WASHINGTON CITY

STORM WATER CAPITAL FACILITIES MASTER PLAN UPDATE

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APPENDIX 3 FOLDED MAP EXHIBITS

CHAPTER 1 – CFP MASTER PLAN OVERVIEW

1.1 Purpose

This report is an update to the 2005 Washington City Storm Water Capital Facilities Master Plan (CFP).[1] Since the completion of the 2005 CFP, new municipal storm drainage infrastructure has been constructed as new growth has continued throughout the community, which has impacted storm water drainage patterns. It is anticipated that new growth will continue throughout Washington City, which will create new impacts to the storm water drainage patterns and require new infrastructure. In addition, existing developed areas within the community still have storm drain infrastructure deficiencies which need to be corrected.

The purpose of this study was to perform the following:

- Assess the capacity of the existing major storm water infrastructure system.
- Identify current and potential future major storm water infrastructure needs.
- Recommend updated values for a storm drain impact fee and a storm drain user fee to help provide funding for the identified needs.

1.2 Project Study Area

Washington City is located along Interstate 15 in Washington County, Utah. The community is part of the St. George Metropolitan Statistical Area known locally as Utah's Dixie. Part of a rapidly growing area, city population numbered 8,186 at the 2000 census and 18,761 at the 2010 census.[2]

The overall study area watershed is outlined in Figure 1-1. The area encompasses a 50 square mile boundary covering the drainage of most of the incorporated and proposed annexation areas in the city where development is anticipated to most likely occur in the near future. The total study area was grouped into 13 separate "drainage basins" defined by the community topography. Storm water generated within each defined drainage basin remains within the basin until discharging into 1) the FEMA regulatory flood plain; or 2) into a regional debris basin facility. These drainage basins are illustrated in Figure 1-1, and represented on each of the four larger community-wide exhibit maps which are included in the folded maps section at the back of this report, labeled Exhibit 1 through Exhibit 4.

Hydrologic modeling results for each drainage basin were utilized to identify general storm drain system deficiencies and make general conceptual recommendations for system improvements.

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[1] Alliance Consulting, Storm Water Capital Facilities Master Plan, Washington City, Utah, July, 2005.

[2] Statistical excerpts taken from the Washington City website and Wikipedia, http://en.wikipedia.org/wiki/-Washington,_Utah, May 28, 2013.

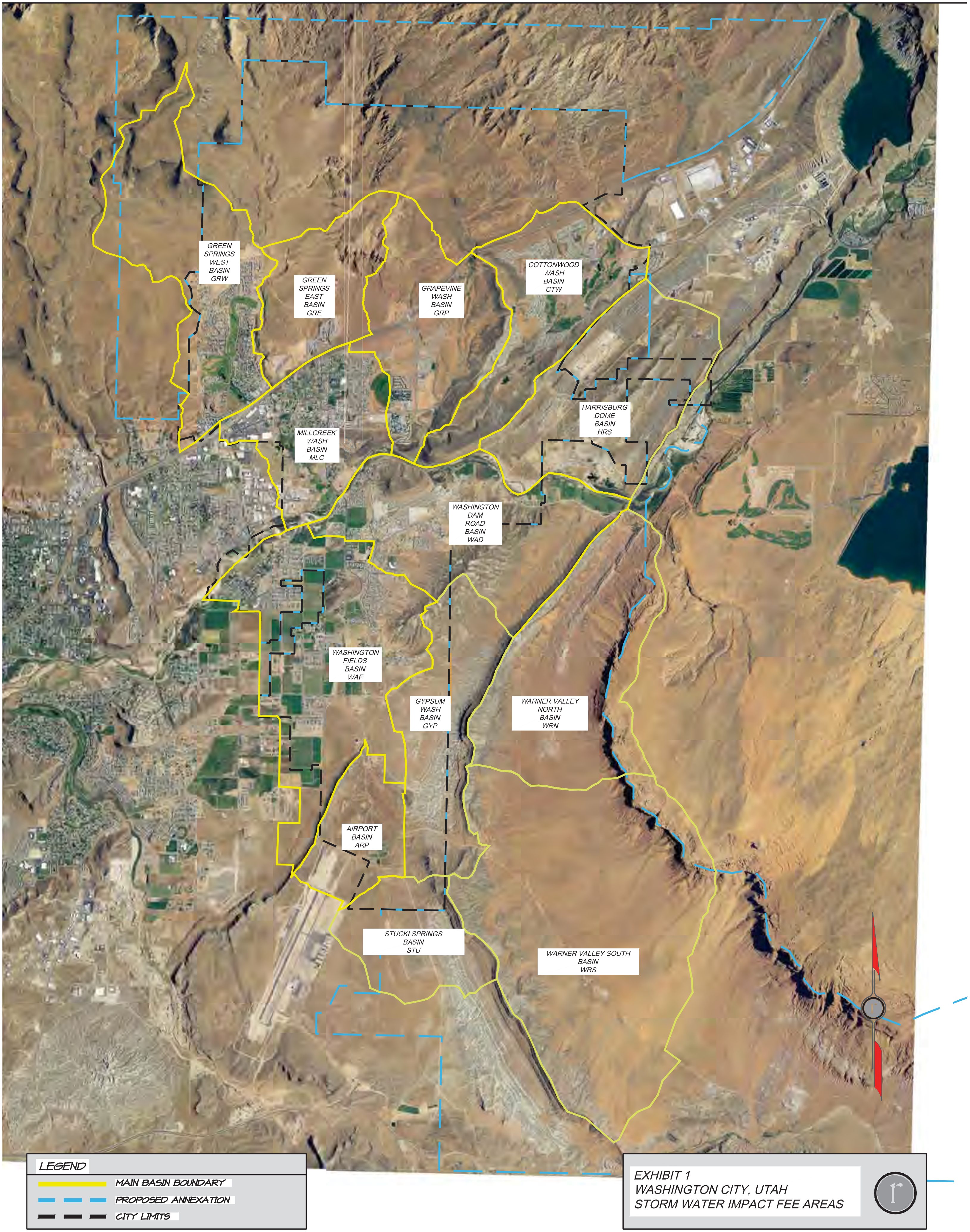

EXHIBIT 1
WASHINGTON CITY, UTAH
STORM WATER IMPACT FEE AREAS

1.3 Report Organization

The contents of this report are summarized as follows:

Chapter 2 is the updated Impact Fee Facilities Plan for Washington City, and presents the recommended storm water public facilities resulting from new development activity.

Chapter 3 is the updated Impact Fee Analysis for Washington City, and presents the approach and assumptions used to estimate project costs and recommend a storm water CFP impact fee.

Chapter 4 is the updated User Fee Analysis for Washington City, and presents the recommended storm water public facilities required resulting from existing deficiencies in the storm water infrastructure, estimated project costs, and an analysis of the storm drain user fee.

Chapter 5 presents a discussion of the updated hydrologic model which was used to estimate the storm water peak run-off values.

Chapter 6 summarizes recommended revisions to city drainage policy and to the current Washington City Hydrology Manual.

Chapter 7 is a bibliography of cited references in the report.

Appendix 1 presents additional master plan storm drain considerations, for areas located outside of the anticipated 10-year development window. Projects were identified in these areas mainly to serve as a reminder to city planners and/or other community developers or stakeholders of areas in the future where drainage needs may need to be addressed.

Appendix 2 presents the spreadsheet tables generated during the study that are cross referenced in the report text..

Appendix 3 presents folded map exhibits that are cross referenced in the report.

CHAPTER 2 – IMPACT FEE FACILITIES PLAN

2.1 Introduction

This chapter summarizes the portion of this CFP Update report that represents the Impact Fee Facilities Plan for Washington City, as defined by the state of Utah's Impact Fees Act[3], specifically to determine the public facilities required to serve development resulting from new development activity for storm water, drainage, and flood control facilities as described UCA §11-36a-102(16)(a), and UCA §11-36a-301(1).

In accordance with UCA §11-36a-302(1)(a)(i),the following points will be addressed in this chapter:

- The existing level of service
- The proposed level of service
- Excess capacity in the system that will accommodate future growth.
- Demands placed upon existing public facilities by new development.
- Means by which Washington City will meet growth demands.

2.2 Existing Level of Service

The Existing Level of Service for storm water conveyance infrastructure in Washington City can be summarized in the following key points:

- *All major public facility drainage systems shall be sized to convey the 100-year 3-hour design storm, with regional detention facilities sized to accommodate the 100-year 24-hour storm.*
- *Conveyance depth for all major public facility drainage systems shall be maintained to a defined maximum value or kept within the public right-of-way.*
- *The minimum pipe diameter for storm drain main trunk lines shall be 18 inches.*

All of the impact fee eligible projects identified in this chapter are considered to be 100% attributable to future development, as discussed in Chapter 3. Except for the areas in the Millcreek Wash drainage basin – discussed in Chapter 4 – the existing fields, natural washes, and drainage patterns fully accommodate the Existing Level of Service. Absent any development, no storm drain improvements would be necessary outside of the Millcreek Wash drainage basin.

2.2.1 100-Year 3-Hour Design Storm

Washington City requires the planning, designing, and implementation for major drainage systems in all residential, commercial, and industrial subdivisions to

3 Utah Code, Title 11, Chapter 36a, known as the "Impact Fees Act", enacted by Chapter 47 during the 2011 General Session of the Utah State Legislature.

conform to the 100-year 3-hour design storm recurrence interval. This requirement is set forth in the Hydrology Manual, a subsection of the Washington City Grading Manual,[4] (refer to Part 8, Chapter 3, Section 3.4.2). This requirement is currently applied to all drainage for streets, culverts, storm drains, and detention for individual subdivisions. The only exception to this requirement is for regional detention facilities, where Washington City staff requires accommodation of the 100-year 24-hour design storm.

The hydrologic model used for this evaluation included the 100-year 3-hour design storm and the 100-year 24-hour design storm. Street and pipeline capacities for the existing system – and for identified projects – in this report were compared to the peak flow values of the 100-year 3-hour design storm. Regional detention capacities were compared to the 100-year 24-hour design storm.

2.2.2 Conveyance Requirements for Drainage Systems

Washington City allows local and collector streets to be used for major (100-year 3-hour) storm runoff provided: 1) residential dwellings, public, commercial, and industrial buildings shall not be inundated at the ground line; and 2) the depth of water at the gutter flowline shall not exceed 12 inches. Arterial streets are to be used for major (100-year 3-hour) storm runoff provided: 1) residential dwellings, public, commercial, and industrial buildings shall not be inundated at the ground line; 2) the depth of water at the gutter flowline shall not exceed 12 inches; and 3) to allow for emergency vehicles, the depth of water shall not exceed 6 inches at the street crown, 12 inches at the gutter flowline, and must not encroach onto private land, whichever is more restrictive (refer to the Hydrology Manual, Section 3.4.4).

Street capacities for the existing system – and for identified projects – in this report were determined assuming a minimum roadway slope, with the maximum value staying within the assumed street right-of-way. Existing storm drain capacities were added to the assumed street value.

In cases where a conveyance system has not yet been constructed and a new project was identified, the project was assumed to be only the storm drain pipeline. The purpose for this assumption was to provide a standard for identifying projects and developing the conceptual opinion of construction cost. A future street might not be able to be constructed to a minimum continuous slope, in which case the storm drain must be sized to convey the entire 100 year 3-hour storm.

2.2.3 Minimum Storm Drain Pipe Size

Washington City requires the minimum pipe diameter for a storm drain main trunk line to be 18 inches (refer to the Hydrology Manual, Table 801, Section 8.8). In

[4] Alliance Consulting, Washington City Grading Manual, Adopted by Ordinance 2006-30, October 11, 2006, see specifically Section 8, *Hydrology Manual,* Chapter 3, "Drainage Policy".

cases where a potential trunk line project was identified, the minimum pipe size evaluated was 18 inches in diameter.

2.3 Proposed Level of Service

No change in the Existing Level of Service is being proposed with this Impact Fee Facilities Plan. Washington City will continue to follow the general requirements for storm drain infrastructure outlined above in Section 2.2.

2.4 Excess Infrastructure Capacity

2.4.1 Hydrologic Model Level of Detail

Storm water infrastructure capacity was determined by preparing a hydrologic computer model of Washington City. The model grouped the overall study area watershed into 13 separate “drainage basins” defined by the community topography. These drainage basins are illustrated in Figure 1-1, and represented on each of the four larger community-wide exhibit maps which are included in the folded maps section at the back of this report, labeled Exhibit 1 through Exhibit 4.

The 13 drainage basins were further divided into “sub-basin” elements, sub-basin “routing” elements, and combined flow “junction” elements. The final model provided over 200 locations within Washington City where generated storm water peak flow values could be compared with existing or proposed future storm water infrastructure conveyance capacity. These comparisons are detailed in Table T-6: Model Results and Evaluation, located in Appendix 2. A more detailed discussion of the hydrologic model is included in Chapter 5.

As detailed in Table T-6, 155 model elements were evaluated, representing 116 different infrastructure locations that were identified as potential areas of concern located in the seven drainage basins expected to see the majority of new growth over the next 10 years. If the estimated capacity of the existing drainage infrastructure was lower than the modeled design storm peak flow value, then additional drainage improvements were recommended. From this evaluation, 38 projects were identified, with 33 projects determined to be impact fee eligible. The remaining 78 locations are noted in Table T-6 as having adequate or excess storm drain capacity for existing infrastructure or proposed master planned future infrastructure.

Table T-6 lists the design peak flow value for each element evaluated in the model, plus the calculated capacity. The difference between the calculated capacity and the design peak flow would be the excess capacity, if applicable.

2.4.2 Culvert and Channel Capacity Analysis Assumptions

Culvert and channel capacities were determined using Manning's equation for open channel flow:[5]

$$Q = \frac{1.49\,(A)^{5/3}(S)^{1/2}}{n(P)^{2/3}}$$

Where
Q = Hydraulic Capacity, in cubic feet per second (cfs)
A = Cross Sectional Flow Area, in square feet
S = Average Slope, in feet per foot
n = Manning's Roughness Coefficient
P = Wetted Perimeter, in feet

Table 2-1 lists the Manning's roughness coefficients used in the model evaluation:

TABLE 2-1: MANNING'S ROUGHNESS COEFFICIENTS

Surface Description	Manning's n Value
Corrugated Metal Pipe (CMP)	0.024
High Density Polyethylene Pipe (HDPE)	0.010
Concrete Pipe (RCP)	0.013
Open Channels	0.078
Asphalt Pavement	0.015

The following parameters were assumed for each evaluation:

- All culvert capacities were evaluated as flowing full in the open channel flow condition, assuming no surcharge.
- The slope of each culvert was assumed to be the average slope of the drainage basin or routing, unless additional information was known to justify a different value.
- If existing drainage or future road drainage infrastructure was determined to be inadequate to accommodate the modeled design storm, the culvert or open channel was sized to accommodate the full modeled design storm value, as discussed in Section 2.2.2.

2.4.3 Street Capacity Analysis

Street capacities were modeled using Manning's equation for open channel flow based on the master planned street cross-section, assuming full street improvements were constructed. Slopes for all street sections were assumed to be at 0.5%. Table T-7, located in Appendix 2, the tables section of this report,

5 Flammer, Jeppson, and Keedy, Fundamental Principles and Applications of Fluid Mechanics, Utah State University, 1986, p. 289.

contains estimated storm water conveyance capacities for Washington City standard roadway cross-sections, assuming various street slope conditions ranging from 0.4% to 3.0%.

2.5 Evaluation of Impact from New Development

An identified project was considered to be eligible for CFP impact fees if it could be tied to changes in drainage patterns and/or conveyance means due to future development. Some general evaluation scenarios included:

- If a current drainage pattern needed to be preserved for future development, such as the need to create a right-of-way for an existing wash that will be encroached upon by development.
- If a current drainage pattern would be altered by future development of the existing area or upstream, such as an existing irrigation canal that will be replaced by a future storm drain pipeline underneath an upgraded roadway.
- If an upstream drainage pattern is changed from a sheet flow condition to a point discharge condition, such as storm water that once spread out over an open field will be collected and routed to an existing pipeline that is too small to handle the flow and will need to be upsized.
- If a project considered eligible for CFP impact fees identified in the 2005 Capital Facilities Plan had not been constructed – or had been partially completed – and has been identified in the Update CFP analysis as still being needed in order to fully convey anticipated design storm water flows.

It should be noted that an increase in peak runoff due to development was not one of the criteria for determining whether a project is eligible for CFP impact fee funding. This is because current Washington City Drainage Policy is to require on-site detention for all new development and redevelopment.[6] Although on-site detention is used to mitigate the effects of the peak flow values of a new development project, it is still anticipated that the total volume of discharge from new development will increase since none of the flows are required to be permanently retained on site. Impacts from this “developed” condition scenario include a longer, sustained release of the peak flow value, hence it is still necessary for Washington City to provide adequate public storm water infrastructure to convey these redirected, lengthened and sustained flows in order to meet the Existing Level of Service.

2.6 Impact Fee Projects

The following sections describe the identified projects determined to be impact fee eligible, grouped by the seven drainage basins anticipated for most of the community growth within the next 10-years to include:

[6] Alliance Consulting, Washington City Hydrology Manual, Washington City, Utah, Section 3.3.6.

- Washington Dam Road
- Washington Fields
- Airport
- Millcreek Wash
- Green Springs West
- Green Springs East
- Grapevine Wash

2.7 Washington Dam Road Basin

The Washington Dam Road (WAD) drainage basin is outlined in Figure 2-1. The basin is located south of the Virgin River extending to the eastern city limits, where most properties are accessed via Washington Dam Road. Most of the storm water drains northward, crossing the Washington Dam Road before discharging into the Virgin River.

The updated hydrologic model identified the following general conceptual storm water system improvements recommended for inclusion in the capital facilities plan. The approximate locations for these improvements are illustrated in Figure 2-1.

2.7.1 Project WAD-01

Description: Install 30" HDPE 1,600 feet to convey storm water from future development along 1300 East Street and tie into Washington Dam Road. This project will be needed in the area as future development expands on the south end of 1300 East Street (Morgan Lane).

Estimated Conceptual Project Cost: $495,422.

2.7.2 Project WAD-02

Description: Install 24" HDPE 1,600 feet to convey storm water from future development along Black Brush Drive and Arabian Way, and tie into Washington Dam Road This project will be needed in the area as future development expands eastward from Horizon Elementary School. This project may be able to incorporate a detention component to reduce the storm drain pipe size.

Estimated Conceptual Project Cost: $766,411.

2.7.3 Project WAD-03

Description: Install 36" HDPE 1,200 feet to convey storm water from future development through the industrial area, connecting into existing 36" pipe in 1775 East Street across from Washington Dam Road. This project will be needed in the area as future development expands southward along 1900 East Street.

Estimated Conceptual Project Cost: $269,523.

2.7.4 Project WAD-04

Description: Install 24" HDPE 1,500 feet to convey storm water from future development along – and to the south of – Granada Royale Drive. This project was originally identified in the 2005 CFP as “Virgin River Sub-Basin 14 Trunk Line”, and has yet to be completed. The original 2005 project has been broken into two different projects with this Update CFP to include WAD-04 and WAD-09.

Estimated Conceptual Project Cost: $189,076.

2.7.5 Project WAD-06

Description: Construct channel improvements with access road to convey storm water from future development, maintaining minimum 50' right-of-way width for 5,800 feet of existing wash. This project was originally identified in the 2005 CFP as “Virgin River Sub-Basin 38 Trunk Line”, and has yet to be completed.

Estimated Conceptual Project Cost: $382,805.

2.7.6 Project WAD-07

Description: Install additional 42" HDPE 3,250 feet alongside existing 24" pipe – near alignments of 1425 South Street and 1410 South Street – to improve capacity for anticipated changes in flow patterns from future development

This project was originally identified in the 2005 CFP as “Virgin River Sub-Basin 51 Trunk Line”. Although the line has been partially completed, it is anticipated that additional flows will be directed this way once development continues in the adjacent fields and foothills to the east.

Estimated Conceptual Project Cost: $1,022,725.

2.7.7 Project WAD-08

Description: Install additional 36" HDPE 2,100 feet to convey storm water from future development discharging from Project WAD-03, extending the pipeline from Washington Dam Road to the Virgin River. This project was originally identified in the 2005 CFP as “Virgin River Sub-Basin 15 Trunk Line”. Although a portion of this storm drain line has been partially installed through this reach, WAD-08 represents the uncompleted portion needed to pick up anticipated future flows from Project WAD-03.

Estimated Conceptual Project Cost: $851,621.

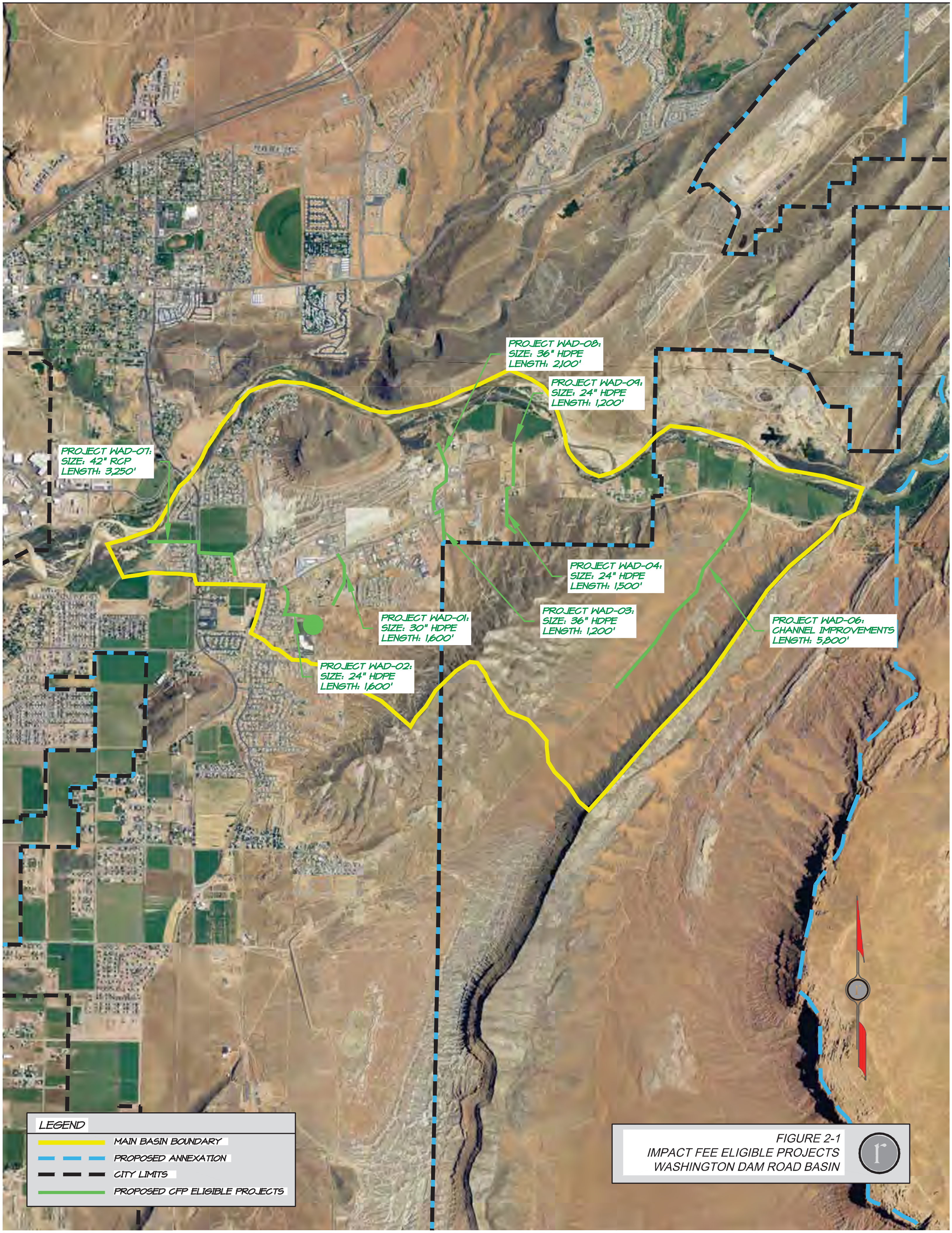

FIGURE 2-1
IMPACT FEE ELIGIBLE PROJECTS
WASHINGTON DAM ROAD BASIN

2.7.8 Project WAD-09

Description: Install 24" HDPE 1,200 feet to convey storm water from future development, and discharging from Project WAD-04, between Washington Dam Road and the Virgin River. This project was originally identified in the 2005 CFP as “Virgin River Sub-Basin 14 Trunk Line”, and has yet to be completed. The original 2005 project has been broken into two different projects with this Update CFP to include WAD-04 and WAD-09.

Estimated Conceptual Project Cost: $218,805.

2.8 Washington Fields Basin

The Washington Fields (WAF) drainage basin is outlined in Figure 2-2. The basin encompasses most of the Washington Fields, extending from the Virgin River southward through the lands that have historically drained toward the Virgin River via irrigation canals, with all drainage discharging into the Virgin River via a large canal adjacent to Merrill Road. The agricultural uses in this area are gradually being developed into residential properties.

The updated hydrologic model identified the following general conceptual storm water system improvements recommended for inclusion in the capital facilities plan. The approximate locations for these improvements are illustrated in Figure 2-2.

2.8.1 Project WAF-01

Description: Install 36" HDPE 4,100 feet to convey storm water from future area development to 240 West Street, then north to approximately 2200 South Street (St. George street address). This project was originally identified in the 2005 CFP as a portion of the “Long Valley Sub-Basin 11 Trunk Line”, and has yet to be completed.

Estimated Conceptual Project Cost: $1,577,781.

2.8.2 Project WAF-02

Description: Install 42" HDPE 1,300 feet along 240 West to convey storm water from future development south of 4200 South Street. This project was originally identified in the 2005 CFP as “Long Valley Sub-Basin 49 Trunk Line”, and has yet to be completed. The original 2005 project has been broken into two different projects with this Update CFP to include WAF-02 and WAF-03.

Estimated Conceptual Project Cost: $575,976.

2.8.3 Project WAF-03

Description: Install 42" HDPE 1,300 feet along 240 West Street to convey storm water from future development between 4200 South Street and 3930 South Street.

This project was originally identified in the 2005 CFP as “Long Valley Sub-Basin 49 Trunk Line”, and has yet to be completed.

The original 2005 project has been broken into two different projects with this Update CFP to include WAF-02 and WAF-03.

Estimated Conceptual Project Cost: $575,976.

2.8.4 Project WAF-04

Description: Install 30" HDPE 5,300 feet to convey storm water from future area development routing along Washington Fields Road and 3650 South Street. This project will be needed in the area as future development expands south of 3650 South Street between Washington Fields Road and Medallion Drive.

Estimated Conceptual Project Cost: $1,631,736.

2.8.5 Project WAF-05

Description: Install 30" HDPE 1,400 feet along 3650 South Street to convey storm water from future area development from 20 East Street to 240 West Street. This project will be needed in the area as future development expands south of 3650 South Street between 20 East Street and 240 West Street.

Estimated Conceptual Project Cost: $430,108.

2.8.6 Project WAF-06

Description: Install 24" HDPE 2,900 feet along Washington Fields Road and 3090 South Street to convey storm water from future area development, plus development from detention pond discharge, Project WAF-10.

This project was originally identified in the 2005 CFP as “Washington Fields Sub-Basin 3 Trunk Line”. The original 2005 project has been broken into three different projects with this Update CFP to include WAF-06, WAF-07, and WAF-11.

Estimated Conceptual Project Cost: $835,236.

2.8.7 Project WAF-07

Description: Install 24" HDPE 2,700 feet to convey storm water from future development draining to 2760 South Street, extending from Washington Fields Road to 20 East Street. This project was originally identified in the 2005 CFP as “Washington Fields Sub-Basin 3 Trunk Line”. The original 2005 project has been broken into three different projects with this Update CFP to include WAF-06, WAF-07, and WAF-11.

Estimated Conceptual Project Cost: $409,371.

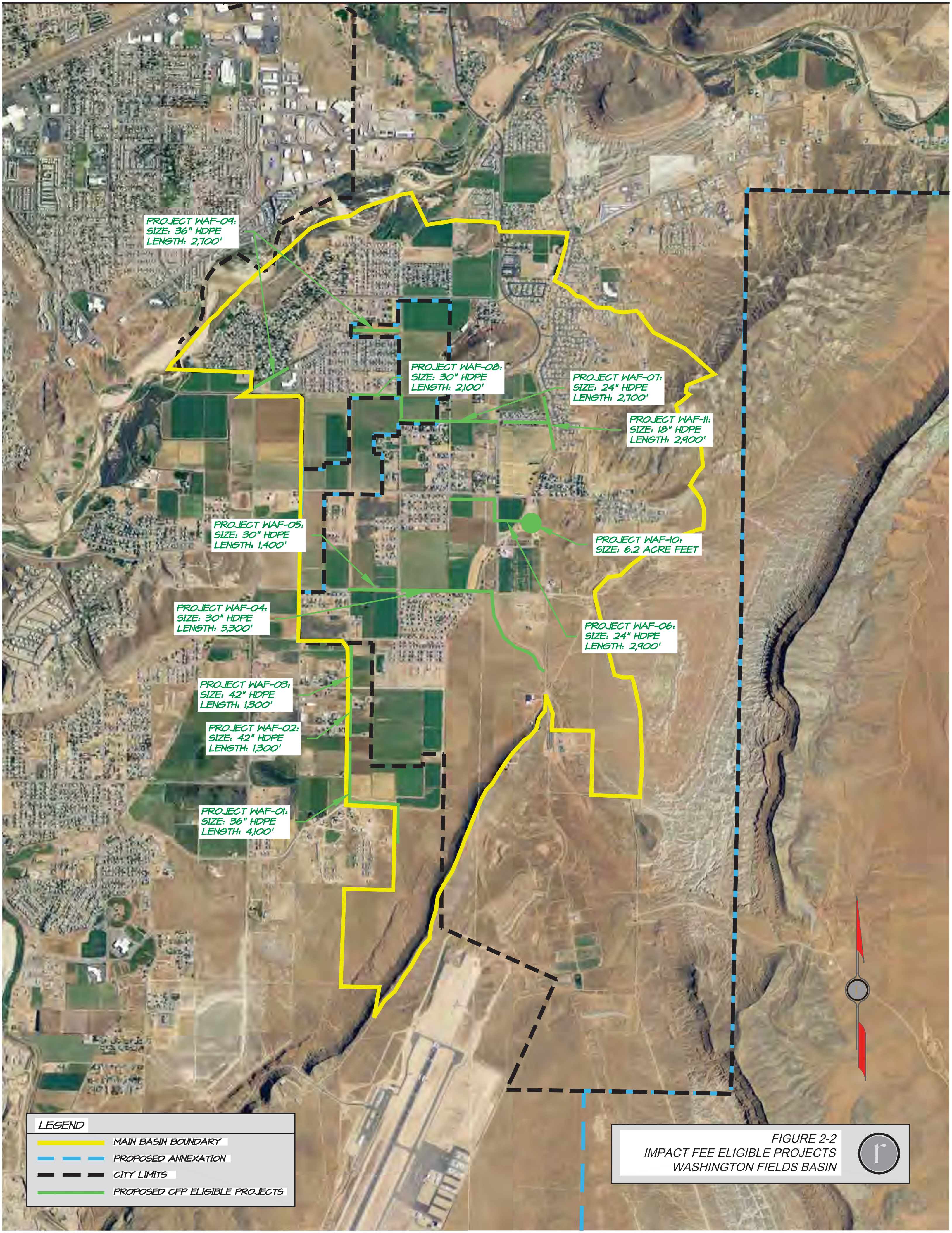

FIGURE 2-2
IMPACT FEE ELIGIBLE PROJECTS
WASHINGTON FIELDS BASIN

2.8.8 Project WAF-08

Description: Install 30" HDPE 2,100 feet to convey storm water from future area development along 20 East Street from 2760 South Street to Merrill Road, then west to 240 West Street. This project was originally identified in the 2005 CFP as "Washington Fields Sub-Basin 2 Trunk Line". Although the line has been partially completed, WAF-08 represents a portion of this need which has not been completed.

Estimated Conceptual Project Cost: $691,541.

2.8.9 Project WAF-09

Description: Install 36" HDPE 2,700 feet in two segments from future area development located east of 20 East Street; with 1,400 feet east of River Willow Lane from 240 West Street to 20 East Street; and 1,300 feet on north side of Riverside Elementary School.

This project was originally identified in the 2005 CFP as "Washington Fields Sub-Basin 1 Trunk Line". Although the line has been partially completed, WAF-09 represents the uncompleted remaining portion.

Estimated Conceptual Project Cost: $689,729.

2.8.10 Project WAF-10

Description: Construct 6.2 acre-foot detention basin to accommodate storm water from future area development located east of Camino Real Road.This project was originally identified in the 2005 CFP as "Washington Fields Sub-Basin 5 Trunk Line", and has yet to be completed.

Estimated Conceptual Project Cost: $619,708.

2.8.11 Project WAF-11

Description: Install18" HDPE pipe 2,900 feet to pick up discharge for development east of Camino Real including new development since 2005 and future development to the east, and connect to new pipe at Washington Fields Road.

This project was originally identified in the 2005 CFP as "Washington Fields Sub-Basin #3 Trunk Line" and has not been fully completed even though development in the area has been in progress. The original 2005 project has been broken into three different projects with this Update CFP to include WAF-06, WAF-07, and WAF-11.

Estimated Conceptual Project Cost: $889,901.

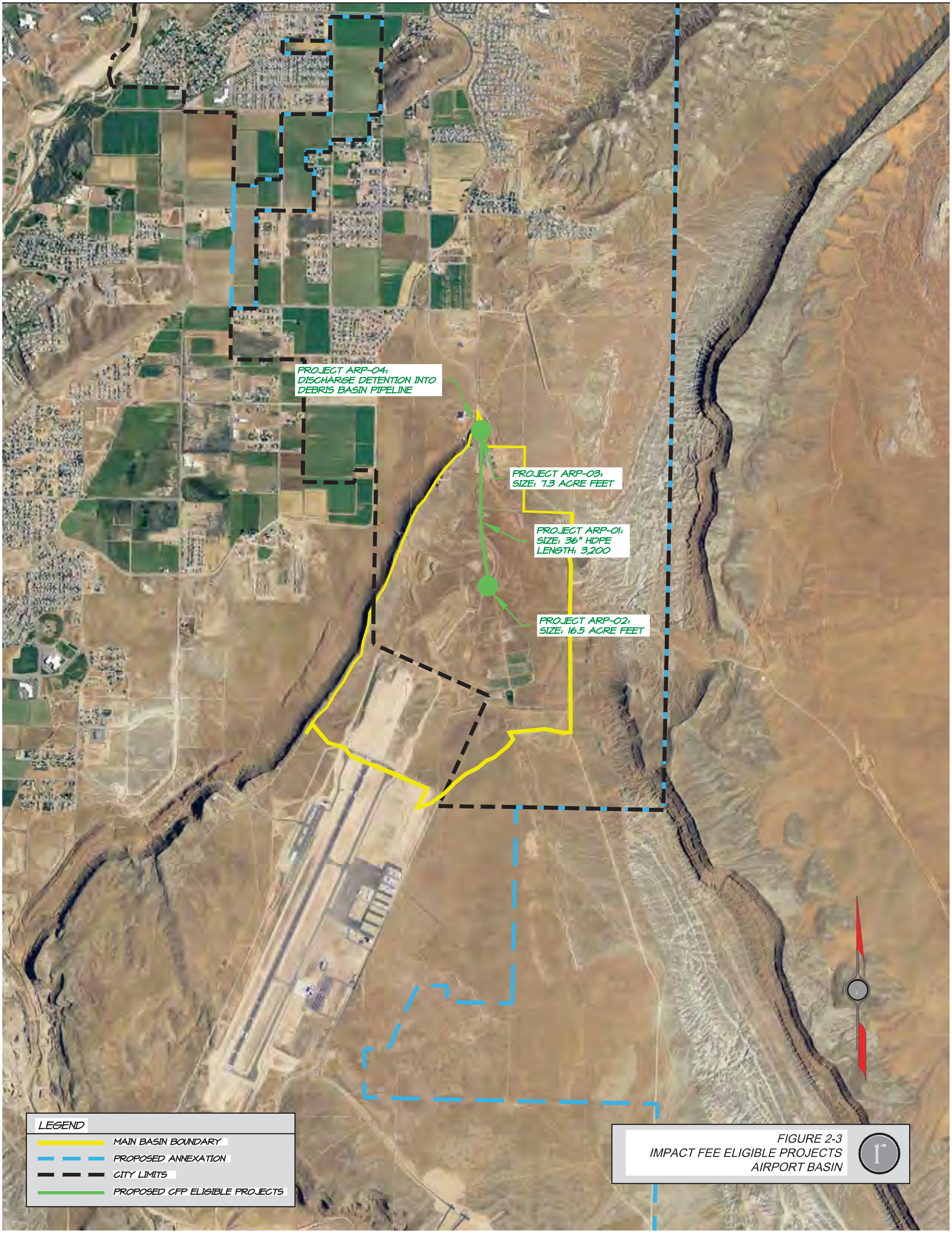

FIGURE 2-3
IMPACT FEE ELIGIBLE PROJECTS
AIRPORT BASIN

2.9 Airport Basin

The Airport (ARP) drainage basin is outlined in Figure 2-3. The basin is located north of the St. George Municipal Airport extending northward to approximately 4200 South Washington Fields Road, including drainage in the Stucki Springs master plan community.

The updated hydrologic model identified the following general conceptual storm water system improvements recommended for inclusion in the capital facilities plan. The approximate locations for the improvements are illustrated in Figure 2-3.

2.9.1 Project ARP-01

Install 36" HDPE 3,200 feet to convey storm water northward along Washington Fields Road to the north end of the Airport drainage basin.

This project was originally identified in the 2005 CFP as "Long Valley Sub-Basin 9 Trunk Line". The 2005 project originally required 5,400 linear feet of 60-inch storm drain; however, a smaller pipeline is now assumed to be adequate to handle anticipated current flows due to 1) construction of the Southern Parkway project, which has cut off a portion of drainage flowing into the Stucki Farms/Airport area; 2) proposed placement of detention Ponds ARP-02 and ARP-03; and 3) the incorporation of future streets to be used in combination with storm drain pipes that will assist with flow conveyance.

<u>Estimated Conceptual Project Cost</u>: $477,268.

2.9.2 Project ARP-02

Construct detention basin(s) totaling a minimum of 18.9 acre-feet, as part of the total 23.8 acre-foot detention needed (see ARP-P110) for the Stucki Springs MP Community, limiting total peak discharge out of the Airport drainage basin to a maximum of 39.0 cfs.

This project was originally identified in the 2005 CFP as "Long Valley Sub-Basin 9 Detention Pond". This basin is sized slightly smaller than the 2005 size of 28.8 acre-feet due to construction of the Southern Parkway project, which has cut off a portion of drainage flowing into the Stucki Farms/Airport area and reduced the detention requirement.

<u>Estimated Conceptual Project Cost</u>: $1,035,669.

2.9.3 Project ARP-03

Construct detention basin(s) totaling a minimum of 4.9 acre-feet, as part of the total 23.8 acre-foot detention needed (see ARP-J120) for the Stucki Springs MP Community, limiting total peak discharge out of the Airport drainage basin to a maximum of 39.0 cfs.

This project was originally identified in the 2005 CFP as “Long Valley Sub-Basin 10 Detention Pond”. His basin is sized smaller than the 2005 size of 16.5 acre-feet due to construction of the Southern Parkway project, which has cut off a portion of drainage flowing into the Stucki Farms/Airport area and reduced the detention requirement.

Estimated Conceptual Project Cost: $670,399.

2.9.4 Project ARP-04

Description: Modify the regional debris basin outlet structures and pipeline system to accommodate future additional storm water storage and discharge. Existing detention outlet of 39.0 cfs is to be discharged into the debris basin outlet pipeline extending 36" HDPE up to 1,000 feet, depending on the route taken and connections needed. Work may also include possible modifications to the NRCS debris basin outlet structures.

This project was originally identified in the 2005 CFP as “Long Valley Sub-Basin 8 Trunk Line”. It is anticipated that the proposed Project ARP-04 will be less expensive than the proposed 2005 project.

Estimated Conceptual Project Cost: $419,095.

