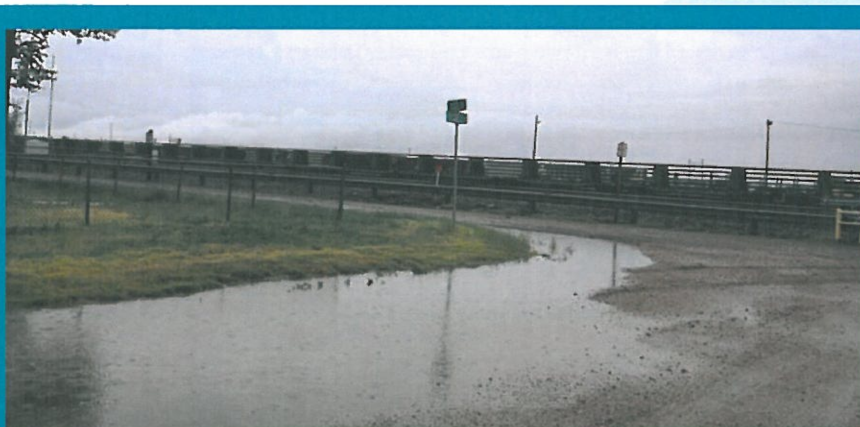
amec foster wheeler

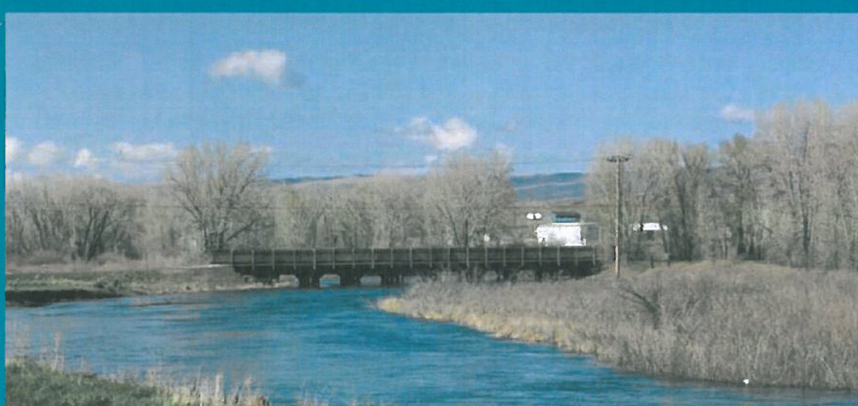
South Laramie Drainage Master Plan – FINAL

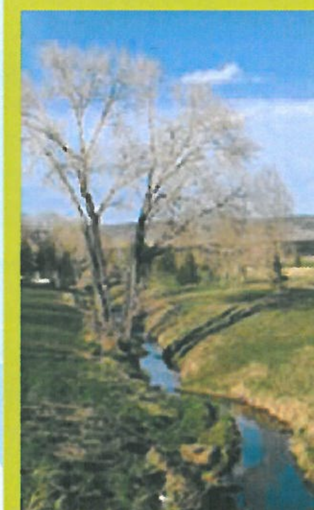
South Laramie Drainage Plan
Laramie, Wyoming

Prepared for:

City of Laramie
Laramie, Wyoming







Prepared by:

Amec Foster Wheeler
920 E. Sheridan St., Suite A
Laramie, Wyoming 82070
(307) 460-3249

July 2017
Project No. 32710198

Professional Engineer (Civil)
AARON GLENN MURRAY
10642
Date 7-14-17
WYOMING

Table of Contents

List of Tables

List of Figures

Appendices

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EXECUTIVE SUMMARY

Purpose and Objective

The primary objectives of the South Laramie Drainage Master Plan were:

- Conduct a field survey to identify and characterize the storm drainage Infrastructure in the Study Area.
- Perform a drainage analysis to confirm and identify flooding hazards in south portion of Laramie, including the West Side neighborhood, and the Turner Tract.
- Provide a prioritized list of drainage improvements necessary to safely manage stormwater runoff.
- Provide recommendations for drainage requirements to be placed on future development, and
- Provide recommendations for the next steps the City should take in its stormwater program.

Much of the study area has not been studied previously. The South Laramie Drainage Master Plan is part of an overall goal to develop a Master Plan for the entire COL. Amec Foster Wheeler developed a rainfall-runoff model to quantify surface runoff, identify drainage issues, develop alternative solutions, and prepare a recommended drainage plan for improvements in the study area.

Planning Process

The South Laramie Drainage Master Plan began with a review of past studies and a field reconnaissance of the study area. The field reconnaissance included a survey of storm drainage infrastructure and an inspection of major drainage features.

The following individuals and project sponsors have given significant input to the study:

Table ES-1: Project Participants and Stakeholders

Participant	Organization
Eric Jaap	City of Laramie
William Winkler	City of Laramie
Carl Lund	City of Laramie
Earl Smith	City of Laramie
Shane Johnson	City of Laramie
Shawn Kraft	City of Laramie
Randy Hunt	City of Laramie
Aaron Murray	Amec Foster Wheeler
John Loranger	Amec Foster Wheeler
Ross Davenport	Amec Foster Wheeler
John Hininger	Amec Foster Wheeler
Rebecca Ryan	Amec Foster Wheeler

Project Area Description

The headwaters of the Study Area originate from the Pole Mountain Ridge and discharge to the Laramie River at various locations with the City of Laramie. The 61 square-mile basin is bounded by the North Laramie Drainage Plan study area to the north, the Pole Mountain Ridge to the east, and Wyoming Highway 230 to the west. The Study Area is shown in Figure 1.

Stormwater flow paths in the South Laramie Drainage Plan Study Area are a combination of surface runoff, stream flow, and the existing storm sewer system. The Laramie River flows through the Study area, generally from south to north. Spring Creek, originates on Pole Mountain and flows through the Study Area and the COL from east to west before its confluence with the Laramie River. Most of the storm sewer infrastructure in the Study Area is located north of Spring Creek within the COL boundary. There are multiple storm sewer outfalls to Spring Creek and the Laramie River, with the largest being a 60-inch storm sewer that discharges to the Laramie River near Steele Street.

Flood hazards were identified for both existing and future development conditions, using PCSWMM, a stormwater modeling software program for simulating rainfall and runoff events. PCSWMM uses the United States Environmental Protection Agency's (EPA) SWMM engine, an open-source program. Flooding hazards include Spring Creek overtopping its banks at multiple locations throughout the City, overtopping of Vista Drive, 3rd Street, and 2nd Street, and street flooding (Regency Drive, 22nd Street, 21st Street, 15th Street, 13th Street, 5th Street, Boswell Drive, Soldier Springs Road, Kearney Street, 3rd Street, 2nd Street, and 1st Street). Flood hazard areas are shown on Figure 20 for existing and future development conditions.

PCSWMM was used to develop a rainfall-runoff model for the Study Area. Major drainage basins were identified and divided into sub-basins. Peak flows were estimated from rainfall and the physical attributes of the sub-basins in the Study Area. The following physical characteristics were determined for each sub-basin and used in the PCSWMM analysis:

- Basin contributing drainage area,
- Width of sub-basin,
- Length of longest flow path of the sub-basin,
- Sub-basin slope,
- Impervious area,
- Depression storage, and
- Soil infiltration rates.

Table ES-2 provides existing and future development condition peak flow information at critical design points along drainage paths for the 100-year flood event.

Table ES-2: Summary of Discharges for Existing and Future Development Conditions

Location	Design Point	Existing Development Conditions	Future Development Conditions
		100-Year (cfs)	100-Year (cfs)
SC at Grand Avenue	SN180	1,917	1,930
SC at 16th Street	SC145	2,216	2,795
SC at 7th Street	SC125	2,283	2,630
SC at 3rd Street	SN105	4,462	5,222
SC at Confluence	LN425	4,462	5,165
3rd Street at Kearney Street (surface)	LN235-S	61	61
3rd Street at Kearney Street (storm sewer)	LN235	69	72
Steele Street and 1st Street (surface)	LN305-S	224	224
Steele Street Discharge to Laramie River	LN420	267	267
Skyline Drive and 15th Street	SS310	1,926	1,926
Skyline Drive and Soldier Springs Road	SS105-S	1,036	1,036
Skyline Drive and HIGHWAY 287	SS305	2,729	2,729
Discharge to Spring Creek at 3rd Street	SS204-S	2,671	2,685

Analysis of Alternatives

The alternative analysis is meant to identify all realistic alternatives in a comprehensive manner that would assure that all reasonably feasible solutions were considered. The following types of alternatives were evaluated: new detention ponds, conveyance structure improvements, and expanding/modifying existing detention ponds.

Potential improvements were screened to determine which alternatives would be looked at in greater detail. The screening process included modeling the improvement to determine feasibility of construction and evaluate its usefulness in mitigating identified flooding hazards. Improvements that did not significantly reduce flooding hazards or that required infrastructure improvements that would not be feasible to construct were removed from further consideration. Promising alternatives were examined further to identify the benefits, estimate construction and operation and maintenance costs, and right-of-way (ROW) and easement requirements. Improvements were modeled to safely pass runoff from the 100-year event.

The South Laramie Drainage Master Plan has identified several alternatives to achieve the project goals. Those alternatives are summarized in Tables ES-3, ES-4, and ES-5 below, grouped by major drainage basin.

Table ES-3: Evaluation of Spring Creek North and Spring Creek Middle Alternatives

Alt	Description of Improvements	Requires Land Acquisition (Number or Properties, Acres)	Water Quality Benefits	Over-topping of Spring Creek	Capital Cost*	Annual O&M Cost	Project Life Cycle Cost**
SN-1	247 AF Pond East of Jacoby GC, Turner Tract TT-3, and Storm Sewer Upgrades	Yes (2, 62)	Yes Water Quality Volume Included in Ponds	No	$24,496,000	$95,000	$37,431,000
SN-2	26th Street and 17th Street Ponds, Turner Tract TT-3, and Storm Sewer Upgrades	Yes (3, 38)	Yes Water Quality Volume Included in Ponds	No	$20,238,000	$58,000	$28,216,000
SN-3	LaPrele Pond Expansion, 17th Street Pond, Turner Tract TT-3, and Storm Sewer Upgrades	Yes (2, 34)	Yes Water Quality Volume Included in Ponds	No	$20,202,000	$55,000	$27,700,000

*includes land acquisition
**based on 50-year service life, 3.64% interest rate

Table ES-4: Evaluation of Laramie River North Alternatives

Alt	Description of Improvements	Requires Land Acquisition (Acres)	Water Quality Benefits	Flooding of Private Property near 1st and Steele	Capital Cost*	Annual O&M Cost	Project Life Cycle Cost**
LN-1	Steele Street Storm Sewer System Upgrades and 2nd Street Connection	No	No	No	$4,263,000	$5,000	$4,884,000
LN-2	Steele Street Storm Sewer System Upgrades, 2nd Street Connection, and Re-purpose 18-in Sanitary Sewer	No	No	No	$4,359,000	$7,000	$5,339,000
LN-3	Steele Street Storm Sewer Upgrades, Re-purpose 18-in Sanitary Sewer, and Rehab 36-in Culvert under UPRR	No	No	No	$3,896,000	$6,000	$4,761,000

*includes land acquisition
**based on 50-year service life, 3.64% interest rate

Table ES-5: Evaluation of Spring Creek South Alternatives

Alt	Description of Improvements	Requires Land Acquisition (Number of Properties, Acres)	Water Quality Benefits	Flooding of 3rd Street and Skyline Drive Areas	UPRR Crossing Bores	Capital Cost*	Annual O&M Cost	Project Life Cycle Cost**
SS-1	Maximize Upstream Detention	Yes (3,99)	Yes WQ Volume Included in Ponds	No	0	$24,123,000	$158,000	$45,706,000
SS-2	Upstream Detention and Flow Diversion	Yes (6,85)	Yes WQ Volume Included in Ponds	No	2	$27,399,000	$131,000	$45,275,000

*includes land acquisition
**based on 50-year service life, 3.64% interest rate

Recommended Master Plan

The recommended plan includes:

Spring Creek North and Spring Creek Middle Major Basin Improvements
The recommended alternative for the Spring Creek North and Spring Creek Middle Major Basins is *Alternative SN-1: Pond East of Jacoby GC, Turner Tract TT-3, and Storm Sewer Upgrades.* Recommended improvements for the Spring Creek North and Spring Creek Middle Major Basins include:

- Recommended Turner Tract Alternative TT-3:
    - Modify outlet of existing detention pond at Boulder Drive and Beech Street and increase storage volume from 5 AF to 21 AF by expanding pond footprint within property limits to restrict flow and maximize pond effectiveness, and
    - Construct new 23-AF detention pond upstream of the new extension of Regency Drive,

- Install improvements on Grays Gable Road to maximize inflow to Jacoby Golf Course ponds,

- Upgrade storm sewer systems on 30th Street, 22nd Street, 21st Street, and 13th Street. Due to the complex interaction between surface water and storm sewer flows in this area, it is recommended that the COL conduct a detailed 2-dimensional hydraulic analysis that includes all portions of the storm sewer system and utilizes the surface topography to route flows exceeding the storm sewer capacity prior to final design and construction of improvements in this area,

- Construct a box culvert from Boswell Drive to Spring Creek, and

- Acquire land and construct new 247-AF detention pond on property owned by the University of Wyoming east of the Jacoby Golf Course.

Laramie River North Major Basin Improvements
The recommended alternative for the Laramie River North Major Basin is *Alternative LN-3: Steele Street Storm Sewer System Upgrades, Re-purpose 18-inch Sanitary Sewer Line, and Restore 36-inch Culvert under UPRR.* The following upgrades to storm sewer infrastructure in the Laramie River North Major Basin are recommended:

- Fifth Street and Ivinson Street to 3rd Street and Grand Avenue – upgrade to 36-inch diameter,
- 3rd Street between Grand Avenue and Kearney Street – upgrade to 42-inch diameter,
- Kearney Street between 3rd Street and 2nd Street – upgrade to 48-inch diameter,
- Steele Street from 2nd Street to Pine Street (under UPRR right-of-way) – bore additional 60-inch storm sewer,

- Re-purposing an 18-inch sanitary sewer for use as a storm sewer from 2nd Street and Sanders Street, under the UPRR ROW, and discharging to the existing Steele Street outfall or directly to the Laramie River, and
- Rehabilitating an existing 36-inch culvert under UPRR ROW at 1st Street and Sanders Street, including constructing an open channel or extension to the Laramie River.

Spring Creek South Major Basin Improvements

The recommended alternative for the Spring Creek South Major Basin is *Alternative SS-1: Maximize Upstream Detention.* The following improvements are recommended for the Spring Creek South Major Basin:

- Re-purposing a 12-inch sanitary sewer for use as a storm sewer from Skyline Drive and Highway 287 to Spring Creek at 3rd Street,
- Acquire land and construct 450 AF of detention south of I-80 and east of Skyline Drive,
- Acquire land and construct 175-AF of detention south of Hidden Springs Road,
- Install twin 36-inch culverts under Highway 287 near Soldier Springs Road
- Acquire UPRR easement and construct open channel across UPRR/WYDOT property southwest of intersection of Highway 287 and I-80
- Install twin 36-inch culverts in UPRR right-of-way under I-80 overpass to discharge at Spring Creek.

Laramie River South Major Basin Improvements

No improvements were identified for the Laramie River South Major Drainage Basin.

Laramie River West Major Basin Improvements

No improvements were identified for the Laramie River West Major Drainage Basin.

Prioritization of Improvements

The current flooding hazard that threatens to impact the most residents is Spring Creek overtopping its banks in various locations as it runs from through the COL from approximately 30th Street to 3rd Street (Spring Creek North and Spring Creek Middle Major Basin). Overflow from Spring Creek in these locations would run through residential areas, with most of the flow ultimately reaching 1st Street and compounding the existing flooding hazard at this location, in which there is not enough capacity across the UPRR right-of-way to convey the flow to the Laramie River (Laramie River North Major Basin). The primary flooding hazard in the Spring Creek South Major Basin is flooding that would occur near Skyline Drive and 3rd Street. While this is an important transportation corridor, the flooding would not impact as many properties as the flooding hazards in other major basins. Based on the potential impact to residents, the recommended improvements are prioritized as follows:

1. Spring Creek North and Spring Creek Middle Major Basin Improvements
2. Laramie River North Major Basin Improvements
3. Spring Creek South Major Basin Improvements

Water Quality Impacts

Amec Foster Wheeler recommends that the COL develop stormwater quality standards that encourage or require the use of Low Impact Development (LID) practices (also called green infrastructure) on new or redeveloped properties both inside and outside the Casper Aquifer Protection Area (CAPA). Standards for properties within the CAPA should include precautions for pollutant removal prior to infiltration. Since the implementation of LID would be a process that would occur over several years, at the pace of development/redevelopment, it is recommended that the capital projects in this master plan include water quality features for removal of sediment and other pollutants. For this reason, the estimated conceptual construction costs for all detention ponds includes excavation of an additional 10% that would be used as a water quality capture volume. This volume would be retained during a storm event and slowly released over 40 hours, requiring a small modification to traditional pond outlet structures.

Drainage Requirements for New Development

While this master plan has identified capital improvements recommended for construction by the City of Laramie to mitigate the identified flooding hazards, the City should continue to impose flood management requirements on new development and re-development properties. Private flood improvements can help provide incremental relief until public improvement projects can be funded and constructed. The following requirements are recommended for new developments or significant re-development properties:

- *Over-detention*: Peak runoff from developed properties should be managed on-site to reduce the 100-year developed peak flow rate to the 10-year historic peak discharge rate.
    - It is recommended that the City consider allowing developers the option to forego construction of on-site flood management if they contribute to the cost of regional flood management facilities that serve the property in question. This may be attractive to developers as it may provide more developable land, while the City can recoup some of the costs of regional facilities. Payments could be based on the fraction of impervious area represented by the development, or similar method.

- *Maintenance of private stormwater facilities*: To ensure continued performance of private, on-site stormwater facilities, regular maintenance (removal of sediment, debris, landscape maintenance, etc.) should be required by ordinance, with an easement that would allow the City to enter the property to conduct maintenance (at the landowner's expense) if the landowner fails to meet maintenance requirements.

- *Downstream impacts*: As a condition of approval, private development should be required to show that downstream infrastructure (storm sewers, open channels, etc.) is present and has adequate capacity to safely convey the runoff from the 100-year event to the ultimate receiving water body (Spring Creek or Laramie River). This may require developments to construct or fund downstream improvements to carry their point discharges across downstream property that used to accept sheet flows, unless it can be shown that the point discharge will not damage downstream property.

- As discussed in the previous section, Amec Foster Wheeler recommends that the COL develop stormwater quality standards that encourage or require the use of LID practices (also called green infrastructure) on new or redeveloped properties both inside and outside the CAPA.

1 INTRODUCTION

1.1 Authorization

The COL has contracted Amec Foster Wheeler for the preparation of the South Laramie Drainage Master Plan in response to drainage problems in the area and as part of an effort to create a master plan for a portion of the City not previously studied.

1.2 Purpose and Scope

The South Laramie Drainage Master Plan is to model and analyze the existing and future stormwater conditions, identify problem areas, and provide alternative methods to the drainage area to enhance public safety and minimize property damage.

Tasks completed to develop the master plan are summarized below:

- Coordinate and meet with project stakeholders,
- Review previous hydrologic studies within the study area,
- Survey existing stormwater infrastructure in the Study Area,
- Obtain Geographic Information System (GIS) data from the COL and update stormwater infrastructure data,
- Perform rainfall, hydrologic, and hydraulic analysis,
- Calibrate model to previous studies and independent analyses,
- Identify existing and potential drainage and/or flooding problems,
- Develop plan alternatives to reduce existing and potential flooding problems, and mitigate the impact of stormwater runoff,
- Evaluate the alternatives based on estimated construction costs, life cycle costs, flood protection benefits, water quality benefits, and requirement for land acquisition,
- Recommend selected alternatives,
- Develop conceptual design for the Recommended Plan,
- Prepare master plan reports for submittal to the COL.

1.3 Mapping

Mapping used in the project was based on 2009 LIDAR topography with 2-foot contour intervals provided by the City of Laramie. For the area surrounding the provided LIDAR data, the National Map Viewer (viewer.nationalmap.gov) was used to download surface elevation data. Parcel data was downloaded from the Albany County Assessor’s office. This surface was then used to generate a set of 2-ft contours used in the model. Land use mapping was provided by the City of Laramie and jurisdictional boundaries were obtained through a geospatial hub (http://www.uwyo.edu/wygisc). Roadway right-of-way (ROW) was established through the base mapping provided by ArcGIS 10.2. The storm sewer infrastructure was provided by the COL.

1.4 Data Collection

Since much of the study area has not previously been evaluated in detail, this South Laramie Drainage Master Plan Report is primarily based on information collected during a survey of stormwater infrastructure and extensive field visits. The 2011 Federal Emergency Management Agency (FEMA) Flood Insurance Study and other studies in the project area provided by the COL were used to supplement the field information.

Previous Reports/References

The following reports were used in preparation of this plan. A full bibliography is provided in the reference section at the end of this report.

1. Flood Insurance Study: Albany County, Wyoming and Incorporated Areas, Federal Emergency Management Agency, Flood Insurance Study Number 56001CV000A, Effective June 16, 2011

2. Techniques for Estimating Flow Characteristics of Wyoming Streams: Water-Resources Investigations 76-112, U.S. Geological Survey, November 1976

3. The North Laramie Drainage Master Plan, Short Elliot Hendrickson, January 2013

4. The West Laramie Drainage Master Plan, Short Elliot Hendrickson, July 2010

5. South Gateway Drainage Study, Coffey Engineering & Surveying, LLC, May 4, 2012.

6. Stormwater Drainage Report for the Turner Tract Preliminary Plat, Joel Farber Consulting, LLC, June 1, 2002

7. Final Drainage Report: Boulder Addition Final Plat, City of Laramie Engineering Division, March 2013

8. Stormwater Drainage Report, City of Laramie Gateway Park/Recreation Campus Drainage Improvements, December 20, 2013

9. Design Report for the New Laramie High School Site Drainage, Dowl HKM, September 2013

10. City of Laramie Draft Storm Drainage Design Criteria, Community Development Department, Engineering Division, Draft-March, 2013

11. Urban Storm Drainage Criteria Manual, Urban Drainage and Flood Control District, Denver, Colorado, 2008

12. Soil Survey of Albany County Area, Wyoming, United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), 1988

Field Reconnaissance
Amec Foster Wheeler conducted the following reconnaissance activities to gather information to support this master plan:

1. A survey of all COL-mapped stormwater manholes and inlets in the study area was performed by subconsultant Coffey Engineering and Surveying, to provide survey-grade elevations for this stormwater infrastructure.

2. A field inspection was conducted on all COL-mapped stormwater manholes and inlets in the study area by Amec Foster Wheeler and Coffey Engineering and Surveying. This field inspection gathered key characteristics for each manhole and inlet. Amec Foster Wheeler coordinated with the COL to collect this data using hand-held tablet computers linked to the COL's GIS database using the *ESRI Collector* application so that the GIS database was updated as the inspections were conducted, without the need for separate paper inspection forms.

3. Field inspection of other infrastructure in the study area, including significant detention ponds, Spring Creek channel (including bridge crossings), and other open channels. Information gathered included detention pond outlet sizes/types, and open channel characteristics (dimensions, ground surface/vegetation condition). The channel ground surface/vegetation information was used to determine Manning's roughness coefficients used in the model. A photograph log of the Spring Creek channel field inspection will be provided in the final report.

1.5 Acknowledgements

A list of project participants and stakeholders follows:

Table 1.5-1: Project Participants and Stakeholders

Participant	Organization
Eric Jaap	City of Laramie
William Winkler	City of Laramie
Carl Lund	City of Laramie
Earl Smith	City of Laramie
Shane Johnson	City of Laramie
Shawn Kraft	City of Laramie
Randy Hunt	City of Laramie
Aaron Murray	Amec Foster Wheeler
John Loranger	Amec Foster Wheeler
Ross Davenport	Amec Foster Wheeler
John Hininger	Amec Foster Wheeler
Rebecca Ryan	Amec Foster Wheeler

The project process has included meetings between the COL and the Amec Foster Wheeler Team. At these meetings, informational needs, drainage policies and preliminary results were identified and discussed. The following table summarizes the meetings conducted.

Table 1.5-2: Meetings Conducted

Meeting (Date/Location)	Purpose
July 29, 2014 Amec Foster Wheeler – Laramie Office	Kick off Meeting to collect basic information, discuss overall scope of work and identify parties to include in the project process.
September 9, 2014 City of Laramie	Progress Meeting #1 - Discuss methodology for collecting and updating stormwater GIS data using ESRI Collector program. Discussed naming convention for stormwater infrastructure.
August 6, 2015 Amec Foster Wheeler – Laramie Office	Progress Meeting #2 – Discuss project status, Turner Tract Study preliminary results
August 19, 2015 Amec Foster Wheeler – Laramie Office	Progress Meeting #3 – Kickoff for Spring Creek Floodplain Mapping task; discuss Turner Tract Study results; model status.
September 30, 2015 Amec Foster Wheeler – Laramie Office	Progress Meeting #4 – Provide update on Spring Creek Floodplain Mapping discussion with FEMA and scope; Provide update on model calibration and comparison with FIS.
December 17, 2015 Amec Foster Wheeler – Laramie Office	50% Review Meeting – Discuss comments from City on 50% Master Plan
January 27, 2016 Amec Foster Wheeler – Laramie Office	Progress Meeting #5 – Provide update on Spring Creek Floodplain Re-mapping. Present draft revised floodplain.

2 STUDY AREA DESCRIPTION

2.1 Project Area

The headwaters of the Study Area originate from the Pole Mountain ridgeline and discharge to the Laramie River at various locations with the City of Laramie. The 61 square-mile basin is bounded by the North Laramie Drainage Plan study area to the north, the Pole Mountain ridgeline to the east, and Wyoming Highway 230 to the west. The Study Area is shown in Figure 1.

2.2 Land Use

The Study Area is approximately 8.8 miles north to south, 13 miles east to west, and generally slopes to the west. Elevation ranges from 8,800 feet on the eastern side to 7,100 feet at the confluence of Spring Creek with the Laramie River.

The eastern portion of the Study Area is undeveloped land managed by the National Forest Service and consists of agricultural land, hilly terrain, and rural residential development. The middle and western portion of the Study Area includes the COL and is heavily developed with two major channels, Spring Creek and the Laramie River. I-80 crosses the Study Area, running primarily east and west, while Highway 287 and the Union Pacific Railroad (UPRR) cross it running north and south. Spring Creek conveys surface flow from basins extending to the top of Pole Mountain and from City Springs near the intersection of 30th Street and Grand. Spring Creek discharges to the Laramie River west of the UPRR.

2.3 Major Basin Descriptions

The Study Area was delineated into six major basins, Laramie River North, Laramie River South, Laramie River West, Spring Creek Middle, Spring Creek North, and Spring Creek South. Each major basin was divided into sub-basins. The sub-basin delineations are shown on Figure 2. All sub-basins were drawn using the LIDAR topography data provided by the COL, where available, and two-foot contours provided by Albany County. The six major basins are described in further detail below.

<u>Laramie River North</u>

The Laramie River North major basin covers approximately 30 city blocks in the COL and is bisected by the UPRR right-of-way. The eastern portion of this basin is completely developed, while the portion west of the UPRR ROW is a mixture of residential, industrial, and undeveloped properties. Flow in the Laramie River North major basin travels west, crossing under the UPRR ROW, and discharges to the Laramie River.

Existing stormwater infrastructure in the Laramie River North major basin consists of a storm sewer system that conveys runoff to a 60-inch storm sewer at Steele Street that carries flow under UPRR ROW to the Laramie River. Another stormsewer system serves the neighborhood west of the UPRR right-of-way and discharges to the Laramie River near Snowy Range Road. There are no significant existing detention ponds in this basin.

Laramie River South

The Laramie River South major basin includes agricultural and rural residential land on the south side of the Study Area, crosses UPRR and Highway 287, and discharges to the Laramie River south of the COL. Most of this basin is located outside of the city limits.

Existing stormwater infrastructure in this basin is very limited, consisting of culverts under roadways and open channels. There are no existing detention ponds in this basin, though there are a few areas where informal ponding occurs behind culvert crossings.

Laramie River West

The Laramie River West major basin consists of the land between Highway 230 and the Laramie River. It includes mostly agricultural and undeveloped land, with rural residential development.

Existing stormwater infrastructure in this basin is very limited, consisting of culverts under roadways and open channels. There are no existing detention ponds in this basin.

Spring Creek Middle

The Spring Creek Middle major basin, which lies south of Spring Creek and north of Interstate-80, includes undeveloped land on the eastern portion, the Turner Tract development, and the nearly fully developed portion of the COL between I-80 and Spring Creek. Slopes on the eastern portion of the basin are relatively steep, coming down from the Pole Mountain ridge. The Spring Creek Middle major basin discharges to Spring Creek.

There are several small, existing storm sewer systems serving the Turner Tract, Grand Avenue, and neighborhoods south of Spring Creek. There are several existing detention ponds in this major basin, most of which are located within the Turner Tract development.

Spring Creek North

This major basin originates in the northeast corner of the Study Area, with a large amount of mostly undeveloped land on the Pole Mountain ridge. Storm runoff from the Pole Mountain Ridge flows through open channels to Spring Creek at City Springs. The Spring Creek North major basin also includes residential development, the Jacoby Golf Course, the University of Wyoming campus. Storm runoff from the Spring Creek North major basin is conveyed to Spring Creek via open channels and various storm sewer systems.

There are five significant detention ponds located in this basin. Three are located on the Jacoby Golf Course. A fourth is an underground pond serving parts of the UW Plaza development. The last pond is located on the University of Wyoming campus (Tailgate Park).

Spring Creek South

The eastern portion of the Spring Creek South major basin includes a large amount of steeper, undeveloped land on Pole Mountain. The western portion of the basin includes undeveloped property, rural residential development, agricultural land, and industrial development. Runoff from the Spring Creek South major basin is directed to the intersection of I-80 and Highway 287. There is no formal outlet to this area, resulting in multiple ponding areas. Flow will eventually overtop the informal ponding areas and flow down Highway 287 and discharge to Spring Creek.

Stormwater infrastructure in the eastern portion of the basin is limited to culverts at road crossings. There is a small storm sewer system in Skyline Drive that runs from 15th Street to the intersection of Skyline Drive and Highway 287. There is only one significant formal detention pond in this basin, located at 15th Street and Skyline Drive. Informal ponding occurs at the intersection of Highway 287 and I-80.

2.4 Flood History

Documented flooding has occurred in both high-frequency and low-frequency events within the study area. One area where repeated flooding has occurred is along First Street from Park Street to Sanders Street, east of the UPRR corridor that runs north-south through Laramie. This area, which is at the downstream end of the Laramie North Major Drainage Basin, is characterized by unpaved streets and few inlets. There is only one active storm sewer, a 60-inch pipe at Steele Street, that carries flow across the UPRR right-of-way and ultimately to the Laramie River. Two other pipes, at Russell Street and Sanders Street, are no longer functioning (South Gateway Drainage Study, Coffey, 2012). For these reasons, runoff during frequent events collects in sump areas around intersections, as shown in Pictures 1 and 2 below from a rain event on July 29, 2014. Local weather stations recorded 1.02 inches of rain on this day, which approximately represents a five-year storm event, or the storm with a 20% chance of occurring in a given year. The South Gateway Drainage Study (Coffey, 2012) recommended upgrades to streets and storm sewers in the area. No improvements have been constructed to date.

Pictures 1 and 2: Flooding at 1st Street on Russell Street and Ord Street on July 29, 2014

A second location in the study area where flooding has frequently occurred is on Garfield Street east of 30th Street, at the access road to a student housing complex. The access road and the church property recently developed to the east, do not have adequate capacity to pass through upstream flows originating from the Turner Tract and upstream drainage basins extending to Pole Mountain. The COL has recently extended Regency Drive in this area, which includes improvements to intercept stormwater flows before they reach the church and housing complex properties. Improvements include a 36-inch pipe to carry flows to Garfield Street before discharging to Spring Creek. While likely effective during minor events, the new improvements will not have the capacity to convey major storm events, due to the large drainage basin tributary to this area. Flooding at the church, housing complex access road, or Garfield Street would be likely.

A third location in the Study Area that has experienced flooding is the West Side Neighborhood, and the southern end of Spruce Street in particular. Flooding in this location has occurred due to the Laramie River overtopping its banks. A temporary berm has been used for flood protection. Under a separate contract, the COL is currently evaluating options to construct permanent flood control improvements to protect this area.

The 2011 Flood Insurance Study for Albany County, Wyoming delineates the 100-year floodplain for Spring Creek and the Laramie River. Spring Creek was evaluated in its entirety, from east (upstream) of the City boundary to its confluence with the Laramie River.

The FEMA Flood Insurance Rate Map (FIRM) for Albany County, Wyoming became effective June 16, 2011 for the Laramie River and Spring Creek (Map numbers 5600011760E, 5600011765E, and 5600011770E). FEMA flood zone designations for Spring Creek are Zone A (flood hazard area subject to inundation by the 1% annual chance flood with no Base Flood Elevations determined), Zone AE (flood hazard area subject to inundation by the 1% annual chance flood with Base Flood Elevations determined), Zone X (flood hazard area subject to inundation by the 0.2% annual chance flood with no Base Flood Elevations determined), and Floodway (channel of the stream plus any adjacent floodplain areas kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in height). Zone A is shown east of the City Boundary, while Base Flood Elevations are provided within the City Boundary (Zone AE).

The FIRM map shows that a large area of the City would be inundated during the 0.2% annual chance flood (500-year event). While the FIRM maps indicate that Spring Creek will stay within its banks during the 1% annual chance flood (100-year event), City staff indicated to Amec Foster Wheeler that there is concern that Spring Creek does not have capacity for major storm events. For this reason, the COL has enforced a development constraint that no additional flow above historic conditions should be discharged to Spring Creek. Amec Foster Wheeler followed this constraint for developing proposed improvements, avoiding alternatives that would increase flow to Spring Creek.

3 HYDROLOGIC ANALYSIS

3.1 Overview

A hydrologic analysis of the study area was performed to develop a Master Plan for the south portion of the COL. The PCSWMM program was used to model rainfall and runoff. The following sources were used for references and calibration:

- Storm Drainage Design Criteria for the City of Laramie, Draft, March 2013,
- EPA SWMM5 Manual,
- Urban Drainage and Flood Control District (UDFCD) Drainage Criteria Manual, and
- HEC-HMS.

The model calibration and quality control procedures are detailed in Section 4.3

Design rainfall, physical runoff characteristics, and runoff hydrographs for the baseline hydrologic model were developed and derived in accordance with the Storm Drainage Design Criteria for the City of Laramie. The following physical characteristics were determined for each sub-basin and used in the input file in the PCSWMM analysis:

- Basin contributing drainage area,
- Width of sub-basin,
- Length of longest flow path of the sub-basin,
- Sub-basin slope,
- Impervious area,
- Depression storage, and
- Soil infiltration rates.

3.2 Design Rainfall

One-hour point precipitation values were developed from NOAA Atlas rainfall depth-frequency maps from the NOAA Atlas Volume II-Wyoming for the COL. The one-hour rainfall depths for the 2-, 5-, 10-, and 100-year events were used for storm designs and are summarized in Table 3.2-1.

Table 3.2-1: Point Rainfall Depth (Inches)

Return Period	1-Hour Rainfall
2-Year	0.63
5-Year	0.94
10-Year	1.15
100-Year	1.86

Model input for CUHP dictates the one-hour point rainfall depths to be distributed over two hours by five-minute increments. Table 3.2-2 summarizes the precipitation distribution depths calculated from NOAA percent rainfall distribution values.

Table 3.2-2: 2-hour Precipitation Distribution Depths

Time (minutes)	2-Year (in.)	5-Year (in.)	10-Year (in.)	100-Year (in.)
0:05	0.012	0.018	0.022	0.019
0:10	0.024	0.033	0.041	0.057
0:15	0.050	0.078	0.090	0.087
0:20	0.096	0.138	0.165	0.152
0:25	0.150	0.225	0.275	0.266
0:30	0.084	0.117	0.132	0.475
0:35	0.038	0.049	0.062	0.266
0:40	0.030	0.040	0.047	0.152
0:45	0.018	0.032	0.042	0.118
0:50	0.018	0.032	0.035	0.095
0:55	0.018	0.027	0.035	0.076
1:00	0.018	0.027	0.035	0.076
1:05	0.018	0.027	0.035	0.076
1:10	0.012	0.027	0.035	0.038
1:15	0.012	0.023	0.035	0.038
1:20	0.012	0.020	0.028	0.023
1:25	0.012	0.020	0.021	0.023
1:30	0.012	0.020	0.021	0.023
1:35	0.012	0.020	0.021	0.023
1:40	0.012	0.014	0.021	0.023
1:45	0.012	0.014	0.021	0.023
1:50	0.012	0.014	0.021	0.023
1:55	0.006	0.014	0.019	0.023
2:00	0.006	0.012	0.014	0.023
2:05	0.000	0.000	0.000	0.000

No area adjustment factors were applied.

3.3 Basin Characteristics

3.3.1 Basin Delineation

Major basins were delineated based on flow directions determined in GIS using the COL's LIDAR and the National Map Viewer outside the City. The major basins were then adjusted and subdivided based on the storm sewer network and defining features such as surface water, storages, parks, and major roads.

Laramie River North

The Laramie River North major basin consists of 10 sub-basins that range in size from 20 acres to 119 acres with an average size of 53 acres. The sub-basin delineation was primarily derived from storm sewer system mapping and the UPRR right-of-way bisecting the basin. Three sub-basins had significant increases in impervious area for future conditions compared to existing conditions. The other seven sub-basins had no significant changes (greater than one percent) between existing and future development conditions.

Laramie River South

The Laramie River South major basin consists of eight sub-basins that range in size from 131 acres to 2,666 acres with an average size of 816 acres. Significant features influencing sub-basin boundaries include Highway 287, UPRR, the Laramie River, and the existing storm sewer system. Three sub-basins had significant increases in impervious area for future conditions compared to existing conditions. The other five sub-basins had no significant changes between existing and future development conditions.

Laramie River West

The Laramie River West major basin consists of five sub-basins that range in size from 46 acres to 840 acres with an average size of 439 acres. The sub-basin delineations were influenced by Interstate-80, the Laramie River, and WY Highway 230. Four sub-basins had significant increases in impervious area for future conditions compared to existing conditions. The other sub-basin had no significant changes between existing and future development conditions.

Spring Creek Middle

The Spring Creek Middle major basin consists of 27 sub-basins that range in size from 5 acres to 624 acres with an average size of 135 acres. The sub-basins were divided by Grand Avenue, Interstate-80, Spring Creek, and the existing storm sewer system. Twenty one sub-basins had significant increases in imperious area for future conditions compared to existing conditions. The remaining six sub-basins had no significant changes between existing and future development conditions.

Spring Creek North

The Spring Creek North major basin consists of 27 sub-basins that range in size from 5 acres to 1,869 acres with an average size of 279 acres. The sub-basins are distinguished by Jacoby Golf Course, Spring Creek, and the University of Wyoming Campus. Ten sub-basins had significant increases in impervious area for future conditions compared to existing conditions. The other 17 sub-basins had no significant changes existing and future development conditions.

Spring Creek South

The Spring Creek South major basin consists of 18 sub-basins that range in size from 100 acres to 3,043 acres with an average size of 1,028 acres. The sub-basins are distinguished by I-80, Highway 287, UPRR, and small developments. One sub-basin had significant increases in impervious area for future conditions compared to existing conditions. The other 17 sub-basins had no significant changes between existing and future development conditions.

3.3.2 Basin Imperviousness

The existing imperviousness for each basin was calculated using an average weighted area method based on typical values for developed areas from the UDFCD Drainage Criteria Manual (Volume 1, Table RO-3), spot-checked with actual measurements of impervious areas form aerial imagery. Undeveloped areas were calculated as 2% impervious. Table 3.3-1 below shows the typical impervious values used.

Table 3.3-1: Recommended Impervious Values (From UDFCD)

Land Use or Surface Characteristics	Percentage Imperviousness
Business:	
Commercial areas	95
Neighborhood areas	85
Residential:	
Single-family	*
Multi-unit (detached)	60
Multi-unit (attached)	75
Half-acre lot or larger	*
Apartments	80
Industrial:	
Light areas	80
Heavy areas	90
Parks, cemeteries	5
Playgrounds	10
Schools	50
Railroad yard areas	15
Undeveloped Areas:	
Historic flow analysis	2
Greenbelts, agricultural	2
Off-site flow analysis (when land use not defined)	45
Streets:	
Paved	100
Gravel (packed)	40
Drive and walks	90
Roofs	90
Lawns, sandy soil	0
Lawns, clayey soil	0

*From Figures RO-3 through RO-5 in UDFCD.

Impervious values for future development conditions were calculated by assuming the undeveloped portion of existing sub-basins will be developed according to its current zoning and then using a typical imperviousness for that zoning category. Table 3.3-2 was developed by correlating the UDFCD recommended values to the COL zoning code.

Table 3.3-2: Recommended Imperviousness Values

City Zoning Code	Description	Percent Imperviousness
AE	Airport Enterprise	15*
AG	Agriculture	2
AV	Aviation	15*
B1	Limited Business	95
B2	General Business	95
BIR	Business in Residential	65
C2	Commercial Wholesale	95
DC	Downtown Commercial	95
I1	Light Industrial	80
I2	Industrial Park	90
IP	Industrial Park	90*
LM	Limited Manufacturing	90*
LR	Low-Density Residential	30
NB	Neighborhood Business	85
O	Open Zone	2
R1	Low-Density Residential	30**
R2	Medium-Density Residential	75**
R2M	Medium-Density Residential with Independent Manufactured Home	60**
R3	Multifamily	70
R3	PUD	70
RR	Rural Residential	30**
TO	Technology Office	95

*From UDFCD Table RO-3
**Provided by the COL

An area-weighted average was applied to sub-basins containing more than one city zoning code. Figures 3 through 8 show existing and future imperviousness for sub-basins in the Study Area.

3.3.3 Flow Length and Basin Width

Sub-basin lengths were determined by measuring the longest flow path of each sub-basin from the most upstream point to the outlet, using available topography data. The sub-basin width was calculated by taking the sub-basin area divided by the basin length.

3.3.4 Slope

For each sub-basin, a percent slope was established from available topographic data by running the slope tool in ArcGIS 10.2 to establish an average slope for the sub-basin.

3.3.5 Soils Information

Soil information was downloaded from the USDA website. Based on this information, each soil type was categorized by its designated NRCS hydrologic soil group. Soils are divided into four NRCS hydrologic soil groups, as defined in Table 3.3-3 below. Areas that are covered by water or that have been disturbed by mining activities are excluded from hydrologic soil classification. Hydrologic soils group definitions were taken from NRCS.

Table 3.3-3: Hydrologic Soils Group Definitions

Soils Group	Definition	Saturated Hydraulic Conductivity (in/hr)
A	Low runoff potential. Soils have high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well to excessively drained sands or gravels.	≥0.45
B	Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well-drained soils with moderately fine to moderately coarse textures. E.g., shallow loess, sandy loams.	0.30 – 0.15
C	Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine textures. E.g., clay loams, shallow sandy loam.	0.15 – 0.05
D	High runoff potential. Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay-pan or clay layer at or near the surface, and shallow soils over nearly impervious material.	0.05 – 0.00

All four NRCS hydrologic soil groups are present within the Study Area, as shown in Figure 9. Soils on the east side of the Study Area are predominantly Group D, with interspersed areas of Group B and C, while soils on the west side of the Study Area, including the COL, are predominantly Group C, with scattered areas of Group A and B soils.
The soil classifications were used in the PCSWMM model by correlating the NRCS hydrologic soil group with typical infiltration rates for those groups. Infiltration rates were based on Horton's equation, as recommended by the UDFCD. Horton's equation utilizes an initial infiltration rate, a final (saturated conditions) infiltration rate, and a decay rate to

determine the infiltration rate as soils progress from dry to saturated conditions during a storm event. Table 3.3-4 shows the recommended Horton's infiltration parameters for each hydrologic soil group (USDCM, 2001). Infiltration parameters for each sub-basin were determined by calculating an area-weighted average of the soil groups present in each sub-basin. PCSWMM input parameters for each sub-basin are provided in Appendix A.

Table 3.3-4: Horton Infiltration Parameters

Hydrologic Soil Group Classification					
	A	B	C	D	Mine
Initial Infiltration Rate (in/hr)	5	4	2	1	3
Final Infiltration Rate (in/hr)	0.45	0.225	0.1	0.025	0.1
Decay Rate – α (in/hr)	2.52	6.48	6.48	6.48	6.48

4 HYDRAULIC ANALYSIS

4.1 Hydrograph Routing

PCSWMM was used to route the hydrographs developed for each sub-basin through surface water features such as detention storage, channels, storm sewer infrastructure, and overland flow. Figures 10-18 show the PCSWMM routing schematics, illustrating the relative location and connectivity of the PCSWMM network. The routing elements are categorized as conveyance elements (pipes or open channels), storage elements (detention ponds or informal storage areas), design nodes (points were multiple conveyances converge), and outfalls (the end of a model network, typically the discharge point to the Laramie River).

Spring Creek North, Spring Creek Middle, and Spring Creek South major basins discharge into Spring Creek at various locations. Spring Creek was modeled using PCSWMM, with design nodes placed at each discharge point to the creek and each crossing modeled using the approximate dimensions of the culvert or bridge. The Laramie River North, Laramie River South, and Laramie River West major basins discharge to the Laramie River.

4.2 Evaluation of Existing Facilities

Hydraulic analysis was performed in the Study Area using PCSWMM as well. Pipe sizes were determined using data provided by the COL and field investigations. Channel roughness and detention ponds were both integral aspects of the modeling. They are discussed in the following sections.

4.2.1 Channel Roughness

Manning's n selection throughout the study area was dependent on factors including surface roughness and sinuosity. Field inspection and photography was determined to be the best method to determine Manning's n for open channels such as Spring Creek. Roughness coefficients for channel design provided in UDFCD were used for Manning's n values for Spring Creek. Appendix C shows photographs of field conditions to determine Manning's n values for given reaches along Spring Creek and basin drainages. *Open Channel Hydraulics (Chow)* was used to determine appropriate values based on materials found during the field investigation. Table MD-1 shows the suggested values from Chow.

Table MD-1: Roughness Coefficients ("n") for Channel Design (after Chow, 1959)

Channel Type	Roughness Coefficient (n)		
	Minimum	Typical	Maximum
I. Excavated or Dredged			
1. Earth, straight and uniform			
a. Gravel, uniform section, clean	0.022	0.025	0.030
b. With short grass, few weeds	0.022	0.027	0.033
2. Earth, winding and sluggish			
a. Grass, some weeds	0.025	0.030	0.033
b. Dense weeds or aquatic plants	0.030	0.035	0.040
c. Earthly bottom and rubble/riprap sides	0.028	0.030	0.035
3. Channels not maintained, weeds and brush uncut			
a. Dense weeds, high as flow depth	0.050	0.080	0.120
b. Clean bottom, brush on sides	0.040	0.050	0.080
II. Natural streams (top width at flood stage 100 ft)			
1. Streams on plain			
a. Clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
b. Clean, winding, some pools and shoals, some weeds and stones	0.035	0.045	0.050
c. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150
III. Lined or Built-up Channels			
1. Concrete			
a. Trowel/float finish	0.011	0.015	0.016
b. Shotcrete	0.016	0.020	0.025
2. Gravel bottom with sides of			
a. Formed concrete	0.017	0.020	0.025
b. Random stone in mortar	0.020	0.023	0.026
c. Dry rubble or riprap	0.023	0.033	0.036

4.2.2 Detention Ponds

Nineteen existing ponds were modelled in PCSWMM using stage-storage curves developed from design reports or from topographic data provided by the COL and National Map Viewer. In general, small detention ponds and ponds serving single properties were not included in the analysis, as these ponds are not likely to impact major storm event runoff. Additionally, maintenance of small, single-site, ponds is not controlled or directed by the COL and the performance of these ponds cannot be guaranteed. Single-site ponds in the Turner Tract were included in the model, since a detailed analysis of this area was required. Table 4.2-1 below lists the existing detention storage included in the model. Detention ponds locations are shown on Figure 19.

