# SPANISH VALLEY

## STORM WATER DRAINAGE MASTER PLAN

**(HAL Project No.: 452.02.100)**

**February 2023**

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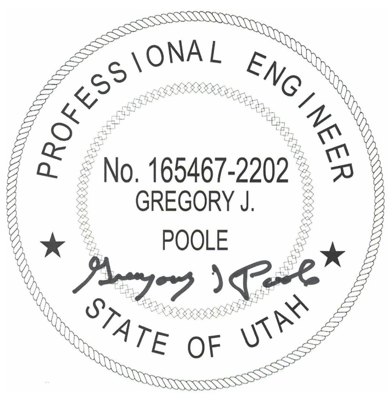


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ENGINEERS

**February 2023**

# ACKNOWLEDGEMENTS

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Tammy Gallegos - Emergency Director

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Elise Erler - SITLA - Development

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Dan Jones – PE, Development Drainage Master Plan

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# EXECUTIVE SUMMARY

Storm water runoff is a difficult resource to manage. In a dry climate such as Utah's, existing drainage ways are often dry and, to the inexperienced, may appear to be prime places to construct buildings. Storm water flows are dependent on many complex time and spatially varied factors. Even a natural undeveloped drainage system is not static: streams can erode in one section while depositing in another; stream courses can also change alignment and cross section dramatically with just one storm runoff event. Urbanization compounds the problem and creates a need for a drainage system with the basic goals of managing nuisance water, protecting development from damage, and protecting downstream waters from adverse quality and quantity impacts.

Spanish Valley is expected to experience significant population growth and development. San Juan County recognizes the importance of developing a drainage master plan to guide development planning. This storm drainage master plan focuses on the San Juan County Spanish Valley floor where most of the development is expected to occur.

The San Juan County Area Plan (2018) and the South Valley Community Structure Plan (2022), prepared by Landmark Design for the School and Institutional Trust Lands Administration (SITLA), provide a framework for future development and a basis for storm drainage master planning.

## KEY MASTER PLAN OBJECTIVES

- Protect developments from flooding in events up to the design storm runoff event.
- Potential development impacts on storm water quality and quantity to Pack Creek must be mitigated.
- Plan facilities with maintenance in mind.

## STUDY AREA

The study area includes the San Juan County Spanish Valley floor south of the county line plus directly tributary areas.

## PACK CREEK MASTER PLAN

Pack Creek poses a flood hazard risk to a significant portion of the San Juan County Spanish Valley floor. The braided nature of the channel network in the southern end of the valley is evidence of an alluvial fan. Above the valley floor Pack Creek flood flows are confined in mountain ravines which have high gradients and convey large quantities of eroded sand, rock, and boulders out onto the valley floor. On the valley floor land slopes are reduced and flood flow velocities are reduced depositing sediment and debris that form a fan shape. The erosion/deposition process results in channel braiding where channels are alternately cut and filled with sediment. This phenomenon is commonly referred to as an alluvial fan.

HAL performed a hydrologic study on Pack Creek previously to help San Juan County and SITLA better understand the flood hazards in Spanish Valley (HAL, 2019). San Juan County and SITLA are pursuing a recommendation from that study to develop debris basins and other facilities with sufficient capacity to convey the 1% chance flood event.

Two debris basins are currently planned as part of a Natural Resources Conservation Service (NRCS) project upstream of the drainage master plan study area. These new debris basins are expected to reduce debris floods on the alluvial fan. In addition to the debris basins, a Pack Creek flood control basin is proposed to reduce the 1% chance flood flows.

The Pack Creek flood control basin is conceptually sized to provide about 423 acre-feet of flood attenuation storage. The flood control basin will normally be dry with available storage space to reduce storm runoff peak flood flowrates during a 100-year 24-hour storm event from 5,200 cfs to 1,500 cfs.

The Pack Creek master plan includes channel improvements below the flood control basin. The master plan improvements include grade control structures, channel forming and lining, and road crossings. The Pack Creek master plan alignment and proposed flood control basin are shown in **Figure EX-1**. The preferred channel cross section is shown in **Figure EX-2**. Conceptual construction cost estimates for the Pack Creek improvements are provided in **Table EX – 1**.

**Table EX-1. Conceptual Cost Estimates for Pack Creek**

| Item | Estimated Construction Cost | Notes |
|---|---|---|
| Flood Control Detention Basin | $6,000,000 | Cost estimate does not include land costs |
| Channel Improvements | $16,800,000 | Total assumed length is 16,400 ft (from proposed detention basin to County line). Cost includes grouted boulder drops and protection for the low flow channel. |
| Typical Road Crossing | $430,000 | Assumes three 9' x 6' box culverts to pass 1,500 cfs without overtopping the road. |

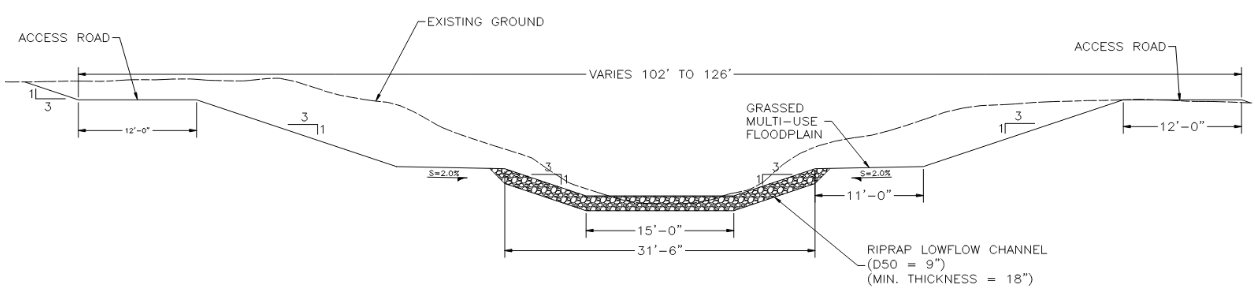
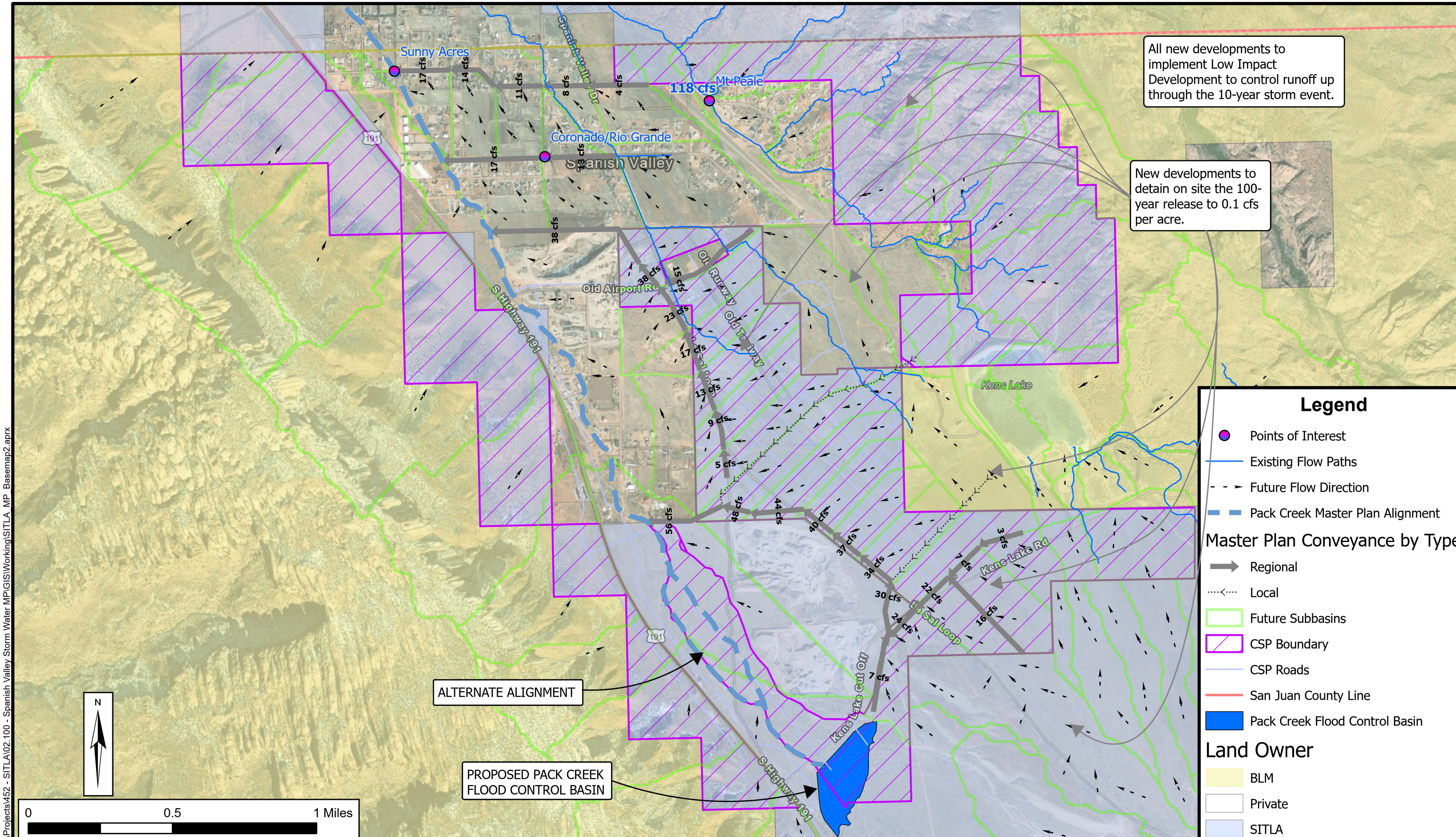



**Figure EX-2 – Preferred Pack Creek Master Plan Cross Section**

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SAN JUAN COUNTY – SPANISH VALLEY

STORM DRAINAGE MASTER PLAN
LOCAL DETENTION ALTERNATIVE

FIGURE
EX-1

## DRAINAGE DESIGN CRITERIA

Several workshops were held with San Juan County staff. The following storm drainage design criteria were selected for implementation in the San Juan County portion of Spanish Valley:

- Design minor storm is the 10-year 24-hour storm event.
- Design major storm is the 100-year 24-hour storm event. Future development buildings are to be protected from flooding in events up to the 100-year storm event.
- Require Low Impact Development to control minor storm runoff:
    - Minimize directly connected impervious area.
    - Use Rain Gardens and Dry Wells (sumps) with pre-treatment to capture and infiltrate runoff from a 10-year storm event close to the source of runoff.
- Require detention basins to control major storm runoff to pre-development rates.
- Downhill cul-de-sacs and sags in streets which are not located at an intersection are to be avoided.
- Maintenance:
    - Assure adequate access.
    - No drainage structures placed on back lot lines.

## SPANISH VALLEY SOILS

Most of the soils in the Spanish Valley floor in the study area are classified as hydrologic soil group A and are highly permeable well drained soils.

## UNDISTURBED NATIVE VEGETATION STORM RUNOFF CHARACTERISTICS

The predevelopment condition was established in the model by applying the design storm to a basin with a Curve Number of 60. This number was selected as the predominant soil group is A and the cover is most like desert shrub in fair to poor condition. The resultant runoff volume and peak discharge per unit area are tabulated in **Table EX-2**. The values in **Table EX-2** represent the hydrologic characteristics of the undisturbed native vegetation condition.

