Council Meeting of March 25, 2015

Agenda Item No. 8.b.

REQUEST FOR COUNCIL ACTION

SUBJECT: Draft North Area Drainage Capital Improvement Projects Plan Update.

SUMMARY: City Staff is working with Hansen Allen and Luce Engineers to prepare an updated 2015 Master Drainage Plan. The study shows the North Area deficiencies in and around 7000 South. A proposed Capital Improvement Projects Plan with associated costs is presented to address those deficiencies. The Plan will be presented to the public at an open house meeting in April.

FISCAL IMPACT: The projects selected will have a fiscal impact to the City.

STAFF RECOMMENDATION:

Staff recommends Council review the Draft North Area Drainage Capital Improvement Projects Plan.

MOTION RECOMMENDED:

"I move to direct City staff to prepare for a public meeting to receive comments on the Draft North Area Drainage Capital Improvement Projects Plan."

Prepared by:

Tim Heyrend, P.E.
Utilities Engineer

Reviewed by:

David Murphy, P.E.
Engineering Manager for CIP

Reviewed by:

Wendell Rigby, P.E.
Director of Public Works

Recommended by:

Bryce Haderlie
Interim City Manager

BACKGROUND DISCUSSION:

City Staff has been working with Hansen Allen and Luce Engineers (HAL) to prepare a city-wide updated 2015 Master Drainage Master Plan and Capital Improvement Projects Plan. To date HAL has completed the study of the north area of the City which is tributary to the 7000 South drainage. Total North Area Capital Project Costs add up to $10.88 Million. West Jordan City last completed an update to the City's Master Drainage Plan in 2007.

The 2015 drainage study uses a more sophisticated hydraulic/hydrologic model (INFOSWMM) than the 2007 study, which is able to define the flow for each individual pipeline and channel city-wide. It also shows areas where potential flooding can occur above the curb and gutter. A commonly used storm hydrograph curve (Farmer-Fletcher) was used to determine the amount of precipitation and pipe flow in a 10-year 1-hour storm event. Other design storms up to the 100 year- 24 hour storm were modelled to evaluate the highest peak flow.

The model results show 21 areas of deficiency as seen on *Figure 1* and detailed in the Table- *North Area – Tributary to 7000 South Identified Deficiencies*. The areas around Constitution Park and 7000 South are deficient with flooding occurring. Many of the deficiencies are due to a lack of storm drain pipes, or pipes with flat slopes that do not drain quickly enough. Some of the deficiencies are located where there are currently reported flooding issues.

