Final Drainage Report

Lot 4, Barbarick Subdivision
El Paso County, Colorado

Prepared for:
RG Investments, LLC.
6035 Erin Parkway Drive, Suite 101
Colorado Springs, CO 80918
Contact: Richard Graham

Prepared by:
Kimley-Horn and Associates, Inc.
2 North Nevada Avenue, Suite 900
Colorado Springs, Colorado 80903
(719) 453-0180
Contact: Eric Gunderson, P.E.

Project #: 196489000

Prepared: December 5, 2023

PCD File Number: COM2346

Kimley»Horn

CERTIFICATION

DESIGN 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 preparation of this report.

SIGNATURE (Affix Seal): _____

Colorado P.E. No. 49487 Date

OWNER/DEVELOPER'S STATEMENT

I, the developer, have read and will comply with all of the requirements specified in this Drainage Report and Plan.

Graham Investments, LLC.
Name of Developer

_____
Authorized Signature Date

_____
Printed Name

_____
Title

_____
Address:

EL PASO COUNTY

Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 and 2, El Paso County Engineering Criteria Manual and Land Development Code as amended.

_____ _____
Josh Palmer, P.E. Date
County Engineer/ ECM Administrator

Conditions:

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And with updated impervious % values.

Please provide MHFD spreadsheet showing the modifications to the outlet structure.

INTRODUCTION

GENERAL PROJECT DESCRIPTION

The Property is approximately 3.93± acres total and 2.31± acres are anticipated to be disturbed. The Project includes a proposed recycling and refuse transfer station building and attendant structure. Water quality and 100-year detention is required for the site and is achieved with the existing full spectrum detention pond to the south of the property. The existing detention pond is adequately sized for the proposed improvements. Minor modifications to the outlet structure are proposed to ensure that water quality detention requirements are met.

PURPOSE AND SCOPE OF STUDY

The purpose of this Final Drainage Report (FDR) is to provide the hydrologic and hydraulic calculations and to document and finalize the drainage design methodology in support of the proposed Project. The Project is located within the jurisdictional limits of El Paso County ("the County"). Thus, the guidelines for the hydrologic and hydraulic design components were based on the criteria for the County and City of Colorado Springs, described below.

LOCATION

The Project is located at Lot 4 (TSN: 5233002013) of the Barbarick Subdivision, just east of Vollmer Rd and northeast of the major intersection of Black Forest Rd and Woodmen Rd. Lot 4 is 5.29 acres. The Project is within a 3.93 acre leased boundary within Lot 4 (Site). More specifically the project location exists within a portion of the southwest Quarter of Section 33, Township 12 South, Range 65 West of the 6th Principal Meridian, County of El Paso, State of Colorado. The Site is bounded by industrial lots zoned I-2 (BWH Properties LLC) & I-3 (HW Diesel Enterprises LLC) to the north and west, respectively. The Site is bounded by existing residential zoned lots to the east, and an undeveloped residential lot to the south. A vicinity map has been provided in the **Appendix A** of this report.

DESCRIPTION OF PROPERTY

The Site is mostly undeveloped and gravel in landcover. Lot 4 is an existing business, which is outside of the limits of the Project and will remain. The purpose of this Project is to construct a recycling and refuse transfer facility which includes a building enclosure, scale house with ground scales, detention pond outlet structure modification, and landscape buffering as required for County code compliance. Lot 4 of the Barbarick Subdivision is inclusive of an existing full spectrum extended detention basin ("EDB"). The Site currently provides water quality and 100-year detention for the Project Area.

The existing topography generally slopes from north to south at approximately 3.0%.

NRCS soil data is available for this Site and it has been noted that soils onsite are generally USCS Type A/B. The NRCS soil data can be found in **Appendix B**. There are no major drainage ways or irrigation facilities within the Site.

DRAINAGE BASINS

MAJOR BASIN DESCRIPTIONS

The Site improvements are located in Zone X, as determined by the Flood Insurance Rate Map (FIRM) number 08041C0533G effective date, December 7, 2018 (see **Appendix D**).

The Project is located within El Paso County's Sand Creek Drainage Basin (FOFO4000).

EXISTING SUB-BASIN DESCRIPTIONS

Historic and existing drainage patterns are described in detail in the FDR for the Barbarick Subdivision, by Matrix Design Group, dated June 6, 2016. In the existing condition, runoff flows from north to south via sheet and concentrated flow over developed and undeveloped land to the existing EDB located to the south of the Site. Below is a description of the existing onsite and off-site sub-basins. For the existing condition, the total weighted basin imperviousness is 73.8% and the cumulative direct runoff for the 5-year and 100-year storm events are 29.46 cfs and 55.96 cfs, respectively.

Sub-Basin E1

Sub-Basin E1 consists of the entrance to the Site, beginning at the dead end of Cliff Allen Pt. E1 is 0.39 acres in size and yields an impervious value of 55.3%. This Sub-Basin accepts flows from the adjacent off-site basin, OE1, to the north. The central section of this Sub-Basin directs flows from the adjacent offsite Sub-Basins and runoff generated within, westwards via vegetated swale. Runoff during the 5-year and 100-year storm events are 0.91 and 1.92 cfs, respectively. Concentrated flows in this Sub-Basin outfall into an existing culvert at design point E1, which runs southwards to the existing EDB to the south of the Site. See **Appendix I** for the Existing Conditions Drainage Map.

Sub-Basin E2

Sub-Basin E2 consists of the rest of the Site, including the existing EDB to the south of the Site. E2 is approximately 2.59 acres in size and yields an impervious value of 62.1%. This Sub-Basin accepts flows from adjacent off-site basins OE2, OE3, and OE4, to the north and west. Flows accepted from off-site and generated on-site flow into the existing EDB at design point E2 via sheet flow with minimal concentrated flows. Runoff during the 5-year and 100-year storm events are 5.75 and 11.64 cfs, respectively. The existing EDB is designed to store up to 1.49 ac-ft to the spillway (Elev: 7023.20). Flows are detained within the EDB and are released downstream at design point ED and outfall to the south, into Sand Creek. See **Appendix I** for the Existing Conditions Drainage Map.

Sub-Basin OE1

Sub-Basin OE1 is the offsite sub-basin just to the north of sub-basin E1. OE1 is approximately 2.34 acres in size and yields an impervious value of 77.5%. Existing land cover for this basin can be described as compacted gravel. The existing land-use for this sub-basin is vehicular and modular storage. Runoff during the 5-year and 100-year storm events are 6.43 and 12.00 cfs respectively. Flows generated within OE1 flow into sub-basin E1 at design point OE1 and ultimately outfall into the EDB to the south of the Site. See **Appendix I** for the Existing

Conditions Drainage Map.

Sub-Basin OE2

Sub-Basin OE2 is the offsite sub-basin just to the north of sub-basin E2. OE2 is approximately 2.48 acres in size and yields an impervious value of 80%. Existing land cover for this basin can be described as compacted gravel. The existing land-use for this sub-basin is vehicular and modular storage. Runoff during the 5-year and 100-year storm events are 7.34 and 13.56 cfs respectively. Flows generated within the OE2 flow into sub-basin E2 and ultimately sheet flow into the EDB to the south of the Site. See **Appendix I** for the Existing Conditions Drainage Map.

Sub-Basin OE3

Sub-Basin OE2 is the offsite sub-basin just to the northwest of sub-basin E2. OE3 is approximately 1.14 acres in size and yields an impervious value of 80%. Existing land cover for this basin can be described as compacted gravel. Land-use for this sub-basin is vehicular and modular storage. Runoff during the 5-year and 100-year storm events are 3.52 and 6.51 cfs respectively. Flows generated within the OE3 flow into sub-basin E2 at design point OE3 and ultimately sheet flow into the EDB to the south of the Site. See **Appendix I** for the Existing Conditions Drainage Map.

Sub-Basin OE4

Sub-Basin OE4 is the offsite sub-basin just to the west of sub-basin E2. OE4 is approximately 0.82 acres in size and yields an impervious value of 80%. Existing land cover for this basin can be described as compacted gravel. Land-use for this sub-basin is vehicular and modular storage. Runoff during the 5-year and 100-year storm events are 2.46 and 4.54 cfs respectively. Flows generated within the OE4 flow into sub-basin E2 at design point OE4 and enter the EDB as concentrated flow to the southwest of the Site. See **Appendix I** for the Existing Conditions Drainage Map.

Sub-Basin OE5

Sub-Basin OE5 is the offsite sub-basin just to the east of sub-basin E2 and south of E1. OE5 is approximately 0.97 acres in size and yields an impervious value of 75.3%. Existing land cover for this basin can be described as compacted gravel. Land-use for this sub-basin is an existing diesel mechanic shop. Runoff during the 5-year and 100-year storm events are 3.05 and 5.79 cfs respectively. Flows generated within the OE5 flow into sub-basin E2 at design point OE5 and enter the EDB as concentrated flow to the southeast of the Site. See **Appendix I** for the Existing Conditions Drainage Map.

PROPOSED SUB-BASIN DESCRIPTIONS

In the proposed condition, runoff flows from north to south via sheet and concentrated flows over developed land and within proposed storm sewer infrastructure to the existing EDB. Below are descriptions for the proposed on-site and off-site sub-basins. For the proposed condition, the total weighted basin imperviousness is 75.5% and the cumulative direct runoff for the 5-year and 100-year storm events are 30.59 cfs and 57.81 cfs, respectively.

Sub-Basin P1

Sub-Basin P1 consists of the entrance to the Site, beginning at the dead end of Cliff Allen Pt. P1 is 0.31 acres in size and yields an impervious value of 81.7%. This Sub-Basin accepts flows from the adjacent off-site basin, O1, to the north. The central section of this Sub-Basin is subject to a portion of the Site improvements including truck scales and a 250 sf attendant shelter for facility operation. This sub-basin directs flows from the adjacent offsite sub-basins and runoff generated within, centrally, towards the proposed CDOT Type C grated area inlet at design point P1. Runoff during the 5-year and 100-year storm events are 1.16 and 2.14 cfs, respectively. These flows are then conveyed through a proposed 18" PVC pipe, tying into the existing 30" HDPE pipe to the east. These flows are discharged into the pond along with the bypass flows from Woodmen View Storage, as shown in the existing drainage report by Matrix Design Group dated June 6, 2016. See **Appendix G** for the existing drainage report and **Appendix I** for the Proposed Conditions Drainage Map.

Sub-Basin P2

Sub-Basin P2 consists of the area just west of sub-basin P1. P2 is 0.15 acres in size and yields an impervious value of 76.4%. P2 accepts flows from the adjacent off-site sub-basin, O2, to the north. This sub-basin is subject to a portion of the Site improvements including the truck scales, attendant shelter, and vegetated swale. Runoff during the 5-year and 100-year storm events are 0.53 and 1.00 cfs, respectively. Flows in this sub-basin are routed towards and into the proposed vegetated swale which conveys flows into the existing storm inlet and 24" CPP at design point P2. These flows are discharged into the existing pond as they do in the existing condition, but at a lesser quantity due to the decrease in tributary area. See **Appendix I** for the Proposed Conditions Drainage Map.

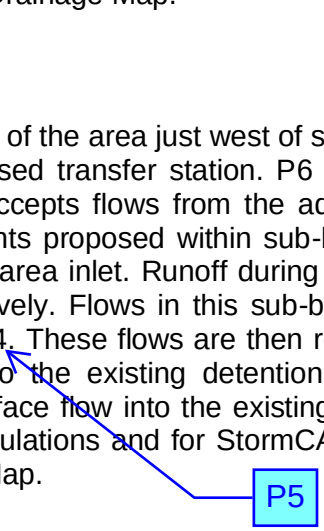
Sub-Basin P3

Sub-Basin P3 consists of the area just west of sub-basin P2 and a portion of the proposed drive isle, to the north of the proposed transfer station. P3 is 0.11 acres in size and yields an impervious value of 82.2%. P3 accepts flows from the adjacent off-site sub-basin, O4, to the north. Site improvements proposed within sub-basin P3 are the 4' concrete drainage pan and CDOT Double Type C grated area inlet. Runoff during the 5-year and 100-year storm events are 0.41 and 0.76 cfs, respectively. Flows in this sub-basin are routed towards and into the proposed inlet at design point P3. These flows are then routed westerly and southwardly within the proposed 24" PVC storm sewer pipe, into the existing detention pond to the south. See **Appendix F** for Inlet Capacity Calculations and for StormCAD Modeling, and **Appendix I** for the Proposed Conditions Drainage Map.

Sub-Basin P4

Sub-Basin P4 consists of the area just west of sub-basin P3 and a portion of the proposed drive isle, to the north of the proposed transfer station. P4 is 0.11 acres in size and yields an impervious value of 82.3%. P3 accepts flows from the adjacent off-site sub-basin, O5, to the north. Site improvements proposed within sub-basin P4 are the 4' concrete drainage pan and CDOT Double Type C grated area inlet. Runoff during the 5-year and 100-year storm events are 0.41 and 0.75 cfs, respectively. Flows in this sub-basin are routed towards and into the proposed inlet at design point P4. These flows are then routed westerly and southwardly within the proposed 24" PVC storm sewer pipe, into the existing detention pond to the south. See **Appendix F** for Inlet Capacity Calculations and for StormCAD Modeling, and **Appendix I** for the

Proposed Conditions Drainage Map.



Sub-Basin P5

Sub-Basin P5 consists of the area just west of sub-basin P4 and includes proposed drive isle, to the west of the proposed transfer station. P6 is 0.13 acres in size and yields an impervious value of 82.0%. P5 accepts flows from the adjacent off-site sub-basin, O6, to the north and west. Site improvements proposed within sub-basin P4 are the 4' concrete drainage pan and CDOT Type C grated area inlet. Runoff during the 5-year and 100-year storm events are 0.50 and 0.91 cfs, respectively. Flows in this sub-basin are routed towards and into the proposed inlet at design point P4. These flows are then routed southwardly within the proposed 24" PVC storm sewer pipe, into the existing detention pond to the south. Any flows bypassing the proposed inlet will surface flow into the existing detention pond to the south. See **Appendix F** for Inlet Capacity Calculations and for StormCAD Modeling, and **Appendix I** for the Proposed Conditions Drainage Map.

Sub-Basin P6

Sub-Basin P6 consists of the majority of the Site. Improvements within this sub-basin include the proposed transfer station building and paved access, numerous concrete drainage pans, and outlets of the proposed storm infrastructure. P6 also consists of the existing detention pond and outlets of the existing storm infrastructure. Sub-basin P6 is 2.04 acres in size and yields an impervious value of 58.9%. P6 accepts surface flows from the adjacent off-site sub-basin, O3, to the north as well as flows from sub-basins P1-P5 via existing and proposed stormwater infrastructure. All existing and proposed storm pipes daylight into the existing detention facility. Runoff during the 5-year and 100-year storm events are 4.12 and 8.62 cfs, respectively. These flows are then routed via surface flows southwardly into the existing detention pond. A portion of these flows will channelize within the proposed concrete drainage pan and discharge into the existing pond as well. The existing detention pond is sized adequately to meet the required water quality and detention requirements. See **Appendix F** for the Pond Capacity and Outlet Structure Design spreadsheet calculations, **Appendix F** for StormCAD Modeling, and **Appendix I** for the Proposed Conditions Drainage Map.

Sub-Basin R1

Sub-Basin R1 consists of the westerly half of the proposed transfer station building and associated roof drain system. R1 is 0.14 acres in size and yields an impervious value of 90%. Runoff during the 5-year and 100-year storm events are 0.43 and 0.79 cfs, respectively. These flows are captured within the gutter and routed into three evenly spaced downspouts. The downspouts are then tied into the proposed 24" PVC storm sewer pipe to the west, and eventually discharging into the existing detention facility. See **Appendix F** for Inlet Capacity Calculations and for StormCAD Modeling, and **Appendix I** for the Proposed Conditions Drainage Map.

Sub-Basin R2

Sub-Basin R2 consists of the easterly half of the proposed transfer station building and associated roof drain system. R2 is 0.14 acres in size and yields an impervious value of 90%. Runoff during the 5-year and 100-year storm events are 0.43 and 0.79 cfs, respectively. These flows are captured within the gutter and routed into three evenly spaced downspouts. The downspouts are then tied into the proposed 24" PVC storm sewer pipe to the north, and

eventually discharging into the existing detention facility. See **Appendix F** for Inlet Capacity Calculations and for StormCAD Modeling, and **Appendix I** for the Proposed Conditions Drainage Map.

Sub-Basin O1

Sub-Basin O1 is the offsite sub-basin just to the north of sub-basin P1. O1 is approximately 1.51 acres in size and yields an impervious value of 76.1%. Existing land cover for this basin can be described as compacted gravel. The existing land-use for this sub-basin is vehicular and modular storage. Runoff during the 5-year and 100-year storm events are 4.06 and 7.63 cfs respectively. Flows generated within O1 flow into sub-basin E1 at design point O1 and ultimately outfall into the EDB to the south of the Site, along with the flows generated within E1. See **Appendix I** for the Proposed Conditions Drainage Map.