**Table EX-2**
**Undisturbed Vegetation Storm Runoff Characteristics**

| Storm Frequency (24-hour) | 10-year | 100-year |
|---|---|---|
| Percent Annual Chance Exceedance | 10% | 1% |
| Precipitation (inches) | 1.80 | 2.81 |
| Runoff Volume (acre-inches/acre) | 0.03 | 0.27 |
| Peak Flowrate (cfs/ac) | 0.004 | 0.1 |

## DEVELOPMENT CHARACTERISTICS

The San Juan County Area Plan (2018) and the South Valley Community Action Plan (2022), prepared by Landmark Design for the School and Institutional Trust Lands Administration (SITLA), provide a framework for future development and a basis for drainage master planning.

## DEVELOPMENT STORM DRAINAGE MASTER PLAN ALTERNATIVES

<u>Minor storm</u>. To prevent increased runoff during the 10-year storm for new development (commensurate with undisturbed native vegetation runoff), sumps or other infiltration means should be implemented to retain and infiltrate the runoff from a 10-year storm event onsite.

Major storm. To prevent increased peak storm runoff flowrates from new development during the 100-year storm (commensurate with undisturbed native vegetation, see **Table EX-2**), detention and conveyance need to be added. There are two primary approaches for construction and maintenance of detention basins: regional and local. A comparison of the pros and cons of regional and local detention alternatives is summarized in **Table EX-3**.

**Table EX-3**
**Pros and Cons of Each Detention Basin Approach**

| Category | Regional | Local |
|---|---|---|
| Maintenance/Number of facilities | Low | High |
| Cost per acre-foot detention storage | Typically lower | Typically higher |
| Opportunity to "double store" | Lower | Higher |
| Conveyance Sizing | Larger | Smaller |
| Funding and Phasing difficulty | Higher | Low |

Due to the funding constraints, the County has indicated a preference for the local detention approach for implementation in the master plan. Regional facilities may be permitted or required on a case-by-case basis.

**Figure EX-1** shows a concept of the design flowrates for major conveyances under the local detention approach. **Table EX-4** provides a conceptual construction cost estimate for the major storm drainage conveyance facilities shown on **Figure EX-1.**

**Table EX-4**
**Conceptual Cost Estimates**
**of the Master Plan Regional Storm Drainage Facilities**

| PROJECT | COST* |
|---|---|
| Master Plan Conveyances | $6,310,000 |
| Coronado (new outfall to Pack Creek) | $512,000 |
| Mt. Peale Drive (drainage crossing replacement) | $102,000 |

* Assumes that the local detention option is selected. Also assumes that Master Plan Conveyances are pipes. Includes 30% for contingency and engineering.

# CHAPTER 1 – INTRODUCTION

## BACKGROUND

Storm water runoff is a difficult resource to manage. In a dry climate such as Utah's, existing drainage ways are often dry and, to the inexperienced, may appear to be prime places to construct buildings. Unlike sanitary sewers and culinary water systems, there are no clearly defined minimum service requirements for storm water systems. Storm water flows are dependent on many complex time and spatially varied factors. Even a natural undeveloped drainage system is not static: streams can erode in one section while depositing in another; stream courses can also change alignment and cross section dramatically with just one storm runoff event. Urbanization compounds the problem and creates a need for a drainage system with the basic goals of managing nuisance water, protecting development from damage, and protecting downstream waters from adverse quality and quantity impacts.

“Stormwater (runoff) management is the planned set of public policies and activities undertaken to regulate runoff under various specified conditions within various portions of the urban drainage system (McPherson 1970). It may establish criteria for control of peak flows or volumes, for runoff detention and retention, or for control of pollution, and may specify criteria for the relative elevations among various elements of the drainage system. Stormwater management is primarily concerned with limiting future flood damages and environmental impacts due to development, whereas flood control aims at reducing the extent of flooding that occurs under current conditions (Walesh 1987).” (After “The Urban Water Resources Research Council of the American Society of Civil Engineers and the Water Environment Federation, 1992”).

Spanish Valley is expected to experience significant population growth and development. San Juan County recognizes the importance of developing a drainage master plan to guide development planning. This storm drainage master plan focuses on the San Juan County Spanish Valley floor where most of the development is expected to occur.

The San Juan County Area Plan (2018) and the South Valley Community Structure Plan (2022), prepared by Landmark Design for the School and Institutional Trust Lands Administration (SITLA), provide a framework for future development and a basis for storm drainage master planning.

Low impact development (LID) techniques should be implemented as close as possible to the source of the runoff. Inherent in development is an increase in impervious area which can increase the volume and peak of storm water runoff. The Spanish Valley study area soils are permeable and LID practices including infiltration will be effective in mitigating the potential impacts. LID practices will potentially reduce initial infrastructure costs. The study area soils are conducive to the use of dry wells (sumps) to infiltrate runoff near the source and thus reduce the size and cost of downstream conveyance systems while recharging the valley fill aquifer.

## KEY MASTER PLAN OBJECTIVES

- Protect developments from flooding in events up to the design storm runoff event (see drainage design criteria below).
- Potential development impacts on storm water quality and quantity to Pack Creek must be mitigated.

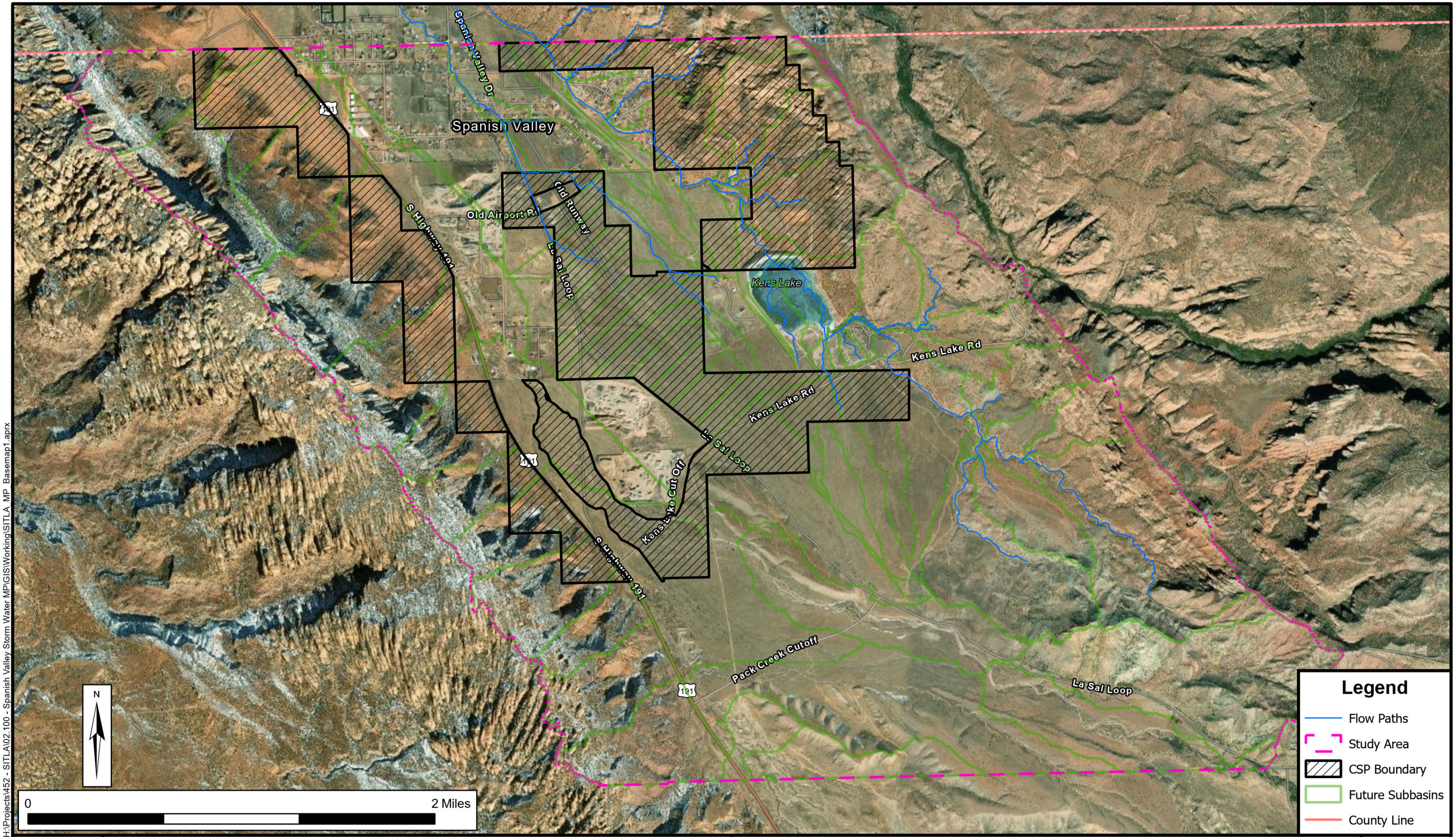
- Plan facilities with maintenance in mind.

## AUTHORIZATION

The San Juan County and SITLA selected Hansen, Allen & Luce, Inc. (HAL) to prepare the Storm Water Drainage Master Plan. The Storm Water Drainage Master Plan has been completed in accordance with the agreement between SITLA and HAL dated March 15, 2022. The Storm Water Drainage Master Plan was completed under the direction of and in cooperation with San Juan County staff.

## STUDY AREA

The portion of Spanish Valley included in the study area is shown on **Figure 1-1** and includes the San Juan County Spanish Valley floor south of the county line plus directly tributary areas.

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| SAN JUAN COUNTY - SPANISH VALLEY | STUDY AREA | FIGURE 1-1 |
|---|---|---|

# CHAPTER 2 – STORM RUNOFF HYDROLOGY

The project team adopted a workshop approach with San Juan County staff to determine the design criteria, study areas, analysis processes, deficiencies, alternatives, and solutions. This section describes the methodology followed in developing the Master Plan.

## DRAINAGE DESIGN CRITERIA

Several workshops were held with San Juan County staff. The following storm drainage design criteria was selected for implementation in the San Juan County portion of Spanish Valley.

- Design minor storm is the 10-year 24-hour storm event.
- Design major storm is the 100-year 24-hour storm event. Future development buildings are to be protected from flooding in events up to the 100-year storm event.
- Require Low Impact Development to control minor storm runoff.
  - Minimize directly connected impervious area.
  - Use Rain Gardens and Dry Wells (sumps) with pre-treatment to capture and infiltrate runoff from a 10-year storm event close to the source of runoff.
- Require detention basins to control major storm runoff to pre-development rates.
- Downhill cul-de-sacs and sags in streets which are not located at an intersection are to be avoided.
- Maintenance:
  - Assure adequate access.
  - No drainage structures placed on back lot lines.

## HYDROLOGY

Hydrology is the study of the movement, distribution, accumulation, and management of water. For this Master Plan, the hydrology performed includes selecting a rainfall design frequency and storm distribution; subbasin area delineations and calculations; calculating runoff potential using soil data, land cover, and impervious surface estimates; and estimating the timing of peak runoff. This chapter details these processes in greater detail.