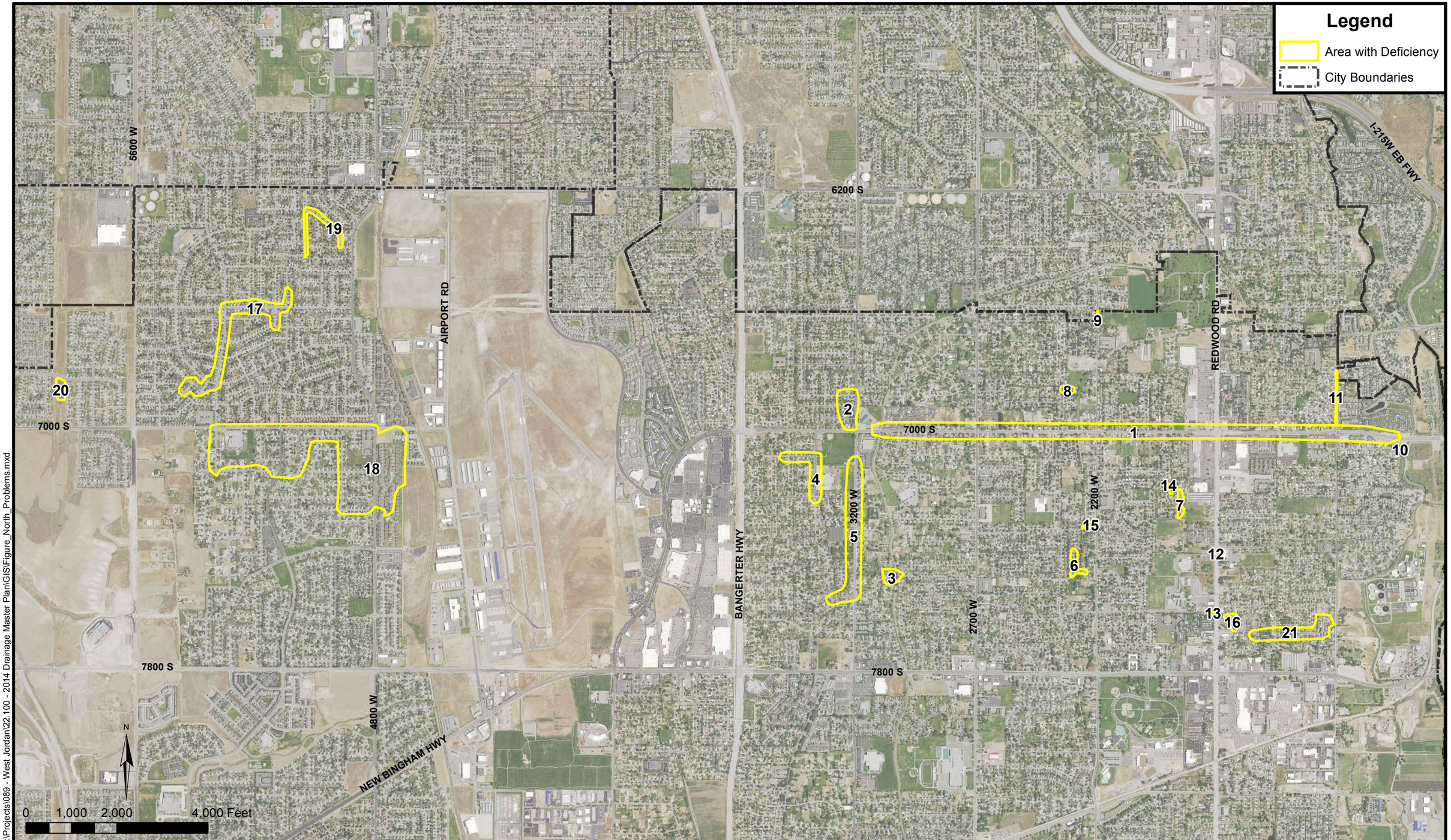
The identified deficiencies from Figure 1 were assigned a Capital Improvement Project to remedy the deficiency (see Figure 2 *North Area Capital Improvement Projects* and the Table- *Capital Improvement Plan – North Area – Tributary to 7000 South*). In the table one may also observe the associated costs with each project.

Figure 3 shows the proposed solution to the flooding area north of Constitution Park. It includes building a new pipeline from 6775 South directly to Constitution Park, with new inlets at the cross streets and a second pipeline in 3200 West routed directly to the canal. Modeling shows that this solution will alleviate surface flooding in the area. It is also proposed that Constitution Park be lowered by 2-feet to allow more storage of runoff water, and allows pipes to provide more flow.

The North Area Capital Improvement Plan will be presented to the public in an Open House format, and any relevant comments received will be incorporated into the study. Comments may be sent to Tim Heyrend timh@wjordan.com, 801-569-5086. The South area Capital Improvement Plan is scheduled for completion near the end of April along with the complete Master Drainage Plan. The results of that study will then be presented to Council and the public.

Attachments:

Draft North Area Deficiencies Figure and Table
North Area Capital Improvement Plan Figure and Tables
Project 2 Schematic figure.



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HANSEN ALLEN & LUCE INC ENGINEERS

