FINAL DRAFT

Dayton Valley Area Drainage Master Plan

Technical Support Data Notebook

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prepared for

Lyon County | Storey County |

Carson Water Subconservancy District

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Appendices

Appendix A – JE Fuller Hydrology Memorandum (dated August 14, 2018)

Appendix B – Digital Aerial Solutions, LLC LiDAR Reports

Appendix C – Digital Data Submittal

Appendix D – Concept Design Sheets, Construction Cost Estimates, and Life-Cycle Cost Estimates

1 INTRODUCTION

1.1 PROJECT PURPOSE

The Dayton Valley Area Drainage Master Plan (DVADMP) was developed to meet three primary objectives: First – evaluate and identify flooding and sedimentation hazards within the project area by the implementation of a work plan which includes data collection, review of previous studies, information gathering from public agencies and local residents, hydrologic and hydraulic modeling, geomorphic assessments, and field surveys. Second – develop a series of alternatives to either partially or wholly mitigate the hazards identified in the first objective. Third – provide stakeholder coordination and public outreach of the project through a series of public meetings to inform of the existing hazards and to present the mitigation alternatives.

Each major task of the project is presented herein with a description of the technical approach, analysis results, interpretation of results, and applicability to the overall project purpose. The results of this study can be used as a planning tool and as input to the design of potential future drainage infrastructure and flood mitigation measures that are appropriate for the physical environment for both existing and future development.

1.2 PROJECT LOCATION

The DVADMP study area is 68 square miles and is located on the southeastern slopes of the Virginia and Flowery Ranges, approximately 15 miles east of Carson City (Figure 1-1). Most of the study area spans Lyon and Storey Counties, with a small portion of the upper-watershed extending into Washoe County. The percent study area by county is: Storey County (60%), Lyon County (38%), and Washoe County (2%). The primary focus area of the DVADMP is the lower watershed area downstream of the mountains, also shown on Figure 1-1.

There are several unincorporated communities within the study area which are listed in Table 1-1 and shown in Figure 1-1.

Table 1-1. Communities within the study area

Unincorporated Community	County
Virginia City (County Seat)	Storey
Gold Hill	Storey
Dayton	Lyon
Silver City	Lyon

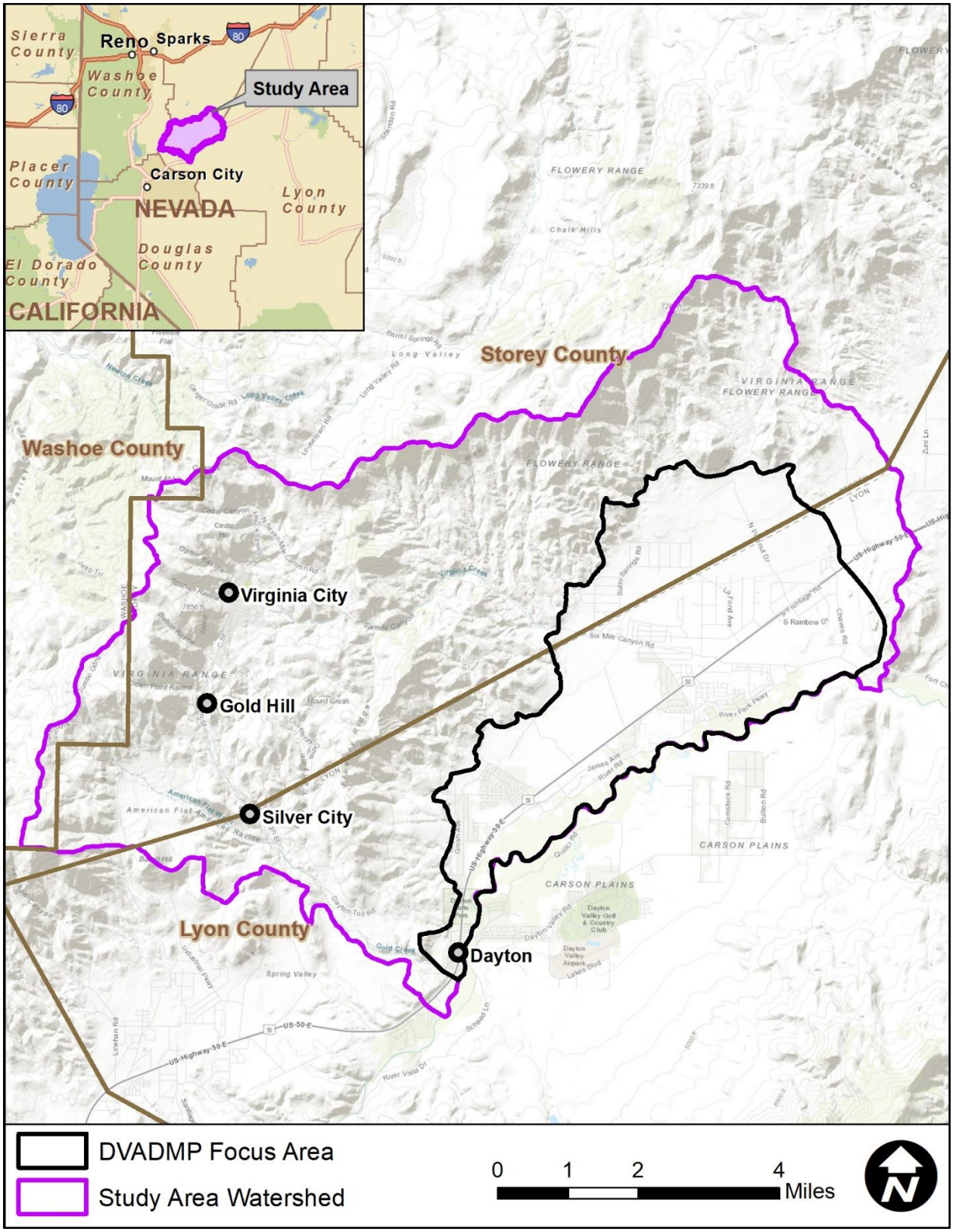


Figure 1-1. Study area vicinity map

1.3 PREVIOUS STUDIES

An early phase of the study included research and collection of previous reports and studies relevant to the ADMP area. These included drainage reports for local subdivisions, flood insurance studies (FIS), and geologic reports. A summary of the different types of reports are summarized in the following sections.

1.3.1 Subdivision Drainage Reports

Several drainage reports and drainage studies were collected from the county agencies and included information that was used directly in the development of the existing conditions hydraulic model (Section 3). The documents provided information on the location and design for drainage facilities within the individual subdivisions. All the collected drainage reports are included in the digital appendix (Appendix C). Table 1-2 lists the collected documents.

Table 1-2. Collected subdivision drainage reports

Title	Author	Date	Subdivision
Drainage Reports and Drainage Studies			
Revised Final Drainage Study for Riverpark Dunes II	TEC Civil Engineering Consultants	August 2005	Riverpark Dunes II
Final Drainage Analysis for Traditions Phase 1, Unit 1, 2, 3 Revision	Capital Engineering	September 2005	Traditions Phase 1
Final Hydrologic Drainage Study for Riverpark Phase 3, Units 16-18 Residential Development	Manhard Consulting	June 2016	Riverpark Phase 3
Technical Drainage Study for the Gold Country Estates Tentative Subdivision – Map Phase 2A	Lumos & Associates, Inc.	October 2016	Gold Country Estates

1.3.2 Flood Insurance Studies

Federal Emergency Management Agency (FEMA) Flood Insurance Studies (FIS) for Lyon and Storey Counties were collected and reviewed for historical flooding records and regulatory discharge estimates for watercourses in the study area. Table 1-3 lists the collected studies and derived information. Although the goal of this study is not to "match" the FIS discharge estimates, they do provide a base-level comparison for the hydraulic model results (see Section 3.4 The consistency of discharges between years in Table 1-3 suggests that there has been no revision to the hydrology for FEMA regulatory studies since at least 1998.

Table 1-3. Flood Insurance Studies

Study Date	County	DVADMP Watercourses	10-year Discharge (cfs)	50-year Discharge (cfs)	100-year Discharge (cfs)
July 1993	Storey	No	-	-	-
January 1998	Lyon	Gold Canyon Creek	1,100	2,100	2,300
		Six Mile Canyon	142	1,284	3,792
February 2000	Lyon	Gold Canyon Creek	1,100	2,100	2,300
		Six Mile Canyon	142	1,284	3,792
January 2009	Lyon	Gold Canyon Creek	1,100	2,100	2,300
		Six Mile Canyon	142	1,284	3,792
January 2009	Storey (current effective)	No	-	-	-
January 2016	Lyon (current effective)	Gold Canyon Creek	1,100	2,100	2,300
		Six Mile Canyon	142	1,284	3,792

1.3.2.1 Effective FEMA Floodplain Mapping

As of the date of this study, Six Mile Canyon, Gold Canyon Creek, and the Carson River are the only watercourses in the study area with FEMA regulatory floodplains (Figure 1-2). Table 1-4 lists the descriptions for each flood zone within the study area. Like FIS data, FEMA floodplain mapping provides a base-level comparison of flood risk for the hydraulic modeling results from this study.

Table 1-4. FEMA flood zones within the study area

Flood Zone	Definition	Flooding Type	Recurrence Interval
A	No base flood elevation is provided	Riverine	1% chance
AE	Base flood elevation (BFE) is provided	Riverine	1% chance
AE with Floodway	BFE and Floodway is provided	Riverine	1% chance
AO 1, 4	Depth 1 foot, Velocity 4 feet/second	Alluvial Fan	1% chance
AO 1, 5	Depth 1 feet, Velocity 5 feet/second	Alluvial Fan	1% chance
AO 2, 7	Depth 2 feet, Velocity 7 feet/second	Alluvial Fan	1% chance
AO 3, 7	Depth 3 feet, Velocity 7 feet/second	Alluvial Fan	1% chance
AO 3, 8	Depth 3 feet, Velocity 8 feet/second	Alluvial Fan	1% chance
X	Flooding outside the SFHA	Riverine, Alluvial Fan	0.2% chance

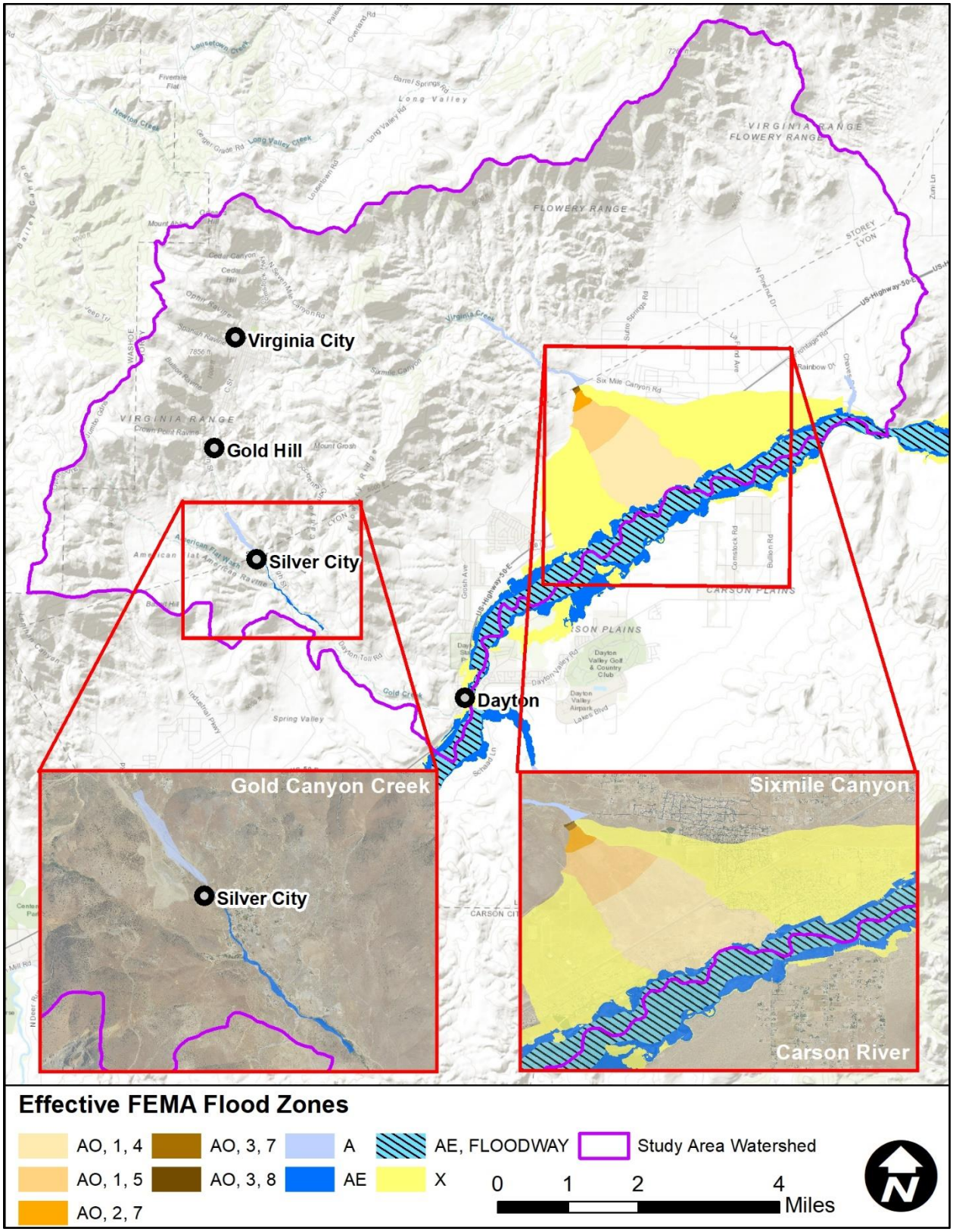


Figure 1-2. Effective FEMA Floodplains

1.3.3 U.S. Army Corps of Engineers Alluvial Fan Mapping

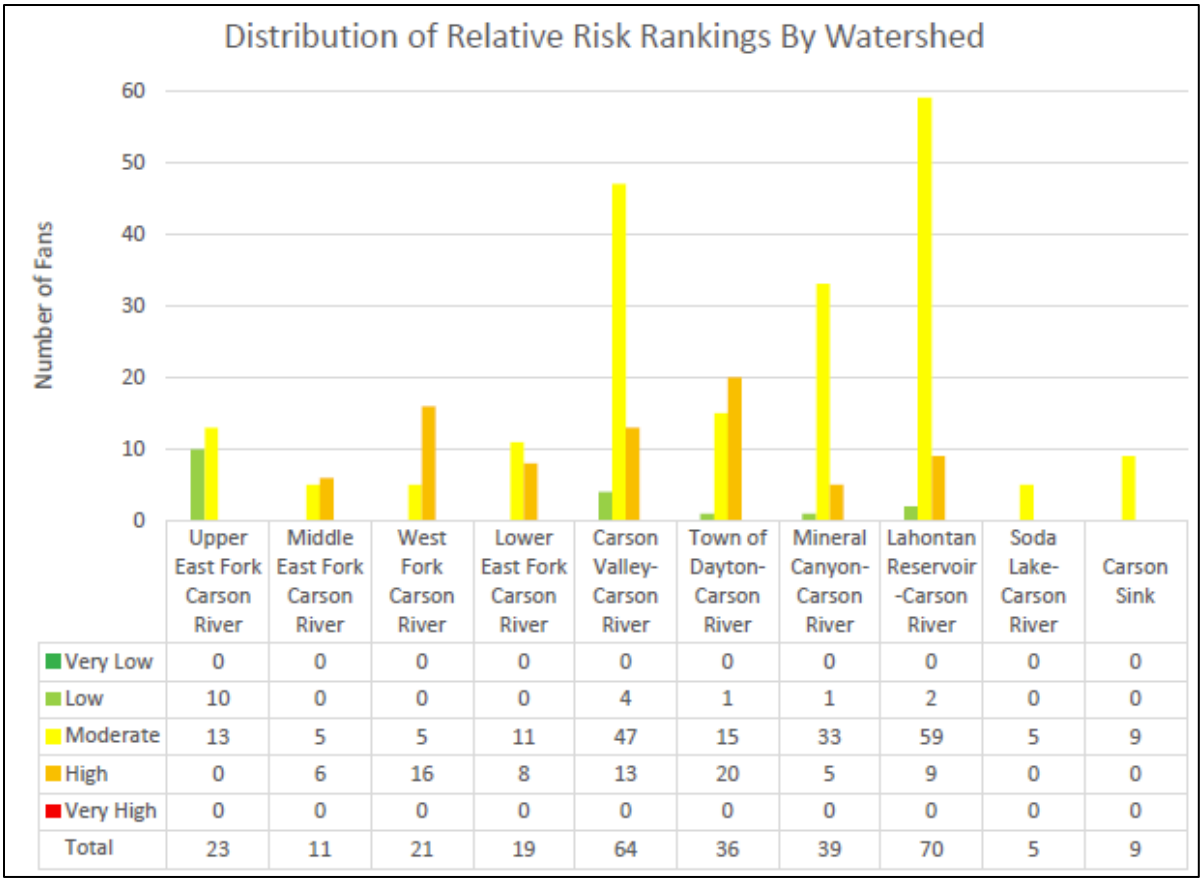
In December 2017 the U.S. Army Corps of Engineers (USACE), Sacramento District, published a study titled *Alluvial Fan Mapping for the Carson River Watershed Methodology* (Floyd, 2017) which included the DVADMP study area. The purpose of the mapping study was to classify the relative risk of alluvial fan landforms within the Carson River Watershed. Alluvial fan landforms were identified and assigned a risk ranking based on the following categories:

- Appearance of active or inactive
- Existence of disturbances
- Presence of infrastructure

Within each category, a series of risk factors were examined. For example, the Active/Inactive category included four risk factors:

  - Soil Development
  - Alluvium
  - Unconfined Flow
  - Incised Channels

The risk factors were assigned a relative score and summed to derive an overall hazard ranking by watershed. Figure 1-3 from the report depicts the distribution of relative risk rankings by watershed. Figure 1-4 shows the identified alluvial fan landforms within the DVADMP study area and their assigned risk.



	Upper East Fork Carson River	Middle East Fork Carson River	West Fork Carson River	Lower East Fork Carson River	Carson Valley-Carson River	Town of Dayton-Carson River	Mineral Canyon-Carson River	Lahontan Reservoir-Carson River	Soda Lake-Carson River	Carson Sink
Very Low	0	0	0	0	0	0	0	0	0	0
Low	10	0	0	0	4	1	1	2	0	0
Moderate	13	5	5	11	47	15	33	59	5	9
High	0	6	16	8	13	20	5	9	0	0
Very High	0	0	0	0	0	0	0	0	0	0
Total	23	11	21	19	64	36	39	70	5	9

Figure 1-3. Distribution of relative risk rankings by watershed, from Floyd (2017)

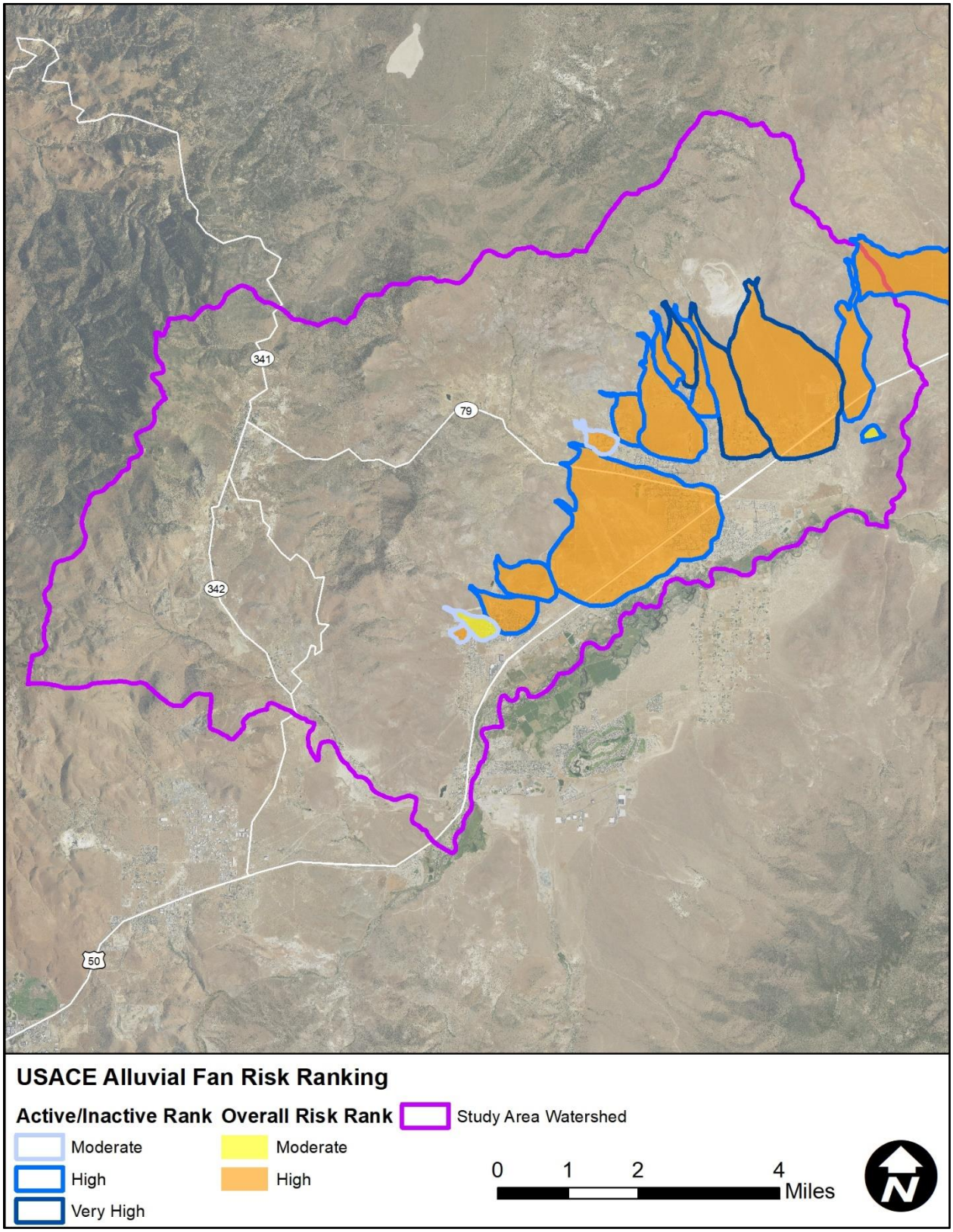


Figure 1-4. USACE alluvial fan risk ranking

1.4 Historical Flow Path Assessment

Understanding the historical evolution of a geomorphic system is critical to understanding present-day processes and predicting future trends. Natural systems can take hundreds of thousands of years to develop, and their morphology is a direct reflection of this long-development period. Anthropogenic changes to a natural system often result in abrupt changes that can be managed for a brief period, but quite often the disturbed system will trend back to its natural condition, despite efforts to change and maintain it.

A historical flow path assessment was conducted for the DVADMP study area to assess the natural flowpaths of the study watercourses with the goal that understanding the natural flowpaths will aid in understanding the current flooding patterns and potential future flooding trends.

1.4.1 Aerial Photography

Historical aerial photography from 1948 (earliest year available) was collected and semi-rectified using ArcGIS software tools. The natural flow paths for the project watercourses were identified and delineated from the photography. Figure 1-5 shows the 1948 aerial photography and Figure 1-6 the modern aerial photography (2017) for the ADMP focus area. The 1948 photographs pre-date much of the development within the focus area and shows the landforms in a (mostly) natural condition. The locations of the main flowpaths for the major drainage channels were interpreted and delineated from the 1948 photographs to compare with the present-day locations (Figure 1-7). The figure indicates that many of the main flowpaths have remained stable over the past 70 years. A few flowpaths have experienced significant changes due to development and channelization. Six Mile Canyon has shifted over 1,000 feet to the east since 1948. The flowpaths in the undeveloped portions of the eastern project area have remained relatively stable since 1948.

1.4.2 Summary

The most significant changes in flow path alignment since 1948 have occurred due to manmade channel realignments. Both the historical and modern aerial photography indicate evidence of distributary and active alluvial fan drainage patterns throughout the project focus area, but many of the main drainage channels have remained laterally stable for at least the past 70 years. This suggests that there may not have been a flood event of sufficient magnitude since at least 1948 to cause major channel avulsions. The major watercourses were investigated during the field verification phase of the ADMP and were not found to be incised or laterally confined within the lower project focus area. In other words there are no physical constraints that should have prevented historical channel avulsions since 1948, which further suggests that there hasn't been a flood event with sufficient energy to cause a major channel avulsion.

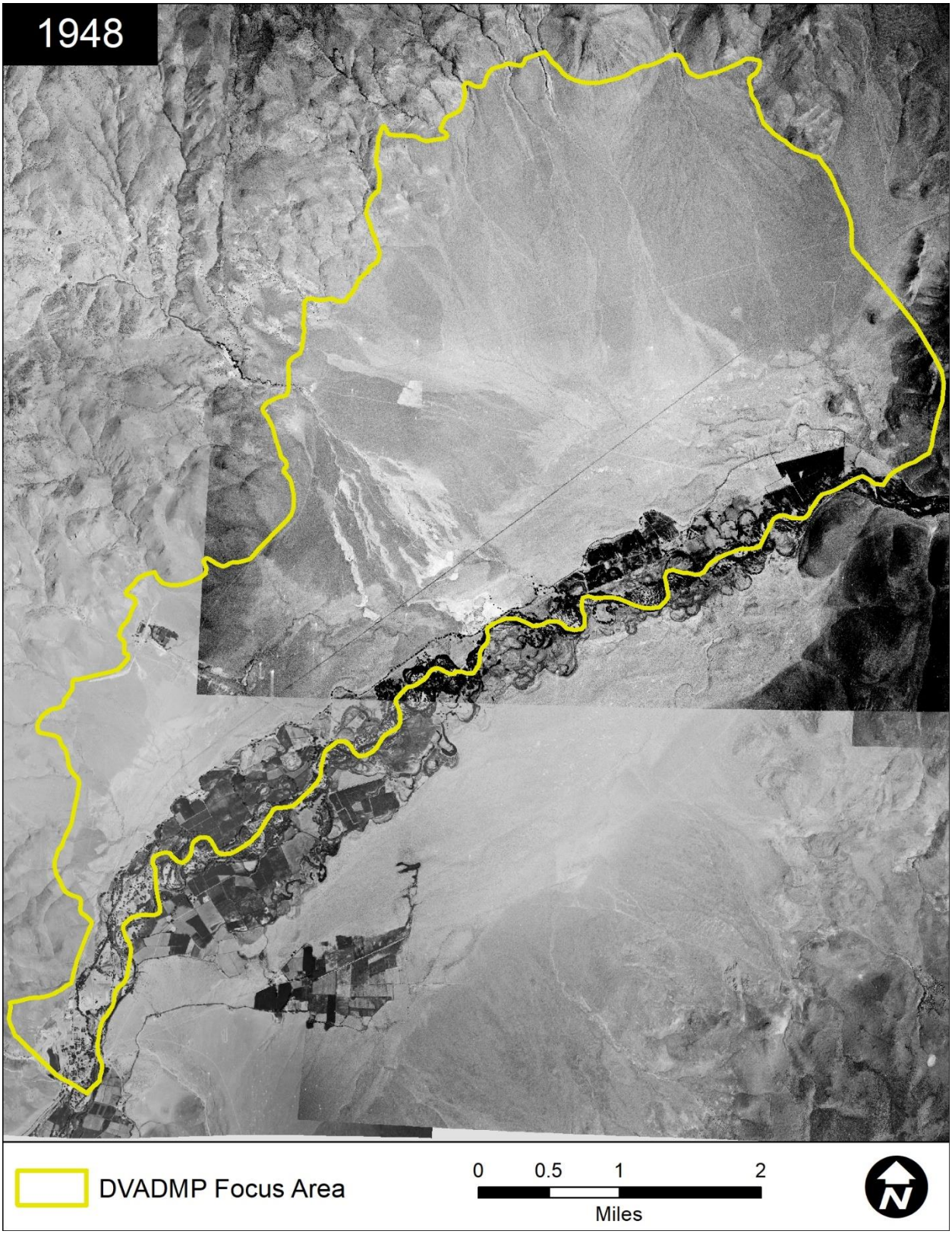


Figure 1-5. 1948 aerial photography

Figure 1-6. 2017 aerial photography

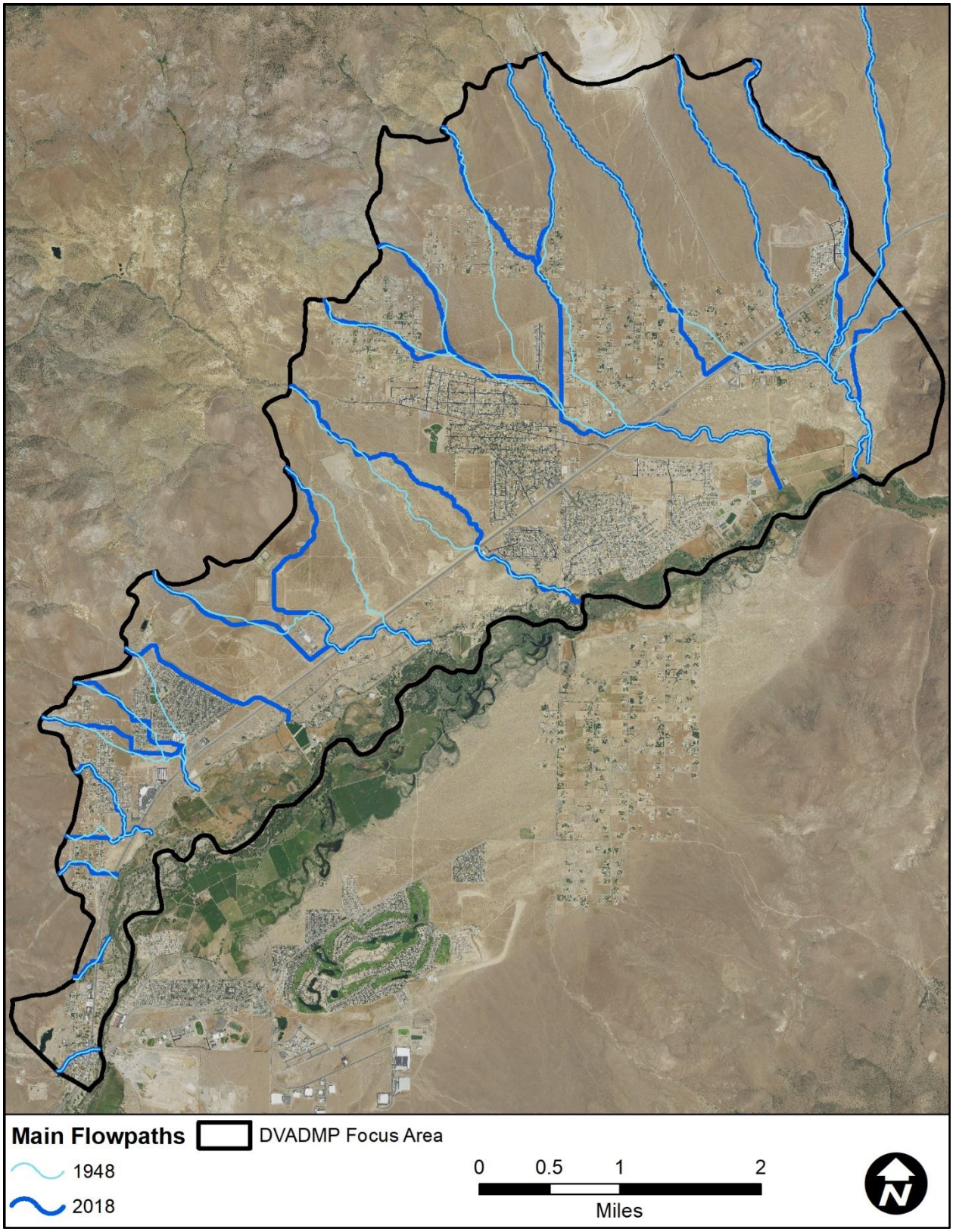


Figure 1-7. Main flowpath comparison (1948-2017)

2 PIEDMONT LANDFORMS

A piedmont is a broad, gently sloping and low relief plain located between mountain ranges and axial drainages and are part of an erosion-depositional system where sediment eroded from mountains is transported by a stream across the piedmont to a valley where it is deposited, or to an axial stream where it is transported out of the valley. Piedmont slopes range from less than 1 percent near the valley floors to more than 10 percent near the mountains. Typical piedmonts consist of pediments and relict fans on the upper slopes adjacent to the mountains and alluvial plains on the lower slopes adjacent to the valley floors or base level streams. Active alluvial fans (fans that are presently aggrading and eroding) can occur anywhere on the piedmont. Lower portions of many piedmonts consist of alluvial plains, low-relief aprons of mostly fine-grained deposits with small, discontinuous channel networks. Many piedmonts are formed by the lateral coalescence of separate alluvial fans into a landform called a bajada.

Piedmonts often have areas of tributary stream channels and distributary stream channels. Floodwater enters the piedmont in channels from the tributary mountain streams and as overland flow along the mountain front and from rainfall directly on the piedmont surface.

Active alluvial fan landforms function primarily as loci of deposition for sediment and detention and infiltration of floodwater, whereas the channels of pediments, relict fans and inactive alluvial fans function as transport corridors for sediment. Much of the deposited sediment on active alluvial fans can be remobilized by subsequent floodwater and redeposited down slope. A most significant difference between flood hazards on active alluvial fans and pediments, relict fans, and inactive alluvial fans is that paths of flow on active alluvial fans can change gradually or suddenly (avulsion) during flooding. The paths of flow on pediments, relict and inactive alluvial fans typically can be considered fixed for purposes of flood hazard assessment.

2.1 FLOWPATH UNCERTAINTY

An avulsion is the process by which flow is diverted out of an established channel into a new course on the adjacent floodplain (Slingerland & Smith, 2004). Avulsions divert flow from one channel into another, leading to a total or partial abandonment of the previous channel (Field, 2001; Bryant et. al., 1995), or may involve simple flowpath shifts in a braided or sheet flooding system (Slingerland & Smith, 2004). Avulsions are commonly associated with alluvial fan flooding, but are also known to occur on riverine systems and river deltas (Slingerland & Smith, 2004).

The occurrence of avulsions is what makes an alluvial fan “active.” Avulsions give the alluvial fan the ability to distribute water and sediment over the surface of the landform, which results in the radial “fan” shape. Avulsions influence flood hazards on an alluvial fan landforms by changing the location, concentration and severity of flooding on the fan surface. That is, an area not previously inundated by flooding (or inundated only by shallow flow) may in a subsequent flood become the locus of flood inundation, sediment deposition, and/or erosion. If an alluvial fan has no risk of avulsion, flood hazard delineation and mitigation become much simpler engineering problems, consisting only of modeling two-dimensional flow and/or normal riverine hydraulic and sedimentation issues.

The occurrence of major avulsions in an alluvial fan drainage system introduces the following complications into an engineering analysis of the flood hazard:

- Uncertain and changing flowpath locations, during and between floods
- Continually changing channel and overbank flowpath topography
- Inundation and/or sedimentation hazards in previously un-flooded areas
- Uncertain and changing flow rate distribution for areas downstream of avulsions
- Uncertain and changing watershed boundaries for areas downstream of avulsions
- Aggrading, net depositional land surfaces and channels with diminishing capacity
- Unsteady, rapidly-varied flow conditions
- High rates of infiltration and flow attenuation across the fan surface

As discussed previously in Section 1.3.3, the ADMP focus area is comprised of multiple active alluvial fan landforms that show clear evidence of both historical and modern flowpath uncertainty conditions. The flowpath uncertainty issue was addressed in this analysis by the use of the maximum flood hazard two-dimensional hydraulic modeling results. Flowpath uncertainty is caused by abrupt channel avulsions that occur during flood events. The cause of the channel avulsion can vary from channel aggradation (sedimentation) causing a rapid lateral shift in channel position, to overbank flooding carving a new channel, to upstream headcutting resulting in channel piracy. Regardless of the cause, the resulting abrupt change in channel position is something that is generally unpredictable and uncertain. The flowpath uncertainty analysis methodology addresses the channel avulsion potential element of the hazard analysis. Flowpath uncertainty modeling was conducted for this study to account for the potential hazards and is discussed in detail in Section 4.

3 HYDROLOGIC AND HYDRAULIC MODELING

3.1 METHOD DESCRIPTION

Since there are two jurisdictions (Storey and Lyon Counties) within the study area, multiple drainage guidelines were reviewed to ensure consistency in modeling methods and usability for the counties. Some of the reviewed documents included:

1) Drainage Guidelines for Lyon County (2006),
2) Nevada Department of Transportation (NDOT) Hydraulics Manual (2006),
3) Truckee Meadows Regional Drainage Manual (2009),
4) Recently completed NDOT Research Report (2015),
5) Flood Control District of Maricopa County (FCDMC) Hydrology Manual (2013).
6) National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Precipitation Frequency Estimate of the United States Volume 1 (NWS, 2011).

Based on these guidelines/manuals and an assessment of the watershed, the procedures that were used for hydrology and infiltration for the DVADMP are as follows:

- Infiltration was simulated using runoff curve number (CN) methodology per the Lyon County Drainage Guidelines.
- Rainfall depths were based on the NOAA Atlas 14 (NOAA14) precipitation estimates.
- The temporal distribution of the 6-hour storms was based on the balanced mass curve, while the 24-hour storms were based on the NDOT GLE mass curve.

All modeling, both hydrologic and hydraulic, was done using the FLO-2D Pro software[1] package, Build No. 16.06.16 with an executable dated February 28, 2017. This version has been used for multiple area drainage master studies and has functioned adequately. FLO-2D was selected for the DVADMP due to the following: 1) to maintain method consistency with other ADMP and drainage studies in the area (Manhard, 2012; JE Fuller, 2018), 2) to streamline model development since there are many small subbasins that would require individual analysis if a lumped parameter model, such as HEC-HMS were used, and 3) FLO-2D is a combined rainfall-runoff model (i.e., both hydrologic and hydraulic processes are simulated within the model).

3.2 MODEL DEVELOPMENT

3.2.1 Spatial Reference System

All data that was generated for the DVADMP used the horizontal control of the Nevada Coordinate System, West Zone, NAD83; while the vertical datum was the North American Vertical Datum of 1988 (NAVD 88). The units of measurement were U.S. Survey Feet.

3.2.2 Model Domains

The boundaries of the modeling domains are shown in Figure 3-1. The upper watershed areas (Gold Canyon and Upper Watershed) were modeled to provide inflow hydrographs to the detailed modeling

[1] https://www.flo-2d.com/

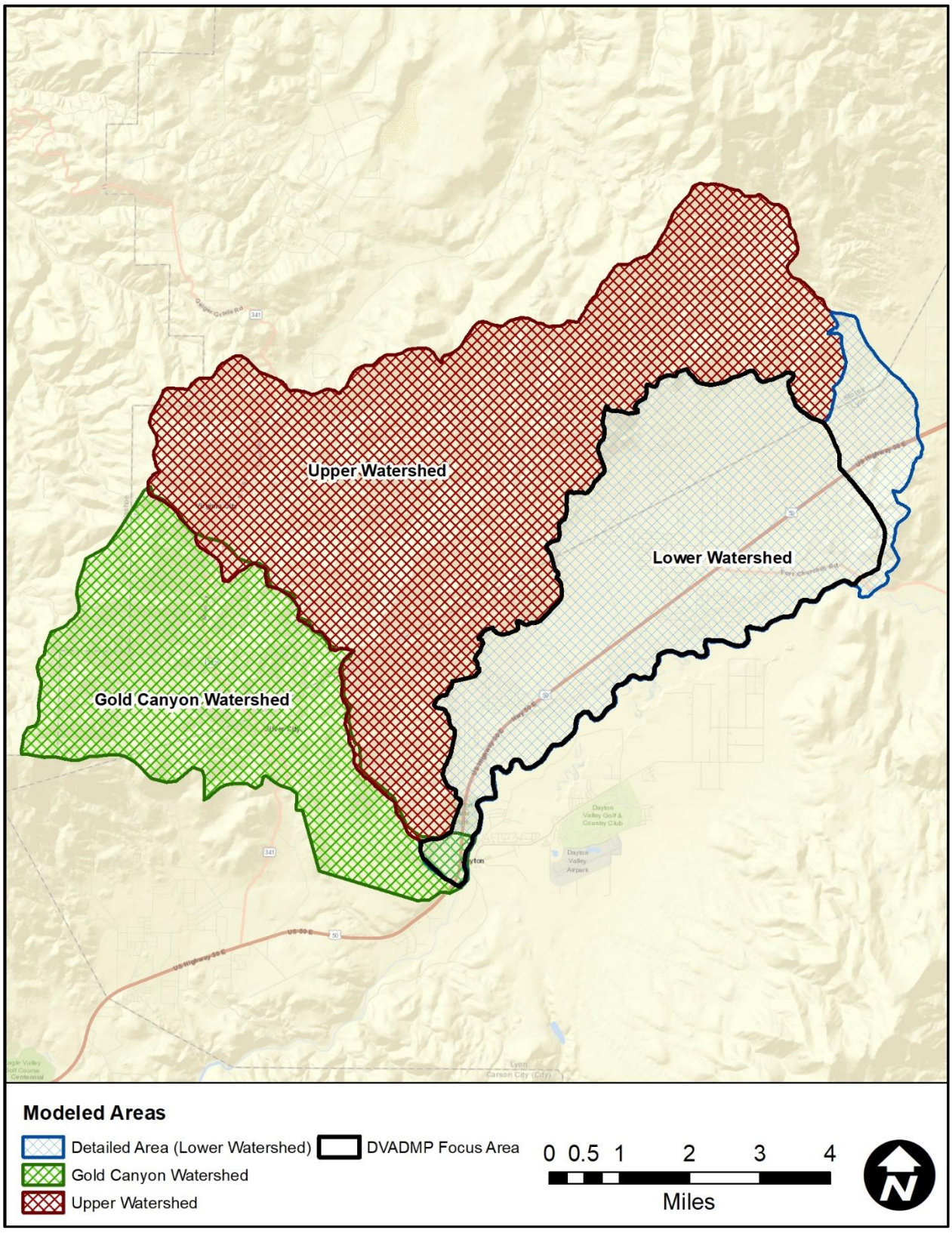


Figure 3-1. Modeling domains used in the Dayton Valley ADMP

area, labeled as "Lower Watershed" in the figure. The upper watershed areas will also be referred to as "off-site areas" throughout this report since the detailed model area is the focus of the flood hazard identification and mitigation alternative development.

Since FLO-2D is a combined rainfall-runoff model, off-site modeling was completed using less detailed (by surface classification and culvert/storm drain modeling) models, with inflow hydrographs from these upstream FLO-2D models being transferred to the upstream boundary of the detailed FLO-2D model.

3.2.3 Grid Size

The Dayton Valley watersheds contain many small drainage features that need to be adequately captured in the model to provide the most accurate results. Some of these features include small 18-inch storm drains and minor drainage ditches. A high-resolution, 15-foot grid-size was selected to provide the necessary detail to model these features while maintaining reasonable model run times based on the overall size of the modeling domains. The domain area and the number of grid cells in each model are shown in Table 3-1.

Table 3-1. FLO-2D model domain areas and number of grid elements

Model Domain	Domain Area (sq. miles)	Number of Grid Elements
Upper	33.2	4,108,472
Lower	21.2	2,625,748
Gold Canyon	15.8	1,956,869

3.2.4 Grid Element Elevations

The limits of all the topographic mapping sources used in the FLO-2D modeling are shown in relation to the model domains as Figure 3-2. There were three mapping sources:

- USGS QL1 LiDAR
- USGS QL2 LiDAR
- NEXTMAP 5-meter DTM

All three mapping sources are discussed in detail below.

3.2.4.1 USGS LiDAR

As a part of the 3D Elevation Program[2], the USGS collected high resolution LiDAR data for a large portion of Carson City and Washoe, Storey, and Lyon counties in Nevada through a contract with Digital Aerial Solutions, LLC (DAS) – Contract Number: G16PC00044. This data was collected at two specifications, QL1 and QL2. The flight parameters and point densities for both datasets are listed in Table 3-2. LiDAR collection began on September 19, 2017 and was completed on October 27, 2017 (DAS, 2018b). The original LiDAR data was collected with elevations in meters, a horizontal spatial reference of UTM Zone 11 N, Meters, NAD83, and a vertical spatial reference of NAVD 88. The DAS LiDAR reports are included in Appendix B.

[2] https://www.usgs.gov/core-science-systems/ngp/3dep

Table 3-2. LiDAR flight parameters, reproduced from DAS (2018b)

Parameter	QL1	QL2
Flying Height Above Ground Level:	8,609 feet	9,072 feet
Nominal Sidelap:	60%	30%
Nominal Speed Over Ground:	155 Knots	155 Knots
Field of View:	15°	24°
Laser Rate:	220.2 kHz	206.2 kHz
Scan Rate:	65.2 Hz	49.2 Hz
Maximum Cross Track Spacing:	1.22 meters	1.62 meters
Maximum Along Track Spacing:	0.61 meters	0.81 meters
Average point Spacing:	0.50 meters	0.67 meters

3.2.4.2 NEXTMAP Data

Approximately 0.56 square miles of the lower watershed (outside of the DVADMP focus area) was not included in the USGS LiDAR mapping area. Topographic data (DTM) was purchased from Intermap[3] for the 0.56 square mile gap area. This DTM product (referred to as NEXTMAP has a 5-meter resolution with elevation values in meters, a horizontal spatial reference of GCS North American 1983, and a vertical spatial reference of NAVD 88. Initial FLO-2D results from the NEXTMAP data were reasonable and compared well with observed flow patterns on aerial photography.

3.2.4.3 Combined FLO-2D Data

Since the LiDAR and NEXTMAP data were both in meters and in a different horizontal coordinate system than the DVADMP, the data was first converted to feet and the Nevada Coordinate System, West Zone, NAD83 and combined into a single raster. This single raster had a grid resolution of 1-foot to maintain accuracy of the LiDAR data even though the NEXTMAP data has a courser resolution. This high-resolution raster was resampled to a 15-foot grid raster that reflects the average grid elevations that are used in the actual FLO-2D models. The three topographic sources and their relation to the FLO-2D model domains are shown in Figure 3-2.

[3] http://www.intermap.com/

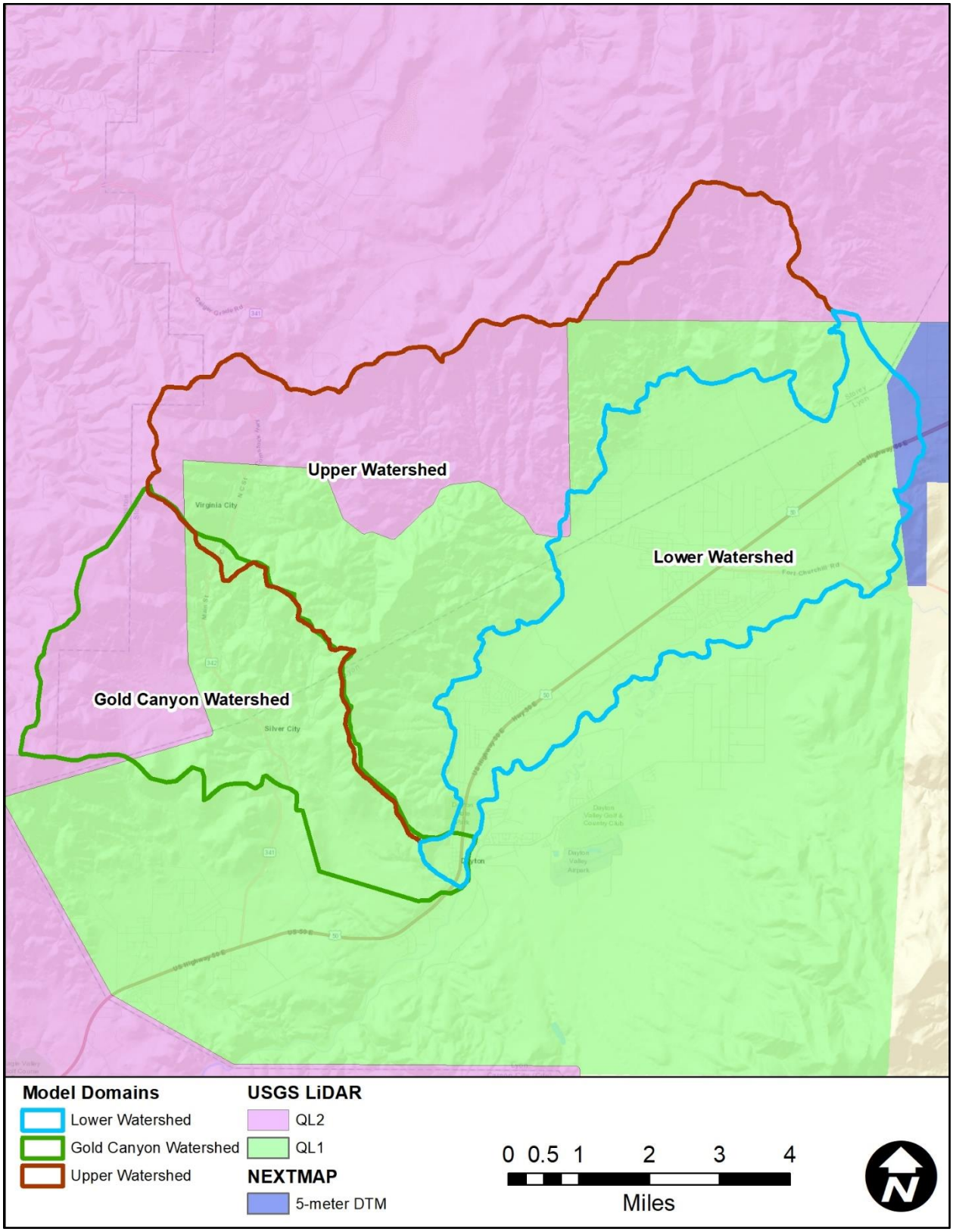


Figure 3-2. Limits of topographic mapping data

3.2.5 Model Inflow/Outflow

In general, outflow nodes were placed along the entire boundary of the model domains to let water free-flow out of the domain. However, the FLO-2D inflow/outflow routine was used to automatically transfer flow between the Upper watershed to the Lower watershed. This means that the boundaries between these two models are coincident, and the outflow nodes from the upper model provided the inflow hydrographs for the inflow nodes in the lower model. These inflow nodes are symbolized in orange along the boundaries of these two models in Figure 3-3.

Since the Gold Canyon watershed was added after the grid layout for the Upper and Lower models was finalized, the automated inflow/outflow routine was not used, and the model boundary was developed to allow for some overlap between the Gold Canyon and Lower models (see Figure 3-3). For Gold Canyon, outflow nodes were placed along the outer boundary, and a floodplain cross-section was placed in a confined section of the Gold Canyon creek. The hydrograph from this cross-section was then supplied as an inflow hydrograph to the Lower model, which is symbolized as a star in Figure 3-3.

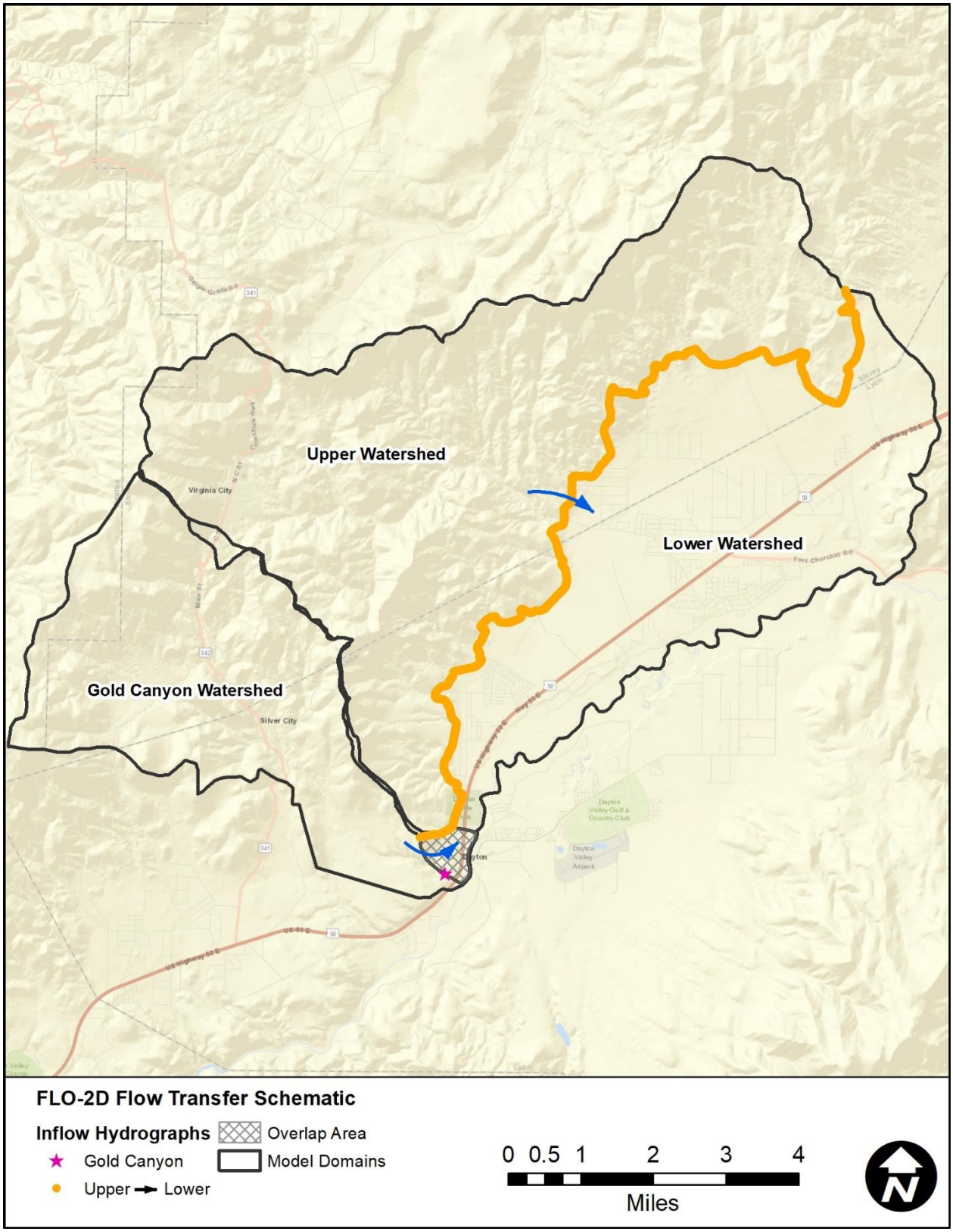


Figure 3-3. Hydrograph flow transfer between FLO-2D models

3.2.6 Precipitation Development

As a part of the DVADMP, three design storms were simulated:

- 25-year, 24-hour
- 100-year, 24- hour
- 100-year, 6-hour

The 24-hour durations were chosen to be consistent with the Counties' drainage regulations, while the 6-hour duration was chosen because this higher intensity duration usually results in higher peak flow estimates for smaller (i.e., < 20 square miles) drainage areas.

3.2.6.1 Precipitation Depths

NOAA Atlas 14 (NOAA14) precipitation depth estimates were downloaded from the National Weather Service (NWS) website (2018) as raster images, then used to apply the spatially varied rainfall estimate for each grid element in the model. This means that the point statistics are used at each grid cell in the FLO-2D model, which is different than the typical centroid-based precipitation estimates that are used in lumped parameter (e.g., HEC-HMS or HEC-1) modeling. Point rainfall statistics were selected because:

1) Using point rainfall has been the general procedure for other ADMP studies in the southwest.
2) Using point statistics results in reasonable but conservative flow estimates.

The maximum rainfall point values for each submodel are shown in Table 3-3.

Table 3-3. Maximum NOAA14 point rainfall estimates (in inches) by recurrence interval and model domain

Model Domain	Storm Event		
	25Y24H	100Y6H	100Y24H
Upper	3.595	2.225	4.607
Lower	2.520	1.848	3.214
Gold Canyon	3.527	2.212	4.516

3.2.6.2 Hyetographs

Due to the large increase in precipitation depth that occurs when the duration increases from 6 to 24 hours (see Table 3-3), the "balanced storm" hyetograph and the SCS Type II both produced peak flow results that were significantly higher than the peak flow estimates from the USGS regression equations (discussed later in this document). Therefore, JEF conducted a preliminary investigation of hydrology methods (see Appendix A), and it was determined by the client team that the NDOT (2015) hyetograph for this region should be used for the 24-hour storms, while the "balanced storm" hyetograph would be used for the 6-hour duration. The 6-hour balanced storm was developed with HEC-HMS version 4.2 using the frequency storm option (USACE, 2016a), while the 24-hour hyetograph was developed with the NDOT calculation spreadsheet using the 90th percentile maximum intensity (MI) from the Virginia Creek HUC-12 watershed. A comparison of the final two temporal distributions that were used in the ADMP is shown in Figure 3-4.

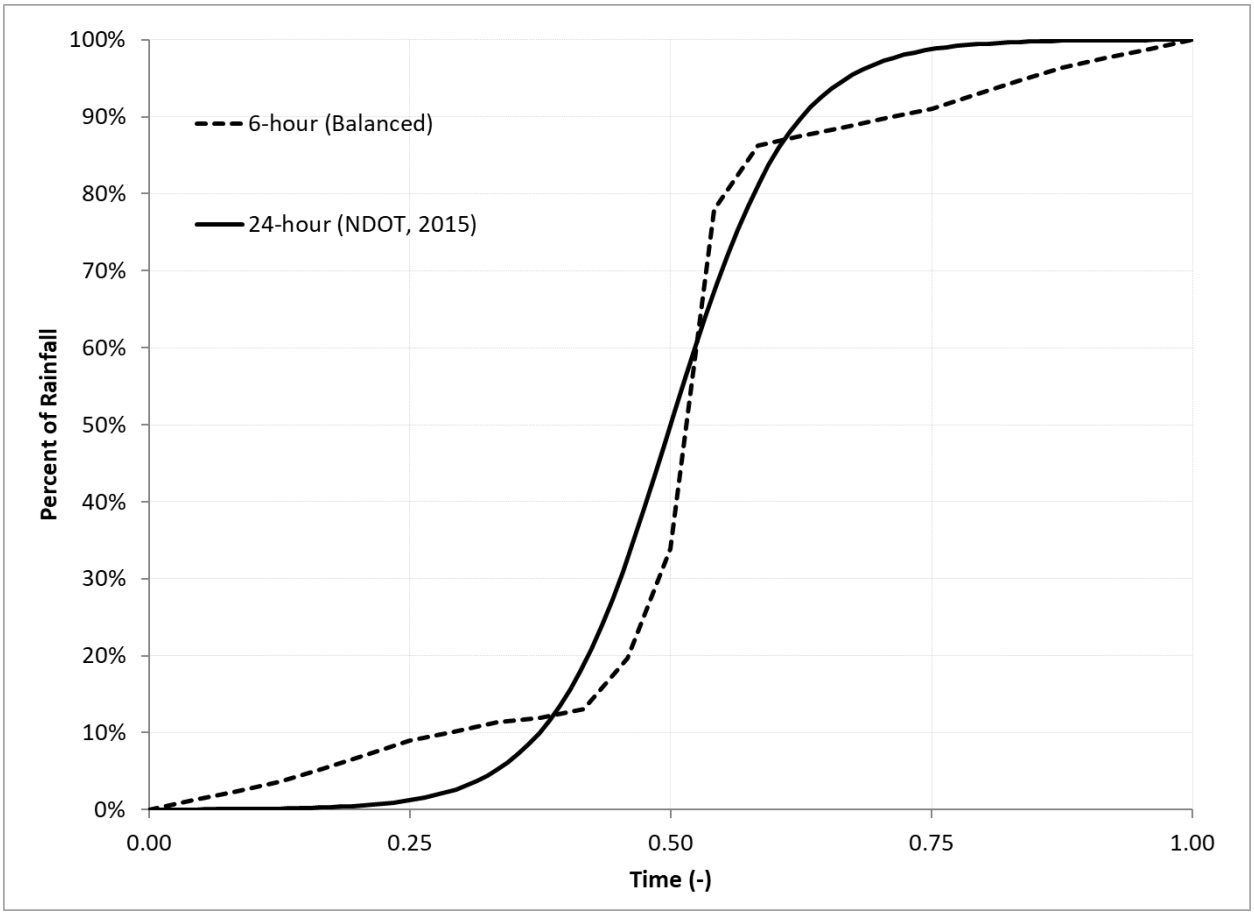


Figure 3-4. Comparison of 6- and 24-hour hyetographs used in the DVADMP

3.2.7 Infiltration Development

As mentioned in Section 3.1, the curve number methodology was used to calculate infiltration for this study. Curve numbers were extracted from the NRCS National Engineering Handbook (2004) which relates hydrologic soil group (HSG) and vegetation coverage type (Table 3-4). The cover type selected for the upper watershed and most of the Gold Canyon watershed was Pinyon-juniper, with desert shrub selected for the lower watershed. The final, composite curve numbers selected for the FLO-2D models are listed in Table 3-5.

Reasonable curve numbers were selected based on the HSG of the soils within the study area and an adjustment to account for surface imperviousness of pavement.

The Soil Survey Geographic (SSURGO) data from the National Resource Conservation Service (NRCS) was downloaded from the web soil survey (NRCS, 2018) and classified by HSG (Figure 3-5).

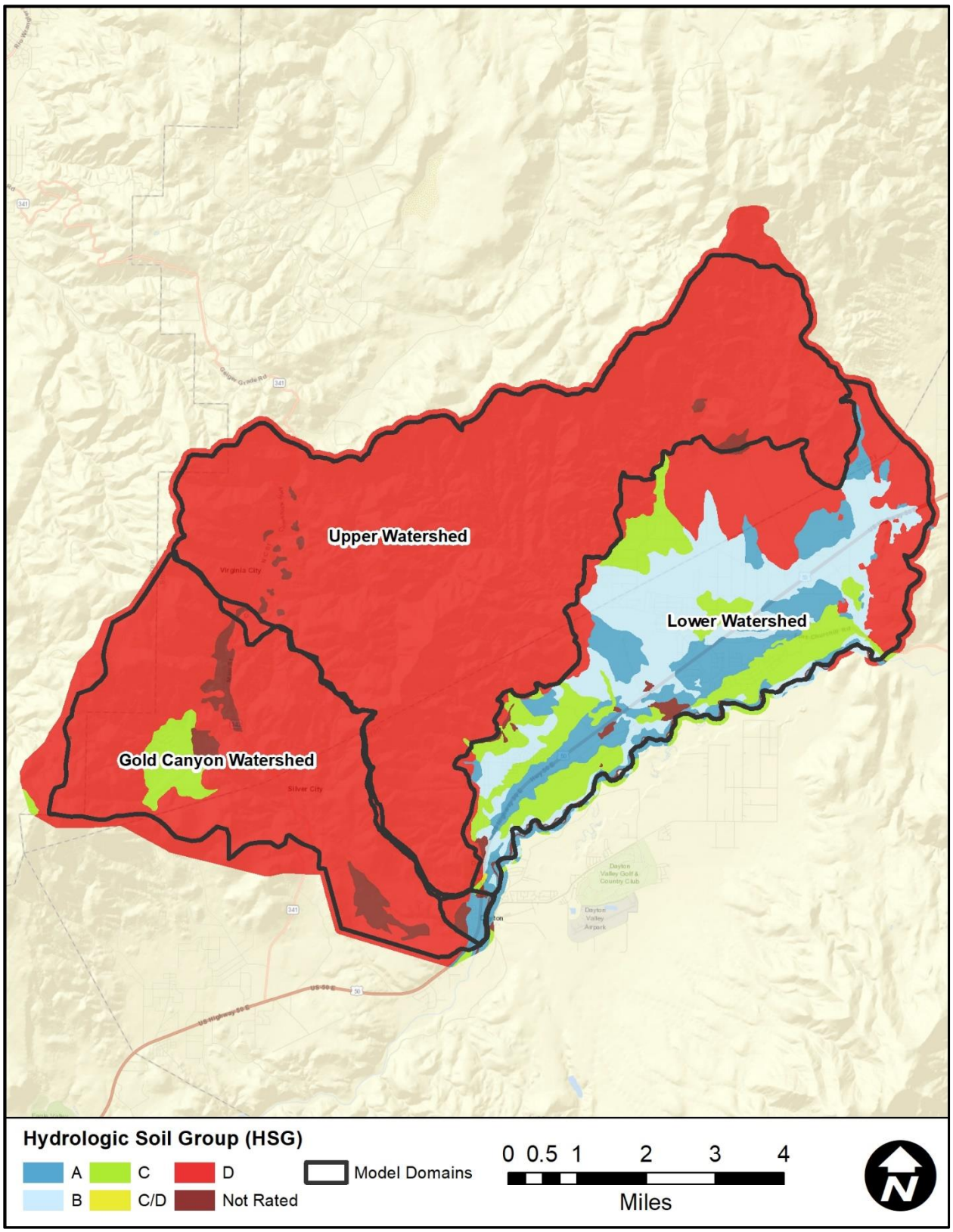


Figure 3-5. Hydrologic Soil Group (HSG) classification for soils Dayton Valley ADMP, from NRCS (2018)

Table 3-4. Runoff curve numbers for arid and semiarid rangelands, from NRCS (2004)

Cover description: cover type	hydrologic condition 2/	Hydrologic soil group: A 3/	B	C	D
Herbaceous—mixture of grass, weeds and low-growing brush, with brush the minor element	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sage-grass—sage with an understory of grass	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, paloverde, mesquite, and cactus	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

1/ Average runoff condition, and $I_a = 0.2s$. For range in humid regions, use table 9–1.

2/ Poor: <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: >70% ground cover.

3/ Curve numbers for group A have been developed only for desert shrub.

Table 3-5. Final runoff curve numbers used in the FLO-2D modeling

Hydrologic Soil Group	Curve Number
A	51
B	51
C	63
C/D	80
D	80
Pavement	99

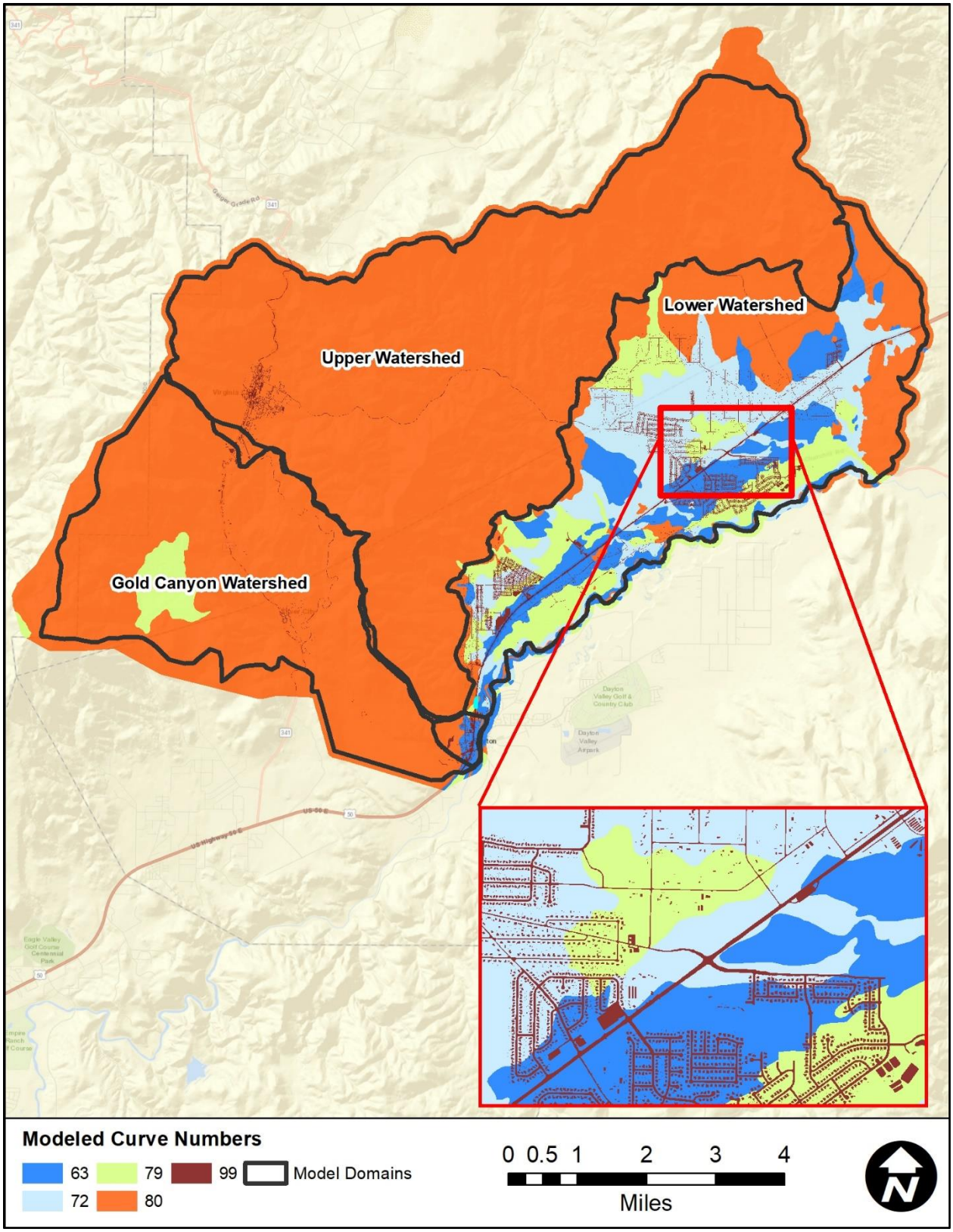


Figure 3-6. Spatial distribution of curve numbers used in the FLO-2D modeling

3.2.8 Grid Element Roughness (Manning's n Values)

The FLO-2D model uses Manning's n value to estimate roughness on each grid. Each grid element is assigned an average n value based on the underlying surface conditions. For this study, a detailed surface feature classification was developed by refining land use data provided by Lyon and Storey Counties and adding more detail in areas where the delineations were generalized. For example, major areas of pavement (parking lots and roads) and wash corridors were delineated in the modeling area since these features are major conveyances. In addition, the counties provided GIS data for building footprints within the study area. This data was also updated by the project team to include new structures that were built after the data was initially generated.

Table 3-6 lists the surface classification and its corresponding Manning's n values that were used in this analysis. The spatial distribution of the surface classification is shown in Figure 3-7.

Table 3-6. Surface classification and corresponding Manning's n value

Surface Classification	Manning's N
Upper Watershed	0.06
Lower Watershed	0.05
Turf	0.06
Pavement	0.02
Buildings	0.05
Washes	0.04
Water	0.04

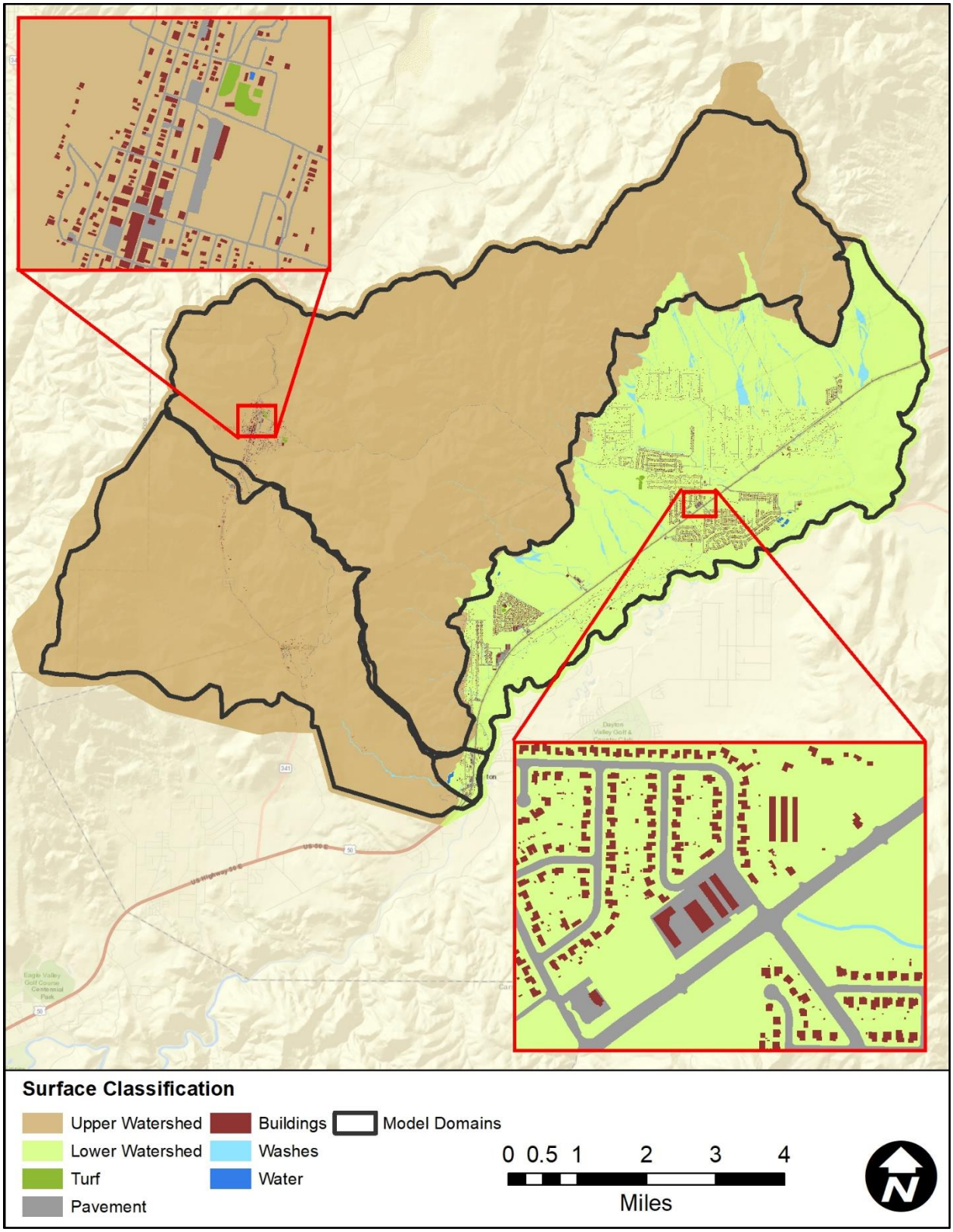


Figure 3-7. Surface classification used to assign grid element roughness in the FLO-2D model

3.2.9 Model Control Parameters

CONT.DAT and TOLER.DAT contain numerical stability and simulation controls for the FLO-2D model. The CONT.DAT file controls simulation time, output report time interval, some numerical controls and model switches, such as infiltration and rain. The total simulation time was set to 12 hours for the 6-hour storm, while the total simulation time was set to 30 hours for the 24-hour simulations. These times were sufficient to ensure the floodwave has traveled through the entire study area.

In the CONT.DAT file, the global Manning's n value adjustment factor (AMANN) and the limiting Froude number (FROUDL) were the numerical controls that were used in the Dayton Valley ADMP study. For this study, these controls were set to:

- AMANN = 0 (depth integrated roughness is used with the SHALLOWN parameter)
- FROUDL = 2.0 (Off-site areas), 1.2 (detailed model area)
- SHALLOWN = 0.1

For the limiting Froude number, a value of 2.0 was used in the off-site, upper watershed areas due to the presence of mountainous and piedmont areas where high flow velocities are possible since slopes can be greater than 20%. In the detailed model area, the limiting Froude number was set to 1.2 to account for the general reduction in slope as compared to the upper watersheds.

The TOLER.DAT file contains the numerical tolerance settings specified for the model. These settings are: the flow exchange tolerance (TOL), percent allowed change in flow depth (DEPTOL), dynamic wave stability criteria (WAVEMAX), and Courant-Friedrich-Lewy numerical stability parameter for floodplain grid element flow exchange (COURANTFP). For the Dayton Valley models, the settings applied were:

- TOL = 0.004 feet (the depth at which FLO-2D begins to route flow)
- DEPTOL = 0 (not used, model uses Courant number as stability criteria)
- WAVEMAX = 0 (not used, model uses Courant number as stability criteria)
- COURANTFP = 0.6 (main stability criterion used by FLO-2D)

These values have been used in similar studies, which yielded reasonable results. For this project, these values have produced good model stability and reasonable results.

3.2.10 Hydraulic Structures

Both culverts and minor storm drains in the study area were simulated with the hydraulic structure routine within the FLO-2D software. Please see the FLO-2D Data Input Manual (FLO-2D Software, Inc., 2016) and the FLO-2D Reference Manual (FLO-2D Software, Inc., 2017) for more details on the application of this routine and its associated modeling options. All structures (culverts and storm drains) that were modeled as a part of this ADMP are shown in Figure 3-8. Lyon County and NDOT provided the project team with culvert and storm drain database files which included the location and size of the structures. JEF staff conducted multiple field verification visits to the study area (Nov 2017, Aug 2018, Nov 2018) to verify the database information for many of the culverts (e.g. locations, sizes, overall condition, etc.). Where field verifications did not match the database records, adjustments were made to the models to be consistent with field observations.

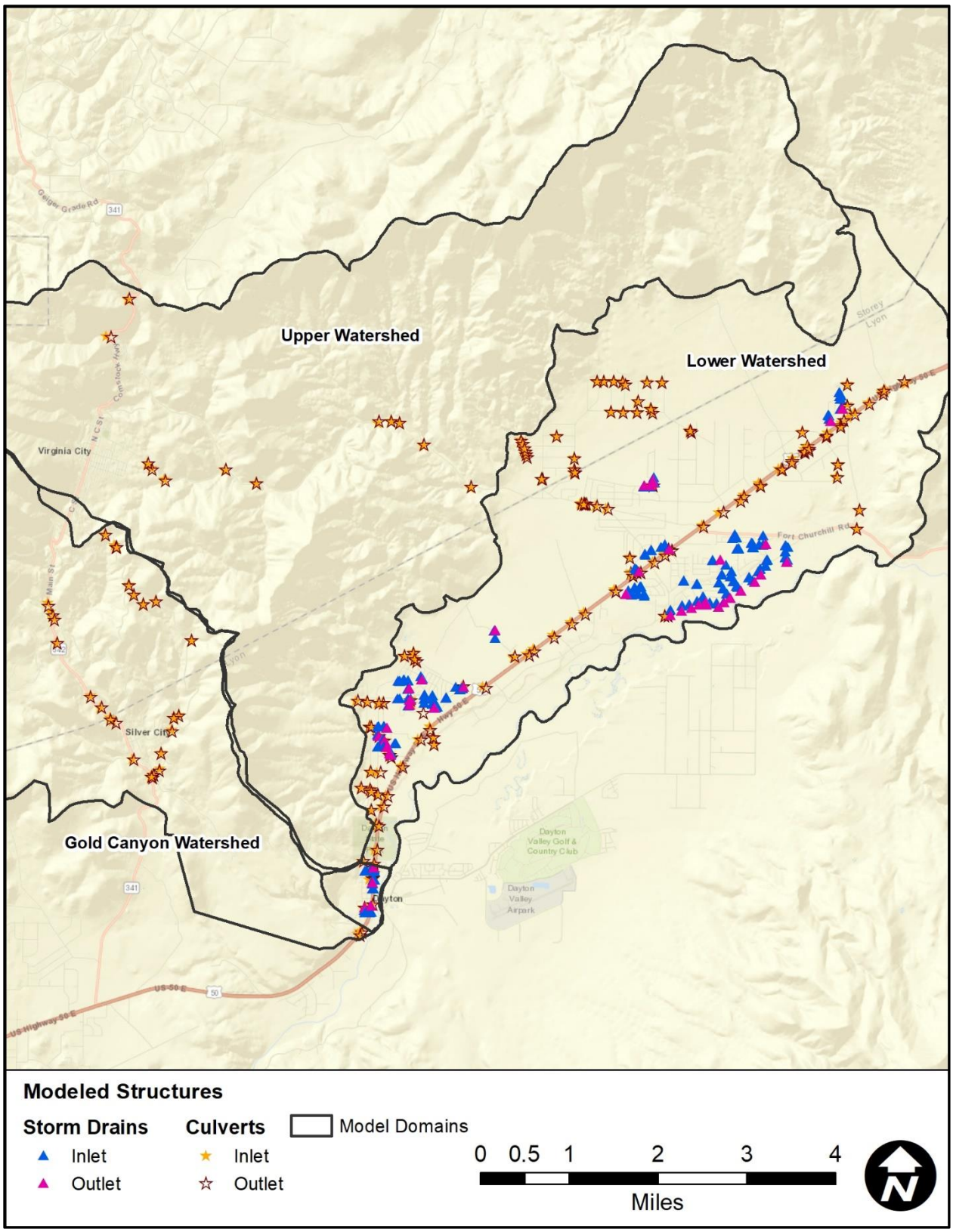


Figure 3-8. Locations of all modeled hydraulic structures (storm drains and culverts)

3.2.10.1 Culverts

In 2016 the Flood Control District of Maricopa County (FCDMC) conducted a comprehensive FLO-2D verification report within which they provided recommendations on modeling hydraulic structures. Per those recommendations, the generalized culvert equation option in FLO-2D was used for the DVADMP models for single barrel box and circular culverts as a first option. If there were multiple barrels, a rating table was developed assuming inlet control for the culvert. The modeling options that were used to model culverts are summarized below.

1) Generalized culvert equations used for single barrel boxes and circular culverts with no clogging.
2) If multiple barrel, a rating table developed based on inlet control.
3) If significant sediment blockage, a rating table developed based on inlet control with a reduced discharge based on percent clogged.
4) If culvert had an irregular shape (i.e., ellipse or arch), a rating table was developed based on a simplified EPA-SWMM model (and reduced if there was significant sediment blockage).
5) If tailwater conditions could affect flow, a rating table was used and the INOUTCONT variable in FLO-2D was set to 2.

3.2.10.1.1 Clogging Factors

If a culvert was observed to have significant sediment blockage during a field investigation, an appropriate reduction in flow was applied to the rating table (i.e., if a culvert was blocked by 50%, the flow was reduced by 50%). To produce a conservative estimate of downstream flows, the culverts in the models for the upper watersheds (model names: Gold Canyon and Upper) were assumed to be completely clear, except one 4-ft by 4-ft box culvert that could not be found in the field. This box culvert assumed an 80% clogging factor.

For the detailed on-site modeling (model name: Lower), smaller culverts (<36 inches) used a 50% clogging factor. Larger culverts (≥ 36 inches and box culverts) did not have a clogging factor except where sediment deposition was observed at the culvert or in the watersheds that exhibited high sediment transport rates. For example, some culverts in the Mark Twain area were clear but the watershed has significant slope with high sediment transport rates. All culverts in this area used a clogging factor.

3.2.10.2 Storm Drains

Since the study area has a relatively small number of minor storm drains (i.e., 18- to 42-inch trunk lines with about 2 to 10 total inlets per trunk line), rating tables were developed to simulate these structures. The rating tables were developed based on the inlet geometry and the connector pipe. This means that at low depths the curb/grate opening controlled flow, but at higher depths the connector pipe capacity controlled. Finally, if multiple inlets were connected to one trunk line outlet, the “D” line functionality that limits the total flow in the storm drain system to a user-specified discharge was used to limit the flow to the trunk line capacity. This capacity was determined by calculating the normal depth full flow of the trunk line and estimated a 20-50% increase in flow to account for some pressure flow. The limited pipe capacities that were used in the FLO-2D modeling are shown in Table 3-7.

Table 3-7. Full flow versus "D" line pipe capacity used in the FLO-2D modeling

Pipe Diameter	Full Flow (normal depth)	Pipe Capacity in FLO-2D
inches	cfs	cfs
12	6	9
15	10	15
18	17	25
24	36	48
30	65	78
36	105	126
42	160	192
48	227	272

3.3 Buildings (as Flow Obstructions)

As discussed previously, building footprints were provided by the counties and updated by JEF based on 2017 aerial imagery. The buildings dataset (GIS shapefile) were used to create a global area-weighted 15-foot blocked obstruction raster. This raster was then used to extract the percentage of area obstructed by buildings and assigned to area reduction factors (ARF) for each grid in each sub-model. The totally blocked grid element routine ("T Line") was not used to simplify file development. Totally blocked grids were rather assigned 1 in the partially blocked grid attribute (i.e., the IDG column). Similarly, to ease file development, width reduction factors (WRF) were not used in this study and were assigned a 0 value in the ARF.DAT file. The buildings that were modeled with the ARF functionality are shown in Figure 3-7.

3.4 Model Results

3.4.1 Floodplain Cross-Sections

Floodplain cross-sections were developed and included in the FPXSEC.DAT file to query flow hydrographs, peak discharges, and flow volumes from the FLO-2D model at key locations, such as:

- Major flow concentration locations,
- Areas near potential mitigation sites, and
- Areas of interest to Lyon and Storey Counties

Major floodplain cross-section locations are shown on Figure 3-9. Hydrograph plots at the floodplain-cross-sections for each storm event are included in Appendix C. The peak flow and volume for each floodplain cross-section are shown in Table 3-8.

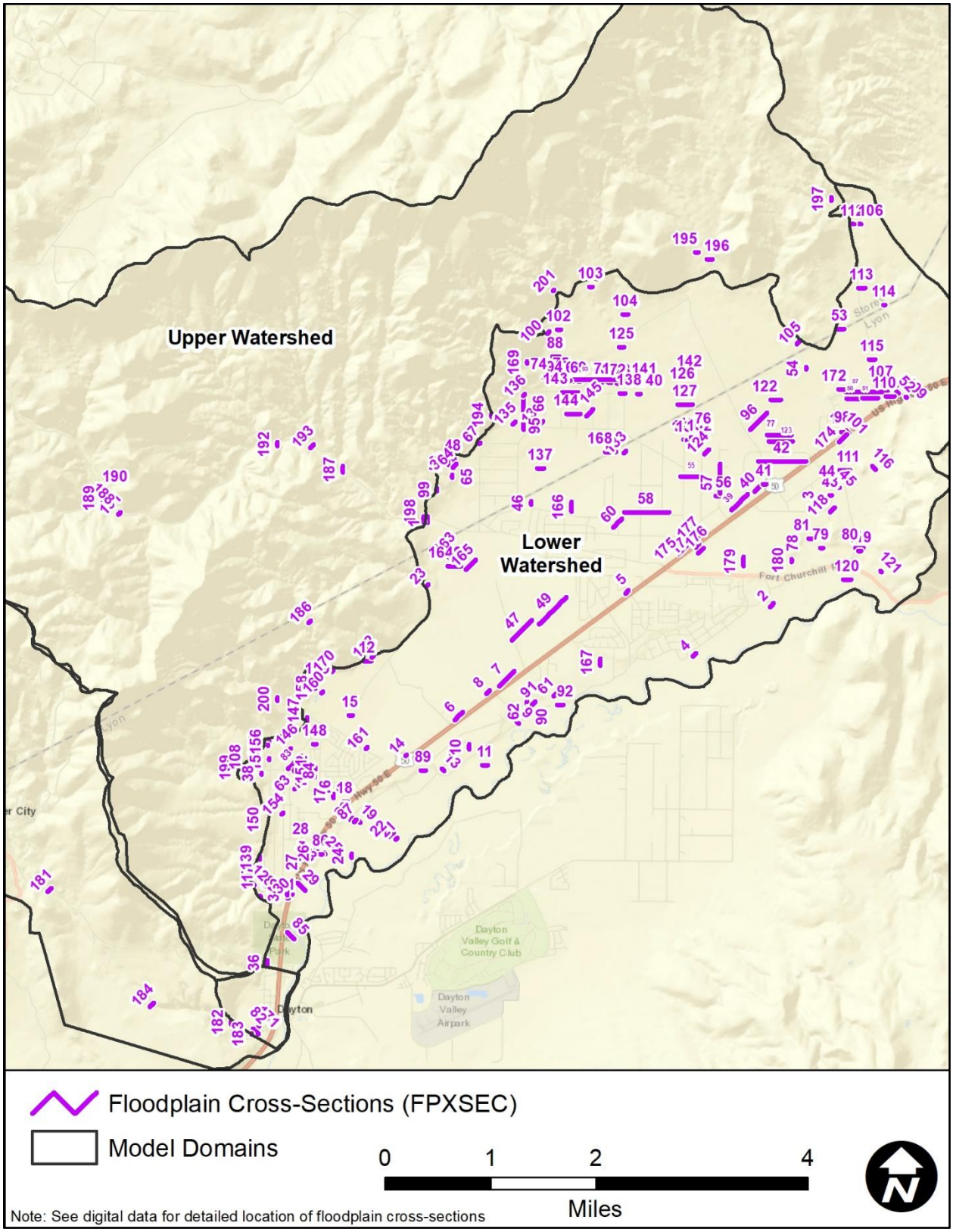


Figure 3-9. Floodplain cross-section locations

Table 3-8. Peak flow and volume results from the FLO-2D floodplain cross-sections

ID	100Y24H		100Y6H		25Y24H	
	Peak Flow	Volume	Peak Flow	Volume	Peak Flow	Volume
	cfs	ac-ft	cfs	ac-ft	cfs	ac-ft
1	4195.6	1422.4	2826.9	397.6	2716.9	900.0
2	0.4	0.3	0.5	0.2	0.4	0.2
3	1199.8	473.4	345.9	126.9	761.3	295.2
4	0.6	0.2	0.9	0.1	0.3	0.1
5	2.9	0.3	1.0	0.1	0.2	0.1
6	103.1	77.3	36.7	17.4	72.8	43.6
7	429.2	143.0	0.5	0.2	1.0	0.5
8	20.5	10.5	7.6	3.3	11.4	4.7
9	2.0	0.5	0.0	0.0	1.7	0.3
10	0.0	0.0	0.0	0.0	0.0	0.0
11	0.1	0.1	0.0	0.0	0.0	0.0
12	18.7	5.4	38.5	2.1	11.1	3.2
13	0.1	0.0	0.0	0.0	0.0	0.0
14	21.8	15.8	0.0	0.0	5.6	2.5
15	74.9	18.5	8.9	0.9	39.4	6.9
16	109.3	45.6	70.1	19.5	71.3	29.9
17	63.7	32.7	29.0	9.5	43.3	20.2
18	115.0	82.3	58.3	28.3	69.8	47.7
19	30.4	25.4	17.0	4.5	21.8	11.3
20	97.0	90.8	83.2	36.0	88.6	60.7
21	45.0	44.2	27.4	11.3	34.5	26.4
22	44.5	44.3	27.1	11.8	34.4	26.7
23	79.5	24.8	158.2	9.7	50.1	14.6
24	114.9	87.2	75.0	28.7	92.5	49.8
25	47.0	41.8	39.7	16.6	41.4	25.3
26	90.0	76.0	71.7	27.9	75.4	42.9
27	159.7	94.7	161.3	29.1	121.9	43.8
28	90.3	43.8	81.0	15.8	64.8	23.8
29	89.0	39.0	26.9	9.4	66.7	24.6
30	19.9	4.4	12.2	0.8	4.5	1.2
31	9.7	2.6	8.2	0.8	4.3	1.2
32	13.0	4.0	10.0	1.6	7.2	2.2
33	18.7	5.8	26.6	2.4	12.0	3.5
34	15.6	5.2	21.5	2.1	11.0	3.2
35	3.3	1.0	8.2	0.4	2.2	0.6
36	42.2	12.8	62.2	5.0	25.5	7.4
37	58.6	18.8	94.1	6.4	38.5	11.2

ID	100Y24H		100Y6H		25Y24H	
	Peak Flow	Volume	Peak Flow	Volume	Peak Flow	Volume
	cfs	ac-ft	cfs	ac-ft	cfs	ac-ft
38	100.2	52.4	84.4	20.3	78.8	32.1
39	148.0	53.0	64.6	15.6	94.9	32.8
40	41.5	14.9	16.8	5.3	23.4	8.9
41	10.8	3.0	3.4	0.6	5.3	1.4
42	1019.8	356.0	904.0	98.2	675.5	225.0
43	257.2	84.0	57.3	24.7	96.5	44.1
44	94.9	28.3	16.2	6.3	35.7	12.8
45	163.7	55.5	42.2	18.8	61.7	31.2
46	143.9	49.5	79.4	16.3	92.5	29.7
47	563.2	143.2	220.4	18.6	303.9	66.2
48	42.4	12.8	68.9	4.4	28.7	7.7
49	2967.8	1164.4	2140.4	365.6	2266.9	809.9
50	98.4	33.8	60.5	10.9	59.2	19.5
51	167.1	55.0	96.4	16.6	103.2	32.7
52	17.4	6.0	7.8	2.2	9.6	3.4
53	43.3	13.5	43.0	4.6	26.7	8.2
54	22.4	7.5	16.8	2.7	14.6	4.5
55	101.1	29.3	40.7	6.6	51.5	14.4
56	28.4	15.9	20.4	6.9	21.7	12.3
57	141.5	50.3	91.4	14.9	95.0	31.3
58	487.2	184.4	267.6	57.9	306.4	118.7
59	54.5	17.9	87.3	6.1	36.8	10.8
60	413.1	149.5	106.2	40.3	194.1	83.5
61	66.7	72.8	0.1	0.0	3.0	1.7
62	72.5	64.3	29.4	9.4	46.6	30.1
63	79.1	43.6	72.1	18.2	67.5	29.1
64	98.2	31.2	154.3	10.6	64.0	18.8
65	4.6	1.5	9.2	0.6	3.0	0.9
66	10.1	3.2	12.1	0.9	5.9	1.8
67	12.3	4.1	25.3	1.4	8.2	2.5
68	7.9	2.7	8.4	0.9	5.1	1.6
69	4.9	1.6	4.1	0.6	3.1	1.0
70	13.7	4.6	10.9	1.6	8.7	2.8
71	4.9	1.5	3.0	0.5	3.0	0.9
72	4.8	1.2	2.2	0.4	2.2	0.7
73	183.4	63.2	211.1	19.2	126.0	41.7
74	26.5	8.7	49.7	2.9	16.5	5.2
75	309.4	100.8	511.7	30.4	199.5	62.7

ID	100Y24H		100Y6H		25Y24H	
	Peak Flow	Volume	Peak Flow	Volume	Peak Flow	Volume
	cfs	ac-ft	cfs	ac-ft	cfs	ac-ft
76	267.6	93.3	233.5	28.1	169.0	57.0
77	1002.8	349.5	1106.7	96.2	674.8	221.7
78	701.6	367.3	210.3	84.8	413.4	211.4
79	1.7	0.4	0.7	0.1	0.7	0.2
80	1506.2	576.6	416.5	156.1	864.5	349.2
81	2.0	1.1	0.0	0.0	1.1	0.6
82	2012.7	755.5	1168.5	212.8	1454.8	490.1
83	70.4	23.0	99.8	8.6	43.7	13.6
84	4.2	1.3	3.1	0.5	2.3	0.7
85	91.3	35.2	38.4	5.6	85.2	24.6
86	90.4	76.4	71.9	28.1	75.7	43.1
87	80.7	78.7	58.5	28.1	66.6	47.4
88	309.0	100.2	514.2	30.2	198.5	62.3
89	17.9	11.9	0.1	0.0	3.4	1.3
90	37.3	27.3	7.0	1.7	18.1	8.5
91	35.5	36.1	21.9	6.9	27.9	20.8
92	47.2	53.8	0.2	0.0	2.9	1.6
93	223.2	76.4	234.7	23.7	152.2	49.6
94	312.0	101.6	513.5	30.6	201.0	63.2
95	11.0	3.5	12.9	1.0	6.3	1.9
96	24.1	6.8	12.3	2.4	11.1	3.5
97	269.0	91.3	149.8	28.6	166.6	53.9
98	99.2	37.6	94.9	11.8	67.0	21.7
99	23.9	6.6	33.5	2.3	16.1	4.2
100	156.4	52.1	254.3	16.2	101.8	32.4
101	235.2	76.2	118.3	18.5	148.7	40.0
102	151.9	47.3	268.8	14.0	96.2	29.6
103	194.6	61.6	306.0	18.0	125.4	38.9
104	144.1	48.0	196.7	13.8	94.2	30.3
105	128.3	41.2	212.1	13.6	82.3	25.0
106	14.1	4.7	20.7	1.5	9.0	2.9
107	33.6	10.9	19.7	4.0	19.8	6.3
108	158.6	51.7	325.9	20.2	102.8	31.8
109	14.0	4.5	16.0	1.7	8.8	2.5
110	51.9	17.7	25.7	6.4	28.8	10.0
111	157.9	53.3	40.4	18.1	59.2	30.1
112	110.4	34.0	133.2	10.3	69.0	20.8
113	131.5	42.0	147.7	12.8	84.1	25.6

ID	100Y24H		100Y6H		25Y24H	
	Peak Flow	Volume	Peak Flow	Volume	Peak Flow	Volume
	cfs	ac-ft	cfs	ac-ft	cfs	ac-ft
114	30.5	10.4	29.4	3.7	18.7	6.2
115	170.9	57.2	110.2	17.7	107.1	34.3
116	22.8	7.0	41.0	2.8	13.9	4.0
117	31.2	9.6	71.5	3.9	20.9	5.8
118	1467.5	562.8	405.5	152.5	844.0	342.0
119	1436.5	567.6	416.6	156.2	861.4	348.8
120	890.0	436.5	377.9	148.1	663.4	305.8
121	12.0	3.8	26.1	1.5	8.7	2.1
122	972.4	342.3	1155.1	94.6	670.3	219.4
123	1026.0	361.6	1072.7	99.5	706.4	231.5
124	159.1	63.1	133.9	21.3	112.6	42.5
125	206.6	65.6	306.1	19.1	132.8	41.3
126	236.8	82.3	257.0	24.4	151.7	50.6
127	257.7	89.2	256.6	26.8	162.8	54.6
128	23.5	7.0	56.3	2.9	15.9	4.2
129	23.0	6.4	23.8	1.4	12.4	3.1
130	66.1	20.0	58.1	4.8	38.7	10.5
131	16.8	3.5	14.9	0.4	4.5	0.8
132	153.6	60.7	134.5	20.4	108.4	41.0
133	396.6	144.6	361.3	46.0	277.8	95.3
134	56.3	17.3	52.7	5.4	33.0	9.9
135	109.2	35.9	170.2	11.7	76.5	22.3
136	15.0	4.9	31.6	1.7	9.6	3.0
137	110.6	37.1	111.6	11.8	76.7	22.9
138	182.7	62.2	205.4	18.8	124.0	40.7
139	98.2	31.6	147.3	12.6	62.7	18.9
140	60.4	15.2	82.4	4.1	30.1	7.4
141	13.9	4.7	18.3	1.6	9.2	3.0
142	12.6	4.0	8.7	1.4	7.5	2.4
143	291.7	90.9	475.8	26.8	180.2	54.3
144	66.6	18.0	94.9	4.8	36.5	9.6
145	259.2	88.0	360.6	27.1	173.4	56.1
146	62.1	19.9	104.8	7.6	39.2	12.0
147	94.1	33.0	151.9	12.8	67.1	21.8
148	21.7	6.1	34.2	2.2	12.2	3.1
149	0.4	0.2	1.8	0.1	0.3	0.1
150	68.7	21.9	115.5	8.5	45.5	13.4
151	42.0	11.7	62.5	3.6	21.8	5.6

ID	100Y24H		100Y6H		25Y24H	
	Peak Flow	Volume	Peak Flow	Volume	Peak Flow	Volume
	cfs	ac-ft	cfs	ac-ft	cfs	ac-ft
152	1.7	0.3	2.7	0.1	0.5	0.1
153	98.2	32.1	92.5	12.3	62.2	19.1
154	79.5	27.6	111.4	10.4	51.6	16.2
155	6.3	1.2	7.5	0.5	3.8	0.7
156	47.4	15.4	122.3	5.9	30.9	9.4
157	3.7	1.0	14.5	0.4	2.0	0.5
158	1.8	0.6	4.2	0.2	1.1	0.3
159	7.7	2.4	19.9	1.0	5.9	1.4
160	9.0	2.2	13.2	0.8	4.5	1.2
161	24.6	19.4	15.8	11.6	17.4	16.2
162	4.0	1.3	11.0	0.5	2.8	0.8
163	4190.5	1423.0	2817.5	397.3	2718.3	900.4
164	596.9	100.6	146.9	3.9	127.3	15.9
165	3596.7	1322.7	2664.4	393.1	2590.9	884.4
166	265.4	93.7	124.0	28.4	162.0	55.0
167	2802.6	1254.9	1621.6	377.1	2283.9	869.1
168	68.5	18.9	52.8	4.8	37.7	9.8
169	9.7	3.1	20.3	1.1	7.9	1.9
170	165.8	52.8	313.1	20.0	106.0	31.8
171	1241.9	591.3	1113.5	211.6	1203.3	456.2
172	81.5	27.7	99.5	9.1	55.7	17.2
173	99.1	37.6	94.8	11.8	67.0	21.7
174	76.2	13.9	2.7	0.2	16.8	1.8
175	684.4	344.8	206.9	83.6	392.1	194.8
176	683.1	360.3	204.8	87.6	402.8	208.4
177	49.9	23.4	16.2	5.1	32.0	14.9
178	0.1	0.0	0.5	0.0	0.1	0.0
179	701.9	368.5	210.6	87.3	413.7	212.6
180	40.0	9.1	0.0	0.0	1.4	0.1
181	2099.7	710.8	1190.1	187.4	1337.5	440.5
182	2318.2	786.6	1179.5	211.8	1472.0	483.9
183	2005.3	751.5	1173.7	212.7	1476.2	485.6
184	2240.1	759.2	1157.1	201.8	1423.2	467.8
185	1238.7	591.9	1115.8	211.4	1205.1	455.7
186	126.4	41.3	312.0	15.3	81.9	25.2
187	3837.1	1310.1	2719.2	365.0	2481.9	829.5
188	841.4	296.8	775.4	79.5	541.4	191.1
189	771.5	238.9	696.5	51.4	468.3	138.7

ID	100Y24H		100Y6H		25Y24H	
	Peak Flow	Volume	Peak Flow	Volume	Peak Flow	Volume
	cfs	ac-ft	cfs	ac-ft	cfs	ac-ft
190	1208.7	422.2	1167.5	114.3	815.7	274.6
191	2105.9	736.0	1764.4	198.0	1379.0	475.8
192	3299.8	1129.2	2450.7	310.7	2149.2	717.2
193	3553.0	1213.9	2559.7	335.6	2297.3	769.3
194	106.2	35.2	185.5	11.7	69.0	21.6
195	57.6	19.7	86.7	5.9	38.1	12.4
196	903.8	312.5	1270.5	85.9	601.2	199.6
197	87.7	29.3	134.4	8.8	57.0	18.1
198	4170.4	1421.3	2896.0	400.4	2693.3	897.8
199	155.0	51.0	348.7	19.4	102.3	31.3
200	131.4	43.0	268.6	16.0	84.7	26.2
201	130.2	44.3	267.8	13.2	86.2	28.0

3.4.2 Depth and Discharge Results

Flow depth and discharge results from the existing conditions FLO-2D modeling are shown on Figure 3-10 through Figure 3-15. These figures are for general illustrative purposes and not practical for obtaining detailed information at site-specific locations. For more detailed results, FLO-2D workmaps, included in Appendix C, have been generated and contain grid-based data for the maximum flow depth, maximum peak discharge, and maximum velocity.

3.4.3 Animations

Google Earth animations of the Lower watershed models have been included with the digital model results (Appendix C). These animations are helpful for visualizing the dynamic nature of the flooding as it moves through the study area.

