

TECHNICAL DRAINAGE REPORT
FOR
MERIDIAN 120 SOUTH VILLAGE 1 AND 2

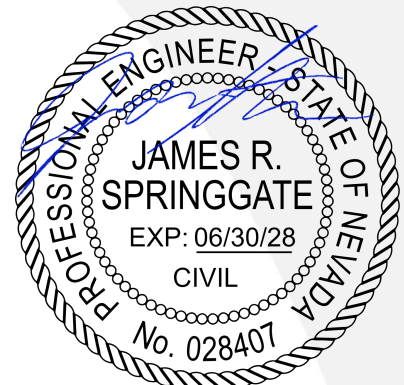
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07/14/2026



WOOD RODGERS
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VILLAGE 1 AND 2 BY WOOD RODGERS INC.

TECHNICAL DRAINAGE REPORT FOR QUILICI RANCH
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1 INTRODUCTION

This report serves as the Technical Drainage Report for the Meridian 120 South Village 1 and 2 subdivision (Project), which will consist of 75 single-family lots. The purpose of this report is to address the drainage plan for the development of the proposed Project site in accordance with Truckee Meadows Regional Drainage Manual (TMRDM) and City of Reno development standards. This report is being submitted in conjunction with the *Steamboat Ditch Breach Analysis for Meridian 120 South Village 1 and 2* by Wood Rodgers Inc. and it is available in **Appendix D** of this report.

1.1 PROJECT LOCATION

The proposed Project site (APN 038-132-37) is situated within Section 16, Township 19 North, Range 18 East, Mount Diablo Meridian (T19N, R18E, MDM), in Washoe County, Nevada. The total parcel area is approximately 77 acres, with the proposed subdivision site consisting of roughly 36 acres and the remaining acreage left relatively undisturbed. The Project site is bounded by existing Belli Ranch Estates to the north, Steamboat Ditch to the south, undeveloped land and Quilici Ranch Backbone to the west, and the existing Belli Ranch Estates subdivision to the east. A vicinity map is included in **Appendix A**.

The Steamboat Ditch runs along the southern boundary of the proposed subdivision and includes an existing gate structure that releases flow within non-irrigation season into a natural channel extending north through the site (Channel-2). As part of the proposed development, this structure will be upgraded to include a concrete overflow weir that allows excess ditch flows during larger storm events to safely enter Channel-2, reducing the potential for overtopping and downstream flooding east of the Project site. The existing channel will remain in place and will continue to convey flows beneath Juniper Bluff Drive through a proposed 10-foot by 4-foot box culvert.

A second overflow weir is proposed along the Steamboat Ditch near the end of Cloudshadow Court (Channel-1) to maintain the historic overflow pathway through the site. Flows released from this weir will be intercepted by downstream cut-off channels and conveyed through the proposed storm drain system (refer to the Proposed Hydrologic Basins Exhibit in **Appendix A**). In addition, several smaller drainage channels currently convey runoff from the Steamboat Ditch corridor toward the northern portion of the site. Under proposed conditions, these flows will be captured by cut-off channels and routed through the Project in a storm drain system to the detention pond.

The Project site is located in FEMA Zone X as is shown on the FEMA FIRM Panel 3014, Map Number 32031C3014G (Exhibit 3), located in **Appendix A**.

1.2 PROJECT DESCRIPTION

The Meridian 120 South Village 1 and 2 Project is located in Reno, Washoe County, Nevada, just south of the Boomtown Garson Road exit from Interstate 80. The Project site is currently undeveloped and generally drains from south to north. Existing drainage patterns are shown on the Existing Hydrologic Basins Exhibit in **Appendix A**. The Project consists of sixty-two



approximately 1/4 acre lots and thirteen approximately 1 acre lots. The Meridian 120 South Village 1 and 2 Development (Project) consists of single-family development areas, paved roads for access, a detention pond, storm drain infrastructure, an emergency access connection, a cul-de-sac, sidewalk, gutter, and associated infrastructure. The storm drain system, channels, and ponds have been designed to the standards of the *Truckee Meadows Regional Drainage Manual*, *City of Reno Public Works Design Manual*, and sound engineering practices.

1.3 REGULATORY PERSPECTIVE

The Project site is located within the City of Reno jurisdiction. The drainage utilities located within the streets are to be public, owned and maintained by the City of Reno, while drainage elements on-site for individual properties may be privately owned. Drainage elements installed to the Steamboat Ditch will be owned, operated, and maintained by the Steamboat Ditch Company.

2 PREVIOUS STUDIES

The *Quilici Ranch Backbone Road Phase 1A Technical Drainage Report* conducted by Terraphase Engineering in 2022 evaluated regional drainage conditions associated with the Steamboat Ditch, located east and upstream of the Project site. The study estimated the Steamboat Ditch capacity to be 107 cfs and documented historical overtopping and breach conditions when inflows exceeded this capacity. The findings were reviewed as part of this analysis to evaluate potential off-site drainage influences and conveyance limitations. Consistent with the study, a ditch capacity of 107 cfs was incorporated into the analysis to assess potential overflow conditions and the routing of excess flows along natural downstream drainage pathways during larger storm events. The report also includes a photo of the existing gate structure, also known as a “Flashboard Gate” that is located above Channel-2, that is also shown below in Figure 1.



Figure 1: Existing Flashboard Gate located above Channel-2 at the Steamboat Ditch.

The *Preliminary Drainage Report for Meridian 120 South Village 1 and 2* prepared by Wood Rodgers in April 2017 was reviewed to better understand the historic drainage conditions, drainage patterns, and conceptual stormwater management approach previously proposed for the site. The report documented the existing drainage network, including the Steamboat Ditch, existing channels traversing the property, and proposed control structures intended to preserve historic flow paths through the development. The study also provided insight into the tentative map drainage concept, including the proposed cut-off channels, culvert crossings, storm drain routing, and detention strategy that were under consideration at the time. While the current Project has advanced beyond the preliminary concepts presented in the 2017 report, the document was useful for understanding the evolution of the site design and identifying historic drainage features and flow conveyance paths that continue to influence the proposed drainage system.

3 METHODS

As the overall drainage area being analyzed is larger than 100 acres, the TMRDM requires the Natural Resources Conservation Service (NRCS) unit hydrograph method be used to attain peak flows for the drainage basins. The NRCS method requires a curve number (CN), accumulated rainfall depth, and lag time for each basin. The equations for the NRCS method are:

$$Q = (P - 0.2S)^2 / (P + 0.8S)$$

$$S = \left(\frac{1000}{CN} \right) - 10$$

Where:

Q = Accumulated excess (inches)

P = Accumulated rainfall depth (inches)

S = Currently available soil moisture storage deficit (inches)

CN = Curve number (unitless)

A = Area of the basin (acres)

The Rational Method Formula was used to compute peak runoff flow rates for the proposed on-site conditions for both the 5-year and 100-year storm events. The Rational Method Formula requires the area of the basin, the rainfall intensity as discussed in Section 3.1.2 of this report corresponding to the time of concentration as discussed in Section 3.1.1 of this report, and the Rational Runoff Coefficient as discussed in Section 3.1.3 of this report. Peak runoff flows are determined using the following equation:



$$Q = ciA$$

Where:

Q = peak runoff in cubic feet per second (cfs).

c = Rational runoff coefficient (unitless)

i = rainfall intensity in (inches/hr)

A = area of the basin (acres)

Off-site peak flows were analyzed using HEC-HMS, version 4.2.1, and on-site peak flows were computed using the TMRDM Rational Method and StormCAD, version 10.03.01.08.

3.1 HYDROLOGIC ANALYSIS

The hydrologic analysis consists of on-site and off-site peak runoff flow computations for the existing and proposed conditions. Different hydrologic methods were applied based on drainage area and the specific design element being evaluated. The NRCS Unit Hydrograph Method was used for the ditch breach analysis and sizing of Culvert-1 because the contributing drainage areas exceed 100 acres and require hydrograph development in accordance with the TMRDM. The Rational Method was used to size the proposed storm drain system, Culvert-2, and establish design peak flows for the detention pond, as the contributing drainage areas for these facilities are less than 100 acres.

The proposed cut-off channels were initially sized using Rational Method peak flows and subsequently evaluated within the HEC-RAS hydraulic model using NRCS-generated hydrographs, as documented in **Appendix D**. Although detention routing was performed in HEC-HMS using the NRCS Unit Hydrograph Method, the target inflow peaks were based on the Rational Method results used for storm drain design. To maintain consistency between analyses, curve numbers were adjusted while keeping drainage areas and times of concentration unchanged until the HEC-HMS peak flows matched the Rational Method peak discharges. This approach allowed detention storage and routing to be evaluated using realistic runoff hydrographs while maintaining consistency with the Rational Method design flows.

The Steamboat Ditch has been assumed to be full in both existing and proposed conditions for the 5-year and 100-year storm events. The overall drainage area of the Project site 5-year and 100-year storm events were modeled per the TMRDM using the NRCS Unit Hydrograph method. The on-site areas draining to proposed storm drain infrastructure were modeled with the Rational Method. Basin areas, Lag Times, and Curve Numbers (CN) were input into the HEC-HMS program to obtain peak runoff flows for the overall drainage area. Basin areas, Times of Concentration, and Rational Runoff Coefficients were input into the StormCAD program to obtain peak runoff flows for on-site hydrologic basins flowing to catch basins.

3.1.1 Time of Concentration and Lag Time

The time of concentration (t_c) is defined as the time required for water to flow from the hydraulically most distant part of the drainage area to the point of consideration. Usually, the point of consideration is the discharge point of the basin or sub-basin. Time of concentration is used in the Rational Method to determine the corresponding rainfall intensity used to calculate



the peak runoff rate of a given storm event for the basin or sub-basin. For basins less than one square mile in total area and slope less than 10 percent, the following equations shall be used in determining time of concentration.

$$t_c = t_i + t_t$$

Where:

t_c = time of concentration (minutes)

t_i = initial, overland flow time (minutes)

t_t = travel time in ditch, channel, gutter, pipe etc. (minutes)

$$t_i = \frac{1.8(1.1 - R)L_o^{1/2}}{S^{1/3}}$$

Where:

t_i = initial overland flow time (minutes)

R = flow runoff coefficient (for Rational Method equal to C_s from table 701 of TMRDM- in **Appendix A**)

L_o = length of overland flow (feet, 500 feet max.)

S = average overland basin slope (percent)

$$t_t = \frac{L}{V * 60}$$

Where:

t_t = travel time

L = length of water course

V = average water velocity

URBANIZED BASIN CHECK AND t_c MINIMUM

The final time of concentration shall be the lesser of t_c calculated above and the following subject to a minimum of 5 minutes for paved areas and 10 minutes for landscaped areas.

$$t_c = \frac{L}{180} + 10$$

Where L = watershed length (feet)

LAG TIME

Lag time (TLAG) for NRCS calculations is defined as:

$$TLAG = t_c * 0.6$$

Tables detailing the TLAG values for the analyzed basins for existing and proposed conditions are included in **Appendix A**.



FOR BASINS GREATER THAN ONE SQUARE MILE IN TOTAL AREA OR SLOPE GREATER THAN 10 PERCENT

Lag time (TLAG) for NRCS calculations is defined as:

$$TLAG = 22.1K_n(L * \frac{L_c}{S^{0.5}})^{0.33}$$

Where:

K_n = Roughness Factor

L = Length of longest water course (miles)

L_c = Length along longest watercourse measured upstream to basin centroid (miles)

S = Representative slope along watercourse (feet/mile)

3.1.2 Design Rainfall Intensities and Depths

Precipitation intensity depth estimates were taken from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 1, Version 5, which provides rainfall information for latitude and longitude. It was determined that the site latitude and longitude are approximately 39.506 North and 119.961 West, and precipitation intensities were used appropriately for the 5-year and 100-year storm events within the Rational Method. For the NRCS Unit Hydrograph Method, the centroid of the largest upstream basin (P-5) was found to be at approximately 39.494 North and 119.962 West, and precipitation depths were used accordingly. Intensity and depth numbers are included in **Appendix A** of this report.

3.1.3 Rational Runoff Coefficients and NRCS Curve Number

Rational Runoff Coefficients were determined for on-site flows using Table 701 of the TMRDM. This table gives values for “C” corresponding to land use of the area being analyzed. A copy of the table is included in **Appendix A**. Proposed land uses for the developed area were chosen as “Pavement” for roadways, “Residential 1 acre” for 1 acre lots, “Residential ¼ acre” for ¼ acre lots, and “Rangeland” for land that will remain undeveloped. See **Appendices B** and **C** for the Rational Coefficients used for the proposed basins in the 5-year and 100-year storm events, respectively.

The Runoff Curve Number (CN) for each basin is determined by overlaying land use information about the basin with soil data available for the basin. Soil types are rated from A to D with correspondingly higher curve number values. The overall CN for a basin is a weighted average for each area based on the land uses and soil curve numbers. Tables of Runoff Curve Numbers For Urban Areas and Runoff Curve Numbers For Arid And Semiarid Rangelands are included in **Appendix A** of this report. A table summarizing the weighted average CN for each basin of the existing and proposed site conditions is included in **Appendix A** of this report.

The land covers for the existing conditions were determined utilizing ArcGIS aerial imagery and site photographs. The existing vegetation at lower elevations is primarily cheat grass with some low bushes and sagebrush, resulting in a primary land use of “Herbaceous, Fair.” At higher elevations, the land use transitions into “Brush, Fair,” “Brush, Good,” and “Meadow”. In proposed conditions, the Project site also incorporates land covers of “Pavement,” “Residential



1/4 Acre,” and “Residential 1 Acre.” Please reference the Existing and Proposed Hydrologic Conditions Exhibits in **Appendix A**.

3.2 HYDRAULIC COMPUTATIONS

Hydraulic calculations for the storm drain system were performed using Bentley StormCAD software, CONNECT Edition. Design rainfall intensities, times of concentration, Rational runoff coefficients, and storm drain components were input into the program to size storm drain pipes and inlets.

The culverts of the Meridian 120 South Village 1 and 2 were sized using Bentley CulvertMaster software, Version 10.03.00.03. Estimated peak flows, estimated tailwater elevations, sizes of culverts and slopes were input into the program to size the proposed culverts.

The cut-off channels, Steamboat Ditch, and existing roadside ditch perpendicular to the emergency access road were evaluated for capacity using Bentley FlowMaster software, version 10.03.00.03. The open channels are discussed further in Section 5.5 of this report.

4 HISTORIC DRAINAGE SYSTEM

Historically, the site has drained primarily to the north and northeast through a combination of shallow overland flow paths, natural drainageways, and existing channels. The Steamboat Ditch is located south of and at a higher elevation than the Project site, making it a significant influence on existing drainage patterns. Based on correspondence from JUB, the Steamboat Ditch has overtopped in this area during periods of high stormwater runoff, including an event during the winter of 2024/2025 when drainage from NFD Road 100 froze within the canal and contributed to overtopping conditions prior to completion of the Toll Brothers improvements. During larger storm events, runoff from upstream tributary basins may overtop the ditch or be released through existing gate structures, following natural drainage pathways across the site before ultimately discharging toward the Truckee River. Existing drainage conditions were evaluated to identify historic flow paths, quantify peak runoff rates at major discharge locations, and establish baseline conditions for comparison with proposed conditions. The existing drainage area was divided into five basins based on drainage divides and discharge locations, which are described below and shown on the Existing Hydrologic Conditions Exhibit in **Appendix A**. Please see the layout of the existing HEC-HMS model below:



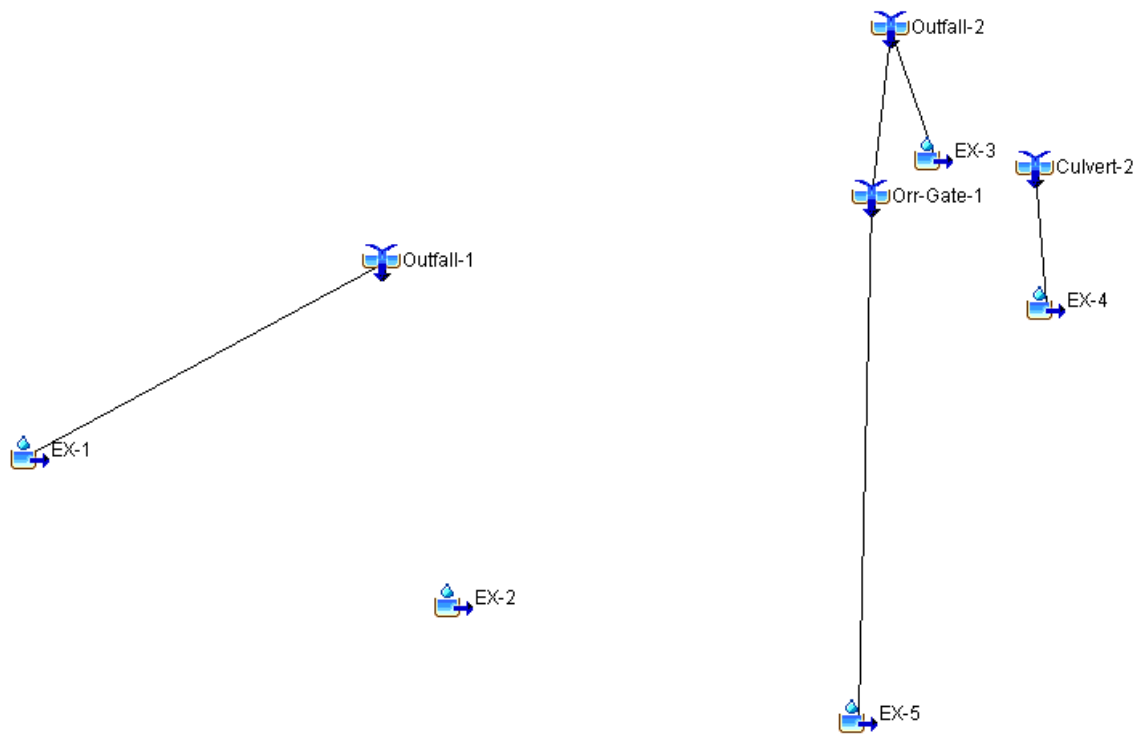


Figure 2: Existing HEC-HMS Model Layout

- Basin EX-1 covers the western portion of the site and discharges to the northern Project boundary through a shallow existing drainage channel. Under existing conditions, runoff from this basin is expected to overtop the assumed to be full Steamboat Ditch, continue north through the Project site, flow toward Warrior Lane, and ultimately discharge to the Truckee River. Basin EX-1 is approximately 71.2 acres and has a 100-year peak discharge of 118.3 cfs. Basin EX-1 makes up the majority of the on-site drainage area, and has the same discharge point as the proposed detention pond, Pond-1.
- Basin EX-2 is located near the center of the Project site and has drainage characteristics similar to Basin EX-1. It drains north, covers 22.2 acres, and has a 100-year peak discharge of 32.8 cfs.
- Basins EX-3 and EX-5 drain to the site's primary drainageway. Basin EX-3 includes the on-site drainageway area, and Basin EX-5 includes the upstream drainage area. In existing conditions, the flow from basin EX-5 is representative of the flow expected to flow out the existing flashboard gate. Together, the basins total approximately 484 acres and produce a combined 100-year discharge of 278.3 cfs at the point where the drainageway exits the site.
- Basin EX-4 is located primarily off-site and includes the western portion of the Project area. It covers 17.7 acres and has a 100-year peak discharge of 26 cfs.

Please see Table 1 and 2 below summarizing the 5-year and 100-year peak flows expected at each discharge point:

Table 1: Existing NRCS Peak Flows at Discharge Points			
Discharge	Contributing Basins	5-Year Peak Flow (cfs)	100-Year Peak Flow (cfs)
Outfall-1	EX-1	44.98	133.02
EX-2	EX-2	22.88	69.48
Outfall-2	EX-3, EX-5	80.92	278.32
Culvert-2	EX-4	17.80	54.62

Table 2: Existing Rational Peak Flows at Discharge Points			
Discharge	Contributing Basins	5-Year Peak Flow (cfs)	100-Year Peak Flow (cfs)
Outfall-1	EX-1	19.3	118.3
EX-2	EX-2	5.3	32.8
Outfall-2	EX-3, EX-5	-	-
Culvert-2	EX-4	4.2	26.0

5 PROPOSED DRAINAGE SYSTEM

The proposed drainage system will consist of curb and gutter to collect and convey runoff produced on-site, Type IV drainage inlets to collect runoff from the gutters, storm drain laterals, pipes, manholes, storm drain main, and more. The system will also include proposed cut-off channels and pipe connection to accommodate discharge from the off-site basins south of the Project site, which will flow into the storm drain pipe network. A control structure is proposed above Cloudshadow Court (Channel-1) at the Steamboat Ditch to allow for the historic drainage above the Steamboat from Basin P-4a to discharge through the Project site safely if overtopping conditions were experienced within the ditch here. Further East, another control structure is proposed to allow for the 100-year peak from the Basin P-5 above Steamboat Ditch to discharge into its historic flow path. An underground storm drain network will direct the flow to Pond-1 and then an existing drainage ditch, which ultimately discharges to the Truckee River (Refer to Proposed Hydrologic Basins Map in **Appendix A**)

Control structures are proposed to be added to Steamboat Ditch in order to regulate the flows for off-site basins being captured and conveyed in the ditch. During the 100-year storm event, approximately 98.2 cfs is expected to flow through the proposed control structure just south of the Cloudshadow Court. Flow calculations from HEC-HMS can be found in **Appendices B and C**. The flows discharged from this control structure will be collected in a concrete structure that transitions to a rip-rap armored trapezoidal channel. This channel flows into the pipes of the on-site storm drain network. These pipes will convey the flow from the off-site basins south of the proposed subdivision through the storm drain. A second control structure is proposed at the south-east corner of the Project (Channel-2). The second proposed control structure will also allow for the historic 100-year peaks to traverse and drain out of the Steamboat Ditch to the existing channel which crosses the site. A box culvert is proposed to convey the existing peaks under the proposed Juniper Bluff Drive.



5.1 PROPOSED RATIONAL DRAINAGE BASINS

The proposed development was divided into 21 basins based on discharge locations and the peak flows for the 5-year and 100-year storm events were calculated. The design and analysis of each storm drain system is discussed in detail in the following sections. Please reference the Proposed Hydrologic Basins Exhibit included in **Appendix A**.

- Network "A" will collect and convey the runoff generated from Basin A-1 and discharges off-site to the east, near Deer Mountain Road.
- Network "B" will collect and convey the runoff generated from basins B-1 through B-14 to discharge point "Pond-1" and then "Outfall-1." These basins make up the discharge that will be conveyed in the proposed storm drain system. Basins B-12, B-13, and B-14 contain areas above Steamboat Ditch that flow across the Steamboat Ditch and run down the hill on to the site and are captured by cut-off drainage channels where flow is captured by 36" flared end sections. The remaining "B" basins are located on-site and consist of sheet and gutter flow. B-12, B-13, and B-14 are all sloped steep to the north.
- Basins labeled with the prefix "OFF" discharge directly off-site and do not contribute flow to the overall storm drain system. In proposed conditions, all OFF basins either match or reduce existing peak discharge rates because the contributing drainage area has been reduced in each basin. Compliance was verified using Rational Method calculations by comparing existing and proposed runoff coefficients and drainage areas. Prior to grading design, the maximum allowable contributing area for each basin was determined using the Rational Method, and site grading was subsequently designed to maintain peak flows at or below existing conditions.

Please see Table 3 for the proposed 5-year and 100-year Rational Method peak flows for on-site drainage areas. Outfall-2 was excluded because its contributing drainage area exceeds 100 acres and was analyzed using the NRCS Method. The peak flows for Pond-1 were determined by summing the Bentley StormCAD peak flows at the "MAIN POND IN" and "B-4 POND IN" outfalls.

Table 3: Proposed Rational Peak Flows at Discharge Points			
Discharge	Contributing Basins	5-Year Peak Flow (cfs)	100-Year Peak Flow (cfs)
Outfall-1	B-1 - B-14	25.5	122.2
OFF-1	OFF-1	0.6	2.2
OFF-2	OFF-2	1.3	4.7
OFF-3	OFF-3	0.4	2.7
OFF-4	OFF-4	0.5	1.7
Outfall-2	OFF-3, OFF-5	-	-
A-1	A-1	1.7	5.5
Culvert-2	OFF-6	3.8	23.6



5.2 PROPOSED NRCS METHOD DRAINAGE BASINS

The proposed drainage area evaluated using the NRCS Unit Hydrograph Method encompasses approximately 594 acres and was divided into seven basins based on topography, drainage divides, and discharge locations. These basins were used to develop hydrographs for Culvert-1 sizing evaluation of flows associated with the Steamboat Ditch overtopping and breach scenarios. Refer to the Proposed Hydrologic Conditions Exhibit in **Appendix A**, and the layout of the proposed HEC-HMS model below:

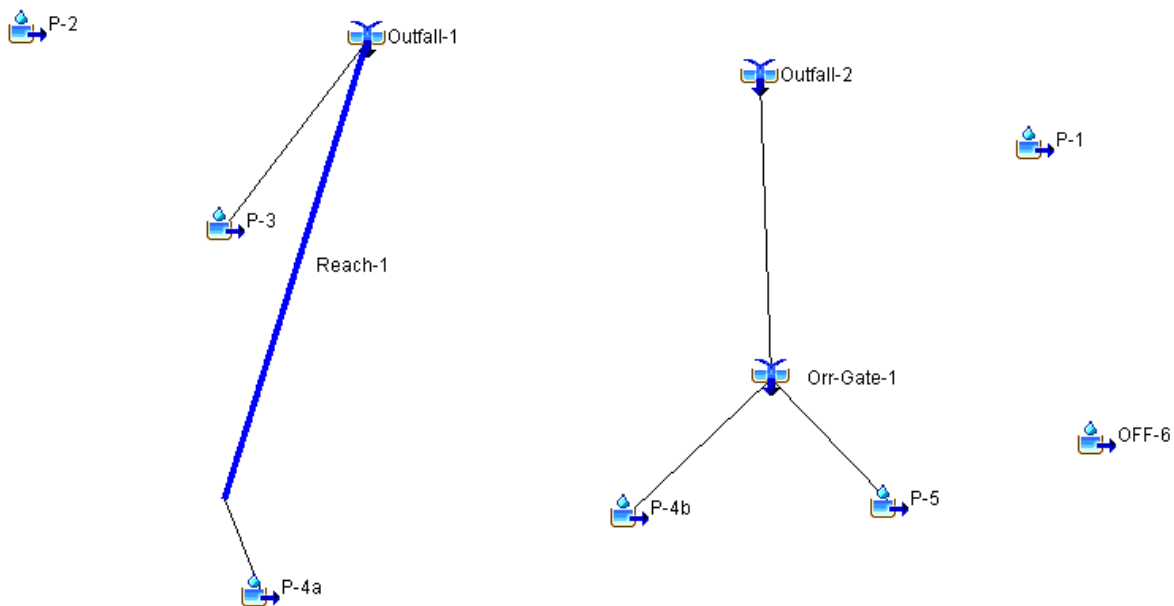


Figure 3: Proposed HEC-HMS Model Layout

- Basin P-1 drains generally north and east. A portion of the basin drains directly to adjacent properties to the north, consistent with existing conditions. The remaining runoff is collected by a catch basin at the end of Juniper Bluff Court and conveyed to the roadside ditch downstream of Culvert-2, or flows into Channel-2. For a more hydrologically accurate breakdown of the on-site area, reference Section 5.1.
- Basin P-2 consists of a small drainage area that discharges directly north to neighboring properties, matching existing drainage patterns.
- Basins P-3 and P-4a drain to Pond-1, where their combined runoff is detained prior to discharge. The detention pond is designed to reduce post-development peak flows to below existing conditions.
- Basins P-4b and P-5 drain to Channel-2 and are conveyed through the proposed 10-foot by 4-foot box culvert beneath Juniper Bluff Drive. These basins represent the primary drainage area contributing to the site's major drainageway.
- Basin P-6, also referred to as basin OFF-6 in HEC-HMS is located almost entirely off-site. The flows from this basin are proposed to flow under the emergency access road at the terminus of Juniper Bluff Court through a 15" culvert.

Table 4 summarizes the NRCS Method peak flows before any detention:

Table 4: Proposed NRCS Method Peak Flows at Discharge Points Prior to Detention			
Discharge	Contributing Basins	5-Year Peak Flow (cfs)	100-Year Peak Flow (cfs)
Outfall-1	P-3, P-4a	66.34	197.46
P-2	P-2	1.01	3.35
Outfall-2	P-4b, P-5	82.04	278.67
OFF-6	OFF-6	17.13	52.85

5.3 PROPOSED STORM DRAIN SYSTEM

The proposed storm drain system was analyzed for capacity using Bentley StormCAD software. Profiles of the “A” and “B” system for the 5-year storm event are included in **Appendix B**, and profiles for the 100-year storm event are included in **Appendix C**.

StormCAD results indicate that Pipe B-2–003-A has a velocity below 3.0 ft/s during the 100-year storm event. However, this condition occurs only at the system peak flow, when elevated downstream hydraulic grade line (HGL) conditions temporarily reduce the available head and limit discharge through the pipe. The reported velocity therefore represents a brief instantaneous condition rather than the pipe's typical operating velocity throughout the storm event.

The minimum velocity criterion is intended to prevent sediment deposition and maintain self-cleaning conditions within the storm drain system. Pipe B-2–003-A meets this criterion during the entire 5-year storm event, with a calculated velocity of 5.53 ft/s. During the 100-year event, velocities fall below 3.0 ft/s only briefly at peak HGL conditions. As water surface elevations recede before and after the peak, pipe velocities increase and provide sufficient flushing to prevent long-term sediment accumulation.

Additional analysis using FlowMaster indicates that, assuming the same inlet head conditions, reducing the outlet HGL from Elevation 4920.31 feet to 4920.29 feet would increase the pipe velocity above 3.0 ft/s. This demonstrates that only 0.02 feet of additional head differential is required to maintain the minimum velocity criteria. Supporting FlowMaster calculations are included in **Appendix A**.

5.4 PROPOSED CULVERTS

This Project includes two proposed drainage culverts, designated Culvert-1 and Culvert-2. Culvert-1 conveys runoff from Basin P-5 and a portion of Basin P-1 beneath Juniper Bluff Drive within the site's primary drainage channel. Although the 100-year peak flow at Outfall-2 is 278.67 cfs, Culvert-1 was sized based on the *Meridian 120 South Steamboat Ditch Breach Analysis* discussed in **Appendix D**. The design flow used for sizing was 360.3 cfs, which includes the routed hydrograph from Basin P-1 combined with potential overtopping flows from the Steamboat



Ditch. The culvert was upsized to provide additional capacity and safely convey flows associated with a potential ditch breach upstream of Channel-2.

Culvert-1 consists of a 10-foot by 4-foot reinforced concrete box culvert with a slope of 5.1 percent over a length of 65.8 feet. The culvert has a maximum conveyance capacity of 361.41 cfs before overtopping onto Juniper Bluff Drive.

Culvert-2 is located along the eastern boundary of the Project and conveys runoff from Basin OFF-6 beneath the proposed emergency access road connecting Juniper Bluff Court to Deer Mountain Road. Hydrologic analyses indicate a 100-year peak discharge of approximately 26 cfs from Basin OFF-6. However, the existing roadside channel west of Deer Mountain Road can convey only approximately 3.3 cfs before overtopping and flowing east across the roadway. Accordingly, Culvert-2 was sized to match the capacity of the existing downstream and upstream drainage system rather than the full basin peak flow.

Culvert-2 consists of a single 15-inch reinforced concrete pipe with a slope of 3.2 percent over a length of 52.3 feet and has a maximum conveyance capacity of 3.59 cfs.

Outlet protection is proposed at both culverts to prevent scour and erosion. Culvert-1 will utilize Class 300 rip-rap, while Culvert-2 will utilize Class 150 rip-rap. Supporting outlet protection calculations are provided in **Appendix C**.

5.5 PROPOSED DRAINAGE CHANNELS

A total of five drainage channels are proposed, as shown on the Proposed Hydrologic Basins Exhibit. Channel-1 is located upstream of Cloudshadow Court and will serve as the primary conveyance path for any flow overtopping the ditch above the court. Overtopping flows will be intercepted by Catch Basin B-13. In the unlikely event that the ditch breaches above Cloudshadow Court and exceeds the capacity of the catch basin, flow will remain within the roadway section and cut-off channels. The roadway and cut-off channels will direct water to the detention pond while minimizing flood impacts.

Channel-2 is located within the western side of the Project within the major drainage course that traverses the site. This channel is proposed to remain as close to existing conditions as practicable. However, the channel will require widening near the ditch overtopping location to ensure any overtopping flows are captured and contained within the channel, preventing runoff from entering the development. Rip-rap protection will also be needed at the outlet of Culvert-1, within this channel.

In addition, three cut-off channels are proposed to intercept runoff from the Steamboat Ditch, as well as runoff from Basins B-12, B-13, and B-14, before it can reach the development. These cut-off channels will utilize 36-inch flared end sections to collect and convey flows through the development and into the detention pond. They will be lined with 12" of Class 150 rip-rap protection.



Channel-3 is located downstream of Culvert-2, east of Juniper Bluff Drive. The channel consists of an existing shallow roadside ditch that will remain at its existing dimensions. Class 150 riprap will be installed at the outlet of the “A” storm drain system and Culvert-2, with localized excavation provided as necessary to accommodate the riprap lining without reducing the existing channel capacity. The downstream portion of Channel-3 is located off-site and has dimensions similar to the on-site reach. Because the downstream channel controls the available conveyance capacity, widening or otherwise upsizing the on-site portion would provide limited hydraulic benefit.

Table 5: Proposed Rational Peak Flows at Discharge Points				
Channel Name	100-Year Peak Flow (cfs)	Channel Section	Available Freeboard During 100-Year Storm Event (ft)	Rip-rap Classification
Channel-1	98.21	3:1 Side Slopes, 20 Foot Top Width, 40 Inch Depth, 5.4% Slope	1.33	Class 300
Channel-2 (Existing)	278.67	Varies (Existing)	Varies	(Outlet and Inlet Only) Class 300
Channel-3 (Existing)	23.6 (Can only convey 3.4 cfs)	1.5:1 Side Slopes, 2 Foot Top Width, 8 Inch Depth, 2.5% Slope	0 (Overtops)	Class 150
Cut-Off Channel 12	37.2	2.5:1 Side Slopes, 15 Foot Top Width, 3 Foot Depth, 3.85% Slope	1.4	Class 150
Cut-Off Channel 13	40.9	2.5:1 Side Slopes, 15 Foot Top Width, 3 Foot Depth, 1.54% Slope	1.1	Class 150
Cut-Off Channel 14	26.7	2.5:1 Side Slopes, 15 Foot Top Width, 3 Foot Depth, 2.2% Slope	1.5	Class 150

Hydraulic conditions in the proposed channels were evaluated using HEC-RAS Version 6.5 and Bentley FlowMaster CONNECT Edition. FlowMaster computations are provided in **Appendix A**, and HEC-RAS results are provided in **Appendix D**. Refer to Table 802 in **Appendix A** for the selected channel roughness values for the cut-off channels and to Table 803 for maximum permissible mean velocities.

5.6 STREET CAPACITIES

Street drainage was evaluated to verify compliance with the Truckee Meadows Regional Drainage Manual (TMRDM) street spread requirements. During the 5-year storm event, the storm drain system and roadway sections were analyzed to ensure that a minimum of 12 feet of



clear travel lane width remains available on each side of the roadway centerline, excluding the median. During the 100-year storm event, roadway sections were evaluated to confirm that runoff remains contained within the public right-of-way and does not encroach onto adjacent properties. The analysis demonstrates that all roadway sections satisfy the applicable TMRDM requirements.

StormCAD results indicate that several catch basins and manholes may surcharge during the 100-year storm event. Although the storm drain system continues to convey runoff under these conditions, a portion of the peak flow may bypass the collection system and be conveyed within the roadway. To verify that the street section can safely convey this flow, a separate street capacity analysis was performed.

Cloudshadow Lane was selected for analysis because all predicted surcharging occurs along this roadway. The most restrictive section of the roadway, with a minimum longitudinal slope of 0.74 percent, was used to provide a conservative capacity evaluation. Using Bentley FlowMaster, the roadway section was calculated to convey approximately 31.4 cubic feet per second (cfs) while remaining within the limits of the public right-of-way. Supporting calculations are provided in **Appendix A**.

To estimate the amount of runoff captured by the storm drain system during the 100-year storm event, a separate StormCAD model titled "Street Capacity Check – 100 Year" was developed. In this model, the contributing drainage areas to selected inlets were incrementally reduced until surcharging was eliminated. The reduction in drainage area is not intended to represent a physical change in the watershed but rather serves as a calibration method to estimate the portion of the peak flow that is not intercepted by the storm drain system and is instead conveyed along the roadway surface. Adjustments were made to Basins B-1, B-5, B-7, B-8, B-10, and B-12, as summarized in Table 5 below.

The original 100-year StormCAD model produces a total peak inflow of 174.25 cfs, while the Street Spread Calibration model produces a total peak inflow of 148.80 cfs. The difference between these values, approximately 25.45 cfs, represents the estimated peak flow conveyed within Cloudshadow Lane rather than captured by the storm drain system. Because this flow is less than the calculated roadway capacity of 31.4 cfs, the roadway is capable of safely conveying the excess runoff during the 100-year storm event. Catchment area FlexTables and supporting model output for the 5-year storm, 100-year storm, and Street Spread Calibration analyses are included in **Appendices B** and **C**. A summary of the results is also provided in Table 6:



Table 6: 100-year Flow on Cloudshadow Lane							
100-Year			100-Year Street Capacity Check				
Basin Name	Acres	Q	Basin Name	Acres	Q	Difference in Area	Difference in Flow
A-1	2.917	5.62	A-1	2.917	5.62	0	0
B-1	5.039	11.89	B-1	2	4.67	3.039	7.22
B-2	1.093	2.21	B-2	1.093	2.21	0	0
B-3	1.252	6.41	B-3	1.252	6.41	0	0
B-4	2.102	4.46	B-4	2.102	4.46	0	0
B-5	3.371	7.82	B-5	2.95	6.84	0.421	0.98
B-6	0.987	3.41	B-6	0.987	3.41	0	0
B-7	3.528	7.86	B-7	3.1	6.91	0.428	0.95
B-8	3.258	7.06	B-8	2.1	4.55	1.158	2.51
B-9	0.5	1.26	B-9	0.5	1.26	0	0
B-10	4.179	9.05	B-10	2.1	4.55	2.079	4.5
B-11	0.375	0.93	B-11	0.375	0.93	0	0
B-12	19.317	37.75	B-12	14.565	28.46	4.752	9.29
B-13	22.787	41.49	B-13	22.787	41.49	0	0
B-14	20.392	27.03	B-14	20.392	27.03	0	0
Totals:	91.097	174.25	Totals:	79.223	148.8	11.874	25.45

5.7 WATER QUALITY CONTROLS

The detention basin will settle any sediment or pollutants within detained runoff volume. Water quality controls that will be utilized during construction include fiber rolls surrounding drainage inlets, rip-rap protection for drainage ditches, and any additional best management practices presented in the site Erosion Control Plan.

5.8 DETENTION REQUIREMENTS

The proposed Project will reduce peak flows at the Outfall-1 through the use of detention and the peak flow at Outfall-2 is expected to increase by less than 0.5% in the 100-year storm and less than 1.5% in the 5-year storm, which in practice is negligible. The majority of the Project is being directed via storm drain to Pond-1 (flows to Outfall-1). In order to negate any peak flow increases to mitigate flooding issues for downstream recipients, detention is required for the Project for the 5-year and 100-year storm events. Detention will also provide benefits such as infiltration (increased ground water recharge), water quality controls (reduced sediment load downstream), and can provide temporary storage during storm events larger than the design storm, adding resilience to the drainage system.

The Project will provide detention through a proposed detention basin, designated **Pond-1**, located along the northern portion of the site as shown on the Proposed Hydrology Exhibit. The pond will discharge through a two-stage outlet structure consisting of a low-flow 18-inch culvert with an invert elevation of 4913.1 feet and a primary orifice outlet set at elevation 4915.3 feet.



The 18-inch culvert is designed to convey flows from the minor design storm (5-year event), while the orifice outlet provides additional discharge capacity during the major design storm (100-year event). An emergency overflow weir will also be provided along the pond side slope at elevation 4917.8 feet, below the pond rim. The emergency weir is intended to function only during extreme events, such as storms exceeding the 100-year event or a Steamboat Ditch breach scenario. The maximum water surface elevation before impacts to adjacent lots occur is 4918.2 feet. Tables 7 and 8 summarize the proposed and existing peak flows for the site's two primary discharge locations under both the 5-year and 100-year storm events. The tables also identify the hydrologic method used to determine each peak flow, including the Rational Method, NRCS Method, or a combined approach where Rational Method peak flows were calibrated using NRCS Unit Hydrograph PRF 484.

Table 7: 100-Year Flow Summary with Detention		
Discharge Point	Existing Conditions	Proposed Conditions
Outfall-1	133.02 (NRCS) 118.3 (Rational)	99.37 (Rational Flow with Unit Hydrograph (PRF 484))
Outfall-2	278.32 (NRCS)	278.67 (NRCS)

Table 8: 5-Year Flow Summary with Detention		
Discharge Point	Existing Conditions	Proposed Conditions
Outfall-1	44.98 (NRCS) 19.3 (Rational)	9.70 (Rational Flow with Unit Hydrograph (PRF 484))
Outfall-2	80.92 (NRCS)	82.04 (NRCS)

The proposed pond was analyzed with HEC-HMS software, version 4.2.1. Peak flows, pond elevation and area, and outlet structures were input into the software to obtain the hydraulic performance of the proposed pond. As summarized in Table 7 where, Pond-1 reduces the 5-year peak discharge from 25.50 cfs to 9.70 cfs, a 62.0% reduction, and the 100-year peak discharge from 122.21 cfs to 99.37 cfs, a 18.7% reduction. The corresponding peak water surface elevations within the pond are 4915.3 feet during the 5-year event and 4916.6 feet during the 100-year event. With the emergency overflow weir set at elevation 4917.8 feet, the pond maintains approximately 1.2 feet of freeboard to the emergency crest during the 100-year design storm. Output from the HEC-HMS software analysis of the ponds is included in **Appendices B and C**.

Table 9: Peak Flow Conditions of Proposed Detention Pond-1								
Pond Name	5-Year Qpeak In (cfs)	5-Year Qpeak Out (cfs)	5-Year Peak WSE (ft)	100-Year Qpeak In (cfs)	100-Year Qpeak Out (cfs)	100-Year Peak WSE (ft)	Freeboard Provided (ft)	Peak Storage Volume (AC-ft)
Pond-1	25.50	9.70	4915.3	122.21	99.37	4916.6	1.2	1.43



5.9 COMPATIBILITY WITH PREVIOUS STUDIES

The results of this study are compatible with the preliminary study *Preliminary Drainage Report for Meridian 120 South Village 1 and 2* prepared by Wood Rodgers, Inc. The overall layout of the Villages, roads, etc. has been modified slightly from the preliminary layout, but proposed drainage patterns are concurrent with patterns expected in the preliminary study. The results of this study are also compatible and consistent with *Meridian 120 South Steamboat Ditch Breach Analysis* by Wood Rodgers, Inc.

6 SPECIAL FLOOD HAZARDS

The entire site lies within FEMA flood hazard area “unshaded X”, which indicates that the Project is outside the 0.2% probability per year flood zone. As the Project area is outside the 0.2% annual probability of flooding, there are no special flood hazard considerations proposed with this Project.

6.1 IMPACTS OF PROPOSED DEVELOPMENT ON FLOOD HAZARD AREA

As the Project is outside the floodplain and will provide detention to mitigate peak flow increases, no negative impacts to downstream Flood Hazard Areas are anticipated.

6.2 FLOODPROOFING MEASURES

Storm drain pipes have been designed to convey the 100-year flow conditions with overland release of runoff. The street section is sufficient to collect and convey runoff through the proposed Project.

6.3 FEMA AND LOCAL CODE COMPLIANCE

The Project will be compliant with all federal and local code requirements.

7 CONCLUSIONS

Based on the hydrologic and hydraulic analyses presented herein, the proposed drainage facilities are anticipated to collect, detain, and convey runoff from the 5-year and 100-year design storm events while maintaining defined overland release routes for flows exceeding the capacity of the underground collection system. The proposed detention basin will reduce peak discharge at Outfall-1, and the modeled change in discharge at Outfall-2 will remain minor relative to existing conditions. Subject to final design, construction, and continued maintenance of the proposed facilities, the analyses indicate that the Project will not create adverse drainage impacts to adjacent or downstream properties under the modeled design conditions. The conveyance of flows is in conformance with the City of Reno Design Manual and the TMRDM. There will be no negative impacts to any adjacent or downstream properties during the 5-year or 100-year storms as a result of development.



8 REFERENCES

Bentley CulvertMaster V3.3, Haestad Methods, Inc.

Bentley FlowMaster CONNECT Edition, Bentley Systems, Inc.

Bentley StormCAD CONNECT Edition, Haestad Methods, Inc.

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Federal Emergency Management Agency (FEMA). Flood Insurance Rate Map (FIRM), Panel 32031C3014G, Effective Date September 28, 2018.

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HEC-RAS River Analysis System, Version 6.5, U.S. Army Corps of Engineers.

National Oceanic and Atmospheric Administration (NOAA). NOAA Atlas 14 Precipitation-Frequency Data Server (PFDS), Point Precipitation Frequency Estimates.

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Terraphase Engineering Inc. (2022). Technical Drainage Report, Backbone Road Phase 1A, Quilici Ranch, Reno, Nevada, Revision 2, Project No. N003.001, August 19, 2022.

Truckee Meadows Regional Drainage Manual, April 30, 2009.

U.S. Army Corps of Engineers. (2024). Creating Land Cover, Manning's n Values, and Percent Impervious Layers (HEC-RAS 2D User's Manual, Version 6.6). Hydrologic Engineering Center, Davis, California.

U.S. Geological Survey. (2020, March 30). USGS one meter x76y438 NV Reno Carson QL1 2017. U.S. Geological Survey.



APPENDIX A

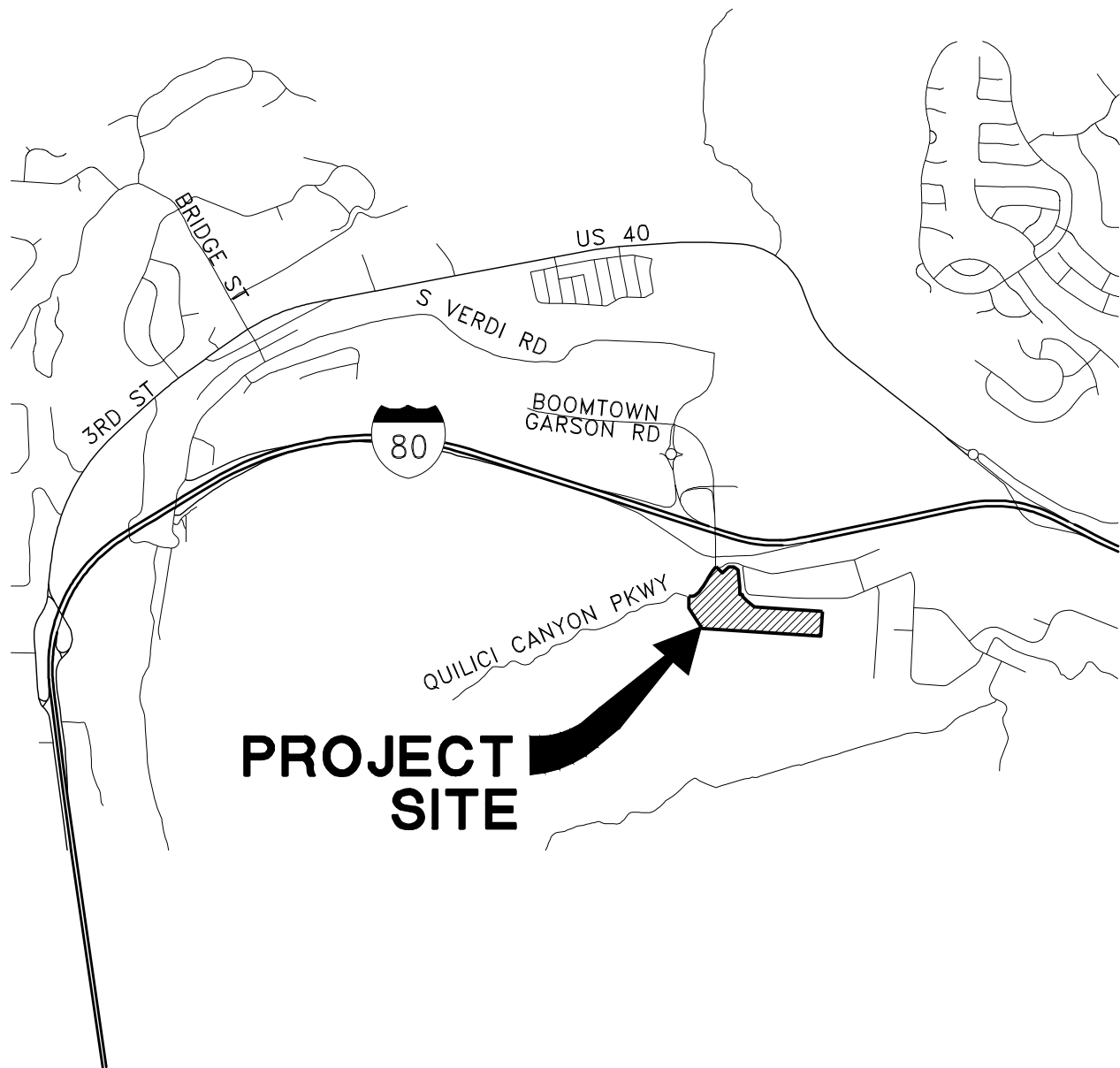
GENERAL FIGURES, TABLES, COMPUTATIONS

VICINITY MAP
MERIDIAN 120 SOUTH
VILLAGES 1 & 2

RENO

NEVADA

APRIL, 2026



**PROJECT
SITE**

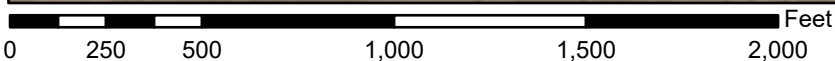


WOOD RODGERS
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Reno, NV 89502 Fax 775.823.4066

National Flood Hazard Layer FIRMette



119°57'58"W 39°30'38"N



1:6,000

119°57'21"W 39°30'10"N

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
		Area of Undetermined Flood Hazard Zone D
GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped



The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on **4/21/2026 at 5:23 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.



NOAA Atlas 14, Volume 1, Version 5
Location name: Reno, Nevada, USA*
Latitude: 39.4942°, Longitude: -119.962°
Elevation: 5498 ft**
 * source: ESRI Maps
 ** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps_&_aerials](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.114 (0.097-0.131)	0.142 (0.122-0.165)	0.187 (0.161-0.220)	0.231 (0.198-0.272)	0.305 (0.254-0.363)	0.375 (0.303-0.450)	0.457 (0.358-0.559)	0.559 (0.421-0.698)	0.726 (0.516-0.934)	0.883 (0.598-1.16)
10-min	0.174 (0.149-0.199)	0.216 (0.185-0.251)	0.285 (0.245-0.335)	0.352 (0.302-0.414)	0.464 (0.387-0.552)	0.570 (0.461-0.685)	0.696 (0.545-0.850)	0.851 (0.640-1.06)	1.11 (0.785-1.42)	1.34 (0.911-1.77)
15-min	0.215 (0.184-0.247)	0.267 (0.230-0.310)	0.353 (0.304-0.415)	0.437 (0.374-0.514)	0.576 (0.480-0.685)	0.706 (0.571-0.850)	0.863 (0.676-1.05)	1.06 (0.794-1.32)	1.37 (0.973-1.76)	1.67 (1.13-2.20)
30-min	0.290 (0.247-0.332)	0.360 (0.309-0.418)	0.476 (0.409-0.558)	0.588 (0.503-0.692)	0.775 (0.647-0.922)	0.951 (0.769-1.14)	1.16 (0.910-1.42)	1.42 (1.07-1.77)	1.85 (1.31-2.37)	2.24 (1.52-2.96)
60-min	0.359 (0.306-0.411)	0.445 (0.382-0.517)	0.589 (0.507-0.691)	0.728 (0.623-0.856)	0.960 (0.800-1.14)	1.18 (0.952-1.42)	1.44 (1.13-1.76)	1.76 (1.32-2.19)	2.28 (1.62-2.94)	2.78 (1.88-3.66)
2-hr	0.486 (0.434-0.551)	0.602 (0.539-0.684)	0.763 (0.677-0.869)	0.904 (0.794-1.03)	1.12 (0.960-1.29)	1.32 (1.10-1.53)	1.55 (1.26-1.82)	1.85 (1.46-2.21)	2.39 (1.81-2.96)	2.90 (2.12-3.69)
3-hr	0.597 (0.539-0.668)	0.741 (0.674-0.832)	0.916 (0.826-1.03)	1.06 (0.950-1.19)	1.26 (1.12-1.43)	1.45 (1.26-1.65)	1.66 (1.42-1.92)	1.97 (1.64-2.31)	2.49 (2.02-2.99)	2.99 (2.36-3.72)
6-hr	0.897 (0.813-0.996)	1.12 (1.01-1.24)	1.36 (1.23-1.52)	1.55 (1.39-1.73)	1.80 (1.59-2.02)	1.98 (1.73-2.23)	2.16 (1.87-2.46)	2.39 (2.04-2.76)	2.82 (2.37-3.31)	3.26 (2.69-3.86)
12-hr	1.27 (1.14-1.41)	1.58 (1.43-1.76)	1.97 (1.77-2.20)	2.28 (2.03-2.54)	2.68 (2.36-3.02)	2.99 (2.61-3.38)	3.30 (2.84-3.78)	3.62 (3.06-4.19)	4.03 (3.33-4.76)	4.37 (3.54-5.24)
24-hr	1.70 (1.54-1.91)	2.13 (1.92-2.39)	2.69 (2.42-3.01)	3.15 (2.83-3.52)	3.79 (3.38-4.24)	4.31 (3.81-4.82)	4.84 (4.25-5.44)	5.41 (4.69-6.11)	6.19 (5.28-7.05)	6.81 (5.73-7.83)
2-day	2.14 (1.89-2.44)	2.69 (2.38-3.08)	3.46 (3.05-3.96)	4.10 (3.60-4.68)	5.01 (4.36-5.74)	5.75 (4.97-6.60)	6.54 (5.60-7.57)	7.38 (6.25-8.62)	8.58 (7.12-10.2)	9.55 (7.78-11.5)
3-day	2.37 (2.09-2.71)	3.00 (2.65-3.44)	3.92 (3.45-4.48)	4.68 (4.10-5.35)	5.77 (5.02-6.62)	6.67 (5.75-7.67)	7.64 (6.51-8.84)	8.69 (7.30-10.1)	10.2 (8.38-12.0)	11.4 (9.24-13.7)
4-day	2.60 (2.29-2.98)	3.31 (2.91-3.80)	4.37 (3.84-5.02)	5.25 (4.60-6.02)	6.53 (5.67-7.50)	7.59 (6.52-8.74)	8.74 (7.42-10.1)	9.99 (8.35-11.6)	11.8 (9.65-13.9)	13.3 (10.7-15.9)
7-day	3.13 (2.69-3.68)	4.02 (3.45-4.73)	5.38 (4.61-6.33)	6.48 (5.54-7.62)	8.06 (6.82-9.50)	9.36 (7.85-11.0)	10.8 (8.95-12.8)	12.2 (10.1-14.6)	14.4 (11.6-17.4)	16.1 (12.8-19.7)
10-day	3.59 (3.10-4.20)	4.63 (3.99-5.42)	6.21 (5.34-7.27)	7.47 (6.41-8.73)	9.23 (7.86-10.8)	10.6 (9.01-12.5)	12.2 (10.2-14.3)	13.8 (11.4-16.3)	16.0 (13.0-19.2)	17.8 (14.3-21.6)
20-day	4.74 (4.10-5.58)	6.11 (5.29-7.20)	8.15 (7.04-9.55)	9.74 (8.39-11.4)	11.9 (10.2-14.0)	13.6 (11.6-16.0)	15.4 (13.0-18.3)	17.3 (14.4-20.6)	19.8 (16.2-23.9)	21.8 (17.7-26.6)
30-day	5.80 (5.02-6.87)	7.48 (6.47-8.87)	9.96 (8.60-11.8)	11.9 (10.2-14.0)	14.5 (12.4-17.1)	16.6 (14.1-19.6)	18.7 (15.8-22.2)	20.9 (17.5-25.0)	24.0 (19.8-28.8)	26.4 (21.5-32.0)
45-day	7.10 (6.16-8.14)	9.17 (7.96-10.5)	12.2 (10.6-14.0)	14.4 (12.5-16.6)	17.5 (15.0-20.1)	19.8 (16.9-22.8)	22.1 (18.8-25.6)	24.5 (20.7-28.5)	27.8 (23.1-32.5)	30.2 (24.9-35.7)
60-day	7.98 (6.84-9.20)	10.4 (8.88-11.9)	13.8 (11.8-15.9)	16.2 (13.9-18.7)	19.4 (16.5-22.4)	21.7 (18.4-25.2)	24.0 (20.2-27.9)	26.3 (22.0-30.7)	29.3 (24.3-34.4)	31.4 (25.9-37.1)

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

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

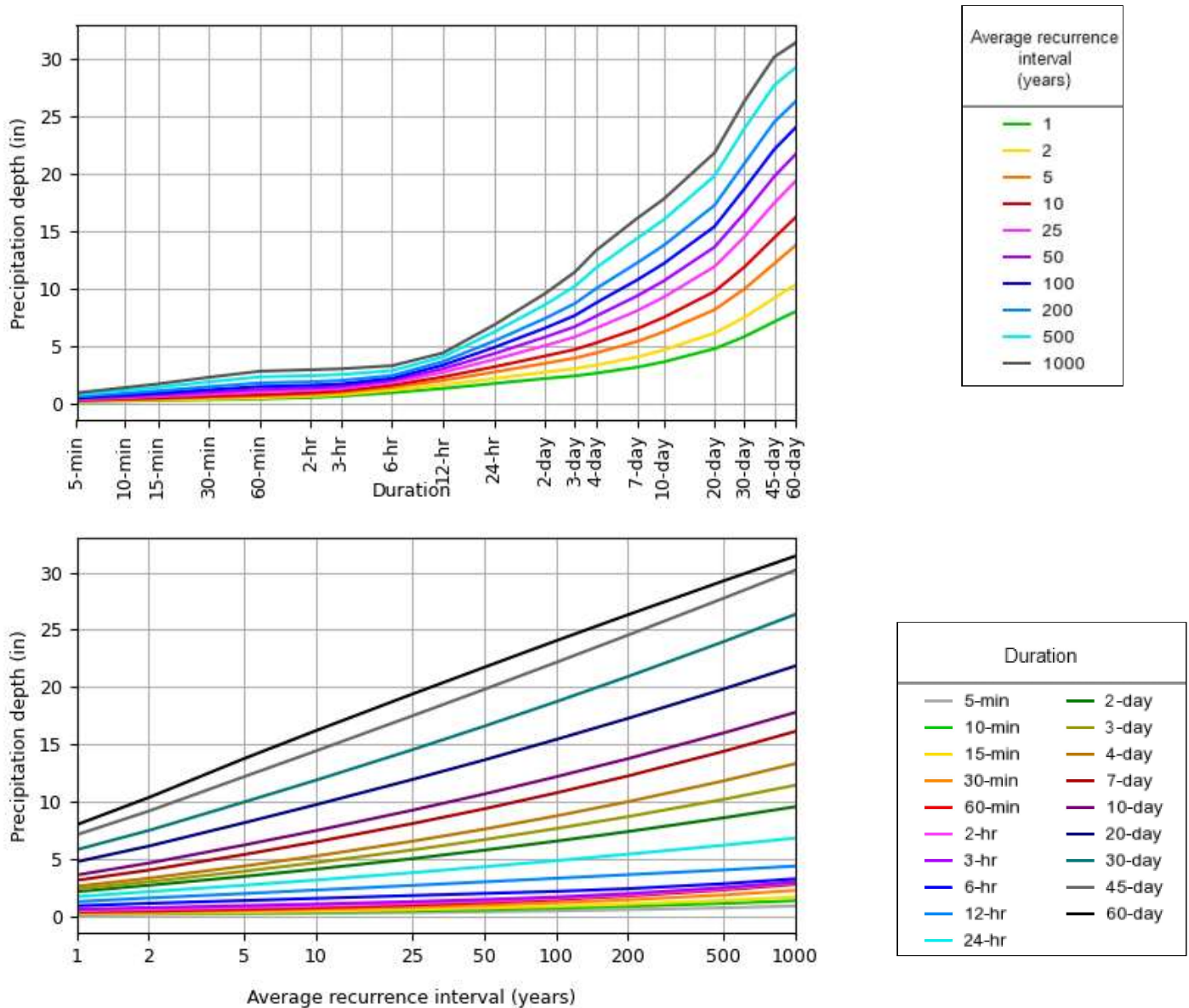
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PF graphical

PDS-based depth-duration-frequency (DDF) curves

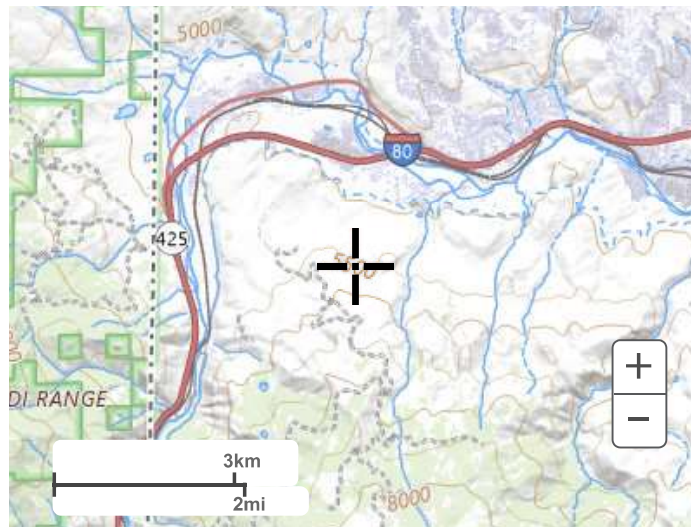
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Elevation: 4917 ft**
 * source: ESRI Maps
 ** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps_&_aerials](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	1.34 (1.14-1.54)	1.67 (1.43-1.93)	2.21 (1.90-2.59)	2.74 (2.33-3.22)	3.61 (3.00-4.30)	4.43 (3.59-5.34)	5.42 (4.25-6.62)	6.62 (4.99-8.28)	8.62 (6.12-11.1)	10.5 (7.12-13.8)
10-min	1.02 (0.870-1.18)	1.27 (1.09-1.48)	1.68 (1.45-1.97)	2.08 (1.78-2.45)	2.74 (2.29-3.26)	3.37 (2.72-4.06)	4.12 (3.23-5.04)	5.05 (3.80-6.30)	6.56 (4.66-8.45)	7.97 (5.41-10.5)
15-min	0.844 (0.720-0.968)	1.05 (0.900-1.22)	1.39 (1.19-1.63)	1.72 (1.47-2.02)	2.27 (1.89-2.70)	2.79 (2.25-3.36)	3.41 (2.67-4.17)	4.17 (3.14-5.20)	5.42 (3.85-6.98)	6.59 (4.47-8.69)
30-min	0.568 (0.486-0.652)	0.706 (0.606-0.822)	0.936 (0.802-1.10)	1.16 (0.988-1.36)	1.53 (1.27-1.82)	1.88 (1.52-2.26)	2.30 (1.80-2.81)	2.81 (2.11-3.50)	3.65 (2.59-4.70)	4.44 (3.01-5.85)
60-min	0.352 (0.300-0.404)	0.437 (0.374-0.508)	0.579 (0.497-0.680)	0.716 (0.611-0.843)	0.945 (0.788-1.12)	1.16 (0.939-1.40)	1.42 (1.11-1.74)	1.74 (1.31-2.17)	2.26 (1.60-2.91)	2.75 (1.86-3.62)
2-hr	0.235 (0.210-0.268)	0.292 (0.261-0.332)	0.370 (0.329-0.423)	0.440 (0.385-0.502)	0.547 (0.467-0.628)	0.644 (0.538-0.748)	0.758 (0.617-0.891)	0.905 (0.714-1.10)	1.17 (0.885-1.47)	1.42 (1.04-1.83)
3-hr	0.192 (0.173-0.215)	0.239 (0.217-0.269)	0.296 (0.267-0.332)	0.342 (0.307-0.385)	0.409 (0.361-0.463)	0.469 (0.407-0.536)	0.540 (0.459-0.625)	0.639 (0.532-0.751)	0.809 (0.654-0.988)	0.973 (0.767-1.23)
6-hr	0.144 (0.130-0.160)	0.179 (0.162-0.199)	0.219 (0.197-0.244)	0.249 (0.224-0.278)	0.289 (0.257-0.325)	0.319 (0.280-0.361)	0.349 (0.302-0.398)	0.387 (0.330-0.447)	0.458 (0.383-0.536)	0.529 (0.436-0.628)
12-hr	0.100 (0.090-0.111)	0.125 (0.113-0.140)	0.156 (0.140-0.174)	0.180 (0.161-0.201)	0.213 (0.188-0.239)	0.237 (0.207-0.269)	0.263 (0.226-0.301)	0.288 (0.244-0.333)	0.321 (0.265-0.379)	0.348 (0.282-0.417)
24-hr	0.067 (0.061-0.075)	0.084 (0.076-0.094)	0.106 (0.096-0.119)	0.124 (0.112-0.139)	0.150 (0.133-0.168)	0.170 (0.150-0.190)	0.191 (0.167-0.215)	0.213 (0.185-0.241)	0.243 (0.208-0.278)	0.268 (0.225-0.308)
2-day	0.042 (0.037-0.048)	0.053 (0.047-0.060)	0.068 (0.060-0.078)	0.080 (0.070-0.092)	0.098 (0.085-0.112)	0.112 (0.097-0.129)	0.128 (0.109-0.148)	0.144 (0.122-0.168)	0.167 (0.139-0.198)	0.186 (0.152-0.224)
3-day	0.031 (0.027-0.035)	0.039 (0.034-0.045)	0.051 (0.045-0.058)	0.061 (0.053-0.070)	0.075 (0.065-0.086)	0.087 (0.075-0.100)	0.099 (0.085-0.115)	0.113 (0.095-0.131)	0.132 (0.109-0.156)	0.148 (0.120-0.177)
4-day	0.025 (0.022-0.029)	0.032 (0.028-0.037)	0.042 (0.037-0.049)	0.051 (0.045-0.059)	0.063 (0.055-0.073)	0.074 (0.063-0.085)	0.085 (0.072-0.098)	0.097 (0.081-0.113)	0.114 (0.094-0.135)	0.129 (0.104-0.154)
7-day	0.017 (0.015-0.020)	0.022 (0.019-0.026)	0.030 (0.025-0.035)	0.036 (0.031-0.042)	0.044 (0.038-0.052)	0.051 (0.043-0.061)	0.059 (0.049-0.070)	0.067 (0.055-0.080)	0.079 (0.064-0.095)	0.088 (0.070-0.108)
10-day	0.014 (0.012-0.016)	0.018 (0.015-0.021)	0.024 (0.020-0.028)	0.029 (0.025-0.033)	0.035 (0.030-0.041)	0.041 (0.035-0.048)	0.047 (0.039-0.055)	0.053 (0.044-0.062)	0.061 (0.050-0.073)	0.068 (0.055-0.082)
20-day	0.009 (0.008-0.010)	0.011 (0.010-0.013)	0.015 (0.013-0.018)	0.018 (0.016-0.022)	0.023 (0.019-0.026)	0.026 (0.022-0.030)	0.029 (0.025-0.034)	0.033 (0.027-0.039)	0.038 (0.031-0.045)	0.041 (0.034-0.050)
30-day	0.007 (0.006-0.008)	0.009 (0.008-0.011)	0.012 (0.011-0.014)	0.015 (0.013-0.017)	0.018 (0.015-0.021)	0.021 (0.018-0.024)	0.023 (0.020-0.028)	0.026 (0.022-0.031)	0.030 (0.025-0.036)	0.033 (0.027-0.040)
45-day	0.006 (0.005-0.006)	0.007 (0.006-0.008)	0.010 (0.009-0.011)	0.012 (0.010-0.014)	0.014 (0.012-0.017)	0.016 (0.014-0.019)	0.018 (0.016-0.021)	0.020 (0.017-0.024)	0.023 (0.019-0.027)	0.025 (0.021-0.029)
60-day	0.005 (0.004-0.005)	0.006 (0.005-0.007)	0.008 (0.007-0.010)	0.010 (0.008-0.011)	0.012 (0.010-0.014)	0.013 (0.011-0.016)	0.015 (0.013-0.017)	0.016 (0.014-0.019)	0.018 (0.015-0.021)	0.019 (0.016-0.023)

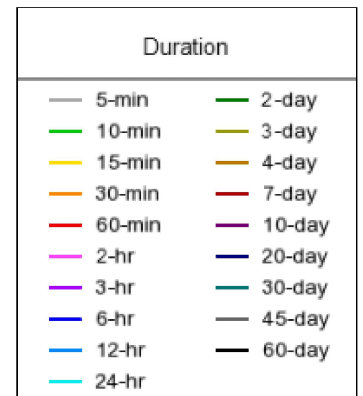
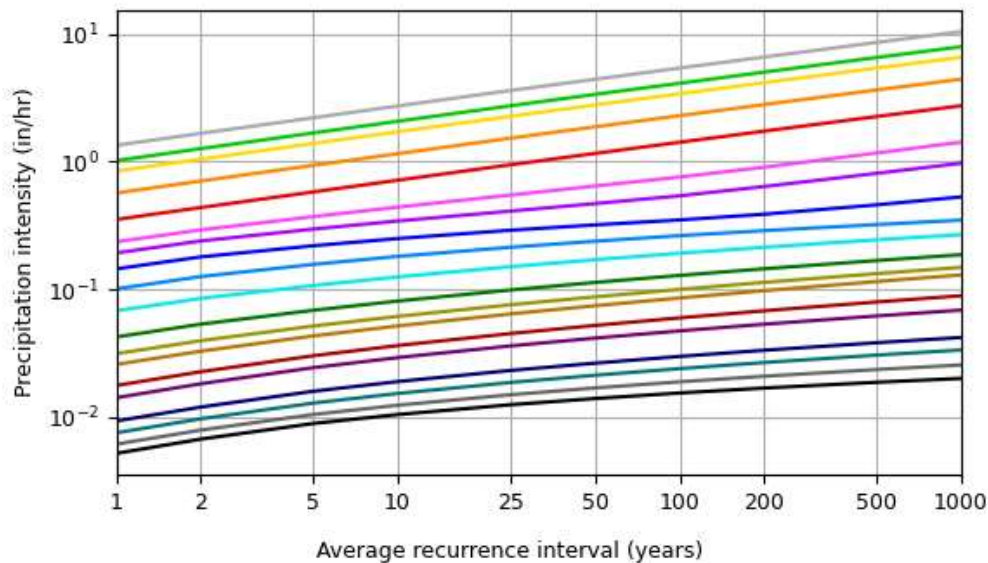
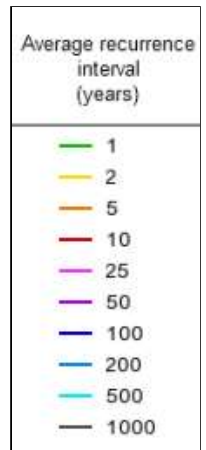
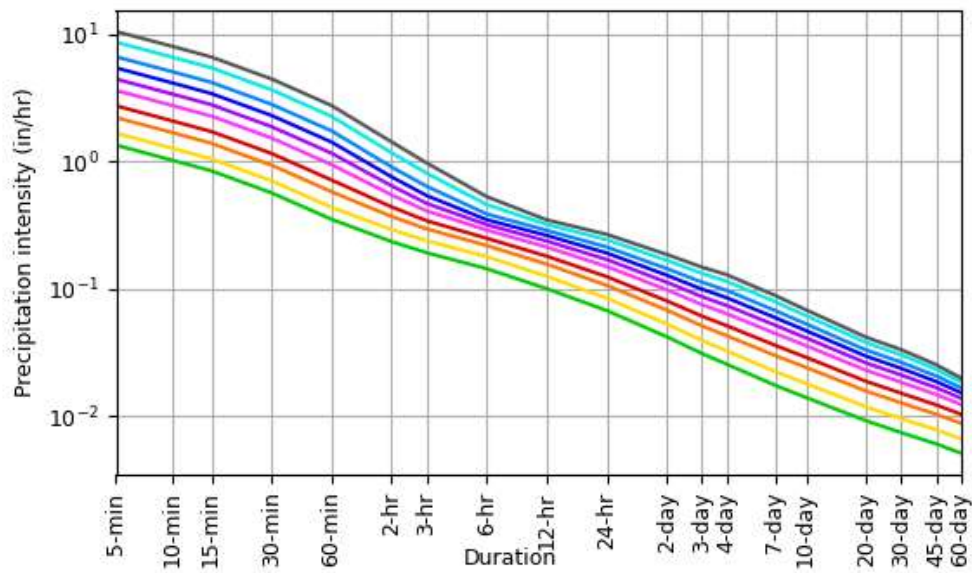
¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).
 Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.
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PF graphical

PDS-based intensity-duration-frequency (IDF) curves

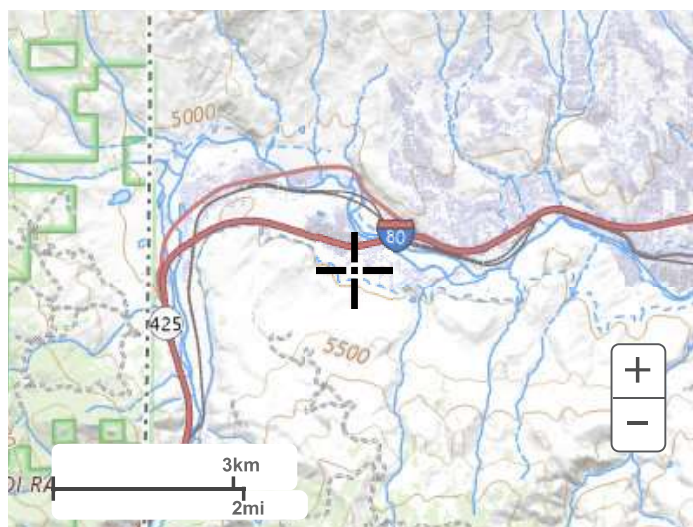
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RATIONAL FORMULA METHOD RUNOFF COEFFICIENTS

Land Use or Surface Characteristics	Aver. % Impervious Area	Runoff Coefficients 5-Year (C ₅)	100-Year (C ₁₀₀)
<u>Business/Commercial:</u>			
Downtown Areas	85	.82	.85
Neighborhood Areas	70	.65	.80
<u>Residential:</u>			
(Average Lot Size)			
1/8 Acre or Less (Multi-Unit)	65	.60	.78
1/4 Acre	38	.50	.65
1/8 Acre	30	.45	.60
1/2 Acre	25	.40	.55
1 Acre	20	.35	.50
<u>Industrial:</u>	72	.68	.82
<u>Open Space:</u>			
(Lawns, Parks, Golf Courses)	5	.05	.30
<u>Undeveloped Areas:</u>			
Range	0	.20	.50
Forest	0	.05	.30
<u>Streets/Roads:</u>			
Paved	100	.88	.93
Gravel	20	.25	.50
<u>Drives/Walks:</u>	95	.87	.90
<u>Roof:</u>	90	.85	.87

Notes:

1. Composite runoff coefficients shown for Residential, Industrial, and Business/Commercial Areas assume irrigated grass landscaping for all pervious areas. For development with landscaping other than irrigated grass, the designer must develop project specific composite runoff coefficients from the surface characteristics presented in this table.

VERSION: April 30, 2009

REFERENCE:

USDCM, DROCOG, 1969
(with modifications)

TABLE
701

WRC ENGINEERING, INC.

RUNOFF CURVE NUMBERS FOR URBAN AREAS¹

Runoff Curve Numbers

Cover Type and Hydrologic Condition	Aver. % Impervious Area ²	Soil Comp A	Soil Comp B	Soil Comp C	Soil Comp D
<i>Fully developed urban area (vegetation established)</i>					
Open space (lawns, parks, golf courses, cemeteries, etc.) ³					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50 to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) ⁴		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
<i>Developing urban areas</i>					
Newly graded areas (pervious only, no vegetation) ⁵		77	86	91	94
Idle lands (CNs are determined using cover types similar to those Table 702 - 3 of 4)					

¹Average runoff condition, and $I_a = 0.2S$

²The average percent impervious area shown was used to develop the composite CNs. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CNs for other combinations of conditions may be computed using figure 2-3 or 2-4 in TR-55 (SCS, 1986).

³CNs shown are equivalent to those of pasture. Composite CNs may be computed for other combinations of open space cover type.

⁴Composite CNs for natural desert landscaping should be computed using figure 2-3 or 2-4 in TR-55 (SCS, 1986) based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CNs are assumed equivalent to desert shrub in poor hydrologic condition.

⁵Composite CNs to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 in TR-55 (SCS, 1986) based on the degree of development (impervious area percentage) and the CNs for the newly graded pervious areas.

VERSION: April 30, 2009

REFERENCE:

210-VI-TR-55, Second Edition, June 1986

TABLE

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WRC ENGINEERING, INC.

RUNOFF CURVE NUMBERS FOR OTHER AGRICULTURAL LANDS¹

Runoff Curve Numbers

Cover Type	Hydrologic Condition	Soil Comp A	Soil Comp B	Soil Comp C	Soil Comp D
Pasture, grassland, or range – continuous forage for grazing ²	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow – continuous grass, protected from grazing and generally mowed for hay	-	30	58	71	78
Brush – brush-weed-grass mixture with brush the major element ³	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 ⁴	48	65	73
Woods – grass combination (orchard or tree farm) ⁵	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods ⁶	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 ⁴	55	70	77
Farmsteads – buildings, lanes, driveways, and surrounding lots	-	59	74	82	86

¹Average runoff condition, and $I_a = 0.2S$

²*Poor*: < 50% ground cover or heavily grazed with no mulch

Fair: 50 to 75% ground cover and not heavily grazed

Good: > 75% ground cover and lightly or only occasionally grazed

³*Poor*: < 50% ground cover

Fair: 50 to 75% ground cover

Good: >75% ground cover

⁴Actual curve number is less than 30; use CN = 30 for runoff computations.

⁵CNs shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CNs for woods and pasture.

⁶*Poor*: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.

Fair: Woods are grazed but not burned, and some forest litter covers the soil.

Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

VERSION: April 30, 2009

WRC ENGINEERING, INC.

REFERENCE:

210-VI-TR-55, Second Edition, June 1986

TABLE

702

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RUNOFF CURVE NUMBERS FOR ARID AND SEMIARID RANGELANDS¹

Runoff Curve Numbers

Cover Description	Hydrologic Condition ²	Soil Comp A ³	Soil Comp B	Soil Comp C	Soil Comp 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
Sagebrush with grass understory	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub – major plants include saltbrush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

¹Average runoff condition, and $I_a = 0.2S$. For range in humid regions, use Table 702 - 3 of 4.

²*Poor*: < 30% ground cover (litter, grass, and brush overstory)

Fair: 30 to 70% ground cover

Good: > 70% ground cover

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

VERSION: April 30, 2009

WRC ENGINEERING, INC.

REFERENCE:

210-VI-TR-55, Second Edition, June 1986

TABLE

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The shape of the SCS Unit Hydrograph is based on studies of various natural unit hydrographs. The basic governing parameters of this curvilinear hydrograph are as follows:

1. The time-to-peak, T_p , of the unit hydrograph approximately equals 0.2 times the time-of-base, T_b .
2. The point of inflection of the falling leg of the unit hydrograph approximately equals 1.7 times T_p .

For ease of calculation, an equivalent triangular unit hydrograph was derived from the natural curvilinear unit hydrograph. From the triangular unit hydrograph, equations for the peak discharge, Q_p , time-to-peak, T_p , and the time of concentration, t_c were developed based on a single lag factor (TLAG). The discharge hydrograph is then determined for the SCS Unit Hydrograph method based on the storm excess precipitation applied to the unit hydrograph whose parameters are determined by TLAG. TLAG is defined and discussed in Section 705.3.

705.2 ASSUMPTIONS

The basic assumptions made when applying the SCS Unit Hydrograph method (and all other unit hydrograph methods) are as follows:

1. The effects of all physical characteristics of a given drainage basin are reflected in the shape of the storm runoff hydrograph for that basin.
2. At a given point on a stream, discharge ordinates of different unit graphs of the same unit time of rainfall excess are mutually proportional to respective volumes.
3. A hydrograph of storm discharge that would result from a series of bursts of excess rain or from continuous excess rain of variable intensity may be constructed from a series of overlapping unit graphs each resulting from a single increment of excess rain of unit duration.

705.3 LAG TIME

Input data for the Soil Conservation Service dimensionless unit hydrograph method (SCS, 1985) consists of a single parameter, TLAG, which is equal to the lag (in hours) between the center of mass of rainfall excess and the peak of the unit hydrograph. For small drainage basins (less than one square mile) and basin slopes less than ten percent the lag time may be related to the time of concentration, t_c , by the following empirical relationship:

$$\text{TLAG} = 0.6 t_c \quad (709)$$

The t_c is computed as presented in Section 702.

For larger drainage basins (greater than one square mile) and basins with a basin slope equal to or greater than ten percent, the lag time (and t_c) is generally governed mostly by the concentrated flow travel time, not the initial overland flow time. In addition, as the basin gets increasingly larger, the average flow velocity (and associated travel time) becomes more difficult to estimate. Therefore, for these basins, the following lag equation is recommended for use in computing TLAG:

$$\text{TLAG} = 22.1 K_n (L L_c / S^{0.5})^{0.33} \quad (710)$$

where K_n = Roughness factor for the basin channels
 L = Length of longest watercourse (miles)

LAG EQUATION ROUGHNESS FACTORS

LAND USE	RANGE OF AVERAGE IMPERVIOUS AREA	K_n
Developed Areas		
Commercial/Industrial/Office/Business	70-85	.05
High and Medium Density Residential	30-65	.05
Low Density Residential	20-25	.07
Rural Residential	10-15	.08
Irrigated Grass (Golf Course/Parks/Cemeteries)	0-5	.10
Undeveloped Areas		
Rock Outcroppings	-	.04
Irrigated Agriculture	-	.10
Rangelands:		
Herbaceous (grasses)	-	.08
Mixed grass and shrub	-	.09
Heavy shrub/brush	-	.10
Forest (Evergreen)	-	.15

VERSION: October 1, 2008

REFERENCE:

U.S. Department of Interior, 1989
(with modifications)TABLE
703

WRC ENGINEERING, INC.

TYPICAL ROUGHNESS COEFFICIENTS FOR OPEN CHANNELS

<u>TYPE OF CHANNEL AND DESCRIPTION</u>	<u>MINIMUM</u>	<u>NORMAL</u>	<u>MAXIMUM</u>
EXCAVATED OR DREDGED			
a. Earth, straight and uniform			
1. Clean, recently completed	0.016	0.018	0.020
2. Clean, after weathering	0.018	0.022	0.025
3. Gravel, uniform section, clean	0.022	0.025	0.030
4. With short grass, few weeds	0.022	0.027	0.033
b. Earth, winding and sluggish			
1. No vegetation	0.023	0.025	0.030
2. Grass, some weeds	0.025	0.030	0.033
3. Dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
4. Earth bottom and rubble sides	0.028	0.030	0.035
5. Stony bottom and weedy banks	0.025	0.035	0.040
6. Cobble bottom and clean sides	0.030	0.040	0.050
c. Dragline-excavated or dredged			
1. No vegetation	0.025	0.028	0.033
2. Light brush on banks	0.035	0.050	0.060
d. Rock cuts			
1. Smooth and uniform	0.025	0.035	0.040
2. Jagged and irregular	0.035	0.040	0.050
e. Channels not maintained, weeds and brush			
1. Dense weeds, high as flow depth	0.050	0.080	0.120
2. Clean bottom, brush on sides	0.040	0.050	0.080
3. Same as above, but highest stage of flow	0.045	0.070	0.110
4. Dense brush, high stage	0.080	0.100	0.140

NATURAL STREAMS

Minor Streams (top width at flood stage < 100 ft)

a. Streams on plain			
1. Clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
2. Same as above, but more stones and weeds	0.030	0.035	0.040
3. Clean, winding, some pools and shoals	0.033	0.040	0.045
4. Same as above, but some weeds and stones	0.035	0.045	0.050
5. Same as above, but lower stages, and more ineffective slopes and sections	0.040	0.048	0.055

VERSION: April 30, 2009

WRC ENGINEERING, INC.

REFERENCE:

Chow, V.T., 1959, Open-Channel Hydraulics

TABLE

802

1 of 3

MAXIMUM PERMISSIBLE MEAN CHANNEL VELOCITIES

MATERIAL/LINING	MAXIMUM PERMISSIBLE MEAN VELOCITY (ft/sec)
NATURAL AND IMPROVED UNLINED CHANNELS	
Fine sand, colloidal	1.50
Sandy Loam, noncolloidal	1.75
Silt Loam, noncolloidal	2.00
Alluvial Silts, noncolloidal	2.00
Ordinary Firm Loam	2.50
Volcanic Ash	2.50
Stiff Clay, very colloidal	3.75
Alluvial Silts, colloidal	3.75
Shales and Hardpans	6.00
Fine Gravel	2.50
Graded Loam to Cobbles when noncolloidal	3.75
Graded Silts to Cobbles when colloidal	4.00
Coarse Gravel, noncolloidal	4.00
Cobbles and Shingles	5.00
Sandy Silt	2.0
Silty Clay	2.5
Poor Sedimentary Rock	10
Sound Rock (Igneous or Hard Metamorphic)	20
FULLY LINED CHANNELS	
Unreinforced vegetation	5
Loose riprap	15
Grouted riprap	15
Gabions	15
Soil-Cement	15
Concrete	35

NOTES:

1. For composite-lined channels, use the lowest of the maximum mean velocities for the materials used in the composite lining.
2. Deviation from the above values is only allowed with appropriate engineering analysis and/or suitable agreements for maintenance responsibilities.
3. Maximum permissible velocities based upon non-clear water conditions.

VERSION: April 30, 2009

WRC ENGINEERING, INC.

REFERENCE:

Natural – Fortier and Scobey, 1926
Fully Lined – Various Sources

TABLE
803

STORM DRAIN LAYOUT EXHIBIT

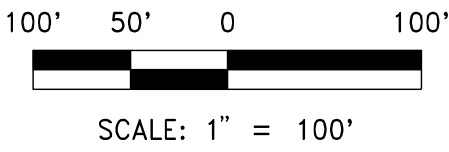
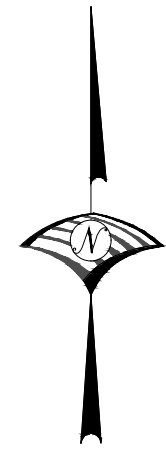
MERIDIAN 120 SOUTH VILLAGES 1 & 2

TAYLOR DERRICK CAPITAL

RENO

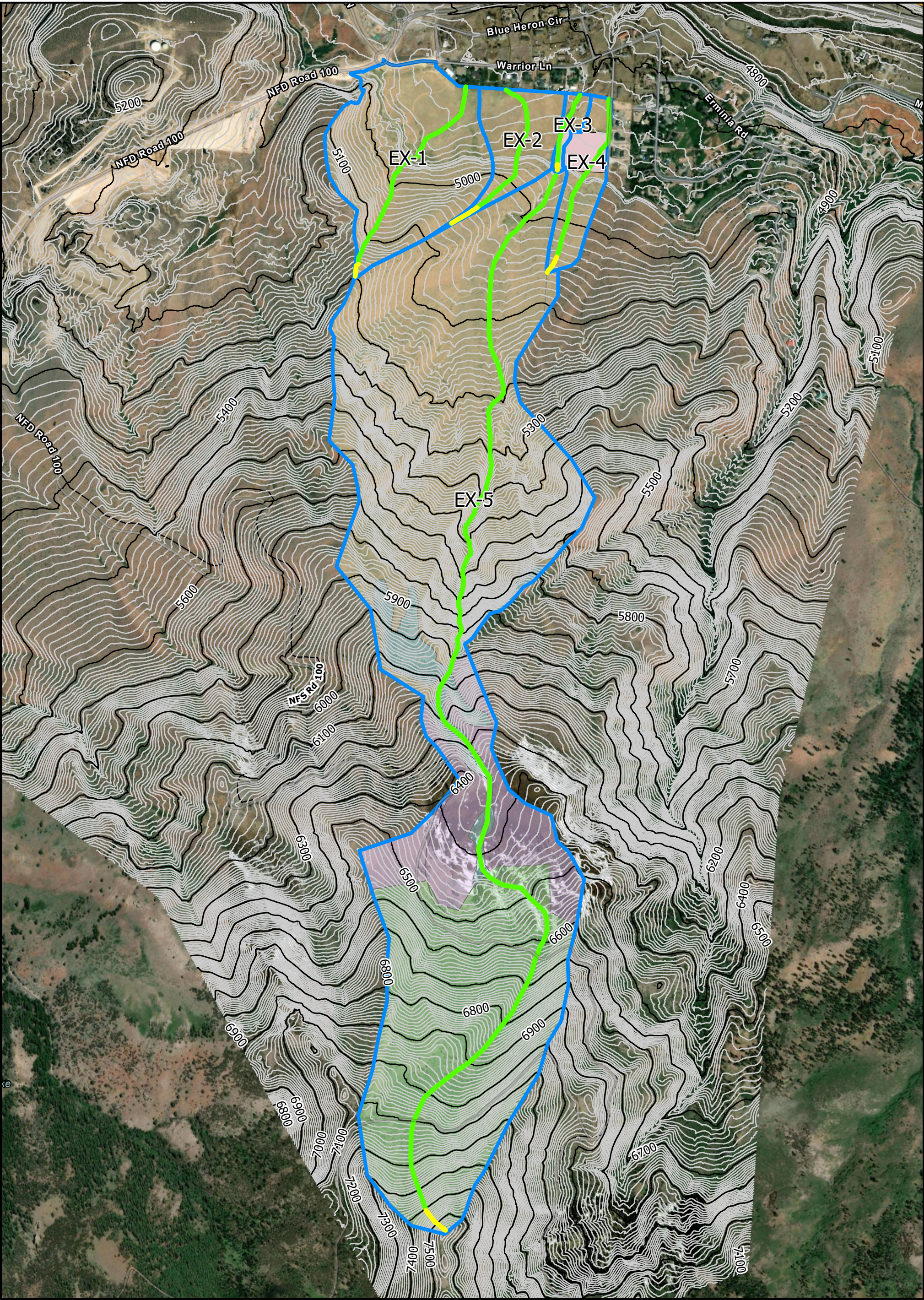
NEVADA

JULY, 2026



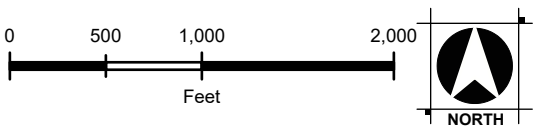
WOOD ROGERS
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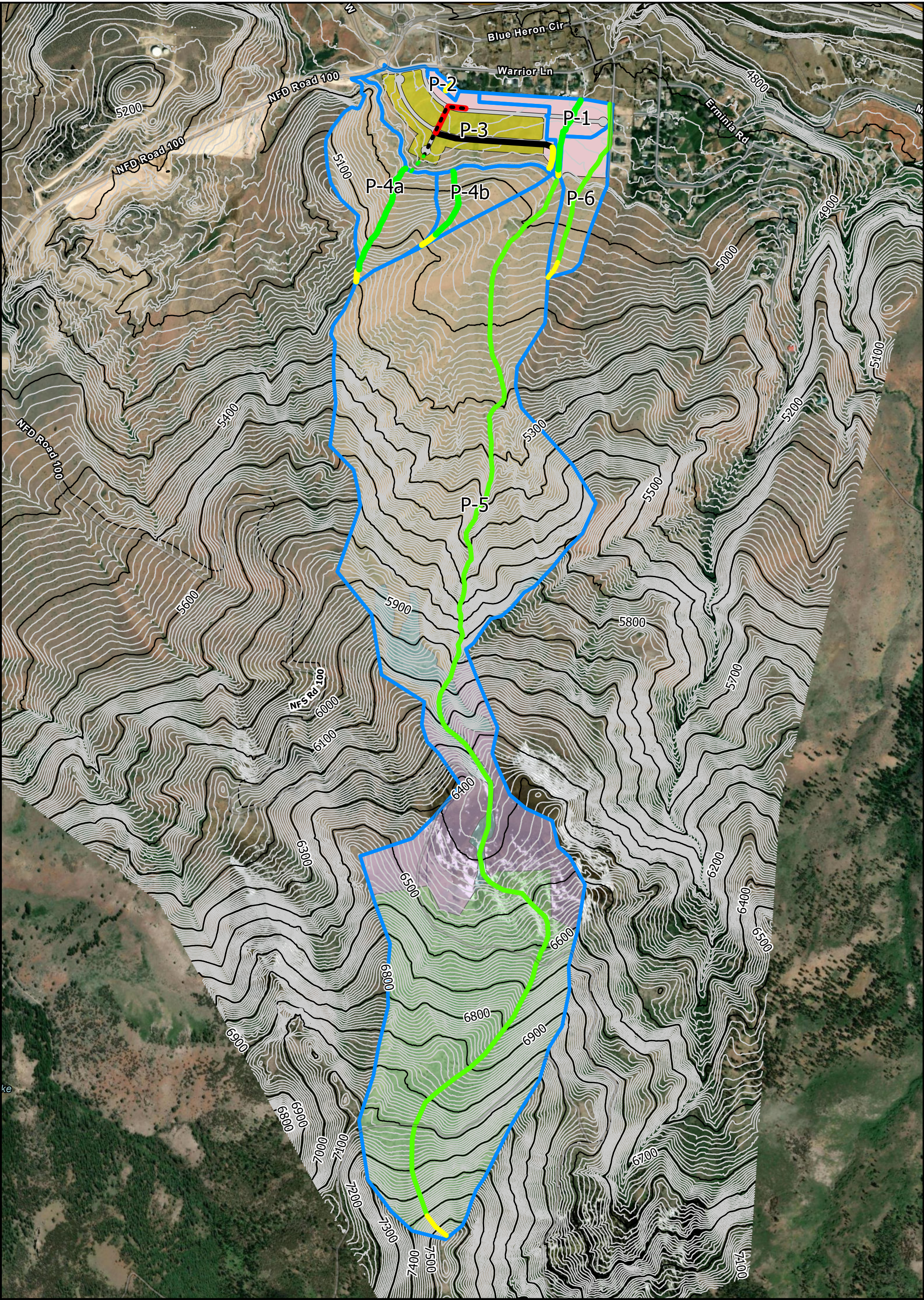
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**EXISTING HYDROLOGIC
CONDITIONS**
MERIDIAN 120 S. VILLAGES 1 & 2
RENO, NEVADA
JUNE 2026

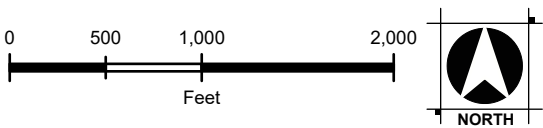
 Existing Hydro Basins	Cover Type	 Residential 1 Acre
 10 ft Elevation Contour	 Brush, Fair	Flow Type
 100 Elevation Contour	 Brush, Good	 Channel
	 Herbaceous, Fair	 Sheet
	 Meadow	

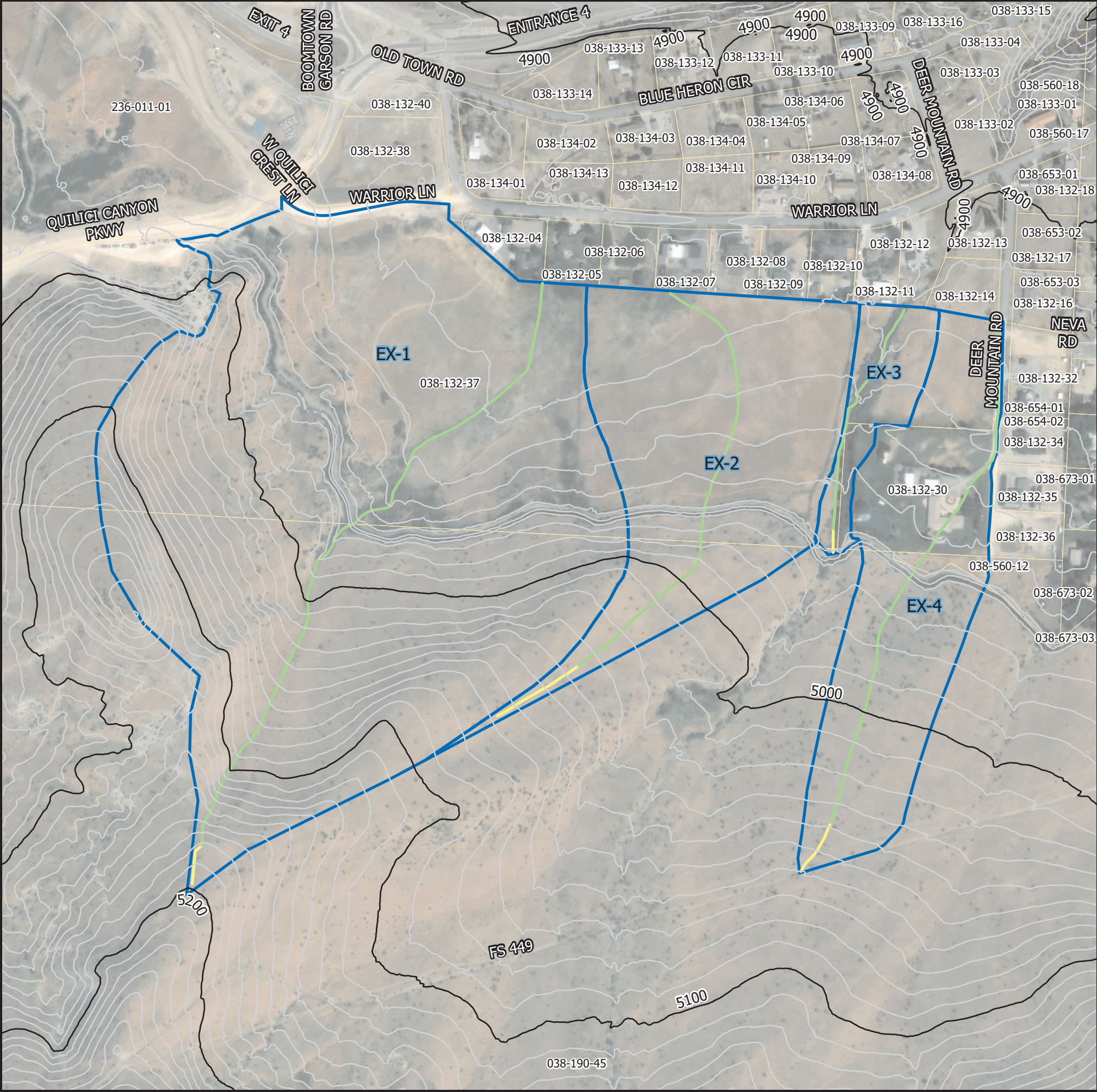




**PROPOSED HYDROLOGIC
CONDITIONS**
MERIDIAN 120 S. VILLAGES 1 & 2
RENO, NEVADA
JUNE 2026

Proposed Hydro Basins	Residential 1/4 Acre	Sheet
10 ft Elevation Contour	Brush, Fair	Channel
100 Elevation Contour	Brush, Good	Reach 1 - Pipe
Cover Type	Meadow	Reach 1 - Channel
Herbaceous, Fair	Proposed Flow Paths	
Pavement	Gutter	
Residential 1 Acre	Pipe	





Existing Hydrologic Basins
Meridian 120 South Villages 1 and 2
Reno, NV
June 2026

Basin

10 ft Elevation Contour

100 Elevation Contour

FlowType

Sheet

Channel

Basin Name	Area (ac.)	C(5yr)	C(100yr)	I(5yr)	I(100yr)	Q(5yr)	Q(100yr)
EX-1	71.34	0.20	0.50	1.35	3.32	19.3	118.3
EX-2	22.24	0.20	0.50	1.20	2.95	5.3	32.8
EX-3	3.83	0.20	0.50	1.48	3.62	1.1	6.9
EX-4	17.67	0.20	0.50	1.20	2.94	4.2	26.0

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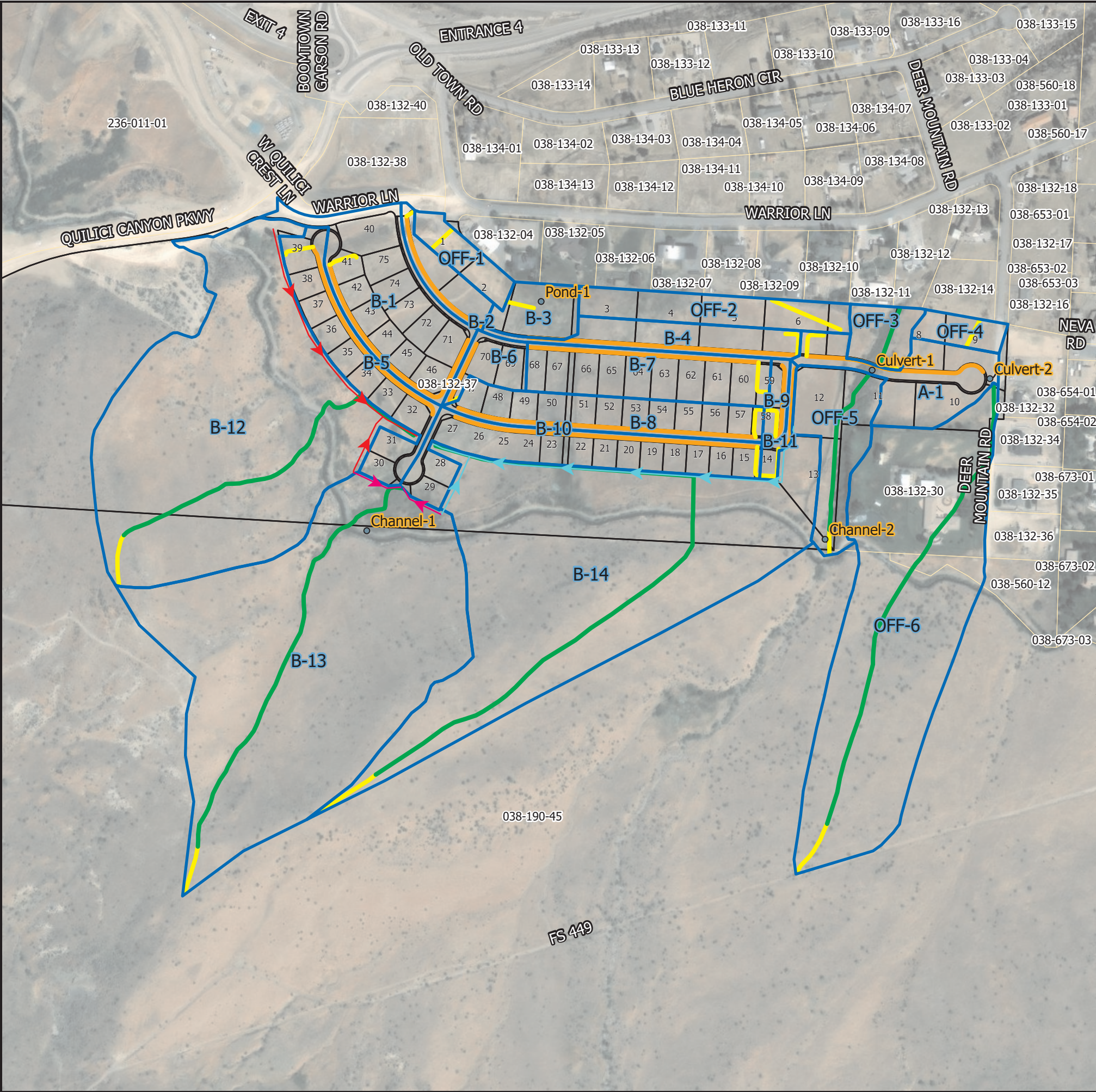
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FEET