Table 4.2-1: Existing Detention Ponds

Pond Name	Model Routing No.	Major Basin	Maximum Storage Volume (acre-feet)
Informal Ponding at Highway 287 Crossing	LS305	Laramie River South	83.8
Informal Ponding at UPRR Crossing	LS315	Laramie River South	308.3
New High School – South	SM305	Spring Creek Middle	1.1
Ice and Event Center	SM310	Spring Creek Middle	1.4
New High School – North	SM311	Spring Creek Middle	1.2
Mountain West Farm Bureau	SM315	Spring Creek Middle	0.8
Laramie County Community College	SM320	Spring Creek Middle	0.3
Beech Street and Boulder Drive	SM325	Spring Creek Middle	4.7
Wal-Mart	SM330	Spring Creek Middle	4.9
Church	SM335	Spring Creek Middle	1.3
Informal Ponding at Vista Drive Crossing	SM340	Spring Creek Middle	1.7
Tailgate Park	SN305	Spring Creek North	9.4
UW Plaza Underground	SN310	Spring Creek North	2.4
Jacoby Pond #5	SN315	Spring Creek North	1.2
Jacoby Pond #4	SN320	Spring Creek North	9.8
Jacoby Pond #1	SN325	Spring Creek North	9.4
Informal Ponding at Highway 287 and Skyline Drive	SS305	Spring Creek South	34.0
Informal Ponding near Skyline Drive	SS306	Spring Creek South	4.7
15th Street and Skyline Drive	SS310	Spring Creek South	3.0

4.3 Quality Control and Model Calibration

Quality control for the model was provided through independent review of model input parameters and calibration of the model. Both hydrologic (sub-basin characteristics) and hydraulic (conveyance element characteristics) were reviewed for accuracy.

The first method used to calibrate the PCSWMM model created for this Study was to compare the results to previous analyses. The only previous comprehensive study of the south Laramie area is the Flood Insurance Study (FIS) for Albany County, Wyoming and Incorporated Areas, effective June 16, 2011. The 2011 FIS was used to support the development of floodplain boundaries for Spring Creek and the Laramie River. The 2011 FIS calculated peak discharges at various cross-section locations along Spring Creek: near Grand Avenue, near 16th Street, near 7th Street, near 3rd Street, and at the confluence with the Laramie River.

The FIS 100-year discharges are compared to the Amec Foster Wheeler PCSWMM analysis in Table 4.3-1 below. As shown in the table, the flows from the PCSWMM model are much higher than the flows determined by the FIS. This discrepancy is most likely due to the difference in methodology used between the two studies. Due to a lack of streamgage records, the 2011 FIS used a regression equation developed by the USGS and Wyoming Highway Department (USGS, 1977). The regression equations are based solely on tributary drainage area, with a different equation for various geographic regions within Wyoming. The Spring Creek drainage basin appears to straddle two geographic regions, Region 4 and Region 2. The FIS used the equation for Region 4. The equation for Region 2 yields peak flows much closer to the PCSWMM model results (Spring Creek at Grand Avenue = 1,555 cfs).

While the FIS utilized only drainage area to determine peak flows, the PCSWMM model is a detailed rainfall-runoff model that uses additional sub-basin characteristics such as slope, soil type, imperviousness, and basin shape to predict runoff from a 100-year rainfall event. Since this detailed analysis is expected to yield a more accurate result than the USGS regression equation, Amec Foster Wheeler created an independent rainfall-runoff model using HEC-HMS, a model developed by the US Army Corps of Engineers, for the portion of the Study Area tributary to Spring Creek at Grand Avenue. This independent analysis yielded a 100-year peak flowrate of 1,851 cfs, which is within 3% of the PCSWMM model result (1,917 cfs).

Table 4.3-1: 100-year Peak Flow Rate Comparison

Hydrologic Method Used	Hydrologic Study	Spring Creek at Grand Ave	Spring Creek at 16th St.	Spring Creek at 7th St.	Spring Creek at 3rd St	Confluence with Laramie River
USGS Regression Equation	**2011 FIS Peak Flow (cfs)**	863	1,007	1,141	1,720	2,159
Detailed Rainfall-Runoff Model	**Amec Foster Wheeler PCSWMM Model (cfs)**	1,917	2,216	2,283	4,462	4,462
	% Difference (±) to 2011 FIS	122%	120%	100%	159%	107%
Detailed Rainfall-Runoff Model	**Independent HEC-HMS Model (cfs)**	1,851	NA	NA	NA	NA
	% Difference (±) to PCSWMM Model	-3%	NA	NA	NA	NA

4.4 Analysis and Results

Peak flows were estimated from rainfall and the physical attributes of the watershed. Table 4.4-1 provides existing development condition peak flow information at critical design points in the Study Area for the 100-year event. Table 4.4-1 also provides future development conditions peak flow information at critical design points in the Study Area for the 100-year event. Peak flow rates at all model nodes (junctions, conduits, storages, and outfalls) are provided in Appendix B for the 2, 5, 10, and 100-year storm events for the future development conditions model.

Table 4.4-1: Summary of Discharges for Existing and Future Development Conditions

Location	Design Point	Existing Development Conditions	Future Development Conditions
		100-Year (cfs)	100-Year (cfs)
SC at Grand Avenue	SN180	1,917	1,930
SC at 16th Street	SC145	2,216	2,795
SC at 7th Street	SC125	2,283	2,630
SC at 3rd Street	SN105	4,462	5,222
SC at Confluence	LN425	4,462	5,165
3rd Street at Kearney Street (surface)	LN235-S	61	61
3rd Street at Kearney Street (storm sewer)	LN235	69	72
Steele Street and 1st Street (surface)	LN305-S	224	224
Steele Street Discharge to Laramie River	LN420	267	267
Skyline Drive and 15th Street	SS310	1,926	1,926
Skyline Drive and Soldier Springs Road	SS105-S	1,036	1,036
Skyline Drive and Highway 287	SS305	2,729	2,729
Discharge to Spring Creek at 3rd Street	SS204-S	2,671	2,685

4.4.1 Evaluation of Existing Storm Sewer Systems

Amec Foster Wheeler conducted a simplified analysis of each existing storm sewer system. The discharges from upstream basins entering the COL were routed through existing storm sewer systems. Where flow exceeded pipe capacities, the overflow was carried via parallel open channels representing the streets. Street sections were modeled based on street slope and the typical cross-section based on the type of street (i.e. local, collector, or arterial). The depth of flow in the street was compared to the specific criteria for street encroachment for local, collector, and arterial streets (Draft Drainage Design Criteria, City of Laramie, March 2013). For local and collector streets, maximum allowable depth of runoff was 0.65 ft. For arterial streets, the maximum depth of runoff was 0.81 ft. If the runoff depth exceeded these limits, then that section of the system was concluded to be a flood hazard.

The model results for the existing storm sewer systems are summarized in Table 4.4-3 below. As shown, there are multiple systems that are undersized and will force the street capacity to be exceeded during a 100-year event, resulting in flooding of private property. Upgrades to these systems are included in the alternative solutions presented later in this report. It should be noted that the storm sewer systems and street network north of Spring Creek from 30th Street to 1st Street is a very complex system that was modeled in a relatively simplified manner for the purposes of master planning. The storm sewer systems in this area often slope in a different direction than the street surfaces above, with excess surface flows routed to other systems. Prior to final design and construction of improvements in this area, **it**

is recommended that the COL conduct a detailed 2-dimensional hydraulic analysis that includes all portions of the storm sewer system and utilizes the surface topography to route flows exceeding the storm sewer capacity.

Table 4.4-3: Existing Storm Sewer System Analysis Results – 100-Year Event

Receiving Water	Outfall Line	Outfall Naming Convention	Major Basin	Modeling Result
Laramie River	Snowy Range Road East	SRE	Laramie River West	Street flow acceptable.
Laramie River	Snowy Range Road West	SRW	Laramie River North	Street flow acceptable.
Laramie River	Steele Street	STL	Laramie River North	Street capacity exceeded in 100-year event along Kearney St. from 3rd St. to 2nd St., along 2nd St. from Kearney St. to Steele St., and along Steele St. from 2nd St. to UPRR. 5' dia. pipe under UPRR ROW is surcharged.
Spring Creek	5th Street	SC5	Spring Creek North	Street flow acceptable.
Spring Creek	9th Street	SC9	Spring Creek North	Street flow acceptable.
Spring Creek	12th Street	SC12	Spring Creek North	Street flow acceptable.
Spring Creek	13th Street	SC13	Laramie River North	Street capacity exceeded from Sheridan St. to Spring Creek.
Spring Creek	15th Street North	SC15N	Spring Creek North	Street flow acceptable.
Spring Creek	15th Street South	SC15S	Spring Creek Middle	Street flow acceptable.
Spring Creek	17th Street	SC17	Spring Creek North	Street flow acceptable.
Spring Creek	21st Street	SC21	Spring Creek North	Street capacity exceeded from Rainbow to Spring Creek.
Spring Creek	22nd Street	SC22	Spring Creek North	Street capacity exceeded from Rainbow to Spring Creek.
Spring Creek	24th Street	SC24	Spring Creek North	Street flow acceptable.
Spring Creek	30th Street	SC30	Spring Creek North	Street capacity exceeded from Ivinson Memorial Hospital to Spring Creek.
Spring Creek	La Prele Street	LAP	Spring Creek Middle	Street flow acceptable.
Spring Creek	Skyline Drive	SKY	Spring Creek South	Street capacity exceeded at Soldier Springs Road to Highway 287.

4.5 Flood Hazards

Flood hazards were identified for both existing and future development conditions, based on PCSWMM model results for the 100-year storm event. Flooding hazards include Spring Creek overtopping its banks at multiple locations throughout the City, overtopping of Vista Drive, and street flooding (Regency Drive, 30th Street, 22nd Street, 21st Street, 13th Street, Soldier Springs Road, Kearney Street, 3rd Street, 2nd Street, and 1st Street). Flood hazard areas are shown on Figure 20 for existing and future development conditions. While the locations of flooding are similar between existing and future development, the depths and extent of flooding at these locations will be greater during future development conditions.

4.6 Previous Analyses

There are no previous master planning studies encompassing the entire South Laramie Drainage area. Two studies have been completed that included a portion of the Study Area:

- South Gateway Drainage Study (Coffey, 2012)
- Stormwater Drainage Report for the Turner Tract Preliminary Plat (Joel Farber Consulting, 2002).

The South Gateway Drainage Study included a small portion of the Laramie North and Spring Creek North major basins, along Highway 287 just north of I-80. This report recommended local street and storm sewer improvements to convey runoff to the existing 60-inch storm sewer at 1st Street and Steele Street, but it did not evaluate improvements to this line to carry major storm event flows across the UPRR property to the Laramie River. The study also included recommendations for re-routing flows to Spring Creek instead of the 60-inch storm sewer but acknowledged that additional evaluation of downstream impacts in Spring Creek would be required.

The Stormwater Drainage Report for the Turner Tract Preliminary Plat divided the study area into six major drainage basins, four on-site basins, and two off-site basins to the east. Seven locations were identified for detention storage within the development, totaling approximately 15 AF, to reduce discharges from each basin to historic discharge rates. One existing pond (Walmart Pond) had already been constructed. The study used the rational method to determine peak discharge rates from each basin, except for the 510-acre off-site basin, which used a regression equation based on drainage area and annual precipitation. The calculated run-on from this basin was reduced to match the capacity of culverts at Grand Avenue and Vista Drive. The report called for open channels to route stormwater flows through the development and discharge into Spring Creek near Garfield Street.

Since the 2002 Turner Tract drainage report, development patterns have differed from the preliminary plat, resulting in stormwater management improvements that have varied from the report. Of the seven detention ponds specified in the 2002 report, four have been constructed (Farm Bureau, LCCC, Ice Arena, and Beech Street ponds). Two detention ponds that were not included in the 2002 report are currently being constructed at the new high school site, which was not part of the preliminary plat. Development patterns have also impacted the open channel flow patterns specified in the 2002 report. The development of a church and an emergency access road to the Point, a student housing complex near Garfield Street and Regency Drive, impede the open channel discharge to Spring Creek, and flooding has been observed in these areas.

5 ALTERNATIVE ANALYSIS

5.1 Alternative Development Process

The alternative analysis is meant to identify all realistic alternatives in a comprehensive manner that would assure that all reasonably feasible solutions were considered. The following types of alternatives were evaluated: new detention ponds, conveyance structure improvements, and expanding/modifying existing detention ponds.

The goal is to minimize the analysis of proposed facilities such that only the most suitable alternatives were chosen for development. A screening matrix was developed to determine which alternatives would be looked at in greater detail. The best alternatives were examined further to identify the benefits, estimate construction and operation and maintenance costs, and locate right-of-way (ROW) and easement requirements. Improvements were modeled to safely pass runoff from the 100-year event.

5.2 Criteria and Constraints

The alternatives considered for the South Laramie Study Area were developed to address flood hazards, including overtopping of Spring Creek. The alternatives were developed using UDFCD and City of Laramie design criteria for allowable street flow and detention pond design. New detention storage was designed to detain flow for the 100-year event under future development conditions. Conveyance was modeled allowing for street flow in addition to storm sewer flow, as storm sewers are typically sized for minor storm events, with major storm events carried in the streets and storm sewer system. Conveying the 100-year storm event in a storm sewer system is usually cost-prohibitive due to extensive utility relocation and high construction costs.

The COL maintains Spring Creek within the South Laramie Study Area within city limits. Though no recently recorded storm events in this basin have caused significant damage to property or threatened human safety due to flooding from Spring Creek, the effective Flood Insurance Study (FEMA, 2011) describes “major flooding” on Spring Creek in 1953 and 1955, resulting in “property damage and interruption of transportation services caused by roadway washouts”. Hydrologic and hydraulic modeling suggests the likely flooding of Spring Creek along with other structures in the basin during major storm events. The protection of private land near Spring Creek and other potentially critical flood areas was of high importance during consideration of alternatives. Due to the likelihood of flooding from Spring Creek, improvements that would divert additional runoff or otherwise increase peak flows to Spring Creek were not considered.

Concurrent with this master plan, a Turner Tract Master Plan was developed (Amec Foster Wheeler, 2016). The recommended improvements for the Turner Tract, Alternative TT-3, included the construction of a new detention pond upstream of Regency Drive, and modifications to the outlet structure and expansion to maximize the effectiveness of the existing detention pond at Beech St. and Boulder Dr. These recommended improvements were included in the analysis of all alternatives described below.

5.3 Types of Improvements

All potential improvements were discussed and screened with the project sponsors and stakeholders to determine which alternatives were developed. Two types of flood mitigation solutions were defined as viable for further development within the South Laramie Study Area.

Detention

This type of improvement would involve constructing new or modifying existing detention facilities to attenuate flows. This would include maximizing storage for peak flow reduction to the greatest extent feasible, modifying existing outlet works and possibly re-routing inflows received by the proposed facility. Detention ponds were modeled to release storm flows at rates less than downstream capacity limitations. Construction of the proposed improvements would minimize downstream drainage infrastructure costs by attenuating flows at the proposed facilities to the greatest extent possible. This alternative assumes that:

- Facilities will be regional and maintained by the COL,
- The construction and maintenance cost of downstream infrastructure will be less with the detention facilities,
- Existing detention facility volumes will be maximized given the site constraints, and
- New detention facility locations will be limited to reasonable sites.

Upgrade Conveyance Structures

This alternative would construct conveyance structures, or upsize existing structures, to increase capacity at below grade flow crossings, street crossings, and open channels. This alternative replaces or constructs new conveyance crossings and minimizes flood damages during the 100-year storm event. This alternative assumes:

- Underground conduits and open channels would be installed to convey the 100-year storm event and
- Access would be constructed to allow for routine maintenance.

5.4 Unit Costs

Unit costs were estimated using 2009 UDFCD unit cost index data, WYDOT bid tabulations, or recent local bid prices. An annual rate of inflation of 3% was used to convert cost data to present worth.

A summary of construction costs of the drainageway improvements, land acquisition, dewatering, mobilization, traffic control, utility coordination/relocation, stormwater management/erosion control, engineering, legal/administrative, construction management, and contingencies can be found in Table 5.4-1.

Table 5.4-1: Unit Costs

Item	Unit	Unit Price
Capital Improvement Costs		
Circular Pipes		
18-inch	LF	$63
24-inch	LF	$84
30-inch	LF	$105
36-inch	LF	$126
42-inch	LF	$147
48-inch	LF	$168
54-inch	LF	$189
60-inch	LF	$210
Bore and Jack, up to 36-inch Diameter	LF	$1,000
Bore and Jack, up to 60-inch Diameter	LF	$2,000
Manholes and Inlets		
Manhole, 4' DIA. (Pipe Diameter less than 36-inch)	EA	$3,000
Manhole, 5' DIA. (Pipe Diameter 36-inch - 42-inch)	EA	$4,500
Manhole, 6' DIA (Pipe Diameter greater than 42-inch)	EA	$9,000
Storm Inlet, Type R/Type 14, 5-foot	EA	$3,500
Concrete Box Culverts		
3' x 6'	LF	$800
4' x 6'	LF	$850
3' x 7'	LF	$1,200
Channel Improvements		
Boulder Edging, 12-inch High	L.F.	$75
Soil Riprap, Type L	C.Y.	$55
Excavation, Low Range	C.Y.	$12
Grouted Boulders, 36-inch	S.Y.	$250
Boulder Edging, 36-inch High	L.F.	$90
Detention/Water Quality Facilities		
Excavation	CY	$15
Outlet Works, Large	EA	$40,000
Outlet Works, Small	EA	$20,000
Inlet Protection	EA	$10,000
Concrete Low-flow Channel	LF	$45
Impermeable Pond Lining (EPDM with 8-ounce underlayment and 4-inch sand bed)	SF	$3.35
Removals		
Removal of Culvert Pipe (Diameter less than 48-inch)	LF	$30
Landscaping and Maintenance Improvements		
Reclamation and seeding (native grasses)	ACRE	$1,000
Trail/Path, Concrete (10-foot Width)	L.F.	$40
Additional Capital Construction Costs		

Item	Unit	Unit Price
Dewatering	%	8
Mobilization	%	5
Traffic Control	%	2
Utility Coordination/Relocation	%	2
Stormwater Management/Erosion Control	%	5
Land Acquisition		
Easement/ROW Acquisition	ACRE	$100,000
Other Cost (percentage of Capital Improvement Costs)		
Engineering	%	10
Legal/Administrative	%	5
Contract Admin/Construction Management	%	5
Contingency	%	25

The costs for conveyance improvements include excavation and backfill, pavement removal and replacement, pipe, erosion protection, and bore and jacking (where applicable). The costs for detention include excavation, inlet protection structures, concrete low-flow channels, re-vegetation and outlet works. Detailed conceptual construction cost estimates for recommended improvements are provided in Appendix D.

5.5 Description of Alternatives

The following potential improvements, in Table 5.5-1 below, were considered to reduce or eliminate flooding hazards in the Study Area. Potential improvements recommended for further analysis were modeled as described in the alternatives outlined in the following sections.

Table 5.5-1 Potential Improvements

Proposed Improvement	Description	Scope Required	Result / Recommendation
Spring Creek Middle and Spring Creek North Major Basins			
Modify outlet of existing pond at Beech Street and Boulder Drive. (Beech Pond)*	Existing pond oversized: Approximately 54% of pond capacity used during 100-year event.	Modify outlet structure to reduce discharge and maximize detention volume.	Decreases peak flow at Regency Drive. **Recommended for further analysis.**
Construct new Turner Tract Pond upstream of Regency Drive*	New pond to reduce peak discharge to capacity of Regency Drive storm sewer.	Would require excavation and embankment construction and outlet structure to discharge into Regency Drive storm sewer.	Decreases peak flow at Regency Drive. **Recommended for further analysis.**

Proposed Improvement	Description	Scope Required	Result / Recommendation
Construct new detention pond on University of Wyoming property upstream of Grand Avenue*	Large on-line detention pond to decrease off-site discharge into Turner Tract and decrease overtopping at Vista Drive.	Purchase property and expand storage volume to create detention pond.	Decreases peak flow to Vista Drive. Decreases peak flow at Regency Drive. **Recommended for further analysis.**
Expand LaPrele Park Pond ("Huck Finn Pond") to include detention storage.	Divert high flows from Spring Creek into expanded pond to reduce peak flow in Spring Creek.	Construct diversion structure on Spring Creek and embankment to create 14 AF of detention storage above the permanent water surface at Huck Finn Pond.	Reduces 100-year peak flow in Spring Creek **Recommended for further analysis.**
Construct new detention pond south of Spring Creek at 17th Street.	Divert high flows from Spring Creek into pond to reduce peak flow in Spring Creek.	Purchase property and construct embankment to create 48 AF of detention storage. Construct diversion structure on Spring Creek.	Reduces 100-year peak flow in Spring Creek **Recommended for further analysis.**
Construct new detention pond south of Spring Creek at 26th Street.	Divert high flows from Spring Creek into pond to reduce peak flow in Spring Creek.	Purchase property and construct embankment to create 15 AF of detention storage. Construct diversion structure on Spring Creek.	Reduces 100-year peak flow in Spring Creek **Recommended for further analysis.**
Construct new detention pond east of Jacoby Golf Course on University of Wyoming property.	Large on-line detention pond to mitigate upstream runoff originating on Pole Mountain.	Purchase property or easement and construct embankment and excavation to create 247 AF detention storage.	Reduces 100-year peak flow in Spring Creek **Recommended for further analysis.**
Maximize Flow to Jacoby Golf Course Ponds.	Jacoby Golf Course Ponds have capacity to accept all runoff from upstream basin, which currently flows to Reynolds Street System (out of study area)	Additional inlets, increasing storm sewer size.	Does not impact 100-year peak flow in Spring Creek. Reduces 100-year peak flow to Reynolds Street **Recommended for further analysis.**
Upgrade Existing Storm Sewer Systems	Modeling indicated that several streets will exceed capacity during 100-year storm events, flooding private property. Upgrading existing storm sewer systems will decrease street flows.	Remove and replace storm sewers in 22nd, 21st, and 13th Streets. Extend storm sewer in 30th Street.	Prevents flooding of private property. **Recommended for further analysis.**
Install box culvert from Boswell Drive to Spring Creek	4' x 6' box culvert to collect and convey surface flows from Boswell Drive near I-80 West off-ramp and convey to Spring Creek.	Acquire easement and Install 4' x 6' box culvert across undeveloped property.	Prevents flooding of private property. **Recommended for further analysis.**

Proposed Improvement	Description	Scope Required	Result / Recommendation
Widen Spring Creek	Expand Spring Creek to maximum cross-section within existing right-of-way and replace culverts/bridges as needed to avoid overtopping.	Excavation to widen channel. Multiple crossing replacements required (3rd Street, 2nd Street, UPRR)	Spring Creek still overtops in multiple areas. **Not recommended for further analysis.**

Laramie River North Major Basin			
Optimize University of Wyoming Pond at 10th Street and Ivinson Street	Existing depression area (0.8 AF) receives only minor local runoff. Routing additional flows into this area could reduce peak discharge to downstream storm sewer system.	Obtain agreement with University. Divert storm sewer at 11th Street and Ivinson Street to pond. Construct outlet structure and construct discharge pipe to storm sewer at 9th Street and Ivinson Street.	Marginal decrease in peak flow to downstream system; does not reduce size of downstream improvements **Not recommended for further analysis.**
Construct new detention pond in Undine Park	Construct detention pond in park to reduce peak flows to Steele Street outfall.	Would require extensive excavation and tree removal or modifications to open areas used as athletic fields.	City Parks Department reluctant to retrofit parks for detention. Due to extensive modifications required, **not recommended for further analysis.**
Upgrade Steele Street outfall storm sewer system	Lack of upstream locations for new detention necessitates upgrades to storm sewer system.	Install second 60-inch storm sewer under UPRR. Upgrade storm sewer in Kearney Street to 54-inch and 3rd Street to 48-inch. Upgrade storm sewer in Grand Avenue and 5th Street to 36-inch. Construct new 24-inch storm sewer in 1st Street from Sanders Street to Steele Street	Passes 100-year storm event while keeping street flows within criteria. **Recommended for further analysis.**
Construct storm sewers to divert flow to Spring Creek	Alleviate peak flows to Steele Street Outfall system by diverting flow in North Laramie Major Drainage Basin to the south, discharging to Spring Creek.	Construct various storm sewers in neighborhoods north of Spring Creek and route to creek.	Would create additional flooding hazard in Spring Creek. Informal City policy prohibits additional storm runoff to Spring Creek. **Not recommended for further analysis.**
Re-purpose 18-inch sanitary sewer for use as storm sewer	Recently abandoned sanitary sewer could be used to carry storm runoff from 2nd Street and Sanders Street across UPRR ROW to Laramie River.	Connect inlets at 2nd Street and Sanders Street to new manhole. Install new manhole near end of Pine Street and install new piping to existing 60-inch outfall or to Laramie River.	While not enough capacity to greatly impact 100-year event, provides relief in this area during minor storms. **Recommended for further analysis.**
Rehabilitate 36-inch culvert under UPRR at Sanders St.	Existing 36-inch steel culvert at 1st Street and Sanders Street is nearly clogged at each end.	Excavate each end of culvert, jet/vacuum to remove sediment in pipe. Inspect pipe to assess condition. Excavate channel or extend culvert to Laramie River.	While not enough capacity to greatly impact 100-year event, provides relief in this area during minor storms. **Recommended for further analysis.**

Spring Creek South Major Basin			
Construct new pond(s) upstream of Skyline Road	Large detention pond would attenuate peak flows reaching Skyline Road and minimize flood hazard at Soldier Springs Road, 3rd Street, and Spring Creek.	Purchase property, excavate and construct embankments to create up to 400 AF of storage.	Decreases peak flows and reduces size of downstream improvements. **Recommended for further analysis.**
Construct new pond(s) upstream of Hidden Springs Road	Large detention pond would attenuate peak flows reaching Skyline Road and minimize flood hazard at Soldier Springs Road, 3rd Street, and Spring Creek.	Purchase property, excavate and construct embankments to create up to 175 AF of storage.	Decreases peak flows and reduces size of downstream improvements. **Recommended for further analysis.**
Divert flow under Highway 287 near Skyline Drive.	Diverting flow from Soldier Springs Road under Highway 287. Would alleviate 3rd Street flood hazard.	Install (bore) twin 36-inch storm sewers under Highway 287. Acquire permit/easement from UPRR. Install twin 36-inch storm sewers to Spring Creek. **Requires large upstream detention to reduce peak flows.**	Greatly reduces flood hazard at 3rd Street and Spring Creek. **Recommended for further analysis.**
Divert flow under UPRR and Soldier Springs near Hidden Springs Road.	Diverting flow before it reaches Skyline Drive area would alleviate 3rd Street flood hazard.	Install (bore) twin 48-inch storm sewers under Soldier Springs Road and UPRR. Acquire permit/easement from UPRR. **Requires upstream detention to reduce peak flows and downstream improvements to convey flow to Spring Creek.**	Greatly reduces flood hazard at 3rd Street and Spring Creek. **Recommended for further analysis.**
Expand existing informal detention on WYDOT and UPRR property.	If flow diverted to these locations, could alleviate 3rd Street flood hazard and reduce size of downstream infrastructure.	Acquire easement or land from WYDOT and UPRR. Excavate existing depressions to create 149 AF (WYDOT) and 24 AF (UPRR) of detention. **Requires downstream improvements to convey flow to Spring Creek.**	Greatly reduces flood hazard at 3rd Street and Spring Creek. **Recommended for further analysis.**
Re-purpose 12-inch sanitary sewer for use as storm sewer	Recently abandoned sanitary sewer could be used to carry storm runoff from Skyline Drive and Highway 287 to Spring Creek at 3rd Street	Connect/install inlets at Skyline Drive and Highway 287 to new manhole. Install new manhole near Spring Creek at 3rd Street and install new piping to Laramie River.	While not enough capacity to greatly impact 100-year event, provides relief in this area during minor storms. **Recommended for further analysis.**
Add/upgrade culverts and storm sewers.	Upgrade conveyance elements to safely carry undetained flows to Spring Creek.	Install 6' x 10' box culvert in Skyline Drive (2,000 ft). Install 4' x 10' box culvert in Soldier Springs Road (2,000 ft). Install two 8' x 4' box culverts under Highway 287 and I-80 overpass.	Construction of required improvements not feasible due to limited ROW and existing utilities. **Not recommended for further analysis.**

* Note: Recommended Turner Tract Alternative TT-3 included in all Study Area Alternatives

5.5.1 Spring Creek North and Spring Creek Middle Improvements

The Spring Creek North and Spring Creek Middle Major Basins each discharge into Spring Creek as it travels through the COL. The most significant flood hazard in this area is Spring Creek itself, so potential improvements were designed with the primary goal of reducing peak flows to Spring Creek. The Turner Tract is located within this area, so recommended Alternative TT-3 from the Turner Tract Master Drainage Plan (Amec Foster Wheeler, 2016) was included among the recommended improvements.

Improvements considered, but not included in the alternatives analysis included excavation to widen Spring Creek to the maximum extent possible within the existing right-of-way. Existing crossings that were determined to be overtopping during the 100-year storm event were assumed to require replacement. This included 3rd St., 2nd St., UPRR, and a private bridge on the lumberyard property just before the confluence with the Laramie River. Modeling of these channel improvements showed that in several areas, Spring Creek still overtopped, despite the larger channel cross-section. In some areas, particularly from 17th Street to 9th Street, existing development on both sides of the channel limited the space available for channel improvements. Based on the ineffectiveness in preventing flooding, Spring Creek channel capacity improvements were not considered for further analysis.

Proposed improvements in these basins include constructing new detention ponds or expanding existing detention ponds to reduce peak flows so that existing conveyance elements (storm sewers, streets, and open channels, including Spring Creek) can safely convey the 100-year storm runoff to the Laramie River. Multiple iterations were run to optimize the preliminary size and outlet configuration for each pond and to determine the effects on downstream ponds. The following improvements, summarized below in Table 6.5.1 and shown on Figure 21, were evaluated. A summary of peak flow rates during the 2, 5, 10, and 100-year storm events at key design points is provided in Tables 5.5-2, 5.5-3, 5.5-4, and 5.5-5.

All alternatives in the Spring Creek North and Spring Creek Middle major basins include the following recommended improvements:

- Alternative TT-3 from the Turner Tract Master Drainage Plan (Amec Foster Wheeler, 2016): *Construct New Turner Tract Pond, Modify Beech Pond Outlet, and Expand Beech Pond*: Alternative TT-3 is based on modifying the outlet for the existing pond located at Beech Street and Boulder Drive (Beech Pond). Modeling of the existing pond indicated that approximately 46% of its capacity was unused during a 100-year storm event. This pond currently has an outlet that is a box culvert 2 feet high by 10 feet wide. The proposed improvements would install a restrictor plate on this outlet to reduce the opening to a circular opening 24 inches in diameter. By restricting the flow, the existing storage volume could be optimized. Additionally, the volume of the Beech Pond would be increased from approximately 5 AF to 21 AF by expanding the pond footprint within the existing property lines. The improvements were modeled assuming that a one-foot freeboard would be maintained. Alternative TT-3 also includes constructing a detention pond upstream of Regency Drive to reduce the 100-year peak discharge to the capacity of the newly-constructed 36-inch storm sewer in Regency Drive. Approximately 23 AF of storage would be required.

- Grays Gable Road Improvements to Maximize Flow to Jacoby Golf Course Ponds: Based on the as-built construction documents provided by the COL, the three detention ponds on Jacoby Golf Course have the capacity to accept all of the 100-year runoff from sub-basin SN080. This sub-basin routes flow to Grays Gable Road near Inca Drive, where some of the flow is intercepted by inlets in the street and diverted to the Jacoby Golf Course Ponds, while the rest of the flow continues down Grays Gable and out of the Study Area. The North Laramie Drainage Master Plan (SEH, 2013) assumed that all the runoff from sub-basin SN080 stayed within the North Laramie Drainage Master Plan Study Area, and developed recommended downstream improvements based on this assumption. Routing as much flow as possible into the Jacoby Golf Course Ponds is likely to decrease the extent of improvements required by the North Laramie Drainage Master Plan. Improvements at Grays Gable would include additional inlets and upsizing the storm sewer under the road.

- Extension of 30th Street Storm Sewer System: The existing storm sewer system in 30th Street would be extended to accept outflow from the last Jacoby Golf Course Pond, which currently would overtop into 30th Street.

- Upgrades to 22nd Street Storm Sewer System: The existing storm sewer system in 22nd Street would be upsized to a 4' x 6' box culvert from Rainbow Street to Spring Creek.

- Upgrades to 21st Street Storm Sewer System: The existing storm sewer system in 21st Street would be upsized to a 36-inch pipe from Rainbow Street to Spring Creek.

- Upgrades to 13th Street Storm Sewer System: The existing storm sewer system in 13th Street would be upsized to a 30-inch pipe from Garfield Street to Sheridan Street, to a 4' x 3.5' box culvert from Sheridan Street to Ord Street, and to a 4' x 6' box culvert from Ord Street to Spring Creek.

- Constructing a 4'x6' box culvert from Boswell Drive to Spring Creek: Runoff from sub-basins north of I-80 will converge at Boswell Drive near the I-80 off-ramp for 3rd Street. The 100-year flow would exceed the capacity of Boswell Drive, so this proposed box culvert would collect the surface flows and convey them north, across undeveloped land to Spring Creek.

Alternative SN-1: Pond East of Jacoby GC, Turner Tract TT-3, and Storm Sewer Upgrades

In addition to the storm sewer upgrades and Turner Tract improvements listed above, Alternative SCN1 includes the construction of a new detention pond on property owned by the University of Wyoming east of the Jacoby Golf Course. This detention pond would detain runoff from a large, mostly undeveloped basin that originates on Pole Mountain. The pond would be designed to store approximately 247 acre-feet during a 100-year event and would significantly reduce the detention required in downstream areas along Spring Creek. The pond would be optimized for the 100-year storm event, and would only minimally detain smaller storm events, allowing for the current informal recreational use to continue (or formalized recreational use in the future). The volume stored during a 100-year event would be discharged in less than 24 hours. While this pond is in the Casper Aquifer Protection Zone, we do not believe that lining this pond would be necessary or beneficial. The benefits of maintaining the aquifer recharge capabilities in this area appear to outweigh any concerns regarding aquifer contamination. The risk of contamination would not be significantly increased by this pond, as it would serve a mostly undeveloped area, and ponding would be rare and of short duration. If future upstream development that includes a source for potential aquifer contamination, it would be more efficient to provide mitigation measures at each upstream site location rather than at a regional pond. Based on this, the construction cost estimate for this detention pond

Construction of the improvements described above would eliminate nearly all flooding hazards from Spring Creek during a 100-year storm event. The segment just upstream of the confluence with the Laramie River (UPRR/lumberyard property) would overtop, though the impact to private property in this area would be minimal.

Alternative SN-2: Ponds at 26th Street and 17th Street, Turner Tract TT-3, and Storm Sewer Upgrades

In addition to the storm sewer upgrades and recommended Turner Tract improvements, this alternative would include the construction of two new, off-line detention ponds south of Spring Creek: one at approximately 26th Street, and one near 17th Street. In both cases, a diversion structure would be constructed on Spring Creek to divert high flows during storm events, and an outlet structure and channel would be constructed to discharge flows back into Spring Creek. Both ponds are located on private property and would require acquisition of the land. A third party has indicated that they would be interested in purchasing the property at 17th Street on behalf of the City with the intent of using it for flood control. Approximately 15 AF of storage would be required at 26th Street and approximately 46 AF would be required at 17th Street.

Construction of the improvements described above would eliminate nearly all flooding hazards from Spring Creek during a 100-year storm event. The segment just upstream of the confluence with the Laramie River (UPRR/lumberyard property) would overtop, though the impact to private property in this area would be minimal.

Alternative SN-3: Pond at 17th Street, Expand Pond in LaPrele Park, Turner Tract TT-3, and Storm Sewer Upgrades

In addition to the storm sewer upgrades and recommended Turner Tract improvements, Alternative SCN3 would include an expansion of the existing fishing pond in LaPrele Park, and construction of a new pond south of Spring Creek at 17th Street. At LaPrele Park, a diversion structure would be constructed on Spring Creek to divert high flows towards the fishing pond (also known as Huck Finn Pond). Approximately 14 AF of detention storage would be created above the permanent water surface of Huck Finn Pond by constructing an embankment between the pond and Spring Creek. A new outlet structure and discharge channel improvements would also be required. Since these improvements would be conducted within an existing City park, land acquisition would not be required.

The new pond at 17th Street would be constructed on a vacant, low-lying parcel of land south of Spring Creek. This land is privately owned and would need to be acquired by the COL. A third party has indicated that they would be interested in purchasing this property on behalf of the City with the intent of using it for flood control. Like the Huck Finn Pond, a diversion structure would be constructed on Spring Creek to divert high flows into the pond. An embankment would be constructed, along with an outlet structure and discharge channel. Approximately 39 AF of detention would be created at this location.

Construction of the improvements described above would eliminate nearly all flooding hazards from Spring Creek during a 100-year storm event. The segment just upstream of the confluence with the Laramie River (UPRR/lumberyard property) would overtop, though the impact to private property in this area would be minimal.

Table 5.5-2: Peak Flow Rates, 100-year Storm, Spring Creek North and Middle Basins

		Peak Flowrate (cfs)			
Location	**SWMM Model Design Point**	**Proposed Development, Existing Infrastructure**	**SN-1**	**SN-2**	**SN-3**
SC at Grand Avenue	SN180	1,930	755	1,930	1,930
SC at 16th Street	SC145	2,884	1,488	2,079	2,070
SC at 7th Street	SC125	2,736	2,176	2,196	2,245
SC at 3rd Street	SN105	5,279	2,223	2,167	2,223
SC at Confluence	LN425	5,279	2,511	2,433	2,465

Table 5.5-3: Peak Flow Rates, 10-year Storm, Spring Creek North and Middle Basins

		Peak Flowrate (cfs)			
Location	**SWMM Model Design Point**	**Proposed Development, Existing Infrastructure**	**SN-1**	**SN-2**	**SN-3**
SC at Grand Avenue	SN180	315	297	315	315
SC at 16th Street	SC145	786	722	529	661
SC at 7th Street	SC125	932	945	771	915
SC at 3rd Street	SN105	1,087	1,046	882	1,020
SC at Confluence	LN425	1,087	1,044	999	1,009

Table 5.5-4: Peak Flow Rates, 5-year Storm, Spring Creek North and Middle Basins

		Peak Flowrate (cfs)			
Location	**SWMM Model Design Point**	**Proposed Development, Existing Infrastructure**	**SN-1**	**SN-2**	**SN-3**
SC at Grand Avenue	SN180	237	225	237	139
SC at 16th Street	SC145	604	555	408	291
SC at 7th Street	SC125	725	726	596	403
SC at 3rd Street	SN105	837	803	678	451
SC at Confluence	LN425	837	845	820	465

Table 5.5-5: Peak Flow Rates, 2-year Storm, Spring Creek North and Middle Basins

		Peak Flowrate (cfs)			
Location	**SWMM Model Design Point**	**Proposed Development, Existing Infrastructure**	**SN-1**	**SN-2**	**SN-3**
SC at Grand Avenue	SN180	136	122	136	136
SC at 16th Street	SC145	347	310	233	291
SC at 7th Street	SC125	414	406	339	403
SC at 3rd Street	SN105	483	455	389	451
SC at Confluence	LN425	483	481	483	465

5.5.2 Laramie River North Major Basin Improvements

The most significant flood hazard in the Laramie River North Major Basin occurs on the Steele Street outfall line, which is the primary outfall for this basin. Several segments of this line are undersized for the 100-year event, resulting in surface flows that will exceed street capacities on 1st and 2nd Streets from Kearney Street to Steele Street. In addition, culverts at Russell Street and Sanders Street are no longer functioning, causing frequent flooding along 1st and 2nd Street in this area. During a 100-year storm event, the flooding in the Laramie River North major basin is estimated at 5.4 AF, which would inundate private property.

The Laramie River North Major Basin is almost entirely developed, leaving little land where regional detention ponds could be constructed. Two areas were considered for detention improvements:

- an existing depression on the University at 10th and Ivinson Street, and
- Undine Park

At 10th and Ivinson, an existing landscaped depression currently receives storm water from a relatively small area of the campus. If an agreement with the University was obtained, improvements could be constructed to divert additional storm flows from Ivinson Street to detain runoff before releasing it back to the Ivinson Street storm sewer system. These improvements could be constructed in concert with the planned street reconstruction of Ivinson Street, and would include a new diversion manhole at 11th Street and a new connection to a 9th Street manhole to receive flows from the detention pond. An outlet structure would be constructed in the pond. Approximately 0.8 AF of storage could be utilized for detention at this location. SWMM modeling of this proposed pond determined that this pond would reduce the peak flow in Ivinson St. by approximately 10 cfs in a 100-year storm event, which is not enough to reduce the required size for downstream upgrades to the storm sewer system. Therefore, this pond was not considered for further analysis.

Undine Park, located at 7th Street and Park Street, represents the only significant City-owned land in the Laramie River North Major Drainage basin. The park is located in an area where a detention pond could be used to decrease the runoff to the Steele Street outfall. However, much of the park is characterized by mature trees and open areas are frequently used as athletic fields. Construction of a pond at Undine Park would require significant excavation, which would impact mature trees and/or the use of open areas for athletics. Additionally, City staff have indicated that the Laramie Parks and Recreation Department is not open to retro-fitting parks for stormwater management purposes. For these reasons, Undine Park was not considered further as a location for detention.

Without viable options for stormwater detention in this basin, enlargements to storm sewer infrastructure will be required to convey the 100-year storm event to the Laramie River. The following storm sewer upgrades are recommended for all alternatives:

- Fifth Street and Ivinson St. to 3rd St. and Grand Avenue – upgrade to 36-inch diameter
- 3rd Street between Grand Avenue and Kearney Street – upgrade to 42-inch diameter
- Kearney Street between 3rd Street and 2nd Street – upgrade to 48-inch diameter
- Steele Street from 2nd Street to Pine Street (under UPRR right-of-way) – bore additional 60-inch storm sewer.

The South Gateway Drainage Study (Coffey, 2012) proposed new storm sewers in 5th Street, 4th Street, and 2nd Street to divert flows from the Steele Street outfall to Spring Creek, but recommended further analysis of the impacts to Spring Creek. Modeling performed for this South Laramie Drainage Master Plan has shown that Spring Creek is already over capacity during major storm events, further justifying the COL's informal policy of not allowing additional storm flows to Spring Creek. Based on this, new storm sewers to route additional flows to Spring Creek were not considered.

Laramie River North Major Basin Improvements are shown in Figure 22. A summary of peak flow rates during the 2, 5, 10, and 100-year storm events at key design points is provided in Tables 5.5-6, 5.5-7, 5.5-8, and 5.5-9.

Alternative LN-1: Steele Street Storm Sewer System Upgrades and 2nd Street Connection

Alternative LN-1 includes the improvements to the Steele Street storm sewer system listed above, plus installing a new 42-inch storm sewer in 2nd Street between Sanders Street and Steele Street to carry flow in this area to the Steele Street storm sewer system. With these improvements, the volume of ponding that results at 1st Street and Steele Street would be reduced from 5.4 AF to 0.5 AF, which would be contained within the existing road ROW.

Alternative LN-2: Steele Street Storm Sewer System Upgrades, 2nd Street Connection, and Re-purpose 18-inch Sanitary Sewer Line

Alternative LN-2 includes the Steele Street storm sewer system improvements listed above, and the new 42-inch storm sewer in 2nd Street between Sanders Street and Steele Street.

In addition, an existing 18-inch sanitary sewer line would be converted to a storm sewer line. As a result of the recently completed South Laramie Sanitary Sewer Extension Project, this sanitary sewer line is no longer needed. If re-purposed as a storm sewer, stormwater inlets at 2nd and Sanders and 1st and Sanders could be connected to the existing sanitary sewer, which could carry storm flows across the UPRR right-of-way to the existing 60-inch Steele Street outfall line at the end of Pine Street. The conversion of this line from sanitary to storm would require approval from the Wyoming Department of Environmental Quality and would likely include a camera inspection to evaluate the pipe condition, and disinfection of the line prior to allowing discharge into the storm sewer system. New manholes would be required at 1st and 2nd Street, along with new inlets, lateral piping, and a connection to the Steele Street outfall or direct discharge to the Laramie River.

Stormwater modeling of the re-purposed sanitary sewer line indicates that this line will not reduce the scope of improvements required on the Steele Street outfall line. However, it will provide relief on Sanders Street at 1st and 2nd Streets during smaller storm events. This relatively inexpensive improvement would at least provide some benefits until other improvements could be constructed.

With these improvements, the volume of ponding that results at 1st Street and Steele Street would be reduced from 5.4 AF to 0.5 AF, which would be contained within the existing road ROW.

Alternative LN-3: Steele Street Storm Sewer System Upgrades, Re-purpose 18-inch Sanitary Sewer Line, and Restore 36-inch Culvert under UPRR

Alternative LN-3 includes the Steele Street storm sewer system improvements listed above, and the re-purposing of the 18-inch sanitary sewer line described in Alternative LN-2. In addition, this alternative includes restoring a 36-inch culvert under UPRR ROW that is currently non-functional.

The clogged 36-inch steel culvert is located at 1st Street and Sanders Street, and is nearly fully clogged at each end (see Pictures 3 and 4 below). It is not known whether this pipe is simply clogged, or if it has collapsed. Restoration efforts for this culvert would include jetting and a vacuum truck to remove the sediment. Once cleaned, a camera inspection would be completed to evaluate the culvert's condition. If the culvert is usable, then an outfall channel would need to be excavated on the downstream (west) end, or the culvert would need to be extended to provide a flowpath to the Laramie River.

Picture 3: Existing 36-inch Culvert at 1st and Sanders Street – East End

Picture 4: Existing 36-inch Culvert at 1st and Sanders Street – West End

The 42-inch storm sewer in 2nd Street between Sanders Street and Steele Street that is included in Alternatives LN-1 and LN-2 would not be required for this alternative, as the 36-inch culvert and re-purposed 18-inch line would provide a drainage outlet for this area.

With these improvements, the volume of ponding that results at 1st Street and Steele Street would be reduced from 5.4 AF to 0.5 AF, which would be contained within the existing road ROW.

Table 5.5-6: Peak Flow Rates, 100-year Storm, Laramie River North Major Basin

		Peak Flowrate (cfs)			
Location	**SWMM Model Design Point**	**Proposed Development, Existing Infrastructure**	**LN-1**	**LN-2**	**LN-3**
3rd Street at Kearney Street (surface)	LN235-S	67	11	13	11
3rd Street at Kearney Street (storm sewer)	LN235	73	140	138	142
Steele Street at 1st Street (surface)	LN305-S	254	181	180	180
Steele Street and 1st Street (ponding volume)	LN305-S	5.4 AF	0.5 AF	0.5 AF	0.5 AF
Steele Street System Discharge to Laramie River	LN420	267	484	528	501

Table 5.5-7: Peak Flow Rates, 10-year Storm, Laramie River North Major Basin

		Peak Flowrate (cfs)			
Location	**SWMM Model Design Point**	**Proposed Development, Existing Infrastructure**	**LN-1**	**LN-2**	**LN-3**
3rd Street at Kearney Street (surface)	LN235-S	1	2	2	2
3rd Street at Kearney Street (storm sewer)	LN235	68	66	66	66
Steele Street at 1st Street (surface)	LN305-S	72	68	69	69
Steele Street and 1st Street (ponding volume)	LN305-S	0.2 AF	0.1 AF	0.1 AF	0.1 AF
Steele Street System Discharge to Laramie River	LN420	220	225	249	234

Table 5.5-8: Peak Flow Rates, 5-year Storm, Laramie River North Major Basin

		Peak Flowrate (cfs)			
Location	SWMM Model Design Point	Proposed Development, Existing Infrastructure	LN-1	LN-2	LN-3
3rd Street at Kearney Street (surface)	LN235-S	1	1	1	1
3rd Street at Kearney Street (storm sewer)	LN235	49	52	52	52
Steele Street at 1st Street (surface)	LN305-S	54	51	52	52
Steele Street and 1st Street (ponding volume)	LN305-S	0.1 AF	0.1 AF	0.1 AF	0.1 AF
Steele Street System Discharge to Laramie River	LN420	175	172	190	181

Table 5.5-9: Peak Flow Rates, 2-year Storm, Laramie River North Major Basin

		Peak Flowrate (cfs)			
Location	SWMM Model Design Point	Proposed Development, Existing Infrastructure	LN-1	LN-2	LN-3
3rd Street at Kearney Street (surface)	LN235-S	0	0	0	0
3rd Street at Kearney Street (storm sewer)	LN235	27	32	32	32
Steele Street at 1st Street (surface)	LN305-S	27	26	26	26
Steele Street and 1st Street (ponding volume)	LN305-S	0 AF	0 AF	0 AF	0 AF
Steele Street System Discharge to Laramie River	LN420	95	95	107	101

5.5.3 Spring Creek South Major Basin Improvements

A significant portion of the Spring Creek watershed is directed by the barriers created by I-80 and the UPRR to the southeast corner of intersection of I-80 and Highway 287. One existing detention pond, located at 15th Street and Skyline Drive, would be overwhelmed during a major storm event. This area contains only a small storm sewer system in Skyline Drive and Soldier Springs Road, with no infrastructure to convey major storm event flows to Spring Creek. During a 100-year storm event, flood flows would overwhelm informal detention storage areas near Soldier Springs Road, before overtopping the road and flowing down Highway 287 (3rd Street to Spring Creek, far exceeding the allowable street capacity on 3rd

Street and possibly inundating private property. Under the proposed improvements, large upstream detention ponds are proposed to decrease stormwater flows to this area along with new crossings to divert flow away from the area. Alternatives for Spring Creek South Major Basin Improvements are shown in Figure 23. A summary of peak flow rates during the 2, 5, 10, and 100-year storm events at key design points is provided in Tables 5.5-10, 5.5-11, 5.5-12, and 5.5-13.

