	Concrete	0.013	1.75	18.18	17.19	21.08	22.09	2.23	4.23	24.49	22.09
P-2	100	103	N/A	N/A	N/A	0.81	5.10	3.30	2.70	146	0.0055	8 inch	Concrete	0.013	0.89	17.19	16.39	22.09	22.09	4.23	5.03	29.39	22.09
P-3	104	103	0.23	0.61	0.14	0.14	5.00	3.33	0.48	28	0.0789	8 inch	Concrete	0.013	3.39	18.60	16.39	21.60	22.09	2.33	5.03	22.13	22.09
P-4	102	103	1.17	0.56	0.65	0.65	5.00	3.33	2.19	14	0.0379	8 inch	Concrete	0.013	2.35	16.92	16.39	21.22	22.09	3.63	5.03	22.55	22.09
P-5	103	107	N/A	N/A	N/A	1.61	5.41	3.19	5.18	309	0.0038	8 inch	Concrete	0.013	0.74	16.39	15.23	22.09	22.03	5.03	6.13	78.87	22.03
P-6	106	105	0.36	0.40	0.14	0.14	5.00	3.33	0.48	26	0.0077	8 inch	Concrete	0.013	1.06	18.61	18.41	21.61	21.41	2.33	2.33	21.45	21.41
P-7	105	107	2.3	0.45	1.03	1.18	7.00	2.79	3.32	41	0.0776	8 inch	Concrete	0.013	3.37	18.41	15.23	21.41	22.03	2.33	6.13	25.12	22.03
P-8	107	511	N/A	N/A	N/A	2.79	7.07	2.78	7.80	86	0.0053	8 inch	Concrete	0.013	0.88	15.23	14.77	22.03	21.20	6.13	5.76	57.08	21.20
P-9	108	511	1.1	0.44	0.48	0.48	5.00	3.33	1.62	14	0.1914	8 inch	Concrete	0.013	5.29	17.45	14.77	20.95	21.20	2.83	5.76	21.45	21.20
P-10	109	511	0.61	0.40	0.24	0.24	5.00	3.33	0.82	28	0.0850	8 inch	Concrete	0.013	3.52	17.15	14.77	21.15	21.20	3.33	5.76	21.33	21.20
P-11	511	O-512	N/A	N/A	N/A	3.51	7.14	2.76	9.79	335	0.0053	8 inch	Concrete	0.013	0.88	14.77	12.99	21.20	21.40	5.76	7.74	233.53	13.66

System Flow > Pipe Capacity

Table 1.2

Pipe	Exist. Size	Prop. Size	Length	Cost /ft	Total
P-1	8 inch	12-inch	47	$25	$1,175
P-2	8 inch	12-inch	146	$25	$3,650
P-5	8 inch	24-inch	309	$60	$18,540
P-7	8 inch	12-inch	41	$25	$1,025
P-8	8 inch	24-inch	86	$60	$5,160
P-11	8 inch	24-inch	335	$60	$20,100
					$49,650

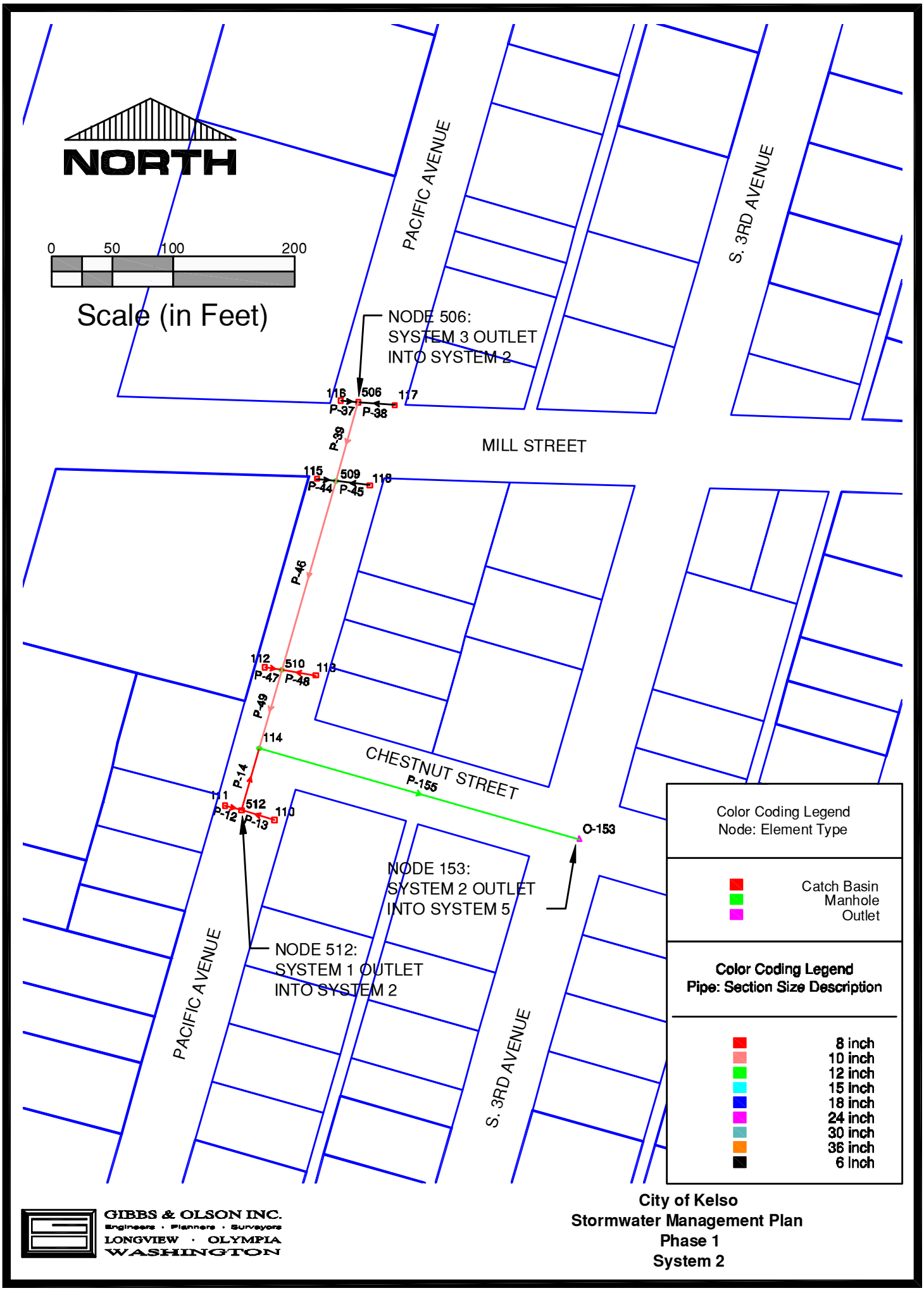
System 2

Modeling results: System 2 consists of the structures along Pacific Avenue, from Mill Street to Chestnut Street. It drains an area between the bank of the rail road on the west and the alley way to the east (between Pacific Avenue and 3rd Avenue), from Mill Street to Chestnut Street. It contains 14 structures, the majority on Pacific Avenue, and outlets into System 4 at node 153 at the intersection of Chestnut Street and S. 3rd Avenue. The total area for system 2 is 6.77 acres and the land use is approximately 50% residential and 50% commercial with an average runoff coefficient of 0.49.

Table 2.1 lists the structure information and connections, along with total flows and capacities. Figure 2 shows a schematic of the structure locations and piping layout. As seen in Table 2.1, pipes P-14, P-37, P-39, P-46, P-49, and P-155 are under capacity. Utilizing the current slopes, the following upsizings with HDPE pipe will gain pipe capacity: P-14 & P-39, upsize to a 24-inch pipe; P-46 and P-49, upsize to 30-inch pipe; P-155, upsize to 36-inch pipe. Pipes P-37 is a 6-inch concrete pipe at the end of a line, and unless problems have been noted at this location in the past, it is not high priority at this time. However, it may be economical to replace this pipe with a 12-inch pipe when pipe P-39 is replaced. The pipes along Pacific Avenue, P-14, P-39, P-46 and P-49, and Chestnut Street, P-155, have very flat slopes and will require an increased pipe slope of 2% or greater, an increase in pipe diameter as mentioned above, or a combination of the two.

With an increase in pipe size and slope, the capacity of the system will be greater and function better.

Recommendations: Given the flat slopes, the large area of impervious surface and the connection to the upstream system, it is recommended the trunk lines along Pacific Avenue and Chestnut Street be upsized to handle the stormwater runoff. The estimated budget to upgrade from the pipe as stated above is approximately $51,905 as shown in Table 2.2.



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City of Kelso
Stormwater Management Plan
Phase 1
System 2

Kelso Stormwater Management Plan
Phase 1
System 2

Upstream Inlet Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	System Flow Time (min)	System Intensity (in/hr)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Material	Manning's n	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
0.48	0.96	0.96	6.00	3.03	2.92	14	0.2736	8 inch	Concrete	0.013	6.32	16.82	12.99	21.62	22.40	4.13	8.74	23.21	22.40
0.40	0.04	0.04	5.00	3.33	0.13	28	0.1525	8 inch	Concrete	0.013	4.72	17.26	12.99	21.26	22.40	3.33	8.74	22.40	22.40
0.00	0.00	4.51	7.14	2.76	12.55	53	0.0053	8 inch	Concrete	0.013	0.88	12.99	12.71	22.40	22.51	8.74	9.13	79.67	22.51
0.53	0.85	0.85	5.00	3.33	2.84	15	0.2100	6 inch	Concrete	0.013	2.57	17.48	14.33	21.58	21.50	3.60	6.67	25.34	21.50
0.45	0.30	0.30	5.00	3.33	1.00	30	0.1147	6 inch	Concrete	0.013	1.90	17.77	14.33	21.57	21.50	3.30	6.67	22.45	21.50
0.00	0.00	7.48	12.78	2.04	15.36	68	0.0053	10 inch	T-Cotta	0.011	1.88	14.33	13.97	21.50	21.50	6.34	6.70	45.44	21.50
0.52	0.34	0.34	5.00	3.33	1.15	15	0.3020	6 inch	PVC	0.010	4.01	18.50	13.97	21.60	21.50	2.60	7.03	21.87	21.50
0.40	0.21	0.21	5.00	3.33	0.70	28	0.1296	6 inch	Concrete	0.013	2.02	17.60	13.97	21.40	21.50	3.30	7.03	21.93	21.50
N/A	N/A	8.03	12.82	2.03	16.47	161	0.0054	10 inch	T-Cotta	0.011	1.90	13.97	13.10	21.50	21.30	6.70	7.37	86.42	21.30
0.54	0.49	0.49	5.00	3.33	1.64	14	0.3614	8 inch	Concrete	0.013	7.26	18.16	13.10	21.56	21.30	2.73	7.53	21.56	21.30
0.40	0.12	0.12	5.00	3.33	0.42	28	0.1843	8 inch	Concrete	0.013	5.19	18.26	13.10	21.46	21.30	2.53	7.53	21.33	21.30
N/A	N/A	8.65	12.91	2.03	17.66	67	0.0058	10 inch	Concrete	0.013	1.67	13.10	12.71	21.30	22.51	7.37	8.97	66.04	22.51
N/A	N/A	13.15	12.94	2.02	26.82	274	0.0023	12 inch	T-Cotta	0.011	2.00	12.71	12.09	22.51	21.59	8.80	8.50	124.30	13.09

System Flow > Pipe Capacity

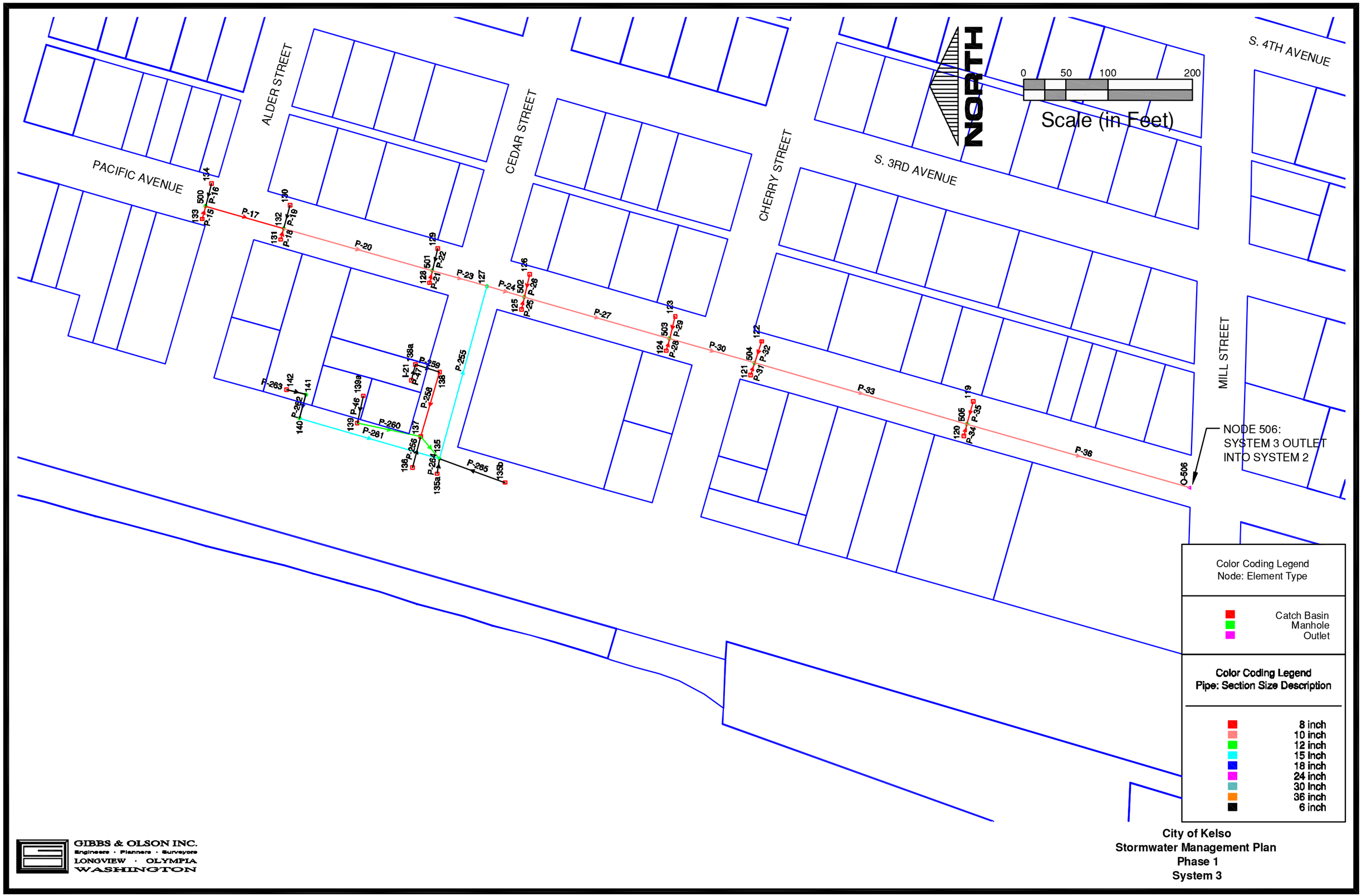
Cost /ft	Total
$60	$3,180
$25	$375
$60	$4,080
$80	$12,880
$80	$5,360
$95	$26,030
	$51,905

System 3

Modeling results: System 3 consists of the structures along Pacific Avenue, from Alder Street to Mill Street, and 1st Avenue from Alder Street to Cedar Street. It drains an area between the bank of the rail road on the west and the alley way to the east (between Pacific Avenue and 3rd Avenue), from Alder Street to Mill Street. It contains 28 structures, the majority on Pacific Avenue, and outlets into System 2 at node 506 at the intersection of Mill Street and Pacific Avenue. The total area for System 3 is 12.54 acres and land use is approximately 50% residential and 50% commercial with an average runoff coefficient of 0.51.

Table 3.1 lists the structure information and connections, along with total flows and capacities. Figure 3 shows a schematic of the structure locations and piping layout. As seen in Table 3.1, pipes P-17, P-20, P-21, P-23, P-24, P-27, P-30, P-33, P-36 and P-259 are under capacity. Pipes P-17, P-21 and P-259 are shown as adverse grade, and replacing these pipes with positive grade with benefit the capacity of the system. For pipes P-21 and P-259, providing 1% slope for the 8-inch pipe will provide the needed flow capacity. Pipe P-17 will require a 12-inch pipe at greater than 2% or a 16-inch pipe or larger at 0.5%. Utilizing the current slopes of 0.54%, the following upsizings to 24-inch HDPE pipe will gain pipe capacity: P-24, P-27, P-30, P-33, and P-36. Pipes P-20 and P-23 are 10-inch terracotta pipes at the beginning of a line, and at the current slopes of 0.1%, would require upsizing to a 24- and 30-inch pipe, respectively. However, if the slopes can be increased to 0.55%, 18-inch pipe will provide the needed capacity. With an increase in pipe size and slope, the capacity of the system will be greater and function better.

Recommendations: Given the flat slopes, the large area of impervious surface this system is draining, it is recommended the trunk lines along Pacific Avenue be upsized to handle the stormwater runoff and provide underground storage for the system. The estimated budget to upgrade from the pipe as stated above is approximately $71,825 as shown in Table 3.2.