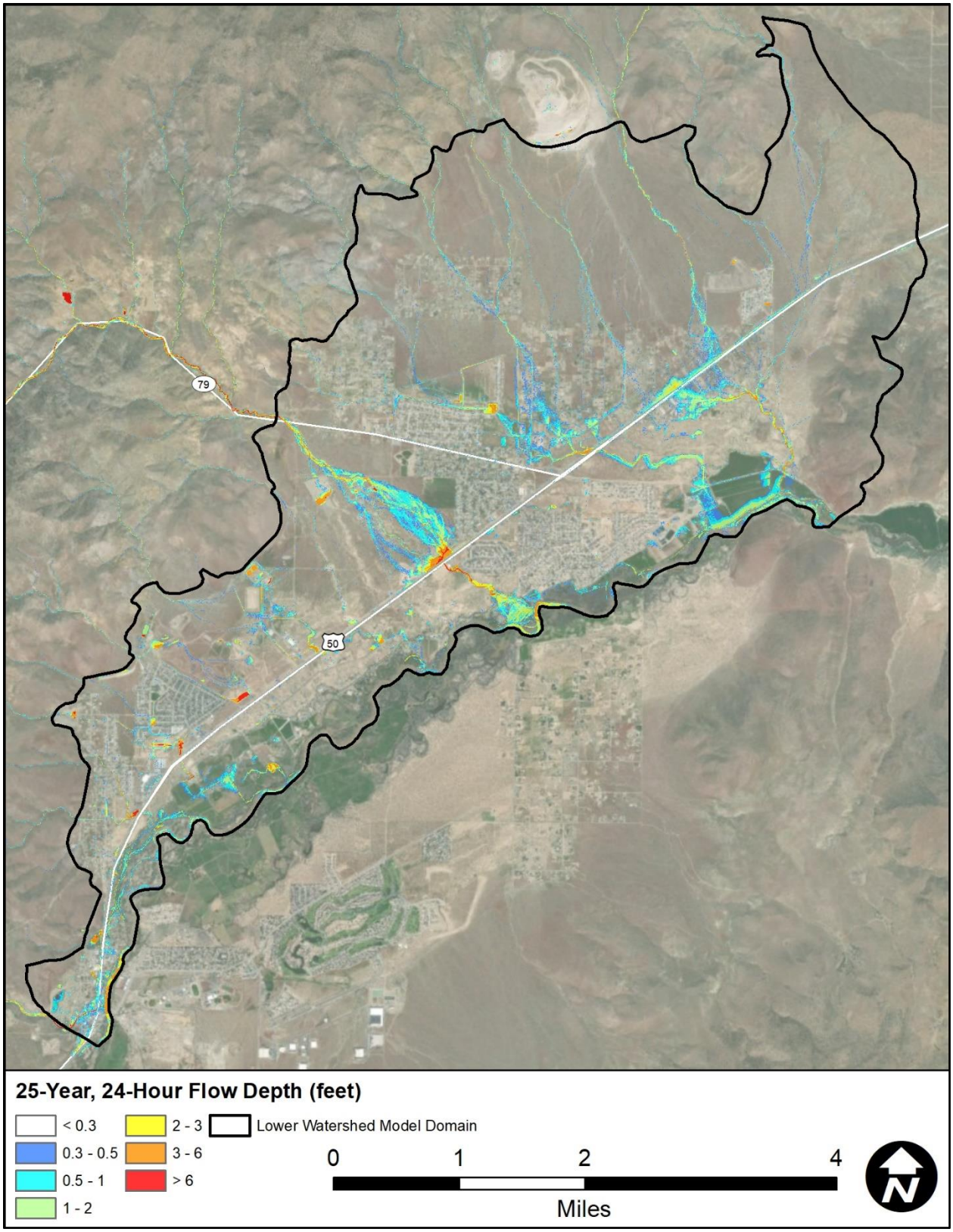


Figure 3-10. Existing conditions 25-year, 24-hour flow depth results

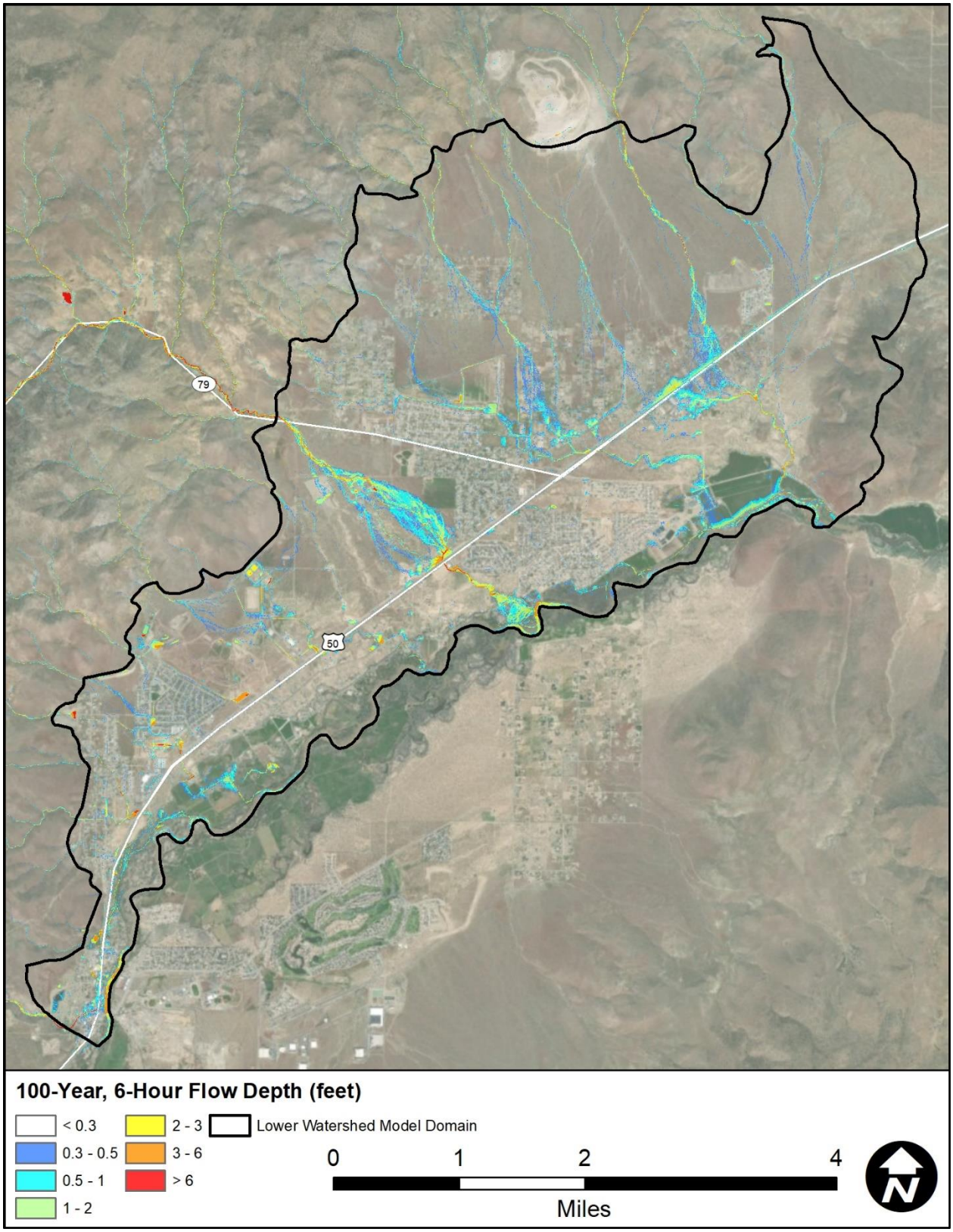


Figure 3-11. Existing conditions 100-year, 6-hour flow depth results

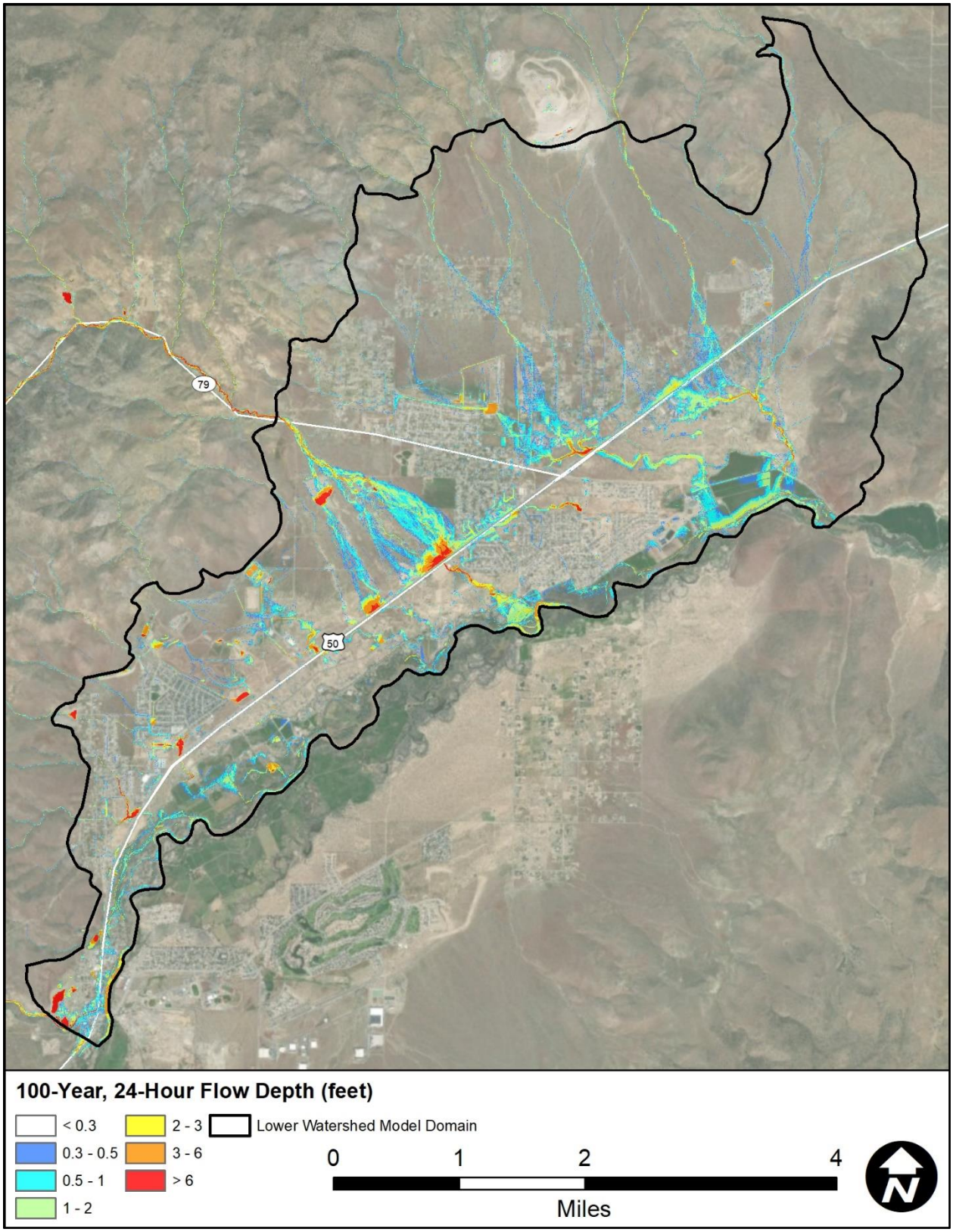


Figure 3-12. Existing conditions 100-year, 24-hour flow depth results

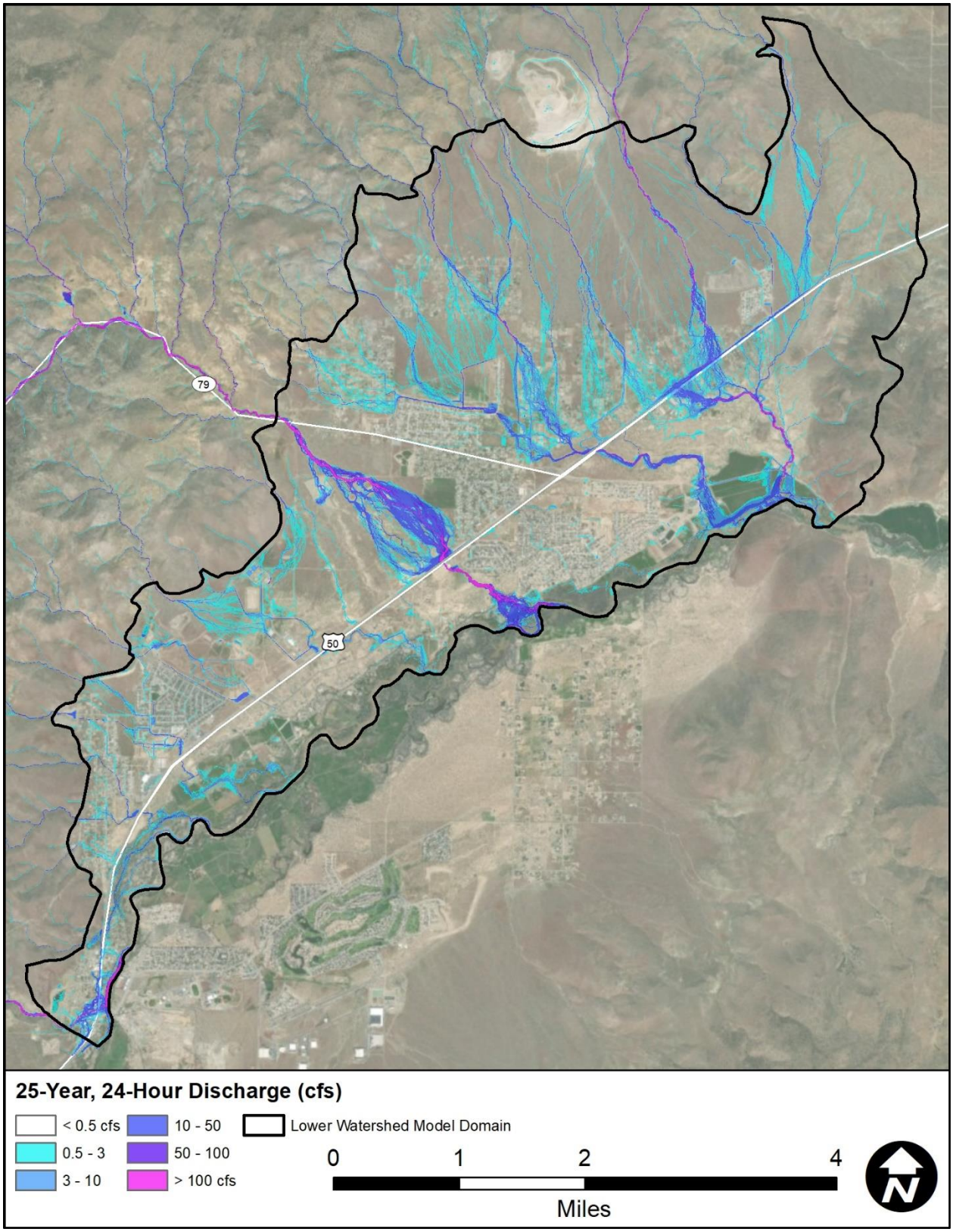


Figure 3-13. Existing conditions 25-year, 24-hour discharge results

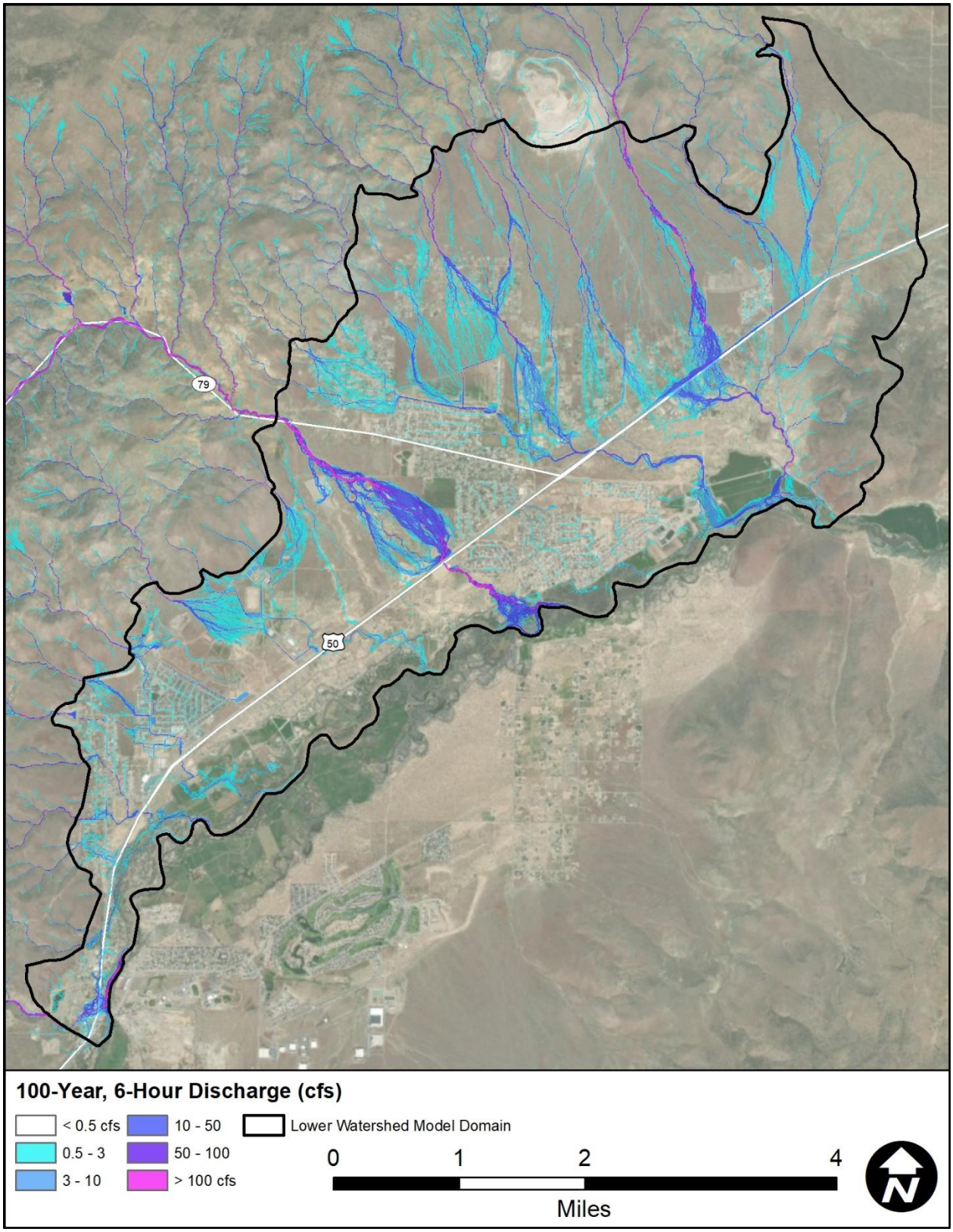


Figure 3-14. Existing conditions 100-year, 6-hour discharge results

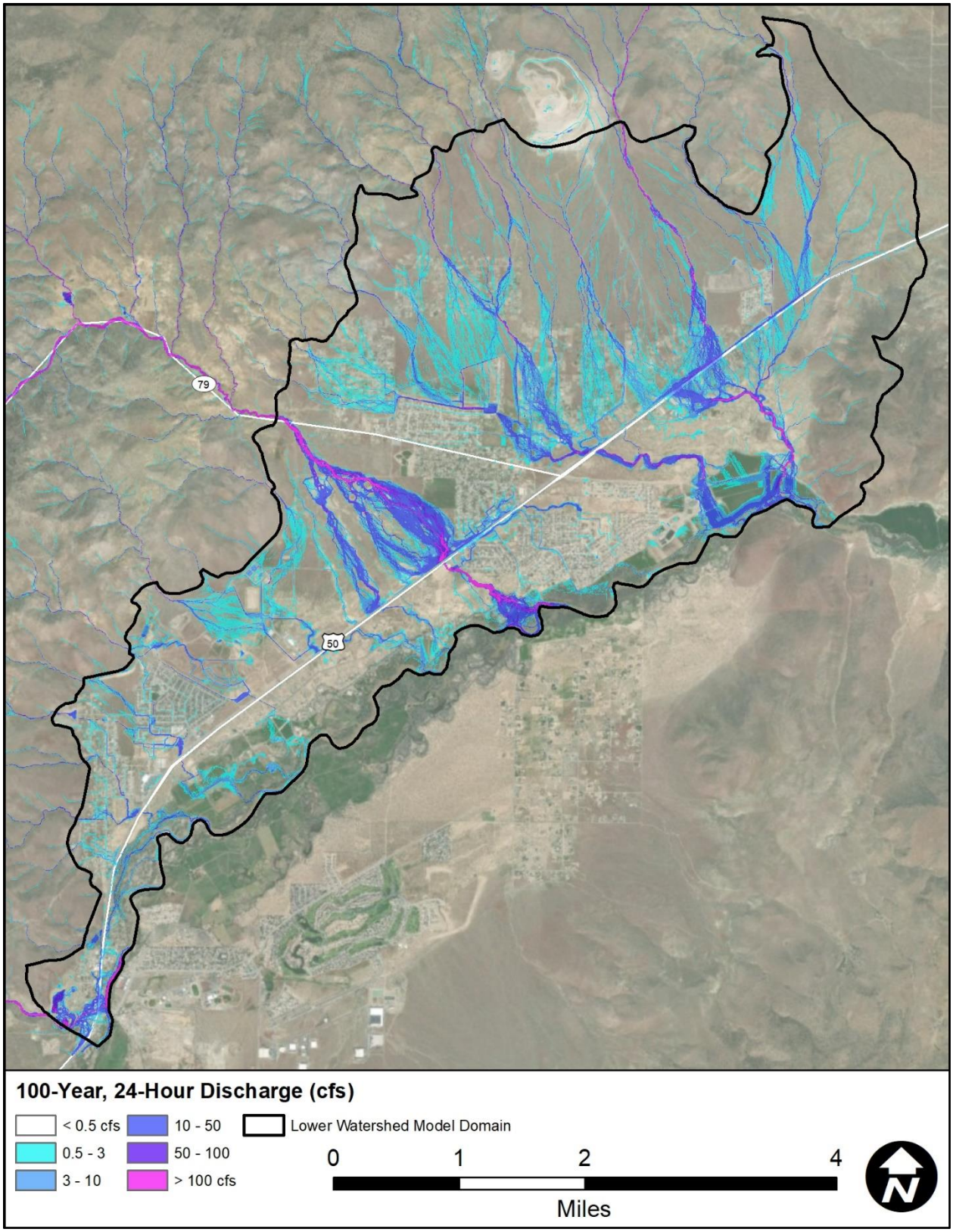


Figure 3-15. Existing conditions 100-year, 24-hour discharge results

3.5 Verification of Results

3.5.1 Comparison with USGS Regression Equations

As a verification of model results, the 100-year 6- and 24-hour results at seven drainage basins were compared with the 100-year USGS regression equation for the Eastern Sierras Region 5 (USGS, 1997). The basins that were used for comparison are shown in Figure 3-16.

The results from this comparison are shown in Table 3-9 and Figure 3-17. Table 3-9 shows both the 100-year 6-hour (labeled as 100Y6H) and the 100-year 24-hour (labeled as 100Y24H) peak flow results from the FLO-2D modeling compared with the 100-year flow from the regression equation.

The comparison indicates that the FLO-2D results generally appear reasonable. The 100-year 6-hour storm controls for smaller drainage basins, but the 100-year 24-hour storm controls for the two largest basins (Six Mile Canyon and Gold Canyon). All results fall below the USGS envelope curve, generally along the 100-year peak discharge line for the low- to middle-elevation study area (which includes USGS Regression Regions 2-16, not just Region 5), and a little above the 100-year discharge relation for Region 5. This comparison indicates that the FLO-2D results may be slightly conservative (i.e., higher) but not unreasonable.

3.5.2 Meeting with County Employees

On November 11, 2018, JEF staff met with employees from both Lyon and Storey Counties. Preliminary results and animations were presented. Based on this informal review, the feedback was that the results depicted what generally occurs during storm events. No major areas of erroneous results were identified during the meeting.

3.5.3 Historical Flooding Documentation

As a part of the public outreach effort, the project team collected photographs and videos of historical flooding from county records, NDOT, and from residents within the ADMP study area. This information was used to help verify and adjust the FLO-2D model if needed. In general, the model results corresponded well with the historical information. Five representative examples from different parts of the study area were chosen to highlight the correlation between model results and actual flooding. These examples are shown in Figure 3-18 through Figure 3-22.

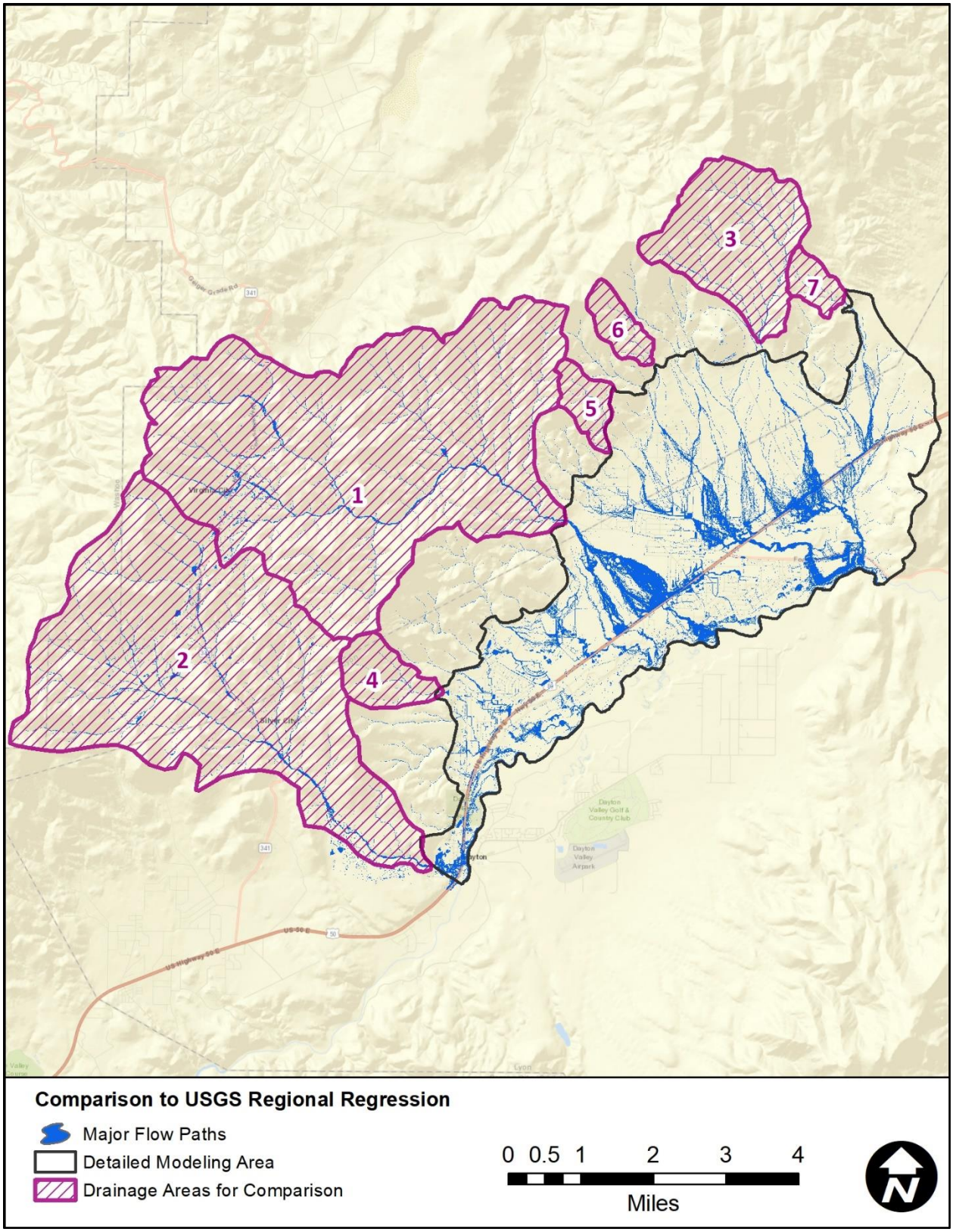


Figure 3-16. Drainage basins used for comparison of FLO-2D results to the USGS 100-year regression equations

Table 3-9. Comparison with 100-year USGS regression equation

Name	ID	Basin Area	Mean Basin Elevation	Latitude	Regression Peak Flow	100Y6H Peak Flow	100Y24H Peak Flow
		sq. miles	feet	dec. degrees	cfs	cfs	cfs
Six Mile Canyon	1	16.72	5,936	39.3	2,289	2,827	4,196
Gold Canyon Creek	2	14.11	5,901	39.3	2,030	1,180	2,318
-	3	3.37	5,761	39.3	698	1,270	904
-	4	0.93	5,319	39.3	324	326	159
-	5	0.58	5,315	39.3	210	186	106
-	6	0.55	5,862	39.3	163	268	130
-	7	0.44	5,106	39.3	185	134	88

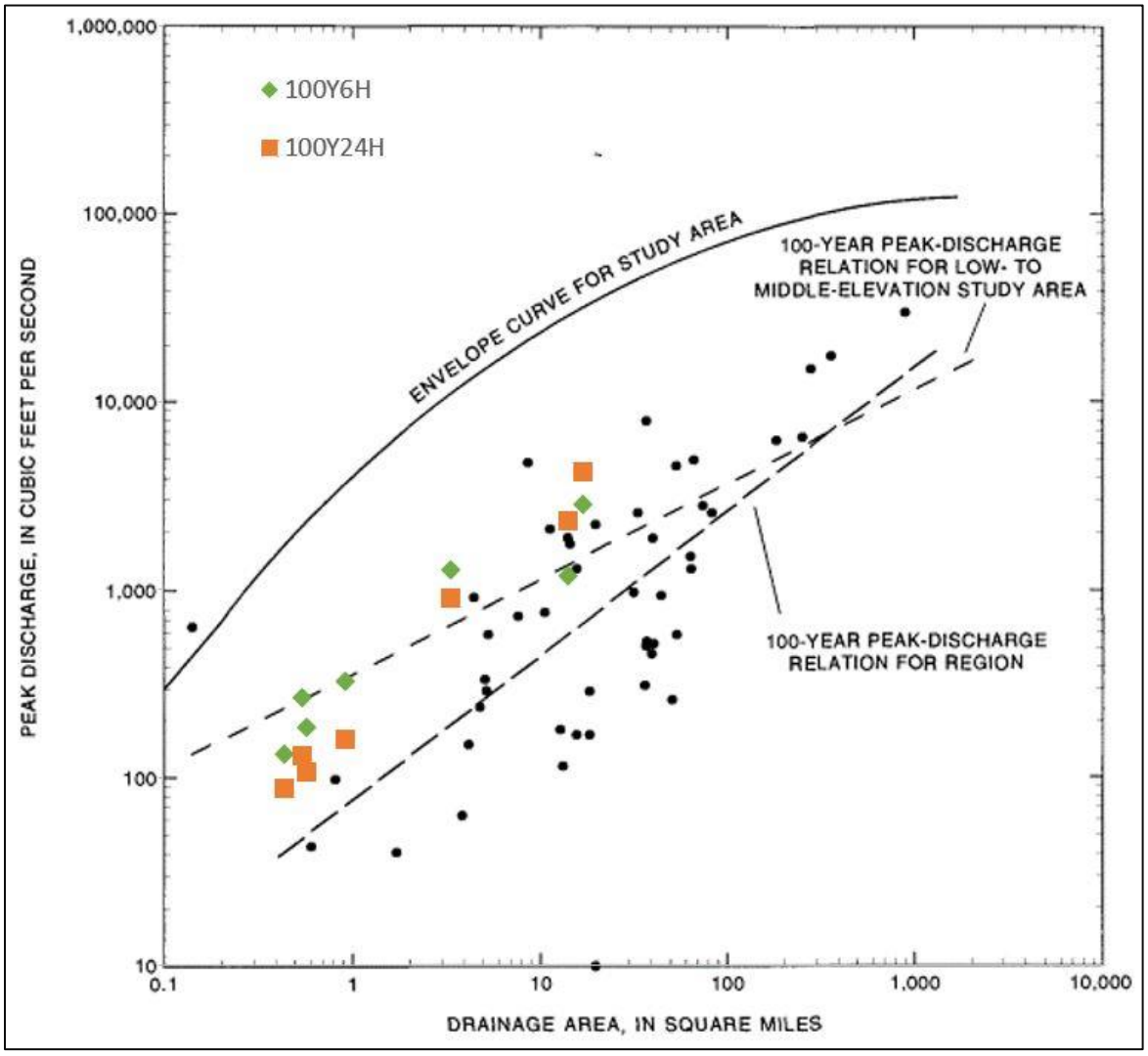


Figure 3-17. Comparison of FLO-2D results with the relations between 100-year peak discharge and drainage area and plot of maximum peak discharge of record and drainage area for gaged sites in the Eastern Sierras Region 5, adapted from USGS (1997).

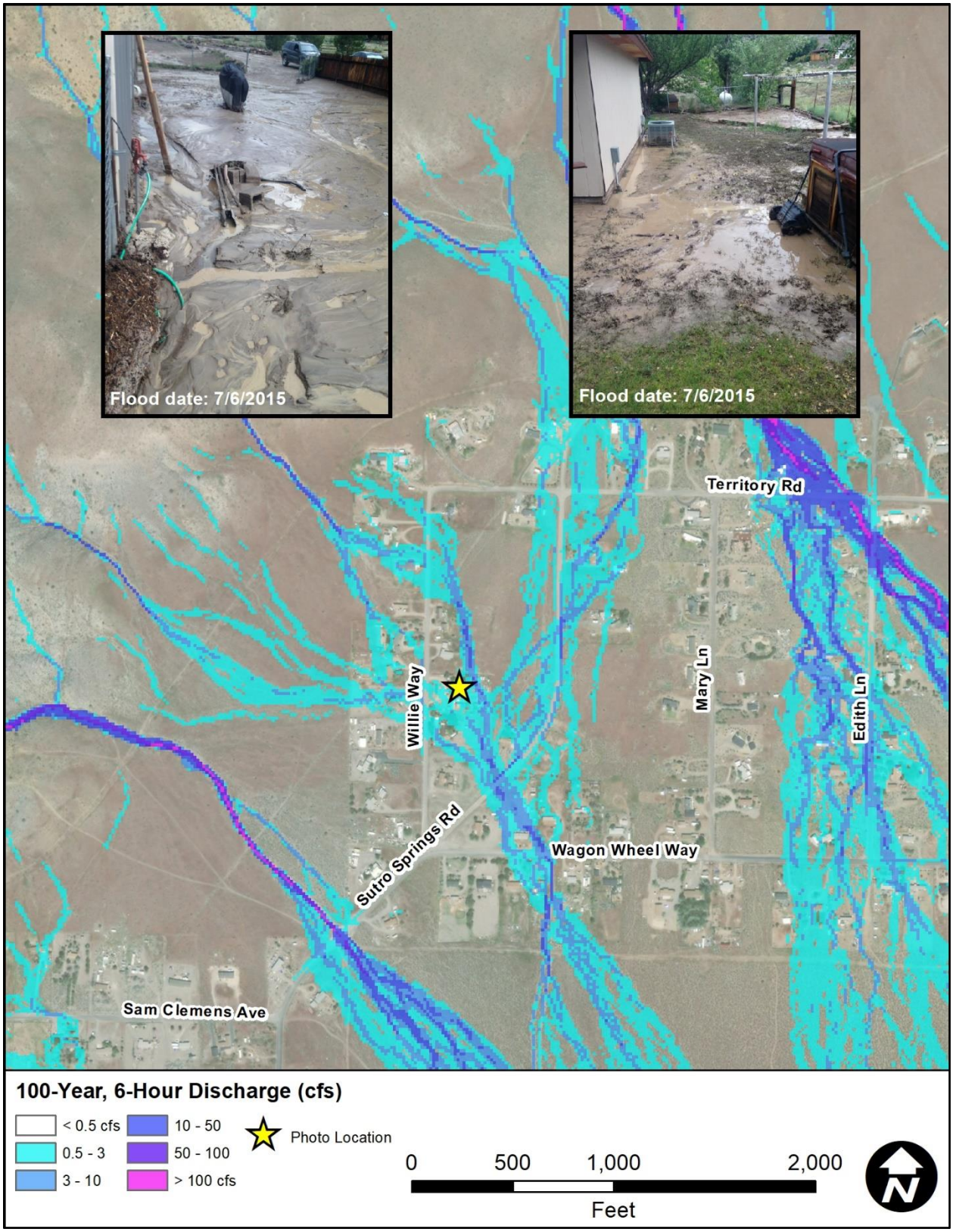


Figure 3-18. Example of broad, shallow flow and sedimentation

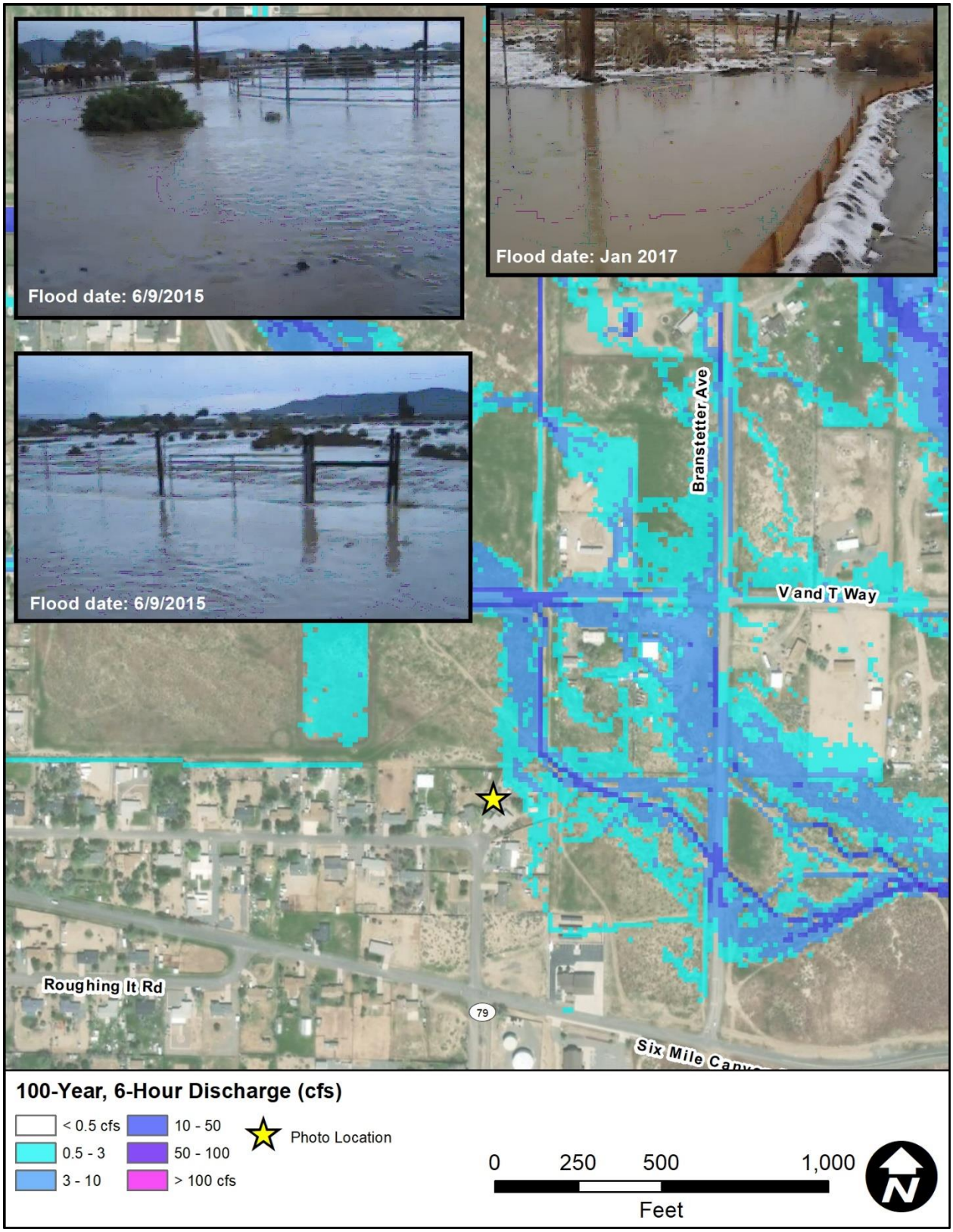


Figure 3-19. Another example of broad, shallow flow

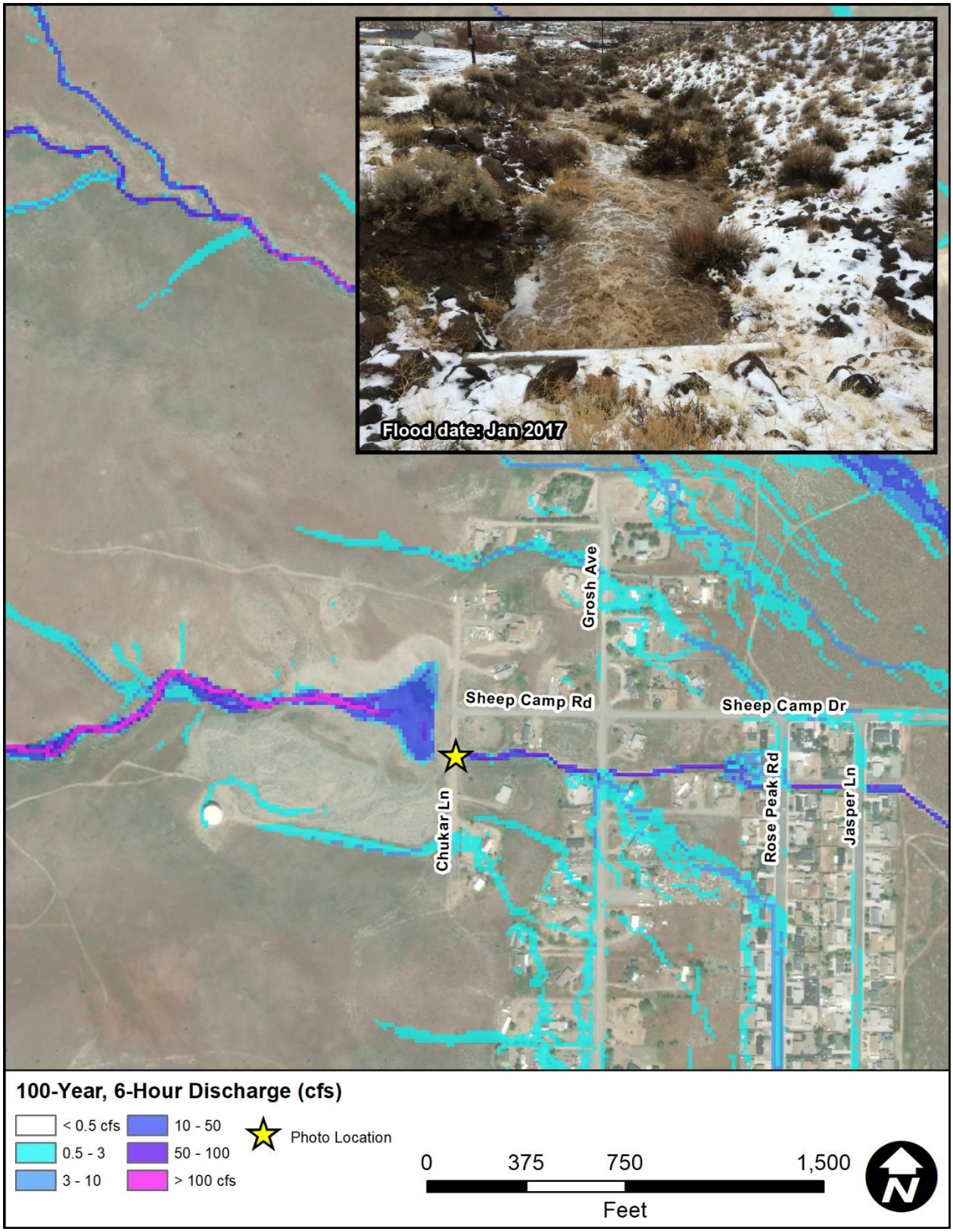


Figure 3-20. Culvert outlet flow from the Sheep Camp detention basin

Figure 3-21. Example of shallow street flooding

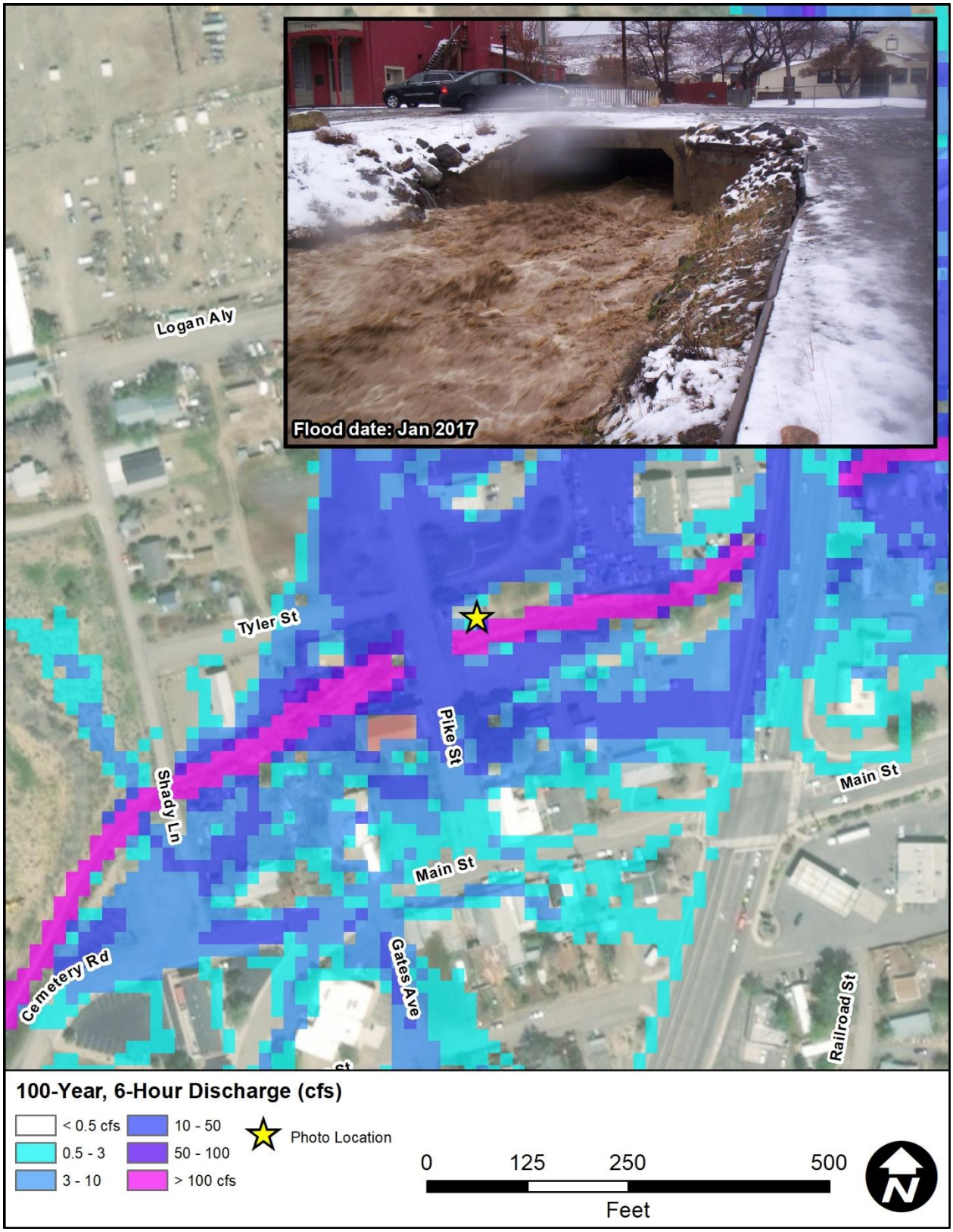


Figure 3-22. Gold Canyon Creek culvert at Pike Street

3.5.4 Gold Canyon Creek HEC-RAS Modeling

Since Gold Canyon Creek is one of the largest watercourses in the study area and immediately impacts the downtown area of Dayton Valley, a separate hydraulic analysis (in HEC-RAS) was conducted to verify the calculated hydraulics in this channel. The capacities of both the channel itself and the two culverts (Pike Street and U.S. 50) were verified. The purpose of this analysis is for general FLO-2D model verification and is not intended to be comprehensive but only a simple check of FLO-2D hydraulic calculations.

For this analysis, the HEC-RAS model was run in the mixed flow regime with the same n values used in the FLO-2D modeling. From the one-dimensional (1D) RAS model, the channel capacity was estimated to be about 2,700 cfs before flow begins to break out into the gravel mine. Also, the Pike Street culvert has a capacity (before the overtopping the roadway) of 500 cfs. However, this capacity assumes a completely clear culvert neglecting the pipe crossing that blocks some of the culvert area (see Figure 3-23). Similarly, the US 50 culvert shows a capacity of 600 cfs (before overtopping). A comparison to the FLO-2D results is shown in Table 3-10. Note the FLO-2D results for the culvert capacities are higher because additional head is applied at the culvert due to some overtopping flow being included in the modeling results. Conversely, the FLO-2D results for channel capacity are slightly lower due to multiple factors, such as:

- The flow has a two-dimensional component due to the bends in the channel, which is not captured in the HEC-RAS calculations, and
- The underlying representation of the topography is difference since the FLO-2D model uses a 15-foot grid while the HEC-RAS model uses cross-sections.

However, despite the differences, the comparison indicates that the FLO-2D results are reasonable in this location. Basically, the downstream culverts (at Pike Street and US 50) do not have the capacity for the 100-year 6-hour or 100-year 24-hour flows, which causes the Gold Canyon Creek to overtop its banks. For reference, the HEC-RAS cross-section and the two FLO-2D floodplain cross-section locations are shown in Figure 3-24.

Figure 3-23. Pike Street (12' x 5') box culvert (Note: pipe crossing through culvert opening)

Table 3-10. HEC-RAS comparison with FLO-2D

Location	HEC-RAS Capacity	FLO-2D Peak Flow	
		100Y6H	100Y24H
	cfs	cfs	cfs
Main Channel	2,700	1,180 (U/S)	2,318 (U/S)
		1,174 (D/S)	2,005 (D/S)
Culverts			
Pike Street	500	652	661
US 50	600	713	738

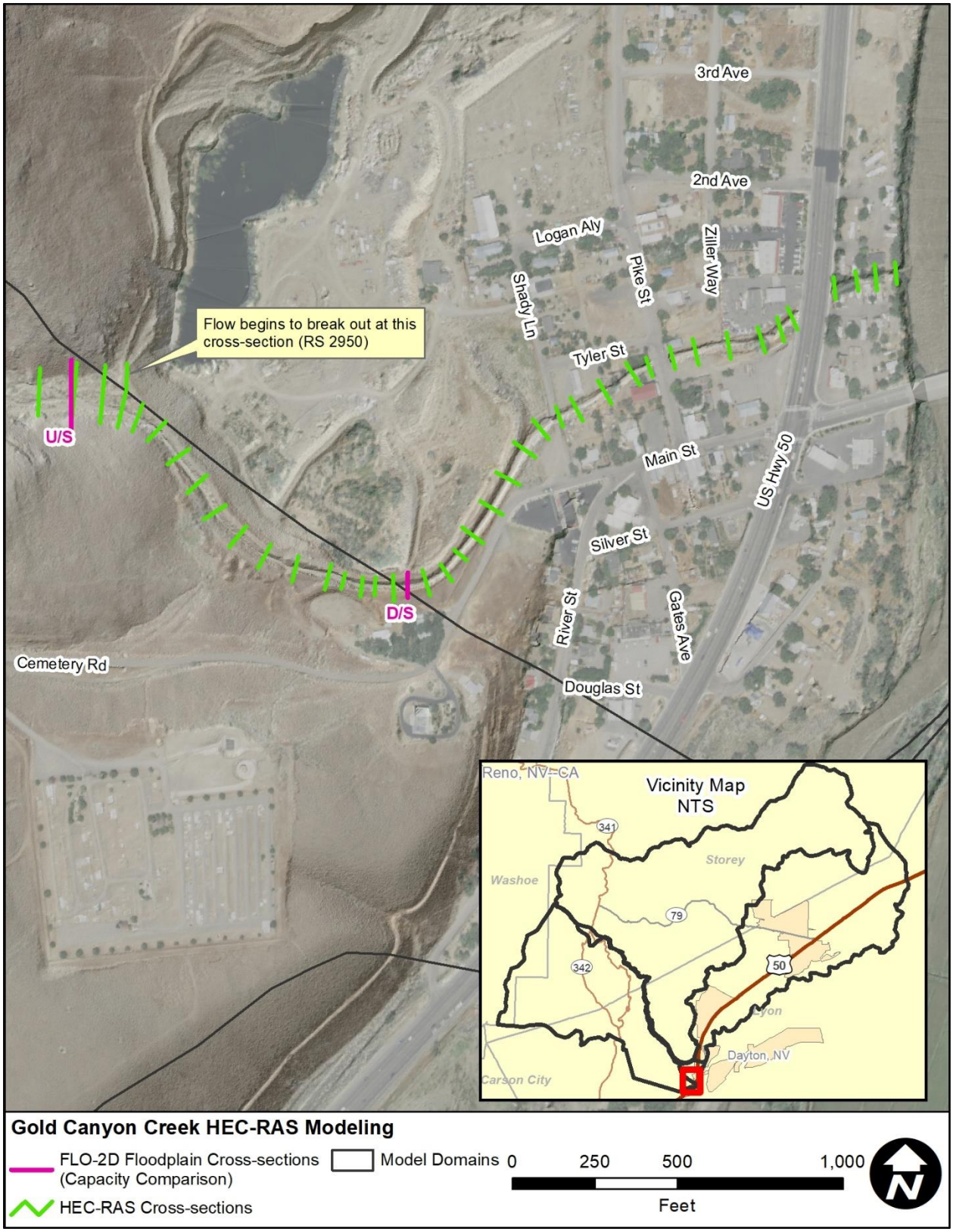


Figure 3-24. HEC-RAS cross-sections for Gold Canyon Creek modeling

3.6 SUMMARY

The existing conditions FLO-2D models were created using the best available information for land cover, land use, topography, and hydrology. Every effort was made to ensure the models represented existing conditions as of the date of the LiDAR survey. Photographs and anecdotal information collected from the Counties and residents within the community were used to help calibrate and verify the modeling results. Like all models, the DVADMP FLO-2D models are a simulation of potential conditions that could occur during a range of storm events. The models cannot duplicate actual, observed storm events at all locations within the community due to the vast number of variables that change with each unique storm event.

The modeling results reflect the complex flooding and sedimentation hazards that exist within the Dayton Valley study area. The results provide valuable, quantitative, detailed information from which future planning and development decisions can be based. The existing conditions models also serve as a foundation from which potential mitigation alternatives can be assessed (Section 7).

Although the ADMP FLO-2D modeling effort was not intended to replicate an actual historical flood event, the comparison of the modeling results with USGS regression equations, anecdotal flood information, and independent hydraulic calculations indicate the project FLO-2D models suitably depict storm runoff conditions, which is an indicator that model input parameters are reasonable. Given the distributary nature of the flooding within the community, and the high sediment transport rates (see Section 5), flooding characteristics (depth, discharge, location) are likely to change from one flood event to the next. Even small anthropogenic changes to the landscape (e.g. dirt piles, berms, construction of outbuildings, landscaping debris piles, etc.) will result in sediment accumulation, channel scour, and changes in flow path directions that may not be represented in the project FLO-2D modeling. In other words, the results of the modeling represent potential flooding conditions as of the date of the project topographic mapping. Updated mapping and FLO-2D modeling are recommended if major changes to the landscape occur in the future.

4 FLOW PATH UNCERTAINTY ANALYSES

The overall objective of flowpath uncertainty modeling was to force flooding in directions that would simulate avulsions, and to estimate maximum depths and discharges over the whole radial width of the alluvial fan area by modeling a series of "virtual" levees. The number, geometry, and alignment of the virtual levees were selected to achieve those objectives. Each virtual levee scenario was optimized to direct flow from a bifurcation point to a different area across the width of the alluvial fan. Adjustments to channel positions due to avulsions at an alluvial fan apex can have significant impacts to downstream developments. Given the coalescing nature of the alluvial fans, there are multiple scenarios.

The following criteria were considered when developing the virtual levees for the ADMP flowpath uncertainty analysis:

- Levee Length. The virtual levee lengths varied at each location. The lengths were determined based on professional judgment to achieve the objective of concentrating flows to various target locations downstream.
- Number of Levee Scenarios. The number of virtual levee scenarios modeled were dependent on the surface morphology and the downstream target objectives.
- Alignment. The virtual levees were aligned at moderate angles to the fan axis so that they did not cause a significant "pile up" of flow in the model results.
- Coding. The virtual levees were coded into the model as to not overtop or fail during the model simulations.
- Model Iteration. Multiple modeling integrations were performed to meet the target area objectives. Several virtual levees scenarios can be run within the same hydraulic model if the model results indicate there is no hydrologic inter-mixing of the two scenario results downstream of the virtual levees.
- Final Hazard Delineation. The maximum depth and velocity at each model grid cell from the maximum flood hazard modeling results were used as the final flood depth and velocity hazard results. In other words, the maximum flow depth at each grid cell was computed using the highest depth value considering all the scenarios. This approach was applied to all the grid cells in the model.
- Conservative Results. The virtual levee scenario employed for this analysis produces conservative flood depth and velocity results, particularly given the fact that actual avulsions do not typically divert the entire hydrograph along a particular alignment.

4.1 MODEL DEVELOPMENT

While an existing (base) conditions hydraulic models depict the existing, fixed-bed condition of an X-year flood hazard event, it does not predict the full flood hazard associated within the active alluvial fan flooding and should not be the only scenario used to compute flow depths. To account for flowpath uncertainty, avulsion scenarios were developed and simulated within the model to account for the possibility of avulsions that would adversely affect (increase the inflow discharge) downstream.

The flowpath uncertainty scenarios were developed by reviewing existing flow bifurcations observed in aerial photography, topography, field reconnaissance, and the base hydraulic model. In locations where

avulsions appeared likely or evidence of prior avulsions was observed, avulsions were simulated by adding berm-like features to redirect flow along an avulsion path (Figure 4-1).

The flowpath uncertainty scenarios were modeled by redirecting flow with a hard barrier accomplished by artificially elevating ground topography. These barriers were given an arbitrary height well-above the ground elevation to ensure no overtopping. The barriers essentially were aligned to direct all the flow in the avulsion direction.

4.2 Composite Results

Given the immense density/quantity of output data associated with two-dimensional modeling, results are best depicted graphically in figures, exhibits, maps, etc. Therefore, the composite (Maximum) flood hazard condition is depicted graphically for the 25-year, 24-hour; 100-year-24-hour, and 100-year,6-hour storm events. Figure 4-2 shows a close-up example of the flowpath uncertainty results for an individual watercourse. Figure 4-3 through Figure 4-5 depicts the maximum flow depth flowpath uncertainty scenarios modeled, and Figure 4-6 through Figure 4-8 depicts the maximum discharge flowpath uncertainty scenarios modeled. See Figure 3-10 through Figure 3-15 for the base model results for comparison.

It is important for the reader to distinguish, for the purpose of this study, the difference between flowpath uncertainty flood scenarios and composite flood hazard conditions. Each of the flow depth models (Base, Scenario 1, Scenario 2) is considered a flowpath uncertainty flood scenario. Composite flood hazard conditions (maximum flow depth, velocity, and discharge) were determined by compiling the flowpath uncertainty scenario rasters using ArcGIS software tools to extract the highest value for each pixel (combined maximum values), then convert those values to a single output raster grid. The output raster represents the potential composite flood hazard condition per model grid element.

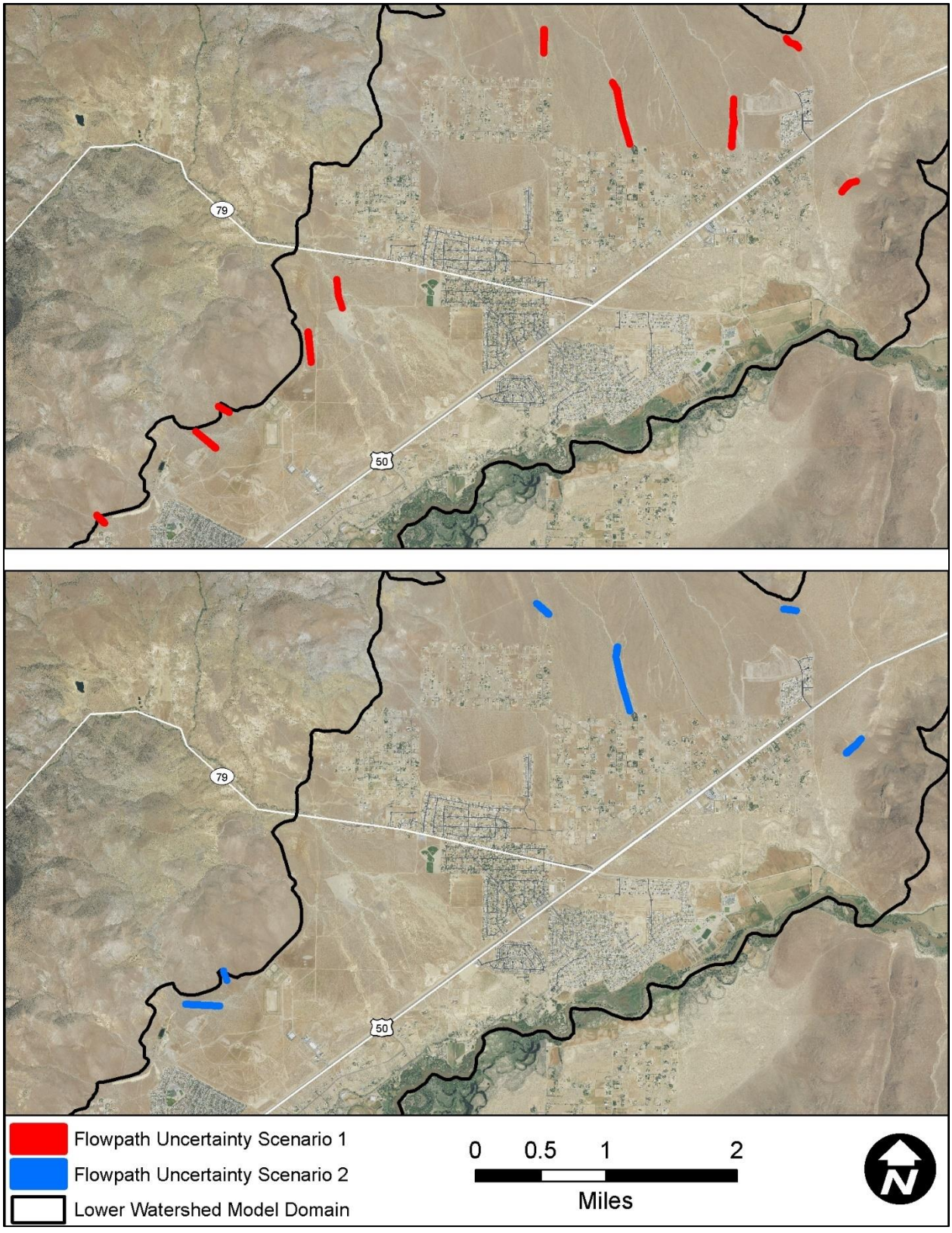


Figure 4-1. Flowpath Uncertainty virtual levee locations

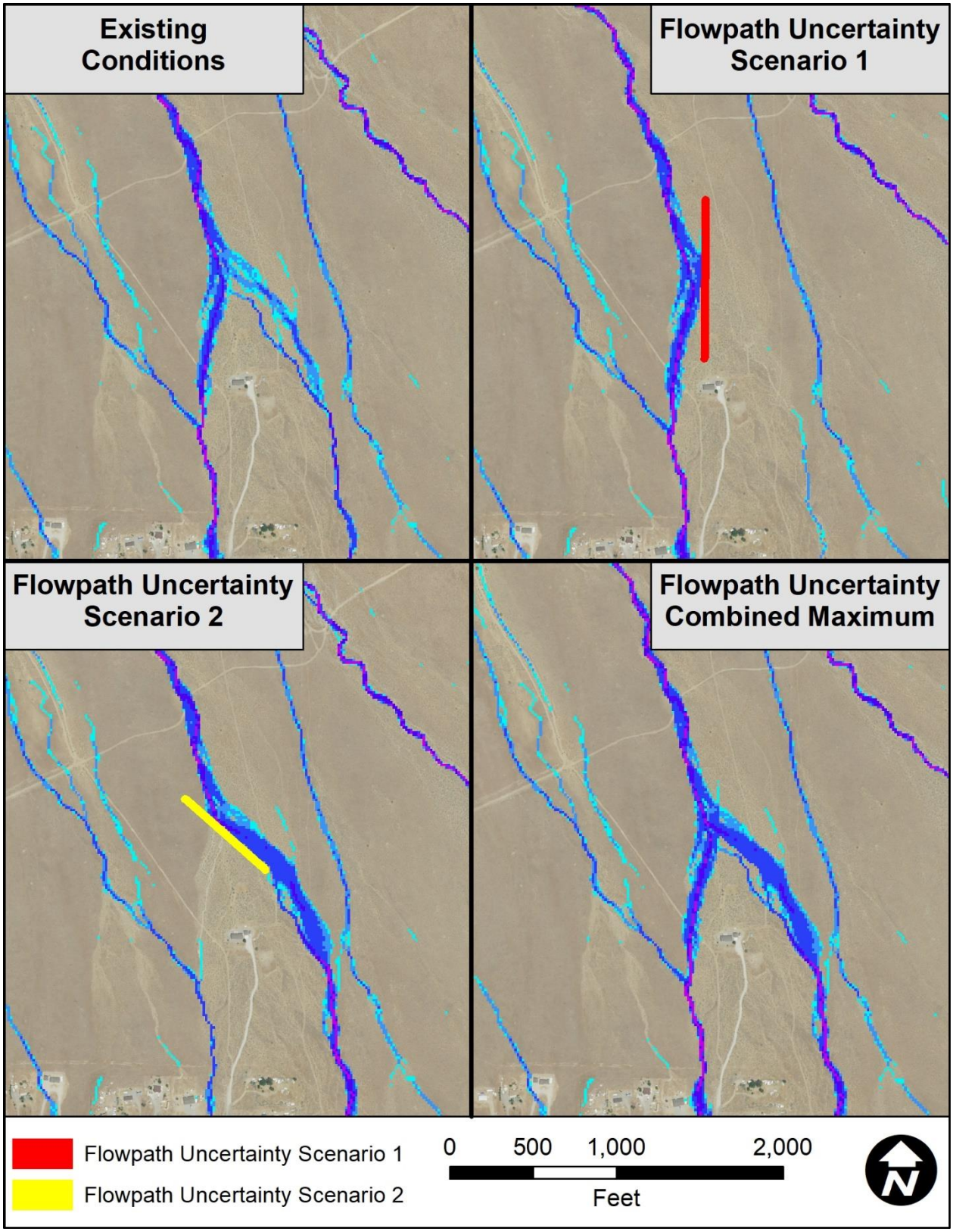


Figure 4-2. Flowpath Uncertainty example

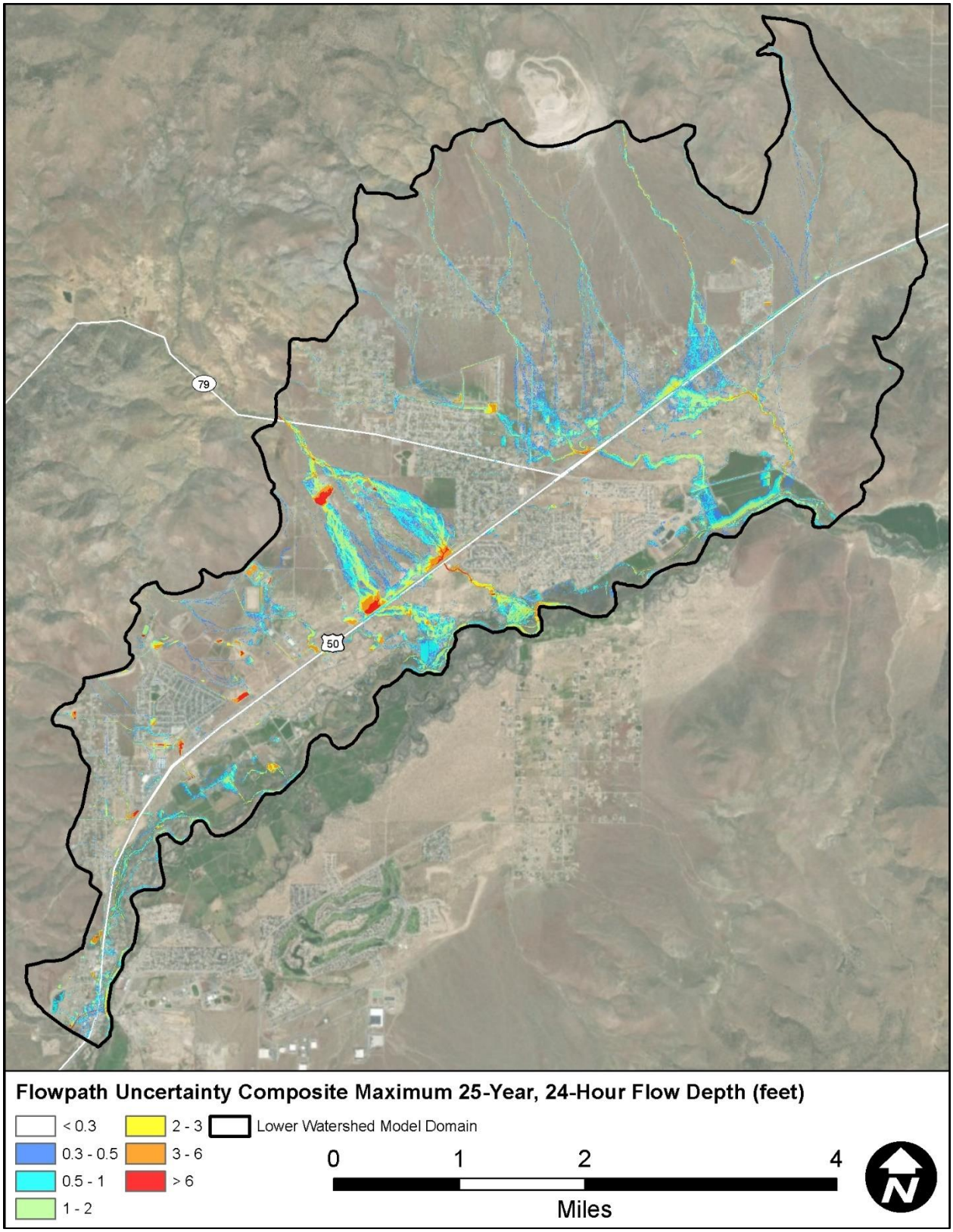


Figure 4-3. Flowpath Uncertainty combined maximum flow depth results (25-Year, 24-Hour)

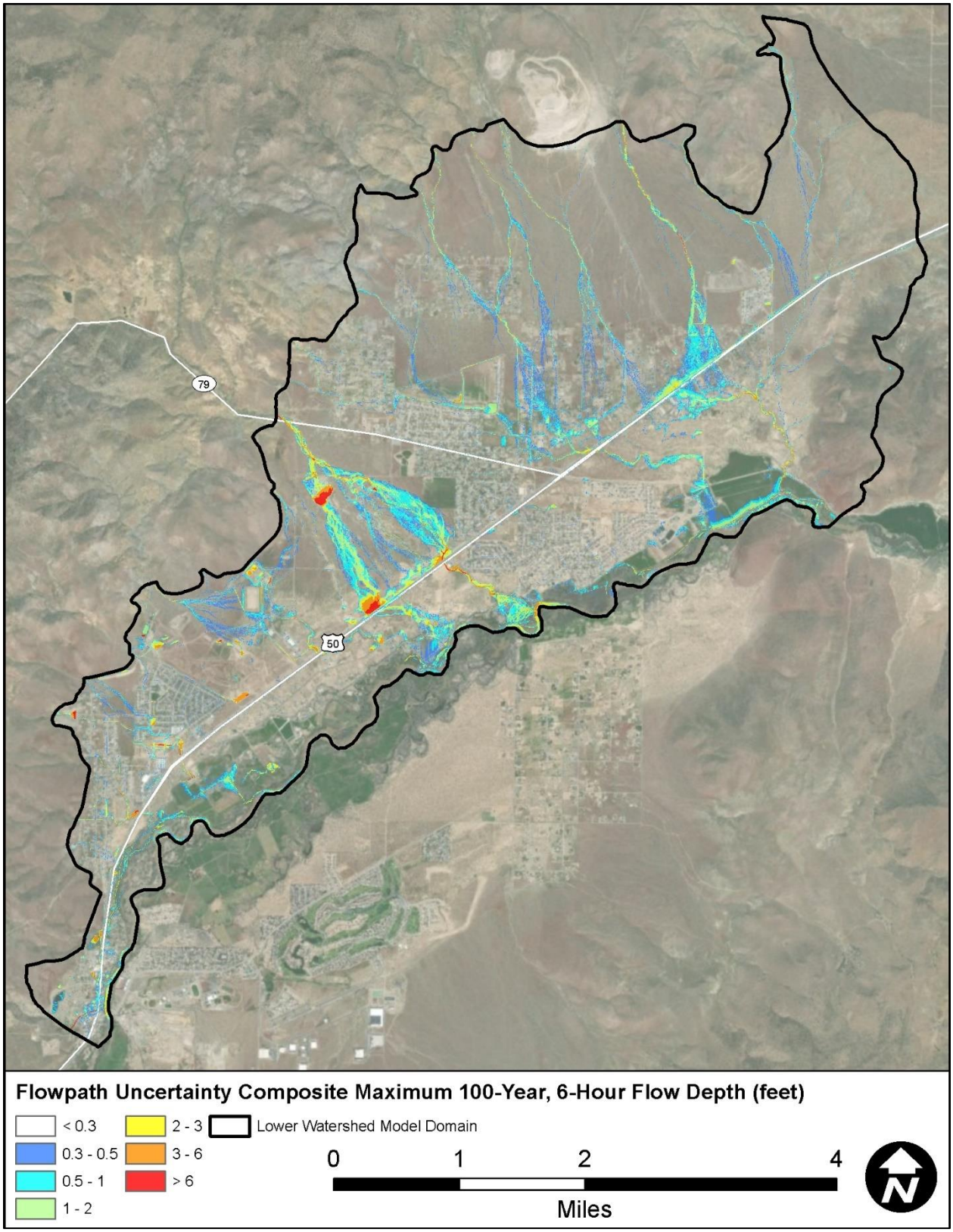


Figure 4-4. Flowpath Uncertainty combined maximum flow depth results (100-Year, 6-Hour)

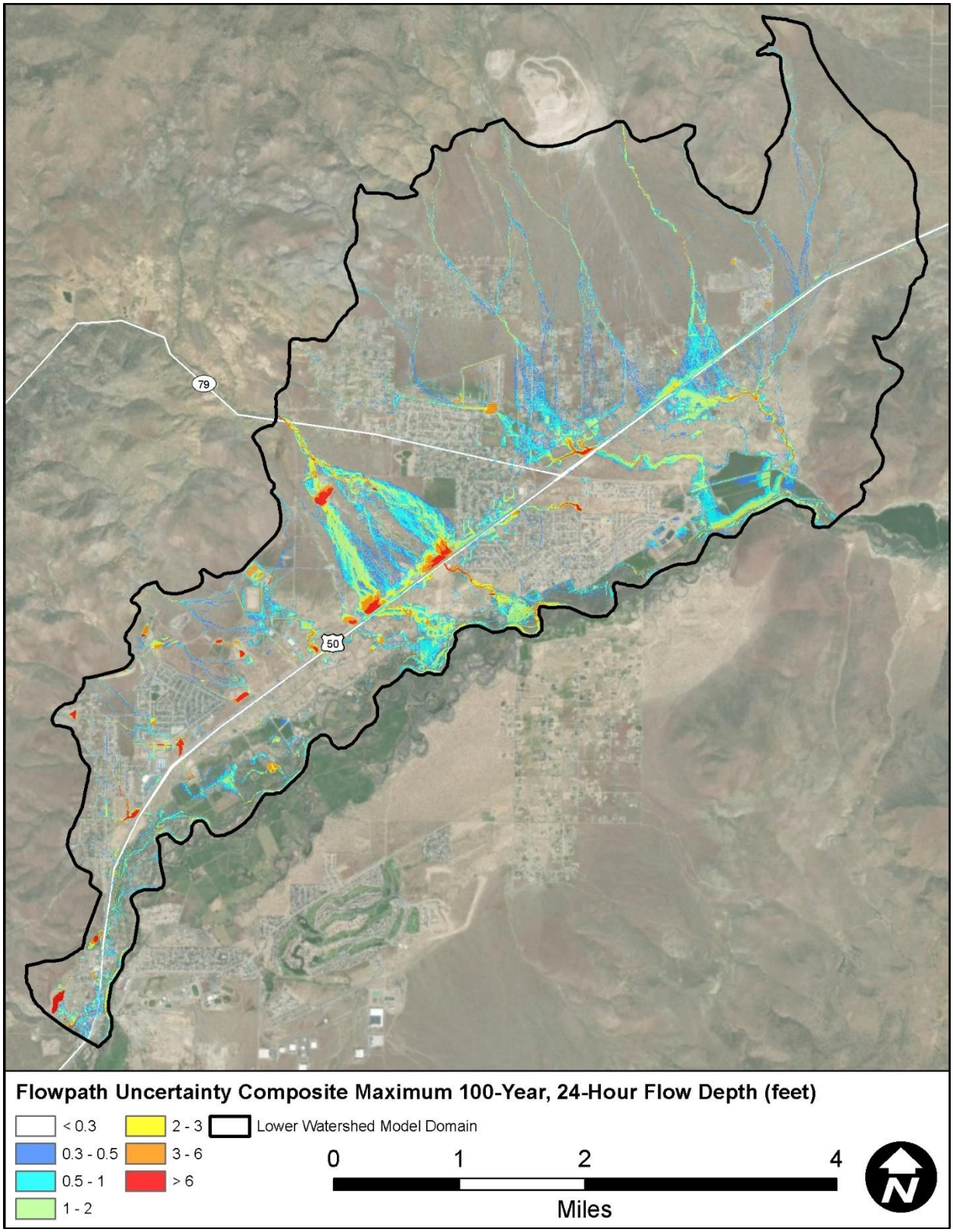


Figure 4-5. Flowpath Uncertainty combined maximum flow depth results (100-Year, 24-Hour)

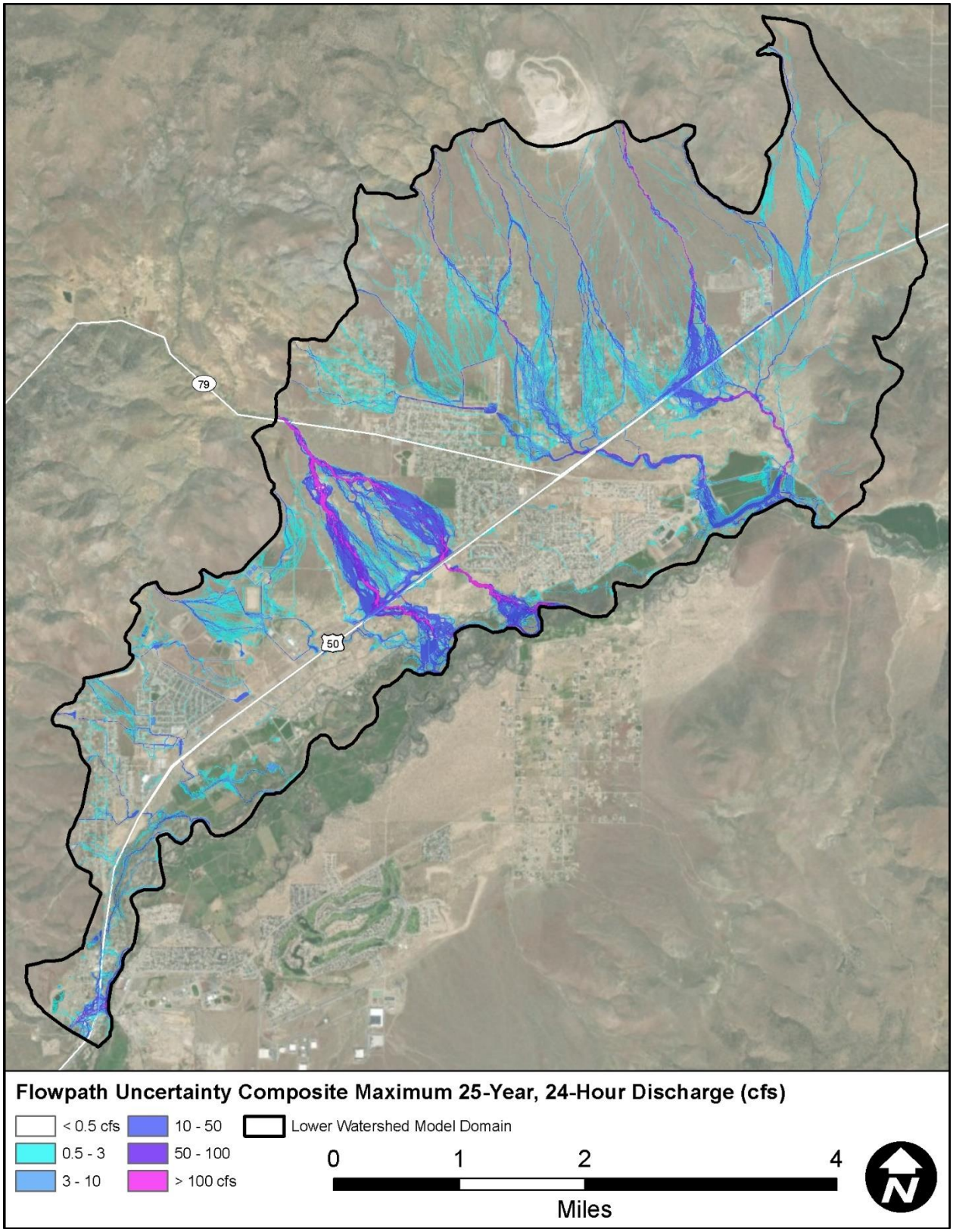


Figure 4-6. Flowpath Uncertainty combined maximum discharge results (25-Year, 24-Hour)

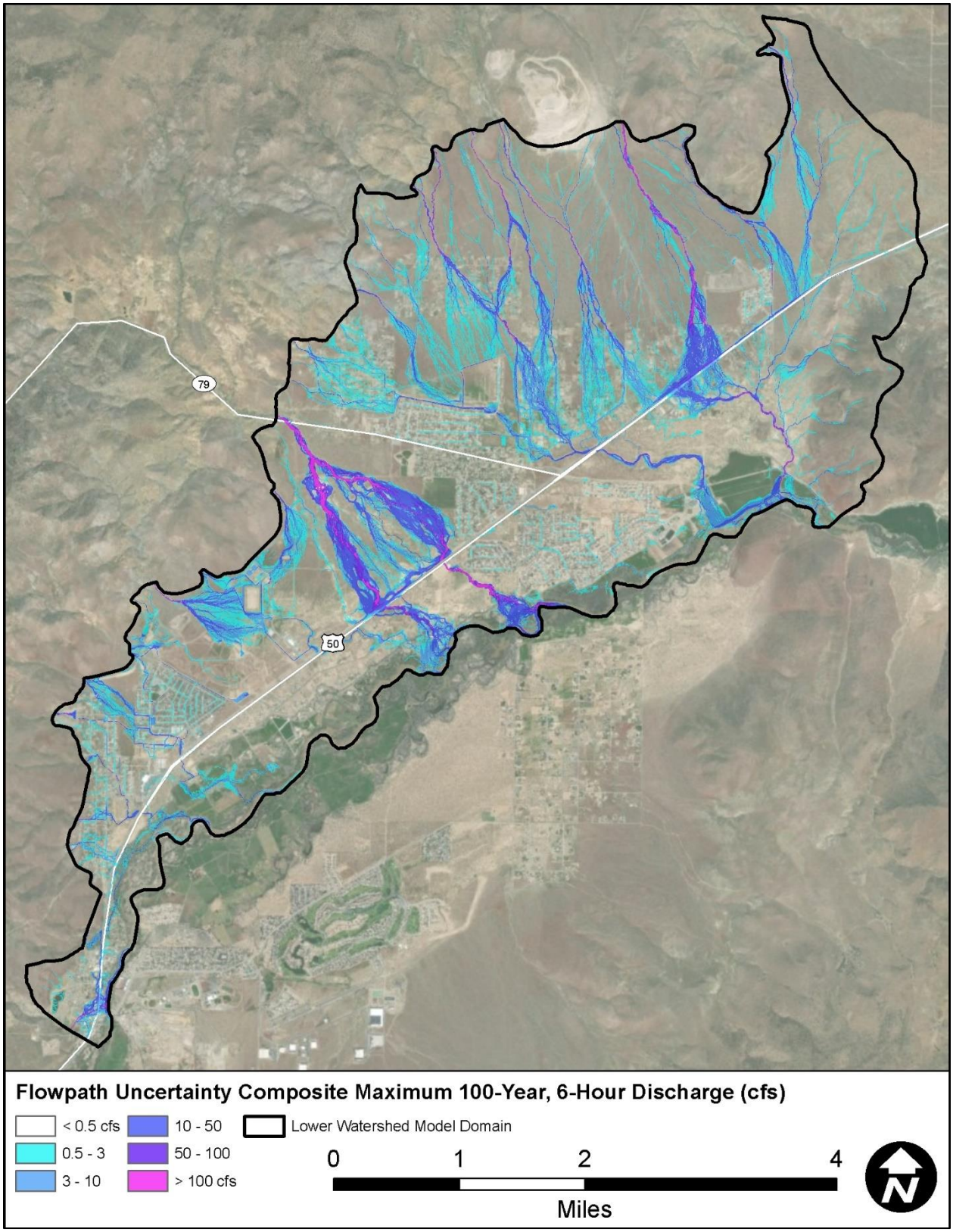


Figure 4-7. Flowpath Uncertainty combined maximum discharge results (100-Year, 6-Hour)

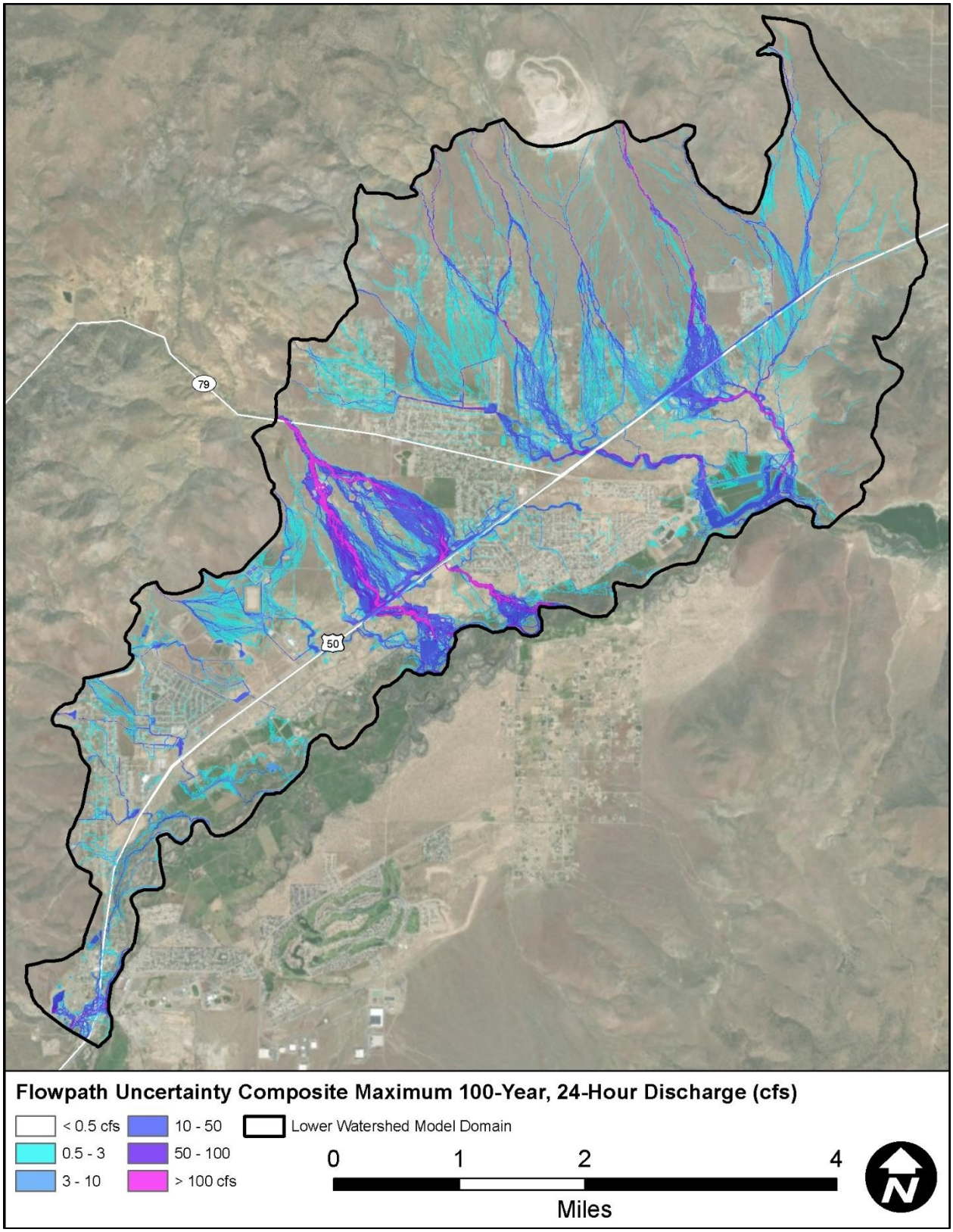


Figure 4-8. Flowpath Uncertainty combined maximum discharge results (100-Year, 24-Hour)

4.2.1 How the Composite Result Data is Used in this Study

The flowpath uncertainty composite results were used in the Flood Mitigation Alternatives portion of the ADMP (see Section 7). When estimating inflow peak discharges and volumes for the proposed mitigation structures, the flowpath uncertainty scenario with the highest values were used. This conservative approach accounts for potential future avulsions that might occur upstream of the proposed mitigation structures.

4.2.1.1 Recommended Future Use

It is recommended that all future use of the ADMP hydraulic data consider the flowpath uncertainty scenario results (i.e. the maximum values considering all scenarios are used at the desired location).

5 SEDIMENTATION ANALYSES

5.1 SEDIMENT SAMPLING AND TRANSPORT ANALYSES

5.1.1 Sediment Sampling

Since the DVADMP study area has known sedimentation issues (see example of a clogged culvert in Figure 5-1), twenty-two sediment samples were collected in November 2018 by JEF staff to help classify the type of sediment being transported to (and through) the detailed model area. The sampling locations are shown along with the sample IDs in Figure 5-2. Due to the size of the sediment in some of the watercourses, eleven of the twenty-two sediment samples were evaluated by the pebble count method (Wolman, 1954). The other eleven were processed via mechanical sieve procedures to compute the sediment gradation. The gradation curves from each of these twenty-two samples are shown in Figure 5-3, while major characteristics of the sediment are tabulated in Table 5-1.

Figure 5-1. Example of sediment deposition at culvert

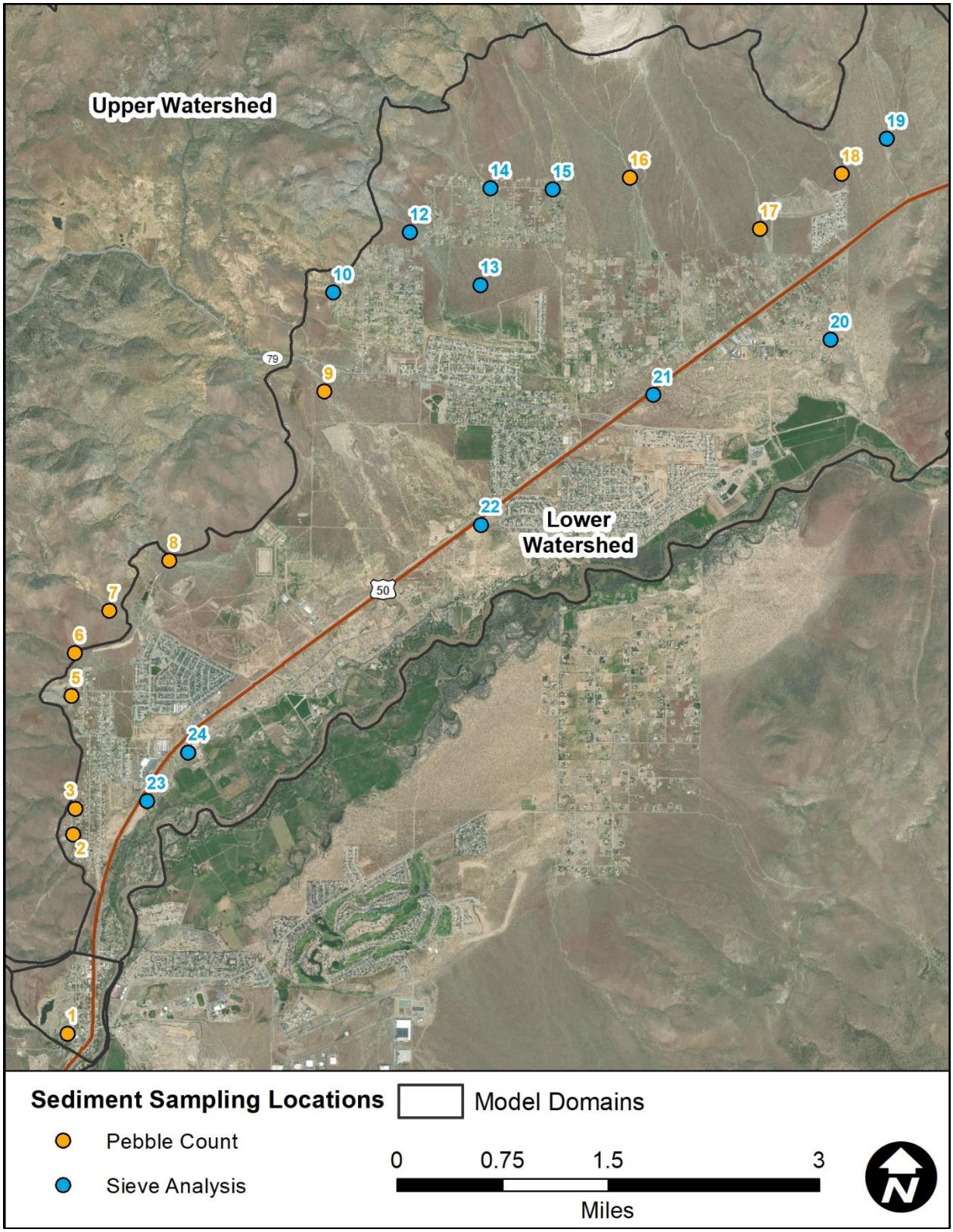


Figure 5-2. Sediment sampling locations labeled with ID

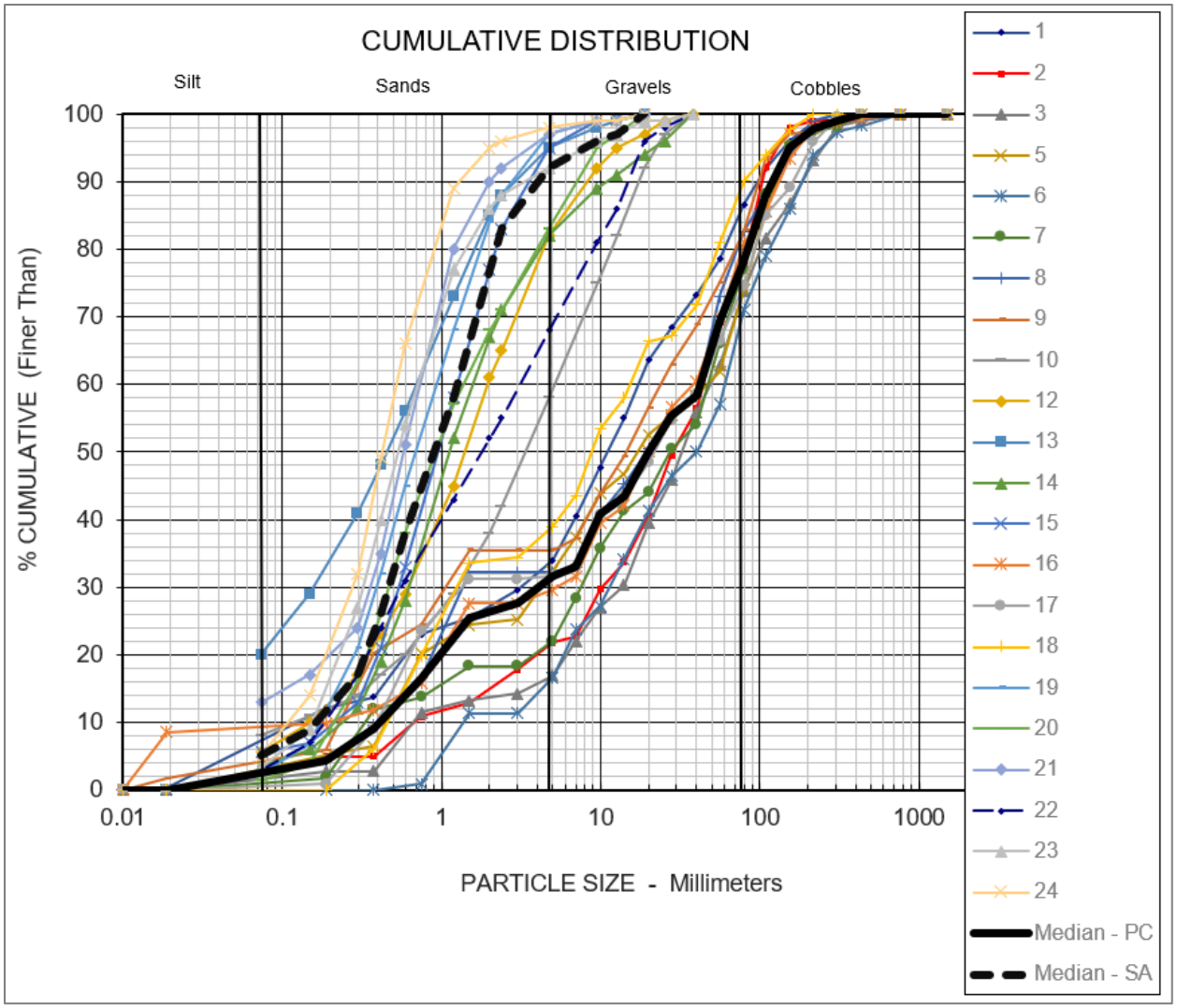


Figure 5-3. Gradation curves for the twenty-two sediment samples

Table 5-1. Major characteristics of the sediment in the within the lower watershed

ID	Type	D16 (mm)	D50 (mm)	D84 (mm)	G	Slope (%)
1	Pebble Count	0.47	11.22	72.18	24.45	1.29
2	Pebble Count	2.45	28.86	92.10	11.98	5.47
3	Pebble Count	4.29	32.91	129.95	9.29	6.04
5	Pebble Count	0.64	17.38	104.94	26.69	6.78
6	Pebble Count	4.75	40.00	141.40	9.57	7.71
7	Pebble Count	1.12	27.43	98.27	22.53	6.00
8	Pebble Count	0.72	19.50	87.73	25.21	4.69
9	Pebble Count	0.32	14.53	83.57	41.04	2.26
10	Sieve Analysis	0.38	3.57	13.96	10.66	7.04
12	Sieve Analysis	0.28	1.44	5.71	7.35	6.16
13	Sieve Analysis	0.04	0.46	1.93	12.39	2.54
14	Sieve Analysis	0.37	1.14	6.12	6.78	6.46
15	Sieve Analysis	0.34	1.00	2.58	4.40	5.48
16	Pebble Count	0.76	20.00	99.39	24.95	3.55
17	Pebble Count	0.56	22.00	106.02	35.57	3.69
18	Pebble Count	0.65	8.96	64.08	16.84	2.47
19	Sieve Analysis	0.24	0.72	2.00	4.58	2.43
20	Sieve Analysis	0.30	0.97	5.16	6.86	1.11
21	Sieve Analysis	0.13	0.58	1.51	5.67	0.62
22	Sieve Analysis	0.28	1.82	11.42	10.19	0.91
23	Sieve Analysis	0.21	0.55	1.82	4.78	0.58
24	Sieve Analysis	0.17	0.43	1.06	4.06	1.28
Median	-	0.37	6.27	39.02	10.43	-
Average	-	0.88	11.61	51.50	14.81	-

5.1.2 Sediment Transport Analyses

The FLO-2D hydraulic modeling was used to assess the trends of both flooding and sedimentation throughout the study area. Hydraulic data from FLO-2D inherently includes both discharge and flow depth at each grid element. This hydraulic data was used to estimate sedimentation using two sediment transport equations on a cell-by-cell scale. For this study, the Zeller-Fullerton and the Yang equations were used to calculate the accumulated sediment transport.

For each modeled storm event, the total accumulated (i.e., throughout the entire storm event) sediment transport capacities were calculated at each cell. These accumulated capacities can identify areas where deposition or scour may be expected. The detailed results will be discussed in Section 5.2.

5.1.2.1 Zeller-Fullerton Equation

Relationships between depth and velocity form the backbone of many sediment transport models. For example, the Meyer-Peter, Muller (MPM) approach is commonly used to estimate bed load in sand bed channels. When it is combined with the Einstein Suspended Load methodology, the total relationship provides an accurate estimate of total sediment transport in sand bed channels. A computer-generated solution of the MPM-Einstein coupled approach was developed and distilled into an empirical, power relationship, commonly called the Zeller-Fullerton equation (Zeller and Fullerton, 1983).

This relationship, shown as Equation (1), is commonly used to estimate sediment transport capacity in sand bed channels.

$$q_s = 0.0064 \frac{n^{1.77} V^{4.32} G^{0.45}}{Y_h{}^{0.30} D_{50}{}^{0.61}} \quad (1)$$

Where:

- q_s is the unit width sediment transport capacity (cfs/ft)
- n is the Manning's roughness coefficient
- V is the channel velocity (ft/s)
- G is the gradation coefficient (dimensionless).
- Y_h is the hydraulic depth (ft)
- D_{50} is the median diameter of the sediment (mm)

This equation was used in the DVADMP because 1) it is very easy to apply programmatically and 2) because it is commonly used on sand bed channels with steep slopes - both of which are prominent features within the focus area.

5.1.2.2 Yang Equation

To verify that the Zeller-Fullerton equation provides reasonable estimates, sediment transport was also computed using the Yang sediment transport methodology. This approach followed the calculation outline found in the HEC-RAS Hydraulic Reference Manual (USACE, 2016b). The grain size distribution was discretized into three equal mass components where sediment transport capacity was computed separately for each compartment and the results were combined while weighting the capacity of each compartment by its relative mass contribution. The governing equation for estimating sediment concentration for each grain size using the Yang approach is as follows:

$$\log C_t = 5.435 - 0.286 \log \frac{\omega d_m}{v} - 0.457 \log \frac{u_*}{\omega} + \left(1.799 - 0.409 \log \frac{\omega d_m}{v} = 0.314 \log \frac{u_*}{\omega}\right) \log \left(\frac{VS}{\omega} - \frac{V_{cr}S}{\omega}\right) \quad (2)$$

$$\log C_t = 6.681 - 0.633 \log \frac{\omega d_m}{v} - 4.816 \log \frac{u_*}{\omega} + \left(2.874 - 0.305 \log \frac{\omega d_m}{v} = 0.282 \log \frac{u_*}{\omega}\right) \log \left(\frac{VS}{\omega} - \frac{V_{cr}S}{\omega}\right) \quad (3)$$

Where:

- C_t is the total sediment concentration (ppm)
- ω is the particle fall velocity (ft/s)
- d_m is the median particle diameter (ft)
- v is the kinematic viscosity (ft^2/s)
- u^* is the shear velocity (ft/s)
- V is the average channel velocity (ft/s)
- S is the energy gradient (ft/ft)

Equation (2) is used for sand with a median diameter < 2mm, while Equation (3) is for gravel with a median diameter is ≥ 2mm. Within a model spanning 2-dimensions in plan-view, such as FLO-2D, the Yang methodology differentiates itself through application of vectorized parameters – average channel velocity and slope, notably. Using time-varying output from FLO-2D, the direction of maximum velocity at each time step was determined and the terms utilized in the Yang equation were applied in that direction. This method allows the sediment transport capacity analysis to adapt to changes in peak flow direction which is especially valuable in areas of flow path uncertainty such as coalescing alluvial fans and areas subject to varied flooding sources.

5.2 RESULTS

5.2.1.1 Sediment Rasters

Since the total accumulated transport is calculated at each cell, an overall map of the study area with sediment transport capacities can be produced similar to the FLO-2D results presented in Section 3. Since the 100-year, 24-hour storm produces the largest amount of flow and sediment, it is used as a representative example. Both the Yang and Zeller-Fullerton methods were calculated, and the results are presented in the following figures. The relative total accumulated sediment transport within the focus area for the Zeller-Fullerton equation is shown in Figure 5-4, while the results from Yang equation are shown in Figure 5-5. Note - The colors in both these figures represent relative transport capacity to each other, so green is relatively low compared to red, but green is higher than areas without color. The same color ramp was applied for both the Zeller-Fullerton and Yang results, so the Yang method is showing more sediment transport.

In general, the results are straightforward. Higher sediment transport rates appear in the channels, while lower rates appear as the flow spreads out over the piedmont. Finally, since these sediment results are based on hydraulic conditions, off-site inflows are considered because inflow hydrographs have been input at all major watercourses through the upstream FLO-2D modeling (see Figure 3-3).

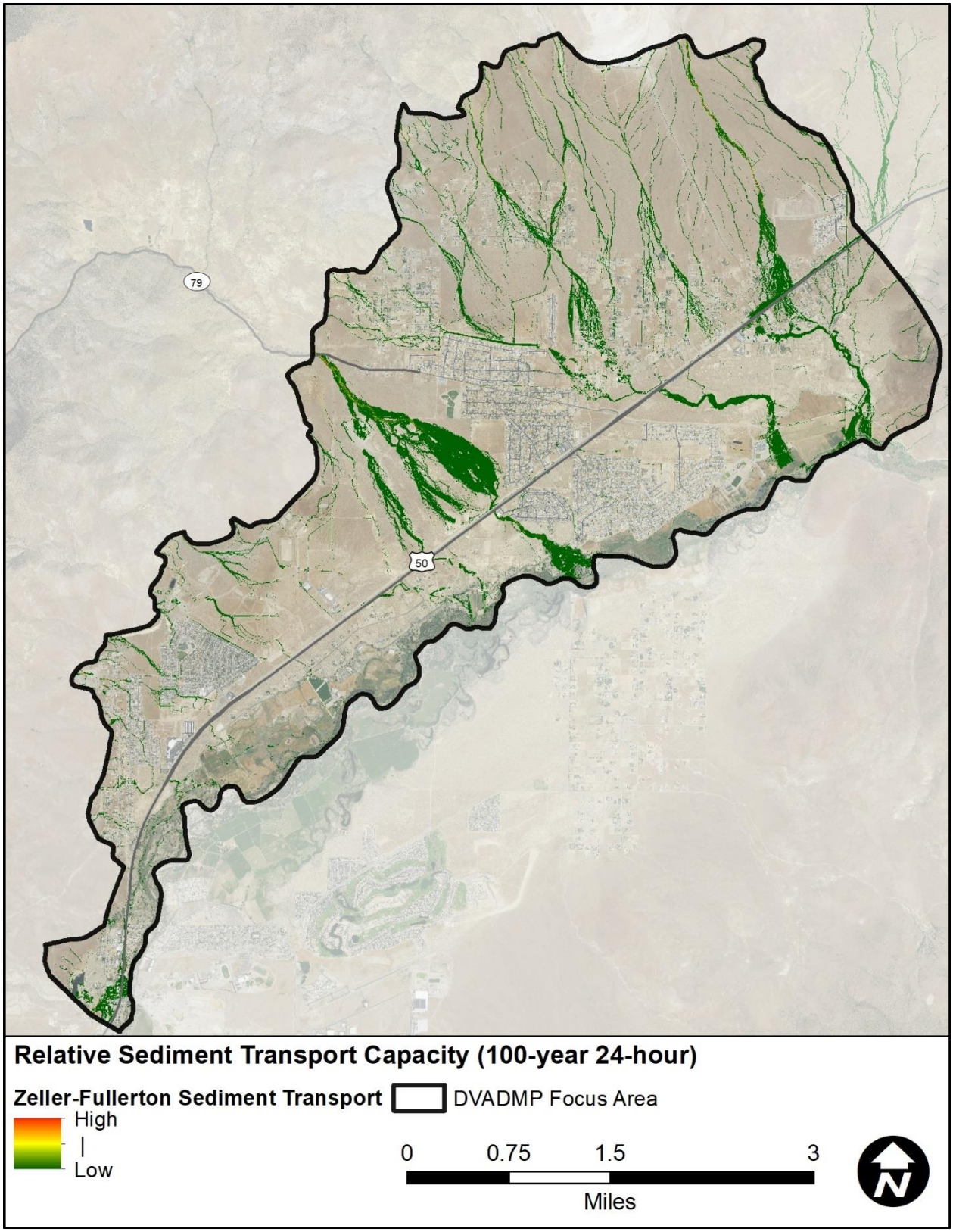


Figure 5-4. Total accumulated sediment transport capacity by the Zeller-Fullerton methodology for the 100-year, 24-hour event

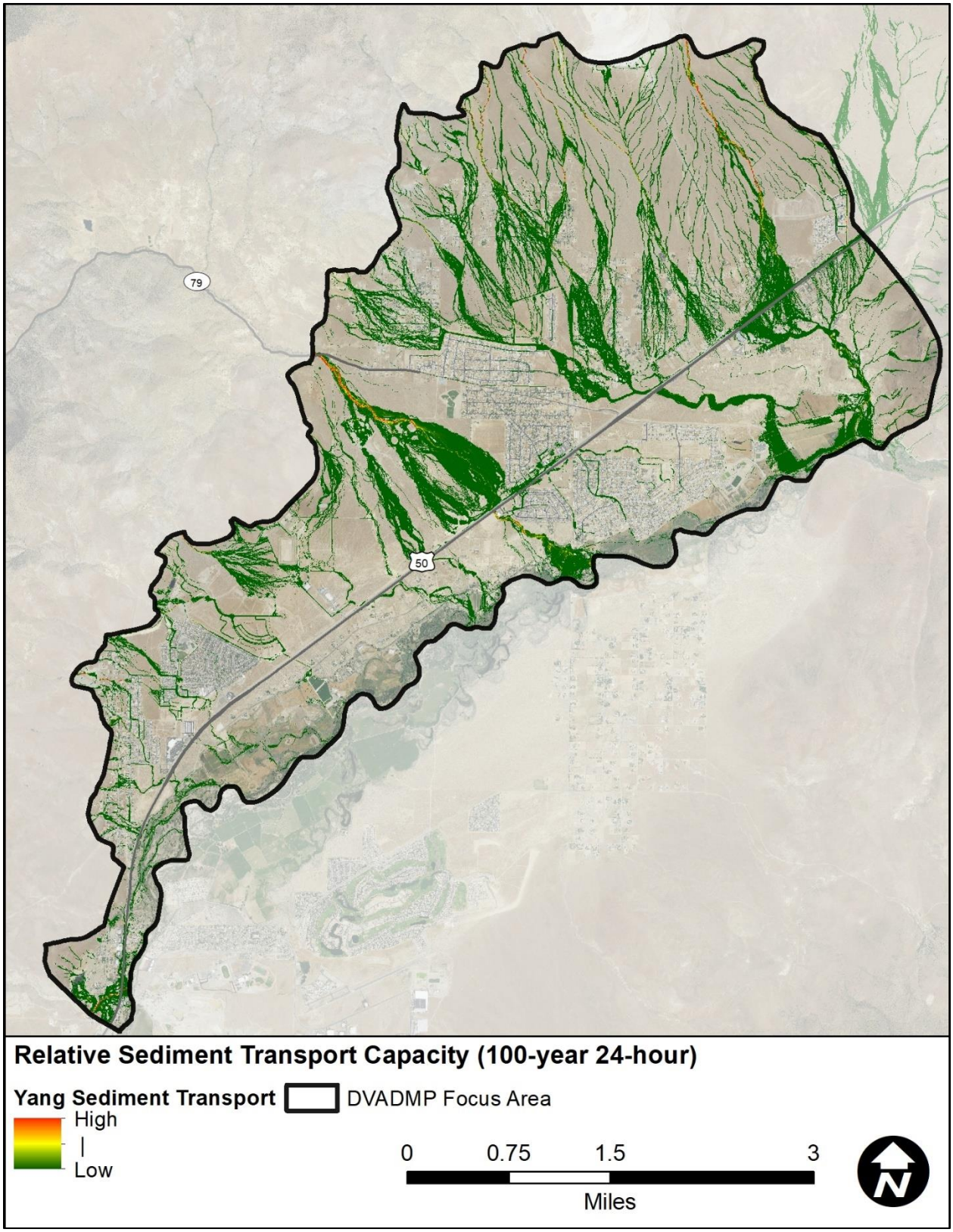


Figure 5-5. Total accumulated sediment transport capacity by the Yang methodology for the 100-year, 24-hour event

5.2.1.2 Sediment Profiles

Sediment transport profiles were developed for the major undeveloped fans within the DVADMP focus area. These profile locations are shown in Figure 5-6 . As before, the 100-year 24-hour event is used as the representative example. Since Six Mile Canyon is the largest fan landform within the focus area, the results from this fan are presented in the report. The other profiles are contained in the digital appendix.

To develop these profiles, the total accumulated sediment transport through each station (or cross-section) over the entire storm event was calculated for both the Yang and Zeller-Fullerton equations. This transport profile was plotted, and the change in slope also calculated.

In this study, these profiles were used in two ways. First, the profiles can be used to identify areas where sediment transport is not in equilibrium or out of balance. This is important because when the sediment transport is out of balance, scour (degradation) or deposition (aggradation) is occurring within the wash. This can be seen in two ways – one with the sediment transport profile itself, the other with the slope change of the sediment transport profile. When sediment transport is increasing (i.e., the slope change is positive), the wash is gathering sediment through degradation. Conversely, when the sediment transport profile is decreasing, and the slope change is negative, the wash is losing sediment through aggradation. The magnitude of the slope change gives an indication of the magnitude of the degradation/aggradation. Second, the resulting profiles from the two equations were used as comparison to gauge the reasonableness of the sediment transport magnitudes.

The 100-year 24-hour sediment transport and change in slope profiles for Six Mile Canyon are shown in Figure 5-7. For this fan, the results are unsurprising. Sediment transport decreases as flow progresses downslope on the fan surface – indicating that landform is aggrading, which is consistent with that landform. More interestingly, though, the results show aggradation upstream of US 50, while also showing degradation downstream of the US 50 culvert. These results are consistent with what would be expected given those hydraulic conditions.

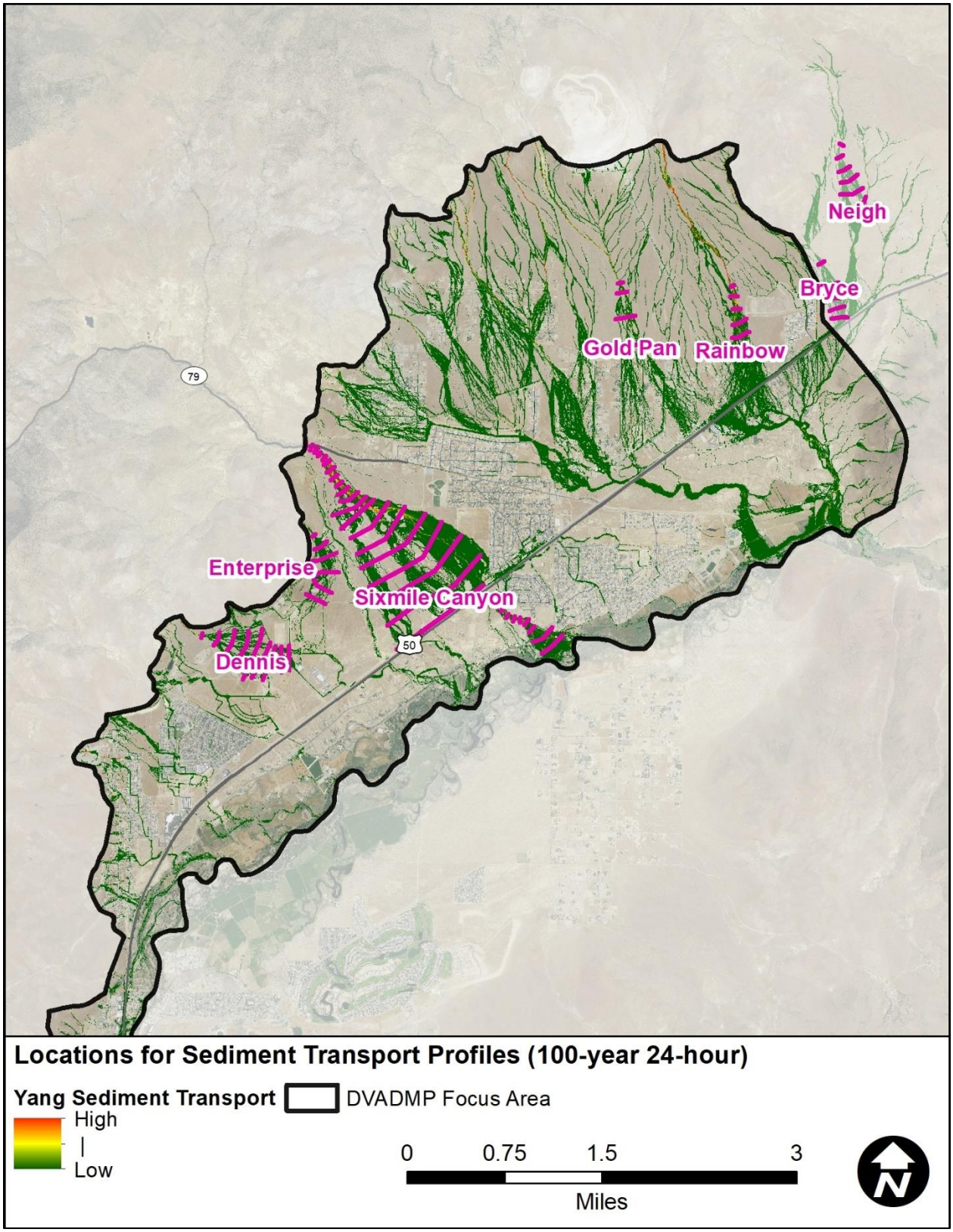


Figure 5-6. Major fan landforms where sediment profiles were calculated

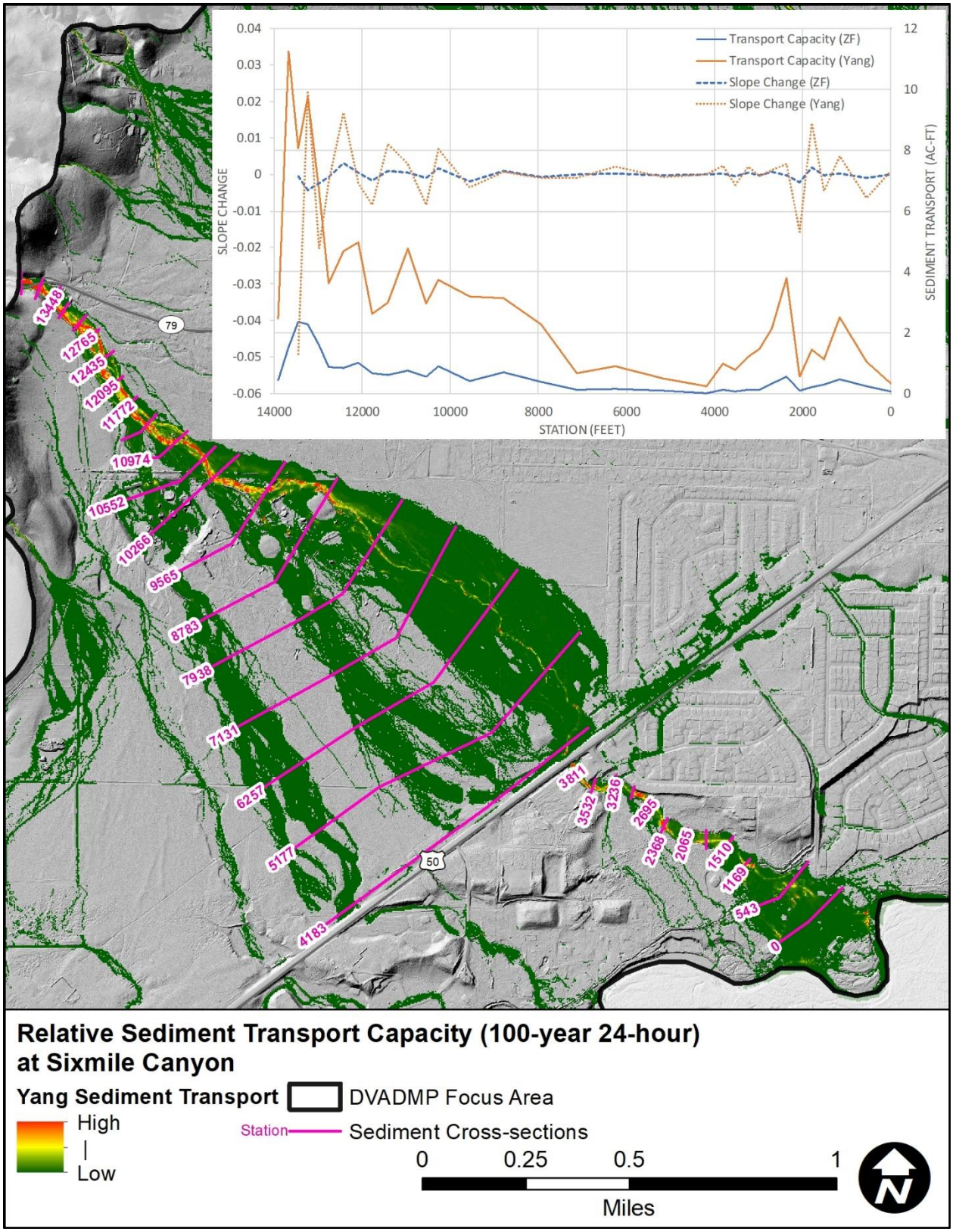


Figure 5-7. Cumulative sediment transport and change in slope comparison for Six Mile Canyon for the 100-year 24-hour event

5.2.1.3 Sediment Considerations for Proposed Alternatives

An estimate of sediment delivery volumes is beneficial when assessing proposed infrastructure locations and designs. Unlike scour, Long-term sediment deposition is a common issue for infrastructure and often cannot be mitigated through on-site improvements. Common examples of sediment deposition challenges for infrastructure included culvert sedimentation and loss of storage volume in detention basins due to deposition. To assist in the design of proposed infrastructure improvements, sediment yield was calculated for the contributing watersheds.

Standard methods for calculation of sediment yield include the Universal Soil Loss Equation (USLE), the Modified Universal Soil Loss Equation (MUSLE). These methods are largely qualitative in input and have origins in agricultural applications. Sediment yield calculations are performed for a suite of flow events which are then probabilistically integrated to represent an average annual sediment yield (often normalized per square mile of contributing area) which can be used for planning purposes. Because the results are generalized based upon annualized probability, they do not provide an acute, single-year sediment volume, but rather provide a means of obtaining reasonable long-term estimates based upon available topographic, hydrologic, and sediment data.

Sediment yield calculations were performed for contributing areas to proposed infrastructure alternatives. Generally, calculated sediment yield results were very high which was attributed to the very steep and long slopes in the upper portions of the watershed. Results generally exceeded 1 ac-ft/sq mi/year which is considered an upper limit of reasonableness (22.92 ac-ft/sq mi/yr for USLE and 6.51 ac-ft/sq mi/yr for MUSLE). The implications of these results are two-fold – 1) contributing watersheds can produce very high sediment volumes and 2) standard sediment yield relationships are likely poorly conditioned for the settings found in the Dayton Valley watershed area.