2.10 Millcreek Wash Basin

The Millcreek Wash (MLC) drainage basin is outlined in Figure 2-4. The basin is located in the central part of Washington City, south of Interstate 15 and north of the Virgin River. Most of the basin drains into the Millcreek Wash except for the southern basins bordering the Virgin River, which discharge directly to the river.

The updated hydrologic model identified the following general conceptual storm water system improvements recommended for inclusion in the capital facilities plan. The approximate locations for these improvements are illustrated in Figure 2-4.

2.10.1 Project MLC-05

Description: Install 3,200 feet 18" HDPE pipe to convey storm water from future development anticipated east of Bluegrass Street and north of Telegraph Street.

This project was originally identified in the 2005 CFP as “Virgin River Sub-Basin 20, New Pipe ID #10, and has yet to be completed.

Estimated Conceptual Project Cost: $352,936.

FIGURE 2-4
IMPACT FEE ELIGIBLE PROJECTS
MILLCREEK WASH BASIN

2.10.2 Project MLC-06

Project MLC-06: Replace cut ditch with 36" HDPE 2,040 feet to convey storm water from future area development to the south, and to the east between Bella Vista Drive and Wildflower Drive, south of Telegraph Street.

Estimated Conceptual Project Cost: $490,590.

2.10.3 Project MLC-08

Project MLC-08: Replace open channel with 42" HDPE 900 feet to convey future development storm water routing from Project MLC-06, running behind Sequoyah Drive and tying into 300 East (Washington Fields Road).

Estimated Conceptual Project Cost: $274,811.

2.11 Green Springs West Basin

The Green Springs West (GRW) drainage basin is outlined in Figure 2-5. The basin is located west of Millcreek Wash and north of Interstate 15. All storm water within this basin drains south and eastward into Millcreek Wash.

The updated hydrologic model identified the following general conceptual storm water system improvements recommended for inclusion in the capital facilities plan. The approximate locations for these improvements are illustrated in Figure 2-5.

2.11.1 Project GRW-01

Description: Construct channel improvements with access road to convey storm water from future development, maintaining minimum 60' right-of-way width for 1,500 feet of existing wash.

Estimated Conceptual Project Cost: $118,802.

2.12 Green Springs East Basin

The Green Springs East (GRE) drainage basin is outlined in Figure 2-6. The basin is located east of Millcreek Wash and north of Interstate 15. All storm water within this basin drains south and westward into Millcreek Wash.

The updated hydrologic model identified the following general conceptual storm water system improvements recommended for inclusion in the capital facilities plan. The approximate locations for these improvements are illustrated in Figure 2-6.

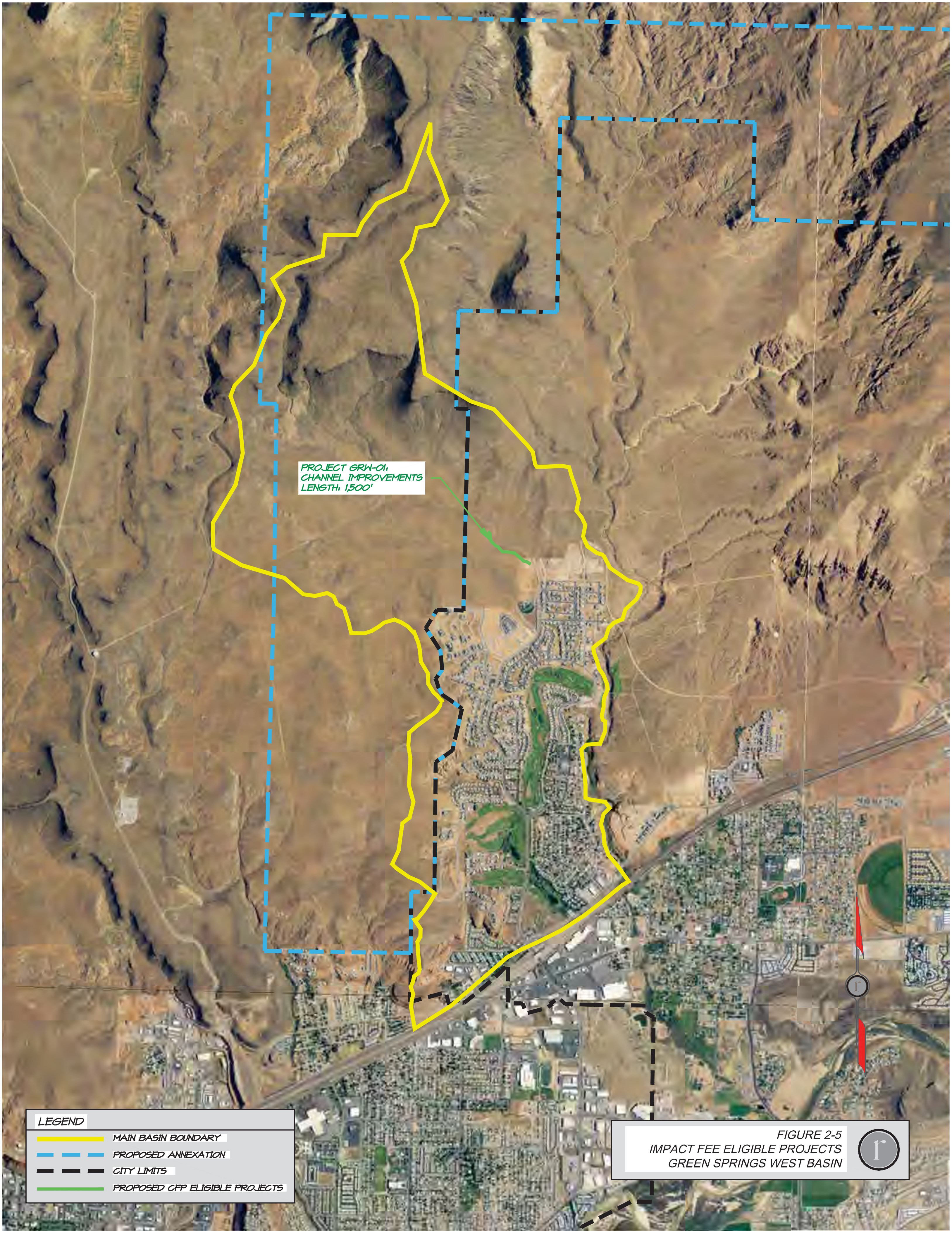

FIGURE 2-5
IMPACT FEE ELIGIBLE PROJECTS
GREEN SPRINGS WEST BASIN

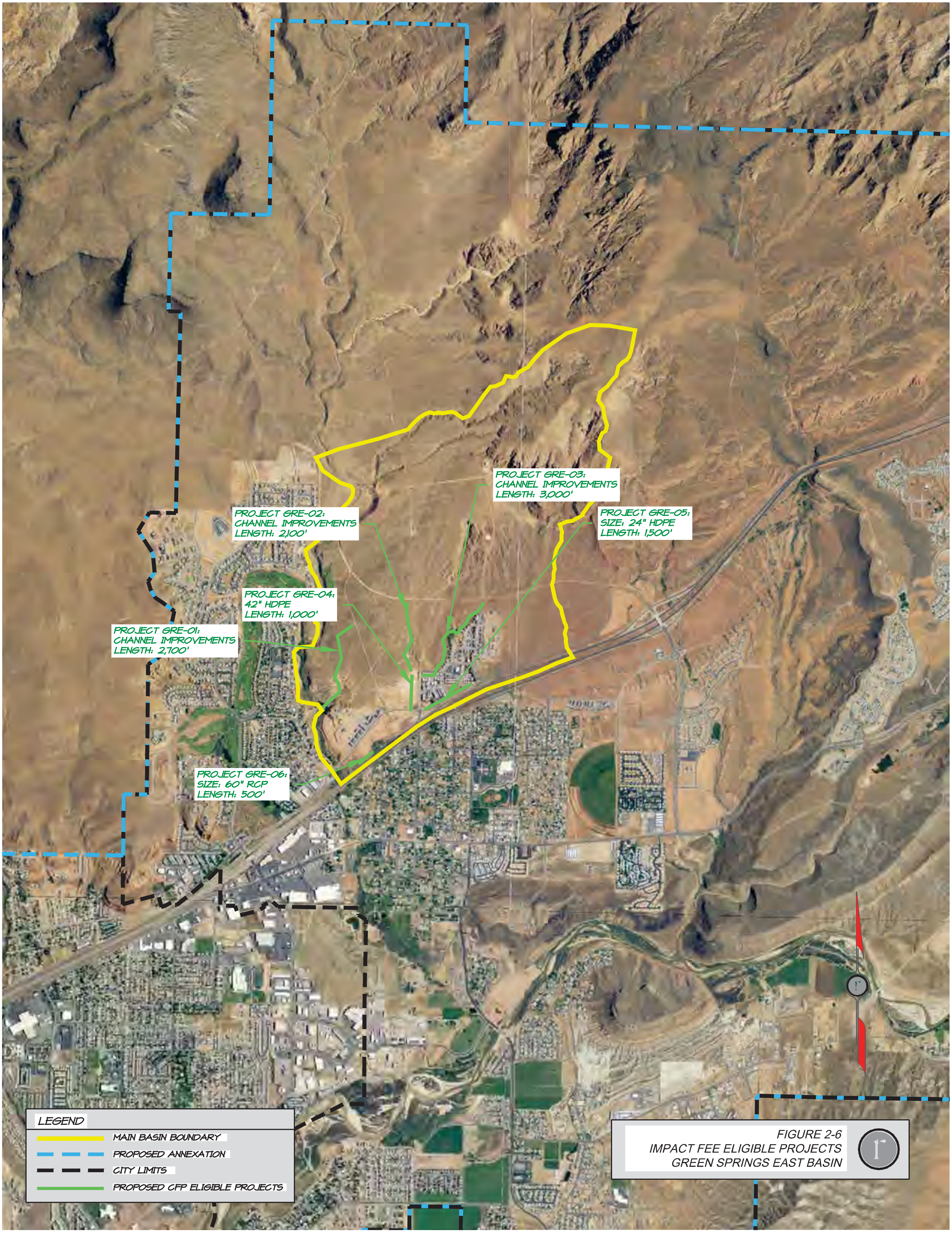

FIGURE 2-6
IMPACT FEE ELIGIBLE PROJECTS
GREEN SPRINGS EAST BASIN

2.12.1 Project GRE-01

Description: Construct channel improvements with access road to convey storm water from future development, maintaining minimum 50' ROW width for 2,700 feet of existing wash.

Estimated Conceptual Project Cost: $178,202.

2.12.2 Project GRE-02

Description: Construct channel improvements with access road to convey storm water from future development, maintaining minimum 50' ROW width for 2,100 feet of existing wash.

Estimated Conceptual Project Cost: $138,602.

2.12.3 Project GRE-03

Description: Construct channel improvements with access road to convey storm water from future development, maintaining minimum 50' ROW width for 3,000 feet of existing wash.

Estimated Conceptual Project Cost: $198,003.

2.12.4 Project GRE-04

Description: Install 42" HDPE 1,000 feet along North Main Street to convey storm water from future development in areas to the north and west, picking up flows from Project GRE-03, extending line from Buena Vista Boulevard to Arrowweed Way.

Estimated Conceptual Project Cost: $280,766.

2.12.5 Project GRE-05

Description: Install 24" HDPE for 1,400 feet along Buena Vista Boulevard east of Main Street to Graham Manor. This project was originally identified in the 2005 CFP as “Millcreek Sub-Basin 18 Trunk Line”. The original 2005 project has been broken into two different projects with this Update CFP to include GRE-05 and GRE-06. Although the line has been partially completed, GRE-05 and GRE-06 represent the uncompleted remaining portion.

Estimated Conceptual Project Cost: $201,774.

2.12.6 Project GRE-06

Description: Add 500 feet of 60" HDPE pipe, and construct outlet structure discharging to open channel along UDOT right-of-way, between the Boilers and Millcreek Wash. This project was originally identified in the 2005 CFP as “Millcreek

Sub-Basin 18 Trunk Line". The original 2005 project has been broken into two different projects with this Update CFP to include GRE-05 and GRE-06. Although the line has been partially completed, GRE-05 and GRE-06 represent the uncompleted remaining portion.

Estimated Conceptual Project Cost: $279,329.

2.13 Grapevine Wash Basin

The Grapevine Wash (GRP) drainage basin is outlined in Figure 2-7. The basin storm water drains to the Grapevine Wash, both north and south of Interstate 15. The boundary extends from approximately 800 East Street eastward to the Washington Black Ridge, and southward to the confluence with Cottonwood Wash and the Virgin River.

Much of this drainage basin includes the Sienna Hills Master Plan Community. This area has been master planned to convey storm water directly to the Grapevine Wash 100-year floodplain. Storm drain infrastructure will be built and paid for by the developer as part of the phased project construction process. For this reason, the project is not subject to – nor eligible for – any storm water capital facilities impact fee expenses or revenues. These areas were also not evaluated for storm drain improvements as part of this study.

The updated hydrologic model identified the following general conceptual storm water system improvements recommended for inclusion in the capital facilities plan, and located outside of the Sienna Hills Master Plan Community. The approximate locations for these improvements are illustrated in Figure 2-7.

2.13.1 Project GRP-01

Description: Install 36" HDPE 1,120 feet to convey storm water from future area development, routing between I-15 and Bluff View Drive. This project was originally identified in the 2005 CFP as "Grapevine Sub-Basin 31 Trunk Line". Although the line has been partially completed, projects GRP-01 and GRP-02 represent the uncompleted remaining portion.

Estimated Conceptual Project Cost: $320,815.

2.13.2 Project GRP-02

Description: Install 48" HDPE 2,200 feet to convey storm water from future area development, routing from 1100 East southward discharging into open channel at East Pine Valley Street. This project was originally identified in the 2005 CFP as "Grapevine Sub-Basin 31 Trunk Line". Although the line has been partially completed, projects GRP-01 and GRP-02 represent the uncompleted remaining portion.

Estimated Conceptual Project Cost: $833,357.

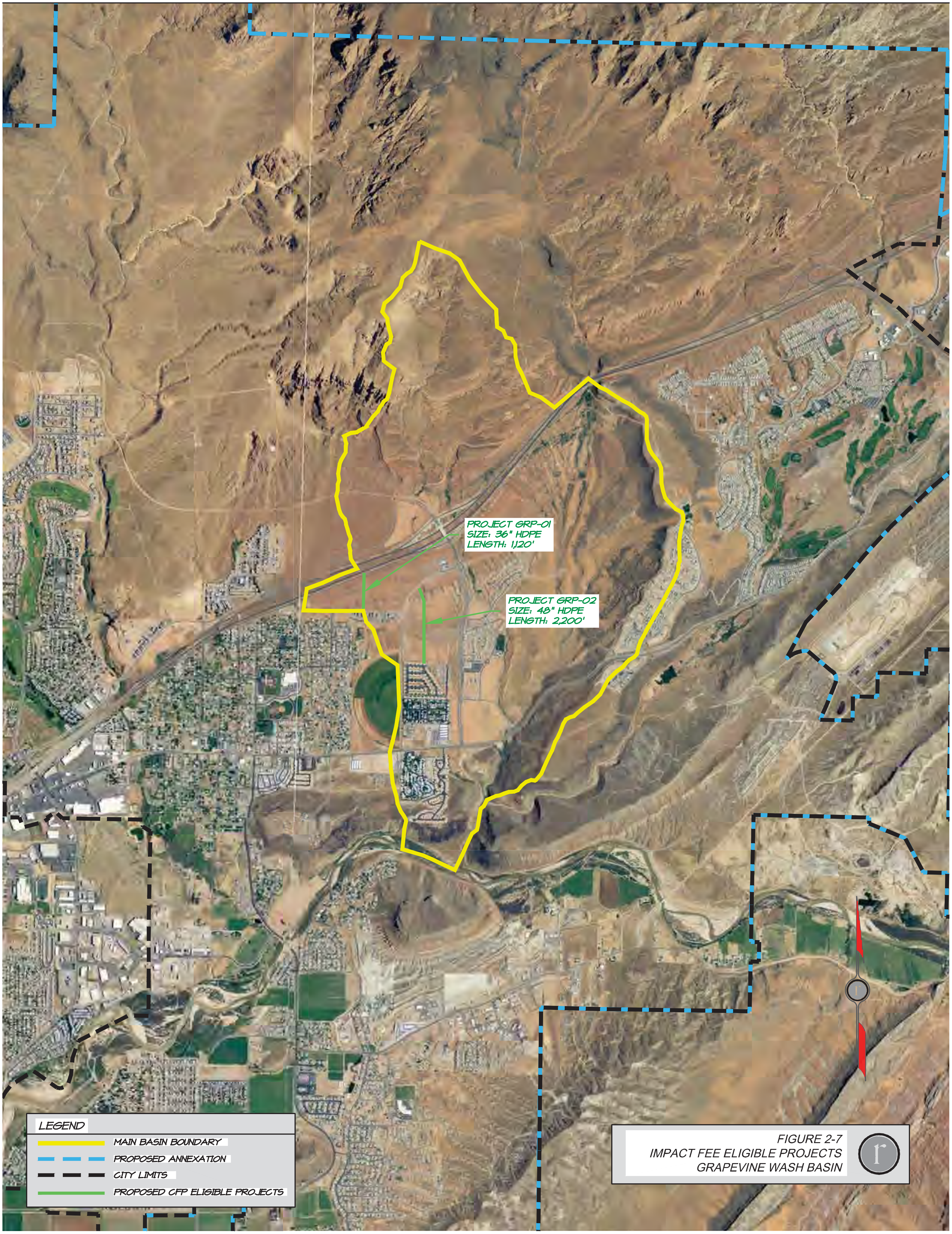

FIGURE 2-7
IMPACT FEE ELIGIBLE PROJECTS
GRAPEVINE WASH BASIN

2.14 All Drainage Basins

The cost to perform the next CFP Update has also been identified as a project need, *Project ALL-01*. The estimated cost for this project is $60,500.

2.15 Means to Meet Growth Demands

It is the intent of Washington City to utilize storm drain impact fees in order to construct the currently identified storm drain infrastructure projects necessary to meet growth demands. As required by Utah's Impact Fees Act, project costs shall also be offset with grants or other alternate sources of payment, where opportunities permit. Chapter 3 discusses the impact fee analysis used to determine the recommended storm drain impact fee for this Update CFP report.

CHAPTER 3 – IMPACT FEE ANALYSIS SUMMARY

3.1 Introduction

This chapter summarizes the portion of this CFP Update report explaining the Impact Fee Analysis for Washington City, in accordance with UCA §11-36a-303, 304, and 305.

3.2 Determination of Opinion of Project Construction Costs

Table T-8, located in Appendix 2, the tables section of this report, contains the opinion of probable construction cost developed for each of the identified projects outlined in Chapter 2.

Unit prices used in the opinions of probable construction cost were given in 2014 dollars based on local experience with recent construction projects, discussions with general earthwork contractors, and from costs provided by area materials suppliers. Unit costs were generally rounded to the upper end of a given price range, since each project is considered to be in a very "conceptual" state of identification, and potential unknowns could increase the final cost of the project. In addition, no increase in cost was assumed for inflation in future years.

The following line items were also added to the opinion of probable construction cost subtotal amount:

- Mobilization/demobilization (5%)
- Construction contingency (20%)
- Design and construction engineering (10%)
- Project Management (10%)

In accordance Utah's Impact Fees Act, UCA §11-36a-306, the above contingency, engineering, and project management costs may not include expenses for overhead, "unless the overhead expense is calculated pursuant to a methodology that is consistent with generally accepted cost accounting practices and the methodological standards set forth by the federal Office of Management and Budget for federal grant reimbursement; and complies in each and every relevant respect with the Impact Fees Act."

Other assumptions used in the opinion of probable construction costs vary by project, as seen in Table T-8, and include the following:

- Estimated trench width.
- Estimated approximate distance between manholes and/or catch basins.
- Estimated conflicts with existing or future utilities as a percentage of the total project length.
- Estimated conflicts with existing or future roadway pavement, curb and gutter, and sidewalk as a percentage of the total project length.

3.3 Ratio of Cost Sharing

Identified projects in Washington City determined to be eligible for CFP impact fee funding were considered to be 100% attributable to future development. The reasons for this are as follows:

3.3.1 Projects with Shared Costs Separated

Identified projects that appeared to be attributed to both existing storm drain infrastructure deficiencies and future development were separated into two or more projects for greater ease in calculating the estimated fees. This occurred in the Millcreek Wash drainage basin. Two projects in this basin are shown running “side-by-side”. Project MLC-07 has been classified as impact fee non-eligible, and Project MLC-08 has been classified as impact fee eligible. In reality, the projects will most likely be constructed as one “project” funded from two different sources.

3.3.2 Projects in Undisturbed Areas

Several identified projects are located in mostly undisturbed, natural desert terrain, especially in the northern areas of Green Springs West and Green Springs East drainage basins, and the eastern areas of Washington Dam Road drainage basin. These improvements were considered to be 100% attributable to future development. The natural washes and drainage patterns fully accommodate the Existing Level of Service as defined in Chapter 2, Section 2.2. Absent any development, no storm drain improvements would be necessary.

3.3.3 Projects in Irrigated Fields or Pasture

Several identified projects are located in existing irrigated farm fields or livestock pastures, mainly in the Washington Fields drainage basin. These improvements were considered to be 100% attributable to future development. The conveyance capacity of the existing irrigation canals – combined with the capacity of the fields adjacent to the canals – fully accommodates the Existing Level of Service as defined in Chapter 2, Section 2.2. Absent any development, no storm drain improvements would be necessary.

3.3.4 Projects Previously Identified in the 2005 CFP

Most of the identified impact fee eligible projects in this CFP Update had been previously identified – and were considered to be 100% attributable to future development – in the 2005 CFP. These projects have not been constructed or have only been partially completed. In these cases, the cost to construct – or to finish construction – was considered to be 100% attributable to future development, even though in some locations development has started to occur within the drainage basin.

When impact fees were collected between 2005 and 2014, projects were funded as fees were collected and/or as other sources of funds became available. Collected funds on a city-wide basis did not always perfectly match the locations where funds were expended, thus some development may have started to occur before full funding had been available to fully install the storm drain improvement. These projects still need to be 100% financed with the CFP impact fee funds.

3.4 Determination of Land Available for Future Development

The estimated acreage of land available for future development has been listed for each drainage area in Table 3-1, below. Exhibit 2 – Developable Areas, located in the Folded Maps section of this report, illustrates the breakdown of how these areas were calculated for the 7 drainage basins determined to have impact-fee eligible with projects.

TABLE 3-1: CALCULATED DEVELOPABLE ACREAGE

Drainage Basin	Total Drainage Area (acre)	Developable Area (acre)
Washington Dam Road (WAD)	2,699	765
Washington Fields (WAF)	3,325	1,688
Airport (ARP)	960	558
Millcreek Wash (MLC)	1,627	306
Green Springs West (GRW)	2,770	229
Green Springs East (GRE)	1,418	636
Grapevine Wash (GRP)	2,078	282
Total All Areas Evaluated	**14,877**	**4,464**

All non-highlighted areas located within the proposed Washington City annexation boundary – shown as a blue line in Exhibit 2 – were included in the developable acreage totals. Areas highlighted in a dark pink shade pattern were assumed to be developed, and were excluded from the total acreage. Areas highlighted in a green shade pattern were also excluded from the total acreage, assumed to be “undevelopable” or have very limited development potential due to the following constraints:

- The area has existing slopes of 15% or greater.
- The area is located within the FEMA jurisdictional 100-year Floodplain or Floodway.
- The area is located in the Warner Valley North drainage basin, which is earmarked for development of a future reservoir by the Washington County Water Conservancy District.
- The area has been designated as a critical and/or endangered species habitat or other sensitive lands.

The following areas in Exhibit 2 highlighted in a light blue or orange shade pattern were not included in the developable acreage totals:

Sienna Hills Master Plan Community: The Sienna Hills Master Plan Community is a large tract of land encompassing most of the Grapevine Wash drainage basin. On Exhibit 2, this area is highlighted in a light blue shade pattern. This area has been master planned to convey storm water directly to the Grapevine Wash 100-year floodplain. Storm drain infrastructure will be built and paid for by the developer as part of the phased project construction process. For this reason, the project is not subject to – nor eligible for – any storm water capital facilities impact fee expenses or revenues.

Coral Canyon Master Plan Community: The Coral Canyon master plan community encompasses the Cottonwood Wash drainage basin. On Exhibit 2, this area is also highlighted in a light blue shade pattern. Similar to the Sienna Hills area, Coral Canyon has been master planned to convey storm water directly to the Cottonwood Wash 100-year floodplain. Most storm water drainage infrastructure has been built. Unbuilt infrastructure in the remaining undeveloped areas will be built and paid for by the developer as part of the phased project construction process. For this reason, the project is not subject to – nor eligible for – any storm water capital facilities impact fee expenses or revenues.

Outlying Areas: Exhibit 2 shows areas highlighted in an orange shade pattern. These areas are located outside of the hydrologic model watershed boundary, but are still within the Washington City proposed annexation boundary. These areas have limited accessibility and are not expected to be developed sooner than 20 years in the future. It is assumed that these areas will be evaluated in future capital facilities plan updates as development becomes more likely.

3.5 Updated Impact Fee Determination

The final recommended storm water impact fee averaging all seven drainage basins determined to have storm water impact fee eligible projects is $4,703 per acre, as summarized in Table 3-2, below.

TABLE 3-2: RECOMMENDED CFP IMPACT FEES

Drainage Basin	Total Project Costs	Developable Area (acre)	Recommend CFP Impact Fee
Washington Dam Road (WAD)	$4,208,515	765	$5,501 per acre
Washington Fields (WAF)	$10,499,317	1,688	$6,220 per acre
Airport (ARP)	$2,609,951	558	$4,677 per acre
Millcreek Wash (MLC)	$1,121,569	306	$3,665 per acre
Green Springs West (GRW)	$119,145	229	$520 per acre
Green Springs East (GRE)	$1,280,365	636	$2,013 per acre
Grapevine Wash (GRP)	$1,157,508	282	$4,105 per acre
Total All Areas Evaluated	**$20,996,369**	**4,464**	**$4,703 per acre**

3.6 Means to Meet Growth Demands

It is the intent of Washington City to utilize storm drain impact fees in order to construct the currently identified storm drain infrastructure projects necessary to meet growth demands. The recommended total storm drain CFP impact fee assumes all projects will need to be fully funded utilizing the impact fee. In accordance with Utah's Impact Fees Act, UCA §11-36a-302(2), Washington City shall generally consider all revenue sources to finance impacts on system improvements. It is important to note when evaluating the possibility of funding storm drainage projects through state and federal assistance programs, grant money is limited, and competition for funds is intense.

3.7 Application of the Storm Water Impact Fee

The recommended storm water impact fee assumes the application of the fee on all developable lands for all recommended projects anticipated for construction within the identified drainage basins over the next 10 years. Developable area includes all future private and public property including future open spaces, parks, streets, and other areas not specifically designated for private ownership. For this reason the following procedure should be followed by the Washington City Public Works Department staff when determining the specific impact fee for new development:

- Application of the storm water impact fee should be made at the time the final plat is recorded.
- The impact fee area calculation should cover the entire plat boundary including dedicated streets and common space areas.
- In specific cases where platting has occurred prior to the collection of the storm water impact fee, the fee should be collected at the time a building permit is issued. In these cases the 'per lot' fee should be the total area of the final plat as described above, then divided by the number of lots, with each lot in the final plat having an equal share of the cost.
- In specific cases where a property is developed on an existing parcel, and/or using some other means besides a final plat – such as a lot split, commercial infill parcel, etc. – the storm water impact fee should be collected at the time a building permit is issued. In these cases the fee amount should include an estimate of the lot area plus an applicable value to the centerline of the property road frontage.

3.8 Certification of Impact Fee Facilities Plan and Analysis

In accordance with Utah's Impact Fees Act, UCA §11-36a-306, Rosenberg Associates, certifies to the best of its knowledge that the Impact Fee Facilities Plan and Impact Fee Analysis presented in this document:

1. Includes only the costs of public facilities that are:
    a. Allowed under the Impact Fees Act; and

b. Actually incurred; or

c. Projected to be incurred or encumbered within six years after the day on which each impact fee is paid;

2. Does not include:

a. Costs of operation and maintenance of public facilities;

b. Costs for qualifying public facilities that will raise the level of service for the facilities, through impact fees, above the level of service that is supported by existing residents; or

c. An expense for overhead, unless the expense is calculated pursuant to a methodology that is consistent with generally accepted cost accounting practices and the methodological standards set forth by the federal Office of Management and Budget for federal grant reimbursement;

3. offsets costs with grants or other alternate sources of payment; and

4. complies in each and every relevant respect with the Impact Fees Act."

CHAPTER 4 – USER FEE DETERMINATION

4.1 Purpose of User Fee

Five projects located within the Millcreek Wash drainage area were determined to be ineligible for storm water impact fee funding. It is recommended that these projects be funded with storm drain user fees.

Washington City currently collects a $6.00 monthly storm drain user fee from each household. This fee has been assessed in varying amounts since its implementation in the summer of 2004. Since that time the fee has been used to fund the following storm water improvement expenses. These expenses are shown as line items in Table T-11 and T-12, located in Appendix 2, the tables section of this report.

- Funding for capital facilities improvements not eligible for CFP impact fee funding. Current needs have been identified by this update as the five projects listed in Chapter 5, Section 5.5.
- Funding for the storm water operational expense budget, currently totaling $3.64 per month per user in the tables, which includes wages, benefits, and related expenses for Washington City Public Works personnel assigned to oversee the maintenance of the existing city storm drain infrastructure system. This activity includes the management and enforcement of storm water quality "best management practices" (BMP's) as required by the US Environmental Protection Agency (EPA). Numbers for the operational expense budget were provided by Washington City Public Works officials, taken from the 2014 fiscal year budget projections.
- Funding currently totaling $1.50 per month per user for city participation in the Washington County Flood Control Authority, an inter-local agency cooperative agreement between Washington County, the City of St. George, Washington City, and Santa Clara City. The purpose of the Flood Control Authority is to better share management, administration, and cost responsibilities for regional storm water drainage and flood control concerns that cross common community boundaries.
- The tables also include a monthly per user credit of $0.76. This is to use future CFP funds to reimburse the user fee fund for installation of 54-inch and 60-inch pipeline installed along 240 West Street between 3650 South Street and Merrill Road, and along Merrill Road between 240 West Street and Harvest Lane. It is assumed that it will take up to 20 years to reimburse the full project cost of $1,542,000, averaging $77,100 per year or $6,425 per month.

4.2 Millcreek Wash Basin

The Millcreek Wash (MLC) drainage basin is outlined in Figure 4-1. The basin is located in the central part of Washington City, south of Interstate 15 and north of the

Virgin River. Most of the basin drains into the Millcreek Wash except for the southern basins bordering the Virgin River, which discharge directly to the river.

The updated hydrologic model identified the following general conceptual storm water system improvements recommended for inclusion in the storm drain user fee fund. The approximate locations for these improvements are illustrated in Figure 4-1.

4.2.1 Project MLC-01

Description: Add 1,400 feet of 24" HDPE pipe along 200 West Street from Telegraph to 200 North Street. Estimated project cost $235,845. This project was originally identified in the 2005 CFP as “Millcreek Sub-Basin 34, Pipe 30”, and has yet to be completed.

Estimated Conceptual Project Cost: $235,845.

4.2.2 Project MLC-02

Description: Add 2,100 feet of 24" HDPE pipe along North Main Street from Telegraph to 300 North Street. This project was originally identified in the 2005 CFP as “Millcreek Sub-Basin 34, Pipe 21”, and has yet to be completed.

Estimated Conceptual Project Cost: $354,726.

4.2.3 Project MLC-03

Description: Add 2,400 feet of 24" HDPE pipe along North 300 East Street from Telegraph to Bulloch Drive. This project was originally identified in the 2005 CFP as “Virgin River Sub-Basin 20, Trunk Line”, and has yet to be completed.

Estimated Conceptual Project Cost: $425,061.

4.2.4 Project MLC-04

Description: Add 2,400 feet of 30" HDPE pipe along Scenic Drive West from Telegraph to Scenic Drive North.

Estimated Conceptual Project Cost: $486,918.

4.2.5 Project MLC-07

Description: Install additional 24" HDPE 1,300 feet routing along Sequoyah Drive and tie into 300 East (Washington Fields Road).

Estimated Conceptual Project Cost: $253,125.

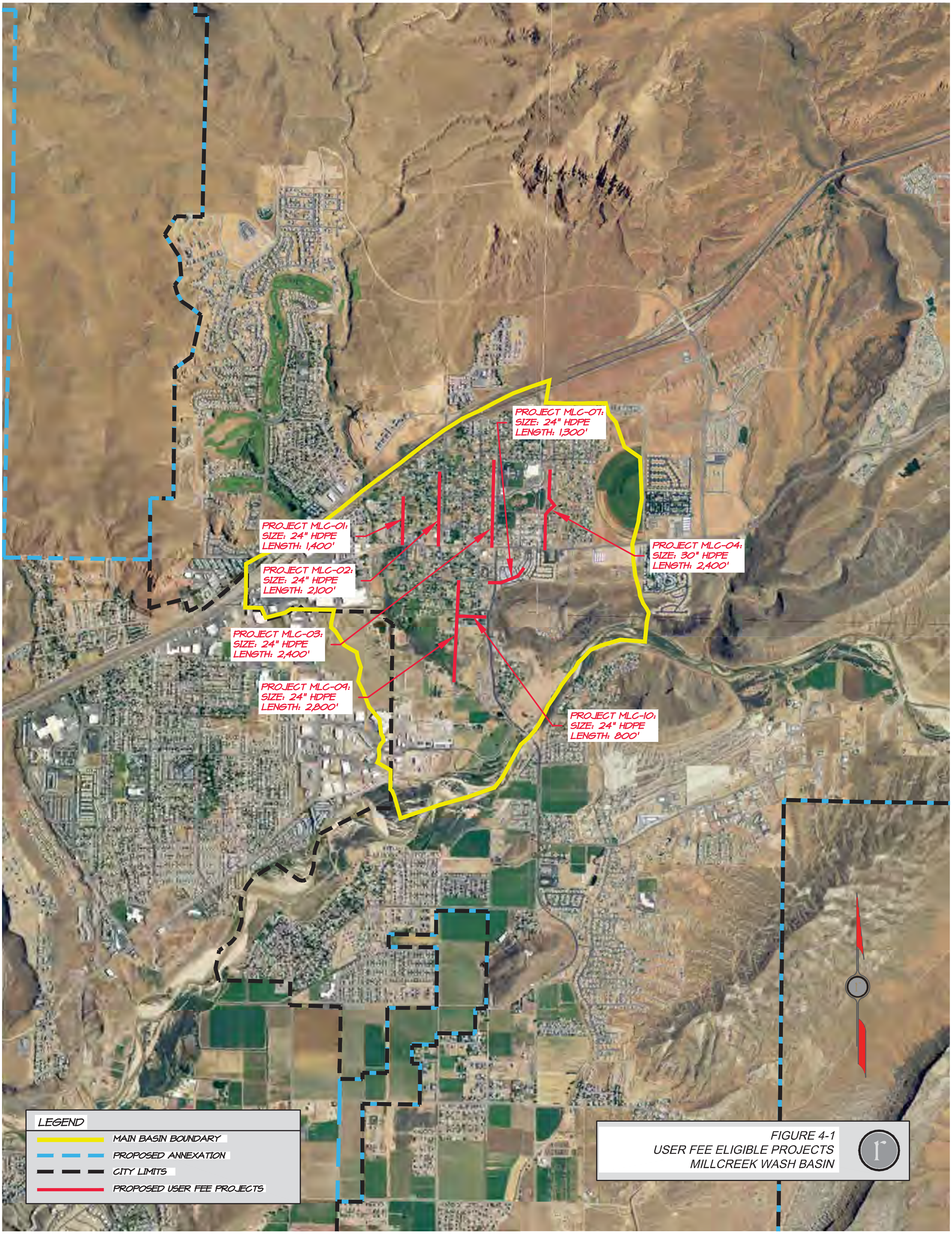

FIGURE 4-1
USER FEE ELIGIBLE PROJECTS
MILLCREEK WASH BASIN

4.2.6 Project MLC-09

Description: Perform road improvements and/or install 24" HDPE storm drain pipe up to 2,800 feet to convey the 100-3 design storm on 100 East Street between 200 South and Millcreek Wash.

This project has been identified to assign an additional conveyance for the Millcreek drainage south of the Telegraph Street system. Since many of the roadways in this area are not fully improved to current city standards with full curb and gutter, much of the conveyance capacity is lost on these streets.

Estimated Conceptual Project Cost: $540,945.

4.2.7 Project MLC-10

Description: Replace existing ditch previously used for irrigation with 800 feet of 24" HDPE storm drain pipe to convey the 100-3 design storm on 400 South Street between 100 East and 300 East.

This project is an extension of Project MLC-09, which was identified to assign an additional conveyance for the Millcreek drainage south of the Telegraph Street system. Since many of the roadways in this area are not fully improved to current city standards with full curb and gutter, much of the conveyance capacity is lost on these streets. In this area storm water drainage along a 2-block stretch of unimproved roadway is draining into a small irrigation canal paralleling the street, which lacks capacity for intense rainfall events and should be replaced with a pipeline and/or roadway improvements.

Estimated Conceptual Project Cost: $160,245.

4.3 Determination of Opinion of Project Construction Costs

Table T-10, located in Appendix 2, the tables section of this report, contains the opinion of probable construction cost developed for each of the identified projects outlined above. The total cost for all identified user fee projects is $2,456,865.

Unit prices used in the opinions of probable construction cost were given in 2014 dollars based on local experience with recent construction projects, discussions with general earthwork contractors, and from costs provided by area materials suppliers. Unit costs were generally rounded to the upper end of a given price range, since each project is considered to be in a very “conceptual” state of identification, and potential unknowns could increase the final cost of the project. The following line items were also added to the opinion of probable construction cost subtotal amount:

- Mobilization/demobilization (5%)
- Construction contingency (20%)
- Design and construction engineering (10%)

Other assumptions used in the opinion of probable construction costs vary by project, as seen in Table T-8, and include the following:

- Estimated trench width.
- Estimated approximate distance between manholes and/or catch basins.
- Estimated conflicts with existing or future utilities as a percentage of the total project length.
- Estimated conflicts with existing or future roadway pavement, curb and gutter, and sidewalk as a percentage of the total project length.

No increase in cost was added to the estimates to cover inflation in future years. This method anticipates that fees from future growth will match or exceed project cost increases due to inflation.

It is recommended that all costs be reviewed in approximately 5 years to determine if assumed project costs and collected fees are adequately covering actual project costs.

4.4 Recommended User Fee Amount

Recommended storm drain user fee amounts for two different "funding window" scenarios are summarized in Table T-11 and Table T-12:

- Table T-11 recommends a total monthly user fee amount of $9.23, assuming a 5-year window to fund the identified storm water capital improvements projects.
- Table T-12 recommends a total monthly user fee amount of $6.80, assuming a 10-year window to fund the identified storm water capital improvements projects.

Since the calculated $6.80 fee for the 10-year funding window is higher than the existing $6.00 monthly fee, it is recommended that the existing fee be raised to $6.80 to permit the construction of the identified improvements within the next 10-year window.

CHAPTER 5 – UPDATED HYDROLOGIC MODEL

5.1 Introduction

This chapter describes the drainage basin characteristics of the study area that provide the basis for developing the updated hydrologic model which was used to estimate the storm water peak run-off values. The steps in evaluating the characteristics included the following:

- Evaluating the watershed area boundaries for waterways that flow through the Washington City corporate limits. These boundaries were previously determined in the 2005 CFP. Updates to these boundaries were determined from observations from Public Works officers, updated aerial photography and mapping, and site visits.
- Evaluating the updated NOAA Atlas 14 point precipitation data and comparing with the previously applicable NOAA Atlas 2 data to establish the final design storm used in the updated model.
- Evaluating the main soil types, land use, and vegetative cover found within the watershed compared with the values assumed in the 2005 CFP. Soils data was obtained from the Natural Resources Conservation Service (NRCS). Land use information was determined mainly from 2004 aerial photography used in the 2005 CFP. Vegetative cover was examined from aerial photographs and site visits.