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Stormwater Management Plan
Phase 1
System 3

Kelso Stormwater Management Plan
Phase 1
System 3

Table 3.1

Pipe Label	Upstream Node	Downstream Node	Upstream Inlet Area (acres)	Upstream Inlet Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	System Flow Time (min)	System Intensity (in/hr)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Material	Manning's n	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-15	133	500	2.87	0.52	1.48	1.48	6.00	3.03	4.52	16	0.1556	8 inch	Concrete	0.013	4.77	21.08	18.59	23.38	23.31	1.63	4.05	25.55	23.31
P-16	134	500	0.43	0.54	0.23	0.23	5.00	3.33	0.78	27	0.1167	6 inch	Concrete	0.013	1.92	21.74	18.59	23.24	23.31	1.00	4.22	23.83	23.31
P-17	500	132	N/A	N/A	N/A	1.71	6.02	3.02	5.22	96	-0.0071	8 inch	Concrete	0.013	-1.02	18.59	19.27	23.31	23.97	4.05	4.03	41.89	23.97
P-18	131	132	0.74	0.54	0.40	0.40	5.00	3.33	1.34	14	0.0421	8 inch	Concrete	0.013	2.48	19.86	19.27	23.16	23.97	2.63	4.03	24.14	23.97
P-19	130	132	0.52	0.48	0.25	0.25	5.00	3.33	0.84	28	0.1025	6 inch	Concrete	0.013	1.80	22.14	19.27	23.44	23.97	0.80	4.20	24.59	23.97
P-20	132	501	N/A	N/A	N/A	2.36	6.13	2.99	7.13	183	0.0010	10 inch	T-Cotta	0.011	0.81	19.27	19.09	23.97	22.65	3.87	2.73	36.52	22.65
P-21	128	501	0.57	0.60	0.34	0.34	5.00	3.33	1.15	15	-0.0300	8 inch	Concrete	0.013	-2.09	18.64	19.09	22.64	22.65	3.33	2.89	22.79	22.65
P-22	129	501	0.27	0.43	0.12	0.12	5.00	3.33	0.39	27	0.0341	6 inch	Concrete	0.013	1.04	20.01	19.09	22.71	22.65	2.20	3.06	22.78	22.65
P-23	501	127	N/A	N/A	N/A	2.82	6.36	2.94	8.35	67	0.0010	10 inch	T-Cotta	0.011	0.84	19.09	19.02	22.65	24.02	2.73	4.17	30.99	24.02
P-24	127	502	N/A	N/A	N/A	3.64	12.26	2.08	7.63	46	0.0054	10 inch	T-Cotta	0.011	1.91	19.02	18.77	24.02	23.00	4.17	3.40	27.00	23.00
P-25	125	502	0.81	0.75	0.61	0.61	5.00	3.33	2.04	15	0.0320	8 inch	Concrete	0.013	2.16	19.25	18.77	22.90	23.00	2.99	3.56	23.43	23.00
P-26	126	502	0.23	0.45	0.10	0.10	5.00	3.33	0.35	28	0.0250	8 inch	Concrete	0.013	1.91	19.47	18.77	23.12	23.00	2.98	3.56	23.02	23.00
P-27	502	503	N/A	N/A	N/A	4.35	12.31	2.08	9.10	179	0.0054	10 inch	Concrete	0.013	1.61	18.77	17.80	23.00	22.60	3.40	3.97	53.51	22.60
P-28	124	503	1.15	0.50	0.57	0.57	5.00	3.33	1.92	15	0.0300	8 inch	Concrete	0.013	2.09	18.25	17.80	22.55	22.60	3.63	4.13	22.98	22.60
P-29	123	503	0.45	0.43	0.19	0.19	5.00	3.33	0.65	27	0.0704	8 inch	Concrete	0.013	3.21	19.70	17.80	22.70	22.60	2.33	4.13	22.68	22.60
P-30	503	504	N/A	N/A	N/A	5.12	12.49	2.06	10.63	105	0.0054	10 inch	Concrete	0.013	1.61	17.80	17.23	22.60	22.60	3.97	4.54	47.31	22.60
P-31	121	504	1.61	0.35	0.56	0.56	5.00	3.33	1.89	15	0.0273	8 inch	Concrete	0.013	2.00	17.64	17.23	22.65	22.60	4.34	4.70	22.97	22.60
P-32	122	504	0.24	0.48	0.11	0.11	5.00	3.33	0.38	27	0.0819	8 inch	Concrete	0.013	3.46	19.44	17.23	22.64	22.60	2.53	4.70	22.63	22.60
P-33	504	505	N/A	N/A	N/A	5.79	12.58	2.05	11.99	262	0.0054	10 inch	Concrete	0.013	1.61	17.23	15.81	22.60	22.00	4.54	5.36	100.48	22.00
P-34	120	505	0.94	0.44	0.41	0.41	5.00	3.33	1.39	15	0.1507	8 inch	CI	0.013	4.69	18.07	15.81	22.07	22.00	3.33	5.52	22.20	22.00
P-35	119	505	0.28	0.48	0.13	0.13	5.00	3.33	0.45	28	0.0682	8 inch	Concrete	0.013	3.16	17.72	15.81	21.92	22.00	3.53	5.52	22.04	22.00
P-36	505	O-506	N/A	N/A	N/A	6.34	12.78	2.04	13.01	274	0.0054	10 inch	T-Cotta	0.011	1.90	15.81	14.33	22.00	21.50	5.36	6.34	84.38	15.16
P-255	135	127	N/A	N/A	N/A	0.82	9.98	2.32	1.91	212	0.0020	15 inch	T-Cotta	0.011	3.44	19.45	19.02	23.95	24.02	3.25	3.75	24.15	24.02
P-256	136	137	0.18	0.40	0.07	0.07	5.00	3.33	0.24	38	0.0353	6 inch	PVC	0.010	1.37	22.88	21.54	24.18	24.24	0.80	2.20	24.00	23.96
P-257	137	135	0.04	0.80	0.03	0.35	8.47	2.53	0.89	34	0.0012	12 inch	PVC	0.010	1.59	20.64	20.60	24.24	23.95	2.60	2.35	23.96	23.95
P-258	138	137	0.06	0.70	0.04	0.10	5.90	3.05	0.31	80	0.0066	8 inch	PVC	0.010	1.28	21.27	20.74	24.17	24.24	2.23	2.83	23.99	23.96
P-259	138a	138	0.04	0.30	0.01	0.06	5.39	3.20	0.19	30	-0.0120	6 inch	PVC	0.010	-0.80	21.71	22.07	23.47	24.17	1.26	1.60	24.01	23.99
P-259a	138b	138a	0.05	0.95	0.05	0.05	5.00	3.33	0.16	19	0.0047	6 inch	PVC	0.010	0.50	21.80	21.71	25.50	23.47	3.20	1.26	23.48	23.47
P-260	139	137	0.19	0.60	0.11	0.14	6.13	2.99	0.43	77	0.0038	12 inch	DI	0.013	2.19	21.98	21.69	25.43	24.24	2.45	1.55	23.97	23.96
P-260a	139a	139	0.03	0.95	0.03	0.03	5.00	3.33	0.10	33	0.0018	6 inch	PVC	0.010	0.31	22.14	22.08	25.50	25.43	2.86	2.85	23.98	23.97
P-261	140	135	N/A	N/A	N/A	0.29	5.97	3.04	0.88	173	0.0027	15 inch	T-Cotta	0.011	3.98	20.02	19.55	25.47	23.95	4.20	3.15	23.97	23.95
P-262	141	140	N/A	N/A	N/A	0.29	5.08	3.30	0.96	29	0.0010	18 inch	Concrete	0.013	3.38	20.20	20.17	25.10	25.47	3.40	3.80	23.98	23.97
P-263	142	141	0.48	0.60	0.29	0.29	5.00	3.33	0.97	23	0.0391	6 inch	Concrete	0.013	1.11	22.75	21.85	24.85	25.10	1.60	2.75	24.66	23.98
P-264	135a	135	0.23	0.40	0.09	0.09	5.00	3.33	0.31	18	0.0167	6 inch	PVC	0.010	0.94	21.45	21.15	23.05	23.95	1.10	2.30	23.98	23.95
P-265	135b	135	0.13	0.68	0.09	0.09	5.00	3.33	0.30	83	0.0264	6 inch	PVC	0.010	1.18	21.70	19.51	23.15	23.95	0.95	3.94	24.09	23.95

System Flow > Pipe Capacity

Kelso Stormwater Management Plan
Phase 1
System 3

Table 3.2

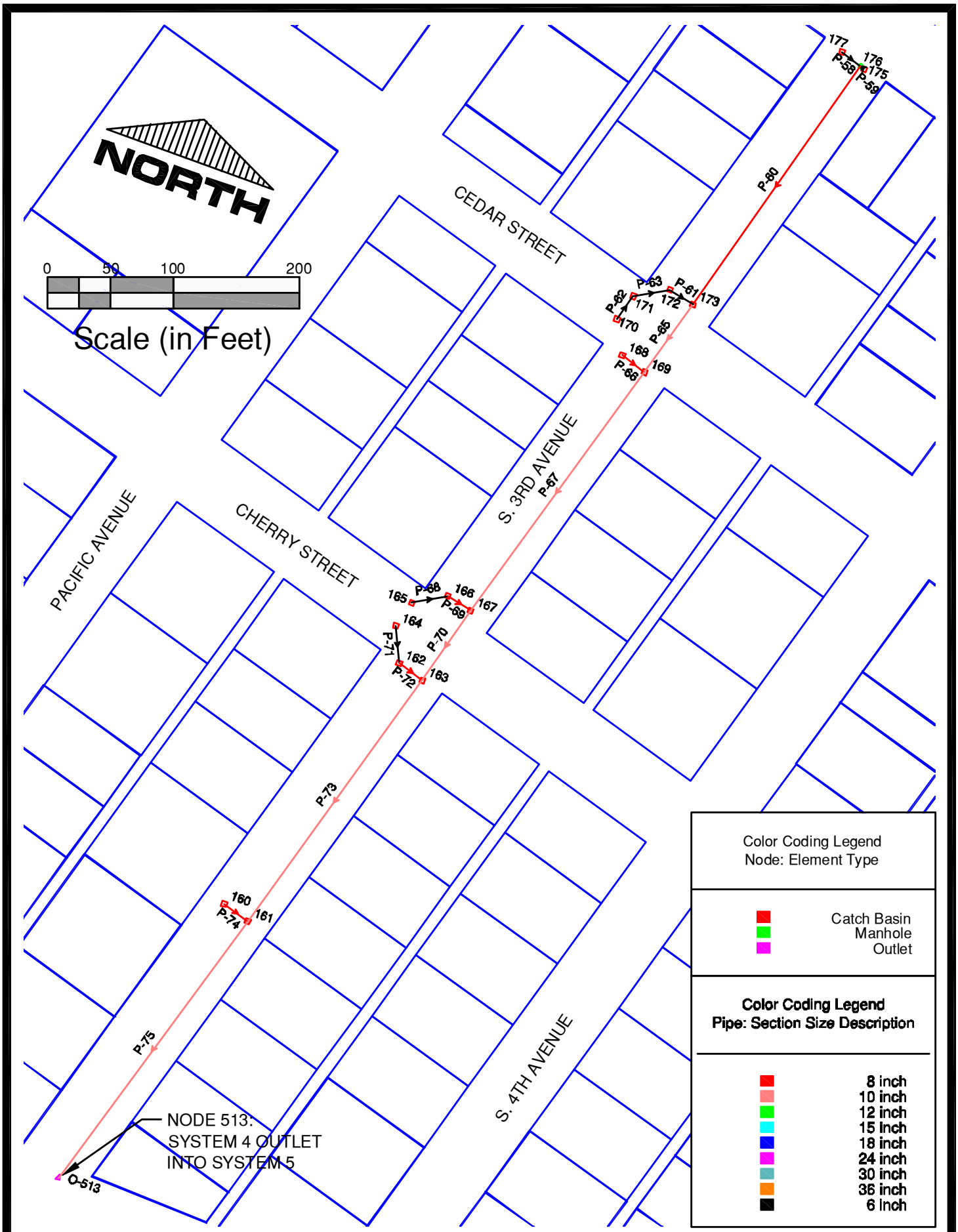
Pipe	Exist. Size	Prop. Size	Length	Cost /ft	Total
P-17	8 inch	12 inch	96	$25	$2,400
P-20	10 inch	24 inch	183	$60	$10,980
P-21	8 inch	12 inch	15	$25	$375
P-23	10 inch	30 inch	67	$80	$5,360
P-24	10 inch	24 inch	46	$60	$2,760
P-27	10 inch	24 inch	179	$60	$10,740
P-30	10 inch	24 inch	105	$60	$6,300
P-33	10 inch	24 inch	262	$60	$15,720
P-36	10 inch	24 inch	274	$60	$16,440
P-259	6 inch	12 inch	30	$25	$750
					$71,825

System 4

Modeling results: System 4 consists of the structures along 3rd Avenue, from Alder Street to Mill Street. It drains an area between the alley way to the west (between Pacific Avenue and 3rd Avenue), and the alley way to the east (between 3rd and 4th Avenues) from Alder Street to Mill Street. It contains 17 structures and outlets into System 5 at node 513 at the intersection of Mill Street and 3rd Avenue. The total area for System 4 is 6.76 acres and the land use is primarily residential, with an average runoff coefficient of 0.41.

Table 4.1 lists the structure information and connections, along with total flows and capacities. Figure 4 shows a schematic of the structure locations and piping layout. As seen in Table 4.1, pipes P-60, P-62, P-65, P-71, P-73 have a negative slope and are under capacity. Replacing pipes pipes P-60, P-62, P-65 and P-71 with a 12-inch pipe at 0.75% and pipe P-73 with an 18-inch pipe at 0.5% will provide the needed capacity. For pipes P-67, P-70 and P-75, replacing the existing 10-inch terracotta pipes with 18-inch HDPE pipes at 1% slope or 21-inch pipes at 0.5% slope will provide the needed flow capacity. With an increase in pipe size and slope, the capacity of the system will be greater and function better.

Recommendations: With a large number of pipes at negative slope and the main trunk line comprised of 10-inch terracotta pipe, providing larger pipe diameters and positive slope will help to handle the stormwater runoff and provide underground storage for the system. The estimated budget to upgrade from the pipe as stated above is approximately $44,275 as shown in Table 4.2.



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City of Kelso
Stormwater Management Plan
Phase 1
System 4

Kelso Stormwater Management Plan
Phase 1
System 4

Table 4.1

Pipe Label	Upstream Node	Downstream Node	Upstream Inlet Area (acres)	Upstream Inlet Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	System Flow Time (min)	System Intensity (in/hr)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Material	Manning's n	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-58	177	176	0.44	0.48	0.21	0.21	5.00	3.33	0.70	19	0.2084	6 inch	CI	0.013	2.56	19.72	15.76	21.72	22.06	1.50	5.80	22.36	22.06
P-59	175	176	0.33	0.54	0.18	0.18	5.00	3.33	0.59	4	0.9625	6 inch	CI	0.013	5.50	19.61	15.76	21.61	22.06	1.50	5.80	22.10	22.06
P-60	176	173	N/A	N/A	N/A	0.39	5.09	3.30	1.28	231	-0.0086	8 inch	Concrete	0.013	-1.12	15.76	17.74	22.06	22.04	5.63	3.63	24.64	22.04
P-61	172	173	0.33	0.40	0.13	0.37	5.28	3.24	1.20	22	0.1114	6 inch	Concrete	0.013	1.87	20.19	17.74	21.99	22.04	1.30	3.80	23.05	22.04
P-62	170	171	0.33	0.40	0.13	0.13	5.00	3.33	0.44	22	-0.0350	6 inch	Concrete	0.013	-1.05	20.41	21.18	21.81	22.18	0.90	0.50	22.32	22.18
P-63	171	172	0.26	0.40	0.10	0.24	5.16	3.27	0.78	29	0.0341	6 inch	Concrete	0.013	1.04	21.18	20.19	22.18	21.99	0.50	1.30	22.55	21.99
P-65	173	169	0.42	0.40	0.17	0.92	6.14	2.99	2.78	66	-0.0008	10 inch	Concrete	0.013	-0.60	17.74	17.79	22.04	21.89	3.47	3.27	22.95	21.89
P-66	168	169	0.25	0.40	0.10	0.10	5.00	3.33	0.34	22	0.1045	8 inch	Concrete	0.013	3.91	20.09	17.79	22.09	21.89	1.33	3.43	21.91	21.89
P-67	169	167	0.43	0.40	0.17	1.19	6.35	2.94	3.53	234	0.0005	10 inch	Concrete	0.013	0.48	17.79	17.68	21.89	21.68	3.27	3.17	27.77	21.68
P-68	165	166	0.25	0.40	0.10	0.10	5.00	3.33	0.34	29	0.0310	6 inch	Concrete	0.013	0.99	20.60	19.70	21.60	21.40	0.50	1.20	21.50	21.4
P-69	166	167	0.28	0.40	0.11	0.21	5.28	3.24	0.69	22	0.0918	8 inch	Concrete	0.013	3.66	19.70	17.68	21.40	21.68	1.03	3.33	21.75	21.68
P-70	167	163	0.42	0.40	0.17	1.57	6.95	2.80	4.44	67	0.0058	10 inch	Concrete	0.013	1.67	17.68	17.29	21.68	21.49	3.17	3.37	24.25	21.49
P-71	164	162	0.32	0.40	0.13	0.13	5.00	3.33	0.43	30	-0.2020	6 inch	Concrete	0.013	-2.52	13.44	19.50	21.44	21.50	7.50	1.50	21.68	21.5
P-72	162	163	0.53	0.40	0.21	0.34	5.23	3.25	1.11	23	0.0961	8 inch	Concrete	0.013	3.75	19.50	17.29	21.50	21.49	1.33	3.53	21.69	21.49
P-73	163	161	0.54	0.40	0.22	2.13	7.09	2.77	5.95	236	-0.0016	10 inch	Concrete	0.013	-0.87	17.29	17.66	21.49	21.36	3.37	2.87	38.79	21.36
P-74	160	161	0.66	0.40	0.26	0.26	5.00	3.33	0.89	23	0.0778	8 inch	Concrete	0.013	3.37	19.45	17.66	21.25	21.36	1.13	3.03	21.48	21.36
P-75	161	O-513	0.97	0.40	0.39	2.78	7.45	2.70	7.58	253	0.0092	10 inch	Concrete	0.013	2.10	17.66	15.34	21.36	21.50	2.87	5.33	46.45	16.17

System Flow > Pipe Capacity

Table 4.2

Pipe	Exist. Size	Prop. Size	Length	Cost /ft	Total
P-60	8 inch	12 inch	231	$25	$5,775
P-62	6 inch	12 inch	22	$25	$550
P-65	10 inch	12 inch	66	$25	$1,650
P-67	10 inch	18 inch	234	$45	$10,530
P-70	10 inch	18 inch	67	$45	$3,015
P-71	6 inch	12 inch	30	$25	$750
P-73	10 inch	18 inch	236	$45	$10,620
P-75	10 inch	18 inch	253	$45	$11,385
					$44,275

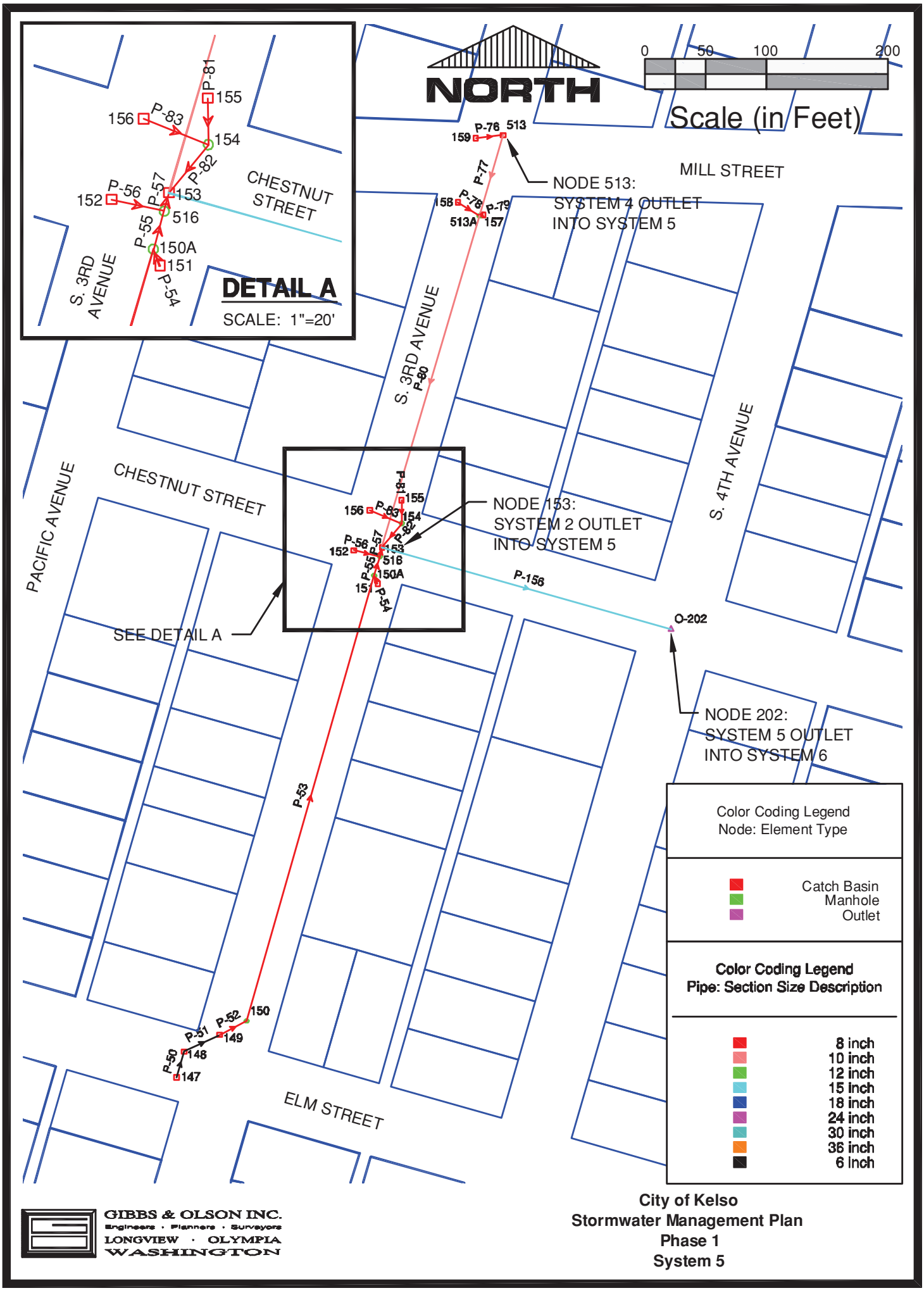
System 5

Modeling results: System 5 consists of the structures along 3rd Avenue, from Elm Street to Mill Street. It drains an area between the alley way to the west (between Pacific Avenue and 3rd Avenue), and the alley way to the east (between 3rd and 4th Avenues) from Elm Street to Mill Street. It contains 15 structures, receives drainage from System 2 at node 153 and system 4 at node 513, and outlets into System 5 at node 513 at the intersection of Mill Street and 3rd Avenue. The total calculated drainage area for system 5 is 6.15 acres and the land use is primarily residential, with an average runoff coefficient of 0.40.

