Providence City Corporation

Storm Water Master Plan

Publication Date: February 2019

Prepared by

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NATHAN WILLIAM WRIGHT
2-26-19
STATE OF UTAH

1.0 INTRODUCTION

Historically Providence has been able to get by with limited storm water planning because it is a relatively small community. However, rapid growth over the past few years has created a need for the City to develop a plan to better manage the storm water system to accommodate future growth. Providence City has retained CRS Engineers to prepare this storm water master plan. The purpose of this report is to identify existing major storm water facilities and develop a long-term plan to manage storm water throughout the City.

1.1 BACKGROUND

Providence City was settled in 1859 and was the 2nd community settled in the Cache Valley. The existing topography slopes from the mountains on the east across the valley to the west. Spring Creek runs through Providence and serves as the major drainage outlet for the City. There are two canals that collect storm water and convey flows north toward Spring Creek. Additionally, two springs drain the west portion of the City. These springs cross through Logan City and discharge into the Blacksmith Fork River.

1.2 SCOPE OF INVESTIGATION

The scope of this study includes the following:

- Inventory of existing major drainage facilities.
- Delineation of hydrologic subbasins.
- Development of a Hydrologic/Hydraulic Model to estimate peak storm water flows throughout the City.
- Evaluate storm water facilities and propose recommendations for management of storm water throughout the City.
- Develop a storm water capital facilities plan.

Factors that were not considered in this report or the storm drainage model scenarios that may contribute to local flooding are as follows:

- *Hydraulic and hydrologic analysis of open channels including; Spring Creek, Providence Blacksmith Fork Canals, Little Ballard Springs, and Big Ballard Springs.* It is assumed in this investigation that sufficient capacity exists in these open channels and other open channels to allow storm water discharge without significant backwater effects.
- *Snowmelt conditions* – periods of peak snowmelt may decrease available capacity in the existing watercourses for storm water flows, creating a potential for flooding to occur.
- *Irrigation flows* – periods of peak irrigation may decrease available capacity in the existing joint watercourses for storm water flows, creating a potential for flooding to occur.
- *Subsurface drainage systems (land drains) installed for reducing groundwater levels for agricultural purposes* – interruption of flow or damage to these facilities caused by ongoing development will likely increase localized flooding. However, prediction of these effects is beyond the scope of this investigation. It should be noted that no specific provisions are included in the proposed storm drain facilities to intercept flows currently carried by land drains.
- *Clogging of inlets and storm drains* – this investigation assumes that the inlet structures and water conveyance systems are free from excessive debris and other items of potential clogging. It also assumes that all pipes, inlet structures and outlet structures are fully functional. Localized flooding may exist due to clogged or partly clogged structures. It has also been assumed that sufficient inlets have been provided to collect storm water. If there is a shortage of inlets in an area, it may lead to local flooding and accumulation of water in the streets.

2.0 EXISTING SYSTEM

A master plan requires inventory of existing major facilities. Prior to this study, the City last updated the storm water map in October of 2007. A copy of this map can be found in Appendix A. This map was used to identify major conveyance facilities in the City. CRS staff worked with City staff to identify additional areas where further investigation was required to get a better understanding of the existing storm water system.

2.1 FIELD RECONNAISSANCE

There were several storm water facilities that were not identified on the City's storm water map. Site visits were made to get an understanding of how the storm water system worked in these areas and collect measurements on major facilities. This data was used to update the City's storm water map. *Figure 2-1* shows the major storm water facilities in the City. Survey data was not available for this project and maps have been shown schematically based on aerial maps. Pipe capacities have been estimated using approximate ground slopes taken from Google Earth and measured pipe sizes.

2.2 CONVEYANCE FACILITIES

There are several types of facilities that are used to convey storm water in the City including streets, open channels, and pipes. These facilities are used to capture and transport water towards the Logan River and out of Providence City. One unique characteristic of storm water in Providence is that irrigation and storm water are combined in the same conveyance facilities. This is common throughout the City but is especially the case in the old downtown areas. This can be problematic as storms can occur while irrigation water is in the system, limiting the capacity in these facilities for storm water conveyance. However, as irrigation demands decrease due to development throughout the City, capacity in these facilities should increase.

2.2.1 STREETS

Streets often act as the first conveyance for storm water flows. The City has two main categories when discussing streets. First, current City standards require that streets are constructed with curb and gutter. This allows for better control in collecting and conveying storm water toward the streets and then towards an outfall. Second, older parts of town have areas where there is little or no curb and gutter. In these cases, storm water typically sheet flows across the existing topography towards the outfall. In this case there is much less control over where storm water will flow and the grading around structures becomes much more important in protecting against flooding damage. However, it does allow for more infiltration as storm water is conveyed across permeable surfaces.

2.2.2 OPEN CHANNELS

There are several open channels that run throughout the City. Of major interest is Spring Creek, Providence Black Smith Fork Canals, Little Ballard Springs, and Big Ballard Springs. These facilities collect storm water from multiple streets and pipes and convey flows downstream towards the Logan River.

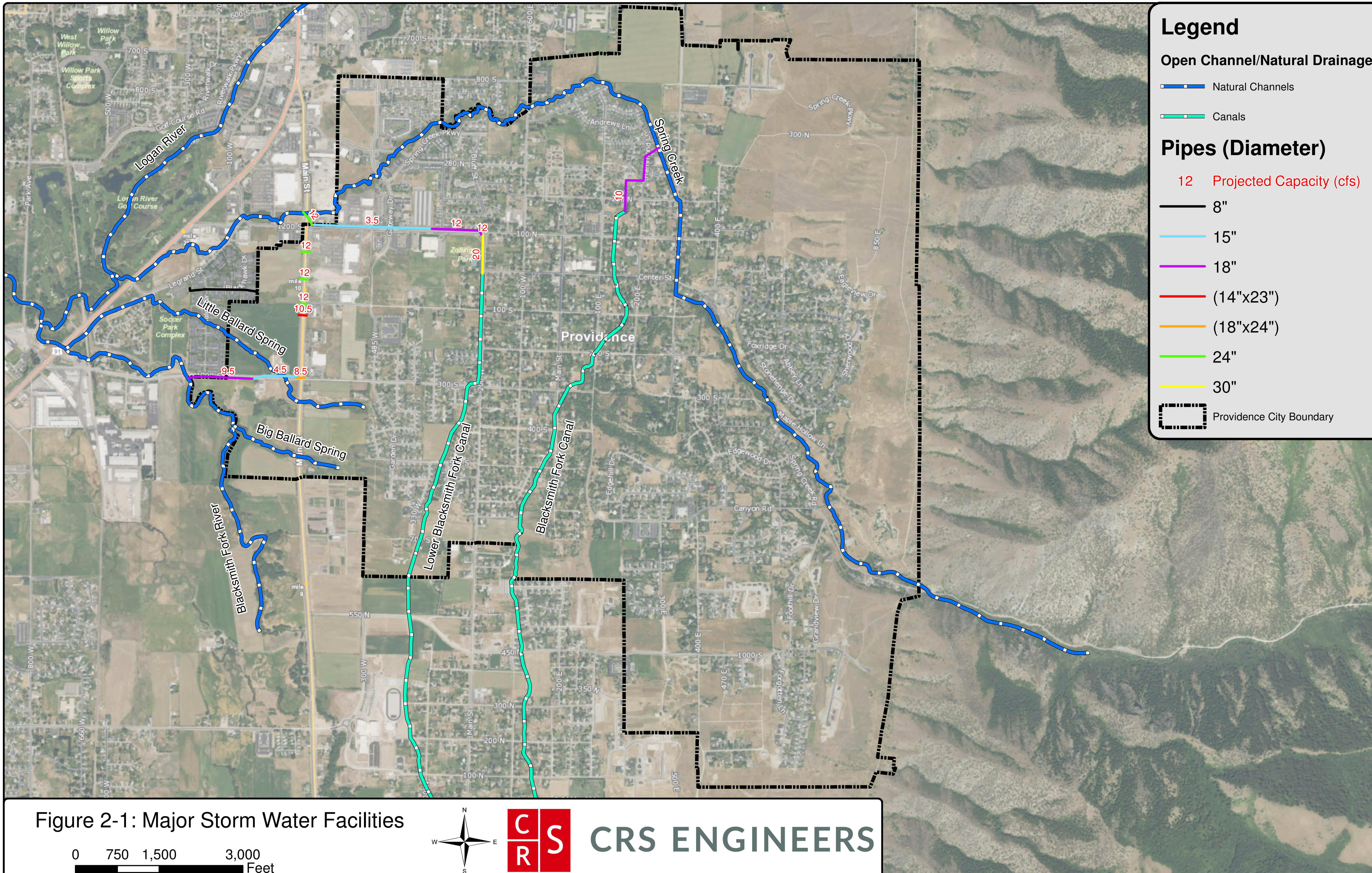

Figure 2-1: Major Storm Water Facilities

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2.2.3 PIPES/CULVERTS

Providence City does not have a large network of pipes collecting storm water throughout the City. However, there are many shorter pipe networks that discharge into open channels. Many of these facilities are not evaluated in this report as they only serve local developments. However, pipes that serve large areas or multiple developments and are considered to be major facilities have been identified in this report and are shown on Figure 2-1.

2.3 STORAGE FACILITIES

Development typically increases the peak discharge of an area as natural permeable areas are replaced with hardscape such as concrete, asphalt, and buildings. City standards require that new development detain flows to 0.2 cfs per acre to try and mimic pre-development conditions. In addition to detention, there are areas of the City where developers elected to retain storm water in the absence of downstream conveyance facilities. Properly designed storage facilities will reduce the peak discharges from these areas allowing downstream conveyance facilities to be smaller.

2.3.1 DETENTION FACILITIES

Providence City does not have any regional detention facilities because the City has chosen to require each development to detain flows to 0.2 cfs per acre. We were not scoped with evaluating all existing detention facilities but have assigned a discharge rate of 0.2 cfs per acre. Detained areas have been identified on Figure 2-2. Detention facilities should be required to have a downstream conveyance system to convey all runoff safely to a designated outfall.