Improvements considered, but not included in the alternatives analysis included upgrading or adding culverts/storm sewers to convey flows to Spring Creek. Large peak flows (approximately 2,000 cfs) reach the eastern end of Skyline Drive during a 100-year storm event. To convey this flow past the existing residential development and under the 15th Street overpass, a 6' x 10' box culvert would be required for approximately 2,000 feet. The available right-of-way under the overpass is not large enough to permit this construction. Peak flows to the Soldier Springs/Skyline Drive intersection are approximately 1,000 cfs during a 100-year storm event. To pass these flows under and along Soldier Springs Road would require a 4' x 10' box culvert for approximately 2,000 feet. With existing utilities and limited right-of-way between Soldier Springs Road and Highway 287, this does not appear to be feasible. Diverting stormwater runoff under Highway 287 and I-80 to prevent flooding on 3rd Street, would require multiple 4' x 8' box culverts, and an easement from UPRR. This is not feasible due to exiting utilities in Highway 287 and limited right-of-way under the I-80 overpass. These improvements were not considered for further analysis.

Both Spring Creek South alternatives would include re-purposing an existing 12-inch sanitary sewer for use as a storm sewer. As a result of the recently completed South Laramie Sanitary Sewer Extension Project, this sanitary sewer line is no longer needed. The existing sanitary sewer runs from this area, crosses under Highway 287 and I-80, and runs north along 3rd Street and crosses Spring Creek. If re-purposed as a storm sewer, stormwater inlets near Highway 287 and Skyline Road would be connected to this pipe and it could be configured to discharge into Spring Creek at 3rd Street. The conversion of this line from sanitary to storm would require approval from the Wyoming Department of Environmental Quality and would likely include a camera inspection to evaluate the pipe condition, and disinfection of the line prior to allowing discharge into the storm sewer system. While this line is too small to have a significant effect during a large storm event, this relatively inexpensive improvement would provide at least a small outlet for this area until other improvements could be constructed.

Alternative SS-1: Maximize Upstream Detention

Under Alternative SS-1, a proposed pond south of I-80 and east of Skyline Drive would store approximately 450 AF of runoff during the 100-year event, reducing the peak flows to the existing 15th Street and Skyline Drive pond to negligible amounts. This pond would be located on land outside of the COL and would have to be acquired by the City. The second proposed pond would be located upstream of Hidden Springs Road and would provide approximately 175 AF of detention storage. This pond would also be located outside of the COL and would require land acquisition.

With the two large regional ponds described above, the discharge to 3rd Street would be greatly reduced, but would still exceed allowable street flow criteria. To alleviate this issue, stormwater flows would be routed under Highway 287 near Soldier Springs Road in twin 36-inch culverts. Once across Highway 287, runoff would flow overland through an existing depression area owned by UPRR and WYDOT and then discharge to Spring Creek in twin 36-inch pipes that would run under the existing I-80 railroad overpass. This would require a permit and easement with UPRR.

The improvements listed above would eliminate flooding of 3rd Street (Highway 287).

Alternative SS-2: Upstream Detention and Flow Diversion
In this alternative, two proposed ponds south of I-80 and east of Skyline Drive would store approximately 164 AF and 46 AF of runoff, respectively, during the 100-year event, reducing the peak flows to the existing 15th Street and Skyline Drive pond to manageable amounts. These ponds would be located on land outside of the COL and would have to be acquired by the City. Another proposed pond would be located upstream of Hidden Springs Road and would provide approximately 150 AF of detention storage. This pond would also be located outside of the COL and would require land acquisition.

The discharge from the pond upstream of Hidden Springs Road would be diverted under Soldier Springs Road and UPRR in proposed twin 48-inch pipes. A new channel would be created along the west side of UPRR to safely convey the flow to a depression area owned by WYDOT that is currently providing informal detention. This informal detention would be expanded to provide 149 AF of storage, requiring an agreement or land acquisition by the COL. The discharge from the expanded WYDOT pond would be carried in a new 48-inch pipe bored under UPRR to allow flow to reach an existing depression area owned by UPRR and WYDOT. The existing informal detention would be expanded to provide 24 AF of storage. To convey flows reaching Highway 287 and Skyline Drive, twin 36-inch bores would be installed under Highway 287. Finally, twin 3.5' x 4' box culverts would be constructed to convey flows under the I-80 overpass to Spring Creek.

The improvements listed above would eliminate flooding of 3rd Street (Highway 287).

Table 5.5-10: Peak Flow Rates, 100-year Storm, Spring Creek South Major Basin

		Peak Flowrate (cfs)		
Location	**SWMM Model Design Point**	**Proposed Development, Existing Infrastructure**	**SS-1**	**SS-2**
Skyline Drive and 15th Street	SS310	1,926	6	191
Skyline Drive and Soldier Springs Road	SS105-S	1,036	233	233
Skyline Drive and Highway 287	SS305	2,729	287	347
Discharge to Spring Creek (via 3rd Street)	SS204-S	2,685	0	0
Discharge to Spring Creek (via I-80 underpass)	RR-1-OUT	0	265	391

Table 5.5-11: Peak Flow Rates, 10-year Storm, Spring Creek South Major Basin

		Peak Flowrate (cfs)		
Location	SWMM Model Design Point	Proposed Development, Existing Infrastructure	SS-1	SS-2
Skyline Drive and 15th Street	SS310	331	4	63
Skyline Drive and Soldier Springs Road	SS105-S	104	104	104
Skyline Drive and Highway 287	SS305	356	113	136
Discharge to Spring Creek (via 3rd Street)	SS204-S	320	0	0
Discharge to Spring Creek (via I-80 underpass)	RR-1-OUT	0	106	86

Table 5.5-12: Peak Flow Rates, 5-year Storm, Spring Creek South Major Basin

		Peak Flowrate (cfs)		
Location	SWMM Model Design Point	Proposed Development, Existing Infrastructure	SS-1	SS-2
Skyline Drive and 15th Street	SS310	120	2	33
Skyline Drive and Soldier Springs Road	SS105-S	78	78	78
Skyline Drive and Highway 287	SS305	111	86	102
Discharge to Spring Creek (via 3rd Street)	SS204-S	61	0	0
Discharge to Spring Creek (via I-80 underpass)	RR-1-OUT	0	86	55

Table 5.5-13: Peak Flow Rates, 2-year Storm, Spring Creek South Major Basin

		Peak Flowrate (cfs)		
Location	**SWMM Model Design Point**	**Proposed Development, Existing Infrastructure**	**SS-1**	**SS-2**
Skyline Drive and 15th Street	SS310	48	1	13
Skyline Drive and Soldier Springs Road	SS105-S	44	44	44
Skyline Drive and Highway 287	SS305	45	54	54
Discharge to Spring Creek (via 3rd Street)	SS204-S	4	0	0
Discharge to Spring Creek (via I-80 underpass)	RR-1-OUT	0	64	28

5.5.4 Laramie River South Major Basin Improvements

No improvements were required for the Laramie River South Major Drainage Basin.

5.5.5 Laramie River West Major Basin Improvements

No improvements were required for the Laramie River West Major Drainage Basin.

5.6 Qualitative Evaluation Procedure

The alternatives outlined above were evaluated in the following categories: flood control and protection, capital cost, operation and maintenance cost, total lifecycle cost, ROW acquisition and easements, and water quality benefits. Table 5.6-1 shows the weighting applied to each category. Tables 5.6-1, 5.6-2, and 5.6-3 summarize the evaluations used to compare the alternatives.

Table 5.6-1: Weighting Applied to Alternative Evaluation Categories

Category	Weight
Requires Land Acquisition and/or UPRR permit	No = 2, Yes = 0
Provides Water Quality Benefits	Yes = 1, No = 0
Meets Flood Protection Goals	Yes = 3, No = 0
Capital Cost	Lowest Cost = 3, Highest Cost = 0
Project Life Cycle Cost*	Lowest Cost = 3, Highest Cost = 0

*includes Annual O&M Costs

Table 5.6-2: Evaluation of Spring Creek North and Spring Creek Middle Alternatives

Alt	Description of Improvements	Land Acquisition (Number of Properties, Acres)	Water Quality Benefits	Prevents Over-topping of Spring Creek	Capital Cost*	Annual O&M Cost	Project Life Cycle Cost**	Evaluation Score
SN-1	247 AF Pond East of Jacoby GC, Turner Tract TT-3, and Storm Sewer Upgrades	Yes (2, 62)	Yes-WQ Volume Included in Ponds	Yes	$24,496,000	$95,000	$37,431,000	4 0+1+3+0+0
SN-2	26th Street and 17th Street Ponds, Turner Tract TT-3, and Storm Sewer Upgrades	Yes (3, 38)	Yes-WQ Volume Included in Ponds	Yes	$20,238,000	$58,000	$28,216,000	8 0+1+3+2+2
SN-3	LaPrele Pond Expansion, 17th Street Pond, Turner Tract TT-3, and Storm Sewer Upgrades	Yes (2, 34)	Yes-WQ Volume Included in Ponds	Yes	$20,202,000	$55,000	$27,700,000	10 0+1+3+3+3

*includes land acquisition
**based on 50-year service life, 3.64% interest rate

Table 5.6-3: Evaluation of Laramie River North Alternatives

Alt	Description of Improvements	Requires Land Acquisition	Water Quality Benefits	Prevents Flooding of Private Property @ 1st St.	Capital Cost*	Annual O&M Cost	Project Life Cycle Cost**	Evaluation Score
LN-1	Steele Street Storm Sewer System Upgrades and 2nd Street Connection	No	No	Yes	$4,263,000	$5,000	$4,884,000	9 2+0+3+2+2
LN-2	Steele Street Storm Sewer System Upgrades, 2nd Street Connection, and Re-purpose 18-in Sanitary Sewer	No	No	Yes	$4,359,000	$7,000	$5,339,000	5 2+0+3+0+0
LN-3	Steele Street Storm Sewer Upgrades, Re-purpose 18-in Sanitary Sewer, and Rehab 36-in Culvert under UPRR	No	No	Yes	$3,896,000	$6,000	$4,761,000	11 2+0+3+3+3

*includes land acquisition
**based on 50-year service life, 3.64% interest rate

Table 5.6-4: Evaluation of Spring Creek South Alternatives

Alt	Description of Improvements	Land Acquisition (Number of Properties, Acres)	Water Quality Benefits	Prevents Flooding at 3rd Street and Skyline Drive	UPRR Crossing Bores	Capital Cost*	Annual O&M Cost	Project Life Cycle Cost**	Evaluation Score***
SS-1	Maximize Upstream Detention	Yes (3,99)	Yes-WQ Volume Included in Ponds	Yes	0	$24,123,000	$158,000	$45,706,000	9 0+1+3+2+3+0
SS-2	Upstream Detention and Flow Diversion	Yes (6,85)	Yes-WQ Volume Included in Ponds	Yes	2	$27,399,000	$131,000	$45,275,000	7 0+1+3+0+0+3

*includes land acquisition
**based on 50-year service life, 3.64% interest rate
***added 2 points if no UPRR crossing bores required, due to difficulty of obtaining required permits

6 Recommended Plan

6.1 Plan Description

The recommended plan includes the following, by major basin. Peak flow rates at all model nodes (junctions, conduits, storages, and outfalls) are provided in Appendix B for the 2, 5, 10, and 100-year storm events for the recommended solutions.

6.1.1 Spring Creek North and Spring Creek Middle Major Basin

The recommended alternative for the Spring Creek North and Spring Creek Middle Major Basins is ***Alternative SN-1: Pond East of Jacoby GC, Turner Tract TT-3, and Storm Sewer Upgrades.*** All three alternatives successfully reduce peak flow rates during the 100-year storm event to levels that can be contained within Spring Creek. All three alternatives also require land acquisition. Alternative SN-1 has the highest initial and lifecycle cost, but the land acquisition in this alternative primarily consists of a University of Wyoming property east of Jacoby Golf Course that is currently used informally for recreational purposes and could continue to be used in this manner if modified to provide flood management. Alternative SN-2 would require the acquisition of two privately owned properties which may be more difficult and more expensive to acquire. Alternative SN-3 requires the acquisition of one privately owned property and the modification of LaPrele Park. COL staff have indicated that the modification of LaPrele Park is not favored by Parks and Recreation staff.

Alternative SN-1 includes:

- Recommended Turner Tract Alternative TT-3:
    - Modify outlet of existing detention pond at Boulder Drive and Beech Street and increase storage volume from 5 AF to 21 AF by expanding pond footprint within property limits to restrict flow and maximize pond effectiveness, and
    - Construct new 23-AF detention pond upstream of the new extension of Regency Drive,

- Install improvements on Grays Gable Road to maximize inflow to Jacoby Golf Course ponds,

- Upgrade storm sewer systems on 30th Street, 22nd Street, 21st Street, and 13th Street. Due to the complex interaction between surface water and storm sewer flows in this area, it is recommended that the COL conduct a detailed 2-dimensional hydraulic analysis that includes all portions of the storm sewer system and utilizes the surface topography to route flows exceeding the storm sewer capacity prior to final design and construction of improvements in this area,

- Construct a box culvert from Boswell Drive to Spring Creek, and

- Acquire land and construct new 247-AF detention pond on property owned by the University of Wyoming east of the Jacoby Golf Course.

6.1.2 Laramie River North Major Basin Improvements

The recommended alternative for the Laramie River North Major Basin is ***Alternative LN-3: Steele Street Storm Sewer System Upgrades, Re-purpose 18-inch Sanitary Sewer Line, and Restore 36-inch Culvert under UPRR***. All three alternatives would reduce the flooding at 1st Street during 100-year event to levels that could be contained within the street ROW. Alternative LN-3 is preferred since it has the lowest initial capital cost and the lowest lifecycle cost.

Alternative LN-3 includes the following storm sewer system upgrades:

- Fifth Street and Ivinson Street to 3rd Street and Grand Avenue – upgrade to 36-inch diameter,
- 3rd St. between Grand Avenue and Kearney Street – upgrade to 42-inch diameter,
- Kearney Street between 3rd Street and 2nd Street – upgrade to 48-inch diameter,
- Steele Street from 2nd Street to Pine Street (under UPRR right-of-way) – bore additional 60-inch storm sewer,
- Re-purposing an 18-inch sanitary sewer for use as a storm sewer from 2nd Street and Sanders Street, under the UPRR ROW, and discharging to the existing Steele Street outfall or directly to the Laramie River, and
- Rehabilitating an existing 36-inch culvert under UPRR ROW at 1st Street and Sanders Street, including constructing an open channel or extension to the Laramie River.

6.1.3 Spring Creek South Major Basin Improvements

The recommended alternative for the Spring Creek South Major Basin is ***Alternative SS-1: Maximize Upstream Detention.*** Both alternatives would eliminate flooding of private property in the Skyline Drive/Soldier Springs Road area and on 3rd Street near I-80. Alternative SS-1 is preferred as it has lower initial capital costs and lifecycle costs. Additionally, while it requires a larger acreage of land acquisition, there are fewer land acquisition locations (three) than for Alternative SS-2 (six), which increases the likelihood of successful negotiations. Also, Alternative SS-1 does not require a bore under UPRR ROW, while Alternative SS-2 would require two bores under UPRR.

Alternative SS-1 includes:

- Re-purposing a 12-inch sanitary sewer for use as a storm sewer from Skyline Drive and Highway 287 to Spring Creek at 3rd Street,
- Acquire land and construct 450 AF of detention south of I-80 and east of Skyline Drive,
- Acquire land and construct 175-AF of detention south of Hidden Springs Road,
- Install twin 36-inch culverts under Highway 287 near Soldier Springs Road
- Acquire UPRR easement and construct open channel across UPRR/WYDOT property southwest of intersection of Highway 287 and I-80
- Install twin 36-inch culverts in UPRR right-of-way under I-80 overpass to discharge at Spring Creek.

6.1.4 Laramie River South Major Basin Improvements
No improvements were identified for the Laramie River South Major Drainage Basin.

6.1.5 Laramie River West Major Basin Improvements
No improvements were identified for the Laramie River West Major Drainage Basin.

6.1.6 Prioritization of Improvements
The current flooding hazard that threatens to impact the most residents is Spring Creek overtopping its banks in various locations as it runs from through the COL from approximately 30th Street to 3rd Street (Spring Creek North and Spring Creek Middle Major Basin). Overflow from Spring Creek in these locations would run through residential areas, with most of the flow ultimately reaching 1st Street and compounding the existing flooding hazard at this location, in which there is not enough capacity across the UPRR right-of-way to convey the flow to the Laramie River (Laramie River North Major Basin). The primary flooding hazard in the Spring Creek South Major Basin is flooding that would occur near Skyline Drive and 3rd Street. While this is an important transportation corridor, the flooding would not impact as many properties as the flooding hazards in other major basins. Based on the potential impact to residents, the recommended improvements are prioritized as follows:

1. Spring Creek North and Spring Creek Middle Major Basin Improvements
2. Laramie River North Major Basin Improvements
3. Spring Creek South Major Basin Improvements

6.2 Water Quality Impacts

The United States Environmental Protection Agency (EPA) regulates stormwater discharges from municipal separate storm sewer systems (MS4s) through the National Pollutant Discharge Elimination System. Phase I regulations, issued in 1990, require permit coverage for cities with populations over 100,000. Phase II regulations, issued in 1999, extended the requirements to specified urbanized areas. The COL has not been designated as an urbanized area and therefore is not currently required to obtain (NPDES) permit coverage for its municipal stormwater discharges. (Cheyenne and Casper are currently the only cities in Wyoming considered as urbanized areas.)

However, the EPA could extend MS4 permit requirements to smaller cities such as the COL, or redefine the “urbanized areas” to include the COL. In discussions with the Wyoming Department of Environmental Quality (WDEQ), who administers MS4 permits on behalf of the EPA, they would also consider an MS4 permit for cities outside the specified “urbanized areas” if a nearby water body was impaired or threatened with impairment. The most likely pollutant of concern in the COL would be sediment discharge to local water bodies. Amec Foster Wheeler recommends that any storm water improvements should be designed to limit sediment discharges. Sediment removal methods typically remove or filter out other pollutants, which are often bound with the sediment.

Low Impact Development (LID) is a stormwater management practice that provides water quality benefits. LID is an approach to managing urban storm water runoff in a manner that attempts to mimic the predevelopment site hydrologic conditions using design techniques that store, infiltrate, evaporate, and detain surface storm water runoff. LID typically provides stormwater treatment by using vegetation and soil as a filter for storm water pollutants. LID techniques are applied close to the source of runoff, at the single lot level, and, if used on a widespread basis, may reduce the required size of downstream conveyance and detention structures. LID also provides aesthetic benefits, by supporting green landscaping without the use of potable water irrigation. Examples of LID techniques include rain gardens, tree wells, pervious pavement, green roofs, and bioswales.

Since LID primarily relies on infiltration of stormwater, the use of LID within the portions of the Turner Tract subject to the Casper Aquifer Protection Area (CAPA), should be carefully considered. While stormwater runoff provides a source of recharge to the Casper Aquifer, stormwater could also carry pollutants into the recharge area. The Casper Aquifer Protection Plan (Wittman Hydro Planning Associates, 2008) recommended that the COL develop design standards for use within the CAPA to "reduce the pollution load and, if possible, provide recharge benefits." LID techniques that include filtering or other water treatment methods could intercept pollutants while still allowing beneficial infiltration to occur. **Amec Foster Wheeler recommends that the COL develop stormwater quality standards that encourage or require the use of LID on new or redeveloped properties both inside and outside the CAPA. Standards for properties within the CAPA should include precautions for pollutant removal prior to infiltration.**

Since the implementation of LID would be a process that would occur over several years, at the pace of development/redevelopment, **it is recommended that the capital projects in this master plan include water quality features for removal of sediment and other pollutants**. For this reason, the estimated conceptual construction costs for all detention ponds includes excavation of an additional 10% that would be used as a water quality capture volume. Water quality capture volume is a technique used by the UDFCD for stormwater quality, and would be additional storage beyond the storage needed for flood management. This volume would be retained during a storm event and slowly released over 40 hours, requiring a small modification to traditional pond outlet structures.

6.3 Operations and Maintenance

Routine inspection of all stormwater facilities is necessary to assure their long term function is maintained. Culvert inlets and outlets should be cleared of excess vegetation and sediment to maintain design capacity. Regular maintenance of the existing and proposed detention ponds will include mowing and removal of sediment, debris and trash in order to maintain functionality. Implementation of the recommended plan should include maintenance access. Annual O&M costs were estimated and included in the evaluation of alternatives.

6.4 Drainage Requirements for New Development

While this master plan has identified capital improvements recommended for construction by the City of Laramie to mitigate the identified flooding hazards, the City should continue to impose flood management requirements on new development and re-development properties. Private flood improvements can help provide incremental relief until public improvement projects can be funded and constructed. The following requirements are recommended for new developments or significant re-development properties:

- *Over-detention*: Peak runoff from developed properties should be managed on-site to reduce the 100-year developed peak flow rate to the 10-year historic peak discharge rate.
    - It is recommended that the City consider allowing developers the option to forego construction of on-site flood management if they contribute to the cost of regional flood management facilities that serve the property in question. This may be attractive to developers as it may provide more developable land, while the City can recoup some of the costs of regional facilities. Payments could be based on the fraction of impervious area represented by the development, or similar method.

- *Maintenance of private stormwater facilities*: To ensure continued performance of private, on-site stormwater facilities, regular maintenance (removal of sediment, debris, landscape maintenance, etc.) should be required by ordinance, with an easement that would allow the City to enter the property to conduct maintenance (at the landowner's expense) if the landowner fails to meet maintenance requirements.

- *Downstream impacts*: As a condition of approval, private development should be required to show that downstream infrastructure (storm sewers, open channels, etc.) is present and has adequate capacity to safely convey the runoff from the 100-year event to the ultimate receiving water body (Spring Creek or Laramie River). This may require developments to construct or fund downstream improvements to carry their point discharges across downstream property that used to accept sheet flows, unless it can be shown that the point discharge will not damage downstream property.

- As discussed in the previous section, Amec Foster Wheeler recommends that the COL develop stormwater quality standards that encourage or require the use of LID practices (also called green infrastructure) on new or redeveloped properties both inside and outside the CAPA.

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FIGURES

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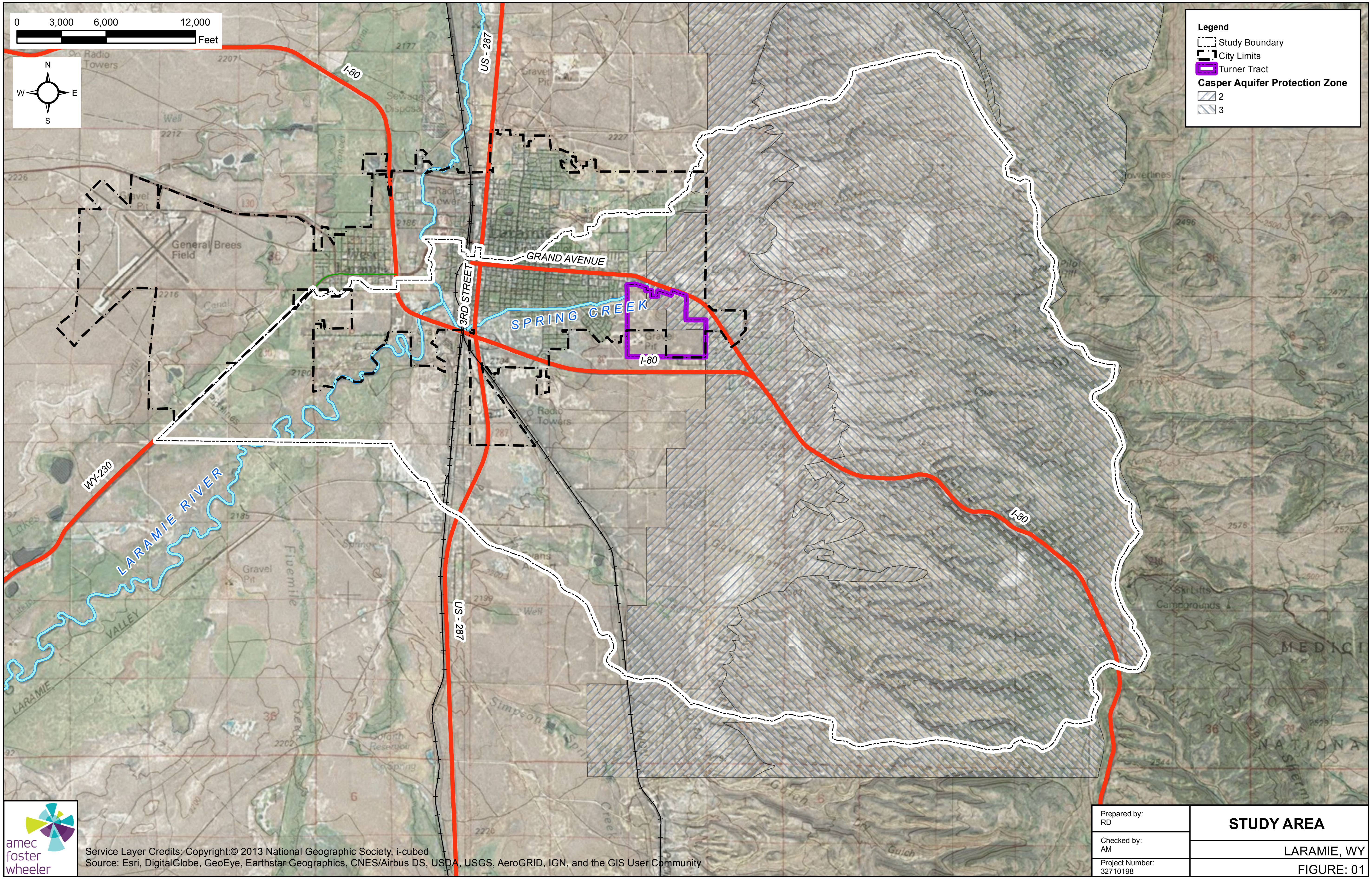

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Prepared by: RD	**STUDY AREA**
Checked by: AM	LARAMIE, WY
Project Number: 32710198	FIGURE: 01

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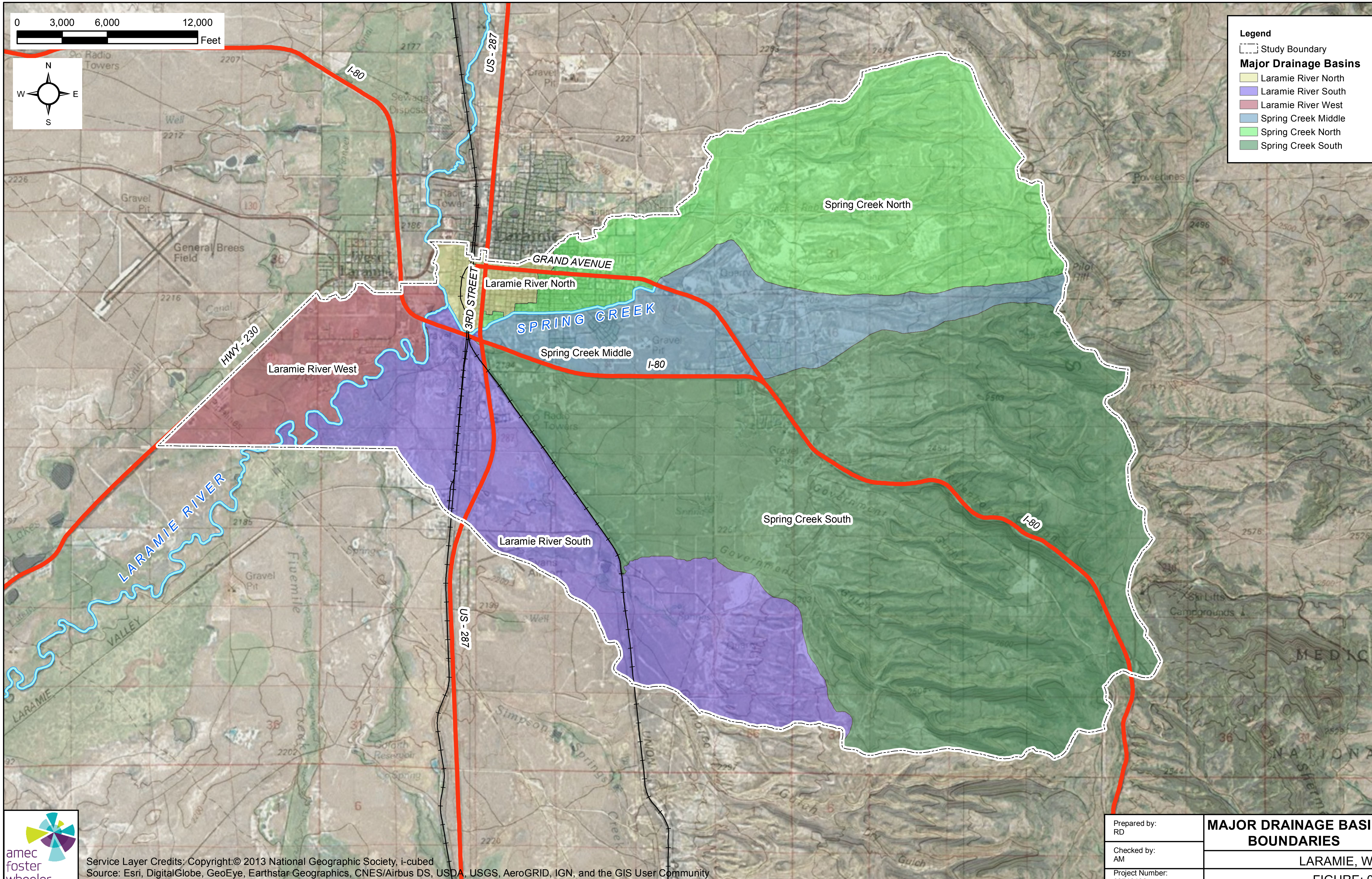

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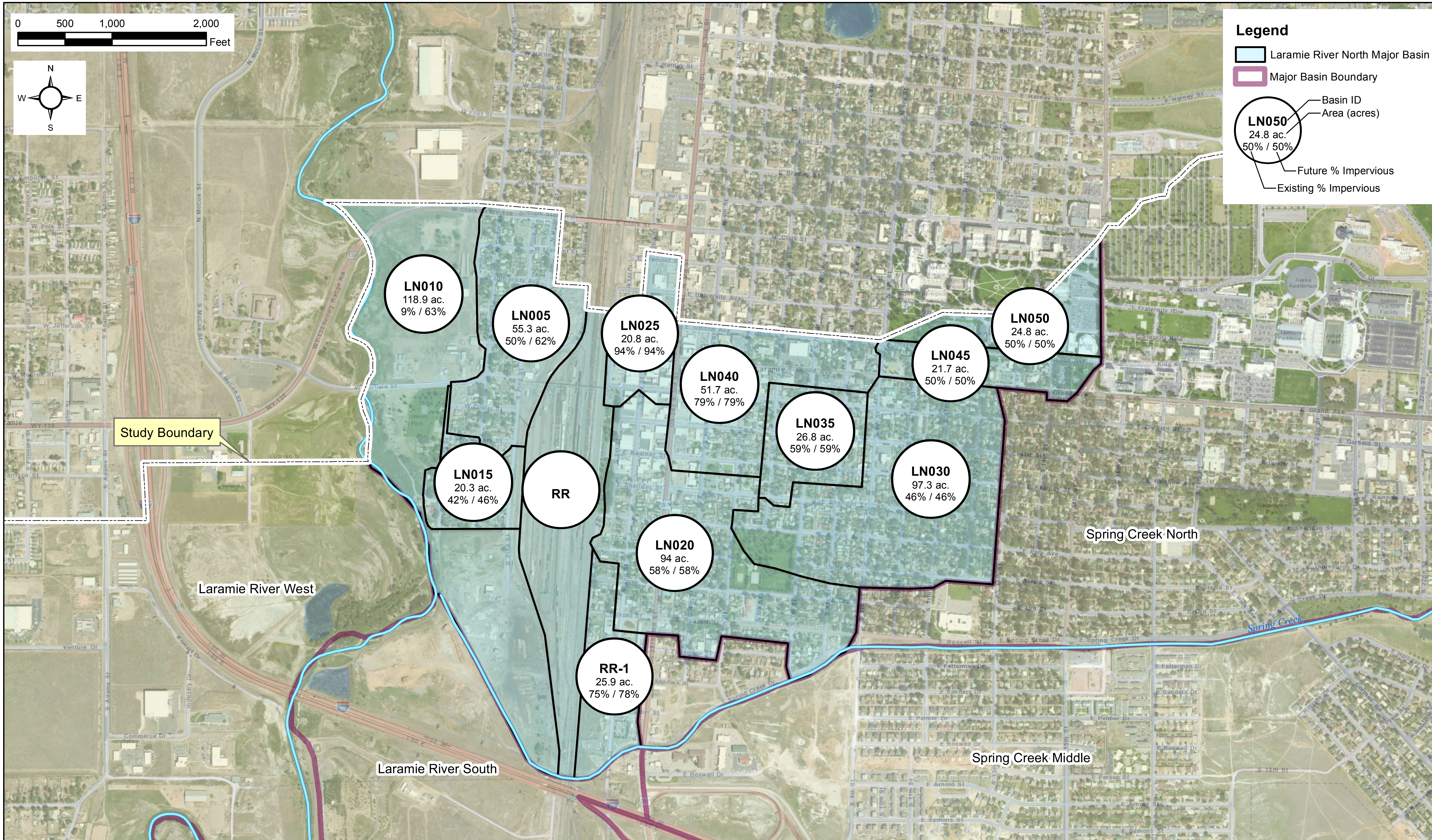

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Checked by: AM	LARAMIE, WY
Project Number: 32710198	FIGURE: 03

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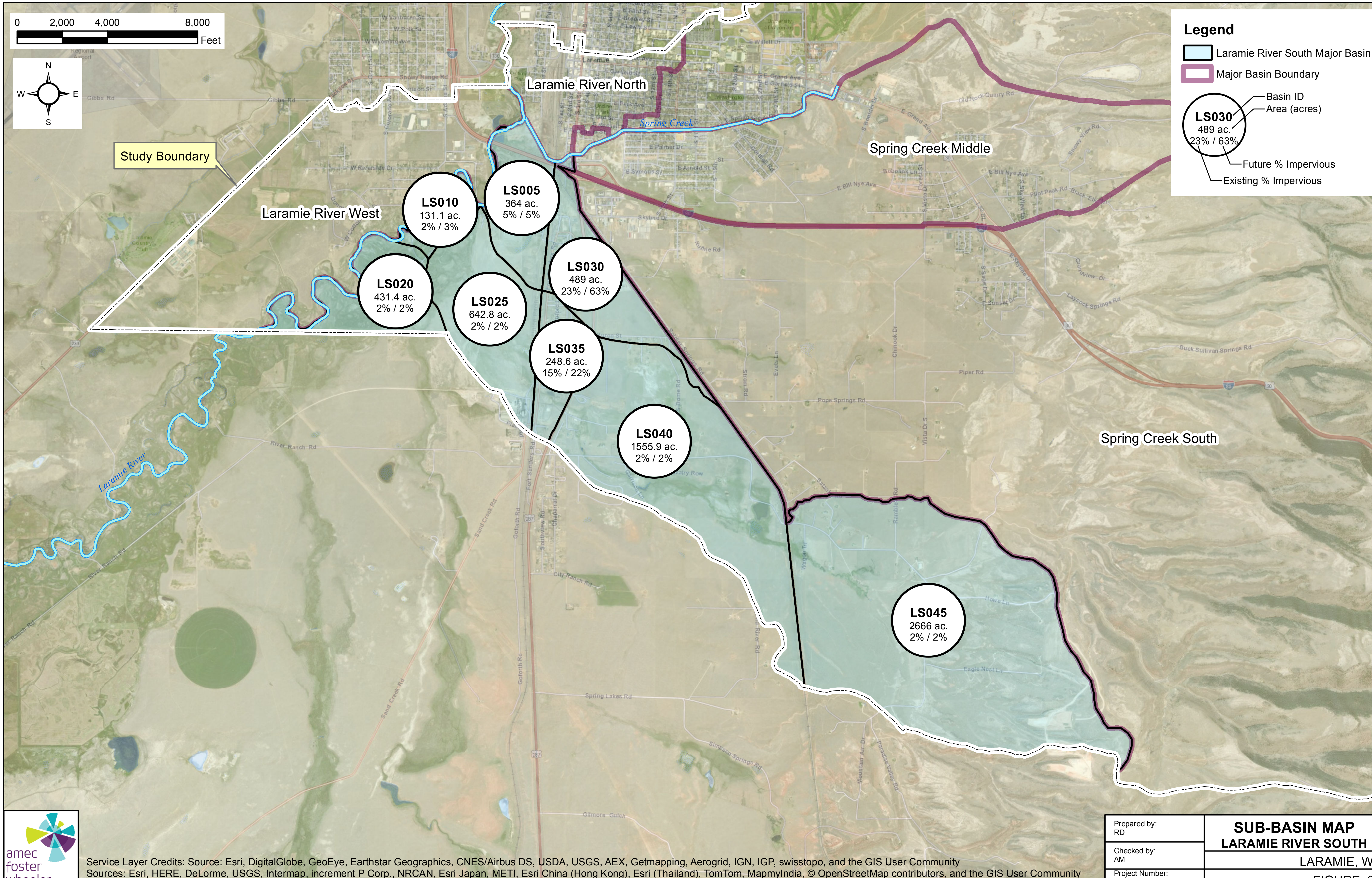

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Checked by: AM	LARAMIE, WY
Project Number: 32710198	FIGURE: 04

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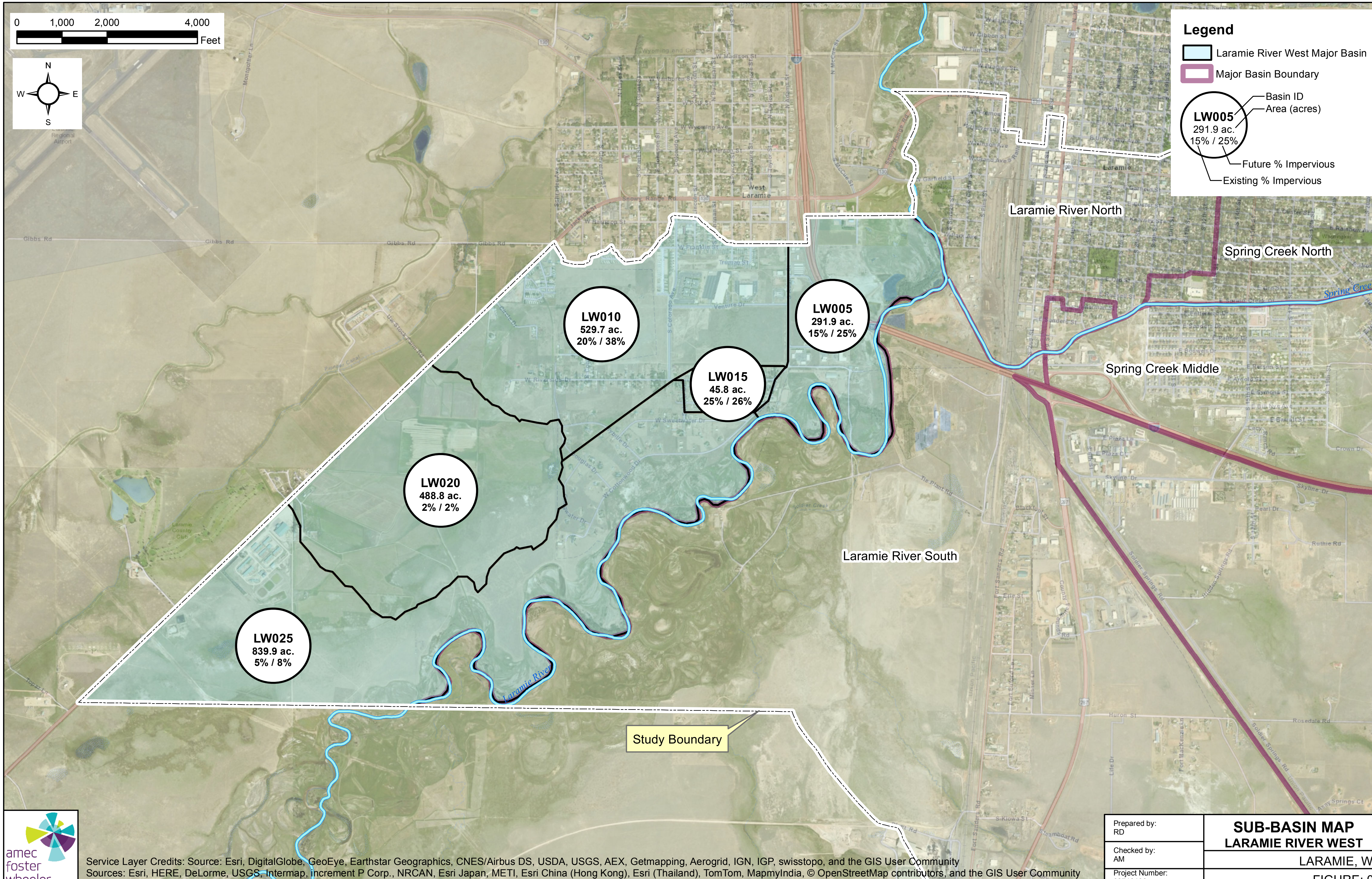

Prepared by: RD	**SUB-BASIN MAP** **LARAMIE RIVER WEST**
Checked by: AM	LARAMIE, WY
Project Number: 32710198	FIGURE: 05

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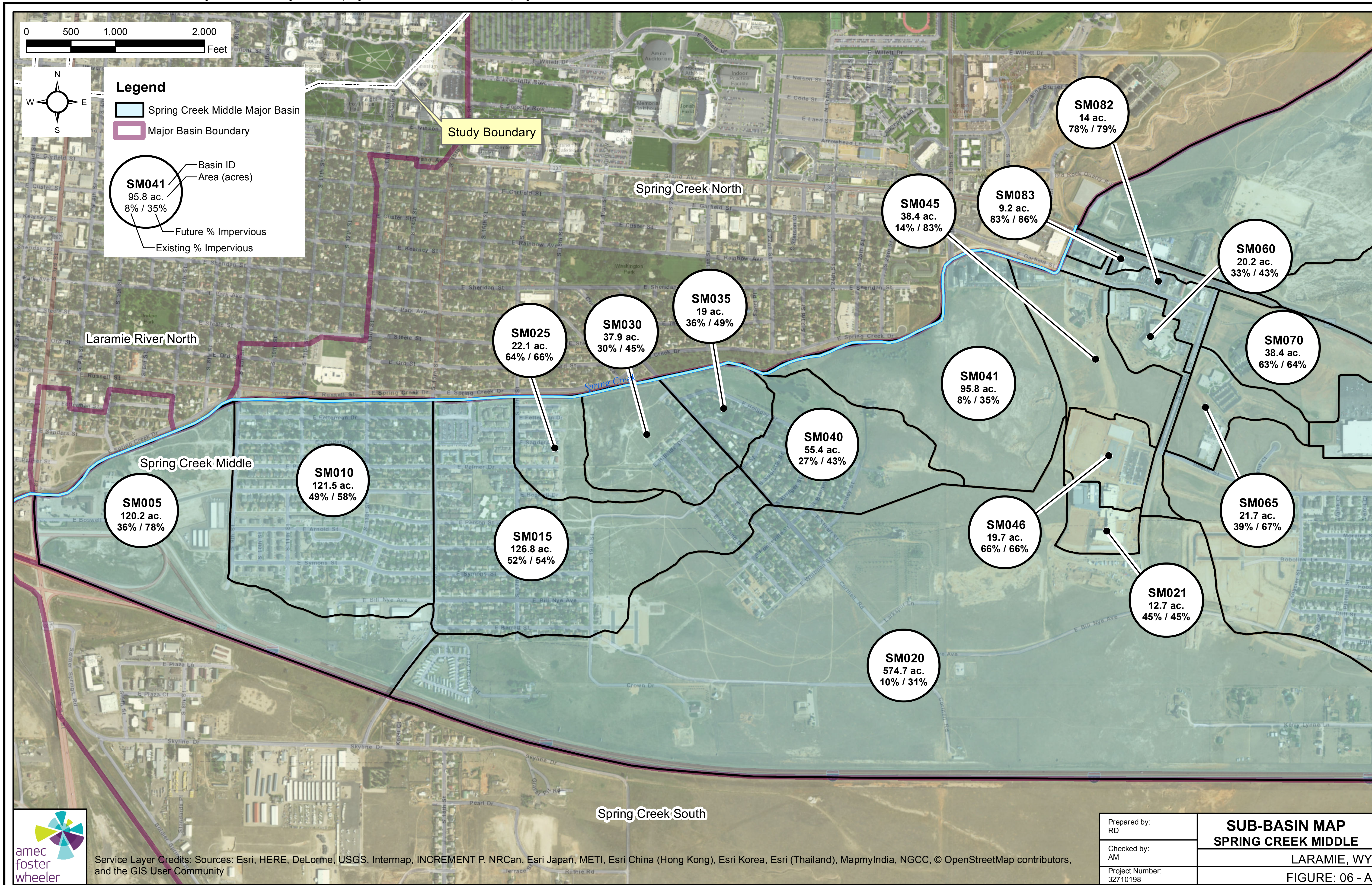

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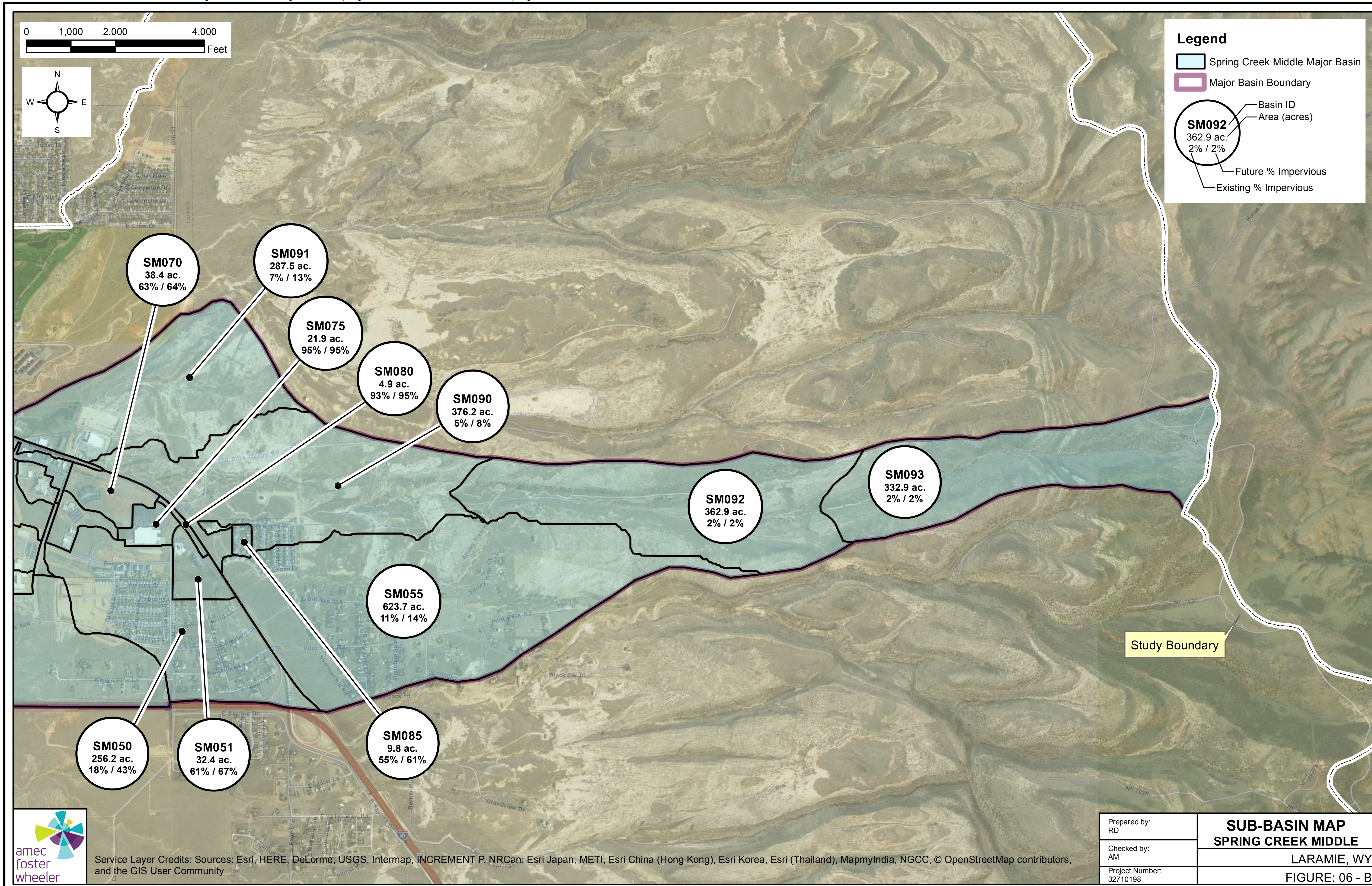

