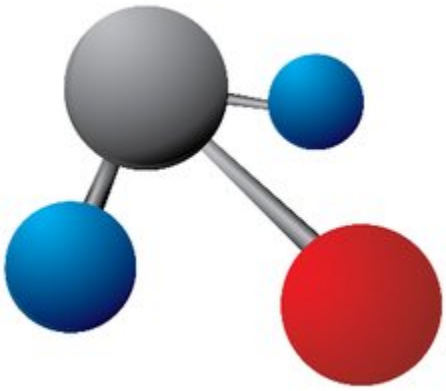
CHEROKEE METROPOLITAN DISTRICT PFAS WATER TREATMENT FACILITY (WTF) PRELIMINARY DRAINAGE REPORT



El Paso County, Colorado

October 2026

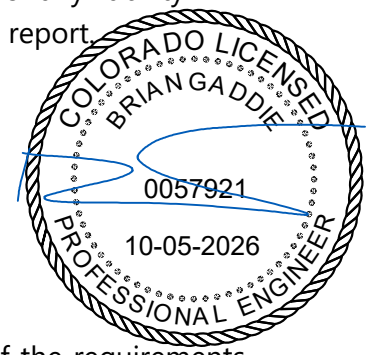
AE2S Project #: 16688-2025-001
El Paso County 1041 Project# EA2639

CHEROKEE METROPOLITAN DISTRICT PFAS WATER TREATMENT FACILITY (WTF)

PRELIMINARY DRAINAGE REPORT

Engineer's Statement:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the county for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.



Brian Gaddie, PE

Name

Developer's Statement:

I, Troy Slocum the developer have read and will comply with all of the requirements specified in this drainage report and plan.

Business Name Cherokee Metropolitan District

By: Troy Slocum

Title: District Engineer

Address: 6250 Palmer Park Blvd

Colorado Springs, CO 80915

EL PASO COUNTY ONLY:

Filed in accordance with Section 51.1 of the El Paso Land Development Code as amended.

Director of Public Works

Date

Conditions:

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1. Project Location and Description

1.1 Location

The Cherokee Metropolitan District's (CMD) PFAS Water Treatment Facility (WTF) site is located near Ellicott Colorado at approximately 23838 State Highway 94 in unincorporated community El Paso County. The PFAS WTF site (Project) is situated north of State Highway 94 and east of Ellicott Highway within Section 7, Township 14 South, Range 62 West, 6th Principal Meridian. The Project is located within the East Half of the Southwest Quarter (E½SW¼) of Section 7, exclusive of highway right-of-way.

The evaluated drainage basin extends north of the Project and encompasses the upland areas that contribute runoff to the Project. The drainage basin consists of predominantly undeveloped and low-density rural residential lands located north of State Highway 94 and east of Ellicott Highway.

Major drainageways within the area consist primarily of natural overland flow paths, shallow swales, and roadside conveyance features that generally direct runoff from the northern and northwestern portions of the basin toward the south and southeast. Existing drainage facilities include roadside ditches and culverts associated with State Highway 94 and Ellicott Highway.

Surrounding development is characterized by rural residential and agricultural land uses. Adjacent platted residential development is located northeast of the site in the vicinity of Langness Circle, with additional rural residential properties located along Ellicott Highway and McDaniels Road.

1.2 Description of Property

The delineated drainage basin encompasses approximately 101 acres and includes the proposed PFAS WTF site and tributary areas immediately north and west of the Project. Land cover within the basin consists primarily of open grassland and pasture, with scattered shrubs and limited tree cover associated with rural residences and shelter belts.

The basin is characterized by gently rolling terrain that generally slopes toward the south and southeast, conveying runoff through a series of broad shallow swales and overland flow paths toward the Project and State Highway 94. Soils consist predominantly of Louviers Alluvium, which ranges from a reddish-brown gravel to a yellowish-brown sand.

Existing utilities and encumbrances include the State Highway 94 and Ellicott Highway rights-of-way, CMD transmission and utility infrastructure, utility easements, access easements, and overhead and underground utility corridors. The property location is shown in Figure 1.



Figure 1 – Vicinity Map

2. Drainage Basins and Sub-Basins

2.1 Major Basin Descriptions

The Project is located within a small tributary watershed in eastern El Paso County identified as Ellicott CHBS1600 on the El Paso County Drainage Basin map. The contributing drainage basin encompasses approximately 101 acres and drains generally from the north and northwest toward the Project and State Highway 94. The watershed consists primarily of undeveloped grassland, pasture, and scattered rural residential development. Major drainage features include shallow natural swales, overland flow paths, roadside ditches, and culvert crossings. No major perennial streams are present within the basin.

The Project is not located within a designated Federal Emergency Management Agency (FEMA) Special Flood Hazard Area (100-year floodplain) based on FEMA mapping. The Project is located within two flood insurance rate map (FIRM) Panels named 08041C0807G and 08041C0809G, which are included in **Appendix A.1.**

No major basin-wide drainage planning studies were identified for the watershed. A review of available mapping and site information did not identify significant irrigation facilities within or adjacent to the drainage basin. Existing drainage infrastructure consists primarily of roadway drainage facilities and culvert crossings associated with State Highway 94 and surrounding rural development.

2.2 Sub-Basin Description

Historically, drainage within the Project has occurred as sheet flow and shallow concentrated flow from the upland areas north of the site toward State Highway 94. Runoff is conveyed through natural swales and overland flow paths across predominantly undeveloped grassland and rural properties, following the existing topography toward roadway drainage facilities.

The Project receives off-site runoff from areas north of the development. To maintain existing drainage patterns, off-site flows will be intercepted and routed around the PFAS WTF improvements through drainage channels. The flow will be conveyed to an existing culvert beneath State Highway 94 located near the southeast corner of the site, allowing upstream drainage to pass through the area without adversely impacting the Project or mixing with site runoff prior to treatment from the onsite detention basin.

3. Drainage Design Criteria

3.1 Development Criteria Reference

The drainage analysis and design for the Project were completed in accordance with the El Paso County Engineering Criteria Manual (County Design Standards), which establishes the minimum requirements for the planning, analysis, design, and maintenance of storm drainage facilities within El Paso County. The Mile High Flood District Urban Storm Drainage Criteria (MHFD) Manual was utilized where specific policy or technical guidance is not provided by the County. The documents form the basis of the hydrologic and hydraulic analyses presented. No deviations from the applicable design criteria are proposed.

Available flood hazard mapping and previous drainage information were reviewed as part of the drainage evaluation. FEMA FIRMs were referenced to assess potential floodplain impacts. No previous drainage reports, basin planning studies, or master drainage plans specific to the Project were identified. The drainage design is based on existing site conditions, current El Paso County and MHFD criteria, and the preservation of historical drainage patterns, including conveyance of off-site runoff around the PFAS WTF improvements and discharge through the existing culvert beneath State Highway 94.

3.2 Hydrologic Criteria

The minor storm design rainfall is the 10-year rainfall event, and the major storm rainfall is the 100-year event in accordance with the County Design Standards. Design discharges for both onsite and offsite flows (existing and proposed conditions) were calculated using the MHFD Peak Runoff Prediction by the Rational Method Workbook.

Rainfall intensities were determined using the rainfall data and procedures identified in the County Design Standards and the MHFD Manual. Runoff coefficients were calculated using methods from the MHFD Rational Method Workbook and were derived based on impervious percentages. Percent imperviousness was calculated on a subcatchment basis utilizing new buildings, water tanks, paved areas, concrete surfaces, and gravel areas as impervious cover.

Time of concentration calculations were based on the impervious area within each subcatchment, as well as the distance and slope of runoff travel. The time of concentration was set to 10 minutes in the proposed condition for subcatchments disturbed and re-graded onsite.

Detention storage volumes and allowable release rates were calculated using the MHFD Detention Basin Spreadsheet. The detention analysis utilized the MHFD Detention Basin

Spreadsheet to size treatment areas for alignment with an extended detention basin design to reduce runoff rates and provide water quality benefits.

3.3 Hydraulic Criteria

Multiple drainage channels throughout the Project were designed to meet the criteria outlined within the County Design Standards. The channels provide conveyance for on-site runoff and bypass conveyance for off-site flows originating north of the development. Earthen channels were designed with a minimum side slope of 4H:1V, freeboard calculations based on Section 10.5.5 of the County Design Standards, and hydraulic characteristics that maintain subcritical flow conditions where practical per the criteria. Channel geometry was evaluated to ensure acceptable velocities for limiting erosion and providing proper channel height.

Culverts were designed to convey both onsite and offsite runoff through the Project to the downstream drainage system. The minimum culvert size proposed for the Project is 15-inch reinforced concrete pipe (RCP). The proposed 15-inch diameter is less than the County's standard minimum culvert diameter of 18 inches. However, the smaller diameter was selected based on Project-specific constraints, including the relatively flat grades across the Project and available pipe cover, while also providing increased flow velocities to promote self-cleaning and reduce the potential for sediment accumulation within the culverts. Hydraulic performance of each culvert was evaluated for the applicable design storm events, including culvert capacity and flow conditions, potential roadway overtopping, and outlet velocities. The analysis demonstrates that the proposed culverts provide adequate hydraulic performance despite the reduced pipe diameter.

The proposed stormwater detention basin was designed using the MHFD Detention Basin Design Workbook to provide detention and controlled release of post-development runoff. The calculated historic 10-year runoff rate is 0.0 cubic feet per second (cfs) due to the highly infiltrative characteristics of the existing undeveloped site. Accordingly, strict application of the requirement to limit post-development discharge to the historic 10-year rate requires complete retention or infiltration of the 10-year runoff event and cannot practicably be achieved using a conventional extended detention basin with a positive outlet. An infiltration-based facility is required to achieve a calculated discharge of 0.0 cfs.

A variance from the historic 10-year release rate criterion is requested to allow a controlled discharge from the proposed extended detention basin. The proposed basin has been designed to minimize post-development discharge rates to the maximum extent practicable while providing positive drainage, reliable long-term operation, and a maintainable stormwater management facility. The proposed 10-year release rate is approximately 0.20 cfs, which represents the minimum practicable release rate considering the required outlet configuration,

available hydraulic head, and long-term operation and maintenance of the basin. The design basin's proposed design does control the 100-year release rate to less than the criteria requires.

4. Drainage Facility Design

4.1 General Drainage Concept

The drainage pattern flows generally from north to south toward the existing culvert beneath State Highway 94 located near the southeast corner of the Project. Existing offsite runoff originates from the tributary basin north of the Project and naturally drains toward the Project along shallow swales and overland flow paths.

An access road extending east-west through the center of the Project serves as a drainage divide between offsite runoff and developed site runoff. Offsite flow originating north of the access road will be intercepted and conveyed eastward within a roadside channel along the north side of the roadway. The offsite runoff will continue to be routed around the proposed Project and discharged through the existing culvert beneath State Highway 94 at the southeast corner of the site.

Runoff originating south of the access road will generally follow existing drainage patterns and site grading toward the same culvert crossing beneath State Highway 94. The drainage design preserves the historic drainage patterns and prevents offsite runoff from passing through the developed portions of the Project.

Where feasible, runoff from impervious surfaces, including buildings, paved areas, and associated site improvements, will be collected by onsite drainage channels and conveyed to the detention basin. The detention basin will provide storage and controlled release of developed runoff prior to discharge to the downstream drainage system. There is a portion of the access road and new impervious area along the east-west portion that cannot be captured and conveyed to the detention basin due to limited easement area. This area will flow through a grass-lined channel providing runoff reduction prior to leaving the site.

4.2 Specific Details

4.2.1 Design Flows

Peak flows were calculated for each drainage subcatchment under existing and proposed conditions using the MHFD Peak Runoff Prediction by the Rational Method Workbook. Detailed hydrologic calculations are included in **Appendix B**. Summaries of the existing and proposed runoff conditions are provided in **Tables 4-1** through **4-4**. The runoff summaries compare flow rates at each designated drainage point throughout the Project.

The Project receives runoff from the tributary basin north of the proposed development in addition to runoff generated within the Project limits under existing conditions.

Offsite runoff remains separated from developed site runoff and is conveyed around the Project through the northern roadside channel system to the existing culvert beneath State Highway 94 near the southeast corner of the site under proposed conditions.

The north offsite drainage area is not included in the runoff summaries. The offsite drainage maintains historic flow patterns and will be routed around the Project.

Minor roadway areas cannot be graded toward the Project and do cause minor increases in proposed runoff rates compared to the historic runoff rate for the analysis completed at Drainage Point 2. The Drainage Point 2 area will be routed to a driveway culvert with riprap that provides attenuation and minor water quality treatment not reflected in the analysis.

Table 4-1 Drainage Point 1 Existing Conditions Runoff Summary

Subcatchment	Area (Acres)	Drainage Point	10-Year Flow (CFS)	100-Year Flow (CFS)
EX_01	18.10	1	0.00	7.18
Sum[1]	**18.10**	**1**	**0.00**	**7.18**

[1] EX_02 included in rational method calculations but not included in rate analysis due to offsite nature of flows only.

Table 4-2 Drainage Point 2 Existing Conditions Runoff Summary

Subcatchment	Area (Acres)	Drainage Point	10-Year Flow (CFS)	100-Year Flow (CFS)
EX_03	14.68	2	3.11	9.78
SUM	**14.68**	**2**	**3.11**	**9.78**

Table 4-3 Drainage Point 1 Proposed Conditions Runoff Summary

Subcatchment	Area (Acres)	Drainage Point	10-Year Flow (CFS)	100-Year Flow (CFS)
IP_03	4.38	3	3.52	9.04
IP_04	1.57	3	1.61	3.77
IP_05	2.56	3	4.66	9.26
IP_06	0.84	3	1.20	2.53
IP_07	1.04	3	1.55	3.25
Pond	-	3	0.20	2.20
IP_08	1.51	1	0.00	1.14
IP_02	5.11	1	0.00	1.94
Sum[1]	**17.01[2]**	**1**	**0.20**	**5.28**

[1] IP_01 not included in runoff calculations due to offsite nature of flows and being routed around the site, and not through the site, similar to existing conditions analysis.
[2] 1.09 acres less acres drains towards DP 1 under proposed conditions due to runoff from the raw water overflow basin producing zero runoff.

Table 4-4 Drainage Point 2 Proposed Conditions Runoff Summary

Subcatchment	Area (Acres)	Drainage Point	10-Year Flow (CFS)	100-Year Flow (CFS)
IP_09	0.20	2	0.32	0.66
IP_10	14.48	2	3.12	9.73
SUM	**14.68**	**2**	**3.44**	**10.39**

4.2.2 Proposed Drainage Facilities

The proposed drainage facilities consist of roadside drainage channels, reinforced concrete pipe culverts, and an onsite detention basin. Hydraulic analyses were completed in accordance with the County Design Standards and the MHFD Manual.

The channels were designed utilizing the applicable criteria established in the County Design Standards, including minimum channel geometry, freeboard, and maximum allowable velocities. Hydraulic calculations were completed using Hydraulic Toolbox software. A summary of channel design parameters is provided in **Table 4-5**, and a summary of hydraulic results is provided in **Table 4-6**.

Table 4-5 Channel Geometry

Channel ID	Mannings n Value	Bottom Width (B, feet)	Side Slope (Z, H:V)	Slope (%)	100-Year Flow (CFS)	Total Channel Height (feet)
01	0.03	6.00	4.00	0.80	21.07	2.00
02	0.03	6.00	4.00	1.00	11.57	2.00
03	0.03	6.00	4.00	0.70	1.14	2.00
04	0.03	6.00	4.00	0.50	3.08	2.00

Table 4-6 Channel Results

Channel ID	100-Year Average Velocity (Feet per Second (FPS))	100-Year Allowable Velocity (FPS)	100-Year Flow Depth (feet)	Freeboard Required Calculation	100-Year Flow Depth plus Freeboard (feet)
01	3.03	5.00	0.77	1.06	1.83
02	2.74	5.00	0.52	1.04	1.56
03	1.12	5.00	0.15	1.00	1.15
04	1.41	5.00	0.30	1.01	1.31

Reinforced concrete pipe culverts were designed to convey runoff beneath the Project access roadway and other proposed crossings. Culvert sizing was completed using HY-8 software. Culverts were evaluated for hydraulic capacity, flow-through velocity for self-cleaning, outlet velocity, and roadway overtopping.

A summary of culvert design parameters is provided in **Table 4-7** and hydraulic results are summarized in **Table 4-8**. Detailed HY-8 output files are included in **Appendix C**.

Table 4-7 Culvert Hydraulic Design Information

Pipe Name	Number of Barrels	Diameter (D, inch)	Manning's n Value	Upstream Invert (feet)	Downstream Invert (feet)	Length (feet)	Slope (%)
01	1	24	0.012	6027.39	6026.57	48.69	1.68
02	2	15[1]	0.012	6011.46	6010.99	88.67	0.54
03	1	15	0.012	6007.94	6007.66	84.11	0.33
05	1	18	0.012	6010.10	6009.96	70.68	0.20
06	1	15	0.012	6012.75	6012.49	109.24	0.24
07	2	15	0.012	6009.85	6009.66	94.28	0.20

[1] Arch pipes with a rise of 11-inch and a span of 18-inch, equivalent to a 15-inch circular diameter pipe, provided due to cover restrictions.

Table 4-8 Culvert Hydraulic Results

Pipe Name	10-Year Flow (CFS)	10-Year Velocity (FPS)	Min Velocity (FPS)	100-Year Flow (CFS)	100-Year Velocity (FPS)	Riprap Required	Roadway Overtopping in 100-Year Event
01	3.45	6.44	2.50	10.39	8.40	Yes	No
02	4.72	2.90	2.50	11.57	5.53	Yes	No
03[1]	1.14	3.01	2.50	1.14	3.01	No	No
05	4.66	4.65	2.50	9.26	6.23	Yes	No
06	1.20	3.19	2.50	2.53	4.02	No	No
07	6.22	4.32	2.50	12.50	5.89	Yes	No

[1] Culvert 03 does not receive flows in the 10-year event. The 100-year design flow and velocity were used to determine requirements.

4.2.3 Riprap and Outlet Protection

The velocity required for additional protection methods, like riprap, was determined to be 5 feet per second (FPS) for the onsite channels. The maximum permissible velocity for channels with grass linings is based on channels seeded with either Kentucky Bluegrass, Tall Fescue, or Reed Canarygrass (max velocity of 5 FPS). The stormwater features onsite will be seeded with El Paso County Conservation District All-Purpose Mix. This mix blends taller grasses with native plantings that will include similar characteristics to Reed Canarygrass. The information was

determined using Table 10-4 from the County Design Standards. Riprap lining is not required for the onsite channels based on the channel velocities shown for the 100-year event in **Table 4-6**.

The 5 FPS velocity requirement was used to determine outlet protection needs for the culvert outlets and additional outlet protection. Four (4) culverts require riprap armoring at the outlet to protect against scour and erosion based on **Table 4-8**. Riprap length, width, and riprap types were determined using MHFD riprap sizing guidelines using the culvert outlet velocities from **Table 4-8**. The culverts that require outlet riprap, the outlet velocities, and sizing requirements based on the MHFD guidelines are shown in **Table 4-9**. Additional riprap sizing information and calculations are included in **Appendix C**. Riprap sizing for the overflow for the Raw Water Overflow Basin are included within Appendix C.

Table 4-9 Culvert Hydraulic Results

Pipe Name	100-Year Velocity (FPS)	Calculated Width (feet)	Calculated Length (feet)	Riprap Type
01	8.40	8.50	6.50	Type M
02	5.53	17.00	5.00	Type L
05	6.23	7.00	5.00	Type L
07	5.89	13.50	7.00	Type M

4.2.4 Detention Storage

The onsite detention basin was designed using the MHFD Detention Basin Design Workbook. The detention analysis compared existing and proposed runoff conditions and was used to determine the storage volume and outlet configuration necessary to satisfy the Full Spectrum Detention requirements of the County Design Standards.

Runoff from developed portions of the Project, including buildings, paved areas, and other impervious surfaces, is conveyed to the detention basin through the proposed channel system. Offsite runoff from the tributary basin north of the site is conveyed around the Project by the northern bypass channel and discharged through the existing culvert beneath State Highway 94 at the southeast corner of the Project.

The detention facility was designed to limit post-development discharge rates to historic pre-development runoff rates. The undeveloped Project exhibits high infiltrative conditions, and the calculated pre-development 10-year discharge rate is approximately 0 cfs. The proposed detention basin does not fully achieve the historic 10-year release rate criterion because a

conventional detention basin outlet design cannot reduce discharge rates to 0 cfs. Compliance with a 0 cfs release rate requires implementation of an infiltration-based stormwater management facility rather than a conventional detention basin. The downstream facilities are not expected to experience negative impacts and will not produce adverse effects with the minimal Project changes.

The proposed detention basin includes approximately 1.3 acre-feet of storage and utilizes an outlet structure similar to Figure 2-a in the El Paso County Drainage Criteria Manual to control releases. The detention analysis demonstrates that the basin provides the maximum practicable reduction in post-development runoff while maintaining a feasible and maintainable drainage design. The detention pond includes an estimated volume of 0.15 acre-feet for the Water Quality Capture Volume (WQCV) and 0.25 acre-feet for the Excess Urban Runoff Volume (EURV) along with the detention and reduction of rates. Detailed detention calculations and MHFD workbook outputs are included in **Appendix D**.

Runoff will be routed through grassed channels to convey Project drainage, instead of storm sewer outside of the detention basin design. The routing method is preferred and provides runoff reduction based on the County Design Standards. The channels will be stabilized after construction providing an additional buffer for treating stormwater and providing the potential for infiltration to occur. The runoff method was used in determining the Water Quality Treatment Summary table within **Appendix D.2**. Appendix D.2 contains a filled out Permanent Control Measures (PCM) Applicability Form for the Project. The Project includes no exclusion areas for PCM requirements and the detention basin described is designed to meet the requirements for El Paso County's PCMs.

4.2.5 Maintenance Access

Maintenance of the detention basin, drainage channels, culverts, and associated stormwater infrastructure will be the responsibility of the CMD. Access to drainage facilities will be provided via the Project access road and internal maintenance routes. The drainage design provides adequate access for routine inspection, sediment removal, vegetation management, repairs, and maintenance activities with gravel road access around the onsite detention basin and channels adjacent to roadways.

4.2.6 Structural and Non-Structural BMPs

Permanent stormwater quality measures are incorporated into the Project design through the detention basin and associated drainage infrastructure. Temporary BMPs will be implemented in accordance with the approved Erosion and Sediment Control Plan. Typical BMPs will include silt fence, vehicle tracking controls, wattles, inlet protection, temporary seeding, and stabilization of

disturbed areas. Disturbed areas not occupied by buildings, pavement, or other improvements will be revegetated to reduce erosion potential and promote long-term site stability .

4.2.7 Easements

No additional stormwater drainage and utility easements will be acquired for the Project. Permanent access easements and temporary construction easements are shown for the east-west portion of the access road and drainage facilities. Easement limits are shown within the Drawings.

5. Conclusions

5.1 Compliance with Standards

The drainage design for the Project complies with El Paso County Stormwater Design Requirements and the MHFD Standards as applicable.

5.2 Drainage Concept

Flow from disturbed constructed areas will be routed into a central detention and water quality basin to the extent possible. De minimis flow for the Project access approach near Ellicott Highway drain directly to the El Paso County Highway ditch due to topography. Other flows that drain around the onsite detention basin will be routed through onsite grassed channels. The flow patterns and drainage discharge points match existing conditions.

Appendix A.1 – FIRM Maps

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242 or visit its website at http://www.ngs.noaa.gov/.

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, and Anderson Consulting Engineers, Inc. These data are current as of 2008.

This map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

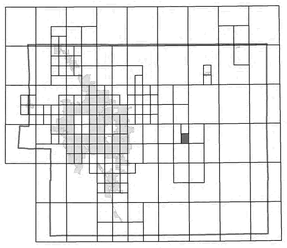
If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

El Paso County Vertical Datum Offset Table

Flooding Source	Vertical Datum Offset (ft)

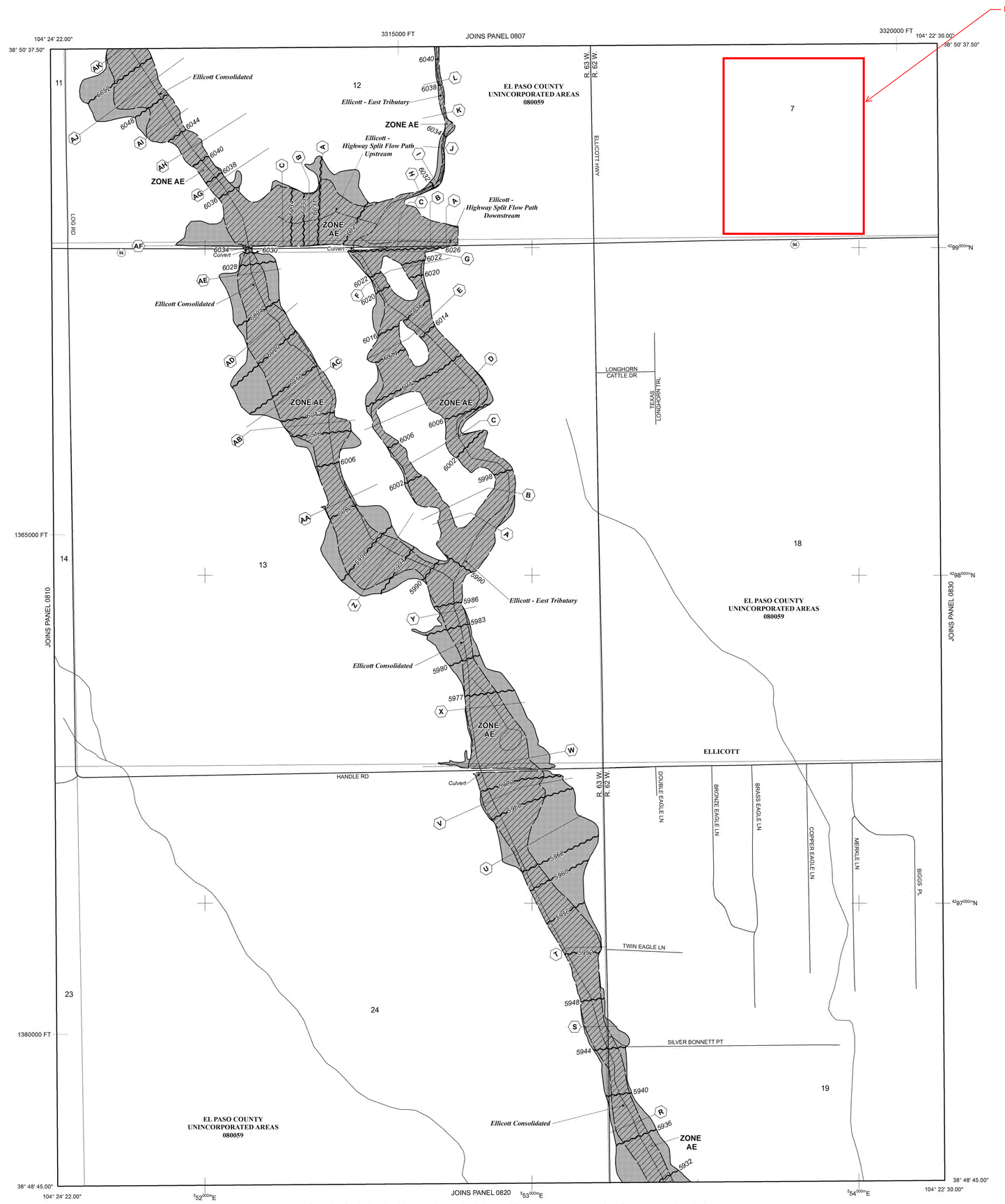
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION

Panel Location Map



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWCB) and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	Floodplain boundary
	Floodway boundary
	Zone D Boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 — 23	Transect line
97° 07' 30.00" 32° 22' 30.00"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000mN	1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 FT	5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
MARCH 17, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
DECEMBER 7, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

For community map revision history prior to countywide mapping, refer to the Community Map History Table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

PANEL 0809G

MAP NUMBER 08041C0809G EFFECTIVE DATE DECEMBER 7, 2018

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 809 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	0809	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER 08041C0809G

MAP REVISED DECEMBER 7, 2018

Federal Emergency Management Agency

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242 or visit its website at http://www.ngs.noaa.gov/.

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, and Anderson Consulting Engineers, Inc. These data are current as of 2008.

This map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

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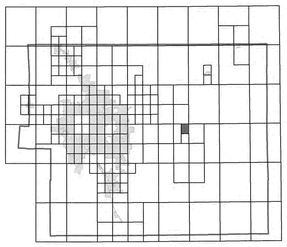
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El Paso County Vertical Datum Offset Table

Flooding Source	Vertical Datum Offset (ft)

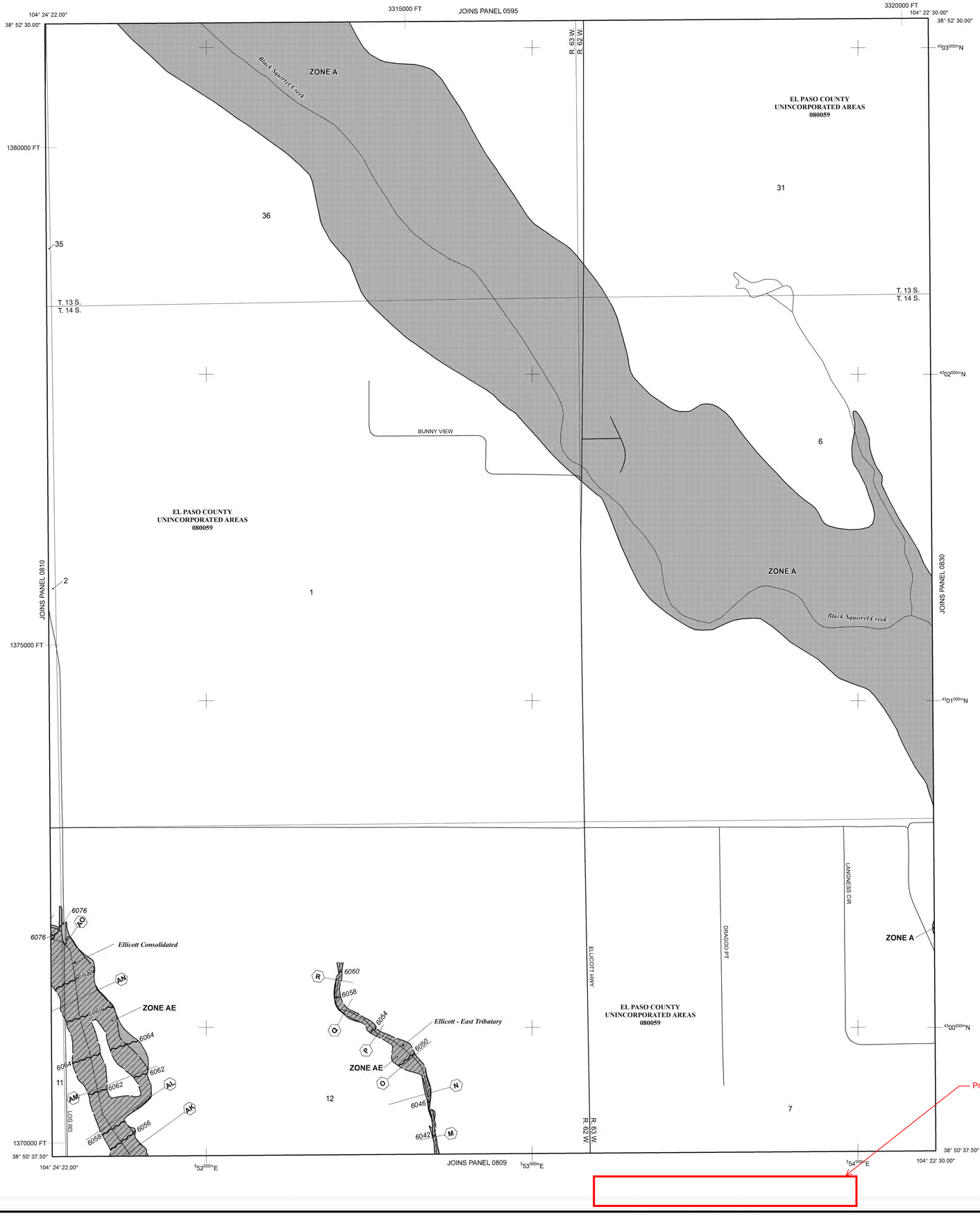
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Panel Location Map



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FLOODWAY AREAS IN ZONE AE

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Floodway boundary
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Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
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250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

PANEL 0807G

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 807 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	0807	G

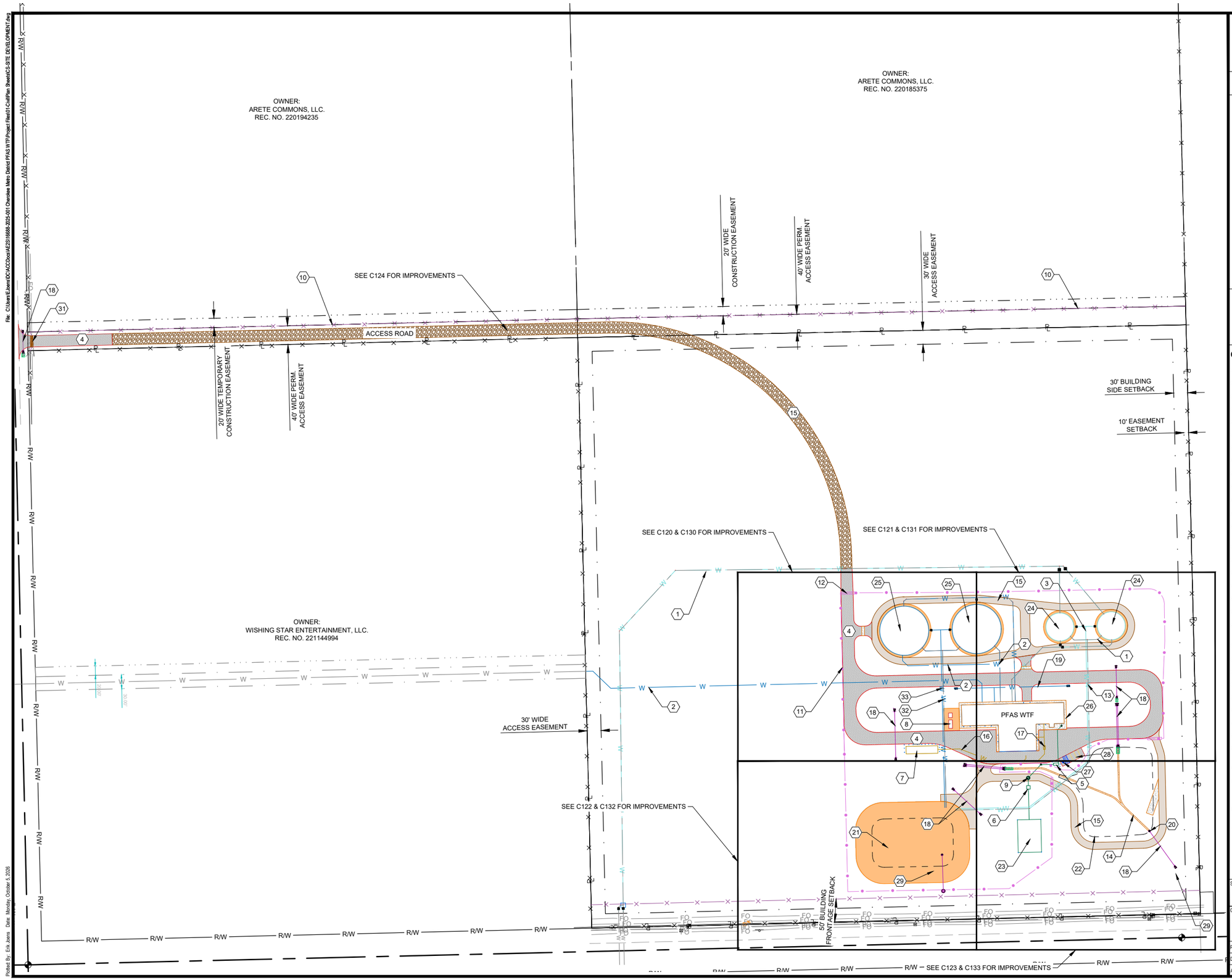
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
08041C0807G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

Appendix A.2 – Overall Site Plan



File: C:\Users\EJoens\DOCS\DocsAE2S\16688-2025-001 Cherokee Metro District PFAS WTP\Project Files\01-Civil\Plan Sheets\C-S SITE DEVELOPMENT.dwg
Plotted By: Erik Joens Date: Monday, October 5, 2026

Certification of Individual Project Design Disciplines Are Included On Their Individual Drawings, Respectively

Advanced Engineering and Environmental Services, LLC
NOT FOR CONSTRUCTION
PRELIMINARY

STATUS: **PRELIMINARY - NOT FOR CONSTRUCTION**

REVISIONS	SYM	DATE	APPR

NORTH

0 100
Scale in Feet

CONSTRUCTION NOTES

1. RAW WATER MAIN, SEE SHEET C250 - C256
2. FINISHED WATER MAIN, SEE SHEETS C260 - C263
3. RAW WATER TANK DRAIN, SEE SHEET C252 AND C253
4. WIDE ASPHALT ROAD PER DETAIL 1/C705
5. SEPTIC TANK PER DETAIL 2/C704
6. SEPTIC PUMP TANK PER DETAIL 1/C704
7. WASTE HOLDING TANK
8. STANDBY GENERATOR, CT CABINET, AND XFRMR
9. SANITARY SEWER, SEE SHEET C290
10. 5-STRAND BARBED WIRE FENCE.
11. CHAIN LINK W/ 3-STRAND BARB-WIRE PER DETAIL 1/C706
12. AUTOMATIC CANTILEVER SLIDE GATE PER DETAIL 2/C706
13. RAW WATER TANK OVERFLOW, SEE SHEET C254 AND C255
14. TRICKLE CHANNEL PER DETAIL 2/C705
15. GRAVEL ROAD PER DETAIL 1/C705
16. WASTE DRAIN, SEE SHEET C291
17. SAND/OIL SEPARATOR
18. STORM CULVERT, SEE SHEETS C280 - C282
19. WATERMAIN TO HYDRANTS
20. POND OUTLET CONTROL STRUCTURE AND OUTFALL PIPE PER DETAIL 3/C705
21. TANK DRAIN AND OVERFLOW BASIN
22. WATER DETENTION POND
23. SEPTIC MOUND AREA
24. RAW WATER TANK
25. FINISHED WATER TANK
26. CONCRETE SIDEWALK PER DETAIL 3/C706
27. VAN ACCESSIBLE ADA SPACE
28. EMPLOYEE PARKING
29. TANK DRAIN AND OVERFLOW BASIN DEWATERING MANHOLE
30. CHAIN LINK DOUBLE SWING GATE
31. INSTALL STEEL WING CATTLE GUARD PER CDOT STANDARD DETAIL M-611-1. CONNECT TO BARBED WIRE FENCE ON EITHER SIDE OF ACCESS ROAD.
32. FINISH WATER TANK OVERFLOW, SEE SHEET C265 AND C266
33. FINISH WATER TANK DRAIN, SEE SHEET C264 AND C262

PROJECT TITLE:
PFAS WATER TREATMENT FACILITY

Advanced Engineering and Environmental Services, LLC www.ae2s.com

SHEET TITLE:
SITE DEVELOPMENT PLAN

CLIENT:
CHEROKEE METROPOLITAN DISTRICT
23838 CO-94, CALHAN, CO 80808

PREPARED BY: JJF
CHECKED BY: BG
APPROVED BY: BG

PROJECT NO: 16688-2025-001
DATE: OCTOBER 2026
ALT. PROJECT NO: 00000-0000

SHEET DESIGNATOR: **SW**

SHEET NO: **C100**

Appendix A.3 – Site Grading Plan

File: C:\Users\EJones\DCWCDocs\AE2S\16688.2025-001 Cherokee Metro District PFAS WTF\Project Files\01-Civil\Plan Sheets\CS-GRADING PLAN.dwg

SEE PLAN AND PROFILES - ACCESS ROADWAY SHEETS FOR ACCESS ROAD GRADING

CHANNEL 01

CHANNEL 02

FINISHED WATER TANK 1
105' Ø 1.5 M GAL
FFE: 6013.00

FINISHED WATER TANK 2
105' Ø 1.5 M GAL
FFE: 6013.00

PFAS WTF
FFE: 6014.00

NORTH

0 20
Scale in Feet

Certification of Individual Project Design Disciplines Are Included On Their Individual Drawings, Respectively

Advanced Engineering and Environmental Services, LLC
NOT FOR CONSTRUCTION
PRELIMINARY

STATUS: **PRELIMINARY - NOT FOR CONSTRUCTION**

REVISIONS			
SYM	DATE		APPR

PFAS WATER TREATMENT FACILITY

PROJECT TITLE:

Advanced Engineering and Environmental Services, LLC www.ae2s.com

SHEET TITLE:

FINISHED SITE GRADING

CLIENT:
CHEROKEE METROPOLITAN DISTRICT
23838 CO-94, CALHAN, CO 80808

PREPARED BY: JJF
CHECKED BY: BG
APPROVED BY: BG

PROJECT NO: 16688-2025-001
DATE: OCTOBER 2026
ALT. PROJECT NO: 00000-0000

SHEET DESIGNATOR: **SW**

SHEET NO: **C130**

Plotted By: Erik Jones Date: Monday, October 5, 2026

File: C:\Users\EJoens\DCWCDocs\4625\16688.2025-001 Cherokee Metro District PFAS WTF\Project Files\01-Civil\Plan Sheets\CS-GRADING PLAN.dwg

Plotted By: Erik Joens Date: Monday, October 5, 2026

FINISHED WATER TANK 2
105' Ø 1.5 M GAL

FFE: 6013.00

RAW WATER
TANK 1
60' Ø 0.5 M GAL

FFE: 6013.00

RAW WATER
TANK 2
60' Ø 0.5 MIL GAL

FFE: 6013.00

PFAS WTF

FFE: 6014.00

30' BUILDING
SIDE SETBACK

CHANNEL 01

10' EASEMENT
SETBACK

OWNER:
RODERICK E. WILSON
& JODI R. WILSON
REC. NO. 215057611

NORTH

0 20
Scale in Feet

Certification of Individual Project Design Disciplines Are Included On Their Individual Drawings, Respectively

Advanced Engineering and Environmental Services, LLC
NOT FOR CONSTRUCTION
PRELIMINARY

STATUS: PRELIMINARY - NOT FOR CONSTRUCTION

REVISIONS	SYM	DATE	APPR

PROJECT TITLE:
PFAS WATER TREATMENT FACILITY

Advanced Engineering and Environmental Services, LLC www.ae2s.com

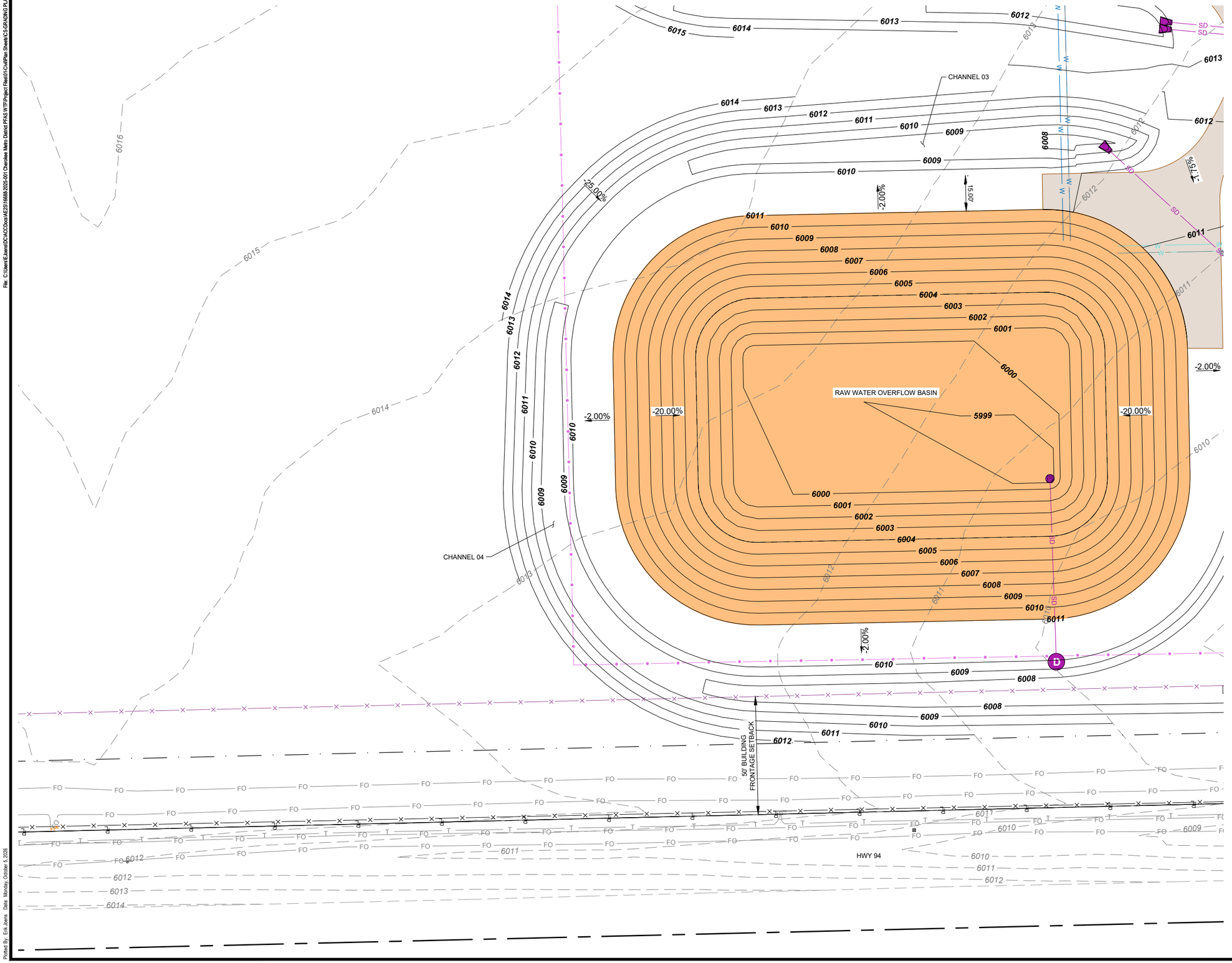
SHEET TITLE:
FINISHED SITE GRADING

CLIENT:
CHEROKEE METROPOLITAN DISTRICT
23838 CO-94, CALHAN, CO 80808

PREPARED BY: JJF
CHECKED BY: BG
APPROVED BY: BG

PROJECT NO: 16688-2025-001
DATE: OCTOBER 2026
ALT. PROJECT NO: 00000-0000

SHEET DESIGNATOR: SW
SHEET NO: C131



Certification of Individual Project Design Disciplines Are Included On Their Individual Drawings, Respectively