2.3.2 RETENTION FACILITIES

In some areas of the City, there are no downstream conveyance facilities. For this reason, retention ponds and or sumps have been installed by developers in areas with high infiltration rates. These ponds/sumps have often been installed for small developments and are located throughout the City. We were not scoped to evaluate each of the existing local retention facilities, but have assigned a zero discharge value for the areas that are retained by these facilities. Figure 2-2 identifies the areas served by retention facilities. Percolation rates associated with retention facilities typically decrease with time, as sediment and vegetation fill in voids near the surface. These facilities should be monitored and maintained as necessary. Additionally, each facility shall have an emergency overflow that directs runoff away from structures and property and safely conveys stormwater to an outfall.

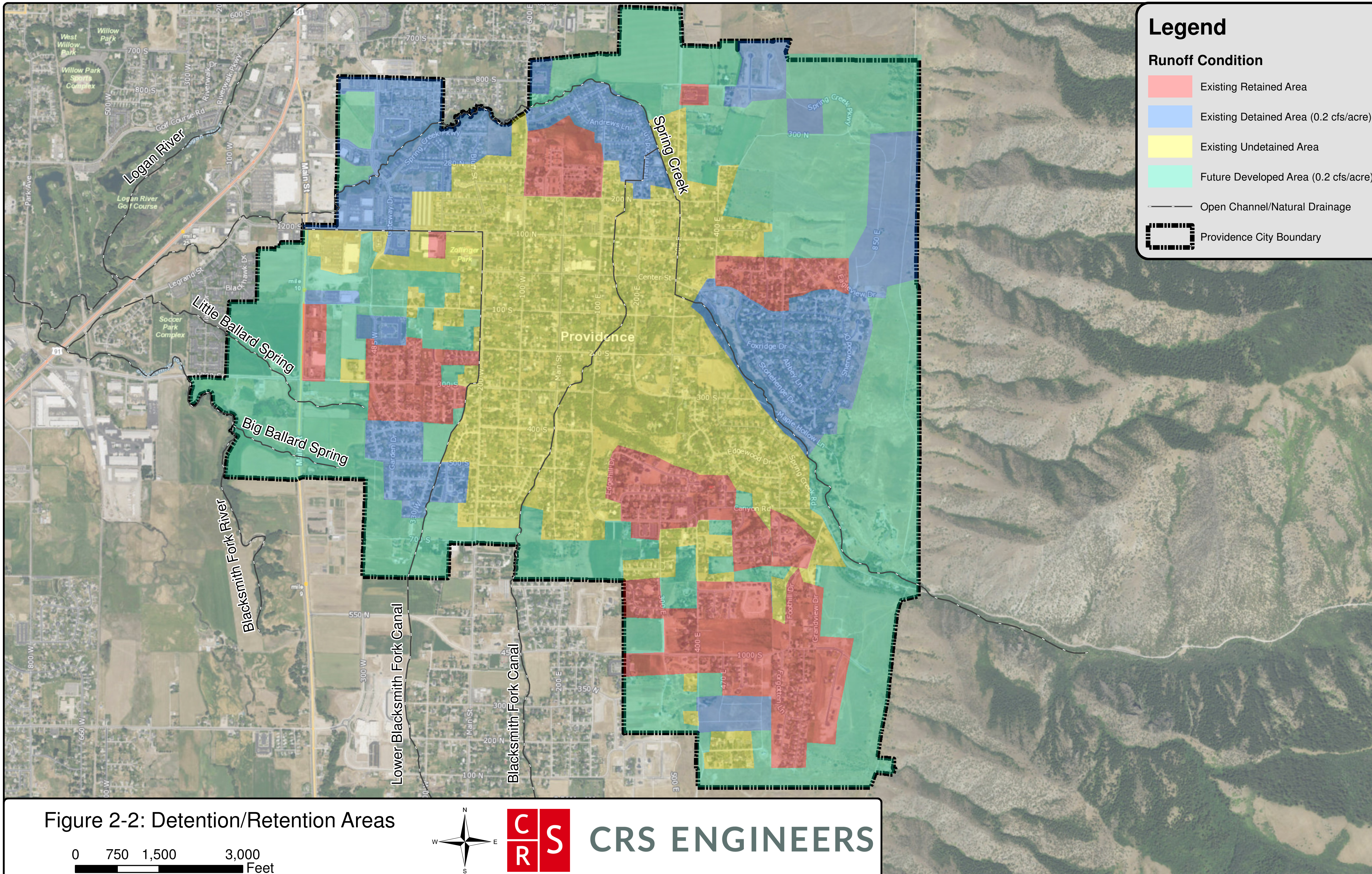

Figure 2-2: Detention/Retention Areas

3.0 METHODOLOGY

This section discusses the criteria, methods, and assumptions used to complete the modeling for this storm water master plan. A hydrologic model was developed using HEC-HMS to estimate runoff volumes and peak discharges for each subbasin in the City based on the design rainfall events. The model was also used to complete basic hydraulic routing of flows through the City. The processes used to complete the model are described in more detail in the following sections.

3.1 SUBBASIN DELINEATION

Subbasins were developed using contour data available for the City. 25 subbasins were delineated throughout the City. These basins were then reviewed by City staff and adjusted as necessary. Figure 3-1 shows the delineation of the subbasin boundaries within the City.

3.2 HYDROLOGIC MODEL INPUT PARAMETERS

There are several different modeling approaches which are generally accepted in the industry. The method chosen for this master plan was the SCS curve number method. This method allows for the separation of pervious and impervious areas and requires curve number data regarding soil types and lag time. A model was developed for evaluation of both the existing and future conditions. The following sub-sections describe significant model input parameters and the methods used.

3.2.1 CURVE NUMBERS

The hydrologic model uses curve numbers to represent the permeability of the ground. Higher curve numbers indicate that less water will infiltrate into the ground, producing greater run off quantities, while lower curve numbers result in greater infiltration and less runoff. Using the NRCS TR55 publication, the combination of the land cover with the hydrologic soil group of the underlying soils allows for the determination of curve number. Each of the major watershed zones was divided into sub-basins. Composite curve numbers for each sub-basin were developed using this method. Hydrologic soil types were taken from the NRCS web-soil survey map shown in Figure 3-2.

3.2.2 LAG TIME

The lag time was calculated for each subbasin. Lag time represents the time between the centroid of precipitation and the peak flow. However, it is often approximated by using the time of concentration. The NRCS has found the lag time to generally be 60 percent of the time of concentration. This process was followed by calculating the time of concentration per the methods outlined in TR-55 manual and then using a lag time that was 60 percent of the time of concentration.

3.2.3 DIRECTLY CONNECTED IMPERVIOUS AREA

Directly connected impervious area (DCIA) is hardscape, (i.e. asphalt, concrete, buildings, etc.) with very low infiltration rates, that is connected directly to a conveyance facility (i.e. pipe, ditch, etc.). Runoff from a DCIA does not run across pervious surface (lawns, fields, open space, etc.) and therefore has very little or no infiltration. Estimated DCIA was calculated for each land use type based on existing