Sub-Basin O2

Sub-Basin O2 is the offsite sub-basin just to the north of sub-basin P2. O2 is approximately 0.74 acres in size and yields an impervious value of 80.0%. Existing land cover for this basin can be described as compacted gravel. The existing land-use for this sub-basin is vehicular and modular storage. Runoff during the 5-year and 100-year storm events are 2.20 and 4.06 cfs respectively. Flows generated within O2 flow into sub-basin E2 at design point O2 and ultimately outfall into the EDB to the south of the Site, along with the flows generated within E2. See **Appendix I** for the Proposed Conditions Drainage Map.

Sub-Basin O3

Sub-Basin O3 is the offsite sub-basin just to the north of sub-basin P6. O3 is approximately 0.44 acres in size and yields an impervious value of 80.0%. Existing land cover for this basin can be described as compacted gravel. The existing land-use for this sub-basin is vehicular and modular storage. Runoff during the 5-year and 100-year storm events are 1.30 and 2.40 cfs respectively. Flows generated within O3 flow into sub-basin E3 at design point O3 and ultimately outfall into the EDB to the south of the Site, along with the flows generated within P6. See **Appendix I** for the Proposed Conditions Drainage Map.

Sub-Basin O4

Sub-Basin O4 is the offsite sub-basin just to the north of sub-basin P3. O4 is approximately 1.05 acres in size and yields an impervious value of 80.0%. Existing land cover for this basin can be described as compacted gravel. The existing land-use for this sub-basin is vehicular and modular storage. Runoff during the 5-year and 100-year storm events are 3.16 and 5.84 cfs respectively. Flows generated within O4 flow into sub-basin P3 at design point O4 and ultimately outfall into the EDB to the south of the Site, along with the flows generated within P3. See **Appendix I** for the Proposed Conditions Drainage Map.

Sub-Basin O5

Sub-Basin O5 is the offsite sub-basin just to the north of sub-basin P4. O5 is approximately 1.08 acres in size and yields an impervious value of 80.0%. Existing land cover for this basin can be described as compacted gravel. The existing land-use for this sub-basin is vehicular and modular storage. Runoff during the 5-year and 100-year storm events are 3.25 and 6.01 cfs respectively. Flows generated within O5 flow into sub-basin P4 at design point O5 and

ultimately outfall into the EDB to the south of the Site, along with the flows generated within P4. See **Appendix I** for the Proposed Conditions Drainage Map.

Sub-Basin O6

Sub-Basin O6 is the offsite sub-basin just to the north and west of sub-basins P4 and P5. O6 is approximately 1.14 acres in size and yields an impervious value of 80.0%. Existing land cover for this basin can be described as compacted gravel. The existing land-use for this sub-basin is vehicular and modular storage. Runoff during the 5-year and 100-year storm events are 3.52 and 6.51 cfs respectively. Flows generated within O6 flow into sub-basin P5 at design point O6 and ultimately outfall into the EDB to the south of the Site, along with the flows generated within P5. See **Appendix I** for the Proposed Conditions Drainage Map.

Sub-Basin O7

Sub-Basin O7 is the offsite sub-basin just to the west of sub-basins P5 and P6. O7 is approximately 0.82 acres in size and yields an impervious value of 80%. Existing land cover for this basin can be described as compacted gravel. Land-use for this sub-basin is vehicular and modular storage. Runoff during the 5-year and 100-year storm events are 2.64 and 4.54 cfs respectively. Flows generated within the O7 flow into sub-basin P6 at design point O7 and enter the EDB as concentrated flow to the southwest of the Site. See **Appendix I** for the Proposed Conditions Drainage Map.

Sub-Basin O8

Sub-Basin O8 is the offsite sub-basin just to the south of sub-basins P1 and P2 and east of P6. O8 is approximately 0.82 acres in size and yields an impervious value of 76.7%. Existing land cover for this basin can be described as compacted gravel. This sub-basin consists of the existing Diesel Mechanic Shop: Dirt Road Diesel. Runoff during the 5-year and 100-year storm events are 2.66 and 5.06 cfs respectively. Flows generated within the O8 flow into sub-basin P6 at design point O8 and enter the EDB as concentrated flow to the south of the Site. See **Appendix I** for the Existing Conditions Drainage Map.

DRAINAGE DESIGN CRITERIA

DEVELOPMENT CRITERIA REFERENCE

The proposed storm facilities are designed to be in compliance with the City of Colorado Springs and El Paso County “Drainage Criteria Manual (DCM)” dated October 2018 (”the MANUAL”), El Paso County “Engineering Criteria Manual” (“the Engineering Manual”), Chapter 6 and Section 3.2.1 of Chapter 13 of the City of Colorado Springs Drainage Criteria Manual dated May 2014 (“the Colorado Springs MANUAL”).

There are no known master plans or studies for the Site.

HYDROLOGIC CRITERIA

The 5-year and 100-year design storm events were used in determining rainfall and runoff for the existing and proposed condition drainage analysis per the MANUAL and DCM. The rainfall depths for the Site were determined from Table 6-2 from the DCM. Refer to **Table 1** below for the rainfall depths utilized for the Site and **Appendix E** for the hydrologic calculations for the

Site.

Table 1: *Rainfall Depths (IN)*

	Duration (HRS)
Storm Event	**1 HR**
5 Year	1.50 IN
100 Year	2.52 IN

Calculations for the runoff coefficients and percent imperviousness are included in the **Appendix E**. The rational method was used to determine the peak flows for the Project. These flows were used to determine the size of the proposed inlets, culvert, storm drain system and on-site swales.

The proposed impervious values in Table 6-6 of the DCM were utilized in this report for the final design.

The existing Site provides one full spectrum extended detention basin. The Site is maintaining the historic drainage patterns as much as possible.

There are no additional provisions selected or deviations from the criteria in both the MANUAL and Colorado Springs MANUAL.

HYDRAULIC CRITERIA

Applicable design methods were utilized to confirm the size of the EDB, which includes the use of the UD-Detention spreadsheet and rational calculations spreadsheet. Storm sewer sizing and hydraulic grade line calculations were computed using StormCAD implementing the standard step method. Bentley FlowMaster (Edition Update 3) was used for the sizing and analysis of the western drive isle/drainage pan, proposed roof drains, and proposed 18” PVC storm pipe connecting to the existing 30” HDPE storm pipe to the east of the Site.

Proposed drainage features on-site have been analyzed and sized for the following storm events:

- Major Storm: 100-year Storm Event

Please clarify existing EDB volume. See highlighted section in page 6.

One EDB is exists on Site and provides the required water quality capture volume, EURV volume and 100-year detention. The existing EDB is located to the south of the Site with an existing volume of 2.89 ac-ft and designed for the 100-year storm event. The minimum required volume for the EDB, in the proposed condition, is 1.387 ac-ft. Developed flows from the Site will be released at controlled rates from the EDB and is ultimately tributary to Sand Creek. Flows that are discharged from the pond will continue south through rip rap, low-tailwater basin for energy dissipation before continuing south. As flows continue south via historic drainage patterns, they will channelize and be conveyed through a 24” corrugated metal pipe (per ALTA Survey by LDC, Inc dated 10/20/2021), running beneath the existing gravel road. It is stated in the existing FDR for the Barbarick Subdivision that this pipe is 12” and that flows in excess of 5.7 cfs would overtop the gravel road, creating a tailwater elevation of 7018.0. This gravel road and corrugated metal pipe will be eliminated in the development of Sterling Ranch. EDB

calculations are provided in the **Appendix F**. The EDB is designed to release the 100-year flow rates below the pre-development flow rate and at or below the anticipated 100-year flows from the final drainage report for the property immediately to the south. The existing EDB as-built certification document *"Pond As-Built Verification for Barabrick Subdivision Lots 1-4 Construction",* prepared by Matrix Design Group, dated January 16, 2017, was utilized for EDB storage calculations and design of the outlet structure modification. The EDB as-built certification is included in the **Appendix G.** See the "Compliance with Previous Studies" section of this report for specific flow rates and compliance details.

Concrete drainage pans, area inlets, grass lined swales, and storm sewer pipes are designed to carry flows to the EDB. Calculations for the proposed improvements are provided in the **Appendix F** and the design points are provided in the Proposed Drainage Map located in **Appendix I**.

Emergency overflows will be routed over the southern embankment of the pond through the emergency spillway. It will follow the historic drainage patterns that conveys drainage southward towards Sand Creek.

THE FOUR STEP PROCESS

The Project was designed in accordance with the four-step process to minimize adverse impacts of urbanization, as outlined in the County's "Four-Step Process" for selecting structural BMPs (ECM Section I.7.2 BMP Selection).

Step 1. **Employ Runoff Reduction Practices** - The Project is proposing a recycling and refuse transfer station. Although the proposed condition increases the Site impervious area by 1.7%, the cumulative direct runoff for the 100-year event only increases by 1.85 cfs. The proposed grading and underground storm system were designed to broadly distribute on-site and off-site flows and slow the runoff velocity and reduce runoff peaks. The existing full spectrum detention pond will be used to capture and maintain flows discharging off Site at or below historic levels. The existing pond is sized adequately for the proposed improvements and only requires a modification of the outlet structure's restrictor plate.

Step 2. Stabilize Drainageways – Proposed drainage ways are stabilized by designing them with slopes that control the flow rates. Concrete drainage pans are utilized in areas of concentrated flow to better convey flows to the proposed inlets or discharge points. Discharge points feature adequately sized rip rap pads which will be constructed to reduce the velocities of runoff entering the pond. It is anticipated this will minimize erosion.

Step 3. Provide Water Quality Capture Volume (WQCV) – Permanent water quality measures and detention facilities will be provided with the Project via the existing Full Spectrum EDB. More specifically, this Project proposes a modification to the existing outlet structure's restrictor plate, to effectively meet water quality and detention requirements.

Step 4. Consider Need for Industrial and Commercial BMPs – The Project is proposing a fully enclosed recycling and refuse transfer station facility. The Project responds to the covering of storage and handling areas by providing a building enclosure where all physical transfer operations will take place.

DRAINAGE FACILITY DESIGN

GENERAL CONCEPT

The existing condition of the Site consists of flows draining from the north to the south with an approximate average slope of 3%, all discharging into the existing full spectrum EDB to the south of the Site. The existing runoff conditions for the Site were developed utilizing the Rational Method described in the Hydrologic Criteria section of this report.

The proposed drainage patterns will match the overall historic patterns for the Barabrick Subdivision. To maintain historic flows, all flows will be routed to the existing full spectrum EDB which will capture and control the release of flows from the Site. Site drainage will be conveyed to the EDB via a series of swales, surface flow, and a storm sewer system.

Provided in the **Appendix E** are hydrologic calculations utilizing the Rational Method for the existing and proposed conditions. Provided in **Appendix F** are the hydraulic calculations for the proposed conditions, including the proposed detention basin sizing. As previously mentioned, the existing drainage map and proposed drainage map can be found in **Appendix I.**

SPECIFIC DETAILS

Sub-basins P1-P6 are subject to Site improvements including the transfer building, attendant shelter, and entrance/exit scales. In the proposed condition flows are routed to CDOT Type C grated area inlets, drainage pans, or swales laid out to effectively control flows as they are conveyed to the existing EDB. Flows captured by the existing EDB are released via the existing 30" CPP which conveying flows southwardly towards Sand Creek at a rate less than in the historic conditions from the existing FDR: "Final Drainage Report for Barbarick Subdivision, Portions of Lots 1, 2, and Lots 3 & 4" prepared by Matrix Design Group on June 6, 2016. (Existing FDR for the Barbarick Subdivision). The EDB is designed to release the 5-year and 100-year on-site flows at a discharge rate of 3.2 cfs and 11.8 cfs, respectively. This is a reduction from the 5-year and 100-year on-site discharge rate of 21.3 cfs and 56.7 cfs (design point H3 of the historic condition) as shown in the existing FDR for the Barbarick Subdivision. Therefore, impact to downstream infrastructure is not anticipated and planned release rates are in compliance with the Existing FDR for the Barbarick Subdivision.

All proposed storm sewer infrastructure and the existing detention facility is located within the private property's boundary and will be owned and maintained by the property owner and will require maintenance consisting of routine inspections, removal of debris from the detention area, and bi-annual inspections for hydraulic performance of the basin. Refer to the DCM for exact maintenance criteria and for other Best Management Practices.

The hydrologic calculations, hydraulic calculations, and Drainage Maps are included in the **Appendix E, Appendix F,** and **Appendix I,** respectively, of this report for reference.

The Site will disturb more than 1 acre and will require a Colorado Discharge Permit System (CDPS) General Permit for Stormwater Discharge Associated with Construction Activities from the Colorado Department of Public Health and Environment (CDPHE).

Since the Site was previously platted, there are no associated drainage and bridge fees due at this time.

Engineer must confirm in the Drainage Report that the existing EDB that the site is tributary to is functioning as intended.

More specifically: I inspected this EDB in Sept 2023. It was in need of maintenance. This maintenance must be completed prior to Preliminary Acceptance (PA) of this project, since it will be utilized in the initial/interim condition as a TSB.

Please clarify this math more with a reference to an appendix for example. Or provide a comparison table here in this text (historic vs original design vs proposed design flowrates). Because this math does not coincide with the total flowrates shown on PDF pg 82 below.

Also update this paragraph per any updates to the table on pg 82 below per my comment on that page.

A cost estimate for the proposed private storm drain improvements is included in **Appendix H** of this report for reference.

GEOTECHNICAL RECOMMENDATIONS

Per the Geotechnical Subsurface Investigation by RMG – Rocky Mountain Group, dated October 23, 2023, it was determined that the soil is generally anticipated to be well draining, however groundwater was encountered at depths anticipated to impact the proposed construction. A subsurface perimeter drain and underslab drain are recommended and are included in the design. Geotechnical recommendations do not impact the existing detention facility to the south of the Site.

COMPLIANCE WITH PREVIOUS STUDIES

The Site area was previously included and studied as part of the existing FDR for the Barbarick Subdivision (*Final Drainage Report for Barbarick Subdivision, Portions of Lots 1,2 and Lots 3 & 4*) prepared by Matrix Design Group on June 6, 2016. The Site lies within sub-basins H1 and D1 of the historic and previously planned drainage conditions. Design points H3 and D2 correspond to Design Point P8, the proposed discharge from the existing detention pond, in the proposed condition. The existing FDR for the Barabrick Subdivision is provided in **Appendix G.**

HISTORIC CONDITION:

Design Point H3 experiences flows of 21.3 cfs and 56.7 cfs for the 5-year and 100-year storm events, respectively.

EXISTION CONDITION:

Design Point D2 experiences a flow of 45.9 cfs (16.5cfs+29.4cfs$_{bypass}$) for the 100-year storm event.

PROPOSED CONDITION:

Design Point P8 experiences a flow of 41.2 cfs (11.8cfs+29.4cfs$_{bypass}$) for the 100-year storm event.

Please clarify that this is the only proposed modification to the existing EDB's outlet structure

The existing EDB will release the 5-year and 100-year storm events at 3.2 and 11.8 cfs respectively. These values are less than the historic flow rates at this design point. With the proposed modified outlet structure restrictor plate, the flows will be further controlled for the 100-year storm event than that of the existing condition at design point D2. Therefore, impact to downstream infrastructure is not anticipated and the planned release rates are in compliance with the Existing FDR for the Barbarick Subdivision.

SUMMARY

The proposed drainage design is to maintain the historic drainage patterns and release rates for the Site. Runoff from the Site will flow through an proposed storm sewer system to an existing full spectrum extended detention basin. The basin ultimately discharges to Sand Creek. The drainage design presented within this report conforms to the criteria presented in both the MANUAL and the Colorado Springs MANUAL. Additionally, the Site runoff and storm drain facilities will not adversely affect the downstream and surrounding developments, including Sand Creek.

REFERENCES

1. El Paso County “Drainage Criteria Manual”, dated October 31, 2018
2. City of Colorado Springs “Drainage Criteria Manual (DCM) Volume 1”, dated May, 2014
3. El Paso County “Engineering Criteria Manual” Revision 6, dated December 13, 2016
4. Chapter 6 and Section 3.2.1. of Chapter 13-City of Colorado Springs Drainage Criteria Manual, May 2014.
5. Urban Drainage and Flood Control District Drainage Criteria Manual (UDFCDCM), Vol. 1, prepared by Wright-McLaughlin Engineers, June 2001, with latest revisions.
6. Flood Insurance Rate Map, El Paso County, Colorado and Incorporated Areas, Map Number 08041C0533G, Effective Date December 7, 2018, prepared by the Federal Emergency Management Agency (FEMA).
7. “Final Drainage Report for Barbarick Subdivision, Portions of Lots 1,2 and Lots 3 &4” prepared by Matrix Design Group. (June 6, 2016)
8. “Geotechnical Subsurface Soil Investigation” prepared by RMG – Rocky Mountain Group. (October 23, 2023).