Due to the poor reasonableness of the sediment yield calculations (USLE and MUSLE), sediment transport capacity analysis was utilized to see if transport capacity is a limiting factor for sediment delivery and to see if transport capacity limitations were of a reasonable magnitude. As proposed alternative locations move further down the depositional piedmont surface, the argument for capacity limited sediment transport becomes more compelling as alluvial fans represent a largely deposition environment, particularly for sediment saturated flows originated above the apex.

Sediment transport capacity calculations were performed as described previously with the Zeller-Fullerton and Yang methods. Through the previously described comparisons, it was determined that the Yang methodology provided a better representation of sediment transport capacity throughout this watershed. Sediment transport capacity rates were integrated over time at pre-defined FLO-2D floodplain cross-section locations to calculate total sediment transport volumes at each cross-section for the suite of storms modeled. Sediment transport volumes per storm were then probabilistically composited based upon likelihood of occurrence within a 100-year span following guidance outlined in SLA (1985) with the following relationship:

$$\text{annual probabilistic value} = 0.4 * (\text{2-year value}) + 0.2 * (\text{5-year value}) + 0.08 * (\text{10-year value}) + 0.04 * (\text{25-year value}) + 0.015 * (\text{100-year value}) + 0.002 * (\text{500-year value}) \quad (4)$$

Equation (4) calculates an annualized average value based upon a non-continuous storm recurrence range for commonly analyzed storm frequencies. Resulting annualized values were divided by the upstream contributing area to calculate the sediment transport capacity in terms equivalent to sediment yield – ac-ft/sq mi/yr. The resulting values (from Yang), shown in Table 5-2, all fell below the upper

threshold limit of 1 ac-ft/sq mi/yr. For all but one of the sub-basins analyzed, the transport capacity volume was less than the sediment yield (USLE and MUSLE) calculated values. The outlier, Sub-Basin ID S9, has a different physical character (i.e., much smaller and flatter) than the other sub-basins analyzed and was the only sub-basin to result in reasonable values calculated with the sediment yield methods. A comparison of the representative sediment transport (Yang) and sediment yield (MUSLE) results is shown in Table 5-2, while the drainage sub-basins used for these calculations are shown Figure 5-8. Please note that some of the sub-basin areas overlap and may not be fully visible in this figure.

Table 5-2. Comparison of sediment transport (Yang) and sediment yield (MUSLE) results

Sub-Basin	Basin Area (sq mi)	Yang Yield per Sq Mi per Year (ac-ft/mi^2/yr)	MUSLE Yield per Sq Mi per Year (ac-ft/mi^2/yr)
S0	1.15	0.122	2.29
S1	14.17	0.257	5.59
S2	17.55	0.013	13.01
S3	1.41	0.384	12.82
S4	0.58	0.015	3.53
S5	0.61	0.264	7.40
S6	1.65	0.242	4.93
S7	4.39	0.046	8.93
S8	4.66	0.028	1.73
S9	0.69	0.670	0.16
S10	16.86	0.110	13.54
S11	3.36	0.002	4.19

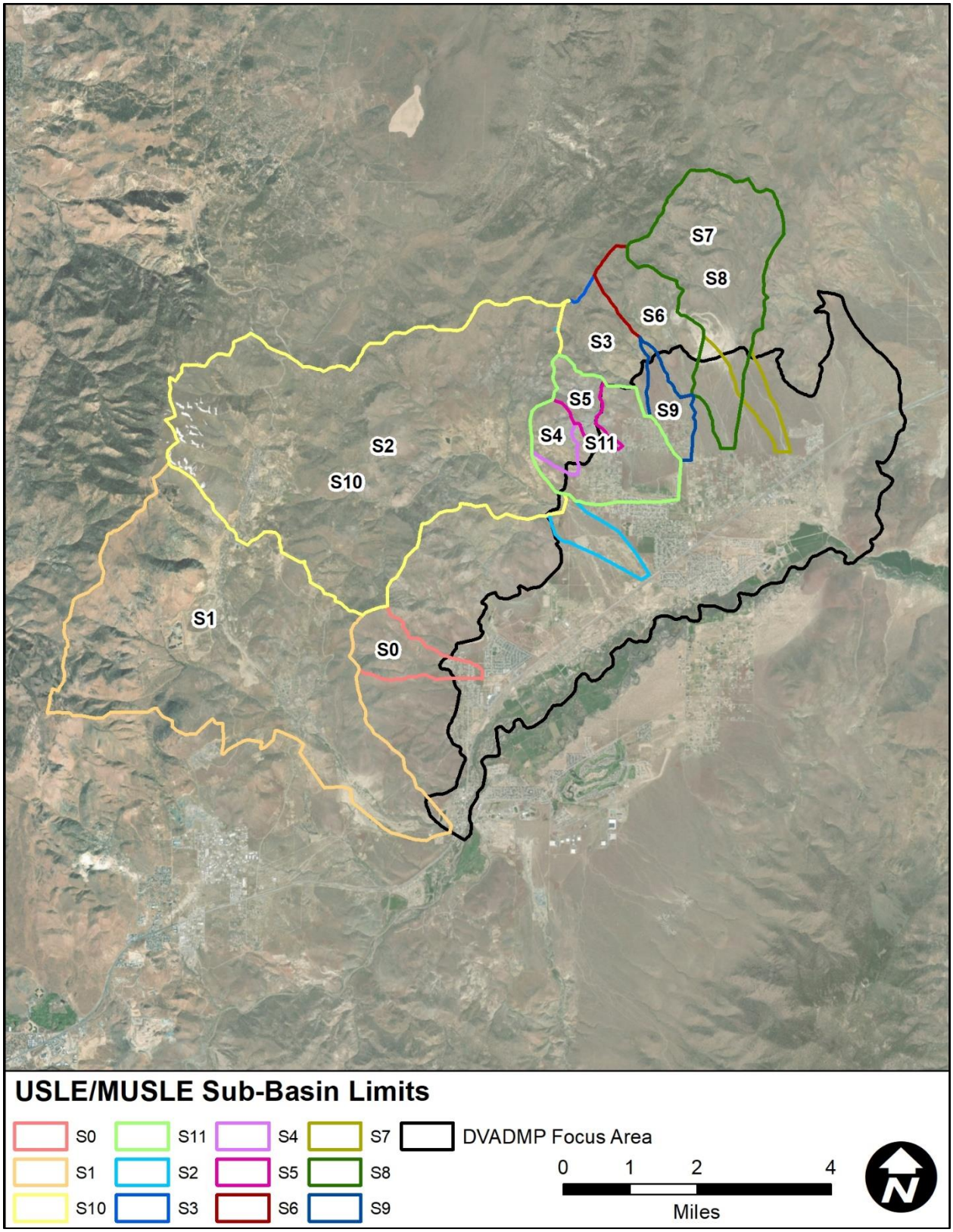


Figure 5-8. USLE/MUSLE Sub-Basins

A secondary consequence of use of the sediment transport capacity values is consideration of storm duration. For purely hydraulic analysis, a single storm duration is typically selected for consideration based upon watershed size. For sediment transport analysis, storm volume, particularly volume above the critical transport threshold velocity, is a parameter with great impact on results. Storm duration considerations are beyond the common considerations of the sediment yield (USLE/MUSLE) calculations, but not actual sediment yield. Neither the SLA method (Equation (4)) or sediment yield methods support multiple-duration averaging (i.e., averaging a 6-hour duration with a 24-hour duration). Further, most of the FLO-2D modeling efforts for this study were focused on the 24-hour storm duration, but only the 25- and 100-year storms were modeled for this duration. Additional 6-hour duration models were developed to provide the full suite of recurrence intervals for Equation (4). However, these additional storms were developed for the sediment calculations only, and not used in the ADMP. For the 24-hour duration, intermediate recurrence values were linearly interpolated from the 25- and 100-year sediment transport capacity results and applied per Equation (4) in the same manner as the 6-hour results. Volumes from the 24-hour storms were used as they resulted in greater unit sediment transport capacities/yields owing to the greater storm duration applied.

Yang sediment transport equations yield results in concentration as parts per million (ppm). The maximum concentrations per grid were converted from a mass per volume result to a volume per volume relationship to determine the maximum sediment concentrations for flow bulking due to sediment. Flow bulking is a useful method for accounting for extra flood volume due to entrained sediment in flood flows.

Consequently, the Yang sediment transport estimates were used in the development of the 15% design alternatives (see Section 7). Three times the annual sediment transport volume plus one design event (100-year or 25-year) sediment transport volume was used as the total sediment volume for each basin. For channels, a 4% bulking factor was applied to the design flow based on calculated sediment concentrations throughout the study area. The total sediment design volumes for the proposed flood mitigation basins are summarized in Table 5-3.

Finally, it should be noted that sediment throughput calculations exhibit wide variability based on the transport equation used, grain size of the sediment, watershed slope, and many other variables. Similarly, since the hydraulic calculations are the backbone of any sediment calculation, infiltration volumes and Manning's n values also affect total sediment volumes. Therefore, most analyses in this study were taken on a relative basis – that is the absolute values are not precise. However, the sediment volumes for basin design do need a computed volume; and, in this case, appropriate safety factors were incorporated in the analyses. Nonetheless, it is recommended that for final design of any basin, a detailed analysis of that specific watershed be done to refine the sediment volumes.

Table 5-3. Sediment design volumes

Basin Name*	25-Year Sediment Storage Volume (ac-ft)	100-Year Sediment Storage Volume (ac-ft)
Gold Pan	0.96	1.01
Lonnie	0.06	0.10
Mark Twain North**	3.51	3.21
Mark Twain South	2.04	3.60
Mark Twain West	3.90	4.89
Prospector	0.07	0.10
Rainbow	1.99	2.25

*The basins listed in this table represent proposed mitigation structures that are described in detail in Section 7.
**The 25-year sediment volume is greater than the 100-year due differing characteristics between the 100-year and 25-year hydrographs on which these volumes were calculated.

6 FLOOD HAZARD CLASSIFICATION

6.1 PURPOSE

During a severe storm event, flood waters flow throughout the Dayton Valley ADMP study watershed. However, not all flood hazards pose a risk to people or to their properties. Flood risk depends on the presence of both a flood hazard and people (or their property). As an example, flow in a constructed flood control channel does not present a risk until someone enters the channel. Identifying areas where flood waters may cause risks that potentially harm people (or property) is an important objective of the ADMP. Identification of potential flood risks in the study area helps the project team prioritize which flood problems should be addressed and in what order.

For the purposes of this study, flood hazards were defined based on the physical characteristics of the flood water – that is, the location, depth, and velocity associated with those flood waters. The hydrology and hydraulic modeling results were used to define flood hazards for three storms:

- the 25-year, 24-hour event,
- the 100-year, 24-hour event, and
- the 100-year, 6-hour event.

The flood risk assessment involved selecting criteria and quantifying flood risks throughout the study watershed using the FLO-2D model results. Three types of potential flood risks were assessed – flooding risks to pedestrians, passenger vehicles, and structures.

In addition to the flooding risks, two other types of flood consequence assessments were conducted:

- Building Inundation Assessment, and
- HAZUS Event-Based Analysis.

The building inundation and HAZUS assessments are planning level analyses to estimate the number of habitable structures and associated damage costs by flow depths greater than six inches. Since this analysis will be done for both the base (i.e., existing) and the with-alternatives conditions (see Section 7), it gives a quantitative estimate of the effectiveness of the potential alternative structures. Both analyses were performed for all three storm events.

The following sections describe the flood classification criteria, methodology, and description of provided electronic files for each potential flooding assessment.

6.2 FLOODING HAZARDS TO PEDESTRIANS

Pedestrian flood hazards were classified using the depth-velocity relationship outlined in the United States Bureau of Reclamation (USBR) Technical Memorandum 11 (TM 11) (1988). The depth-velocity relationships presented in TM 11 are a good basis for flood hazard classification since the criteria are widely accepted. TM 11 presents two possible classifications for pedestrians; flood danger levels for adults and for children. It was decided to use the flood danger classification for children throughout the entire watershed to simplify the methodology and to be conservative. The depth-velocity flood danger level relationship from TM 11 is shown as Figure 6-1.

The following three categories exist for pedestrian flood hazards:

- *Low*: These are areas with depths and velocities corresponding to the Low Danger Zone as shown in Figure 6-1. Low pedestrian hazards are not displayed on the map exhibits because, per TM11, low hazard zones do not present a threat to children of almost any size (excluding infants) and cover all areas not classified with a higher flood hazard.
- *Moderate*: Areas with depths and velocities corresponding to the Judgment Zone in Figure 6-1 have been labeled as having a moderate potential flood hazard to pedestrians.
- *High*: Areas with depths and velocities corresponding to the High Danger Zone in Figure 6-1 have been labeled as having a high potential flood hazard to pedestrians.

The flood hazards to pedestrians have been digitized in GIS in the form of a raster. The rasters generated for the risk analysis coincide with the FLO-2D grid elements with a 15-foot by 15-foot pixel size. The raster contains values of 1, 2, and 3 which correlates to a low, moderate, and high hazard classification, respectively. Since the 100-year, 24-hour storm produces the largest peak runoff for most areas (see Table 3-8), the flooding hazard from this storm event is shown as Figure 6-2.

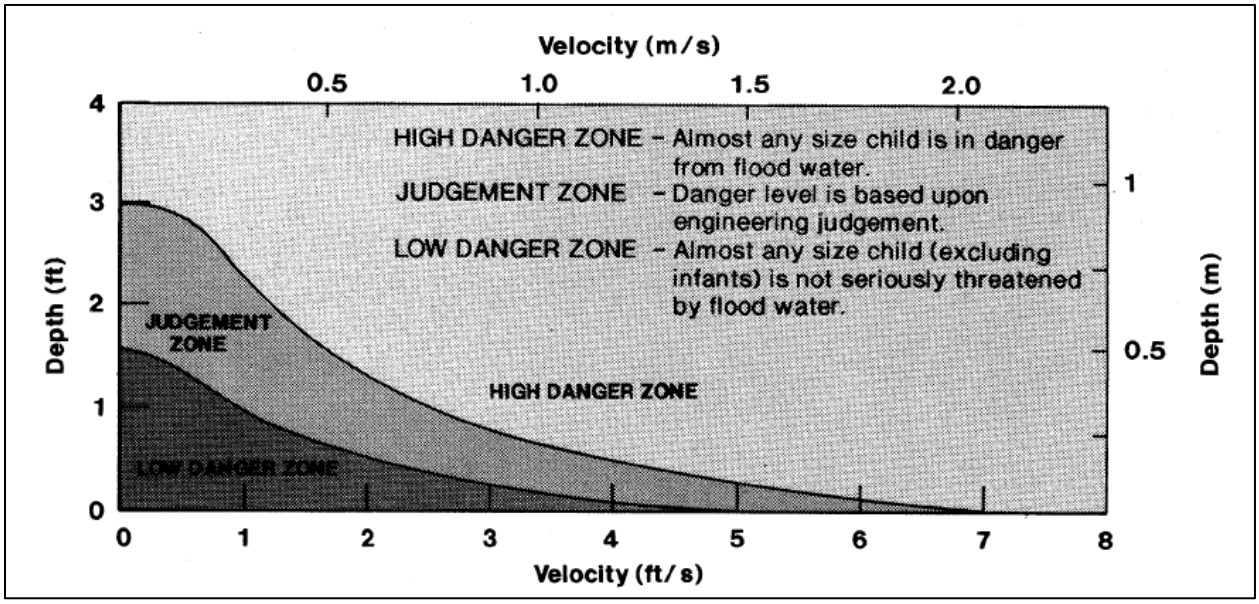


Figure 6-1. Depth-Velocity flood danger level relationship for children, from USBR (1988)

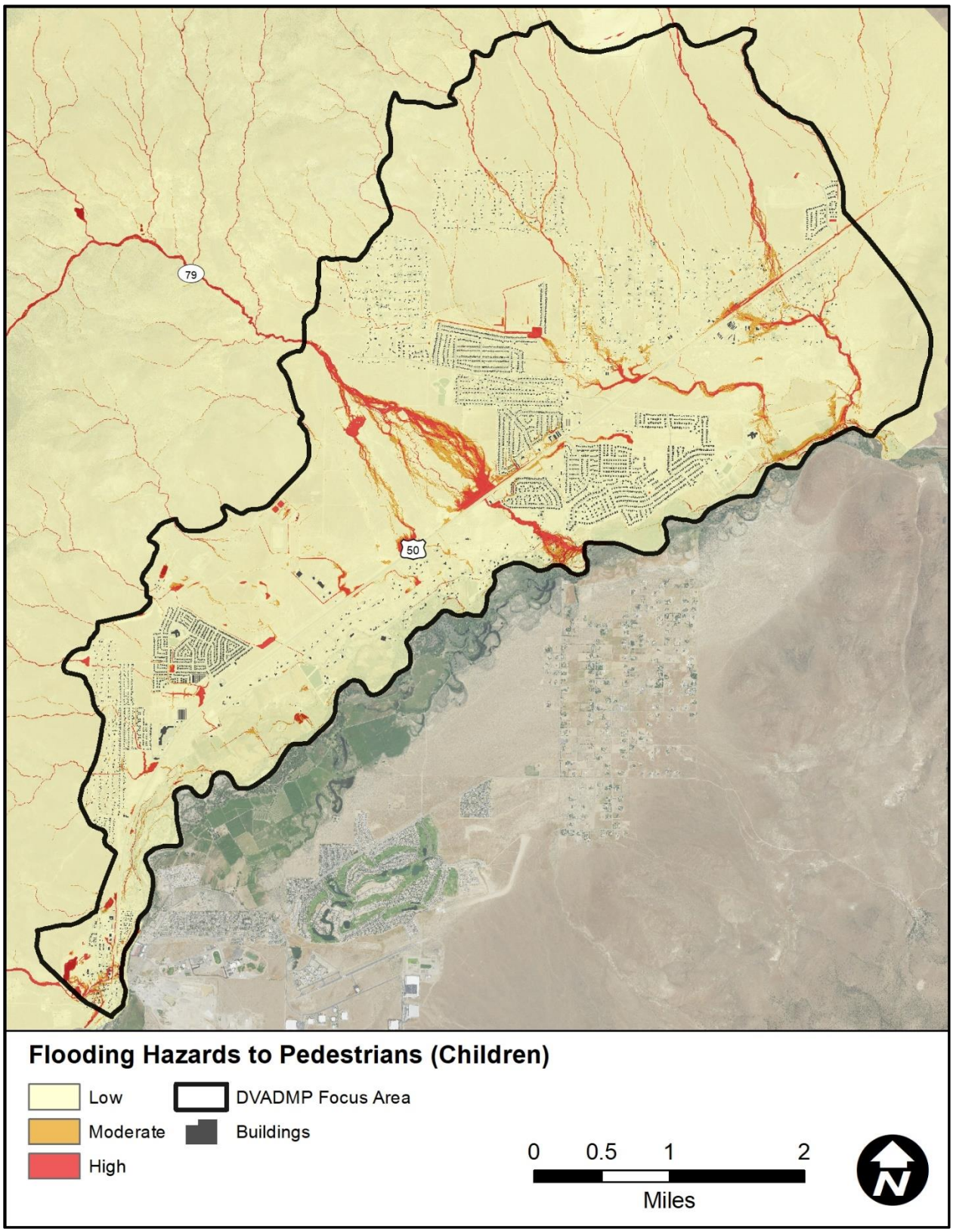


Figure 6-2. Flooding hazards to children based on the 100-year, 24-hour FLO-2D results (entire focus area)

6.3 Flooding Hazards to Passenger Vehicles

Potential hazards to passenger vehicles were classified using a combination of minimum depth criteria and depth-velocity relationship in TM 11 as shown in Figure 6-3. The following four categories exist for passenger vehicle flood hazards:

- *Low*: This hazard category is based solely on minimum depth criteria and is for roadway crossings with depths less than half a foot. Low passenger vehicle hazards are not displayed on the map exhibits because low hazard zones indicate areas where vehicles "are not seriously in danger"; and, as such, almost any size passenger vehicle can safely pass. Also, this hazard classification covers all areas not classified with a higher flood hazard.
- *Moderate*: This hazard category is based on a combination of minimum depth criteria and the depth-velocity relationship in TM 11. Specifically, these are roadway crossings with depths and velocities falling into the Low Danger Zone (as shown in Figure 6-3) that also have greater than a half a foot of depth. The threshold depth of half a foot was chosen because half a foot of water will reach the bottom of most passenger cars and can cause loss of control and possible stalling.
- *High*: Roadway crossings with depths and velocities corresponding to the Judgment Zone in Figure 6-3 have been labeled as having a high potential flood hazard for passenger vehicles.
- *Very High*: Roadway crossings with depths and velocities corresponding to the High Danger Zone in Figure 6-3 have been labeled as having a very high potential flood hazard for passenger vehicles.

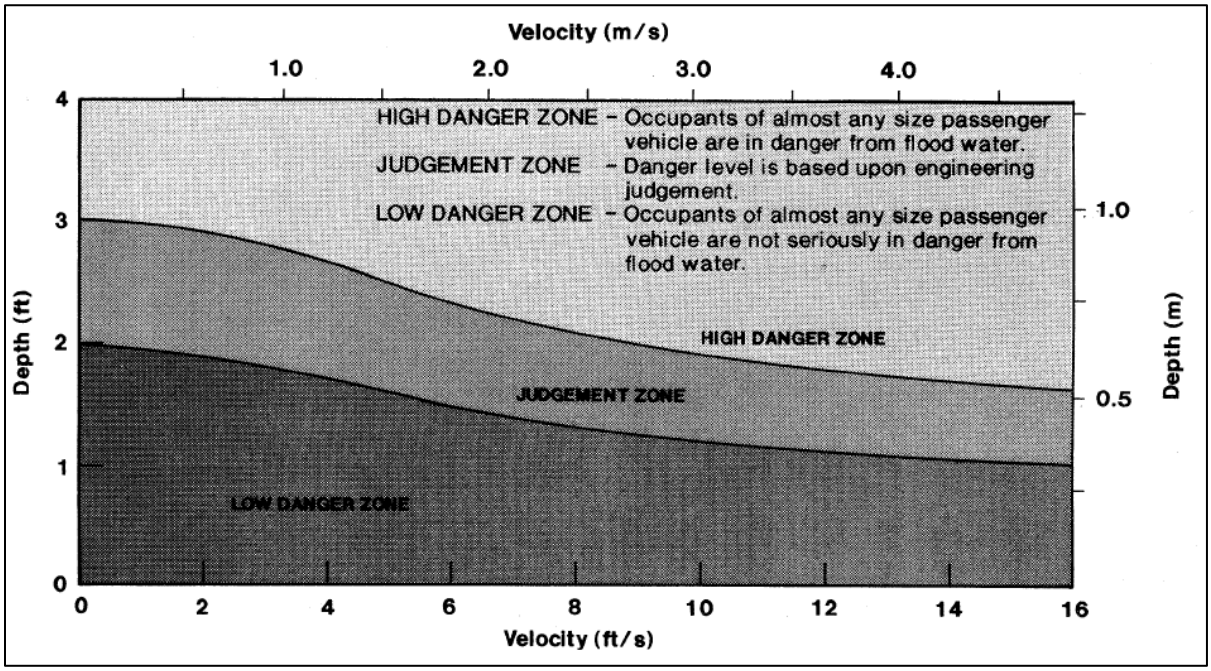


Figure 6-3. Depth-Velocity flood danger level relationship for passenger vehicles, from USBR (1988)

The flood hazards to passenger vehicles have also been digitized in GIS in the form of a raster. The raster contains values of 1, 2, 3, and 4. These values correlate to the low, moderate, high, and very high classifications, respectively. As an example, the flooding hazards to vehicles raster layer for the 100-year 24-hour storm event is shown as Figure 6-4.

To isolate the actual risk to vehicles, the street centerlines GIS layer was intersected with the hazards zones to produce a "Potential Risk to Passenger Vehicles" map. This isolates the road crossings that pose a risk to vehicles during a 100-year 24-hour storm (Figure 6-5). The two other storm events, 100-year 6-hour and the 25-year 24-hour, are shown in Figure 6-6 and Figure 6-7, respectively.

During these three storm events, there are only fifteen (15) distinct crossing areas with a very high hazard. These areas are summarized in the list below and shown on Figure 6-8. Additionally, the high hazard crossings are also shown on Figure 6-8. There are thirty (30) distinct high hazard crossing areas.

1) Unnamed dirt road near the north limit of the focus area.
2) Unnamed dirt road near the northeast limit of the focus area.
3) Unnamed dirt road near the north edge of the Mark Twain area.
4) Unpaved section of Sutro Springs Road north of the Mark Train area.
5) Unpaved north end section of Gold Pan Way.
6) North frontage road of US 50 east of Rainbow Drive.
7) Rainbow Drive south of US 50 west of Chaves Road.
8) Fort Churchill Road east of Chaves Road intersection north of the Carson River.
9) Sandefer Lane crossing of Six Mile Canyon near the Carson River.
10) Overland Loop just west of Occidental Drive (only during the 100-year 24-hour storm event).
11) Unnamed dirt road near the northwest edge of the Mark Twain area near the mountain front.
12) Unnamed dirt road and Six Mile Canyon Road crossings of Six Mile Canyon.
    Note: The Six Mile Canyon Road Bridge was not explicitly modeled in FLO-2D. That is, the cells were lowered to allow FLO-2D to calculate conveyance through overland flow calculations rather than hydraulic structures calculations. However, this crossing does show overtopping during a 100-year 24-hour event.
13) Sutro Tunnel Road near Corral Drive.
    Note: This section of Sutro Tunnel Drive is unpaved and adjacent to a drainage channel. Currently, it does not appear to be a dedicated roadway, but any future roadway improvements should be cognizant of potentially hazardous drainage conditions.
14) Dayton Village Parkway just east of the intersection with Sweetwater Circle.
    Note: This section of Dayton Village Parkway is unpaved, and the road centerline follows the alignment of a drainage channel. Currently, it does not appear to be a dedicated roadway, but any future roadway improvements should be cognizant of potentially hazardous drainage conditions.
15) Shady Lane and Pike Street crossings of Gold Canyon in Old Dayton.

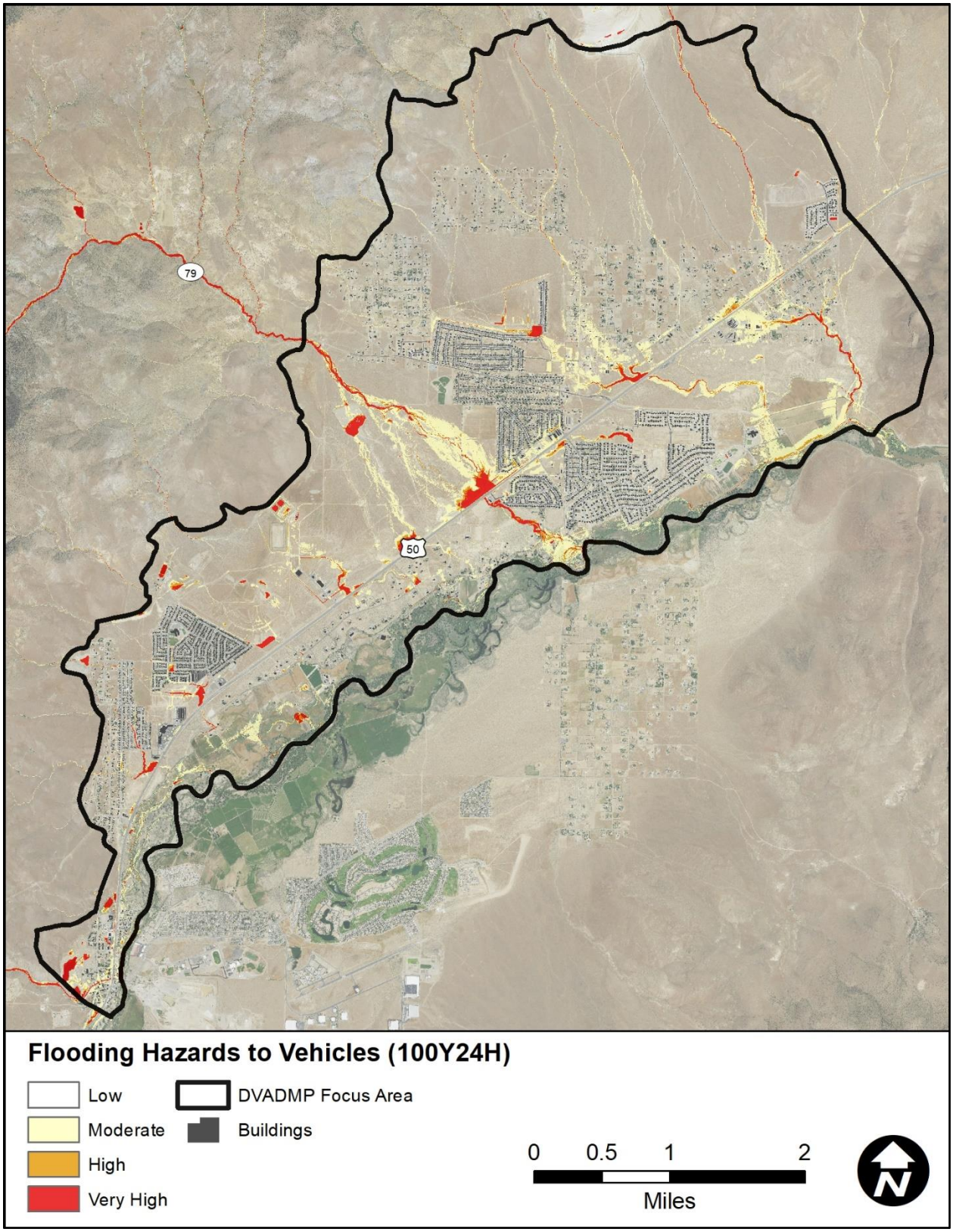


Figure 6-4. Flooding hazards to vehicles raster based on the 100-year, 24-hour FLO-2D results (entire focus area)

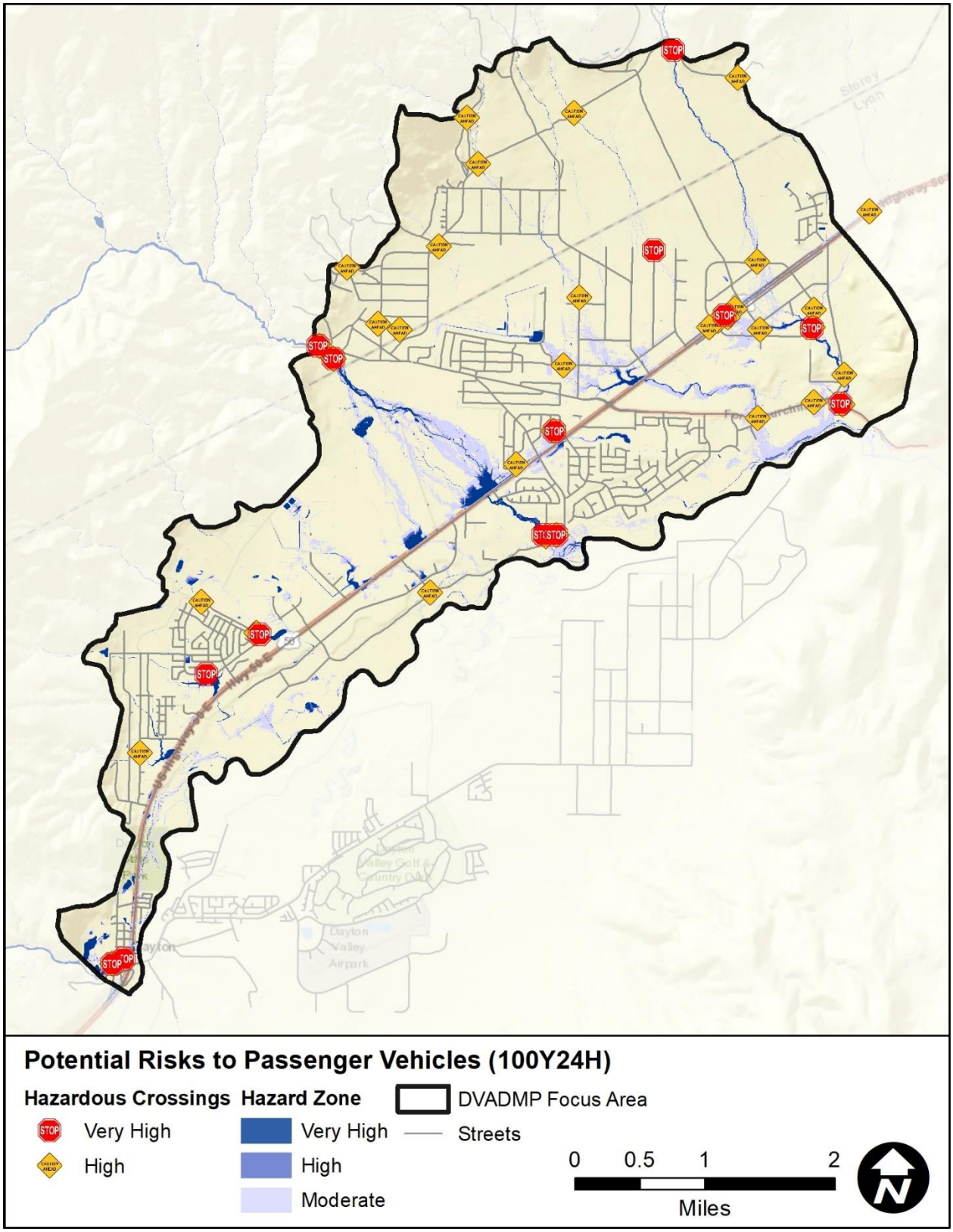


Figure 6-5. Hazardous wash crossings during a 100-year 24-hour event

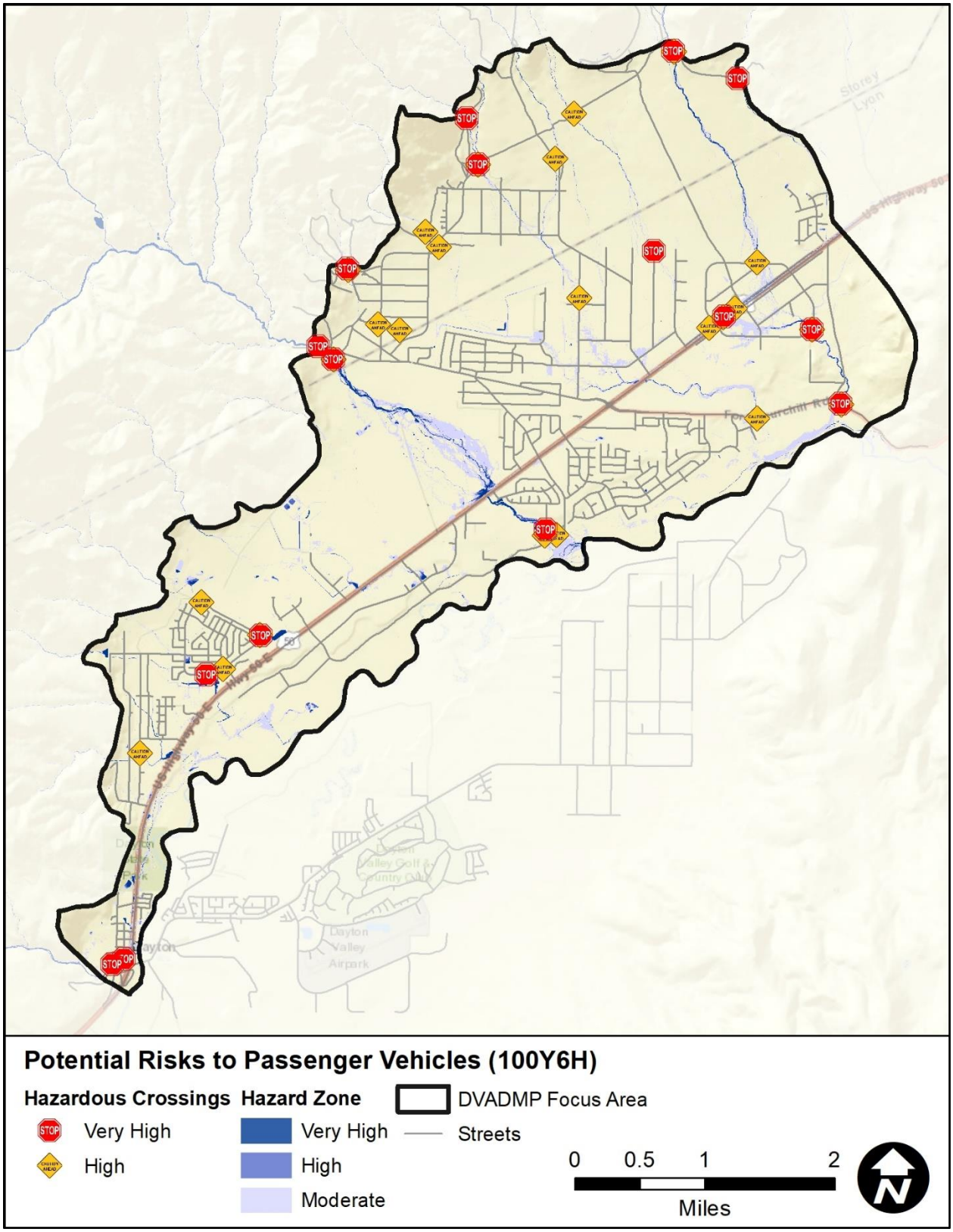


Figure 6-6. Hazardous wash crossings during a 100-year 6-hour event

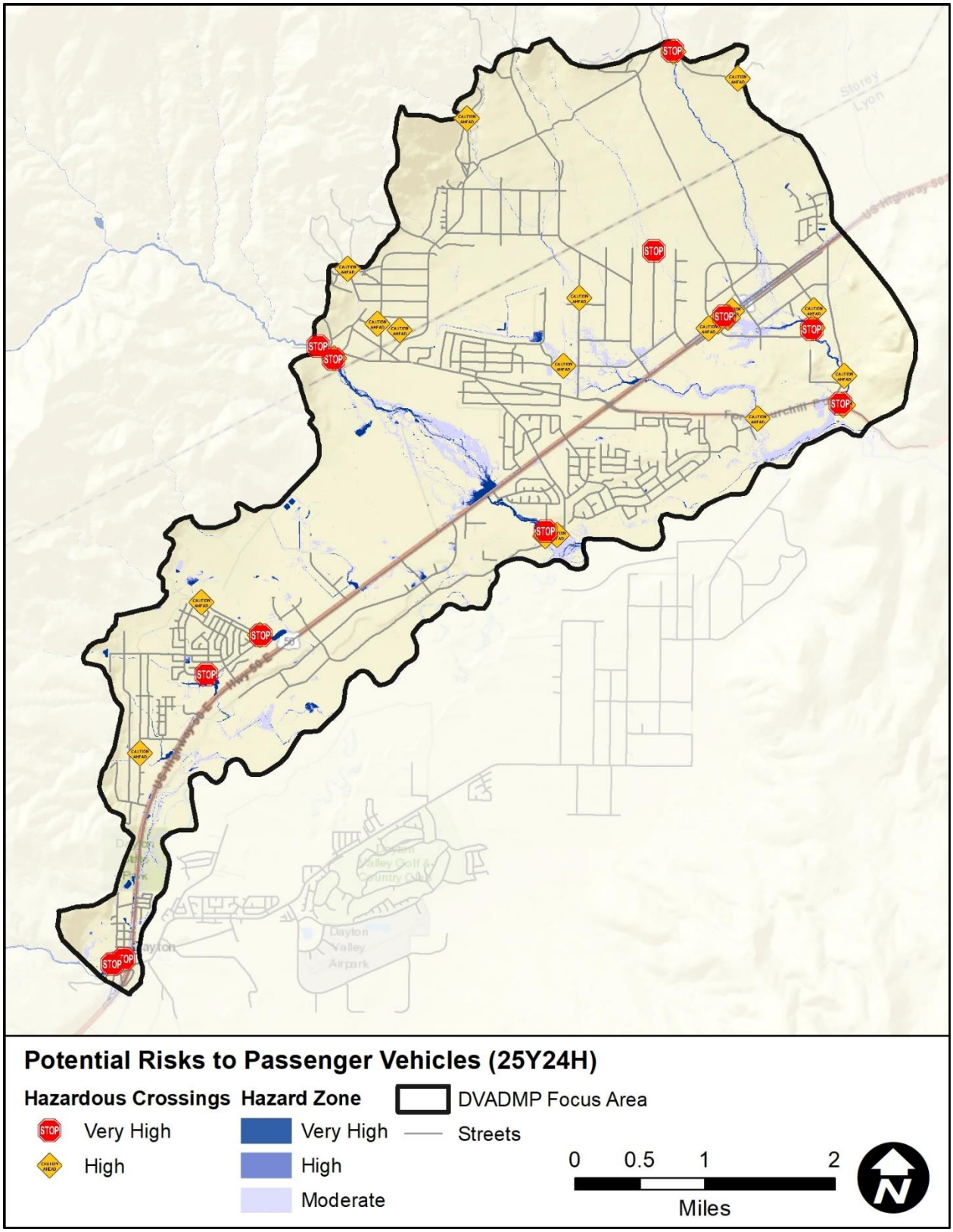


Figure 6-7. Hazardous wash crossings during a 25-year 24-hour event

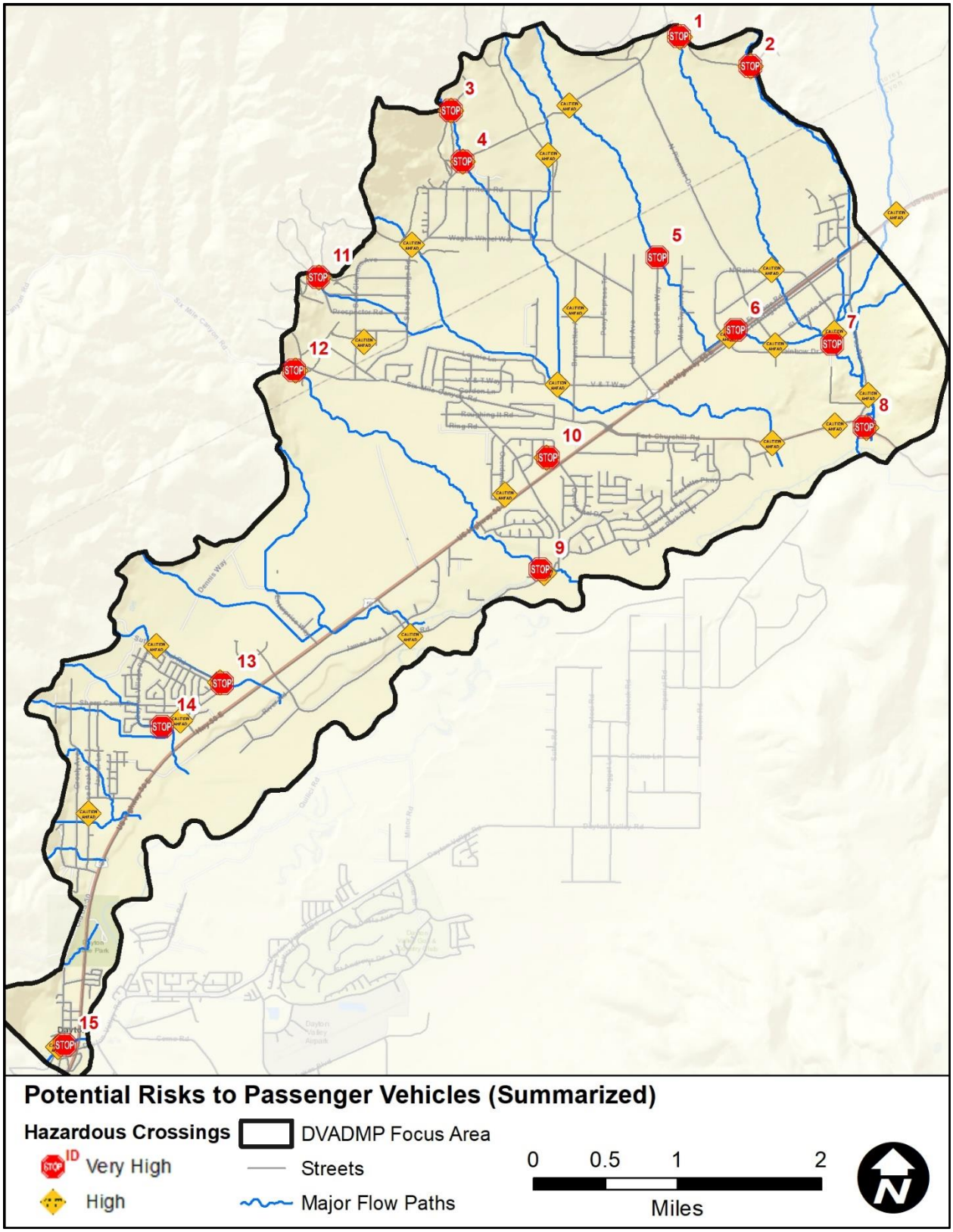


Figure 6-8. Summarized very high and high hazardous crossings across all events

6.4 Flooding Hazards to Structures

Potential hazards to buildings were classified using the depth-velocity relationship from TM 11. The depth-velocity relationship from TM 11 is shown as Figure 6-9. The following three categories exist for potential flood hazards to structures:

- *Low*: Buildings that have contact with at least one FLO-2D grid element that has a depth-velocity relationship corresponding to the low danger zone in Figure 6-9 have been designated as having a low potential flood hazard.
- *Moderate*: Buildings that have contact with at least one FLO-2D grid element that has a depth-velocity relationship corresponding to the judgment danger zone in Figure 6-9 have been designated as having a moderate potential flood hazard.
- *High*: Buildings that have contact with at least one FLO-2D grid element that has a depth-velocity relationship corresponding to the high danger zone in Figure 6-9 have been designated as having a high potential flood hazard.

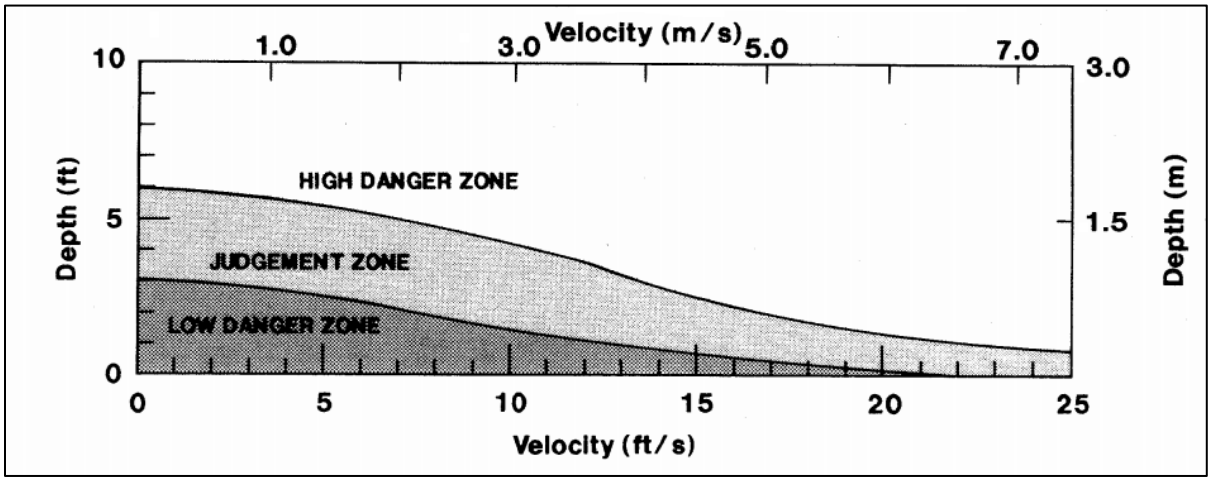


Figure 6-9. Depth-Velocity flood danger level relationship for structures built on foundations, from USBR (1988)

From the building footprint data (i.e., a building polygon shapefile), there are 7,891 structures within the DVADMP focus area (including a slight buffer); however, not all these structures are habitable. Buildings with less than 600 square feet (e.g., unattached garages or sheds) were not considered because they were assumed to be uninhabited due to their size. After applying this filter, there are 5,022 structures in the study area.

To create the building flood hazard classification, the building polygon shapefile is intersected with the flood hazard layer using GIS software tools. When multiple grid cells from the flood hazard layer intersect one building polygon, the maximum hazard classification is assigned to the building. The result is a building polygon shapefile with a hazard attribute classifying low, moderate, or high flood hazards.

The tabulated building hazard results are shown in Table 6-1. Due to the relatively shallow flooding in the project area, there is only one building with a high hazard based on the TM 11 criteria and only one classified with a moderate hazard. The 100-year 24-hour flooding hazards to buildings raster for the DVADMP focus area is shown in Figure 6-10. An example of the buildings classification for the Mark Twain area of the ADMP is shown in Figure 6-11.

Table 6-1. Buildings flooding hazard classification results (base conditions)

Base Conditions				
Recurrence Interval	**Building Count**	**Building Count**	**Building Count**	**Total Building Count**
	Low	**Moderate**	**High**	
25Y24H	5020	1	1	5022
100Y24H	5020	1	1	5022
100Y6H	5020	1	1	5022

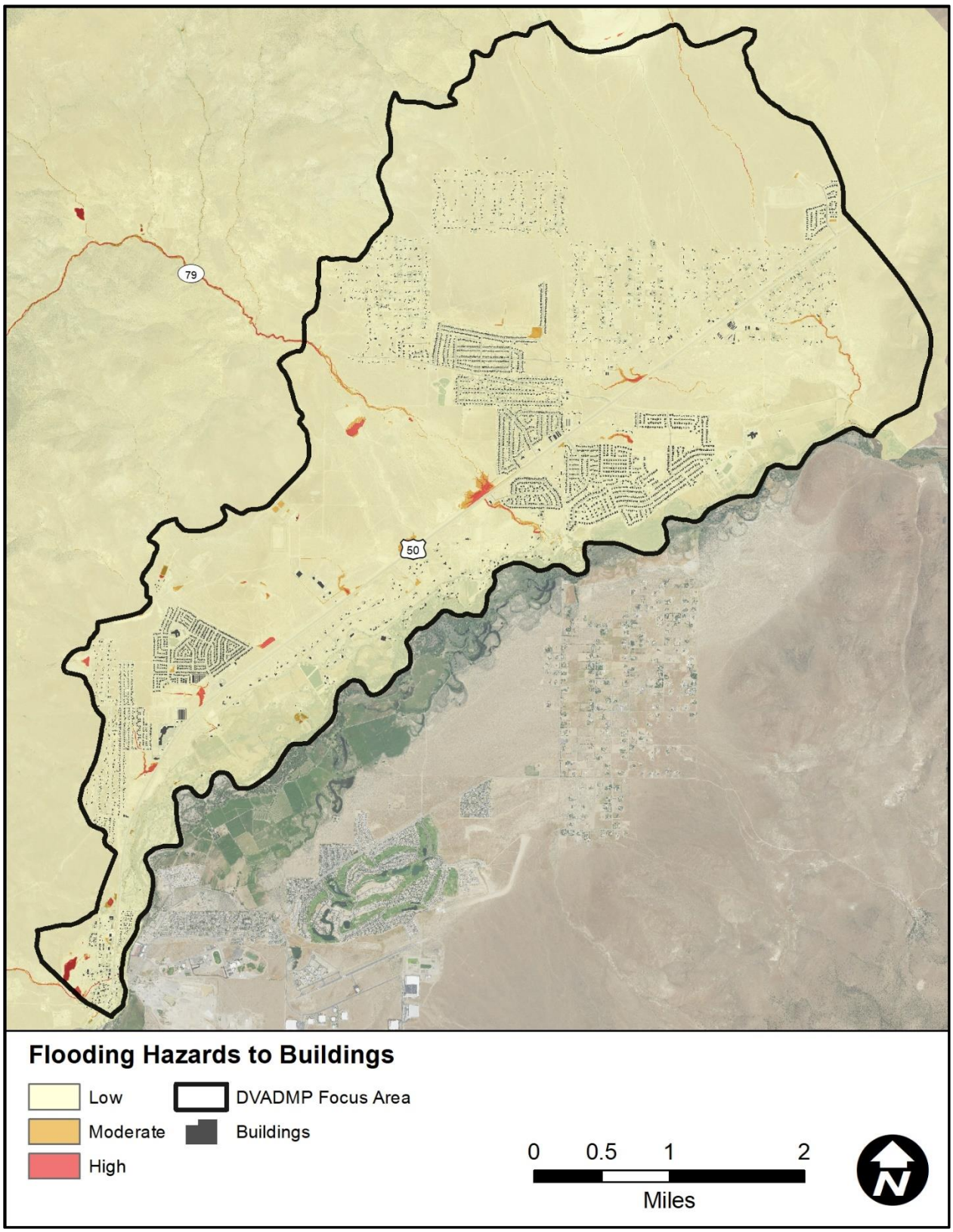


Figure 6-10. Flooding hazards to buildings raster based on the 100-year, 24-hour FLO-2D results (entire focus area)

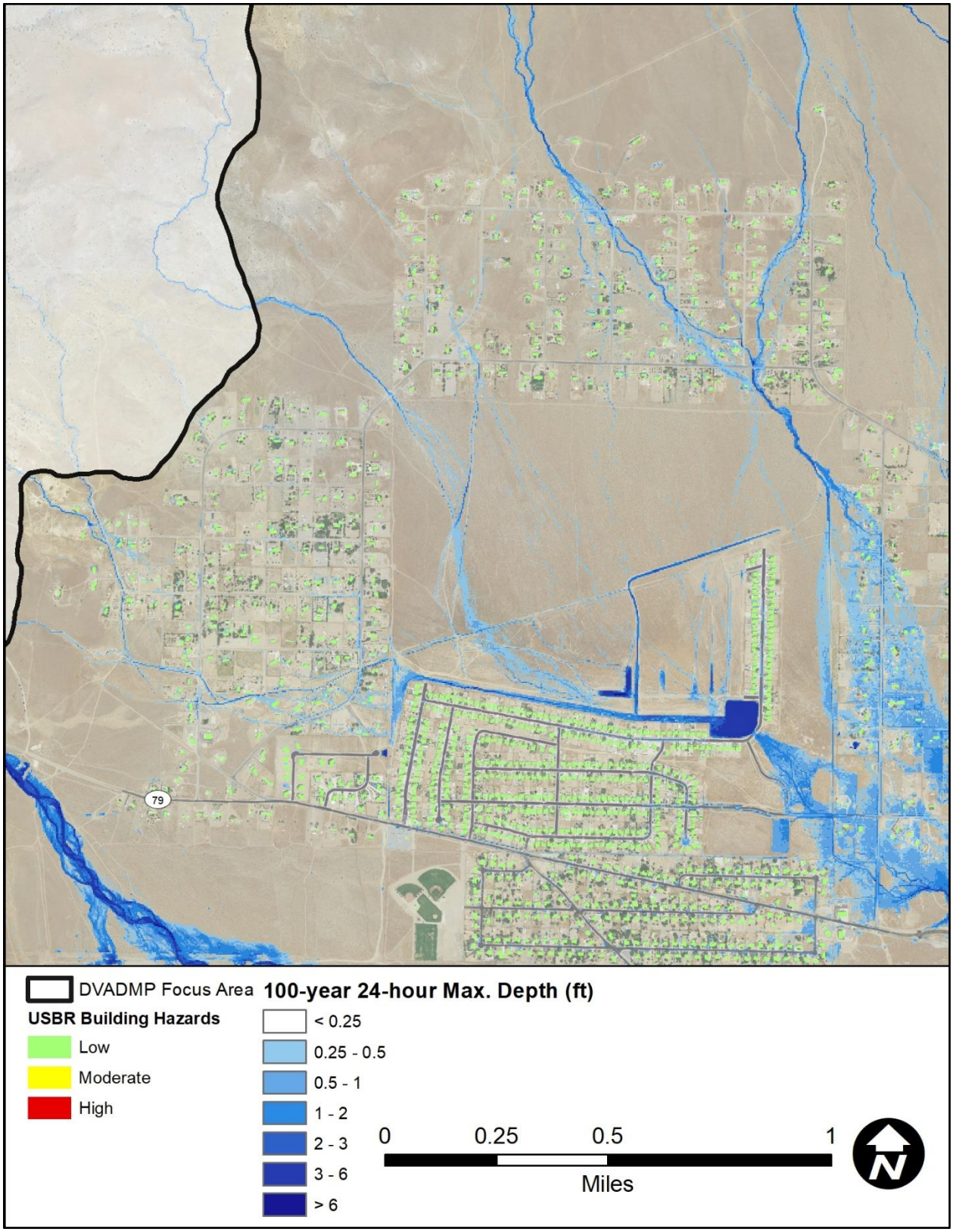


Figure 6-11. USBR building flooding hazard classification based on the 100-year, 24-hour FLO-2D results (Mark Twain area)

6.5 Building Inundation Assessment

6.5.1 Methodology

To verify and contrast the flooding hazards to building results, a separate building impact analysis was conducted using the building footprint data (obtained during initial data collection from Lyon and Storey Counties and supplemented with the 2017 NAIP aerial photography) and the maximum depth results from the FLO-2D modeling for the base conditions. The maximum depth layers only consider the maximum depth that occurred during the simulation. For this analysis, the same 600 square foot filter that was used in the "flooding hazard to structures" analysis (see Section 6.4) was applied.

In this section, the documentation will focus on the base conditions analyses, while the with-alternatives results will be presented later in Section 7.

6.5.2 Base Conditions

Each building was classified based on the maximum flow depth that accumulated adjacent to the structure outline. The structures were tabulated into four groups:

1) 0.25 ft < Depth (h) ≤ 0.5 ft – Low
2) 0.5 ft ≤ Depth (h) ≤ 1.0 ft – Moderate
3) 1.0 ft < Depth (h) – High
4) 0.25 ft < Depth (h) (inclusive of groups 1 through 3 above)

The results for existing conditions are tabulated in Table 6-2, while the results for the 100-year 24-hour storm for the Mark Twain area are shown in Figure 6-12. From these results, the shorter duration, high intensity storms (e.g., 100-year 6-hour) have the potential to impact a large amount of structures, but the 100-year 24-hour storm still impacts the most structures. Due to the amount of rainfall volume, these results are expected.

As noted in the previous section, some large commercial buildings show ponding due to a recessed shipping dock or the geometry of the building blocking the flow. Figure 6-12 shows multiple buildings with *Moderate* to *High* inundation risk that are not adjacent to an offsite flow corridor. Their flooding risk is a result of local rainfall accumulation within topographically low areas adjacent to the buildings. For commercial buildings, this is typically the result runoff accumulation in below-grade loading dock ramps.

Table 6-2. Buildings that are impacted by various depths (base conditions)

Base Conditions				
Recurrence Interval	**Building Count Flow Depth**	**Building Count Flow Depth**	**Building Count Flow Depth**	**Total Building Count**
	0.25' < h ≤ 0.5'	**0.5'< h ≤ 1'**	**1' < h**	**0.25' < h**
25Y24H	562	146	57	**765**
100Y24H	658	231	81	**970**
100Y6H	714	161	53	**928**

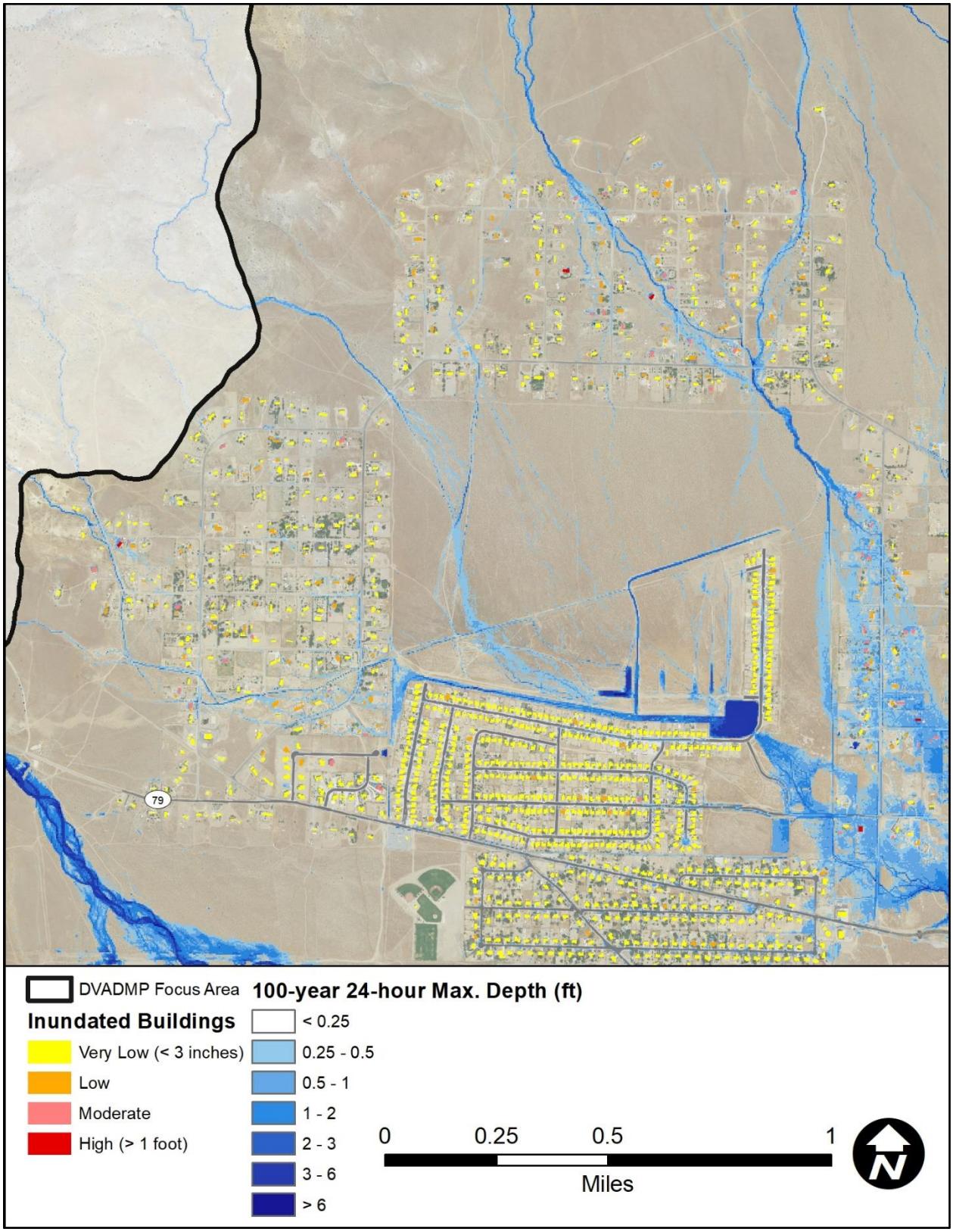


Figure 6-12. Building inundation assessment based on the 100-year, 24-hour FLO-2D results (Mark Twain area)

6.6 HAZUS ANALYSES

6.6.1 Methodology and Purpose

FEMA's HAZUS program[4] is a standardized computer software package that automates FEMA's methodology for estimating potential economic losses and human displacement due to natural disasters such as earthquakes, floods and hurricanes. For flood related losses, HAZUS has the capability to perform varying levels of analyses that are distinguished primarily on the amount of user provided data. A Level 1 analysis is primarily based on generalized data provided with the software and rudimentary estimations of hydrology and flood depths to estimate flood risk. A Level 2 analysis blends user generated data with software data. A Level 3 analysis primarily uses all user generated input data. The analysis performed in this study would be considered a simple Level 2 since more detailed flood risk data (flood depth grids from FLO-2D) has been generated external to the model and imported for use in conducting the loss analyses.

In HAZUS, the flood depth grids are analyzed against a general building stock (GBS) database that is spatially tied to the 2010 Census blocks. The HAZUS analysis also considers single location essential facilities (e.g. – fire stations, hospitals, etc.). Both data sets contain attributes that represent an estimate of the number of buildings, building type, population, building replacement costs and so forth. However, the GBS data are generalized to the level of a census block. Since these estimates are based on the resolution of census blocks, the loss estimates are considered valid for a planning level of analysis. For a more complete explanation of the HAZUS modeling package, see the link provided in the footnote below.

Flood hazard loss estimates for the base and with-project conditions were calculated for the DVADMP study using HAZUS 4.2 with the Service Pack 01 (SP01) update. In the 4.2 release of HAZUS, an erroneous multiplier was removed from the business interruption calculations that will significantly increase the economic losses from business interruptions. This correction should be recognized when comparing results from older versions of HAZUS. Additionally, the state databases were updated with 2018 valuations with the SP01 update. However, for this study, the business interruption estimates were not included because they were estimated in the hundreds of millions of dollars; and, as such, completely overwhelmed the direct building losses.

The purpose of the HAZUS analyses is to quantify the economic benefit from reduced flood damages that may be realized with the construction of all or part of the alternatives. The HAZUS default damage curves were used for all types of structures, with two exceptions. The United States Army Corps of Engineers (USACE) New Orleans District depth-damage curve (ID 143) was used for one story slab foundation residential structures, while the USACE New Orleans depth-damage curve (ID 57) was used for the contents of those same structures. With these curves, more reasonable estimates of the economic damages were calculated.

As before, the documentation in this section will focus on the base conditions analyses, while the with-project results will be presented after the alternatives are discussed. The two scenarios will be compared in that section.

[4] HAZUS-MH 4.2 (https://msc.fema.gov/portal/resources/hazus)

6.6.2 Base Conditions

These estimates only include direct building loss. According to HAZUS literature (FEMA, 2015), "the direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents." In these tables, the total property column includes residential, commercial, industrial and miscellaneous other structures. Therefore, the total property represents the sum of other four categories. Finally, all estimates are based on the HAZUS GBS database, which is tied to 2010 census data and 2018 dollars.

A results summary is presented as Table 6-3. From these results, the 100-year 24-hour storm event causes significantly more damage than the other storms. Based on the results, the 25-year 24-hour event causes slightly more damage than the 100-year 6-hour storm, which is surprising but not unreasonable given the magnitudes of the precipitation in this region (see Table 3-3).

Table 6-3. Summary of flood damage estimates (base conditions)

Base Conditions					
Recurrence Interval	**Direct Building Economic Loss**				
	Residential	**Commercial**	**Industrial**	**Others**	**Total Property***
	$ millions	**$ millions**	**$ millions**	**$ millions**	**$ millions**
25Y24H	6.93	0.89	0.22	1.28	9.32
100Y24H	12.11	1.43	0.45	1.43	15.41
100Y6H	6.25	0.73	0.16	1.05	8.20
*May not be additive due to rounding in internal HAZUS calculations					

6.7 SUMMARY

In Chapter 6, the methodologies and results from five separate hazard assessments were presented. These included:

- Flooding hazards to pedestrians
- Flooding hazards to vehicles
- Flood hazards to buildings
- Building inundation assessment
- HAZUS analyses

These analyses help identify areas that have a higher risk of flooding and which property and infrastructure are most susceptible to damage. Having this information helps focus the mitigation alternative to areas where they are most needed. Additionally, the last two analyses (the building inundation assessment and the HAZUS analysis) help show if the proposed alternatives are reasonable and cost-effective. The HAZUS analysis is a FEMA approved methodology for computing potential economic losses and is a standard requirement for most grant applications.

7 REGIONAL FLOOD MITIGATION ALTERNATIVES

7.1 INTRODUCTION

The development of the regional alternatives comprised the following elements:

1) Flood hazard identification
2) Alternative formulation/evaluation
3) Development of conceptual 15% design plans and cost estimates (Detention Basin/Channel/Culvert analysis only)

JE Fuller (JEF) served as the lead on the flood hazard identification and alternative formulations with assistance from Lumos and Associates (Lumos), who were the lead in the development of the 15% design plans and cost estimates for the detention basin/channel/culvert analyses. Figure 7-1 summarizes the process for developing the regional alternatives.

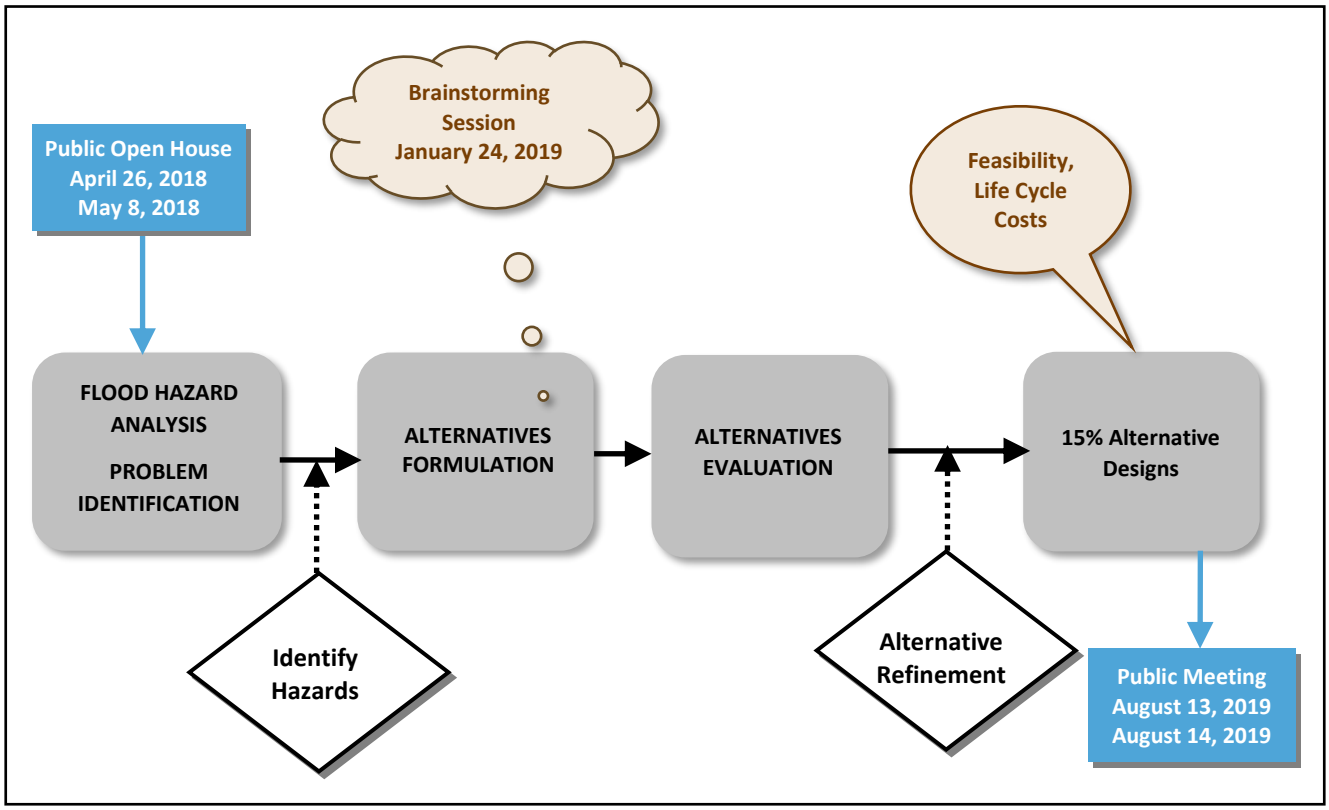


Figure 7-1. Development process for the regional flood mitigation alternatives for the Dayton Valley ADMP

7.2 DETENTION BASIN/CHANNEL/CULVERT CONCEPT DESIGN CHARACTERISTICS

On January 24, 2019, the project team (JEF and Lumos) conducted an all-day brainstorming session to develop initial mitigation concepts and verify their feasibility. The meeting resulted in the concept of regional basins with collector and conveyance channels along with supporting culverts. Each basin that was designed to account for both flow volume and sediment volume was sized to account for a sediment volume equal to three (3) times the annual sediment load plus the sediment load from one (1)

100-year event or 25-year event. The final basin design volumes are summarized in Table 7-1. This table shows the basin name, the total (water and sediment) storage volume for both the 25- and 100-year designs. The controlling 100-year duration was the 24-hour storm for all mitigation alternatives. The basins were named for either the source watercourse, the local subdivision name, or an adjacent street name.

A total of nine regional basins with a series of collector and conveyance channels, multiple culvert improvements, seven canal siphons, and a side-weir diversion structure were selected for this study. The proposed structure locations are shown in Figure 7-2.

Table 7-1. Summary of design characteristics for the regional basins

Basin Name	25-Year Sediment Storage Volume (ac-ft)	100-Year Sediment Storage Volume (ac-ft)	25-Year Flow Storage Volume (ac-ft)	100-Year Flow Storage Volume (ac-ft)	25-Year Total Storage Volume (ac-ft)	100-Year Total Storage Volume (ac-ft)
Gold Pan	0.96	1.01	59	88	60.0	89.0
Lonnie	0.06	0.10	69	84	69.1	84.1
Mark Twain North[1]	3.51	3.21	31	50	34.5	53.2
Mark Twain South	2.04	3.60	30	40	32.0	43.6
Mark Twain West	3.90	4.89	28	43	31.9	47.9
Prospector	0.07	0.10	2.1	3.7	2.2	3.8
Rainbow	1.99	2.25	33	46	35.0	48.3
Six Mile Canyon[2]	13.5	-	156	-	169.5	-
Sutro Springs	0.77	1.04	28	45	28.8	46.0

1. The 25-year sediment volume is greater than the 100-year due differing characteristics between the 100-year and 25-year hydrographs on which these volumes were calculated.
2. The 100-year data for Six Mile Canyon was not included because the 100-year alternative is a conveyance channel from the canyon mouth to the Carson River, thus water and sediment storage is not applicable.

Although each individual basin, channel, and culvert function individually to reduce the flooding and sediment hazards downstream, most are designed to work together as a system. To quantify their impact, the alternative structures were grouped into "systems" which are referenced in the proceeding sections. The basin system groupings are listed in Table 7-2 and illustrated in Figure 7-2. An example of a 3D surface map showing some of the basins and channels combined with the project LiDAR data is shown in Figure 7-3.

Table 7-2. Mitigation system nomenclature

System Name	Included Structures
Mark Twain	• Branstetter Culvert • Gold Pan Basin • Gold Pan Conveyance Channel • La Fond Culvert • Lonnie Basin • Lonnie Conveyance Channel • Mark Twain Collector Channel Northeast • Mark Twain Collector Channel Northwest • Mark Twain Conveyance Channel North • Mark Twain Conveyance Channel South • Mark Twain South Basin • Mark Twain West Basin • Prospector Basin • Prospector Storm Drain • Sutro Springs Basin • Sutro Springs Collector Channel East • Sutro Springs Conveyance Channel West • Sutro Springs Culvert • V&T Culvert • Wagon Wheel Culvert
Rainbow	• Chaves-US 50 Culvert • El Dorado Culvert • El Dorado South Culvert • Rainbow Basin • Rainbow Collector Channel • Rainbow Conveyance Channel North • Rainbow Conveyance Channel South • Rainbow Culvert • Rainbow-US 50 Culvert
Ft. Churchill*	• Ft Churchill Culvert • Ft. Churchill Conveyance Channel
Rose Peak	• Grosh Culvert • Rose Peak Culvert
Six Mile Canyon	• Six Mile Canyon Channel
Gold Canyon	• Gold Canyon Weir and Spillway
Cardelli	• Siphon #s 1 through 7
*The Ft. Churchill System is hydraulically connected to, and directly impacted by both the Mark Twain and Rainbow Systems.	

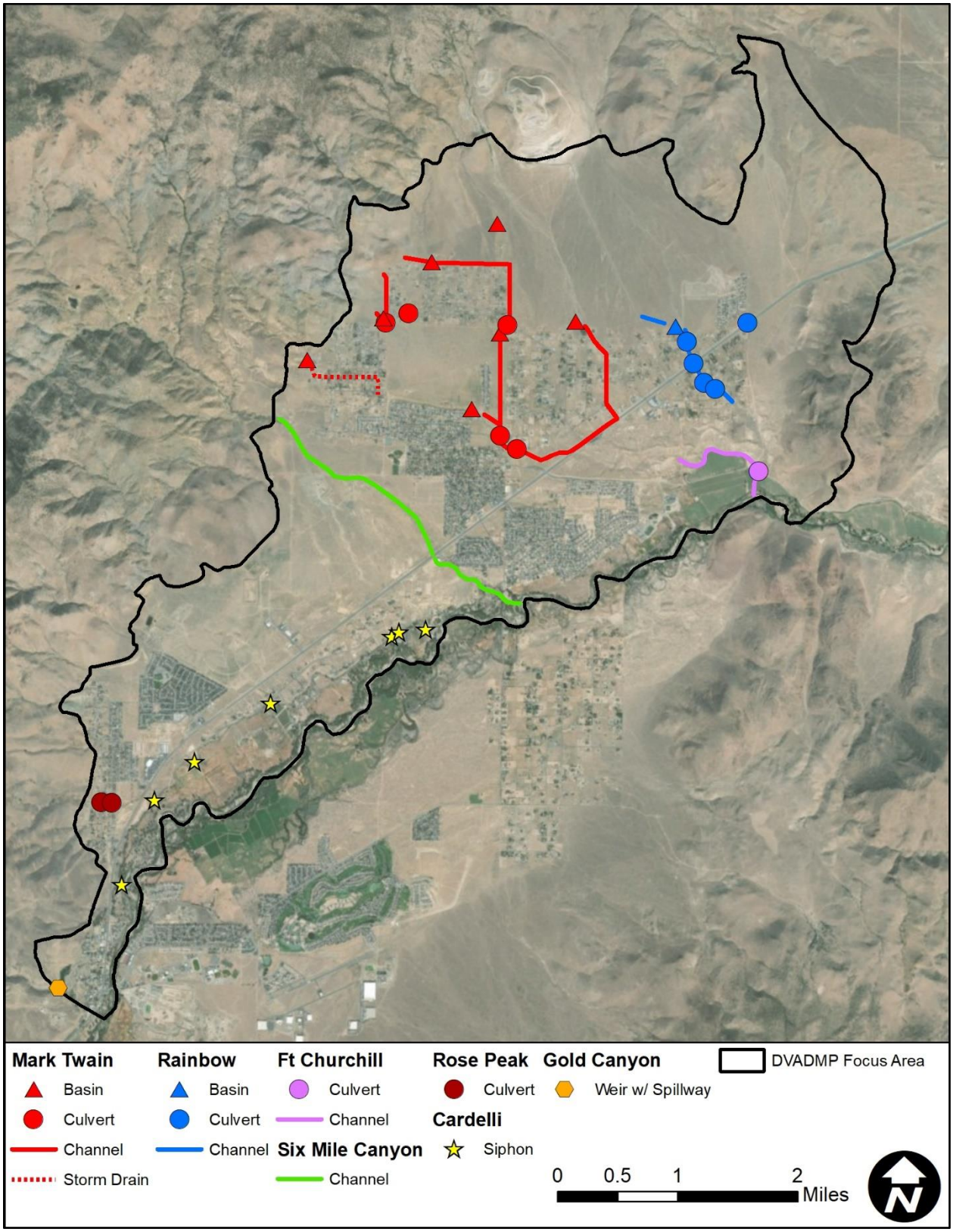


Figure 7-2. Mitigation Systems

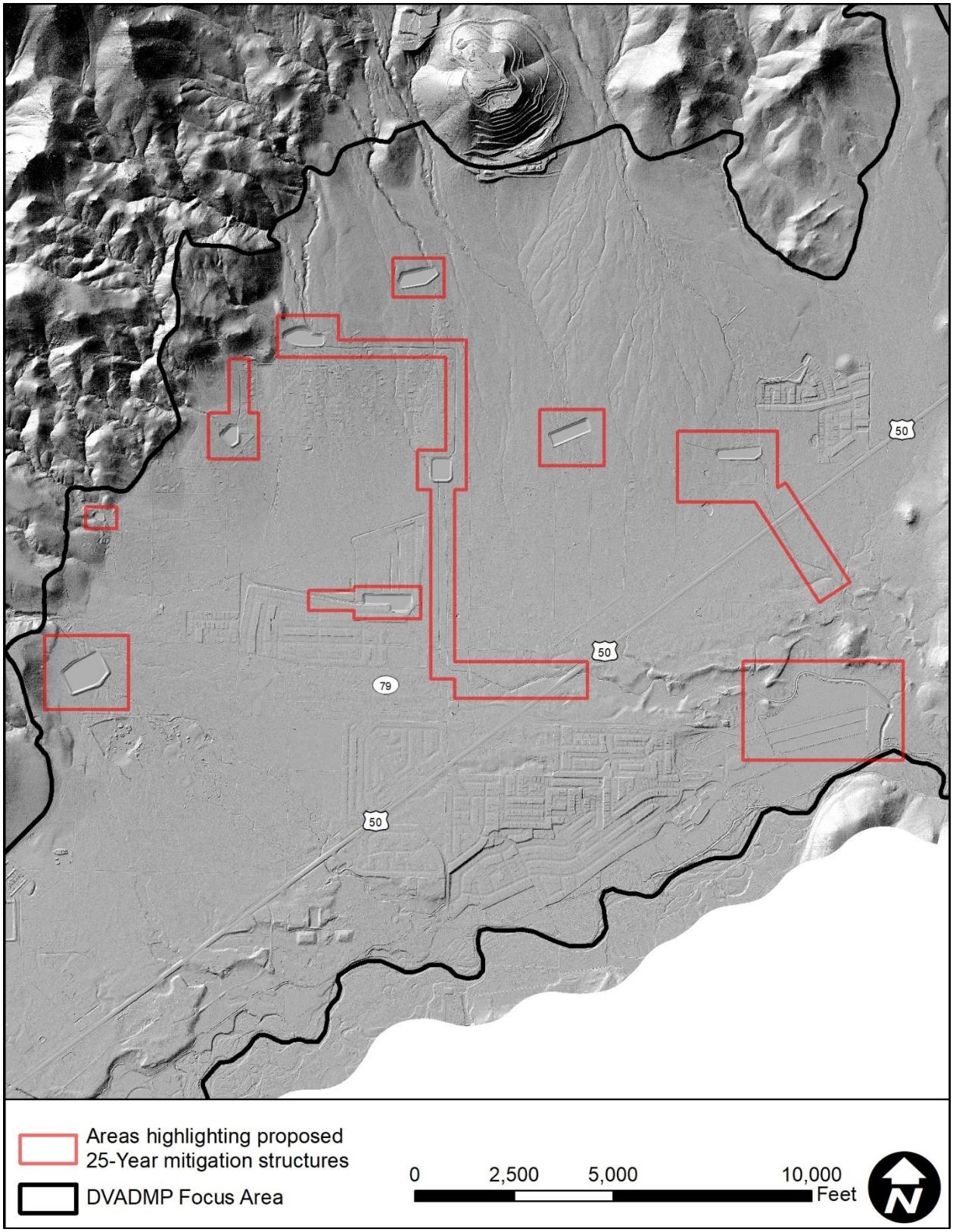


Figure 7-3. Proposed mitigation structures with 3D terrain

7.3 Gold Canyon

Gold Canyon posed a unique challenge in comparison with the rest of the ADMP study area:

- Second-largest watershed in the ADMP study area.
- The distance between the mountain front and existing development is short.
- There is not adequate terrain for an inline mitigation basin.

As Gold Canyon exists the mountains, it flows down a narrow, manmade channel that is approximately 1,700 feet in length before it encounters the Shady Lane bridge. The manmade channel is cut into the hillside with the slope falling away into an aggregate mining operation. The ADMP modeling results indicate significant potential flooding of the Dayton community from upstream of Shady Lane to Highway 50. The options for mitigation alternatives were limited given the constraints of the watercourse. The recommended alternative is a lateral weir and spillway located near the canyon mouth. The proposed design concept is to divert all flows greater than the downstream culvert capacities into the gravel mine immediately east of the channel.

7.4 Cardelli Ditch

One of the directives of the ADMP was to address the issue of offsite runoff entering the Cardelli Ditch during storm events and causing adverse flooding to properties adjacent to the ditch. After evaluating the FLO-2D results we identified seven key locations where offsite flows were directly impacting the ditch (Figure 7-4). The recommended alternative for each of the impacted locations is an engineered siphon combined with an over-chute. The siphon will allow the ditch to perform normally while offsite runoff will bypass the ditch via the over-chutes.

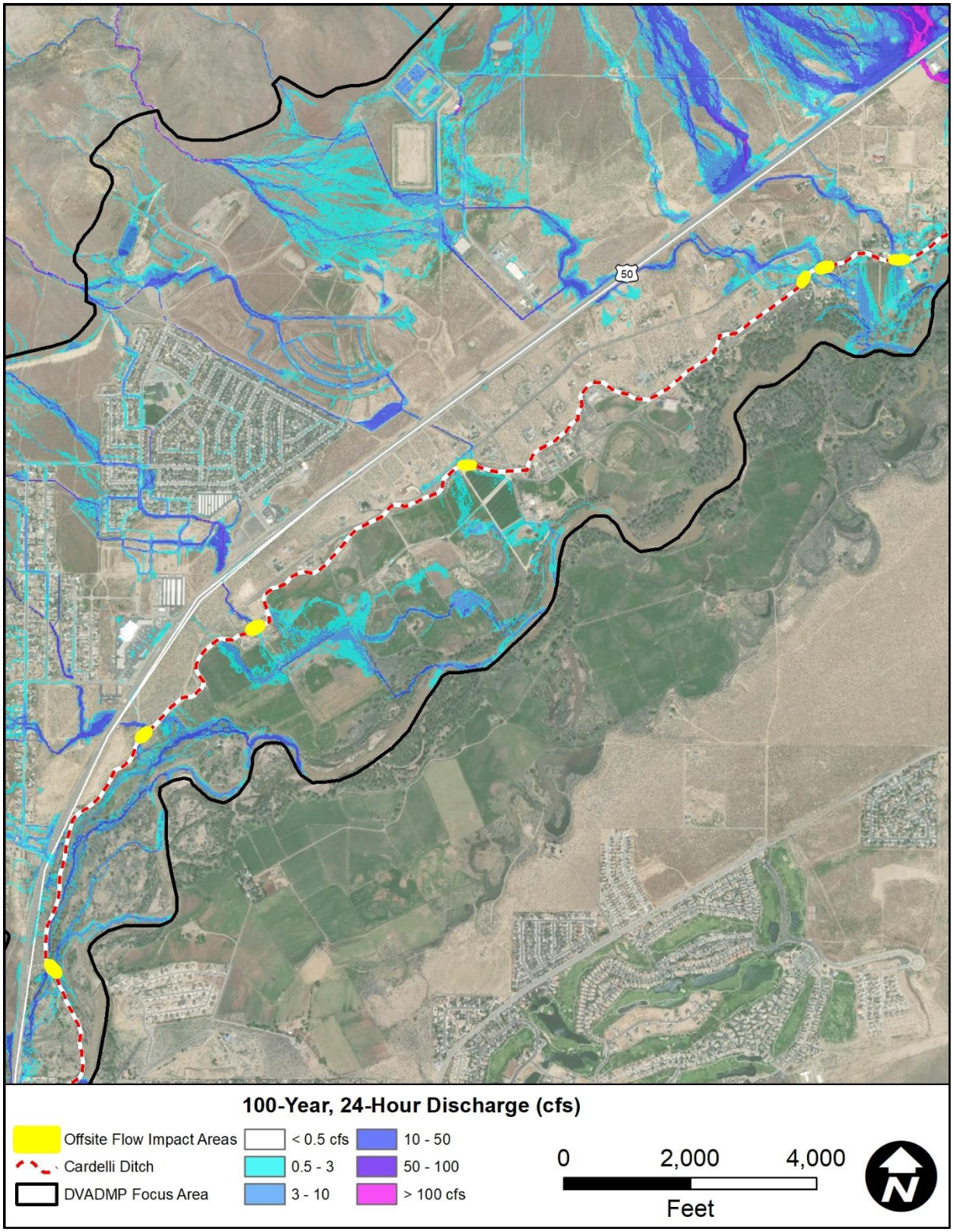


Figure 7-4. Identified areas of offsite impacts to the Cardelli Ditch

7.5 Basin System Flood Mitigation Conceptual 15% Design Plans

Lumos was tasked with developing conceptual, 15% design plans for the 25-year and 100-year systems. The Lumos plan sets and accompanying technical report are included in Appendix D. An example design plan for a 100-year basin is shown in Figure 7-5. Note – Despite their detail, these design plans are still concept designs and are meant to outline costs and general characteristics of the proposed structures to allow for recommendation and prioritization. The design volumes, structure alignments, and other characteristics will be refined during final design based on constraints that are outside the scope of this study (e.g., utility conflicts).

7.5.1 Future Design

Preliminary FLO-2D modeling of the 15% design alternatives yielded the following design items that should be considered when the mitigation structures advance to final design. Some notable examples are highlighted below.

- The project team was tasked to determine an appropriate culvert size under US Highway 50 at Chaves Road for the 100-year and 25-year storms (Appendix D). For future design considerations, a flood control channel that extends from the culvert south along Chaves Road to the unnamed watercourse southeast of Rainbow Drive is recommended.
- The Mark Twain South Basin should have an inlet spillway on the west side that is designed for inflows from the remnant onsite flow that is generated downstream of the channel that is north of Territory Road.
- The southernmost culverts in the Rainbow System that cross Rainbow Drive should consider the improved routing of the flow from the US50/Chaves culvert (and subsequent downstream channel). With the faster travel time, a larger culvert may be needed at Rainbow Drive.
- The full grading volume for the Lonnie Basin may not be needed. The preliminary modeling indicates that the upstream basins control most of the flow, and the key component at this basin is the reduction of outflow through two 36-inch culverts (from the original five 36-inch culverts). The sizing of this basin may be optimized during final design.
- All basins should consider the dynamic nature of the upstream topography. Channels may shift, and new inlet locations may be needed.
- Inlets can be added to the Prospector storm drain system to mitigate onsite flooding downstream of the Prospector Basin. Additional inlets were not considered in this analysis.
- Preliminary design of the Gold Canyon diversion structure indicates the that existing storage capacity of the adjacent gravel mine may be exceeded during the 100-year, 24-hour storm. Consideration of additional grading of the mine may be necessary during final design.

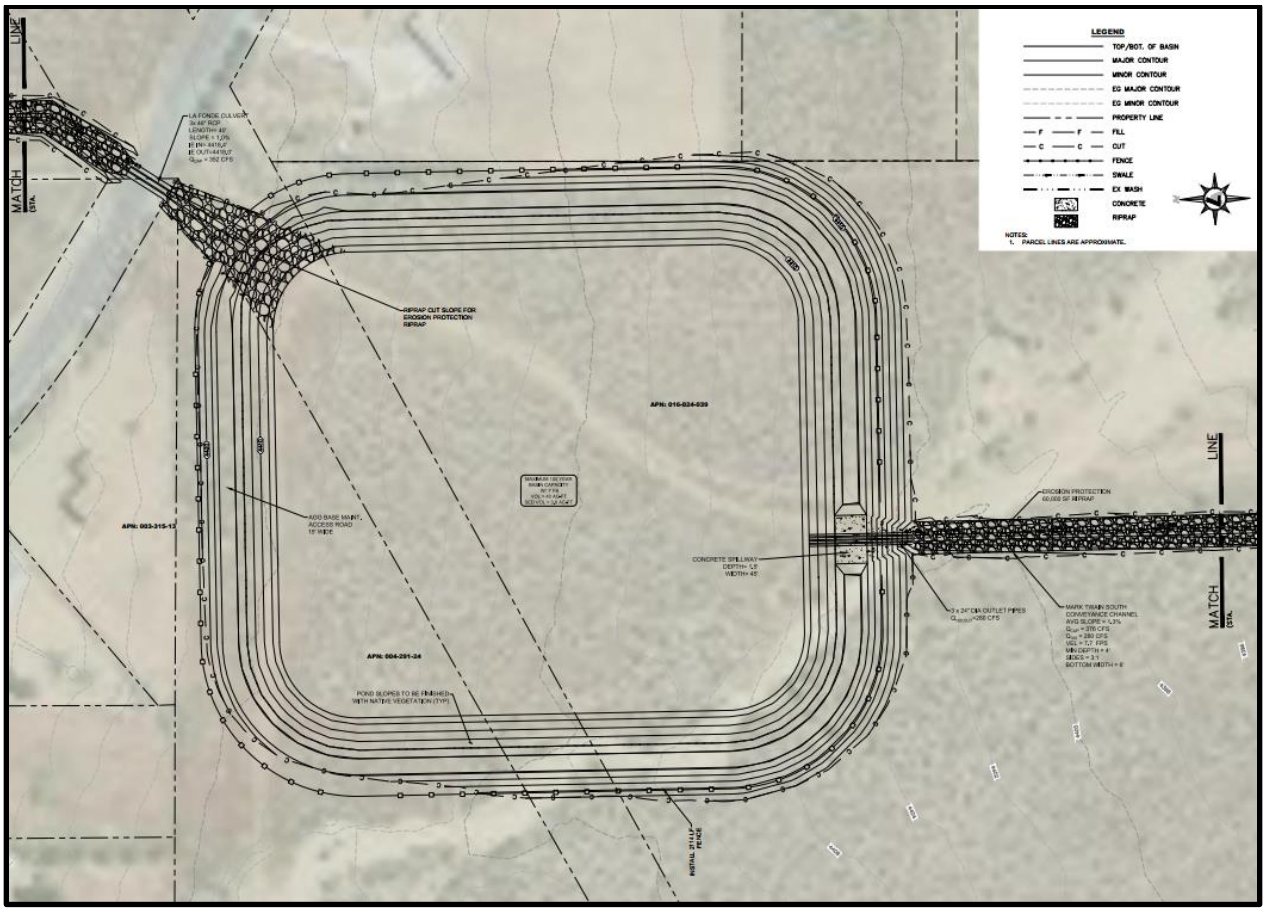


Figure 7-5. Example 15% design plan sheet

7.6 BENEFITS SUMMARY

The depth and HAZUS analyses that were performed for existing conditions (Section 6.6) were repeated for the proposed conditions. The analyses were run using two scenarios for each of the three storm events for a total of six proposed conditions models. The scenarios were:

1) All 25-year proposed structures in place, and
2) All 100-year proposed structures in place.

The proposed conditions HAZUS analyses are summarized in Table 7-3 and Table 7-4. The last column in the tables show the estimated benefit for each storm event when compared to existing base conditions for that same storm event. The results from these two analyses were used to identify the most effective systems and recommend an initial phasing plan (see Section 8.1).

Table 7-3. Summary of depth analyses for the two proposed conditions scenarios

Recurrence Interval	Proposed Conditions Building Counts				Existing Conditions Building Count[1]	Buildings Removed (Benefit)
	Building Count Flow Depth	Building Count Flow Depth	Building Count Flow Depth	Total Building Count		
	0.25' < h ≤ 0.5'	0.5'< h ≤ 1'	1' < h			
Proposed Conditions (25-year Systems)						
25Y24H	443	114	54	**611**	**765**	**154**
100Y24H	564	164	69	**797**	**970**	**173**
100Y6H	597	107	52	**756**	**928**	**172**
Proposed Conditions (100-year Systems)						
25Y24H	415	60	23	**498**	**765**	**267**
100Y24H	485	87	27	**599**	**970**	**371**
100Y6H	564	71	25	**660**	**928**	**268**

1. From Table 6-2

Table 7-4. Summary of flood damage estimates and potential benefit for the two proposed conditions scenarios

Recurrence Interval	Direct Building Economic Loss					
	Residential	Commercial	Industrial	Others	Total Property[1]	Total Benefit
	$ millions	$ millions	$ millions	$ millions	$ millions	$ millions
Base Conditions						
25Y24H	6.93	0.89	0.22	1.28	9.32	-
100Y24H	12.11	1.43	0.45	1.43	15.41	-
100Y6H	6.25	0.73	0.16	1.05	8.20	-
Proposed Conditions (25-year Systems)						
25Y24H	9.80	0.76	0.35	0.83	11.75	-2.43[2]
100Y24H	13.03	1.15	0.48	0.94	15.60	-0.19[2]
100Y6H	8.47	0.67	0.32	0.02	10.22	-2.02[2]
Proposed Conditions (100-year Systems)						
25Y24H	4.93	0.52	0.08	0.71	6.24	3.08
100Y24H	7.43	0.88	0.17	0.83	9.30	6.11
100Y6H	4.59	0.47	0.10	0.66	5.82	2.38

1. May not be additive due to rounding in internal HAZUS calculations.
2. Negative values indicate the alternative does not result in a net benefit. See Section 7.6.1.

7.6.1 Six Mile Canyon 25-Year Basin Alternative

A basin alternative was investigated for Six Mile Canyon for the 25-year, 24-hour storm event. To evaluate the full impact of the alternative, the 100-year, 24-hour storm was modeled in FLO-2D with the 25-year basin. The modeling results indicate that for the basin to be effective, a channel would need to be constructed that contains the 100-year, 24-hour storm runoff, and extend from the basin to US Highway 50. Without the channel, the basin results in adverse flooding conditions downstream (Figure 7-6). The cost of this alternative would be comparable to the Six Mile Canyon 100-year alternative that was evaluated for this study. Therefore, the 25-year alternative for Six Mile Canyon is not recommended at this time.

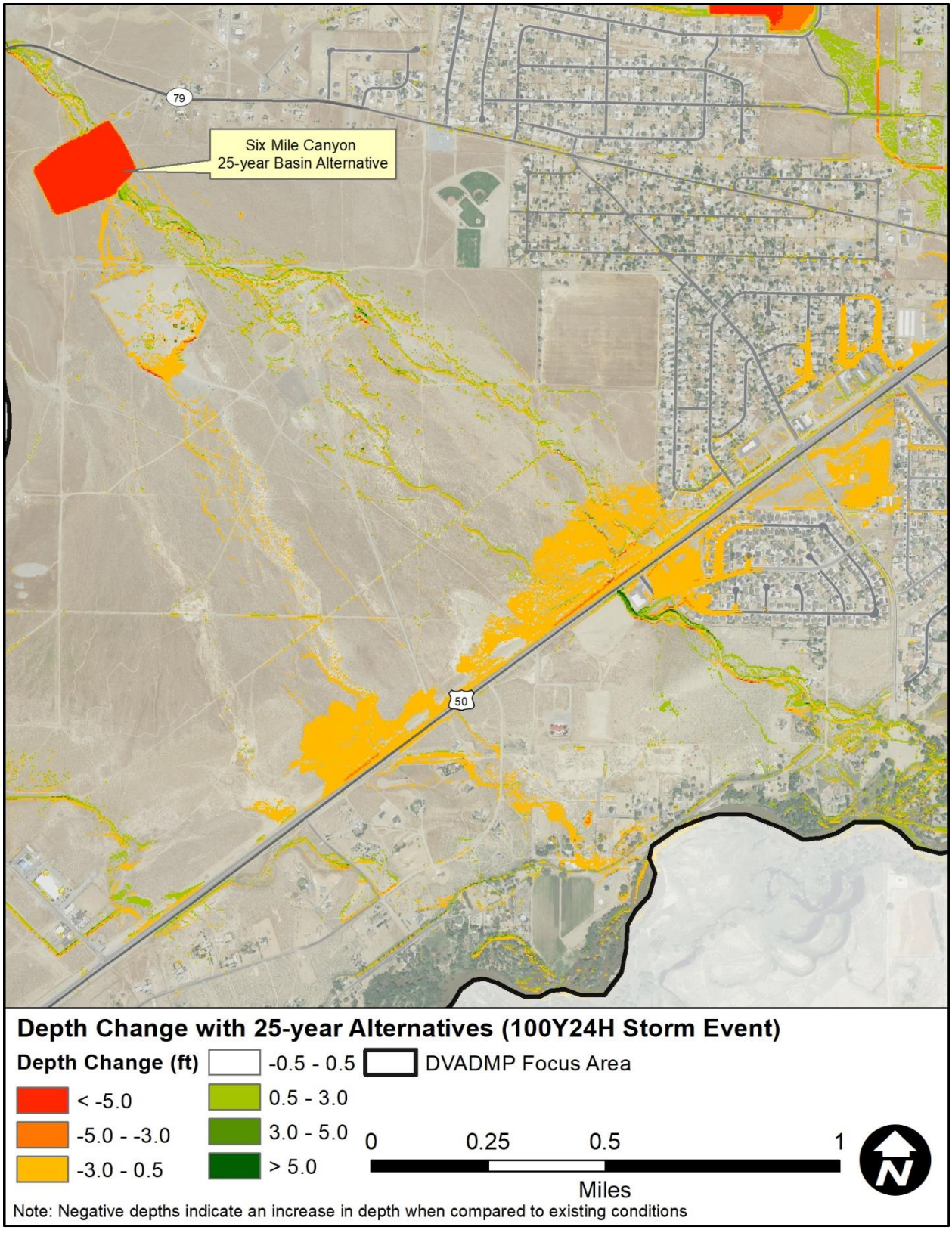


Figure 7-6. Impacts of the Six Mile Canyon 25-year basin alternative

8 ADMP SUMMARY AND RECOMMENDATIONS

8.1 PROJECT PHASING

The regional alternatives presented in this report can be designed and constructed in phases as funding is acquired or becomes available. It is recommended that each system be constructed as its own project, however funding availability may limit how many structures can be constructed simultaneously. That said, constructing the basin systems piecemeal should be done cautiously so as not to cause adverse flooding conditions due to point-source releases of stormwater from a basin outlet.

To determine the effectiveness of each system, the downstream areas that would benefit from each system were delineated (Figure 8-1). With these areas, the total benefits, costs and effectiveness could be separated by system, and cost/benefit/effectiveness matrix could be developed (Table 8-1).

Table 8-1 serves as a relative benefit/cost/effectiveness comparison and a decision tool for developing a phasing plan for the regional alternatives. These statistics were developed by isolating the total benefits for the study area (presented in Section 7) for each regional alternative system and by separating the total construction and maintenance costs (presented in Appendix D).

Additional statistics that relate benefit/cost/effectiveness of the regional alternatives are listed in Table 8-2 and Table 8-3. Table 8-2 lists the number of buildings removed from flow depths greater than 0.25 feet (3 inches). The primary purpose of the table is to compare the 25-year designs to the 100-year designs. The results indicate that the 100-year designs provide the highest level of benefit, and that for some systems, the 25-year design may result in adverse flooding conditions for a 100-year storm.

Table 8-3 and Table 8-4 compares the volume and peak flow reductions at key downstream floodplain cross-section locations for the 25-year and 100-year systems. The results suggest a similar finding to those derived from Table 8-2. Figure 8-2 shows the locations of the floodplain cross-sections.

Table 8-5 shows the results of an analysis that compared the total acreage currently impacted by flooding (flood depths >0.25 feet) with the acreage removed from the flooding hazard by the alternatives. The results provided another set of benefit information used in the priority recommendation.

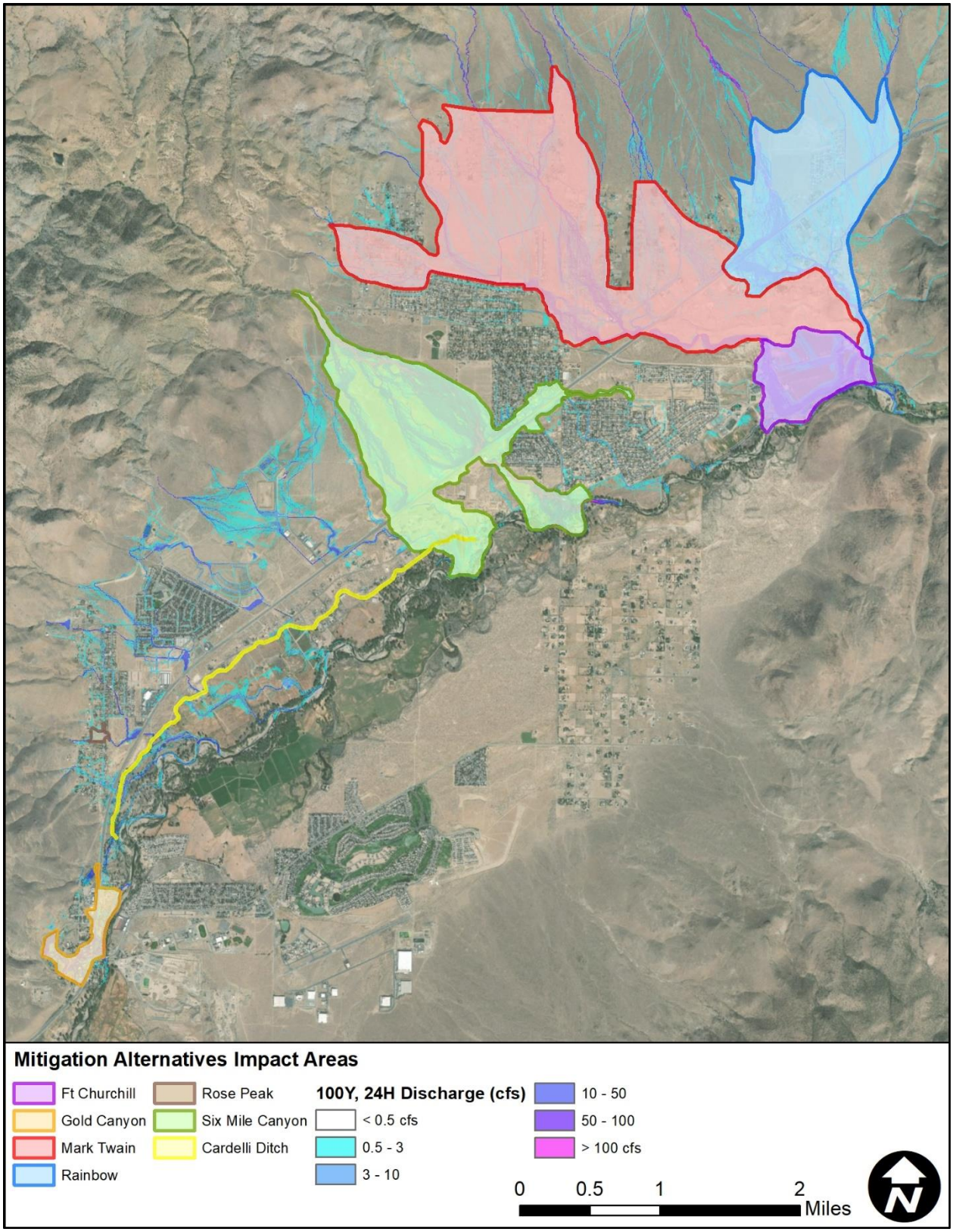


Figure 8-1. Mitigation Alternative impact areas

Table 8-1. Relative benefit comparison by system

Alternative System	Potential Percent Buildings Removed[1] from Inundation (100-Year Alternatives)	Potential Percent Buildings Removed[1] from Inundation (25-Year Alternatives)	Current Inundated Buildings in System Area[1] (100-Year Alternatives)	Current Inundated Buildings in System Area[1] (25-Year Alternatives)	Construction Cost[2] (100-Year Alternatives)	Annual Maintenance Cost[2] (100-Year Alternatives)	Construction Cost[2] (25-Year Alternatives)	Annual Maintenance Cost[2] (25-Year Alternatives)
	100-year 24-hour	25-year 24-hour	100-year 24-hour	25-year 24-hour				
Gold Canyon	58%	58%	69	66	$960,000	$1,900	-	-
Rose Peak	11%	0%	9	7	$300,000	-	$156,000	-
Six Mile	75%	0%	44	13	$17,500,000	$17,400	$3,800,000	$25,000
Mark Twain	69%	71%	277	213	$28,540,000	$85,000	$20,600,000	$74,000
Rainbow	61%	65%	114	93	$5,500,000	$12,300	$3,600,400	$12,000
Ft. Churchill	100%	100%	1	1	$2,530,000	$15,100	$1,900,000	$15,000
Cardelli Ditch Siphons	-	-	-	-	$1,310,000	-	-	-

1. Flow depth > 0.25 feet. Buildings greater than 600 square feet.
2. Construction and Maintenance costs have been rounded for simplification. See Appendix D for a detailed breakdown of cost estimates.

Table 8-2. Comparison of buildings removed from flooding hazards

Number Buildings Removed (potential inundation >0.25 feet)				
Regional Alternative System	**25-Year Alternatives**		**100-Year Alternatives**	
	25-Year, 24-Hour Storm	**100-Year, 24-Hour Storm**	**25-Year, 24-Hour Storm**	**100-Year, 24-Hour Storm**
Gold Canyon	38	42	38	40
Rose Peak	0	0	1	1
Six Mile	0	-23[1]	4	33
Mark Twain	151	151	157	191
Rainbow	60	45	61	70
Ft. Churchill	1	0	1	1
TOTALS	**250**	**215**	**262**	**336**

1. Negative value indicates an adverse impact to buildings that aren't currently impacted by flood depths >0.25 feet.

Table 8-3. Design storm volume reduction benefit comparison

FPXSEC ID	Percent Volume Reduction at Key Locations									
	Existing Conditions		25-Year Alternative Structures				100-Year Alternative Structures			
	25-Year, 24-Hour Storm	100-Year, 24-Hour Storm	25-Year, 24-Hour Storm	100-Year, 24-Hour Storm	25-Year, 24-Hour Storm Reduction	100-Year, 24-Hour Storm Reduction	25-Year, 24-Hour Storm	100-Year, 24-Hour Storm	25-Year, 24-Hour Storm Reduction	100-Year, 24-Hour Storm Reduction
	AC-FT	AC-FT	AC-FT	AC-FT	%	%	AC-FT	AC-FT	%	%
42	225.0	356.0	223.2	354.05	0.80	0.0	216.5	347.3	3.8	2.4
47	66.2	143.2	44.8	97.66	32.4	0.0	0.0	0.0	100.0	100.0
55	14.4	29.3	0.3	0.71	97.6	0.0	0.3	1416.4	97.9	97.7
82[1]	490.1	755.5	-	-	-	-	284.5	0.7	42.0	50.5
123	231.5	361.6	222.4	352.69	3.9	0.0	215.7	186.5	6.8	4.3
134	9.9	17.3	2.2	4.13	78.3	0.0	2.0	373.9	79.8	79.0
143	54.3	90.9	0.2	6.14	99.7	0.0	0.1	345.9	99.8	99.7
164	15.9	100.6	52.7	200.96	0.0	49.9	0.9	3.6	94.3	98.5

See Section 3.4.1 for a description of FPXSEC data.
1. FPXSEC #82 is located on Gold Canyon. Only a 100-year alternative was evaluated.

Table 8-4. Design storm peak flow reduction benefit comparison

FPXSEC ID	Percent Peak Flow Reduction at Key Locations									
	Existing Conditions		25-Year Alternative Structures				100-Year Alternative Structures			
	25-Year, 24-Hour Storm	100-Year, 24-Hour Storm	25-Year, 24-Hour Storm	100-Year, 24-Hour Storm	25-Year, 24-Hour Storm Reduction	100-Year, 24-Hour Storm Reduction	25-Year, 24-Hour Storm	100-Year, 24-Hour Storm	25-Year, 24-Hour Storm Reduction	100-Year, 24-Hour Storm Reduction
	CFS	CFS	CFS	CFS	%	%	CFS	CFS	%	%
42	675.5	1019.8	608.0	999.6	10.0	2.0	604.3	885.8	10.5	13.1
47	303.9	563.2	189.6	401.2	37.6	28.8	0.0	0.0	100.0	100.0
55	51.5	2967.8	0.8	1.6	98.4	99.9	0.7	4191.1	98.6	98.5
82[1]	1454.8	101.1	-	-	-	-	584.4	1.5	59.8	70.2
123	706.4	487.2	607.1	1001.0	14.1	0.0	601.6	252.7	14.8	13.9
134	32.9	2012.7	6.6	14.8	79.9	99.3	6.2	600.6	81.2	80.3
143	180.2	1026.0	0.8	50.9	99.6	95.0	0.3	883.1	99.8	99.8
164	127.3	56.3	440.0	1101.8	0.0	0.0	3.0	11.1	97.6	99.2

1. FPXSEC #82 is located on Gold Canyon. Only a 100-year alternative was evaluated.

Table 8-5. Acreage removed from the flooding hazard

Alternative System	Total Acres Impacted by Flooding (depth >0.25 feet)	Total Acres Impacted by Flooding (depth >0.25 feet)	Percent Acres Removed from Flooding Hazard (depth >0.25 feet)	Percent Acres Removed from Flooding Hazard (depth >0.25 feet)
	100-year 24-hour Storm with 100-Year Alternatives	25-year 24-hour Storm with 25-Year Alternatives	100-year 24-hour Storm with 100-Year Alternatives	25-year 24-hour Storm with 25-Year Alternatives
Gold Canyon	46.3	36	65.5	64.6
Rose Peak	2.7	2.1	23.2	0.60
Six Mile	458.7	289.6	86.5	0.0
Mark Twain	331.5	241.7	66.2	62.3
Rainbow	216.8	160.1	127.1	41.0
Ft. Churchill	117.8	88.3	81.5	40.9

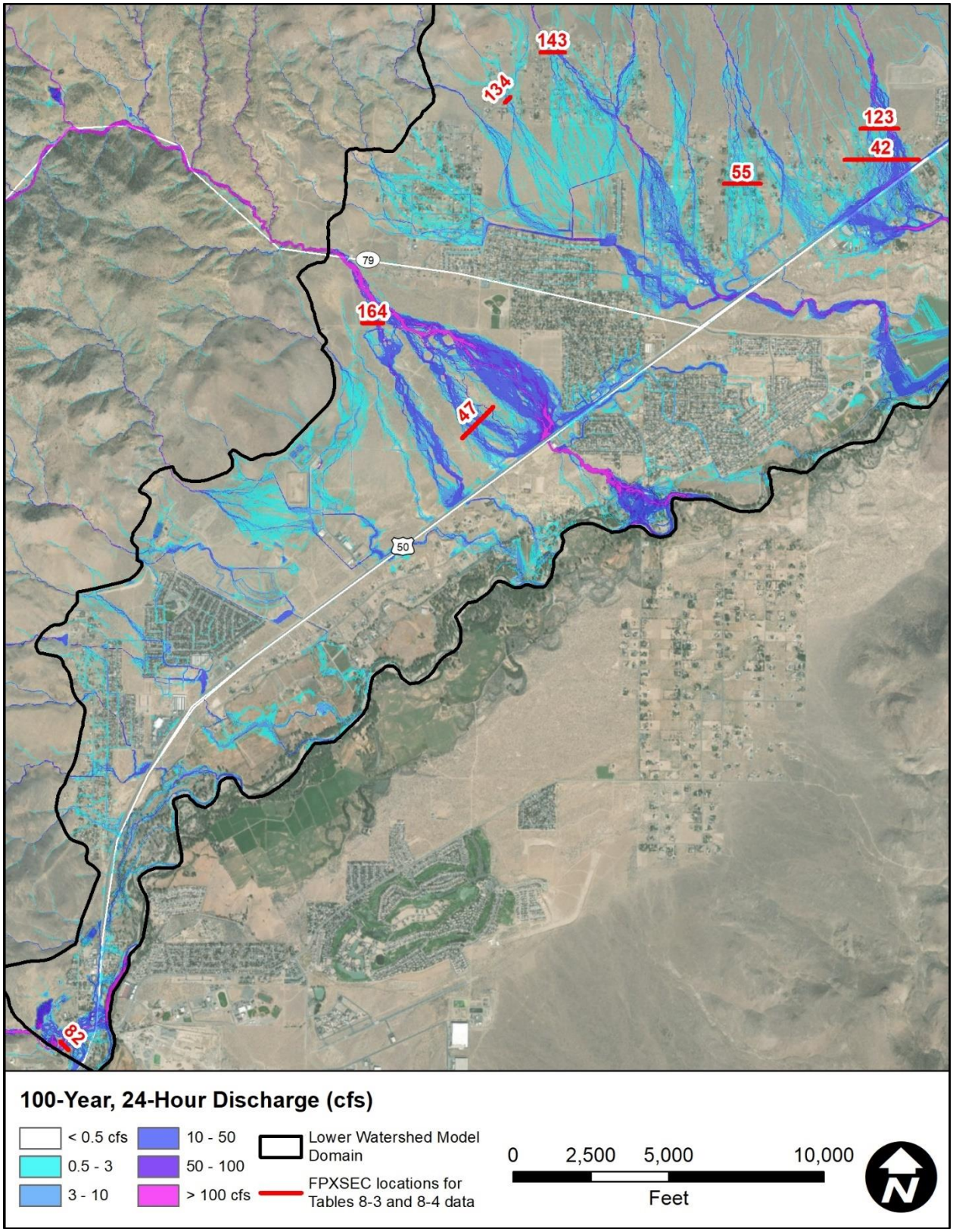


Figure 8-2. FPXSEC locations for data in Tables 8-3 and 8-4

8.1.1 Initial Prioritization and Design Level

Based on the results listed in Table 8-1 through Table 8-5, an initial prioritization list and design level is summarized in Table 8-6. This highest priority system is the 100-year Rainbow System when considering both total benefit and overall cost. Since the Mark Twain System is comprised of multiple basins, channels, and storm drains, a separate priority matrix was developed (Table 8-7). Although all the structures in the Mark Twain System are designed to work together as a system, they could be constructed separately on differing time schedules. The results of this study provide many factors to consider when prioritizing the order in which to construct the alternatives. Plotting multiple factors on a single plot can provide a visual to aid in interpreting the data. Figure 8-3 is a plot that compares the area removed from the flooding risk vs. the number of buildings removed vs. the total construction cost. The relative size of the bubbles in the plot represent the construction cost. The plot suggests that the Six Mile alternative has the highest benefit when considering acres removed from the flooding risk, but has a relatively low benefit of removing buildings from the flood risk. Most of the flooding impact area from Six Mile Canyon is undeveloped, thus the low building impact would be expected. The Mark Twain System shows a high benefit in buildings removed from the flood risk, and a relatively high benefit in acres removed from the flood risk. The relatively large bubble sizes indicate a higher cost than the other System alternatives.