Advanced Engineering and Environmental Services, LLC NOT FOR CONSTRUCTION PRELIMINARY

STATUS: **PRELIMINARY - NOT FOR CONSTRUCTION**

REVISIONS			
SYM	DATE		APPR

NORTH

0 20
Scale in Feet

PFAS WATER TREATMENT FACILITY

Advanced Engineering and Environmental Services, LLC www.ae2s.com

PROJECT TITLE:

SHEET TITLE:

FINISHED SITE GRADING

CLIENT:
CHEROKEE METROPOLITAN DISTRICT
23838 CO-94, CALHAN, CO 80808

PREPARED BY: JJF
CHECKED BY: BG
APPROVED BY: BG

PROJECT NO: 16688-2025-001
DATE: OCTOBER 2026
ALT. PROJECT NO: 00000-0000

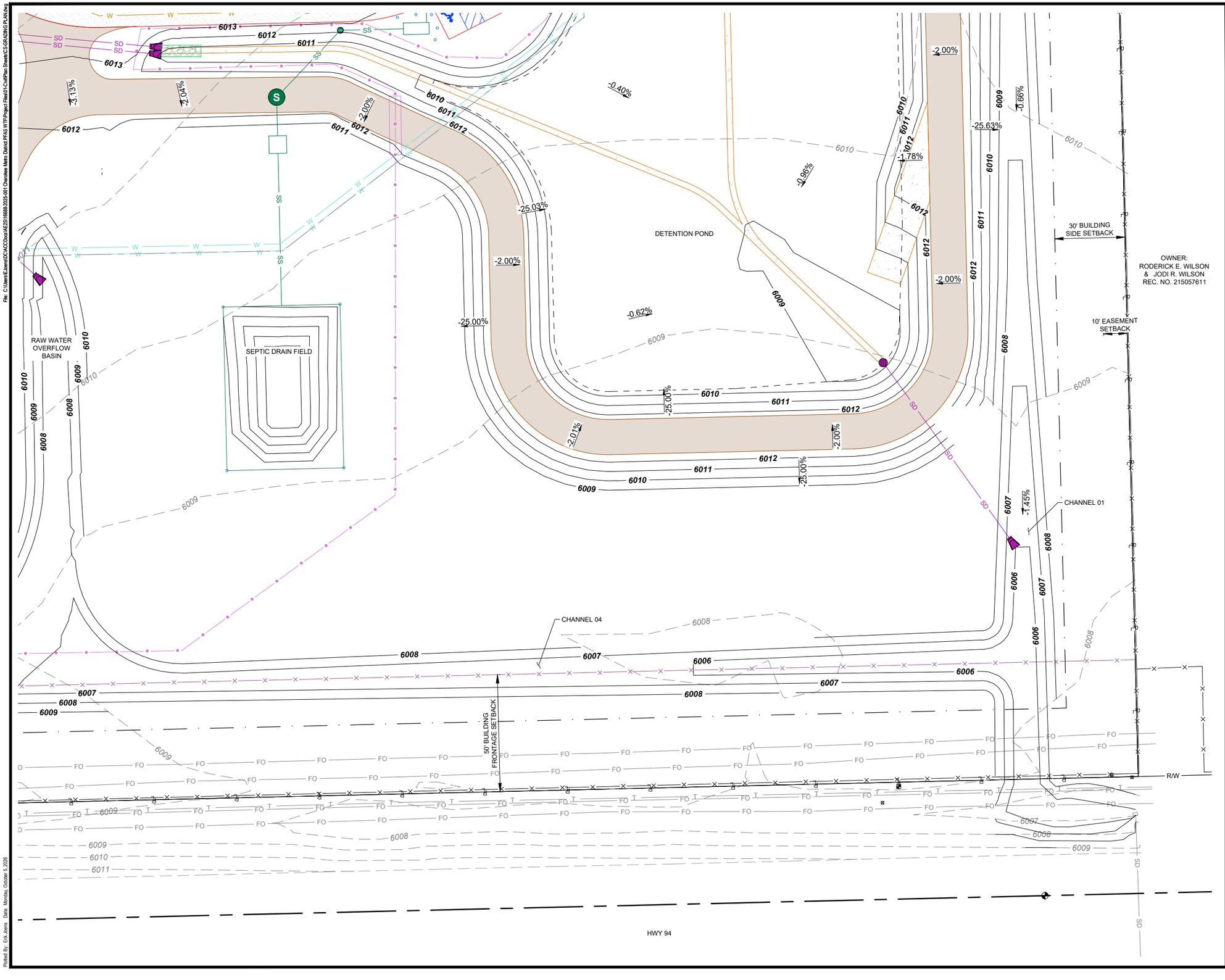
SHEET DESIGNATOR: **SW**

SHEET NO: **C132**

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Plotted By: Erik Joens Date: Monday, October 5, 2026

File: C:\Users\EJoens\DCWCDocs\AE2S\16688\2025-001 Cherokee Metro District PFAS WTF\Project Files\01-Civil\Plan Sheets\CS-GRADING PLAN.dwg



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Advanced Engineering and Environmental Services, LLC
NOT FOR CONSTRUCTION
PRELIMINARY

NORTH

0 20
Scale in Feet

REVISIONS	SYM	DATE	APPR
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PROJECT TITLE:
PFAS WATER TREATMENT FACILITY
Advanced Engineering and Environmental Services, LLC www.ae2s.com

SHEET TITLE:
FINISHED SITE GRADING

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CHEROKEE METROPOLITAN DISTRICT
23838 CO-94, CALHAN, CO 80808

PREPARED BY: JJF
CHECKED BY: BG
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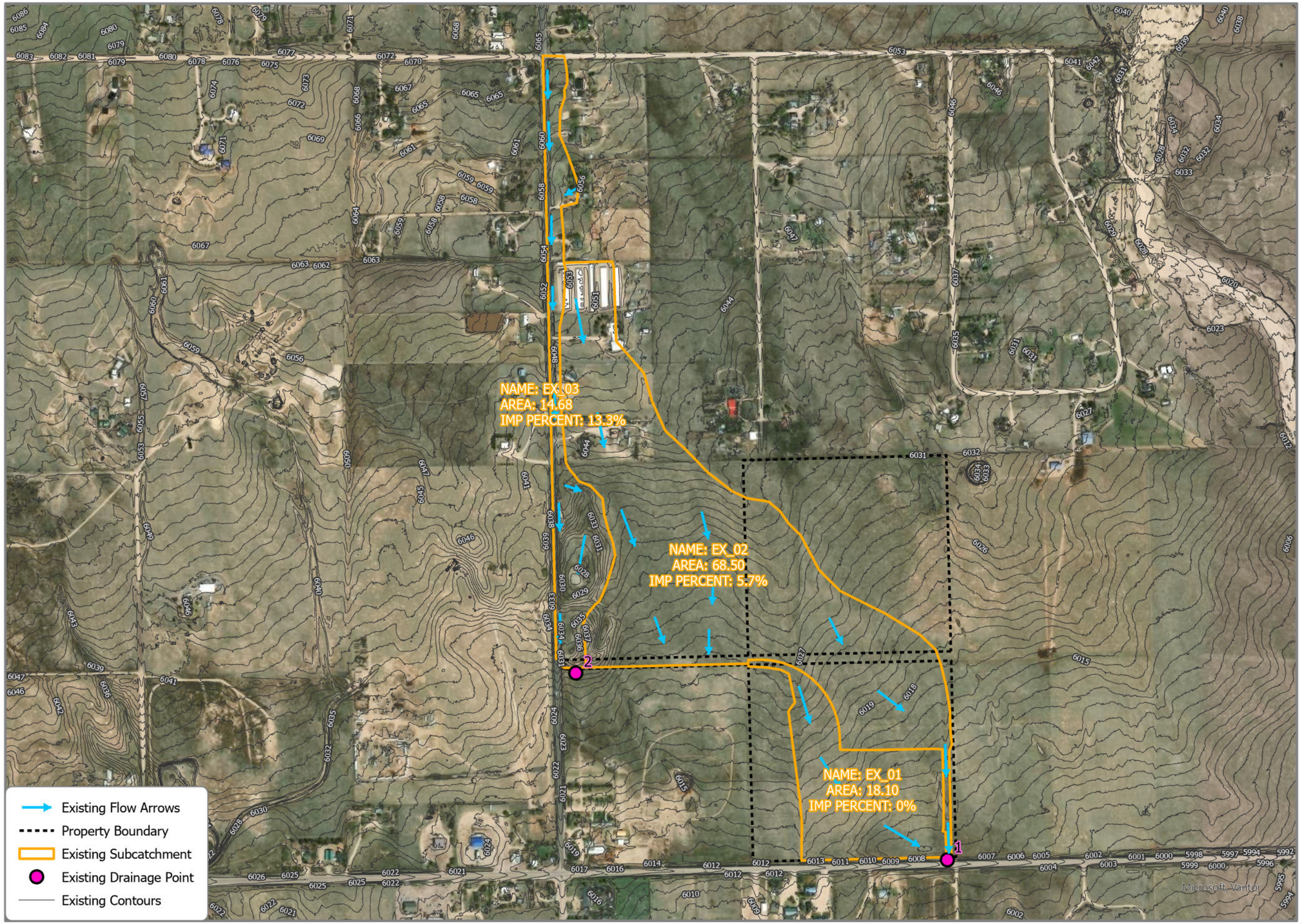
PROJECT NO: 16688-2025-001
DATE: OCTOBER 2026
ALT. PROJECT NO: 00000-0000

SHEET DESIGNATOR: **SW**
SHEET NO: **C133**

Plotted By: Erik Joens Date: Monday, October 5, 2026

Appendix A.4 – Existing Conditions Drainage Exhibit

www.ae2s.com | Advanced Engineering and Environmental Services, LLC



N

0 300 600

Feet

1 inch equals 600 feet



Locator Map Not to Scale

Cherokee
El Paso County, CO

Figure 1

EXISTING CONDITIONS

CHEROKEE PFAS WATER TREATMENT FACILITY/ EL PASO COUNTY, CO

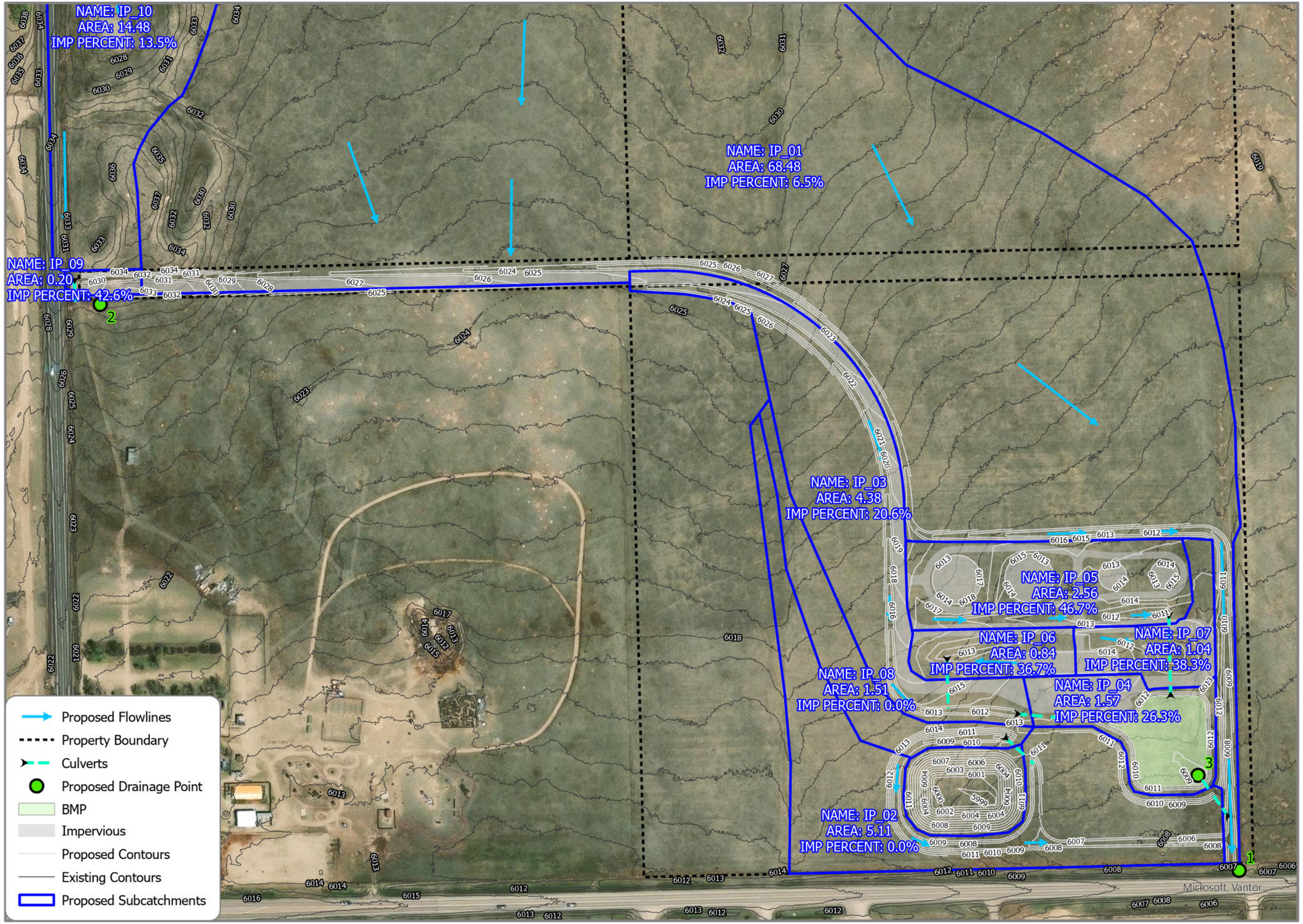
Date: 10/4/2026

Information depicted may include data unverified by AE2S. Any reliance upon such data is at the user's own risk. AE2S does not warrant this map or its features are either spatially or temporally accurate.

Coordinate System: NAD 1983 2011 StatePlane Colorado Central FIPS 0502 Ft US | Edited by: SLarson | C:\Users\SLarson\AE2S\Cherokee Metro District PFAS WTF - Documents\10.0 GIS\Cherkoee PFAS WTP.aprx | Existing

Appendix A.5 – Proposed Conditions Drainage Exhibit

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N

0 100 200

Feet

1 inch equals 200 feet



Locator Map Not to Scale

Cherokee
El Paso County, CO

Figure 2

PROPOSED CONDITIONS

CHEROKEE PFAS WATER TREATMENT FACILITY/ EL PASO COUNTY, CO

Date: 10/4/2026

Information depicted may include data unverified by AE2S. Any reliance upon such data is at the user's own risk. AE2S does not warrant this map or its features are either spatially or temporally accurate.

Coordinate System: NAD 1983 2011 StatePlane Colorado Central FIPS 0502 Ft US | Edited by: SLarson | C:\Users\SLarson\AE2S\Cherokee Metro District PFAS WTF - Documents\10.0 GIS\Cherkoee PFAS WTP.aprx | Improved

Appendix B.1 – NOAA Atlas 14 Point Precipitation Frequency Estimates

NOAA Atlas 14, Volume 8, Version 2
Location name: Ellicott, Colorado, USA*
Latitude: 38.8412°, Longitude: -104.374°
Elevation: 6011 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

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	**2.89** (2.32-3.66)	**3.54** (2.83-4.49)	**4.67** (3.72-5.94)	**5.68** (4.49-7.24)	**7.14** (5.51-9.48)	**8.35** (6.29-11.2)	**9.62** (7.00-13.2)	**11.0** (7.67-15.4)	**12.9** (8.65-18.4)	**14.4** (9.41-20.8)
10-min	**2.12** (1.70-2.68)	**2.59** (2.08-3.29)	**3.42** (2.72-4.34)	**4.15** (3.29-5.30)	**5.23** (4.04-6.94)	**6.11** (4.60-8.19)	**7.04** (5.12-9.64)	**8.03** (5.62-11.2)	**9.42** (6.34-13.5)	**10.5** (6.88-15.2)
15-min	**1.72** (1.38-2.18)	**2.11** (1.68-2.67)	**2.78** (2.22-3.53)	**3.38** (2.68-4.30)	**4.25** (3.28-5.64)	**4.97** (3.74-6.66)	**5.72** (4.17-7.84)	**6.53** (4.57-9.15)	**7.66** (5.15-11.0)	**8.56** (5.60-12.4)
30-min	**1.31** (1.05-1.66)	**1.60** (1.28-2.03)	**2.10** (1.67-2.67)	**2.55** (2.02-3.25)	**3.20** (2.47-4.25)	**3.74** (2.82-5.02)	**4.31** (3.14-5.90)	**4.92** (3.44-6.89)	**5.77** (3.88-8.27)	**6.44** (4.21-9.31)
60-min	**0.836** (0.669-1.06)	**1.03** (0.823-1.30)	**1.37** (1.09-1.74)	**1.66** (1.32-2.12)	**2.10** (1.62-2.79)	**2.46** (1.85-3.29)	**2.84** (2.06-3.88)	**3.24** (2.26-4.53)	**3.80** (2.55-5.44)	**4.24** (2.77-6.13)
2-hr	**0.508** (0.409-0.640)	**0.630** (0.506-0.793)	**0.841** (0.673-1.06)	**1.03** (0.818-1.30)	**1.30** (1.01-1.71)	**1.52** (1.15-2.03)	**1.76** (1.29-2.39)	**2.01** (1.41-2.79)	**2.35** (1.60-3.35)	**2.63** (1.73-3.78)
3-hr	**0.361** (0.291-0.452)	**0.449** (0.362-0.564)	**0.603** (0.485-0.758)	**0.739** (0.591-0.932)	**0.938** (0.730-1.23)	**1.10** (0.836-1.46)	**1.27** (0.935-1.72)	**1.45** (1.03-2.01)	**1.71** (1.16-2.42)	**1.91** (1.26-2.73)
6-hr	**0.205** (0.167-0.256)	**0.247** (0.200-0.308)	**0.322** (0.260-0.402)	**0.390** (0.313-0.489)	**0.494** (0.389-0.648)	**0.581** (0.446-0.769)	**0.675** (0.501-0.912)	**0.777** (0.554-1.07)	**0.922** (0.633-1.30)	**1.04** (0.693-1.48)
12-hr	**0.112** (0.091-0.138)	**0.132** (0.107-0.163)	**0.168** (0.137-0.209)	**0.202** (0.163-0.252)	**0.254** (0.201-0.332)	**0.298** (0.230-0.392)	**0.346** (0.258-0.464)	**0.398** (0.286-0.546)	**0.472** (0.327-0.663)	**0.532** (0.358-0.752)
24-hr	**0.060** (0.049-0.074)	**0.071** (0.058-0.087)	**0.090** (0.073-0.110)	**0.107** (0.087-0.133)	**0.134** (0.107-0.174)	**0.157** (0.122-0.206)	**0.182** (0.137-0.243)	**0.210** (0.152-0.287)	**0.249** (0.174-0.348)	**0.281** (0.190-0.395)
2-day	**0.033** (0.027-0.041)	**0.038** (0.032-0.047)	**0.048** (0.039-0.059)	**0.057** (0.047-0.070)	**0.071** (0.057-0.092)	**0.083** (0.065-0.108)	**0.096** (0.073-0.128)	**0.111** (0.081-0.150)	**0.131** (0.092-0.182)	**0.148** (0.101-0.207)
3-day	**0.024** (0.020-0.029)	**0.028** (0.023-0.034)	**0.035** (0.029-0.043)	**0.042** (0.034-0.051)	**0.052** (0.042-0.066)	**0.060** (0.047-0.078)	**0.070** (0.053-0.092)	**0.079** (0.058-0.107)	**0.094** (0.066-0.129)	**0.105** (0.072-0.146)
4-day	**0.019** (0.016-0.023)	**0.023** (0.019-0.028)	**0.029** (0.024-0.035)	**0.034** (0.028-0.041)	**0.042** (0.034-0.053)	**0.049** (0.038-0.062)	**0.056** (0.042-0.073)	**0.063** (0.046-0.085)	**0.074** (0.052-0.102)	**0.083** (0.057-0.115)
7-day	**0.013** (0.011-0.016)	**0.015** (0.013-0.019)	**0.019** (0.016-0.023)	**0.022** (0.018-0.027)	**0.027** (0.022-0.035)	**0.032** (0.025-0.040)	**0.036** (0.027-0.047)	**0.041** (0.030-0.054)	**0.047** (0.033-0.065)	**0.053** (0.036-0.073)
10-day	**0.010** (0.009-0.013)	**0.012** (0.010-0.015)	**0.015** (0.012-0.018)	**0.018** (0.014-0.021)	**0.021** (0.017-0.027)	**0.024** (0.019-0.031)	**0.028** (0.021-0.036)	**0.031** (0.023-0.042)	**0.036** (0.026-0.049)	**0.040** (0.028-0.055)
20-day	**0.007** (0.005-0.008)	**0.008** (0.006-0.009)	**0.010** (0.008-0.012)	**0.011** (0.009-0.014)	**0.014** (0.011-0.017)	**0.016** (0.012-0.020)	**0.017** (0.013-0.023)	**0.019** (0.014-0.026)	**0.022** (0.016-0.030)	**0.024** (0.017-0.033)
30-day	**0.005** (0.004-0.006)	**0.006** (0.005-0.007)	**0.008** (0.006-0.009)	**0.009** (0.007-0.011)	**0.011** (0.009-0.013)	**0.012** (0.010-0.015)	**0.013** (0.010-0.017)	**0.015** (0.011-0.019)	**0.017** (0.012-0.022)	**0.018** (0.012-0.025)
45-day	**0.004** (0.003-0.005)	**0.005** (0.004-0.006)	**0.006** (0.005-0.007)	**0.007** (0.006-0.008)	**0.008** (0.007-0.010)	**0.009** (0.007-0.012)	**0.010** (0.008-0.013)	**0.011** (0.008-0.015)	**0.012** (0.009-0.017)	**0.013** (0.009-0.018)
60-day	**0.004** (0.003-0.004)	**0.004** (0.003-0.005)	**0.005** (0.004-0.006)	**0.006** (0.005-0.007)	**0.007** (0.005-0.008)	**0.008** (0.006-0.009)	**0.008** (0.006-0.011)	**0.009** (0.007-0.012)	**0.010** (0.007-0.013)	**0.011** (0.007-0.014)

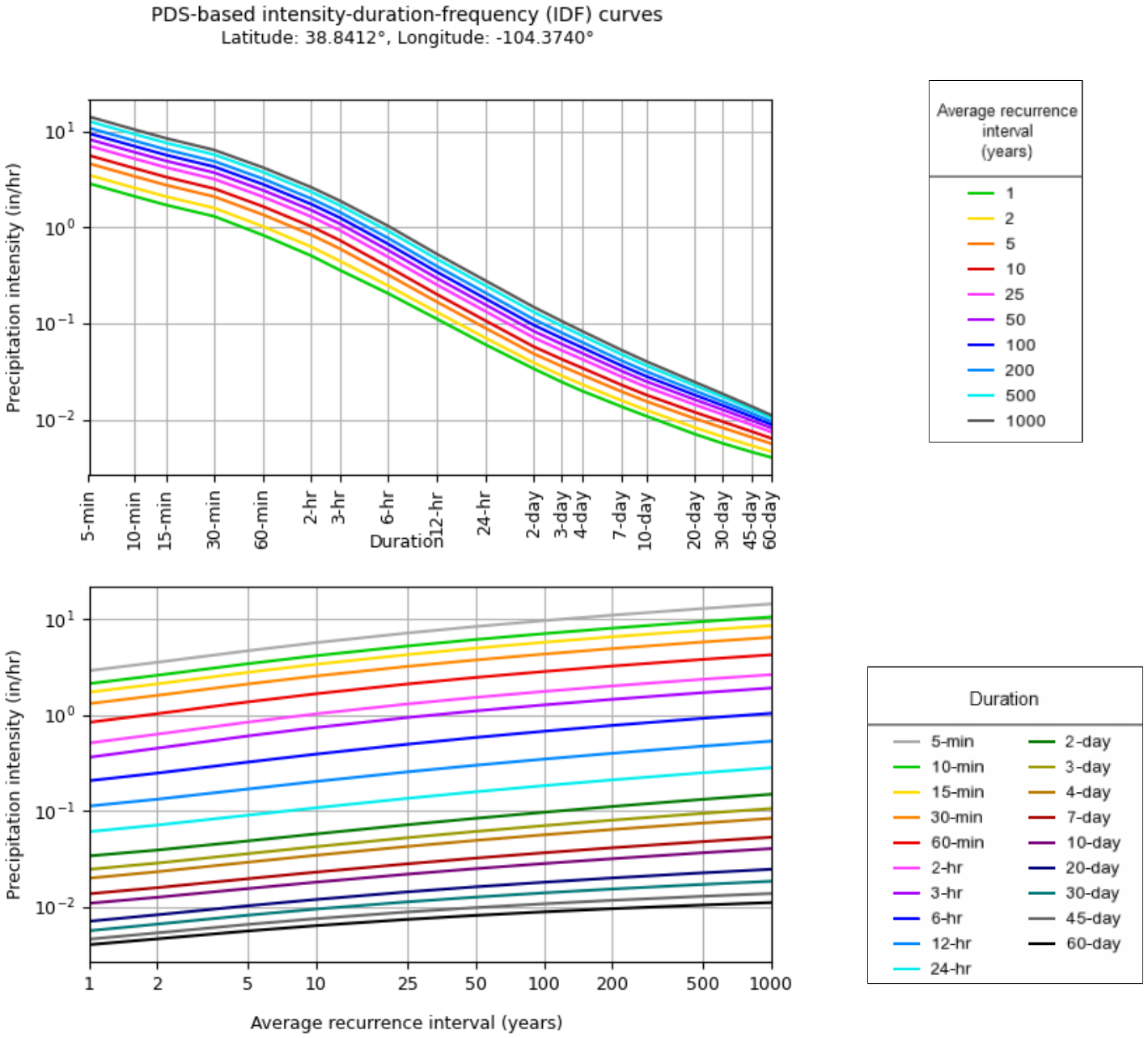
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

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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PF graphical



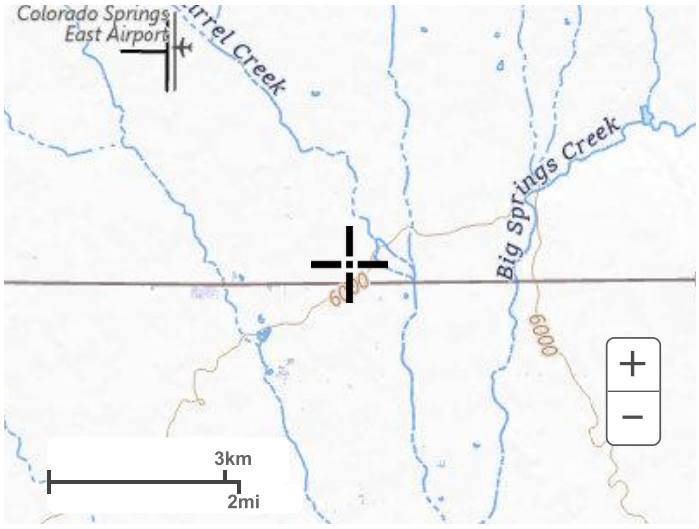
NOAA Atlas 14, Volume 8, Version 2

Created (GMT): Mon Oct 5 01:54:46 2026

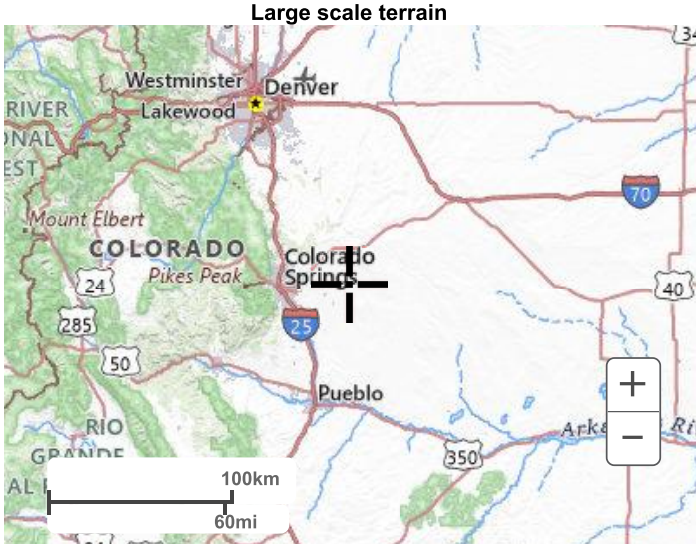
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Maps & aerials

Small scale terrain



Large scale terrain



Large scale map



Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Appendix B.2 – Existing Conditions Rational Method Calculations

Calculation of Peak Runoff using Rational Method

Designer:
Company:
Date: 10/4/2026
Project:
Location:

MHFD-Rational, Version 3.00 (August 2025)

Cells of this color are for required user-input
Cells of this color are for optional override values

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_i^{0.33}}$$

$$t_t = \frac{L_t}{60K\sqrt{S_t}} = \frac{L_t}{60V_t}$$

Computed $t_c = t_i + t_t$

Regional $t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$

$t_{c\,minimum}$ = 5 (urban)
$t_{c\,minimum}$ = 10 (non-urban)

Selected $t_c = \max\{t_{minimum}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$

Calculation of Peak Runoff using Rational Method

Provide input for area, soil type, and imperviousness on the Runoff Coeffs worksheet.

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group(s)	Imperviousness	Runoff Coefficient, C							Overland (Initial) Flow Time					Channelized (Travel) Flow Time						
				WQE & 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)	Overland Flow Time t_i (min)	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)
EX_01	18.10	A	0.0%	0.00	0.00	0.00	0.00	0.03	0.11	0.25	100.00			0.020	15.80	1340.00			0.015	7	0.86	26.05
EX_02	68.48	A	5.7%	0.05	0.05	0.05	0.05	0.07	0.15	0.29	100.00			0.020	15.10	5915.00			0.010	7	0.70	140.83
EX_03	14.68	A	13.3%	0.11	0.11	0.12	0.12	0.14	0.21	0.34	100.00			0.020	14.15	2300.00			0.015	7	0.86	44.71

Calculation of Peak Runoff using Rational Method

Designer:
Company:
Date:
Project:
Location:

Select MHFD location for NOAA Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained from the NOAA website (click this link)

	WQE	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
1-hour rainfall depth, P1 (in) =	0.84	1.03	1.36	1.65	2.09	2.44	2.82	3.79

	a	b	c
Rainfall Intensity Equation Coefficients =	28.50	10.00	0.786

$$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$$

$$Q(cfs) = CIA$$

Subcatchment Name	Time of Concentration				Rainfall Intensity, I (in/hr)								Peak Flow, Q (cfs)							
	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	**(Optional)** Override t_c (min)	WQE	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	WQE	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
EX_01	41.85	46.26	41.85		1.07	1.32	1.74	2.11	2.67	3.12	3.61	4.85	0.00	0.00	0.00	0.00	0.00	1.41	7.18	22.29
EX_02	155.93	125.68	125.68		0.50	0.62	0.82	0.99	1.26	1.47	1.69	2.28	1.64	2.02	2.73	3.36	4.31	7.37	17.89	45.31
EX_03	58.86	52.53	52.53		0.92	1.14	1.50	1.82	2.31	2.69	3.11	4.19	1.52	1.87	2.53	3.11	3.99	5.49	9.78	20.89

Appendix B.3 – Proposed Conditions Rational Method Calculations

Calculation of Peak Runoff using Rational Method

Designer:
Company:
Date: 10/4/2026
Project:
Location:

MHFD-Rational, Version 3.00 (August 2025)

Cells of this color are for required user-input
Cells of this color are for optional override values

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_i^{0.33}}$$

$$t_t = \frac{L_t}{60K\sqrt{S_t}} = \frac{L_t}{60V_t}$$

Computed $t_c = t_i + t_t$

Regional $t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$

$t_{c\,minimum} = 5$ (urban)
$t_{c\,minimum} = 10$ (non-urban)

Selected $t_c = \max\{t_{minimum}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$

Calculation of Peak Runoff using Rational Method

Provide input for area, soil type, and imperviousness on the Runoff Coeffs worksheet.

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group(s)	Imperviousness	Runoff Coefficient, C							Overland (Initial) Flow Time					Channelized (Travel) Flow Time						
				WQE & 2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)	Overland Flow Time t_i (min)	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)
IP_01	68.48	A	6.5%	0.05	0.06	0.06	0.06	0.08	0.16	0.30	100.00			0.02	14.99	5915.00			0.02	7.00	0.86	114.99
											100.00			0.02		2385.00			0.02	7.00	0.86	46.37
IP_02	5.11	A	0.0%	0.00	0.00	0.00	0.00	0.03	0.11	0.25	100.00			0.02	15.80	1500.00			0.02	7.00	0.86	29.16
IP_03	4.38	A	20.6%	0.17	0.18	0.18	0.18	0.20	0.27	0.39	50.00			0.02	9.37	100.00			0.02	7.00	0.99	1.68
IP_04	1.57	A	26.3%	0.22	0.23	0.23	0.23	0.25	0.31	0.42	50.00			0.02	8.87	1515.00			0.02	7.00	0.99	25.51
IP_05	2.56	A	46.7%	0.39	0.40	0.41	0.41	0.42	0.47	0.56	50.00			0.02	7.09	100.00			0.02	7.00	0.99	1.68
IP_06	0.84	A	36.7%	0.31	0.32	0.32	0.32	0.34	0.40	0.49	50.00			0.02	7.96	100.00			0.02	7.00	0.99	1.68
IP_07	1.04	A	38.3%	0.32	0.33	0.33	0.34	0.35	0.41	0.50	50.00			0.02	7.83	100.00			0.02	7.00	0.99	1.68
IP_08	1.51	A	0.0%	0.00	0.00	0.00	0.00	0.03	0.11	0.25	50.00			0.02	11.17	100.00			0.02	7.00	0.99	1.68
											50.00			0.02		100.00			0.02	7.00	0.99	1.68
IP_09	0.20	A	42.6%	0.36	0.37	0.37	0.38	0.39	0.44	0.53	50.00			0.02	7.45	100.00			0.02	7.00	0.99	1.68
IP_10	14.48	A	13.5%	0.11	0.12	0.12	0.12	0.14	0.22	0.34	100.00			0.02	14.13	2300.00			0.02	7.00	0.86	44.71

Calculation of Peak Runoff using Rational Method

Designer:
Company:
Date:
Project:
Location:

Select MHFD location for NOAA Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained from the NOAA website (click this link)

	WQE	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
1-hour rainfall depth, P1 (in) =	0.84	1.03	1.36	1.65	2.09	2.44	2.82	3.79

	a	b	c
Rainfall Intensity Equation Coefficients =	28.50	10.00	0.786

$$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$$

$$Q(cfs) = CIA$$

Subcatchment Name	Time of Concentration				Rainfall Intensity, I (in/hr)								Peak Flow, Q (cfs)							
	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	**(Optional)** Override t_c (min)	WQE	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	WQE	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
IP_01	129.98	106.11	106.11		0.57	0.70	0.92	1.12	1.42	1.66	1.91	2.57	2.12	2.62	3.54	4.36	5.59	9.14	21.07	52.16
IP_02	44.96	48.68	44.96		1.02	1.26	1.66	2.02	2.55	2.98	3.45	4.63	0.00	0.00	0.00	0.00	0.00	0.38	1.94	6.01
IP_03	11.05	23.48	11.05	10.00	2.26	2.79	3.68	4.46	5.65	6.60	7.63	10.25	1.71	2.11	2.86	3.52	4.51	5.81	9.04	17.37
IP_04	34.38	35.61	34.38	10.00	2.26	2.79	3.68	4.46	5.65	6.60	7.63	10.25	0.78	0.97	1.31	1.61	2.06	2.59	3.77	6.82
IP_05	8.77	18.82	8.77	10.00	2.26	2.79	3.68	4.46	5.65	6.60	7.63	10.25	2.27	2.80	3.79	4.66	5.98	7.16	9.26	14.58
IP_06	9.65	20.59	9.65	10.00	2.26	2.79	3.68	4.46	5.65	6.60	7.63	10.25	0.58	0.72	0.98	1.20	1.54	1.87	2.53	4.22
IP_07	9.51	20.32	9.51	10.00	2.26	2.79	3.68	4.46	5.65	6.60	7.63	10.25	0.76	0.93	1.26	1.55	1.99	2.42	3.25	5.36
IP_08	12.86	27.31	12.86		2.03	2.51	3.31	4.02	5.09	5.94	6.87	9.23	0.00	0.00	0.00	0.00	0.00	0.22	1.14	3.55
IP_09	9.13	19.55	9.13	10.00	2.26	2.79	3.68	4.46	5.65	6.60	7.63	10.25	0.16	0.19	0.26	0.32	0.41	0.50	0.66	1.06
IP_10	58.84	52.43	52.43		0.92	1.14	1.50	1.82	2.31	2.70	3.12	4.19	1.52	1.88	2.54	3.12	4.00	5.49	9.73	20.71

Appendix C.1 – Channel Sizing Calculations

Hydraulic Analysis Report

Project Data

Project Title: 2026.09.30 - Cherokee Channel & Riprap Analysis

Designer:

Project Date: Wednesday, September 30, 2026

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Channel 01 - 100 Year

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width 6.00 ft

Longitudinal Slope: 0.0080 ft/ft

Manning's n: 0.0300

Flow 21.0700 cfs

Result Parameters

Depth 0.7675 ft

Area of Flow 6.9617 ft^2

Wetted Perimeter 12.3293 ft

Hydraulic Radius 0.5646 ft

Average Velocity 3.0265 ft/s

Top Width 12.1403 ft

Froude Number: 0.7043

Critical Depth 0.6271 ft

Critical Velocity 3.9490 ft/s

Critical Slope: 0.0170 ft/ft

Critical Top Width 11.02 ft

Calculated Max Shear Stress 0.3832 lb/ft^2

Calculated Avg Shear Stress 0.2819 lb/ft^2

Channel Analysis: Channel 02 - 100 Year

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width 6.00 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0300

Flow 11.5700 cfs

Result Parameters

Depth 0.5228 ft

Area of Flow 4.2299 ft^2

Wetted Perimeter 10.3110 ft

Hydraulic Radius 0.4102 ft

Average Velocity 2.7353 ft/s

Top Width 10.1823 ft

Froude Number: 0.7479

Critical Depth 0.4392 ft

Critical Velocity 3.3959 ft/s

Critical Slope: 0.0188 ft/ft

Critical Top Width 9.51 ft

Calculated Max Shear Stress 0.3262 lb/ft^2

Calculated Avg Shear Stress 0.2560 lb/ft^2

Channel Analysis: Channel 03 - 100 Year

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width 6.00 ft

Longitudinal Slope: 0.0070 ft/ft

Manning's n: 0.0300

Flow 1.1400 cfs

Result Parameters

Depth 0.1540 ft

Area of Flow 1.0192 ft^2

Wetted Perimeter 7.2703 ft

Hydraulic Radius 0.1402 ft

Average Velocity 1.1185 ft/s

Top Width 7.2324 ft

Froude Number: 0.5251

Critical Depth 0.1015 ft

Critical Velocity 1.7531 ft/s

Critical Slope: 0.0289 ft/ft

Critical Top Width 6.81 ft

Calculated Max Shear Stress 0.0673 lb/ft^2

Calculated Avg Shear Stress 0.0612 lb/ft^2

Channel Analysis: Channel 04 - 100 Year

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width 6.00 ft

Longitudinal Slope: 0.0050 ft/ft

Manning's n: 0.0300

Flow 3.0800 cfs

Result Parameters

Depth 0.3022 ft

Area of Flow 2.1785 ft^2

Wetted Perimeter 8.4920 ft

Hydraulic Radius 0.2565 ft

Average Velocity 1.4138 ft/s

Top Width 8.4176 ft

Froude Number: 0.4897

Critical Depth 0.1927 ft

Critical Velocity 2.3604 ft/s

Critical Slope: 0.0238 ft/ft

Critical Top Width 7.54 ft

Calculated Max Shear Stress 0.0943 lb/ft^2

Calculated Avg Shear Stress 0.0800 lb/ft^2

Appendix C.2 – Culvert Sizing Calculations

HY-8 Culvert Analysis Report

Minimum Flow: 2.07 cfs

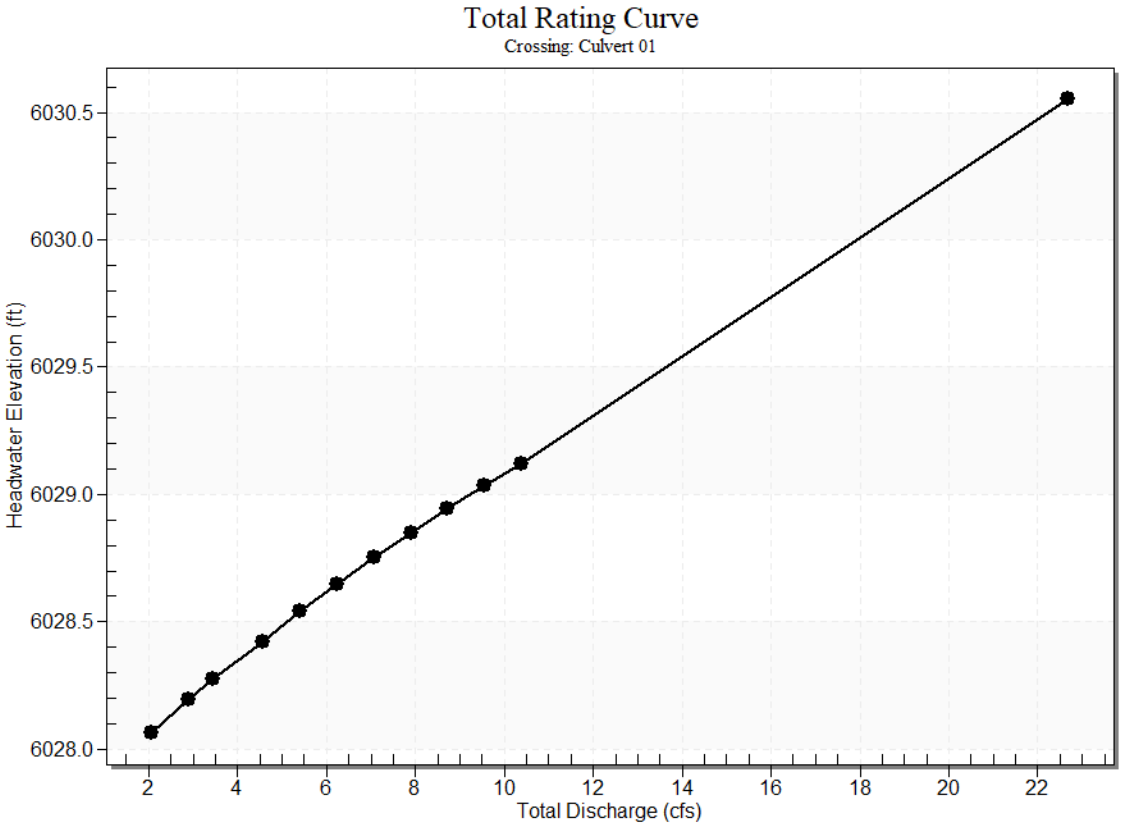
Design Flow: 3.45 cfs

Maximum Flow: 10.39 cfs

Table 11 - Summary of Culvert Flows at Crossing: Culvert 01

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 01 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6028.07	2.07	2.07	0.00	1
6028.20	2.90	2.90	0.00	1
6028.27	3.45	3.45	0.00	1
6028.42	4.57	4.57	0.00	1
6028.54	5.40	5.40	0.00	1
6028.65	6.23	6.23	0.00	1
6028.75	7.06	7.06	0.00	1
6028.85	7.89	7.89	0.00	1
6028.94	8.73	8.73	0.00	1
6029.03	9.56	9.56	0.00	1
6029.12	10.39	10.39	0.00	1
6030.50	21.14	21.14	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 01



Culvert Data: Culvert 01

Table 6 - Culvert Summary Table: Culvert 01

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.07 cfs	2.07 cfs	6028.07	0.68	0.139	1-JS1t	0.34	0.50	0.95	0.13	1.42	1.65
2.90 cfs	2.90 cfs	6028.20	0.81	0.180	1-JS1t	0.41	0.59	0.97	0.15	1.91	1.89
3.45 cfs	3.45 cfs	6028.27	0.88	0.208	1-S2n	0.44	0.65	0.45	0.17	6.44	2.02
4.57 cfs	4.57 cfs	6028.42	1.03	0.269	1-S2n	0.51	0.75	0.53	0.20	6.92	2.25