NORTH

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Proposed Hydrologic Basins Meridian 120 South Villages 1 and 2 Reno, NV June 2026				Basin Cut-Off 12 Cut-Off 13 Cut-Off 14 Civil Linework Labels FlowType Gutter Sheet Channel			
Basin Name	Area (ac.)	C(5yr)	C(100yr)	I(5yr)	I(100yr)	Q(5yr)	Q(100yr)
A-1	2.92	0.40	0.54	1.43	3.50	1.7	5.5
B-1	5.04	0.54	0.68	1.40	3.43	3.8	11.7
B-10	4.18	0.50	0.65	1.34	3.29	2.8	8.9
B-11	0.37	0.50	0.65	1.53	3.75	0.3	0.9
B-12	19.32	0.20	0.50	1.57	3.85	6.1	37.2
B-13	22.79	0.20	0.50	1.46	3.59	6.7	40.9
B-14	20.39	0.20	0.50	1.07	2.62	4.3	26.7
B-2	1.09	0.35	0.50	1.63	3.99	0.6	2.2
B-3	1.25	0.88	0.93	2.21	5.42	2.4	6.3
B-4	2.10	0.46	0.59	1.46	3.57	1.4	4.4
B-5	3.37	0.50	0.65	1.43	3.52	2.4	7.7
B-6	0.99	0.50	0.65	2.14	5.24	1.1	3.4
B-7	3.53	0.50	0.65	1.38	3.38	2.4	7.8
B-8	3.26	0.50	0.65	1.34	3.29	2.2	7.0
B-9	0.50	0.50	0.65	1.55	3.81	0.4	1.2
OFF-1	1.07	0.35	0.50	1.65	4.04	0.6	2.2
OFF-2	2.40	0.35	0.50	1.59	3.91	1.3	4.7
OFF-3	1.12	0.20	0.50	1.93	4.74	0.4	2.7
OFF-4	0.78	0.35	0.50	1.76	4.32	0.5	1.7
OFF-5	2.91	0.20	0.50	1.54	3.78	0.9	5.5
OFF-6	15.59	0.20	0.50	1.23	3.02	3.8	23.6



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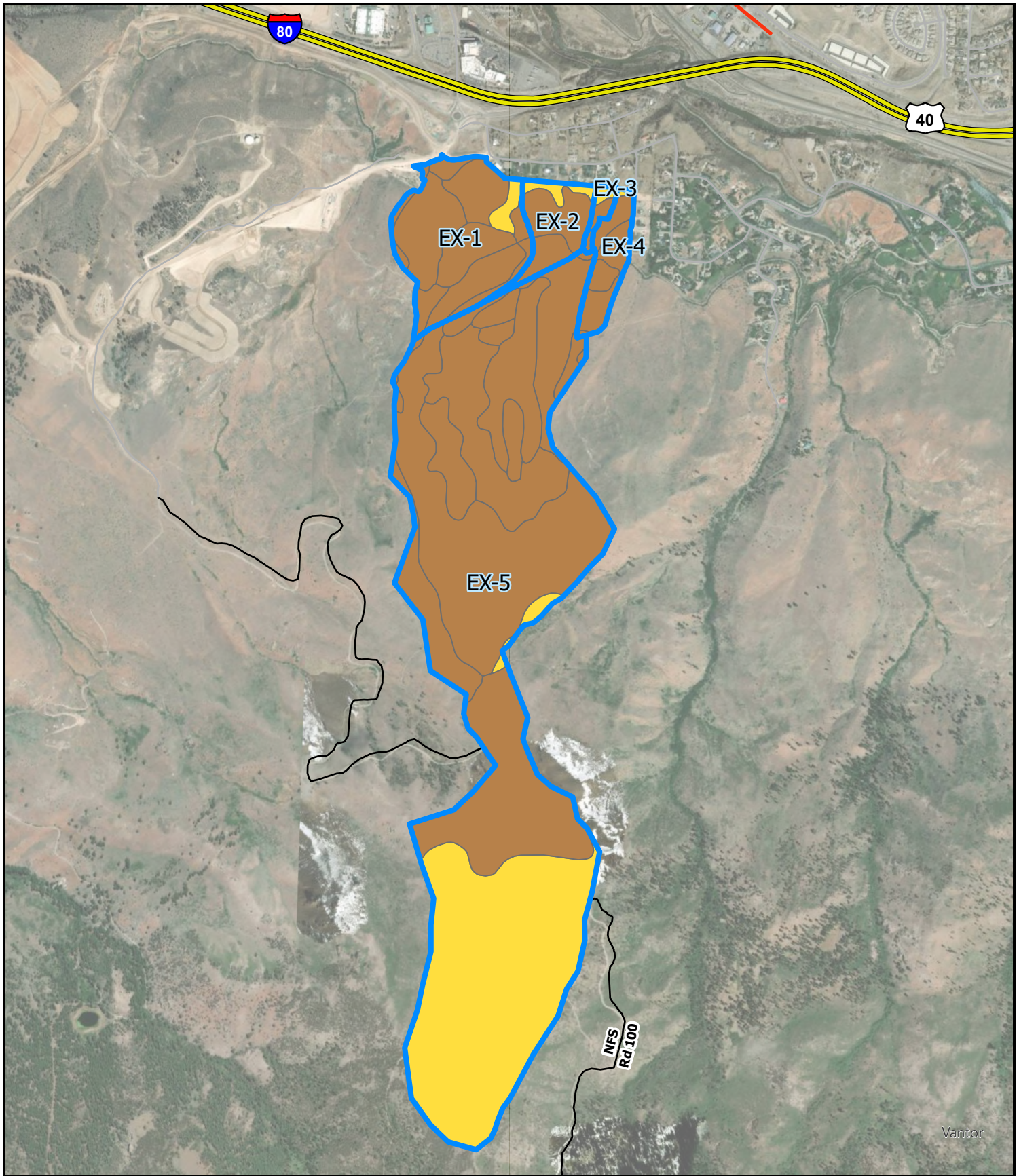
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FEET



NORTH

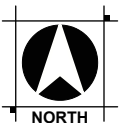
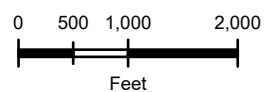


NRCS SOILS
MERIDIAN 120 SOUTH
VILLAGES 1 AND 2
RENO, NV
JUNE 2026

 Existing Hydro Basins

Hydro Group

-  C
-  D



Project: Meridian 120 South Villages 1 and 2

Project Location: Reno, NV



WOOD RODGERS

Existing Curve Numbers

Watershed EX-1			
Land Use	Soil Group	Area (ac.)	Curve Number
Herbaceous, Fair	C	3.75	81
Herbaceous, Fair	D	67.44	89
Total Area (ac.)		71.19	
Final Curve Number		88.6	
Watershed EX-2			
Land Use	Soil Group	Area (ac.)	Curve Number
Herbaceous, Fair	C	3.4	81
Herbaceous, Fair	D	18.75	89
Total Area (ac.)		22.15	
Final Curve Number		87.8	
Watershed EX-3			
Land Use	Soil Group	Area (ac.)	Curve Number
Herbaceous, Fair	C	1.26	81
Herbaceous, Fair	D	1.96	89
Residential 1 Acre	D	0.62	84
Total Area (ac.)		3.84	
Final Curve Number		85.6	
Watershed EX-4			
Land Use	Soil Group	Area (ac.)	Curve Number
Herbaceous, Fair	C	0.44	81
Herbaceous, Fair	D	12.38	89
Residential 1 Acre	D	4.85	84
Total Area (ac.)		17.67	
Final Curve Number		87.4	
Watershed EX-5			
Land Use	Soil Group	Area (ac.)	Curve Number
Herbaceous, Fair	C	0.71	81
Herbaceous, Fair	D	240.98	89
Brush, Good	C	153.54	65
Brush, Good	D	4.44	73
Brush, Fair	C	5	70
Brush, Fair	D	51.08	77
Meadow	C	2.22	71
Meadow	D	22.29	78
Total Area (ac.)		480.26	
Final Curve Number		79.1	

Project: Meridian 120 South Villages 1 and 2

Project Location: Reno, NV



WOOD RODGERS

Proposed Curve Numbers

Watershed P-1			
Land Use	Soil Group	Area (ac.)	Curve Number
Residential 1 Acre	C	4.1	79
Residential 1 Acre	D	4.42	84
Pavement	C	0.13	98
Pavement	D	0.69	98
Herbaceous, Fair	D	0.08	89
Total Area (ac.)	9.42		
Final Curve Number	83.1		
Watershed P-2			
Land Use	Soil Group	Area (ac.)	Curve Number
Residential 1 Acre	D	1.03	84
Pavement	D	0.03	98
Total Area (ac.)	1.06		
Final Curve Number	84.4		
Watershed P-3			
Land Use	Soil Group	Area (ac.)	Curve Number
Residential 1 Acre	C	1.33	79
Residential 1 Acre	D	2.95	84
Residential 1/4 Acre	C	2.28	83
Residential 1/4 Acre	D	15.85	87
Pavement	C	0.63	98
Pavement	D	4.75	98
Herbaceous, Fair	C	0.38	81
Herbaceous, Fair	D	9.39	89
Total Area (ac.)	37.56		
Final Curve Number	88.3		
Watershed P-4a			
Land Use	Soil Group	Area (ac.)	Curve Number
Herbaceous, Fair	D	36.59	89
Total Area (ac.)	36.59		
Final Curve Number	89		
Watershed P-4b			
Land Use	Soil Group	Area (ac.)	Curve Number
Herbaceous, Fair	D	14.02	89
Total Area (ac.)	14.02		
Final Curve Number	89		
Watershed P-5			
Land Use	Soil Group	Area (ac.)	Curve Number
Herbaceous, Fair	C	0.71	81
Herbaceous, Fair	D	240.98	89
Brush, Good	C	153.54	65
Brush, Good	D	4.44	73
Brush, Fair	C	5	70
Brush, Fair	D	51.08	77
Meadow	C	2.22	71
Meadow	D	22.29	78
Total Area (ac.)	480.26		
Final Curve Number	79.1		
Watershed P-6			
Land Use	Soil Group	Area (ac.)	Curve Number
Residential 1 Acre	D	5.91	84
Herbaceous, Fair	D	10.61	89
Total Area (ac.)	16.52		
Final Curve Number	87.2		

Project: Meridian 120 South Villages 1 and 2

Project Location: Reno, NV

Time of Concentration Table - SCS Method



Drainage Basin	Drainage Area (AC)	CN	Initial Flow Time, T _i				Travel Time, T _t				Total (T _i +T _t)	Urbanized Basins Check	Final	
			Overland Flow				Channelized Flow							
			L _i (ft)	S (ft/ft)	R	T _i (min)	L _t (ft)	S (ft/ft)	V (ft/s)	T _{t2} (min)	T _c (min)	T _c *(min)	T _c (min)	TLAG
EX-2	22.15	87.8	343	0.058	0.77	6.2	1672	0.076	4.4	6.3	12.4	21.2	12.4	7.5
EX-3	3.83	85.6	66	0.050	0.74	3.1	855	0.051	3.7	3.9	10.0	15.1	10.0	6.0
EX-4	17.66	87.4	207	0.048	0.76	5.2	1953	0.074	4.4	7.4	12.6	22.0	12.6	7.6
Basins over 1 mi ² or greater than 10% average slope are analyzed using TLAG = 22.1*Kn(L*Lc/S^0.5)^0.33														
	Drainage Area (AC)	CN	Kn	L	Lc	S (ft/mi)	TLAG (hours)	TLAG (min)						
EX-1	71.31	88.6	0.09	0.50	0.25	583.0	0.35	21.08						
EX-5	480.27	79.1	0.12	2.62	1.18	987.8	1.23	74.04						

Time of Concentration

Proposed Onsite Basins

Project: Meridian 120 South Villages 1 and 2

Project Location: Reno, NV

Time of Concentration Table - SCS Method



Drainage Basin	Drainage Area (AC)	CN/c	Initial Flow Time, T _i				Travel Time, T _t														Total (T _i +T _t)	Urbanized Basins Check	Final	
			Overland Flow				Gutter Flow				Channelized Flow				Piped Flow									
			L _i (ft)	S (ft/ft)	R	T _i (min)	L _s (ft)	S (ft/ft)	V(ft/s)	T _{t1} (min)	L _t (ft)	S (ft/ft)	V (ft/s)	T _{t2} (min)	L _t (ft)	n	Pipe ø	S (ft/ft)	V (ft/s)	T _{t3} (min)				
P-1	9.43	83	66	0.050	0.71	3.4	0	0.000	0.0	0.0	859	0.051	3.7	3.9	0	0.000	0	0.000	0.0	0.0	10.0	15.1	10.0	6.0
P-2	1.06	84	93	0.054	0.72	3.7	0	0.000	0.0	0.0	0	0.000	0.0	0.0	0	0.000	0	0.000	0.0	0.0	10.0	10.5	10.0	6.0
P-3	37.56	88	243	0.029	0.78	6.4	1346	0.013	2.4	9.5	0	0.000	0.0	0.0	527	0.013	36	0.042	4.5	2.0	17.9	21.8	17.9	10.7
P-6	16.51	87	207	0.048	0.76	5.2	0	0.000	0.0	0.0	1953	0	4.4	0.0	0	0.000	0	0.000	0.0	0.0	10.0	22.0	10.0	6.0
Basins over 1 mi ² or greater than 10% average slope are analyzed using TLAG = 22.1*Kn(L*Lc/S^0.5)^0.33																								
	Drainage Area (AC)	CN	Kn	L	Lc	S (ft/mi)	TLAG (hours)	TLAG (min)																
P-4a	36.59	89	0.09	0.27	0.08	875.0	0.19	11.17																
P-4b	14.02	89	0.09	0.19	0.07	2122.0	0.13	8.06																
P-5	478.96	79	0.12	2.62	1.18	987.8	1.23	74.04																

Project: Meridian 120 South Villages 1 and 2

Project Location: Reno, NV

Proposed Reach Time of Concentration Table - SCS Method



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Drainage Basin	Travel Time, T _t										Total (T _i +T _t)	Final	
	Channelized Flow				Piped Flow								
	L _t (ft)	S (ft/ft)	V (ft/s)	T _{t2} (min)	L _t (ft)	n	Pipe ø	S (ft/ft)	V (ft/s)	T _{t3} (min)	T _c (min)	T _c (min)	TLAG
Reach-1	228	0.133	5.9	0.6	831	0.013	36	0.019	4.0	3.5	4.1	4.1	2.5

Culvert Calculator Report

Culvert-1 10x4 Box Culvert (100-Year Flow)

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	4,929.27 ft	Headwater Depth/Height	1.25
Computed Headwater Elevation	4,928.28 ft	Discharge	278.67 cfs
Inlet Control HW Elev.	4,928.07 ft	Tailwater Elevation	4,926.92 ft
Outlet Control HW Elev.	4,928.28 ft	Control Type	Outlet Control
Grades			
Upstream Invert	4,923.27 ft	Downstream Invert	4,919.92 ft
Length	65.81 ft	Constructed Slope	0.0509 ft/ft
Hydraulic Profile			
Profile	CompositePressureProfileS1	Depth, Downstream	7.00 ft
Slope Type	N/A	Normal Depth	1.14 ft
Flow Regime	Subcritical	Critical Depth	2.89 ft
Velocity Downstream	6.97 ft/s	Critical Slope	0.0032 ft/ft
Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	10.00 ft
Section Size	10 x 4 ft	Rise	4.00 ft
Number Sections	1		
Outlet Control Properties			
Outlet Control HW Elev.	4,928.28 ft	Upstream Velocity Head	0.91 ft
Ke	0.50	Entrance Loss	0.45 ft
Inlet Control Properties			
Inlet Control HW Elev.	4,928.07 ft	Flow Control	Unsubmerged
Inlet Type	8/4 inch chamfers; 15° skewed headwall	Area Full	40.0 ft²
K	0.52200	HDS 5 Chart	11
M	0.66700	HDS 5 Scale	3
C	0.04020	Equation Form	2
Y	0.73000		

Culvert Calculator Report

Culvert-2 - One 15" RCP

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	4,922.58 ft	Headwater Depth/Height	1.00
Computed Headwater Elevation	4,922.58 ft	Discharge	3.59 cfs
Inlet Control HW Elev.	4,922.48 ft	Tailwater Elevation	4,920.07 ft
Outlet Control HW Elev.	4,922.58 ft	Control Type	Entrance Control
Grades			
Upstream Invert	4,921.33 ft	Downstream Invert	4,919.65 ft
Length	52.33 ft	Constructed Slope	0.0321 ft/ft
Hydraulic Profile			
Profile	S2	Depth, Downstream	0.45 ft
Slope Type	Steep	Normal Depth	0.44 ft
Flow Regime	Supercritical	Critical Depth	0.77 ft
Velocity Downstream	9.03 ft/s	Critical Slope	0.0046 ft/ft
Section			
Section Shape	Circular	Mannings Coefficient	0.011
Section Material	Concrete	Span	1.25 ft
Section Size	15 inch	Rise	1.25 ft
Number Sections	1		
Outlet Control Properties			
Outlet Control HW Elev.	4,922.58 ft	Upstream Velocity Head	0.32 ft
Ke	0.50	Entrance Loss	0.16 ft
Inlet Control Properties			
Inlet Control HW Elev.	4,922.48 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	1.2 ft ²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Cloudshadow Lane Cross Section

Project Description	
Friction Method	Manning
Solve For	Formula
	Discharge
Input Data	
Channel Slope	0.0074 ft/ft
Normal Depth	6.6 in

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	4,920.126
0+00.50	4,920.126
0+04.50	4,920.046
0+05.00	4,920.046
0+05.00	4,919.546
0+06.50	4,919.670
0+23.00	4,920.000
0+39.50	4,919.670
0+41.00	4,919.546
0+41.00	4,920.046
0+41.50	4,920.046
0+45.50	4,920.126
0+46.00	4,920.126

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00.00, 4,920.126)	(0+06.50, 4,919.670)	0.015
(0+06.50, 4,919.670)	(0+39.50, 4,919.670)	0.016
(0+39.50, 4,919.670)	(0+46.00, 4,920.126)	0.015

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Discharge	31.37 cfs
Roughness Coefficient	0.016
Elevation Range	4,919.546 to 4,920.126 ft
Flow Area	10.1 ft ²
Wetted Perimeter	42.688 ft
Hydraulic Radius	2.8 in

Cloudshadow Lane Cross Section

Results

Top Width	41.67 ft
Normal Depth	6.6 in
Critical Depth	6.8 in
Critical Slope	0.0059 ft/ft
Velocity	3.10 ft/s
Velocity Head	0.150 ft
Specific Energy	0.70 ft
Froude Number	1.110
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.000 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	6.6 in
Critical Depth	6.8 in
Channel Slope	0.0074 ft/ft
Critical Slope	0.0059 ft/ft

Channel-1 Capacity

Project Description	
Friction Method	Manning
Solve For	Formula Discharge
Input Data	
Roughness Coefficient	0.040
Channel Slope	0.0540 ft/ft
Normal Depth	40.0 in
Left Side Slope	3.000 H:V
Right Side Slope	3.000 H:V
Results	
Discharge	390.53 cfs
Flow Area	33.3 ft ²
Wetted Perimeter	21.1 ft
Hydraulic Radius	19.0 in
Top Width	20.00 ft
Critical Depth	48.3 in
Critical Slope	0.0198 ft/ft
Velocity	11.72 ft/s
Velocity Head	2.13 ft
Specific Energy	5.47 ft
Froude Number	1.600
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	40.0 in
Critical Depth	48.3 in
Channel Slope	0.0540 ft/ft
Critical Slope	0.0198 ft/ft

Channel-1 Peak Flow

Project Description	
Friction Method	Manning
Solve For	Formula
	Normal Depth
Input Data	
Roughness Coefficient	0.040
Channel Slope	0.0540 ft/ft
Left Side Slope	3.000 H:V
Right Side Slope	3.000 H:V
Discharge	98.21 cfs
Results	
Normal Depth	23.8 in
Flow Area	11.8 ft ²
Wetted Perimeter	12.6 ft
Hydraulic Radius	11.3 in
Top Width	11.92 ft
Critical Depth	27.8 in
Critical Slope	0.0238 ft/ft
Velocity	8.30 ft/s
Velocity Head	1.07 ft
Specific Energy	3.06 ft
Froude Number	1.468
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	23.8 in
Critical Depth	27.8 in
Channel Slope	0.0540 ft/ft
Critical Slope	0.0238 ft/ft

Cut-Off Channel 12 Capacity

Project Description	
Friction Method	Manning
	Formula
Solve For	Discharge
Input Data	
Roughness Coefficient	0.040
Channel Slope	0.0385 ft/ft
Normal Depth	36.0 in
Left Side Slope	2.500 H:V
Right Side Slope	2.500 H:V
Results	
Discharge	204.43 cfs
Flow Area	22.5 ft ²
Wetted Perimeter	16.2 ft
Hydraulic Radius	16.7 in
Top Width	15.00 ft
Critical Depth	40.1 in
Critical Slope	0.0217 ft/ft
Velocity	9.09 ft/s
Velocity Head	1.28 ft
Specific Energy	4.28 ft
Froude Number	1.308
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	36.0 in
Critical Depth	40.1 in
Channel Slope	0.0385 ft/ft
Critical Slope	0.0217 ft/ft

Cut-Off 12 Peak Flow

Project Description	
Friction Method	Manning
Solve For	Formula
	Normal Depth
Input Data	
Roughness Coefficient	0.040
Channel Slope	0.0385 ft/ft
Left Side Slope	2.500 H:V
Right Side Slope	2.500 H:V
Discharge	37.20 cfs
Results	
Normal Depth	19.0 in
Flow Area	6.3 ft ²
Wetted Perimeter	8.5 ft
Hydraulic Radius	8.8 in
Top Width	7.92 ft
Critical Depth	20.3 in
Critical Slope	0.0272 ft/ft
Velocity	5.93 ft/s
Velocity Head	0.55 ft
Specific Energy	2.13 ft
Froude Number	1.176
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	19.0 in
Critical Depth	20.3 in
Channel Slope	0.0385 ft/ft
Critical Slope	0.0272 ft/ft

Cut-Off Channel 13 Capacity

Project Description	
Friction Method	Manning
	Formula
Solve For	Discharge
Input Data	
Roughness Coefficient	0.040
Channel Slope	0.0154 ft/ft
Normal Depth	36.0 in
Left Side Slope	2.500 H:V
Right Side Slope	2.500 H:V
Results	
Discharge	129.44 cfs
Flow Area	22.5 ft ²
Wetted Perimeter	16.2 ft
Hydraulic Radius	16.7 in
Top Width	15.00 ft
Critical Depth	33.4 in
Critical Slope	0.0231 ft/ft
Velocity	5.75 ft/s
Velocity Head	0.51 ft
Specific Energy	3.51 ft
Froude Number	0.828
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	36.0 in
Critical Depth	33.4 in
Channel Slope	0.0154 ft/ft
Critical Slope	0.0231 ft/ft

Cut-Off Channel 13 Peak Flow

Project Description	
Friction Method	Manning
Solve For	Formula
	Normal Depth
Input Data	
Roughness Coefficient	0.040
Channel Slope	0.0154 ft/ft
Left Side Slope	2.500 H:V
Right Side Slope	2.500 H:V
Discharge	40.90 cfs
Results	
Normal Depth	23.4 in
Flow Area	9.5 ft ²
Wetted Perimeter	10.5 ft
Hydraulic Radius	10.9 in
Top Width	9.74 ft
Critical Depth	21.1 in
Critical Slope	0.0269 ft/ft
Velocity	4.31 ft/s
Velocity Head	0.29 ft
Specific Energy	2.24 ft
Froude Number	0.770
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	23.4 in
Critical Depth	21.1 in
Channel Slope	0.0154 ft/ft
Critical Slope	0.0269 ft/ft

Cut-Off Channel 14 Capacity

Project Description	
Friction Method	Manning
	Formula
Solve For	Discharge
Input Data	
Roughness Coefficient	0.040
Channel Slope	0.0220 ft/ft
Normal Depth	36.0 in
Left Side Slope	2.500 H:V
Right Side Slope	2.500 H:V
Results	
Discharge	154.57 cfs
Flow Area	22.5 ft ²
Wetted Perimeter	16.2 ft
Hydraulic Radius	16.7 in
Top Width	15.00 ft
Critical Depth	35.8 in
Critical Slope	0.0225 ft/ft
Velocity	6.87 ft/s
Velocity Head	0.73 ft
Specific Energy	3.73 ft
Froude Number	0.989
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	36.0 in
Critical Depth	35.8 in
Channel Slope	0.0220 ft/ft
Critical Slope	0.0225 ft/ft

Cut-Off Channel 14 Peak Flow

Project Description	
Friction Method	Manning
Solve For	Formula
	Normal Depth
Input Data	
Roughness Coefficient	0.040
Channel Slope	0.0220 ft/ft
Left Side Slope	2.500 H:V
Right Side Slope	2.500 H:V
Discharge	26.70 cfs
Results	
Normal Depth	18.6 in
Flow Area	6.0 ft ²
Wetted Perimeter	8.4 ft
Hydraulic Radius	8.7 in
Top Width	7.77 ft
Critical Depth	17.8 in
Critical Slope	0.0285 ft/ft
Velocity	4.43 ft/s
Velocity Head	0.30 ft
Specific Energy	1.86 ft
Froude Number	0.886
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	18.6 in
Critical Depth	17.8 in
Channel Slope	0.0220 ft/ft
Critical Slope	0.0285 ft/ft

Emergency Access Channel Capacity

Project Description	
Friction Method	Manning
Solve For	Formula Discharge
Input Data	
Roughness Coefficient	0.025
Channel Slope	0.0400 ft/ft
Normal Depth	8.0 in
Left Side Slope	1.500 H:V
Right Side Slope	1.500 H:V
Results	
Discharge	3.37 cfs
Flow Area	0.7 ft ²
Wetted Perimeter	2.4 ft
Hydraulic Radius	3.3 in
Top Width	2.00 ft
Critical Depth	9.5 in
Critical Slope	0.0158 ft/ft
Velocity	5.06 ft/s
Velocity Head	0.40 ft
Specific Energy	1.06 ft
Froude Number	1.544
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	8.0 in
Critical Depth	9.5 in
Channel Slope	0.0400 ft/ft
Critical Slope	0.0158 ft/ft

Steamboat Ditch - 8 Foot Top Width

Project Description	
Friction Method	Manning
Solve For	Formula Discharge
Input Data	
Roughness Coefficient	0.022
Channel Slope	0.0015 ft/ft
Normal Depth	36.0 in
Left Side Slope	0.3333 H:V
Right Side Slope	0.3333 H:V
Bottom Width	6.00 ft
Results	
Discharge	78.76 cfs
Flow Area	21.0 ft ²
Wetted Perimeter	12.324 ft
Hydraulic Radius	20.4 in
Top Width	8.00 ft
Critical Depth	20.3 in
Critical Slope	0.0090 ft/ft
Velocity	3.75 ft/s
Velocity Head	0.219 ft
Specific Energy	3.22 ft
Froude Number	0.408
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.000 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	(N/A) ft/s
Upstream Velocity	(N/A) ft/s
Normal Depth	36.0 in
Critical Depth	20.3 in
Channel Slope	0.0015 ft/ft
Critical Slope	0.0090 ft/ft

Steamboat Ditch Capacity - 12 Foot Top Width

Project Description	
Friction Method	Manning
Solve For	Formula Discharge
Input Data	
Roughness Coefficient	0.022
Channel Slope	0.0015 ft/ft
Normal Depth	36.0 in
Left Side Slope	1.000 H:V
Right Side Slope	1.000 H:V
Bottom Width	6.00 ft
Results	
Discharge	106.97 cfs
Flow Area	27.0 ft ²
Wetted Perimeter	14.5 ft
Hydraulic Radius	22.4 in
Top Width	12.00 ft
Critical Depth	23.0 in
Critical Slope	0.0075 ft/ft
Velocity	3.96 ft/s
Velocity Head	0.24 ft
Specific Energy	3.24 ft
Froude Number	0.466
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	36.0 in
Critical Depth	23.0 in
Channel Slope	0.0015 ft/ft
Critical Slope	0.0075 ft/ft

APPENDIX B

5-YEAR STORM

Project: Meridian 120 South Villages 1 and 2

Project Location: Reno, NV

Time of Concentration Table, 5-year

Drainage Basin	Drainage Area (AC)	Weighted Average C-Factor 5-Year	Overland			Channelized Flow				Total (Ti+Tt)	Urbanized Basins Check	Final	NOAA ATLAS 14 Rainfall Intensity	Rational Flow
			Li (ft)	S (ft/ft)	Ti (min)	Ls(ft)	S (ft/ft)	V(ft/s)	Tt1 (min)	Tc (min)	Tc*(min)	Tc (min)	(in/hour)	Q5-year (cfs)
EX-1	71.34	0.20	149.3	0.134	8.4	2506.1	0.109	5.3	7.9	16.3	24.8	16.3	1.35	19.3
EX-2	22.24	0.20	343.3	0.058	16.8	1671.6	0.076	4.4	6.3	23.0	21.2	21.2	1.20	5.3
EX-3	3.83	0.20	85.0	0.038	9.6	853.9	0.051	3.7	3.9	13.5	15.2	13.5	1.48	1.1
EX-4	17.67	0.20	207.4	0.048	13.9	1952.6	0.074	4.4	7.4	21.3	22.0	21.3	1.20	4.2

Project: Meridian 120 South Villages 1 and 2

Project Location: Reno, NV

Time of Concentration Table, 5-year

Drainage Basin	Drainage Area (AC)	Weighted Average C-Factor 5-Year	Overland			Channelized Flow				Gutter Flow				Total (Ti+Tt)	Urbanized Basins Check	Final	NOAA ATLAS 14 Rainfall Intensity	Rational Flow
			Li (ft)	S (ft/ft)	Ti (min)	Ls(ft)	S (ft/ft)	V(ft/s)	Tt1 (min)	Lt (ft)	S (ft/ft)	V (ft/s)	Tt2 (min)	Tc (min)	Tc*(min)	Tc (min)	(in/hour)	Q5-year (cfs)
A-1	2.92	0.40	127.4	0.010	14.2					657.0	0.010	2.0	5.4	19.5	14.4	14.4	1.43	1.7
B-1	5.04	0.54	106.6	0.010	10.4					869.7	0.026	3.3	4.4	14.8	15.4	14.8	1.40	3.8
B-10	4.18	0.50	111.3	0.011	11.0					1091.9	0.018	2.7	6.6	17.6	16.7	16.7	1.34	2.8
B-11	0.37	0.50	152.6	0.010	13.3					319.8	0.038	4.0	1.3	14.7	12.6	12.6	1.53	0.3
B-12	19.32	0.20	178.1	0.162	8.6	1301.0	0.168	6.6	3.3					11.9	18.2	11.9	1.57	6.1
B-13	22.79	0.20	175.5	0.114	9.6	1583.6	0.158	6.4	4.1					13.7	19.8	13.7	1.46	6.7
B-14	20.39	0.20	229.4	0.013	22.7	2599.1	0.077	4.5	9.7					32.3	25.7	25.7	1.07	4.3
B-2	1.09	0.35	33.3	0.022	6.0					505.3	0.007	1.7	4.9	10.9	13.0	10.9	1.63	0.6
B-3	1.25	0.88	100.2	0.014	3.6									3.6	10.6	5.0	2.21	2.4
B-4	2.10	0.46	116.5	0.070	6.6					967.9	0.012	2.2	7.3	13.9	16.0	13.9	1.46	1.4
B-5	3.37	0.50	107.1	0.012	10.6					766.0	0.029	3.5	3.7	14.2	14.9	14.2	1.43	2.4
B-6	0.99	0.50	32.9	0.051	3.6					233.6	0.008	1.9	2.1	5.7	11.5	5.7	2.14	1.1
B-7	3.53	0.50	141.2	0.018	10.6					829.5	0.012	2.2	6.2	16.8	15.4	15.4	1.38	2.4
B-8	3.26	0.50	124.7	0.010	12.1					1074.2	0.019	2.8	6.4	18.5	16.7	16.7	1.34	2.2
B-9	0.50	0.50	129.9	0.012	11.6					264.7	0.041	4.1	1.1	12.7	12.2	12.2	1.55	0.4
OFF-1	1.07	0.35	99.6	0.010	13.5									13.5	10.6	10.6	1.65	0.6
OFF-2	2.40	0.35	267.5	0.026	16.1									16.1	11.5	11.5	1.59	1.3
OFF-3	1.12	0.20	63.4	0.077	6.6	213.4	0.046	3.4	1.0					7.6	11.5	7.6	1.93	0.4
OFF-4	0.78	0.35	101.2	0.032	9.2									9.2	10.6	9.2	1.76	0.5
OFF-5	2.91	0.20	85.0	0.038	9.6	597.9	0.049	3.6	2.8					12.4	13.8	12.4	1.54	0.9
OFF-6	15.59	0.20	207.4	0.048	13.9	1733.7	0.079	4.5	6.4					20.2	20.8	20.2	1.23	3.8

Project: Meridian 120 South Villages 1 and 2
Street Spread Analysis, 5-year Storm

6/22/2026

METHODOLOGY

TYPE 4R DROP INLET CALCULATIONS (NEENAH GRATE 3067-LL)

ON GRADE(Example)

Q100= 4.50 Clogging Factor = 1.0
 Slope= On Grade

Qcap=E*Q100*Clogging Factor

*E= 68%

Qcap=3.06 cfs

Qcapacity = 3.06cfs

IN SUMP (Example)

Q100= 6.07 Clogging Factor = 1.0
 Slope= Sump Condition

Shallow flow condition-check weir and orifice

weir perimeter-5.8 ft-(3 sides)

orifice free open area=2.1 ft2

weir calculations- $Q=CLH^{3/2} * \text{Clogging Factor}$

Qcap=6.83cfs

where C=3.33, L=weir perimeter, H=head(ft.), solve for Q

C= 3.33

L= 5.8 ft

*H= 0.50 ft

orifice calculations- $Q=C(A)(2*g*H)^{1/2} * \text{Clogging Factor}$

Qcap=7.15cfs

where C=0.6, A=open area, H=head(ft.), solve for Q

C= 0.6

A= 2.1 ft2

*H= 0.50 ft

g= 32.2 ft/s2

Qcapacity = 6.83cfs

*E calculated using HEC-22 Urban Drainage Design Manual

*H taken from curb design

5-YR DESIGN FLOW Catch Basins

CB#	Sump	Qbase	Qexcess	Qnet	Sump Depth	Slope (%)	# CB'S	On-Grade Efficiency	Qcap(on grade)	Qcap(sump)	Qcapacity	Qaccepted	Bypass Flow	Bypass To	REMARKS
A-1	Y	1.68	0.00	1.68	0.50	1.91	1			6.83	6.83	1.68	0.00	OFF	
B-1	Y	3.79	0.00	3.79	0.50	1.00	2			6.83	13.66	3.79	0.00	B-6	
B-2	N	0.62	0.00	0.62		0.74	1	0.83	0.52	0.52	0.52	0.10	0.10	B-4	0.1cfs to B-4
B-3	Y	2.43	0.00	2.43	0.50	4.40	1			6.83	6.83	2.43	0.00	OFF	
B-4	Y	1.40	0.10	1.50	0.50	0.74	1			6.83	6.83	1.50	0.00	OFF	
B-5	Y	2.42	0.00	2.42	0.50	0.60	2			6.83	13.66	2.42	0.00	B-10	
B-6	Y	1.05	0.00	1.05	0.50	1.00	1			6.83	6.83	1.05	0.00	B-7	
B-7	Y	2.43	0.00	2.43	0.50	0.74	2			6.83	13.66	2.43	0.00	B-7	
B-8	Y	2.18	0.00	2.18	0.50	0.60	2			6.83	13.66	2.18	0.00	B-6	
B-9	Y	0.39	0.00	0.39	0.50	4.40	1			6.83	6.83	0.39	0.00	B-11	
B-10	Y	2.80	0.00	2.80	0.50	0.60	2			6.83	13.66	2.80	0.00	B-8	
B-11	Y	0.29	0.00	0.29	0.50	4.40	1			6.83	6.83	0.29	0.00	OFF	

Project: Meridian 120 South Villages 1 and 2

Street Spread Analysis, 5-year Storm

6/22/2026

METHODOLOGY

CONVENTIONAL CURB AND GUTTER CALCULATIONS

Manning's Equation:

$$T = [(Qn) / (Ku * Sx^{1.67} * SI^{0.5})]^{0.375}$$

Where:

T = Width of flow (spread) (ft)

Q = Flow Rate (cfs)

n = Manning's Coefficient (unitless)

Ku = 0.56

Sx = Cross Slope (ft/ft)

SI = Longitudinal slope (ft/ft)

5-YR DESIGN FLOW Catch Basins

CB#	Sump	Qnet	Slope (%)	Type of Street	Allowable Spread (ft)	Street Spread (ft)	Pass or Fail	REMARKS
A-1	Y	1.68	1.91	Local	12.00	6.96		
B-1	Y	3.79	1.00	Local	12.00	11.34		
B-2	N	0.62	0.74	Local	12.00	5.35		
B-3	Y	2.43	4.40	Local	12.00	6.79		
B-4	Y	1.50	0.74	Local	12.00	8.20		
B-5	Y	2.42	0.60	Local	12.00	10.48		
B-6	Y	1.05	1.00	Local	12.00	6.48		
B-7	Y	2.43	0.74	Local	12.00	10.04		
B-8	Y	2.18	0.60	Local	12.00	10.01		
B-9	Y	0.39	4.40	Local	12.00	2.23		
B-10	Y	2.80	0.60	Local	12.00	11.12		
B-11	Y	0.29	4.40	Local	12.00	2.23		

Scenario: 5-YEAR
Current Time Step: 0.000 h
FlexTable: Catchment Table

ID	Label	Outflow Element	Area (User Defined) (acres)	Runoff Coefficient (Rational)	Time of Concentration (min)	Flow (Total Out) (cfs)	Notes
164	A-1	A-1	3.464	0.403	14.358	2.02	-
157	B-1	B-1	5.039	0.538	15.132	3.81	-
159	B-2	B-2	1.093	0.350	10.904	0.63	-
171	B-3	MAIN POND IN	1.252	0.880	5.000	2.46	-
161	B-4	B-4	2.102	0.456	13.858	1.42	-
154	B-5	B-5	3.371	0.500	14.240	2.45	-
158	B-6	B-6	0.987	0.500	5.705	1.07	-
160	B-7	B-7	3.528	0.500	15.393	2.47	-
156	B-8	B-8	3.258	0.500	16.661	2.22	-
162	B-9	B-9	0.500	0.500	12.192	0.39	-
155	B-10	B-10	4.179	0.500	16.684	2.84	-
163	B-11	B-11	0.375	0.500	12.624	0.29	-
152	B-12	B-12	19.317	0.200	11.896	6.15	-
153	B-13	B-13	22.787	0.200	13.735	6.77	-
151	B-14	B-14	20.392	0.200	25.714	4.40	-
191	OFF-6	002-D	15.586	0.200	20.242	3.89	-
207	P-5	002-C	478.957	0.600	118.900	109.44	-

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Scenario: 5-YEAR
Current Time Step: 0.000 h
FlexTable: Conduit Table

Label	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Length (Scaled) (ft)	Manning's n	Capacity (Full Flow) (cfs)	Elevation Ground (Start) (ft)	Elevation Crown (Start) (ft)	Hydraulic Grade Line (In) (ft)	Energy Grade Line (In) (ft)
001-A - POND IN	001-A	MAIN POND IN	4,914.10	4,914.01	0.003	48.0	35.3	0.013	72.53	4,919.32	4,918.10	4,915.65	4,916.09
001-B - 001-A	001-B	001-A	4,917.22	4,914.20	0.008	15.0	400.0	0.013	5.61	4,921.72	4,918.47	4,917.52	4,917.63
002-A - 001-A	002-A	001-A	4,914.36	4,914.20	0.002	42.0	65.5	0.013	50.30	4,919.51	4,917.86	4,915.95	4,916.36
002-B - 001-B	002-B	001-B	4,920.30	4,917.32	0.007	15.0	400.0	0.013	5.58	4,929.02	4,921.55	4,920.62	4,920.73
003-A - 002-A	003-A	002-A	4,914.78	4,914.46	0.002	42.0	126.3	0.013	50.30	4,920.31	4,918.28	4,916.40	4,916.80
003-B - 002-B	003-B	002-B	4,922.38	4,920.40	0.017	15.0	112.9	0.013	8.54	4,931.12	4,923.63	4,922.70	4,922.81
004-A - 003-A	004-A	003-A	4,915.03	4,914.88	0.002	42.0	58.6	0.013	50.30	4,919.97	4,918.53	4,916.62	4,917.03
004-B - 003-B	004-B	003-B	4,923.37	4,922.48	0.018	15.0	51.0	0.013	8.55	4,930.78	4,924.62	4,923.69	4,923.81
005-A - 004-A	005-A	004-A	4,915.72	4,915.13	0.002	42.0	239.0	0.013	50.16	4,921.92	4,919.22	4,917.22	4,917.58
006-A - 005-A	006-A	005-A	4,915.97	4,915.82	0.002	42.0	62.1	0.013	49.88	4,922.21	4,919.47	4,917.33	4,917.63
007-A - 006-A	007-A	006-A	4,918.27	4,916.07	0.023	36.0	97.5	0.013	100.06	4,926.47	4,921.27	4,919.44	4,919.87
B-1 - 004-A	B-1	004-A	4,917.24	4,915.13	0.071	12.0	31.5	0.013	9.51	4,920.24	4,918.24	4,918.07	4,918.54
B-2 - 003-A	B-2	003-A	4,918.43	4,917.53	0.179	12.0	7.0	0.013	15.09	4,922.43	4,919.43	4,918.71	4,918.81
B-4 - POND IN	B-4	B-4 POND IN	4,916.44	4,915.91	0.019	12.0	28.4	0.013	4.87	4,919.44	4,917.44	4,916.97	4,917.18
B-5 - 001-E	A-1	001-E	4,920.40	4,919.41	0.022	12.0	44.4	0.013	5.32	4,923.73	4,921.40	4,921.01	4,921.26
B-5 - 006-A	B-5	006-A	4,919.45	4,916.07	0.114	12.0	31.5	0.013	12.02	4,924.47	4,920.45	4,920.12	4,920.42
B-6 - 004-A	B-6	004-A	4,917.22	4,916.93	0.083	10.0	5.5	0.013	6.31	4,920.22	4,918.05	4,917.68	4,917.87
B-7 - 001-A	B-7	001-A	4,916.44	4,914.20	0.058	12.0	40.2	0.013	8.57	4,919.44	4,917.44	4,917.11	4,917.41
B-8 - 005-A	B-8	005-A	4,919.05	4,917.72	0.032	12.0	43.6	0.013	6.33	4,922.05	4,920.05	4,919.69	4,919.96
B-09 - 004-B	B-9	004-B	4,925.78	4,923.47	0.173	12.0	14.5	0.013	14.83	4,930.78	4,926.78	4,926.04	4,926.13
B-10 - 005-A	B-10	005-A	4,919.05	4,915.82	0.058	12.0	57.7	0.013	8.56	4,922.05	4,920.05	4,919.77	4,920.11
B-11 - 004-B	B-11	004-B	4,925.78	4,923.47	0.087	12.0	28.3	0.013	10.51	4,930.78	4,926.78	4,926.00	4,926.08
B-12 - 007-A	B-12	007-A	4,919.91	4,918.36	0.031	24.0	49.3	0.013	40.10	4,922.91	4,921.91	4,920.79	4,921.12
B-13 - 007-A	B-13	007-A	4,926.89	4,918.37	0.047	30.0	181.2	0.013	88.90	4,929.76	4,929.39	4,927.75	4,928.07
B-14 - 007-A	B-14	007-A	4,920.20	4,918.36	0.078	24.0	23.4	0.013	63.37	4,923.20	4,922.20	4,920.94	4,921.21
CULVERT-1	002-C	001-C	4,923.28	4,920.70	0.046	-	55.8	0.013	665.72	4,928.36	4,927.28	4,925.46	4,926.55
CULVERT-2	002-D	001-D	4,922.17	4,920.62	0.029	15.0	52.6	0.013	11.08	4,923.67	4,923.42	4,922.92	4,923.22

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Scenario: 5-YEAR
Current Time Step: 0.000 h
FlexTable: Catch Basin Table

Label	Flow (Captured) (cfs)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Total Bypassed) (cfs)	Flow (Known) (cfs)	Inlet Location
002-C	109.44	4,928.36	4,923.28	0.00	0.00	In Sag
002-D	3.89	4,923.67	4,922.17	0.00	0.00	In Sag
A-1	2.02	4,923.73	4,920.40	0.00	0.00	In Sag
B-1	3.81	4,920.24	4,917.24	0.00	0.00	In Sag
B-2	0.46	4,922.43	4,917.72	0.17	0.00	On Grade
B-4	1.57	4,919.44	4,916.44	0.00	0.00	In Sag
B-5	2.45	4,924.47	4,919.45	0.00	0.00	In Sag
B-6	1.07	4,920.22	4,917.22	0.00	0.00	In Sag
B-7	2.47	4,919.44	4,916.44	0.00	0.00	In Sag
B-8	2.22	4,922.05	4,919.05	0.00	0.00	In Sag
B-9	0.39	4,930.78	4,925.78	0.00	0.00	In Sag
B-10	2.84	4,922.05	4,919.05	0.00	0.00	In Sag
B-11	0.29	4,930.78	4,925.78	0.00	0.00	In Sag
B-12	6.15	4,922.91	4,919.91	0.00	0.00	In Sag
B-13	6.77	4,929.76	4,926.89	0.00	0.00	In Sag
B-14	4.40	4,923.20	4,920.20	0.00	0.00	In Sag

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Scenario: 5-YEAR
Current Time Step: 0.000 h
FlexTable: Manhole Table

Label	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Hydraulic Grade Line (Out) (ft)	Depth (Out) (ft)	Flow (Total Out) (cfs)	Elevation (Ground) (ft)
001-A	4,919.32	4,914.10	4,917.81	3.71	23.96	4,919.32
001-B	4,921.72	4,917.22	4,917.84	0.62	0.61	4,921.72
002-A	4,919.51	4,914.36	4,917.84	3.47	21.87	4,919.51
002-B	4,929.02	4,920.30	4,920.62	0.32	0.66	4,929.02
003-A	4,920.31	4,914.78	4,917.88	3.10	22.15	4,920.31
003-B	4,931.12	4,922.38	4,922.70	0.32	0.67	4,931.12
004-A	4,919.97	4,915.03	4,917.90	2.88	21.98	4,919.97
004-B	4,930.78	4,923.37	4,923.69	0.32	0.68	4,930.78
005-A	4,921.92	4,915.72	4,917.97	2.25	19.10	4,921.92
006-A	4,922.21	4,915.97	4,917.99	2.02	15.23	4,922.21
007-A	4,926.47	4,918.27	4,919.44	1.17	13.49	4,926.47

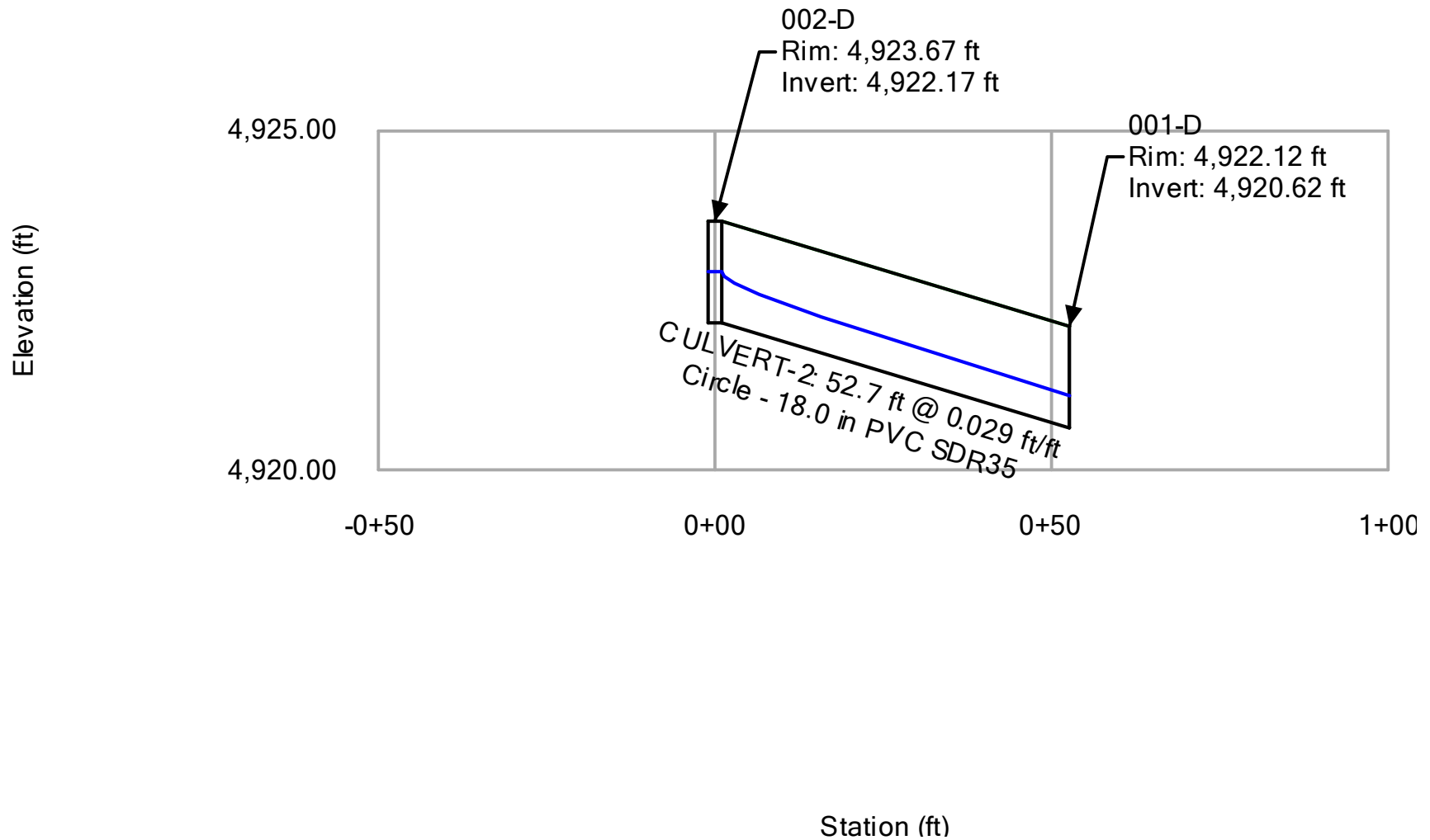
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Scenario: 5-YEAR
Current Time Step: 0.000 h
FlexTable: Outfall Table

ID	Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)	Notes
100	001-C	4,925.78	4,920.70	Free Outfall	-	4,921.86	109.39	105 x 6 x 48 inch Concrete Rectangular Headwall VH
109	001-D	4,922.12	4,920.62	Free Outfall	-	4,921.10	3.88	12 inch RCP FES
121	MAIN POND IN	4,918.51	4,914.01	User Defined Tailwater	4,915.30	4,915.46	23.88	48" RCP FES
122	B-4 POND IN	4,916.94	4,915.91	User Defined Tailwater	4,915.30	4,916.30	1.57	12" RCP FES
123	001-E	4,920.66	4,919.41	Free Outfall	-	4,919.84	2.01	18" RCP FES

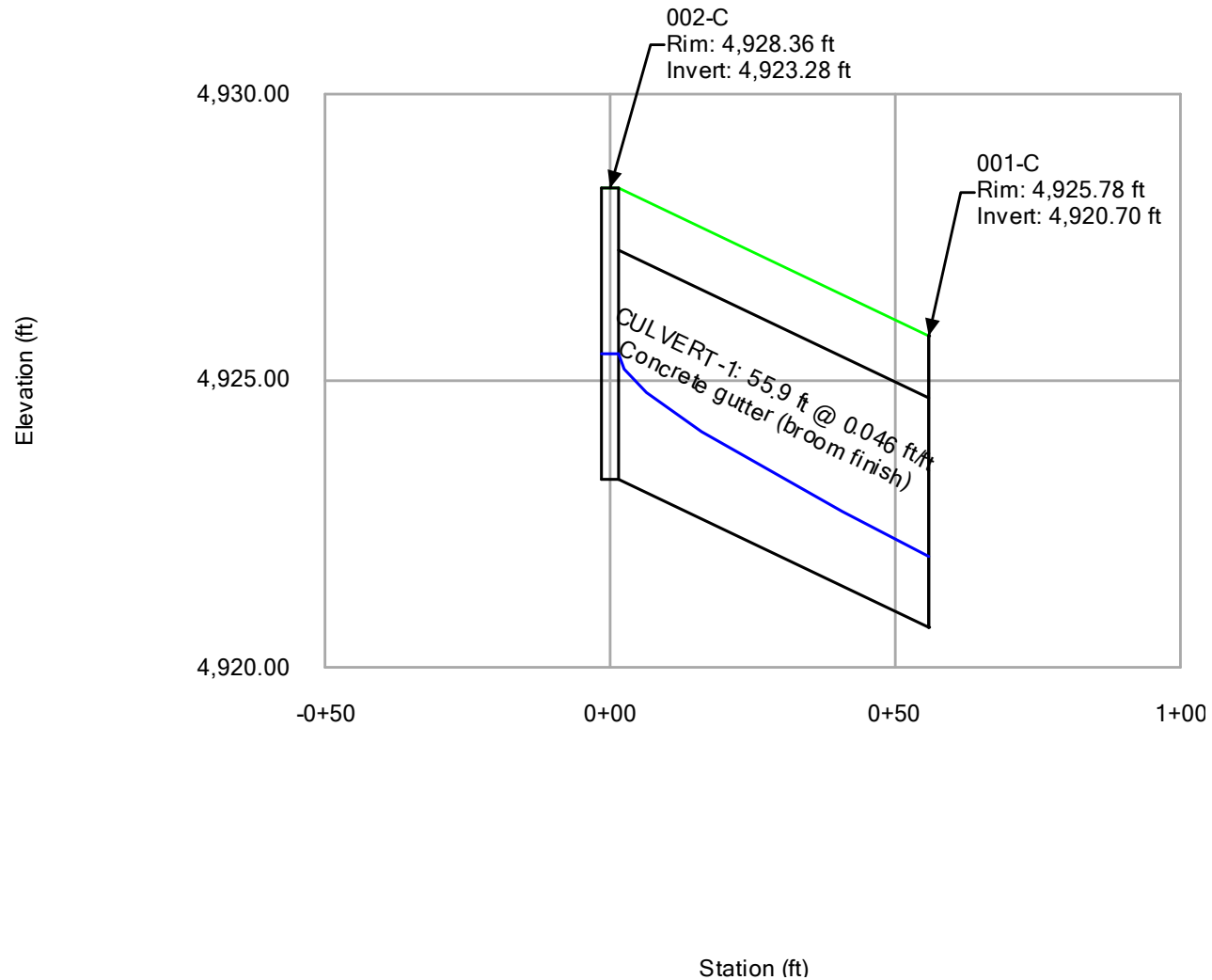
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Profile Report
Engineering Profile - A1 002-D - 001-D (M120S_V1&2.stsw)



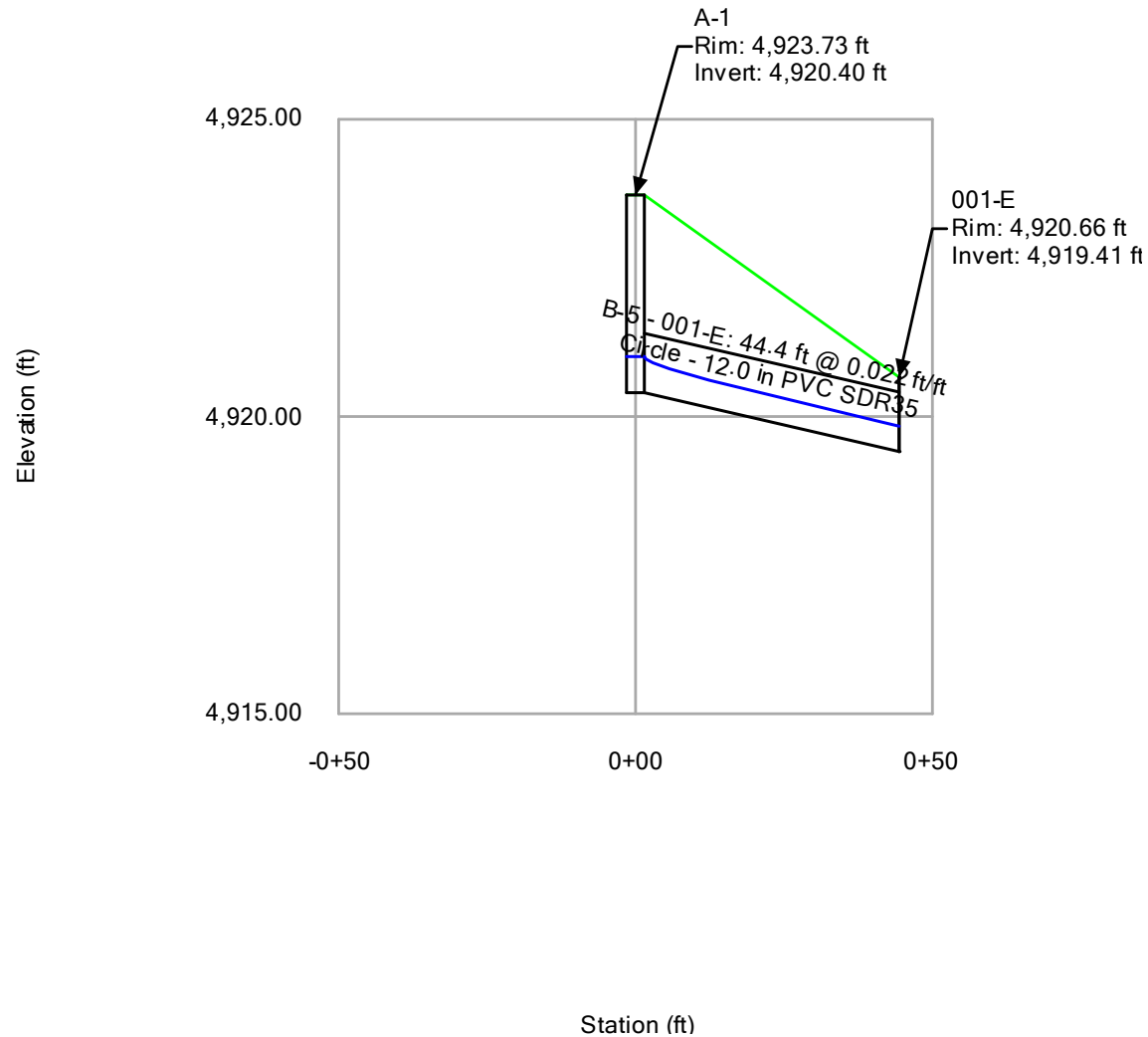
Profile Report

Engineering Profile - A2 P-5 - Culvert-1 (M120S_V1&2.stsw)

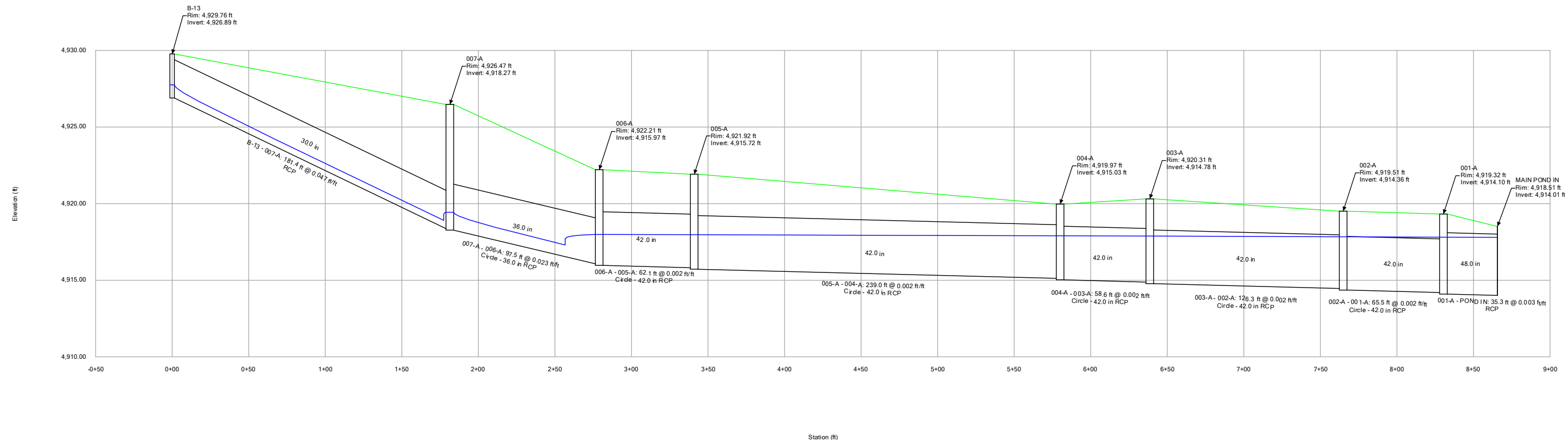


Profile Report

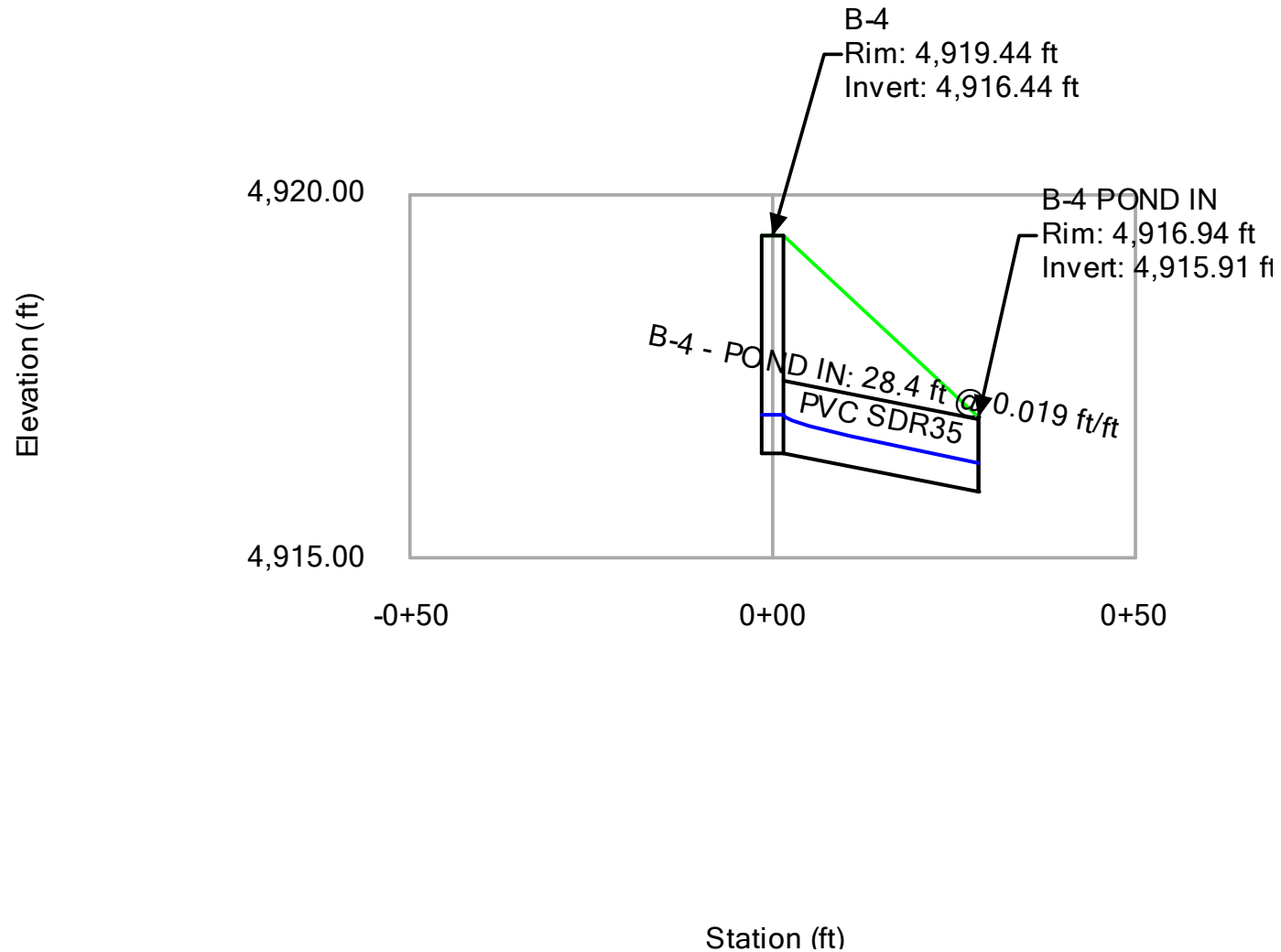
Engineering Profile - A3 A-1 - 001-E (M120S_V1&2.stsw)



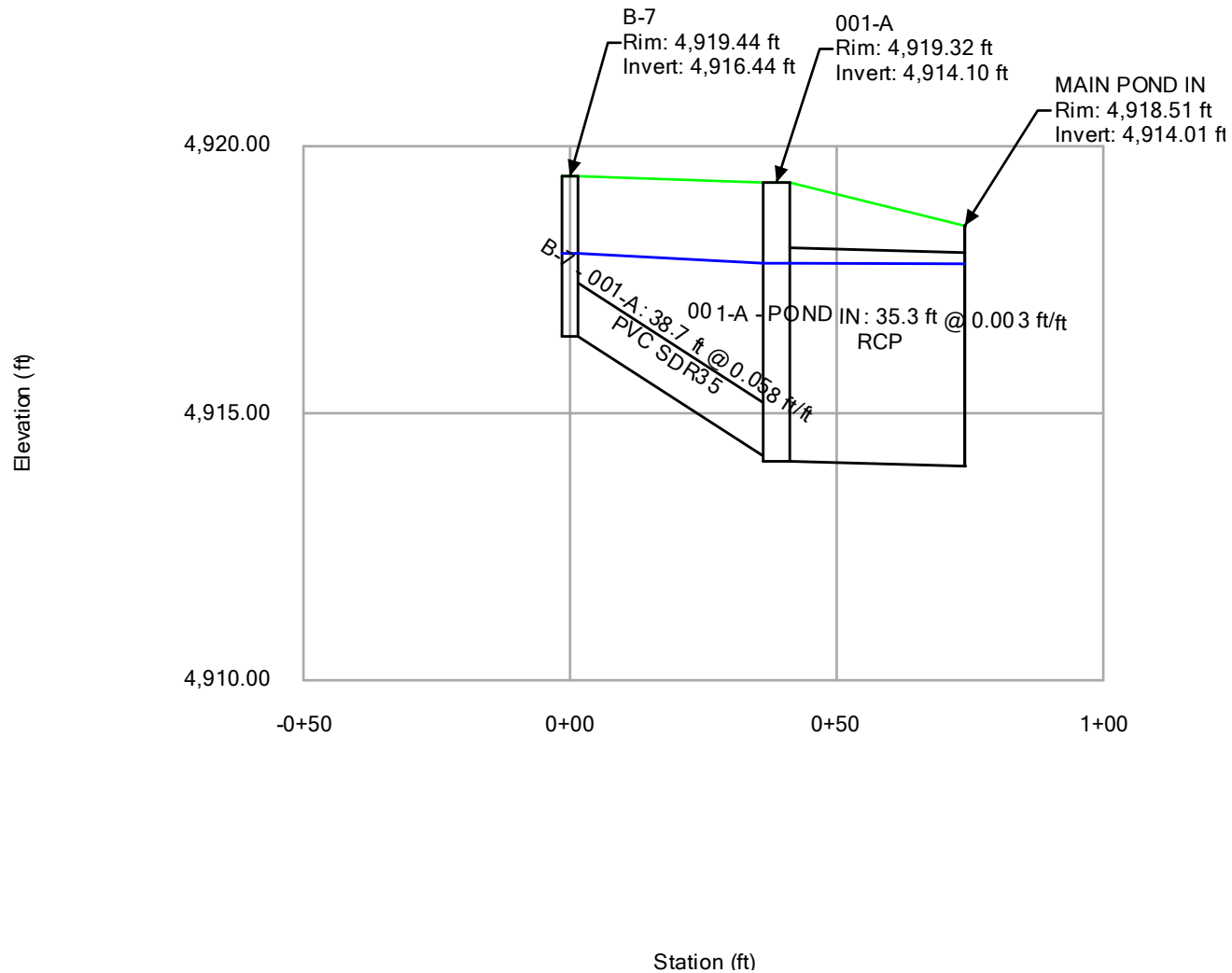
Profile Report
Engineering Profile - A4 B-13 - Pond (M120S_V1&2.stsw)



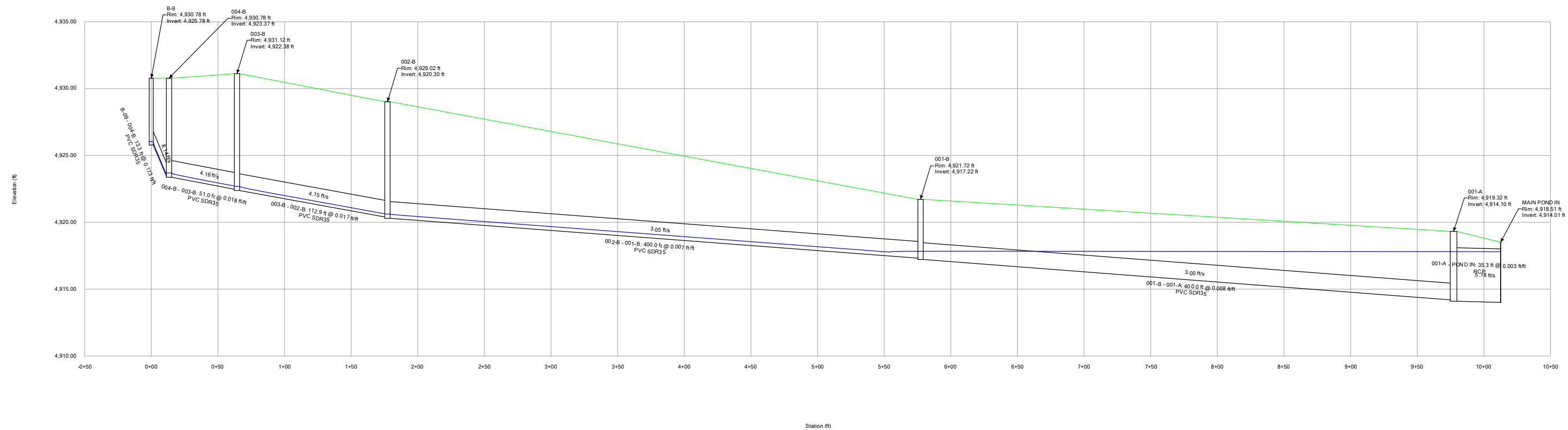
Profile Report
Engineering Profile - A5 B-4 - Pond (M120S_V1&2.stsw)



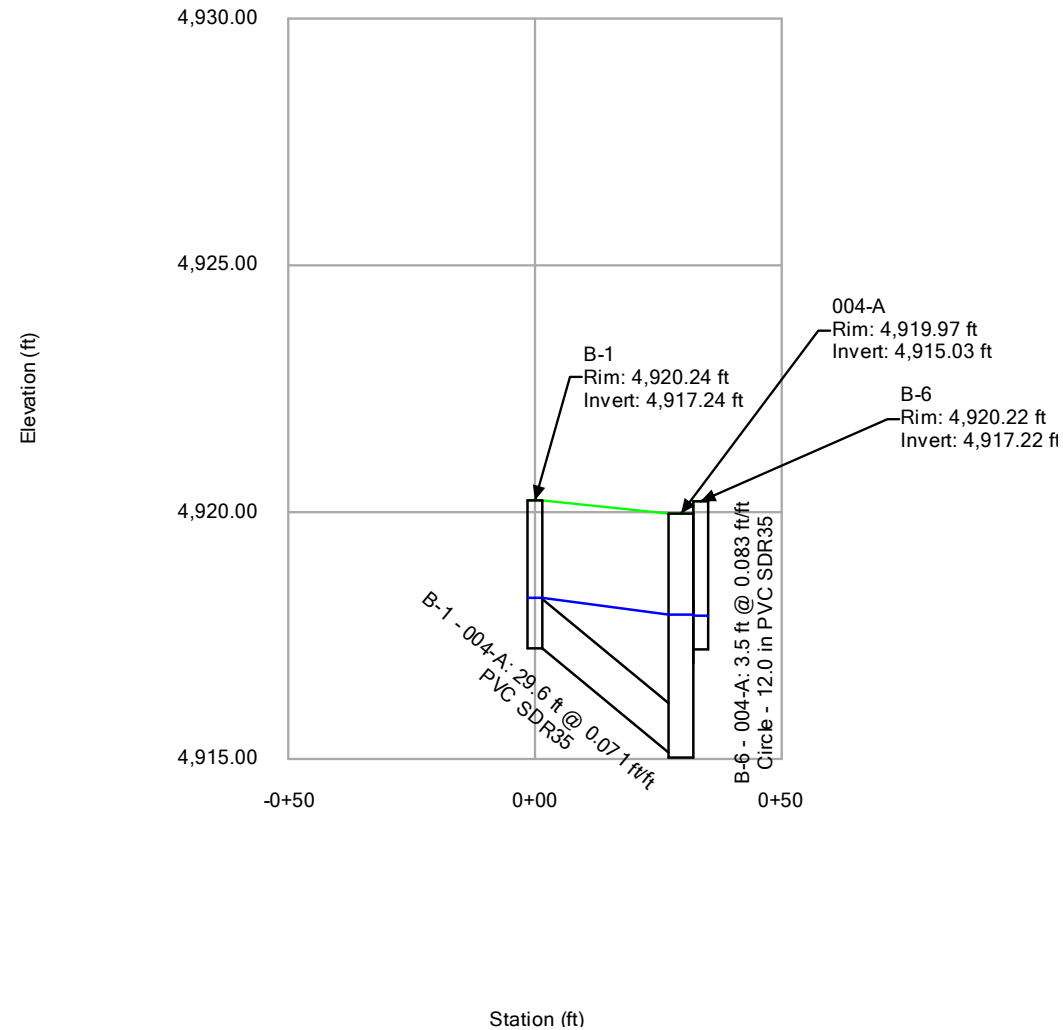
Profile Report **Engineering Profile - A6 B-7 - Pond (M120S_V1&2.stsw)**



Profile Report
Engineering Profile - A7 B-9 - Pond (M120S_V1&2.stsw)

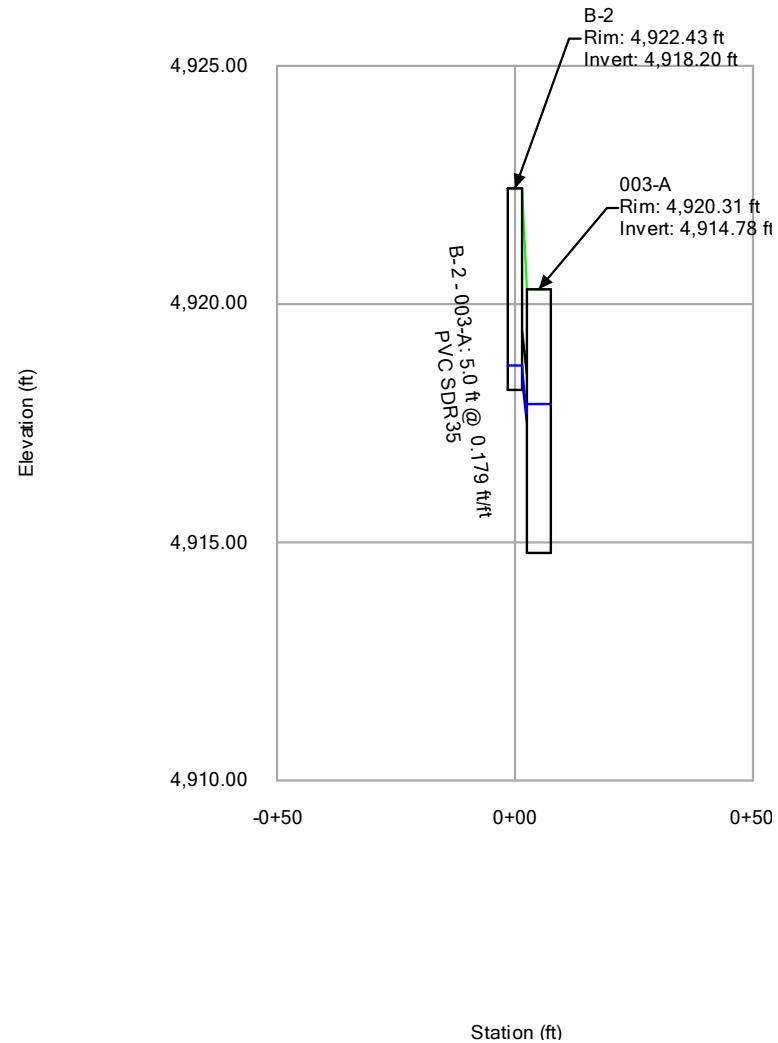


Profile Report **Engineering Profile - A8 B-1 - 004-A - B-6 (M120S_V1&2.stsw)**



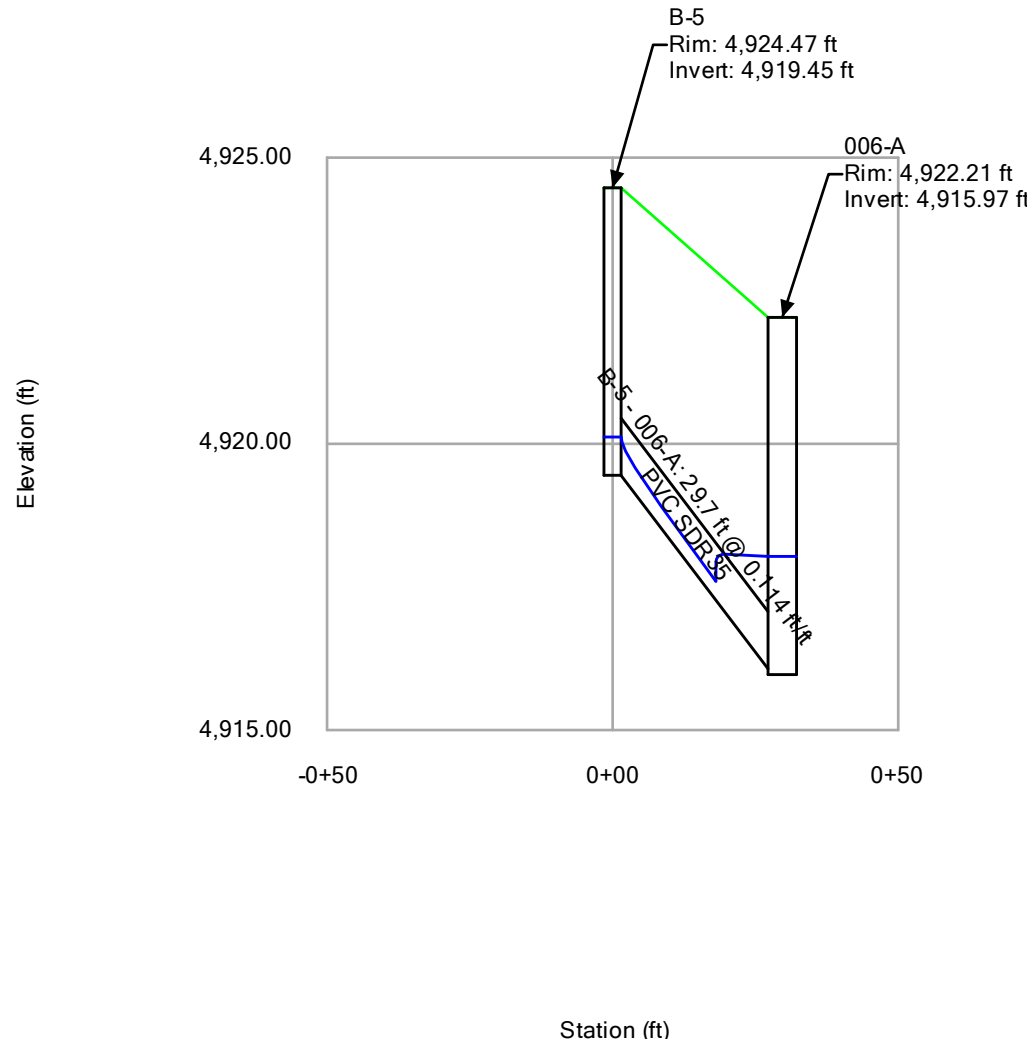
Profile Report

Engineering Profile - A8 B-2 - 003-A (M120S_V1&2.stsw)



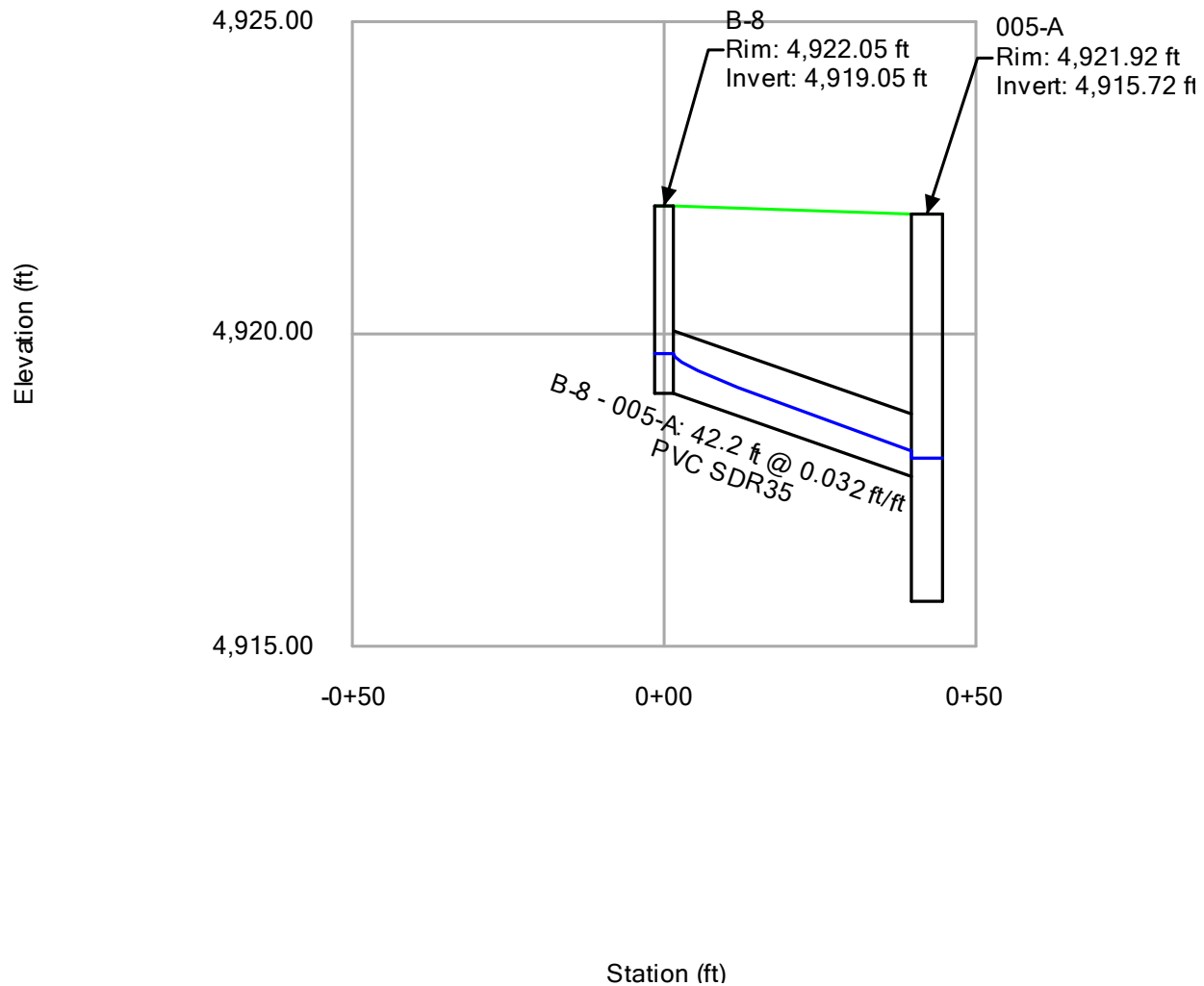
Profile Report

Engineering Profile - A9 B-5 - 006-A (M120S_V1&2.stsw)

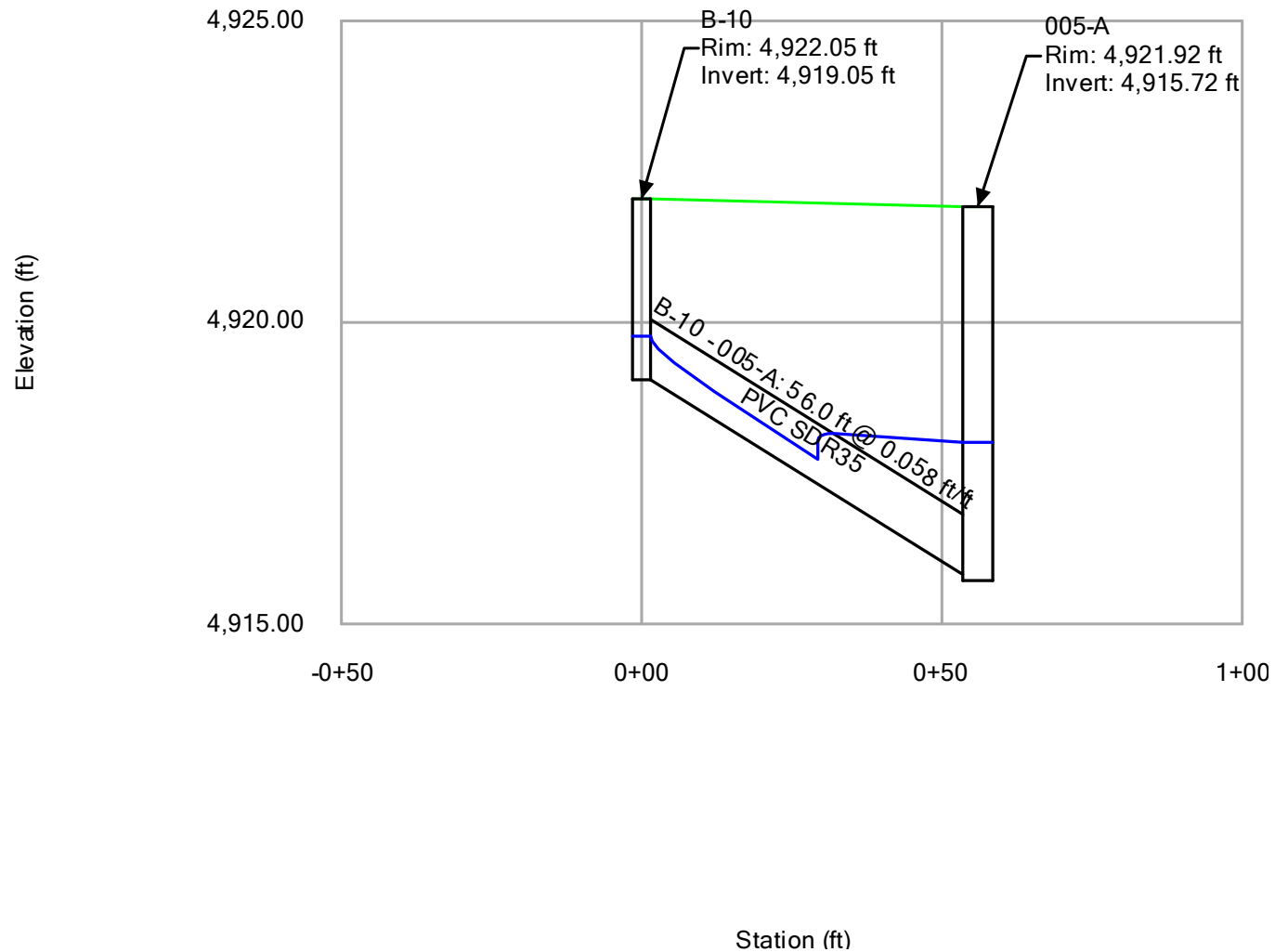


Profile Report

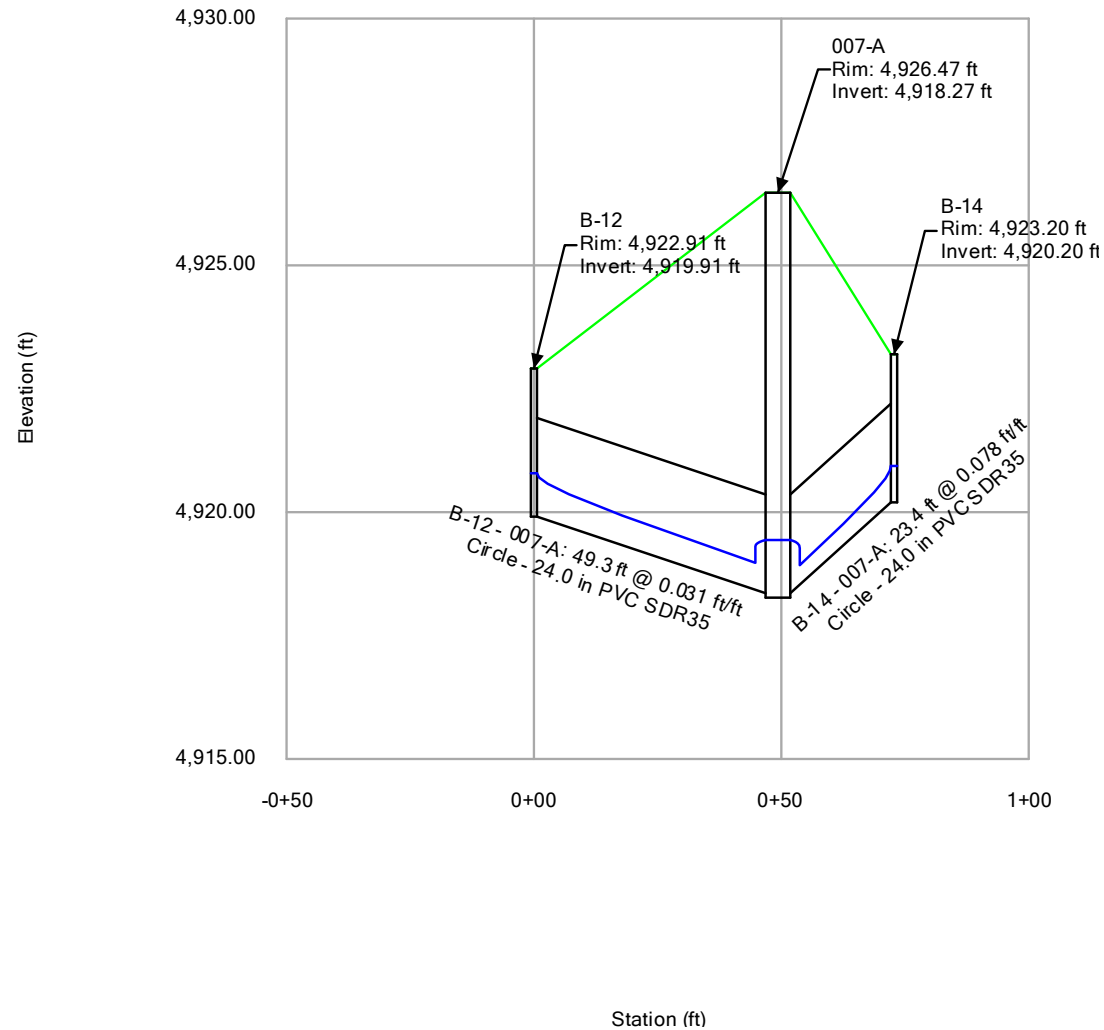
Engineering Profile - A91 B-8 - 005-A (M120S_V1&2.stsw)



Profile Report **Engineering Profile - A92 B-10 - 005-A (M120S_V1&2.stsw)**



Profile Report **Engineering Profile - A94 B-12 - 007-A - B-14 (M120S_V1&2.stsw)**



Project: Meridian S OA Simulation Run: Exist 5-yr

Start of Run: 01Jan2026, 00:00

Basin Model: Existing

End of Run: 02Jan2026, 00:00

Meteorologic Model: 5-yr

Compute Time: 23Jun2026, 14:39:50

Control Specifications: Control 1

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Culvert-2	0.0275955	17.80	01Jan2026, 12:09	2.20
EX-1	0.1114200	44.98	01Jan2026, 12:23	9.33
EX-2	0.0346078	22.88	01Jan2026, 12:09	2.81
EX-3	0.0059829	3.88	01Jan2026, 12:07	0.44
EX-4	0.0275955	17.80	01Jan2026, 12:09	2.20
EX-5	0.7504100	80.50	01Jan2026, 13:22	36.52
Orr-Gate-1	0.7504100	80.50	01Jan2026, 13:22	36.52
Outfall-1	0.1114200	44.98	01Jan2026, 12:23	9.33
Outfall-2	0.7563929	80.92	01Jan2026, 13:22	36.95

Project: Meridian S OA Simulation Run: Prop 5-yr

Start of Run: 01Jan2026, 00:00

Basin Model: Proposed

End of Run: 02Jan2026, 00:00

Meteorologic Model: 5-yr

Compute Time: 23Jun2026, 14:41:16

Control Specifications: Control 1

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
OFF-6	0.0243793	17.13	01Jan2026, 12:07	1.92
Orr-Gate-1	0.7702771	82.04	01Jan2026, 13:22	38.30
Outfall-1	0.1158588	66.34	01Jan2026, 12:13	9.78
Outfall-2	0.7702771	82.04	01Jan2026, 13:22	38.30
P-1	0.0147329	8.32	01Jan2026, 12:07	0.94
P-2	0.0016635	1.01	01Jan2026, 12:07	0.11
P-3	0.0586876	33.80	01Jan2026, 12:12	4.88
P-4a	0.0571712	33.27	01Jan2026, 12:12	4.91
P-4b	0.0219071	14.87	01Jan2026, 12:09	1.89
P-5	0.74837	80.28	01Jan2026, 13:22	36.42
Reach-1	0.0571712	33.27	01Jan2026, 12:14	4.91

Project: Meridian S OA Simulation Run: Proposed Rational - 5 Year

Start of Run: 01Jan2026, 00:00 Basin Model: Proposed Rational - 5 Year
End of Run: 02Jan2026, 00:00 Meteorologic Model: 5-yr
Compute Time: 13Jul2026, 13:01:49 Control Specifications:Control 1

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Outfall-1	0.1	9.70	01Jan2026, 12:36	0.86
Pond-1	0.1	9.70	01Jan2026, 12:36	0.86
P-3	0.1	25.50	01Jan2026, 12:15	0.87

Project: Meridian S OA Simulation Run: Proposed Rational - 5 Year
Reservoir: Pond-1

Start of Run:	01Jan2026, 00:00	Basin Model:	Proposed Rational - 5 Year
End of Run:	02Jan2026, 00:00	Meteorologic Model:	5-yr
Compute Time:	13Jul2026, 13:01:49	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	25.50 (CFS)	Date/Time of Peak Inflow:	01Jan2026, 12:15
Peak Discharge:	9.70 (CFS)	Date/Time of Peak Discharge	01Jan2026, 12:36
Inflow Volume:	4.65 (AC-FT)	Peak Storage:	0.67 (AC-FT)
Discharge Volume	4.57 (AC-FT)	Peak Elevation:	4915.3 (FT)

APPENDIX C

100-YEAR STORM

Project: Meridian 120 South Villages 1 and 2

Project Location: Reno, NV

Time of Concentration Table, 100-year

Drainage Basin	Drainage Area (AC)	Weighted Average C-Factor 100-Year	Overland			Channelized Flow				Total (Ti+Tt)	Urbanized Basins Check	Final	NOAA ATLAS 14 Rainfall Intensity	Rational Flow
			Li (ft)	S (ft/ft)	Ti (min)	Ls(ft)	S (ft/ft)	V(ft/s)	Tt1 (min)	Tc (min)	Tc*(min)	Tc (min)	(in/hour)	Q100-year (cfs)
EX-1	71.34	0.50	149.3	0.134	8.4	2506.1	0.109	5.3	7.9	16.3	24.8	16.3	3.32	118.3
EX-2	22.24	0.50	343.3	0.058	16.8	1671.6	0.076	4.4	6.3	23.0	21.2	21.2	2.95	32.8
EX-3	3.83	0.50	85.0	0.038	9.6	853.9	0.051	3.7	3.9	13.5	15.2	13.5	3.62	6.9
EX-4	17.67	0.50	207.4	0.048	13.9	1952.6	0.074	4.4	7.4	21.3	22.0	21.3	2.94	26.0

Project: Meridian 120 South Villages 1 and 2

Project Location: Reno, NV

Time of Concentration Table, 100-year

Drainage Basin	Drainage Area (AC)	Weighted Average C-Factor 100 Year	Overland			Channelized Flow				Gutter Flow				Total (Ti+Tt)	Urbanized Basins Check	Final	NOAA ATLAS 14 Rainfall Intensity	Rational Flow
			Li (ft)	S (ft/ft)	Ti (min)	Ls(ft)	S (ft/ft)	V(ft/s)	Tt1 (min)	Lt (ft)	S (ft/ft)	V (ft/s)	Tt2 (min)	Tc (min)	Tc*(min)	Tc (min)	(in/hour)	Q100-year (cfs)
A-1	2.92	0.54	127.4	0.010	14.2					657.0	0.010	2.0	5.4	19.5	14.4	14.4	3.50	5.5
B-1	5.04	0.68	106.6	0.010	10.4					869.7	0.026	3.3	4.4	14.8	15.4	14.8	3.43	11.7
B-10	4.18	0.65	111.3	0.011	11.0					1091.9	0.018	2.7	6.6	17.6	16.7	16.7	3.29	8.9
B-11	0.37	0.65	152.6	0.010	13.3					319.8	0.038	4.0	1.3	14.7	12.6	12.6	3.75	0.9
B-12	19.32	0.50	178.1	0.162	8.6	1301.0	0.168	6.6	3.3					11.9	18.2	11.9	3.85	37.2
B-13	22.79	0.50	175.5	0.114	9.6	1583.6	0.158	6.4	4.1					13.7	19.8	13.7	3.59	40.9
B-14	20.39	0.50	229.4	0.013	22.7	2599.1	0.077	4.5	9.7					32.3	25.7	25.7	2.62	26.7
B-2	1.09	0.50	33.3	0.022	6.0					505.3	0.007	1.7	4.9	10.9	13.0	10.9	3.99	2.2
B-3	1.25	0.93	100.2	0.014	3.6									3.6	10.6	5.0	5.42	6.3
B-4	2.10	0.59	116.5	0.070	6.6					967.9	0.012	2.2	7.3	13.9	16.0	13.9	3.57	4.4
B-5	3.37	0.65	107.1	0.012	10.6					766.0	0.029	3.5	3.7	14.2	14.9	14.2	3.52	7.7
B-6	0.99	0.65	32.9	0.051	3.6					233.6	0.008	1.9	2.1	5.7	11.5	5.7	5.24	3.4
B-7	3.53	0.65	141.2	0.018	10.6					829.5	0.012	2.2	6.2	16.8	15.4	15.4	3.38	7.8
B-8	3.26	0.65	124.7	0.010	12.1					1074.2	0.019	2.8	6.4	18.5	16.7	16.7	3.29	7.0
B-9	0.50	0.65	129.9	0.012	11.6					264.7	0.041	4.1	1.1	12.7	12.2	12.2	3.81	1.2
OFF-1	1.07	0.50	99.6	0.010	13.5									13.5	10.6	10.6	4.04	2.2
OFF-2	2.40	0.50	267.5	0.026	16.1									16.1	11.5	11.5	3.91	4.7
OFF-3	1.12	0.50	63.4	0.077	6.6	213.4	0.046	3.4	1.0					7.6	11.5	7.6	4.74	2.7
OFF-4	0.78	0.50	101.2	0.032	9.2									9.2	10.6	9.2	4.32	1.7
OFF-5	2.91	0.50	85.0	0.038	9.6	597.9	0.049	3.6	2.8					12.4	13.8	12.4	3.78	5.5
OFF-6	15.59	0.50	207.4	0.048	13.9	1733.7	0.079	4.5	6.4					20.2	20.8	20.2	3.02	23.6

Project: Meridian 120 South Villages 1 and 2
Street Spread Analysis, 100-year Storm

6/22/2026

METHODOLOGY

TYPE 4R DROP INLET CALCULATIONS (NEENAH GRATE 3067-LL)

ON GRADE(Example)

Q100= 4.50 Clogging Factor = 1.0
 Slope= On Grade

Qcap=E*Q100*Clogging Factor

*E= 68%

Qcap=3.06 cfs

Qcapacity = 3.06cfs

IN SUMP (Example)