Table 5.1 lists the structure information and connections, along with total flows and capacities. Figure 5 shows a schematic of the structure locations and piping layout. As seen in Table 5.1, pipe P-51 has a negative slope and is under capacity. Replacing this pipe with at least an 8-inch pipe and a minimum slope of 3.5% will provide the capacity needed to handle the existing flow. Pipes P-53, P-55, P-57, P-77, P-80 and P-156 are shown as under capacity. Utilizing the existing slopes for pipes P-53 and P-55 but increasing the size from 8-inch to 12-inch pipe will provide the necessary capacity. Pipe P-57 will need to increase in size to 12-inch and increase the slope from 1.25% to 2% to provide capacity. If the slope for pipe P-57 cannot be increased, a 15-inch pipe at the existing 1.25% slope will provided the needed capacity. Pipes P-77 and P-80 need to be increased in size from 10-inch to 18-inch to handle to drainage flow while maintaining the existing slope of 0.9%.

Pipe P-156 is the down stream pipe for the convergence of System 2 and System 5. To handle the flow from the upstream systems, pipe P-156 needs to be increased from a 15-inch pipe to a 24-inch pipe at 3%, a 27-inch pipe at 1.6%, a 30-inch pipe at 0.9% or a 36-inch pipe at 0.35%.

Recommendations: While the upstream and down stream nodes of pipe P-156 have cover to facilitate an increased pipe size and slope, the constraints of the upstream and down stream systems make a large change in slope such as 3% difficult to accommodate. Therefore, it is recommended pipe P-156 be replaced with a larger pipe at a flatter slope to limit the impacts to the other systems. The estimated budget to upgrade from the pipe as stated above is approximately $50,435 as shown in Table 5.2.



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System 5

Table 5.1

Pipe Label	Upstream Node	Downstream Node	Upstream Inlet Area (acres)	Upstream Inlet Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	System Flow Time (min)	System Intensity (in/hr)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Material	Manning's n	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-50	147	148	0.35	0.40	0.14	0.14	5.00	3.33	0.47	22	0.0082	6 inch	Concrete	0.013	0.51	19.55	19.37	21.85	21.87	1.80	2.00	22.02	21.87
P-51	148	149	1.23	0.40	0.49	0.63	5.15	3.28	2.09	32	-0.0053	6 inch	Concrete	0.013	-0.41	19.37	19.54	21.87	21.84	2.00	1.80	26.27	21.84
P-52	149	150	0.71	0.40	0.28	0.92	5.20	3.26	3.01	25	0.0848	8 inch	Concrete	0.013	3.52	19.54	17.42	21.84	22.02	1.63	3.93	23.57	22.02
P-53	150	150A	N/A	N/A	N/A	0.92	5.25	3.25	3.00	381	0.0132	8 inch	Concrete	0.013	1.39	17.42	12.41	22.02	21.00	3.93	7.92	44.44	21
P-54	151	150A	0.56	0.40	0.22	0.22	5.00	3.33	0.75	7	1.0086	8 inch	Concrete	0.013	12.14	19.47	12.41	21.17	21.00	1.03	7.92	21.03	21
P-55	150A	516	N/A	N/A	N/A	1.14	5.99	3.03	3.48	16	0.0138	8 inch	Concrete	0.013	1.42	12.41	12.19	21.00	21.00	7.92	8.14	22.33	21
P-56	152	516	0.95	0.40	0.38	0.38	5.00	3.33	1.28	22	0.3105	8 inch	Concrete	0.013	6.73	19.02	12.19	21.02	21.00	1.33	8.14	21.25	21
P-57	516	153	N/A	N/A	N/A	1.52	6.02	3.02	4.63	8	0.0125	8 inch	Concrete	0.013	1.35	12.19	12.09	21.00	21.59	8.14	8.83	22.76	21.59
P-76	159	513	0.48	0.40	0.19	0.19	5.00	3.33	0.64	23	0.1800	8 inch	Concrete	0.013	5.13	19.48	15.34	21.28	21.50	1.13	5.49	21.57	21.5
P-77	513	513A	0.00	0.00	0.00	2.97	7.45	2.70	8.10	69	0.0093	10 inch	Concrete	0.013	2.11	15.34	14.70	21.50	21.10	5.33	5.57	30.52	21.1
P-78	158	513A	0.49	0.40	0.20	0.20	5.00	3.33	0.66	21	0.1686	8 inch	Concrete	0.013	4.96	18.24	14.70	21.14	21.10	2.23	5.73	21.16	21.1
P-79	157	513A	0.66	0.40	0.26	0.26	5.00	3.33	0.89	3	0.3333	8 inch	Concrete	0.013	6.98	15.70	14.70	21.10	21.10	4.73	5.73	21.12	21.1
P-80	513A	153	N/A	N/A	N/A	3.43	7.53	2.69	9.30	284	0.0092	10 inch	Concrete	0.013	2.10	14.70	12.09	21.10	21.59	5.57	8.67	72.74	21.59
P-81	155	154	0.23	0.40	0.09	0.09	5.00	3.33	0.31	19	0.2358	8 inch	Concrete	0.013	5.87	18.92	14.44	20.92	21.94	1.33	6.83	21.84	21.83
P-82	154	153	N/A	N/A	N/A	0.28	5.36	3.21	0.91	26	0.0904	8 inch	Concrete	0.013	3.63	14.44	12.09	21.94	21.59	6.83	8.83	21.74	21.59
P-83	156	154	0.47	0.40	0.19	0.19	5.00	3.33	0.63	29	0.1441	8 inch	Concrete	0.013	4.59	18.62	14.44	21.12	21.94	1.83	6.83	21.91	21.83
P-156	153	O-202	0.00	0.00	0.00	18.38	12.94	2.02	37.49	247	0.0013	15 inch	T-Cotta	0.011	2.70	12.09	11.78	21.59	19.98	8.25	6.95	72.61	13.03

System Flow > Pipe Capacity

Table 5.2

Pipe	Exist. Size	Prop. Size	Length	Cost /ft	Total
P-51	6 inch	12 inch	32	$25	$800
P-53	8 inch	12 inch	381	$25	$9,525
P-55	8 inch	12 inch	16	$25	$400
P-57	8 inch	18 inch	8	$45	$360
P-77	10 inch	18 inch	69	$45	$3,105
P-80	10 inch	18 inch	284	$45	$12,780
P-156	15 inch	36 inch	247	$95	$23,465
					$50,435

System 6

Modeling results: System 6 consists of the structures along 4th Avenue, from Laurel Street to Chestnut Street. It drains an area between the alley way to the west (between 3rd and 4th Avenues), and the alley way to the east (between 4th and 5th Avenues) from Laurel Street to Chestnut Street. It contains 22 structures and outlets into System 7 at node 220 at the intersection of Chestnut Street and 5th Avenue. The total calculated drainage area for system 6 is 7.97 acres and the land use is primarily residential, with an average runoff coefficient of 0.40.

Table 6.1 lists the structure information and connections, along with total flows and capacities. Figure 6 shows a schematic of the structure locations and piping layout. As seen in Table 6.1, P-86, P-87, P-88, P-91, P-96, P-99 and P-157 are under capacity. Pipes P-86 and P-87 are shown with a negative slope. Replacing pipes P-86, P-87 and P-88 with a 12inch pipe and a minimum slope of 0.5% will provide the capacity needed to handle the existing flow. Pipes P-91, P-96 and P-99 all have an existing slope of just over 0.5%. Increasing the size of these pipes from 8 and 10-inch to 18-inch while maintaining the existing slope will provide the additional capacity needed for these pipes.

Pipe P-157 is the down stream pipe for the convergence of System 5 and System 6. To handle the flow from the upstream systems, pipe P-157 needs to be increased from a 15-inch pipe to a 36-inch pipe at 0.5%.

Recommendations: The estimated budget to upgrade from the pipe as stated above is approximately $63,380 as shown in Table 6.2.

NODE 220:
SYSTEM 6 OUTLETS
INTO SYSTEM 7

NODE 202:
SYSTEM 5 OUTLETS
INTO SYSTEM 6

O-220
P-157
201
200
P-105
202
P-100
196
P-104
P-103
P-101
199
P-102
198
197
P-99
519
194
P-97
195
P-98
P-96
193
189
P-93
P-95
P-92
192
P-94
191
190
P-91
518
187
P-90
188
P-89
P-88
184
P-87
183
P-86
517
182
P-85
P-84
179

ELM STREET
LAUREL STREET
CHESTNUT STREET

S. 6TH AVENUE
S. 5TH AVENUE
S. 4TH AVENUE
S. 3RD AVENUE
PACIFIC AVENUE

NORTH

0 50 100 200

Scale (in Feet)

Color Coding Legend
Node: Element Type

Catch Basin
Manhole
Outlet

Color Coding Legend
Pipe: Section Size Description

8 inch
10 inch
12 inch
15 inch
18 inch
24 inch
30 inch
36 inch
6 inch

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City of Kelso
Stormwater Management Plan
Phase 1
System 6

Kelso Stormwater Management Plan
Phase 1
System 6

Table 6.1

Pipe Label	Upstream Node	Downstream Node	Upstream Inlet Area (acres)	Upstream Inlet Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	System Flow Time (min)	System Intensity (in/hr)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Material	Manning's n	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-84	179	517	0.70	0.40	0.28	0.28	5.00	3.33	0.94	115	0.0122	8 inch	Concrete	0.013	1.33	17.82	16.42	18.49	19.50	0.00	2.41	20.20	19.5
P-85	517	182	N/A	N/A	N/A	0.28	5.71	3.11	0.88	11	0.0509	8 inch	PVC	0.010	3.54	16.42	15.86	19.50	19.46	2.41	2.93	19.49	19.46
P-86	182	183	0.22	0.40	0.09	0.37	5.78	3.09	1.14	33	-0.0224	8 inch	Concrete	0.013	-1.81	15.86	16.60	19.46	19.80	2.93	2.53	20.10	19.8
P-87	183	184	0.89	0.40	0.36	0.72	5.95	3.04	2.22	26	-0.0062	8 inch	Concrete	0.013	-0.95	16.60	16.76	19.80	20.86	2.53	3.43	21.74	20.86
P-88	184	518	N/A	N/A	N/A	0.72	6.02	3.02	2.20	213	0.0058	8 inch	Concrete	0.013	0.92	16.76	15.52	20.86	20.00	3.43	3.81	27.09	20
P-89	188	518	0.40	0.40	0.16	0.16	5.00	3.33	0.54	9	0.2278	8 inch	Concrete	0.013	5.77	17.57	15.52	20.27	20.00	2.03	3.81	20.02	20
P-90	187	518	0.59	0.40	0.24	0.24	5.00	3.33	0.79	20	0.1080	8 inch	Concrete	0.013	3.97	17.68	15.52	20.18	20.00	1.83	3.81	20.09	20
P-91	518	193	N/A	N/A	N/A	1.12	6.58	2.88	3.26	221	0.0058	8 inch	Concrete	0.013	0.92	15.52	14.23	20.00	20.83	3.81	5.93	36.87	20.83
P-92	189	193	0.17	0.40	0.07	0.07	5.00	3.33	0.23	34	0.1165	8 inch	Concrete	0.013	4.12	18.19	14.23	20.39	20.83	1.53	5.93	20.84	20.83
P-93	190	193	0.35	0.40	0.14	0.14	5.00	3.33	0.47	30	0.1233	8 inch	Concrete	0.013	4.24	17.93	14.23	20.23	20.83	1.63	5.93	20.88	20.83
P-94	191	193	0.70	0.40	0.28	0.28	5.00	3.33	0.94	28	0.1579	8 inch	Concrete	0.013	4.80	18.65	14.23	20.25	20.83	0.93	5.93	21.00	20.83
P-95	192	193	0.80	0.40	0.32	0.32	5.00	3.33	1.07	31	0.1274	8 inch	Concrete	0.013	4.31	18.18	14.23	20.18	20.83	1.33	5.93	21.07	20.83
P-96	193	519	N/A	N/A	N/A	1.93	6.98	2.80	5.44	230	0.0053	10 inch	Concrete	0.013	1.60	14.23	13.00	20.83	19.85	5.77	6.02	34.01	19.85
P-97	194	519	0.14	0.40	0.06	0.06	5.00	3.33	0.19	20	0.2400	8 inch	Concrete	0.013	5.92	17.80	13.00	19.80	19.85	1.33	6.18	19.85	19.85
P-98	195	519	0.60	0.40	0.24	0.24	5.00	3.33	0.81	8	0.2475	8 inch	Concrete	0.013	6.01	14.98	13.00	19.89	19.85	4.24	6.18	19.89	19.85
P-99	519	202	N/A	N/A	N/A	2.22	7.36	2.72	6.10	230	0.0053	10 inch	Concrete	0.013	1.60	13.00	11.78	19.85	19.98	6.02	7.37	37.80	19.98
P-100	196	202	0.36	0.40	0.14	0.14	5.00	3.33	0.48	34	0.1735	8 inch	Concrete	0.013	5.03	17.68	11.78	19.68	19.98	1.33	7.53	20.03	19.98
P-101	197	202	0.65	0.40	0.26	0.26	5.00	3.33	0.87	30	0.1907	8 inch	Concrete	0.013	5.28	17.50	11.78	19.50	19.98	1.33	7.53	20.14	19.98
P-102	198	202	0.12	0.40	0.05	0.05	5.00	3.33	0.16	29	0.2010	8 inch	Concrete	0.013	5.42	17.61	11.78	19.61	19.98	1.33	7.53	19.99	19.98
P-103	199	202	0.39	0.40	0.16	0.16	5.00	3.33	0.52	32	0.1806	8 inch	Concrete	0.013	5.14	17.56	11.78	19.67	19.98	1.44	7.53	20.04	19.98
P-104	200	202	0.27	0.40	0.11	0.11	5.00	3.33	0.36	38	0.1455	8 inch	Concrete	0.013	4.61	17.31	11.78	19.41	19.98	1.43	7.53	20.01	19.98
P-105	201	202	0.62	0.40	0.25	0.25	5.00	3.33	0.83	41	0.1378	8 inch	Concrete	0.013	4.49	17.43	11.78	19.53	19.98	1.43	7.53	20.17	19.98
P-157	202	O-220	0.00	0.00	0.00	21.57	12.94	2.02	43.99	273	0.0043	15 inch	T-Cotta	0.011	5.00	11.78	10.61	19.98	20.61	6.95	8.75	102.51	11.86

System Flow > Pipe Capacity

Table 6.2

Pipe	Exist. Size	Prop. Size	Length	Cost /ft	Total
P-86	8 inch	12 inch	33	$25	$825
P-87	8 inch	12 inch	26	$25	$650
P-88	8 inch	12 inch	213	$25	$5,325
P-91	8 inch	18 inch	221	$45	$9,945
P-96	10 inch	18 inch	230	$45	$10,350
P-99	10 inch	18 inch	230	$45	$10,350
P-157	15 inch	36 inch	273	$95	$25,935
					$63,380

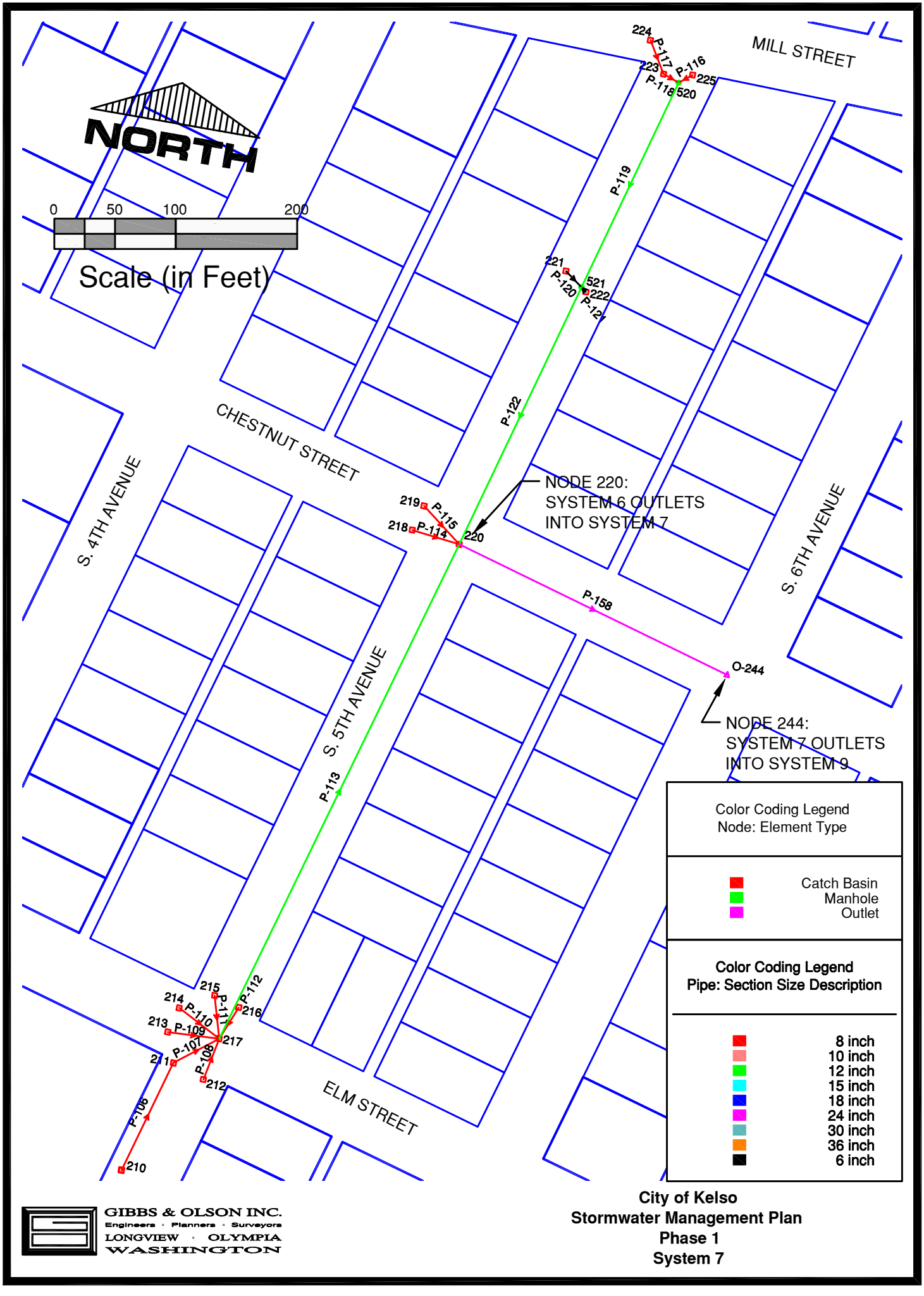
System 7

Modeling results: System 7 consists of the structures along 5th Avenue, from Elm Street to Mill Street. It drains an area between the alley way to the west (between 4th and 5th Avenues), and the alley way to the east (between 5th and 6th Avenues) from Elm Street to Mill Street. It contains 19 structures and outlets into System 9 at node 244 at the intersection of Chestnut Street and 6th Avenue. The total calculated drainage area for System 7 is 7.55 acres and the land use is primarily residential, with an average runoff coefficient of 0.4.