5.40 cfs	5.40 cfs	6028.54	1.15	0.317	1-S2n	0.56	0.82	0.58	0.22	7.20	2.41
6.23 cfs	6.23 cfs	6028.65	1.26	0.368	1-S2n	0.60	0.88	0.62	0.24	7.46	2.55
7.06 cfs	7.06 cfs	6028.75	1.36	0.422	1-S2n	0.64	0.94	0.67	0.26	7.68	2.67
7.89 cfs	7.89 cfs	6028.85	1.46	0.480	1-S2n	0.68	1.00	0.71	0.28	7.88	2.79
8.73 cfs	8.73 cfs	6028.94	1.55	0.542	1-S2n	0.72	1.05	0.75	0.30	8.06	2.90
9.56 cfs	9.56 cfs	6029.03	1.64	0.608	1-S2n	0.75	1.10	0.79	0.32	8.24	3.00
10.39 cfs	10.39 cfs	6029.12	1.73	0.677	1-S2n	0.79	1.15	0.83	0.34	8.40	3.10

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

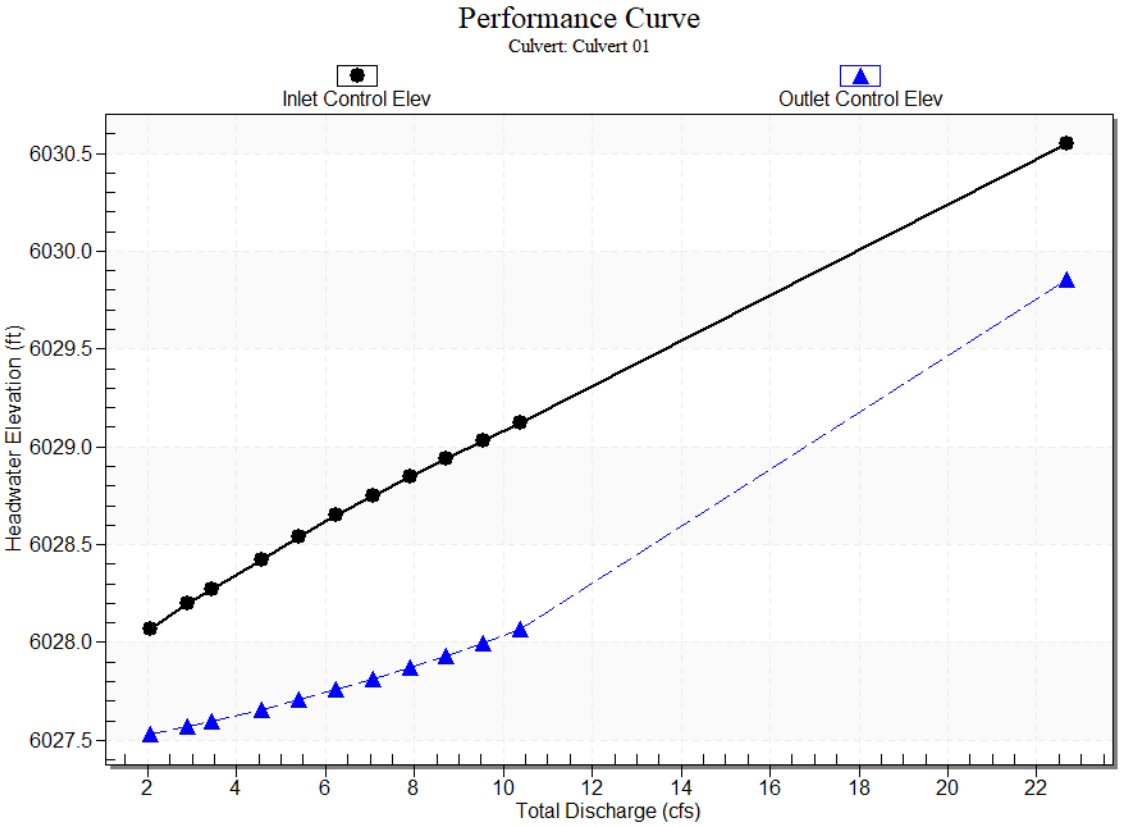
Inlet Elevation (invert): 6027.39 ft,

Outlet Elevation (invert): 6026.57 ft

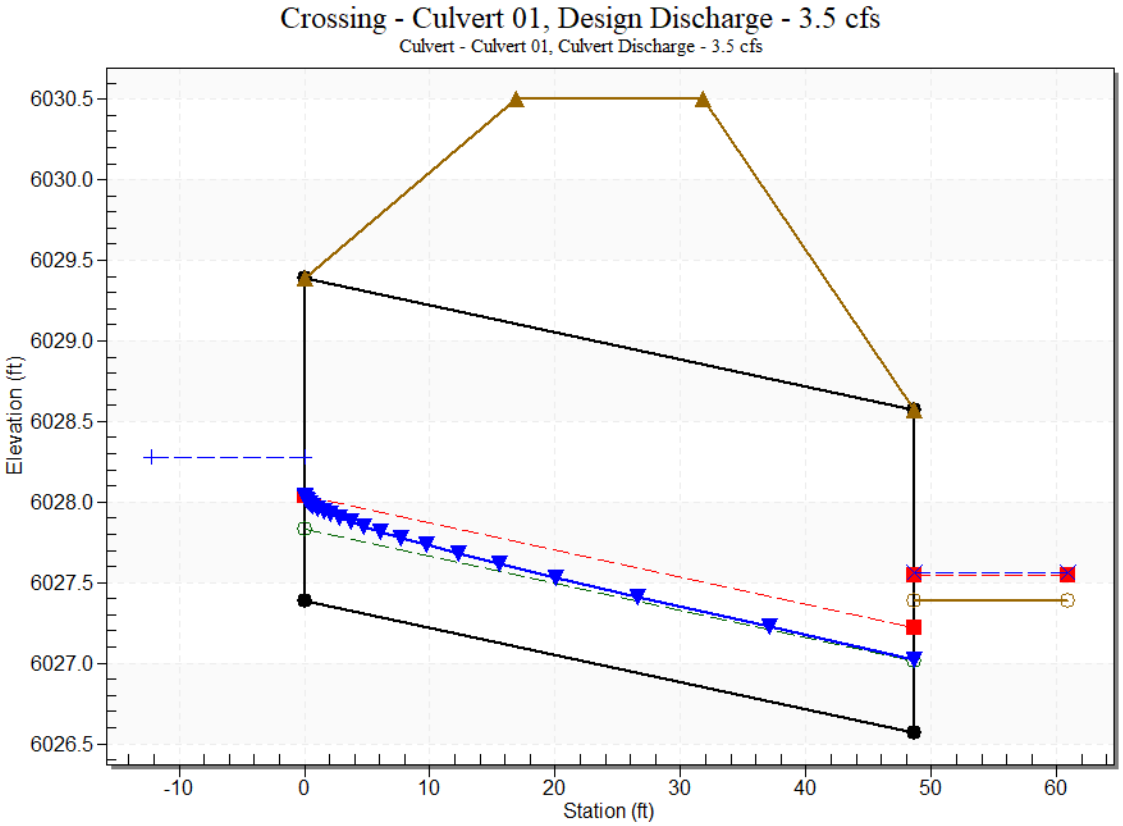
Culvert Length: 48.70 ft,

Culvert Slope: 0.0168

Culvert Performance Curve Plot: Culvert 01



Water Surface Profile Plot for Culvert: Culvert 01



Site Data - Culvert 01

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 6027.39 ft

Outlet Station: 48.69 ft

Outlet Elevation: 6026.57 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 01

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Data for Crossing: Culvert 01

Table 12 - Downstream Channel Rating Curve (Crossing: Culvert 01)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
2.07	6027.52	0.13	1.65	0.20	0.82
2.90	6027.54	0.15	1.89	0.24	0.85
3.45	6027.56	0.17	2.02	0.27	0.86
4.57	6027.59	0.20	2.25	0.32	0.88
5.40	6027.61	0.22	2.41	0.35	0.90
6.23	6027.63	0.24	2.55	0.38	0.91
7.06	6027.65	0.26	2.67	0.41	0.92
7.89	6027.67	0.28	2.79	0.44	0.92
8.73	6027.69	0.30	2.90	0.47	0.93
9.56	6027.71	0.32	3.00	0.50	0.94
10.39	6027.73	0.34	3.10	0.52	0.94

Tailwater Channel Data - Culvert 01

Tailwater Channel Option: Rectangular Channel

Bottom Width: 10.00 ft

Channel Slope: 0.0250

Channel Manning's n: 0.0350

Channel Invert Elevation: 6027.39 ft

Roadway Data for Crossing: Culvert 01

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 35.00 ft

Crest Elevation: 6030.50 ft

Roadway Surface: Paved

Roadway Top Width: 15.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 2.83 cfs

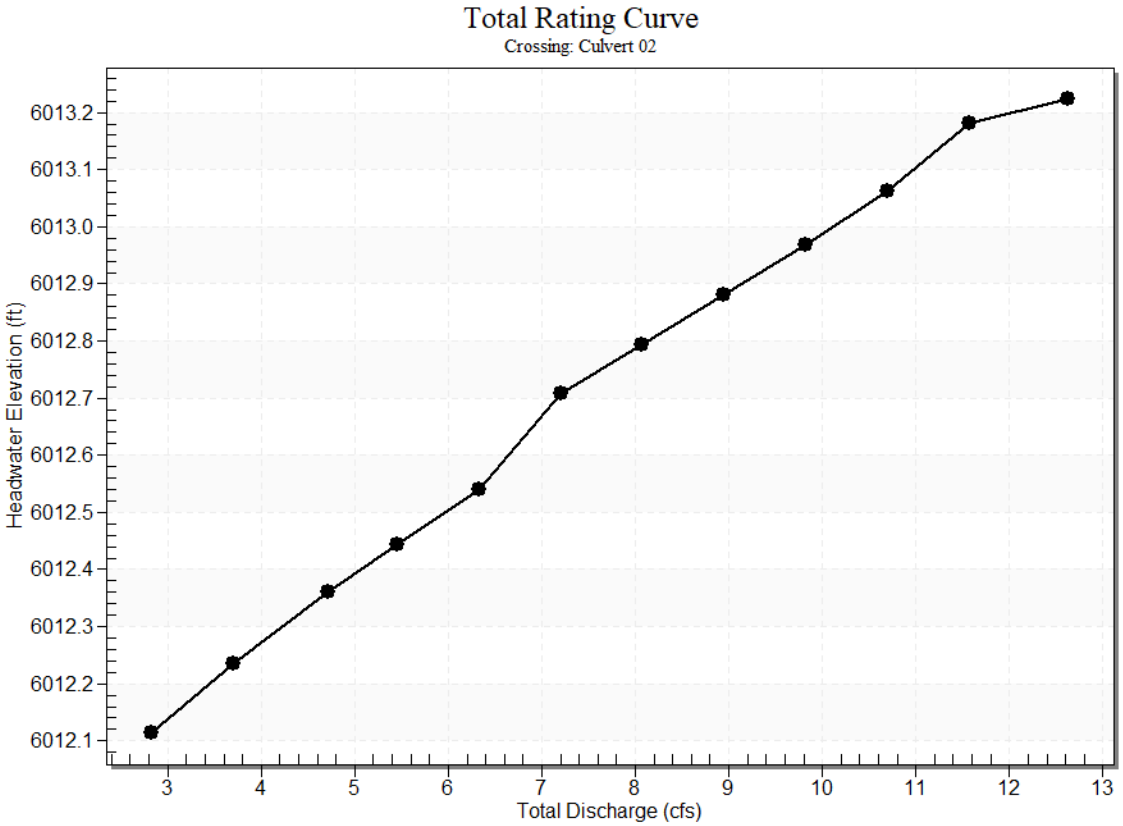
Design Flow: 4.72 cfs

Maximum Flow: 11.57 cfs

Table 1 - Summary of Culvert Flows at Crossing: Culvert 02

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 02 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6012.11	2.83	2.83	0.00	1
6012.24	3.70	3.70	0.00	1
6012.36	4.72	4.72	0.00	1
6012.44	5.45	5.45	0.00	1
6012.54	6.33	6.33	0.00	1
6012.71	7.20	7.20	0.00	1
6012.79	8.07	8.07	0.00	1
6012.88	8.95	8.95	0.00	1
6012.97	9.82	9.82	0.00	1
6013.06	10.70	10.70	0.00	1
6013.18	11.57	11.57	0.00	1
6013.20	11.69	11.69	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 02



Culvert Data: Culvert 02

Table 1 - Culvert Summary Table: Culvert 02

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.83 cfs	2.83 cfs	6012.11	0.65	0.303	1-JS1t	0.45	0.47	0.71	0.24	1.98	1.73
3.70 cfs	3.70 cfs	6012.24	0.78	0.390	1-JS1t	0.52	0.54	0.75	0.28	2.43	1.89
4.72 cfs	4.72 cfs	6012.36	0.90	0.503	1-JS1t	0.60	0.61	0.79	0.32	2.90	2.05
5.45 cfs	5.45 cfs	6012.44	0.98	0.592	1-JS1t	0.65	0.66	0.81	0.34	3.22	2.15

6.33 cfs	6.33 cfs	6012.54	1.08	0.708	1-S2n	0.71	0.72	0.71	0.37	4.38	2.26
7.20 cfs	7.20 cfs	6012.71	1.17	1.248	3-M1t	0.77	0.77	0.87	0.40	3.94	2.36
8.07 cfs	8.07 cfs	6012.79	1.27	1.334	7-M1t	0.84	0.81	0.90	0.43	4.28	2.44
8.95 cfs	8.95 cfs	6012.88	1.37	1.420	7-M1t	0.91	0.86	0.92	0.45	4.60	2.52
9.82 cfs	9.82 cfs	6012.97	1.48	1.508	3-M2t	0.98	0.90	0.95	0.48	4.92	2.60
10.70 cfs	10.70 cfs	6013.06	1.59	1.604	3-M2t	1.09	0.94	0.97	0.50	5.23	2.67
11.57 cfs	11.57 cfs	6013.18	1.72	1.721	3-M2t	1.25	0.97	0.99	0.52	5.53	2.74

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

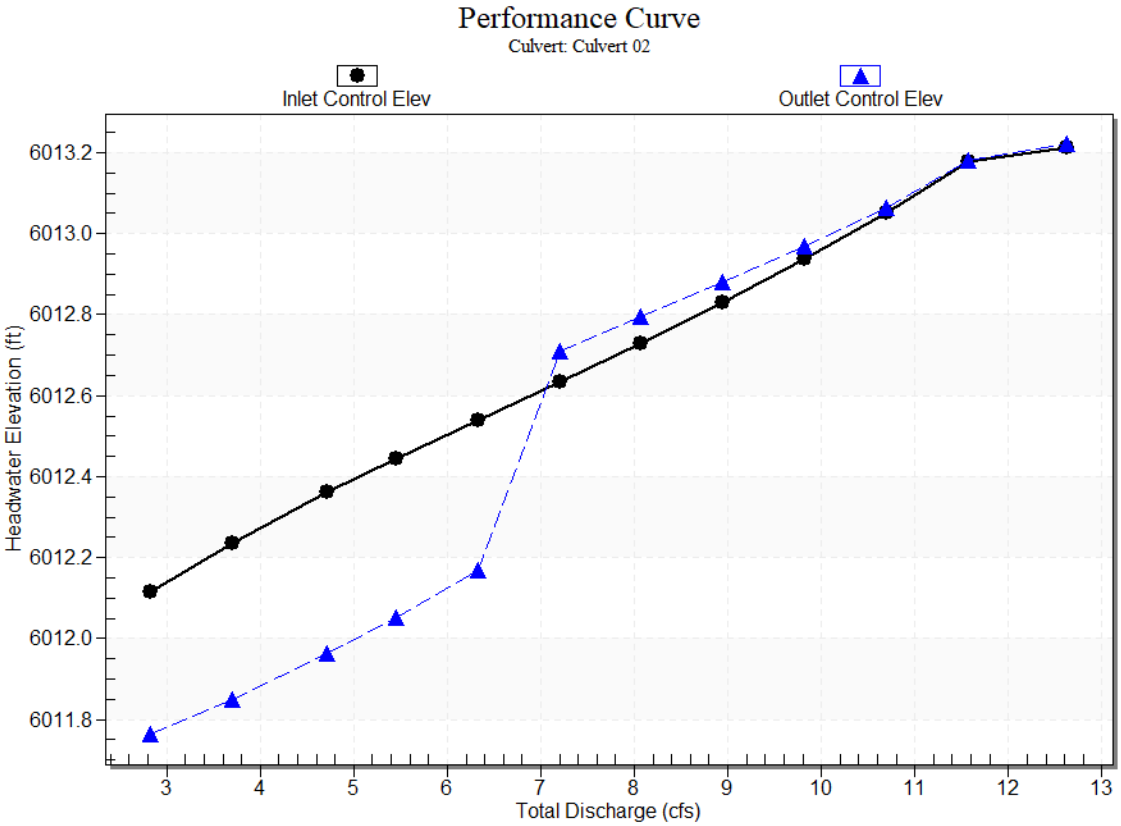
Inlet Elevation (invert): 6011.46 ft,

Outlet Elevation (invert): 6010.99 ft

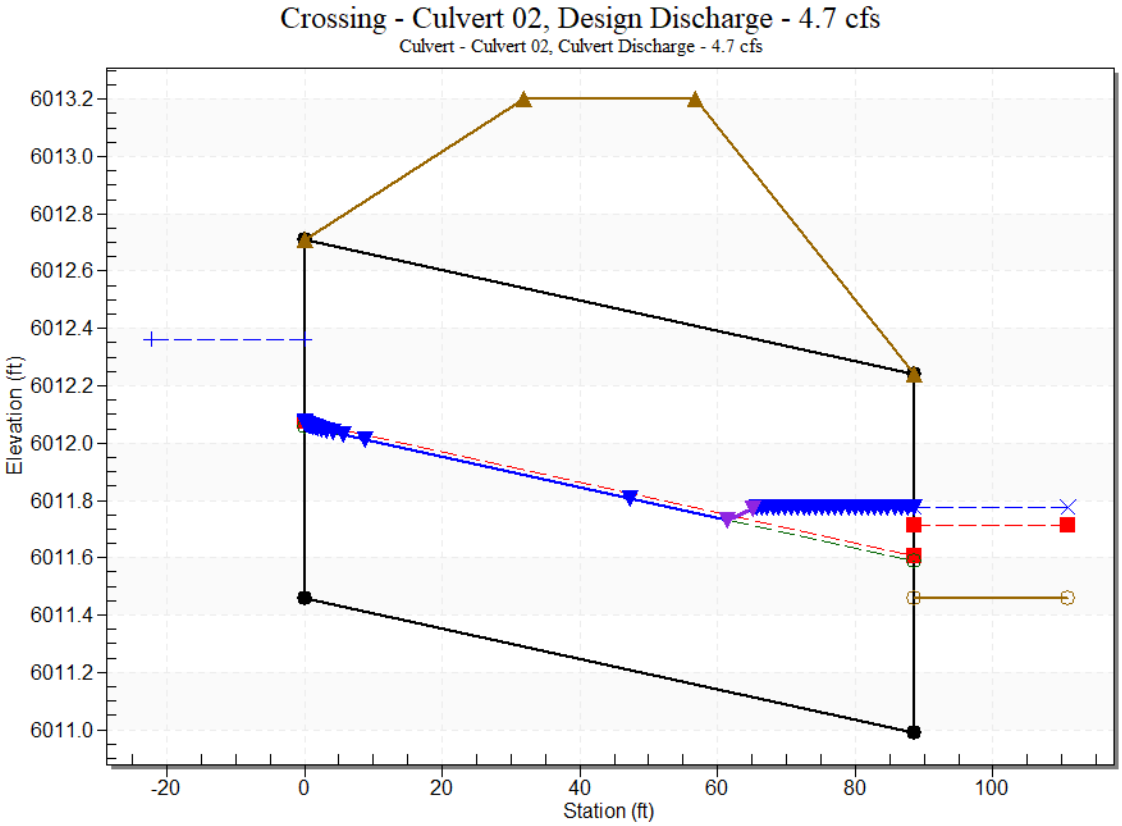
Culvert Length: 88.67 ft,

Culvert Slope: 0.0053

Culvert Performance Curve Plot: Culvert 02



Water Surface Profile Plot for Culvert: Culvert 02



Site Data - Culvert 02

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 6011.46 ft

Outlet Station: 88.67 ft

Outlet Elevation: 6010.99 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 02

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Data for Crossing: Culvert 02

Table 2 - Downstream Channel Rating Curve (Crossing: Culvert 02)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
2.83	6011.70	0.24	1.73	0.15	0.67
3.70	6011.74	0.28	1.89	0.17	0.68
4.72	6011.78	0.32	2.05	0.20	0.70
5.45	6011.80	0.34	2.15	0.21	0.71
6.33	6011.83	0.37	2.26	0.23	0.71
7.20	6011.86	0.40	2.36	0.25	0.72
8.07	6011.89	0.43	2.44	0.27	0.73
8.95	6011.91	0.45	2.52	0.28	0.73
9.82	6011.94	0.48	2.60	0.30	0.74
10.70	6011.96	0.50	2.67	0.31	0.74
11.57	6011.98	0.52	2.74	0.33	0.75

Tailwater Channel Data - Culvert 02

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 6.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0300

Channel Invert Elevation: 6011.46 ft

Roadway Data for Crossing: Culvert 02

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 70.00 ft

Crest Elevation: 6013.20 ft

Roadway Surface: Paved

Roadway Top Width: 25.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

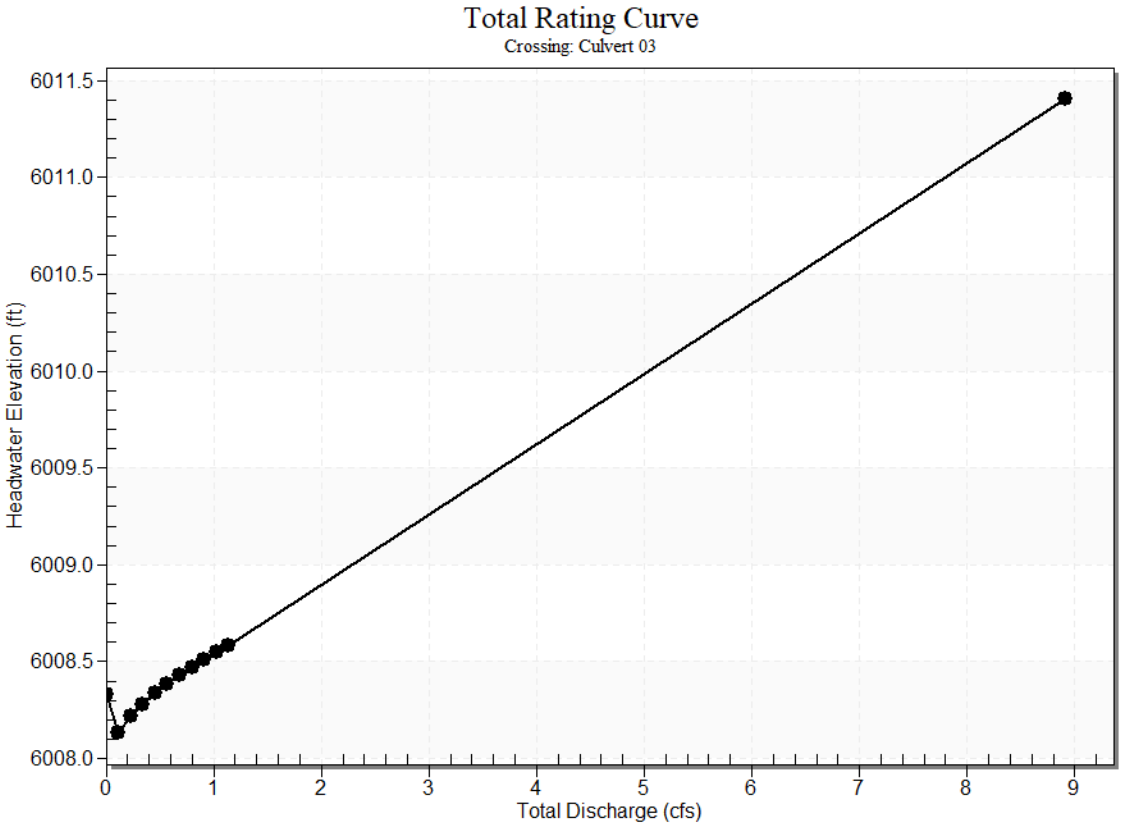
Design Flow: 0.00 cfs

Maximum Flow: 1.14 cfs

Table 3 - Summary of Culvert Flows at Crossing: Culvert 03

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 03 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6008.33	0.00	0.00	0.00	1
6008.13	0.11	0.11	0.00	1
6008.22	0.23	0.23	0.00	1
6008.28	0.34	0.34	0.00	1
6008.33	0.46	0.46	0.00	1
6008.38	0.57	0.57	0.00	1
6008.43	0.68	0.68	0.00	1
6008.47	0.80	0.80	0.00	1
6008.51	0.91	0.91	0.00	1
6008.55	1.03	1.03	0.00	1
6008.58	1.14	1.14	0.00	1
6011.40	8.82	8.82	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 03



Culvert Data: Culvert 03

Table 2 - Culvert Summary Table: Culvert 03

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00 cfs	0.00 cfs	6008.33	0.39	0.023	3-M1t	0.01	0.00	0.28	0.00	0.00	0.07
0.11 cfs	0.11 cfs	6008.13	0.18	0.194	3-M1t	0.14	0.13	0.32	0.04	0.46	0.47
0.23 cfs	0.23 cfs	6008.22	0.25	0.276	3-M1t	0.20	0.18	0.34	0.06	0.85	0.61
0.34 cfs	0.34 cfs	6008.28	0.31	0.340	3-M1t	0.25	0.23	0.36	0.08	1.19	0.72

0.46 cfs	0.46 cfs	6008.33	0.36	0.395	3-M1t	0.28	0.26	0.37	0.09	1.50	0.80
0.57 cfs	0.57 cfs	6008.38	0.40	0.444	3-M1t	0.32	0.29	0.38	0.10	1.79	0.87
0.68 cfs	0.68 cfs	6008.43	0.44	0.488	3-M1t	0.35	0.32	0.39	0.11	2.06	0.93
0.80 cfs	0.80 cfs	6008.47	0.48	0.530	3-M1t	0.38	0.35	0.40	0.12	2.32	0.98
0.91 cfs	0.91 cfs	6008.51	0.51	0.569	3-M1t	0.40	0.37	0.42	0.14	2.56	1.03
1.03 cfs	1.03 cfs	6008.55	0.55	0.606	3-M2t	0.43	0.40	0.42	0.14	2.79	1.08
1.14 cfs	1.14 cfs	6008.58	0.58	0.641	3-M2t	0.45	0.42	0.43	0.15	3.01	1.12

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

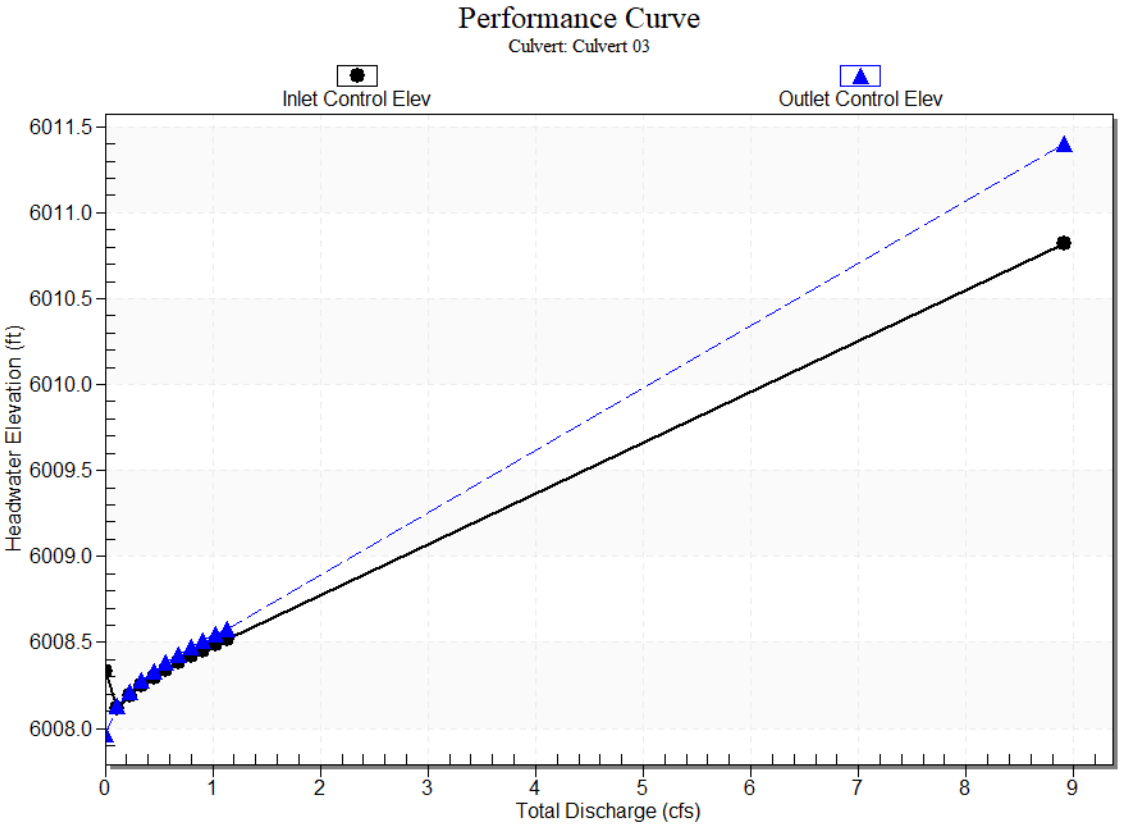
Inlet Elevation (invert): 6007.94 ft,

Outlet Elevation (invert): 6007.66 ft

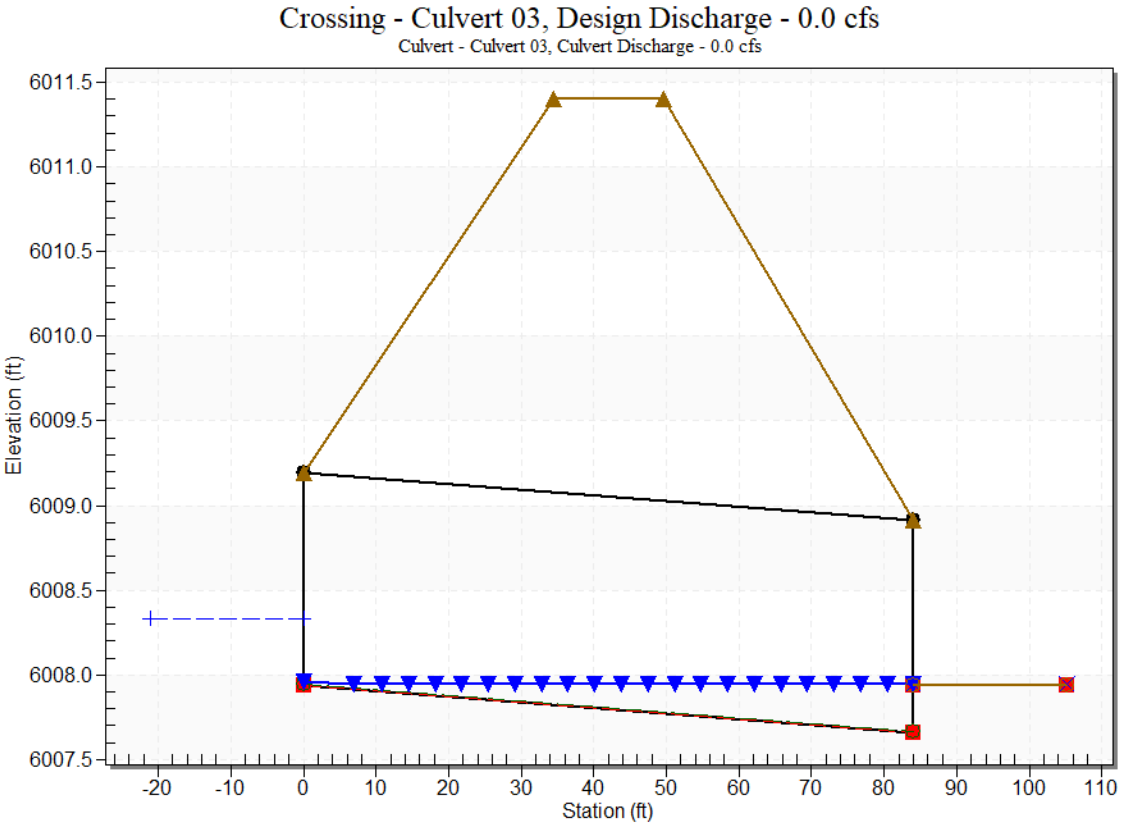
Culvert Length: 84.11 ft,

Culvert Slope: 0.0033

Culvert Performance Curve Plot: Culvert 03



Water Surface Profile Plot for Culvert: Culvert 03



Site Data - Culvert 03

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 6007.94 ft

Outlet Station: 84.11 ft

Outlet Elevation: 6007.66 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 03

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Data for Crossing: Culvert 03

Table 4 - Downstream Channel Rating Curve (Crossing: Culvert 03)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	6007.94	0.00	0.07	0.00	0.26
0.11	6007.98	0.04	0.47	0.02	0.42
0.23	6008.00	0.06	0.61	0.03	0.45
0.34	6008.02	0.08	0.72	0.03	0.47
0.46	6008.03	0.09	0.80	0.04	0.48
0.57	6008.04	0.10	0.87	0.04	0.49
0.68	6008.05	0.11	0.93	0.05	0.50
0.80	6008.06	0.12	0.98	0.05	0.51
0.91	6008.08	0.14	1.03	0.06	0.51
1.03	6008.08	0.14	1.08	0.06	0.52
1.14	6008.09	0.15	1.12	0.07	0.53

Tailwater Channel Data - Culvert 03

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 6.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0070

Channel Manning's n: 0.0300

Channel Invert Elevation: 6007.94 ft

Roadway Data for Crossing: Culvert 03

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 75.00 ft

Crest Elevation: 6011.40 ft

Roadway Surface: Paved

Roadway Top Width: 15.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 2.80 cfs

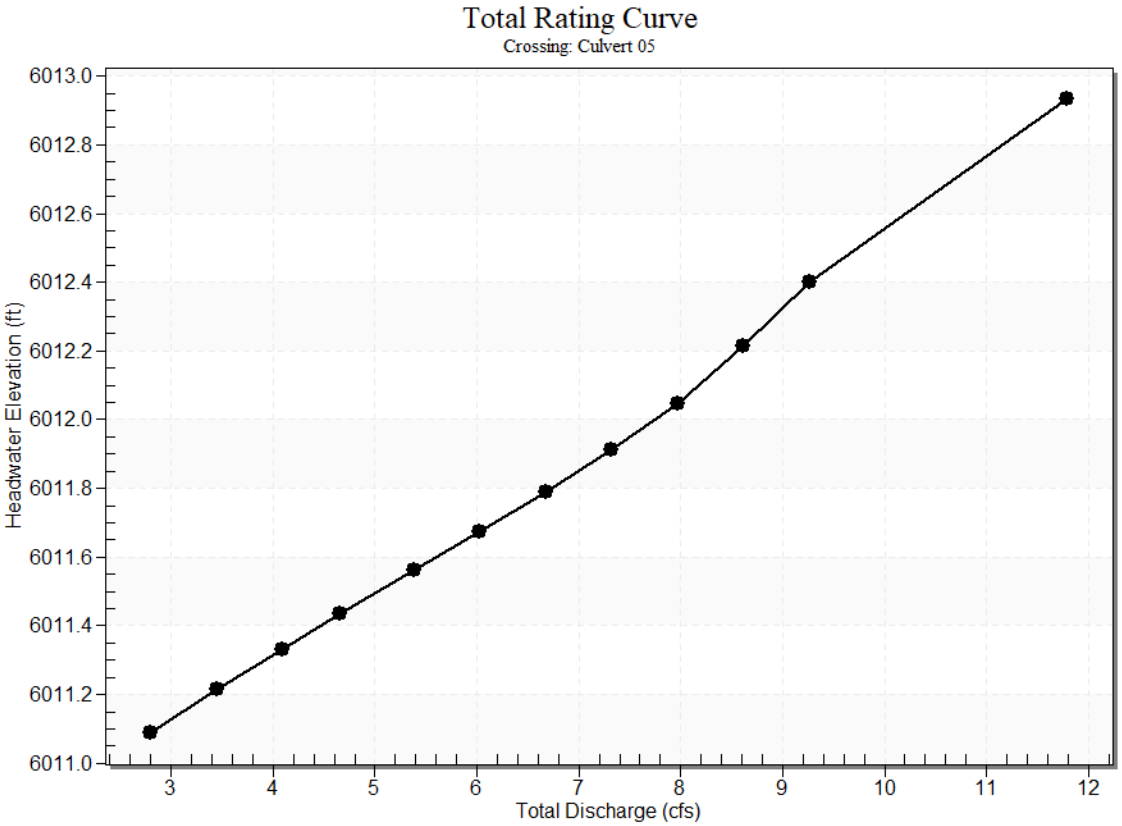
Design Flow: 4.66 cfs

Maximum Flow: 9.26 cfs

Table 5 - Summary of Culvert Flows at Crossing: Culvert 05

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 05 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6011.09	2.80	2.80	0.00	1
6011.21	3.45	3.45	0.00	1
6011.33	4.09	4.09	0.00	1
6011.43	4.66	4.66	0.00	1
6011.56	5.38	5.38	0.00	1
6011.67	6.03	6.03	0.00	1
6011.79	6.68	6.68	0.00	1
6011.91	7.32	7.32	0.00	1
6012.05	7.97	7.97	0.00	1
6012.22	8.61	8.61	0.00	1
6012.40	9.26	9.26	0.00	1
6012.90	10.96	10.96	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 05



Culvert Data: Culvert 05

Table 3 - Culvert Summary Table: Culvert 05

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.80 cfs	2.80 cfs	6011.09	0.91	0.989	2-M2c	0.80	0.64	0.64	0.18	3.93	1.55
3.45 cfs	3.45 cfs	6011.21	1.03	1.114	2-M2c	0.91	0.71	0.71	0.21	4.20	1.68
4.09 cfs	4.09 cfs	6011.33	1.15	1.232	2-M2c	1.02	0.77	0.77	0.23	4.45	1.79
4.66 cfs	4.66 cfs	6011.43	1.24	1.334	2-M2c	1.13	0.83	0.83	0.25	4.65	1.89

5.38 cfs	5.38 cfs	6011.56	1.36	1.461	2-M2c	1.34	0.89	0.89	0.27	4.90	2.00
6.03 cfs	6.03 cfs	6011.67	1.47	1.574	7-M2c	1.50	0.95	0.95	0.29	5.12	2.09
6.68 cfs	6.68 cfs	6011.79	1.58	1.691	7-M2c	1.50	1.00	1.00	0.31	5.34	2.17
7.32 cfs	7.32 cfs	6011.91	1.70	1.813	7-M2c	1.50	1.05	1.05	0.33	5.55	2.25
7.97 cfs	7.97 cfs	6012.05	1.82	1.948	7-M2c	1.50	1.09	1.09	0.34	5.77	2.32
8.61 cfs	8.61 cfs	6012.22	1.95	2.115	7-M2c	1.50	1.14	1.14	0.36	6.00	2.39
9.26 cfs	9.26 cfs	6012.40	2.09	2.302	7-M2c	1.50	1.18	1.18	0.38	6.23	2.46

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

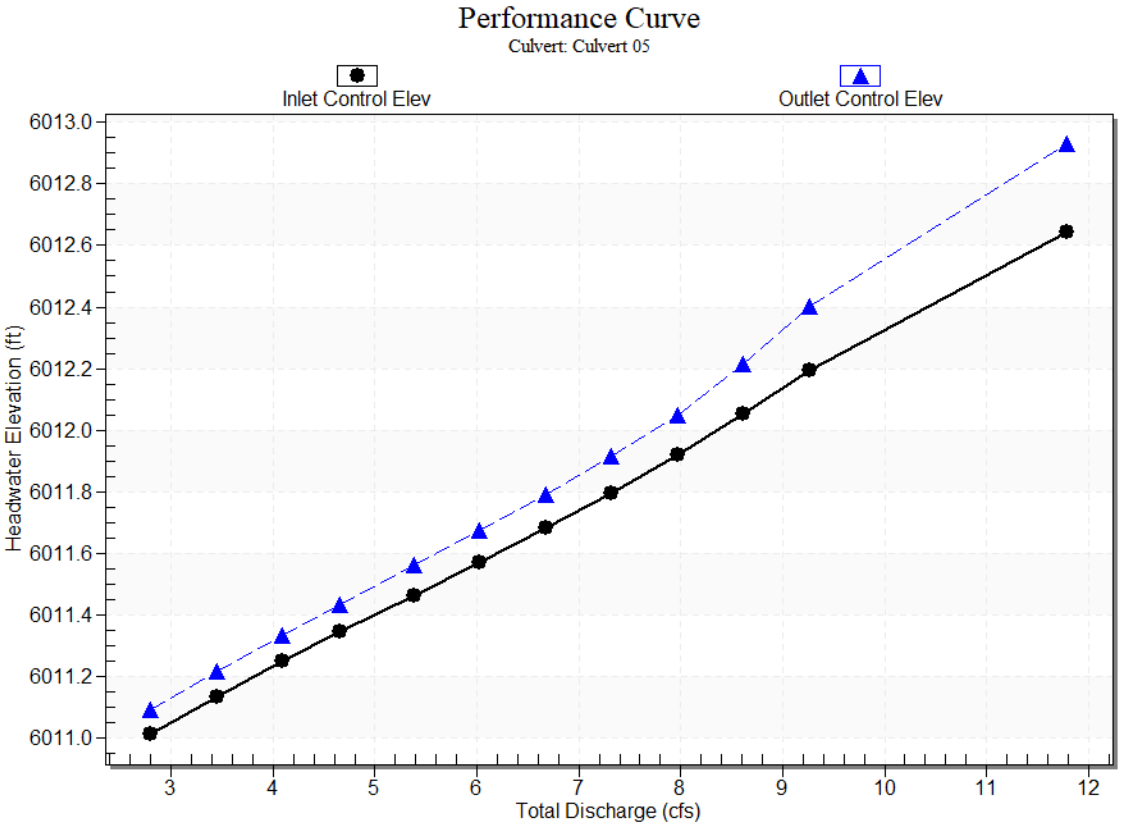
Inlet Elevation (invert): 6010.10 ft,

Outlet Elevation (invert): 6009.96 ft

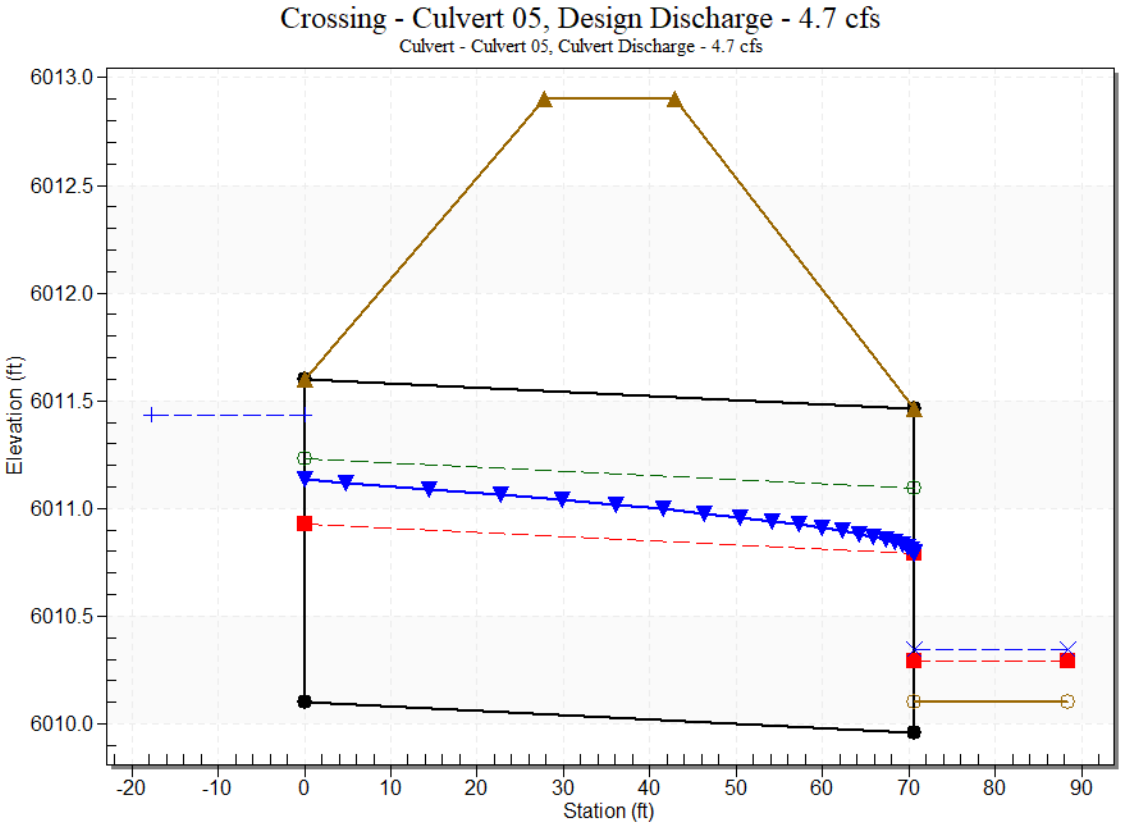
Culvert Length: 70.68 ft,

Culvert Slope: 0.0020

Culvert Performance Curve Plot: Culvert 05



Water Surface Profile Plot for Culvert: Culvert 05



Site Data - Culvert 05

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 6010.10 ft

Outlet Station: 70.68 ft

Outlet Elevation: 6009.96 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 05