APPENDIX

APPENDIX A: VICINITY MAP

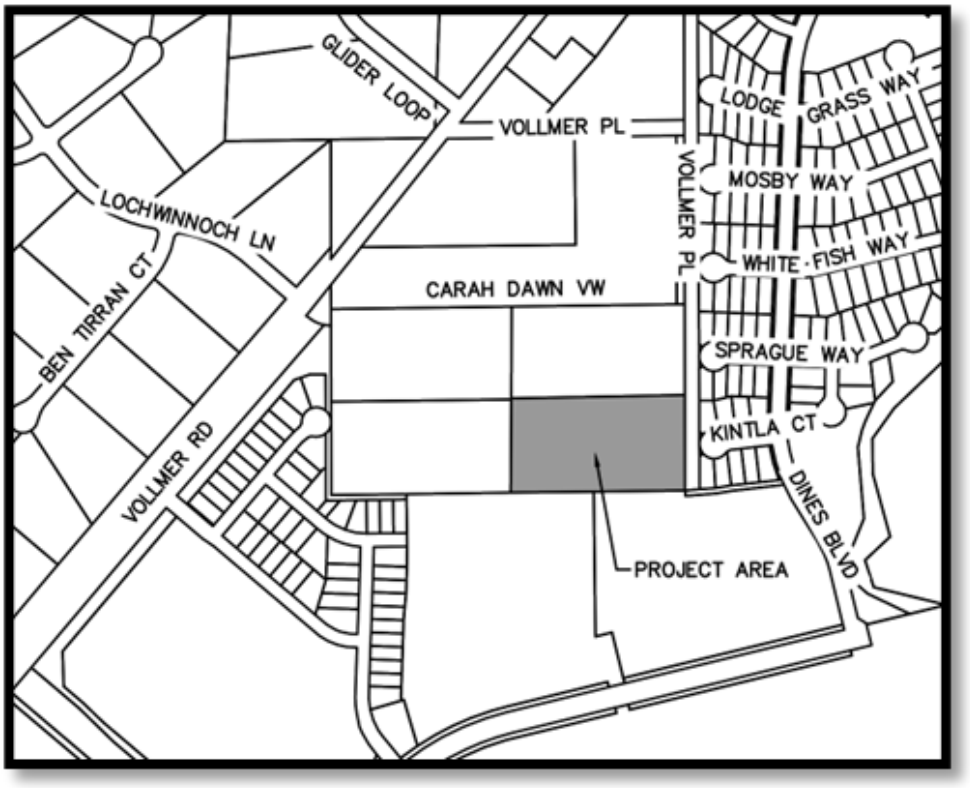


Figure 1: Vicinity Map (Not to Scale)

APPENDIX B: NRCS SOIL STUDY

United States Department of Agriculture

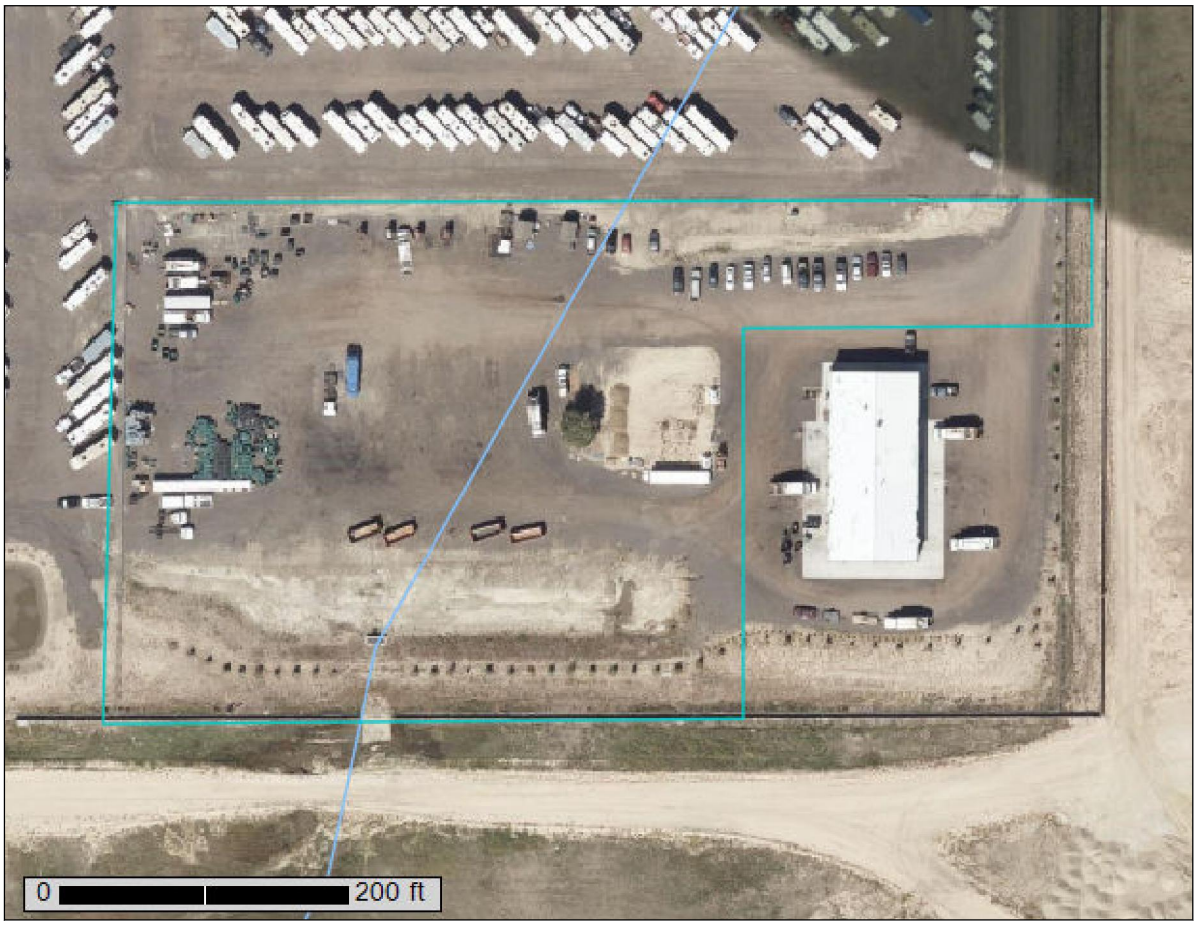
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for El Paso County Area, Colorado

Barbarick Transfer Station



December 5, 2023

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

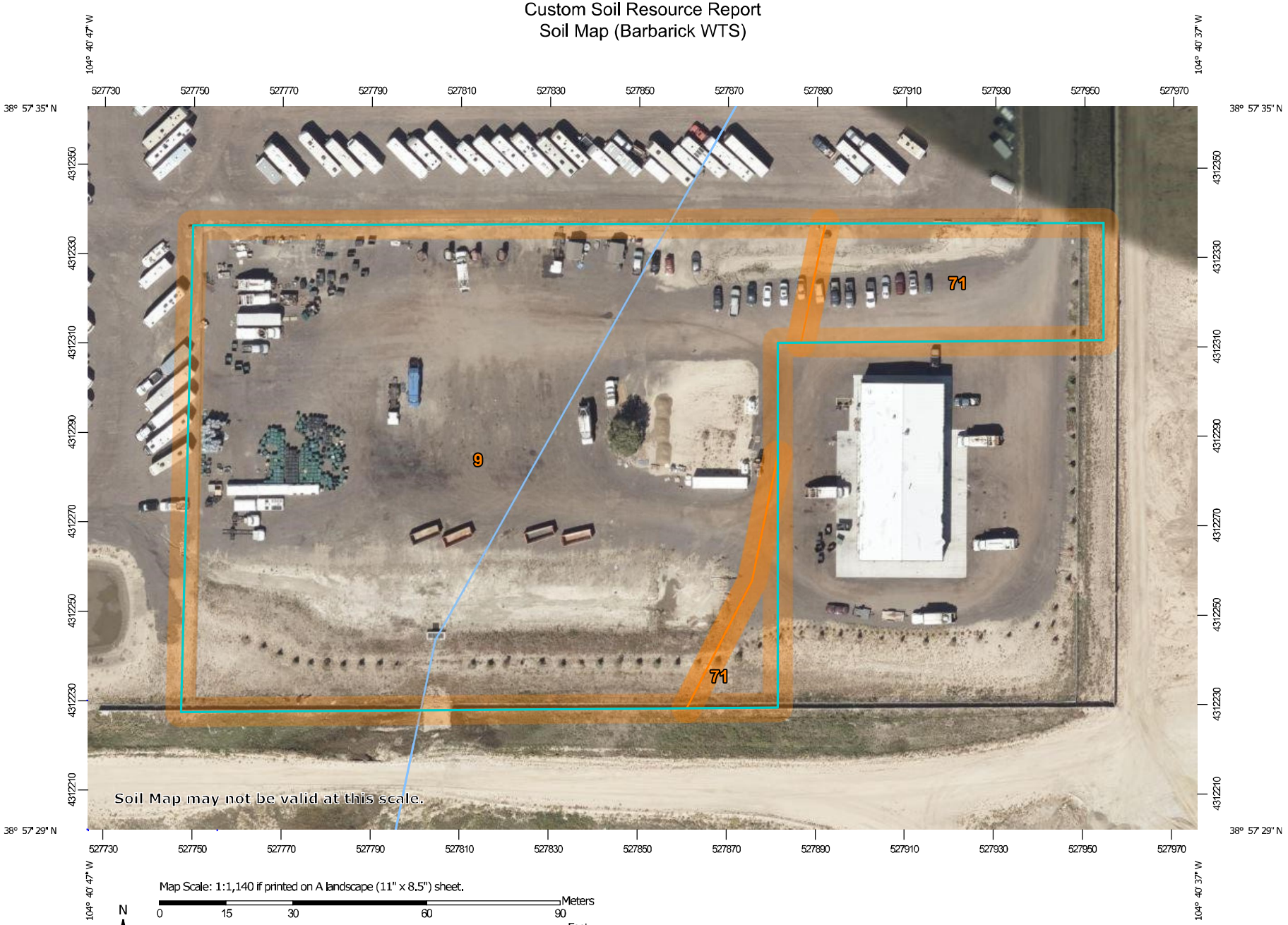
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map (Barbarick WTS)



Map Scale: 1:1,140 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 21, Aug 24, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 19, 2018—Oct 20, 2018

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend (Barbarick WTS)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
9	Blakeland-Fluvaquentic Haplaquolls	3.5	86.7%
71	Pring coarse sandy loam, 3 to 8 percent slopes	0.5	13.3%
Totals for Area of Interest		**4.1**	**100.0%**

Map Unit Descriptions (Barbarick WTS)

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however,

onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

El Paso County Area, Colorado

9—Blakeland-Fluvaquentic Haplaquolls

Map Unit Setting

National map unit symbol: 36b6
Elevation: 3,500 to 5,800 feet
Mean annual precipitation: 13 to 17 inches
Mean annual air temperature: 46 to 55 degrees F
Frost-free period: 110 to 165 days
Farmland classification: Not prime farmland

Map Unit Composition

Blakeland and similar soils: 60 percent
Fluvaquentic haplaquolls and similar soils: 38 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Blakeland

Setting

Landform: Hills, flats
Landform position (three-dimensional): Side slope, talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium derived from arkose and/or eolian deposits derived from arkose

Typical profile

A - 0 to 11 inches: loamy sand
AC - 11 to 27 inches: loamy sand
C - 27 to 60 inches: sand

Properties and qualities

Slope: 1 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: Low (about 4.5 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Description of Fluvaquentic Haplaquolls

Setting

Landform: Swales
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 12 inches: variable
H2 - 12 to 60 inches: stratified very gravelly sand to loam

Properties and qualities

Slope: 1 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 6.00 in/hr)
Depth to water table: About 0 to 24 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 6.2 inches)

Interpretive groups

Land capability classification (irrigated): 6w
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: D
Ecological site: R048AY241CO - Mountain Meadow
Hydric soil rating: Yes

Minor Components

Other soils

Percent of map unit: 1 percent
Hydric soil rating: No

Pleasant

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

71—Pring coarse sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 369k
Elevation: 6,800 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Pring and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pring

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock

Typical profile

A - 0 to 14 inches: coarse sandy loam
C - 14 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: R048AY222CO - Loamy Park
Hydric soil rating: No

Minor Components

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Other soils

Percent of map unit:
Hydric soil rating: No

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

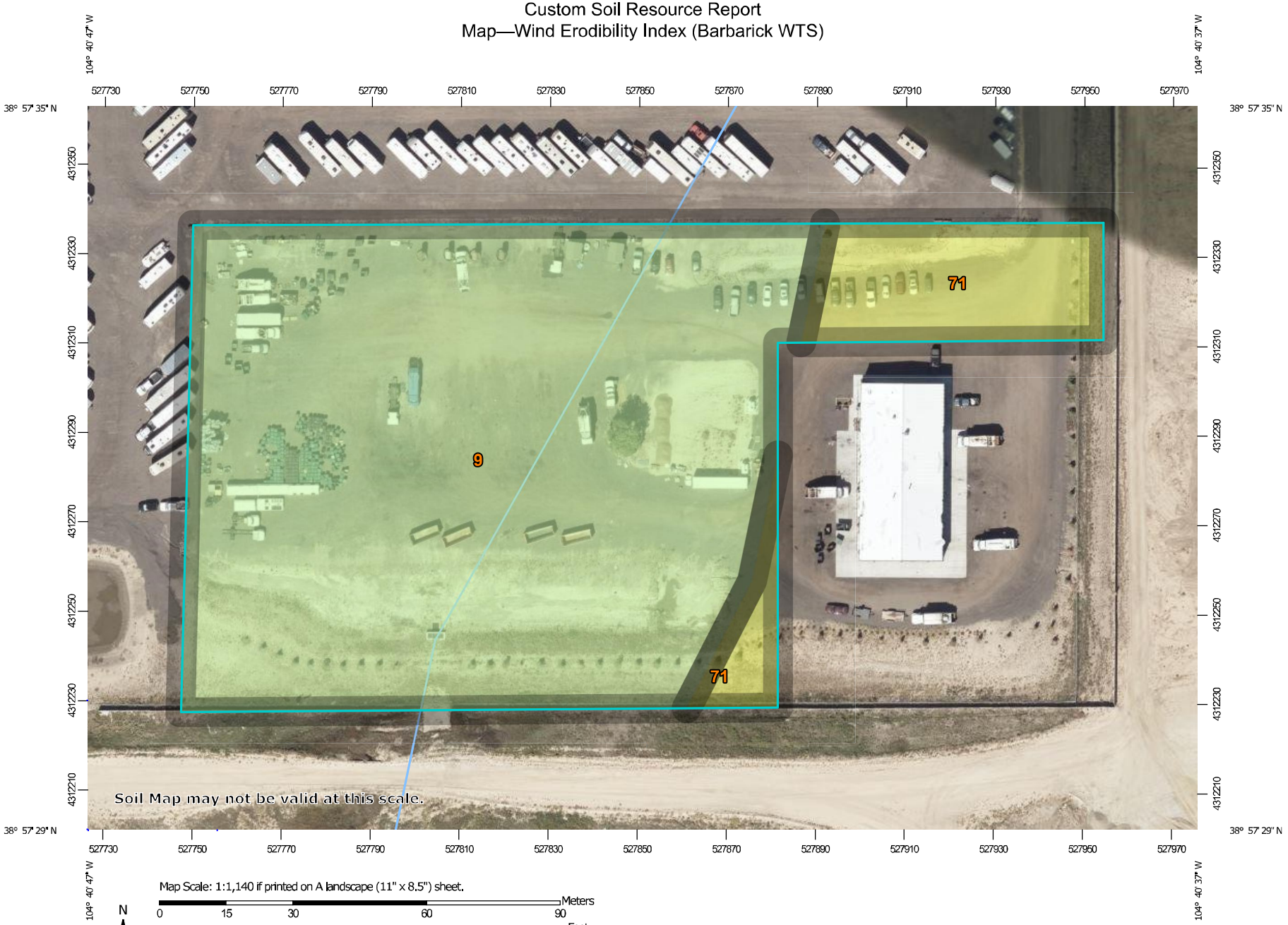
Soil Erosion Factors

Soil Erosion Factors are soil properties and interpretations used in evaluating the soil for potential erosion. Example soil erosion factors can include K factor for the whole soil or on a rock free basis, T factor, wind erodibility group and wind erodibility index.