Hydrologic modeling was performed using methods recommended in the US Army Corps HEC-HMS,[7] and provided all the design flows for this CFP Update.

5.2 Study Area Boundaries

Washington City is located at an average elevation of 2,800 feet above sea level. The Washington City watershed is drained by the Virgin River and by several washes tributary to the Virgin River including Millcreek Wash, Grapevine Wash, and Cottonwood Wash. The total watershed study area in this CFP Update is approximately 50 square miles, which includes most of the incorporated area. Exhibit 3 – Hydrologic Model, included in the folded maps section of this report, shows an outline of the city corporate limits and the watershed study area.

The overall study area watershed was divided into 51 smaller drainage basins in the 2005 CFP. Several of these have been further divided in this update study to pinpoint runoff values at additional locations, bringing the current total number of drainage basins to 93. These basins have been grouped into 13 larger drainage areas, outlined and labeled in Exhibit 3, with geographic characteristics described in Chapter 2 through Chapter 14 of this report, and summarized in Table 5-1 below. Drainage basin subarea boundaries are outlined and labeled in Exhibit 3.

[7] US Army Corps of Engineers, Hydraulic Engineering Circular Hydrologic Modeling System (HEC-HMS) software, Version 3.5.

TABLE 5-1: DRAINAGE AREA DESCRIPTIONS

Drainage Area		Drainage Basins
WAD	**Washington Dam Road** Area located south of the Virgin River extending to the eastern city limits, where most properties are accessed via Washington Dam Road. Most of these basins drain northward, with storm water crossing the Washington Dam Road before discharging into the Virgin River, or being conveyed by the Washington Dam Road.	WAD-B110, WAD-B120, WAD-B130, WAD-B140 WAD-B150, WAD-B160, WAD-B170, WAD-B180 WAD-B190, WAD-B200, WAD-B210, WAD-B220 WAD-B230
WAF	**Washington Fields** Area encompassing most of the Washington Fields, extending from the Virgin River southward through the lands that have historically drained toward the Virgin River via irrigation canals, with all drainage discharging into the Virgin River via a large canal adjacent to Merrill Road. The agricultural uses in this area are gradually being developed into residential properties. Due to the progress of residential development coupled with challenges associated with conveying storm water across the flat terrain, this area has been divided into the most drainage basins.	WFD-B110, WFD-B120, WFD-B130, WFD-B140 WFD-B150, WFD-B160, WFD-B170, WFD-B180 WFD-B190, WFD-B200, WFD-B210, WFD-B220 WFD-B230, WFD-B240, WFD-B250, WFD-B260 WFD-B270, WFD-B280, WFD-B288, WFD-B290 WFD-B300, WFD-B310, WFD-B320, WFD-B330 WFD-B340, WFD-B350, WFD-B360, WFD-B370
ARP	**Airport** Area located north of the St. George Municipal Airport extending northward to approximately 4200 South Washington Fields Road, including drainage in the Stucki Springs master plan community.	ARP-B110, ARP-B120, ARP-B130, ARP-B140
MLC	**Millcreek Wash** Area located in the central part of Washington City, south of Interstate 15 and North of the Virgin River. Most of these basins drain into the Millcreek Wash except for the southern basins bordering the Virgin River, which discharge directly to the river.	MLC-B110, MLC-B120, MLC-B130, MLC-B140 MLC-B150, MLC-B160, MLC-B170, MLC-B180 MLC-B190
GRW	**Green Springs West** Area located west of Millcreek Wash and north of Interstate 15. All basins within this area drain south and eastward into Millcreek Wash.	GRW-B110, GRW-B120, GRW-B130, GRW-B140
GRE	**Green Springs East** Area located east of Millcreek Wash and north of Interstate 15. Basins within this area drain south and westward into Millcreek Wash.	GRE-B110, GRE-B120, GRE-B130, GRE-B140 GRE-B150, GRE-B160
GRP	**Grapevine Wash** Area draining into the Grapevine Wash, both north and south of Interstate 15. The boundary extends from approximately 800 East eastward to the Washington Black Ridge, and southward to the confluence with Cottonwood Wash and the Virgin River.	GRP-B110, GRP-B120, GRP-B130, GRP-B140 GRP-B150, GRP-B160, GRP-B170

Drainage Area		Drainage Basins
CTW	**Cottonwood Wash** Area draining into the Cottonwood Wash, encompassing mainly the Coral Canyon master plan communities.	CTW-B110, CTW-B120, CTW-B130
HRS	**Harrisburg Dome** Area located mainly in the undeveloped eastern edge of the Washington City limits, including the Washington County Regional Landfill. All basins within this area drain southwesterly into the Virgin River.	HRS-B110, HRS-B120, HRS-B130, HRS-B140 HRS-B150
GYP	**Gypsum Wash** Largely undeveloped area bordering the east side of the Washington Fields that drains into the NRCS Gypsum Wash debris basin.	GYP-B110, GYP-B120, GYP-B130
STU	**Stucki Springs** Largely undeveloped area bordering the south boundary of Washington City that drains into the NRCS Stucki Springs debris basin.	STU-B110, STU-B120
WRN	**Warner Valley North** Undeveloped area located in the north half of the Warner Valley, outside of the incorporated city limits. These basins all drain into the Virgin River.	WRN-B110, WRN-B120, WRN-B130
WRS	**Warner Valley South** Undeveloped area located in the south half of the Warner Valley, outside of the incorporated city limits. These basins all drain into the NRCS Warner debris basin.	WRS-B110, WRS-B120, WRS-B130, WRS-B140 WRS-B150, WRS-B160

Physical characteristics of each drainage basin used to develop the hydrologic model including basin areas, drainage length, and average slope are listed in Table T-1, in Appendix 2, the tables section of this report.

5.3 Design Storm Selection

5.3.1 Rainfall Intensity

The results of the computer modeling are highly dependent on the selection of the "design storm." This storm, typically expressed in terms of its expected recurrence interval (e.g., 10 years), is used to determine rainfall intensity. The recurrence interval, also called a return period or event frequency, is the length of time expected to elapse between rainfall events of equal or greater magnitude. For example, a 10-year recurrence interval represents a storm event that is expected to occur once every 10 years, on average. This does not imply that two storm events of that same size will not occur in the same year, nor does it mean that the next storm event of that size will not occur for another 10 years. Rather, a 10-percent chance of occurrence exists in any given year. The length of the design storm also affects storm flows and runoff.

The highest peak discharges from small watersheds in the United States are usually caused by intense, brief rainfalls that may occur as distinct events or as part of a longer storm. These intense rainstorms do not usually extended over a large area and intensities vary greatly.[8]

5.3.2 NOAA Atlas 14 Point Precipitation Frequency

In 2006, the National Oceanic and Atmospheric Administration (NOAA) published the NOAA Atlas 14,[9] which updated estimated precipitation frequency values for the Semi-Arid Southwestern United States. These new values were utilized in the updated model. Table 5-2 lists the new NOAA Atlas 14 values next to the previously applicable NOAA Atlas 2 values for selected durations and return frequencies.[10]

TABLE 5-2: NOAA ATLAS POINT PRECIPITATION FREQUENCY ESTIMATES

Duration	5-Year		10-Year		25-Year		100-Year	
	Atlas 2 (in)	Atlas 14 (in)	Atlas 2 (in)	Atlas 14 (in)	Atlas 2 (in)	Atlas 14 (in)	Atlas 2 (in)	Atlas 14 (in)
5 min	0.31	0.2	0.37	0.27	0.46	0.35	0.61	0.49
10 min	0.48	0.33	0.58	0.41	0.72	0.53	0.95	0.75
15 min	0.61	0.41	0.74	0.50	0.91	0.65	1.20	0.93
30 min	0.85	0.55	1.02	0.68	1.26	0.88	1.67	1.25
1 hr	1.07	0.68	1.29	0.84	1.60	1.09	2.11	1.54
2 hr	1.12	0.78	1.35	0.95	1.67	1.20	2.19	1.65
3 hr	1.17	0.85	1.40	1.01	1.73	1.25	2.26	1.69
6 hr	1.29	1.05	1.54	1.24	1.89	1.51	2.45	1.97
12 hr	1.40	1.24	1.66	1.46	2.03	1.74	2.62	2.19
24 hr	1.51	1.41	1.79	1.63	2.18	1.94	2.9	2.41
48-hr	1.60	1.53	1.93	1.77	2.37	2.08	2.96	2.57
72 hr	1.68	1.62	2.02	1.87	2.46	2.19	3.08	2.70

As seen in the table, the newly determined maximum precipitation values are in some cases significantly less for the Washington City area than the old NOAA Atlas

8 US Department of Agriculture, Natural Resource Conservation Service, Technical Release 55 (TR-55), 2nd Edition, June, 1986, Appendix B.

9 Bonnin, Martin, Lin, Parzybok, Yekta, and Riley, NOAA Atlas 14, *Precipitation-Frequency Atlas of the United States, Volume 1 Version 4.0: Semiarid Southwest*, revised 2011.

10 NOAA Atlas 2 values taken from the Alliance Consulting, Washington City Hydrology Manual, Washington City, Utah, Section 5.3.

2 values. These lower values contribute to lower modeled storm water peak runoff values.

According to the NOAA Atlas 14, the new point precipitation frequency estimates are based on improvements in three primary areas: 1) denser data networks with a greater period of record; 2) the application of regional frequency analysis using L-moments for selecting and parameterizing probability distributions; and 3) new techniques for spatial interpolation and mapping. The new techniques for spatial interpolation and mapping account for topography and have allowed significant improvements in areas of complex terrain.

5.3.3 Synthetic Rainfall Distribution

Due to a lack of long-range statistical data for the Washington City watershed, a synthetic rainfall distribution was used in lieu of actual storm event records. The NRCS has developed four synthetic rainfall distributions (Type I, IA, II, and III) commonly used in the United States. This distribution accounts for rainfall variation during a storm as well as geographic regions. The Type II distribution represents a large portion of the country, including the Washington County, Utah area, and is considered by the NRCS to be the most intense short duration rainfall.[11] The Type II distribution was used in this study to model the 24-hour design storm.

A modified Type II distribution, known as the Farmer-Fletcher distribution, was used in this study to model the 3-hour design storms.[12] The Farmer-Fletcher distribution table for the 3-hour design storm is shown in Table 5-3 below:

TABLE 5-3: FARMER-FLETCHER DISTRIBUTION FOR 3-HOUR DESIGN STORM

Time (min)	Precipitation (%)	Time (min)	Precipitation (%)	Time (min)	Precipitation (%)	Time (min)	Precipitation (%)
5	0	50	71	95	93	140	97
10	1	55	77	100	93	145	97
15	1	60	81	105	94	150	97
20	2	65	84	110	94	155	98
25	2	70	86	115	94	160	98
30	3	75	88	120	95	165	99
35	28	80	90	125	95	170	99
40	48	85	91	130	96	175	100
45	62	90	92	135	96	180	100

[11] USDA NRCS, Technical Release 55, Appendix B.

[12] E.E. Farmer and J.E. Fletcher, *Rainfall Intensity-Duration-Frequency Relations for the Wasatch Mountains of Northern Utah*, Water Resources Research, Volume 8, No. 1, February, 1972.

5.4 Areal Reduction Factors

Aerial reduction factors are frequently used to reduce point-precipitation data over large areas. The Washington City Hydrology Manual outlines a process for determining reduction factors based on a process developed by the U.S. Army Corps of Engineers.[13] Due to the smaller size of the drainage basins evaluated in the update model – the majority being less than one square mile, and no area larger than 3 square miles – it was determined that no aerial reduction factors would be utilized for this model.

5.5 Curve Number Determination

A portion of rainfall is typically intercepted and stored in local depressions, or it infiltrates into the soil at the ground surface. Infiltration is dependent on soil type, land use, and vegetative cover, which is expressed as a curve number coefficient in the hydrologic model. The curve number, expressed for each subarea, is included as Table T-2, in Appendix 2, the tables section of this report.

5.5.1 Soil Types

The Natural Resource Conservation Service Soil Survey[14] was used to determine soil type. An excerpt of the NRCS soil survey map is included in the Exhibits section of this report as *Exhibit 4 – Hydrologic Soil Groups*. The study area contains soil types from all four hydrologic soil groups:

Hydrologic Soil Group A: Type A soils have high infiltration rates, even when thoroughly wetted, and consisting chiefly of deep, well to excessively drained sands or gravels. These soils have a high rate of water transmission.

Hydrologic Soil Group B: Type B soils have moderate infiltration rates when thoroughly wetted, and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission

Hydrologic Soil Group C: Type C consists predominantly of soils with high clay content, including clay loams and some shallow sandy loams, which have slow infiltration rates when thoroughly wetted. This soil group consists chiefly of soils with a layer that impedes downward movement of water, or soils with fine texture. These soils have a slow rate of water transmission.

Hydrologic Soil Group D: Type D soils consist of heavy clays or rock. These soils have very slow infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a claypan or clay layer at or near the surface, and rock outcroppings or shallow soils over nearly impervious material.

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13 Alliance Consulting, Washington City Hydrology Manual, Washington City, Utah, Section 5.4.

14 United States Department of Agriculture, Natural Resources Conservation Service. Soil Survey Geographic (SSIRGO) Database, Washington County Area, Utah. Obtained from the Soil Data Mart (http://soildatamart.nrcs.usda.gov/).

These soils have a very slow rate of water transmission.

Unclassified Areas: As seen in *Exhibit 4*, there are a number of areas within the project study area that have not been classified into a hydrologic soil group by the NRCS. In these areas a determination was made based on field observations and comparing the observed soils with adjacent classified soils. In some locations, the infiltration rate was also measured.

5.5.2 Land Use and Vegetative Cover

In addition to soil hydrologic group, land use patterns and vegetative cover determine the value of the runoff Curve Number. In developing the computer models for this study, land uses and vegetative cover were examined based on field observations and the 2012 aerial photography provided by the Washington City Public Works Department. Areas of specific land uses identified in the aerial image were measured on the project base map using AutoCAD.

Land use measurements were compared to the 2008 Washington City Zoning Map.[15] Where discrepancies existed between current zoning and existing land uses, the existing land uses were utilized. Since Washington City drainage policy requires that peak flow values cannot be increased by new development, no analysis of future peak flows were made in this study based on city zoning or other projected land use measurements. The final estimated Curve Number values for each of the drainage basins, considering soil types, land use, and vegetative cover, have been listed Table T-2, located in Appendix 2, the tables section of this report.

5.6 Routing of Rainfall Runoff

5.6.1 Drainage Length

Watershed drainage lengths and lag times are the final parameters needed to generate a storm water runoff value for a drainage basin in the hydrologic model. The drainage length is determined using available topographic mapping, and is defined as the longest length the water must travel within the drainage area, from the furthest most upper point of the watershed to the lowest point. This distance and average slope for each basin has been calculated and summarized in Table T-1 and Table T-3, located in Appendix 2, the tables section of this report.

5.6.2 Watershed Lag Time

The watershed lag time (t_p) is the time for the rainfall to travel along the drainage length, or the time for from the center of mass of rainfall excess to the peak of the storm runoff hydrograph.

15 Washington City, Utah, *Official Zoning* Map, Ordinance No. 2008-27, July 2, 2008.

Lag time was calculated using the SCS Lag Equation: [16]

$$t_p = 0.6*t_c$$

where

$$t_c = \frac{1.67L^{0.8}[(1{,}000/CN)-9]^{0.7}}{1{,}900(S)^{1/2}}$$

and CN = Curve Number
S = Average Slope, in percent
L = Drainage Length, in feet

Lag time values are summarized in Table T-3, in Appendix 2.

5.6.3 Routing and Combining Flow

In addition to Lag Time, routing of flow from one subarea through another downstream subarea also needs to be accounted for in the HEC-HMS hydrologic model in order to attenuate and translate sub-basin rainfall to runoff. For this study, the Kinematic Wave Method was used to simulate rainfall runoff routing. This method estimates travel time for overland flow or channel flow, including culvert pipe flow through. Routings used in the hydrologic model are illustrated schematically and labeled in Exhibit 3. Routing assumptions and parameters are summarized in Table T-4, located in Appendix 2, the tables section of this report.

Storm water runoff defined for each drainage basin combines with adjacent drainage basins and routings as flows accumulate to areas downstream. The HEC-HMS model uses junctions to determine combined flow values. Some junctions are further defined as ponds, which may retain all storm water flow entering in, or detain a portion of storm water before discharging back into the drainage system network. Junctions used in the hydrologic model are illustrated schematically and labeled in Exhibit 3. Junction properties are summarized in Table T-5, located in Appendix 2, the tables section of this report.

5.7 Model Output Results

Model output results for each basin, routing, and junction are listed in Table T-6, located in Appendix 2, the tables section of this report. The model included results from the following design storms:

- 10-year, 3-hour design storm
- 100-year, 3-hour design storm
- 100-year, 24-hour design storm

[16] Philip B. Bedient and Wayne C. Huber, Hydrology and Floodplain Analysis, Addison Wesley Publishing Company, 1989.

CHAPTER 6 – DRAINAGE POLICY RECOMMENDATIONS

6.1 Recommend Modifications to the Hydrology Manual

Methods used to determine modeling parameters for storm water drainage studies being prepared for proposed development within Washington City should be aligned with this Storm Water CFP Update. This chapter summarizes recommended revisions to city drainage policy and to the current Washington City Hydrology Manual.[17]

6.2 NOAA Atlas 14 Point Precipitation Frequency

It is recommended that Section 5.3 be modified to replace the NOAA Atlas 2 point precipitation frequency values be updated with the NOAA Atlas 14.[18] Table 5.3 – Washington City Rainfall Data, should be replaced with the following:

TABLE 5.3: WASHINGTON CITY RAINFALL DATA

Duration	5-Year		10-Year		25-Year		100-Year	
	(in)	(in/hr)	(in)	(in/hr)	(in)	(in/hr)	(in)	(in/hr)
5 min	0.20	2.40	0.27	3.24	0.35	4.20	0.49	5.88
10 min	0.33	1.98	0.41	2.46	0.53	3.18	0.75	4.50
15 min	0.41	1.64	0.50	2.00	0.65	2.60	0.93	3.72
30 min	0.55	1.10	0.68	1.36	0.88	1.76	1.25	2.50
1 hr	0.68	0.68	0.84	0.84	1.09	1.09	1.54	1.54
2 hr	0.78	0.39	0.95	0.48	1.20	0.10	1.65	0.83
3 hr	0.85	0.28	1.01	0.34	1.25	0.42	1.69	0.56
6 hr	1.05	0.18	1.24	0.21	1.51	0.25	1.97	0.33
12 hr	1.24	0.10	1.46	0.12	1.74	0.15	2.19	0.18
24 hr	1.41	0.06	1.63	0.07	1.94	0.08	2.41	0.10
48-hr	1.53	0.03	1.77	0.04	2.08	0.04	2.57	0.05
72 hr	1.62	0.02	1.87	0.03	2.19	0.03	2.70	0.04

6.3 Synthetic Rainfall Distribution

In addition to the change to the NOAA Atlas 14 for Washington City rainfall data, it is recommended that the modified NRCS Type II Farmer-Fletcher rainfall distribution be used to model all 3-hour design storms, and that the NRCS Type II rainfall distribution be used to model all other design storms.

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17 Alliance Consulting, Washington City Hydrology Manual, Washington City, Utah.

18 Bonnin, Martin, Lin, Parzybok, Yekta, and Riley, NOAA Atlas 14, *Precipitation-Frequency Atlas of the United States, Volume 1 Version 4.0: Semiarid Southwest*, revised 2011.

6.4 Areal Reduction Factors

Section 5.4 discusses the use of aerial reduction factors. Since aerial reduction factors are typically used for large drainage basins, it is recommended that they not be utilized for drainage evaluations typically performed for development within Washington City, unless approved by the City Engineer.

6.5 Curve Number Determination

Section 6.3.1 discusses SCS Curve Number (CN) determination, referencing Table 6.3. A determination of the CN is dependent on the hydrologic soil group classified by the US Natural Resource Conservation Service (NRCS). As seen in Exhibit 4, soils types in many areas within Washington City have not been assigned a hydrologic soils group by the NRCS. It has been common practice for engineers to assume a Type D soil condition to these areas, as it yields a higher, more conservative peak flow value.

Washington City Public Works staff has noted areas in the southern Washington Fields that seem to yield low storm water runoff during high intensity events. Drainage research was performed upstream of the Gypsum Wash and Stucki Springs detention basins by Horrocks Engineers for the Southern Parkway.[19] Working in partnership with the NRCS, the Horrocks study determined that certain soils in the area could be hydrologically re-classified, resulting in a lower hydrologic curve number (CN), and a lower modeled storm water peak runoff value. The curve numbers updated in the Horrocks study were utilized in the applicable subareas for this update model as well.

After reviewing the Horrocks information, and after performing additional field infiltrometer testing, it was determined that several unclassified locations within the Washington Fields area exhibit infiltration rates more typical of a Type B, or even a Type A designation.

Assigning a Type D soil to the "pre-developed" hydrologic model may result in an undersized detention pond and/or increase peak flow in downstream storm drainage infrastructure designed for a low peak flow value. For this reason, it is recommended that drainage reports prepared for proposed new development in areas which have not been assigned a hydrologic soils group by the NRCS contain documentation of field infiltrometer testing and test pit excavations to justify the soils group used. The final soils group assigned should be reviewed and approved by the City Engineer.

6.5.1 Infiltrometer Testing Procedure

Infiltrometer testing should follow the procedure outlined in the "Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer", ASTM

[19] Horrocks Engineers (on behalf of the Utah Department of Transportation), Hydraulics/Design Report for Modifications to Stucki Debris Basin Auxiliary Spillway, Southern Parkway; New Airport to Washington Dam Road (Segment 3), UDOT Project No. S-LC53(45), August, 2010, Revised September, 2010. See Section 4 for a discussion on hydrologic soil groups.

Designation 3385-88.[20] In summary, a 24" diameter impermeable outer ring (steel pipe) is driven approximately 6" into the existing soil. A second 12" diameter impermeable ring is placed within the outer ring and driven approximately 3" into the existing soil. A diagram illustrating the apparatus used to conduct the infiltrometer tests is illustrated in Figure 5-1.

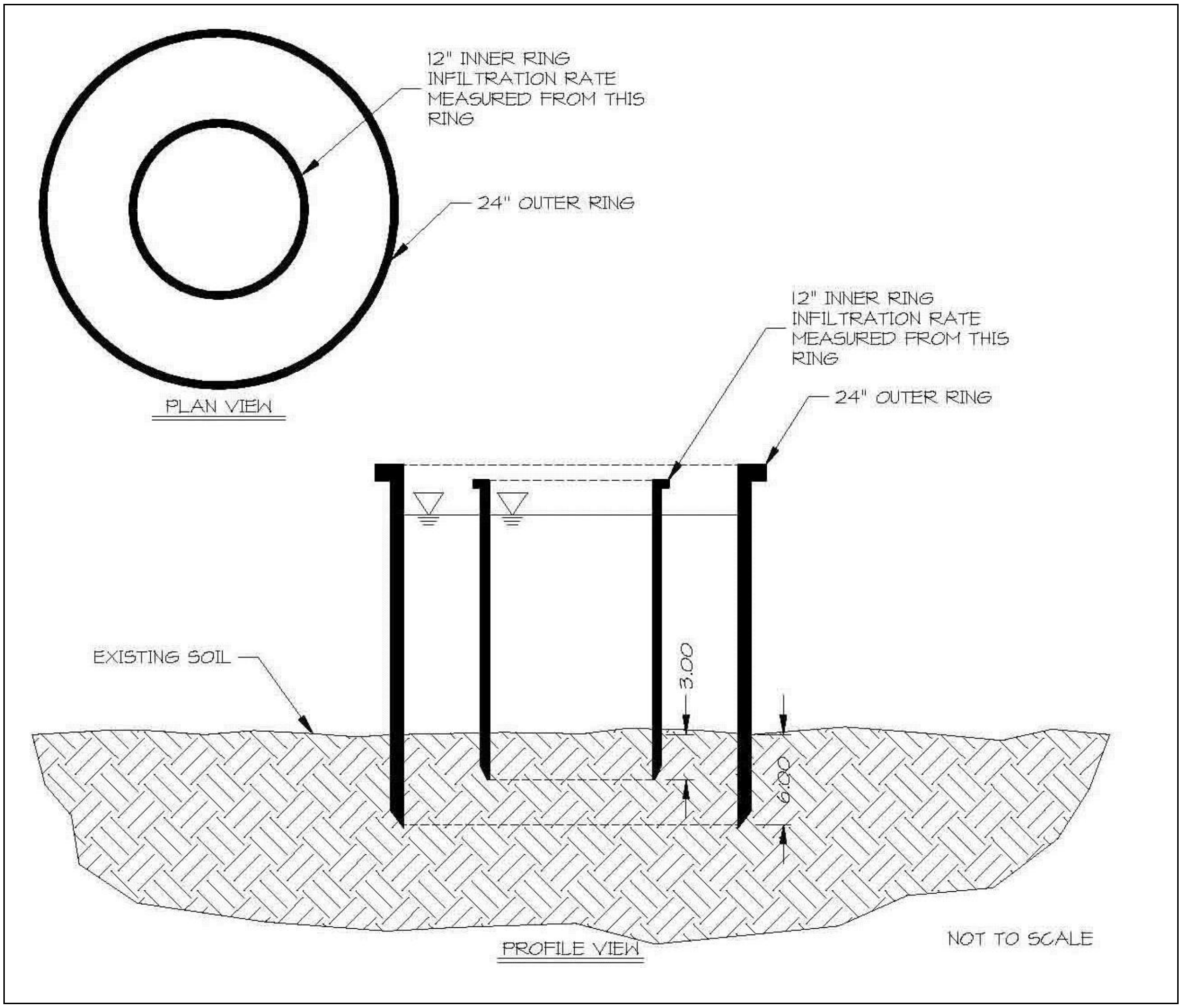


Figure 6-1 Plan and Profile View of Infiltration Test Apparatus

Both rings are then filled with water and the rate of infiltration is measured in inches/hour from the top rim of the inner ring while the outer ring ensures vertical flow of the water under the inner ring. Infiltration rates and test times vary greatly depending on the differing soil types; therefore, no specific time of test is designated

[20] American Society for Testing and Materials (ASTM), *Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer*, ASTM Designation: D 3385-88, April,1998.

by ASTM. Tests should be performed in an undisturbed “native soils” location at the existing grade.

6.5.2 Test Pit Excavations

Test pits should be excavated with a rubber-tired backhoe at each infiltration test location to a minimum depth of 4 feet to document the following field conditions:

- The soil profile should be logged.
- The soil profile log should note the presence, depth, and thickness of any impermeable layers.
- No groundwater should be present within the 4 feet of the ground surface.

6.5.3 Infiltrometer Testing and Test Pit Excavation Results

Infiltration rates at each test location should be compared to Table 7-1 from the “NRCS Part 630 Hydrology National Engineering Handbook”[21] which defines hydrologic soil groups with given water table depths and infiltration rates. Based on these criteria, and with the guidelines established by the local NRCS Soil Survey, a soils group should be designated and documented in the drainage study report.

[21] United States Department of Agriculture, Natural Resources Conservation Service. *Part 630 - Hydrology National Engineering Handbook, Chapter 7 Hydrologic Soil Groups*. 210-VI-NEH. January, 2009.

CHAPTER 7 – REFERENCES

1. Alliance Consulting, Storm Water Capital Facilities Master Plan, Washington City, Utah, July, 2005.

2. Alliance Consulting, Washington City Grading Manual, Adopted by Ordinance 2006-30, October 11, 2006, see specifically Section 8, Hydrology Manual, Chapter 3, “Drainage Policy”.

3. American Society for Testing and Materials (ASTM), *Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer*, ASTM Designation: D 3385-88, April, 1998.

4. Bonnin, Martin, Lin, Parzybok, Yekta, and Riley, NOAA Atlas 14, *Precipitation-Frequency Atlas of the United States, Volume 1 Version 4.0: Semiarid Southwest*, revised 2011.

5. E.E. Farmer and J.E. Fletcher, *Rainfall Intensity-Duration-Frequency Relations for the Wasatch Mountains of Northern Utah*, Water Resources Research, Volume 8, No. 1, February, 1972.

6. Flammer, Jeppson, and Keedy, Fundamental Principles and Applications of Fluid Mechanics, Utah State University, 1986, p. 289.

7. Horrocks Engineers (on behalf of the Utah Department of Transportation), Hydraulics/Design Report for Modifications to Stucki Debris Basin Auxiliary Spillway, Southern Parkway; New Airport to Washington Dam Road (Segment 3), UDOT Project No. S-LC53(45), August, 2010, Revised September, 2010.

8. Philip B. Bedient and Wayne C. Huber, Hydrology and Floodplain Analysis, Addison Wesley Publishing Company, 1989.

9. US Army Corps of Engineers, Hydraulic Engineering Circular Hydrologic Modeling System (HEC-HMS) software, Version 3.5.

10. US Department of Agriculture, Natural Resources Conservation Service. Soil Survey Geographic (SSIRGO) Database, Washington County Area, Utah. Obtained from the Soil Data Mart (http://soildatamart.nrcs.usda.gov/).

10. US Department of Agriculture, Natural Resource Conservation Service, Technical Release 55 (TR-55), 2nd Edition, June, 1986, Appendix B.

11. United States Department of Agriculture, Natural Resources Conservation Service. *Part 630 - Hydrology National Engineering Handbook, Chapter 7 Hydrologic Soil Groups*. 210-VI-NEH. January, 2009.

12. Utah Code, Title 11, Chapter 36a, known as the "Impact Fees Act", enacted by Chapter 47 during the 2011 General Session of the Utah State Legislature.

13. Washington City, Utah, *Official Zoning Map*, Ordinance No. 2008-27, July 2, 2008.

14. Washington City, Utah website, http://washingtoncity.org.

15. Wikipedia, http://en.wikipedia.org/wiki/-Washington,Utah.

APPENDIX 1 – LONG RANGE GROWTH BASINS

A1.1 Harrisburg Dome Drainage Basin

A1.1.1 Basin Description

The Harrisburg Dome (HRS) drainage basin is outlined in Figure A1-1. This area is located mainly in the undeveloped eastern edge of the Washington City limits, and includes the Washington County Regional Landfill. All basins within this area drain southwesterly into the Virgin River.

A1.1.2 Identified Future Infrastructure Projects

The updated hydrologic model identified the following general conceptual storm water system improvements for the Harrisburg Dome drainage basin. Since these projects were more than 10 years away from anticipated construction, they were not included in the current impact fee determination. The approximate locations for these improvements are illustrated in Figure A1-1.

Project HRS-01: Drainage channel improvements with access road maintaining minimum 60' ROW width for 8,900 feet of existing. Estimated project cost $704,890.

Project HRS-02: Drainage channel improvements with access road maintaining minimum 60' ROW width for 7,600 feet of existing wash. Estimated project cost $601,928.

Project HRS-03: Drainage channel improvements with access road maintaining minimum 60' ROW width for 7,200 feet of existing wash. Estimated project cost $570,248.

Project HRS-04: Drainage channel improvements with access road maintaining minimum 70' ROW width for 7,300 feet of existing wash. Estimated project cost $578,168.

Cost breakdowns for each recommended project are included in Appendix 2, the tables section of this report. The total cost for all identified future infrastructure projects is $2,455,234.

A1.1.3 Developable Area

The total watershed area of the Harrisburg Dome drainage basin is 2,569 acres. The estimated acreage of land available for future development was calculated to be 721 acres. The remaining watershed area is determined to be unsuitable for development, as discussed in Chapter 11, Section 11.5 and Chapter 12, Section 12.4. The developable area is illustrated in Exhibit 2, one of the larger folded maps included in Appendix 3 at the back of this report.

As noted above, since these projects were more than 10 years away from anticipated construction, they were not included in the current impact fee determination or storm drain user fee funding.

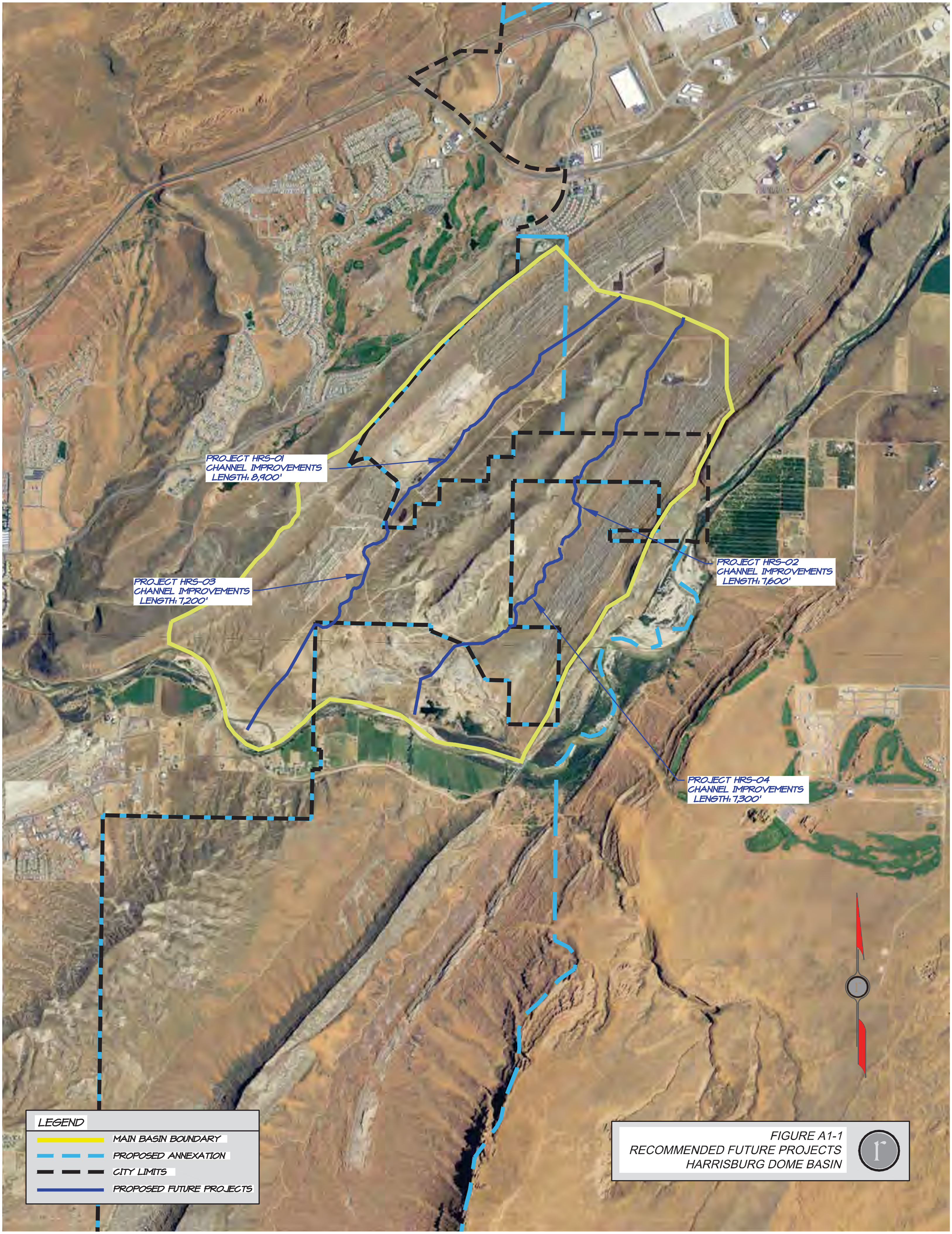


FIGURE A1-1
RECOMMENDED FUTURE PROJECTS
HARRISBURG DOME BASIN

A1.2 Gypsum Wash Drainage Basin

A1.2.1 Basin Description

The Gypsum Wash (GYP) drainage basin is outlined in Figure A1-2. This is largely an undeveloped area bordering the east side of the Washington Fields. All storm water generated in this basin drains into the Gypsum Wash debris basin, a flood and debris flow control structure that constructed by the US Natural Resource Conservation Service (NRCS) in the 1970s. Management and maintenance of this facility is currently being assumed by the Washington County Flood Control Authority.

A1.2.2 Identified Future Infrastructure Projects

The updated hydrologic model identified one general conceptual storm water system improvement for the Gypsum Wash drainage basin. Since the project was more than 10 years away from anticipated construction, it was not included in the current impact fee determination. The approximate location for the improvement is illustrated in Figure A1-2.

Project GYP-01: Install 42" HDPE 4,200 feet along the wash or future roadway, extending to the NRCS Gypsum Wash debris basin. Estimated project cost $1,171,415.

A cost breakdown for this project is included in Appendix 2, the tables section of this report.

A1.2.3 Developable Area

The total watershed area of the Gypsum Wash drainage basin is 1,890 acres. The estimated acreage of land available for future development was calculated to be 224 acres. The remaining watershed area is determined to be unsuitable for development, as discussed in Chapter 11, Section 11.5 and Chapter 12, Section 12.4. The developable area is illustrated in Exhibit 2, one of the larger folded maps included in Appendix 3 at the back of this report.

A1.3 Stucki Springs Drainage Basin

A1.3.1 Basin Description

The Stucki Springs (STU) drainage basin is outlined in Figure A1-3. This is largely an undeveloped area bordering the south boundary of Washington City. All storm water generated in this basin drains into the Stucki Springs debris basin, a flood and debris flow control structure that constructed by the US Natural Resource

Conservation Service (NRCS) in the 1970s. Management and maintenance of this facility is currently being assumed by the Washington County Flood Control Authority.

A1.3.2 Identified Future Infrastructure Projects

The updated hydrologic model identified the following general conceptual storm water system improvements for the Stucki Springs drainage basin. Since these projects were more than 10 years away from anticipated construction, they were not included in the current impact fee determination. The approximate locations for these improvements are illustrated in Figure A1-3.

Project STU-01: Drainage channel improvements with access road maintaining minimum 50' ROW width for 3,700 feet of existing wash. Estimated project cost $244,203.

Project STU-02: Drainage channel improvements with access road maintaining minimum 60' ROW width for 2,200 feet of existing wash. Estimated project cost $145,202.

Cost breakdowns for each recommended project are included in Appendix 2, the tables section of this report. The total cost for all identified future infrastructure projects is $389,405.

A1.3.3 Developable Area

The total watershed area of the Stucki Springs drainage basin is 1,267 acres. The estimated acreage of land available for future development was calculated to be 496 acres. The remaining watershed area is determined to be unsuitable for development, as discussed in Chapter 11, Section 11.5 and Chapter 12, Section 12.4. The developable area is illustrated in Exhibit 2, one of the larger folded maps included in Appendix 3 at the back of this report.

As noted above, since these projects were more than 10 years away from anticipated construction, they were not included in the current impact fee determination or storm drain user fee funding.

A1.4 Warner Valley North Drainage Basin

A1.4.1 Basin Description

The Warner Valley North (WRN) drainage basin is outlined in Figure A1-4. This is an undeveloped area located in the north half of the Warner Valley, outside of the incorporated city limits. This basin drains northward into the Virgin River.