CITY OF WEST JORDAN
2015 STORM DRAIN MASTER PLAN

NORTH AREA DEFICIENCIES

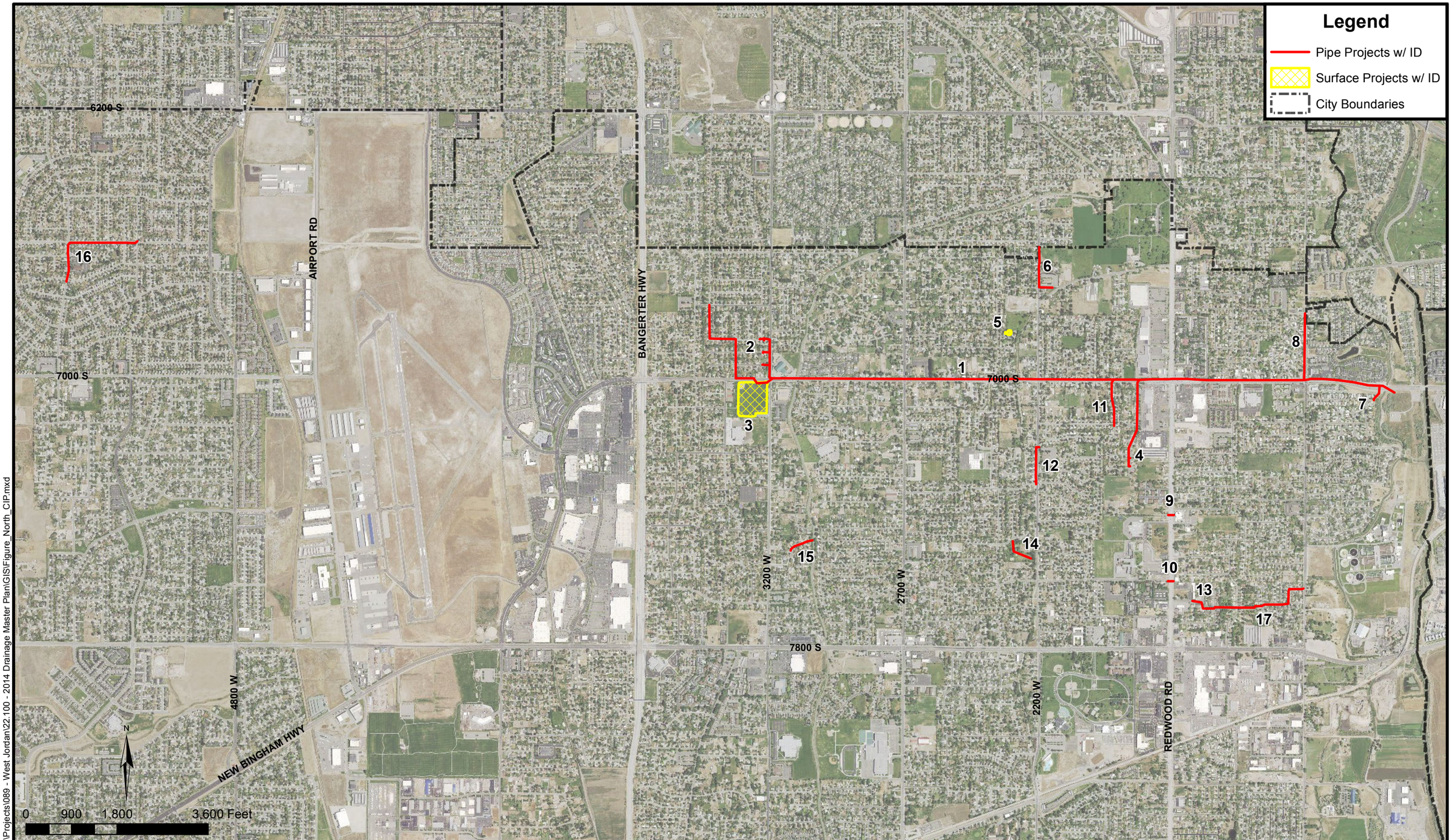
FIGURE 1

NORTH AREA - TRIBUTARY TO 7000 SOUTH - IDENTIFIED DEFICIENCIES

Problem ID #	LOCATION	PROBLEM DESCRIPTION
1	7000 South from 3000 West to the Jordan River	Existing storm drains along 7000 South discharges into the South Jordan Canal. Storm drains east of the South Jordan Canal do not have sufficient capacity to convey flows to Bateman pond.
2	3200 W and 6880 South, 6920 South, and 6960 South	City and modeling has identified flooding in this area, especially in the downhill cul-de-sac in 6960 South. Inadequate pipe capacity, low surface elevations, and conflicts with the outlet structure of the Constitution Park detention basin.
4	Paddington Road from New World Drive to Millerberg Way	Conflicts with the inlet works into Constitution Park detention basin create backwater effects that flood Paddington Way.
5	7000 South between Thorndale Way and Orion Hill Road and the neighborhoods directly south	Pipes are generally at or just over capacity with surcharging at most inlets.
5	3200 West from 7545 South to Constitution Park	Pipes have inadequate slopes/elevation head to convey storm flows. Spill elevations into Constitution Park create backflow conditions for inflows into the detention basin.
6	Harvest Ridge Drive between 7400 South and Jordan Meadows Lane	City has identified flooding issues here in the past. The existing storm drain has low slopes and the required head to spill into the Jordan Meadows detention basin creates backwater effects. The area is a low spot in the curb and gutter system.
7	Executive Drive between 7265 South and Richland Circle	City has identified flooding issues here in the past. The existing storm drain has low slopes. Flows are over pipe capacity. The area is a low spot in the curb and gutter system, and ponding flows flood downhill driveways on the east side of the road. Connection issues between dual irrigation and storm drain lines.
8	Straw Circle	City has identified flooding issues here in the past. The required head to spill into the Harvest Park detention basin creates backwater effects. The area is a low spot in the curb and gutter system and has a downsloping driveway.
9	6645 South and 2200 West	Piped storm drain daylights to open ditch which is frequently clogged with weeds, debris, and leaves.
10	7055 South and 1115 West	City has identified erosion issues at the west end of 7055 South at this location. Current inlets do not connect into the storm drain system.
11	Temple Drive from 6790 South to Storm Drainage near 7000 South	City has identified that this area lacks storm drain conveyances.
12	Drake Lane and Redwood Road	City has identified that ADS pipes crossing Redwood Road are damaged and need replaced.
13	7600 South and Redwood Road	City has identified that ADS pipes crossing Redwood Road are damaged and need replaced.
14	Camelot Way and 7175 South	City has identified flooding in low spot of curb and gutter. The inlets tie into irrigation/storm drain lines in backyards and lack and access manhole.
15	Harvest Lane from 2200 West to 2290 West	City has identified flooding in this area. Modeling shows that storm drain may have adverse grades and act as bubble up in Arthur Drive.