Wind Erodibility Index (Barbarick WTS)

The wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

Map—Wind Erodibility Index (Barbarick WTS)



Map Scale: 1:1,140 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

0
38
48
56
86
134
160
180
220
250
310
Not rated or not available

Soil Rating Lines

0
38
48
56
86
134
160
180
220
250
310
Not rated or not available

Soil Rating Points

0
38
48
56
86
134
160
180
220
250
310
Not rated or not available

Water Features

Streams and Canals

Transportation

Rails
Interstate Highways
US Routes
Major Roads
Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 21, Aug 24, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 19, 2018—Oct 20, 2018

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Wind Erodibility Index (Barbarick WTS)

Map unit symbol	Map unit name	Rating (tons per acre per year)	Acres in AOI	Percent of AOI
9	Blakeland-Fluvaquentic Haplaquolls	134	3.5	86.7%
71	Pring coarse sandy loam, 3 to 8 percent slopes	86	0.5	13.3%
Totals for Area of Interest			**4.1**	**100.0%**

Rating Options—Wind Erodibility Index (Barbarick WTS)

Units of Measure: tons per acre per year

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

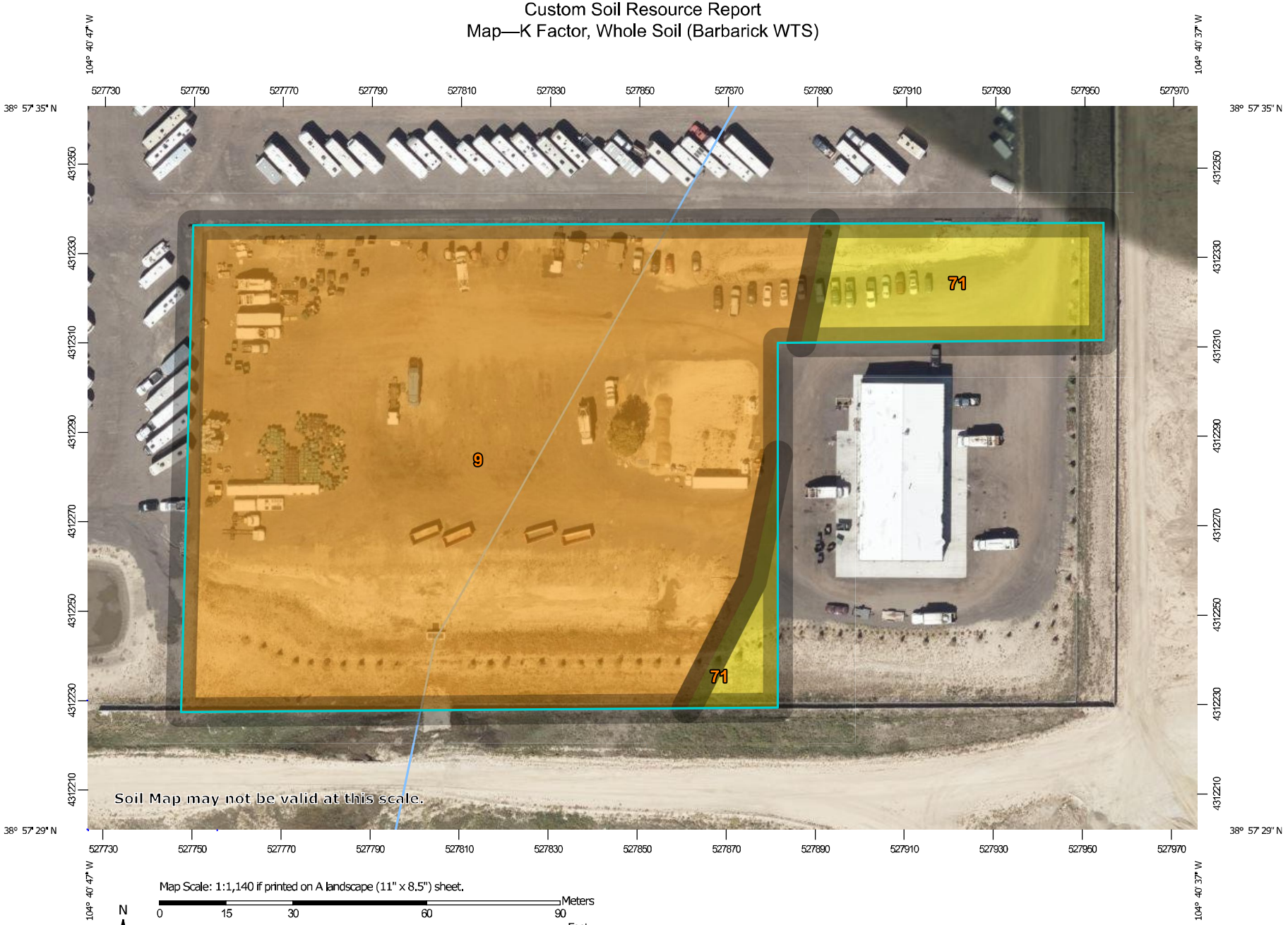
K Factor, Whole Soil (Barbarick WTS)

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

"Erosion factor Kw (whole soil)" indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

Factor K does not apply to organic horizons and is not reported for those layers.

Custom Soil Resource Report
Map—K Factor, Whole Soil (Barbarick WTS)



Map Scale: 1:1,140 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 15 30 60 90

Feet
0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- .02
- .05
- .10
- .15
- .17
- .20
- .24
- .28
- .32
- .37
- .43
- .49
- .55
- .64
- Not rated or not available

Soil Rating Lines
- .02
- .05
- .10
- .15
- .17
- .20
- .24
- .28
- .32
- .37
- .43
- .49
- .55
- .64
- Not rated or not available

Soil Rating Points
- .02
- .05
- .10
- .15
- .17
- .20
- .24
- .28
- .32
- .37
- .43
- .49
- .55
- .64
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 21, Aug 24, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 19, 2018—Oct 20, 2018

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—K Factor, Whole Soil (Barbarick WTS)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
9	Blakeland-Fluvaquentic Haplaquolls	.10	3.5	86.7%
71	Pring coarse sandy loam, 3 to 8 percent slopes	.17	0.5	13.3%
Totals for Area of Interest			**4.1**	**100.0%**

Rating Options—K Factor, Whole Soil (Barbarick WTS)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group (Barbarick WTS)

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained

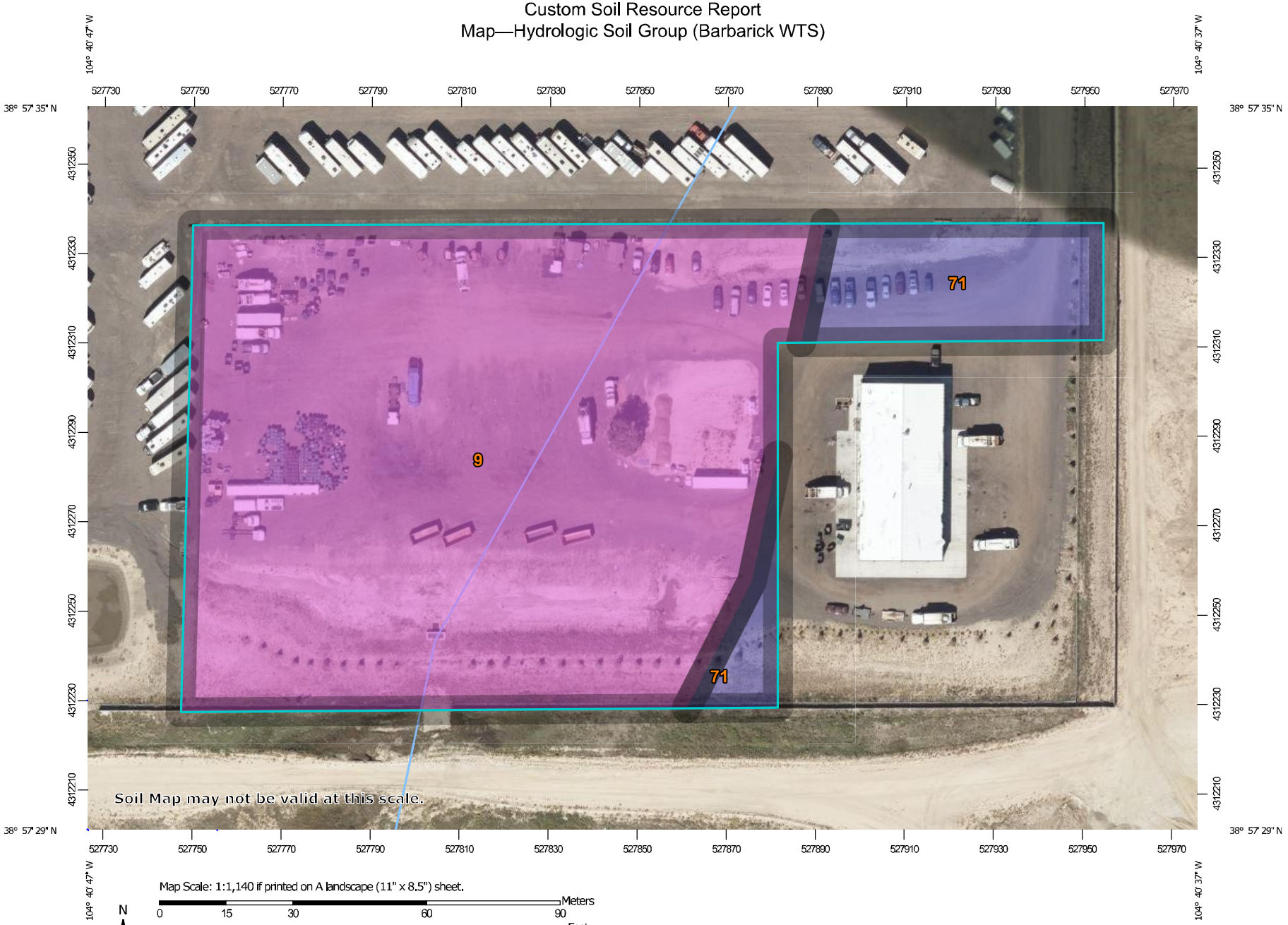
soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Map—Hydrologic Soil Group (Barbarick WTS)



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Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

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- Aerial Photography

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Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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71	Pring coarse sandy loam, 3 to 8 percent slopes	B	0.5	13.3%
Totals for Area of Interest			**4.1**	**100.0%**

Rating Options—Hydrologic Soil Group (Barbarick WTS)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

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APPENDIX C: GEOTECHNICAL SUBSURFACE INVESTIGATION

Architectural
Structural
Geotechnical

RMG
Engineers / Architects

Materials Testing
Forensic
Civil/Planning

SUBSURFACE SOIL INVESTIGATION

Please move soils report to its own submittal outside of the drainage report.

8812 Cliff Allen Point
Lot 4, Amended Plat, Barbarick Sub.
Colorado Springs, Colorado

PREPARED FOR:

Vollmer Road Partners, LLLP
6035 Erin Park Drive, Ste. 101
Colorado Springs, CO 80918

JOB NO. 194534

October 23, 2023

Respectfully Submitted,

RMG – Rocky Mountain Group

Jared McElmeel, E.I.
Geotechnical Staff Engineer

Reviewed by,

RMG – Rocky Mountain Group

COLORADO REGISTERED
ANTHONY P. MUNGER
10/25/23
39818
PROFESSIONAL ENGINEER

Tony Munger, P.E.
Sr. Geotechnical Project Manager

TABLE OF CONTENTS

GENERAL SITE AND PROJECT DESCRIPTION

Project Description and Scope of Work

RMG has completed a geotechnical investigation for the two proposed new structures at Cliff Allen Point in the eastern portion of Colorado Springs, El Paso County, Colorado. One new structure is to be a "transfer station" consisting of a one-story pre-engineered metal building (PEMB) located in the northwest corner of the site. It is our understanding that this structure is to consist of cast-in-place foundation walls for the structure, plus a concrete "ramp" consisting of retaining walls along the two sides and the "front" wall of the structure along the upper side of the "ramp". The lower side of the "ramp" is to taper down to meet the existing grade. The other new structure is to be a shed located north of the existing structure, between two new vehicle scales. The purpose of the investigation was to evaluate the subsurface soil conditions and provide geotechnical design and construction criteria for the project. These services were provided in accordance with our Proposal for RMG Job No. 194534 dated September 13, 2023.

RMG understands the proposed PEMB is to have a footprint of approximately 10,240 square feet and paved access. The shed is to be approximately 250 to 300 square feet.

Existing Site Conditions

The site is currently a partially developed parcel in a commercial complex. At the time of the subsurface investigation, the site appears to have been slightly modified from a natural state. An existing structure is located near the eastern portion of the site and is to remain. The proposed new PEMB is to be constructed near the northwest corner of the site. The shed is to be located north of the existing structure along the access road to the new structure. The site is currently utilized as a storage yard and vegetation is limited to outer edges of the property. The location of the site is shown on the Site Vicinity Map, Figure 1.

FIELD INVESTIGATION AND LABORATORY TESTING

Drilling

The subsurface conditions on the site were investigated by drilling three (3) exploratory test borings to depths of approximately 20 to 35 feet within the proposed PEMB footprint and one 15-foot test boring to a depth of approximately 15 feet within the proposed shed location. The approximate locations of the test borings are presented in the Test Boring Location Plan, Figure 2.

The test borings were advanced with a power-driven, continuous-flight auger drill rig. Soil samples were obtained in general accordance with ASTM D-1586 utilizing a 2-inch OD split-barrel sampler or in general accordance with ASTM D-3550 utilizing a 2½-inch OD modified California sampler. Samples were returned to RMG's materials testing laboratory for testing and analysis. An Explanation of Test Boring Logs is presented in Figure 3. The Test Boring Logs are presented in Figures 4 and 5.

Laboratory Testing

The moisture content for the recovered samples was obtained in the laboratory. Grain-size analysis, Atterberg Limits, and Denver Swell/Consolidation tests were performed on selected samples for purposes of classification and to develop pertinent engineering properties. A Summary of Laboratory Test Results is presented in Figure 6. Soil Classification Data are presented in Figure 7.

SUBSURFACE CONDITIONS

Subsurface Materials

The test borings revealed the soil strata across the site to be fairly consistent from boring to boring. The subsurface materials encountered in the test borings consisted of silty sand fill, native silty to clayey sand, silty to clayey sandstone, and sandy claystone.

Additional descriptions and the interpreted distribution (approximate depths) of the subsurface materials are presented on the Test Boring Logs. The classifications shown on the logs are based upon visual classification of the samples at the depths indicated. Stratification lines shown on the logs represent the approximate boundaries between material types and the actual transitions may be gradual and vary with location.

Groundwater

Groundwater was observed at depths of approximately 3 feet to 14.5 feet in the test borings at the time of drilling, and at depths of approximately 2 feet to 2.5 feet when checked after letting the water level in the borings stabilize for one day. Groundwater is expected to be a significant factor in foundation design. Fluctuations in groundwater and subsurface moisture conditions may occur due to seasonal variations in rainfall and other factors not readily apparent at this time.

Soil Parameters

The following table presents estimated in-situ soil parameters.

Soil Description	Unit Weight (lb/ft^3)	Friction Angle (degree)	Active Earth Pressure Ka	Passive Earth Pressure Kp	At-Rest Earth Pressure Ko	Modulus of Elasticity E_s (lb/in^2)	Poisson's Ratio μ_s
Native Sand, Silty	120	28	0.361	2.77	0.531	1,200	0.20
Sandstone, Silty to Clayey	125	30	0.333	3.00	0.500	3,500	0.30

Seismic Design

In accordance with the Minimum Design Loads and Associated Criteria for Buildings and Other Structures, ASCE/SEI 7-16, seismic design parameters have been determined for this site. The seismic site class has been interpreted from the results of the soil test borings drilled within the project site. The Applied Technology Council seismic design tool has been used to determine the seismic response acceleration parameters. The soil on this site is not considered susceptible to liquefaction.

The following recommended seismic design parameters are based upon Seismic Site Class D, and a 2-percent probability of exceedance in 50 years. The Seismic Design Category is "B".

Period (sec)	Mapped MCE Spectral Response Acceleration (g)		Site Coefficients		Adjusted MCE Spectral Response Acceleration (g)		Design Spectral Response Acceleration (g)	
0.2	S_s	0.193	F_a	1.6	S_{ms}	0.309	S_{ds}	0.206
1.0	S_1	0.056	F_v	2.4	S_{m1}	0.135	S_{d1}	0.09

Notes: MCE = Maximum Considered Earthquake
g = acceleration due to gravity

CONCLUSIONS AND RECOMMENDATIONS

The following discussion is based on the subsurface conditions encountered in the test borings and the project characteristics previously described. If conditions are different from those described in this report or the project characteristics change, RMG should be retained to review and revise our recommendations as necessary.

Geotechnical Considerations

Based on the subsurface soil conditions encountered in our test borings, it is our opinion that a shallow foundation system is suitable for the proposed structures. Soil improvements required to achieve the allowable bearing capacity presented herein are discussed below. Deep foundation systems, while not anticipated to be necessary, are also a suitable alternative for the proposed structure(s). If a deep foundation system is desired, please contact personnel of RMG for revised recommendations.

Site Preparation

We recommend removing (overexcavating) the foundation areas and backfilling with compacted structural fill. The on-site material is suitable as structural fill. Site preparation should include clearing and grubbing the site of all vegetation, topsoil, and any other deleterious material within the construction area and disposing this material appropriately. Following clearing and grubbing, the area within the foundation footprint and a 2-foot perimeter beyond should be excavated to 1 foot below the bottom of footing elevation. The excavated material may be stockpiled for reuse as structural fill. An Open Excavation Observation should be made at this point to verify soil conditions are as reported in the soil boring logs herein.