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Data for Crossing: Culvert 05

Table 6 - Downstream Channel Rating Curve (Crossing: Culvert 05)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
2.80	6010.28	0.18	1.55	0.11	0.64
3.45	6010.31	0.21	1.68	0.13	0.65
4.09	6010.33	0.23	1.79	0.14	0.66
4.66	6010.35	0.25	1.89	0.15	0.67
5.38	6010.37	0.27	2.00	0.17	0.68
6.03	6010.39	0.29	2.09	0.18	0.68
6.68	6010.41	0.31	2.17	0.19	0.69
7.32	6010.43	0.33	2.25	0.20	0.69
7.97	6010.44	0.34	2.32	0.21	0.70
8.61	6010.46	0.36	2.39	0.22	0.70
9.26	6010.48	0.38	2.46	0.23	0.71

Tailwater Channel Data - Culvert 05

Tailwater Channel Option: Rectangular Channel

Bottom Width: 10.00 ft

Channel Slope: 0.0100

Channel Manning's n: 0.0300

Channel Invert Elevation: 6010.10 ft

Roadway Data for Crossing: Culvert 05

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 40.00 ft

Crest Elevation: 6012.90 ft

Roadway Surface: Paved

Roadway Top Width: 15.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.72 cfs

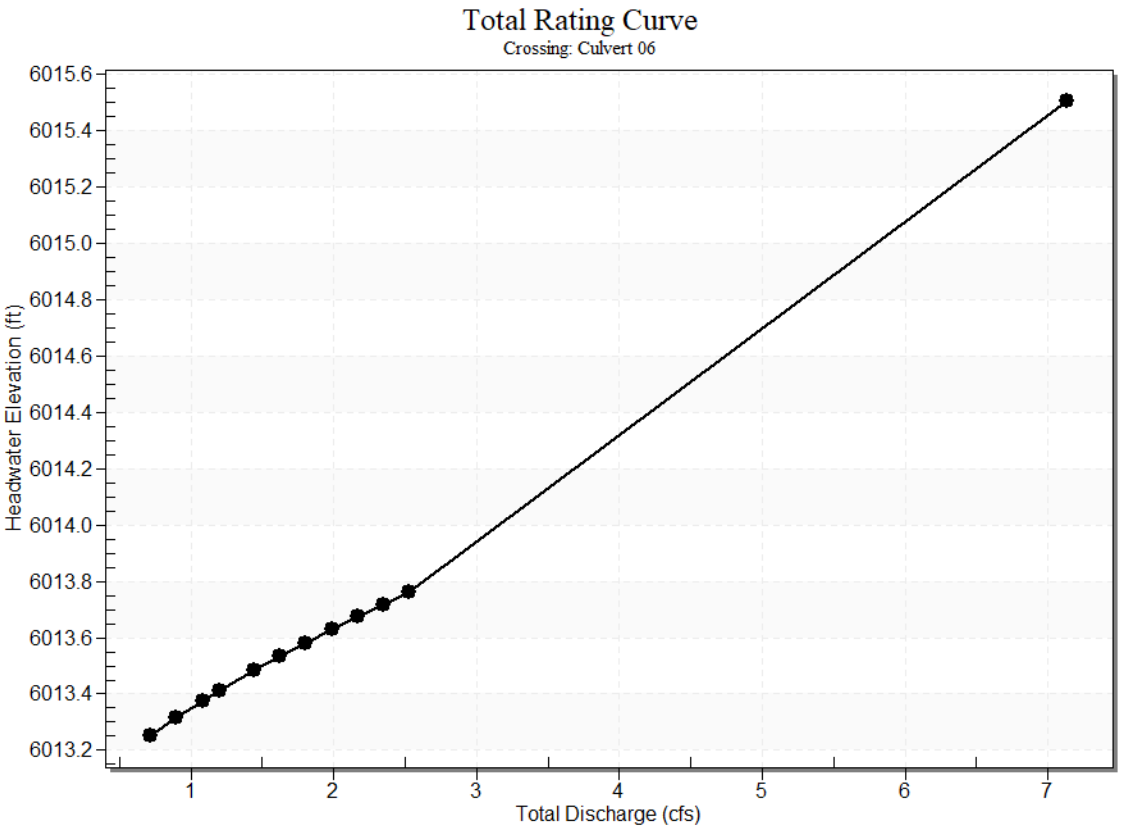
Design Flow: 1.20 cfs

Maximum Flow: 2.53 cfs

Table 7 - Summary of Culvert Flows at Crossing: Culvert 06

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 06 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6013.25	0.72	0.72	0.00	1
6013.32	0.90	0.90	0.00	1
6013.38	1.08	1.08	0.00	1
6013.41	1.20	1.20	0.00	1
6013.48	1.44	1.44	0.00	1
6013.53	1.62	1.62	0.00	1
6013.58	1.81	1.81	0.00	1
6013.63	1.99	1.99	0.00	1
6013.67	2.17	2.17	0.00	1
6013.72	2.35	2.35	0.00	1
6013.76	2.53	2.53	0.00	1
6015.50	7.00	7.00	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 06



Culvert Data: Culvert 06

Table 4 - Culvert Summary Table: Culvert 06

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.72 cfs	0.72 cfs	6013.25	0.45	0.503	3-M2t	0.39	0.33	0.34	0.08	2.67	0.91
0.90 cfs	0.90 cfs	6013.32	0.51	0.567	2-M2c	0.44	0.37	0.37	0.09	2.94	0.99
1.08 cfs	1.08 cfs	6013.38	0.56	0.625	2-M2c	0.48	0.41	0.41	0.10	3.10	1.07
1.20 cfs	1.20 cfs	6013.41	0.60	0.662	2-M2c	0.51	0.43	0.43	0.11	3.19	1.11
1.44 cfs	1.44 cfs	6013.48	0.66	0.733	2-M2c	0.57	0.48	0.48	0.12	3.37	1.19
1.62 cfs	1.62 cfs	6013.53	0.72	0.783	2-M2c	0.61	0.51	0.51	0.13	3.49	1.25
1.81 cfs	1.81 cfs	6013.58	0.77	0.832	2-M2c	0.65	0.53	0.53	0.14	3.61	1.30
1.99 cfs	1.99 cfs	6013.63	0.81	0.878	2-M2c	0.68	0.56	0.56	0.15	3.72	1.35
2.17 cfs	2.17 cfs	6013.67	0.86	0.923	2-M2c	0.72	0.59	0.59	0.15	3.82	1.40
2.35 cfs	2.35 cfs	6013.72	0.90	0.968	2-M2c	0.76	0.61	0.61	0.16	3.93	1.44
2.53 cfs	2.53 cfs	6013.76	0.94	1.013	2-M2c	0.80	0.64	0.64	0.17	4.02	1.49

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

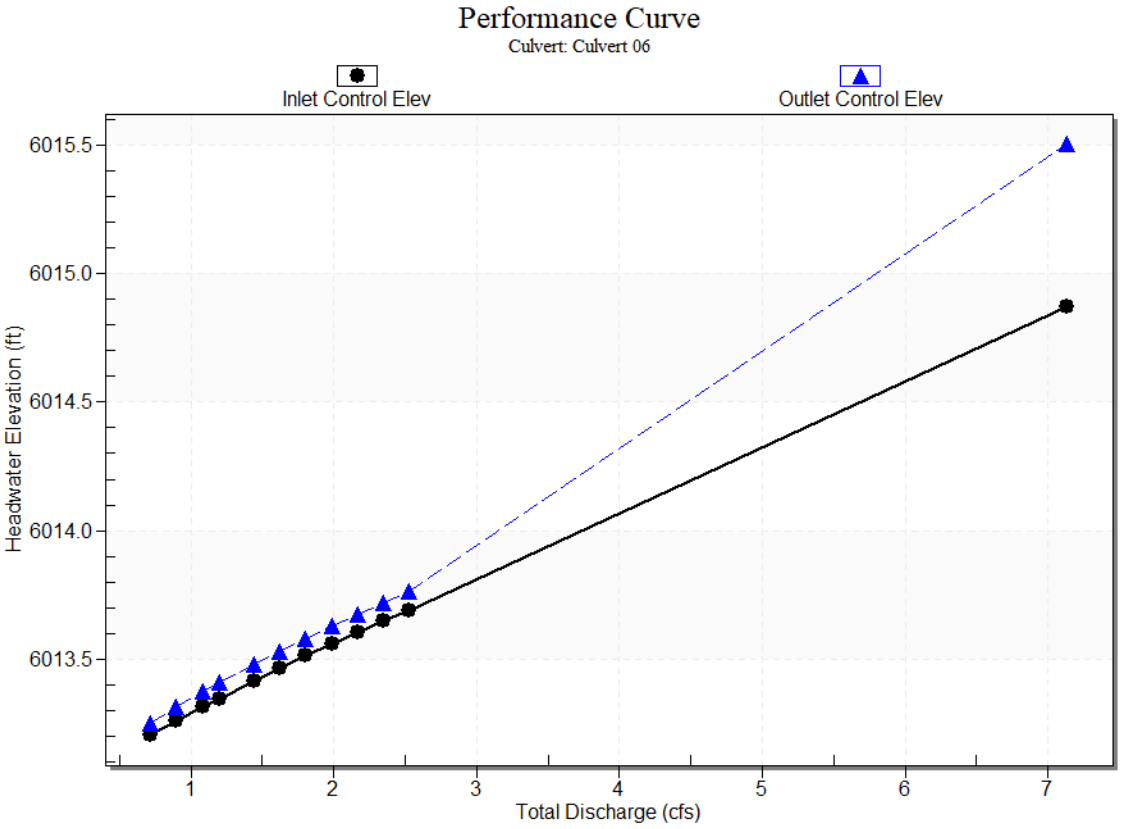
Inlet Elevation (invert): 6012.75 ft,

Outlet Elevation (invert): 6012.49 ft

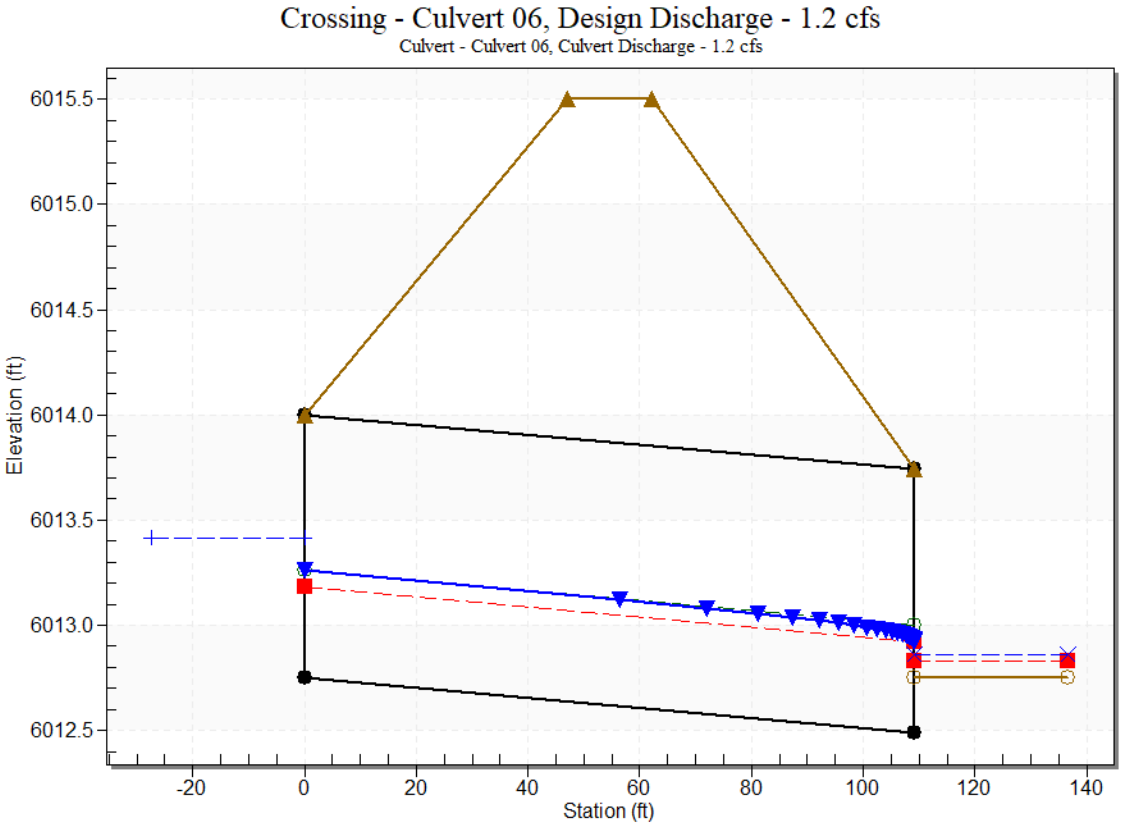
Culvert Length: 109.24 ft,

Culvert Slope: 0.0024

Culvert Performance Curve Plot: Culvert 06



Water Surface Profile Plot for Culvert: Culvert 06



Site Data - Culvert 06

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 6012.75 ft

Outlet Station: 109.24 ft

Outlet Elevation: 6012.49 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 06

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Data for Crossing: Culvert 06

Table 8 - Downstream Channel Rating Curve (Crossing: Culvert 06)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.72	6012.83	0.08	0.91	0.05	0.57
0.90	6012.84	0.09	0.99	0.06	0.58
1.08	6012.85	0.10	1.07	0.06	0.59
1.20	6012.86	0.11	1.11	0.07	0.59
1.44	6012.87	0.12	1.19	0.08	0.60
1.62	6012.88	0.13	1.25	0.08	0.61
1.81	6012.89	0.14	1.30	0.09	0.62
1.99	6012.90	0.15	1.35	0.09	0.62
2.17	6012.90	0.15	1.40	0.10	0.63
2.35	6012.91	0.16	1.44	0.10	0.63
2.53	6012.92	0.17	1.49	0.11	0.64

Tailwater Channel Data - Culvert 06

Tailwater Channel Option: Rectangular Channel

Bottom Width: 10.00 ft

Channel Slope: 0.0100

Channel Manning's n: 0.0300

Channel Invert Elevation: 6012.75 ft

Roadway Data for Crossing: Culvert 06

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 90.00 ft

Crest Elevation: 6015.50 ft

Roadway Surface: Paved

Roadway Top Width: 15.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3.73 cfs

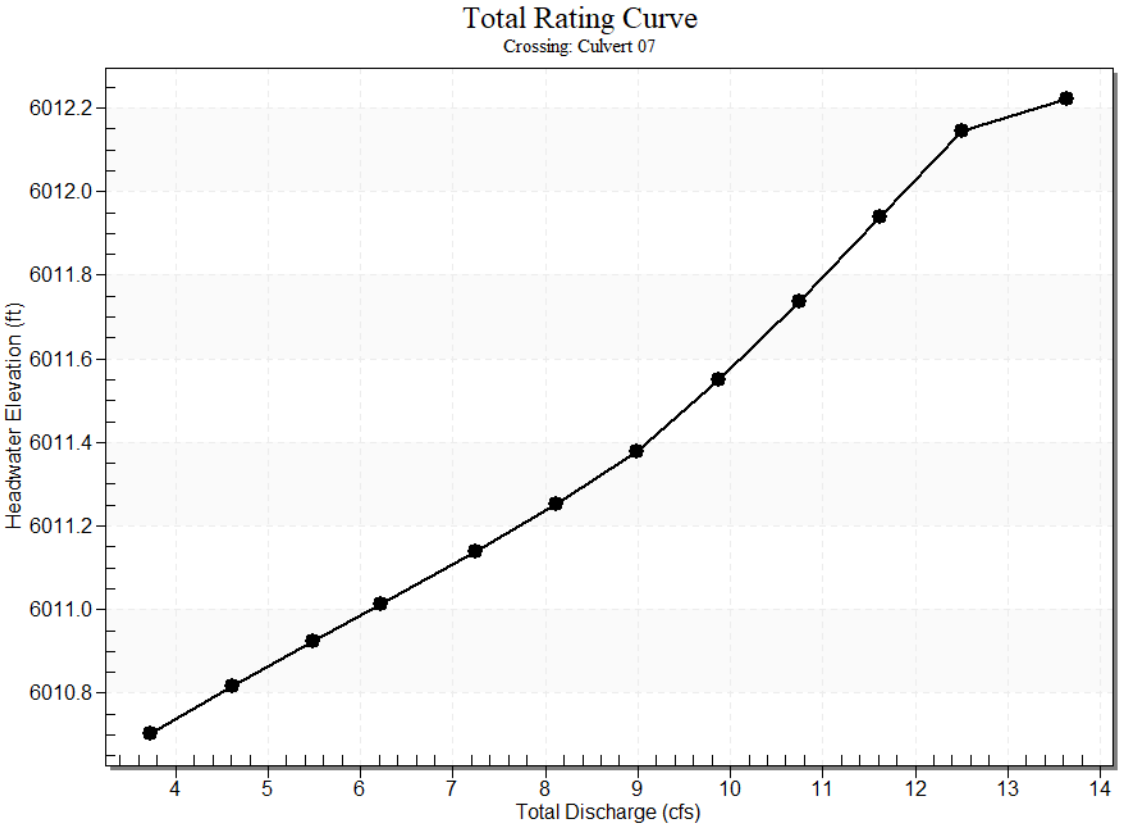
Design Flow: 6.22 cfs

Maximum Flow: 12.50 cfs

Table 9 - Summary of Culvert Flows at Crossing: Culvert 07

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 07 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6010.70	3.73	3.73	0.00	1
6010.82	4.61	4.61	0.00	1
6010.92	5.48	5.48	0.00	1
6011.01	6.22	6.22	0.00	1
6011.14	7.24	7.24	0.00	1
6011.25	8.12	8.12	0.00	1
6011.38	8.99	8.99	0.00	1
6011.55	9.87	9.87	0.00	1
6011.74	10.75	10.75	0.00	1
6011.94	11.62	11.62	0.00	1
6012.15	12.50	12.50	0.00	1
6012.20	12.75	12.75	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 07



Culvert Data: Culvert 07

Table 5 - Culvert Summary Table: Culvert 07

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.73 cfs	3.73 cfs	6010.70	0.78	0.854	2-M2c	0.69	0.54	0.54	0.22	3.65	1.73
4.61 cfs	4.61 cfs	6010.82	0.89	0.966	2-M2c	0.79	0.61	0.61	0.25	3.90	1.88
5.48 cfs	5.48 cfs	6010.92	0.99	1.074	2-M2c	0.90	0.66	0.66	0.27	4.14	2.01
6.22 cfs	6.22 cfs	6011.01	1.07	1.164	2-M2c	1.01	0.71	0.71	0.29	4.32	2.11
7.24 cfs	7.24 cfs	6011.14	1.18	1.289	7-M2c	1.25	0.77	0.77	0.32	4.58	2.24
8.12 cfs	8.12 cfs	6011.25	1.28	1.402	7-M2c	1.25	0.82	0.82	0.35	4.79	2.34
8.99 cfs	8.99 cfs	6011.38	1.38	1.529	7-M2c	1.25	0.86	0.86	0.37	5.00	2.43
9.87 cfs	9.87 cfs	6011.55	1.49	1.699	7-M2c	1.25	0.90	0.90	0.39	5.21	2.52
10.75 cfs	10.75 cfs	6011.74	1.60	1.886	7-M2c	1.25	0.94	0.94	0.41	5.43	2.60
11.62 cfs	11.62 cfs	6011.94	1.73	2.090	7-M2c	1.25	0.98	0.98	0.43	5.66	2.68
12.50 cfs	12.50 cfs	6012.15	1.86	2.296	7-M2c	1.25	1.01	1.01	0.45	5.89	2.76

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

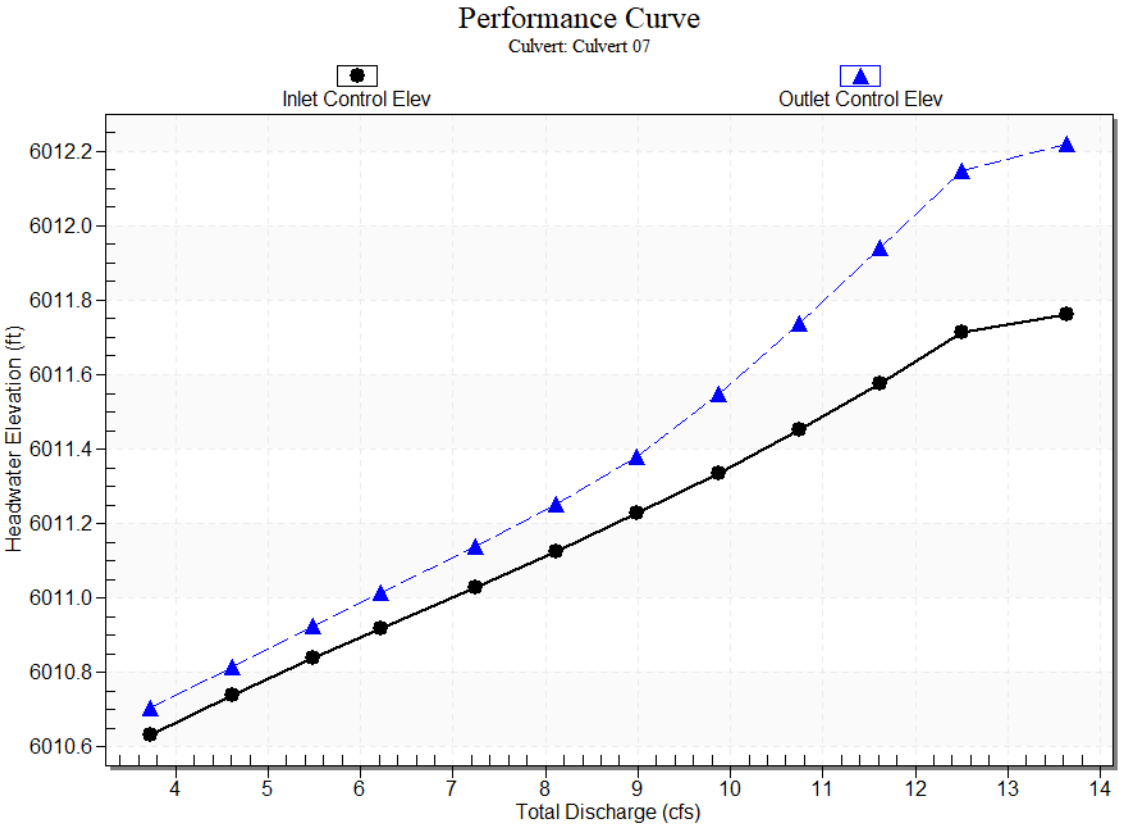
Inlet Elevation (invert): 6009.85 ft,

Outlet Elevation (invert): 6009.66 ft

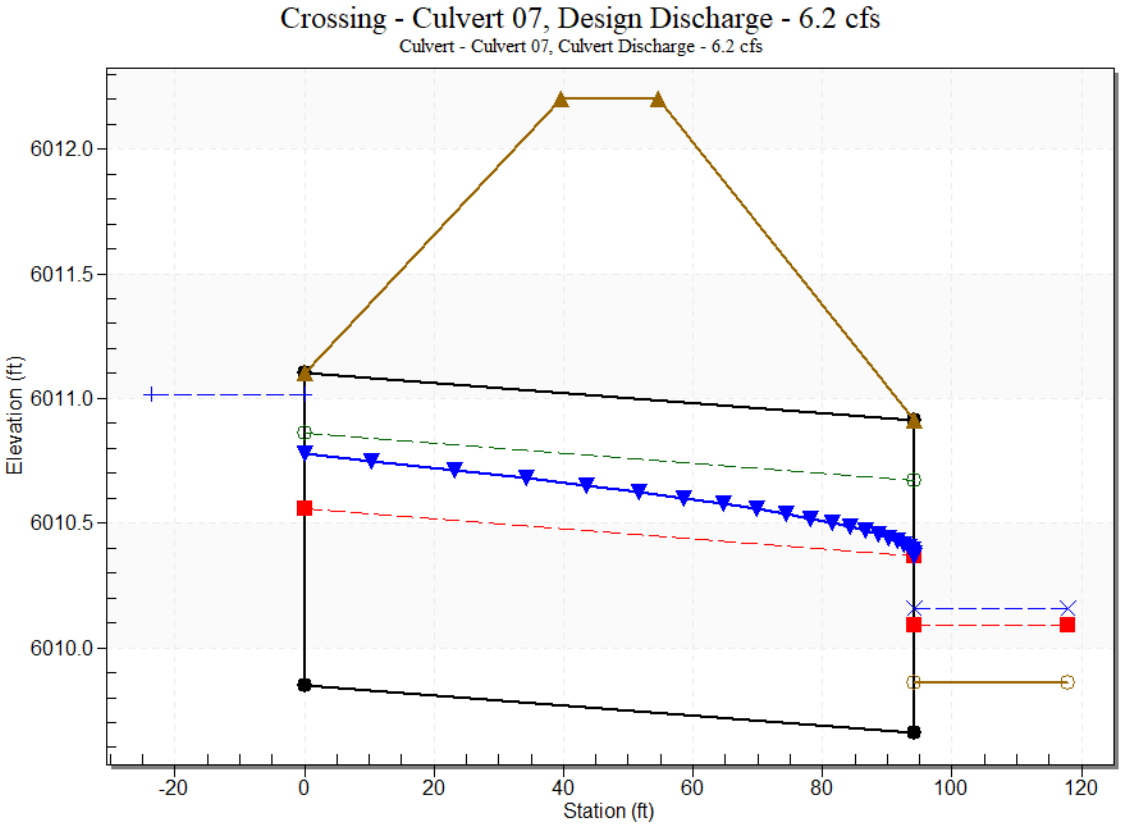
Culvert Length: 94.28 ft,

Culvert Slope: 0.0020

Culvert Performance Curve Plot: Culvert 07



Water Surface Profile Plot for Culvert: Culvert 07



Site Data - Culvert 07

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 6009.85 ft

Outlet Station: 94.28 ft

Outlet Elevation: 6009.66 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 07

Barrel Shape: Circular

Barrel Diameter: 1.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Data for Crossing: Culvert 07

Table 10 - Downstream Channel Rating Curve (Crossing: Culvert 07)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
3.73	6010.08	0.22	1.73	0.13	0.66
4.61	6010.11	0.25	1.88	0.15	0.67
5.48	6010.13	0.27	2.01	0.17	0.68
6.22	6010.15	0.29	2.11	0.18	0.69
7.24	6010.18	0.32	2.24	0.20	0.69
8.12	6010.21	0.35	2.34	0.22	0.70
8.99	6010.23	0.37	2.43	0.23	0.71
9.87	6010.25	0.39	2.52	0.24	0.71
10.75	6010.27	0.41	2.60	0.26	0.71
11.62	6010.29	0.43	2.68	0.27	0.72
12.50	6010.31	0.45	2.76	0.28	0.72

Tailwater Channel Data - Culvert 07

Tailwater Channel Option: Rectangular Channel

Bottom Width: 10.00 ft

Channel Slope: 0.0100

Channel Manning's n: 0.0300

Channel Invert Elevation: 6009.86 ft

Roadway Data for Crossing: Culvert 07

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 90.00 ft

Crest Elevation: 6012.20 ft

Roadway Surface: Paved

Roadway Top Width: 15.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Appendix C.3 – Outfall Protection Calculations

Culvert	Culvert 01	Culvert 02	Culvert 05	Culvert 07	Overflow
Q100 (cfs)	10.39	10.70	9.26	12.50	17.82
# of Barrels	1.00	2.00	1.00	2.00	1.00
Q100/Barrels (cfs)	10.39	5.35	9.26	6.25	17.82
100-yr Exit Velocity (fps)	8.40	5.53	6.23	5.89	5.67
Permissible Velocity (fps)	5.00	5.00	5.00	5.00	5.00
Required Area (sf)	2.08	2.14	1.85	2.50	3.56
Outfall Invert (ft)	6026.57	6010.99	6009.96	6009.66	-
Normal Depth (ft)	0.79	1.25	1.50	1.25	2.00
Tailwater Depth (ft)	0.34	0.52	0.38	0.38	1.00
Conduit Diameter (ft)	2.00	1.25	1.50	1.25	2.00
TW:D Ratio	0.17	0.42	0.25	0.30	0.50
Froude Parameter	1.84	3.06	3.36	3.58	3.15
Expansion Factor	1.95	5.80	1.95	2.45	5.55
Theta (Radian)	0.25	0.09	0.25	0.20	0.09
Theta (Degrees)	14.38	4.93	14.38	11.53	5.15
Apron Length (ft)	8.02	16.62	6.58	13.06	8.68
Apron Width (ft)	6.11	4.12	4.87	6.58	3.56
Design Apron Length (ft)	**8.50**	**17.00**	**7.00**	**13.50**	**9.00**
Design Apron Width (ft)	**6.50**	**5.00**	**5.00**	**7.00**	**4.00**
D Normal (ft)	2	1.25	1.50	1.25	1.5
D Adjusted (ft)	1.40	1.25	1.50	1.25	2.00
T_TW/D_adjusted	0.24	0.42	0.25	0.30	0.50
Q/D_adjusted^1.5	6.31	7.66	5.04	8.94	6.30
Rip Rap Type:	**Type M**	**Type L**	**Type L**	**Type M**	**Type M[1]**

[1] Overflow D_{50} upsized one sized based on calculations due to unknown flow considerations due to overflow nature.

Culvert 01
Culvert 02
Culvert 05
Culvert 07
Overflow

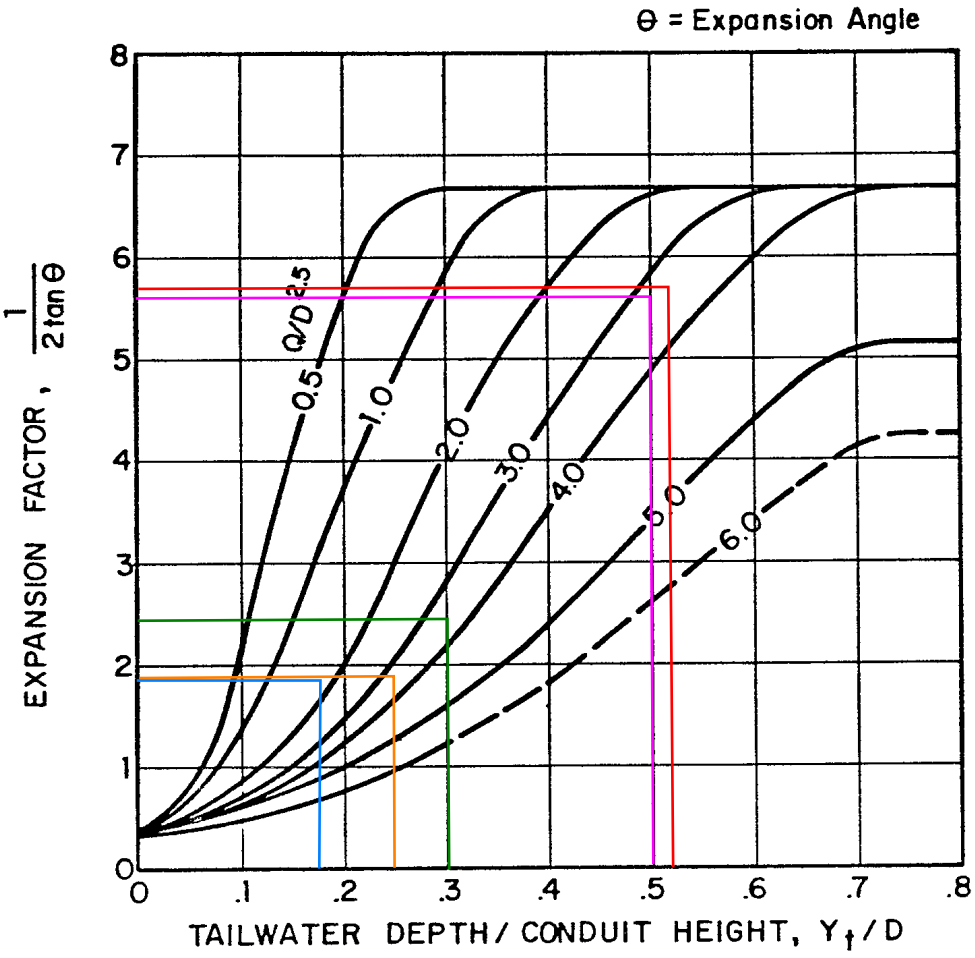


Figure 9-35. Expansion factor for circular conduits

$$H_a = \frac{(H + Y_n)}{2}$$ Equation 9-19

Where the maximum value of H_a shall not exceed H, and:

D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

D_c = diameter of circular culvert (ft)

H_a = parameter to use in place of H in Figure 9-39 when flow is supercritical (ft)

H = height of rectangular culvert (ft)

Y_n = normal depth of supercritical flow in the culvert (ft)

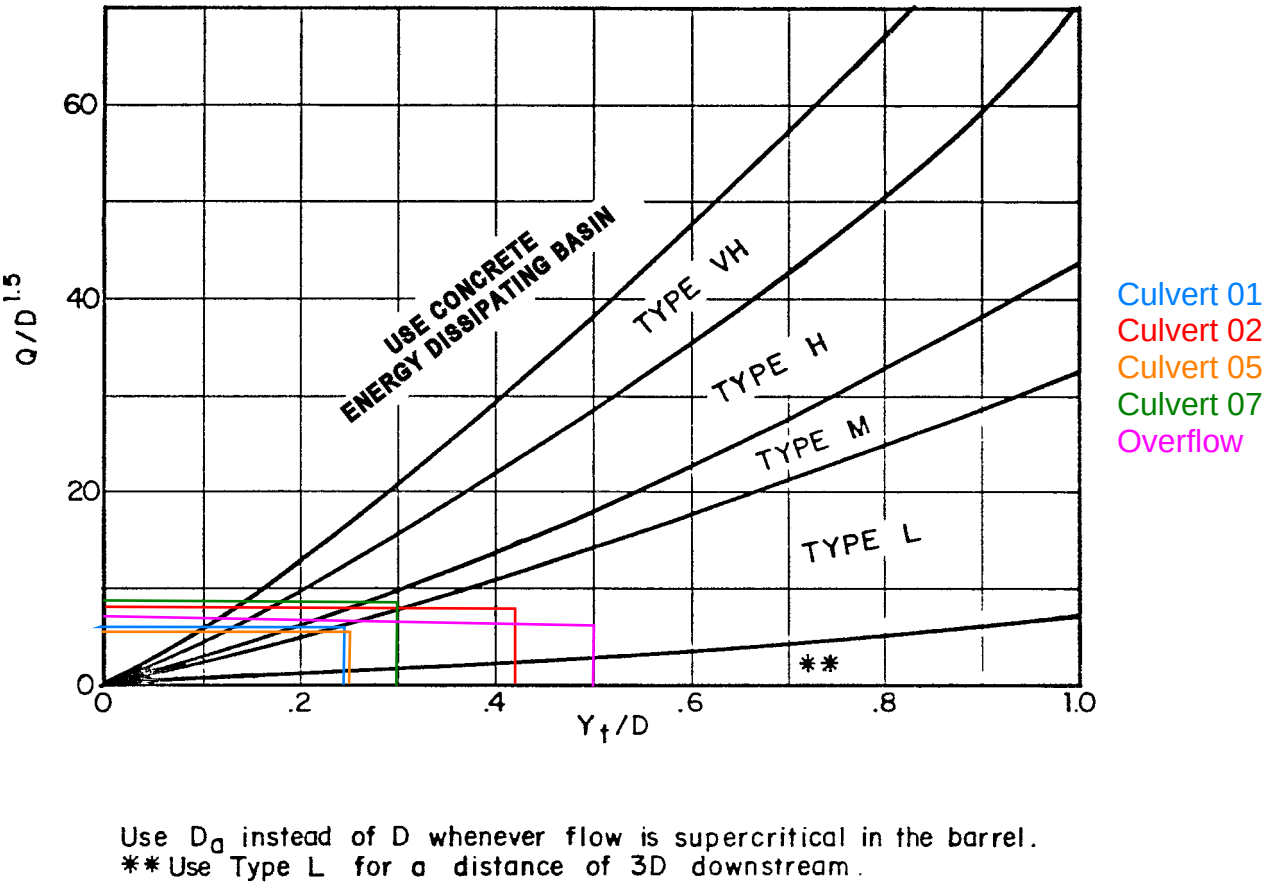


Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for Q/D2.5 ≤ 6.0)

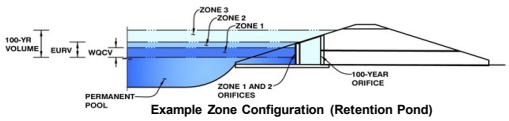
Appendix D.1 – MHFD Detention Basin Design Workbook

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.08 (April 2026)

Project: _____

Basin ID: _____



Example Zone Configuration (Retention Pond)

Watershed Information

Selected SCM Type =	**EDB**	
Watershed Area =	11.05	acres
Watershed Length =	1,690	ft
Watershed Length to Centroid =	875	ft
Watershed Slope =	0.015	ft/ft
Watershed Imperviousness =	35.09%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.153	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.405	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.03 in.) =	0.239	acre-feet	1.03	inches
5-yr Runoff Volume (P1 = 1.36 in.) =	0.353	acre-feet	1.36	inches
10-yr Runoff Volume (P1 = 1.65 in.) =	0.452	acre-feet	1.65	inches
25-yr Runoff Volume (P1 = 2.09 in.) =	0.742	acre-feet	2.09	inches
50-yr Runoff Volume (P1 = 2.44 in.) =	0.994	acre-feet	2.44	inches
100-yr Runoff Volume (P1 = 2.82 in.) =	1.331	acre-feet	2.82	inches
500-yr Runoff Volume (P1 = 3.22 in.) =	1.674	acre-feet	3.22	inches
Approximate 2-yr Detention Volume =	0.222	acre-feet		
Approximate 5-yr Detention Volume =	0.309	acre-feet		
Approximate 10-yr Detention Volume =	0.398	acre-feet		
Approximate 25-yr Detention Volume =	0.552	acre-feet		
Approximate 50-yr Detention Volume =	0.654	acre-feet		
Approximate 100-yr Detention Volume =	0.800	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.153	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.252	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.396	acre-feet
Total Detention Basin Volume =	0.800	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

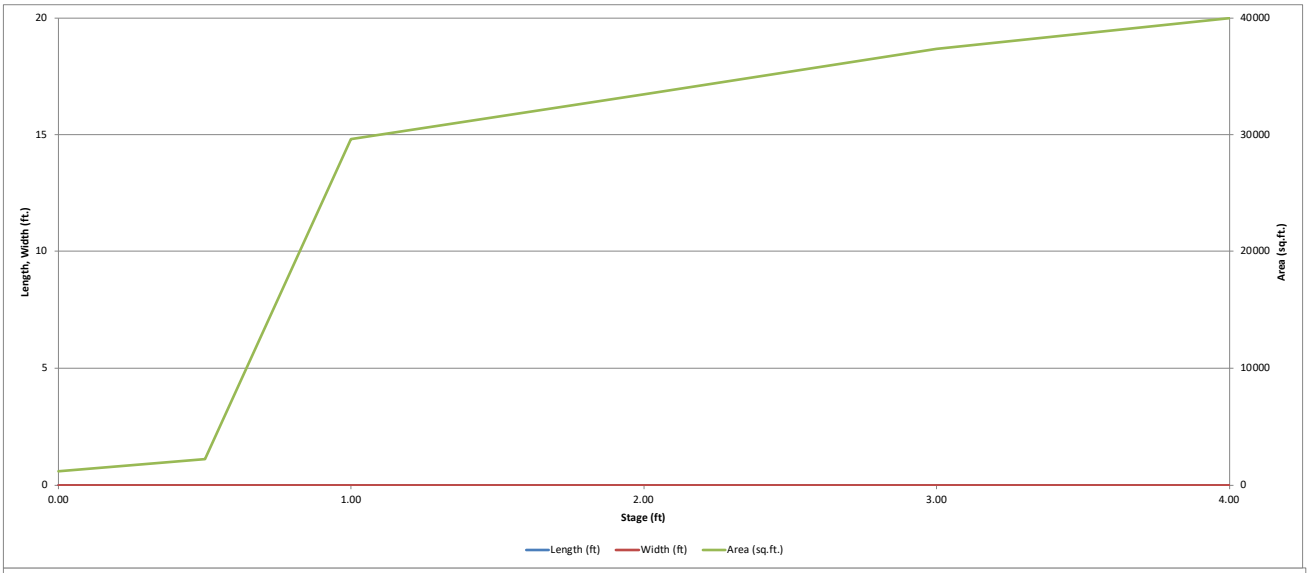
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

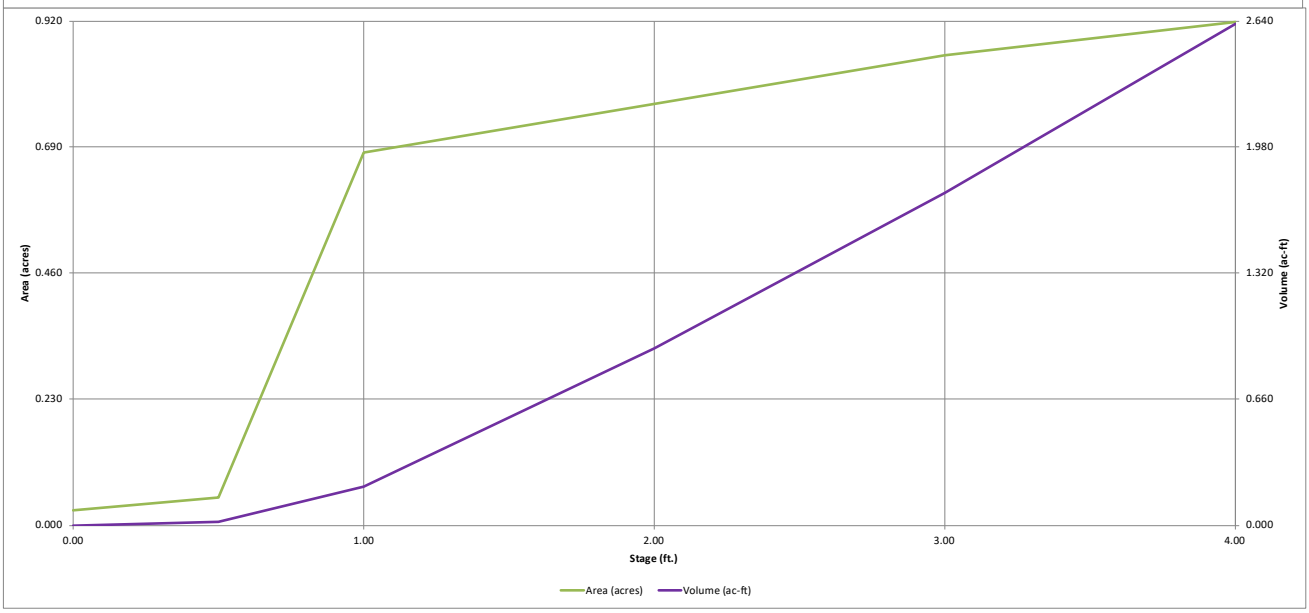
Depth Increment = 1.00 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	1,200	0.028		
6009	--	0.50	--	--	--	2,224	0.051	856	0.020
6010	--	1.00	--	--	--	29,611	0.680	8,814	0.202
6011	--	2.00	--	--	--	33,462	0.768	40,351	0.926
6012	--	3.00	--	--	--	37,337	0.857	75,750	1.739
6012.5	--	4.00	--	--	--	40,000	0.918	114,419	2.627

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.08 (April 2026)



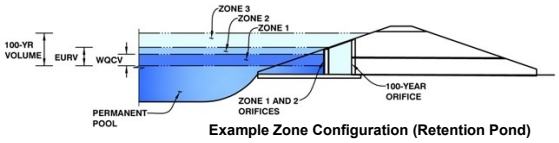


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.08 (April 2026)

Project:

Basin ID:



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.93	0.153	Orifice Plate
Zone 2 (EURV)	1.30	0.252	Orifice Plate
Zone 3 (100-year)	1.84	0.396	Weir&Pipe (Restrict)
Total (all zones)		0.800	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration SCM)

Underdrain Orifice Invert Depth =		ft (distance below the filtration media surface)	Underdrain Orifice Area =		ft^2
Underdrain Orifice Diameter =		inches	Underdrain Orifice Centroid =		feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation SCM)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	1.50	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	sq. inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.50	1.00	1.20				
Orifice Area (sq. inches)	1.00	1.25	2.80	2.80				

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

Calculated Parameters for Vertical Orifice

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.80	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	2.55	N/A	feet
Overflow Weir Front Edge Length =	3.00	N/A	feet	Overflow Weir Slope Length =	3.09	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	3.65	N/A	
Horiz. Length of Weir Sides =	3.00	N/A	feet	Overflow Grate Open Area w/o Debris =	6.46	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	6.46	N/A	ft^2
Debris Clogging % =	0%	N/A	%				

Calculated Parameters for Overflow Weir

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.77	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.75	N/A	feet
Restrictor Plate Height Above Pipe Invert =	24.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	2.50	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.28	feet
Spillway Crest Length =	25.00	feet	Stage at Top of Freeboard =	3.78	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.90	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	2.43	acre-ft