16	Sunrise Place 1655 West	Isolated storm drainage in the strip mall bubbles up in the road and floods the strip mall parking lot.
17	6600 South and Clernates Drive	The system along 6600 south from Beargrass Road to the intersection of Clernates and along Clernates from 6600 South to Wake Robin Drive is generally overcapacity in a 10-year event. This is causing water to flow in the surficial street system where it is unable to be tracked by the model. This accounts for City observations of inlet capacity issues in this area – which the model reveals are more of a pipe capacity issue.

NORTH AREA - TRIBUTARY TO 7000 SOUTH - IDENTIFIED DEFICIENCIES

Problem ID #	LOCATION	PROBLEM DESCRIPTION
18	5030 West and Pawnee Drive	The system along Pawnee Drive and 5030 West is generally overcapacity and causing surcharging during the 10-year storm event. This area has not been known to cause excessive issues in the past.
19	7480 South and Autumn Drive	City has identified local flooding issues here in the past.
20	5820 West and Discovery Drive	City has identified problems with overgrowth of weeds in the detention facility.
21	Approximately 7660 South from Sunrise Place to Temple Drive	Modeling shows that the existing storm drain/irrigation piping has insufficient capacity to convey flows to the North Jordan Canal.



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ENGINEERS

CITY OF WEST JORDAN
2015 STORM DRAIN MASTER PLAN

NORTH AREA CAPITAL IMPROVEMENT PROJECTS

FIGURE
2

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CITY OF WEST JORDAN
STORM DRAIN MASTER PLAN

PROJECT 2 SCHEMATIC

FIGURE 3

CAPITAL IMPROVEMENT PLAN – NORTH AREA COMPARISON TO 2007 CIP (3-11-2015)

2015 PROJECT ID #	LOCATION	2007 PREFERRED SOLUTION	2015 PREFERRED SOLUTION	2007 Flow Rates (cfs)	2015 Flow Rates (cfs)	2007 PROJECT COST*	2015 PROJECT COST
1	7000 South from 3000 West to the Jordan River	Construct new 7000 South outfall with sizes ranging from 36-inch to 66-inch before the outfall to the Jordan River.	Install trunk line from Constitution Park consisting of 125 feet of 36-inch pipe, 4,670 feet of 42-inch pipe, 2,320 feet of 48-inch pipe, 3,380 feet of 60-inch pipe, 300 feet of 7x4 foot box culvert, and 1,610 feet of 66-inch pipe including outlet works.	25 - 273	51 - 507	$4,370,300	$6,132,000
2	3200 W and 6880 South, 6920 South, and 6960 South	The problems in these areas were not identified in the 2007 model. Therefore, no solutions were offered for the area.	Install 42-inch interceptor storm drain in 3370 West, 6880 South, 3300 West, and 7000 South from 6775 South to Constitution Park. Abandon existing storm drain in 6775 South east of the interceptor pipe. Separate the inlets in 6880 South, 6920 South, and 6960 South by installing a new parallel storm drain in 3200 West which bypasses the detention basin and connects to Project 16.	-	132	$0	$1,323,000
3	3200 W and 6880 South, 6920 South, and 6960 South	Reconstruct the outlet of the Constitution Park detention basin.	Lower Constitution Park base elevations by 2 feet, reconstruct incoming spill structures and piping so flows into the basin spill at or near the basin's lowest elevation, and reconstruct outlet works with a minimum 14-inch diameter orifice plate.	25	13	$24,400	$1,296,000