Prior to the Open Excavation Observation, the upper 6 inches of the exposed subsurface soils should then be scarified and moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557) or 98 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698) prior to placing structural fill.

Upon verification, the native material previously removed may be used as structural fill. The material should not be excessively wet, should be free of organic matter and construction debris, and should not

contain rock fragments greater than 3-inches in any dimension. The fill material should be moisture-conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and placed in lifts of not more than 10 inches. Each loose lift should be compacted to a minimum of 95 percent of Modified Proctor maximum dry density as determined by the Modified Proctor test (ASTM D-1557) or 98 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698). The first density tests should be conducted when 12 inches of compacted fill have been placed.

Groundwater conditions are anticipated to be encountered at the time of foundation excavation and may result in either water flow into the excavation or destabilization of the foundation bearing soils, stabilization techniques should be implemented. Various stabilization methods can be employed and can be discussed at the time of construction. However, a method that affords potentially a reduced amount of overexcavation (versus other methods) and provides increased performance under moderately to severely unstable conditions is the use of a layered geogrid and structural fill system.

Additionally, dependent upon the rate of groundwater flow into the excavation, a geosynthetic vertical drain and/or perimeter drain may be required around the lower portions of the excavation to allow for installation of the layered geogrid and structural fill system.

Foundation Recommendations

Structures may be supported on shallow foundations bearing on approved soils when prepared in accordance with the recommendations above. When so prepared, a maximum allowable bearing pressure of 2,000 psf with no minimum dead load requirement may be used for design. The foundation design should be prepared by a qualified Colorado Registered Professional Engineer using the recommendations presented in this report. This foundation system should be designed to span a minimum of 10 feet under the design loads. The bottoms of exterior foundations should be at least 30 inches below finished grade for frost protection. When prepared and properly compacted, total settlement of 1-inch or less with differential settlement on the order of ½ inch or less is estimated. Settlement in granular material generally occurs relatively rapidly with construction loads. Long term consolidation settlement should not be an issue, provided that the site material is prepared as recommended above.

Retaining Wall Parameters

It is our understanding that two retaining walls along the sides of the new "ramp" that is to be constructed along one side of the new "transfer station", but that the type of retaining wall construction has not been determined yet. Based on the intended usage, we assume that the retaining walls will be constructed as either cast-in-place concrete retaining walls or mechanically-stabilized earth (MSE) retaining walls. Our recommendations for those two types of retaining walls are presented below. If an alternate retaining wall construction is to be used, contact personnel of RMG for revised recommendations.

Cast-in-Place Concrete Retaining Walls:

Foundation Soils

Retaining walls should be excavated to the design bearing elevation. An open excavation observation should be made at this point to verify soil conditions are as reported in the report referenced above and that the retaining wall is not bearing on existing fill or deleterious material. Upon verification the upper 6-inches of the exposed subsurface soils should then be scarified and moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture

content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698) or a minimum of 92 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557) prior to placing concrete forms. When so prepared, a maximum allowable bearing pressure of 2,000 psf with no minimum dead load requirement may be used for design. The foundation design should be prepared by a qualified Colorado Registered Professional Engineer using the recommendations presented in this report. This foundation system should be designed to span a minimum of 10 feet under the design loads. If these retaining walls are to be mechanically attached to (or poured monolithically with) the "transfer station" foundation, the bottoms of exterior foundations should be at least 30 inches below finished grade for frost protection.

Retained Soils

On-site (undisturbed) sand soils:
Unit weight = 120 pcf
Active Equivalent Fluid Pressure = 40 pcf
Friction angle, ϕ = 28 deg.
Cohesion, c = 0 psf

Mechanically-Stabilized Earth (MSE) Retaining Walls:

Foundation Soils

Retaining walls should be excavated to the design bearing elevation. An open excavation observation should be made at this point to verify soil conditions are as reported in the report referenced above and that the retaining wall is not bearing on existing fill or deleterious material. Upon verification the upper 6-inches of the exposed subsurface soils should then be scarified and moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698) or a minimum of 92 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557) prior to placing concrete forms.

On-site (undisturbed) sand soils or structural fill compacted as indicated herein:

Maximum allowable bearing pressure:	2,000 psf
Minimum dead load pressure:	None

It should be noted that MSE walls are generally designed and constructed with the expectation that some movement will occur. Compared to structurally reinforced retaining walls, MSE walls can tolerate a larger magnitude of movement. The amount of movement is dependent on several factors including (but not limited to) the wall height, construction methods, backfill selection and placement, and foundation soils.

Retained Soils

On-site (undisturbed) sand soils:
Unit weight = 120 pcf
Active Equivalent Fluid Pressure = 40 pcf
Friction angle, ϕ = 28 deg.
Cohesion, c = 0 psf

Reinforced Backfill Zone

Backfill materials placed within the Reinforced Backfill Zone shall consist of granular, non- or low-expansive soil containing no particles larger than 1½" in diameter, no more than 30% (by weight) passing through a #200 sieve screen, and a liquid limit of 25 or less and a plasticity index of 6 or less. The on-site sand soils are anticipated to be suitable for use in the Reinforced Backfill Zone.

Backfill should generally be free of topsoil, organics, particles greater than 4 inches in diameter, debris, or other deleterious material. Backfill should be placed in loose lifts not exceeding 8 to 12 inches, moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 92 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698) or to a minimum of 85 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557).

Backfill soils prepared as indicated herein:

Unit weight = 120 pcf
Active Equivalent Fluid Pressure = 40 pcf
Friction angle, ϕ = 28 deg.
Cohesion, c = 0 psf

Retaining Wall Drainage

To reduce hydrostatic loading on retaining walls, a subsurface drain system should be placed behind the walls. The drain system should consist of free-draining granular soils containing less than five percent fines (by weight) passing a No. 200 sieve placed adjacent to the wall. The free-draining granular material should be graded to prevent the intrusion of fines or be encapsulated in a suitable filter fabric. A drainage system consisting of perforated drain lines (placed near the base of the wall) should be used to intercept and discharge water which would tend to saturate the backfill. Where used, drain lines should be embedded in a uniformly graded filter material and provided with adequate clean-outs for periodic maintenance. An impervious soil should be used in the upper layer of backfill to reduce the potential for water infiltration. As an alternative, a prefabricated drainage structure, such as geocomposite, may be used as a substitute for the granular backfill adjacent to the wall.

Open Excavation Observations

As referenced above, foundation excavations should be observed by RMG prior to placing structural fill, forms, or concrete to verify the foundation bearing conditions for each structure. Based on the conditions observed in the foundation excavation, the recommendations made at the time of construction may vary from those contained herein. In the case of differences, the Open Excavation Observation report shall be considered to be the governing document to be used to modify the site preparation recommendations as necessary.

Floor Slabs

The in-situ native sand soil should be stable at its natural moisture content. However, if the groundwater table is encountered, the native soils may need to "dry out" prior to being used under the foundation

components and slabs. Any fill material placed below slabs should be granular, non-expansive material to reduce the potential for slab movement.

Areas under floor slabs should be overexcavated a minimum of 1-foot and the upper 6 inches of the exposed subsurface soils should then be scarified and moisture-conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557) or 98 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698) prior to placing structural fill. Floor slabs should bear upon a minimum of 1-foot of structural fill compacted to a minimum of 95 percent of Modified Proctor maximum dry density as determined by the Modified Proctor test (ASTM D-1557) or 98 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698). Non-structural slabs should be isolated from foundation members with expansion material. To reduce the possibility of capillary rise of groundwater into the floor slab, and to reduce the potential for concrete curling, a minimum 3-inch layer of ¾-inch crushed stone over 6-mil vapor retarder may be placed atop the compacted structural fill. A conventionally-reinforced or post-tensioned slab supported on stemwalls or grade beams may also be considered for strength and to reduce the potential for movement, curling, and differential settlement.

Exterior Concrete Flatwork

Reinforced concrete exterior slabs should be constructed similarly to floor slabs on compacted structural fill, with the additional caveat they be isolated from the building with expansion material and have a downturned reinforced thickened edge. Conventionally-reinforced or post-tensioned slabs supported on stemwalls or grade beams may also be considered to reduce the potential for movement, curling, and differential settlement.

Lateral Earth Pressures

Foundation and basement walls should be designed to resist lateral pressures. For non-expansive backfill materials, we recommend an equivalent fluid pressure of 40 pcf for design. Expansive soils or bedrock should not be used as backfill against walls. The above lateral pressure applies to level, drained backfill conditions. Equivalent Fluid Pressures for sloping/undrained conditions should be determined on an individual basis.

CONSTRUCTION CONSIDERATIONS

Surface Grading and Drainage

A contributing factor to foundation settlement and floor slab heave in Colorado Front Range soils is the introduction of excess water. Improper site grading and irrigation water are respectively the most common cause and source of excess water. The ground surface should be sloped from the building with a minimum gradient of 10 percent for the first 10 feet. This is equivalent to 12 inches of fall across this 10-foot zone. Where a 10-foot zone cannot be achieved, a well-defined swale should be created a minimum 5 feet from the foundation and parallel with the wall, with a minimum slope of 2 percent to collect the surface water and transport it around and away from the structure. Roof drains should extend across backfill zones and landscaped areas to a region that is graded to direct flow away from the structure(s). Future maintenance operations should include activities to maintain the surface grading and drainage recommendations herein to help prevent water from being directed toward and/or ponding near the foundations.

Landscaping should be selected to reduce irrigation requirements. Plants used close to foundation walls should be limited to those with low moisture requirements and irrigated grass should not be located within 5 feet of the foundation. To help control weed growth, geotextiles should be used below landscaped areas adjacent to foundations. Impervious plastic membranes are not recommended. Irrigation devices should not be placed within 5 feet of the foundation. Irrigation should be limited to the amount sufficient to maintain vegetation. Application of excess water will increase the likelihood of slab and foundation movements.

Perimeter Drain

The site soil is generally anticipated to be well-draining, and groundwater was encountered at depths anticipated to impact the proposed construction. A subsurface perimeter drain is recommended around portions of the structure which will have habitable or storage space located below the finished ground surface. This includes crawlspace areas if applicable. Where slab-on-grade foundation systems are utilized, a subsurface perimeter drain will not be required around the foundation. An underslab drain should be anticipated.

Underslab Drain

Shallow groundwater conditions were encountered in the test borings at the time of field exploration. An underslab drainage layer is also be recommended to help intercept groundwater before it enters the slab area should the groundwater levels rise. Careful attention should be paid to grade and discharge of the drain pipe. A typical drain detail is presented in Figure 8.

It must be understood that the drain is designed to intercept some types of subsurface moisture and not others. Therefore, the drain could operate properly and not mitigate all moisture problems relating to foundation performance or moisture intrusion into the basement area.

Foundation Stabilization

If groundwater conditions encountered at the time of foundation excavation result in either water flow into the excavation or destabilization of the foundation bearing soils, stabilization techniques should be implemented. Various stabilization methods can be employed and can be discussed at the time of construction. However, a method that affords potentially a reduced amount of overexcavation (versus other methods) and provides increased performance under moderately to severely unstable conditions is the use of a layered geogrid and structural fill system.

Additionally, dependent upon the rate of groundwater flow into the excavation, a geosynthetic vertical drain and an overexcavation perimeter drain may be required around the lower portions of the excavation to allow for installation of the layered geogrid and structural fill system.

Concrete

Sulfate testing was performed on selected samples based on ASTM C1580. Test results showed 0.0% by weight, indicating the soils present Class 0 (negligible) sulfate exposure. Based on these results Type I/II cement or an equivalent mixture according to ACI 201.2R-10 is suggested for concrete in contact with the subsurface materials. Cement type shall be designed and approved by a licensed Colorado Professional Engineer and Foundation Designer. Calcium chloride should not be used for the onsite soils. The concrete

should not be placed on frozen ground. If placed during periods of cold temperatures, the concrete should be kept from freezing. This may require covering the concrete with insulated blankets and heating. Concrete work should be completed in accordance with the latest applicable guidelines and standards published by ACI.

Exterior Backfill

Backfill around foundation stemwalls and other buried structures should be placed in loose lifts of not more than 10-inches, moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to 85 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557) or to 92 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698) on exterior sides of walls in landscaped areas. In areas where backfill supports pavement and concrete flatwork, the materials should be compacted to 92 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557) or to 95 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698).

Fill placed on slopes should be benched into the slope. Maximum bench heights should not exceed 4 feet, and bench widths should be wide enough to accommodate compaction equipment.

The appropriate government/utility specifications should be used for fill placed in utility trenches. If material is imported for backfill, the material should be approved by the Geotechnical Engineer prior to hauling it to the site.

The backfill should not be placed on frozen subgrade or allowed to freeze during moisture conditioning and placement. Backfill should be compacted by mechanical means, and foundation walls should be braced during backfilling and compaction.

Structural Fill - General

Areas to receive structural fill should have topsoil, organic material, or debris removed. The upper 6 inches of the exposed surface soils should be scarified and moisture-conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557) or to 98 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698) prior to placing structural fill. Structural fill placed on slopes should be benched into the slope. Maximum bench heights should not exceed 4 feet, and bench widths should be wide enough to accommodate compaction equipment.

Structural fill should be placed in loose lifts of not more than 10-inches, moisture-conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557) or to 98 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698). The materials should be compacted by mechanical means.

Materials used for structural fill should be approved by the RMG prior to use. Structural fill should not be placed on frozen subgrade or allowed to freeze during moisture conditioning and placement.

To verify the condition of the compacted soils, density tests should be performed during placement. The first density tests should be conducted when 24 inches of fill have been placed.

CLOSING

This report has been prepared for the exclusive purpose of providing geotechnical engineering information and recommendations for development described in this report. RMG should be retained to review the final construction documents prior to construction to verify our findings, conclusions and recommendations have been appropriately implemented.

This report has been prepared for the exclusive use by **Vollmer Road Partners, LLLP** for application as an aid in the design and construction of the proposed development in accordance with generally accepted geotechnical engineering practices. The analyses and recommendations in this report are based in part upon data obtained from test borings, site observations and the information presented in referenced reports. The nature and extent of variations may not become evident until construction. If variations then become evident, RMG must be retained to review and revise the recommendations presented in this report as appropriate.

Our professional services were performed using that degree of care and skill ordinarily exercised, under similar circumstances, by geotechnical engineers practicing in this or similar localities. RMG does not warrant the work of regulatory agencies or other third parties supplying information which may have been used during the preparation of this report. No warranty, express or implied is made by the preparation of this report. Third parties reviewing this report should draw their own conclusions regarding site conditions and specific construction techniques to be used on this project.

The scope of services for this project does not include, either specifically or by implication, environmental assessment of the site or identification of contaminated or hazardous materials or conditions. Development of recommendations for the mitigation of environmentally related conditions, including but not limited to biological or toxicological issues, are beyond the scope of this report. If the Client desires investigation into the potential for such contamination or conditions, other studies should be undertaken.

If we can be of further assistance in discussing the contents of this report or analysis of the proposed development, from a geotechnical engineering point-of-view, please feel free to contact us.