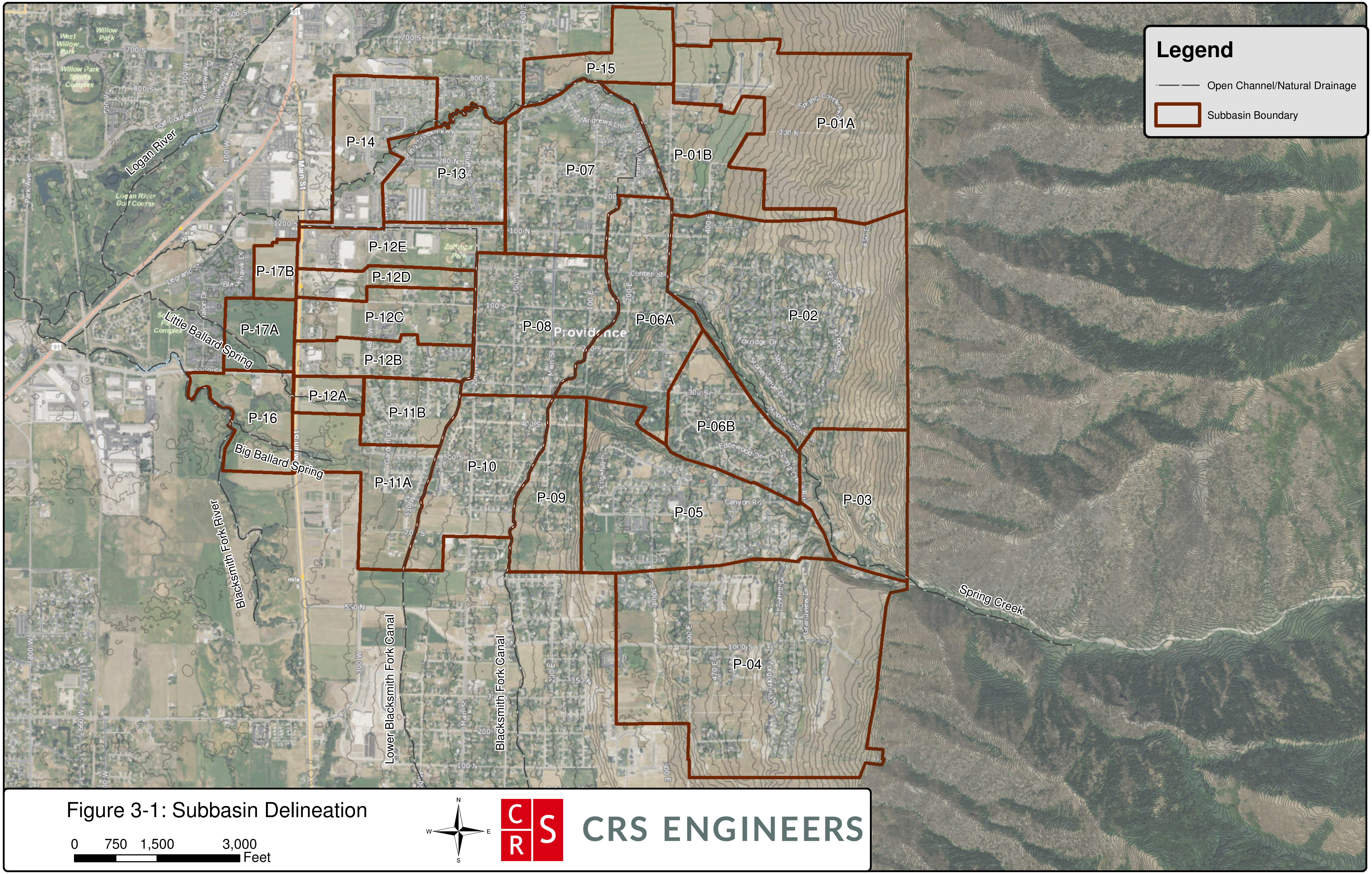

Figure 3-1: Subbasin Delineation

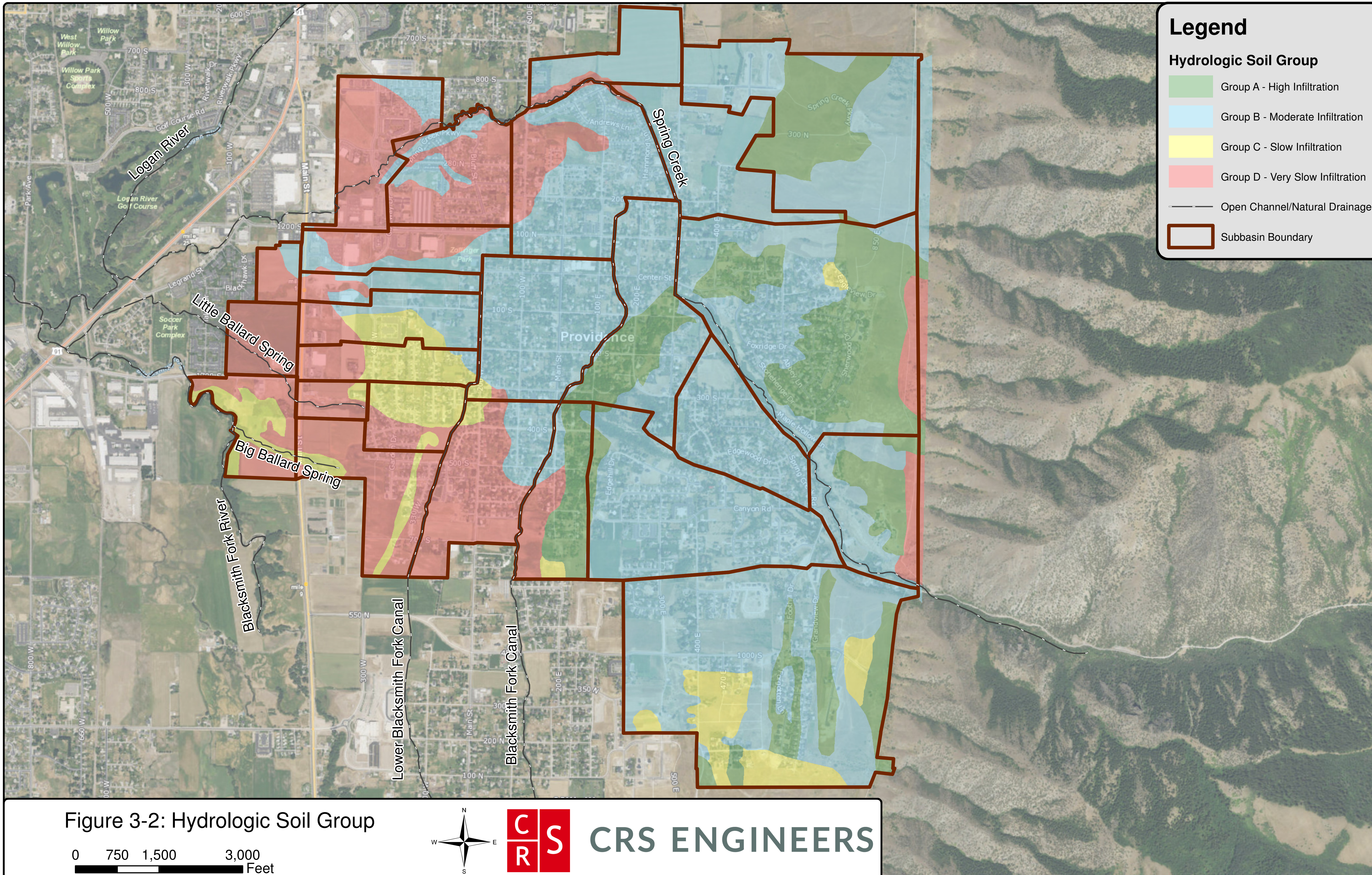

Figure 3-2: Hydrologic Soil Group

aerial maps. DCIA estimates were made for each subbasin under existing and future conditions based on the City's land use/zoning maps.

3.3 PRECIPITATION DATA

3.3.1 DESIGN STORM

There are two types of storms that are typical for the Cache Valley. Short duration high intensity "cloudburst" type storms and long duration storms. The Farmer Fletcher storm distribution was developed based on research completed in areas of Davis County. This distribution is for short duration storms and has a high intensity associated with cloud burst events that are often seen in Northern Utah. These storms typically produce large peak runoffs in developed areas even though the volumes are generally small compared to long duration storms. However, low volumes associated with short duration storms may lead to storage facilities being undersized. Therefore, a long duration storm was also evaluated. The NOAA Atlas 14 storm distribution is intended for longer duration storms ranging from 6- to 96- hour durations. NOAA developed this distribution for the semiarid southwest which includes all of Utah. The NOAA Atlas 14 storm distribution is a commonly accepted method and has been used by FEMA, NRCS, and other local jurisdictions throughout Utah. Both of these storms were modeled, and the worst case was used for sizing storm water facilities.

Precipitation data specific to the area was obtained from the NOAA Atlas 14 publication. This information has been included in Appendix B. The total precipitation of the two chosen storms is shown in Table 3-1.

Table 3-1: Precipitation Data

Return period	Duration	Precip. (in)
25-yr	1-hr	0.974
100-yr	24-hr	3.27

3.4 HYDRAULIC MODELING CRITERIA

A hydraulic model consists of storm water facilities used to convey, store, and route storm water through a system. HEC-HMS was used to develop peak runoff from each subbasin for both existing and future scenarios. Peak runoff was then routed through the system using simulated conveyance and storage facilities. Parameters associated with these facilities are discussed in more detail in the following sections.

3.4.1 CONVEYANCE SYSTEM

As can be seen in Figure 2-1, there are several canals and natural channels that run from east to west and south to north through Providence City. These channels have historically divided the City into several drainage areas as each channel served as an outfall for runoff. The canals and other conveyance networks throughout the City combine storm water and irrigation flows. This complicates modeling of the system as irrigation users can open gates, create dams, and control the system. This could be beneficial if storm water is dispersed through multiple irrigation systems and is spread over pervious areas where it can infiltrate. However, it can also be detrimental as irrigation base flows can be in the system during a storm, reducing the capacity of the system available for storm water. Although irrigation turnouts may be open during a rainfall event, we have assumed all turnouts are closed. For this report, we have only accounted for capacity in the main networks and have not accounted for any flow distribution in laterals serving irrigation users.

Figure 2-1 shows the major conveyance facilities that have been evaluated. These facilities have been measured for size only and approximate slopes have been estimated using available contour data. This will give an approximate capacity for these facilities. These assumptions help in master planning, but prior to final construction it is recommended that all major facilities be surveyed for slope determination, and capacities verified. These capacities should be compared to peak runoffs presented in this report.

3.4.2 DETENTION FACILITIES

As stated previously, there are several areas of the City that have local detention facilities. However, the areas served by the detention facilities have been modeled to have a restricted discharge of 0.2 cfs per acre which is in accordance with the City's standards. All future detention areas have been modeled in the same manner.

3.4.3 RETENTION FACILITIES

Similar to the detention facilities, there are many retention ponds/sumps that serve local developments. These areas were modeled to produce zero runoff in the design storm. These facilities should continue to be monitored and maintained to assure proper operation.

4.0 SYSTEM ANALYSIS

This section discusses the criteria, methods, and assumptions used to evaluate the storm water system for this master plan. The acceptable level of service for the different types of facilities found within the storm water system are described and facilities are evaluated based on these criteria. Existing and future deficiencies are also identified.

4.1 EVALUATION CRITERIA

In order to evaluate facilities, an existing level of service must be established. The City desires to have major facilities meet the following criteria.

4.1.1 PIPELINES

Storm water facilities should be designed to convey peak flows without allowing storm water to surcharge during the design storm event. This means that the design storm should be contained underground. In events larger than the design storm, storm water could bubble up and flow along the surface in roadways or other conveyance facilities.

4.1.2 CANALS

City staff are not aware of any deficiencies with the existing canal system and no canals were evaluated as part of this scope. However, to maintain the current function of the system, storm water discharge into the canal will be limited to current existing flows. All runoff associated with future development will need to be conveyed in new storm drain facilities.

4.1.3 STORAGE FACILITIES

Storage facilities include, detention basins, retention basins, sumps, and any other facility that stores storm water runoff. These basins should be designed based on a 100-year storm as outlined in the City's design standards.

4.1.4 NATURAL CHANNELS

There are several natural channels that run through Providence City including Spring Creek, Little Ballard Springs, and Big Ballard Springs. These facilities typically convey water from mountain areas outside of the City or other natural sources. Evaluation of these natural channels was not part of the original scope. For the purpose of this study we have assumed these channels have adequate capacity to convey storm water runoff.

4.2 EXISTING SYSTEM ANALYSIS

The results of the model can be seen in Figure 4-1. Discharge arrows are shown for each subbasin with estimated peak runoff for each subbasin during the design storm. In addition to peak runoff, pipe capacity has been shown for each major conveyance facility. Based on the results presented in Figure 4-1 a few deficiencies were identified.

4.3 FUTURE SYSTEM ANALYSIS

The existing model was then updated to simulate future growth. The results of the projected build out scenario can be seen in Figure 4-2. Similarly, peak runoff from each basin is shown along with the capacity of the existing pipes.