### Design Frequencies

Spanish Valley selected design storm event frequencies of 10-year (10% chance of being equaled or exceeded in any given year) and 100-year (1% chance of being equaled or exceeded in any given year) for this study. Criteria included:

- 10-year 24-hour design capacity for the initial retention system. The initial retention system includes sumps, rain gardens, bioretention cells, rainwater harvesting, and infiltration basins, trenches, or galleries. Stormwater discharge should be zero for storms smaller than or equal to this event.
- 100-year conveyance capacity where flooding of homes may occur.
- 100-year 24-hour storm runoff capacity on all detention facilities. Release rate should be restricted to the pre-development discharge rate (0.1 cfs/acre, see **Table 2-3** Undisturbed Vegetation Storm Runoff Characteristics, below).
- A minimum freeboard of 1-foot for open channel conveyances and detention facilities should be provided during a 1% chance storm event.

### Design Storms

The design storm distribution is how the precipitation falls throughout a storm of a particular duration. Selection of an appropriate storm distribution is important because it determines peak flows through pipes and channels and peak storage volumes in detention ponds. These results, determined in part by storm distribution, dictate the sizing of projects designed to solve existing deficiencies.

The storm distribution selected for use in this plan is the 24-hour NRCS Nested distribution which can be seen in **Figure 2-1**.

Precipitation depths were obtained from *NOAA Atlas 14: Precipitation-Frequency Atlas of the United States* (Bonnin et al. 2004; NOAA 2013). The design storm rainfall depths modeled for this Master Plan are seen in **Table 2-1**.

**Table 2-1**
**Modeled Rainfall Depths**

| Storm Frequency | 24-hr Depths |
|---|---|
| 10-yr Rainfall Amount (in) | 1.80 |
| 100-yr Rainfall Amount (in) | 2.50 |

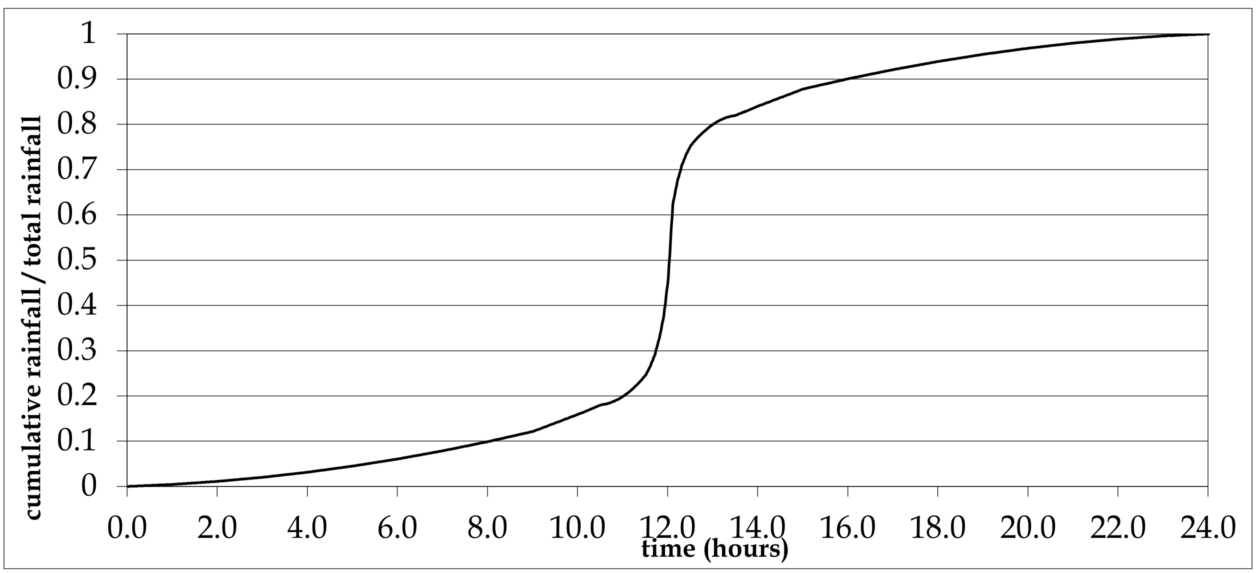



**Figure 2-1 24-hour NRCS Nested Distribution**

## DEVELOPMENT OF THE HYDROLOGIC MODELS

As part of the Master Plan, HAL developed a hydrologic computer model to simulate runoff during storm events. The software used to develop this hydrologic model was HEC-HMS version 4.10.

### Subbasins

A drainage basin, also called a subbasin, watershed or catchment, is an area in which all rainfall or snowmelt runoff will collect to a common point (the lowest point in the basin). Drainage basin boundaries depend upon both the topography and the location of storm drainage facilities. Subbasin characteristics developed for this plan were based on aerial imagery, soil data, GIS mapping, land use information from the County, and engineering literature. Important subbasin characteristics described below include 1) area, 2) hydrologic soil group, 3) percentage of impervious area, 4) SCS curve number (CN), 5) Subbasin width, and 6) overland flow characteristics. Much of the methodology is documented in *Technical Release 55: Urban Hydrology for Small Watersheds* (NRCS, 1986), hereafter referred to as TR-55.

**Subbasin Area**

The amount of runoff is proportional to the area of the subbasin. The study area was divided into drainage subbasins based on best available mapping and planning. The estimated future subbasins are shown on **Figure 2-2**.

**Hydrologic Soil Group**

Hydrologic soil group is a general indication of a soil's infiltration capacity and is a key determinant of runoff behavior. The Natural Resources Conservation Service (NRCS) has classified soils into four hydrologic groups A, B, C, and D. Soils of group A have the highest infiltration rate and therefore produce the least amount of runoff. Group A soils include permeable gravels and well-drained sands. Group B soils have moderate infiltration rates and moderately fine or coarse textures. Group C soils have a lower infiltration rate and finer textures, sometimes with a layer that impedes infiltration. Soils of group D have the lowest infiltration rate and produce the highest amount of runoff. Group D soils include fine silts, clays, and other soils with low infiltration rates. Soil groups are described in TR-55 (NRCS, 1986).

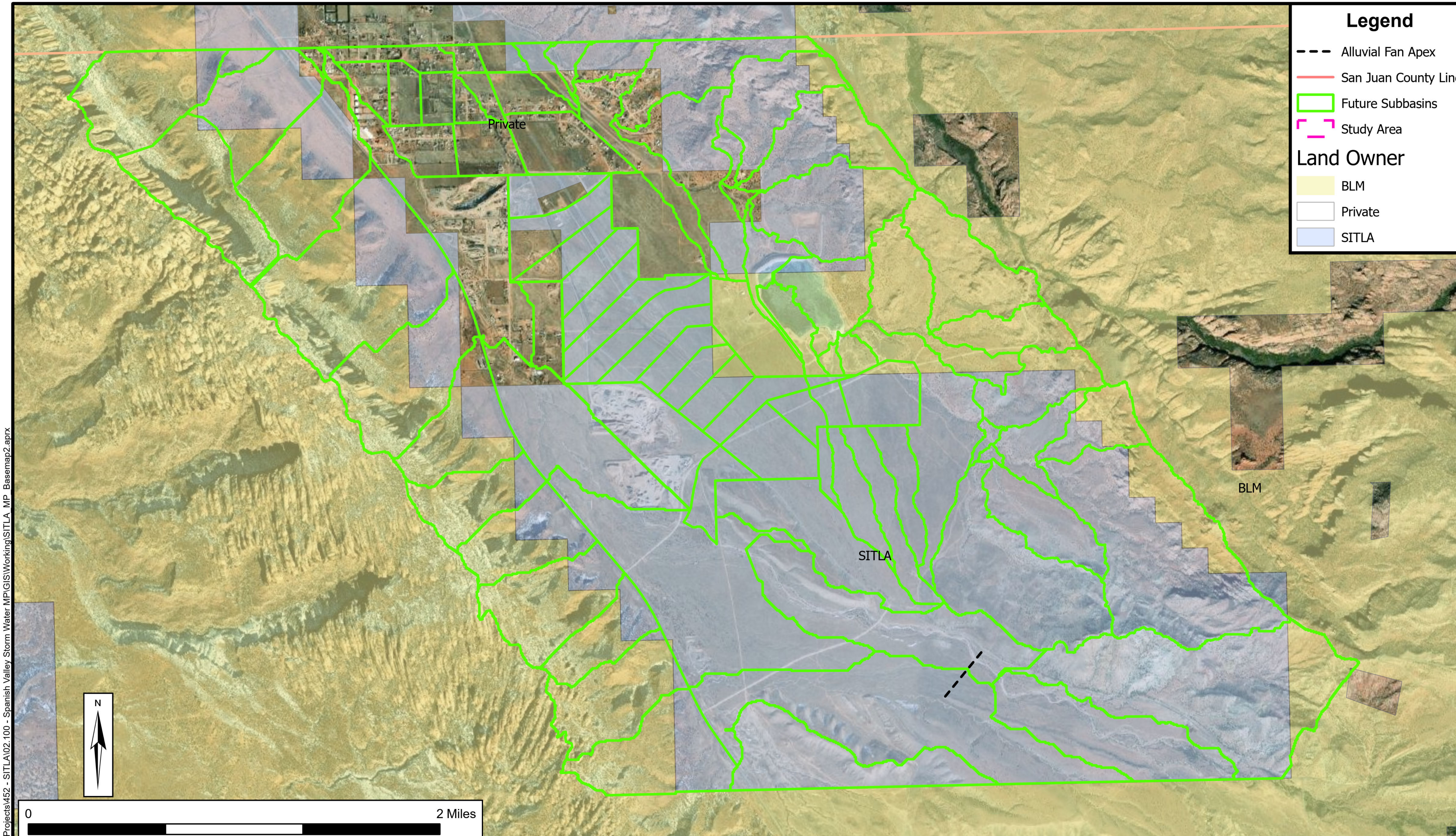
Group A soil is the most prevalent in the Study area and is geologically associated with the valley fill. As the landscape changes to the rocky cliffs, the soil type also changes to soil type D. Soil data for this study originated from the NRCS Web Soil Survey (Canyonlands Area Soil Survey, 2020). A soil map of the Study area is shown in **Figure 2-3**. The hydrologic soil group is a factor used to determine the CN for each subbasin.

**Land Use**

Different types of land cover in a watershed determine to what degree water infiltrates, accumulates (remains as puddles), or flows over the land (runoff). Various land covers have higher or lower amounts of interception and evapotranspiration. The land cover used in the hydrologic model was developed through a field visit and through available aerial imagery. The predominant land cover for undeveloped areas is most closely associated with TR-55's desert shrub in poor to fair condition or sagebrush in poor hydrologic condition. To develop curve numbers for poor to fair condition, a linear average was computed for the desert shrub between poor and fair conditions. As sagebrush with grass understory does not have a curve number for soil type A, it was assumed to be the same as desert shrub in poor to fair condition. The existing land cover can be seen in **Figure 2-4**.

**Impervious Area**

Impervious areas within each subbasin were assumed to be disconnected from the runoff network, which assumes that runoff will flow over a pervious region at some point in its flow to Pack Creek. The future model also assumed that impervious areas would remain disconnected, through implementation of Low Impact Development (LID) practices and careful planning. The future model shows the need for and impact of not implementing LID, and therefore design future flows assume development occurs according to this Master Plan. Flows from the future hydrologic model were reduced by applying the discharge per area requirement to the upstream detained area and adding it to the more local undetained flows.