Q100= 6.07 Clogging Factor = 1.0
 Slope= Sump Condition

Shallow flow condition-check weir and orifice

weir perimeter-5.8 ft-(3 sides)

orifice free open area=2.1 ft2

weir calculations- $Q=CLH^{3/2} * \text{Clogging Factor}$

Qcap=6.83cfs

where C=3.33, L=weir perimeter, H=head(ft.), solve for Q

C= 3.33

L= 5.8 ft

*H= 0.50 ft

where C=0.6, A=open area, H=head(ft.), solve for Q

C= 0.6

A= 2.1 ft2

*H= 0.50 ft

g= 32.2 ft/s2

orifice calculations- $Q=C(A)(2*g*H)^{1/2} * \text{Clogging Factor}$

Qcap=7.15cfs

Qcapacity = 6.83cfs

*E calculated using HEC-22 Urban Drainage Design Manual

*H taken from curb design

100-YR DESIGN FLOW Catch Basins

CB#	Sump	Qbase	Qexcess	Qnet	Sump Depth	Slope (%)	# CB'S	On-Grade Efficiency	Qcap(on grade)	Qcap(sump)	Qcapacity	Qaccepted	Bypass Flow	Bypass To	REMARKS
A-1	Y	5.54	0.00	5.54	0.50	1.91	1			6.83	6.83	5.54	0.00	OFF	
B-1	Y	11.73	0.00	11.73	0.50	1.00	2			6.83	13.66	11.73	0.00	B-6	
B-2	N	2.18	0.00	2.18		0.74	1	0.61	1.34		1.34	1.34	0.84	B-4	0.84cfs to B-4
B-3	Y	6.31	0.00	6.31	0.50	4.40	1			6.83	6.83	6.31	0.00	OFF	
B-4	Y	4.40	0.84	5.24	0.50	0.74	1			6.83	6.83	5.24	0.00	OFF	
B-5	Y	7.71	0.00	7.71	0.50	0.60	2			6.83	13.66	7.71	0.00	B-10	
B-6	Y	3.36	0.00	3.36	0.50	1.00	1			6.83	6.83	3.36	0.00	B-7	
B-7	Y	7.75	0.00	7.75	0.50	0.74	2			6.83	13.66	7.75	0.00	B-7	
B-8	Y	6.96	0.00	6.96	0.50	0.60	2			6.83	13.66	6.96	0.00	B-6	
B-9	Y	1.24	0.00	1.24	0.50	4.40	1			6.83	6.83	1.24	0.00	B-11	
B-10	Y	8.92	0.00	8.92	0.50	0.60	2			6.83	13.66	8.92	0.00	B-8	
B-11	Y	0.91	0.00	0.91	0.50	4.40	1			6.83	6.83	0.91	0.00	OFF	

Project: Meridian 120 South Villages 1 and 2

Street Spread Analysis, 100-year Storm

6/22/2026

METHODOLOGY

CONVENTIONAL CURB AND GUTTER CALCULATIONS

Manning's Equation:

$$T = [(Qn) / (Ku * Sx^{1.67} * SI^{0.5})]^{0.375}$$

Where:

T = Width of flow (spread) (ft)

Q = Flow Rate (cfs)

n = Manning's Coefficient (unitless)

Ku = 0.56

Sx = Cross Slope (ft/ft)

SI = Longitudinal slope (ft/ft)

100-YR DESIGN FLOW Catch Basins

CB#	Sump	Qnet	Slope (%)	Type of Street	Allowable Spread (ft)	Street Spread (ft)	Pass or Fail	REMARKS
A-1	Y	5.54	1.91	Local	Flooded	11.61		
B-1	Y	11.73	1.00	Local	Flooded	17.82		
B-2	N	2.18	0.74	Local	Flooded	9.58		
B-3	Y	6.31	4.40	Local	Flooded	10.30		
B-4	Y	5.24	0.74	Local	Flooded	13.73		
B-5	Y	7.71	0.60	Local	Flooded	16.66		
B-6	Y	3.36	1.00	Local	Flooded	10.79		
B-7	Y	7.75	0.74	Local	Flooded	16.03		
B-8	Y	6.96	0.60	Local	Flooded	16.03		
B-9	Y	1.24	4.40	Local	Flooded	4.79		
B-10	Y	8.92	0.60	Local	Flooded	17.68		
B-11	Y	0.91	4.40	Local	Flooded	3.97		

Scenario: 100-YEAR
Current Time Step: 0.000 h
FlexTable: Catchment Table

ID	Label	Outflow Element	Area (User Defined) (acres)	Runoff Coefficient (Rational)	Time of Concentration (min)	Flow (Total Out) (cfs)	Notes
164	A-1	A-1	2.917	0.543	14.358	5.62	-
157	B-1	B-1	5.039	0.678	14.838	11.89	-
159	B-2	B-2	1.093	0.500	10.904	2.21	-
171	B-3	MAIN POND IN	1.252	0.930	5.000	6.41	-
161	B-4	B-4	2.102	0.586	13.858	4.46	-
154	B-5	B-5	3.371	0.650	14.240	7.82	-
158	B-6	B-6	0.987	0.650	5.705	3.41	-
160	B-7	B-7	3.528	0.650	15.393	7.86	-
156	B-8	B-8	3.258	0.650	16.661	7.06	-
162	B-9	B-9	0.500	0.650	12.192	1.26	-
155	B-10	B-10	4.179	0.650	16.684	9.05	-
163	B-11	B-11	0.375	0.650	12.624	0.93	-
152	B-12	B-12	19.317	0.500	11.896	37.75	-
153	B-13	B-13	22.787	0.500	13.735	41.49	-
151	B-14	B-14	20.392	0.500	25.714	27.03	-
191	OFF-6	002-D	15.586	0.500	20.242	23.87	-
207	P-5	002-C	478.957	0.730	117.970	277.20	-

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Scenario: Street Capacity Check - 100 Year
Current Time Step: 0.000 h
FlexTable: Catchment Table

ID	Label	Outflow Element	Area (User Defined) (acres)	Runoff Coefficient (Rational)	Time of Concentration (min)	Flow (Total Out) (cfs)	Notes
164	A-1	A-1	2.917	0.543	14.358	5.62	-
157	B-1	B-1	2.000	0.678	15.132	4.67	-
159	B-2	B-2	1.093	0.500	10.904	2.21	-
171	B-3	MAIN POND IN	1.252	0.930	5.000	6.41	-
161	B-4	B-4	2.102	0.586	13.858	4.46	-
154	B-5	B-5	2.950	0.650	14.240	6.84	-
158	B-6	B-6	0.987	0.650	5.705	3.41	-
160	B-7	B-7	3.100	0.650	15.393	6.91	-
156	B-8	B-8	2.100	0.650	16.661	4.55	-
162	B-9	B-9	0.500	0.650	12.192	1.26	-
155	B-10	B-10	2.100	0.650	16.684	4.55	-
163	B-11	B-11	0.375	0.650	12.624	0.93	-
152	B-12	B-12	14.565	0.500	11.896	28.46	-
153	B-13	B-13	22.790	0.500	13.735	41.49	-
151	B-14	B-14	20.392	0.500	25.714	27.03	-
191	OFF-6	002-D	15.586	0.500	20.242	23.87	-
207	P-5	002-C	478.957	0.730	117.970	277.20	-

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Scenario: 100-YEAR
Current Time Step: 0.000 h
FlexTable: Conduit Table

Label	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Length (Scaled) (ft)	Manning's n	Capacity (Full Flow) (cfs)	Elevation Ground (Start) (ft)	Elevation Crown (Start) (ft)	Hydraulic Grade Line (In) (ft)	Energy Grade Line (In) (ft)
001-A - POND IN	001-A	MAIN POND IN	4,914.10	4,914.01	0.003	48.0	35.3	0.013	72.53	4,919.32	4,918.10	4,917.81	4,919.25
001-B - 001-A	001-B	001-A	4,917.22	4,914.20	0.008	15.0	400.0	0.013	5.61	4,921.72	4,918.47	4,918.17	4,918.23
002-A - 001-A	002-A	001-A	4,914.36	4,914.20	0.002	42.0	65.5	0.013	50.30	4,919.51	4,917.86	4,918.59	4,920.62
002-B - 001-B	002-B	001-B	4,920.30	4,917.32	0.007	15.0	400.0	0.013	5.58	4,929.02	4,921.55	4,920.88	4,921.10
003-A - 002-A	003-A	002-A	4,914.78	4,914.46	0.002	42.0	126.3	0.013	50.30	4,920.31	4,918.28	4,920.11	4,922.16
003-B - 002-B	003-B	002-B	4,922.38	4,920.40	0.017	15.0	112.9	0.013	8.54	4,931.12	4,923.63	4,922.96	4,923.19
004-A - 003-A	004-A	003-A	4,915.03	4,914.88	0.002	42.0	58.6	0.013	50.30	4,919.97	4,918.53	4,920.81	4,922.85
004-B - 003-B	004-B	003-B	4,923.37	4,922.48	0.018	15.0	51.0	0.013	8.55	4,930.78	4,924.62	4,923.96	4,924.18
005-A - 004-A	005-A	004-A	4,915.72	4,915.13	0.002	42.0	239.0	0.013	50.16	4,921.92	4,919.22	4,922.36	4,924.06
006-A - 005-A	006-A	005-A	4,915.97	4,915.82	0.002	42.0	62.1	0.013	49.88	4,922.21	4,919.47	4,922.40	4,923.70
007-A - 006-A	007-A	006-A	4,918.27	4,916.07	0.023	36.0	97.5	0.013	100.06	4,926.47	4,921.27	4,923.71	4,925.84
B-1 - 004-A	B-1	004-A	4,917.24	4,915.13	0.071	12.0	31.5	0.013	9.51	4,920.24	4,918.24	4,923.27	4,926.83
B-2 - 003-A	B-2	003-A	4,918.43	4,917.53	0.179	12.0	7.0	0.013	15.09	4,922.43	4,919.43	4,920.12	4,920.14
B-4 - POND IN	B-4	B-4 POND IN	4,916.44	4,915.91	0.019	12.0	28.4	0.013	4.87	4,919.44	4,917.44	4,917.56	4,918.33
B-5 - 001-E	A-1	001-E	4,920.40	4,919.41	0.022	12.0	44.4	0.013	5.32	4,923.73	4,921.40	4,921.34	4,922.18
B-5 - 006-A	B-5	006-A	4,919.45	4,916.07	0.114	12.0	31.5	0.013	12.02	4,924.47	4,920.45	4,923.64	4,925.18
B-6 - 004-A	B-6	004-A	4,917.22	4,916.93	0.083	10.0	5.5	0.013	6.31	4,920.22	4,918.05	4,920.05	4,920.66
B-7 - 001-A	B-7	001-A	4,916.44	4,914.20	0.058	12.0	40.2	0.013	8.57	4,919.44	4,917.44	4,919.70	4,921.25
B-8 - 005-A	B-8	005-A	4,919.05	4,917.72	0.032	12.0	43.6	0.013	6.33	4,922.05	4,920.05	4,923.57	4,924.83
B-09 - 004-B	B-9	004-B	4,925.78	4,923.47	0.173	12.0	14.5	0.013	14.83	4,930.78	4,926.78	4,926.25	4,926.44
B-10 - 005-A	B-10	005-A	4,919.05	4,915.82	0.058	12.0	57.7	0.013	8.56	4,922.05	4,920.05	4,925.53	4,927.58
B-11 - 004-B	B-11	004-B	4,925.78	4,923.47	0.087	12.0	28.3	0.013	10.51	4,930.78	4,926.78	4,926.18	4,926.33
B-12 - 007-A	B-12	007-A	4,919.91	4,918.36	0.031	24.0	49.3	0.013	40.10	4,922.91	4,921.91	4,925.09	4,927.33
B-13 - 007-A	B-13	007-A	4,926.89	4,918.37	0.047	30.0	181.2	0.013	88.90	4,929.76	4,929.39	4,929.05	4,930.37
B-14 - 007-A	B-14	007-A	4,920.20	4,918.36	0.078	24.0	23.4	0.013	63.37	4,923.20	4,922.20	4,924.05	4,925.20
CULVERT-1	002-C	001-C	4,923.28	4,920.70	0.046	-	55.8	0.013	665.72	4,928.36	4,927.28	4,927.28	4,929.35
CULVERT-2	002-D	001-D	4,922.17	4,920.62	0.029	15.0	52.6	0.013	11.08	4,923.67	4,923.42	4,924.83	4,927.67

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Scenario: 100-YEAR
Current Time Step: 0.000 h
FlexTable: Catch Basin Table

Label	Flow (Captured) (cfs)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Total Bypassed) (cfs)	Flow (Known) (cfs)	Inlet Location
002-C	277.20	4,928.36	4,923.28	0.00	0.00	In Sag
002-D	23.87	4,923.67	4,922.17	0.00	0.00	In Sag
A-1	5.62	4,923.73	4,920.40	0.00	0.00	In Sag
B-1	11.89	4,920.24	4,917.24	0.00	0.00	In Sag
B-2	1.02	4,922.43	4,917.72	1.19	0.00	On Grade
B-4	5.53	4,919.44	4,916.44	0.00	0.00	In Sag
B-5	7.82	4,924.47	4,919.45	0.00	0.00	In Sag
B-6	3.41	4,920.22	4,917.22	0.00	0.00	In Sag
B-7	7.86	4,919.44	4,916.44	0.00	0.00	In Sag
B-8	7.06	4,922.05	4,919.05	0.00	0.00	In Sag
B-9	1.26	4,930.78	4,925.78	0.00	0.00	In Sag
B-10	9.05	4,922.05	4,919.05	0.00	0.00	In Sag
B-11	0.93	4,930.78	4,925.78	0.00	0.00	In Sag
B-12	37.75	4,922.91	4,919.91	0.00	0.00	In Sag
B-13	41.49	4,929.76	4,926.89	0.00	0.00	In Sag
B-14	27.03	4,923.20	4,920.20	0.00	0.00	In Sag

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Scenario: 100-YEAR
Current Time Step: 0.000 h
FlexTable: Manhole Table

Label	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Hydraulic Grade Line (Out) (ft)	Depth (Out) (ft)	Flow (Total Out) (cfs)	Elevation (Ground) (ft)
001-A	4,919.32	4,914.10	4,918.06	3.96	116.92	4,919.32
001-B	4,921.72	4,917.22	4,918.44	1.22	1.99	4,921.72
002-A	4,919.51	4,914.36	4,918.84	4.47	109.86	4,919.51
002-B	4,929.02	4,920.30	4,920.88	0.58	2.12	4,929.02
003-A	4,920.31	4,914.78	4,920.31	5.53	110.45	4,920.31
003-B	4,931.12	4,922.38	4,922.96	0.58	2.15	4,931.12
004-A	4,919.97	4,915.03	4,919.97	4.94	110.06	4,919.97
004-B	4,930.78	4,923.37	4,923.96	0.59	2.16	4,930.78
005-A	4,921.92	4,915.72	4,921.92	6.20	100.61	4,921.92
006-A	4,922.21	4,915.97	4,922.21	6.24	88.19	4,922.21
007-A	4,926.47	4,918.27	4,923.71	5.44	82.73	4,926.47

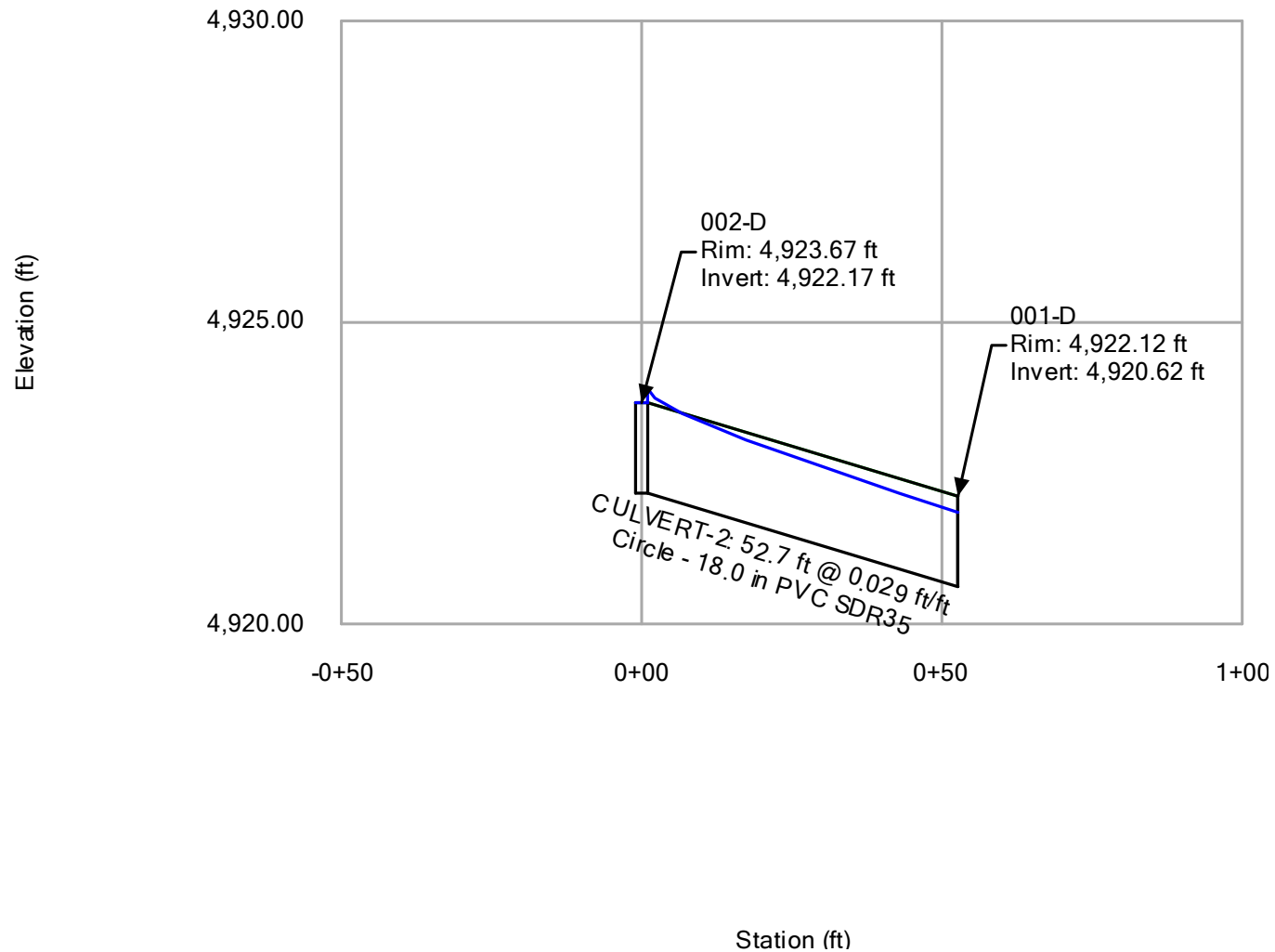
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Scenario: 100-YEAR
Current Time Step: 0.000 h
FlexTable: Outfall Table

ID	Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)	Notes
100	001-C	4,925.78	4,920.70	Free Outfall	-	4,923.16	277.06	105 x 6 x 48 inch Concrete Rectangular Headwall VH 12 inch RCP FES 48" RCP FES 12" RCP FES 18" RCP FES
109	001-D	4,922.12	4,920.62	Free Outfall	-	4,922.10	23.83	
121	MAIN POND IN	4,918.51	4,914.01	User Defined Tailwater	4,916.60	4,917.27	116.70	
122	B-4 POND IN	4,916.94	4,915.91	User Defined Tailwater	4,916.60	4,916.85	5.51	
123	001-E	4,920.66	4,919.41	Free Outfall	-	4,920.30	5.60	

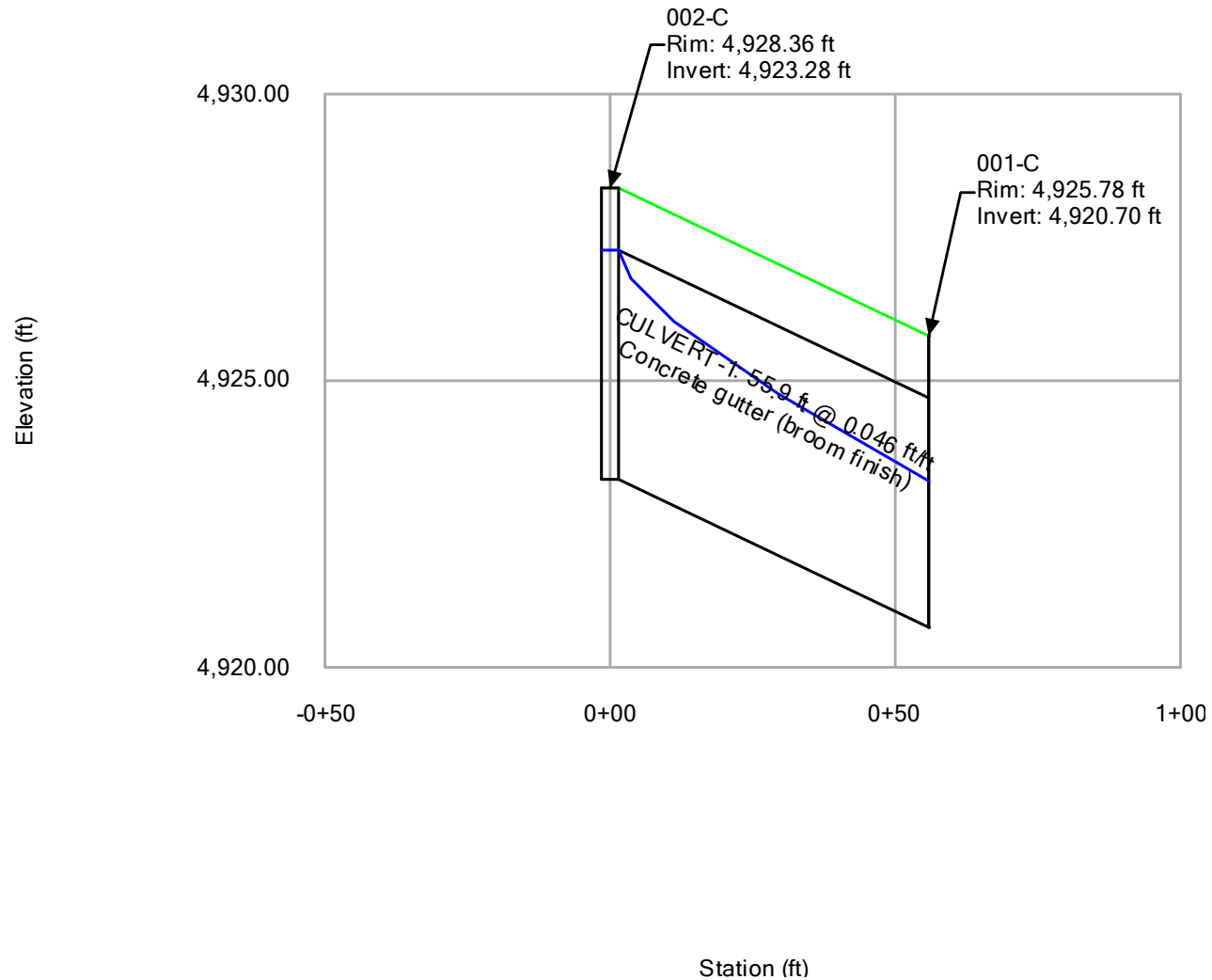
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Profile Report
Engineering Profile - A1 002-D - 001-D (M120S_V1&2.stsw)



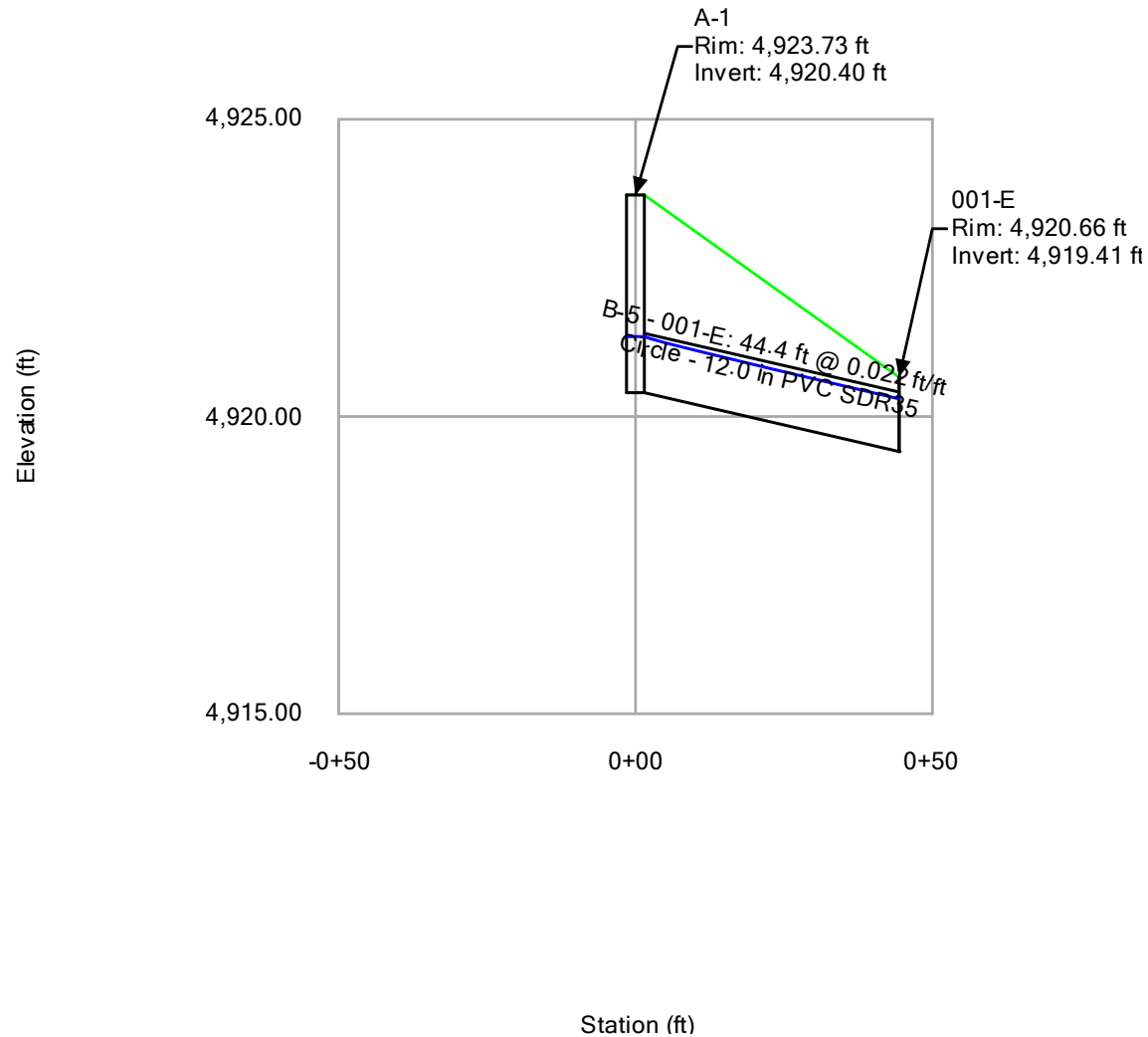
Profile Report

Engineering Profile - A2 P-5 - Culvert-1 (M120S_V1&2.stsw)

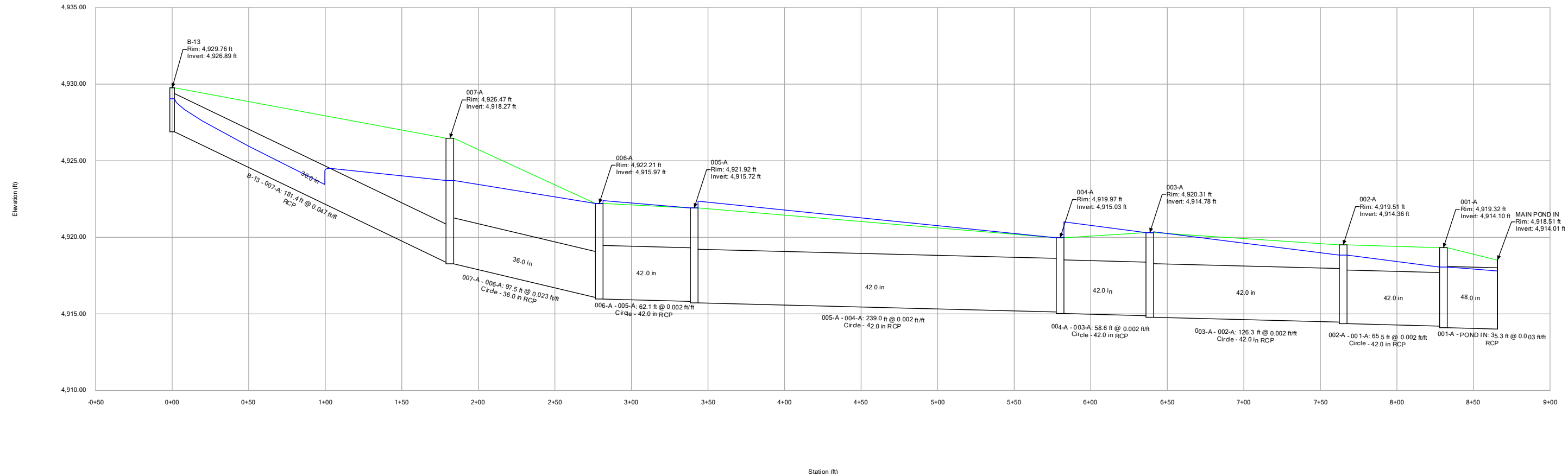


Profile Report

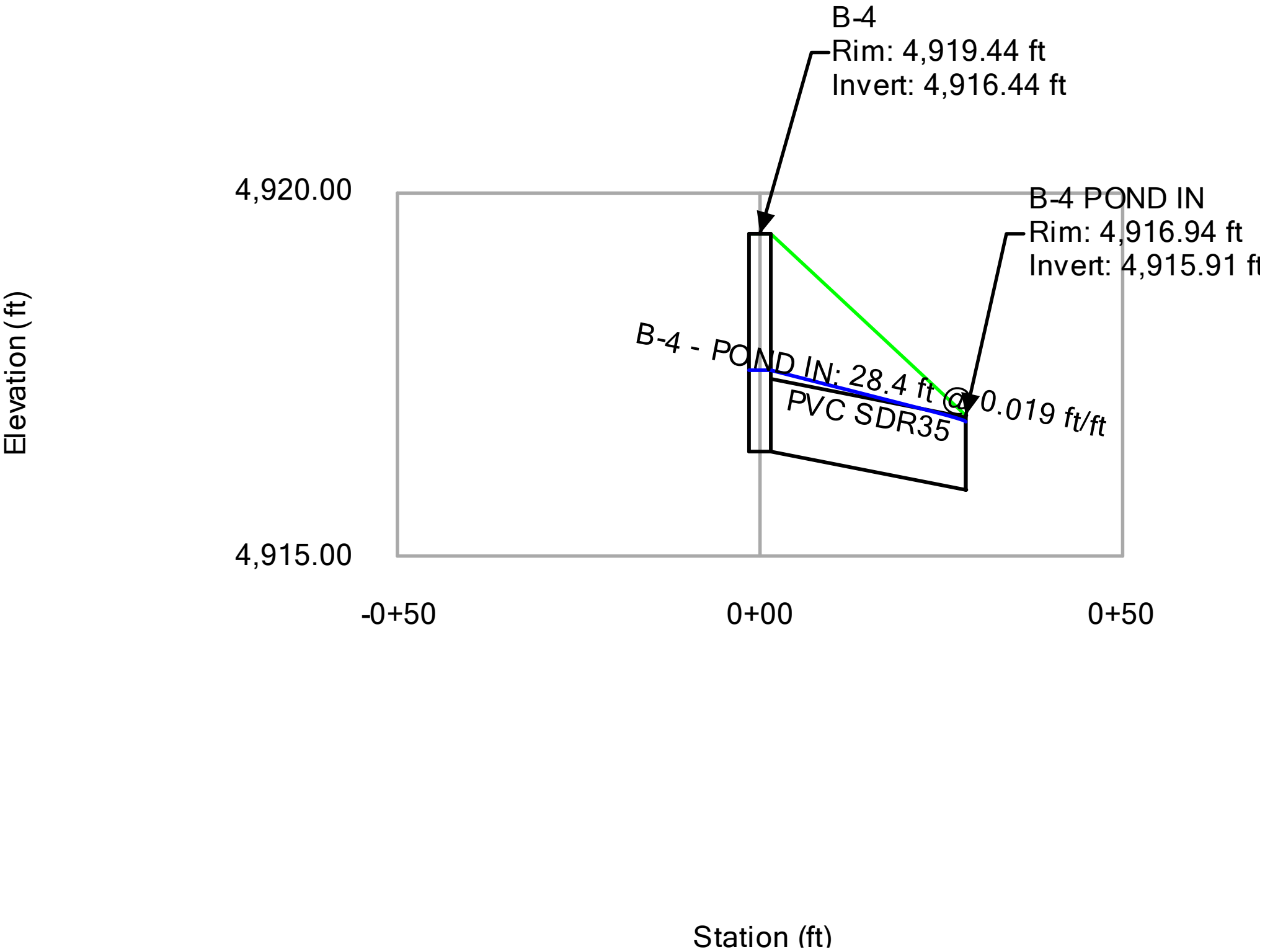
Engineering Profile - A3 A-1 - 001-E (M120S_V1&2.stsw)



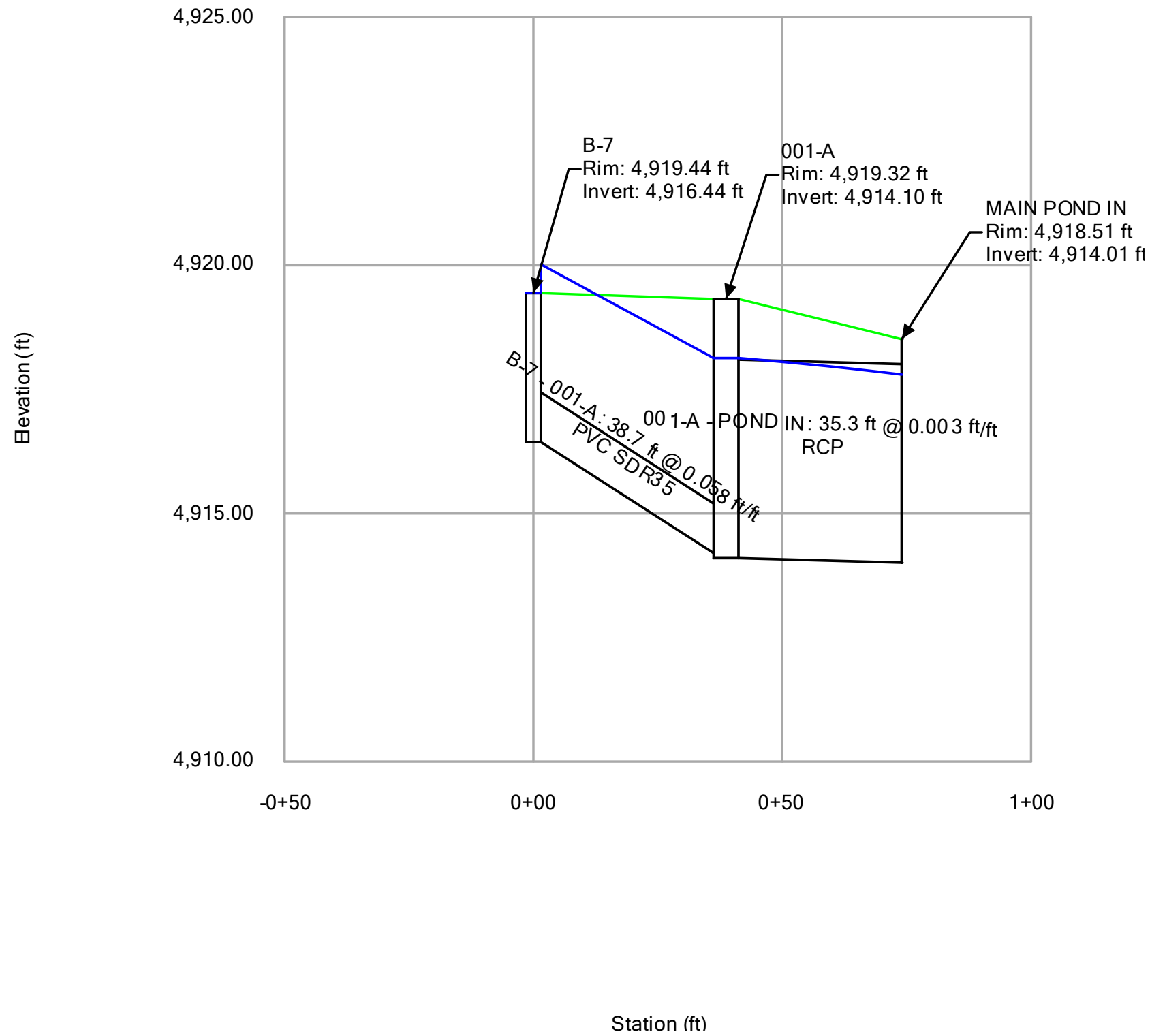
Profile Report
Engineering Profile - A4 B-13 - Pond (M120S_V1&2.stsw)



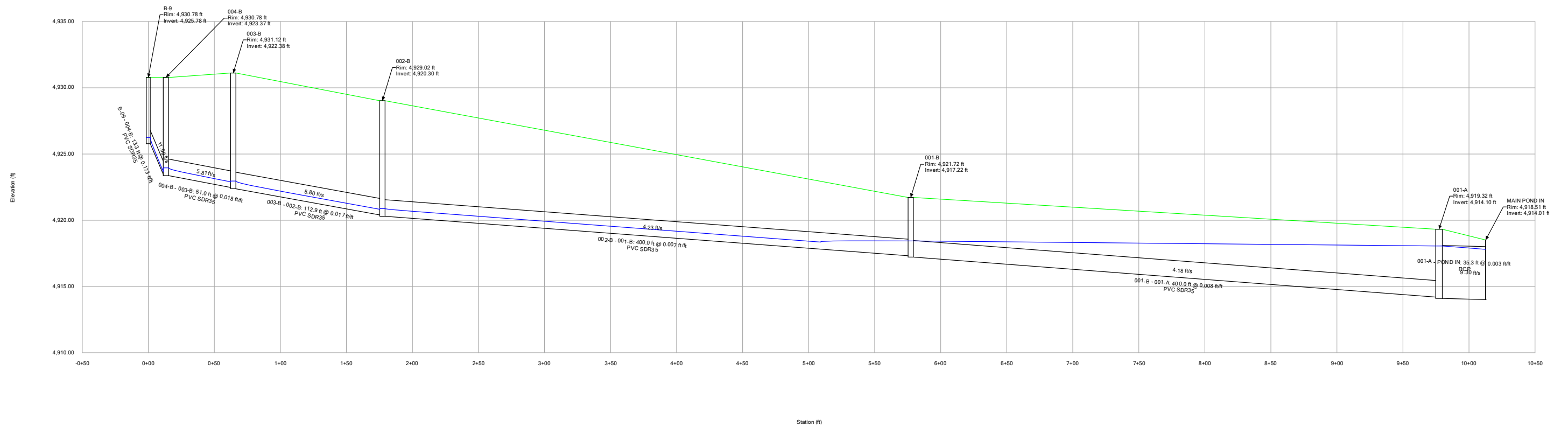
Profile Report
Engineering Profile - A5 B-4 - Pond (M120S_V1&2.stsw)



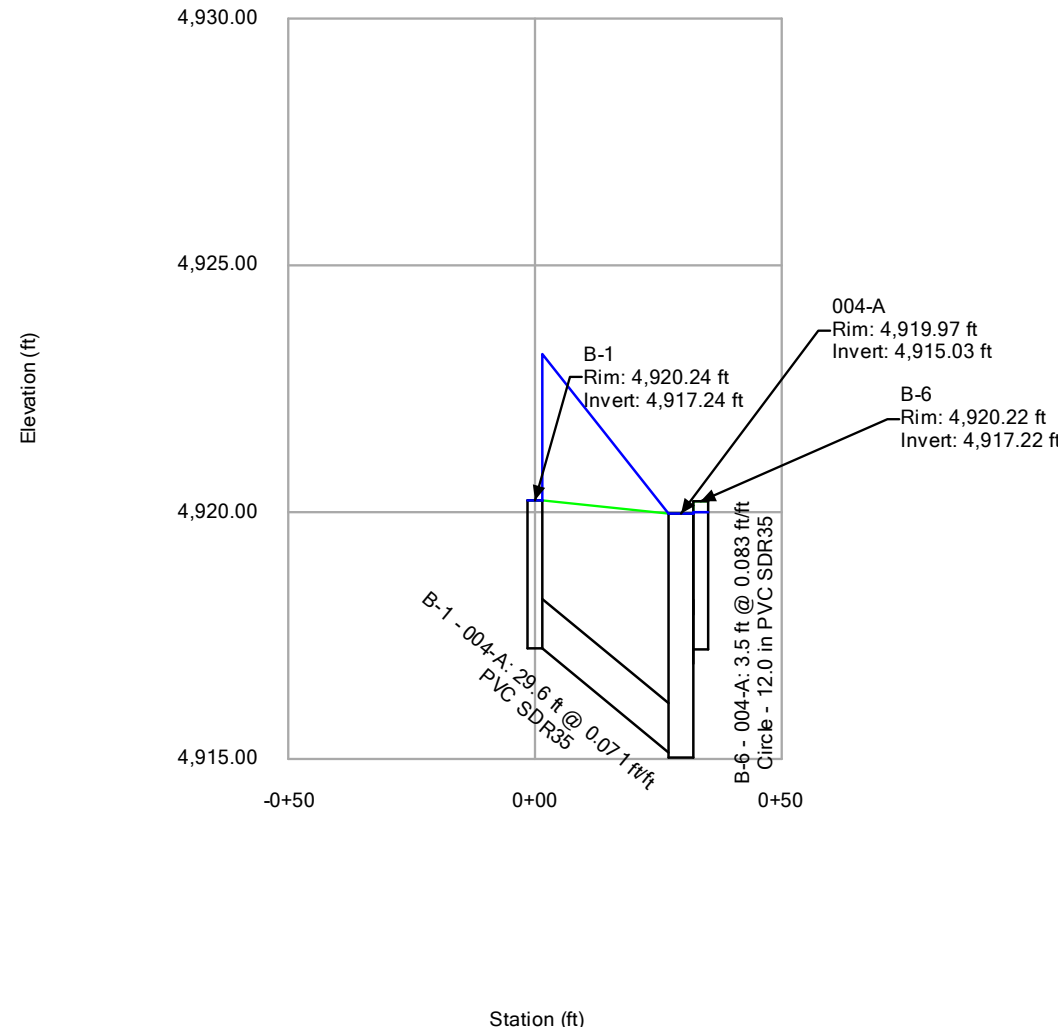
Profile Report
Engineering Profile - A6 B-7 - Pond (M120S_V1&2.stsw)



Profile Report
Engineering Profile - A7 B-9 - Pond (M120S_V1&2.stsw)

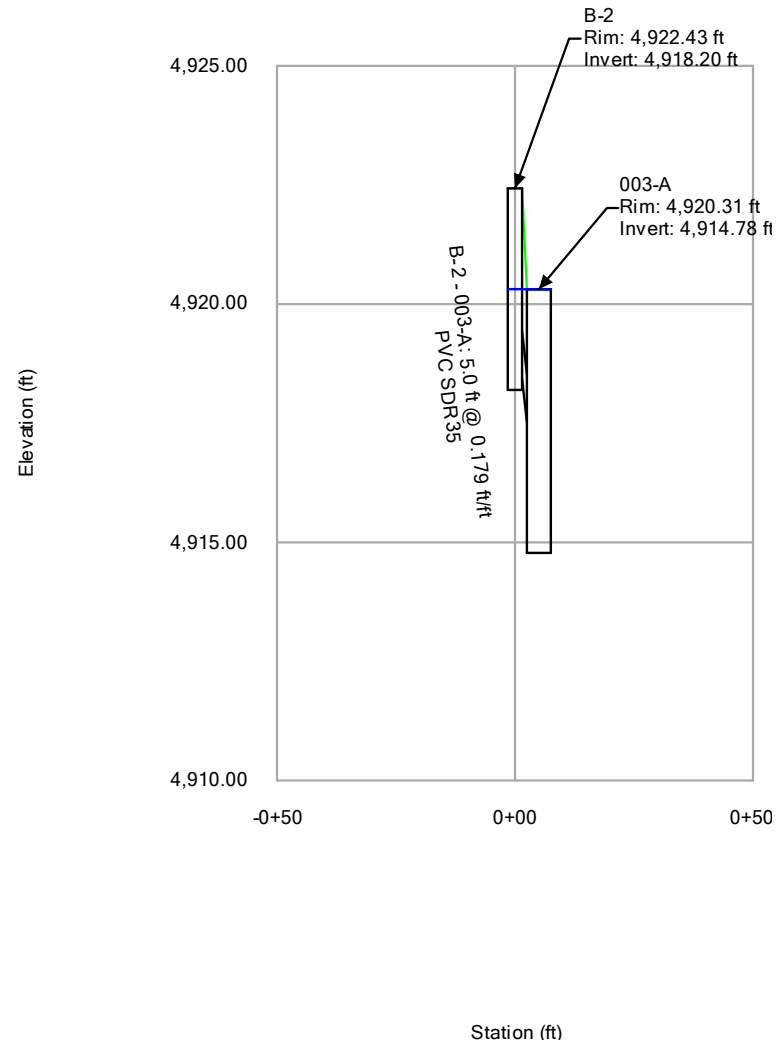


Profile Report **Engineering Profile - A8 B-1 - 004-A - B-6 (M120S_V1&2.stsw)**



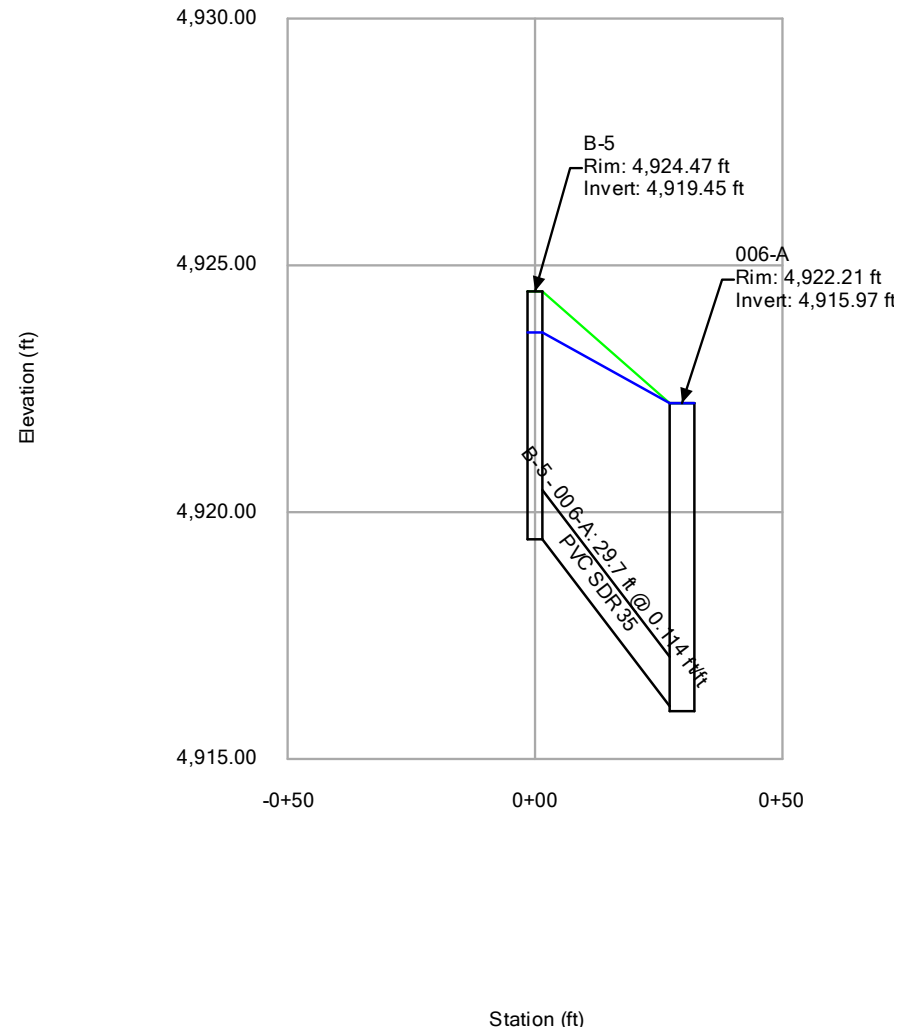
Profile Report

Engineering Profile - A8 B-2 - 003-A (M120S_V1&2.stsw)



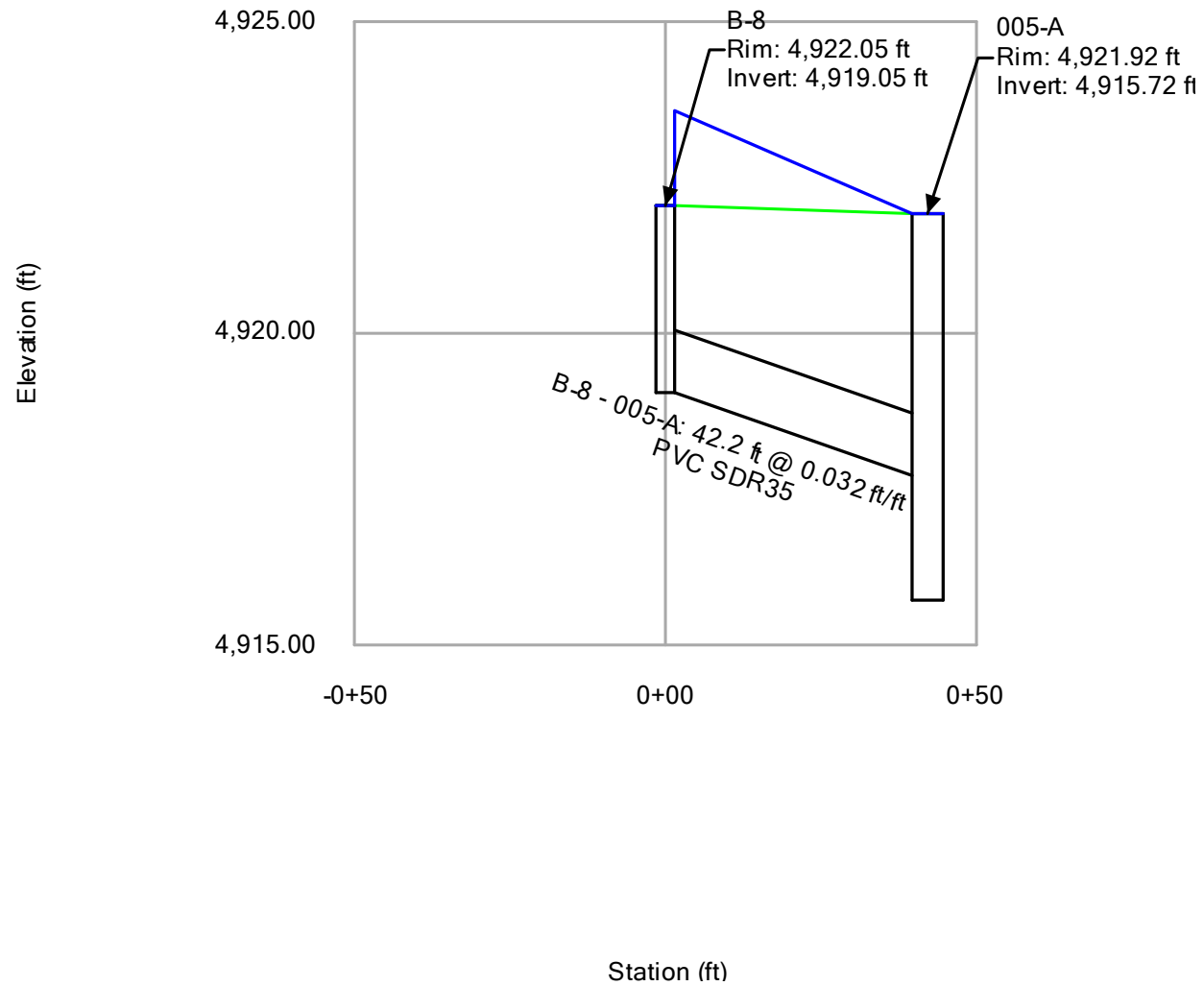
Profile Report

Engineering Profile - A9 B-5 - 006-A (M120S_V1&2.stsw)



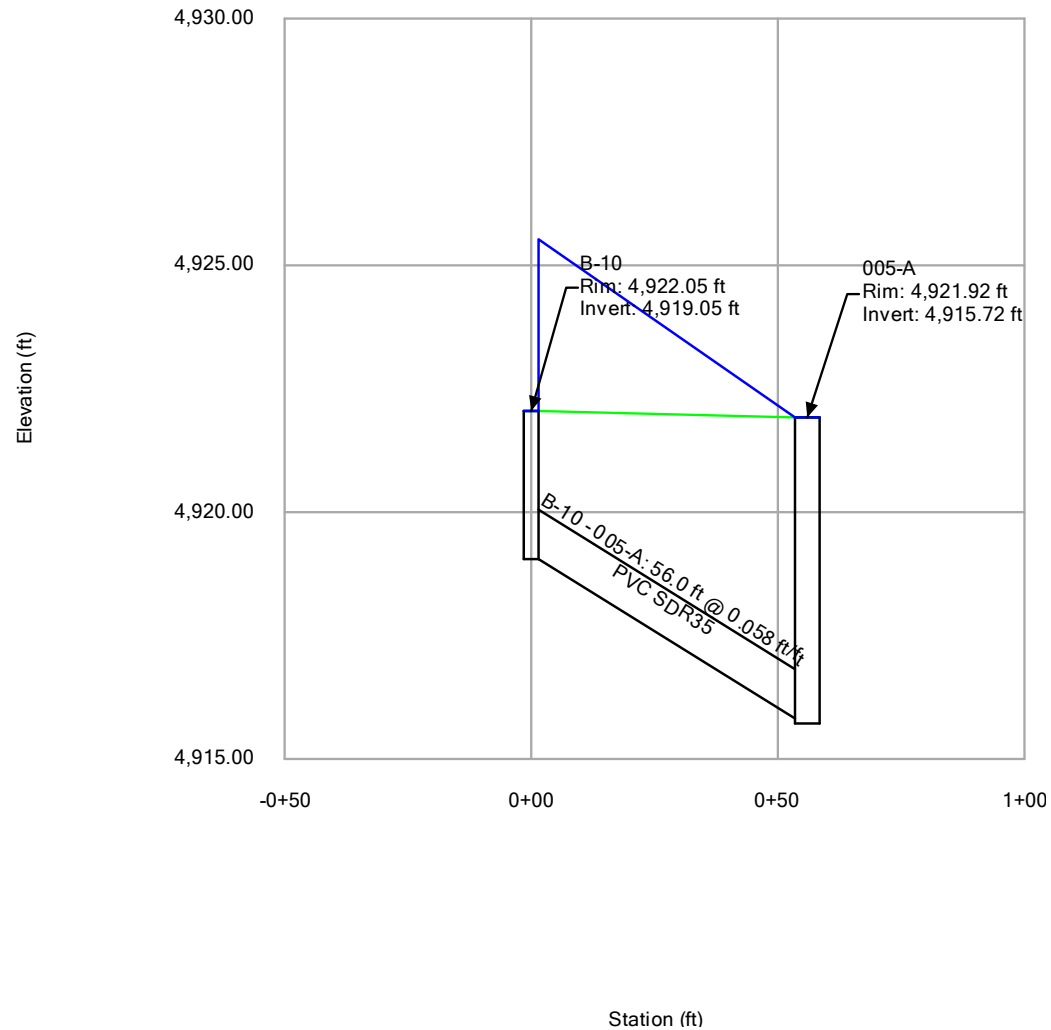
Profile Report

Engineering Profile - A91 B-8 - 005-A (M120S_V1&2.stsw)

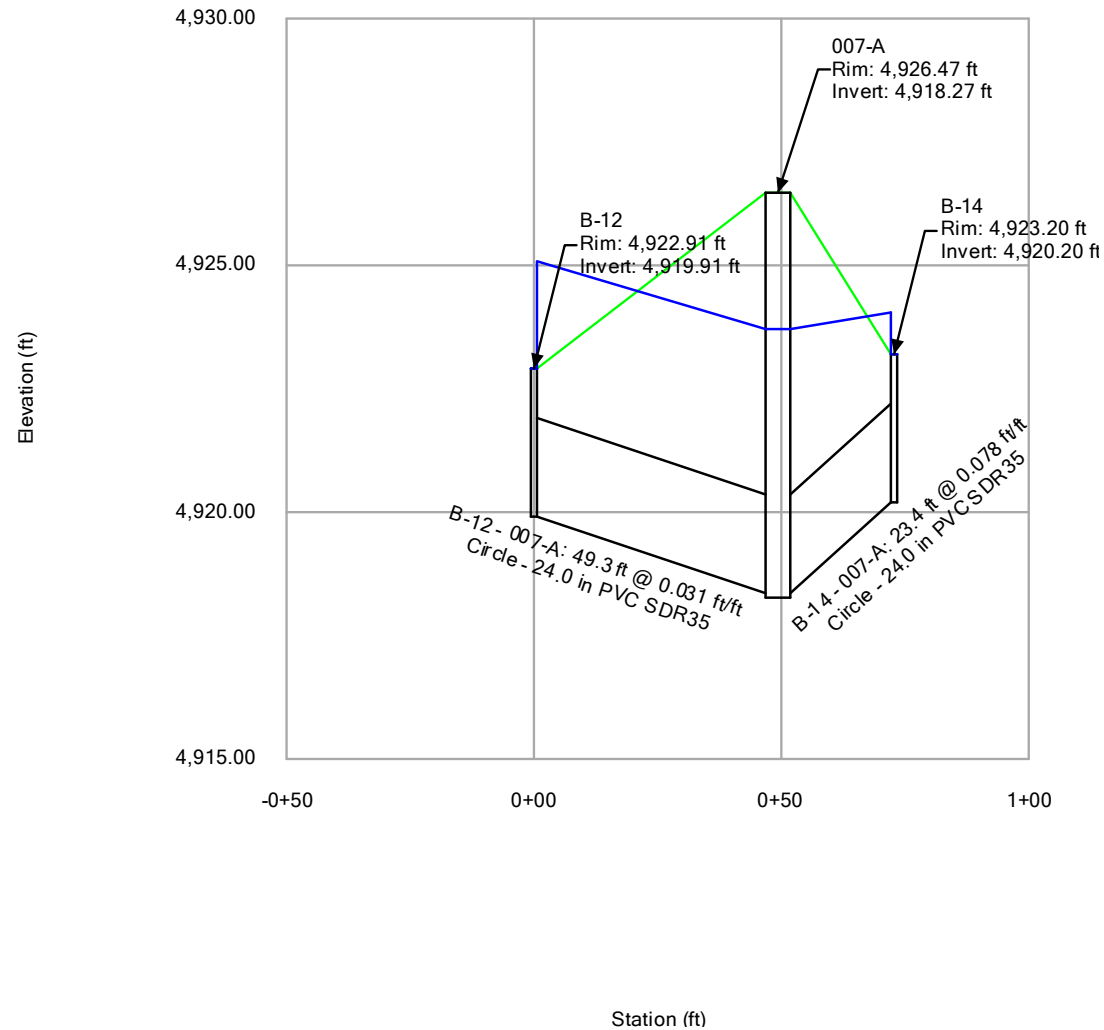


Profile Report

Engineering Profile - A92 B-10 - 005-A (M120S_V1&2.stsw)



Profile Report **Engineering Profile - A94 B-12 - 007-A - B-14 (M120S_V1&2.stsw)**



B-2-003-A with Peak System Head

Project Description	
Friction Method	Manning
	Formula
Solve For	Discharge
Input Data	
Pressure 1	0.8150 psi
Pressure 2	1.2034 psi
Elevation 1	4,918.43 ft
Elevation 2	4,917.53 ft
Length	5.0 ft
Roughness Coefficient	0.013
Diameter	12.0 in
Results	
Discharge	1.02 cfs
Headloss	0.00 ft
Energy Grade 1	4,920.34 ft
Energy Grade 2	4,920.33 ft
Hydraulic Grade 1	4,920.31 ft
Hydraulic Grade 2	4,920.31 ft
Flow Area	0.8 ft ²
Wetted Perimeter	3.1 ft
Velocity	1.30 ft/s
Velocity Head	0.03 ft
Friction Slope	0.0008 ft/ft

B-2-003-A Minimum System Head for a Velocity over 3 fps

Project Description	
Friction Method	Manning
	Formula
Solve For	Discharge
Input Data	
Pressure 1	0.8150 psi
Pressure 2	1.1957 psi
Elevation 1	4,918.43 ft
Elevation 2	4,917.53 ft
Length	5.0 ft
Roughness Coefficient	0.013
Diameter	12.0 in
Results	
Discharge	2.36 cfs
Headloss	0.02 ft
Energy Grade 1	4,920.45 ft
Energy Grade 2	4,920.43 ft
Hydraulic Grade 1	4,920.31 ft
Hydraulic Grade 2	4,920.29 ft
Flow Area	0.8 ft ²
Wetted Perimeter	3.1 ft
Velocity	3.00 ft/s
Velocity Head	0.14 ft
Friction Slope	0.0044 ft/ft

Project: Meridian S OA Simulation Run: Prop 100-yr

Start of Run: 01Jan2026, 00:00 Basin Model: Proposed
End of Run: 02Jan2026, 00:00 Meteorologic Model: 100-yr
Compute Time: 23Jun2026, 14:44:37 Control Specifications: Control 1

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
OFF-6	0.0243793	52.85	01Jan2026, 12:07	4.45
Orr-Gate-1	0.7702771	278.67	01Jan2026, 13:17	104.45
Outfall-1	0.1158588	197.46	01Jan2026, 12:13	21.97
Outfall-2	0.7702771	278.67	01Jan2026, 13:17	104.45
P-1	0.0147329	28.62	01Jan2026, 12:07	2.38
P-2	0.0016635	3.35	01Jan2026, 12:07	0.28
P-3	0.0586876	101.43	01Jan2026, 12:12	11.03
P-4a	0.0571712	98.21	01Jan2026, 12:12	10.95
P-4b	0.0219071	43.91	01Jan2026, 12:09	4.21
P-5	0.7483700	277.18	01Jan2026, 13:17	100.25
Reach-1	0.0571712	98.21	01Jan2026, 12:14	10.94

Project: Meridian S OA Simulation Run: Prop 100-yr

Start of Run: 01Jan2026, 00:00 Basin Model: Proposed
End of Run: 02Jan2026, 00:00 Meteorologic Model: 100-yr
Compute Time: 23Jun2026, 14:44:37 Control Specifications: Control 1

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
OFF-6	0.0243793	52.85	01Jan2026, 12:07	4.45
Orr-Gate-1	0.7702771	278.67	01Jan2026, 13:17	104.45
Outfall-1	0.1158588	197.46	01Jan2026, 12:13	21.97
Outfall-2	0.7702771	278.67	01Jan2026, 13:17	104.45
P-1	0.0147329	28.62	01Jan2026, 12:07	2.38
P-2	0.0016635	3.35	01Jan2026, 12:07	0.28
P-3	0.0586876	101.43	01Jan2026, 12:12	11.03
P-4a	0.0571712	98.21	01Jan2026, 12:12	10.95
P-4b	0.0219071	43.91	01Jan2026, 12:09	4.21
P-5	0.7483700	277.18	01Jan2026, 13:17	100.25
Reach-1	0.0571712	98.21	01Jan2026, 12:14	10.94

Project: Meridian S OA Simulation Run: Proposed Rational - 100 Year

Start of Run: 01Jan2026, 00:00 Basin Model: Proposed Rational - 100 Year
End of Run: 02Jan2026, 00:00 Meteorologic Model: 100-yr
Compute Time: 23Jun2026, 14:46:51 Control Specifications: Control 1

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Outfall-1	0.1	99.37	01Jan2026, 12:22	15.40
Pond-1	0.1	99.37	01Jan2026, 12:22	15.40
P-3	0.1	122.21	01Jan2026, 12:15	15.78

Project: Meridian S OA Simulation Run: Proposed Rational - 100 Year
Reservoir: Pond-1

Start of Run:	01Jan2026, 00:00	Basin Model:	Proposed Rational - 100 Year
End of Run:	02Jan2026, 00:00	Meteorologic Model:	100-yr
Compute Time:	23Jun2026, 14:46:51	Control Specifications:	Control 1

Volume Units: AC-FT

Computed Results

Peak Inflow:	122.21 (CFS)	Date/Time of Peak Inflow:	01Jan2026, 12:15
Peak Discharge:	99.37 (CFS)	Date/Time of Peak Discharge	01Jan2026, 12:22
Inflow Volume:	15.78 (AC-FT)	Peak Storage:	1.43 (AC-FT)
Discharge Volume	15.40 (AC-FT)	Peak Elevation:	4916.6 (FT)

METHODOLOGY

RIP-RAP ROCK SIZE PER EQUATION 863 OF THE TMRDM

ROCK SIZING (EXAMPLE)

$$d50 = 0.02Q^{4/3} / (TW Do^{4/3})$$

Q=100cfs

TW=2.5ft

Do=3.0ft

d50= 0.86 ft Size Class 300 Rip-Rap

OUTLET PROTECTION LENGTH PER EQUATION 859 OF THE TMRDM

PROTECTION LENGTH (EXAMPLE)

$$La = (1.8Q / Do^{1.5}) + 7D50$$

Q=100cfs

Do=3.0ft

D50=0.86ft

La= 40.7 ft

PROTECTION WIDTH (EXAMPLE)

$$W = 3Do + La \text{ for } TW < Do/2 \text{ or } W = 3Do + 0.4La \text{ for } TW > Do/2$$

Do=3.0ft

La=40.66ft

W= 49.7 ft

Outlet	100-year Flow (cfs)	Tailwater Depth (ft)	Outlet Diameter (ft)	Rip-Rap Protection d50 (ft)	Chosen Rip-Rap Class	Outlet Protection Length (ft)	Outlet Protection Width (ft)	
Culvert-1 (10' by 4' Box Culvert)	278.67	2.00	10.00	0.84	CLASS 300	21.8	51.78	
Outlet	100-year Flow (cfs)	Tailwater Depth (ft)	Outlet Diameter (ft)	Rip-Rap Protection d50 (ft)	Chosen Rip-Rap Class	Outlet Protection Length (ft)	Outlet Protection Width (ft)	
Detention Pond Inlet	116.7	3.00	4.00	0.60	CLASS 150	30.4	24.18	
Outlet	100-year Flow (cfs)	Tailwater Depth (ft)	Outlet Diameter (ft)	Rip-Rap Protection d50 (ft)	Chosen Rip-Rap Class	Outlet Protection Length (ft)	Outlet Protection Width (ft)	
Detention Pond Outlet	99.4	1.00	4.00	1.45	CLASS 400	32.5	44.51	
Outlet	100-year Flow (cfs)	Tailwater Depth (ft)	Outlet Diameter (ft)	Rip-Rap Protection d50 (ft)	Chosen Rip-Rap Class	Outlet Protection Length (ft)	Outlet Protection Width (ft)	
"A" System Outlet	5.5	0.40	1.25	0.36	CLASS 150	9.6	13.36	
Outlet	100-year Flow (cfs)	Tailwater Depth (ft)	Outlet Diameter (ft)	Rip-Rap Protection d50 (ft)	Chosen Rip-Rap Class	Outlet Protection Length (ft)	Outlet Protection Width (ft)	
Culvert-2	3.4	0.20	1.25	0.38	CLASS 150	7.0	10.72	

APPENDIX D

STEAMBOAT DITCH BREACH ANALYSIS FOR MERIDIAN 120 SOUTH VILLAGE 1 AND 2
TECHNICAL DRAINAGE REPORT FOR QUILICI RANCH BACKBONE ROAD PHASE 1A BY
TERRAPHASE ENGINEERING INC.

STEAMBOAT DITCH BREACH ANALYSIS
FOR
MERIDIAN 120 SOUTH VILLAGE 1 AND 2

Prepared for:

**Taylor Derrick Capital
1301 Seven Hills Road #230
Henderson, NV**

July 10th, 2026

Prepared by:

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(775) 823-4068
James Springgate, PE**



WOOD RODGERS
BUILDING RELATIONSHIPS ONE PROJECT AT A TIME

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APPENDIX C

TECHNICAL DRAINAGE REPORT FOR
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1 INTRODUCTION

This report serves as the Steamboat Ditch Breach Analysis for the Meridian 120 South Village 1 and 2 subdivision (Project), which will consist of 75 single-family lots. The purpose of this report is to analyze the drainage conditions of the Project site if the Steamboat Ditch embankment were to fail, in accordance with Truckee Meadows Regional Drainage Manual (TMRDM) and City of Reno development standards. This report is being submitted in conjunction with the *Technical Drainage Report for Meridian 120 South Village 1 and 2* by Wood Rodgers Inc and it is available in **Appendix C** of this report.

1.1 PROJECT LOCATION

The proposed Project site (APN 038-132-37) is situated within Section 16, Township 19 North, Range 18 East, Mount Diablo Meridian (T19N, R18E, MDM), in Washoe County, Nevada. The total parcel area is approximately 77 acres, with the proposed subdivision site consisting of roughly 36 acres and the remaining acreage left relatively undisturbed. The Project site is bounded by Interstate 80 to the north, Steamboat Ditch to the south, undeveloped land and Quilici Ranch Backbone to the west, and the existing Belli Ranch Estates subdivision to the east. A vicinity map is included in **Appendix A**.

The Steamboat Ditch runs along the southern boundary of the proposed subdivision and includes an existing gate structure that releases flow within non-irrigation season into a natural channel extending north through the site (Channel-2). As part of the proposed development, this structure will be upgraded to include a concrete overflow weir that allows excess ditch flows during larger storm events to safely enter Channel-2, reducing the potential for overtopping and downstream flooding east of the Project site. The existing channel will remain in place and will continue to convey flows beneath Juniper Bluff Drive through a proposed 10-foot by 4-foot box culvert.

A second overflow weir is proposed along the Steamboat Ditch near the end of Cloudshadow Court (Channel-1) to maintain the historic overflow pathway through the site. Flows released from this weir will be intercepted by downstream cut-off channels and conveyed through the proposed storm drain system (refer to the Proposed Hydrologic Basins Exhibit in **Appendix A**). In addition, several smaller drainage channels currently convey runoff from the Steamboat Ditch corridor toward the northern portion of the site. Under proposed conditions, these flows will be captured by cut-off channels and routed through the Project storm drain system to the detention pond.

The Project site is located in FEMA Zone X as is shown on the FEMA FIRM Panel 3014, Map Number 32031C3014G (Exhibit 3), located in **Appendix A**.

1.2 PROJECT DESCRIPTION

The Meridian 120 South Village 1 and 2 Project is located in Reno, Washoe County, Nevada, just south of the Boomtown Garson Road exit from Interstate 80. The Project site is currently undeveloped and generally drains from south to north. Existing drainage patterns are shown on the Existing Hydrologic Basins Exhibit in **Appendix A**. The Project consists of sixty-two



approximately 1/4 acre lots and thirteen approximately 1 acre lots. The Meridian 120 South Village 1 and 2 Development (Project) consists of single-family development areas, paved roads for access, a detention pond, storm drain infrastructure, an emergency access connection, a cul-de-sac, sidewalk, gutter, and associated infrastructure. The storm drain system, channels, and ponds have been designed to the standards of the *Truckee Meadows Regional Drainage Manual*, *City of Reno Public Works Design Manual*, and sound engineering practices.

2 PREVIOUS STUDIES

The *Quilici Ranch Backbone Road Phase 1A Technical Drainage Report* conducted by Terraphase Engineering in 2022 evaluated regional drainage conditions associated with the Steamboat Ditch, located east and upstream of the Project site. The study estimated the Steamboat Ditch capacity to be 107 cfs and documented historical overtopping and breach conditions when inflows exceeded this capacity. The findings were reviewed as part of this analysis to evaluate potential off-site drainage influences and conveyance limitations. Consistent with the study, a ditch capacity of 107 cfs was incorporated into the analysis to assess potential overflow conditions and the routing of excess flows along natural downstream drainage pathways during larger storm events. The report also includes a photo of the existing gate structure, also known as a “Flashboard Gate” that is located above Channel-2, that is also shown below in Figure 1.



Figure 1: Existing Flashboard Gate located above Channel-2 at the Steamboat Ditch.

3 METHODS

As the area being analyzed is larger than 100 acres, the TMRDM requires the Natural Resources Conservation Service (NRCS) unit hydrograph method be used to attain peak flows for the drainage basins. The NRCS method requires a curve number (CN), accumulated rainfall depth, and lag time for each basin. The equations for the NRCS method are:

$$Q = (P - 0.2S)^2 / (P + 0.8S)$$

$$S = \left(\frac{1000}{CN} \right) - 10$$

Where:

Q = Accumulated excess (inches)

P = Accumulated rainfall depth (inches)

S = Currently available soil moisture storage deficit (inches)

CN = Curve number (unitless)

A = Area of the basin (acres)

Analysis of peak flows was performed using HEC-HMS Version 4.2.1.

3.1 HYDROLOGIC ANALYSIS

The NRCS Unit Hydrograph Method was used to generate runoff hydrographs for the ditch breach analysis using HEC-HMS Version 4.2.1. The NRCS method was selected because the runoff area is over 100 acres and it also computes a complete runoff hydrograph, including the timing, peak discharge, and runoff volume required for unsteady hydraulic modeling in HEC-RAS. Hydrologic model inputs included drainage area, weighted curve number (CN), lag time, and 24-hour design rainfall depths obtained from NOAA Atlas 14. Weighted curve numbers were developed based on proposed land cover and hydrologic soil groups, while lag times were calculated in accordance with the Truckee Meadows Regional Drainage Manual (TMRDM). The resulting hydrographs represent runoff entering the Steamboat Ditch at the Channel-1 and Channel-2 overflow locations and were used as inflow boundary conditions in the HEC-RAS model to evaluate the performance of the proposed overflow weirs and simulate potential ditch breach scenarios.

3.1.1 Lag Time

The time of concentration (t_c) is defined as the time required for water to flow from the hydraulically most distant part of the drainage area to the point of consideration. Usually, the point of consideration is the discharge point of the basin or sub-basin. Time of concentration is used in the Rational Method to determine the corresponding rainfall intensity used to calculate the peak runoff rate of a given storm event for the basin or sub-basin. For basins less than one square mile in total area and slope less than 10 percent, the following equations shall be used in determining time of concentration.



$$t_c = t_i + t_t$$

Where:

t_c = time of concentration (minutes)

t_i = initial, overland flow time (minutes)

t_t = travel time in ditch, channel, gutter, pipe etc. (minutes)

$$t_i = \frac{1.8(1.1 - R)L_o^{1/2}}{S^{1/3}}$$

Where:

t_i = initial overland flow time (minutes)

R = flow runoff coefficient (for Rational Method equal to C_s from table 701 of TMRDM- in **Appendix A**)

L_o = length of overland flow (feet, 500 feet max.)

S = average overland basin slope (percent)

$$t_t = \frac{L}{V * 60}$$

Where:

t_t = travel time

L = length of water course

V = average water velocity

URBANIZED BASIN CHECK AND t_c MINIMUM

The final time of concentration shall be the lesser of t_c calculated above and the following subject to a minimum of 5 minutes for paved areas and 10 minutes for landscaped areas.

$$t_c = \frac{L}{180} + 10$$

Where L = watershed length (feet)

LAG TIME

Lag time (TLAG) for NRCS calculations is defined as:

$$TLAG = t_c * 0.6$$

Tables detailing the t_c and TLAG values for the analyzed basins for existing and proposed conditions are included in Appendices B and C, respectively.

FOR BASINS GREATER THAN ONE SQUARE MILE IN TOTAL AREA OR SLOPE GREATER THAN 10 PERCENT

Lag time (TLAG) for NRCS calculations is defined as:



$$TLAG = 22.1K_n(L * \frac{L_c}{S^{0.5}})^{0.33}$$

Where:

K_n = Roughness Factor

L = Length of longest water course (miles)

L_c = Length along longest watercourse measured upstream to basin centroid (miles)

S = Representative slope along watercourse (feet/mile)

3.1.2 Design Rainfall Depths

Precipitation depth estimates were taken from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 1, Version 5, which provides rainfall information for latitude and longitude. It was determined that the centroid of the largest basin (P-5) latitude and longitude are approximately 39.494 North and 119.962 West. Depth numbers are included in Appendix A of this report.

3.1.3 Curve Number

The Runoff Curve Number (CN) for each basin is determined by overlaying land use information about the basin with soil data available for the basin. Soil types are rated from A to D with correspondingly higher curve number values. The overall CN for a basin is a weighted average for each area based on the land uses and soil curve numbers. Tables of Runoff Curve Numbers For Urban Areas and Runoff Curve Numbers For Arid And Semiarid Rangelands are included in **Appendix A** of this report. A table summarizing the weighted average CN for each basin of the existing and proposed site conditions is included in **Appendix A** of this report.

The land covers were determined utilizing ArcGIS aerial imagery and site photographs. The existing vegetation at lower elevations is primarily cheat grass with some low bushes and sagebrush, resulting in a primary land use of "Herbaceous, Fair" At higher elevations, the land use transitions into "Brush, Fair," "Brush, Good," and "Meadow". Please reference the Proposed Hydrologic Conditions Exhibits in **Appendix A**.

4 HISTORIC DRAINAGE SYSTEM

Historically, the site has drained primarily to the north and northeast through a combination of shallow overland flow paths, natural drainageways, and existing channels. The Steamboat Ditch is located south of and at a higher elevation than the Project site, making it a significant influence on existing drainage patterns. Based on correspondence from JUB, the Steamboat Ditch has overtopped in this area during periods of high stormwater runoff, including an event during the winter of 2024/2025 when drainage from NFD Road 100 froze within the canal and contributed to overtopping conditions prior to completion of the Toll Brothers improvements. During larger storm events, runoff from upstream tributary basins may overtop the ditch or be released through existing gate structures, following natural drainage pathways across the site before ultimately discharging toward the Truckee River. Existing drainage conditions were evaluated to identify historic flow paths, quantify peak runoff rates at major discharge locations, and establish baseline conditions for comparison with proposed conditions.



5 DITCH BREACH ANALYSIS

5.1 STEAMBOAT DITCH BACKGROUND

According to the *Technical Drainage Report for Quilici Ranch Backbone Road Phase 1A* prepared by Terraphase Engineering, the Steamboat Ditch typically conveys approximately 50 cfs for irrigation operations and has an estimated capacity of 107 cfs based on Manning's equation. The report also references the following historical information from the project-related Cultural Resources Inventory Short Report:

"Construction of the Steamboat Ditch was completed on July 1, 1880. The constructed ditch dimensions were 6-feet wide at the bottom, 8-feet wide at the top, and had a total depth of 3-feet. Of the 3-foot depth, the upper one-foot was comprised of excavated material placed on the downslope embankment. The constructed longitudinal slope of the Steamboat Ditch was 8-feet per mile or 0.15%."

Using these dimensions and slope, the ditch capacity was independently calculated as approximately 78 cfs with Manning's equation. However, 107 cfs was used in this analysis for consistency with prior reports and to provide a conservative basis; the ditch top width was also independently verified as 12 feet. It is likely that Terraphase computed this capacity using a top width of 12 feet rather than 8 feet, as a top width of 12 feet gives a capacity of 107 cfs, as can be seen in **Appendix A**.

The report also notes that irrigation diversions from the Truckee River generally occur between April 1 and October 30, although diversions may cease earlier during dry years. During the non-irrigation season, diversion gates are opened to allow flow to follow natural drainage pathways rather than being routed into the Steamboat Ditch. One such gate was identified within the Project vicinity; at Channel-2.

5.2 POINTS OF ANALYSIS

The Steamboat Ditch was evaluated at two locations for the ditch breach analysis, Channel-1 and Channel-2, where the ditch receives the largest off-site tributary flows upstream of the Project site. Because these locations represent the greatest potential for overtopping or embankment failure, two overflow control structures are proposed. These structures will serve as overflow weirs composed of trapezoidal concrete embankments. Each weir will be set 3 inches above the typical ditch water surface elevation during the summer irrigation season. The HEC-RAS model was used to evaluate the drainage performance of the Village 1 and 2.

Channel-1 and Channel-2 were modeled as independent breach scenarios because their downstream conveyance paths and associated drainage facilities are hydraulically separate. Accordingly, a simultaneous breach at both locations would not alter the modeled routing or hydraulic performance of either system relative to the individual breach scenarios. A detail of the Channel-1 and Channel-2 overflow weir is provided below in Figures 2 and 3, respectively:



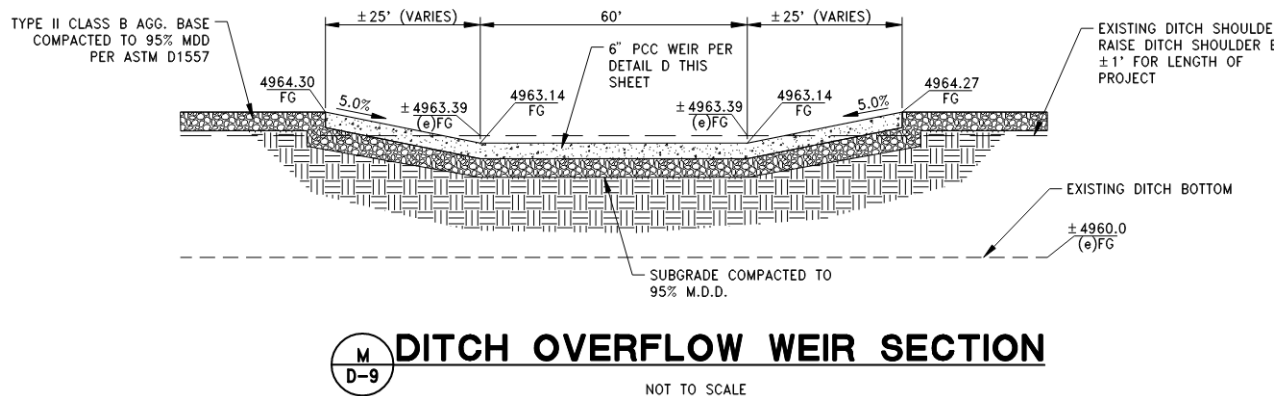


Figure 2: Channel-1 Steamboat Ditch Overflow Weir Section

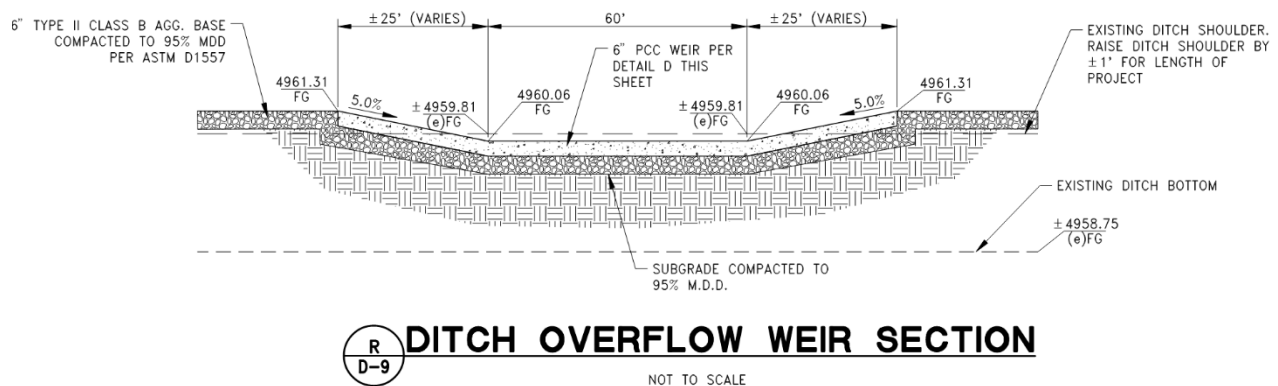


Figure 3: Channel-2 Steamboat Ditch Overflow Weir Section

5.3 DEVELOPMENT OF HYDROGRAPHS

Hydrographs were developed for off-site runoff contributing to Channel-1 and Channel-2 using HEC-HMS Version 4.2.1 and the NRCS Unit Hydrograph Method. Channel-1 receives runoff from Basin P-4a, while Channel-2 receives runoff from Basins P-4b and P-5. The basin extents are shown on the Proposed Hydrologic Conditions Exhibit in **Appendix A**. Within the HEC-HMS model, “Reach-1” represents the hydrograph location for Channel-1, and “Orr-Gate-1” represents the hydrograph location for Channel-2. The corresponding HEC-HMS results are also included in **Appendix A**.

To evaluate potential Steamboat Ditch embankment-failure conditions, the Channel-1 and Channel-2 hydrographs were adjusted to include flow released from the ditch during a progressive breach. Embankment erosion was assumed to occur at a rate of 9 inches every 5 minutes, resulting in complete failure of the 36-inch embankment after 20 minutes. As a conservative assumption, erosion was initiated when the peak runoff hydrograph reached the ditch.

Ditch conveyance capacities were calculated for remaining embankment heights of 36, 27, 18, 9, and 0 inches. These capacities were used to develop the breach curves shown in Figures 5 and 7 and included in Appendix A. Each breach curve was aligned with the timing of the corresponding

peak inflow to estimate the additional flow released from the Steamboat Ditch during the breach event.

Figures 4 and 6 present the resulting Channel-1 and Channel-2 hydrographs, respectively. The blue curves represent the original off-site runoff hydrographs, while the green curves represent the combined hydrographs, including the original runoff and the cumulative flow released from the Steamboat Ditch during the assumed breach. The ditch is assumed to contain 107 cfs continuously.

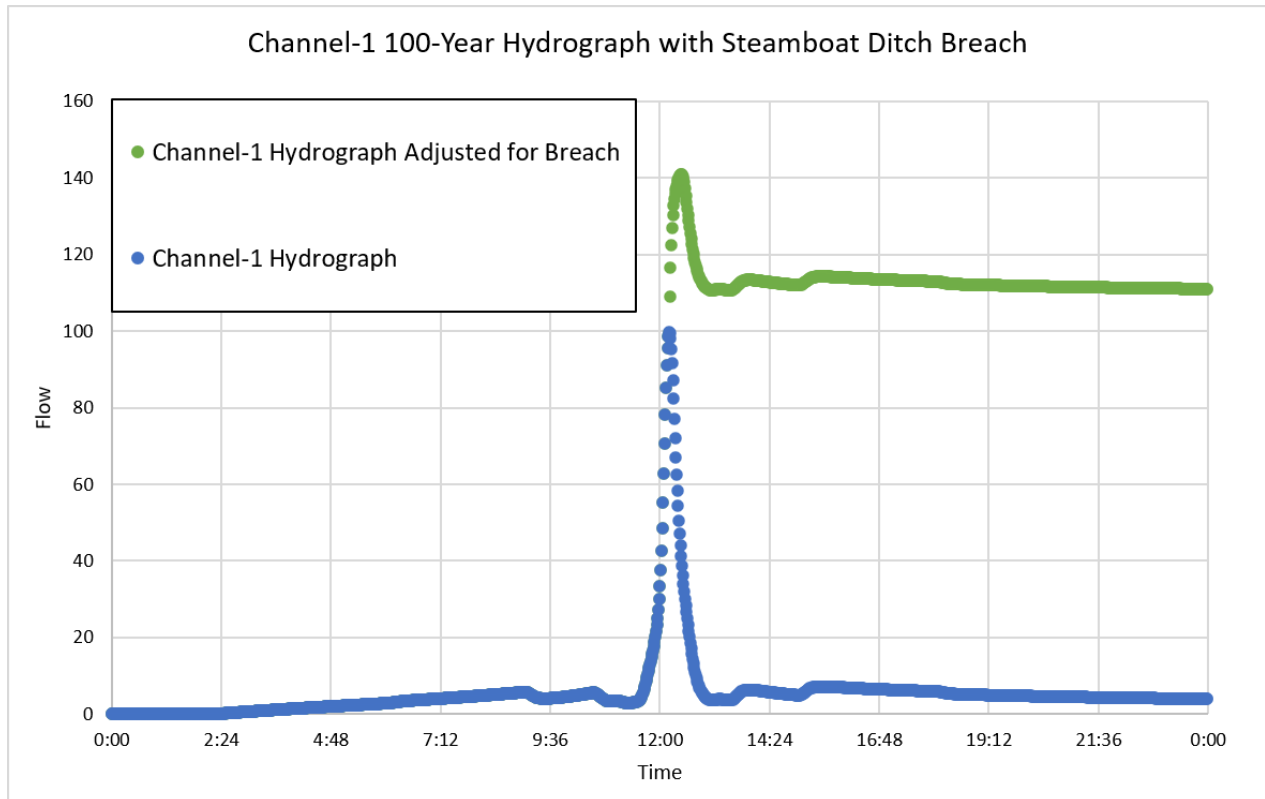


Figure 4: Channel-1 100-Year Hydrograph, including flow released from the Steamboat Ditch during a progressive 20-minute embankment breach beginning at the time of peak runoff.

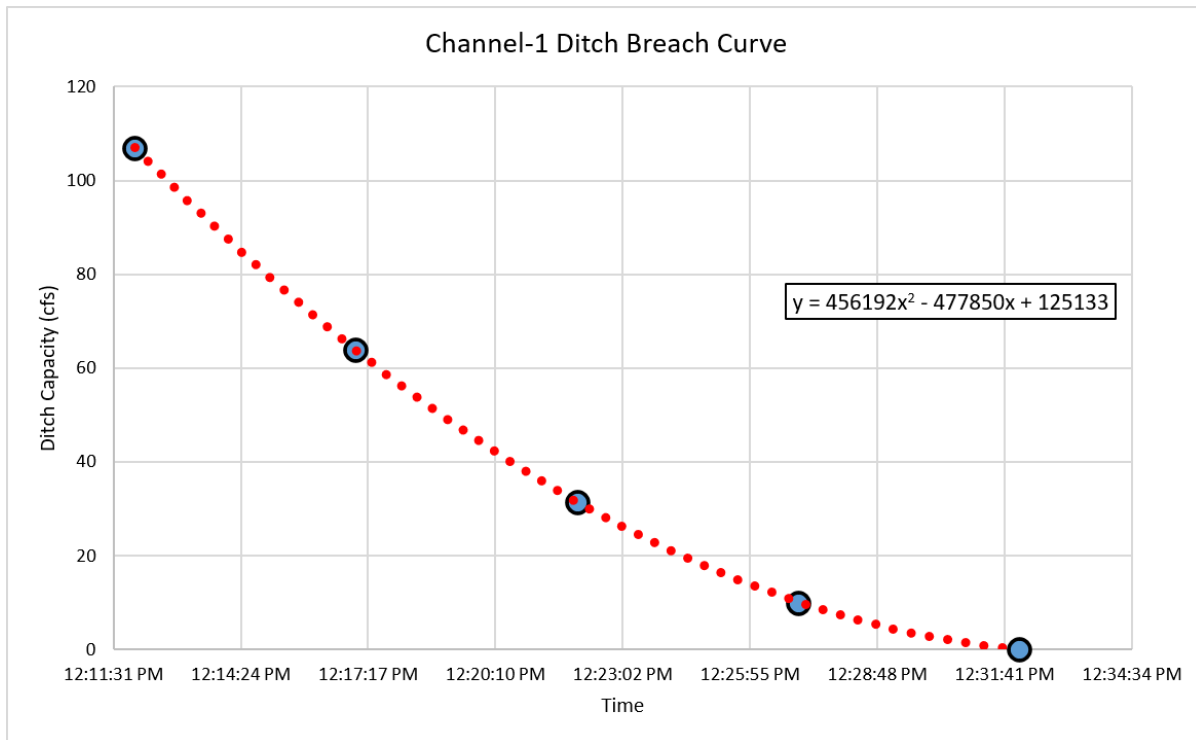


Figure 5: Channel-1 Ditch Breach Curve showing the assumed reduction in ditch conveyance capacity beginning at the peak-flow time of 12:12 p.m., based on embankment erosion of 9 inches every 5 minutes.

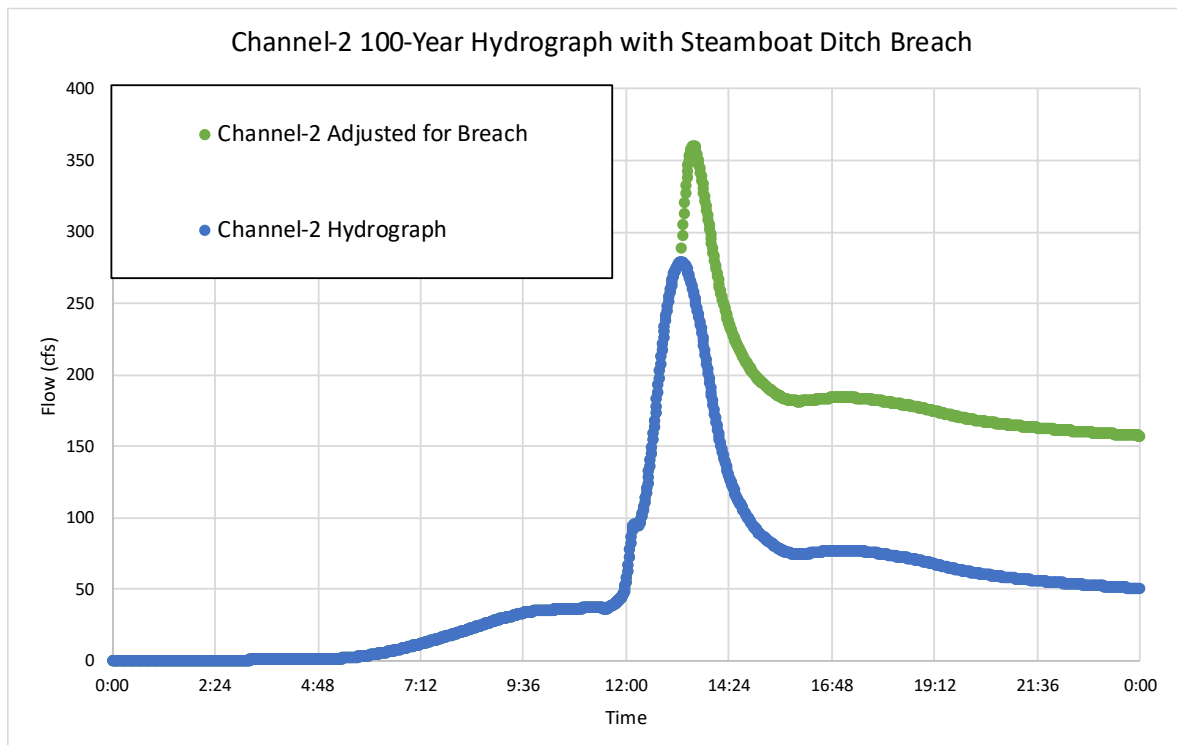


Figure 6: Channel-2 100-Year Hydrograph, including flow released from the Steamboat Ditch during a progressive 20-minute embankment breach beginning at the time of peak runoff.

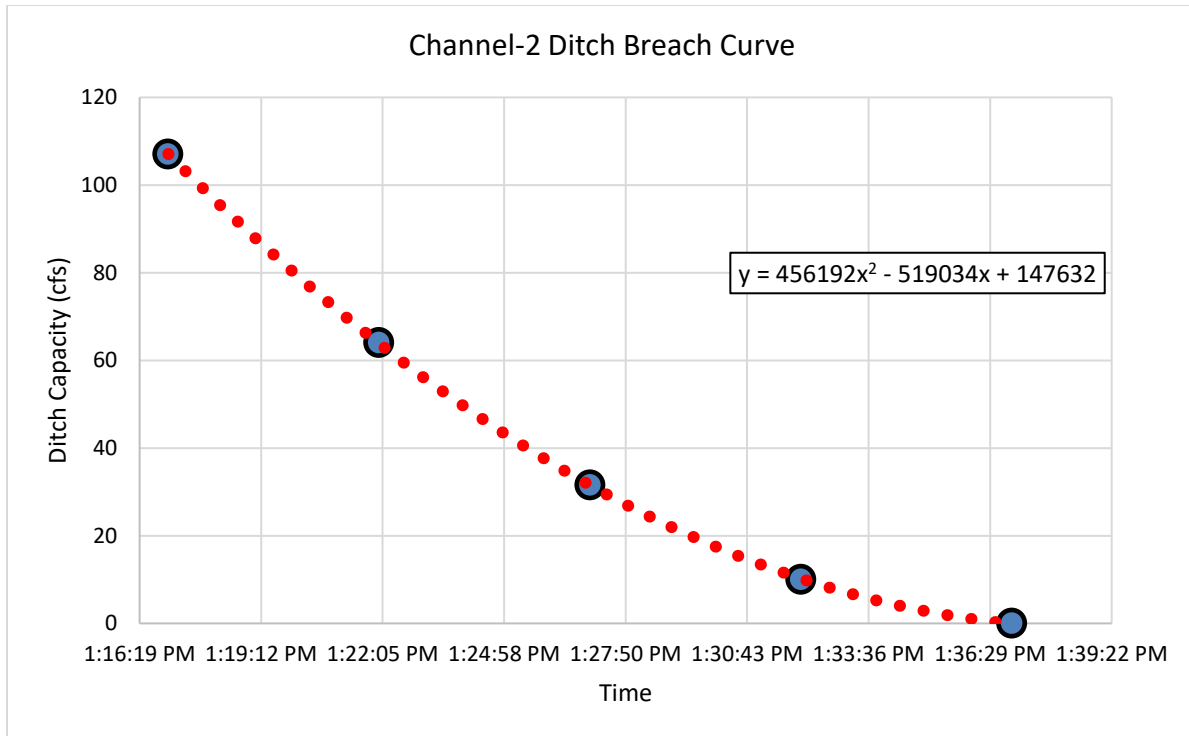


Figure 7: Channel-2 Ditch Breach Curve showing the assumed reduction in ditch conveyance capacity beginning at the corresponding peak-flow time, based on embankment erosion of 9 inches every 5 minutes.

5.4 MODEL DEVELOPMENT AND REFINEMENT

The Steamboat Ditch embankment breach model utilizes an unsteady 2d flow data model with a 24-hour duration and was created using HEC-RAS version 6.5.

5.4.1 Manning's n Selection

The HEC-RAS model utilizes a digital elevation model (DEM) terrain raster that is made up of the finished grade surface of Village 1 and 2, along with the existing grade terrain raster taken from the U.S. Geological Survey (2017) with the existing surface, to cover any "holes" or areas the finished grade may have missed. The proposed finished grade surface was utilized in priority to the existing grade surface. The model utilizes Manning's n coefficients to represent different surface characteristics that impact the velocity/friction of flow. Attached within Appendix A is the National Land Cover Database (NLCD) Land Cover Types that was obtained from the HEC-RAS 2D User's Manual. The manual was used as a guideline for selecting Manning's n values. For example, the NLCD Land Cover Table gives a range of 0.08 – 0.16 for "Developed, Medium Intensity" and 0.12 was selected for "Residential ¼ Acre" or another example is the table gives a value of 0.025 – 0.05 for "Grassland/Herbaceous" and land covers of "Herbaceous, Fair" were given a Manning's n value of 0.035. Refer to Appendix A for an exhibit showing the Manning's n land covers on the development area, with the following Manning's n values used within the analysis:

Table 1: HEC-RAS Manning's n Land Cover Summary Table	
Land Cover	Manning's n
Pavement	0.02
Cut-Off Channel	0.025
Herbaceous, Fair	0.035
Main Channel	0.08
Residential 1 Acre	0.09
NoData	0.1
Residential 1/4 Acre	0.12

5.4.2 Boundary Condition Methodology

The model uses boundary condition lines to convey flow in and out of the model. There is a total of four boundary condition lines within the model, one for Channel-1 inflow, one for Channel-1 outflow, one for Channel-2 inflow, and one for Channel-2 outflow. The inflow boundary conditions utilize the hydrographs discussed above in Section 5.3 and are drawn using civil linework to match the location of the proposed weirs. The inflow boundary conditions lines are drawn directly below the Steamboat Ditch, below the crest of the weir. The weirs were not directly added to the model, but instead the hydrographs explained above were input directly below the weir structure, upstream of the subdivision. The normal-depth boundary condition requires a downstream friction slope. The Channel-1 boundary condition outflow line was given a slope of 0.01 to match the average downstream slope, and Channel-2 was given a friction slope of 0.04 to resemble the steeper downstream slope in the natural channel. Please see the extent of the boundary condition lines below, with inflows in yellow and outflows in green.

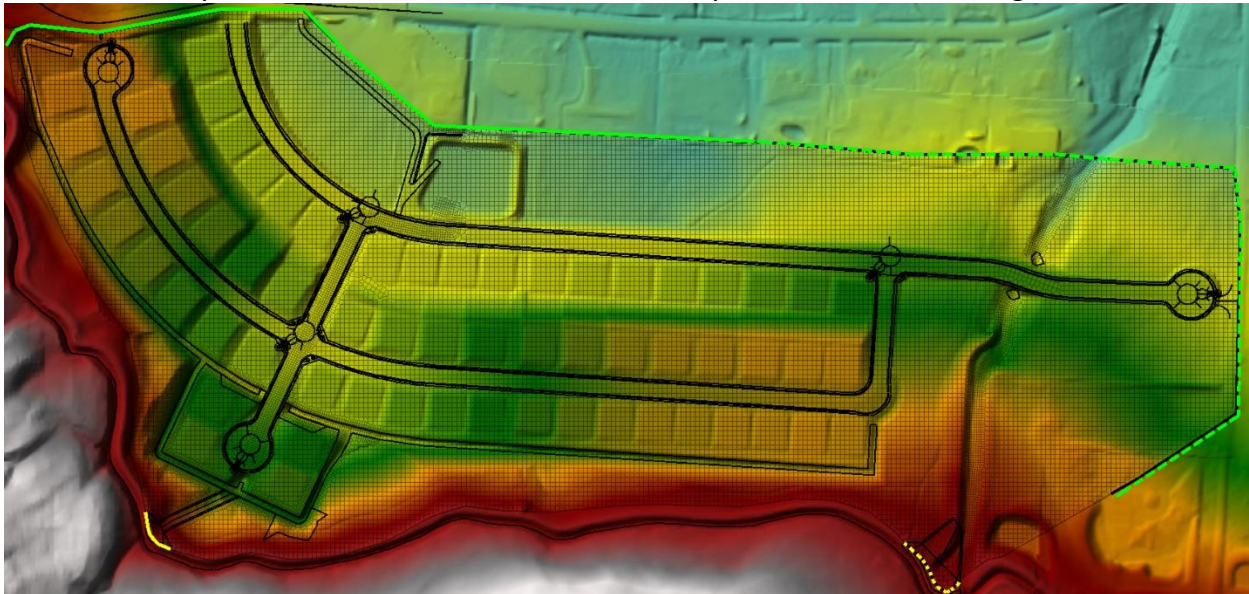


Figure 8: HEC-RAS flow area showing boundary condition lines. Inflow boundaries are shown in yellow, outflow boundaries in green, Channel-1 with solid lines, and Channel-2 with dashed lines.

5.4.3 SA/2D Connection Methodology

The HEC-RAS model incorporates four culvert crossings. Two of these culverts are located at the downstream termini of Cut-off Channel 12 and Cut-off Channel 14 (refer to the Proposed Hydrologic Basins Exhibit in Appendix A). In HEC-RAS 2D, culverts are modeled as part of a SA/2D Area Connection, which requires a connecting embankment (weir) geometry. The weir represents the roadway, berm, or grade separation through which the culvert passes and allows the model to evaluate both culvert flow and potential overtopping if the culvert capacity is exceeded. Because the culverts associated with Cut-off Channels 12 and 14 discharge through the same embankment feature, a single weir structure was used to represent both crossings, resulting in a total of three weirs within the model.