*Adjusted to 2015 dollars using CPI calculator from US Bureau of Labor Statistics (http://www.bls.gov/data/inflation_calculator.htm)

CAPITAL IMPROVEMENT PLAN – NORTH AREA – TRIBUTARY TO 7000 SOUTH (3-12-2015)

PROJECT ID #	PROBLEM ID ADDRESSED	LOCATION	PROBLEM DESCRIPTION	PREFERRED SOLUTION	PROJECT COST ($)
1	1	7000 South from 3000 West to the Jordan River	Existing storm drains along 7000 South discharges into the South Jordan Canal. Storm drains east of the South Jordan Canal do not have sufficient capacity to convey flows to Bateman pond.	Install trunk line from Constitution Park consisting of 125 feet of 36-inch pipe, 4,670 feet of 42-inch pipe, 2,320 feet of 48-inch pipe, 3,380 feet of 60-inch pipe, 300 feet of 7x4 foot box culvert, and 1,610 feet of 66-inch pipe including outlet works.	$6,132,000
2	2	3200 W and 6880 South, 6920 South, and 6960 South	City and modeling has identified flooding in this area, especially in the downhill cul-de-sac in 6960 South. Inadequate pipe capacity, low surface elevations, and conflicts with the outlet structure of the Constitution Park detention basin.	Install 42-inch interceptor storm drain in 3370 West, 6880 South, 3300 West, and 7000 South from 6775 South to Constitution Park. Separate the inlets in 6880 South, 6920 South, and 6960 South by installing a new parallel storm drain in 3200 West which bypasses the detention basin and connects to Project 16.	$1,323,000
3	2, 4, 5	3200 W and 6880 South, 6920 South, and 6960 South	City and modeling has identified flooding in this area, especially in the downhill cul-de-sac in 6960 South. Inadequate pipe capacity, low surface elevations, and conflicts with the outlet structure of the Constitution Park detention basin.	Lower Constitution Park base elevations by 2 feet, reconstruct incoming spill structures and piping so flows into the basin spill at or near the basin's lowest elevation, and reconstruct outlet works with a minimum 14-inch diameter orifice plate.	$1,296,000
4	7	Executive Drive between 7265 South and Richland Circle	City has identified flooding issues here in the past. The existing storm drain has low slopes. Modeling reveals that 10-year flows are over pipe capacity. The area is a low spot in the curb and gutter system, and ponding flows flood downhill driveways on the east side of the road. Connection issues between dual irrigation and storm drain lines.	Increase street inlet capacity and upsize existing 24-inch pipe to a 36 inch pipe with 30-inch pipe at the south end of Executive Drive. This solution should be done in conjunction with Project 11.	$544,000

CAPITAL IMPROVEMENT PLAN – NORTH AREA – TRIBUTARY TO 7000 SOUTH (3-12-2015)

PROJECT ID #	PROBLEM ID ADDRESSED	LOCATION	PROBLEM DESCRIPTION	PREFERRED SOLUTION	PROJECT COST ($)
5	8	Straw Circle	City has identified flooding issues here in the past. The required head to spill into the Harvest Park detention basin creates backwater effects. The area is a low spot in the curb and gutter system and has a downsloping driveway.	Due to elevation limitations with the outfall to the canal, piping solutions will have minimal effectiveness in alleviating the problems seen in Straw Circle. Surface drainage is likely critical to drainage in this area and appears to function sufficiently until flows reach the end of Straw Circle. The preferred solution should convey surface flows to the detention basin through a street-to-detention spillway with additional re-grading at the homes most affected by surface flows.	$26,000
6	9	6645 South and 2200 West	Piped storm drain daylights to open ditch which is frequently clogged with weeds, debris, and leaves.	Install 27-inch storm drain to replace the open ditch and continue 27-inch along 2200 West to alleviate surcharging.	$267,000
7	10	7055 South and 1115 West	City has identified erosion issues at the west end of 7055 South at this location. Current inlets do not connect into the storm drain system.	Replace inlets and connect to new 7000 S storm drain.	$54,000
8	11	Temple Drive from 6790 South to Storm Drainage near 7000 South	City has identified that this area lacks storm drain conveyances.	Install and upsize storm drains in 1300 West from Bateman Point Drive to 7000 South to 18-inch pipe.	$217,000
9	12	Drake Lane and Redwood Road	City has identified that ADS pipes crossing Redwood Road are damaged and need replaced.	Install new pipes by pipe bursting or similar trenchless construction.	$154,000
10	13	7600 South and Redwood Road	City has identified that ADS pipes crossing Redwood Road are damaged and need replaced.	Install new pipes by pipe bursting or similar trenchless construction.	$131,000
11	14	Camelot Way and 7175 South	City has identified flooding in low spot of curb and gutter. The inlets tie into irrigation/storm drain lines in backyards and lack and access manhole.	Install new 30-inch storm drain with inlets in Camelot Way from 7125 South to the new trunk line in 7000 South.	$250,000