Table 7.1 lists the structure information and connections, along with total flows and capacities. Figure 7 shows a schematic of the structure locations and piping layout. As seen in Table 7.1, P-106, P-107, P-113, P-116, P-117, P-118 and P-158 are under capacity. Pipe P-116 is shown with a negative slope. Replacing pipes P-106, P-107, P-116, P-117 and P-118 with a 12inch pipe and a minimum slope of 0.5% will provide the capacity needed to handle the modeled flow. Pipe P-113 has an existing slope of just over 1%. Increasing the size of this pipe from 12 to 18-inch while maintaining the existing slope will provide the additional capacity needed for this pipe.

Pipe P-158 is the down stream pipe for the convergence of System 6 and System 7. To handle the flow from the upstream systems, pipe P-158 needs to be increased from a 15-inch pipe to a 36-inch pipe at 0.6% or a 42-inch pipe at the existing slope of 0.4%.

Recommendations: The estimated budget to upgrade from the pipe as stated above is approximately $58,410 as shown in Table 7.2.



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Stormwater Management Plan
Phase 1
System 7

Kelso Stormwater Management Plan
Phase 1
System 7

Table 7.1

Pipe Label	Upstream Node	Downstream Node	Upstream Inlet Area (acres)	Upstream Inlet Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	System Flow Time (min)	System Intensity (in/hr)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Material	Manning's n	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-106	210	211	0.84	0.40	0.34	0.34	5.00	3.33	1.13	98	0.0004	8 inch	PVC	0.010	0.32	16.15	16.11	18.15	18.11	1.33	1.33	18.62	18.11
P-107	211	217	0.22	0.40	0.09	0.42	5.51	3.17	1.35	43	0.0074	8 inch	Concrete	0.013	1.04	16.11	15.79	18.11	18.79	1.33	2.33	19.33	18.79
P-108	212	217	0.53	0.40	0.21	0.21	5.00	3.33	0.71	36	0.0089	8 inch	Concrete	0.013	1.14	16.11	15.79	18.01	18.79	1.23	2.33	18.91	18.79
P-109	213	217	0.31	0.40	0.12	0.12	5.00	3.33	0.42	43	0.0272	8 inch	Concrete	0.013	1.99	16.96	15.79	18.26	18.79	0.63	2.33	18.84	18.79
P-110	214	217	0.65	0.40	0.26	0.26	5.00	3.33	0.87	41	0.0180	8 inch	Concrete	0.013	1.62	16.53	15.79	18.43	18.79	1.23	2.33	19.00	18.79
P-111	215	217	1.34	0.40	0.54	0.54	5.00	3.33	1.80	36	0.0308	8 inch	Concrete	0.013	2.12	16.90	15.79	17.90	18.79	0.33	2.33	19.59	18.79
P-112	216	217	0.65	0.40	0.26	0.26	5.00	3.33	0.87	30	0.0390	8 inch	Concrete	0.013	2.39	16.96	15.79	17.96	18.79	0.33	2.33	18.95	18.79
P-113	217	220	0.33	0.40	0.13	1.95	5.69	3.11	6.11	453	0.0114	12 inch	Concrete	0.013	3.81	15.79	10.61	18.79	20.61	2.00	9.00	33.94	20.61
P-114	218	220	0.33	0.40	0.13	0.13	5.00	3.33	0.44	41	0.1500	8 inch	Concrete	0.013	4.68	16.76	10.61	18.76	20.61	1.33	9.33	20.67	20.61
P-115	219	220	0.66	0.40	0.26	0.26	5.00	3.33	0.89	43	0.1393	8 inch	Concrete	0.013	4.51	16.60	10.61	18.80	20.61	1.53	9.33	20.84	20.61
P-116	225	520	0.18	0.40	0.07	0.07	5.00	3.33	0.24	13	-0.0185	8 inch	Concrete	0.013	-1.64	16.48	16.72	18.48	18.50	1.33	1.11	18.51	18.5
P-117	224	223	0.22	0.40	0.09	0.09	5.00	3.33	0.30	30	0.0003	8 inch	Concrete	0.013	0.22	16.73	16.72	18.53	18.62	1.13	1.23	18.61	18.6
P-118	223	520	0.37	0.40	0.15	0.24	5.59	3.14	0.75	14	0.0000	8 inch	Concrete	0.013	0.00	16.72	16.72	18.62	18.50	1.23	1.11	18.55	18.5
P-119	520	521	N/A	N/A	N/A	0.31	5.70	3.11	0.97	186	0.0146	12 inch	Concrete	0.013	4.30	16.72	14.01	18.50	19.45	0.78	4.44	19.59	19.45
P-120	221	521	0.72	0.40	0.29	0.29	5.00	3.33	0.97	18	0.1311	6 inch	Concrete	0.013	2.03	16.37	14.01	18.97	19.45	2.10	4.94	19.98	19.45
P-121	222	521	0.20	0.40	0.08	0.08	5.00	3.33	0.27	5	0.5480	6 inch	Concrete	0.013	4.15	16.75	14.01	19.15	19.45	1.90	4.94	19.46	19.45
P-122	521	220	N/A	N/A	N/A	0.68	8.22	2.57	1.75	234	0.0145	12 inch	Concrete	0.013	4.29	14.01	10.61	19.45	20.61	4.44	9.00	21.17	20.61
P-158	220	O-244	0.00	0.00	0.00	24.59	12.94	2.02	50.15	245	0.0039	24 inch	Concrete	0.013	14.16	10.61	9.65	20.61	18.85	8.00	7.20	23.69	11.63

System Flow > Pipe Capacity

Table 7.2

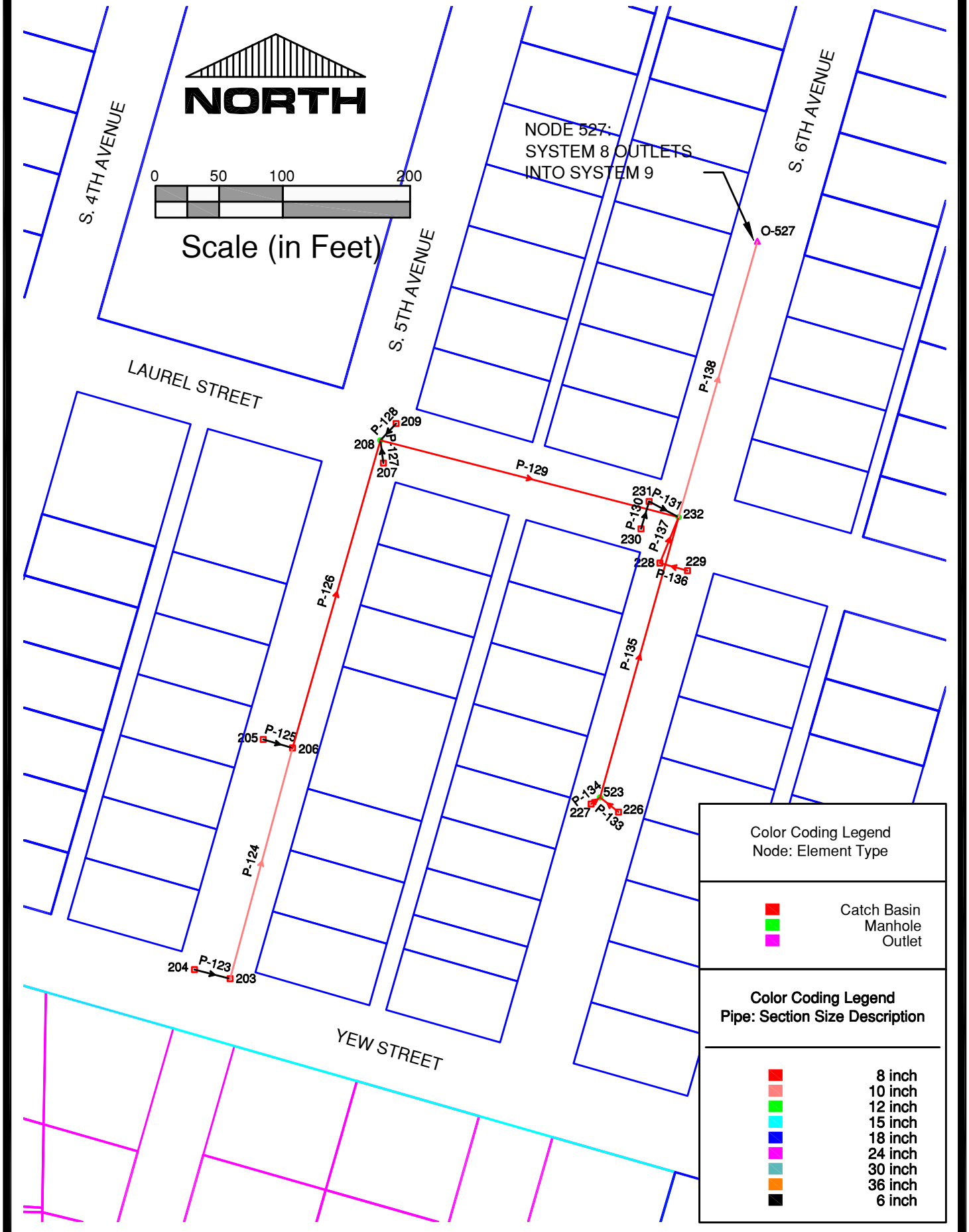
Pipe	Exist. Size	Prop. Size	Length	Cost /ft	Total
P-106	8 inch	12 inch	98	$25	$2,450
P-107	8 inch	12 inch	43	$25	$1,075
P-113	12 inch	18 inch	453	$45	$20,385
P-116	8 inch	12 inch	13	$25	$325
P-117	8 inch	12 inch	30	$25	$750
P-118	8 inch	12 inch	14	$25	$350
P-158	24 inch	42 inch	245	$135	$33,075
					$58,410

System 8

Modeling results: System 8 consists of the structures along 5th and 6th Avenue, from Yew Street to midway between Laurel and Elm Street. It drains an area between the alley way to the west (between 4th and 5th Avenues), and the alley way to the east (between 6th and 7th Avenues) from Yew Street to midway between Laurel and Elm Street. It contains 16 structures and outlets into System 9 at node 527 on 6th Avenue midway between Laurel and Elm Street. The total calculated drainage area for System 8 is 6.43 acres and the land use is primarily residential, with an average runoff coefficient of 0.4.

Table 8.1 lists the structure information and connections, along with total flows and capacities. Figure 8 shows a schematic of the structure locations and piping layout. As seen in Table 8.1, P-123, P-124, P-126, P-129, P-130, P-135 and P-138 are under capacity. Pipe P-135 is shown with a negative slope. Replacing pipes P-123, P-124, P-130 and P-135 with a 12inch pipe and a minimum slope of 0.5% will provide the capacity needed to handle the modeled flow. Pipes P-126 and P-129 have an existing slope of just over 0.2% to 0.3%. Increasing the size of these pipes from 8 to 18-inch while maintaining their existing slopes will provide the additional capacity needed for these pipes. Pipe P-138 has an existing slope of slightly greater than 0.5%. Increasing this pipe size from 10 to 18-inches while maintaining the existing slope appears to provide close to the capacity needed, but will likely be adequate based on the other upstream improvements.

Recommendations: The estimated budget to upgrade from the pipe as stated above is approximately $43,985 as shown in Table 8.2.



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Stormwater Management Plan
Phase 1
System 8

Kelso Stormwater Management Plan
Phase 1
System 8

Table 8.1

Pipe Label	Upstream Node	Downstream Node	Upstream Inlet Area (acres)	Upstream Inlet Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	System Flow Time (min)	System Intensity (in/hr)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Material	Manning's n	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-123	204	203	0.66	0.40	0.26	0.26	5.00	3.33	0.89	29	0.0124	6 inch	PVC	0.010	0.81	16.22	15.86	18.42	18.16	1.70	1.80	18.59	18.16
P-124	203	206	0.50	0.40	0.20	0.46	5.11	3.29	1.54	188	0.0022	10 inch	PVC	0.010	1.33	15.86	15.45	18.16	19.15	1.47	2.87	19.70	19.15
P-125	205	206	0.70	0.40	0.28	0.28	5.00	3.33	0.94	24	0.0617	6 inch	PVC	0.010	1.81	16.93	15.45	19.13	19.15	1.70	3.20	19.55	19.15
P-126	206	208	0.31	0.40	0.12	0.87	6.22	2.97	2.60	251	0.0032	8 inch	PVC	0.010	0.89	15.45	14.64	19.15	19.94	3.03	4.63	26.81	19.94
P-127	207	208	0.43	0.40	0.17	0.17	5.00	3.33	0.58	18	0.1161	6 inch	PVC	0.010	2.49	16.73	14.64	19.03	19.94	1.80	4.80	20.05	19.94
P-128	209	208	0.99	0.40	0.40	0.40	5.00	3.33	1.33	18	0.1094	6 inch	PVC	0.010	2.41	16.61	14.64	18.91	19.94	1.80	4.80	20.54	19.94
P-129	208	232	N/A	N/A	N/A	1.44	6.78	2.84	4.11	242	0.0024	8 inch	PVC	0.010	0.77	14.64	14.06	19.94	18.96	4.63	4.23	35.53	18.96
P-130	230	231	0.33	0.40	0.13	0.13	5.00	3.33	0.44	22	0.0032	6 inch	Concrete	0.013	0.32	16.16	16.09	18.46	18.49	1.80	1.90	18.63	18.49
P-131	231	232	0.51	0.40	0.20	0.34	5.16	3.27	1.11	26	0.0781	6 inch	Concrete	0.013	1.57	16.09	14.06	18.49	18.96	1.90	4.40	19.98	18.96
P-133	226	523	0.50	0.40	0.20	0.20	5.00	3.33	0.67	18	0.2150	8 inch	Concrete	0.013	5.60	17.83	13.96	19.03	19.00	0.53	4.37	19.06	19.00
P-134	227	523	0.91	0.40	0.36	0.36	5.00	3.33	1.22	9	0.3644	8 inch	Concrete	0.013	7.29	17.24	13.96	19.04	19.00	1.13	4.37	19.09	19.00
P-135	523	232	N/A	N/A	N/A	0.56	5.16	3.28	1.86	228	-0.0004	8 inch	Concrete	0.013	-0.25	13.96	14.06	19.00	18.96	4.37	4.23	24.38	18.96
P-136	229	228	0.37	0.40	0.15	0.15	5.00	3.33	0.50	23	0.0261	8 inch	Concrete	0.013	1.95	16.67	16.07	18.57	18.47	1.23	1.73	18.51	18.47
P-137	228	232	0.22	0.40	0.09	0.24	5.27	3.24	0.77	39	0.0515	8 inch	Concrete	0.013	2.74	16.07	14.06	18.47	18.96	1.73	4.23	19.12	18.96
P-138	232	O-527	N/A	N/A	N/A	2.57	7.12	2.77	7.17	225	0.0051	10 inch	Concrete	0.013	1.56	14.06	12.92	18.96	19.00	4.07	5.25	37.88	13.75

System Flow > Pipe Capacity

Table 8.2

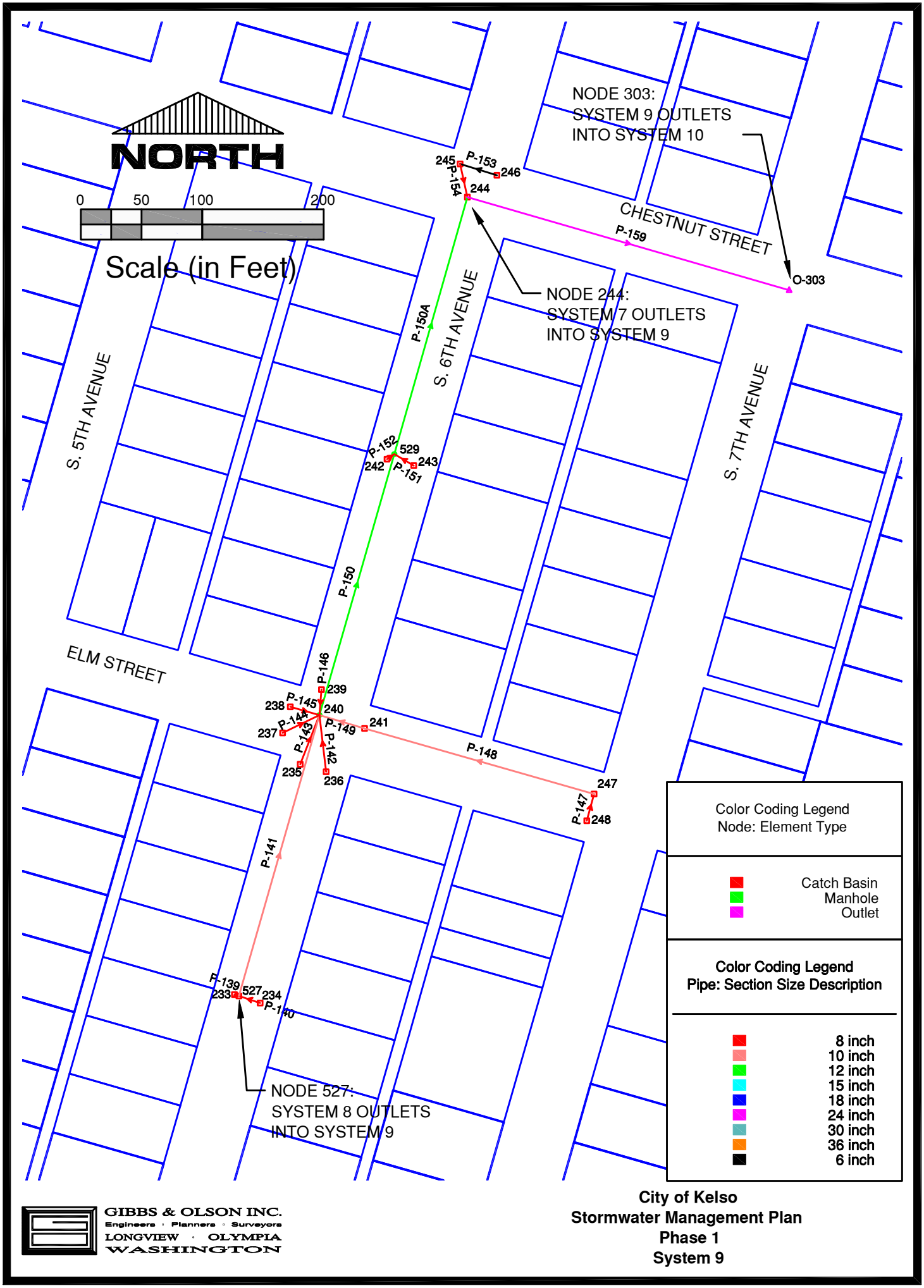
Pipe	Exist. Size	Prop. Size	Length	Cost /ft	Total
P-123	6 inch	12 inch	29	$25	$725
P-124	10 inch	12 inch	188	$25	$4,700
P-126	8 inch	18 inch	251	$45	$11,295
P-129	8 inch	18 inch	242	$45	$10,890
P-130	6 inch	12 inch	22	$25	$550
P-135	8 inch	12 inch	228	$25	$5,700
P-138	10 inch	18 inch	225	$45	$10,125
					$43,985

System 9

Modeling results: System 9 consists of the structures along 6th Avenue, from midway between Laurel and Elm Street to Chestnut Street. It drains an area between the alley way to the west (between 5th and 6th Avenues), and the alley way to the east (between 6th and 7th Avenues) from midway between Laurel and Elm Street to Chestnut Street. It contains 18 structures and outlets into System 10 at node 303 on Chestnut Street. The total calculated drainage area for System 8 is 8.40 acres and the land use is primarily residential, with an average runoff coefficient of 0.4.

Table 9.1 lists the structure information and connections, along with total flows and capacities. Figure 9 shows a schematic of the structure locations and piping layout. As seen in Table 9.1, P-141, P-148, P-149, P-150, P-150a and P-159 are under capacity. Replacing pipes P-148 and P-149 a 12inch pipe at their existing slopes will provide the capacity needed to handle the modeled flow. Pipes P-141, P-150 and P-150a have an existing slope of 0.34% to 0.55%. Increasing the size of these pipes from 10 and 12-inch to 24-inch while maintaining their existing slopes will provide the additional capacity needed for these pipes. Pipe P-159 has an existing slope of 0.35%. Increasing this pipe size from 24 to 42-inches while maintaining the existing slope will provide the capacity needed.