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SAN JUAN COUNTY - SPANISH VALLEY

STORM DRAINAGE MASTER PLAN
FUTURE SUBBASINS

FIGURE 2-2

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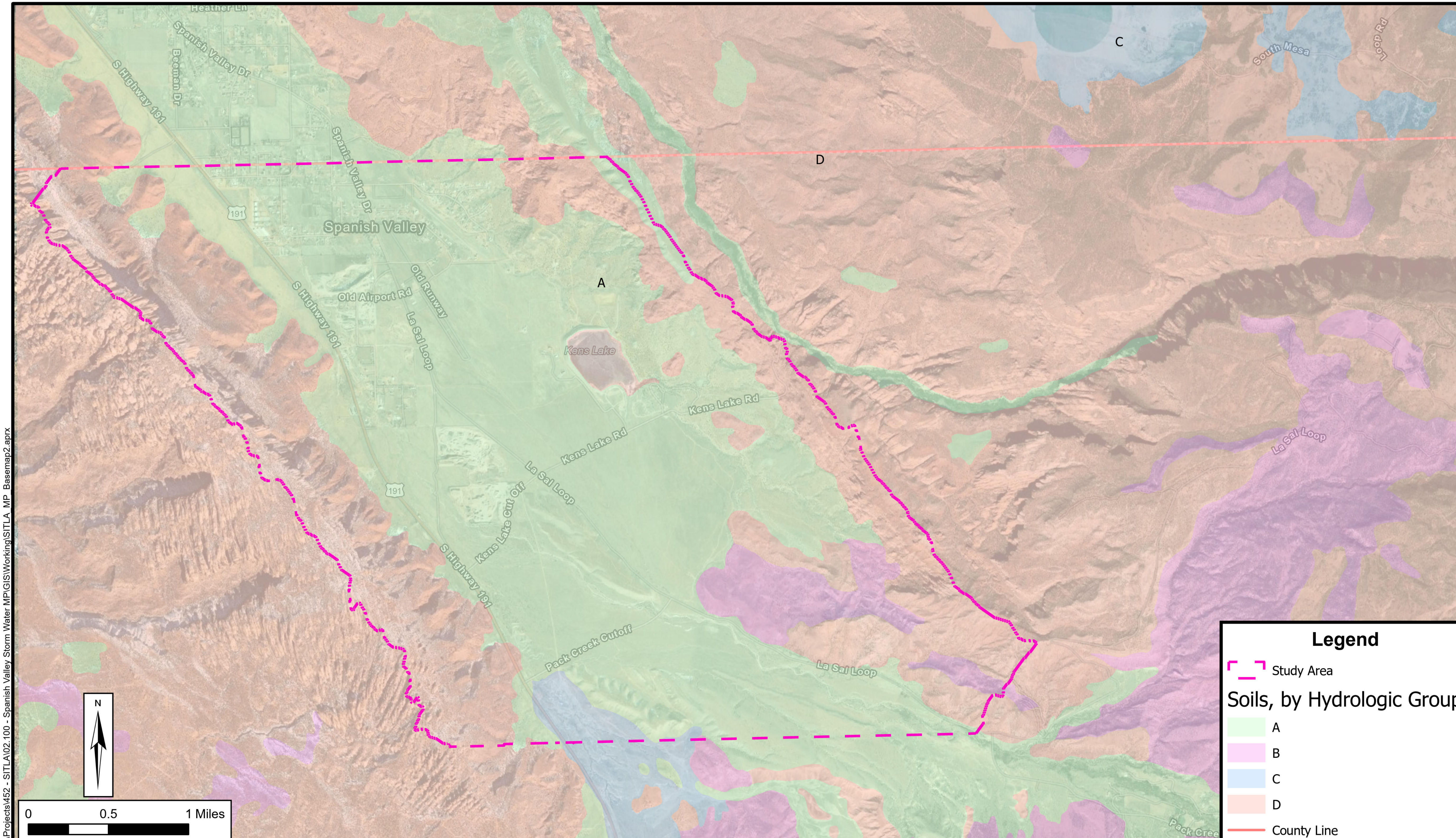


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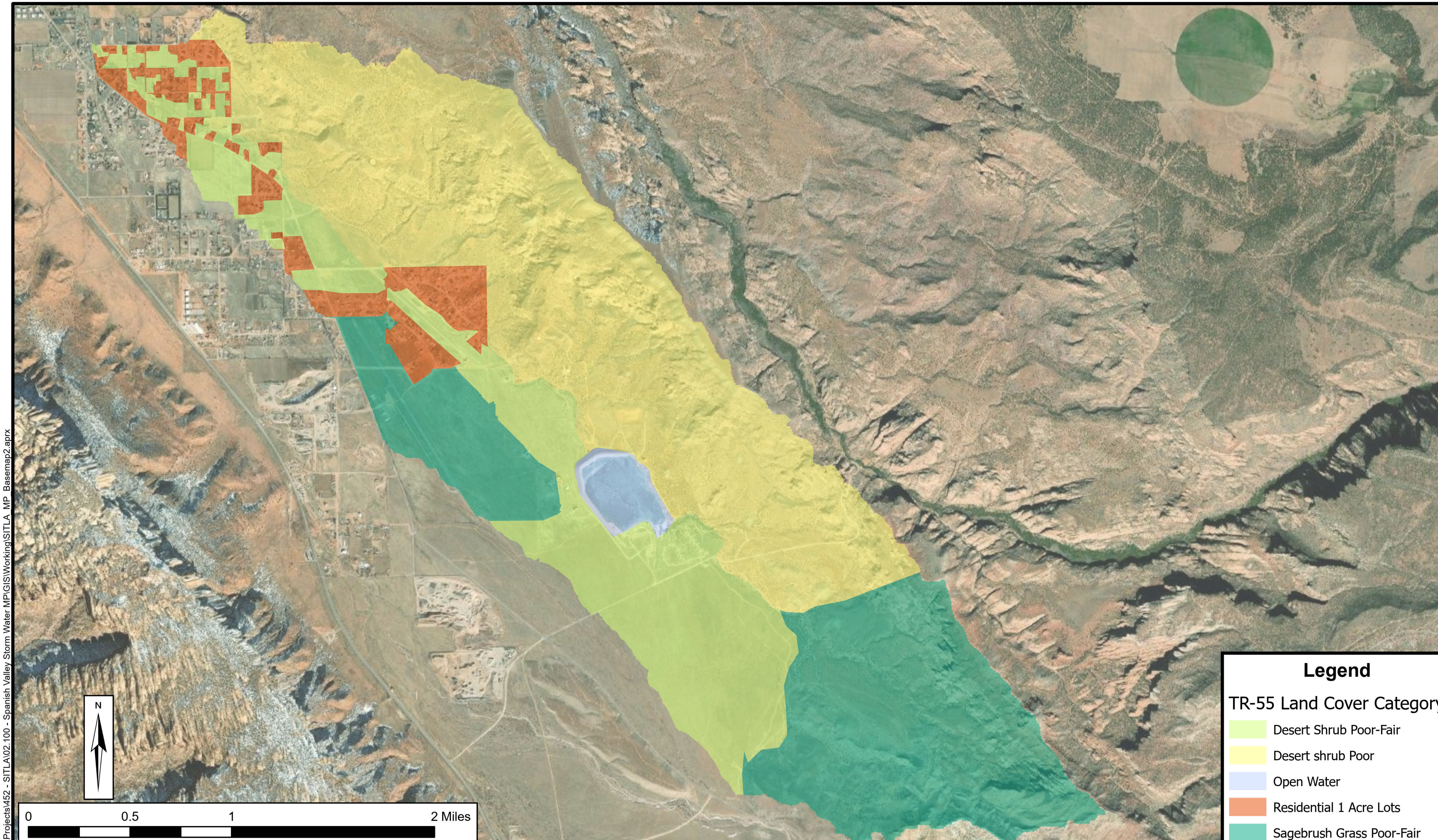
**SAN JUAN COUNTY - SPANISH VALLEY**

**STORM DRAINAGE MASTER PLAN**
**HYDROLOGIC SOIL GROUP**

**FIGURE 2-3**

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SAN JUAN COUNTY - SPANISH VALLEY

STORM DRAINAGE MASTER PLAN
EXISTING LAND COVER

FIGURE
2-4

### SCS Curve Number

Each subbasin was assigned a curve number based on hydrologic soil group, land use, and ground cover type as outlined in Chapter 2 of TR-55 (NRCS, 1986). The curve number describes the relationship between precipitation and runoff for the pervious and unconnected impervious portions of the subbasin. Practical curve numbers range from 30 to 98. Areas that are more pervious have lower curve numbers. For example, a well-vegetated subbasin with sandy soils and little impervious area would have a lower curve number than a poorly vegetated subbasin with clay soils and a significant amount of impervious area. Curve numbers used in the model for existing conditions on the valley floor are shown on **Table 2-2**.

**Table 2-2**
**Curve Number Assignment Table**

| TR-55 Category | CN |
|---|---|
| Sagebrush Grass, Poor-Fair | 60 |
| Desert Shrub, Poor | 64 |
| Desert Shrub, Poor-Fair | 60 |
| Residential 1 Acre Lots | 68 |
| Open Water | 98 |

## UNDISTURBED NATIVE VEGETATION STORM RUNOFF CHARACTERISTICS

The predevelopment condition was established in the model by applying the design storm to a basin with a Curve Number of 60. This number was selected based on Hydrologic Soil Group A with a cover which is most similar to desert shrub in fair to poor condition. The timing and area of the basin were selected from Subbasin-15, which is a basin that is nearly untouched by development. The resultant runoff volume and peak discharge per unit area are tabulated in **Table 2-3**.

**Table 2-3**
**Undisturbed Vegetation Storm Runoff Characteristics**

| Storm Frequency | 10-year | 100-year |
|---|---|---|
| Percent Annual Chance Exceedance | 10% | 1% |
| Precipitation (inches) | 1.80 | 2.81 |
| Runoff Volume (acre-inches/acre) | 0.03 | 0.27 |
| Peak Flowrate (cfs/ac) | 0.004 | 0.1 |

**Table 2-3** represents the hydrologic characteristics of the undisturbed native vegetation condition. This is an important baseline as it is the metric against which new development is graded. For a new development to have no adverse effects on its downstream neighbors, it must detain to the undisturbed flowrates reported above. All development will increase volume and there is potential for increased flows due to hydrograph aggregation from several detention basins; however, the peak flows should not exceed predevelopment conditions. As the discharge per acre is quite low for a 10-year event, and as the soils are well suited for infiltration, San Juan County has selected a full retention policy for the 10-year event. For the 100-year event, Spanish Valley has selected a detention release rate of no greater than 0.1 cfs per tributary acre.

## DEVELOPMENT CHARACTERISTICS

### Community Structure Action Plan

A draft version of a document titled the Community Structure Plan for the South Valley Community dated July 13, 2022, was provided to HAL. The Community Structure Plan (CSP) describes a land-use vision of the community and includes planning and description of community boundaries, development densities, a circulation plan, and utility connections and improvements.

Volume weighting was performed to the Curve Numbers to account for increased future impervious percentage. The assumed future percentage impervious was developed according to zoning maps provided in the Planned Community Rezone Application (e.g. Map 2, CSP). Predicted future impervious percentage is shown in **Figure 2-5**.