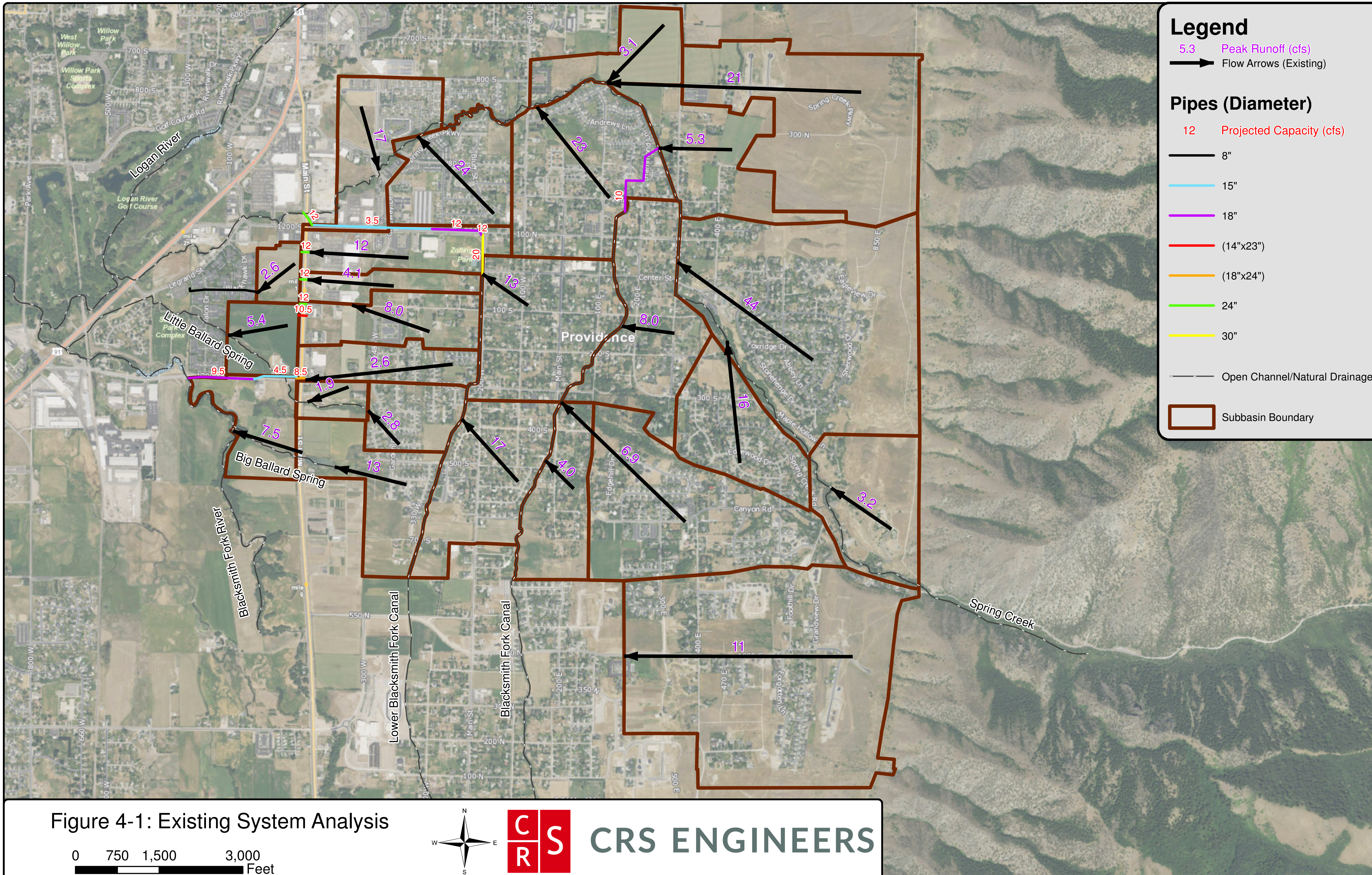

Figure 4-1: Existing System Analysis

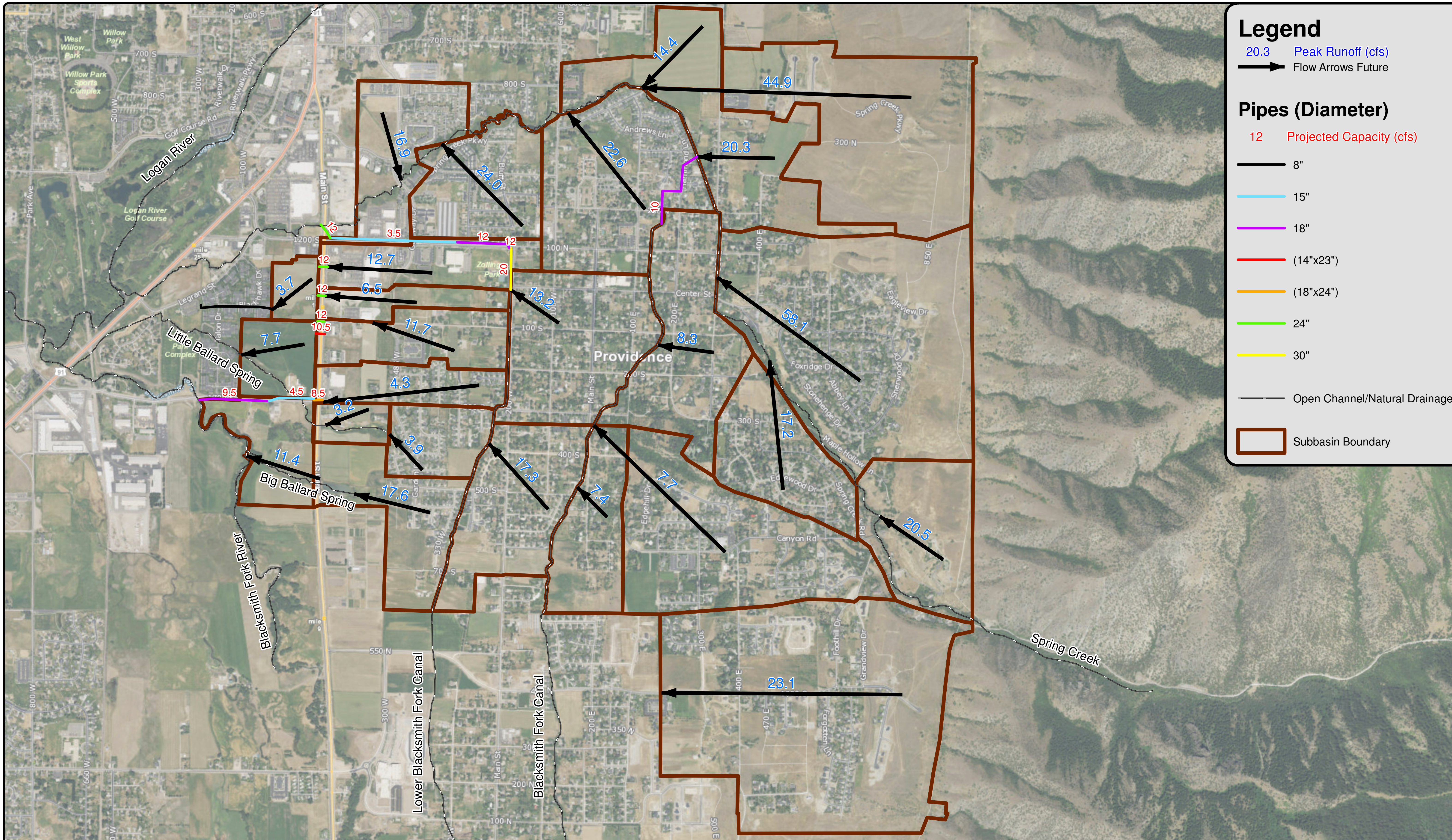

Figure 4-2: Future System Analysis

5.0 CAPITAL FACILITIES PLAN

Generally, the existing storm water system works well for the design storm. However, there are a few areas of the City that require improvements. The proposed improvements are to mitigate existing deficiencies and/or provide capacity for projected growth.

5.1 RECOMMENDED IMPROVEMENTS

After the hydrologic and hydraulic models were developed, a meeting was held with City staff. The following items were discussed in order to refine and calibrate the model.

- review areas that have been identified by the model as deficient and identify any additional problem areas known to City staff
- review solutions and propose alternatives that could be considered
- compare solutions based upon schematic cost estimates, function, feasibility, public conception, etc.
- selected preferred alternatives

Based on the results of the model and decisions made during meetings with City personnel the following projects have been identified as part of this master plan. Several conveyance and storage projects have been recommended. as shown in Figure 5-1. Table 5-1 and 5-2 summarize those projects along with the estimated cost of each project. In addition to these projects, it is recommended that the City begin collecting Survey data on storm water facilities and updating the maps as necessary.

Table 5-1: Conveyance Facilities

Project Label	Address	Pipe Size (Inches)*	Estimated Flow (cfs)	Description	Estimated 2019 Cost
P-1A	Spring Creek Parkway & 300 E	24	44.9	Install new 24" pipe with 44.9 cfs capacity	$80,634.40
P-1B	Spring Creek Parkway & 300 E	30	54.9	Install new 30" pipe with 54.9 cfs capacity	$196,743.36
P-2	300 N 300 E	24	20.3	Install new 24" pipe with 20.3 cfs capacity	$138,961.78
P-3A	500 S 200 W	18	4.5	Install new 18" pipe and overflow structure with a minimum of 4.5 cfs capacity.	$300,233.08
P-3B	500 S Garden Dr.	24	14.7	Install new 24" pipe and overflow structure with a minimum of 14.7 cfs capacity.	$352,743.50
P-4	100 N Gateway Dr.	24	20	Install new 24" pipe with a minimum of 20 cfs capacity.	$495,049.40
P-5	800 W 100 N	30	22.9	Install new 30" pipe with 22.9 cfs capacity.	$115,375.00

* Pipe sizes are approximate. Pipe size will need to be determined during design for proposed flows shown in this report.