FIGURES

NOT TO SCALE

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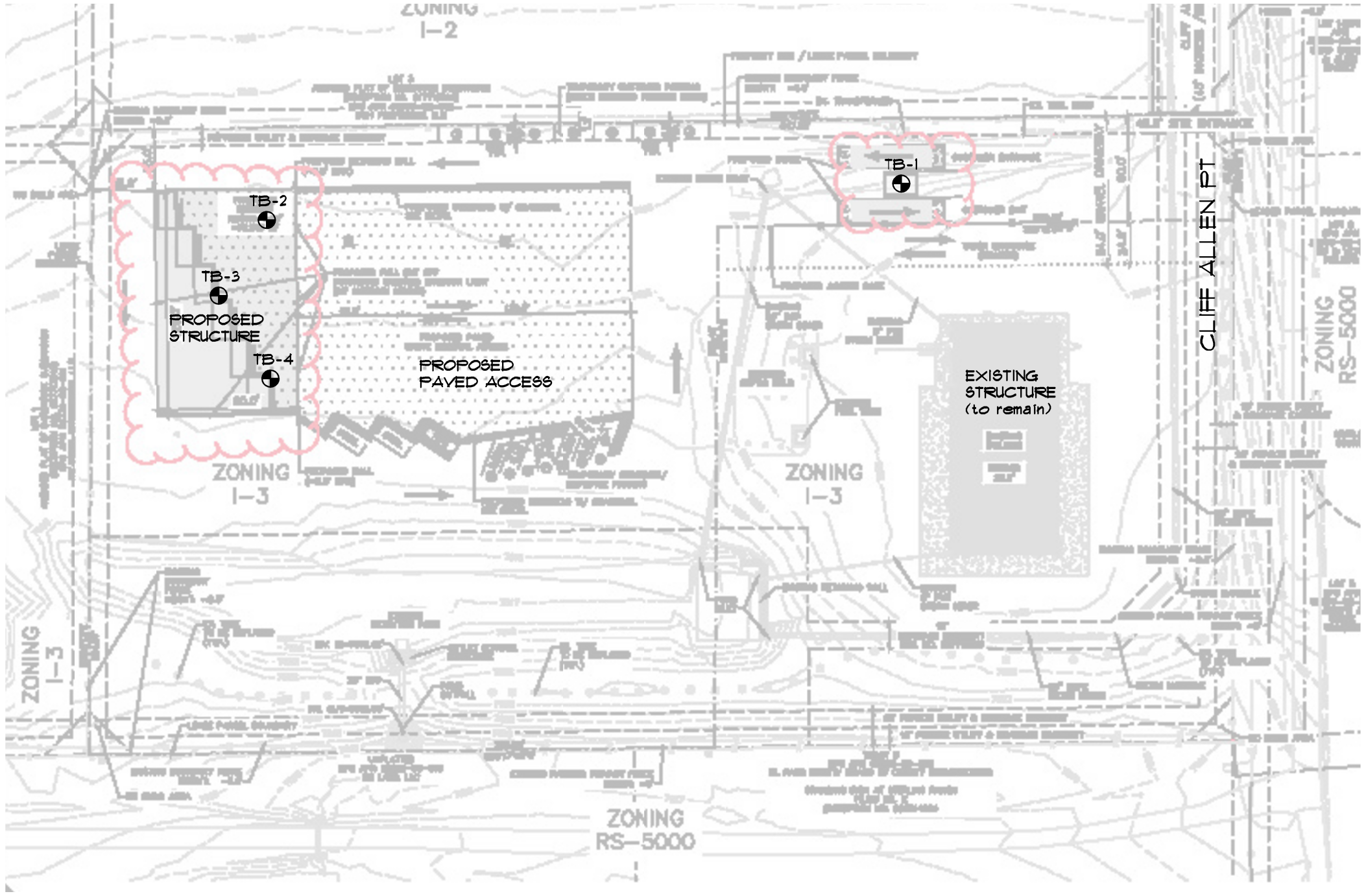
SITE VICINITY MAP

8812 CLIFF ALLEN POINT
LOT 4, AMENDED PLAT BARBARICK SUB
EL PASO COUNTY, CO
VOLLMER ROAD PARTNERS, LLLP

JOB No. 194534

FIG No. 1

DATE 10-23-2023



REFERENCE
NOT TO SCALE

BASE MAP PROVIDED BY KIMLEY HORN

DENOTES APPROXIMATE
LOCATION OF TEST BORINGS

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8812 CLIFF ALLEN POINT
LOT 4, AMENDED PLAT
BARBARIK SUB

EL PASO COUNTY, CO
VOLLMER ROAD PARTNERS, LLLP

ENGINEER:	TM
DRAWN BY:	KZ
CHECKED BY:	TM
ISSUED:	10-23-2023
REVISION:	DATE:
	JOB #:

TEST BORING
LOCATION MAP

SHEET No.
FIG-2

SOILS DESCRIPTION


CLAYSTONE


FILL: SAND, SILTY TO CLAYEY


SANDSTONE


SILTY SAND


SILTY TO CLAYEY SAND

SYMBOLS AND NOTES


XX

STANDARD PENETRATION TEST - MADE BY DRIVING A SPLIT-BARREL INTO THE SOIL/ROCK BY DROPPING A 140 LB. HAMMER 30", ASTM D-1556. NUMBER INDICATES NUMBER OF HAMMER BLOWS PER FOOT (UNLESS OTHERWISE INDICATED).


MEASURED GROUNDWATER LEVEL


BULK

DISTURBED BULK SAMPLE


XX

CALIFORNIA SAMPLE - PENETRATION TESTS MADE BY DRIVING SAMPLER INTO THE SOIL/ROCK BY DROPPING A 140 LB. HAMMER 30", ASTM D-3550. NUMBER INDICATES NUMBER OF HAMMER BLOWS PER FOOT (UNLESS OTHERWISE INDICATED).


DIRECT PUSH SAMPLE.

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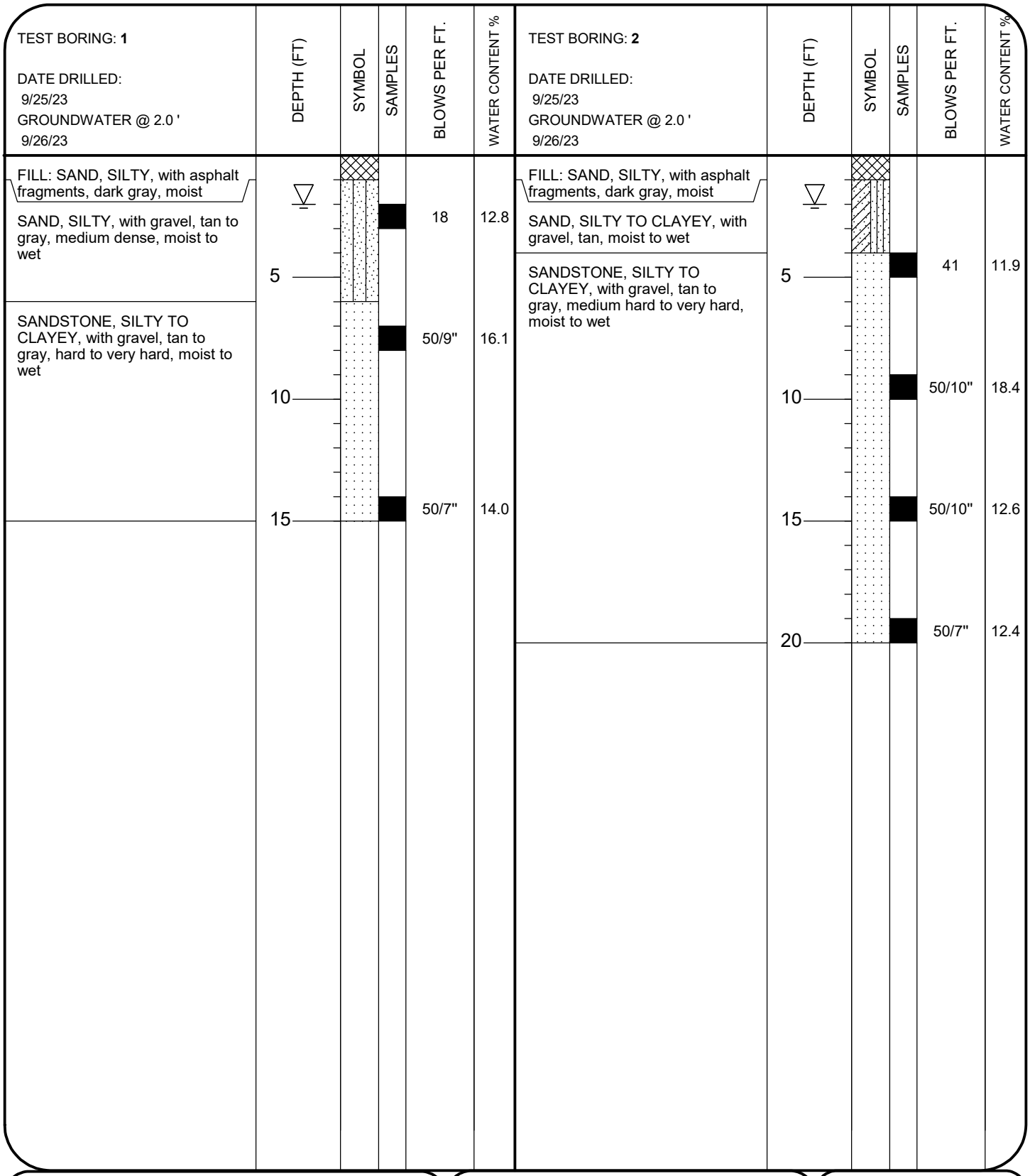
EXPLANATION OF TEST BORING LOGS

JOB No. 194534

FIGURE No. 3

DATE Oct/23/2023



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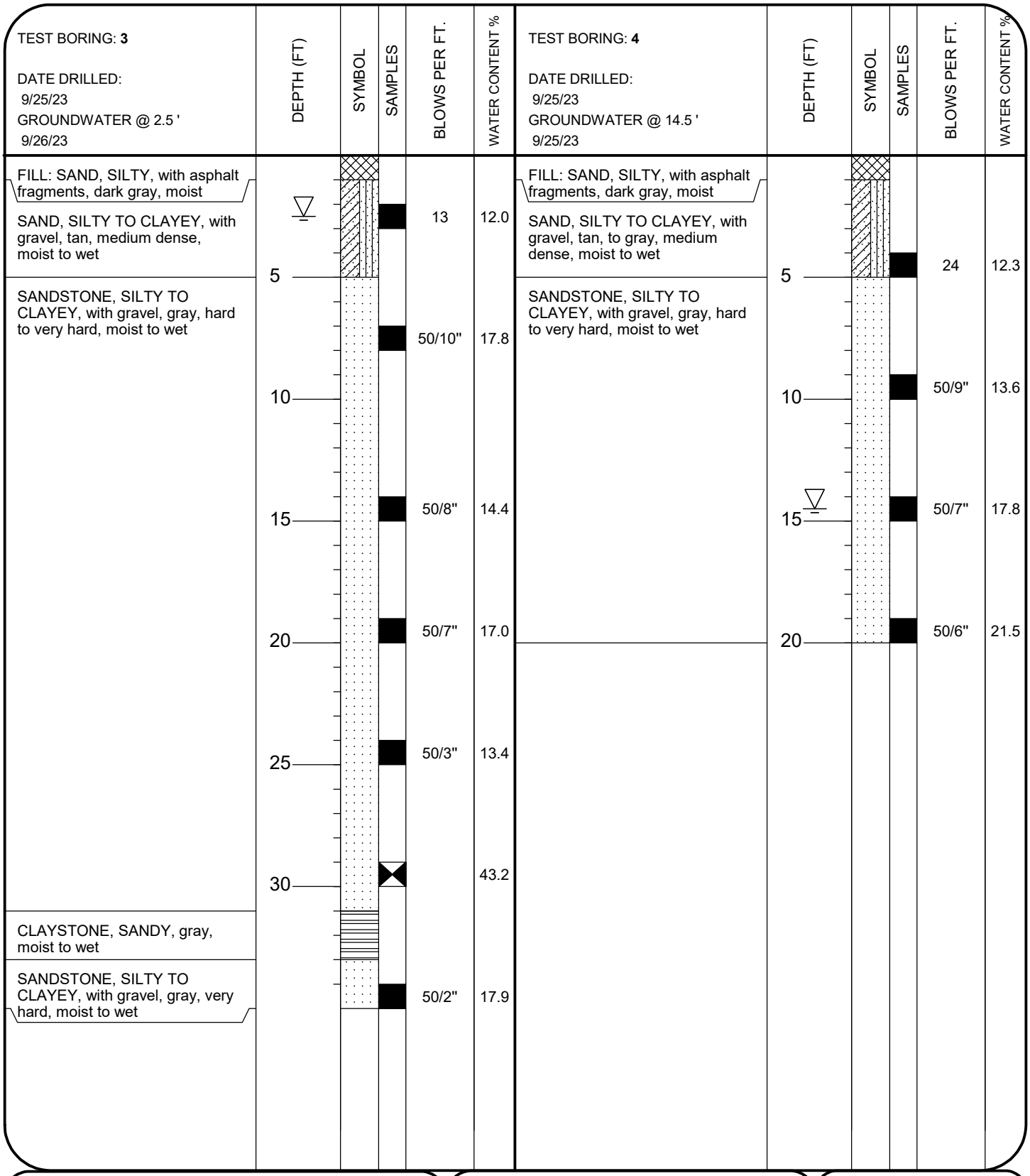
TEST BORING LOG

JOB No. 194534

FIGURE No. 4

DATE Oct/23/2023



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TEST BORING LOG

JOB No. 194534

FIGURE No. 5

DATE Oct/23/2023

Test Boring No.	Depth	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plasticity Index	% Retained No.4 Sieve	% Passing No. 200 Sieve	Load at Saturation (psf)	% Swell/ Collapse	USCS Classification
1	2.0	12.8		39	24	12.3	20.2			SC
1	7.0	16.1								
1	14.0	14.0		36	20					
2	4.0	11.9								
2	9.0	18.4				3.6	11.3			
2	14.0	12.6								
2	19.0	12.4								
3	2.0	12.0								
3	7.0	17.8		42	25	0.3	19.1			SC
3	14.0	14.4								
3	19.0	17.0								
3	24.0	13.4		30	10		27.2			SC
3	29.0	43.2								
3	34.0	17.9								
4	4.0	12.3		40	24	4.0	22.5			SC
4	9.0	13.6								
4	14.0	17.8								
4	19.0	21.5								

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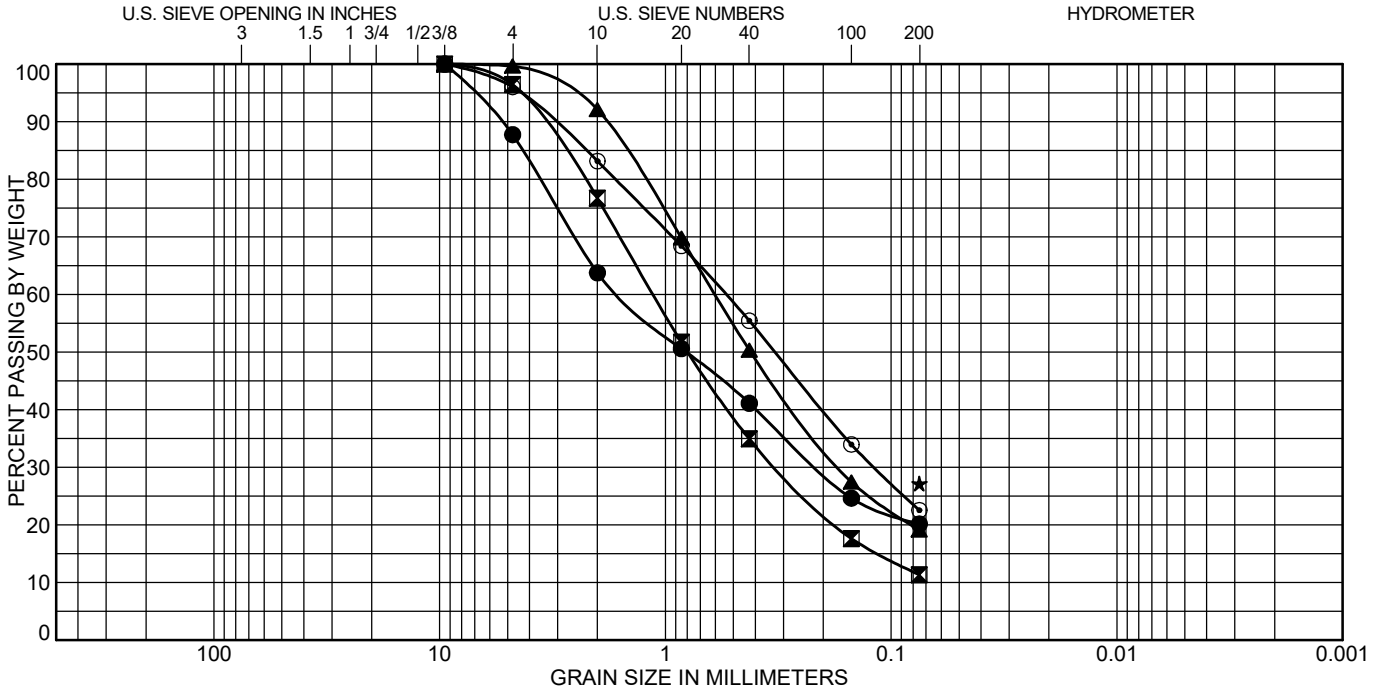
SUMMARY OF LABORATORY TEST RESULTS

JOB No. 194534
FIGURE No. 6
PAGE 1 OF 1
DATE Oct/23/2023



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Test Boring	Depth (ft)	Classification	LL	PL	PI
●	1	2.0	CLAYEY SAND(SC)	39	15	24
⧓	2	9.0				
▲	3	7.0	CLAYEY SAND(SC)	42	17	25
★	3	24.0	CLAYEY SAND(SC)	30	20	10
⊙	4	4.0	CLAYEY SAND(SC)	40	16	24

	Test Boring	Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	1	2.0	12.3	67.6	20.2	
⧓	2	9.0	3.6	85.1	11.3	
▲	3	7.0	0.3	80.5	19.1	
★	3	24.0			27.2	
⊙	4	4.0	4.0	73.5	22.5	