Under proposed conditions, each cut-off channel will terminate in a flared end section connected to a 24-inch lateral pipe. These lateral pipes convey runoff to the proposed storm drain system, which ultimately discharges to the detention pond. To accurately represent this drainage pathway and prevent unrealistic ponding or flow blockage within the 2D model, simplified culvert representations were incorporated into HEC-RAS. While these modeled culverts are not intended to be an exact representation of the proposed storm drain network, the pipe diameters, inlet elevations, and outlet elevations are consistent with the proposed design. For modeling simplicity, the lateral pipes discharge directly to the detention pond rather than connecting to the proposed 36-inch storm drain main.

The model also includes the proposed culvert crossing beneath Juniper Bluff Drive (Culvert-1), which consists of a 10-foot by 4-foot reinforced concrete box culvert. A fourth culvert was included to represent the outlet structure from the proposed detention pond (Pond-1). The hydraulic performance of Pond-1 was evaluated in greater detail using HEC-HMS and is discussed in Section 5.8 of the *Technical Drainage Report for Meridian 120 South Village 1 and 2*. Figure 9 illustrates the locations of the four culvert barrels modeled in HEC-RAS, shown in blue:

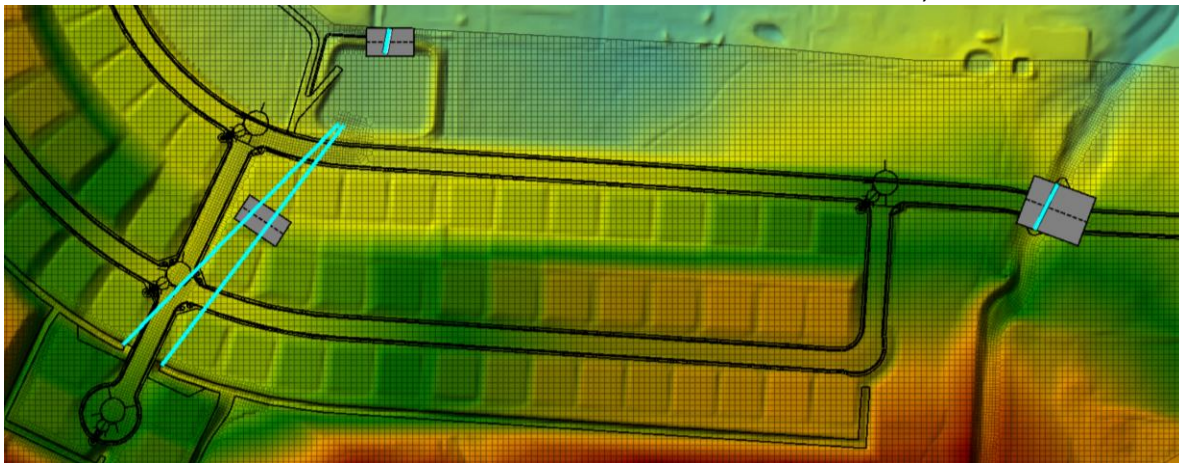


Figure 9: HEC-RAS model showing culvert locations (blue) and SA/2D connection embankments/weirs (gray).

5.4.4 Refinement Region Methodology

The HEC-RAS model utilizes multiple breaklines along hydraulically sensitive features to improve the representation of flow paths and terrain within the computational mesh. Breaklines were placed along channels, roadway embankments, cut-off ditch alignments, culverts, and other linear features where abrupt changes in elevation or flow direction occur. These breaklines force cell faces and cell centers to align with key topographic features, resulting in a more accurate representation of flow conveyance, water surface elevations, and hydraulic connectivity throughout the model. The use of breaklines also allows for greater model accuracy in critical areas without requiring excessive refinement of the entire mesh, improving both computational efficiency and overall model performance.

5.4.5 Terrain Modifications

The model also incorporates select terrain modifications representing anticipated future grading for the proposed 1-acre lots. These modifications were used to evaluate minimum lot elevations and localized grading measures needed to reduce the potential for inundation during a hypothetical ditch-breach event. For example, Lots 1, 2, and 3 were modeled with a minimum pad elevation of 4,921 feet. This minimum elevation will be incorporated into the Final Improvement Plans. An additional conceptual terrain modification was included along the perimeter of Lot 27 and the southern edge of Lot 28, as shown in Figure 10:

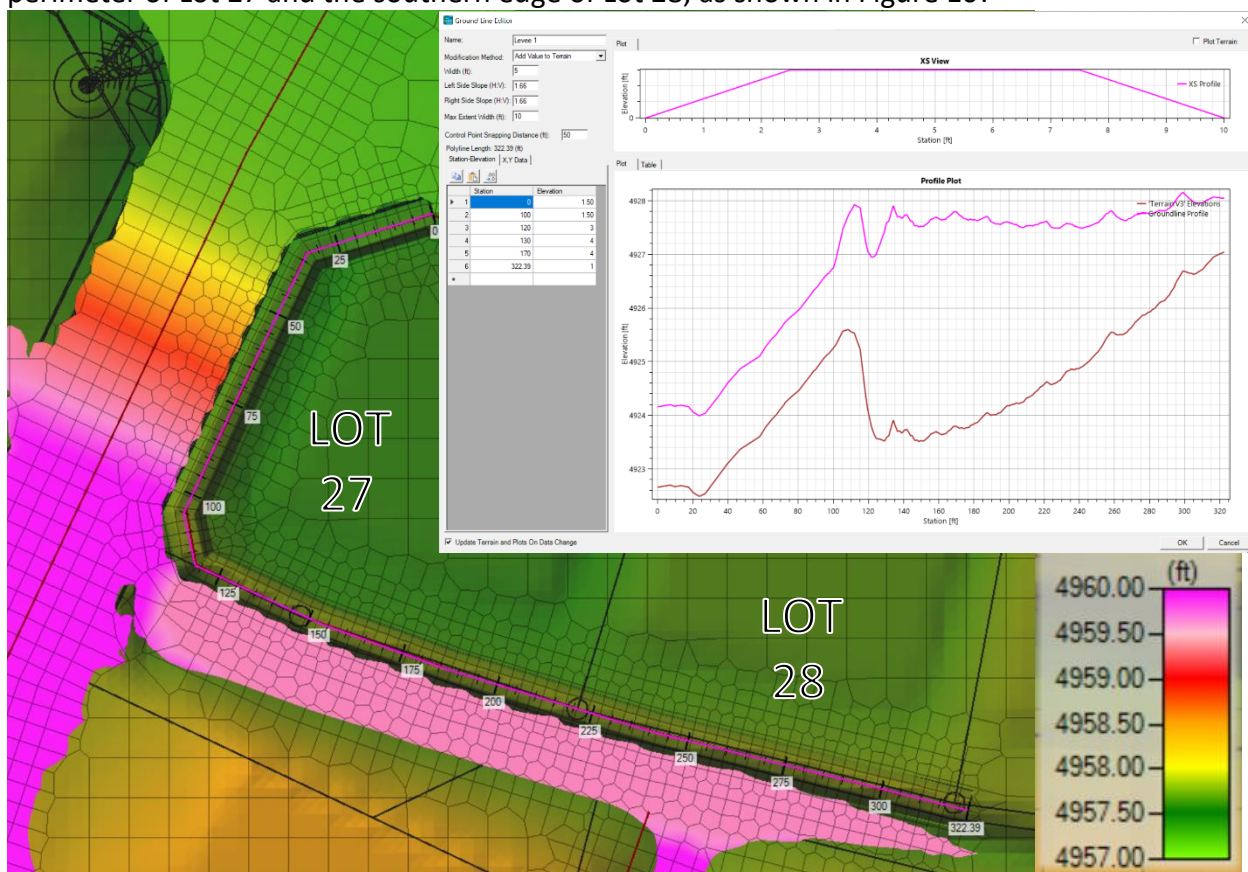


Figure 10: Conceptual Terrain Modification Along Lots 27 and 28 (within the profile plot the pink line represents terrain modification; red line represents the current Civil 3D surface)

The modification was included to prevent modeled breach flow from entering the proposed lots and to maintain the intended conveyance path through the Project site. This feature is not currently represented in the Civil 3D grading surface.

The next design submittal will incorporate a continuous engineered flood-protection feature in this area, such as raised perimeter grading, a berm, a floodwall, or another hydraulically equivalent measure. The final Civil 3D surface and HEC-RAS terrain will be updated to reflect the selected design. The hydraulic results presented in this report are contingent upon the final improvement being constructed to an elevation and alignment consistent with the terrain modification represented in the model.

5.4.6 HEC-RAS Results

The HEC-RAS Results indicate that if the Steamboat Ditch were to breach above Channel-1 or Channel-2, where the Project site receives the most off-site flow, the flow would be passed safely through the project site. The results indicate that modeled flow may extend beyond the roadway right-of-way in localized areas. However, the maximum modeled water-surface elevations remain below the proposed residential pad elevations when the terrain modifications described in Section 5.4.5 are included. Results are available within Appendix B for maximum velocity and depth rasters generated by HEC-RAS.

6 CONCLUSIONS

The Steamboat Ditch breach analysis evaluated potential overtopping and embankment-failure conditions at the Channel-1 and Channel-2 locations, where the largest off-site tributary flows enter the ditch upstream of the Project. Hydrologic inflow hydrographs were developed using the NRCS Unit Hydrograph Method, and were routed through the proposed development using an unsteady two-dimensional HEC-RAS model.

Based on the assumptions and proposed grading represented in the hydraulic model, flows from the evaluated breach scenarios can be routed through the Project site by the proposed overflow weirs, drainage channels, culverts, storm drain system, and detention facilities. The modeling indicates that localized flow may extend outside of the roadway right-of-way; however, the proposed residential pads are not anticipated to experience inundation, with the minimum pad elevations that are incorporated into the Final Improvement Plans.

The final grading design will include the minimum pad elevation of 4,921 feet for Lots 1 through 3 and an appropriate flood-protection feature along the southern and western perimeter of Lot 27 and the southern edge of Lot 28.

The proposed drainage facilities are anticipated to adequately manage flows from the evaluated Steamboat Ditch breach scenarios without adversely affecting proposed building pads or adjacent properties.



7 REFERENCES

City of Reno. *Public Works Design Manual*. Revised March 11, 2026.

HEC-HMS Hydraulic Modeling System, Version 4.2.1, U.S. Army Corps of Engineers.

HEC-RAS River Analysis System, Version 6.5, U.S. Army Corps of Engineers.

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Technical Drainage Study for Meridian 120 South Village 1 and 2, Reno, Nevada, Submittal 1, July 2026

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Terraphase Engineering Inc. (2022). *Technical Drainage Report, Backbone Road Phase 1A, Quilici Ranch, Reno, Nevada, Revision 2, Project No. N003.001, August 19, 2022.*

U.S. Army Corps of Engineers. (2024). *Creating Land Cover, Manning's n Values, and Percent Impervious Layers (HEC-RAS 2D User's Manual, Version 6.6)*. Hydrologic Engineering Center, Davis, California.

U.S. Geological Survey. (2020, March 30). *USGS one meter x76y438 NV Reno Carson QL1 2017*. U.S. Geological Survey



APPENDIX A

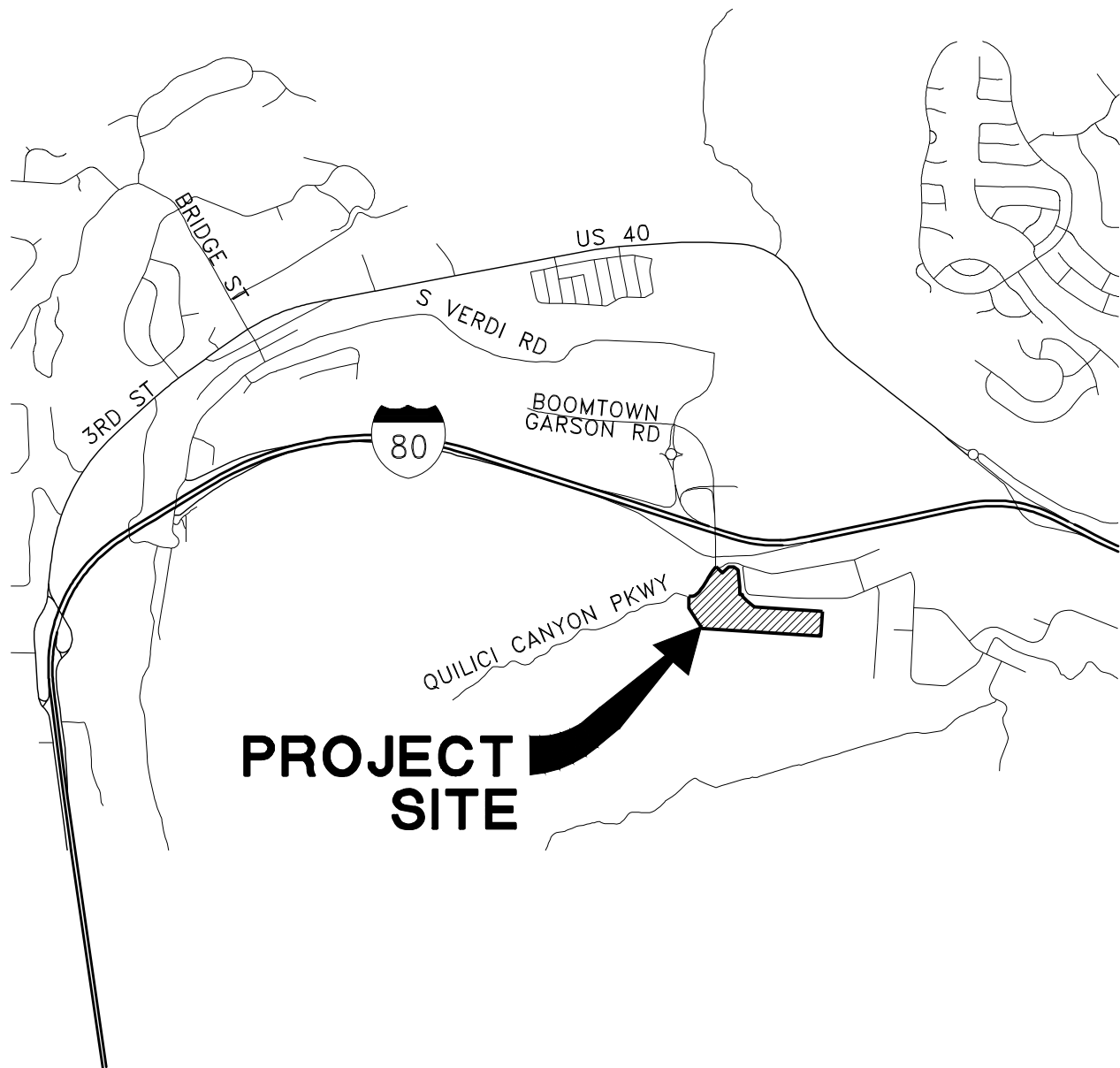
GENERAL FIGURES

VICINITY MAP
MERIDIAN 120 SOUTH
VILLAGES 1 & 2

RENO

NEVADA

APRIL, 2026



**PROJECT
SITE**

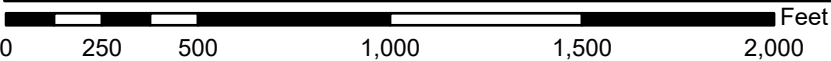


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Reno, NV 89502 Fax 775.823.4066

National Flood Hazard Layer FIRMMette



119°57'58"W 39°30'38"N



1:6,000

119°57'21"W 39°30'10"N

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
		Area of Undetermined Flood Hazard Zone D
GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
		Profile Baseline
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped



The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on **4/21/2026 at 5:23 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.



NOAA Atlas 14, Volume 1, Version 5
Location name: Reno, Nevada, USA*
Latitude: 39.4942°, Longitude: -119.962°
Elevation: 5498 ft**
 * source: ESRI Maps
 ** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps_&_aerials](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.114 (0.097-0.131)	0.142 (0.122-0.165)	0.187 (0.161-0.220)	0.231 (0.198-0.272)	0.305 (0.254-0.363)	0.375 (0.303-0.450)	0.457 (0.358-0.559)	0.559 (0.421-0.698)	0.726 (0.516-0.934)	0.883 (0.598-1.16)
10-min	0.174 (0.149-0.199)	0.216 (0.185-0.251)	0.285 (0.245-0.335)	0.352 (0.302-0.414)	0.464 (0.387-0.552)	0.570 (0.461-0.685)	0.696 (0.545-0.850)	0.851 (0.640-1.06)	1.11 (0.785-1.42)	1.34 (0.911-1.77)
15-min	0.215 (0.184-0.247)	0.267 (0.230-0.310)	0.353 (0.304-0.415)	0.437 (0.374-0.514)	0.576 (0.480-0.685)	0.706 (0.571-0.850)	0.863 (0.676-1.05)	1.06 (0.794-1.32)	1.37 (0.973-1.76)	1.67 (1.13-2.20)
30-min	0.290 (0.247-0.332)	0.360 (0.309-0.418)	0.476 (0.409-0.558)	0.588 (0.503-0.692)	0.775 (0.647-0.922)	0.951 (0.769-1.14)	1.16 (0.910-1.42)	1.42 (1.07-1.77)	1.85 (1.31-2.37)	2.24 (1.52-2.96)
60-min	0.359 (0.306-0.411)	0.445 (0.382-0.517)	0.589 (0.507-0.691)	0.728 (0.623-0.856)	0.960 (0.800-1.14)	1.18 (0.952-1.42)	1.44 (1.13-1.76)	1.76 (1.32-2.19)	2.28 (1.62-2.94)	2.78 (1.88-3.66)
2-hr	0.486 (0.434-0.551)	0.602 (0.539-0.684)	0.763 (0.677-0.869)	0.904 (0.794-1.03)	1.12 (0.960-1.29)	1.32 (1.10-1.53)	1.55 (1.26-1.82)	1.85 (1.46-2.21)	2.39 (1.81-2.96)	2.90 (2.12-3.69)
3-hr	0.597 (0.539-0.668)	0.741 (0.674-0.832)	0.916 (0.826-1.03)	1.06 (0.950-1.19)	1.26 (1.12-1.43)	1.45 (1.26-1.65)	1.66 (1.42-1.92)	1.97 (1.64-2.31)	2.49 (2.02-2.99)	2.99 (2.36-3.72)
6-hr	0.897 (0.813-0.996)	1.12 (1.01-1.24)	1.36 (1.23-1.52)	1.55 (1.39-1.73)	1.80 (1.59-2.02)	1.98 (1.73-2.23)	2.16 (1.87-2.46)	2.39 (2.04-2.76)	2.82 (2.37-3.31)	3.26 (2.69-3.86)
12-hr	1.27 (1.14-1.41)	1.58 (1.43-1.76)	1.97 (1.77-2.20)	2.28 (2.03-2.54)	2.68 (2.36-3.02)	2.99 (2.61-3.38)	3.30 (2.84-3.78)	3.62 (3.06-4.19)	4.03 (3.33-4.76)	4.37 (3.54-5.24)
24-hr	1.70 (1.54-1.91)	2.13 (1.92-2.39)	2.69 (2.42-3.01)	3.15 (2.83-3.52)	3.79 (3.38-4.24)	4.31 (3.81-4.82)	4.84 (4.25-5.44)	5.41 (4.69-6.11)	6.19 (5.28-7.05)	6.81 (5.73-7.83)
2-day	2.14 (1.89-2.44)	2.69 (2.38-3.08)	3.46 (3.05-3.96)	4.10 (3.60-4.68)	5.01 (4.36-5.74)	5.75 (4.97-6.60)	6.54 (5.60-7.57)	7.38 (6.25-8.62)	8.58 (7.12-10.2)	9.55 (7.78-11.5)
3-day	2.37 (2.09-2.71)	3.00 (2.65-3.44)	3.92 (3.45-4.48)	4.68 (4.10-5.35)	5.77 (5.02-6.62)	6.67 (5.75-7.67)	7.64 (6.51-8.84)	8.69 (7.30-10.1)	10.2 (8.38-12.0)	11.4 (9.24-13.7)
4-day	2.60 (2.29-2.98)	3.31 (2.91-3.80)	4.37 (3.84-5.02)	5.25 (4.60-6.02)	6.53 (5.67-7.50)	7.59 (6.52-8.74)	8.74 (7.42-10.1)	9.99 (8.35-11.6)	11.8 (9.65-13.9)	13.3 (10.7-15.9)
7-day	3.13 (2.69-3.68)	4.02 (3.45-4.73)	5.38 (4.61-6.33)	6.48 (5.54-7.62)	8.06 (6.82-9.50)	9.36 (7.85-11.0)	10.8 (8.95-12.8)	12.2 (10.1-14.6)	14.4 (11.6-17.4)	16.1 (12.8-19.7)
10-day	3.59 (3.10-4.20)	4.63 (3.99-5.42)	6.21 (5.34-7.27)	7.47 (6.41-8.73)	9.23 (7.86-10.8)	10.6 (9.01-12.5)	12.2 (10.2-14.3)	13.8 (11.4-16.3)	16.0 (13.0-19.2)	17.8 (14.3-21.6)
20-day	4.74 (4.10-5.58)	6.11 (5.29-7.20)	8.15 (7.04-9.55)	9.74 (8.39-11.4)	11.9 (10.2-14.0)	13.6 (11.6-16.0)	15.4 (13.0-18.3)	17.3 (14.4-20.6)	19.8 (16.2-23.9)	21.8 (17.7-26.6)
30-day	5.80 (5.02-6.87)	7.48 (6.47-8.87)	9.96 (8.60-11.8)	11.9 (10.2-14.0)	14.5 (12.4-17.1)	16.6 (14.1-19.6)	18.7 (15.8-22.2)	20.9 (17.5-25.0)	24.0 (19.8-28.8)	26.4 (21.5-32.0)
45-day	7.10 (6.16-8.14)	9.17 (7.96-10.5)	12.2 (10.6-14.0)	14.4 (12.5-16.6)	17.5 (15.0-20.1)	19.8 (16.9-22.8)	22.1 (18.8-25.6)	24.5 (20.7-28.5)	27.8 (23.1-32.5)	30.2 (24.9-35.7)
60-day	7.98 (6.84-9.20)	10.4 (8.88-11.9)	13.8 (11.8-15.9)	16.2 (13.9-18.7)	19.4 (16.5-22.4)	21.7 (18.4-25.2)	24.0 (20.2-27.9)	26.3 (22.0-30.7)	29.3 (24.3-34.4)	31.4 (25.9-37.1)

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

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

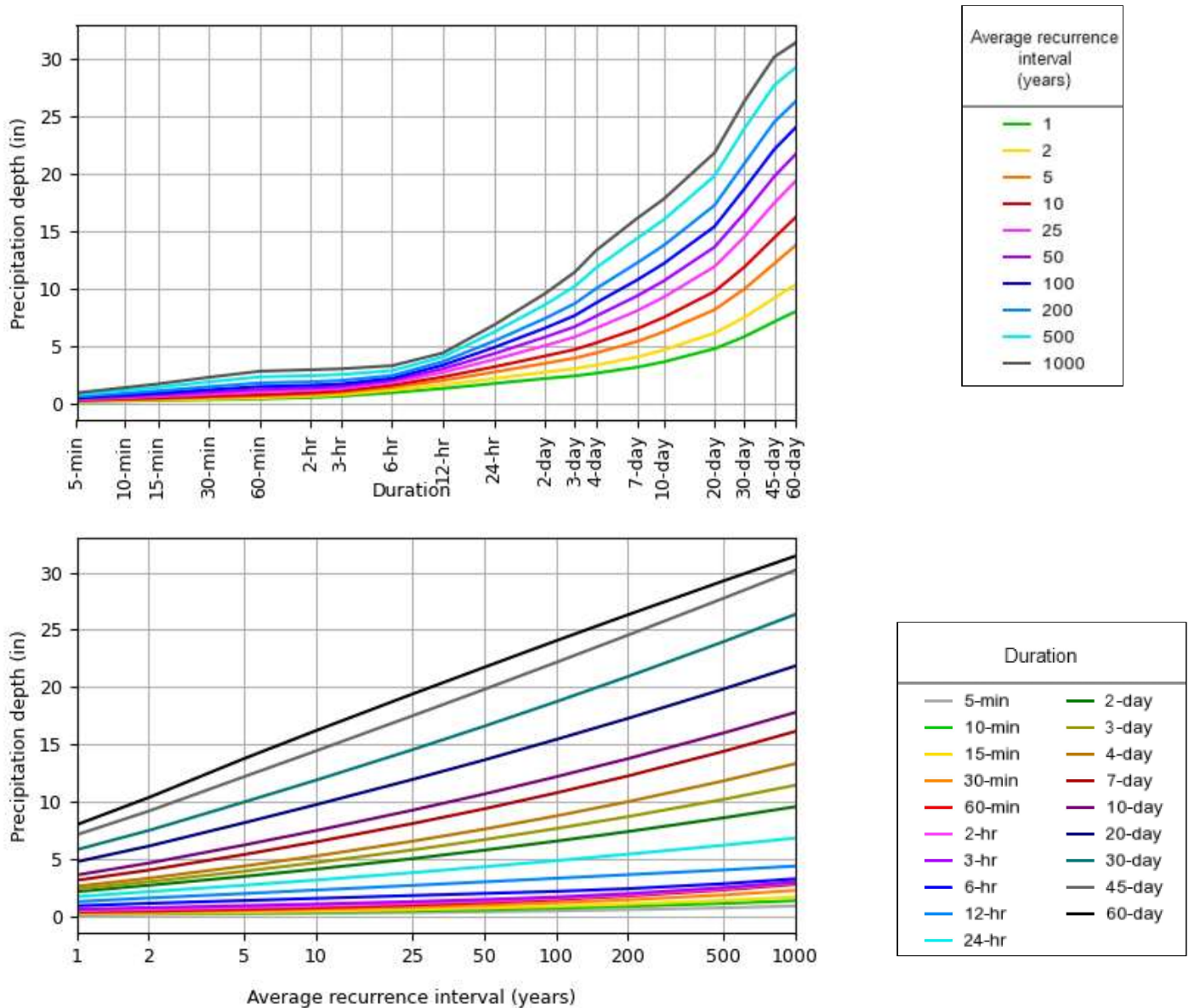
Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

PF graphical

PDS-based depth-duration-frequency (DDF) curves

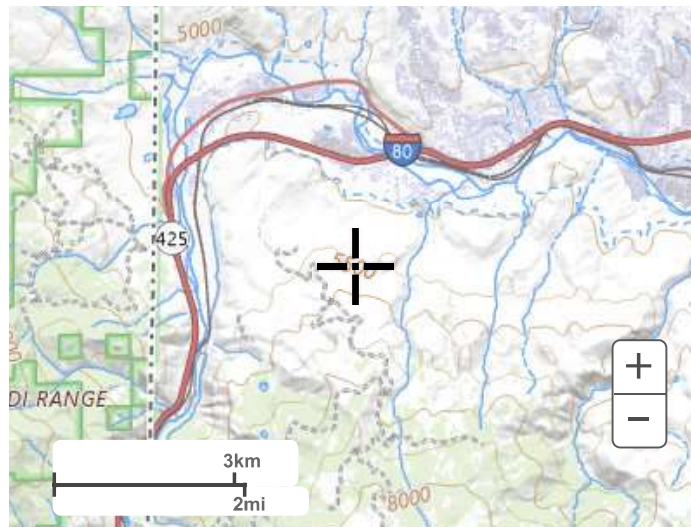
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NOAA Atlas 14, Volume 1, Version 5

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[Back to Top](#)**Maps & aerials****Small scale terrain**



Large scale terrain



Large scale map



Large scale aerial



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RUNOFF CURVE NUMBERS FOR URBAN AREAS¹

Runoff Curve Numbers

Cover Type and Hydrologic Condition	Aver. % Impervious Area ²	Soil Comp A	Soil Comp B	Soil Comp C	Soil Comp D
<i>Fully developed urban area (vegetation established)</i>					
Open space (lawns, parks, golf courses, cemeteries, etc.) ³					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50 to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) ⁴		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
<i>Developing urban areas</i>					
Newly graded areas (pervious only, no vegetation) ⁵		77	86	91	94
Idle lands (CNs are determined using cover types similar to those Table 702 - 3 of 4)					

¹Average runoff condition, and $I_a = 0.2S$

²The average percent impervious area shown was used to develop the composite CNs. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CNs for other combinations of conditions may be computed using figure 2-3 or 2-4 in TR-55 (SCS, 1986).

³CNs shown are equivalent to those of pasture. Composite CNs may be computed for other combinations of open space cover type.

⁴Composite CNs for natural desert landscaping should be computed using figure 2-3 or 2-4 in TR-55 (SCS, 1986) based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CNs are assumed equivalent to desert shrub in poor hydrologic condition.

⁵Composite CNs to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 in TR-55 (SCS, 1986) based on the degree of development (impervious area percentage) and the CNs for the newly graded pervious areas.

VERSION: April 30, 2009

REFERENCE:

210-VI-TR-55, Second Edition, June 1986

TABLE

702

1 of 4

WRC ENGINEERING, INC.

RUNOFF CURVE NUMBERS FOR OTHER AGRICULTURAL LANDS¹

Runoff Curve Numbers

Cover Type	Hydrologic Condition	Soil Comp A	Soil Comp B	Soil Comp C	Soil Comp D
Pasture, grassland, or range – continuous forage for grazing ²	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow – continuous grass, protected from grazing and generally mowed for hay	-	30	58	71	78
Brush – brush-weed-grass mixture with brush the major element ³	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 ⁴	48	65	73
Woods – grass combination (orchard or tree farm) ⁵	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods ⁶	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 ⁴	55	70	77
Farmsteads – buildings, lanes, driveways, and surrounding lots	-	59	74	82	86

¹Average runoff condition, and $I_a = 0.2S$

²*Poor*: < 50% ground cover or heavily grazed with no mulch

Fair: 50 to 75% ground cover and not heavily grazed

Good: > 75% ground cover and lightly or only occasionally grazed

³*Poor*: < 50% ground cover

Fair: 50 to 75% ground cover

Good: >75% ground cover

⁴Actual curve number is less than 30; use CN = 30 for runoff computations.

⁵CNs shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CNs for woods and pasture.

⁶*Poor*: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.

Fair: Woods are grazed but not burned, and some forest litter covers the soil.

Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

VERSION: April 30, 2009

WRC ENGINEERING, INC.

REFERENCE:

210-VI-TR-55, Second Edition, June 1986

TABLE

702

3 of 4

RUNOFF CURVE NUMBERS FOR ARID AND SEMIARID RANGELANDS¹

Runoff Curve Numbers

Cover Description	Hydrologic Condition ²	Soil Comp A ³	Soil Comp B	Soil Comp C	Soil Comp 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
Sagebrush with grass understory	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub – major plants include saltbrush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

¹Average runoff condition, and $I_a = 0.2S$. For range in humid regions, use Table 702 - 3 of 4.

²*Poor*: < 30% ground cover (litter, grass, and brush overstory)

Fair: 30 to 70% ground cover

Good: > 70% ground cover

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

VERSION: April 30, 2009

WRC ENGINEERING, INC.

REFERENCE:

210-VI-TR-55, Second Edition, June 1986

TABLE

702

4 of 4

The shape of the SCS Unit Hydrograph is based on studies of various natural unit hydrographs. The basic governing parameters of this curvilinear hydrograph are as follows:

1. The time-to-peak, T_p , of the unit hydrograph approximately equals 0.2 times the time-of-base, T_b .
2. The point of inflection of the falling leg of the unit hydrograph approximately equals 1.7 times T_p .

For ease of calculation, an equivalent triangular unit hydrograph was derived from the natural curvilinear unit hydrograph. From the triangular unit hydrograph, equations for the peak discharge, Q_p , time-to-peak, T_p , and the time of concentration, t_c were developed based on a single lag factor (TLAG). The discharge hydrograph is then determined for the SCS Unit Hydrograph method based on the storm excess precipitation applied to the unit hydrograph whose parameters are determined by TLAG. TLAG is defined and discussed in Section 705.3.

705.2 ASSUMPTIONS

The basic assumptions made when applying the SCS Unit Hydrograph method (and all other unit hydrograph methods) are as follows:

1. The effects of all physical characteristics of a given drainage basin are reflected in the shape of the storm runoff hydrograph for that basin.
2. At a given point on a stream, discharge ordinates of different unit graphs of the same unit time of rainfall excess are mutually proportional to respective volumes.
3. A hydrograph of storm discharge that would result from a series of bursts of excess rain or from continuous excess rain of variable intensity may be constructed from a series of overlapping unit graphs each resulting from a single increment of excess rain of unit duration.

705.3 LAG TIME

Input data for the Soil Conservation Service dimensionless unit hydrograph method (SCS, 1985) consists of a single parameter, TLAG, which is equal to the lag (in hours) between the center of mass of rainfall excess and the peak of the unit hydrograph. For small drainage basins (less than one square mile) and basin slopes less than ten percent the lag time may be related to the time of concentration, t_c , by the following empirical relationship:

$$\text{TLAG} = 0.6 t_c \quad (709)$$

The t_c is computed as presented in Section 702.

For larger drainage basins (greater than one square mile) and basins with a basin slope equal to or greater than ten percent, the lag time (and t_c) is generally governed mostly by the concentrated flow travel time, not the initial overland flow time. In addition, as the basin gets increasingly larger, the average flow velocity (and associated travel time) becomes more difficult to estimate. Therefore, for these basins, the following lag equation is recommended for use in computing TLAG:

$$\text{TLAG} = 22.1 K_n (L L_c / S^{0.5})^{0.33} \quad (710)$$

where K_n = Roughness factor for the basin channels
 L = Length of longest watercourse (miles)

LAG EQUATION ROUGHNESS FACTORS

LAND USE	RANGE OF AVERAGE IMPERVIOUS AREA	K_n
Developed Areas		
Commercial/Industrial/Office/Business	70-85	.05
High and Medium Density Residential	30-65	.05
Low Density Residential	20-25	.07
Rural Residential	10-15	.08
Irrigated Grass (Golf Course/Parks/Cemeteries)	0-5	.10
Undeveloped Areas		
Rock Outcroppings	-	.04
Irrigated Agriculture	-	.10
Rangelands:		
Herbaceous (grasses)	-	.08
Mixed grass and shrub	-	.09
Heavy shrub/brush	-	.10
Forest (Evergreen)	-	.15

VERSION: October 1, 2008

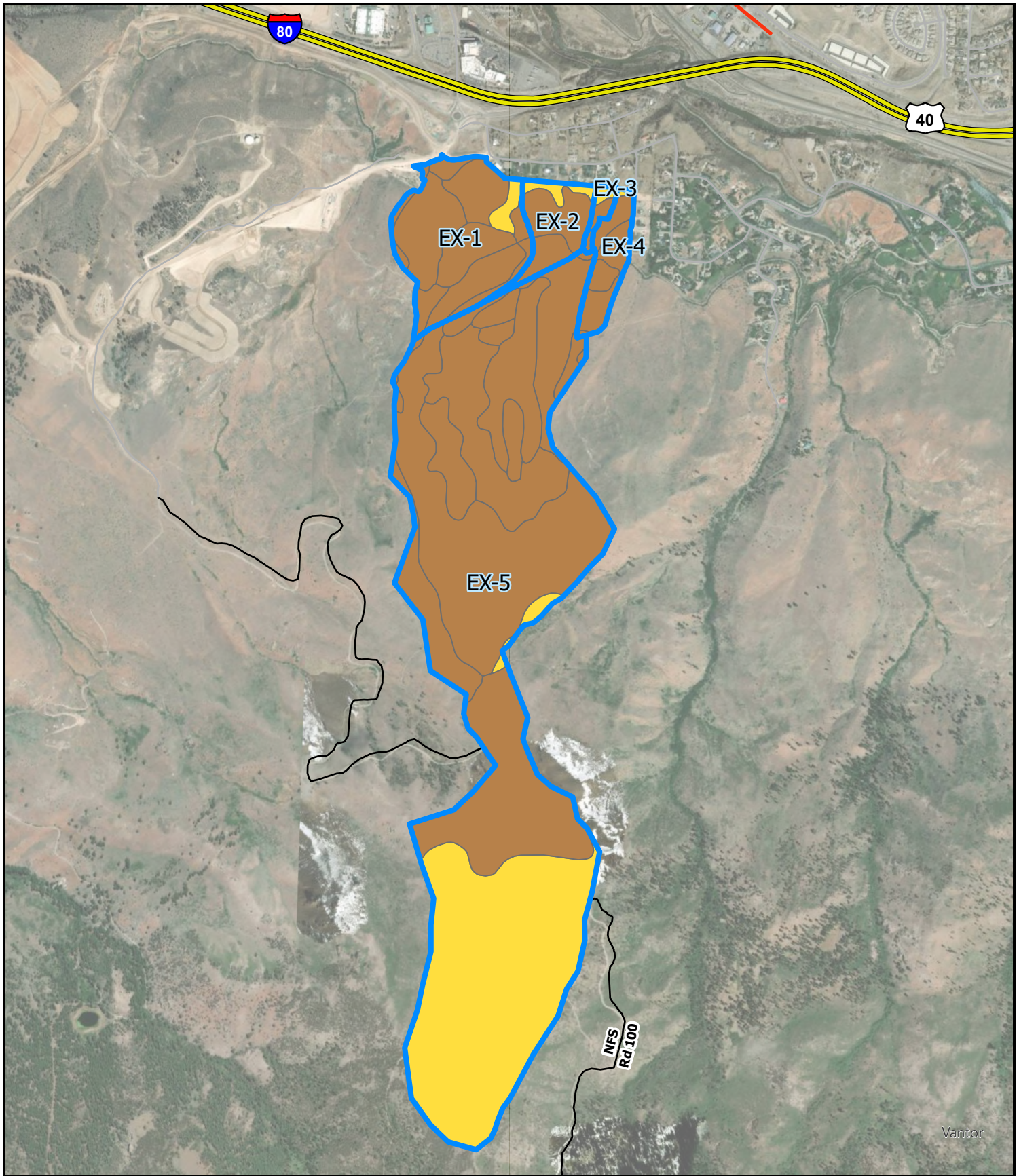
REFERENCE:

U.S. Department of Interior, 1989
(with modifications)TABLE
703

WRC ENGINEERING, INC.

NLCD Land Cover Types - Obtained from HEC-RAS 2D User's Manual

NLCD Value	n Value Range	Description
11	0.025 - 0.05	Open Water - areas of open water, generally with less than 25% cover of vegetation or soil. This is for natural streams on mild to moderate slopes.
12	n/a	Perennial Ice/Snow - areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.
21	0.03 - 0.05	Developed, Open Space - areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.
22	0.06 - 0.12	Developed, Low Intensity - areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units.
23	0.08 - 0.16	Developed, Medium Intensity -areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units.
24	0.12 - 0.20	Developed High Intensity -highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.
31	0.023 - 0.030	Barren Land (Rock/Sand/Clay) - areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.
41	0.10 - 0.20	Deciduous Forest - areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.
42	0.08 - 0.16	Evergreen Forest - areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.
43	0.08 - 0.20	Mixed Forest - areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.
51	0.025 - 0.05	Dwarf Scrub - Alaska only areas dominated by shrubs less than 20 centimeters tall with shrub canopy typically greater than 20% of total vegetation. This type is often co-associated with grasses, sedges, herbs, and non-vascular vegetation.
52	0.07 - 0.16	Shrub/Scrub - areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.
71	0.025 - 0.05	Grassland/Herbaceous - areas dominated by gramanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.
72	0.025 - 0.05	Sedge/Herbaceous - Alaska only areas dominated by sedges and forbs, generally greater than 80% of total vegetation. This type can occur with significant other grasses or other grass like plants, and includes sedge tundra, and sedge tussock tundra.
73	n/a	Lichens - Alaska only areas dominated by fruticose or foliose lichens generally greater than 80% of total vegetation.
74	n/a	Moss - Alaska only areas dominated by mosses, generally greater than 80% of total vegetation.
81	0.025 - 0.05	Pasture/Hay -areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.
82	0.020 - 0.05	Cultivated Crops -areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.
90	0.045 - 0.15	Woody Wetlands - areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
95	0.05 - 0.085	Emergent Herbaceous Wetlands - Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

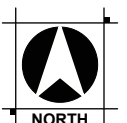
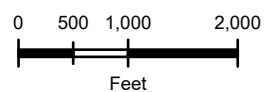


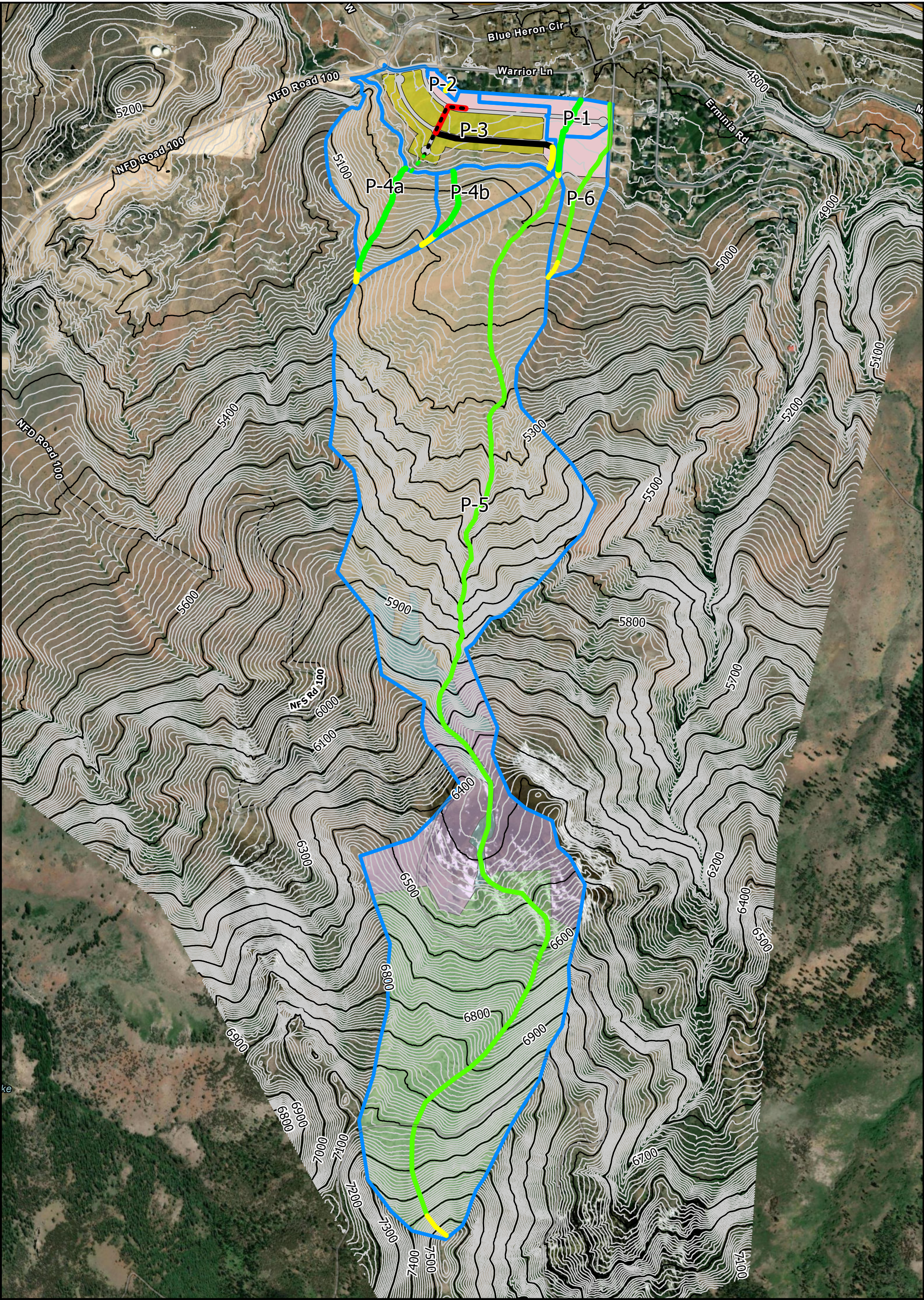
NRCS SOILS
MERIDIAN 120 SOUTH
VILLAGES 1 AND 2
RENO, NV
JUNE 2026

 Existing Hydro Basins

Hydro Group

-  C
-  D

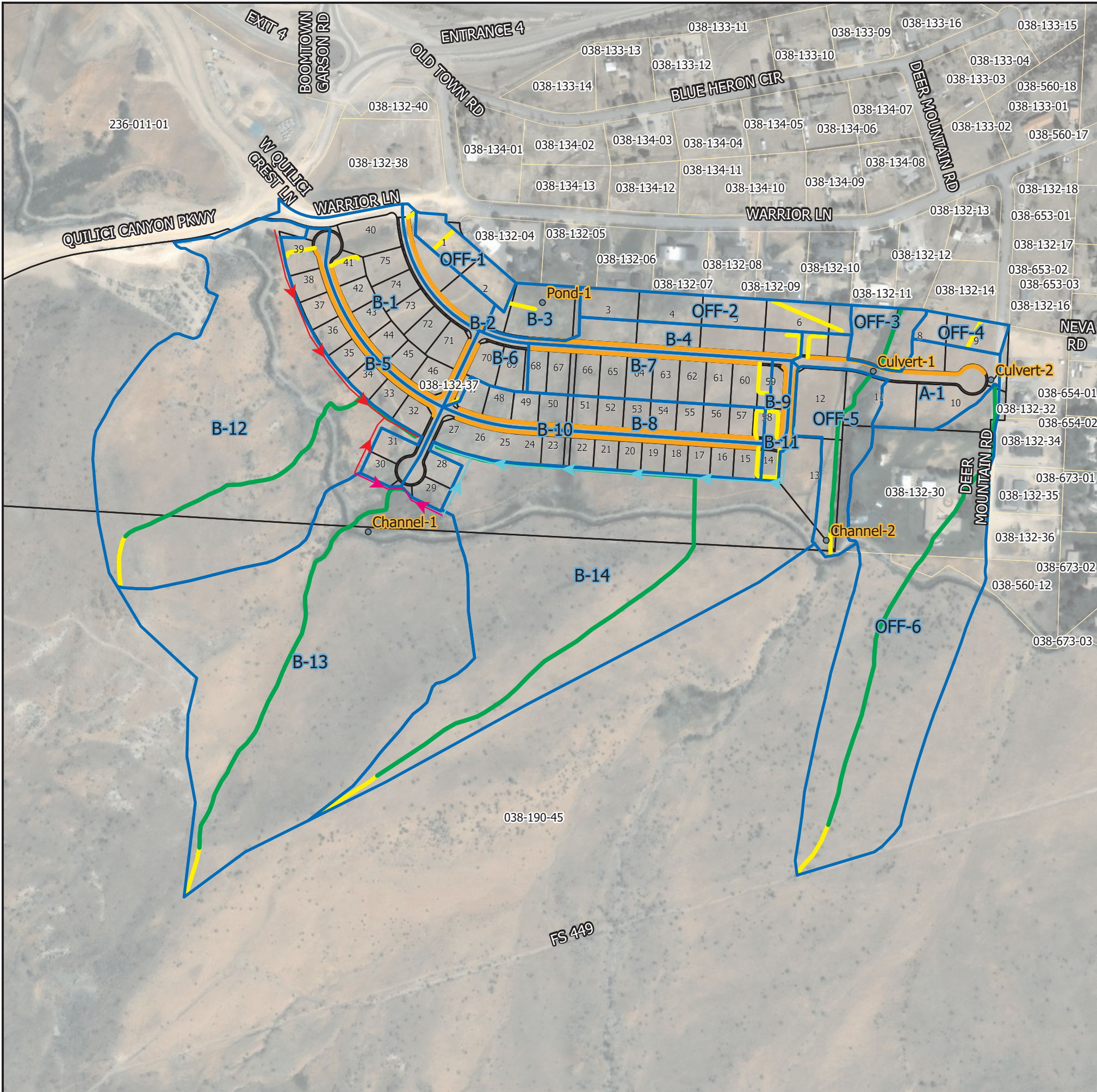




**PROPOSED HYDROLOGIC
CONDITIONS**
MERIDIAN 120 S. VILLAGES 1 & 2
RENO, NEVADA
JUNE 2026

Proposed Hydro Basins	Residential 1/4 Acre	Sheet
10 ft Elevation Contour	Brush, Fair	Channel
100 Elevation Contour	Brush, Good	Reach 1 - Pipe
Cover Type	Meadow	Reach 1 - Channel
Herbaceous, Fair	Proposed Flow Paths	
Pavement	Gutter	
Residential 1 Acre	Pipe	





Proposed Hydrologic Basins Meridian 120 South Villages 1 and 2 Reno, NV June 2026				Basin Cut-Off 12 Cut-Off 13 Cut-Off 14 Civil Linework Labels FlowType Gutter Sheet Channel			
Basin Name	Area (ac.)	C(5yr)	C(100yr)	I(5yr)	I(100yr)	Q(5yr)	Q(100yr)
A-1	2.92	0.40	0.54	1.43	3.50	1.7	5.5
B-1	5.04	0.54	0.68	1.40	3.43	3.8	11.7
B-10	4.18	0.50	0.65	1.34	3.29	2.8	8.9
B-11	0.37	0.50	0.65	1.53	3.75	0.3	0.9
B-12	19.32	0.20	0.50	1.57	3.85	6.1	37.2
B-13	22.79	0.20	0.50	1.46	3.59	6.7	40.9
B-14	20.39	0.20	0.50	1.07	2.62	4.3	26.7
B-2	1.09	0.35	0.50	1.63	3.99	0.6	2.2
B-3	1.25	0.88	0.93	2.21	5.42	2.4	6.3
B-4	2.10	0.46	0.59	1.46	3.57	1.4	4.4
B-5	3.37	0.50	0.65	1.43	3.52	2.4	7.7
B-6	0.99	0.50	0.65	2.14	5.24	1.1	3.4
B-7	3.53	0.50	0.65	1.38	3.38	2.4	7.8
B-8	3.26	0.50	0.65	1.34	3.29	2.2	7.0
B-9	0.50	0.50	0.65	1.55	3.81	0.4	1.2
OFF-1	1.07	0.35	0.50	1.65	4.04	0.6	2.2
OFF-2	2.40	0.35	0.50	1.59	3.91	1.3	4.7
OFF-3	1.12	0.20	0.50	1.93	4.74	0.4	2.7
OFF-4	0.78	0.35	0.50	1.76	4.32	0.5	1.7
OFF-5	2.91	0.20	0.50	1.54	3.78	0.9	5.5
OFF-6	15.59	0.20	0.50	1.23	3.02	3.8	23.6



WOOD RODGERS

BUILDING RELATIONSHIPS ONE PROJECT AT A TIME

1361 Corporate Boulevard
Reno, NV 89502

Tel: 775.823.4068

Fax: 775.823.4066

0

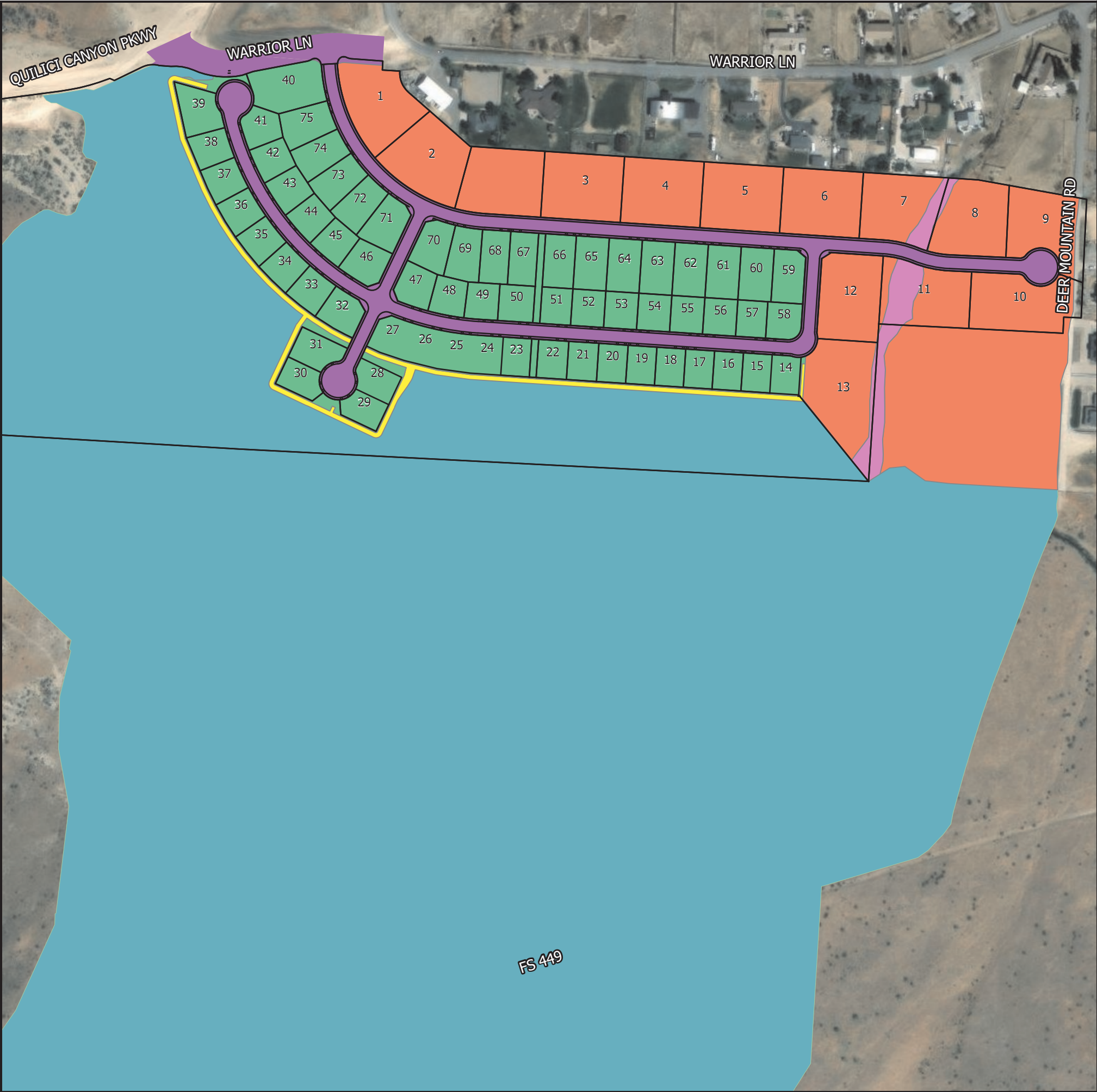
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FEET



NORTH



HEC-RAS Manning's n Land Cover
Meridian 120 South Villages 1 and 2
Reno, NV
June 2026

- Civil Linework

Manning's n Land Cover

Herbaceous, Fair

Pavement
- Residential 1 Acre

Cut-Off Channel

Main Channel

Residential 1/4 Acre

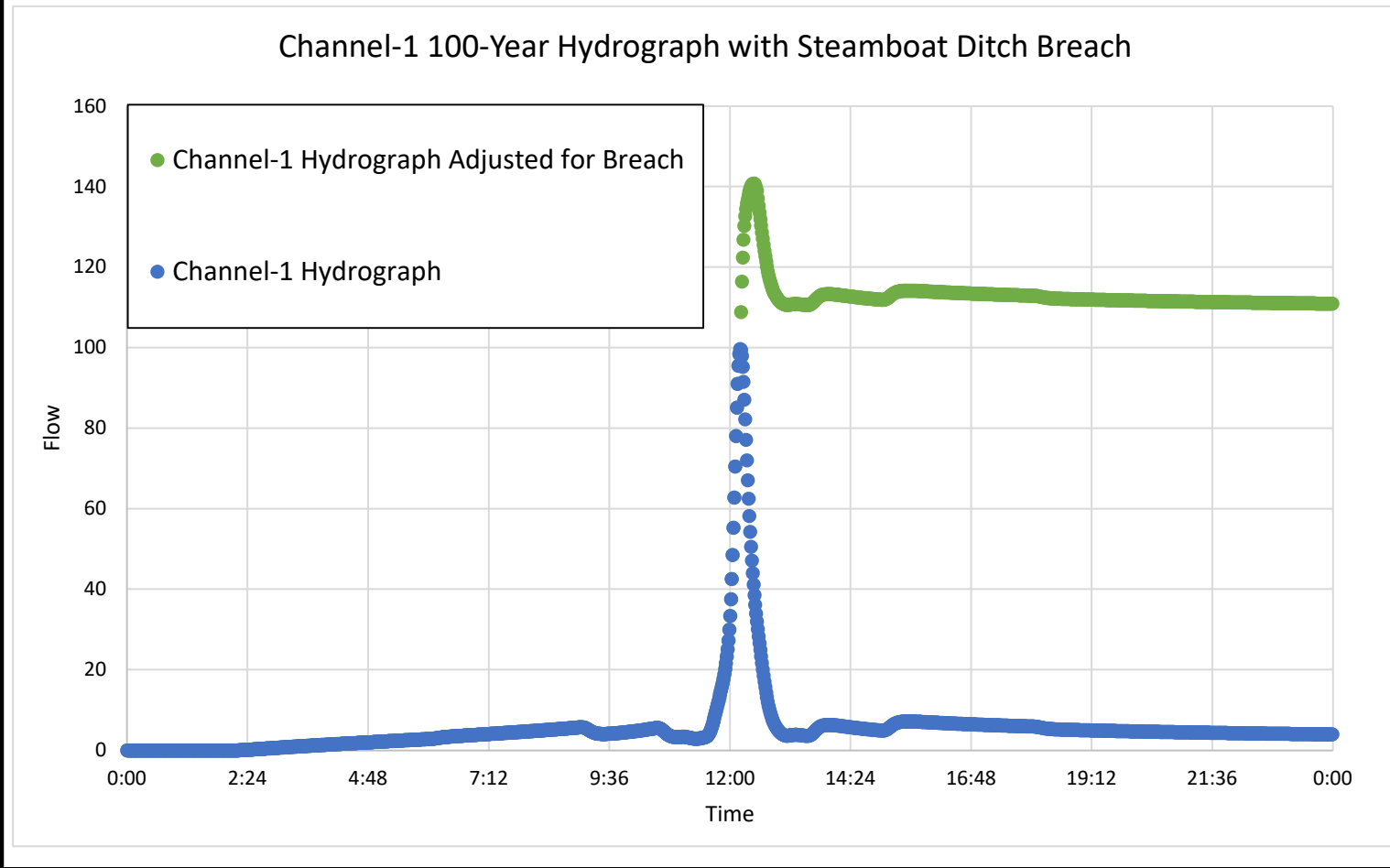
Table 5: HEC-RAS Manning's n Land Cover Summary Table

Land Cover	Manning's n
NoData	0.1
Residential 1 Acre	0.09
Residential 1/4 Acre	0.12
Pavement	0.02
Herbaceous, Fair	0.035
Main Channel	0.08
Cut-Off Channel	0.025

Project: Meridian 120 South Villages 1 and 2

Project Location: Reno, NV

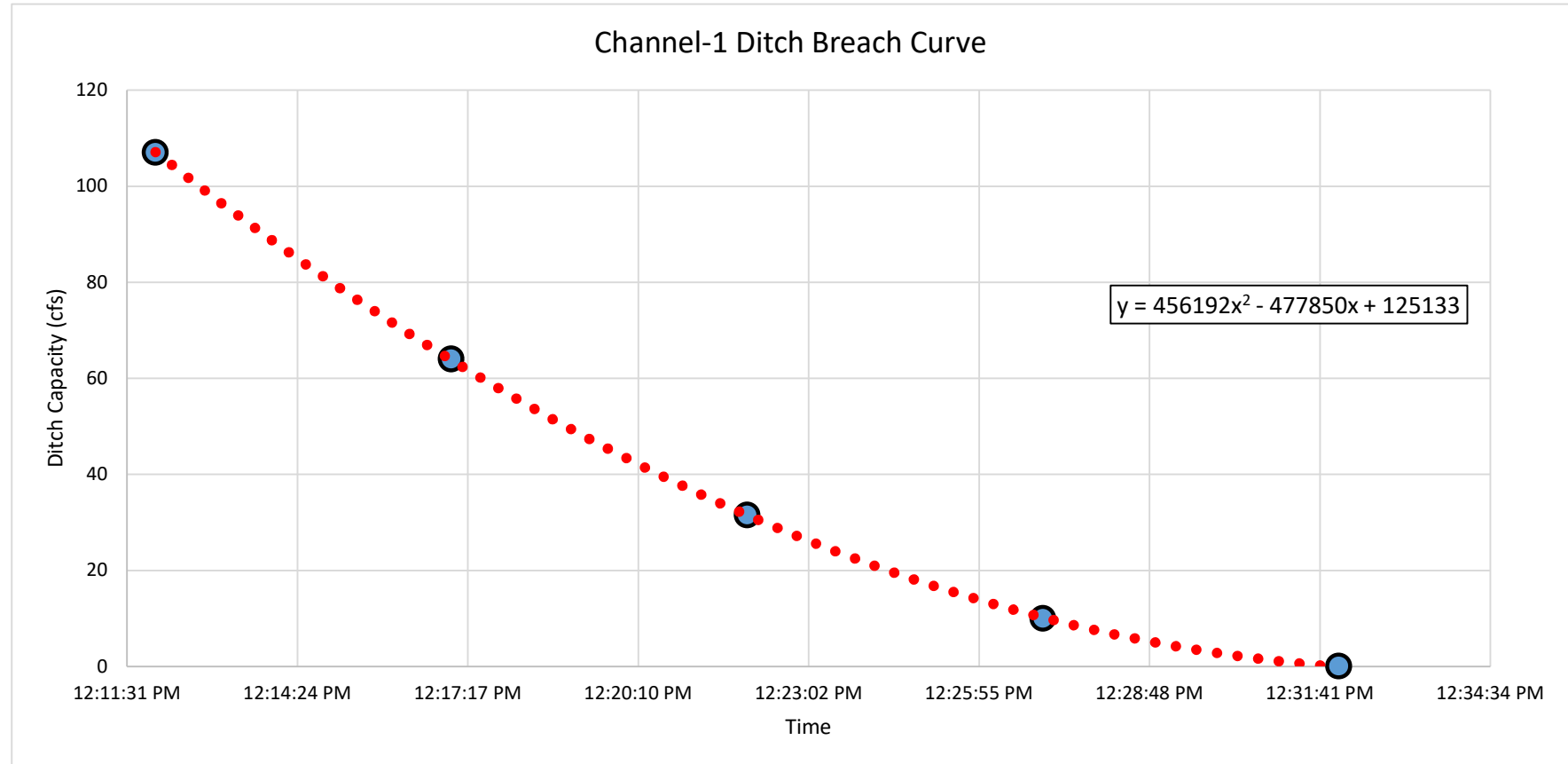
Channel-1 100-Year Hydrograph with Steamboat Ditch Breach



Project: Meridian 120 South Villages 1 and 2

Project Location: Reno, NV

Channel-1 100-Year Hydrograph with Steamboat Ditch Breach



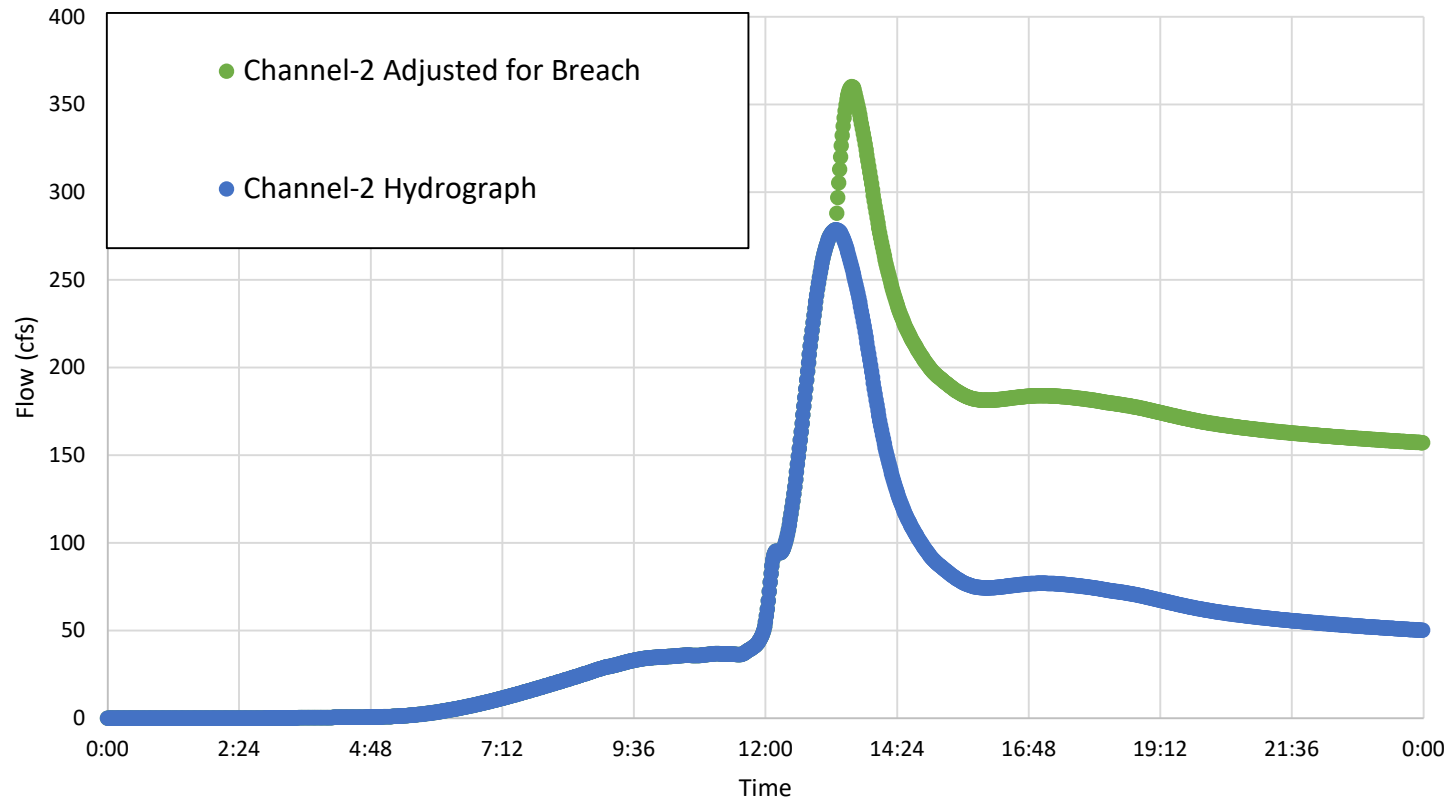
Project: Meridian 120 South Villages 1 and 2

Project Location: Reno, NV

Channel-2 100-Year Hydrograph with Steamboat Ditch Breach



Channel-2 100-Year Hydrograph with Steamboat Ditch Breach



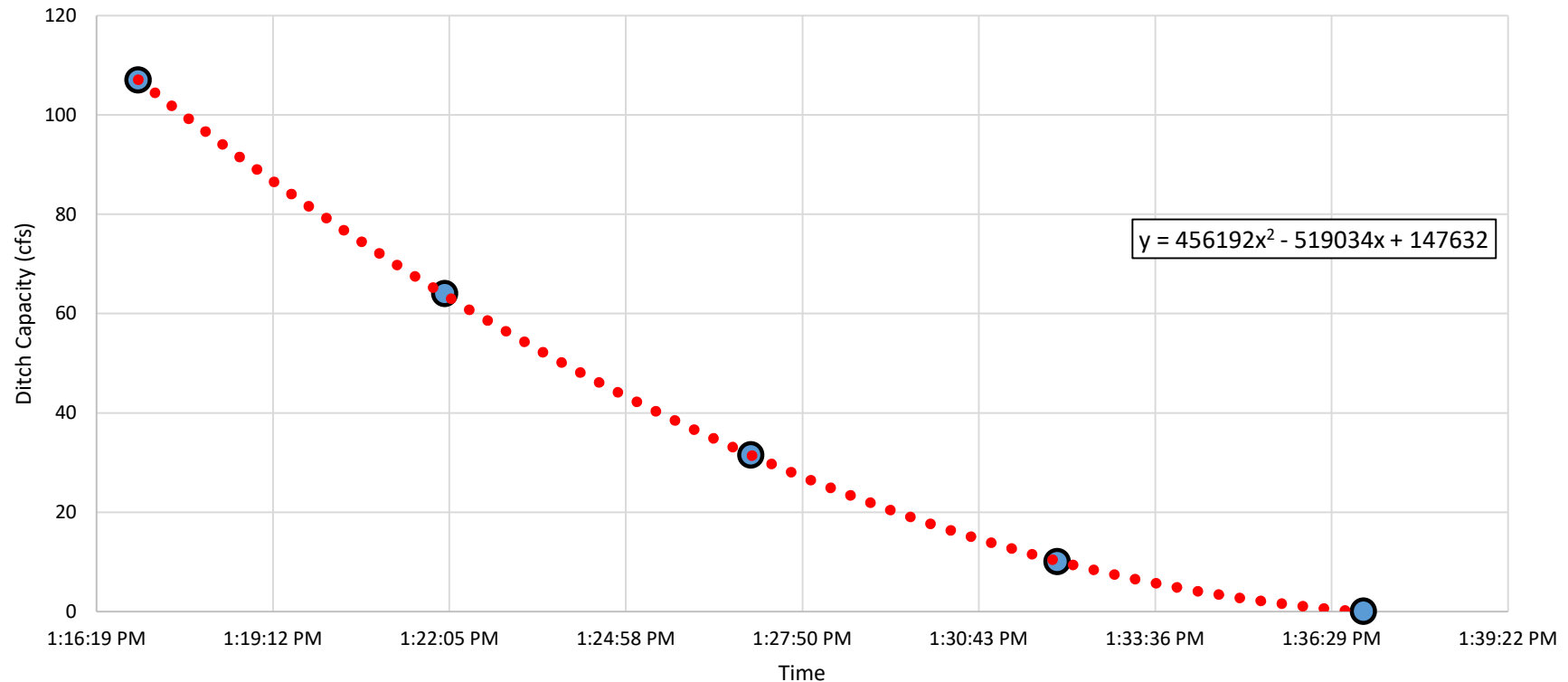
Project: Meridian 120 South Villages 1 and 2

Project Location: Reno, NV

Channel-2 Steamboat Ditch Capacity as a Function of Time



Channel-2 Ditch Breach Curve



Project: Meridian 120 South Villages 1 and 2

Project Location: Reno, NV



WOOD RODGERS

Proposed Curve Numbers

Watershed P-1			
Land Use	Soil Group	Area (ac.)	Curve Number
Residential 1 Acre	C	4.1	79
Residential 1 Acre	D	4.42	84
Pavement	C	0.13	98
Pavement	D	0.69	98
Herbaceous, Fair	D	0.08	89
Total Area (ac.)	9.42		
Final Curve Number	83.1		
Watershed P-2			
Land Use	Soil Group	Area (ac.)	Curve Number
Residential 1 Acre	D	1.03	84
Pavement	D	0.03	98
Total Area (ac.)	1.06		
Final Curve Number	84.4		
Watershed P-3			
Land Use	Soil Group	Area (ac.)	Curve Number
Residential 1 Acre	C	1.33	79
Residential 1 Acre	D	2.95	84
Residential 1/4 Acre	C	2.28	83
Residential 1/4 Acre	D	15.85	87
Pavement	C	0.63	98
Pavement	D	4.75	98
Herbaceous, Fair	C	0.38	81
Herbaceous, Fair	D	9.39	89
Total Area (ac.)	37.56		
Final Curve Number	88.3		
Watershed P-4a			
Land Use	Soil Group	Area (ac.)	Curve Number
Herbaceous, Fair	D	36.59	89
Total Area (ac.)	36.59		
Final Curve Number	89		
Watershed P-4b			
Land Use	Soil Group	Area (ac.)	Curve Number
Herbaceous, Fair	D	14.02	89
Total Area (ac.)	14.02		
Final Curve Number	89		
Watershed P-5			
Land Use	Soil Group	Area (ac.)	Curve Number
Herbaceous, Fair	C	0.71	81
Herbaceous, Fair	D	240.98	89
Brush, Good	C	153.54	65
Brush, Good	D	4.44	73
Brush, Fair	C	5	70
Brush, Fair	D	51.08	77
Meadow	C	2.22	71
Meadow	D	22.29	78
Total Area (ac.)	480.26		
Final Curve Number	79.1		
Watershed P-6			
Land Use	Soil Group	Area (ac.)	Curve Number
Residential 1 Acre	D	5.91	84
Herbaceous, Fair	D	10.61	89
Total Area (ac.)	16.52		
Final Curve Number	87.2		

Proposed Onsite Basins

Project Location: Reno, NV



WOOD RODGERS

Drainage Basin	Drainage Area (AC)	CN/c	Initial Flow Time, T _i				Travel Time, T _t														Total (T _i +T _t)	Urbanized Basins Check	Final	
			Overland Flow				Gutter Flow				Channelized Flow				Piped Flow									
			L _i (ft)	S (ft/ft)	R	T _i (min)	L _s (ft)	S (ft/ft)	V(ft/s)	T _{t1} (min)	L _t (ft)	S (ft/ft)	V (ft/s)	T _{t2} (min)	L _t (ft)	n	Pipe ø	S (ft/ft)	V (ft/s)	T _{t3} (min)				
P-1	9.43	83	66	0.050	0.71	3.4	0	0.000	0.0	0.0	859	0.051	3.7	3.9	0	0.000	0	0.000	0.0	0.0	10.0	15.1	10.0	6.0
P-2	1.06	84	93	0.054	0.72	3.7	0	0.000	0.0	0.0	0	0.000	0.0	0.0	0	0.000	0	0.000	0.0	0.0	10.0	10.5	10.0	6.0
P-3	37.56	88	243	0.029	0.78	6.4	1346	0.013	2.4	9.5	0	0.000	0.0	0.0	527	0.013	36	0.042	4.5	2.0	17.9	21.8	17.9	10.7
P-6	16.51	87	207	0.048	0.76	5.2	0	0.000	0.0	0.0	1953	0	4.4	0.0	0	0.000	0	0.000	0.0	0.0	10.0	22.0	10.0	6.0
Basins over 1 mi ² or greater than 10% average slope are analyzed using TLAG = 22.1*Kn(L*Lc/S^0.5)^0.33																								
	Drainage Area (AC)	CN	Kn	L	Lc	S (ft/mi)	TLAG (hours)	TLAG (min)																
P-4a	36.59	89	0.09	0.27	0.08	875.0	0.19	11.17																
P-4b	14.02	89	0.09	0.19	0.07	2122.0	0.13	8.06																
P-5	478.96	79	0.12	2.62	1.18	987.8	1.23	74.04																

Project: Meridian 120 South Villages 1 and 2

Project Location: Reno, NV

Proposed Reach Time of Concentration Table - SCS Method



WOOD RODGERS

Drainage Basin	Travel Time, T _t										Total (T _i +T _t)	Final	
	Channelized Flow				Piped Flow								
	L _t (ft)	S (ft/ft)	V (ft/s)	T _{t2} (min)	L _t (ft)	n	Pipe ∅	S (ft/ft)	V (ft/s)	T _{t3} (min)	T _c (min)	T _c (min)	TLAG
Reach-1	228	0.133	5.9	0.6	831	0.013	36	0.019	4.0	3.5	4.1	4.1	2.5

Steamboat Ditch - 8 Foot Top Width

Project Description	
Friction Method	Manning
Solve For	Formula Discharge
Input Data	
Roughness Coefficient	0.022
Channel Slope	0.0015 ft/ft
Normal Depth	36.0 in
Left Side Slope	0.3333 H:V
Right Side Slope	0.3333 H:V
Bottom Width	6.00 ft
Results	
Discharge	78.76 cfs
Flow Area	21.0 ft ²
Wetted Perimeter	12.324 ft
Hydraulic Radius	20.4 in
Top Width	8.00 ft
Critical Depth	20.3 in
Critical Slope	0.0090 ft/ft
Velocity	3.75 ft/s
Velocity Head	0.219 ft
Specific Energy	3.22 ft
Froude Number	0.408
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.000 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	(N/A) ft/s
Upstream Velocity	(N/A) ft/s
Normal Depth	36.0 in
Critical Depth	20.3 in
Channel Slope	0.0015 ft/ft
Critical Slope	0.0090 ft/ft

Steamboat Ditch - 12 Foot Top Width (Full)

Project Description	
Friction Method	Manning
Solve For	Formula Discharge
Input Data	
Roughness Coefficient	0.022
Channel Slope	0.0015 ft/ft
Normal Depth	36.0 in
Left Side Slope	1.0000 H:V
Right Side Slope	1.0000 H:V
Bottom Width	6.00 ft
Results	
Discharge	107.51 cfs
Flow Area	27.0 ft ²
Wetted Perimeter	14.485 ft
Hydraulic Radius	22.4 in
Top Width	12.00 ft
Critical Depth	23.1 in
Critical Slope	0.0074 ft/ft
Velocity	3.98 ft/s
Velocity Head	0.246 ft
Specific Energy	3.25 ft
Froude Number	0.468
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.000 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	(N/A) ft/s
Upstream Velocity	(N/A) ft/s
Normal Depth	36.0 in
Critical Depth	23.1 in
Channel Slope	0.0015 ft/ft
Critical Slope	0.0074 ft/ft

Steamboat Ditch 27 in Depth

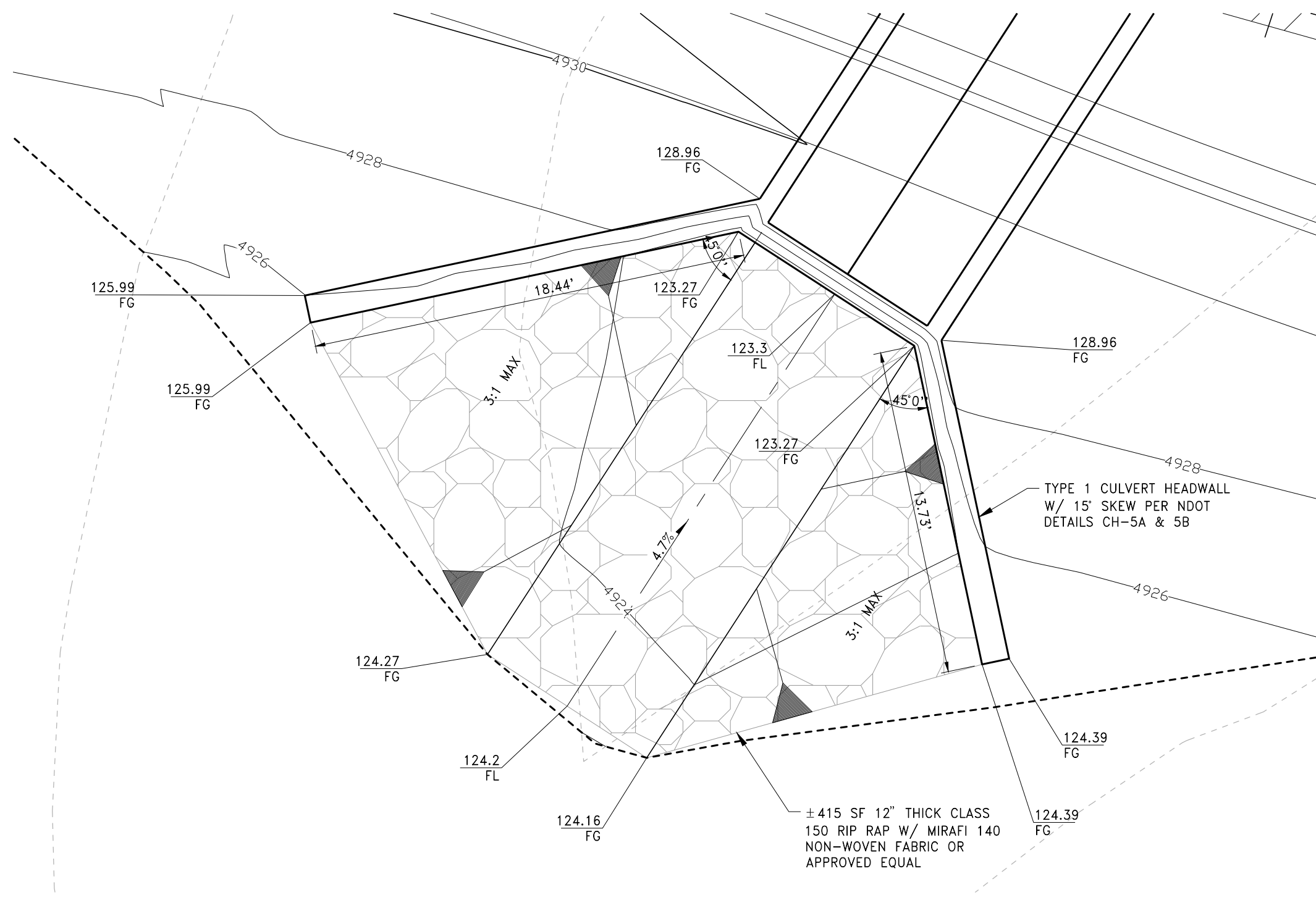
Project Description	
Friction Method	Manning
	Formula
Solve For	Discharge
Input Data	
Roughness Coefficient	0.022
Channel Slope	0.0015 ft/ft
Normal Depth	27.0 in
Left Side Slope	1.0000 H:V
Right Side Slope	1.0000 H:V
Bottom Width	6.00 ft
Results	
Discharge	63.98 cfs
Flow Area	18.6 ft ²
Wetted Perimeter	12.364 ft
Hydraulic Radius	18.0 in
Top Width	10.50 ft
Critical Depth	16.8 in
Critical Slope	0.0079 ft/ft
Velocity	3.45 ft/s
Velocity Head	0.185 ft
Specific Energy	2.43 ft
Froude Number	0.457
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.000 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	(N/A) ft/s
Upstream Velocity	(N/A) ft/s
Normal Depth	27.0 in
Critical Depth	16.8 in
Channel Slope	0.0015 ft/ft
Critical Slope	0.0079 ft/ft

Steamboat Ditch 18 in Depth

Project Description	
Friction Method	Manning
	Formula
Solve For	Discharge
Input Data	
Roughness Coefficient	0.022
Channel Slope	0.0015 ft/ft
Normal Depth	18.0 in
Left Side Slope	1.0000 H:V
Right Side Slope	1.0000 H:V
Bottom Width	6.00 ft
Results	
Discharge	31.48 cfs
Flow Area	11.3 ft ²
Wetted Perimeter	10.243 ft
Hydraulic Radius	13.2 in
Top Width	9.00 ft
Critical Depth	10.8 in
Critical Slope	0.0086 ft/ft
Velocity	2.80 ft/s
Velocity Head	0.122 ft
Specific Energy	1.62 ft
Froude Number	0.441
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.000 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	(N/A) ft/s
Upstream Velocity	(N/A) ft/s
Normal Depth	18.0 in
Critical Depth	10.8 in
Channel Slope	0.0015 ft/ft
Critical Slope	0.0086 ft/ft

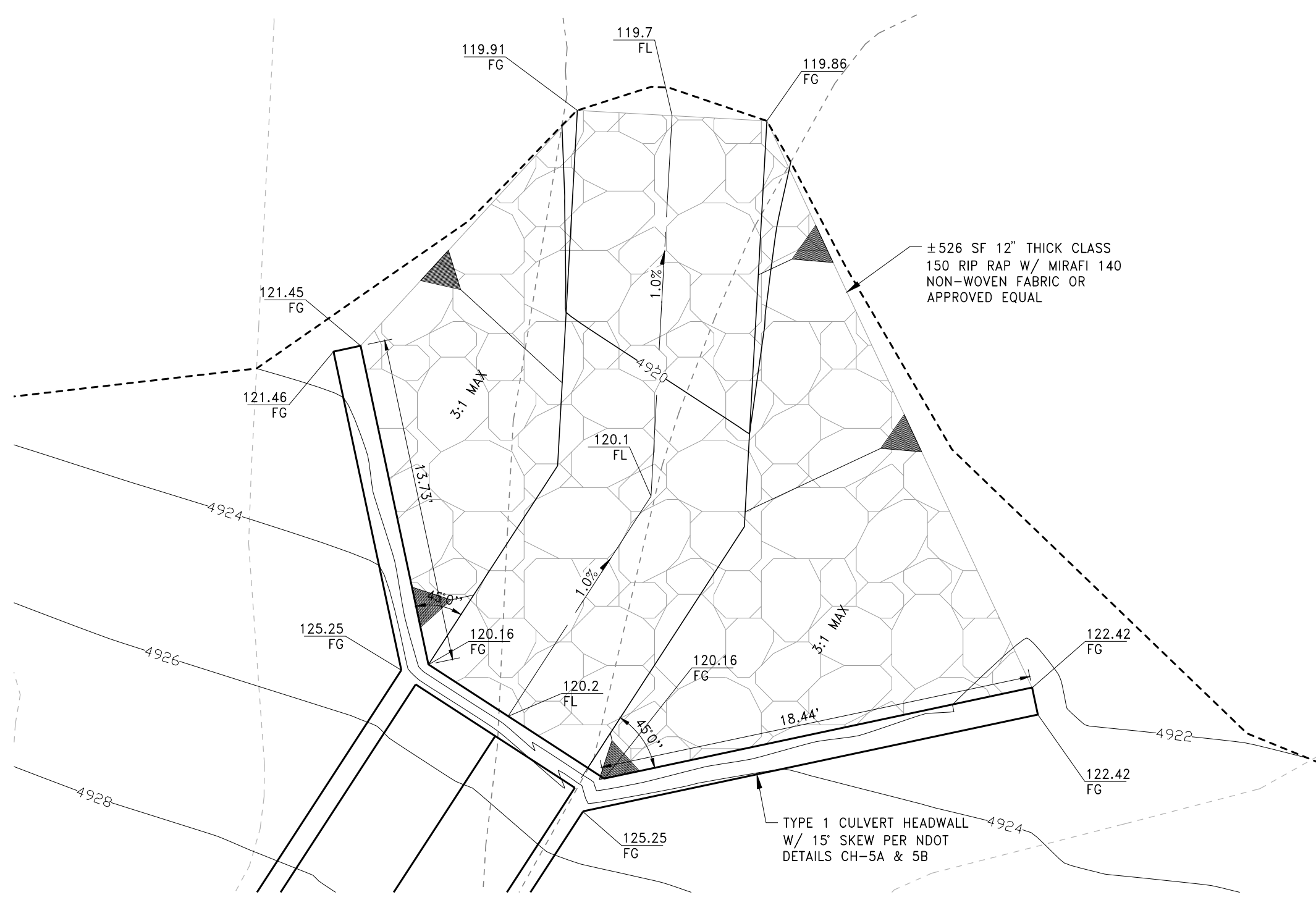
Steamboat Ditch 9 in Depth

Project Description	
Friction Method	Manning
	Formula
Solve For	Discharge
Input Data	
Roughness Coefficient	0.022
Channel Slope	0.0015 ft/ft
Normal Depth	9.0 in
Left Side Slope	1.0000 H:V
Right Side Slope	1.0000 H:V
Bottom Width	6.00 ft
Results	
Discharge	9.71 cfs
Flow Area	5.1 ft ²
Wetted Perimeter	8.121 ft
Hydraulic Radius	7.5 in
Top Width	7.50 ft
Critical Depth	5.1 in
Critical Slope	0.0103 ft/ft
Velocity	1.92 ft/s
Velocity Head	0.057 ft
Specific Energy	0.81 ft
Froude Number	0.412
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.000 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	(N/A) ft/s
Upstream Velocity	(N/A) ft/s
Normal Depth	9.0 in
Critical Depth	5.1 in
Channel Slope	0.0015 ft/ft
Critical Slope	0.0103 ft/ft



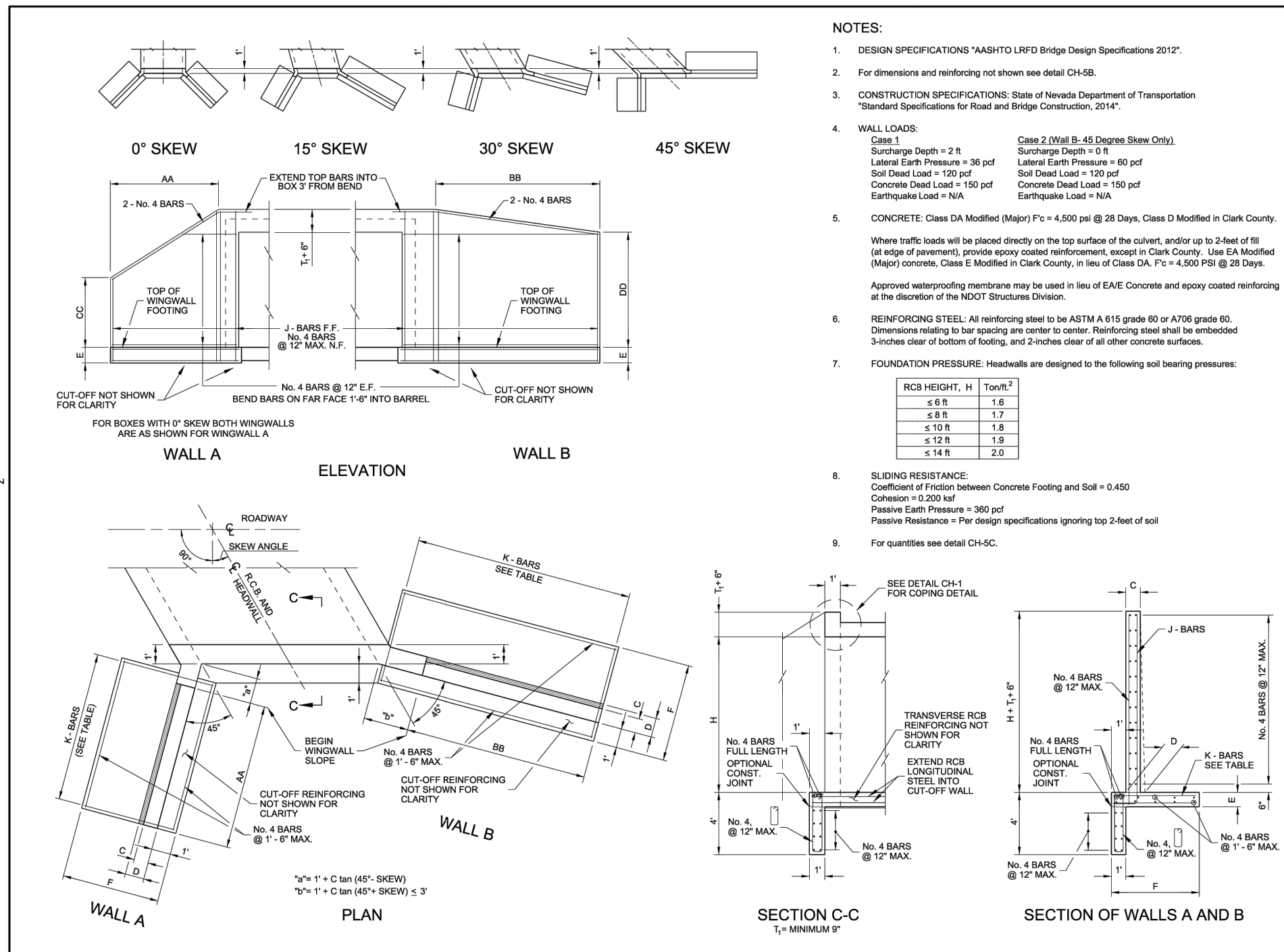
CULVERT 1 SOUTHERN HEADWALL

SCALE: 1"=5'

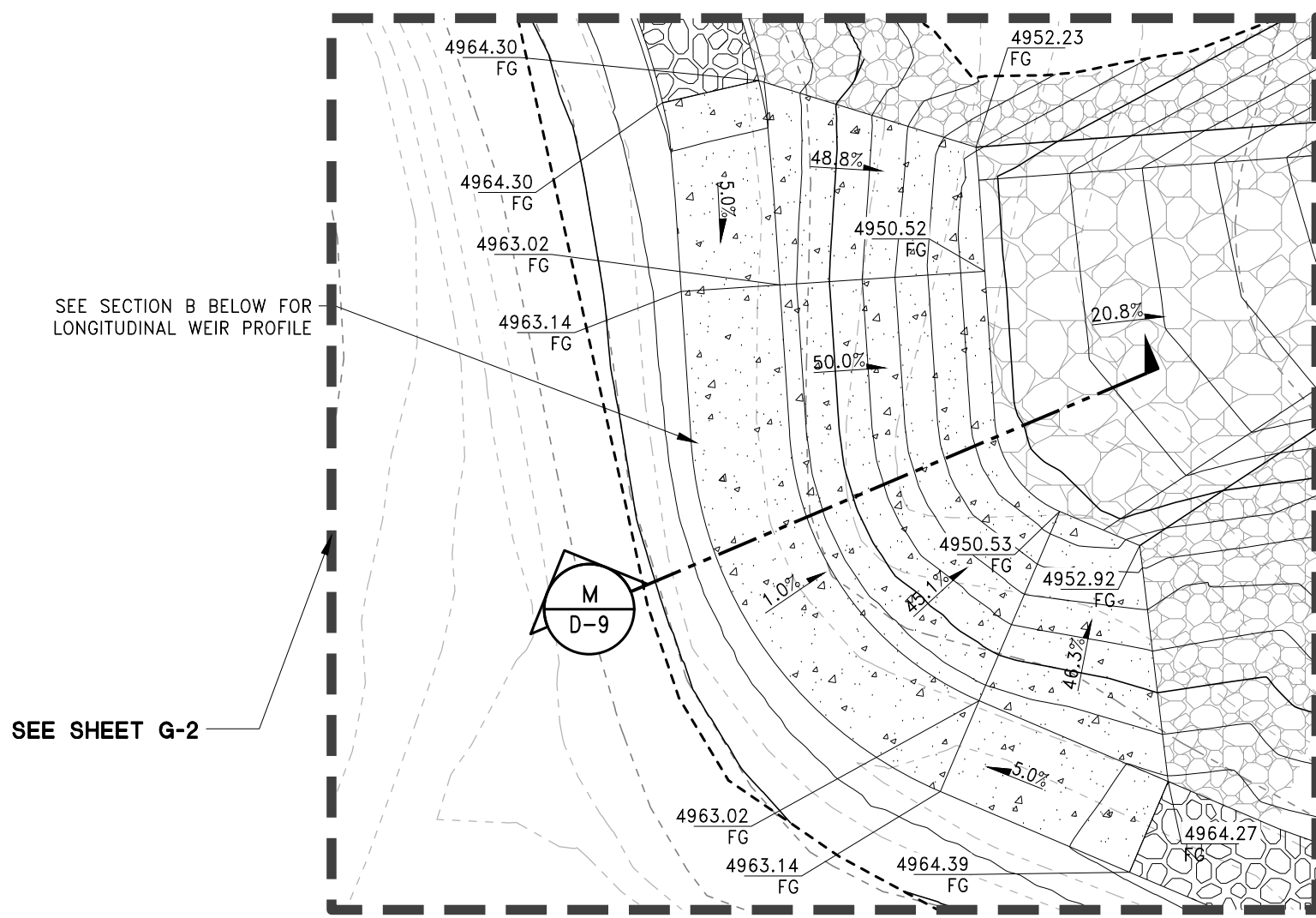


CULVERT 1 NORTHERN HEADWALL

SCALE: 1"=5'