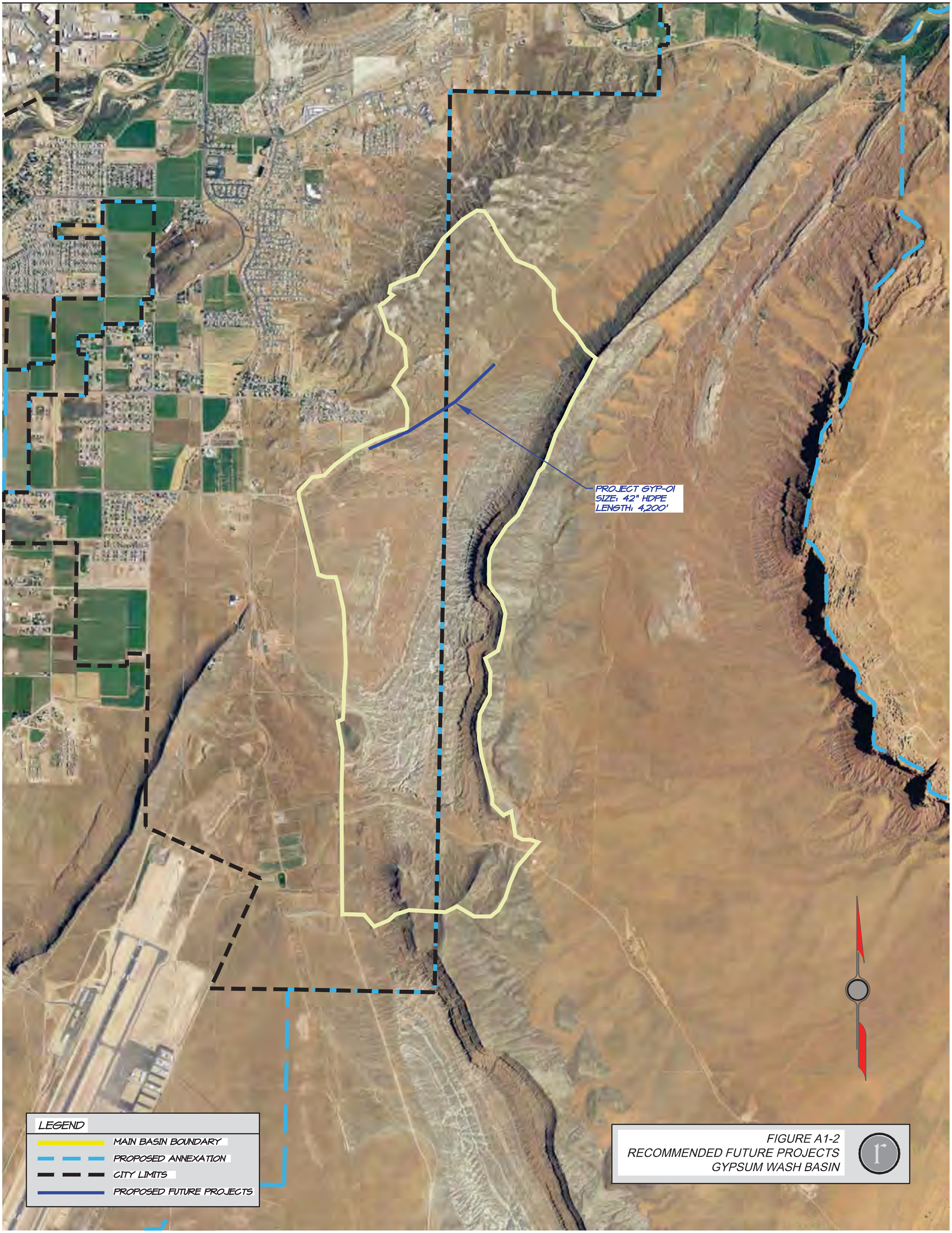
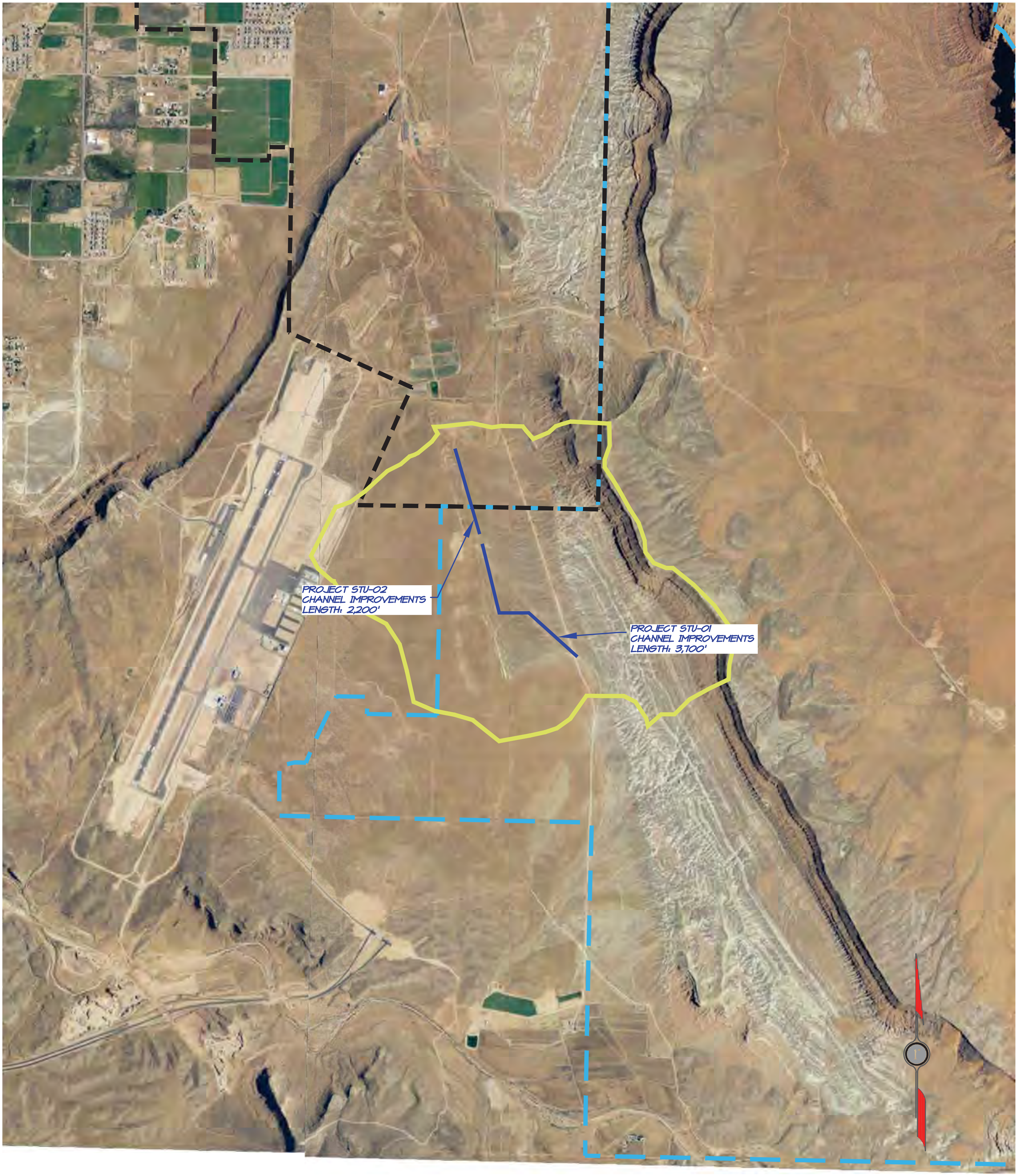


FIGURE A1-2
RECOMMENDED FUTURE PROJECTS
GYPSUM WASH BASIN



LEGEND

- MAIN BASIN BOUNDARY
- PROPOSED ANNEXATION
- CITY LIMITS
- PROPOSED FUTURE PROJECTS

FIGURE A1-3
RECOMMENDED FUTURE PROJECTS
STUCKI SPRINGS BASIN

A1.4.2 Identified Future Infrastructure Projects

The updated hydrologic model identified one general conceptual storm water system improvement for the Warner Valley North drainage basin. Since the project was more than 10 years away from anticipated construction, it was not included in the current impact fee determination. The approximate location for the improvement is illustrated in Figure A1-4.

Project WRN-01: Drainage channel improvements with access road maintaining minimum 50' ROW width for 7,800 feet of existing wash. Estimated project cost is $514,807.

A cost breakdown for this project is included in Appendix 2, the tables section of this report.

A1.4.3 Developable Area

The total watershed area of the Warner Valley North drainage basin is 3,000 acres. The estimated acreage of land available for future development was calculated to be 643 acres. The remaining watershed area is determined to be unsuitable for development, as discussed in Chapter 11, Section 11.5 and Chapter 12, Section 12.4. The developable area is illustrated in Exhibit 2, one of the larger folded maps included in Appendix 3 at the back of this report.

A1.5 Warner Valley South Drainage Basin

A1.5.1 Basin Description

The Warner Valley South (WRS) drainage basin is outlined in Figure A1-5. This is largely an undeveloped area bordering the south boundary of Washington City. All storm water generated in this basin drains into the Warner Draw debris basin, a flood and debris flow control structure that constructed by the US Natural Resource Conservation Service (NRCS) in the 1970s. Management and maintenance of this facility is currently being assumed by the Washington County Flood Control Authority.

A1.4.2 Identified Future Infrastructure Projects

The updated hydrologic model identified the following general conceptual storm water system improvements for the Warner Valley South drainage basin. Since these projects were more than 10 years away from anticipated construction, they were not included in the current impact fee determination. The approximate locations for these improvements are illustrated in Figure A1-5.

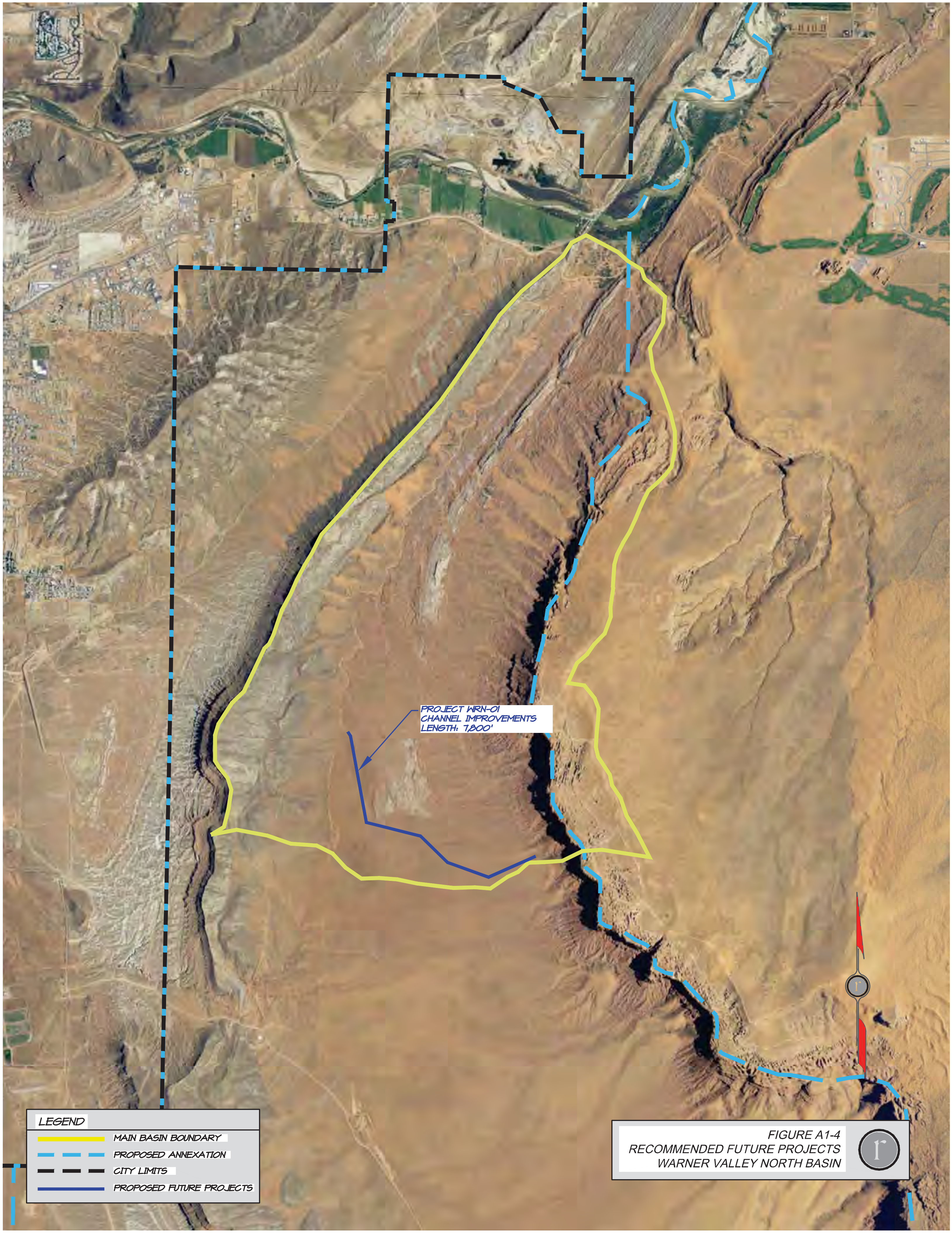


FIGURE A1-4
RECOMMENDED FUTURE PROJECTS
WARNER VALLEY NORTH BASIN

Project WRS-01: Drainage channel improvements with access road maintaining minimum 50' ROW width for 4,600 feet of existing wash. Estimated project cost $303,604.

Project WRS-02: Drainage channel improvements with access road maintaining minimum 50' ROW width for 7,600 feet of existing wash. Estimated project cost $501,607.

Project WRS-03: Drainage channel improvements with access road maintaining minimum 50' ROW width for 2,700 feet of existing wash. Estimated project cost $178,202.

Project WRS-04: Drainage channel improvements with access road maintaining minimum 50' ROW width for 2,300 feet of existing wash. Estimated project cost $151,802.

Project WRS-05: Drainage channel improvements with access road maintaining minimum 50' ROW width for 8,400 feet of existing wash. Estimated project cost $554,408.

Project WRS-06: Drainage channel improvements with access road maintaining minimum 60' ROW width for 5,600 feet of existing wash. Estimated project cost $369,605.

Project WRS-07: Drainage channel improvements with access road maintaining minimum 70' ROW width for 2,500 feet of existing wash. Estimated project cost $165,002.

Project WRS-08: Drainage channel improvements with access road maintaining minimum 70' ROW width for 7,700 feet of existing wash. Estimated project cost $508,207.

Cost breakdowns for each recommended project are included in Appendix 2, the tables section of this report. The total cost for all identified future infrastructure projects is $2,732,438.

A1.4.3 Developable Area

The total watershed area of the Warner Valley South drainage basin is 5,886 acres. The estimated acreage of land available for future development was calculated to be 3,606 acres. The remaining watershed area is determined to be unsuitable for development, as discussed in Chapter 11, Section 11.5 and Chapter 12, Section 12.4. The developable area is illustrated in Exhibit 2, one of the larger folded maps included in Appendix 3 at the back of this report.

As noted above, since these projects were more than 10 years away from anticipated construction, they were not included in the current impact fee determination or storm drain user fee funding.

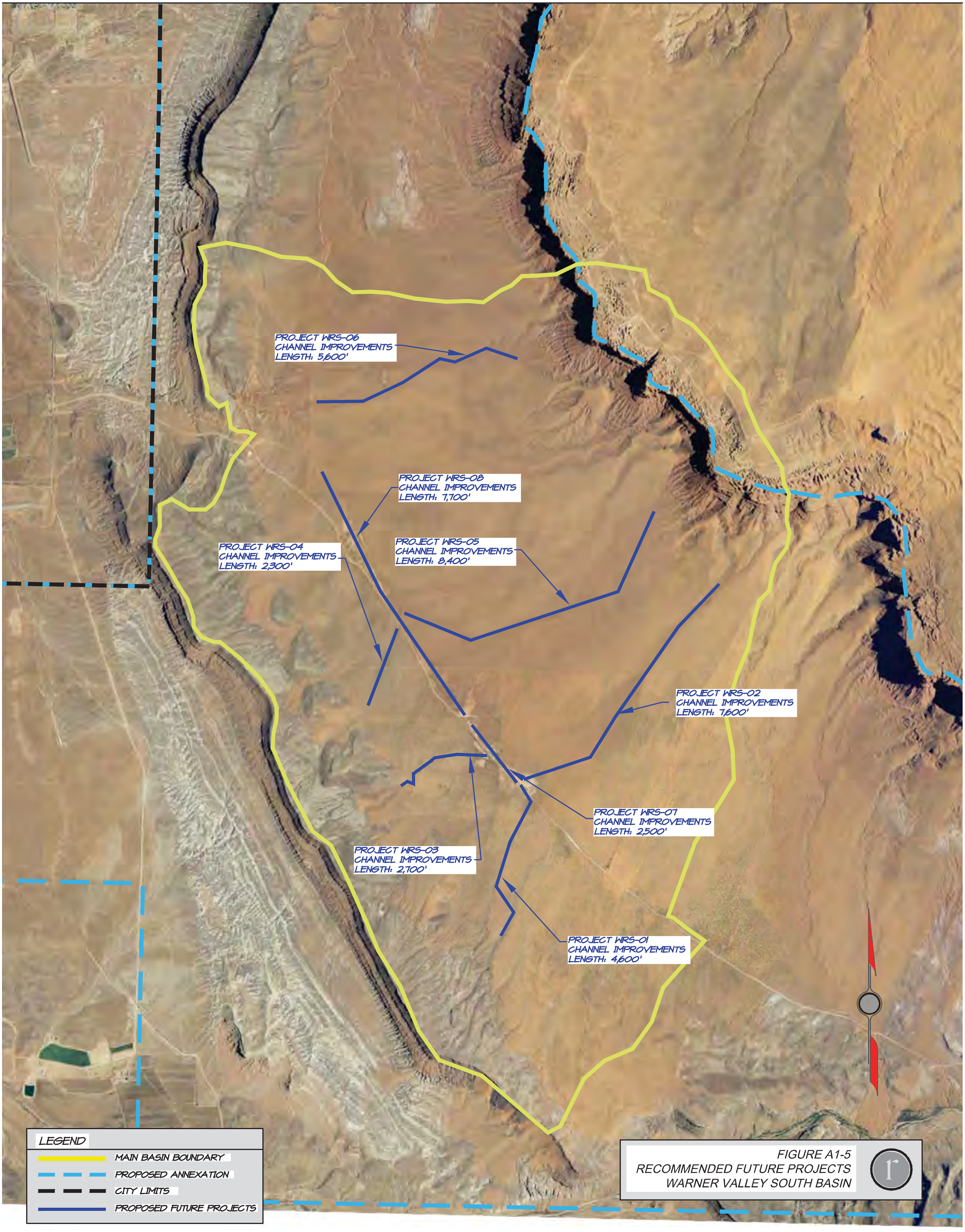


FIGURE A1-5
RECOMMENDED FUTURE PROJECTS
WARNER VALLEY SOUTH BASIN

APPENDIX 2 – TABLES

TABLE T-1: DRAINAGE BASIN INFORMATION

Drainage Area	Basin	Area			Drainage Length	Average Slope
		(sq ft)	(acres)	(sq mi)	Lo (ft)	S (%)
Washington Dam Road	WAD-B110	8,973,758	206	0.3219	6,727	3.6
Washington Dam Road	WAD-B120	4,495,324	103	0.1612	3,316	3.6
Washington Dam Road	WAD-B130	6,653,098	153	0.2386	4,638	3.8
Washington Dam Road	WAD-B140	7,708,899	177	0.2765	3,222	1.4
Washington Dam Road	WAD-B150	3,801,069	87	0.1363	3,805	4.5
Washington Dam Road	WAD-B160	5,183,965	119	0.1859	2,921	20.9
Washington Dam Road	WAD-B170	12,379,904	284	0.4441	5,540	3.5
Washington Dam Road	WAD-B180	7,582,721	174	0.2720	2,500	4.1
Washington Dam Road	WAD-B200	5,649,528	130	0.2026	1,897	5.9
Washington Dam Road	WAD-B210	4,231,614	97	0.1518	2,818	2.8
Washington Dam Road	WAD-B220	5,588,437	128	0.2005	2,627	9.4
Washington Dam Road	WAD-B230	45,300,256	1,040	1.6249	13,612	4.0
Washington Fields	WAF-B110	9,337,908	214	0.3350	2,235	2.6
Washington Fields	WAF-B120	3,158,364	73	0.1133	2,447	0.6
Washington Fields	WAF-B130	4,935,363	113	0.1770	2,674	0.5
Washington Fields	WAF-B140	3,301,435	76	0.1184	2,800	0.9
Washington Fields	WAF-B150	3,301,394	76	0.1184	2,640	0.7
Washington Fields	WAF-B160	4,861,222	112	0.1744	2,990	0.9
Washington Fields	WAF-B170	3,523,243	81	0.1264	2,683	0.9
Washington Fields	WAF-B180	4,814,953	111	0.1727	1,556	1.9
Washington Fields	WAF-B190	4,427,840	102	0.1588	1,555	1.0
Washington Fields	WAF-B200	1,849,927	42	0.0664	2,353	0.8
Washington Fields	WAF-B210	2,242,377	51	0.0804	1,962	0.9
Washington Fields	WAF-B220	3,490,868	80	0.1252	2,203	0.7
Washington Fields	WAF-B230	8,881,724	204	0.3186	7,267	6.4
Washington Fields	WAF-B240	5,793,742	133	0.2078	3,222	2.3
Washington Fields	WAF-B250	7,204,397	165	0.2584	4,393	1.2
Washington Fields	WAF-B260	3,512,923	81	0.1260	1,994	1.0
Washington Fields	WAF-B270	7,120,973	163	0.2554	2,911	0.7
Washington Fields	WAF-B278	4,911,000	113	0.1762	4,100	5.0
Washington Fields	WAF-B280	6,690,399	154	0.2400	2,949	1.6
Washington Fields	WAF-B290	3,415,801	78	0.1225	3,309	0.9
Washington Fields	WAF-B300	4,403,888	101	0.1580	2,663	1.0
Washington Fields	WAF-B310	4,453,464	102	0.1597	3,079	0.6
Washington Fields	WAF-B320	3,896,054	89	0.1398	3,025	0.6
Washington Fields	WAF-B330	1,077,776	25	0.0387	1,246	0.5
Washington Fields	WAF-B340	5,596,519	128	0.2007	2,418	0.7
Washington Fields	WAF-B350	9,869,570	227	0.3540	5,514	0.4
Washington Fields	WAF-B360	8,587,089	197	0.3080	3,430	5.0

TABLE T-1: DRAINAGE BASIN INFORMATION

Drainage Area	Basin	Area (sq ft)	Area (acres)	Area (sq mi)	Drainage Length Lo (ft)	Average Slope S (%)
Washington Fields	WAF-B370	10,169,166	233	0.3648	6,406	0.8
Airport	ARP-B110	7,654,516	176	0.2746	3,571	2.6
Airport	ARP-B120	21,217,304	487	0.7611	5,979	1.4
Airport	ARP-B130	4,362,961	100	0.1565	3,208	4.0
Airport	ARP-B140	8,576,795	197	0.3077	3,033	0.9
Millcreek Wash	MLC-B110	2,081,946	48	0.0747	1,764	2.6
Millcreek Wash	MLC-B120	7,424,984	170	0.2663	3,869	2.5
Millcreek Wash	MLC-B130	4,505,295	103	0.1616	3,048	3.5
Millcreek Wash	MLC-B135	5,197,759	119	0.1864	4,448	2.9
Millcreek Wash	MLC-B140	3,679,525	84	0.1320	4,513	2.5
Millcreek Wash	MLC-B150	6,440,985	148	0.2310	5,399	2.9
Millcreek Wash	MLC-B155	5,299,488	122	0.1901	4,063	2.4
Millcreek Wash	MLC-B160	9,656,927	222	0.3464	4,410	2.2
Millcreek Wash	MLC-B170	9,367,976	215	0.3360	3,556	3.6
Millcreek Wash	MLC-B180	4,488,941	103	0.1610	3,953	8.3
Millcreek Wash	MLC-B190	12,734,851	292	0.4568	5,962	2.4
Green Springs West	GRW-B110	65,514,237	1,504	2.3500	18,645	6.4
Green Springs West	GRW-B120	11,006,469	253	0.3948	9,065	3.4
Green Springs West	GRW-B130	7,782,000	179	0.2791	6,489	3.3
Green Springs West	GRW-B140	36,368,038	835	1.3045	9,322	3.2
Green Springs East	GRE-B110	19,541,149	449	0.7009	12,349	4.5
Green Springs East	GRE-B120	6,545,158	150	0.2348	2,763	5.1
Green Springs East	GRE-B130	5,151,022	118	0.1848	4,289	7.3
Green Springs East	GRE-B140	11,957,664	275	0.4289	7,842	7.7
Green Springs East	GRE-B150	13,002,743	299	0.4664	7,001	2.7
Green Springs East	GRE-B160	5,564,440	128	0.1996	3,869	3.0
Grapevine Wash	GRP-B110	4,258,376	98	0.1527	5,194	5.5
Grapevine Wash	GRP-B120	11,913,149	273	0.4273	9,824	6.5
Grapevine Wash	GRP-B130	11,465,718	263	0.4113	7,852	6.2
Grapevine Wash	GRP-B140	13,337,739	306	0.4784	4,460	4.3
Grapevine Wash	GRP-B160	10,141,578	233	0.3638	6,547	3.6
Grapevine Wash	GRP-B170	39,413,564	905	1.4138	11,478	3.5
Cottonwood Wash	CTW-B110	32,740,776	752	1.1744	8,017	2.5
Cottonwood Wash	CTW-B120	27,998,415	643	1.0043	10,946	1.7
Cottonwood Wash	CTW-B130	27,803,173	638	0.9973	15,648	2.2
Harrisburg Dome	HRS-B110	4,367,554	100	0.1567	1,701	3.4
Harrisburg Dome	HRS-B120	25,676,331	589	0.9210	8,973	1.4
Harrisburg Dome	HRS-B130	25,773,705	592	0.9245	7,239	1.4
Harrisburg Dome	HRS-B140	25,873,651	594	0.9281	7,758	1.4

TABLE T-1: DRAINAGE BASIN INFORMATION

Drainage Area	Basin	Area			Drainage Length	Average Slope
		(sq ft)	(acres)	(sq mi)	Lo (ft)	S (%)
Harrisburg Dome	HRS-B150	30,194,058	693	1.0831	7,500	0.9
Gypsum Wash	GYP-B110	25,312,701	581	0.9080	5,945	3.5
Gypsum Wash	GYP-B120	35,860,322	823	1.2863	4,502	3.9
Gypsum Wash	GYP-B130	21,171,276	486	0.7594	5,830	2.5
Stucki Springs	STU-B110	28,892,023	663	1.0364	7,094	2.4
Stucki Springs	STU-B120	26,307,622	604	0.9437	6,431	2.0
Warner Valley North	WRN-B110	42,661,342	979	1.5303	10,691	2.7
Warner Valley North	WRN-B120	57,365,141	1,317	2.0577	14,235	3.7
Warner Valley North	WRN-B130	30,657,734	704	1.0997	10,618	5.7
Warner Valley South	WRS-B110	42,927,391	985	1.5398	8,753	3.4
Warner Valley South	WRS-B120	44,684,308	1,026	1.6028	10,195	3.5
Warner Valley South	WRS-B130	16,761,582	385	0.6012	6,686	3.4
Warner Valley South	WRS-B140	40,613,623	932	1.4568	10,818	2.8
Warner Valley South	WRS-B150	55,276,758	1,269	1.9828	13,902	2.2
Warner Valley South	WRS-B160	56,113,076	1,288	2.0128	10,357	2.1

TABLE T-2: MODEL CURVE NUMBER VALUES

Land Use Description Summary	SCS Curve Number (CN) Values								Totals	
	%	A	%	B	%	C	%	D	%	CN
Cultivated Land Straight Row; Poor Condition		66		77		85		89		
Cultivated Land Straight Row; Fair Condition		58		72		81		85		
Pasture or Range Land; Poor Condition		68		79		86		89		
Pasture or Range Land; Fair Condition		49		69		79		84		
Pasture or Range Land; Good Condition		39		61		74		80		
Open Space; Poor Condition; Grass Cover < 50%		68		79		86		89		
Open Space; Fair Condition; Grass Cover 50% to 75%		49		69		79		84		
Open Space; Good Condition; Grass Cover > 75%		39		61		74		80		
Impervious Areas; Paved Parking Lots, Roofs, Driveways		98		98		98		98		
Impervious Areas; Streets and Roads; Paved; Curbs and Storm Sewers		98		98		98		98		
Impervious Areas; Streets and Roads; Paved; Open Ditches (w/ Right-of-Way)		83		89		92		93		
Impervious Areas; Streets and Roads; Gravel (w/ Right-of-Way)		76		85		89		91		
Impervious Areas; Streets and Roads; Dirt (w/ Right-of-Way)		72		82		87		89		
Urban Districts; Commercial and Business; Average 85% Impervious		89		92		94		95		
Urban Districts; Industrial; Average 72% Impervious		81		88		91		93		
Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious		77		85		90		92		
Residential Districts; 1/4 Acre; Average 38% Impervious		61		75		83		87		
Residential Districts; 1/3 Acre; Average 30% Impervious		57		72		81		86		
Residential Districts; 1/2 Acre; Average 25% Impervious		54		70		80		85		
Residential Districts; 1 Acre; Average 20% Impervious		51		68		79		84		
Residential Districts; 2 Acre; Average 12% Impervious		46		65		77		82		
Natural Desert Vegetation; Fair Condition		55		72		81		86		
Artificial Desert Landscaping		96		96		96		96		
Newly Graded Area (Pervious Only)		77		86		91		94		

Basin Land Use Description	SCS Curve Number (CN) Values								Totals	
	%	A	%	B	%	C	%	D	%	CN
WAD-B110									100	84
Urban Districts; Industrial; Average 72% Impervious		81	*25*	88		91		93	*25*	*22*
Residential Districts; 1/4 Acre; Average 38% Impervious		61		75	*75*	83		87	*75*	*62*
WAD-B120									100	82
Urban Districts; Industrial; Average 72% Impervious		81	*20*	88		91		93	*20*	*18*
Residential Districts; 1/4 Acre; Average 38% Impervious		61	*15*	75		83		87	*15*	*11*
Natural Desert Vegetation; Fair Condition		55		72	*65*	81		86	*65*	*53*
WAD-B130									100	81
Urban Districts; Industrial; Average 72% Impervious		81	*15*	88		91		93	*15*	*13*
Residential Districts; 1/4 Acre; Average 38% Impervious		61	*20*	75		83		87	*20*	*15*
Natural Desert Vegetation; Fair Condition		55		72	*65*	81		86	*65*	*53*

TABLE T-2: MODEL CURVE NUMBER VALUES

Land Use Description Summary	SCS Curve Number (CN) Values								Totals	
	%	A	%	B	%	C	%	D	%	CN
WAD-B140									100	77
Cultivated Land Straight row; Fair Condition		58	30	72		81		85	30	22
Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious		77	25	85		90		92	25	21
Residential Districts; 1/4 Acre; Average 38% Impervious		61	25	75		83		87	25	19
Residential Districts; 1/2 Acre; Average 25% Impervious		54	10	70		80		85	10	7
Natural Desert Vegetation; Fair Condition		55	5	72		81	5	86	10	8
WAD-B150									100	83
Residential Districts; 1/2 Acre; Average 25% Impervious		54		70	5	80		85	5	4
Natural Desert Vegetation; Fair Condition		55		72	60	81	30	86	90	74
Newly Graded Area (Pervious Only)		77		86	5	91		94	5	5
WAD-B160									100	83
Residential Districts; 1/2 Acre; Average 25% Impervious		54	15	70	15	80		85	30	23
Natural Desert Vegetation; Fair Condition		55		72		81	70	86	70	60
WAD-B170									100	84
Urban Districts; Industrial; Average 72% Impervious	10	81	10	88		91		93	20	17
Natural Desert Vegetation; Fair Condition		55		72	40	81	40	86	80	67
WAD-B180									100	84
Urban Districts; Industrial; Average 72% Impervious	5	81	35	88	10	91		93	50	44
Natural Desert Vegetation; Fair Condition		55		72	50	81		86	50	41
WAD-B200									100	78
Residential Districts; 2 Acre; Average 12% Impervious		46	20	65		77		82	20	13
Natural Desert Vegetation; Fair Condition		55		72	80	81		86	80	65
WAD-B210									100	59
Cultivated Land Straight row; Fair Condition	25	58	10	72		81		85	35	22
Pasture or Range Land; Fair Condition	10	49		69		79		84	10	5
Residential Districts; 2 Acre; Average 12% Impervious	10	46		65		77		82	10	5
Natural Desert Vegetation; Fair Condition	35	55		72		81	10	86	45	28
WAD-B220									100	81
Cultivated Land Straight row; Fair Condition		58		72	15	81		85	15	12
Residential Districts; 1 Acre; Average 20% Impervious		51		68	10	79		84	10	8
Natural Desert Vegetation; Fair Condition		55	2	72	73	81		86	75	61
WAD-B230									100	70
Cultivated Land Straight row; Fair Condition		58	7	72	2	81		85	9	7
Natural Desert Vegetation; Fair Condition	36	55	13	72	32	81	10	86	91	64
WAF-B110									100	78
Natural Desert Vegetation; Fair Condition		55	45	72	30	81	25	86	100	78
WAF-B120									100	74
Pasture or Range Land; Fair Condition		49	70	69		79		84	70	48
Natural Desert Vegetation; Fair Condition		55		72		81	30	86	30	26
WAF-B130									100	79

TABLE T-2: MODEL CURVE NUMBER VALUES

Land Use Description Summary	SCS Curve Number (CN) Values								Totals	
	%	A	%	B	%	C	%	D	%	CN
Cultivated Land Straight row; Fair Condition		58	20	72	80	81		85	100	79
WAF-B140									100	69
Pasture or Range Land; Fair Condition		49	100	69		79		84	100	69
WAF-B150									100	79
Cultivated Land Straight row; Fair Condition		58	25	72	70	81		85	95	75
Residential Districts; 1 Acre; Average 20% Impervious		51		68	5	79		84	5	4
WAF-B160									100	69
Pasture or Range Land; Fair Condition		49	100	69		79		84	100	69
WAF-B170									100	81
Cultivated Land Straight row; Fair Condition		58		72	28	81		85	28	23
Residential Districts; 1/4 Acre; Average 38% Impervious		61	15	75	57	83		87	72	59
WAF-B180									100	73
Natural Desert Vegetation; Fair Condition		55	95	72		81	5	86	100	73
WAF-B190									100	73
Natural Desert Vegetation; Fair Condition		55	95	72		81	5	86	100	73
WAF-B200									100	69
Pasture or Range Land; Fair Condition		49	100	69		79		84	100	69
WAF-B210									100	74
Residential Districts; 1/3 Acre; Average 30% Impervious		57	80	72	20	81		86	100	74
WAF-B220									100	79
Cultivated Land Straight row; Fair Condition		58	25	72	45	81		85	70	54
Residential Districts; 1/3 Acre; Average 30% Impervious		57		72	30	81		86	30	24
WAF-B230									100	76
Residential Districts; 1/2 Acre; Average 25% Impervious		54	25	70		80		85	25	18
Residential Districts; 1 Acre; Average 20% Impervious		51	10	68	5	79		84	15	11
Natural Desert Vegetation; Fair Condition		55	15	72	45	81		86	60	47
WAF-B240									100	76
Cultivated Land Straight row; Fair Condition		58	15	72		81		85	15	11
Residential Districts; 1/2 Acre; Average 25% Impervious		54	15	70	10	80		85	25	19
Natural Desert Vegetation; Fair Condition		55	20	72	40	81		86	60	47
WAF-B250									100	72
Cultivated Land Straight row; Fair Condition		58	100	72		81		85	100	72
WAF-B260									100	71
Cultivated Land Straight row; Fair Condition		58	60	72		81		85	60	43
Residential Districts; 1/2 Acre; Average 25% Impervious		54	40	70		80		85	40	28
WAF-B270									100	81
Cultivated Land Straight row; Fair Condition		58		72	58	81		85	58	47
Residential Districts; 1/4 Acre; Average 38% Impervious		61		75	12	83		87	12	10
Residential Districts; 1/2 Acre; Average 25% Impervious		54		70	30	80		85	30	24
WAF-B278									100	76

TABLE T-2: MODEL CURVE NUMBER VALUES

Land Use Description Summary	SCS Curve Number (CN) Values								Totals	
	%	A	%	B	%	C	%	D	%	CN
Residential Districts; 1/2 Acre; Average 25% Impervious		54	25	70		80		85	25	18
Residential Districts; 1 Acre; Average 20% Impervious		51	10	68	5	79		84	15	11
Natural Desert Vegetation; Fair Condition		55	15	72	45	81		86	60	47
WAF-B280									100	72
Cultivated Land Straight row; Fair Condition		58	75	72		81		85	75	54
Residential Districts; 1/3 Acre; Average 30% Impervious		57	20	72		81		86	20	14
Natural Desert Vegetation; Fair Condition		55		72	5	81		86	5	4
WAF-B290									100	70
Cultivated Land Straight row; Fair Condition		58	20	72		81		85	20	14
Residential Districts; 1/2 Acre; Average 25% Impervious		54	40	70		80		85	40	28
Residential Districts; 1 Acre; Average 20% Impervious		51	40	68		79		84	40	27
WAF-B300									100	72
Cultivated Land Straight row; Fair Condition		58	18	72	23	81		85	41	32
Residential Districts; 1/2 Acre; Average 25% Impervious		54	23	70		80		85	23	16
Residential Districts; 2 Acre; Average 12% Impervious		46	28	65		77		82	28	18
Natural Desert Vegetation; Fair Condition		55		72	8	81		86	8	6
WAF-B310									100	77
Cultivated Land Straight row; Fair Condition		58	20	72	55	81		85	75	59
Residential Districts; 1/4 Acre; Average 38% Impervious		61	5	75	5	83		87	10	8
Residential Districts; 1/2 Acre; Average 25% Impervious		54	15	70		80		85	15	11
WAF-B320									100	78
Cultivated Land Straight row; Fair Condition		58	30	72	70	81		85	100	78
WAF-B330									100	90
Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious		77	5	85	90	90	5	92	100	90
WAF-B340									100	80
Cultivated Land Straight row; Fair Condition		58	35	72	30	81		85	65	50
Natural Desert Vegetation; Fair Condition		55		72		81	35	86	35	30
WAF-B350									100	78
Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious		77	10	85		90		92	10	9
Residential Districts; 1/3 Acre; Average 30% Impervious		57		72	15	81	30	86	45	38
Residential Districts; 1/2 Acre; Average 25% Impervious		54	45	70		80		85	45	32
WAF-B360									100	77
Residential Districts; 1/3 Acre; Average 30% Impervious		57	40	72	50	81		86	90	69
Natural Desert Vegetation; Fair Condition		55		72	10	81		86	10	8
WAF-B370									100	76
Cultivated Land Straight row; Fair Condition		58	15	72	25	81		85	40	31
Residential Districts; 1/4 Acre; Average 38% Impervious		61	10	75	10	83		87	20	16
Residential Districts; 1/3 Acre; Average 30% Impervious		57	35	72		81		86	35	25
Natural Desert Vegetation; Fair Condition		55		72		81	5	86	5	4
ARP-B110									100	78

TABLE T-2: MODEL CURVE NUMBER VALUES

Land Use Description Summary	SCS Curve Number (CN) Values								Totals	
	%	A	%	B	%	C	%	D	%	CN
Natural Desert Vegetation; Fair Condition	15	55		72	75	81		86	90	69
Newly Graded Area (Pervious Only)		77		86	10	91		94	10	9
ARP-B120									100	73
Natural Desert Vegetation; Fair Condition	15	55	55	72	15	81	15	86	100	73
ARP-B130									100	86
Natural Desert Vegetation; Fair Condition		55	10	72	10	81	40	86	60	50
Newly Graded Area (Pervious Only)		77		86	40	91		94	40	36
ARP-B140									100	76
Natural Desert Vegetation; Fair Condition		55	70	72		81	30	86	100	76
MLC-B110									100	91
Urban Districts; Commercial and Business; Average 85% Impervious		89	68	92	10	94		95	78	72
Urban Districts; Industrial; Average 72% Impervious		81	11	88		91		93	11	10
Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious		77	8	85		90		92	8	7
Natural Desert Vegetation; Fair Condition		55	3	72		81		86	3	2
MLC-B120									100	92
Urban Districts; Commercial and Business; Average 85% Impervious		89	50	92	35	94		95	85	79
Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious		77		85	2	90		92	2	2
Residential Districts; 1/4 Acre; Average 38% Impervious		61		75	5	83		87	5	4
Natural Desert Vegetation; Fair Condition		55	3	72		81		86	3	2
Newly Graded Area (Pervious Only)		77		86		91	5	94	5	5
MLC-B130									100	77
Residential Districts; 1/4 Acre; Average 38% Impervious		61	75	75	25	83		87	100	77
MLC-B135									100	77
Residential Districts; 1/4 Acre; Average 38% Impervious		61	75	75	25	83		87	100	77
MLC-B140									100	83
Open Space; Good Condition; Grass Cover > 75%	5	39		61		74	10	80	15	10
Impervious Areas; Paved Parking Lots, Roofs, Driveways	5	98		98		98		98	5	5
Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious		77		85	30	90		92	30	27
Residential Districts; 1/4 Acre; Average 38% Impervious		61		75	50	83		87	50	42
MLC-B150									100	86
Open Space; Good Condition; Grass Cover > 75%		39		61	5	74	5	80	10	8
Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious		77	30	85	25	90	5	92	60	53
Residential Districts; 1/4 Acre; Average 38% Impervious		61		75	20	83	5	87	25	21
Newly Graded Area (Pervious Only)		77	5	86		91		94	5	4
MLC-B155									100	73
Open Space; Good Condition; Grass Cover > 75%		39	45	61	15	74		80	60	39
Residential Districts; 1/4 Acre; Average 38% Impervious		61		75		83	20	87	20	17
Newly Graded Area (Pervious Only)		77	20	86		91		94	20	17
MLC-B160									100	86
Urban Districts; Industrial; Average 72% Impervious		81	10	88		91		93	10	9