Recommendations: The estimated budget to upgrade from the pipe as stated above is approximately $84,260 as shown in Table 9.2.



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City of Kelso
Stormwater Management Plan
Phase 1
System 9

Kelso Stormwater Management Plan
Phase 1
System 9

Table 9.1

Pipe Label	Upstream Node	Downstream Node	Upstream Inlet Area (acres)	Upstream Inlet Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	System Flow Time (min)	System Intensity (in/hr)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Material	Manning's n	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-139	233	527	0.38	0.40	0.15	0.15	5.00	3.33	0.51	4	0.7525	8 inch	Concrete	0.013	10.48	15.93	12.92	17.93	19.00	1.33	5.41	19.01	19.00
P-140	234	527	0.36	0.40	0.14	0.14	5.00	3.33	0.48	18	0.2117	8 inch	Concrete	0.013	5.56	16.73	12.92	18.03	19.00	0.63	5.41	19.03	19.00
P-141	527	240	0.00	0.00	0.00	2.87	7.12	2.77	7.99	241	0.0034	10 inch	Concrete	0.013	1.28	12.92	12.10	19.00	17.80	5.25	4.87	49.89	17.80
P-142	236	240	0.40	0.40	0.16	0.16	5.00	3.33	0.54	47	0.0611	8 inch	Concrete	0.013	2.99	14.97	12.10	17.47	17.80	1.83	5.03	17.89	17.80
P-143	235	240	0.27	0.40	0.11	0.11	5.00	3.33	0.36	43	0.0674	8 inch	Concrete	0.013	3.14	15.00	12.10	17.51	17.80	1.84	5.03	17.84	17.80
P-144	237	240	0.25	0.40	0.10	0.10	5.00	3.33	0.34	34	0.0918	8 inch	Concrete	0.013	3.66	15.22	12.10	17.52	17.80	1.63	5.03	17.83	17.80
P-145	238	240	0.27	0.40	0.11	0.11	5.00	3.33	0.36	25	0.1116	8 inch	Concrete	0.013	4.04	14.89	12.10	17.49	17.80	1.93	5.03	17.82	17.80
P-146	239	240	0.37	0.40	0.15	0.15	5.00	3.33	0.50	21	0.1610	8 inch	Concrete	0.013	4.85	15.48	12.10	17.48	17.80	1.33	5.03	17.84	17.80
P-147	248	247	0.89	0.40	0.36	0.36	6.00	3.03	1.09	23	0.0448	8 inch	Concrete	0.013	2.56	15.22	14.19	16.52	16.49	0.63	1.63	16.68	16.49
P-148	247	241	1.46	0.40	0.58	0.94	6.50	2.90	2.75	197	0.0062	10 inch	Concrete	0.013	1.72	14.19	12.97	16.49	17.47	1.47	3.67	20.57	17.47
P-149	241	240	0.57	0.40	0.23	1.17	7.15	2.76	3.25	39	0.0223	10 inch	Concrete	0.013	3.27	12.97	12.10	17.47	17.80	3.67	4.87	18.66	17.80
P-150	240	529	N/A	N/A	N/A	4.66	7.39	2.71	12.74	224	0.0055	12 inch	Concrete	0.013	2.64	12.10	10.87	17.80	17.75	4.70	5.88	46.39	17.75
P-150a	529	244	N/A	N/A	N/A	5.29	7.62	2.67	14.24	220	0.0055	12 inch	Concrete	0.013	2.65	10.87	9.65	17.75	18.85	5.88	8.20	54.00	18.85
P-151	243	529	0.68	0.40	0.27	0.27	5.00	3.33	0.91	19	0.2905	8 inch	Concrete	0.013	6.51	16.39	10.87	17.69	17.75	0.63	6.21	17.86	17.75
P-152	242	529	0.90	0.40	0.36	0.36	5.00	3.33	1.21	7	0.7257	8 inch	Concrete	0.013	10.29	15.95	10.87	17.75	17.75	1.13	6.21	17.82	17.75
P-153	246	245	0.47	0.40	0.19	0.19	5.00	3.33	0.63	32	0.0400	6 inch	PVC	0.010	1.46	16.44	15.16	17.94	17.46	1.00	1.80	17.70	17.46
P-154	245	244	1.13	0.40	0.45	0.64	5.17	3.27	2.11	28	0.1968	8 inch	Concrete	0.013	5.36	15.16	9.65	17.46	18.85	1.63	8.53	19.71	18.85
P-159	244	O-303	0.00	0.00	0.00	30.52	12.94	2.02	62.25	276	0.0035	24 inch	PVC	0.010	17.39	9.65	8.68	18.85	18.28	7.20	7.60	23.05	10.68

System Flow > Pipe Capacity

Table 9.2

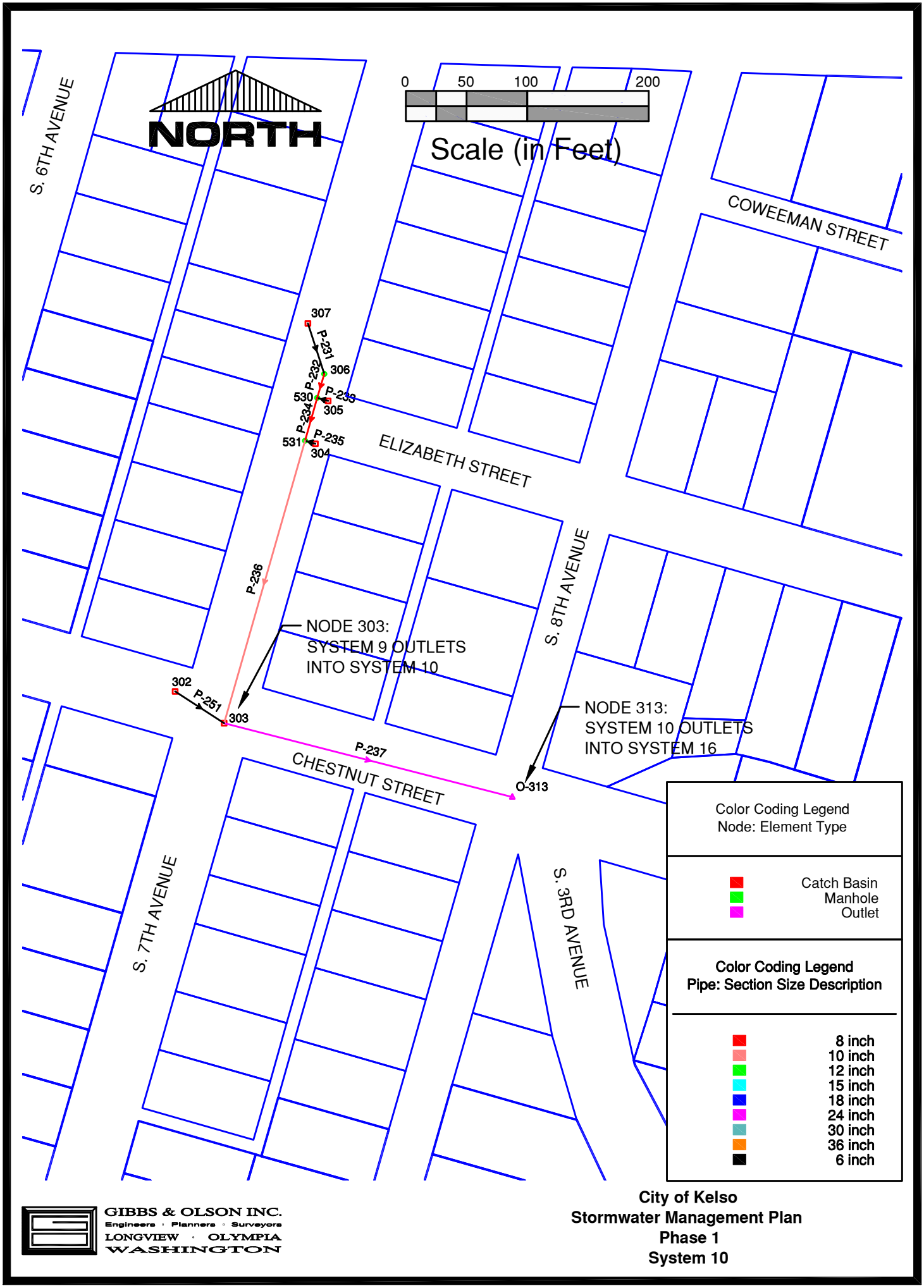
Pipe	Exist. Size	Prop. Size	Length	Cost /ft	Total
P-141	10 inch	24 inch	241	$60	$14,460
P-148	10 inch	12 inch	197	$25	$4,925
P-149	10 inch	12 inch	39	$25	$975
P-150	12 inch	24 inch	224	$60	$13,440
P-150a	12 inch	24 inch	220	$60	$13,200
P-159	24 inch	42 inch	276	$135	$37,260
					$84,260

System 10

Modeling results: System 10 consists of the structures along 7th Avenue, from Elizabeth to Chestnut Street. It drains an area between the alley way to the west (between 6th and 7th Avenues), and the alley way to the east (between 7th and 8th Avenues) from midway between Elm Street and Chestnut Street to Elizabeth Street. It contains 7 structures and outlets into System 16 at node 313 on Chestnut Street. The total calculated drainage area for System 10 is 2.0 acres and the land use is primarily residential, with an average runoff coefficient of 0.4.

Table 10.1 lists the structure information and connections, along with total flows and capacities. Figure 10 shows a schematic of the structure locations and piping layout. As seen in Table 10.1, P-237 is under capacity. Pipe P-237 has an existing slope of 0.58% and increasing this pipe size from 24 to 42-inches while maintaining the existing slope will provide the capacity needed.

Recommendations: The estimated budget to upgrade from the pipe as stated above is approximately $33,075 as shown in Table 10.2.



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City of Kelso
Stormwater Management Plan
Phase 1
System 10

Kelso Stormwater Management Plan
Phase 1
System 10

Table 10.1

Pipe Label	Upstream Node	Downstream Node	Upstream Inlet Area (acres)	Upstream Inlet Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	System Flow Time (min)	System Intensity (in/hr)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Material	Manning's n	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-231	307	306	0.34	0.40	0.14	0.14	5.00	3.33	0.46	44	0.0238	6 inch	Concrete	0.013	0.86	14.17	13.12	16.87	17.12	2.20	3.50	16.83	16.54
P-232	306	530	N/A	N/A	N/A	0.14	5.32	3.23	0.44	21	0.0147	8 inch	Concrete	0.013	1.47	13.12	12.81	17.12	16.50	3.33	3.02	16.53	16.50
P-233	305	530	0.24	0.40	0.10	0.10	5.00	3.33	0.32	9	0.1909	6 inch	Concrete	0.013	2.45	14.53	12.81	16.63	16.50	1.60	3.19	16.53	16.50
P-234	530	531	N/A	N/A	N/A	0.23	5.59	3.14	0.73	37	0.0148	8 inch	Concrete	0.013	1.47	12.81	12.27	16.50	17.00	3.02	4.07	17.14	17.00
P-235	304	531	1.42	0.40	0.57	0.57	5.00	3.33	1.91	9	0.2640	6 inch	Concrete	0.013	2.88	14.64	12.27	17.14	17.00	2.00	4.23	18.04	17.00
P-236	531	303	N/A	N/A	N/A	0.80	5.88	3.06	2.47	242	0.0148	10 inch	Concrete	0.013	2.67	12.27	8.68	17.00	18.28	3.90	8.76	21.35	18.28
P-237	303	O-313	0.00	0.00	0.00	31.32	12.94	2.02	63.88	245	0.0058	24 inch	PVC	0.010	22.30	8.68	7.28	18.28	17.48	7.60	8.20	20.84	9.28
P-251	302	303	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48	0.1203	6 inch	Concrete	0.013	1.95	14.46	8.68	17.26	18.28	2.30	9.10	18.28	18.28

System Flow > Pipe Capacity

Table 10.2

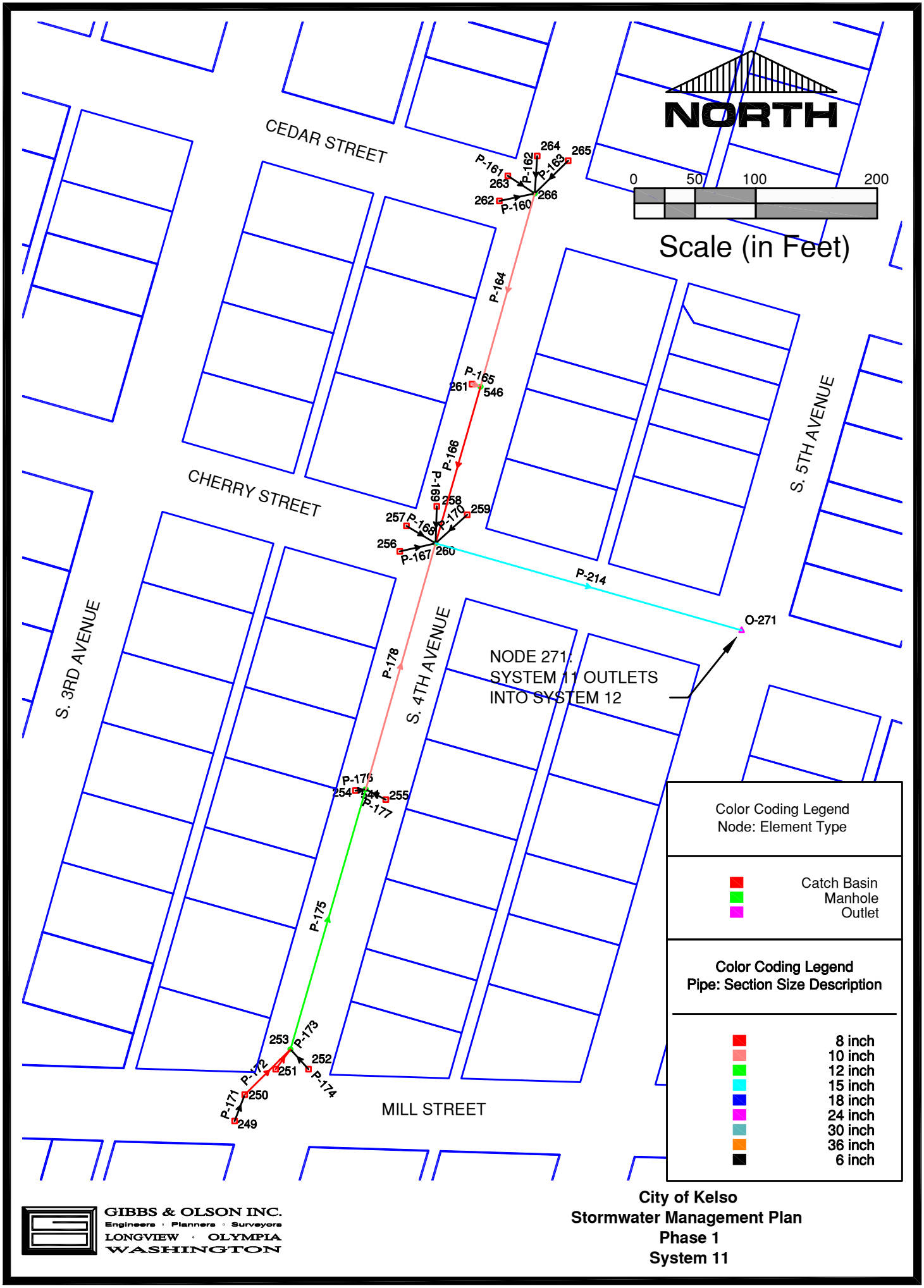
Pipe	Exist. Size	Prop. Size	Length	Cost /ft	Total
P-237	24 inch	42 inch	245	$135	$33,075

System 11

Modeling results: System 11 consists of the structures along 4th Avenue, from Cedar Street to Mill Street. It drains an area between the alley way to the west (between 3rd and 4th Avenues), and the alley way to the east (between 4th and 5th Avenues) from Cedar Street to Mill Street. It contains 19 structures and outlets into System 12 at node 271 on Cherry Street. The total calculated drainage area for System 11 is 5.01 acres and the land use is primarily residential, with an average runoff coefficient of 0.41.

Table 11.1 lists the structure information and connections, along with total flows and capacities. Figure 11 shows a schematic of the structure locations and piping layout. As seen in Table 11.1, pipes P-166, P-171, P-178 and P-214 are under capacity. Increasing the size of pipes P-166 and P-171 from 6 and 8 to 12-inch while maintaining the existing slopes of approximately 1% will provide the capacity needed. Increasing the size of pipes P-178 and P-214 from 10 and 15-inches to 18-inches at the current slope will provide the capacity needed for the storm water runoff.

Recommendations: The estimated budget to upgrade from the pipe as stated above is approximately $25,210 as shown in Table 11.2.