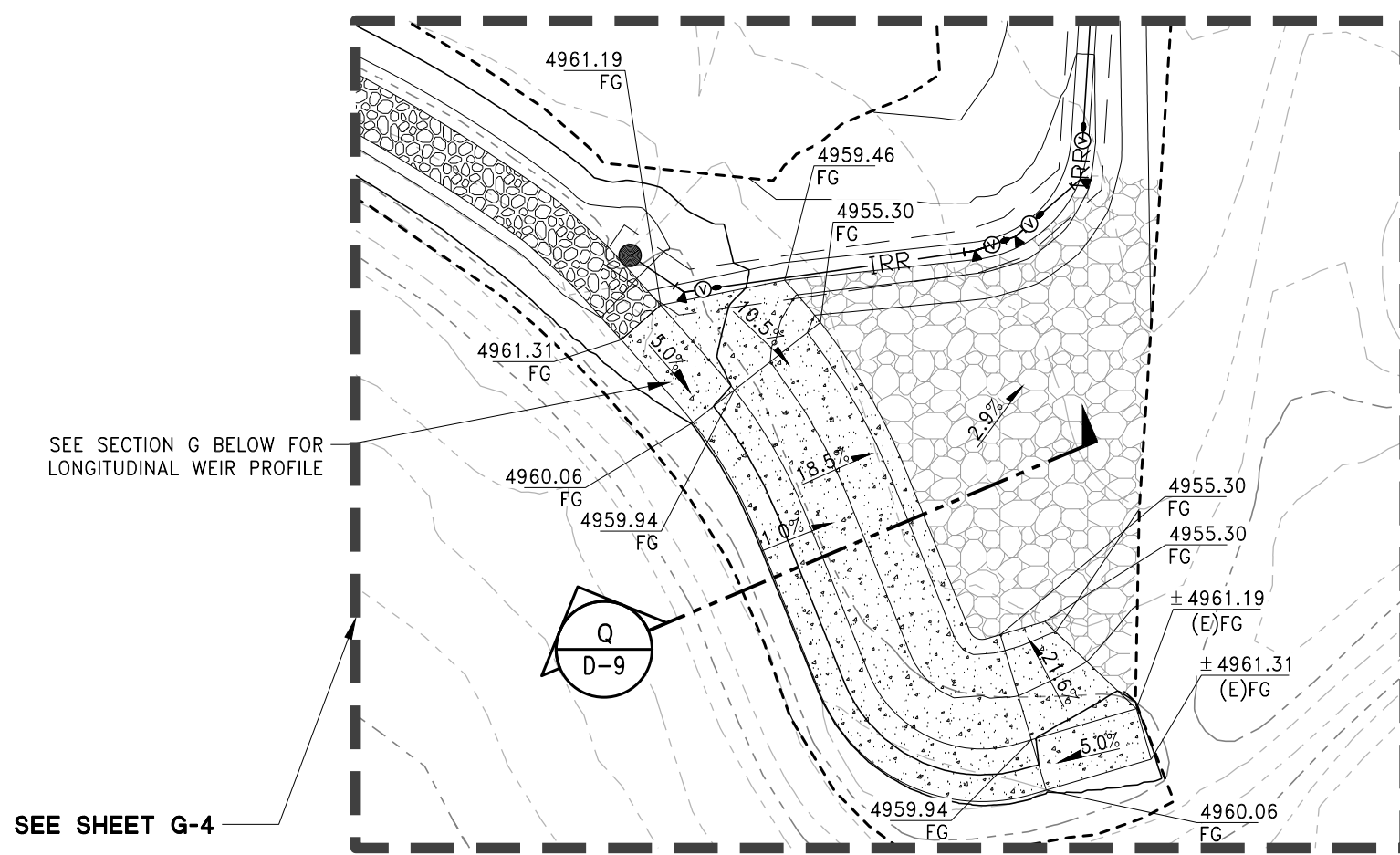


NOTES:
1. DESIGN SPECIFICATIONS "ASHTO LRFD Bridge Design Specifications 2012".
2. For dimensions and reinforcing not shown see detail CH-6B.
3. CONSTRUCTION SPECIFICATIONS "State of Nevada Department of Transportation Standard Specifications for Road and Bridge Construction, 2014".
4. WALL LOADS: Class 2 (Dist. R, 45 Degree Skew Only).
Surcharge Depth = 2 ft
Lateral Earth Pressure = 30 psf
Soil Dead Load = 120 psf
Concrete Dead Load = 150 psf
Earthquake Load = N/A
5. CONCRETE: Class DA Modified (Major F = 4,500 psi @ 28 Days, Class D Modified in Clark County).
Where traffic loads will be placed directly on the top surface of the culvert, extend up to 2 feet of fill (at edge of pavement), provide epoxy coated reinforcement, except in Clark County. Use EA Modified (Major) concrete, Class C Modified in Clark County. Use Class DA, F = 4,500 PSI @ 28 Days.
Approved waterproofing membrane may be used in lieu of EAC Concrete and epoxy coated reinforcing at the discretion of the NDOT Structures Division.
6. REINFORCING STEEL: All reinforcing steel to be ASTM A 615 grade 60 or A706 grade 60. Dimensions relating to bar spacing are center to center. Reinforcing steel shall be embedded 3-inches clear of bottom of footing, and 2-inches clear of all other concrete surfaces.
7. FOUNDATION PRESSURE: Headwalls are designed to the following soil bearing pressures:
RCB HEIGHT, H
F.T. IN. F.T. IN. F.T. IN. F.T. IN.
1-6 1-6 1-6 1-6
6-12 1-7 1-7 1-7
12-18 1-8 1-8 1-8
18-24 1-9 1-9 1-9
24-30 1-10 1-10 1-10
30-36 1-11 1-11 1-11
36-42 1-12 1-12 1-12
42-48 1-13 1-13 1-13
48-54 1-14 1-14 1-14
54-60 1-15 1-15 1-15
60-66 1-16 1-16 1-16
66-72 1-17 1-17 1-17
72-78 1-18 1-18 1-18
78-84 1-19 1-19 1-19
84-90 1-20 1-20 1-20
90-96 1-21 1-21 1-21
96-102 1-22 1-22 1-22
102-108 1-23 1-23 1-23
108-114 1-24 1-24 1-24
114-120 1-25 1-25 1-25
120-126 1-26 1-26 1-26
126-132 1-27 1-27 1-27
132-138 1-28 1-28 1-28
138-144 1-29 1-29 1-29
144-150 1-30 1-30 1-30
150-156 1-31 1-31 1-31
156-162 1-32 1-32 1-32
162-168 1-33 1-33 1-33
168-174 1-34 1-34 1-34
174-180 1-35 1-35 1-35
180-186 1-36 1-36 1-36
186-192 1-37 1-37 1-37
192-198 1-38 1-38 1-38
198-204 1-39 1-39 1-39
204-210 1-40 1-40 1-40
210-216 1-41 1-41 1-41
216-222 1-42 1-42 1-42
222-228 1-43 1-43 1-43
228-234 1-44 1-44 1-44
234-240 1-45 1-45 1-45
240-246 1-46 1-46 1-46
246-252 1-47 1-47 1-47
252-258 1-48 1-48 1-48
258-264 1-49 1-49 1-49
264-270 1-50 1-50 1-50
270-276 1-51 1-51 1-51
276-282 1-52 1-52 1-52
282-288 1-53 1-53 1-53
288-294 1-54 1-54 1-54
294-300 1-55 1-55 1-55
300-306 1-56 1-56 1-56
306-312 1-57 1-57 1-57
312-318 1-58 1-58 1-58
318-324 1-59 1-59 1-59
324-330 1-60 1-60 1-60
330-336 1-61 1-61 1-61
336-342 1-62 1-62 1-62
342-348 1-63 1-63 1-63
348-354 1-64 1-64 1-64
354-360 1-65 1-65 1-65
360-366 1-66 1-66 1-66
366-372 1-67 1-67 1-67
372-378 1-68 1-68 1-68
378-384 1-69 1-69 1-69
384-390 1-70 1-70 1-70
390-396 1-71 1-71 1-71
396-402 1-72 1-72 1-72
402-408 1-73 1-73 1-73
408-414 1-74 1-74 1-74
414-420 1-75 1-75 1-75
420-426 1-76 1-76 1-76
426-432 1-77 1-77 1-77
432-438 1-78 1-78 1-78
438-444 1-79 1-79 1-79
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456-462 1-82 1-82 1-82
462-468 1-83 1-83 1-83
468-474 1-84 1-84 1-84
474-480 1-85 1-85 1-85
480-486 1-86 1-86 1-86
486-492 1-87 1-87 1-87
492-498 1-88 1-88 1-88
498-504 1-89 1-89 1-89
504-510 1-90 1-90 1-90
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2004-2010 1-340 1-340 1-340
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2016-2022 1-342 1-342 1-342
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2040-2046 1-346 1-346 1-346
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2070-2076 1-351 1-351 1-351
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2082-2088 1-353 1-353 1-353
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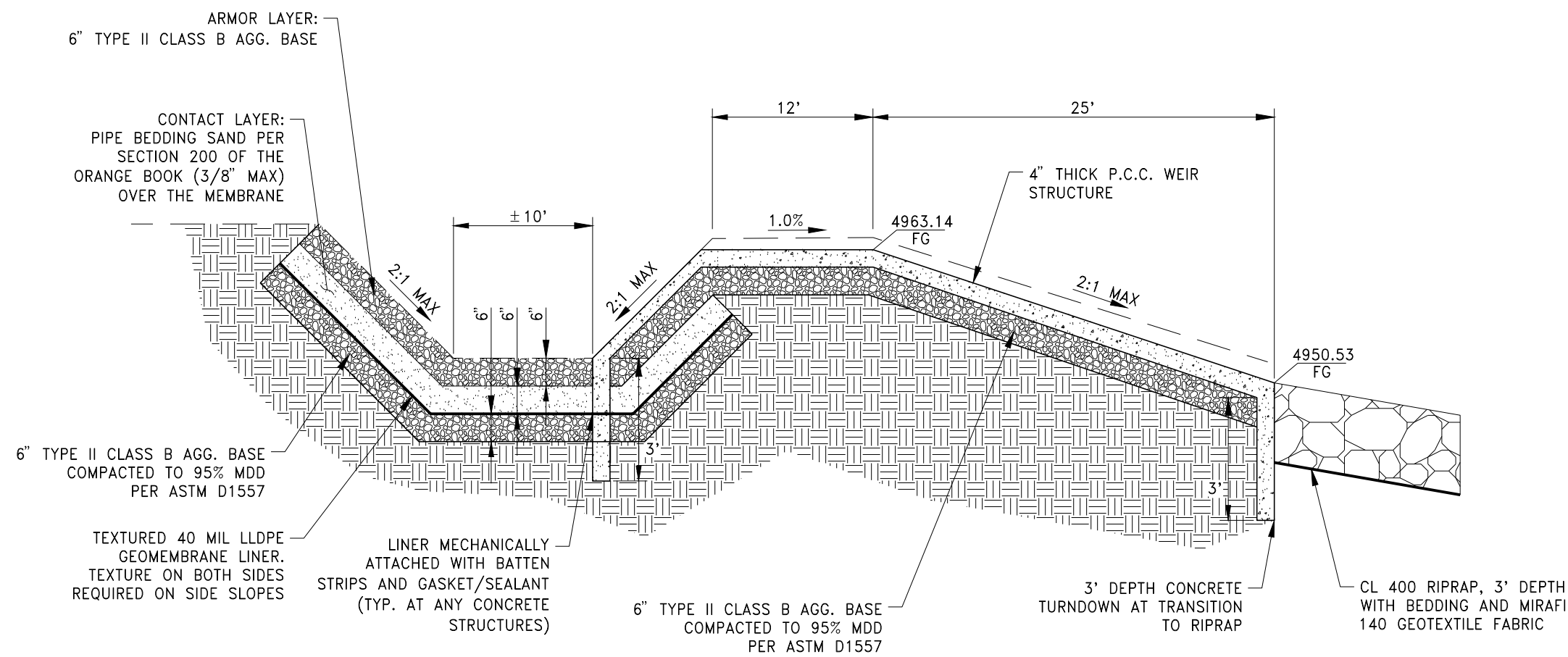
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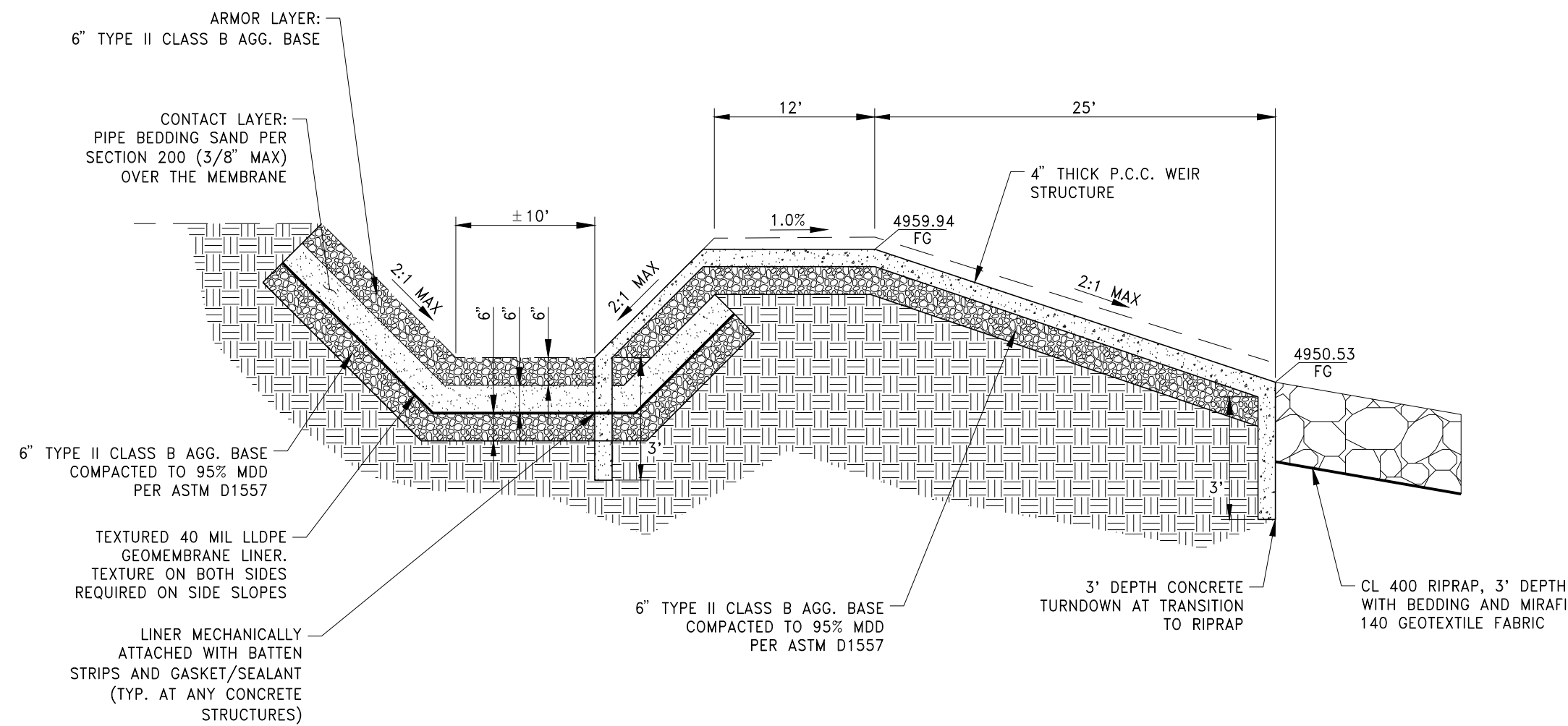
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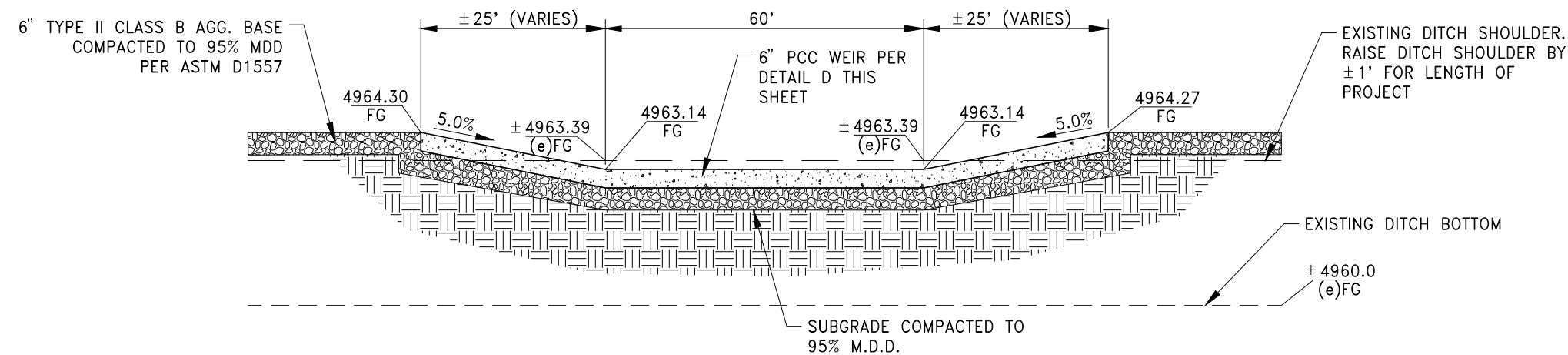


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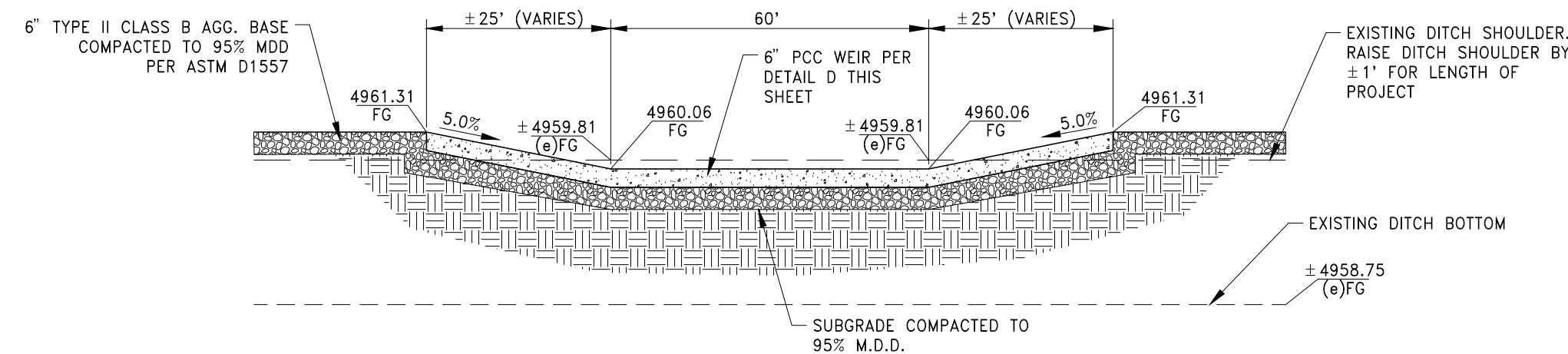


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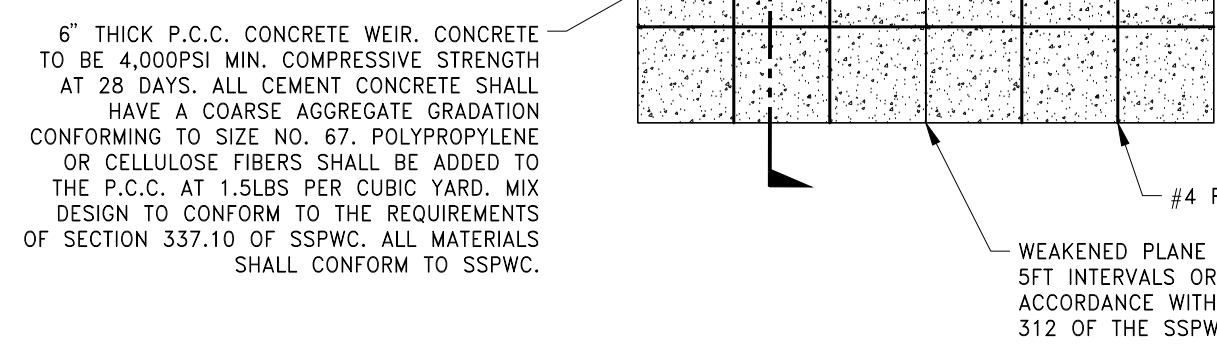
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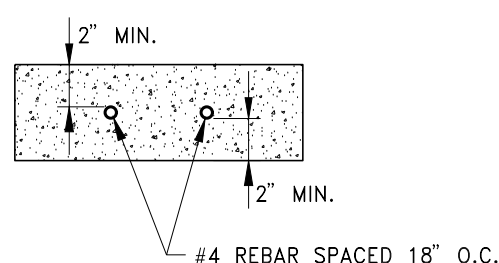
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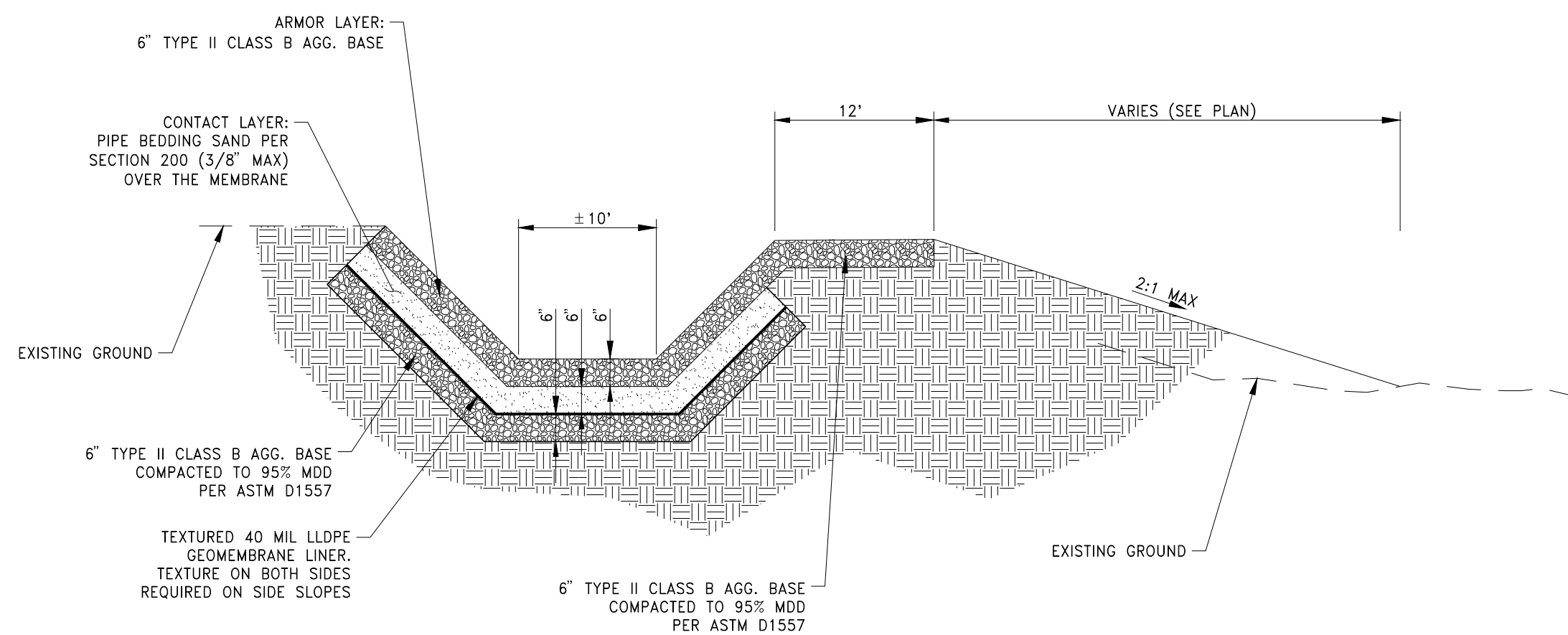
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CONCRETE SECTION

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DITCH LINER SECTION

NOT TO SCALE

WOOD RODGERS BUILDING RELATIONSHIPS ONE PROJECT AT A TIME 1381 Corporate Boulevard Reno, NV 89502 Tel 775.823.4068 Fax 775.823.4065		KYLE MATTHEW CASTLE PROFESSIONAL ENGINEER - STATE OF NEVADA EXP: 12/31/26 CIVIL No. 030045		DATE: JULY 2026 SCALE: AS SHOWN DRAWN BY: JRS DESIGNED BY: JRS CHECKED BY: KMC		NEVADA	
IMPROVEMENT PLANS FOR MERIDIAN 120 SOUTH VILLAGES 1 & 2						CITY OF RENO	
PROJECT NO. 3173094						DRAWING D-9	
SHT 42 OF 59							

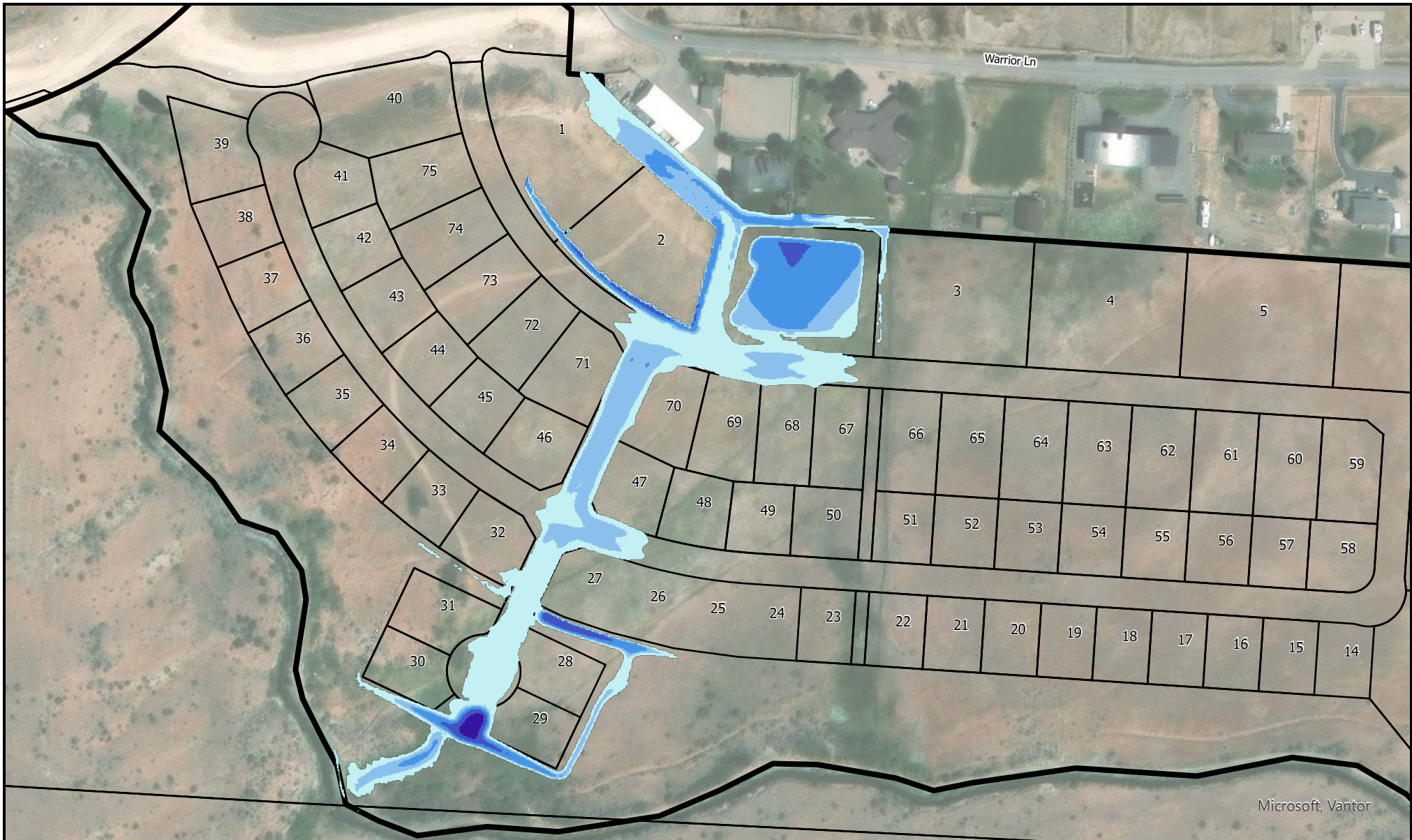
Project: Meridian S OA Simulation Run: Prop 100-yr

Start of Run: 01Jan2026, 00:00 Basin Model: Proposed
End of Run: 02Jan2026, 00:00 Meteorologic Model: 100-yr
Compute Time: 23Jun2026, 14:44:37 Control Specifications: Control 1

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
OFF-6	0.0243793	52.85	01Jan2026, 12:07	4.45
Orr-Gate-1	0.7702771	278.67	01Jan2026, 13:17	104.45
Outfall-1	0.1158588	197.46	01Jan2026, 12:13	21.97
Outfall-2	0.7702771	278.67	01Jan2026, 13:17	104.45
P-1	0.0147329	28.62	01Jan2026, 12:07	2.38
P-2	0.0016635	3.35	01Jan2026, 12:07	0.28
P-3	0.0586876	101.43	01Jan2026, 12:12	11.03
P-4a	0.0571712	98.21	01Jan2026, 12:12	10.95
P-4b	0.0219071	43.91	01Jan2026, 12:09	4.21
P-5	0.7483700	277.18	01Jan2026, 13:17	100.25
Reach-1	0.0571712	98.21	01Jan2026, 12:14	10.94

APPENDIX B

HEC-RAS RESULTS

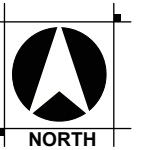
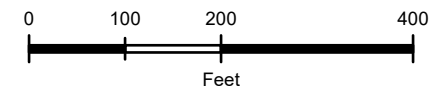
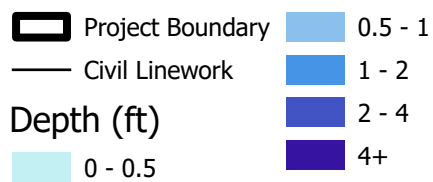


CHANNEL 1 DEPTH

MERIDIAN 120 SOUTH VILLAGES 1 AND 2

RENO, NV

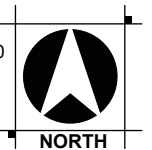
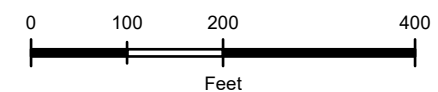
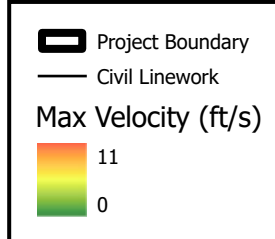
JULY 2026



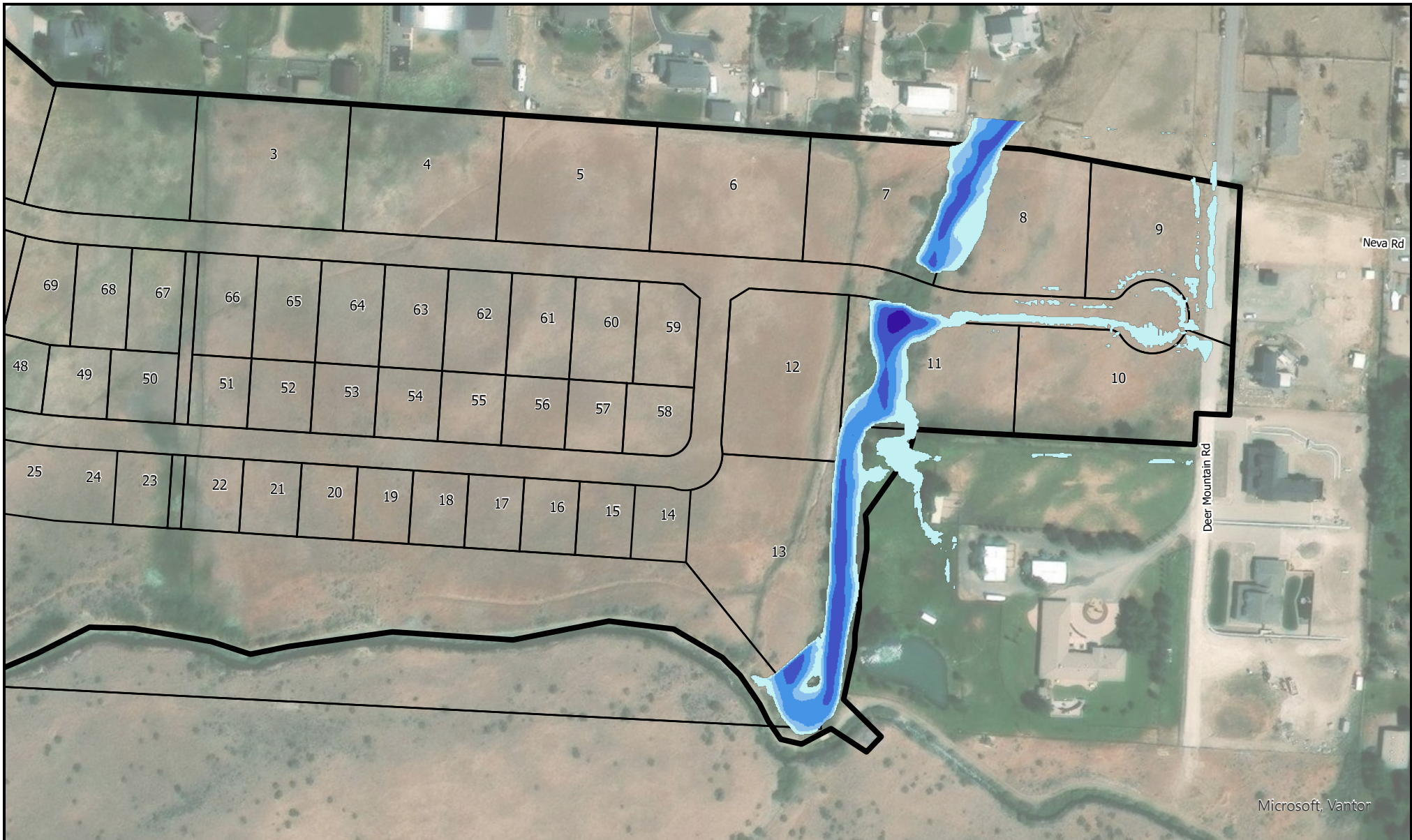
WOOD RODGERS



CHANNEL 1 VELOCITY
MERIDIAN 120 SOUTH VILLAGES 1 AND 2
RENO, NV
JULY 2026




WOOD RODGERS

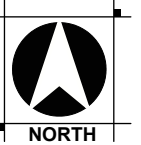
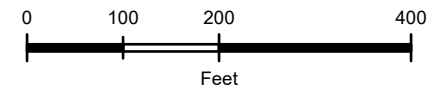
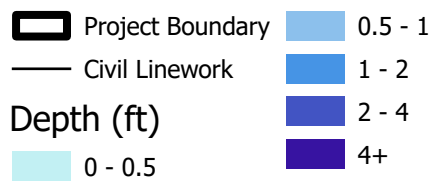


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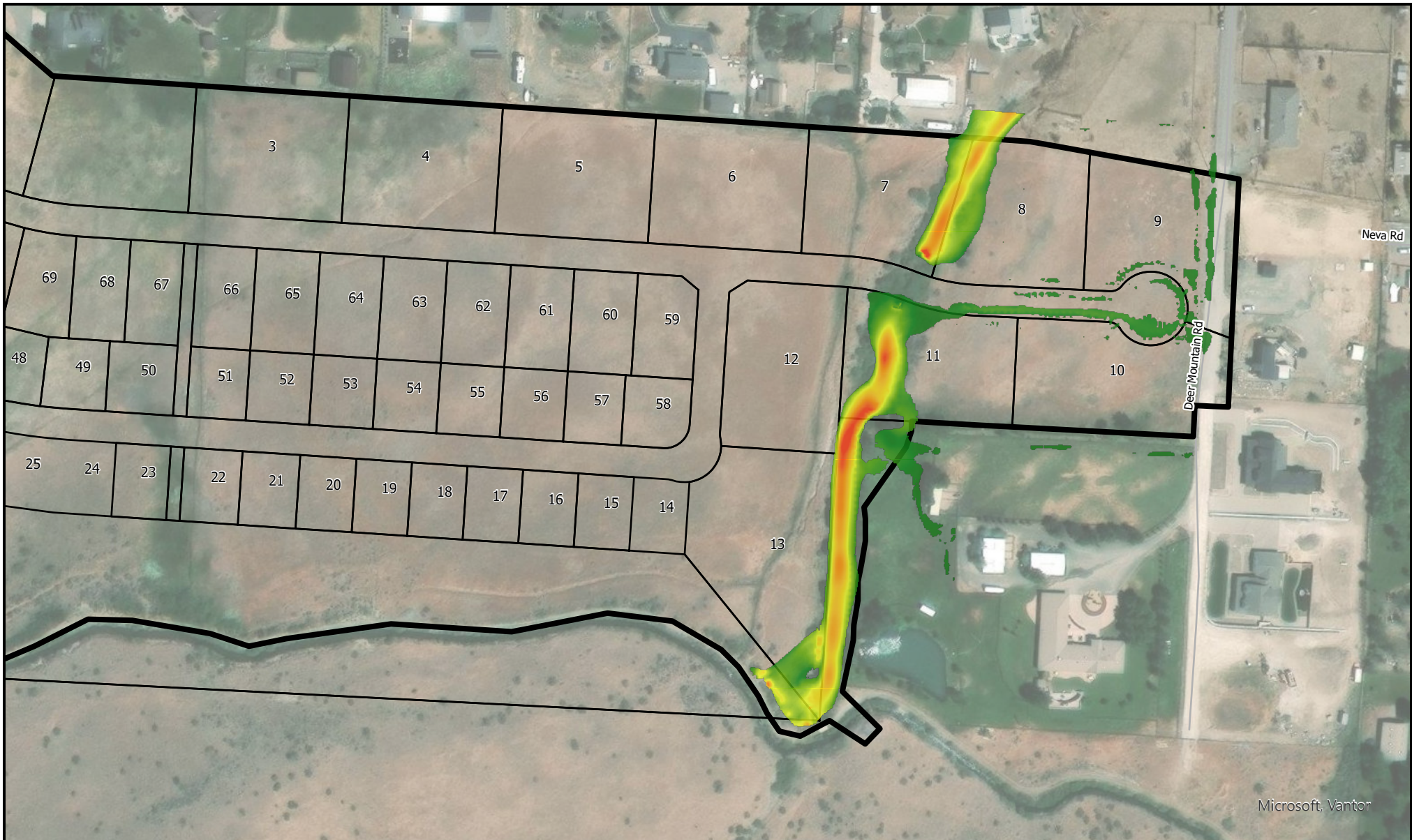
MERIDIAN 120 SOUTH VILLAGES 1 AND 2

RENO, NV

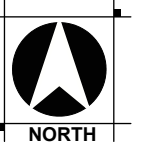
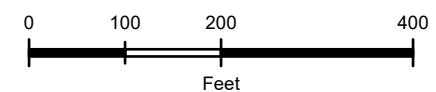
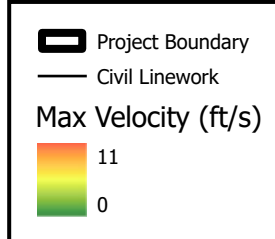
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WOOD RODGERS



CHANNEL 2 VELOCITY
MERIDIAN 120 SOUTH VILLAGES 1 AND 2
RENO, NV
JULY 2026



WOOD RODGERS

APPENDIX C

TECHNICAL DRAINAGE REPORT FOR MERIDIAN 120 SOUTH VILLAGE 1 AND 2
TECHNICAL DRAINAGE REPORT FOR QUILICI RANCH BACKBONE ROAD PHASE 1A BY
TERRAPHASE ENGINEERING INC.

Technical Drainage Report Backbone Road Phase 1A

Quilici Ranch, Reno, Nevada

Prepared for

RCI Engineering
500 S. Rancho Drive, Suite 17
Las Vegas, NV 89106

Prepared by

Terraphase Engineering Inc.
300 S Wells Ave, Suite 13
Reno, Nevada 89502

REVISION 2
August 19, 2022

Project Number N003.001



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Appendix C	Computations
Appendix D	Field Data





Acronyms and Abbreviations

BMP	best management practice
cfs	cubic feet per second
FEMA	Federal Emergency Management
FIRM	Flood Insurance Rate Map'
fps	feet per second
NDOT	Nevada Department of Transportation
RCB	Reinforced Concrete Box
RCP	Reinforced Concrete Pipe
SFHA	Special Flood Hazard Area
Tc	Time of concentration
Terraphase	Terraphase Engineering Inc.
TDS	Technical Drainage Study
TMRDM	Truckee Meadows Regional Drainage Manual

Signature

All engineering information, conclusions, and recommendations in this document have been prepared under the responsible charge of a Nevada Professional Engineer.



Mark Gookin, Principal

Name, Title

August 19, 2022

Date

1 Executive Summary

The Quilici Ranch Phase 1A Technical Drainage Report addresses drainage concerns for both the backbone road Quilici Ranch development and existing facilities. The tributary watersheds (watersheds C, D and E) encompass nearly 864 acres (Figure ES-1) of relatively steep terrain which generally drains toward the east and north. At the northeastern project limit, the watershed is bounded by the Steamboat Ditch and Interstate 80 (I-80). The backbone road area consists of a road system encompassing a total of 21 acres. Most of the watershed is currently undeveloped with vegetation ranging from grass-shrub rangeland to alpine conditions in limited areas.

Complicating Drainage Issues

To the extent that it has capacity, the Steamboat Ditch intercepts all flows currently generated by watershed E (Figures ES-2 and ES-3) but only has capacity for flows totaling approximately 100 cubic feet per second (cfs). As a result, frequent overtopping and occasional breach of the ditch has occurred during large storm events. Breach of the Steamboat Ditch resulting from watershed “E” discharges has caused erosion of the Ditch embankment and flooding which resulted in closure of portions of the eastbound lanes of I-80. Downstream from the Steamboat Ditch, in most cases, the natural drainage patterns have been maintained. An additional complication is that a portion of the backbone roadway system is proposed to be maintained by the Nevada Department of Transportation (NDOT). NDOT and the City of Reno have slightly different standards for conveyance of storm flows.

Conclusion

The proposed drainage system resolves the issue of Steamboat Ditch flows combining with local runoff by conveying 100-year flows under the Steamboat Ditch – greatly reducing the potential for overtopping and breach. This Technical Drainage Report addresses both on-site and off-site drainage analyses and improvements required for compliance with the policies and criteria set forth in the Truckee Meadows Regional Drainage Manual. The issue of different standards between the City of Reno and NDOT is resolved by the proposed drainage design exceeding the criteria of both entities. The proposed drainage improvements provide for acceptance and conveyance of storm flows to adequate discharge points in compliance with the requirements of the City of Reno and NDOT.





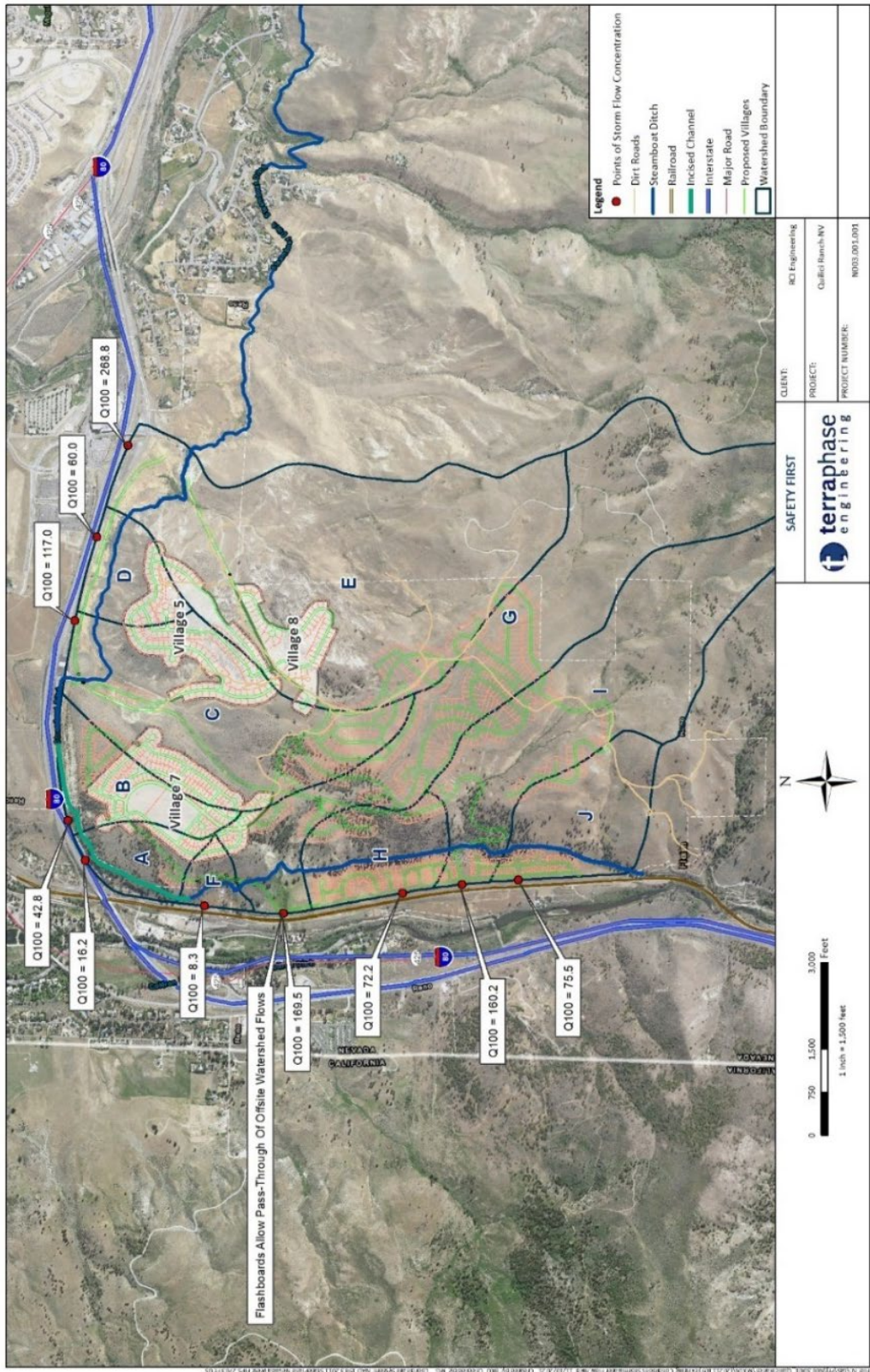


Figure ES-2 Steamboat Ditch features in relation to Watershed E (flows are existing conditions)



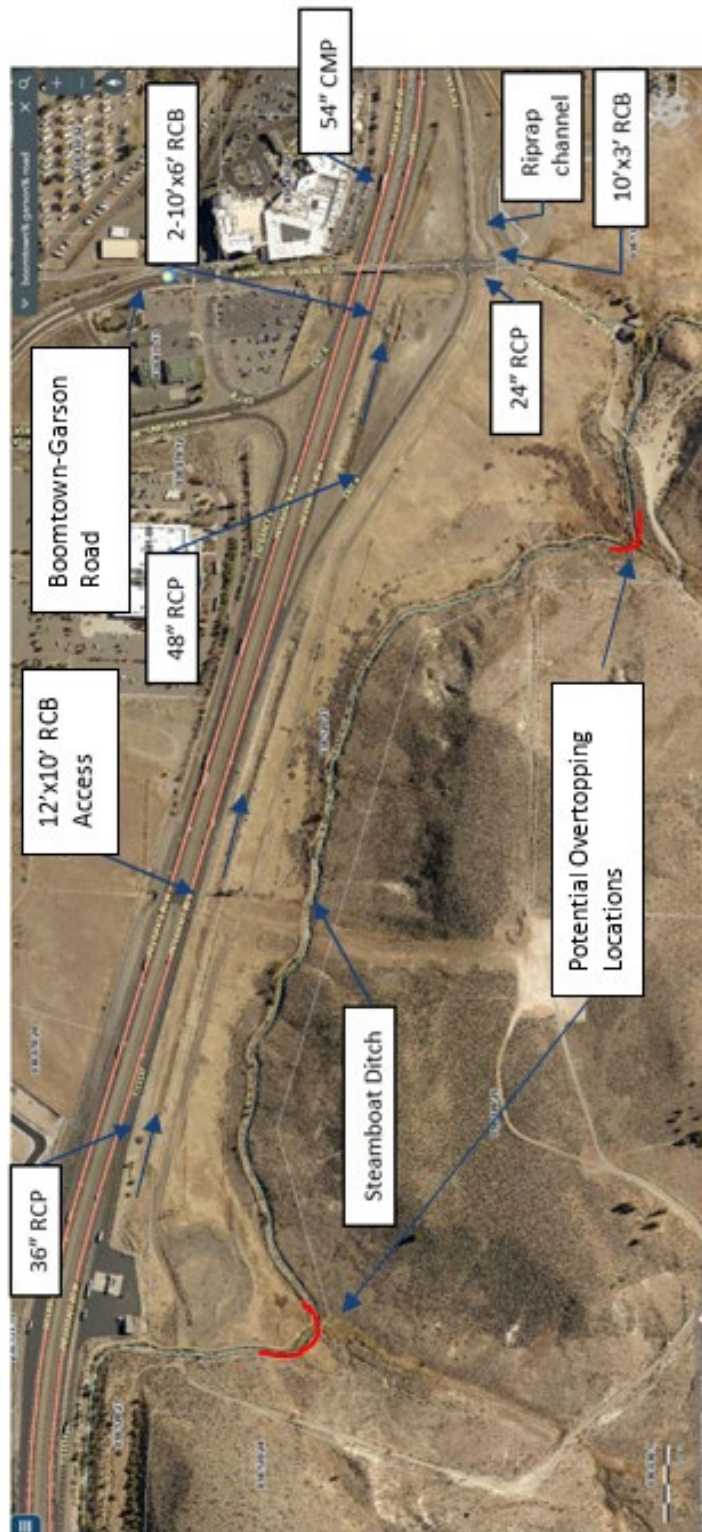


Figure ES-3 Existing drainage facilities in the Boomtown/Garson Interchange area

2 Drainage Report

2.1 Introduction

Terraphase Engineering Inc. (Terraphase) has developed this Technical Drainage Report for the Quilici Ranch Backbone Roads Phase 1A along the proposed extension of Boomtown Garson Road (refer to Figures 1 and 2) within the city of Reno, Nevada, corporate boundaries and affects Assessor Parcel Numbers:

- 038-030-10
- 038-190-37
- 038-120-26
- 038-120-04.

The Site is located within the Verdi, Nevada, quadrangle within Sections 16, 17, 20, and 21, Township 19, Range 18. The Site is bounded by improved and unimproved land as follows:

- North – U.S. Interstate I-80 and Steamboat Ditch
- East – Vacant undeveloped land
- West – Union Pacific Railroad
- South – Vacant undeveloped land

2.1.1 Site Description

Quilici Ranch is a proposed subdivision located in the northwest Reno/Verdi, Nevada, area that will ultimately consist of eight villages (Villages 5–12). This Technical Drainage Report pertains only to Phase 1A of the backbone road system. The proposed developed area consists of approximately 21 acres (Figure 2).

2.1.2 Existing Site Conditions

A. Topography, ground cover, soils

Blasdel Parkway generally slopes downhill to the northeast with gradients ranging from 1 – 8 percent. Kinkead Lane generally slopes to the east with an overall slope that is fairly flat with multiple roadway sags. Off-site flows approach the proposed developed areas from significant drainages to the south (refer to Figure 3, Hydrologic Soils Groups and Topography). Terraphase documented Site vegetation conditions through over 100 ground-level photographs collected throughout the development area and tributary watersheds with the predominant vegetative cover being classified as “Sagebrush and Grass Understory – Fair” (Figure 4).

Hydrologic soils group classifications are presented graphically in Figure 3; detailed calculations of areas for the various classifications are provided in Appendix C. The tributary watershed areas consist mainly of soil types C/D and D.





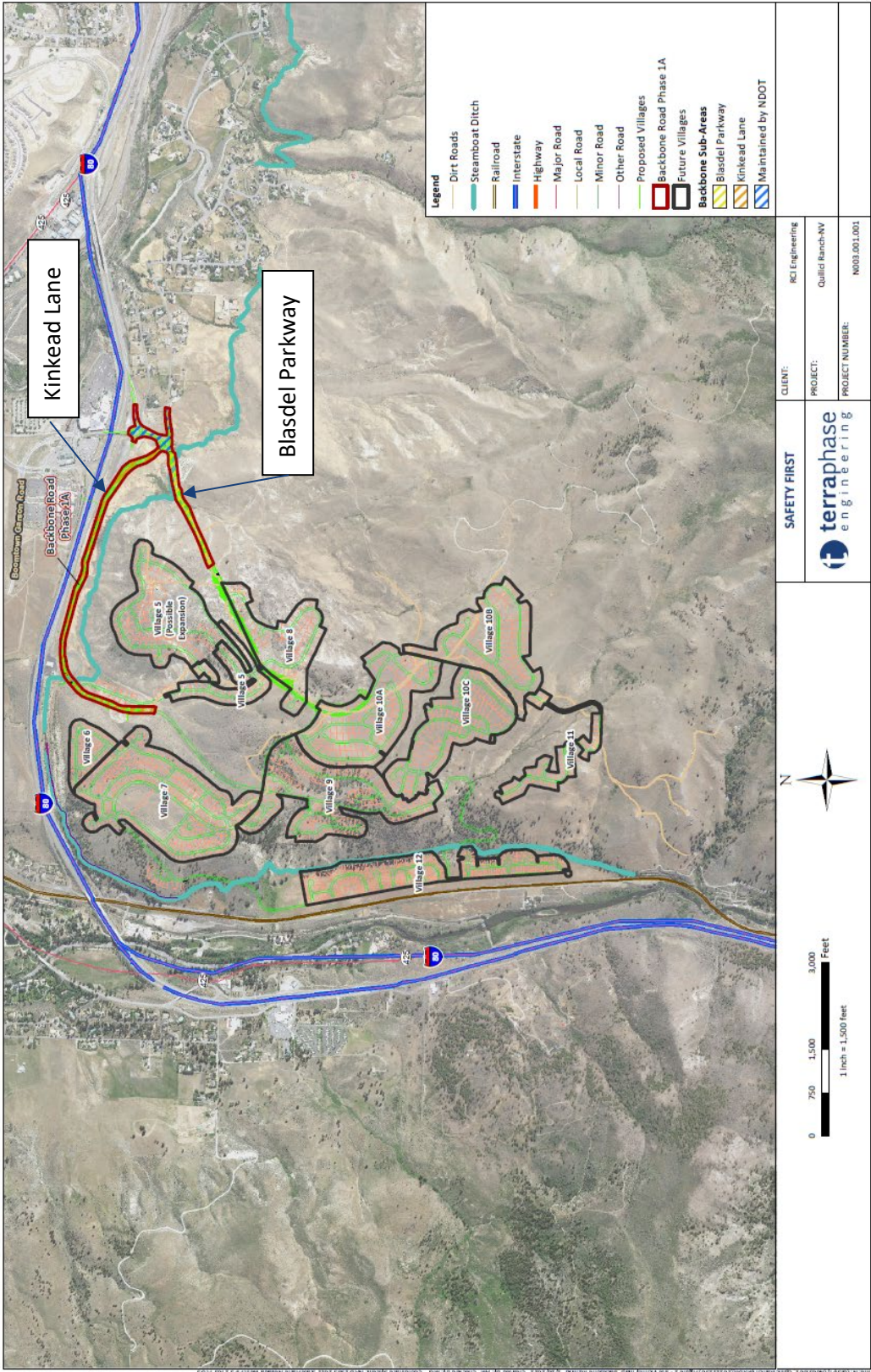


Figure 2 Vicinity Map



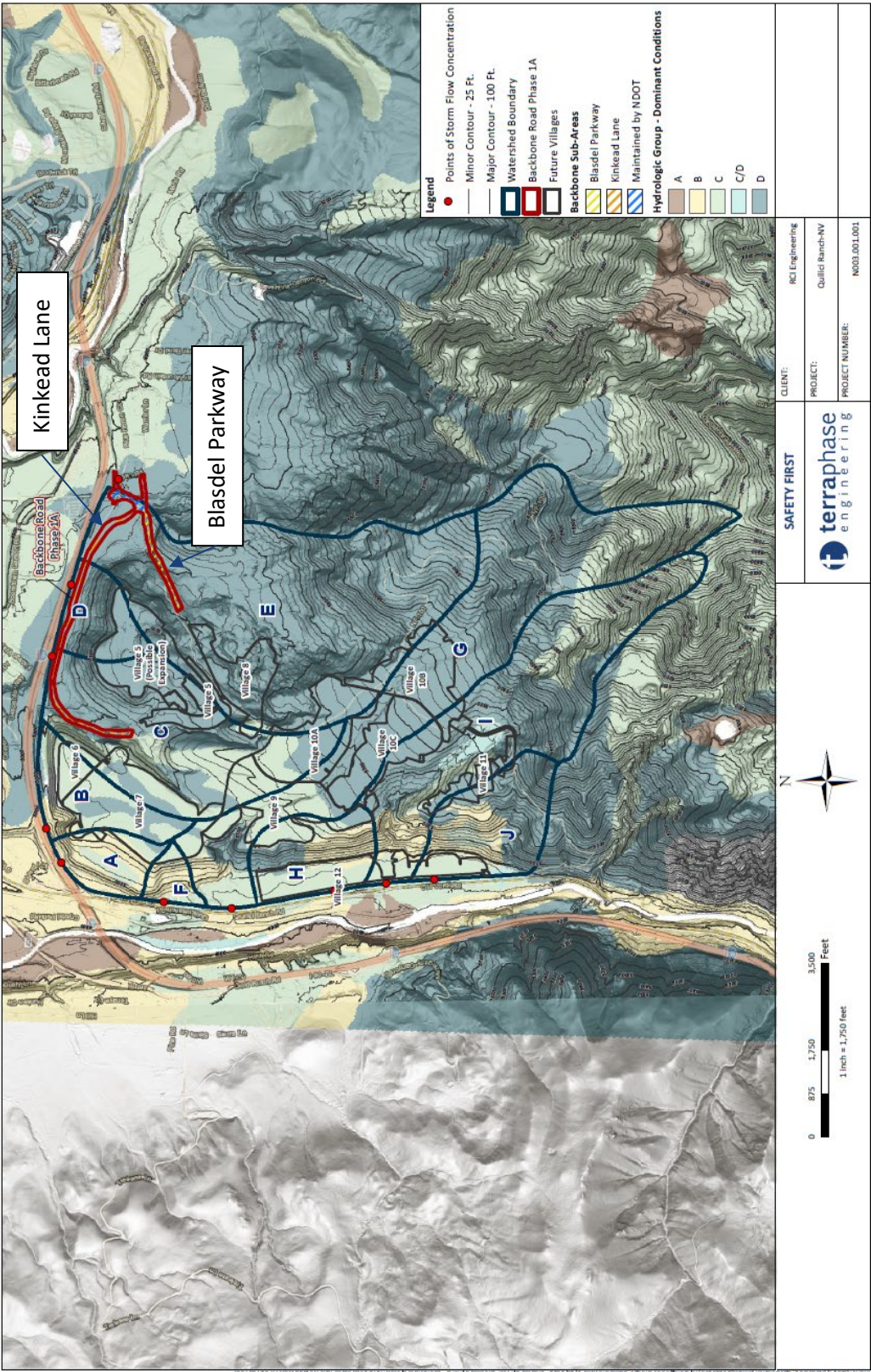


Figure 3 Hydrologic Soil Groups and Topography





Figure 4 Typical Vegetation Cover within the Project Area

B. Existing drainage and irrigation facilities

The following sections describe improved irrigation and drainage facilities in the project area.

B.1 Steamboat Ditch

The dominant improved irrigation and drainage feature in the project area is the Steamboat Ditch (refer to Figure 2). The Steamboat Ditch was constructed to divert water off the Truckee River for the purpose of agricultural irrigation in the Truckee Meadows areas. A description of the original 1880 Steamboat Ditch construction is found within the project-related Cultural Resources Inventory Short Report:

Construction of the Steamboat Ditch was completed on July 1, 1880. The constructed ditch dimensions were 6-feet wide at the bottom, 8-feet wide at the top, and had a total depth of 3-feet. Of the 3-foot depth, the upper one-foot was comprised of excavated material placed on the downslope embankment. The constructed longitudinal slope of the Steamboat Ditch was 8-feet per mile or 0.15%.

Based on the above description of the original Steamboat Ditch geometry, the capacity can be estimated using Mannings equation:

$$Q = 1.486/n AR^{2/3} S^{1/2}$$

Where: **Q** = Flow in cubic feet per second (cfs)
N = Manning's roughness coefficient (estimated at 0.022)
A = Cross sectional area
R = Hydraulic radius
S = Longitudinal channel slope

Based on the above parameters, an estimate of the original capacity of the Steamboat Ditch is approximately 107 cubic feet per second (cfs) with a flow velocity of 4 feet per second (fps). This calculated value can be compared against the historically identified flow of "5000 inches miner's measurement as near as can be determined". A single miner's inch amounts to approximately 1.5 cubic feet per minute or 0.025 cfs. Thus, "5000 inches miner's measurement" amounts to 125 cfs which compares reasonably well with that identified using Manning's equation. Currently, the ditch is consistently operated for irrigation purposes at flows below 80 cfs (personal communication, Bryan Byrne, August 4, 2021) and Washoe County reports that the Steamboat Ditch most typically conveys approximately 50 cfs during the irrigation season (Northern Nevada Regional Water Planning Commission 2016, Figure 2-11).

Flows are diverted from the Truckee River for the Steamboat Ditch Company's use during the irrigation season which runs from April 1 – October 30 except during dry years. During 2021, diversions to the ditch ceased by the end of August. During the winter, all gates which are in place are opened to allow for drainage to proceed along natural flow paths rather than to be diverted into Steamboat Ditch (Figure 5; Bryan Byrne, personal communication, August 4, 2021). Only one such gate was found to be present along the Steamboat Ditch corridor within the Project vicinity but is not located downstream from those areas tributary to the backbone roads.



Figure 5 Steamboat Ditch Typical Natural Drainageway Flashboard Gate (outside of project area)

In order to better understand points of stormwater inflows and outflows and those areas with greatest potential for overtopping of the ditch embankment due to the combination of irrigation conveyance flows and stormwater inflow, Terraphase conducted field reconnaissance during July and August of 2021. Based on our field reconnaissance, some general observations can be made:

- The curved portion of the Steamboat Ditch where the ditch turns from north-south trending to east-west is well-incised and thus this area poses little risk for ditch overtopping or breach (refer to incised channel area of Figure 6);
- Generally, no significant stabilization measures have been provided for the acceptance of stormwater inflows;
- Generally, no measures have been provided to allow for bypass of stormwater inflows (note single exception shown in Figures 5 and 6); and,
- Where significant tributary areas direct flows to the Steamboat Ditch, evidence of occasional overtopping is apparent based on downslope vegetation and erosional indications.

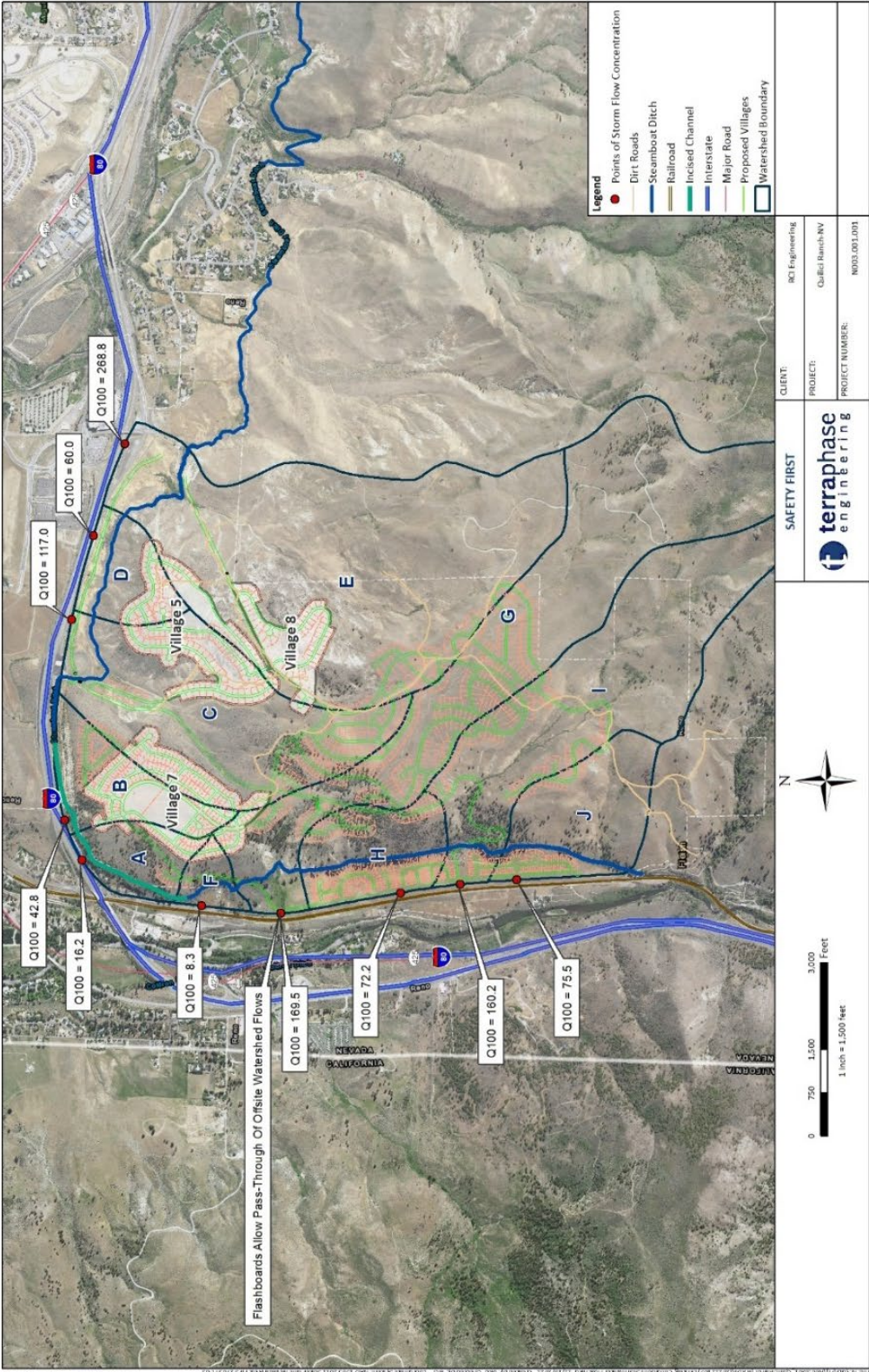


Figure 6 Steamboat ditch features in relation to large watersheds
Note: Flows are cfs, existing conditions.

Because the Steamboat Ditch is subject to overtopping during significant storm events, the project proposes to reduce this flooding hazard by conveying storm flows under the Ditch and discharging into the existing downstream drainage features where such adequate downstream conveyance still exists.

B.2 Drainage Facilities

The predominant existing drainage facilities related to Phase 1A of the project are those associated with watershed “E” (refer to Figure 6) and the acceptance and stable conveyance of flows associated with I-80 and the Boomtown Garson Road interchange. Currently, flows from watershed “E” are accepted into a 10’ wide by 3’ high reinforced concrete box (RCB) and discharged into a riprap lined channel which conveys flows eastward to a discharge at the Truckee River. Based on information contained within the associated drainage report (PBS&J, August 7, 2007), the RCB and channel have been sized to convey the 50-year storm flows assuming no interception by the Steamboat Ditch. Refer to Figure 7 below for identification of additional existing NDOT drainage facilities.

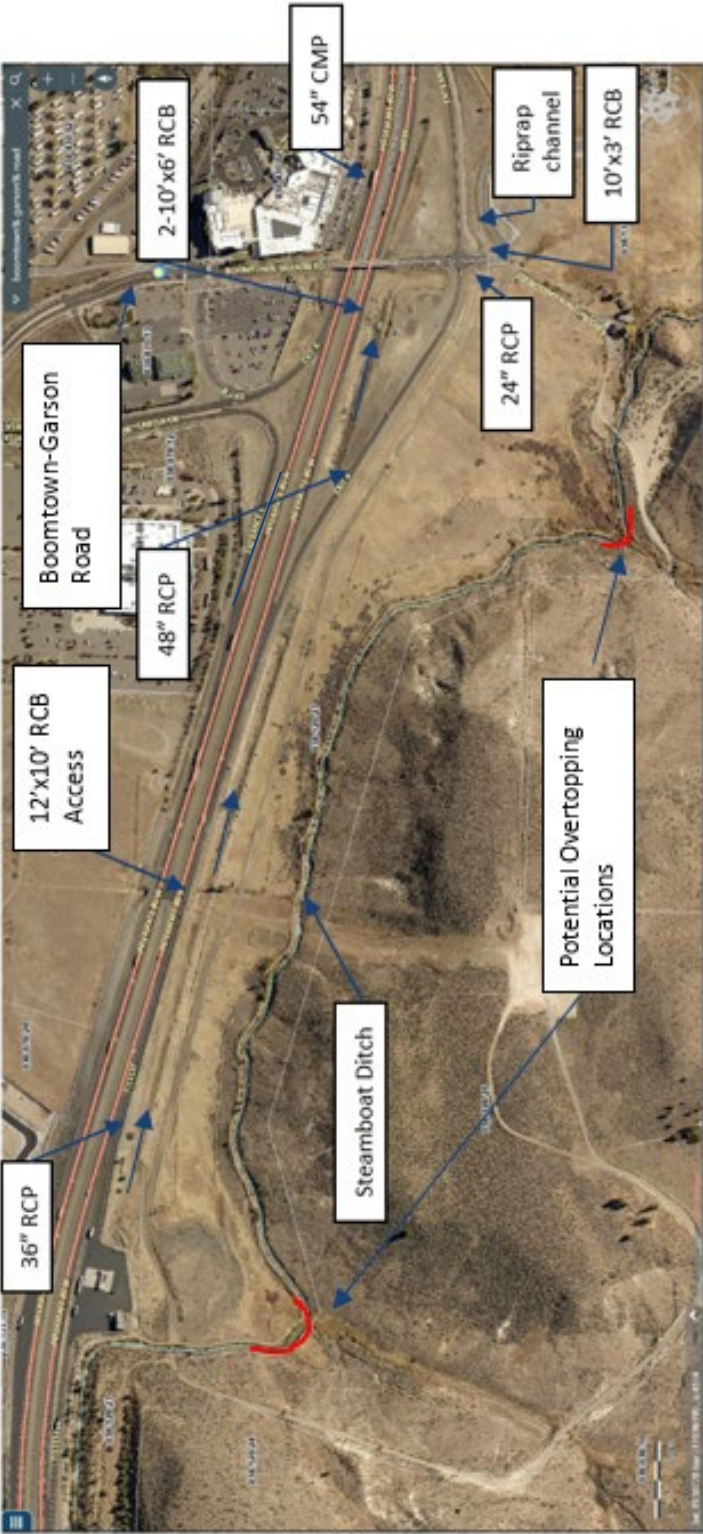


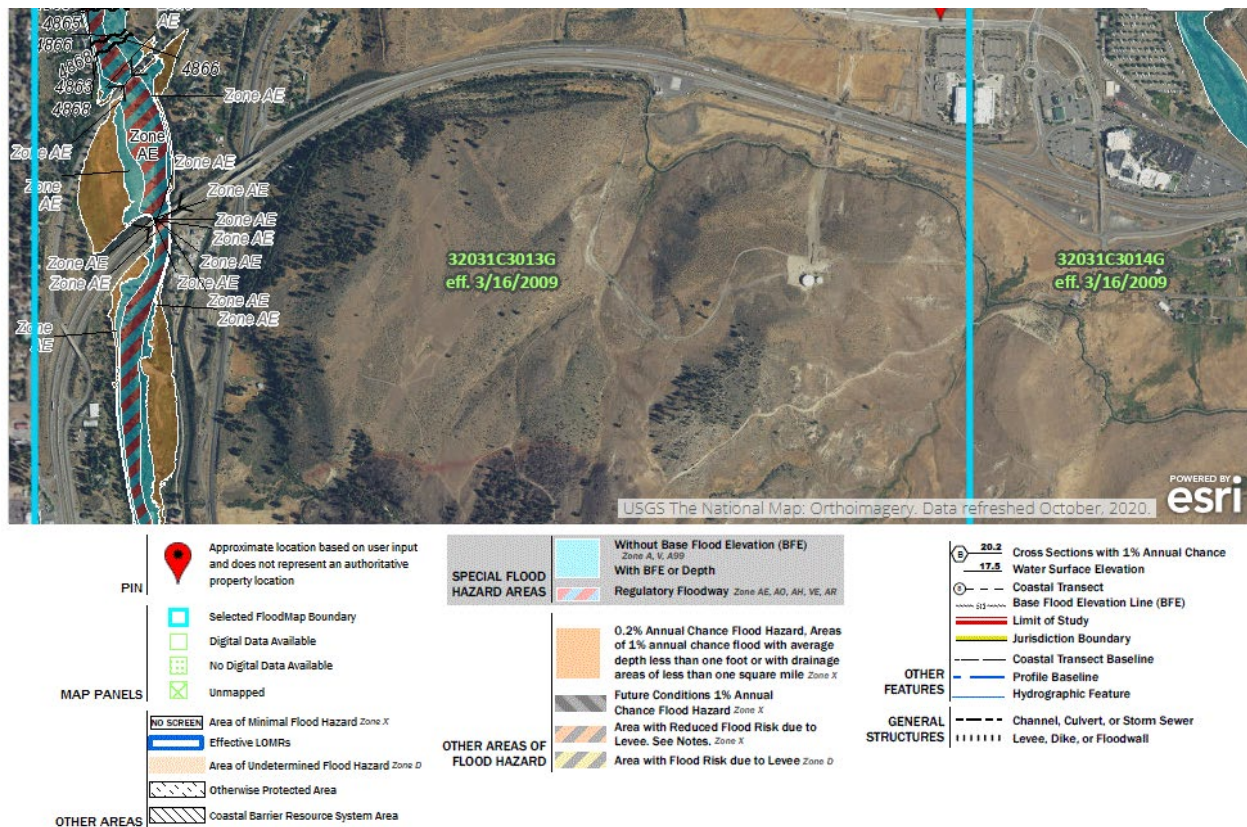
Figure 7 Existing drainage facilities in the project area



C. Existing flood hazards

The project area lies outside of any FEMA-mapped Special Flood Hazard Area (SFHA). According to Flood Insurance Rate Map (FIRM) Community-Panel Numbers 32031C3013G and 32031C3014G, the project site lies in Zone X. Zone X is determined to be outside the 0.2% annual chance floodplain (refer to Figure 8). Terraphase has reviewed available aerial imagery for the area dating back to 1946 (<http://www.nbmj.unr.edu/Collections/HistoricalAirPhotos/HistoricalAirPhotos.html>) and there is no evidence of debris flows or alluvial fan flooding. Watercourses in the project area are generally well defined and follow consistent flow paths. However, there is evidence both from review of historical aerial imagery and field observations that the Steamboat Ditch has experienced overtopping / breach in the Watershed E confluence area.

The major offsite watersheds which flow through the site are contained within well-defined watercourses. Therefore, standard provisions for building elevations (in relation to top of curb) and armoring of fill slopes in areas adjacent to watercourses should provide for adequate flood protection in compliance with City of Reno ordinances and FEMA requirements.



2.1.3 Description of Proposed Project

The proposed project consists of those backbone roads as depicted in Figures 2 and 3, and the project improvement plans.

2.2 Previous Studies

A number of drainage studies have evaluated the conditions in the area of Boomtown Garson Road and two studies have included analysis of the entirety of the watersheds affecting Quilici Ranch as follows (chronological order):

- Boomtown Garson Area
 - NDOT *Memo*, April 1973 (Boomtown Garson Area)
 - NDOT *Memo*, May 1973 (Boomtown Garson Area)
 - NDOT *Memo*, February 1976 (Boomtown Garson Area)
 - NDOT *Memo*, March 1982 (Boomtown Garson Area)
 - NDOT *Memo*, November 1982 (Boomtown Garson Area)
 - NDOT *Memo*, June 1982 (Boomtown Garson Area)
 - NDOT *Memo*, July, 1986 (Boomtown Garson Area)
- *Hydrologic and Hydraulic Report, Mortensen et al. Development*, Nimbus 2003 (entire Quilici development area)
- Cabela's Interim NDOT Encroachment Permit Drainage Memorandum, PBS&J, August, 2007 (Boomtown Garson Area)
- *Preliminary Drainage Report Santerra/Quilici*, Manhard Consulting 2020 (entire Quilici development area)

The relevance of these studies to the Quilici project and some of the related decisions are presented in Table 1 below.

Table 1 Previous Study Relevance

Study	Relevance
NDOT 4/73	Q50=200cfs Allowed for failure of Steamboat Ditch With inclusion of Ditch failure, total flow estimated at 300 cfs Indicates; "I found no reason for the existing high capacity system" (referring to the conveyance of flows on the north side of I-80). 2-10'x6' RCB intended to convey flows to the north side of I-80 Suggests plugging southerly cell in 2-10'x6' RCB
NDOT 5/73	Suggests single 72" pipe along north side of I-80 to convey the watershed E flows

Table 1 Previous Study Relevance

Study	Relevance
NDOT 2/76	Indicates “The situation has changed significantly since you informed me of the plans to upgrade and change the alignment of the Steamboat Ditch and the improvements will be such as to preclude the possibility of breakage.” Suggests plugging one cell of 2-10’x6’ RCB and transitioning to 54” pipe along the north side of I-80.
NDOT 3/82	Identifies watershed E Q10=125cfs, Q25=149cfs
NDOT 6/82	Identifies peak flows “To allow for breakage of Steamboat Ditch” of Q10=100cfs; Q50=200cfs Recommends replacing the existing 24” RCP under the EB offramp with 2-36” RCP or as a 10-year alternative, 1-36” RCP; Also looked at 4-24” RCPs. Calls for Garson Road to “act as a dike and push the water through the two 36” CMPs (recommended feature). Flows will proceed north to 2-10’x6’ RCBs.
NDOT 11/82	Indicates NDOT did not move forward with upgrading 24” under EB offramp.
NDOT 7/86	Switches to upgrading channel on south side. Provides flowrates for “west”, “center” and “east” drainage but no associated hydrology map available. Estimates 22 cfs passes through the 24” RCP to the Boomtown side. Included design of channel along the south side of I-80 and cattle guard culvert 6’w x 27”h.
Nimbus 7/2003	Identifies a 100-year flow of 647cfs and 50-year of 425cfs at the Boomtown/Garson concentration point. Employed overly conservative CNs based on their future developed condition assumptions.
PBSJ 8/2007	Utilized Nimbus 7/2003 flows to design 10’x3’ RCB at Boomtown Road and downstream riprap channel to convey flows east to Truckee River. Describes drainage patterns to the east along the south side of I-80: Flows are expected to bypass the 36” culvert and 12’x10’ RCB located to the west of Boomtown Garson Road. The 48” RCP has capacity to accept and convey flows to “gore” area and ultimately to the 2-10’x6’ RCB which flows to the 54” RCP along the north side of I-80 for discharge to the Truckee River.
Manhard 10/2020	New HEC-HMS analysis estimates 100-year watershed E flow of 97 cfs Lag times appear to be significantly overstated due to assumption of “Forest with Heavy Ground Litter & Hay Meadow (overland flow)” for travel time velocity estimation.

The primary conclusions formed by reviewing the past drainage studies for the area are:

1. Pre-2000 NDOT hydrologic and hydraulic analysis consisted of either very rough approximations or lacks sufficient backup to fully understand the work that was done;
2. The Nimbus analysis was overly conservative due to excessively high curve numbers (CNs) employed;



3. The drainage facilities located along the south side of I-80 are likely sufficiently sized for the 100-year event due to reliance on the prior Nimbus work for identification of peak flows;
4. The Manhard analysis understates peak flows due to the excessively slow overland flow velocities used in the analysis; and,
5. There is significant excess capacity in the existing 54" RCP along the north side of I-80 due to the decision made 30 years ago to route watershed "E" flows along the south side of the highway.

2.3 Hydrologic and Hydraulic Analysis

A. Method used for runoff computations

Rational Method

Peak storm flow and runoff volumes were determined using the methods presented in the Truckee Meadows Regional Drainage Manual (the manual). For onsite proposed development areas, the hydrologic analysis used to determine peak storm runoff flow rates was the Rational Method. This method was chosen due to the small drainage areas and the simplistic drainage basins.

The Rational Method equation is in the form of:

$$Q = CiA$$

Where: Q = maximum rate of runoff (cfs)
 C = runoff coefficient (see Table 701, Manual)
 i = average intensity of rainfall (in/hr)
 A = contributing basin area (acres)

Runoff coefficients were determined based on Table 701 (in the manual). For areas with multiple development types, weighted average curve numbers were determined based on the proportions of the various areas. Precipitation intensities are dependent upon both the location of the area as well as the associated times of concentration. The initial times of concentration (t_i) were determined using equation 702 from the manual:

$$t_i = 1.8 (1.1 - R) L_o^{1/2} / S^{1/3}$$

Where: t_i = initial or overland flow time (minutes)
 R = flow runoff coefficient
 L_o = length of overland flow (feet, 500 feet maximum)
 S = average overland basin slope (percent)

Travel Time. The results of the initial t_c calculation were checked against equation 704 from the manual which requires that the resultant t_c not exceed that given by the equation below. Whichever equation (701 and 704 in the manual) has a lesser t_c at the first design point will govern in an urbanized watershed. The minimum t_c for urbanized paved areas and vegetated landscaped or undeveloped areas are 5 minutes and 10 minutes, respectively. Equation 704 is presented below.

$$t_c = L/180 + 10$$



Where: t_c = time of concentration at the first design point in an urban watershed (minutes)
 L = watershed length (feet)

Refer to Appendix C for detailed t_c calculations.

Precipitation data was taken from NOAA Atlas 14, Volume 1, Version 5. Interpolated rainfall intensities were determined for times of concentration (t_c) which are between the tabular values presented in the NOAA Atlas 14 data (refer to Figure 9 and Appendix A for detailed calculations of interpolated intensity values).

HEC-HMS Method

For determination of peak flows from large offsite watershed areas and to best estimate the attenuation effects of proposed detention areas, the HEC-HMS computer simulation was employed (required for detention facilities for development areas > 10 acres per section 1303.1.2 of the Manual). The following describes the required parameters employed in the model. Refer to Appendix C for the area, curve number, lag time, and culvert sizing calculations.

The following methods and types were used:

- Loss Method for the subbasins: SCS Curve Number
- Transform Method for the subbasins: SCS Unit Hydrograph
- Baseflow Method for the subbasins: Constant Monthly
- Routing Method for the reaches: Lag
- Initial Type for the reaches: Discharge = Inflow

The following assumptions were made:

- The initial abstraction defines the amount of precipitation that must fall before surface excess results. The initial abstraction input value was left blank and was automatically calculated as 0.2 times the potential retention, which is calculated from the curve number.
- The baseflow is the portion of the streamflow that is sustained between precipitation events and was assumed to be 0 cfs.
- The time interval included in the control specification is the time interval used to perform computations during a simulation and defined as 5 min.
- The intensity duration specifies the shortest time period of the storm and was assumed to be 5 min.
- The intensity position determines when in the storm the period of peak intensity will occur and was assumed to be 50%.
- It is assumed that there is no run-on, and sources were not added to the basin model.

B. Design storm intensities for 5- and 100-year storms.

Precipitation frequencies used to calculate the design storm intensities were found through NOAA Atlas Volume 1, Version 5. The precipitation frequencies listed in Figure 9 are representative of the project location for the backbone road. Design storm intensities were calculated using the following equation:

$$I = PF/(t_c/60)$$

Where: **I** = Intensity (inches/hour)
PF = precipitation frequency (inches)
t_c = concentration time

For instances where the time of concentration is not listed as a duration in the PF table (Figure 9), the PF was determined by interpolating, using the following equation:

$$Y2 = Y1 + (X2 - X1) * ((Y3 - Y1) / (X3 - X1))$$

Where: **X1** = lower duration value
X2 = higher duration value
X3 = time of concentration
Y1 = PF value corresponding to X1
Y2 = PF value corresponding to X2
Y3 = interpolated PF value

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Precipitation Frequency Data Server



NOAA Atlas 14, Volume 1, Version 5
Location name: Reno, Nevada, USA*
Latitude: 39.4868°, Longitude: -119.9914°
Elevation: 4947.23 ft**
* source: ESRI Maps
** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps & aeriels](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.117 (0.101-0.135)	0.146 (0.126-0.169)	0.193 (0.166-0.225)	0.238 (0.205-0.279)	0.315 (0.263-0.372)	0.386 (0.314-0.462)	0.472 (0.372-0.573)	0.577 (0.437-0.716)	0.751 (0.537-0.959)	0.914 (0.624-1.20)
10-min	0.179 (0.153-0.205)	0.222 (0.192-0.257)	0.294 (0.253-0.343)	0.363 (0.312-0.425)	0.478 (0.401-0.566)	0.587 (0.477-0.703)	0.718 (0.565-0.872)	0.879 (0.665-1.09)	1.14 (0.817-1.46)	1.39 (0.950-1.82)
15-min	0.222 (0.190-0.254)	0.276 (0.237-0.319)	0.364 (0.314-0.425)	0.450 (0.386-0.527)	0.593 (0.496-0.702)	0.728 (0.592-0.871)	0.890 (0.701-1.08)	1.09 (0.824-1.35)	1.42 (1.01-1.81)	1.72 (1.18-2.26)
30-min	0.299 (0.255-0.343)	0.371 (0.320-0.429)	0.490 (0.422-0.572)	0.605 (0.520-0.709)	0.799 (0.669-0.945)	0.980 (0.797-1.17)	1.20 (0.943-1.46)	1.47 (1.11-1.82)	1.91 (1.36-2.44)	2.32 (1.59-3.04)
60-min	0.370 (0.316-0.424)	0.459 (0.395-0.531)	0.607 (0.522-0.708)	0.749 (0.644-0.878)	0.988 (0.828-1.17)	1.21 (0.986-1.45)	1.48 (1.17-1.80)	1.82 (1.37-2.25)	2.36 (1.69-3.02)	2.87 (1.96-3.76)
2-hr	0.502 (0.450-0.567)	0.622 (0.559-0.704)	0.787 (0.701-0.892)	0.933 (0.822-1.06)	1.16 (0.995-1.32)	1.36 (1.15-1.57)	1.60 (1.32-1.87)	1.91 (1.52-2.27)	2.48 (1.89-3.02)	3.02 (2.22-3.78)
3-hr	0.619 (0.561-0.689)	0.767 (0.701-0.858)	0.947 (0.858-1.06)	1.10 (0.986-1.23)	1.31 (1.16-1.47)	1.50 (1.31-1.70)	1.73 (1.48-1.98)	2.04 (1.71-2.38)	2.59 (2.10-3.07)	3.11 (2.47-3.81)
6-hr	0.938 (0.852-1.04)	1.16 (1.06-1.29)	1.42 (1.28-1.57)	1.61 (1.45-1.79)	1.87 (1.67-2.09)	2.06 (1.82-2.31)	2.25 (1.96-2.55)	2.49 (2.14-2.86)	2.95 (2.49-3.43)	3.40 (2.83-4.00)
12-hr	1.34 (1.21-1.49)	1.67 (1.51-1.86)	2.07 (1.87-2.31)	2.40 (2.14-2.67)	2.82 (2.50-3.16)	3.15 (2.76-3.55)	3.48 (3.01-3.97)	3.81 (3.24-4.39)	4.25 (3.53-4.99)	4.60 (3.75-5.48)
24-hr	1.82 (1.64-2.04)	2.28 (2.05-2.55)	2.87 (2.58-3.21)	3.36 (3.01-3.76)	4.04 (3.60-4.52)	4.59 (4.06-5.14)	5.16 (4.53-5.81)	5.76 (5.00-6.52)	6.59 (5.63-7.52)	7.25 (6.11-8.34)
2-day	2.29 (2.03-2.62)	2.89 (2.56-3.31)	3.73 (3.28-4.26)	4.41 (3.87-5.05)	5.40 (4.70-6.19)	6.20 (5.36-7.13)	7.06 (6.03-8.18)	7.98 (6.74-9.32)	9.28 (7.69-11.0)	10.3 (8.42-12.4)
3-day	2.56 (2.25-2.93)	3.24 (2.86-3.72)	4.24 (3.73-4.86)	5.07 (4.44-5.81)	6.26 (5.43-7.20)	7.25 (6.23-8.35)	8.31 (7.07-9.63)	9.46 (7.94-11.0)	11.1 (9.13-13.2)	12.5 (10.1-15.0)
4-day	2.82 (2.48-3.24)	3.59 (3.16-4.13)	4.75 (4.17-5.46)	5.72 (5.00-6.57)	7.12 (6.17-8.20)	8.29 (7.11-9.57)	9.57 (8.10-11.1)	11.0 (9.13-12.8)	13.0 (10.6-15.3)	14.6 (11.7-17.5)
7-day	3.39 (2.92-3.99)	4.37 (3.76-5.13)	5.86 (5.03-6.89)	7.08 (6.05-8.31)	8.82 (7.48-10.4)	10.3 (8.61-12.1)	11.8 (9.82-14.0)	13.5 (11.1-16.1)	15.8 (12.7-19.1)	17.8 (14.1-21.7)
10-day	3.91 (3.37-4.57)	5.04 (4.36-5.90)	6.78 (5.85-7.94)	8.17 (7.02-9.55)	10.1 (8.63-11.9)	11.7 (9.90-13.7)	13.4 (11.2-15.8)	15.1 (12.5-18.0)	17.6 (14.3-21.1)	19.6 (15.8-23.8)
20-day	5.19 (4.49-6.08)	6.69 (5.80-7.85)	8.94 (7.74-10.4)	10.7 (9.22-12.5)	13.1 (11.2-15.3)	15.0 (12.8-17.6)	17.0 (14.3-20.1)	19.1 (15.9-22.7)	21.9 (18.0-26.4)	24.2 (19.6-29.4)
30-day	6.34 (5.50-7.48)	8.18 (7.10-9.65)	10.9 (9.46-12.9)	13.0 (11.2-15.3)	15.9 (13.7-18.7)	18.2 (15.5-21.5)	20.6 (17.4-24.4)	23.0 (19.3-27.4)	26.4 (21.9-31.7)	29.1 (23.8-35.2)
45-day	7.76 (6.75-8.88)	10.0 (8.73-11.5)	13.4 (11.6-15.3)	15.8 (13.8-18.1)	19.2 (16.6-22.1)	21.8 (18.7-25.1)	24.4 (20.8-28.2)	27.0 (22.9-31.4)	30.6 (25.6-35.9)	33.4 (27.6-39.4)
60-day	8.76 (7.53-10.1)	11.4 (9.79-13.1)	15.2 (13.0-17.5)	17.9 (15.4-20.6)	21.4 (18.3-24.7)	24.0 (20.4-27.8)	26.6 (22.5-30.9)	29.2 (24.5-34.0)	32.5 (27.0-38.1)	34.9 (28.8-41.2)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

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Figure 9 NOAA Atlas 14 Precipitation-Duration table



C. Method used to determine hydrologic parameters and computations

HEC-HMS Method

Storm Duration

The 5-yr, 24-hr storm event and 100-yr, 24-hr storm event were used in this analysis, and the primary culvert and detention facility sizing were based on the 100-yr, 24-hr storm event, which is the more conservative storm event.

Curve Number

The curve number (CN) is a hydrologic parameter that characterizes the runoff properties for a particular soil and ground cover. The area of each sub watershed or watershed was broken down into subareas based on the Hydrologic Soil Group maps from the United States Department of Agriculture (USDA) Natural Resources Conservation Services Soil Survey. A CN was assigned to each Hydrologic Soil Group, and a CN was calculated for each sub watershed or watershed using an area-weighted method. The cover description for the undeveloped area was assigned to be Arid and Semiarid Rangelands – Sagebrush with grass understory (Fair) based on Terraphase's field observations of vegetative conditions. The cover description for the developed area was assigned to be Residential districts by average lot size. The curve number for Hydrologic Soil Group C/D was calculated as the rounded average of the curve numbers for Hydrologic Soil Groups C and D. Refer to Appendix C for the CN calculations.

Lag time

The lag time was calculated based on the slope, velocity, and time of concentration for each watershed or sub watershed.

The slope, s , is unitless and was calculated using the following relationship:

$$s = H/L$$

Where: H = the elevation drop in feet and L is the sub watershed length in feet

The velocity, V , is in feet per second and was calculated using the following relationship, which is for a Short-Grass Pasture cover description:

$$V = 6.962s^{0.5}$$

Where: s = the slope in feet/feet

The time of concentration, t_c , is in hours and was calculated using the following relationship:

$$t_c = s/(3600V)$$

Where: s = the slope, which is unitless
 V = the velocity in ft per sec



The lag time is equal to the lag between the center of mass of rainfall excess and the peak of the unit hydrograph. For small drainage basins (less than one square mile) and basin slopes less than ten percent, the lag time, TLAG, is in hours and may be related to the time of concentration by the following empirical relationship:

$$\text{TLAG} = 0.6t_c$$

Where: t_c = the time of concentration in hours

The culvert sizes were initially estimated using the orifice equation based on peak flows without attenuation. To calculate the head acting on the centerline of the culvert, the orifice equation was used:

$$Q = C_d A(2gh)^{1/2}$$

Where: Q = the flow in cubic feet per sec
 C_d = the unitless coefficient of discharge
 A = the area of the orifice in square feet
 g = the acceleration from gravity, and h is the head acting on the centerline in feet

The following values were used:

- $C_d = 0.62$ (for sharp orifice)
- $g = 32.2 \text{ ft/sec}^2$

The selected culvert size was the smallest size that was sufficient to prevent overflowing of the proposed detention facilities. This size was initially input into the HEC-HMS model which routed flows from detention basins through the outlet culverts.

Rational Method

The average flow velocity is used to calculate the travel time. A velocity of 2.5 ft/s was assumed for the determination of the initial t_i throughout the rational method computations as it is a typical (conservative) value. The runoff coefficients (c-values) vary by village depending on lot size and requirements from the TMRDM (Table 701). C-values for roadway calculations were determined to be 0.88 and 0.93 for 5-year and 100-year flows, respectively.

For areas with varying c-values, the average c-value was calculated and applied to the analysis.

D. Method used for hydraulic parameters and computations

On-site Storm Drain System

The on-site storm drain system was preliminarily sized at the Master Drainage Study stage using Manning's equation and pipe full capacity calculations (assuming 80% of available slope to account for minor losses). Street flow calculations at the Master Plan stage were performed based on a spreadsheet analysis which employed methodologies using a modification of the Manning's equation obtained from the Urban Drainage Design Manual which resulted in the preliminary identification of inlet locations. Inlet locations were determined as necessary to meet the City of Reno's criteria as specified in the Manual, in Section 304.4, for roadway spread and depth times velocity considerations for both minor and major on-site storm events. Subsequently, additional inlets were added to maintain drainage patterns. During

preparation of this Technical Drainage Study, inlet and required pipe sizes were determined and re-evaluated at a more specific level using FlowMaster, StormCAD and HY-8. Once the locations of the inlets were determined, the inlets were sized using FlowMaster. All sag inlets were sized with a 50% clogging factor to account for accumulation of debris. Additionally, rip rap armoring at all sag locations is provided to handle emergency overflow situations. The inlets in Phase 1A consist of 4-R catch basins and high-capacity curb inlets. See Appendix C for FlowMaster results and parameters.

Channels and Backbone Storm Drains

The channels (and associated culverts) which convey major flows around the developed areas have been analyzed using HEC-RAS. Manning's n-values have been based upon extensive field reconnaissance and over 100 ground level photographs (Figure 10). HEC-RAS results and parameters are included in Appendix C.

Parameters employed in the HEC-RAS analysis include:

- Typical channel Manning's n-value – 0.06 (assumed based on over 60 site photos)
- Typical culvert Manning's n-value – 0.013 (RCP assumed)
- Culvert headwall conditions – Chart # 58, Scale # 2; Chart # 55, Scale #1, Contraction/Expansion Coefficients: 0.1/0.3, respectively.

The major, "backbone" storm drain which conveys flows from watershed "E" to the roundabout area was analyzed using the StormCAD computer simulation.



Figure 10 Drainage feature in project meadow area upstream from Steamboat Ditch

E. Computer programs used for modeling

The following programs were used for modeling:

- HEC-RAS 6.0, Release date May 28, 2021
- HEC-HMS 4.8, Release date: April 7, 2021
- StormCAD CONNECT Edition, Update 3, Release date: June 26, 2021
- FlowMaster CONNECT Edition, Update 3, Release date: March 20, 2020
- HY-8 7.7, Release date: June 2, 2021

2.4 Historic Drainage System

A. Major basins (100 acres or more) and relationship to major drainage facilities

Refer to Figure 11 and existing and proposed offsite hydrology maps located in Appendix B.

B. Sub-basin and site drainage

Sub-basin and site drainage is presented in the hydrology map for Village 8 located in Appendix B of this report.

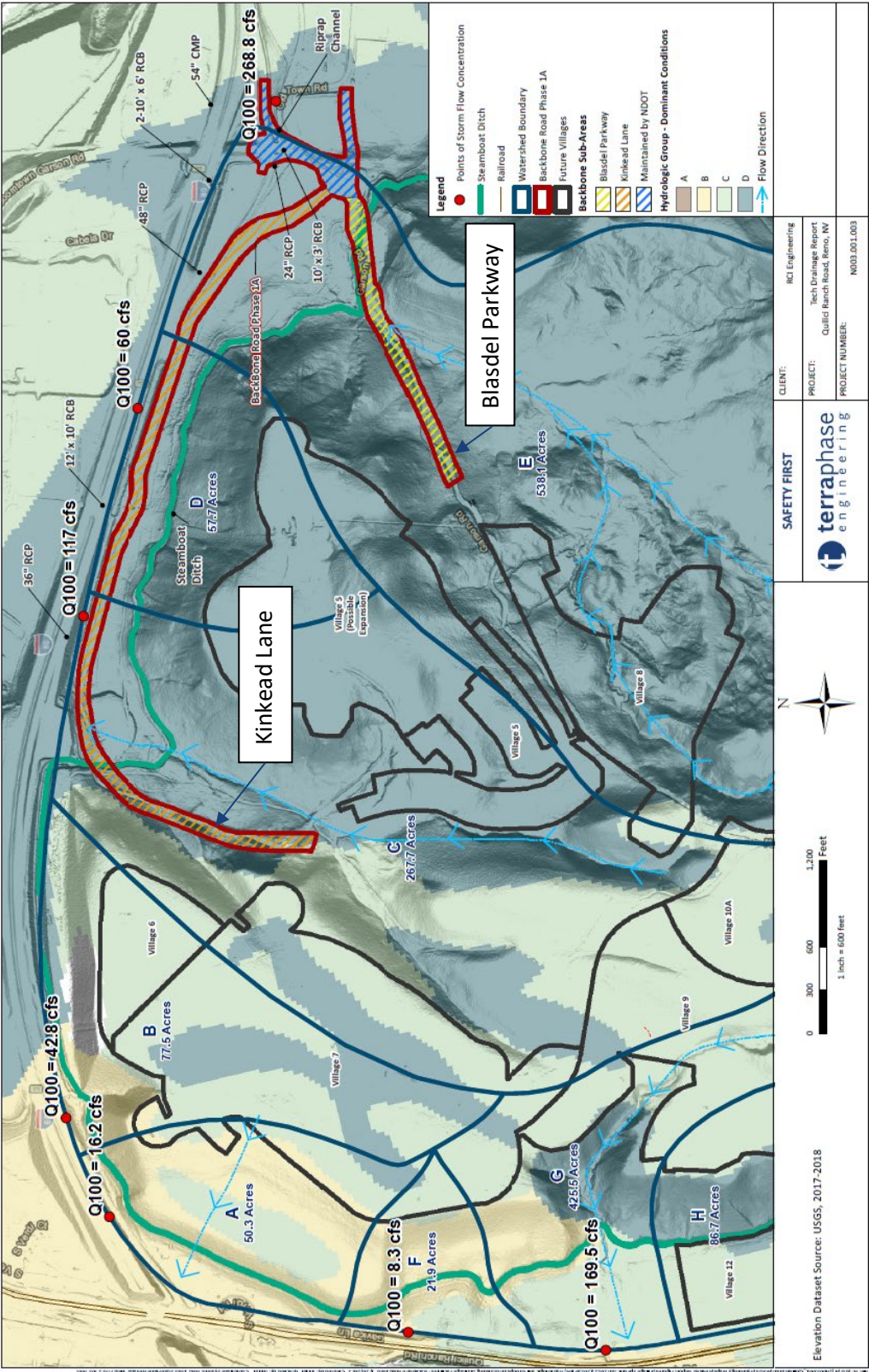


Figure 11 Existing conditions, major watersheds hydrology map



C. Discussion of hydrologic and hydraulic analysis results

Existing drainages are shown on Figure 11, with major watersheds depicted with boundaries in dark blue (also refer to larger maps in Appendix B). Runoff paths are shown in light blue with flow arrows indicating flow direction. In the area of the Phase 1A Backbone Roads, water is conveyed over the surface in ephemeral gullies with Steamboat Ditch as a prominent feature with its maintenance road, and below it, minor ditches carrying water lateral to the slope to prevent erosion in the case of large storm events or an overtopped ditch. Speaking to this history are abandoned splitter boxes, and a large trapezoidal storm water swale constructed to carry runoff from I-80 to the east and into the Truckee River either through a 48" RCP toward the north side of I80 (and conveyed in a 54" RCP) or to the existing ditch along the south side of I80 after crossing Boomtown-Garson Road.

A model of the existing natural watercourses was created in HEC-RAS. This model was created using flows determined from the HEC-HMS model. Figure 11 indicates watershed boundaries, flow directions of natural water courses, and points of storm flow concentration with respect to the proposed villages. The model output is shown in Appendix C.

2.5 Proposed Drainage System

A. Major basins and tributary sub-basins

Major basin and tributary sub-basins with a footprint of proposed development in backbone roads are shown in the village-specific hydrology map located in Appendix B of this report.

The proposed plan follows existing drainage patterns as much as feasible, utilizing detention basins and culverts to attenuate storm flows and replicate a pre-development discharge curve. Figure 11 shows major drainageways with existing flow concentration points leaving the developed area with Q_{100} called out for each drainage area. The offsite hydrology map located in Appendix B shows post-construction attenuated flows leaving the proposed site, reducing flood hazard by avoiding direct discharge to Steamboat Ditch in all drainages related to the Backbone Road Phase 1A project.

B. Results of hydrologic and hydraulic analyses

Hydrologic and hydraulic analyses were conducted for Village 8 (which is tributary to the backbone roadways), and the rational method was used to calculate the minor and major storm peak flows. Specific sub-area designations, c-values and 5- and 100-year flows are shown in the on-site hydrology maps in Appendix B. Calculations of the rational method are shown in Appendix C. Table 2 includes an overall summary of the 5-year and 100-year peak flows derived by using the rational method.

Table 2 Summary of Rational Method Peak Flow Results

Station / Road Location	5-year Flow	100-year Flow
48+20 / W Kinhead Ln	3.8 cfs	10.0 cfs
41+41 / W Kinhead Ln	9.9 cfs	60 cfs
28+20 / W Kinhead Ln	2.0 cfs	5.5 cfs
20+20 / W Kinhead Ln	4.8 cfs	23.1 cfs
219+25 / Blasdel Pkwy	2.0 cfs	5.0 cfs
222+35 / Blasdel Pkwy	3.5 cfs	8.6 cfs
14+35 / S Boomtown Garson Rd	2.7 cfs	6.8 cfs
11+40 / Warrior Ln	1.2 cfs	7.4 cfs
2+27 / S Boomtown Garson Rd	0.6 cfs	1.4 cfs

C. Description of proposed storm drainage system to manage design storm runoff

The Phase 1A Backbone Road drainage system consists of flow being discharged into one detention pond and being discharged from the road in sag areas. A roadside ditch will run just south of Kinhead Lane along the north end of Quilici Ranch where culverts C through F are located. The culverts will carry flow under the road at all sag points. Flow will be taken off Blasdel Parkway through two inlets and directed into a detention pond. A detailed drawing of the Phase 1A drainage system can be found in Appendix B. Riprap calculations and culvert sizing information can be found in Appendix C.

There is currently no anticipated phasing of future downstream facilities that compromise the off-site drainage system. The storm drainage system is designed to handle both minor and major storm events within and throughout the development. In many cases, the catch basins will accept the 100-year peak flow. In cases where the catch basins will not accept the 100-year flow, the drainage system has been designed to still meet the TMRDM criteria for minor and major storm events.

Table 3 Inlet Discharge Locations

Inlet	Flow (cfs)	Discharges to	Outlet Point
Storm Drain N	13.6	Natural water course East of Village 8	Ditch along NDOT roundabout
Storm Drain O	10.1	Blasdel Pkwy SD / Detention Pond	Ditch along NDOT roundabout
Storm Drain P3 & P4	2.1	Blasdel Pkwy SD / Detention Pond	Ditch along NDOT roundabout
Storm Drain P5	4.3	Blasdel Pkwy SD / Detention Pond	Ditch along NDOT roundabout
Storm Drain P6	1	Blasdel Pkwy SD / Detention Pond	Ditch along NDOT roundabout

D. Potential for and risk of sediment inflow and debris flow into proposed facilities

Urbanization is affiliated with risks of increasing flow velocities and creating energy scour in drainageways, resulting in potential erosion and downstream sedimentation. Reducing discharge during storm events

through detention facilities reduces impacts to downstream facilities by spreading out peak flows and mimicking an undeveloped site. The development of the upstream watershed further reduces the sources of sediment through direct stabilization of soils.

E. Water quality structural controls

Site design planning efforts for water quality enhancement are as follows:

- Post-construction structural controls have been proposed to reduce the risks of sediment inflow and debris flow via erosion. The use of riprap armoring at culvert inlets and outlets will address the risk of erosion. Placement of detention basins in each village will attenuate peak flows and velocities.
- Addressing stormwater inputs throughout the developed site and providing detention in various basins, will keep the discharge to natural drainages at existing levels, reducing the risk of a flashy hydrograph within, and leaving the developed areas.
- Proposed detention facilities will be “soft bottom” ponds which allow for infiltration of low flows and vegetation growth which provide biological nutrient uptake.
- Storm drainage inlets will be equipped with “t-sections” to encourage capture of sediment.

F. Detention requirements for 5- and 100-year storms

Adequate storage has been provided to attenuate 100-year peak flows and flows are attenuated through refinements to the detention outlet structures. By providing for conveyance of discharged flows from the detention basins under the Steamboat Ditch, it is expected that the risk of ditch breach to the downstream property owners has been greatly reduced. Refer to hydrology maps and calculations in appendices B and C. Significant attenuation of 5-year (and lesser) storms will occur due to the soft bottom nature of the proposed detention areas. However, outlet structures have not been designed to specifically attenuate 5-year peak flows. The related manual exemption has been articulated in 1.7.c.

G. Compatibility of proposed design with previous studies

As discussed in Section 1.2, the analysis presented in this Technical Drainage Report has been prepared using methodologies generally consistent with that done in previous studies but corrected to accurately reflect the density of proposed development and to estimate Lag times.

H. Drainage easements or right-of-way relevant to project

Where drainage facilities are proposed outside of the road right-of-way, drainage easements are provided as shown on the project improvement plans. This includes both storm drain conveyance facilities and rock-lined emergency overflow located adjacent to roadway sags.

I. Parties and/or entities responsible for maintenance of drainage systems

It is anticipated that the proposed drainage facilities will be publicly maintained.