Calculated Parameters for Spillway

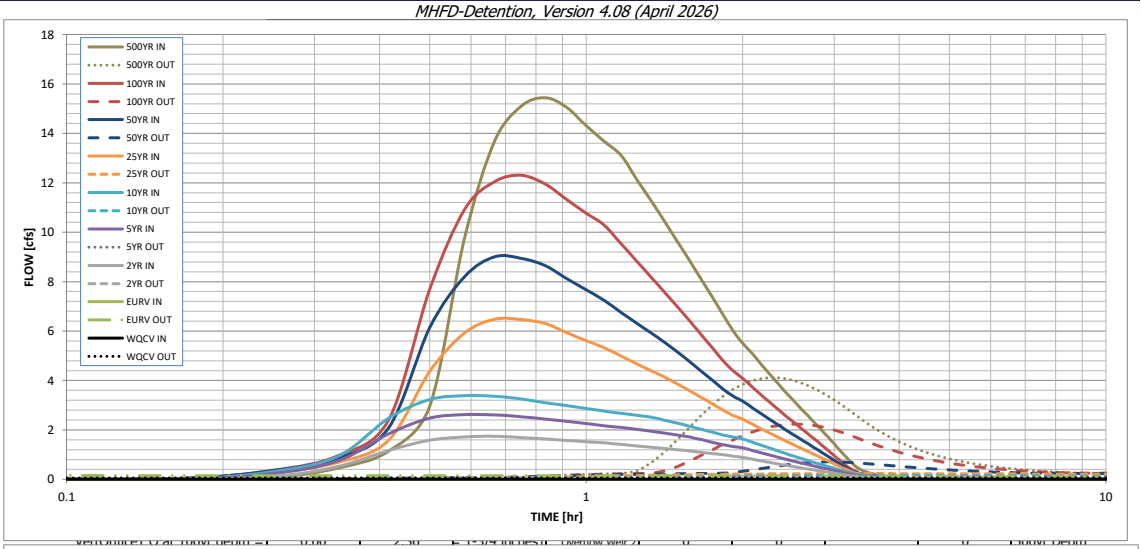
Routed Hydrograph Results

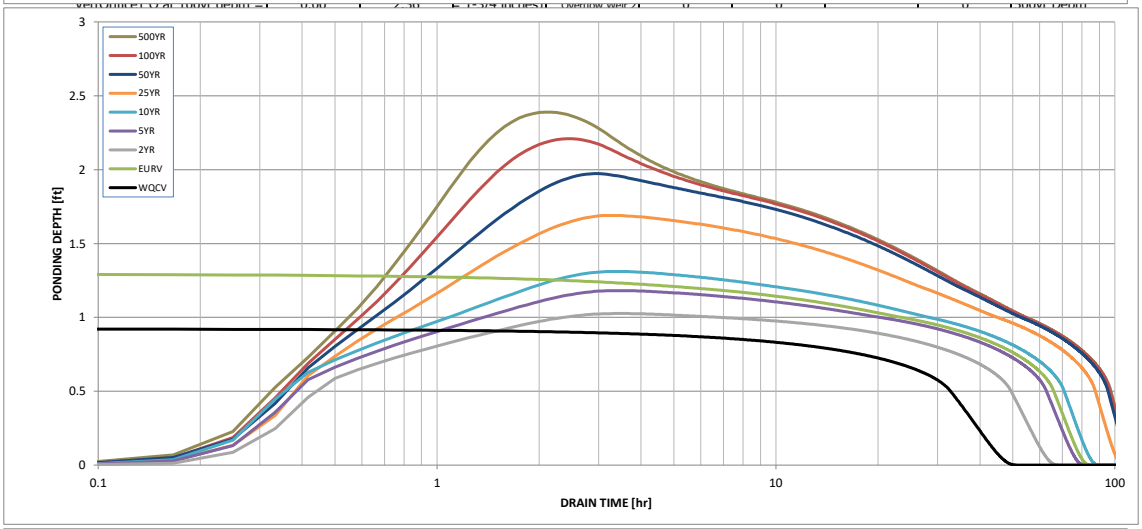
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

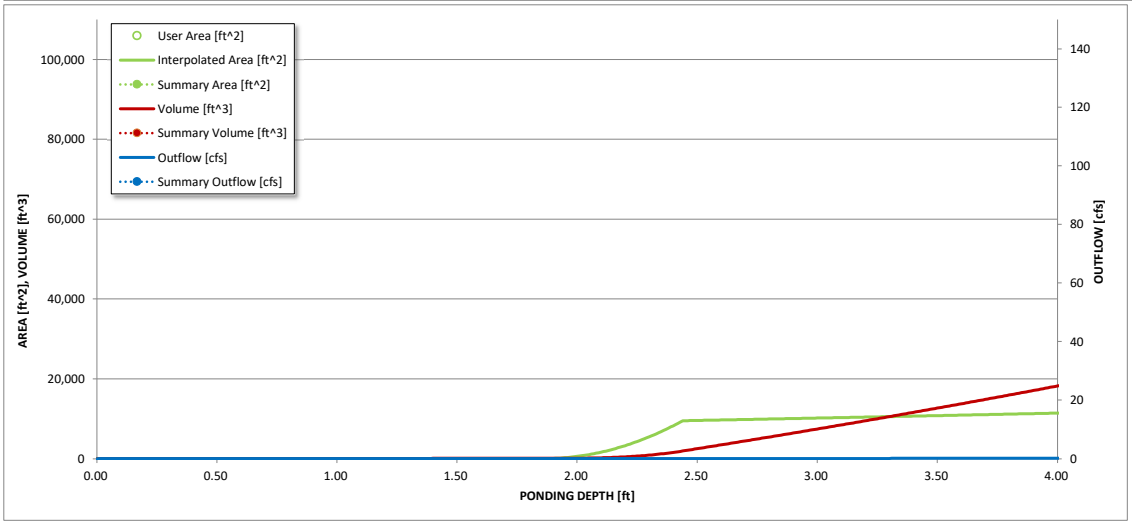
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.03	1.36	1.65	2.09	2.44	2.82	3.22
CUHP Runoff Volume (acre-ft) =	0.153	0.405	0.239	0.353	0.452	0.742	0.994	1.331	1.674
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.239	0.353	0.452	0.742	0.994	1.331	1.674
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.2	0.3	1.8	3.5	5.8	8.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.02	0.03	0.17	0.32	0.52	0.73
Peak Inflow Q (cfs) =	N/A	N/A	1.7	2.6	3.4	6.5	9.0	12.3	15.4
Peak Outflow Q (cfs) =	0.1	0.2	0.1	0.1	0.2	0.2	0.7	2.2	4.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.6	0.1	0.2	0.4	0.5
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	0.1	0.3	0.6
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	43	70	57	68	74	87	92	90	88
Time to Drain 99% of Inflow Volume (hours) =	**46**	76	62	74	81	95	101	100	99
Maximum Ponding Depth (ft) =	0.93	1.30	1.03	1.18	1.31	1.69	1.97	2.21	2.39
Area at Maximum Ponding Depth (acres) =	0.59	0.71	0.68	0.70	0.71	0.74	0.77	0.79	0.80
Maximum Volume Stored (acre-ft) =	0.158	0.410	0.216	0.326	0.417	0.692	0.903	1.082	1.225

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.08 (April 2026)







1

S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0	0.00	0.00	0.00	0.00	0.00	0.04	0.03	0.07
	0:15:00	0	0.00	0.12	0.23	0.32	0.26	0.35	0.37	0.46
	0:20:00	0	0.00	0.52	0.75	0.94	0.70	0.87	0.96	1.14
	0:25:00	0	0.00	1.17	1.84	2.47	1.59	2.09	2.41	2.96
	0:30:00	0	0.00	1.59	2.47	3.23	4.37	6.14	7.69	9.77
	0:35:00	0	0.00	1.71	2.61	3.38	5.92	8.20	10.92	13.69
	0:40:00	0	0.00	1.74	2.61	3.36	6.48	9.01	12.05	15.10
	0:45:00	0	0.00	1.69	2.54	3.25	6.47	8.94	12.30	15.45
	0:50:00	0	0.00	1.63	2.44	3.10	6.31	8.65	11.95	15.06
	0:55:00	0	0.00	1.58	2.35	2.98	5.94	8.13	11.33	14.31
	1:00:00	0	0.00	1.52	2.26	2.87	5.61	7.67	10.77	13.67
	1:05:00	0	0.00	1.48	2.17	2.76	5.32	7.24	10.29	13.12
	1:10:00	0	0.00	1.41	2.10	2.67	4.98	6.75	9.53	12.15
	1:15:00	0	0.00	1.35	2.02	2.60	4.68	6.32	8.84	11.28
	1:20:00	0	0.00	1.30	1.95	2.51	4.40	5.92	8.18	10.42
	1:25:00	0	0.00	1.25	1.87	2.39	4.13	5.54	7.56	9.60
	1:30:00	0	0.00	1.20	1.79	2.27	3.85	5.14	6.97	8.83
	1:35:00	0	0.00	1.15	1.71	2.15	3.58	4.76	6.40	8.09
	1:40:00	0	0.00	1.09	1.60	2.02	3.31	4.37	5.85	7.37
	1:45:00	0	0.00	1.04	1.50	1.90	3.05	4.00	5.31	6.67
	1:50:00	0	0.00	1.00	1.41	1.80	2.80	3.66	4.81	6.02
	1:55:00	0	0.00	0.94	1.33	1.71	2.59	3.37	4.39	5.50
	2:00:00	0	0.00	0.89	1.27	1.64	2.43	3.16	4.09	5.11
	2:05:00	0	0.00	0.82	1.17	1.51	2.24	2.91	3.75	4.68
	2:10:00	0	0.00	0.75	1.08	1.39	2.06	2.67	3.43	4.28
	2:15:00	0	0.00	0.69	0.99	1.27	1.88	2.44	3.13	3.90
	2:20:00	0	0.00	0.63	0.90	1.15	1.72	2.22	2.85	3.55
	2:25:00	0	0.00	0.57	0.82	1.05	1.56	2.02	2.59	3.21
	2:30:00	0	0.00	0.52	0.74	0.95	1.41	1.82	2.33	2.89
	2:35:00	0	0.00	0.47	0.67	0.85	1.27	1.63	2.09	2.59
	2:40:00	0	0.00	0.42	0.60	0.76	1.14	1.45	1.86	2.30
	2:45:00	0	0.00	0.38	0.54	0.68	1.01	1.28	1.63	2.01
	2:50:00	0	0.00	0.33	0.47	0.60	0.88	1.11	1.40	1.72
	2:55:00	0	0.00	0.29	0.41	0.52	0.75	0.94	1.18	1.44
	3:00:00	0	0.00	0.25	0.35	0.44	0.63	0.77	0.96	1.16
	3:05:00	0	0.00	0.21	0.30	0.37	0.51	0.61	0.75	0.89
	3:10:00	0	0.00	0.17	0.24	0.30	0.40	0.46	0.55	0.65
	3:15:00	0	0.00	0.14	0.20	0.24	0.30	0.33	0.39	0.46
	3:20:00	0	0.00	0.12	0.16	0.20	0.23	0.26	0.29	0.35
	3:25:00	0	0.00	0.10	0.14	0.17	0.18	0.21	0.23	0.27
	3:30:00	0	0.00	0.09	0.12	0.15	0.15	0.17	0.18	0.21
	3:35:00	0	0.00	0.07	0.10	0.13	0.13	0.14	0.14	0.17
	3:40:00	0	0.00	0.06	0.09	0.11	0.10	0.12	0.12	0.13
	3:45:00	0	0.00	0.05	0.07	0.09	0.09	0.10	0.09	0.10
	3:50:00	0	0.00	0.05	0.06	0.08	0.07	0.08	0.07	0.08
	3:55:00	0	0.00	0.04	0.05	0.06	0.06	0.06	0.06	0.07
	4:00:00	0	0.00	0.03	0.04	0.05	0.05	0.05	0.05	0.05
	4:05:00	0	0.00	0.03	0.03	0.04	0.04	0.04	0.04	0.04
	4:10:00	0	0.00	0.02	0.03	0.03	0.03	0.03	0.03	0.03
	4:15:00	0	0.00	0.02	0.02	0.03	0.02	0.02	0.02	0.02
	4:20:00	0	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.02
	4:25:00	0	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	4:30:00	0	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	4:35:00	0	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
	4:40:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

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Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Elevation [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

Appendix D.2 – PCM Applicability Form With Water Quality Tables

2880 International Circle, Suite 110
Colorado Springs, CO 80910
Phone: 719-520-6300
Email: Stormwater@elpasoco.com
publicworks.elpasoco.com/stormwater/

EL PASO COUNTY
PCM APPLICABILITY FORM

EPC Project Number: EA2639

This form is to be used by the Engineer of Record to determine if the proposed construction activities are eligible for an exclusion to stormwater quality permanent control measure (PCM) requirements. All "applicable construction activity" within El Paso County (EPC) must comply with the post-construction stormwater management criteria. Reference ECM Appendix I for information about PCMs.

Note that this form only addresses stormwater quality for the site. Even if the site is fully excluded from needing a stormwater quality PCM, the site may still need to address stormwater detention (per DCMv1 Chap 1.5 and ECM Chap 3.2.8.B). However, if the site requires stormwater detention, then it must also address stormwater quality (per DCMv2 Chap 4.1 and ECM Appendix I.7.3). Refer to the Reference Information pages below for more guidance.

Part I. Project Summary			
Project Name:	Cherokee Metropolitan District - PFAS Water Treatment Facility		
Is Stormwater Detention Required?	☒ Yes ☐ No	**Is Water Quality Treatment Required? (i.e.: non-excluded disturbance >1ac)**	☒ Yes ☐ No
Is an ESQCP Required? If "No," Check Applicable Reason	☒ Yes ☐ No	☐ Not an Applicable Construction Activity ☐ Oil & Gas ☐ R-Factor	
Engineer of Record Email Address:	Brian.Gaddie@AE2S.com		

Part II. PCM Exclusions

Note: Questions A through K directly correlate to Part I.E.4.a.i (A) to (K) on page 27 of the 2016 CDPS Statewide Standard MS4 General Permit COR090000 (i.e.: the MS4 Permit), as amended. Document exclusions that apply to the whole project or parts of it.

Questions	Excluded Acreage	Yes	No	Notes
A. Is this project a "Pavement Management Site?"			X	This exclusion applies to the maintenance, rehabilitation, and reconstruction of pavement on existing roads, bridges, bike lanes, and parking along roads. Areas used primarily for parking (i.e.: separate lots not along roadway) or access to parking are not included. No increase in impervious area is allowable.
B. Review two options below to see if project is an "Excluded Roadway Development."				Does not include sidewalks. Does include curb & gutter.
• Does the project include improvements to an existing roadway that adds < 1 acre of paved or gravel area per mile of roadway?			X	If selected, list the proposed additional acreage per mile in Part IV Notes below.
• Does the project include improvements to an existing roadway that adds ≤ 8.25 ft of paved width at any location?			X	If selected, list the proposed additional width in Part IV Notes below.

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Part II. PCM Exclusions (continued)				
Questions	**Excluded Acreage**	**Yes**	**No**	**Notes**
C. Does the project include "Excluded Existing Roadway Areas?"			X	For redevelopment of existing roadways. This exclusion only excludes the original roadway area, it does NOT apply to the entire project. This exclusion applies only when the proposed project will expand the existing roadway width by <2x on average. If selected, list the proposed expanded width in Part IV Notes below.
D. Is the project considered an Aboveground or Underground Utilities activity?			X	Activity can not permanently alter the terrain, ground cover, or drainage patterns from existing conditions.
E. Is the project considered a "Large Lot Single-Family Site"? *This exclusion only pertains to the lots and does not include roadways.*			X	Must be a single-family residential lot or agricultural zoned land with ≥ 2.5 acres per dwelling and total lot impervious area < 10%. If "Yes," notate the percent impervious below in Part IV: Notes.
F. Do Non-Residential or Non-Commercial Infiltration Conditions exist? *Post-development surface conditions do not result in concentrated stormwater flow or surface water discharge during an 80th percentile stormwater runoff event, and the 80th percentile event must be infiltrated.*			X	Exclusion does not apply to residential or commercial sites for buildings. A site-specific study is required and must show rainfall and soil conditions, allowable slopes, surface conditions, and ratios of imperviousness area to pervious area.
G. Is the project land disturbance to Undeveloped Land where undeveloped land remains undeveloped following the activity?			X	Project must be on land with no human made structures such as buildings or pavement. The proposed development must return the disturbed area to its historical condition. See CDPHE's "Standard MS4 Permit FAQ" for more detail on how this exclusion applies.
H. Is the project a Stream Stabilization Site?			X	
I. Is the project a Bike or Pedestrian Trail?			X	Bike lanes for roadways are not included in this exclusion but may qualify if attached to a larger roadway activity that is excluded in A, B or C above. Pedestrian trails (e.g. sidewalks) that are attached to a roadway do not apply.
J. Is the project Oil and Gas Exploration?			X	Activities and facilities associated with oil and gas exploration are excluded.
K. Is the project in a County Growth Area?				El Paso County does not apply this exclusion.

If any exclusions above apply (via a "Yes" for any row), runoff from those areas is excluded from stormwater quality treatment requirements. All runoff from remaining non-excluded disturbed areas will need to be treated by a stormwater quality PCM, unless remaining area is <1ac. If remaining area is >1ac, select at least one Design Standard on the next page.

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Part III: PCM Information		
Questions	**Yes**	**No**
1. Which of the following Design Standard(s) will the project utilize? *(If a PCM is required, you must select at least one. See Control Measure Requirements identified in MS4 Permit Part I.E.4.a.iv on page 29.)*		
A. Water Quality Capture Volume (WQCV) Standard	X	
B. Pollutant Removal Standard - 80% Total Suspended Solids Removal (TSS) *(must treat runoff to <30mg/L of TSS)*		
C. Runoff Reduction Standard		
D. Applicable Development Site Draining to a Regional WQCV Control Measure *(no conveyance via "Waters of the State")*		
E. Applicable Development Site Draining to a Regional WQCV Facility *(conveyance allowable via "Waters of the State," if the 8 conditions in the MS4 permit are met and documented in the drainage report)*		
F. Constrained Redevelopment Sites Standard *(must be pre-approved by ECM Administrator)*		
G. Previous Permit Term Standard		
2. Will any of the PCMs be located within any other jurisdiction besides EPC?		X

Part IV: Notes
Provide info regarding all applicable PCM(s) and PCM Exclusion(s) including location, PCM name(s)/number(s), and additional relevant filings or reports or maintenance agreements, etc. Attach an additional sheet if you need more space. Attaching a detailed summary table would replace the need for any notes here.

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Part V: Signatures

Applicant: This PCM Applicability Form was prepared under my direction and supervision and is correct to the best of my knowledge and belief. It was prepared along with the project design, construction plans, drainage report, specifications, and maintenance and access agreements as required. And it has been reviewed for compliance with the Post Construction Stormwater Management criteria and MS4 Permit requirements.



Signature and Stamp of Engineer of Record
(If the project is not an Applicable Construction Activity, this line can be signed by the Applicant or their rep, they do not have to be an engineer)

10/5/2026
Date

El Paso County: This PCM Applicability Form has been reviewed and the project design, construction plans, drainage report, specifications, and maintenance and access agreements as required, have been reviewed for compliance with the Post Construction Stormwater Management process and MS4 Permit requirements.

Signature of El Paso County Project Engineer

Date

Reference Information:

If a PCM is required, then these additional documents will also need to be submitted:

- PCM Maintenance Agreement
- PCM O&M Manual
- MHFD Detention Basin Design Workbook*
- Proof of Submittal of: Notice of Intent to Construct a Non-Jurisdictional Water Impoundment Structure*

*Not required for all PCMs, check ECM Appendix I for requirements

The following are screenshots of example Water Quality Treatment Summary Tables. The Excel versions can be found at the EPC DPW Stormwater website linked below. These are optional tables that can be used to summarize water quality treatment and applicable exclusions. Select the table that best suits the project based on the number of basins, PCMs, and/or exclusions. A PDF of the selected table(s) can be attached to this form and/or to the Drainage Report. It is helpful to also include a basic overview map with color shading or hatch patterns that shows areas tributary to each type of PCM (pond, runoff reduction, etc.) and those areas that are not captured by a PCM, with the applicable exclusion(s) labeled.

https://publicworks.elpasoco.com/stormwater/

Water Quality Treatment Summary Table		
Basin ID(s)	**PCM Tributary Area (ac)**	**PCM ID**
A1 - A5	4	Pond 1
B1 - B3	3.25	Pond 2
C, D	5.5	Runoff Reduction
E	10	Excluded*
* Excluded based on ECM App I.7.1.B.5		

Water Quality Treatment Summary Table							
Basin ID	**Total Area (ac)**	**Total Proposed Disturbed Area (ac)**	**Area Trib to Pond A (ac)**	**Disturbed Area Treated via Runoff Reduction (ac)**	**Disturbed Area Excluded from WQ per ECM App I.7.1.C.1 (ac)**	**Disturbed Area Excluded from WQ per ECM App I.7.1.B.# (ac)**	**Applicable WQ Exclusions (App I.7.1.B.#)**
A	4.50	4.50	4.50				
B	1.25	1.25		1.25			
C	6.00	4.00				4.00	ECM App I.7.1.B.5
D	2.50	2.50	1.00		0.50	1.00	ECM App I.7.1.B.7
E	3.00		3.00				
F	8.25						
Total	25.50	12.25	8.50	1.25	0.50	5.00	

Min Required Area to Receive WQ Treatment	**Total Proposed Disturbed Area (ac)**	**Total Proposed Treated Area (ac)**	**Total Proposed Disturbed Area Excluded from WQ (ac)**	**Net Treatment (ac)**
6.75	12.25	9.75	5.50	3.00

Design Standard D, definition of "Waters of the State of Colorado" per MS4 Permit:

> *"Any and all surface waters and subsurface waters which are contained in or flow in or through this state, but does not include waters in sewage systems, waters in treatment works of disposal systems, waters in potable water distribution systems, and all water withdrawn for use until use and treatment have been completed. This definition can include water courses that are usually dry."*
>
> The following website shows Waters of the State of Colorado:
>
> https://cdphe.maps.arcgis.com/apps/Viewer/index.html?appid=f1541d2f21834642ba1551c674fd4a79

Design Standard E, additional info from the MS4 Permit:

> *Before discharging to a water of the state, at least 20 percent of the upstream imperviousness of the applicable development site must be disconnected from the storm drainage system and drain through a receiving pervious area control measure comprising a footprint of at least 10 percent of the upstream disconnected impervious area of the applicable development site. The control measure must be designed in accordance with a design manual identified by the permittee. In addition, the stream channel between the discharge point of the applicable development site and the regional WQCV facility must be stabilized.*
>
> Below are the 8 conditions that must be met:
>
> *1) The regional WQCV facility must be implemented, functional, and maintained following good engineering, hydrologic and pollution control practices.*
>
> *2) The regional WQCV facility must be designed and maintained for 100% WQCV for its entire drainage area.*
>
> *3) The regional WQCV facility must have capacity to accommodate the drainage from the applicable development site.*
>
> *4) The regional WQCV facility be designed and built to comply with all assumptions for the development activities planned by the permittee within its drainage area, including the imperviousness of its drainage area and the applicable development site.*
>
> *5) Evaluation of the minimum drain time shall be based on the pollutant removal mechanism and functionality of the facility. Consideration of drain time shall include maintaining vegetation necessary for operation of the facility (e.g., wetland vegetation).*
>
> *6) The permittee shall meet the requirements in Parts I.E.4.a.v. and vii. and Part I.E.4.b. for the regional WQCV facility consistent with requirements and actions for control measures.*
>
> *7) The regional WQCV facility must be subject to the permittee's authority consistent with requirements and actions for a Control Measure in accordance with Part I.E.4.a.iv.*
>
> *8) Regional Facilities must be designed and implemented with flood control or water quality as the primary use. Recreational ponds and reservoirs may not be considered Regional Facilities. Water bodies listed by name in surface water quality classifications and standards regulations (5 CCR 1002-32 through 5 CCR 1002-38) may not be considered regional facilities.*

Water Quality Treatment Summary Table							
Basin ID	Total Area (ac)	Total Proposed Disturbed Area (ac)	WQ Treatment		WQ Exclusions		Applicable WQ Exclusions (App I.7.1.B)
			Area Trib to Pond A (ac)	Disturbed Area Treated via Runoff Reduction (ac)	Disturbed Area Excluded from WQ per ECM App I.7.1.C.1 (ac)	Disturbed Area Excluded from WQ per ECM App I.7.1.B (ac)	
IP_01	68.48	3.13		3.13			
IP_02	5.11	2.44		2.44			
IP_03	4.38	2.21	4.38	2.21			
IP_04	1.57	1.57	1.57				
IP_05	2.56	2.56	2.56				
IP_06	0.84	0.84	0.84				
IP_07	1.04	1.04	1.04				
IP_08	1.51	0.35		0.35			
IP_09	0.20	0.18					
IP_10	14.48	0.00					
Total	100.17	14.32	10.39	8.13	0.00	0.00	

Min Required Area to Receive WQ (ac)	Total Proposed Disturbed Area (ac)	Total Proposed Treated Area (ac)	Total Proposed Disturbed Area Excluded from WQ (ac)	Net Treatment (ac)
14.32	14.32	18.52	0.00	4.20

Appendix E.1 – Geotechnical Report

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GEOTECHNICAL ENGINEERING REPORT
CHEROKEE METROPOLITAN DISTRICT
PFAS WATER TREATMENT FACILITY
NEAR ELLICOTT HIGHWAY & SH94
EL PASO COUNTY, COLORADO

Prepared by:

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Project No. 25-2-263

June 3, 2026

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FIG. 1 - LOCATION OF EXPLORATORY BORINGS AND TEST PITS
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TABLE I - SUMMARY OF LABORATORY TEST RESULTS

SUMMARY

1. Beneath a layer of topsoil, the generalized subsurface profile encountered in the borings consisted of granular overburden soil types, to include silty sand (SM), poorly-to well-graded sand with varied amounts of silt (SP, SW, SP-SM, SW-SM), clayey sand (SC), and silty-clayey sand (SM-SC). Infrequent lenses of lean clay with varied amounts of sand (CL), were encountered in five of the borings, and ranged from approximately 0.5 to 4 feet in thickness where encountered. The overburden soils extended to the maximum 4 to 60-foot depths explored.

2. Groundwater was not encountered in the borings at the time of drilling, or when the borings were checked 7 to 8 days later. The borings were backfilled with auger cuttings after performing the follow-up water level check. Groundwater is expected to fluctuate over time due to seasonal and climatic factors as well as the irrigation regimen of the developed area. Based on our understanding of the proposed construction and the anticipated depths of construction, we do not expect groundwater to be a design consideration for this project.

3. With proper site preparation, shallow spread footing foundations with slab-on-grade floors or mat foundations should be feasible. Because of the loose upper soils encountered, proper site preparation should include complete removal of topsoil and organic materials down to the natural granular soils, followed by overexcavation, moisture conditioning and recompaction of the native subgrade to a depth of at least 3 feet below foundation and floor slab bearing elevations. During the subgrade moisture conditioning and recompaction process, any clay soils encountered should be replaced with suitable structural fill. The intent of this recommendation is to provide an anticipated total settlement potential of approximately 1 inch or less.

4. With proper moisture conditioning, the on-site granular soils will be suitable for reuse as structural fill, including structural fill beneath foundations, floor slabs, exterior flatwork, and pavements. Clay materials should be considered unsuitable, and should be placed in nonstructural or landscape areas, or removed from the site. The “Site Grading and Earthwork” section of the report provides additional discussion on suitability of the on-site soils and imported fill requirements.

5. The following table presents the recommended pavement thicknesses based on assumed traffic loading as discussed herein.

PAVEMENT SECTION THICKNESS (in.)		
Asphalt Over Aggregate Base Course	Aggregate Base Surfaced	Unreinforced Concrete over Aggregate Base Course
5 over 6	6	6 over 6

*: We recommend truck areas where truck turning movements are concentrated be paved with a Portland Cement Concrete (PCC) section or aggregate surfacing rather than the asphalt alternative. The use of a flexible pavement in these areas could result in pavement fatigue cracking and/or rutting/shoving of the pavement due to the concentrated wheel loads.

PURPOSE OF REPORT

This report presents the results of a geotechnical engineering study for the proposed PFAS water treatment facility to be located in the vicinity of North Ellicott Highway and State Highway 94 in El Paso County, Colorado. The project site is shown on the attached Fig. 1. The study was conducted for the purpose of developing recommendations for site grading, foundations, pavements, and other geotechnical considerations related to the proposed construction. The study was performed in general accordance with our Proposal No. C25-274R, dated March 10, 2026.

This report has been prepared to summarize the data obtained during this study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations related to the proposed construction are included in the report.

PROPOSED CONSTRUCTION

We understand the proposed construction will include the components summarized in the table below and as generally shown on Fig. 1. Overall, site grading is anticipated to consist of maximum cuts/fill of less than 2 feet.

Item	Grade	Details
Finished water tanks (2)	At-grade	105’ diameter, 1.5 M gallon, prestressed concrete
Raw water tanks (2)	At-grade	60’ diameter, 0.5 M gallon, prestressed concrete
Treatment facility building	At-grade, no basement. Structure will include a wet well which extends 12’ below grade.	Pre-fab metal building, approximately16,300 sf
Leach field	Assumed minimum of 12” to maximum of 48” below grade.	100’x100’ leach field
Buried piping	Assumed invert depths below grade in range of 6’ to 10’ for water and sewer, and 4’ for electric and other conduits.	6” to 24” diameter water and sewer lines
Driveway and parking	At-grade	Gravel surfaced or asphalt paved

SITE CONDITIONS

The subject site is located on vacant land north of State Highway 94, east of N Ellicott Highway in El Paso County, Colorado. The site is generally surrounded by vacant land and livestock

pastures, with a pumpkin patch and farm located beyond to the west of the proposed development. The site is nearly level with a slight slope down to the east and south, and is vegetated by native grasses, weeds, and cacti.

SITE GEOLOGY

The project site is located within the Colorado Piedmont of the Great Plains physiographic province. Structurally, this area is east of the Ute Pass and Rampart Range Faults, which bound this portion of the Front Range. Regional uplift east of the Front Range has exposed Upper Cretaceous to Paleocene-age, gently northeast dipping claystone, siltstone, sandstone and thin coal beds representing a regressional sea sequence. The entirety of the subject site is mapped as Louviers Alluvium. This alluvium is described as thin reddish-brown gravel to yellowish-brown sand deposited on terraces 60 to 70 feet above streams on the plains, dating to the Pleistocene epoch. This alluvial deposit is expected to be underlain by early Tertiary to late Cretaceous-age deposits of the Denver Basin Group at an unknown depth, which consist of arkosic sandstone interbedded with claystone.

FIELD EXPLORATION

The field exploration of subsurface conditions consisted of drilling nine 4-inch diameter borings (B1-B9) and three 8-inch diameter percolation test holes (P1-P3), and excavating two test pits (EX1, EX2). The borings and percolation test holes were drilled between April 20 and 21, 2026 and the test pits were excavated on April 27, 2026. The locations were approximated using a handheld GPS unit, and are shown on Fig. 1. Logs of the exploratory borings and test pits are presented on Figs. 2 thru 4, and corresponding legend and notes are presented on Fig. 5.

The borings and test pits were logged by representatives of Kumar & Associates, Inc. Samples of the soils were taken with a 2-inch I.D. California sampler. The sampler was driven into the various strata with blows from a 140-pound hammer falling 30 inches. Penetration resistance values, when properly evaluated, provide an indication of the relative density or consistency of the soils. Bulk disturbed samples were also collected. Depths at which the samples were taken and the penetration resistance values are shown on the boring logs.

LABORATORY TESTING

Samples obtained from the exploratory borings and test pits were visually classified in the laboratory and samples were selected for laboratory testing. Laboratory testing included index property tests such as in-situ moisture content and dry unit weight, grain size analysis, and

Atterberg limits. Additional testing included in-situ swell-consolidation, electrical resistivity, concentration of water soluble sulfates and water soluble chlorides, and pH. The testing was conducted in general accordance with recognized test procedures, primarily those of the American Society for Testing of Materials (ASTM). Results of the laboratory testing program are shown on Figs. 2 thru 4, and 6 thru 19, and are summarized on Table I.

SUBSURFACE CONDITIONS

Beneath a layer of topsoil, the generalized subsurface profile encountered in the borings consisted of granular overburden soil types, to include silty sand (SM), poorly-to well-graded sand with varied amounts of silt (SP, SW, SP-SM, SW-SM), clayey sand (SC), and silty-clayey sand (SM-SC). Infrequent lenses of lean clay with varied amounts of sand (CL), were encountered in five of the borings, and ranged from approximately 0.5 to 4 feet in thickness where encountered. The overburden soils extended to the maximum 4 to 60-foot depths explored. The following subsurface descriptions are of a generalized nature to highlight the soil types encountered in the borings drilled for this study. The boring logs should be reviewed for more detailed information.

Native Granular Soils: Native granular soils encountered included silty sand (SM), poorly-to well-graded sand with varied amounts of silt (SP, SW, SP-SM, SW-SM), clayey sand (SC), and silty-clayey sand (SM-SC). Occasional gravel was encountered in each of these soil types. The native granular soils extended to the maximum 4 to 60-foot depths explored in each of borings. The native granular soils varied from slightly moist to moist, with color varying from tan, brown, gray-brown, tan-gray, and tan-orange. Sampler penetration blow counts indicate the granular soils are generally medium dense to very dense, with occasional loose zones in the upper approximately 5 feet in some of the borings.

The in-situ moisture content of the granular soils tested varied from 1.6% to 13.4%, with an average of 5.7%. The in-situ densities varied from 93.4 pcf to 129.4 pcf, with an average of 116.2 pcf.

Swell-consolidation test results presented on Figs. 6 thru 8 indicate the tested samples of silty sand were nonexpansive when wetted under a 1,000 psf surcharge. A tested sample clayey sand had a low swell potential.

Native Clay Soils: Infrequent lenses of lean clay with varied amounts of sand (CL), were encountered in five of the borings, and ranged from approximately 0.5 to 4 feet in thickness where

encountered. The clay was slightly moist to moist, and brown, gray, and gray-brown in color. Sampler penetration blow counts indicate the clay soils are medium stiff to very stiff.

In-situ moisture content of the clay soils tested varied from 12.1% to 22.5%, with an average of 17.8%. The in-situ densities varied from 96.7 pcf to 106.7 pcf, with an average of 101.2 pcf. Swell-consolidation test results presented on Figs. 6 thru 8 indicate the tested sample of clay had a nil to low swell potential when wetted under a 1,000 psf surcharge.

Groundwater: Groundwater was not encountered in the borings at the time of drilling, or when the borings were checked 7 to 8 days later. The borings were backfilled with auger cuttings after performing the follow-up water level check. Groundwater is expected to fluctuate over time due to seasonal and climatic factors as well as the irrigation regimen of the developed area. Based on our understanding of the proposed construction and the anticipated depths of construction, we do not expect groundwater to be a design consideration for this project.

GEOTECHNICAL ENGINEERING CONSIDERATIONS

As discussed above, the subgrade soils encountered were found to be loose in the upper approximately 5 feet in some of the borings. Without densification of the loose soils, foundations and floor slabs placed on loose granular materials can experience excess total and/or differential settlement, which may lead to distress to the structure or slab.

With proper site preparation, shallow spread footing foundations with slab-on-grade floors or mat foundations should be feasible. Because of the loose upper soils encountered, proper site preparation should include complete removal of topsoil and organic materials down to the natural granular soils, followed by overexcavation, moisture conditioning and recompaction of the native subgrade to a depth of at least 3 feet below foundation and floor slab bearing elevations. During the subgrade moisture conditioning and recompaction process, any clay soils encountered should be replaced with suitable structural fill. The intent of this recommendation is to provide an anticipated total settlement potential of approximately 1 inch or less. If extreme wetting of the subgrade is allowed, settlement could be greater.

The on-site granular soils encountered are suitable for reuse as structural fill with proper moisture conditioning. The “Site Grading and Earthwork” section of the report provides additional discussion.

The foundation recommendations that follow include spread footing and mat foundations. If other foundation alternatives are preferred, we should be consulted.

FOUNDATION RECOMMENDATIONS

The design and construction criteria presented below should be observed for a spread footing or mat foundation system. The construction details should be considered when preparing project documents.

1. We recommend that spread footing and mat foundations be supported on the native granular soils, with overexcavation, moisture conditioning and recompaction of the native subgrade to a minimum depth of 3 feet below foundation bearing elevation. During the subgrade moisture conditioning and recompaction process, any clay soils encountered should be removed and replaced with suitable structural fill.

2. Structural fill should meet the material and placement requirements outlined in the "Site Grading and Earthwork" section of this report. New structural fill should extend down from the edges of the foundations at a 1 horizontal to 1 vertical projection.

3. Footings supported on properly compacted structural fill as recommended herein should be designed for a maximum allowable soil bearing pressure of 2,500 psf.

4. If the mat cannot be considered rigid, the soil pressure distribution should be computed using a method which models the soil-structure interaction, such as the beam on an elastic foundation procedure. A modulus of vertical subgrade reaction of 150 pci can be used for compacted on-site soils. This value is based on correlations to a 1 ft. x 1 ft. sample plate and should be decreased as appropriate to account for the actual foundation size and geometry.

5. Spread footings should have a minimum footing width of 16 inches for continuous footings and of 24 inches for isolated pads.

6. Exterior footings and footings beneath unheated areas should be provided with adequate soil cover above their bearing elevation for frost protection. Placement of foundations at least 30 inches below the exterior grade is typically used in this area.

7. Criteria for the lateral resistance of a spread footing placed on native granular materials or properly compacted structural fill is presented in the “Foundation Walls & Retaining Structures” section of this report.

8. Continuous foundation walls should be reinforced top and bottom to span an unsupported length of at least 10 feet.

9. Granular foundation soils should be densified with a smooth vibratory compactor prior to placement of formwork and reinforcing steel.

10. A representative of the geotechnical engineer should confirm proper subgrade preparations have been met prior to placing foundation formwork. Loose disturbed material should be removed from the foundation subgrade prior to placement of concrete. Placement of structural fill should be observed and tested by a representative of the geotechnical engineer. In addition, representatives of the geotechnical and/or structural engineer should check reinforcement placement prior to concrete placement.

SITE SEISMIC CRITERIA

Using estimated shear wave velocities for the subgrade materials encountered based on standard penetration testing, calculations for an assumed 100-foot profile indicate a design Site Class D per the 2021 International Building Code (IBC). Based on the subsurface profile and area seismicity, liquefaction is not a design consideration. Using an online 3rd party graphical user interface tool developed by the Office of Statewide Health and Planning Development (OSHPD) that references USGS seismic design maps and ASCE 7-16, the following probabilistic values are reported for the project site.

Type	Value
MCE_R Ground motion, 0.2s period S_s	0.165
MCE_R Ground motion, 1.0s period S_1	0.052

FLOOR SLABS

Excluding the occasional loose upper native soils, the native granular soils are suitable to support light to moderately loaded slab-on-grade construction. Proper site preparation should include overexcavation of the native soils to a minimum a depth 3 feet below the proposed floor slab elevation as detailed below. Assuming floor slabs are properly constructed as described in this

report, and that good surface drainage and irrigation practices are designed, constructed and maintained, we believe the risk of slab movements will be relatively low, with potential movements of about 1 inch or less anticipated. If extreme wetting of the subgrade is allowed, settlement could be greater. The following measures should be taken to reduce the damage which could result from movement should the underslab materials be subjected to moisture changes.

1. Floor slabs should be supported on a minimum 3 feet of moisture-conditioned fill. During the overexcavation, moisture conditioning and recompaction process, any clay soils encountered should be removed and replaced with suitable structural fill.

2. Structural fill should meet the material and placement requirements outlined in the "Site Grading and Earthwork" section of this report.

3. Floor slabs should be designed using a subgrade modulus (k) of 150 pci.

4. Floor slabs should be separated from all bearing walls and columns with expansion joints which allow unrestrained vertical movement.

5. Floor slabs should not extend beneath exterior doors or over foundation grade beams, unless saw cut at the beam after construction.

6. Floor slab control joints should be used to reduce damage due to shrinkage cracking. The appropriate joint spacing is dependent on slab thickness, concrete aggregate size and slump, and should be consistent with recognized guidelines such as those of the Portland Cement Association (PCA) or American Concrete Institute (ACI). The joint spacing and any requirements for slab reinforcement should be established by the designer based on experience and the intended slab use.

7. If moisture-sensitive floor coverings will be used, mitigation of moisture penetration into the slabs, such as by use of a vapor barrier, may be required. If an impervious vapor barrier membrane is used, special precautions will be required to reduce potential differential curing problems which could cause the slabs to warp. Section 302.1R of the ACI Manual of Concrete Practice addresses this topic.

8. All plumbing lines should be tested before operation. Where plumbing lines or other slab protrusions enter through the floor, a positive bond break should be provided. Flexible connections should be provided for slab-bearing mechanical equipment.

The precautions and recommendations listed above will not prevent the movement of floor slabs if the underlying expansive materials are subjected to alternate wetting and drying cycles. However, the precautions should reduce the damage if such movement occurs.

FOUNDATION WALLS & RETAINING STRUCTURES

Foundation walls and retaining structures which are laterally supported and that are expected to undergo a moderate amount of deflection should be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of 55 pcf for backfill consisting of the on-site granular soils, or 50 pcf if imported CDOT Class I structural backfill is used. Cantilevered retaining structures that are expected to deflect sufficiently to mobilize the full active earth pressure condition should be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of 45 pcf for backfill consisting of the on-site granular soils, or 40 pcf for CDOT Class I structural backfill.

All foundation and retaining structures should be designed for appropriate hydrostatic and surcharge pressures such as adjacent buildings, traffic, construction materials and equipment. The pressures recommended above assume drained conditions behind the walls and a horizontal backfill surface. The buildup of water behind a wall or an upward sloping backfill surface will increase the lateral pressure imposed on a foundation wall or retaining structure.

The lateral resistance of a foundation or retaining wall footing placed on properly compacted nonexpansive fill material will be a combination of the sliding resistance of the foundation on the foundation materials and passive earth pressure against the side of the footing. Resistance to sliding at the bottoms of the footings may be calculated based on an allowable coefficient of friction of 0.30. Passive pressure against the sides of the footings may be calculated using an allowable equivalent fluid unit weight of 180 pcf.

The onsite granular soils, minus any clay soils, are suitable for use as wall backfill. Imported granular wall back fill, if used, should meet the requirements of a CDOT Class I structural backfill with less than 20% passing the No. 200 sieve. Proposed material should be approved by the geotechnical engineer prior to use.

The granular backfill behind foundation and retaining walls should be sloped from the base of the wall at an angle of at least 45 degrees from the vertical. Backfill should be placed in uniform lifts and compacted to the criteria presented in the "Site Grading and Earthwork" section of the report. Care should be taken not to overcompact the backfill since this could cause excessive lateral pressure on the walls. Some settlement of deep foundation wall backfills will occur even if the material is placed properly.

EXTERIOR FLATWORK

We recommend subgrade preparation beneath exterior flatwork immediately adjacent to the building and within a 10-foot zone around the perimeter of the building including sidewalks where reduction of settlement potential is considered more important be prepared to the same requirement of overexcavation required for the structure, which includes providing a minimum 3-foot depth of overexcavation, moisture-conditioning and recompaction below the bearing elevation of the flatwork.

Fill placed for support of exterior flatwork should meet the material and compaction requirements for structural fill presented in the "Site Grading and Earthwork" section of this report.

Proper surface drainage measures as recommended in the "Surface Drainage" section of this report are also critical to reducing moisture or frost-related movement. Settlement of fill below exterior flatwork adjacent to the buildings may result in adverse drainage conditions with runoff directed toward the structure. Site grading and drainage design should consider those possibilities, particularly at entryways. Positive drainage and grades should be maintained throughout the life of the facility.

WATER SOLUBLE SULFATES

The concentration of water soluble sulfates measured in samples of the on-site soils obtained from the borings ranged from less than 0.01% to approximately 0.04%. These concentrations of water soluble sulfates represent Class S0 severity exposures to sulfate attack on concrete exposed to these materials. The degree of attack is based on a range of Class S0, Class S1, Class S2, and Class S3 severity exposure as presented in ACI 201. Based on the laboratory data and our experience, we believe special sulfate resistant cement will not be required for concrete exposed to the on-site soils.

BURIED METAL CORROSION CONSIDERATIONS

The potential for corrosion of buried metal placed beneath the ground surface at the site was evaluated based on the results of laboratory tests on samples of well graded sand with silt and gravel (SW-SM) and lean clay (CL) obtained from the borings. The samples were tested to determine pH, water soluble sulfates, chlorides, and electrical resistivity. The laboratory test results are summarized in Table I, and shown on the boring logs, Figs. 2 thru 4. Electrical resistivity test results are presented graphically on Fig. 19.

The pH test results indicate a value of 8.2, which suggest the site materials are slightly alkaline. The concentration of water soluble sulfates ranged from less than 0.01% to approximately 0.04% as discussed in the previous section, and the concentration of water soluble chlorides was 0.02%.

The electrical resistivity test results presented on Fig. 19 indicate minimum resistivity values (saturated) of 10,000 ohm-cm and 800 ohm-cm for tested samples of well graded sand with silt and gravel and lean clay, respectively, with corresponding values at the in-situ moisture content of 14,960 ohm-cm and 865 ohm-cm for the tested samples. These values suggest excellent corrosion resistance for the granular soil sample, and poor corrosion resistance for the clay soil sample.

Corrosion of buried metal is a complex process and requires an understanding of the combined effects of pH, soil moisture, and other conditions not evaluated as part of this report. We recommend the applicable pipe designer or qualified corrosion engineer review the information presented herein to ultimately determine the need for and appropriate level of corrosion protection for buried metals at the site.

PERCOLATION TESTING

The location of percolation test holes (P1 thru P3), and the corresponding profile test pits (EX1 and EX2) are shown on Fig. 1. The percolation test holes were drilled to a depth of 4 feet using 8-inch diameter continuous-flight augers, and the test pits were excavated to a depth of 8 feet using a min-excavator. Below a layer of topsoil, the subgrade soils encountered were granular, and generally included silty sand (SM) in the upper approximately 1.5 to 4 feet, followed by well-graded sand with varied amounts of silt and gravel (SW-SM, SW). Groundwater was not encountered during the excavation of test pits or when the percolation tests were conducted. Logs of the percolation test holes and test pits are included on Fig.4 for reference.