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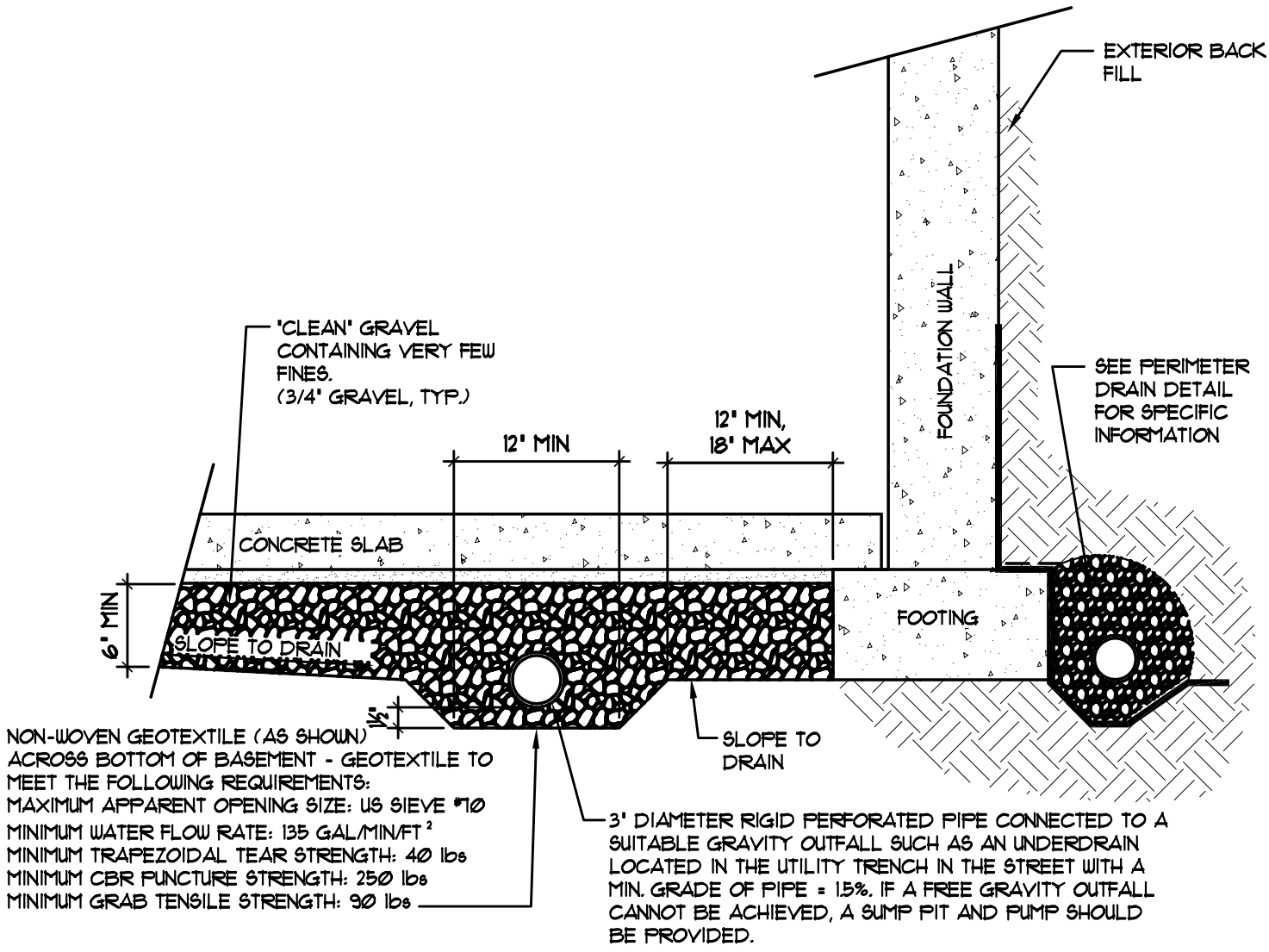
SOIL CLASSIFICATION DATA

JOB No. 194534

FIGURE No. 7

DATE Oct/23/2023



GENERAL NOTES:

1. ALL DRAIN PIPE SHALL BE PERFORATED PLASTIC, WITH THE EXCEPTION OF THE DISCHARGE PORTION WHICH SHALL BE SOLID, NON-PERFORATED PIPE.
2. DRAIN PIPE SHALL HAVE POSITIVE FALL THROUGHOUT.
3. DRAIN PIPE SHALL BE PROVIDED WITH A FREE GRAVITY OUTFALL, IF POSSIBLE. IF A GRAVITY OUTFALL CANNOT BE ACHIEVED, THEN A SUMP PIT AND PUMP SHALL BE USED. THE OUTFALL SHOULD EXTEND PAST BACKFILL ZONES AND DISCHARGE TO A LOCATION THAT IS GRADED TO DIRECT WATER OFF-SITE.
4. ALL DRAIN COMPONENTS SHALL BE RATED/APPROVED BY THE MANUFACTURER FOR THE INSTALLED DEPTH AND APPLICATION
5. DRAIN SYSTEM, INCLUDING THE OUTFALL OF THE DRAIN, SHALL BE OBSERVED BY QUALIFIED PERSONNEL PRIOR TO BACKFILLING TO VERIFY INSTALLATION.

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UNDERSLAB DRAIN

FIG No. 8

APPENDIX D: FEMA FIRM MAP

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.

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/.

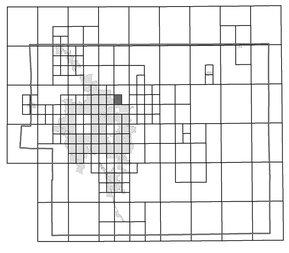
If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

El Paso County Vertical Datum Offset Table

Flooding Source	Vertical Datum Offset (ft)

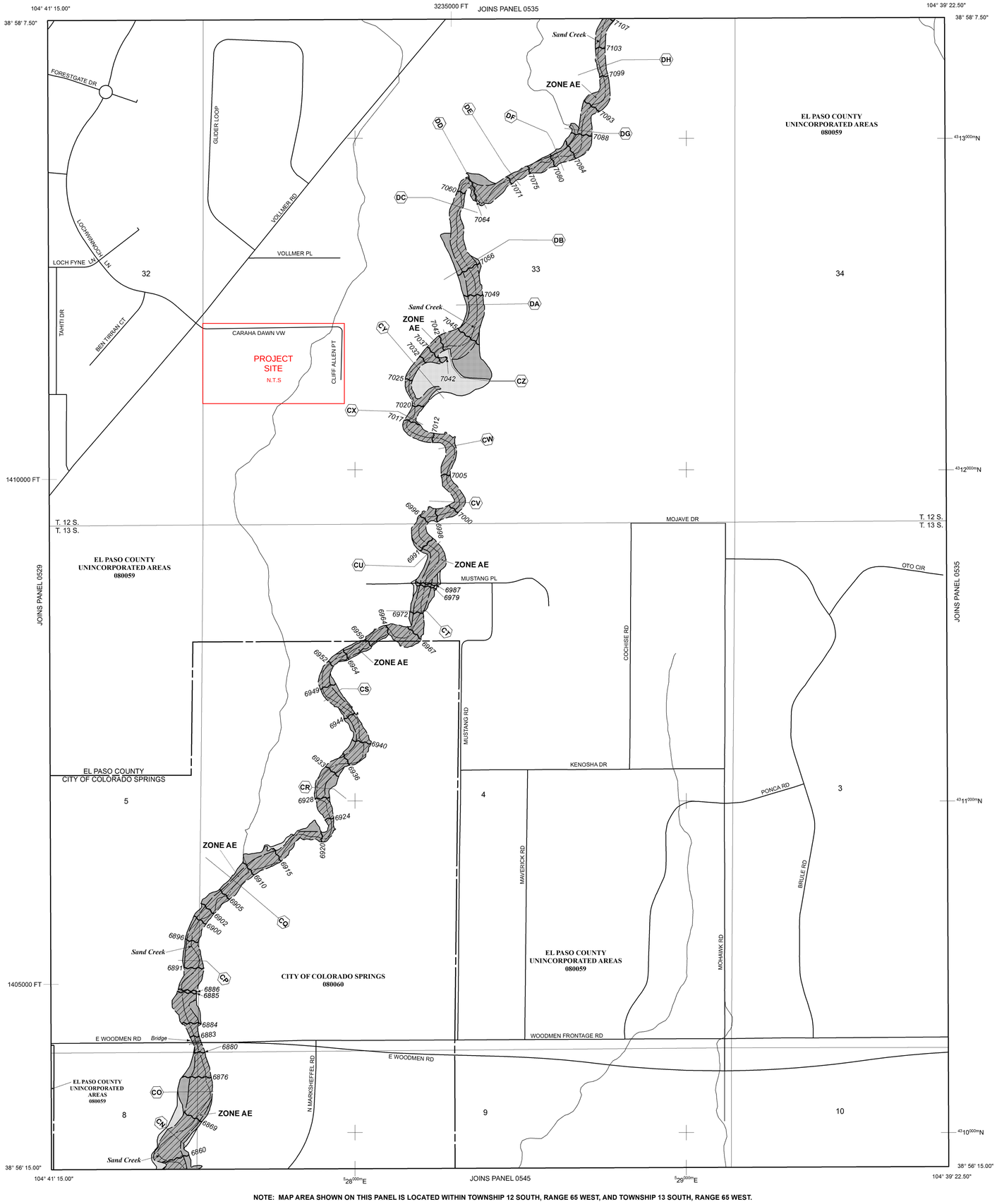
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION

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.



NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 12 SOUTH, RANGE 65 WEST, AND TOWNSHIP 13 SOUTH, RANGE 65 WEST.

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 0533G

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 533 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0533	G
EL PASO COUNTY	080059	0533	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 08041C0533G

MAP REVISED DECEMBER 7, 2018

Federal Emergency Management Agency

APPENDIX E: HYDROLOGIC ANALYSIS

Weighted Imperviousness Calculations - Existing Conditions

	AREA	AREA	GRAVEL	GRAVEL	GRAVEL				LANDSCAPE	LANDSCAPE	LANDSCAPE				PAVEMENT	TOTAL	PAVEMENT				ROOF	TOTAL	ROOF				WEIGHTED	WEIGHTED COEFFICIENTS			
SUB-BASIN	(SF)	(Acres)	AREA	IMP.	C2	C5	C10	C100	AREA	IMP	C2	C5	C10	C100	AREA	IMP	C2	C5	C10	C100	AREA	IMP	C2	C5	C10	C100	IMP	C2	C5	C10	C100
E1	16,873	**0.39**	11,670	80%	0.68	0.7	0.71	0.77	5,204	0%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	0	90%	0.71	0.73	0.75	0.81	55.3%	0.48	0.51	0.54	0.64
E2	112,891	**2.59**	87,610	80%	0.68	0.7	0.71	0.77	25,281	0%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	0	90%	0.71	0.73	0.75	0.81	62.1%	0.53	0.56	0.58	0.68
OE1	101,771	**2.34**	98,528	80%	0.68	0.7	0.71	0.77	3,243	0%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	0	90%	0.71	0.73	0.75	0.81	77.5%	0.66	0.68	0.69	0.76
OE2	108,087	**2.48**	108,087	80%	0.68	0.7	0.71	0.77	0	0%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	0	90%	0.71	0.73	0.75	0.81	80.0%	0.68	0.70	0.71	0.77
OE3	49,856	**1.14**	49,856	80%	0.68	0.7	0.71	0.77	0	0%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	0	90%	0.71	0.73	0.75	0.81	80.0%	0.68	0.70	0.71	0.77
OE4	35,615	**0.82**	35,615	80%	0.68	0.7	0.71	0.77	0	0%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	0	90%	0.71	0.73	0.75	0.81	80.0%	0.68	0.70	0.71	0.77
OE5	42,290	**0.97**	31,640	80%	0.68	0.7	0.71	0.77	3,715	0%	0.02	0.08	0.15	0.35	2,959	100%	0.89	0.90	0.92	0.96	3,977	90%	0.71	0.73	0.75	0.81	75.3%	0.64	0.66	0.68	0.75
TOTAL	**467,384**	**10.73**	**423,005**	**80%**	**0.68**	**0.70**	**0.71**	**0.77**	**37,443**	**0%**	**0.02**	**0.08**	**0.15**	**0.35**	**2,959**	**100%**	**0.89**	**0.90**	**0.92**	**0.96**	**3,977**	**90%**	**0.71**	**0.73**	**0.75**	**0.81**	**73.8%**	**0.63**	**0.65**	**0.67**	**0.74**

FYI: The gravel coefficients shown are higher than the coefficients listed in Table 6-6 Runoff Coefficients for Rational Method in the DCM Vol. 1. Please note where provided coefficients are being obtained/calculated or revise to match DCM.

Barbarick Transfer Station

Time of Concentration - Existing Conditions

Watercourse Coefficient

Forest & Meadow	2.50	Short Grass Pasture & Lawns	7.00	Grassed Waterway	15.00
Fallow or Cultivation	5.00	Nearly Bare Ground	10.00	Paved Area & Shallow Gutter	20.00

	SUB-BASIN DATA				INITIAL / OVERLAND* TIME			TRAVEL TIME T(t)					T(c) CHECK (URBANIZED BASINS)			FINAL T©*
DESIGN POINT	DRAIN BASIN	AREA sq. ft.	AREA ac.	C(5)	Length ft.	Slope %	T(i) min	Length ft.	Slope %	Coeff.	Velocity fps	T(t) min.	COMP. T(c)	TOTAL LENGTH	L/180+10	min.
E1	E1	16,873	0.39	0.51	60	4.0%	5.3	160	1.8%	10.00	1.3	2.0	7.3	220	11.2	7.3
E2	E2	112,891	2.59	0.56	280	3.2%	11.2	0	0.0%	10.00	0.0	0.0	11.2	280	11.6	11.2
OE1	OE1	101,771	2.34	0.68	300	2.0%	10.6	0	0.0%	10.00	0.0	0.0	10.6	300	11.7	10.6
OE2	OE2	108,087	2.48	0.70	300	2.5%	9.4	0	0.0%	10.00	0.0	0.0	9.4	300	11.7	9.4
OE3	OE3	49,856	1.14	0.70	300	3.5%	8.4	0	0.0%	10.00	0.0	0.0	8.4	300	11.7	8.4
OE4	OE4	35,615	0.82	0.70	300	3.0%	8.8	35	13.0%	10.00	3.6	0.2	9.0	335	11.9	9.0
OE5	OE5	42,290	0.97	0.66	163	3.8%	6.6	30	25.0%	10.00	5.0	0.1	6.7	193	11.1	6.7
TOTAL	TOTAL	467,384	10.73													

*Note: El Paso County Drainage Manual Chapter 6 indicates that the maximum overland flow length is 100ft for urbanized areas and 300ft for rural areas. The minimum time of concentration is 5 min for developed conditions, 10 min for undeveloped conditions.

Per aerial imagery and parcel location. The site is in an urbanized area. Please revise initial/overland time length to meet max 100ft criteria.

Barbarick Transfer Station
Time of Concentration - Existing Conditions *Design Storm* *5 Year Strom Event*
(Rational Method Procedure)

BASIN INFORMATION				DIRECT RUNOFF				CUMMULATIVE RUNOFF				NOTES
DESIGN POINT	DRAIN BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	C x A	I in/hr	Q cfs	
E1	E1	0.39	0.51	7.3	0.20	4.61	0.91					
E2	E2	2.59	0.56	11.2	1.45	3.96	5.75					
OE1	OE1	2.34	0.68	10.6	1.59	4.04	6.43					
OE2	OE2	2.48	0.70	9.4	1.74	4.23	7.34					
OE3	OE3	1.14	0.70	8.4	0.80	4.40	3.52					
OE4	OE4	0.82	0.70	9.0	0.57	4.29	2.46					
OE5	OE5	0.97	0.66	6.7	0.64	4.74	3.05					
TOTAL	TOTAL	10.73	0.65				29.46					

Barbarick Transfer Station
Time of Concentration - Existing Conditions *Design Storm* *100 Year Storm Event*
(Rational Method Procedure)

BASIN INFORMATION				DIRECT RUNOFF				CUMMULATIVE RUNOFF				NOTES
DESIGN POINT	DRAIN BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	C x A	I in/hr	Q cfs	
E1	E1	0.39	0.64	7.3	0.25	7.73	1.92					
E2	E2	2.59	0.68	11.2	1.75	6.64	11.64					
OE1	OE1	2.34	0.76	10.6	1.77	6.79	12.00					
OE2	OE2	2.48	0.77	9.4	1.91	7.10	13.56					
OE3	OE3	1.14	0.77	8.4	0.88	7.38	6.51					
OE4	OE4	0.82	0.77	9.0	0.63	7.21	4.54					
OE5	OE5	0.97	0.75	6.7	0.73	7.95	5.79					
TOTAL	TOTAL	10.73	0.74				55.96					

Please revise to clarify this is existing conditions runoff table.

SUMMARY - PROPOSED RUNOFF TABLE					
DESIGN POINT	BASIN DESIGNATION	BASIN AREA (ACRES)	BASIN IMPERVIOUSNESS (%)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)
E1	E1	0.39	55.3%	0.91	1.92
E2	E2	2.59	62.1%	5.75	11.64
OE1	OE1	2.34	77.5%	6.43	12.00
OE2	OE2	2.48	80.0%	7.34	13.56
OE3	OE3	1.14	80.0%	3.52	6.51
OE4	OE4	0.82	80.0%	2.46	4.54
OE5	OE5	0.97	75.3%	3.05	5.79
TOTAL		10.73	73.8%	29.46	55.96

Note that crushed asphalt has been installed across most or all of these basins. The County considers crushed asphalt to be 100% impervious. Please revise these values accordingly. And then adjust the report discussion above with the subsequent new Total runoff values.