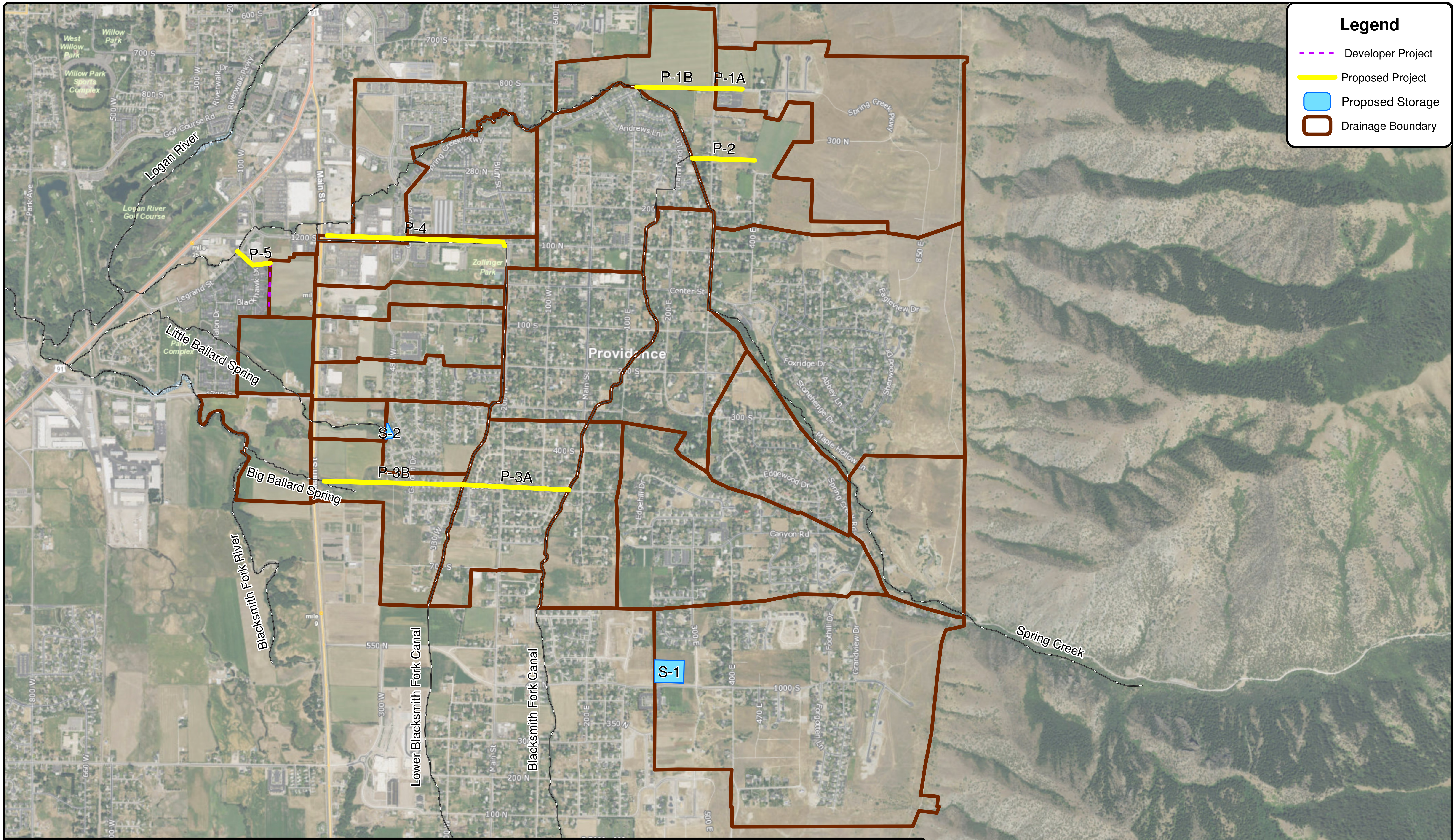

Figure 5-1: Proposed Projects

0 750 1,500 3,000 Feet

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Table 5-2: Storage Facilities

Project Label	Address	Detention Volume (AF)	Proposed Release Rate (cfs)	Description	Estimated 2019 Cost
S-1	1000 S 200 E	14.3	0	Construct new 14.3 AF retention pond with overflow to 1000 S	$975,701.34
S-2	400 S 485 W	2.3	0.5	Upsize existing detention basin for a total of 2.3 AF. Reduce orifice to allow a maximum of 0.5 cfs release rate.	$132,036.22

5.2 CONVEYANCE PROJECTS

Due to the lack of existing conveyance facilities in the City, the majority of the proposed projects are for new conveyance facilities. These facilities will primarily take runoff associated with new development to major outfalls along Spring Creek and Little Ballard Springs. There are also some conveyance facilities which are necessary to mitigate existing capacity issues and provide additional capacity for future growth. The proposed conveyance projects are outlined below.

It is important to note that all pipe sizes are approximate and have been used for cost estimating. During design final pipe sizes will need to be calculated based on actual design slopes and sized for the estimated flows shown in Table 5-1.

- P-1 – Spring Creek Parkway Projects

  This project is necessary to continue an existing storm drain line that ends near 400 East. This project will convey both existing flows as well as provide additional capacity for future development.

  The project has two parts. P-1A is the extension of a recently installed 24” pipeline that ends near 400 East. It is estimated that a new 24 inch pipe can be extended approximately 740 feet along the north edge of Spring Creek Parkway ending at a manhole on the east side of the intersection of Spring Creek Parkway and 300 East. From this point P-1B continues with a new 30 inch pipe from the end of project P-1A west to Spring Creek.

- P-2 – 300 North Extension

  This project will allow runoff associated with future development to the east to cross through the existing development providing a new discharge to Spring Creek. Currently, runoff discharges on the undeveloped land, but as this land develops runoff is anticipated to increase and will require a new route to Spring Creek.

  Project P-2 is projected to be a new 24 inch pipe that is proposed to run from approximately 350 E to Spring Creek at approximately 300 North. The exact location of this pipeline may vary based on future development, but runoff from the entire subbasin should be able to be conveyed to and through this pipe.

- P-3 500 South Canal Overflow

  The existing Blacksmith Fork Canals are believed to handle existing storm water and irrigation flows. However, the City desires to remove runoff associated with future development. For this reason, this project should be design to allow all base flows to remain in the canal while taking additional storm water flows in a new pipeline that discharges into Big Ballard Springs. This project will require coordination with the irrigation company to assure that irrigation baseflows remain in the channel, and the stormwater can be diverted out of the canal.

  It is estimated that approximately 1800 linear feet of 18-inch pipe will be require from the upper canal to the lower canal (P-3A). In addition to the pipe an overflow structure will be required at the upper canal. A new overflow structure and approximately 2000 linear feet of 24-inch pipe is proposed from the lower canal to Big Springs (P-3B). Project P-3B will not only convey runoff associated with future development, but also an additional 10.5 cfs which will allow for existing facilities in 100 North to handle projected flows.

- P-4 – 100 North Upsize

  The existing system in 100 north has been sized primarily for irrigation flows. For this reason, pipe sizes decrease as you go downstream. However, storm water functions differently from irrigation as flows increase as you go downstream. For this reason it is proposed that existing pipes be upsized to accommodate storm water runoff. The existing crossing of Highway 165 is a 24-inch pipe which as an estimated capacity of 20 cfs. In order to avoid needing to replacing this pipeline, additional flows are proposed to be taken out of the canal at 500 South as part of project 3B.

  It is estimated that this project will require approximately 3,020 linear feet of new 24-inch pipe be installed along the north side of 100 North. Coordination with the irrigation company will be required to verify that storm water runoff and irrigation base flows can be conveyed in this new pipe.

- P-5 – 800 West Project

  An existing 8-inch pipe runs from the existing ditch through the Blackhawk development towards Little Ballard Springs. The existing 8” line has very little capacity and is outside of Providence City limits. Local irrigators indicated that irrigation use is limited to daytime hours as the 8-inch line can be overwhelmed by irrigation runoff. Although we are not aware of any flooding caused from storm water, a major concern exists in relying on the existing 8-inch line.

  Due to relatively flat topography it is estimated that approximately 660 linear of feet of 30-inch pipe would be required to convey existing and future storm water runoff through Logan City to a new outfall in Spring Creek.

5.3 STORAGE PROJECTS

- S-1 – 1000 S Retention Pond

  This project is necessary to control runoff from the southeast portion of the City that discharges into Millville City. Retention has been readily used in this part of the City due to the high infiltration rates in the area. This project will allow for future development in this part of the City to discharge to a large regional retention pond. Before final design percolation rates should be calculated to verify the pond can drain in accordance with City standards.

Project S-1 will add 14.3 acre feet of storage capacity, while taking advantage of the estimated infiltration capacity of the existing soil. In addition to acting as a storm water facility, the site could potentially be used as a local park/recreational fields for use by the citizens of Providence.

Currently, a significant portion of subbasin P-04 is being retained. This plan allows for flexibility in development in this area by allowing detention. However, if detention is elected by the developer, the City may require underground conveyance of all discharge to the proposed retention pond. As an alternative, retention in some areas may be acceptable to the City, if adequate infiltration rates can be proven. If local retention facilities are allowed, the proposed retention volume or project S-1 could be reduced.

- S-2 – 400 South Detention Pond Expansion

  Due to constraints of existing downstream facilities in Logan City, this project is intended to limit storm water discharge associated with future development without increasing the total amount of stormwater discharged from Little Ballard Springs into Logan City.