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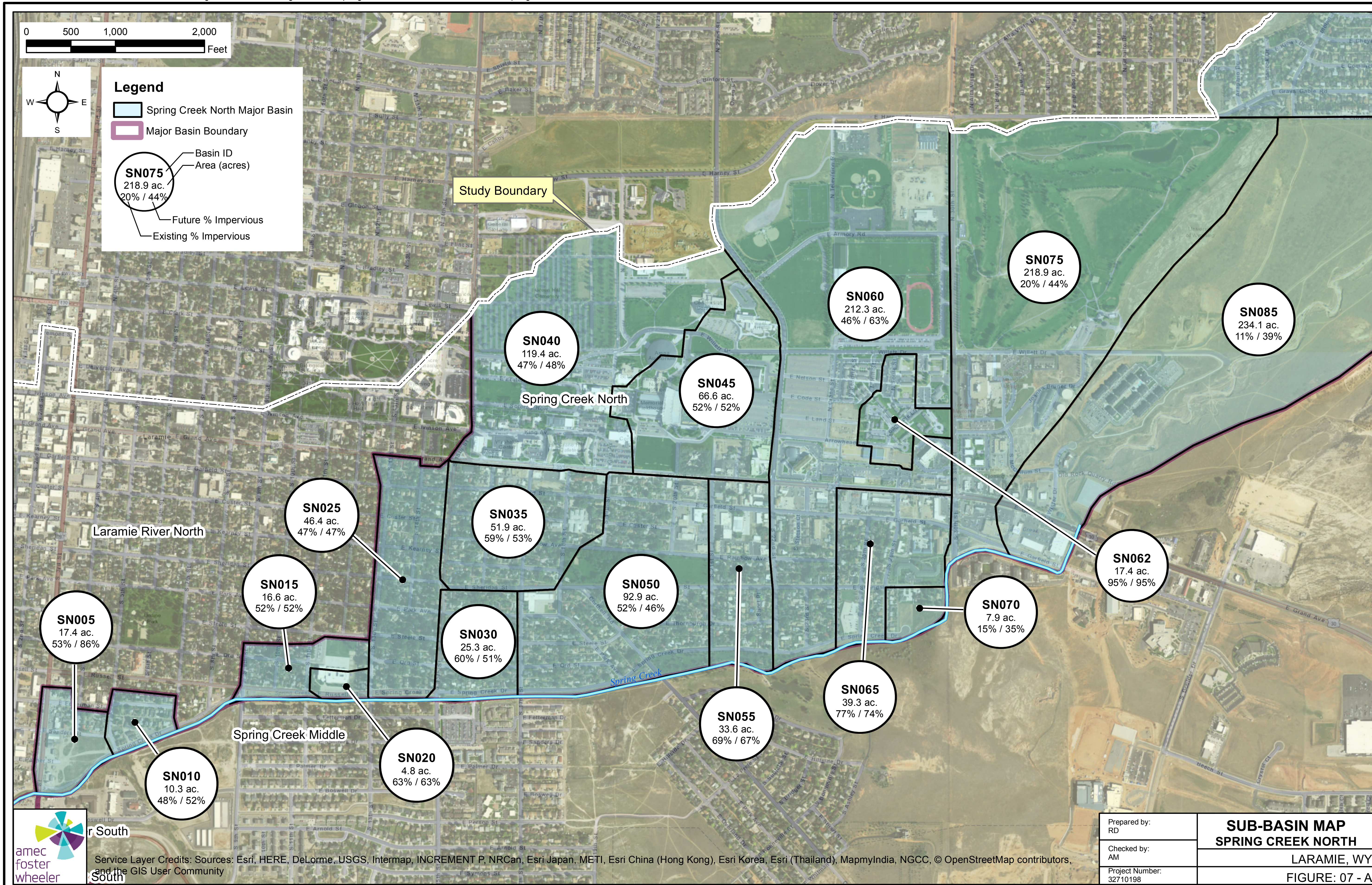

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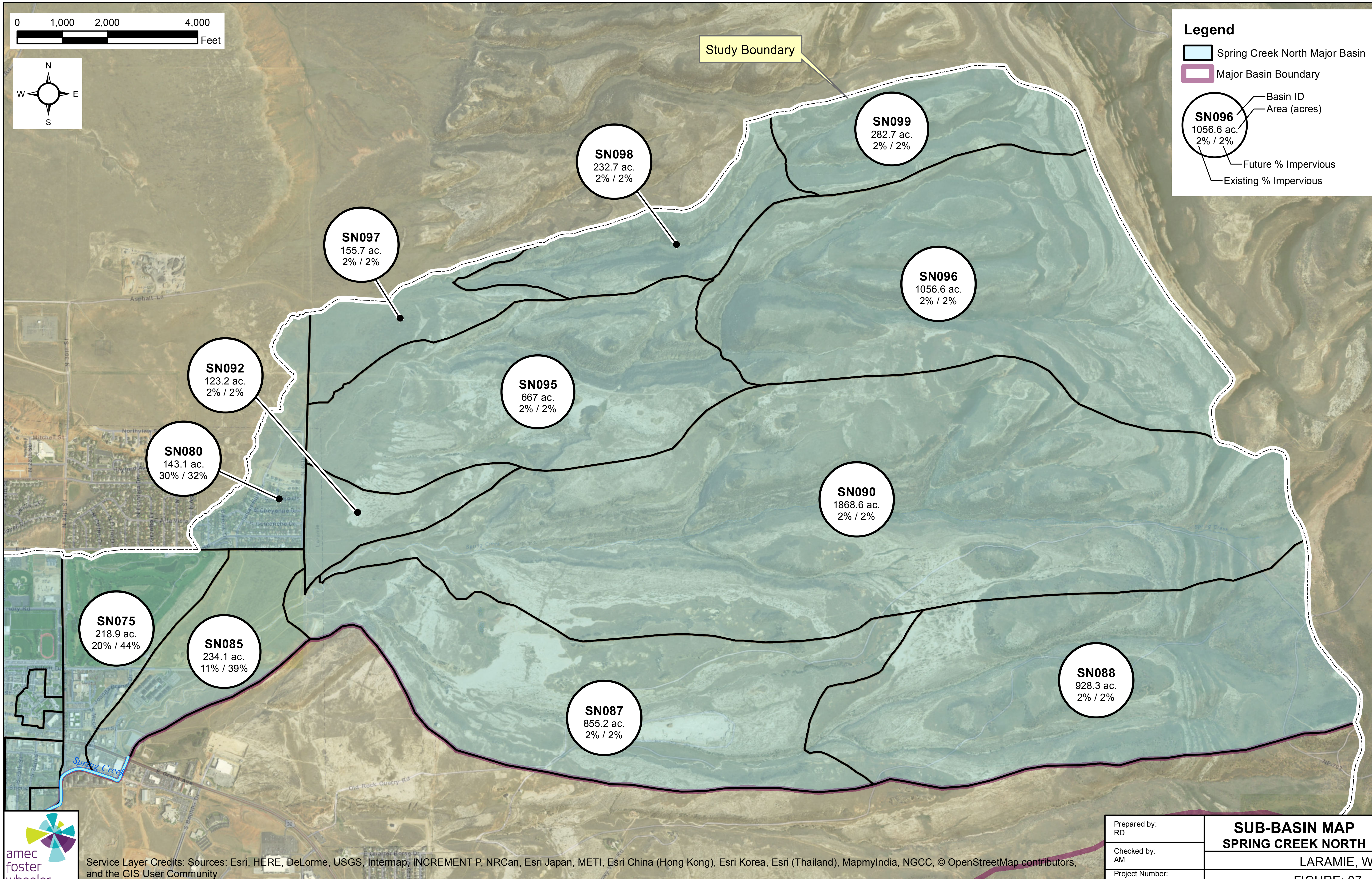

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Checked by: AM	LARAMIE, WY
Project Number: 32710198	FIGURE: 07 - B

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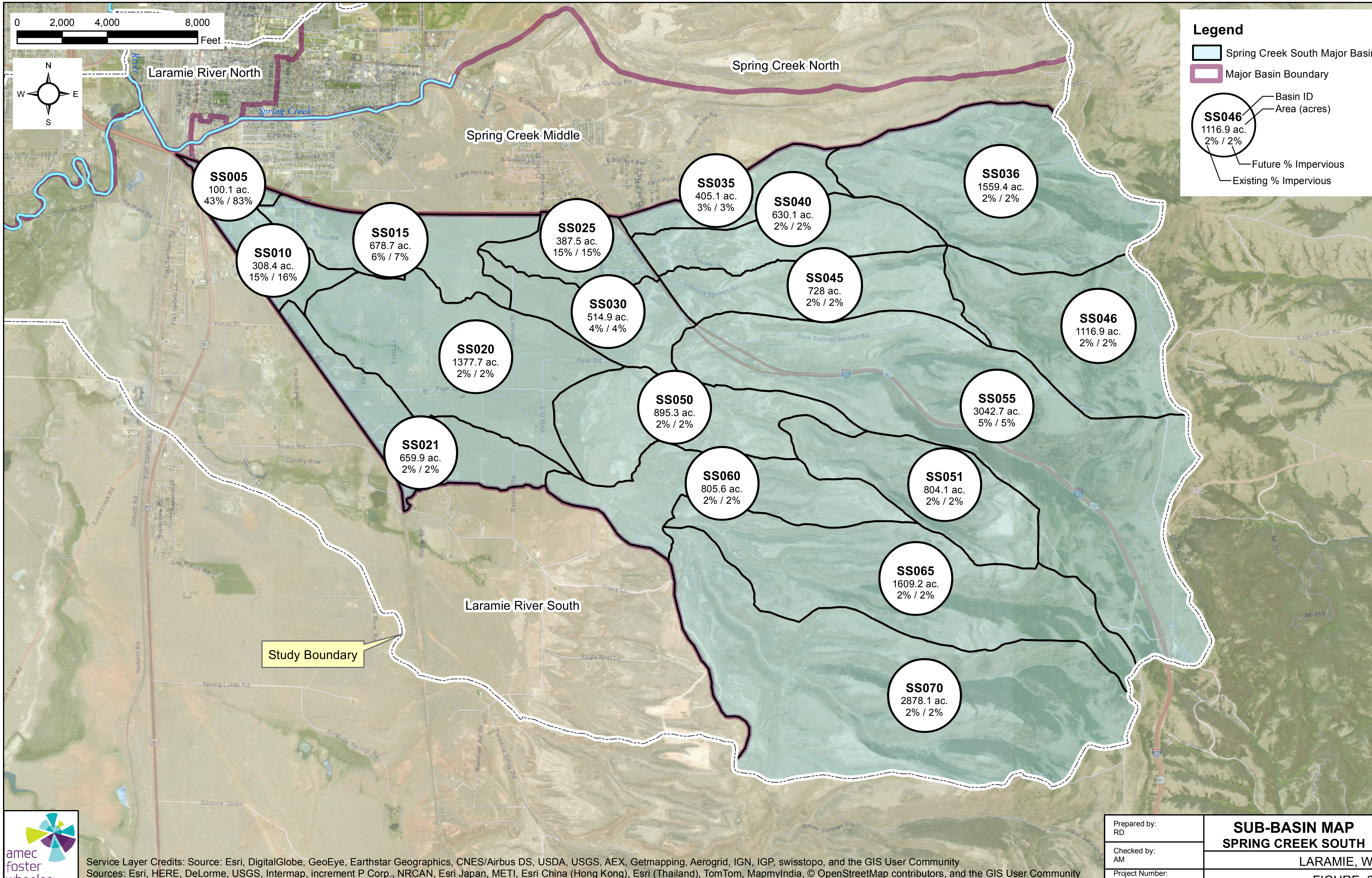

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Project Number: 32710198	FIGURE: 08

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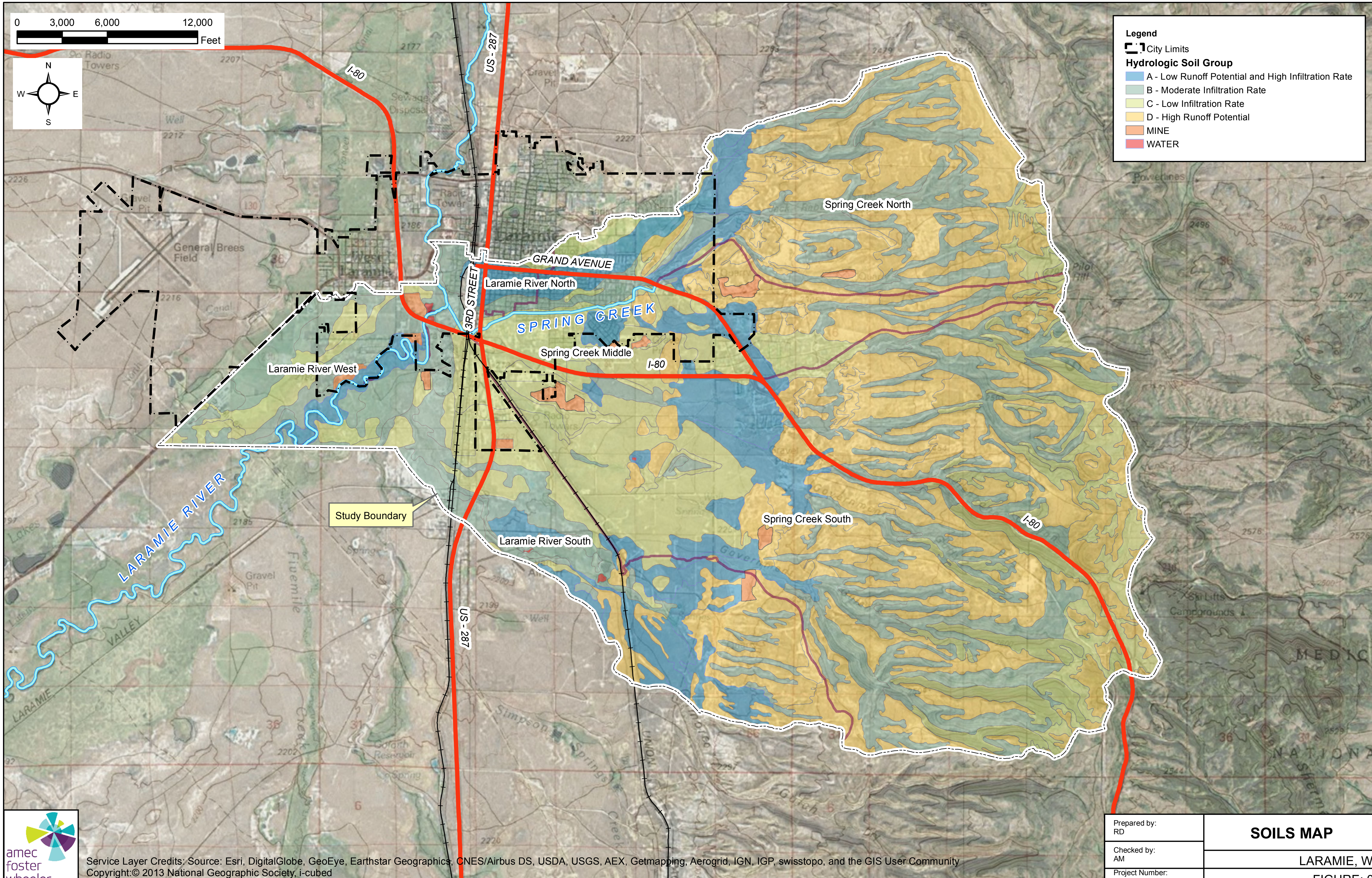

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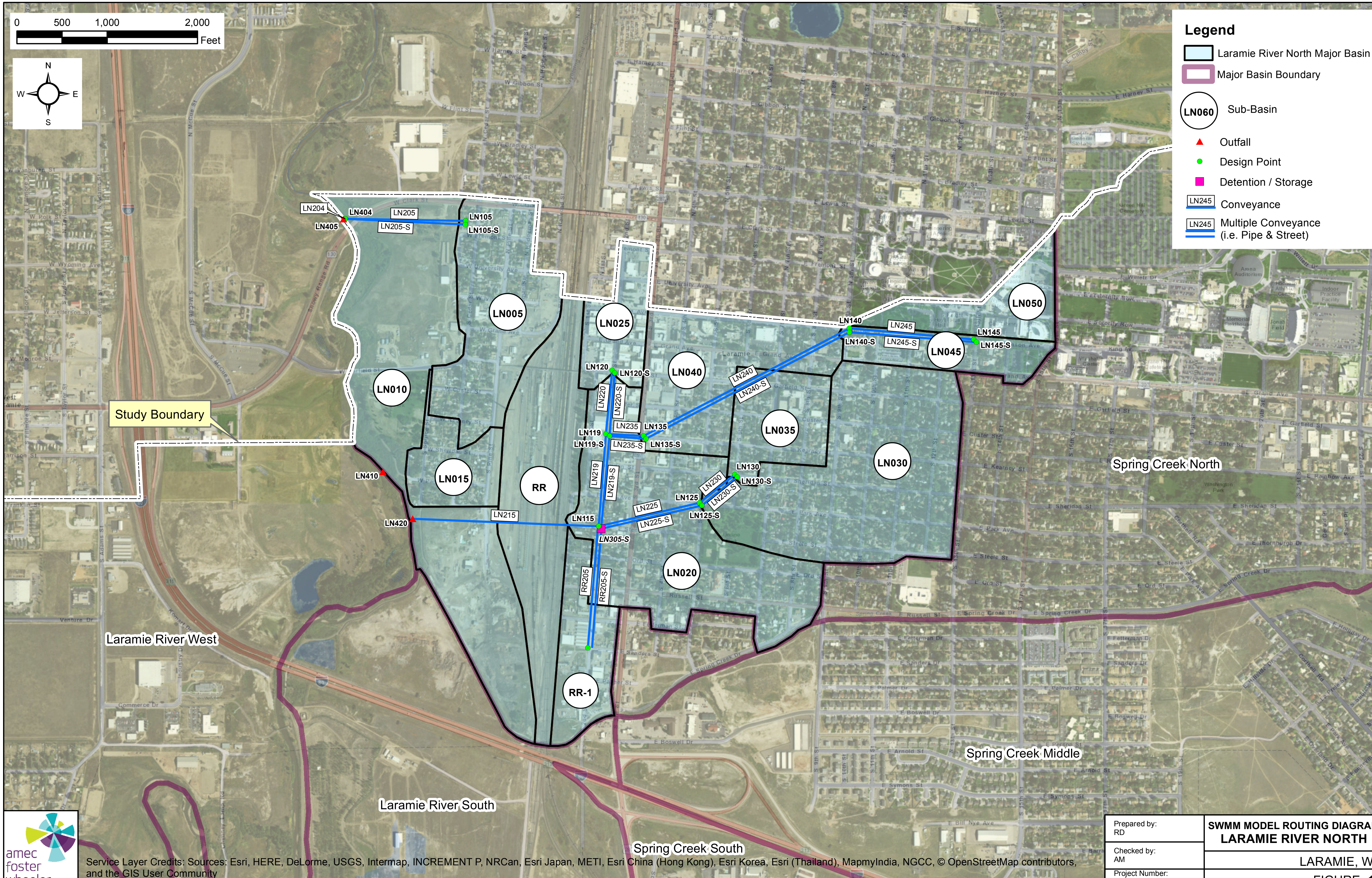

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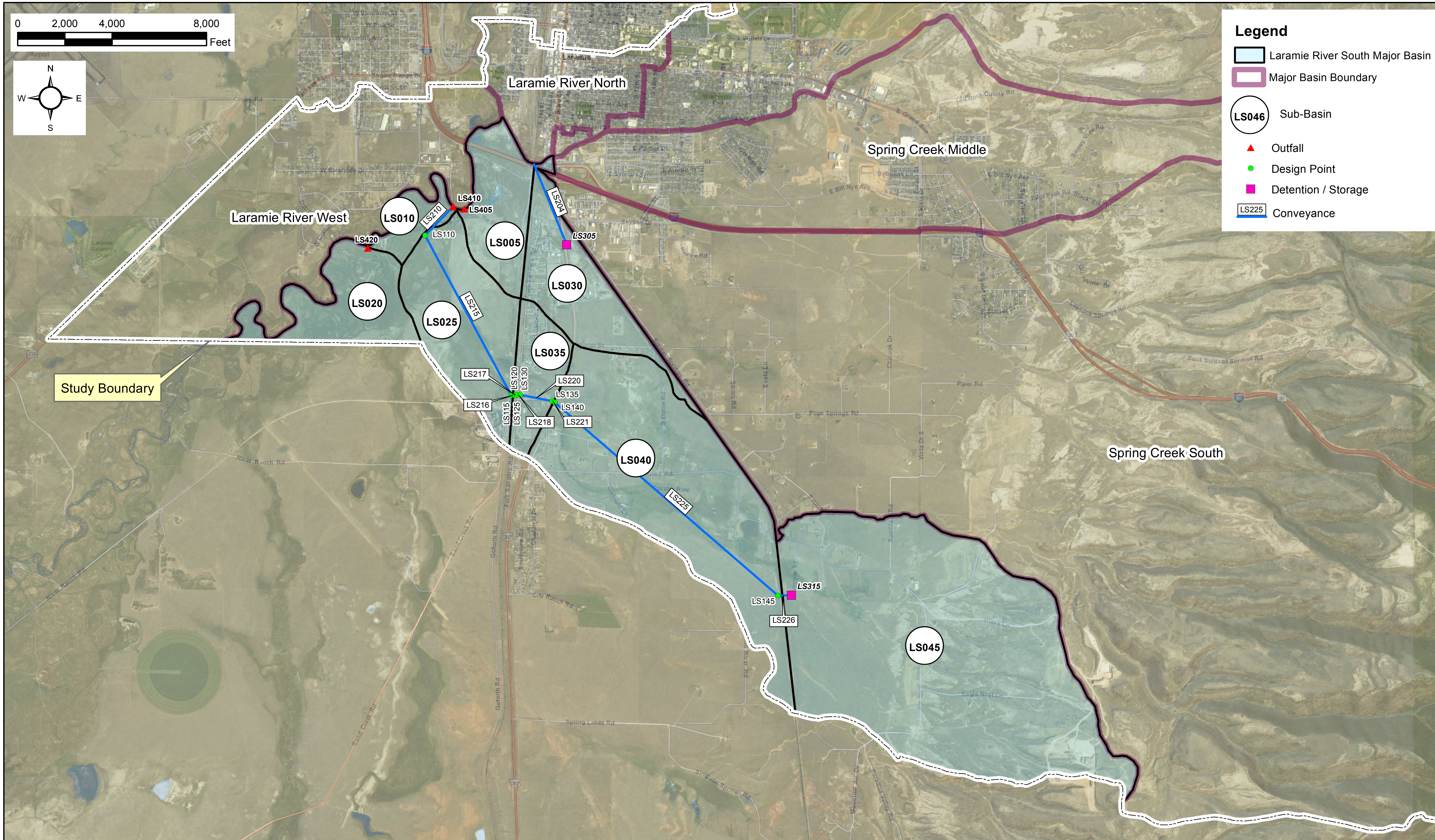

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Checked by: AM	LARAMIE, WY
Project Number: 32710198	FIGURE: 11

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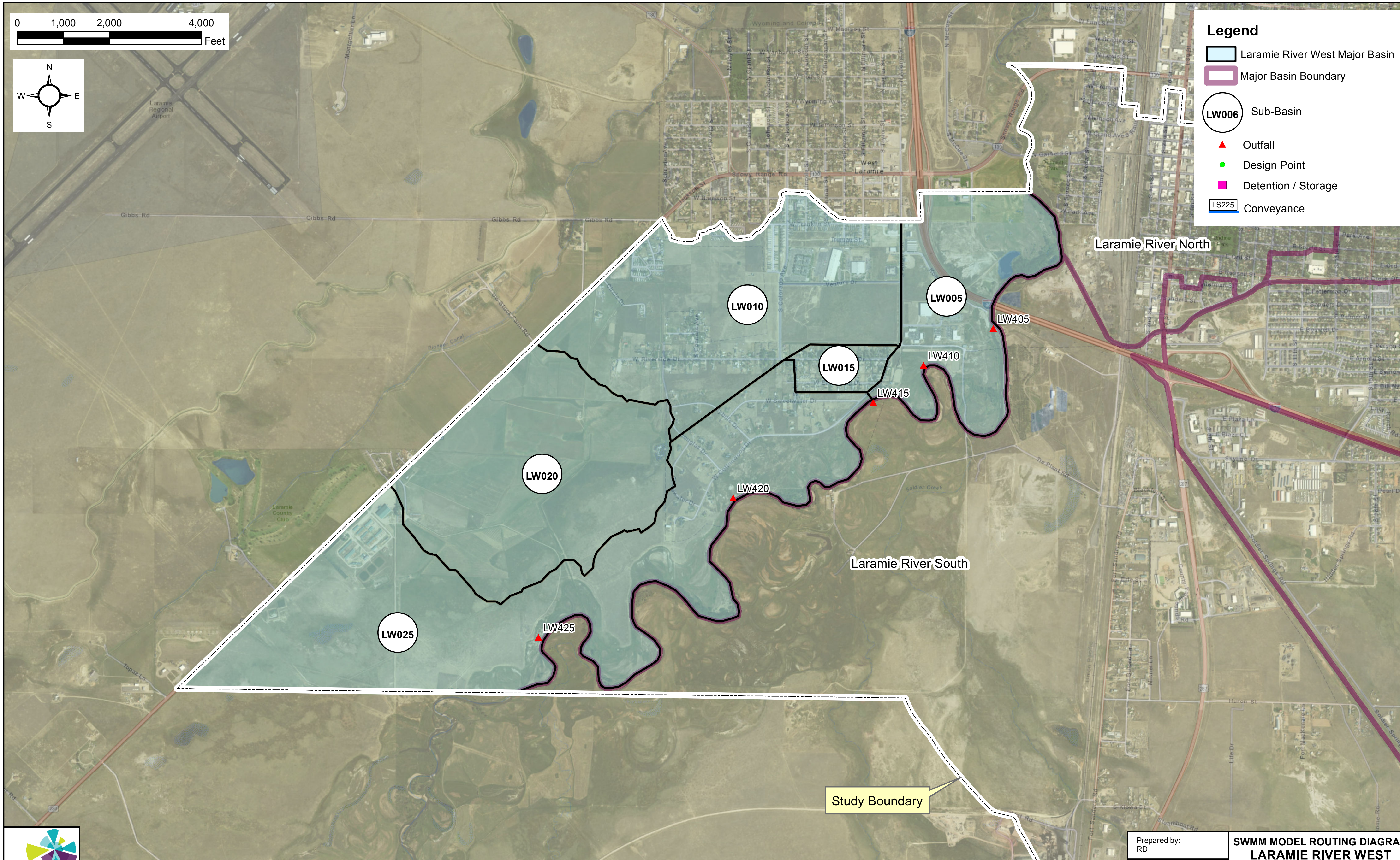

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Checked by: AM	LARAMIE, WY
Project Number: 32710198	FIGURE: 12

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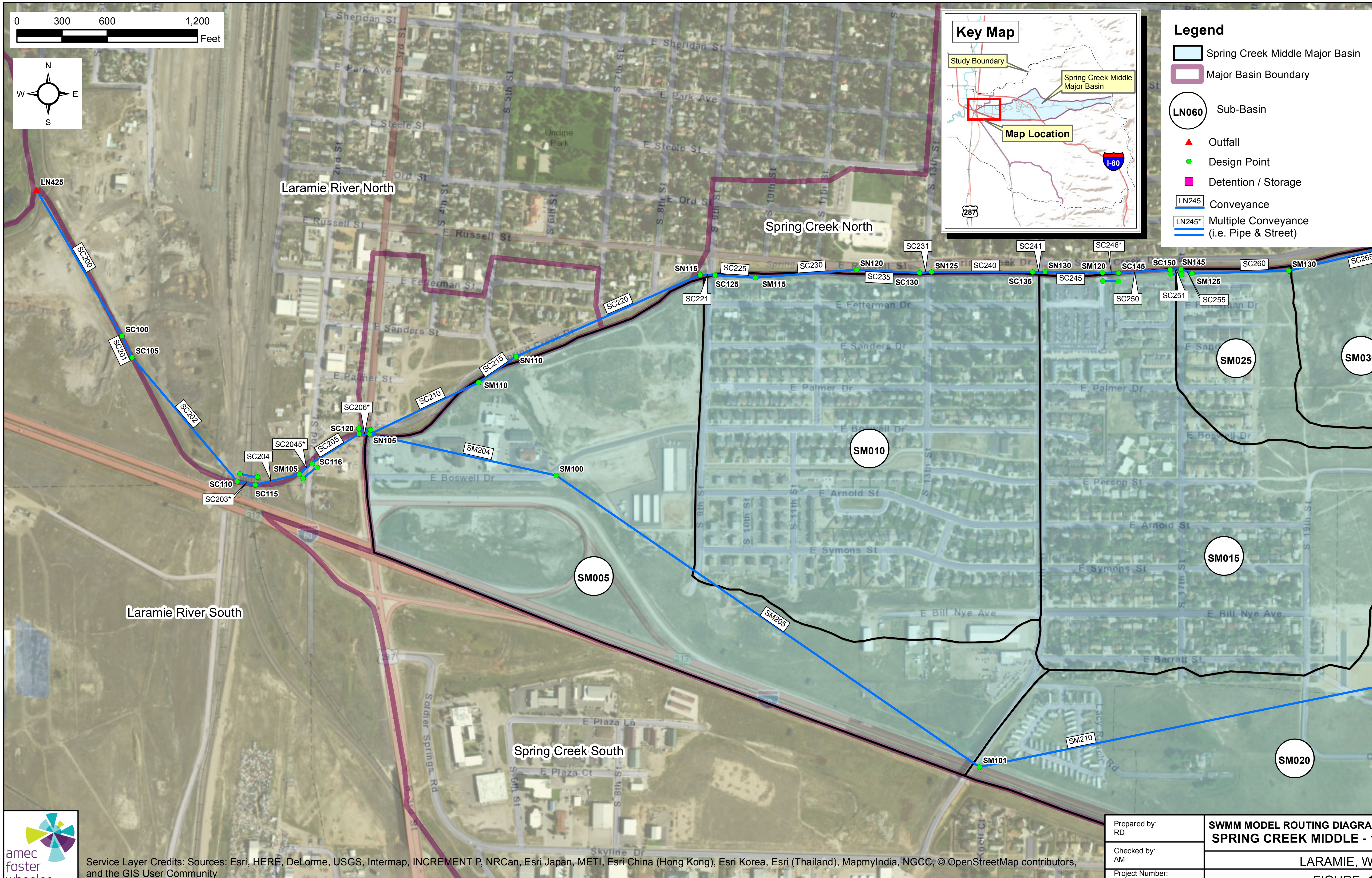

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Checked by: AM	LARAMIE, WY
Project Number: 32710198	FIGURE: 13

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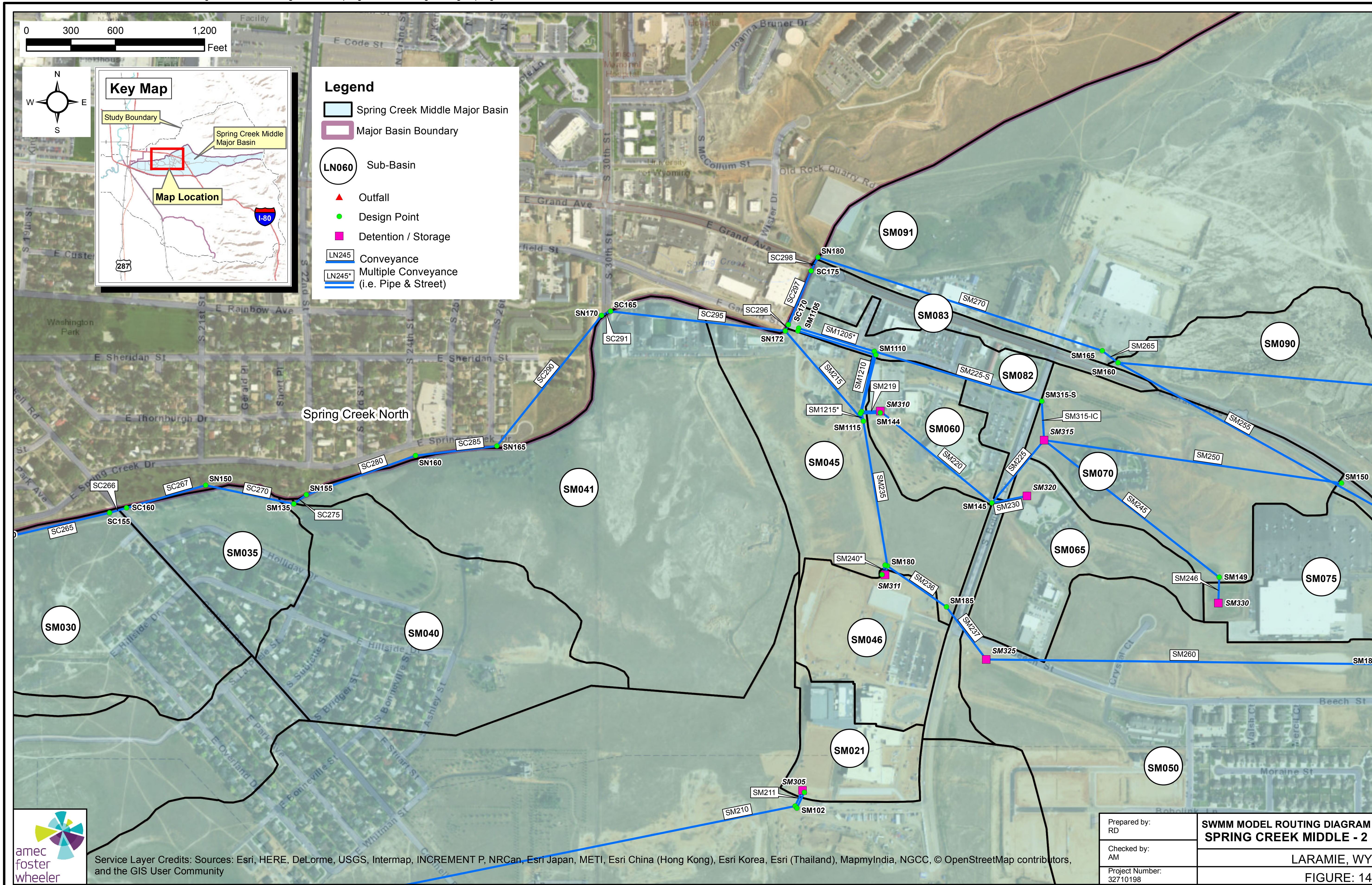

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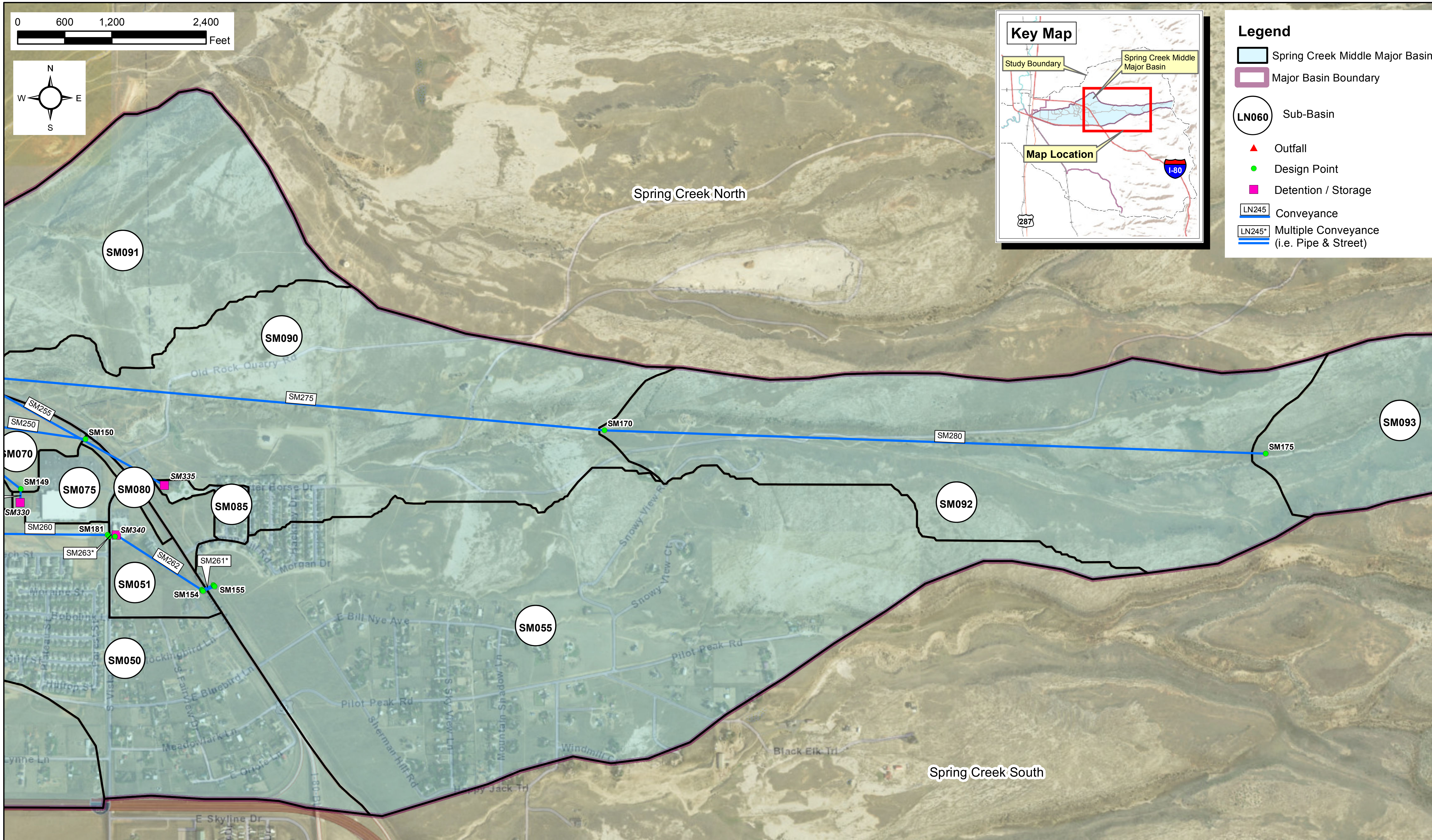

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Checked by: AM	LARAMIE, WY
Project Number: 32710198	FIGURE: 15

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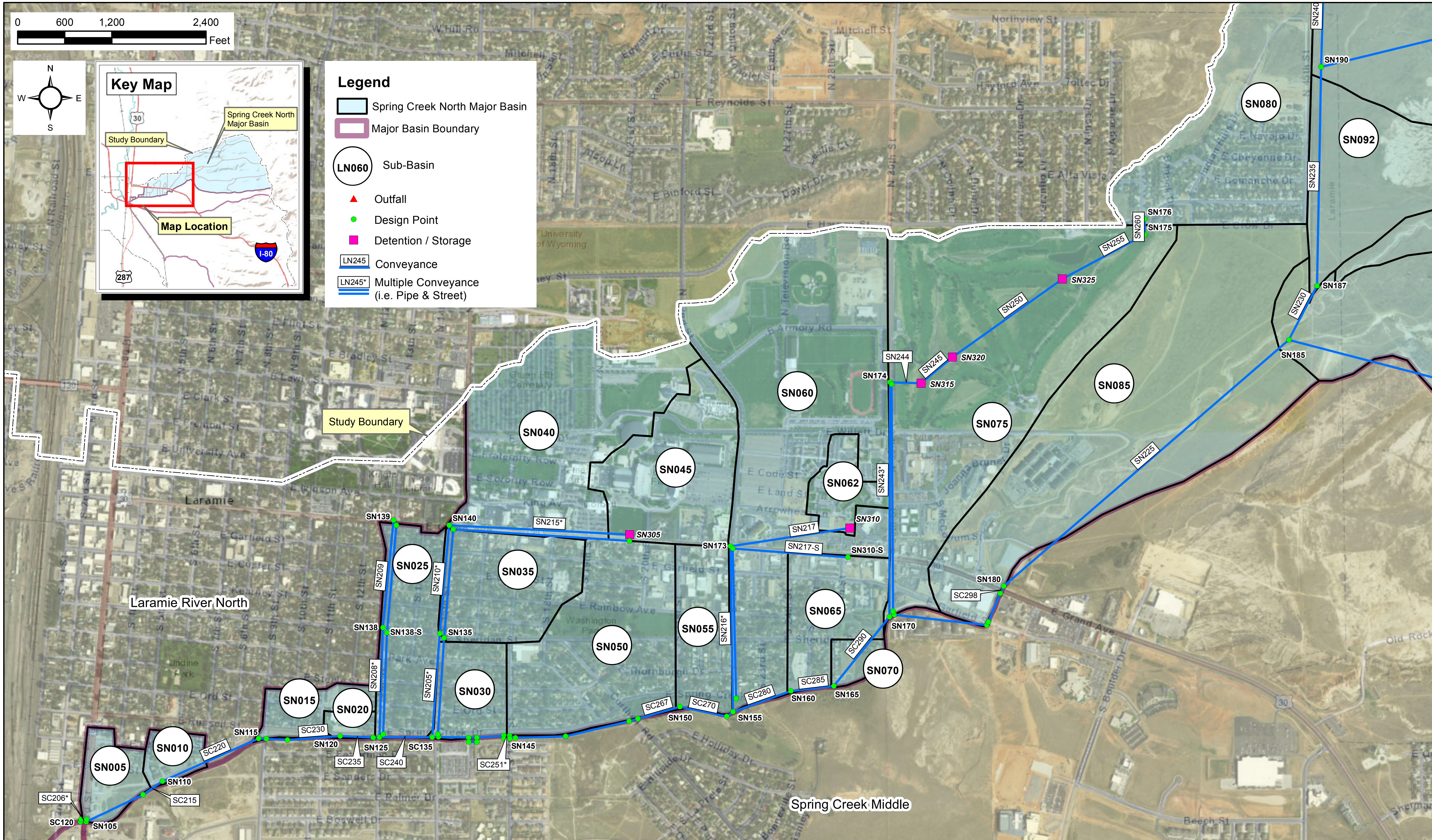

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Checked by: AM	LARAMIE, WY
Project Number: 32710198	FIGURE: 16

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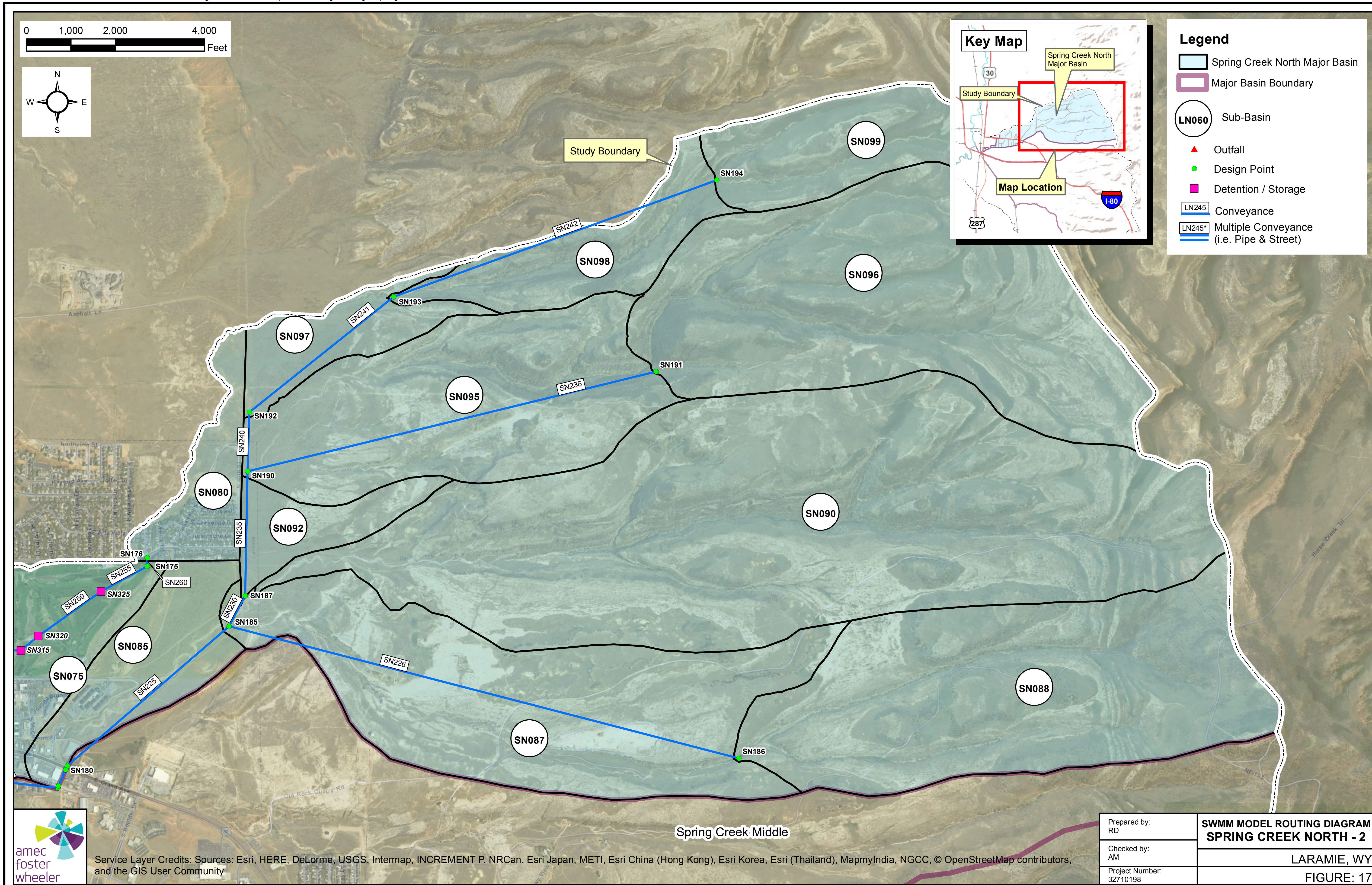