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Stormwater Management Plan
Phase 1
System 11

Kelso Stormwater Management Plan
Phase 1
System 11

Table 11.1

Pipe Label	Upstream Node	Downstream Node	Upstream Inlet Area (acres)	Upstream Inlet Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	System Flow Time (min)	System Intensity (in/hr)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Material	Manning's n	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-160	262	266	0.21	0.40	0.08	0.08	5.00	3.33	0.28	30	0.0800	6 inch	Concrete	0.013	1.59	19.23	16.83	20.83	21.33	1.10	4.00	21.41	21.33
P-161	263	266	0.30	0.40	0.12	0.12	5.00	3.33	0.40	27	0.0719	6 inch	Concrete	0.013	1.50	18.77	16.83	20.87	21.33	1.60	4.00	21.47	21.33
P-162	264	266	0.47	0.40	0.19	0.19	5.00	3.33	0.63	31	0.0561	6 inch	Concrete	0.013	1.33	18.57	16.83	20.67	21.33	1.60	4.00	21.72	21.33
P-163	265	266	0.26	0.40	0.10	0.10	5.00	3.33	0.35	38	0.0634	6 inch	Concrete	0.013	1.41	19.24	16.83	20.64	21.33	0.90	4.00	21.48	21.33
P-164	266	546	N/A	N/A	N/A	0.50	5.36	3.21	1.61	166	0.0099	10 inch	Concrete	0.013	2.18	16.83	15.18	21.33	20.50	3.67	4.49	21.39	20.50
P-165	261	546	0.49	0.40	0.20	0.20	5.00	3.33	0.66	8	0.4925	10 inch	Concrete	0.013	15.38	19.12	15.18	20.92	20.50	0.97	4.49	20.51	20.50
P-166	546	260	N/A	N/A	N/A	0.69	6.30	2.95	2.06	134	0.0099	8 inch	Concrete	0.013	1.20	15.18	13.85	20.50	21.35	4.65	6.83	20.35	16.46
P-167	256	260	0.17	0.40	0.07	0.07	5.00	3.33	0.23	30	0.1653	6 inch	Concrete	0.013	2.28	18.81	13.85	20.91	21.35	1.60	7.00	19.05	16.46
P-168	257	260	0.21	0.40	0.08	0.08	5.00	3.33	0.28	28	0.1786	6 inch	Concrete	0.013	2.37	18.85	13.85	20.95	21.35	1.60	7.00	19.12	16.46
P-169	258	260	0.22	0.40	0.09	0.09	5.00	3.33	0.30	30	0.1603	6 inch	Concrete	0.013	2.25	18.66	13.85	20.76	21.35	1.60	7.00	18.93	16.46
P-170	259	260	0.18	0.40	0.07	0.07	5.00	3.33	0.24	35	0.1357	6 inch	Concrete	0.013	2.07	18.60	13.85	20.70	21.35	1.60	7.00	18.85	16.46
P-171	249	250	0.59	0.40	0.24	0.24	5.00	3.33	0.79	23	0.0109	6 inch	Concrete	0.013	0.58	18.60	18.35	20.20	20.35	1.10	1.50	20.81	20.35
P-172	250	253	0.30	0.40	0.12	0.36	5.10	3.30	1.18	53	0.0430	8 inch	Concrete	0.013	2.51	18.35	16.07	20.35	20.67	1.33	3.93	21.18	20.67
P-173	251	253	0.40	0.50	0.20	0.20	5.00	3.33	0.67	20	0.0790	8 inch	Concrete	0.013	3.40	17.65	16.07	20.25	20.67	1.93	3.93	20.73	20.67
P-174	252	253	0.26	0.40	0.10	0.10	5.00	3.33	0.35	22	0.0664	6 inch	Concrete	0.013	1.45	17.53	16.07	20.13	20.67	2.10	4.10	20.76	20.67
P-175	253	541	N/A	N/A	N/A	0.66	5.36	3.21	2.14	223	0.0051	12 inch	Concrete	0.013	2.55	16.07	14.93	20.67	20.50	3.60	4.57	21.30	20.50
P-176	254	541	0.60	0.40	0.24	0.24	5.00	3.33	0.81	8	0.3788	6 inch	Concrete	0.013	3.45	17.96	14.93	20.56	20.50	2.10	5.07	20.66	20.50
P-177	255	541	0.35	0.40	0.14	0.14	5.00	3.33	0.47	19	0.1526	6 inch	Concrete	0.013	2.19	17.83	14.93	20.43	20.50	2.10	5.07	20.63	20.50
P-178	541	260	N/A	N/A	N/A	1.04	6.72	2.85	2.99	211	0.0051	10 inch	Concrete	0.013	1.57	14.93	13.85	20.50	21.35	4.74	6.67	20.39	16.46
P-214	260	O-271	N/A	N/A	N/A	2.04	7.36	2.72	5.60	262	0.0036	15 inch	Concrete	0.013	3.87	13.85	12.91	21.35	20.21	6.25	6.05	16.13	14.16

System Flow > Pipe Capacity

Table 11.2

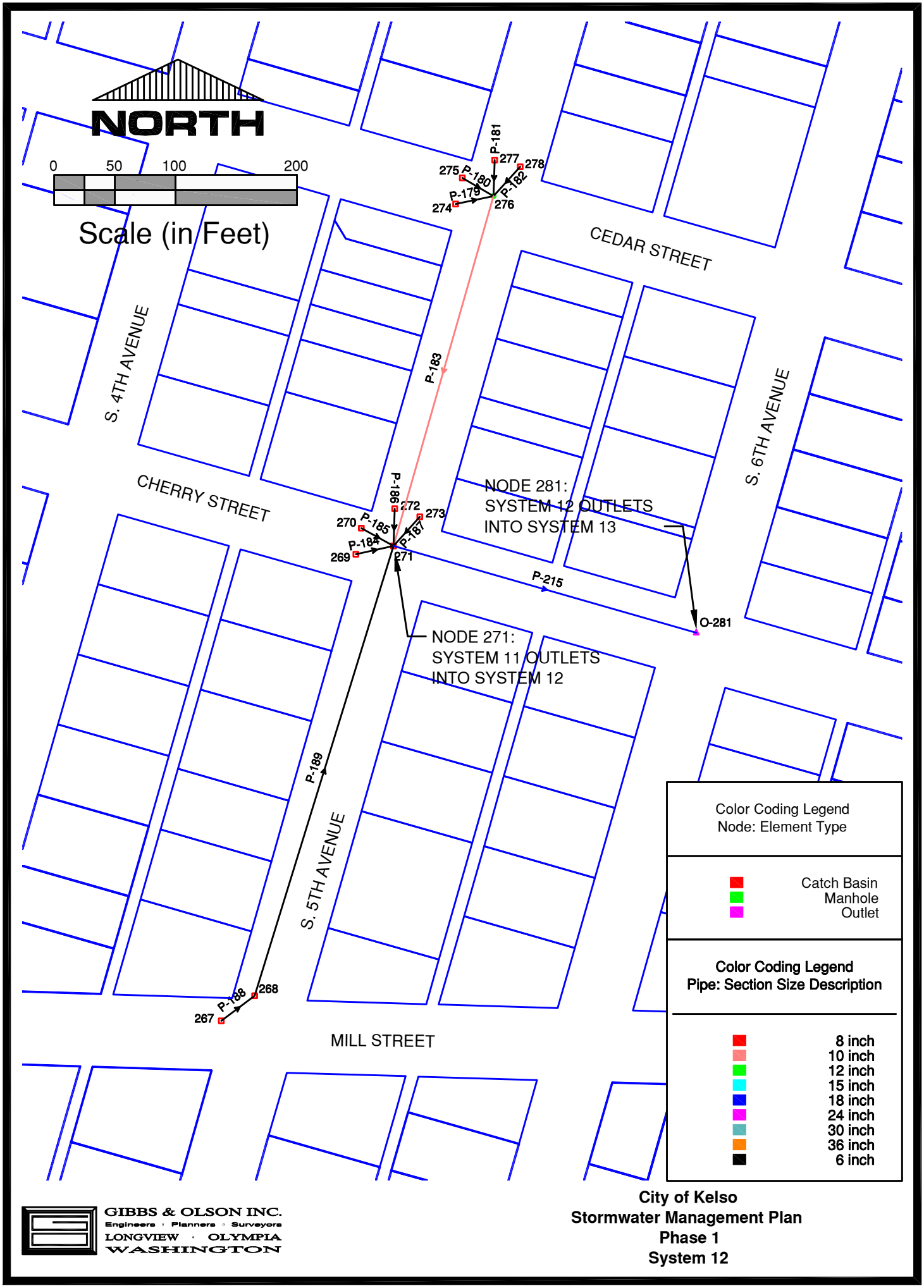
Pipe	Exist. Size	Prop. Size	Length	Cost /ft	Total
P-166	8 inch	12 inch	134	$25	$3,350
P-171	6 inch	12 inch	23	$25	$575
P-178	10 inch	18 inch	211	$45	$9,495
P-214	15 inch	18 inch	262	$45	$11,790
					$25,210

System 12

Modeling results: System 12 consists of the structures along 5th Avenue, from Cedar Street to Mill Street. It drains an area between the alley way to the west (between 4th and 5th Avenues), and the alley way to the east (between 5th and 6th Avenues) from Cedar Street to Mill Street. It contains 13 structures and outlets into System 13 at node 281 on Cherry Street. The total calculated drainage area for System 12 is 5.29 acres and the land use is primarily residential, with an average runoff coefficient of 0.4.

Table 12.1 lists the structure information and connections, along with total flows and capacities. Figure 12 shows a schematic of the structure locations and piping layout. As seen in Table 12.1, pipes P-179, P-180, P-183, P-189 and P-215 are under capacity. Pipe P-180 is shown with a negative slope. Increasing the size of pipes P-179, P-180, P-183 and P-189 from 6 and 10 to 12-inch while maintaining the existing slopes of approximately 1% to 3.5% will provide the capacity needed. Pipe P-215 is the downstream pipe for the convergence of Systems 11 and 12. Increasing the size of pipe P-215 from 18-inches to 24-inches at the current slope will provide the capacity needed for the storm water runoff.

Recommendations: The estimated budget to upgrade from the pipe as stated above is approximately $34,350 as shown in Table 12.2.



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City of Kelso
Stormwater Management Plan
Phase 1
System 12

Kelso Stormwater Management Plan
Phase 1
System 12

Table 12.1

Pipe Label	Upstream Node	Downstream Node	Upstream Inlet Area (acres)	Upstream Inlet Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	System Flow Time (min)	System Intensity (in/hr)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Material	Manning's n	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-179	274	276	1.08	0.40	0.43	0.43	5.00	3.33	1.45	32	0.0350	6 inch	Concrete	0.013	1.05	18.03	16.91	19.63	20.01	1.10	2.60	22.15	20.01
P-180	275	276	0.40	0.40	0.16	0.16	5.00	3.33	0.54	30	-0.0123	6 inch	Concrete	0.013	-0.62	16.54	16.91	19.53	20.01	2.49	2.60	20.28	20.01
P-181	277	276	0.48	0.40	0.19	0.19	5.00	3.33	0.64	30	0.0403	6 inch	Concrete	0.013	1.13	18.12	16.91	19.52	20.01	0.90	2.60	20.41	20.01
P-182	278	276	0.30	0.40	0.12	0.12	5.00	3.33	0.40	33	0.0321	6 inch	Concrete	0.013	1.01	17.97	16.91	19.37	20.01	0.90	2.60	20.18	20.01
P-183	276	271	N/A	N/A	N/A	0.90	5.27	3.24	2.95	300	0.0133	10 inch	Concrete	0.013	2.53	16.91	12.91	20.01	20.21	2.27	6.47	22.60	17.15
P-184	269	271	0.63	0.40	0.25	0.25	5.00	3.33	0.85	32	0.1328	6 inch	Concrete	0.013	2.04	17.16	12.91	19.66	20.21	2.00	6.80	17.87	17.15
P-185	270	271	0.17	0.40	0.07	0.07	5.00	3.33	0.23	30	0.1509	6 inch	Concrete	0.013	2.18	17.44	12.91	19.64	20.21	1.70	6.80	17.68	17.15
P-186	272	271	0.37	0.40	0.15	0.15	5.00	3.33	0.50	31	0.1421	6 inch	Concrete	0.013	2.12	17.32	12.91	19.32	20.21	1.50	6.80	17.68	17.15
P-187	273	271	0.45	0.40	0.18	0.18	5.00	3.33	0.60	32	0.1257	6 inch	Concrete	0.013	1.99	16.93	12.91	19.23	20.21	1.80	6.80	17.52	17.15
P-188	267	268	0.47	0.40	0.19	0.19	5.00	3.33	0.63	35	0.0237	6 inch	Concrete	0.013	0.86	17.34	16.51	18.64	18.81	0.80	1.80	19.25	18.81
P-189	268	271	0.94	0.40	0.38	0.56	5.18	3.27	1.86	388	0.0093	6 inch	Concrete	0.013	0.54	16.51	12.91	18.81	20.21	1.80	6.80	59.71	17.15
P-215	271	O-281	0.00	0.00	0.00	4.16	7.36	2.72	11.39	260	0.0037	18 inch	Concrete	0.013	6.41	12.91	11.94	20.21	18.94	5.80	5.50	16.50	13.44

System Flow > Pipe Capacity

Table 12.2

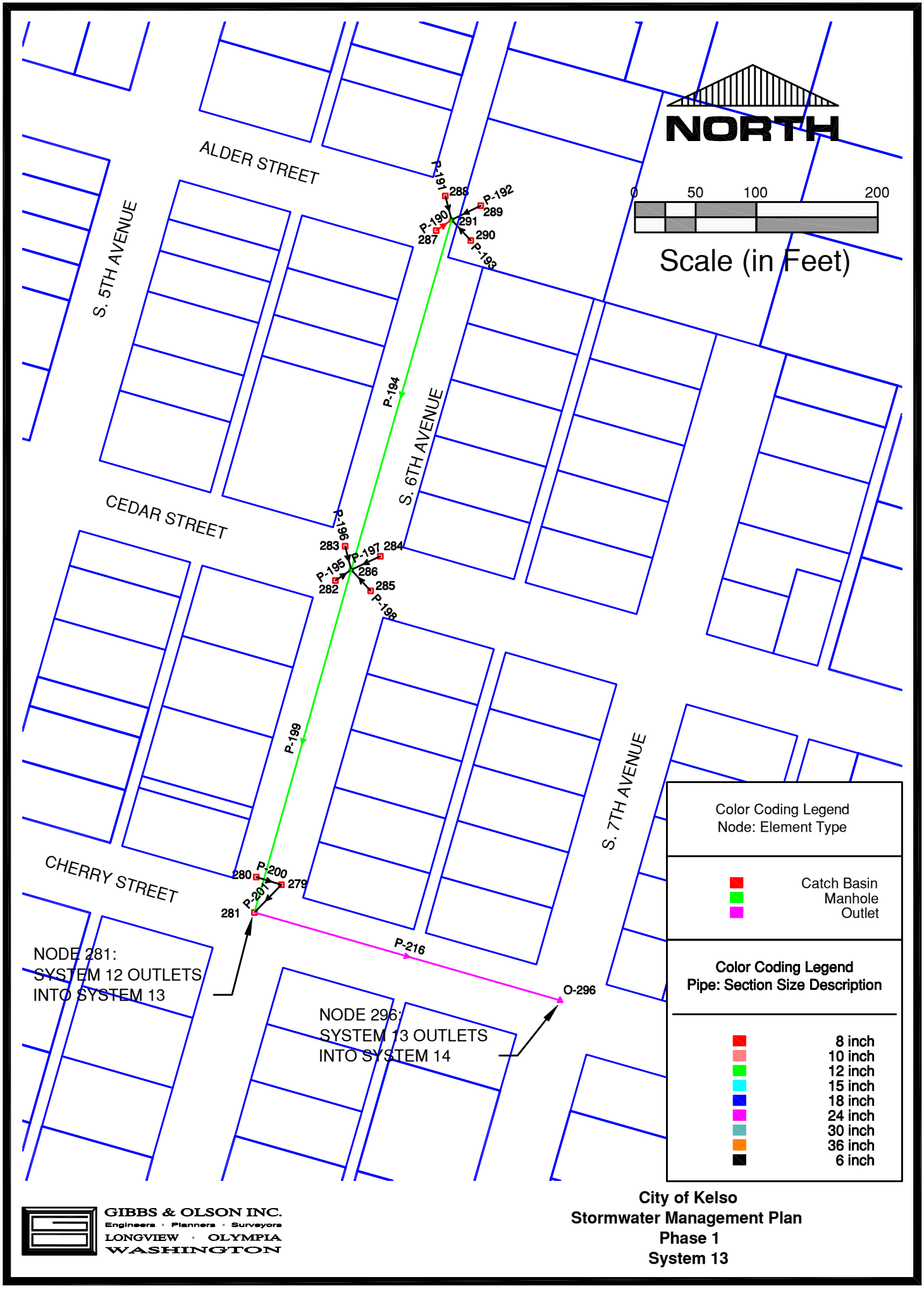
Pipe	Exist. Size	Prop. Size	Length	Cost /ft	Total
P-179	6 inch	12 inch	32	$25	$800
P-180	6 inch	12 inch	30	$25	$750
P-183	10 inch	12 inch	300	$25	$7,500
P-189	6 inch	12 inch	388	$25	$9,700
P-215	18 inch	24 inch	260	$60	$15,600
					$34,350

System 13

Modeling results: System 13 consists of the structures along 6th Avenue, from Alder Street to Cherry Street. It drains an area between the alley way to the west (between 5th and 6th Avenues), and the alley way to the east (between 6th and 7th Avenues) from Alder Street to Cherry Street. It contains 14 structures and outlets into System 14 at node 296 at the intersection of 7th Avenue and Cherry Street. The total calculated drainage area for System 13 is 5.44 acres and the land use is primarily residential, with an average runoff coefficient of 0.4.

Table 13.1 lists the structure information and connections, along with total flows and capacities. Figure 13 shows a schematic of the structure locations and piping layout. As seen in Table 13.1, pipes P-190, P-191, P-192, P-193, P-199, P-200, P-201 and P-216 are under capacity. Pipes P-190, P-192 and P-193 are shown with a negative slope. Increasing the size of pipes P-190, P-191, P-192 and P-193 from 6 and 8 to 12-inch at a minimum slope of 0.5% will provide the capacity needed. Increasing the size of pipe P-199 from 12 to 18-inches while maintaining the existing slope will provide the needed capacity. Pipes P-200 and P-201 are existing 6-inch pipes with slopes of 4% and 8% respectively. Increasing these pipes from 6 to 8-inches while maintaining their existing slopes will provide the needed capacity for the storm drainage. Pipe P-216 is the downstream pipe for the convergence of Systems 13 and 14. The system flow in pipe P-216 is slightly greater than the capacity for a 24-inch pipe, but the hydraulic grade is below the ground level, and it is not recommended to replace this line with a large pipe at this time.

Recommendations: The estimated budget to upgrade from the pipe as stated above is approximately $16,660 as shown in Table 13.2.



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City of Kelso
Stormwater Management Plan
Phase 1
System 13

Table 13.1

Pipe Label	Upstream Node	Downstream Node	Upstream Inlet Area (acres)	Upstream Inlet Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	System Flow Time (min)	System Intensity (in/hr)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Material	Manning's n	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-190	287	291	0.42	0.40	0.17	0.17	5.00	3.33	0.56	15	-0.0019	8 inch	Concrete	0.013	-0.53	15.17	15.20	17.17	17.80	1.33	1.94	17.83	17.80
P-191	288	291	0.50	0.40	0.20	0.20	5.00	3.33	0.67	20	0.0040	6 inch	Concrete	0.011	0.42	15.28	15.20	17.28	17.80	1.50	2.10	18.01	17.80
P-192	289	291	0.27	0.40	0.11	0.11	5.00	3.33	0.36	27	-0.0307	6 inch	Concrete	0.013	-0.98	14.37	15.20	17.17	17.80	2.30	2.10	17.91	17.80
P-193	290	291	0.18	0.40	0.07	0.07	5.00	3.33	0.24	23	-0.0355	6 inch	Concrete	0.013	-1.06	14.38	15.20	17.08	17.80	2.20	2.10	17.84	17.80
P-194	291	286	N/A	N/A	N/A	0.55	5.31	3.23	1.78	300	0.0055	12 inch	Concrete	0.013	2.63	15.20	13.56	17.80	17.86	1.60	3.30	18.61	17.86
P-195	282	286	0.75	0.40	0.30	0.30	5.00	3.33	1.01	16	0.0979	6 inch	Concrete	0.013	1.76	15.13	13.56	17.23	17.86	1.60	3.80	18.38	17.86
P-196	283	286	0.84	0.40	0.34	0.34	5.00	3.33	1.13	20	0.1061	6 inch	Concrete	0.013	1.83	15.68	13.56	17.28	17.86	1.10	3.80	18.67	17.86
P-197	284	286	0.18	0.40	0.07	0.07	5.00	3.33	0.24	27	0.0767	6 inch	Concrete	0.013	1.55	15.63	13.56	17.23	17.86	1.10	3.80	17.91	17.86
P-198	285	286	0.29	0.40	0.12	0.12	5.00	3.33	0.39	24	0.0530	6 inch	Concrete	0.013	1.29	14.83	13.56	17.33	17.86	2.00	3.80	17.98	17.86
P-199	286	281	N/A	N/A	N/A	1.37	7.51	2.69	3.72	293	0.0055	12 inch	Concrete	0.013	2.65	13.56	11.94	17.86	18.94	3.30	6.00	17.60	14.4
P-200	280	279	1.30	0.40	0.52	0.52	5.00	3.33	1.75	22	0.0399	6 inch	Concrete	0.013	1.12	15.49	14.61	17.89	17.71	1.90	2.60	19.84	17.71
P-201	279	281	0.71	0.40	0.28	0.80	5.04	3.32	2.69	32	0.0835	6 inch	Concrete	0.013	1.62	14.61	11.94	17.71	18.94	2.60	6.50	21.74	14.4
P-216	281	O-296	0.00	0.00	0.00	6.79	8.55	2.51	17.20	262	0.0056	24 inch	Concrete	0.013	16.96	11.94	10.47	18.94	17.27	5.00	4.80	13.98	12.47