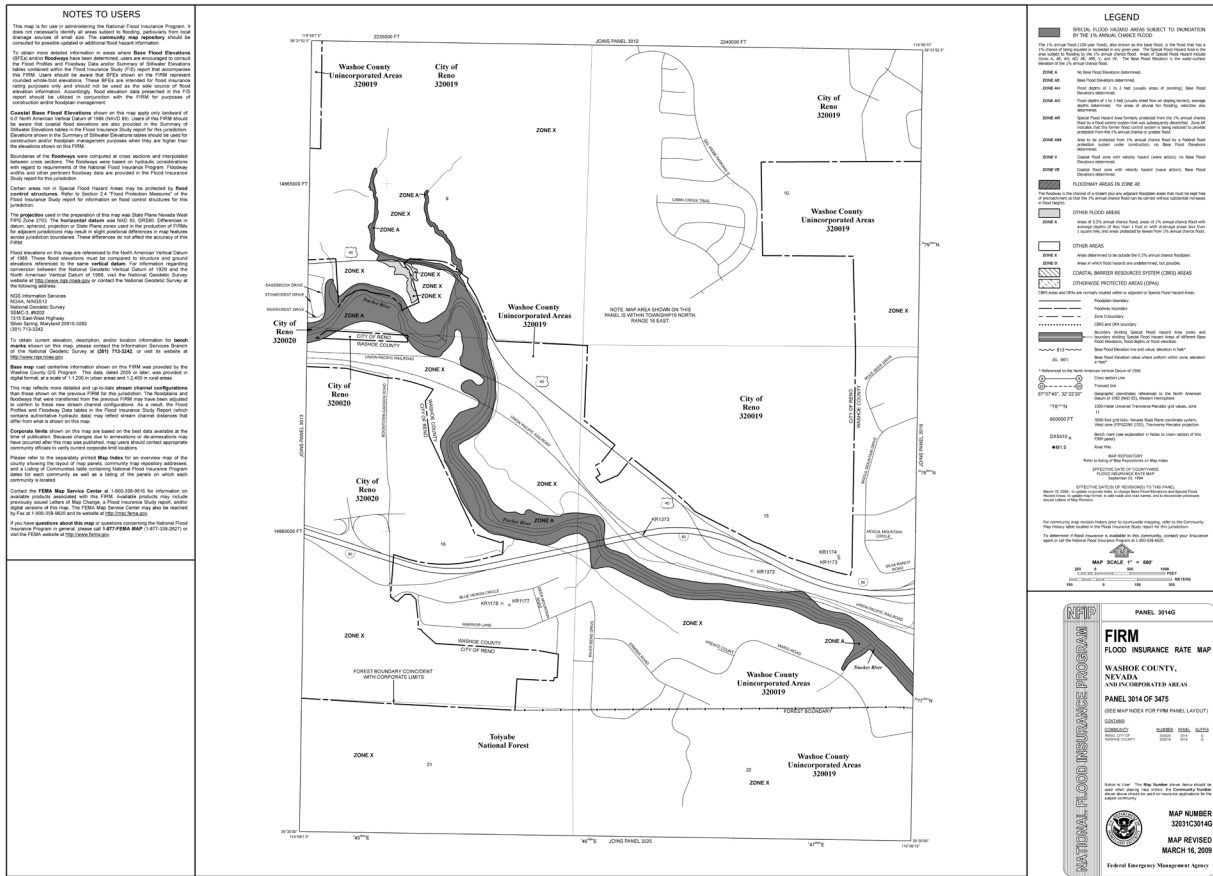


Figure 13 FEMA FIRM Panel for area 32031C3014G

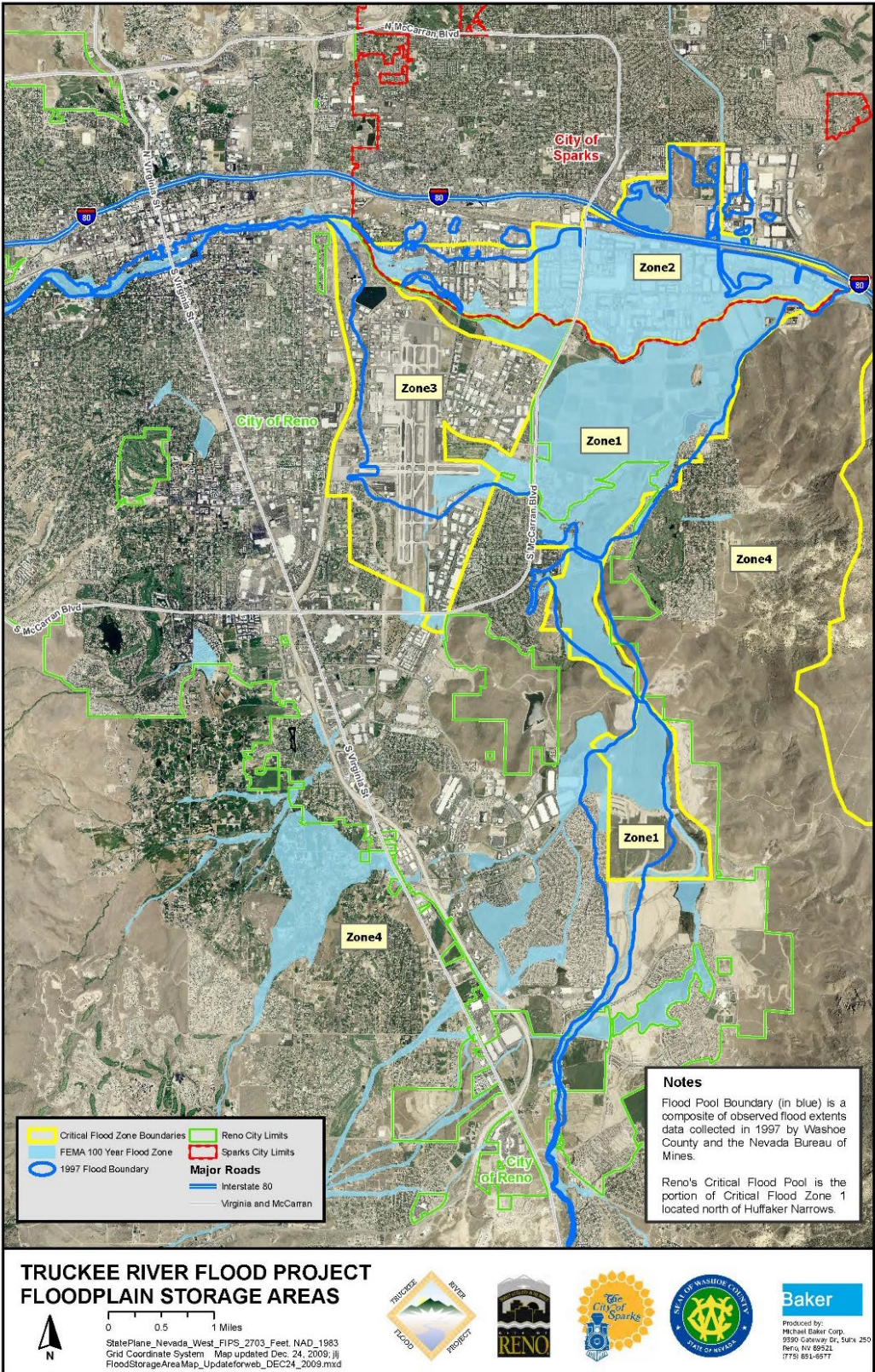


Figure 14 Relationship of Critical Flood Zones to project area (approximately 8 miles west)

2.7 Conclusions

This section discusses the impacts of the proposed drainage system improvements, including:

A. Impacts of proposed drainage system improvements

The proposed drainage improvements results in adherence to City of Reno and NDOT criteria related to flow spread and depth times velocities considerations. Additionally, stormwater is conveyed in stabile conveyance features and discharged in a manner consistent with the existing conditions. The exception being that the existing channel located along the south side of I-80 will more frequently carry storm flows due to the proposed drainage improvements conveying flows under Steamboat Ditch (it should be noted that this same channel will also be more protected from failure of Steamboat Ditch and resultant flood and debris flows).

B. Compliance with all manual policies and requirements

This Technical Drainage Report demonstrates the feasibility of the project to comply with Manual policies and requirements.

Specifically related to that portion of the backbone roadway system to be maintained by NDOT, the proposed inlet and storm drainage system exceeds requirements. Immediately south of the portion of Blasdel Parkway where NDOT maintenance responsibility begins are located drainage inlets on both sides of the road which intercept remaining nuisance flows approaching the NDOT right-of-way from the south. Thus, entering the NDOT Blasdel Parkway right-of-way from the south, the roadway will initially be nearly dry even during storm events of 100-year magnitude. Additional inlets are provided within the roundabout areas such that the 100-year flow (onto the eastbound I-80 ramp) will have no bypass. During the 100-year event, the minor bypass flows will flow off the ramp shoulders into the adjacent channels. During events of lesser magnitude (25-year), no bypass is anticipated with all flows fully intercepted and discharged into the existing riprap-lined channel for conveyance to the Truckee River.

C. Requested manual exemptions

In order to ensure that discharged flows are readily conveyed within existing downstream facilities and that a design can be developed of the proposed Blasdel Parkway storm drain which is practical and can be constructed which passes under the Steamboat Ditch, detention of 100-year flows has been provided which achieves attenuation of peak flows to existing conditions levels. Although significant 5-year attenuation will occur, attenuation of 5-year peak flows to existing conditions levels is not necessary. As stated in the TMRDM:

“However, detention may not be necessary where downstream drainage facilities in their original or previously improved condition are adequate in capacity to carry flows from fully developed upstream areas without negatively impacting downstream properties.”

The proposed storm drain system, in conjunction with downstream facilities, provides adequate capacity for stabile conveyance of both the 5- and 100-year peak flows to the discharge with the Truckee River (PBS&J, 2007). Therefore, attenuation of peak 5-year flows is not required.

D. Compliance with state and federal regulations

The Technical Drainage Report demonstrates the feasibility of the project to comply with State and Federal regulations.

E. Compliance with local plain / flood hazard regulations

The project as proposed is in compliance with local floodplain/flood hazard regulations.

F. Benefits provided by the proposed facilities to off-site systems

The conveyance of discharged flows under the Steamboat Ditch to historic drainage pathways greatly reduces the potential for Steamboat Ditch breach and associated downstream impacts.

G. Adverse effects to off-site systems and mitigation measures for these effects

Although the project proposes to attenuate peak flow discharges through the use of detention basins, during large storm events flow volumes will increase. Flows from the project are conveyed to a well-armored existing ditch sized for flows significantly above the 100-year event and which extends to a discharge point at the Truckee River. The presence of a stable ditch sized for much greater magnitude flows mitigates the effects of the volume increase.

H. Ability to provide emergency all weather access

The proposed drainage system is in compliance with all pertinent state and federal regulations, local flood plain/flood hazard regulations, and all Truckee Meadows Regional Drainage Manual and NDOT policies and requirements. The proposed design meets all City criteria for storm events up to 100-year magnitude. For larger events, storm flow emergency escape is provided at all sag locations. There are no requested manual exemptions.

3 Drainage Plan

Refer to Appendix B for 24- by 36-inch hydrology maps. See appendix C for tables indicating culvert, pipe, and detention facility information.

3.1 Calculations Exemption

This Technical Drainage Study does not deviate from any calculation requirements.

3.2 Improvement Plans

Terraphase understands that up-to-date improvement plans have been prepared and will be submitted consistent with this Technical Drainage Report and in accordance with section 506 of the TMRDM.

4 References

- ENGEO. 2020. *Santerra-Quilici Properties Geotechnical Exploration*.
- Manhard Consulting. 2020. *Preliminary Drainage Report for Santerra/Quilici*.
- Nimbus. 2003. *Hydrologic and Hydraulic Report, Mortensen et al. Development*.
- Northern Nevada Regional Water Planning Commission. 2016. *2004-2025 Washoe County Comprehensive Regional Water Management Plan*.
- PBS&J. 2007. Cabela's Interim NDOT Encroachment Permit Drainage Memorandum.

Appendix A

NOAA Atlas 14 Data



NOAA Atlas 14, Volume 1, Version 5
Location name: Reno, Nevada, USA*
Latitude: 39.4868°, Longitude: -119.9914°
Elevation: 4947.23 ft**

* source: ESRI Maps

** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps_&_aerials](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.117 (0.101-0.135)	0.146 (0.126-0.169)	0.193 (0.166-0.225)	0.238 (0.205-0.279)	0.315 (0.263-0.372)	0.386 (0.314-0.462)	0.472 (0.372-0.573)	0.577 (0.437-0.716)	0.751 (0.537-0.959)	0.914 (0.624-1.20)
10-min	0.179 (0.153-0.205)	0.222 (0.192-0.257)	0.294 (0.253-0.343)	0.363 (0.312-0.425)	0.478 (0.401-0.566)	0.587 (0.477-0.703)	0.718 (0.565-0.872)	0.879 (0.665-1.09)	1.14 (0.817-1.46)	1.39 (0.950-1.82)
15-min	0.222 (0.190-0.254)	0.276 (0.237-0.319)	0.364 (0.314-0.425)	0.450 (0.386-0.527)	0.593 (0.496-0.702)	0.728 (0.592-0.871)	0.890 (0.701-1.08)	1.09 (0.824-1.35)	1.42 (1.01-1.81)	1.72 (1.18-2.26)
30-min	0.299 (0.255-0.343)	0.371 (0.320-0.429)	0.490 (0.422-0.572)	0.605 (0.520-0.709)	0.799 (0.669-0.945)	0.980 (0.797-1.17)	1.20 (0.943-1.46)	1.47 (1.11-1.82)	1.91 (1.36-2.44)	2.32 (1.59-3.04)
60-min	0.370 (0.316-0.424)	0.459 (0.395-0.531)	0.607 (0.522-0.708)	0.749 (0.644-0.878)	0.988 (0.828-1.17)	1.21 (0.986-1.45)	1.48 (1.17-1.80)	1.82 (1.37-2.25)	2.36 (1.69-3.02)	2.87 (1.96-3.76)
2-hr	0.502 (0.450-0.567)	0.622 (0.559-0.704)	0.787 (0.701-0.892)	0.933 (0.822-1.06)	1.16 (0.995-1.32)	1.36 (1.15-1.57)	1.60 (1.32-1.87)	1.91 (1.52-2.27)	2.48 (1.89-3.02)	3.02 (2.22-3.78)
3-hr	0.619 (0.561-0.689)	0.767 (0.701-0.858)	0.947 (0.858-1.06)	1.10 (0.986-1.23)	1.31 (1.16-1.47)	1.50 (1.31-1.70)	1.73 (1.48-1.98)	2.04 (1.71-2.38)	2.59 (2.10-3.07)	3.11 (2.47-3.81)
6-hr	0.938 (0.852-1.04)	1.16 (1.06-1.29)	1.42 (1.28-1.57)	1.61 (1.45-1.79)	1.87 (1.67-2.09)	2.06 (1.82-2.31)	2.25 (1.96-2.55)	2.49 (2.14-2.86)	2.95 (2.49-3.43)	3.40 (2.83-4.00)
12-hr	1.34 (1.21-1.49)	1.67 (1.51-1.86)	2.07 (1.87-2.31)	2.40 (2.14-2.67)	2.82 (2.50-3.16)	3.15 (2.76-3.55)	3.48 (3.01-3.97)	3.81 (3.24-4.39)	4.25 (3.53-4.99)	4.60 (3.75-5.48)
24-hr	1.82 (1.64-2.04)	2.28 (2.05-2.55)	2.87 (2.58-3.21)	3.36 (3.01-3.76)	4.04 (3.60-4.52)	4.59 (4.06-5.14)	5.16 (4.53-5.81)	5.76 (5.00-6.52)	6.59 (5.63-7.52)	7.25 (6.11-8.34)
2-day	2.29 (2.03-2.62)	2.89 (2.56-3.31)	3.73 (3.28-4.26)	4.41 (3.87-5.05)	5.40 (4.70-6.19)	6.20 (5.36-7.13)	7.06 (6.03-8.18)	7.98 (6.74-9.32)	9.28 (7.69-11.0)	10.3 (8.42-12.4)
3-day	2.56 (2.25-2.93)	3.24 (2.86-3.72)	4.24 (3.73-4.86)	5.07 (4.44-5.81)	6.26 (5.43-7.20)	7.25 (6.23-8.35)	8.31 (7.07-9.63)	9.46 (7.94-11.0)	11.1 (9.13-13.2)	12.5 (10.1-15.0)
4-day	2.82 (2.48-3.24)	3.59 (3.16-4.13)	4.75 (4.17-5.46)	5.72 (5.00-6.57)	7.12 (6.17-8.20)	8.29 (7.11-9.57)	9.57 (8.10-11.1)	11.0 (9.13-12.8)	13.0 (10.6-15.3)	14.6 (11.7-17.5)
7-day	3.39 (2.92-3.99)	4.37 (3.76-5.13)	5.86 (5.03-6.89)	7.08 (6.05-8.31)	8.82 (7.48-10.4)	10.3 (8.61-12.1)	11.8 (9.82-14.0)	13.5 (11.1-16.1)	15.8 (12.7-19.1)	17.8 (14.1-21.7)
10-day	3.91 (3.37-4.57)	5.04 (4.36-5.90)	6.78 (5.85-7.94)	8.17 (7.02-9.55)	10.1 (8.63-11.9)	11.7 (9.90-13.7)	13.4 (11.2-15.8)	15.1 (12.5-18.0)	17.6 (14.3-21.1)	19.6 (15.8-23.8)
20-day	5.19 (4.49-6.08)	6.69 (5.80-7.85)	8.94 (7.74-10.4)	10.7 (9.22-12.5)	13.1 (11.2-15.3)	15.0 (12.8-17.6)	17.0 (14.3-20.1)	19.1 (15.9-22.7)	21.9 (18.0-26.4)	24.2 (19.6-29.4)
30-day	6.34 (5.50-7.48)	8.18 (7.10-9.65)	10.9 (9.46-12.9)	13.0 (11.2-15.3)	15.9 (13.7-18.7)	18.2 (15.5-21.5)	20.6 (17.4-24.4)	23.0 (19.3-27.4)	26.4 (21.9-31.7)	29.1 (23.8-35.2)
45-day	7.76 (6.75-8.88)	10.0 (8.73-11.5)	13.4 (11.6-15.3)	15.8 (13.8-18.1)	19.2 (16.6-22.1)	21.8 (18.7-25.1)	24.4 (20.8-28.2)	27.0 (22.9-31.4)	30.6 (25.6-35.9)	33.4 (27.6-39.4)
60-day	8.76 (7.53-10.1)	11.4 (9.79-13.1)	15.2 (13.0-17.5)	17.9 (15.4-20.6)	21.4 (18.3-24.7)	24.0 (20.4-27.8)	26.6 (22.5-30.9)	29.2 (24.5-34.0)	32.5 (27.0-38.1)	34.9 (28.8-41.2)

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

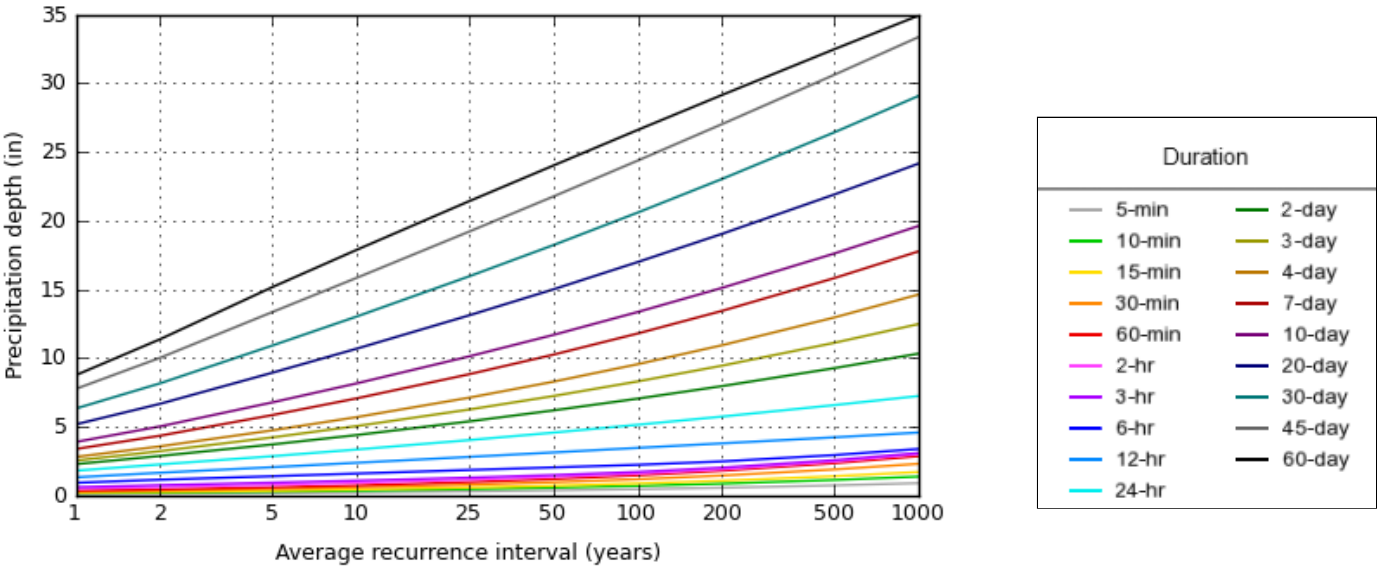
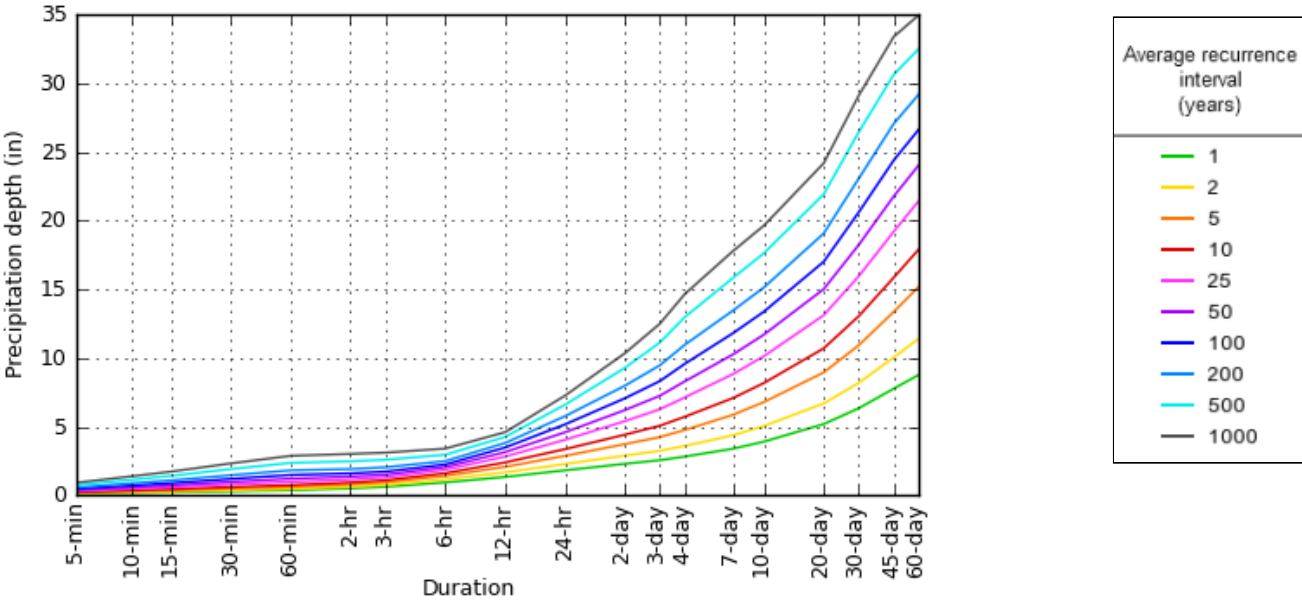
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper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

Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

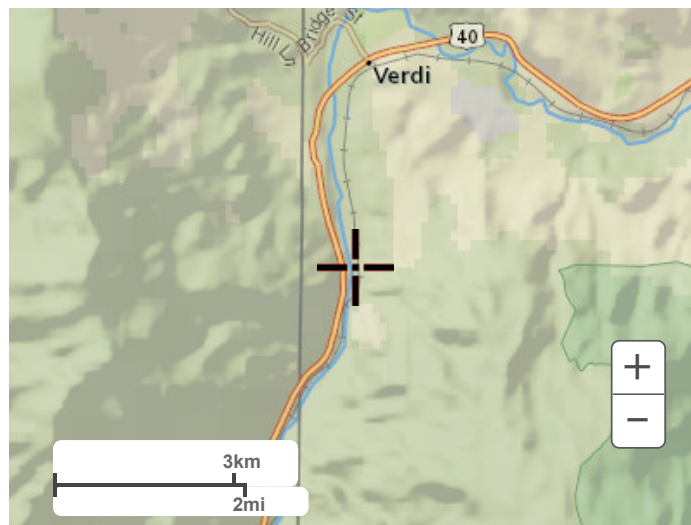
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 39.4868°, Longitude: -119.9914°



Maps & aerials

Small scale terrain



Large scale terrain



Large scale map



Large scale aerial



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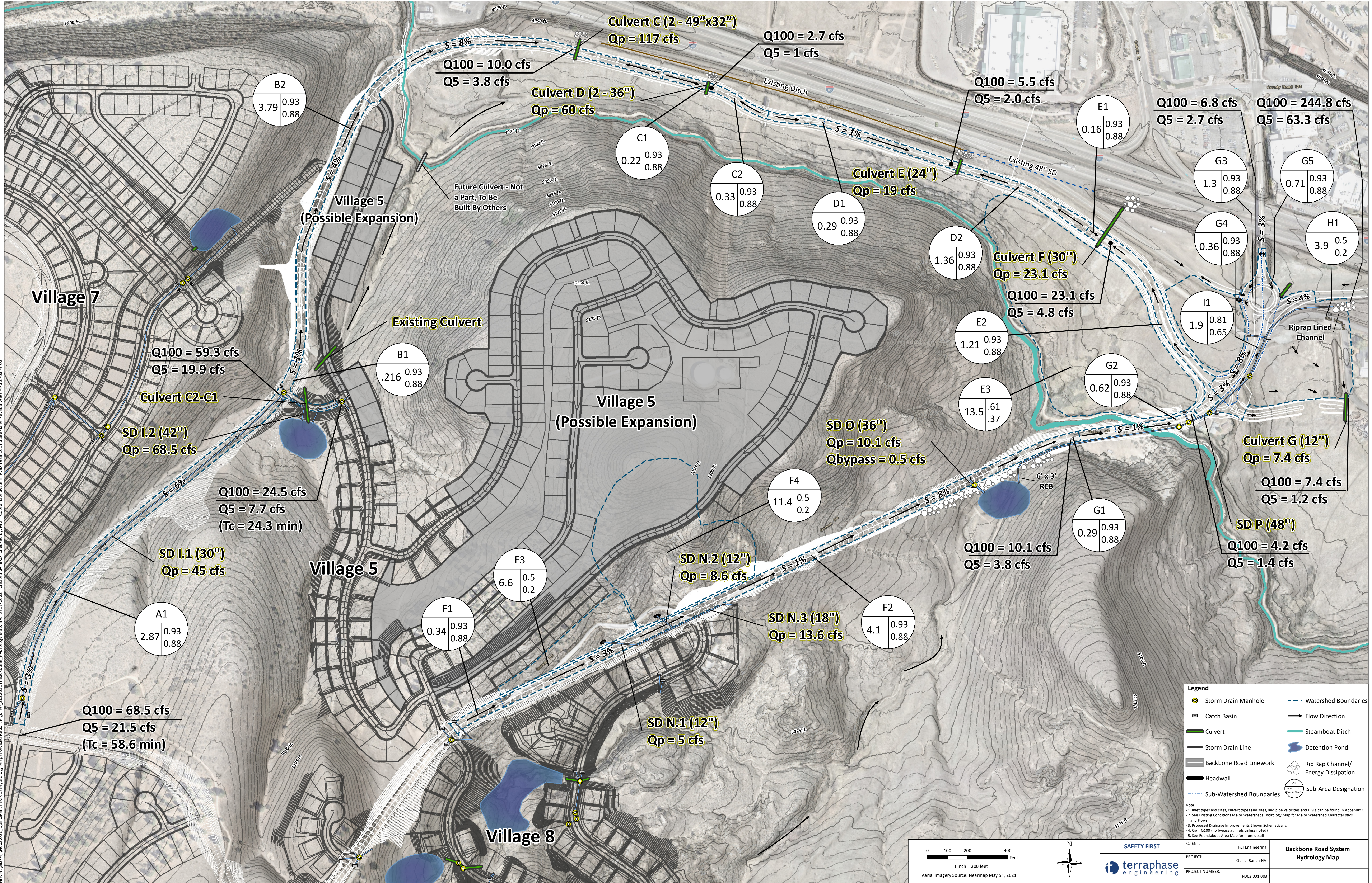
Appendix B

Hydrology Maps

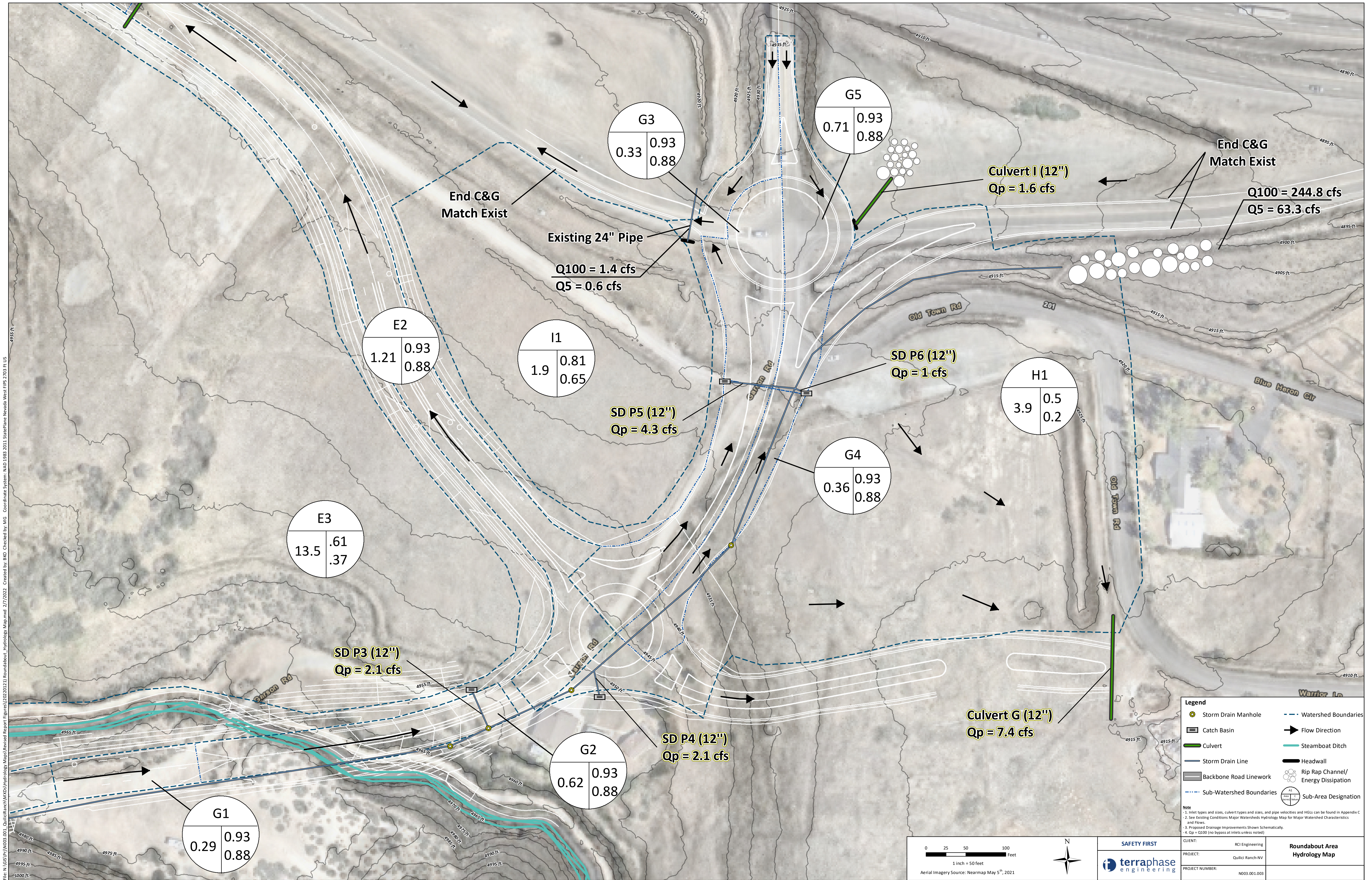
Includes:

- Existing Conditions (Major Basins)
- Proposed Conditions (Major Basins)
- Village 8 Onsite Hydrology Map
- Roundabout Area Onsite Hydrology Map

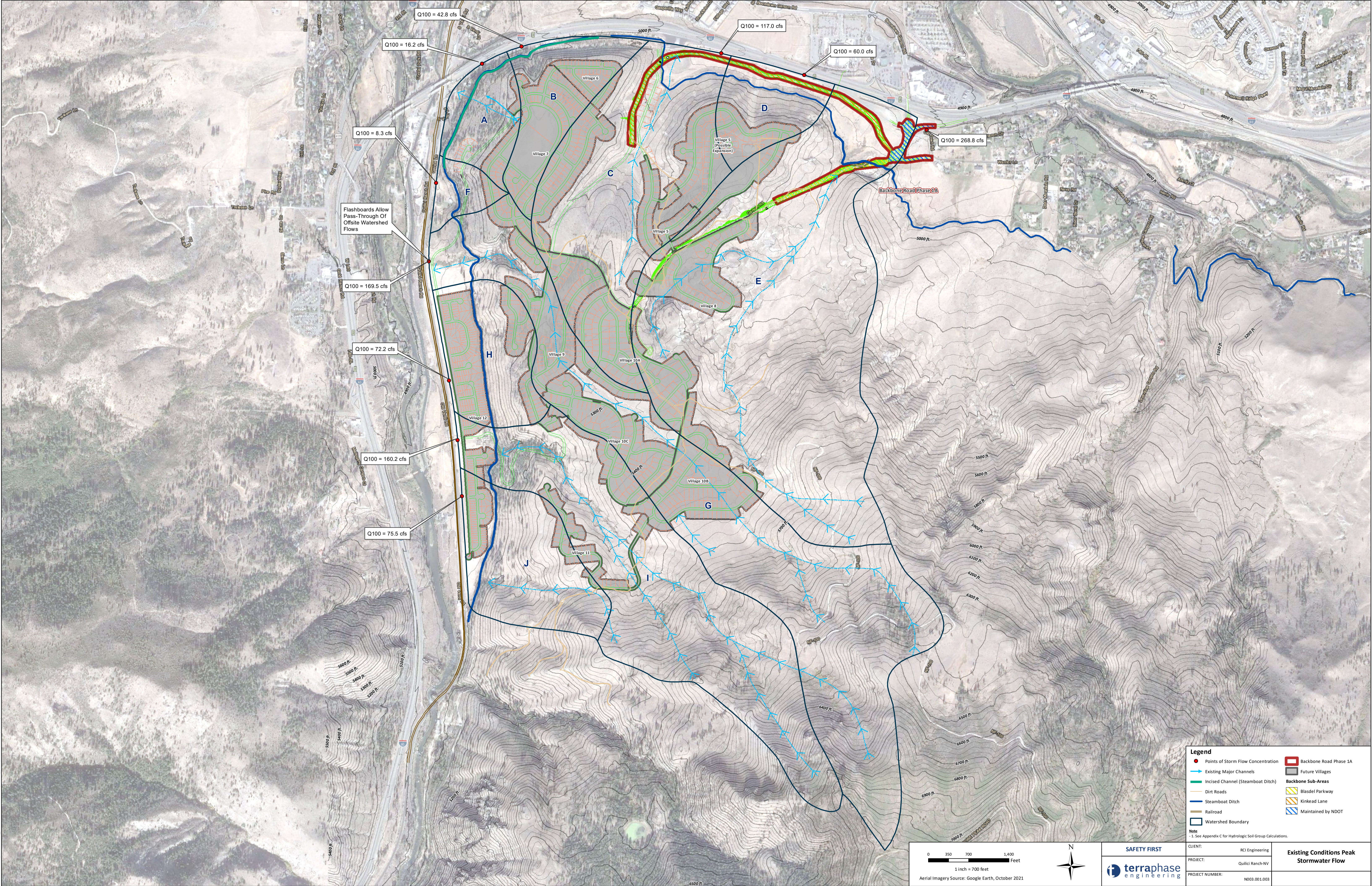




File: N:\GIS\Projects\003_001_QuiliciRanch\MapDocs\Hydrology\Map\Revised Report Figures\20220121 Roundabout_Hydrology Map.mxd 3/7/2022 Created by: BKO Checked by: MGO Coordinate System: NAD 1983 2011 StatePlane Nevada West FIPS 2003 F.T. US

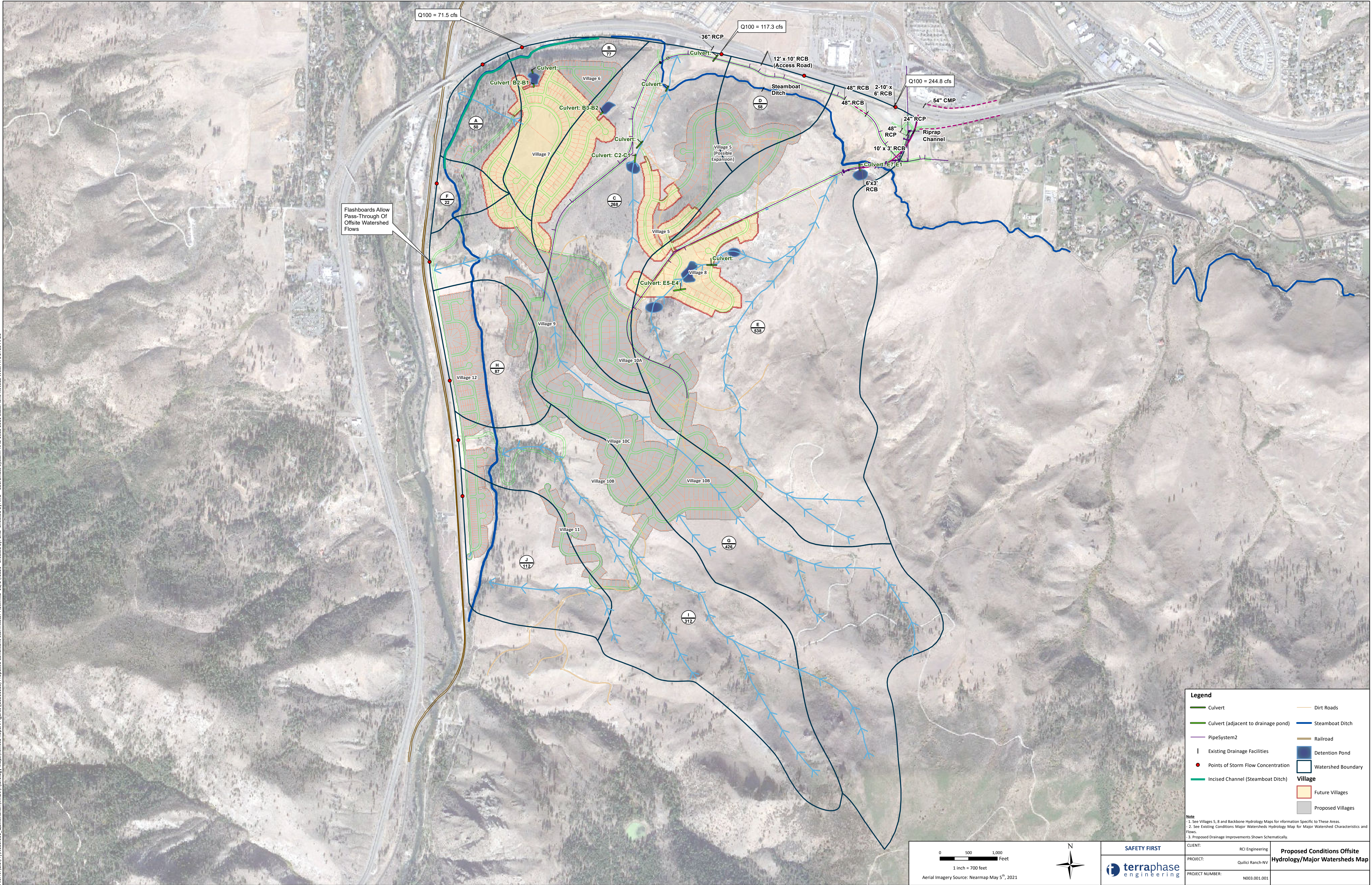


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Legend	
● Points of Storm Flow Concentration	Backbone Road Phase 1A
→ Existing Major Channels	Future Villages
→ Incised Channel (Steamboat Ditch)	Backbone Sub-Areas
→ Dirt Roads	Blasdel Parkway
→ Steamboat Ditch	Kinkaid Lane
→ Railroad	Maintained by NDOT
→ Watershed Boundary	
Note: *1. See Appendix C for Hydrologic Soil Group Calculations.	
CLIENT: RCJ Engineering	
PROJECT: Quilici Ranch-NV	
PROJECT NUMBER: N003.001.003	
Existing Conditions Peak Stormwater Flow	

File: N:\GIS\PT\N003_001_QuiliciRanch\MXDs\Hydrology Maps\Revised Report Figures\20211123 Proposed Conditions Stormwater Flow.mxd 11/24/2021 Created by: BKO Checked by: MG Coordinate System: NAD 1983 2011 StatePlane Nevada West FIPS 2703 F.T US



Legend

Culvert	Dirt Roads
Culvert (adjacent to drainage pond)	Steamboat Ditch
PipeSystem2	Railroad
Existing Drainage Facilities	Detention Pond
Points of Storm Flow Concentration	Watershed Boundary
Incised Channel (Steamboat Ditch)	Village
	Future Villages
	Proposed Villages

Note

- 1. See Villages 5, 8 and Backbone Hydrology Maps for information specific to these areas.
- 2. See Existing Conditions Major Watersheds Hydrology Map for Major Watershed Characteristics and Flows.
- 3. Proposed Drainage Improvements Shown Schematically.

Proposed Conditions Offsite Hydrology/Major Watersheds Map

CLIENT:	RCI Engineering
PROJECT:	Quilici Ranch-NV
PROJECT NUMBER:	N003.001.001

0 500 1,000 Feet

1 inch = 700 feet

Aerial Imagery Source: Nearmap May 5th, 2021

SAFETY FIRST

terraphase
engineering

Appendix C

Computations

Includes:

- Rational Hydrology
- HEC-HMS Parameters and Results
- HEC-RAS Parameters and Results
- StormCAD Parameters and Results
- Hydrologic Soils Group Calculations
- Rip-Rap Sizing Calculations.
- FlowMaster Parameters and Results
- HY-8 Parameters and Results



Rational Hydrology

Phase 1A

5yr

	Travel Time			Overland Flow Time							Peak Flow Rate		
Design Point	L (ft)	V (ft/s)	Tt (min)	R	S (%)	Lo (ft)	Ti (min)	Tc (min)	PF (interpolated)	I (in/hr)	C	A (acres)	Q (cfs)
C1 (roadway)	221	2.5	1.5	0.88	1.5	221	5.1	6.6	0.23	2.09	0.88	0.218	0.400
(check)						221		11.2	0.31	1.66	0.88	0.218	0.318
C2 (roadway)	360	2.5	2.4	-	-	-	-	9.0	0.27	1.80	0.88	0.551	0.871

	Travel Time			Overland Flow Time							Peak Flow Rate		
Design Point	L (ft)	V (ft/s)	Tt (min)	R	S (%)	Lo (ft)	Ti (min)	Tc (min)	PF (interpolated)	I (in/hr)	C	A (acres)	Q (cfs)
D1 (roadway)	256	2.5	1.7	0.88	1.5	256	5.5	7.2	0.24	1.99	0.88	0.294	0.514
(check)						256		11.4	0.31	1.63	0.88	0.294	0.421
D2 (roadway)	1394	2.5	9.3	-	-	-	-	16.5	0.38	1.38	0.88	1.657	2.011

	Travel Time			Overland Flow Time							Peak Flow Rate		
Design Point	L (ft)	V (ft/s)	Tt (min)	R	S (%)	Lo (ft)	Ti (min)	Tc (min)	PF (interpolated)	I (in/hr)	C	A (acres)	Q (cfs)
E1 (roadway)	117	2.5	0.8	0.88	1.5	117	3.7	4.5	0.19	2.52	0.88	0.160	0.355
(check)						117		10.7	0.30	1.69	0.88	0.160	0.238
E2 (roadway)	881	2.5	5.9	-	-	-	-	10.4	0.30	1.73	0.88	1.369	2.086

	Travel Time			Overland Flow Time							Peak Flow Rate		
Design Point	L (ft)	V (ft/s)	Tt (min)	R	S (%)	Lo (ft)	Ti (min)	Tc (min)	PF (interpolated)	I (in/hr)	C	A (acres)	Q (cfs)
E3.1	232	2.5	1.5	0.2	1.5	149	17.3	18.8	0.40	1.28	0.2	0.342	0.087
(check)						149		10.8	0.31	1.72	0.2	0.342	0.117
E3.2	912	2.5	6.1	-	-	-	-	16.9	0.38	1.35	0.2	9.912	2.673

	Travel Time			Overland Flow Time							Peak Flow Rate		
Design Point	L (ft)	V (ft/s)	Tt (min)	R	S (%)	Lo (ft)	Ti (min)	Tc (min)	PF (interpolated)	I (in/hr)	C	A (acres)	Q (cfs)
F1 (roadway)	367	2.5	2.4	0.88	1.5	367	6.6	9.1	0.28	1.85	0.88	0.341	0.556
(check)						367		12.0	0.32	1.59	0.88	0.341	0.479
F2 (roadway)	3160	2.5	21.1	-	-	-	-	30.1	0.49	0.98	0.88	4.425	3.798

	Travel Time			Overland Flow Time							Peak Flow Rate		
Design Point	L (ft)	V (ft/s)	Tt (min)	R	S (%)	Lo (ft)	Ti (min)	Tc (min)	PF (interpolated)	I (in/hr)	C	A (acres)	Q (cfs)
F3 (check)						100		10.6	0.30	1.71	0.2	6.570	2.241
F3	350	2.5	2.3	-	-	-	-	12.9	0.33	1.54	0.2	6.570	2.019

	Travel Time			Overland Flow Time							Peak Flow Rate		
Design Point	L (ft)	V (ft/s)	Tt (min)	R	S (%)	Lo (ft)	Ti (min)	Tc (min)	PF (interpolated)	I (in/hr)	C	A (acres)	Q (cfs)
F4 (check)						100		10.6	0.30	1.71	0.2	11.400	3.888
F4	390	2.5	2.6	-	-	-	-	13.2	0.34	1.55	0.2	11.400	3.536

	Travel Time			Overland Flow Time							Peak Flow Rate		
Design Point	L (ft)	V (ft/s)	Tt (min)	R	S (%)	Lo (ft)	Ti (min)	Tc (min)	PF (interpolated)	I (in/hr)	C	A (acres)	Q (cfs)
G1 (roadway)	244	2.5	1.6	0.88	1.5	244	5.4	7.0	0.23	1.96	0.88	0.292	0.504
(check)						244		11.4	0.31	1.64	0.88	0.292	0.421
G2 (roadway)	535	2.5	3.6	-	-	-	-	10.6	0.30	1.70	0.88	0.911	1.362
G3 (roadway)	402	2.5	2.7	-	-	-	-	13.3	0.34	1.54	0.88	1.241	1.678
G4 (roadway)	262	2.5	1.7	-	-	-	-	15.0	0.36	1.44	0.88	1.601	2.026
G5 (roadway)	404	2.5	2.7	-	-	-	-	17.7	0.39	1.32	0.88	2.311	2.686

	Travel Time			Overland Flow Time							Peak Flow Rate		
Design Point	L (ft)	V (ft/s)	Tt (min)	R	S (%)	Lo (ft)	Ti (min)	Tc (min)	PF (interpolated)	I (in/hr)	C	A (acres)	Q (cfs)
H1 (check)						100		10.6	0.30	1.71	0.2	0.300	0.102
H1	401	2.5	2.7	-	-	-	-	13.2	0.34	1.54	0.2	3.950	1.218

	Travel Time			Overland Flow Time							Peak Flow Rate		
Design Point	L (ft)	V (ft/s)	Tt (min)	R	S (%)	Lo (ft)	Ti (min)	Tc (min)	PF (interpolated)	I (in/hr)	C	A (acres)	Q (cfs)
I1 (check)						244		11.4	0.31	1.64	0.2	1.897	0.621
I1	244	2.5	1.6	-	-	-	-	13.0	0.34	1.57	0.2	1.897	0.596

Phase 1A

100yr

	Travel Time			Overland Flow Time				Peak Flow Rate					
Design Point	L (ft)	V (ft/s)	Tt (min)	R	S (%)	Lo (ft)	Ti (min)	Tc (min)	PF (interpolated)	I (in/hr)	C	A (acres)	Q (cfs)
C1 (roadway)	221	2.5	1.5	0.93	1.5	221	4.0	5.4	0.50	5.51	0.93	0.218	1.117
(check)						221		11.2	0.76	4.06	0.93	0.218	0.823
C2 (roadway)	360	2.5	2.4	-	-	-	-	7.8	0.70	5.35	0.93	0.551	2.743

	Travel Time			Overland Flow Time				Peak Flow Rate					
Design Point	L (ft)	V (ft/s)	Tt (min)	R	S (%)	Lo (ft)	Ti (min)	Tc (min)	PF (interpolated)	I (in/hr)	C	A (acres)	Q (cfs)
D1 (roadway)	256	2.5	1.7	0.93	1.5	256	4.3	6.0	0.55	5.51	0.93	0.294	1.508
(check)						256		11.4	0.77	4.04	0.93	0.294	1.106
D2 (roadway)	1394	2.5	9.3	-	-	-	-	15.3	0.90	3.53	0.93	1.657	5.447

	Travel Time			Overland Flow Time				Peak Flow Rate					
Design Point	L (ft)	V (ft/s)	Tt (min)	R	S (%)	Lo (ft)	Ti (min)	Tc (min)	PF (interpolated)	I (in/hr)	C	A (acres)	Q (cfs)
E1 (roadway)	117	2.5	0.8	0.93	1.5	117	2.9	3.7	0.37	6.05	0.93	0.160	0.900
(check)						117		10.7	0.74	4.17	0.93	0.160	0.620
E2 (roadway)	881	2.5	5.9	-	-	-	-	9.5	0.84	5.28	0.93	1.369	6.723

	Travel Time			Overland Flow Time				Peak Flow Rate					
Design Point	L (ft)	V (ft/s)	Tt (min)	R	S (%)	Lo (ft)	Ti (min)	Tc (min)	PF (interpolated)	I (in/hr)	C	A (acres)	Q (cfs)
E3.1	232	2.5	1.5	0.5	1.5	149	11.5	13.1	0.82	3.77	0.5	0.342	0.644
(check)						149		10.8	0.75	4.16	0.5	0.342	0.711
E3.2	912	2.5	6.1	-	-	-	-	16.9	0.93	3.30	0.5	9.912	16.356

	Travel Time			Overland Flow Time				Peak Flow Rate					
Design Point	L (ft)	V (ft/s)	Tt (min)	R	S (%)	Lo (ft)	Ti (min)	Tc (min)	PF (interpolated)	I (in/hr)	C	A (acres)	Q (cfs)
F1 (roadway)	367	2.5	2.4	0.93	1.5	367	5.1	7.6	0.68	5.39	0.93	0.341	1.710
(check)						367		12.0	0.79	3.94	0.93	0.341	1.249
F2 (roadway)	3160	2.5	21.1	-	-	-	-	28.6	1.17	2.45	0.93	4.425	10.089

	Travel Time			Overland Flow Time				Peak Flow Rate					
Design Point	L (ft)	V (ft/s)	Tt (min)	R	S (%)	Lo (ft)	Ti (min)	Tc (min)	PF (interpolated)	I (in/hr)	C	A (acres)	Q (cfs)
F3 (check)						100		10.6	0.74	4.21	0.2	6.570	5.527
F3	350	2.5	2.3	-	-	-	-	12.9	0.82	3.82	0.2	6.570	5.016

	Travel Time			Overland Flow Time				Peak Flow Rate					
Design Point	L (ft)	V (ft/s)	Tt (min)	R	S (%)	Lo (ft)	Ti (min)	Tc (min)	PF (interpolated)	I (in/hr)	C	A (acres)	Q (cfs)
F4 (check)						100		10.6	0.74	4.21	0.2	11.400	9.590
F4	390	2.5	2.6	-	-	-	-	13.2	0.83	3.79	0.2	11.400	8.631

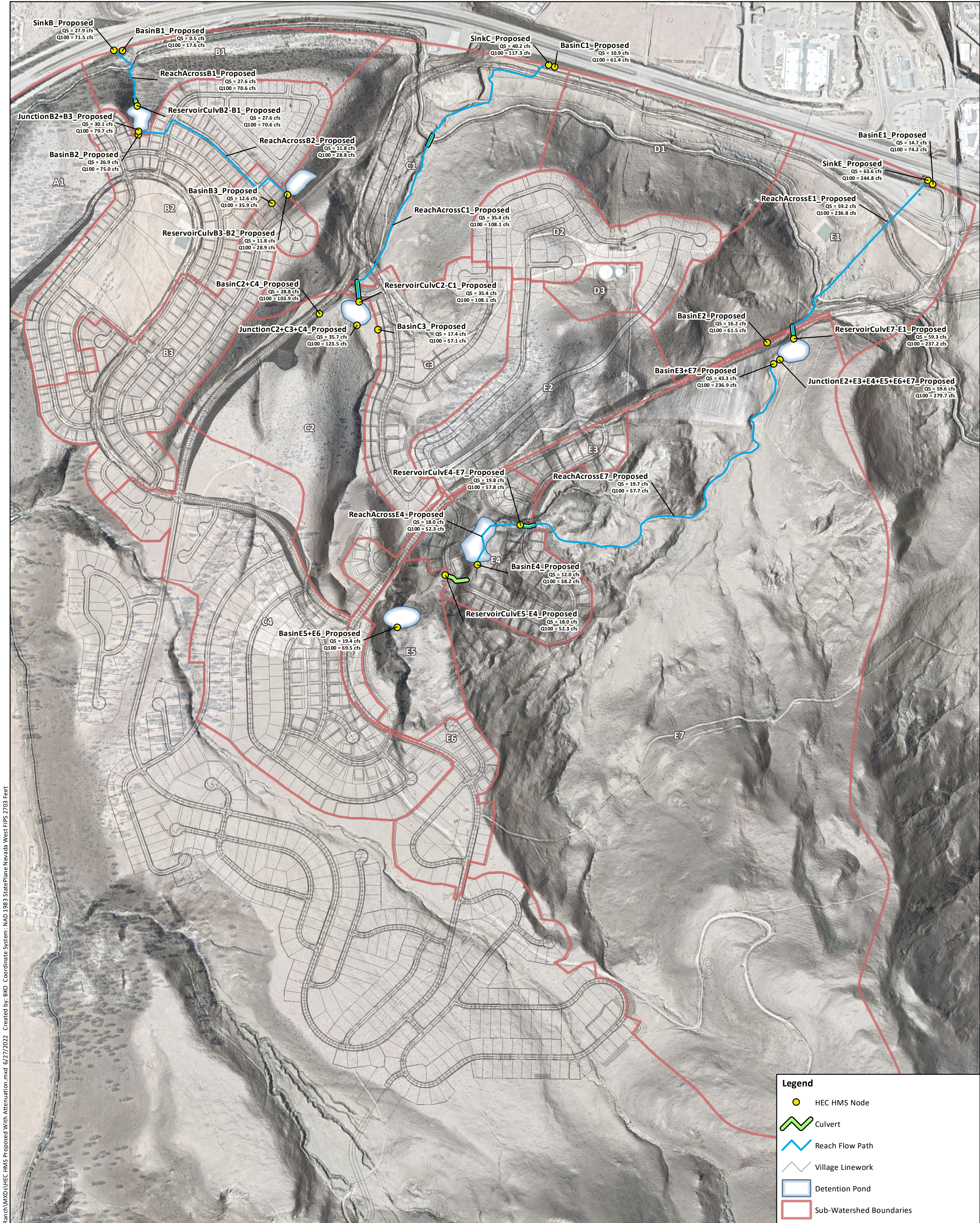
	Travel Time			Overland Flow Time				Peak Flow Rate					
Design Point	L (ft)	V (ft/s)	Tt (min)	R	S (%)	Lo (ft)	Ti (min)	Tc (min)	PF (interpolated)	I (in/hr)	C	A (acres)	Q (cfs)
G1 (roadway)	244	2.5	1.6	0.93	1.5	244	4.2	5.8	0.54	5.58	0.93	0.292	1.516
(check)						244		11.4	0.77	4.07	0.93	0.292	1.105
G2 (roadway)	535	2.5	3.6	-	-	-	-	9.4	0.77	4.93	0.93	0.911	4.178
G3 (roadway)	402	2.5	2.7	-	-	-	-	12.0	0.79	3.93	0.88	1.241	4.296
G4 (roadway)	262	2.5	1.7	-	-	-	-	13.8	0.85	3.70	0.88	1.601	5.208
G5 (roadway)	404	2.5	2.7	-	-	-	-	16.5	0.92	3.35	0.88	2.311	6.808

	Travel Time			Overland Flow Time				Peak Flow Rate					
Design Point	L (ft)	V (ft/s)	Tt (min)	R	S (%)	Lo (ft)	Ti (min)	Tc (min)	PF (interpolated)	I (in/hr)	C	A (acres)	Q (cfs)
H1 (check)						100		10.6	0.74	4.21	0.5	0.300	0.631
H1	401	2.5	2.7	-	-	-	-	13.2	0.83	3.76	0.5	3.950	7.435

	Travel Time			Overland Flow Time				Peak Flow Rate					
Design Point	L (ft)	V (ft/s)	Tt (min)	R	S (%)	Lo (ft)	Ti (min)	Tc (min)	PF (interpolated)	I (in/hr)	C	A (acres)	Q (cfs)
I1 (check)						244		11.4	0.77	4.07	0.2	1.897	1.544
I1	244	2.5	1.6	-	-	-	-	13.0	0.82	3.79	0.2	1.897	1.438

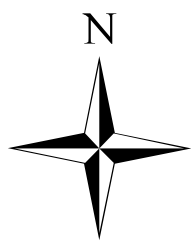
HEC-HMS Parameters & Results

Watershed	HEC-HMS Node	Drainage Area (Sq Miles)	Peak Discharge (CFS)						Flows Upstream of Pond					
			Existing		Proposed - Without Attenuation		Proposed - With Attenuation		Watershed B		Watershed B	Watershed E		
			5-Year, 24-Hour	100-Year, 24-Hour	5-Year, 24-Hour	100-Year, 24-Hour	5-Year, 24-Hour	100-Year, 24-Hour	ReservoirCulvB2-B1_Proposed	ReservoirCulvB3-B2_Proposed	ReservoirCulvC2-C1_Proposed	ReservoirCulvE4-E7_Proposed	ReservoirCulvE5-E4_Proposed	ReservoirCulvE7-E1_Proposed
B	BasinB1_Proposed	0.04	N/A	N/A	0.5	17.6	0.50	17.60						
B	BasinB2_Proposed	0.10	N/A	N/A	26.9	75	26.90	75.00	X					
B	BasinB3_Proposed	0.07	N/A	N/A	12.6	35.9	12.60	35.90	X	X				
B	JunctionB2+B3_Proposed	0.17	N/A	N/A	38.3	107.2	30.10	79.70	X					
B	ReachAcrossB1_Proposed	0.17	N/A	N/A	38.2	106.7	27.60	70.60						
B	ReachAcrossB2_Proposed	0.07	N/A	N/A	N/A	N/A	11.80	28.80	X					
B	ReservoirCulvB2-B1_Proposed	0.17	N/A	N/A	N/A	N/A	27.60	70.60	X					
B	ReservoirCulvB3-B2_Proposed	0.07	N/A	N/A	N/A	N/A	11.80	28.90	X					
B	SinkB_Proposed/Existing	0.20	3.10	42.80	38.5	107.7	27.90	71.50						
C	BasinC1_Proposed	0.11	N/A	N/A	10.9	61.4	10.90	61.40						
C	BasinC2+C4_Proposed	0.21	N/A	N/A	28.8	103.9	28.80	103.90			X			
C	BasinC3_Proposed	0.05	N/A	N/A	17.4	57.1	17.40	57.10			X			
C	JunctionC2+C3+C4_Proposed	0.26	N/A	N/A	35.7	123.5	35.70	123.50			X			
C	ReachAcrossC1_Proposed	0.26	N/A	N/A	35.6	123.4	35.40	108.10						
C	ReservoirCulvC2-C1_Proposed	0.26	N/A	N/A	N/A	N/A	35.40	108.10			X			
C	SinkC_Proposed/Existing	0.38	16.20	117.00	41.4	147.1	40.20	117.30						
E	BasinE1_Proposed	0.10	N/A	N/A	14.7	74.2	14.70	74.20						
E	BasinE2_Proposed	0.06	N/A	N/A	16.2	61.5	16.20	61.50						X
E	BasinE3+E7_Proposed	0.56	N/A	N/A	43.3	236.9	43.30	236.90						X
E	BasinE4_Proposed	0.04	N/A	N/A	12	38.2	12.00	38.20				X		X
E	BasinE5+E6_Proposed	0.07	N/A	N/A	19.4	69.5	19.40	69.50				X	X	X
E	JunctionDownE4_Proposed	0.11	N/A	N/A	31.1	106.7	N/A	N/A						
E	JunctionE2+E3+E4+E5+E6+E7_Proposed	0.73	N/A	N/A	77.9	344.1	59.60	279.70						X
E	JunctionUpE4_Proposed	0.07	N/A	N/A	19.4	69.5	N/A	N/A						
E	ReachAcrossE1_Proposed	0.73	N/A	N/A	77.2	343.8	59.20	236.80						
E	ReachAcrossE4_Proposed	0.07	N/A	N/A	19.4	69.5	18.00	52.30				X		X
E	ReachAcrossE7_Proposed	0.11	N/A	N/A	30.9	105.9	19.70	57.70						X
E	ReservoirCulvE4-E7_Proposed	0.11	N/A	N/A	N/A	N/A	19.80	57.80						
E	ReservoirCulvE5-E4_Proposed	0.07	N/A	N/A	N/A	N/A	18.00	52.30				X	X	X
E	ReservoirCulvE7-E1_Proposed	0.73	N/A	N/A	N/A	N/A	59.30	237.20						X
E	SinkE_Proposed/Existing	0.83	47.60	268.80	82.4	356.8	63.60	244.80						



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Feet
1 inch = 500 feet



Aerial Imagery Source: Nearmap, June 1st, 2022

SAFETY FIRST



CLIENT: RCI Engineering

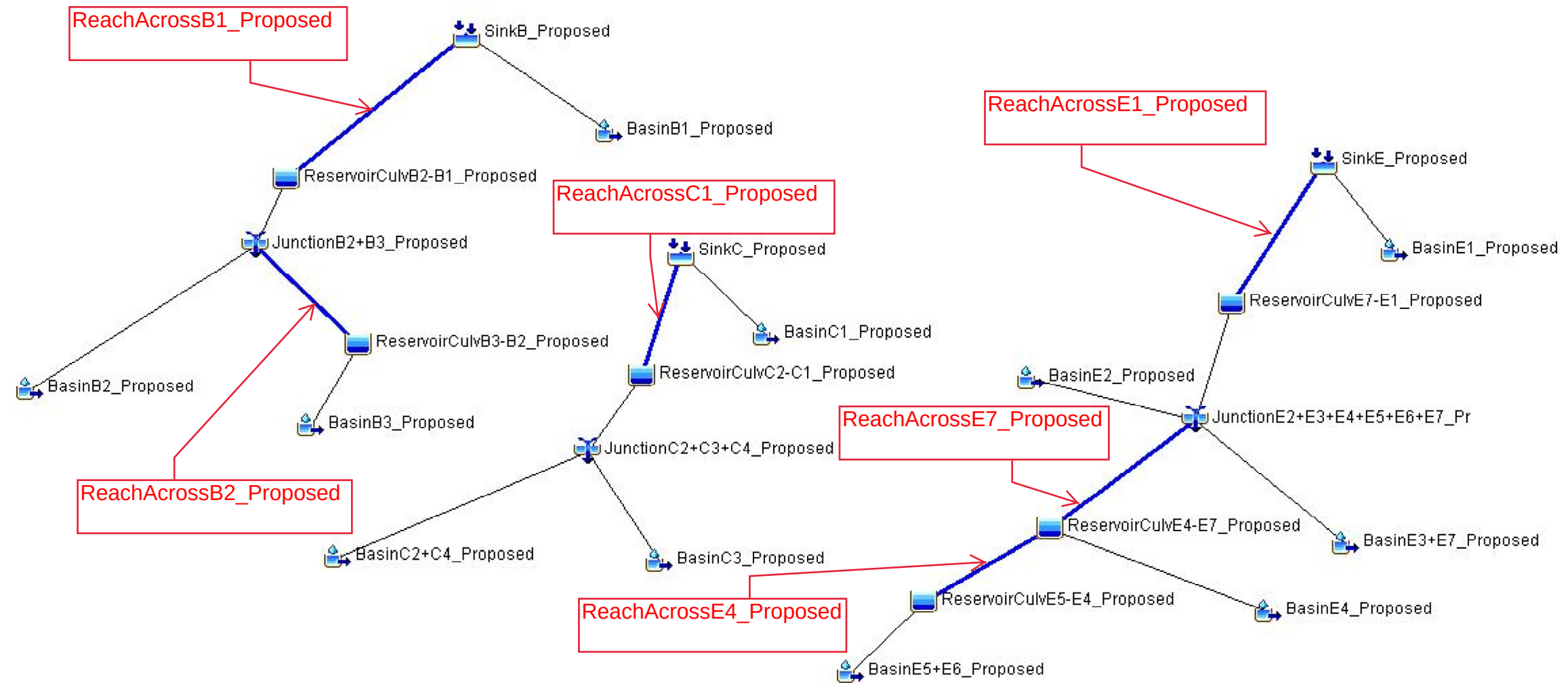
PROJECT: Quilici Ranch - NV

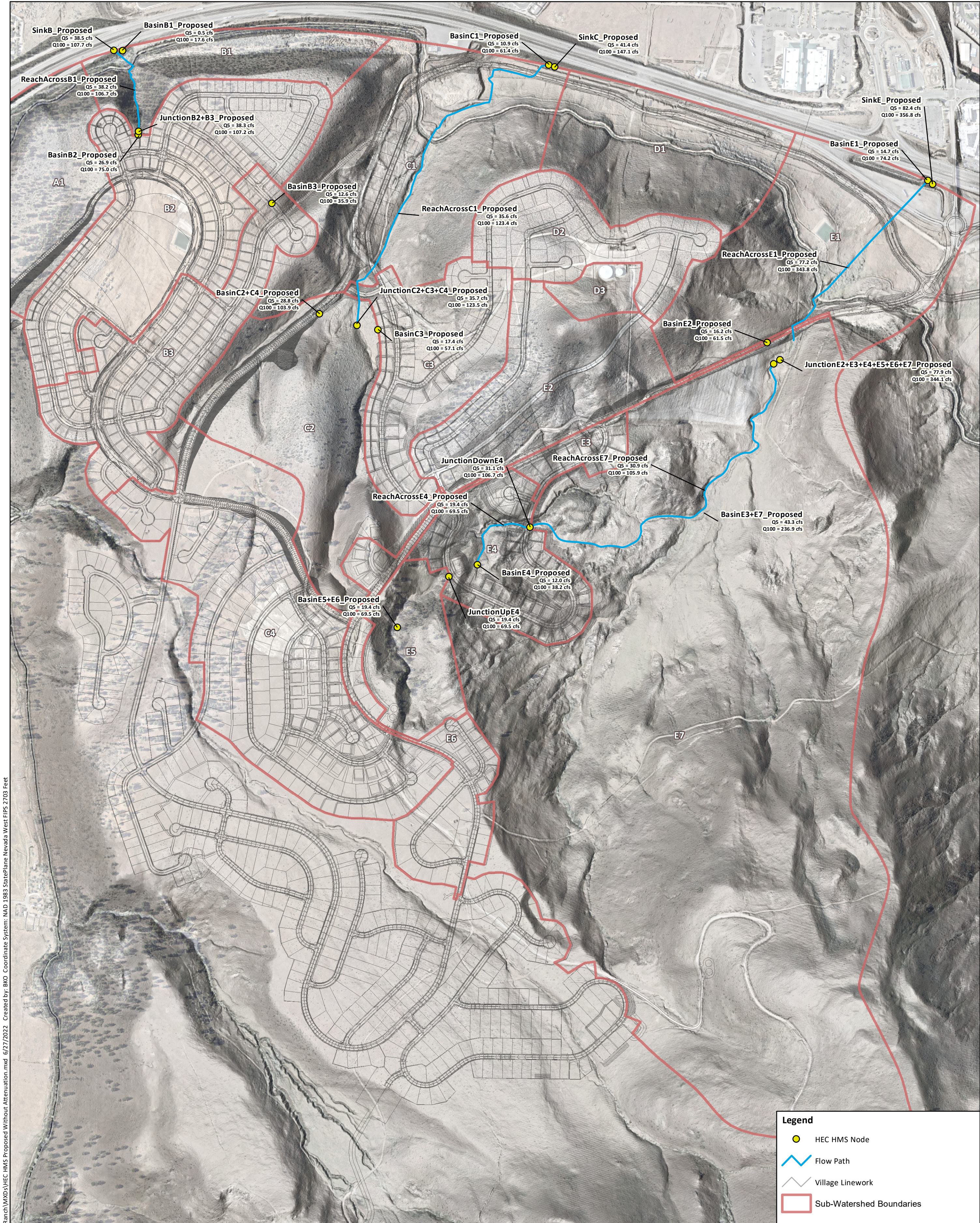
PROJECT NUMBER: N003.001.001

**HEC-HMS Nodes for the
Proposed Conditions
(With Attenuation)**

FIGURE 2

- Legend**
- HEC HMS Node
 - ~ Culvert
 - ~ Reach Flow Path
 - ~ Village Linework
 - Detention Pond
 - Sub-Watershed Boundaries





Legend

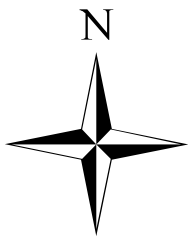
- HEC HMS Node
- Flow Path
- Village Linework
- Sub-Watershed Boundaries

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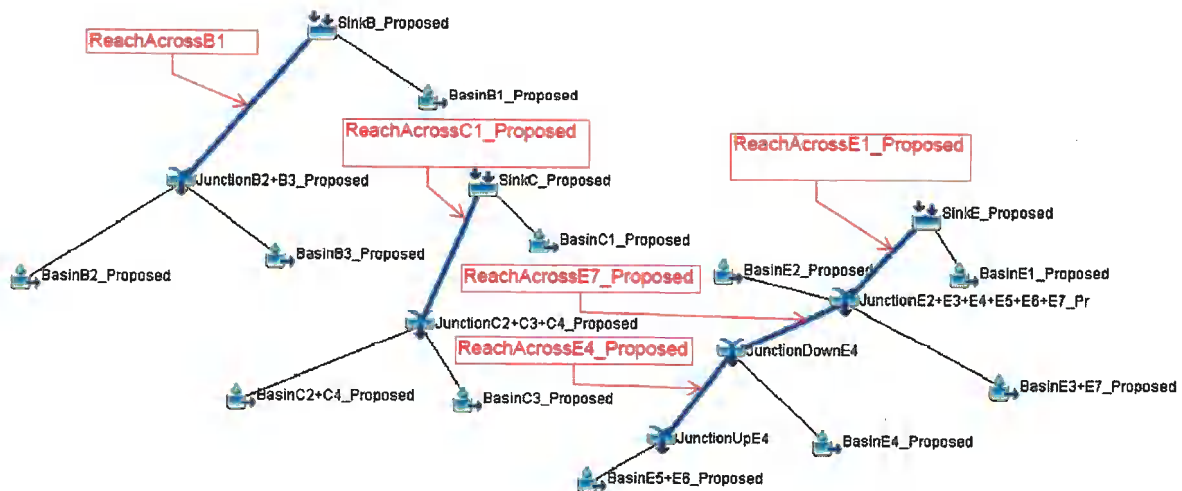
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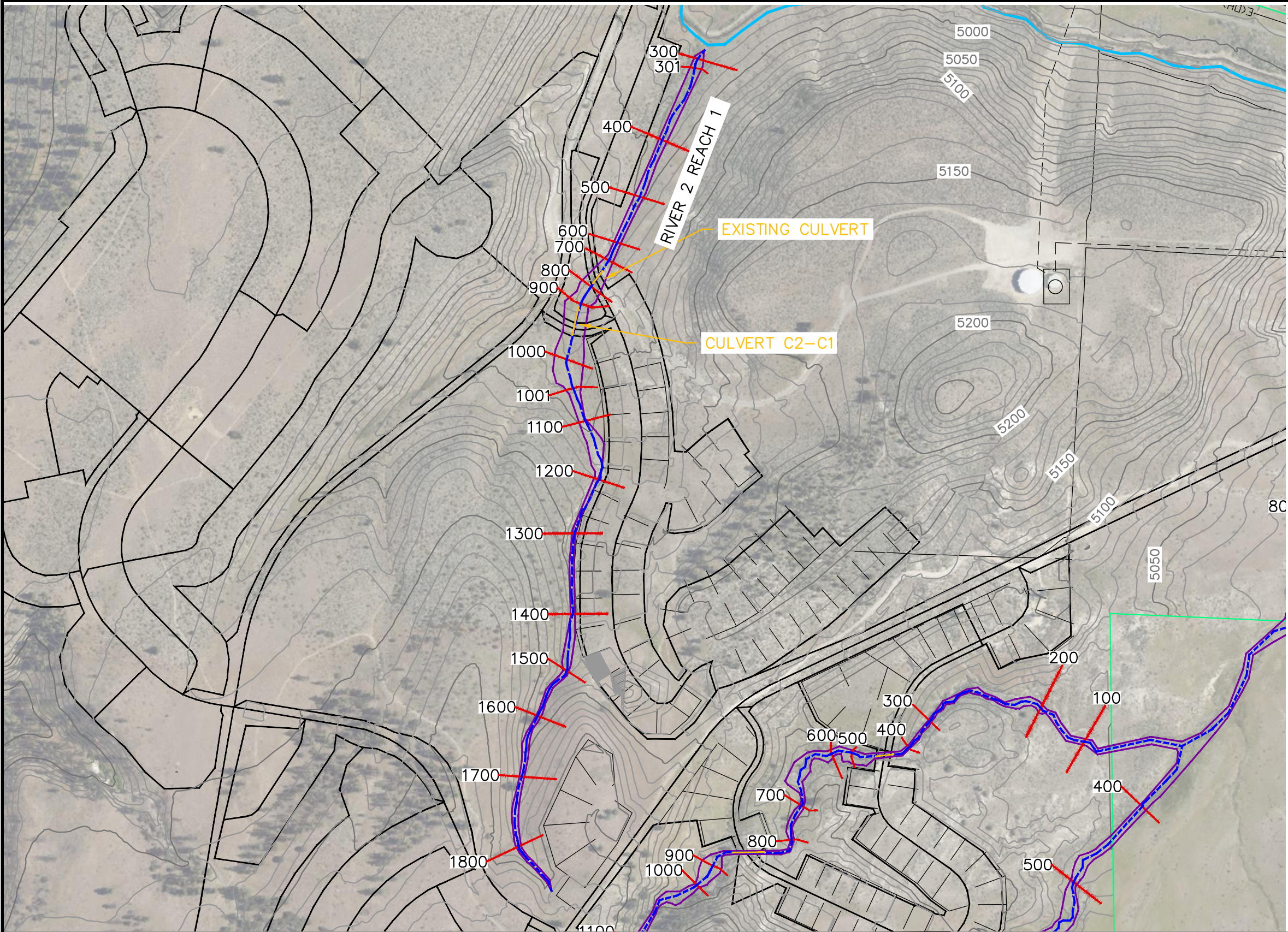


SAFETY FIRST 	CLIENT:	RCI Engineering	HEC-HMS Nodes for the Proposed Conditions (Without Attenuation)
	PROJECT:	Quilici Ranch - NV	
	PROJECT NUMBER:	N003.001.001	
			FIGURE 1

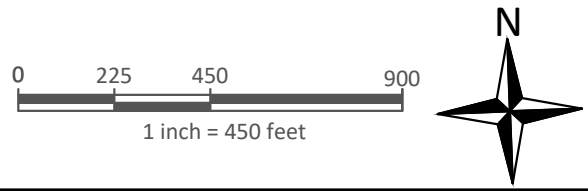


HEC-RAS Parameters & Results

J:\Projects\N003 - RCI Engineering\Technical\Figures\HEC-RAS Channels V8 and BBR.dwg Drawn by: AM



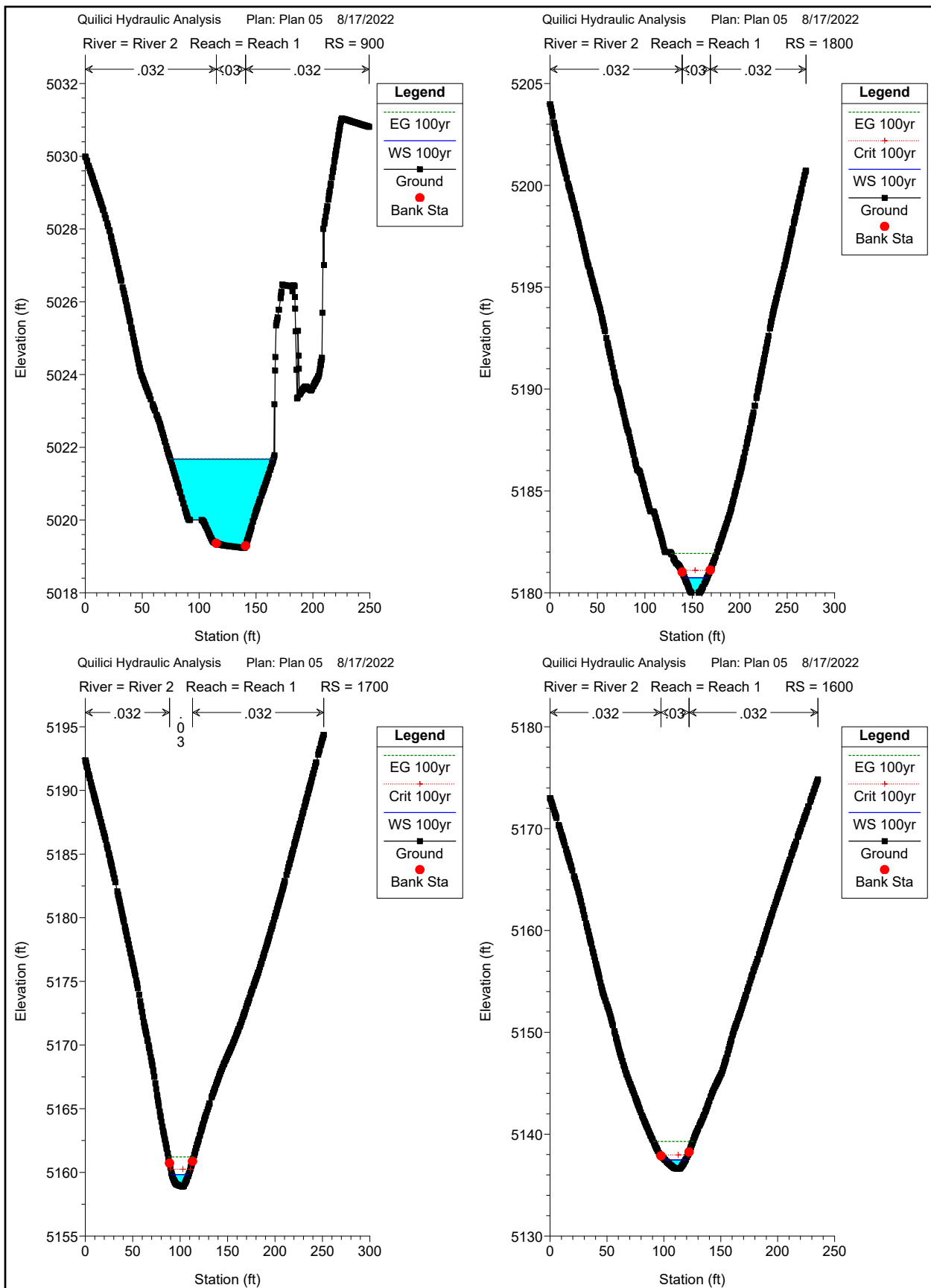
- Legend
- MINOR CONTOURS (10 FT)
 - MAJOR CONTOURS (50 FT)
 - HEC-RAS CHANNEL CENTERLINE
 - HEC-RAS CROSS-SECTION
 - PROPOSED DEVELOPMENT
 - PROPOSED CULVERT
 - FLOODPLAIN BOUNDARY
 - STEAMBOAT DITCH

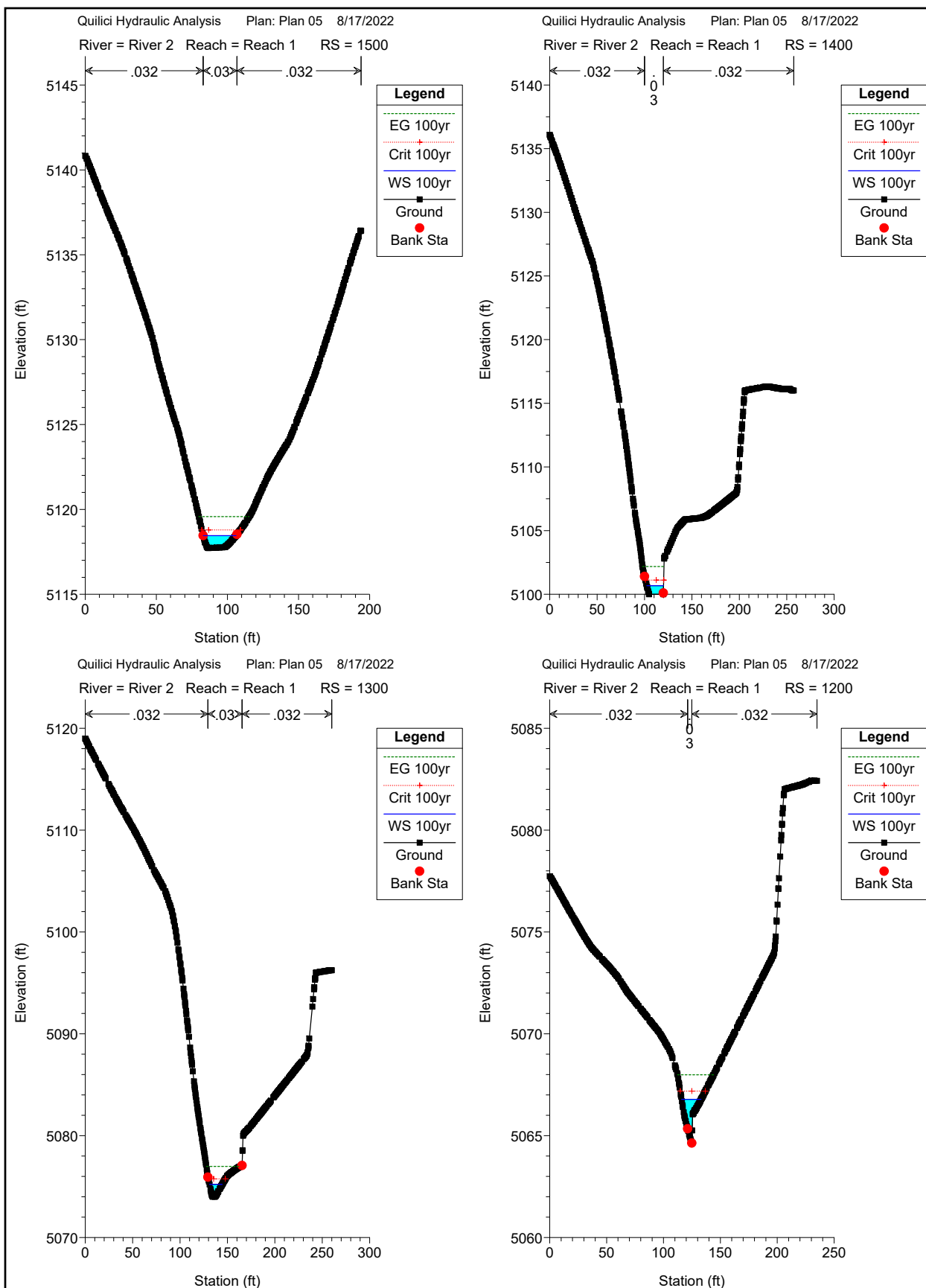


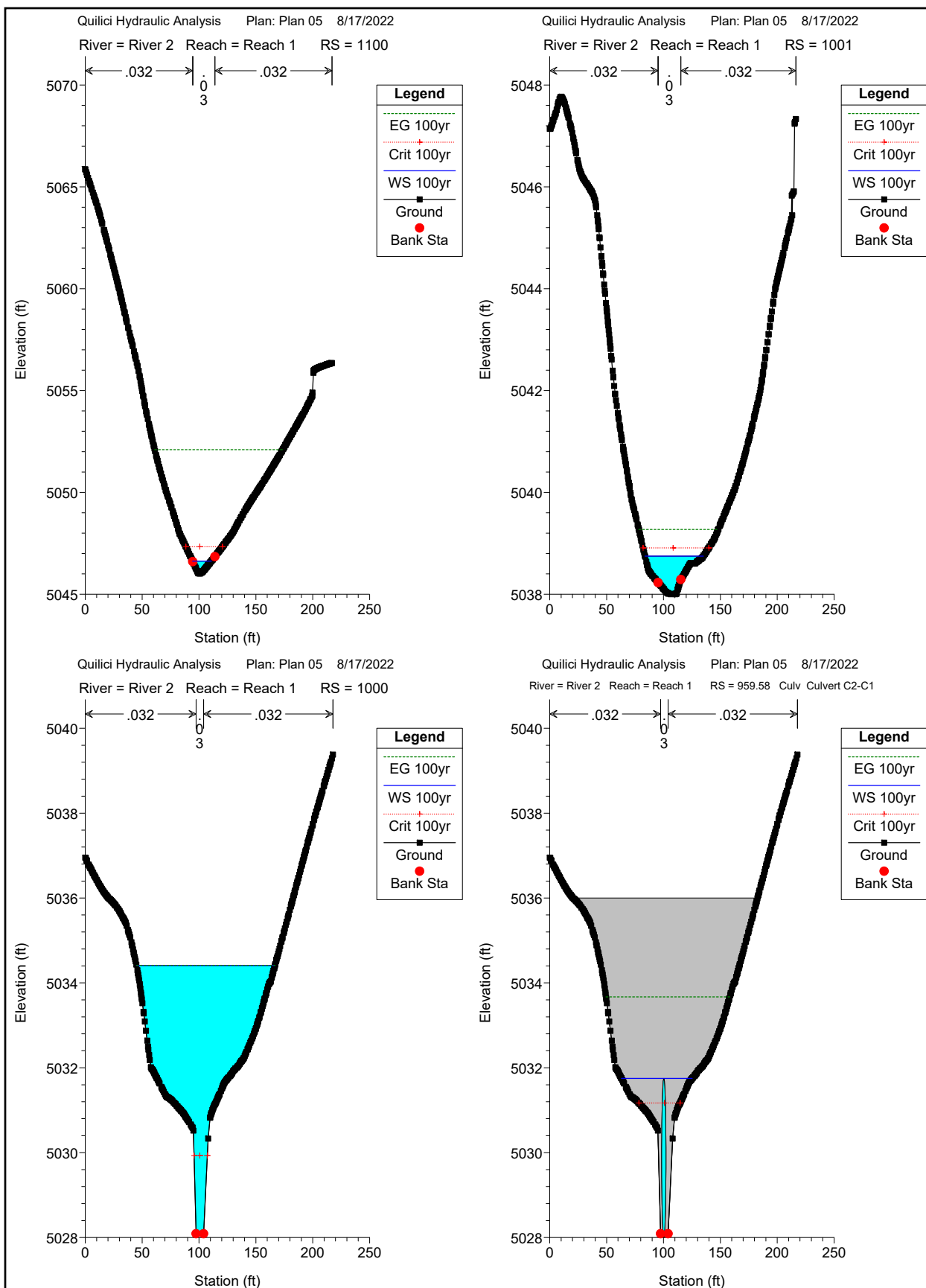
CLIENT:	RCI	Backbone Road Ph1A HEC-RAS Work Map
PROJECT:	Quilici Ranch	
PROJECT NUMBER:	N003.002	
		Figure 1

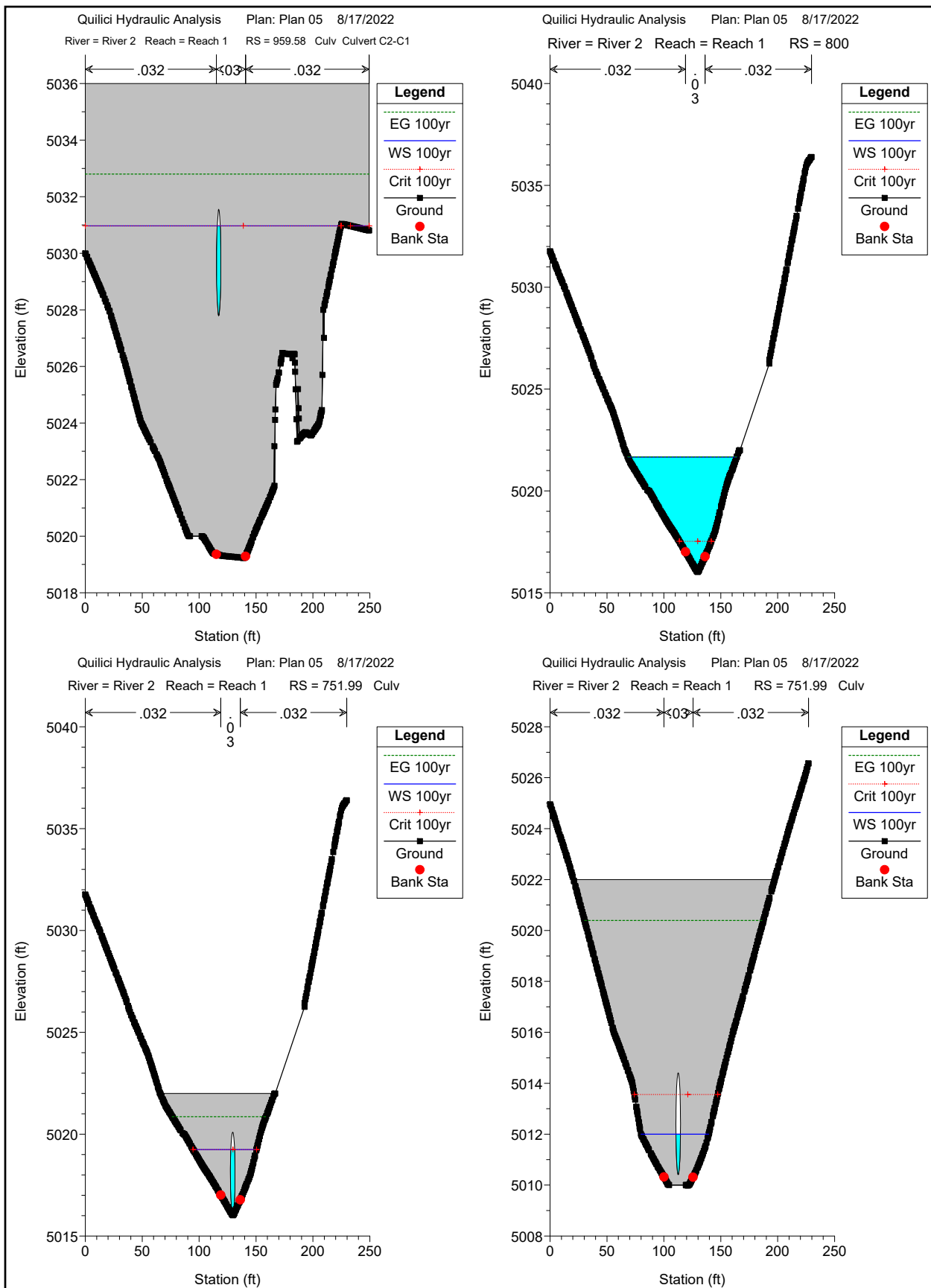
HEC-RAS Plan: 100 yr River: River 2 Reach: Reach 1 Profile: 100yr

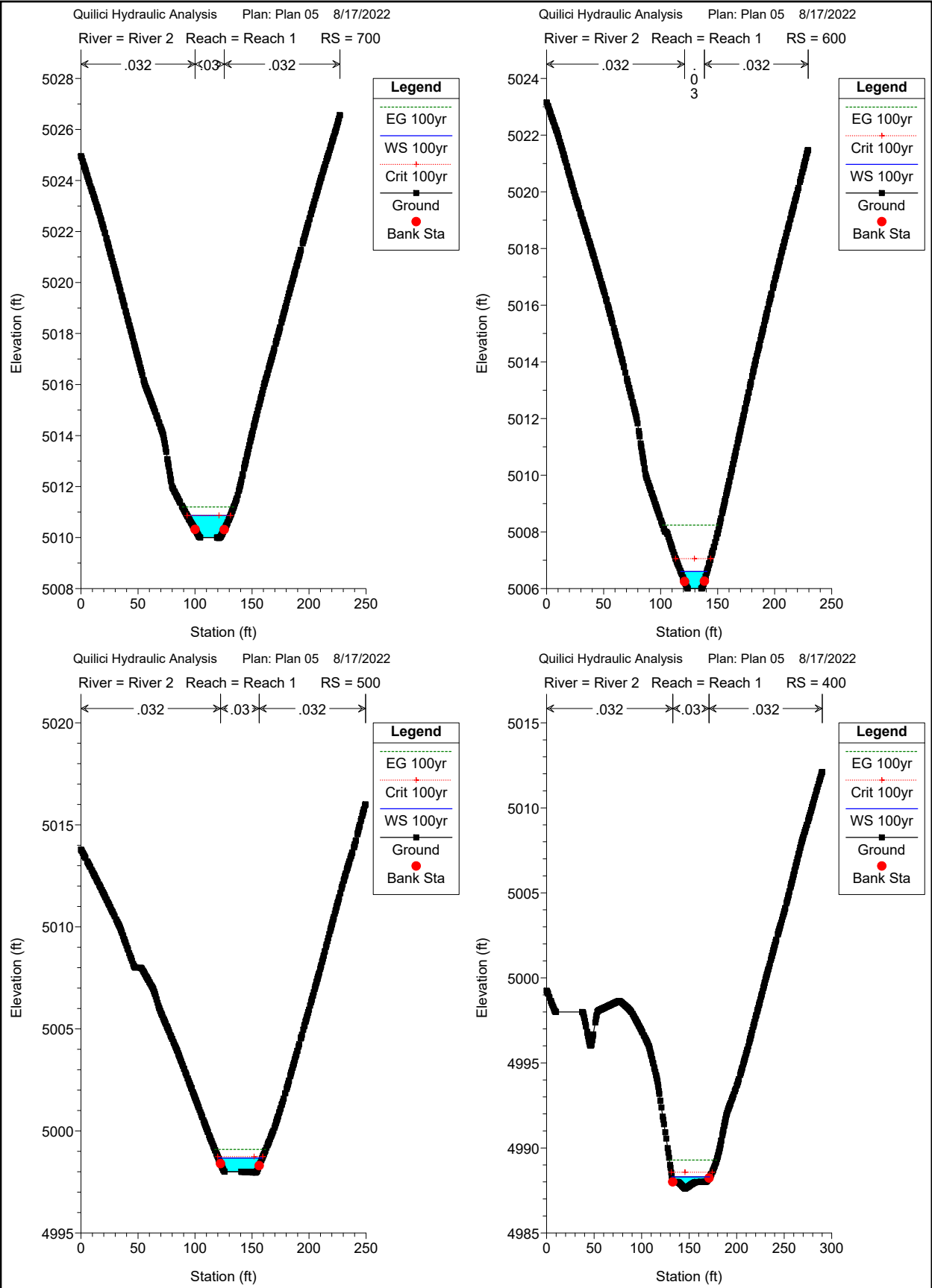
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	1800	100yr	108.10	5180.00	5180.74	5181.10	5181.93	0.075369	8.76	12.34	23.79	2.14
Reach 1	1700	100yr	108.10	5158.89	5159.83	5160.25	5161.21	0.065416	9.42	11.48	17.75	2.06
Reach 1	1600	100yr	108.10	5136.62	5137.48	5137.96	5139.28	0.105813	10.78	10.02	18.19	2.56
Reach 1	1500	100yr	108.10	5117.72	5118.45	5118.79	5119.58	0.066004	8.52	12.69	23.03	2.02
Reach 1	1400	100yr	108.10	5100.00	5100.67	5101.12	5102.18	0.074737	9.86	11.00	17.64	2.19
Reach 1	1300	100yr	108.10	5074.00	5075.22	5075.75	5076.98	0.069297	10.66	10.14	13.40	2.16
Reach 1	1200	100yr	108.10	5064.64	5066.78	5067.19	5067.99	0.020280	10.35	14.88	17.06	1.36
Reach 1	1100	100yr	108.10	5046.02	5046.63	5047.34	5052.10	0.576699	18.76	5.76	16.53	5.56
Reach 1	1001	100yr	108.10	5038.00	5038.75	5038.91	5039.27	0.028088	6.33	20.87	51.25	1.37
Reach 1	1000	100yr	108.10	5028.09	5034.41	5029.93	5034.41	0.000012	0.58	328.10	121.77	0.04
Reach 1	959.58		Culvert									
Reach 1	900	100yr	108.10	5019.23	5021.67		5021.68	0.000107	0.92	149.25	90.74	0.10
Reach 1	800	100yr	108.10	5016.02	5021.67	5017.53	5021.67	0.000014	0.56	277.67	95.67	0.04
Reach 1	751.99		Culvert									
Reach 1	700	100yr	108.10	5009.98	5010.87	5010.87	5011.20	0.012208	4.79	24.50	38.19	0.93
Reach 1	600	100yr	108.10	5006.00	5006.60	5007.06	5008.24	0.094084	10.45	10.93	23.19	2.44
Reach 1	500	100yr	117.30	4997.96	4998.67	4998.74	4999.10	0.019765	5.24	22.90	38.63	1.14
Reach 1	400	100yr	117.30	4987.61	4988.30	4988.57	4989.29	0.093653	7.99	14.78	39.92	2.28
Reach 1	301	100yr	117.30	4974.59	4975.52	4975.63	4975.98	0.019562	5.78	23.27	41.67	1.17
Reach 1	300	100yr	117.30	4972.00	4972.68	4973.12	4974.27	0.106043	10.11	11.67	24.70	2.52