Percolation tests were performed on April 28, 2026, following the "Regulations of the El Paso County Board of Health – El Paso County, Colorado", Chapter 8, On-site Wastewater Treatment Systems (OWTS) criteria. The measured percolation rates of the soils tested are presented below. The measurements were made at 10-minute intervals for a total of 8 readings at each location. Tests were performed 24 hours after a presoak period. The values presented reflect the final reading made at each test hole. The field percolation rate, which is the average rate of the percolation rates determined for all percolation test holes within the proposed soil treatment area, is 2.83 minutes/inch.

Percolation Test Hole	Depth to Groundwater (ft)	Final Percolation Rate (min./inch)	EPC OWTS Soil Type[1]	USDA Hydrologic Soil Group[2]
P1	(none)	3.33	1	A
P2	(none)	2.67	1	A
P3	(none)	2.50	1	A

[1] The soil type presented in the table above was determined in accordance with the criteria listed in Table 10-1 of the El Paso County OWTS regulations, which considers USDA criteria for classification and texture. In accordance with USDA, the soils encountered within the percolation test holes classified as loamy sand to sand, single-grain, and structureless.

[2] The hydrologic soil group presented in the table above was determined for the soils within the proposed infiltration area in accordance with the criteria listed in the United States Department of Agriculture's *National Engineering Handbook, Part 630: Hydrology*. Group A soils are considered to have a low runoff potential and water is transmitted freely through the soil.

Several factors can affect the rate of percolation, including soil density and moisture content, the percentage of silt and clay, as well as other environmental and construction influences. The designer should consider that actual percolation rates can be highly variable and may differ by an order of magnitude or more from those indicated. Although unlikely, shallow groundwater will result in a lower percolation rate than that reported above if it is within about 4 feet of the proposed infiltration zone.

UNDERDRAIN SYSTEM

We understand the pump wet well will extend approximately 12 feet below grade. Typically, where below grade construction is used, we recommend consideration be given to protect the space with an underdrain system. Although free water was not encountered during our field exploration, localized perched water conditions can sometimes develop within the structure backfill zone

during times of heavy precipitation after construction. Such a system will likely require a sump and pump.

However, considering the proposed construction and the subsurface conditions encountered, it is our opinion that the use of an underdrain can be optional, and it's inclusion should be ultimately decided by the designer. The designer should be aware that without an underdrain, there may be an increased potential for periodic wetting of the interior space during times of precipitation, depending on the construction type. Water proofing the space can be utilized to reduce the magnitude of potential wetting.

If used, the underdrain system should consist of a perimeter drain placed at least 12 inches below the vault floor elevation, and consist of a perforated pipe placed in the bottom of a trench and surrounded above the invert level with free-draining gravel. This free-draining gravel should extend up to the slab level and should be surrounded with filter fabric. Free-draining gravel used in the drain system should consist of minus 2-inch aggregate with less than 20% passing the No. 4 sieve and less than 5% passing the No. 200 sieve. The perimeter drain pipe should be at least 4 inches in diameter. and graded at a minimum ½% slope to a gravity outlet or sump where water may be removed by pumping.

SURFACE DRAINAGE

Proper surface drainage is very important for acceptable performance of the development during construction and after the construction has been completed. Drainage recommendations provided by local, state and national entities should be followed based on the intended use. The following recommendations should be used as guidelines and changes should be made only after consultation with the geotechnical engineer.

1. Excessive wetting or drying of foundation and slab subgrades should be avoided during construction.

2. The ground surface surrounding the exterior of the buildings and other structures should be sloped to drain away from the foundations in all directions. We recommend a minimum slope of 6 inches in the first 10 feet in unpaved areas. Site drainage beyond the 10-foot zone should be designed to promote runoff and reduce infiltration. A minimum slope of 3 inches in the first 10 feet is recommended in the paved areas. These slopes may be

changed as required for handicap access points in accordance with the Americans with Disabilities Act.

3. Ponding of water should not be allowed in backfill material or in a zone within 10 feet of foundations or foundation walls, whichever is greater.

4. Roof downspouts and drains should discharge well beyond the limits of all backfill.

5. Irrigated turf and other excessive landscape irrigation should be avoided within 10 feet of foundations.

PAVEMENT DESIGN

Subgrade Materials: Based on the results of the field exploration and laboratory testing, the pavement subgrade materials encountered at the site classify as A-1-a, A-1-b, A-2-4, A-2-6, A-4, and A-6 with group index of 0 to 13 in accordance with the American Association of State Highway and Transportation Officials (AASHTO) soil classification system. A-1 and A-2 soils were the predominant soil classification, and were assumed for the design. Based on our experience with similar soil types, an R-value of 15 and a resilient modulus value of 4,195 psi were assumed for design of flexible pavements, and a corrected subgrade modulus of 150 pci was assumed for design of rigid pavements.

Design Traffic: Traffic loading information for the planned pavement areas was not available to us at the time of our report preparation. We have assumed traffic will primarily consist of automobiles and pickup trucks, with occasional truck traffic, to include tractor trailers for media replacement and equipment maintenance. Based on our experience with similar facilities, for our pavement thickness design calculations we assumed an equivalent 18-kip daily load application (EDLA) of 20 for areas of combined auto and truck traffic. If it is determined that actual traffic is significantly different from that estimated, we should be contacted to reevaluate the pavement thickness design.

Pavement Sections: The recommended sections were determined using the DARWin 3.01 pavement design software based on the 1993 AASHTO pavement design procedures. Based on the subgrade conditions encountered and the assumed traffic loading, we recommend the following pavement sections:

PAVEMENT SECTION THICKNESS (in.)		
Asphalt Over Aggregate Base Course	Aggregate Base Surfaced	Unreinforced Concrete over Aggregate Base Course
5 over 6	6	6 over 6

*: We recommend truck areas where truck turning movements are concentrated be paved with a Portland Cement Concrete (PCC) section or aggregate surfacing rather than the asphalt alternative. The use of a flexible pavement in these areas could result in pavement fatigue cracking and/or rutting/shoving of the pavement due to the concentrated wheel loads.

A full-depth asphalt section alternative was not included because it has been our experience it can be difficult to construct given the presence of occasionally clean sands. The clean sands will have a tendency to rut from pavement vehicles even if properly compacted, potentially contaminating the bottom lift of asphalt. The usage of an aggregate base course layer will reduce the magnitude of this potential issue.

Pavement Materials: The asphalt pavement mix should conform to specifications for Superpave Hot Mix Asphalt (HMA). A PG 58-28 asphalt binder should be suitable for the mix. In the event that a PG 64-22 asphalt binder is used in the mix, the asphalt section will provide adequate structural support but will be subject to a higher potential for low temperature related transverse cracking.

Class 6 aggregate base course should be used for the base layer of both asphalt and concrete pavement options, and also where aggregate surfaced areas will be utilized. Aggregate base course should be a Class 6 material conforming to the requirements presented in the CDOT Standard Specifications for Road and Bridge Construction.

Concrete pavement should meet the requirements of a Class P Mix, per Section 601 of the CDOT Standard Specifications, and should be based on a mix design established by a qualified engineer. The concrete should contain transverse joints not greater than 12 to 15 feet on centers and longitudinal joints no greater than 14 feet. Joint spacing and geometry should be established by a qualified designer/engineer. The joints should be hand formed, sawed or formed by premolded filler. The joints should be at least 1/4 of the slab thickness. Expansion joints should be provided at the end of each construction sequence and between the concrete slab and adjacent structures. Expansion joints where required, should be filled with a ½ inch-thick asphalt impregnated fiber. Concrete should be cured by protecting against loss of moisture, rapid temperature changes and mechanical injury for at least three days after placement. The concrete

sections presented above are assumed to be unreinforced. Providing dowels at construction joints will help reduce the risk of differential movements between panel sections. Providing a grid mat of deformed rebar or welded wire mesh within the concrete pavement section will assist in mitigating corner breaks and differential panel movements. If a rebar mat is installed, we recommend that the bars be placed in the lower half of the pavement section. Also, if reinforcing is used, we have commonly seen No. 4 rebar placed at 24-inch center in each direction, however, we recommend that a structural engineer evaluate the placement and spacing of rebar if needed.

Subgrade Preparation: Fill placed for support of pavements should meet the material and compaction requirements for structural fill presented in the "Site Grading and Earthwork" section of this report. Prior to placing compacted fill or pavement materials, the exposed subgrade soils should be scarified to a depth of at least 12 inches, moisture conditioned, and compacted according to the specifications in the "Site Grading and Earthwork" Section of this report.

Proof Roll: Before paving, the subgrade should be proof rolled with a heavily loaded, pneumatic-tired vehicle. The vehicle should have a gross vehicle weight of at least 50,000 pounds with a loaded single axle weight of 18,000 pounds and a tire pressure of 100 psi. Areas which deform excessively (> 1/2") under heavy wheel loads are not stable and should be removed and replaced with suitable material to achieve a stable subgrade prior to paving or placement of base course.

Drainage: The collection and diversion of surface drainage away from paved areas is extremely important to the satisfactory performance of the pavement. Drainage design should provide for the removal of water from paved areas and prevent the wetting of the subgrade soils.

Maintenance: Periodic maintenance of paved areas is critical to achieve the design life of the pavement. Crack sealing should be performed annually as new cracks appear. Chip seals, fog seals, or slurry seals applied at approximate intervals of 3 to 5 years are usually necessary for asphalt. As conditions warrant, it may be necessary to perform patching and overlay at approximate 10-year intervals.

Aggregate Surfacing Option: For the pavement section presented, the owner should be aware that periodic maintenance will be required for the aggregate-surfaced areas. The majority of the maintenance will consist of periodic grading to remove ruts and potholes that will inevitably be created by the environment and traffic. Occasionally during the lifetime of the surface, the

aggregate base layer may have to be scarified, additional aggregate added to increase the thickness to that originally required, and the wearing surface recompacted to the specified density.

SITE GRADING AND EARTHWORK

Temporary Excavations: We recommend temporary excavation slopes be constructed in accordance with OSHA regulations. In accordance with OSHA criteria, the on-site native soils should be considered a Type C soil due to the variability. Temporary unretained excavations should have slopes no steeper than 1.5:1 (H:V) in Type C soils. A properly braced excavation or the use of a trench box should be used where the indicated unretained slopes cannot be accommodated. Flatter slopes will be required where groundwater seepage is encountered. OSHA regulations require that excavations greater than 20 feet in depth be designed by a professional engineer. If soils different from those indicated in this report are encountered, the OSHA soil type may vary and the required cut slopes may need to be adjusted. A contractor's competent person should make decisions regarding cut slopes.

Excavated slopes may soften or loosen due to construction traffic and erode from surface runoff. Measures to keep surface runoff from excavation slopes, including diversion berms, should be considered.

Excavation Considerations: In our opinion, the overburden soils encountered in the exploratory borings drilled for this study can be excavated with heavy-duty construction equipment. Groundwater was not encountered in our exploratory borings. Based on our understanding of the proposed construction and the anticipated depths of construction, we do not expect groundwater to be a design consideration for this project. If groundwater is encountered, we believe the excavation can be dewatered using perimeter and/or lateral trenches combined with sumps. The trenches should be sloped to sumps where water can be pumped from the excavation. The bottom and sides of the excavation may become unstable, especially in the granular soils if the groundwater level is not lowered in advance of excavation and maintained at a sufficient depth below the bottom of the excavation. Dewatering must be maintained through the time period the excavation is open. The dewatering system should be properly designed, installed, and maintained by an experienced dewatering contractor.

Cut and Fill Slopes: Permanent cut and fill slopes should not be steeper than 3:1 (horizontal to vertical). Slopes will generally be stable at 2:1; however, 2:1 slopes will be prone to increased surface erosion and it will be difficult to maintain vegetation on them. The risk of slope instability

will be significantly increased if seepage is encountered in cuts. If seepage is encountered in permanent excavations, an investigation should be conducted to determine if the seepage will adversely affect the cut stability.

We understand detention ponds may be constructed utilizing on-site soils and designed for infiltration, or lined and designed for detention. Evaluation of the pond slopes is beyond the scope of our study. The slopes recommended above are considered to be suitable for general embankment construction, however, in pond applications with rapid fill or drawdown considerations, the granular soils will have an increased potential for sloughing and erosion and flatter slopes in the range of 3:1 or 4:1 may be required.

No formal stability analyses were performed to evaluate the slopes recommended above. Published literature and our experience with similar cuts and fills indicate the recommended slopes should have adequate factors of safety. If a detailed stability analysis is required, we should be notified.

Good surface drainage should be provided for all permanent cuts and fills to direct the surface runoff away from the slope faces. Permanent cut and fill slopes and other stripped areas should be protected against erosion by revegetation or other means. Fills should be benched into any hillsides exceeding 4 horizontal to 1 vertical. Site grading should be planned to provide positive surface drainage away from all building and pavement areas.

Subgrade Stabilization: Unstable subgrade may be encountered during subgrade preparations. Unstable soils may be stabilized by scarifying/ripping the subgrade and allowing it to dry, or by overexcavation and replacement of the subgrade with suitable, imported, angular, well-graded materials. Other alternatives include the use of Type 2 biaxial geogrid reinforcement in combination with a layer of Class 6 aggregate base course. It has been our experience that the use of a crushed concrete product meeting a Class 6 gradation can perform well when trying to achieve stabilization. Specific stabilization requirements should be evaluated at the time of construction. We are unable to accurately predict or quantify areas where unstable subgrade conditions may occur, however, we recommend this work activity, if required, be included as a line item in the bid schedule to avoid cost overruns.

Fill Material: The following recommended material and compaction requirements are presented for fill placements on the project site. A geotechnical engineer should evaluate the suitability of all proposed fill materials for the project prior to placement.

1. *Structural Fill*: With proper moisture conditioning, the on-site granular soils (SP, SW, SP-SM, SW-SM, SM, SC-SM, and SC) will be suitable for reuse as structural fill, including structural fill beneath foundations, floor slabs, exterior flatwork, and pavements. Imported structural fill, if required, should consist of a nonexpansive soil material having a maximum particle size of 2 inches, a maximum of 40% passing the No. 200 sieve, and a maximum plasticity index of 10. (We recognize that some of the tested samples of the onsite granular soils do not meet the specification for gradation and/or plasticity index; however, given the properties, it is our opinion they will be acceptable for reuse, if properly moisture conditioned.)

2. *Reuse of Clay Soils*: Clay soils (CL, CH) should be considered unsuitable for use as structural fill, and should be placed in nonstructural or landscape areas, or removed from the site.

3. *Subgrade Preparation*: The ground surface shall be stripped of vegetation/organics down to the natural granular soils, followed by overexcavation, moisture conditioning and recompaction of the native subgrade to a depth of at least 3 feet below the foundation and floor slab bearing elevations. As discussed in the “Exterior Flatwork” section, the overexcavation zone should also include beneath exterior flatwork immediately adjacent to the building and within a 10-foot zone around the perimeter of the building including sidewalks where reduction of settlement potential is considered more important. During the subgrade moisture conditioning and recompaction process, any clay soils encountered should be replaced with suitable structural fill. The prepared subgrade should extend down and outward from the edges of the foundations at a minimum 1:1 horizontal to vertical projection.

   In pavement areas, the subgrade should be scarified to a depth of 12 inches, moisture conditioned as necessary, and compacted in a manner specified below for the subsequent layers of fill.

   Loose or unstable soils shall be removed, where present, in order to provide a stable platform prior to placement of fill.

4. *Pipe Bedding*: The use and requirements for bedding material should be in accordance with the pipe manufacturer's recommendations, local building authority, or utility district requirements. In confined areas of the pipeline where compaction is difficult, placement of a cementitious flowfill around the pipe should be considered, at the discretion of the designer.

5. *Utility Trench Backfill*: Materials excavated from the utility trenches may be used for trench backfill above the pipe zone fill provided they do not contain unsuitable material or particles larger than 2 inches.

6. *Material Suitability*: All fill material should be free of vegetation, brush, sod, trash and debris, and other deleterious substances, and should not contain rocks or lumps having a diameter of more than 2 inches.

7. *Lift Thickness*: The maximum allowable loose lift thickness should be limited to 8 inches.

Compaction Requirements: A representative of the geotechnical engineer should observe fill placement operations on a part- to full-time basis, depending on the speed at which grading and fill operations are occurring. We recommend the following minimum compaction criteria be used on the project.

rea	Percentage of Modified Proctor Maximum Dry Density (ASTM D 1557)
Foundation Subgrade	95
Floor Slab Subgrade	90
Foundation Backfill	90
Pavement Subgrade	90
Aggregate Base Course	90
Exterior Flatwork/Utility Trenches	90
Landscape Areas, and Other Misc. Overlot Fill Areas	90
Compaction should be achieved at a moisture content within +/- 2% of the optimum.	

Grading During Inclement Weather: If grading occurs during the time of year with freezing temperatures, fill should not contain frost or be placed on frozen ground. A loose lift or blanket of soil should be placed on prepared subgrade at the end of day to protect against frost, and the

presence of frost should be checked at the beginning of each day. Any frost should be removed prior to placement of new fill. During periods of precipitation, excessive wetting of building pad and pavement subgrades should be avoided. Measures should be implemented to keep surface runoff from ponding in subgrade areas, to include usage of diversion berms, creation of temporary low areas where water can be directed and removed by pumping, or other methods as appropriate.

DESIGN AND CONSTRUCTION SUPPORT SERVICES

Kumar & Associates, Inc. should be retained to review the project plans and specifications for conformance with the recommendations provided in our report. We are also available to assist the design team in preparing specifications for geotechnical aspects of the project, and performing additional studies if necessary to accommodate possible changes in the proposed construction.

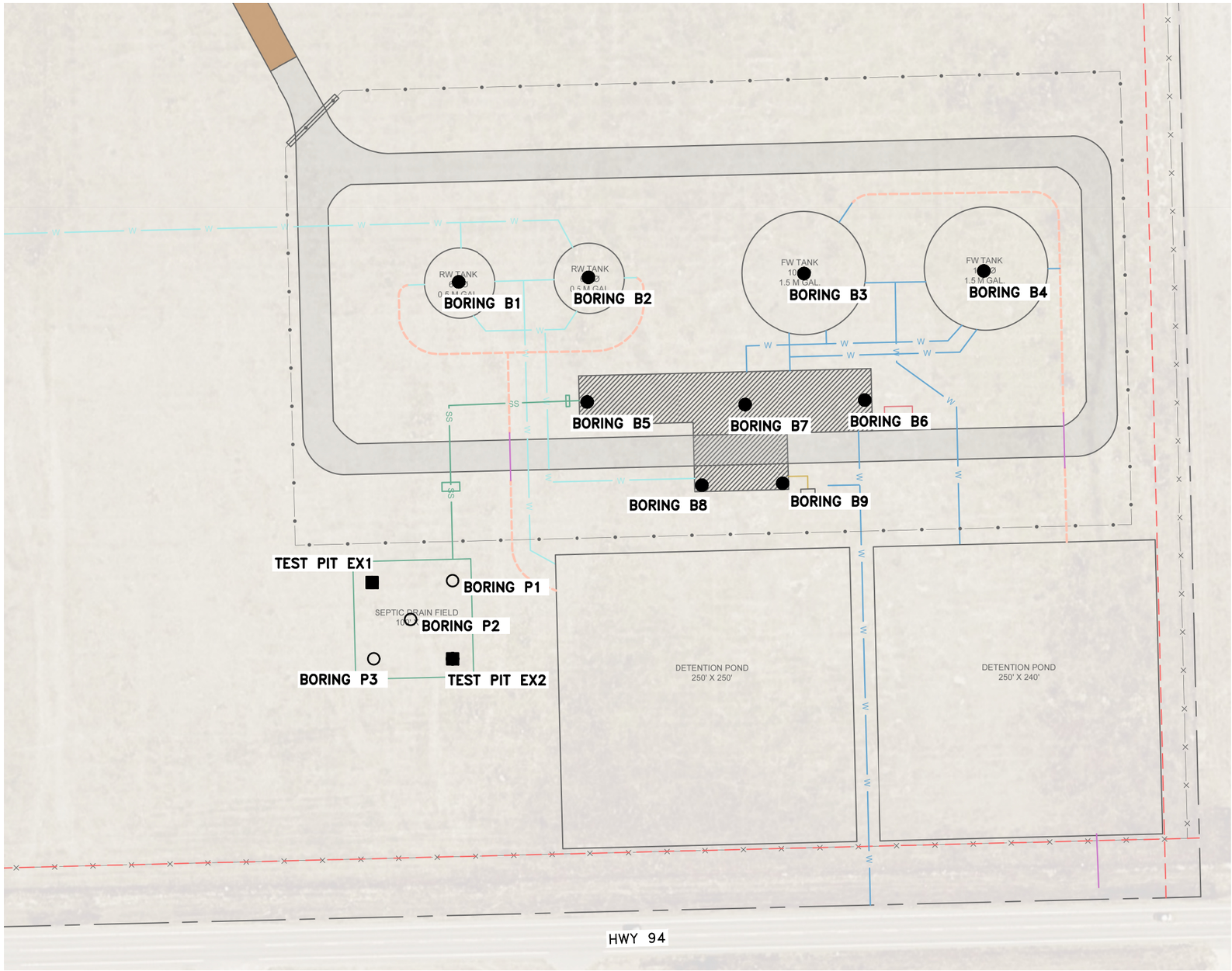
We recommend that Kumar & Associates, Inc. be retained to provide construction observation and testing services to document that the intent of this report and the requirements of the plans and specifications are being followed during construction. This will allow us to identify possible variations in subsurface conditions from those encountered during this study and to allow us to re-evaluate our recommendations, if needed.

LIMITATIONS

This report has been completed for exclusive use by the client for geotechnical related design and construction criteria for the project. The conclusions and recommendations submitted in this report are based upon the data obtained from the exploratory borings and test pits at the locations indicated on Fig. 1 or as described in the report, and the proposed type of construction. This report may not reflect subsurface variations that occur, and the nature and extent of variations across the site may not become evident until site grading and excavations are performed. If during construction, fill, soil, rock or water conditions appear to be different from those described herein, Kumar & Associates, Inc. should be advised at once so that a re-evaluation of the recommendations presented in this report can be made. Kumar & Associates, Inc. is not responsible for liability associated with interpretation of subsurface data by others.

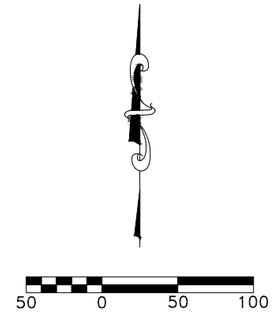
The scope of services for this project does not include identification of contaminated or hazardous materials or conditions. If the owner is concerned about the potential for such contamination, other studies should be undertaken.

DPC:sw



LEGEND:

- ● EXPLORATORY BORING LOCATION.
- ○ PERCOLATION TEST HOLE LOCATION.
- ■ TEST PIT LOCATION.



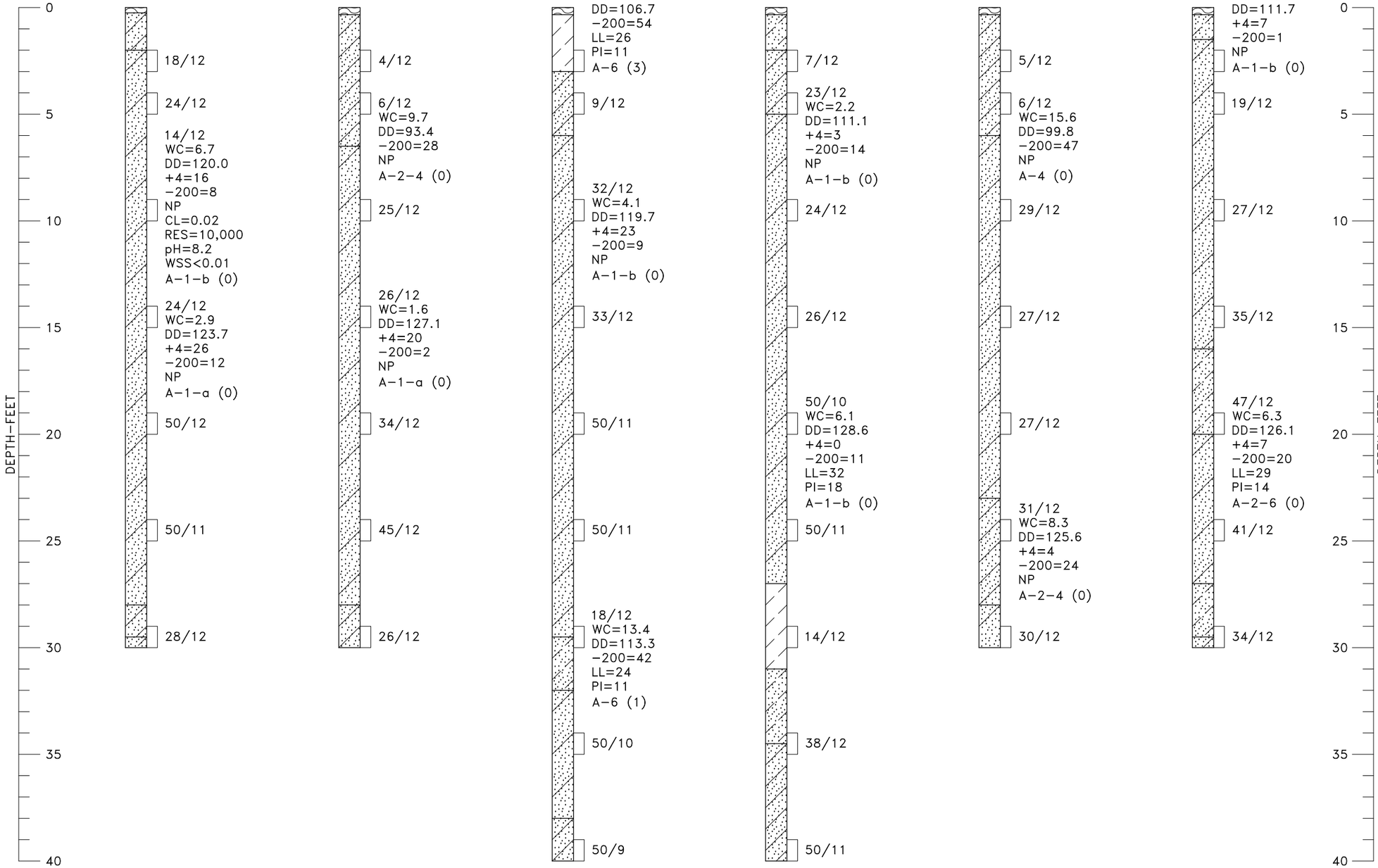
APPROXIMATE SCALE–FEET



VICINITY MAP
NOT TO SCALE

25–2–263	Kumar & Associates		LOCATION OF EXPLORATORY BORINGS AND TEST PITS	Fig. 1

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25−2−263	Kumar & Associates		LOGS OF EXPLORATORY BORINGS	Fig. 2

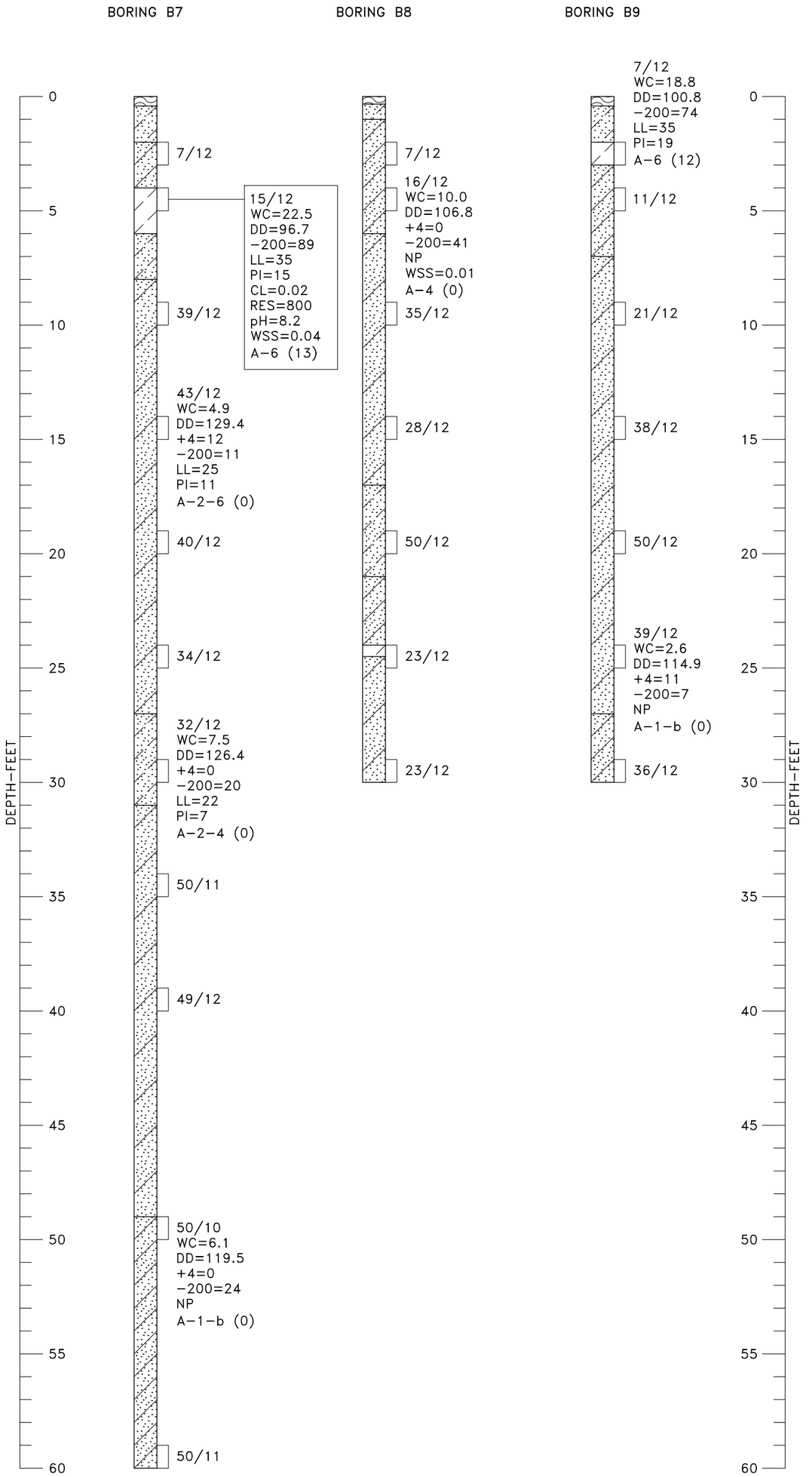
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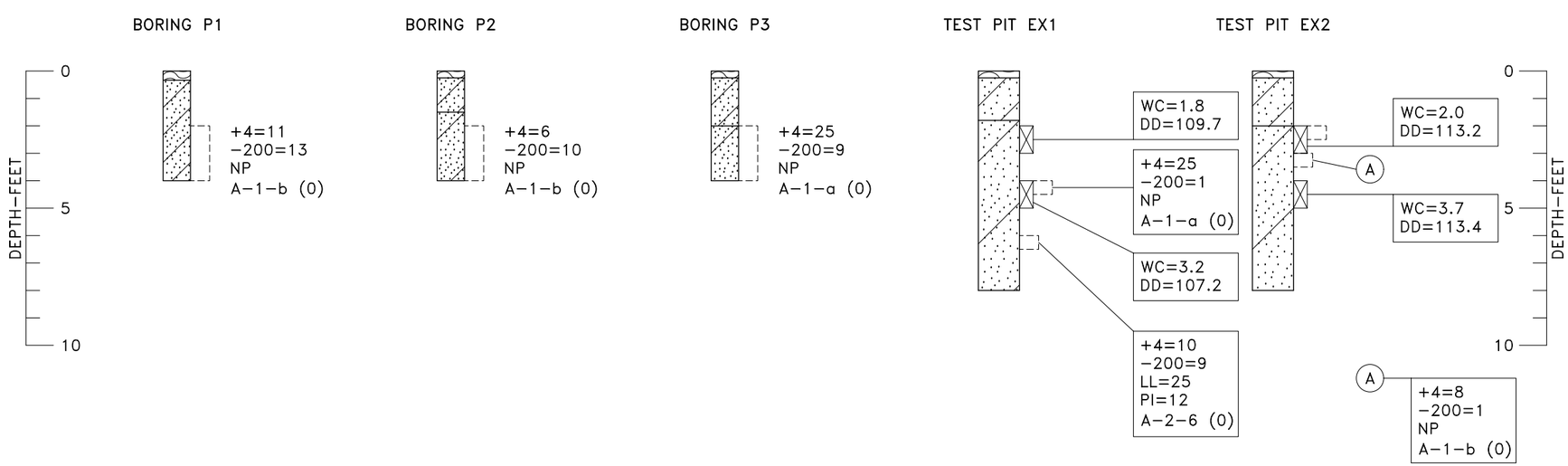
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Kumar & Associates

LOGS OF EXPLORATORY BORINGS

Fig. 3





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25−2−263	Kumar & Associates		LOGS OF EXPLORATORY BORINGS AND TEST PITS	Fig. 4

LEGEND


TOPSOIL.


SILTY SAND (SM), WITH OCCASIONAL GRAVEL, LOOSE TO VERY DENSE, SLIGHTLY MOIST TO MOIST, TAN, BROWN TO GRAY–BROWN.


POORLY TO WELL GRADED SAND WITH VARIED AMOUNTS OF SILT AND GRAVEL, (SP, SW, SP–SM, SW–SM), MEDIUM DENSE TO VERY DENSE, SLIGHTLY MOIST TO MOIST, TAN, BROWN, TAN–GRAY, AND TAN–ORANGE.


CLAYEY SAND (SC), AND SILTY CLAYEY SAND (SC–SM), WITH OCCASIONAL LENSES OF SANDY LEAN CLAY (CL), WITH OCCASIONAL GRAVEL, MEDIUM DENSE TO DENSE, SLIGHTLY MOIST TO MOIST, BROWN TO TAN.


LEAN CLAY (CL), WITH VARIED AMOUNTS OF SAND, MEDIUM STIFF TO VERY STIFF, SLIGHTLY MOIST TO MOIST, BROWN, GRAY, AND GRAY–BROWN.


DRIVE SAMPLE, 2–INCH I.D. CALIFORNIA LINER SAMPLE.


HAND DRIVE SAMPLE, 2–INCH I.D.


DISTURBED BULK SAMPLE.

18/12 DRIVE SAMPLE BLOW COUNT. INDICATES THAT 18 BLOWS OF A 140–POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE THE SAMPLER 12 INCHES.

NOTES

1. THE EXPLORATORY BORINGS WERE DRILLED BETWEEN APRIL 20 AND 21, 2026 WITH A CONTINUOUS–FLIGHT POWER AUGER (4–INCH DIAMTER FOR B1–B9 AND 8–INCH DIAMETER FOR P1–P3). TEST PITS EX1 AND EX2 WERE EXCAVATED MINI–EXCAVATOR ON APRIL 27, 2026.

2. THE LOCATIONS OF THE EXPLORATORY BORINGS AND TEST PITS WERE MEASURED APPROXIMATELY BY HANDHELD GPS DEVICE AND SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

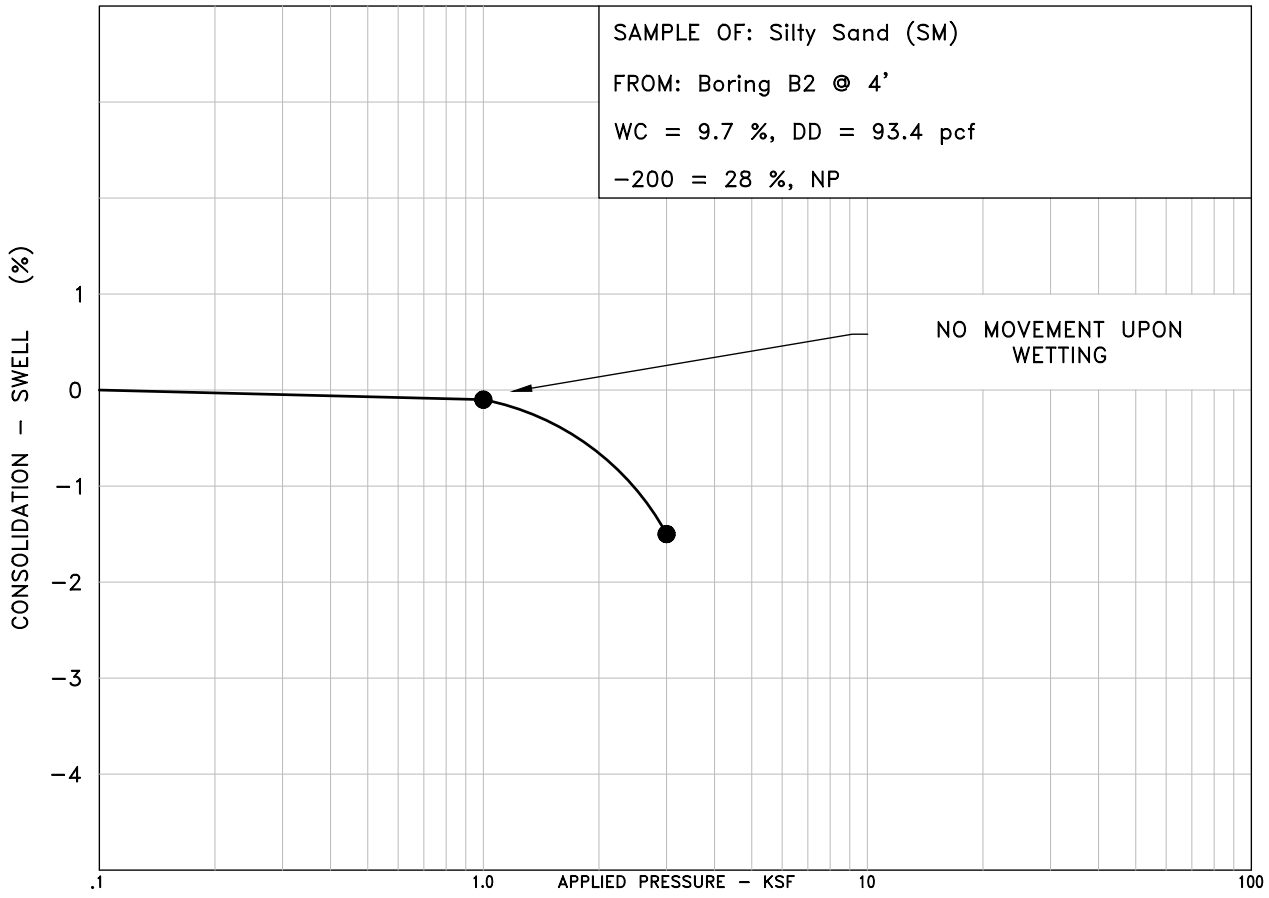
3. THE ELEVATIONS OF THE EXPLORATORY BORINGS AND TEST PITS WERE NOT MEASURED AND THE LOGS OF THE EXPLORATORY BORINGS AND TEST PITS ARE PLOTTED TO DEPTH.

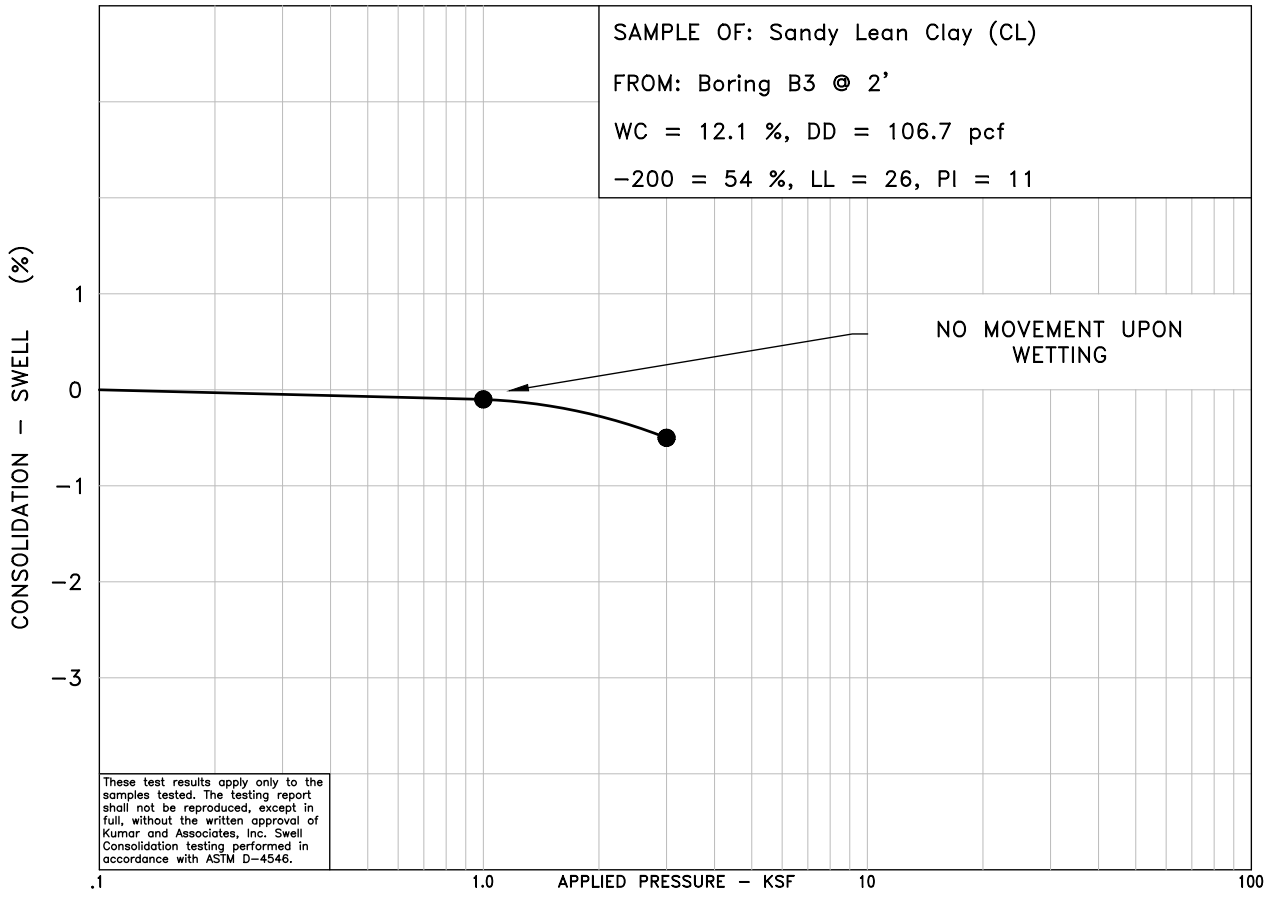
4. THE LINES BETWEEN MATERIALS SHOWN ON THE EXPLORATORY BORING LOGS AND TEST PITS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.

5. GROUNDWATER WAS NOT ENCOUNTERED IN THE BORINGS AT THE TIME OF DRILLING OR WHEN CHECKED 7 TO 8 DAYS LATER. FLUCTUATIONS IN THE WATER LEVEL MAY OCCUR WITH TIME.

6. LABORATORY TEST RESULTS:
   WC = WATER CONTENT (%) (ASTM D2216);
   DD = DRY DENSITY (pcf) (ASTM D2216);
   +4 = PERCENTAGE RETAINED ON NO. 4 SIEVE (ASTM D6913);
   −200= PERCENTAGE PASSING NO. 200 SIEVE (ASTM D1140);
   LL = LIQUID LIMIT (ASTM D4318);
   PI = PLASTICITY INDEX (ASTM D4318);
   NP = NON–PLASTIC (ASTM D4318);
   WSS = WATER SOLUBLE SULFATES (%) (CP–L 2103);
   pH = HYDROGEN ION CONCENTRATION (ASTM E 70);
   RES = MINIMUM LABORATORY RESISTIVITY (ohm–cm.) (ASTM G 57);
   A-2-6 (0) = AASHTO CLASSIFICATION (GROUP INDEX) (AASHTO M 145);
   CL = CHLORIDE CONTENT (%) (AASHTO T291).