System Flow > Pipe Capacity

Table 13.2

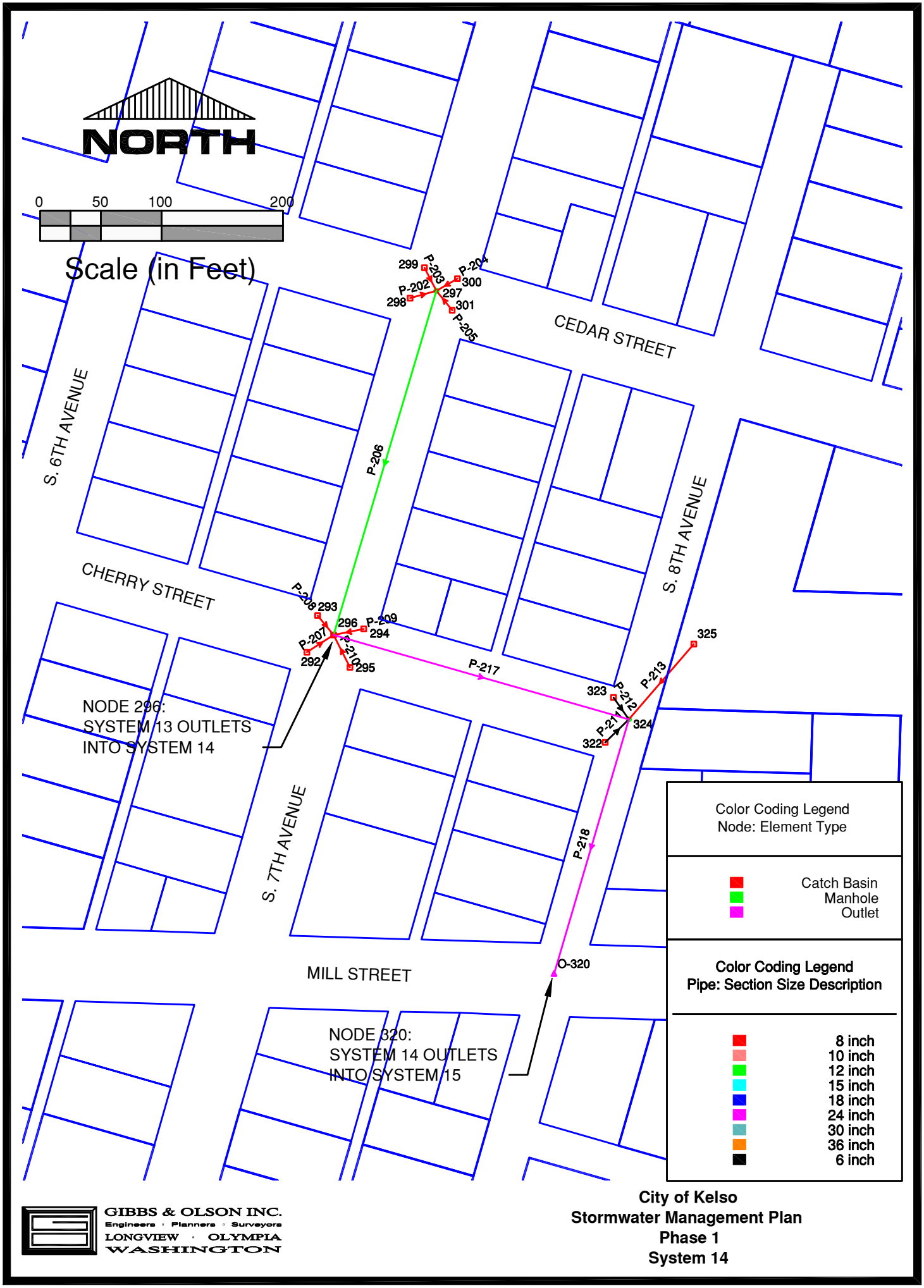
Pipe	Exist. Size	Prop. Size	Length	Cost /ft	Total
P-190	8 inch	12	15	$25	$375
P-191	6 inch	12	20	$25	$500
P-192	6 inch	12	27	$25	$675
P-193	6 inch	12	23	$25	$575
P-199	12 inch	18	293	$45	$13,185
P-200	6 inch	12	22	$25	$550
P-201	6 inch	12	32	$25	$800
P-216	24 inch	24	0	$60	$0
					$16,660

System 14

Modeling results: System 14 consists of the structures along 7th and 8th Avenues, from Cedar Street to Mill Street. It drains an area between the alley way to the west (between 6th and 7th Avenues), and the alley way to the east (between 7th and 8th Avenues) from Cedar Street to Mill Street. It contains 15 structures and outlets into System 15 at node 320 at the intersection of 8th Avenue and Mill Street. The total calculated drainage area for System 14 is 4.25 acres and the land use is primarily residential, with an average runoff coefficient of 0.4.

Table 14.1 lists the structure information and connections, along with total flows and capacities. Figure 14 shows a schematic of the structure locations and piping layout. As seen in Table 14.1, pipes P-206, P-211, P-212, P-217 and P-218 are under capacity. Pipes P-206 and P-211 are shown with a negative slope. Increasing the size of pipes P-211 and P-212 from 6 to 12-inch at a minimum slope of 0.5% will provide the capacity needed. Pipe P-206 is an existing 12-inch pipe with a negative slope. Providing a minimum slope of 0.5% for this pipe will provide the needed capacity for the storm drainage. Pipes P-217 and P-218 are the downstream pipes for the convergence of Systems 13 and 14. The system flow in pipes P-217 and 218 are greater than the capacity for a 24-inch pipe at their existing slopes, but the hydraulic grades are below the ground level. However, it does appear the drainage structures are close to the existing ground, and increasing the existing pipes from 24 to 30-inches would provide additional system capacity.

Recommendations: The estimated budget to upgrade from the pipe as stated above is approximately $46,385 as shown in Table 14.2.



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City of Kelso
Stormwater Management Plan
Phase 1
System 14

Kelso Stormwater Management Plan
Phase 1
System 14

Table 14.1

Pipe Label	Upstream Node	Downstream Node	Upstream Inlet Area (acres)	Upstream Inlet Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	System Flow Time (min)	System Intensity (in/hr)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Material	Manning's n	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-202	298	297	0.74	0.40	0.28	0.28	5.00	3.33	0.93	23	0.0800	8 inch	PVC	0.010	4.44	12.11	10.27	14.71	15.37	1.93	4.43	14.14	13.4
P-203	299	297	0.72	0.40	0.31	0.31	5.00	3.33	1.05	22	0.0884	8 inch	PVC	0.010	4.67	12.22	10.27	14.72	15.37	1.83	4.43	14.17	13.4
P-204	300	297	0.06	0.40	0.05	0.05	5.00	3.33	0.17	20	0.0896	8 inch	PVC	0.010	4.70	12.07	10.27	14.57	15.37	1.84	4.43	13.41	13.4
P-205	301	297	0.13	0.40	0.30	0.30	5.00	3.33	0.99	21	0.0879	8 inch	PVC	0.010	4.66	12.12	10.27	14.62	15.37	1.83	4.43	15.46	15.37
P-206	297	296	N/A	0.40	0.29	0.29	5.00	3.33	0.97	296	-0.0007	12 inch	PVC	0.010	-1.19	10.27	10.47	15.37	17.27	4.10	5.80	15.45	15.37
P-207	292	296	0.39	0.40	0.02	0.02	5.00	3.33	0.08	26	0.1204	8 inch	PVC	0.010	5.45	13.60	10.47	16.50	17.27	2.23	6.13	15.37	15.37
P-208	293	296	0.36	0.40	0.05	0.05	5.00	3.33	0.17	21	0.1552	8 inch	PVC	0.010	6.19	13.73	10.47	16.53	17.27	2.13	6.13	15.37	15.37
P-209	294	296	0.07	N/A	N/A	0.66	6.44	2.92	1.94	25	0.1245	8 inch	PVC	0.010	5.54	13.58	10.47	16.48	17.27	2.23	6.13	16.50	15.98
P-210	295	296	0.18	0.40	0.16	0.16	5.00	3.33	0.52	30	0.1089	8 inch	PVC	0.010	5.18	13.74	10.47	16.64	17.27	2.24	6.13	16.01	15.98
P-211	322	324	0.69	0.40	0.14	0.14	5.00	3.33	0.48	27	-0.3594	6 inch	Concrete	0.013	-3.36	0.00	9.70	12.27	13.40	11.77	3.20	16.00	15.98
P-212	323	324	0.78	0.40	0.03	0.03	5.00	3.33	0.09	22	0.0331	6 inch	VCP	0.013	1.02	10.43	9.70	12.33	13.40	1.40	3.20	15.98	15.98
P-213	325	324	0.13	0.40	0.07	0.07	5.00	3.33	0.24	82	0.0016	8 inch	PVC	0.010	0.63	9.83	9.70	11.73	13.40	1.23	3.03	15.99	15.98
P-217	296	324	0.00	0.00	0.00	7.85	8.55	2.51	19.89	253	0.0030	24 inch	Concrete	0.013	12.44	10.47	9.70	17.27	13.40	4.80	1.70	15.36	13.40
P-218	324	O-320	N/A	N/A	N/A	8.49	9.22	2.42	20.69	219	0.0020	24 inch	Concrete	0.013	10.16	9.70	9.26	13.40	16.26	1.70	5.00	13.09	11.26

System Flow > Pipe Capacity

Table 14.2

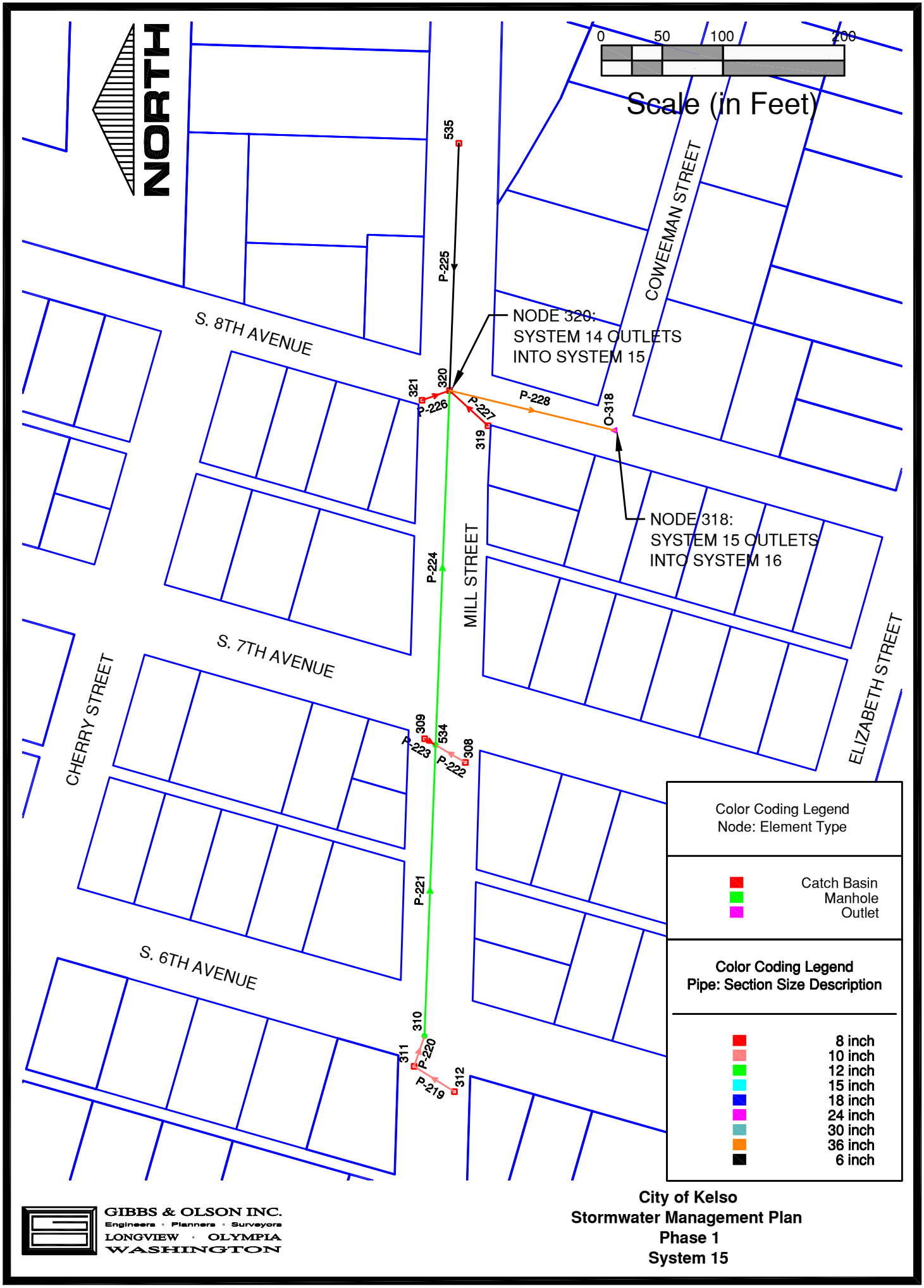
Pipe	Exist. Size	Prop. Size	Length	Cost /ft	Total
P-206	12 inch	12 inch	296	$25	$7,400
P-211	6 inch	12 inch	27	$25	$675
P-212	6 inch	12 inch	22	$25	$550
P-217	24 inch	30 inch	253	$80	$20,240
P-218	24 inch	30 inch	219	$80	$17,520
					$46,385

System 15

Modeling results: System 15 consists of the structures along Mill Street, from 6th Avenue to 8th Avenue. It drains an area between Cherry Street to the north and Elizabeth Street to the west. It contains 10 structures and outlets into System 16 at node 318 at the intersection of 8th Avenue and Coweeman Street. The total calculated drainage area for System 15 is 8.01 acres and the land use is primarily residential, with an average runoff coefficient of 0.41.

Table 15.1 lists the structure information and connections, along with total flows and capacities. Figure 15 shows a schematic of the structure locations and piping layout. As seen in Table 15.1, pipes P-220, P-221, P-224 and P-225 are under capacity. Pipe P-226 is shown with a negative slope. Increasing the size of pipe P-220 from 10 to 12-inches and pipes P-221 and P-224 from 12 to 18-inches at their existing slopes will provide the capacity needed. Pipe P-225 is listed as an existing 21-inch pipe with a negative slope, but is conveying only 1.06 cfs. Relaying the pipe with a positive slope of 0.3% or greater will provide the capacity needed.

Recommendations: The estimated budget to upgrade from the pipe as stated above is approximately $36,830 as shown in Table 15.2.



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City of Kelso
Stormwater Management Plan
Phase 1
System 15

Kelso Stormwater Management Plan
Phase 1
System 15

Table 15.1

Pipe Label	Upstream Node	Downstream Node	Upstream Inlet Area (acres)	Upstream Inlet Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	System Flow Time (min)	System Intensity (in/hr)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Material	Manning's n	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-219	312	311	1.76	0.40	0.70	0.70	9.00	2.45	1.74	39	0.0317	10 inch	Concrete	0.013	3.90	14.87	13.64	18.07	17.94	2.36	3.47	18.19	17.94
P-220	311	310	1.55	0.40	0.62	1.32	9.20	2.42	3.23	26	0.0191	10 inch	Concrete	0.013	3.03	13.64	13.14	17.94	18.64	3.47	4.67	19.20	18.64
P-221	310	534	N/A	N/A	N/A	1.32	9.28	2.41	3.21	240	0.0095	12 inch	Concrete	0.013	3.47	13.14	10.86	18.64	17.20	4.50	5.34	19.15	17.20
P-222	308	534	1.22	0.40	0.49	0.49	8.00	2.60	1.28	28	0.0692	10 inch	Concrete	0.013	5.76	12.79	10.86	17.29	17.20	3.66	5.51	17.30	17.20
P-223	309	534	1.13	0.40	0.45	0.45	7.00	2.79	1.27	11	0.1411	8 inch	Concrete	0.013	4.54	12.41	10.86	17.11	17.20	4.03	5.68	17.32	17.20
P-224	534	320	N/A	N/A	N/A	2.26	10.25	2.29	5.22	292	0.0055	12 inch	Concrete	0.013	2.63	10.86	9.26	17.20	16.26	5.34	6.00	18.49	12.22
P-225	535	320	0.77	0.45	0.35	0.35	6.00	3.03	1.06	204	-0.0454	21 inch	Concrete	0.013	-33.76	0.00	9.26	14.00	16.26	12.25	5.25	12.23	12.22
P-226	321	320	0.20	0.40	0.08	0.08	5.00	3.33	0.27	24	0.1108	8 inch	Concrete	0.013	4.02	11.92	9.26	15.62	16.26	3.03	6.33	12.16	12.22
P-227	319	320	1.38	0.40	0.55	0.55	8.00	2.60	1.45	43	0.0510	8 inch	PVC	0.010	3.55	11.45	9.26	15.45	16.26	3.33	6.33	12.59	12.22
P-228	320	O-318	0.00	0.00	0.00	11.73	13.74	1.96	23.19	140	0.0026	36 inch	Concrete	0.013	33.79	9.26	8.90	16.26	15.90	4.00	4.00	12.04	11.90

System Flow > Pipe Capacity

Table 15.2

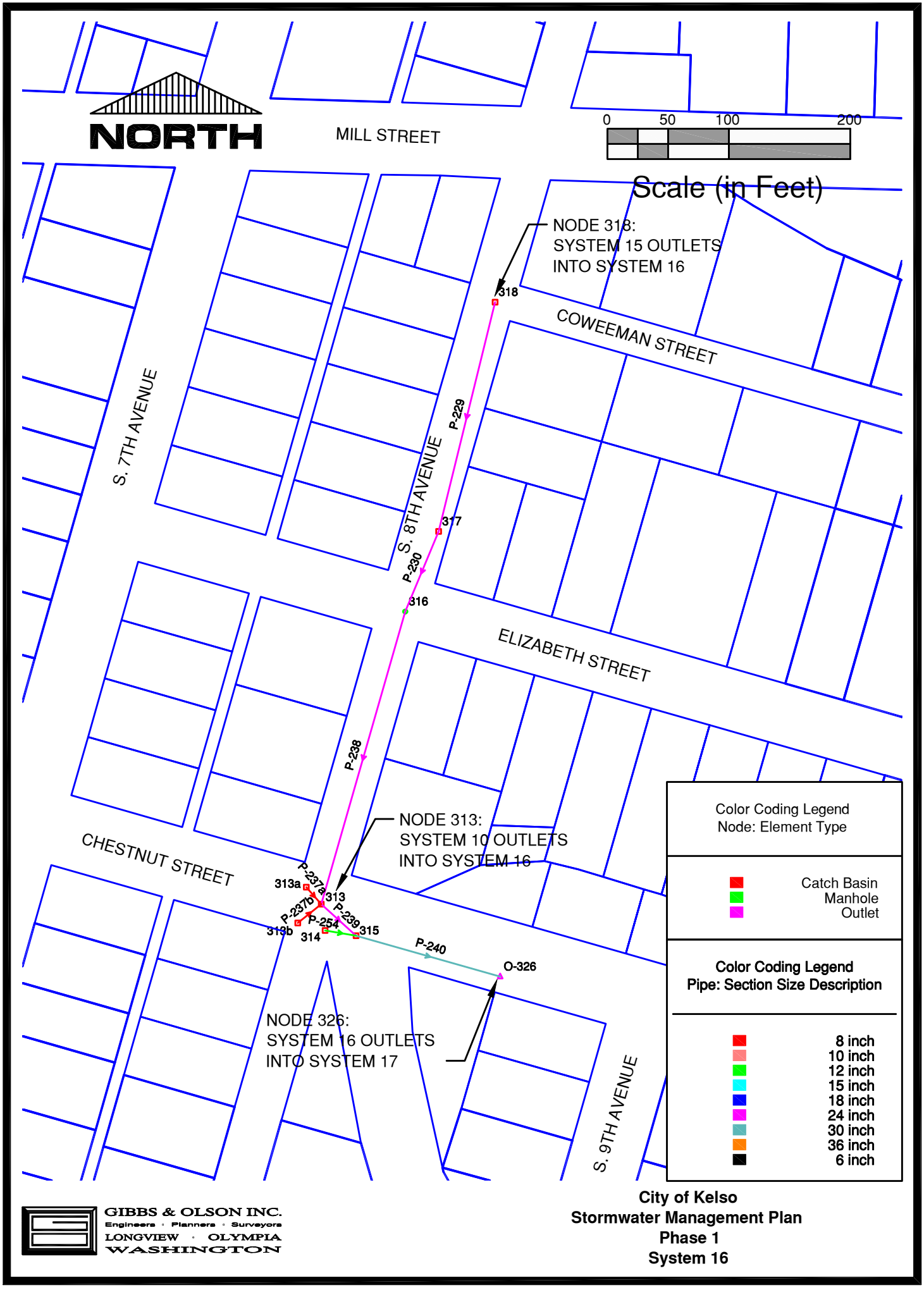
Pipe	Exist. Size	Prop. Size	Length	Cost /ft	Total
P-220	10 inch	12 inch	26	$25	$650
P-221	12 inch	18 inch	240	$45	$10,800
P-224	12 inch	18 inch	292	$45	$13,140
P-225	21 inch	24 inch	204	$60	$12,240
					$36,830

System 16

Modeling results: System 16 consists of the structures along 8th Avenue, from Coweeman Street to Chestnut Street. It drains an area from the alley way to the west (between 7th and 8th Streets) and 9th Avenue to the east, between Coweeman and Chestnut Streets. It contains 9 structures and outlets into System 17 at node 326 on Chestnut Street midway between 8th and 9th Streets. The total calculated drainage area for System 16 is 1.9 acres and the land use is primarily residential, with an average runoff coefficient of 0.40.