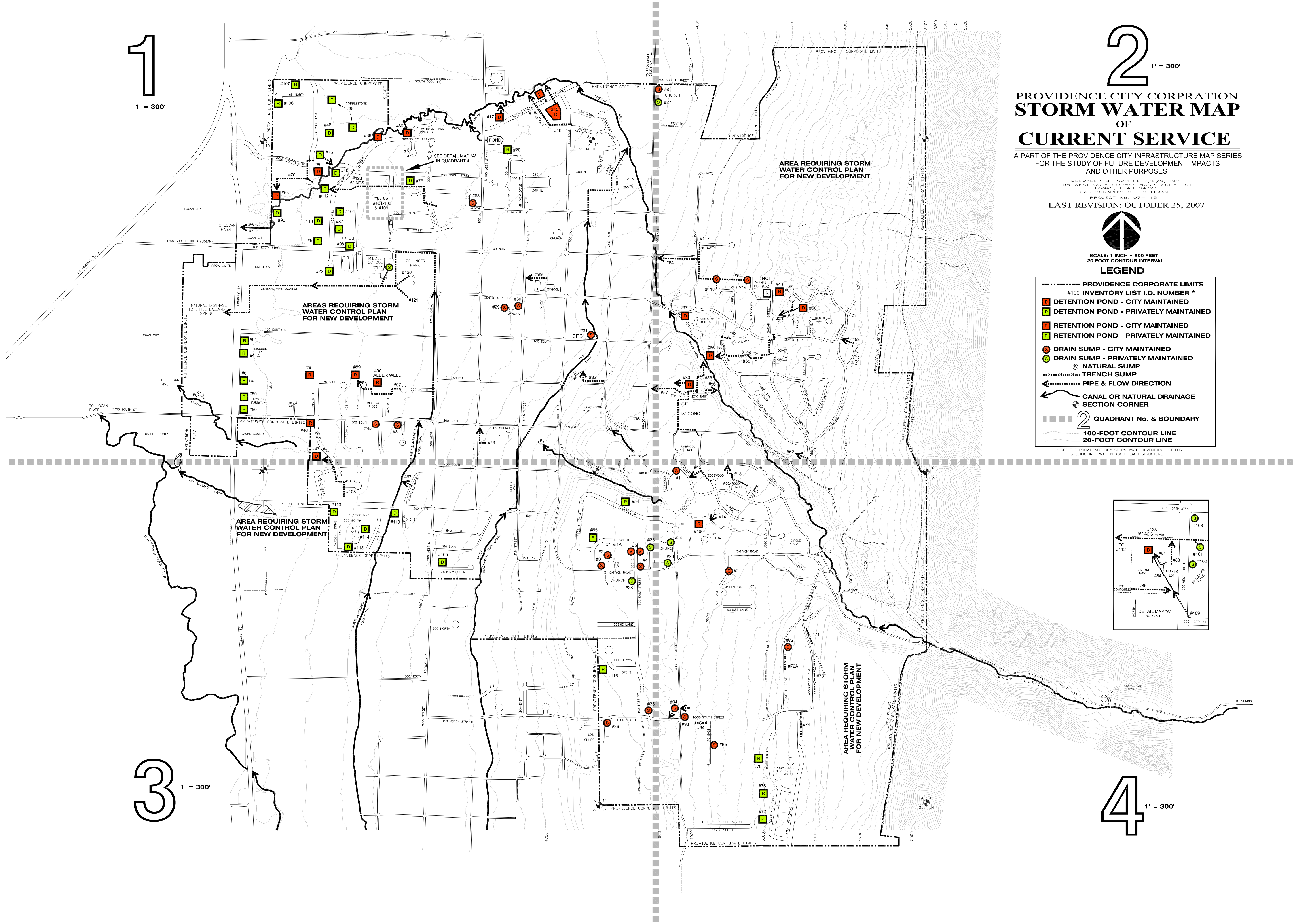
  Project S-2 is planned to increase the capacity of the existing pond by raising the banks surrounding the pond. Adding capacity will allow for the release rate in the pond to be decreased to 0.5 cfs. This will accommodate projected future downstream development without increasing the net stormwater discharges into downstream facilities in Logan City.

5.4 COST ESTIMATES

A schematic level estimate of the storm water improvement costs can be found in Appendix C. It includes quantity estimates, unit costs, and total estimated costs for all the proposed projects identified in this master plan, including installation and/or construction of new detention ponds, pipes, ditches, control structures, and other channel improvements.

All projects are identified by the project number or name corresponding to Figure 5-1. Each project is broken down into smaller cost elements to determine unit costs for the various parts of the projects. The unit costs were determined based on past projects completed by CRS Engineers. A contingency markup of 20% is applied to each project.

APPENDIX A
2007 STORM WATER MAP


PROVIDENCE CITY CORPRATION
STORM WATER MAP
OF
CURRENT SERVICE
A PART OF THE PROVIDENCE CITY INFRASTRUCTURE MAP SERIES
FOR THE STUDY OF FUTURE DEVELOPMENT IMPACTS
AND OTHER PURPOSES
PREPARED BY SKYLINE A/E/S, INC.
95 WEST GOLF COURSE ROAD, SUITE 101
LOGAN, UTAH 84321
CARTOGRAPHY: G.L. GETTMAN
PROJECT No. 07-115
LAST REVISION: OCTOBER 25, 2007
SCALE: 1 INCH = 500 FEET
20 FOOT CONTOUR INTERVAL
LEGEND
PROVIDENCE CORPORATE LIMITS
#100 INVENTORY LIST I.D. NUMBER *
DETENTION POND - CITY MAINTAINED
DETENTION POND - PRIVATELY MAINTAINED
RETENTION POND - CITY MAINTAINED
RETENTION POND - PRIVATELY MAINTAINED
DRAIN SUMP - CITY MAINTAINED
DRAIN SUMP - PRIVATELY MAINTAINED
NATURAL SUMP
TRENCH SUMP
PIPE & FLOW DIRECTION
CANAL OR NATURAL DRAINAGE
SECTION CORNER
QUADRANT No. & BOUNDARY
100-FOOT CONTOUR LINE
20-FOOT CONTOUR LINE
* SEE THE PROVIDENCE CITY STORM WATER INVENTORY LIST FOR SPECIFIC INFORMATION ABOUT EACH STRUCTURE.
1
1" = 300'
2
1" = 300'
3
1" = 300'
4
1" = 300'
AREAS REQUIRING STORM WATER CONTROL PLAN FOR NEW DEVELOPMENT
AREA REQUIRING STORM WATER CONTROL PLAN FOR NEW DEVELOPMENT
AREA REQUIRING STORM WATER CONTROL PLAN FOR NEW DEVELOPMENT
AREA REQUIRING STORM WATER CONTROL PLAN FOR NEW DEVELOPMENT
SEE DETAIL MAP "A" IN QUADRANT 4
DETAIL MAP "A"
NO SCALE
PROVIDENCE CORPORATE LIMITS
TO LOGAN RIVER
TO LITTLE BALLARD SPRING
TO SPRING