TABLE T-2: MODEL CURVE NUMBER VALUES

Land Use Description Summary	SCS Curve Number (CN) Values								Totals	
	%	A	%	B	%	C	%	D	%	CN
Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious		77	10	85		90	10	92	20	18
Residential Districts; 1/4 Acre; Average 38% Impervious		61	10	75		83		87	10	8
Natural Desert Vegetation; Fair Condition		55		72		81	55	86	55	47
Newly Graded Area (Pervious Only)		77		86		91	5	94	5	5
MLC-B170									100	74
Cultivated Land Straight row; Fair Condition		58	35	72		81		85	35	25
Residential Districts; 1/4 Acre; Average 38% Impervious		61	60	75		83		87	60	45
Natural Desert Vegetation; Fair Condition		55		72	5	81		86	5	4
MLC-B180									100	86
Open Space; Good Condition; Grass Cover > 75%		39	2	61		74		80	2	1
Impervious Areas; Streets and Roads; Paved; Curbs and Storm Sewers		98	3	98		98		98	3	3
Residential Districts; 1/4 Acre; Average 38% Impervious		61		75		83	15	87	15	13
Natural Desert Vegetation; Fair Condition		55		72		81	50	86	50	43
Newly Graded Area (Pervious Only)		77	30	86		91		94	30	26
MLC-B190									100	70
Cultivated Land Straight row; Fair Condition	48	58		72		81		85	48	28
Urban Districts; Industrial; Average 72% Impervious	30	81		88	12	91		93	42	35
Natural Desert Vegetation; Fair Condition	2	55	2	72	6	81		86	10	7
GRW-B110									100	84
Natural Desert Vegetation; Fair Condition		55		72	40	81	60	86	100	84
GRW-B120									100	84
Natural Desert Vegetation; Fair Condition		55		72	40	81	60	86	100	84
GRW-B130									100	74
Residential Districts; 1/4 Acre; Average 38% Impervious	25	61		75	45	83	15	87	85	66
Natural Desert Vegetation; Fair Condition	15	55		72		81		86	15	8
GRW-B140									100	80
Open Space; Good Condition; Grass Cover > 75%		39	2	61	10	74		80	12	9
Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious		77	3	85		90		92	3	3
Residential Districts; 1/4 Acre; Average 38% Impervious	3	61		75	55	83		87	58	47
Natural Desert Vegetation; Fair Condition		55	2	72	25	81		86	27	22
GRE-B110									100	67
Natural Desert Vegetation; Fair Condition	60	55		72	15	81	25	86	100	67
GRE-B120									100	81
Natural Desert Vegetation; Fair Condition		55		72	100	81		86	100	81
GRE-B130									100	64
Natural Desert Vegetation; Fair Condition	65	55		72	35	81		86	100	64
GRE-B140									100	81
Natural Desert Vegetation; Fair Condition	15	55		72		81	85	86	100	81
GRE-B150									100	81
Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious		77		85	30	90		92	30	27

TABLE T-2: MODEL CURVE NUMBER VALUES

Land Use Description Summary	SCS Curve Number (CN) Values								Totals	
	%	A	%	B	%	C	%	D	%	CN
Natural Desert Vegetation; Fair Condition	*10*	55		72	*60*	81		86	*70*	*54*
GRE-B160									100	82
Impervious Areas; Streets and Roads; Paved; Open Ditches (w/ Right-of-Way)		83		89	*5*	92		93	*5*	*5*
Natural Desert Vegetation; Fair Condition		55		72	*95*	81		86	*95*	*77*
GRP-B110									100	81
Natural Desert Vegetation; Fair Condition		55		72	*100*	81		86	*100*	*81*
GRP-B120									100	84
Impervious Areas; Streets and Roads; Paved; Open Ditches (w/ Right-of-Way)		83		89	*5*	92		93	*5*	*5*
Natural Desert Vegetation; Fair Condition		55		72	*75*	81		86	*75*	*61*
Newly Graded Area (Pervious Only)		77		86	*20*	91		94	*20*	*18*
GRP-B130									100	81
Natural Desert Vegetation; Fair Condition		55		72	*100*	81		86	*100*	*81*
GRP-B140									100	90
Impervious Areas; Streets and Roads; Paved; Curbs and Storm Sewers		98		98	*5*	98		98	*5*	*5*
Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious		77		85	*25*	90		92	*25*	*23*
Natural Desert Vegetation; Fair Condition		55	*3*	72	*8*	81		86	*11*	*9*
Newly Graded Area (Pervious Only)		77		86	*59*	91		94	*59*	*54*
GRP-B160									100	87
Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious		77	*35*	85	*10*	90	*10*	92	*55*	*48*
Natural Desert Vegetation; Fair Condition		55		72	*15*	81	*10*	86	*25*	*21*
Newly Graded Area (Pervious Only)		77		86	*10*	91	*10*	94	*20*	*19*
GRP-B170									100	82
Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious		77		85		90	*15*	92	*15*	*14*
Residential Districts; 1/4 Acre; Average 38% Impervious		61		75		83		87	*0*	*0*
Natural Desert Vegetation; Fair Condition	*5*	55	*3*	72	*72*	81		86	*80*	*63*
Newly Graded Area (Pervious Only)		77		86	*5*	91		94	*5*	*5*
CTW-B110									100	82
Residential Districts; 1/4 Acre; Average 38% Impervious		61	*15*	75	*35*	83		87	*50*	*40*
Natural Desert Vegetation; Fair Condition		55		72	*25*	81	*25*	86	*50*	*42*
CTW-B120									100	82
Open Space; Good Condition; Grass Cover > 75%		39	*2*	61	*15*	74		80	*17*	*12*
Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious	*20*	77	*15*	85	*5*	90		92	*40*	*33*
Natural Desert Vegetation; Fair Condition		55	*3*	72	*20*	81		86	*23*	*18*
Newly Graded Area (Pervious Only)		77		86	*20*	91		94	*20*	*18*
CTW-B130									100	81
Natural Desert Vegetation; Fair Condition		55	*20*	72	*40*	81	*40*	86	*100*	*81*
HRS-B110									100	91
Newly Graded Area (Pervious Only)		77		86	*100*	91		94	*100*	*91*
HRS-B120									100	81
Impervious Areas; Streets and Roads; Dirt (w/ Right-of-Way)		72		82		87	*5*	89	*5*	*4*

TABLE T-2: MODEL CURVE NUMBER VALUES

Land Use Description Summary	SCS Curve Number (CN) Values								Totals	
	%	A	%	B	%	C	%	D	%	CN
Natural Desert Vegetation; Fair Condition		55	25	72	35	81	35	86	95	76
HRS-B130									100	78
Natural Desert Vegetation; Fair Condition	15	55	10	72	45	81	30	86	100	78
HRS-B140									100	83
Natural Desert Vegetation; Fair Condition		55	2	72	48	81	50	86	100	83
HRS-B150									100	83
Natural Desert Vegetation; Fair Condition		55		72	35	81	35	86	70	58
Newly Graded Area (Pervious Only)	10	77	20	86		91		94	30	25
GYP-B110									100	81
Natural Desert Vegetation; Fair Condition		55	25	72	25	81	50	86	100	81
GYP-B120									100	81
Natural Desert Vegetation; Fair Condition		55	5	72	80	81	15	86	100	81
GYP-B130									100	80
Natural Desert Vegetation; Fair Condition	8	55		72	77	81	15	86	100	80
STU-B110									100	70
Natural Desert Vegetation; Fair Condition	40	55	20	72	20	81	20	86	100	70
STU-B120									100	73
Natural Desert Vegetation; Fair Condition	25	55	20	72	40	81	15	86	100	73
WRN-B110									100	77
Natural Desert Vegetation; Fair Condition	5	55	35	72	50	81	10	86	100	77
WRN-B120									100	78
Natural Desert Vegetation; Fair Condition	15	55		72	75	81	10	86	100	78
WRN-B130									100	78
Natural Desert Vegetation; Fair Condition	15	55		72	75	81	10	86	100	78
WRS-B110									100	72
Natural Desert Vegetation; Fair Condition	35	55		72	55	81	10	86	100	72
WRS-B120									100	66
Natural Desert Vegetation; Fair Condition	50	55	24	72	16	81	10	86	100	66
WRS-B130									100	70
Natural Desert Vegetation; Fair Condition	45	55		72	45	81	10	86	100	70
WRS-B140									100	72
Natural Desert Vegetation; Fair Condition	30	55	15	72	55	81		86	100	72
WRS-B150									100	69
Natural Desert Vegetation; Fair Condition	30	55	50	72	20	81		86	100	69
WRS-B160									100	76
Natural Desert Vegetation; Fair Condition	5	55	45	72	40	81	10	86	100	76

TABLE T-3: MODEL LAG TIME CALCULATIONS

Basin	SCS CN	Drainage Length Lo (ft)	Average Slope S (%)	t_c (hr)	Lag Time (hr)	Lag Time (min)
WAD-B110	84.3	6,727	3.57	1.123	0.674	40.42
WAD-B120	81.5	3,316	3.62	0.694	0.416	24.98
WAD-B130	80.9	4,638	3.79	0.906	0.543	32.60
WAD-B140	76.5	3,222	1.40	1.271	0.763	45.77
WAD-B150	83.0	3,805	4.47	0.665	0.399	23.93
WAD-B160	82.7	2,921	20.90	0.251	0.151	9.03
WAD-B170	83.7	5,540	3.54	0.984	0.590	35.41
WAD-B180	84.5	2,500	4.10	0.471	0.283	16.97
WAD-B200	77.8	1,897	5.90	0.390	0.234	14.04
WAD-B210	59.1	2,818	2.80	1.288	0.773	46.38
WAD-B220	80.6	2,627	9.40	0.368	0.221	13.23
WAD-B230	70.3	13,612	4.00	2.833	1.700	101.99
WAF-B110	78.2	2,235	2.60	0.662	0.397	23.83
WAF-B120	74.1	2,447	0.60	1.670	1.002	60.12
WAF-B130	79.2	2,674	0.50	1.690	1.014	60.83
WAF-B140	69.0	2,800	0.90	1.748	1.049	62.91
WAF-B150	78.7	2,640	0.70	1.438	0.863	51.75
WAF-B160	69.0	2,990	0.90	1.842	1.105	66.30
WAF-B170	81.2	2,683	0.90	1.185	0.711	42.64
WAF-B180	72.7	1,556	1.90	0.680	0.408	24.46
WAF-B190	72.7	1,555	1.00	0.936	0.562	33.70
WAF-B200	69.0	2,353	0.80	1.613	0.968	58.06
WAF-B210	73.8	1,962	0.90	1.152	0.691	41.49
WAF-B220	78.8	2,203	0.70	1.240	0.744	44.64
WAF-B230	75.5	7,267	6.39	1.174	0.705	42.28
WAF-B240	76.1	3,222	2.27	1.010	0.606	36.37
WAF-B250	72.0	4,393	1.20	2.000	1.200	72.00
WAF-B260	71.2	1,994	1.00	1.191	0.714	42.86
WAF-B270	80.9	2,911	0.70	1.447	0.868	52.11
WAF-B278	75.5	4,100	5.00	0.840	0.504	30.24
WAF-B280	72.5	2,949	1.60	1.244	0.746	44.77
WAF-B290	69.6	3,309	0.90	1.965	1.179	70.76
WAF-B300	72.4	2,663	1.00	1.453	0.872	52.31
WAF-B310	77.4	3,079	0.60	1.826	1.096	65.74
WAF-B320	78.3	3,025	0.60	1.750	1.050	63.00
WAF-B330	89.9	1,246	0.50	0.632	0.379	22.75
WAF-B340	79.6	2,418	0.70	1.301	0.781	46.85
WAF-B350	78.0	5,514	0.40	3.501	2.101	126.05
WAF-B360	77.4	3,430	5.00	0.689	0.413	24.79

TABLE T-3: MODEL LAG TIME CALCULATIONS

Basin	SCS CN	Drainage Length Lo (ft)	Average Slope S (%)	t_c (hr)	Lag Time (hr)	Lag Time (min)
WAF-B370	76.4	6,406	0.80	2.927	1.756	105.38
ARP-B110	78.1	3,571	2.60	0.966	0.579	34.77
ARP-B120	72.9	5,979	1.40	2.311	1.387	83.20
ARP-B130	86.1	3,208	4.00	0.550	0.330	19.79
ARP-B140	76.2	3,033	0.90	1.524	0.914	54.87
MLC-B110	90.6	1,764	2.60	0.355	0.213	12.77
MLC-B120	91.7	3,869	2.45	0.653	0.392	23.52
MLC-B130	77.0	3,048	3.48	0.760	0.456	27.36
MLC-B135	77.0	4,448	2.92	1.123	0.674	40.42
MLC-B140	83.4	4,513	2.50	1.005	0.603	36.19
MLC-B150	85.6	5,399	2.93	0.993	0.596	35.76
MLC-B155	73.2	4,063	2.36	1.298	0.779	46.71
MLC-B160	86.0	4,410	2.18	0.964	0.578	34.70
MLC-B170	74.3	3,556	3.60	0.916	0.549	32.96
MLC-B180	86.0	3,953	8.30	0.452	0.271	16.29
MLC-B190	70.5	5,962	2.37	1.895	1.137	68.23
MLC-B155	73.2	4,063	2.36	1.298	0.779	46.71
GRW-B110	84.0	18,645	6.40	1.912	1.147	68.83
GRW-B120	84.0	9,065	3.40	1.473	0.884	53.04
GRW-B130	73.9	6,489	3.30	1.563	0.938	56.25
GRW-B140	80.3	9,322	3.20	1.751	1.050	63.02
GRE-B110	66.7	12,349	4.50	2.726	1.636	98.14
GRE-B120	81.0	2,763	5.10	0.513	0.308	18.48
GRE-B130	64.1	4,289	7.30	0.982	0.589	35.33
GRE-B140	81.4	7,842	7.70	0.952	0.571	34.26
GRE-B150	81.1	7,001	2.70	1.480	0.888	53.27
GRE-B160	81.6	3,869	3.00	0.861	0.517	30.99
GRP-B110	81.0	5,194	5.50	0.819	0.491	29.49
GRP-B120	83.6	9,824	6.50	1.154	0.692	41.54
GRP-B130	81.0	7,852	6.20	1.074	0.644	38.65
GRP-B140	89.7	4,460	4.30	0.601	0.360	21.62
GRP-B160	87.2	6,547	3.60	0.985	0.591	35.45
GRP-B170	81.6	11,478	3.50	1.901	1.140	68.42
CTW-B110	82.1	8,017	2.50	1.662	0.997	59.83
CTW-B120	81.5	10,946	1.70	2.630	1.578	94.67
CTW-B130	81.2	15,648	2.20	3.109	1.866	111.94
HRS-B110	91.0	1,701	3.40	0.296	0.178	10.67
HRS-B120	80.9	8,973	1.40	2.522	1.513	90.80
HRS-B130	77.7	7,239	1.40	2.344	1.407	84.40

TABLE T-3: MODEL LAG TIME CALCULATIONS

Basin	SCS CN	Drainage Length Lo (ft)	Average Slope S (%)	t_c (hr)	Lag Time (hr)	Lag Time (min)
HRS-B140	83.3	7,758	1.40	2.074	1.245	74.68
HRS-B150	83.4	7,500	0.90	2.516	1.509	90.56
GYP-B110	81.3	5,945	3.50	1.135	0.681	40.85
GYP-B120	81.3	4,502	3.90	0.859	0.516	30.93
GYP-B130	79.7	5,830	2.50	1.389	0.834	50.02
STU-B110	69.8	7,094	2.40	2.203	1.322	79.32
STU-B120	73.5	6,431	2.00	2.018	1.211	72.66
WRN-B110	77.1	10,691	2.70	2.351	1.411	84.65
WRN-B120	77.6	14,235	3.70	2.485	1.491	89.44
WRN-B130	77.6	10,618	5.70	1.583	0.950	57.00
WRS-B110	72.4	8,753	3.40	2.040	1.224	73.43
WRS-B120	66.3	10,195	3.50	2.673	1.604	96.24
WRS-B130	69.8	6,686	3.40	1.766	1.059	63.56
WRS-B140	71.9	10,818	2.80	2.704	1.622	97.33
WRS-B150	68.7	13,902	2.20	4.060	2.436	146.17
WRS-B160	76.2	10,357	2.10	2.669	1.601	96.08

LAG TIME

$l = 0.6\, t_c$

TIME OF CONCENTRATION

$$t_c = \frac{1.67\, L_O^{0.8} \left(\frac{1000}{CN} - 9 \right)^{0.7}}{1900 \sqrt{S_{percent}}}$$

Where:
CN = SCS runoff curve number
S = Average slope in percent
Lo = Length in ft

TABLE T-4: MODEL ROUTING SUMMARY

Drainage Area	Name	Description	Route Length *(ft)*	Average Slope *(%)*	Manning *(n)*	Pipe Diameter *(in)*	Bottom Width *(ft)*	Side Slopes *(H:1V)*
Washington Dam Road	WAD-R110	J110 thru B120	1,212	2.64	0.010	36		
Washington Dam Road	WAD-R120	J120 thru B140	3,420	1.11	0.010	36		
Washington Dam Road	WAD-R130	B150 thru B160	750	4.80	0.015		0.0	50.00
Washington Dam Road	WAD-R140	B180 thru B190	3,392	2.50	0.023		30.0	3.00
Washington Dam Road	WAD-R150	B200 thru B210	2,771	2.53	0.023		40.0	3.00
Washington Fields	WAF-R110	B110 thru B130	3,435	0.90	0.023		6.0	10.00
Washington Fields	WAF-R120	B120 thru B130	2,533	0.80	0.023		3.0	1.00
Washington Fields	WAF-R130	J110 thru B150	1,209	0.50	0.023		6.0	10.00
Washington Fields	WAF-R140	B140 thru B150	2,541	0.60	0.023		6.0	3.00
Washington Fields	WAF-R150	J120 thru B170	1,343	0.66	0.023		6.0	10.00
Washington Fields	WAF-R160	B160 thru B170	2,542	0.90	0.015		3.0	1.00
Washington Fields	WAF-R170	J130 thru B220	1,343	0.55	0.010	48		
Washington Fields	WAF-R180	B180 thru B190	1,854	1.08	0.023		30.0	10.00
Washington Fields	WAF-R190	J140 thru B200	3,107	0.80	0.015		0.0	50.00
Washington Fields	WAF-R200	J150 thru B210	2,610	1.40	0.023		10.0	10.00
Washington Fields	WAF-R210	J160 thru B220	1,317	1.40	0.015		2.0	1.00
Washington Fields	WAF-R220	J170 thru B270	2,590	0.54	0.010	54		
Washington Fields	WAF-R240	B240 thru B250	3,079	1.05	0.023		10.0	5.00
Washington Fields	WAF-R260	J190 thru B260	1,265	0.97	0.013	60		
Washington Fields	WAF-R270	J200 thru B270	1,379	0.62	0.010	54		
Washington Fields	WAF-R280	J280 thru B310	2,590	0.50	0.010	54		
Washington Fields	WAF-R288	P120 thru B280	2,050	1.46	0.015		3.0	1.00
Washington Fields	WAF-R290	B280 thru B300	2,631	0.90	0.015		3.0	1.00
Washington Fields	WAF-R300	B290 thru B300	643	0.60	0.015		3.0	1.00
Washington Fields	WAF-R310	J230 thru B310	1,968	0.30	0.015		3.0	1.00
Washington Fields	WAF-R320	J240 thru B320	1,438	0.40	0.010	54		
Washington Fields	WAF-R330	J250 thru B330	1,388	0.40	0.023		5.0	3.00
Washington Fields	WAF-R340	B340 thru B350	4,648	0.30	0.010	54		
Washington Fields	WAF-R350	J270 at Mall Drive	2,857	0.50	0.023		5.0	3.00
Washington Fields	WAF-R360	B360 thru B370	6,741	0.90	0.010	42		
Airport	ARP-R110	B130 thru B120	5,270	1.10	0.023		50.0	15.00
Airport	ARP-R120	B110 thru B120	5,862	1.00	0.023		15.0	10.00
Airport	ARP-R130	J120 thru B140	3,471	1.00	0.023		30.0	10.00
Mill Creek	MLC-R110	J115 thru B130	1,494	1.74	0.010		0.0	50.00
Mill Creek	MLC-R115	B140 thru B135	1,525	1.31	0.010		0.0	50.00
Mill Creek	MLC-R120	J120 thru B160	3,986	3.20	0.010	48		
Mill Creek	MLC-R130	J140 thru B160	1,722	2.32	0.015		0.0	50.00
Mill Creek	MLC-R140	B155 thru B150	1,118	3.04	0.015		0.0	50.00
Green Springs West	GRW-R110	P110 thru B120	1,339	2.00	0.010	48		

TABLE T-4: MODEL ROUTING SUMMARY

Drainage Area	Name	Description	Route Length *(ft)*	Average Slope *(%)*	Manning *(n)*	Pipe Diameter *(in)*	Bottom Width *(ft)*	Side Slopes *(H:1V)*
Green Springs West	GRW-R120	J110 thru B120	1,523	4.60	0.023		8.0	3.00
Green Springs East	GRE-R110	B130 thru B150	3,488	3.80	0.023		10.0	5.00
Green Springs East	GRE-R120	B140 thru B150	3,159	3.05	0.023		6.0	5.00
Green Springs East	GRE-R130	J110 thru B150	1,286	2.18	0.015		0.0	50.00
Green Springs East	GRE-R140	B160 thru B150	1,967	3.40	0.023		8.0	5.00
Green Springs East	GRE-R150	J120 thru B150	2,535	2.00	0.013	60		
Grapevine Wash	GRP-R110	B110 thru B140	4,000	1.96	0.013	72		
Grapevine Wash	GRP-R120	B120 thru B140	3,246	4.30	0.023		0.0	50.00
Grapevine Wash	GRP-R130	J110 thru B140	1,052	2.70	0.013	84		
Grapevine Wash	GRP-R140	J120 thru B170	713	1.10	0.023		18.0	2.00
Grapevine Wash	GRP-R150	B130 thru B140	6,986	3.20	0.023		6.0	2.00
Harrisburg Dome	HRS-R110	B120 thru B130	7,206	1.40	0.023		10.0	4.00
Harrisburg Dome	HRS-R120	B140 thru B150	7,277	1.10	0.023		6.0	3.00
Gypsum Wash	GYP-R110	P120 thru B120	6,441	0.65	0.023		15.0	5.00
Gypsum Wash	GYP-R120	P130 thru B120	3,719	1.80	0.023		8.0	3.00
Stucki Springs	STU-R110	P120 thru B120	3,610	0.45	0.023		10.0	5.00
Warner Valley North	WRN-R110	B110 thru B120	9,840	1.50	0.023		20.0	3.00
Warner Valley North	WRN-R120	J110 thru B130	6,746	1.00	0.023		6.0	2.00
Warner Valley South	WRS-R110	B110 thru B130	2,300	0.38	0.023		0.0	50.00
Warner Valley South	WRS-R120	J110 thru B140	8,019	0.38	0.023		0.0	50.00
Warner Valley South	WRS-R130	J120 thru B160	3,105	1.00	0.023		10.0	4.00

TABLE T-5: MODEL JUNCTION SUMMARY

Drainage Area	Junction	Upstream Connections
Washington Dam Road	WAD-J110	B110, B130
Washington Dam Road	WAD-J120	R110, B120
Washington Dam Road	WAD-J130	R120, B140
Washington Dam Road	WAD-J140	R130, B160
Washington Dam Road	WAD-J150	R140, B190
Washington Dam Road	WAD-J160	R150, B210
Washington Fields	WAF-J110	R110, R120, B130
Washington Fields	WAF-J120	R130, R140, B150
Washington Fields	WAF-J130	R150, R160, B170
Washington Fields	WAF-J140	R180, B190
Washington Fields	WAF-J150	R190, B200
Washington Fields	WAF-J160	R200, B210
Washington Fields	WAF-J170	R170, R210, B220
Washington Fields	WAF-J190	R240, B250
Washington Fields	WAF-J200	R260, B260
Washington Fields	WAF-J210	R220, R270
Washington Fields	WAF-J220	R280, B310
Washington Fields	WAF-J228	R288, B280
Washington Fields	WAF-J230	R290, R300, B300
Washington Fields	WAF-J240	J220, R310
Washington Fields	WAF-J250	R320, B320
Washington Fields	WAF-J260	R340, B350
Washington Fields	WAF-J270	J260, R330, B330
Washington Fields	WAF-J280	R280, B310
Washington Fields	WAF-J290	R360, B07370
Washington Fields	WAF-P110	B230, B240
Airport	ARP-J110	R120, B120
Airport	ARP-J120	J110, R110
Airport	ARP-P110	R130, B140
Mill Creek	MLC-J110	R110, B130
Mill Creek	MLC-J115	R115, B135
Mill Creek	MLC-J120	R120, B160
Mill Creek	MLC-J130	R130
Mill Creek	MLC-J140	R140, B150
Green Springs West	GRW-J110	R110, B130
Green Springs West	GRW-J120	R120, B120
Green Springs West	GRW-P110	B110
Green Springs East	GRE-J110	R110, R120
Green Springs East	GRE-J120	J110, R140
Green Springs East	GRE-J130	R150, B150
Grapevine Wash	GRP-J110	R110, R120

TABLE T-5: MODEL JUNCTION SUMMARY

Drainage Area	Junction	Upstream Connections
Grapevine Wash	GRP-J120	R130, B140
Grapevine Wash	GRP-J130	R140, R150
Harrisburg Dome	HRS-J110	R110, B130
Harrisburg Dome	HRS-J120	R120, B150
Gypsum Wash	GYP-P110	R110, R120
Gypsum Wash	GYP-P120	B130
Stucki Springs	STU-P110	R110, B120
Warner Valley North	WRN-J110	R110, B120
Warner Valley North	WRN-J120	R120, B130
Warner Valley South	WRS-J110	R110, B120, B130
Warner Valley South	WRS-J120	R120, B140, B150
Warner Valley South	WRS-P110	R130, B160

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results								
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)	Infrastructure Description	*n*	S (%)	Capacity (cfs)
WAD-B110	WAD-B110	22.6	77.9	95.3	*Existing Infrastructure*			
					1300 East Street Local			35.4
					Proposed Infrastructure			
					HDPE Pipe 1 each 30 in diameter	0.010	3.6	101.0
					Recommended Improvement PROJECT WAD-01			
					Install 30" HDPE 1,600 feet to convey storm water from future development along 1300 East Street and tie into Washington Dam Road.			
WAD-B120	WAD-B120	9.3	40.2	42.7	*Existing Infrastructure*			
					Washington Dam Road Arterial			37.5
					HDPE Pipe 1 each 36 in diameter	0.010	3.6	165.4
					Total Existing			*202.9*
					Recommended Improvement			
					None. Existing infrastructure combined assumed to be adequate for 100-3.			
WAD-B130	WAD-B130	11.0	48.4	61.2	*Existing Infrastructure*			
					Arabian Way Local			35.4
					Proposed Infrastructure			
					HDPE Pipe 1 each 24 in diameter	0.010	3.8	57.4
					Recommended Improvement PROJECT WAD-02			
					Install 24" HDPE 1,600 feet to convey storm water from future development along Black Brush Drive and Arabian Way, and tie into Washington Dam Road.			
WAD-B140	WAD-B140	4.3	29.1	40.7	*Existing Infrastructure*			
					Indian Springs Drive Collector			54.8
					HDPE Pipe 2 each 18 in diameter	0.010	1.4	32.4
					HDPE Pipe 1 each 20 in diameter	0.010	1.4	21.5
					Total Existing			*108.6*
					Recommended Improvement			
					None. Existing infrastructure combined assumed to be adequate for 100-3.			
WAD-B150	WAD-B150	10.4	40.1	40.4	*Existing Infrastructure*			
					Seminole Way Local			35.4
					HDPE Pipe 1 each 36 in diameter	0.010	4.5	183.8
					Total Existing			*219.2*
					Recommended Improvement			
					None. Existing infrastructure combined assumed to be adequate for 100-3.			

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	*n*	S	Capacity
Location	**Route**	**10-3 (cfs)**	**100-3 (cfs)**	**100-24 (cfs)**			**(%)**	**(cfs)**
WAD-B160	WAD-B160	19.5	79.6	77.1	*Existing Infrastructure*			
					Apache Drive Local			35.4
					Recommended Improvement			
					None. Most storm water discharges directly to the Virgin River.			
WAD-B170	WAD-B170	30.8	110.6	134.6	*Existing Infrastructure*			
					1775 East Street Local			35.4
					HDPE Pipe 1 each 36 in diameter	0.010	3.5	163.5
					Total Existing			*199.0*
					Recommended Improvement			
					None. Existing infrastructure combined assumed to be adequate for 100-3.			
WAD-B180	WAD-B180	30.6	109.1	119.5	*Existing Infrastructure*			
					Natural Wash 5 ft width 2.5 ft depth 2.0 :1 sides	0.078	4.1	129.2
					Proposed Infrastructure			
					HDPE Pipe 1 each 36 in diameter	0.010	4.1	176.0
					Recommended Improvement PROJECT WAD-03			
					Install 36" HDPE 1,200 feet to convey storm water from future development through the industrial area, connecting into existing 36" pipe in 1775 East Street across from Washington Dam Road.			
WAD-B200	WAD-B200	6.9	44.9	57.3	*Existing Infrastructure*			
					Granada Royale Incomplete Local			0.0
					Proposed Infrastructure			
					HDPE Pipe 1 each 24 in diameter	0.010	5.9	71.6
					Recommended Improvement PROJECT WAD-04			
					Install 24" HDPE 1,500 feet to convey storm water from future development along - and to the south of - Granada Royale Drive.			
WAD-B210	WAD-B210	0.0	0.4	2.3	*See WAD-J150*			
WAD-B220	WAD-B220	12.5	60.6	71.3	*Existing Infrastructure*			
					Natural Wash 5 ft width 1.5 ft depth 2.0 :1 sides	0.078	9.4	71.4
					Proposed Infrastructure			
					HDPE Pipe 1 each 24 in diameter	0.010	9.4	90.4
					Recommended Improvement PROJECT WAD-05			

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	n	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
					Install 24" HDPE 1,300 ft along existing wash across Washington Dam Road to the Virgin River. *(NOTE: Project removed since all of the drainage area it services is considered to be undevelopable, either 15% plus hillside or 100-year floodplain.)*			
WAD-B230	WAD-B230	2.1	45.2	88.7	*Existing Infrastructure*			
					Natural Wash 10 ft width 2.0 ft depth 2.0 :1 sides	0.078	4.0	138.8
					47 ft top width w/ 25' access road			
					Recommended Improvement PROJECT WAD-06			
					Construct channel improvements with access road to convey storm water from future development, maintaining minimum 50' right-of-way width for 5,800 feet of existing wash.			
WAD-R110	WAD-R110	33.2	124.8	155.0	*See WAD-J110*			
WAD-R120	WAD-R120	41.2	158.0	191.7	*See WAD-J130*			
WAD-R130	WAD-R130	10.3	39.8	39.2	*See WAD-J140*			
WAD-R140	WAD-R140	30.0	107.5	97.2	*See WAD-J150*			
WAD-R150	WAD-R150	6.9	43.9	44.2	*See WAD-J160*			
WAD-J110	None	33.4	125.1	156.5	*Model Control Point*			
WAD-J120	WAD-R110	41.4	158.3	197.7	*Existing Infrastructure*			
					Washington Dam Road Arterial			37.5
					HDPE Pipe 1 each 36 in diameter	0.010	2.6	141.2
					Total Existing			*178.8*
					Recommended Improvement			
					None. Existing infrastructure assumed to be adequate for 100-3.			
WAD-J130	WAD-R120	44.8	183.7	232.3	*Existing Infrastructure*			
					1470 South Street Local			35.4
					HDPE Pipe 1 each 24 in diameter	0.010	1.1	31.1
					HDPE Pipe 1 each 18 in diameter	0.010	1.1	14.4
					Total Existing			*80.9*
					Proposed Infrastructure			
					HDPE Pipe 1 each 42 in diameter	0.010	1.1	138.1

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	n	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
					Recommended Improvement PROJECT WAD-07 Install additional 42" HDPE 3,250 feet alongside existing 24" pipe - near alignments of 1425 South Street and 1410 South Street - to improve capacity for anticipated changes in flow patterns from future development.			
WAD-J140	WAD-R130	24.5	98.8	115.7	*Existing Infrastructure* Indian Springs Drive Collector *Recommended Improvement* None. Most flows discharge in various locations directly to the Virgin River.			 54.8
WAD-J150	WAD-R140	57.2	199.3	218.2	*Existing Infrastructure* 1900 East Street Local RCP Pipe 1 each 36 in diameter *Total Existing* *Proposed Infrastructure* HDPE Pipe 1 each 36 in diameter *Recommended Improvement PROJECT WAD-08* Install additional 36" HDPE 2,100 feet to convey storm water from future development discharging from Project WAD-03, extending the pipeline from Washington Dam Road to the Virgin River.	 0.013 0.010	 2.5 2.5	 35.4 105.7 *141.1* 137.4
WAD-J160	WAD-R150	6.9	43.9	44.6	*Existing Infrastructure* None. *Proposed Infrastructure* HDPE Pipe 1 each 24 in diameter *Recommended Improvement PROJECT WAD-09* Install 24" HDPE 1,200 feet to convey storm water from future development, and discharging from Project WAD-04, between Washington Dam Road and the Virgin River.	 0.010	 2.5	 46.9
WAF-B110	WAF-B110	10.5	61.1	69.5	*See WAF-R110*			
WAF-B120	WAF-B120	0.8	7.5	12.3	*Existing Infrastructure* None. Irrigated field. *Recommended Improvement* None. Estimated flows can be conveyed via surface routing in future roadways.			

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	n	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
WAF-B130	WAF-B130	4.1	20.2	29.0	*Existing Infrastructure* None. Irrigated field. *Recommended Improvement* None. Estimated flows can be conveyed via surface routing in future roadways.			
WAF-B140	WAF-B140	0.1	3.8	7.3	*Existing Infrastructure* None. Irrigated field. *Recommended Improvement* None. Estimated flows can be conveyed via surface routing in future roadways.			
WAF-B150	WAF-B150	2.8	14.5	19.8	*Existing Infrastructure* 4200 South Street Incomplete Maj Collector *Recommended Improvement* None. Roadway infrastructure once fully complete is assumed to be adequate for 100-3 (improved min capacity = 57.0 cfs)			0.0
WAF-B160	WAF-B160	0.1	5.4	10.3	*Existing Infrastructure* None. Irrigated field. *Recommended Improvement* None. Estimated flows can be conveyed via surface routing in future roadways.			
WAF-B170	WAF-B170	5.3	22.3	29.0	*Existing Infrastructure* Treasure Valley Road Collector *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.		0.5	54.8
WAF-B180	WAF-B180	1.1	16.2	22.7	*Existing Infrastructure* None. Surface flows in small indistinct washes. *Recommended Improvement* None. Estimated flows can be conveyed via surface routing in future roadways.			
WAF-B190	WAF-B190	0.9	12.8	20.1	*Existing Infrastructure* Washington Fields Road Incomplete Arterial			0.0

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	n	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
					Recommended Improvement None. Roadway infrastructure once fully complete is assumed to be adequate for 100-3 (improved min capacity = 37.5 cfs)			
WAF-B200	WAF-B200	0.1	2.2	4.3	*Existing Infrastructure* Washington Fields Road Incomplete Arterial *Recommended Improvement* None. Roadway infrastructure once fully complete is assumed to be adequate for 100-3 (improved min capacity = 37.5 cfs)			 0.0
WAF-B210	WAF-B210	0.6	6.6	10.0	*Existing Infrastructure* Stonehedge Drive Local *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.		 0.5	 35.4
WAF-B220	WAF-B220	3.3	17.2	23.3	*Existing Infrastructure* None. Irrigated field. *Recommended Improvement* None. Estimated flows can be conveyed via surface routing in future roadways.			
WAF-B230	WAF-B230	4.0	31.6	46.0	*Existing Infrastructure* Majestic Drive Collector HDPE Pipe 1 each 36 in diameter *Total Existing* *Proposed Infrastructure* HDPE Pipe 1 each 18 in *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.	 0.010 0.010	 0.5 6.4 1.0	 54.8 219.7 *274.5* 13.7
WAF-B240	WAF-B240	3.3	24.1	35.2	*Existing Infrastructure* Galilee Way Local *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.		 0.5	 35.4
WAF-B250	WAF-B250	0.8	11.6	20.1	*Existing Infrastructure*			

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	n	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
					300 East Street Incomplete Collector *Recommended Improvement* None. Roadway infrastructure once fully complete is assumed to be adequate for 100-3 (improved min capacity = 54.8 cfs)			0.0
WAF-B260	WAF-B260	0.3	7.2	11.5	*Existing Infrastructure* 20 East Street Incomplete Maj Collector *Recommended Improvement* None. Roadway infrastructure once fully complete is assumed to be adequate for 100-3 (improved min capacity = 57.0 cfs)			0.0
WAF-B270	WAF-B270	8.9	38.4	49.9	*See WAF-R220*			
WAF-B278	WAF-B278	2.6	21.1	29.9	*Existing Infrastructure* Camino Real Collector *Recommended Improvement* None. Roadway infrastructure adequate for 100-3 (min capacity = 54.8 cfs)		0.5	54.8
WAF-B280	WAF-B280	0.8	12.7	19.3	*Existing Infrastructure* Washington Fields Road Incomplete Arterial *Recommended Improvement* None. Roadway infrastructure once fully complete is assumed to be adequate for 100-3 (improved min capacity = 37.5 cfs)			0.0
WAF-B290	WAF-B290	0.1	4.0	7.5	*Existing Infrastructure* 20 East Street Incomplete Maj Collector *Recommended Improvement* None. Roadway infrastructure once fully complete is assumed to be adequate for 100-3 (improved min capacity = 57.0 cfs)			0.0
WAF-B300	WAF-B300	0.6	9.4	15.5	*Existing Infrastructure* None. Irrigated field. *Recommended Improvement* None. Estimated flows can be conveyed via surface routing in future roadways.			