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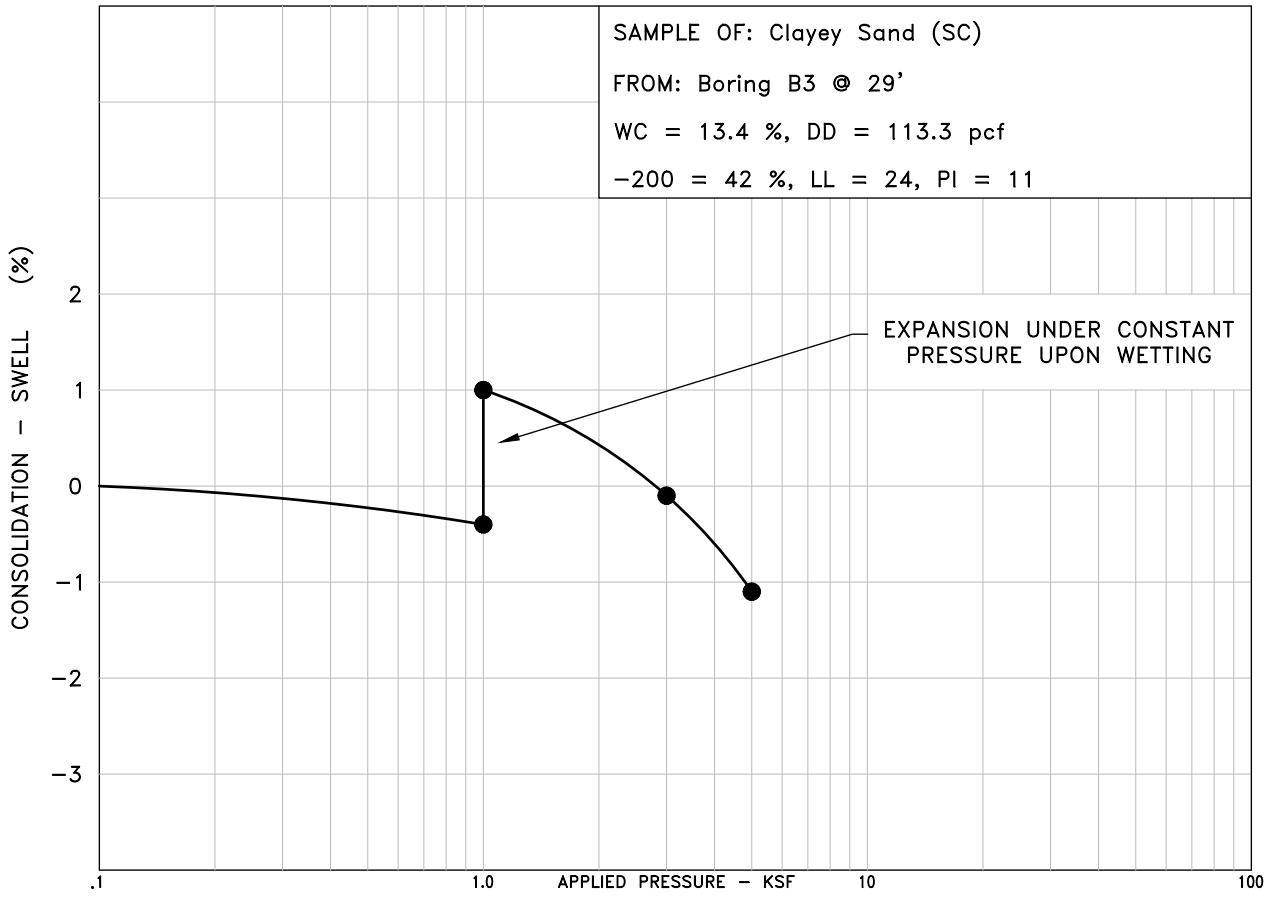


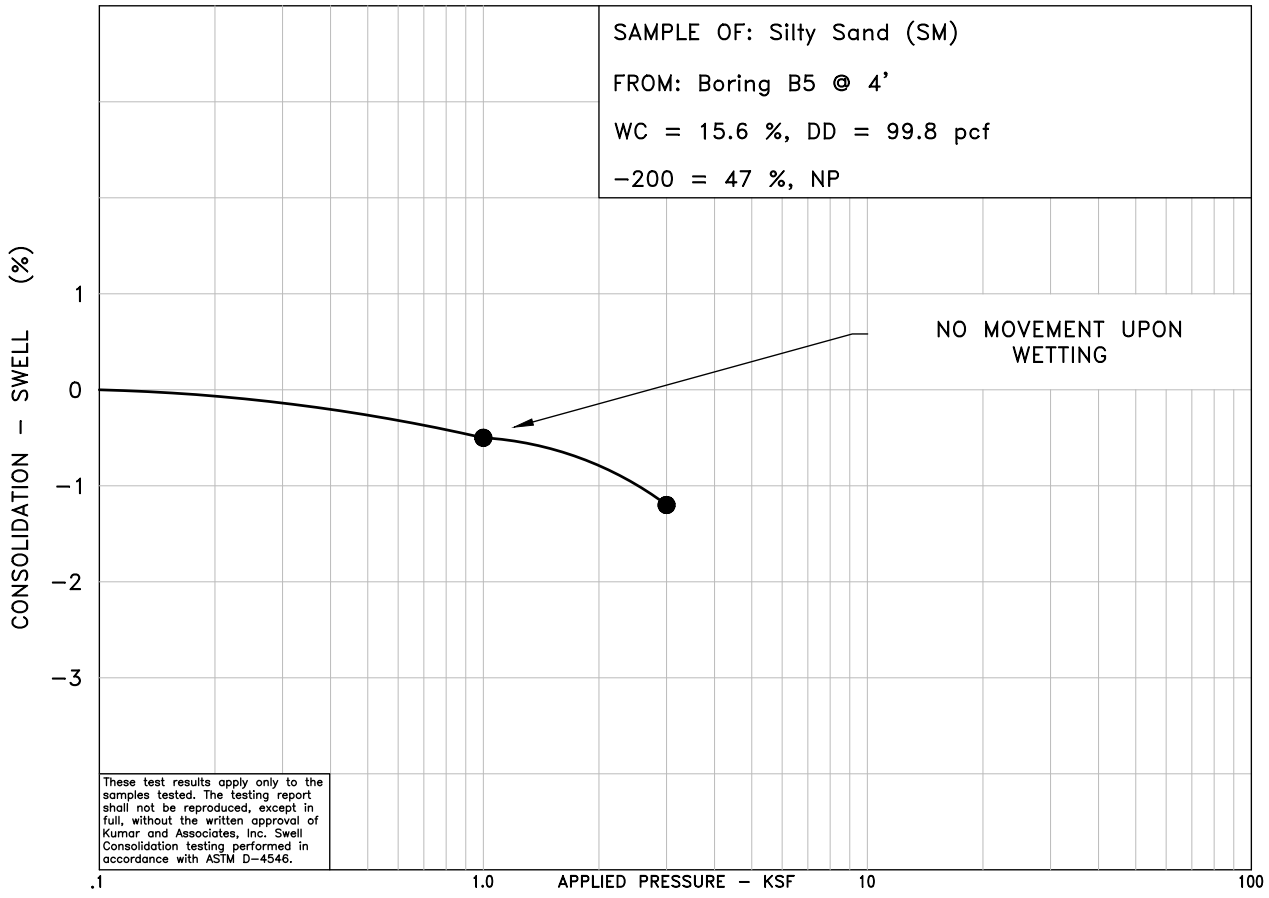


These test results apply only to the samples tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Swell Consolidation testing performed in accordance with ASTM D-4546.

25-2-263	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 6

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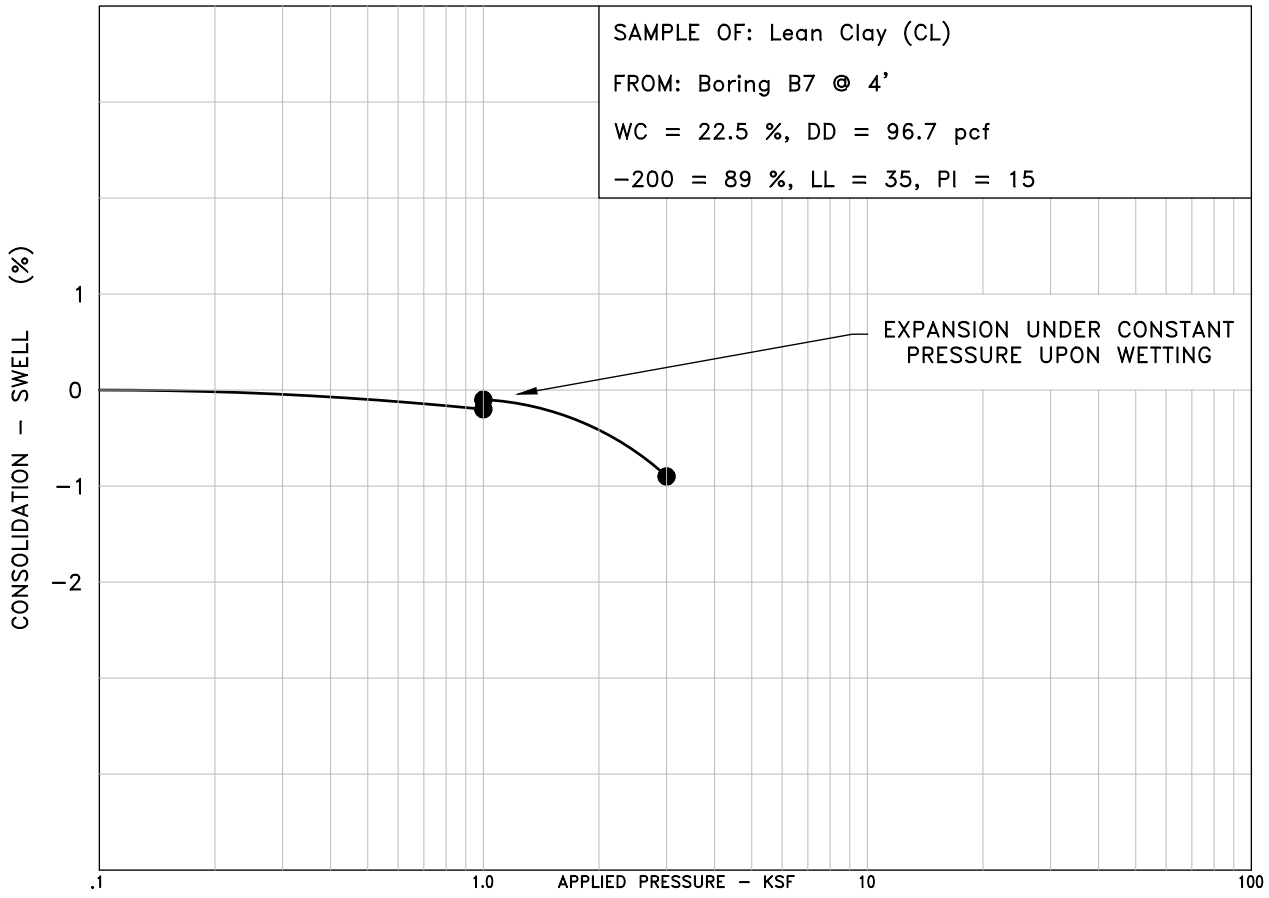


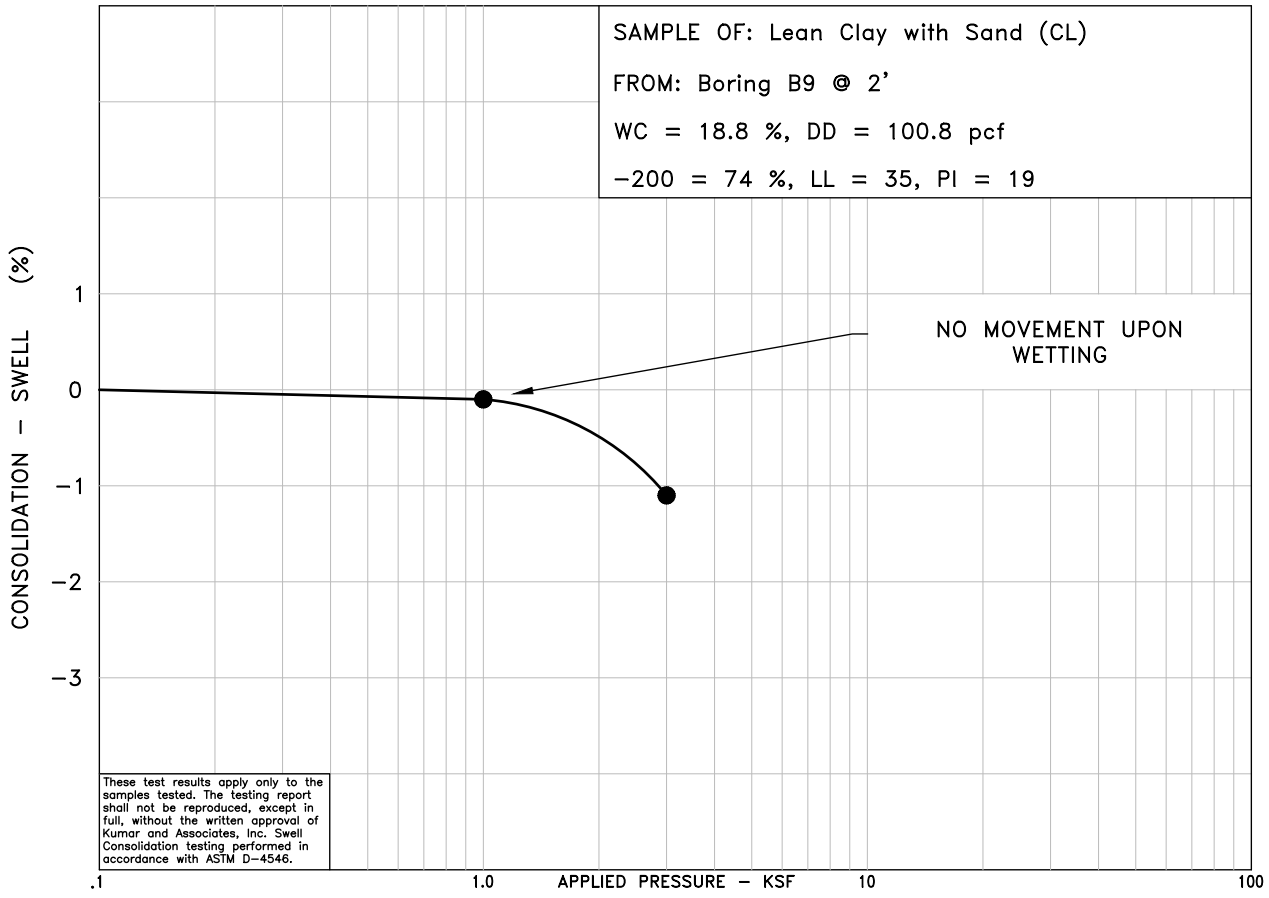


These test results apply only to the samples tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Swell Consolidation testing performed in accordance with ASTM D−4546.

25−2−263	Kumar & Associates	SWELL−CONSOLIDATION TEST RESULTS	Fig. 7

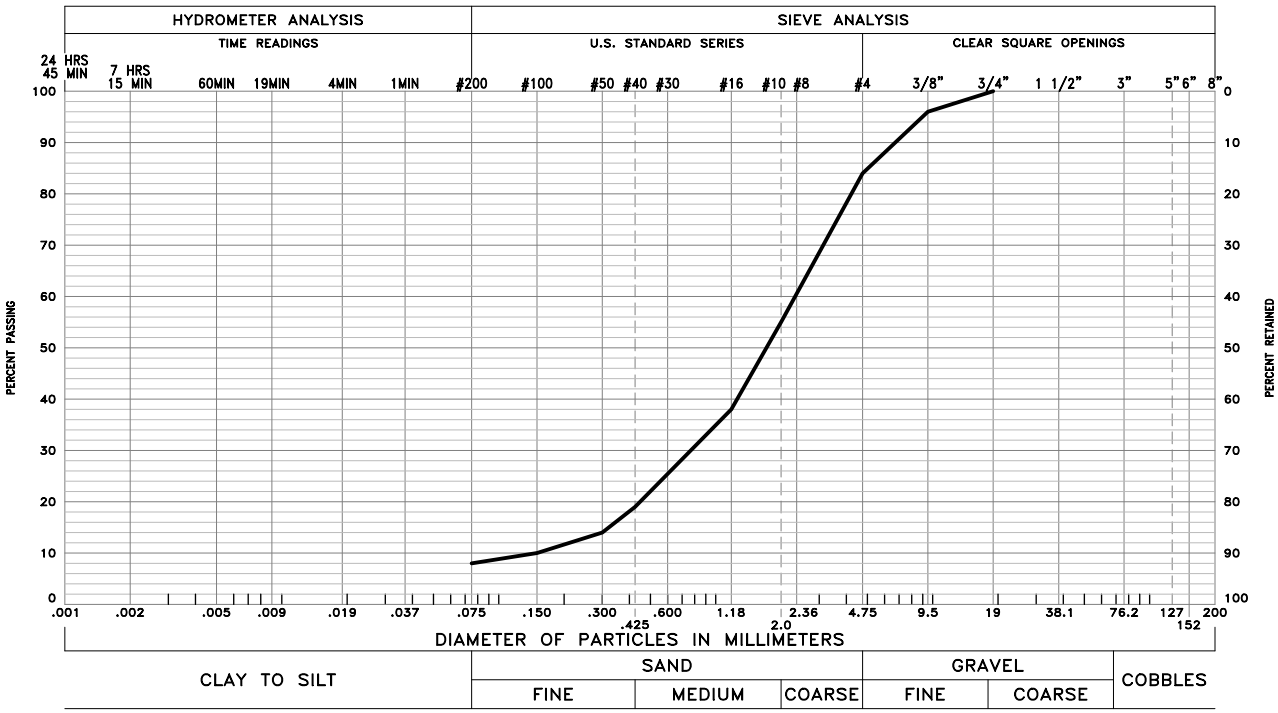
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25−2−263	Kumar & Associates	SWELL−CONSOLIDATION TEST RESULTS	Fig. 8

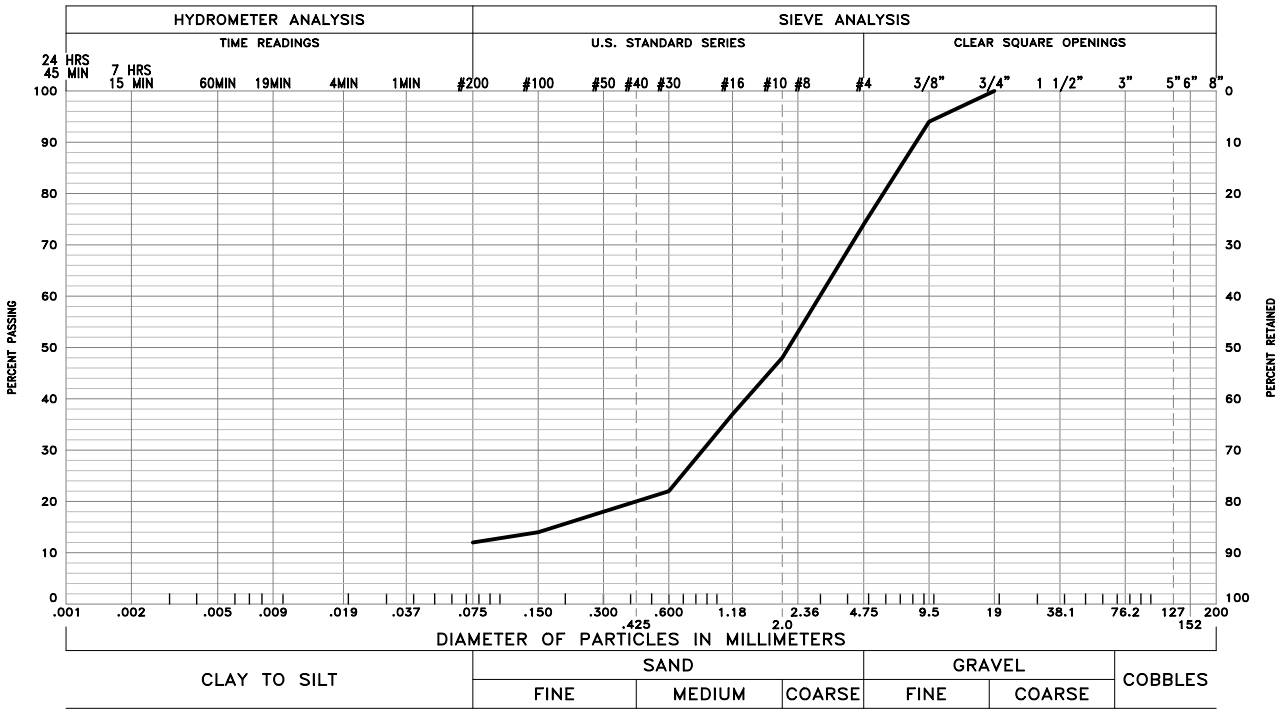
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GRAVEL 16 % SAND 76 % SILT AND CLAY 8 %

LIQUID LIMIT – PLASTICITY INDEX NP

SAMPLE OF: Well Graded Sand with Silt & Gravel (SW-SM) FROM: Boring B1 @ 9'



GRAVEL 26 % SAND 62 % SILT AND CLAY 12 %

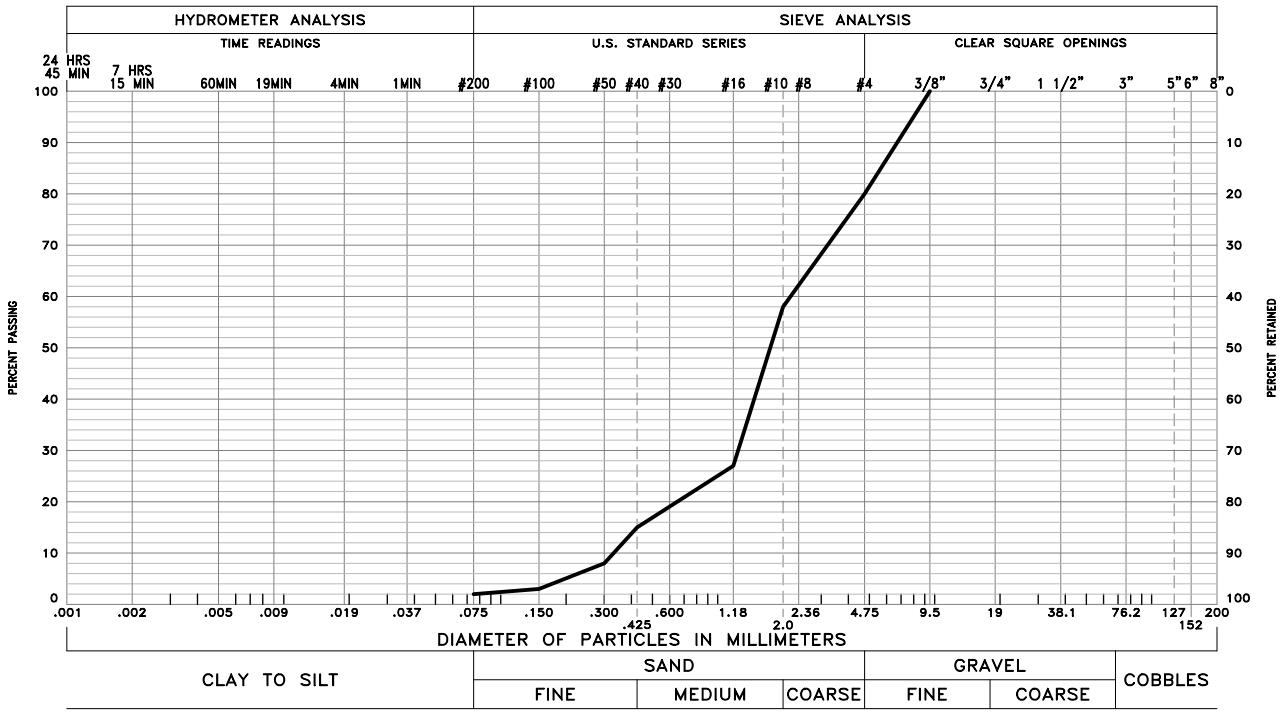
LIQUID LIMIT – PLASTICITY INDEX NP

SAMPLE OF: Well Graded Sand with Silt & Gravel (SW-SM) FROM: Boring B1 @ 14'

These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D6913, ASTM D7928, ASTM C136 and/or ASTM D1140.

25-2-263	Kumar & Associates	GRADATION TEST RESULTS	Fig. 9

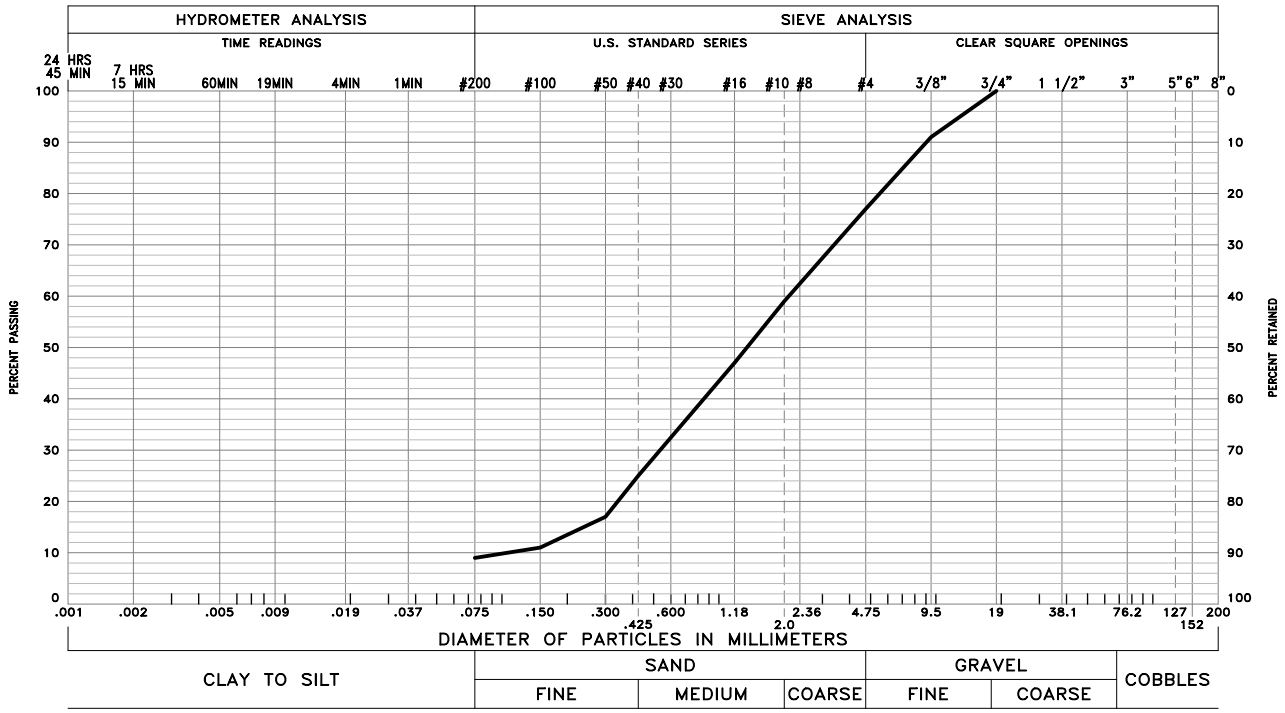
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GRAVEL 20 % SAND 78 % SILT AND CLAY 2 %

LIQUID LIMIT – PLASTICITY INDEX NP

SAMPLE OF: Well Graded Sand with Gravel (SW) FROM: Boring B2 @ 14'



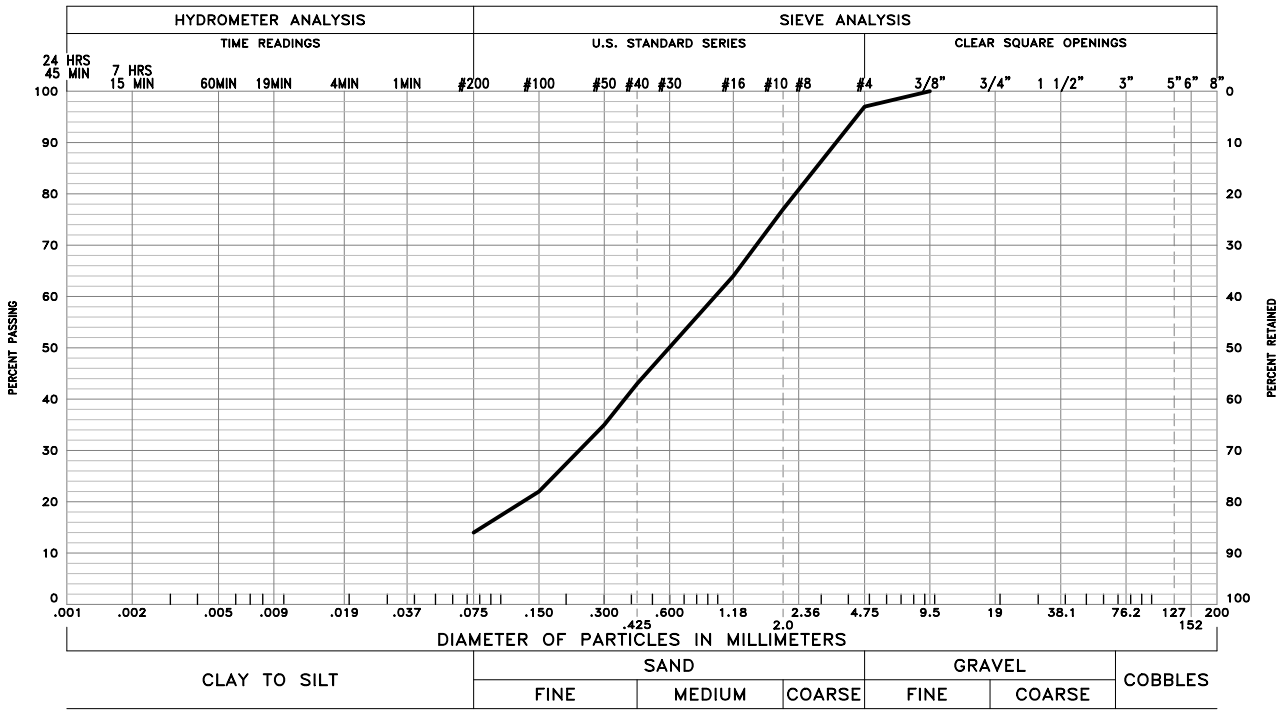
GRAVEL 23 % SAND 68 % SILT AND CLAY 9 %

LIQUID LIMIT – PLASTICITY INDEX NP

SAMPLE OF: Well Graded Sand with Silt & Gravel (SW-SM) FROM: Boring B3 @ 9'

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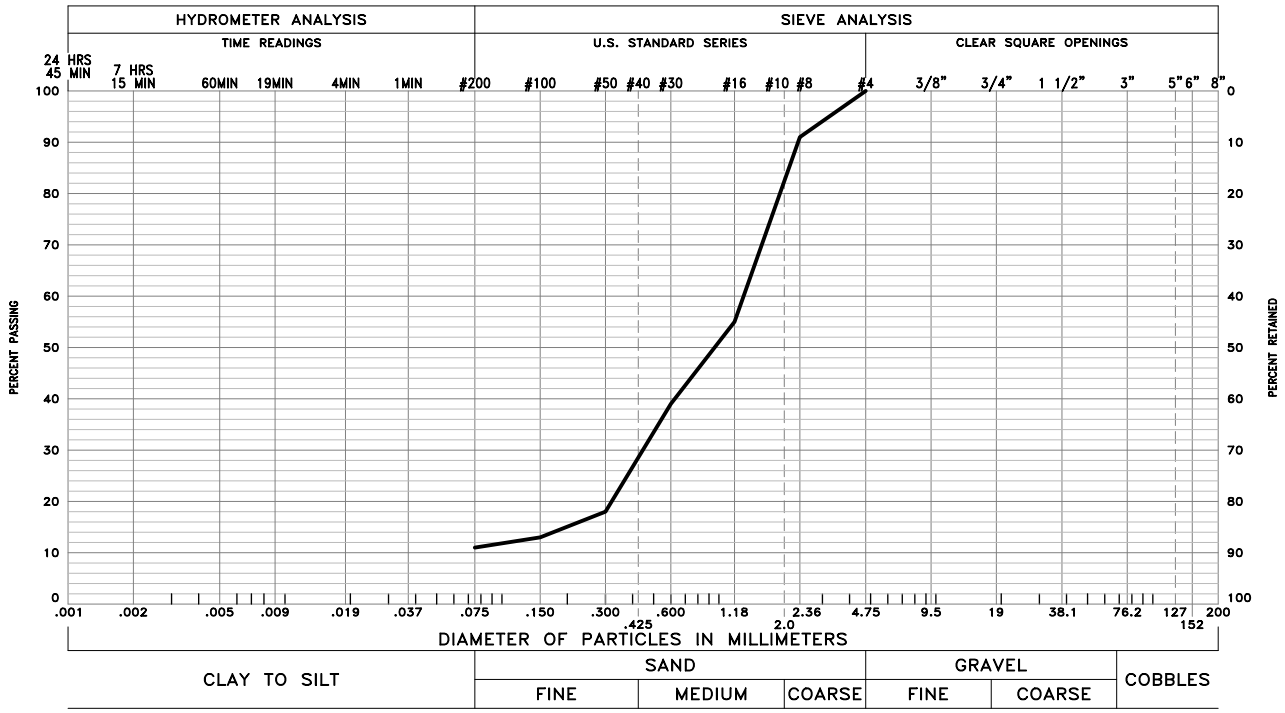
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GRAVEL 3 % SAND 83 % SILT AND CLAY 14 %

LIQUID LIMIT – PLASTICITY INDEX NP

SAMPLE OF: Silty Sand (SM) FROM: Boring B4 @ 4'



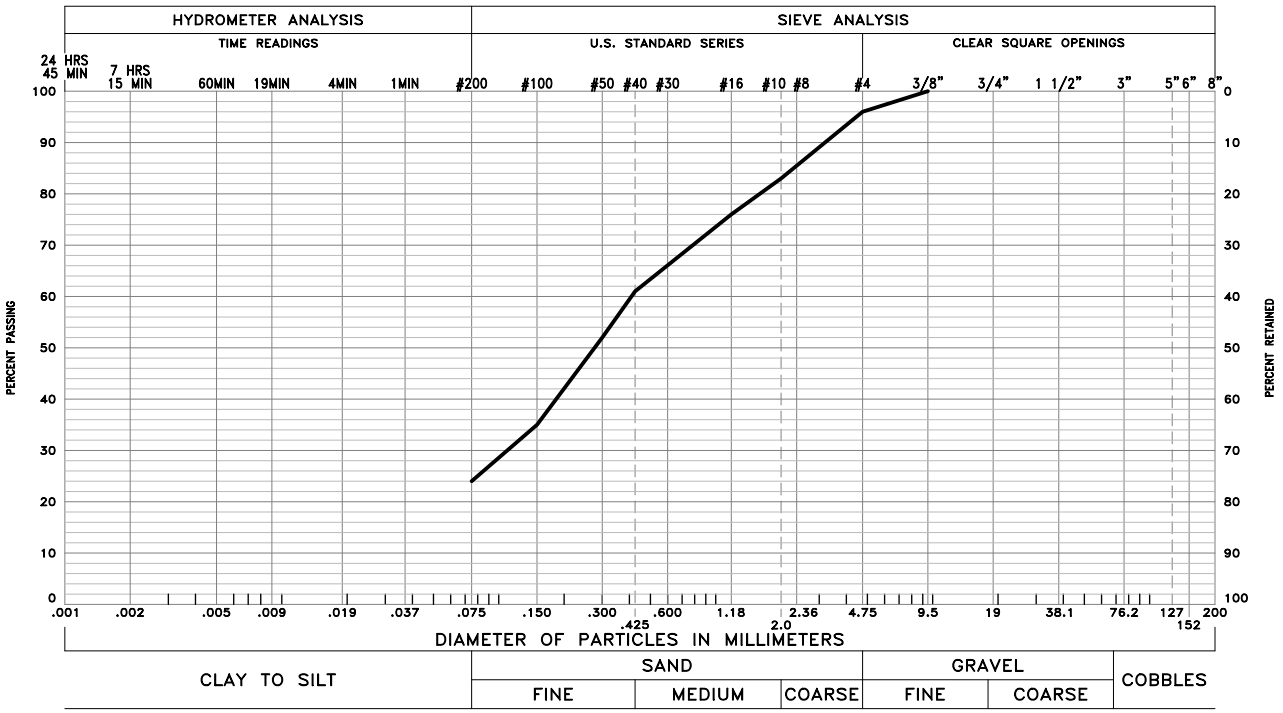
GRAVEL 0 % SAND 89 % SILT AND CLAY 11 %

LIQUID LIMIT 32 PLASTICITY INDEX 18

SAMPLE OF: Well Graded Sand with Silt (SW-SM) FROM: Boring B4 @ 19'

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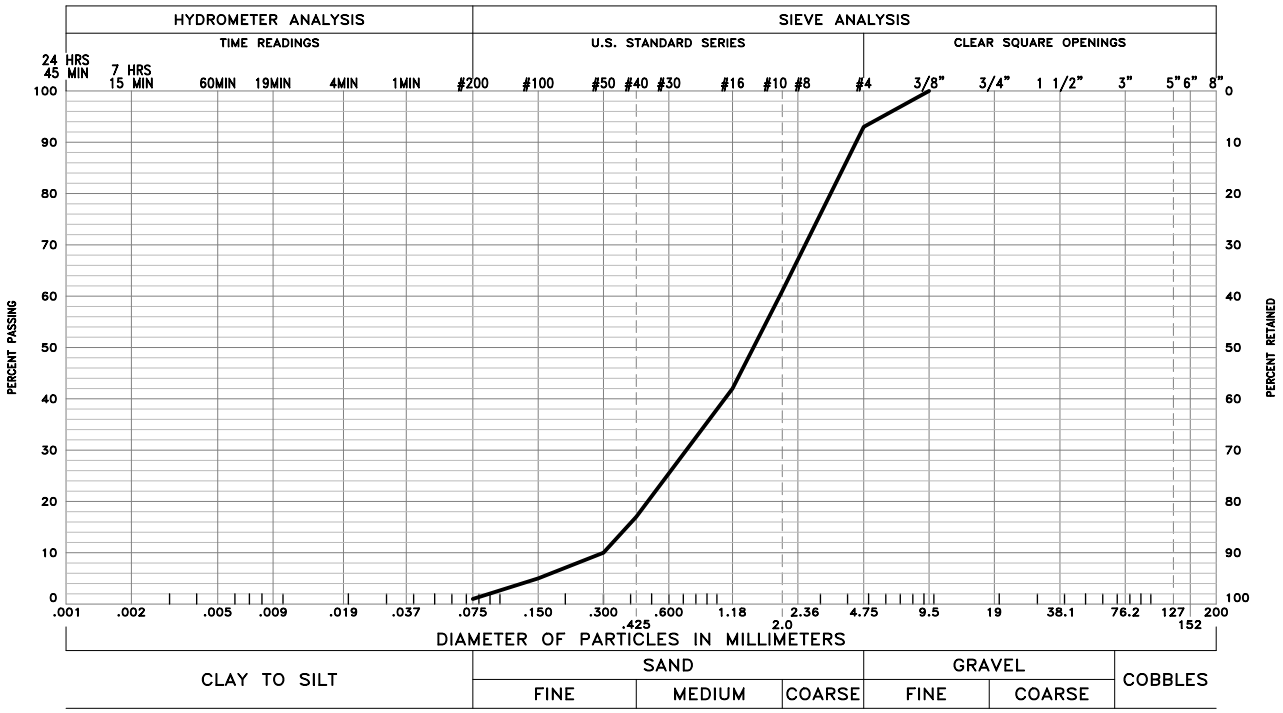
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GRAVEL 4 % SAND 72 % SILT AND CLAY 24 %

LIQUID LIMIT – PLASTICITY INDEX NP

SAMPLE OF: Silty Sand (SM) FROM: Boring B5 @ 24'



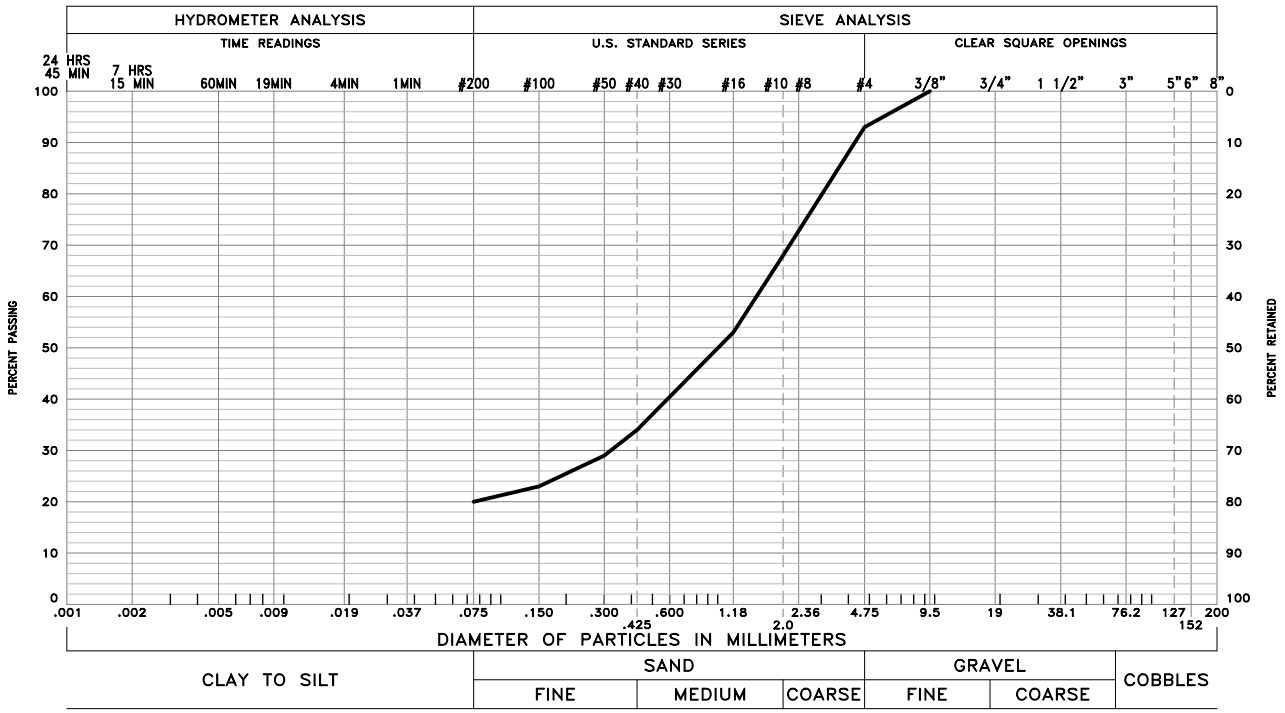
GRAVEL 7 % SAND 92 % SILT AND CLAY 1 %

LIQUID LIMIT – PLASTICITY INDEX NP

SAMPLE OF: Poorly Graded Sand (SP) FROM: Boring B6 @ 2'

These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D6913, ASTM D7928, ASTM C136 and/or ASTM D1140.

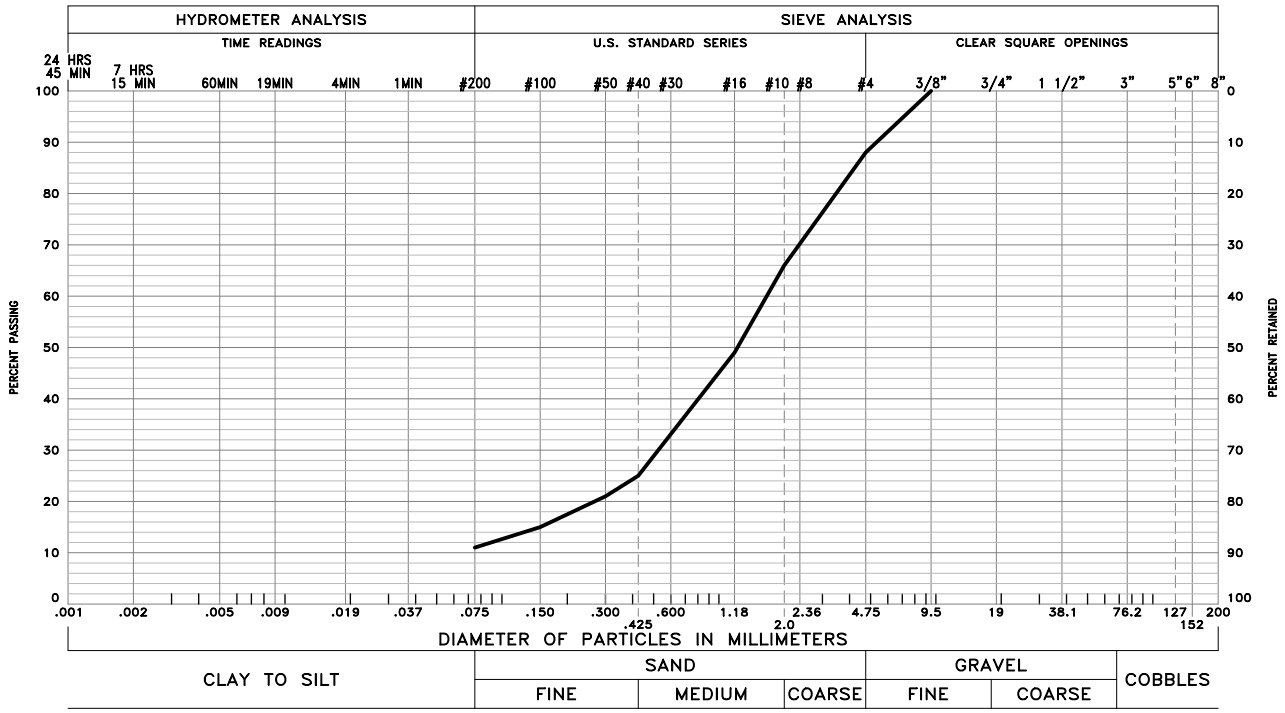
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GRAVEL 7 % SAND 73 % SILT AND CLAY 20 %

LIQUID LIMIT 29 PLASTICITY INDEX 14

SAMPLE OF: Clayey Sand (SC) FROM: Boring B6 @ 19'



GRAVEL 12 % SAND 67 % SILT AND CLAY 11 %

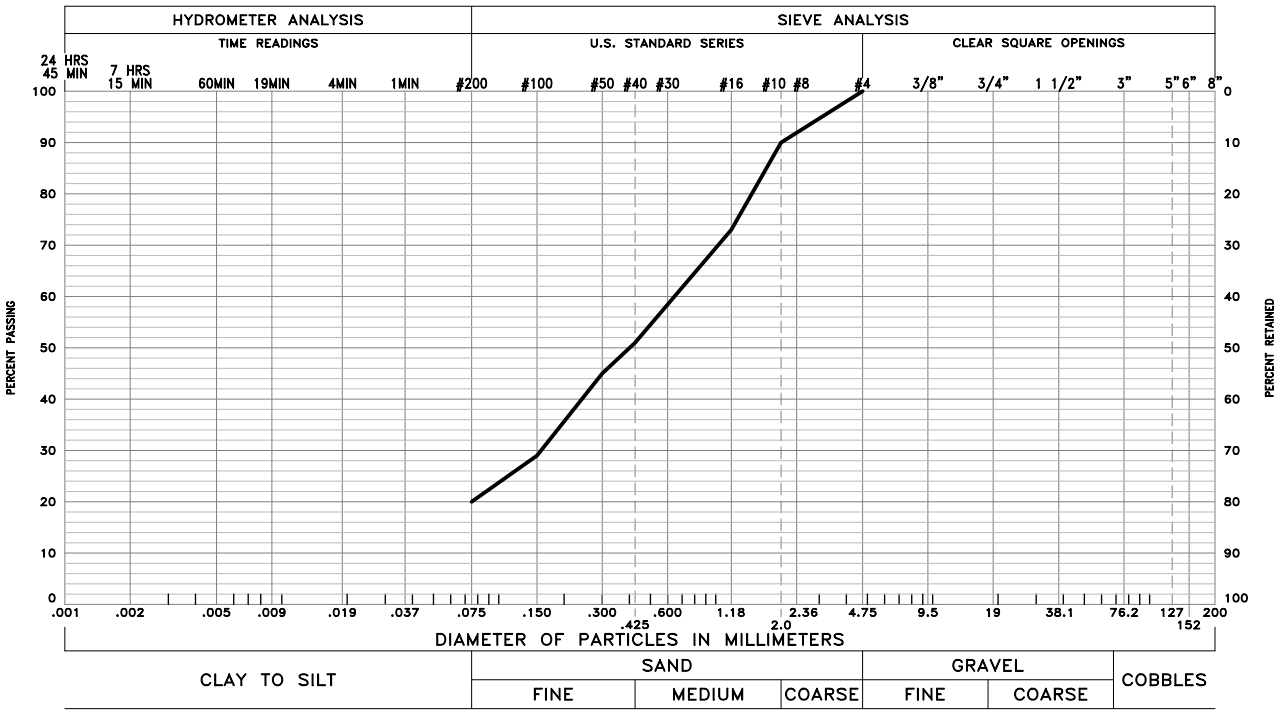
LIQUID LIMIT 25 PLASTICITY INDEX 11

SAMPLE OF: Well Graded Sand with Silt (SW-SM) FROM: Boring B7 @ 14'

These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D6913, ASTM D7928, ASTM C136 and/or ASTM D1140.