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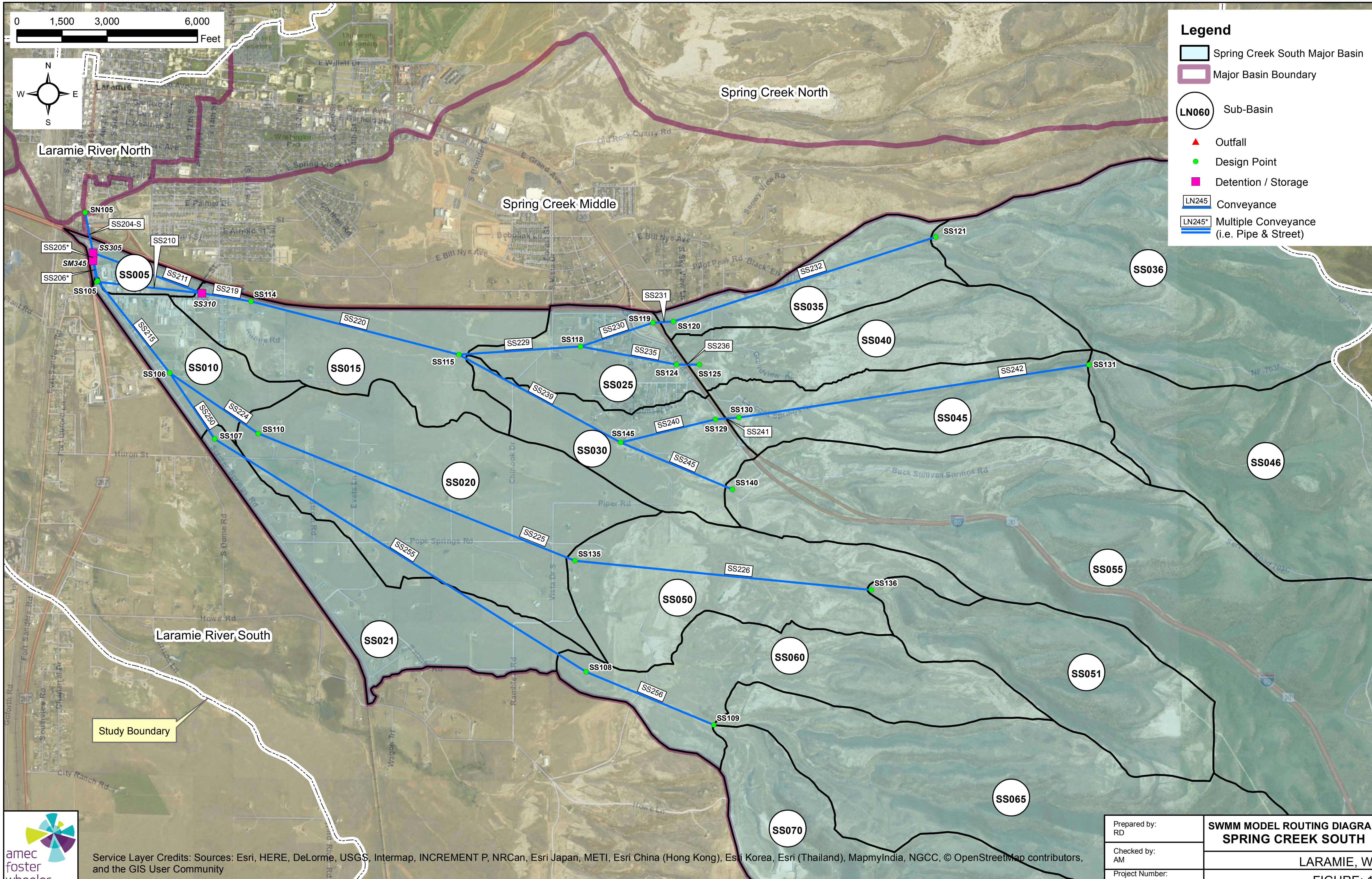

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Checked by: AM	LARAMIE, WY
Project Number: 32710198	FIGURE: 18

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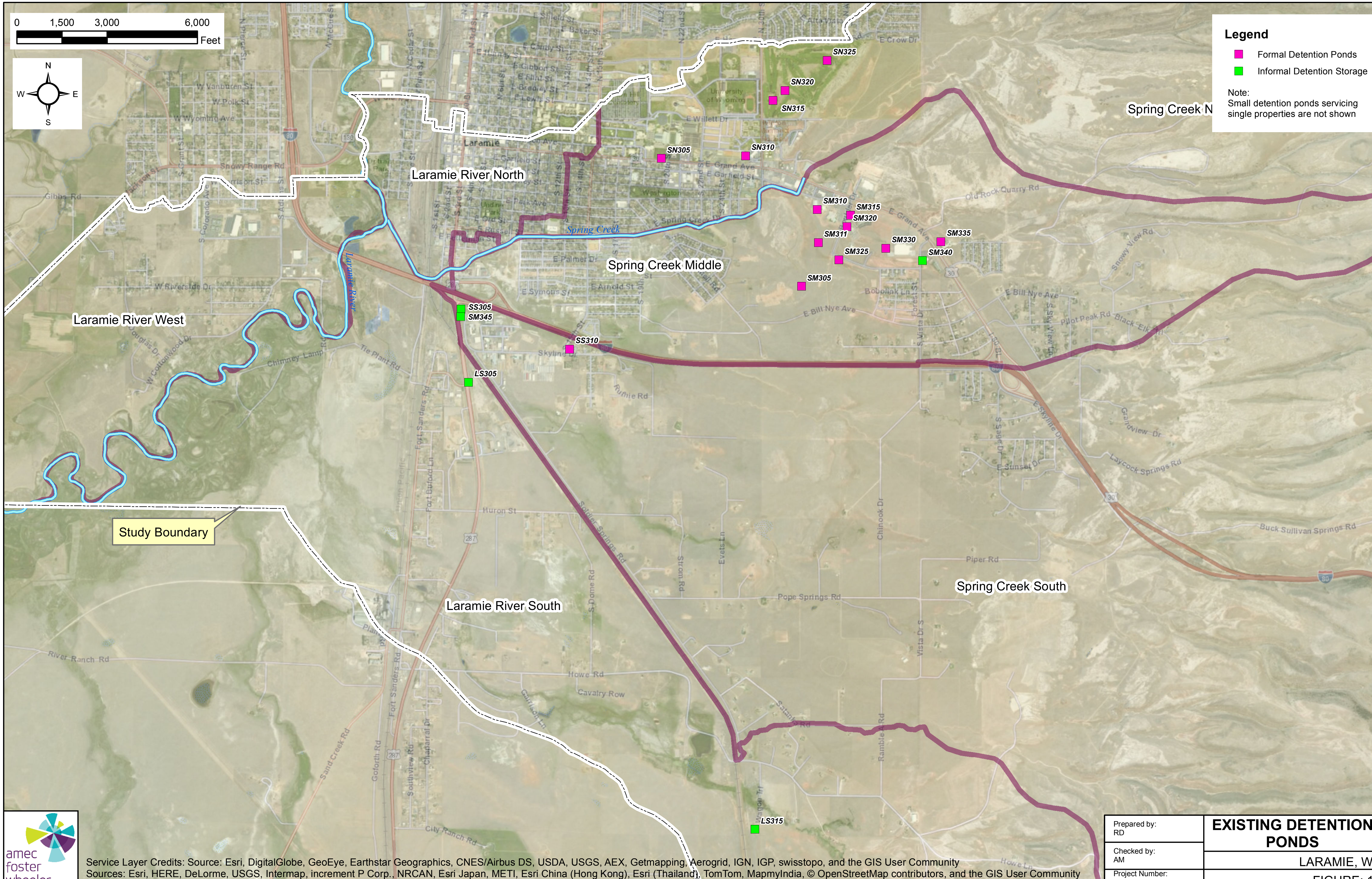

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Prepared by: RD	EXISTING DETENTION PONDS
Checked by: AM	LARAMIE, WY
Project Number: 32710198	FIGURE: 19

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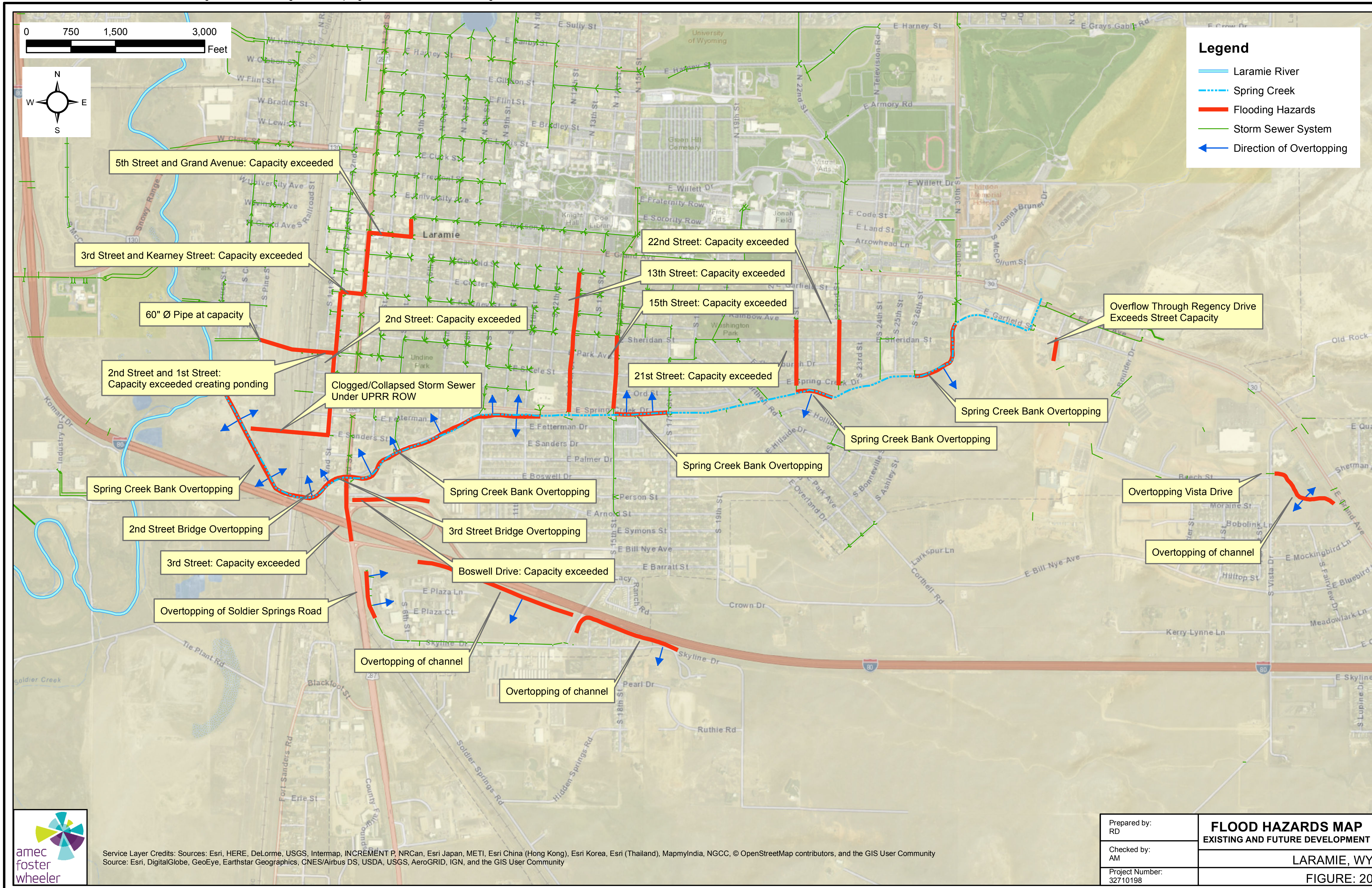

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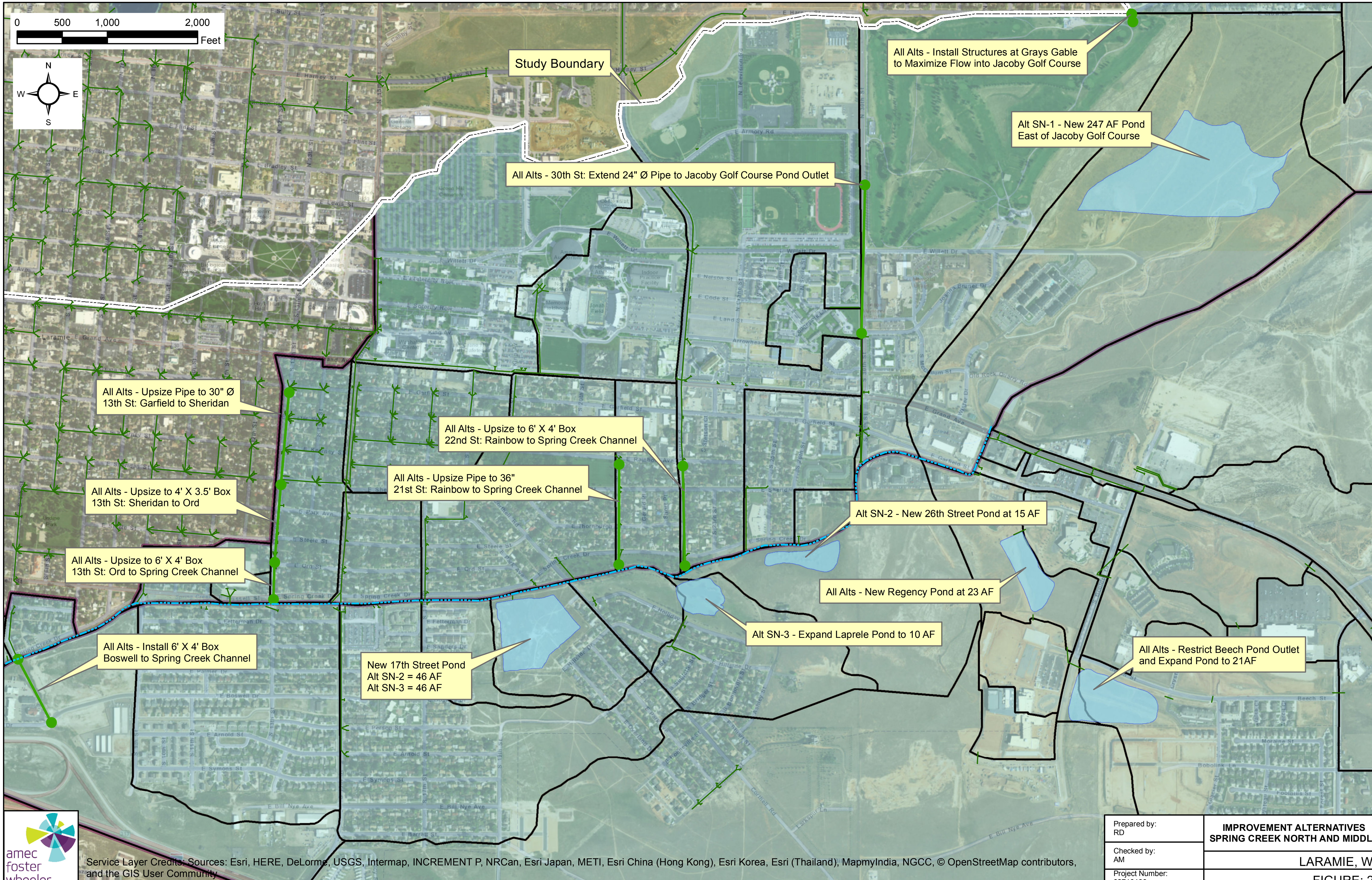

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Checked by: AM	LARAMIE, WY
Project Number: 32710198	FIGURE: 21

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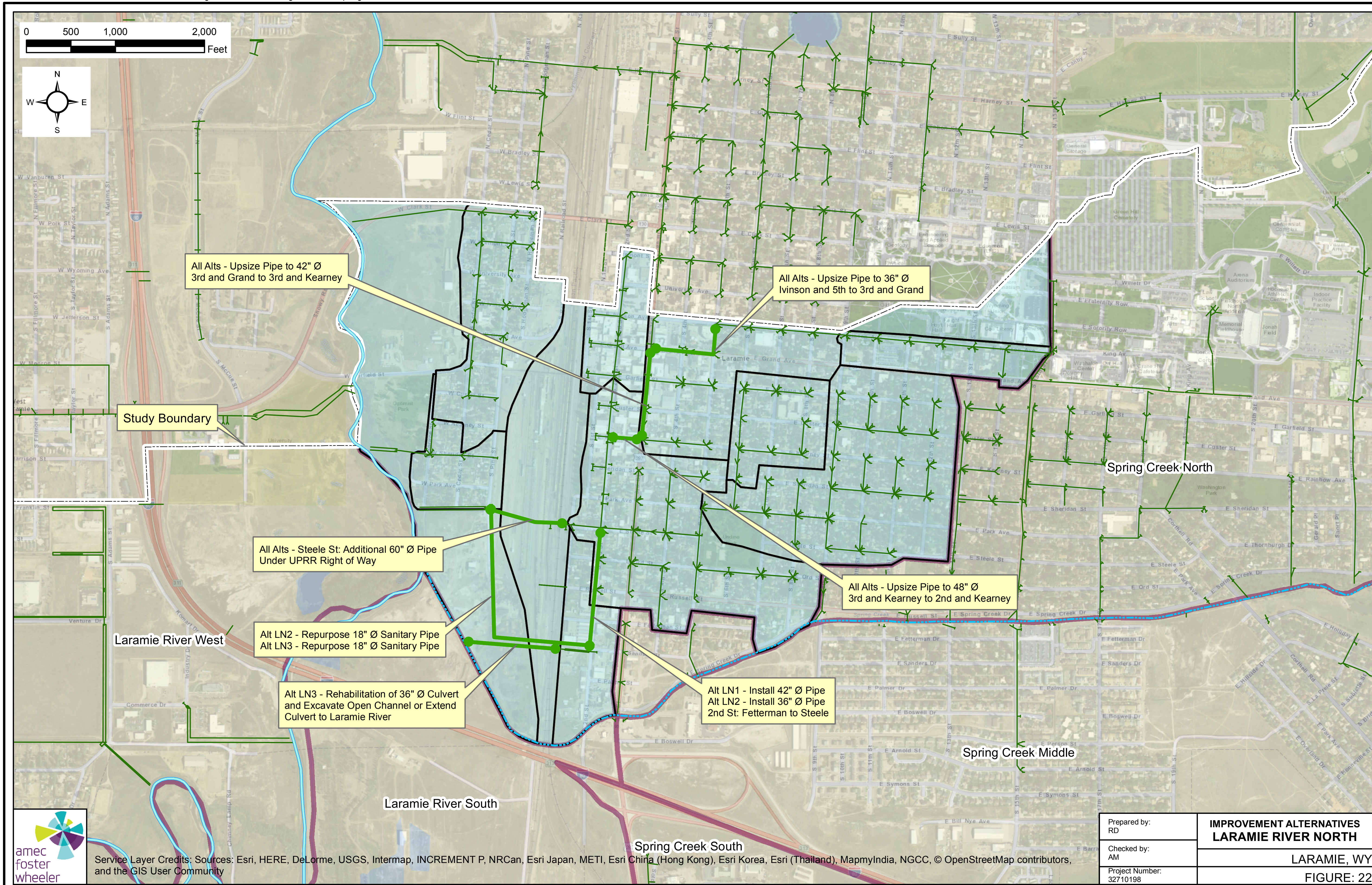

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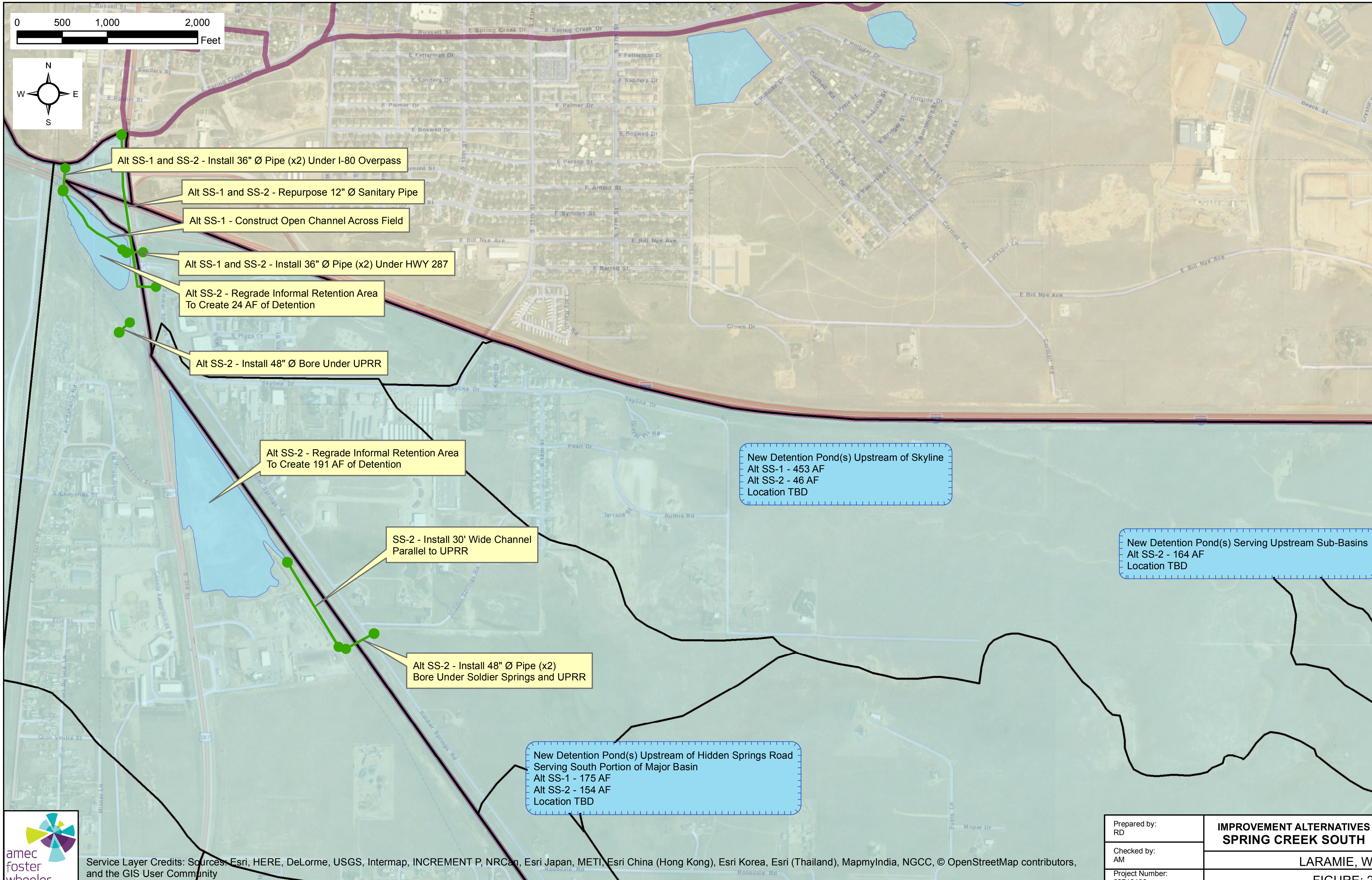

APPENDIX A

SWMM Model Input

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Name	Area (ac)	Peak Runoff (cfs)	cfs per acre	Imperv. (%)	Max. Infil. Rate (in/hr)	Min. Infil. Rate (in/hr)	Slope (%)
LN005	55.3	105	1.89	50	4.16	0.26	2.8
LN010	118.9	66	0.55	9	3.87	0.22	3.1
LN015	20.3	44	2.17	42	4.01	0.23	3.3
LN020	94.0	152	1.62	58	4.51	0.35	1.3
LN025	20.8	64	3.06	94	5	0.45	1.9
LN030	97.3	136	1.39	46	4.71	0.38	1.9
LN035	26.8	57	2.12	59	4.99	0.45	1.7
LN040	51.7	98	1.89	79	4.89	0.43	1.4
LN045	21.7	44	2.03	50	3.5	0.24	2.8
LN050	24.8	64	2.57	50	2.02	0.1	5.1
LS005	342.5	88	0.26	4	3.28	0.18	4.2
LS010	131.1	15	0.11	2	4.56	0.35	1.5
LS020	360.5	43	0.12	2	3.57	0.24	1.6
LS025	642.8	76	0.12	2	3.53	0.2	1.6
LS030	463.2	348	0.75	23	2.04	0.1	4.3
LS035	248.6	219	0.88	15	2.68	0.14	3.4
LS040	1555.9	180	0.12	2	3.42	0.22	5.9
LS045	2666.0	384	0.14	2	2.82	0.2	19.0
LS055	70.9	9	0.13	2	3.45	0.19	1.1
LW005	291.9	217	0.74	15	3.7	0.22	3.0
LW010	529.7	370	0.70	20	3.33	0.18	2.3
LW015	45.8	58	1.26	25	3.96	0.22	1.2
LW020	488.8	66	0.14	2	3.2	0.18	2.4
LW025	839.9	234	0.28	5	3.67	0.23	2.9
SM005	747.5	450	0.60	16	2.28	0.13	7.6
SM010	29.2	26	0.90	12	2	0.1	3.9
SM015	106.4	194	1.83	52	2	0.1	4.1
SM020	101.9	158	1.55	49	2.61	0.17	3.3
SM025	21.9	79	3.61	77	2	0.1	6.7
SM030	47.9	81	1.70	34	3.12	0.23	8.2
SM035	155.4	130	0.83	13	2.58	0.18	14.7
SM040	14.8	49	3.34	64	5	0.45	11.7
SM045	61.2	38	0.62	10	3.15	0.24	16.6
SM050	288.6	275	0.95	23	2.84	0.2	8.2
SM055	623.7	359	0.58	11	2.17	0.13	12.5
SM060	16.7	33	1.96	36	2.5	0.16	6.3
SM065	21.7	44	2.04	39	3.94	0.33	6.9
SM070	38.4	126	3.27	63	2.3	0.13	14.9
SM075	21.9	87	3.97	95	4.58	0.4	6.9
SM080	4.9	19	3.86	93	5	0.45	5.2
SM082	14.0	44	3.14	78	2	0.1	5.7
SM083	9.2	31	3.36	83	2.19	0.11	7.0
SM085	9.8	26	2.62	55	5	0.45	5.9
SM090	1072.0	217	0.20	3	2.07	0.11	27.1
SM091	287.5	157	0.55	7	1.78	0.1	19.6
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SN010	10.3	24	2.31	48	2.74	0.15	1.9
SN015	16.6	36	2.20	52	3.5	0.19	2.3
SN020	4.8	16	3.43	63	2.29	0.12	1.7
SN025	46.4	77	1.66	47	4.45	0.35	2.4
SN030	25.3	60	2.36	60	3.75	0.26	2.1
SN035	51.9	100	1.93	59	5	0.45	2.3
SN040	119.4	186	1.55	47	2.79	0.19	3.7
SN045	66.6	122	1.84	52	4.77	0.42	4.0
SN050	92.9	155	1.67	52	3.5	0.25	2.9
SN055	33.6	85	2.52	69	3.83	0.26	4.0
SN060	212.3	285	1.34	46	3.6	0.26	4.3
SN062	17.4	65	3.72	95	4.8	0.4	5.2
SN065	39.3	99	2.53	77	3.92	0.22	3.7
SN070	7.9	8	0.97	15	2.77	0.15	3.0
SN075	218.9	216	0.99	20	3.19	0.25	14.3
SN080	143.1	200	1.40	30	3.87	0.32	15.9
SN085	234.1	143	0.61	11	3.75	0.27	14.9
SN087	1783.6	356	0.20	2	2.04	0.1	27.0
SN090	1868.6	440	0.24	2	2.25	0.11	33.6
SN092	123.2	34	0.28	2	2.88	0.22	13.3
SN095	1723.6	394	0.23	2	2.08	0.11	33.3
SN097	671.1	147	0.22	2	2.82	0.17	37.8
SS005	93.5	168	1.80	43	2	0.1	5.9
SS010	308.4	224	0.73	15	2.08	0.1	6.3
SS015	678.7	230	0.34	6	2.69	0.16	7.9
SS020	1377.7	239	0.17	2	2.16	0.12	8.4
SS021	659.9	82	0.12	2	2.69	0.18	4.9
SS025	387.5	276	0.71	15	4.73	0.42	8.5
SS030	514.9	115	0.22	4	3.86	0.32	11.5
SS035	1964.6	469	0.24	2	2.27	0.11	48.9
SS040	630.1	212	0.34	2	1.63	0.07	22.8
SS045	1844.9	433	0.23	2	2.03	0.1	41.9
SS050	1699.4	370	0.22	2	2.23	0.12	36.3
SS055	3042.7	928	0.30	5	2.05	0.1	49.5
SS060	5292.9	676	0.13	2	2.42	0.13	17.2

SL_Basins				Basin Length	Impervious Area	Calculations						Hydrologic Soil Group.xls		
Basin_ID	WATERSHED	ACRES	Slope_Per	Length	AWA Impervious	Ration X:1	Width (W=A/L)	Width ($W=A/L*C_F$)	IR Width	A1	A2	AWA Infiltration (I)	AWA Infiltration (F)	AWA Decay Coefficient
LN005	Laramie River North	55.3	2.8	2,881	50	3.4	836	1254	4,147	43.2	12.1	4.16	0.26	5.83
LN010	Laramie River North	118.9	3.1	1,835	9	0.7	2823	4234	2,868	85.5	33.5	3.87	0.22	6.48
LN015	Laramie River North	20.3	3.3	1,383	42	2.2	641	961	2,269	13.8	6.5	4.01	0.23	6.45
LN020	Laramie River North	94.0	1.3	3,573	58	3.1	1147	1720	6,173	59.8	34.2	4.51	0.35	4.10
LN025	Laramie River North	20.8	1.9	1,707	94	3.2	532	797	3,279	11.2	9.6	5.00	0.45	2.52
LN030	Laramie River North	97.3	1.9	4,404	46	4.6	962	1444	10,180	33.5	63.8	2.03	0.10	6.48
LN035	Laramie River North	26.8	1.7	2,104	59	3.8	556	834	3,115	20.4	6.5	4.99	0.45	2.55
LN040	Laramie River North	51.7	1.4	3,656	79	5.9	616	924	5,188	40.9	10.8	4.89	0.43	2.96
LN045	Laramie River North	21.7	2.8	2,476	50	6.5	382	573	3,907	15.4	6.3	3.50	0.24	5.28
LN050	Laramie River North	24.8	5.1	1,806	50	3.0	599	898	3,499	13.2	11.6	2.02	0.10	6.48
LS005	Laramie River South	364.0	4.9	5,183	5	1.7	3059	4588	6,479	318.5	45.5	3.26	0.18	6.43
LS010	Laramie River South	131.1	1.5	4,188	2	3.1	1364	2046	5,928	103.9	27.2	4.56	0.35	4.26
LS020	Laramie River South	431.4	1.5	6,178	2	2.0	3042	4563	9,689	308.8	122.6	3.55	0.23	5.67
LS025	Laramie River South	642.8	1.6	9,851	2	3.5	2842	4263	18,390	364.2	278.6	3.53	0.20	6.48
LS030	Laramie River South	489.0	4.9	13,310	23	8.3	1600	2401	16,703	426.7	62.3	2.03	0.10	6.48
LS035	Laramie River South	248.6	3.4	2,739	15	0.7	3953	5929	2,879	242.2	6.3	2.68	0.14	6.48
LS040	Laramie Rive South	1555.9	5.9	20,478	2	6.2	3310	4965	32,022	1117.3	438.6	3.42	0.22	5.67
LS045	Laramie River South	2666.0	19.0	19,869	2	3.4	5845	8767	32,529	1816.6	849.3	2.82	0.20	5.05
LW005	Laramie River West	291.9	3.0	4,630	15	1.7	2747	4120	7,554	199.7	92.2	3.70	0.22	5.63
LW010	Laramie River West	529.7	2.3	8,315	20	3.0	2775	4163	9,762	483.7	46.1	3.33	0.18	6.48
LW015	Laramie River West	45.8	1.2	1,615	25	1.3	1235	1853	3,197	23.4	22.4	3.96	0.22	6.48
LW020	Laramie River West	488.8	2.4	7,616	2	2.7	2796	4194	11,933	350.3	138.6	3.20	0.18	6.45
LW025	Laramie River West	839.9	2.9	7,228	5	1.4	5062	7593	10,608	643.5	196.4	3.67	0.23	5.79
RR-1		25.9	1.3	2,304	75	4.7	490	735				3.18	0.19	6.09
SM005	Spring Creek Middle	120.2	4.5	5,847	36	6.5	896	1344	10,008	77.5	42.8	2.00	0.10	6.48
SM010	Spring Creek Middle	121.5	3.9	4,389	49	3.6	1206	1809	6,165	96.9	24.6	2.00	0.10	6.48
SM015	Spring Creek Middle	126.8	3.3	5,478	52	5.4	1008	1513	9,220	83.5	43.3	2.57	0.17	5.73
SM020	Spring Creek Middle	574.7	7.6	13,313	10	7.1	1880	2821	#DIV/0!			2.31	0.13	6.03
SM021	Spring Creek Middle	12.7	2.8	1,263	45	2.9	437	656	#DIV/0!			2.89	0.20	5.30
SM025	Spring Creek Middle	22.1	6.8	2,590	64	7.0	372	559	5,044	19.9	17.9	2.03	0.10	6.44
SM030	Spring Creek Middle	37.9	8.6	2,903	30	5.1	568	853	5,653	19.9	17.9	3.16	0.24	4.95
SM035	Spring Creek Middle	19.0	7.5	1,318	36	2.1	627	940	1,499	17.7	1.3	3.84	0.32	4.05
SM040	Spring Creek Middle	55.4	12.6	3,038	27	3.8	794	1191	5,442	33.5	21.9	3.80	0.31	4.10
SM041	Spring Creek Middle	93.8	17.0	2,758	8	1.9	1482	2223	4,944	57.9	38.0	1.99	0.12	5.95
SM045	Spring Creek Middle	38.4	18.9	2,441	14	3.6	685	1027	#DIV/0!			2.51	0.16	5.64
SM046	Spring Creek Middle	19.7	4.0	1,377	66	2.2	623	935	#DIV/0!			4.15	0.35	3.59
SM050	Spring Creek Middle	256.2	8.0	8,885	18	7.1	1256	1884	#DIV/0!			2.65	0.18	5.60
SM051	Spring Creek Middle	32.4	9.3	2,233	61	3.5	631	947	#DIV/0!			4.33	0.37	3.40
SM055	Spring Creek Middle	623.7	12.5	12,772	11	6.0	2127	3191	23,788	354.7	269.0	2.17	0.13	5.91
SM060	Spring Creek Middle	20.2	7.5	3,026	33	10.4	291	436	#DIV/0!			2.77	0.19	5.41
SM065	Spring Creek Middle	21.7	6.9	1,834	39	3.6	515	773	2,645	16.9	4.8	3.94	0.33	3.91
SM070	Spring Creek Middle	38.4	14.9	2,447	63	3.6	684	1026	3,282	31.9	6.6	2.30	0.13	6.09
SM075	Spring Creek Middle	21.9	6.9	1,862	95	3.6	513	769	2,241	19.7	2.2	4.58	0.40	3.07
SM080	Spring Creek Middle	4.9	5.2	1,673	93	13.1	128	192	2,855	3.2	1.7	5.00	0.45	2.52
SM082	Spring Creek Middle	14.0	5.7	2,444	78	9.8	249	374	3,939	9.7	4.3	2.00	0.10	6.48
SM083	Spring Creek Middle	9.2	7.0	2,501	83	15.6	160	241	4,200	6.1	3.1	2.19	0.11	6.48
SM085	Spring Creek Middle	9.8	5.9	1,919	55	8.6	223	334	3,224	6.5	3.3	5.00	0.45	2.52
SM090	Spring Creek Middle	376.2	21.5	9,900	5	6.0	1655	2483	15,446	270.8	105.4	2.22	0.13	5.72
SM091	Spring Creek Middle	287.5	19.6	6,750	7	3.6	1855	2783	10,746	202.4	85.1	1.78	0.10	5.95
SM092	Spring Creek Middle	362.9	23.1	10,382	2	6.8	1523	2284	20,111	192.9	170.0	2.17	0.10	6.48
SM093	Spring Creek Middle	332.9	44.0	9,468	2	6.2	1531	2297	18,507	174.0	158.9	1.81	0.08	6.48
SN005	Spring Creek North	17.4	1.4	1,427	53	2.7	532	799	1,869	14.7	2.7	2.57	0.14	6.48
SN010	Spring Creek North	10.3	1.9	1,354	48	4.1	333	499	2,119	7.4	2.9	2.74	0.15	6.48
SN015	Spring Creek North	16.6	2.3	1,964	52	5.3	367	551	3,403	10.5	6.1	3.50	0.19	6.48
SN020	Spring Creek North	4.8	1.7	626	63	1.9	333	499	1,168	2.7	2.1	2.29	0.12	6.48
SN025	Spring Creek North	46.4	2.4	3,316	47	5.4	610	914	4,416	38.7	7.7	4.45	0.35	4.01
SN030	Spring Creek North	25.3	2.1	1,937	60	3.4	569	853	2,763	19.9	5.4	3.75	0.26	5.33
SN035	Spring Creek North	51.9	2.3	3,001	59	4.0	753	1129	5,601	29.4	22.5	5.00	0.45	2.52
SN040	Spring Creek North	119.4	3.7	5,092	47	5.0	1022	1532	9,056	72.9	46.5	2.79	0.19	5.44
SN045	Spring Creek North	66.6	4.0	3,856	52	5.1	753	1129	5,349	53.7	12.9	4.77	0.42	2.82
SN050	Spring Creek North	92.9	2.9	4,272	52	4.5	947	1421	6,572	67.9	25.0	3.50	0.25	5.19
SN055	Spring Creek North	33.6	4.0	2,720	69	5.0	539	808	3,129	31.1	2.5	3.83	0.26	5.44
SN060	Spring Creek North	212.3	4.3	7,601	46	6.2	1217	1825	12,016	150.6	61.7	3.60	0.26	4.92
SN062	Spring Creek North	17.4	5.2	1,912	95	4.8	397	596	2,426	15.1	2.3	4.80	0.40	3.31
SN065	Spring Creek North	39.3	3.7	3,013	77	5.3	568	852	3,303	37.4	1.9	3.92	0.22	6.48
SN070	Spring Creek North	7.9	3.0	1,255	15	4.6	276	414	1,424	7.4	0.5	2.77	0.15	6.48
SN075	Spring Creek North	218.9	14.3	7,560	20	6.0	1261	1892	12,691	144.6	74.3	3.19	0.25	4.58
SN080	Spring Creek North	143.1	15.9	6,391	30	6.6	975	1463	12,512	74.6	68.5	3.87	0.32	3.95
SN085	Spring Creek North	234.1	14.9	7,038	11	4.9	1449	2174	11,856	154.0	80.1	3.75	0.27	5.08
SN087	Spring Creek North	855.2	19.8	15,838	2	6.7	2352	3528	24,494	621.5	233.7	2.06	0.10	6.26
SN088	Spring Creek North	928.3	33.6	13,334	2	4.4	3033	4549	24,502	539.6	388.8	2.01	0.09	6.48
SN090	Spring Creek North	1868.6	33.6	22,732	2	6.3	3581	5371	43,795	1002.9	865.7	2.25	0.11	6.43
SN092	Spring Creek North	123.2	13.3	6,467	2	7.8	830	1245	11,210	78.0	45.2	2.88	0.22	4.86
SN095	Spring Creek North	667.0	34.0	10,575	2	3.8	2748	4121	17,271	455.9	211.2	2.11	0.12	5.91
SN096	Spring Creek North	1056.6	32.7	13,478	2	3.9	3415	5122	23,247	673.7	382.9	2.06	0.10	6.48
SN097	Spring Creek North	155.7	16.5	7,408	2	8.1	916	1374	12,256	104.8	51.0	3.52	0.29	4.08
SN098	Spring Creek North	232.7	52.7	9,297	2	8.5	1090	1635	18,543	117.0	115.7	2.65	0.13	6.48
SN099	Spring Creek North	282.7	36.9	6,994	2	4.0	1761	2641	10,782	206.2	76.6	2.56	0.13	6.48
SS005	Spring Creek South	100.1	7.0	4,587	43	4.8	951	1426	5,749	87.4	12.7	2.00	0.10	6.48
SS010	Spring Creek South	308.4	6.3	8,882	15	5.9	1512	2268	16,962	168.1	140.3	2.08	0.10	6.48
SS015	Spring Creek South	678.7	7.9	13,096	6	5.8	2257	3386	25,074	368.3	310.4	2.69	0.16	5.92
SS020	Spring Creek South	1377.7	8.4	16,557	2	4.6	3625	5437	31,567	753.2	624.5	2.16	0.12	6.27
SS021	Spring Creek South	659.9	4.9	15,798	2	8.7	1820	2730	24,328	481.8	178.2	2.69	0.18	5.54
SS025	Spring Creek South	387.5	8.5	8,600	15	4.4	1963	2944	15,594	229.9	157.6	4.73	0.42	2.84
SS030	Spring Creek South	514.9	11.5	11,482	4	5.9	1953	2930	22,192	274.7	240.1	3.86	0.32	3.76
SS035	Spring Creek South	405.1	21.6	11,944	3	8.1	1478	2216	18,858	287.9	117.3	2.07	0.11	6.23
SS036	Spring Creek South	1559.4	56.0	16,485	2	4.0	4121	6181	29,173	959.3	600.1	2.32	0.11	6.48
SS040	Spring Creek South	630.1	22.8	14,395	2	7.5	1907	2860	23,392	433.2	196.9	1.63	0.07	6.46
SS045	Spring Creek South	728.0	37.9	15,885	2	8.0	1996	2994	25,250	513.4	214.6	2.15	0.10	6.48
SS046	Spring Creek South	1116.9	44.4	14,185	2	4.1	3430	5145	24,640	705.3	411.6	1.96	0.09	6.48
SS050	Spring Creek South	895.3	18.9	12,870	2	4.2	3030	4546	19,279	672.4	222.9	2.16	0.13	5.72
SS051	Spring Creek South	804.1	55.4	13,811	2	5.4	2536	3804	21,072	592.7	211.4	2.31	0.11	6.48
SS055	Spring Creek South	3042.7	49.5	31,882	5	7.7	4157	6236	54,565	1960.4	1082.3	2.05	0.10	6.43
SS060	Spring Creek South	805.6	28.3	17,313	2	8.5	2027	3040	29,094	531.5	274.1	2.23	0.13	5.94
SS065	Spring Creek South	1609.2	58.2	24,096	2	8.3	2909	4364	44,737	919.4	688.8	2.48	0.13	6.45
SS070	Spring Creek South	2878.1	63.0	26,737	2	5.7	4689	7034	42,583	2026.0	853.2	2.45	0.12	6.45

SL_Basins				Basin Length	Impervious Area	Calculations						Hydrologic Soil Group.xls		
Basin_ID	WATERSHED	ACRES	Slope_Per	Length	AWA Impervious	Ration X:1	Width (W=A/L)	Width (W=A/L*C_F)	IR Width	A1	A2	AWA Infiltration (I)	AWA Infiltration (F)	AWA Decay Coefficient
LN005	Laramie River North	55.3	2.8	2,881	62	3.4	836	1254	4,147	43.2	12.1	4.16	0.26	5.83
LN010	Laramie River North	118.9	3.1	1,835	63	0.7	2823	4234	2,868	85.5	33.5	3.87	0.22	6.48
LN015	Laramie River North	20.3	3.3	1,383	46	2.2	641	961	2,269	13.8	6.5	4.01	0.23	6.45
LN020	Laramie River North	94.0	1.3	3,573	58	3.1	1147	1720	6,173	59.8	34.2	4.51	0.35	4.10
LN025	Laramie River North	20.8	1.9	1,707	94	3.2	532	797	3,279	11.2	9.6	5.00	0.45	2.52
LN030	Laramie River North	97.3	1.9	4,404	46	4.6	962	1444	10,180	33.5	63.8	2.03	0.10	6.48
LN035	Laramie River North	26.8	1.7	2,104	59	3.8	556	834	3,115	20.4	6.5	4.99	0.45	2.55
LN040	Laramie River North	51.7	1.4	3,656	79	5.9	616	924	5,188	40.9	10.8	4.89	0.43	2.96
LN045	Laramie River North	21.7	2.8	2,476	50	6.5	382	573	3,907	15.4	6.3	3.50	0.24	5.28
LN050	Laramie River North	24.8	5.1	1,806	50	3.0	599	898	3,499	13.2	11.6	2.02	0.10	6.48
LS005	Laramie River South	364.0	4.9	5,183	5	1.7	3059	4588	6,479	318.5	45.5	3.26	0.18	6.43
LS010	Laramie River South	131.1	1.5	4,188	3	3.1	1364	2046	5,928	103.9	27.2	4.56	0.35	4.26
LS020	Laramie River South	431.4	1.5	6,178	2	2.0	3042	4563	9,689	308.8	122.6	3.55	0.23	5.67
LS025	Laramie River South	642.8	1.6	9,851	2	3.5	2842	4263	18,390	364.2	278.6	3.53	0.20	6.48
LS030	Laramie River South	489.0	4.9	13,310	63	8.3	1600	2401	16,703	426.7	62.3	2.03	0.10	6.48
LS035	Laramie River South	248.6	3.4	2,739	22	0.7	3953	5929	2,879	242.2	6.3	2.68	0.14	6.48
LS040	Laramie Rive South	1555.9	5.9	20,478	2	6.2	3310	4965	32,022	1117.3	438.6	3.42	0.22	5.67
LS045	Laramie River South	2666.0	19.0	19,869	2	3.4	5845	8767	32,529	1816.6	849.3	2.82	0.20	5.05
LW005	Laramie River West	291.9	3.0	4,630	25	1.7	2747	4120	7,554	199.7	92.2	3.70	0.22	5.63
LW010	Laramie River West	529.7	2.3	8,315	38	3.0	2775	4163	9,762	483.7	46.1	3.33	0.18	6.48
LW015	Laramie River West	45.8	1.2	1,615	26	1.3	1235	1853	3,197	23.4	22.4	3.96	0.22	6.48
LW020	Laramie River West	488.8	2.4	7,616	2	2.7	2796	4194	11,933	350.3	138.6	3.20	0.18	6.45
LW025	Laramie River West	839.9	2.9	7,228	8	1.4	5062	7593	10,608	643.5	196.4	3.67	0.23	5.79
RR1		25.9	1.3	2,304	78	4.7	490	735				3.18	0.19	6.09
SM005	Spring Creek Middle	120.2	4.5	5,847	78	6.5	896	1344	10,008	77.5	42.8	2.00	0.10	6.48
SM010	Spring Creek Middle	121.5	3.9	4,389	58	3.6	1206	1809	6,165	96.9	24.6	2.00	0.10	6.48
SM015	Spring Creek Middle	126.8	3.3	5,478	54	5.4	1008	1513	9,220	83.5	43.3	2.57	0.17	5.73
SM020	Spring Creek Middle	574.7	7.6	13,313	31	7.1	1880	2821	#DIV/0!			2.31	0.13	6.03
SM021	Spring Creek Middle	12.7	2.8	1,263	45	2.9	437	656	#DIV/0!			2.89	0.20	5.30
SM025	Spring Creek Middle	22.1	6.8	2,590	66	7.0	372	559	5,044	19.9	17.9	2.03	0.10	6.44
SM030	Spring Creek Middle	37.9	8.6	2,903	45	5.1	568	853	5,653	19.9	17.9	3.16	0.24	4.95
SM035	Spring Creek Middle	19.0	7.5	1,318	49	2.1	627	940	1,499	17.7	1.3	3.84	0.32	4.05
SM040	Spring Creek Middle	55.4	12.6	3,038	43	3.8	794	1191	5,442	33.5	21.9	3.80	0.31	4.10
SM041	Spring Creek Middle	93.8	17.0	2,758	35	1.9	1482	2223	4,944	57.9	38.0	1.99	0.12	5.95
SM045	Spring Creek Middle	38.4	18.9	2,441	83	3.6	685	1027	#DIV/0!			2.51	0.16	5.64
SM046	Spring Creek Middle	19.7	4.0	1,377	***66***	2.2	623	935	#DIV/0!			4.15	0.35	3.59
SM050	Spring Creek Middle	256.2	8.0	8,885	43	7.1	1256	1884	#DIV/0!			2.65	0.18	5.60
SM051	Spring Creek Middle	32.4	9.3	2,233	67	3.5	631	947	#DIV/0!			4.33	0.37	3.40
SM055	Spring Creek Middle	623.7	12.5	12,772	14	6.0	2127	3191	23,788	354.7	269.0	2.17	0.13	5.91
SM060	Spring Creek Middle	20.2	7.5	3,026	43	10.4	291	436	#DIV/0!			2.77	0.19	5.41
SM065	Spring Creek Middle	21.7	6.9	1,834	67	3.6	515	773	2,645	16.9	4.8	3.94	0.33	3.91
SM070	Spring Creek Middle	38.4	14.9	2,447	64	3.6	684	1026	3,282	31.9	6.6	2.30	0.13	6.09
SM075	Spring Creek Middle	21.9	6.9	1,862	95	3.6	513	769	2,241	19.7	2.2	4.58	0.40	3.07
SM080	Spring Creek Middle	4.9	5.2	1,673	95	13.1	128	192	2,855	3.2	1.7	5.00	0.45	2.52
SM082	Spring Creek Middle	14.0	5.7	2,444	79	9.8	249	374	3,939	9.7	4.3	2.00	0.10	6.48
SM083	Spring Creek Middle	9.2	7.0	2,501	86	15.6	160	241	4,200	6.1	3.1	2.19	0.11	6.48
SM085	Spring Creek Middle	9.8	5.9	1,919	61	8.6	223	334	3,224	6.5	3.3	5.00	0.45	2.52
SM090	Spring Creek Middle	376.2	21.5	9,900	8	6.0	1655	2483	15,446	270.8	105.4	2.22	0.13	5.72
SM091	Spring Creek Middle	287.5	19.6	6,750	13	3.6	1855	2783	10,746	202.4	85.1	1.78	0.10	5.95
SM092	Spring Creek Middle	362.9	23.1	10,382	2	6.8	1523	2284	20,111	192.9	170.0	2.17	0.10	6.48
SM093	Spring Creek Middle	332.9	44.0	9,468	2	6.2	1531	2297	18,507	174.0	158.9	1.81	0.08	6.48
SN005	Spring Creek North	17.4	1.4	1,427	86	2.7	532	799	1,869	14.7	2.7	2.57	0.14	6.48
SN010	Spring Creek North	10.3	1.9	1,354	52	4.1	333	499	2,119	7.4	2.9	2.74	0.15	6.48
SN015	Spring Creek North	16.6	2.3	1,964	52	5.3	367	551	3,403	10.5	6.1	3.50	0.19	6.48
SN020	Spring Creek North	4.8	1.7	626	63	1.9	333	499	1,168	2.7	2.1	2.29	0.12	6.48
SN025	Spring Creek North	46.4	2.4	3,316	47	5.4	610	914	4,416	38.7	7.7	4.45	0.35	4.01
SN030	Spring Creek North	25.3	2.1	1,937	60	3.4	569	853	2,763	19.9	5.4	3.75	0.26	5.33
SN035	Spring Creek North	51.9	2.3	3,001	59	4.0	753	1129	5,601	29.4	22.5	5.00	0.45	2.52
SN040	Spring Creek North	119.4	3.7	5,092	48	5.0	1022	1532	9,056	72.9	46.5	2.79	0.19	5.44
SN045	Spring Creek North	66.6	4.0	3,856	52	5.1	753	1129	5,349	53.7	12.9	4.77	0.42	2.82
SN050	Spring Creek North	92.9	2.9	4,272	54	4.5	947	1421	6,572	67.9	25.0	3.50	0.25	5.19
SN055	Spring Creek North	33.6	4.0	2,720	72	5.0	539	808	3,129	31.1	2.5	3.83	0.26	5.44
SN060	Spring Creek North	212.3	4.3	7,601	63	6.2	1217	1825	12,016	150.6	61.7	3.60	0.26	4.92
SN062	Spring Creek North	17.4	5.2	1,912	95	4.8	397	596	2,426	15.1	2.3	4.80	0.40	3.31
SN065	Spring Creek North	39.3	3.7	3,013	77	5.3	568	852	3,303	37.4	1.9	3.92	0.22	6.48
SN070	Spring Creek North	7.9	3.0	1,255	35	4.6	276	414	1,424	7.4	0.5	2.77	0.15	6.48
SN075	Spring Creek North	218.9	14.3	7,560	44	6.0	1261	1892	12,691	144.6	74.3	3.19	0.25	4.58
SN080	Spring Creek North	143.1	15.9	6,391	32	6.6	975	1463	12,512	74.6	68.5	3.87	0.32	3.95
SN085	Spring Creek North	234.1	14.9	7,038	39	4.9	1449	2174	11,856	154.0	80.1	3.75	0.27	5.08
SN087	Spring Creek North	855.2	19.8	15,838	2	6.7	2352	3528	24,494	621.5	233.7	2.06	0.10	6.26
SN088	Spring Creek North	928.3	33.6	13,334	2	4.4	3033	4549	24,502	539.6	388.8	2.01	0.09	6.48
SN090	Spring Creek North	1868.6	33.6	22,732	2	6.3	3581	5371	43,795	1002.9	865.7	2.25	0.11	6.43
SN092	Spring Creek North	123.2	13.3	6,467	2	7.8	830	1245	11,210	78.0	45.2	2.88	0.22	4.86
SN095	Spring Creek North	667.0	34.0	10,575	2	3.8	2748	4121	17,271	455.9	211.2	2.11	0.12	5.91
SN096	Spring Creek North	1056.6	32.7	13,478	2	3.9	3415	5122	23,247	673.7	382.9	2.06	0.10	6.48
SN097	Spring Creek North	155.7	16.5	7,408	2	8.1	916	1374	12,256	104.8	51.0	3.52	0.29	4.08
SN098	Spring Creek North	232.7	52.7	9,297	2	8.5	1090	1635	18,543	117.0	115.7	2.65	0.13	6.48
SN099	Spring Creek North	282.7	36.9	6,994	2	4.0	1761	2641	10,782	206.2	76.6	2.56	0.13	6.48
SS005	Spring Creek South	100.1	7.0	4,587	83	4.8	951	1426	5,749	87.4	12.7	2.00	0.10	6.48
SS010	Spring Creek South	308.4	6.3	8,882	16	5.9	1512	2268	16,962	168.1	140.3	2.08	0.10	6.48
SS015	Spring Creek South	678.7	7.9	13,096	7	5.8	2257	3386	25,074	368.3	310.4	2.69	0.16	5.92
SS020	Spring Creek South	1377.7	8.4	16,557	2	4.6	3625	5437	31,567	753.2	624.5	2.16	0.12	6.27
SS021	Spring Creek South	659.9	4.9	15,798	2	8.7	1820	2730	24,328	481.8	178.2	2.69	0.18	5.54
SS025	Spring Creek South	387.5	8.5	8,600	15	4.4	1963	2944	15,594	229.9	157.6	4.73	0.42	2.84
SS030	Spring Creek South	514.9	11.5	11,482	4	5.9	1953	2930	22,192	274.7	240.1	3.86	0.32	3.76
SS035	Spring Creek South	405.1	21.6	11,944	3	8.1	1478	2216	18,858	287.9	117.3	2.07	0.11	6.23
SS036	Spring Creek South	1559.4	56.0	16,485	2	4.0	4121	6181	29,173	959.3	600.1	2.32	0.11	6.48
SS040	Spring Creek South	630.1	22.8	14,395	2	7.5	1907	2860	23,392	433.2	196.9	1.63	0.07	6.46
SS045	Spring Creek South	728.0	37.9	15,885	2	8.0	1996	2994	25,250	513.4	214.6	2.15	0.10	6.48
SS046	Spring Creek South	1116.9	44.4	14,185	2	4.1	3430	5145	24,640	705.3	411.6	1.96	0.09	6.48
SS050	Spring Creek South	895.3	18.9	12,870	2	4.2	3030	4546	19,279	672.4	222.9	2.16	0.13	5.72
SS051	Spring Creek South	804.1	55.4	13,811	2	5.4	2536	3804	21,072	592.7	211.4	2.31	0.11	6.48
SS055	Spring Creek South	3042.7	49.5	31,882	5	7.7	4157	6236	54,565	1960.4	1082.3	2.05	0.10	6.43
SS060	Spring Creek South	805.6	28.3	17,313	2	8.5	2027	3040	29,094	531.5	274.1	2.23	0.13	5.94
SS065	Spring Creek South	1609.2	58.2	24,096	2	8.3	2909	4364	44,737	919.4	688.8	2.48	0.13	6.45
SS070	Spring Creek South	2878.1	63.0	26,737	2	5.7	4689	7034	42,583	2026.0	853.2	2.45	0.12	6.45