### Infill Assumptions

As one-acre lots are subdivided into quarter-acre lots, infill is expected to happen which will result in an increase in impervious area. The projected future impervious percentage is shown in **Figure 2-5**. We recommend that new lots be required to provide sumps to capture and infiltrate the runoff from storm events up to a 10-year 24-hour storm from the new impervious area.

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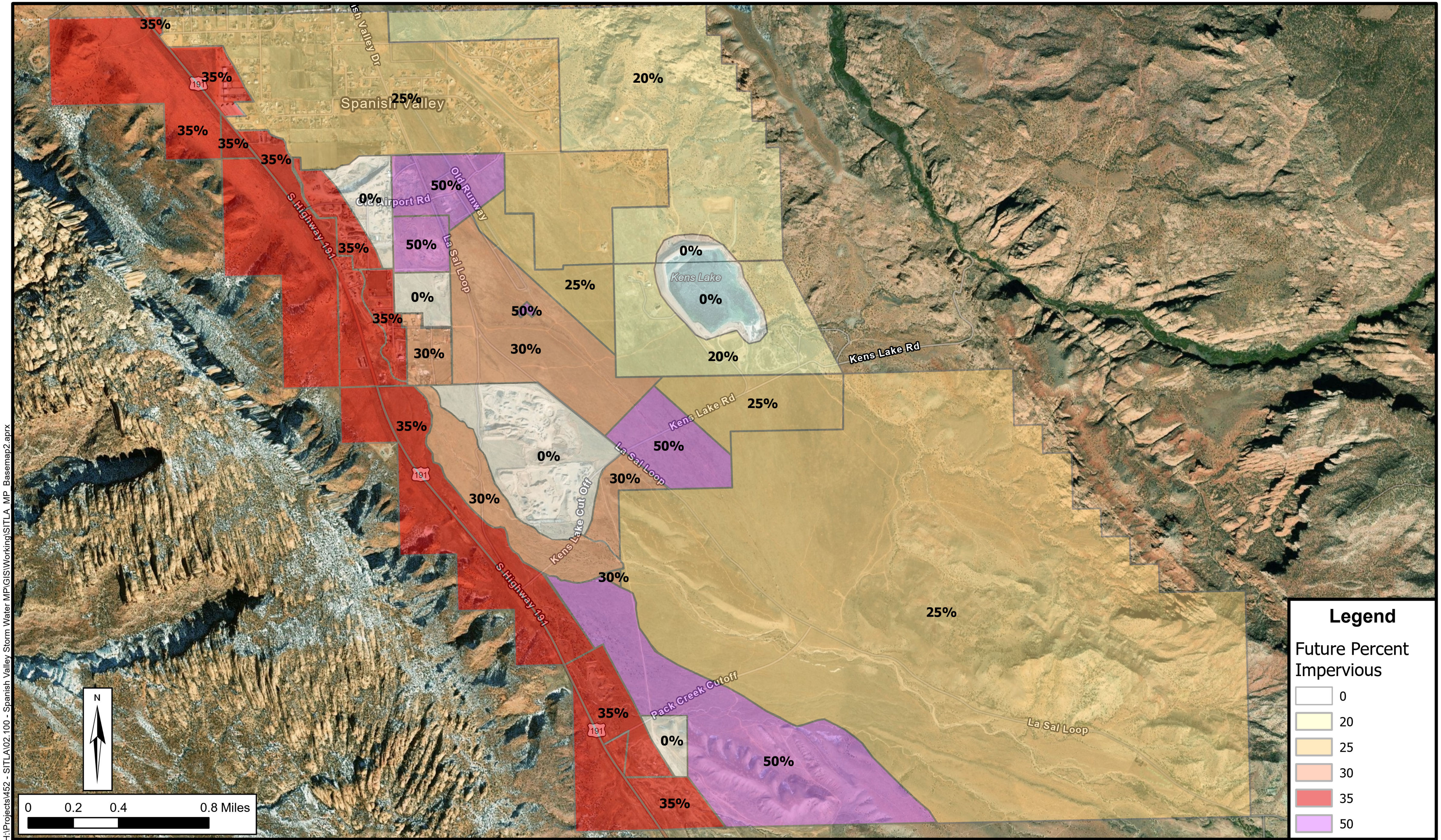


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STORM DRAINAGE MASTER PLAN
ASSUMED FUTURE PERCENT IMPERVIOUS

FIGURE
2-5

# CHAPTER 3 – PACK CREEK MASTER PLAN

HAL performed a hydrologic study on Pack Creek previously to help San Juan County and SITLA better understand the flood hazards in Spanish Valley (HAL, 2019). San Juan County and SITLA are pursuing recommendations from that study to develop debris basins and other facilities with sufficient capacity to convey the 1% chance flood event.

The results of the prior study predict that the 1% annual chance exceedance peak flood flow for Pack Creek at the San Juan County line is about 5,200 cfs. The 10% annual chance exceedance peak flood flow estimated by the HMS model is about 2,400 cfs.

Pack Creek poses a flood hazard risk to a significant portion of the San Juan County Spanish Valley floor. The braided nature of the channel network in the southern end of the valley is evidence of an alluvial fan. Above the valley floor, Pack Creek flood flows are confined in mountain ravines which have high gradients and convey large quantities of eroded sand, rock, and boulders out onto the valley floor. On the valley floor, land slopes are reduced; and flood flow velocities are reduced depositing sediment and debris forming a fan shape. The erosion/deposition process results in channel braiding where channels are alternately cut and filled with sediment. This phenomenon is commonly referred to as an alluvial fan.

The Pack Creek alluvial fan presents a special flood hazard (see SITLA Flood Hazard Mapping memo, HAL 2019). Two debris basins are currently planned as part of a Natural Resources Conservation Service (NRCS) project upstream of the drainage master plan study area. These new debris basins are expected to reduce debris floods on the alluvial fan. In addition to the debris basins, a flood control basin is proposed to reduce the 1% chance flood flows.

Pack Creek is an intermittent stream through the study reach with visibly flowing water occurring during periods of snow melt and rainfall events. The creek bed is dry much of the year (see **Figure 3-1**). The water table is deep in the valley floor, and the stream channel lacks riparian vegetation.

**Figure 3-1. Pack Creek Channel in Valley Floor**

## FLOOD CONTROL BASIN

San Juan County and SITLA are exploring the option of constructing a detention basin on Pack Creek to reduce peak flowrates and protect existing homes and structures; it will also make more land developable. The general location of the proposed detention basin is southeast of the gravel pits that are owned by SITLA. A conceptual figure showing the approximate size, location, and extents of the potential basin is shown in **Figure 3-2.**

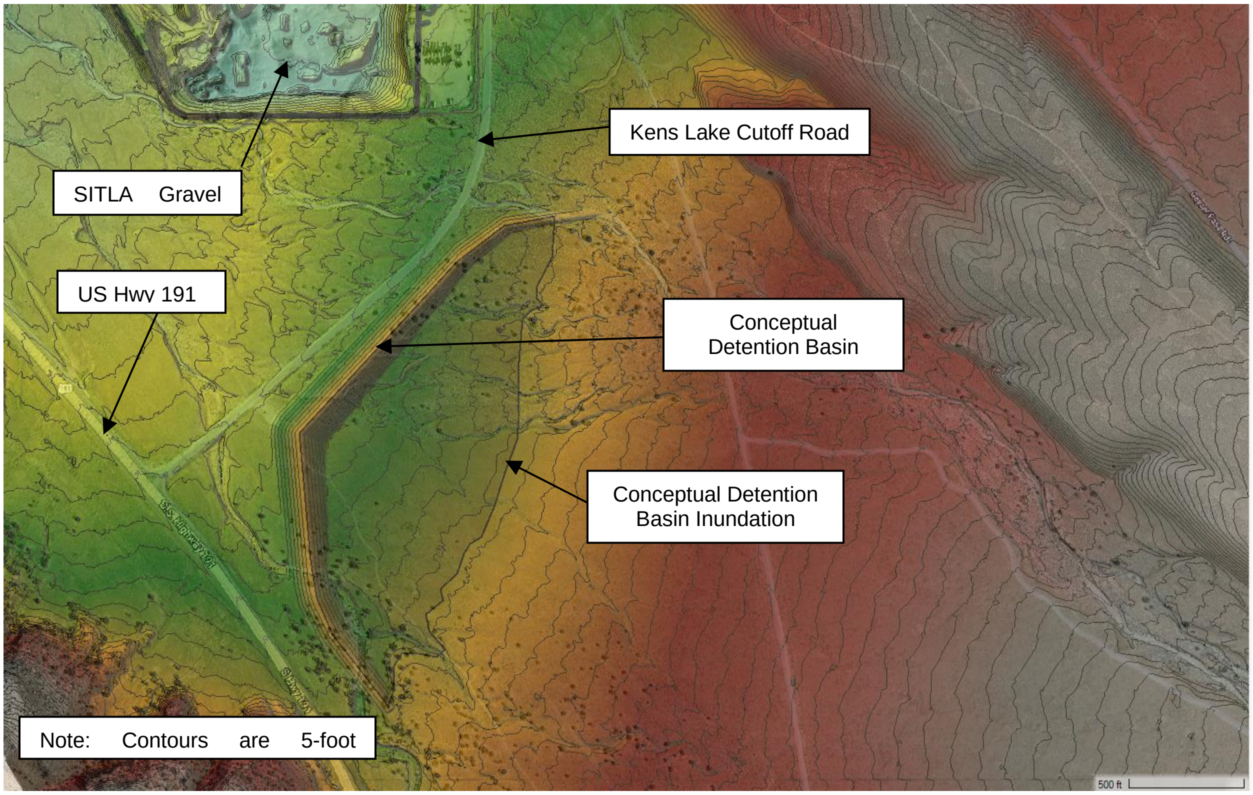



**Figure 3-2. Conceptual Detention Basin Location and Extents**

The detention basin would be downstream of debris basins that are currently in the design phase. The hydrologic model developed previously was used to estimate the required detention volume for various release rates. A hypothetical dam was added to the existing terrain data at a location selected by SITLA and San Juan County. A storage elevation curve was developed based on anticipated grading and the assumption that much of the material to create the detention basin embankment could come from material excavated on site.

It was estimated the required berm height would be approximately 35 feet above lowest existing elevation and would require about 156 acre-ft of material for the prism of the detention embankment. It was assumed that 100 of the 156 acre-ft of required volume could be extracted within the first 8 feet above the lowest existing elevation. The estimated elevation storage curve for the potential detention basin is shown in **Figure 3-3** below.