It is recommended that Lyon County, Storey County, and the residents of the community work collaboratively to validate/refine the study results and in advancing any of the elements presented in this Area Drainage Master Plan.

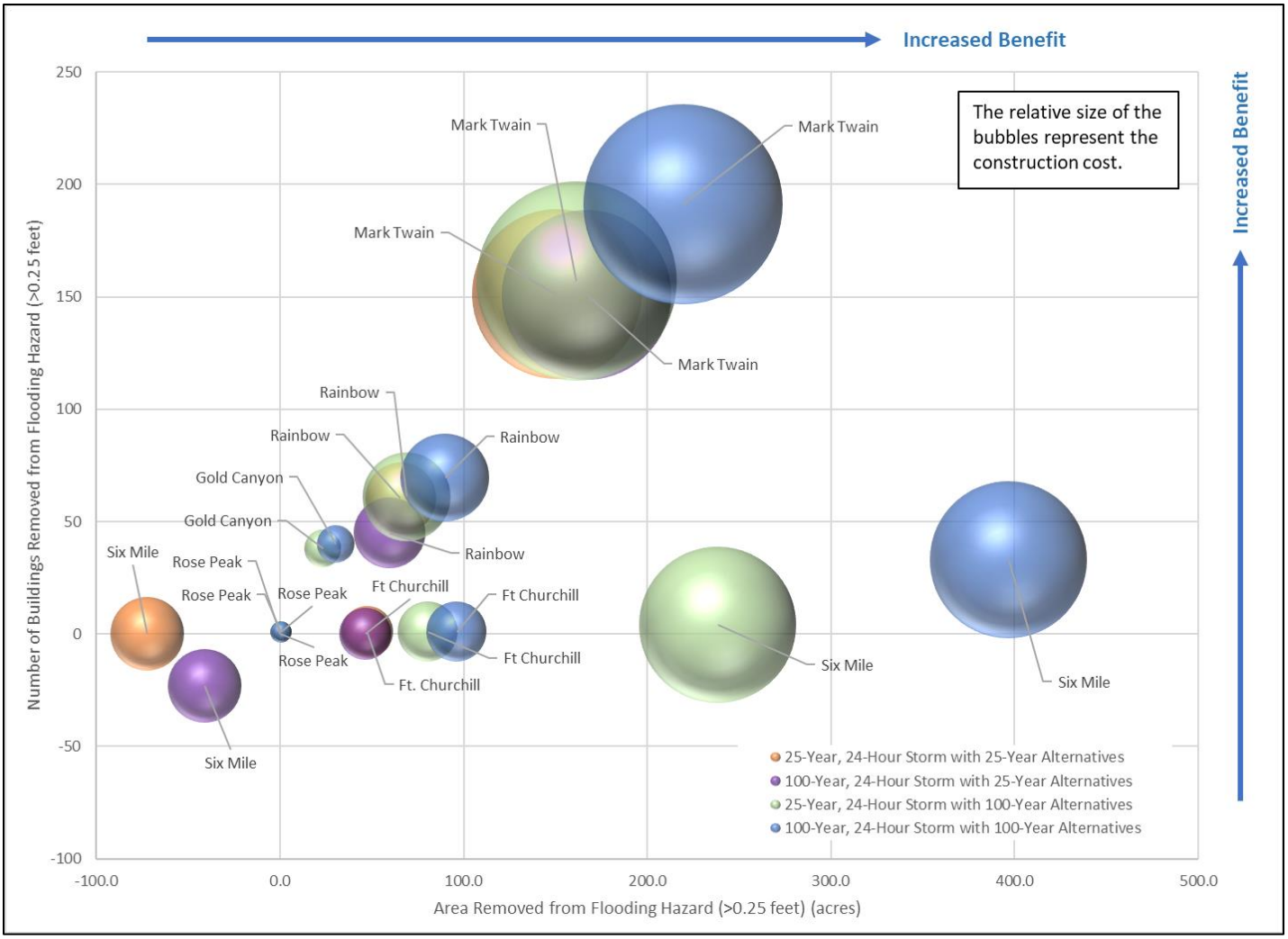


Figure 8-3. Plot to aid in visually comparing multiple benefit statistics

Table 8-6. Initial prioritization and design level matrix for all ADMP alternatives

ADMP Study Area		
Priority	**System**	**Design Level**
1	Rainbow	100-Year
2	Mark Twain	100-Year
3	Gold Canyon	100-Year
4	Ft Churchill	100-Year
5	Six Mile	100-Year

Table 8-7. Initial prioritization and design level matrix for the Mark Twain System

Mark Twain System		
Priority	**Structure**	**Design Level**
1	Gold Pan Basin and Storm Drain	100-Year
2	Prospector Basin and Storm Drain	100-Year
3	Sutro Springs Basin and Channels	100-Year
4	North Basin, West Basin, South Basin, and Channels	100-Year
5	Lonnie Basin	100-Year

8.1.2 Alternatives Not Recommended

The following alternatives are not recommended for construction based on the final results of the ADMP analyses:

- Six Mile Canyon 25-Year Basin – The FLO-2D modeling results for the 25-year basin indicate a significantly high likelihood that the basin would result in adverse flooding conditions for both the 25-year and 100-year storms.
- Rose Peak Culverts 25-Year and 100-Year – The FLO-2D modeling results indicate the main flooding source for Grosh Avenue and Rose Peak Road is not a result of undersized culverts, but rather local flooding and offsite flows breaking out of the existing drainage channels. Improving the channel capacities in this area should significantly reduce the flooding impacts.
- Ft. Churchill 25-Year – The Ft. Churchill channel receives significant inflows from both the Rainbow and Mark Twain Systems. As a result, a 25-year Ft. Churchill channel would not adequately contain 100-year flows from the upstream systems, thus should be constructed to the same design level.

8.2 Potential Funding Sources

There are numerous potential grant sources that could be explored by the community and the counties to partially or fully fund the alternatives presented in this study. Some examples of grants that can be obtained through FEMA are shown in Table 8-8.

Table 8-8. Potential grant funding sources

Grant	Funding Agency	Qualifications	Description
Pre-Disaster Mitigation (PDM)	FEMA	FEMA approved Hazard Mitigation Plan[1,2].	Funds the planning, design and construction of mitigation projects and provides opportunities for raising public awareness about reducing future losses before disaster strikes. PDM grants are awarded to projects that show a net benefit, i.e. a benefit cost ration greater than 1.
Flood Mitigation Assistance (FMA)	FEMA	Structures insured under the NFIP. Projects submitted for consideration must be consistent with the goals and objectives identified in the agency's Hazard Mitigation Plan.	Funds awarded to projects and planning efforts that reduce or eliminate long-term risk of flood damage to structures insured under the NFIP.
Hazard Mitigation Grant Program (HMGP)	FEMA	Presidential Major Disaster Declaration. 25% cost share from applicant.	Funding for projects listed in the community's Hazard Mitigation Plan. Funds are only released if there is a Federally declared disaster.
1. https://www.lyon-county.org/DocumentCenter/View/8670/Lyon-County-MJHMP--FINALDec-10-2018 2. https://www.storeycounty.org/DocumentCenter/View/14776/Appendix-I---SC-Hazard-Mitigation-Plan-2015-PDF?bidId=			

8.3 DVADMP LIMITATIONS

While the results are based on detailed topography, hydrology, and hydraulic modeling, they represent the existing conditions as of the date of the LiDAR mapping. Because of the unique landform and sediment characteristics of the watershed, the topography and distribution of flow can be very dynamic (i.e., small culverts or drainage channels can quickly fill with sediment causing water to change course from what it was previously). Therefore, during final design of any of the alternatives, or prior to any future development within the project area, a detailed assessment of upstream flow distribution should be undertaken.

Furthermore, this study did not analyze rain on snow events, flooding recurrence intervals greater than 100-year, or post-wildfire flooding events. These types of event are considered outside the scope of the typical area drainage master plan process. The hydrology used in this study was state of the art, engineering design storms based on recent NDOT research. These atypical events could create hydraulic conditions that exceed these design storms.

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APPENDIX A

JE Fuller Hydrology Memorandum

Memorandum

DATE: **August 14, 2018**
TO: Damon McAlister
FROM: Mike Kellogg, Richard Waskowsky
CC: Ed James, Brian Wilson, Austin Osborne, Rob Pyzel, Chuck Reno

RE: Dayton Valley ADMP Hydrology

Dear Damon,

This memorandum (memo) is presented to stakeholders of the Dayton Valley ADMP (DVADMP) to present the project team's recommendation for hydrologic analysis of the study area. The memo includes an evaluation of standards and guidelines from several agencies in Nevada, and presents the results of multiple approaches that could be applied in the ADMP. The focus of this memo is the selection of the most appropriate rainfall hyetograph for the storm events to be included in the ADMP. The memo is organized as follows:

- DVADMP Background
- Drainage Design Manual Review
- Recent studies near the DVAMP study area
- Preliminary DVADMP modeling result comparisons
- DVADMP Model Use in Lyon and Storey Counties

DVADMP BACKGROUND

The final, approved hydrologic approach for the ADMP will be integral to the project hydraulic modeling (FLO-2D). The intent of the existing conditions hydraulic modeling will be to serve as the regulatory "offsite" hydraulic information for the entire ADMP study area. Future development within the study area will incorporate the ADMP modeling results directly into their analyses. Given this, it is the project team's desire to ensure that the technical approach to the hydrologic and hydraulic modeling is as scientifically correct as is possible.

This memo includes standards and guidelines from multiple agencies and describes the results of the application of several of these standards to the ADMP study area. A significant discrepancy occurs in the peak discharge results between the 100-year 6-hour storm and 100-year 24-hour storm using standards commonly applied to this region of Nevada. This discrepancy occurs because the precipitation estimates for the 24-hour storms are generally twice what 6-hour precipitation estimates based on the NOAA 14 statistics in the upstream regions of the study area. As a result of this discrepancy, the project team has investigated alternative methodologies, including one from Nevada Department of Transportation (NDOT) that is currently under review. It is the project team's position that any methodology that is ultimately accepted for use within the ADMP area would only be applicable to the ADMP area. In other words, the hydrologic methodology which is ultimately approved by Lyon County and Storey County for the ADMP would not necessarily be applied county-wide (or anywhere outside of the ADMP area). This concept is commonly applied by regulatory agencies where warranted in specific geographic locations. The ADMP study are limits are shown in the following figure.

Long Valley Creek
Meeker Pond
6864 ft
Flowery Range
7339 ft
341
341
341
7266 ft
Newton Creek
Long Valley
341
Virginia City
Virginia Creek
US Highway 50 E
Mount Grosh
Main St
American Flat
Sutro
Gold Canyon
7156 ft
Carson Plains
341
Dayton
341
50
N
W
E
S
Eldorado Canyon Reservoir
Centennial Park
DVADMP Study Boundary
0 0.5 1 2 3 4
Miles
Empire
Brunswick
Hackett Canyon
Como
Sources: Esri, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community

DRAINAGE DESIGN MANUAL REVIEW

Truckee Meadows Regional Drainage Manual (2009) p.601

The following guidance is directly from the manual:

> *RAINFALL FOR CITY OF RENO AND UNINCORPORATED WASHOE COUNTY*
>
> *NOAA Atlas 14 (at www.nws.noaa.gov/ohd/hdsc/) is to be used for rainfall in the City of Reno and the unincorporated areas of Washoe County. A 24-hr storm duration shall be the standard design storm duration for hydrologic methods other than the Rational Method.*

The manual specifies the 24-hour storm duration but does not specify a rainfall hyetograph.

NDOT Drainage Manual (2006) p.3-4

The following guidance is directly from the manual:

> *Within Clark County, rainfall distribution shall be developed in accordance with the CCRFCD manual. Rainfall distribution for the remainder of the state shall be developed using the procedure outlined in NOAA Atlas 14, Precipitation-Frequency Atlas of the Western United States, Nevada, referred to as the "Balanced Storm." With sufficient justification, alternate storm distributions may be used with approval of the PHE.*

The manual specifies the "Balanced Storm" hyetograph be used, but allows for other storm distributions with approval.

Clark County Regional Flood Control District Hydrologic Criteria and Drainage Design Manual (1999) p.505

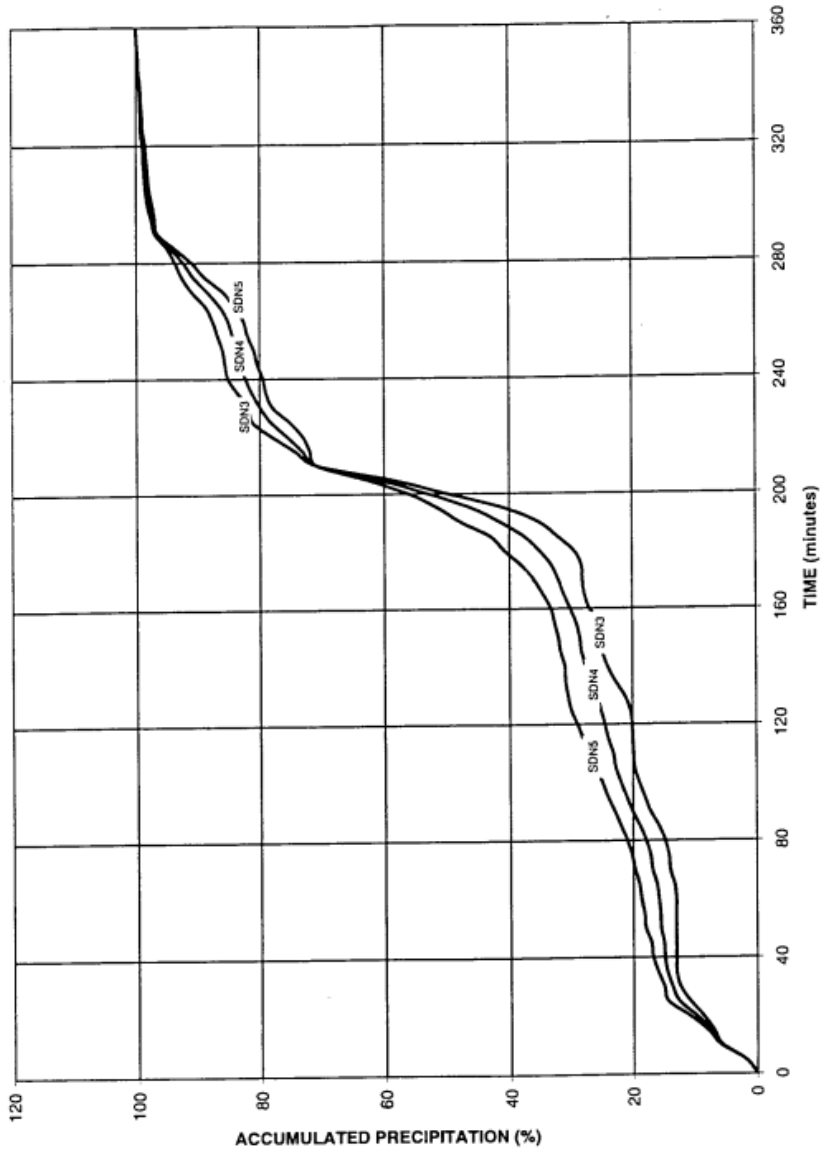
The following guidance is directly from the manual:

> *The design storm within the jurisdiction of the MANUAL shall be a 6-hour duration storm. The 6-hour duration storm is to be used for all HEC-1 runoff modeling in the Clark County area. The exception to the 6-hour design storm duration is when the SCS TR-55 method is used to compute runoff values. For SCS TR-55, a Type ll rainfall distribution shall be used in conjunction with the 24-hour rainfall depth as described in TR-55.*
>
> *6-Hour Design Storm Distribution*
> *Three different 6-hour storm distributions are to be used as design storms in the Clark County area. The three design storm distributions, labeled SDN 3, SDN 4, and SDN 5, are graphically presented in Figure 515 and tabularized in Table 503. For drainage areas less than 8 square miles in size, use SDN 3. For drainage areas greater than or equal to 8 and less than 12 square miles in size, use SDN 4. For drainage areas greater than or equal to 12 square miles in size, use SDN 5.*

The manual specifies using the SCS Type II distribution if the TR-55 method is being applied. For other methods (HEC-1) the 6-hour distribution from Figure 515 shall be used. Figure 515 is shown below.

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

SIX-HOUR DESIGN STORM DISTRIBUTIONS



Notes:
1. For drainage areas less than 8 square miles in size, use SDN 3.
2. For drainage areas greater than or equal to 8 square miles and less than 12 square miles in size, use SDN 4.
3. For drainage areas greater than or equal to 12 square miles, use SDN 5.
4. Refer to **Table 503** for a tabulation of storm distribution.

Revision	Date

REFERENCE:

FIGURE 515

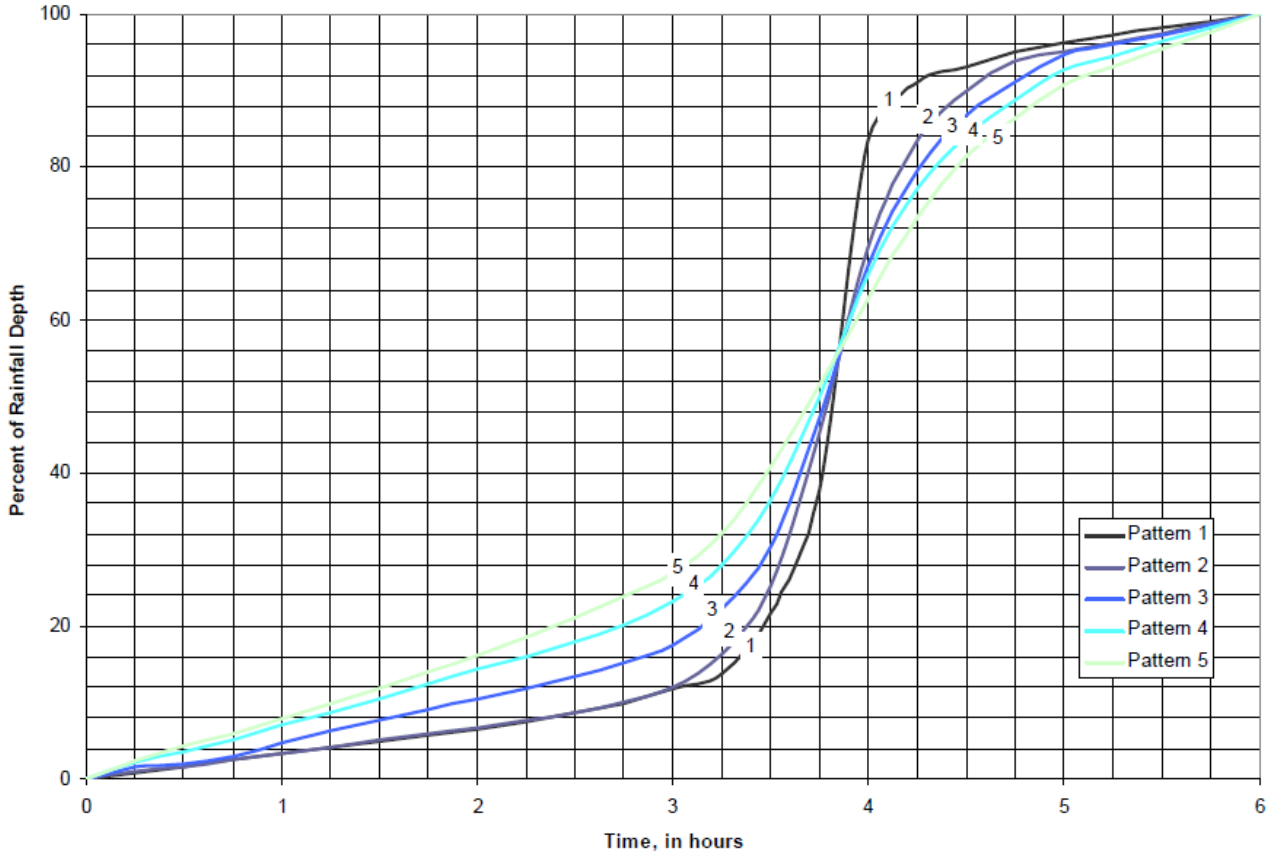
Flood Control District of Maricopa County Drainage Design Manual (2013) pp 212-214

The following guidance is directly from the manual:

> *6-hour Storm Distribution*
> *The 6-hour storm distributions are used for flood studies and design of stormwater drainage facilities in Maricopa County of drainage areas less than 20 square miles, except for on-site stormwater storage facilities (see Policies and Standards Manual). These distributions would also be used for drainage areas larger than 20 square miles and smaller than 100 square miles by critically centering the storm over all or portions of the drainage area to estimate the peak flood discharges that could be realized on such watersheds due to the occurrence of a local storm over the watershed.*
>
> *The Maricopa County 6-hour local storm distributions consist of five dimensionless storm patterns. Pattern No. 1 represents the rainfall intensities that can be expected in the "eye" of a local storm. These high, short-duration rainfall intensities would only occur over a relatively small area near the center of the storm cell. Pattern No. 1 is an offset, dimensionless form of the hypothetical distribution derived from rainfall statistics found in the NOAA Atlas for the Western United States, Arizona (Miller et al. 1973) and Arkell and Richards (1986) for the Phoenix Sky Harbor Airport location. Pattern Numbers 2 through 5 are modifications of the U.S. Army Corps of Engineers (1974) analysis of the Queen Creek storm of 19 August 1954. The dimensionless form of these 6-hour storm distributions are shown in and Table 2.4.*

The manual specifies the 6-hour storm for drainage areas less then 20 square miles. The manual gives five 6-hour local storm patterns (plotted below). Pattern 1 is the most intense, and it's expected to model the most intense rainfall that occurs at the center of the storm. Typically, the Flood Control District of Maricopa County uses Pattern 1 for all FLO-2D hydrologic modeling. The distribution of patterns is usually reserved for lumped parameter modeling with HEC-1, and the appropriate pattern is chosen based on drainage area.

Figure 2.4
6-HOUR MASS CURVES FOR MARICOPA COUNTY



RECENT STUDIES NEAR DVADMP STUDY AREA

Johnson Lane ADMP (2018) (JE Fuller)

- Storm Events Modeled
  - 25-year, 24-hour
  - 100-year, 24-hour
  - 100-year, 6-hour
  - Hypothetical July 2015
- Storm Distributions
  - "Balanced Storm" from HMS Frequency (25-year, 24-hour; 100-year, 24-hour)
  - FCDMC Pattern 1 (100-year, 6-hour)
  - Local Gage Distribution (Hypothetical July 2015)

Flood Insurance Study, Douglas County, Nevada (2016) (Buckbrush Wash) (Kimley-Horn)

- Storm Events Modeled
  - 3-hour cloudburst
  - 100-year, 24-hour

- Storm Distributions
  - HMS Frequency Storm (Balanced)

Ramsey Canyon Watershed Flood Control Study (2012) (Manhard)

- Storm Events Modeled
  - 100-year, 24-hour
- Storm Distributions
  - HMS Frequency Storm (Balanced)

DVADMP PRELIMINARY RESULTS

NOAA Atlas 14 Rainfall Depths

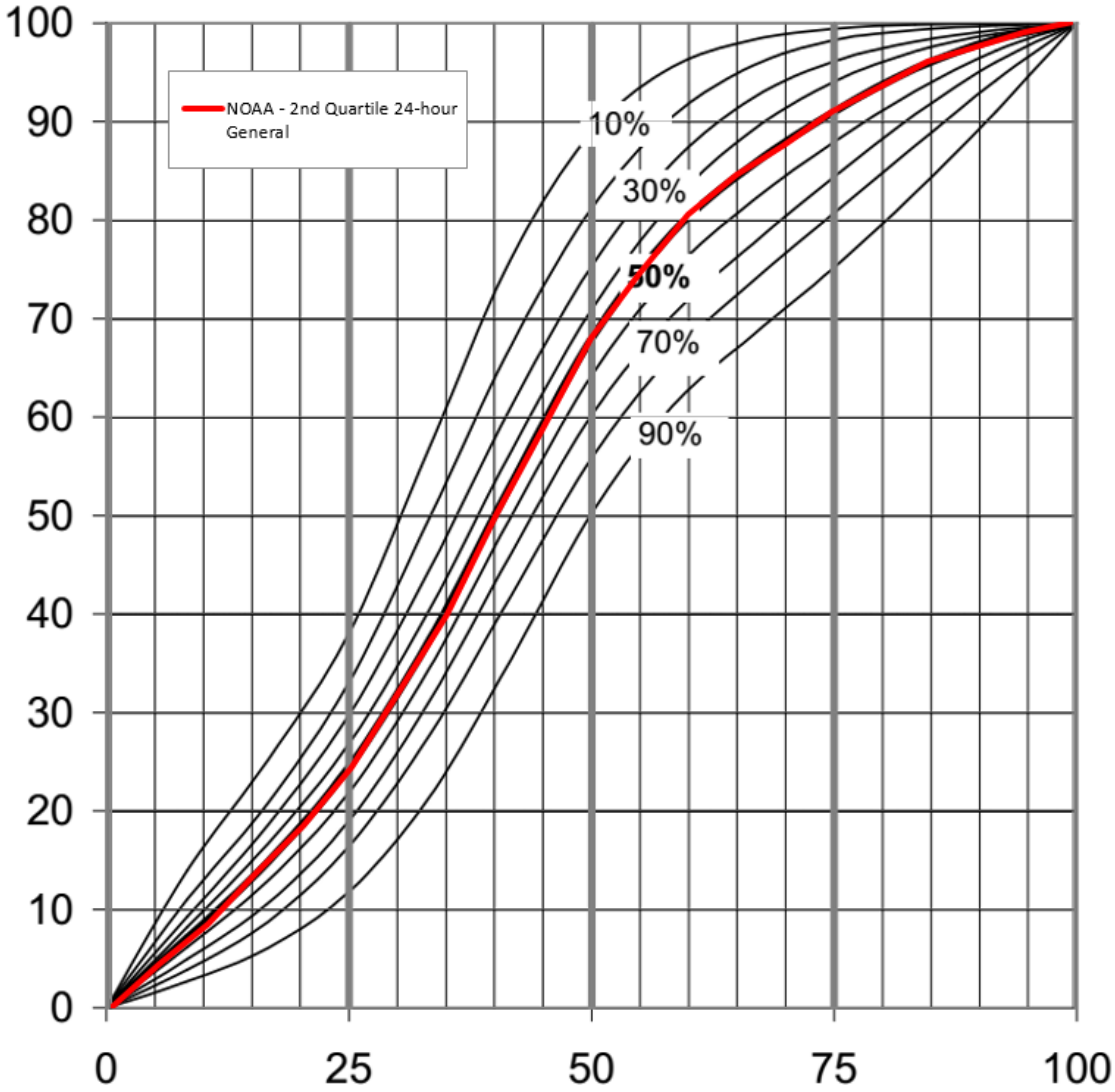
Model Domain	Storm Event							100Y6H / 100Y24H
	10Y6H	25Y6H	25Y24H	50Y6H	100Y6H	100Y24H	500Y6H	
Gold Canyon	1.549	1.811	3.527	2.013	2.212	4.516	2.804	49%[1]

1. Note that the 100-year, 24-hour depth is more than double the 100-year, 6-hour depth. This is unusual and results in significantly higher peak discharge estimates for the SCS Type II and HMS Frequency Storm patterns as shown in the table below.

Preliminary FLO-2D Modeling Results (Gold Canyon)

Storm	Rainfall Distribution	Peak Discharge (cfs)
100Y6H	HMS Frequency Storm (Balanced)	1,439
100Y24H	SCS Type II	6,517
100Y24H	NOAA General Pattern[2]	1,068
100Y24H	HMS Frequency Storm (Balanced)	6,723
100Y24H	NDOT 90th Percent MI GLE[3]	2,409

2. The NOAA general pattern is plotted as the red line below. This is taken from NOAA 14 Precipitation Frequency Estimate of the United States Volume 1 (NWS, 2011).
3. The NDOT 90th Percent MI GLE is developed from data from the NDOT research report (2015). It is developed based on the 90th percentile Maximum Intensity (MI) for the HUC 12 watersheds in the study area. The generalized log equation (GLE) is adjusted based on the MI.



Developed from NOAA 14, page A.1-11

Discharge per Watershed Area Comparison

Study	Drainage Area (sq. mi)	Peak Discharge (cfs)	Storm Pattern	Discharge/Area
Ramsey Canyon (Manhard)	28.9	2,588	HMS Frequency Storm (Balanced)	90
Unnamed Trib at Opal (Manhard)	10.0	1,052	HMS Frequency Storm (Balanced)	105
Gold Canyon FEMA Effective	14.2	2,300	unknown	162
Gold Canyon (Prelim DVADMP 24-Hour)	14.2	1,068	NOAA General Pattern	75
Gold Canyon (Prelim DVADMP 24-Hour)	14.2	6,517	SCS Type II	459
Gold Canyon (Prelim DVADMP 24-Hour)	14.2	6,723	HMS Frequency Storm (Balanced)	473
Gold Canyon (Prelim DVADMP 24-Hour)	14.2	2,409	NDOT 90th Percent MI GLE	169
Gold Canyon (Prelim DVADMP 6-Hour)	14.2	1,907	HMS Frequency Storm (Balanced)	134
FEMA FIS-Buckbrush Wash (Douglas County, 2016)	4.6	350	HMS Frequency Storm (Balanced)	76
JLADMP 2018-Johnson Lane Wash (24-hour)	10.2	1,302	HMS Frequency Storm (Balanced)	127
JLADMP 2018-Buckbrush Wash (24-hour)	4.2	679	HMS Frequency Storm (Balanced)	162
JLADMP 2018-Johnson Lane Wash (6-hour)	10.2	1,583	FCDMC Pattern 1	155
JLADMP 2018-Buckbrush Wash (6-hour)	4.2	812	FCDMC Pattern 1	193

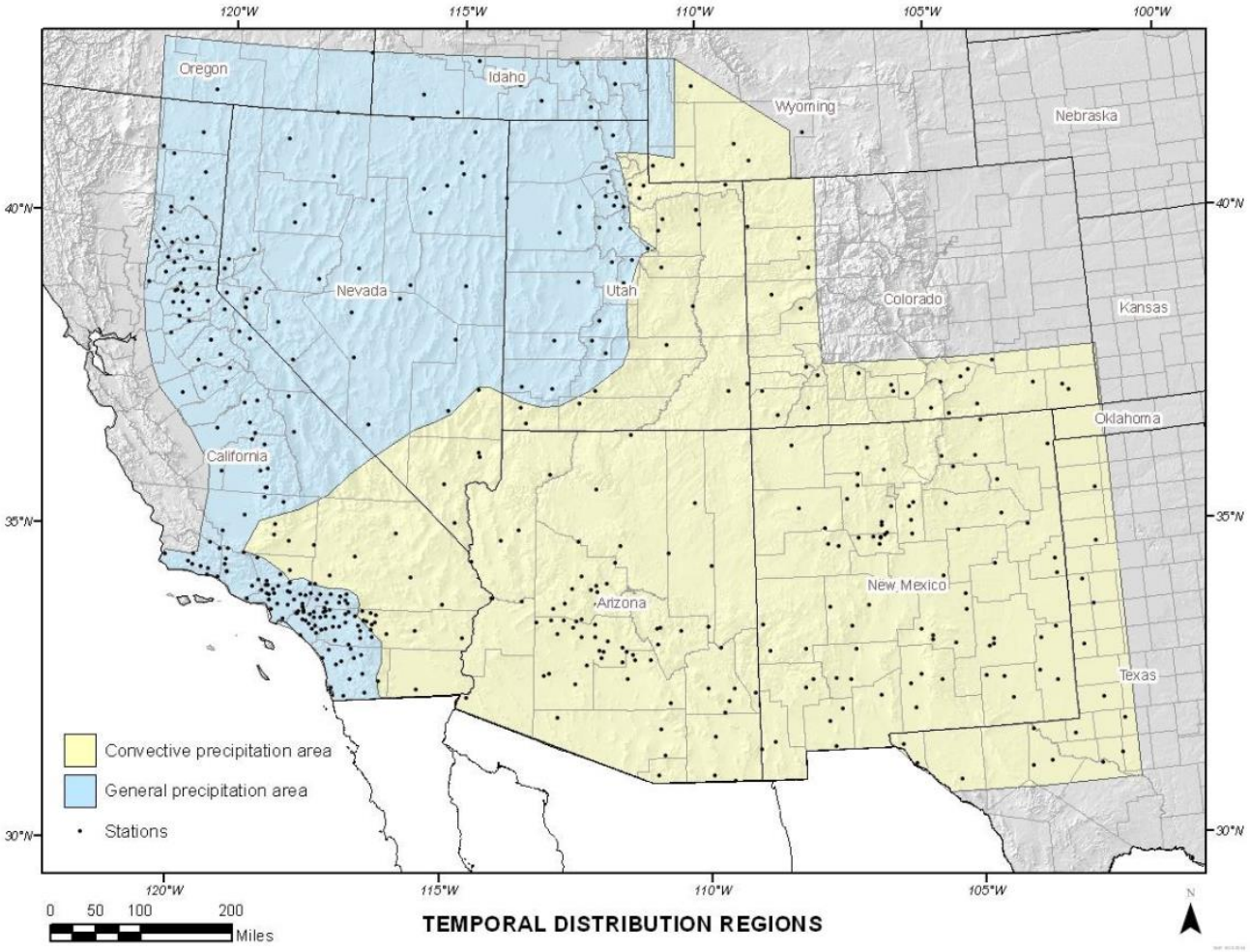
Recommendation

Based on the results of the preliminary modeling, we are recommending the following for use in the DVADMP study:

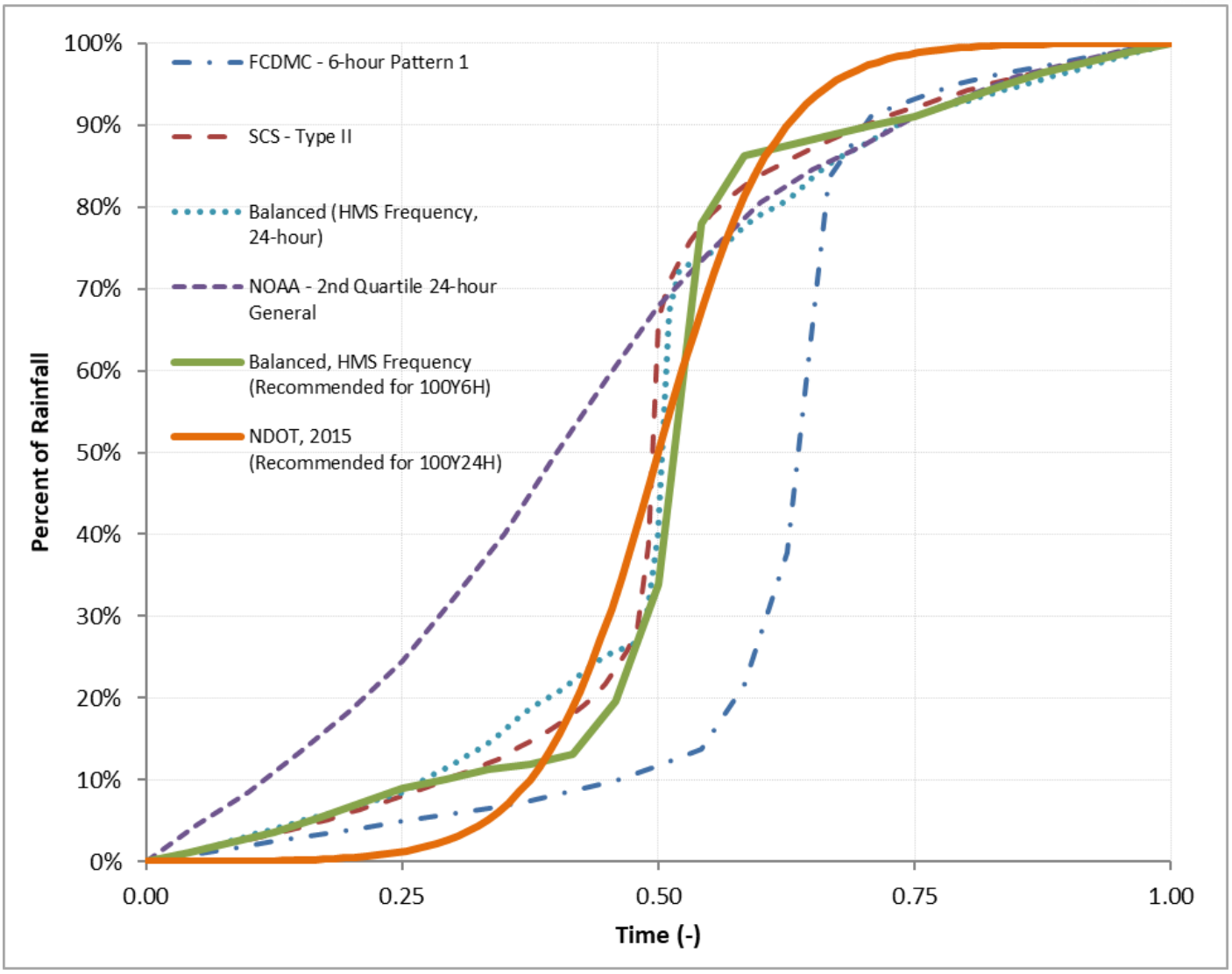
- 100-year, 6-hour = HMS Frequency Storm (Balanced)
- 25-year, 24-Hour = NDOT 90th Percent MI GLE
- 100-year, 24-hour = NDOT 90th Percent MI GLE

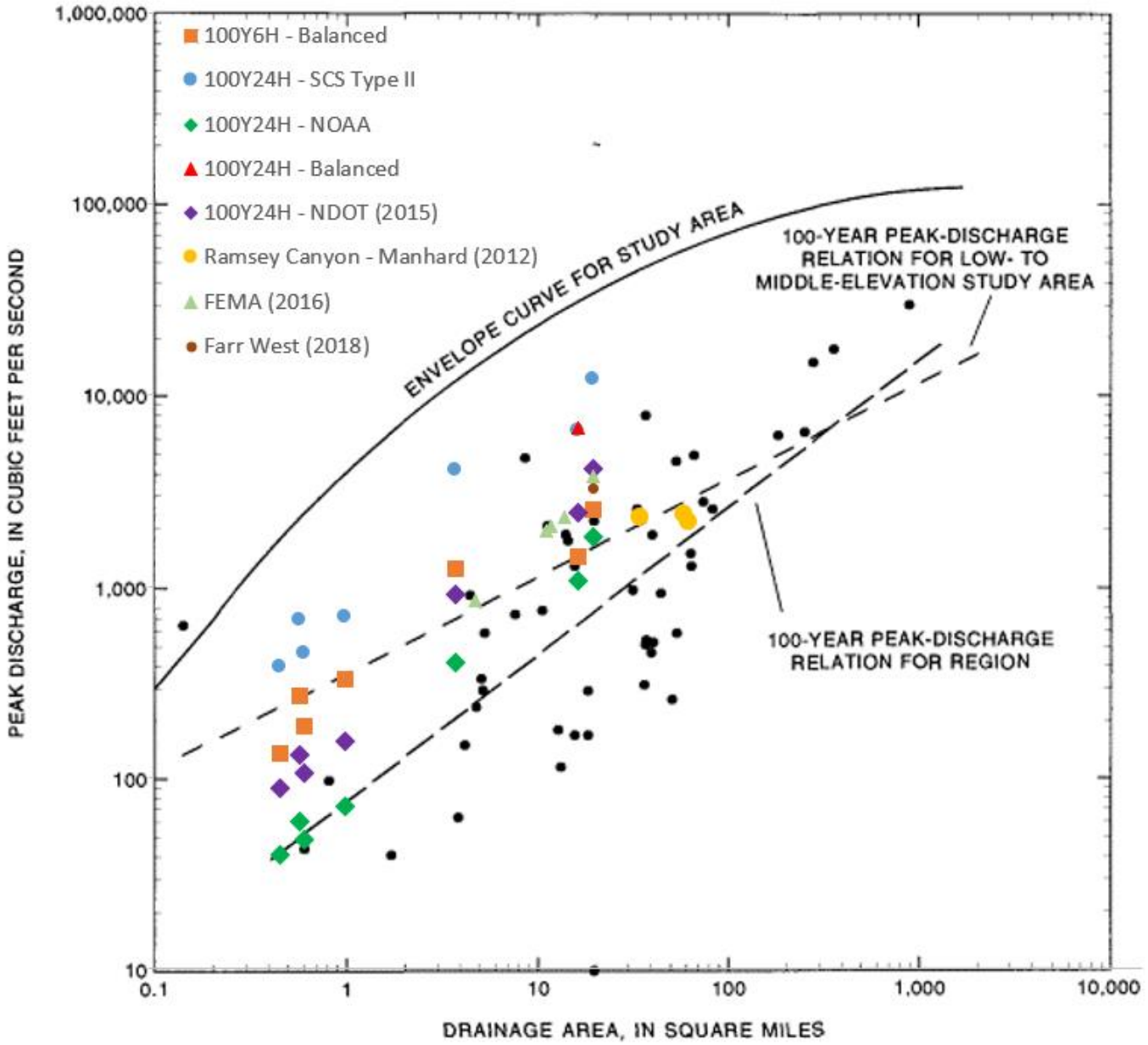
NOAA Atlas 14 includes a figure of temporal storm distributions by regions (shown below). The figure indicates that all northern Nevada falls under a "General" distribution which is characterized as less intense than convective precipitation areas (southern Nevada and Arizona). This provides further evidence to support a less intense hyetograph for the 24-hour storm.

Plot comparison of the Rainfall Distributions, and results compared with the USGS Regression Equations (1997) are shown below. The preliminary results indicate that the calculated discharges (with the recommended methods) are conservative but within the cloud of observed values.



From NOAA 14 (NWS, 2011)


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent of Rainfall
0.00
0.25
0.50
0.75
1.00
Time (-)
FCDMC - 6-hour Pattern 1
SCS - Type II
Balanced (HMS Frequency, 24-hour)
NOAA - 2nd Quartile 24-hour General
Balanced, HMS Frequency (Recommended for 100Y6H)
NDOT, 2015 (Recommended for 100Y24H)



Adapted from USGS (1997)

DVADMP MODEL USE IN LYON AND STOREY COUNTIES

Review of SOW

As a part of the DVADMP, JEF will develop drainage guidelines for the project area. These guidelines will address flood hazards identified in the study area and potential styles of development (master planned community, subdivision, commercial, lot splits, single lot). The development guidelines will identify development issues, recommended development practices, engineering analyses, and best management practices. They will also document how stakeholders (developers and jurisdictions) should use the FLO-2D results.

Examples of FLO-2D Use in Other Jurisdictions

To highlight how FLO-2D (or other detailed regional modeling) is typically used, some examples from other jurisdictions are outlined below.

Flood Control District of Maricopa County (Arizona)

The FCDMC provides and online web access tool that can be used to view FLO-2D results. Typically, the models are used by stakeholders (e.g., municipal jurisdictions or developers) to calculate off-site flow. Any on-site improvements are designed to handle on-site rain and to convey off-site runoff without causing adverse impacts to neighboring properties. The online viewer can be found at:

http://gis.maricopa.gov/flo-2dModels/

Douglas County (Nevada)

Douglas County uses the FLO-2D results similarly to the FCDMC, but an online web access tool is not available. However, JEF developed a project-specific ArcMap document that has all the relevant FLO-2D data loaded and symbolized for ease of use. With this product, Douglas County can provide the stakeholders (developers and residents) with off-site discharges from the study area FLO-2D model.

Possible Use in Lyon and Story Counties

Currently, it is envisioned that FLO-2D model results will be used to guide development within the study area. The model results and methodology would only apply to areas within the study area. The development guidelines will highlight how best to use the data, and a general ArcGIS ArcMap document will be provided with the all FLO-2D data loaded, similar to what was done for Douglas County.

REFERENCES

Clark County Regional Flood Control District, 1999, Hydrologic Criteria and Drainage Design Manual. Latest revision date: October 14, 2010.

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JE Fuller, (2018), Johnson Lane Area Drainage Master Plan Technical Report, July 2, 2018.

Manhard Consulting, Ltd. (Manhard), 2012, Ramsey Canyon Watershed Flood Control Study, May 24, 2012.

National Weather Service (NWS), 2011, NOAA Atlas 14. Precipitation-Frequency Atlas of the United States. Volume 1, Version 5.0: Semiarid Southwest (Arizona, Southeast California, Nevada, New Mexico, Utah), Revised 2011.

Nevada Department of Transportation (NDOT), 2006, Drainage Manual, Second Edition, December 2006.

Nevada Department of Transportation (NDOT), 2015, Streamlining Hydrologic Prediction Processes Using New and More Accurate Techniques and Methods, NDOT Research Report, Report No. 530-13-803.

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Washoe County, 2009, Truckee Meadows Regional Drainage Manual, April 30, 2009.

APPENDIX B

Digital Aerial Solutions LiDAR Report

NV Reno Carson Urban Lidar 2017 B17

SURVEY REPORT

USGS Contract: G16PC00044

Task Order Number: G17PD01257

Government Point-of-Contact (POC)

Organization: USGS/NGTOC

Telephone: (573) 308-3756

Address: Gail Dunn

1400 Independence Road, MS 663

Rolla, MO 65401

Contractor Point-of-Contact (POC)

Address: Digital Aerial Solutions, LLC

Telephone: (813) 628-0788

ATTN: Joshua Helton (VP)

4027 Crescent Park Drive

Riverview, FL 33578

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OVERVIEW

Digital Aerial Solutions, LLC (DAS) with contract number G16PC00044 was contracted by the USGS/NGTOC under task order number G17PD01257 collect a high resolution LiDAR data set covering 1534 square miles affecting Carson City, Douglas, Lyon, Sierra, Storey and Washoe counties in Nevada. Each of these categories was spread out as evenly as possible throughout the Area of Interest (AOI). The survey was completed using the Global Positioning System (GPS). Each observation was identified in the field and surveyed utilizing GPS receivers, collecting GNSS and GLONASS information and utilizing a Leica Smart-Net RTK network. In accordance with section C.1.b.(viii) of the task order, the spatial reference system used was:

Spatial Reference System:

Coordinate System:	Universal Transverse Mercator 11 North
Horizontal Datum:	North American Datum 1983 of (2011)
Vertical Datum:	North American Vertical Datum of 1988
Units:	Meters
Geoid Model:	Geoid 12B

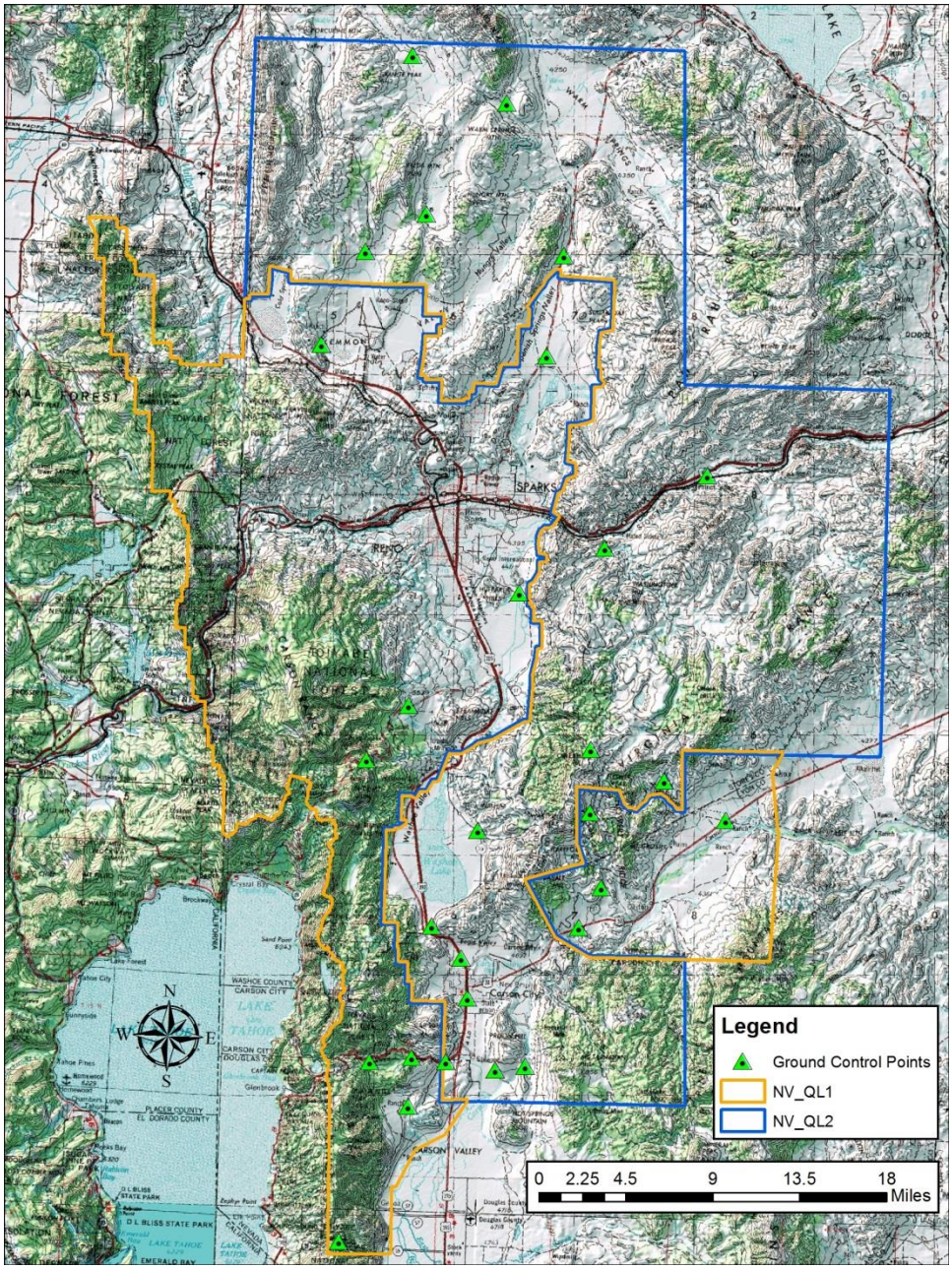
Section C.1.b.(ix) of the task order outlines the ground control minimum requirements and specifications for this LiDAR project. 30 Supplemental ground control points were collected and used to support the airborne GPS solution and positional accuracy. DAS also collected more than the required number of Non-Vegetated Vertical Accuracy (NVA) and Vegetated Vertical Accuracy (VVA) Quality Checkpoints as stated in the task order. These checkpoints serve as an independent delivery to the client and were not incorporated into the vertical solution.

Glossary of Terms

Term		Definition
ATTN	-	Attention
BG	-	Bare-Ground Checkpoint (see NVA)
CO	-	Colorado, USA
CTRL	-	Control
DAS	-	Digital Aerial Solutions, LLC
Ellip	-	Ellipsoid Height
FIPS	-	Federal Information Processing Standard
FL	-	Florida
GPS	-	Global Positioning Systems
HVEG	-	High Vegetation(see VVA)
ID	-	Identification
LVEG	-	Low Vegetation (see VVA)
LiDAR	-	Light Detection and Ranging
MVEG	-	Medium Vegetation (see VVA)
NAD83	-	North American Datum of 1983
NAVD88	-	North American Vertical Datum of 1988
NGS	-	National Geodetic Survey
NGTOC	-	National Geospatial Technical Operations Center
NVA	-	Non-Vegetated Vertical Accuracy
Ortho	-	Orthometric Height
POC	-	Point of Contact
PT	-	Pavement(see NVA)
RTK	-	Real Time Kinematics
SD	-	Sand(see NVA)
USGS	-	United States Geological Survey
VP	-	Vice President
VVA	-	Vegetated Vertical Accuracy

Supplemental Ground Control

The Map shows the overall distribution of the Supplemental Ground Control throughout the AOI. The following tables contain a list of the control using Easting, Northing, and Orthometric height. The coordinate system displayed is UTM 11N, NAD83 (2011), NAVD88, Geoid 12B and using Meters for measurement.



Point ID	Easting X (Meters)	Northing Y (Meters)	Ortho (Meters)
GCP.BG.01	260969.099	4338273.650	1423.118
GCP.BG.10	277392.198	4356378.341	1648.380
GCP.BG.11	277392.199	4356378.343	1648.371
GCP_NVA.BG.02	256020.902	4329290.092	1528.339
GCP_NVA.BG.03	250244.158	4318040.241	2163.541
GCP_NVA.BG.04	272152.037	4347496.544	1554.815
GCP_NVA.BG.06	271231.517	4353733.300	1907.229
GCP_NVA.BG.07	271263.717	4359012.689	2074.733
GCP_NVA.BG.11	252561.759	4358148.771	2308.951
GCP.HP.01	258003.661	4344308.104	1550.248
GCP.HP.02	272445.392	4375771.769	1338.888
GCP.HP.11	282521.926	4353104.002	1323.601
GCP.HP.12	257558.262	4403563.812	1563.345
GCP_NVA.HP.03	259189.646	4332992.955	1480.408
GCP_NVA.HP.06	263293.752	4332298.771	1438.997
GCP_NVA.HP.08	270245.594	4344174.034	1481.727
GCP_NVA.HP.09	256091.814	4362654.773	1771.648
GCP_NVA.HP.16	260442.590	4341638.183	1442.508
GCP_NVA.HP.24	280973.185	4381806.092	1308.072
GCP_NVA.LV.10	261848.550	4352267.561	1569.989
GCP.PS.01	248807.550	4392717.700	1520.357
GCP.PS.02	256445.016	4416808.361	1513.873
GCP_NVA.PS.04	256325.956	4333359.564	1631.584
GCP_NVA.PS.06	252854.437	4332996.338	1824.366
GCP_NVA.PS.08	265773.119	4332626.121	1415.375
GCP_NVA.PS.13	265301.972	4372050.220	1347.786
GCP_NVA.PS.18	252471.425	4400483.183	1575.459
GCP_NVA.PS.28	264254.101	4412809.060	1476.773
GCP_NVA.PS.30	269039.062	4400110.380	1434.329
GCP_NVA.PS.31	267592.540	4391765.602	1372.906

GCP.BG.01

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP.BG.01	260969.099	4338273.650	1398.696	1423.118

Point ID	LATITUDE	LONGITUDE
GCP.BG.01	39° 9' 39.10338"	-119° 45' 59.36652"

GCP.BG.10

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP.BG.10	277392.198	4356378.341	1624.190	1648.380

Point ID	LATITUDE	LONGITUDE
GCP.BG.10	39° 19' 41.49649"	-119° 34' 57.26532"

GCP.BG.11

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP.BG.11	277392.199	4356378.343	1624.181	1648.371

Point ID	LATITUDE	LONGITUDE
GCP.BG.11	39° 19' 41.49656"	-119° 34' 57.26532"

GCP_NVA.BG.02

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.BG.02	256020.902	4329290.092	1503.877	1528.339

Point ID	LATITUDE	LONGITUDE
GCP_NVA.BG.02	39° 4' 43.08596"	119° 49' 13.683"

GCP_NVA.BG.03

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.BG.03	250244.158	4318040.241	2139.306	2163.541

Point ID	LATITUDE	LONGITUDE
GCP_NVA.BG.03	38° 58' 32.71462"	-119° 52' 58.98324"

GCP_NVA.BG.04

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.BG.04	272152.037	4347496.544	1530.542	1554.815

Point ID	LATITUDE	LONGITUDE
GCP_NVA.BG.04	39° 14' 48.77308"	-119° 38' 25.08576"

GCP_NVA.BG.06

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.BG.06	271231.517	4353733.300	1883.094	1907.229

Point ID	LATITUDE	LONGITUDE
GCP_NVA.BG.06	39° 18' 10.00015"	-119° 39' 11.07288"

GCP_NVA.BG.07

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.BG.07	271263.717	4359012.689	2050.668	2074.733

Point ID	LATITUDE	LONGITUDE
GCP_NVA.BG.07	39° 21' 1.10513"	-119° 39' 16.19964"

GCP_NVA.BG.11

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.BG.11	252561.759	4358148.771	2285.225	2308.951

Point ID	LATITUDE	LONGITUDE
GCP_NVA.BG.11	39° 20' 14.57466"	-119° 52' 15.5046"

GCP.HP.01

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP.HP.01	258003.661	4344308.104	1525.997	1550.248

Point ID	LATITUDE	LONGITUDE
GCP.HP.01	39° 12' 51.67526"	-119° 48' 10.5552"

GCP.HP.02

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP.HP.02	272445.392	4375771.769	1314.749	1338.888

Point ID	LATITUDE	LONGITUDE
GCP.HP.02	39° 30' 5.28743"	-119° 38' 47.41368"

GCP.HP.11

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP.HP.11	282521.926	4353104.002	1299.269	1323.601

Point ID	LATITUDE	LONGITUDE
GCP.HP.11	39° 18' 0.08032"	-119° 31' 19.40484"

GCP.HP.12

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP.HP.12	257558.262	4403563.812	1539.593	1563.345

Point ID	LATITUDE	LONGITUDE
GCP.HP.12	39° 44' 51.04536"	-119° 49' 46.66584"

GCP_NVA.HP.03

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.HP.03	259189.646	4332992.955	1455.930	1480.408

Point ID	LATITUDE	LONGITUDE
GCP_NVA.HP.03	39° 6' 46.23397"	-119° 47' 6.67824"

GCP_NVA.HP.06

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.HP.06	263293.752	4332298.771	1414.475	1438.997

Point ID	LATITUDE	LONGITUDE
GCP_NVA.HP.06	39° 6' 27.78678"	-119° 44' 15.10728"

GCP_NVA.HP.08

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.HP.08	270245.594	4344174.034	1457.430	1481.727

Point ID	LATITUDE	LONGITUDE
GCP_NVA.HP.08	39° 12' 59.29888"	-119° 39' 40.46616"

GCP_NVA.HP.09

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.HP.09	270245.594	4344174.034	1747.778	1481.727

Point ID	LATITUDE	LONGITUDE
GCP_NVA.HP.09	39° 22' 44.1754"	-119° 49' 54.12108"

GCP_NVA.HP.16

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.HP.16	260442.590	4341638.183	1418.162	1442.508

Point ID	LATITUDE	LONGITUDE
GCP_NVA.HP.16	39° 11' 27.59921"	-119° 46' 25.56552"

GCP_NVA.HP.24

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.HP.24	280973.185	4381806.092	1283.954	1308.072

Point ID	LATITUDE	LONGITUDE
GCP_NVA.HP.24	39° 33' 28.80727"	-119° 32' 57.85728"

GCP_NVA.LV.10

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.LV.10	261848.550	4352267.561	1545.803	1569.989

Point ID	LATITUDE	LONGITUDE
GCP_NVA.LV.10	39° 17' 13.40131"	-119° 45' 40.52664"

GCP.PS.01

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP.PS.01	248807.550	4392717.700	1496.610	1520.357

Point ID	LATITUDE	LONGITUDE
GCP.PS.01	39° 38' 50.57023"	-119° 55' 39.03276"

GCP.PS.02

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP.PS.02	256445.016	4416808.361	1490.221	1513.873

Point ID	LATITUDE	LONGITUDE
GCP.PS.02	39° 51' 58.97732"	-119° 50' 51.08712"

GCP_NVA.PS.04

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.PS.04	256325.956	4333359.564	1607.187	1631.584

Point ID	LATITUDE	LONGITUDE
GCP_NVA.PS.04	39° 6' 55.24783"	-119° 49' 6.25404"

GCP_NVA.PS.06

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.PS.06	252854.437	4332996.338	1800.073	1824.366

Point ID	LATITUDE	LONGITUDE
GCP_NVA.PS.06	39° 6' 39.96108"	-119° 51' 30.1608"

GCP_NVA.PS.08

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.PS.08	265773.119	4332626.121	1390.895	1415.375

Point ID	LATITUDE	LONGITUDE
GCP_NVA.PS.08	39° 6' 40.80467"	-119° 42' 32.39532"

GCP_NVA.PS.13

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.PS.13	265301.972	4372050.220	1323.615	1347.786

Point ID	LATITUDE	LONGITUDE
GCP_NVA.PS.13	39° 27' 57.79202"	-119° 43' 41.46996"

GCP_NVA.PS.18

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.PS.18	252471.425	4400483.183	1551.711	1575.459

Point ID	LATITUDE	LONGITUDE
GCP_NVA.PS.18	39° 43' 5.98415"	-119° 53' 15.97812"

GCP_NVA.PS.28

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.PS.28	264254.101	4412809.060	1453.081	1476.773

Point ID	LATITUDE	LONGITUDE
GCP_NVA.PS.28	39° 49' 57.34283"	-119° 45' 17.58672"

GCP_NVA.PS.30

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.PS.30	269039.062	4400110.380	1410.436	1434.329

Point ID	LATITUDE	LONGITUDE
GCP_NVA.PS.30	39° 43' 10.6288"	-119° 41' 40.43112"

GCP_NVA.PS.31

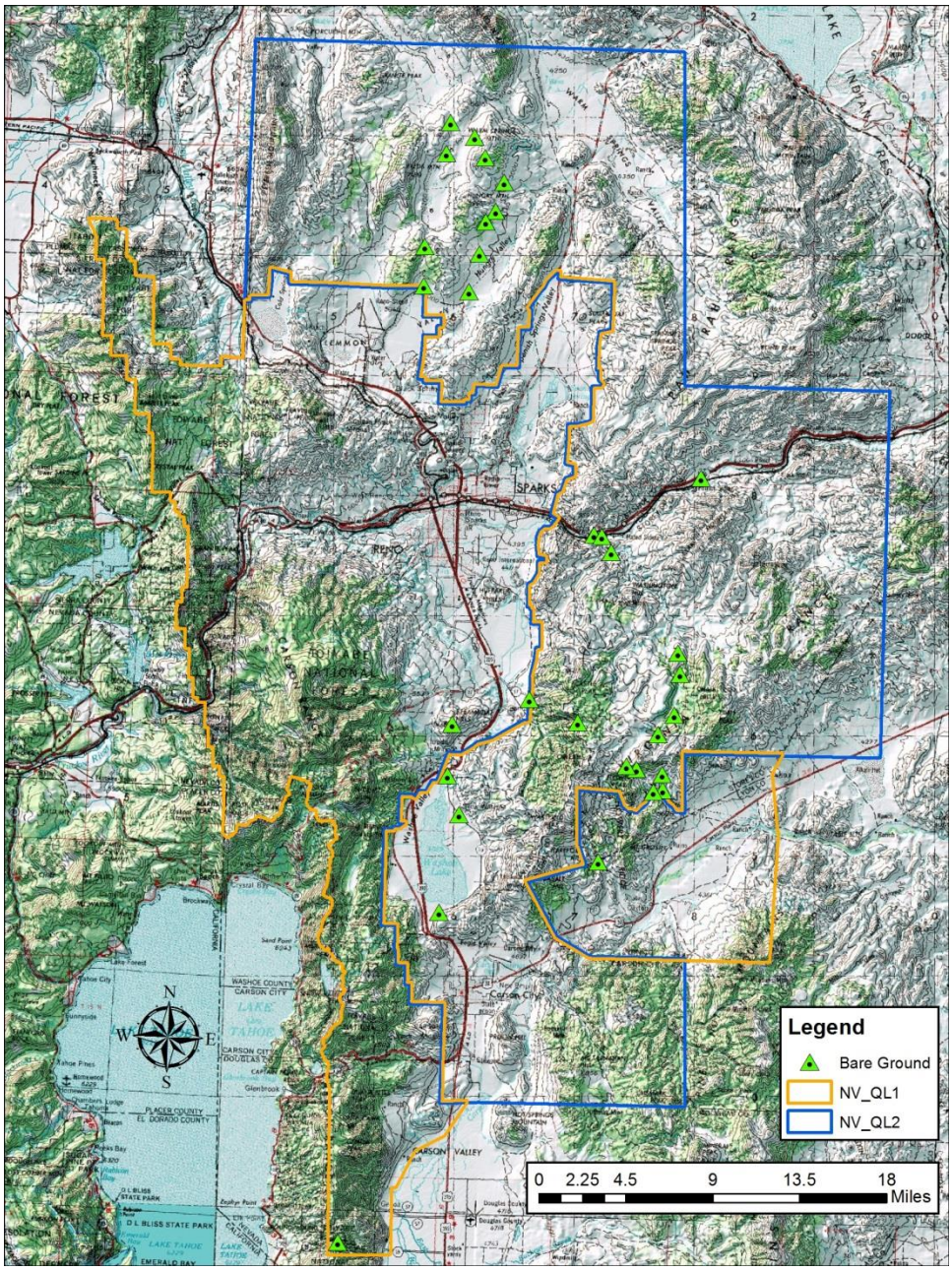
Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
GCP_NVA.PS.31	267592.540	4391765.602	1348.901	1372.906

Point ID	LATITUDE	LONGITUDE
GCP_NVA.PS.31	39° 38' 38.83801"	-119° 42' 30.546"

Non-Vegetated Vertical Accuracy Checkpoints

Bare Earth

The Map shows the overall distribution of the Non-Vegetated Vertical Accuracy Checkpoint, Bare Earth throughout the AOI. The following tables contain a list of the control using Easting, Northing, and Orthometric height. The coordinate system displayed is UTM 11N, NAD83 (2011), NAVD88, Geoid 12B and using Meters for measurement.



Point ID	Easting X (Meters)	Northing Y (Meters)	Ortho (Meters)
NVA.BG.03A	250244.122	4318038.929	2163.561
NVA.BG.05	271973.423	4349694.748	1560.549
NVA.BG.08	270241.281	4361309.801	1934.795
NVA.BG.09	266248.56	4363224.658	1481.683
NVA.BG.10	259795.06	4361167.423	1838.814
NVA.BG.11	258724.86	4345532.127	1543.781
NVA.BG.12	260353.727	4353643.357	1552.69
NVA.BG.13	259421.284	4356882.446	1547.528
NVA.BG.14	271607.062	4376914.191	1354.109
NVA.BG.15	272251.052	4376819.247	1331.011
NVA.BG.16	273058.573	4375480.444	1345.184
NVA.BG.17	280558.528	4381665.727	1304.147
NVA.BG.24	277346.7	4355681.048	1537.208
NVA.BG.25	276571.055	4355540.406	1558.04
NVA.BG.26	277323.692	4356988.818	1736.75
NVA.BG.27	275141.375	4357400.1	1778.342
NVA.BG.28	274341.871	4357659.906	1931.523
NVA.BG.29	276948.999	4360293.082	1837.21
NVA.BG.30	278296.379	4361923.176	1793.652
NVA.BG.31	278800.915	4365322.289	1758.492
NVA.BG.32	278601.896	4367091.565	1714.901
NVA.BG.33	257416.204	4397686.049	1543.609
NVA.BG.34	257536.856	4400939.036	1675.732
NVA.BG.35	259328.032	4408701.385	1579.476
NVA.BG.36	259678.057	4411293.895	1616.269
NVA.BG.37	261661.994	4410052.846	1627.899
NVA.BG.38	262545.573	4408347.662	1746.511
NVA.BG.39	264149.326	4406305.152	1543.064
NVA.BG.40	263437.076	4403900.184	1562.443
NVA.BG.41	262593.578	4403012.766	1598.613
NVA.BG.42	262060.194	4400355.207	1549.99
NVA.BG.43	261180.16	4397202.348	1551.117

NVA.BG.03A

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.03A	250244.122	4318038.929	2139.326	2163.561

Point ID	LATITUDE	LONGITUDE
NVA.BG.03A	38° 58' 32.67206"	-119° 52' 58.98324"

NVA.BG.05

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.05	271973.423	4349694.748	1536.314	1560.549

Point ID	LATITUDE	LONGITUDE
NVA.BG.05	39° 15' 59.83664"	-119° 38' 35.20572"

NVA.BG.08

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.08	270241.281	4361309.801	1910.741	1934.795

Point ID	LATITUDE	LONGITUDE
NVA.BG.08	39° 22' 14.56385"	-119° 40' 1.70436"

NVA.BG.09

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.09	266248.56	4363224.658	1457.560	1481.683

Point ID	LATITUDE	LONGITUDE
NVA.BG.09	39° 23' 12.75338"	-119° 42' 50.79204"

NVA.BG.10

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.10	259795.060	4361167.423	1814.798	1838.814

Point ID	LATITUDE	LONGITUDE
NVA.BG.10	39° 21' 59.72155"	-119° 47' 17.59884"

NVA.BG.11

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.11	258724.860	4345532.127	1519.533	1543.781

Point ID	LATITUDE	LONGITUDE
NVA.BG.11	39° 13' 32.05704"	-119° 47' 42.09072"

NVA.BG.12

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.12	260353.727	4353643.357	1528.535	1552.690

Point ID	LATITUDE	LONGITUDE
NVA.BG.12	39° 17' 56.49468"	-119° 46' 44.61636"

NVA.BG.13

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.13	259421.284	4356882.446	1523.451	1547.528

Point ID	LATITUDE	LONGITUDE
NVA.BG.13	39° 19' 40.51236"	-119° 47' 27.67236"

NVA.BG.14

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.14	271607.062	4376914.191	1329.981	1354.109

Point ID	LATITUDE	LONGITUDE
NVA.BG.14	39° 30' 41.5053"	-119° 39' 23.88888"

NVA.BG.15

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.15	272251.052	4376819.247	1306.879	1331.011

Point ID	LATITUDE	LONGITUDE
NVA.BG.15	39° 30' 39.04398"	-119° 38' 56.832"

NVA.BG.16

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.16	273058.573	4375480.444	1321.043	1345.184

Point ID	LATITUDE	LONGITUDE
NVA.BG.16	39° 29' 56.43089"	-119° 38' 21.40908"

NVA.BG.17

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.17	280558.528	4381665.727	1280.030	1304.147

Point ID	LATITUDE	LONGITUDE
NVA.BG.17	39° 33' 23.87729"	-119° 33' 15.0498"

NVA.BG.24

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.24	277346.700	4355681.048	1512.998	1537.208

Point ID	LATITUDE	LONGITUDE
NVA.BG.24	39° 19' 18.85786"	-119° 34' 58.332"

NVA.BG.25

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.25	276571.055	4355540.406	1533.837	1558.040

Point ID	LATITUDE	LONGITUDE
NVA.BG.25	39° 19' 13.58047"	-119° 35' 30.525"

NVA.BG.26

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.26	277323.692	4356988.818	1712.579	1736.750

Point ID	LATITUDE	LONGITUDE
NVA.BG.26	39° 20' 1.21614"	-119° 35' 0.85236"

NVA.BG.27

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.27	275141.375	4357400.100	1754.206	1778.342

Point ID	LATITUDE	LONGITUDE
NVA.BG.27	39° 20' 12.51136"	-119° 36' 32.41224"

NVA.BG.28

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.28	274341.871	4357659.906	1907.402	1931.523

Point ID	LATITUDE	LONGITUDE
NVA.BG.28	39° 20' 20.18072"	-119° 37' 6.08952"

NVA.BG.29

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.29	276948.999	4360293.082	1813.106	1837.210

Point ID	LATITUDE	LONGITUDE
NVA.BG.29	39° 21' 47.94577"	-119° 35' 20.44104"

NVA.BG.30

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.30	278296.379	4361923.176	1769.555	1793.652

Point ID	LATITUDE	LONGITUDE
NVA.BG.30	39° 22' 42.01903"	-119° 34' 26.13288"

NVA.BG.31

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.31	278800.915	4365322.289	1734.402	1758.492

Point ID	LATITUDE	LONGITUDE
NVA.BG.31	39° 24' 32.63652"	-119° 34' 9.1074"

NVA.BG.32

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.32	278601.896	4367091.565	1690.802	1714.901

Point ID	LATITUDE	LONGITUDE
NVA.BG.32	39° 25' 29.78753"	-119° 34' 19.5294"

NVA.BG.33

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.33	257416.204	4397686.049	1519.796	1543.609

Point ID	LATITUDE	LONGITUDE
NVA.BG.33	39° 41' 40.4768"	-119° 49' 44.83776"

NVA.BG.34

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.34	257536.856	4400939.036	1651.969	1675.732

Point ID	LATITUDE	LONGITUDE
NVA.BG.34	39° 43' 25.9882"	-119° 49' 44.08464"

NVA.BG.35

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.35	259328.032	4408701.385	1555.756	1579.476

Point ID	LATITUDE	LONGITUDE
NVA.BG.35	39° 47' 39.29521"	-119° 48' 39.1626"

NVA.BG.36

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.36	259678.057	4411293.895	1592.576	1616.269

Point ID	LATITUDE	LONGITUDE
NVA.BG.36	39° 49' 3.64181"	-119° 48' 27.88092"

NVA.BG.37

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.37	261661.994	4410052.846	1604.197	1627.899

Point ID	LATITUDE	LONGITUDE
NVA.BG.37	39° 48' 25.44458"	-119° 47' 2.90652"

NVA.BG.38

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.38	262545.573	4408347.662	1722.791	1746.511

Point ID	LATITUDE	LONGITUDE
NVA.BG.38	39° 47' 31.08905"	-119° 46' 23.56932"

NVA.BG.39

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.39	264149.326	4406305.152	1519.290	1543.064

Point ID	LATITUDE	LONGITUDE
NVA.BG.39	39° 46' 26.51927"	-119° 45' 13.57416"

NVA.BG.40

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.40	263437.076	4403900.184	1538.641	1562.443

Point ID	LATITUDE	LONGITUDE
NVA.BG.40	39° 45' 7.88987"	-119° 45' 40.36464"

NVA.BG.41

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.41	262593.578	4403012.766	1574.810	1598.613

Point ID	LATITUDE	LONGITUDE
NVA.BG.41	39° 44' 38.29434"	-119° 46' 14.61684"

NVA.BG.42

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.42	262060.194	4400355.207	1526.153	1549.99

Point ID	LATITUDE	LONGITUDE
NVA.BG.42	39° 43' 11.65775"	-119° 46' 33.54528"

NVA.BG.43

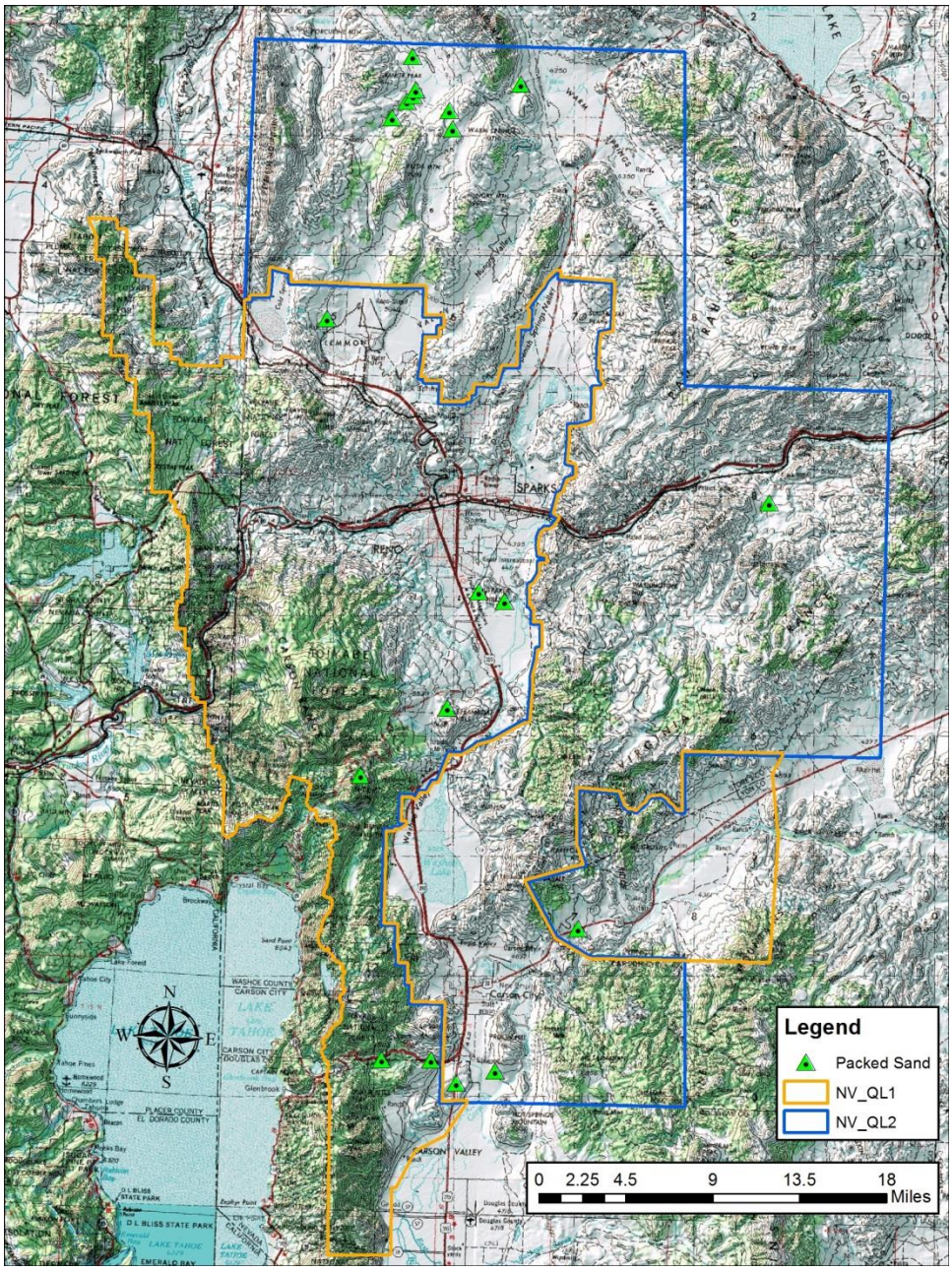
Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.BG.43	261180.16	4397202.348	1527.251	1551.117

Point ID	LATITUDE	LONGITUDE
NVA.BG.43	39° 41' 28.62467"	-119° 47' 6.35532"

Non-Vegetated Vertical Accuracy Checkpoints

Packed Sand

The Map shows the overall distribution of the Non-Vegetated Vertical Accuracy Checkpoints, Packed Sand throughout the AOI. The following tables contain a list of the control using Easting, Northing, and Orthometric height. The coordinate system displayed is UTM 11N, NAD83 (2011), NAVD88, Geoid 12B and using Meters for measurement.



Point ID	Easting X (Meters)	Northing Y (Meters)	Ortho (Meters)
NVA.PS.01	260077.748	4331270.429	1499.361
NVA.PS.02	257949.35	4333225.197	1534.277
NVA.PS.05	253843.07	4333261.732	1763.536
NVA.PS.06	263283.818	4332312.137	1439.166
NVA.PS.08	270232.562	4344152.078	1481.648
NVA.PS.09	259304.563	4362515.291	1673.398
NVA.PS.11	261949.149	4372209.098	1352.894
NVA.PS.12	264091.47	4371438.505	1373.478
NVA.PS.14	286148.928	4379619.688	1376.758
NVA.PS.17	249279.308	4394940.003	1549.494
NVA.PS.19	254736.826	4411680.533	1609.864
NVA.PS.20	255956.585	4413033.566	1575.988
NVA.PS.21	256466.575	4413504.973	1561.61
NVA.PS.22	256684.262	4413982.568	1552.958
NVA.PS.23	256429.905	4416791.861	1514.027
NVA.PS.26	259511.422	4412301.519	1603.816
NVA.PS.27	259741.516	4410771.315	1624.1
NVA.PS.29	265439.212	4414492.122	1408.449
NVA.PS10	252100.416	4356929.867	2413.397

NVA.PS.01

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.PS.01	260077.748	4331270.429	1474.834	1499.361

Point ID	LATITUDE	LONGITUDE
NVA.PS.01	39° 5' 51.3019"	-119° 46' 27.55092"

NVA.PS.02

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.PS.02	257949.35	4333225.197	1509.838	1534.277

Point ID	LATITUDE	LONGITUDE
NVA.PS.02	39° 6' 52.52238"	-119° 47' 58.56108"

NVA.PS.05

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.PS.05	253843.07	4333261.732	1739.211	1763.536

Point ID	LATITUDE	LONGITUDE
NVA.PS.05	39° 6' 49.56678"	-119° 50' 49.39188"

NVA.PS.06

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.PS.06	263283.818	4332312.137	1414.644	1439.166

Point ID	LATITUDE	LONGITUDE
NVA.PS.06	39° 6' 28.21018"	-119° 44' 15.53712"

NVA.PS.08

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.PS.08	270232.562	4344152.078	1457.351	1481.648

Point ID	LATITUDE	LONGITUDE
NVA.PS.08	39° 12' 58.57499"	-119° 39' 40.98204"

NVA.PS.09

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.PS.09	259304.563	4362515.291	1649.401	1673.398

Point ID	LATITUDE	LONGITUDE
NVA.PS.09	39° 22' 42.90121"	-119° 47' 39.8148"

NVA.PS.11

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.PS.11	261949.149	4372209.098	1328.732	1352.894

Point ID	LATITUDE	LONGITUDE
NVA.PS.11	39° 27' 59.62583"	-119° 46' 1.8282"

NVA.PS.12

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.PS.12	264091.470	4371438.505	1349.303	1373.478

Point ID	LATITUDE	LONGITUDE
NVA.PS.12	39° 27' 36.78077"	-119° 44' 31.2936"

NVA.PS.14

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.PS.14	286148.928	4379619.688	1352.663	1376.758

Point ID	LATITUDE	LONGITUDE
NVA.PS.14	39° 32' 22.65212"	-119° 29' 18.64032"

NVA.PS.17

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.PS.17	249279.308	4394940.003	1525.729	1549.494

Point ID	LATITUDE	LONGITUDE
NVA.PS.17	39° 40' 3.05976"	-119° 55' 22.29852"

NVA.PS.19

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.PS.19	254736.826	4411680.533	1586.162	1609.864

Point ID	LATITUDE	LONGITUDE
NVA.PS.19	39° 49' 11.08826"	-119° 51' 55.98612"

NVA.PS.20

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.PS.20	255956.585	4413033.566	1552.291	1575.988

Point ID	LATITUDE	LONGITUDE
NVA.PS.20	39° 49' 56.1846"	-119° 51' 6.5556"

NVA.PS.21

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.PS.21	256466.575	4413504.973	1537.918	1561.61

Point ID	LATITUDE	LONGITUDE
NVA.PS.21	39° 50' 11.98302"	-119° 50' 45.75696"

NVA.PS.22

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.PS.22	256684.262	4413982.568	1529.272	1552.958

Point ID	LATITUDE	LONGITUDE
NVA.PS.22	39° 50' 27.67974"	-119° 50' 37.24764"

NVA.PS.23

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.PS.23	256429.905	4416791.861	1490.375	1514.027

Point ID	LATITUDE	LONGITUDE
NVA.PS.23	39° 51' 58.42717"	-119° 50' 51.70056"

NVA.PS.26

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.PS.26	259511.422	4412301.519	1580.132	1603.816

Point ID	LATITUDE	LONGITUDE
NVA.PS.26	39° 49' 36.1164"	-119° 48' 36.2124"

NVA.PS.27

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.PS.27	259741.516	4410771.315	1600.402	1624.1

Point ID	LATITUDE	LONGITUDE
NVA.PS.27	39° 48' 46.77617"	-119° 48' 24.52572"

NVA.PS.29

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.PS.29	265439.212	4414492.122	1384.770	1408.449

Point ID	LATITUDE	LONGITUDE
NVA.PS.29	39° 50' 53.05283"	-119° 44' 29.9544"

NVA.PS10

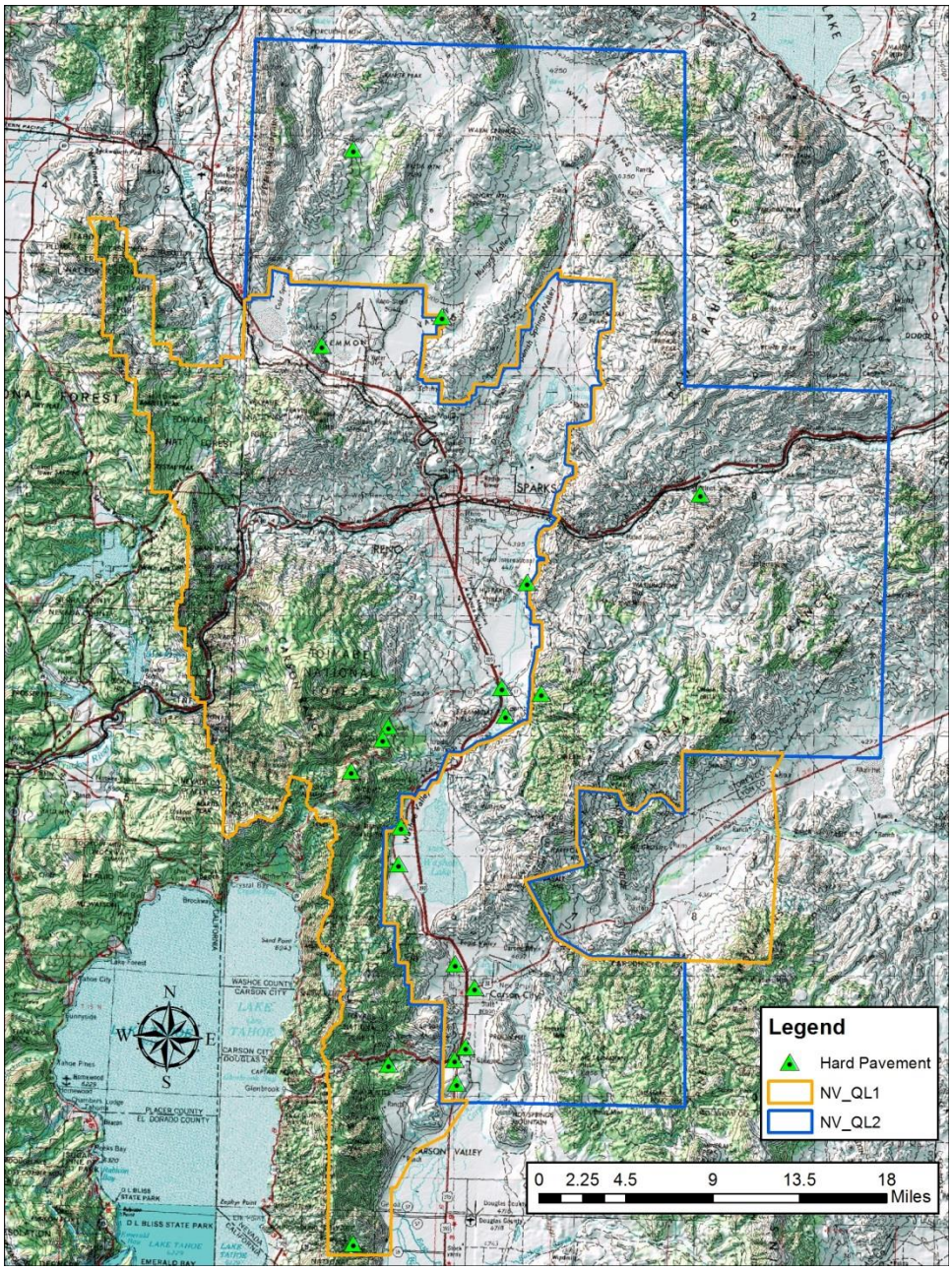
Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.PS10	252100.416	4356929.867	2389.685	2413.397

Point ID	LATITUDE	LONGITUDE
NVA.PS10	39° 19' 34.60894"	-119° 52' 33.13308"

Non-Vegetated Vertical Accuracy Checkpoints

Hard Pavement

The Map shows the overall distribution of the Non-Vegetated Vertical Accuracy Checkpoints, Hard Pavement throughout the AOI. The following tables contain a list of the control using Easting, Northing, and Orthometric height. is UTM 11N, NAD83 (2011), NAVD88, Geoid 12B and using Meters for measurement.



Point ID	Easting X (Meters)	Northing Y (Meters)	Ortho (Meters)
NVA.HP.01	260090.266	4331304.003	1501.797
NVA.HP.02	259930.611	4333245.923	1454.073
NVA.HP.04	254432.307	4332876.681	1708.791
NVA.HP.05	260856.059	4334298.574	1445.82
NVA.HP.07	251482.829	4317967.107	2075.945
NVA.HP.08	267162.876	4363743.27	1642.658
NVA.HP.10	254431.015	4361015.03	1849.759
NVA.HP.11	253952.746	4359955.868	1906.247
NVA.HP.13	255477.844	4352644.52	1549.053
NVA.HP.14	255258.558	4349548.263	1541.022
NVA.HP.17	259991.982	4341231.157	1450.091
NVA.HP.19	264174.186	4361930.152	1413.747
NVA.HP.20	263855.503	4364228.647	1390.093
NVA.HP.22	265964.295	4372987.633	1364.119
NVA.HP.23	280396.462	4380333.896	1310.768
NVA.HP.25	248838.345	4392713.852	1519.603
NVA.HP.26	251494.758	4409036.363	1759.634
NVA.HP.34	258876.235	4395146.386	1509.969
NVA.HP12	251311.849	4357262.871	2515.081
VVA.HP.15	261606.381	4339243.81	1423.046

NVA.HP.01

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.HP.01	260090.266	4331304.003	1477.271	1501.797

Point ID	LATITUDE	LONGITUDE
NVA.HP.01	39° 5' 52.40216"	-119° 46' 27.07284"

NVA.HP.02

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.HP.02	259930.611	4333245.923	1429.583	1454.073

Point ID	LATITUDE	LONGITUDE
NVA.HP.02	39° 6' 55.16636"	-119° 46' 36.18228"

NVA.HP.04

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.HP.04	254432.307	4332876.681	1684.438	1708.791

Point ID	LATITUDE	LONGITUDE
NVA.HP.04	39° 6' 37.68926"	-119° 50' 24.38448"

NVA.HP.05

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.HP.05	260856.059	4334298.574	1421.329	1445.82

Point ID	LATITUDE	LONGITUDE
NVA.HP.05	39° 7' 30.19048"	-119° 45' 59.02452"

NVA.HP.07

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.HP.07	251482.829	4317967.107	2051.627	2075.945

Point ID	LATITUDE	LONGITUDE
NVA.HP.07	38° 58' 31.6132"	-119° 52' 7.473"

NVA.HP.08

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.HP.08	267162.876	4363743.27	1618.557	1642.658

Point ID	LATITUDE	LONGITUDE
NVA.HP.08	39° 23' 30.44717"	-119° 42' 13.26276"

NVA.HP.10

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.HP.10	254431.015	4361015.03	1825.950	1849.759

Point ID	LATITUDE	LONGITUDE
NVA.HP.10	39° 21' 49.35571"	-119° 51' 1.29168"

NVA.HP.11

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.HP.11	253952.746	4359955.868	1882.455	1906.247

Point ID	LATITUDE	LONGITUDE
NVA.HP.11	39° 21' 14.55066"	-119° 51' 19.85508"

NVA.HP.13

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.HP.13	255477.844	4352644.52	1524.980	1549.053

Point ID	LATITUDE	LONGITUDE
NVA.HP.13	39° 17' 19.22647"	-119° 50' 6.63468"

NVA.HP.14

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.HP.14	255258.558	4349548.263	1516.879	1541.022

Point ID	LATITUDE	LONGITUDE
NVA.HP.14	39° 15' 38.68639"	-119° 50' 11.72832"

NVA.HP.17

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.HP.17	259991.982	4341231.157	1425.744	1450.091

Point ID	LATITUDE	LONGITUDE
NVA.HP.17	39° 11' 13.96349"	-119° 46' 43.8078"

NVA.HP.19

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.HP.19	264174.186	4361930.152	1389.614	1413.747

Point ID	LATITUDE	LONGITUDE
NVA.HP.19	39° 22' 28.77841"	-119° 44' 15.7686"

NVA.HP.20

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.HP.20	263855.503	4364228.647	1365.954	1390.093

Point ID	LATITUDE	LONGITUDE
NVA.HP.20	39° 23' 42.93967"	-119° 44' 31.98912"

NVA.HP.22

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.HP.22	265964.295	4372987.633	1339.954	1364.119

Point ID	LATITUDE	LONGITUDE
NVA.HP.22	39° 28' 28.81477"	-119° 43' 14.96676"

NVA.HP.23

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.HP.23	280396.462	4380333.896	1286.656	1310.768

Point ID	LATITUDE	LONGITUDE
NVA.HP.23	39° 32' 40.56943"	-119° 33' 20.24964"

NVA.HP.25

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.HP.25	248838.345	4392713.852	1495.855	1519.603

Point ID	LATITUDE	LONGITUDE
NVA.HP.25	39° 38' 50.47811"	-119° 55' 37.73712"

NVA.HP.26

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.HP.26	251494.758	4409036.363	1735.933	1759.634

Point ID	LATITUDE	LONGITUDE
NVA.HP.26	39° 47' 42.04252"	-119° 54' 8.58132"

NVA.HP.34

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.HP.34	258876.235	4395146.386	1486.102	1509.969

Point ID	LATITUDE	LONGITUDE
NVA.HP.34	39° 40' 19.6855"	-119° 48' 40.26852"

NVA.HP12

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
NVA.HP12	251311.849	4357262.871	2491.417	2515.081

Point ID	LATITUDE	LONGITUDE
NVA.HP12	39° 19' 44.58292"	-119° 53' 6.47088"

VVA.HP.15

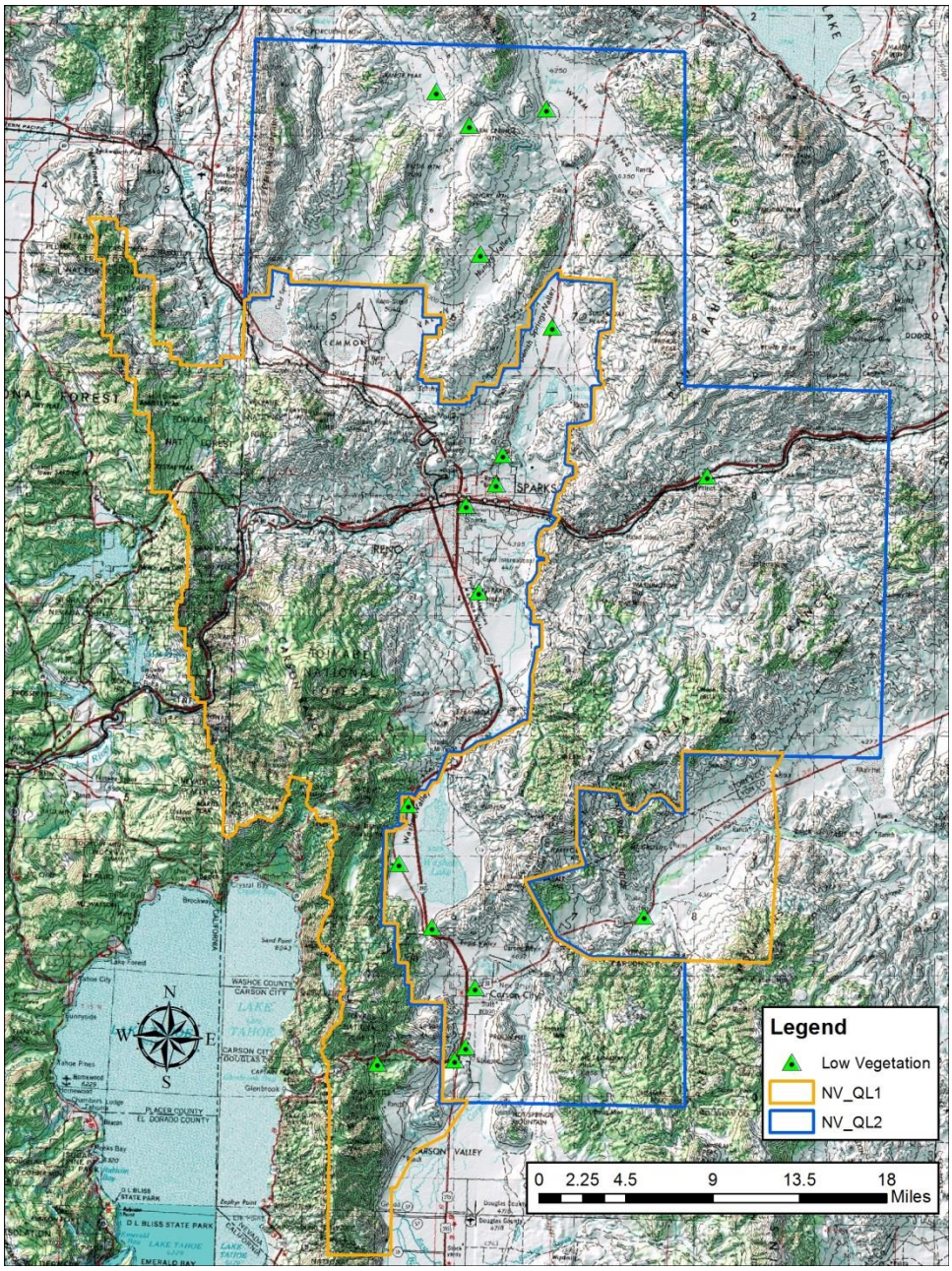
Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.HP.15	261606.381	4339243.81	1398.635	1423.046

Point ID	LATITUDE	LONGITUDE
VVA.HP.15	39° 10' 11.16804"	-119° 45' 34.07148"

Vegetated Vertical Accuracy Checkpoints

Low Vegetation

The Map shows the overall distribution of the Vegetated Vertical Accuracy Checkpoints, Low Vegetation throughout the AOI. The following tables contain a list of the control using Easting, Northing, and Orthometric height. The coordinate system displayed is UTM 11N, NAD83 (2011), NAVD88, Geoid 12B and using Meters for measurement.



Point ID	Easting X (Meters)	Northing Y (Meters)	Ortho (Meters)
VVA.LV.01	259940.397	4333201.911	1454.564
VVA.LV.02	253498.44	4332973.635	1740.606
VVA.LV.03	260858.66	4334330.938	1446.07
VVA.LV.04	275740.261	4345190.586	1330.834
VVA.LV.05	256089.83	4354472.255	1556.336
VVA.LV.06	255272.953	4349568.976	1539.967
VVA.LV.07	261655.447	4339236.857	1422.16
VVA.LV.08	258033.599	4344308.81	1550.807
VVA.LV.09	261929.033	4372226.508	1353.061
VVA.LV.11	281000.312	4381820.762	1307.682
VVA.LV.14	258406.485	4413882.723	1541.97
VVA.LV.16	261156.124	4411042.802	1599.527
VVA.LV.17	267569.48	4412428.563	1316.993
VVA.LV.19	268087.132	4394276.469	1386.738
VVA.LV.20	263977.132	4383624.562	1391.741
VVA.LV.21	263370.479	4381176.125	1347.699
VVA.LV.22	260908.054	4379408.603	1353.934
VVA.LV.28	262075.273	4400359.356	1549.826

VVA.LV.01

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.LV.01	259940.397	4333201.911	1430.073	1454.564

Point ID	LATITUDE	LONGITUDE
VVA.LV.01	39° 6' 53.74998"	-119° 46' 35.71932"

VVA.LV.02

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.LV.02	253498.44	4332973.635	1716.287	1740.606

Point ID	LATITUDE	LONGITUDE
VVA.LV.02	39° 6' 39.88188"	-119° 51' 3.34836"

VVA.LV.03

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.LV.03	260858.66	4334330.938	1421.579	1446.07

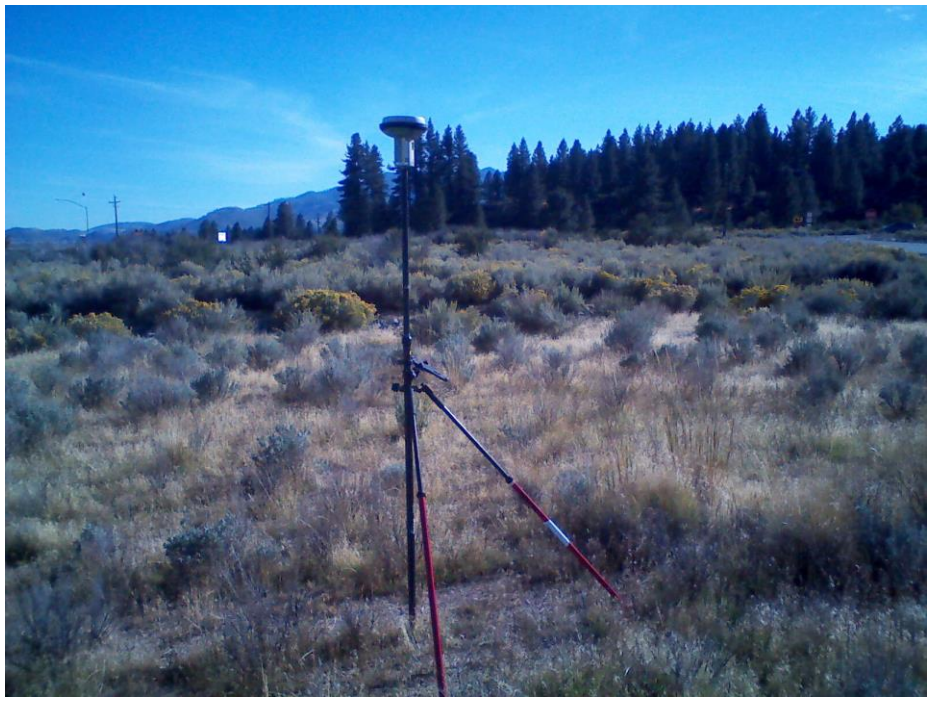
Point ID	LATITUDE	LONGITUDE
VVA.LV.03	39° 7' 31.24171"	-119° 45' 58.95756"

VVA.LV.04

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.LV.04	275740.261	4345190.586	1306.503	1330.834

Point ID	LATITUDE	LONGITUDE
VVA.LV.04	39° 13' 37.41164"	-119° 35' 52.78344"

VVA.LV.05



Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.LV.05	256089.83	4354472.255	1532.298	1556.336

Point ID	LATITUDE	LONGITUDE
VVA.LV.05	39° 18' 19.06542"	-119° 49' 43.5036"

VVA.LV.06

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.LV.06	255272.953	4349568.976	1515.824	1539.967

Point ID	LATITUDE	LONGITUDE
VVA.LV.06	39° 15' 39.37212"	-119° 50' 11.1552"

VVA.LV.07

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.LV.07	261655.447	4339236.857	1397.748	1422.16

Point ID	LATITUDE	LONGITUDE
VVA.LV.07	39° 10' 10.99114"	-119° 45' 32.0202"

VVA.LV.08

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.LV.08	258033.599	4344308.81	1526.556	1550.807

Point ID	LATITUDE	LONGITUDE
VVA.LV.08	39° 12' 51.72815"	-119° 48' 9.30924"

VVA.LV.09

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.LV.09	261929.033	4372226.508	1328.900	1353.061

Point ID	LATITUDE	LONGITUDE
VVA.LV.09	39° 28' 0.1699"	-119° 46' 2.69148"

VVA.LV.11

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.LV.11	281000.312	4381820.762	1283.565	1307.682

Point ID	LATITUDE	LONGITUDE
VVA.LV.11	39° 33' 29.3076"	-119° 32' 56.73912"

VVA.LV.14

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.LV.14	258406.485	4413882.723	1518.292	1541.97

Point ID	LATITUDE	LONGITUDE
VVA.LV.14	39° 50' 26.21436"	-119° 49' 24.73752"

VVA.LV.16

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.LV.16	261156.124	4411042.802	1575.833	1599.527

Point ID	LATITUDE	LONGITUDE
VVA.LV.16	39° 48' 57.00618"	-119° 47' 25.45404"

VVA.LV.17

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.LV.17	267569.48	4412428.563	1293.248	1316.993

Point ID	LATITUDE	LONGITUDE
VVA.LV.17	39° 49' 48.3024"	-119° 42' 57.77496"

VVA.LV.19

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.LV.19	268087.132	4394276.469	1362.759	1386.738

Point ID	LATITUDE	LONGITUDE
VVA.LV.19	39° 40' 0.67591"	-119° 42' 12.9888"

VVA.LV.20

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.LV.20	263977.132	4383624.562	1367.654	1391.741

Point ID	LATITUDE	LONGITUDE
VVA.LV.20	39° 34' 11.50457"	-119° 44' 51.62712"

VVA.LV.21

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.LV.21	263370.479	4381176.125	1323.571	1347.699

Point ID	LATITUDE	LONGITUDE
VVA.LV.21	39° 32' 51.57301"	-119° 45' 13.88412"

VVA.LV.22

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.LV.22	260908.054	4379408.603	1329.805	1353.934

Point ID	LATITUDE	LONGITUDE
VVA.LV.22	39° 31' 51.84991"	-119° 46' 54.64884"

VVA.LV.28

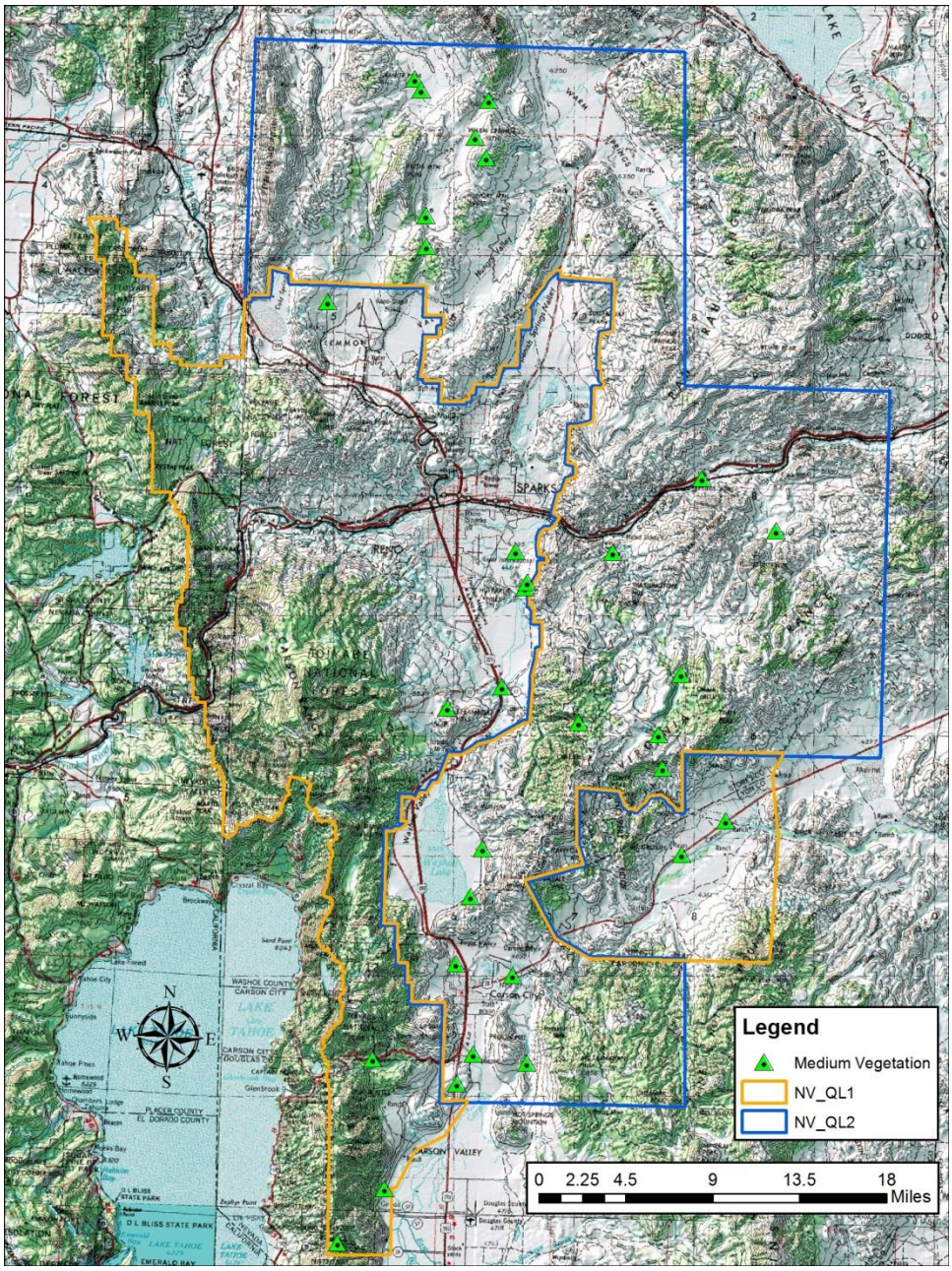
Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.LV.28	262075.273	4400359.356	1525.989	1549.826

Point ID	LATITUDE	LONGITUDE
VVA.LV.28	39° 43' 11.80729"	-119° 46' 32.91816"

Vegetated Vertical Accuracy Checkpoints

Medium Vegetation

The Map shows the overall distribution of the Vegetated Vertical Accuracy Checkpoints, Medium Vegetation throughout the AOI. The following tables contain a list of the control using Easting, Northing, and Orthometric height. The coordinate system displayed is UTM 11N, NAD83 (2011), NAVD88, Geoid 12B and using Meters for measurement.