Basin ID	Pipe Start (Ø"), downstream CS	Material	Pipe End (Ø"), model (actual)	Material
LN005	18 / Local	UKN / Asphalt	27 / Minor Arterial	UKN / Asphalt
LN010	Basin Drainage	open channel	no outlet	open channel
LN015	21 / Local	UKN / Asphalt	21 / Local	UKN / Gravel
LN020	18 / Local	UKN / Asphalt	60 / Local	UKN / Asphalt
LN025	21 / Local	UKN / Asphalt	36 / Local	UKN / Asphalt
LN030	12 / Local	UKN / Asphalt	45 / Local	UKN / Asphalt
LN035	12 / Local	UKN / Asphalt	27 / Local	UKN / Asphalt
LN040	24 / Local	UKN / Asphalt	36 / Principal Arterial	UKN / Asphalt
LN045	12 / Local	UKN / Asphalt	24 / Local	UKN / Asphalt
LN050	UKN (University) / Parking Lot	UKN / Asphalt	UKN / Parking Lot	UKN / Asphalt
LS005	Basin Drainage	open channel	no outlet structure / River	open channel
LS010	Basin Drainage	open channel	no outlet structure / River	open channel
LS020	Basin Drainage	open channel	no outlet structure / River	open channel
LS025	Basin Drainage	open channel	no outlet structure / River	open channel
LS030	Basin Drainage	open channel	no outlet structure / River	open channel
LS035	CS LS035	open channel	24(T)x48(W) Wood Box	Rectangular Closed
LS040	CS LS040	open channel	60 (x2)	Concrete
LS045	CS LS045	open channel	Pond	open channel
LS050	Basin Drainage	open channel	no outlet structure	open channel
LS055	Basin Drainage	open channel	no outlet structure / River	open channel
LW005	see note	open channel	no outlet structure / River	open channel
LW010	see note		UKN	UKN
LW015	Basin Drainage	open channel	UKN	UKN
LW020	Basin Drainage	open channel	18	UKN
LW025	Basin Drainage	open channel	no outlet structure / River	open channel
SM005	Basin Drainage	open channel	no outlet structure / River	open channel
SM010	Basin Drainage	open channel	no outlet structure / River	open channel
SM015	See Note	UKN / Asphalt	Outlet structure?	open channel and pipe?
SM020	27 / Local	UKN / Asphalt	(24)	Concrete
SM025	See Note	??? / Asphalt	(8)	PVC
SM030	See Note	??? / Asphalt	Oval 3.5(T)X6'(W)	Corrugated Steel
SM035	Basin Drainage	open channel	no outlet structure / Creek	open channel
SM040	15 / Local	UKN / Asphalt	24	UKN
SM045	CS SM045-01,02	open channel	Valley gutter / Basin Drainage	Concrete
SM050	Local	Asphalt	2(T)'x10'(W)	Concrete
SM055	Basin Drainage	open channel	24 (x2)	Corrugated Steel
SM060	Local / CS SM060	open channel	Pond / 24 (x2)	PVC
SM065	CS SM065	open channel	Pond / Pipe UKN	UKN
SM070	CS SM070	open channel	Pond / Pipe UKN	UKN
SM075	UKN (Wal-Mart) / Parking	UKN / Asphalt	Pond / Pipe UKN	UKN
SM080	Basin Drainage?	open channel	UKN	UKN
SM082	Collector	Asphalt	24	PVC
SM083	18 / Arterial	UKN / Asphalt	(24)	Concrete
SM085	Local	Asphalt	Pond	
SM090	CS SM090-01	open channel	no outlet structure / Creek	open channel
SN005	UKN / Arterial	UKN / Asphalt	UKN	UKN
SN010	18 / Local	UKN / Asphalt	21 (24)	Concrete
SN015	18 / Local	UKN / Asphalt	27 (24 con., 36 pvc, 15 pvc, 15 con)	
SN020	18 / Basin Drainage	UKN / Asphalt	18	PVC
SN025	12 / Local	UKN / Asphalt	42 (36)	Concrete
SN030	43x68/ Local	UKN and open channel	(4X 24)	PVC
SN035	15 / Local	UKN / Asphalt	43x68/ Local	UKN / Asphalt
SN040	29x45/ Local	UKN / Asphalt	38x60/ Arterial	UKN / Asphalt
SN045	UKN / Local	UKN / Asphalt	30 / Arterial	UKN / Asphalt
SN050	27 / Local	UKN / Asphalt	36	Concrete
SN055	24 / Local	UKN / Asphalt	24 (20)	Concrete
SN060	30 / Arterial	UKN / Asphalt	48 (72(W)X36(T) Concrete box)	Rectangular Closed
SN062	UKN	UKN	Pond	
SN065	15 / Local	UKN / Asphalt	15	Concrete
SN070	15	UKN	15	Concrete
SN075	24 / Arterial/CS SN075	UKN / Asphalt	45 (36)	PVC
SN080	Local	Asphalt	15	UKN
SN085	CS SN085	open channel	no outlet structure / Creek	open channel
SN087	CS SN087	open channel	no outlet structure / Ditch	open channel
SN090	Basin Drainage	open channel		open channel
SN092	CS SN092	open channel	no outlet structure / Ditch	open channel
SN095	CS SN095	open channel	no outlet structure / Ditch	open channel
SN097	Basin Drainage	open channel		open channel
SS005	UKN	open channel	Pond	
SS010	CS SS010	open channel	30	UKN
SS015	CS SS015	open channel	Pond	
SS020	CS SS020	open channel	no outlet structure	open channel
SS025	CS SS025	open channel	no outlet structure / Ditch	open channel
SS030	Basin Drainage	open channel		open channel
SS035	Basin Drainage	open channel	(x2) 6' (W) x 4" (T) Concrete Box	Rectangular Closed
SS040	Basin Drainage	open channel	(x2) 6' x 6' Concrete Box	Rectangular Closed
SS045	Basin Drainage	open channel	8' x 8' Concrete Box	Rectangular Closed
SS050	Basin Drainage	open channel		open channel
SS055	Basin Drainage	open channel		open channel

Basin ID	Basin Area	AWA Impervious	Area Error Check	Imp 1	Imp 2	Imp 3	Imp 4	Imp 5	Imp 6	Imp 7	Imp 8	Imp 9	Imp 10	Imp 11	Imp 12
				2.0	15.0	25.0									
LW025	839.9	5	0%	658.6	176.8	4.3									
				2.0	15.0										
LW020	488.8	2	0%	482.4	7.2										
				2.0	15.0	25.0	30.0	40.0	45.0	50.0	55.0	60.0	65.0	90.0	95.0
LW010	529.7	20	0%	334.1	20.8	69.2	9.6	2.8	1.6	15.4	5.1	3.4	6.5	60.6	0.9
				2.0	15.0	25.0									
LW015	45.8	25	0%	0.6	0.0	45.2									
				2.0	15.0	25.0	47.0	60.0	65.0	80.0	90.0	95.0			
LW005	291.9	15	0%	230.6	0.0	4.5	21.1	9.6	0.3	22.6	2.8	0.4			
				2.0											
LS020	431.4	2	0%	431.4											
				2.0											
LS055	70.9	2	0%	70.9											
				2.0											
LS010	131.1	2	0%	131.2											
				2.0											
LS025	642.8	2	0%	642.8											
				2.0	5.0	47.0									
LS005	364.0	5	0%	337.4	0.3	26.3									
				2.0	5.0	15.0	40.0	45.0	47.0	55.0	90.0	95.0			
LN010	118.9	9	0%	60.1	39.2	9.6	2.1	1.9	4.0	0.0	0.0	2.1			
				2.0	5.0	15.0	40.0	45.0	55.0	60.0	90.0	95.0			
LN005	55.3	50	0%	0.2	9.5	0.0	3.7	8.3	16.4	8.5	7.6	1.1			
				2.0	5.0	45.0	90.0								
LN015	20.3	42	0%	0.0	1.9	18.3	0.1								
				75.0	95.0										
LN025	20.8	94	-2%	0.9	19.6										
				50.0	60.0	95.0									
LN040	51.7	79	0%	18.1	0.7	33.0									
				50.0	95.0										
LN035	26.8	59	0%	21.4	5.5										
				2.0	10.0	45.0	50.0	60.0	75.0	95.0					
LN020	94.0	58	0%	0.1	5.2	24.3	37.8	1.0	4.9	20.9					
				2.0	50.0	95.0									
SN005	17.4	53	0%	6.2	3.7	7.6									
				2.0	50.0										
SN010	10.3	48	0%	0.4	10.0										
				2.0	40.0	46.0	50.0	55.0	60.0	65.0	70.0	95.0			
SM010	121.5	49	0%	8.6	5.7	7.0	72.7	12.6	0.0	1.0	13.5	0.3			
				2.0	40.0	45.0	47.0	50.0	55.0	60.0	95.0				
SM005	120.2	36	0%	40.4	23.7	0.0	43.3	0.0	0.2	0.0	12.5				
				2.0	35.0	47.0	90.0	95.0							
SS005	100.1	43	0%	42.2	0.0	23.6	22.5	11.8							
				2.0	10.0	20.0	40.0	45.0	47.0	65.0	75.0	95.0			
LS030	489.0	23	0%	279.5	16.1	1.5	44.8	46.4	47.4	17.8	2.1	34.1			
				2.0	45.0	47.0									
LS035	248.6	15	0%	173.2	65.6	9.8									
				2.0	40.0	47.0	90.0	95.0							
SS010	308.4	15	0%	263.1	1.0	1.8	3.4	39.2							
				2.0	15.0	20.0	35.0	40.0	47.0	95.0					
SS015	678.6	6	0%	607.3	8.8	2.5	9.6	12.6	32.0	5.8					
				2.0	7.0	10.0	25.0	47.0	85.0						
SS025	387.5	15	0%	156.0	110.9	27.1	29.2	41.0	23.3						
				2.0											
SS020	1377.7	2	0%	1,377.7											
				2.0											
SS021	659.9	2	0%	659.9											
				2.0											
LS045	3059.4	2	0%	3,059.4											
				2.0	7.0	25.0	47.0								
SS030	514.9	4	0%	438.3	62.9	5.1	8.6								
				50.0											
LN050	24.8	50	0%	24.8											
				50.0											
LN045	21.7	50	0%	21.7											
				10.0	45.0	50.0	70.0								
LN030	97.3	46	0%	4.9	38.1	53.7	0.6								
				45.0	75.0	95.0									
RR-1	25.9	75	0%	1.5	21.8	2.6									
				2.0	45.0	50.0	70.0								
SN015	16.6	52	0%	0.1	11.4	0.4	4.7								
				45.0	50.0	70.0									
SN020	4.8	63	0%	1.2	0.2	3.4									
				2.0	40.0	46.0	55.0	60.0	64.0	70.0	95.0				
SM015	126.8	52	0%	27.4	0.2	0.1	49.0	4.4	10.0	19.5	16.3				
				2.0	20.0	50.0	95.0								
SN040	119.4	47	0%	6.0	3.3	109.5	0.5								
				45.0	50.0	60.0									
SN025	46.4	47	0%	31.5	14.8	0.1									
				2.0	45.0	50.0	60.0	95.0							
SN035	51.9	59	0%	0.6	0.4	15.5	31.2	4.2							
				45.0	50.0	60.0	95.0								
SN030	25.3	60	0%	0.8	0.0	24.1	0.4								
				2.0	7.0	40.0	45.0	47.0	55.0	60.0	64.0				
SM020	574.7	10	0%	449.4	40.8	0.0	0.5	43.5	6.6	9.4	24.4				
				2.0	20.0	50.0	55.0	77.0	80.0						
SN080	143.1	30	0%	80.2	2.0	1.4	29.1	11.8	18.5						
				2.0	50.0	95.0									
SN045	66.6	52	0%	3.9	55.6	7.2									
				95.0											
SN062	17.4	95	0%	17.4											
				2.0	50.0	60.0	70.0	95.0							
SN050	92.9	52	0%	16.1	7.9	61.2	0.3	7.4							
				2.0	70.0	95.0									
SM025	22.1	64	0%	2.0	19.7	0.4									
				2.0	64.0	70.0									
SM030	37.9	30	0%	21.1	14.0	2.8									
				2.0	60.0	95.0									
SN055	33.6	69	0%	2.8	17.4	13.4									
				2.0	64.0										
SM040	55.4	27	0%	33.5	21.9										
				2.0	64.0										
SM035	19.0	36	0%	8.5	10.5										
				2.0	20.0	50.0	60.0	95.0							

Basin ID	Basin Area	AWA Impervious	Area Error Check	Imp 1	Imp 2	Imp 3	Imp 4	Imp 5	Imp 6	Imp 7	Imp 8	Imp 9	Imp 10	Imp 11	Imp 12
SN060	212.3	46	0%	1.5	125.2	3.9	19.0	62.7							
				2.0	60.0	95.0									
SN065	39.3	77	0%	0.9	18.1	20.3									
				2.0	60.0										
SN070	7.9	15	0%	6.1	1.8										
				2.0	5.0	20.0	50.0	70.0	80.0	85.0	90.0	95.0			
SN075	218.9	20	0%	166.5	5.2	5.4	0.0	1.0	0.2	3.6	6.5	30.4			
				2.0	5.0	40.0	50.0	80.0	90.0	95.0					
SN085	234.1	11	0%	208.7	3.0	0.4	1.3	0.9	1.2	18.7					
SN097	155.7	2													
SN098	232.7	2													
SN099	282.7	2													
SN095	667.0	2													
SN096	1056.6	2													
SN092	123.2	2													
SN090	1868.6	2													
SN087	855.2	2													
				2.0	40.0	95.0									
SM083	9.2	83	0%	0.5	1.1	7.6									
				40.0	95.0										
SM082	14.0	78	0%	4.4	9.6										
				2.0	40.0	95.0									
SM060	16.7	36	0%	1.6	15.1	0.0									
				2.0	40.0	66.0	95.0								
SM045	38.4	14	0%	32.6	1.3	0.0	4.4								
				2.0	40.0	95.0									
SM070	38.4	63	0%	0.0	22.0	16.4									
				2.0	40.0	95.0									
SM065	21.7	39	0%	1.7	19.4	0.6									
				2.0	45.0	50.0	95.0								
SM085	9.8	55	0%	0.6	4.8	2.2	2.2								
				95.0											
SM075	21.9	95	0%	21.9											
				2.0	7.0	40.0	47.0	55.0	66.0	95.0					
SM050	256.2	18	0%	83.5	102.3	3.4	19.2	44.5	0.0	3.2					
				2.0	7.0	55.0	95.0								
SM051	32.4	61	0%	1.9	10.2	0.3	19.9								
				2.0	95.0										
SM080	4.9	93	-1%	0.1	4.8										
				2.0	30.0	45.0	47.0	50.0	95.0						
SM055	623.7	11	0%	444.3	160.7	3.8	4.4	10.5	0.0						
				2.0	30.0	47.0									
SS035	405.1	3	0%	396.4	7.3	1.5									
SS036	1559.4	2													
				2.0	47.0										
SS040	630.1	2	0%	627.6	2.5										
				2.0	47.0										
SS045	728.0	2	0%	723.6	4.4										
SS046	1116.9	2													
				2.0	47.0										
SS055	3042.7	5	0%	2,851.0	191.7										
SS050	895.3	2													
SS051	804.1	2													
SS060	805.6	2													
SS065	1609.2	2													
SS070	2878.1	2													
				2.0	47.0										
LS040	1555.9	2	0%	1,542.2	13.7										
				2.0	40.0	45.0	50.0	95.0							
SM090	376.2	5	0%	356.8	0.7	0.4	15.8	2.8							
				2.0	40.0	95.0									
SM091	287.5	7	0%	253.1	32.2	2.2									
SM092	362.9	2													
SM093	332.9	2													
				2.0	95.0										
SM041	95.8	8	0%	89.6	6.2										
SN088	928.3	2													

Basin ID	Basin Area	AWA Impervious	Area Error Check	Imp 1	Imp 2	Imp 3	Imp 4	Imp 5	Imp 6	Imp 7	Imp 8	Imp 9	Imp 10	Imp 11	Imp 12
				15.0	45.0	50.0	55.0	60.0	90.0	95.0					
LN005	55.3	62	0%	0.0	8.3	9.5	16.4	8.5	7.8	4.8					
				2.0	15.0	45.0	47.0	50.0	55.0	75.0	90.0	95.0			
LN010	118.9	63	0%	8.0	9.6	1.9	0.2	39.2	0.0	14.0	39.5	6.6			
				45.0	50.0	75.0	90.0	95.0							
LN015	20.3	46	0%	18.3	1.9	0.0	0.1	0.0							
				10.0	45.0	50.0	60.0	75.0	95.0						
LN020	94.0	58	0%	5.2	24.3	37.8	1.0	4.9	21.0						
				75.0	95.0										
LN025	20.8	94	-2%	0.9	19.6										
				10.0	45.0	50.0	70.0								
LN030	97.3	46	0%	4.9	38.1	53.7	0.6								
				50.0	95.0										
LN035	26.8	59	0%	21.4	5.5										
				50.0	60.0	95.0									
LN040	51.7	79	0%	18.1	0.7	33.0									
LN045	21.7	50													
LN050	24.8	50													
				2.0	47.0	50.0	90.0								
LS005	364.0	5	0%	336.9	26.3	0.3	0.4								
				2.0	30.0										
LS010	131.1	3	0%	127.9	3.3										
LS020	431.4	2													
LS025	642.8	2													
				2.0	20.0	45.0	47.0	65.0	75.0	90.0	95.0				
LS030	489.0	63	0%	107.8	1.5	46.4	47.5	17.8	1.5	83.3	183.6				
				2.0	45.0	47.0	90.0								
LS035	248.6	22	0%	155.1	65.6	9.9	18.1								
				2.0	47.0	95.0									
LS040	1555.9	2	0%	1,542.2	13.7	0.0									
LS045	2666.0	2													
				2.0	15.0	25.0	30.0	47.0	60.0	65.0	75.0	80.0	90.0	95.0	
LW005	291.9	25	0%	196.6	0.0	4.5	0.3	21.1	9.6	0.3	0.0	22.6	35.6	1.3	
				2.0	15.0	25.0	30.0	40.0	50.0	55.0	60.0	65.0	70.0	90.0	95.0
LW010	529.7	38	2%	216.1	20.8	69.2	24.5	2.8	15.4	5.1	20.8	6.5	1.6	60.6	95.7
				15.0	25.0	95.0									
LW015	45.8	26	0%	0.0	45.2	0.6									
				2.0	15.0										
LW020	488.8	2	0%	482.4	7.2										
				2.0	15.0	25.0	30.0								
LW025	839.9	8	0%	577.1	176.8	4.3	81.8								
				45.0	75.0	95.0									
RR-1	25.9	78	0%	1.5	18.2	6.2									
				45.0	47.0	50.0	55.0	60.0	95.0						
SM005	120.2	78	0%	0.0	43.3	0.3	0.2	0.0	76.7						
				46.0	50.0	55.0	70.0	75.0	95.0						
SM010	121.5	58	0%	7.0	72.7	12.4	13.5	2.6	13.2						
				2.0	30.0	46.0	55.0	64.0	70.0	75.0	95.0				
SM015	126.8	54	0%	18.3	9.0	0.1	49.0	10.0	19.5	4.5	16.4				
				2.0	7.0	30.0	45.0	47.0	55.0	60.0	64.0	70.0	75.0	95.0	
SM020	574.7	31	0%	269.0	40.8	56.8	0.5	43.5	6.6	9.4	24.4	27.2	7.7	88.8	
				30.0	45.0	66.0									
SM021	12.7	45	31%	0.0	16.6	0.0									
				30.0	70.0	64.0									
SM025	22.1	66	0%	2.0	19.7	0.4									
				30.0	70.0	64.0									
SM030	37.9	45	0%	21.1	2.8	14.0									
				30.0	64.0										
SM035	19.0	49	0%	8.5	10.5										
				30.0	64.0										
SM040	55.4	43	0%	33.4	21.9										
				30.0	95.0										
SM041	95.8	35	0%	88.9	6.7										
				30.0	40.0	66.0	95.0								
SM045	38.4	83	1%	6.3	1.3	0.0	31.2								
SM046	----	66													
				2.0	7.0	40.0	47.0	70.0	75.0	90.0	95.0				
SM050	256.2	43	0%	13.6	102.3	1.5	19.2	55.2	35.3	10.7	18.7				
				7.0	70.0	95.0									
SM051	32.4	67	0%	10.2	0.3	21.8									
				2.0	30.0	45.0	47.0	50.0	95.0						
SM055	623.7	14	0%	413.3	169.3	3.8	4.4	10.5	22.4						
				2.0	40.0	45.0	66.0	90.0	95.0						
SM060	20.2	43	1%	2.8	14.0	0.1	0.8	0.9	1.8						
				40.0	90.0	95.0									
SM065	21.7	67	0%	10.0	11.1	0.6									
				2.0	40.0	90.0	95.0								
SM070	38.4	64	0%	0.0	21.8	0.0	16.4								
SM075	21.9	95													
SM080	4.9	95													
				40.0	95.0										
SM082	14.0	79	1%	4.2	9.9										
				2.0	40.0	95.0									
SM83	9.2	86	0%	0.5	0.6	8.0									
				45.0	50.0	95.0									
SM085	9.8	61	0%	4.8	2.2	2.8									
				2.0	45.0	50.0	95.0								
SM090	376.2	8	0%	344.3	0.4	15.8	16.0								
				2.0	30.0	95.0									
SM091	287.5	13	0%	249.6	3.5	34.4									
SM092	362.9	2													

Basin ID	Basin Area	AWA Impervious	Area Error Check	Imp 1	Imp 2	Imp 3	Imp 4	Imp 5	Imp 6	Imp 7	Imp 8	Imp 9	Imp 10	Imp 11	Imp 12
SM093	332.9	2													
				50.0	95.0										
SN005	17.4	86	0%	3.7	13.8										
				50.0	95.0										
SN010	10.3	52	0%	10.0	0.4										
				45.0	50.0	70.0	95.0								
SN015	16.6	52	0%	11.4	0.4	4.7	0.1								
				45.0	50.0	70.0									
SN020	4.8	63	0%	1.2	0.2	3.4									
				45.0	50.0										
SN025	46.4	47	0%	31.5	14.9										
				45.0	50.0	60.0	95.0								
SN030	25.3	60	0%	0.8	0.0	24.1	0.4								
				2.0	45.0	50.0	60.0	90.0							
SN035	51.9	59	0%	0.6	0.4	15.5	31.2	4.2							
				2.0	50.0	95.0									
SN040	119.4	48	0%	6.0	112.8	0.5									
				2.0	50.0	95.0									
SN045	66.6	52	0%	3.9	55.6	7.2									
				2.0	30.0	60.0	70.0	95.0							
SN050	92.9	54	0%	12.5	3.6	69.2	0.3	7.4							
				30.0	60.0	95.0									
SN055	33.6	72	2%	2.8	17.4	14.0									
				30.0	50.0	95.0									
SN060	212.3	63	0%	1.5	148.1	62.7									
SN062	17.4	95													
				30.0	60.0	60.0	95.0								
SN065	39.3	77	0%	0.9	13.2	4.9	20.3								
				30.0	50.0										
SN070	7.9	35	0%	6.1	1.8										
				2.0	30.0	50.0	70.0	85.0	90.0	95.0					
SN075	218.9	44	0%	1.4	162.4	5.3	6.1	3.4	6.5	33.5					
				2.0	30.0	70.0	75.0								
SN080	143.1	32	0%	36.4	76.3	18.5	11.8								
				2.0	30.0	70.0	90.0	95.0							
SN085	234.1	39	0%	34.5	139.1	39.0	1.2	20.4							
				2.0	30.0										
SN087	855.2	2	0%	845.7	9.5										
SN088	928.3	2													
SN090		2													
SN092		2													
SN095		2													
SN096		2													
SN097		2													
SN098		2													
SN099		2													
				35.0	47.0	90.0	95.0								
SS005	100.1	83	0%	0.0	23.6	22.6	54.0								
				2.0	30.0	40.0	47.0	90.0	95.0						
SS010	308.4	16	0%	258.8	2.3	1.0	1.8	3.4	41.2						
				2.0	15.0	20.0	30.0	35.0	40.0	47.0	95.0				
SS015	678.7	7	0%	597.0	8.8	2.5	9.1	10.4	11.8	32.0	7.0				
SS020	1377.7	2													
SS021	659.9	2													
				2.0	7.0	10.0	25.0	47.0	85.0						
SS025	387.5	15	0%	156.0	110.9	27.1	29.2	41.0	23.3						
				2.0	7.0	25.0	47.0								
SS030	514.9	4	0%	438.3	62.9	5.1	8.6								
				2.0	30.0	47.0									
SS035	405.1	3	0%	396.4	7.3	1.5									
SS036		2													
				2.0	47.0										
SS040	630.1	2	0%	627.6	2.5										
				2.0	47.0										
SS045	728.0	2	0%	723.6	4.4										
SS046		2													
SS050		2													
SS051		2													
				2.0	47.0										
SS055	3042.7	5	0%	2,851.0	191.7										
SS060		2													
SS065		2													
SS070		2													

	ROW Impervious Area				
Section	Total	Left	Right	Percent Impervious	
I-80 East	199.6	52.6	48.0	50.4%	
287 South	174.1	75.8		43.5%	
1-80 West	179.4	32.2	42.7	41.8%	
				45.2%	Average
				47%	California DOT

LS305

Elevation	Area (ft.)								
7169.0	399	230							
7169.5	2466	12742	6955						
7170.0	47216	36450	-1862						
7170.5	131311	-5248							
7171.0	152381	2005	-2282						
7171.5	182230	62	-663						
7172.0	270185	-80	-10615						
7172.5	380981	-13341	468	-971	22823	3220.0			
7173.0	495,977	12447	-390	-10508					
7173.5	563,002	26976	1790	11617	-39	90.0	-7716		
7174.0	777,042	-476	5886	390	25	44.0	-15	-14	-13
7174.5	952,843	-22375							
7175.0	1,020,384	-17027							
7175.5	1,087,106	-15283	3615						
7176.0	1,191,658	-13911							
7176.5	1,334,070	-12738	-66269						

0.5	629
1.0	22163
1.5	81804
2.0	126063
2.5	152104
3.0	181629
3.5	259490
4.0	393180
4.5	497526
5.0	595720
5.5	782869
6.0	930468
6.5	1003357
7.0	1075438
7.5	1177747

LS310

Elevation	Area (ft.)	Area (acre)

LS315

Elevation	Area (ft.)	Area (acre)
7292.0	26698	0.6
7294.0	168517	3.9
7296.0	393823	9.0
7298.0	584677	13.4
7300.0	780460	17.9
7302.0	1025083	23.5
7304.0	1541585	35.4
7306.0	2194679	50.4

2.0	26698
4.0	168517
6.0	393823
8.0	584677
10.0	780460
12.0	1025083
14.0	1541585
16.0	2194679

SS305

Elevation	Area (ft.)	Area (acre)
7159.0	641	0.0
7160.0	9562	0.2
7161.0	43971	1.0
7162.0	82304	1.9
7163.0	122023	2.8
7164.0	150547	3.5
7165.5	178816	4.1

0.5	641
1.0	9562
1.5	43971
2.0	82304
2.5	122023
3.0	150547
3.5	178816

1.0	9695
2.0	30096
3.0	83347
4.0	114789
5.0	152682

amec foster wheeler

SS310	(revised)			
Elevation	Area (ft.)	Area 2 (ft.)	Area 3 (ft.)	Area 4 (ft.)
7194.0	1233			
7194.5	2821			
7195.0	4258	1462		
7195.5	6009	5366	228	
7196.0	8595	16652		
7196.5	38423			
7197.0	47256			184.6
7197.5	60698			
7198.0	72266			
0.5	1233			
1.0	2821			
1.5	5720			
2.0	11604			
2.5	25247			
3.0	38423			
3.5	47441			
4.0	60698			
4.5	72266			

SN305			
Elevation	Area (ft)		
7208.0	7,367		
7209.0	25,031		
7210.0	53,867		
7211.0	84,352		
7212.0	118,404		
7213.0	135,288	3.11	
	Area to Volume check		
7200			
7201	80584	1.8	
		0.0	
		0.0	
7204	97846	6.7	8.6
		0.0	
7206	110103	5.1	13.6
Area (ft.)	Volume (acre-ft)		
220794	18		
0.5	7367		
1.0	25031		
2.0	53867		
3.0	84352		
4.0	118404		
5.0	135288		

SN310	Underground	
Elevation	Volume (ft^3)	Elevation
7201.0	14,700	
7202.0	29,400	
7203.0	44,100	
7204.0	58,800	
7205.0	73,500	
7206.0	88,200	
7207.0	102,900	
7207.1	103,929	
Total (ft^2)	14,700	
Depth	Area (ft)	
1	14,700	
2	14,700	
3	14,700	
4	14,700	
5	14,700	
6	14,700	
7	14,700	

SM305	Huckfinn
Area (ft.)	Area (acre)

SM310		
Elevation	Area (ft.)	Area (acre)
7268.0	4096	0.1
7269.0	10741	0.2
7270.0	32344	0.7
7271.0	38784	0.9
7272.0	45962	1.1
estimated		
From GIS		
Elevation	Depth	Area
7267.5	0.5	1480.0
7268.0	1.0	4025.0
7268.5	1.5	10911
7269.0	2.0	18496.0
7269.5	2.5	26099.0
7270.4	3.4	35204.0
Overflow		
Station	Elevation	
0	7272.1	
10	7271.9	
20	7271.3	
30	7270.7	
40	7270.2	
50	7269.7	
60	7269.9	
70	7271.0	
80	7272.1	
90	7272.5	

SM315		
Elevation	Area (ft.)	Area (acre)
7292.0	1031	0.0
7293.0	5466	0.1
7294.0	32544	0.7
Elevation	Depth	Area
7292.0	0.5	970
7292.5	1.0	4642
7293.0	1.5	9854
7293.5	2.0	17882
7294.0	2.5	32868

SM320		
Elevation	Area (ft.)	Area (acre)
7296.0	14375.43	0.3
7297.0	17758	0.4
estimated		
Elevation	Depth	Area
7294.5	0.5	174.0
7295.0	1.0	4980.0
7295.5	1.5	10665
7296.0	2.0	14254.0

SM325		
Elevation	Area (ft.)	Area (acre)
7300	45149	1.0
7301	64973	1.5
7302	99443	2.3
Elevation	Depth	Area
7298.5	0.5	4109
7299.0	1.0	17131
7299.5	1.5	30560
7300.0	2.0	44354
7300.5	2.5	57204
7301.0	3.0	71267
7301.5	3.5	85568
7302.0	4.0	99836

SM330	Wal-Mart (from CAD)	
Elevation	Area (ft.)	Area (acre)
7332.0	44600	1.0
7333.0	47573	1.1
7334.0	50592	1.2
7335.0	53364	1.2
7336.0	56608	1.3
estimated		
Elevation	Depth	Area
7331.0	0.5	38365
7331.5	1.0	41883
7332.0	1.5	44190
7332.5	2.0	46038
7333.0	2.5	47637
7333.5	3.0	49132
7334.0	3.5	50595
7334.5	4.0	52083
7335.0	4.5	53719

SM335		
Elevation	Area (ft.)	Area (acre)
7370.0	14426	0.3
7371.0	17331	0.4
7372.0	20415	0.5
Elevation	Depth	Area
7368.0	0.5	658
7368.5	1.0	5328
7369.0	1.5	9089
7369.5	2.0	12051
7370.0	2.5	14227
7370.5	3.0	15848
7371.0	3.5	17275
7371.5	4.0	18775
7372.0	4.5	20598

Jacoby (from report) Table 3.8 Summary of Pond Storage Volumes

Pond #	Depth (ft)	Stored Surface Area (ac)	Stored Volume (ac-ft)	Detention Vol. (ac-ft)	Total Area Pond (ac)	Total Pond Volume (ac-ft)
1	3.0	1.1	2.7	6.8	1.7	9.4
2	0.0	0.0	0.0	0.5	0.5	0.5
3	3.0	0.6	1.5	3.9	1.1	5.4
4	7.0	1.8	9.4	13.1	2.7	22.6
5	4.0	0.3	1.0	1.5	0.5	2.5
6	4.0	0.5	1.4	1.0	0.6	2.4

SN325

Jacoby 1 (from construction drawings)

Elevation	Area (ft.)
0.5	49087
2.0	59412
4.0	69304
6.0	79003

SN320

Jacoby 4 (from construction drawings)

Elevation	Area	Depth	Area
7263.6	346	0.6	346
7264.0	7937	1.0	7937
7265.0	37813	2.0	37813
7266.0	69605	3.0	69605
7267.0	85609	4.0	85609
7268.0	91608	5.0	91608
7269.0	97603	6.0	97603
7269.4	100029	6.4	100029

SN315

Jacoby 5 (from construction drawings)

Elevation	Area		Depth	Area
7257.4	7064		1.0	20228
7258.0	8440		2.0	25184
7259.0	11139		2.2	26250
7260.0	13861			
7261.0	16660	detention		
7262.0	20228			
7263.0	25184			
7263.2	26250			

SM311

High School North Pond

Depth	Area
0.5	5402
1.5	6808
2.5	8316
3.5	9924
4.5	11633
5.5	13443

SM305

High School South Pond

Depth	Area
1.0	5827
2.0	7838
3.0	9962
4.0	12142
5.0	13954

SM340

Depth	Area
0.5	10099
1.0	19061
2.0	57338

SM1310

Depth	Area
1.0	8507
2.0	25433
3.0	48489
4.0	69901
5.0	94380

SM345

Depth	Area
1.0	3056
2.0	8063
3.0	22662
4.0	170960

On Campus Pond

Depth	Area
1.0	19098
2.0	30045
3.0	58921

Laprele Pond

Depth	Area
0.0	48438
2.0	97455
4.0	169227

maximized

Depth	Area
0.0	144747
2.0	156775
4.0	169227

Prop Trade Pond

Depth	Area
0.0	123805
2.0	135668
4.0	147945
6.0	160634

maximized

Depth	Area
0.0	253238
2.0	271131
4.0	289447
6.0	308186

RR Pond

Depth	Area
0.0	283504
2.0	304646
4.0	326241
6.0	348342

LN305-S

Depth	Area
0.0	0
0.7	503036
1.0	1138299

Depth	Area	Volume
0.7	503036	7.5
0.4	1138299	9.1
		16.7

LS305

Depth	Area
0.5	629
1.0	22163
1.5	81804
2.0	126063
2.5	152104
3.0	181629
3.5	259490
4.0	393180
4.5	497526
5.0	595720
5.5	782869
6.0	930468
6.5	1003357
7.0	1075438
7.5	1177747

Depth	Area	Volume
1.0	22163	0.5
0.5	81804	0.9
0.5	126063	1.4
0.5	152104	1.7
0.5	181629	2.1
0.5	259490	3.0
0.5	393180	4.5
0.5	497526	5.7
0.5	595720	6.8
0.5	782869	9.0
0.5	930468	10.7
0.5	1003357	11.5
0.5	1075438	12.3
0.5	1177747	13.5
		83.8

LS315

Depth	Area
2.0	26698
4.0	168517
6.0	393823
8.0	584677
10.0	780460
12.0	1025083
14.0	1541585
16.0	2194679

Depth	Area	Volume
2.0	26698	1.2
2.0	168517	7.7
2.0	393823	18.1
2.0	584677	26.8
2.0	780460	35.8
2.0	1025083	47.1
2.0	1541585	70.8
2.0	2194679	100.8
		308.3

SM305

Depth	Area
1.0	5827
2.0	7838
3.0	9962
4.0	12142
5.0	13954

Depth	Area	Volume
1.0	5827	0.1
1.0	7838	0.2
1.0	9962	0.2
1.0	12142	0.3
1.0	13954	0.3
		1.1

SM310

Depth	Area
0.5	1480
1.0	4025
1.5	10911
2.0	18496
2.5	26099
3.4	35204

Depth	Area	Volume
0.5	1480	0.0
0.5	4025	0.0
0.5	10911	0.1
0.5	18496	0.2
0.5	26099	0.3
0.9	35204	0.7
		1.4

SM311

Depth	Area
0.5	5402
1.5	6808
2.5	8316
3.5	9924
4.5	11633
5.5	13443

Depth	Area	Volume
0.5	5402	0.1
1.0	6808	0.2
1.0	8316	0.2
1.0	9924	0.2
1.0	11633	0.3
1.0	13443	0.3
		1.2

SM315

Depth	Area
0.5	970
1.0	4642
1.5	9854
2.0	17882
2.5	32868

Depth	Area	Volume
0.5	970	0.0
0.5	4642	0.1
0.5	9854	0.1
0.5	17882	0.2
0.5	32868	0.4
		0.8

SM320

Depth	Area
0.5	174
1.0	4980
1.5	10665
2.0	14254

Depth	Area	Volume
0.5	174	0.0
0.5	4980	0.1
0.5	10665	0.1
0.5	14254	0.2
		0.3

SM325

Depth	Area
0.5	4109
1.0	17131
1.5	30560
2.0	44354
2.5	57204
3.0	71267
3.5	85568
4.0	99836

Depth	Area	Volume
0.5	4109	0.0
0.5	17131	0.2
0.5	30560	0.4
0.5	44354	0.5
0.5	57204	0.7
0.5	71267	0.8
0.5	85568	1.0
0.5	99836	1.1
		4.7

SM330

Depth	Area
0.5	38365
1.0	41883
1.5	44190
2.0	46038
2.5	47637
3.0	49132
3.5	50595
4.0	52083
4.5	53719

Depth	Area	Volume
0.5	38365	0.4
0.5	41883	0.5
0.5	44190	0.5
0.5	46038	0.5
0.5	47637	0.5
0.5	49132	0.6
0.5	50595	0.6
0.5	52083	0.6
0.5	53719	0.6
		4.9

SM335

Depth	Area
0.5	658
1.0	5328
1.5	9089
2.0	12051
2.5	14227
3.0	15848
3.5	17275
4.0	18775
4.5	20598

Depth	Area	Volume
0.5	658	0.0
0.5	5328	0.1
0.5	9089	0.1
0.5	12051	0.1
0.5	14227	0.2
0.5	15848	0.2
0.5	17275	0.2
0.5	18775	0.2
0.5	20598	0.2
		1.3

SM340

Depth	Area
0.5	10099
1.0	19061
2.0	57338

Depth	Area	Volume
0.5	10099	0.1
0.5	19061	0.2
1.0	57338	1.3
		1.7

SM345

Depth	Area
1.0	3056
2.0	8063
3.0	22662
4.0	170960

Depth	Area	Volume
1.0	3056	0.1
1.0	8063	0.2
1.0	22662	0.5
1.0	170960	3.9
		4.7

SN305

Depth	Area
0.5	7367
1.0	25031
2.0	53867
3.0	84352
4.0	118404
5.0	135288

Depth	Area	Volume
0.5	7367	0.1
0.5	25031	0.3
1.0	53867	1.2
1.0	84352	1.9
1.0	118404	2.7
1.0	135288	3.1
		9.4

SN310

Depth	Area
1.0	14700
2.0	14700
3.0	14700
4.0	14700
5.0	14700
6.0	14700
7.0	14700

Depth	Area	Volume
1.0	14700	0.3
1.0	14700	0.3
1.0	14700	0.3
1.0	14700	0.3
1.0	14700	0.3
1.0	14700	0.3
1.0	14700	0.3
		2.4

SN315

Depth	Area
1.0	20228
2.0	25184
2.2	26250

Depth	Area	Volume
1.0	20228	0.5
1.0	25184	0.6
0.2	26250	0.1
		1.2

SN320

Depth	Area
0.6	346
1.0	7937
2.0	37813
3.0	69605
4.0	85609
5.0	91608
6.0	97603
6.4	100029

Depth	Area	Volume
0.6	346	0.0
0.4	7937	0.1
1.0	37813	0.9
1.0	69605	1.6
1.0	85609	2.0
1.0	91608	2.1
1.0	97603	2.2
0.4	100029	0.9
		9.8

SN325

Depth	Area
0.5	49087
2.0	59412
4.0	69304
6.0	79003

Depth	Area	Volume
0.5	49087	0.6
1.5	59412	2.0
2.0	69304	3.2
2.0	79003	3.6
		9.4

SS305

Depth	Area
1.0	9695
2.0	30096
3.0	83347
4.0	114789
5.0	152682
6.0	167453
7.0	184049
8.0	206502
9.0	532116

Depth	Area	Volume
1.0	9695	0.2
1.0	30096	0.7
1.0	83347	1.9
1.0	114789	2.6
1.0	152682	3.5
1.0	167453	3.8
1.0	184049	4.2
1.0	206502	4.7
1.0	532116	12.2
		34.0

SS310

Depth	Area
0.5	1233
1.0	2821
1.5	5720
2.0	11604
2.5	25247
3.0	38423
3.5	47441
4.0	60698
4.5	72266

Depth	Area	Volume
0.5	1233	0.0
0.5	2821	0.0
0.5	5720	0.1
0.5	11604	0.1
0.5	25247	0.3
0.5	38423	0.4
0.5	47441	0.5
0.5	60698	0.7
0.5	72266	0.8
		3.0

From City of Laramie Standard Drawings (ST-1, ST-2, CS-4, CS-6)

Street type	Curb height	Crown	RoW	Road Width
Local	0.5	1.375	60	23
Collector	0.5	1.4927	80	26.375
Arterial	0.5	1.7722	100	34.375

APPENDIX B

SWMM Model Peak Flow Rate Output

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Model Output - Peak Flow Rates Existing Infrastructure, Future Development Conditions				
Node ID	Storm Event			
	100-Year	10-Year	5-Year	2-Year
Junctions				
LN105	117	118	54	22
LN105-S	107	106	93	0
LN115	277	220	175	95
LN119	207	89	69	38
LN119-S	186	38	1	0
LN120	56	27	21	11
LN120-S	64	28	22	12
LN125	138	76	59	32
LN125-S	164	60	46	24
LN130	45	24	19	10
LN130-S	57	25	20	11
LN135	108	64	49	27
LN135-S	129	46	34	19
LN140	35	25	20	12
LN140-S	62	22	16	9
LN145	36	25	20	12
LN145-S	64	30	23	12
LN405	103	45	34	22
LS110	158	40	32	19
LS115	168	57	48	32
LS120	296	144	111	61
LS125	160	70	52	14
LS130	43	2	1	0
LS135	21	0	0	0
LS140	180	95	76	46
LS145	0	0	0	0
SC100	5,166	1,605	1,321	846
SC105	5,167	996	812	563
SC110	5,178	1,272	816	635
SC110-S	226	0	0	0
SC115	6,757	1,066	838	495
SC115-S	1,268	0	0	0
SC116	5,215	1,065	837	493
SC116-S	199	0	0	0
SC120	5,215	1,062	835	493
SC120-S	629	0	0	0
SC125	2,630	965	764	448
SC130	2,624	915	727	426