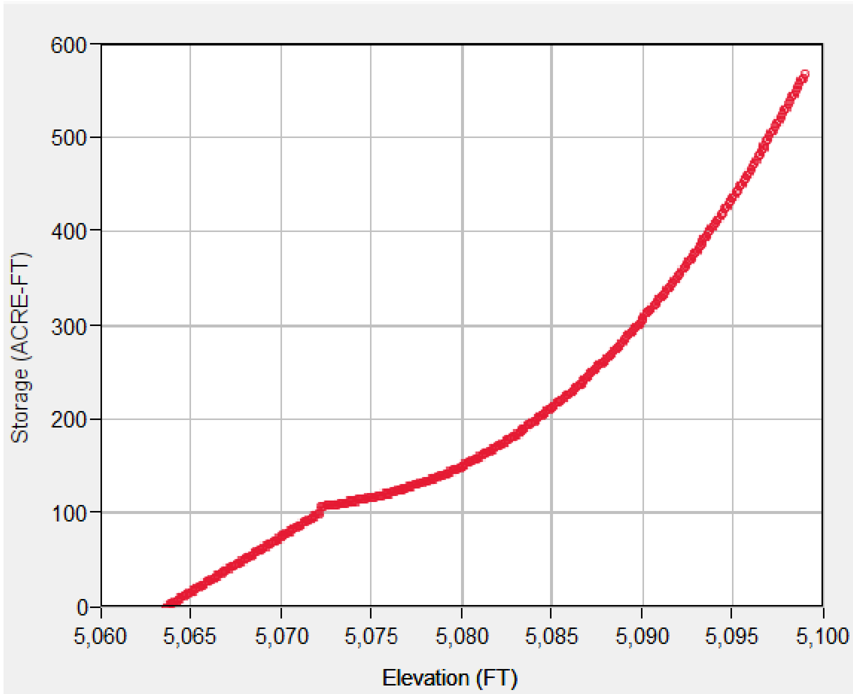



**Figure 3-3. Hypothetical Future Pack Creek Detention Basin Storage vs. Elevation Curve**

A recent relatively high flow event on Pack Creek was reported at approximately 1,500 cfs. Existing dwellings along Pack Creek in San Juan County and in Grand County were not impacted by the flow. Minor damage occurred during the event but was mostly attributed to excessive debris and not necessarily the flowrate. The general thought has been if the upstream debris basins significantly reduce debris loads and the flowrate can be reduced to 1,500 cfs via the flood control detention basin, then existing dwellings along Pack Creek in San Juan and Grand counties will not be flooded in a 1% chance event.

The model was then run with an orifice sized to release 400 cfs up to 8 feet of depth and 100-acre-ft of volume (2-5 year event). A second orifice was set at a depth of 8 feet and sized to release a combined 1,500 cfs for the 100-year flood event. A summary of the orifice configuration is shown in **Table 3-1.**

**Table 3-1. Summary of Assumed Orifice Configuration**

| Orifice # | Elevation (ft) | Area (sf) | Coefficient |
|---|---|---|---|
| 1 | 5064 | 29 | 0.61 |
| 2 | 5072 | 31 | 0.61 |

The required volume based on the configuration described above is approximately 423 acre-feet. The model results are shown in **Figure 3-4.**

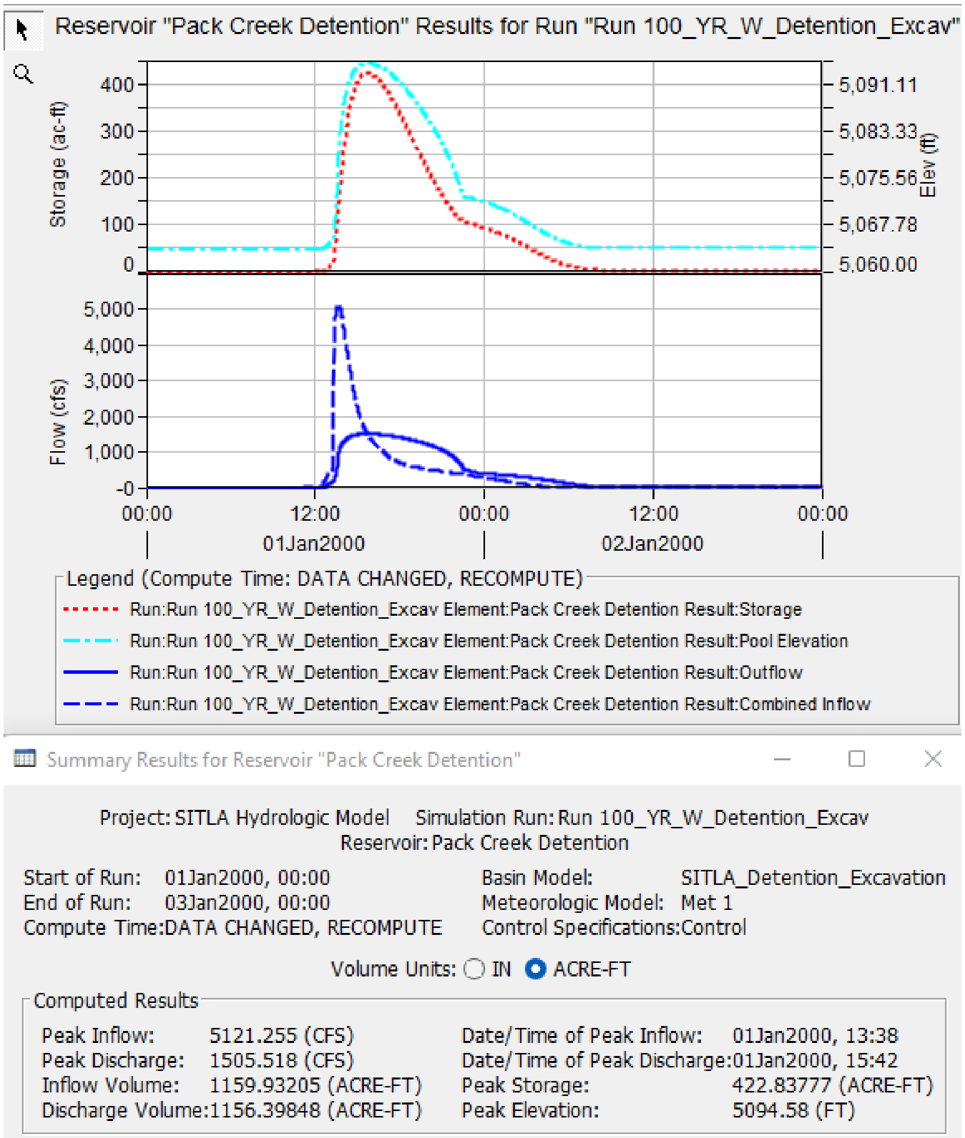



**Figure 3-4. HEC-HMS Pack Creek Model Detention Analysis Results**

## PACK CREEK CHANNEL MASTER PLAN CROSS SECTION

Below the proposed flood control basin, Pack Creek will need stabilization and increased conveyance to accommodate the existing and proposed developments. The following channel design criteria were selected in consultation with SITLA and San Juan County.

Design Flow

- Low Flow Channel capacity = 400 cfs (approximately 2 to 5-year detained release)
- Total Channel capacity = 1,500 cfs (100-year detained release)

Channel Hydraulics

- Maximum Froude Number in low flow channel = 0.8
- Low Flow Channel riprap design based on safety factor method with a safety factor of 1.5. Calculated D50 is 9-inches.
- Composite channel will be sized to convey the 1,500 cfs.

The recommended Pack Creek channel design includes the use of grade control structures. The existing slopes are too steep for subcritical flow; Froude numbers less than or equal to 0.8 are desirable for a stable channel design. The recommended Pack Creek Channel design involves a series of stable channel reaches and grade control structures as needed based on ground slopes. An example profile of how this may look is shown in **Figure 3-5**. The typical spacing between drops for a 3- and 4-foot drop are provided in **Table 3-2**.

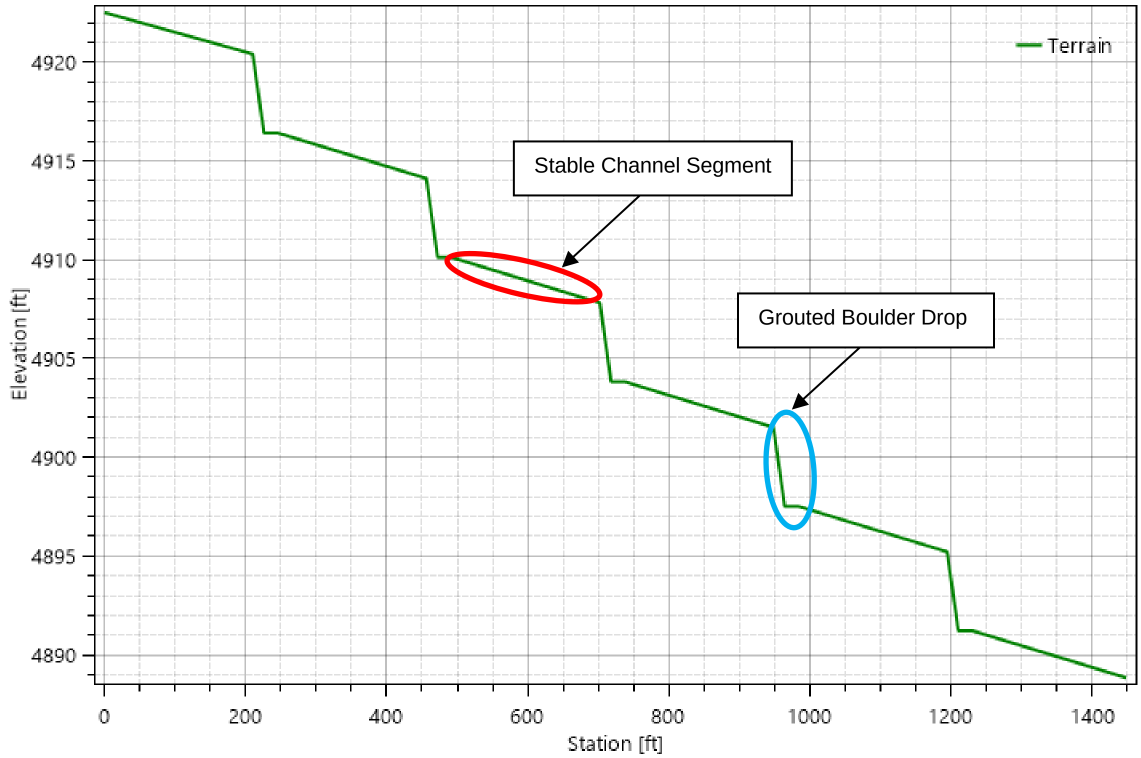



**Figure 3-5. Typical Pack Creek Design Channel Profile**

**Table 3-2.Typical Spacing Between Drops**

| | **Typical 3' Drop Spacing (ft)** | **Typical 4' Drop Spacing (ft)** |
|---|---|---|
| | **Design Channel Slope (ft/ft)** | **Design Channel Slope (ft/ft)** |
| **Ground Slope (ft/ft)** | 0.01 | 0.01 |
| 0.030 | 150 | 200 |
| 0.025 | 200 | 267 |
| 0.020 | 300 | 400 |

The preferred method for grade control is the Grouted Sloping Boulder Drops with criteria as specified in the Urban Storm Drainage Criteria Manual, Volume 2, Mile High Flood District Denver, Colorado (MHFD, 2016). **Figure 3-6** shows an example of a grouted boulder drop profile with a free draining stilling basin.