Point ID	Easting X (Meters)	Northing Y (Meters)	Ortho (Meters)
VVA.MV.01	260123.163	4331257.599	1502.811
VVA.MV.03	253103.693	4333306.699	1794.299
VVA.MV.04	261453.963	4333719.388	1439.973
VVA.MV.05	265944.636	4332937.55	1418.247
VVA.MV.06	254068.118	4322510.346	1460.026
VVA.MV.08	250189.547	4318008.106	2166.073
VVA.MV.10	264764.773	4340278.581	1412.03
VVA.MV.11	278855.283	4350324.596	1326.654
VVA.MV.12	270277.978	4361313.335	1932.919
VVA.MV.14	259321.83	4362521.322	1672.985
VVA.MV.15	260036.705	4341230.108	1448.416
VVA.MV.16	261250.282	4346845.995	1549.494
VVA.MV.18	262230.859	4350800.154	1561.104
VVA.MV.19	263874.341	4364265.688	1389.309
VVA.MV.20	265801.209	4372569.162	1386.607
VVA.MV.21	265983.351	4372995.75	1365.034
VVA.MV.22	265023.936	4375571.919	1338.797
VVA.MV.23	273103.663	4375508.195	1345.511
VVA.MV.24	280543.625	4381675.251	1304.599
VVA.MV.25	286709.35	4377289.998	1457.819
VVA.MV.27	249355.773	4396343.949	1578.84
VVA.MV.28	256604.726	4414894.456	1546.168
VVA.MV.30	257149.992	4413997.34	1546.964
VVA.MV.31	262784.504	4413127.863	1531.308
VVA.MV.37	282521.392	4353137.669	1322.79
VVA.MV.39	277274.264	4357491.917	1773.836
VVA.MV.40	276930.14	4360314.501	1835.441
VVA.MV.41	278801.133	4365338.805	1758.597
VVA.MV.42	257564.889	4400938.394	1676.647
VVA.MV.43	257515.177	4403556.876	1563.513
VVA.MV.45	261651.638	4410039.138	1627.872
VVA.MV.47	262558.096	4408354.54	1746.299

VVA.MV.01

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.01	260123.163	4331257.599	1478.283	1502.811

Point ID	LATITUDE	LONGITUDE
VVA.MV.01	39° 5' 50.93113"	-119° 46' 25.64616"

VVA.MV.03

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.03	253103.693	4333306.699	1770.003	1794.299

Point ID	LATITUDE	LONGITUDE
VVA.MV.03	39° 6' 50.27098"	-119° 51' 20.20068"

VVA.MV.04

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.04	261453.963	4333719.388	1415.468	1439.973

Point ID	LATITUDE	LONGITUDE
VVA.MV.04	39° 7' 12.01339"	-119° 45' 33.41952"

VVA.MV.05

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.05	265944.636	4332937.55	1393.773	1418.247

Point ID	LATITUDE	LONGITUDE
VVA.MV.05	39° 6' 51.06204"	-119° 42' 25.64748"

VVA.MV.06

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.06	254068.118	4322510.346	1435.584	1460.026

Point ID	LATITUDE	LONGITUDE
VVA.MV.06	39° 1' 1.44505"	-119° 50' 26.04984"

VVA.MV.08

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.08	250189.547	4318008.106	2141.840	2166.073

Point ID	LATITUDE	LONGITUDE
VVA.MV.08	38° 58' 31.61741"	-119° 53' 1.20804"

VVA.MV.10

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.10	264764.773	4340278.581	1387.635	1412.03

Point ID	LATITUDE	LONGITUDE
VVA.MV.10	39° 10' 47.79289"	-119° 43' 23.8926"

VVA.MV.11

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.11	278855.283	4350324.596	1302.319	1326.654

Point ID	LATITUDE	LONGITUDE
VVA.MV.11	39° 16' 26.6659"	-119° 33' 49.05324"

VVA.MV.12

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.12	270277.978	4361313.335	1908.865	1932.919

Point ID	LATITUDE	LONGITUDE
VVA.MV.12	39° 22' 14.7135"	-119° 40' 0.17688"

VVA.MV.14

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.14	259321.83	4362521.322	1648.987	1672.985

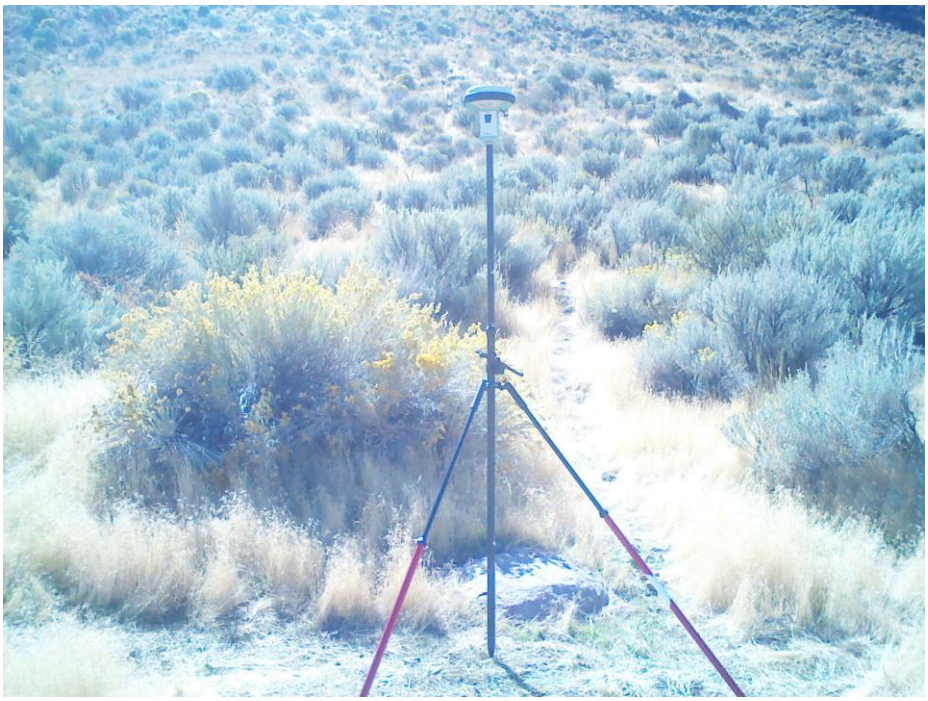
Point ID	LATITUDE	LONGITUDE
VVA.MV.14	39° 22' 43.11397"	-119° 47' 39.10164"

VVA.MV.15

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.15	260036.705	4341230.108	1424.068	1448.416

Point ID	LATITUDE	LONGITUDE
VVA.MV.15	39° 11' 13.97393"	-119° 46' 41.94444"

VVA.MV.16



Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.16	261250.282	4346845.995	1525.254	1549.494

Point ID	LATITUDE	LONGITUDE
VVA.MV.16	39° 14' 17.14168"	-119° 45' 58.55904"

VVA.MV.18

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.18	262230.859	4350800.154	1536.903	1561.104

Point ID	LATITUDE	LONGITUDE
VVA.MV.18	39° 16' 26.23285"	-119° 45' 22.7214"

VVA.MV.19

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.19	263874.341	4364265.688	1365.170	1389.309

Point ID	LATITUDE	LONGITUDE
VVA.MV.19	39° 23' 44.15838"	-119° 44' 31.24968"

VVA.MV.20

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.20	265801.209	4372569.162	1362.442	1386.607

Point ID	LATITUDE	LONGITUDE
VVA.MV.20	39° 28' 15.09596"	-119° 43' 21.25632"

VVA.MV.21

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.21	265983.351	4372995.75	1340.870	1365.034

Point ID	LATITUDE	LONGITUDE
VVA.MV.21	39° 28' 29.09644"	-119° 43' 14.18052"

VVA.MV.22

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.22	265023.936	4375571.919	1314.614	1338.797

Point ID	LATITUDE	LONGITUDE
VVA.MV.22	39° 29' 51.6264"	-119° 43' 57.56052"

VVA.MV.23

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.23	273103.663	4375508.195	1321.369	1345.511

Point ID	LATITUDE	LONGITUDE
VVA.MV.23	39° 29' 57.37294"	-119° 38' 19.55724"

VVA.MV.24

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.24	280543.625	4381675.251	1280.482	1304.599

Point ID	LATITUDE	LONGITUDE
VVA.MV.24	39° 33' 24.1722"	-119° 33' 15.68484"

VVA.MV.25

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.25	286709.35	4377289.998	1433.732	1457.819

Point ID	LATITUDE	LONGITUDE
VVA.MV.25	39° 31' 7.65466"	-119° 28' 52.49424"

VVA.MV.27

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.27	249355.773	4396343.949	1555.084	1578.84

Point ID	LATITUDE	LONGITUDE
VVA.MV.27	39° 40' 48.62111"	-119° 55' 21.01116"

VVA.MV.28

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.28	256604.726	4414894.456	1522.492	1546.168

Point ID	LATITUDE	LONGITUDE
VVA.MV.28	39° 50' 57.13933"	-119° 50' 41.81028"

VVA.MV.30

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.30	257149.992	4413997.34	1523.279	1546.964

Point ID	LATITUDE	LONGITUDE
VVA.MV.30	39° 50' 28.63799"	-119° 50' 17.69496"

VVA.MV.31

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.31	262784.504	4413127.863	1507.636	1531.308

Point ID	LATITUDE	LONGITUDE
VVA.MV.31	39° 50' 6.19937"	-119° 46' 19.75908"

VVA.MV.37

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.37	282521.392	4353137.669	1298.459	1322.79

Point ID	LATITUDE	LONGITUDE
VVA.MV.37	39° 18' 1.1709"	-119° 31' 19.4664"

VVA.MV.39

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.39	277274.264	4357491.917	1749.681	1773.836

Point ID	LATITUDE	LONGITUDE
VVA.MV.39	39° 20' 17.4737"	-119° 35' 3.51564"

VVA.MV.40

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.40	276930.14	4360314.501	1811.338	1835.441

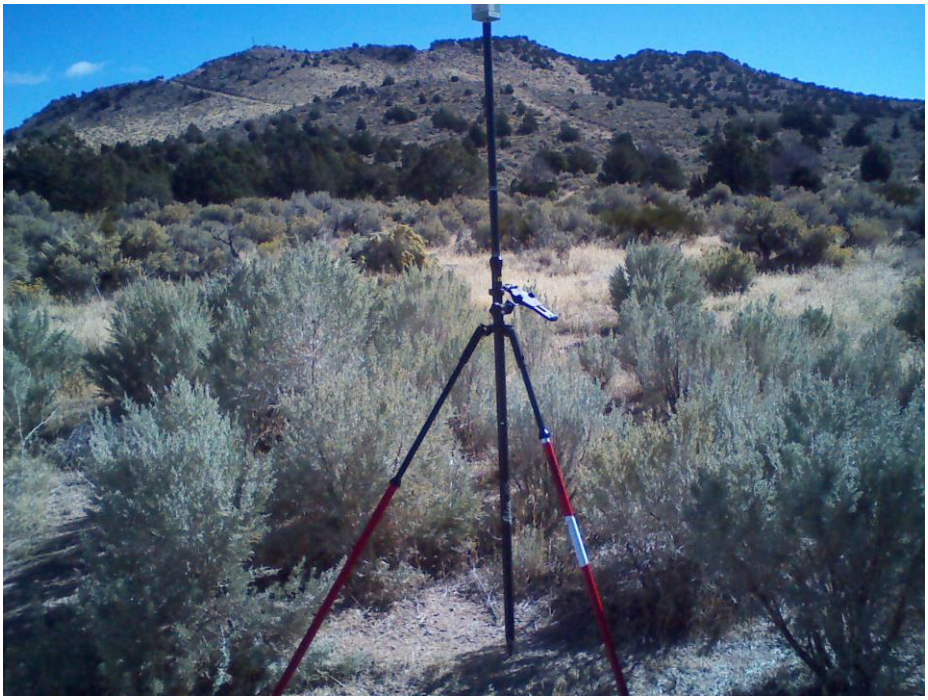
Point ID	LATITUDE	LONGITUDE
VVA.MV.40	39° 21' 48.62236"	-119° 35' 21.25392"

VVA.MV.41

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.41	278801.133	4365338.805	1734.507	1758.597

Point ID	LATITUDE	LONGITUDE
VVA.MV.41	39° 24' 33.17195"	-119° 34' 9.1182"

VVA.MV.42



Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.42	257564.889	4400938.394	1652.883	1676.647

Point ID	LATITUDE	LONGITUDE
VVA.MV.42	39° 43' 25.99608"	-119° 49' 42.9078"

VVA.MV.43

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.43	257515.177	4403556.876	1539.761	1563.513

Point ID	LATITUDE	LONGITUDE
VVA.MV.43	39° 44' 50.77655"	-119° 49' 48.46512"

VVA.MV.45

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.45	261651.638	4410039.138	1604.170	1627.872

Point ID	LATITUDE	LONGITUDE
VVA.MV.45	39° 48' 24.99001"	-119° 47' 3.32376"

VVA.MV.47

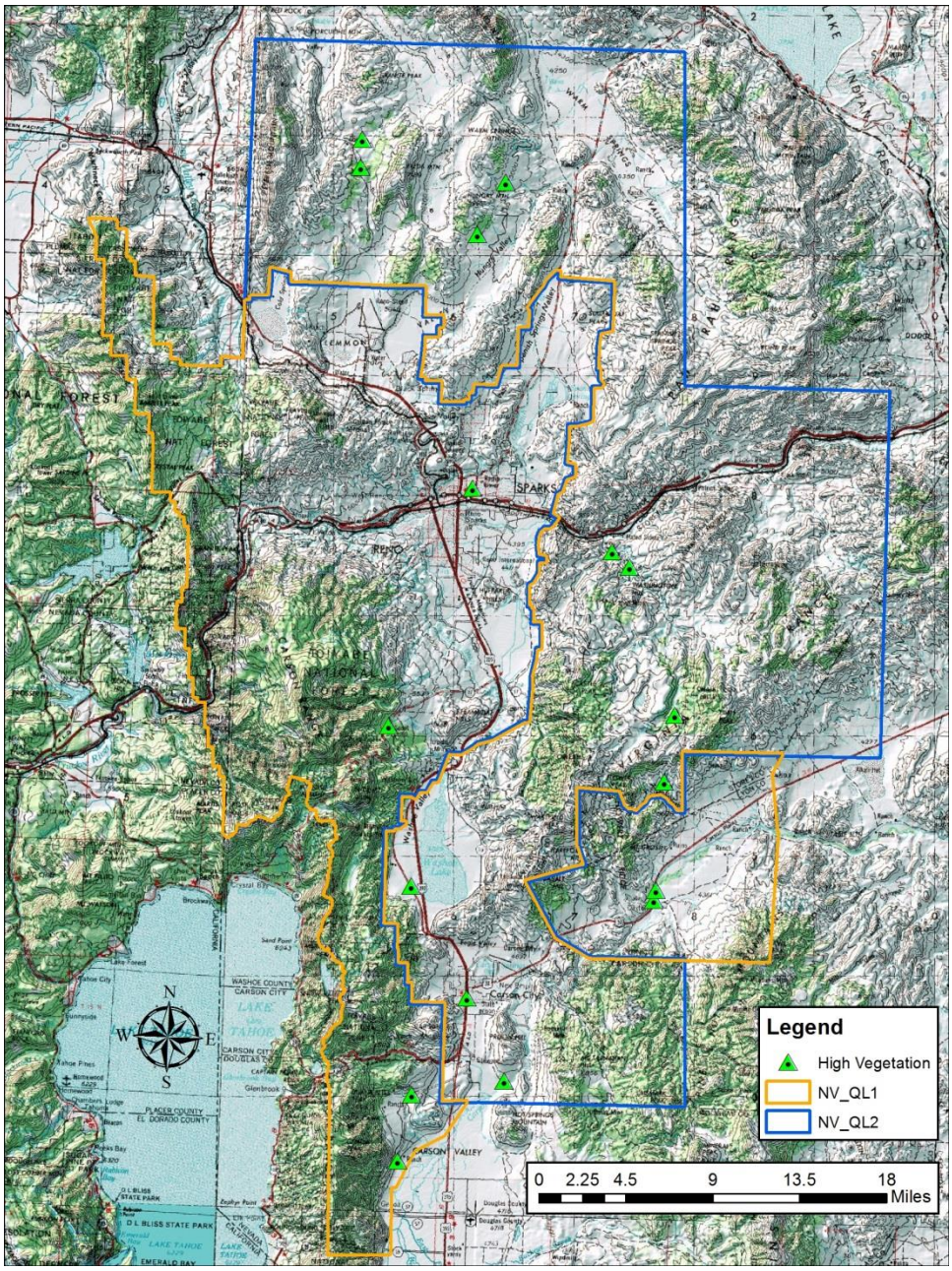
Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.MV.47	262558.096	4408354.54	1722.579	1746.299

Point ID	LATITUDE	LONGITUDE
VVA.MV.47	39° 47' 31.32445"	-119° 46' 23.05236"

Vegetated Vertical Accuracy Checkpoints

High Vegetation

The Map shows the overall distribution of the Vegetated Vertical Accuracy Checkpoints, High Vegetation throughout the AOI. The following tables contain a list of the control using Easting, Northing, and Orthometric height. The coordinate system displayed is UTM 11N, NAD83 (2011), NAVD88, Geoid 12B and using Meters for measurement.



Point ID	Easting X (Meters)	Northing Y (Meters)	Ortho (Meters)
VVA.HV.03	264053.116	4331467.387	1413.68
VVA.HV.04	256327.202	4330313.766	1571.086
VVA.HV.05	255144.678	4324824.1	1448.548
VVA.HV.06	276516.238	4346526.834	1327.67
VVA.HV.07	276669.651	4347338.265	1321.574
VVA.HV.08	254408.565	4361040.25	1850.649
VVA.HV.09	256290.205	4347719.943	1543.684
VVA.HV.11	260946.977	4338375.064	1424.562
VVA.HV.12	273066.04	4375519.736	1344.23
VVA.HV.13	274508.97	4374275.62	1370.766
VVA.HV.14	252236.994	4409888.614	1677.846
VVA.HV.17	252114.228	4407548.112	1766.893
VVA.HV.18	261410.453	4380811.423	1353.853
VVA.HV.19	277397.356	4356344.905	1645.479
VVA.HV.20	278279.178	4361935.702	1794.376
VVA.HV.27	264170.594	4406300.763	1542.25
VVA.HV.28	261825.682	4401955.08	1589.923

VVA.HV.03

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.HV.03	264053.116	4331467.387	1389.155	1413.68

Point ID	LATITUDE	LONGITUDE
VVA.HV.03	39° 6' 1.58803"	-119° 43' 42.48588"

VVA.HV.04

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.HV.04	256327.202	4330313.766	1546.629	1571.086

Point ID	LATITUDE	LONGITUDE
VVA.HV.04	39° 5' 16.56218"	-119° 49' 2.27028"

VVA.HV.05

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.HV.05	255144.678	4324824.1	1424.084	1448.548

Point ID	LATITUDE	LONGITUDE
VVA.HV.05	39° 2' 17.50049"	-119° 49' 44.32692"

VVA.HV.06

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.HV.06	276516.238	4346526.834	1303.333	1327.67

Point ID	LATITUDE	LONGITUDE
VVA.HV.06	39° 14' 21.43496"	-119° 35' 22.04448"

VVA.HV.07

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.HV.07	276669.651	4347338.265	1297.237	1321.574

Point ID	LATITUDE	LONGITUDE
VVA.HV.07	39° 14' 47.87268"	-119° 35' 16.6182"

VVA.HV.08

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.HV.08	254408.565	4361040.25	1826.842	1850.649

Point ID	LATITUDE	LONGITUDE
VVA.HV.08	39° 21' 50.14984"	-119° 51' 2.26188"

VVA.HV.09

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.HV.09	256290.205	4347719.943	1519.487	1543.684

Point ID	LATITUDE	LONGITUDE
VVA.HV.09	39° 14' 40.49477"	-119° 49' 26.35392"

VVA.HV.11

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.HV.11	260946.977	4338375.064	1400.142	1424.562

Point ID	LATITUDE	LONGITUDE
VVA.HV.11	39° 9' 42.3675"	-119° 46' 0.41592"

VVA.HV.12

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.HV.12	273066.04	4375519.736	1320.089	1344.23

Point ID	LATITUDE	LONGITUDE
VVA.HV.12	39° 29' 57.71119"	-119° 38' 21.14484"

VVA.HV.13

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.HV.13	274508.97	4374275.62	1346.633	1370.766

Point ID	LATITUDE	LONGITUDE
VVA.HV.13	39° 29' 18.7633"	-119° 37' 19.27704"

VVA.HV.14

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.HV.14	252236.994	4409888.614	1654.143	1677.846

Point ID	LATITUDE	LONGITUDE
VVA.HV.14	39° 48' 10.43024"	-119° 53' 38.5692"

VVA.HV.17

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.HV.17	252114.228	4407548.112	1743.195	1766.893

Point ID	LATITUDE	LONGITUDE
VVA.HV.17	39° 46' 54.48101"	-119° 53' 40.54416"

VVA.HV.18

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.HV.18	261410.453	4380811.423	1329.741	1353.853

Point ID	LATITUDE	LONGITUDE
VVA.HV.18	39° 32' 37.80377"	-119° 46' 35.44032"

VVA.HV.19

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.HV.19	277397.356	4356344.905	1621.288	1645.479

Point ID	LATITUDE	LONGITUDE
VVA.HV.19	39° 19' 40.41775"	-119° 34' 57.01044"

VVA.HV.20

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.HV.20	278279.178	4361935.702	1770.279	1794.376

Point ID	LATITUDE	LONGITUDE
VVA.HV.20	39° 22' 42.40906"	-119° 34' 26.8662"

VVA.HV.27

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.HV.27	264170.594	4406300.763	1518.476	1542.25

Point ID	LATITUDE	LONGITUDE
VVA.HV.27	39° 46' 26.39827"	-119° 45' 12.6756"

VVA.HV.28

Point ID	Easting **X** (m)	Northing **Y** (m)	Ellipsoid Height (m)	Orthometric Height (m)
VVA.HV.28	261825.682	4401955.08	1566.113	1589.923

Point ID	LATITUDE	LONGITUDE
VVA.HV.28	39° 44' 3.25583"	-119° 46' 45.46668"

APPENDIX C

Digital Data Submittal

(separate submittal)

APPENDIX D

Concept Design Sheets

Construction Cost Estimates

Life-Cycle Cost Estimates

DAYTON VALLEY
AREA DRAINAGE MASTER PLAN
DESIGN SUMMARY
AND LIFE CYCLE COST ANALYSIS

PREPARED FOR:

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JULY 2019
JN: 9416.000

Introduction

Lumos & Associates has completed the preliminary designs and grading of improvements for the washes and tributaries that impact the Dayton Valley on the north side of the Carson River. This analysis was performed as part of the Dayton Valley Area Drainage Master Plan (ADMP), being provided by JE Fuller to Lyon and Storey Counties. This summary presents an overview of the 15% preliminary designs and schematic grading, cost estimate, and life cycle cost analysis for both the 25-year and 100-year storm events based on hydrologic data provided by JE Fuller.

Conceptual Design

Improvements were designed in accordance with the most recent revision of the Drainage Guidelines for Lyon County. Preliminary designs include grading for the detention basins based on two alternatives sized for storms with a 25-year and 100-year recurrence interval. The proposed detention basins were analyzed using the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS), version 4.2.1. Modeling accounted for the 25- and 100-year storm events. Inflow hydrographs were obtained from JE Fuller's modeling effort, and input directly into the HEC-HMS application as discharge gage time-series data. Basin volumes and outlet structure configurations were then assigned based on site constraints. Outlet configurations were sized to reduce the existing runoff flow rates to the greatest extent possible given basin size constraints. Basin size was restricted by existing property and right-of-way boundaries and by existing terrain features and topography. The shape of each basin was designed to conform to the terrain to limit the change in elevation from one side of the basin to the other and to optimize the excavation quantities.

Collection channels were sized using flowrate data provided by JE Fuller with the purpose of conveying stormwater to the corresponding detention basin. Outlet and conveyance channels were sized based on the outlet capacity of the corresponding detention basin or based on the downstream capacity of governing structures such as existing culverts. Bentley FlowMaster® V8i was used for all channel-sizing calculations. For all tables and attachments within this report, channels and basins that are hydraulically dependent are grouped into systems. Attachment B includes the model output, geometry schematic, and summary table.

Based upon the conceptual designs, slightly more than 1 million cubic yards of material for the 25-year and 1.1 million cubic yards for the 100-year basin storage alternative will be generated during construction of the improvements. This material can provide salvage value, but this value has not been quantified for the preliminary cost estimate. Earthwork and storage volumes used in the cost estimate for each system are provided in Table 1:

Table 1: System Earthwork and Storage Volumes

System Name	25-year Storage			100-year Storage		
	Cut (Cu Yd)	Fill (Cu Yd)	Vol (ac-ft)	Cut (Cu Yd)	Fill (Cu Yd)	Vol (ac-ft)
Six Mile Canyon Channel	-	-	-	56,052	145,752	-
Six Mile Canyon Basin	165,004	82,519	156	-	-	-
Prospector Basin and SD	9,964	2,111	2.1	12,232	1,816	3.7
Sutro Springs System	77,575	10,313	28	216,643	4,133	45
Lonnie Basin	112,538	858	69	176,282	572	84
Mark Twain West Basin, Northeast Collection, and North Conveyance	211,679	8,353	28	245,702	8,235	43
Mark Twain South Basin and South Conveyance	54,948	33,456	30	67,847	32,109	40
Mark Twain North Basin and Outlet Channel	126,480	16,277	31	156,467	15,830	50
Gold Pan System	143,688	4,458	59	243,753	4,004	88
Rainbow System	83,038	16,968	41	114,546	16,297	61
Ft Churchill Channel	73,230	9,508	-	62,121	1,513	-
Gold Canyon Spillway	7,037	0	-	7,037	0	-
Siphons #1 - 7	10,332	6,833	-	10,332	6,833	-
Net Cut	**847,000**			**853,000**		
Total Material Moved	**1,041,500**			**1,090,000**		

Other considerations for the preliminary designs were erosion protection, spillways, outlet configurations, and fencing. In addition, pavement patching, storm drain manholes, and headwalls were considered for the proposed culverts and storm drain sections. Vehicle access and turnaround was not considered in the preliminary design, but an assumed cost for basin access was added to the cost estimates. Erosion protection costs were estimated based on area comparisons with projects of similar flow depth and velocities as the Dayton Valley ADMP; however, riprap sizes have not been determined due to the conceptual nature of the designs. Preliminary designs for siphons have been designed at critical location within the Cardelli irrigation ditch to allow stormwater to pass over the ditch and flow toward the Carson River. Siphons were designed using data from the US District Court Water Master's office. Due to large fluctuations in the discharge of the irrigation ditch, both seasonally and daily, pipe sizes provided within the 15% plans are preliminary, and additional analysis will be needed prior to final design. Design details for each facility can be found in the 15% plan set.

Preliminary Cost Estimates

Preliminary cost estimates were prepared for the drainage improvements determined necessary for the 25- and 100-year design alternatives. The 100-year storage alternative requires larger basins and channels resulting in a higher cost than the 25-year storage alternative. In addition to initial construction costs, non-construction costs were also considered which include additional environmental and agency permitting, design, and construction services. The total estimated cost for the 25-year storage alternative is approximately $31,000,000 compared to the 100-year storage alternative at a cost of roughly $37,500,000. These costs include land acquisition costs that would be required since many of the proposed alternatives are located on private property.

The estimated cost of the Six Mile Canyon channel and the Cardelli siphons were determined separately and is not included in the aforementioned totals. A detention basin was not feasible when considering the high runoff flowrates estimated for the 100-year scenario; therefore, a channel was proposed to convey the 100-year design storm to the Carson River. The channel at Six Mile Canyon is estimated to cost approximately $17,400,000, primarily due to the erosion protection measures required based on high channel velocities and the slope of the existing topography. Other forms of channel lining, such as concrete, should be considered. The proposed siphons are designed independent of design storms and are estimated to cost approximately $1,310,000 for all seven. Due to the interdependency of proposed facilities within each system, it is recommended that each system be constructed in its entirety so the system functions as intended; however, the entire project could be phased over a longer period to reduce the financial impact. The majority of the design alternatives are proposed to be constructed on private land. A detailed cost estimate for each system alternative can be found in Attachment A.

Land Acquisition

The majority of improvements designed as part of the Dayton Valley ADMP are located on private land parcels. Some improvements may require drainage or access easements, while other improvements are too large and will require the purchase of land. Costs associated with land acquisition will be a significant part of the estimated total, and may make particular design alternatives or systems infeasible. Costs for each category are estimations based on observations of current market conditions. Parcels for which design improvements are proposed have been categorized as either "developed" or "undeveloped". Parcels that contain existing structures, or parcels within a planned community with existing access and infrastructure, are classified as "developed". "Undeveloped" parcels have no existing or apparent structures, have no existing access, and require significant improvements to develop. The estimated cost per square foot of undeveloped land is $0.28, while the estimated cost per square foot of developed land is estimated to be $1.84. Lumos & Associates is not a realtor and is not certified to determine land values. These costs are general estimates used solely for a cost analysis to determine feasibility. Improvements on public land owned by the Counties or by the States have not been considered in this estimate. Estimated areas of land to be acquired are provided in Table 2.

Table 2: Estimated Land Acquisition Areas

System Name	25-Year Alternative Undeveloped Land Area (Ac)	100-Year Alternative Undeveloped Land Area (Ac)	25-Year Alternative Developed Land Area (Ac)	100-Year Alternative Developed Land Area (Ac)
Six Mile Canyon Channel	45.4		0	0
Six Mile Canyon Basin	25.1		0	0
Prospector Basin and SD	0	0	1.9	1.9
Sutro Springs System	7.0	9.7	0	0
Lonnie Basin	0	0	0	0
Mark Twain West Basin, Northeast Collection, and North Conveyance	17.1	18.7	0	0
Mark Twain South Basin and South Conveyance	6.9	6.9	0	0
Mark Twain North Basin and Outlet Channel	11.5	11.7	0	0
Gold Pan System	10.3	13.2	0	0
Rainbow System	10.3	10.3	4	4.1
Ft Churchill Channel	10.3	10.3	0	0
Gold Canyon Spillway	0.1		0	
Siphon 1	0		0	
Siphon 2	0		0.6	
Siphon 3	0		0.3	
Siphons 4 - 7	0		0	

Note: All areas include a 10% contingency.

Annual O&M Costs

It is estimated that basins and channels will require debris removal, repairs to the lining and slopes, and revegetation after the work is complete. Maintenance costs were annualized from the future value using a discount rate in the Circular A94 Appendix C from the Office of Management and Budget for an assumed maintenance schedule of once every 10 years for a period of 20 years. The cost for the maintenance of culverts and siphons is considered part of routine county maintenance and is therefore not determined. Table 3 shows the estimated yearly maintenance cost.

Table 3: Estimated Annualized O&M Cost for Each System Alternative

Regional Alternative System	Annual Maint. Cost (25-Year)	Annual Maint. Cost (100-Year)
Six Mile Canyon Channel	-	$ 18,900
Six Mile Canyon Basin	$ 24,800	-
Prospector Basin and SD	$ 2,400	$ 2,900
Sutro Springs System	$ 8,200	$ 12,200
Lonnie	$ 11,300	$ 12,800
Mark Twain System	$ 41,700	$ 44,200
Gold Pan System	$ 11,500	$ 14,700
Rainbow System	$ 12,400	$ 13,100
Ft Churchill Channel	$ 15,300	$ 15,300
Gold Canyon Spillway	$ 2,300	$ 2,300
Total	**$ 129,900**	**$ 136,400**

[1] Equipment Costs based on 2017 FEMA Schedule of Equipment Rates

[2] Maintenance costs includes riprap repairs, debris removal and disposal, and revegetation.

[3] Costs include labor based on 2019 labor rates for equipment operators from the US Bureau of Labor and Statistics.

Lifecycle Cost Analysis

A life cycle present worth analysis was prepared for a 20-year period considering the estimated total project costs and the annual O&M costs. Salvaged and valuable materials like soils excavated during construction and during routine maintenance were not considered in the analysis. The life cycle cost analysis and net present value (NPV) for each alternative are presented in Table 4.

Table 4: Life Cycle Cost Analysis

Alternative	Present Value				20-Yr NPV[3] (25-Year)	20-Yr NPV[3] (100-Year)
	Total Project Cost[1] (25-Year)	Total Project Cost[1] (100-Year)	O&M[2] (for 20 Yrs) (25-Year)	O&M[2] (for 20 Yrs) (100-Year)		
Six Mile Canyon Channel	-	$ 17,435,888	-	$ 327,700	$ -	$ 17,763,588
Six Mile Canyon Basin	$ 3,795,140	-	$ 430,000	-	$ 4,225,140	$ -
Prospector Basin and SD	$ 2,299,200	$ 2,588,900	$ 41,600	$ 50,300	$ 2,340,800	$ 2,639,200
Sutro Springs System	$ 1,737,000	$ 4,053,400	$ 142,200	$ 211,500	$ 1,879,200	$ 4,264,900
Lonnie	$ 1,982,400	$ 3,006,000	$ 195,900	$ 221,900	$ 2,178,300	$ 3,227,900
Mark Twain System	$ 8,899,600	$ 10,507,800	$ 723,000	$ 766,400	$ 9,622,600	$ 11,274,200
Gold Pan System	$ 5,583,600	$ 7,331,000	$ 199,400	$ 254,900	$ 5,783,000	$ 7,585,900
Rainbow System	$ 5,658,800	$ 6,387,800	$ 215,000	$ 235,800	$ 5,873,800	$ 6,623,600
Ft Churchill Channel	$ 1,850,400	$ 2,526,000	$ 265,300	$ 265,300	$ 2,115,700	$ 2,791,300
Gold Canyon Spillway	$ 960,200	$ 960,200	$ 39,900	$ 39,900	$ 1,000,100	$ 1,000,100
Siphons and Culverts	$ 1,840,000	$ 2,330,800	-	-	$ 1,840,000	$ 2,330,800

[1] Total project cost includes construction and non-construction costs.

[2] Considers 20-year real discount rate of 1.5 percent per Circular A94 Appendix C from the Office of Management and Budget, revised November 2018 (https://www.whitehouse.gov/omb/circulars_a094/a94_appx-c).

[3] Total 20-YR NPV = Total Project Cost + O&M (uniform series present worth) – Salvage (single payment present worth).

All improvements shown within the 15% plan set are preliminary, but the volumes and quantities obtained from the designs provide an approximate estimate for the expected costs of the project.

Design Assumptions

The following are assumption made during the design of the conceptual basin, channel, and storm drain alternatives:

- Downstream culvert capacities at HWY 50 were a limiting factor for the size of downstream conveyance channels for systems where NDOT culverts are not specified to be replaced.
- Basin interior slopes were designed to be a maximum of 4H:1V. Exterior slopes where erosion will not affect stability are designed to be 3H:1V.
- Basins were limited to a maximum depth of twelve feet.
- An orifice condition is assumed for outlet structures with submerged outlet pipes. All spillways are assumed to be broad-crested weirs.
- Public right-of-ways were considered "hard boundaries" and were not to be encroached upon by channels or basins.
- All attempts were made to limit the number of properties encroached upon by design alternatives.
- The change in elevation of the existing topography within each basin area was limited to a maximum of 25'.
- Channels were designed in accordance with the sizing criteria provided in the *Truckee Meadows Regional Drainage Manual*.
- Channel depths and widths were sized to whole foot increments.
- Channel side slopes are designed to be a maximum of 3H:1V.
- The channel reach with the least slope governs the size of the entire channel. The size of reaches was not varied for the conceptual designs.
- All channels were designed with a minimum freeboard of 1'. Super elevation of the water surface was not considered for the conceptual designs.
- Velocities in riprap channels were limited to 15 fps. Sections above 15 fps are intended to be concrete lined.
- "Large diameter riprap" is assumed to have a D_{50} of 18 to 22 inches. "Standard diameter riprap" is assumed to have a D_{50} less than 12 inches.
- Riprap mats thicknesses shall be a minimum of twice the average riprap diameter.
- Stormdrain pipelines were sized so the hydraulic grade line is no greater than the crown of the proposed pipeline.
- The pipeline reach with the least slope governs the size of the entire pipeline.
- Velocities indicated on the plans are the velocities at normal depth for the design flowrate.
- Channel dimensions and grading will vary with the channel lining and method of erosion control selected during final design.

Attachments

A: Itemized Preliminary Cost Estimate

B: Hydraulic Calculation

C: 15% Preliminary Design Plan Set

References

1. U.S. Department of Agriculture, Soil Conservation Service, Engineering Division, *Urban Hydrology for Small Watersheds*, Technical Release 55, Second Edition June 1986
2. Drainage Guidelines for Lyon County, Rev. September 20, 2018
3. Circular A94 Appendix C from the Office of Management and Budget, revised November 2018.
4. 2017 FEMA Schedule of Equipment Rates.

Attachment A: Itemized Preliminary Cost Estimate

DAYTON VALLEY ADMP
Engineer's Opinion of Probable Cost - 7/26/19

GENERAL NOTE:
This preliminary estimate of probable construction cost is the Engineer's best judgement as a professional engineer generally familiar with this type of construction. However, since the Engineer has no control over market conditions, the Engineer does not guarantee that proposals, bids, or actual construction cost will not vary from this estimate.

DAYTON VALLEY ADMP
SIX MILE CANYON BASIN
25 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 30,000	$ 30,000
2	Clearing and Grubbing	LS	1	$ 20,000	$ 20,000
3	Cut/Fill Onsite	CY	82,519	$ 5.00	$ 412,595
4	Cut Offhaul	CY	82,484	$ 10.00	$ 824,840
5	60" RCP Outlet Piping	LF	1,215	$ 300.00	$ 364,500
6	Riprap	SF	44,373	$ 3.00	$ 133,100
7	Wire Fence	LF	3,790	$ 10.00	$ 37,900
8	9" Concrete Access on 6" Agg Base	LS	1	$ 5,000.00	$ 5,000
9	Concrete Spillway	SF	24,386	$ 10.00	$ 243,860
10	Native Vegetation Finish and Erosion Control	AC	21.9	$ 7,500	$ 164,100
11	Contingency, 30%	LS	1	$ 670,800	$ 670,800
		Subtotal Construction Costs			$ 2,907,000
Non-Construction Costs					
12	Land Acquisition	SF	1,095,500	$ 0.28	$ 306,740
13	Permitting, Engineering, Construction Management, Administration, Testing, and Inspection, 20%				$ 581,400
		Subtotal Non-Construction Costs			$ 888,140
Total Project Costs					$ 3,795,140

DAYTON VALLEY ADMP
SIX MILE CANYON CHANNEL
100 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 30,000	$ 30,000
2	Clearing and Grubbing	LS	1	$ 20,000	$ 20,000
3	Cut/Fill Onsite	CY	56,052	$ 5.00	$ 280,260
4	Fill Import and Riprap Bedding	CY	89,700	$ 10.00	$ 897,000
5	Large Diameter Riprap	SF	1,378,833	$ 5.00	$ 6,894,200
6	Non-Woven Geotextile	SF	1,378,833	$ 0.60	$ 827,300
7	Gabion Drop Structures	EA	13	$ 45,000	$ 585,000
8	144"x72" Box Culvert + Headwalls	LF	680	$ 1,000	$ 680,000
9	Hwy Patching	SF	18,600	$ 9.00	$ 167,400
10	Concrete Section	SF	44,000	$ 10	$ 440,000
11	Contingency, 30%	LS	1	$ 3,246,300	$ 3,246,300
		Subtotal Construction Costs			$ 14,068,000
Non-Construction Costs					
12	Land Acquisition	SF	1,979,600	$ 0.28	$ 554,288
13	Permitting, Engineering, Construction Management, Administration,				$ 2,813,600
		Subtotal Non-Construction Costs			$ 3,367,888
Total Project Costs					$ 17,435,888

Note 1: Standard diameter riprap assumed to be D50 < 12"
Large diameter riprap assumed to be 18" < D50 < 22"

DAYTON VALLEY ADMP
PROSPECTOR BASIN AND STORM DRAIN
ALTERNATIVE NO. 1 - 25 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 30,000	$ 30,000
2	Clearing and Grubbing	LS	1	$ 10,000	$ 10,000
3	Cut/Fill Onsite	CY	2,111	$ 5.00	$ 10,555
4	Cut Offhaul	CY	7,853	$ 10.00	$ 78,530
5	Riprap	SF	1,450	$ 3.00	$ 4,400
6	Non-Woven Geotextile	SF	1,450	$ 0.60	$ 900
7	Concrete Spillway	SF	1,587	$ 10.00	$ 15,900
8	Wire Fence	LF	1,035	$ 10.00	$ 10,400
9	36" HDPE Outlet Piping	LF	110	$ 200	$ 22,000
10	9" Concrete Access on 6" Agg Base	LS	1	$ 5,000.00	$ 5,000
11	36" HDPE Storm Drain	LF	4,262	$ 200.00	$ 852,400
12	4" AC Patching	SF	21,310	$ 4.50	$ 95,895
13	48" SDMH	EA	1	$ 7,000.00	$ 7,000
14	60" SDMH	EA	14	$ 8,000.00	$ 112,000
15	Native Vegetation Finish and Erosion Control	AC	1.5	$ 7,500	$ 10,875
16	Contingency, 30%	LS	1	$ 379,800	$ 379,800
		Subtotal Construction Costs			$ 1,646,000
Non-Construction Costs					
17	Land Acquisition	SF	176,100	$ 1.84	$ 324,000
18	Permitting, Engineering, Construction Management, Administration, Testing, and Inspection, 20%				$ 329,200
		Subtotal Non-Construction Costs			$ 653,200
Total Project Costs					$ 2,299,200

DAYTON VALLEY ADMP
PROSPECTOR BASIN AND STORM DRAIN
ALTERNATIVE NO. 2 - 100 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 30,000	$ 30,000
2	Clearing and Grubbing	LS	1	$ 10,000	$ 10,000
3	Cut/Fill Onsite	CY	1,816	$ 5.00	$ 9,080
4	Cut Offhaul	CY	10,416	$ 10.00	$ 104,160
5	Riprap	SF	1,450	$ 3.00	$ 4,400
6	Non-Woven Geotextile	SF	1,450	$ 0.60	$ 900
7	Concrete Spillway	SF	1,587	$ 10.00	$ 15,900
8	Wire Fence	LF	1,035	$ 10.00	$ 10,400
9	24" HDPE Outlet Piping	LF	250	$ 150	$ 37,500
10	9" Concrete Access on 6" Agg Base	LS	1	$ 5,000.00	$ 5,000
11	42" HDPE Storm Drain	LF	4,262	$ 225.00	$ 958,950
12	4" AC Patching	SF	21,310	$ 4.50	$ 95,895
13	48" SDMH	EA	2	$ 7,000.00	$ 14,000
14	72" SDMH	EA	14	$ 10,000.00	$ 140,000
15	Native Vegetation Finish and Erosion Control	AC	1.5	$ 7,500	$ 10,875
16	Contingency, 30%	LS	1	$ 434,100	$ 434,100
		Subtotal Construction Costs			$ 1,882,000
Non-Construction Costs					
17	Land Acquisition	SF	179,600	$ 1.84	$ 330,500
18	Permitting, Engineering, Construction Management, Administration, Testing, and Inspection, 20%				$ 376,400
		Subtotal Non-Construction Costs			$ 706,900
Total Project Costs					$ 2,588,900

DAYTON VALLEY ADMP
SUTRO SPRINGS SYSTEM
ALTERNATIVE NO. 1 - 25 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 30,000	$ 30,000
2	Clearing and Grubbing	LS	1	$ 15,000	$ 15,000
3	Cut/Fill Onsite	CY	10,313	$ 5.00	$ 51,565
4	Cut Offhaul	CY	67,262	$ 10.00	$ 672,600
5	Wire Fence	LF	1,910	$ 10.00	$ 19,100
6	Concrete Spillway	SF	1,382	$ 10.00	$ 13,800
7	Riprap	SF	45,702	$ 3.00	$ 137,100
8	Geotextile	SF	45,702	$ 0.60	$ 27,400
9	24" RCP Outlet Piping	LF	300	$ 120	$ 36,000
10	4" AC Patching	SF	300	$ 4.50	$ 1,350
11	9" Concrete Access on 6" Agg Base	LS	1	$ 5,000.00	$ 5,000
12	Native Vegetation Finish and Erosion Control	AC	6.6	$ 7,500	$ 49,500
13	Contingency, 30%	LS	1	$ 317,500	$ 317,500
		Subtotal Construction Costs			$ 1,376,000
Non-Construction Costs					
14	Land Acquisition	SF	306,400	$ 0.28	$ 85,800
15	Permitting, Engineering, Construction Management, Administration, Testing, and Inspection				$ 275,200
		Subtotal Non-Construction Costs			$ 361,000
Total Project Costs					$ 1,737,000

DAYTON VALLEY ADMP
SUTRO SPRINGS SYSTEM
ALTERNATIVE NO. 2 - 100 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 30,000	$ 30,000
2	Clearing and Grubbing	LS	1	$ 15,000	$ 15,000
3	Cut/Fill Onsite	CY	4,133	$ 5.00	$ 20,665
4	Cut Offhaul	CY	212,510	$ 10.00	$ 2,125,100
5	Wire Fence	LF	2,325	$ 10.00	$ 23,300
6	Concrete Spillway	SF	1,382	$ 10.00	$ 13,800
7	Riprap	SF	49,702	$ 3.00	$ 149,100
8	Geotextile	SF	49,702	$ 0.60	$ 29,800
9	24" RCP Outlet Piping	LF	300	$ 120	$ 36,000
10	4" AC Patching	SF	300	$ 4.50	$ 1,350
11	9" Concrete Access on 6" Agg Base	LS	1	$ 5,000.00	$ 5,000
12	Native Vegetation Finish and Erosion Control	AC	9.7	$ 7,500	$ 72,750
13	Contingency, 30%	LS	1	$ 756,600	$ 756,600
		Subtotal Construction Costs			$ 3,279,000
Non-Construction Costs					
14	Land Acquisition	SF	423,500	$ 0.28	$ 118,600
15	Permitting, Engineering, Construction Management, Administration,				$ 655,800
		Subtotal Non-Construction Costs			$ 774,400
Total Project Costs					$ 4,053,400

DAYTON VALLEY ADMP
WAGON WHEEL CULVERT
ALTERNATIVE NO. 1 - 25 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 10,000	$ 10,000
2	30" RCP Outlet Piping	LF	70	$ 180	$ 12,600
3	4" AC Patching	SF	350	$ 4.50	$ 1,575
4	Inlet/Outlet Protection	LS	1	$ 2,500.00	$ 2,500
5	Headwalls	LS	1	$ 4,000.00	$ 4,000
6	Contingency, 30%	LS	1	$ 8,000	$ 8,000
			Subtotal Construction Costs		$ 39,000
Non-Construction Costs					
7	Permitting, Engineering, Construction Management, Administration, Testing, and Inspection, 20%				$ 7,800
			Subtotal Non-Construction Costs		$ 7,800
Total Project Costs					$ 46,800

DAYTON VALLEY ADMP
WAGON WHEEL CULVERT
ALTERNATIVE NO. 2 - 100 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 10,000	$ 10,000
2	36" RCP Outlet Piping	LF	70	$ 200	$ 14,000
3	4" AC Patching	SF	350	$ 4.50	$ 1,575
4	Inlet/Outlet Protection	LS	1	$ 2,500.00	$ 2,500
5	Headwalls	LS	1	$ 4,000.00	$ 4,000
6	Contingency, 30%	LS	1	$ 8,400	$ 8,400
			Subtotal Construction Costs		$ 41,000
Non-Construction Costs					
7	Permitting, Engineering, Construction Management, Administration,				$ 8,200
			Subtotal Non-Construction Costs		$ 8,200
Total Project Costs					$ 49,200

DAYTON VALLEY ADMP
LONNIE BASIN
ALTERNATIVE NO. 1 - 25 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 30,000	$ 30,000
2	Clearing and Grubbing	LS	1	$ 10,000	$ 10,000
3	Cut Offhaul	CY	111,680	$ 10.00	$ 1,116,800
4	Abandon Ex Pipes	LS	1	$ 2,500.00	$ 2,500
5	Riprap	SF	728	$ 3.00	$ 2,200
6	Wire Fence	LF	2,690	$ 10.00	$ 26,900
7	9" Concrete Access on 6" Agg Base	LS	1	$ 5,000.00	$ 5,000
8	Native Vegetation Finish and Erosion Control	AC	10.3	$ 7,500	$ 77,250
9	Contingency, 30%	LS	1	$ 381,200	$ 381,200
			Subtotal Construction Costs		$ 1,652,000
Non-Construction Costs					
10	Permitting, Engineering, Construction Management, Administration, Testing, and Inspection, 20%				$ 330,400
			Subtotal Non-Construction Costs		$ 330,400
Total Project Costs					$ 1,982,400

DAYTON VALLEY ADMP
LONNIE BASIN
ALTERNATIVE NO. 2 - 100 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 30,000	$ 30,000
2	Clearing and Grubbing	LS	1	$ 10,000	$ 10,000
3	Cut Offhaul	CY	175,710	$ 10.00	$ 1,757,100
4	Abandon Ex Pipes	LS	1	$ 2,500.00	$ 2,500
5	Riprap	SF	1,192	$ 3.00	$ 3,600
6	Wire Fence	LF	2,963	$ 10.00	$ 29,600
7	9" Concrete Access on 6" Agg Base	LS	1	$ 5,000.00	$ 5,000
8	Native Vegetation Finish and Erosion Control	AC	11.8	$ 7,500	$ 88,500
9	Contingency, 30%	LS	1	$ 577,900	$ 577,900
			Subtotal Construction Costs		$ 2,505,000
Non-Construction Costs					
10	Permitting, Engineering, Construction Management, Administration, Testing, and Inspection, 20%				$ 501,000
			Subtotal Non-Construction Costs		$ 501,000
Total Project Costs					$ 3,006,000

DAYTON VALLEY ADMP
MARK TWAIN WEST BASIN, NORTHEAST COLLECTION, AND NORTH CONVEYANCE CHANNELS
ALTERNATIVE NO. 1 - 25 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 30,000	$ 30,000
2	Clearing and Grubbing	LS	1	$ 20,000	$ 20,000
3	Cut/Fill Onsite	CY	8,353	$ 5.00	$ 41,765
4	Cut Offhaul	CY	203,326	$ 10.00	$ 2,033,260
5	Standard Diameter Riprap	SF	76,650	$ 3.00	$ 230,000
6	Non-Woven Geotextile	SF	151,733	$ 0.60	$ 91,000
7	Large Diameter Riprap	SF	75,083	$ 6.00	$ 450,500
8	Concrete Spillway	SF	4,257	$ 10.00	$ 42,600
9	Wire Fence	LF	2,628	$ 10.00	$ 26,300
10	24" Outlet Piping	LF	225	$ 120	$ 27,000
11	9" Concrete Access on 6" Agg Base	LS	1	$ 5,000.00	$ 5,000
12	Native Vegetation Finish and Erosion Control	AC	12.1	$ 7,500	$ 90,750
13	Contingency, 30%	LS	1	$ 926,500	$ 926,500
		Subtotal Construction Costs			$ 4,015,000
Non-Construction Costs					
14	Land Acquisition	SF	745,300	$ 0.28	$ 208,700
15	Permitting, Engineering, Construction Management, Administration, Testing, and Inspection, 20%				$ 803,000
		Subtotal Non-Construction Costs			$ 1,011,700
Total Project Costs					$ 5,026,700

DAYTON VALLEY ADMP
MARK TWAIN WEST BASIN, NORTHEAST COLLECTION, AND NORTH CONVEYANCE CHANNELS
ALTERNATIVE NO. 2 - 100 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 30,000	$ 30,000
2	Clearing and Grubbing	LS	1	$ 20,000	$ 20,000
3	Cut/Fill Onsite	CY	8,235	$ 5.00	$ 41,175
4	Cut Offhaul	CY	237,467	$ 10.00	$ 2,374,670
5	Standard Diameter Riprap	SF	86,818	$ 3.00	$ 260,500
6	Non-Woven Geotextile	SF	168,348	$ 0.60	$ 101,000
7	Large Diameter Riprap	SF	81,530	$ 6.00	$ 489,200
8	Concrete Spillway	SF	4,368	$ 10.00	$ 43,700
9	Wire Fence	LF	2,582	$ 10.00	$ 25,800
10	24" Outlet Piping	LF	225	$ 120	$ 27,000
11	9" Concrete Access on 6" Agg Base	LS	1	$ 5,000.00	$ 5,000
12	Native Vegetation Finish and Erosion Control	AC	13.1	$ 7,500	$ 98,250
13	Contingency, 30%	LS	1	$ 1,054,900	$ 1,054,900
		Subtotal Construction Costs			$ 4,572,000
Non-Construction Costs					
14	Land Acquisition	SF	812,500	$ 0.28	$ 227,500
15	Permitting, Engineering, Construction Management, Administration,				$ 914,400
		Subtotal Non-Construction Costs			$ 1,141,900
Total Project Costs					$ 5,713,900

Note 1: Standard diameter riprap assumed to be D50 < 12"
Large diameter riprap assumed to be 18" < D50 < 22"

DAYTON VALLEY ADMP
MARK TWAIN SOUTH BASIN AND SOUTH CONVEYANCE CHANNEL
ALTERNATIVE NO. 1 - 25 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 30,000	$ 30,000
2	Clearing and Grubbing	LS	1	$ 20,000	$ 20,000
3	Cut/Fill Onsite	CY	33,456	$ 5.00	$ 167,280
4	Cut Offhaul	CY	21,492	$ 10.00	$ 214,920
5	Standard Diameter Riprap	SF	45,139	$ 3.00	$ 135,400
6	Non-Woven Geotextile	SF	45,139	$ 0.60	$ 27,100
7	Concrete Spillway	SF	2,366	$ 10.00	$ 23,700
8	Wire Fence	LF	2,207	$ 10.00	$ 22,100
9	24" Outlet Piping	LF	380	$ 120	$ 45,600
10	9" Concrete Access on 6" Agg Base	LS	1	$ 5,000.00	$ 5,000
11	2 Barrel 48" Culverts	LF	80	$ 250.00	$ 20,000
12	3 Barrel 36" Culverts	LF	276	$ 200.00	$ 55,200
13	4" AC Patching	SF	2,900	$ 4.50	$ 13,050
14	Native Vegetation Finish and Erosion Control	AC	15.0	$ 7,500	$ 112,500
15	Contingency, 30%	LS	1	$ 267,600	$ 267,600
		Subtotal Construction Costs			$ 1,160,000
Non-Construction Costs					
16	Land Acquisition	SF	299,100	$ 0.28	$ 83,700
17	Permitting, Engineering, Construction Management, Administration,				$ 232,000
		Subtotal Non-Construction Costs			$ 315,700
Total Project Costs					$ 1,475,700

DAYTON VALLEY ADMP
MARK TWAIN SOUTH BASIN AND SOUTH CONVEYANCE CHANNEL
ALTERNATIVE NO. 2 - 100 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 30,000	$ 30,000
2	Clearing and Grubbing	LS	1	$ 20,000	$ 20,000
3	Cut/Fill Onsite	CY	32,109	$ 5.00	$ 160,545
4	Cut Offhaul	CY	35,738	$ 10.00	$ 357,380
5	Standard Diameter Riprap	SF	68,353	$ 3.00	$ 205,100
6	Non-Woven Geotextile	SF	68,353	$ 0.60	$ 41,000
7	Concrete Spillway	SF	2,463	$ 10.00	$ 24,600
8	Wire Fence	LF	2,114	$ 10.00	$ 21,100
9	24" Outlet Piping	LF	380	$ 120	$ 45,600
10	9" Concrete Access on 6" Agg Base	LS	1	$ 5,000.00	$ 5,000
11	3 Barrel 48" Culverts	LF	240	$ 250.00	$ 60,000
12	2 Barrel 72"x36" Box Culvert	LF	104	$ 500.00	$ 52,000
13	4" AC Patching	SF	3,000	$ 4.50	$ 13,500
14	Native Vegetation Finish and Erosion Control	AC	15.2	$ 7,500	$ 114,000
15	Contingency, 30%	LS	1	$ 344,900	$ 344,900
		Subtotal Construction Costs			$ 1,495,000
Non-Construction Costs					
16	Land Acquisition	SF	299,500	$ 0.28	$ 83,900
17	Permitting, Engineering, Construction Management, Administration,				$ 299,000
		Subtotal Non-Construction Costs			$ 382,900
Total Project Costs					$ 1,877,900

Note 1: Standard diameter riprap assumed to be D50 < 12"
Large diameter riprap assumed to be 18" < D50 < 22"

DAYTON VALLEY ADMP
MARK TWAIN NORTH BASIN AND OUTLET CHANNEL
ALTERNATIVE NO. 1 - 25 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 15,000	$ 15,000
2	Clearing and Grubbing	LS	1	$ 5,000	$ 5,000
3	Cut/Fill Onsite	CY	16,277	$ 5.00	$ 81,385
4	Cut Offhaul	CY	110,203	$ 10.00	$ 1,102,030
5	Place Riprap at Basin Outlets	SF	24,259	$ 3.00	$ 72,800
6	Non-Woven Geotextile	SF	24,259	$ 0.60	$ 14,600
7	Concrete Inlets	SF	1,815	$ 10.00	$ 18,200
8	Wire Fence	LF	2,606	$ 10.00	$ 26,100
9	24" HDPE Outlet Piping	LF	228	$ 120	$ 27,360
10	9" Concrete Access on 6" Agg Base	LS	1	$ 5,000.00	$ 5,000
11	Sediment Gage	EA	1	$ 2,500.00	$ 2,500
12	Native Vegetation Finish and Erosion Control	AC	10.2	$ 7,500	$ 76,500
13	Contingency, 30%	LS	1	$ 433,900	$ 433,900
		Subtotal Construction Costs			$ 1,881,000
Non-Construction Costs					
14	Land Acquisition	SF	500,000	$ 0.28	$ 140,000
15	Permitting, Engineering, Construction Management, Administration, Testing, and Inspection, 20%				$ 376,200
		Subtotal Non-Construction Costs			$ 516,200
Total Project Costs					$ 2,397,200

DAYTON VALLEY ADMP
MARK TWAIN NORTH BASIN AND OUTLET CHANNEL
ALTERNATIVE NO. 2 - 100 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 15,000	$ 15,000
2	Clearing and Grubbing	LS	1	$ 5,000	$ 5,000
3	Cut/Fill Onsite	CY	15,830	$ 5.00	$ 79,150
4	Cut Offhaul	CY	140,637	$ 10.00	$ 1,406,370
5	Place Riprap at Basin Outlets	SF	25,923	$ 3.00	$ 77,800
6	Non-Woven Geotextile	SF	25,923	$ 0.60	$ 15,600
7	Concrete Inlets	SF	3,988	$ 10.00	$ 39,900
8	Wire Fence	LF	2,606	$ 10.00	$ 26,100
9	24" HDPE Outlet Piping	LF	228	$ 120	$ 27,360
10	9" Concrete Access on 6" Agg Base	LS	1	$ 5,000.00	$ 5,000
11	Sediment Gage	EA	1	$ 2,500.00	$ 2,500
12	Native Vegetation Finish and Erosion Control	AC	10.3	$ 7,500	$ 77,250
13	Contingency, 30%	LS	1	$ 533,100	$ 533,100
		Subtotal Construction Costs			$ 2,311,000
Non-Construction Costs					
14	Land Acquisition	SF	510,000	$ 0.28	$ 142,800
15	Permitting, Engineering, Construction Management, Administration,				$ 462,200
		Subtotal Non-Construction Costs			$ 605,000
Total Project Costs					$ 2,916,000

DAYTON VALLEY ADMP
GOLD PAN SYSTEM
ALTERNATIVE NO. 1 - 25 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 30,000	$ 30,000
2	Clearing and Grubbing	LS	1	$ 10,000	$ 10,000
3	Cut/Fill Onsite	CY	4,458	$ 5.00	$ 22,290
4	Cut Offhaul	CY	139,230	$ 10.00	$ 1,392,300
5	Riprap	SF	73,034	$ 3.00	$ 219,100
6	Non-Woven Geotextile	SF	73,034	$ 0.60	$ 43,800
7	Concrete Spillway	SF	855	$ 10.00	$ 8,600
8	Wire Fence	LF	2,920	$ 10.00	$ 29,200
9	24" HDPE Outlet Piping	LF	136	$ 120	$ 16,320
10	9" Concrete Access on 6" Agg Base	LS	1	$ 5,000.00	$ 5,000
11	48" HDPE Storm Drain	LF	5,400	$ 250.00	$ 1,350,000
12	4" AC Patching	SF	30,000	$ 4.50	$ 135,000
13	72" SDMH	EA	16	$ 10,000.00	$ 160,000
14	Sediment Gage	EA	1	$ 2,500.00	$ 2,500
15	Native Vegetation Finish and Erosion Control	AC	9.9	$ 7,500	$ 74,250
16	Contingency, 30%	LS	1	$ 1,049,500	$ 1,049,500
		Subtotal Construction Costs			$ 4,548,000
Non-Construction Costs					
17	Land Acquisition	SF	450,000	$ 0.28	$ 126,000
18	Permitting, Engineering, Construction Management, Administration,				$ 909,600
		Subtotal Non-Construction Costs			$ 1,035,600
Total Project Costs					$ 5,583,600

DAYTON VALLEY ADMP
GOLD PAN SYSTEM
ALTERNATIVE NO. 2 - 100 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 30,000	$ 30,000
2	Clearing and Grubbing	LS	1	$ 10,000	$ 10,000
3	Cut/Fill Onsite	CY	4,004	$ 5.00	$ 20,020
4	Cut Offhaul	CY	239,749	$ 10.00	$ 2,397,490
5	Riprap	SF	91,172	$ 3.00	$ 273,500
6	Non-Woven Geotextile	SF	91,172	$ 0.60	$ 54,700
7	Concrete Spillway	SF	1,075	$ 10.00	$ 10,800
8	Wire Fence	LF	3,258	$ 10.00	$ 32,600
9	24" HDPE Outlet Piping	LF	136	$ 120	$ 16,320
10	9" Concrete Access on 6" Agg Base	LS	1	$ 5,000.00	$ 5,000
11	48" HDPE Storm Drain	LF	5,400	$ 250.00	$ 1,350,000
12	4" AC Patching	SF	30,000	$ 4.50	$ 135,000
13	72" SDMH	EA	16	$ 10,000.00	$ 160,000
14	Sediment Gage	EA	1	$ 2,500.00	$ 2,500
15	Native Vegetation Finish and Erosion Control	AC	13.0	$ 7,500	$ 97,500
16	Contingency, 30%	LS	1	$ 1,378,600	$ 1,378,600
		Subtotal Construction Costs			$ 5,975,000
Non-Construction Costs					
17	Land Acquisition	SF	575,000	$ 0.28	$ 161,000
18	Permitting, Engineering, Construction Management, Administration, Testing, and Inspection, 20%				$ 1,195,000
		Subtotal Non-Construction Costs			$ 1,356,000
Total Project Costs					$ 7,331,000

DAYTON VALLEY ADMP
RAINBOW BASIN AND CHANNEL
ALTERNATIVE NO. 1 - 25 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 30,000	$ 30,000
2	Clearing and Grubbing	LS	1	$ 20,000	$ 20,000
3	Cut/Fill Onsite	CY	16,968	$ 5.00	$ 84,840
4	Cut Offhaul	CY	66,070	$ 10.00	$ 660,700
5	Standard Diameter Riprap	SF	193,000	$ 3.00	$ 579,000
6	Non-Woven Geotextile	SF	193,000	$ 0.60	$ 115,800
7	Concrete Spillway	SF	4,738	$ 10.00	$ 47,400
8	Wire Fence	LF	3,000	$ 10.00	$ 30,000
9	48" Outlet Piping	LF	404	$ 250	$ 100,875
10	9" Concrete Access on 6" Agg Base	LS	1	$ 5,000.00	$ 5,000
11	72"x42" Box Culvert	LF	1,635	$ 750.00	$ 1,226,250
13	4" AC Patching	SF	7,500	$ 4.50	$ 33,750
14	Hwy Patching	SF	35,970	$ 9.00	$ 323,730
15	Sediment Gage	EA	1	$ 2,500.00	$ 2,500
16	Native Vegetation Finish and Erosion Control	AC	10.5	$ 7,500	$ 78,750
17	Contingency, 30%	LS	1	$ 1,001,600	$ 1,001,600
			Subtotal Construction Costs		$ 4,341,000
Non-Construction Costs					
18	Land Acquisition	SF	448,700	$ 0.28	$ 125,600
19	Land Acquisition (developed)	SF	176,100	$ 1.84	$ 324,000
20	Permitting, Engineering, Construction Management, Administration,				$ 868,200
			Subtotal Non-Construction Costs		$ 1,317,800
Total Project Costs					$ 5,658,800

DAYTON VALLEY ADMP
RAINBOW BASIN AND CHANNEL
ALTERNATIVE NO. 2 - 100 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 30,000	$ 30,000
2	Clearing and Grubbing	LS	1	$ 20,000	$ 20,000
3	Cut/Fill Onsite	CY	16,297	$ 5.00	$ 81,485
4	Cut Offhaul	CY	98,249	$ 10.00	$ 982,490
5	Standard Diameter Riprap	SF	207,000	$ 3.00	$ 621,000
6	Non-Woven Geotextile	SF	207,000	$ 0.60	$ 124,200
7	Concrete Spillway	SF	4,738	$ 10.00	$ 47,400
8	Wire Fence	LF	3,000	$ 10.00	$ 30,000
9	48" Outlet Piping	LF	480	$ 250	$ 120,000
10	9" Concrete Access on 6" Agg Base	LS	1	$ 5,000.00	$ 5,000
11	96"x48" Box Culvert	LF	966	$ 825.00	$ 796,950
12	84"x48" Box Culvert	LF	669	$ 800.00	$ 535,200
13	4" AC Patching	SF	10,000	$ 4.50	$ 45,000
14	Hwy Patching	SF	30,912	$ 9.00	$ 278,208
15	Sediment Gage	EA	1	$ 2,500.00	$ 2,500
16	Native Vegetation Finish and Erosion Control	AC	11.0	$ 7,500	$ 82,500
17	Contingency, 30%	LS	1	$ 1,140,600	$ 1,140,600
			Subtotal Construction Costs		$ 4,943,000
Non-Construction Costs					
18	Land Acquisition	SF	448,900	$ 0.28	$ 125,700
19	Land Acquisition (developed)	SF	179,600	$ 1.84	$ 330,500
20	Permitting, Engineering, Construction Management, Administration,				$ 988,600
			Subtotal Non-Construction Costs		$ 1,444,800
Total Project Costs					$ 6,387,800

Note 1: Standard diameter riprap assumed to be D50 < 12"
Large diameter riprap assumed to be 18" < D50 < 22"

DAYTON VALLEY ADMP
FT CHURCHILL CHANNEL
ALTERNATIVE NO. 1 - 25 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 30,000	$ 30,000
2	Clearing and Grubbing	LS	1	$ 20,000	$ 20,000
3	Cut/Fill Onsite	CY	9,508	$ 5.00	$ 47,540
4	Cut Export	CY	63,722	$ 10.00	$ 637,200
5	Large Diameter Riprap	SF	3,630	$ 5.00	$ 18,200
6	Non-Woven Geotextile	SF	3,630	$ 0.60	$ 2,200
7	96"x60" Box Culvert + Headwalls	LF	290	$ 850	$ 246,500
8	Vegetated Lining	AC	10.3	$ 10,000.00	$ 103,000
9	Contingency, 30%	LS	1	$ 331,400	$ 331,400
			Subtotal Construction Costs		$ 1,437,000
Non-Construction Costs					
10	Land Acquisition	SF	450,000	$ 0.28	$ 126,000
11	Permitting, Engineering, Construction Management, Administration,				$ 287,400
			Subtotal Non-Construction Costs		$ 413,400
Total Project Costs					$ 1,850,400

DAYTON VALLEY ADMP
FT CHURCHILL CHANNEL
ALTERNATIVE NO. 2 - 100 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 30,000	$ 30,000
2	Clearing and Grubbing	LS	1	$ 20,000	$ 20,000
3	Cut/Fill Onsite	CY	1,513	$ 5.00	$ 7,565
4	Cut Export	CY	60,608	$ 10.00	$ 606,100
5	Large Diameter Riprap	SF	69,736	$ 5.00	$ 348,700
6	Non-Woven Geotextile	SF	69,736	$ 0.60	$ 41,800
7	120"x72" Box Culvert + Headwalls	LF	450	$ 900	$ 405,000
8	Vegetated Lining	AC	7.9	$ 10,000.00	$ 79,000
9	Contingency, 30%	LS	1	$ 461,400	$ 461,400
			Subtotal Construction Costs		$ 2,000,000
Non-Construction Costs					
10	Land Acquisition	SF	450,000	$ 0.28	$ 126,000
11	Permitting, Engineering, Construction Management, Administration,				$ 400,000
			Subtotal Non-Construction Costs		$ 526,000
Total Project Costs					$ 2,526,000

Note 1: Standard diameter riprap assumed to be D50 < 12"
Large diameter riprap assumed to be 18" < D50 < 22"

DAYTON VALLEY ADMP
CHAVES CULVERT
ALTERNATIVE NO. 1 - 25 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 10,000	$ 10,000
2	84"x48" Box Culvert	LF	200	$ 800	$ 160,000
3	Hyw Patching	SF	3,400	$ 9.00	$ 30,600
4	Inlet/Outlet Protection	LS	1	$ 2,500.00	$ 2,500
5	Erosion Control	LS	1	$ 5,000.00	$ 5,000
6	Headwalls	LS	1	$ 4,000.00	$ 4,000
7	Contingency, 30%	LS	1	$ 60,900	$ 60,900
			Subtotal Construction Costs		$ 273,000
Non-Construction Costs					
8	Permitting, Engineering, Construction Management, Administration,				$ 54,600
			Subtotal Non-Construction Costs		$ 54,600
Total Project Costs					$ 327,600

DAYTON VALLEY ADMP
CHAVES CULVERT
ALTERNATIVE NO. 2 - 100 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 10,000	$ 10,000
2	84"x48" Box Culvert	LF	400	$ 800	$ 320,000
3	Hyw Patching	SF	10,000	$ 9.00	$ 90,000
4	Inlet/Outlet Protection	LS	1	$ 2,500.00	$ 2,500
5	Erosion Control	LS	1	$ 5,000.00	$ 5,000
6	Headwalls	LS	1	$ 4,000.00	$ 4,000
7	Contingency, 30%	LS	1	$ 126,800	$ 126,800
					$ 559,000
Non-Construction Costs					
8	Permitting, Engineering, Construction Management, Administration,				$ 111,800
			Subtotal Non-Construction Costs		$ 111,800
Total Project Costs					$ 670,800

DAYTON VALLEY ADMP
GROSH AND ROSEPEAK CULVERTS
ALTERNATIVE NO. 1 - 25 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 10,000	$ 10,000
2	42" RCP Culverts	LF	275	$ 225	$ 61,875
3	4" AC Patching	SF	4,125	$ 4.50	$ 18,563
4	Inlet/Outlet Protection	LS	1	$ 2,500.00	$ 2,500
5	Erosion Control	LS	1	$ 5,000.00	$ 5,000
6	Headwalls	LS	1	$ 4,000.00	$ 4,000
7	Contingency, 30%	LS	1	$ 27,900	$ 27,900
			Subtotal Construction Costs		$ 130,000
Non-Construction Costs					
8	Permitting, Engineering, Construction Management, Administration,				$ 26,000
			Subtotal Non-Construction Costs		$ 26,000
Total Project Costs					$ 156,000

DAYTON VALLEY ADMP
GROSH AND ROSEPEAK CULVERTS
ALTERNATIVE NO. 2 - 100 YEAR ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 10,000	$ 10,000
2	42" RCP Culverts	LF	550	$ 225	$ 123,750
3	4" AC Patching	SF	11,000	$ 4.50	$ 49,500
4	Inlet/Outlet Protection	LS	1	$ 2,500.00	$ 2,500
5	Erosion Control	LS	1	$ 5,000.00	$ 5,000
6	Headwalls	LS	1	$ 4,000.00	$ 4,000
7	Contingency, 30%	LS	1	$ 55,700	$ 55,700
			Subtotal Construction Costs		$ 251,000
Non-Construction Costs					
8	Permitting, Engineering, Construction Management, Administration,				$ 50,200
			Subtotal Non-Construction Costs		$ 50,200
Total Project Costs					$ 301,200

DAYTON VALLEY ADMP
CARDELLI SIPHON #1
ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 10,000	$ 10,000
2	24" HDPE	LF	472	$ 120	$ 56,640
3	Grading	CY	2,250	$ 10.00	$ 22,500
4	Riprap	SF	15,000	$ 3.00	$ 45,000
5	Headwall/End Sections	LS	1	$ 5,000.00	$ 5,000
6	Erosion Control	LS	1	$ 5,000.00	$ 5,000
7	Contingency, 30%	LS	1	$ 41,700	$ 41,700
			Subtotal Construction Costs		$ 186,000
Non-Construction Costs					
8	Permitting, Engineering, Construction Management, Administration, Testing, and Inspection, 20%				$ 37,200
			Subtotal Non-Construction Costs		$ 37,200
Total Project Costs					$ 223,200

DAYTON VALLEY ADMP
CARDELLI SIPHON #2
ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 10,000	$ 10,000
2	24" HDPE	LF	560	$ 120	$ 67,200
3	Grading	CY	2,600	$ 10.00	$ 26,000
4	Riprap	SF	24,000	$ 3.00	$ 72,000
5	Headwall/End Sections	LS	1	$ 5,000.00	$ 5,000
6	Erosion Control	LS	1	$ 5,000.00	$ 5,000
7	Contingency, 30%	LS	1	$ 54,100	$ 54,100
			Subtotal Construction Costs		$ 240,000
Non-Construction Costs					
8	Land Acquisition	SF	25,000	$ 1.84	$ 46,000
9	Permitting, Engineering, Construction Management, Administration,				$ 48,000
			Subtotal Non-Construction Costs		$ 94,000
Total Project Costs					$ 334,000

DAYTON VALLEY ADMP
CARDELLI SIPHON #3
ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 10,000	$ 10,000
2	24" HDPE	LF	246	$ 120	$ 29,520
3	Grading	CY	1,700	$ 10.00	$ 17,000
4	Riprap	SF	23,000	$ 3.00	$ 69,000
5	Headwall/End Sections	LS	1	$ 5,000.00	$ 5,000
6	Erosion Control	LS	1	$ 5,000.00	$ 5,000
7	Contingency, 30%	LS	1	$ 39,200	$ 39,200
			Subtotal Construction Costs		$ 175,000
Non-Construction Costs					
8	Land Acquisition	SF	15,000	$ 1.84	$ 27,600
9	Permitting, Engineering, Construction Management, Administration,				$ 35,000
			Subtotal Non-Construction Costs		$ 62,600
Total Project Costs					$ 237,600

DAYTON VALLEY ADMP
CARDELLI SIPHON #4
ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 10,000	$ 10,000
2	24" HDPE	LF	408	$ 120	$ 48,960
3	Grading	CY	900	$ 10.00	$ 9,000
4	Riprap	SF	13,000	$ 3.00	$ 39,000
5	60" SDMH	EA	1	$ 8,000.00	$ 8,000
6	Headwall/End Sections	LS	1	$ 5,000.00	$ 5,000
7	Erosion Control	LS	1	$ 5,000.00	$ 5,000
8	Contingency, 30%	LS	1	$ 36,000	$ 36,000
			Subtotal Construction Costs		$ 161,000
Non-Construction Costs					
9	Permitting, Engineering, Construction Management, Administration,				$ 32,200
			Subtotal Non-Construction Costs		$ 32,200
Total Project Costs					$ 193,200

DAYTON VALLEY ADMP
CARDELLI SIPHON #5 AND #6
ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 10,000	$ 10,000
2	24" HDPE	LF	934	$ 120	$ 112,080
3	Headwall/End Sections	LS	1	$ 5,000.00	$ 5,000
4	Erosion Control	LS	1	$ 5,000.00	$ 5,000
5	Contingency, 30%	LS	1	$ 38,100	$ 38,100
			Subtotal Construction Costs		$ 171,000
Non-Construction Costs					
6	Permitting, Engineering, Construction Management, Administration,				$ 34,200
			Subtotal Non-Construction Costs		$ 34,200
Total Project Costs					$ 205,200

DAYTON VALLEY ADMP
CARDELLI SIPHON #7
ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 10,000	$ 10,000
2	24" HDPE	LF	460	$ 120	$ 55,200
3	Headwall/End Sections	LS	1	$ 5,000.00	$ 5,000
4	Erosion Control	LS	1	$ 5,000.00	$ 5,000
5	Contingency, 30%	LS	1	$ 21,100	$ 21,100
			Subtotal Construction Costs		$ 97,000
Non-Construction Costs					
6	Permitting, Engineering, Construction Management, Administration,				$ 19,400
			Subtotal Non-Construction Costs		$ 19,400
Total Project Costs					$ 116,400

DAYTON VALLEY ADMP
GOLD CANYON SPILLWAY
ESTIMATED COST
JULY 2019

Item	Description	Unit	Quantity	Unit Price	Total Price
Construction Costs					
1	Mobilization and Demobilization	LS	1	$ 30,000	$ 30,000
2	Clearing and Grubbing	LS	1	$ 30,000	$ 30,000
3	Excavation to Bedrock	CY	7,037	$ 10.00	$ 70,370
4	Screen Excavated Material	SF	7,037	$ 20.00	$ 140,741
5	Large Diameter Riprap	SF	32,505	$ 6.00	$ 195,030
6	Place Grouted Riprap	SF	7,000	$ 8.00	$ 56,000
7	Erosion Control	LS	1	$ 10,000	$ 10,000
8	Contingency, 50%	LS	1	$ 266,100	$ 266,100
			Subtotal Construction Costs		$ 799,000
Non-Construction Costs					
9	Land Acquisition	SF	5,000	$ 0.28	$ 1,400
10	Permitting, Engineering, Construction Management, Administration, Testing, and Inspection, 20%				$ 159,800
			Subtotal Non-Construction Costs		$ 161,200
Total Project Costs					$ 960,200

Note 1: Standard diameter riprap assumed to be D50 < 12"
Large diameter riprap assumed to be 18" < D50 < 22"

Attachment B: Hydraulic Calculation

Hydraulic Calculations

for

The Dayton Valley
Area Drainage Master Plan
Civil Plans

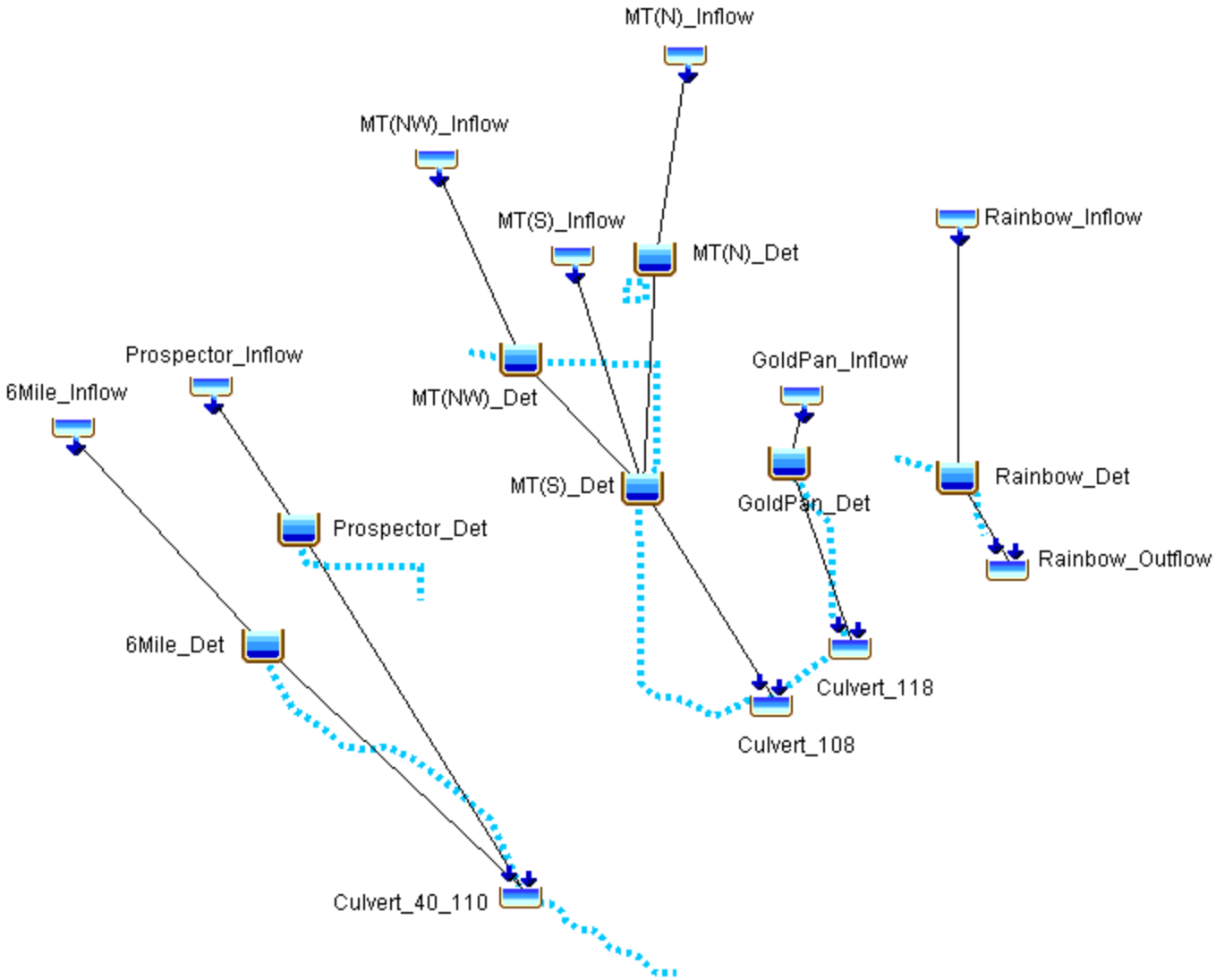
Lumos and Associates, Inc.
308 N. Curry St, Suite 200
Carson City, NV 89703

June 2019

HEC-HMS Output Data

	6 Mile Canyon West Detention	Mark Twain (NW) Detention	Mark Twain (N) Detention	Mark Twain (S) Detention	Rainbow Detention	Prospector Detention	Gold Pan Detention
Flow Data - 100yr Event							
Q_{in} [cfs]	-	338	207	330	1027	98	268
Q_{out} [cfs]	-	159	129	280	923	79	99
Flow Data - 25yr Event							
Q_{in} [cfs]	2717	217	133	213	686	64	169
Q_{out} [cfs]	2599	89	86	134	616	54	56
Basin Dimensions							
Surface Area [ac]	17.7	7.0	4.0	5.9	7.1	1.0	6.8
Depth [ft]	12.0	9.5	7.0	10.0	11.0	7.6	9.5
FB_{100} [ft]	-	1.2	1.2	1.5	1.3	1.0	1.2
FB_{25} [ft]	1.1	4.1	2.9	3.7	4.3	3.4	4.5
Spillway Dimensions							
Depth from Top [ft]	2	1.5	-	2.5	1	-	1.5
Length [ft]	500	100	-	45	80	-	40
Outlet Pipe Dimensions							
Diameter	5ft	2ft	3ft	2ft	4ft	2ft	2ft
No.	x5	x3	x2	x4	x5	x2	x2

Pipe ID	Q_{25} [cfs]	Q_{100} [cfs]
Culvert 40 & 110	2653	2677
Culvert 108	134	280
Culvert 118	56	99
Rainbow Outflow	616	923


MT(N)_Inflow
MT(NW)_Inflow
MT(S)_Inflow
MT(N)_Det
Rainbow_Inflow
Prospector_Inflow
6Mile_Inflow
MT(NW)_Det
GoldPan_Inflow
MT(S)_Det
GoldPan_Det
Rainbow_Det
Prospector_Det
Rainbow_Outflow
6Mile_Det
Culvert_118
Culvert_108
Culvert_40_110

```
Basin: Detention_Basins
     Last Modified Date: 18 June 2019
     Last Modified Time: 17:06:37
     Version: 4.2.1
     Filepath Separator: \
     Unit System: English
     Missing Flow To Zero: No
     Enable Flow Ratio: No
     Compute Local Flow At Junctions: No

     Enable Sediment Routing: No

     Enable Quality Routing: No
End:

Sink: Culvert_108
     Last Modified Date: 18 June 2019
     Last Modified Time: 18:44:57
     Canvas X: 2360504.3562468733
     Canvas Y: 1.4781982441767834E7
     Label X: -32.0
     Label Y: -30.0
End:

Source: MT(NW)_Inflow
     Last Modified Date: 18 June 2019
     Last Modified Time: 17:46:38
     Canvas X: 2352230.1467726734
     Canvas Y: 1.4794962409225168E7
     Label X: -56.0
     Label Y: 23.0
     Downstream: MT(NW)_Det

     Flow Method: GAGE_FLOW
     Flow Gage: MT(NW)_Inflow
     End Flow Method:
End:

Reservoir: MT(NW)_Det
     Last Modified Date: 18 June 2019
     Last Modified Time: 18:17:01
     Canvas X: 2354302.1474409606
     Canvas Y: 1.4790300407721521E7
     Label X: -74.0
     Label Y: -24.0
     Downstream: MT(S)_Det

     Route: Controlled Outflow
```

```
     Routing Curve: Elevation-Area
     Initial Elevation: 100
     Elevation-Area Table: Basin - MT1
     Adaptive Control: On
     Main Tailwater Condition: None
     Auxiliary Tailwater Condition: None

     Conduit: Culvert
     Conduit Outlet: Main
     Culvert Shape: Circular
     Chart Number: 1
     Scale Number: 1
     Solution Control: Automatic
     Diameter: 2
     Number Barrels: 3
     Culvert Length: 20
     Entrance Loss Coefficient: 0.5
     Exit Loss Coefficient: 1
     Top Manning's n: 0.013
     Inlet Invert Elevation: 100.5
     Outlet Invert Elevation: 100
     End Conduit:

     Spillway: Broad-Crested Spillway
     Spillway Outlet: Main
     Spillway Crest Length: 100
     Spillway Crest Elevation: 108
     Spillway Coefficient: 2.8
     End Spillway:

     Evaporation Method: Zero Evaporation
     End Evaporation:
End:

Source: MT(S)_Inflow
     Last Modified Date: 25 June 2019
     Last Modified Time: 23:51:21
     Canvas X: 2355145.827941642
     Canvas Y: 1.4793220137861075E7
     From Canvas X: 363.21097696293145
     From Canvas Y: 394.0150863714516
     Label X: -41.0
     Label Y: 23.0
     Downstream: MT(S)_Det

     Flow Method: GAGE_FLOW
     Flow Gage: MT(S)_Inflow
     End Flow Method:
```

```
End:

Source: MT(N)_Inflow
     Last Modified Date: 17 June 2019
     Last Modified Time: 23:53:26
     Canvas X: 2356642.0414482076
     Canvas Y: 1.4794575843847381E7
     From Canvas X: -3072.3508123839274
     From Canvas Y: 1048.8027756027877
     Label X: -47.0
     Label Y: 25.0
     Downstream: MT(N)_Det

     Flow Method: GAGE_FLOW
     Flow Gage: MT(N)_Inflow
     End Flow Method:
End:

Reservoir: MT(N)_Det
     Last Modified Date: 18 June 2019
     Last Modified Time: 18:08:55
     Canvas X: 2357151.902613344
     Canvas Y: 1.4792084271016883E7
     From Canvas X: 670.5967000173405
     From Canvas Y: 3651.6285376399755
     Label X: -48.0
     Label Y: 21.0
     Downstream: MT(S)_Det

     Route: Controlled Outflow
     Routing Curve: Elevation-Area
     Initial Elevation: 100
     Elevation-Area Table: Basin - MT(N)
     Adaptive Control: On
     Main Tailwater Condition: None
     Auxiliary Tailwater Condition: None

     Conduit: Culvert
     Conduit Outlet: Main
     Culvert Shape: Circular
     Chart Number: 1
     Scale Number: 1
     Solution Control: Automatic
     Diameter: 3
     Number Barrels: 2
     Culvert Length: 20
     Entrance Loss Coefficient: 0.5
     Exit Loss Coefficient: 1
```

```
     Top Manning's n: 0.013
     Inlet Invert Elevation: 100.5
     Outlet Invert Elevation: 100
     End Conduit:

     Evaporation Method: Zero Evaporation
     End Evaporation:
End:

Reservoir: MT(S)_Det
     Last Modified Date: 25 June 2019
     Last Modified Time: 23:55:19
     Canvas X: 2357009.611468457
     Canvas Y: 1.4787487591558902E7
     From Canvas X: 148.26099168602377
     From Canvas Y: 104.0985185559839
     Label X: -87.0
     Label Y: -1.0
     Downstream: Culvert_108

     Route: Controlled Outflow
     Routing Curve: Elevation-Area
     Initial Elevation: 100
     Elevation-Area Table: Basin - MT2
     Adaptive Control: On
     Main Tailwater Condition: None
     Auxiliary Tailwater Condition: None

     Conduit: Culvert
     Conduit Outlet: Main
     Culvert Shape: Circular
     Chart Number: 1
     Scale Number: 1
     Solution Control: Automatic
     Diameter: 2
     Number Barrels: 4
     Culvert Length: 20
     Entrance Loss Coefficient: 0.5
     Exit Loss Coefficient: 1
     Top Manning's n: 0.013
     Inlet Invert Elevation: 100.5
     Outlet Invert Elevation: 100
     End Conduit:

     Spillway: Broad-Crested Spillway
     Spillway Outlet: Main
     Spillway Crest Length: 45
     Spillway Crest Elevation: 107.5
```

```
     Spillway Coefficient: 2.8
     End Spillway:

     Evaporation Method: Zero Evaporation
     End Evaporation:
End:

Source: 6Mile_Inflow
     Last Modified Date: 18 June 2019
     Last Modified Time: 15:32:10
     Canvas X: 2343358.296569111
     Canvas Y: 1.4788375739250755E7
     From Canvas X: 330.9304942251183
     From Canvas Y: -14.918997690081596
     Label X: -51.0
     Label Y: 23.0
     Downstream: 6Mile_Det

     Flow Method: GAGE_FLOW
     Flow Gage: 6Mile_Inflow
     End Flow Method:
End:

Reservoir: 6Mile_Det
     Last Modified Date: 18 June 2019
     Last Modified Time: 15:32:12
     Canvas X: 2347975.0235069045
     Canvas Y: 1.4783332624419188E7
     From Canvas X: 279.83239718247205
     From Canvas Y: -56.90259428694844
     Label X: -90.0
     Label Y: -2.0
     Downstream: Culvert_40_110

     Route: Controlled Outflow
     Routing Curve: Elevation-Area
     Initial Elevation: 100
     Elevation-Area Table: Basin - 6Mile
     Adaptive Control: On
     Main Tailwater Condition: None
     Auxiliary Tailwater Condition: None

     Conduit: Culvert
     Conduit Outlet: Main
     Culvert Shape: Circular
     Chart Number: 1
     Scale Number: 2
     Solution Control: Automatic
```

```
     Diameter: 5
     Number Barrels: 5
     Culvert Length: 20
     Entrance Loss Coefficient: 0.5
     Exit Loss Coefficient: 1
     Top Manning's n: 0.013
     Inlet Invert Elevation: 100.5
     Outlet Invert Elevation: 100
     End Conduit:

     Spillway: Broad-Crested Spillway
     Spillway Outlet: Main
     Spillway Crest Length: 500
     Spillway Crest Elevation: 110
     Spillway Coefficient: 2.8
     End Spillway:

     Evaporation Method: Zero Evaporation
     End Evaporation:
End:

Sink: Culvert_40_110
     Last Modified Date: 18 June 2019
     Last Modified Time: 15:56:23
     Canvas X: 2354263.7686092868
     Canvas Y: 1.4777389962443357E7
     From Canvas X: 240.0602355650626
     From Canvas Y: -161.39642956107855
     Label X: -118.0
     Label Y: -11.0
End:

Source: Rainbow_Inflow
     Last Modified Date: 18 June 2019
     Last Modified Time: 16:30:30
     Canvas X: 2364971.1110609802
     Canvas Y: 1.4793510227843469E7
     From Canvas X: 633.4753761230968
     From Canvas Y: -66.009855190292
     Label X: 2.0
     Label Y: 4.0
     Downstream: Rainbow_Det

     Flow Method: GAGE_FLOW
     Flow Gage: Rainbow_Inflow
     End Flow Method:
End:
```

```
Reservoir: Rainbow_Det
     Last Modified Date: 24 July 2019
     Last Modified Time: 20:11:17
     Canvas X: 2364937.1213760218
     Canvas Y: 1.4787637620809466E7
     From Canvas X: 596.0209461669438
     From Canvas Y: -138.60364003106952
     Label X: -10.0
     Label Y: 16.0
     Downstream: Rainbow_Outflow

     Route: Controlled Outflow
     Routing Curve: Elevation-Area
     Initial Elevation: 4384.5
     Elevation-Area Table: Basin - Rainbow
     Adaptive Control: On
     Main Tailwater Condition: None
     Auxiliary Tailwater Condition: None

     Conduit: Culvert
     Conduit Outlet: Main
     Culvert Shape: Circular
     Chart Number: 1
     Scale Number: 2
     Solution Control: Automatic
     Diameter: 4
     Number Barrels: 5
     Culvert Length: 20
     Entrance Loss Coefficient: 0.5
     Exit Loss Coefficient: 1
     Top Manning's n: 0.013
     Inlet Invert Elevation: 4385
     Outlet Invert Elevation: 4384.5
     End Conduit:

     Spillway: Broad-Crested Spillway
     Spillway Outlet: Main
     Spillway Crest Length: 80
     Spillway Crest Elevation: 4394.5
     Spillway Coefficient: 2.8
     End Spillway:

     Evaporation Method: Zero Evaporation
     End Evaporation:
End:

Sink: Rainbow_Outflow
     Last Modified Date: 24 July 2019
```

```
     Last Modified Time: 18:57:57
     Canvas X: 2365779.411953206
     Canvas Y: 1.478588084331991E7
     From Canvas X: 583.9748737518676
     From Canvas Y: -221.4546087179333
     Label X: 4.0
     Label Y: -2.0
End:

Source: Prospector_Inflow
     Last Modified Date: 18 June 2019
     Last Modified Time: 15:50:27
     Canvas X: 2346709.5525165726
     Canvas Y: 1.4789400395577958E7
     From Canvas X: 3682.1864416869357
     From Canvas Y: 1009.7373295128345
     Label X: -61.0
     Label Y: 21.0
     Downstream: Prospector_Det

     Flow Method: GAGE_FLOW
     Flow Gage: Prospector_Inflow
     End Flow Method:
End:

Reservoir: Prospector_Det
     Last Modified Date: 18 June 2019
     Last Modified Time: 17:28:13
     Canvas X: 2348858.7026340268
     Canvas Y: 1.4786177678980602E7
     From Canvas X: 1155.9276981814764
     From Canvas Y: 2571.3833087086678
     Label X: 6.0
     Label Y: -2.0
     Downstream: Culvert_40_110

     Route: Controlled Outflow
     Routing Curve: Elevation-Area
     Initial Elevation: 100
     Elevation-Area Table: Baisn - Prospector
     Adaptive Control: On
     Main Tailwater Condition: None
     Auxiliary Tailwater Condition: None

     Conduit: Culvert
     Conduit Outlet: Main
     Culvert Shape: Circular
     Chart Number: 1
```

```
     Scale Number: 2
     Solution Control: Automatic
     Diameter: 2
     Number Barrels: 2
     Culvert Length: 20
     Entrance Loss Coefficient: 0.5
     Exit Loss Coefficient: 1
     Top Manning's n: 0.013
     Inlet Invert Elevation: 100.5
     Outlet Invert Elevation: 100
     End Conduit:

     Evaporation Method: Zero Evaporation
     End Evaporation:
End:

Source: GoldPan_Inflow
     Last Modified Date: 18 June 2019
     Last Modified Time: 00:06:43
     Canvas X: 2361161.360555208
     Canvas Y: 1.4789195531487405E7
     From Canvas X: 1704.6443743272685
     From Canvas Y: -809.3295789118856
     Label X: -41.0
     Label Y: 23.0
     Downstream: GoldPan_Det

     Flow Method: GAGE_FLOW
     Flow Gage: GoldPan_Inflow
     End Flow Method:
End:

Reservoir: GoldPan_Det
     Last Modified Date: 18 June 2019
     Last Modified Time: 17:46:47
     Canvas X: 2360858.7602885943
     Canvas Y: 1.4787787508137899E7
     From Canvas X: 3751.0312508377247
     From Canvas Y: 442.23893036693335
     Label X: -42.0
     Label Y: -25.0
     Downstream: Culvert_118

     Route: Controlled Outflow
     Routing Curve: Elevation-Area
     Initial Elevation: 100
     Elevation-Area Table: Basin - GoldPan
     Adaptive Control: On
```

```
     Main Tailwater Condition: None
     Auxiliary Tailwater Condition: None

     Conduit: Culvert
     Conduit Outlet: Main
     Culvert Shape: Circular
     Chart Number: 1
     Scale Number: 1
     Solution Control: Automatic
     Diameter: 2
     Number Barrels: 2
     Culvert Length: 20
     Entrance Loss Coefficient: 0.5
     Exit Loss Coefficient: 1
     Top Manning's n: 0.013
     Inlet Invert Elevation: 100.5
     Outlet Invert Elevation: 100
     End Conduit:

     Spillway: Broad-Crested Spillway
     Spillway Outlet: Main
     Spillway Crest Length: 40
     Spillway Crest Elevation: 108
     Spillway Coefficient: 2.8
     End Spillway:

     Evaporation Method: Zero Evaporation
     End Evaporation:
End:

Sink: Culvert_118
     Last Modified Date: 18 June 2019
     Last Modified Time: 17:06:42
     Canvas X: 2362340.591525301
     Canvas Y: 1.4783472586222095E7
     From Canvas X: 1128.0411845240742
     From Canvas Y: 820.1047943290323
     Label X: -32.0
     Label Y: -30.0
End:

Basin Schematic Properties:
     Last View N: 1.4799878872283868E7
     Last View S: 1.4770380093931662E7
     Last View W: 2337699.679773246
     Last View E: 2371651.3805484357
     Maximum View N: 1.4799878872283868E7
     Maximum View S: 1.4770380093931662E7
```

```
     Maximum View W: 2337699.679773246
     Maximum View E: 2371651.3805484357
     Extent Method: Elements Maps
     Buffer: 50
     Draw Icons: Yes
     Draw Icon Labels: Name
     Draw Map Objects: No
     Draw Gridlines: No
     Draw Flow Direction: No
     Fix Element Locations: No
     Fix Hydrologic Order: No
     Map: hec.map.aishape.AiShapeMap
     Map File Name: maps\Drainage_Paths.shp
     Minimum Scale: -2147483648
     Maximum Scale: 2147483647
     Map Shown: Yes
End:
```

Flow Master Channel and SD Calculations

Trapezoidal Channel (Channels.fm8) Report

Label	Roughness Coefficient	Channel Slope (ft/ft)	Normal Depth (ft)
Sutro Springs Convey WEST - 100YR	0.030	0.05700	1.86
Sutro Springs Collect EAST - 100YR	0.030	0.04000	1.25
Sutro Springs Convey WEST - 25YR	0.030	0.05700	1.50
Marktwain Collect NORTHWEST - 25YR	0.030	0.04700	0.80
Marktwain Collect NORTHWEST - 100YR	0.030	0.00940	1.34
Ft Churchill REACH 1 - 100YR	0.030	0.00230	5.50
Ft Churchill REACH 2 - 100YR	0.030	0.01820	5.00
Ft Churchill REACH 2 - 25YR	0.030	0.00230	6.02
Ft Churchill REACH 1 - 25YR	0.030	0.00100	6.00
6 Mile Upperstream (Velocity) - 100YR	0.043	0.01650	6.14
6 Mile Downstream - 100YR	0.030	0.00600	6.62
Mark Twain Collector NORTHEAST - 100YR	0.030	0.01900	2.58
Mark Twain Collector NORTHEAST - 25YR	0.030	0.02700	2.27
Mark Twain Convey NORTH - 25YR	0.030	0.04500	2.54
Mark Twain Convey NORTH - 100YR	0.030	0.04500	2.10
Mark Twain Convey SOUTH - 25YR	0.030	0.01200	2.24
Mark Twain Convey SOUTH - 100YR	0.030	0.01300	2.61
Rainbow Collect - 25YR	0.030	0.02800	0.90
Rainbow Collect - 100YR	0.030	0.02800	1.19
Rainbow Convey - 25YR	0.030	0.00800	3.51
Rainbow Convey - 100YR	0.030	0.03000	3.88
Rainbow Convey SOUTH - 100YR	0.030	0.00700	4.81
Sutro Springs Collect EAST - 25YR	0.030	0.04000	1.50
Gold Pan Convey - 25YR	0.030	0.03300	1.58
Gold Pan Convey - 100YR	0.030	0.03300	1.96
6 Mile Upperstream (Depth) - 100YR	0.043	0.01000	6.98
Marktwain NORTH Outlet Channel - 100 YR	0.030	0.05600	1.96
Marktwain NORTH Outlet Channel - 25 YR	0.030	0.05600	1.69
Existing Gold Canyon Channel	0.030	0.03000	4.95

Trapezoidal Channel (Channels.fm8) Report

Bottom Width (ft)	Discharge (ft^3/s)	Velocity (ft/s)	Flow Type
2.00	170.32	12.03	Supercritical
1.00	44.60	7.55	Supercritical
1.00	83.14	10.08	Supercritical
1.00	17.00	6.29	Supercritical
5.00	54.00	4.47	Subcritical
12.00	976.71	5.22	Subcritical
20.00	2942.02	14.71	Supercritical
16.00	1365.30	5.66	Subcritical
5.00	470.50	3.41	Subcritical
36.00	4363.00	11.73	Subcritical
36.00	4363.00	10.56	Subcritical
6.00	330.00	9.30	Supercritical
3.00	213.00	9.60	Supercritical
3.00	213.00	12.34	Supercritical
6.00	330.00	12.77	Supercritical
3.00	138.00	6.35	Subcritical
6.00	280.00	7.74	Supercritical
0.00	11.30	4.69	Supercritical
0.00	24.10	5.66	Supercritical
3.00	320.00	6.75	Subcritical
3.00	790.00	13.90	Supercritical
6.00	790.00	8.03	Subcritical
1.00	69.65	8.44	Supercritical
0.00	56.00	7.44	Supercritical
0.00	99.00	8.58	Supercritical
36.00	4363.00	9.79	Subcritical
0.00	129.00	11.17	Supercritical
0.00	86.00	10.10	Supercritical
18.00	2700.00	19.55	Supercritical

Circular Pipe (Channels.fm8) Report

Label	Roughness Coefficient	Channel Slope (ft/ft)	Diameter (ft)
Gold Pan Storm Drain - 25/100 YR	0.012	0.00450	4.00
Prospector Storm Drain - 25 YR	0.013	0.01040	3.00
Prospector Storm Drain - 100 YR	0.013	0.01040	4.00

Discharge (ft³/s)	Percent Full (%)	Velocity (ft/s)	Maximum Discharge (ft³/s)
104.38	100.0	8.31	112.29
59.00	72.0	10.83	73.16
79.00	52.3	11.88	157.57

Discharge Full (ft³/s)
104.38
68.02
146.48

Culvert Calculations

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: Wagon Wheel Way

Headwater Elevation (ft)	Total Discharge (cfs)	Wagon Wheel - 25YR - 30" CMP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
4477.63	32.98	32.98	0.00	1
4477.63	32.98	32.98	0.00	1
4477.63	32.98	32.98	0.00	1
4477.63	32.98	32.98	0.00	1
4477.63	32.98	32.98	0.00	1
4477.63	32.98	32.98	0.00	1
4477.63	32.98	32.98	0.00	1
4477.63	32.98	32.98	0.00	1
4477.63	32.98	32.98	0.00	1
4477.63	32.98	32.98	0.00	1
4477.63	32.98	32.98	0.00	1
4478.95	41.39	41.39	0.00	Overtopping

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: Wagon Wheel Way

Headwater Elevation (ft)	Total Discharge (cfs)	Wagon Wheel - 100YR - 36" CMP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
4478.87	56.34	56.34	0.00	1
4478.87	56.34	56.34	0.00	1
4478.87	56.34	56.34	0.00	1
4478.87	56.34	56.34	0.00	1
4478.87	56.34	56.34	0.00	1
4478.87	56.34	56.34	0.00	1
4478.87	56.34	56.34	0.00	1
4478.87	56.34	56.34	0.00	1
4478.87	56.34	56.34	0.00	1
4478.87	56.34	56.34	0.00	1
4478.87	56.34	56.34	0.00	1
4478.95	57.01	57.01	0.00	Overtopping

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: Rose Peak Culvert 25-Year

Headwater Elevation (ft)	Total Discharge (cfs)	Rose Peak Culvert - 25 Year - (1) 42" Discharge (cfs)	Roadway Discharge (cfs)	Iterations
4363.90	62.70	62.70	0.00	1
4363.90	62.70	62.70	0.00	1
4363.90	62.70	62.70	0.00	1
4363.90	62.70	62.70	0.00	1
4363.90	62.70	62.70	0.00	1
4363.90	62.70	62.70	0.00	1
4363.90	62.70	62.70	0.00	1
4363.90	62.70	62.70	0.00	1
4363.90	62.70	62.70	0.00	1
4363.90	62.70	62.70	0.00	1
4363.90	62.70	62.70	0.00	1
4363.92	62.98	62.98	0.00	Overtopping

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: Rose Peak Culvert 100-Year

Headwater Elevation (ft)	Total Discharge (cfs)	Rose Peak Culvert - 100 Year - (2) 42" Discharge (cfs)	Roadway Discharge (cfs)	Iterations
4363.86	147.30	147.30	0.00	1
4363.86	147.30	147.30	0.00	1
4363.86	147.30	147.30	0.00	1
4363.86	147.30	147.30	0.00	1
4363.86	147.30	147.30	0.00	1
4363.86	147.30	147.30	0.00	1
4363.86	147.30	147.30	0.00	1
4363.86	147.30	147.30	0.00	1
4363.86	147.30	147.30	0.00	1
4363.86	147.30	147.30	0.00	1
4363.86	147.30	147.30	0.00	1
4363.92	149.15	149.15	0.00	Overtopping

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: Grosh Culvert 25-Year

Headwater Elevation (ft)	Total Discharge (cfs)	Grosh Culvert - 25 Year - (1) 42" Discharge (cfs)	Roadway Discharge (cfs)	Iterations
4380.68	62.70	62.70	0.00	1
4380.68	62.70	62.70	0.00	1
4380.68	62.70	62.70	0.00	1
4380.68	62.70	62.70	0.00	1
4380.68	62.70	62.70	0.00	1
4380.68	62.70	62.70	0.00	1
4380.68	62.70	62.70	0.00	1
4380.68	62.70	62.70	0.00	1
4380.68	62.70	62.70	0.00	1
4380.68	62.70	62.70	0.00	1
4380.68	62.70	62.70	0.00	1
4381.27	73.06	73.06	0.00	Overtopping

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: Grosh Culvert 100-Year

Headwater Elevation (ft)	Total Discharge (cfs)	Grosh Culvert - 100 Year - (2) 42" Discharge (cfs)	Roadway Discharge (cfs)	Iterations
4380.55	147.28	147.28	0.00	1
4380.55	147.28	147.28	0.00	1
4380.55	147.28	147.28	0.00	1
4380.55	147.28	147.28	0.00	1
4380.55	147.28	147.28	0.00	1
4380.55	147.28	147.28	0.00	1
4380.55	147.28	147.28	0.00	1
4380.55	147.28	147.28	0.00	1
4380.55	147.28	147.28	0.00	1
4380.55	147.28	147.28	0.00	1
4380.55	147.28	147.28	0.00	1
4381.27	169.42	169.42	0.00	Overtopping

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: Chaves Culvert 25 Year

Headwater Elevation (ft)	Total Discharge (cfs)	Chaves Culvert - 25 Year - 48x84 Box Discharge (cfs)	Roadway Discharge (cfs)	Iterations
4370.03	280.66	280.66	0.00	1
4370.03	280.66	280.66	0.00	1
4370.03	280.66	280.66	0.00	1
4370.03	280.66	280.66	0.00	1
4370.03	280.66	280.66	0.00	1
4370.03	280.66	280.66	0.00	1
4370.03	280.66	280.66	0.00	1
4370.03	280.66	280.66	0.00	1
4370.03	280.66	280.66	0.00	1
4370.03	280.66	280.66	0.00	1
4370.03	280.66	280.66	0.00	1
4370.20	287.02	287.02	0.00	Overtopping

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: Chaves Culvert 100 Year

Headwater Elevation (ft)	Total Discharge (cfs)	Chaves Culvert - 100 Year - (2) 36x72 Box Discharge (cfs)	Roadway Discharge (cfs)	Iterations
4370.16	387.78	387.78	0.00	1
4370.16	387.78	387.78	0.00	1
4370.16	387.78	387.78	0.00	1
4370.16	387.78	387.78	0.00	1
4370.16	387.78	387.78	0.00	1
4370.16	387.78	387.78	0.00	1
4370.16	387.78	387.78	0.00	1
4370.16	387.78	387.78	0.00	1
4370.16	387.78	387.78	0.00	1
4370.16	387.78	387.78	0.00	1
4370.16	387.78	387.78	0.00	1
4370.20	389.36	389.36	0.00	Overtopping

Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Jul 24 2019

RAINBOW CULVERT 1 - 25 YEAR

Invert Elev Dn (ft)	=	4360.50
Pipe Length (ft)	=	66.50
Slope (%)	=	1.01
Invert Elev Up (ft)	=	4361.17
Rise (in)	=	42.0
Shape	=	Box
Span (in)	=	72.0
No. Barrels	=	3
n-Value	=	0.012
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

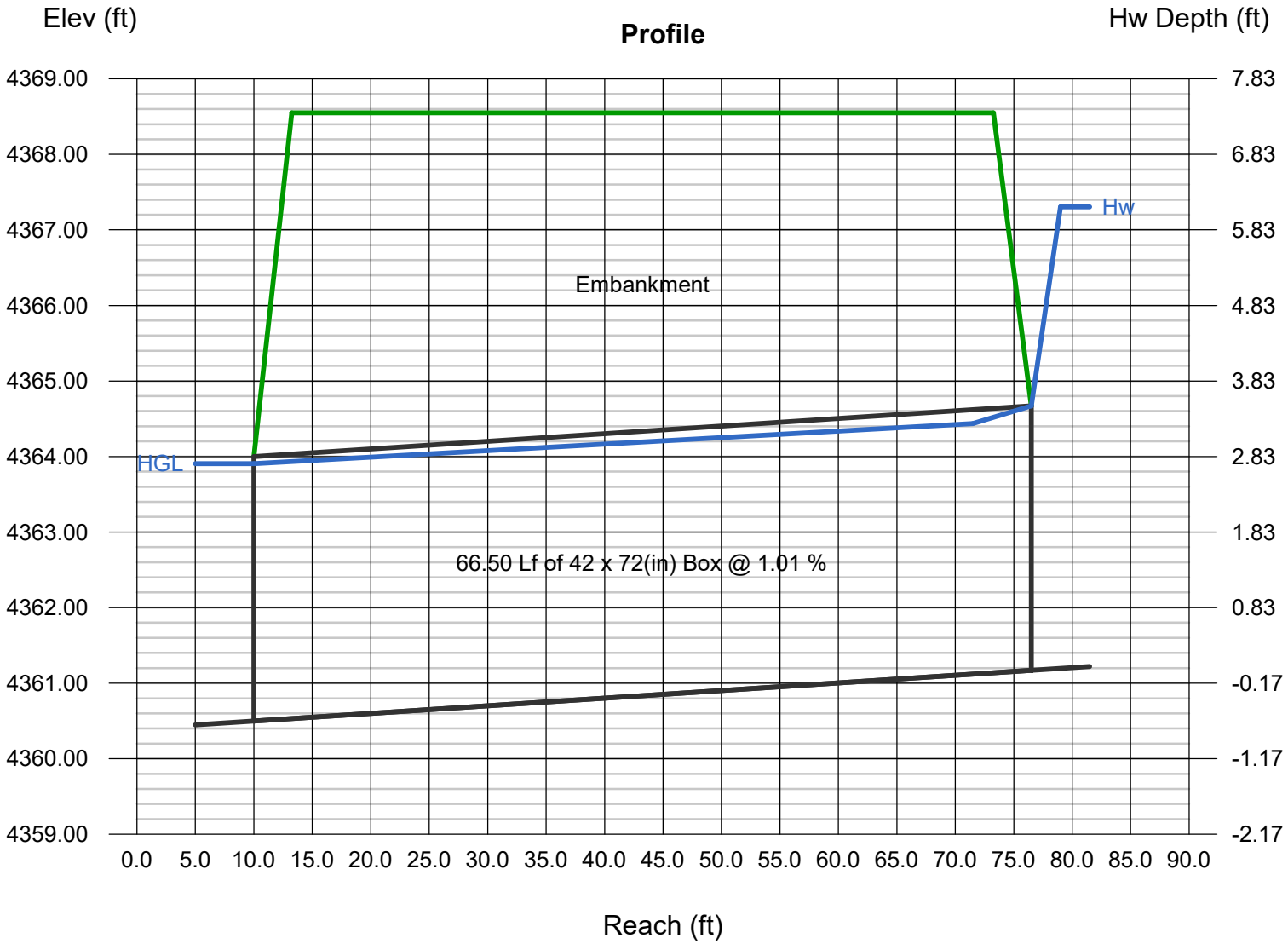
Top Elevation (ft)	=	4368.55
Top Width (ft)	=	60.00
Crest Width (ft)	=	25.00

Calculations

Qmin (cfs)	=	616.00
Qmax (cfs)	=	616.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	616.00
Qpipe (cfs)	=	616.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	10.05
Veloc Up (ft/s)	=	10.34
HGL Dn (ft)	=	4363.91
HGL Up (ft)	=	4364.48
Hw Elev (ft)	=	4367.31
Hw/D (ft)	=	1.75
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Jul 24 2019

RAINBOW CULVERT 1 - 100 YEAR

Invert Elev Dn (ft)	=	4360.50
Pipe Length (ft)	=	66.50
Slope (%)	=	1.01
Invert Elev Up (ft)	=	4361.17
Rise (in)	=	48.0
Shape	=	Box
Span (in)	=	84.0
No. Barrels	=	3
n-Value	=	0.012
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

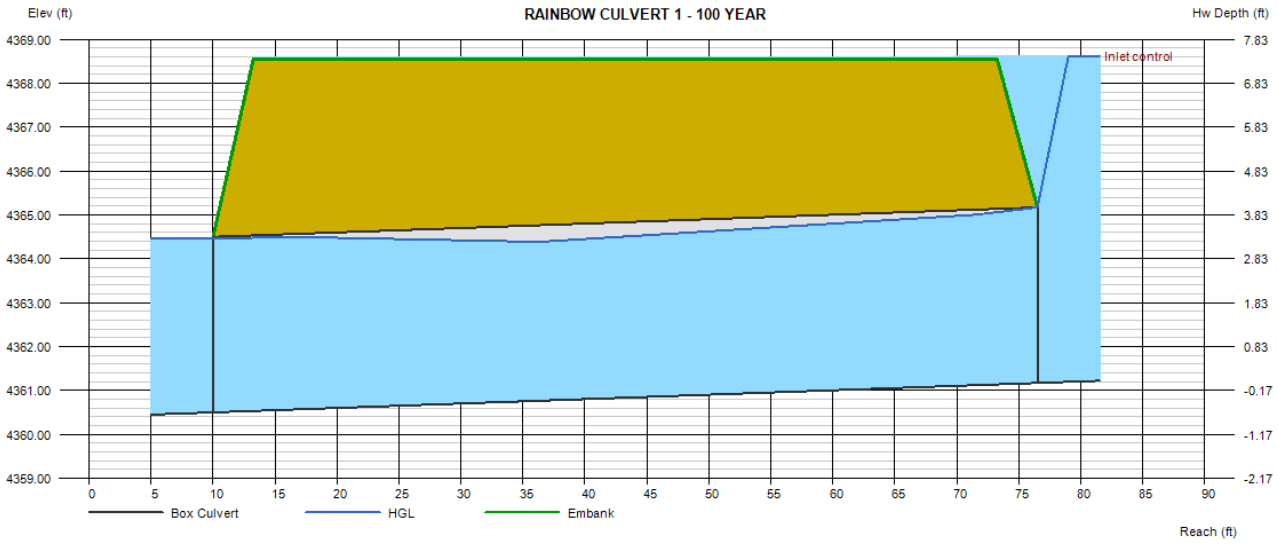
Top Elevation (ft)	=	4368.55
Top Width (ft)	=	60.00
Crest Width (ft)	=	25.00