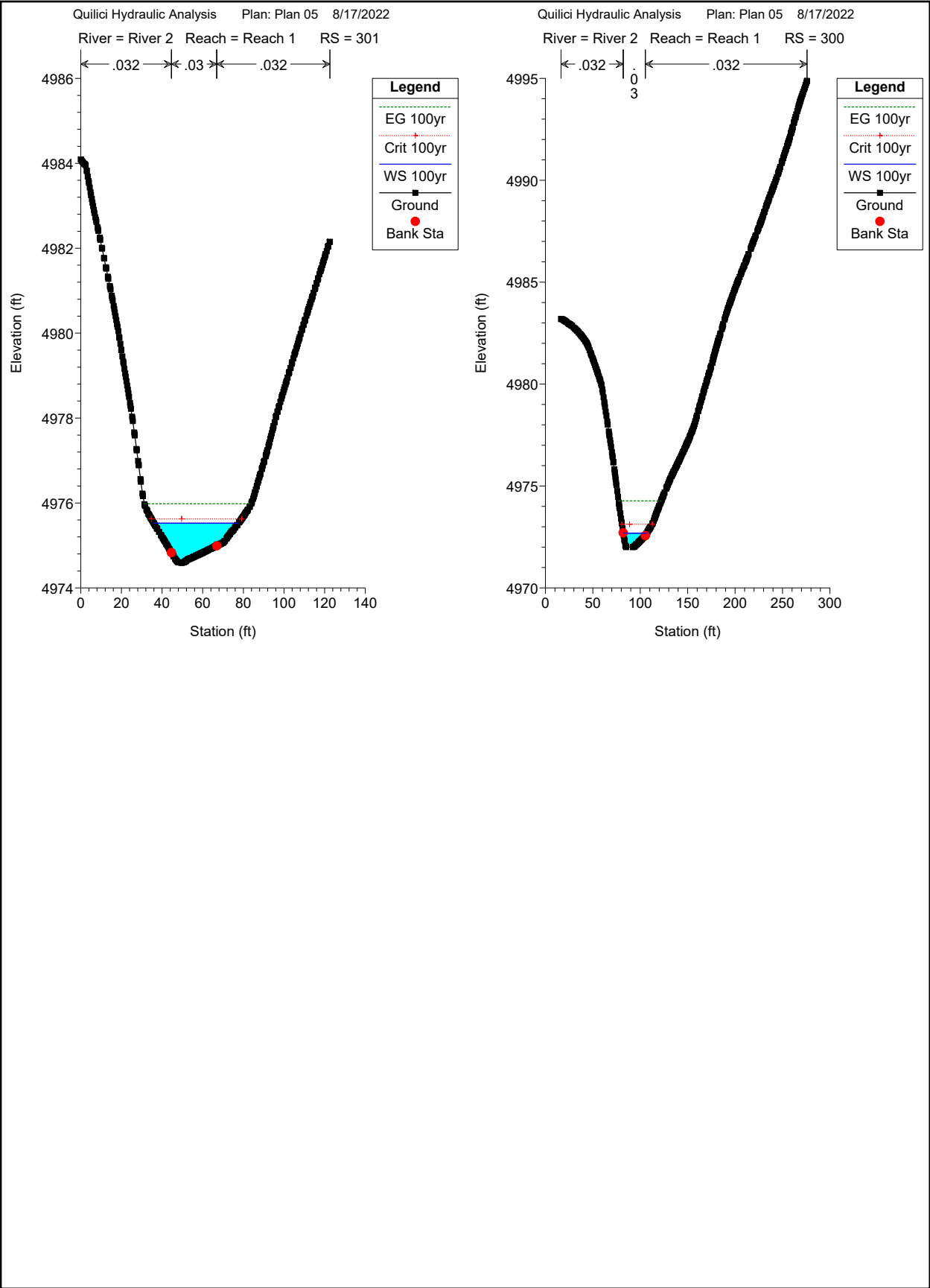


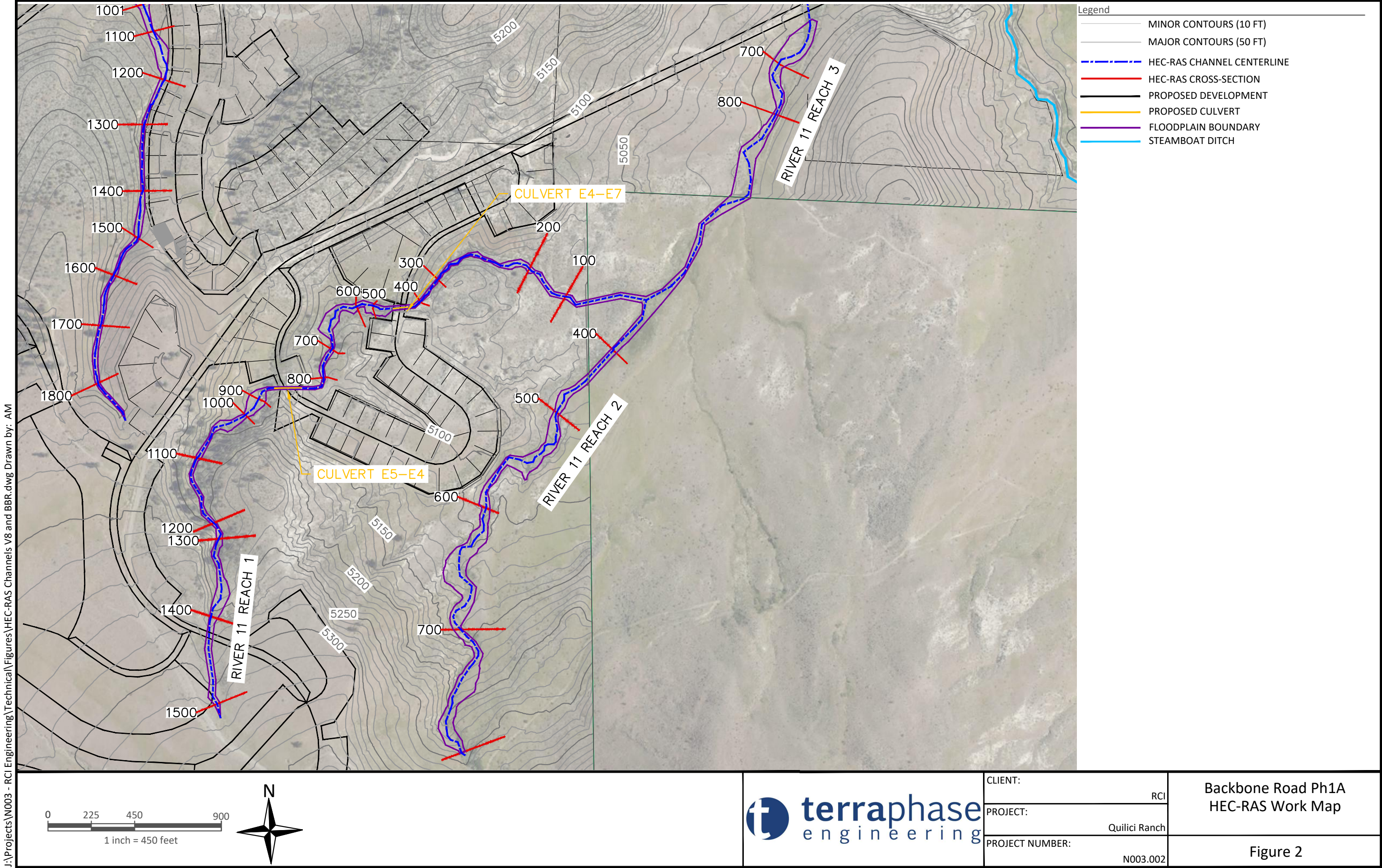






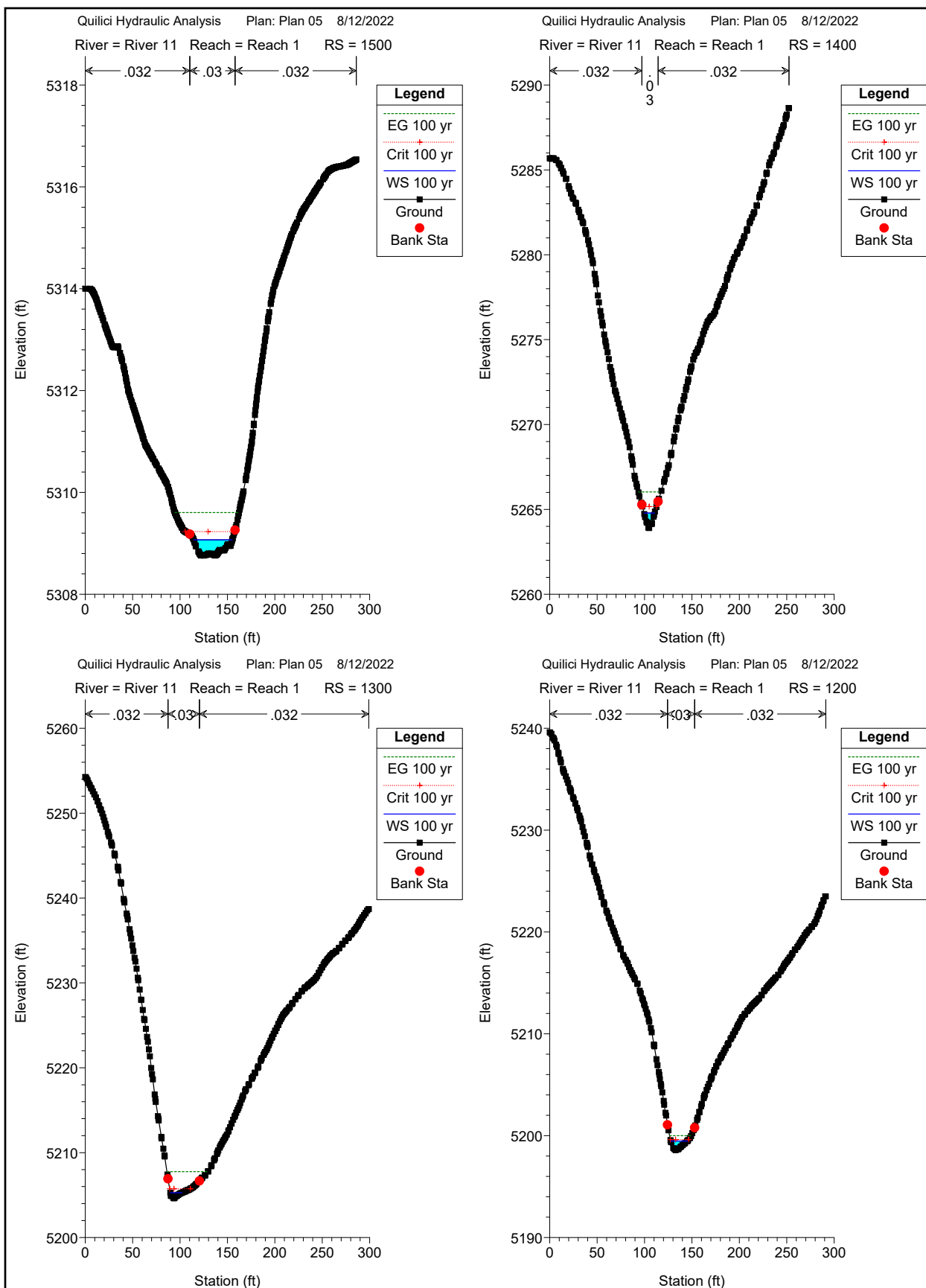


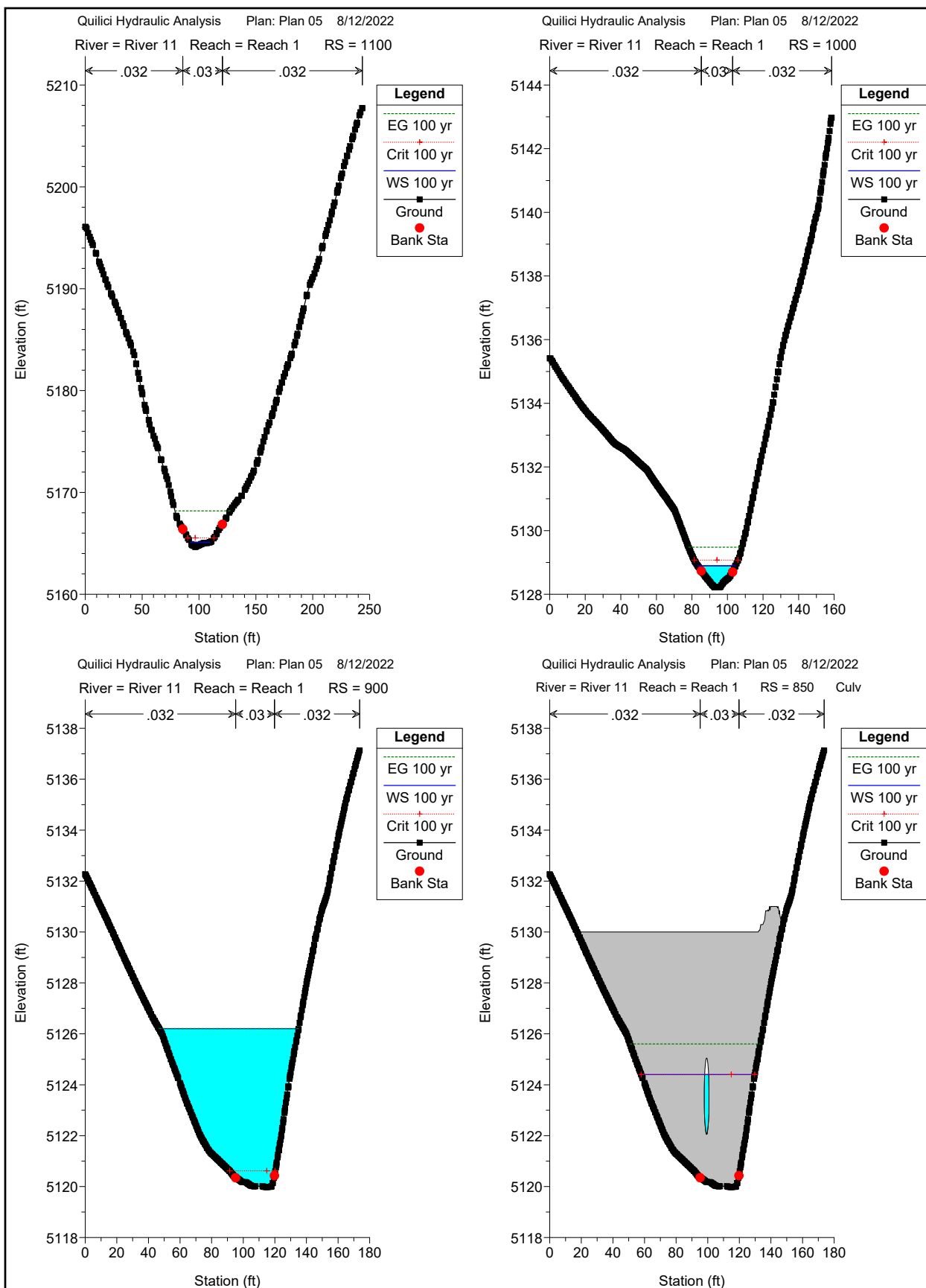


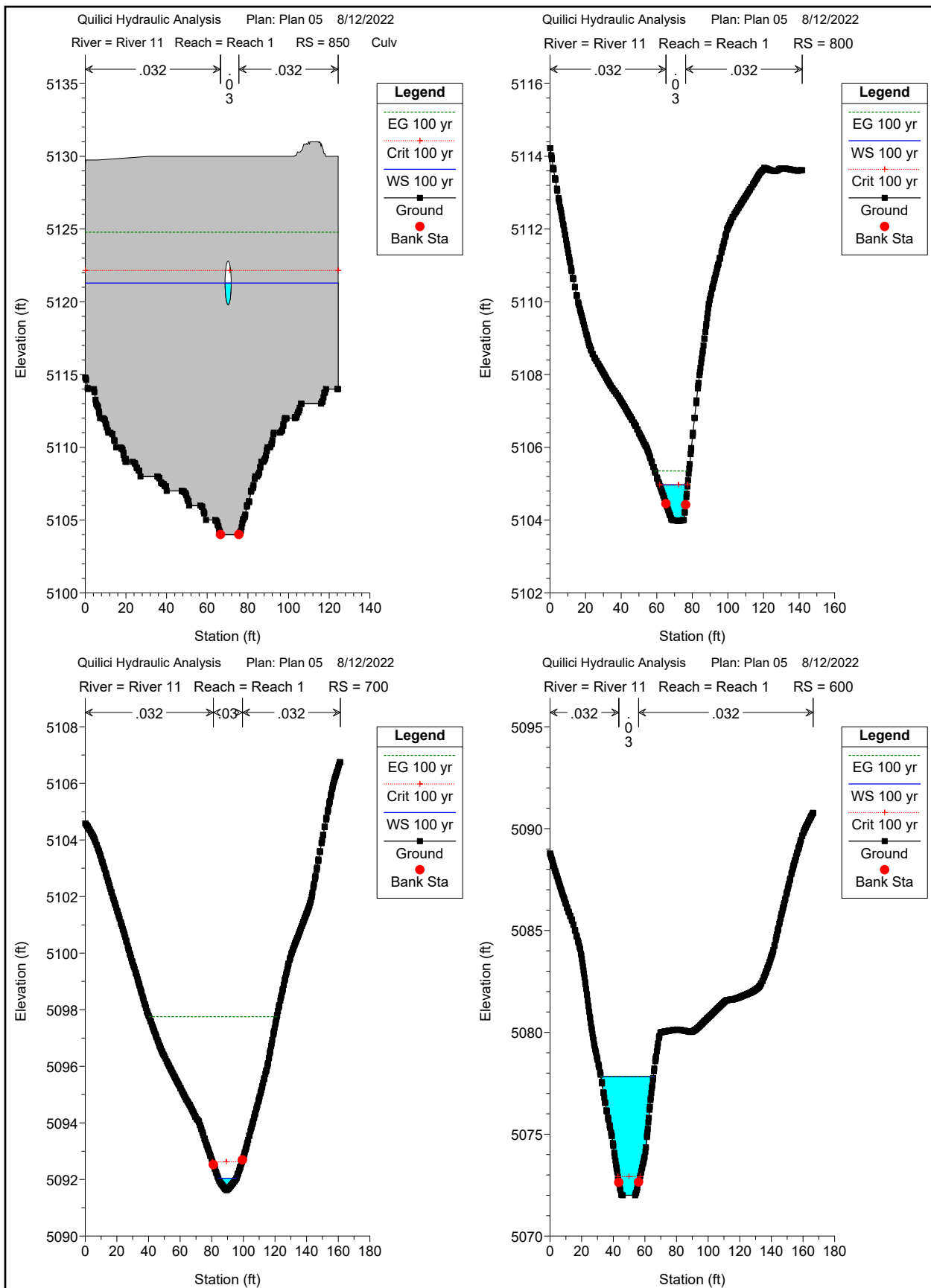


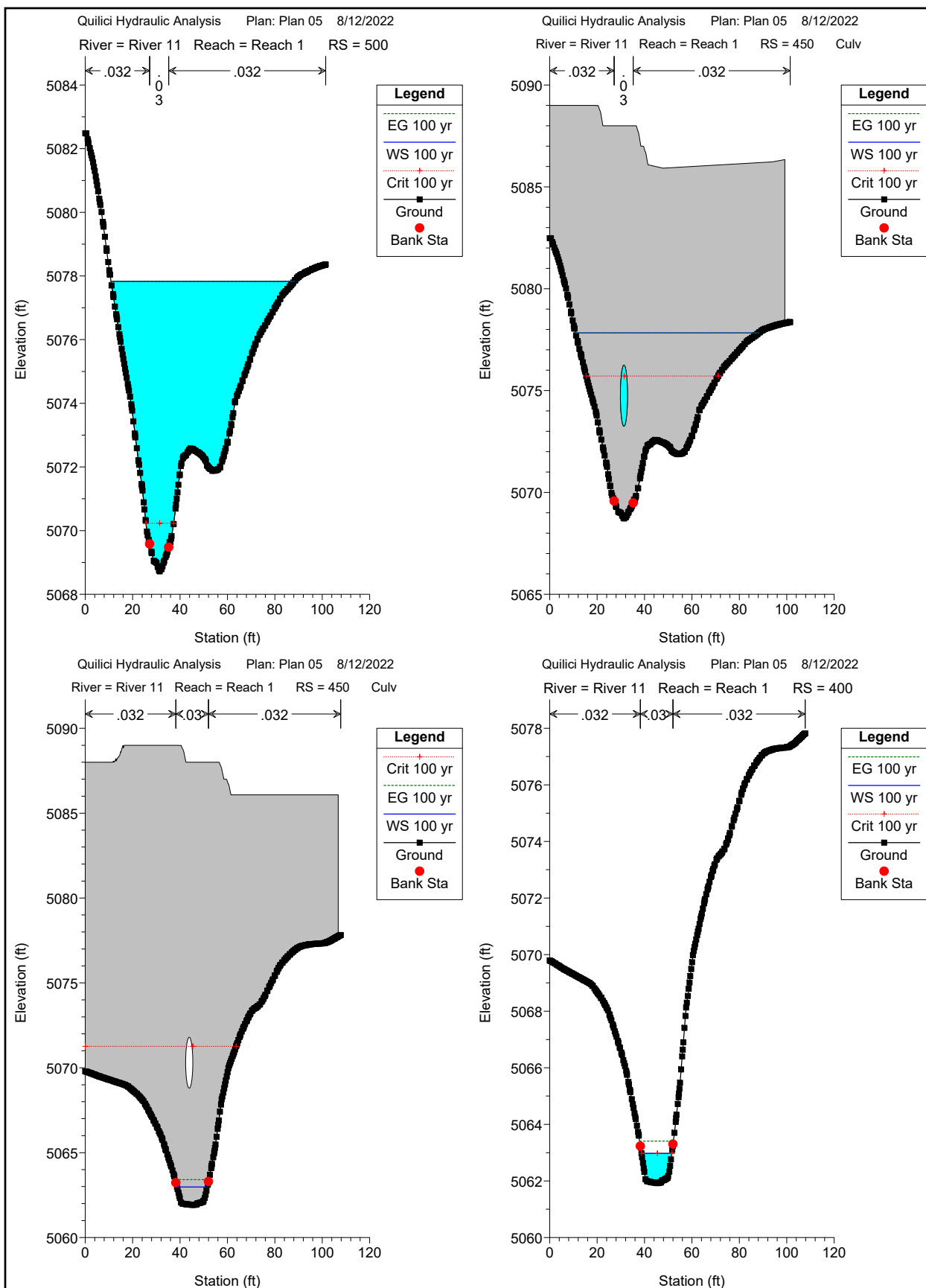
HEC-RAS Plan: 100 yr Profile: 100 yr

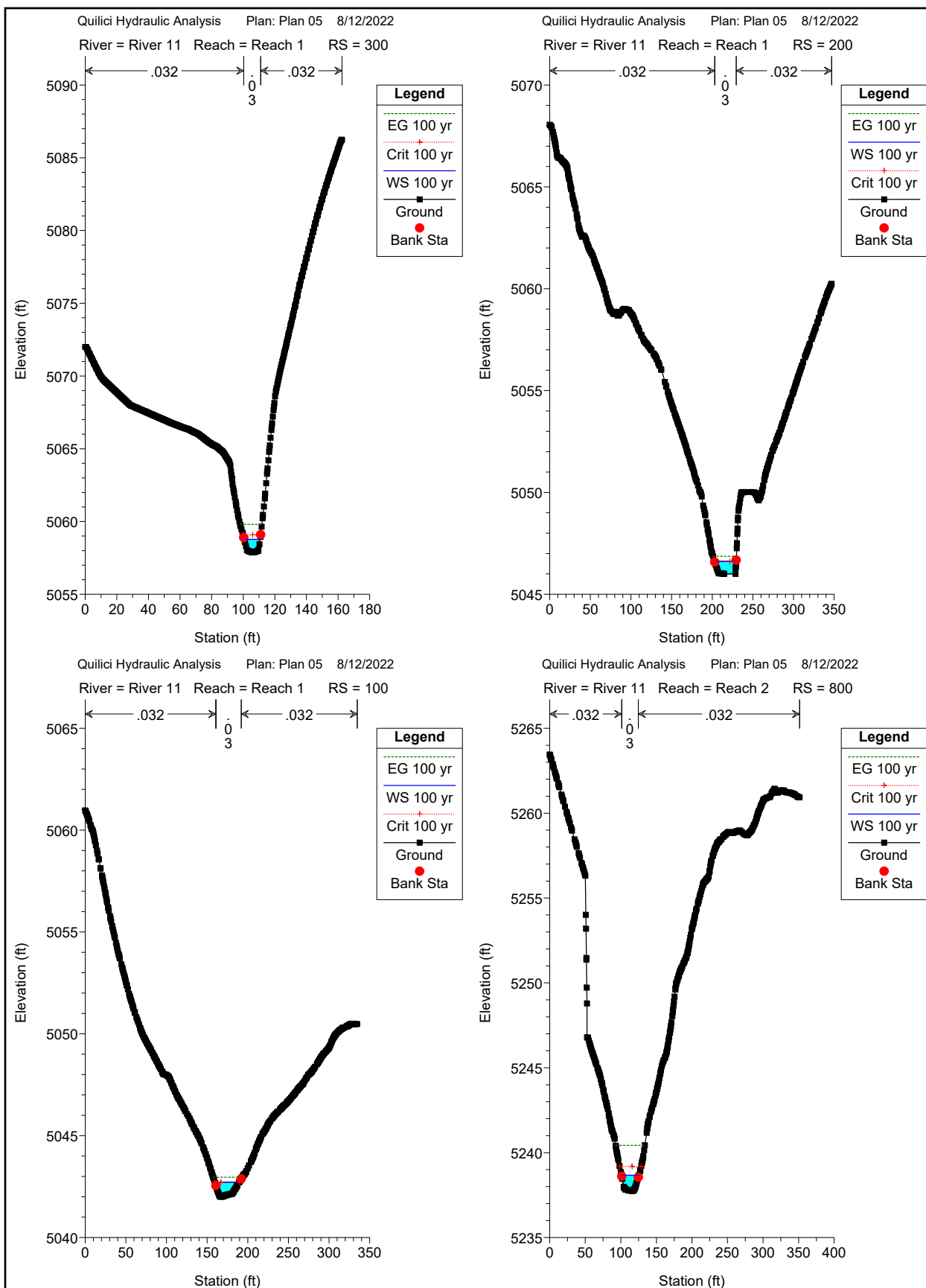
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	1500	100 yr	52.30	5308.76	5309.07	5309.23	5309.60	0.106734	5.87	8.90	40.69	2.21
Reach 1	1400	100 yr	52.30	5263.90	5264.79	5265.16	5266.03	0.078232	8.95	5.85	11.10	2.17
Reach 1	1300	100 yr	52.30	5204.62	5205.27	5205.74	5207.76	0.284525	12.66	4.13	12.30	3.85
Reach 1	1200	100 yr	52.30	5198.57	5199.48	5199.62	5200.00	0.033775	5.79	9.04	17.68	1.43
Reach 1	1100	100 yr	52.30	5164.64	5165.11	5165.53	5168.19	0.634870	14.09	3.71	17.33	5.37
Reach 1	1000	100 yr	52.30	5128.22	5128.89	5129.08	5129.48	0.041770	6.17	8.69	21.21	1.58
Reach 1	900	100 yr	52.30	5119.98	5126.21	5120.62	5126.21	0.000001	0.19	362.90	88.34	0.01
Reach 1	850		Culvert									
Reach 1	800	100 yr	52.30	5103.97	5104.97	5104.97	5105.35	0.012346	5.06	11.06	15.73	0.95
Reach 1	700	100 yr	52.30	5091.62	5092.04	5092.62	5097.75	1.027640	19.17	2.73	11.53	6.95
Reach 1	600	100 yr	52.30	5072.00	5077.83	5072.92	5077.83	0.000011	0.51	128.87	33.20	0.04
Reach 1	500	100 yr	57.80	5068.72	5077.83	5070.23	5077.83	0.000002	0.27	335.11	77.32	0.02
Reach 1	450		Culvert									
Reach 1	400	100 yr	57.80	5061.92	5062.97	5062.97	5063.41	0.014722	5.28	10.94	12.81	1.01
Reach 1	300	100 yr	57.80	5057.87	5058.77	5059.08	5059.81	0.045339	8.16	7.09	10.02	1.71
Reach 1	200	100 yr	57.80	5046.00	5046.62	5046.60	5046.87	0.014597	3.98	14.51	26.74	0.95
Reach 1	100	100 yr	57.80	5042.00	5042.71	5042.71	5042.96	0.016427	4.00	14.52	30.04	1.00
Reach 2	800	100 yr	179.10	5237.75	5238.67	5239.18	5240.43	0.072311	10.66	16.85	24.42	2.21
Reach 2	700	100 yr	179.10	5140.00	5140.97	5141.61	5144.27	0.218633	15.20	12.87	29.54	3.67
Reach 2	600	100 yr	179.10	5086.14	5087.56	5087.94	5088.70	0.030545	8.93	22.90	34.07	1.53
Reach 2	500	100 yr	179.10	5053.35	5054.29	5054.67	5055.58	0.062659	9.13	19.65	31.47	2.02
Reach 2	400	100 yr	179.10	5038.88	5040.60	5040.89	5041.56	0.018294	8.23	24.89	26.15	1.24
Reach 3	800	100 yr	236.90	4994.00	4994.36	4995.96	5051.46	6.578539	60.62	3.91	11.72	18.47
Reach 3	700	100 yr	236.90	4988.00	4988.70	4988.97	4989.70	0.042515	8.02	29.79	44.08	1.69

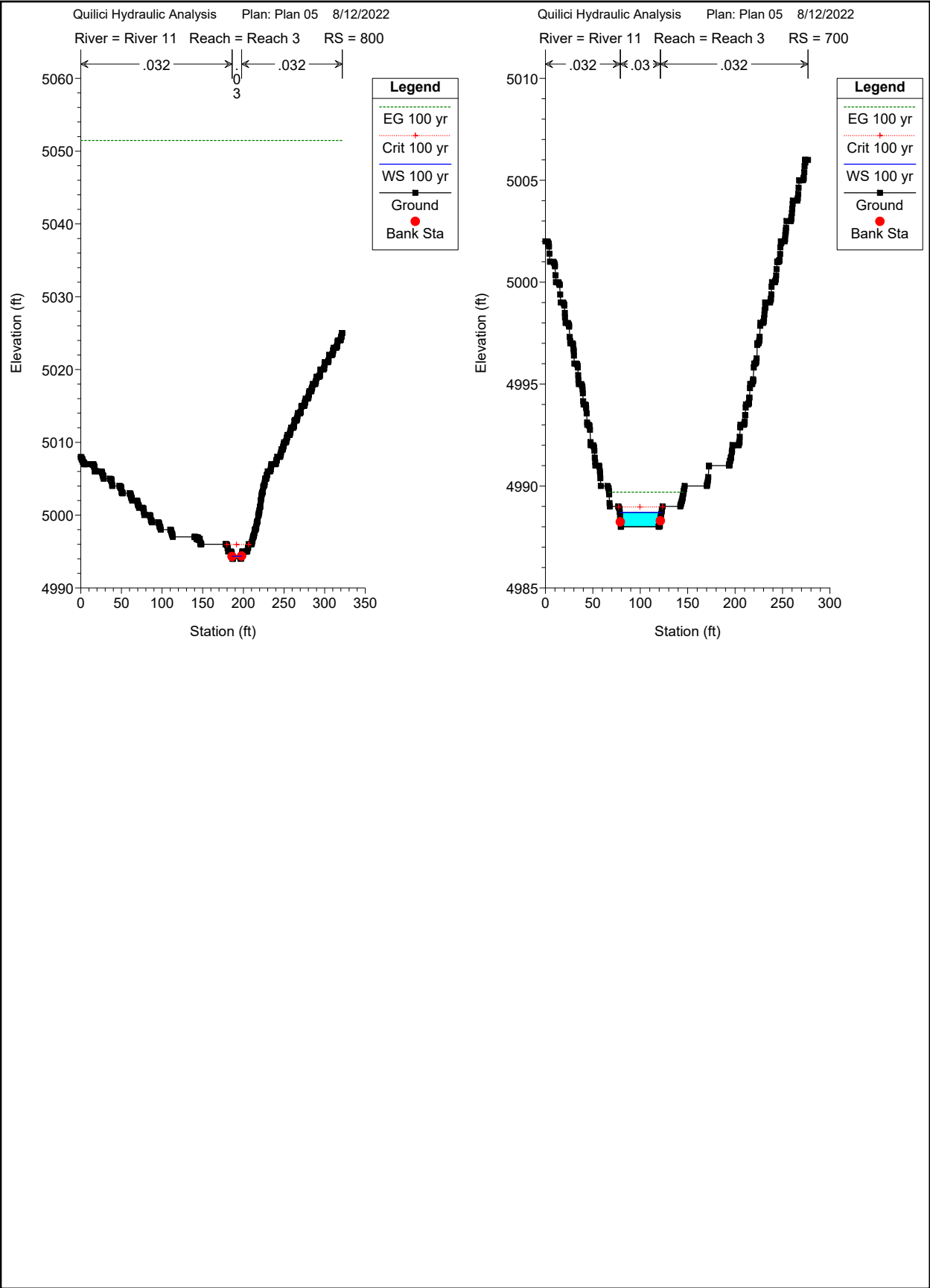










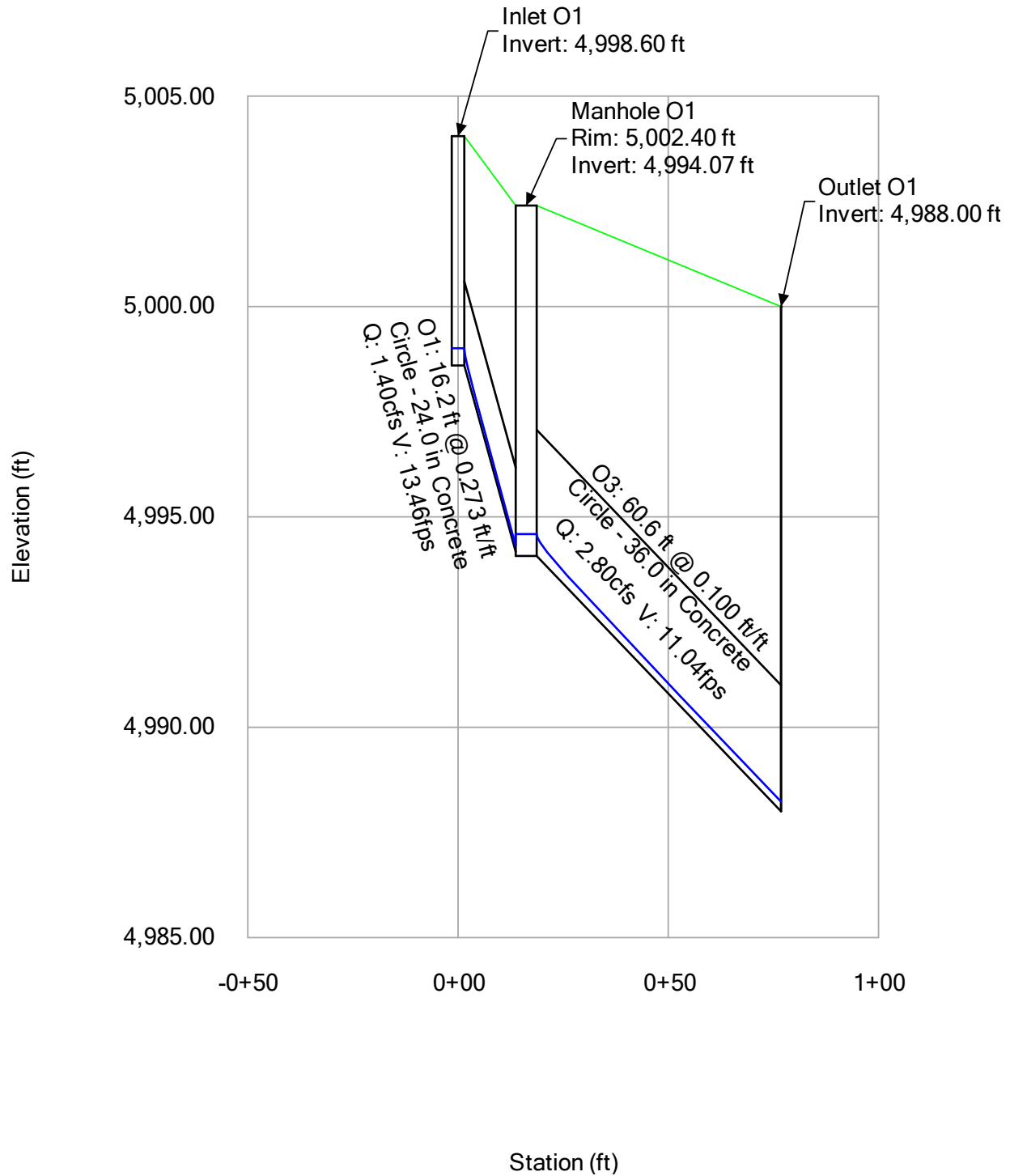


StormCAD Parameters & Results

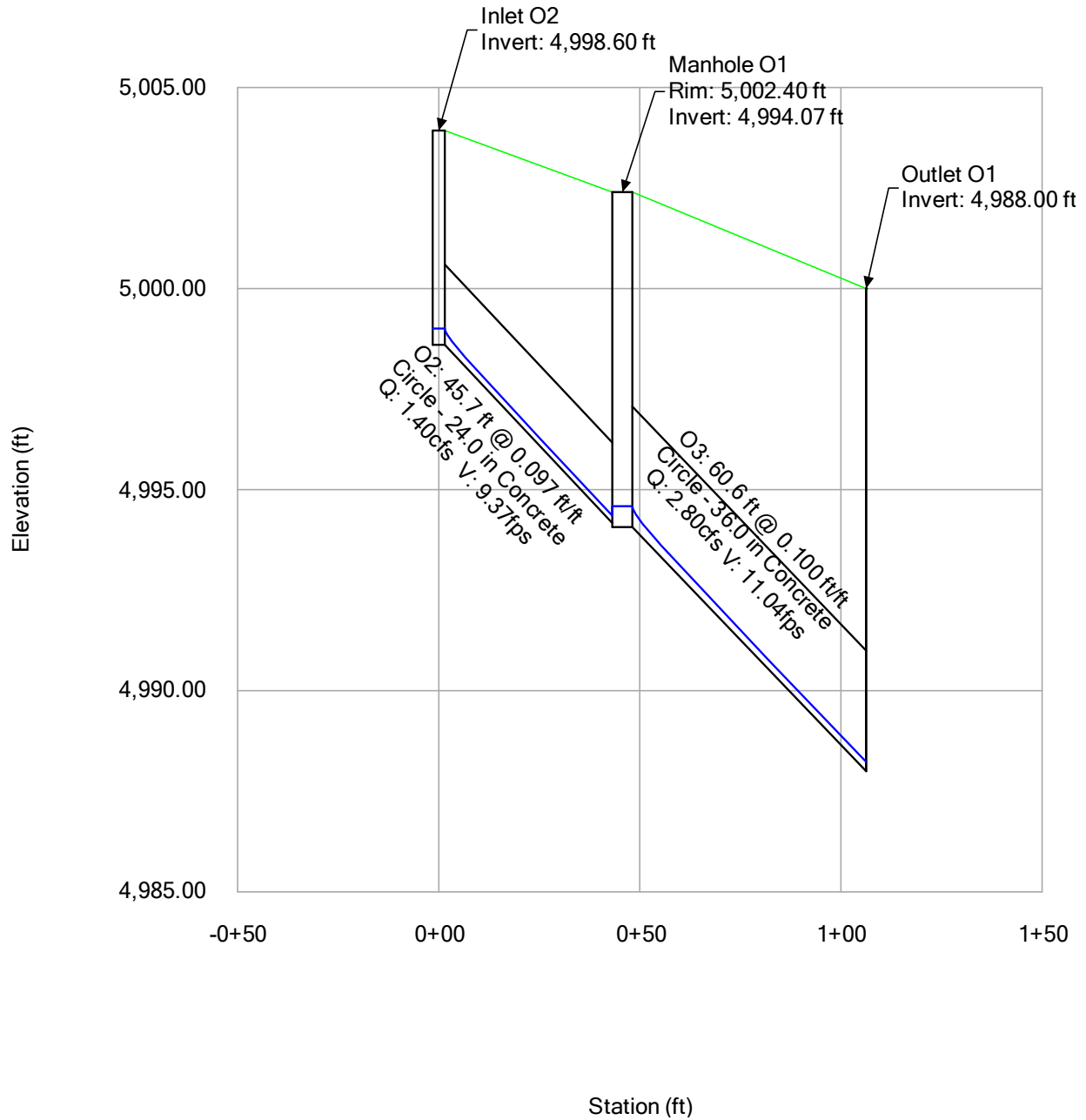
StormCAD 5yr Results

Label	Invert (Start) (ft)	Invert (Stop) (ft)	Velocity (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Flow (cfs)
O1	4,998.60	4,994.17	13.46	4,999.01	4,994.59	0.273	24	1.4
O2	4,998.60	4,994.17	9.37	4,999.01	4,994.59	0.097	24	1.4
O3	4,994.07	4,988.00	11.04	4,994.59	4,988.23	0.1	36	2.8
Pipe - (302)	4,975.07	4,971.71	12.7	4,976.52	4,973.88	0.02	6x3 RCB	59.3
Pipe - (306)	4,971.71	4,962.26	12.29	4,973.16	4,964.43	0.021	6x3 RCB	59.3
Pipe - (307)	4,962.26	4,954.48	15.04	4,963.71	4,956.65	0.034	6x3 RCB	59.3
Pipe - (193)	4,954.48	4,953.04	12.27	4,955.93	4,956.13	0.018	6x3 RCB	59.3
Pipe - (309)	4,953.04	4,952.72	9.8	4,955.95	4,955.94	0.009	60	59.3
PIPE Z9 STUB	4,952.73	4,952.64	10.95	4,955.50	4,955.53	0.009	60	59.3
PIPE Z8 Z9	4,952.54	4,951.21	15.78	4,954.71	4,952.67	0.025	60	59.3
PIPE Z7 Z8	4,950.12	4,948.02	12.58	4,952.29	4,949.52	0.013	60	59.3
PIPE Z6 Z7	4,945.72	4,943.76	12.83	4,947.89	4,945.26	0.014	60	59.3
PIPE Z5 Z6	4,940.13	4,938.91	12.84	4,942.30	4,940.47	0.014	60	59.3
PIPE Z4 Z5	4,934.86	4,934.01	12.84	4,937.03	4,935.62	0.014	60	59.3
PIPE Z3 Z4	4,930.28	4,929.41	12.82	4,932.45	4,931.02	0.014	60	59.3
PIPE Z2 Z3	4,926.13	4,925.35	12.88	4,928.30	4,926.97	0.014	60	59.3
PIPE Z1 Z2	4,922.48	4,920.61	12.83	4,924.65	4,922.11	0.014	60	59.3
PIPE Z0 Z1	4,918.70	4,917.15	11.4	4,920.87	4,918.75	0.01	60	59.3

Profile Report **Engineering Profile - Inlet O1 to Outlet O1 (Proposed Phase 1A and Village 8_5-yr, 24-hr_07.27.22.stsw)**

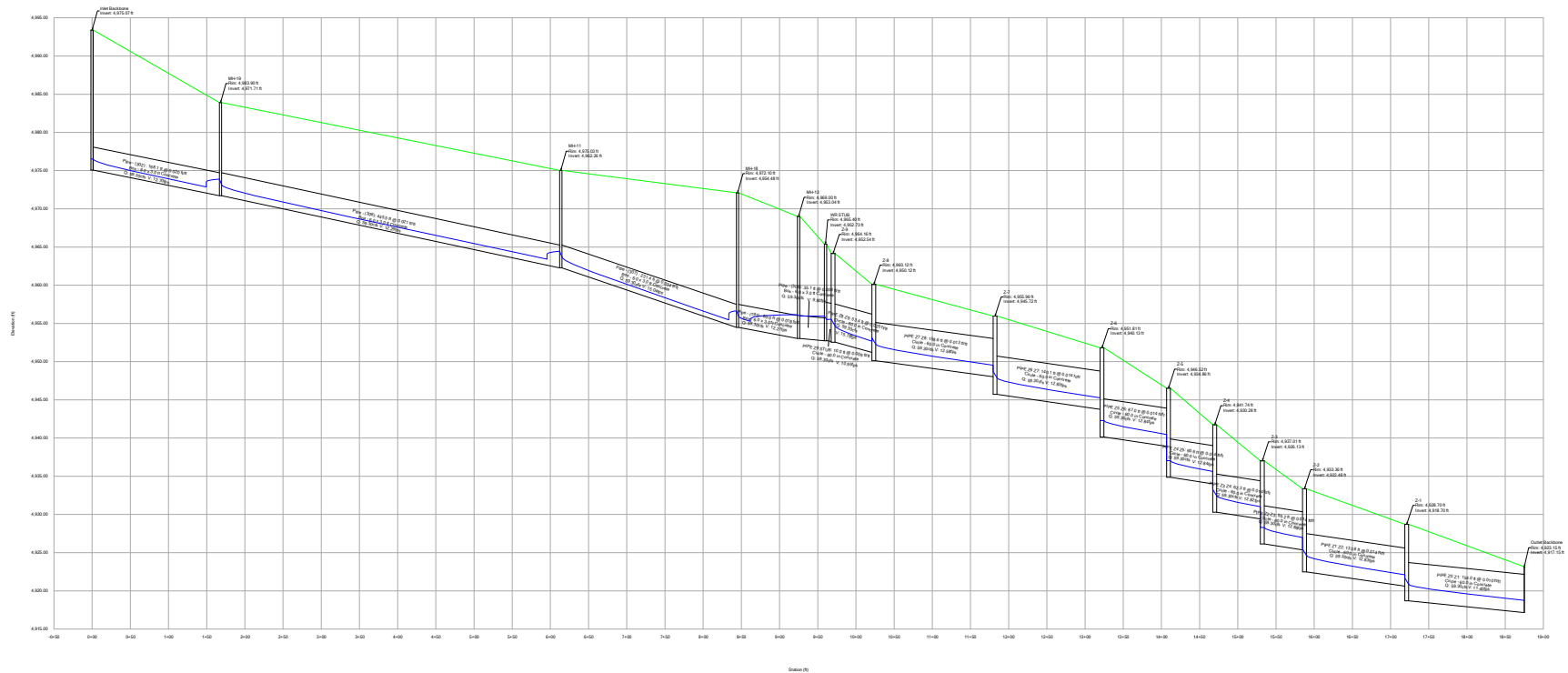


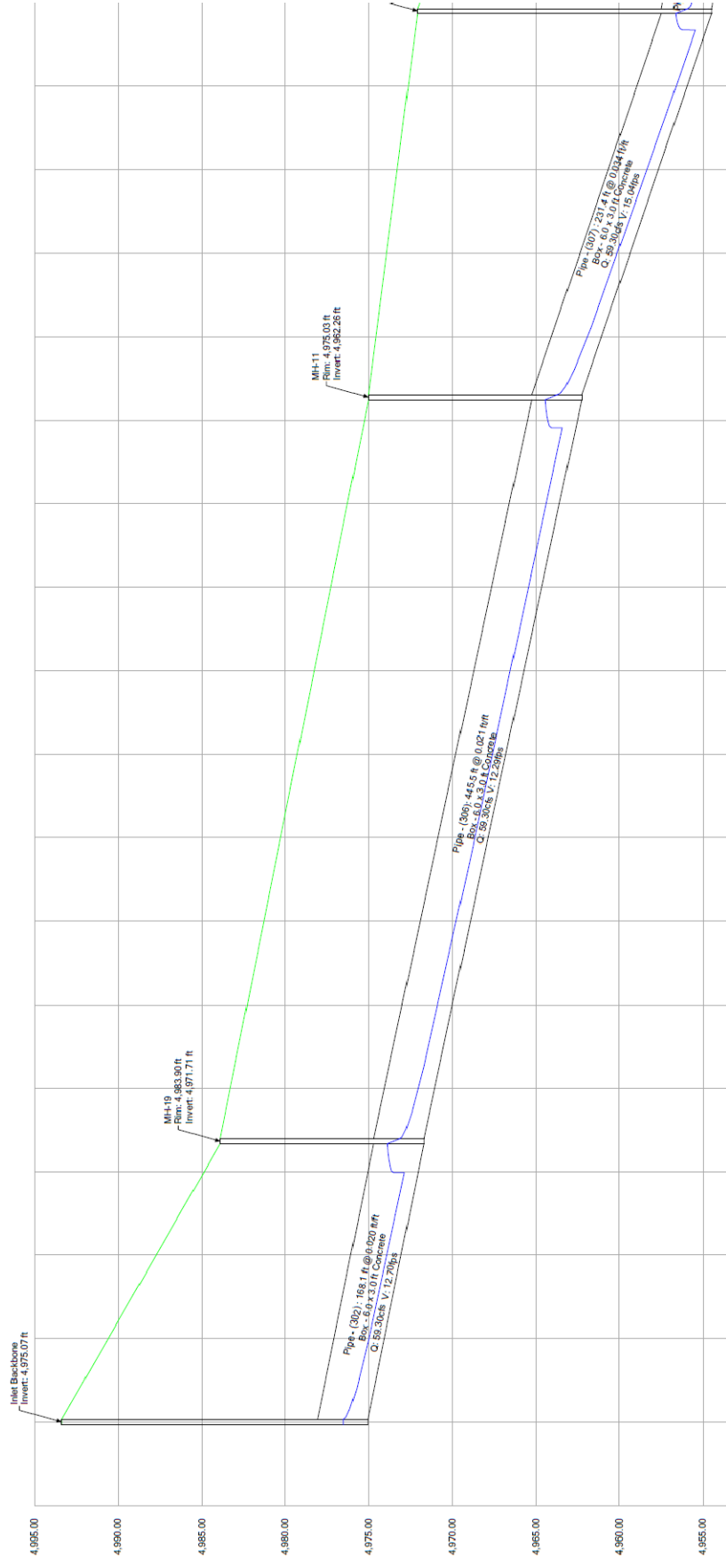
Profile Report **Engineering Profile - Inlet O2 to Outlet O1 (Proposed Phase 1A and Village 8_5-yr, 24-hr_07.27.22.stsw)**

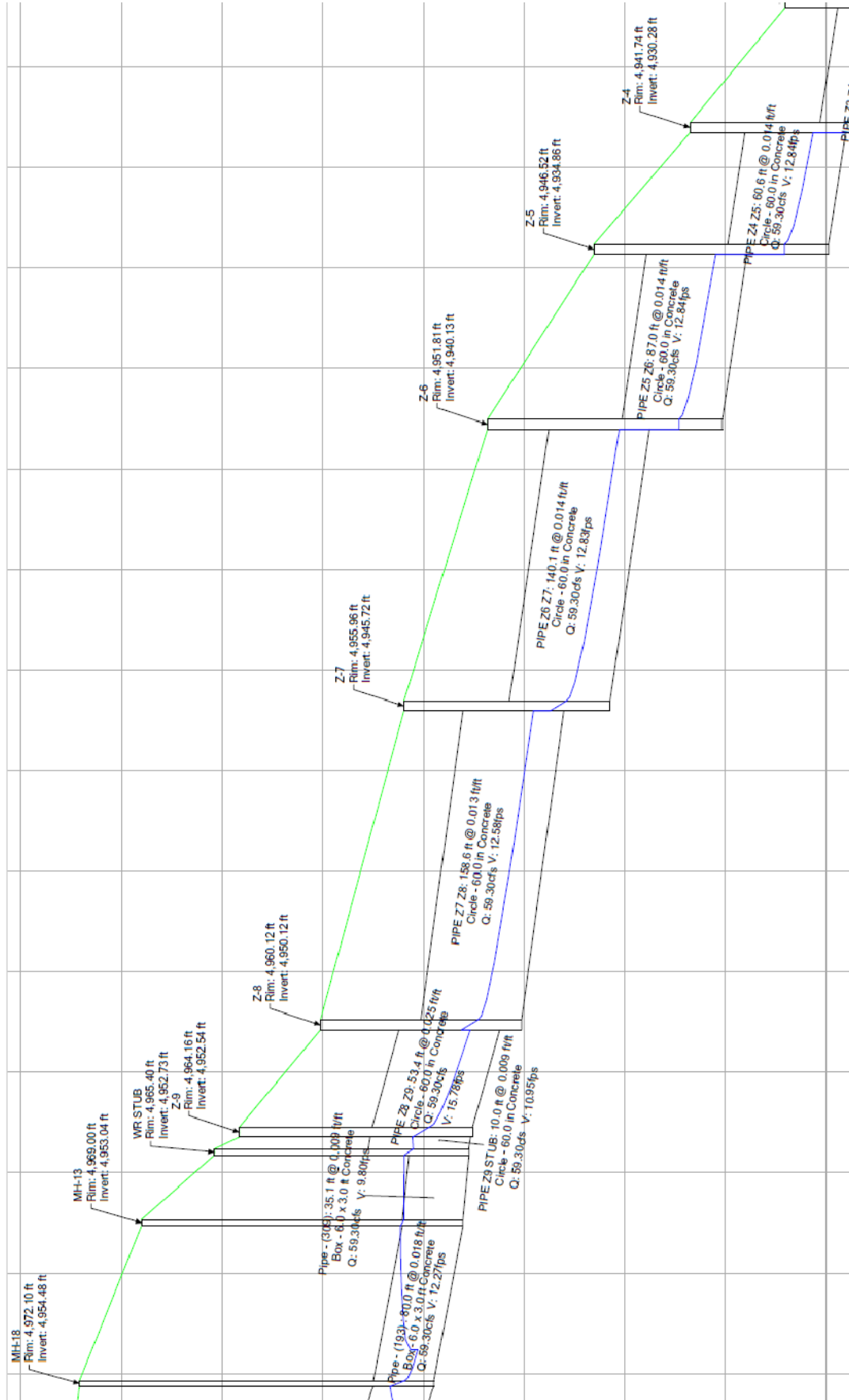


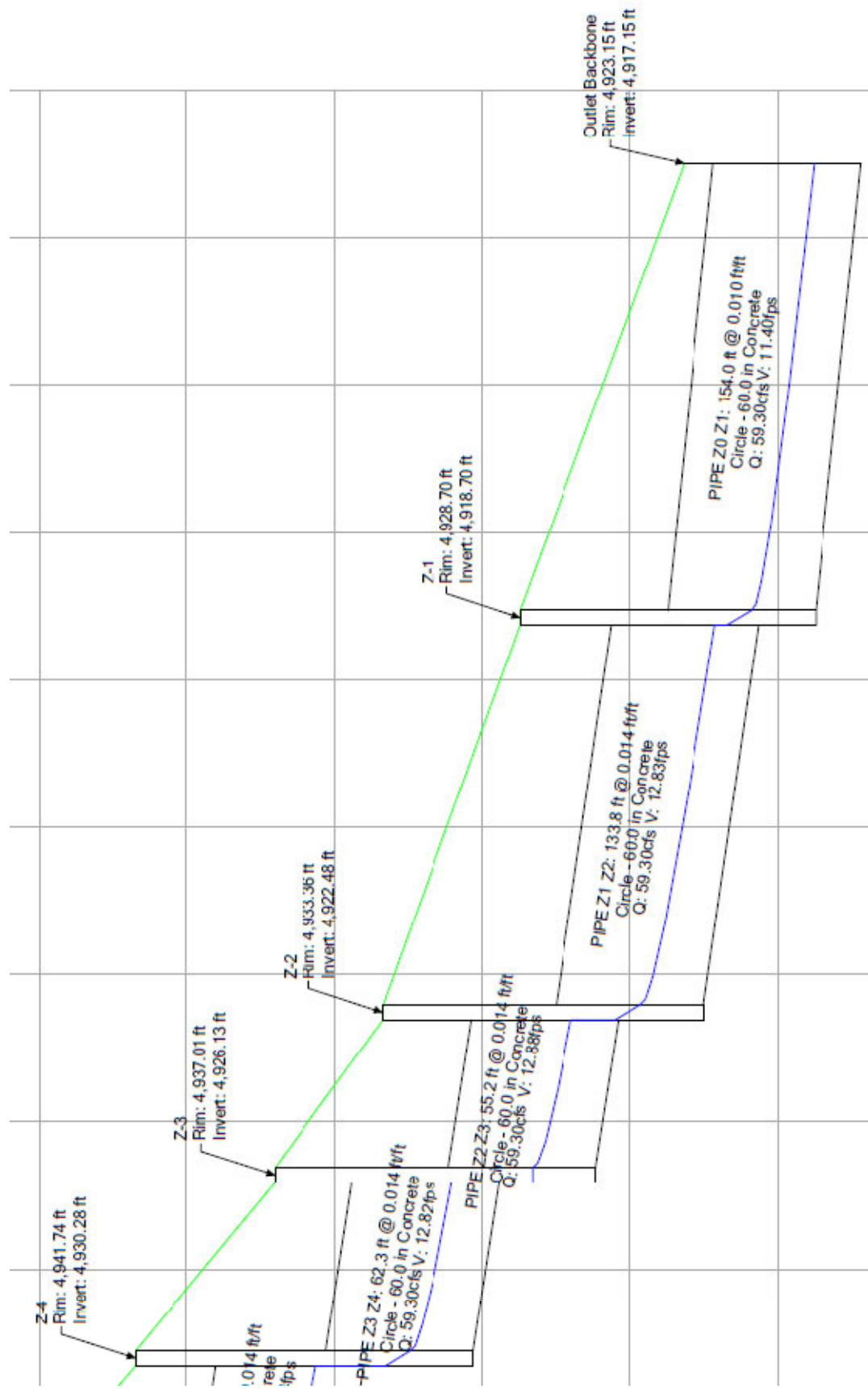
Profile Report

Engineering Profile - Inlet Backbone to Outlet Backbone (Proposed Phase 1A and Village 8_5-yr, 24-hr_07.27.22.stsw)







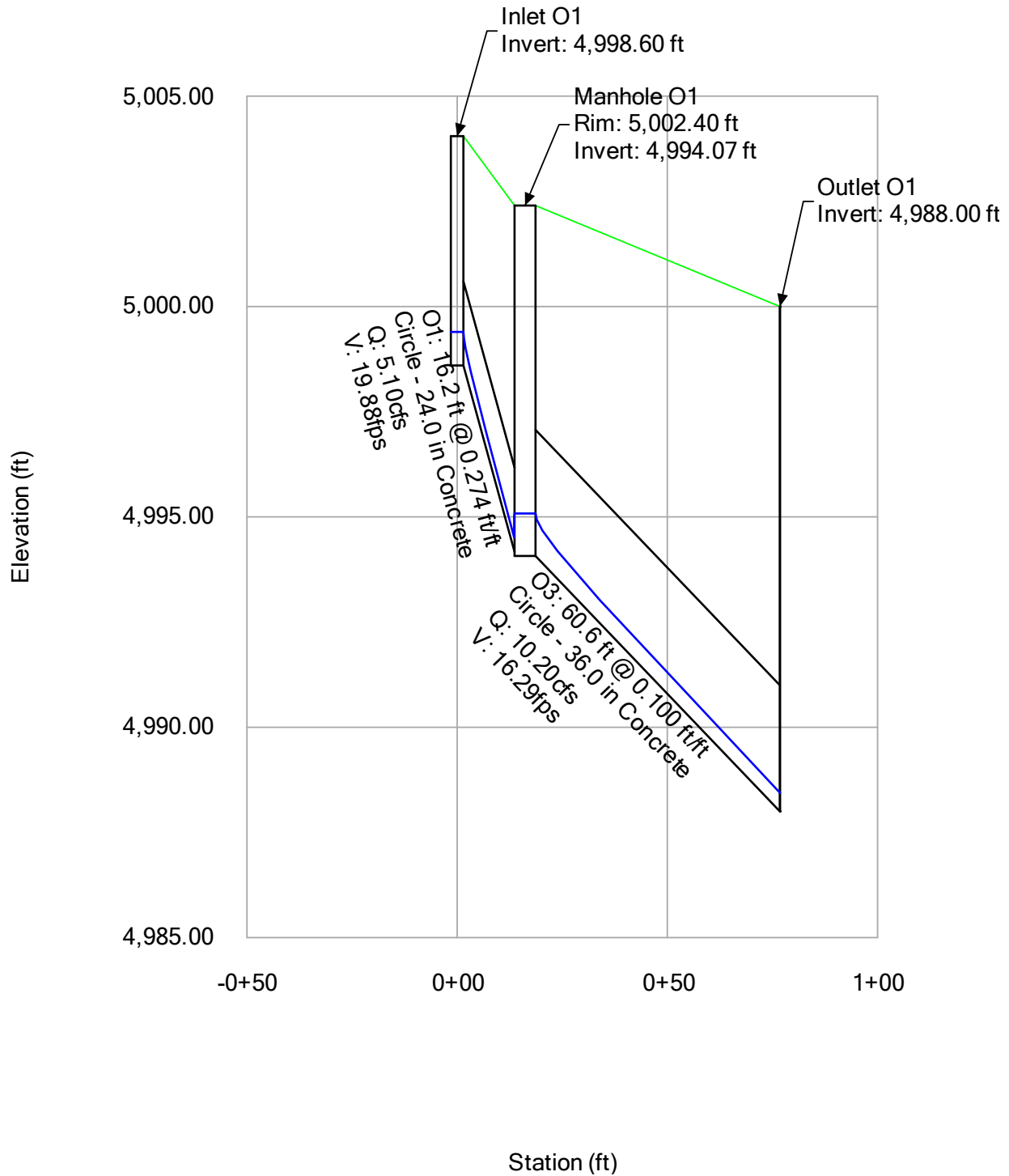


StormCAD 100yr Results

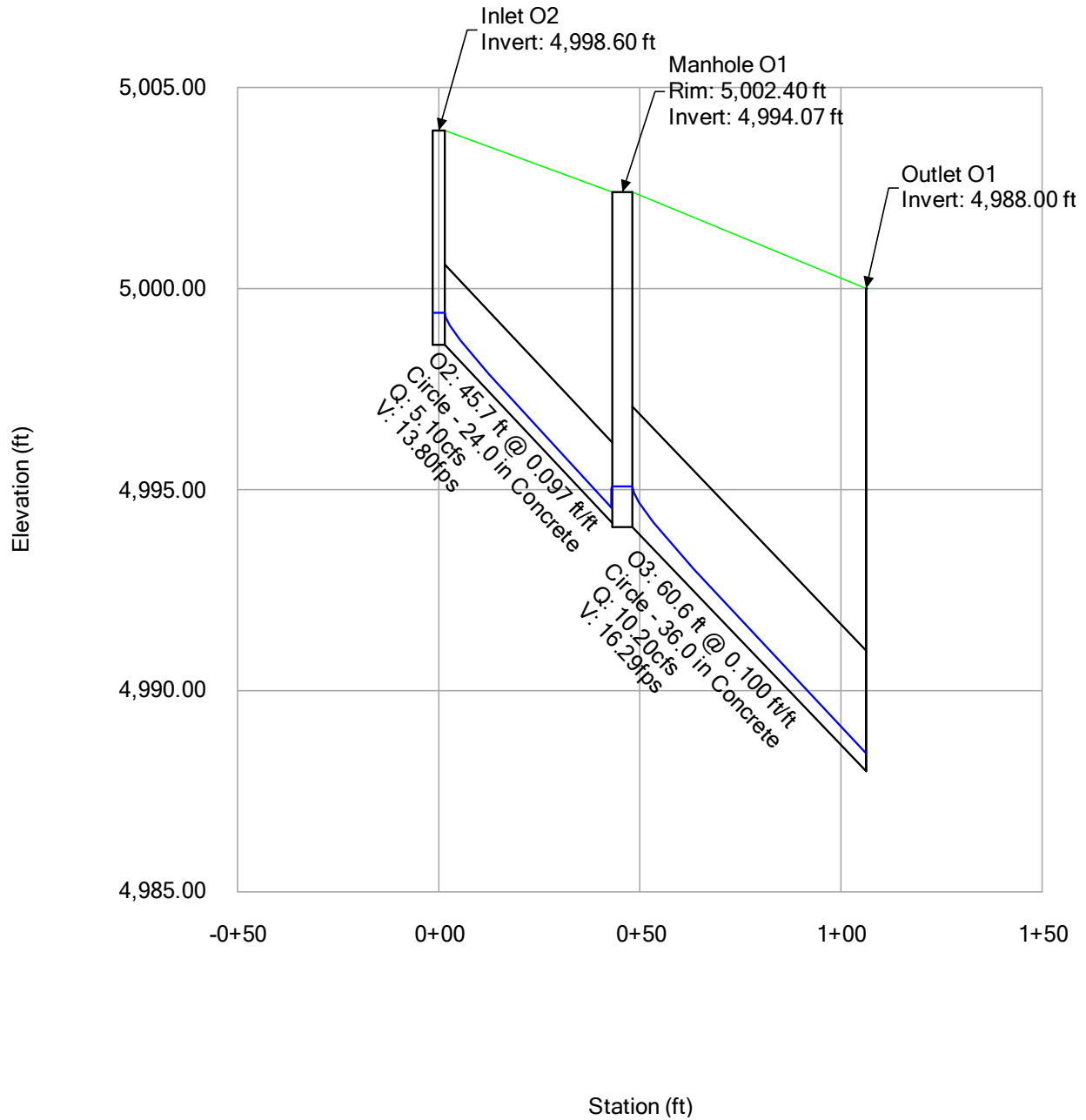
Label	Invert (Start) (ft)	Invert (Stop) (ft)	Velocity (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Flow (cfs)
O1	4,998.60	4,994.17	19.88	4,999.40	4,995.08	0.274	24	5.1
O2	4,998.60	4,994.17	13.8	4,999.40	4,995.08	0.097	24	5.1
O3	4,994.07	4,988.00	16.29	4,995.08	4,988.44	0.1	36	10.2
Pipe - (302)	4,975.07	4,971.71	19.77	4,978.07	4,973.93	0.02	6x3 RCB	237.2
Pipe - (306)	4,971.71	4,962.26	19.07	4,974.71	4,965.89	0.021	6x3 RCB	237.2
Pipe - (307)	4,962.26	4,954.48	13.18	4,965.89	4,963.27	0.034	6x3 RCB	237.2
Pipe - (193)	4,954.48	4,953.04	13.18	4,963.27	4,962.36	0.018	6x3 RCB	237.2
Pipe - (309)	4,953.04	4,952.72	12.08	4,962.36	4,962.11	0.009	60	237.2
PIPE Z9 STUB	4,952.73	4,952.64	12.08	4,959.84	4,959.77	0.009	60	237.2
PIPE Z8 Z9	4,952.54	4,951.21	12.08*	4,957.50	4,957.13	0.025	60	237.2
PIPE Z7 Z8	4,950.12	4,948.02	18.05	4,954.46	4,952.73	0.013	60	237.2
PIPE Z6 Z7	4,945.72	4,943.76	17.3	4,950.06	4,947.27	0.014	60	237.2
PIPE Z5 Z6	4,940.13	4,938.91	18.47	4,944.47	4,942.46	0.014	60	237.2
PIPE Z4 Z5	4,934.86	4,934.01	18.47	4,939.20	4,937.65	0.014	60	237.2
PIPE Z3 Z4	4,930.28	4,929.41	18.43	4,934.62	4,933.05	0.014	60	237.2
PIPE Z2 Z3	4,926.13	4,925.35	17.38	4,930.47	4,929.07	0.014	60	237.2
PIPE Z1 Z2	4,922.48	4,920.61	18.44	4,926.82	4,925.71	0.014	60	237.2
PIPE Z0 Z1	4,918.70	4,917.15	16.14	4,923.04	4,920.83	0.01	60	237.2

*StormCAD produced erroneous velocity result. Velocity calculated based on pipe full condition consistent with StormCAD HGL output.

Profile Report **Engineering Profile - Inlet O1 to Outlet O1 (Proposed Phase 1A and Village 8_100-yr, 24-hr_07.26.22.stsw)**

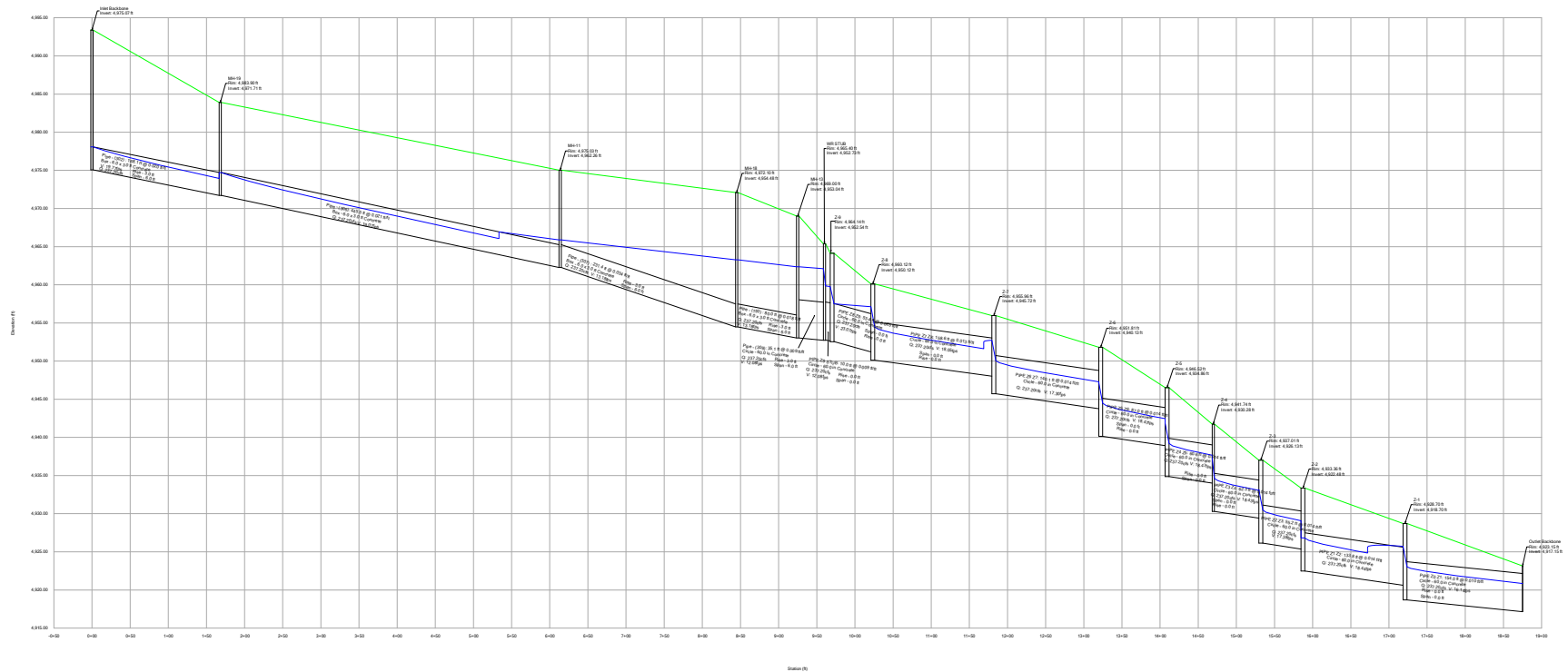


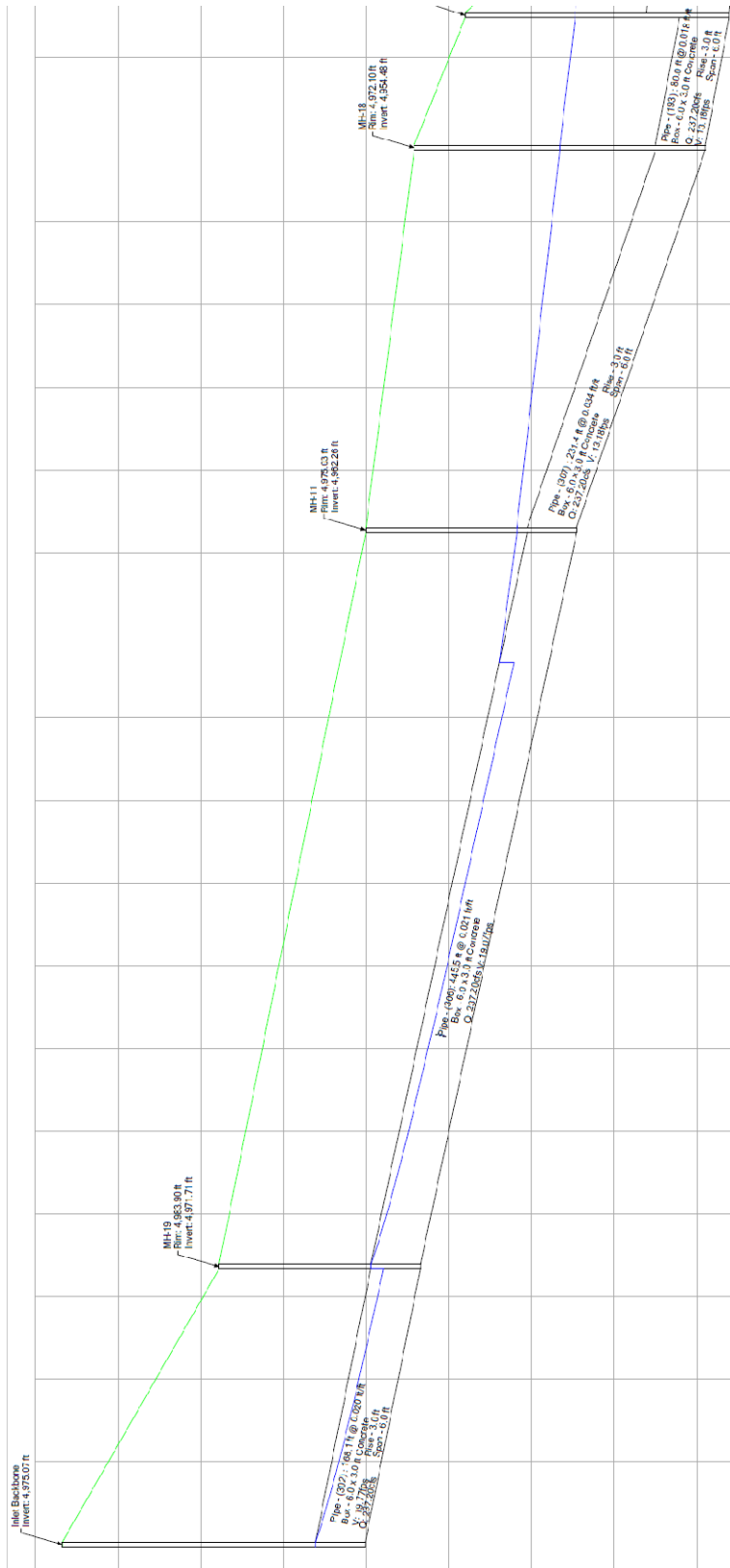
Profile Report **Engineering Profile - Inlet O2 to Outlet O1 (Proposed Phase 1A and Village 8_100-yr, 24-hr_07.26.22.stsw)**

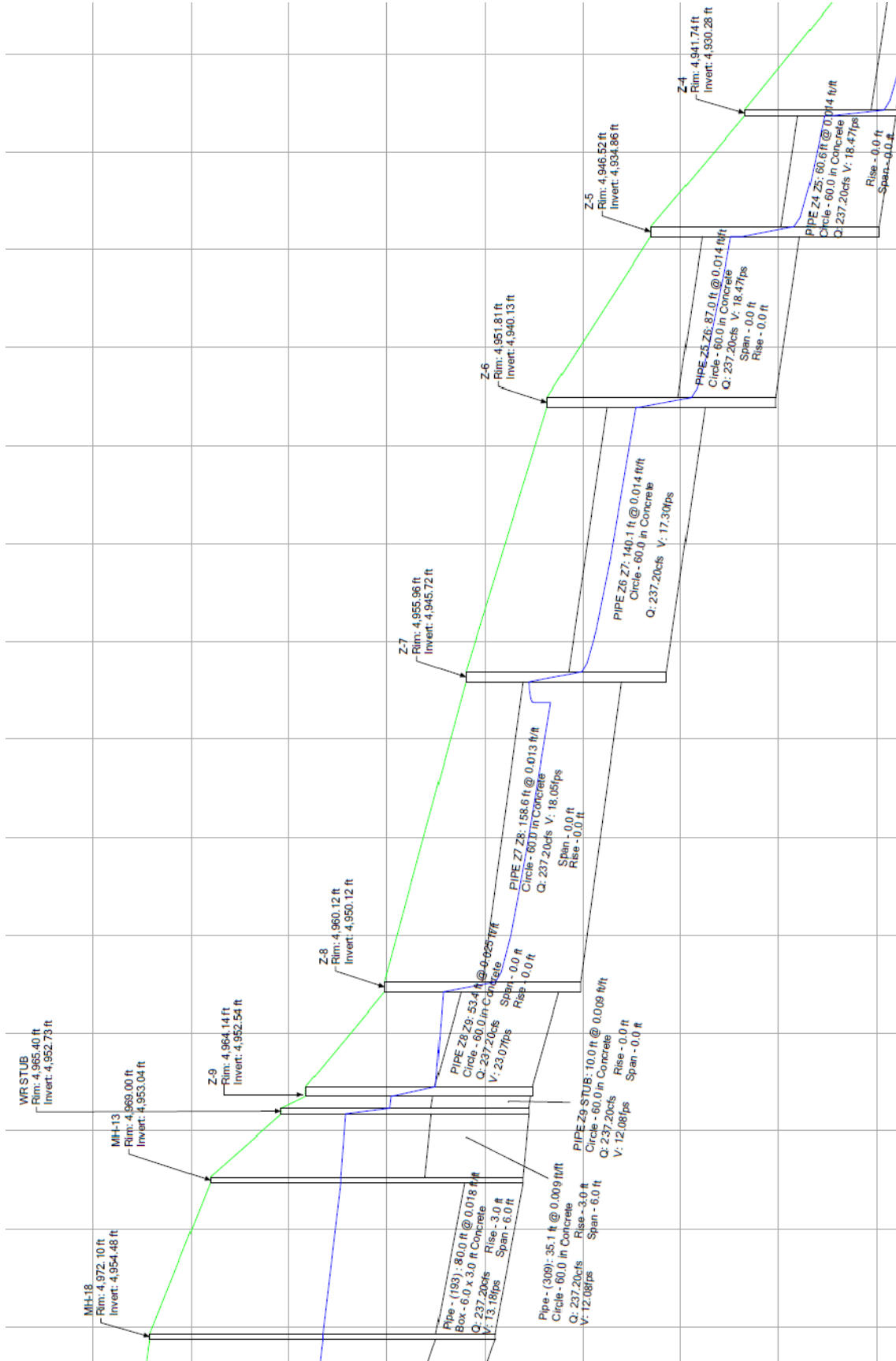


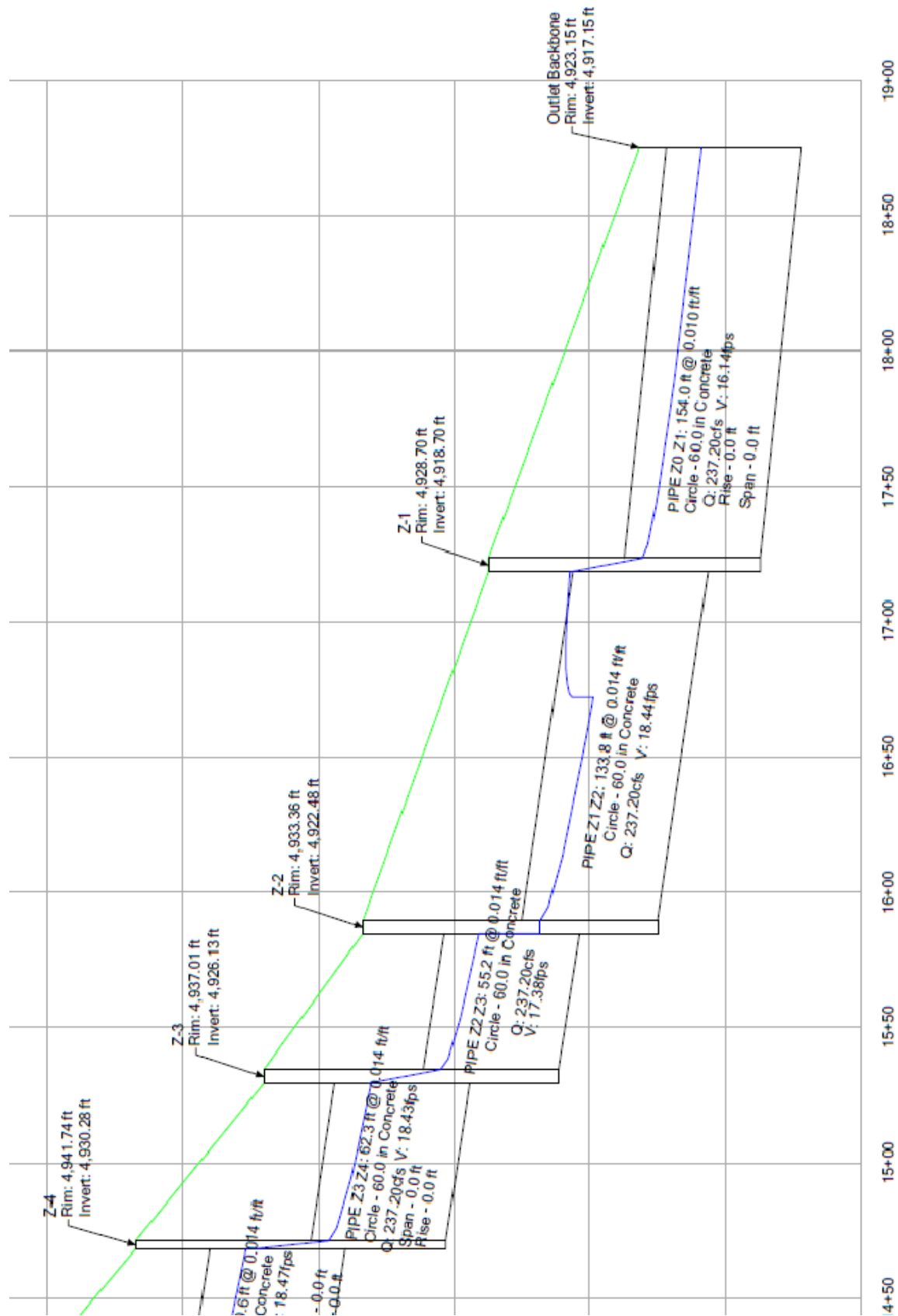
Profile Report

Engineering Profile - Inlet Backbone to Outlet Backbone (Proposed Phase 1A and Village 8_100-yr, 24-hr_07.26.22.stsw)



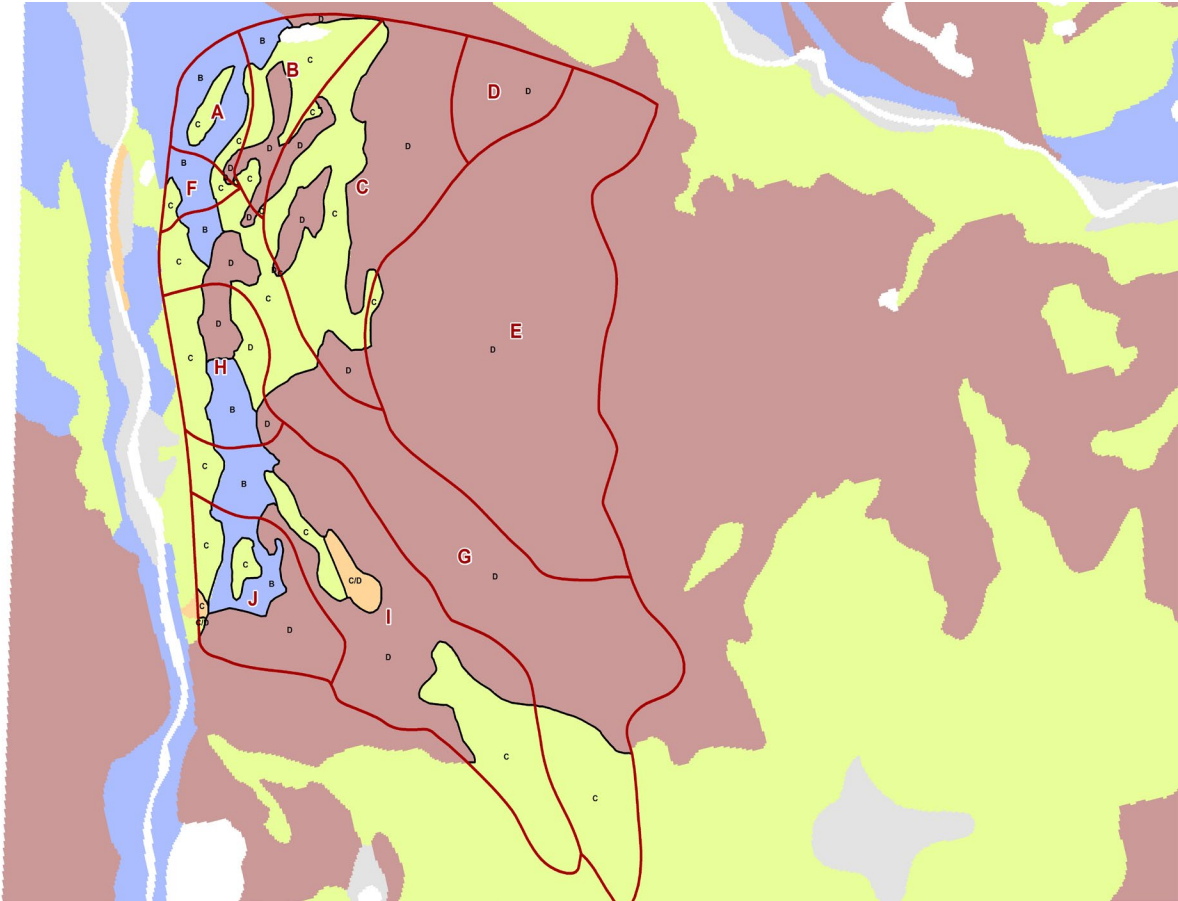






Hydrologic Soil Group Calculations

HEC-HMS Parameters and Results:
Existing Conditions - Parameters:



Watershed	Hydrologic Soil Group Area (ac)				Total Area (ac)	Total Area (sq mi)
	B	C	C/D	D		
A	34.30	14.41	-	1.63	50.34	0.08
B*	8.84	48.35	-	20.30	77.48	0.12
C	-	96.01	-	171.65	267.66	0.42
D	-	-	-	57.69	57.69	0.09
E	-	3.21	-	534.87	538.08	0.84

*Assumes uncategorized area (4.20 ac) is Hydrologic Soil Group C

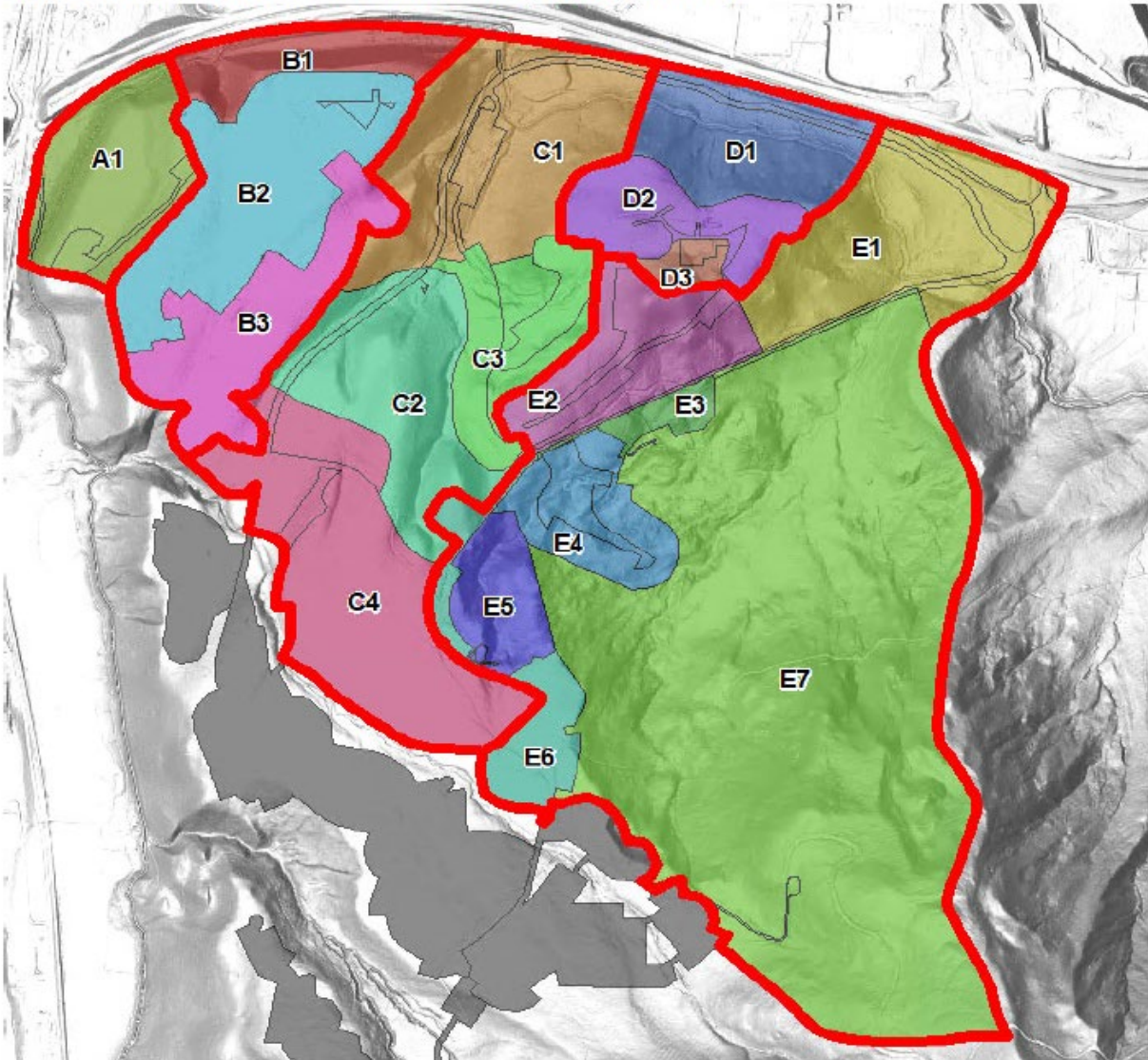
Watershed	Curve Numbers				Fraction based on Area				Weighted Average Curve Number
	B	C	C/D	D	B	C	C/D	D	
A	51	63	-	70	0.681	0.286	-	0.032	55
B	51	63	-	70	0.114	0.624	-	0.262	63
C	-	63	-	70	-	0.359	-	0.641	67
D	-	-	-	70	-	-	-	1.000	70
E	-	63	-	70	-	0.006	-	0.994	70

Watershed	Elevation Drop, H (ft)	Watershed Length, L (ft)	Slope, s (ft/ft)	Velocity, V (ft/s)	Time of Concentration, t_c (min)	Lag time, TLAG (min)
A	170	2790	0.061	1.719	37.06	22.23
B	160	3100	0.052	1.582	42.67	25.60
C	380	7270	0.052	1.592	86.12	51.67
D	310	2680	0.116	2.368	28.86	17.32
E	1160	10720	0.108	2.290	88.01	52.81



Proposed Conditions - Parameters:

Watershed and subwatershed boundaries for proposed conditions:



Watershed	Watershed Area (sq mi)	Subwatershed	Subwatershed Area (sq mi)	Hydrologic Soil Group	Proposed Conditions - Developed		Proposed Conditions - Undeveloped	
					Area (sq mi)	Total Area (sq mi)	Area (sq mi)	Total Area (sq mi)
A	0.065	A1	0.065	B	0.004	0.007	0.046	0.058
				C	0.003		0.012	
B	0.203	B1	0.036	B	-	-	0.013	0.036
				C			0.018	
				D			0.005	
		B2	0.100	B	0.004	0.098	-	0.002
				C	0.067		0.002	
				D	0.026		-	
		B3	0.067	B	0.044	0.067	-	-
				C	0.023		-	
C	0.376	C1	0.112	C	0.001	0.015	0.027	0.097
				D	0.014		0.070	
		C2	0.082	C	0.002	0.004	0.029	0.078
				D	0.002		0.049	
		C3	0.053	C	0.00004	0.035	-	0.018
				D	0.035		0.018	
		C4	0.129	C	0.058	0.111	0.014	0.018
				D	0.053		0.004	
D	0.112	D1	0.061	D	0.004	0.004	0.057	0.057
		D2	0.043	D	0.040	0.040	0.003	0.003
		D3	0.009	D	0.002	0.002	0.006	0.006
E	0.827	E1	0.101	D	0.013	0.013	0.088	0.088
		E2	0.060	D	0.027	0.027	0.033	0.033
		E3	0.010	D	0.010	0.010	-	-
		E4	0.041	D	0.029	0.029	0.012	0.012
		E5	0.030	C	-	0.001	0.000	0.029
				D	0.001		0.029	
		E6	0.038	C	0.007	0.038	-	-
				D	0.031		-	
		E7	0.545	D	0.003	0.003	0.542	0.542

*Assumes uncategorized area (4.20 ac) is Hydrologic Soil Group C



Subwatershed	Curve Numbers						Fraction based on Area						Weighted Average Curve Number
	Developed			Undeveloped			Developed			Undeveloped			
	B	C	D	B	C	D	B	C	D	B	C	D	
A1	85	90	-	51	63	-	0.065	0.042	-	0.708	0.184	-	57
B1	-	-	-	51	63	70	-	-	-	0.351	0.504	0.145	60
B2	85	90	92	-	63	-	0.044	0.672	0.263	-	0.021	-	90
B3	85	90	-	-	-	-	0.658	0.342	-	-	-	-	87
C1	-	90	92	-	63	70	-	0.005	0.129	-	0.238	0.628	71
C2	-	90	92	-	63	70	-	0.019	0.027	-	0.360	0.594	68
C3	-	90	92	-	-	70	-	0.001	0.663	-	-	0.336	85
C4	-	90	92	-	63	70	-	0.446	0.411	-	0.111	0.032	87
D1	-	-	92	-	-	70	-	-	0.065	-	-	0.935	71
D2	-	-	92	-	-	70	-	-	0.937	-	-	0.063	91
D3	-	-	92	-	-	70	-	-	0.251	-	-	0.749	76
E1	-	-	92	-	-	70	-	-	0.129	-	-	0.871	73
E2	-	-	92	-	-	70	-	-	0.446	-	-	0.554	80
E3	-	-	92	-	-	-	-	-	1.000	-	-	-	92
E4	-	-	92	-	-	70	-	-	0.705	-	-	0.295	86
E5	-	-	92	-	63	70	-	-	0.019	-	0.013	0.968	70
E6	-	90	92	-	-	-	-	0.189	0.811	-	-	-	92
E7	-	-	92	-	-	70	-	-	0.006	-		0.994	70

Subwatershed or Watershed	Area (sq mi)	Weighted Average Curve Number
C2+C4	0.211	80
E5+E6	0.068	82
E3+E7	0.556	71
E (E1+E2+E3+E4+E5+E6+E7)	0.827	73

Subwatershed/Reach	Elevation Drop, H (ft)	Subwatershed Length, L (ft)	Slope, s (ft/ft)	Velocity, V (ft/s)	Initial Time (sec)	Time of Concentration, t _c (hr)	Lag time, TLAG (hr)	Lag time, TLAG (min)
B1/Reach Across B1	142	775	0.183	2.980	600	0.2	0.1	9
B2/Reach Across B2	18	2265	0.008	0.621	600	1.2	0.7	42
B3	25	3300	0.008	0.606	600	1.7	1.0	60
C1/Reach Across C1	75	2400	0.031	1.231	600	0.7	0.4	26
C2+C4	274	6475	0.042	1.432	600	1.4	0.9	51
C3	102	2015	0.051	1.566	600	0.5	0.3	19
E1	260	2610	0.100	2.197	600	0.5	0.3	18
E2	272	2410	0.113	2.339	600	0.5	0.3	16
E3	39	650	0.060	1.705	600	0.3	0.2	10
E4	42	1995	0.021	1.010	600	0.7	0.4	26
E5	150	2075	0.072	1.872	600	0.5	0.3	17
E6	245	3435	0.071	1.859	600	0.7	0.4	24
E7	1098	9100	0.121	2.418	600	1.2	0.7	44



Subwatershed/Reach	Elevation Drop, H (ft)	Subwatershed Length, L (ft)	Slope, s (ft/ft)	Velocity, V (ft/s)	Time of Concentration, t _c (hr)	Lag time, TLAG (hr)	Lag time, TLAG (min)
Reach Across E1	67	1545	0.043	1.450	0.3	0.2	11
E5+E6	245	3435	0.071	1.859	0.5	0.3	18
Reach Across E4	42	755	0.056	1.642	0.1	0.1	5
Reach Across E7	101	3300	0.031	1.218	0.8	0.5	27
E3+E7	1098	9100	0.121	2.418	1.0	0.6	38

Watershed	Culvert	100-yr, 24-hr Peak Flow for Proposed Conditions Without Attenuation (cfs)	Culvert Diameter, D (ft)	Head Acting on Centerline, h (ft)	Head Above Top of Culvert (ft)
B	Culvert B2-B1	107.2	3.50	5.01	3.26
	Culvert B3-B2	35.9	2.00	5.27	4.27
C	Culvert C2-C1	123.5	3.75	5.05	3.18
E	Culvert E5-E4	69.5	2.50	8.10	6.85
	Culvert E4-E7	106.7	3.00	9.20	7.70



Culvert	Culvert Chart	Culvert Scale	Culvert Length (ft)	Culvert Inlet Elevation (ft)	Culvert Entrance Coefficient	Culvert Outlet Elevation (ft)	Culvert Exit Coefficient	Manning's n
Culvert B2-B1	1: Concrete Pipe Culvert	1: Square edge entrance with headwall	50	5114	1.0	5114	1.0	0.012
Culvert B3-B2	1: Concrete Pipe Culvert	1: Square edge entrance with headwall	50	5112	1.0	5112	1.0	0.012
Culvert C2-C1	1: Concrete Pipe Culvert	1: Square edge entrance with headwall	133	5028	1.0	5028	1.0	0.012
Culvert E5-E4	1: Concrete Pipe Culvert	1: Square edge entrance with headwall	46	5117	1.0	5117	1.0	0.012
Culvert E4-E7	1: Concrete Pipe Culvert	1: Square edge entrance with headwall	46	5079	1.0	5079	1.0	0.012
Culvert E7-E1 (Backbone)	9: Flared Wingwalls and Top Edge Bevel	1: Wingwall flared 45 deg; inlet top edge	110	4982	1.0	4982	1.0	0.012

Proposed Pond	Contour Elevation (ft)	Incremental Area (sq ft)	Area within Contour (sq ft)
Upstream of Culvert B2-B1	5,114	5,051	5,051
	5,116	9,166	14,217
	5,118	3,347	17,564
	5,120	3,621	21,185
	5,122	3,895	25,080
Upstream of Culvert B3-B2	5,112	2,855	2,855
	5,114	4,799	7,654
	5,116	2,347	10,001
	5,118	2,634	12,635
	5,120	2,922	15,557
Upstream of Culvert C2-C1	5,028	838	838
	5,030	3,384	4,222
	5,032	6,026	10,248
	5,034	9,673	19,921
	5,036	12,595	32,516
Upstream of Culvert E5-E4	5,117	694	694
	5,119	1,801	2,495
	5,121	2,944	5,440
	5,123	3,265	8,705
	5,125	3,771	12,476
	5,127	4,674	17,150
	5,129	5,417	22,567
Upstream of Culvert E4-E7	5,079	14,941	14,941
	5,081	6,096	21,037
	5,083	8,164	29,202
	5,085	8,483	37,685
	5,087	7,731	45,416
	5,089	7,644	53,060
Upstream of Culvert E7-E1 (Backbone)	4,982	1,379	1,379
	4,984	3,417	4,796
	4,986	6,149	10,945
	4,988	9,038	19,983
	4,990	11,893	31,876
	4,992	15,203	47,079
	4,994	17,360	64,439
	4,996	17,519	81,958
	4,998	18,150	100,108



Existing Conditions and Proposed Conditions – Results:

Watershed	Location	Existing Conditions		Proposed Conditions			
		Peak Discharge (cfs)		Peak Discharge (cfs)			
		5-yr, 24-hr Storm Event	100-yr, 24-hr Storm Event	5-yr, 24-hr Storm Event		100-yr, 24-hr Storm Event	
				Without Attenuation (Without Culverts/Ponds)	With Attenuation (With Culverts/Ponds)	Without Attenuation (Without Culverts/Ponds)	With Attenuation (With Culverts/Ponds)
A	Watershed A outlet	0.6	16.2				
B	Culvert B3-B2	-	-	12.6	11.8	35.9	28.9
	Culvert B2-B1	-	-	38.3	27.6	107.2	70.6
	Watershed B outlet	3.1	42.8	38.5	27.9	107.7	71.5
C	Culvert C2-C1	-	-	35.7	35.4	123.5	108.1
	Watershed C outlet	16.2	117.0	41.4	40.2	147.1	117.3
D	Watershed D outlet	9.9	60.0				
E	Culvert E5-E4	-	-	19.4	18.0	69.5	52.3
	Culvert E4-E7	-	-	38.2	19.8	106.7	57.8
	Culvert E7-E1 (Backbone)	-	-	77.9	59.3	344.1	237.2
	Watershed E outlet	47.6	268.8	82.4	63.6	356.8	244.8



RipRap Sizing Calculations

RipRap Calculations

Storm Drain	Station / Location	Diam. (in)	D _o (ft)	Q ₁₀₀ (cfs)	L _a (ft)	d ₅₀ (ft)	W (ft)	Thickness
Culvert C	48+20	2-49"x32"	8.2	117	15	0.2	39.6	0.4
Culvert D	41+45	2-36"	3	60	19	0.6	28	1.2
Culvert E	28+20	24	2	19	12	0.42	18	0.84
Culvert F	20+20	24	2	23.1	14	0.45	20	0.9
N	219+60	18	1.5	16.6	10	0.35	14.5	0.7
O	239+30	36	3	10.1	5	0.3	14	0.6
Culvert G	Warrior Lane	12	1	7.4	12	0.45	15	0.9
Culvert I	I-80 E. Entrance	12	1	1.6	6	0.2	9	0.4
Culvert J	existing 24" SD	existing storm drain & riprap						
Ditch S of I-80E entrance	existing 48" SD	48"	1.7	268.8			5.1	0

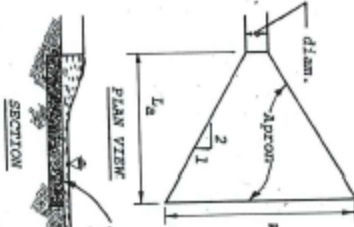
*For poorly defined channels, it is assumed that $TW < D_o / 2$.

L_a = length of outlet protection
d₅₀ = median stone diameter
W = width of riprap outlet

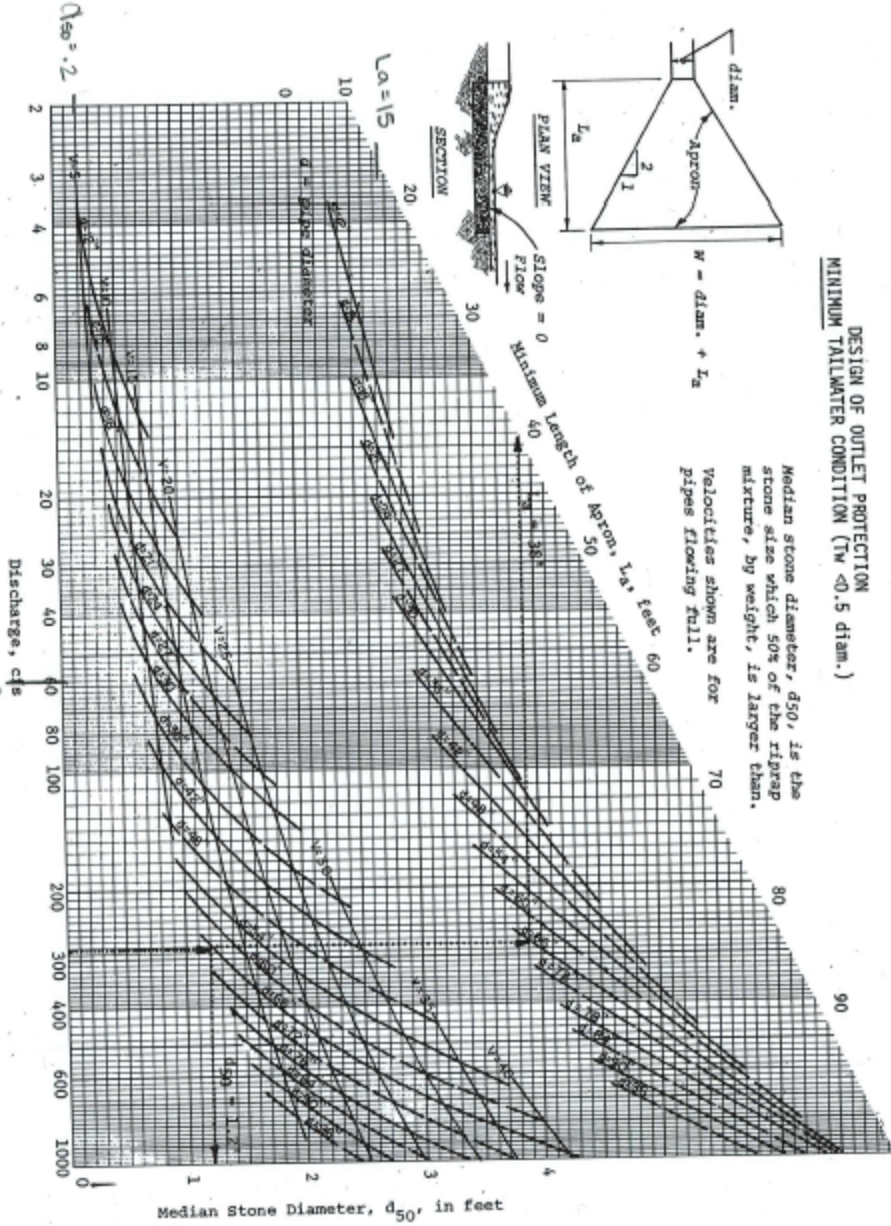
DESIGN OF OUTLET PROTECTION
MINIMUM TAILWATER CONDITION ($T_w < 0.5$ diam.)

Median stone diameter, d_{50} , is the stone size which 50% of the riprap mixture, by weight, is larger than. Velocities shown are for pipes flowing full.

$$W = \text{diam.} + L_a$$



Minimum length of Apron, L_a , feet
50 60 70 80 90



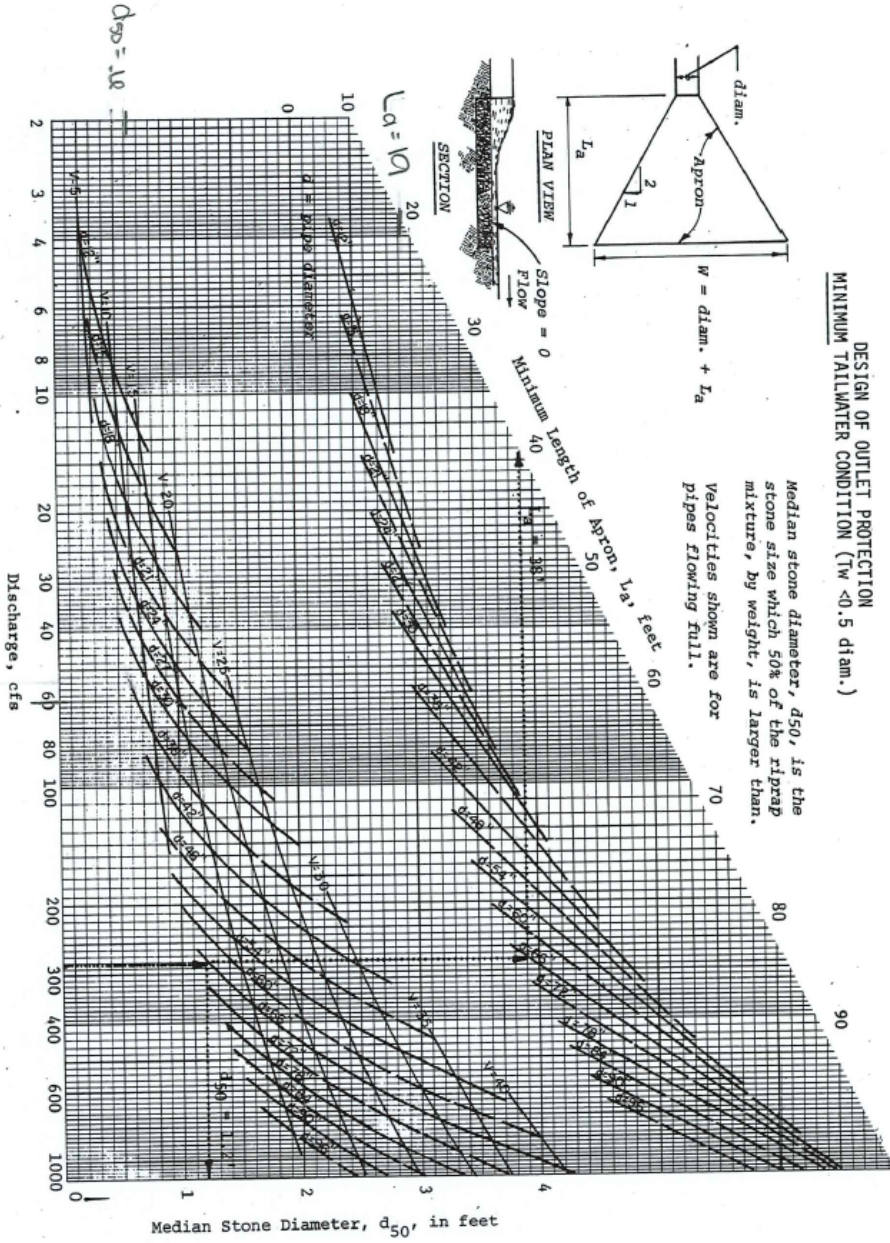
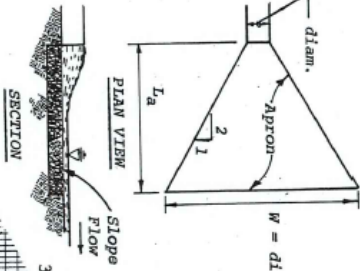
CONVERT D

DESIGN OF OUTLET PROTECTION
MINIMUM TAILWATER CONDITION ($T_w < 0.5$ diam.)