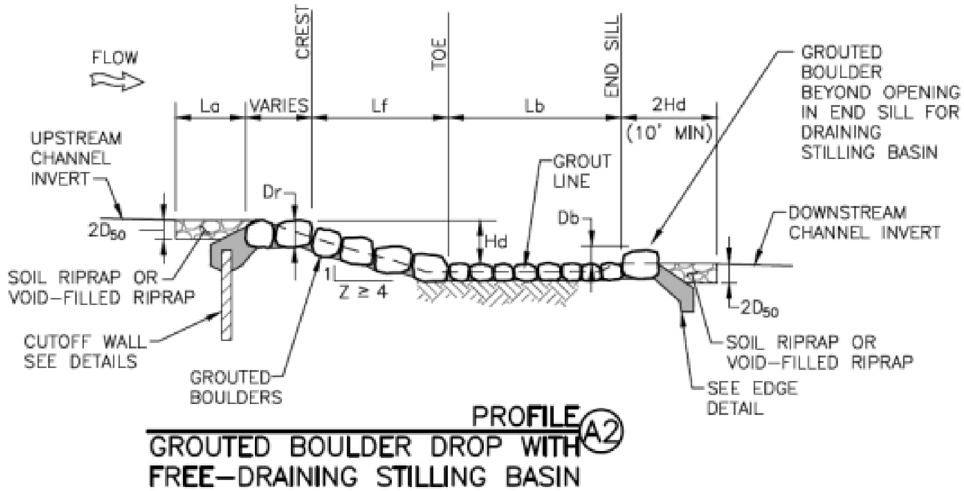



**Figure 3-6. Grouted Boulder Drop Profile Drawing (MHFD, 2016)**

**Preferred Pack Creek Channel Section**

The preferred composite design channel cross section for Pack Creek downstream of the proposed detention basin is shown in **Figure 3-7**.

Low flow channel

- Bottom Width of 15 feet
- Side slopes of 3H:1V
- Channel slope of 1%
- Riprap protection D50 of 9-inches
- Depth of approximately 2.75 feet

The Preferred Composite Channel Cross Section extends out beyond the top of the low flow channel by 11 feet on each side, and then has 3:1 side slopes up to the existing grade (total required width varies based on proximity to drop structures).

**Narrow Pack Creek Channel Section**

In areas where top width is limited due to existing development, gabion walls could be used to reduce the required top width while keeping the low flow channel the same. The typical narrow cross section configuration is shown in **Figure 3-8**.

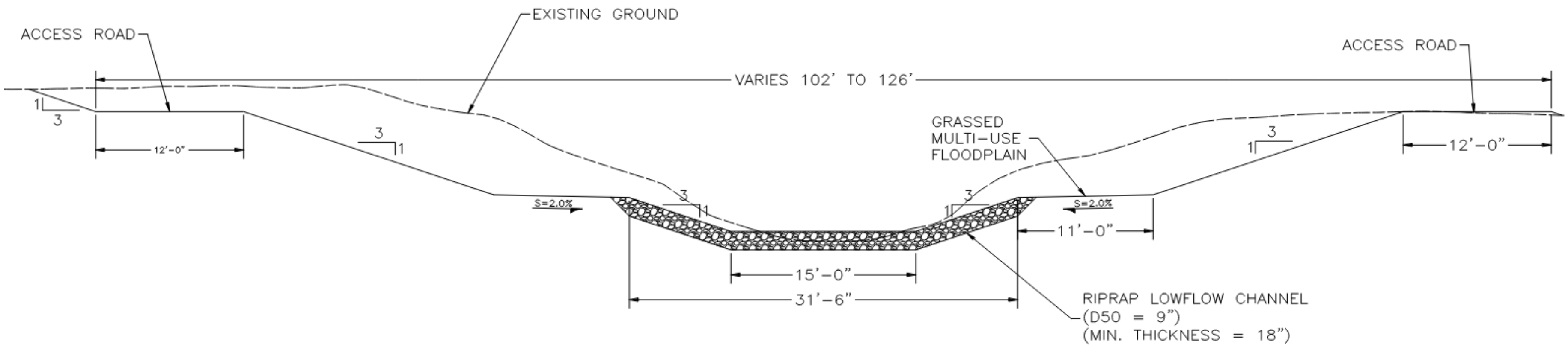



**Figure 3-7. Pack Creek Preferred Cross Section**

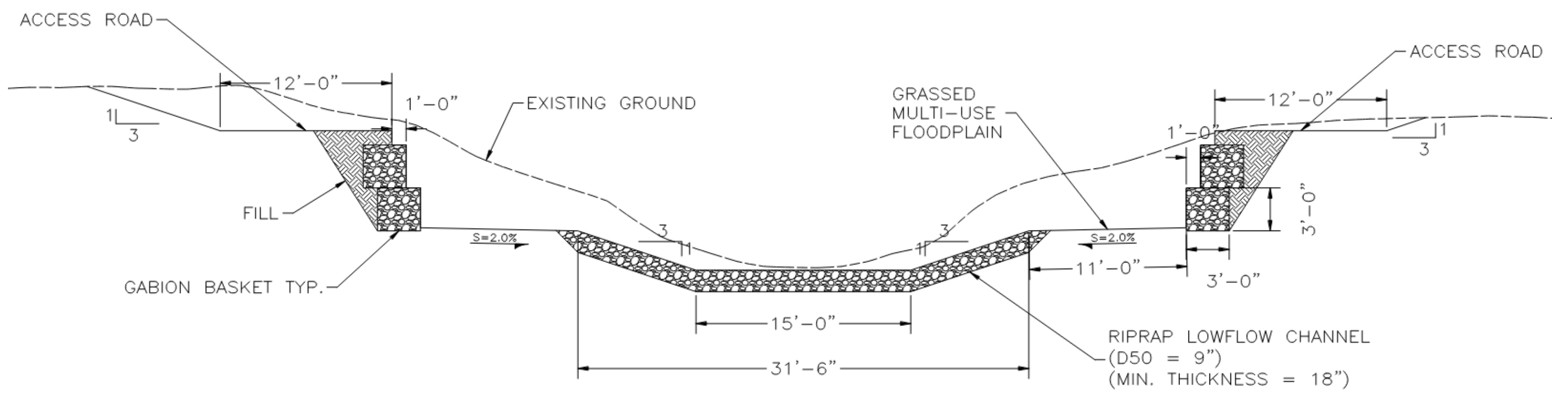



**Figure 3-8. Pack Creek Narrow Cross Section (for use where existing channel encroachments preclude use of the preferred cross section)**

## MASTER PLAN TYPICAL ROAD CROSSING

Two alternatives for crossings to allow conveying the 100-year flood event without impacting buildings have been investigated: 1) use of box culverts with sufficient capacity to convey the 100-year flood event without overtopping the road, and 2) use of a depressed road surface in the section of the crossing with a culvert sized sufficiently to convey 1,500 cfs with combined culvert and weir flow over the road.

### Box Culverts Sized for 100-Year Flood Event

Because of the available gradients through the study reach (generally greater than 2%), box culverts for the road crossings have been conceptually sized and are shown below based on inlet control conditions.

- Approximate Size is three 9' x 6' box culverts to pass the 1,500 cfs.
- Approximate Size is one 15' x 6' box culvert to pass the 1,100 cfs (the additional 400 cfs of weir flow would require approximately 1.5 feet of head and 75 feet of weir length).

In the situation where weir flow over the road is possible, signs should be placed in the road to warn of the flood prone nature of the crossing.

We recommend that the culverts be sized to carry the full 1,500 cfs without overtopping the road. Because the flows are being detained, the likelihood that the channel will experience flows of this magnitude is increased significantly.

### Existing Crossings

The existing crossing at Sunny Acres Lane is severely undersized and should be improved as the design channel is constructed in that area. The existing crossing at Old Airport Road currently has sufficient capacity to pass the 1,500 cfs without overtopping. No existing dirt road crossing has sufficient capacity for the design flows. These crossings should either be removed or improved to provide sufficient capacity for the design flow of 1,500 cfs. This will become increasingly important as development occurs, because bottlenecks in the creek increase flood risk.

## CONCEPTUAL CONSTRUCTION COST ESTIMATES

Construction cost estimates for the detention basin, channel improvements, and typical road crossings are provided in **Table 3-3**. The unit cost for channel improvements is approximately $1,000 per linear foot.

**Table 3-3. Conceptual Cost Estimates for Pack Creek**

| Item | Estimated Construction Cost | Notes |
|---|---|---|
| Detention Basin | $6,000,000 | Cost estimate does not include land costs |
| Channel Improvements | $16,800,000 | Total assumed length is 16,400 ft (from proposed detention basin to County line). Cost includes grouted boulder drops and protection for the low flow channel. |
| Typical Road Crossing | $430,000 | Assumes three 9' x 6' box culverts to pass 1,500 cfs without overtopping the road. |

# CHAPTER 4 – STORM DRAINAGE MASTER PLAN

The existing storm drainage system in Spanish Valley is primarily open channel, comprised mostly of creeks, washes, roadside swales, irrigation ditches, and some culvert road crossings. The proposed development will change the landscape of Spanish Valley and will require associated drainage improvements. This chapter discusses the existing drainage deficiencies and the plan to prevent future deficiencies for both existing and future landowners as land develops.

## EXISTING DRAINAGE DEFICIENCIES

The existing deficiencies in this master plan were identified by San Juan County staff for areas which constituted known drainage issues. Identified existing drainage deficiencies and possible solutions are described below by location.

### Coronado

The residence of 110 East Coronado Street has been flooded several times according to the County. The contributing drainage area to 110 East Coronado Street for minor storm events appears to be limited to local drainage. Major storm events could contribute flow from south of Coronado Street or east of Cabrillo Street. This location is particularly hazardous as the driveway directs flow away from the road into or near the house. Some possible solutions which would resolve the minor event flooding include:

1. Adding sumps on both sides of the driveway which would intercept and infiltrate the road drainage.
2. Increasing conveyance by improving the ditch along the east side of the driveway.
3. Developing storage in the undeveloped land east of the driveway.

The ideal option is of course elevation of the structure and, wherever possible, this option should be employed. This example serves as a reminder why homes should be elevated and driveways sloped down to the road.

There is an irrigation ditch on the south side of Coronado which, if it overtops, would spill some flow north across Coronado during large events. Solving the major event flooding would require also installing detention or retention upstream. Good siting for this basin or these basins would include the areas immediately south of the property and/or the southeast corner of the intersection at Coronado and La Sal Loop Rd.

### Rio Grande

Any flow from the major event that does not cross Coronado at the location discussed above, crosses Rio Grande Drive just to the west. According to LiDAR, the minimum crest elevation for Rio Grande is approximately one foot lower than that of Coronado’s (4791.2 compared to 4792.2). This means that this conveyance path receives 100% of the storm runoff from south of Coronado Street until the flood is large enough to overtop Coronado, at which time both locations experience major flooding. A potential solution for this location includes a culvert under Rio Grande Drive to convey the design peak flow. The selected master plan solution is to construct a new conveyance to Pack Creek from the west end of Coronado.

**Mt. Peale**

The crossing of the open drainage way (wash) just east of Sky Ranch airport with Mt. Peale Drive results in the closing of the road during flood events. The neighborhood just east of the crossing has more than 50 homes and is currently accessible only via Mt. Peale Drive. It is recommended that the design event for this crossing be the 100-year storm. The 100-year design flow for this crossing is 118 cfs. A 54-inch diameter culvert operating under inlet control is adequate to pass the design flow (118 cfs) with a headwater depth of 5.2 feet.

**Sunny Acres**

The County identified the Sunny Acres Drive crossing of Pack Creek as prone to flooding; it needs to be replaced. This crossing is addressed in the Pack Creek master plan (see Chapter 3).