Calculations

Qmin (cfs)	=	927.00
Qmax (cfs)	=	927.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	927.00
Qpipe (cfs)	=	927.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	11.14
Veloc Up (ft/s)	=	11.25
HGL Dn (ft)	=	4364.46
HGL Up (ft)	=	4365.09
Hw Elev (ft)	=	4368.62
Hw/D (ft)	=	1.86
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Jul 24 2019

RAINBOW CULVERT 2 - 25 YEAR

Invert Elev Dn (ft)	=	4345.80
Pipe Length (ft)	=	322.00
Slope (%)	=	0.50
Invert Elev Up (ft)	=	4347.41
Rise (in)	=	42.0
Shape	=	Box
Span (in)	=	72.0
No. Barrels	=	3
n-Value	=	0.012
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

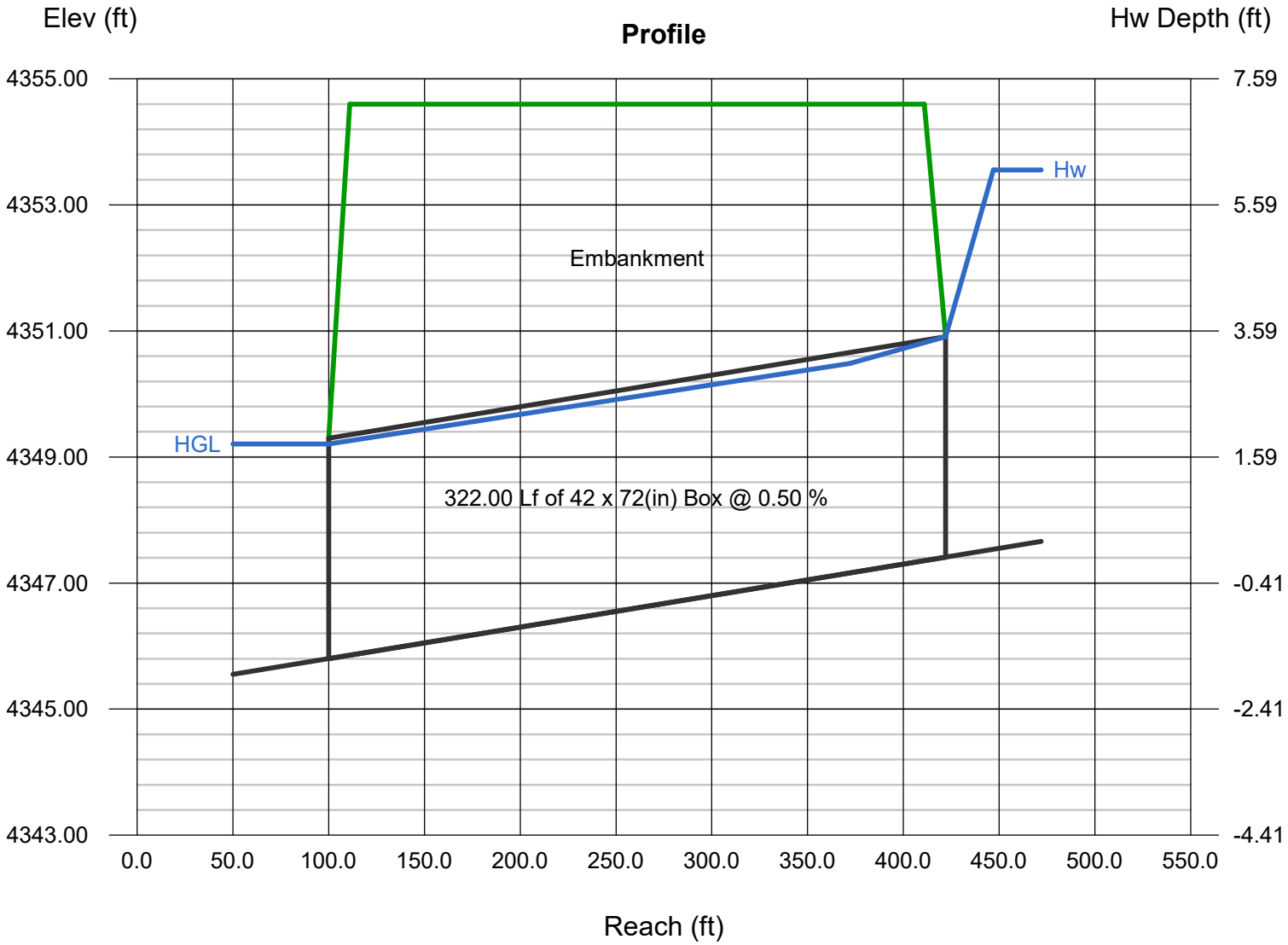
Top Elevation (ft)	=	4354.60
Top Width (ft)	=	300.00
Crest Width (ft)	=	25.00

Calculations

Qmin (cfs)	=	616.00
Qmax (cfs)	=	616.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	616.00
Qpipe (cfs)	=	616.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	10.05
Veloc Up (ft/s)	=	10.34
HGL Dn (ft)	=	4349.21
HGL Up (ft)	=	4350.72
Hw Elev (ft)	=	4353.55
Hw/D (ft)	=	1.76
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Jul 24 2019

RAINBOW CULVERT 2 - 100 YEAR

Invert Elev Dn (ft)	=	4345.80
Pipe Length (ft)	=	322.00
Slope (%)	=	0.50
Invert Elev Up (ft)	=	4347.41
Rise (in)	=	48.0
Shape	=	Box
Span (in)	=	96.0
No. Barrels	=	3
n-Value	=	0.012
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

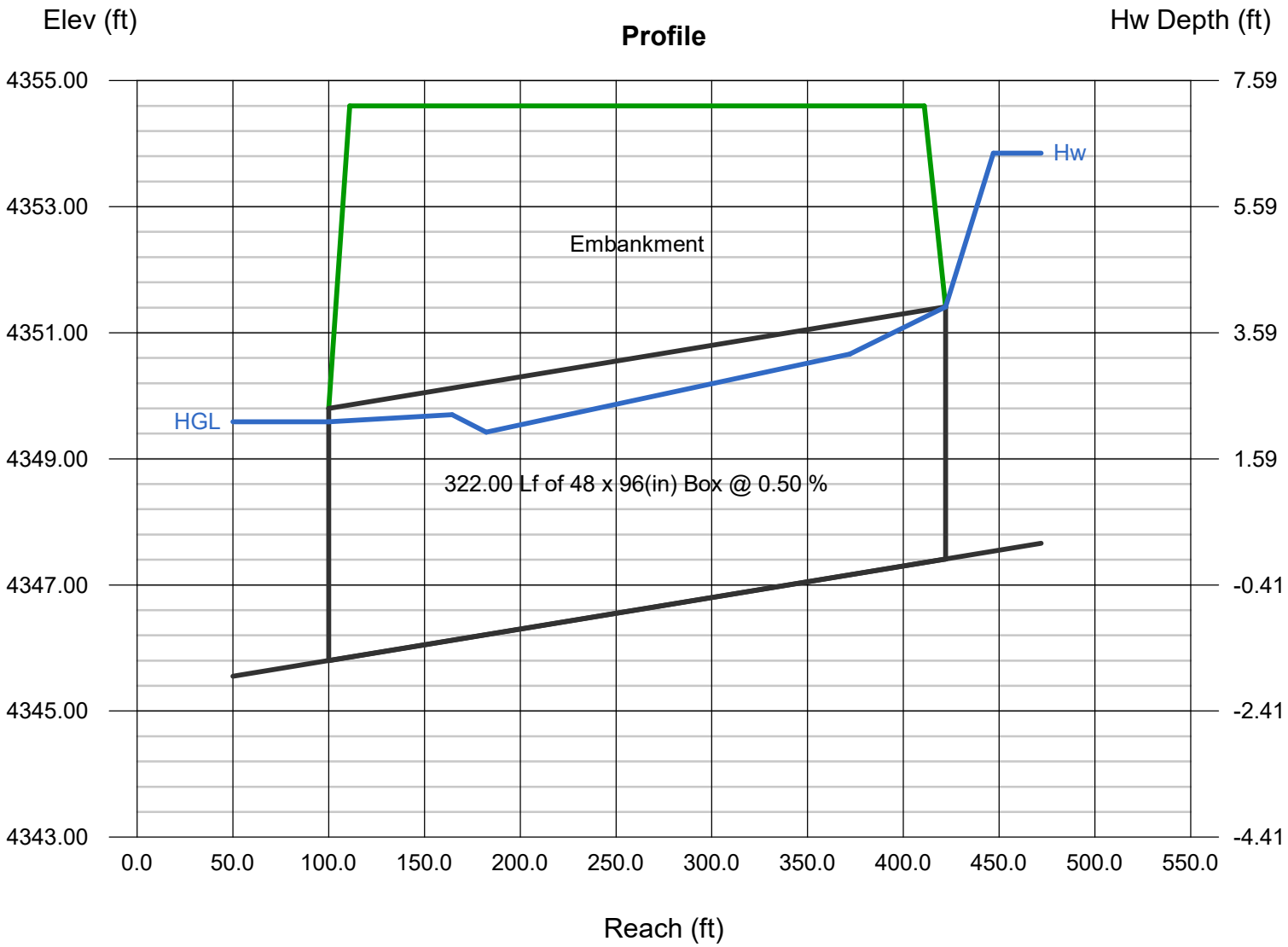
Top Elevation (ft)	=	4354.60
Top Width (ft)	=	300.00
Crest Width (ft)	=	25.00

Calculations

Qmin (cfs)	=	923.00
Qmax (cfs)	=	923.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	923.00
Qpipe (cfs)	=	923.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	10.15
Veloc Up (ft/s)	=	10.75
HGL Dn (ft)	=	4349.59
HGL Up (ft)	=	4350.99
Hw Elev (ft)	=	4353.85
Hw/D (ft)	=	1.61
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Jul 24 2019

RAINBOW CULVERT 3 - 25 YEAR

Invert Elev Dn (ft)	= 4331.75
Pipe Length (ft)	= 57.00
Slope (%)	= 0.75
Invert Elev Up (ft)	= 4332.18
Rise (in)	= 42.0
Shape	= Box
Span (in)	= 72.0
No. Barrels	= 3
n-Value	= 0.012
Culvert Type	= Flared Wingwalls
Culvert Entrance	= 30D to 75D wingwall flares
Coeff. K,M,c,Y,k	= 0.026, 1, 0.0347, 0.81, 0.4

Embankment

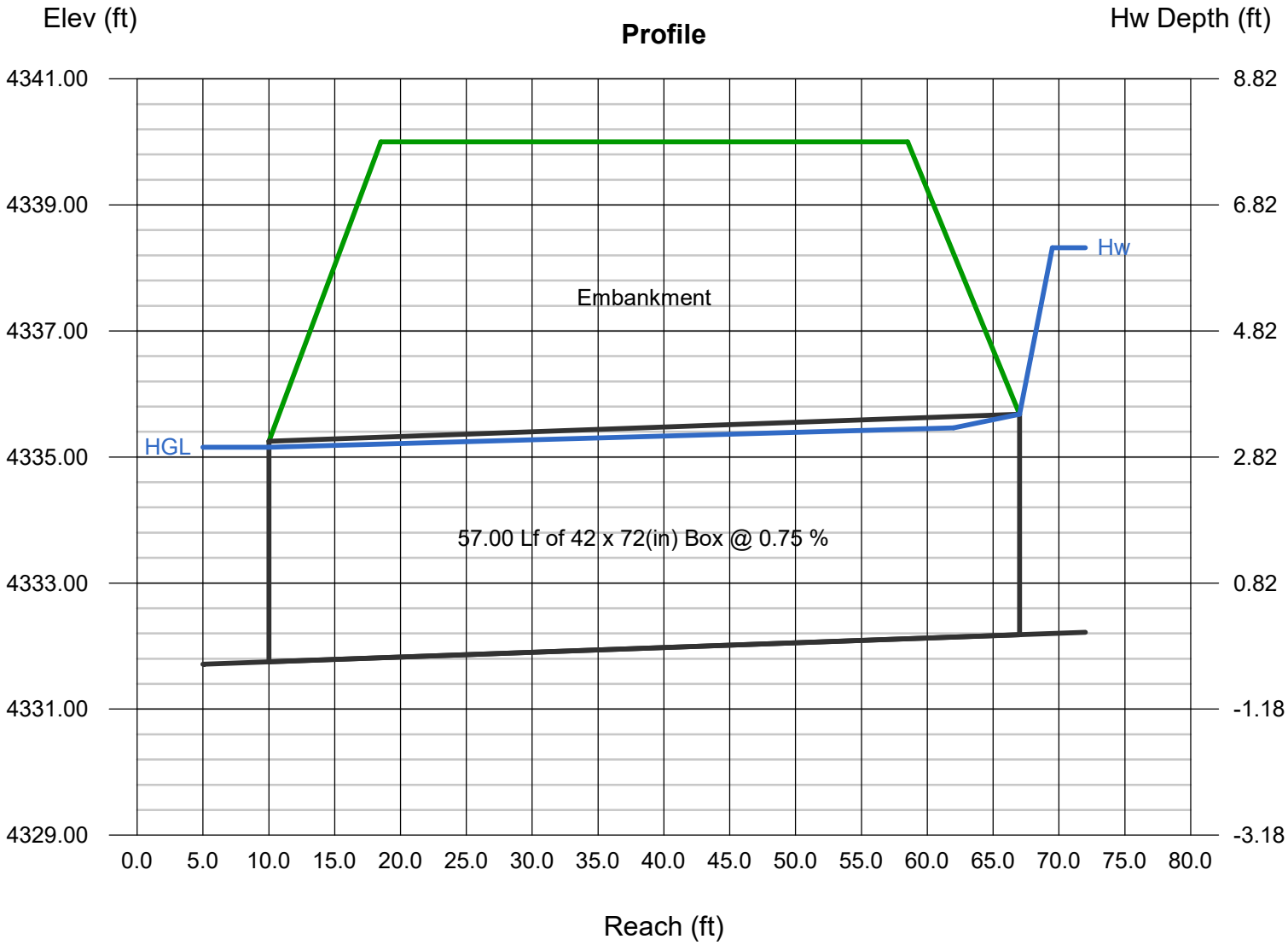
Top Elevation (ft)	= 4340.00
Top Width (ft)	= 40.00
Crest Width (ft)	= 25.00

Calculations

Qmin (cfs)	= 616.00
Qmax (cfs)	= 616.00
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 616.00
Qpipe (cfs)	= 616.00
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 10.05
Veloc Up (ft/s)	= 10.34
HGL Dn (ft)	= 4335.16
HGL Up (ft)	= 4335.49
Hw Elev (ft)	= 4338.32
Hw/D (ft)	= 1.75
Flow Regime	= Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Jul 24 2019

RAINBOW CULVERT 3 - 100 YEAR

Invert Elev Dn (ft)	=	4331.75
Pipe Length (ft)	=	57.00
Slope (%)	=	0.75
Invert Elev Up (ft)	=	4332.18
Rise (in)	=	48.0
Shape	=	Box
Span (in)	=	84.0
No. Barrels	=	3
n-Value	=	0.012
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

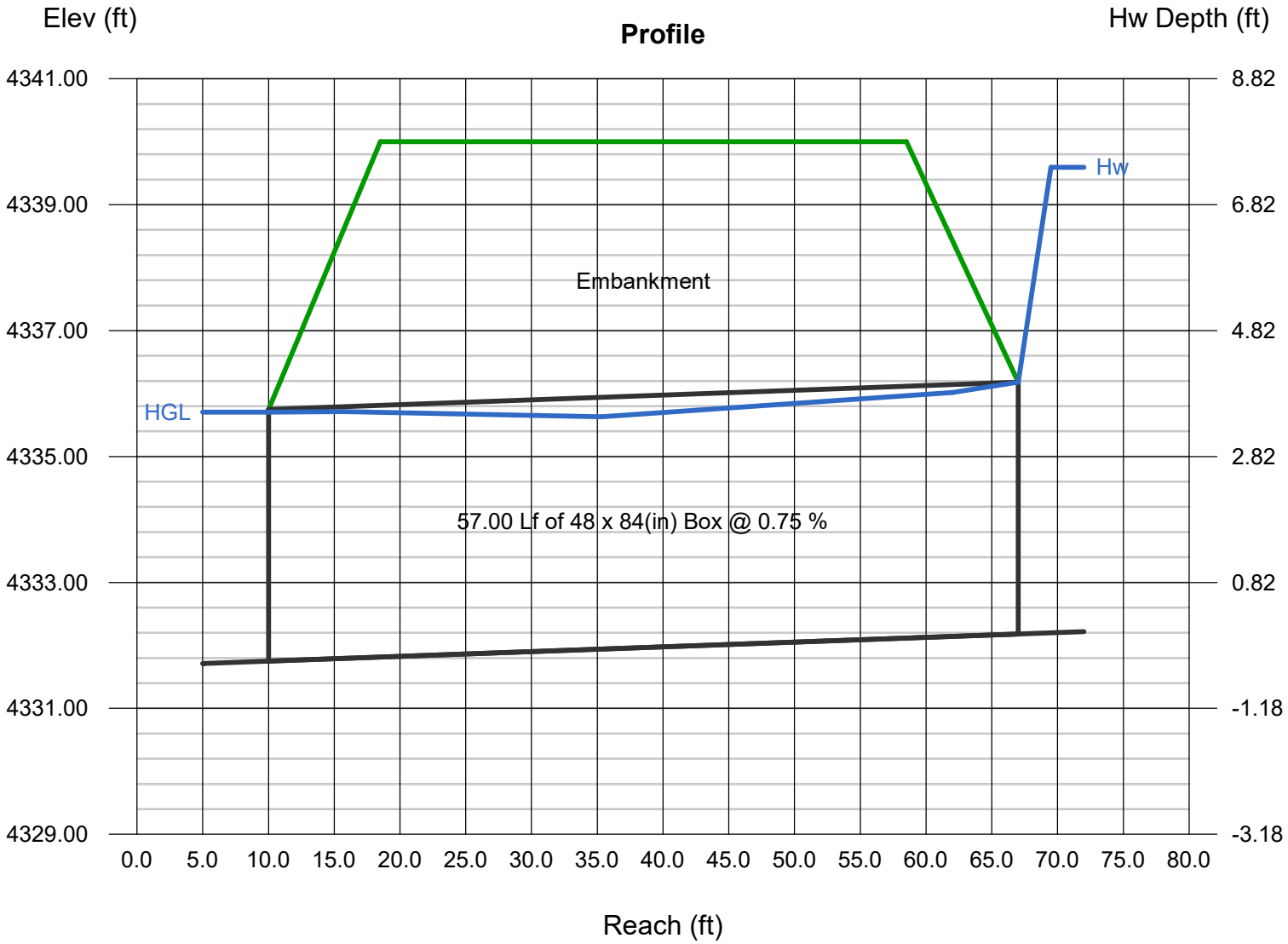
Top Elevation (ft)	=	4340.00
Top Width (ft)	=	40.00
Crest Width (ft)	=	25.00

Calculations

Qmin (cfs)	=	923.00
Qmax (cfs)	=	923.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	923.00
Qpipe (cfs)	=	923.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	11.11
Veloc Up (ft/s)	=	11.24
HGL Dn (ft)	=	4335.71
HGL Up (ft)	=	4336.09
Hw Elev (ft)	=	4339.60
Hw/D (ft)	=	1.85
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Jul 24 2019

RAINBOW CULVERT 4 - 25 YEAR

Invert Elev Dn (ft)	=	4324.00
Pipe Length (ft)	=	51.40
Slope (%)	=	0.99
Invert Elev Up (ft)	=	4324.51
Rise (in)	=	42.0
Shape	=	Box
Span (in)	=	72.0
No. Barrels	=	3
n-Value	=	0.012
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

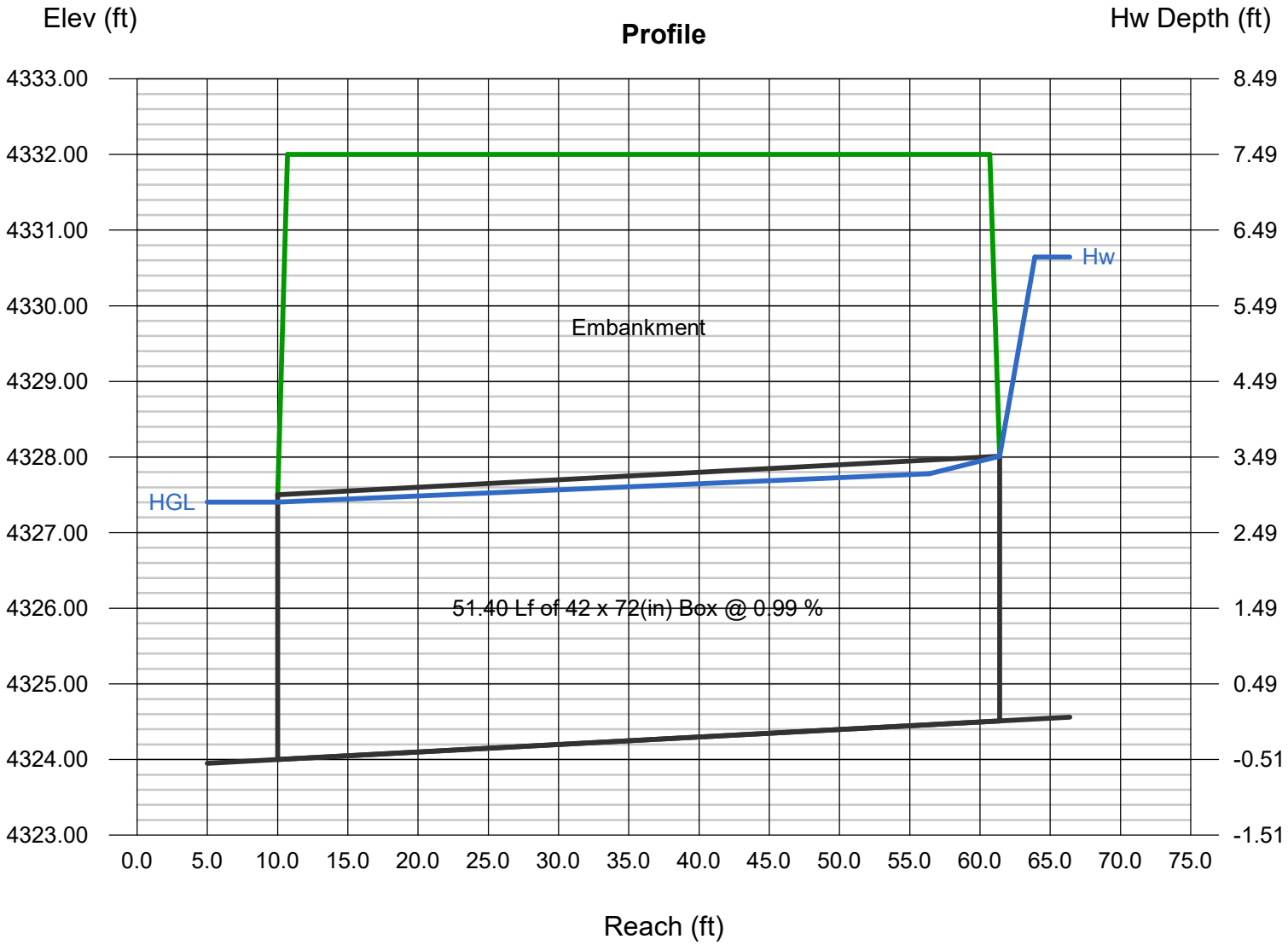
Top Elevation (ft)	=	4332.00
Top Width (ft)	=	50.00
Crest Width (ft)	=	25.00

Calculations

Qmin (cfs)	=	616.00
Qmax (cfs)	=	616.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	616.00
Qpipe (cfs)	=	616.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	10.05
Veloc Up (ft/s)	=	10.34
HGL Dn (ft)	=	4327.41
HGL Up (ft)	=	4327.82
Hw Elev (ft)	=	4330.65
Hw/D (ft)	=	1.75
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Jul 24 2019

RAINBOW CULVERT 4 - 100 YEAR

Invert Elev Dn (ft)	=	4324.00
Pipe Length (ft)	=	51.40
Slope (%)	=	0.99
Invert Elev Up (ft)	=	4324.51
Rise (in)	=	48.0
Shape	=	Box
Span (in)	=	84.0
No. Barrels	=	3
n-Value	=	0.012
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

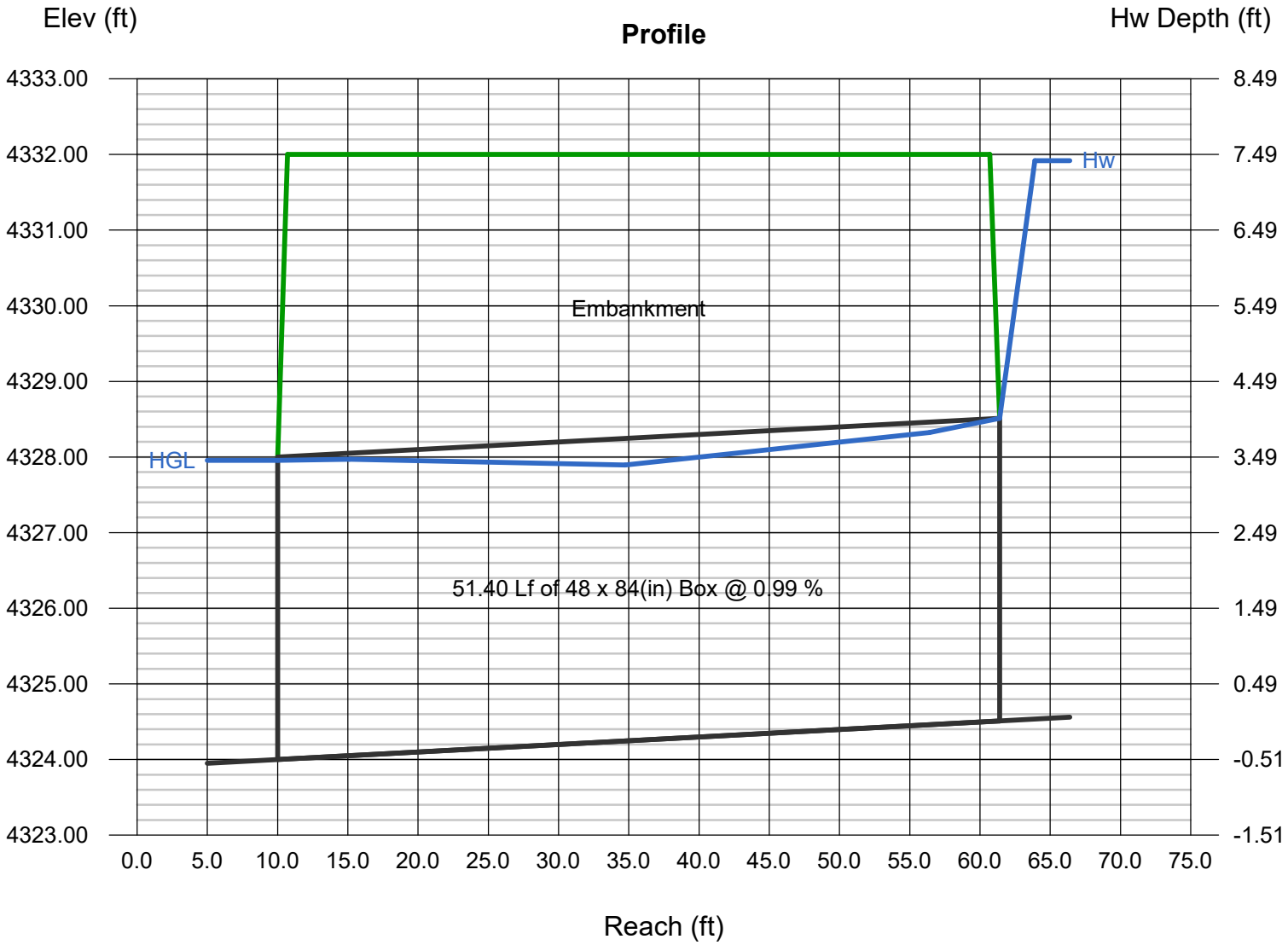
Top Elevation (ft)	=	4332.00
Top Width (ft)	=	50.00
Crest Width (ft)	=	25.00

Calculations

Qmin (cfs)	=	923.00
Qmax (cfs)	=	923.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	923.00
Qpipe (cfs)	=	923.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	11.11
Veloc Up (ft/s)	=	11.24
HGL Dn (ft)	=	4327.96
HGL Up (ft)	=	4328.42
Hw Elev (ft)	=	4331.92
Hw/D (ft)	=	1.85
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Jul 1 2019

Ft. Churchill Culvert - 25 Year

Invert Elev Dn (ft)	=	4277.11
Pipe Length (ft)	=	160.00
Slope (%)	=	2.00
Invert Elev Up (ft)	=	4280.31
Rise (in)	=	60.0
Shape	=	Box
Span (in)	=	96.0
No. Barrels	=	2
n-Value	=	0.012
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

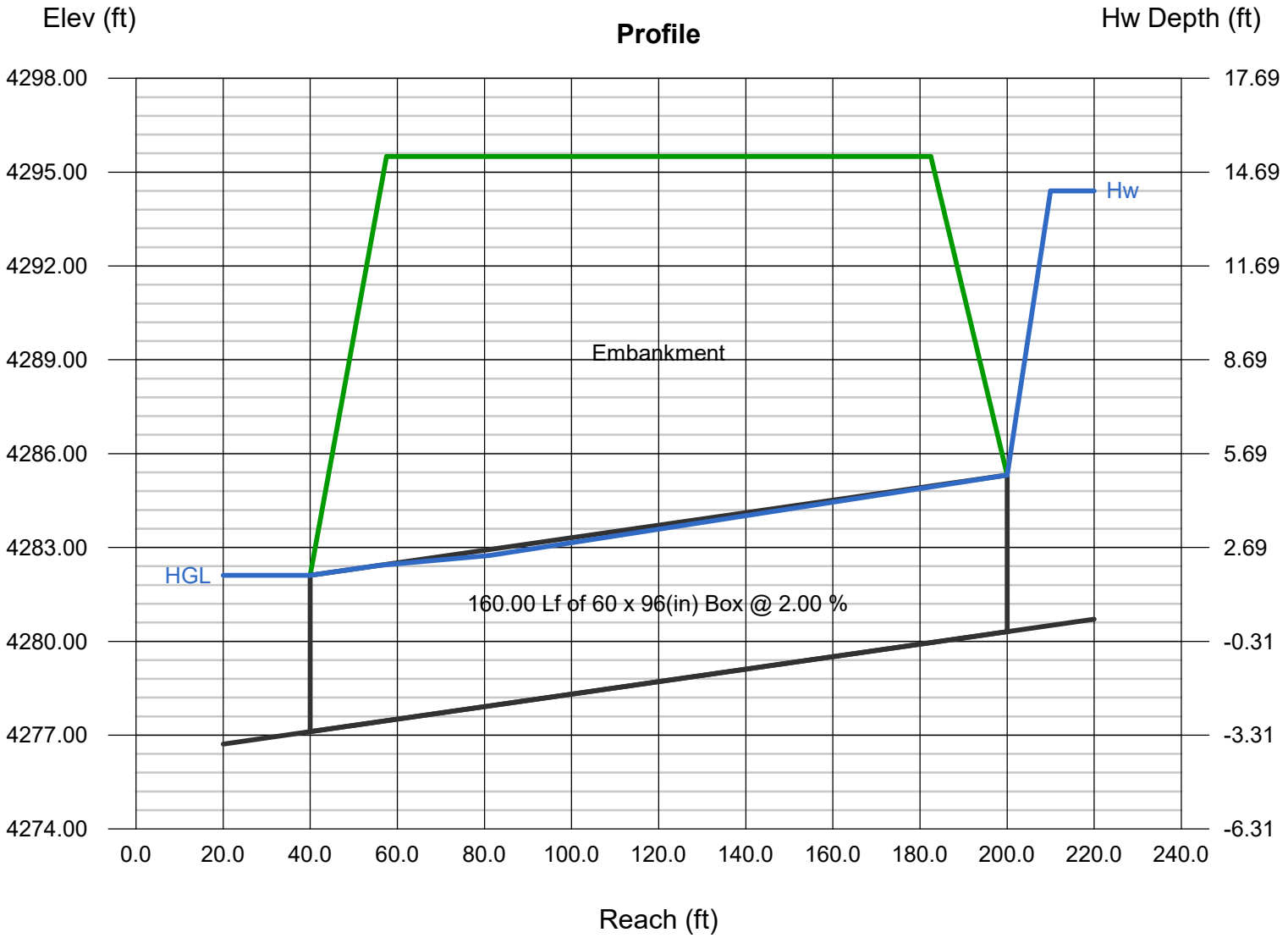
Top Elevation (ft)	=	4295.50
Top Width (ft)	=	125.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	1364.00
Qmax (cfs)	=	1364.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	1364.00
Qpipe (cfs)	=	1364.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	17.05
Veloc Up (ft/s)	=	17.05
HGL Dn (ft)	=	4282.11
HGL Up (ft)	=	4285.31
Hw Elev (ft)	=	4294.40
Hw/D (ft)	=	2.82
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Jul 1 2019

Ft. Churchill Culvert - 100 Year

Invert Elev Dn (ft)	=	4282.30
Pipe Length (ft)	=	160.00
Slope (%)	=	2.00
Invert Elev Up (ft)	=	4285.50
Rise (in)	=	72.0
Shape	=	Box
Span (in)	=	120.0
No. Barrels	=	3
n-Value	=	0.012
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

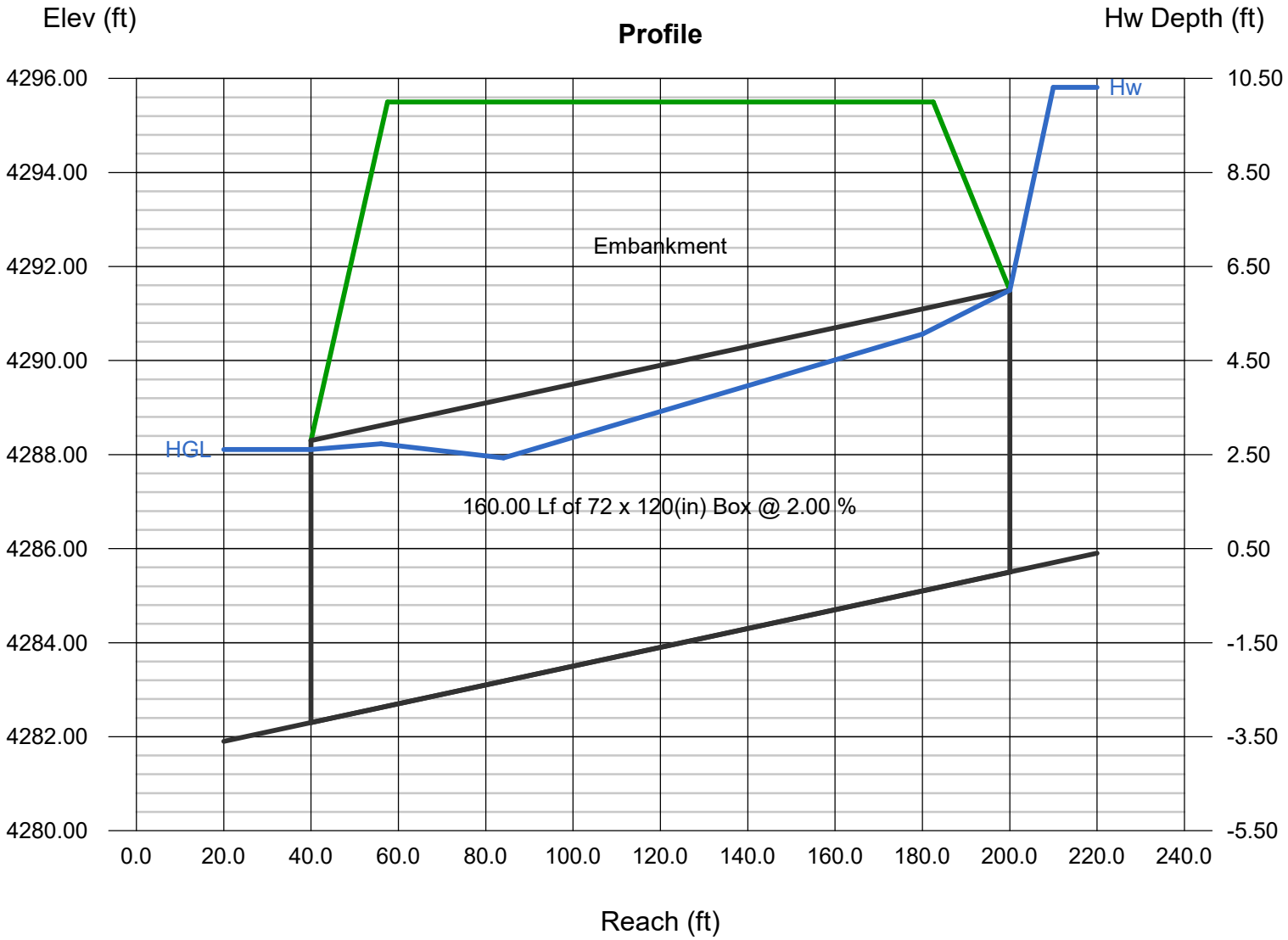
Top Elevation (ft)	=	4295.50
Top Width (ft)	=	125.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	2268.00
Qmax (cfs)	=	2268.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	2268.00
Qpipe (cfs)	=	2268.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	13.02
Veloc Up (ft/s)	=	13.47
HGL Dn (ft)	=	4288.11
HGL Up (ft)	=	4291.11
Hw Elev (ft)	=	4295.81
Hw/D (ft)	=	1.72
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Jul 1 2019

Mark Twain Culvert 1 - 25yr

Invert Elev Dn (ft)	=	4418.02
Pipe Length (ft)	=	40.00
Slope (%)	=	1.00
Invert Elev Up (ft)	=	4418.42
Rise (in)	=	48.0
Shape	=	Circular
Span (in)	=	48.0
No. Barrels	=	2
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end projecting (C)
Coeff. K,M,c,Y,k	=	0.0045, 2, 0.0317, 0.69, 0.2

Embankment

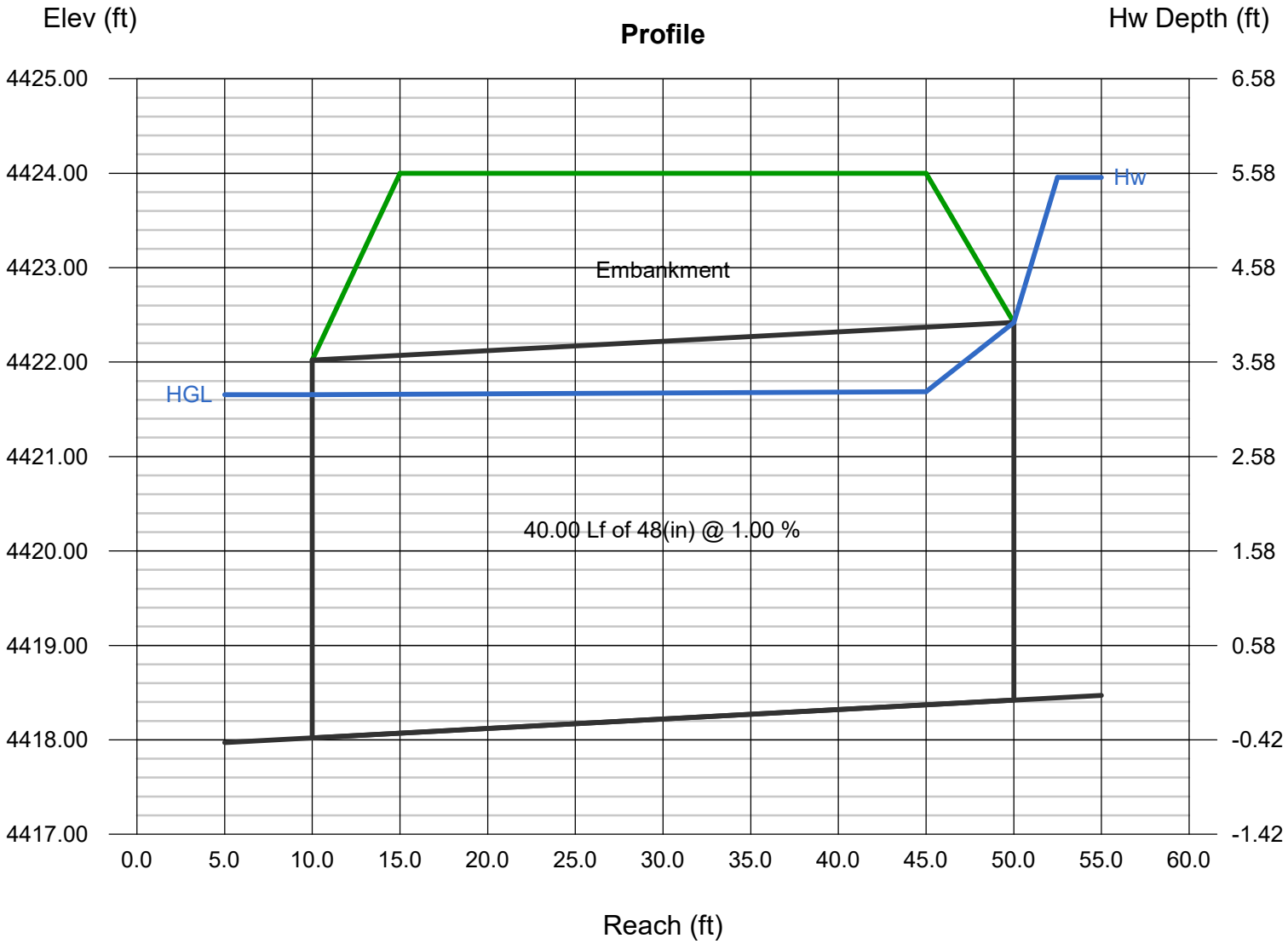
Top Elevation (ft)	=	4424.00
Top Width (ft)	=	30.00
Crest Width (ft)	=	25.00

Calculations

Qmin (cfs)	=	236.00
Qmax (cfs)	=	236.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	236.00
Qpipe (cfs)	=	236.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	9.84
Veloc Up (ft/s)	=	10.73
HGL Dn (ft)	=	4421.66
HGL Up (ft)	=	4421.69
Hw Elev (ft)	=	4423.96
Hw/D (ft)	=	1.38
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Jul 1 2019

Mark Twain Culvert 1 - 100yr

Invert Elev Dn (ft)	=	4418.02
Pipe Length (ft)	=	40.00
Slope (%)	=	1.00
Invert Elev Up (ft)	=	4418.42
Rise (in)	=	48.0
Shape	=	Circular
Span (in)	=	48.0
No. Barrels	=	3
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end projecting (C)
Coeff. K,M,c,Y,k	=	0.0045, 2, 0.0317, 0.69, 0.2

Embankment

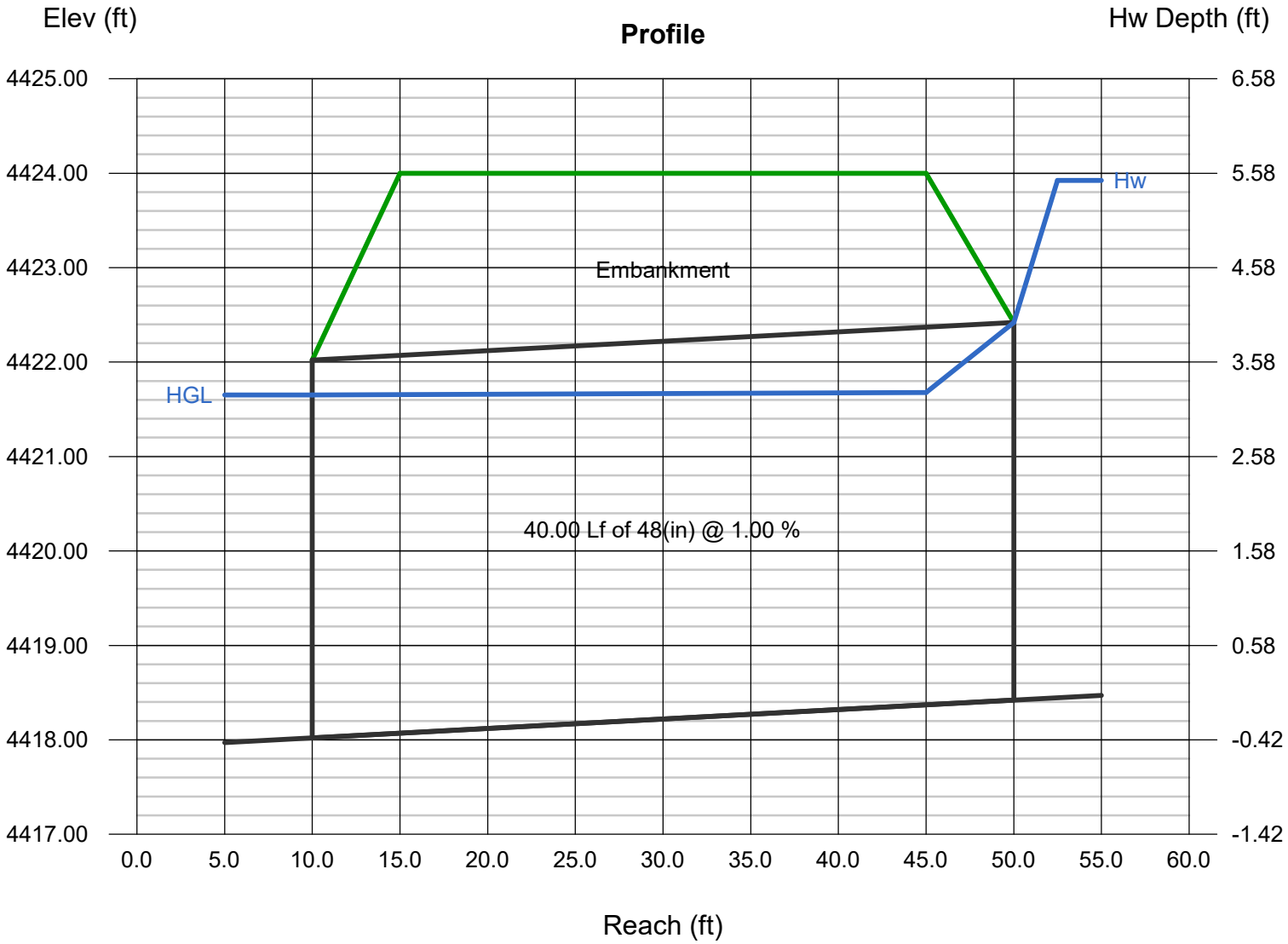
Top Elevation (ft)	=	4424.00
Top Width (ft)	=	30.00
Crest Width (ft)	=	25.00

Calculations

Qmin (cfs)	=	352.00
Qmax (cfs)	=	352.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	352.00
Qpipe (cfs)	=	352.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	9.79
Veloc Up (ft/s)	=	10.69
HGL Dn (ft)	=	4421.65
HGL Up (ft)	=	4421.68
Hw Elev (ft)	=	4423.92
Hw/D (ft)	=	1.38
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Jul 1 2019

Mark Twain Culvert 2 - 25 yr

Invert Elev Dn (ft)	=	4342.71
Pipe Length (ft)	=	40.00
Slope (%)	=	1.00
Invert Elev Up (ft)	=	4343.11
Rise (in)	=	36.0
Shape	=	Circular
Span (in)	=	36.0
No. Barrels	=	3
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end projecting (C)
Coeff. K,M,c,Y,k	=	0.0045, 2, 0.0317, 0.69, 0.2

Embankment

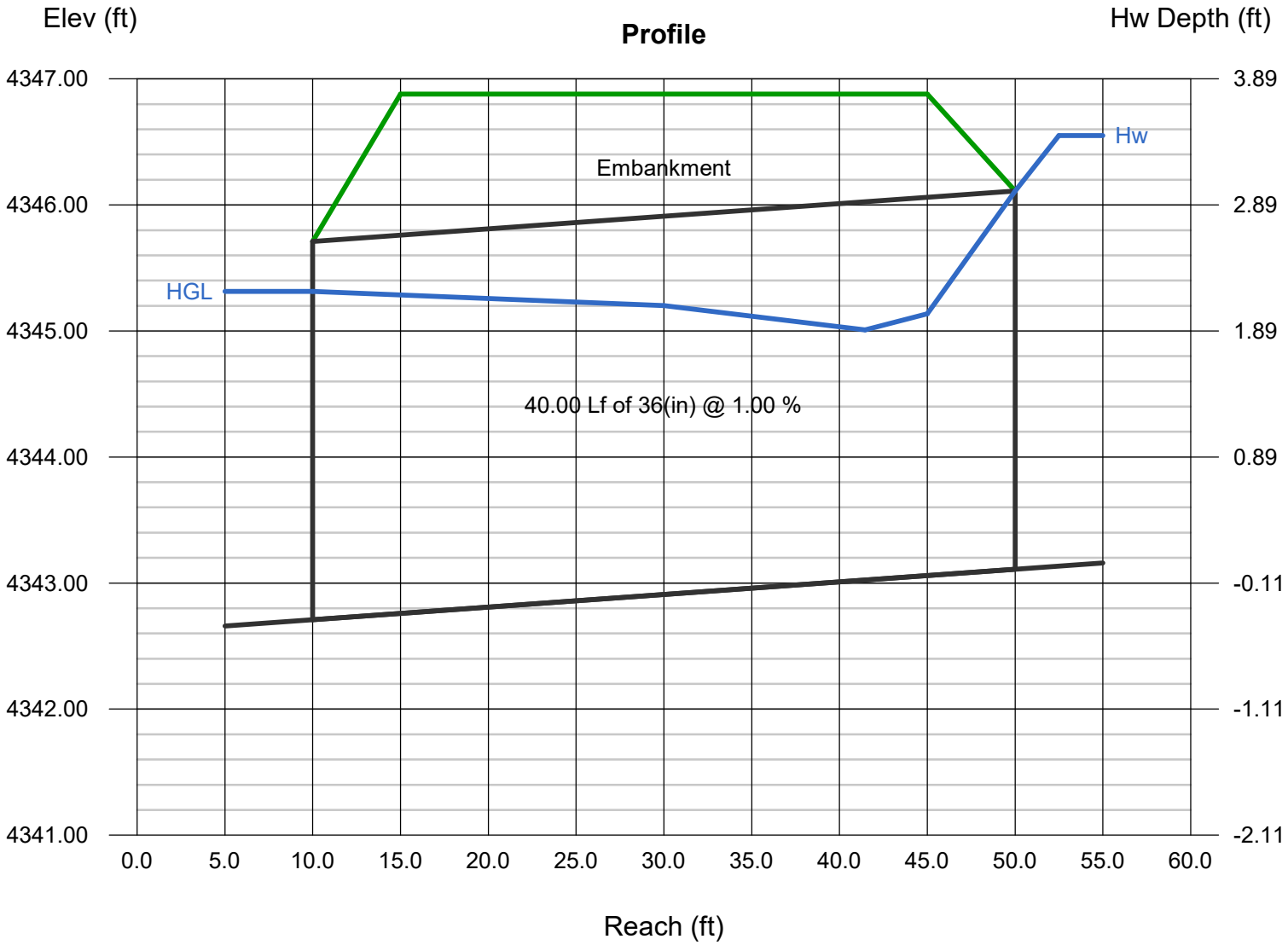
Top Elevation (ft)	=	4346.88
Top Width (ft)	=	30.00
Crest Width (ft)	=	25.00

Calculations

Qmin (cfs)	=	138.00
Qmax (cfs)	=	138.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	138.00
Qpipe (cfs)	=	138.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	7.06
Veloc Up (ft/s)	=	8.25
HGL Dn (ft)	=	4345.31
HGL Up (ft)	=	4345.32
Hw Elev (ft)	=	4346.55
Hw/D (ft)	=	1.15
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Jul 1 2019

Mark Twain Culvert 2 - 100 yr

Invert Elev Dn (ft)	=	4342.00
Pipe Length (ft)	=	40.00
Slope (%)	=	0.50
Invert Elev Up (ft)	=	4342.20
Rise (in)	=	48.0
Shape	=	Circular
Span (in)	=	48.0
No. Barrels	=	3
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end projecting (C)
Coeff. K,M,c,Y,k	=	0.0045, 2, 0.0317, 0.69, 0.2

Embankment

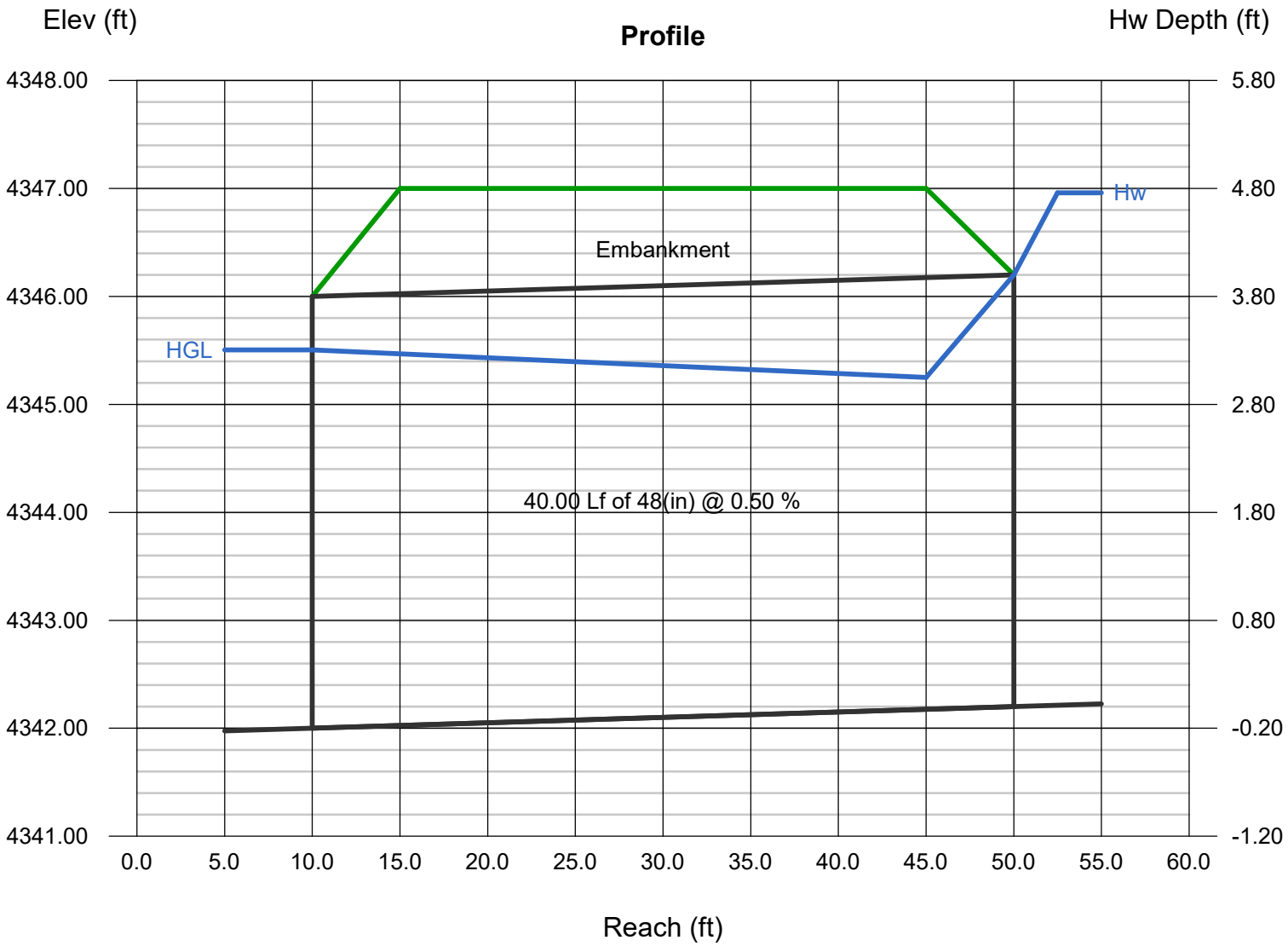
Top Elevation (ft)	=	4347.00
Top Width (ft)	=	30.00
Crest Width (ft)	=	25.00

Calculations

Qmin (cfs)	=	297.00
Qmax (cfs)	=	297.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	297.00
Qpipe (cfs)	=	297.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	8.48
Veloc Up (ft/s)	=	9.75
HGL Dn (ft)	=	4345.51
HGL Up (ft)	=	4345.21
Hw Elev (ft)	=	4346.96
Hw/D (ft)	=	1.19
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Jul 1 2019

Mark Twain Culvert 3 - 25 yr

Invert Elev Dn (ft)	=	4337.60
Pipe Length (ft)	=	40.00
Slope (%)	=	1.00
Invert Elev Up (ft)	=	4338.00
Rise (in)	=	36.0
Shape	=	Circular
Span (in)	=	36.0
No. Barrels	=	3
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0018, 2, 0.0292, 0.74, 0.2

Embankment

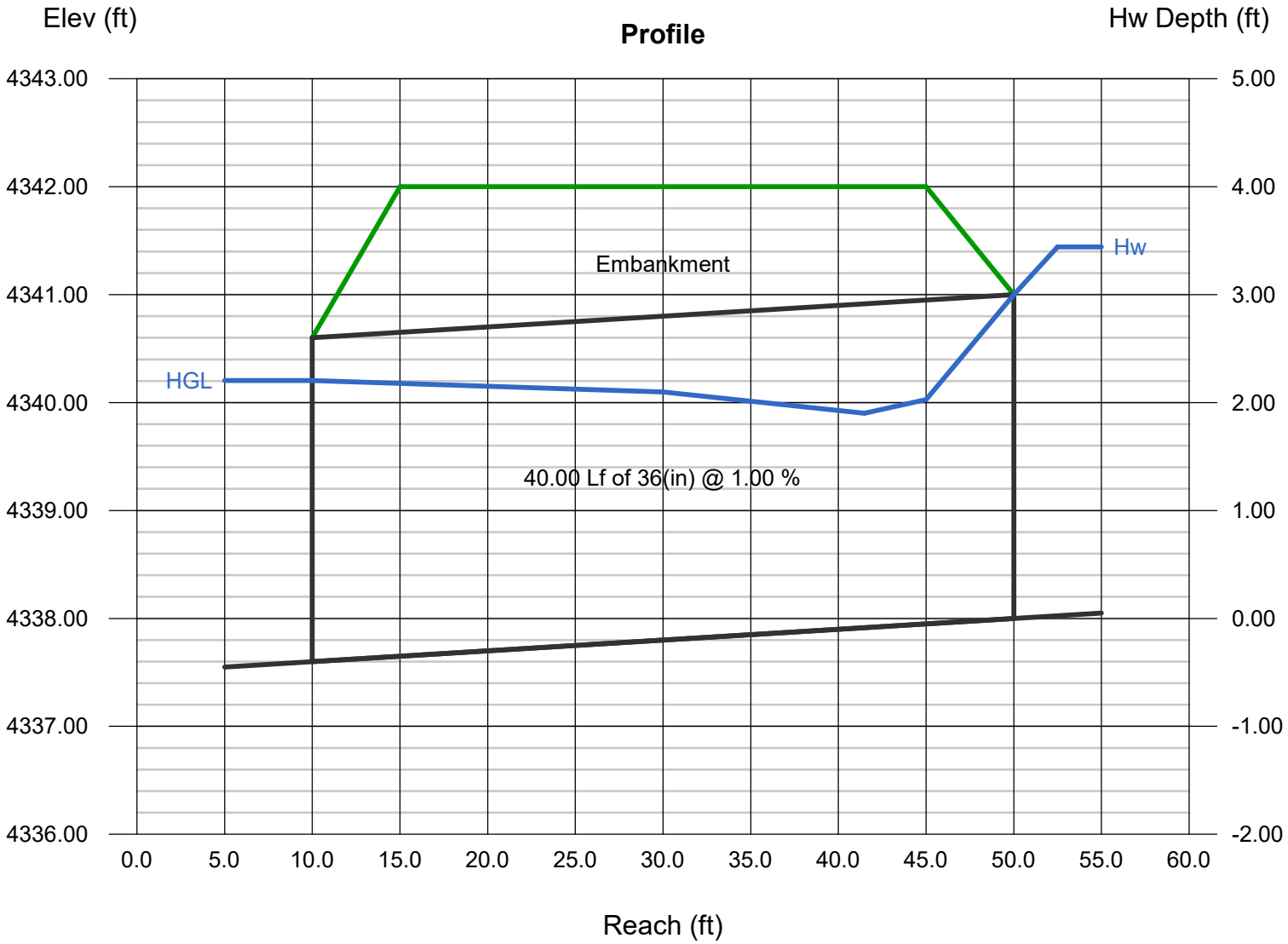
Top Elevation (ft)	=	4342.00
Top Width (ft)	=	30.00
Crest Width (ft)	=	25.00

Calculations

Qmin (cfs)	=	138.00
Qmax (cfs)	=	138.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	138.00
Qpipe (cfs)	=	138.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	7.06
Veloc Up (ft/s)	=	8.25
HGL Dn (ft)	=	4340.20
HGL Up (ft)	=	4340.21
Hw Elev (ft)	=	4341.44
Hw/D (ft)	=	1.15
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Jul 1 2019

Mark Twain Culvert 3 - 100 yr

Invert Elev Dn (ft)	=	4337.60
Pipe Length (ft)	=	40.00
Slope (%)	=	1.00
Invert Elev Up (ft)	=	4338.00
Rise (in)	=	36.0
Shape	=	Box
Span (in)	=	72.0
No. Barrels	=	2
n-Value	=	0.013
Culvert Type	=	Flared Wingwalls, Top Edge Bevel
Culvert Entrance	=	45D wingwall flare d=0.043D
Coeff. K,M,c,Y,k	=	0.51, 0.667, 0.0309, 0.8, 0.2

Embankment

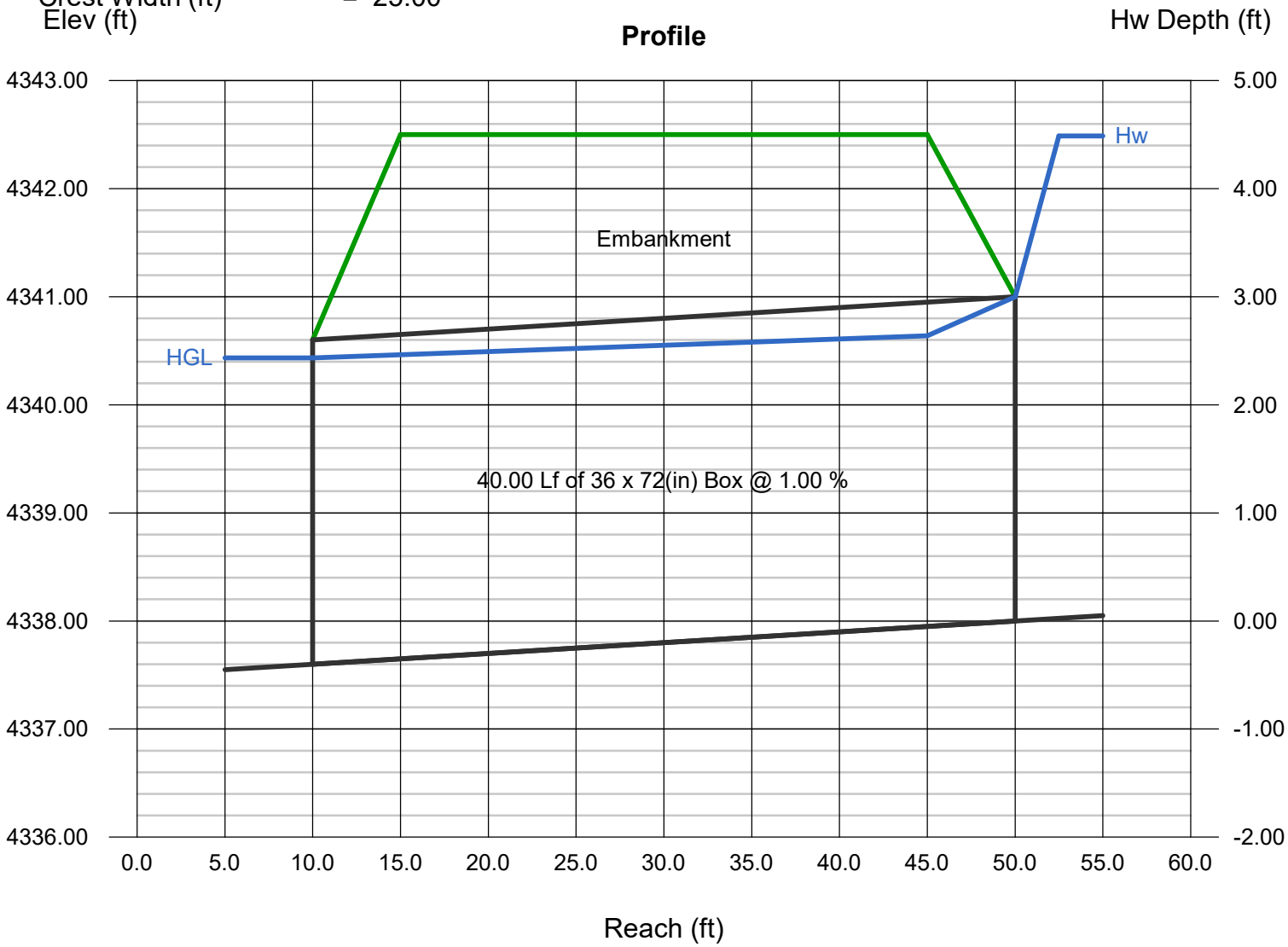
Top Elevation (ft)	=	4342.50
Top Width (ft)	=	30.00
Crest Width (ft)	=	25.00

Calculations

Qmin (cfs)	=	297.00
Qmax (cfs)	=	297.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	297.00
Qpipe (cfs)	=	297.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	8.73
Veloc Up (ft/s)	=	9.28
HGL Dn (ft)	=	4340.43
HGL Up (ft)	=	4340.67
Hw Elev (ft)	=	4342.49
Hw/D (ft)	=	1.50
Flow Regime	=	Inlet Control



Weir and Orifice Calculations

Circular Orifice (Orifices.fm8) Report

Label	Solve For	Discharge (ft³/s)	Headwater Elevation (ft)
Lonnie Orifice - 25/100 YR	Discharge	42.81	4358.00
Sutro Springs Orifice - 25 YR	Discharge	43.65	4536.00
Sutro Springs Orifice - 100 YR	Discharge	51.95	4541.00

Centroid Elevation (ft)	Tailwater Elevation (ft)	Discharge Coefficient	Diameter (ft)
4355.47	4355.72	0.50	3.00
4524.00	4506.00	0.50	2.00
4524.00	4506.00	0.50	2.00

Headwater Height Above Centroid (ft)	Tailwater Height Above Centroid (ft)	Flow Area (ft²)	Velocity (ft/s)
2.53	0.25	7.07	6.06
12.00	-18.00	3.14	13.89
17.00	-18.00	3.14	16.54

Notes	Messages

Broad Crested Weir (Weirs.fm8) Report

Label	Solve For	Discharge (ft³/s)	Headwater Elevation (ft)
Gold Canyon Weir	Headwater Elevation	2100.00	4424.00

Crest Elevation (ft)	Tailwater Elevation (ft)	Crest Surface Type	Crest Breadth (ft)
4422.00	4420.00	Gravel	5.00

Crest Length (ft)	Headwater Height Above Crest (ft)	Tailwater Height Above Crest (ft)	Weir Coefficient (US)
240.00	2.00	-2.00	3.09

Submergence Factor	Adjusted Weir Coefficient (US)	Flow Area (ft²)	Velocity (ft/s)
1.00	3.09	480.68	4.37

Wetted Perimeter (ft)	Top Width (ft)	Notes	Messages
244.01	240.00		

US District Court Water Master
Cardelli Ditch Flow Data

U.S. DISTRICT COURT WATER MASTER

C66 ROCK POINT / CARDELLI DITCH

Combined diversion for both ditches.

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 1996

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1				0	46	24	29	8.2				
2							28		9.1			
3									7.6			
4						23						
5						34		8.5	11			
6						23						
7								8.4				
8				29			26					
9								6.9				
10				33		16	35					
11						15	34		13			
12						26			12			
13					52			0	10			
14					55			0				
15				29			40	8.9				
16									22			
17				31		31			11			
18						31						
19						30	36	6.5	12			
20							28	9.8				
21							28					
22				29	29			8.2				
23									12			
24				29		29						
25						30	7.4		11			
26							6.9					
27												
28						32		0				
29				46	33		8.2	0				
30		------			33	31	16	6.9				
31		------		------	32	------			------		------	
TOTAL				848	1,240	804	769.0	172.4	356.5			
MEAN				28.3	40.0	26.8	24.8	5.56	11.9			
MAX				46	55	34	40	9.8	22			
MIN				0	29	15	6.9	0	7.6			
AC-FT				1,680	2,460	1,590	1,530	342	707			

YEAR 1996 TOTAL 4,189.0 MEAN 63.5 MAX 55 MIN 0 AC-FT 8,310

c:\stations\C96\C66.96\QAS.BIN Record for the period 4-1-96 to 10-1-96.

U.S. DISTRICT COURT WATER MASTER

C66 ROCK POINT / CARDELLI DITCH

Combined diversion for both ditches.

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 1997

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
N O D A T A T H I S W A T E R Y E A R												

U.S. DISTRICT COURT WATER MASTER

C66 ROCK POINT / CARDELLI DITCH

Combined diversion for both ditches.

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 1998

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1				0S		38	31		22			
2				0S		0S	40					
3				0S				10				
4				0S	28e				9.7			
5				0S	28e			0 S				
6				0S			31	0 S				
7				0S					24			
8				0S	28		30		24			
9				0S		32						
10				0S		0S	29	10	23			
11				0S	29							
12				0S				15				
13				0S	28		37	15				
14				0S	19							
15				0S		0S	26		28			
16				0S			18		24			
17				0S		21		25	23			
18				0S	11	0S						
19				0S				21				
20				0S	19		25	18				
21					23				25			
22				28e		0S	25					
23							28		25			
24						20		9.0	27			
25						19						
26								16				
27				28e				16				
28							22					
29		------		28e	29	31	17					
30		------							18			
31		------		------	39	------	12	15	------		------	
TOTAL				110	792	439	822	405.4	681.7			
MEAN				3.65	25.5	14.6	26.5	13.1	22.7			
MAX				28	39	38	40	25	28			
MIN				0	11	0	12	0	9.7			
AC-FT				217	1,570	871	1,630	804	1,350			

YEAR 1998 TOTAL 3,249.2 MEAN 38.7 MAX 40 MIN 0 AC-FT 6,440

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U.S. DISTRICT COURT WATER MASTER

C66 ROCK POINT / CARDELLI DITCH

Combined diversion for both ditches.

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 1999

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1				0S			41		14			
2						28						
3								19				
4						24		16				
5							40					
6								14				
7				0S		29	31		21			
8				0S			23		15			
9						29		23				
10					27	25			7.8			
11								31				
12				0S	26		18	27				
13					29		18		11			
14				0S		27						
15							23		15			
16						29		25	9.7			
17					29	28						
18								25				
19				23	30		25	21				
20					29				17			
21				22		31	25		21			
22							24		23			
23						28		12				
24					26	28						
25								18				
26				18	35		40	9.2				
27					35		40		19			
28				33		28	35					
29		------							22			
30		------				36		13				
31		------		------	30	------		13	------		------	
TOTAL				320	918	854	913	589.4	488.8			
MEAN				10.7	29.6	28.5	29.5	19.0	16.3			
MAX				33	35	36	41	31	23			
MIN				0	26	24	18	9.2	7.8			
AC-FT				635	1,820	1,690	1,810	1,170	969			

YEAR 1999 TOTAL 4,082.9 MEAN 57.5 MAX 41 MIN 0 AC-FT 8,090

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U.S. DISTRICT COURT WATER MASTER

C66 ROCK POINT / CARDELLI DITCH

Combined diversion for both ditches.

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 2000

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1												
2								0 S				
3				0S			29	0 S				
4									0S			
5				23		29	24		0S			
6							21		0S			
7						0S		7.0e				
8					33	41						
9								0 S				
10				24	26		11	0 S				
11					23		15		0S			
12				25		38			0S			
13							18		0S			
14						40		0 S				
15					29	43		0 S				
16								0 S				
17				0S	26		15					
18					24				0S			
19				24		42	0S		0S			
20							0S		0S			
21						42		0 S				
22					49	42		0 S				
23								0 S				
24				28	27		0S					
25					35				0S			
26				28		25	0S		0S			
27							0S		0S			
28						41		0 S				
29					24	42		0 S				
30		------			24			0 S				
31		------		------	27	------	0S		------		------	
TOTAL				570	896	1,063	317	15.5	0			
MEAN				19.0	28.9	35.4	10.2	.50	0			
MAX				28	49	43	29	7.0	0			
MIN				0	23	0	0	0	0			
AC-FT				1,130	1,780	2,110	629	31	0			

YEAR 2000 TOTAL 2,861.6 MEAN 40.3 MAX 49 MIN 0 AC-FT 5,680

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U.S. DISTRICT COURT WATER MASTER
C66 ROCK POINT / CARDELLI DITCH

Combined diversion for both ditches.

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 2001

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1								0S				
2				38			0S					
3												
4				21		26			0			
5						25	0S					
6												
7					39	21		0S				
8					25							
9				25	32		0S	0S				
10												
11						26			0			
12				23		25	0S					
13						24						
14				23	32			0S				
15					32							
16							0S	0				
17					32							
18							0S					
19				19		7.8						
20						7.0						
21					25	7.0e		0				
22					38	0 S						
23				21	37		0S					
24												
25				24		0 S	0S					
26						0 S						
27						0 S						
28								0				
29		------			35							
30		------			29		0S					
31		------		------	33	------			------		------	
TOTAL				728	1,005	389.5	0	0	0			
MEAN				24.3	32.4	13.0	0	0	0			
MAX				38	39	26	0	0	0			
MIN				19	25	0	0	0	0			
AC-FT				1,440	1,990	773	0	0	0			

YEAR 2001 TOTAL 2,122.0 MEAN 41.6 MAX 39 MIN 0 AC-FT 4,200

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U.S. DISTRICT COURT WATER MASTER
C66 ROCK POINT / CARDELLI DITCH

Combined diversion for both ditches.

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 2002

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1				40			23					
2									0			
3						25	13		0			
4				47								
5						32	9.7	0S				
6					47	41						
7								0S				
8				37	35		0 S					
9					42				0			
10						28	0 S		0			
11				42			0 S					
12						33		0S				
13					34	32	0 S					
14					33			0				
15				38	35							
16												
17				32		40	0 S					
18							0 S					
19						35		0S				
20						32						
21					24			0S				
22					21		0 S					
23				31	24							
24				32			0 S					
25						19	7.8e					
26						19		0				
27						13						
28					25			0				
29		------			30		0 S					
30		------			33		0 S					
31		------		------		------	0 S		------		------	
TOTAL				1,121	989	873	110.6	0	0			
MEAN				37.4	31.9	29.1	3.57	0	0			
MAX				47	47	41	23	0	0			
MIN				31	21	13	0	0	0			
AC-FT				2,220	1,960	1,730	219	0	0			

YEAR 2002 TOTAL 3,093.7 MEAN 52.4 MAX 47 MIN 0 AC-FT 6,130

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U.S. DISTRICT COURT WATER MASTER
C66 ROCK POINT / CARDELLI DITCH

Combined diversion for both ditches.

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 2003

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1				30	17		29		0			
2						26	20		0			
3				16		21	16		0			
4						21		8.7				
5					2.0							
6					17			7.0				
7							10	0	0			
8				7.4	19				0			
9						19	6.0					
10				7.4			0					
11						23		S				
12					22	22						
13								0				
14					21		0 S	0				
15				17	20							
16						19	S					
17				16			0					
18					25	30		0				
19						25		0				
20				11								
21					24		0	0				
22					22			0				
23						13	0					
24												
25						38		0				
26				7.4	24	34	0	0				
27					25			0				
28					25		0	0				
29		------		23			0					
30		------					0					
31		------		------		------			------		------	
TOTAL				450.7	627.2	728	179.4	37.4	0			
MEAN				15.0	20.2	24.3	5.79	1.21	0			
MAX				30	25	38	29	8.7	0			
MIN				7.4	2.0	13	0	0	0			
AC-FT				894	1,240	1,440	356	74	0			

YEAR 2003 TOTAL 2,022.1 MEAN 30.6 MAX 38 MIN 0 AC-FT 4,000

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U.S. DISTRICT COURT WATER MASTER
C66 ROCK POINT / CARDELLI DITCH

Combined diversion for both ditches.

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 2004

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1				21				0				
2						22		0				
3					31	22		0				
4												
5				12	21		0s					
6					25							
7				17		21	0					
8							0	0				
9						27		0				
10					20	20		0				
11												
12				16	17		0					
13					15							
14						21	0					
15				16		21	0	0				
16						21		0				
17					25			0				
18							0					
19				20	23		0					
20					17							
21				20			0					
22								0				
23								0				
24					16			0				
25							0					
26							0					
27												
28					22	4.6e	0					
29						4.6e						
30		------				4.6e						
31		------		------	25	------			------		------	
TOTAL				523	664	514.9	0	0				
MEAN				17.4	21.4	17.2	0	0				
MAX				21	31	27	0	0				
MIN				12	15	4.6	0	0				
AC-FT				1,040	1,320	1,020	0	0				

YEAR 2004 TOTAL 1,701.7 MEAN 31.5 MAX 31 MIN 0 AC-FT 3,380

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U.S. DISTRICT COURT WATER MASTER

C66 ROCK POINT / CARDELLI DITCH

Combined diversion for both ditches.

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 2005

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1						19		2.0				
2					26	22						
3								0 s				
4				9.7	25		13	0 s				
5					29							
6				7.0		21	7.0		0			
7							28		0			
8						17		0	0			
9					23	17						
10								0 s				
11				8.3	23		16	0 s				
12					21				0			
13						20	16					
14							9.2		0			
15						8.3		0	0			
16					26	7.4						
17					26			0				
18							0	0	0			
19					19				0			
20						8.3	8.7		0			
21							0					
22						12		0				
23					17	11		0				
24								0				
25				16	18		0		0			
26					17		8.7		0			
27						14			0			
28				16			0					
29		------				13						
30		------				15						
31		------		------	16	------		0	------		------	
TOTAL				342.0	682	439.3	275.4	4.8	0			
MEAN				11.4	22.0	14.6	8.88	.15	0			
MAX				16	29	22	28	2.0	0			
MIN				7.0	16	7.4	0	0	0			
AC-FT				678	1,350	871	546	9.5	0			

YEAR 2005 TOTAL 1,743.4 MEAN 25.3 MAX 29 MIN 0 AC-FT 3,450

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s = stock water only

U.S. DISTRICT COURT WATER MASTER

C66 ROCK POINT / CARDELLI DITCH

Combined diversion for both ditches.

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 2006

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1					0			0				
2								0				
3				0	18		17	0				
4							10		0			
5					15	18	7.4		0			
6				11					0			
7						18		0				
8					17	18		0				
9					19			0				
10					19		0					
11									0			
12						15	0		0			
13						13	0		0			
14						13		0				
15					17			0				
16												
17				7.0	18		0	0				
18									0			
19				0		13	0		0			
20						12	0		0			
21						8.3		0				
22					18			0				
23					18							
24				9.2	13		0		0			
25				9.2		21	0		0			
26						15	0		0			
27												
28						7.4						
29		------			9.2			0				
30		------			9.2			0				
31		------		------	8.3	------			------		------	
TOTAL				182.0	440.0	429.3	88.9	0	0			
MEAN				6.07	14.2	14.3	2.87	0	0			
MAX				11	19	21	17	0	0			
MIN				0	0	7.4	0	0	0			
AC-FT				361	873	851	176	0	0			

YEAR 2006 TOTAL 1,140.1 MEAN 16.5 MAX 21 MIN 0 AC-FT 2,260

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Diversion dam in need of repair - unable to divert any water from river after July 10th.

U.S. DISTRICT COURT WATER MASTER

C66 ROCK POINT / CARDELLI DITCH

Combined diversion for both ditches.

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 2007

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1								0				
2				0	0		0					
3					0		0					
4				0		0	0					
5						0						
6						0						
7					0			0			8.3	
8								0				
9				0	0		0					
10				0	0		0					
11					0	0	0					
12						0						
13						0		0				
14								0				
15					0							
16					0		0					
17							0					
18						0	0					
19						0						
20						0		0				
21					0			0				
22					0							
23					0		0					
24				0			0					
25						0	0					
26				0	0	0		0				
27						0		0				
28												
29		------			0							
30		------		0	0		0					
31		------		------		------	0		------		------	
TOTAL				0	0	0	0	0			249.0	
MEAN				0	0	0	0	0			8.30	
MAX				0	0	0	0	0			8.3	
MIN				0	0	0	0	0			8.3	
AC-FT				0	0	0	0	0			494	

YEAR 2007 TOTAL 249.0 MEAN 4.37 MAX 8.3 MIN 0 AC-FT 494

Y:\C07\c66.07\QAS.BINThis ditch was dry for most of the season except for the one reading that was taken 11/7/07.

U.S. DISTRICT COURT WATER MASTER
C66 ROCK POINT / CARDELLI DITCH

Combined diversion for both ditches.

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 2008

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1				0			0		0			
2				0		8.5				0		
3							10	0	0			
4												
5					10	8.2		0	0	0		
6					8.5	8.2	12					
7				7.9	8.5			0	0	0		
8						12						
9				7.3			10		0	0		
10						5.4		0				
11							5.9		0			
12					16	7.9		0		0		
13					21		.20			0		
14				8.5	12				0			
15							3.0	0		0		
16						9.2			0			
17				7.9		5.9		0				
18							1.0		0			
19					27							
20					25	7.6	0	0				
21				16	10				0			
22						1.8	0	0				
23												
24							.80	0				
25						0			0			
26					5.9	0		0	0			
27					5.4		0					
28				13	3.9			0	0			
29						0	0					
30		------		9.6					0			
31		------		------		------	0		------		------	
TOTAL				234.0	395.8	172.4	94.99	0	0	0		
MEAN				7.80	12.8	5.75	3.06	0	0	0		
MAX				16	27	12	12	0	0	0		
MIN				0	3.9	0	0	0	0	0		
AC-FT				464	785	342	188	0	0	0		

YEAR 2008 TOTAL 897.14 MEAN 11.1 MAX 27 MIN 0 AC-FT 1,780

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U.S. DISTRICT COURT WATER MASTER
C66 ROCK POINT / CARDELLI DITCH

Combined diversion for both ditches.

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 2009

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1				11			13		0			
2											6.4	
3				11	17	12	.60					
4				11				0	0			
5												
6					19	13					3.0	
7				9.2	17		5.9					
8				9.2				0	0			
9						10	7.3			0		
10				8.9					0			
11						10						
12							2.1	0				
13												
14				8.5	26			0				
15									0			
16				5.9	21	9.6				11		
17				4.2			0					
18						10			0			
19				8.5	24			0				
20								0				
21									0			
22				8.2	23		0					
23												
24				16		24	0					
25									0			
26				13	21			0				
27						7.3						
28				10			0		0			
29		------						0				
30		------		10	14							
31		------		------		------	0		------		------	
TOTAL				289.2	627	359.6	89.59	0	0	171	141.0	
MEAN				9.64	20.2	12.0	2.89	0	0	5.50	4.70	
MAX				16	26	24	13	0	0	11	6.4	
MIN				4.2	14	7.3	0	0	0	0	3.0	
AC-FT				574	1,240	713	178	0	0	338	280	

YEAR 2009 TOTAL 1,676.80 MEAN 26.6 MAX 26 MIN 0 AC-FT 3,320

Y:\c66.09\QAS.BIN

U.S. DISTRICT COURT WATER MASTER

C66 ROCK POINT / CARDELLI DITCH

Combined diversion for both ditches.

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 2010

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1				.25E					0			
2				.15E	1.1		10					
3				.15E				9.6				
4												
5				.15E			18	8.2				
6					.70							
7				.40E								
8						.80		5.9	0			
9				.40E	.25E		21					
10									0			
11						5.4	21					
12				.25E				3.3	0			
13												
14					.25E							
15				.25E		3.9	21	.70				
16				.40E	.10E				0			
17						4.2						
18				.40E			7.3					
19									0			
20				3.0				.80				
21					0	4.2						
22							1.1	.15E				
23				2.4					0			
24					0	4.6						
25				1.8								
26									0			
27						13		0				
28				1.8	1.8		31					
29		------						0				
30		------		1.3	3.9				0			
31		------		------		------	12		------		------	
TOTAL				26.20	27.90	154.71	490.5	98.68	0			
MEAN				.87	.90	5.16	15.8	3.18	0			
MAX				3.0	3.9	13	31	9.6	0			
MIN				.15	0	.80	1.1	0	0			
AC-FT				52	55	307	973	196	0			

YEAR 2010 TOTAL 797.99 MEAN 13.8 MAX 31 MIN 0 AC-FT 1,580

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U.S. DISTRICT COURT WATER MASTER

C66 ROCK POINT / CARDELLI DITCH

Combined diversion for both ditches.

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 2011

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1				.50		9.6	13		15			
2				.10	13							
3						9.2	12					
4				0	13	9.2		8.9				
5				1.4					16			
6					14	12						
7							12	16				
8				1.4	14	13						
9								14	22			
10					.70	13						
11				2.7			7.9		22			
12					.20	14						
13				1.6								
14						13						
15				9.6	9.2		10					
16								.20	7.0			
17				14		14	21					
18					7.6			3.6	14			
19				16		12						
20					8.2							
21							18		12			
22				16								
23					25			8.5				
24					25	14	14					
25				14					13			
26				5.4		13		26				
27												
28					0		14	16				
29		------										
30		------		14					14			
31		------		------		------	12		------		------	
TOTAL				207.21	335.58	365.0	415.1	361.15	450.0			
MEAN				6.91	10.8	12.2	13.4	11.7	15.0			
MAX				16	25	14	21	26	22			
MIN				0	0	9.2	7.9	.20	7.0			
AC-FT				411	666	724	823	716	893			

YEAR 2011 TOTAL 2,134.03 MEAN 32.8 MAX 26 MIN 0 AC-FT 4,230

U.S. DISTRICT COURT WATER MASTER
C66 ROCK POINT / CARDELLI DITCH

Combined diversion for both ditches.

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 2012

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1					2.7	3.0		0				
2							5.9					
3					18			0	0	0		
4					16		4.2					
5						2.7		0	0	0		
6					14		2.4	0	0			
7												
8							1.6					
9						4.2	.70e					
10					10		0	0	0	0		
11					12	5.0						
12						3.6		0	0	0		
13					11							
14						1.3e	.18e	0	0			
15										0		
16					10		.10e					
17								0	0	0		
18					10	0			0			
19							0	0		0		
20						21			0			
21					9.6	12		0		0		
22				13								
23					5.4		0		0			
24										0		
25				3.6	7.9				0			
26						5.4	0					
27				5.4			0	0	0	0		
28					7.9	6.4				0		
29								0	0			
30		------			5.9		0			0		
31		------		------		------		0	------	0	------	
TOTAL				110.0	310.9	176.2	35.96	0	0	0		
MEAN				7.33	10.0	5.87	1.16	0	0	0		
MAX				13	18	21	5.9	0	0	0		
MIN				3.6	2.7	0	0	0	0	0		
AC-FT				218	617	349	71	0	0	0		

YEAR 2012 TOTAL 633.03 MEAN 7.91 MAX 21 MIN 0 AC-FT 1,260

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U.S. DISTRICT COURT WATER MASTER
c66 Rock Point / Cardelli Ditch

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 2014

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1				4.0								
2				15	5.0	12	1.2	0				
3												
4				12		1.8		0				
5					23		.30					
6				3.9		5.7					0	
7					1.8		.13e	0				
8						15				0		
9					1.2		.08e	0		0		
10				.90		15						
11					5.1							
12				.22			.08e	0				
13										0		
14				23	5.7	7.6	.05e	0				
15			19	16								
16			6.7		9.6	3.8	.08e	0		0		
17								0		0		
18			27	7.9	17	7.6						
19					14							
20			2.4			5.7		0		0		
21				10			0	0				
22								0				
23				9.4	8.9	3.1				0		
24			11				0			0		
25						1.8	0					
26			2.8	5.0	7.9							
27												
28			7.6	5.1	7.6	1.5	0			0		
29		------										
30		------		4.6	9.4	3.1	0					
31		------		------		------			------		------	
TOTAL			338.8	250.76	277.1	193.2	4.96	0		0	0	
MEAN			10.9	8.36	8.94	6.44	.16	0		0	0	
MAX			27	23	23	15	1.2	0		0	0	
MIN			2.4	.22	1.2	1.5	0	0		0	0	
AC-FT			672	497	550	383	9.8	0		0	0	

YEAR 2014 TOTAL 1,064.75 MEAN 13.3 MAX 27 MIN 0 AC-FT 2,110

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U.S. DISTRICT COURT WATER MASTER
c66 Rock Point / Cardelli Ditch

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 2015

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1				2.9	4.7	7.9	.20					
2												
3				1.0				0				
4					5.7		.25e					
5								0				
6					.90	8.5	.13e					
7				0			.13e					
8				0		4.6		0				
9					4.6							
10				0		4.6		0				
11					7.6	13	0					
12				3.4				0				
13					11		0					
14								0				
15				14		9.6	0			0		
16			21		11							
17				2.3		2.5		0		0		
18			22		7.3	1.4	0					
19				2.7				0				
20			14		7.9		0			0		
21								0				
22			12	.10e		.45e	0			0		
23					12	4.2				0		
24			2.0	0			0	0				
25						3.4				0		
26					12		0					
27			9.6	7.3				0		0		
28					4.2		0					
29		------	13	9.2		.80		0				
30		------			2.8					0		
31		------		------		------		0	------		------	
TOTAL			414.5	99.00	218.67	152.38	1.69	0		0		
MEAN			13.4	3.30	7.05	5.08	.055	0		0		
MAX			22	14	12	13	.25	0		0		
MIN			2.0	0	.90	.45	0	0		0		
AC-FT			822	196	434	302	3.4	0		0		

YEAR 2015 TOTAL 886.25 MEAN 11.2 MAX 22 MIN 0 AC-FT 1,760

U.S. DISTRICT COURT WATER MASTER
c66 Rock Point / Cardelli Ditch

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 2016

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1				.70		8.9		0	0			
2				1.9								
3						7.1		0				
4							7.0		0			
5				7.9	6.3	7.4		0				
6				7.6	.70							
7					.32		.40		0			
8						7.9		0				
9				8.5			2.5		0			
10					.21	7.3		0				
11					.25		3.4					
12				9.2			4.3		0	1.2		
13						7.1		0		.90		
14				.52	9.6		5.1		0			
15				.60		5.7		0	0			
16					3.4							
17						11				.20		
18				10	3.1		2.9	0				
19						6.3			0			
20							.05	0		0		
21				10	8.2				0			
22								0	0			
23				.20	7.9	9.7	1.5					
24						8.1		0				
25					7.3		.50		0			
26				11				0				
27						3.2	.01					
28				6.3	7.0				0			
29							0	0				
30		------		4.6	8.5	8.8			0			
31		------		------		------		0	------		------	
TOTAL				169.33	149.71	227.3	71.45	0	0	17.83		
MEAN				5.64	4.83	7.58	2.31	0	0	.58		
MAX				11	9.6	11	7.0	0	0	1.2		
MIN				.20	.21	3.2	0	0	0	0		
AC-FT				336	297	451	142	0	0	35		

YEAR 2016 TOTAL 635.62 MEAN 7.66 MAX 11 MIN 0 AC-FT 1,260

U.S. DISTRICT COURT WATER MASTER
c66 Rock Point / Cardelli Ditch

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 2017

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1				0	4.0	10						
2												
3					4.8	6.7	13	14				
4				0								
5				0	5.8	11	13	13	5.3			
6												
7				0			13		4.9			
8					18	5.7		15	6.0			
9				0				13				
10					2.3	6.1	12					
11				0				12				
12					4.9	2.2	11		6.2			
13				0								
14						8.5		9.0	7.9			
15					.88				8.1			
16								6.2				
17			0	0		11	9.7					
18			0					9.3	7.9			
19					.59	15	6.6					
20			0	0					7.4			
21						17	8.4	5.1				
22			0	13					8.1			
23					6.0							
24			0			14	6.4	5.5				
25				4.5	9.3			6.1	8.8			
26				3.6		13	5.1					
27			0		12				9.3			
28				4.1		12		5.8				
29		------					12		8.1			
30		------			6.2	14		4.8				
31		------	0	------		------	14	4.0	------		------	
TOTAL			0	58.2	178.30	313.3	320.8	271.9	220.0			
MEAN			0	1.94	5.75	10.4	10.4	8.77	7.33			
MAX			0	13	18	17	14	15	9.3			
MIN			0	0		2.2	5.1	4.0	4.9			
AC-FT			0	115	354	621	636	539	436			

YEAR 2017 TOTAL 1,362.50 MEAN 16.0 MAX 18 MIN AC-FT 2,700

U.S. DISTRICT COURT WATER MASTER<)4,
c66 Rock Point / Cardelli Ditch

DAILY DISCHARGE IN CUBIC FEET PER SECOND FOR 2018

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1						5.7						
2				5.4	4.6							
3												
4							4.8					
5					7.7				0			
6						4.3		2.0				
7							8.4					
8								0				
9									0			
10			0									
11				6.9	7.6		0		0			
12												
13						7.3			0			
14				2.3								
15							2.1	0				
16												
17						6.1			0			
18				1.5			0					
19					3.3			0				
20												
21							0		0			
22				2.8								
23						7.1		0				
24					6.1							
25							1.0	0				
26				6.7					0			
27						8.3						
28			0									
29		------										
30		------				6.1	2.6					
31		------		------		------			------		------	
TOTAL			0	128.0	181.7	192.4	73.2	10.3	0			
MEAN			0	4.27	5.86	6.41	2.36	.33	0			
MAX			0	6.9	7.7	8.3	8.4	2.0	0			
MIN			0	1.5	3.3	4.3	0	0	0			
AC-FT			0	254	360	382	145	20	0			

YEAR 2018 TOTAL 585.66 MEAN 14.3 MAX 8.4 MIN 0 AC-FT 1,160

Attachment C: 15% Preliminary Design Plan Set

LYON AND STOREY COUNTIES

DAYTON VALLEY ADMP

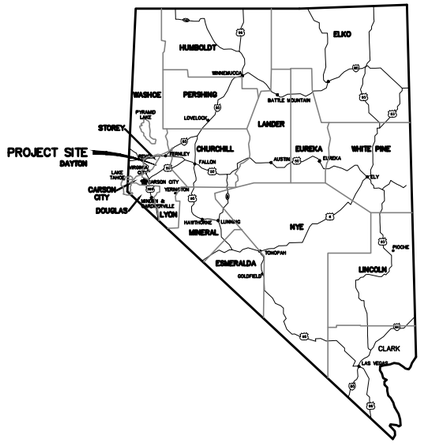
JULY 2019

OWNER:

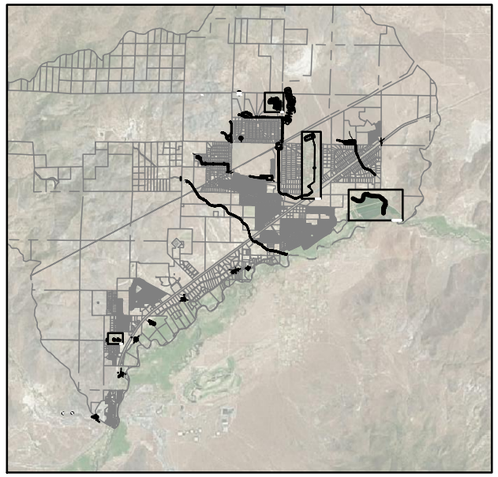
LYON COUNTY
27 S. MAIN STREET
YERINGTON, NV 89447
PHONE: 775-463-6531

OWNER:

STOREY COUNTY
110 TOLL ROAD
P.O. BOX 526
VIRGINIA CITY, NV 89440
PH: 775-847-0966



LOCATION MAP



VICINITY MAP

SHEET INDEX:

TITLE SHEET ____ C1.0
OVERALL INDEX ____ C2.0
INDEX SHEET ____ C2.1
INDEX SHEET ____ C2.2
SIX MILE CANYON BASIN - 25 YEAR ____ C3.0
SIX MILE CANYON CHANNEL ____ C4.0-C4.6
PROSPECTOR SYSTEM ____ C5.0-C5.5
SUTRO SPRINGS SYSTEM - 25 YEAR ____ C6.0-C6.1
WAGON WHEEL CULVERT- 25 YEAR ____ C6.2
SUTRO SPRINGS SYSTEM - 100 YEAR ____ C6.3-C6.4
WAGON WHEEL CULVERT- 100 YEAR ____ C6.5
LONNIE SYSTEM - 25 YEAR ____ C7.0
LONNIE SYSTEM - 100 YEAR ____ C7.1
MARK TWAIN SYSTEM - 25 YEAR ____ C8.0-C8.6
MARK TWAIN SYSTEM - 100 YEAR ____ C8.7-C8.13
MARK TWAIN NORTH - 25 YEAR ____ C9.0
MARK TWAIN NORTH - 100 YEAR ____ C9.1
MARK TWAIN NORTH OUTLET CHANNEL- 25 YEAR ____ C9.2
MARK TWAIN NORTH OUTLET CHANNEL- 100 YEAR ____ C9.3
GOLD PAN SYSTEM - 25 YEAR ____ C10.0-10.2
GOLD PAN SYSTEM - 100 YEAR ____ C10.3-C10.5
RAINBOW BASIN - 25 YEAR ____ C11.0-C11.2
RAINBOW BASIN - 100 YEAR ____ C11.2-C11.3
FT CHURCHILL CHANNEL - 25 YEAR ____ C12.0-C12.2
FT CHURCHILL CHANNEL - 100 YEAR ____ C12.3-C12.5
CHAVES CULVERT - 25 YEAR ____ C13.0
CHAVES CULVERT - 100 YEAR ____ C13.1
GROSH AND ROSEPEAK CULVERTS ____ C14.0-C14.1
CARDELLI SIPHONS ____ C15.0-C15.5
GOLD CANYON SPILLWAY ____ C16.0
DETAILS ____ D1
CHANNEL DETAILS ____ D2

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LYON AND STOREY COUNTY
DAYTON VALLEY ADMP
TITLE SHEET
NEVADA
DAYTON/STOREY COUNTY

REV	DATE	DESCRIPTION	BY
		PRELIMINARY 15% DESIGN JULY 2019	

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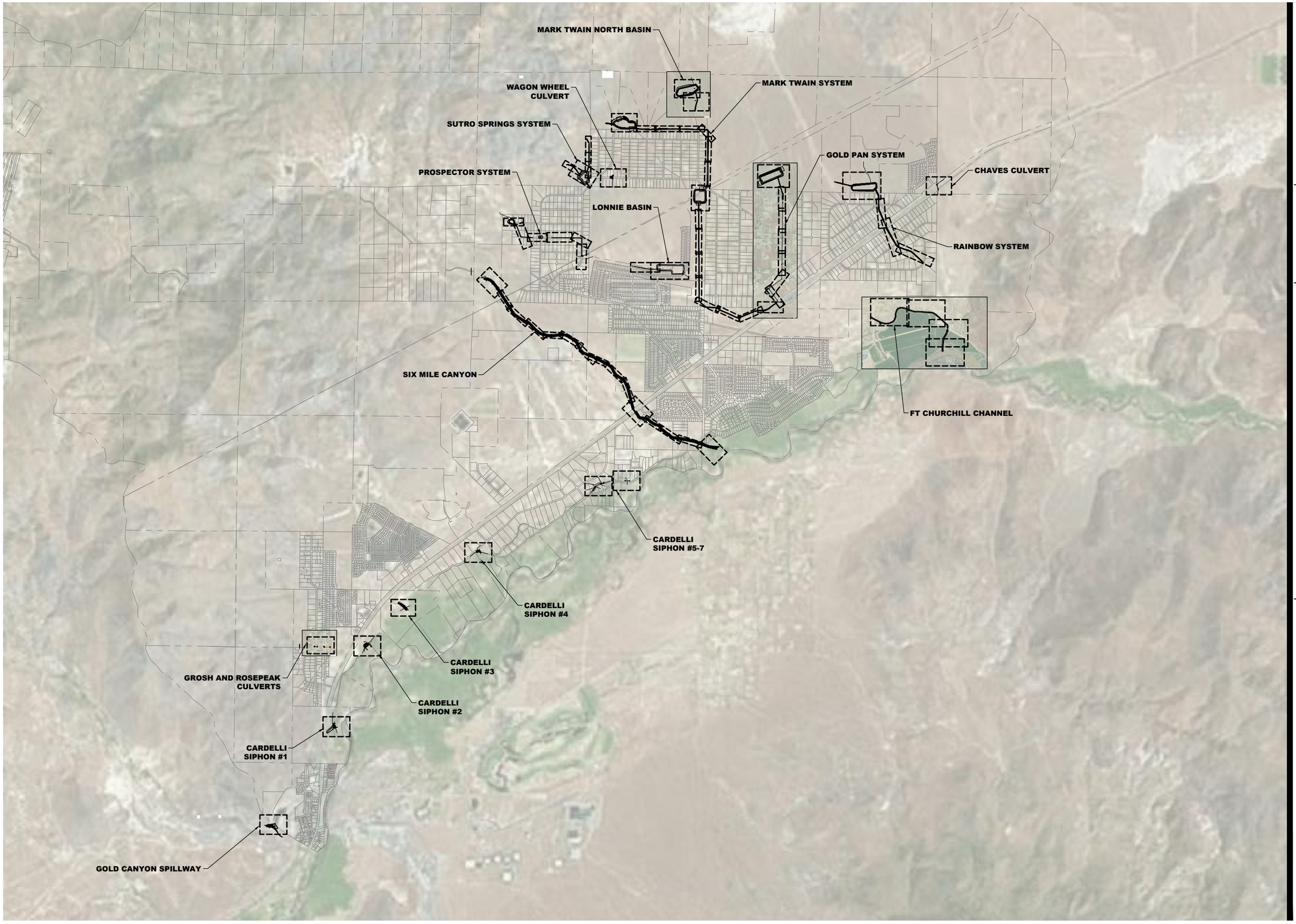

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP

OVERALL INDEX SHEET

DAYTON/STOREY COUNTY NEVADA

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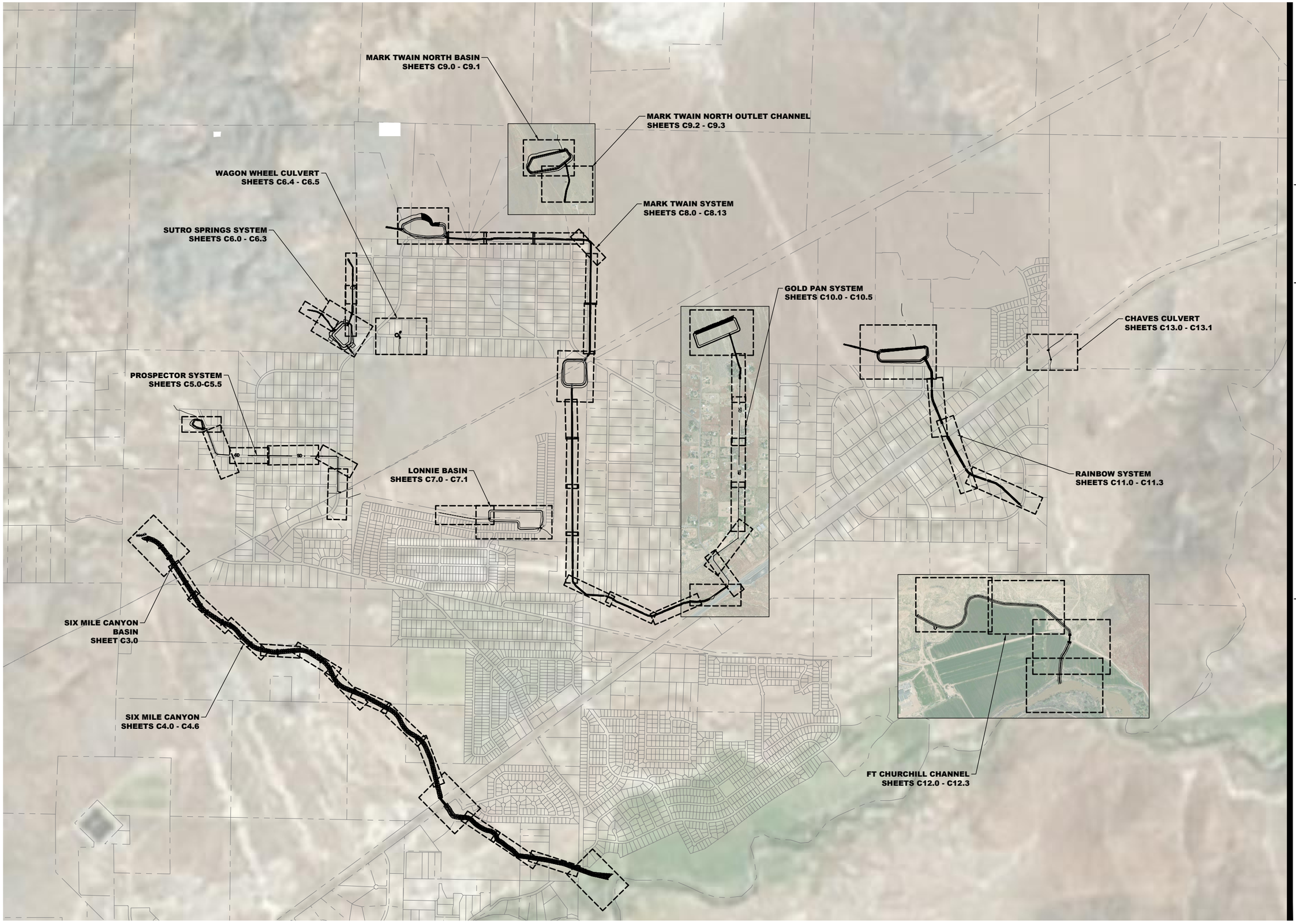

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP

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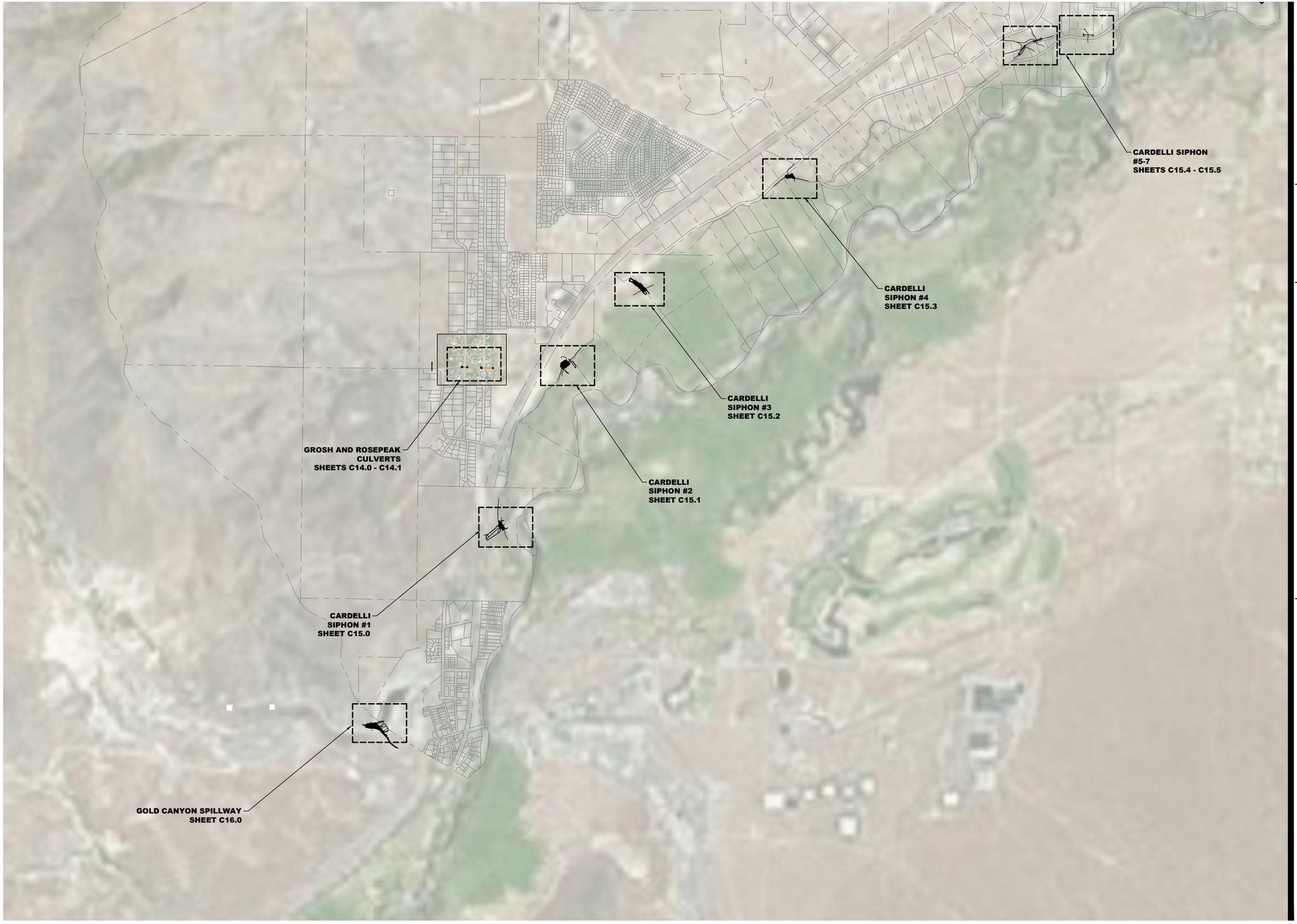

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP

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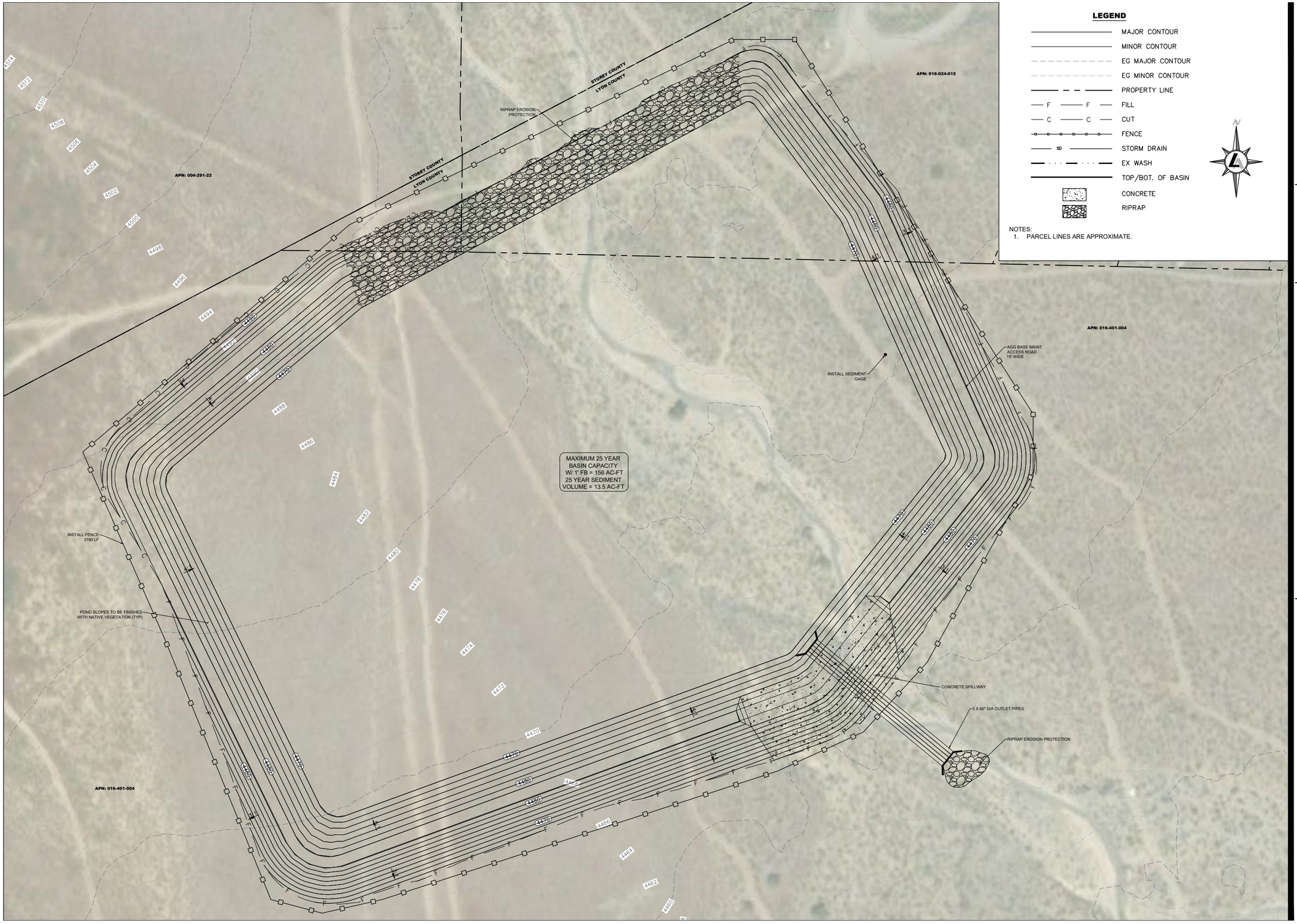

LEGEND

- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F — F — FILL
- C — C — CUT
- FENCE
- SD — STORM DRAIN
- EX WASH
- TOP/BOT. OF BASIN
- CONCRETE
- RIPRAP

NOTES:
1. PARCEL LINES ARE APPROXIMATE.