Node ID	Storm Event			
	100-Year	10-Year	5-Year	2-Year
SC135	2,730	884	700	411
SC135-S	1	0	0	0
SC145	2,795	760	605	360
SC145-S	0	0	0	0
SC150	3,470	926	764	494
SC150-S	25	0	0	0
SC155	3,186	831	680	388
SC160	2,268	703	561	333
SC165	2,121	419	338	203
SC170	1,926	284	246	168
SC175	1,926	285	221	125
SM100	556	174	125	66
SM101	572	230	177	93
SM102	16	11	9	6
SM102-S	0	0	0	0
SM105	5,214	1,117	883	526
SM105-S	199	0	0	0
SM110	2,611	969	766	449
SM1105	95	95	91	73
SM1110	95	95	91	73
SM1110-S	124	20	15	8
SM115	2,633	966	766	449
SM120	2,767	810	643	380
SM120-S	0	0	0	0
SM125	2,301	724	577	342
SM130	2,269	718	575	339
SM135	3,775	678	541	321
SM144	230	102	91	73
SM144-S	160	17	0	0
SM145	70	34	26	15
SM145-S	124	19	13	7
SM149	29	12	9	5
SM150	19	9	7	4
SM154	347	134	100	53
SM154-S	110	75	59	34
SM154-S-S	56	40	33	19
SM155	425	194	146	82
SM155-S	239	130	105	59
SM155-S-S	178	52	41	24
SM160	403	93	74	44
SM165	366	68	22	12
SM170	309	64	25	13

Node ID	Storm Event			
	100-Year	10-Year	5-Year	2-Year
SM175	184	40	18	12
SM180	332	134	103	57
SM180-S	29	0	0	0
SM181	171	55	42	24
SM181-S	78	0	0	0
SM185	294	126	98	56
SM305-S	0	0	0	0
SM310-S	36	34	0	0
SM311-S	41	0	0	0
SM315-S	25	0	0	0
SM340-S	78	0	0	0
SM345-S	996	86	30	16
SN105	5,222	1,065	838	495
SN105-S	630	0	0	0
SN110	2,636	973	770	452
SN115	3,367	969	768	450
SN120	2,618	916	728	426
SN125	2,649	920	730	427
SN130	2,681	810	643	380
SN135	188	89	68	37
SN135-S	133	52	39	20
SN137-S	49	3	2	1
SN138	100	60	47	26
SN138-S	150	63	48	25
SN139	8	5	4	2
SN139-S	17	7	5	3
SN140	137	68	53	29
SN140-S1	213	88	67	35
SN145	4,523	1,041	888	594
SN145-S	596	0	0	0
SN150	2,456	700	558	330
SN155	2,235	663	527	312
SN155-S	106	50	25	7
SN160	2,176	560	439	260
SN165	2,184	539	424	251
SN170	2,461	510	407	242
SN170-S	274	122	85	41
SN172	2,121	625	519	334
SN173	263	68	67	47
SN173-S	337	134	101	52
SN174	101	28	28	21
SN174-S	363	159	125	70

Node ID	Storm Event			
	100-Year	10-Year	5-Year	2-Year
SN175	175	101	76	43
SN176	209	101	76	43
SN180	1,930	315	237	136
SN185	1,530	192	151	96
SN186	353	71	50	33
SN187	1,030	131	106	69
SN190	727	121	43	26
SN191	387	74	57	38
SN192	255	30	9	6
SN193	256	34	13	9
SN194	151	21	15	10
SN305-S	122	54	42	23
SN310-S	7	0	0	0
SS105	52	13	10	10
SS105-S	1,036	104	78	44
SS106	1,033	90	14	5
SS107	1,315	177	44	20
SS108	1,354	195	116	66
SS109	1,153	295	240	157
SS110	675	89	72	45
SS114	1,951	335	122	58
SS115	1,960	358	156	86
SS118	773	146	49	13
SS119	585	101	28	9
SS120	671	113	40	24
SS121	569	103	84	56
SS124	212	51	34	22
SS125	212	51	34	22
SS129	644	130	46	23
SS130	684	133	47	29
SS131	454	92	60	40
SS135	556	86	52	33
SS136	333	56	44	29
SS140	928	441	347	201
SS145	1,317	290	219	125
Conduits				
LN204	99	44	33	20
LN205	30	29	28	22
LN205-S	73	16	6	0
LN215	267	221	164	94
LN219	98	89	66	37
LN219-S	50	0	0	0

Node ID	Storm Event			
	100-Year	10-Year	5-Year	2-Year
LN220	48	32	21	11
LN220-S	15	1	1	0
LN225	113	77	59	32
LN225-S	53	5	3	1
LN230	44	24	19	10
LN230-S	23	1	1	0
LN235	72	68	49	27
LN235-S	61	1	1	0
LN240	22	20	16	10
LN240-S	41	10	7	4
LN245	35	25	20	12
LN245-S	22	2	2	1
LS204	0	0	0	0
LS210	62	8	4	2
LS215	103	27	16	8
LS216	168	57	48	32
LS217	160	70	52	14
LS218	43	2	1	0
LS220	18	0	0	0
LS221	21	0	0	0
LS225	0	0	0	0
LS226	0	0	0	0
SC200	5,165	968	659	391
SC201	5,166	1,605	1,321	846
SC202	5,167	903	665	376
SC203	4,986	1,272	816	635
SC203-S	226	0	0	0
SC204	5,214	1,066	838	495
SC2045	5,015	1,117	883	526
SC2045-S	199	0	0	0
SC205	5,215	1,065	837	493
SC206	4,587	1,062	835	493
SC206-S	629	0	0	0
SC210	2,609	967	763	448
SC215	2,611	969	766	449
SC220	2,635	970	768	451
SC221	3,363	964	763	447
SC225	2,630	965	764	448
SC230	2,613	914	726	426
SC231	2,624	915	727	426
SC235	2,618	914	726	426
SC240	2,642	880	698	410

Node ID	Storm Event			
	100-Year	10-Year	5-Year	2-Year
SC241	2,709	809	643	380
SC245	2,681	810	643	380
SC246	2,748	756	602	357
SC246-S	0	0	0	0
SC250	2,795	760	605	360
SC251	3,465	926	764	494
SC251-S	25	0	0	0
SC255	4,442	1,003	859	578
SC260	2,298	713	568	337
SC265	2,265	705	565	334
SC266	3,186	831	680	388
SC267	2,267	697	556	330
SC270	2,451	677	540	321
SC275	3,772	658	525	312
SC280	2,176	557	437	259
SC285	2,170	528	415	247
SC290	2,167	500	397	236
SC291	2,424	409	311	188
SC295	2,121	419	338	203
SC296	1,926	510	421	264
SC297	1,926	284	221	125
SC298	1,926	285	221	125
SM1205	95	95	91	73
SM1205-S	124	19	13	7
SM1210	95	95	91	73
SM1210-S	95	17	0	0
SM1215	210	102	90	60
SM1235	160	16	0	0
SM204	136	127	97	54
SM205	369	112	79	41
SM210	8	2	1	0
SM211	16	11	9	6
SM211-S	0	0	0	0
SM219	41	39	33	19
SM219-S	34	1	0	0
SM220	67	32	25	14
SM225	17	12	10	6
SM225-S	24	0	0	0
SM230	62	32	25	14
SM235	328	130	98	51
SM236	294	129	100	57
SM237	294	126	98	56

Node ID	Storm Event			
	100-Year	10-Year	5-Year	2-Year
SM240	16	11	8	7
SM240-S	29	0	0	0
SM245	29	10	7	4
SM246	29	12	9	5
SM250	13	6	4	2
SM255	0	0	0	0
SM260	169	53	39	23
SM261	241	68	49	23
SM261-S	57	39	31	17
SM261-S-S	56	40	33	19
SM262	343	132	98	52
SM263	93	55	42	24
SM263-S	78	0	0	0
SM265	366	68	22	12
SM270	366	68	22	12
SM275	282	57	20	2
SM280	174	38	16	2
SM315-IC	25	0	0	0
SN139-IC	6	5	4	2
SN205	185	88	67	36
SN205-S	1	0	0	0
SN208	100	59	46	26
SN208-S	49	3	2	1
SN209	4	5	4	2
SN209-S	11	1	1	0
SN210	131	67	52	28
SN210-S	38	8	5	2
SN215	0	0	0	0
SN215-S	24	7	5	2
SN216	78	66	66	46
SN216-S	106	50	25	7
SN217	5	4	4	4
SN217-S	7	0	0	0
SN225	1,454	165	49	20
SN226	321	64	22	6
SN230	1,029	124	102	66
SN235	623	26	4	1
SN236	365	67	22	9
SN240	181	19	3	1
SN241	235	30	4	1
SN242	146	20	3	1
SN243	14	14	14	14

Node ID	Storm Event			
	100-Year	10-Year	5-Year	2-Year
SN243-S	274	122	85	41
SN244	0	0	0	0
SN245	0	0	0	0
SN250	0	0	0	0
SN255	178	100	76	43
SN260	175	101	76	43
SS204-S	2,685	320	61	4
SS205	77	20	15	16
SS205-S	996	86	24	13
SS206	52	11	5	2
SS206-S	996	86	30	16
SS210	13	11	10	10
SS211	1,903	295	83	7
SS215	1,020	87	14	5
SS219	1,926	331	120	48
SS220	1,877	334	122	42
SS224	316	30	5	1
SS225	449	56	12	4
SS226	316	52	13	5
SS229	697	132	41	10
SS230	585	100	28	9
SS231	585	101	28	9
SS232	539	89	23	11
SS235	208	50	22	9
SS236	212	51	34	22
SS239	1,261	224	86	33
SS240	640	128	44	15
SS241	644	130	46	23
SS242	443	88	32	9
SS245	782	257	195	110
SS250	725	60	10	3
SS255	1,245	176	43	16
SS256	1,150	166	97	54
Storages				
LN305-S	224	72	54	27
LS305	597	219	162	87
LS315	384	173	140	90
SM305	37	18	13	7
SM309	401	158	119	64
SM310	286	52	38	22
SM311	203	37	30	17
SM315	133	62	47	26

Node ID	Storm Event			
	100-Year	**10-Year**	**5-Year**	**2-Year**
SM320	68	33	25	14
SM325	357	150	116	61
SM330	87	40	30	17
SM335	28	14	10	6
SM340	414	159	117	62
SN305	93	46	36	21
SN310	65	29	22	13
SN315	0	0	0	0
SN320	0	0	0	0
SN325	178	100	76	43
SS305	2,729	356	111	45
SS306	86	19	14	14
SS310	1,926	331	120	48
Outfalls				
LN404	99	44	33	20
LN410	367	170	127	73
LN420	267	221	164	94
LN425	5,165	968	659	391
LS405	114	58	47	29
LS410	62	13	10	7
LS420	52	28	23	14
LW405	309	141	105	61
LW410	539	215	162	84
LW415	59	30	23	12
LW420	74	32	26	16
LW425	345	174	134	73

Model Output - Peak Flow Rates Recommended Master Plan Proposed Infrastructure, Future Development Conditions				
Node ID	Storm Event			
	100-Year	10-Year	5-Year	2-Year
Junctions				
E-JACOBE-O	292	61	12	2
LN105	33	33	30	18
LN105-S	117	52	41	22
LN114	485	231	179	100
LN115	476	224	172	96
LN119	194	89	70	42
LN119-S	35	2	1	0
LN120	61	28	22	12
LN120-S	64	28	22	12
LN125	145	76	59	32
LN125-S	168	60	46	24
LN130	44	24	19	10
LN130-S	57	25	20	11
LN135	138	66	52	32
LN135-S	98	39	29	15
LN135-S-1	171	0	0	0
LN135-S-2	17	0	0	0
LN135-S-3	55	10	4	0
LN135-U-1	80	33	27	17
LN135-U-2	76	34	27	18
LN135-U-3	57	34	27	18
LN140	181	35	32	20
LN140-S	67	23	16	9
LN145	28	25	20	12
LN145-S	64	30	23	12
LN405	108	46	37	21
LS110	158	40	32	19
LS115	168	57	48	32
LS120	296	144	111	61
LS125	198	70	52	14
LS130	43	2	1	0
LS135	21	0	0	0
LS140	180	95	76	46
LS145	0	0	0	0
RR105	18	13	10	6
RR105-A	53	16	10	6
RR105-B	52	16	10	5
RR105-C	52	19	15	5

Node ID	Storm Event			
	100-Year	10-Year	5-Year	2-Year
RR105-S	66	27	21	11
RR105-S-A	53	16	10	6
SC100	3,362	1,651	1,399	916
SC105	2,400	1,037	845	607
SC110	2,349	2,872	1,992	1,201
SC110-S	55	0	0	0
SC115	3,287	2,188	1,443	865
SC115-S	744	0	0	0
SC116	2,199	1,044	799	455
SC116-S	0	0	0	0
SC120	2,199	1,042	799	453
SC120-S	0	0	0	0
SC125	2,176	945	726	406
SC125-1	36	17	12	7
SC125-2	0	0	0	0
SC125-U1	30	17	12	7
SC130	2,325	895	685	384
SC135	1,809	873	673	375
SC135-S	0	0	0	0
SC135-S1	132	29	22	12
SC135-U1	272	128	98	55
SC145	1,488	722	555	310
SC145-S	0	0	0	0
SC150	1,534	722	555	311
SC150-1-S	97	5	1	0
SC150-2-S	159	68	53	28
SC150-2-U	66	60	52	28
SC150-S	0	0	0	0
SC155	1,611	805	617	338
SC160	1,387	664	519	291
SC165	852	319	253	143
SC170	753	272	209	119
SC175	753	272	209	119
SM100	545	171	123	63
SM101	572	230	177	93
SM102	16	11	9	6
SM102-S	0	0	0	0
SM105	2,199	1,260	846	487
SM105-S	0	0	0	0
SM110	2,112	984	759	430
SM1105	102	63	50	30
SM1110	102	63	50	30

Node ID	Storm Event			
	100-Year	10-Year	5-Year	2-Year
SM1110-S	44	19	15	8
SM1120	131	34	28	17
SM115	2,394	946	728	407
SM120	1,618	777	598	334
SM120-S	0	0	0	0
SM125	1,434	680	527	296
SM130	1,408	677	531	298
SM135	1,286	629	492	275
SM144	100	59	47	29
SM144-S	0	0	0	0
SM145	70	34	26	15
SM145-S	4	1	1	0
SM149	29	12	9	5
SM150	19	9	7	4
SM154	319	133	99	52
SM154-S	101	75	58	33
SM154-S-S	50	40	33	19
SM155	425	194	146	82
SM155-S	246	136	107	60
SM155-S-S	155	55	42	24
SM160	403	93	74	44
SM165	366	68	22	12
SM170	309	64	25	13
SM175	184	40	18	12
SM180	131	35	29	18
SM180-S	26	0	0	0
SM181	188	55	42	24
SM181-S	96	0	0	0
SM185	131	34	28	17
SM305-S	0	0	0	0
SM310-S	0	0	0	0
SM311-S	118	0	0	0
SM315-S	22	0	0	0
SM340-S	96	0	0	0
SM345-S	175	42	30	16
SN105	2,223	1,046	803	455
SN105-S	0	0	0	0
SN105-S1	122	95	66	33
SN105-U	1	0	0	0
SN110	2,217	988	762	433
SN110-1	37	12	9	5
SN110-2	95	0	0	0

Node ID	Storm Event			
	100-Year	10-Year	5-Year	2-Year
SN110-U1	11	11	9	5
SN115	2,173	950	730	407
SN120	2,807	895	686	385
SN125	1,918	897	691	388
SN130	1,618	777	598	334
SN135	198	105	82	46
SN135-S	129	52	40	20
SN137-S	45	0	0	0
SN137-S1	91	4	2	1
SN137-U1	138	42	31	15
SN138	106	40	29	15
SN138-S	94	38	29	15
SN138-S1	40	10	6	2
SN139	28	9	6	2
SN139-S	38	10	7	2
SN140	135	65	51	29
SN140-S1	212	88	67	35
SN145	1,493	676	522	292
SN145-S	0	0	0	0
SN145-S-1	19	0	0	0
SN150	1,375	660	516	288
SN150-1	59	0	0	0
SN150-2	189	42	32	17
SN150-2-U	91	40	31	16
SN155	1,232	611	475	265
SN155-S	0	0	0	0
SN155-S1	275	57	35	13
SN155-U1	208	140	105	58
SN160	1,038	483	381	212
SN160-S1	77	33	23	9
SN160-S2	140	44	34	18
SN160-S2-U	12	12	13	11
SN160-S3	92	17	9	3
SN165	980	457	365	205
SN170	885	412	335	189
SN170-S	0	0	0	0
SN171-S	96	21	11	4
SN172	853	412	352	215
SN172-S	363	159	125	70
SN172-U	127	117	96	58
SN173	178	94	74	46
SN173-S	448	150	107	56

Node ID	Storm Event			
	100-Year	10-Year	5-Year	2-Year
SN174	0	0	0	0
SN174-S	0	0	0	0
SN175	21	13	11	7
SN176	209	101	76	43
SN180	755	297	225	122
SN185	1,530	191	149	96
SN186	353	71	50	33
SN187	1,030	131	106	69
SN190	727	121	43	26
SN191	388	74	57	38
SN192	255	30	9	6
SN193	256	34	13	9
SN194	151	21	15	10
SN305-S	122	54	42	23
SN310-S	156	33	17	6
SS105	18	7	5	2
SS105-S	233	104	78	44
SS107	1,357	173	39	20
SS108	1,354	195	115	65
SS109	1,153	295	240	157
SS110	674	89	72	45
SS114	6	3	2	0
SS114-1	0	0	0	0
SS118	774	146	49	13
SS119	585	101	28	9
SS120	671	113	40	24
SS121	569	103	84	56
SS124	212	51	34	22
SS125	212	51	34	22
SS129	644	130	46	23
SS130	684	133	47	29
SS131	454	92	60	40
SS135	556	86	52	33
SS136	333	56	44	29
SS140	928	441	348	201
SS145	1,317	289	218	124
SS305A	193	34	5	1
SS310-A1	0	0	0	0
SS320	1,942	351	156	86
Conduits				
E-JACOBE-P	292	61	12	2
LN204	103	43	35	20

Node ID	Storm Event			
	100-Year	10-Year	5-Year	2-Year
LN205	30	29	28	18
LN205-S	79	17	8	3
LN214	484	225	172	95
LN215	476	222	170	95
LN219	186	89	70	42
LN219-S	5	0	0	0
LN220	63	28	22	12
LN220-S	3	1	0	0
LN225	144	76	59	32
LN225-S	35	5	3	1
LN230	44	23	19	10
LN230-S	29	1	1	0
LN235	140	66	52	32
LN235-1	82	33	27	17
LN235-2	76	33	27	17
LN235-3	58	33	27	18
LN235-S	11	2	1	0
LN235-S-1	0	0	0	0
LN235-S-2	8	0	0	0
LN235-S-3	17	0	0	0
LN240	25	24	24	18
LN240-S	55	10	4	0
LN245	24	24	20	12
LN245-S	27	3	2	1
LS204	71	58	58	51
LS210	62	8	4	2
LS215	102	27	15	8
LS216	168	57	48	32
LS217	198	70	52	14
LS218	43	2	1	0
LS220	18	0	0	0
LS221	21	0	0	0
LS225	0	0	0	0
LS226	0	0	0	0
RR-1-IN	231	97	73	41
RR-1-OUT	265	106	86	64
RR205	10	10	9	5
RR205-A	53	16	10	6
RR205-B	52	16	10	5
RR205-C	52	16	10	5
RR205-D	52	16	10	9
RR205-S	3	0	0	0

Node ID	Storm Event			
	100-Year	10-Year	5-Year	2-Year
SC200	2,511	1,044	845	481
SC201	3,343	1,643	1,392	913
SC202	2,400	1,037	845	502
SC203	2,348	2,872	1,992	1,201
SC203-S	9	0	0	0
SC204	2,199	1,046	810	476
SC2045	2,199	1,260	846	487
SC2045-S	0	0	0	0
SC205	2,198	1,043	799	455
SC206	2,199	1,042	799	453
SC206-S	0	0	0	0
SC210	2,104	982	756	428
SC215	2,106	981	756	428
SC215-S1	27	0	0	0
SC215-U1	10	10	9	5
SC220	2,090	952	732	411
SC221	2,162	944	725	405
SC221-1	0	0	0	0
SC221-U1	29	17	13	7
SC225	2,176	945	726	406
SC230	2,288	893	686	384
SC231	2,325	895	685	384
SC235	2,802	893	685	384
SC240	1,807	871	671	374
SC241	1,619	777	598	334
SC245	1,618	777	598	334
SC246	1,487	722	555	310
SC246-S	0	0	0	0
SC250	1,488	722	555	310
SC251	1,492	676	522	292
SC251-S	0	0	0	0
SC251-S2	97	5	1	0
SC251-S3	65	3	0	0
SC251-S4	19	0	0	0
SC251-U2	64	59	52	28
SC255	1,476	676	522	292
SC260	1,402	668	518	291
SC265	1,372	663	519	292
SC266	1,611	805	617	338
SC267	1,368	657	513	287
SC270	1,282	627	491	275
SC275	1,227	607	473	264

Node ID	Storm Event			
	100-Year	10-Year	5-Year	2-Year
SC280	1,034	480	379	212
SC285	965	443	351	197
SC290	885	406	327	182
SC291	852	310	241	134
SC295	852	319	253	143
SC296	753	350	303	194
SC297	753	272	209	119
SC298	753	272	209	119
SM1215	100	59	47	29
SM1250	131	34	28	17
SM204	122	95	66	33
SM204U	153	46	38	25
SM205	361	110	79	41
SM210	8	2	1	0
SM211	16	11	9	6
SM211-S	0	0	0	0
SM215-IC	22	0	0	0
SM219	5	0	0	0
SM219-S	0	0	0	0
SM220	66	31	24	14
SM2205	102	63	50	30
SM2205-1	102	63	50	30
SM2205-S	4	1	1	0
SM2210	98	59	47	29
SM2210-S	0	0	0	0
SM2235	0	0	0	0
SM225	17	12	10	6
SM225-S	22	0	0	0
SM230	62	32	25	14
SM235	131	35	29	18
SM236	131	34	28	17
SM237	131	34	28	17
SM240	17	9	7	2
SM240-S	26	0	0	0
SM245	29	10	7	4
SM246	29	12	9	5
SM250	13	6	4	2
SM255	0	0	0	0
SM260	178	55	41	23
SM261	220	66	47	23
SM261-S	51	39	31	17
SM261-S-S	50	40	33	19

Node ID	Storm Event			
	100-Year	10-Year	5-Year	2-Year
SM262	318	130	96	51
SM263	92	55	42	24
SM263-S	96	0	0	0
SM265	366	68	22	12
SM270	367	68	22	12
SM275	282	57	20	2
SM280	174	38	16	2
SN105-O1	123	95	66	33
SN176-MD	187	87	65	35
SN205	191	103	80	45
SN205-1	271	125	98	56
SN205-S	29	3	2	1
SN205-S1	0	0	0	0
SN205-S2	81	2	1	0
SN208	106	39	29	15
SN208-1	137	45	35	18
SN208-S	13	2	1	0
SN208-S-1	45	0	0	0
SN209	26	9	6	2
SN209-S	40	10	6	2
SN209-S1	10	0	0	0
SN210	130	64	50	29
SN210-S	31	8	5	2
SN210-S1	29	4	3	1
SN215	0	0	0	0
SN215-S	24	7	5	2
SN216	178	92	74	46
SN216-1	206	139	103	57
SN216-S	275	57	35	13
SN216-S-1	0	0	0	0
SN216-S-2	112	7	3	1
SN216-S-3	59	0	0	0
SN216-S-3-U	64	40	30	16
SN217	5	4	4	4
SN217-S	127	22	11	4
SN217-S1	156	33	17	6
SN224	288	60	12	2
SN225	1,538	169	50	17
SN226	318	63	22	5
SN230	1,029	124	101	66
SN235	623	26	4	1
SN236	365	67	22	9

Node ID	Storm Event			
	100-Year	10-Year	5-Year	2-Year
SN240	181	19	3	1
SN240-IC2	38	10	7	2
SN241	235	30	4	1
SN242	146	20	3	1
SN243	0	0	0	0
SN243-1	104	102	95	58
SN243-S	0	0	0	0
SN243-S1	96	21	11	4
SN243-S3	0	0	0	0
SN243-S4	92	17	9	3
SN243-S5	61	10	5	2
SN243-S6	77	33	23	9
SN243-U6	7	7	7	7
SN244	0	0	0	0
SN245	0	0	0	0
SN250	0	0	0	0
SN255	20	13	11	7
SN260	21	13	11	7
SS204-S	0	0	0	0
SS204-U1	1	0	0	0
SS204-U2	1	0	0	0
SS205	17	6	4	2
SS205-S	180	31	21	11
SS206	18	6	5	2
SS206-S	175	42	30	16
SS210	5	0	0	0
SS211	0	0	0	0
SS215	193	34	5	1
SS219	6	4	2	1
SS219-A	6	3	2	0
SS219-A-O	0	0	0	0
SS220	2,115	343	157	35
SS224	270	24	4	1
SS225	449	56	12	4
SS226	316	52	13	5
SS229	691	132	41	10
SS230	585	100	28	9
SS231	585	101	28	9
SS232	539	89	23	11
SS235	208	50	22	9
SS236	212	51	34	22
SS239	1,269	217	86	34

Node ID	Storm Event			
	100-Year	10-Year	5-Year	2-Year
SS240	640	128	44	15
SS241	644	130	46	23
SS242	443	88	32	9
SS245	781	256	194	110
SS250	1,375	121	21	7
SS255	1,287	172	39	14
SS256	1,150	166	96	54
SS305B-P	193	34	5	1
Storages				
E-JACOBE	1,538	169	50	17
LN305-S	181	68	51	26
LS305	597	219	162	87
LS315	384	173	140	90
RR-1	313	153	125	78
SM1305	240	115	89	52
SM305	37	18	13	7
SM310	2	0	0	0
SM311	470	34	26	15
SM315	133	62	47	26
SM320	68	33	25	14
SM325	358	150	116	62
SM330	87	40	30	17
SM335	28	14	10	6
SM340	376	156	116	61
SN305	93	46	36	21
SN310	65	29	22	13
SN315	0	0	0	0
SN320	0	0	0	0
SN325	20	13	11	7
SS305	287	113	86	45
SS305B	1,547	141	24	8
SS306	18	6	5	2
SS310	6	4	2	1
SS310-A	2,161	344	166	54
Outfalls				
LN404	103	43	35	20
LN410	367	170	127	73
LN420	484	225	172	95
LN425	2,511	1,044	845	481
LS405	114	58	47	29
LS410	62	13	10	7
LS420	52	28	23	14

Node ID	Storm Event			
	100-Year	10-Year	5-Year	2-Year
LW405	309	141	105	61
LW410	539	215	162	84
LW415	59	30	23	12
LW420	74	32	26	16
LW425	345	174	134	73
SN176-O	187	87	65	35

APPENDIX C

Manning's n Values for Spring Creek

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Manning's n Values for Spring Creek

SC200 – 2nd Street Downstream
Left: 0.030, Middle: 0.030, Right: 0.027

SC205 – 2nd Street Upstream
Left: 0.027, Middle: 0.040, Right: 0.045

Manning's n Values for Spring Creek

SC210 – Between 3rd and 5th Street Downstream
Left: 0.035, Middle: 0.040, Right: 0.045

SC210 – Around 5th Street Downstream
Left: 0.035, Middle: 0.040, Right: 0.045

Manning's n Values for Spring Creek

SC210 – Around 5th Street Upstream
Left: 0.035, Middle: 0.040, Right: 0.045

SC215 – Between 3rd and 5th Street Upstream
Left: 0.035, Middle: 0.030, Right: 0.030

Manning's n Values for Spring Creek

SC220 – 7th Street Downstream
Left: 0.035, Middle: 0.030, Right: 0.035

SC220 – 7th Street Upstream
Left: 0.035, Middle: 0.030, Right: 0.035

Manning's n Values for Spring Creek

SC225 – 7th Street Upstream
Left: 0.030, Middle: 0.035, Right: 0.030

SC225 – 9th Street Upstream
Left: 0.030, Middle: 0.035, Right: 0.030

Manning's n Values for Spring Creek

SC230 – Between 10th and 11th Street Upstream
Left: 0.045, Middle: 0.040, Right: 0.045

SC230 – Between 10th and 11th Street Downstream
Left: 0.045, Middle: 0.040, Right: 0.045

Manning's n Values for Spring Creek

SC235 – Between 11th and 13th Street Upstream
Left: 0.045, Middle: 0.040, Right: 0.045

SC235 – Between 11th and 13th Street Downstream
Left: 0.045, Middle: 0.040, Right: 0.045

Manning's n Values for Spring Creek

SC240 – Between 13th and 15th Street Downstream
Left: 0.045, Middle: 0.040, Right: 0.045

SC245 – Between 13th and 15th Street Upstream
Left: 0.045, Middle: 0.040, Right: 0.045

Manning's n Values for Spring Creek

SC250 – 16th Street Downstream
Left: 0.035, Middle: 0.030, Right: 0.035

SC255 – 16th Street Upstream
Left: 0.045, Middle: 0.040, Right: 0.045

Manning's n Values for Spring Creek

SC260 – 17th Street Upstream
Left: 0.035, Middle: 0.030, Right: 0.035

SC265 – Bridge on Corthell Street Downstream
Left: 0.035, Middle: 0.030, Right: 0.035

Manning's n Values for Spring Creek

SC270 – Near 21st and Spring Creek Drive Upstream
Left: 0.040, Middle: 0.035, Right: 0.035

SC270 – Near 21st and Spring Creek Drive Downstream
Left: 0.040, Middle: 0.035, Right: 0.035

Manning's n Values for Spring Creek

SC275 – Near 22nd and Spring Creek Drive Upstream
Left: 0.035, Middle: 0.030, Right: 0.030

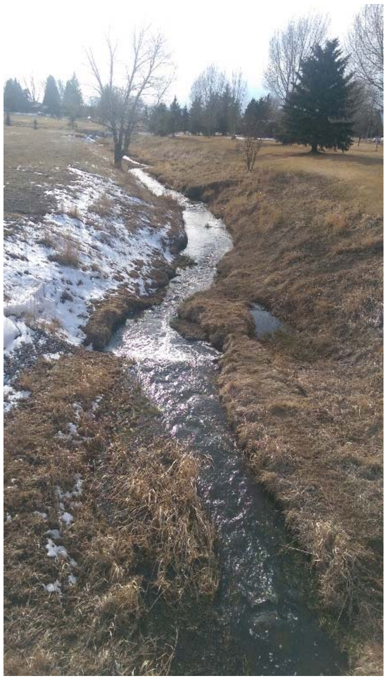
SC275 – Near 22nd and Spring Creek Drive Downstream
Left: 0.035, Middle: 0.030, Right: 0.030

Manning's n Values for Spring Creek

SC275 – Bridge on Corthell Street Upstream
Left: 0.035, Middle: 0.030, Right: 0.030

SC280 – Near 23rd and Spring Creek Drive Upstream
Left: 0.030, Middle: 0.027, Right: 0.030

Manning's n Values for Spring Creek



SC280 – Near 23rd and Spring Creek Downstream
Left: 0.030, Middle: 0.027, Right: 0.030

SC285 – Near 24th and Spring Creek Drive Upstream
Left: 0.035, Middle: 0.030, Right: 0.035

Manning's n Values for Spring Creek

SC285 – End of 30th Street Downstream
Left: 0.035, Middle: 0.030, Right: 0.035

SC285 – Near 24th and Spring Creek Drive Downstream
Left: 0.035, Middle: 0.030, Right: 0.035

Manning's n Values for Spring Creek

SC290 – West End of Spring Creek Upstream
Left: 0.035, Middle: 0.030, Right: 0.035

SC290 – West End of Spring Creek Downstream
Left: 0.035, Middle: 0.030, Right: 0.035

Manning's n Values for Spring Creek

SC290 – 30th Street Bridge Downstream
Left: 0.035, Middle: 0.030, Right: 0.035

SC295 – 30th Street Bridge Upstream
Left: 0.027, Middle: 0.030, Right: 0.030

Manning's n Values for Spring Creek

SC295 – 30th Street Bridge Downstream
Left: 0.027, Middle: 0.030, Right: 0.030

SC297 – 30th Street Bridge Upstream
Left: 0.027, Middle: 0.030, Right: 0.030

APPENDIX D

Conceptual Cost Details

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Summary of Laramie River North Alternatives

Alternative	Project	Description	Major Drainage Basin	Project Cost	Annual O&M Cost	Total Lifecycle Cost
LN-1	60" Pipe Bore Under UPRR ROW at Steele Street	Install additional 60" storm sewer under UPRR ROW beginning at Steele St.	Laramie River North	**$2,089,315**	**$800**	**$2,198,579**
	Steele St. System Storm Sewer Upgrades	Upsize storm sewer to 36" from Ivinson & 5th to 3rd & Grand; Upsize storm sewer to 42" from 3rd & Grand to 3rd & Kearney; Upsize storm sewer to 48" from 3rd & Kearney to 2nd & Kearney	Laramie River North	**$1,428,920**	**$2,400**	**$1,756,711**
	2nd Street Storm Sewer Connection to Steele Street	Install new 42" circular storm sewer pipe on 2nd St. from Sanders Dr. to Steele St.	Laramie River North	**$744,661**	**$1,350**	**$929,043**
	Bore 60" Pipe Under UPRR ROW at Steele St. + Grand Avenue Storm Sewer Upgrades + Storm Sewer Improvements on 3rd Street, Kearny Street, and 2nd Street		**Total**	**$4,262,896**	**$4,550**	**$4,884,334**
LN-2	60" Pipe Bore Under UPRR ROW at Steele Street	Install additional 60" storm sewer under UPRR ROW beginning at Steele St.	Laramie River North	**$2,089,315**	**$800**	**$2,198,579**
	Steele St. System Storm Sewer Upgrades	Upsize storm sewer to 36" from Ivinson & 5th to 3rd & Grand; Upsize storm sewer to 42" from 3rd & Grand to 3rd & Kearney; Upsize storm sewer to 48" from 3rd & Kearney to 2nd & Kearney	Laramie River North	**$1,428,920**	**$2,400**	**$1,756,711**
	2nd Street Storm Sewer Connection to Steele Street	Install new 42" circular storm sewer pipe on 2nd St. from Sanders Dr. to Steele St.	Laramie River North	**$744,661**	**$1,350**	**$929,043**
	Re-purpose 18" Sanitary Sewer	Re-purpose 18" sanitary sewer for use as storm sewer from the intersection of 1st St. and Sanders St. to dead-end of Pine St.	Laramie River North	**$95,865**	**$2,630**	**$455,070**
	Re-purpose 18" Sanitary Sewer + Improvements Listed in LN-1		**Total**	**$4,358,760**	**$7,180**	**$5,339,403**
LN-3	60" Pipe Bore Under UPRR ROW at Steele Street	Install additional 60" storm sewer under UPRR ROW beginning at Steele St.	Laramie River North	**$2,089,315**	**$800**	**$2,198,579**
	Steele St. System Storm Sewer Upgrades	Upsize storm sewer to 36" from Ivinson & 5th to 3rd & Grand; Upsize storm sewer to 42" from 3rd & Grand to 3rd & Kearney; Upsize storm sewer to 48" from 3rd & Kearney to 2nd & Kearney	Laramie River North	**$1,428,920**	**$2,400**	**$1,756,711**
	Re-purpose 18" Sanitary Sewer	Re-purpose 18" sanitary sewer for use as storm sewer from the intersection of 1st St. and Sanders St. to dead-end of Pine St.	Laramie River North	**$95,865**	**$2,630**	**$455,070**
	Clean and Restore 36" Culvert Under UPRR ROW	Clean and restore functionality of 36" culvert at 1st St. and Sanders St. and construct open channel to Laramie River	Laramie River North	**$282,350**	**$500**	**$350,640**
	Bore 60" Pipe Under UPRR ROW at Steele St. + Grand Avenue Storm Sewer Upgrades + Re-purpose 18" Sanitary Sewer for Use as Storm Sewer + Clean and Restore 36" Culvert at 1st Street and Sanders Street + Storm Sewer Improvements on East Kearney Street and 3rd Street		**Total**	**$3,896,450**	**$6,330**	**$4,761,000**

Project	60" Pipe Bore Under UPRR ROW at Steele Street				
Major Basin	Laramie River North				
Description	Install additional 60" storm sewer under UPRR ROW beginning at Steele St.				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Install additional 60" circular pipe		400	LF	$210	$84,000
Bore under UPRR		400	LF	$2,500	$1,000,000
Street Repair		400	LF	$165	$65,926
Subtotal					**$1,149,926**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$91,994
Mobilization		1	-	5%	$57,496
Traffic Control		1	-	2%	$22,999
Utility Coordination/Relocation		1	-	2%	$22,999
Stormwater Management/Erosion Control		1	-	5%	$57,496
Subtotal					**$252,984**
Land Acquisition					
Easement/ROW Acquisition		0.6	ACRE	$100,000	$55,096
Subtotal					**$55,096**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$140,291
Legal/Administrative		1	-	5%	$70,145
Contract Admin/Construction Management		1	-	5%	$70,145
Contingency		1	-	25%	$350,727
Subtotal					**$631,309**
Total Cost					**$2,089,315**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		800	LF/YR	$1.00	$800
Maintain Engineered Channel		0	LF/YR	$0.25	$0
Maintain Detention Pond		0	ACRE	$1,500	$0
Total					**$800**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$109,264**

Project	Steele St. System Storm Sewer Upgrades			
Major Basin	Laramie River North			
Description	Upsize storm sewer to 36" from Ivinson & 5th to 3rd & Grand; Upsize storm sewer to 42" from 3rd & Grand to 3rd & Kearney; Upsize storm sewer to 48" from 3rd & Kearney to 2nd & Kearney			
Capital Improvement Costs	**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Remove existing storm sewer	2400	LF	$30	$72,000
Install 36" circular pipe from Ivinson & 5th to 3rd & Grand	1000	LF	$126	$126,000
Install 42" circular pipe from 3rd & Grand to 3rd & Kearney	1000	LF	$147	$147,000
Install 48" circular pipe from 3rd & Kearney to 2nd & Kearney	400	LF	$168	$67,200
Street Repair	2400	LF	$165	$395,556
Subtotal				**$807,756**
Additional Capital Construction Costs				
Dewatering	1	-	8%	$64,620.44
Mobilization	1	-	5%	$40,388
Traffic Control	1	-	2%	$16,155
Utility Coordination/Relocation	1	-	2%	$16,155
Stormwater Management/Erosion Control	1	-	5%	$40,388
Subtotal				**$177,706**
Land Acquisition				
Easement/ROW Acquisition	0	ACRE	$100,000	$0
Subtotal				**$0**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	1	-	10%	$98,546
Legal/Administrative	1	-	5%	$49,273
Contract Admin/Construction Management	1	-	5%	$49,273
Contingency	1	-	25%	$246,365
Subtotal				**$443,458**
Total Cost				**$1,428,920**
Annual Operation and Maintenance Cost	**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert	2400	LF/YR	$1.00	$2,400
Maintain Engineered Channel	0	LF/YR	$0.25	$0
Maintain Detention Pond	0	ACRE	$1,500	$0
Total				**$2,400**
Maintenance Costs Service Life = 50		Interest Rate =	3.64%	**$327,792**

Project	2nd Street Storm Sewer Connection to Steele Street Outfall System				
Major Basin	Laramie River North				
Description	Install new 42" circular storm sewer pipe on 2nd St. from Sanders Dr. to Steele St.				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Install new 42" circular pipe on 2nd St.		1350	LF	$147	$198,450
Street Repair		1350	LF	$165	$222,500
Subtotal					**$420,950**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$33,676
Mobilization		1	-	5%	$21,048
Traffic Control		1	-	2%	$8,419
Utility Coordination/Relocation		1	-	2%	$8,419
Stormwater Management/Erosion Control		1	-	5%	$21,048
Subtotal					**$92,609**
Land Acquisition					
Easement/ROW Acquisition		0	ACRE	$100,000	$0
Subtotal					**$0**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$51,356
Legal/Administrative		1	-	5%	$25,678
Contract Admin/Construction Management		1	-	5%	$25,678
Contingency		1	-	25%	$128,390
Subtotal					**$231,102**
Total Cost					**$744,661**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		1350	LF/YR	$1.00	$1,350
Maintain Engineered Channel		0	LF/YR	$0.25	$0
Maintain Detention Pond		0	ACRE	$1,500	$0
Total					**$1,350**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$184,383**

Project	Re-purpose 18" Sanitary Sewer				
Major Basin	Laramie River North				
Description	Re-purpose 18" sanitary sewer for use as storm sewer from the intersection of 1st St. and Sanders St. to dead-end of Pine St.				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Camera inspection of existing line		2630	LF	$2	$5,260
Jet and Disinfect existing sanitary sewer line		2630	LF	$5	$13,150
Install 4' manhole		2	EA	$3,000	$6,000
Install inlets		2	EA	$3,500	$7,000
Install 18" circular pipe to connect inlets		100	LF	$63	$6,300
Street repair		100	LF	$165	$16,481
Subtotal					**$54,191**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$4,335.32
Mobilization		1	-	5%	$2,710
Traffic Control		1	-	2%	$1,084
Utility Coordination/Relocation		1	-	2%	$1,084
Stormwater Management/Erosion Control		1	-	5%	$2,710
Subtotal					**$11,922**
Land Acquisition					
Easement/ROW Acquisition		0	ACRE	$100,000	$0
Subtotal					**$0**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$6,611
Legal/Administrative		1	-	5%	$3,306
Contract Admin/Construction Management		1	-	5%	$3,306
Contingency		1	-	25%	$16,528
Subtotal					**$29,751**
Total Cost					**$95,865**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		2630	LF/YR	$1.00	$2,630
Maintain Engineered Channel		0	LF/YR	$0.25	$0
Maintain Detention Pond		0	ACRE	$1,500	$0
Total					**$2,630**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$359,205**

Project	Clean and Restore 36" Culvert Under UPRR ROW				
Major Basin	Laramie River North				
Description	Clean and restore functionality of 36" culvert at 1st St. and Sanders St. and construct open channel to Laramie River				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Remove debris around inlet and outlet of culvert		2	EA	$2,000	$4,000
Camera test 36" culvert		400	LF	$2	$800
Outfall Protection (at end of culvert and channel)		2	EA	$27,035	$54,069
Soil Riprap, Type L, discharge channel		1185	C.Y.	$55	$65,185
Excavation to construct channel to Spring Creek		2370	C.Y.	$15	$35,556
Subtotal					**$159,610**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$12,768.81
Mobilization		1	-	5%	$7,981
Traffic Control		1	-	2%	$3,192
Utility Coordination/Relocation		1	-	2%	$3,192
Stormwater Management/Erosion Control		1	-	5%	$7,981
Subtotal					**$35,114**
Land Acquisition					
Easement/ROW Acquisition		0	ACRE	$100,000	$0
Subtotal					**$0**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$19,472
Legal/Administrative		1	-	5%	$9,736
Contract Admin/Construction Management		1	-	5%	$9,736
Contingency		1	-	25%	$48,681
Subtotal					**$87,626**
Total Cost					**$282,350**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		400	LF/YR	$1.00	$400
Maintain Engineered Channel		400	LF/YR	$0.25	$100
Maintain Detention Pond		0	ACRE	$1,500	$0
Total					**$500**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$68,290**

Summary of Spring Creek North and Spring Creek Middle Alternatives

Alternative	Project	Description	Major Drainage Basin	Project Cost	Annual O&M Cost	Total Lifecycle Cost
SN-1	Pond East of Jacoby Golf Course	Construct a new, 247 AF detention pond east of Jacoby Golf Course	Spring Creek North	**$8,169,026**	**$60,000**	**$16,363,814**
	TT-5	Construct new, 20 AF detention pond upstream of Regency Dr., Restrict Beech Pond Outlet to a circular, 24-inch opening, and construct new, 28 AF detention pond on UW property upstream of Grand Ave.	Spring Creek Middle	**$8,383,521**	**$27,657**	**$12,160,875**
	Grey's Gable Storm Sewer Upgrades	Capture and route stormwater runoff from Grey's Gable Road to Jacoby Golf Course	Spring Creek North	**$208,745**	**$100**	**$222,403**
	30th Street Storm Sewer Upgrades	Extend 24" storm sewer on 30th St. to Jacoby Golf Course Pond Outlet	Spring Creek North	**$764,145**	**$1,650**	**$989,502**
	22nd Street Storm Sewer Upgrades	Upgrade storm sewer from 36" circular pipe to 6' x 4' culvert box on 22nd St. from Rainbow St. to Spring Creek Channel	Spring Creek North	**$2,084,195**	**$1,100**	**$2,234,433**
	21st Street Storm Sewer Upgrades	Upgrade storm sewer from existing pipe to 36" circular pipe on 21st St. from Rainbow Street to Spring Creek Channel	Spring Creek North	**$675,363**	**$1,100**	**$825,601**
	13th Street Storm Sewer Upgrades	On 13th St., upgrade storm sewer from 15" to 30" from Garfield to Sheridan, from 36" to 4' x 3.5' box culvert from Sheridan to Ord, and from 42" to 6' x 4' box culvert from Ord St. to Spring Creek Channel	Laramie River North	**$2,905,502**	**$2,300**	**$3,219,636**
	4'x6' Box Culvert from Boswell Drive to Spring Creek Channel	Install a new 6' x 4' box culvert on Boswell Dr. from the east side of the North I-80 Interchange along Boswell Drive to Spring Creek on the east side of Highway 287.	Spring Creek Middle	**$1,305,841**	**$800**	**$1,415,105**
	Pond East of Jacoby Golf Course (247 AF) + Turner Tract Recommended Improvements (TT-5) + Improvements on Grey's Gable + Storm Sewer Upgrades on 30th Street, 22nd Street, 21st Street, and 13th Street + 4'x6' Box Culvert from Boswell to Spring Creek		**Total**	**$24,496,338**	**$94,707**	**$37,431,369**
SN-2	TT-5	Construct new, 20 AF detention pond upstream of Regency Dr., Restrict Beech Pond Outlet to a circular, 24-inch opening, and construct new, 28 AF detention pond on UW property upstream of Grand Ave.	Spring Creek Middle	**$8,383,521**	**$27,657**	**$12,160,875**
	Grey's Gable Storm Sewer Upgrades	Capture and route stormwater runoff from Grey's Gable Road to Jacoby Golf Course	Spring Creek North	**$208,745**	**$100**	**$222,403**
	30th Street Storm Sewer Upgrades	Extend 24" storm sewer on 30th St. to Jacoby Golf Course Pond Outlet	Spring Creek North	**$764,145**	**$1,650**	**$989,502**
	22nd Street Storm Sewer Upgrades	Upgrade storm sewer from 36" circular pipe to 6' x 4' culvert box on 22nd St. from Rainbow St. to Spring Creek Channel	Spring Creek North	**$2,084,195**	**$1,100**	**$2,234,433**
	21st Street Storm Sewer Upgrades	Upgrade storm sewer from existing pipe to 36" circular pipe on 21st St. from Rainbow Street to Spring Creek Channel	Spring Creek North	**$675,363**	**$1,100**	**$825,601**
	13th Street Storm Sewer Upgrades	On 13th St., upgrade storm sewer from 15" to 30" from Garfield to Sheridan, from 36" to 4' x 3.5' box culvert from Sheridan to Ord, and from 42" to 6' x 4' box culvert from Ord St. to Spring Creek Channel	Laramie River North	**$2,905,502**	**$2,300**	**$3,219,636**
	4'x6' Box Culvert from Boswell Drive to Spring Creek Channel	Install a new 6' x 4' box culvert on Boswell Dr. from the east side of the North I-80 Interchange along Boswell Drive to Spring Creek on the east side of Highway 287.	Spring Creek Middle	**$1,305,841**	**$800**	**$1,415,105**
	26th Street Pond	Construct a new, 15 AF detention pond on the south side and upstream of Spring Creek at 26th St.	Spring Creek North	**$1,155,119**	**$5,560**	**$1,914,454**
	17th Street Pond, 46 AF	Construct a new, 46 AF detention pond on the south side and upstream of Spring Creek at 17th St.	Spring Creek Middle	**$2,755,762**	**$18,144**	**$5,233,799**
	26th Street Pond (15 AF) + 17th Street Pond (46 AF) + Turner Tract Recommended Improvements (TT-5) + Improvements on Grey's Gable + Storm Sewer Upgrades on 30th Street, 22nd Street, 21st Street, and 13th Street + 4'x6' Box Culvert from Boswell to Spring Creek		**Total**	**$20,238,193**	**$58,410**	**$28,215,807**
SN-3	TT-5	Construct new, 20 AF detention pond upstream of Regency Dr., Restrict Beech Pond Outlet to a circular, 24-inch opening, and construct new, 28 AF detention pond on UW property upstream of Grand Ave.	Spring Creek Middle	**$8,383,521**	**$27,657**	**$12,160,875**
	Grey's Gable Storm Sewer Upgrades	Capture and route stormwater runoff from Grey's Gable Road to Jacoby Golf Course	Spring Creek North	**$208,745**	**$100**	**$222,403**
	30th Street Storm Sewer Upgrades	Extend 24" storm sewer on 30th St. to Jacoby Golf Course Pond Outlet	Spring Creek North	**$764,145**	**$1,650**	**$989,502**
	22nd Street Storm Sewer Upgrades	Upgrade storm sewer from 36" circular pipe to 6' x 4' culvert box on 22nd St. from Rainbow St. to Spring Creek Channel	Spring Creek North	**$2,084,195**	**$1,100**	**$2,234,433**
	21st Street Storm Sewer Upgrades	Upgrade storm sewer from existing pipe to 36" circular pipe on 21st St. from Rainbow Street to Spring Creek Channel	Spring Creek North	**$675,363**	**$1,100**	**$825,601**
	13th Street Storm Sewer Upgrades	On 13th St., upgrade storm sewer from 15" to 30" from Garfield to Sheridan, from 36" to 4' x 3.5' box culvert from Sheridan to Ord, and from 42" to 6' x 4' box culvert from Ord St. to Spring Creek Channel	Laramie River North	**$2,905,502**	**$2,300**	**$3,219,636**
	4'x6' Box Culvert from Boswell Drive to Spring Creek Channel	Install a new 6' x 4' box culvert on Boswell Dr. from the east side of the North I-80 Interchange along Boswell Drive to Spring Creek on the east side of Highway 287.	Spring Creek Middle	**$1,305,841**	**$800**	**$1,415,105**
	LaPrele Park Pond Expansion	Expand LaPrele Park Pond (Huck Finn Pond) by 10 AF to accept high flows diverted from Spring Creek	Spring Creek Middle	**$1,119,368**	**$2,043**	**$1,398,332**
	17th Street Pond, 46 AF	Construct a new, 46 AF detention pond on the south side and upstream of Spring Creek at 17th St.	Spring Creek Middle	**$2,755,762**	**$18,144**	**$5,233,799**
	LaPrele Park Pond Expansion + 17th Street Pond (46 AF) + Improvements on Grey's Gable + Storm Sewer Upgrades on 30th Street, 22nd Street, 21st Street, and 13th Street + 4'x6' Box Culvert from Boswell to Spring Creek		**Total**	**$20,202,442**	**$54,893**	**$27,699,685**