CAPITAL IMPROVEMENT PLAN – NORTH AREA – TRIBUTARY TO 7000 SOUTH (3-12-2015)

PROJECT ID #	PROBLEM ID ADDRESSED	LOCATION	PROBLEM DESCRIPTION	PREFERRED SOLUTION	PROJECT COST ($)
12	15	Harvest Lane from 2200 West to 2290 West	City has identified flooding in this area. Modeling shows that storm drain may have adverse grades and act as bubble up in Arthur Drive.	Install new 21-inch storm drain in 2200 West from Harvest Lane to 7200 South (approximately) with 18-inch pipe and inlets at the intersection of 2200 West and Harvest Lane.	$153,000
13	16	Sunrise Place 1655 West	Isolated storm drainage in the strip mall bubbles up in the road and floods the strip mall parking lot.	Install new 18-inch storm drain from the existing bubble up grate in Sunrise Place to the existing 18-inch storm drain in Sunrise Place East.	$91,000
14	6	Harvest Ridge Drive between 7400 South and Jordan Meadows Lane	City has identified flooding issues here in the past. The existing storm drain has low slopes and the required head to spill into the Jordan Meadows detention basin creates backwater effects. The area is also a low spot in the curb and gutter system.	Install new 24-inch storm drain that will be disconnected from the other storm drain line coming to the detention from the west. This will alleviate the backwater effects in Harvest Ridge Drive.	$162,000
15	3	7480 South and Autumn Drive	City has identified local flooding issues here in the past.	Due to lack of surface options without causing flooding to adjacent homes, this solution should include 100-year storm event capacity. Upsize existing 15-inch outfall to the canal with a 30-inch with increased inlet capacity and add 18-inch storm drain with inlets in Spring Drive.	$78,000

CAPITAL IMPROVEMENT PLAN – NORTH AREA – TRIBUTARY TO 7000 SOUTH (3-12-2015)

PROJECT ID #	PROBLEM ID ADDRESSED	LOCATION	PROBLEM DESCRIPTION	PREFERRED SOLUTION	PROJECT COST ($)
16	17	6600 South and Clernates Drive	The system along 6600 south from Beargrass Road to the intersection of Clernates and along Clernates from 6600 South to Wake Robin Drive is generally overcapacity in a 10-year event. This is causing water to flow in the surficial street system where it is unable to be tracked by the model. This accounts for City observations of inlet capacity issues in this area – which the model reveals are more of a pipe capacity issue.	Upsize piping in the area to be able to convey 10-year flows in the pipe without surcharging. Pipes generally are upsized from 30-inch to 42-inch within the project area along 6600 South and south on Clernates to Saguaro.	$955,000
17	21	Approximately 7660 South from Sunrise Place to Temple Drive	Modeling shows that the existing storm drain/irrigation piping has insufficient capacity to convey flows to the North Jordan Canal.	Upsize storm drain piping to 21” following the existing storm/irrigation alignment.	$392,000

Maximum Design Flow Rates to 7000 South

Point Location	1	2	3	4	5	6	7	8	9	10	11	12	13
Storm Event	10 yr 24 hr	10 yr 1 hr	10 yr 1 hr	10 yr 1 hr	10 yr 1 hr	10 yr 1 hr	10 yr 1 hr	10 yr 1 hr	10 yr 1 hr	10 yr 1 hr	10 yr 1 hr	10 yr 3 hr	10 yr 1 hr
Flow Rate (cfs)	13	37	51	58	78	144	177	343	423	65	461	111	507

*Preliminary design of outlet structure for Constitution Park uses a 100 year 24 hour storm limited to inlet pipe capacity. With the modified detention basin (basin lowered by 2 feet), a 14" orifice plate at minimum is recommended.