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results								
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)	Infrastructure Description	*n*	S (%)	Capacity (cfs)
WAF-B310	WAF-B310	2.4	14.4	21.6	*See WAF-R280*			
WAF-B320	WAF-B320	2.6	14.2	20.9	*See WAF-R320*			
WAF-B330	WAF-B330	8.1	21.4	18.9	*Existing Infrastructure* Harvest Lane Collector *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.		 0.5	 54.8
WAF-B340	WAF-B340	5.9	28.6	37.5	*Existing Infrastructure* None. Irrigated field. *Recommended Improvement* None. Estimated flows can be conveyed via surface routing in future roadways.			
WAF-B350	WAF-B350	3.9	20.6	32.7	*Existing Infrastructure* 240 West Street Collector HDPE Pipe 1 each 36 in diameter *Total Existing* *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.	 0.010	 0.5 0.4	 54.8 55.0 *109.8*
WAF-B360	WAF-B360	8.0	50.5	60.9	*Existing Infrastructure* Silver Falls Drive Local HDPE Pipe 1 each 30 in diameter *Total Existing* *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.	 0.010	 0.5 5.0	 35.4 119.5 *155.0*
WAF-B370	WAF-B370	3.6	23.3	37.5	*See WAF-J290*			
WAF-R110	WAF-R110	10.3	60.7	69.0	*Existing Infrastructure* 240 West Street Incomplete Collector *Proposed Infrastructure* HDPE Pipe 1 each 36 in *Recommended Improvement PROJECT WAF-01* Install 36" HDPE 4,100 feet to convey storm water	 0.010	 0.9	 0.0 82.5

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results								
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)	Infrastructure Description	n	S (%)	Capacity (cfs)
					from future area development to 240 West Street, then north to approximately 2200 South Street (St. George street address).			
WAF-R120	WAF-R120	0.8	7.5	11.5	*Existing Infrastructure* None. Irrigated field. *Recommended Improvement* None. Estimated flows can be conveyed via surface routing in future roadways.			
WAF-R130	WAF-R130	13.7	76.3	93.5	*Existing Infrastructure* 240 West Street Incomplete Collector *Proposed Infrastructure* HDPE Pipe 1 each 42 in *Recommended Improvement PROJECT WAF-02* Install 42" HDPE 1,300 feet along 240 West to convey storm water from future development south of 4200 South Street.	 0.010	 0.5	 0.0 92.7
WAF-R140	WAF-R140	0.1	3.8	7.0	*Existing Infrastructure* 4200 South Street Incomplete Maj Collector *Recommended Improvement* None. Roadway infrastructure once fully complete is assumed to be adequate for 100-3 (improved min capacity = 57.0 cfs)			 0.0
WAF-R150	WAF-R150	16.3	89.7	116.9	*Existing Infrastructure* 240 West Street Incomplete Collector *Proposed Infrastructure* HDPE Pipe 1 each 42 in *Recommended Improvement PROJECT WAF-03* Install 42" HDPE 1,300 feet along 240 West Street to convey storm water from future development between 4200 South Street and 3930 South Street.	 0.010	 0.7	 0.0 106.5
WAF-R160	WAF-R160	0.1	5.4	10.2	*Existing Infrastructure* 3930 South Street Incomplete Maj Collector *Recommended Improvement* None. Roadway infrastructure once fully complete is assumed to be adequate for 100-3 (improved min capacity = 57.0 cfs)			 0.0

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	*n*	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
WAF-R170	WAF-R170	20.9	114.4	150.3	*Existing Infrastructure* 240 West Street Incomplete Collector HDPE Pipe 1 each 48 in diameter *Total Existing* *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.	 0.010	 0.6	 0.0 138.8 *138.8*
WAF-R180	WAF-R180	1.1	16.2	21.8	*Existing Infrastructure* None. Surface flows in small indistinct washes. *Recommended Improvement* None. Estimated flows can be conveyed via surface routing in future roadways.			
WAF-R190	WAF-R190	2.0	28.6	35.2	*See WAF-J150*			
WAF-R200	WAF-R200	2.0	30.3	39.1	*Existing Infrastructure* 3650 South Street Incomplete Arterial *Proposed Infrastructure* HDPE Pipe 1 each 30 in diameter *Recommended Improvement PROJECT WAF-04* Install 30" HDPE 5,300 feet to convey storm water from future area development routing along Washington Fields Road and 3650 South Street.	 0.010	 1.4	 0.0 63.2
WAF-R210	WAF-R210	2.4	36.3	47.5	*Existing Infrastructure* 3650 South Street Incomplete Arterial *Proposed Infrastructure* HDPE Pipe 1 each 30 in diameter *Recommended Improvement PROJECT WAF-05* Install 30" HDPE 1,400 feet along 3650 South Street to convey storm water from future area development from 20 East Street to 240 West Street.	 0.010	 1.4	 0.0 63.2
WAF-R220	WAF-R220	24.5	163.9	217.0	*Existing Infrastructure* 240 West Street Incomplete Collector HDPE Pipe 1 each 54 in diameter *Total Existing* *Recommended Improvement* None. Existing infrastructure combined assumed to	 0.010	 0.5	 0.0 188.3 *188.3*

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results								
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)	Infrastructure Description	*n*	S (%)	Capacity (cfs)
					be adequate for 100-3.			
WAF-R240	WAF-R240	6.5	23.0	23.0	*Existing Infrastructure* Washington Fields Road Incomplete Maj Collector *Proposed Infrastructure* HDPE Pipe 1 each 24 in diameter *Recommended Improvement PROJECT WAF-06* Install 24" HDPE 2,900 feet along Washington Fields Road and 3090 South Street to convey storm water from future area development, plus development from detention pond discharge, Project WAF-10.	 0.010	 1.1	 0.0 30.2
WAF-R260	WAF-R260	7.1	34.6	43.0	*Existing Infrastructure* 3090 South Street Incomplete Maj Collector RCP Pipe 1 each 60 in diameter *Total Existing* *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.	 0.013	 1.0	 0.0 257.1 *257.1*
WAF-R270	WAF-R270	7.4	39.9	52.7	*Existing Infrastructure* 3090 South Street Incomplete Maj Collector HDPE Pipe 1 each 54 in diameter *Total Existing* *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.	 0.010	 0.6	 0.0 201.8 *201.8*
WAF-R280	WAF-R280	38.8	240.7	316.6	*See WAF-J220*			
WAF-R288	WAF-R288	2.3	5.0	5.0	*See WAF-R290*			
WAF-R290	WAF-R290	3.1	17.7	24.2	*Existing Infrastructure* None. Irrigated field. *Proposed Infrastructure* HDPE Pipe 1 each 24 in *Recommended Improvement PROJECT WAF-07* Install 24" HDPE 2,700 feet to convey storm water from future development draining to 2760 South Street, extending from Washington Fields Road to 20 East Street.	 0.010	 0.9	 28.0

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	n	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
WAF-R300	WAF-R300	0.1	4.0	7.5	*Existing Infrastructure* 20 East Street Incomplete Maj Collector *Recommended Improvement* None. Roadway infrastructure once fully complete is assumed to be adequate for 100-3 (improved min capacity = 57.0 cfs)			 0.0
WAF-R310	WAF-R310	3.7	30.2	45.7	*Existing Infrastructure* 3090 South Street Incomplete Maj Collector HDPE Pipe 1 each 18 in diameter *Total Existing* *Proposed Infrastructure* HDPE Pipe 1 each 30 in diameter *Recommended Improvement PROJECT WAF-08* Install 30" HDPE 2,100 feet to convey storm water from future area development along 20 East Street from 2760 South Street to Merrill Road, then west to 240 West Street.	 0.010 0.010	 0.3 0.3	 0.0 7.5 *7.5* 29.3
WAF-R320	WAF-R320	44.6	282.6	380.9	*See WAF-J250*			
WAF-R330	WAF-R330	47.1	296.7	395.2	*Existing Infrastructure* Merrill Road Incomplete Arterial HDPE Pipe 1 each 18 in diameter *Total Existing* *Proposed Infrastructure* HDPE Pipe 2 each 54 in diameter *Recommended Improvement* None: To be improved by the Washington County Flood Control Authority.	 0.010 0.010	 0.4 0.4	 0.0 8.7 *8.7* 324.2
WAF-R340	WAF-R340	5.9	28.5	36.3	*See WAF-J260*			
WAF-R350	WAF-R350	55.7	338.5	442.8	*See WAF-J280*			
WAF-R360	WAF-R360	8.0	50.3	59.6	*See WAF-J290*			
WAF-J110	None	13.7	76.4	100.1	*Model Control Point*			
WAF-J120	None	16.4	90.0	117.1	*Model Control Point*			

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	*n*	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
WAF-J130	None	21.0	114.4	150.7	*Model Control Point*			
WAF-J140	WAF-R180	2.0	28.8	41.8	*Existing Infrastructure* None. Surface flows in small indistinct washes. *Recommended Improvement* None. Estimated flows can be conveyed via surface routing in future roadways.			
WAF-J150	WAF-R190	2.0	30.5	39.4	*Existing Infrastructure* Washington Fields Road Incomplete Arterial *Recommended Improvement* None. Roadway infrastructure once fully complete is assumed to be adequate for 100-3 (improved min capacity = 37.5 cfs).			0.0
WAF-J160	None	2.4	36.4	47.9	*Model Control Point*			
WAF-J170	None	24.7	165.1	218.6	*Model Control Point*			
WAF-J190	None	7.1	34.6	43.1	*Model Control Point*			
WAF-J200	None	7.4	40.0	53.2	*Model Control Point*			
WAF-J210	None	38.9	241.0	319.6	*Model Control Point*			
WAF-J220	WAF-R280	41.2	254.6	338.2	*Existing Infrastructure* 240 West Street Incomplete Collector HDPE Pipe 2 each 54 in diameter *Total Existing* *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.	 0.010	 0.5	 0.0 362.4 *362.4*
WAF-J228	WAF-R288	3.1	17.7	24.3	*See WAF-R290*			
WAF-J230	None	3.7	30.2	46.7	*Model Control Point*			
WAF-J240	None	44.7	284.3	384.0	*Model Control Point*			

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	*n*	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
WAF-J250	WAF-R320	47.2	296.7	401.9	*Existing Infrastructure* Merrill Road Incomplete Arterial HDPE Pipe 2 each 54 in diameter *Total Existing* *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.	 0.010	 0.4	 0.0 324.2 *324.2*
WAF-J260	WAF-R340	7.6	37.7	55.4	*Existing Infrastructure* Irrigation Channe 5 ft width 3.0 ft depth 2.0 :1 sides *Proposed Infrastructure* HDPE Pipe 1 each 36 in diameter *Recommended Improvement PROJECT WAF-09* Install 36" HDPE 2,700 feet in two segments from future area development located east of 20 East Street; with 1,400 feet east of River Willow Lane from 240 West Street to 20 East Street; and 1,300 feet on north side of Riverside Elementary School.	 0.078 0.010	 0.3 0.3	 50.9 47.6
WAF-J270	None	55.7	338.8	458.1	*Model Control Point*			
WAF-J280	WAF-R350	55.7	338.5	442.8	*Existing Infrastructure* Open Channel 25 ft width 4.0 ft depth 2.0 :1 sides *Recommended Improvement* None: To be improved by the Washington County Flood Control Authority.	 0.078	 0.5	 377.3
WAF-J290	WAF-R360	9.1	56.9	77.3	*Existing Infrastructure* 2000 South Street Maj Collector HDPE Pipe 1 each 42 in diameter *Total Existing* *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.	 0.010	 0.9	 0.0 124.4 *124.4*
WAF-P110	Q_{in} Q_{out} Storage	7.3 6.5 0.1	55.1 23.0 2.4	81.2 23.0 6.2	*Existing Infrastructure* None. *Recommended Improvement PROJECT WAF-10* Construct 6.2 acre-foot detention basin to accommodate storm water from future area development located east of Camino Real Road.			

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	n	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
WAF-P120	Q_{in}	2.6	21.1	29.9	*Existing Infrastructure*			
	Q_{out}	2.3	5.0	5.0	None.			
	Storage	0.0	1.1	2.8				
					Proposed Infrastructure			
					HDPE Pipe 1 each 18 in diameter	0.010	0.5	9.7
					Recommended Improvement PROJECT WAF-11			
					Install18" HDPE pipe 2,900 feet to pick up discharge for development east of Camino Real including new development since 2005 and future development to the east, and connect to new pipe at Washington Fields Road.			
ARP-B110	ARP-B110	7.1	40.5	56.1	*See ARP-J120*			
ARP-B120	ARP-B120	3.0	34.6	60.3	*See ARP-J120*			
ARP-B130	ARP-B130	20.9	66.7	68.9	*See ARP-J120*			
ARP-B140	ARP-B140	3.9	27.8	41.8	*Existing Infrastructure*			
w/ARP-J110 detention		23.5	39.0	39.0	Washington Fields Road Incomplete Arterial			0.0
	Total	27.4	66.8	80.8				
					Proposed Infrastructure			
					HDPE Pipe 1 each 36 in diameter	0.010	1.0	86.9
					Recommended Improvement PROJECT ARP-01			
					Install 36" HDPE 3,200 feet to convey storm water northward along Washington Fields Road to the north end of the Airport drainage basin.			
ARP-R110	ARP-R110	20.6	65.1	61.5	*See ARP-J120*			
ARP-R120	ARP-R120	7.1	40.2	49.2	*See ARP-J120*			
ARP-R130	ARP-R130	20.9	104.9	140.5	*See ARP-B140*			
ARP-J110	ARP-R120	9.1	65.7	102.4	*Model Control Point*			
ARP-J120	None	21.0	105.3	143.6	*Existing Infrastructure*			
					None.			
					Recommended Improvement PROJECT ARP-02			
					Construct detention basin(s) totaling a minimum of 18.9 acre-feet, as part of the total 23.8 acre-foot			

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	*n*	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
					detention needed (see ARP-P110) for the Stucki Springs MP Community, limiting total peak discharge out of the Airport drainage basin to a maximum of 39.0 cfs.			
ARP-P110	None	23.5	39.0	39.0	*Existing Infrastructure*			
	Q_{in}	24.7	132.6	182.3	Washington Fields Road Incomplete Arterial			0.0
	Q_{out}	23.5	39.0	39.0				
	Storage	0.3	9.1	23.8	*Recommended Improvement PROJECT ARP-03*			
					Construct detention basin(s) totaling a minimum of 4.9 acre-feet, as part of the total 23.8 acre-foot detention needed (see ARP-J120) for the Stucki Springs MP Community, limiting total peak discharge out of the Airport drainage basin to a maximum of 39.0 cfs.			
					HDPE Pipe 1 each 36 in diameter	0.010	0.5	61.5
					Recommended Improvement PROJECT ARP-04			
					Modify the regional debris basin outlet structures and pipeline system to accommodate future additional storm water storage and discharge. Existing detention outlet of 39.0 cfs is to be discharged into the debris basin outlet pipeline extending 36" HDPE up to 1,000 feet, depending on the route taken and connections needed. Work may also include possible modifications to the NRCS debris basin outlet structures.			
MLC-B110	MLC-B110	22.4	57.1	50.2	*Existing Infrastructure*			
					Green Springs Drive Maj Arterial		0.5	41.8
					HDPE Pipe 1 each 18 in diameter	0.010	2.6	22.1
					Total Existing			*63.9*
					Recommended Improvement			
					None. Existing infrastructure adequate for 100-3.			
MLC-B120	MLC-B120	69.2	167.7	137.9	*Existing Infrastructure*			
					Telegraph Street Maj Arterial		0.5	41.8
					200 South Street Local		0.5	35.4
					CMP Pipe 1 each 30 in diameter	0.024	2.5	34.9
					CMP Pipe 1 each 24 in diameter	0.024	2.5	19.2
					HDPE Pipe 1 each 24 in diameter	0.010	2.5	46.1
					HDPE Pipe 1 each 16 in diameter	0.010	2.5	15.7
					Total Existing			*193.1*
					Recommended Improvement			
					None. Existing infrastructure combined assumed to be adequate for 100-3.			

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	n	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
MLC-B130	MLC-B130	3.7	24.1	31.3	*Existing Infrastructure* 200 West Street Incomplete Local *Proposed Infrastructure* HDPE Pipe 1 each 24 in *Recommended Improvement PROJECT MLC-01* Add 1,400 ft of 24" HDPE pipe along 200 West Street from Telegraph to 200 North Street.	 0.010	 3.5	 0.0 55.0
MLC-B135	MLC-B135	3.5	22.4	32.1	*Existing Infrastructure* Main Street Incomplete Arterial *Proposed Infrastructure* HDPE Pipe 1 each 24 in *Recommended Improvement PROJECT MLC-02* Add 2,100 ft of 24" HDPE pipe along North Main Street from Telegraph to 300 North Street.	 0.010	 2.9	 0.0 50.4
MLC-B140	MLC-B140	8.6	31.7	38.9	*Existing Infrastructure* 300 East Street Incomplete Maj Collector *Proposed Infrastructure* HDPE Pipe 1 each 24 in *Recommended Improvement PROJECT MLC-03* Add 2,400 ft of 24" HDPE pipe along North 300 East Street from Telegraph to Bulloch Drive.	 0.010	 2.5	 0.0 46.6
MLC-B150	MLC-B150	21.0	67.7	78.5	*Existing Infrastructure* Scenic Drive West Incomplete Local *Proposed Infrastructure* HDPE Pipe 1 each 30 in *Recommended Improvement PROJECT MLC-04* Add 2,400 ft of 30" HDPE pipe along Scenic Drive West from Telegraph to Scenic Drive North.	 0.010	 2.9	 0.0 91.5
MLC-B155	MLC-B155	1.1	13.5	20.4	*Existing Infrastructure* None. Storm water flows on west side of turf field. *Proposed Infrastructure* HDPE Pipe 1 each 18 in *Recommended Improvement PROJECT MLC-05* Install 3,200 feet 18" HDPE pipe to convey storm water from future development anticipated east of	 0.010	 2.4	 0.0 21.0

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results								
Location	**Route**	**10-3 (cfs)**	**100-3 (cfs)**	**100-24 (cfs)**	**Infrastructure Description**	***n***	**S (%)**	**Capacity (cfs)**
					Bluegrass Street and north of Telegraph Street.			
MLC-B160	MLC-B160	34.0	107.3	121.7	*Existing Infrastructure* Cut Ditch 5 ft width 3.0 ft depth 2.0 :1 sides *Proposed Infrastructure* HDPE Pipe 1 each 36 in *Recommended Improvement PROJECT MLC-06* Replace cut ditch with 36" HDPE 2,040 feet to convey storm water from future area development to the south, and to the east between Bella Vista Drive and Wildflower Drive, south of Telegraph Street.	 0.078 0.010	 2.2 2.2	 137.3 128.3
MLC-B170	MLC-B170	3.4	33.4	50.1	*Existing Infrastructure* 100 East Street (not fully improved) Maj Collector *Proposed Infrastructure* HDPE Pipe 1 each 24 in *Recommended Improvement PROJECT MLC-09* Perform road improvements and/or install 24" HDPE storm drain pipe up to 2,800 feet to convey the 100-3 design storm on 100 East Street between 200 South and Millcreek Wash. *Recommended Improvement PROJECT MLC-10* Replace existing ditch previously used for irrigation with 800 feet of 24" HDPE storm drain pipe to convey the 100-3 design storm on 400 South Street between 100 East and 300 East.	 0.010	 0.5 3.6	 57.0 55.9
MLC-B180	MLC-B180	23.1	74.6	79.6	*Existing Infrastructure* Natural washes discharging directly to the Virgin River *Recommended Improvement* None. Washes generally flow unobstructed and discharge to the Virgin River.			
MLC-B190	MLC-B190	0.8	17.4	31.1	*Existing Infrastructure* Industrial Drive Maj Collector HDPE Pipe 1 each 24 in diameter *Total Existing* *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.	 0.010	 0.5 2.4	 57.0 45.4 *102.4*

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	n	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
MLC-R110	MLC-R110	12.0	53.6	64.5	*Existing Infrastructure*			
					Telegraph Street Maj Arterial		0.5	41.8
					CMP Pipe 1 each 36 in diameter	0.024	1.7	47.8
					Total Existing			*89.6*
					Recommended Improvement			
					None. Existing infrastructure combined assumed to be adequate for 100-3.			
MLC-R115	MLC-R115	8.6	31.6	36.5	*Existing Infrastructure*			
					Telegraph Street Maj Arterial		0.5	41.8
					CMP Pipe 1 each 36 in diameter	0.024	1.3	41.5
					Total Existing			*83.3*
					Recommended Improvement			
					None. Existing infrastructure combined assumed to be adequate for 100-3.			
MLC-R120	MLC-R120	54.4	181.1	208.7	*Existing Infrastructure*			
					Washington Fields Road Arterial		0.5	37.5
					HDPE Pipe 1 each 48 in diameter	0.010	3.2	334.9
					Total Existing			*372.4*
					Recommended Improvement			
					None. Existing infrastructure combined assumed to be adequate for 100-3.			
MLC-R130	MLC-R130	21.2	76.9	92.4	*Existing Infrastructure*			
					Sequoyah Drive Local		0.5	35.4
					CMP Pipe 1 each 30 in diameter	0.024	2.3	33.9
					Total Existing			*69.3*
					Proposed Infrastructure			
					HDPE Pipe 1 each 24 in	0.010	2.3	44.9
					Recommended Improvement PROJECT MLC-07			
					Install additional 24" HDPE 1,300 ft routing along Sequoyah Drive and tie into 300 East (Washington Fields Road).			
MLC-R140	MLC-R140	1.1	13.4	20.3	*Existing Infrastructure*			
					Telegraph Street Maj Arterial		0.5	41.8
					CMP Pipe 1 each 36 in diameter	0.024	3.0	63.1
					Total Existing			*104.9*
					Recommended Improvement			
					None. Existing infrastructure combined assumed to be adequate for 100-3.			
MLC-J110	MLC-R110	15.2	73.8	95.8	*Existing Infrastructure*			
					Telegraph Street Maj Arterial		0.5	41.8
					CMP Pipe 1 each 36 in diameter	0.024	1.7	47.8
					Total Existing			*89.6*

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	*n*	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
					Recommended Improvement None. Existing infrastructure combined assumed to be adequate for 100-3.			
MLC-J115	MLC-R115	12.0	53.8	68.5	*Existing Infrastructure* Telegraph Street Maj Arterial CMP Pipe 1 each 36 in diameter *Total Existing* *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.	 0.024	 0.5 1.3	 41.8 41.5 *83.3*
MLC-J120	MLC-R120	54.4	181.1	208.7	*Existing Infrastructure* Washington Fields Road Arterial HDPE Pipe 1 each 48 in diameter *Total Existing* *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.	 0.010	 0.5 3.2	 37.5 334.9 *372.4*
MLC-J130	MLC-R130	54.4	181.8	214.2	*Existing Infrastructure* Cut Ditch 5 ft width 3.0 ft depth 2.0 :1 sides *Proposed Infrastructure* HDPE Pipe 1 each 42 in *Recommended Improvement PROJECT MLC-08* Replace open channel with 42" HDPE 900 feet to convey future development storm water routing from Project MLC-06, running behind Sequoyah Drive and tying into 300 East (Washington Fields Road).	 0.078 0.010	 2.3 2.3	 141.7 199.7
MLC-J140	MLC-R140	21.2	77.3	97.2	*Existing Infrastructure* Telegraph Street Maj Arterial CMP Pipe 1 each 36 in diameter *Total Existing* *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.	 0.024	 0.5 3.0	 41.8 63.1 *104.9*
GRW-B110	GRW-B110	110.0	380.7	497.3	*Existing Infrastructure* Natural Wash 15 ft width 3.0 ft depth 2.0 :1 sides 56 ft top width w/ 25' access road *Recommended Improvement PROJECT GRW-01* Construct channel improvements with access road to convey storm water from future development,	 0.078	 6.4	 517.7

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	*n*	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
					maintaining minimum 60' right-of-way width for 1,500 feet of existing wash.			
GRW-B120	GRW-B120	24.3	87.7	86.7	*Existing Infrastructure*			
					Wellington Street Local		0.5	35.4
					Fairway Drive Collector		0.5	54.8
					HDPE Pipe 2 each 18 in diameter	0.010	3.4	50.5
					Total Existing			*140.6*
					Recommended Improvement			
					None. Existing infrastructure adequate for 100-3.			
GRW-B130	GRW-B130	2.0	20.8	31.8	*Existing Infrastructure*			
					Blue Mountain Road Local		0.5	35.4
					HDPE Pipe 1 each 48 in	0.010	3.3	340.1
					Total Existing			*375.5*
					Recommended Improvement			
					None. Existing infrastructure adequate for 100-3.			
GRW-B140	GRW-B140	35.9	161.4	226.9	*Existing Infrastructure*			
					RCP Pipe 1 each 60 in	0.013	3.2	467.1
					Recommended Improvement			
					None. Cotton Mill II LOMR (p.2) - system designed 413.5 cfs for the Buena Vista/I-15 culverts.			
GRW-R110	GRW-R110	109.7	270.0	270.0	*Existing Infrastructure*			
					HDPE Pipe 1 each 48 in	0.010	2.0	264.7
					Recommended Improvement			
					None. Existing infrastructure within 10% for 100-3.			
GRW-R120	GRW-R120	111.6	290.7	301.6	*Existing Infrastructure*			
					Natural Wash 10 ft width 3.0 ft depth 2.0 :1 sides	0.078	4.6	317.3
					Recommended Improvement			
					None. Channel flows with no obstruction.			
GRW-J110	GRW-R110	111.6	290.8	301.8	*Existing Infrastructure*			
					HDPE Pipe 1 each 48 in	0.010	2.0	264.7
					Recommended Improvement			
					None. Existing infrastructure within 10% for 100-3.			
GRW-J120	GRW-R120	117.7	337.5	375.1	*Existing Infrastructure*			
					Natural Wash 15 ft width 3.0 ft depth 2.0 :1 sides	0.078	4.6	438.9

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	*n*	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
					Recommended Improvement None. Channel flows with no obstruction.			
GRW-P110	None	109.7	270.0	270.0	*Existing Infrastructure* Existing detention pond size about 7.6 acre-feet *Recommended Improvement* None. Existing detention pond appears to be sized to accommodate the 100-3 design storm (7.6 acre-feet).			
GRE-B110	GRE-B110	0.0	11.3	26.5	*Existing Infrastructure* Natural Wash 5 ft width 1.5 ft depth 2.0 :1 sides *Recommended Improvement* None. Channel routes through undevelopable area, so it is assumed that no ROW will be required.	0.078	4.5	49.4
GRE-B120	GRE-B120	14.2	64.4	76.5	*Existing Infrastructure* Natural Wash 5 ft width 2.0 ft depth 2.0 :1 sides 42 ft top width w/ 25' access road *Recommended Improvement PROJECT GRE-01* Construct channel improvements with access road to convey storm water from future development, maintaining minimum 50' ROW width for 2,700 feet of existing wash.	0.078	5.1	92.1
GRE-B130	GRE-B130	0.0	3.2	7.4	*Existing Infrastructure* Natural Wash 5 ft width 1.0 ft depth 2.0 :1 sides *Recommended Improvement* None. Future road improvements should be adequate.	0.078	7.3	29.5
GRE-B140	GRE-B140	21.0	88.2	112.5	*Existing Infrastructure* Natural Wash 5 ft width 2.0 ft depth 2.0 :1 sides *Recommended Improvement* None. Channel routes through undevelopable area, so it is assumed that no ROW will be required.	0.078	7.7	113.1
GRE-B150	GRE-B150	16.5	70.3	92.0	*See GRE-R130*			
GRE-B160	GRE-B160	10.6	44.5	54.1	*See GRE-R140*			

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	*n*	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
GRE-R110	GRE-R110	0.0	3.2	7.2	*Existing Infrastructure* Natural Wash 5 ft width 1.5 ft depth 2.0 :1 sides 40 ft top width w/ 25' access road *Recommended Improvement PROJECT GRE-02* Construct channel improvements with access road to convey storm water from future development, maintaining minimum 50' ROW width for 2,100 feet of existing wash.	0.078	3.8	45.4
GRE-R120	GRE-R120	20.8	88.1	104.8	*Existing Infrastructure* Natural Wash 10 ft width 2.0 ft depth 2.0 :1 sides 47 ft top width w/ 25' access road *Recommended Improvement PROJECT GRE-03* Construct channel improvements with access road to convey storm water from future development, maintaining minimum 50' ROW width for 3,000 feet of existing wash.	0.078	3.1	121.2
GRE-R130	GRE-R130	20.7	88.4	106.3	*Existing Infrastructure* North Main Street Incomplete Arterial			0.0
					Proposed Infrastructure HDPE Pipe 1 each 42 in	0.010	0.5	92.7
					Recommended Improvement PROJECT GRE-04 Install 42" HDPE 1,000 feet along North Main Street to convey storm water from future development in areas to the north and west, picking up flows from Project GRE-03, extending line from Buena Vista Boulevard to Arrowweed Way.			
GRE-R140	GRE-R140	10.6	44.2	52.5	*Existing Infrastructure* North Main Street Incomplete Arterial			0.0
					Proposed Infrastructure HDPE Pipe 1 each 24 in	0.010	3.4	54.4
					Recommended Improvement PROJECT GRE-05 Install 24" HDPE for 1,400 ft along Buena Vista Boulevard east of Main Street to Graham Manor.			
GRE-R150	GRE-R150	30.5	129.8	154.2	*See GRE-J130*			

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results								
Location	**Route**	**10-3 (cfs)**	**100-3 (cfs)**	**100-24 (cfs)**	**Infrastructure Description**	***n***	**S (%)**	**Capacity (cfs)**
GRE-J110	None	20.8	89.1	110.7	*Model Control Point*			
GRE-J120	None	30.6	130.3	158.7	*Model Control Point*			
GRE-J130	GRE-R150	46.4	195.6	240.2	*Existing Infrastructure*			
					CMP Pipe 1 each 60 in	0.024	2.0	200.0
					Proposed Infrastructure			
					RCP Pipe 1 each 60 in	0.010	2.0	480.0
					Improved Chann 10 ft width 3.5 ft depth 2.0 :1 sides	0.078	2.0	281.7
					Recommended Improvement PROJECT GRE-06			
					Add 500 ft of 60" HDPE pipe, and construct outlet structure discharging to open channel along UDOT right-of-way, between the Boilers and Millcreek.			
GRP-B110	GRP-B110	7.5	33.0	39.8	*Not evaluated. Part of SITLA Sienna MP Community.*			
GRP-B120	GRP-B120	26.6	95.7	118.4	*Not evaluated. Part of SITLA Sienna MP Community.*			
GRP-B130	GRP-B130	17.6	75.9	100.1	*Not evaluated. Part of SITLA Sienna MP Community.*			
GRP-B140	GRP-B140	100.8	265.5	242.0	*See GRP-R110 and GRP-R120*			
GRP-B160	GRP-B160	41.6	123.0	136.3	*Existing Infrastructure*			
					Sandy Talus Drive Local		0.5	35.4
					Telegraph Street Maj Arterial		0.5	41.8
					HDPE Pipe 1 each 24 in diameter	0.010	3.6	55.9
					RCP Pipe 1 each 84 in diameter	0.013	3.6	1,215.1
					Total Existing			*1,348.3*
					Recommended Improvement			
					None. Existing infrastructure combined assumed to be adequate for 100-3.			
GRP-B170	GRP-B170	45.7	185.6	255.0	*Not evaluated. Part of SITLA Sienna MP Community.*			
GRP-R110	GRP-R110	7.5	33.0	38.6	*Existing Infrastructure*			
w/ 30% GRP-B140		30.2	79.7	72.6	Open channel 5 ft width 3.0 ft depth 2.0 :1 sides	0.078	2.0	130.2
combined		*37.7*	*112.7*	*111.2*				
					Proposed Infrastructure			
					HDPE Pipe 1 each 36 in	0.010	2.0	121.7
					Recommended Improvement PROJECT GRP-01			
					Install 36" HDPE 1,120 feet to convey storm water			

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results								
Location	**Route**	**10-3 (cfs)**	**100-3 (cfs)**	**100-24 (cfs)**	**Infrastructure Description**	***n***	**S (%)**	**Capacity (cfs)**
					from future area development, routing between I-15 and Bluff View Drive.			
GRP-R120 w/ 30% GRP-B140 *combined*	GRP-R120	26.6 30.2 *56.8*	95.1 79.7 *174.8*	105.1 72.6 *177.7*	Open channel 5 ft width 3.0 ft depth 2.0 :1 sides *Proposed Infrastructure* HDPE Pipe 1 each 48 in *Recommended Improvement PROJECT GRP-02* Install 48" HDPE 2,200 feet to convey storm water from future area development, routing from 1100 East southward discharging into open channel at East Pine Valley Street.	0.078 0.010	4.3 1.5	192.8 229.3
GRP-R130	GRP-R130	32.9	123.0	140.3	*Existing Infrastructure* Sandy Talus Drive Local RCP Pipe 1 each 84 in diameter *Total Existing* *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.	0.013	0.5 2.7	35.4 1,052.3 *1,087.8*
GRP-R140	GRP-R140	101.9	311.0	328.6	*Not evaluated. Part of SITLA Sienna MP Community.*			
GRP-R140	GRP-R140	101.9	311.0	328.6	*Existing Infrastructure* Sandy Talus Drive Local RCP Pipe 1 each 84 in diameter *Total Existing* *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.	0.013	0.5 1.1	35.4 671.7 *707.1*
GRP-R150	GRP-R150	17.5	75.7	85.6	*Not evaluated. Part of SITLA Sienna MP Community.*			
GRP-J110	None	32.9	123.0	143.7	*Model Control Point*			
GRP-J120	GRP-R130	102.0	311.5	328.9	*Existing Infrastructure* Sandy Talus Drive Local RCP Pipe 1 each 84 in diameter *Total Existing* *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.	0.013	0.5 2.7	35.4 1,052.3 *1,087.8*

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	n	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
GRP-J130	GRP-R140	102.0	347.8	414.2	*Existing Infrastructure* Sandy Talus Drive Local RCP Pipe 1 each 84 in diameter *Total Existing* *Recommended Improvement* None. Existing infrastructure combined assumed to be adequate for 100-3.	 0.013	 0.5 1.1	 35.4 671.7 *707.1*
CTW-B110	CTW-B110	45.3	178.4	239.1	*Not evaluated. Part of Coral Canyon MP Community.*			
CTW-B120	CTW-B120	26.9	109.0	154.7	*Not evaluated. Part of Coral Canyon MP Community.*			
CTW-B130	CTW-B130	21.2	86.4	127.6	*Not evaluated. Part of Coral Canyon MP Community.*			
HRS-B110	HRS-B110	53.0	134.0	107.6	*Not evaluated. Landfill containment area.*			
HRS-B120	HRS-B120	21.6	91.0	132.5	*Existing Infrastructure* Natural Wash 10 ft width 3.0 ft depth 2.0 :1 sides 51 ft top width w/ 25' access road *Recommended Improvement PROJECT HRS-01* Drainage channel improvements with access road maintaining minimum 60' ROW width for 8,900 ft of existing wash.	 0.078	 1.4	 175.1
HRS-B130	HRS-B130	12.5	71.1	109.4	*See HRS-J110*			
HRS-B140	HRS-B140	36.7	132.5	174.7	*Existing Infrastructure* Natural Wash 10 ft width 3.0 ft depth 2.0 :1 sides 51 ft top width w/ 25' access road *Recommended Improvement PROJECT HRS-02* Drainage channel improvements with access road maintaining minimum 60' ROW width for 7,600 ft of existing wash.	 0.078	 1.4	 175.1
HRS-B150	HRS-B150	37.7	133.9	184.9	*See HRS-J120*			
HRS-R110	HRS-R110	21.5	90.9	126.7	*See HRS-J110*			
HRS-R120	HRS-R120	36.7	132.3	171.5	*See HRS-J120*			

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	n	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
HRS-J110	HRS-R110	33.7	159.6	234.7	*Existing Infrastructure* Natural Wash 15 ft width 3.0 ft depth 2.0 :1 sides 56 ft top width w/ 25' access road *Recommended Improvement PROJECT HRS-03* Drainage channel improvements with access road maintaining minimum 60' ROW width for 7,200 ft of existing wash.	0.078	1.4	242.1
HRS-J120	HRS-R120	74.4	266.0	356.3	*Existing Infrastructure* Natural Wash 20 ft width 3.5 ft depth 2.0 :1 sides 63 ft top width w/ 25' access road *Recommended Improvement PROJECT HRS-04* Drainage channel improvements with access road maintaining minimum 70' ROW width for 7,300 ft of existing wash.	0.078	1.1	362.6
GYP-B110	GYP-B110	39.4	166.6	217.4	*Existing Infrastructure* Natural Wash 10 ft width 3.0 ft depth 2.0 :1 sides 38 ft top width w/ 20' access road	0.078	3.5	276.8
					Proposed Infrastructure HDPE Pipe 1 each 42 in diameter *Recommended Improvement PROJECT GYP-01* Install 42" HDPE 4,200 ft along the wash or future roadway, extending to the NRCS Gypsum Wash Debris Basin.	0.010	3.5	245.3
GYP-B120	GYP-B120	65.2	278.9	341.9	*Existing Infrastructure* Natural Wash 10 ft width 3.5 ft depth 2.0 :1 sides *Recommended Improvement* None. All flows discharge directly to the NRCS Gypsum Wash Debris Basin.	0.078	3.9	393.3
GYP-B130	GYP-B130	21.9	104.5	137.1	*Existing Infrastructure* Natural Wash 5 ft width 3.0 ft depth 2.0 :1 sides *Recommended Improvement* None. All flows diverted by the dike and future Southern Parkway directly to the NRCS Gypsum Wash Debris Basin.	0.078	2.5	147.0
GYP-R110	GYP-R110	21.5	66.1	66.0	*Existing Infrastructure* Natural Wash 5 ft width 3.0 ft depth 2.0 :1 sides	0.078	0.7	75.0

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	n	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
					Recommended Improvement None. All flows diverted by the dike and future Southern Parkway directly to the NRCS Gypsum Wash Debris Basin.			
GYP-R120	GYP-R120	39.1	132.0	132.0	*Existing Infrastructure* Natural Wash 10 ft width 2.5 ft depth 2.0 :1 sides *Recommended Improvement* None. All flows discharge directly to the NRCS Gypsum Wash Debris Basin.	0.078	1.8	140.7
GYP-P110	None	94.1	132.0	132.0	*Existing Infrastructure* Existing NRCS Gypsum Wash debris basin. *Recommended Improvement* None. Basin already in place exceeds minimum modeled storage requirement of 56.2 acre-feet.			
GYP-P120	None	21.6	66.0	66.0	*Existing Infrastructure* Southern Parkway detention area currently under construction. *Recommended Improvement* None. Basin under construction exceeds minimum modeled storage requirement of 7.4 acre-feet.			
STU-B110	STU-B110	1.2	32.0	62.2	*Existing Infrastructure* Natural Wash 5 ft width 2.0 ft depth 2.0 :1 sides 42 ft top width w/ 25' access road *Recommended Improvement PROJECT STU-01* Drainage channel improvements with access road maintaining minimum 50' ROW width for 3,700 ft of existing wash.	0.078	2.4	63.2
STU-B120	STU-B120	4.7	50.9	83.9	*See STU-P110*			
STU-R110	STU-R110	1.1	31.9	59.3	*See STU-P110*			
STU-P110	STU-R110	4.8	79.4	132.0	*Existing Infrastructure* Natural Wash 10 ft width 3.5 ft depth 2.0 :1 sides 53 ft top width w/ 25' access road *Recommended Improvement PROJECT STU-02* Drainage channel improvements with access road	0.078	0.5	133.6

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results								
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)	Infrastructure Description	*n*	S (%)	Capacity (cfs)
					maintaining minimum 60' ROW width for 2,200 ft of existing wash.			
STU-P110	None	4.8	79.4	132.0	*Existing Infrastructure* Existing NRCS Stucki Springs debris basin. *Recommended Improvement* None. Basin already in place exceeds minimum modeled storage requirement of 1.3 acre-feet.			
WRN-B110	WRN-B110	18.2	110.3	172.5	*Existing Infrastructure* Natural Wash 10 ft width 2.5 ft depth 2.0 :1 sides 49 ft top width w/ 25' access road *Recommended Improvement PROJECT WRN-01* Drainage channel improvements with access road maintaining minimum 50' ROW width for 7,800 ft of existing wash.	0.078	2.7	172.3
WRN-B120	WRN-B120	26.3	149.6	233.6	*See WRN-J110*			
WRN-B130	WRN-B130	19.1	112.1	164.7	*See WRN-J120*			
WRN-R110	WRN-R110	18.2	110.1	164.0	*See WRN-J110*			
WRN-R120	WRN-R120	43.6	258.0	385.6	*See WRN-J120*			
WRN-J110	WRN-R110	43.7	258.0	397.6	*Existing Infrastructure* Natural Wash 20 ft width 3.5 ft depth 2.0 :1 sides *Recommended Improvement* None. Channel routes through undevelopable area, so it is assumed that no ROW will be required.	0.078	1.5	423.4
WRN-J120	WRN-R120	54.2	323.5	503.5	*Existing Infrastructure* Natural Wash 35 ft width 3.5 ft depth 2.0 :1 sides *Recommended Improvement* None. Channel routes through undevelopable area, so it is assumed that no ROW will be required.	0.078	1.0	571.3
WRS-B110	WRS-B110	5.3	71.9	123.6	*Existing Infrastructure* Natural Wash 5 ft width 3.0 ft depth 2.0 :1 sides 46 ft top width w/ 25' access road	0.078	3.4	171.5

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	n	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
					Recommended Improvement PROJECT WRS-01 Drainage channel improvements with access road maintaining minimum 50' ROW width for 4,600 ft of existing wash.			
WRS-B120	WRS-B120	0.0	24.4	58.4	*Existing Infrastructure* Natural Wash 5 ft width 2.0 ft depth 2.0 :1 sides 42 ft top width w/ 25' access road *Recommended Improvement PROJECT WRS-02* Drainage channel improvements with access road maintaining minimum 50' ROW width for 7,600 ft of existing wash.	0.078	3.5	76.3
WRS-B130	WRS-B130	0.7	21.7	40.2	*Existing Infrastructure* Natural Wash 5 ft width 1.5 ft depth 2.0 :1 sides 40 ft top width w/ 25' access road *Recommended Improvement PROJECT WRS-03* Drainage channel improvements with access road maintaining minimum 50' ROW width for 2,700 ft of existing wash.	0.078	3.4	43.0
WRS-B140	WRS-B140	3.8	51.9	94.9	*Existing Infrastructure* Natural Wash 5 ft width 2.5 ft depth 2.0 :1 sides 44 ft top width w/ 25' access road *Recommended Improvement PROJECT WRS-04* Drainage channel improvements with access road maintaining minimum 50' ROW width for 2,300 ft of existing wash.	0.078	2.8	106.8
WRS-B150	WRS-B150	0.6	34.0	74.7	*Existing Infrastructure* Natural Wash 5 ft width 2.5 ft depth 2.0 :1 sides 44 ft top width w/ 25' access road *Recommended Improvement PROJECT WRS-05* Drainage channel improvements with access road maintaining minimum 50' ROW width for 8,400 ft of existing wash.	0.078	2.2	94.7
WRS-B160	WRS-B160	18.1	119.8	192.9	*Existing Infrastructure* Natural Wash 10 ft width 3.0 ft depth 2.0 :1 sides 51 ft top width w/ 25' access road *Recommended Improvement PROJECT WRS-06* Drainage channel improvements with access road	0.078	2.1	214.4

TABLE T-6: MODEL RESULTS AND EVALUATION

Model Results					Infrastructure Description	*n*	S	Capacity
Location	Route	10-3 (cfs)	100-3 (cfs)	100-24 (cfs)			(%)	(cfs)
					maintaining minimum 60' ROW width for 5,600 ft of existing wash.			
WRS-R110	WRS-R110	5.3	71.7	121.9	*See WRS-J110*			
WRS-R120	WRS-R120	6.0	112.8	208.6	*See WRS-J120*			
WRS-R130	WRS-R130	9.0	192.0	358.5	*See WRS-P110*			
WRS-J110	WRS-R110	6.0	113.0	214.3	*Existing Infrastructure* Natural Wash 20 ft width 3.0 ft depth 2.0 :1 sides 61 ft top width w/ 25' access road *Recommended Improvement PROJECT WRS-07* Drainage channel improvements with access road maintaining minimum 70' ROW width for 2,500 ft of existing wash.	0.078	0.4	161.6
WRS-J120	WRS-R120	9.0	192.1	366.8	*Existing Infrastructure* Natural Wash 25 ft width 4.0 ft depth 2.0 :1 sides 70 ft top width w/ 25' access road *Recommended Improvement PROJECT WRS-08* Drainage channel improvements with access road maintaining minimum 70' ROW width for 7,700 ft of existing wash.	0.078	0.4	328.9
WRS-P110	None	21.0	132.0	132.0	*Existing Infrastructure* Existing NRCS Warner Draw debris basin. *Recommended Improvement* None. Basin already in place exceeds minimum modeled storage requirement of 107.8 acre-feet.			