Median stone diameter, d_{50} , is the stone size which 50% of the riprap mixture, by weight, is larger than. Velocities shown are for pipes flowing full.

$$W = \text{diam.} + L_a$$

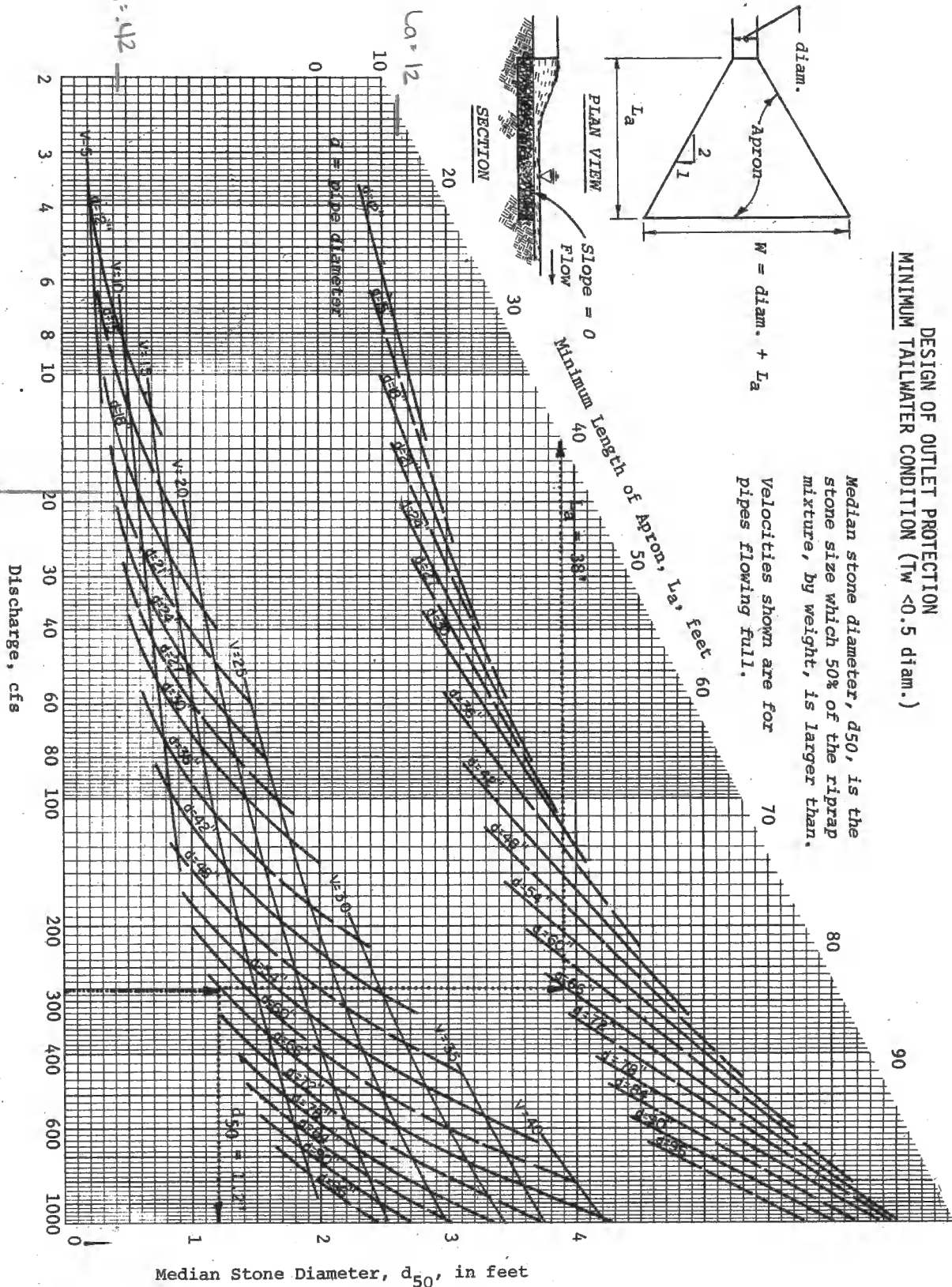
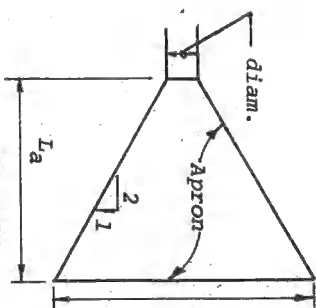
Minimum Length of Apron, L_a , feet



DESIGN OF OUTLET PROTECTION MINIMUM TAILWATER CONDITION ($T_w < 0.5$ diam.)

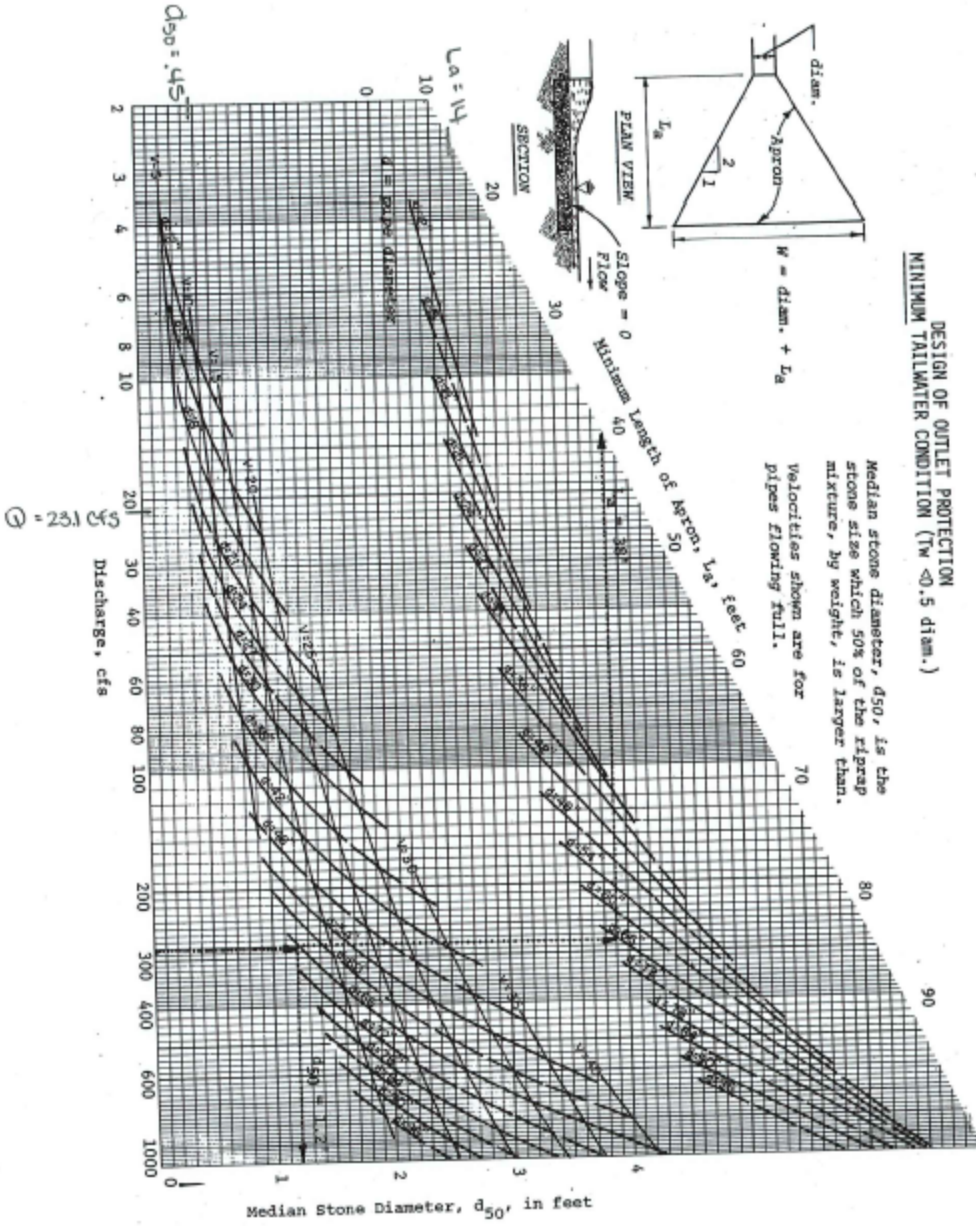
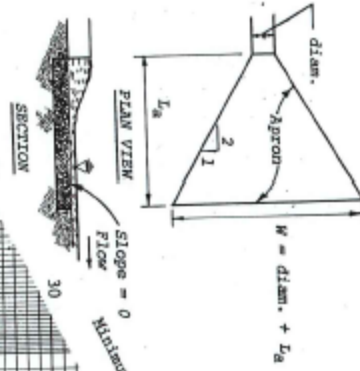
Median stone diameter, d_{50} , is the stone size which 50% of the riprap mixture, by weight, is larger than.

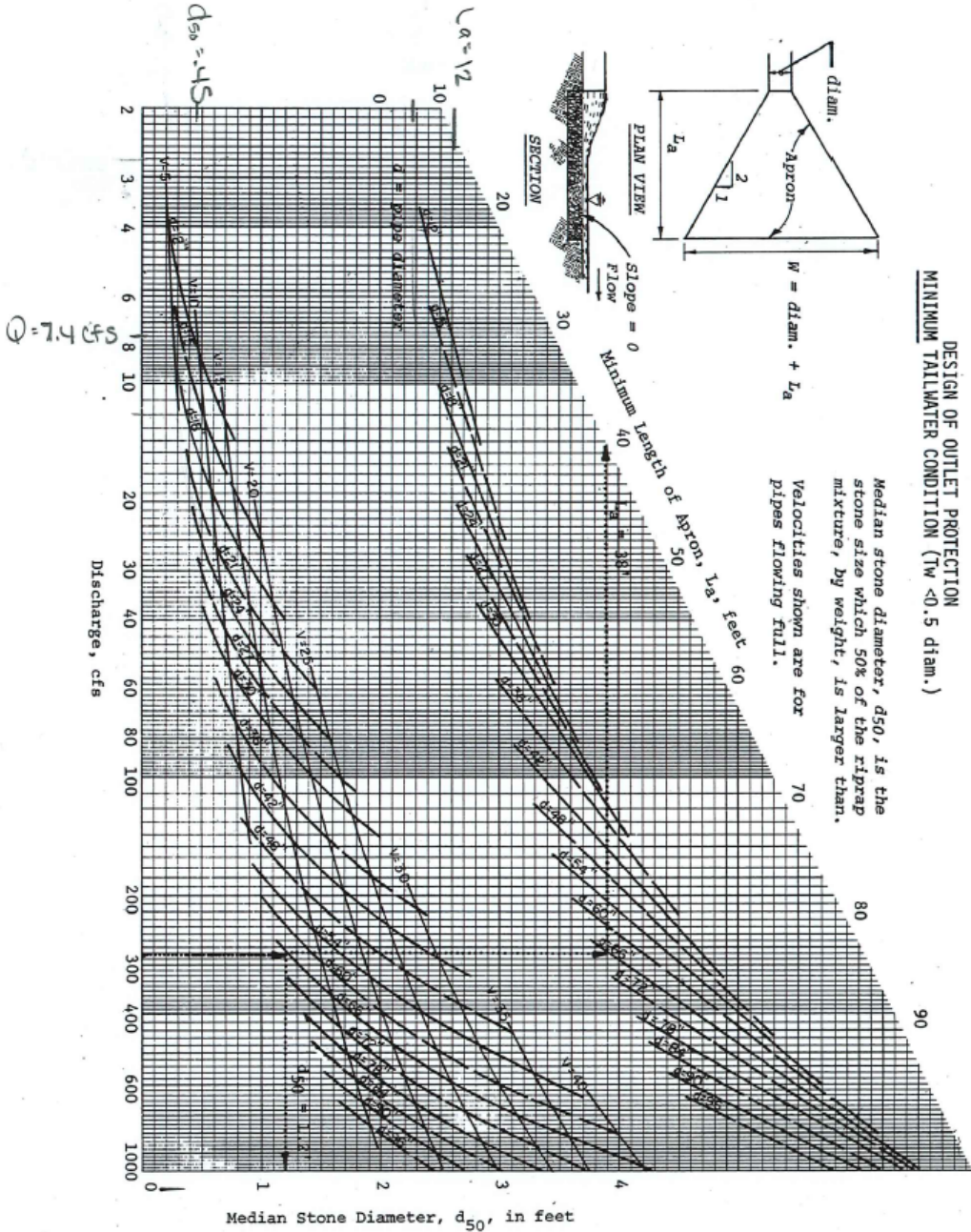
Velocities shown are for pipes flowing full.



DESIGN OF OUTLET PROTECTION MINIMUM TAILWATER CONDITION ($V_w < 0.5$ diam.)

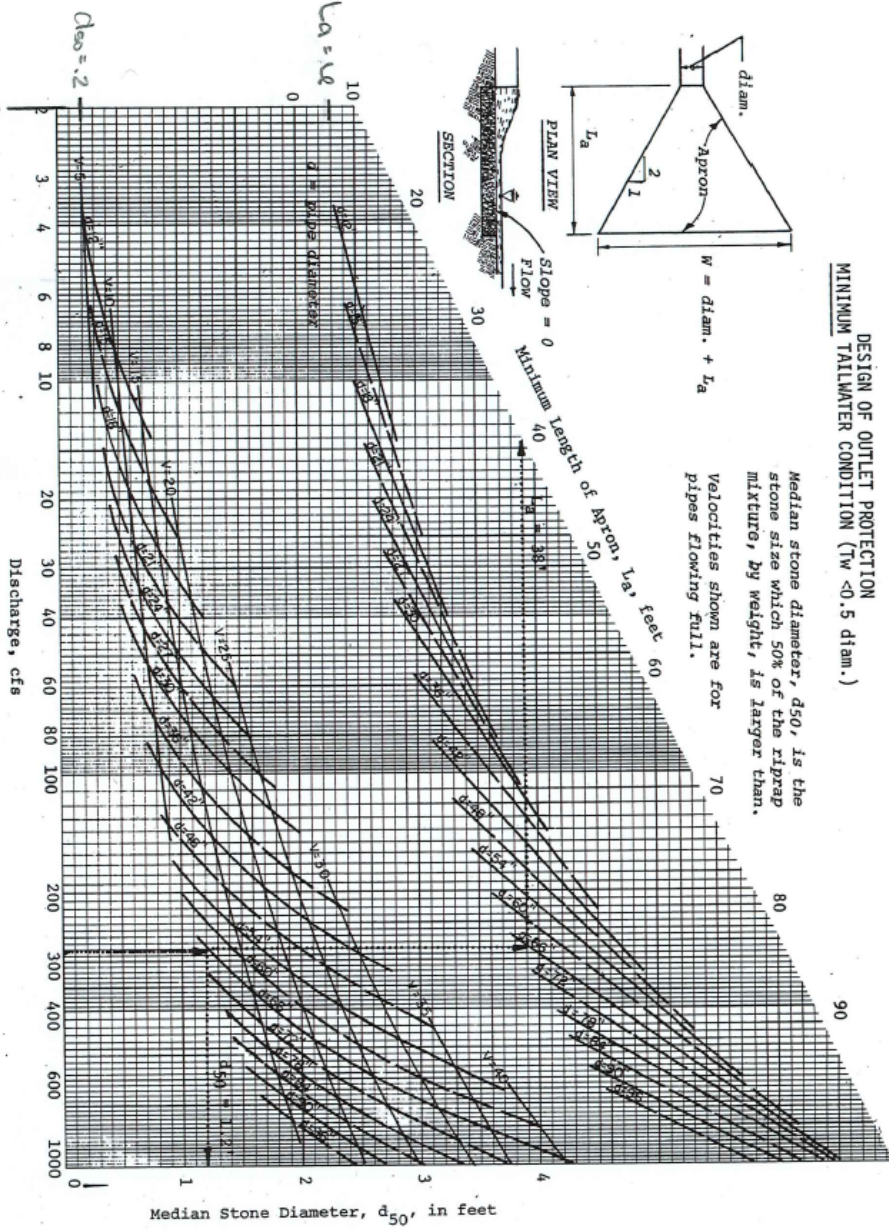
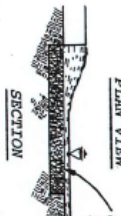
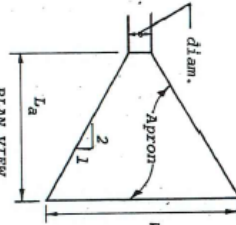
Median stone diameter, d_{50} , is the stone size which 50% of the riprap mixture, by weight, is larger than. Velocities shown are for pipes flowing full.



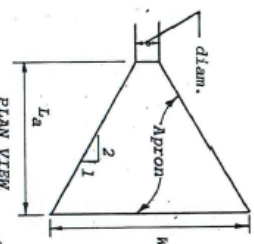


DESIGN OF OUTLET PROTECTION
MINIMUM TAILWATER CONDITION ($T_w < 0.5 \text{ diam.}$)

Median stone diameter, d_{50} , is the stone size which 50% of the riprap mixture, by weight, is larger than. Velocities shown are for pipes flowing full.

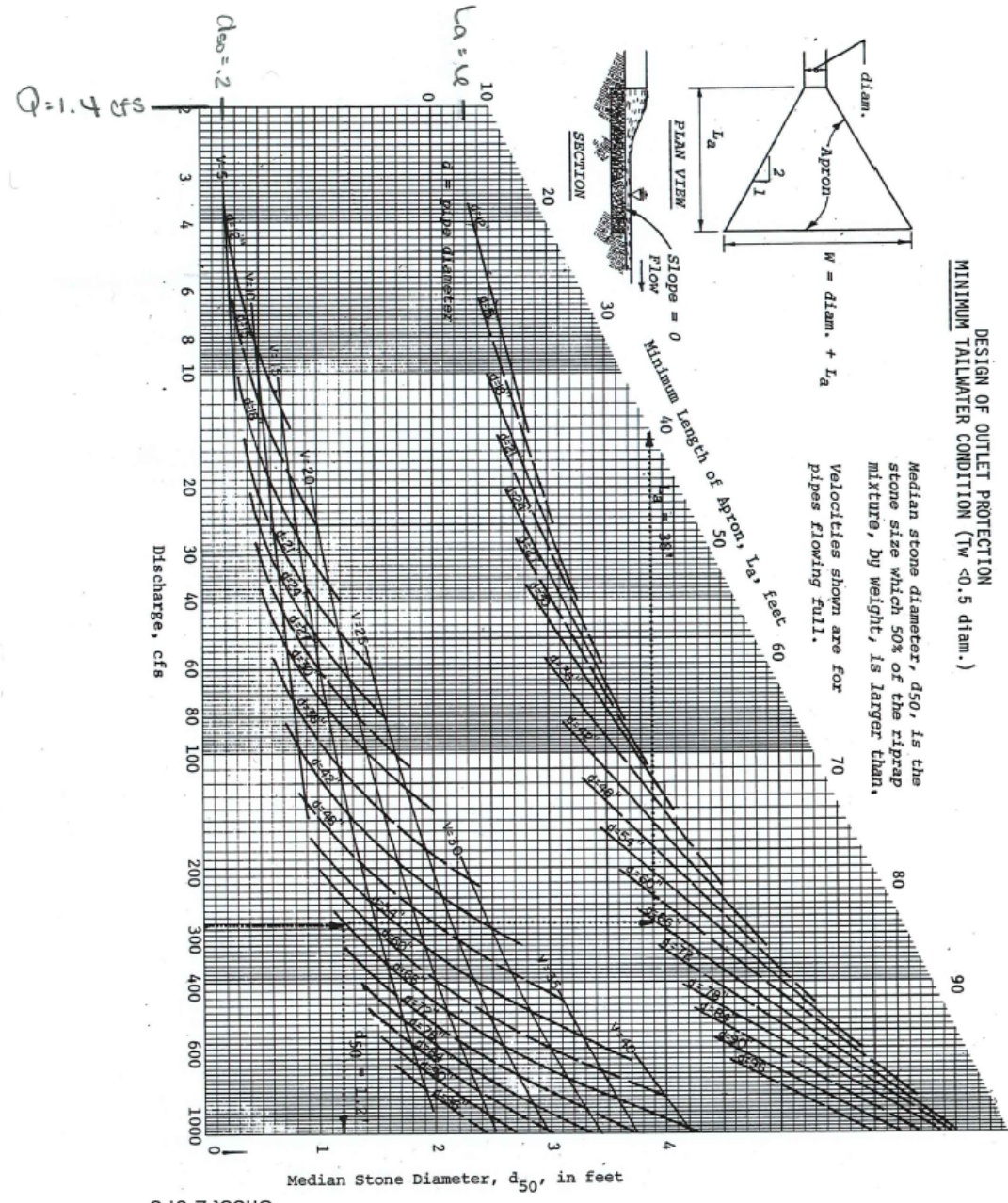


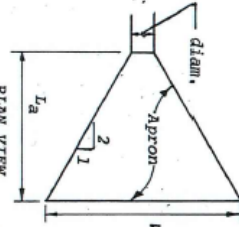
CULVERT 5



DESIGN OF OUTLET PROTECTION
 MINIMUM TAILWATER CONDITION ($T_w < 0.5$ diam.)

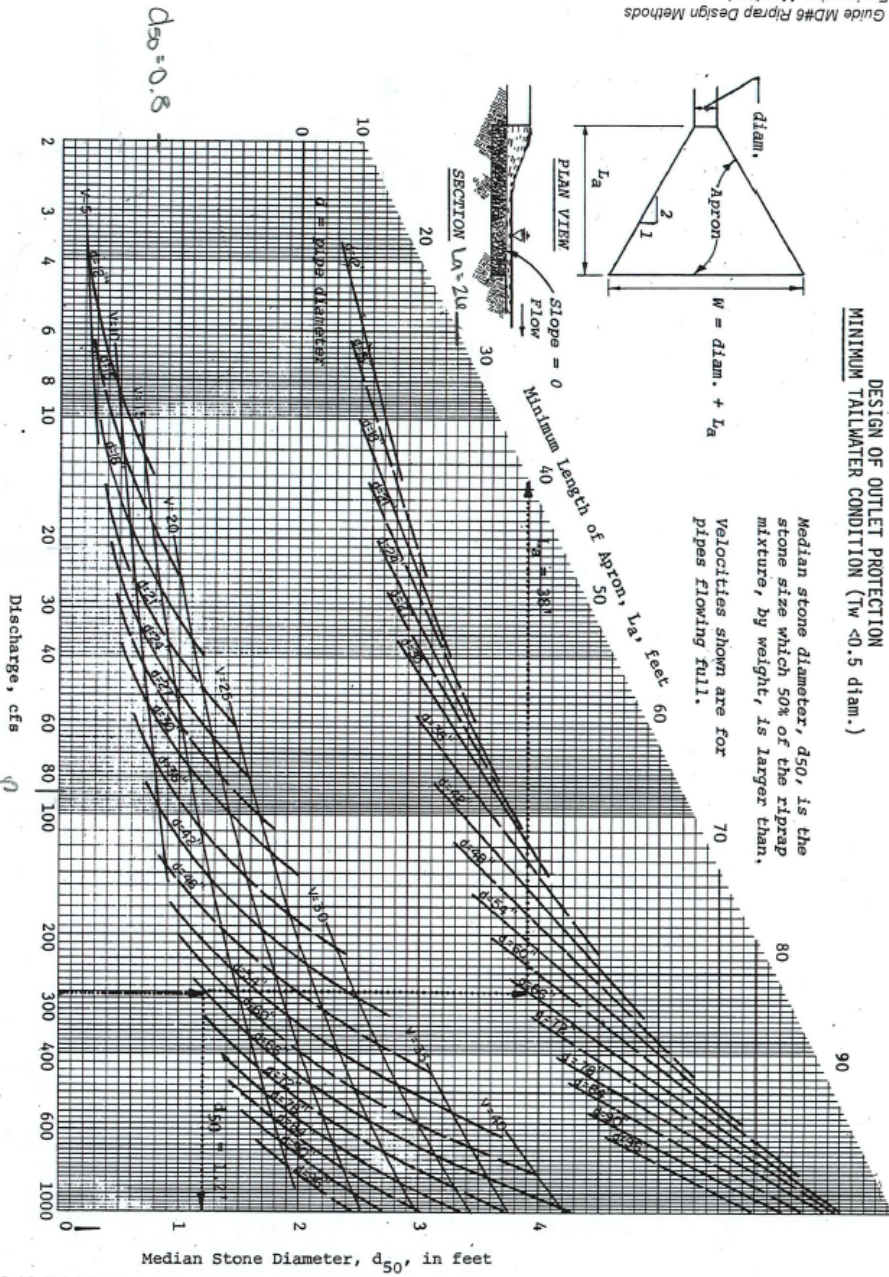
Median stone diameter, d_{50} , is the stone size which 50% of the riprap mixture, by weight, is larger than. Velocities shown are for pipes flowing full.





DESIGN OF OUTLET PROTECTION
MINIMUM TAILWATER CONDITION ($T_w < 0.5$ diam.)

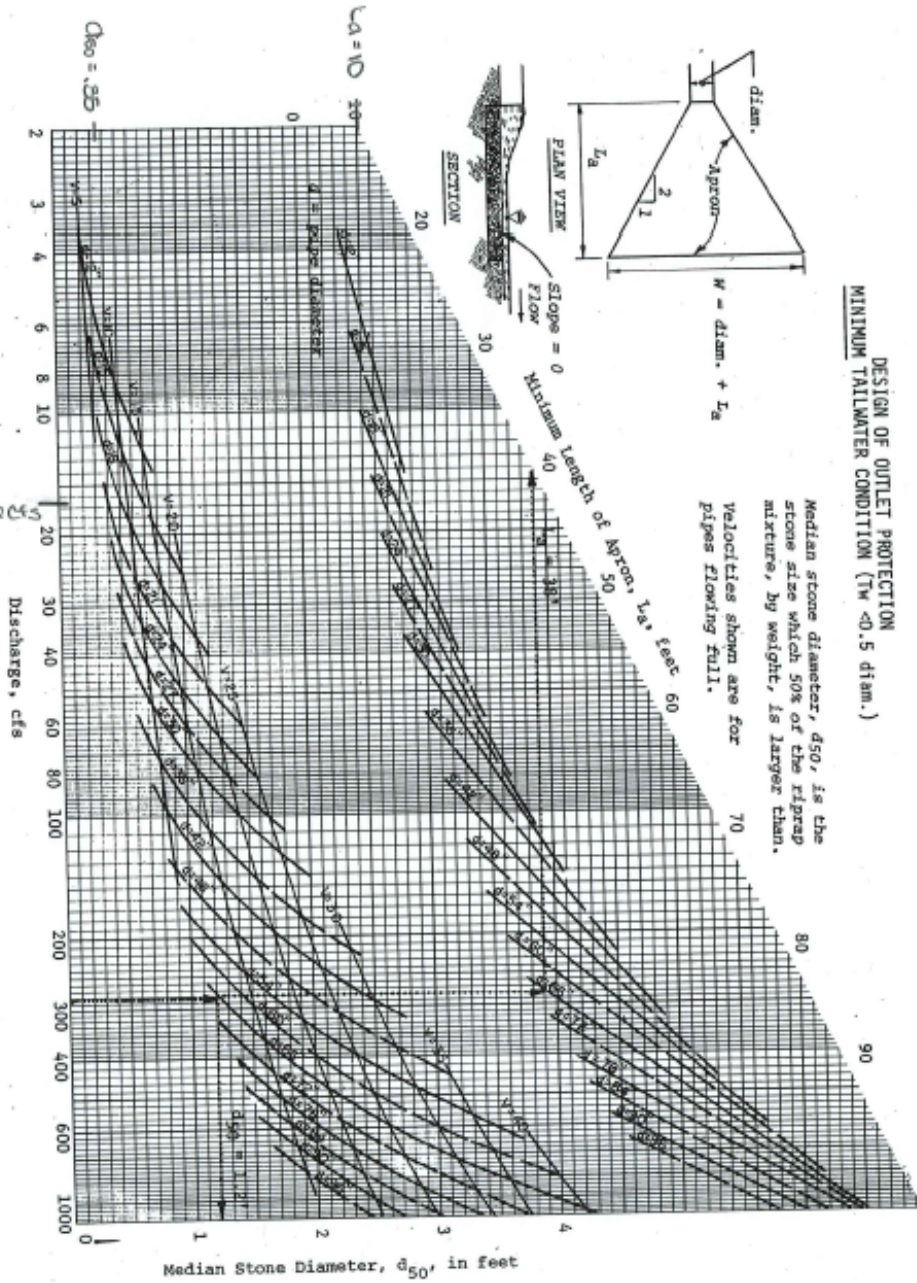
Median stone diameter, d_{50} , is the stone size which 50% of the riprap mixture, by weight, is larger than. Velocities shown are for pipes flowing full.



DESIGN OF OUTLET PROTECTION
MINIMUM TAILWATER CONDITION ($T_w < 0.5$ diam.)



Median stone diameter, d_{50} , is the stone size which 50% of the riprap mixture, by weight, is larger than. Velocities shown are for pipes flowing full.



Storm Drain D

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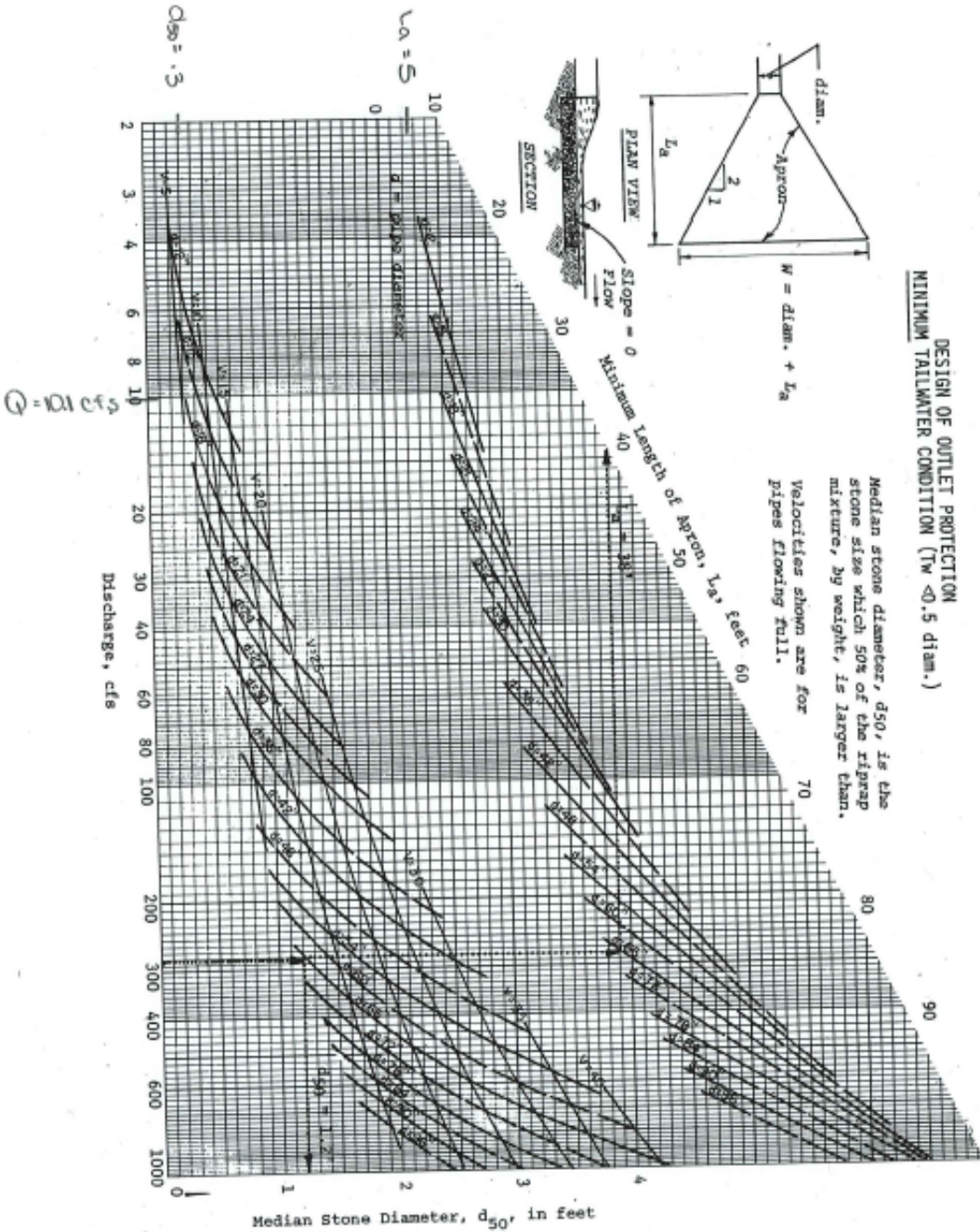
DESIGN OF OUTLET PROTECTION MINIMUM TAILWATER CONDITION ($T_w < 0.5$ diam.)



Median stone diameter, d_{50} , is the stone size which 50% of the riprap mixture, by weight, is larger than. Velocities shown are for pipes flowing full.



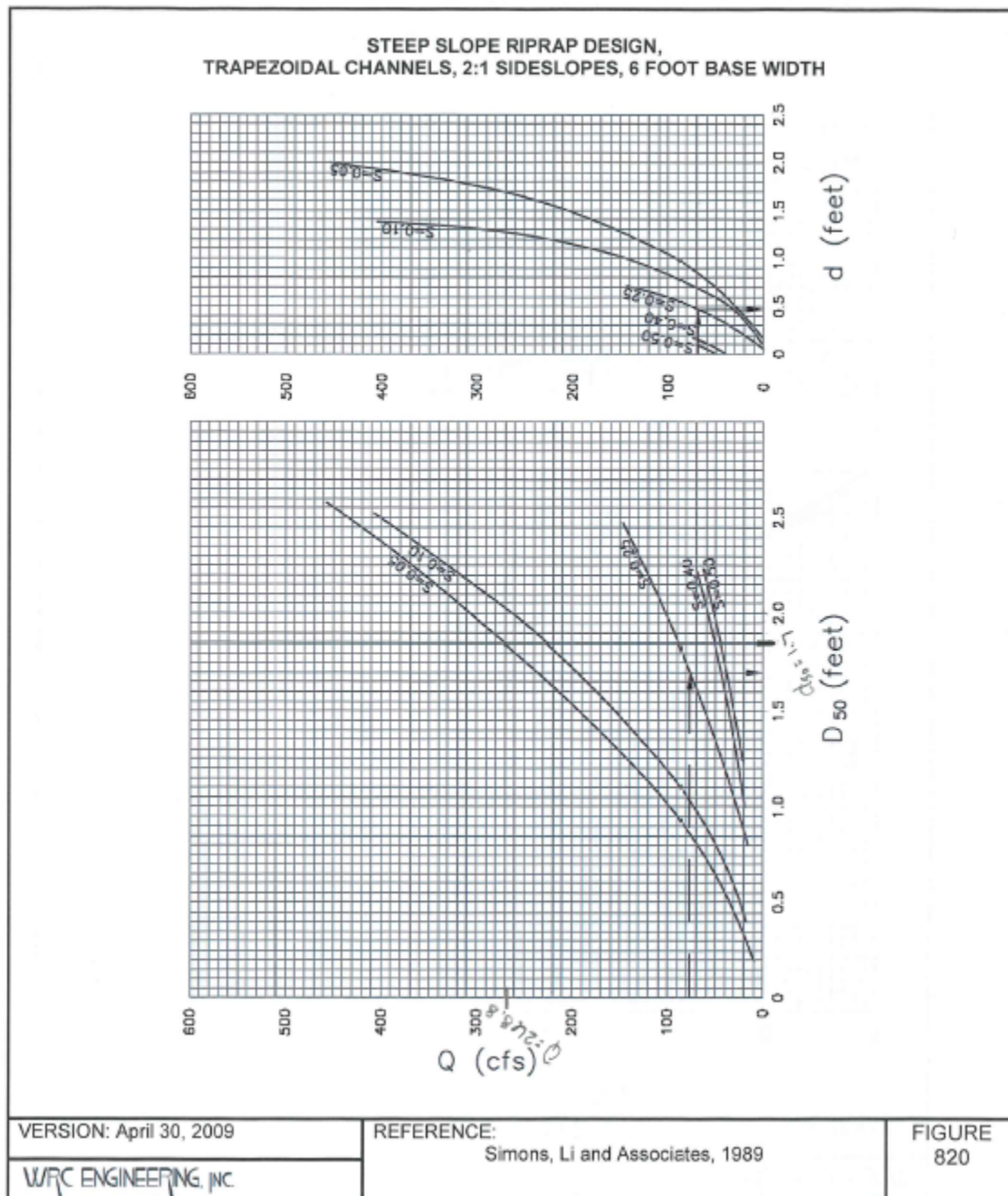
Minimum Length of Apron, L_a , feet



Sheet 2 of 3



Ditch South of I-80 East Entrance:



FlowMaster Results

Backbone Road																		
Station	Inlet Name	SD Diam (in)	Roadway Type	Q _s	Q ₁₀₀	Approach Gutter Depth _s (in)	Velocity _s (ft/s)	DV _s (ft ² /s)	Spread _s (ft)	Approach Gutter Depth ₁₀₀ (in)	Velocity ₁₀₀ (ft/s)	DV ₁₀₀ (ft ² /s)	Spread ₁₀₀ (ft)	Inlet Size	Inlet Type	Clogging	Bypass Q ₁₀₀	Bypass Q _s
239+25.00	O.1	24	Collector	1.4	6.1	2.7	9.02	2.0	1.7	4.7	11.68	4.6	4.8	2'x6'	high capacity	0%	0.25	0
239+25.00	O.2	24	Collector	1.4	6.1	2.7	9.02	2.0	1.7	4.7	11.68	4.6	4.8	2'x6'	high capacity	0%	0.25	0

Roundabout																		
Station	Inlet Name	SD Diam (in)	Roadway Type	Q _s	Q ₁₀₀	Approach Gutter Depth _s (in)	Velocity _s (ft/s)	DV _s (ft ² /s)	Spread _s (ft)	Approach Gutter Depth ₁₀₀ (in)	Velocity ₁₀₀ (ft/s)	DV ₁₀₀ (ft ² /s)	Spread ₁₀₀ (ft)	Inlet Size	Inlet Type	Clogging	Bypass Q ₁₀₀	Bypass Q _s
21+64	P.3	12	Collector	0.7	2.1	2.7	4.5	1.0	1.4	4.1	5.9	2.0	2.6	2'x3'	4-R	50%	0	0
20+23	P.4	12	Collector	0.7	2.1	2.7	4.5	1.0	1.4	4.1	5.9	2.0	2.6	2'x3'	4-R	50%	0	0
15+95	P.5	12	Collector	1.7	4.3	3.4	-	-	8.2	5.2	-	-	15.7	2'x6'	high capacity	50%	0	0
15+95	P.6	12	Collector	0.33	1	2	4.2	0.7	1	2.6	7.1	1.5	1.3	2'x3'	4-R	0%	0	0

Grate Inlet On Grade (Ph1A Inlets 100 yr Flow.fm8)

Label	Solve For	Discharge (cfs)	Slope (ft/ft)	Gutter Width (ft)	Gutter Cross Slope (ft/ft)
O.1 (Sta. 239+25.00)	Efficiency	6.10	0.080	2.00	0.166
O.2 (Sta. 239+25.00)	Efficiency	6.10	0.080	2.00	0.166
Road Cross Slope (ft/ft)	Manning Coefficient	Efficiency (%)	Grate Width (ft)	Grate Length (ft)	Grate Type
0.020	0.013	95.85	2.00	6.0	P-50 mm (P-1- 7/8")
0.020	0.013	95.85	2.00	6.0	P-50 mm (P-1- 7/8")
Clogging (%)	Intercepted Flow (cfs)	Bypass Flow (cfs)	Spread (ft)	Depth (in)	Flow Area (ft²)
0.0	5.85	0.25	4.8	4.7	0.5
0.0	5.85	0.25	4.8	4.7	0.5
Gutter Depression (in)	Total Depression (in)	Velocity (ft/s)	Splash Over Velocity (ft/s)	Frontal Flow Factor	Side Flow Factor
3.5	3.5	11.68	15.04	1.000	0.090
3.5	3.5	11.68	15.04	1.000	0.090
Grate Flow Ratio	Active Grate Length (ft)	Grate Flow Option	Notes	Messages	

0.954 6.0 Exclude None

Grate Length
should be within
the defined
range of HEC-
22's Chart 5
(approx. 0.5-4.5
ft / 0.15-1.35
m).

0.954 6.0 Exclude None

Grate Length
should be within
the defined
range of HEC-
22's Chart 5
(approx. 0.5-4.5
ft / 0.15-1.35
m).

Grate Inlet On Grade (Roundabout Inlets 100 yr Flow.fm8)

Label	Solve For	Discharge (cfs)	Slope (ft/ft)	Gutter Width (ft)	Gutter Cross Slope (ft/ft)
Grate Inlet On Grade - P.3	Efficiency	2.10	0.030	2.00	0.166
Grate Inlet On Grade - P.4	Efficiency	2.10	0.030	2.00	0.166
Grate Inlet On Grade - P.6	Efficiency	1.00	0.080	2.00	0.166
Road Cross Slope (ft/ft)	Manning Coefficient	Efficiency (%)	Grate Width (ft)	Grate Length (ft)	Grate Type
0.020	0.016	99.91	2.00	3.0	P-50 mm (P-1- 7/8")
0.020	0.016	99.91	2.00	3.0	P-50 mm (P-1- 7/8")
0.020	0.016	100.00	2.00	3.0	P-50 mm (P-1- 7/8")
Clogging (%)	Intercepted Flow (cfs)	Bypass Flow (cfs)	Spread (ft)	Depth (in)	Flow Area (ft ²)
50.0	2.10	0.00	2.6	4.1	0.4
50.0	2.10	0.00	2.6	4.1	0.4
0.0	1.00	0.00	1.3	2.6	0.1
Gutter Depression (in)	Total Depression (in)	Velocity (ft/s)	Splash Over Velocity (ft/s)	Frontal Flow Factor	Side Flow Factor
3.5	3.5	5.88	6.99	1.000	0.014
3.5	3.5	5.88	6.99	1.000	0.014
3.5	3.5	7.10	9.97	1.000	0.047
Grate Flow Ratio	Active Grate Length (ft)	Grate Flow Option	Notes	Messages	
0.999	1.5	Exclude None			
0.999	1.5	Exclude None			
1.000	3.0	Exclude None		Grate Length should be within the defined range of HEC- 22's Chart 5 (approx. 0.5-4.5 ft / 0.15-1.35 m).	

Grate Inlet In Sag (Roundabout Inlets 100 yr Flow.fm8)

Label	Solve For	Discharge (cfs)	Spread (ft)	Gutter Width (ft)	Gutter Cross Slope (ft/ft)
Grate Inlet In Sag - P.5	Spread	4.30	15.7	2.00	0.080
Road Cross Slope (ft/ft)	Grate Width (ft)	Grate Length (ft)	Local Depression (in)	Local Depression Width (in)	Grate Type
0.020	2.00	6.0	2.0	24.0	P-50 mm (P-1- 7/8")
Clogging (%)	Depth (in)	Gutter Depression (in)	Total Depression (in)	Open Grate Area (ft²)	Active Grate Weir Length (ft)
50.0	5.2	1.4	3.4	5.4	8.0
Notes	Messages				

Grate Inlet On Grade (Ph1A Inlets 5 yr Flow.fm8)

Label	Solve For	Discharge (cfs)	Slope (ft/ft)	Gutter Width (ft)	Gutter Cross Slope (ft/ft)
O.1 (Sta. 239+25.00)	Efficiency	1.40	0.080	2.00	0.166
O.2 (Sta. 239+25.00)	Efficiency	1.40	0.080	2.00	0.166
Road Cross Slope (ft/ft)	Manning Coefficient	Efficiency (%)	Grate Width (ft)	Grate Length (ft)	Grate Type
0.020	0.013	100.00	2.00	6.0	P-50 mm (P-1- 7/8")
0.020	0.013	100.00	2.00	6.0	P-50 mm (P-1- 7/8")
Clogging (%)	Intercepted Flow (cfs)	Bypass Flow (cfs)	Spread (ft)	Depth (in)	Flow Area (ft²)
0.0	1.40	0.00	1.4	2.7	0.2
0.0	1.40	0.00	1.4	2.7	0.2
Gutter Depression (in)	Total Depression (in)	Velocity (ft/s)	Splash Over Velocity (ft/s)	Frontal Flow Factor	Side Flow Factor
3.5	3.5	9.02	15.04	1.000	0.135
3.5	3.5	9.02	15.04	1.000	0.135
Grate Flow Ratio	Active Grate Length (ft)	Grate Flow Option	Notes	Messages	

1.000 6.0 Exclude None

1.000 6.0 Exclude None

Grate Length
should be within
the defined
range of HEC-
22's Chart 5
(approx. 0.5-4.5
ft / 0.15-1.35
m).
Grate Length
should be within
the defined
range of HEC-
22's Chart 5
(approx. 0.5-4.5
ft / 0.15-1.35
m).

Grate Inlet On Grade (Roundabout Inlets 5 yr Flow.fm8)

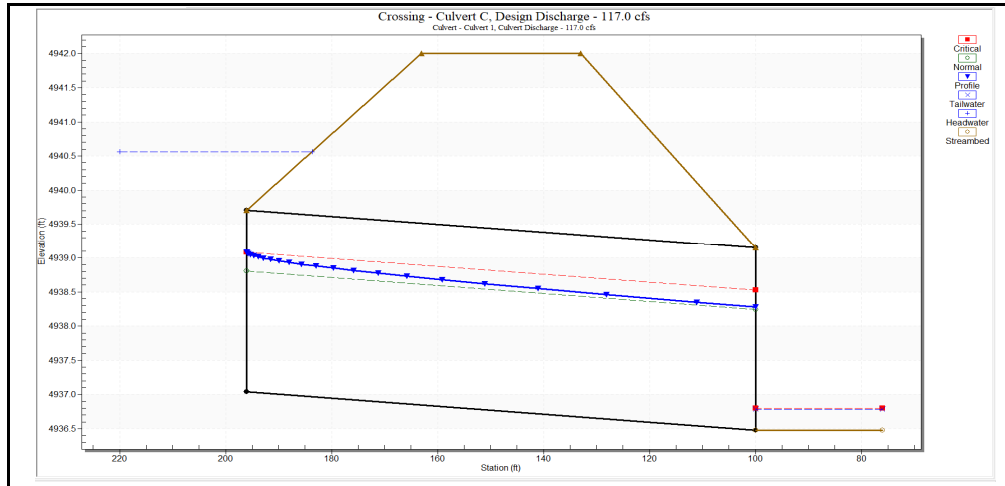
Label	Solve For	Discharge (cfs)	Slope (ft/ft)	Gutter Width (ft)	Gutter Cross Slope (ft/ft)
Grate Inlet On Grade - P.3	Efficiency	0.70	0.030	2.00	0.166
Grate Inlet On Grade - P.4	Efficiency	0.70	0.030	2.00	0.166
Grate Inlet On Grade - P.6	Efficiency	0.33	0.040	2.00	0.166
Road Cross Slope (ft/ft)	Manning Coefficient	Efficiency (%)	Grate Width (ft)	Grate Length (ft)	Grate Type
0.020	0.016	100.00	2.00	3.0	P-50 mm (P-1- 7/8")
0.020	0.016	100.00	2.00	3.0	P-50 mm (P-1- 7/8")
0.020	0.016	100.00	2.00	3.0	P-50 mm (P-1- 7/8")
Clogging (%)	Intercepted Flow (cfs)	Bypass Flow (cfs)	Spread (ft)	Depth (in)	Flow Area (ft ²)
50.0	0.70	0.00	1.4	2.7	0.2
50.0	0.70	0.00	1.4	2.7	0.2
0.0	0.33	0.00	1.0	2.0	0.1
Gutter Depression (in)	Total Depression (in)	Velocity (ft/s)	Splash Over Velocity (ft/s)	Frontal Flow Factor	Side Flow Factor
3.5	3.5	4.49	6.99	1.000	0.022
3.5	3.5	4.49	6.99	1.000	0.022
3.5	3.5	4.15	9.97	1.000	0.114
Grate Flow Ratio	Active Grate Length (ft)	Grate Flow Option	Notes	Messages	
1.000	1.5	Exclude None			
1.000	1.5	Exclude None			
1.000	3.0	Exclude None		Grate Length should be within the defined range of HEC- 22's Chart 5 (approx. 0.5-4.5 ft / 0.15-1.35 m).	

Grate Inlet In Sag (Roundabout Inlets 5 yr Flow.fm8)

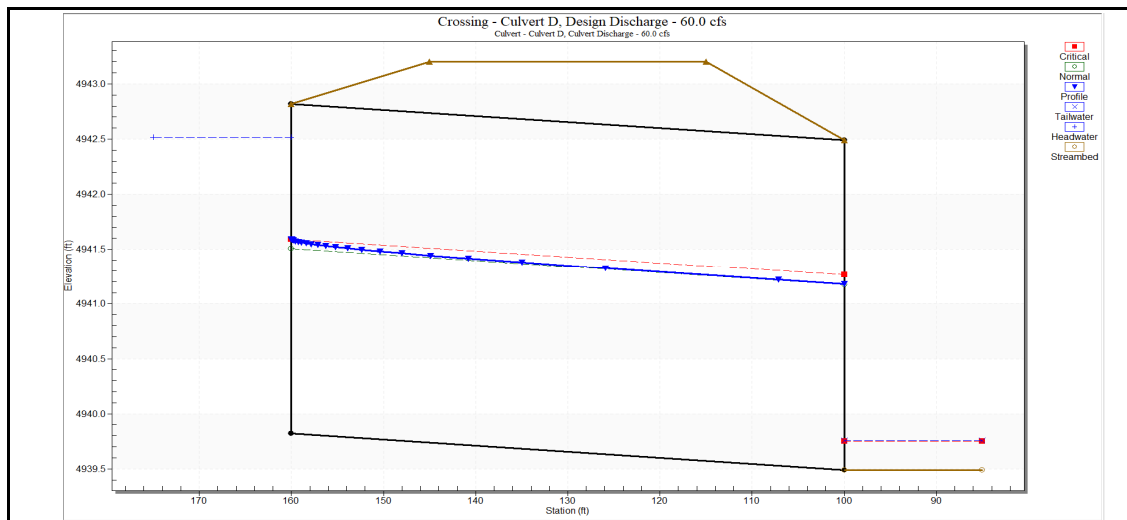
Label	Solve For	Discharge (cfs)	Spread (ft)	Gutter Width (ft)	Gutter Cross Slope (ft/ft)
Grate Inlet In Sag - P.5	Spread	1.70	8.2	2.00	0.080
Road Cross Slope (ft/ft)	Grate Width (ft)	Grate Length (ft)	Local Depression (in)	Local Depression Width (in)	Grate Type
0.020	2.00	6.0	2.0	24.0	P-50 mm (P-1- 7/8")
Clogging (%)	Depth (in)	Gutter Depression (in)	Total Depression (in)	Open Grate Area (ft²)	Active Grate Weir Length (ft)
50.0	3.4	1.4	3.4	5.4	8.0
Notes	Messages				

HY-8 Parameters and Results

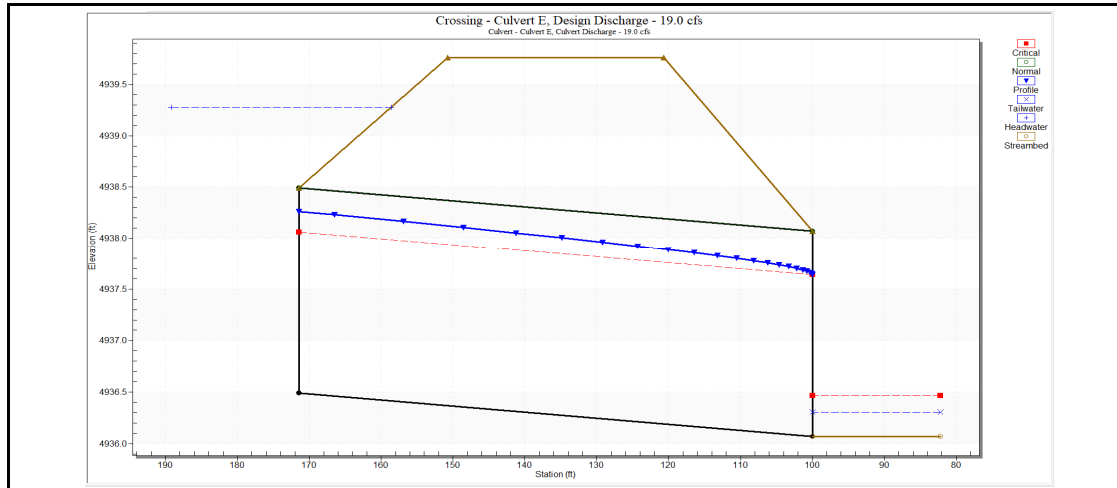
Culvert C (Station 48+20)										
Flow Event	Culvert Discharge (cfs)	Headwater Elevation (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Culvert Type	Culvert Size (in)	Riprap d_{50} (in)
5 year	16.20	4938.02	1-S2n	0.61	0.72	0.09	5.19	Elliptical	2 - 49x32	2.4
100 year	117.00	4940.56	5-S2n	1.76	2.04	0.31	9.19			



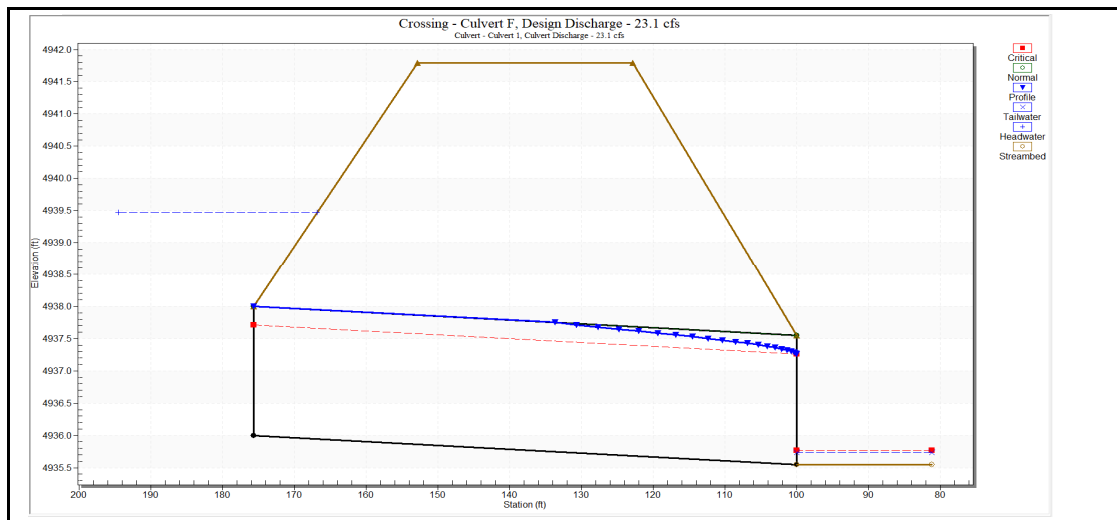
Culvert D (Station 41+50)										
Flow Event	Culvert Discharge (cfs)	Headwater Elevation (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Culvert Type	Culvert Size (in)	Riprap d_{50} (in)
5 year	9.90	4940.77	1-S2n	0.64	0.7	0.09	4.49	Circular	2 - 36"	7.2
100 year	60.00	4942.51	1-S2n	1.68	1.77	0.27	7.32			



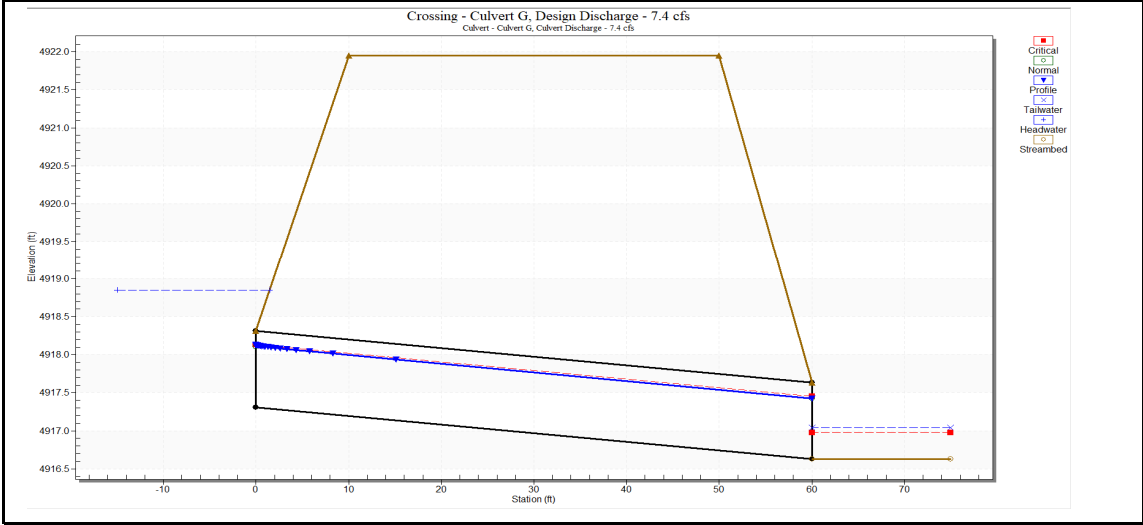
Culvert E (Station 28+20)										
Flow Event	Culvert Discharge (cfs)	Headwater Elevation (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Culvert Type	Culvert Size (in)	Riprap d ₅₀ (in)
5 year	9.90	4938.18	1-S2n	1.08	1.13	0.16	5.71	Circular	24	5
100 year	19.00	4939.28	7-M2c	2	1.57	0.23	7.19			



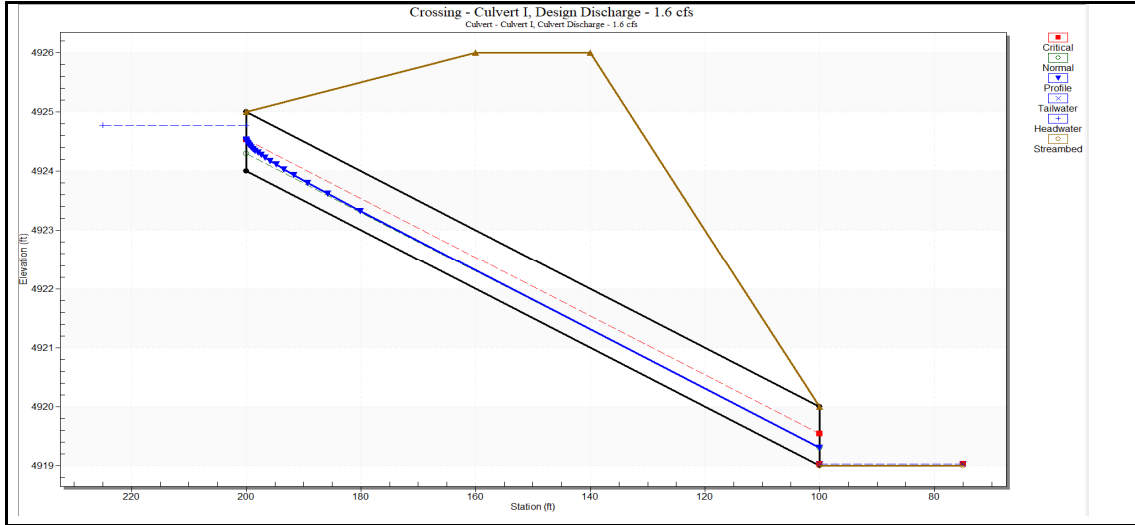
Culvert F (Station 20+20)										
Flow Event	Culvert Discharge (cfs)	Headwater Elevation (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Culvert Type	Culvert Size (in)	Riprap d ₅₀ (in)
5 year	4.80	4937.08	1-S2n	0.72	0.77	0.07	4.75	Circular	24	5.4
100 year	23.10	4939.47	7-M2c	2	1.71	0.18	8.08			



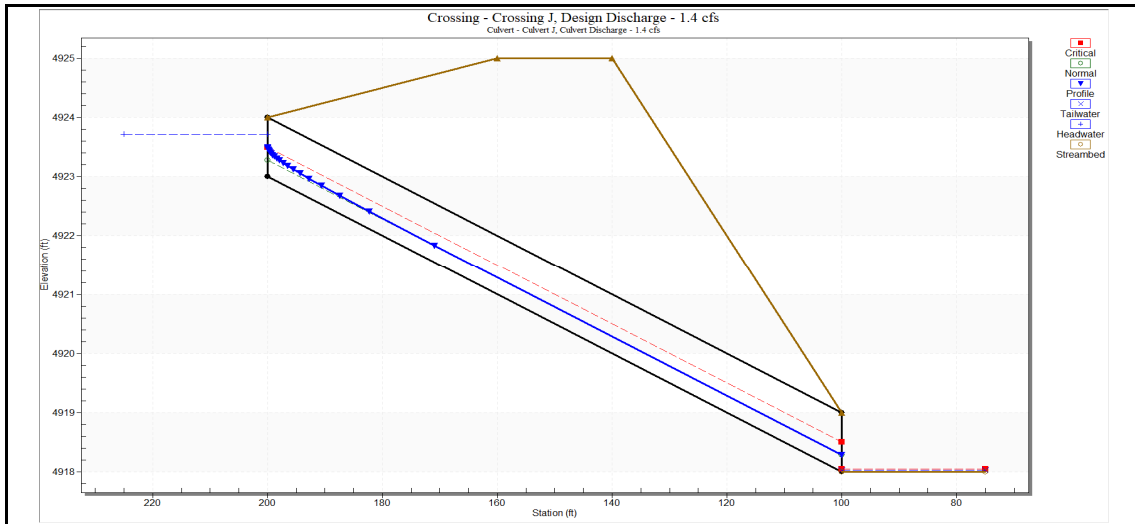
Culvert G (Warrior Lane)										
Flow Event	Culvert Discharge (cfs)	Headwater Elevation (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Culvert Type	Culvert Size (in)	Riprap d ₅₀ (in)
5 year	1.20	4917.75	1-S2n	0.27	0.32	14	3.53	Circular	12	5.4
100 year	7.40	4918.85	5-S2n	0.8	0.82	0.41	5.51			



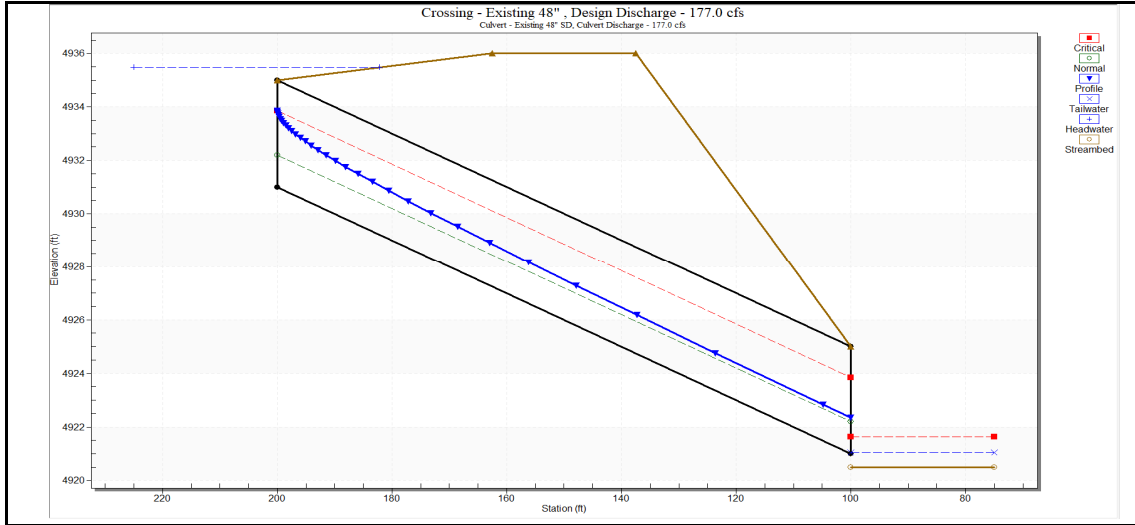
Culvert I (Warrior Lane)										
Flow Event	Culvert Discharge (cfs)	Headwater Elevation (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Culvert Type	Culvert Size (in)	Riprap d ₅₀ (in)
5 year	0.66	4924.45	1-S2n	0.19	0.34	0.01	6.16	Circular	12	2.4
100 year	1.60	4924.78	1-S2n	0.3	0.54	0.02	7.94			



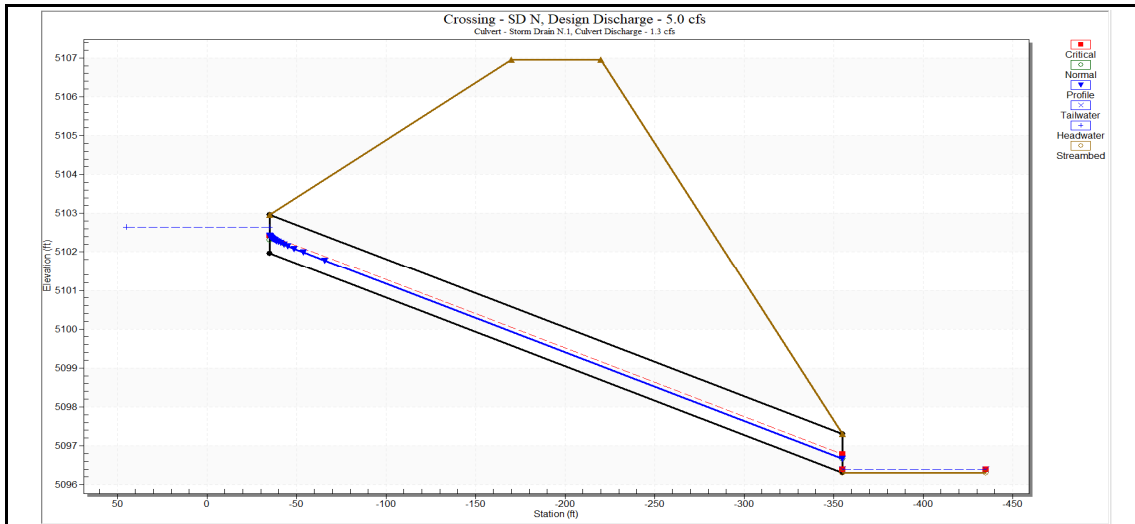
Culvert J (Existing Storm Drain)										
Flow Event	Culvert Discharge (cfs)	Headwater Elevation (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Culvert Type	Culvert Size (in)	Riprap d ₅₀ (in)
5 year	0.60	4923.43	1-S2n	0.19	0.32	0.02	5.98	Circular	24	existing
100 year	1.40	4923.71	1-S2n	0.28	0.5	0.03	7.65			



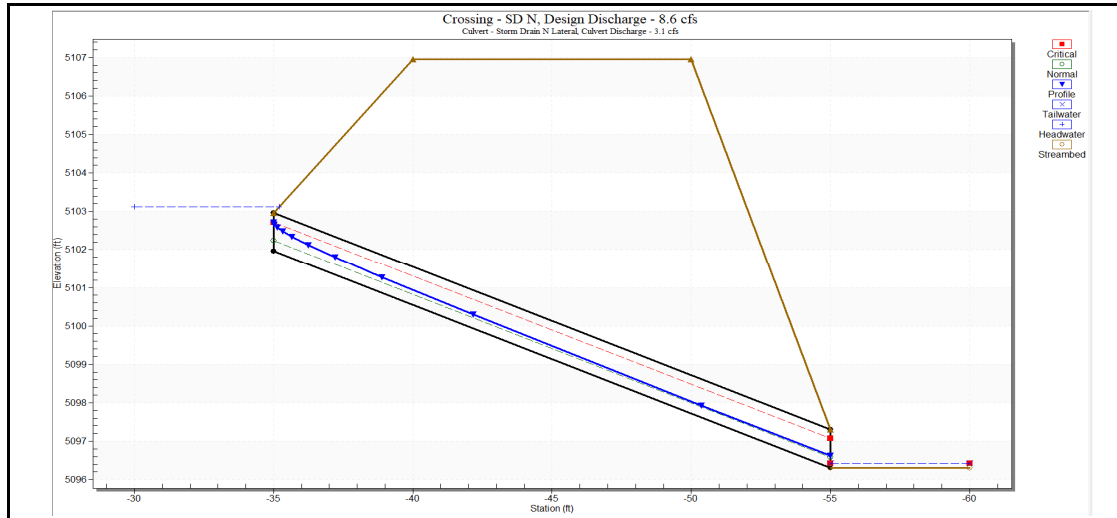
Existing 48" SD										
Flow Event	Culvert Discharge (cfs)	Headwater Elevation (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Culvert Type	Culvert Size (in)	Riprap d ₅₀ (in)
5 year	26.10	4932.34	1-S2n	0.46	1.06	0.18	5.36	Circular	48	existing
100 year	177.00	4935.47	5-S2n	1.19	2.85	0.55	23.9			



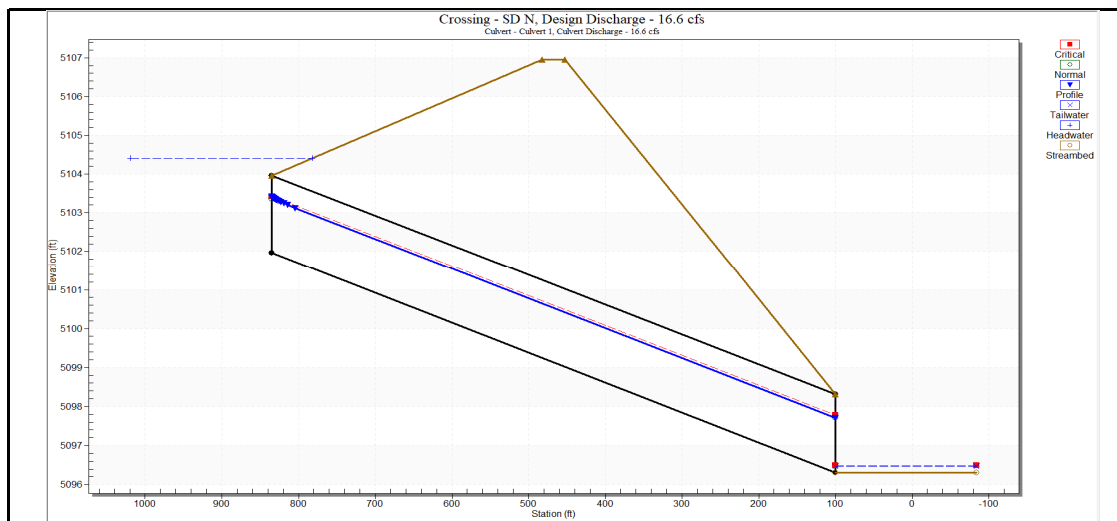
Storm Drain N.1 (Sta. 219+35)										
Flow Event	Culvert Discharge (cfs)	Headwater Elevation (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Culvert Type	Culvert Size (in)	Riprap d ₅₀ (in)
5 year	0.75	5102.36	1-S2n	0.26	0.3	0.04	3.08	Circular	12	n/a
100 year	2.08	5102.64	1-S2n	0.44	0.5	0.08	4.1			



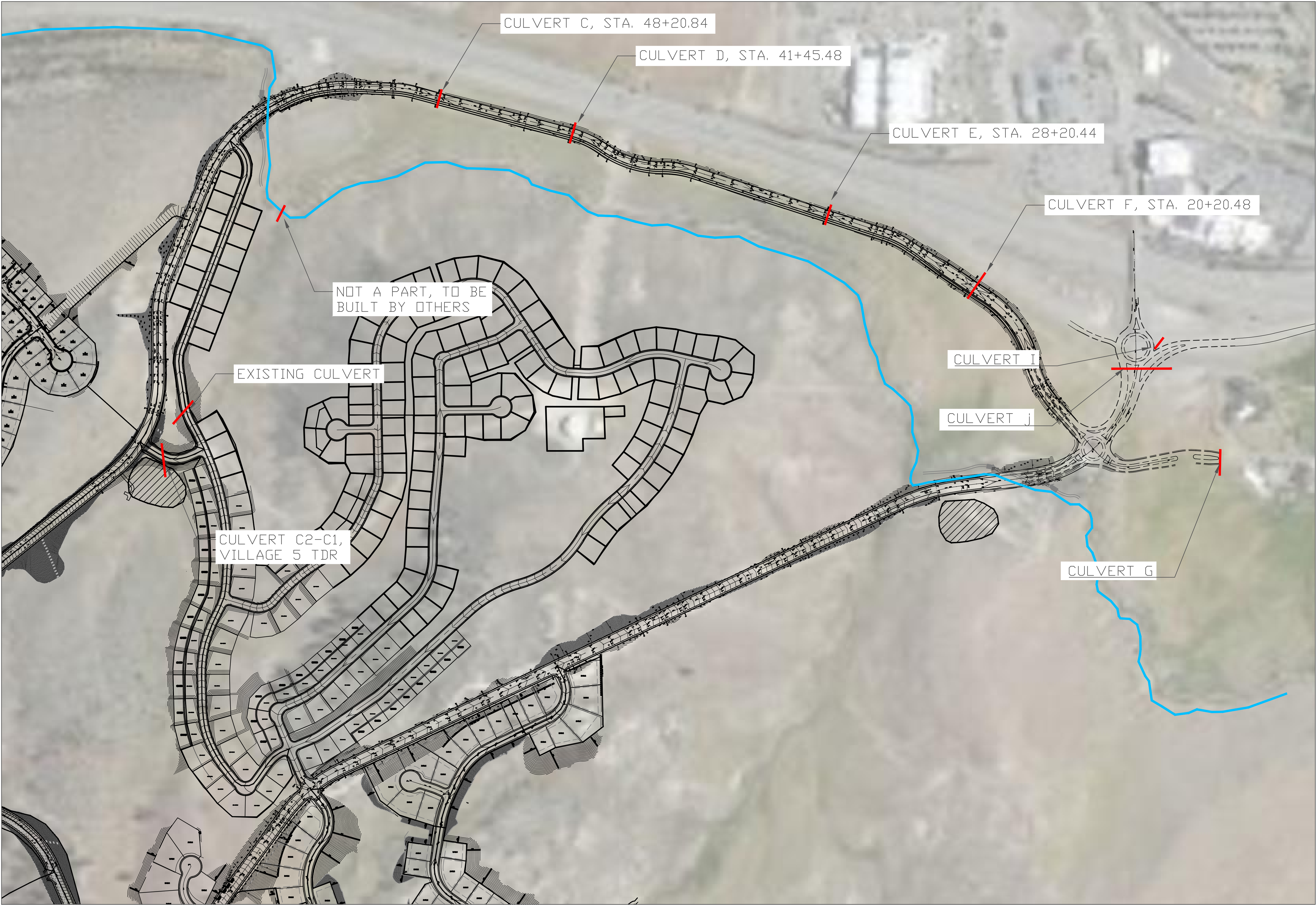
Storm Drain N.2 (Sta. 222+35)										
Flow Event	Culvert Discharge (cfs)	Headwater Elevation (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Culvert Type	Culvert Size (in)	Riprap d ₅₀ (in)
5 year	1.92	5102.61	1-S2n	0.42	0.48	0.06	4.01	Circular	12	n/a
100 year	5.45	5103.13	1-S2n	0.72	0.82	0.11	5.4			



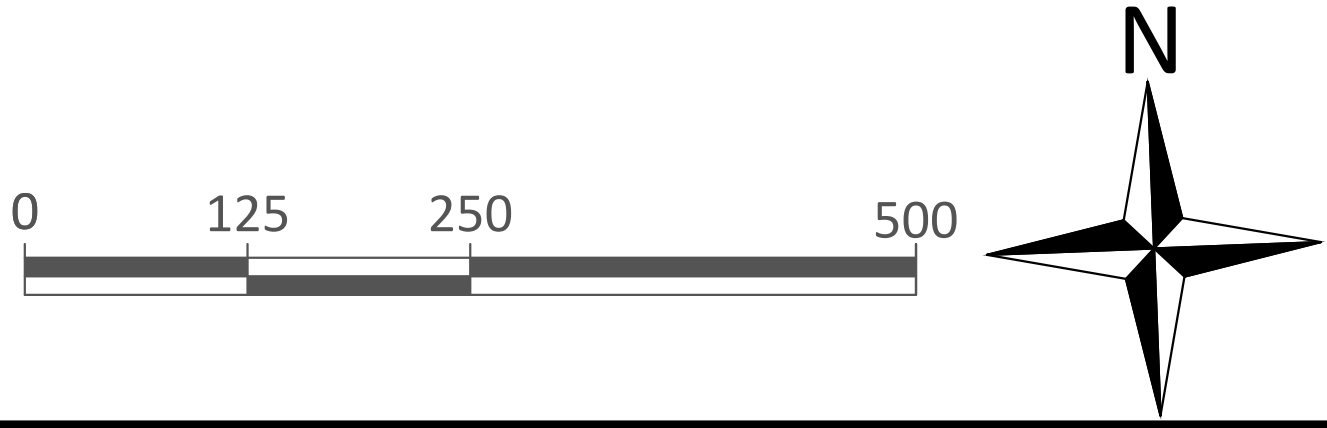
Storm Drain N.3 (Sta. 222+35)										
Flow Event	Culvert Discharge (cfs)	Headwater Elevation (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Culvert Type	Culvert Size (in)	Riprap d ₅₀ (in)
5 year	3.80	5102.9	1-S2n	0.59	0.68	0.07	4.88	Circular	18	0.35
100 year	16.60	5104.41	5-S2n	1.4	1.47	0.16	7.08			



J:\Projects\N003 - RCI Engineering\Technical\Figures\Culvert Crossings Map.dwg Drawn by: AM



Legend	
	CULVERT
	PROPOSED DEVELOPMENT
	STEAMBOAT DITCH



	CLIENT:	RCI	Backbone Road Ph1A Culvert Location Map
	PROJECT:	Quilici Ranch	
	PROJECT NUMBER:	N003.002	
			Figure 1

Appendix D

Field Data

Includes:

- Photo Location Map
- Field Photos

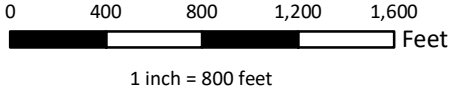


File: N:\GIS\Prj\N003.001_QuiliciRanch\MXD\20210730 PhotoLog2.mxd 8/2/2021 Created by: AD Checked by: Initial Coordinate System: NAD 1983 2011 StatePlane Nevada West FIPS 2703 F10S



Legend
● Photo Locations from 7/16/2021 Site Visit

Notes: Aerial imagery source - Maxar (April 30, 2020)



SAFETY FIRST  terraphase engineering	CLIENT:	RCI Engineering	Photo Location Map
	PROJECT:	Quilici Ranch-NV	
	PROJECT NUMBER:	N003.001.003	



Photograph 1:
NF-100 Road bridge
crossing. Photo
facing
north/northeast.
Image 4336
Date: July 16, 2021



Photograph 2:
Steamboat ditch
from NF-100 Road
wooden bridge.
Photo facing west.
Image 4337
Date: July 16, 2021



Photograph 3:
Steamboat ditch
from NF-100 Road
wooden bridge.
Photo facing east.
Image 4338
Date: July 16, 2021



Photograph 4:
Low point off NF-100
Road. Photo facing
east.
Image 4340
Date: July 16, 2021



Jul 16, 2021 at 8:37:51 AM
Garson Rd
Reno NV 89519
United States

Photograph 5:

Meadow near NF-100 Road. Dried areas where seasonal water pools. Photo facing north.

Image 4341

Date: July 16, 2021



Jul 16, 2021 at 8:38:44 AM
Reno NV 89519
United States

Photograph 6:

Meadow near NF-100 Road. Evidence of drainage through meadow. Photo facing south.

Image 4342

Date: July 16, 2021



Jul 16, 2021 at 8:38:47 AM
Reno NV 89519
United States

Photograph 7:

Drainage pattern in meadow near NF-100 Road. Photo facing north.

Image 4343

Date: July 16, 2021



Jul 16, 2021 at 8:38:50 AM
Reno NV 89519
United States

Photograph 8:

Meadow near NF-100 Road. Photo facing east.

Image 4344

Date: July 16, 2021



Jul 16, 2021 at 8:38:55 AM
Reno NV 89519
United States

Photograph 9:
Meadow with a dry wash near NF-100 Road. Photo facing east.

Image 4345

Date: July 16, 2021



Jul 16, 2021 at 8:40:24 AM
Reno NV 89519
United States

Photograph 10:
Drainage pattern next to gravel road. Photo facing north.

Image 4346

Date: July 16, 2021



Jul 16, 2021 at 8:40:34 AM
Reno NV 89519
United States

Photograph 11:

Drainage in meadow.

Photo facing
south/southeast.

Image 4347

Date: July 16, 2021



Jul 16, 2021 at 8:40:40 AM
Reno NV 89519
United States

Photograph 12:

Drainage next to
gravel road.

Image 4348

Date: July 16, 2021

Safety First 



Client: RCI Engineering

Project: Surface Water Survey – Steamboat Ditch

Project Number: N003.001.001

Photo Log

Page 6



Jul 16, 2021 at 8:40:45 AM
Reno NV 89519
United States

Photograph 13:

Drainage next to gravel road. Photo facing east.

Image 4349

Date: July 16, 2021



Jul 16, 2021 at 8:41:15 AM
I-80 E
Reno NV 89519
United States

Photograph 14:

Drainage between gravel road and Highway 80 East. Photo facing west.

Image 4350

Date: July 16, 2021

Safety First 



Client: RCI Engineering

Project: Surface Water Survey – Steamboat Ditch

Project Number: N003.001.001

Photo Log

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Jul 16, 2021 at 8:41:19 AM
I-80 E
Reno NV 89519
United States

Photograph 15:
Drainage between
gravel road and
Highway 80 East.
Photo facing east.
Image 4351
Date: July 16, 2021



Jul 16, 2021 at 8:41:25 AM
I-80 E
Reno NV 89519
United States

Photograph 16:
Standing in drainage
next to gravel road.
Photo facing south.
Image 4352
Date: July 16, 2021



Photograph 17:

Standing in drainage
between gravel road
and Highway 80 east.
Photo facing north.

Image 4353

Date: July 16, 2021



Photograph 18:

Drainage through the
fence near Highway
80 East. Photo facing
north.

Image 4354

Date: July 16, 2021



Photograph 19:
 Drainage features
 from gravel road.
 Photo facing south.
 Image 4355
 Date: July 16, 2021



Photograph 20:
 Drainage area near
 fence between gravel
 road and Highway 80
 East. Photo facing
 east.
 Image 4356
 Date: July 16, 2021



Photograph 21:
Monitoring well near
gravel road.

Image 4357

Date: July 16, 2021



Photograph 22:
Drainage area near
gravel road and
monitoring well.
Photo facing east.

Image 4358

Date: July 16, 2021



Jul 16, 2021 at 8:45:49 AM
Garson Rd
Reno NV 89519
United States

Photograph 23:

Utility boxes in meadow. Photo facing south.

Image 4359

Date: July 16, 2021



Jul 16, 2021 at 8:45:54 AM
Garson Rd
Reno NV 89519
United States

Photograph 24:

Drainage area near gravel road. Photo facing east/northeast.

Image 4360

Date: July 16, 2021

Safety First 



Client: RCI Engineering

Project: Surface Water Survey – Steamboat Ditch

Project Number: N003.001.001

Photo Log

Page 12



Photograph 25:
Drainage area near
fence by Highway 80
East. Photo facing
west.

Image 4361

Date: July 16, 2021



Photograph 26:
Low point off gravel
road which has
washed out and been
repaired with coarse
road gravels. Photo
facing north.

Image 4362

Date: July 16, 2021



Photograph 27:

Low point off gravel road from intersection with NF-100 Road which has washed out and been repaired with coarse road gravels. Photo facing north.

Image 4363

Date: July 16, 2021



Photograph 28:

Debris from flooding caught in bushes. Photo facing south.

Image 4364

Date: July 16, 2021

Safety First 



Client: RCI Engineering

Project: Surface Water Survey – Steamboat Ditch

Project Number: N003.001.001

Photo Log

Page 14



Photograph 29:
Steamboat Ditch from
Steamboat Ditch Trail.
Photo facing west.
Image 4366
Date: July 16, 2021



Photograph 30:
Steamboat Ditch from
Steamboat Ditch Trail.
Photo facing
west/southwest.
Image 4367
Date: July 16, 2021



Photograph 31:
 Steamboat Ditch from
 Steamboat Ditch Trail
 with concrete
 impoundment. Photo
 facing south.
 Image 4368
 Date: July 16, 2021



Photograph 32:
 Steamboat Ditch with
 seeps along dirt
 impoundment. Photo
 facing south.
 Image 4369
 Date: July 16, 2021



Photograph 33:
 Water main/gate.
 Note, no water was
 flowing out.
 Image 4370
 Date: July 16, 2021



Photograph 34:
 Water main/gate.
 Note, no water was
 flowing out. Photo
 facing south.
 Image 4371
 Date: July 16, 2021



Photograph 35:
Facing
north/northwest
towards Verdi, NV
from Steamboat Ditch
Trail.
Image 4372
Date: July 16, 2021



Photograph 36:
Facing
north/northwest
towards Verdi, NV
from Steamboat Ditch
Trail.
Image 4374
Date: July 16, 2021



Photograph 37:

Pipe to Steamboat Ditch intersection with rock lined drainage and HDPE pipe. Photo facing south.

Image 4375

Date: July 16, 2021



Photograph 38:

Pipe to Steamboat Ditch intersection with rock lined drainage and HDPE pipe. Photo facing east/southeast.

Image 4376

Date: July 16, 2021



Photograph 39:

Pipe to Steamboat Ditch intersection with rock lined drainage and HDPE pipe. Photo facing west/southwest.

Image 4377

Date: July 16, 2021



Photograph 40:

Photo facing away from Steamboat Ditch, facing north. Looking toward underpass footpath under Highway 80.

Image 4378

Date: July 16, 2021



Photograph 41:
 Rock lined drainage
 from Steamboat Ditch.
 Photo facing north.
 Image 4379
 Date: July 16, 2021



Photograph 42:
 Rock lined drainage
 intersection to
 drainage area that
 flows under Highway
 80 from Steamboat
 Ditch. Photo facing
 north.
 Image 4381
 Date: July 16, 2021



Photograph 43:
Dirt banks of
Steamboat Ditch.
Photo facing south.
Image 4382
Date: July 16, 2021



Photograph 44:
Low point and large
(flooded) meadow. N
value of 0.08. Photo
facing
north/northeast.
Image 4383
Date: July 16, 2021



Photograph 45:
Heavily vegetated
drainage into
Steamboat Ditch.
Photo facing
south/southwest.
Image 4384
Date: July 16, 2021



Photograph 46:
Heavily vegetated
drainage into
Steamboat Ditch.
Photo facing south.
Image 4385
Date: July 16, 2021



Photograph 47:
 Drainage feature in meadow near Steamboat Ditch. Photo facing east/southeast.
 Image 4386
 Date: July 16, 2021



Photograph 48:
 Drainage pipe above Steamboat Ditch in the background. Photo facing south.
 Image 4387
 Date: July 16, 2021



Photograph 49:
Drainage pipe above
Steamboat Ditch in
the background,
zoomed in. Photo
facing south.

Image 4388

Date: July 16, 2021



Photograph 50:
Drainage area near
Steamboat Ditch Trail.
Photo facing east.

Image 4389

Date: July 16, 2021

Safety First 



Client: RCI Engineering

Project: Surface Water Survey – Steamboat Ditch

Project Number: N003.001.001

Photo Log

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Photograph 51:
Steamboat Ditch Trail,
concrete bridge
crossing. Photo facing
north.

Image 4390

Date: July 16, 2021



Photograph 52:
Steamboat Ditch from
the concrete bridge.
Photo facing south.

Image 4391

Date: July 16, 2021



Photograph 53:
Steamboat Ditch from
the concrete bridge.
Photo facing north.
Image 4392
Date: July 16, 2021



Photograph 54:
Dirt embankment
incised on ditch.
Photo facing
north/northwest.
Image 4393
Date: July 16, 2021



Photograph 55:
Dirt embankment
incised on ditch.
Photo facing
north/northwest.
Image 4394
Date: July 16, 2021



Photograph 56:
Dirt embankment
incised on ditch.
Photo facing
northwest.
Image 4396
Date: July 16, 2021



Photograph 57:
Dirt embankment
incised on ditch.
Photo facing
northeast.
Image 4397
Date: July 16, 2021



Photograph 58:
Wash with N value of
0.035 contains
cobbles, sand, silt, and
pebbles. Photo facing
west.
Image 4398
Date: July 16, 2021



Photograph 59:

Wash with N value of 0.035 contains cobbles, sand, silt, and pebbles. Photo facing east.

Image 4399

Date: July 16, 2021



Photograph 60:

Turn in Steamboat Ditch, off trail. Photo facing west.

Image 4400

Date: July 16, 2021



Photograph 61:

Barbed wire fence near Steamboat Ditch, off trail. Photo facing west/southwest.

Image 4401

Date: July 16, 2021



Photograph 62:

Steamboat Ditch hidden in the forest. Photo facing west/northwest.

Image 4402

Date: July 16, 2021



Photograph 63:
Steamboat Ditch in
the forest. Photo
facing north.

Image 4403

Date: July 16, 2021



Photograph 64:
Drainage in the forest
near Steamboat Ditch.
Photo facing south.

Image 4404

Date: July 16, 2021



Photograph 65:
Steamboat Ditch with dirt embankment in the forest. Photo facing northwest.
Image 4405
Date: July 16, 2021



Photograph 66:
Steamboat Ditch with view of Highway 80 in the background. Photo facing north/northeast.
Image 4406
Date: July 16, 2021



Jul 16, 2021 at 10:04:05 AM
690 Front St
Verdi NV 89439
United States

Photograph 67:
Steamboat Ditch Trail
marker. Photo facing
west.

Image 4407

Date: July 16, 2021



Jul 16, 2021 at 10:04:08 AM
I-80 E
Reno NV 89519
United States

Photograph 68:
Steamboat Ditch dirt
road near Highway 80
bend in the road. Dirt
embankment pushed
up near the ditch.
Photo facing
west/northwest.

Image 4408

Date: July 16, 2021



Photograph 69:

Steamboat Ditch dirt road near Highway 80 bend in the road. Dirt embankment pushed up near the ditch. Photo facing north.

Image 4409

Date: July 16, 2021



Photograph 70:

Steamboat Ditch dirt road near Highway 80 bend in the road. Dirt embankment pushed up near the ditch. Photo facing north.

Image 4410

Date: July 16, 2021



Photograph 71:
Steamboat Ditch dirt road near Highway 80 bend in the road. Dirt embankment pushed up near the ditch.
Image 4411

Date: July 16, 2021



Photograph 72:
Steamboat Ditch dirt road near Highway 80 bend in the road. Photo west.
Image 4412

Date: July 16, 2021



Photograph 73:

Steamboat Ditch dirt road near Highway 80 bend in the road. Dirt embankment pushed up near the ditch. Photo facing north. Image 4413

Date: July 16, 2021



Photograph 74:

Steamboat Ditch dirt road near Highway 80 bend in the road. Dirt embankment pushed up near the ditch. Photo facing west. Image 4414

Date: July 16, 2021

Safety First ⚠️



Client: RCI Engineering

Project: Surface Water Survey – Steamboat Ditch

Project Number: N003.001.001

Photo Log

Page 37



Photograph 75:

Steamboat Ditch dirt embankment. Facing down at the ditch.

Image 4415

Date: July 16, 2021



Photograph 76:

Train tracks near the Steamboat ditch. Photo facing northwest.

Image 4416

Date: July 16, 2021

Safety First ⚠️



Client: RCI Engineering

Project: Surface Water Survey – Steamboat Ditch

Project Number: N003.001.001

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Photograph 77:
Steamboat Ditch in
the forest. Photo
facing west.

Image 4417

Date: July 16, 2021



Photograph 78:
Steamboat Ditch with
dirt embankment.
Photo facing the ditch.

Image 4418

Date: July 16, 2021



Photograph 79:

Steamboat Ditch dirt embankment in the forest. Photo facing northwest.

Image 4419

Date: July 16, 2021



Photograph 80:

Steamboat Ditch with dirt embankment. Photo facing west.

Image 4420

Date: July 16, 2021



Photograph 81:
 Steamboat Ditch with
 dirt embankment.
 Photo facing west.
 Image 4421
 Date: July 16, 2021



Photograph 82:
 Steamboat Ditch with
 heavy vegetation.
 Photo facing west.
 Image 4422
 Date: July 16, 2021



Photograph 83:

Steamboat Ditch near
a residence of Verdi,
NV. Photo facing west.

Image 4423

Date: July 16, 2021



Photograph 84:

Steamboat Ditch with
gate. Photo facing the
ditch.

Image 4424

Date: July 16, 2021

Safety First 



Client: RCI Engineering

Project: Surface Water Survey – Steamboat Ditch

Project Number: N003.001.001

Photo Log

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Photograph 85:
Steamboat Ditch with
gate. Photo facing
west.

Image 4425

Date: July 16, 2021



Photograph 86:
Steamboat Ditch near
a ranch. Photo facing
south.

Image 4426

Date: July 16, 2021



Photograph 87:
Steamboat Ditch near
a ranch. Photo facing
west.

Image 4427

Date: July 16, 2021



Photograph 88:
Steamboat Ditch near
a ranch. Photo facing
southwest.

Image 4429

Date: July 16, 2021



Photograph 89:
Steamboat Ditch near a ranch. Cattle visible in the bushes. Photo facing west.
Image 4430
Date: July 16, 2021



Photograph 90:
Steamboat Ditch near a ranch. Horses drinking and cooling off in the ditch. Photo facing southwest.
Image 4432
Date: July 16, 2021



Photograph 91:

Steamboat Ditch near a ranch. Horses near the ditch. Photo facing west.

Image 4433

Date: July 16, 2021



Photograph 92:

Steamboat Ditch near a ranch. Horses near the ditch. Photo facing west.

Image 4434

Date: July 16, 2021



Photograph 93:
Steamboat Ditch near
fencing from a ranch.
Photo facing north.
Image 4436
Date: July 16, 2021



Photograph 94:
Drainage intersection
with the Steamboat
Ditch. Photo facing
east.
Image 4437
Date: July 16, 2021



Photograph 95:

Drainage intersection with the Steamboat Ditch. Photo facing east.

Image 4438

Date: July 16, 2021



Photograph 96:

Drainage intersection with the Steamboat Ditch. Photo facing the bottom of the drainage.

Image 4439

Date: July 16, 2021



Photograph 97:
Culvert with
flashboards at the
Steamboat Ditch and
drainage intersection.
Photo facing west.
Image 4440
Date: July 16, 2021



Photograph 98:
Bend in the
Steamboat Ditch.
Photo facing north.
Image 4441
Date: July 16, 2021



Photograph 99:
Culvert with
flashboards at the
Steamboat Ditch and
drainage intersection.
Photo facing west.
Image 4442
Date: July 16, 2021



Photograph 100:
Dry pond near NF-100
Road. Photo facing
north.
Image 4444
Date: July 16, 2021



Photograph 101:
 Terrain and drainage
 patterns near NF-100
 Road. Photo facing
 east.
 Image 4445
 Date: July 16, 2021



Photograph 102:
 Vegetated areas
 above NF-100 Road
 where there are
 naturally occurring
 springs. Photo facing
 east.
 Image 4446
 Date: July 16, 2021



Photograph 103:
Draining next to NF-100 Road. Utility(?) buildings in the background. Photo facing northwest.
Image 4447
Date: July 16, 2021



Photograph 104:
Drainage near NF-100 Road. Photo facing east.
Image 4446
Date: July 16, 2021



Photograph 105:
Meadow with large drainage feature on the hillside. Photo facing south.

Image 4449

Date: July 16, 2021



Photograph 106:
Drainage piping located near NF-100oad. Photo facing south.

Image 4450

Date: July 16, 2021



Photograph 107:

Drainage near
highway sign and
underpass footpath
under Highway 80.
Photo facing north.

Image 4451

Date: July 16, 2021

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Client: RCI Engineering

Project: Surface Water Survey – Steamboat Ditch

Project Number: N003.001.001

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Photograph 1: Main stormwater swale along I-80, facing eastward (Image 0242) Date: November 17, 2021	Photograph 2: Stormwater flow incision south from NDOT facility (Image 0241) Date: November 17, 2021
	
Photograph 3: Erosion west of stormwater swale ripping along access road and originating partially from NDOT facility (Image 0248) Date: November 17, 2021	Photograph 4: 36-inch stormwater outlet entering swale from I-80, clogged with debris and trash (Image 0252) Date: November 17, 2021



Photograph 5: Surface runoff from I-80 causing rilling and swale sedimentation (Image 0340)

Date: November 17, 2021



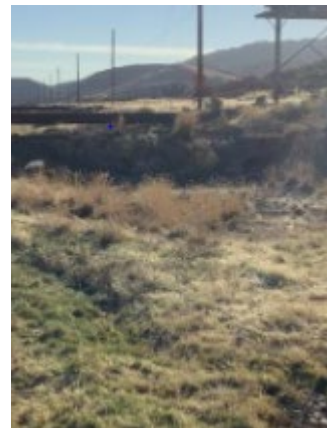
Photograph 6: Minor ditches and erosional features feeding into storm water swale (Image 0248)

Date: November 17, 2021



Photograph 7: Standing water in stormwater swale west of 10'x12' access road tunnel under I-80 (Image 0263)

Date: November 17, 2021



Photograph 8: Stormwater swale bottom with crossing irrigation pipe (Image 0321)

Date: November 17, 2021

	
Photograph 9: Stormwater runoff from I-580 causing rilling and significant erosion and downslope deposition in stormwater swale bottom; facing north (Image 0292) Date: November 17, 2021	Photograph 10: Conveyance pipe over stormwater swale perpendicular to I-80; facing north (Image 0317) Date: November 17, 2021
	
Photograph 11: 10'x12' Access Road under I-80; facing north (Image 0276) Date: November 17, 2021	Photograph 12: Large culverts under dirt access road intersecting stormwater swale. Note elevation of conveyance pipe past dirt access road; see bunch grass (Image 0269) Date: November 17, 2021

	
Photograph 13: Culverts require maintenance – these were 2x36" or so with severely diminished cross-sectional areas; facing east (Image 0271) Date: November 17, 2021	Photograph 14: Dirt access road heading away from I-80 and towards Steamboat Ditch; facing south (Image 0272) Date: November 17, 2021
	
Photograph 15: Puddled water in storm drain swale just east of dirt access road from recent rainfall; facing east (Image 0278) Date: November 17, 2021	Photograph 16: Conveyance pipe and concrete foot on south side of stormwater swale. Note disconnection between foot and pipe on right side of photo; facing east (Image 0277) Date: November 17, 2021



Photograph 17: Concrete foot at conveyance pipe disconnected from upslope pipe. Note minor ditch running to the right of stormwater swale; facing east (Image 0278)

Date: November 17, 2021



Photograph 18: Old water pipe and ditch just upslope from concrete foot and conveyance pipe; facing south (Image 0279)

Date: November 17, 2021



Photograph 19: Heavy sedimentation in swale bottom below rilling from I-80 (Image 0263)

Date: November 17, 2021



Photograph 20: Minor ditches carry stormwater under Boomtown-Garson Road from Steamboat Ditch to the stormwater swale area; facing south. Note culvert at top of photo for road crossing (Image 0344)

Date: November 17, 2021

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Photograph 21: Stormwater swale flows into 48" RCB at east end of swale close to corner of Cabelas Store building; facing northeast (Image 0294)

Date: November 17, 2021



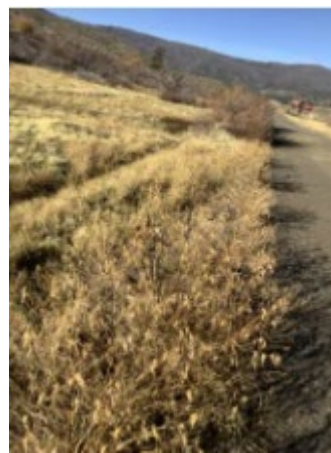
Photograph 22: Native vegetation over storm drain box culvert as water heads east; facing north (Image 0295)

Date: November 17, 2021



Photograph 23: Stormwater had entered RCB heading east towards Truckee River. Minor ditches carry overland flows east to meet stormwater after passing through 48" RCB; facing east (Image 0296)

Date: November 17, 2021



Photograph 24: Roadside minor ditches for stormwater conveyance and Steamboat Ditch conveyance along Boomtown Garson Road under Steamboat Ditch; facing west (Image 0304)

Date: November 17, 2021

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Photograph 25: Stormwater connection to Steamboat Ditch, note PVC outlet. Note revegetation efforts above ditch and old BMPs from construction. Location: top of dirt Access Road, above 10'x12' RCB; facing southwest (Image 346) Date: November 17, 2021	Photograph 26: View of 12x10 RCB and dirt access road from Steamboat Ditch Road; facing southwest (Image 0309) Date: November 17, 2021
	
Photograph 27: Splitter on roadside below SBD Road and above swale near access road to 10x12 RCB; facing southeast (Image 0315) Date: November 17, 2021	Photograph 28: Stormwater pipe from I-80 outletting into west end of swale system far above bottom of swale without energy dissipation devices; facing north (Image 0252) Date: November 17, 2021

	
Photograph 29: Steamboat Ditch just west of NDOT facility showing apron and large rockery solution to erosion problem; facing south (Image 0332) Date: November 17, 2021	Photograph 30: Stormwater runoff from NDOT asphalt pad and storage area; facing east. Date: November 17, 2021 Image 0337
	
Photograph 31: Steamboat Ditch canal downstream of apron west of NDOT facility above road crossing over ditch near stormwater runoff from NDOT property; facing north (Image 0327) Date: November 17, 2021	Photograph 32: Road split at Steamboat Ditch, southwest of NDOT facility; facing south (Image 0326) Date: November 17, 2021



Photograph 33: Steamboat Ditch access road west of NDOT facility; facing south (Image 0330)

Date: November 17, 2021



Photograph 34: Erosion sign from NDOT asphalt pad crossing dirt road and entering ditch; facing southwest (Image 0338)

Date: November 17, 2021