APPENDIX B
NOAA ATLAS 14
PRECIPITATION DATA

NOAA Atlas 14, Volume 1, Version 5
Location name: Providence, Utah, USA*
Latitude: 41.7081°, Longitude: -111.8127°
Elevation: 4651.03 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.108 (0.096-0.122)	0.137 (0.122-0.156)	0.190 (0.168-0.215)	0.236 (0.207-0.267)	0.310 (0.268-0.354)	0.376 (0.317-0.430)	0.454 (0.373-0.525)	0.542 (0.431-0.636)	0.685 (0.522-0.818)	0.811 (0.593-0.988)
10-min	0.165 (0.146-0.185)	0.209 (0.186-0.237)	0.288 (0.255-0.327)	0.359 (0.315-0.407)	0.471 (0.408-0.538)	0.572 (0.482-0.654)	0.690 (0.568-0.798)	0.825 (0.657-0.968)	1.04 (0.794-1.25)	1.24 (0.903-1.50)
15-min	0.205 (0.181-0.230)	0.259 (0.231-0.294)	0.357 (0.316-0.406)	0.445 (0.391-0.504)	0.584 (0.505-0.667)	0.708 (0.597-0.811)	0.856 (0.704-0.990)	1.02 (0.814-1.20)	1.29 (0.984-1.54)	1.53 (1.12-1.86)
30-min	0.276 (0.243-0.309)	0.348 (0.311-0.395)	0.481 (0.426-0.547)	0.599 (0.526-0.678)	0.787 (0.680-0.898)	0.954 (0.804-1.09)	1.15 (0.947-1.33)	1.38 (1.10-1.62)	1.74 (1.33-2.08)	2.06 (1.51-2.51)
60-min	0.341 (0.301-0.382)	0.431 (0.385-0.489)	0.595 (0.527-0.676)	0.741 (0.651-0.840)	0.974 (0.842-1.11)	1.18 (0.995-1.35)	1.43 (1.17-1.65)	1.71 (1.36-2.00)	2.15 (1.64-2.57)	2.55 (1.87-3.11)
2-hr	0.450 (0.405-0.498)	0.564 (0.509-0.620)	0.742 (0.664-0.817)	0.904 (0.802-0.999)	1.16 (1.00-1.28)	1.39 (1.18-1.55)	1.65 (1.37-1.85)	1.95 (1.58-2.23)	2.43 (1.87-2.84)	2.86 (2.12-3.41)
3-hr	0.531 (0.488-0.587)	0.663 (0.608-0.737)	0.842 (0.772-0.930)	1.01 (0.917-1.12)	1.27 (1.13-1.41)	1.49 (1.31-1.67)	1.75 (1.50-1.98)	2.05 (1.70-2.35)	2.51 (2.00-2.95)	2.92 (2.24-3.49)
6-hr	0.732 (0.674-0.804)	0.907 (0.831-0.998)	1.13 (1.04-1.25)	1.33 (1.20-1.47)	1.62 (1.45-1.80)	1.86 (1.64-2.08)	2.13 (1.85-2.39)	2.42 (2.06-2.76)	2.90 (2.39-3.37)	3.31 (2.66-3.91)
12-hr	0.980 (0.897-1.08)	1.22 (1.11-1.34)	1.49 (1.36-1.65)	1.73 (1.57-1.92)	2.08 (1.86-2.31)	2.36 (2.09-2.63)	2.66 (2.31-3.00)	2.97 (2.54-3.38)	3.44 (2.87-3.97)	3.82 (3.11-4.47)
24-hr	1.27 (1.17-1.40)	1.58 (1.44-1.73)	1.92 (1.75-2.10)	2.21 (2.01-2.42)	2.61 (2.37-2.86)	2.93 (2.65-3.21)	3.27 (2.94-3.58)	3.62 (3.23-3.97)	4.10 (3.63-4.51)	4.48 (3.93-4.94)
2-day	1.50 (1.37-1.65)	1.84 (1.68-2.02)	2.23 (2.04-2.46)	2.56 (2.34-2.82)	3.02 (2.74-3.32)	3.39 (3.06-3.72)	3.78 (3.39-4.16)	4.18 (3.73-4.60)	4.74 (4.18-5.23)	5.18 (4.53-5.74)
3-day	1.65 (1.52-1.82)	2.03 (1.87-2.24)	2.47 (2.26-2.72)	2.84 (2.59-3.12)	3.36 (3.05-3.68)	3.77 (3.41-4.13)	4.20 (3.77-4.60)	4.65 (4.14-5.10)	5.27 (4.64-5.80)	5.76 (5.03-6.36)
4-day	1.81 (1.66-1.99)	2.23 (2.05-2.45)	2.71 (2.48-2.98)	3.12 (2.85-3.42)	3.69 (3.35-4.04)	4.14 (3.75-4.54)	4.62 (4.15-5.05)	5.11 (4.56-5.60)	5.80 (5.11-6.36)	6.34 (5.53-6.98)
7-day	2.20 (2.01-2.42)	2.72 (2.49-3.00)	3.31 (3.03-3.66)	3.81 (3.47-4.20)	4.50 (4.08-4.96)	5.05 (4.55-5.56)	5.62 (5.03-6.19)	6.21 (5.52-6.85)	7.02 (6.19-7.77)	7.66 (6.69-8.51)
10-day	2.49 (2.29-2.74)	3.08 (2.83-3.38)	3.76 (3.45-4.12)	4.32 (3.95-4.73)	5.07 (4.62-5.55)	5.66 (5.13-6.19)	6.27 (5.65-6.87)	6.88 (6.16-7.56)	7.72 (6.85-8.50)	8.37 (7.37-9.25)
20-day	3.27 (3.04-3.53)	4.04 (3.76-4.36)	4.87 (4.52-5.26)	5.52 (5.11-5.96)	6.37 (5.89-6.88)	7.01 (6.46-7.57)	7.65 (7.02-8.28)	8.28 (7.57-8.97)	9.09 (8.25-9.90)	9.70 (8.76-10.6)
30-day	3.98 (3.70-4.29)	4.90 (4.56-5.29)	5.88 (5.47-6.35)	6.67 (6.19-7.20)	7.71 (7.14-8.32)	8.49 (7.85-9.17)	9.28 (8.54-10.0)	10.1 (9.22-10.9)	11.1 (10.1-12.0)	11.9 (10.7-12.9)
45-day	4.97 (4.63-5.32)	6.11 (5.69-6.55)	7.26 (6.76-7.78)	8.15 (7.57-8.73)	9.29 (8.61-9.96)	10.1 (9.36-10.9)	11.0 (10.1-11.8)	11.8 (10.8-12.7)	12.8 (11.7-13.8)	13.5 (12.3-14.7)
60-day	5.89 (5.49-6.31)	7.23 (6.75-7.76)	8.52 (7.94-9.14)	9.49 (8.84-10.2)	10.7 (9.97-11.5)	11.6 (10.8-12.5)	12.4 (11.5-13.4)	13.2 (12.2-14.3)	14.2 (13.1-15.4)	15.0 (13.7-16.2)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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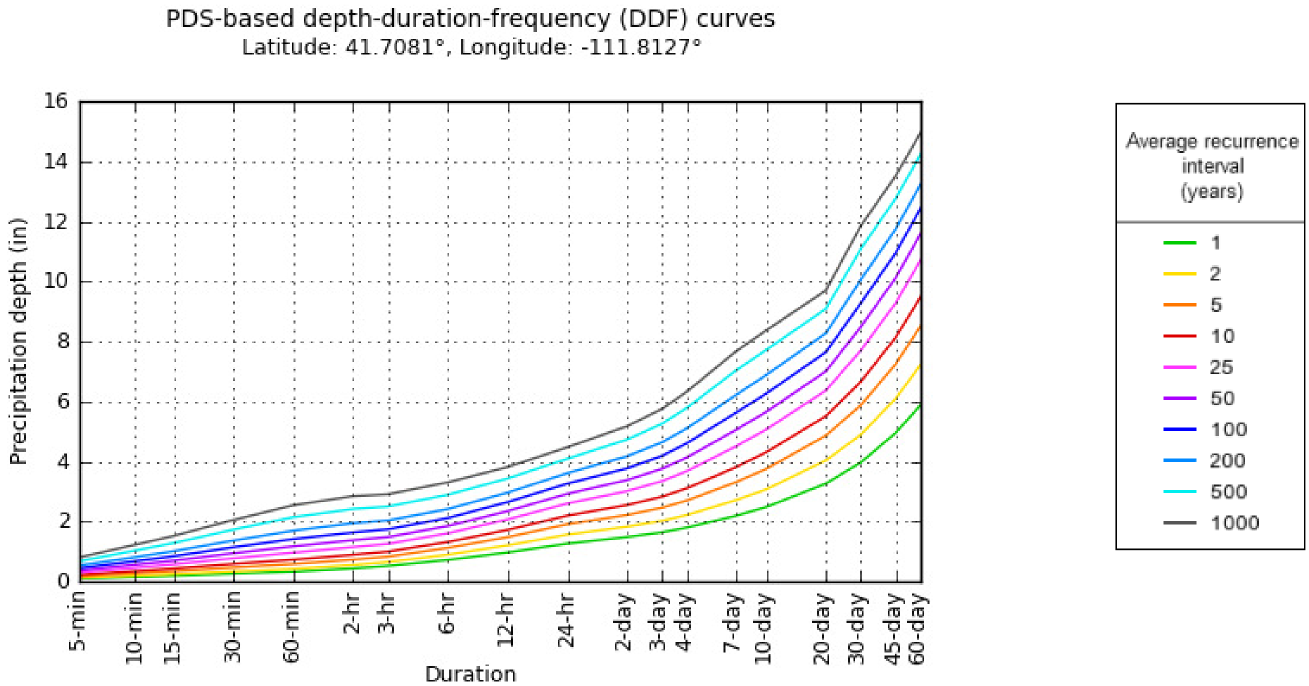
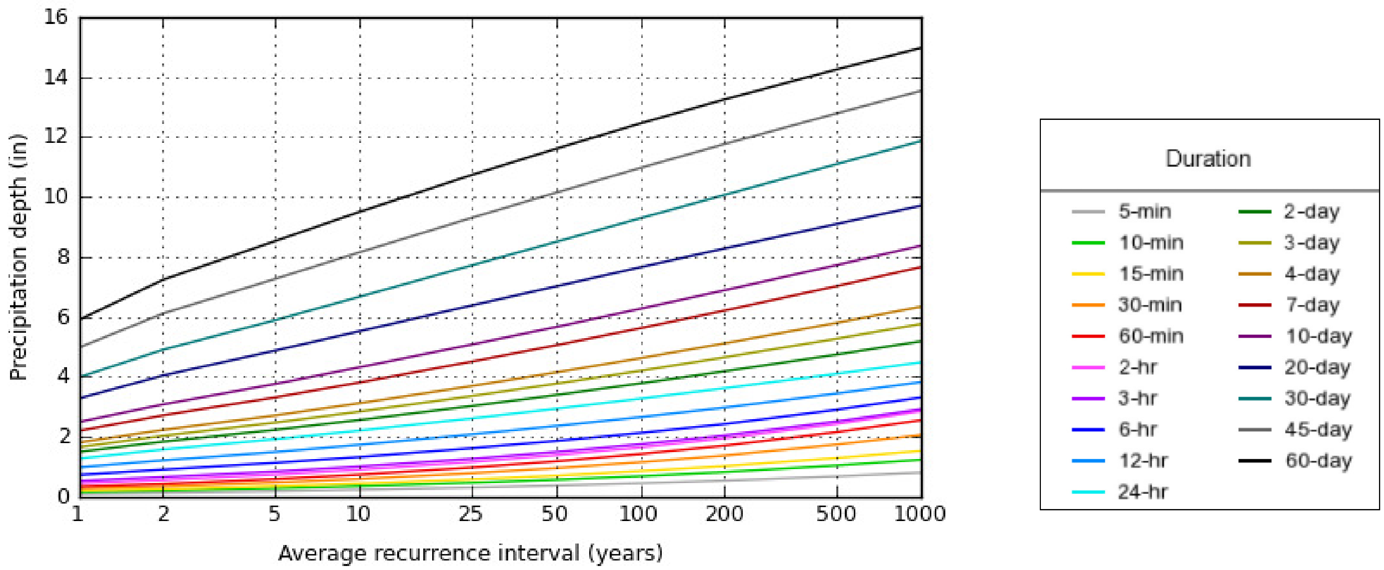
PF graphical





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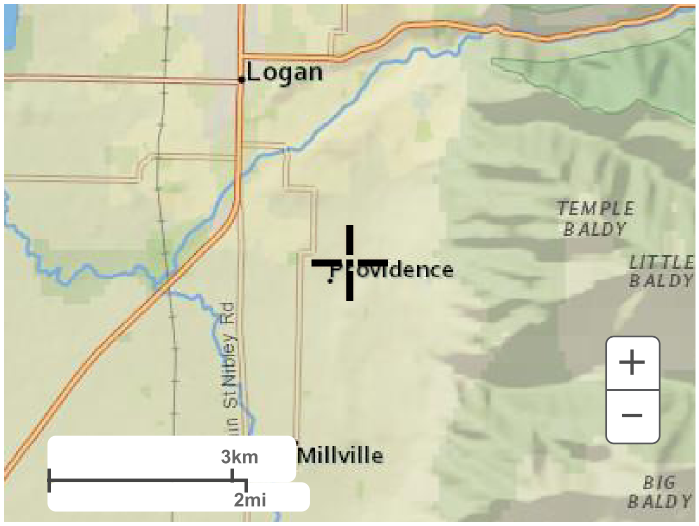
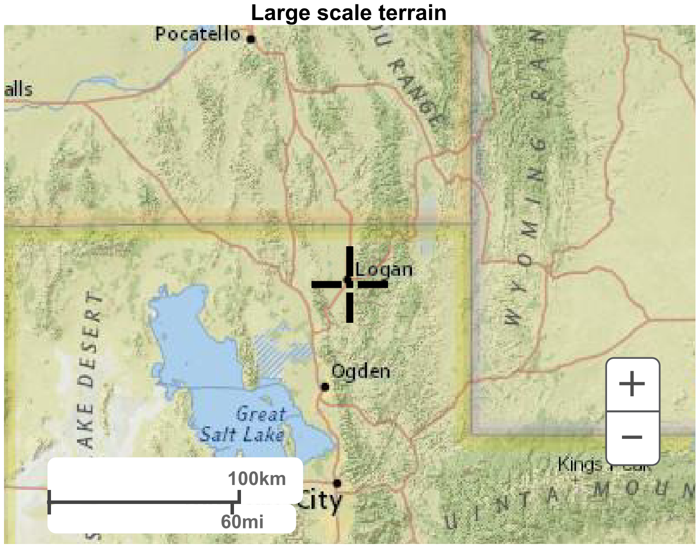
Maps & aerials