TABLE T-7: STANDARD ROADWAY STORM WATER CAPACITIES

Assumptions

Standard Curb and Gutter (Type HB30-7) as per *Standard Drawing No. 100*

Standard Road Cross Sections as per *Standard Drawing No. 140*

Mannings Roughness Coefficient for Asphalt Pavement = 0.0150

Flow Condition	Gutter Depth		Water Spread		Flow Area	WP	Capacity (cfs) 0.40% Slope		Capacity (cfs) 0.50% Slope	
			Asphalt	Sidewalk						
	(in)	(ft)	(ft)	(ft)	(sq ft)	(ft)	1 Side	2 Sides	1 Side	2 Sides
Local Roadway (35' Pavement Width)										
Water to lip of gutter	2.50	0.21	0.00	0.00	0.21	2.22	0.27	0.54	0.30	0.60
Water up to outside travel lane	3.82	0.32	5.50	0.00	0.73	7.83	0.94	1.89	1.06	2.11
Water to road centerline	6.70	0.56	17.50	0.00	3.97	20.07	8.47	16.94	9.47	18.94
Water to top back of curb	7.00	0.58	35.00	0.00	9.82	40.20	N/A	24.12	N/A	26.97
Water to back of 4' sidewalk	8.00	0.67	35.00	4.00	12.12	45.19	N/A	31.68	N/A	35.42
Local Collector (42' Pavement Width)										
Water to lip of gutter	2.50	0.21	0.00	0.00	0.21	2.22	0.27	0.54	0.30	0.60
Water up to outside travel lane	3.82	0.32	5.50	0.00	0.73	7.83	0.94	1.89	1.06	2.11
Water covers outside travel lane	6.70	0.56	17.50	0.00	3.97	20.07	8.47	16.94	9.47	18.94
Water to top back of curb	7.00	0.58	18.75	0.00	4.47	21.35	9.92	19.83	11.09	22.17
Water to road centerline	7.54	0.63	21.00	2.16	5.53	26.26	12.30	24.59	13.75	27.49
Water to back of 5' sidewalk	8.25	0.69	42.00	5.00	16.15	48.20	N/A	48.97	N/A	54.75
Major Collector (46' Pavement Width)										
Water to lip of gutter	2.50	0.21	0.00	0.00	0.21	2.22	0.27	0.54	0.30	0.60
Water up to outside travel lane	3.82	0.32	5.50	0.00	0.73	7.83	0.94	1.89	1.06	2.11
Water covers outside travel lane	6.70	0.56	17.50	0.00	3.97	20.07	8.47	16.94	9.47	18.94
Water to top back of curb	7.00	0.58	18.75	0.00	4.47	21.35	9.92	19.83	11.09	22.17
Water to road centerline	7.54	0.63	23.00	4.08	6.63	30.18	15.18	30.36	16.97	33.95
Water to back of 5' sidewalk	8.25	0.69	46.00	5.00	18.33	62.20	N/A	51.00	N/A	57.02
Arterial (65' Pavement Width)										
Water to lip of gutter	2.50	0.21	0.00	0.00	0.21	2.22	0.27	0.54	0.30	0.60
Water up to outside travel lane	3.82	0.32	5.50	0.00	0.73	7.83	0.94	1.89	1.06	2.11
Water covers outside travel lane	6.70	0.56	17.50	0.00	3.97	20.07	8.47	16.94	9.47	18.94
Water to top back of curb	7.00	0.58	18.75	0.00	4.47	21.35	9.92	19.83	11.09	22.17
Water to back of 5' sidewalk	8.25	0.69	23.96	5.00	7.22	32.06	16.79	33.57	18.77	37.54
Water to road centerline	10.30	0.86	32.50	13.20	14.02	48.80	38.36	76.73	42.89	85.78
Major Arterial (89' Pavement Width)										
Water to lip of gutter	2.50	0.21	0.00	0.00	0.21	2.22	0.27	0.54	0.30	0.60
Water up to outside travel lane	3.82	0.32	5.50	0.00	0.73	7.83	0.94	1.89	1.06	2.11
Water covers outside travel lane	6.70	0.56	17.50	0.00	3.97	20.07	8.47	16.94	9.47	18.94
Water to top back of curb	7.00	0.58	18.75	0.00	4.47	21.35	9.92	19.83	11.09	22.17
Water to back of 6' sidewalk	8.50	0.71	25.00	6.00	7.90	34.10	18.70	37.41	20.91	41.82
Water to road centerline	13.18	1.10	44.50	24.72	28.41	72.33	95.75	191.50	107.05	214.10

TABLE T-7: STANDARD ROADWAY STORM WATER CAPACITIES

Assumptions
Standard Curb and Gutter (Type HB30-7) as per *Standard Drawing No. 100*
Standard Road Cross Sections as per *Standard Drawing No. 140*
Mannings Roughness Coefficient for Asphalt Pavement = 0.0150

Flow Condition	Capacity (cfs) 1.00% Slope		Capacity (cfs) 1.50% Slope		Capacity (cfs) 2.00% Slope		Capacity (cfs) 2.50% Slope		Capacity (cfs) 3.00% Slope	
	1 Side	2 Sides	1 Side	2 Sides	1 Side	2 Sides	1 Side	2 Sides	1 Side	2 Sides
Local Roadway (35' Pavement Width)										
Water to lip of gutter	0.43	0.85	0.52	1.05	0.60	1.21	0.68	1.35	0.74	1.48
Water up to outside travel lane	1.49	2.99	1.83	3.66	2.11	4.22	2.36	4.72	2.59	5.17
Water to road centerline	13.39	26.78	16.40	32.80	18.94	37.88	21.17	42.35	23.19	46.39
Water to top back of curb	N/A	38.14	N/A	46.71	N/A	53.94	N/A	60.30	N/A	66.06
Water to back of 4' sidewalk	N/A	50.10	N/A	61.35	N/A	70.85	N/A	79.21	N/A	86.77
Local Collector (42' Pavement Width)										
Water to lip of gutter	0.43	0.85	0.52	1.05	0.60	1.21	0.68	1.35	0.74	1.48
Water up to outside travel lane	1.49	2.99	1.83	3.66	2.11	4.22	2.36	4.72	2.59	5.17
Water covers outside travel lane	13.39	26.78	16.40	32.80	18.94	37.88	21.17	42.35	23.19	46.39
Water to top back of curb	15.68	31.36	19.20	38.41	22.17	44.35	24.79	49.58	27.16	54.32
Water to road centerline	19.44	38.88	23.81	47.62	27.49	54.99	30.74	61.48	33.67	67.34
Water to back of 5' sidewalk	N/A	77.43	N/A	94.83	N/A	109.50	N/A	122.43	N/A	134.11
Major Collector (46' Pavement Width)										
Water to lip of gutter	0.43	0.85	0.52	1.05	0.60	1.21	0.68	1.35	0.74	1.48
Water up to outside travel lane	1.49	2.99	1.83	3.66	2.11	4.22	2.36	4.72	2.59	5.17
Water covers outside travel lane	13.39	26.78	16.40	32.80	18.94	37.88	21.17	42.35	23.19	46.39
Water to top back of curb	15.68	31.36	19.20	38.41	22.17	44.35	24.79	49.58	27.16	54.32
Water to road centerline	24.00	48.01	29.40	58.80	33.95	67.89	37.95	75.90	41.57	83.15
Water to back of 5' sidewalk	N/A	80.64	N/A	98.77	N/A	114.05	N/A	127.51	N/A	139.68
Arterial (65' Pavement Width)										
Water to lip of gutter	0.43	0.85	0.52	1.05	0.60	1.21	0.68	1.35	0.74	1.48
Water up to outside travel lane	1.49	2.99	1.83	3.66	2.11	4.22	2.36	4.72	2.59	5.17
Water covers outside travel lane	13.39	26.78	16.40	32.80	18.94	37.88	21.17	42.35	23.19	46.39
Water to top back of curb	15.68	31.36	19.20	38.41	22.17	44.35	24.79	49.58	27.16	54.32
Water to back of 5' sidewalk	26.54	53.09	32.51	65.02	37.54	75.07	41.97	83.94	45.97	91.95
Water to road centerline	60.66	121.31	74.29	148.58	85.78	171.56	95.91	191.81	105.06	210.12
Major Arterial (89' Pavement Width)										
Water to lip of gutter	0.43	0.85	0.52	1.05	0.60	1.21	0.68	1.35	0.74	1.48
Water up to outside travel lane	1.49	2.99	1.83	3.66	2.11	4.22	2.36	4.72	2.59	5.17
Water covers outside travel lane	13.39	26.78	16.40	32.80	18.94	37.88	21.17	42.35	23.19	46.39
Water to top back of curb	15.68	31.36	19.20	38.41	22.17	44.35	24.79	49.58	27.16	54.32
Water to back of 6' sidewalk	29.57	59.15	36.22	72.44	41.82	83.65	46.76	93.52	51.22	102.45
Water to road centerline	151.39	302.78	185.42	370.83	214.10	428.20	239.37	478.74	262.22	524.44

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAD-01

Description Install 30" HDPE 1,600 feet to convey storm water from future development along 1300 East Street and tie into Washington Dam Road.

Location	WAD-B110	**Model 100-3 Storm**	77.9	cfs
Route	WAD-B110	**Pipeline Capacity**	101.0	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	16,000	2.00	32,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.12	Earthwork	Rock Excavation	Cu Yd	148	70.00	10,370
3.30	Storm Drain Pipe	30" Smoothwall HDPE	Ln Ft	1,600	50.00	80,000
4.30	Pipe End Section	30" Smoothwall HDPE	Each	2	800.00	1,600
5.30	Concrete Catch Basin	30" Double Curb Inlet	Each	5	3,500.00	17,500
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	400	25.00	10,000
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	16,000	9.00	144,000
7.20	Road Reconstruction	Restore Curb and Gutter	Ln Ft	800	30.00	24,000
7.30	Road Reconstruction	Restore Concrete Sidewalk	Sq Ft	400	12.00	4,800
7.40	Road Reconstruction	Traffic Control	Lump	1	14,400.00	14,400
		Mobilization		*5%*		*17,084*
		Construction Contingency		*20%*		*68,334*
		Design and Construction Engineering		*10%*		*34,167*
		Project Management		*10%*		*34,167*
		Total Project Cost				***495,422***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAD-02

Description Install 24" HDPE 1,600 feet to convey storm water from future development along Black Brush Drive and Arabian Way, and tie into Washington Dam Road.

Location	WAD-B130	**Model 100-3 Storm**	48.4	cfs
Route	WAD-B130	**Pipeline Capacity**	57.4	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	16,000	2.00	32,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.12	Earthwork	Rock Excavation	Cu Yd	148	70.00	10,370
3.24	Storm Drain Pipe	24" Smoothwall HDPE	Ln Ft	1,600	40.00	64,000
4.24	Pipe End Section	24" Smoothwall HDPE	Each	2	400.00	800
5.24	Concrete Catch Basin	24" Double Curb Inlet	Each	5	3,500.00	17,500
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	400	25.00	10,000
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	16,000	9.00	144,000
7.20	Road Reconstruction	Restore Curb and Gutter	Ln Ft	800	30.00	24,000
7.30	Road Reconstruction	Restore Concrete Sidewalk	Sq Ft	400	12.00	4,800
7.40	Road Reconstruction	Traffic Control	Lump	1	14,400.00	14,400
		Mobilization		*5%*		*16,244*
		Construction Contingency		*20%*		*64,974*
		Design and Construction Engineering		*10%*		*32,487*
		Project Management		*10%*		*32,487*
		Total Project Cost				***471,062***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAD-02 *(continued)*

Description Possible area for detention in combination with the storm drain pipeline.

Location WAD-B130

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
2.05	Earthwork	SWPPP/Construction BMPs	Acre	2.86	3,000.00	8,568
2.10	Earthwork	Excavation and Fill	Cu Yd	3,945	30.00	118,361
2.20	Earthwork	Dust Control	Acre	3	2,000.00	5,712
3.24	Storm Drain Pipe	24" Smoothwall HDPE	Ln Ft	80	40.00	3,200
8.20	Bank Lining	2' Thick Riprap	Cu Yd	160	100.00	16,000
9.10	Basin/Pipeline	Outlet Structure	Lump	1	30,000.00	30,000
10.10	Access Road	Road Base	Cu Yd	483	45.00	21,737
11.10	Right-of-Way Fence	6' High	Ln Ft	7	40.00	270
11.20	Right-of-Way Fence	12' Gated Opening	Each	1	2,500.00	2,500
		Mobilization		*5%*		*9,889*
		Construction Contingency		*20%*		*39,556*
		Design and Construction Engineering		*10%*		*19,778*
		Project Management		*10%*		*19,778*
		Total Project Cost				***295,349***

Total Project Cost ***766,411***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAD-03

Description Install 36" HDPE 1,200 feet to convey storm water from future development through the industrial area, connecting into existing 36" pipe in 1775 East Street across from Washington Dam Road.

Location	WAD-B180	**Model 100-3 Storm**	109.1	cfs
Route	WAD-B180	**Pipeline Capacity**	176.0	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	12,000	2.00	24,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.12	Earthwork	Rock Excavation	Cu Yd	111	70.00	7,778
3.36	Storm Drain Pipe	36" Smoothwall HDPE	Ln Ft	1,200	90.00	108,000
4.36	Pipe End Section	36" Smoothwall HDPE	Each	2	800.00	1,600
5.36	Concrete Catch Basin	36" Double Curb Inlet	Each	4	8,500.00	34,000
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	300	25.00	7,500
		Mobilization		*5%*		*9,294*
		Construction Contingency		*20%*		*37,176*
		Design and Construction Engineering		*10%*		*18,588*
		Project Management		*10%*		*18,588*
		Total Project Cost				***269,523***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAD-04

Description Install 24" HDPE 1,500 feet to convey storm water from future development along - and to the south of - Granada Royale Drive.

Location	WAD-B200	**Model 100-3 Storm**	44.9 cfs
Route	WAD-B200	**Pipeline Capacity**	71.6 cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	15,000	2.00	30,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.12	Earthwork	Rock Excavation	Cu Yd	139	70.00	9,722
3.24	Storm Drain Pipe	24" Smoothwall HDPE	Ln Ft	1,500	40.00	60,000
4.24	Pipe End Section	24" Smoothwall HDPE	Each	2	400.00	800
5.24	Concrete Catch Basin	24" Double Curb Inlet	Each	5	3,500.00	17,500
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	375	25.00	9,375
		Mobilization		*5%*		*6,520*
		Construction Contingency		*20%*		*26,079*
		Design and Construction Engineering		*10%*		*13,040*
		Project Management		*10%*		*13,040*
		Total Project Cost				***189,076***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAD-05

Description Install 24" HDPE 1,300 ft along existing wash across Washington Dam Road to the Virgin River. (NOTE: Project removed since all of the drainage area it services is considered to be undevelopable, either 15% plus hillside or 100-year floodplain.)

Location	WAD-B220	**Model 100-3 Storm**	60.6 cfs
Route	WAD-B230	**Pipeline Capacity**	90.4 cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	13,000	2.00	26,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.12	Earthwork	Rock Excavation	Cu Yd	120	70.00	8,426
2.14	Earthwork	Dewatering	Ln Ft	650	20.00	13,000
3.24	Storm Drain Pipe	24" Smoothwall HDPE	Ln Ft	1,300	40.00	52,000
4.24	Pipe End Section	24" Smoothwall HDPE	Each	1	400.00	400
5.24	Concrete Catch Basin	24" Double Curb Inlet	Each	4	3,500.00	14,000
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	325	25.00	8,125
9.10	Basin/Pipeline	Outlet Structure	Lump	1	30,000.00	30,000
		Mobilization		*5%*		*7,748*
		Construction Contingency		*20%*		*30,990*
		Design and Construction Engineering		*10%*		*15,495*
		Project Management		*10%*		*15,495*
		Total Project Cost				***195,679***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAD-06

Description Construct channel improvements with access road to convey storm water from future development, maintaining minimum 50' right-of-way width for 5,800 feet of existing wash.

Location	WAD-B230	**Model 100-24 Storm**	88.7	cfs
Route	WAD-B230	**Channel Capacity**	138.8	cfs

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
1.10	Channel and Access Road Improvements	Acre	6.66	50,000.00	332,874
	Survey and Legal Document Prep		*5%*		*16,644*
	Project Management		*10%*		*33,287*
	Total Project Cost				***382,805***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAD-07

Description Install additional 42" HDPE 3,250 feet alongside existing 24" pipe - near alignments of 1425 South Street and 1410 South Street - to improve capacity for anticipated changes in flow patterns from future development.

Location	WAD-J130	**Model 100-3 Storm**	183.7 cfs
Route	WAD-R120	**Pipeline Capacity**	138.1 cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	32,500	2.00	65,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.12	Earthwork	Rock Excavation	Cu Yd	301	70.00	21,065
2.14	Earthwork	Dewatering	Ln Ft	2,438	20.00	48,750
3.42	Storm Drain Pipe	42" Smoothwall HDPE	Ln Ft	3,250	130.00	422,500
4.42	Pipe End Section	42" Smoothwall HDPE	Each	1	1,200.00	1,200
5.42	Concrete Catch Basin	42" Double Curb Inlet	Each	11	8,500.00	93,500
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	813	25.00	20,313
9.10	Basin/Pipeline	Outlet Structure	Lump	1	30,000.00	30,000
		Mobilization		*5%*		*35,266*
		Construction Contingency		*20%*		*141,065*
		Design and Construction Engineering		*10%*		*70,533*
		Project Management		*10%*		*70,533*
		Total Project Cost				***1,022,725***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAD-08

Description Install additional 36" HDPE 2,100 feet to convey storm water from future development discharging from Project WAD-03, extending the pipeline from Washington Dam Road to the Virgin River.

Location	WAD-J150	**Model 100-3 Storm**	199.3	cfs
Route	WAD-R140	**Pipeline Capacity**	137.4	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	21,000	2.00	42,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.14	Earthwork	Dewatering	Ln Ft	2,100	20.00	42,000
3.36	Storm Drain Pipe	36" Smoothwall HDPE	Ln Ft	2,100	90.00	189,000
4.36	Pipe End Section	36" Smoothwall HDPE	Each	1	800.00	800
5.36	Concrete Catch Basin	36" Double Curb Inlet	Each	7	8,500.00	59,500
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	525	25.00	13,125
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	21,000	9.00	189,000
7.40	Road Reconstruction	Traffic Control	Lump	1	18,900.00	18,900
9.10	Basin/Pipeline	Outlet Structure	Lump	1	30,000.00	30,000
		Mobilization		*5%*		*29,366*
		Construction Contingency		*20%*		*117,465*
		Design and Construction Engineering		*10%*		*58,733*
		Project Management		*10%*		*58,733*
		Total Project Cost				***851,621***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAD-09

Description Install 24" HDPE 1,200 feet to convey storm water from future development, and discharging from Project WAD-04, between Washington Dam Road and the Virgin River.

Location	WAD-J160	**Model 100-3 Storm**	43.9	cfs
Route	WAD-R150	**Pipeline Capacity**	46.9	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	12,000	2.00	24,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.14	Earthwork	Dewatering	Ln Ft	1,200	20.00	24,000
3.24	Storm Drain Pipe	24" Smoothwall HDPE	Ln Ft	1,200	40.00	48,000
4.24	Pipe End Section	24" Smoothwall HDPE	Each	1	400.00	400
5.24	Concrete Catch Basin	24" Double Curb Inlet	Each	4	3,500.00	14,000
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	300	25.00	7,500
9.10	Basin/Pipeline	Outlet Structure	Lump	1	30,000.00	30,000
		Mobilization		*5%*		*7,545*
		Construction Contingency		*20%*		*30,180*
		Design and Construction Engineering		*10%*		*15,090*
		Project Management		*10%*		*15,090*
		Total Project Cost				***218,805***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAF-01

Description Install 36" HDPE 4,100 feet to convey storm water from future area development to 240 West Street, then north to approximately 2200 South Street (St. George street address).

Location	WAF-R110	**Model 100-3 Storm**	60.7	cfs
Route	WAF-R110	**Pipeline Capacity**	82.5	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	41,000	2.00	82,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.14	Earthwork	Dewatering	Ln Ft	4,100	20.00	82,000
3.36	Storm Drain Pipe	36" Smoothwall HDPE	Ln Ft	4,100	90.00	369,000
4.36	Pipe End Section	36" Smoothwall HDPE	Each	2	800.00	1,600
5.36	Concrete Catch Basin	36" Double Curb Inlet	Each	14	8,500.00	119,000
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	1,025	25.00	25,625
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	41,000	9.00	369,000
7.40	Road Reconstruction	Traffic Control	Lump	1	36,900.00	36,900
		Mobilization		*5%*		*54,406*
		Construction Contingency		*20%*		*217,625*
		Design and Construction Engineering		*10%*		*108,813*
		Project Management		*10%*		*108,813*
		Total Project Cost				***1,577,781***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAF-02

Description Install 42" HDPE 1,300 feet along 240 West to convey storm water from future development south of 4200 South Street.

Location	WAF-R130	**Model 100-3 Storm**	76.3	cfs
Route	WAF-R130	**Pipeline Capacity**	92.7	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	13,000	2.00	26,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.14	Earthwork	Dewatering	Ln Ft	1,300	20.00	26,000
3.42	Storm Drain Pipe	42" Smoothwall HDPE	Ln Ft	1,300	130.00	169,000
4.42	Pipe End Section	42" Smoothwall HDPE	Each	2	1,200.00	2,400
5.42	Concrete Catch Basin	42" Double Curb Inlet	Each	4	8,500.00	34,000
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	325	25.00	8,125
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	13,000	9.00	117,000
7.40	Road Reconstruction	Traffic Control	Lump	1	11,700.00	11,700
		Mobilization		*5%*		*19,861*
		Construction Contingency		*20%*		*79,445*
		Design and Construction Engineering		*10%*		*39,723*
		Project Management		*10%*		*39,723*
		Total Project Cost				***575,976***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAF-03

Description Install 42" HDPE 1,300 feet along 240 West Street to convey storm water from future development between 4200 South Street and 3930 South Street.

Location	WAF-R150	**Model 100-3 Storm**	89.7	cfs
Route	WAF-R150	**Pipeline Capacity**	106.5	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	13,000	2.00	26,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.14	Earthwork	Dewatering	Ln Ft	1,300	20.00	26,000
3.42	Storm Drain Pipe	42" Smoothwall HDPE	Ln Ft	1,300	130.00	169,000
4.42	Pipe End Section	42" Smoothwall HDPE	Each	2	1,200.00	2,400
5.42	Concrete Catch Basin	42" Double Curb Inlet	Each	4	8,500.00	34,000
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	325	25.00	8,125
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	13,000	9.00	117,000
7.40	Road Reconstruction	Traffic Control	Lump	1	11,700.00	11,700
		Mobilization		*5%*		*19,861*
		Construction Contingency		*20%*		*79,445*
		Design and Construction Engineering		*10%*		*39,723*
		Project Management		*10%*		*39,723*
		Total Project Cost				***575,976***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAF-04

Description Install 30" HDPE 5,300 feet to convey storm water from future area development routing along Washington Fields Road and 3650 South Street.

Location	WAF-R200	**Model 100-3 Storm**	30.3	cfs
Route	WAF-R200	**Pipeline Capacity**	63.2	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	53,000	2.00	106,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.22	3,000.00	3,650
2.14	Earthwork	Dewatering	Ln Ft	5,300	20.00	106,000
3.30	Storm Drain Pipe	30" Smoothwall HDPE	Ln Ft	5,300	50.00	265,000
4.30	Pipe End Section	30" Smoothwall HDPE	Each	2	800.00	1,600
5.30	Concrete Catch Basin	30" Double Curb Inlet	Each	18	3,500.00	63,000
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	1,325	25.00	33,125
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	53,000	9.00	477,000
7.20	Road Reconstruction	Restore Curb and Gutter	Ln Ft	530	30.00	15,900
7.30	Road Reconstruction	Restore Concrete Sidewalk	Sq Ft	530	12.00	6,360
7.40	Road Reconstruction	Traffic Control	Lump	1	47,700.00	47,700
		Mobilization		*5%*		*56,267*
		Construction Contingency		*20%*		*225,067*
		Design and Construction Engineering		*10%*		*112,534*
		Project Management		*10%*		*112,534*
		Total Project Cost				***1,631,736***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAF-05

Description Install 30" HDPE 1,400 feet along 3650 South Street to convey storm water from future area development from 20 East Street to 240 West Street.

Location	WAF-R210	**Model 100-3 Storm**	36.3	cfs
Route	WAF-R210	**Pipeline Capacity**	63.2	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	14,000	2.00	28,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.14	Earthwork	Dewatering	Ln Ft	1,400	20.00	28,000
3.30	Storm Drain Pipe	30" Smoothwall HDPE	Ln Ft	1,400	50.00	70,000
4.30	Pipe End Section	30" Smoothwall HDPE	Each	2	800.00	1,600
5.30	Concrete Catch Basin	30" Double Curb Inlet	Each	5	3,500.00	17,500
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	350	25.00	8,750
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	14,000	9.00	126,000
7.20	Road Reconstruction	Restore Curb and Gutter	Ln Ft	28	30.00	840
7.30	Road Reconstruction	Restore Concrete Sidewalk	Sq Ft	28	12.00	336
7.40	Road Reconstruction	Traffic Control	Lump	1	12,600.00	12,600
		Mobilization		*5%*		*14,831*
		Construction Contingency		*20%*		*59,325*
		Design and Construction Engineering		*10%*		*29,663*
		Project Management		*10%*		*29,663*
		Total Project Cost				***430,108***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAF-06

Description Install 24" HDPE 2,900 feet along Washington Fields Road and 3090 South Street to convey storm water from future area development, plus development from detention pond discharge, Project WAF-10.

Location	WAF-R240	**Model 100-3 Storm**	23.0	cfs
Route	WAF-R240	**Pipeline Capacity**	30.2	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	29,000	2.00	58,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.14	Earthwork	Dewatering	Ln Ft	2,900	20.00	58,000
3.24	Storm Drain Pipe	24" Smoothwall HDPE	Ln Ft	2,900	40.00	116,000
4.24	Pipe End Section	24" Smoothwall HDPE	Each	2	400.00	800
5.24	Concrete Catch Basin	24" Double Curb Inlet	Each	10	3,500.00	35,000
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	725	25.00	18,125
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	29,000	9.00	261,000
7.40	Road Reconstruction	Traffic Control	Lump	1	26,100.00	26,100
		Mobilization		*5%*		*28,801*
		Construction Contingency		*20%*		*115,205*
		Design and Construction Engineering		*10%*		*57,603*
		Project Management		*10%*		*57,603*
		Total Project Cost				***835,236***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAF-07

Description Install 24" HDPE 2,700 feet to convey storm water from future development draining to 2760 South Street, extending from Washington Fields Road to 20 East Street.

Location	WAF-R290	**Model 100-3 Storm**	17.7	cfs
Route	WAF-R290	**Pipeline Capacity**	28.0	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	27,000	2.00	54,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.14	Earthwork	Dewatering	Ln Ft	2,700	20.00	54,000
3.24	Storm Drain Pipe	24" Smoothwall HDPE	Ln Ft	2,700	40.00	108,000
4.24	Pipe End Section	24" Smoothwall HDPE	Each	2	400.00	800
5.24	Concrete Catch Basin	24" Double Curb Inlet	Each	9	3,500.00	31,500
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	675	25.00	16,875
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	1,350	9.00	12,150
7.40	Road Reconstruction	Traffic Control	Lump	1	2,000.00	2,000
		Mobilization		*5%*		*14,116*
		Construction Contingency		*20%*		*56,465*
		Design and Construction Engineering		*10%*		*28,233*
		Project Management		*10%*		*28,233*
		Total Project Cost				***409,371***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAF-08

Description Install 30" HDPE 2,100 feet to convey storm water from future area development along 20 East Street from 2760 South Street to Merrill Road, then west to 240 West Street.

Location	WAF-R310	**Model 100-3 Storm**	30.2	cfs
Route	WAF-R310	**Pipeline Capacity**	29.3	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	21,000	2.00	42,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.14	Earthwork	Dewatering	Ln Ft	2,100	20.00	42,000
3.30	Storm Drain Pipe	30" Smoothwall HDPE	Ln Ft	2,100	50.00	105,000
4.30	Pipe End Section	30" Smoothwall HDPE	Each	2	800.00	1,600
5.30	Concrete Catch Basin	30" Double Curb Inlet	Each	7	3,500.00	24,500
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	525	25.00	13,125
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	21,000	9.00	189,000
7.20	Road Reconstruction	Restore Curb and Gutter	Ln Ft	1,050	30.00	31,500
7.30	Road Reconstruction	Restore Concrete Sidewalk	Sq Ft	525	12.00	6,300
7.40	Road Reconstruction	Traffic Control	Lump	1	18,900.00	18,900
		Mobilization		*5%*		*23,846*
		Construction Contingency		*20%*		*95,385*
		Design and Construction Engineering		*10%*		*47,693*
		Project Management		*10%*		*47,693*
		Total Project Cost				***691,541***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAF-09

Description Install 36" HDPE 2,700 feet in two segments from future area development located east of 20 East Street; with 1,400 feet east of River Willow Lane from 240 West Street to 20 East Street; and 1,300 feet on north side of Riverside Elementary School.

Location	WAF-J260	**Model 100-3 Storm**	37.7	cfs
Route	WAF-R340	**Pipeline Capacity**	47.6	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	27,000	2.00	54,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.14	Earthwork	Dewatering	Ln Ft	2,700	20.00	54,000
3.36	Storm Drain Pipe	36" Smoothwall HDPE	Ln Ft	2,700	90.00	243,000
4.36	Pipe End Section	36" Smoothwall HDPE	Each	2	800.00	1,600
5.36	Concrete Catch Basin	36" Double Curb Inlet	Each	9	8,500.00	76,500
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	675	25.00	16,875
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	2,700	9.00	24,300
7.40	Road Reconstruction	Traffic Control	Lump	1	2,400.00	2,400
		Mobilization		*5%*		*23,784*
		Construction Contingency		*20%*		*95,135*
		Design and Construction Engineering		*10%*		*47,568*
		Project Management		*10%*		*47,568*
		Total Project Cost				***689,729***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAF-10

Description Construct 6.2 acre-foot detention basin to accommodate storm water from future area development located east of Camino Real Road.

Location WAF-P110

Model 100-24 Q_{in} 81.20 cfs
Model 100-24 Q_{out} 23.00 cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.12	Land Acquisition for Project and Access		Acre	4.53	50,000.00	226,322
2.05	Earthwork	SWPPP/Construction BMPs	Acre	4.53	3,000.00	13,579
2.10	Earthwork	Excavation and Fill	Cu Yd	5,407	30.00	162,199
2.20	Earthwork	Dust Control	Acre	5	2,000.00	9,053
3.48	Storm Drain Pipe	48" Smoothwall HDPE	Ln Ft	80	160.00	12,800
8.20	Bank Lining	2' Thick Riprap	Cu Yd	160	100.00	16,000
9.10	Basin/Pipeline	Outlet Structure	Lump	1	30,000.00	30,000
10.10	Access Road	Road Base	Cu Yd	645	45.00	29,043
11.10	Right-of-Way Fence	6' High	Ln Ft	9	40.00	340
11.20	Right-of-Way Fence	12' Gated Opening	Each	1	2,500.00	2,500
		Mobilization		*5%*		*13,097*
		Construction Contingency		*20%*		*52,387*
		Design and Construction Engineering		*10%*		*26,194*
		Project Management		*10%*		*26,194*
		Total Project Cost				***619,708***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAF-11

Description Install18" HDPE pipe 2,900 feet to pick up discharge for development east of Camino Real including new development since 2005 and future development to the east, and connect to new pipe at Washington Fields Road.

Location	WAF-P120	**Model 100-3 Storm**	5.0	cfs
Route	N/A	**Pipeline Capacity**	9.7	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	29,000	2.00	58,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.14	Earthwork	Dewatering	Ln Ft	2,900	20.00	58,000
3.18	Storm Drain Pipe	18" Smoothwall HDPE	Ln Ft	2,900	35.00	101,500
4.18	Pipe End Section	18" Smoothwall HDPE	Each	2	400.00	800
5.18	Concrete Catch Basin	18" Double Curb Inlet	Each	10	3,500.00	35,000
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	725	25.00	18,125
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	29,000	9.00	261,000
7.20	Road Reconstruction	Restore Curb and Gutter	Ln Ft	1,450	30.00	43,500
7.30	Road Reconstruction	Restore Concrete Sidewalk	Sq Ft	725	12.00	8,700
7.40	Road Reconstruction	Traffic Control	Lump	1	26,100.00	26,100
		Mobilization		*5%*		*30,686*
		Construction Contingency		*20%*		*122,745*
		Design and Construction Engineering		*10%*		*61,373*
		Project Management		*10%*		*61,373*
		Total Project Cost				***889,901***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WAF-12

Description Replenish the user fee fund for installation of 54-inch and 60-inch pipe installed along 240 West Street between 3650 South Street and Merrill Road, and along Merrill Road between 240 West Street and Harvest Lane.

Total Project Cost	***1,542,000***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT ARP-01

Description Install 36" HDPE 3,200 feet to convey storm water northward along Washington Fields Road to the north end of the Airport drainage basin.

Location	ARP-B140	**Model 100-3 Storm**	66.8	cfs
Route	ARP-B140	**Pipeline Capacity**	86.9	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	41,000	2.00	82,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.14	Earthwork	Dewatering	Ln Ft	0	20.00	0
3.18	Storm Drain Pipe	18" Smoothwall HDPE	Ln Ft	4,100	35.00	143,500
4.18	Pipe End Section	18" Smoothwall HDPE	Each	2	400.00	800
5.18	Concrete Catch Basin	18" Double Curb Inlet	Each	14	3,500.00	49,000
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	410	25.00	10,250
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	4,100	9.00	36,900
7.20	Road Reconstruction	Restore Curb and Gutter	Ln Ft	0	30.00	0
7.30	Road Reconstruction	Restore Concrete Sidewalk	Sq Ft	0	12.00	0
7.40	Road Reconstruction	Traffic Control	Lump	1	3,700.00	3,700
		Mobilization		*5%*		*16,458*
		Construction Contingency		*20%*		*65,830*
		Design and Construction Engineering		*10%*		*32,915*
		Project Management		*10%*		*32,915*
		Total Project Cost				***477,268***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT ARP-02

Description Construct detention basin(s) totaling a minimum of 18.9 acre-feet, as part of the total 23.8 acre-foot detention needed (see ARP-P110) for the Stucki Springs MP Community, limiting total peak discharge out of the Airport drainage basin to a maximum of 39.0 cfs.

Location ARP-J120

Model 100-24 Q_{in} see ARP-P110 for total

Model 100-24 Q_{out} see ARP-P110 for total

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.12	Land Acquisition for Project and Access		Acre	9.21	50,000.00	460,610
2.05	Earthwork	SWPPP/Construction BMPs	Acre	9.21	3,000.00	27,637
2.10	Earthwork	Excavation and Fill	Cu Yd	8,438	30.00	253,125
2.20	Earthwork	Dust Control	Acre	9	2,000.00	18,424
3.48	Storm Drain Pipe	48" Smoothwall HDPE	Ln Ft	80	160.00	12,800
8.20	Bank Lining	2' Thick Riprap	Cu Yd	160	100.00	16,000
9.10	Basin/Pipeline	Outlet Structure	Lump	1	30,000.00	30,000
10.10	Access Road	Road Base	Cu Yd	982	45.00	44,198
11.10	Right-of-Way Fence	6' High	Ln Ft	12	40.00	486
11.20	Right-of-Way Fence	12' Gated Opening	Each	1	2,500.00	2,500
		Mobilization		*5%*		*18,877*
		Construction Contingency		*20%*		*75,507*
		Design and Construction Engineering		*10%*		*37,753*
		Project Management		*10%*		*37,753*
		Total Project Cost				***1,035,669***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT ARP-03

Description Construct detention basin(s) totaling a minimum of 4.9 acre-feet, as part of the total 23.8 acre-foot detention needed (see ARP-J120) for the Stucki Springs MP Community, limiting total peak discharge out of the Airport drainage basin to a maximum of 39.0 cfs.