HANSEN ALLEN & LUCE inc
ENGINEERS

City of West Jordan
Storm Drain Master Plan
7000 South Design Flows

Figure 4

AVERAGE STORM DRAIN SYSTEM COST PER FOOT

Diameter (in)	Diameter (ft)	Outside Diameter (ft)	Pipe Material & Installation (1)	Excavation	Imported Bedding Installed	Hauling Excess Native Mat'l	Trench Backfill Installed (3)	Trench Box per Day (2)	Average Daily Output	Trench Box Cost	Top Trench Width (ft)	Road Repair Width (ft)	Asphalt Cost	Manhole Cost	Inlet Cost	Curb & Gutter Cost	Utility Relocation	Trench Dewatering (4)	Total Cost per Foot of Pipe	Cost Out of Street (3)
15	1.3	1.46	37.50	5.13	15.24	4.89	0.90	210.00	150	1.40	4.86	8.86	35.13	9.20	13.5	0.00	0	0.00	123	89
18	1.5	1.75	45.00	5.77	17.24	5.72	0.96	210.00	132	1.59	5.15	9.15	36.12	0.00	13.5	0.00	0	0.00	126	91
21	1.8	2.04	52.00	6.46	19.29	6.62	1.02	210.00	120	1.75	5.44	9.44	37.11	9.20	13.5	0.00	0	0.00	147	111
24	2.0	2.33	62.00	7.18	21.39	7.58	1.08	210.00	100	2.10	5.73	9.73	38.10	9.20	13.5	0.00	0	0.00	162	125
27	2.3	2.63	87.50	7.94	23.54	8.60	1.13	210.00	92	2.28	6.03	10.03	39.08	9.20	13.5	0.00	0	0.00	193	155
30	2.5	2.92	95.00	8.74	25.73	9.69	1.19	210.00	88	2.39	6.32	10.32	40.07	9.20	13.5	0.00	0	0.00	206	167
33	2.8	3.21	108.50	9.58	27.98	10.84	1.25	210.00	76	2.76	6.61	10.61	41.06	9.20	13.5	0.00	0	0.00	225	185
36	3.0	3.50	122.00	10.46	30.27	12.05	1.31	210.00	72	2.92	6.90	10.90	42.04	15.70	13.5	0.00	0	0.00	250	210
42	3.5	4.08	149.00	12.33	35.00	14.66	1.42	210.00	72	2.92	7.48	11.48	44.02	15.70	13.5	0.00	0	0.00	289	246
48	4.0	4.67	172.00	14.35	39.92	17.53	1.54	210.00	64	3.28	8.07	12.07	45.99	21.70	13.5	0.00	0	0.00	330	286
54	4.5	5.25	210.50	16.53	45.03	20.65	1.65	210.00	54	3.89	8.65	12.65	47.96	21.70	13.5	0.00	0	0.00	381	335
60	5.0	5.83	249.00	18.87	50.34	24.02	1.77	210.00	48	4.38	9.23	13.23	49.94	32.00	13.5	0.00	0	0.00	444	396
66	5.5	6.42	297.00	21.36	55.84	27.64	1.89	210.00	44	4.77	9.82	13.82	51.91	32.00	13.5	0.00	0	0.00	506	456
72	6.0	7.00	345.00	24.01	61.54	31.51	2.00	210.00	40	5.25	10.40	14.40	53.89	32.00	13.5	0.00	0	0.00	569	517
78	6.5	7.58	400.00	26.81	67.43	35.64	2.12	210.00	36	5.83	10.98	14.98	55.86	32.00	13.5	0.00	0	0.00	639	586
84	7.0	8.17	455.00	29.77	73.51	40.02	2.23	210.00	32	6.56	11.57	15.57	57.83	32.00	13.5	0.00	0	0.00	710	655
6' x 3' box	6.0	6.00	315.00	19.57	41.67	25.03	1.80	210.00	140	1.50	9.40	13.40	50.50	9.20	13.50	0.00	0	0.00	478	429
8' x 8' box	8.0	8.00	475.00	28.91	53.58	38.74	2.20	210.00	100	2.10	11.40	15.40	57.27	9.20	13.50	0.00	0	0.00	680	626

Reference: 2015 RSMeans Heavy Construction Cost Data
Updated: 9/2014 RBS; 3/2015 GLJ