N

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
SIX MILE CANYON BASIN
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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C3.0

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DESIGNED BY:	RTS
CHECKED BY:	RTS
JOB NO.:	9416.000

C:\Users\sprettyman\AppData\Local\Temp\AcPublish_12040\6-Mile Canyon Basin 25-Yr.dwg,C3.0 6 MILE CANYON BASIN - 25 YR, 07/22/2019 01:39 pm sprettyman

LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F — F — FILL
- C — C — CUT
- FENCE
- SD — STORM DRAIN
- EX WASH
- CONCRETE
- RIPRAP

NOTES:
1. PARCEL LINES ARE APPROXIMATE.

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
SIX MILE CANYON CHANNEL
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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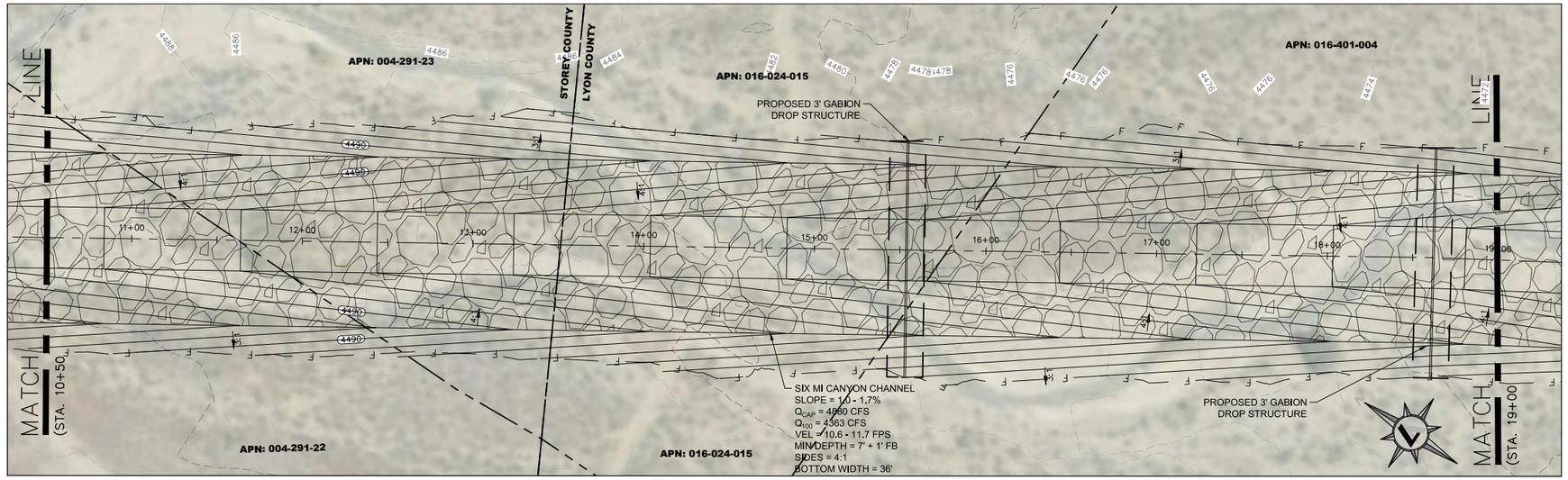

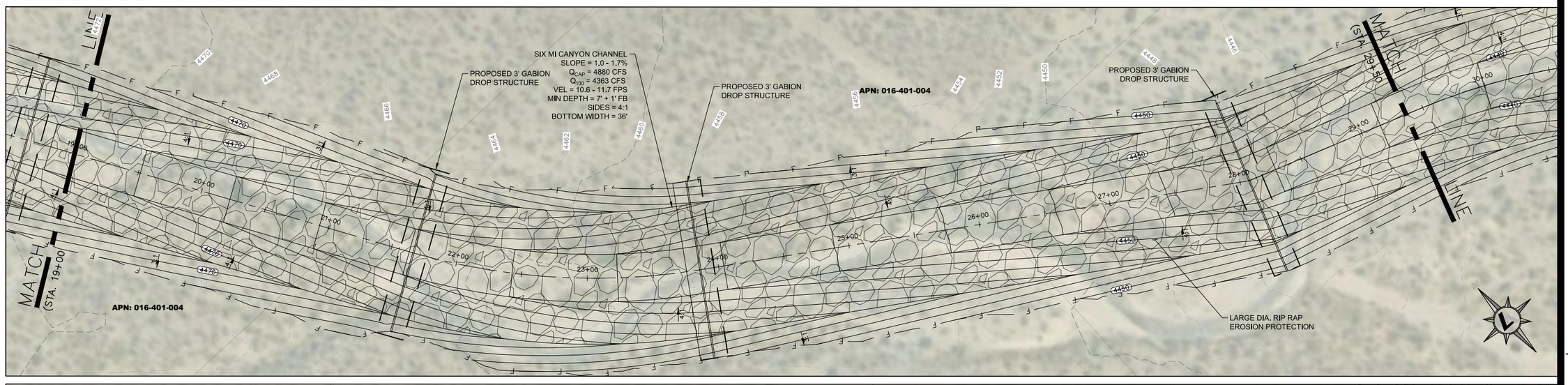

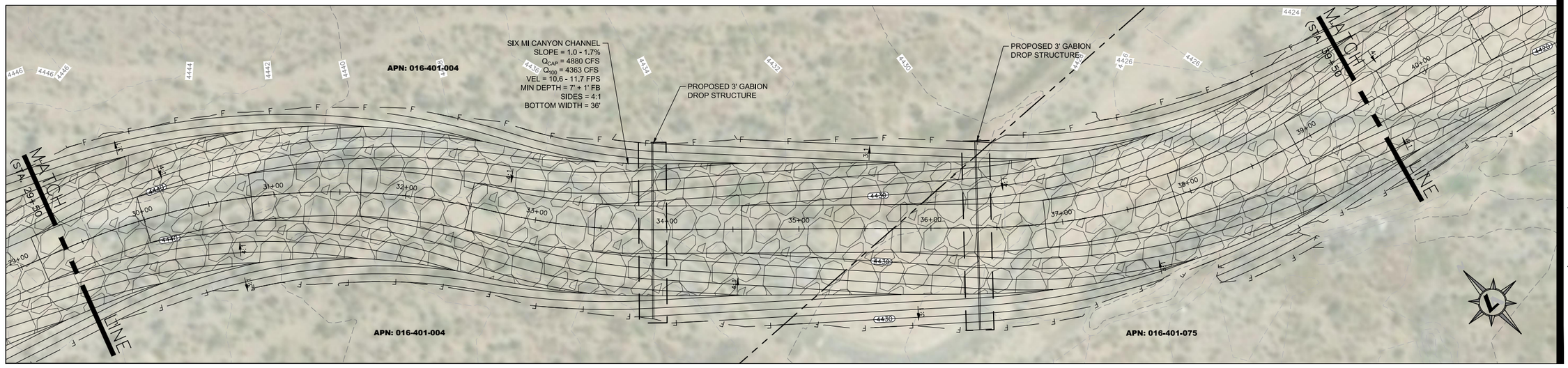

LEGEND

- TOP/BOT. OF BASIN
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
SIX MILE CANYON CHANNEL
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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C4.1

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JOB NO.:	9416.000

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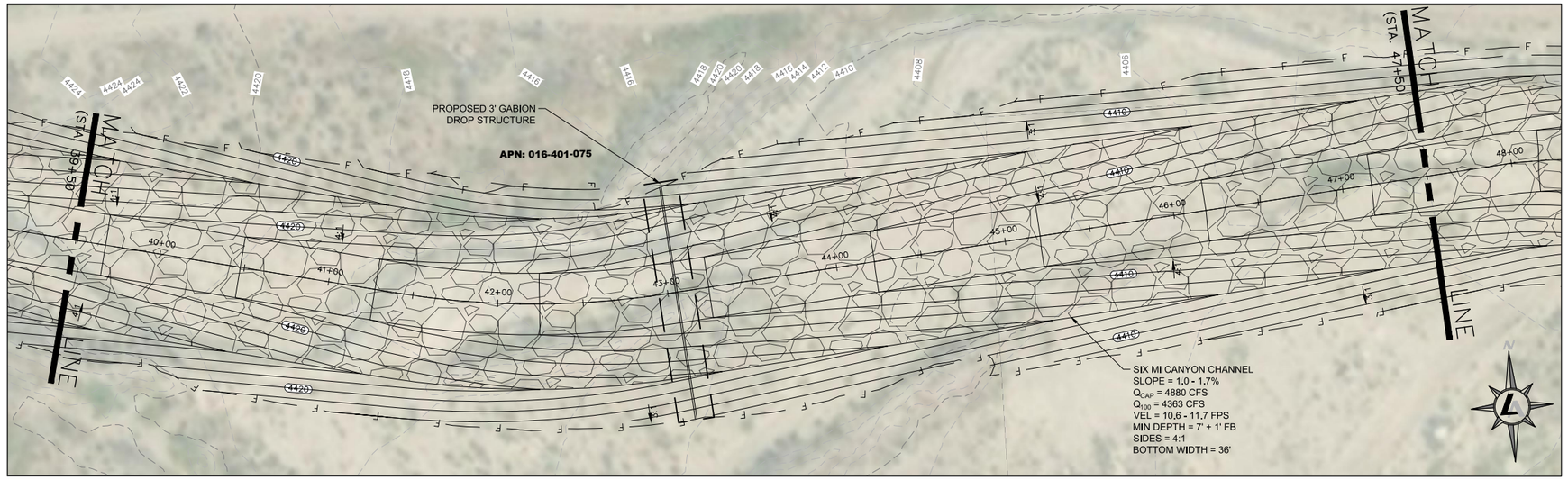

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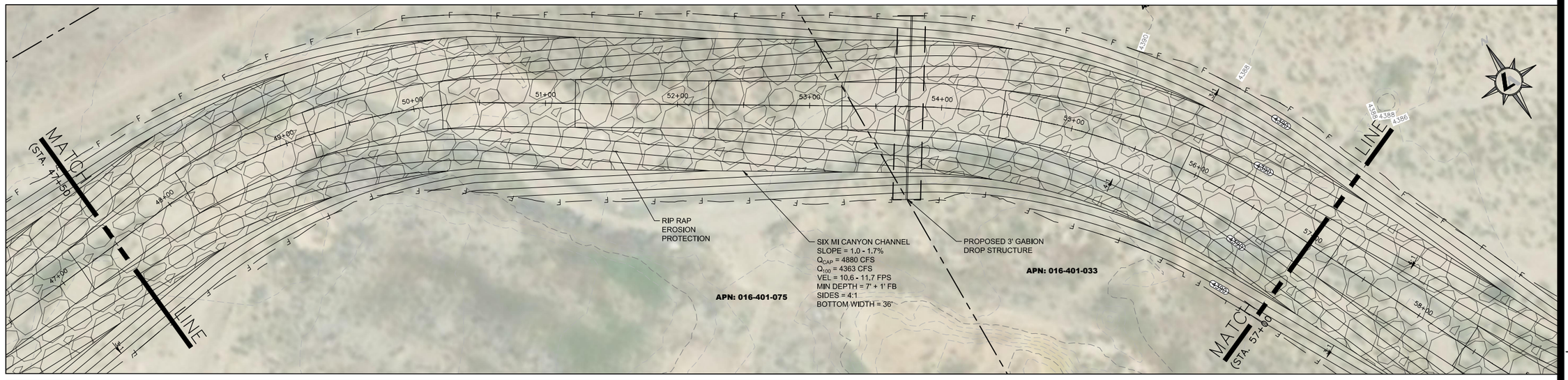

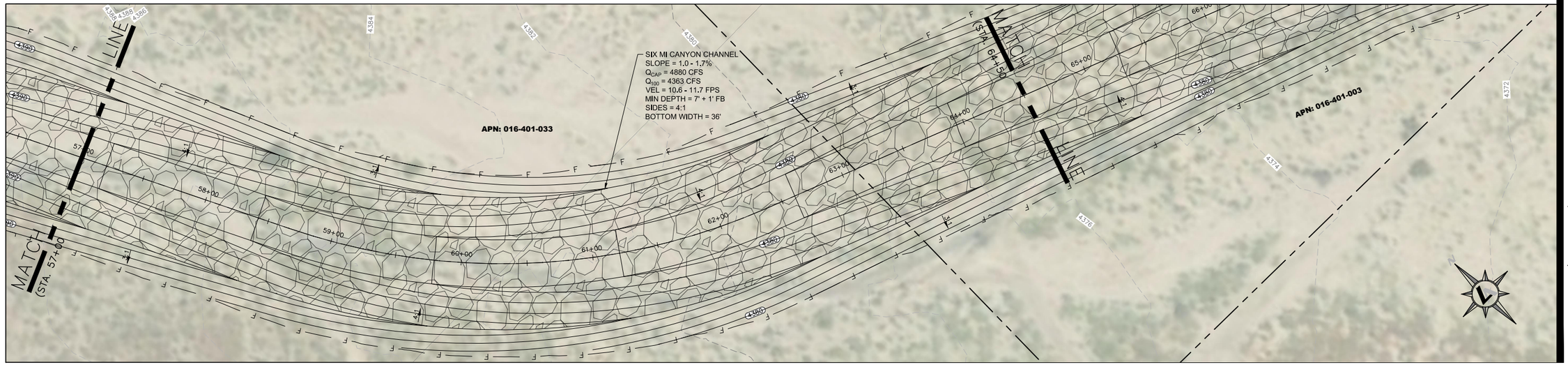

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
SIX MILE CANYON CHANNEL
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY
		PRELIMINARY	
		15% DESIGN	
		JULY 2019	

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C4.2

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JOB NO.:	9416.000

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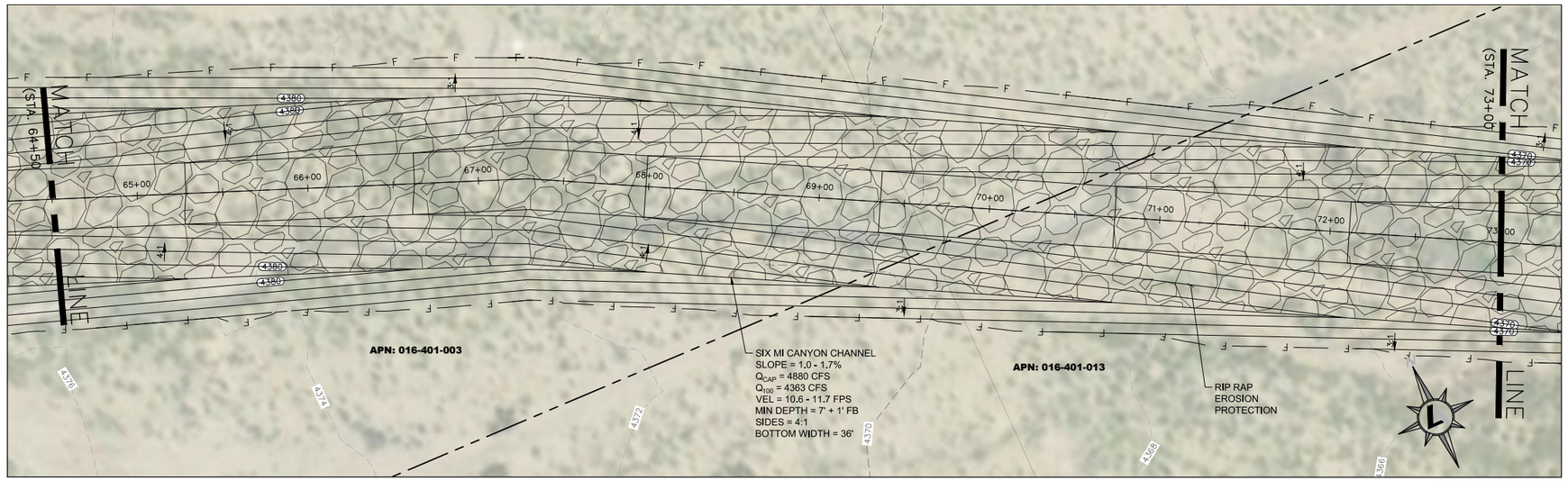

LEGEND

- TOP/BOT. OF BASIN
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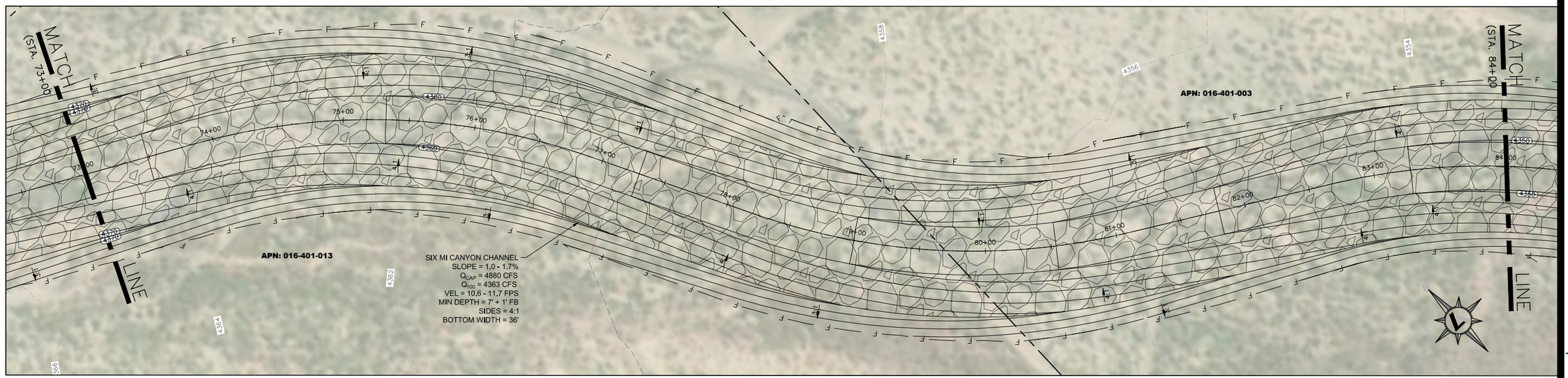

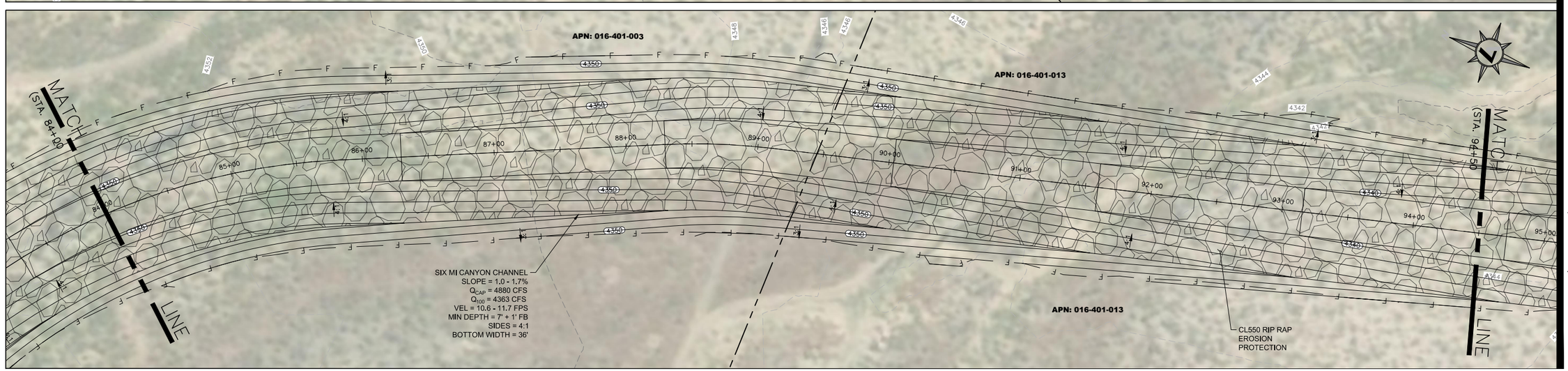

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
SIX MILE CANYON CHANNEL
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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C4.3

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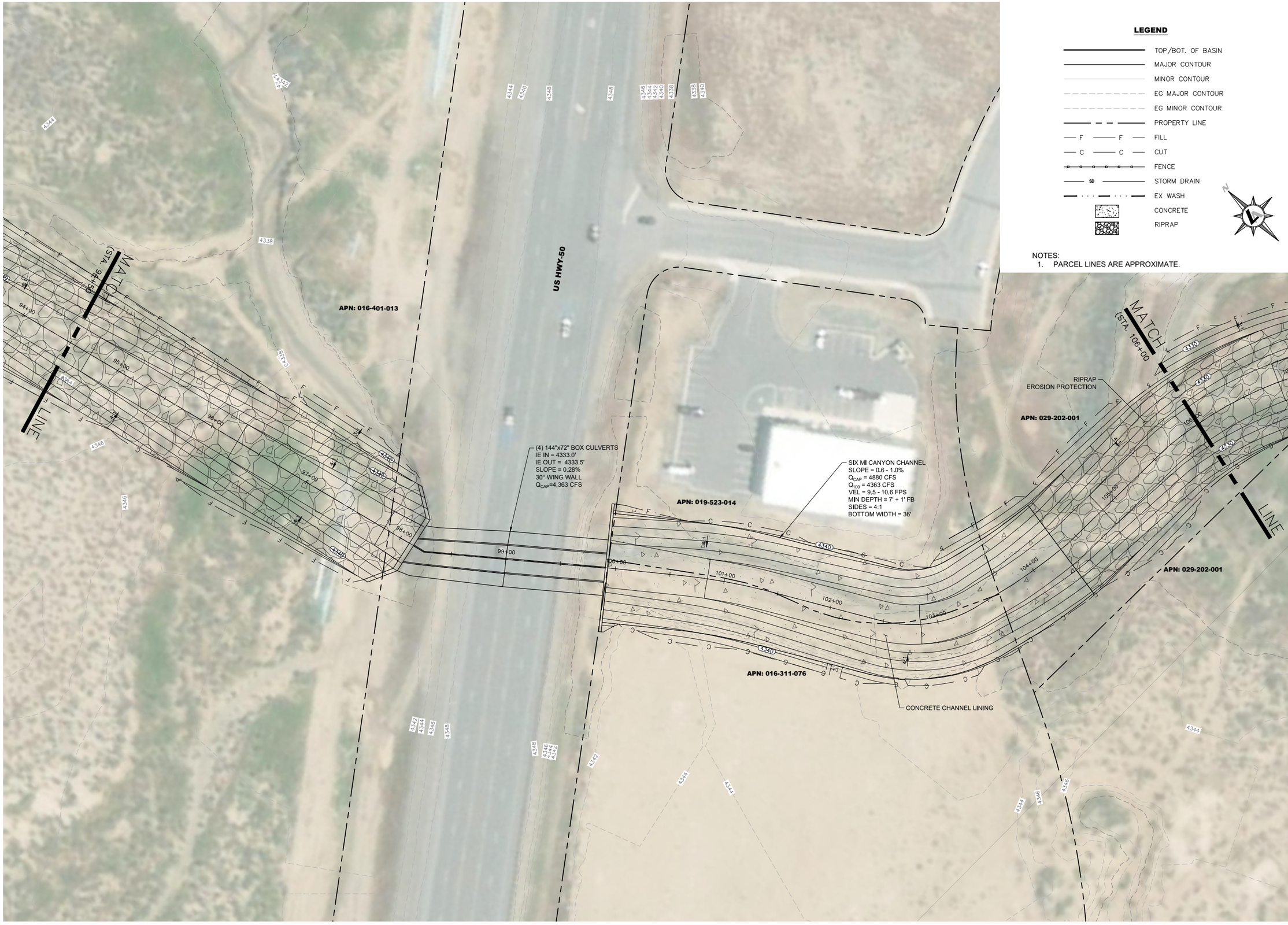

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
SIX MILE CANYON CHANNEL
100 YEAR DESIGN

NEVADA

LYON/STOREY COUNTY

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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C4.4

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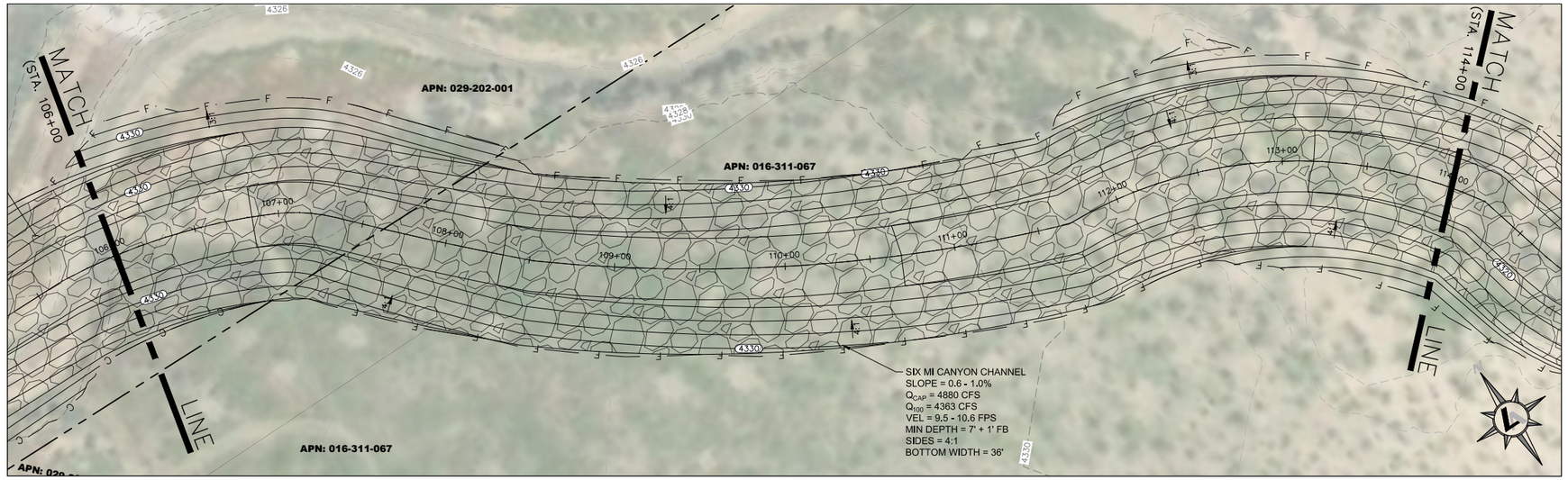

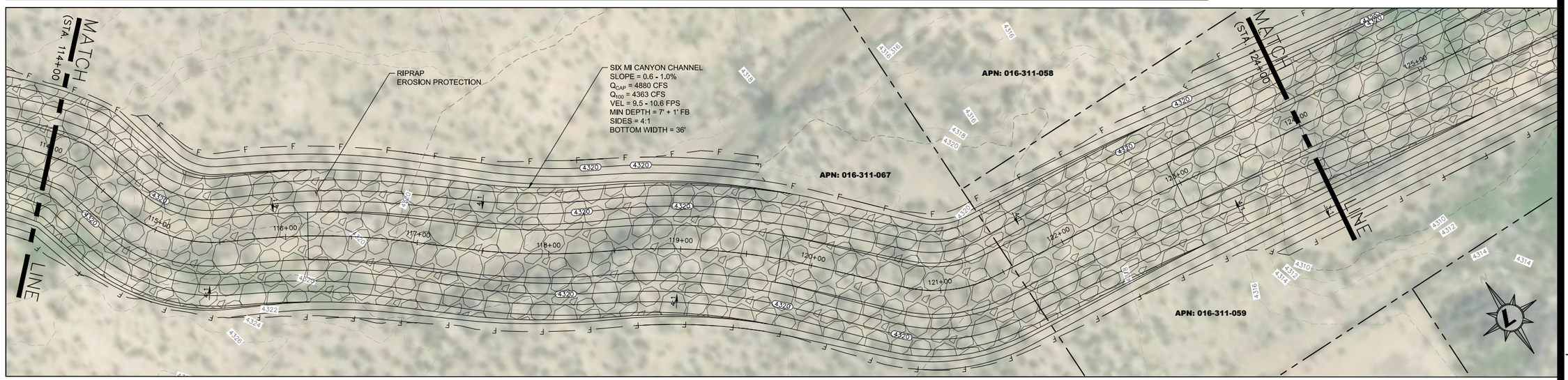

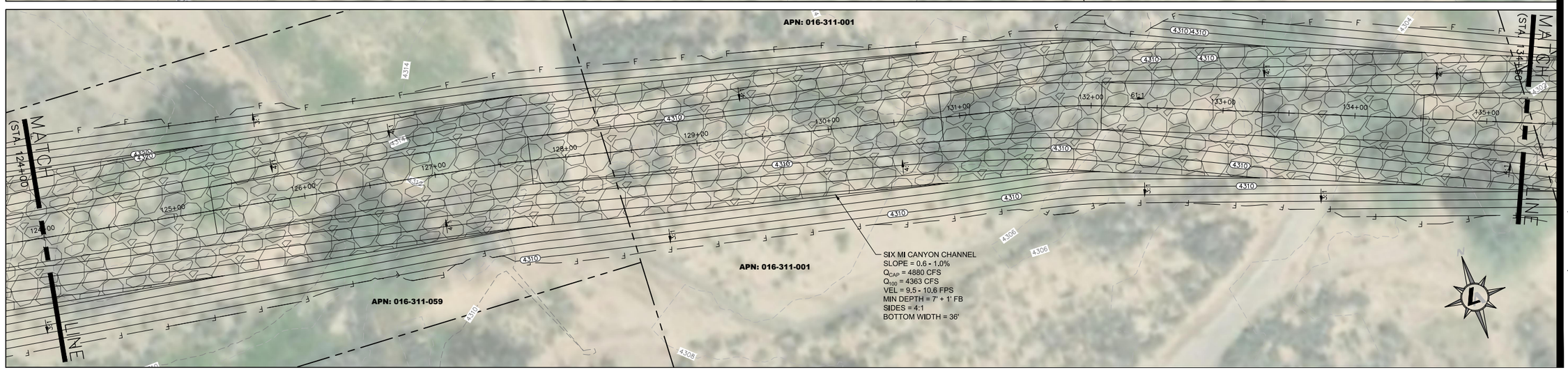

LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F — F FILL
- C — C CUT
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- SD STORM DRAIN
- EX WASH
- CONCRETE
- RIPRAP

NOTES:
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
SIX MILE CANYON CHANNEL
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JUNE 2019

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C4.5

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
SIX MILE CANYON CHANNEL
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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C4.6

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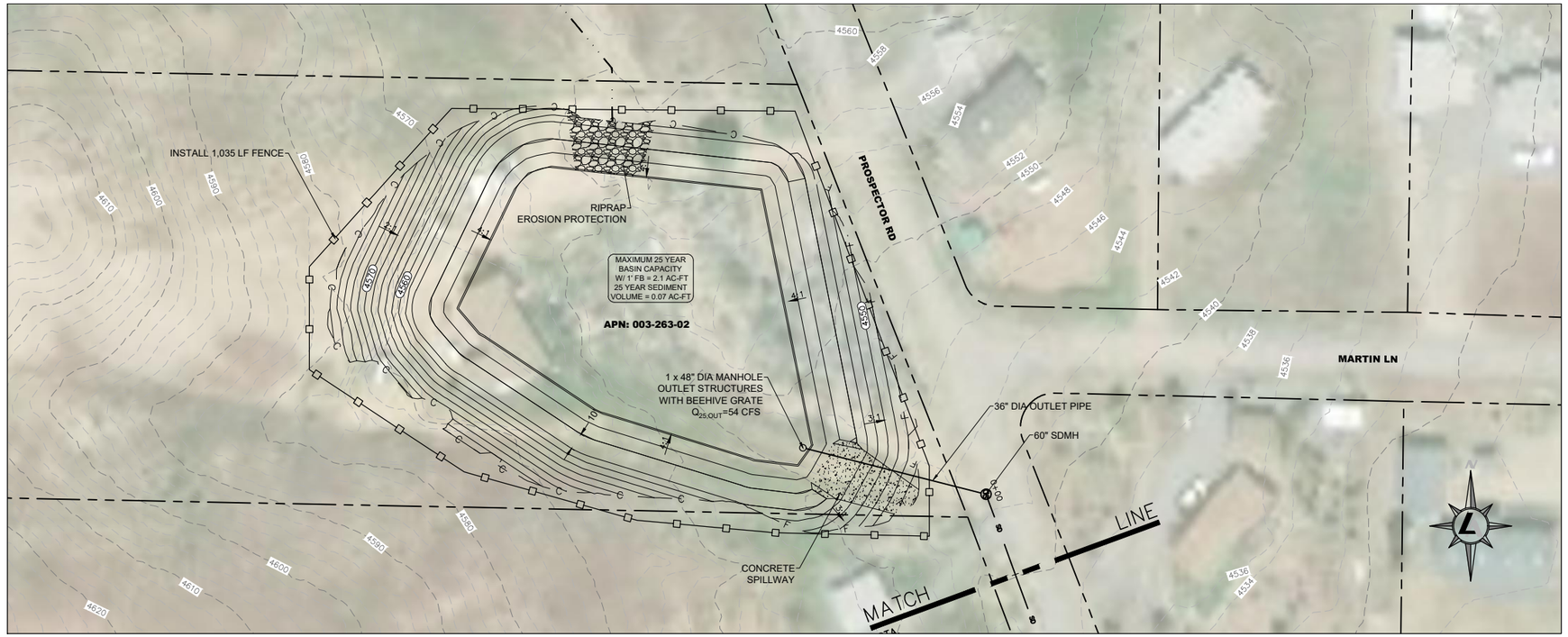

LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
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- PROPERTY LINE
- F — F — FILL
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
PROSPECTOR BASIN AND STORM DRAIN
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
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JULY 2019

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C5.0

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JOB NO.:	9416.000

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LEGEND

- TOP/BOT. OF BASIN
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LYON AND STOREY COUNTY

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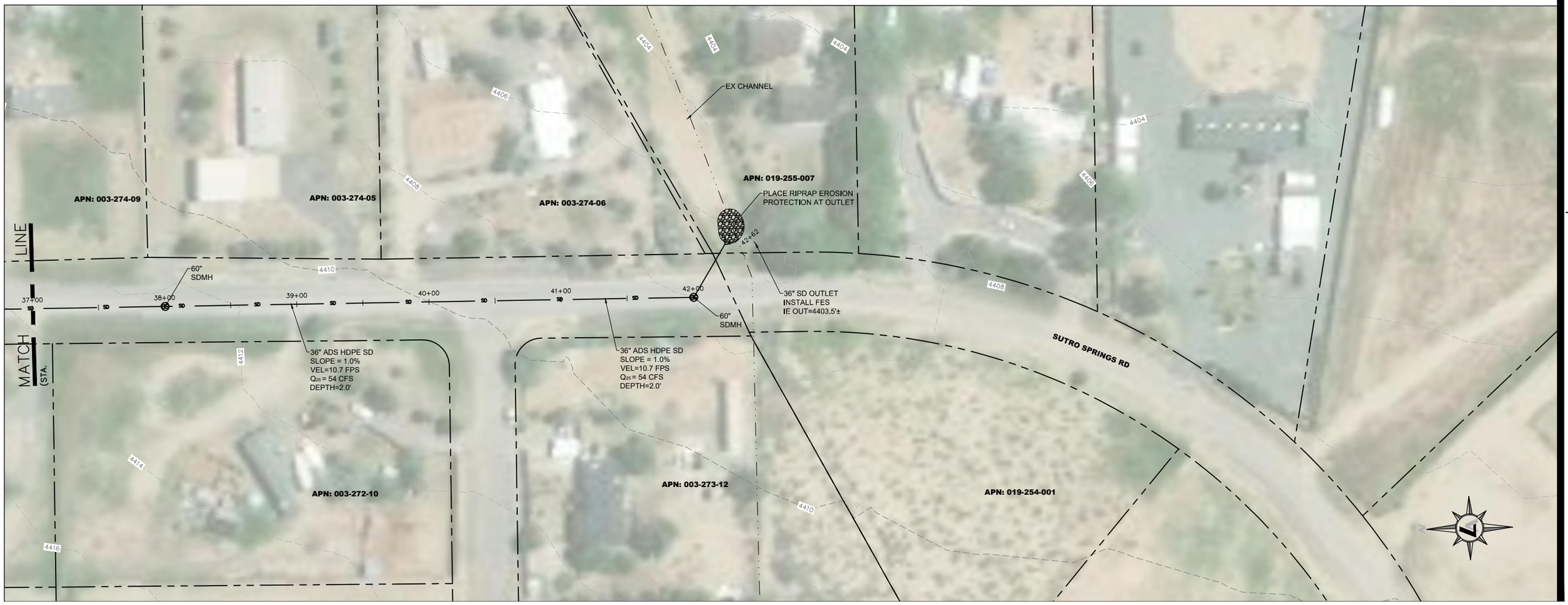

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LYON AND STOREY COUNTY

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25 YEAR DESIGN

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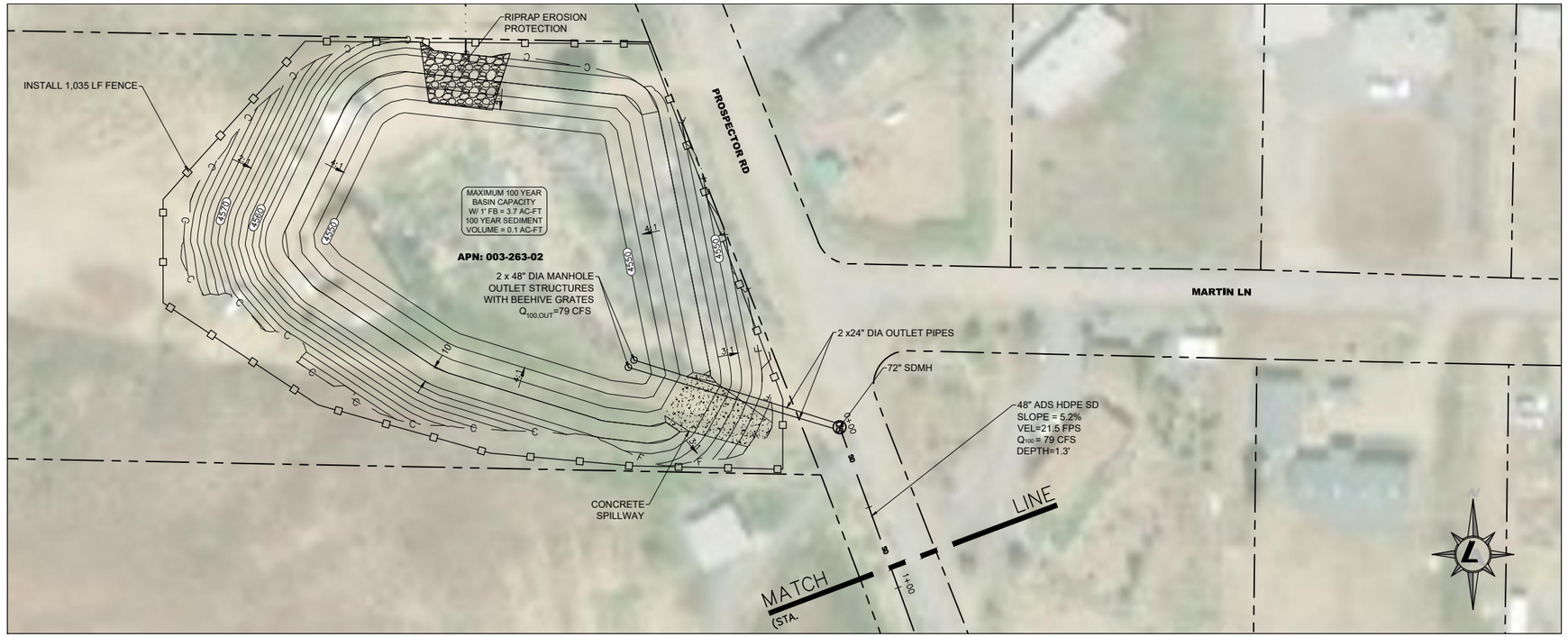

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LYON AND STOREY COUNTY

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C5.3

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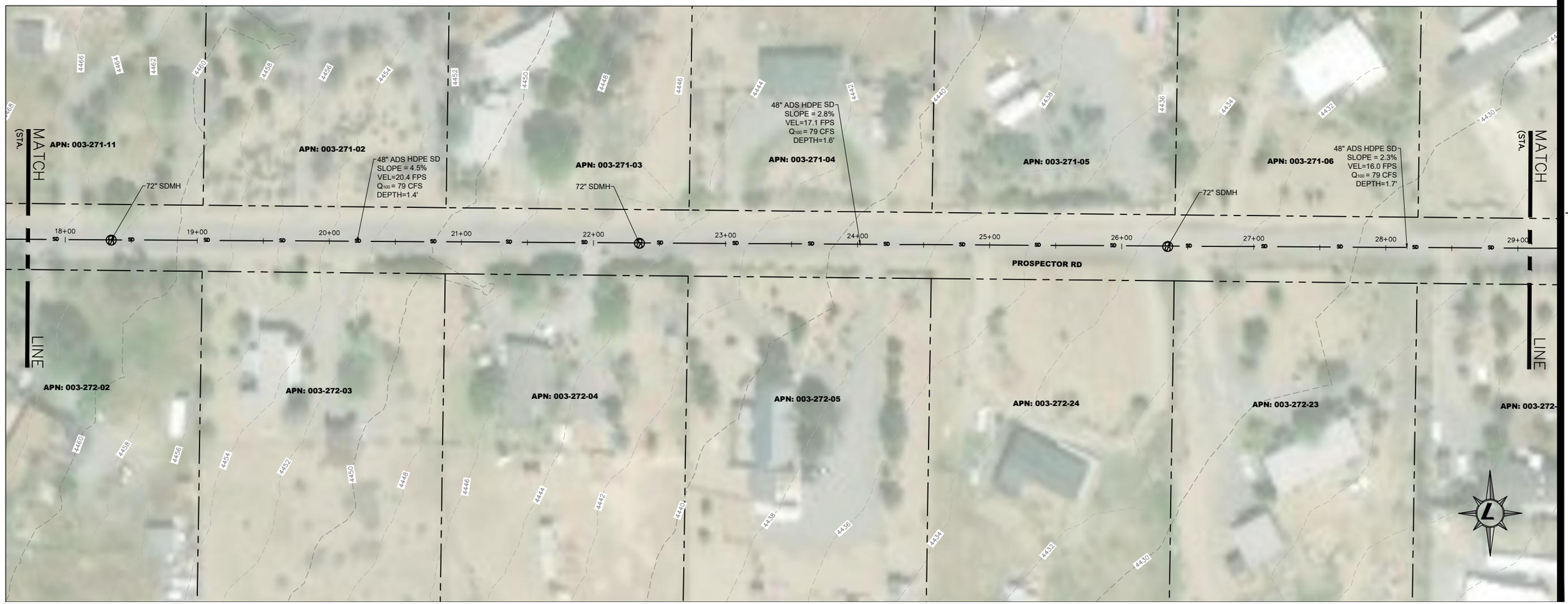

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
PROSPECTOR BASIN AND STORM DRAIN
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

BAR IS 1 INCH ON ORIGINAL DRAWING
0 40'
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C5.4

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DESIGNED BY:	RTS
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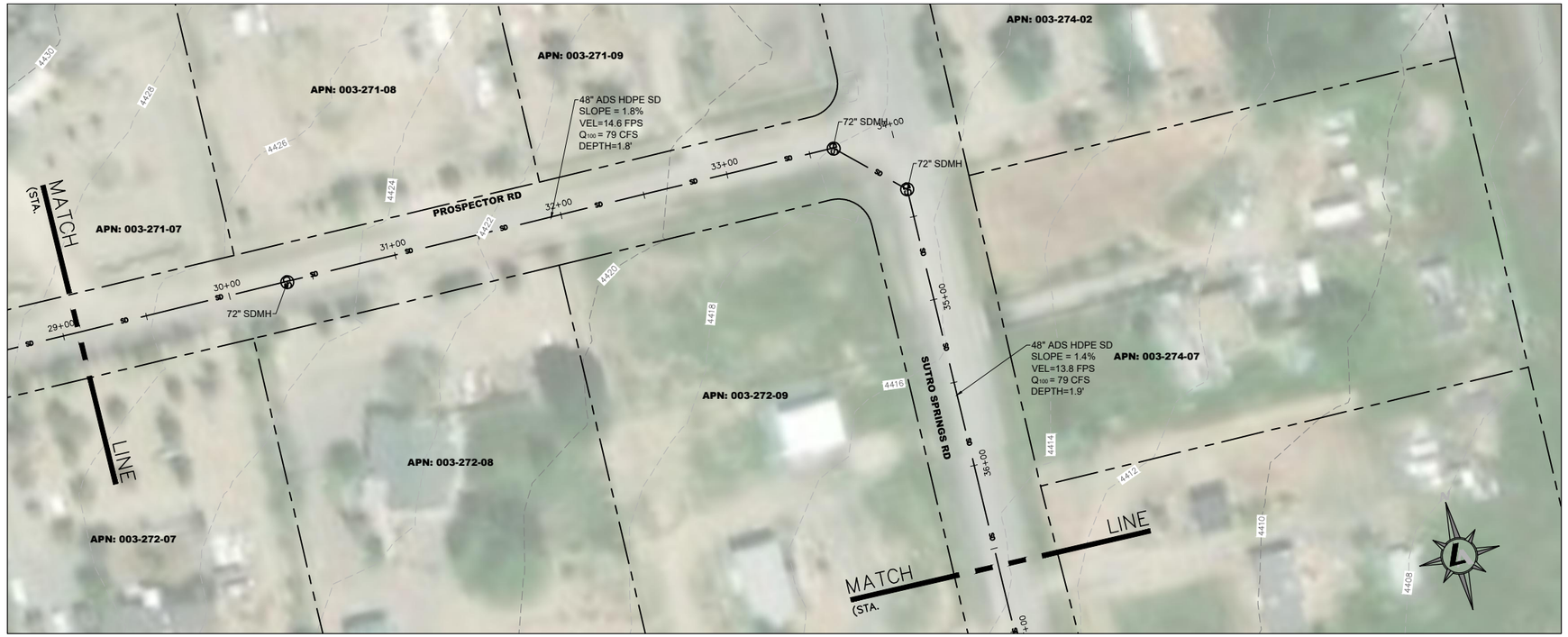
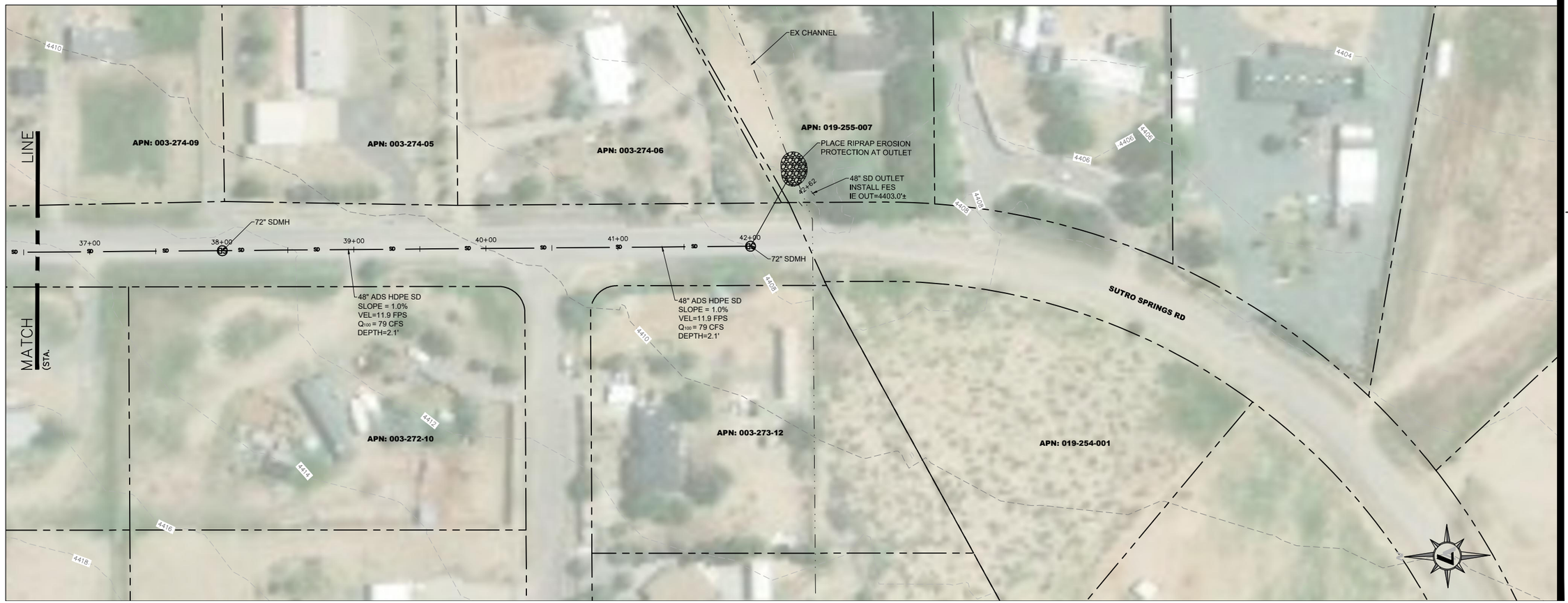
JOB NO.:	9416.000

L:\LAProj\9416.000 - Dayton Valley Area Drainage Master Plan\DWG\Civil3D\Grading\Systems\Prospector 100-Yr.dwg,C5.4 PROSPECTOR BASIN AND SD - 100 YEAR, 07/19/2019 03:38 pm sprattyman





LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F — F — FILL
- C — C — CUT
- FENCE
- SWALE
- EX WASH
- CONCRETE
- RIPRAP

NOTE:
1. PARCEL LINES ARE APPROXIMATE.

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
PROSPECTOR BASIN AND STORM DRAIN
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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CHECKED BY:	RTS
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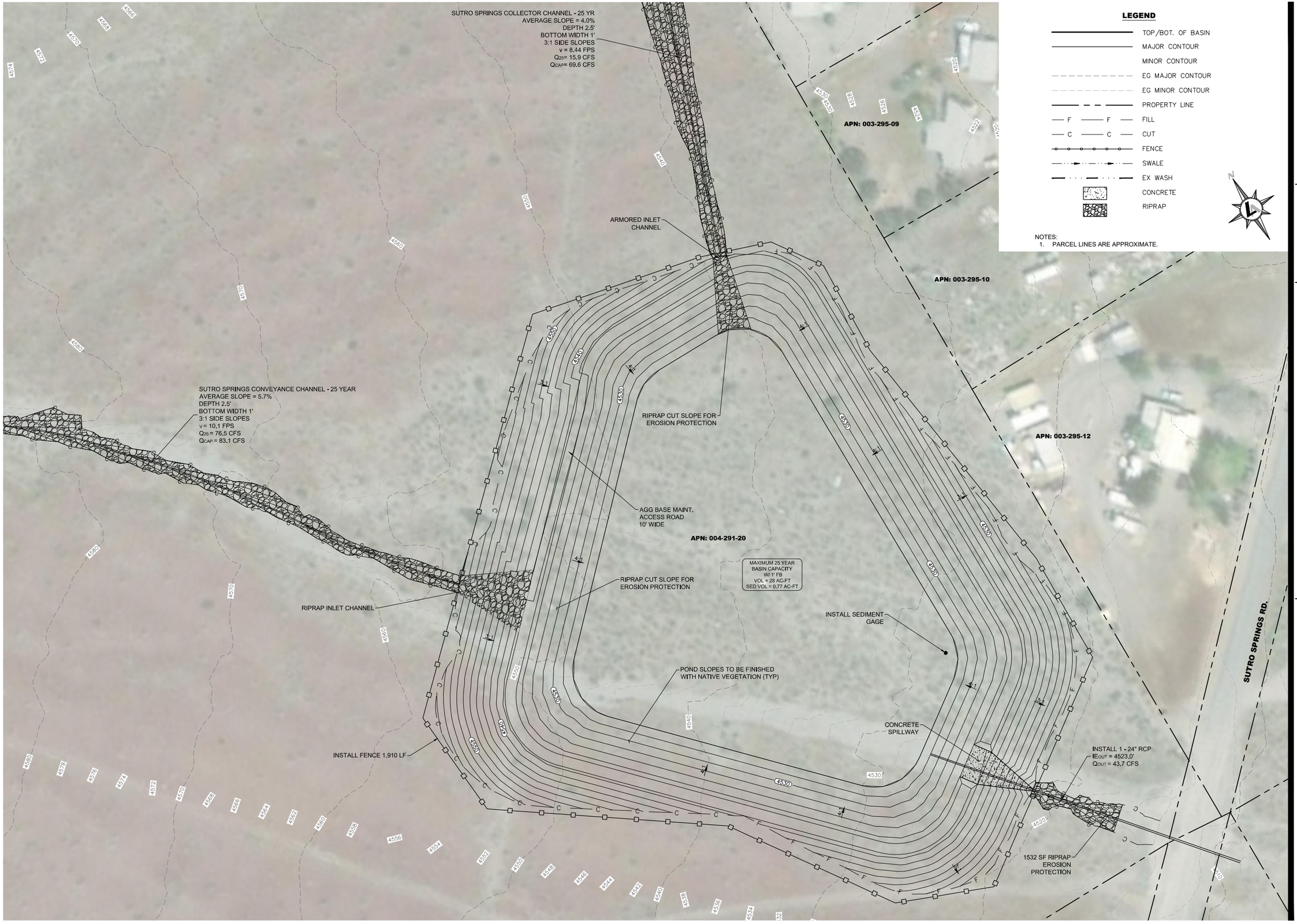

LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F — F — FILL
- C — C — CUT
- FENCE
- SWALE
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- CONCRETE
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
SUTRO SPRINGS BASIN
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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C6.0

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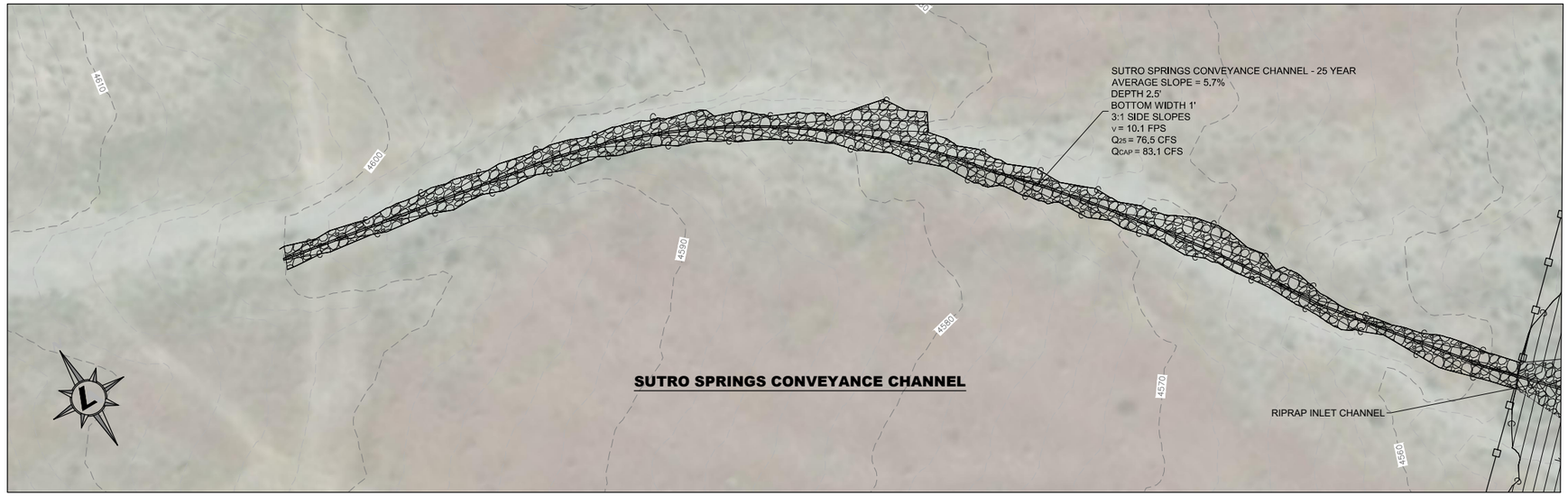
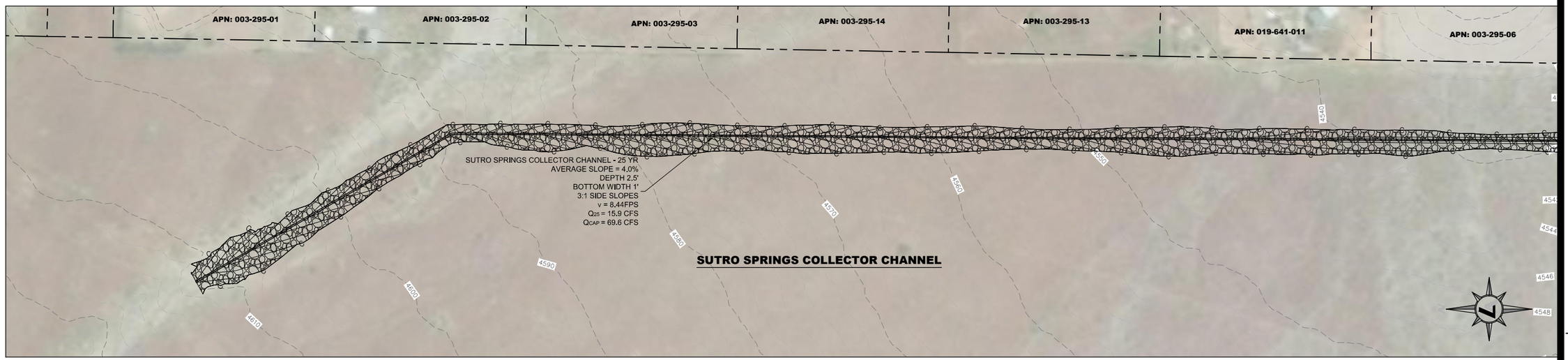
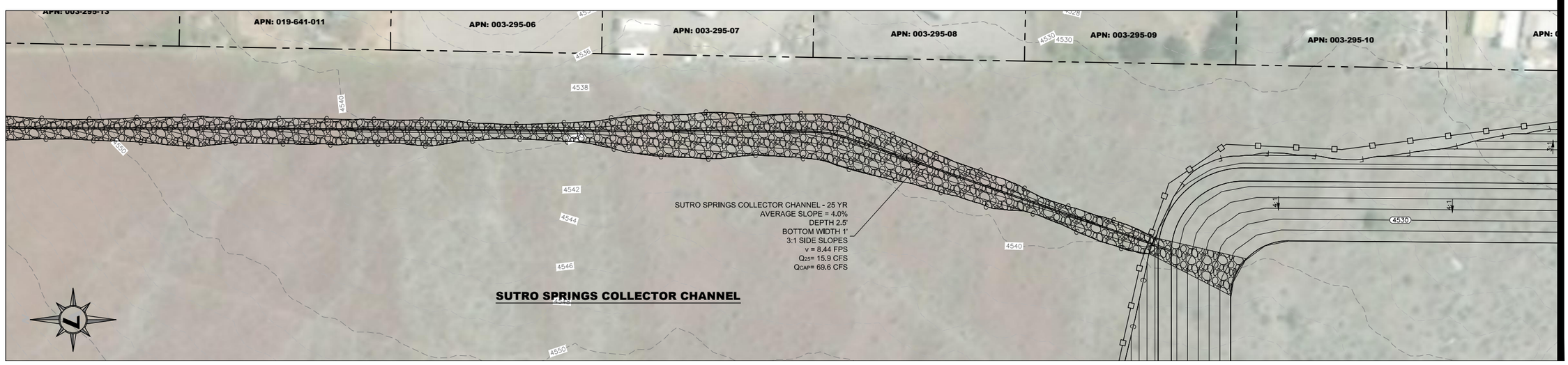


LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F F FILL
- C C CUT
- FENCE
- SWALE
- EX WASH
- CONCRETE
- RIPRAP

NOTES:
1. PARCEL LINES ARE APPROXIMATE.





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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
SUTRO SPRINGS CHANNELS
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F F FILL
- C C CUT
- FENCE
- SWALE
- EX WASH
- CONCRETE
- RIPRAP

NOTES:
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
WAGON WHEEL CULVERT
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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DESIGNED BY:	RTS
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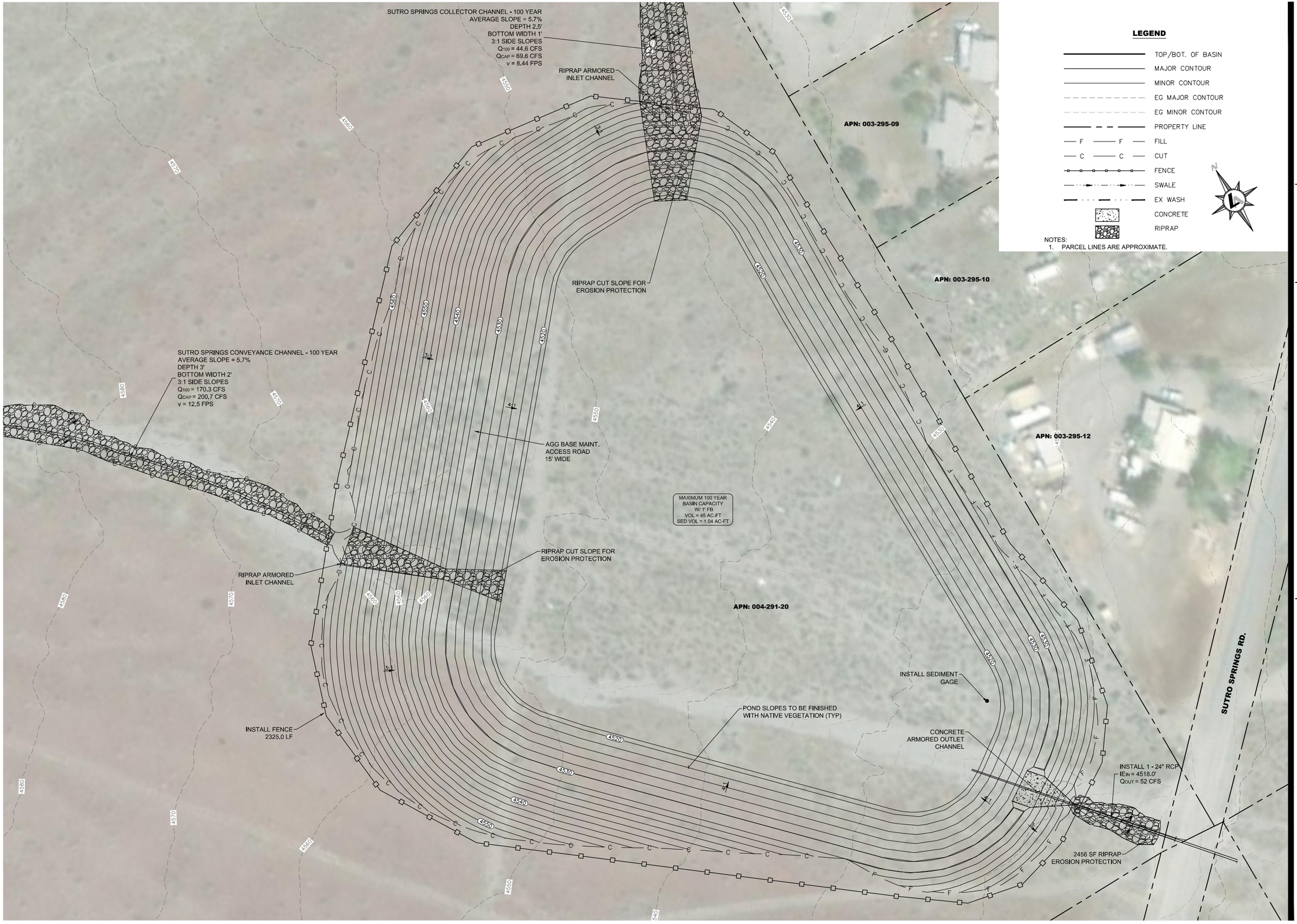

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
SUTRO SPRINGS BASIN
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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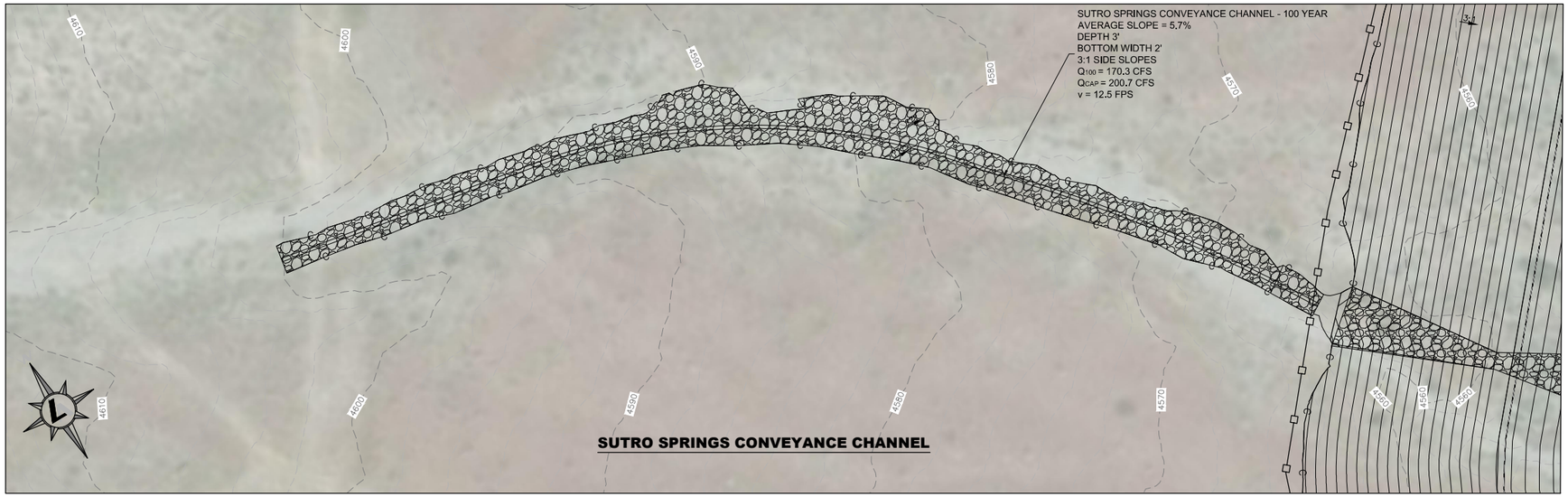

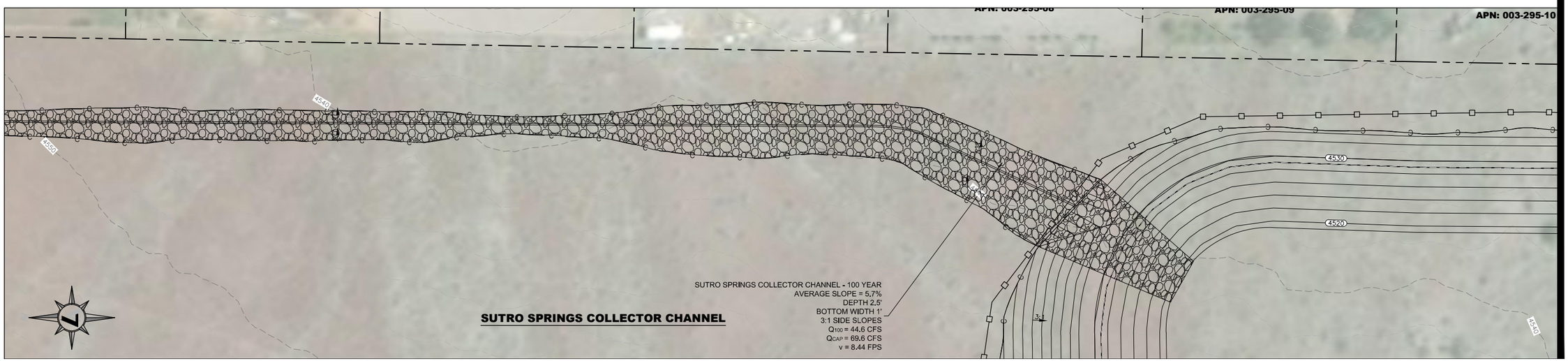

LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F F FILL
- C C CUT
- FENCE
- SWALE
- EX WASH
- CONCRETE
- RIPRAP

NOTES:
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
SUTRO SPRINGS CHANNELS
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F F FILL
- C C CUT
- FENCE
- SWALE
- EX WASH
- CONCRETE
- RIPRAP

NOTES:
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
WAGON WHEEL CULVERT
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JLUY 2019

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LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
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- EG MINOR CONTOUR
- PROPERTY LINE
- F F FILL
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- FENCE
- SWALE
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- RIPRAP

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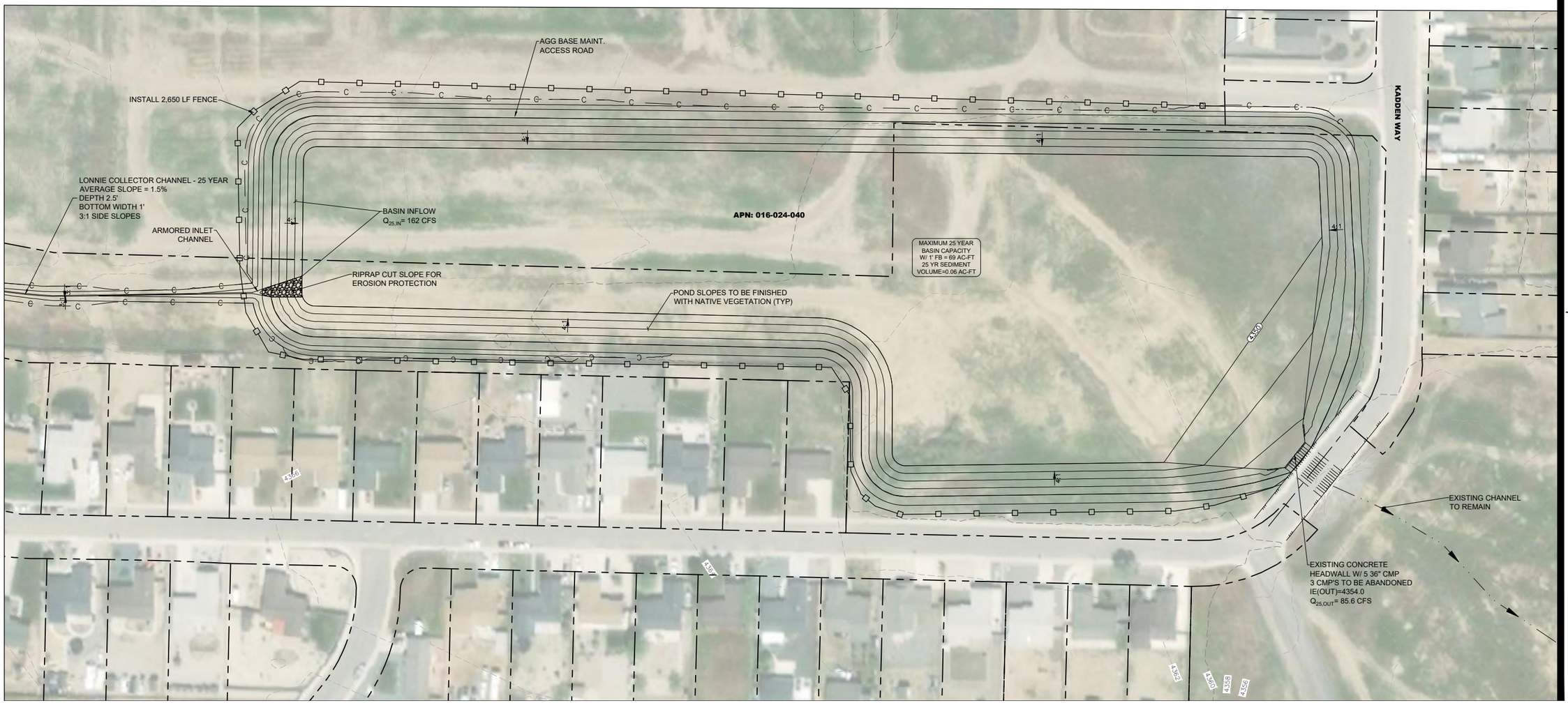
NOTE:
1. PARCEL LINES ARE APPROXIMATE.



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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
LONNIE BASIN AND CHANNEL
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
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- EG MINOR CONTOUR
- PROPERTY LINE
- F — F — FILL
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- FENCE
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- CONCRETE
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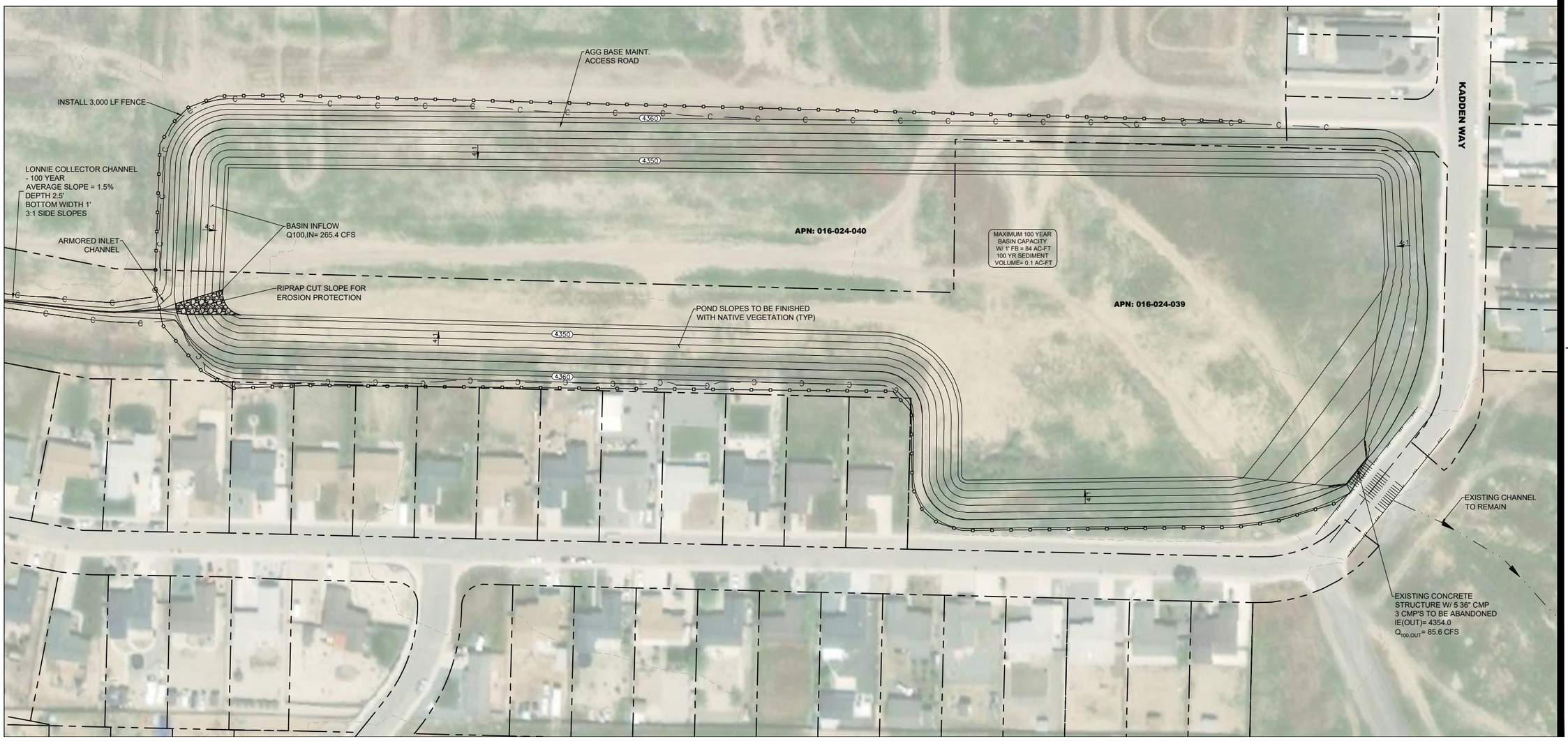

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
LONNIE BASIN AND CHANNEL
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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C7.1

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DESIGNED BY:	RTS
CHECKED BY:	RTS
JOB NO.:	9416.000

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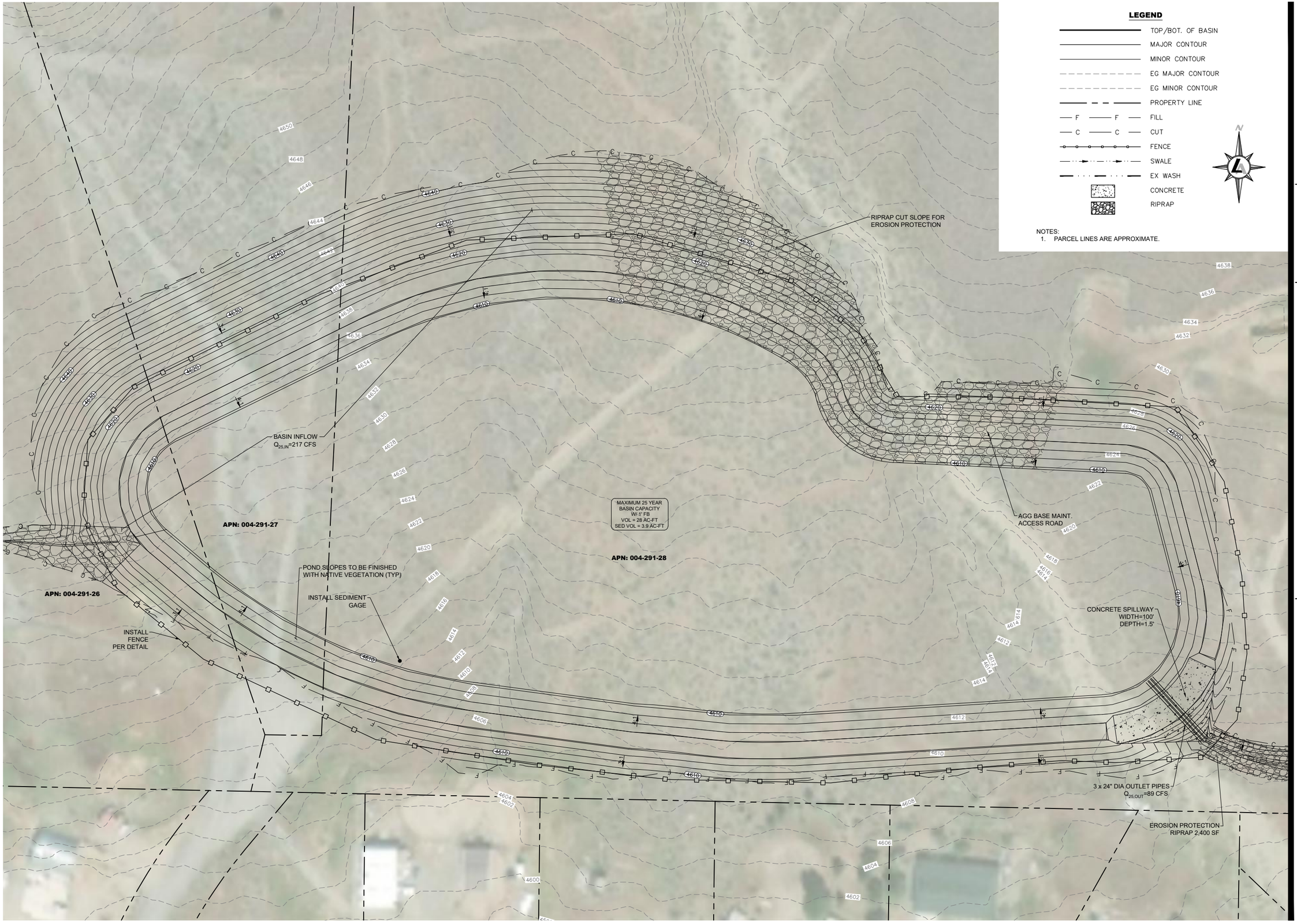

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
MARK TWAIN SYSTEM WEST BASIN
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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0 60'
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C8.0

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DESIGNED BY:	RTS
CHECKED BY:	RTS
JOB NO.:	9416.000

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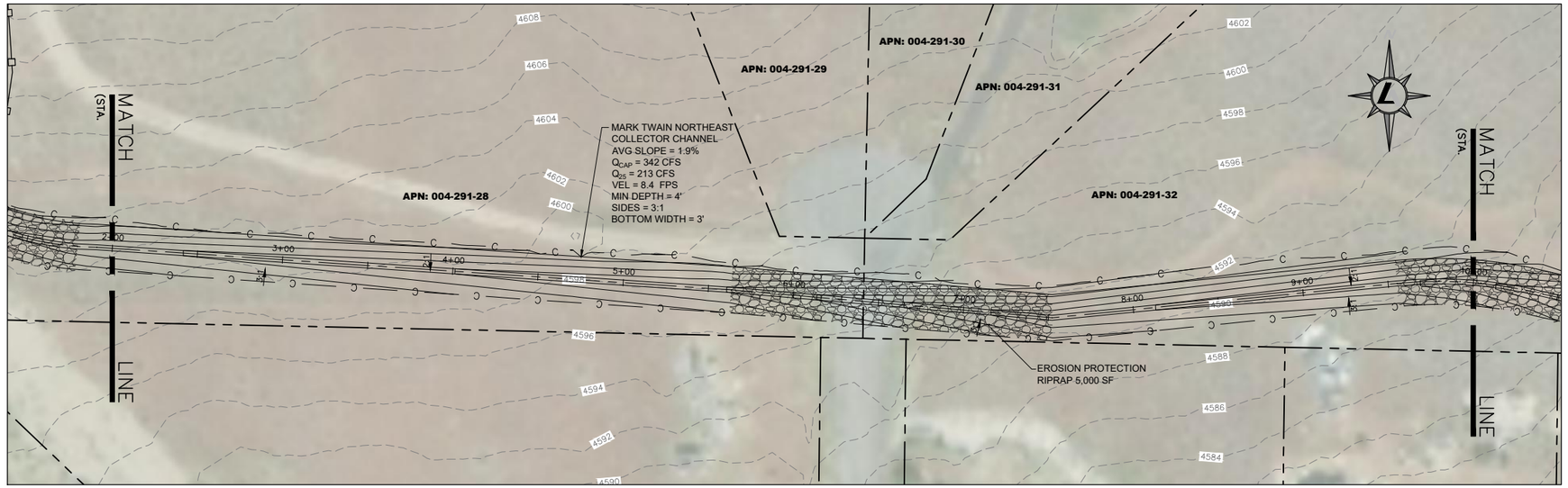

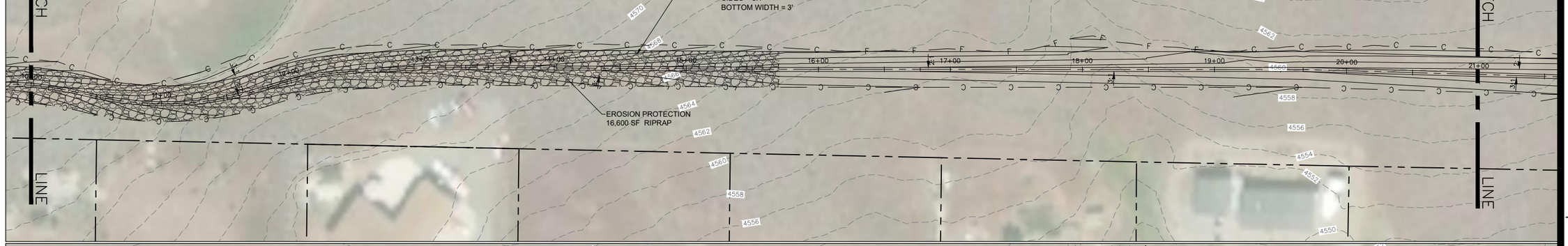

LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F — F — FILL
- C — C — CUT
- FENCE
- SWALE
- EX WASH
- CONCRETE
- RIPRAP

NOTES:
1. VEGETATED LINING SHALL BE PROVIDED IN ALL CHANNEL SECTIONS WITH A DESIGN VELOCITY GREATER THAN 5 FPS WHERE OTHER EROSION PROTECTION IS NOT SPECIFIED.
2. PARCEL LINES ARE APPROXIMATE.

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
MARK TWAIN SYSTEM
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JUNE 2019

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C8.1

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DESIGNED BY:	RTS
CHECKED BY:	RTS
JOB NO.:	9416.000

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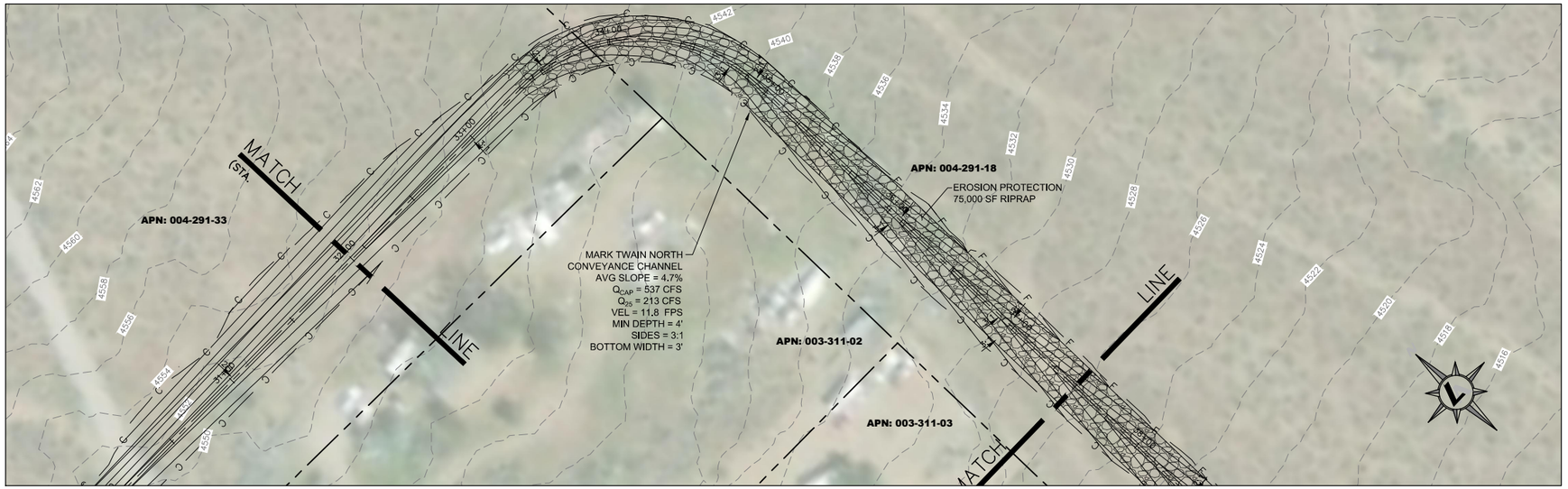

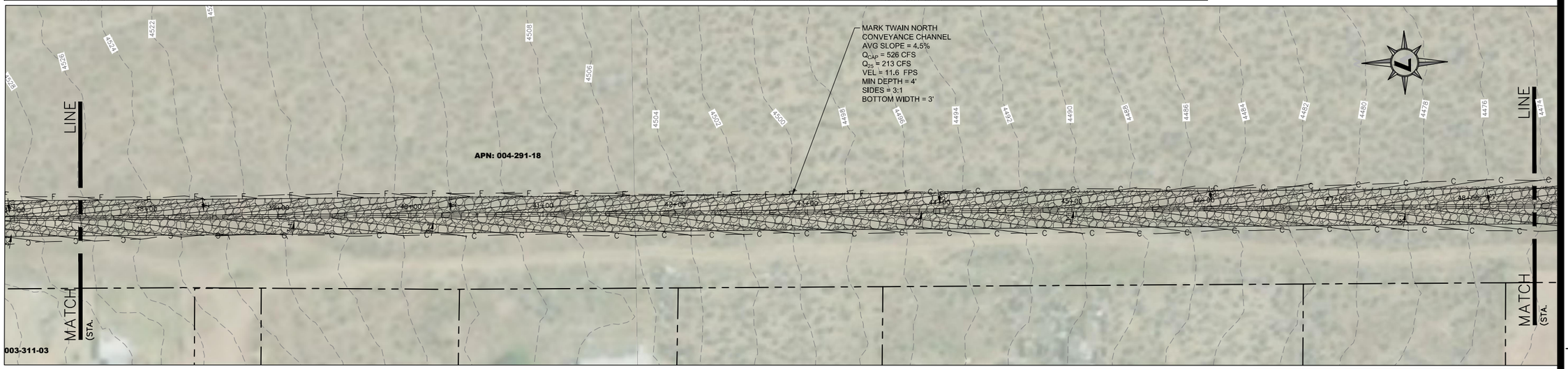

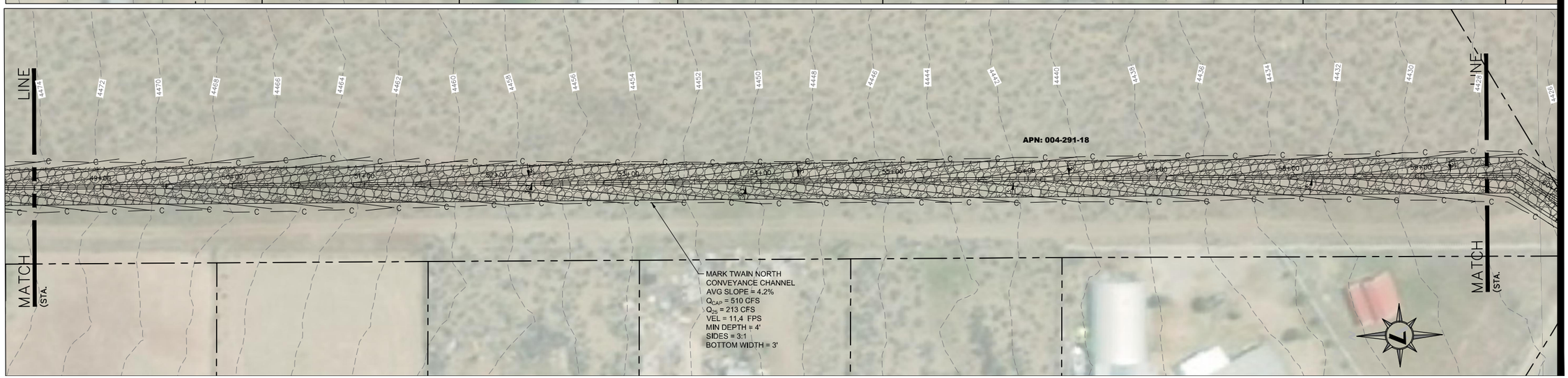

LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F — F — FILL
- C — C — CUT
- FENCE
- SWALE
- EX WASH
- CONCRETE
- RIPRAP

NOTES:

1. VEGETATED LINING SHALL BE PROVIDED IN ALL CHANNEL SECTIONS WITH A DESIGN VELOCITY GREATER THAN 5 FPS WHERE OTHER EROSION PROTECTION IS NOT SPECIFIED.
2. PARCEL LINES ARE APPROXIMATE.

LUMOS & ASSOCIATES
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
MARK TWAIN SYSTEM
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV | DATE | DESCRIPTION | BY

PRELIMINARY
15% DESIGN
JULY 2019

BAR IS 1 INCH ON ORIGINAL DRAWING
0 60'
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C8.2

DRAWN BY:	KLM
DESIGNED BY:	RTS
CHECKED BY:	RTS
JOB NO.:	9416.000

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LA FONDE CULVERT
2x 48" RCP
LENGTH= 40'
SLOPE = 1.0%
IE IN= 4418.4'
IE OUT=4418.0'
Q_{CAP} = 236 CFS

MATCH LINE (STA. 60+63)

LAFONDE

RIPRAP CUT SLOPE FOR EROSION PROTECTION

INSTALL SEDIMENT GAGE

APN: 016-024-039

APN: 003-315-13

APN: 004-291-24

MAXIMUM 25 YEAR BASIN CAPACITY
W/ 1' FB
VOL = 30 AC-FT
SED VOL = 2.04 AC-FT

AGG BASE MAINT. ACCESS ROAD
15' WIDE

POND SLOPES TO BE FINISHED WITH NATIVE VEGETATION (TYP)

INSTALL FENCE
2207 LINEAR FT.

4 x 24" DIA OUTLET PIPES
$Q_{25,OUT}$=138 CFS

CONCRETE SPILLWAY
DEPTH = 1.5'
WIDTH = 45'

MARK TWAIN SOUTH CONVEYANCE CHANNEL
AVG SLOPE = 1.2%
Q_{CAP} = 271 CFS
Q_{25} = 138 CFS
VEL = 6.4 FPS
MIN DEPTH = 4'
SIDES = 3:1
BOTTOM WIDTH = 3'

MATCH LINE (STA. 60+63)

LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F — F — FILL
- C — C — CUT
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- CONCRETE
- RIPRAP

NOTES:
1. PARCEL LINES ARE APPROXIMATE.

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
MARK TWAIN SYSTEM SOUTH BASIN
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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C8.3

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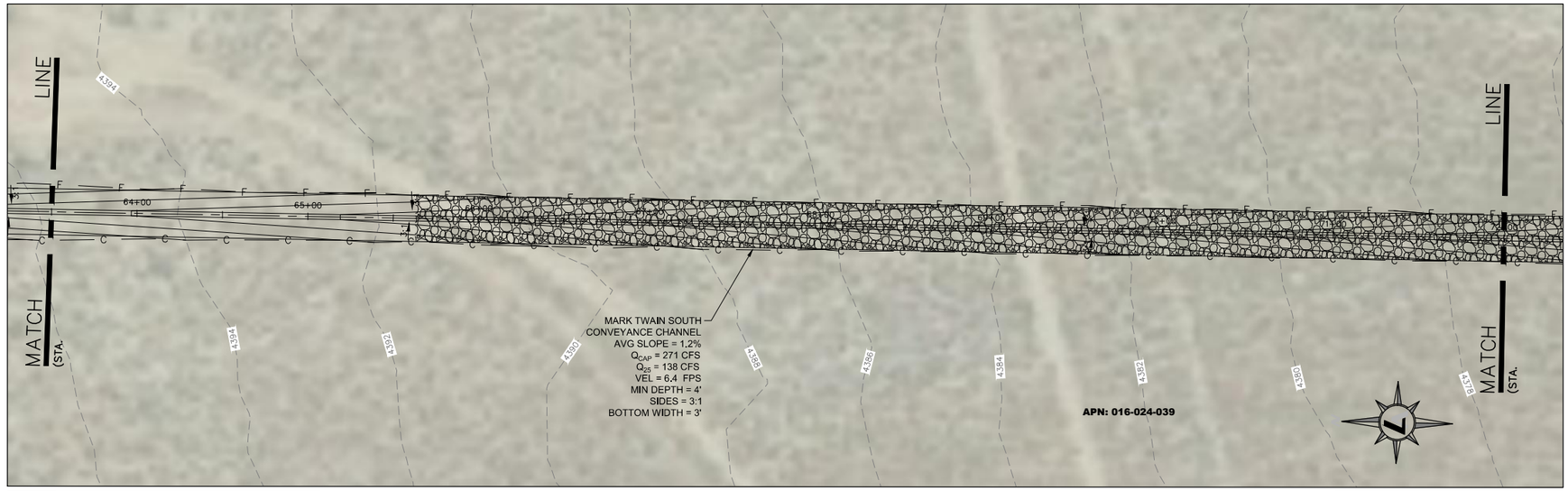

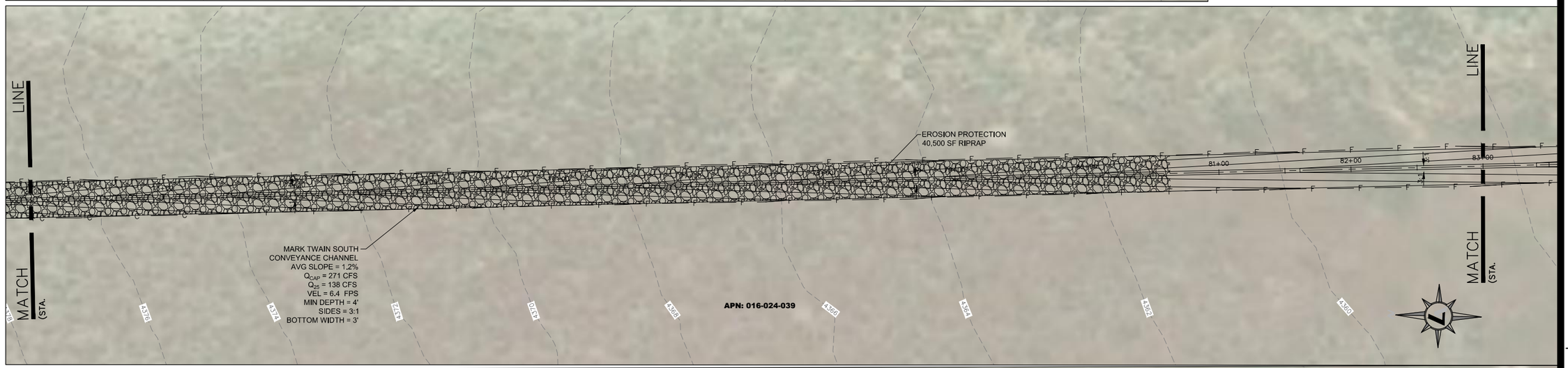

LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
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NOTES:
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
MARK TWAIN SYSTEM
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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C8.4

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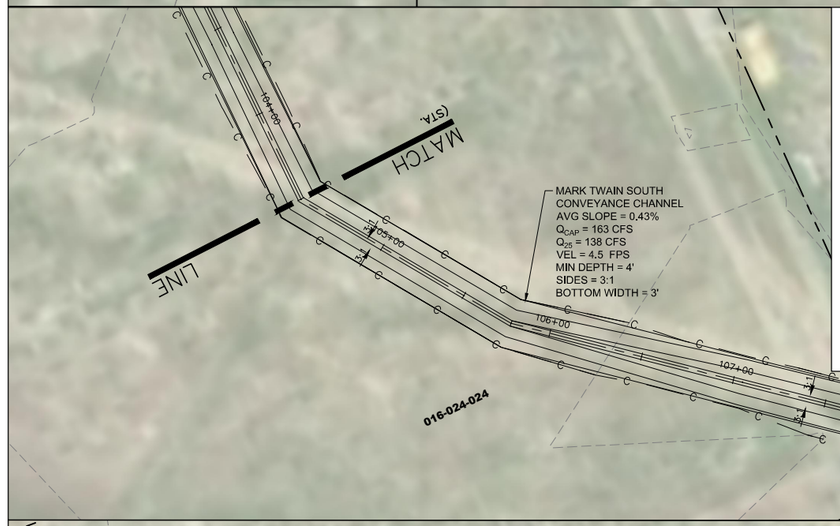

LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
MARK TWAIN SYSTEM
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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C8.5

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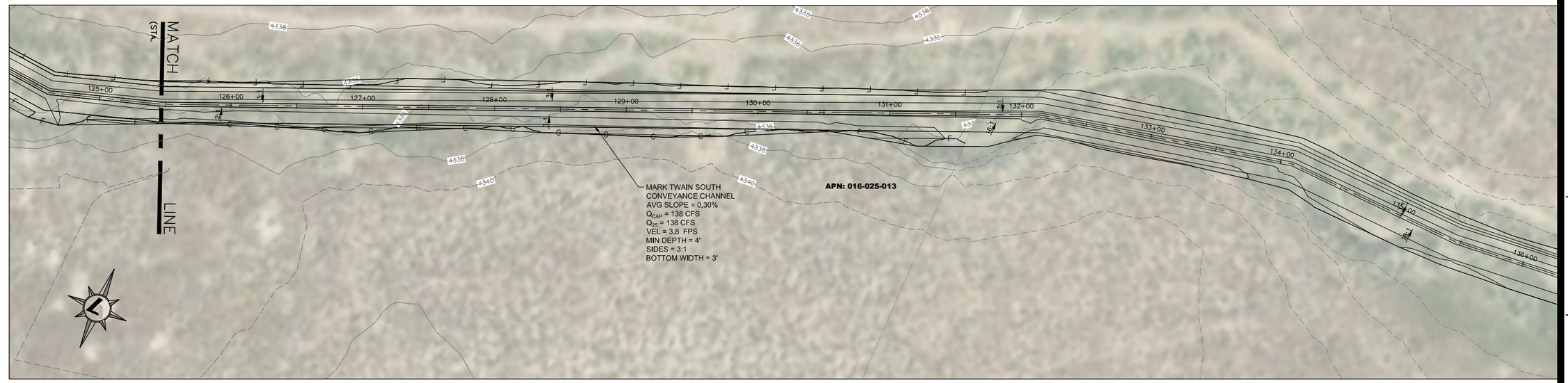

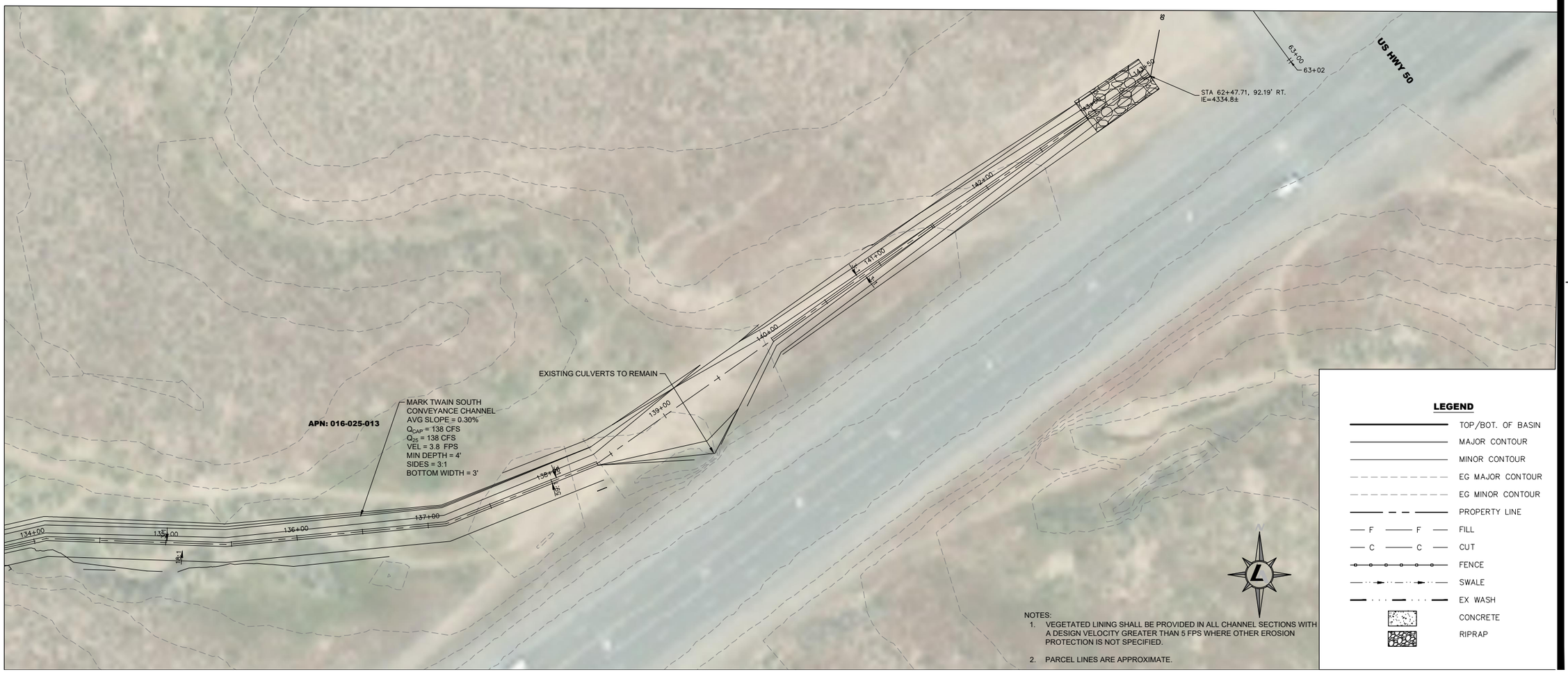

LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
MARK TWAIN SYSTEM
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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C8.6

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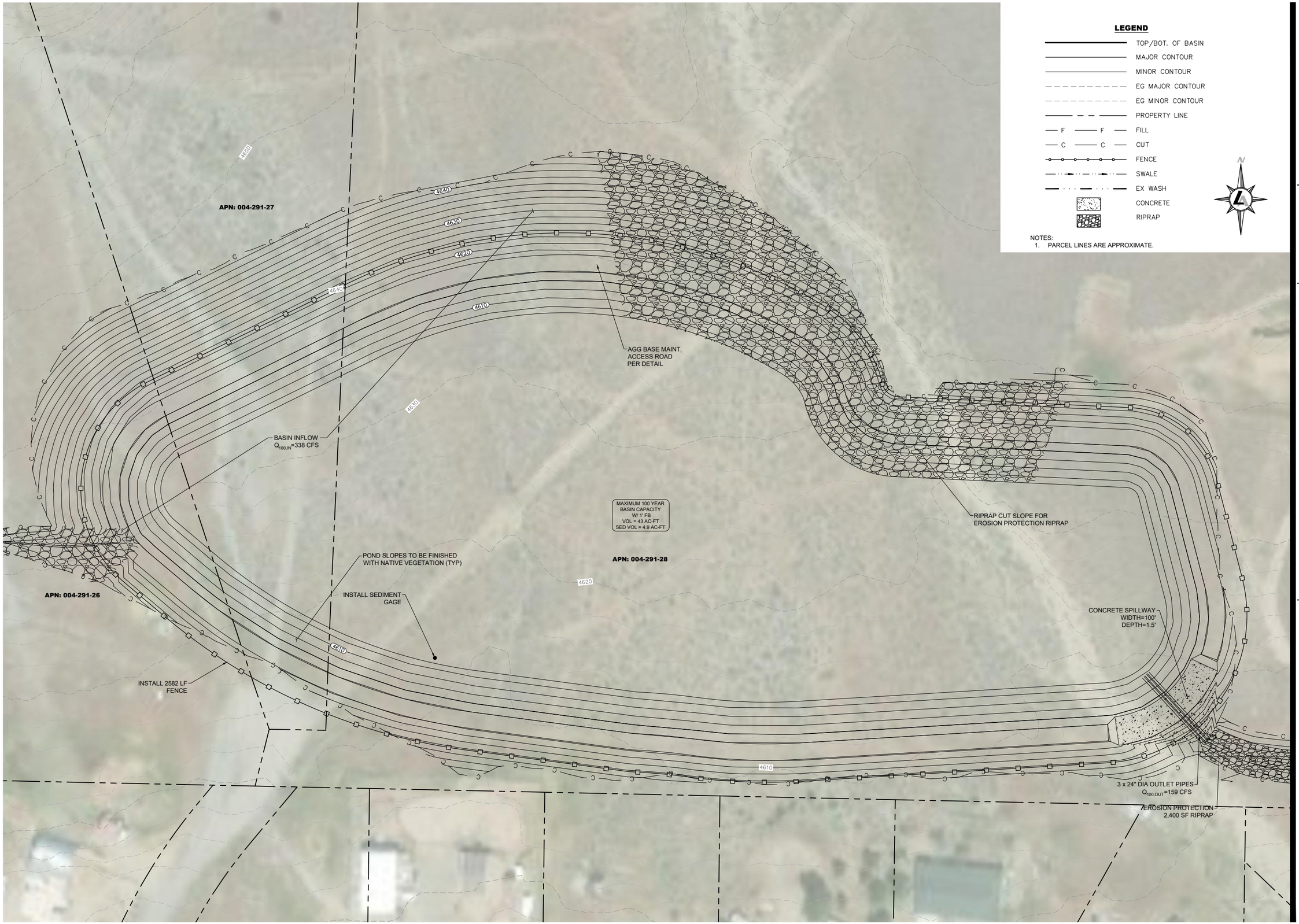

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
MARK TWAIN SYSTEM WEST BASIN
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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0 60"
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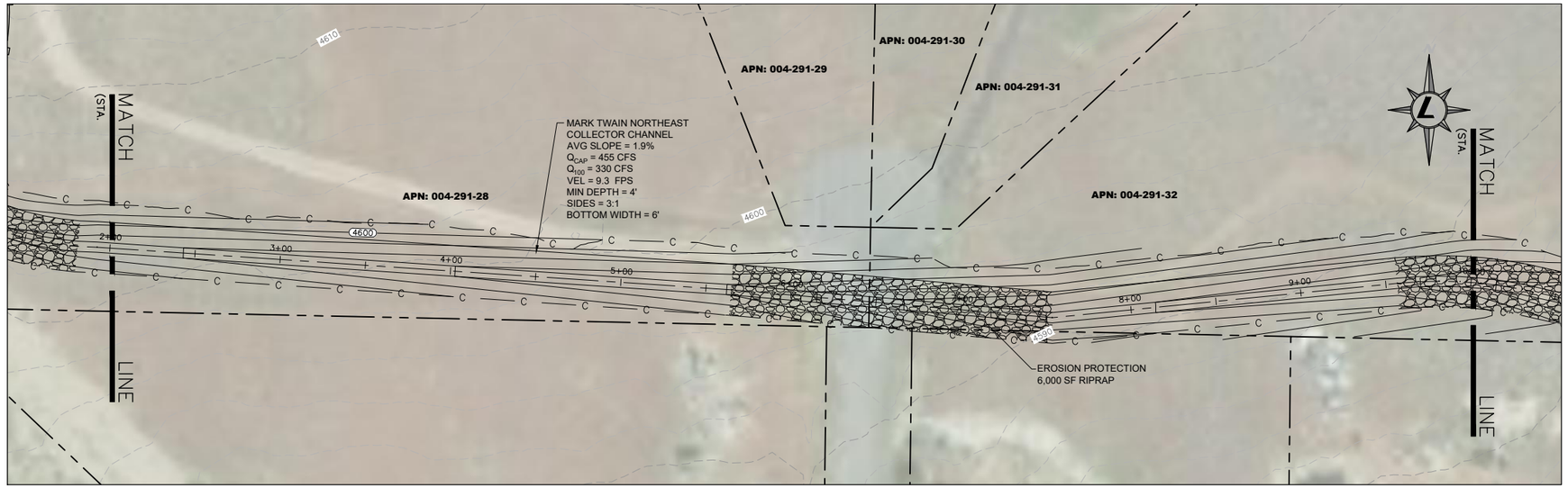

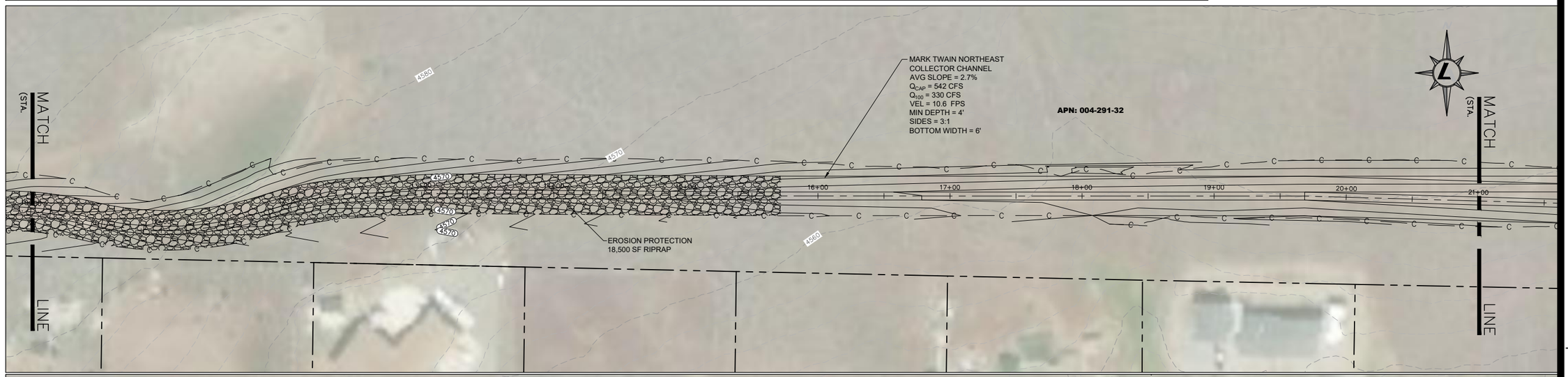

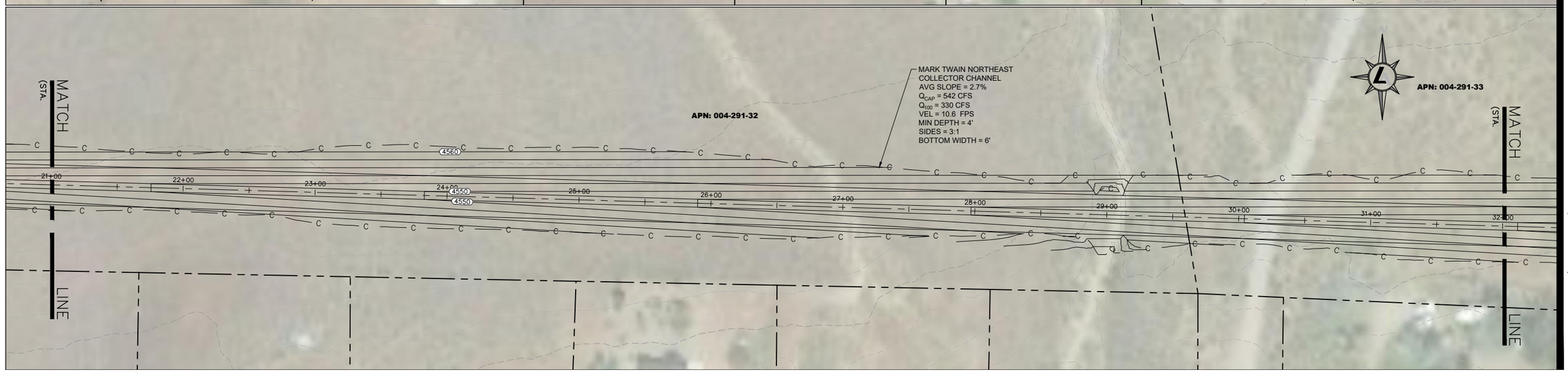

LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F F FILL
- C C CUT
- FENCE
- SWALE
- EX WASH
- CONCRETE
- RIPRAP

NOTES:

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
MARK TWAIN SYSTEM
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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C8.8

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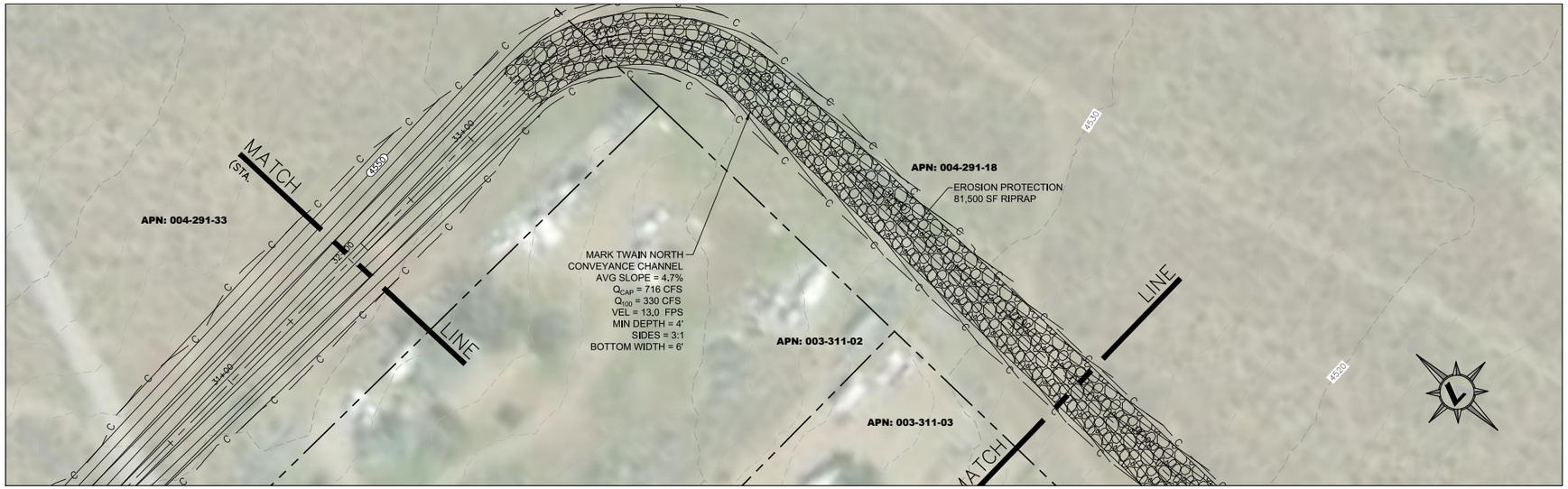

LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
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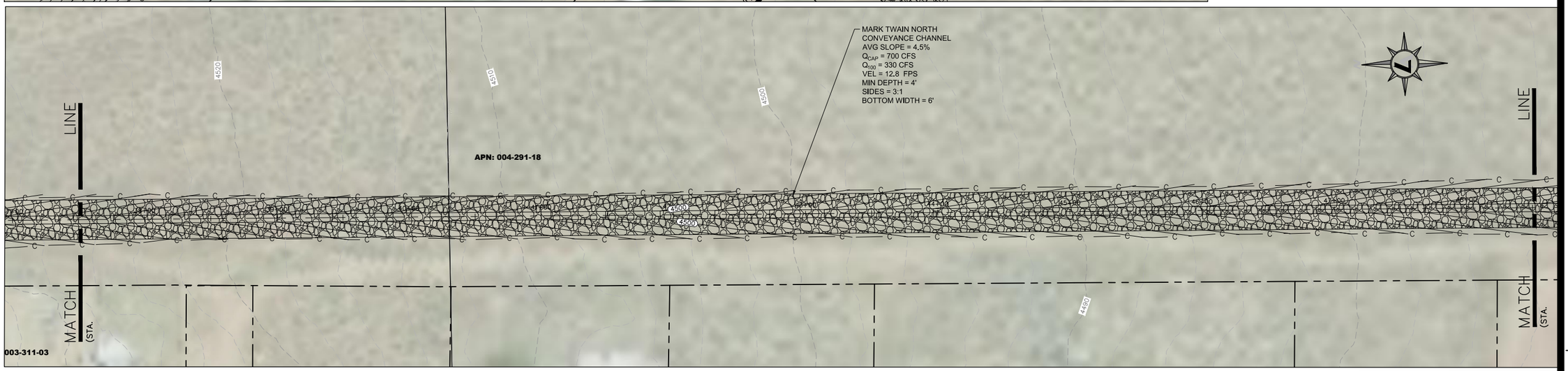

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
MARK TWAIN SYSTEM
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY
0			

PRELIMINARY
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CHECKED BY:	RTS
JOB NO.:	9416.000

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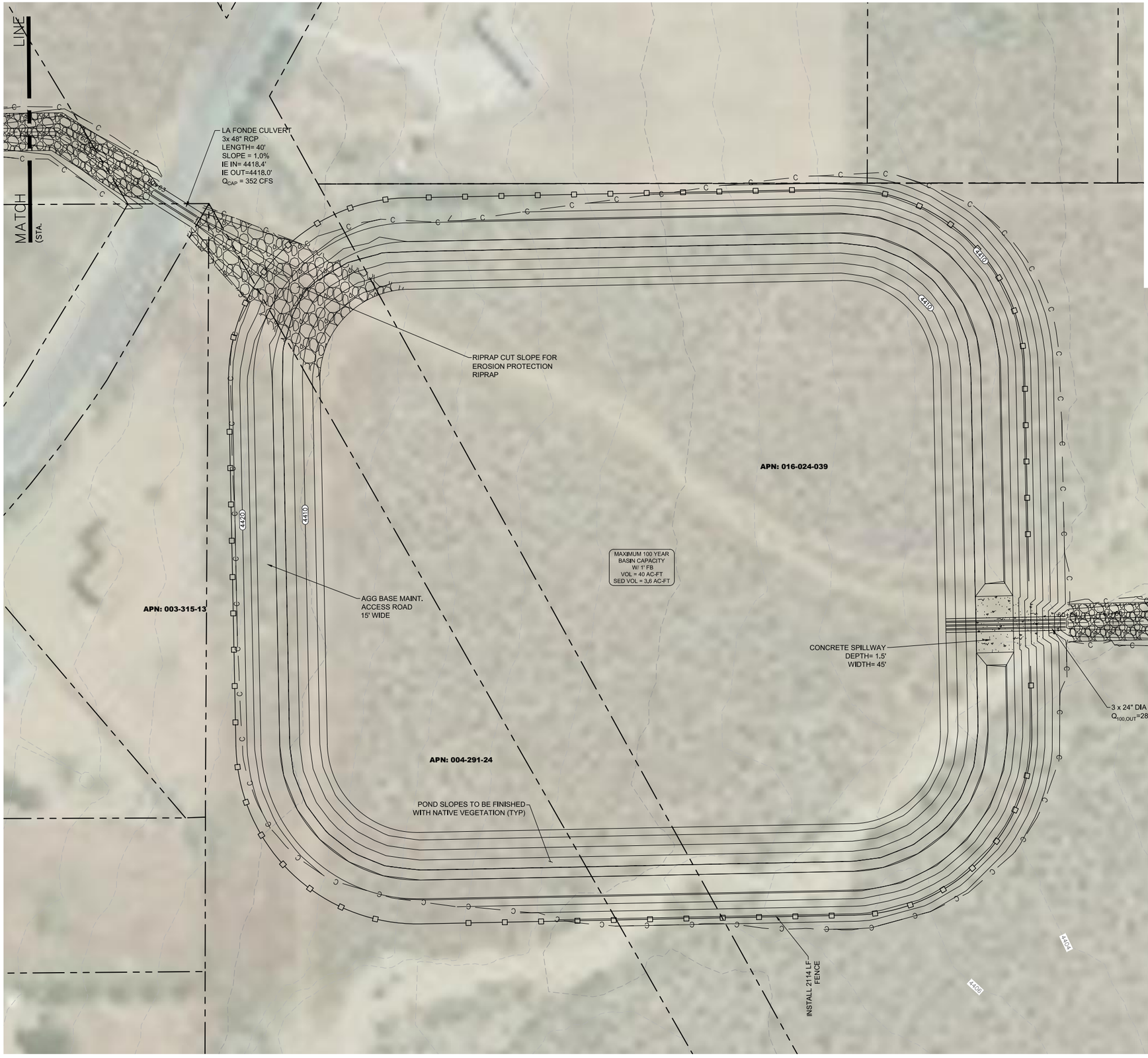

LEGEND

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
MARK TWAIN SYSTEM SOUTH BASIN
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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C8.10

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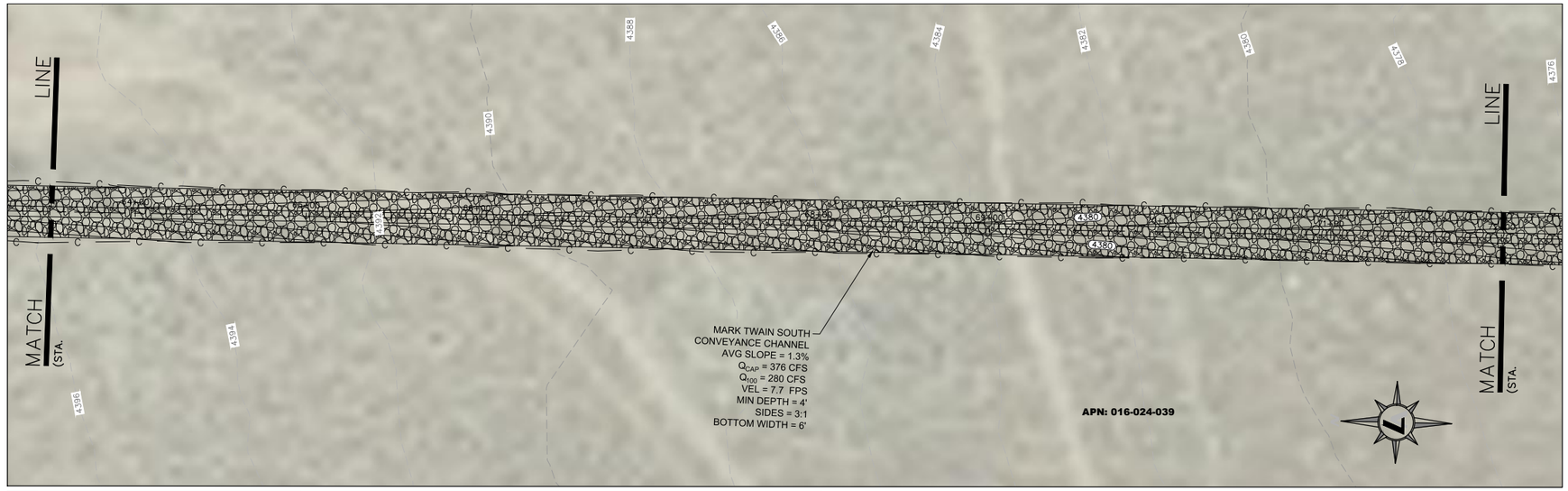

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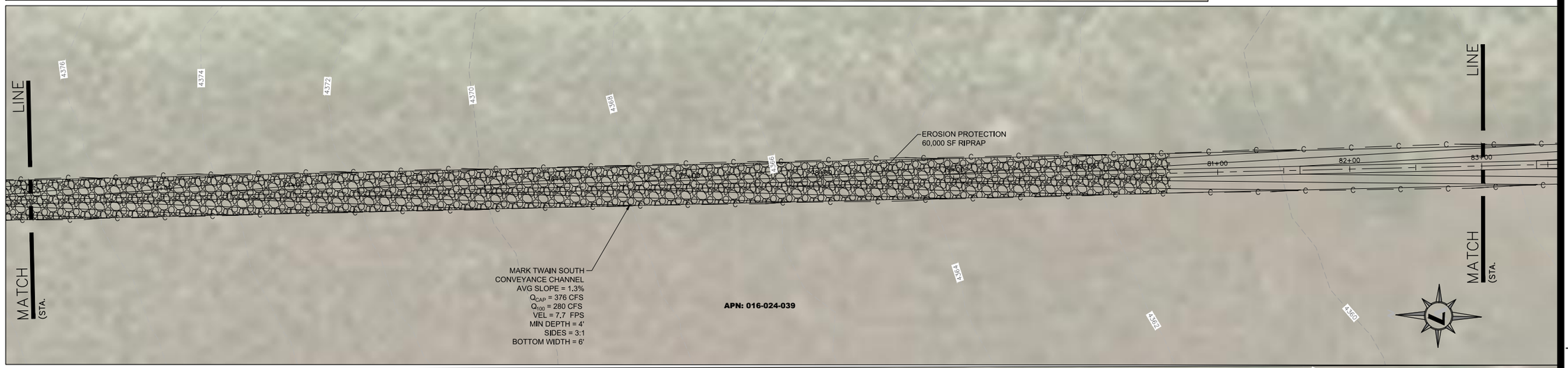

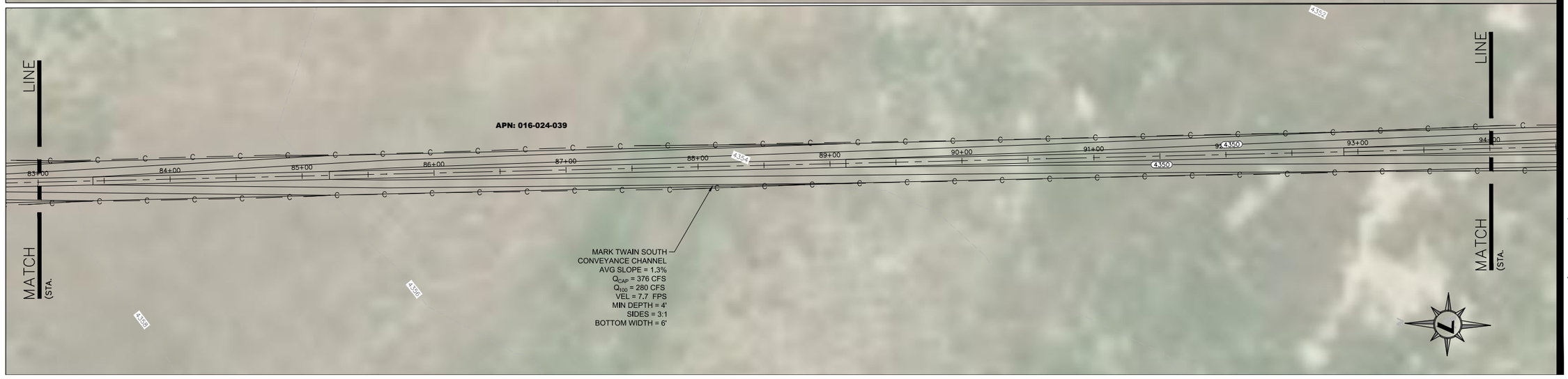

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
MARK TWAIN SYSTEM
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

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C8.11

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DESIGNED BY:	RTS
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JOB NO.:	9416.000

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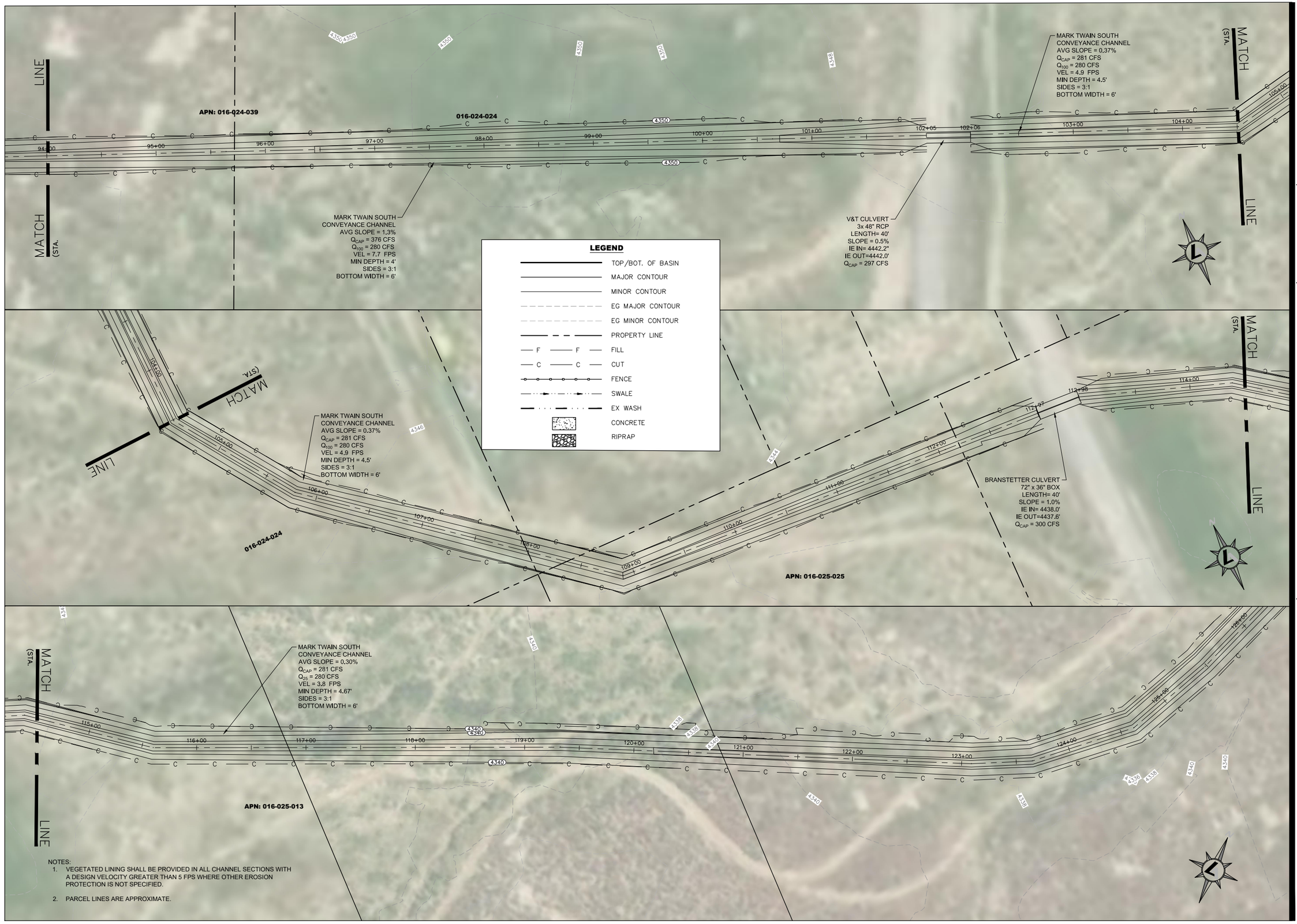

NOTES:

1. VEGETATED LINING SHALL BE PROVIDED IN ALL CHANNEL SECTIONS WITH A DESIGN VELOCITY GREATER THAN 5 FPS WHERE OTHER EROSION PROTECTION IS NOT SPECIFIED.
2. PARCEL LINES ARE APPROXIMATE.

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
MARK TWAIN SYSTEM
100 YEAR DESIGN

NEVADA

LYON/STOREY COUNTY

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
MARK TWAIN SYSTEM
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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DESIGNED BY:	RTS
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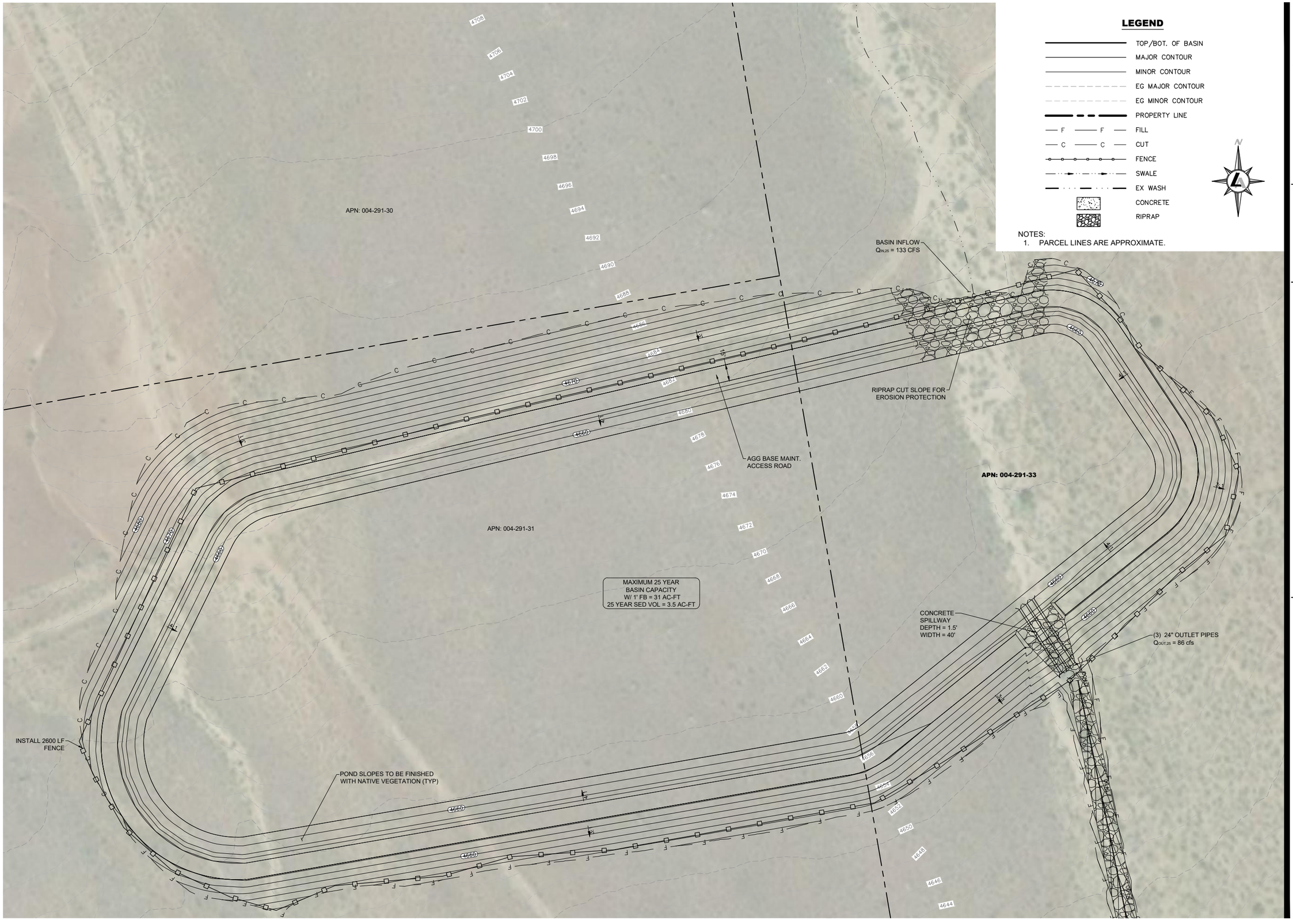

NOTES:
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
MARK TWAIN NORTH BASIN
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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C9.0

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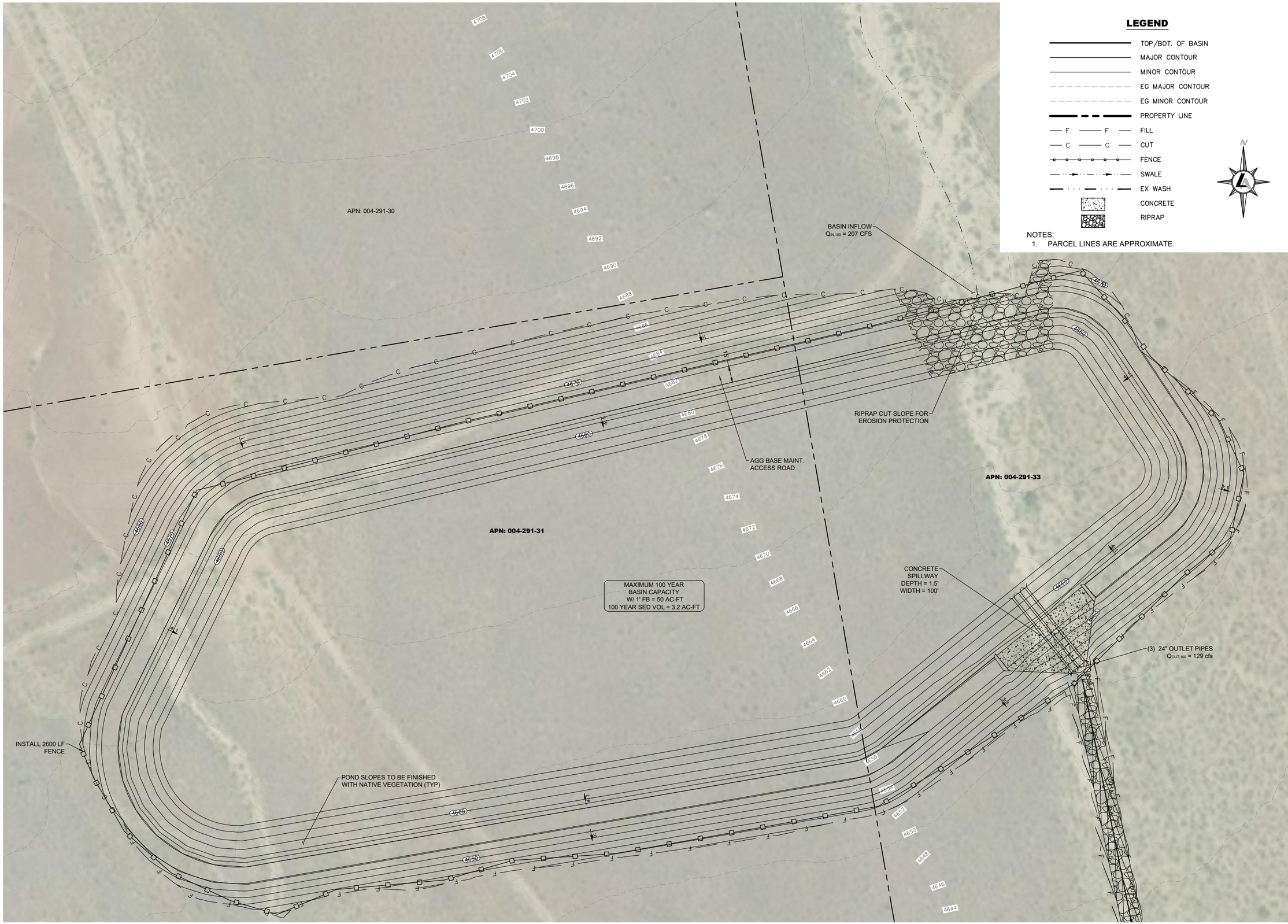
DESIGNED BY:	RTS
CHECKED BY:	RTS
JOB NO.:	9416.000

L:\LAPro\9416.000 - Dayton Valley Area Drainage Master Plan\DWG\Civil3D\Grading\Basins\Mark Twain North 25-Yr.dwg,C9.0 MARK TWAIN NORTH - 25YR, 07/19/2019 11:52 am sprettyman



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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
MARK TWAIN NORTH BASIN
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F — F — FILL
- C — C — CUT
- FENCE
- SWALE
- EX WASH
- CONCRETE
- RIPRAP

NOTES:
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
MARK TWAIN NORTH OUTLET CHANNEL
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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DESIGNED BY:	RTS
CHECKED BY:	RTS
JOB NO.:	9416.000

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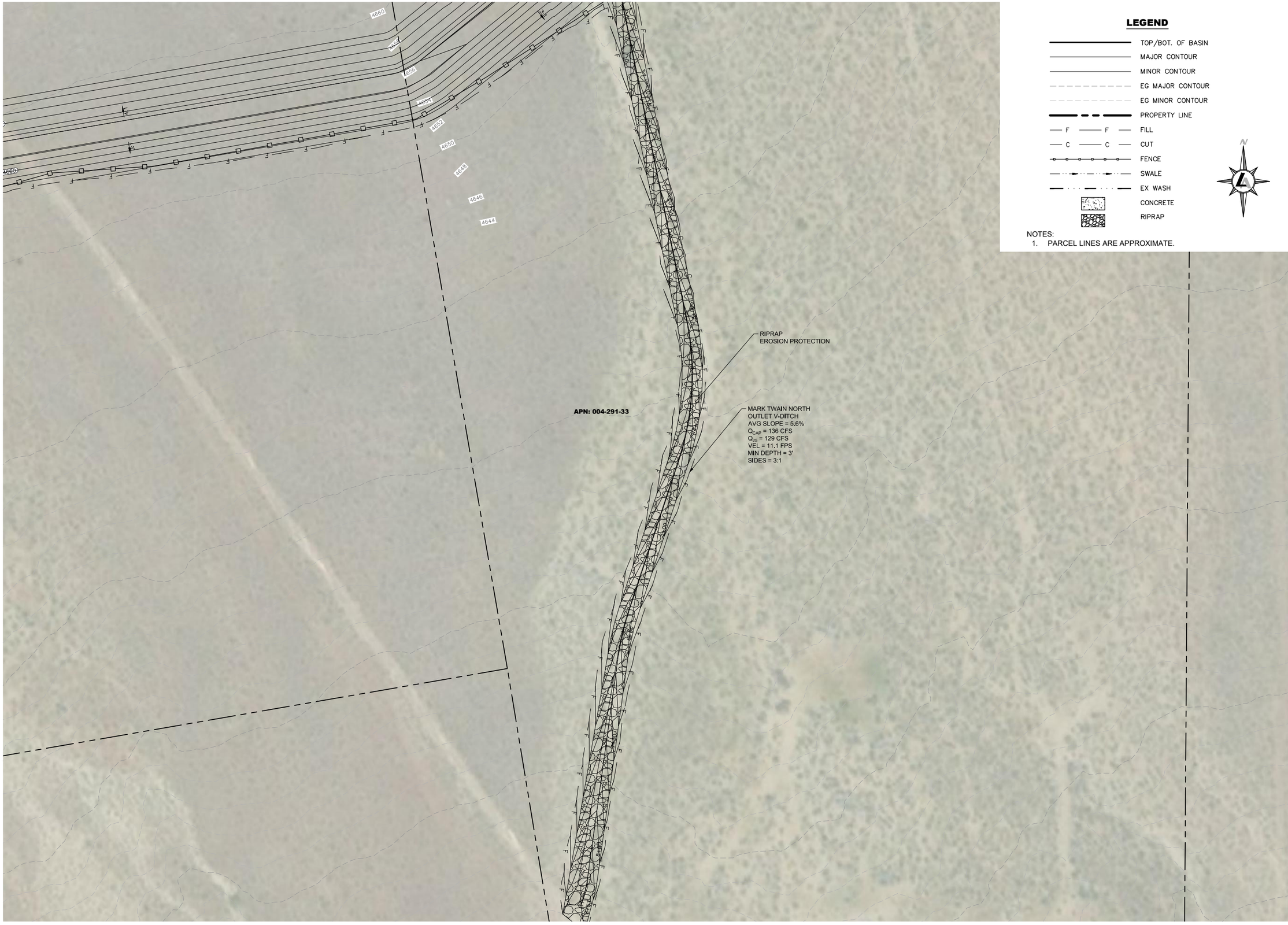

LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F F FILL
- C C CUT
- FENCE
- SWALE
- EX WASH
- CONCRETE
- RIPRAP

NOTES:
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
MARK TWAIN NORTH OUTLET CHANNEL
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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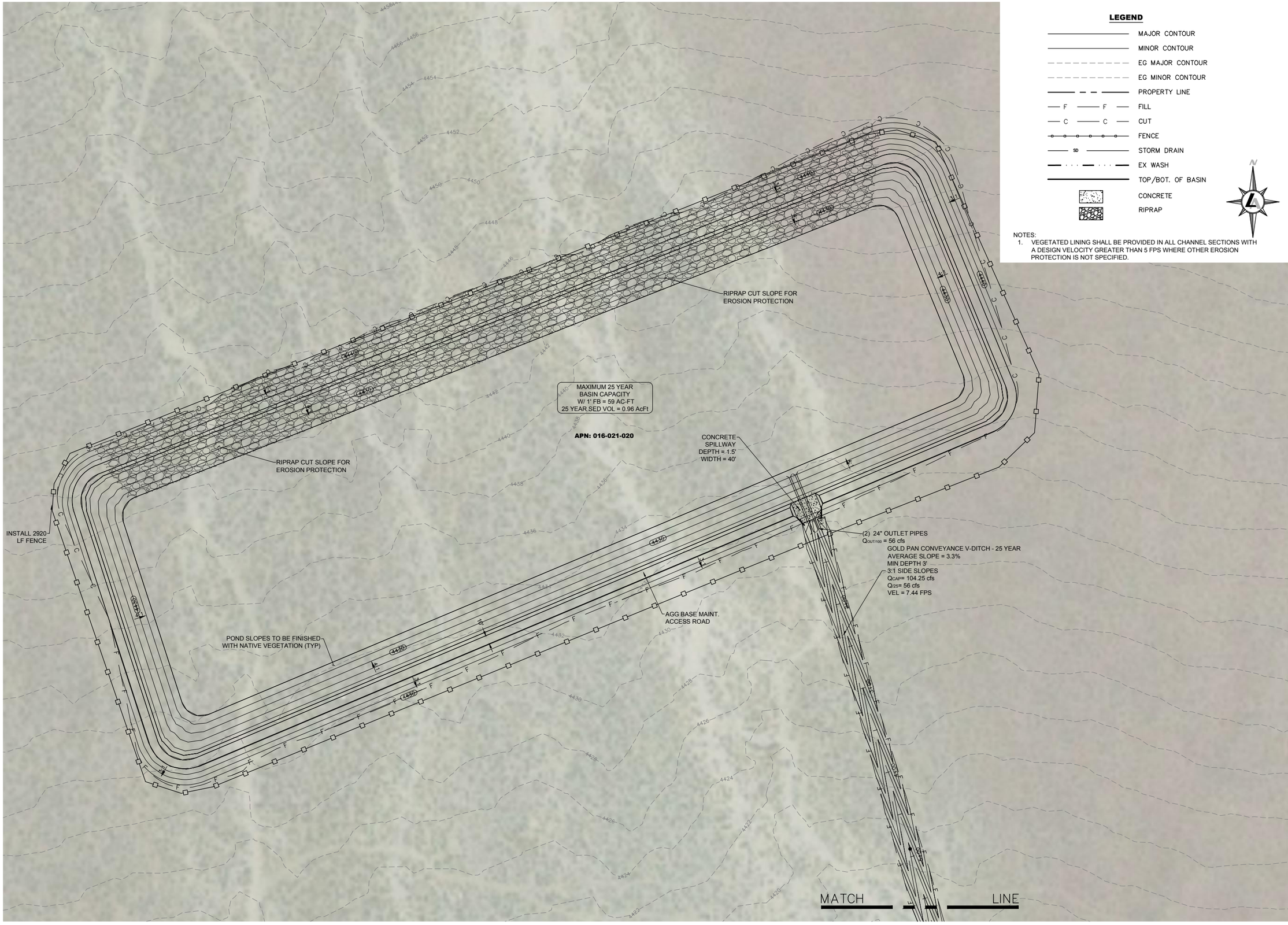

LEGEND

- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- FILL
- CUT
- FENCE
- STORM DRAIN
- EX WASH
- TOP/BOT. OF BASIN
- CONCRETE
- RIPRAP

NOTES:
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
GOLD PAN BASIN & STORMDRAIN
25 YEAR DESIGN

NEVADA

LYON/STOREY COUNTY

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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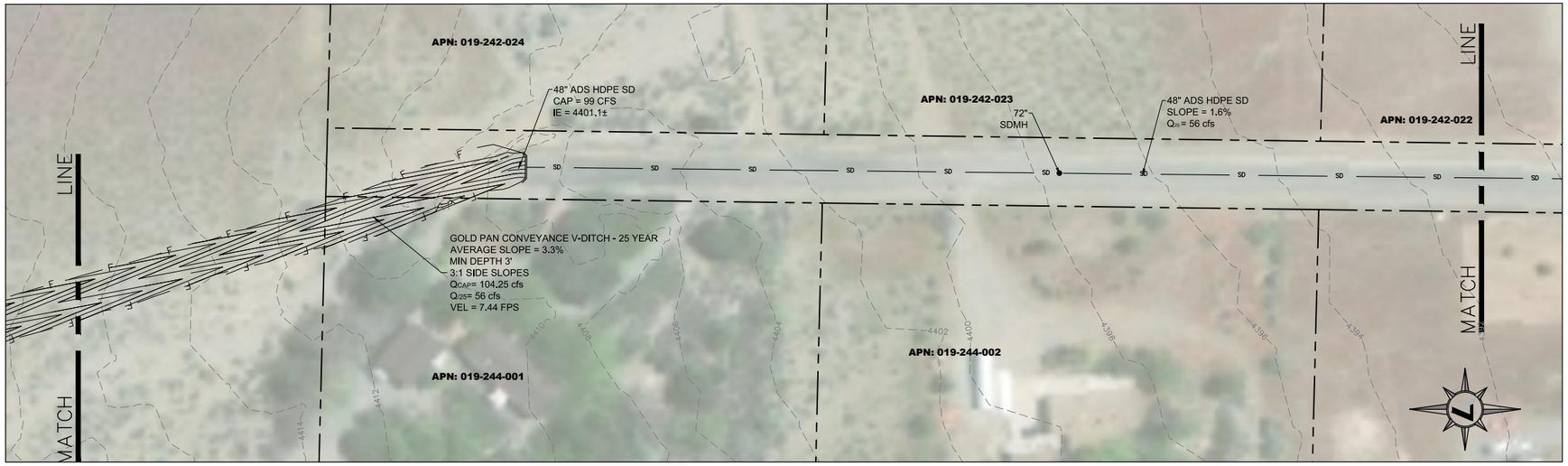

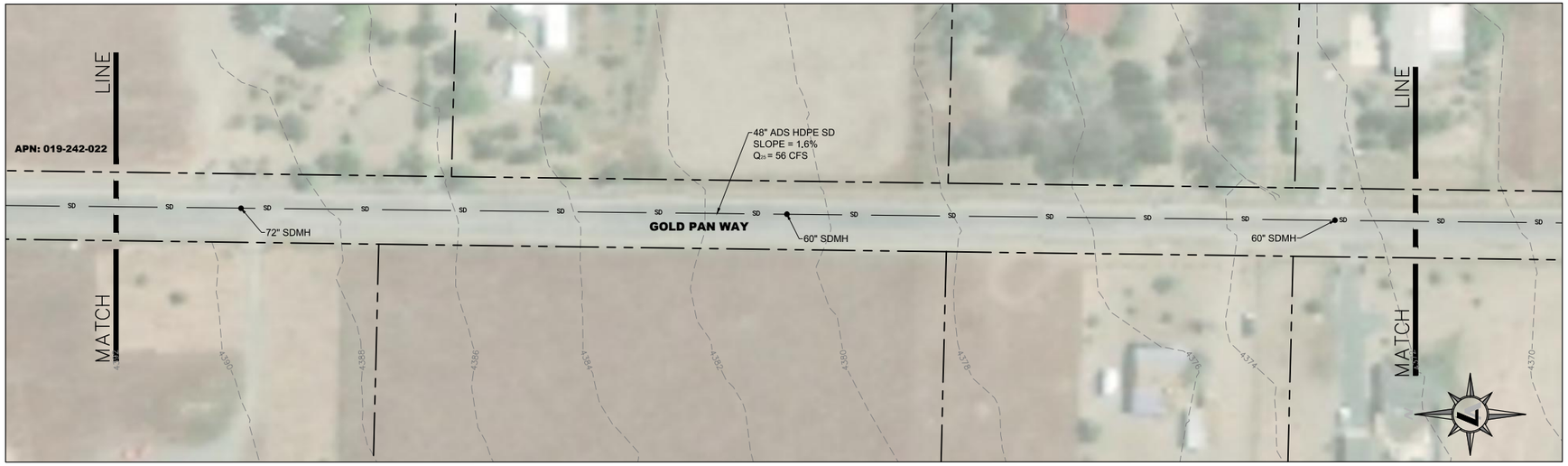

LEGEND

- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE

NOTES:

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
GOLD PAN BASIN & STORMDRAIN
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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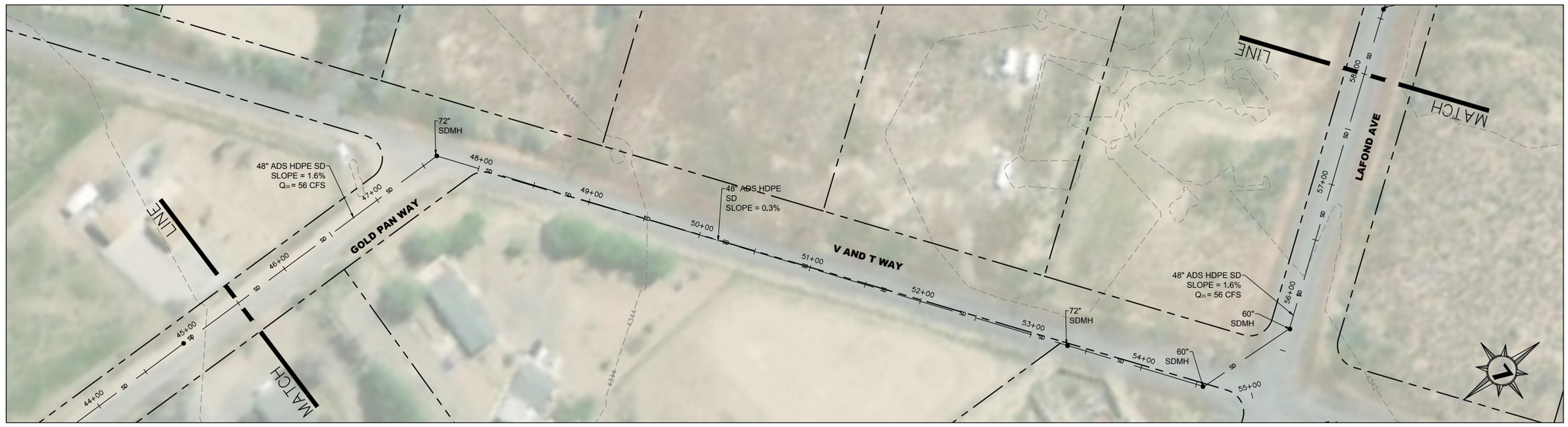

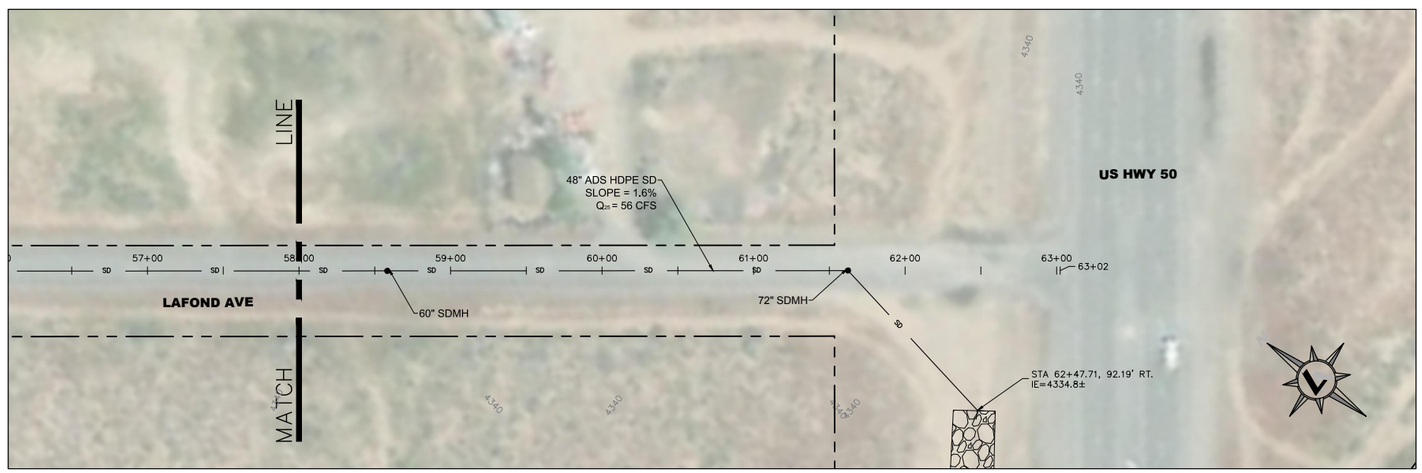

LEGEND

- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE

NOTES:

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
GOLD PAN BASIN & STORMDRAIN
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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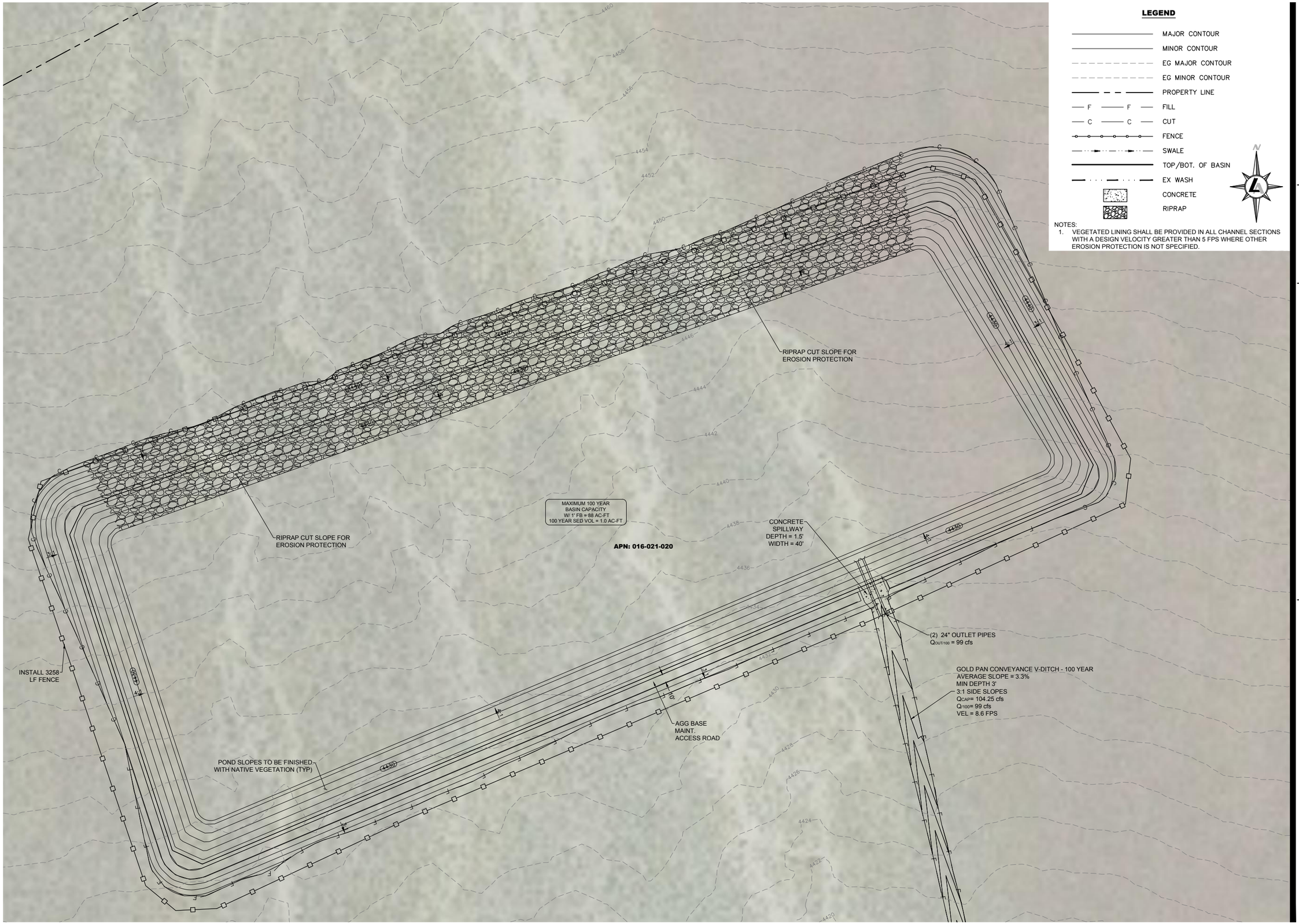

LEGEND

- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- FILL
- CUT
- FENCE
- SWALE
- TOP/BOT. OF BASIN
- EX WASH
- CONCRETE
- RIPRAP

NOTES:
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
GOLD PAN BASIN & STORMDRAIN
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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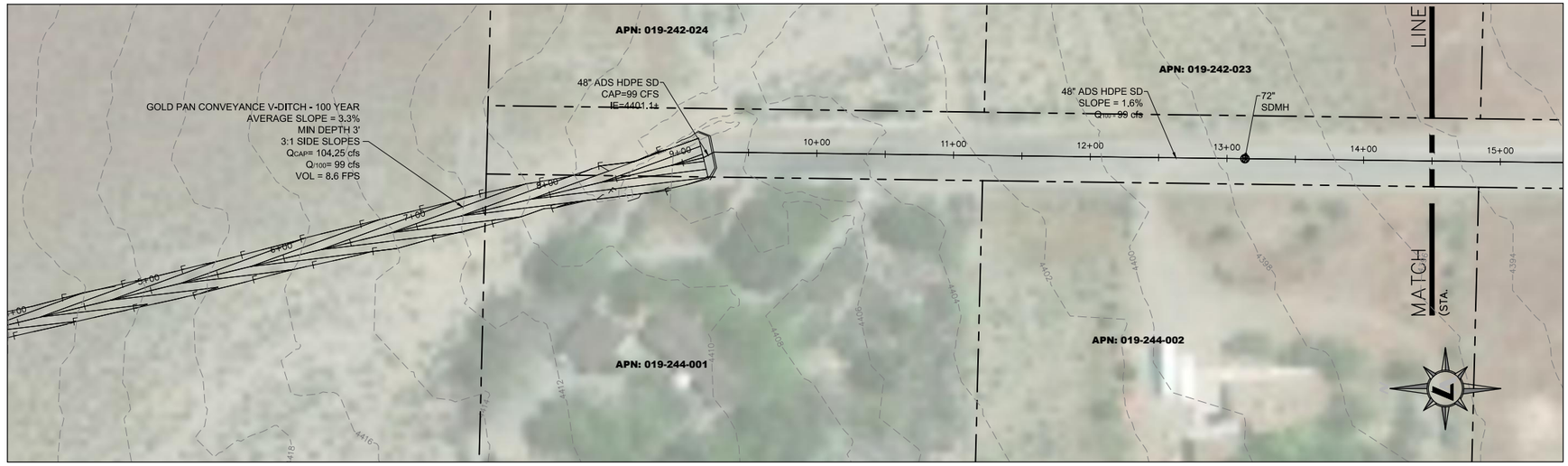

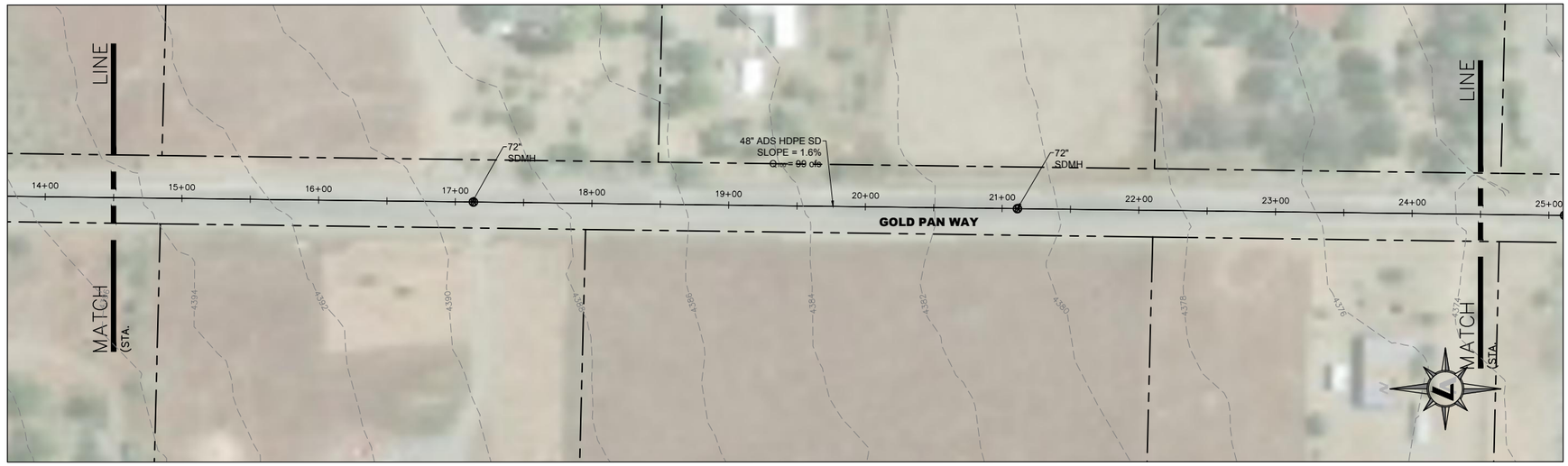

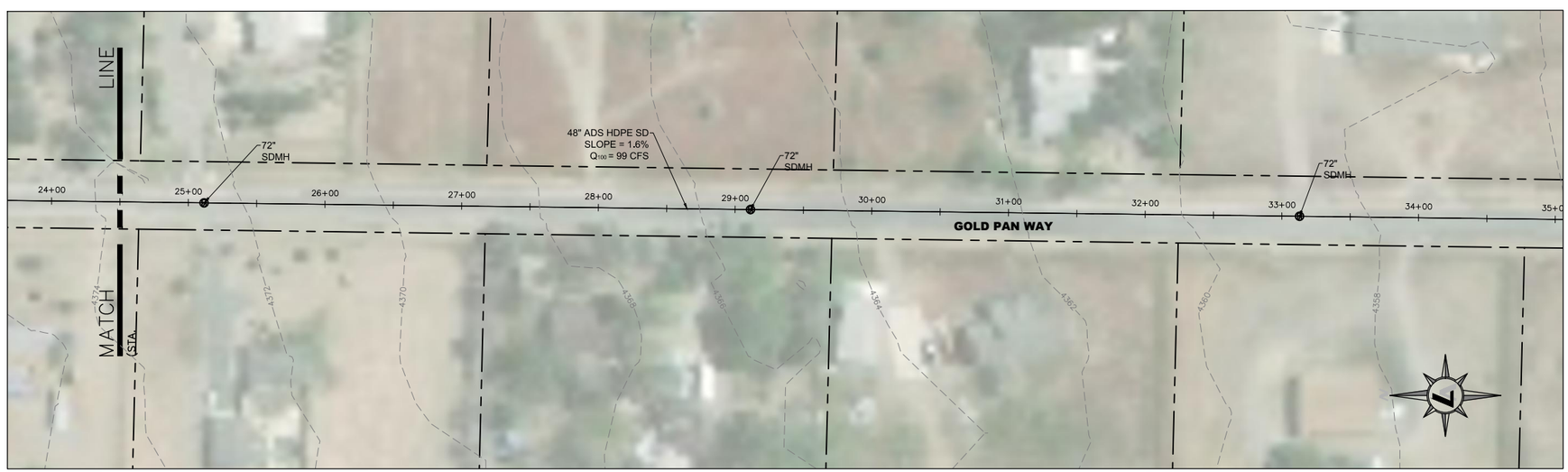

LEGEND

- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE

NOTES:
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
GOLD PAN BASIN & STORMDRAIN
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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JOB NO.:	9416.000

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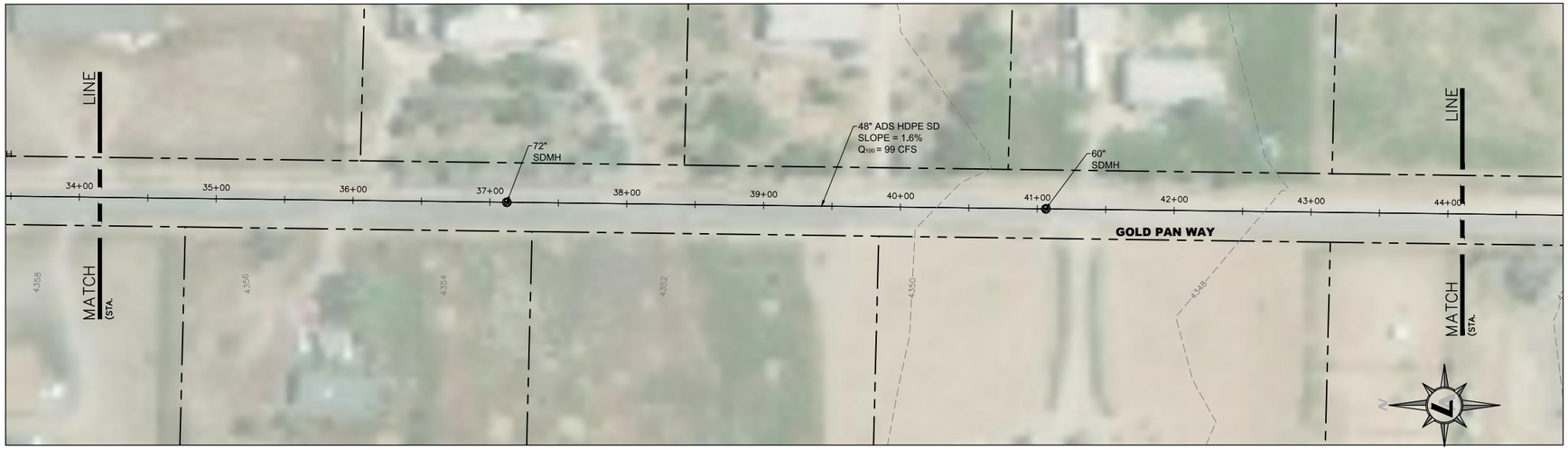

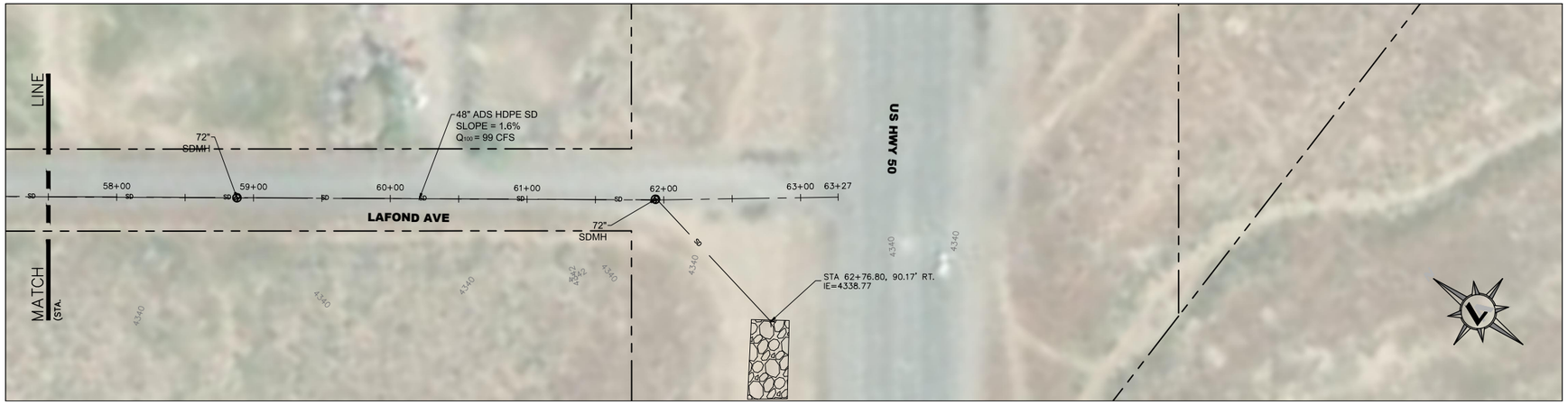

LEGEND

- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F — F — FILL

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
GOLD PAN BASIN & STORMDRAIN
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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DESIGNED BY:	RTS
CHECKED BY:	RTS
JOB NO.:	9416.000

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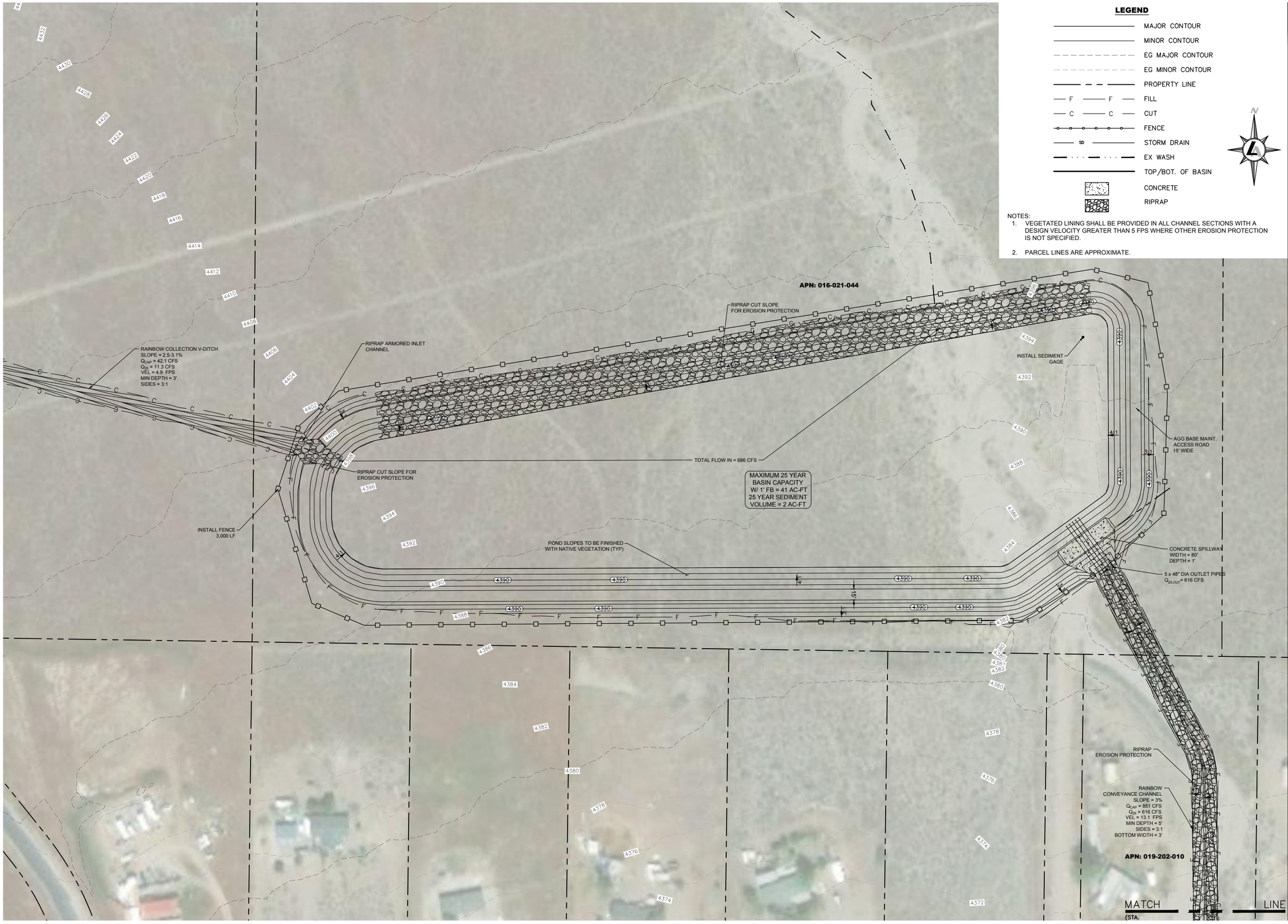

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
RAINBOW BASIN
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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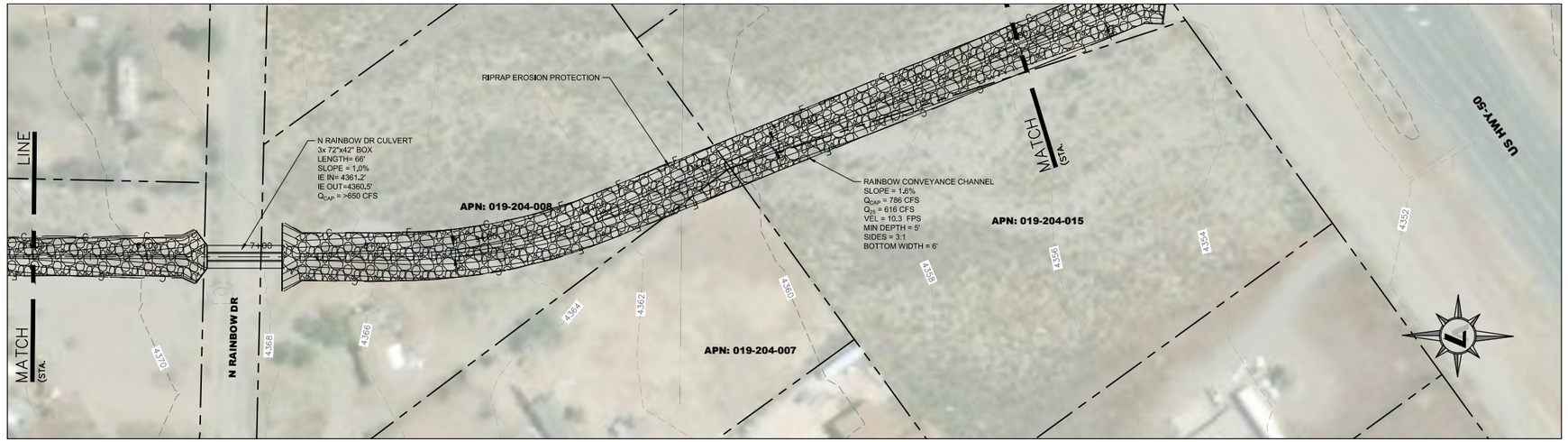
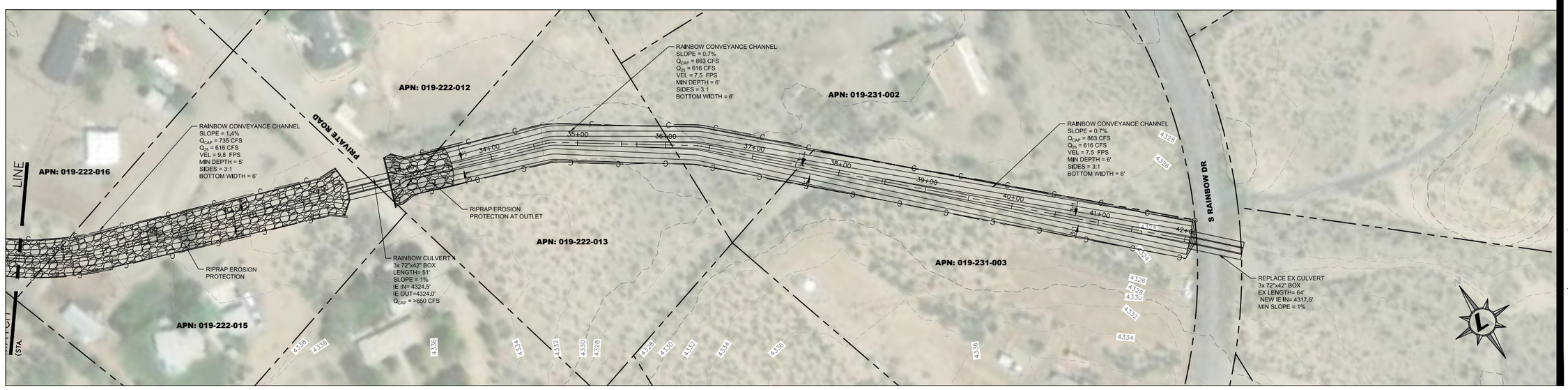
CHECKED BY:	RTS
JOB NO.:	9416.000

L:\VLAPro\9416.000 - Dayton Valley Area Drainage Master Plan\DWG\Civil3D\Grading\Systems\Rainbow 25-Yr_Revised.dwg,C11.2 RAINBOW BASIN - 25 YR, 07/26/2019 09:40 am rspreeman





LEGEND

- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F F FILL
- C C CUT
- FENCE
- SD STORM DRAIN
- EX WASH
- TOP/BOT. OF BASIN
- CONCRETE
- RIPRAP

NOTES:

1. VEGETATED LINING SHALL BE PROVIDED IN ALL CHANNEL SECTIONS WITH A DESIGN VELOCITY GREATER THAN 5 FPS WHERE OTHER EROSION PROTECTION IS NOT SPECIFIED.
2. PARCEL LINES ARE APPROXIMATE.

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
RAINBOW CHANNEL
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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C11.1

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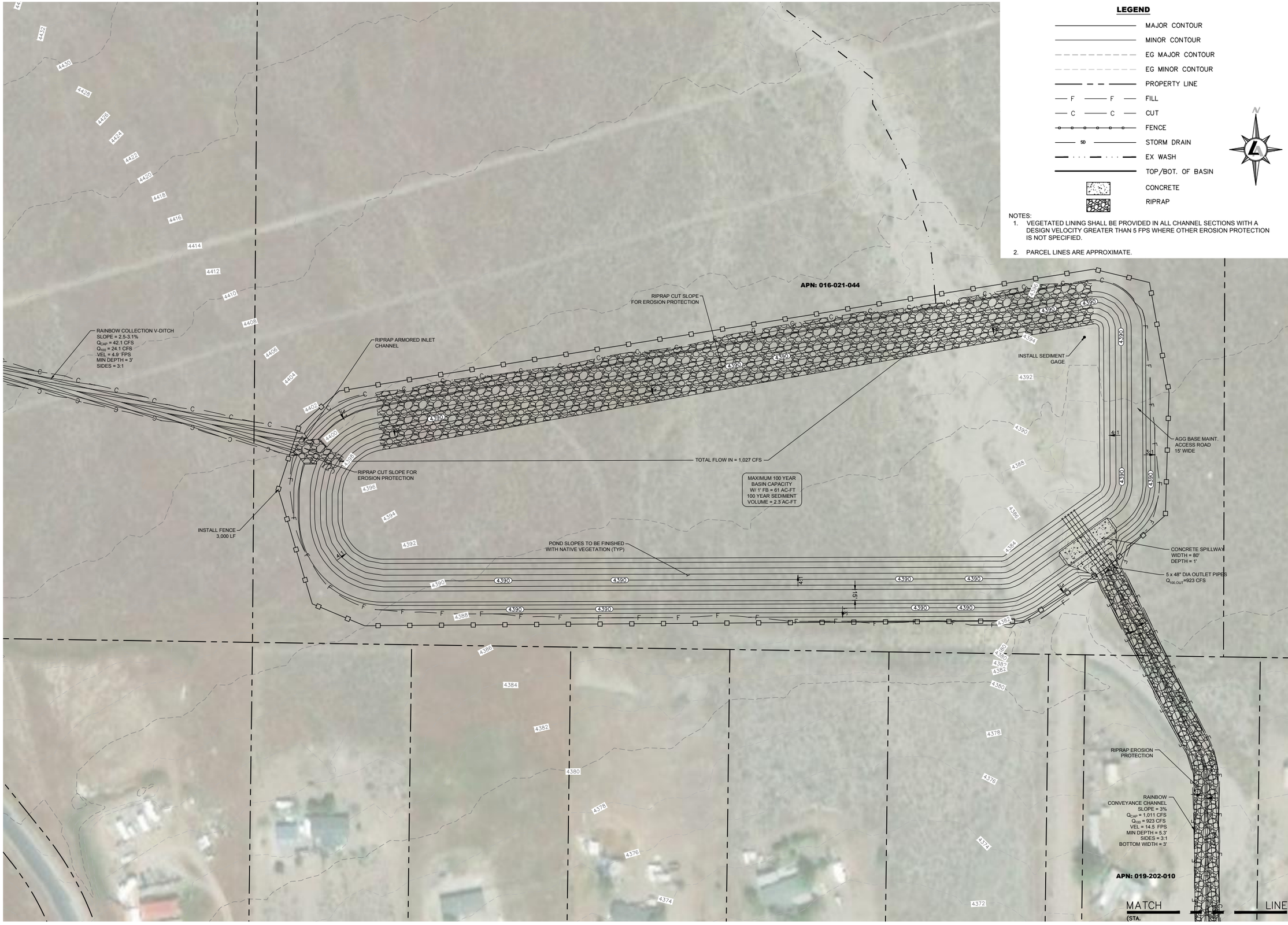

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
RAINBOW BASIN
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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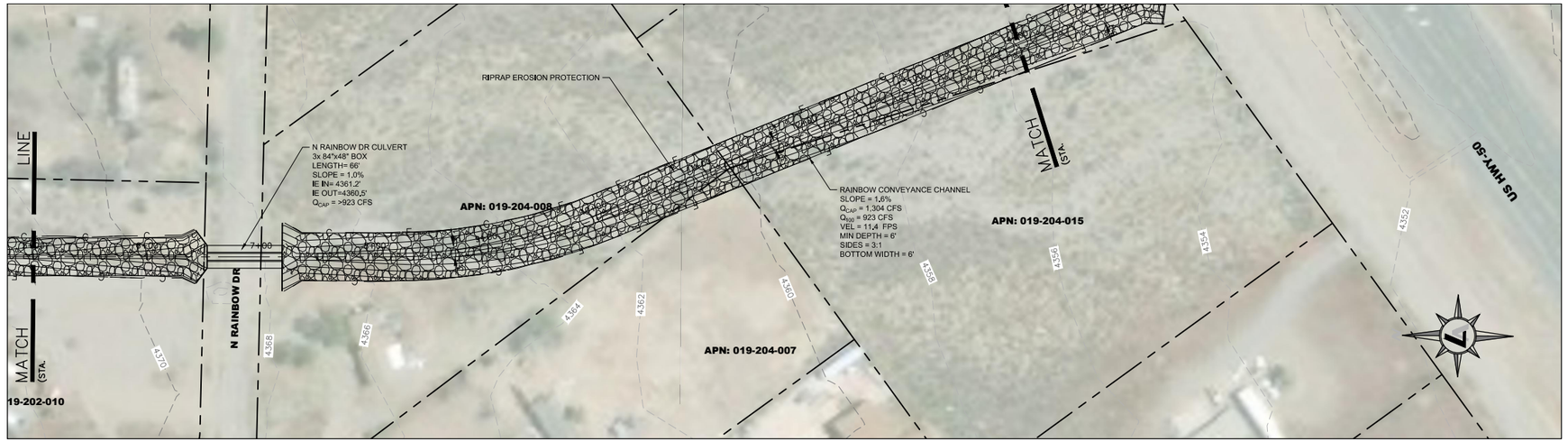

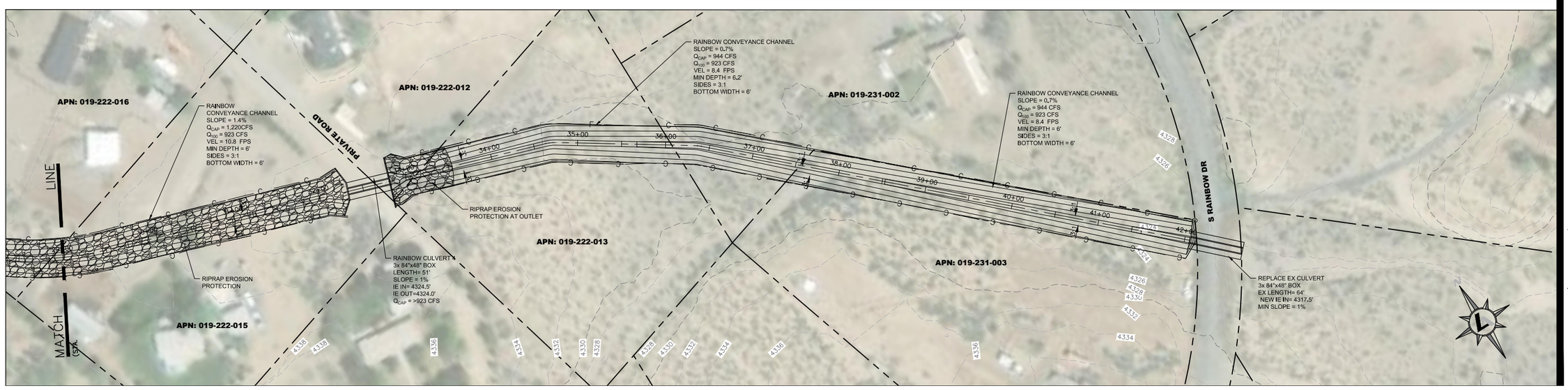

LEGEND

- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F — F — FILL
- C — C — CUT
- FENCE
- SD — STORM DRAIN
- EX WASH
- TOP/BOT. OF BASIN
- CONCRETE
- RIPRAP

NOTES:

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
RAINBOW CHANNEL
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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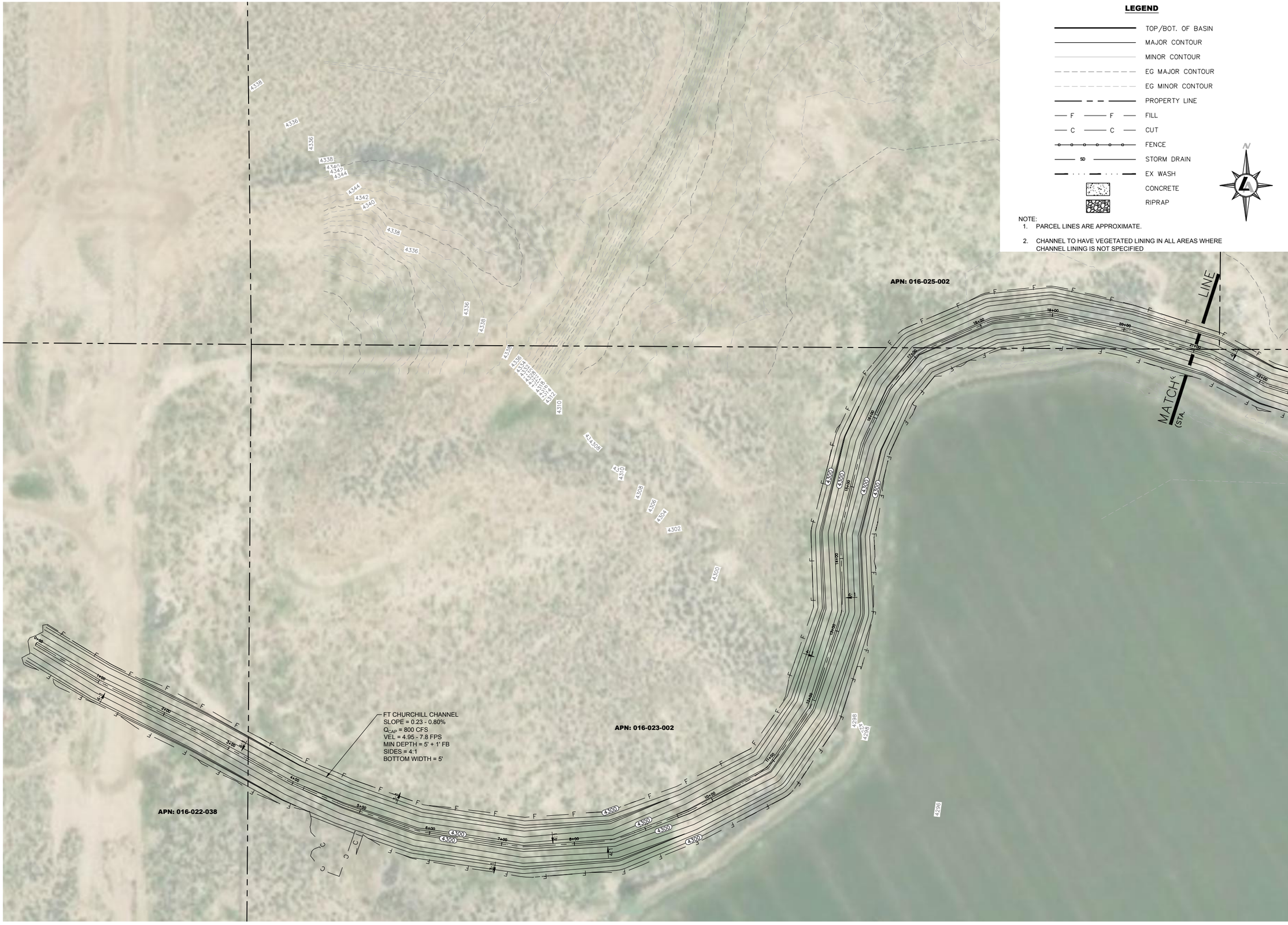
07/26/2019 09:35 am rspreeman



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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
CHURCHILL CHANNEL
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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C:\Users\rspreeman\AppData\Local\Temp\AcPublish_11208\Churchill Channel 25yr.dwg,C12.0 CHURCHILL CHANNEL – 25 YR, 07/19/2019 07:22 pm rspreeman

LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F — F — FILL
- C — C — CUT
- FENCE
- SD — STORM DRAIN
- EX WASH
- CONCRETE
- RIPRAP

NOTE:
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
CHURCHILL CHANNEL
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

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15% DESIGN
JULY 2019

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LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
CHURCHILL CHANNEL
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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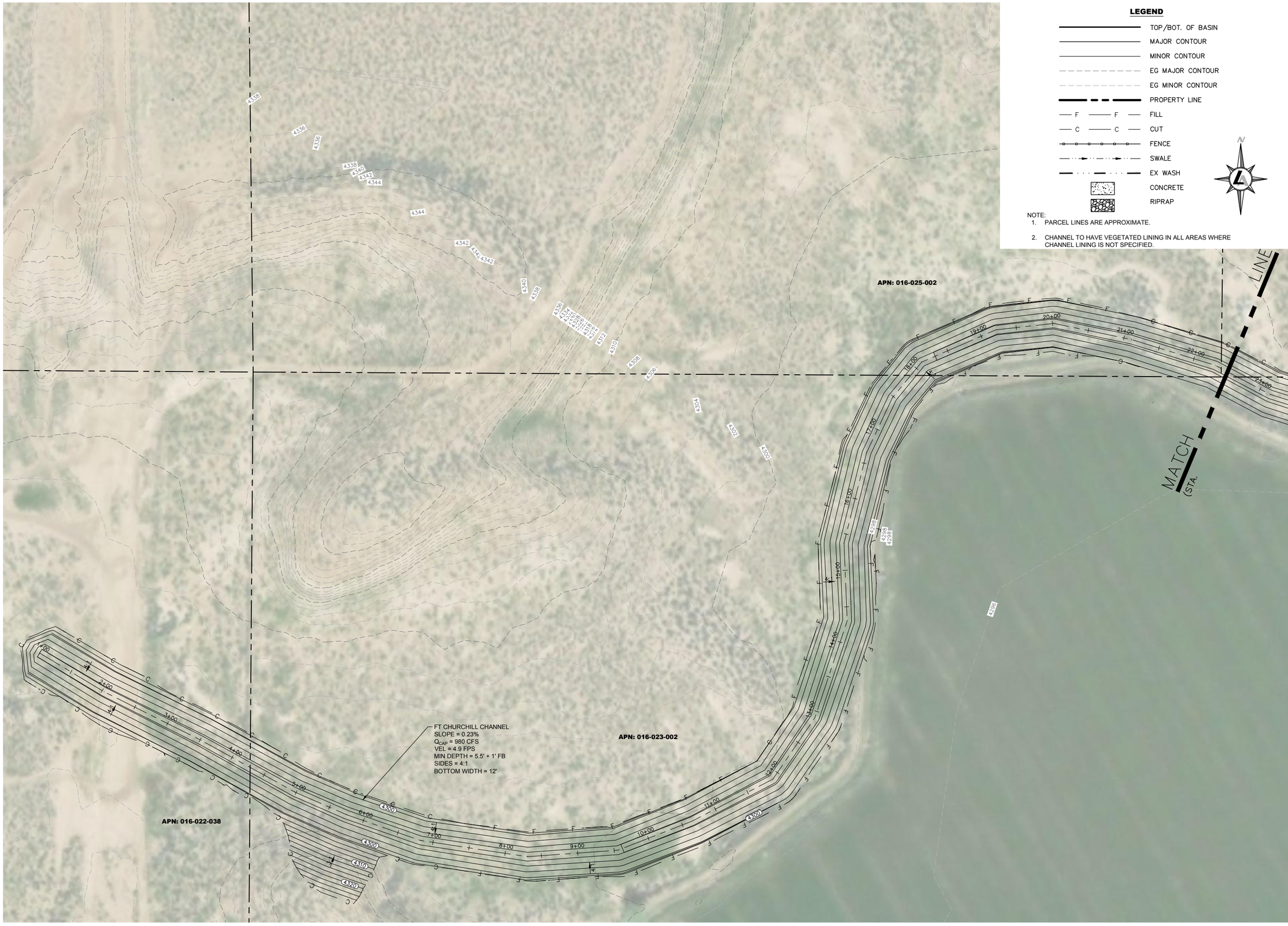

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
CHURCHILL CHANNEL
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F F FILL
- C C CUT
- FENCE
- SWALE
- EX WASH
- CONCRETE
- RIPRAP

NOTE:
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
CHURCHILL CHANNEL
100 YEAR DESIGN

NEVADA

LYON/STOREY COUNTY

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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LEGEND

- TOP/BOT. OF BASIN
- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F — F — FILL
- C — C — CUT
- FENCE
- SWALE
- EX WASH
- CONCRETE
- RIPRAP

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
CHURCHILL CHANNEL
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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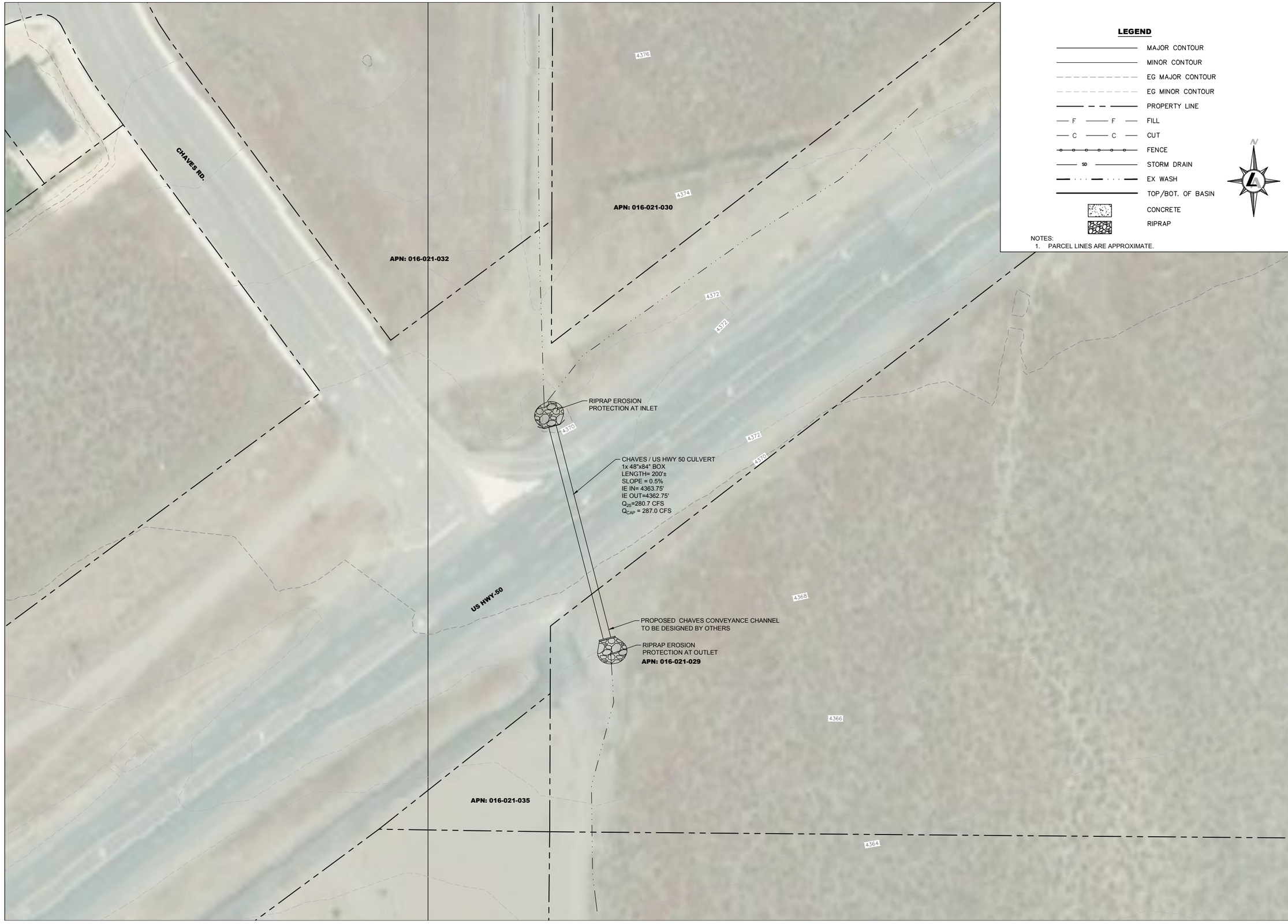

LEGEND

- MAJOR CONTOUR
- MINOR CONTOUR
- EG MAJOR CONTOUR
- EG MINOR CONTOUR
- PROPERTY LINE
- F — F — FILL
- C — C — CUT
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- CONCRETE
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
CHAVES CULVERT
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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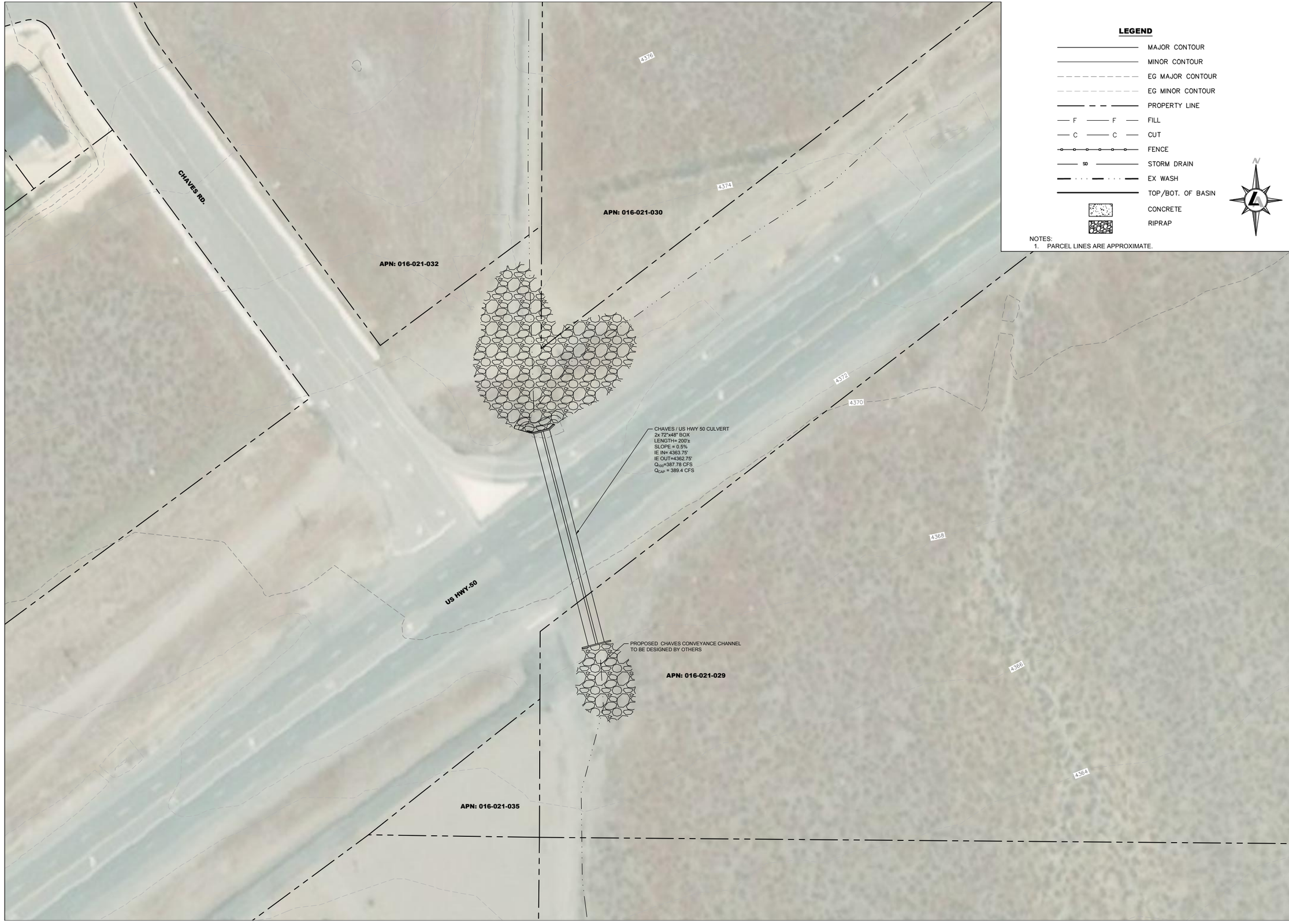

LEGEND

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- EG MAJOR CONTOUR
- EG MINOR CONTOUR
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- F — F — FILL
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
CHAVES CULVERT
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

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GROSH AVE.

ROSE PEAK RD.

APN: 019-042-015

APN: 019-042-016

APN: 019-032-001

APN: 019-041-012

APN: 019-031-009

APN: 019-563-009

APN: 019-563-010

APN: 019-563-011

APN: 019-562-007

APN: 019-562-006

APN: 019-562-005

APN: 016-404-010

GROSH CULVERT - 25 YEAR
1x 42" RCP
LENGTH= 75'±
IE IN= 4376.8'
IE OUT=4372.0'
Q_{100}=62.7 CFS
Q_{CAP} = 73.1 CFS

ROSE PEAK CULVERT - 25 YEAR
1x 42" RCP
LENGTH= 200'±
IE IN= 4359.9'
IE OUT=4354.5'
Q_{100}=62.7 CFS
Q_{CAP} = 63.0 CFS

RIPRAP EROSION PROTECTION AT INLET

RIPRAP EROSION PROTECTION AT OUTLET

INSTALL HEADWALL

RIPRAP EROSION PROTECTION AT INLET

RIPRAP EROSION PROTECTION AT OUTLET

INSTALL HEADWALL

LUMOS & ASSOCIATES
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CARSON CITY, NV 89703
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
GROSH AND ROSE PEAK CULVERTS
25 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

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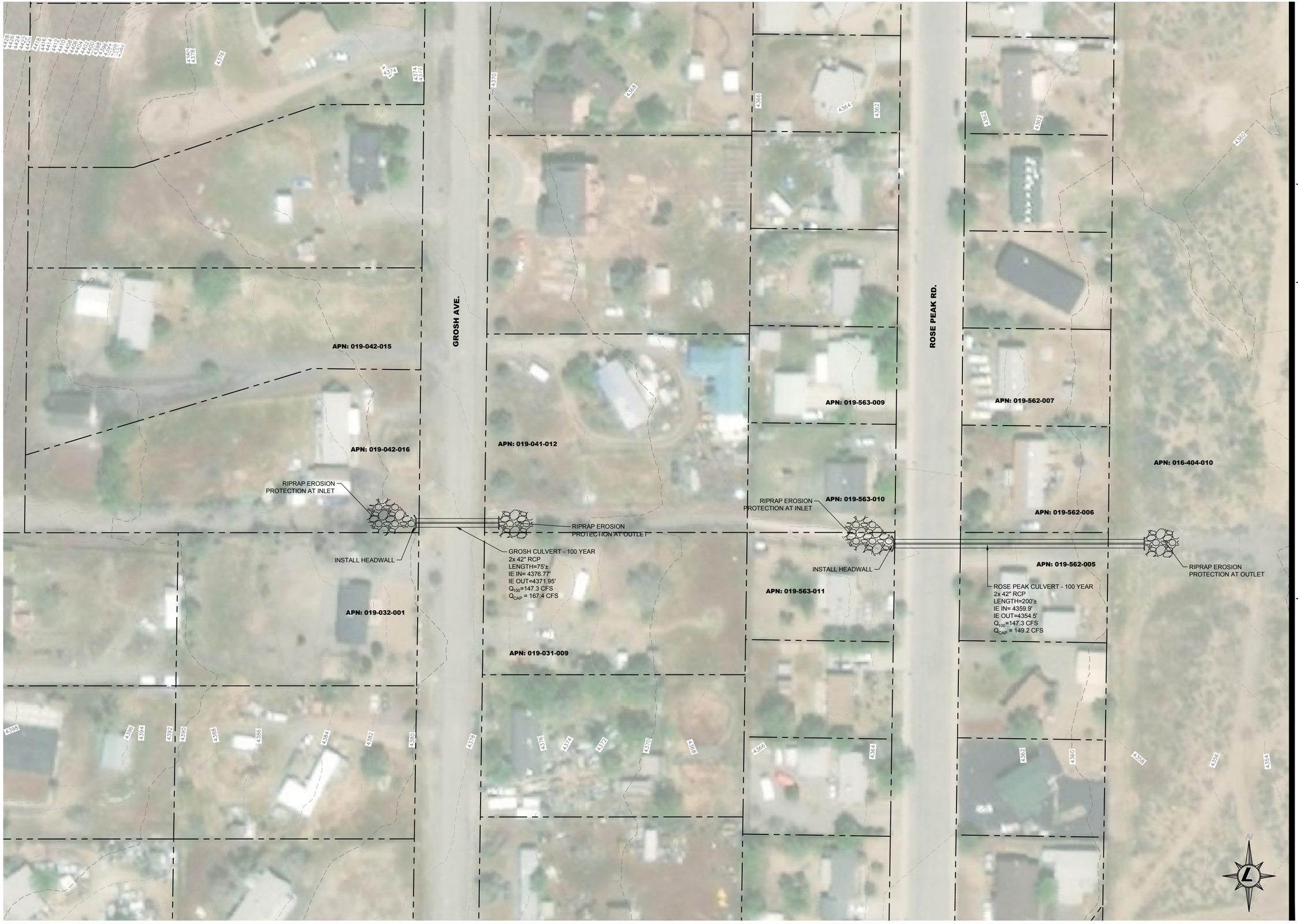

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
CARDELLI SIPHON #1
25/100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
15% DESIGN
JULY 2019

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
CARDELLI SIPHON #2
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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
CARDELLI SIPHON #3
25/100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
CARDELLI SIPHON #4
25/100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
CARDELLI SIPHON #5 AND #6
25/100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV | DATE | DESCRIPTION | BY

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
CARDELLI SIPHON #7
25/100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

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LYON AND STOREY COUNTY

DAYTON VALLEY ADMP
GOLD CANYON SPILLWAY
100 YEAR DESIGN

LYON/STOREY COUNTY NEVADA

REV	DATE	DESCRIPTION	BY

PRELIMINARY
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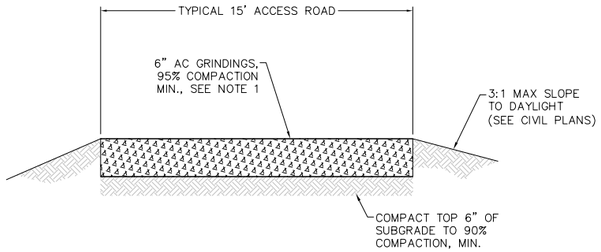
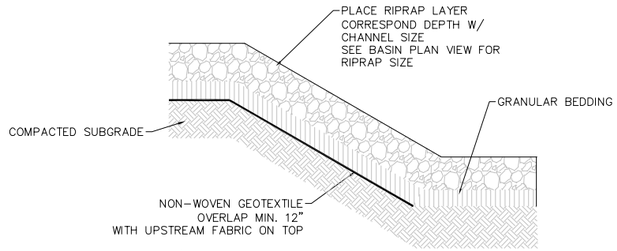


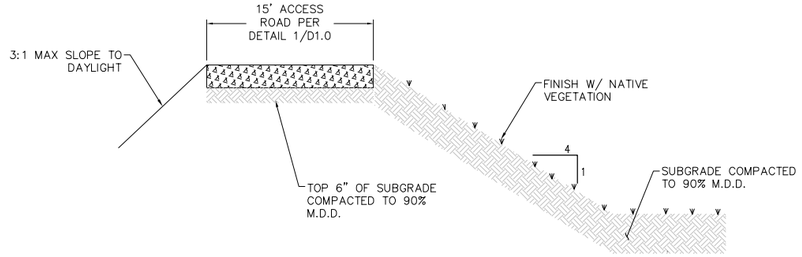
TYPICAL ACCESS ROAD SECTON 1

N.T.S.



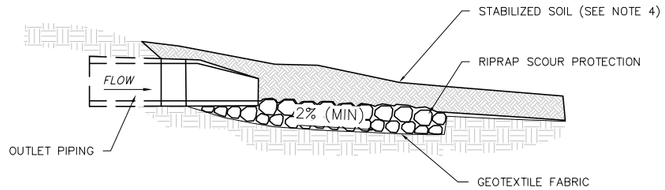
RIPRAP INLET/OUTLET 2

N.T.S.



BASIN SIDE SLOPE SECTION VIEW 3

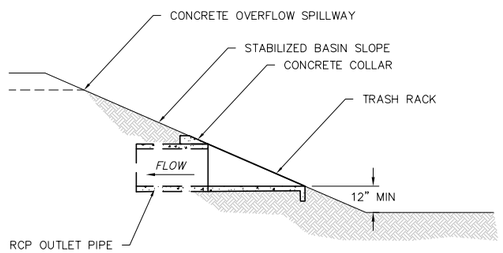
N.T.S.



NOTES:
1. THE MINIMUM THICKNESS OF RIPRAP SHOULD BE 1.5 TIMES THE MAXIMUM STONE DIAMETER, BUT NOT LESS THAN 4".
2. INSTALL FABRIC TO PREVENT SOIL EROSION BENEATH RIPRAP.
3. RIPRAP MAY BE INSTALLED USING MECHANICAL EQUIPMENT. AVOID DAMAGING FABRIC.
4. STABILIZE ALL DISTURBED AREAS IMMEDIATELY AFTER CONSTRUCTION.
5. INSPECT RIPRAP OUTLET STRUCTURES AFTER HEAVY RAINS AND SPRING SNOWMELT. REPAIR AS REQUIRED.

BASIN DISCHARGE/CHANNEL INLET PROTECTION 4

N.T.S.



BASIN OUTLET STRUCTURE 5

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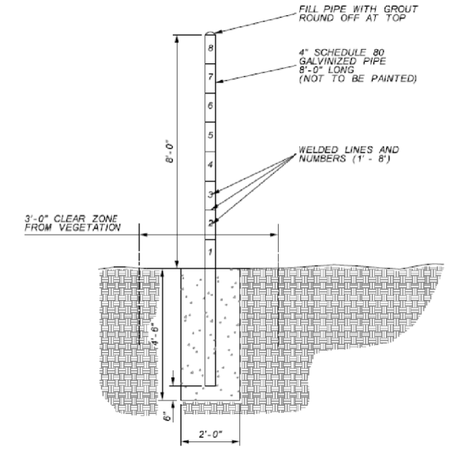
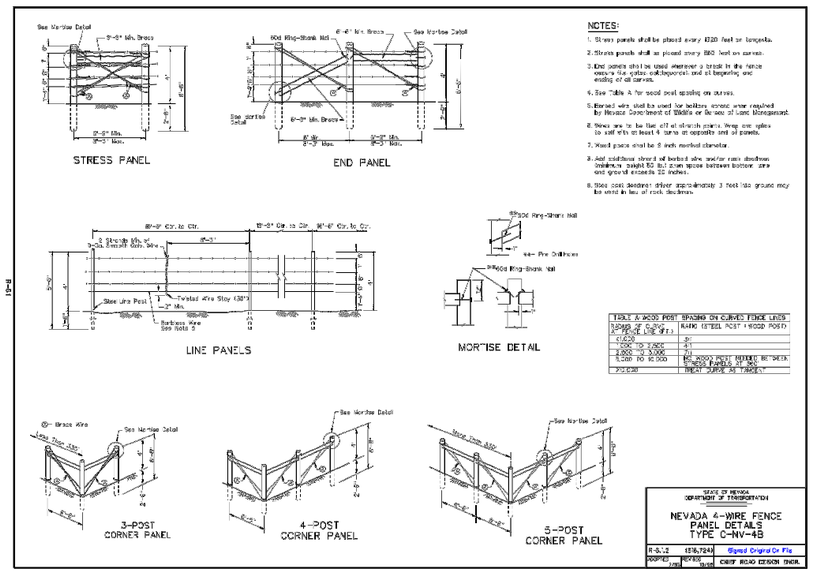


SEDIMENT GAGE DETAIL 6

N.T.S.



NOTES:
1. Stress panels shall be placed every 4320 feet in tangents.
2. Stress panels shall be placed every 660 feet on curves.
3. End panels shall be used wherever a break in the fence occurs—like gates, cattleguards, and at beginning and ending of all curves.
4. See Table A for wood post spacing on curves.
5. Barbed wire shall be used for bottom strand where required by Nevada Department of Wildlife or Bureau of Land Management.
6. Wires are to be tied off at stretch points. Wrap one splice to self with at least 4 turns at opposite end of panels.
7. Wood posts shall be 8 inch nominal diameter.
8. Add additional strand of barbed wire and/or rail where deadmen (minimum weight 80 lb.) when space between bottom wire and ground exceeds 22 inches.
9. Steel post deadmen driven approximately 3 feet into ground may be used in lieu of rock deadmen.

TABLE A WOOD POST SPACING ON CURVED FENCE LINES	
RADIUS OF CURVE (FT.) (FENCE LINE OF)*	RATIO (STEEL POST + WOOD POST)
01-000	3/1
1,001 TO 2,000	4/1
2,001 TO 3,000	All
3,001 TO 10,000	All WOOD POST BETWEEN BRACE PANELS TO BE STEEL POSTS
10,001	TREAT AS A STRAIGHT FENCE

STATE OF NEVADA DEPARTMENT OF TRANSPORTATION
NEVADA 4-WIRE FENCE PANEL DETAILS TYPE C-NV-4B
R-S-1.2 | 1976,1984 | Signed Original On File
ADOPTED | REVISED | CHIEF ROAD DESIGN ENGR.

WIRE FENCING-PANEL DETAILS 7

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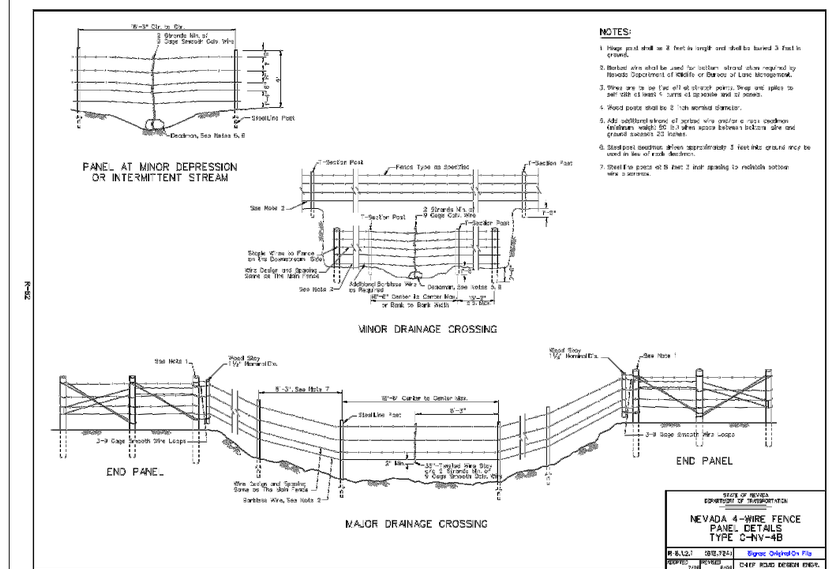

NOTES:
1. Hinge post shall be 8 feet in length and shall be buried 3 feet in ground.
2. Barbed wire shall be used for bottom strand where required by Nevada Department of Wildlife or Bureau of Land Management.
3. Wires are to be tied off at stretch points. Wrap and splice to self with at least 4 turns at opposite end of panels.
4. Wood posts shall be 8 inch nominal diameter.
5. Add additional strand of barbed wire and/or rail where deadmen (minimum weight 80 lb.) when space between bottom wire and ground exceeds 22 inches.
6. Steel post deadmen driven approximately 3 feet into ground may be used in lieu of rock deadmen.
7. Steel fence posts at least 3 inch spacing to maintain bottom wire clearance.

STATE OF NEVADA DEPARTMENT OF TRANSPORTATION
NEVADA 4-WIRE FENCE PANEL DETAILS TYPE C-NV-4B
R-S-1.2 | 1976,1984 | Signed Original On File
ADOPTED | REVISED | CHIEF ROAD DESIGN ENGR.

FENCELINE DRAINAGE CROSSING 8

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DAYTON VALLEY ADMP
DETAILS
LYON/STOREY COUNTY NEVADA

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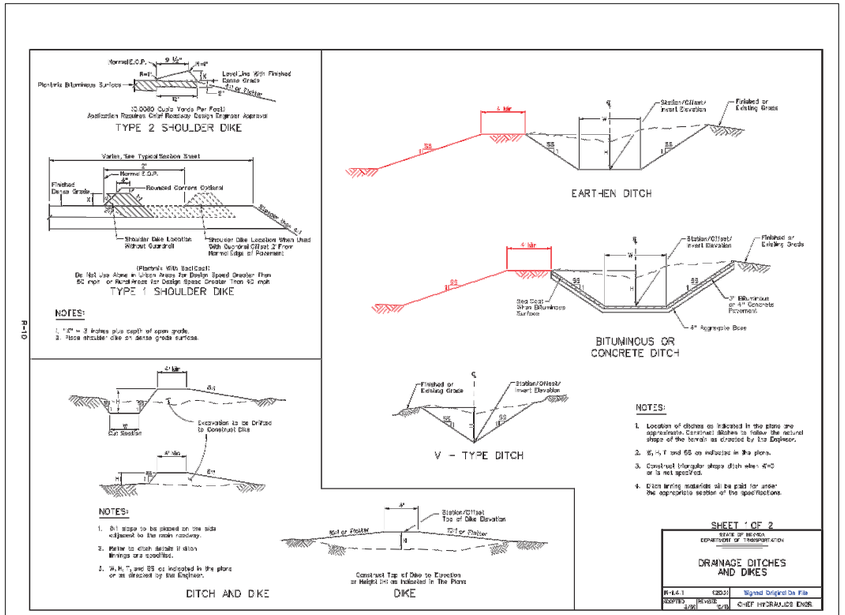

EARTHEN AND CONCRETE CAHNNELS (1)

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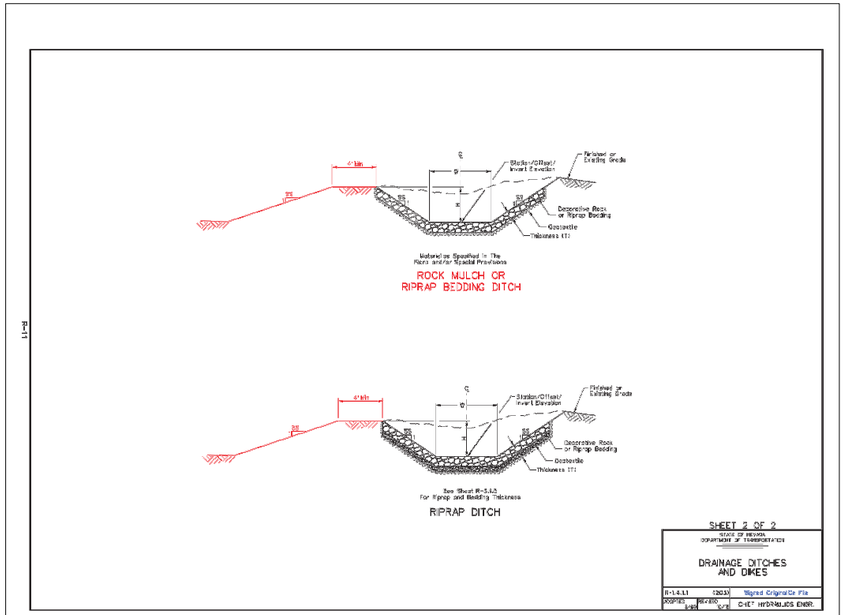

RIPRAP CHANNEL DETAILS (2)

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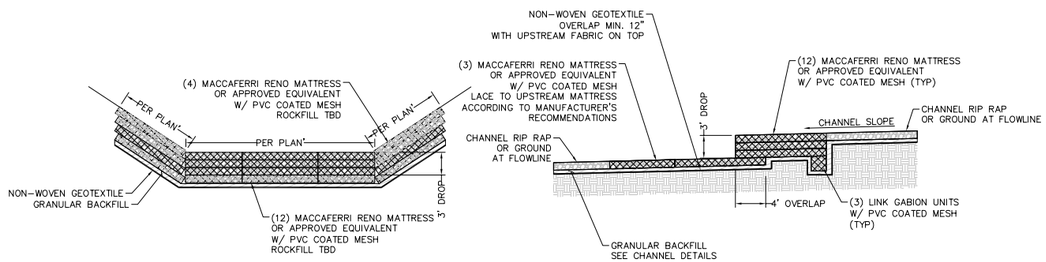

DROP STRUCTURE DETAILS (3)

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DAYTON VALLEY ADMP

CHANNEL DETAILS

LYON/STOREY COUNTY NEVADA

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