Location ARP-P110

Model 100-24 Q_{in} 182.30 cfs (total)

Model 100-24 Q_{out} 39.00 cfs (total)

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.12	Land Acquisition for Project and Access		Acre	5.06	50,000.00	253,095
2.05	Earthwork	SWPPP/Construction BMPs	Acre	5.06	3,000.00	15,186
2.10	Earthwork	Excavation and Fill	Cu Yd	5,815	30.00	174,454
2.20	Earthwork	Dust Control	Acre	5	2,000.00	10,124
3.48	Storm Drain Pipe	48" Smoothwall HDPE	Ln Ft	80	160.00	12,800
8.20	Bank Lining	2' Thick Riprap	Cu Yd	160	100.00	16,000
9.10	Basin/Pipeline	Outlet Structure	Lump	1	30,000.00	30,000
10.10	Access Road	Road Base	Cu Yd	691	45.00	31,086
11.10	Right-of-Way Fence	6' High	Ln Ft	9	40.00	360
11.20	Right-of-Way Fence	12' Gated Opening	Each	1	2,500.00	2,500
		Mobilization		*5%*		*13,866*
		Construction Contingency		*20%*		*55,465*
		Design and Construction Engineering		*10%*		*27,732*
		Project Management		*10%*		*27,732*
		Total Project Cost				***670,399***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT ARP-04

Description Modify the regional debris basin outlet structures and pipeline system to accommodate future additional storm water storage and discharge. Existing detention outlet of 39.0 cfs is to be discharged into the debris basin outlet pipeline extending 36" HDPE up to 1,000 feet, depending on the route taken and connections needed. Work may also include possible modifications to the NRCS debris basin outlet structures.

Location	ARP-P110	**Model 100-3 Storm**	39.0	cfs
Route	None	**Pipeline Capacity**	61.5	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	8,000	2.00	16,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.14	Earthwork	Dewatering	Ln Ft	400	20.00	8,000
3.36	Storm Drain Pipe	36" Smoothwall HDPE	Ln Ft	800	90.00	72,000
4.36	Pipe End Section	36" Smoothwall HDPE	Each	2	800.00	1,600
5.36	Concrete Catch Basin	36" Double Curb Inlet	Each	3	8,500.00	25,500
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	200	25.00	5,000
9.10	Basin/Pipeline	Outlet Structure	Lump	4	30,000.00	120,000
		Mobilization		*5%*		*12,555*
		Construction Contingency		*20%*		*50,220*
		Feasibility Study		*Lump*		*55,000*
		Design and Construction Engineering		*10%*		*25,110*
		Project Management		*10%*		*25,110*
		Total Project Cost				***419,095***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT MLC-05

Description Install 3,200 feet 18" HDPE pipe to convey storm water from future development anticipated east of Bluegrass Street and north of Telegraph Street.

Location	MLC-B155	**Model 100-3 Storm**	13.5	cfs
Route	MLC-B155	**Pipeline Capacity**	21.0	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	32,000	2.00	64,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
3.18	Storm Drain Pipe	18" Smoothwall HDPE	Ln Ft	3,200	35.00	112,000
4.18	Pipe End Section	18" Smoothwall HDPE	Each	2	400.00	800
5.18	Concrete Catch Basin	18" Double Curb Inlet	Each	11	3,500.00	38,500
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	640	25.00	16,000
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	640	9.00	5,760
7.20	Road Reconstruction	Restore Curb and Gutter	Ln Ft	32	30.00	960
7.30	Road Reconstruction	Restore Concrete Sidewalk	Sq Ft	32	12.00	384
7.40	Road Reconstruction	Traffic Control	Lump	1	2,000.00	2,000
		Mobilization		*5%*		*12,170*
		Construction Contingency		*20%*		*48,681*
		Design and Construction Engineering		*10%*		*24,340*
		Project Management		*10%*		*24,340*
		Total Project Cost				***352,936***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT MLC-06

Description Replace cut ditch with 36" HDPE 2,040 feet to convey storm water from future area development to the south, and to the east between Bella Vista Drive and Wildflower Drive, south of Telegraph Street.

Location	MLC-B160	**Model 100-3 Storm**	107.3	cfs
Route	MLC-B160	**Pipeline Capacity**	128.3	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	20,400	2.00	40,800
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.14	Earthwork	Dewatering	Ln Ft	2,040	20.00	40,800
3.36	Storm Drain Pipe	36" Smoothwall HDPE	Ln Ft	2,040	90.00	183,600
4.36	Pipe End Section	36" Smoothwall HDPE	Each	2	800.00	1,600
5.36	Concrete Catch Basin	36" Double Curb Inlet	Each	7	8,500.00	59,500
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	61	25.00	1,530
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	612	9.00	5,508
7.40	Road Reconstruction	Traffic Control	Lump	1	2,000.00	2,000
		Mobilization		*5%*		*16,917*
		Construction Contingency		*20%*		*67,668*
		Design and Construction Engineering		*10%*		*33,834*
		Project Management		*10%*		*33,834*
		Total Project Cost				***490,590***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT MLC-08

Description Replace open channel with 42" HDPE 900 feet to convey future development storm water routing from Project MLC-06, running behind Sequoyah Drive and tying into 300 East (Washington Fields Road).

Location	MLC-J130	**Model 100-3 Storm**	181.8	cfs
Route	MLC-R130	**Pipeline Capacity**	199.7	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	9,000	2.00	18,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.14	Earthwork	Dewatering	Ln Ft	900	20.00	18,000
3.42	Storm Drain Pipe	42" Smoothwall HDPE	Ln Ft	900	130.00	117,000
4.42	Pipe End Section	42" Smoothwall HDPE	Each	2	1,200.00	2,400
5.42	Concrete Catch Basin	42" Double Curb Inlet	Each	3	8,500.00	25,500
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	225	25.00	5,625
		Mobilization		*5%*		*9,476*
		Construction Contingency		*20%*		*37,905*
		Design and Construction Engineering		*10%*		*18,953*
		Project Management		*10%*		*18,953*
		Total Project Cost				***274,811***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT GRW-01

Description Construct channel improvements with access road to convey storm water from future development, maintaining minimum 60' right-of-way width for 1,500 feet of existing wash.

Location	GRW-B110	**Model 100-24 Storm**	497.3	cfs
Route	GRW-B110	**Channel Capacity**	517.7	cfs

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
1.10	Channel and Access Road Improvements	Acre	2.07	50,000.00	103,306
	Survey and Legal Document Prep		*5%*		*5,165*
	Project Management		*10%*		*10,331*
	Total Project Cost				***118,802***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT GRE-01

Description Construct channel improvements with access road to convey storm water from future development, maintaining minimum 50' ROW width for 2,700 feet of existing wash.

Location	GRE-B120	**Model 100-24 Storm**	76.5 cfs
Route	GRE-B120	**Channel Capacity**	92.1 cfs

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
1.10	Channel and Access Road Improvements	Acre	3.10	50,000.00	154,959
	Survey and Legal Document Prep		*5%*		*7,748*
	Project Management		*10%*		*15,496*
	Total Project Cost				***178,202***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT GRE-02

Description Construct channel improvements with access road to convey storm water from future development, maintaining minimum 50' ROW width for 2,100 feet of existing wash.

Location	GRE-R110	**Model 100-24 Storm**	7.2	cfs
Route	GRE-R110	**Channel Capacity**	45.4	cfs

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
1.10	Channel and Access Road Improvements	Acre	2.41	50,000.00	120,523
	Survey and Legal Document Prep		*5%*		*6,026*
	Project Management		*10%*		*12,052*
	Total Project Cost				***138,602***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT GRE-03

Description Construct channel improvements with access road to convey storm water from future development, maintaining minimum 50' ROW width for 3,000 feet of existing wash.

Location	GRE-R120	**Model 100-24 Storm**	104.8 cfs
Route	GRE-R120	**Channel Capacity**	121.2 cfs

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
1.10	Channel and Access Road Improvements	Acre	3.44	50,000.00	172,176
	Survey and Legal Document Prep		*5%*		*8,609*
	Project Management		*10%*		*17,218*
	Total Project Cost				***198,003***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT GRE-04

Description Install 42" HDPE 1,000 feet along North Main Street to convey storm water from future development in areas to the north and west, picking up flows from Project GRE-03, extending line from Buena Vista Boulevard to Arrowweed Way.

Location	GRE-R130	**Model 100-3 Storm**	88.4	cfs
Route	GRE-R130	**Pipeline Capacity**	92.7	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	10,000	2.00	20,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.12	Earthwork	Rock Excavation	Cu Yd	93	70.00	6,481
3.42	Storm Drain Pipe	42" Smoothwall HDPE	Ln Ft	1,000	130.00	130,000
4.42	Pipe End Section	42" Smoothwall HDPE	Each	2	1,200.00	2,400
5.42	Concrete Catch Basin	42" Double Curb Inlet	Each	3	8,500.00	25,500
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	250	25.00	6,250
		Mobilization		*5%*		*9,682*
		Construction Contingency		*20%*		*38,726*
		Design and Construction Engineering		*10%*		*19,363*
		Project Management		*10%*		*19,363*
		Total Project Cost				***280,766***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT GRE-05

Description Install 24" HDPE for 1,400 ft along Buena Vista Boulevard east of Main Street to Graham Manor.

Location	GRE-R140	**Model 100-3 Storm**	44.2 cfs
Route	GRE-R140	**Pipeline Capacity**	54.4 cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	8,400	2.00	16,800
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.12	Earthwork	Rock Excavation	Cu Yd	78	70.00	5,444
3.24	Storm Drain Pipe	24" Smoothwall HDPE	Ln Ft	1,400	40.00	56,000
4.24	Pipe End Section	24" Smoothwall HDPE	Each	2	400.00	800
5.24	Concrete Catch Basin	24" Double Curb Inlet	Each	5	3,500.00	17,500
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	350	25.00	8,750
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	2,520	9.00	22,680
7.20	Road Reconstruction	Restore Curb and Gutter	Ln Ft	140	30.00	4,200
7.30	Road Reconstruction	Restore Concrete Sidewalk	Sq Ft	140	12.00	1,680
7.40	Road Reconstruction	Traffic Control	Lump	1	2,300.00	2,300
		Mobilization		*5%*		*6,958*
		Construction Contingency		*20%*		*27,831*
		Design and Construction Engineering		*10%*		*13,915*
		Project Management		*10%*		*13,915*
		Total Project Cost				***201,774***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT GRE-06

Description Add 500 ft of 60" HDPE pipe, and construct outlet structure discharging to open channel along UDOT right-of-way, between the Boilers and Millcreek.

Location	GRE-J130	**Model 100-3 Storm**	195.6	cfs
Route	GRE-R150	**Pipeline Capacity**	480.0	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST - PIPELINE

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	5,000	2.00	10,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.12	Earthwork	Rock Excavation	Cu Yd	46	70.00	3,241
2.14	Earthwork	Dewatering	Ln Ft	500	20.00	10,000
3.60	Storm Drain Pipe	60" Smoothwall HDPE	Ln Ft	500	220.00	110,000
4.60	Pipe End Section	60" Smoothwall HDPE	Each	1	2,400.00	2,400
5.60	Concrete Catch Basin	60" Double Curb Inlet	Each	2	12,000.00	24,000
9.10	Basin/Pipeline	Outlet Structure	Lump	1	30,000.00	30,000
		Mobilization		*5%*		*9,632*
		Construction Contingency		*20%*		*38,528*
		Design and Construction Engineering		*10%*		*19,264*
		Project Management		*10%*		*19,264*
		Total Project Cost				***279,329***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT GRP-01

Description Install 36" HDPE 1,120 feet to convey storm water from future area development, routing between I-15 and Bluff View Drive.

Location	GRP-R110	**Model 100-3 Storm**	112.7	cfs
Route	GRP-R110	**Pipeline Capacity**	121.7	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	11,200	2.00	22,400
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.14	Earthwork	Dewatering	Ln Ft	1,120	20.00	22,400
3.36	Storm Drain Pipe	36" Smoothwall HDPE	Ln Ft	1,120	90.00	100,800
4.36	Pipe End Section	36" Smoothwall HDPE	Each	2	800.00	1,600
5.36	Concrete Catch Basin	36" Double Curb Inlet	Each	4	8,500.00	34,000
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	280	25.00	7,000
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	2,800	9.00	25,200
7.20	Road Reconstruction	Restore Curb and Gutter	Ln Ft	56	30.00	1,680
7.30	Road Reconstruction	Restore Concrete Sidewalk	Sq Ft	56	12.00	672
7.40	Road Reconstruction	Traffic Control	Lump	1	2,500.00	2,500
		Mobilization		*5%*		*11,063*
		Construction Contingency		*20%*		*44,250*
		Design and Construction Engineering		*10%*		*22,125*
		Project Management		*10%*		*22,125*
		Total Project Cost				***320,815***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT GRP-02

Description Install 48" HDPE 2,200 feet to convey storm water from future area development, routing from 1100 East southward discharging into open channel at East Pine Valley Street.

Location	GRP-R120	**Model 100-3 Storm**	174.8	cfs
Route	GRP-R120	**Pipeline Capacity**	229.3	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	22,000	2.00	44,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.12	Earthwork	Rock Excavation	Cu Yd	204	70.00	14,259
2.14	Earthwork	Dewatering	Ln Ft	2,200	20.00	44,000
3.48	Storm Drain Pipe	48" Smoothwall HDPE	Ln Ft	2,200	160.00	352,000
4.48	Pipe End Section	48" Smoothwall HDPE	Each	2	1,600.00	3,200
5.48	Concrete Catch Basin	48" Double Curb Inlet	Each	7	12,000.00	84,000
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	550	25.00	13,750
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	1,100	9.00	9,900
7.20	Road Reconstruction	Restore Curb and Gutter	Ln Ft	110	30.00	3,300
7.30	Road Reconstruction	Restore Concrete Sidewalk	Sq Ft	110	12.00	1,320
7.40	Road Reconstruction	Traffic Control	Lump	1	2,000.00	2,000
		Mobilization		*5%*		*28,736*
		Construction Contingency		*20%*		*114,946*
		Design and Construction Engineering		*10%*		*57,473*
		Project Management		*10%*		*57,473*
		Total Project Cost				***833,357***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT HRS-01

Description Drainage channel improvements with access road maintaining minimum 60' ROW width for 8,900 ft of existing wash.

Location	HRS-B120	**Model 100-24 Storm**	132.5	cfs
Route	HRS-B120	**Channel Capacity**	175.1	cfs

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
1.10	Channel and Access Road Improvements	Acre	12.26	50,000.00	612,948
	Survey and Legal Document Prep		*5%*		*30,647*
	Project Management		*10%*		*61,295*
	Total Project Cost				***704,890***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT HRS-02

Description Drainage channel improvements with access road maintaining minimum 60' ROW width for 7,600 ft of existing wash.

Location	HRS-B140	**Model 100-24 Storm**	174.7	cfs
Route	HRS-B140	**Channel Capacity**	175.1	cfs

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
1.10	Channel and Access Road Improvements	Acre	10.47	50,000.00	523,416
	Survey and Legal Document Prep		*5%*		*26,171*
	Project Management		*10%*		*52,342*
	Total Project Cost				***601,928***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT HRS-03

Description Drainage channel improvements with access road maintaining minimum 60' ROW width for 7,200 ft of existing wash.

Location	HRS-J110	**Model 100-24 Storm**	234.7	cfs
Route	HRS-R110	**Channel Capacity**	242.1	cfs

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
1.10	Channel and Access Road Improvements	Acre	9.92	50,000.00	495,868
	Survey and Legal Document Prep		*5%*		*24,793*
	Project Management		*10%*		*49,587*
	Total Project Cost				***570,248***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT HRS-04

Description Drainage channel improvements with access road maintaining minimum 70' ROW width for 7,300 ft of existing wash.

Location	HRS-J120	**Model 100-24 Storm**	356.3	cfs
Route	HRS-R120	**Channel Capacity**	362.6	cfs

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
1.10	Channel and Access Road Improvements	Acre	10.06	50,000.00	502,755
	Survey and Legal Document Prep		*5%*		*25,138*
	Project Management		*10%*		*50,275*
	Total Project Cost				***578,168***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT GYP-01

Description Install 42" HDPE 4,200 ft along the wash or future roadway, extending to the NRCS Gypsum Wash Debris Basin.

Location	GYP-B110	**Model 100-3 Storm**	166.6	cfs
Route	GYP-B110	**Pipeline Capacity**	245.3	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	42,000	2.00	84,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.12	Earthwork	Rock Excavation	Cu Yd	389	70.00	27,222
3.42	Storm Drain Pipe	42" Smoothwall HDPE	Ln Ft	4,200	130.00	546,000
4.42	Pipe End Section	42" Smoothwall HDPE	Each	2	1,200.00	2,400
5.42	Concrete Catch Basin	42" Double Curb Inlet	Each	14	8,500.00	119,000
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	1,050	25.00	26,250
		Mobilization		*5%*		*40,394*
		Construction Contingency		*20%*		*161,574*
		Design and Construction Engineering		*10%*		*80,787*
		Project Management		*10%*		*80,787*
		Total Project Cost				***1,171,415***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT STU-01

Description Drainage channel improvements with access road maintaining minimum 50' ROW width for 3,700 ft of existing wash.

Location	STU-B110	**Model 100-24 Storm**	62.2	cfs
Route	STU-B110	**Channel Capacity**	63.2	cfs

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
1.10	Channel and Access Road Improvements	Acre	4.25	50,000.00	212,351
	Survey and Legal Document Prep		*5%*		*10,618*
	Project Management		*10%*		*21,235*
	Total Project Cost				***244,203***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT STU-02

Description Drainage channel improvements with access road maintaining minimum 60' ROW width for 2,200 ft of existing wash.

Location	STU-P110	**Model 100-24 Storm**	132	cfs
Route	STU-R110	**Channel Capacity**	133.6	cfs

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
1.10	Channel and Access Road Improvements	Acre	2.53	50,000.00	126,263
	Survey and Legal Document Prep		*5%*		*6,313*
	Project Management		*10%*		*12,626*
	Total Project Cost				***145,202***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WRN-01

Description Drainage channel improvements with access road maintaining minimum 50' ROW width for 7,800 ft of existing wash.

Location	WRN-B110	**Model 100-24 Storm**	172.5 cfs
Route	WRN-B110	**Channel Capacity**	172.3 cfs

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
1.10	Channel and Access Road Improvements	Acre	8.95	50,000.00	447,658
	Survey and Legal Document Prep		*5%*		*22,383*
	Project Management		*10%*		*44,766*
	Total Project Cost				***514,807***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WRS-01

Description Drainage channel improvements with access road maintaining minimum 50' ROW width for 4,600 ft of existing wash.

Location	WRS-B110	**Model 100-24 Storm**	123.6 cfs
Route	WRS-B110	**Channel Capacity**	171.5 cfs

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
1.10	Channel and Access Road Improvements	Acre	5.28	50,000.00	264,004
	Survey and Legal Document Prep		*5%*		*13,200*
	Project Management		*10%*		*26,400*
	Total Project Cost				***303,604***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WRS-02

Description Drainage channel improvements with access road maintaining minimum 50' ROW width for 7,600 ft of existing wash.

Location	WRS-B120	**Model 100-24 Storm**	58.4	cfs
Route	WRS-B120	**Channel Capacity**	76.3	cfs

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
1.10	Channel and Access Road Improvements	Acre	8.72	50,000.00	436,180
	Survey and Legal Document Prep		*5%*		*21,809*
	Project Management		*10%*		*43,618*
	Total Project Cost				***501,607***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WRS-03

Description Drainage channel improvements with access road maintaining minimum 50' ROW width for 2,700 ft of existing wash.

Location	WRS-B130	**Model 100-24 Storm**	40.2 cfs
Route	WRS-B130	**Channel Capacity**	43.0 cfs

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
1.10	Channel and Access Road Improvements	Acre	3.10	50,000.00	154,959
	Survey and Legal Document Prep		*5%*		*7,748*
	Project Management		*10%*		*15,496*
	Total Project Cost				***178,202***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WRS-04

Description Drainage channel improvements with access road maintaining minimum 50' ROW width for 2,300 ft of existing wash.

Location	WRS-B140	**Model 100-24 Storm**	94.9 cfs
Route	WRS-B140	**Channel Capacity**	106.8 cfs

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
1.10	Channel and Access Road Improvements	Acre	2.64	50,000.00	132,002
	Survey and Legal Document Prep		*5%*		*6,600*
	Project Management		*10%*		*13,200*
	Total Project Cost				***151,802***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WRS-05

Description Drainage channel improvements with access road maintaining minimum 50' ROW width for 8,400 ft of existing wash.

Location	WRS-B150	**Model 100-24 Storm**	74.7	cfs
Route	WRS-B150	**Channel Capacity**	94.7	cfs

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
1.10	Channel and Access Road Improvements	Acre	9.64	50,000.00	482,094
	Survey and Legal Document Prep		*5%*		*24,105*
	Project Management		*10%*		*48,209*
	Total Project Cost				***554,408***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WRS-06

Description Drainage channel improvements with access road maintaining minimum 60' ROW width for 5,600 ft of existing wash.

Location	WRS-B160	**Model 100-24 Storm**	192.9	cfs
Route	WRS-B160	**Channel Capacity**	214.4	cfs

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
1.10	Channel and Access Road Improvements	Acre	6.43	50,000.00	321,396
	Survey and Legal Document Prep		*5%*		*16,070*
	Project Management		*10%*		*32,140*
	Total Project Cost				***369,605***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WRS-07

Description Drainage channel improvements with access road maintaining minimum 70' ROW width for 2,500 ft of existing wash.

Location	WRS-J110	**Model 100-24 Storm**	214.3 cfs
Route	WRS-R120	**Channel Capacity**	161.6 cfs

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
1.10	Channel and Access Road Improvements	Acre	2.87	50,000.00	143,480
	Survey and Legal Document Prep		*5%*		*7,174*
	Project Management		*10%*		*14,348*
	Total Project Cost				***165,002***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT WRS-08

Description Drainage channel improvements with access road maintaining minimum 70' ROW width for 7,700 ft of existing wash.

Location	WRS-J120	**Model 100-24 Storm**	366.8	cfs
Route	WRS-R120	**Channel Capacity**	328.9	cfs

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
1.10	Channel and Access Road Improvements	Acre	8.84	50,000.00	441,919
	Survey and Legal Document Prep		*5%*		*22,096*
	Project Management		*10%*		*44,192*
	Total Project Cost				***508,207***

TABLE T-8: CFP CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT ALL-01

Description Perform future CFP update study and prepare report.

CONCEPTUAL OPINION OF COST

No.	Description	Units	Quantity	Unit Cost	Total
N/A	CFP Update Study and Report	Lump	1.00	55,000.00	55,000
	Project Management		*10%*		*5,500*
	Total Project Cost				***60,500***

TABLE T-9: 2014-2023 CFP COST SUMMARY

Area	Project	Cost	Total	Prorated[1]	Developable Acreage	Cost per Acre
Washington Dam Road	WAD - 01	$495,422	$4,196,388	$4,208,515	765	$5,501
	WAD - 02	$766,411				
	WAD - 03	$269,523				
	WAD - 04	$189,076				
	WAD - 06	$382,805				
	WAD - 07	$1,022,725				
	WAD - 08	$851,621				
	WAD - 09	$218,805				
Washington Fields	WAF - 01	$1,577,781	$10,469,064	$10,499,317	1,688	$6,220
	WAF - 02	$575,976				
	WAF - 03	$575,976				
	WAF - 04	$1,631,736				
	WAF - 05	$430,108				
	WAF - 06	$835,236				
	WAF - 07	$409,371				
	WAF - 08	$691,541				
	WAF - 09	$689,729				
	WAF - 10	$619,708				
	WAF - 11	$889,901				
	WAF - 12	$1,542,000				
Airport	ARP - 01	$477,268	$2,602,430	$2,609,951	558	$4,677
	ARP - 02	$1,035,669				
	ARP - 03	$670,399				
	ARP - 04	$419,095				
Millcreek Wash	MLC - 05	$352,936	$1,118,337	$1,121,569	306	$3,665
	MLC - 06	$490,590				
	MLC - 08	$274,811				
Green Springs West	GRW - 01	$118,802	$118,802	$119,145	229	$520
Green Springs East	GRE - 01	$178,202	$1,276,676	$1,280,365	636	$2,013
	GRE - 02	$138,602				
	GRE - 03	$198,003				
	GRE - 04	$280,766				
	GRE - 05	$201,774				
	GRE - 06	$279,329				
Grapevine Wash	GRP - 01	$320,815	$1,154,173	$1,157,508	282	$4,105
	GRP - 02	$833,357				
All Drainage Areas	ALL - 01	$60,500	$60,500	N/A[1]	N/A[1]	N/A[1]
Totals			**$20,996,369**	**$20,996,369**	**4,464**	**$4,703**

[1] *Total cost includes basin cost plus a $60,500 cost for a future CFP update (Project ALL-01), prorated to all drainage basins as a ratio of basin project cost.*

TABLE T-10: USER FEE CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT MLC-01

Description Add 1,400 ft of 24" HDPE pipe along 200 West Street from Telegraph to 200 North Street.

Location	MLC-B130	**Model 100-3 Storm**	24.1	cfs
Route	MLC-B130	**Pipeline Capacity**	55.0	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	14,000	2.00	28,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
3.24	Storm Drain Pipe	24" Smoothwall HDPE	Ln Ft	1,400	40.00	56,000
4.24	Pipe End Section	24" Smoothwall HDPE	Each	2	400.00	800
5.24	Concrete Catch Basin	24" Double Curb Inlet	Each	5	3,500.00	17,500
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	280	25.00	7,000
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	6,300	9.00	56,700
7.40	Road Reconstruction	Traffic Control	Lump	1	5,700.00	5,700
		Mobilization		*5%*		*8,735*
		Construction Contingency		*20%*		*34,940*
		Design and Construction Engineering		*10%*		*17,470*
		Total Project Cost				***235,845***

TABLE T-10: USER FEE CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT MLC-02

Description Add 2,100 ft of 24" HDPE pipe along North Main Street from Telegraph to 300 North Street.

Location	MLC-B135	**Model 100-3 Storm**	22.4	cfs
Route	MLC-B135	**Pipeline Capacity**	50.4	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	21,000	2.00	42,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
3.24	Storm Drain Pipe	24" Smoothwall HDPE	Ln Ft	2,100	40.00	84,000
4.24	Pipe End Section	24" Smoothwall HDPE	Each	2	400.00	800
5.24	Concrete Catch Basin	24" Double Curb Inlet	Each	7	3,500.00	24,500
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	420	25.00	10,500
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	9,450	9.00	85,050
7.20	Road Reconstruction	Restore Curb and Gutter	Ln Ft	105	30.00	3,150
7.30	Road Reconstruction	Restore Concrete Sidewalk	Sq Ft	105	12.00	1,260
7.40	Road Reconstruction	Traffic Control	Lump	1	8,500.00	8,500
		Mobilization		*5%*		*13,138*
		Construction Contingency		*20%*		*52,552*
		Design and Construction Engineering		*10%*		*26,276*
		Total Project Cost				***354,726***

TABLE T-10: USER FEE CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT MLC-03

Description Add 2,400 ft of 24" HDPE pipe along North 300 East Street from Telegraph to Bulloch Drive.

Location	MLC-B140	**Model 100-3 Storm**	31.7	cfs
Route	MLC-B140	**Pipeline Capacity**	46.6	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	24,000	2.00	48,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
3.24	Storm Drain Pipe	24" Smoothwall HDPE	Ln Ft	2,400	40.00	96,000
4.24	Pipe End Section	24" Smoothwall HDPE	Each	2	400.00	800
5.24	Concrete Catch Basin	24" Double Curb Inlet	Each	8	3,500.00	28,000
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	480	25.00	12,000
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	10,800	9.00	97,200
7.20	Road Reconstruction	Restore Curb and Gutter	Ln Ft	480	30.00	14,400
7.30	Road Reconstruction	Restore Concrete Sidewalk	Sq Ft	480	12.00	5,760
7.40	Road Reconstruction	Traffic Control	Lump	1	9,700.00	9,700
		Mobilization		*5%*		*15,743*
		Construction Contingency		*20%*		*62,972*
		Design and Construction Engineering		*10%*		*31,486*
		Total Project Cost				***425,061***

TABLE T-10: USER FEE CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT MLC-04

Description Add 2,400 ft of 30" HDPE pipe along Scenic Drive West from Telegraph to Scenic Drive North.

Location	MLC-B150	**Model 100-3 Storm**	67.7	cfs
Route	MLC-B150	**Pipeline Capacity**	91.5	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	24,000	2.00	48,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
3.30	Storm Drain Pipe	30" Smoothwall HDPE	Ln Ft	2,400	50.00	120,000
4.30	Pipe End Section	30" Smoothwall HDPE	Each	2	800.00	1,600
5.30	Concrete Catch Basin	30" Double Curb Inlet	Each	8	3,500.00	28,000
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	960	25.00	24,000
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	12,000	9.00	108,000
7.20	Road Reconstruction	Restore Curb and Gutter	Ln Ft	480	30.00	14,400
7.30	Road Reconstruction	Restore Concrete Sidewalk	Sq Ft	240	12.00	2,880
7.40	Road Reconstruction	Traffic Control	Lump	1	10,800.00	10,800
		Mobilization		*5%*		*18,034*
		Construction Contingency		*20%*		*72,136*
		Design and Construction Engineering		*10%*		*36,068*
		Total Project Cost				***486,918***

TABLE T-10: USER FEE CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT MLC-07

Description Install additional 24" HDPE 1,300 ft routing along Sequoyah Drive and tie into 300 East (Washington Fields Road).

Location	MLC-R130	**Model 100-3 Storm**	76.9	cfs
Route	MLC-R130	**Pipeline Capacity**	44.9	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	13,000	2.00	26,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.14	Earthwork	Dewatering	Ln Ft	260	20.00	5,200
3.24	Storm Drain Pipe	24" Smoothwall HDPE	Ln Ft	1,300	40.00	52,000
4.24	Pipe End Section	24" Smoothwall HDPE	Each	2	400.00	800
5.24	Concrete Catch Basin	24" Double Curb Inlet	Each	4	3,500.00	14,000
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	260	25.00	6,500
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	6,500	9.00	58,500
7.20	Road Reconstruction	Restore Curb and Gutter	Ln Ft	520	30.00	15,600
7.40	Road Reconstruction	Traffic Control	Lump	1	5,900.00	5,900
		Mobilization		*5%*		*9,375*
		Construction Contingency		*20%*		*37,500*
		Design and Construction Engineering		*10%*		*18,750*
		Total Project Cost				***253,125***

TABLE T-10: USER FEE CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT MLC-09

Description Perform road improvements and/or install 24" HDPE storm drain pipe up to 2,800 feet to convey the 100-3 design storm on 100 East Street between 200 South and Millcreek Wash.

Location	MLC-B170	**Model 100-3 Storm**	33.4	cfs
Route	MLC-B170	**Pipeline Capacity**	55.9	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	28,000	2.00	56,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.14	Earthwork	Dewatering	Ln Ft	560	20.00	11,200
3.24	Storm Drain Pipe	24" Smoothwall HDPE	Ln Ft	2,800	40.00	112,000
4.24	Pipe End Section	24" Smoothwall HDPE	Each	2	400.00	800
5.24	Concrete Catch Basin	24" Double Curb Inlet	Each	9	3,500.00	31,500
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	560	25.00	14,000
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	14,000	9.00	126,000
7.20	Road Reconstruction	Restore Curb and Gutter	Ln Ft	1,120	30.00	33,600
7.40	Road Reconstruction	Traffic Control	Lump	1	12,600.00	12,600
		Mobilization		*5%*		*20,035*
		Construction Contingency		*20%*		*80,140*
		Design and Construction Engineering		*10%*		*40,070*
		Total Project Cost				***540,945***

TABLE T-10: USER FEE CONCEPTUAL OPINIONS OF PROJECT CONSTRUCTION COST

PROJECT MLC-10

Description Replace existing ditch previously used for irrigation with 800 feet of 24" HDPE storm drain pipe to convey the 100-3 design storm on 400 South Street between 100 East and 300 East.

Location	MLC-B170	**Model 100-3 Storm**	33.4	cfs
Route	MLC-B170	**Pipeline Capacity**	55.9	cfs

CONCEPTUAL OPINION OF CONSTRUCTION COST

No.	Description		Units	Quantity	Unit Cost	Total
1.20	Clear and Grub	(or Asphalt Removal)	Sq Ft	8,000	2.00	16,000
2.05	Earthwork	SWPPP/Construction BMPs	Acre	1.00	3,000.00	3,000
2.14	Earthwork	Dewatering	Ln Ft	160	20.00	3,200
3.24	Storm Drain Pipe	24" Smoothwall HDPE	Ln Ft	800	40.00	32,000
4.24	Pipe End Section	24" Smoothwall HDPE	Each	2	400.00	800
5.24	Concrete Catch Basin	24" Double Curb Inlet	Each	3	3,500.00	10,500
6.10	Utility Conflicts	Relocate Utilities	Ln Ft	160	25.00	4,000
7.10	Road Reconstruction	Restore Asphalt and Base	Sq Ft	4,000	9.00	36,000
7.20	Road Reconstruction	Restore Curb and Gutter	Ln Ft	320	30.00	9,600
7.40	Road Reconstruction	Traffic Control	Lump	1	3,600.00	3,600
		Mobilization		*5%*		*5,935*
		Construction Contingency		*20%*		*23,740*
		Design and Construction Engineering		*10%*		*11,870*
		Total Project Cost				***160,245***

TABLE T-11: STORM DRAIN USER FEE COST SUMMARY

Years to Fund	**5**
Number of Users	**8,448**

Expense		**Project Cost**	**Yearly Cost**	**Monthly Cost**	**User Fee**
Storm Water User Fee Improvement Projects					
Millcreek Wash	MLC - 01	$235,845	$47,169	$3,931	
Millcreek Wash	MLC - 02	$354,726	$70,945	$5,912	
Millcreek Wash	MLC - 03	$425,061	$85,012	$7,084	
Millcreek Wash	MLC - 04	$486,918	$97,384	$8,115	
Millcreek Wash	MLC - 07	$253,125	$50,625	$4,219	
Millcreek Wash	MLC - 09	$540,945	$108,189	$9,016	
Millcreek Wash	MLC - 10	$160,245	$32,049	$2,671	
	Subtotal	*$2,456,865*	*$491,373*	*$40,948*	*$4.85*
Reimburse User Fee from CFP Funds[1]		*-$1,542,000*	*-$77,100*	*-$6,425*	*-$0.76*
2014-2015 Storm Water Operational Expense Budget					
Employee Regular Salaries and Wages		N/A	$116,550	$9,713	
Employee Part-time/Temporary Wages		N/A	$8,247	$687	
Employee Overtime		N/A	$1,552	$129	
Employee Benefits		N/A	$77,765	$6,480	
Uniforms		N/A	$200	$17	
Conference and Travel		N/A	$3,300	$275	
Office Expenses and Supplies		N/A	$1,000	$83	
Equipment		N/A	$1,500	$125	
Equipment Supplies and Maintenance		N/A	$4,500	$375	
Fuel and Oil		N/A	$3,000	$250	
Building and Grounds		N/A	$5,450	$454	
Utilities		N/A	$2,300	$192	
Telephone		N/A	$3,830	$319	
Professional and Technical		N/A	$32,163	$2,680	
Special Department Supplies		N/A	$32,500	$2,708	
Transfer to General Fund		N/A	$75,000	$6,250	
	Subtotal		*$368,857*	*$30,738*	*$3.64*
Washington County Flood Control Authority Fee		*N/A*	*N/A*	*N/A*	*$1.50*
Total Recommended User Fee					**$9.23**

[1] *CFP funds reimbursing User Fee funds used for installation of 54-inch and 60-inch pipeline installed along 240 West Street between 3650 South Street and Merrill Road, and along Merrill Road between 240 West Street and Harvest Lane. It is assumed that it will take up to 20 years to reimburse the full project cost of $1,542,000, averaging $77,100 per year or $6,425 per month.*

TABLE T-12: STORM DRAIN USER FEE COST SUMMARY

Years to Fund	**10**
Number of Users	**8,448**

Expense	Project Cost	Yearly Cost	Monthly Cost	User Fee
Storm Water User Fee Improvement Projects				
Millcreek Wash MLC - 01	$235,845	$23,585	$1,965	
Millcreek Wash MLC - 02	$354,726	$35,473	$2,956	
Millcreek Wash MLC - 03	$425,061	$42,506	$3,542	
Millcreek Wash MLC - 04	$486,918	$48,692	$4,058	
Millcreek Wash MLC - 07	$253,125	$25,313	$2,109	
Millcreek Wash MLC - 08	$540,945	$54,095	$4,508	
Millcreek Wash MLC - 09	$160,245	$16,025	$1,335	
Subtotal	*$2,456,865*	*$245,687*	*$20,474*	*$2.42*
Reimburse User Fee from CFP Funds[1]	*-$1,542,000*	*-$77,100*	*-$6,425*	*-$0.76*
2014-2015 Storm Water Operational Expense Budget				
Employee Regular Salaries and Wages	N/A	$116,550	$9,713	
Employee Part-time/Temporary Wages	N/A	$8,247	$687	
Employee Overtime	N/A	$1,552	$129	
Employee Benefits	N/A	$77,765	$6,480	
Uniforms	N/A	$200	$17	
Conference and Travel	N/A	$3,300	$275	
Office Expenses and Supplies	N/A	$1,000	$83	
Equipment	N/A	$1,500	$125	
Equipment Supplies and Maintenance	N/A	$4,500	$375	
Fuel and Oil	N/A	$3,000	$250	
Building and Grounds	N/A	$5,450	$454	
Utilities	N/A	$2,300	$192	
Telephone	N/A	$3,830	$319	
Professional and Technical	N/A	$32,163	$2,680	
Special Department Supplies	N/A	$32,500	$2,708	
Transfer to General Fund	N/A	$75,000	$6,250	
Subtotal		*$368,857*	*$30,738*	*$3.64*
Washington County Flood Control Authority Fee	*N/A*	*N/A*	*N/A*	*$1.50*
Total Recommended User Fee				**$6.80**

[1] *CFP funds reimbursing User Fee funds used for installation of 54-inch and 60-inch pipeline installed along 240 West Street between 3650 South Street and Merrill Road, and along Merrill Road between 240 West Street and Harvest Lane. It is assumed that it will take up to 20 years to reimburse the full project cost of $1,542,000, averaging $77,100 per year or $6,425 per month.*

TABLE T-13: STORM DRAIN USER FEE COST SUMMARY

Years to Fund	**20**
Number of Users	**8,448**

Expense		**Project Cost**	**Yearly Cost**	**Monthly Cost**	**User Fee**
Storm Water User Fee Improvement Projects					
Millcreek Wash	MLC - 01	$235,845	$11,792	$983	
Millcreek Wash	MLC - 02	$354,726	$17,736	$1,478	
Millcreek Wash	MLC - 03	$425,061	$21,253	$1,771	
Millcreek Wash	MLC - 04	$486,918	$24,346	$2,029	
Millcreek Wash	MLC - 07	$253,125	$12,656	$1,055	
Millcreek Wash	MLC - 08	$540,945	$27,047	$2,254	
Millcreek Wash	MLC - 09	$160,245	$8,012	$668	
	Subtotal	*$2,456,865*	*$122,843*	*$10,237*	*$1.21*
Reimburse User Fee from CFP Funds[1]		*-$1,542,000*	*-$77,100*	*-$6,425*	*-$0.76*
2014-2015 Storm Water Operational Expense Budget					
Employee Regular Salaries and Wages		N/A	$116,550	$9,713	
Employee Part-time/Temporary Wages		N/A	$8,247	$687	
Employee Overtime		N/A	$1,552	$129	
Employee Benefits		N/A	$77,765	$6,480	
Uniforms		N/A	$200	$17	
Conference and Travel		N/A	$3,300	$275	
Office Expenses and Supplies		N/A	$1,000	$83	
Equipment		N/A	$1,500	$125	
Equipment Supplies and Maintenance		N/A	$4,500	$375	
Fuel and Oil		N/A	$3,000	$250	
Building and Grounds		N/A	$5,450	$454	
Utilities		N/A	$2,300	$192	
Telephone		N/A	$3,830	$319	
Professional and Technical		N/A	$32,163	$2,680	
Special Department Supplies		N/A	$32,500	$2,708	
Transfer to General Fund		N/A	$75,000	$6,250	
	Subtotal		*$368,857*	*$30,738*	*$3.64*
Washington County Flood Control Authority Fee		*N/A*	*N/A*	*N/A*	*$1.50*
Total Recommended User Fee					**$5.59**

[1] *CFP funds reimbursing User Fee funds used for installation of 54-inch and 60-inch pipeline installed along 240 West Street between 3650 South Street and Merrill Road, and along Merrill Road between 240 West Street and Harvest Lane. It is assumed that it will take up to 20 years to reimburse the full project cost of $1,542,000, averaging $77,100 per year or $6,425 per month.*

APPENDIX 3 – FOLDED MAP EXHIBITS