Assumptions:		Costs:	
N	**Total Import Trench Backfill? (Y/N)**	$ 5.82	/CY Native Trench backfill - 31 23 16.13: 3020 $2.93 plus compcation 31 23 23.23: $1.26; convert from loose to compacted volume. $4.19/LCY * 1.39 LCY/ECY
N	**Dewatering? (Y/N)**	$ 35.72	/CY Imported Select Fill recent bid including haul off of excess plus imported (10 miles one way) = $23.15 + $12.57 = $35.72
Y	**Catch Basins & Inlets? (Y/N)**	$ 6.15	/CY Excavation - 31 23 16.13 1375: 10-14 ft deep, 1 CY excavator, Trench Box.
	One side of street C&G is regraded (30' street).	$ 30.45	/SY 4" Asphalt Pavement - 32 12 16.13: 9" Bank run gravel base course ($23.15/CY), 2" Binder ($9.50/SY), 2" Wear ($10.55/SY [4"=$20.05/SY]) and Hauling ($9.20/LCY * 1.39LCY/ECY * 0.361CY/SY)
10	v:1h trench side slope (use trench boxes)	$ 2.58	/LF 4" Asphalt cutting - 02 41 19.25: Saw cutting asphalt up to 3" deep ($1.65/LF), each additional inch of depth ($0.93/LF)
3	' average depth to top of pipe	$ 2,300.00	/EA 4' Manhole (for pipes =< 2.5' diameter) - 33 49 13.10: Precast 8' deep ($2,300/ea), each add'l foot of depth ($280/VLF)
0.33	' thick asphalt road covering	$ 3,925.00	/EA 5' Manhole (for pipes > 2.5' and <= 3.5') -33 49 13.10: Precast 8' deep ($3,925/ea), each add'l foot of depth ($470/VLF)
0.75	' thick untreated base course	$ 5,425.00	/EA 6' Manhole (for pipes > 3.5' and <= 4.5') - 33 49 13.10: Precast 8' deep ($5,425/ea), each add'l foot of depth ($655/VLF)
250	' Average distance between manholes	$ 8,000.00	/EA Manholes (for pipes > 4.5')
3	+ Outside Diameter = Bottom trench width	$ 1,350.00	/EA Catch basins -33 44 13.13: Curb inlet frame, grate, and curb box, Large 24" x 36" heavy duty
1	' bedding over pipe	$ 13.97	/LF Curb & Gutter - 32 16 13.13: Steel forms, 24" wide, straight ($12.20/LF) and radius ($14.10). Plus 8" road base ($23.15 /cy or $1.20/lf) Calculated based on percentage of C&G on radius.
0.5	' bedding under pipe	$ 10.01	/CY Hauling - 31 23 23.20: 20 CY dump truck, line 4622 and conversion from loose to compacted volume. $7.20/LCY * 1.39 LCY/ECY
1	Inlets per 100 ft of pipe	$ 210.00	/day Trench Box (7' deep, 16' x 8',31 52 16.10 4500)
30%	of curb & gutter is on radius	$ 28.00	/CY Stabilization Gravel - recent bid
N	**Include Utility Relocation? (Y/N)**	$ 1,107.00	/day Dewatering - 31 23 19.20: 4" diaphragm pump, 8 hrs attended ($980/day). Second pump ($127/day)
N	**Include Curb and Gutter? (Y/N)**		
43.4%	Inflation since 1998. Used in updating Utility Relocation costs from 1998 tab. Rate from Consumer Price Index (CPI) by US Bureau of Labor Statistics. See http://data.bls.gov/cgi-bin/cpicalc.pl		
87.4%	RSMeans City Cost Index for Salt Lake City. NOT USED here.		

NOTES:

(1) Assumes Class 3 RCP (33 41 13.60). 33", 54", 66", & 78" costs were estimated by linear interpolation between sizes. Costs for these sizes may be much higher because they are odd sizes.
(2) 7' deep trench box (16' x 8') - on page 263
(3) Backfill Material & Installation assumes in street. For out of street unit costs, the backfill material cost has been added in place of base course and asphalt.
(4) Dewatering assumes 1' stabilization gravel at the bottom of the trench plus dewatering pumps
(5) Conversion from loose to compacted volumes assumes 125 PCF for compacted density and 90 PCF for loose density. Or (125 PCF/ECY)/(90 PCF/LCY) = 1.39 LCY/ECY
(6) Conversion from cubic yards to square yards for hauling of asphalt paving assumed a total thickness of 13". 3 ft x 3 ft x (13 in)/(12 in/ft) = 0.361 CY/SY

Abbreviations:

VLF	vertical lineal foot
PCF	pounds per cubic foot
LCY	loose cubic yard
ECY	embankment cubic yard