25-2-263	Kumar & Associates	GRADATION TEST RESULTS	Fig. 13

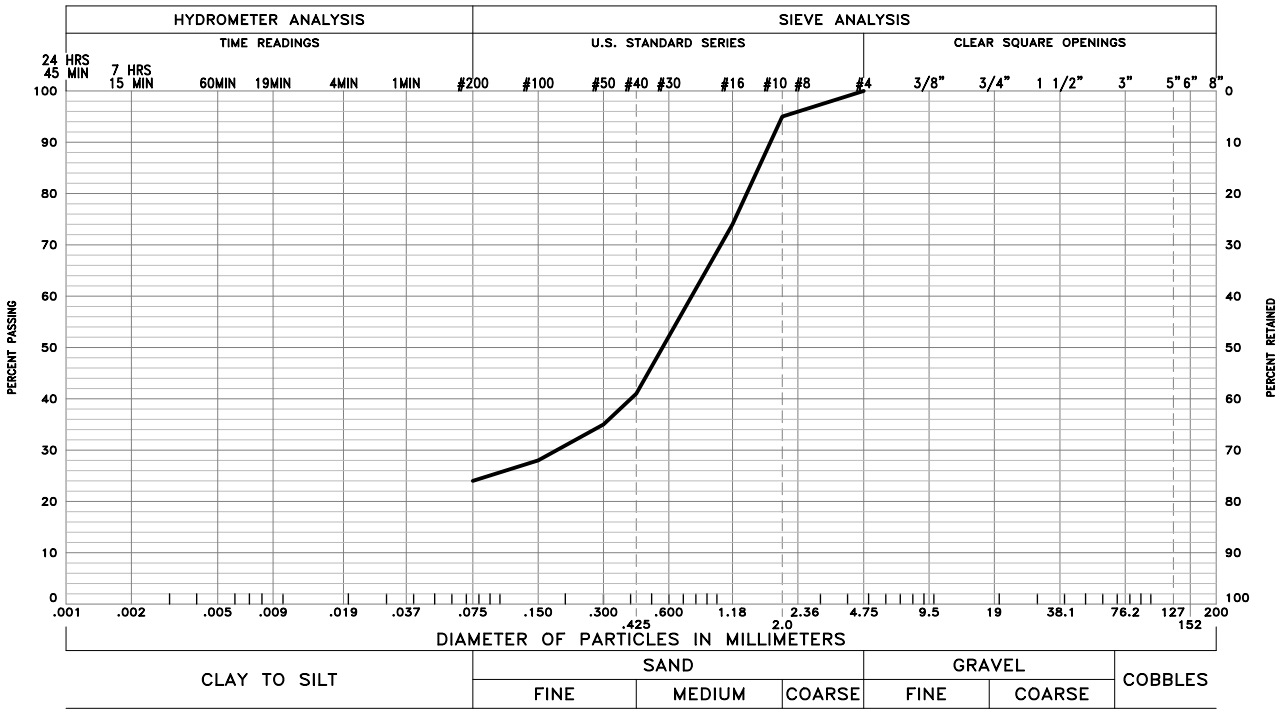
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GRAVEL 0 % SAND 80 % SILT AND CLAY 20 %

LIQUID LIMIT 22 PLASTICITY INDEX 7

SAMPLE OF: Silty Clayey sand (SC-SM) FROM: Boring B7 @ 29'



GRAVEL 0 % SAND 76 % SILT AND CLAY 24 %

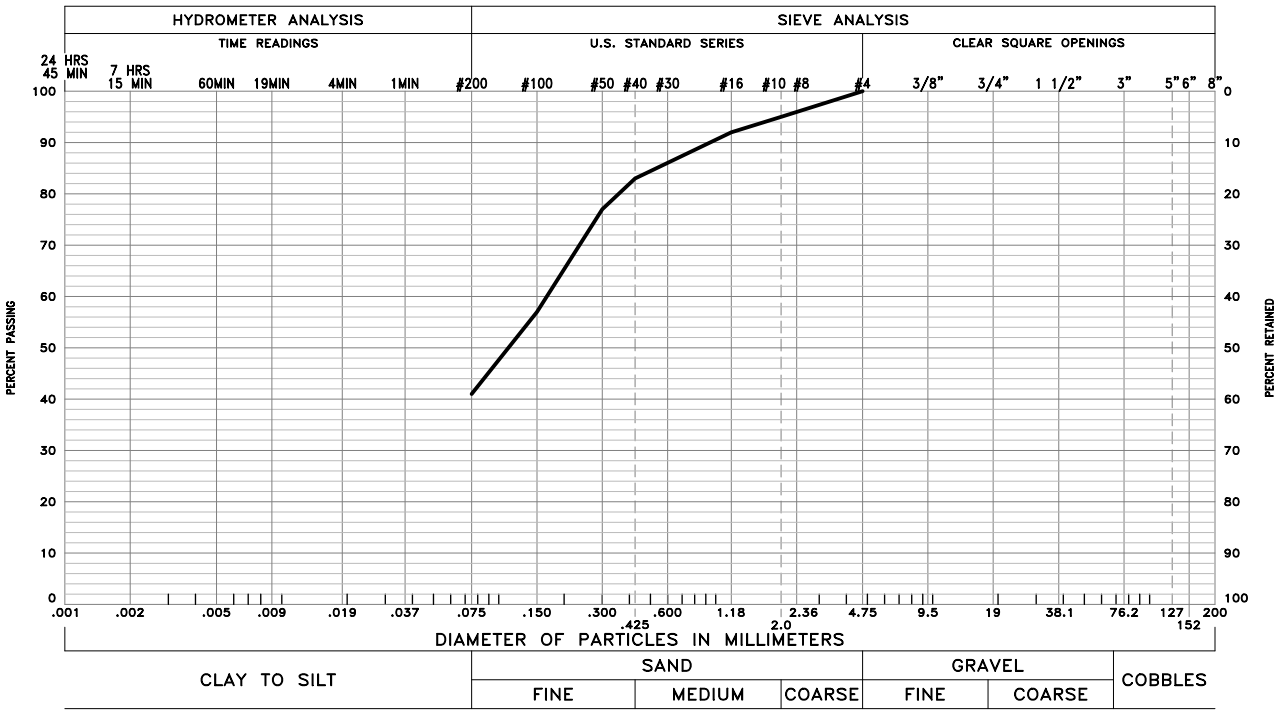
LIQUID LIMIT - PLASTICITY INDEX NP

SAMPLE OF: Silty Sand (SM) FROM: Boring B7 @ 49'

These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D6913, ASTM D7928, ASTM C136 and/or ASTM D1140.

25-2-263	Kumar & Associates	GRADATION TEST RESULTS	Fig. 14

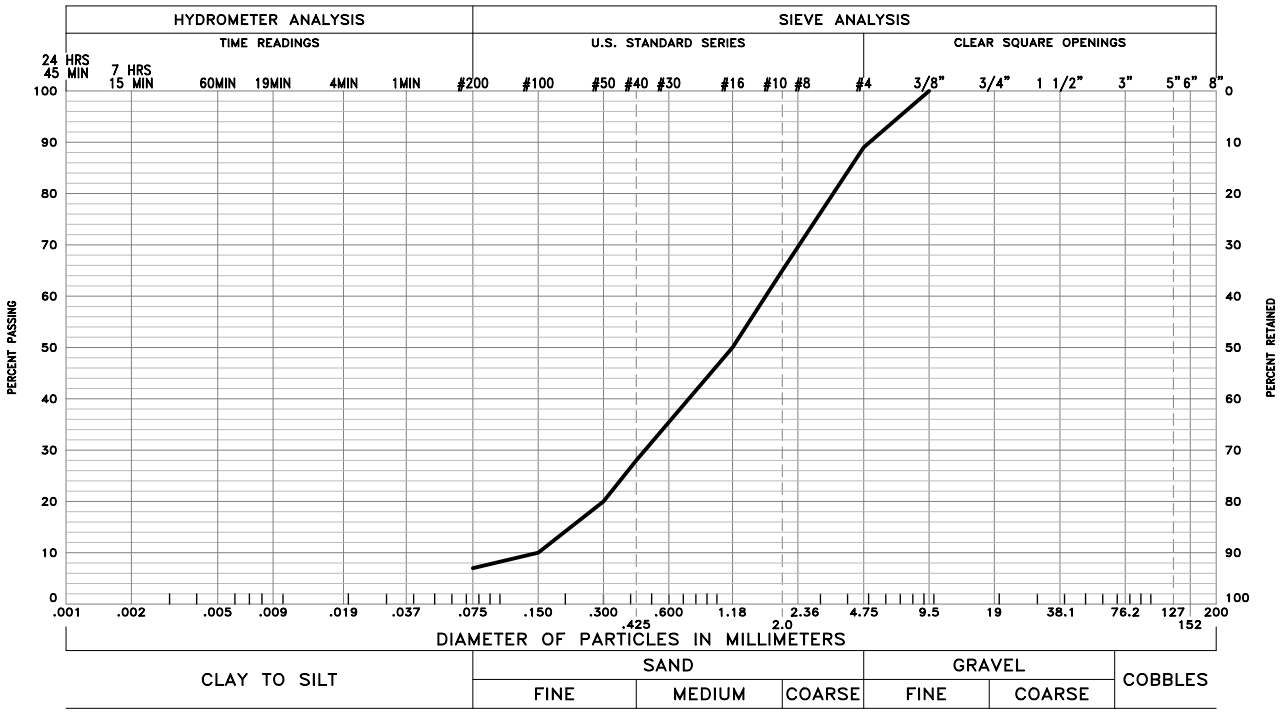
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GRAVEL 0 % SAND 59 % SILT AND CLAY 41 %

LIQUID LIMIT – PLASTICITY INDEX NP

SAMPLE OF: Silty Sand (SM) FROM: Boring B8 @ 4'



GRAVEL 11 % SAND 82 % SILT AND CLAY 7 %

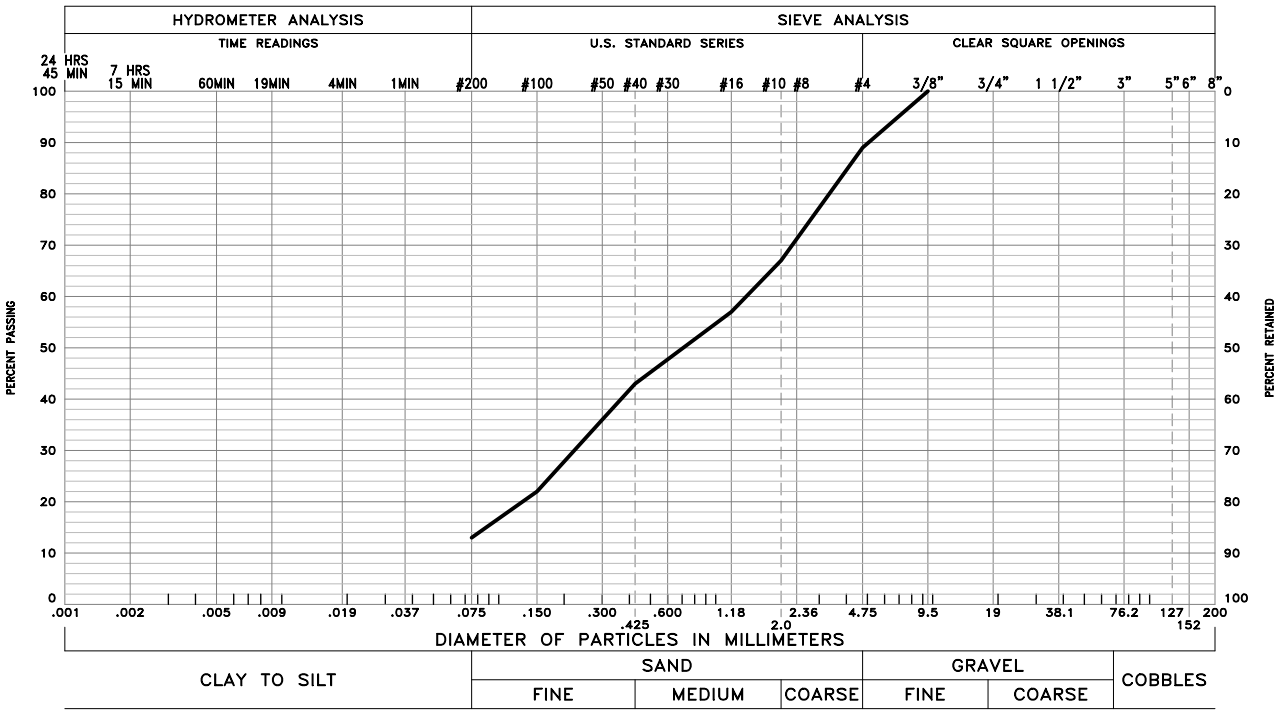
LIQUID LIMIT – PLASTICITY INDEX NP

SAMPLE OF: Poorly Graded Sand with Silt (SP-SM) FROM: Boring B9 @ 24'

These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D6913, ASTM D7928, ASTM C136 and/or ASTM D1140.

25-2-263	Kumar & Associates	GRADATION TEST RESULTS	Fig. 15

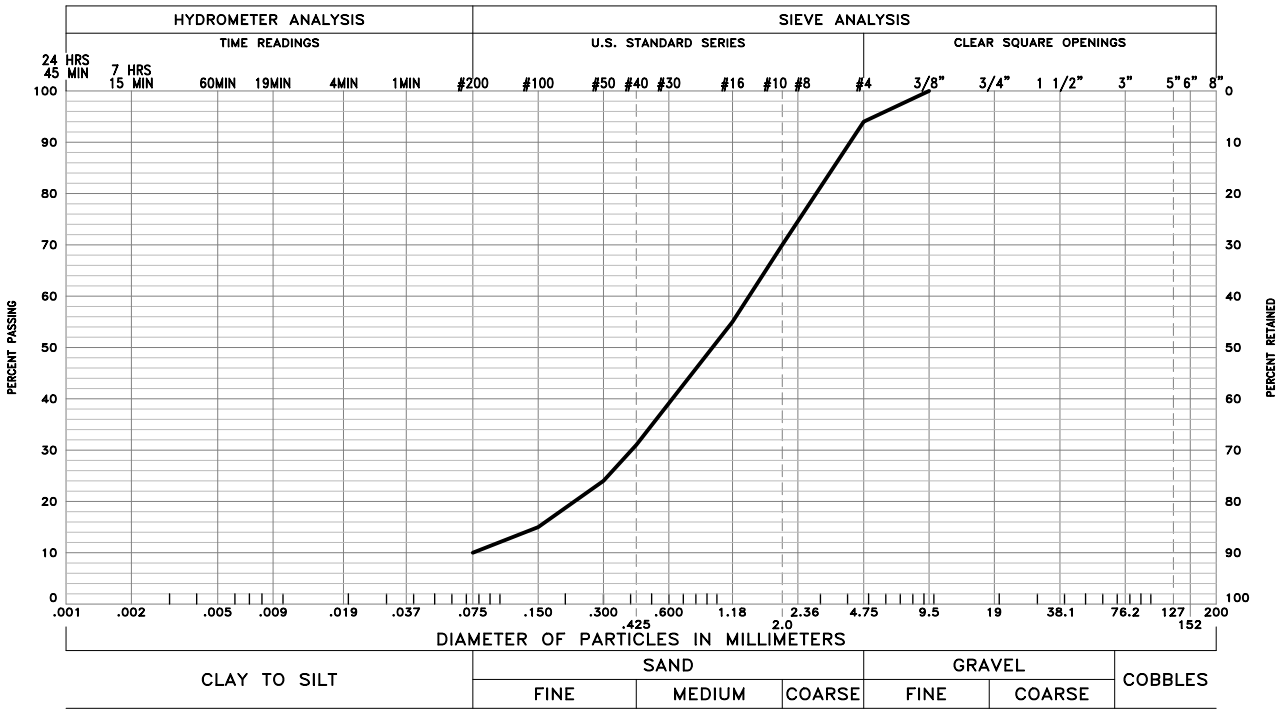
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GRAVEL 11 % SAND 76 % SILT AND CLAY 13 %

LIQUID LIMIT – PLASTICITY INDEX NP

SAMPLE OF: Silty Sand (SM) FROM: Boring P1 @ 2'–4'



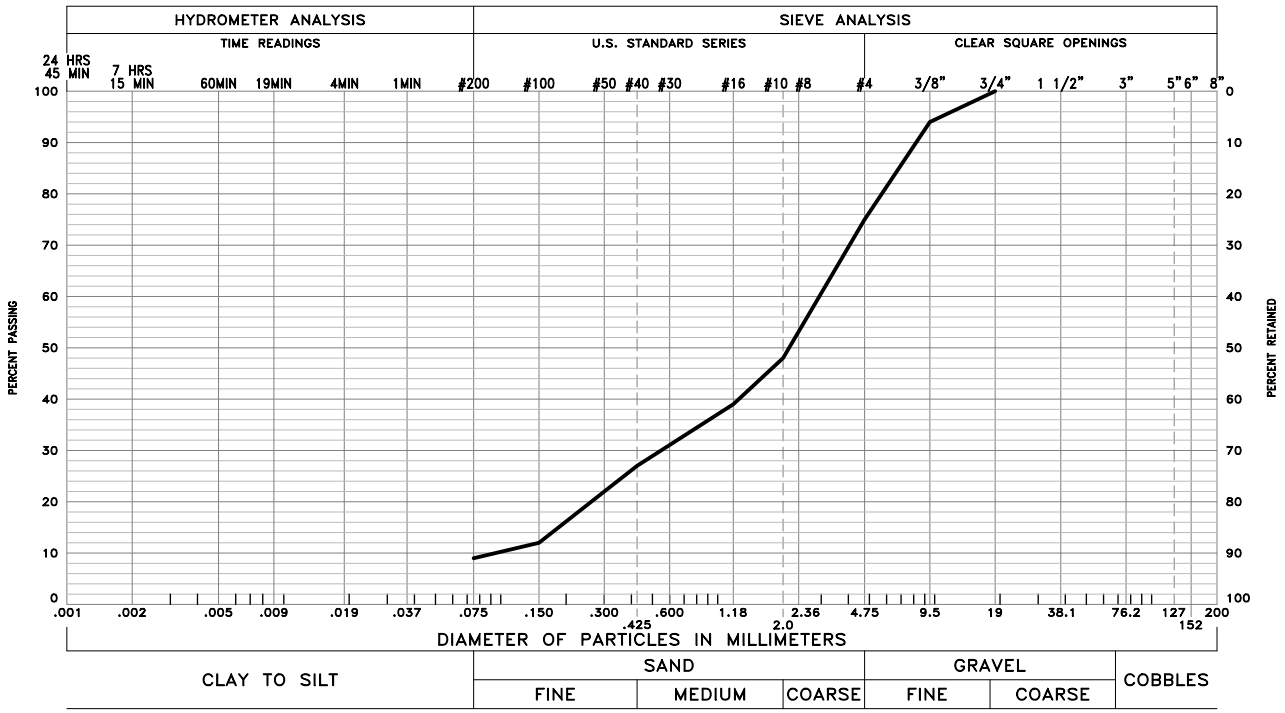
GRAVEL 6 % SAND 84 % SILT AND CLAY 10 %

LIQUID LIMIT – PLASTICITY INDEX NP

SAMPLE OF: Well Graded Sand with Silt (SW–SM) FROM: Boring P2 @ 2'–4'

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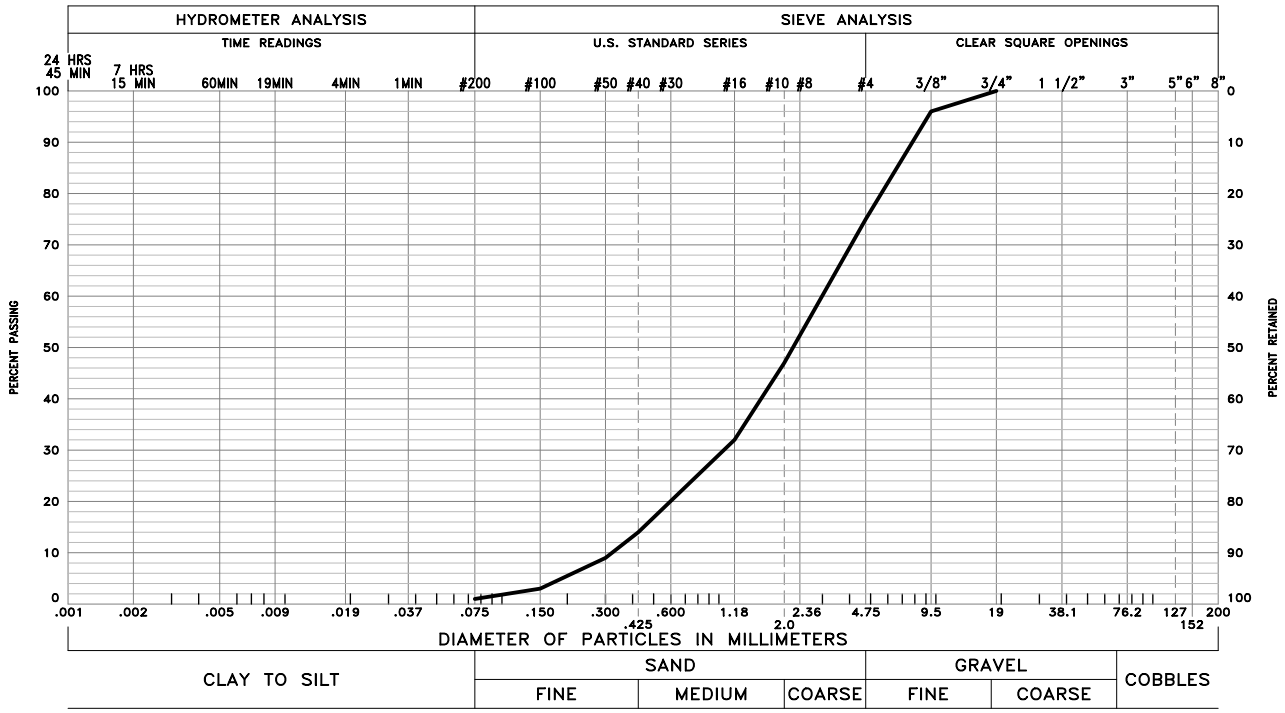
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GRAVEL 25 % SAND 66 % SILT AND CLAY 9 %

LIQUID LIMIT – PLASTICITY INDEX NP

SAMPLE OF: Well Graded Sand with Silt & Gravel (SW-SM) FROM: Boring P3 @ 2'-4'



GRAVEL 25 % SAND 74 % SILT AND CLAY 1 %

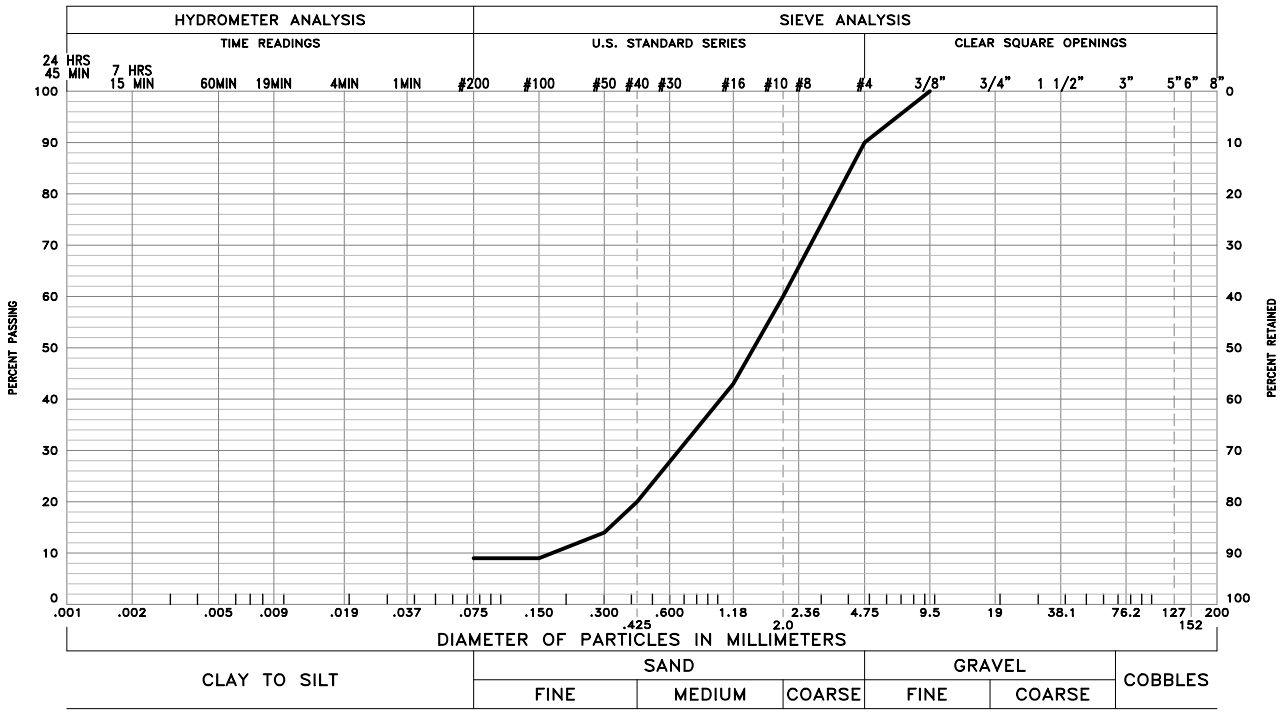
LIQUID LIMIT – PLASTICITY INDEX NP

SAMPLE OF: Well Graded Sand with Gravel (SW) FROM: Boring EX1 @ 4'-4.5'

These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D6913, ASTM D7928, ASTM C136 and/or ASTM D1140.

25-2-263	Kumar & Associates	GRADATION TEST RESULTS	Fig. 17

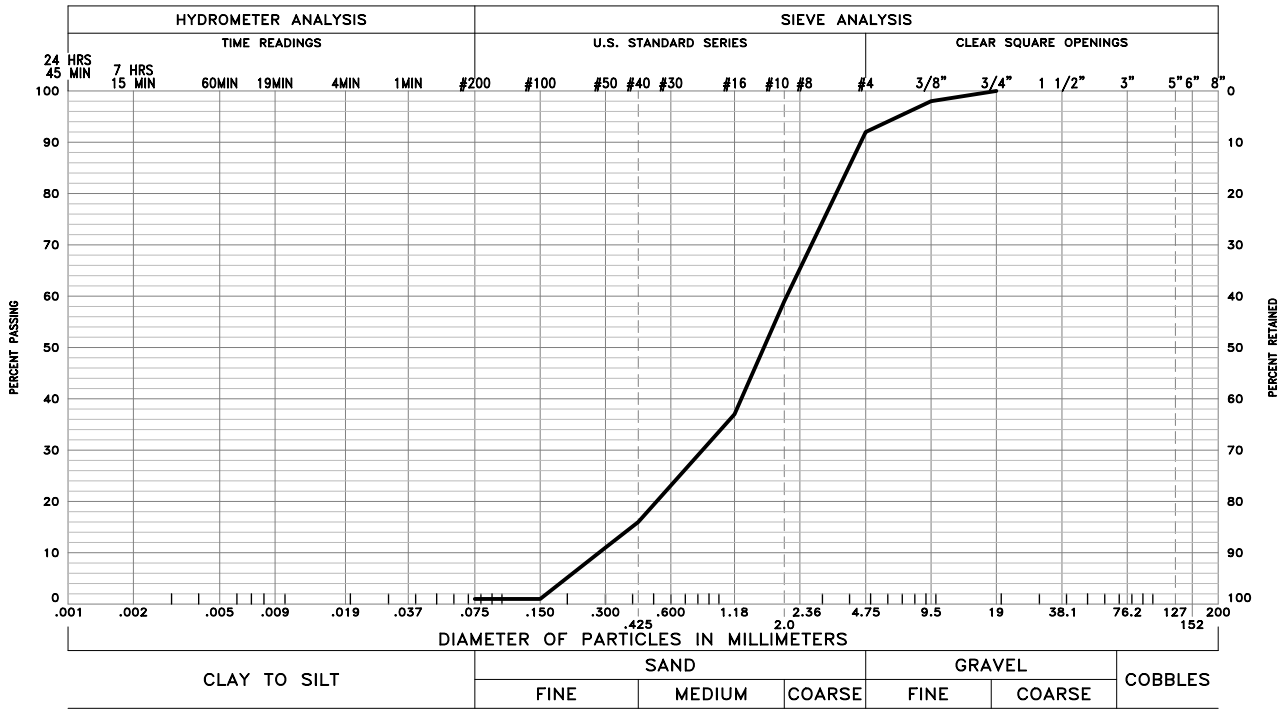
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GRAVEL 10 % SAND 81 % SILT AND CLAY 9 %

LIQUID LIMIT 25 PLASTICITY INDEX 12

SAMPLE OF: Well Graded Sand with Silt (SW-SM) FROM: Boring EX1 @ 6'-6.5'



GRAVEL 8 % SAND 91 % SILT AND CLAY 1 %

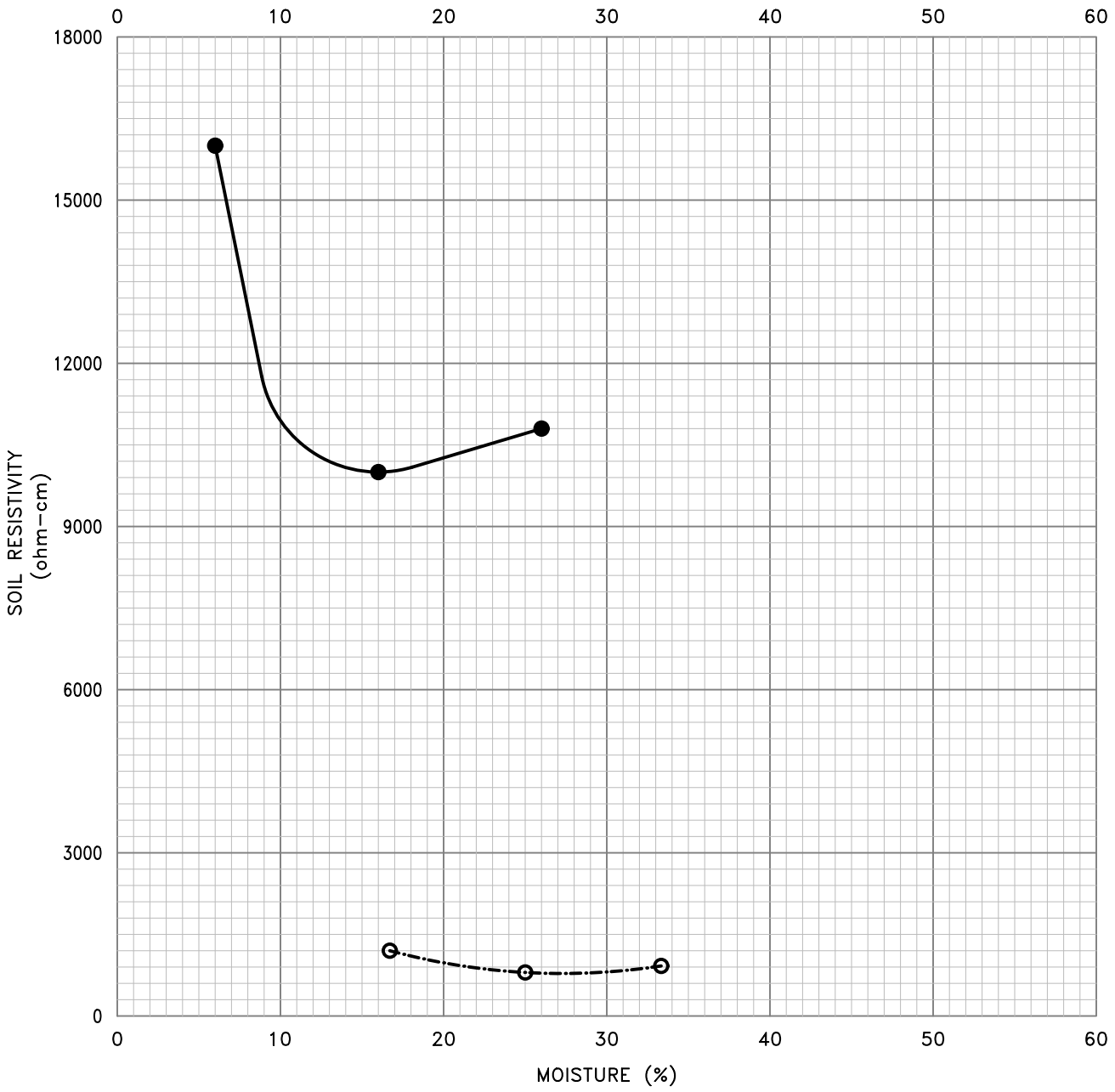
LIQUID LIMIT - PLASTICITY INDEX NP

SAMPLE OF: Well Graded Sand (SW) FROM: Boring EX2 @ 3'-3.5'

These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D6913, ASTM D7928, ASTM C136 and/or ASTM D1140.

25-2-263	Kumar & Associates	GRADATION TEST RESULTS	Fig. 18

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CURVE SYMBOL	SAMPLE IDENTIFICATION	SOIL OR BEDROCK TYPE	MINIMUM RESISTIVITY (ohm-cm)	RESISTIVITY AT IN SITU MOISTURE CONTENT (ohm-cm)
●	Boring 1 @ 9'	Well Graded Sand with Silt & Gravel (SW-SM)	10,000	14,960
○	Boring 7 @ 4'	Lean Clay (CL)	800	865

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25-2-263	Kumar & Associates	LABORATORY RESISTIVITY RESULTS	Fig. 19

Kumar and Associates, Inc.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Project No.: 25-2-263
Project Name: Cherokee Metropolitan District - PFAS Water Treatment Facility
Date Sampled: 4/20/2026 - 4/27/2026
Date Received: 4/22/2026 - 4/28/2026

SAMPLE LOCATION		DATE TESTED	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	GRADATION		PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		WATER SOLUBLE CHLORIDES (%)	MINIMUM ELECTRICAL RESISTIVITY (ohm-cm)	pH	WATER SOLUBLE SULFATES (%)	AASHTO CLASSIFICATION (Group Index)	SOIL OR BEDROCK TYPE (Unified Soil Classification)
BORING	DEPTH (ft)				GRAVEL (%)	SAND (%)		LIQUID LIMIT	PLASTICITY INDEX						
B1	9	5/8/26	6.7	120.0	16	76	8		NP	0.02	10,000	8.2	< 0.01	A-1-b (0)	Well Graded Sand w/Silt & Gravel (SW-SM)
	14	5/8/26	2.9	123.7	26	62	12		NP					A-1-a (0)	Well Graded Sand w/Silt & Gravel (SW-SM)
B2	4	5/8/26	9.7	93.4			28		NP					A-2-4 (0)	Silty Sand (SM)
	14	5/8/26	1.6	127.1	20	78	2		NP					A-1-a (0)	Well Graded Sand w/Gravel (SW)
B3	2	5/8/26	12.1	106.7			54	26	11					A-6 (3)	Sandy Lean Clay (CL)
	9	5/8/26	4.1	119.7	23	68	9		NP					A-1-b (0)	Well Graded Sand w/Silt & Gravel (SW-SM)
	29	5/8/26	13.4	113.3			42	24	11					A-6 (1)	Clayey Sand (SC)
B4	4	5/8/26	2.2	111.1	3	83	14		NP					A-1-b (0)	Silty Sand (SM)
	19	5/8/26	6.1	128.6	0	89	11	32	18					A-1-b (0)	Well Graded Sand w/Silt (SW-SM)
B5	4	5/8/26	15.6	99.8			47		NP					A-4 (0)	Silty Sand (SM)
	24	5/8/26	8.3	125.6	4	72	24		NP					A-2-4 (0)	Silty Sand (SM)
B6	2	5/8/26	1.9	111.7	7	92	1		NP					A-1-b (0)	Poorly Graded Sand (SP)
	19	5/8/26	6.3	126.1	7	73	20	29	14					A-2-6 (0)	Clayey Sand (SC)
B7	4	5/8/26	22.5	96.7			89	35	15	0.02	800	8.2	0.04	A-6 (13)	Lean Clay (CL)
	14	5/8/26	4.9	129.4	12	67	11	25	11					A-2-6 (0)	Well Graded Sand w/Silt (SW-SM)
	29	5/8/26	7.5	126.4	0	80	20	22	7					A-2-4 (0)	Silty Clayey Sand (SC-SM)
	49	5/8/26	6.1	119.5	0	76	24		NP					A-1-b (0)	Silty Sand (SM)

Kumar and Associates, Inc.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Project No.: 25-2-263
Project Name: Cherokee Metropolitan District - PFAS Water Treatment Facility
Date Sampled: 4/20/2026 - 4/27/2026
Date Received: 4/22/2026 - 4/28/2026

SAMPLE LOCATION		DATE TESTED	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	GRADATION		PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		WATER SOLUBLE CHLORIDES (%)	MINIMUM ELECTRICAL RESISTIVITY (ohm-cm)	pH	WATER SOLUBLE SULFATES (%)	AASHTO CLASSIFICATION (Group Index)	SOIL OR BEDROCK TYPE (Unified Soil Classification)
BORING	DEPTH (ft)				GRAVEL (%)	SAND (%)		LIQUID LIMIT	PLASTICITY INDEX						
B8	4	5/8/26	10.0	106.8	0	59	41		NP				0.01	A-4 (0)	Silty Sand (SM)
B9	2	5/8/26	18.8	100.8			74	35	19					A-6 (12)	Lean Clay w/Sand (CL)
	24	5/8/26	2.6	114.9	11	82	7		NP					A-1-b (0)	Poorly Graded Sand w/Silt (SP-SM)
P1	2 - 4	5/8/26			11	76	13		NP					A-1-b (0)	Silty Sand (SM)
P2	2 - 4	5/8/26			6	84	10		NP					A-1-b (0)	Well Graded Sand w/Silt (SW-SM)
P3	2 - 4	5/8/26			25	66	9		NP					A-1-a (0)	Well Graded Sand w/Silt & Gravel (SW-SM)
EX1	2	5/8/26	1.8	109.7											Well Graded Sand w/Silt (SW-SM)
	4	5/8/26	3.2	107.2											Well Graded Sand w/Silt (SW-SM)
	4 - 4.5	5/8/26			25	74	1		NP					A-1-a (0)	Well Graded Sand w/Gravel (SW)
	6 - 6.5	5/8/26			10	81	9	25	12					A-2-6 (0)	Well Graded Sand w/Silt (SW-SM)
EX2	2	5/8/26	2.0	113.2											Well Graded Sand w/Silt (SW-SM)
	4	5/8/26	3.7	113.4											Well Graded Sand w/Silt (SW-SM)
	3 - 3.5	5/8/26			8	91	1		NP					A-1-b (0)	Well Graded Sand (SW)

Appendix F.1 – Drainage Report Checklist

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EL PASO COUNTY PLANNING AND COMMUNITY DEVELOPMENT DEPARTMENT

PRELIMINARY DRAINAGE REPORT (PDR) CHECKLIST

Revised: January 2022

Preliminary Drainage Report

The purpose of the Preliminary Drainage Report is to identify specific solutions to problems onsite and offsite resulting from proposed land development, including issues existing prior to development. The PDR shall generally conform to the following outline format and major headings, and contain the applicable information listed.

		Applicant	PCD
	Please confirm each item below has been included by placing a check mark in the "Applicant" column. See right for an example. The "PCD" column is for office use only.	✓	Office use only
	Report Contents		
1	Table of contents, pages numbered	✓	
2	Existing/Historic and Developed Conditions Plans at the end of the report	✓	
	General Location		
1	City and County, and local streets within and adjacent to the subdivision.	✓	
2	Township, Range, section, 1/4 section.	✓	
3	Major drainage ways and existing facilities.	✓	
4	Names of surrounding platted developments.	✓	
	Description of Property		
1	Area in acres	✓	
2	Ground cover, (type of trees, shrubs, vegetation)	✓	
3	General topography	✓	
4	General soil conditions	✓	
5	Major drainageways	✓	
6	Irrigation facilities	✓	
7	Utilities and other encumbrances	✓	
	Major Basin Descriptions		
1	Reference should be made to major drainageway planning studies; Such as Drainage Basin Planning Studies; Flood Hazard delineation reports, and flood insurance studies or maps if available.	✓	
2	A floodplain statement shall be provided indicating whether any portion of the development is in a designated floodplain as delineated on the current FEMA mapping.	✓	
3	Major basin drainage characteristics.	✓	
4	Identification of all nearby irrigation facilities and other obstructions which could influence or be influenced by local drainage.	✓	
	Sub-Basin Descriptions		
1	Discussion of historic drainage patterns of the property in question	✓	
2	Discussion of offsite drainage flow patterns and their impact on the development	✓	

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PRELIMINARY DRAINAGE REPORT (PDR) CHECKLIST

Revised: January 2022

	Drainage Design Criteria		
1	Reference all criteria, master plans, and technical information used for report preparation and design; any deviation from such material must be discussed and justified.	✓	
2	Discussion of previous drainage studies (i.e. PDR, drainage basin planning studies, master plans, flood insurance studies) for the site in question that influence or are influenced by the drainage design and how the studies affect drainage design for the site	✓	
	Four-Step Process		
1	Runoff reduction proposed.	✓	
2	Stabilization of drainage ways proposed/discussed.	✓	
3	Proposed Stormwater Quality Capture Volume (WQCV) proposed.	✓	
4	Identify Best Management Practices (BMP's) to be used to control industrial and commercial pollutants.	✓	
	Hydrologic Criteria		
1	Identify design rainfall.	✓	
2	Identify runoff calculation method.	✓	
3	Identify design storm recurrence intervals	✓	
4	Identify detention discharge and storage calculation method.	✓	
5	Note ECM Appendix I Full Spectrum Detention (FSD) requirement.	✓	
	Drainage Facility Design - General Concept		
1	Discussion of compliance with offsite runoff considerations.	✓	
2	Discussion of anticipated and proposed drainage patterns.	✓	
3	Discussion of the content of tables, charts, figures, plates or drawings presented in the report.	✓	
	Drainage Facility Design - Specific Details		
1	Presentation of existing and proposed hydrologic conditions including approximate flow rates entering and exiting the subdivision with all necessary calculations.	✓	
2	Presentation of approach to accommodate drainage impacts on existing or proposed improvements and facilities.	✓	
3	Presentation of proposed facilities with respect to alignment, material and structure type.	✓	
4	Discussion of drainage impact of site constraints such as streets, utilities, existing and proposed structures.	✓	
5	Environmental features and issues shall be presented if applicable.	✓	
6	Discussion of maintenance access and aspects of the preliminary design.	✓	
7	Discussion and analysis of existing and proposed downstream drainage facilities and their ability to convey developed runoff from the proposed development.	✓	
	Drawing Contents		
1	General Location Map: A map shall be provided in sufficient detail to identify drainage flows entering and leaving the development and general drainage patterns. The map should be at a scale of 1”=50’ to 1”=2000’. The map shall identify any major construction (i.e. development, irrigation ditches, existing detention facilities, culverts, storm sewers, etc.) that shall influence or be influenced by the subdivision.	✓	
2	Drainage Plan: Map (s) of the proposed development at a scale of 1”=20’ to 1”=200’ shall be included to identify existing and proposed conditions on or adjacent to the site in question.	✓	
3	The drainage plan shall delineate all sub-basins and proposed initial and major facilities as well as provide a summary of all initial and major flow rates at design points. All floodplains affecting the site shall be shown.	✓	