Project	Pond East of Jacoby Golf Course				
Major Basin	Spring Creek North				
Description	Construct a new, 247 AF detention pond east of Jacoby Golf Course				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Excavation of 247 AF detention pond		199247	C.Y.	$10	$1,992,467
Outlet structure, large		1	EA	$40,000	$40,000
Emergency Spillway, Large		1	EA	$40,000	$40,000
Concrete Low Flow Channel		1000	L.F.	$45	$45,000
Seeding/Reclamation		40	ACRE	$1,000	$40,000
Water Quality Capture Volume		19925	C.Y.	$10	$199,247
Subtotal					**$2,356,713**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$188,537
Mobilization		1	-	5%	$117,836
Traffic Control		1	-	2%	$47,134
Utility Coordination/Relocation		1	-	2%	$47,134
Stormwater Management/Erosion Control		1	-	5%	$117,836
Subtotal					**$518,477**
Land Acquisition					
ROW/Easement Acquisition, Reach 3		40	ACRE	$100,000	$4,000,000
Subtotal					**$4,000,000**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$287,519
Legal/Administrative		1	-	5%	$143,760
Contract Admin/Construction Management		1	-	5%	$143,760
Contingency		1	-	25%	$718,798
Subtotal					**$1,293,836**
Total Cost					**$8,169,026**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		0	LF/YR	$1.00	$0
Maintain Engineered Channel		0	LF/YR	$0.25	$0
Maintain Detention Pond		40	ACRE	$1,500	$60,000
Total					**$60,000**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$8,194,788**

Project	Turner Tract Alternative 5 - Regency Pond				
Major Basin	Spring Creek Middle				
Description	Construct new, 20 AF detention pond upstream of Spring Creek in Basin SM045, location TBD				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Excavation of 20 AF detention pond		16133	C.Y.	$15	$242,000
Outlet structure, large		1	EA	$40,000	$40,000
Emergency Spillway, Large		1	EA	$40,000	$40,000
Concrete Low Flow Channel		500	L.F.	$45	$22,500
Seeding/Reclamation		4.5	ACRE	$1,000	$4,492
Water Quality Capture Volume		1613	C.Y.	$15	$24,200
Pond Liner		195652	SF	$3	$655,435
Subtotal					**$1,028,626**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$82,290
Mobilization		1	-	5%	$51,431
Traffic Control		1	-	2%	$20,573
Utility Coordination/Relocation		1	-	2%	$20,573
Stormwater Management/Erosion Control		1	-	5%	$51,431
Subtotal					**$226,298**
Land Acquisition					
		0	ACRE	$100,000	$0
Subtotal					**$0**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$125,492
Legal/Administrative		1	-	5%	$62,746
Contract Admin/Construction Management		1	-	5%	$62,746
Contingency		1	-	25%	$313,731
Subtotal					**$564,716**
Total Cost					**$1,819,640**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		0	LF/YR	$1.00	$0
Maintain Engineered Channel		0	LF/YR	$0.25	$0
Maintain Detention Pond		4.5	ACRE	$1,500	$6,737
Total					**$6,737**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$920,184**

Project	Turner Tract Alternative 5 - Beech Pond				
Major Basin	Spring Creek Middle				
Description	Restrict Beech Pond outlet to a circular, 24" opening, no expansion of pond. The pond is located upstream of SM083 in Basin SM050, location TBD.				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
No excavation		0	C.Y.	$15	$0
Outlet structure, small		1	EA	$20,000	$20,000
Emergency Spillway, Large		0	EA	$40,000	$0
Concrete Low Flow Channel		0	L.F.	$45	$0
Seeding/Reclamation		0.0	ACRE	$1,000	$0
Water Quality Capture Volume		0	C.Y.	$15	$0
Pond Liner		0	SF	$3	$0
Subtotal					**$20,000**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$1,600.00
Mobilization		1	-	5%	$1,000.00
Traffic Control		1	-	2%	$400.00
Utility Coordination/Relocation		1	-	2%	$400.00
Stormwater Management/Erosion Control		1	-	5%	$1,000.00
Subtotal					**$4,400**
Land Acquisition					
		0	ACRE	$100,000	$0
Subtotal					**$0**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$2,440
Legal/Administrative		1	-	5%	$1,220
Contract Admin/Construction Management		1	-	5%	$1,220
Contingency		1	-	25%	$6,100
Subtotal					**$10,980**
Total Cost					**$35,380**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		0	LF/YR	$1.00	$0
Maintain Engineered Channel		0	LF/YR	$0.25	$0
Maintain Detention Pond		0.0	ACRE	$1,500	$0
Total					**$0**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$0**

Project	Turner Tract Alternative 4 & 5 - Pond Upstream of Grand				
Major Basin	Spring Creek Middle				
Description	Construct new, 28 AF detention pond on UW property upstream of SM051 in Basin SM055, location TBD				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Excavation of new, 28 AF detention pond on UW property		22,587	C.Y.	$15	$338,800
Outlet structure, large		1	EA	$40,000	$40,000
Emergency Spillway, Large		1	EA	$40,000	$40,000
Concrete Low Flow Channel		500	L.F.	$45	$22,500
Seeding/Reclamation		13.9	ACRE	$1,000	$13,946
Water Quality Capture Volume		2,259	C.Y.	$15	$33,880
Inlet protection for pond		1	EA	$10,000	$10,000
Pond Liner		607,500	SF	$3	$2,035,125
Subtotal					**$2,534,251**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$202,740.10
Mobilization		1	-	5%	$126,712.56
Traffic Control		1	-	2%	$50,685.03
Utility Coordination/Relocation		1	-	2%	$50,685.03
Stormwater Management/Erosion Control		1	-	5%	$126,712.56
Subtotal					**$557,535**
Land Acquisition					
		22	ACRE	$100,000	$2,200,000
Subtotal					**$2,200,000**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$309,179
Legal/Administrative		1	-	5%	$154,589
Contract Admin/Construction Management		1	-	5%	U
Contingency		1	-	25%	$772,947
Subtotal					**$1,236,715**
Total Cost					**$6,528,501**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		0	LF/YR	$1.00	$0
Maintain Engineered Channel		0	LF/YR	$0.25	$0
Maintain Detention Pond		13.9	ACRE	$1,500	$20,919
Total					**$20,919**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$2,857,171**

Project	Grey's Gable Storm Sewer Upgrades			
Major Basin	Spring Creek North			
Description	Capture and route stormwater runoff from Grey's Gable Road to Jacoby Golf Course			
Capital Improvement Costs	**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Install Storm Sewer Inlet	10	EA	$3,500	$35,000
				$0
Install 4'x4' box culvert under Grey's Gable	80	LF	$800	$64,000
Connect new storm sewer inlets	20	LF	$126	$2,520
Street repair	100	LF	$165	$16,481
Subtotal				**$118,001**
Additional Capital Construction Costs				
Dewatering	1	-	8%	$9,440
Mobilization	1	-	5%	$5,900
Traffic Control	1	-	2%	$2,360
Utility Coordination/Relocation	1	-	2%	$2,360
Stormwater Management/Erosion Control	1	-	5%	$5,900
Subtotal				**$25,960**
Land Acquisition				
ROW/Easement Acquisition, Reach 3	0	ACRE	$100,000	$0
Subtotal				**$0**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	1	-	10%	$14,396
Legal/Administrative	1	-	5%	$7,198
Contract Admin/Construction Management	1	-	5%	$7,198
Contingency	1	-	25%	$35,990
Subtotal				**$64,783**
Total Cost				**$208,745**
Annual Operation and Maintenance Cost	**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert	100	LF/YR	$1.00	$100
Maintain Engineered Channel	0	LF/YR	$0.25	$0
Maintain Detention Pond	0	ACRE	$1,500	$0
Total				**$100**
Maintenance Costs	Service Life = 50	Interest Rate =	3.64%	**$13,658**

Project	30th Street Storm Sewer Upgrades				
Major Basin	Spring Creek North				
Description	Extend 24" storm sewer on 30th St. to Jacoby Golf Course Pond Outlet				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Connect Golf Course to storm sewer system on 30th		1	EA	$20,000	$20,000
					$0
Install 24" circular pipe on 30th		1650	LF	$84	$138,600
Street Repair		1650	LF	$165	$271,944
Curb and Gutter		20	LF	$71	$1,420
Outfall (toewall, wingwall, and cover)		0	EA	$27,035	$0
Seeding/Reclamation		0	ACRE	$1,000	$0
Subtotal					**$431,964**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$34,557
Mobilization		1	-	5%	$21,598
Traffic Control		1	-	2%	$8,639
Utility Coordination/Relocation		1	-	2%	$8,639
Stormwater Management/Erosion Control		1	-	5%	$21,598
Subtotal					**$95,032**
Land Acquisition					
Easement/ROW Acquisition		0	ACRE	$100,000	$0
Subtotal					**$0**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$52,700
Legal/Administrative		1	-	5%	$26,350
Contract Admin/Construction Management		1	-	5%	$26,350
Contingency		1	-	25%	$131,749
Subtotal					**$237,148**
Total Cost					**$764,145**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		1650	LF/YR	$1.00	$1,650
Maintain Engineered Channel		0	LF/YR	$0.25	$0
Maintain Detention Pond		0	ACRE	$1,500	$0
Total					**$1,650**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$225,357**

Project	22nd Street Storm Sewer Upgrades			
Major Basin	Spring Creek North			
Description	Upgrade storm sewer from 36" circular pipe to 6' x 4' culvert box on 22nd St. from Rainbow St. to Spring Creek Channel			
Capital Improvement Costs	**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Remove 36" circular pipe on 22nd St.	1100	LF	$30	$33,000
Install 6' x 4' culvert box on 22nd St.	1100	LF	$850	$935,000
Street Repair	1100	LF	$165	$181,296
Curb and Gutter	26	LF	$71	$1,846
Outfall (toewall, wingwall, and cover)	1	EA	$27,035	$27,035
Seeding/Reclamation	0.0	ACRE	$1,000	$0
Subtotal				**$1,178,177**
Additional Capital Construction Costs				
Dewatering	1	-	8%	$94,254
Mobilization	1	-	5%	$58,909
Traffic Control	1	-	2%	$23,564
Utility Coordination/Relocation	1	-	2%	$23,564
Stormwater Management/Erosion Control	1	-	5%	$58,909
Subtotal				**$259,199**
Land Acquisition				
Easement/ROW Acquisition	0	ACRE	$100,000	$0
Subtotal				**$0**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	1	-	10%	$143,738
Legal/Administrative	1	-	5%	$71,869
Contract Admin/Construction Management	1	-	5%	$71,869
Contingency	1	-	25%	$359,344
Subtotal				**$646,819**
Total Cost				**$2,084,195**
Annual Operation and Maintenance Cost	**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert	1100	LF/YR	$1.00	$1,100
Maintain Engineered Channel	0	LF/YR	$0.25	$0
Maintain Detention Pond	0	ACRE	$1,500	$0
Total				**$1,100**
Maintenance Costs Service Life = 50		Interest Rate =	3.64%	**$150,238**

Project	21st Street Storm Sewer Upgrades
Major Basin	Spring Creek North
Description	Upgrade storm sewer from existing pipe to 36" circular pipe on 21st St. from Rainbow Street to Spring Creek Channel

Capital Improvement Costs	**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Remove <48" circular pipe on 21st St.	1100	LF	$30	$33,000
Install 36" circular pipe on 21st St.	1100	LF	$126	$138,600
Street Repair	1100	LF	$165	$181,296
Curb and Gutter	26	LF	$71	$1,846
Outfall (toewall, wingwall, and cover)	1	EA	$27,035	$27,035
Seeding/Reclamation	0.0	ACRE	$1,000	$0
Subtotal				**$381,777**
Additional Capital Construction Costs				
Dewatering	1	-	8%	$30,542
Mobilization	1	-	5%	$19,089
Traffic Control	1	-	2%	$7,636
Utility Coordination/Relocation	1	-	2%	$7,636
Stormwater Management/Erosion Control	1	-	5%	$19,089
Subtotal				**$83,991**
Land Acquisition				
Easement/ROW Acquisition	0	ACRE	$100,000	$0
Subtotal				**$0**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	1	-	10%	$46,577
Legal/Administrative	1	-	5%	$23,288
Contract Admin/Construction Management	1	-	5%	$23,288
Contingency	1	-	25%	$116,442
Subtotal				**$209,596**
Total Cost				**$675,363**

Annual Operation and Maintenance Cost	**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert	1100	LF/YR	$1.00	$1,100
Maintain Engineered Channel	0	LF/YR	$0.25	$0
Maintain Detention Pond	0	ACRE	$1,500	$0
Total				**$1,100**

Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$150,238**

Project	13th Street Storm Sewer Upgrades				
Major Basin	Laramie River North				
Description	On 13th St., upgrade storm sewer from 15" to 30" from Garfield to Sheridan, from 36" to 4' x 3.5' box culvert from Sheridan to Ord, and from 42" to 6' x 4' box culvert from Ord St. to Spring Creek Channel				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Remove circular pipe on 13th St.		2300	LF	$30	$69,000
Install 30" circular pipe on 13th St.		1000	LF	$105	$105,000
Install 4' x 3.5' box culvert on 13th St.		900	LF	$800	$720,000
Install 6' x 4' box culvert on 13th St.		400	LF	$850	$340,000
Street Repair		2300	LF	$165	$379,074
Curb and Gutter		26	LF	$71	$1,846
Outfall (toewall, wingwall, and cover)		1	EA	$27,035	$27,035
Seeding/Reclamation		0.50	ACRE	$1,000	$500
Subtotal					**$1,642,455**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$131,396
Mobilization		1	-	5%	$82,123
Traffic Control		1	-	2%	$32,849
Utility Coordination/Relocation		1	-	2%	$32,849
Stormwater Management/Erosion Control		1	-	5%	$82,123
Subtotal					**$361,340**
Land Acquisition					
Easement/ROW Acquisition		0	ACRE	$100,000	$0
Subtotal					**$0**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$200,379
Legal/Administrative		1	-	5%	$100,190
Contract Admin/Construction Management		1	-	5%	$100,190
Contingency		1	-	25%	$500,949
Subtotal					**$901,708**
Total Cost					**$2,905,502**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		2300	LF/YR	$1.00	$2,300
Maintain Engineered Channel		0	LF/YR	$0.25	$0
Maintain Detention Pond		0	ACRE	$1,500	$0
Total					**$2,300**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$314,134**

Project	4'x6' Box Culvert from Boswell Drive to Spring Creek Channel				
Major Basin	Spring Creek Middle				
Description	Install a new 6' x 4' box culvert on Boswell Dr. from the east side of the North I-80 Interchange along Boswell Drive to Spring Creek on the east side of Highway 287.				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Install new 6' x 4' box culvert on Boswell Dr.		800	LF	$850	$680,000
					$0
					$0
					$0
Outfall (toewall, wingwall, and cover)		1	EA	$27,035	$27,035
Subtotal					**$707,035**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$56,563
Mobilization		1	-	5%	$35,352
Traffic Control		1	-	2%	$14,141
Utility Coordination/Relocation		1	-	2%	$14,141
Stormwater Management/Erosion Control		1	-	5%	$35,352
Subtotal					**$155,548**
Land Acquisition					
Easement/ROW Acquisition		0.6	ACRE	$100,000	$55,096
Subtotal					**$55,096**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$86,258
Legal/Administrative		1	-	5%	$43,129
Contract Admin/Construction Management		1	-	5%	$43,129
Contingency		1	-	25%	$215,646
Subtotal					**$388,162**
Total Cost					**$1,305,841**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		800	LF/YR	$1.00	$800
Maintain Engineered Channel		0	LF/YR	$0.25	$0
Maintain Detention Pond		0	ACRE	$1,500	$0
Total					**$800**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$109,264**

Project	26th Street Pond			
Major Basin	Spring Creek North			
Description	Construct a new, 15 AF detention pond on the south side and upstream of Spring Creek at 26th St.			
Capital Improvement Costs	**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Excavation of 15 AF pond on 26th St.	12100	C.Y.	$15	$181,500
Outlet structure, large	1	EA	$40,000	$40,000
Inlet structure to pond	1	EA	$10,000	$10,000
Emergency Spillway, Large	1	EA	$40,000	$40,000
Concrete Low Flow Channel	700	L.F.	$45	$31,500
Seeding/Reclamation	3.7	ACRE	$1,000	$3,673
Water Quality Capture Volume	1210	C.Y.	$15	$18,150
Diversion structure	1	EA	$50,000	$50,000
Excavation of diversion channel, 100 LF	830	C.Y.	$15	$12,444
Excavation of discharge channel, 100 LF	830	C.Y.	$15	$12,444
Soil Riprap, Type L, diversion & discharge channel	830	C.Y.	$55	$45,630
Subtotal				**$445,342**
Additional Capital Construction Costs				
Dewatering	1	-	8%	$35,627
Mobilization	1	-	5%	$22,267
Traffic Control	1	-	2%	$8,907
Utility Coordination/Relocation	1	-	2%	$8,907
Stormwater Management/Erosion Control	1	-	5%	$22,267
Subtotal				**$97,975**
Land Acquisition				
ROW/Easments, Reach 3	3.7	ACRE	$100,000	$367,309
Subtotal				**$367,309**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	1	-	10%	$54,332
Legal/Administrative	1	-	5%	$27,166
Contract Admin/Construction Management	1	-	5%	$27,166
Contingency	1	-	25%	$135,829
Subtotal				**$244,493**
Total Cost				**$1,155,119**
Annual Operation and Maintenance Cost	**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert	0	LF/YR	$1.00	$0
Maintain Engineered Channel	200	LF/YR	$0.25	$50
Maintain Detention Pond	3.7	ACRE	$1,500	$5,510
Total				**$5,560**
Maintenance Costs Service Life = 50		Interest Rate =	3.64%	**$759,335**

Project	17th Street Pond, 46 AF				
Major Basin	Spring Creek Middle				
Description	Construct a new, 46 AF detention pond on the south side and upstream of Spring Creek at 17th St.				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Excavation of 48 AF pond		37107	C.Y.	$15	$556,600
Emergency Spillway, Large		1	EA	$40,000	$40,000
Concrete Low Flow Channel		550	L.F.	$45	$24,750
Seeding/Reclamation		12.1	ACRE	$1,000	$12,052
Water Quality Capture Volume		3711	C.Y.	$15	$55,660
Diversion structure		1	EA	$50,000	$50,000
Excavation of diversion channel, 160 LF		1327	C.Y.	$15	$19,911
Inlet structure to pond		1	EA	$10,000	$10,000
Outlet structure, large		1	EA	$40,000	$40,000
Excavation of discharge channel, 100 LF		830	C.Y.	$15	$12,444
Soil Riprap, Type L, diversion & discharge channel		1001	C.Y.	$55	$55,081
Subtotal					**$876,499**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$70,120
Mobilization		1	-	5%	$43,825
Traffic Control		1	-	2%	$17,530
Utility Coordination/Relocation		1	-	2%	$17,530
Stormwater Management/Erosion Control		1	-	5%	$43,825
Subtotal					**$192,830**
Land Acquisition					
Easement/ROW Acquisition		12.1	ACRE	$100,000	$1,205,234
Subtotal					**$1,205,234**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$106,933
Legal/Administrative		1	-	5%	$53,466
Contract Admin/Construction Management		1	-	5%	$53,466
Contingency		1	-	25%	$267,332
Subtotal					**$481,198**
Total Cost					**$2,755,762**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		0	LF/YR	$1.00	$0
Maintain Engineered Channel		260	LF/YR	$0.25	$65
Maintain Detention Pond		12.1	ACRE	$1,500.00	$18,079
Total					**$18,144**
Maintenance Costs	Service Life =	50	Interest Rate =	3.6374%	**$2,478,037**

Project	LaPrele Park Pond Expansion				
Major Basin	Spring Creek Middle				
Description	Expand LaPrele Park Pond (Huck Finn Pond) by 10 AF to accept high flows diverted from Spring Creek				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Excavation, expansion of pond by 14 AF		16133	C.Y.	$15	$242,000
Emergency Spillway, Large		1	EA	$40,000	$40,000
Concrete Low Flow Channel		0	L.F.	$45	$0
Seeding/Reclamation		1.3	ACRE	$1,000	$1,250
Water Quality Capture Volume		1613	C.Y.	$15	$24,200
Diversion structure		1	EA	$50,000	$50,000
Excavation, diversion channel, 570 LF		4729	C.Y.	$15	$70,933
Inlet structure, to pond		1	EA	$10,000	$10,000
Outlet structure, large		1	EA	$40,000	$40,000
Excavation, discharge channel, 100 LF		830	C.Y.	$15	$12,444
Soil Riprap, Type L, diversion & discharge channel		2581	C.Y.	$55	$141,941
Subtotal					**$632,769**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$50,621
Mobilization		1	-	5%	$31,638
Traffic Control		1	-	2%	$12,655
Utility Coordination/Relocation		1	-	2%	$12,655
Stormwater Management/Erosion Control		1	-	5%	$31,638
Subtotal					**$139,209**
Land Acquisition					
Easement/ROW Acquisition		0	ACRE	$100,000	$0
Subtotal					**$0**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$77,198
Legal/Administrative		1	-	5%	$38,599
Contract Admin/Construction Management		1	-	5%	$38,599
Contingency		1	-	25%	$192,994
Subtotal					**$347,390**
Total Cost					**$1,119,368**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		0	LF/YR	$1.00	$0
Maintain Engineered Channel		670	LF/YR	$0.25	$168
Maintain Detention Pond		1.25	ACRE	$1,500	$1,875
Total					**$2,043**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$278,964**

Summary of Spring Creek South Alternatives

Alternative	Project	Description	Major Drainage Basin	Project Cost	Annual O&M Cost	Total Lifecycle Cost
SS-1	Pond Serving Northeast Portion of Spring Creek South Basin (450 AF)	Construct a new, 450 AF detention pond south of I-80, upstream of Basin SS015, location TBD	Spring Creek South	**$14,917,417**	**$112,500**	**$30,282,645**
	Pond Serving Southern Portion of Spring Creek South Basin (175 AF)	Construct a new, 175 AF detention pond south of Hidden Springs Rd., upstream of Basin SS005, location TBD	Spring Creek South	**$6,762,790**	**$34,866**	**$11,524,741**
	Twin 36" Pipe Bore Under Highway 287	Bore twin, 36" pipe under Highway 287 south of the I-80 and Highway 287 interchange	Spring Creek South	**$1,637,772**	**$540**	**$1,711,526**
	Grade New Channel Through Field Southwest of I-80 and Hwy 28	Grade new channel through field located to the southwest of the intersection of I-80 and Highway 287	Spring Creek South	**$434,542**	**$9,500**	**$1,732,050**
	Twin 36" Pipe Under I-80 Overpass	Install Two 36" pipes under I-80 overpass	Spring Creek South	**$370,336**	**$620**	**$455,015**
	Re-purpose 12" Sanitary Sewer	Re-purpose 12" sanitary sewer for use as storm sewer from Skyline Road at Highway 287 to Spring Creek at S. 3rd Street	Spring Creek South	**$79,333**	**$1,800**	**$325,177**
	Pond Serving Northeast Portion of Spring Creek South Basin + Pond Serving Southern Portion of Spring Creek South Basin + Twin 36" Bore Under Highway 287 + Grade Channel Through Existing Wetland Area + Twin 42" Culverts Under I-80 Overpass		**Total**	**$24,122,858**	**$158,026**	**$45,705,977**
SS-2	Pond Serving Northeast Portion of Spring Creek South Major Basin (164 AF)	Construct a new, 164 AF detention pond south of I-80, upstream of Sub-basin SS015, location TBD	Spring Creek South	**$6,448,067**	**$34,866**	**$11,210,018**
	Pond East of Skyline Road (46 AF)	Construct a new, 46 AF detention pond upstream of Skyline Rd., south of I-80 and east of Hwy 287, upstream of Basin SS005, location TBD	Spring Creek South	**$2,044,639**	**$11,500**	**$3,615,307**
	Pond Serving Southern Portion of Spring Creek South Basin (154 AF)	Construct a new, 154 AF detention pond south of Hidden Springs Rd., upstream of Basin SS005, location TBD	Spring Creek South	**$6,054,702**	**$33,574**	**$10,640,285**
	Twin 48" Pipe Bore Under UPRR	Bore twin 48" pipes under UPRR near Hidden Springs Road	Spring Creek South	**$1,246,495**	**$650**	**$1,335,272**
	Grade New Channel Along UPRR to Informal WYDOT Pond	Grade new channel along UPRR to informal WYDOT pond located to the southeast of the intersection of the UPRR and Highway 287	Spring Creek South	**$434,663**	**$300**	**$475,637**
	Expand Informal Detention SE of UPRR & Hwy 287	Expand informal detention area located to the southeast of the intersection of the UPRR and Highway 287 (near WYDOT)	Spring Creek South	**$6,552,848**	**$34,435**	**$11,256,009**
	Expand Informal Detention SW of I-80 and Hwy 287	Expand informal detention located to the southwest of the intersection of I-80 and Highway 287, east of UPRR	Spring Creek South	**$1,631,703**	**$12,397**	**$3,324,841**
		Bore 48" pipe under UPRR near the intersection with Highway 287	Spring Creek South	**$898,274**	**$200**	**$925,590**
	Twin 36" Pipe Bore Under Highway 287	Bore twin, 36" pipe under Highway 287 south of the I-80 and Highway 287 interchange	Spring Creek South	**$1,637,772**	**$540**	**$1,711,526**
	Twin 36" Pipe Under I-80 Overpass	Install Two 36" pipes under I-80 overpass	Spring Creek South	**$370,336**	**$620**	**$455,015**
	Re-purpose 12" Sanitary Sewer	Re-purpose 12" sanitary sewer for use as storm sewer from Skyline Road at Highway 287 to Spring Creek at S. 3rd Street	Spring Creek South	**$79,333**	**$1,800**	**$325,177**
	Pond Serving Northeast Portion of Spring Creek South Basin + Pond East of Skyline Road + Pond Serving Southern Portion of Spring Creek Basin + Twin 48" Bore Under UPRR + Grade New Channel Along UPRR to Informal WYDOT Pond + Expand Informal WYDOT Pond + Expand Informal Wetland Detention + Highway 287 Crossing South of I-80, 36" Circular Pipes + Twin 3.5'x4' Box Culverts Under I-80 Overpass + Re-purpose 12" Sanitary Sewer		**Total**	**$27,398,834**	**$130,882**	**$45,274,677**

Project	Pond Serving Northeast Portion of Spring Creek South Basin (450 AF)				
Major Basin	Spring Creek South				
Description	Construct a new, 450 AF detention pond south of I-80, upstream of Basin SS015, location TBD				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Excavation of 450 AF detention pond		363000	C.Y.	$10	$3,630,000
Outlet structure, large		1	EA	$40,000	$40,000
Emergency Spillway, Large		1	EA	$40,000	$40,000
Concrete Low Flow Channel		1000	L.F.	$45	$45,000
Seeding/Reclamation		75.0	ACRE	$1,000	$75,000
Water Quality Capture Volume		36300	C.Y.	$10	$363,000
Subtotal					**$4,193,000**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$335,440
Mobilization		1	-	5%	$209,650
Traffic Control		1	-	2%	$83,860
Utility Coordination/Relocation		1	-	2%	$83,860
Stormwater Management/Erosion Control		1	-	5%	$209,650
Subtotal					**$922,460**
Land Acquisition					
ROW/Easement Acquisition		75.0	ACRE	$100,000	$7,500,000
Subtotal					**$7,500,000**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$511,546
Legal/Administrative		1	-	5%	$255,773
Contract Admin/Construction Management		1	-	5%	$255,773
Contingency		1	-	25%	$1,278,865
Subtotal					**$2,301,957**
Total Cost					**$14,917,417**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		0	LF/YR	$1.00	$0
Maintain Engineered Channel		0	LF/YR	$0.25	$0
Maintain Detention Pond		75	ACRE	$1,500	$112,500
Total					**$112,500**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$15,365,228**

Project	Pond Serving Southern Portion of Spring Creek South Basin (175 AF)				
Major Basin	Spring Creek South				
Description	Construct a new, 175 AF detention pond south of Hidden Springs Rd., upstream of Basin SS005, location TBD				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Excavation of 175 AF detention pond		141167	C.Y.	$15	$2,117,500
Outlet structure, large		1	EA	$40,000	$40,000
Emergency Spillway, Large		1	EA	$40,000	$40,000
Concrete Low Flow Channel		1700	L.F.	$45	$76,500
Seeding/Reclamation		23.2	ACRE	$1,000	$23,244
Water Quality Capture Volume		14117	C.Y.	$15	$211,750
Subtotal					**$2,508,994**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$200,720
Mobilization		1	-	5%	$125,450
Traffic Control		1	-	2%	$50,180
Utility Coordination/Relocation		1	-	2%	$50,180
Stormwater Management/Erosion Control		1	-	5%	$125,450
Subtotal					**$551,979**
Land Acquisition					
Easement/ROW Acquisition		23	ACRE	$100,000	$2,324,380
Subtotal					**$2,324,380**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$306,097
Legal/Administrative		1	-	5%	$153,049
Contract Admin/Construction Management		1	-	5%	$153,049
Contingency		1	-	25%	$765,243
Subtotal					**$1,377,438**
Total Cost					**$6,762,790**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		0	LF/YR	$1.00	$0
Maintain Engineered Channel		0	LF/YR	$0.25	$0
Maintain Detention Pond		23.2	ACRE	$1,500	$34,866
Total					**$34,866**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$4,761,951**

Project	Twin 36" Pipe Bore Under Highway 287				
Major Basin	Spring Creek South				
Description	Bore twin, 36" pipe under Highway 287 south of the I-80 and Highway 287 interchange				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
					$0
Bore 36" Circular Pipe, 270' each		540	LF	$1,500	$810,000
Headwall and Toewall		4	EA	$1,001	$4,005
Wingwall		4	EA	$25,033	$100,133
Subtotal					**$914,139**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$73,131
Mobilization		1	-	5%	$45,707
Traffic Control		1	-	2%	$18,283
Utility Coordination/Relocation		1	-	2%	$18,283
Stormwater Management/Erosion Control		1	-	5%	$45,707
Subtotal					**$201,111**
Land Acquisition					
Easement/ROW Acquisition		0.21	ACRE	$100,000	$20,661
Subtotal					**$20,661**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$111,525
Legal/Administrative		1	-	5%	$55,762
Contract Admin/Construction Management		1	-	5%	$55,762
Contingency		1	-	25%	$278,812
Subtotal					**$501,862**
Total Cost					**$1,637,772**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		540	LF/YR	$1.00	$540
Maintain Engineered Channel			LF/YR	$0.25	$0
Maintain Detention Pond			ACRE	$1,500	$0
Total					**$540**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$73,753**

Project	Grade New Channel Through Field Southwest of I-80 and Hwy 287				
Major Basin	Spring Creek South				
Description	Grade new channel through field located to the southwest of the intersection of I-80 and Highway 287				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Excavation of 4:1 - 30' wide channel along UPRR to pond		7206	C.Y.	$15	$108,089
Soil Riprap, Type L		1963	C.Y.	$55	$107,966
Subtotal					**$216,055**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$17,284
Mobilization		1	-	5%	$10,803
Traffic Control		1	-	2%	$4,321
Utility Coordination/Relocation		1	-	2%	$4,321
Stormwater Management/Erosion Control		1	-	5%	$10,803
Subtotal					**$47,532**
Land Acquisition					
		0.5	ACRE	$100,000	$52,342
Subtotal					**$52,342**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$26,359
Legal/Administrative		1	-	5%	$13,179
Contract Admin/Construction Management		1	-	5%	$13,179
Contingency		1	-	25%	$65,897
Subtotal					**$118,614**
Total Cost					**$434,542**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert			LF/YR	$1.00	$0
Maintain Engineered Channel		760	LF/YR	$0.25	$190
Maintain Detention Pond			ACRE	$1,500	$0
Total					**$9,500**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$1,297,508**

Project	Twin 36" Pipe Under I-80 Overpass				
Major Basin	Spring Creek South				
Description	Install Two 36" pipes under I-80 overpass				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Install 36" circular pipe (310' x 2)		620	LF	$147	$91,140
					$0
Headwall and Toewall		2	EA	$1,001	$2,003
Wingwall		2	EA	$25,033	$50,067
Outfall (toewall, wingwall, and cover)		2	EA	$27,035	$54,069
Subtotal					**$197,279**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$15,782
Mobilization		1	-	5%	$9,864
Traffic Control		1	-	2%	$3,946
Utility Coordination/Relocation		1	-	2%	$3,946
Stormwater Management/Erosion Control		1	-	5%	$9,864
Subtotal					**$43,401**
Land Acquisition					
Easement/ROW Acquisition		0.2	ACRE	$100,000	$21,350
Subtotal					**$21,350**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$24,068
Legal/Administrative		1	-	5%	$12,034
Contract Admin/Construction Management		1	-	5%	$12,034
Contingency		1	-	25%	$60,170
Subtotal					**$108,306**
Total Cost					**$370,336**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		620	LF/YR	$1.00	$620
Maintain Engineered Channel		0	LF/YR	$0.25	$0
Maintain Detention Pond		0	ACRE	$1,500	$0
Total					**$620**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$84,679**

Project	Re-purpose 12" Sanitary Sewer				
Major Basin	Spring Creek South				
Description	Re-purpose 12" sanitary sewer for use as storm sewer from Skyline Road at Highway 287 to Spring Creek at S. 3rd Street				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Camera testing of existing line		1800	LF	$2	$3,600
Disinfect existing sanitary sewer line		1800	LF	$5	$9,000
Install 4' manhole		2	EA	$3,000	$6,000
Install inlets		2	EA	$3,500	$7,000
Install 12" circular pipe to connect inlets		100	LF	$28	$2,765
Street repair		100	LF	$165	$16,481
Subtotal					**$44,846**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$3,587.72
Mobilization		1	-	5%	$2,242
Traffic Control		1	-	2%	$897
Utility Coordination/Relocation		1	-	2%	$897
Stormwater Management/Erosion Control		1	-	5%	$2,242
Subtotal					**$9,866**
Land Acquisition					
Easement/ROW Acquisition		0	ACRE	$100,000	$0
Subtotal					**$0**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$5,471
Legal/Administrative		1	-	5%	$2,736
Contract Admin/Construction Management		1	-	5%	$2,736
Contingency		1	-	25%	$13,678
Subtotal					**$24,621**
Total Cost					**$79,333**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		1800	LF/YR	$1.00	$1,800
Maintain Engineered Channel		0	LF/YR	$0.25	$0
Maintain Detention Pond		0	ACRE	$1,500	$0
Total					**$1,800**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$245,844**

Project	Pond Serving Northeast Portion of Spring Creek South Major Basin (164 AF)				
Major Basin	Spring Creek South				
Description	Construct a new, 164 AF detention pond south of I-80, upstream of Sub-basin SS015, location TBD				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Excavation of 164 AF detention pond		132293	C.Y.	$15	$1,984,400
Outlet structure, large		1	EA	$40,000	$40,000
Emergency Spillway, Large		1	EA	$40,000	$40,000
Concrete Low Flow Channel		1000	L.F.	$45	$45,000
Seeding/Reclamation		23.2	ACRE	$1,000	$23,244
Water Quality Capture Volume		13229	C.Y.	$15	$198,440
Subtotal					**$2,331,084**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$186,487
Mobilization		1	-	5%	$116,554
Traffic Control		1	-	2%	$46,622
Utility Coordination/Relocation		1	-	2%	$46,622
Stormwater Management/Erosion Control		1	-	5%	$116,554
Subtotal					**$512,838**
Land Acquisition					
ROW/Easement Acquisition, Reach 3		23.2	ACRE	$100,000	$2,324,380
Subtotal					**$2,324,380**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$284,392
Legal/Administrative		1	-	5%	$142,196
Contract Admin/Construction Management		1	-	5%	$142,196
Contingency		1	-	25%	$710,981
Subtotal					**$1,279,765**
Total Cost					**$6,448,067**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		0	LF/YR	$1.00	$0
Maintain Engineered Channel		0	LF/YR	$0.25	$0
Maintain Detention Pond		23.2	ACRE	$1,500	$34,866
Total					**$34,866**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$4,761,951**

Project	Pond East of Skyline Road (46 AF)				
Major Basin	Spring Creek South				
Description	Construct a new, 46 AF detention pond upstream of Skyline Rd., south of I-80 and east of Hwy 287, upstream of Basin SS005, location TBD				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Excavation of 46 AF detention pond		37107	C.Y.	$15	$556,600
Outlet structure, large		1	EA	$40,000	$40,000
Emergency Spillway, Large		1	EA	$40,000	$40,000
Concrete Low Flow Channel		500	L.F.	$45	$22,500
Seeding/Reclamation		7.7	ACRE	$1,000	$7,667
Water Quality Capture Volume		3711	C.Y.	$15	$55,660
Subtotal					**$722,427**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$57,794
Mobilization		1	-	5%	$36,121
Traffic Control		1	-	2%	$14,449
Utility Coordination/Relocation		1	-	2%	$14,449
Stormwater Management/Erosion Control		1	-	5%	$36,121
Subtotal					**$158,934**
Land Acquisition					
Easement/ROW Acquisition		7.7	ACRE	$100,000	$766,667
Subtotal					**$766,667**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$88,136
Legal/Administrative		1	-	5%	$44,068
Contract Admin/Construction Management		1	-	5%	$44,068
Contingency		1	-	25%	$220,340
Subtotal					**$396,612**
Total Cost					**$2,044,639**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		0	LF/YR	$1.00	$0
Maintain Engineered Channel		0	LF/YR	$0.25	$0
Maintain Detention Pond		7.7	ACRE	$1,500	$11,500
Total					**$11,500**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$1,570,668**

Project	Pond Serving Southern Portion of Spring Creek South Basin (154 AF)				
Major Basin	Spring Creek South				
Description	Construct a new, 154 AF detention pond south of Hidden Springs Rd., upstream of Basin SS005, location TBD				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Excavation of 154 AF detention pond		121000	C.Y.	$15	$1,815,000
Outlet structure, large		1	EA	$40,000	$40,000
Emergency Spillway, Large		1	EA	$40,000	$40,000
Concrete Low Flow Channel		1300	L.F.	$45	$58,500
Seeding/Reclamation		22	ACRE	$1,000	$22,383
Water Quality Capture Volume		12100	C.Y.	$15	$181,500
Subtotal					**$2,157,383**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$172,591
Mobilization		1	-	5%	$107,869
Traffic Control		1	-	2%	$43,148
Utility Coordination/Relocation		1	-	2%	$43,148
Stormwater Management/Erosion Control		1	-	5%	$107,869
Subtotal					**$474,624**
Land Acquisition					
Easement/ROW Acquisition		22.4	ACRE	$100,000	$2,238,292
Subtotal					**$2,238,292**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$263,201
Legal/Administrative		1	-	5%	$131,600
Contract Admin/Construction Management		1	-	5%	$131,600
Contingency		1	-	25%	$658,002
Subtotal					**$1,184,403**
Total Cost					**$6,054,702**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		0	LF/YR	$1.00	$0
Maintain Engineered Channel		0	LF/YR	$0.25	$0
Maintain Detention Pond		22.4	ACRE	$1,500	$33,574
Total					**$33,574**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$4,585,582**

Project	Twin 48" Pipe Bore Under UPRR				
Major Basin	Spring Creek South				
Description	Bore twin 48" pipes under UPRR near Hidden Springs Road				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Install 48" circular pipe across Soldier Springs Road		400	LF	$168	$67,200
Bore under UPRR		250	LF	$2,500	$625,000
Street Repair		40	LF	$165	$6,593
Subtotal					**$698,793**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$55,903
Mobilization		1	-	5%	$34,940
Traffic Control		1	-	2%	$13,976
Utility Coordination/Relocation		1	-	2%	$13,976
Stormwater Management/Erosion Control		1	-	5%	$34,940
Subtotal					**$153,734**
Land Acquisition					
Easement/ROW Acquisition		0.1	ACRE	$100,000	$10,331
Subtotal					**$10,331**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$85,253
Legal/Administrative		1	-	5%	$42,626
Contract Admin/Construction Management		1	-	5%	$42,626
Contingency		1	-	25%	$213,132
Subtotal					**$383,637**
Total Cost					**$1,246,495**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		650	LF/YR	$1.00	$650
Maintain Engineered Channel		0	LF/YR	$0.25	$0
Maintain Detention Pond		0	ACRE	$1,500	$0
Total					**$650**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$88,777**

Project	Grade New Channel Along UPRR to Informal WYDOT Pond				
Major Basin	Spring Creek South				
Description	Grade new channel along UPRR to informal WYDOT pond located to the southeast of the intersection of the UPRR and Highway 287				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Excavation of 4:1 - 30' wide channel along UPRR to pond		11378	C.Y.	$15	$170,667
Seeding/Reclamation		0.8	ACRE	$1,000	$826
Soil Riprap, Type L		500	C.Y.	$55	$27,500
Subtotal					**$198,993**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$15,919
Mobilization		1	-	5%	$9,950
Traffic Control		1	-	2%	$3,980
Utility Coordination/Relocation		1	-	2%	$3,980
Stormwater Management/Erosion Control		1	-	5%	$9,950
Subtotal					**$43,778**
Land Acquisition					
		0.8	ACRE	$100,000	$82,645
Subtotal					**$82,645**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$24,277
Legal/Administrative		1	-	5%	$12,139
Contract Admin/Construction Management		1	-	5%	$12,139
Contingency		1	-	25%	$60,693
Subtotal					**$109,247**
Total Cost					**$434,663**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert			LF	$1.00	$0
Maintain Engineered Channel		1200	LF	$0.25	$300
Maintain Detention Pond			ACRE	$1,500	$0
Total					**$300**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$40,974**

Project	Expand Informal Detention SE of UPRR & Hwy 287				
Major Basin	Spring Creek South				
Description	Expand informal detention area located to the southeast of the intersection of the UPRR and Highway 287 (near WYDOT)				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Excavation to regrade 149 AF detention pond		135520	C.Y.	$15	$2,032,800
Outlet structure, large		1	EA	$40,000	$40,000
Emergency Spillway, Large		1	EA	$40,000	$40,000
Concrete Low Flow Channel		1500	L.F.	$45	$67,500
Seeding/Reclamation		23.0	ACRE	$1,000	$22,957
Water Quality Capture Volume		13552	C.Y.	$15	$203,280
Subtotal					**$2,406,537**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$192,523
Mobilization		1	-	5%	$120,327
Traffic Control		1	-	2%	$48,131
Utility Coordination/Relocation		1	-	2%	$48,131
Stormwater Management/Erosion Control		1	-	5%	$120,327
Subtotal					**$529,438**
Land Acquisition					
		23.0	ACRE	$100,000	$2,295,684
Subtotal					**$2,295,684**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$293,597
Legal/Administrative		1	-	5%	$146,799
Contract Admin/Construction Management		1	-	5%	$146,799
Contingency		1	-	25%	$733,994
Subtotal					**$1,321,189**
Total Cost					**$6,552,848**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert			LF/YR	$1.00	$0
Maintain Engineered Channel			LF/YR	$0.25	$0
Maintain Detention Pond		23.0	ACRE	$1,500	$34,435
Total					**$34,435**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$4,703,161.34**

Project	Expand Informal Detention SW of I-80 and Hwy 287				
Major Basin	Spring Creek South				
Description	Expand informal detention located to the southwest of the intersection of I-80 and Highway 287, east of UPRR				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Excavation to regrade 24 AF detention pond		19360	C.Y.	$15	$290,400
Outlet structure from pond		1	EA	$20,000	$20,000
Emergency Spillway, Large		1	EA	$40,000	$40,000
Concrete Low Flow Channel		1500	L.F.	$45	$67,500
Seeding/Reclamation		8.3	ACRE	$1,000	$8,264
Water Quality Capture Volume		1936	C.Y.	$15	$29,040
Subtotal					**$455,204**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$36,416
Mobilization		1	-	5%	$22,760
Traffic Control		1	-	2%	$9,104
Utility Coordination/Relocation		1	-	2%	$9,104
Stormwater Management/Erosion Control		1	-	5%	$22,760
Subtotal					**$100,145**
Land Acquisition					
		8.3	ACRE	$100,000	$826,446
Subtotal					**$826,446**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$55,535
Legal/Administrative		1	-	5%	$27,767
Contract Admin/Construction Management		1	-	5%	$27,767
Contingency		1	-	25%	$138,837
Subtotal					**$249,907**
Total Cost					**$1,631,703**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert			LF/YR	$1.00	$0
Maintain Engineered Channel			LF/YR	$0.25	$0
Maintain Detention Pond		8.3	ACRE	$1,500	$12,397
Total					**$12,397**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$1,693,138.08**

Project	48" Pipe Bore Under UPRR				
Major Basin	Spring Creek South				
Description	Bore 48" pipe under UPRR near the intersection with Highway 287				
Capital Improvement Costs		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
			LF	$168	$0
Bore under UPRR		200	LF	$2,500	$500,000
Subtotal					**$500,000**
Additional Capital Construction Costs					
Dewatering		1	-	8%	$40,000
Mobilization		1	-	5%	$25,000
Traffic Control		1	-	2%	$10,000
Utility Coordination/Relocation		1	-	2%	$10,000
Stormwater Management/Erosion Control		1	-	5%	$25,000
Subtotal					**$110,000**
Land Acquisition					
Easement/ROW Acquisition		0.1	ACRE	$100,000	$13,774
Subtotal					**$13,774**
Other Costs (percentage of Capital Improvement Costs)					
Engineering		1	-	10%	$61,000
Legal/Administrative		1	-	5%	$30,500
Contract Admin/Construction Management		1	-	5%	$30,500
Contingency		1	-	25%	$152,500
Subtotal					**$274,500**
Total Cost					**$898,274**
Annual Operation and Maintenance Cost		**QTY**	**Unit**	**Unit Cost**	**Total Cost**
Maintain Culvert		200	LF/YR	$1.00	$200
Maintain Engineered Channel		0	LF/YR	$0.25	$0
Maintain Detention Pond		0	ACRE	$1,500	$0
Total					**$200**
Maintenance Costs	Service Life =	50	Interest Rate =	3.64%	**$27,316**