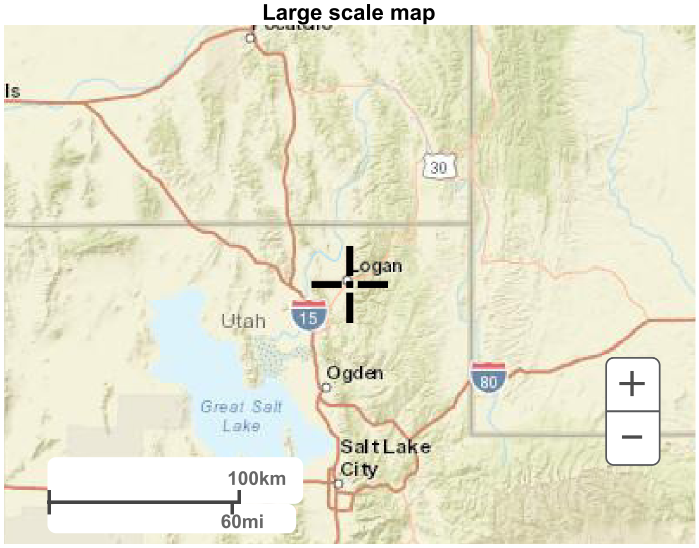
Small scale terrain



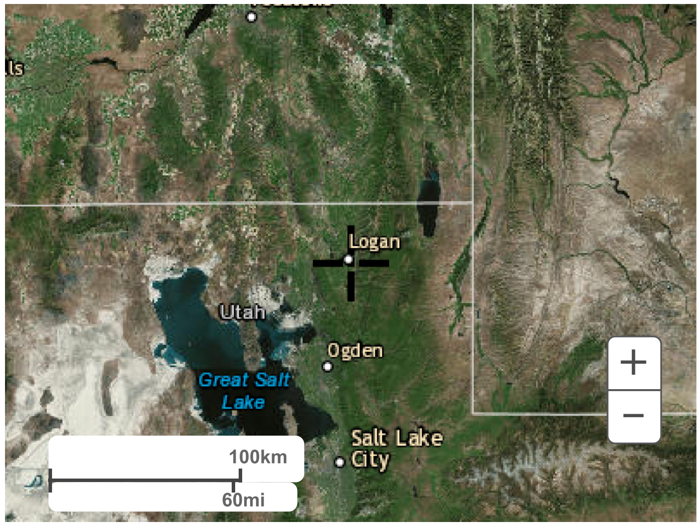
Large scale terrain



Large scale map



Large scale aerial



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APPENDIX C
COST ESTIMATES

BID TABULATIONS
PROVIDENCE STORM DRAIN MASTER PLAN
JANUARY 2019

				P-1A	
ITEM No.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	BID UNIT PRICE	BID PRICE
1.	Mobilization	LS	1	$5,553.33	$5,553.33
2.	24" HDPE Storm Drain Pipe	LF	450	$70.00	$31,500.00
3.	Storm Drain Catch Basin	EA	3	$3,200.00	$9,600.00
4.	Asphalt	SY	600	$12.00	$7,200.00
5.	Granular Borrow	CY	233.3	$19.50	$4,550.00
6.	Untreated Base Coarse	CY	77.8	$34.50	$2,683.33
7.	Professional Services(10%)	LS	1	$6,108.67	$6,108.67
8.	Contingency (20%)	CY	1	$13,439.07	$13,439.07
TOTAL OF ALL UNIT PRICE BID ITEMS					$80,634.40

BID TABULATIONS
PROVIDENCE STORM DRAIN MASTER PLAN
JANUARY 2019

ITEM No.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	P-1B BID UNIT PRICE	P-1B BID PRICE
1.	Mobilization	LS	1	$11,040.59	$11,040.59
2.	30" HDPE Storm Drain Pipe	LF	1360	$85.00	$115,600.00
3.	Storm Drain Catch Basin	EA	6	$3,200.00	$19,200.00
4.	Asphalt	SY	133.33333	$12.00	$1,600.00
5.	Granular Borrow	CY	51.9	$19.50	$1,011.11
6.	Untreated Base Coarse	CY	17.3	$34.50	$596.30
7.	Professional Services(10%)	LS	1	$14,904.80	$14,904.80
8.	Contingency (20%)	CY	1	$32,790.56	$32,790.56
TOTAL OF ALL UNIT PRICE BID ITEMS					$196,743.36

BID TABULATIONS
PROVIDENCE STORM DRAIN MASTER PLAN
JANUARY 2019

ITEM No.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	P-2 UNIT PRICE	P-2 ESITMATED PRICE
1.	Mobilization	LS	1	$9,570.37	$9,570.37
2.	24" HDPE Storm Drain Pipe	LF	1070	$70.00	$74,900.00
3.	Storm Drain Catch Basin	EA	6	$3,200.00	$19,200.00
4.	Asphalt	SY	66.66666667	$12.00	$800.00
5.	Granular Borrow	CY	25.9	$19.50	$505.56
6.	Untreated Base Coarse	CY	8.6	$34.50	$298.15
7.	Professional Services(10%)	LS	1	$10,527.41	$10,527.41
8.	Contingency (20%)	CY	1	$23,160.30	$23,160.30
TOTAL OF ALL UNIT PRICE BID ITEMS					$138,961.78

BID TABULATIONS
PROVIDENCE STORM DRAIN MASTER PLAN
JANUARY 2019

ITEM No.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	P-3A UNIT PRICE	P-3A ESITMATED PRICE
1.	Mobilization	LS	1	$12,874.49	$12,874.49
2.	18" HDPE Storm Drain Pipe	LF	1820	$60.00	$109,200.00
3.	Storm Drain Catch Basin	EA	10	$3,200.00	$32,000.00
4	Diversion Structure	EA	1	$15,000.00	$15,000.00
5.	Asphalt	SY	2426.666667	$12.00	$29,120.00
6.	Granular Borrow	CY	943.7	$19.50	$18,402.22
7.	Untreated Base Coarse	CY	314.6	$34.50	$10,852.59
8	Professional Services(10%)	LS	1	$22,744.93	$22,744.93
9.	Contingency (20%)	CY	1	$50,038.85	$50,038.85
TOTAL OF ALL UNIT PRICE BID ITEMS					$300,233.08

BID TABULATIONS

PROVIDENCE STORM DRAIN MASTER PLAN

JANUARY 2019

				P-3B	
ITEM No.	**DESCRIPTION**	**UNIT**	**ESTIMATED QUANTITY**	**UNIT PRICE**	**ESITMATED PRICE**
1.	Mobilization	LS	1	$15,126.22	$15,126.22
2.	24" HDPE Storm Drain Pipe	LF	2380	$70.00	$166,600.00
3.	Storm Drain Catch Basin	EA	8	$3,200.00	$25,600.00
4	Diversion Structure	EA	1	$15,000.00	$15,000.00
5.	Asphalt	SY	1866.7	$12.00	$22,400.00
6.	Granular Borrow	CY	725.9	$19.50	$14,155.56
7.	Untreated Base Coarse	CY	242.0	$34.50	$8,348.15
8	Professional Services(10%)	LS	1	$26,722.99	$26,722.99
9.	Contingency (20%)	CY	1	$58,790.58	$58,790.58
TOTAL OF ALL UNIT PRICE BID ITEMS					$352,743.50

BID TABULATIONS
PROVIDENCE STORM DRAIN MASTER PLAN
JANUARY 2019

ITEM No.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	P-4 UNIT PRICE	P-4 ESITMATED PRICE
1.	Mobilization	LS	1	$21,228.53	$21,228.53
2.	24" HDPE Storm Drain Pipe	LF	3090	$70.00	$216,300.00
3.	Storm Drain Catch Basin	EA	12	$3,200.00	$38,400.00
4.	Asphalt	SY	4120.0	$12.00	$49,440.00
5.	Granular Borrow	CY	1602.2	$19.50	$31,243.33
6.	Untreated Base Coarse	CY	534.1	$34.50	$18,425.56
7.	Professional Services(10%)	LS	1	$37,503.74	$37,503.74
8.	Contingency (20%)	CY	1	$82,508.23	$82,508.23
TOTAL OF ALL UNIT PRICE BID ITEMS					$495,049.40

BID TABULATIONS
PROVIDENCE STORM DRAIN MASTER PLAN
JANUARY 2019

				P-5	
ITEM No.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	ESITMATED PRICE
1.	Mobilization	LS	1	$4,826.80	$4,826.80
2.	30" HDPE Storm Drain Pipe	LF	660	$85.00	$56,100.00
3.	Storm Drain Catch Basin	EA	4	$3,200.00	$12,800.00
4.	Asphalt	SY	480.0	$12.00	$5,760.00
5.	Granular Borrow	CY	186.7	$19.50	$3,640.00
6.	Untreated Base Coarse	CY	62.2	$34.50	$2,146.67
7.	Professional Services(10%)	LS	1	$8,527.35	$8,527.35
8.	Contingency (20%)	CY	1	$21,574.19	$21,574.19
TOTAL OF ALL UNIT PRICE BID ITEMS					$115,375.00

BID TABULATIONS
PROVIDENCE STORM DRAIN MASTER PLAN
JANUARY 2019

ITEM No.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	S-1 UNIT PRICE	S-1 ESITMATED PRICE
1.	Mobilization	LS	1	$41,839.68	$41,839.68
2.	Earthwork	CY	23070.7	$19.50	$449,878.00
3.	Landscape	SY	21780	$2.50	$54,450.00
4.	Outlet Structure	EA	1.0	$8,000.00	$8,000.00
5.	Emergency Spillway	EA	1.0	$5,000.00	$5,000.00
6.	Land Acquisition	Acre	4.5	$40,000.00	$180,000.00
7.	Professional Services(10%)	LS	1	$73,916.77	$73,916.77
8.	Contingency (20%)	CY	1	$162,616.89	$162,616.89
TOTAL OF ALL UNIT PRICE BID ITEMS					$975,701.34

BID TABULATIONS

PROVIDENCE STORM DRAIN MASTER PLAN

JANUARY 2019

ITEM No.	DESCRIPTION	UNIT	ESTIMATED QUANTITY	S-2 UNIT PRICE	 ESITMATED PRICE
1.	Mobilization	LS	1	$7,409.44	$7,409.44
2.	Earthwork	CY	3710.7	$19.50	$72,358.00
3.	Landscape	SY	2904	$2.50	$7,260.00
4.	Outlet Structure	EA	1.0	$8,000.00	$8,000.00
5.	Emergency Spillway	EA	1.0	$5,000.00	$5,000.00
6.	Professional Services(10%)	LS	1	$10,002.74	$10,002.74
7.	Contingency (20%)	LS	1	$22,006.04	$22,006.04
TOTAL OF ALL UNIT PRICE BID ITEMS					$132,036.22