Table 16.1 lists the structure information and connections, along with total flows and capacities. Figure 16 shows a schematic of the structure locations and piping layout. As seen in Table 16.1, pipes P-229, P-230, P-238, P-239 and P-240 are under capacity. Pipes P-229, P-230 and P-239 are shown with a negative slope. Increasing the size of pipes P-229, P-230 and P-238 from 24 to 30-inches will provide the capacity needed. Pipes P-239 and P-240 are the down stream pipes for System 10 and System 16. Increasing these pipes from 24 and 30-inches to 48-inch HDPE with a minimum slope of 0.5% will provide the capacity needed. However, there is approximately 1-foot of cover at the end of line P-249 and would not accommodate a 48-inch pipe. This may require the utilization of an arch pipe or the combination of two smaller diameter pipes. Increasing the slope of the upstream pipes will provide additional storage for the system.

Recommendations: The estimated budget to upgrade from the pipe as stated above is approximately $69,070 as shown in Table 16.2.



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City of Kelso
Stormwater Management Plan
Phase 1
System 16

Kelso Stormwater Management Plan
Phase 1
System 16

Table 16.1

Pipe Label	Upstream Node	Downstream Node	Upstream Inlet Area (acres)	Upstream Inlet Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	System Flow Time (min)	System Intensity (in/hr)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Material	Manning's n	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-229	318	317	0	0	0	11.73	13.74	1.96	23.18	194	-0.00014	24 inch	Concrete	0.013	-2.69	8.9	8.93	15.90	16.18	5.00	5.25	18.22	16.18
P-230	317	316	0.87	0.4	0.35	12.08	14.18	1.93	23.48	72	-0.00347	24 inch	Concrete	0.013	-13.33	8.93	9.18	16.18	17.47	5.25	6.29	18.25	17.47
P-238	316	313	N/A	N/A	N/A	12.08	14.34	1.92	23.34	251	0.006345	24 inch	Concrete	0.013	18.02	8.87	7.28	17.47	17.48	6.60	8.20	20.15	17.48
P-239	313	315	0	0	0	43.4	14.9	1.88	82.2	39	-0.03371	24 inch	Concrete	0.013	-41.53	7.28	8.59	17.48	15.20	8.20	4.61	20.36	15.20
P-240	315	O-326	0.03	0.4	0.01	43.81	14.93	1.88	82.91	124	0.002823	30 inch	CMP	0.024	11.8	8.59	8.24	15.20	11.74	4.11	1.00	28.03	10.74
P-237a	313a	313	0	0	0	0	0	0	0	19	0.502874	8 inch	Concrete	0.013	8.57	16.83	7.28	17.50	17.48	0.00	9.54	17.48	17.48
P-237b	313b	313	0	0	0	0	0	0	0	25	0.382184	8 inch	Concrete	0.013	7.47	16.83	7.28	17.50	17.48	0.00	9.54	17.48	17.48
P-254	314	315	1	0.4	0.4	0.4	6	3.03	1.22	26	0.159231	12 inch	PVC	0.010	18.48	12.73	8.59	16.83	15.20	3.10	5.61	15.22	15.20

System Flow > Pipe Capacity

Table 16.2

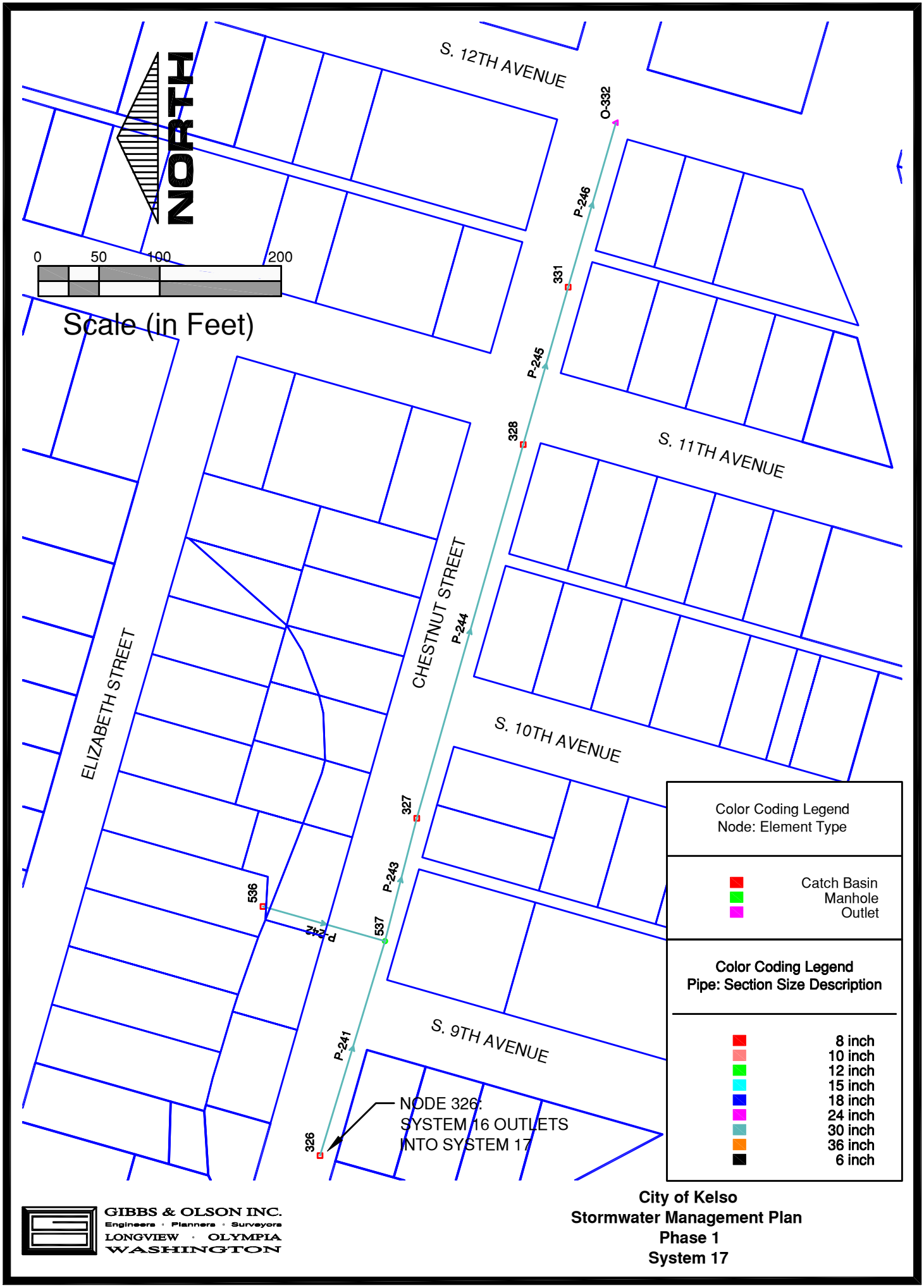
Pipe	Exist. Size	Prop. Size	Length	Cost /ft	Total
P-229	24 inch	30 inch	194	$80	$15,520
P-230	24 inch	30 inch	72	$80	$5,760
P-238	24 inch	30 inch	251	$80	$20,080
P-239	24 inch	48 inch	39	$170	$6,630
P-240	30 inch	48 inch	124	$170	$21,080
					$69,070

System 17

Modeling results: System 17 consists of the structures along Chestnut Street, from 9th Avenue to 12th Avenue. It drains an area from Elizabeth Street to south of Chestnut Street. It contains 7 structures and outlets into an existing structure at the intersection of Chestnut Street and 12th Avenue. The total calculated drainage area for System 17 is 4.4 acres and the land use is primarily residential, with an average runoff coefficient of 0.40.

Table 17.1 lists the structure information and connections, along with total flows and capacities. Figure 17 shows a schematic of the structure locations and piping layout. As seen in Table 17.1, pipes P-241, P-242, P-243, P-244, P-245 and P-246 are under capacity. Pipe P-242 is shown with a negative slope. Increasing the size of all the pipes in System 17 from 30-inch CMP to 48-inch HDPE would provide the capacity needed. However, there is insufficient ground cover to accommodate 48-inch pipes. To provide the capacity needed for runoff flows of approximately 84 cfs may require the utilization of arch pipes or the combination of two smaller diameter pipes. Increasing the slope of the pipes in the upstream systems will provide additional storage for the system.

Recommendations: The estimated budget to upgrade from the pipe as stated above is approximately $168,470 as shown in Table 17.2.



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City of Kelso
Stormwater Management Plan
Phase 1
System 17

Kelso Stormwater Management Plan
Phase 1
System 17

Table 17.1

Pipe Label	Upstream Node	Downstream Node	Upstream Inlet Area (acres)	Upstream Inlet Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	System Flow Time (min)	System Intensity (in/hr)	Total System Flow (cfs)	Length (ft)	Constructed Slope (ft/ft)	Section Size	Material	Manning's n	Full Capacity (cfs)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P-241	326	537	0.54	0.5	0.27	44.08	14.93	1.88	83.41	185	0.0039	30 inch	CMP	0.024	13.96	8.24	7.51	11.74	11.50	1.00	1.49	37.58	11.50
P-242	536	537	1.78	0.4	0.71	0.71	9.00	2.45	1.76	105	-0.0715	30 inch	CMP	0.024	-59.42	0.00	7.51	0.00	11.50	-2.50	1.49	11.51	11.50
P-243	537	327	N/A	N/A	N/A	44.79	15.11	1.87	84.23	105	0.0040	30 inch	CMP	0.024	14.05	7.51	7.09	11.50	11.19	1.49	1.60	26.28	11.19
P-244	327	328	1.67	0.4	0.67	45.46	15.21	1.86	85.18	320	0.0033	30 inch	CMP	0.024	12.79	7.09	6.03	11.19	9.93	1.60	1.40	56.97	9.93
P-245	328	331	0.14	0.4	0.06	45.52	15.52	1.84	84.40	135	0.0010	30 inch	CMP	0.024	7.15	6.03	5.89	9.93	9.39	1.40	1.00	28.88	9.39
P-246	331	O-332	0.27	0.4	0.11	45.62	15.65	1.83	84.23	141	0.0082	30 inch	CMP	0.024	20.06	5.89	4.74	9.39	8.44	1.00	1.20	27.51	7.24

System Flow > Pipe Capacity

Table 17.2

Pipe	Exist. Size	Prop. Size	Length	Cost /ft	Total
P-241	30 inch	48 inch	185	$170	$31,450
P-242	30 inch	48 inch	105	$170	$17,850
P-243	30 inch	48 inch	105	$170	$17,850
P-244	30 inch	48 inch	320	$170	$54,400
P-245	30 inch	48 inch	135	$170	$22,950
P-246	30 inch	48 inch	141	$170	$23,970
					$168,470

Appendix C

Location	2-Year MRI		5-Year MRI		10-Year MRI		25-Year MRI		50-Year MRI		100-Year MRI	
	m	n	m	n	m	n	m	n	m	n	m	n
Aberdeen and Hoquiam	5.10	0.488	6.22	0.488	7.06	0.487	8.17	0.487	9.02	0.487	9.86	0.487
Bellingham	4.29	0.549	5.59	0.555	6.59	0.559	7.90	0.562	8.89	0.563	9.88	0.565
Bremerton	3.79	0.480	4.84	0.487	5.63	0.490	6.68	0.494	7.47	0.496	8.26	0.498
Centralia and Chehalis	3.63	0.506	4.85	0.518	5.76	0.524	7.00	0.530	7.92	0.533	8.86	0.537
Clarkston and Colfax	5.02	0.628	6.84	0.633	8.24	0.635	10.07	0.638	11.45	0.639	12.81	0.639
Colville	3.48	0.558	5.44	0.593	6.98	0.610	9.07	0.626	10.65	0.635	12.26	0.642
Ellensburg	2.89	0.590	5.18	0.631	7.00	0.649	9.43	0.664	11.30	0.672	13.18	0.678
Everett	3.69	0.556	5.20	0.570	6.31	0.575	7.83	0.582	8.96	0.585	10.07	0.586
Forks	4.19	0.410	5.12	0.412	5.84	0.413	6.76	0.414	7.47	0.415	8.18	0.416
Hoffstadt Cr. (SR 504)	3.96	0.448	5.21	0.462	6.16	0.469	7.44	0.476	8.41	0.480	9.38	0.484
Hoodsport	4.47	0.428	5.44	0.428	6.17	0.427	7.15	0.428	7.88	0.428	8.62	0.428
Kelso and Longview	4.25	0.507	5.50	0.515	6.45	0.509	7.74	0.524	8.70	0.526	9.67	0.529
Leavenworth	3.04	0.530	4.12	0.542	5.62	0.575	7.94	0.594	9.75	0.606	11.08	0.611
Metaline Falls	3.36	0.527	4.90	0.553	6.09	0.566	7.45	0.570	9.29	0.592	10.45	0.591
Moses Lake	2.61	0.583	5.05	0.634	6.99	0.655	9.58	0.671	11.61	0.681	13.63	0.688
Mt. Vernon	3.92	0.542	5.25	0.552	6.26	0.557	7.59	0.561	8.60	0.564	9.63	0.567
Naselle	4.57	0.432	5.67	0.441	6.14	0.432	7.47	0.443	8.05	0.440	8.91	0.436
Olympia	3.82	0.466	4.86	0.472	5.62	0.474	6.63	0.477	7.40	0.478	8.17	0.480
Omak	3.04	0.583	5.06	0.618	6.63	0.633	8.74	0.647	10.35	0.654	11.97	0.660
Pasco and Kennewick	2.89	0.590	5.18	0.631	7.00	0.649	9.43	0.664	11.30	0.672	13.18	0.678
Port Angeles	4.31	0.530	5.42	0.531	6.25	0.531	7.37	0.532	8.19	0.532	9.03	0.532
Poulsbo	3.83	0.506	4.98	0.513	5.85	0.516	7.00	0.519	7.86	0.521	8.74	0.523
Queets	4.26	0.422	5.18	0.423	5.87	0.423	6.79	0.423	7.48	0.423	8.18	0.424
Seattle	3.56	0.515	4.83	0.531	5.62	0.530	6.89	0.539	7.88	0.545	8.75	0.5454
Sequim	3.50	0.551	5.01	0.569	6.16	0.577	7.69	0.585	8.88	0.590	10.04	0.593
Snoqualmie Pass	3.61	0.417	4.81	0.435	6.56	0.459	7.72	0.459	8.78	0.461	10.21	0.476
Spokane	3.47	0.556	5.43	0.591	6.98	0.609	9.09	0.626	10.68	0.635	12.33	0.643
Stevens Pass	4.73	0.462	6.09	0.470	8.19	0.500	8.53	0.484	10.61	0.499	12.45	0.513
Tacoma	3.57	0.516	4.78	0.527	5.70	0.533	6.93	0.539	7.86	0.542	8.79	0.545
Vancouver	2.92	0.477	4.05	0.496	4.92	0.506	6.06	0.515	6.95	0.520	7.82	0.525
Walla Walla	3.33	0.569	5.54	0.609	7.30	0.627	9.67	0.645	11.45	0.653	13.28	0.660
Wenatchee	3.15	0.535	4.88	0.566	6.19	0.579	7.94	0.592	9.32	0.600	10.68	0.605
Yakima	3.86	0.608	5.86	0.633	7.37	0.644	9.40	0.654	10.93	0.659	12.47	0.663

Index to Rainfall Coefficients (English Units)

Figure 2-5.4A

Rainfall Intensity Charts
Longview/Kelso, WA

	Rainfall Coefficients				
	2 Yr.	10 Yr.	25 Yr.	50 Yr.	100 Yr.
m =	4.25	6.45	7.74	8.7	9.67
n =	0.507	0.509	0.524	0.526	0.529

Intensities (in/hr)					
	Return Periods				
Durations	2 year	10 year	25 year	50 year	100 year
5 min	1.879	2.843	3.330	3.731	4.127
6 min	1.713	2.591	3.027	3.390	3.748
7 min	1.585	2.396	2.792	3.126	3.454
8 min	.1.481	2.238	2.603	2.914	3.219
9 min	1.395	2.108	2.447	2.739	3.024
10 min	1.322	1.998	2.316	2.591	2.860
15 min	1.077	1.625	1.873	2.094	2.308
16 min	1.042	1.573	1.810	2.024	2.231
17 min	1.011	1.525	1.754	1.960	2.160
18 min	0.982	1.481	1.702	1.902	2.096
19 min	0.955	1.441	1.655	1.849	2.037
20 min	0.931	1.404	1.611	1.800	1.982
21 min	0.908	1.369	1.570	1.754	1.932
22 min	0.887	1.337	1.532	1.712	1.885
23 min	0.867	1.307	1.497	1.672	1.841
24 min	0.848	1.279	1.464	1.635	1.800
25 min	0.831	1.253	1.433	1.600	1.762
26 min	0.815	1.228	1.404	1.568	1.725
27 min	0.799	1.205	1.376	1.537	1.691
28 min	0.785	1.183	1.350	1.508	1.659
29 min	0.771	1.162	1.326	1.480	1.629
30 min	0.758	1.142	1.302	1.454	1.600
40 min	0.655	0.987	1.120	1.250	1.374
50 min	0.585	0.881	0.997	1.111	1.221
60 min	0.533	0.803	0.906	1.010	1.109
120 min	0.375	0.564	0.630	0.701	0.768
180 min	0.305	0.459	0.509	0.567	0.620
360 min	0.215	0.322	0.354	0.393	0.430
720 min	0.151	0.227	0.246	0.273	0.298
1440 min	0.106	0.159	0.171	0.190	0.206
24 HR	2.555 in.	3.821 in.	4.111 in.	4.554 in.	4.953 in.

I = m/t^n

P:\Road Dept\[Rainfall intensities.xls]Longview-Kelso
2/22/2002

TABLE 9.4.1 Runoff Coefficients Recommended by American Society of Civil Engineers and Water Pollution Control Federation

	Runoff coefficients
Description of area:	
Business	
Downtown	0.70–0.95
Neighborhood	0.50–0.70
Residential	
Single-family	0.30–0.50
Multiunits, detached	0.40–0.60
Multiunits, attached	0.60–0.75
Residential (suburban)	0.25–0.40
Apartment	0.50–0.70
Industrial	
Light	0.50–0.80
Heavy	0.60–0.90
Parks, cemeteries	0.10–0.25
Playgrounds	0.20–0.35
Railroad yard	0.20–0.35
Unimproved	0.10–0.30
Character of surface:	
Pavement	
Asphaltic and concrete	0.70–0.95
Brick	0.70–0.85
Roofs	0.75–0.95
Lawns, sandy soil	
Flat, 2 percent	0.05–0.10
Average, 2–7 percent	0.10–0.15
Steep, 7 percent	0.15–0.20
Lawns, heavy soil	
Flat, 2 percent	0.13–0.17
Average, 2 to 7 percent	0.18–0.22
Steep, 7 percent	0.25–0.35

Source: Ref. 1. Used with permission.