## MASTER PLAN ALTERNATIVES

<u>Minor storm</u>. To prevent increased runoff during the 10-year storm for new development (commensurate with undisturbed native vegetation runoff), sumps or other infiltration means should be implemented to retain and infiltrate the runoff from a 10-year storm event onsite.

<u>Major storm</u>. To prevent increased runoff from new development during the 100-year storm (commensurate with undisturbed native vegetation), detention and conveyance need to be added. There are two primary approaches for construction and maintenance of detention basins: regional and local. The following paragraphs describe the advantages and disadvantages of each approach.

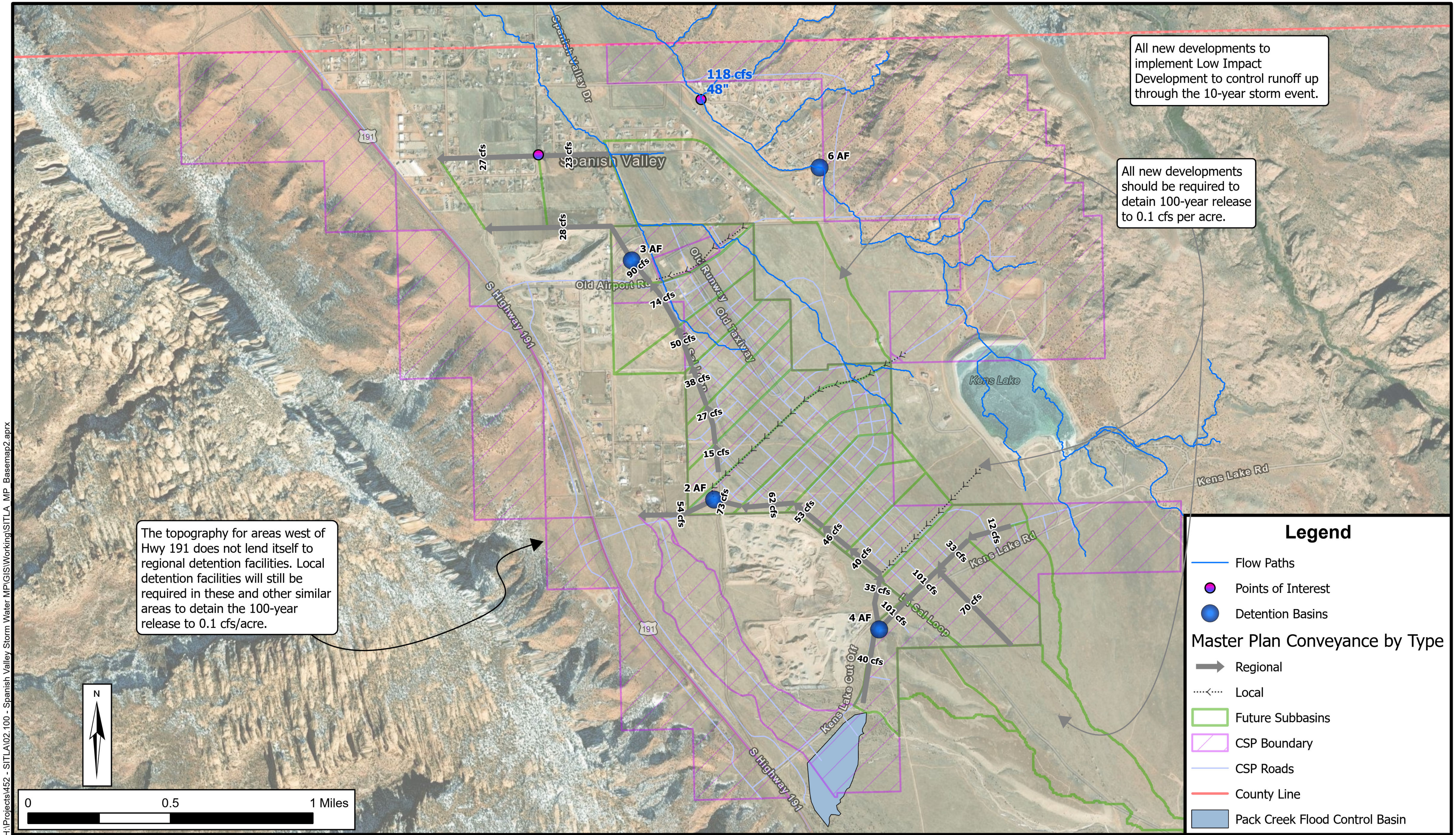
**Regional Detention Basins**

Regional detention facilities serve to detain flows from a large contributing area. The advantage of regional detention facilities is that they are few. Maintenance is consolidated for maintenance personnel with fewer basins. Regional detention basins are larger and provide an increased opportunity for multi-use facilities. Regional detention basins are usually maintained by the local government entity. The cost per unit storage is generally lower due to economy of scale. As the system detains flow in fewer places, there is less opportunity to “double-store” volume, which happens when water has been detained once already and is mixed with undetained flows prior to entering another detention facility.

A disadvantage of regional detention facilities is the higher requirement for coordination on the funding. Construction of the regional facility will need to happen early in the development process to provide the required benefits. Additionally, the conveyance sizing to direct flows to the regional facility are larger as the flow is accumulated prior to being detained. **Figure 4-1** shows a concept of the pipes and basins under the regional detention approach.

**Development Detention Basins**

Local detention basins only serve the development for which they were constructed. Their strengths and weaknesses are generally opposite those of regional facilities. As they must occur for every development, local detention policy will result in creation of many detention basins. Maintenance costs are higher, and the cost per unit storage is generally larger than for regional facilities. The system detains flow in more places and there is more opportunity to “double-store” volume. The sizing of the conveyances to route the flow from the local facilities is smaller than it would have been in the regional case, but care should be taken not to commingle detained flows




| | | |
|---|---|---|
| SAN JUAN COUNTY – SPANISH VALLEY | STORM DRAINAGE MASTER PLAN<br>REGIONAL DETENTION ALTERNATIVE | FIGURE<br>4-1 |

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with undetained flows. **Figure 4-2** shows a concept of the pipes and basins under the local detention approach. **Table 4-1** provides a summary of the pros and cons of each approach.

**Table 4-1**
**Pros and Cons of Each Detention Basin Approach**

| Category | Regional | Local |
|---|---|---|
| Maintenance/Number of facilities | Low | High |
| Cost per unit volume | Typically lower | Typically higher |
| Opportunity to "double store" | Lower | Higher |
| Conveyance Sizing | Larger | Smaller |
| Funding and Phasing difficulty | Higher | Low |

Due to the funding constraints, the County has chosen the local detention approach for implementation in the master plan. Regional facilities may be permitted or required on a case-by-case basis.

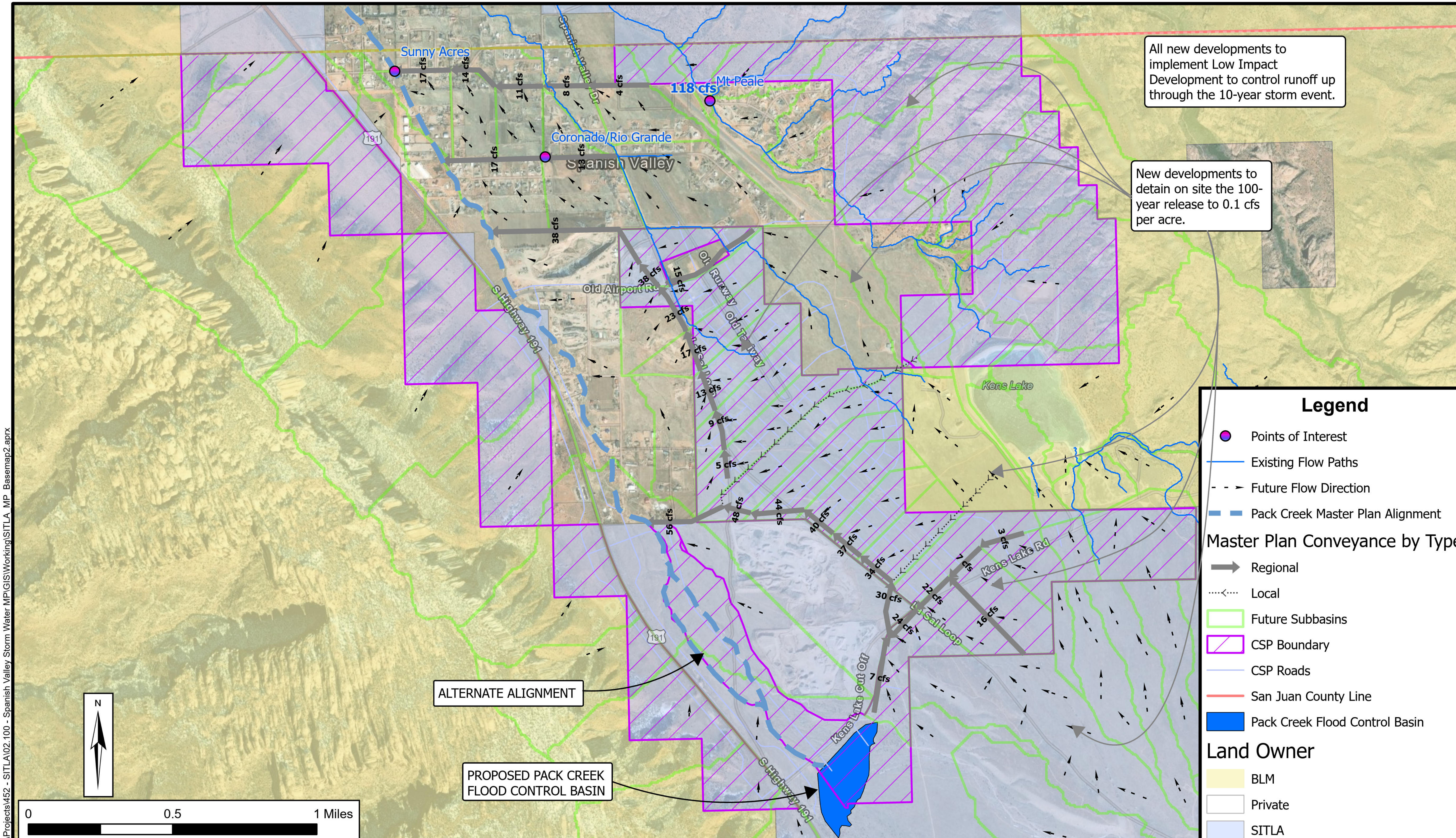
## CONCEPTUAL CONSTRUCTION COST ESTIMATES

Construction cost estimates for the master plan conveyances and existing deficiencies on Mt. Peale Drive and Coronado Street are provided in **Table 4-2**. This cost estimate assumes that the local detention option is selected and that the Master Plan Conveyances are pipes.

**Table 4-2**
**Conceptual Cost Estimates**
**of the Master Plan Regional Storm Drainage Facilities**

| PROJECT | COST* |
|---|---|
| Master Plan Conveyances | $6,310,000 |
| Coronado (new outfall to Pack Creek) | $512,000 |
| Mt. Peale Drive (drainage crossing replacement) | $102,000 |

* Assumes that the local detention option is selected. Also assumes that Master Plan Conveyances are pipes. Includes 30% for contingency and engineering.

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STORM DRAINAGE MASTER PLAN
LOCAL DETENTION ALTERNATIVE

FIGURE
4-2

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