Weighted Imperviousness Calculations - Proposed Conditions

	AREA	AREA	GRAVEL	GRAVEL	GRAVEL				LANDSCAPE	LANDSCAPE	LANDSCAPE				PAVEMENT	TOTAL	PAVEMENT				ROOF	TOTAL	ROOF				WEIGHTED	WEIGHTED COEFFICIENTS			
SUB-BASIN	(SF)	(Acres)	AREA	IMP.	C2	C5	C10	C100	AREA	IMP	C2	C5	C10	C100	AREA	IMP	C2	C5	C10	C100	AREA	IMP	C2	C5	C10	C100	IMP	C2	C5	C10	C100
P1	13,663	**0.31**	12,504	80%	0.68	0.7	0.71	0.77	0	0%	0.02	0.08	0.15	0.35	1,159	100%	0.89	0.90	0.92	0.96	0	90%	0.71	0.73	0.75	0.81	81.7%	0.70	0.72	0.73	0.79
P2	6,602	**0.15**	5,123	80%	0.68	0.7	0.71	0.77	509	0%	0.02	0.08	0.15	0.35	720	100%	0.89	0.90	0.92	0.96	250	90%	0.71	0.73	0.75	0.81	76.4%	0.65	0.68	0.69	0.76
P3	4,792	**0.11**	4,258	80%	0.68	0.7	0.71	0.77	0	0%	0.02	0.08	0.15	0.35	534	100%	0.89	0.90	0.92	0.96	0	90%	0.71	0.73	0.75	0.81	82.2%	0.70	0.72	0.73	0.79
P4	4,781	**0.11**	4,235	80%	0.68	0.7	0.71	0.77	0	0%	0.02	0.08	0.15	0.35	547	100%	0.89	0.90	0.92	0.96	0	90%	0.71	0.73	0.75	0.81	82.3%	0.70	0.72	0.73	0.79
P5	5,806	**0.13**	5,237	80%	0.68	0.7	0.71	0.77	0	0%	0.02	0.08	0.15	0.35	569	100%	0.89	0.90	0.92	0.96	0	90%	0.71	0.73	0.75	0.81	82.0%	0.70	0.72	0.73	0.79
P6	88,931	**2.04**	28,161	80%	0.68	0.7	0.71	0.77	30,941	0%	0.02	0.08	0.15	0.35	29,829	100%	0.89	0.90	0.92	0.96	0	90%	0.71	0.73	0.75	0.81	58.9%	0.52	0.55	0.59	0.69
R1	5,882	**0.14**	0	80%	0.68	0.7	0.71	0.77	0	0%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	5,882	90%	0.71	0.73	0.75	0.81	90.0%	0.71	0.73	0.75	0.81
R2	5,882	**0.14**	0	80%	0.68	0.7	0.71	0.77	0	0%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	5,882	90%	0.71	0.73	0.75	0.81	90.0%	0.71	0.73	0.75	0.81
O1	65,975	**1.51**	62,732	80%	0.68	0.7	0.71	0.77	3,243	0%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	0	90%	0.71	0.73	0.75	0.81	76.1%	0.65	0.67	0.68	0.75
O2	32,389	**0.74**	32,389	80%	0.68	0.7	0.71	0.77	0	0%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	0	90%	0.71	0.73	0.75	0.81	80.0%	0.68	0.70	0.71	0.77
O3	19,087	**0.44**	19,087	80%	0.68	0.7	0.71	0.77	0	0%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	0	90%	0.71	0.73	0.75	0.81	80.0%	0.68	0.70	0.71	0.77
O4	45,546	**1.05**	45,546	80%	0.68	0.7	0.71	0.77	0	0%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	0	90%	0.71	0.73	0.75	0.81	80.0%	0.68	0.70	0.71	0.77
O5	46,861	**1.08**	46,861	80%	0.68	0.7	0.71	0.77	0	0%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	0	90%	0.71	0.73	0.75	0.81	80.0%	0.68	0.70	0.71	0.77
O6	49,856	**1.14**	49,856	80%	0.68	0.7	0.71	0.77	0	0%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	0	90%	0.71	0.73	0.75	0.81	80.0%	0.68	0.70	0.71	0.77
O7	35,615	**0.82**	35,615	80%	0.68	0.7	0.71	0.77	0	0%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	0	90%	0.71	0.73	0.75	0.81	80.0%	0.68	0.70	0.71	0.77
O8	35,714	**0.82**	20,976	80%	0.68	0.7	0.71	0.77	3,715	0%	0.02	0.08	0.15	0.35	6,935	100%	0.89	0.90	0.92	0.96	4,088	90%	0.71	0.73	0.75	0.81	76.7%	0.66	0.68	0.70	0.77
TOTAL	**467,384**	**10.73**	**372,580**	**80%**	**0.68**	**0.70**	**0.71**	**0.77**	**38,408**	**0%**	**0.02**	**0.08**	**0.15**	**0.35**	**40,293**	**100%**	**0.89**	**0.90**	**0.92**	**0.96**	**16,102**	**90%**	**0.71**	**0.73**	**0.75**	**0.81**	**75.5%**	**0.64**	**0.67**	**0.68**	**0.75**

FYI: The gravel coefficients shown are higher than the coefficients listed in Table 6-6 Runoff Coefficients for Rational Method in the DCM Vol. 1. Please note where provided coefficients are being obtained/calculated or revise to match DCM.

Barbarick Transfer Station

Time of Concentration - Proposed Conditions

Watercourse Coefficient

Forest & Meadow	2.50	Short Grass Pasture & Lawns	7.00	Grassed Waterway	15.00
Fallow or Cultivation	5.00	Nearly Bare Ground	10.00	Paved Area & Shallow Gutter	20.00

	SUB-BASIN DATA				INITIAL / OVERLAND* TIME			TRAVEL TIME T(t)					T(c) CHECK (URBANIZED BASINS)			FINAL T©*
DESIGN POINT	DRAIN BASIN	AREA sq. ft.	AREA ac.	C(5)	Length ft.	Slope %	T(i) min	Length ft.	Slope %	Coeff.	Velocity fps	T(t) min.	COMP. T(c)	TOTAL LENGTH	L/180+10	min.
P1	P1	13,663	0.31	0.72	52	2.0%	4.0	30	2.5%	10.00	1.6	0.3	5.0	82	10.5	5.0
P2	P2	6,602	0.15	0.68	72	2.6%	4.8	42	3.5%	15.00	2.8	0.2	5.1	114	10.6	5.1
P3	P3	4,792	0.11	0.72	31	2.8%	2.7	25	1.6%	20.00	2.5	0.2	5.0	56	10.3	5.0
P4	P4	4,781	0.11	0.72	40	1.6%	3.7	26	1.2%	20.00	2.2	0.2	5.0	66	10.4	5.0
P5	P5	5,806	0.13	0.72	33	4.4%	2.4	136	1.9%	20.00	2.8	0.8	5.0	169	10.9	5.0
P6	P6	88,931	2.04	0.55	225	2.6%	11.0	438	1.0%	20.00	2.0	3.7	14.6	663	13.7	13.7
R1	R1	5,882	0.14	0.73	105	0.5%	8.8	0	0.0%	20.00	0.0	0.0	8.8	105	10.6	8.8
R2	R2	5,882	0.14	0.73	105	0.5%	8.8	0	0.0%	20.00	0.0	0.0	8.8	105	10.6	8.8
O1	O1	65,975	1.51	0.67	300	2.0%	10.9	0	0.0%	10.00	0.0	0.0	10.9	300	11.7	10.9
O2	O2	32,389	0.74	0.70	300	2.5%	9.4	0	0.0%	10.00	0.0	0.0	9.4	300	11.7	9.4
O3	O3	19,087	0.44	0.70	300	2.5%	9.4	0	0.0%	10.00	0.0	0.0	9.4	300	11.7	9.4
O4	O4	45,546	1.05	0.70	300	3.0%	8.8	0	0.0%	10.00	0.0	0.0	8.8	300	11.7	8.8
O5	O5	46,861	1.08	0.70	300	3.0%	8.8	0	0.0%	10.00	0.0	0.0	8.8	300	11.7	8.8
O6	O6	49,856	1.14	0.70	300	3.5%	8.4	0	0.0%	10.00	0.0	0.0	8.4	300	11.7	8.4
O7	O7	35,615	0.82	0.70	300	3.0%	8.8	35	13.0%	10.00	3.6	0.2	9.0	335	11.9	9.0
O8	O8	35,714	0.82	0.68	163	3.8%	6.3	30	25.0%	10.00	5.0	0.1	6.4	193	11.1	6.4
TOTAL	TOTAL	467,384	10.73													

*Note: El Paso County Drainage Manual Chapter 6 indicates that the maximum overland flow length is 100ft for urbanized areas and 300ft for rural areas. The minimum time of concentration is 5 min for developed conditions, 10 min for undeveloped conditions.

Final time of concentration values do not meet minimum values for rural areas. Per comment in existing conditions runoff table the area is considered more of an urban area.

Barbarick Transfer Station

Time of Concentration - Proposed Conditions *Design Storm* *5 Year Strom Event*

(Rational Method Procedure)

BASIN INFORMATION				DIRECT RUNOFF				CUMMULATIVE RUNOFF				NOTES
DESIGN POINT	DRAIN BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	C x A	I in/hr	Q cfs	
P1	P1	0.31	0.72	5.0	0.22	5.17	1.16	15.9	1.0	3.44	3.49	O1 is tributary to P1
P2	P2	0.15	0.68	5.1	0.10	5.15	0.53					
P3	P3	0.11	0.72	5.0	0.08	5.17	0.41	8.8	0.8	4.32	3.50	O4 is tributary to P3
P4	P4	0.11	0.72	5.0	0.08	5.17	0.41	8.8	0.8	4.32	3.60	O5 is tributary to P4
P5	P5	0.13	0.72	5.0	0.10	5.17	0.50	8.4	0.9	4.40	3.94	O6 is tributary to P5
P6	P6	2.04	0.55	13.7	1.13	3.66	4.12					
R1	R1	0.14	0.73	8.8	0.10	4.33	0.43					
R2	R2	0.14	0.73	8.8	0.10	4.33	0.43					
O1	O1	1.51	0.67	10.9	1.01	4.01	4.06					
O2	O2	0.74	0.70	9.4	0.52	4.23	2.20					
O3	O3	0.44	0.70	9.4	0.31	4.23	1.30					
O4	O4	1.05	0.70	8.8	0.73	4.32	3.16					
O5	O5	1.08	0.70	8.8	0.75	4.32	3.25					
O6	O6	1.14	0.70	8.4	0.80	4.40	3.52					
O7	O7	0.82	0.70	9.0	0.57	4.29	2.46					
O8	O8	0.82	0.68	6.4	0.56	4.79	2.66					
TOTAL	TOTAL	10.73	0.67				30.59					

Barbarick Transfer Station
Time of Concentration - Proposed Conditions *Design Storm* *100 Year Storm Event*
(Rational Method Procedure)

BASIN INFORMATION				DIRECT RUNOFF				CUMMULATIVE RUNOFF				NOTES
DESIGN POINT	DRAIN BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	C x A	I in/hr	Q cfs	
P1	P1	0.31	0.79	5.0	0.25	8.68	2.14	10.9	1.1	6.73	7.63	O1 is tributary to P1
P2	P2	0.15	0.76	5.1	0.12	8.65	1.00					
P3	P3	0.11	0.79	5.0	0.09	8.68	0.76	8.8	0.9	7.25	6.47	O4 is tributary to P3
P4	P4	0.11	0.79	5.0	0.09	8.68	0.75	8.8	0.9	7.25	6.64	O5 is tributary to P4
P5	P5	0.13	0.79	5.0	0.11	8.68	0.91	8.4	0.9	7.38	6.51	O6 is tributary to P5
P6	P6	2.04	0.69	13.7	1.40	6.14	8.62					
R1	R1	0.14	0.81	8.8	0.11	7.27	0.79					
R2	R2	0.14	0.81	8.8	0.11	7.27	0.79					
O1	O1	1.51	0.75	10.9	1.13	6.73	7.63					
O2	O2	0.74	0.77	9.4	0.57	7.10	4.06					
O3	O3	0.44	0.77	9.4	0.34	7.10	2.40					
O4	O4	1.05	0.77	8.8	0.81	7.25	5.84					
O5	O5	1.08	0.77	8.8	0.83	7.25	6.01					
O6	O6	1.14	0.77	8.4	0.88	7.38	6.51					
O7	O7	0.82	0.77	9.0	0.63	7.21	4.54					
O8	O8	0.82	0.77	6.4	0.63	8.04	5.06					
TOTAL	TOTAL	10.73	0.75				57.81					

SUMMARY - PROPOSED RUNOFF TABLE					
DESIGN POINT	BASIN DESIGNATION	BASIN AREA (ACRES)	BASIN IMPERVIOUSNESS (%)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)
P1	P1	0.31	81.7%	1.16	2.14
P2	P2	0.15	76.4%	0.53	1.00
P3	P3	0.11	82.2%	0.41	0.76
P4	P4	0.11	82.3%	0.41	0.75
P5	P5	0.13	82.0%	0.50	0.91
P6	P6	2.04	58.9%	4.12	8.62
R1	R1	0.14	90.0%	0.43	0.79
R2	R2	0.14	90.0%	0.43	0.79
O1	O1	1.51	76.1%	4.06	7.63
O2	O2	0.74	80.0%	2.20	4.06
O3	O3	0.44	80.0%	1.30	2.40
O4	O4	1.05	80.0%	3.16	5.84
O5	O5	1.08	80.0%	3.25	6.01
O6	O6	1.14	80.0%	3.52	6.51
O7	O7	0.82	80.0%	2.46	4.54
O8	O8	0.82	76.7%	2.66	5.06
TOTAL		10.73	75.5%	30.59	57.81

Note that crushed asphalt has been installed across most or all of these basins. The County considers crushed asphalt to be 100% impervious. Please revise these values accordingly. And then adjust the report discussion above with the subsequent new Total runoff values.

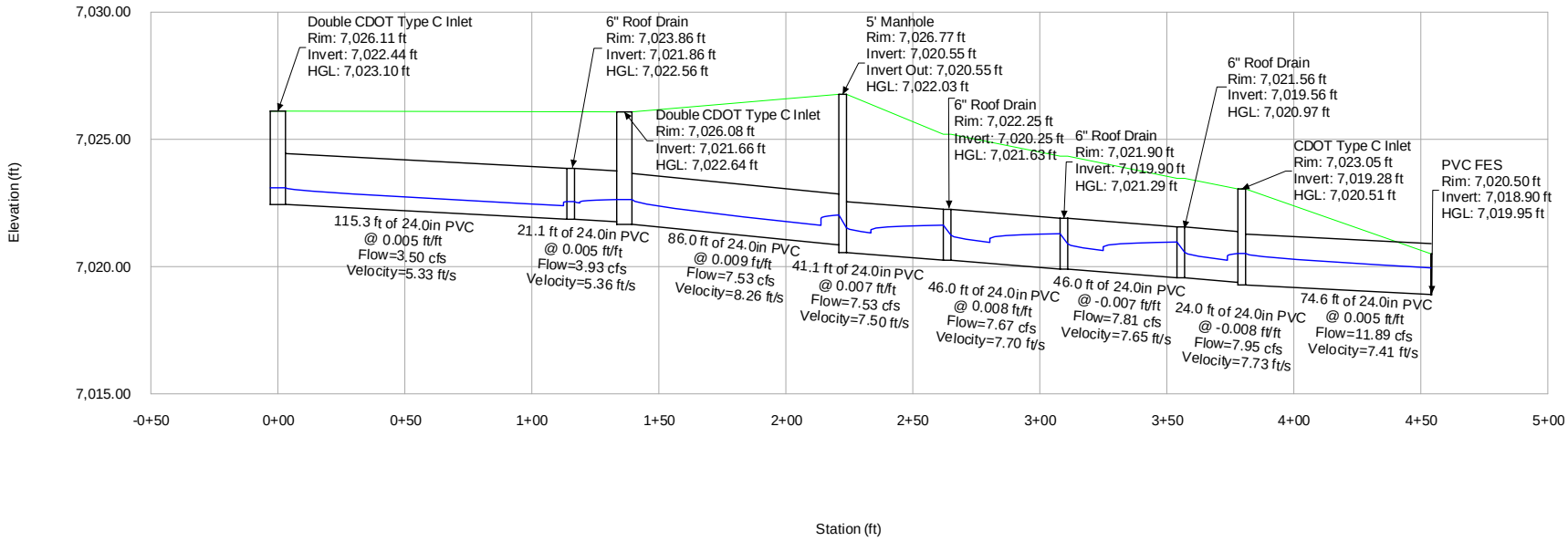
APPENDIX F: HYDRAULIC ANALYSIS

Please provide stormcad layout to help identify the location of the storm sewers.

5-Year Event

Profile Report

Engineering Profile - Barbarick WTS - Storm Sewer Profile (Barbarick WTS.stsw)

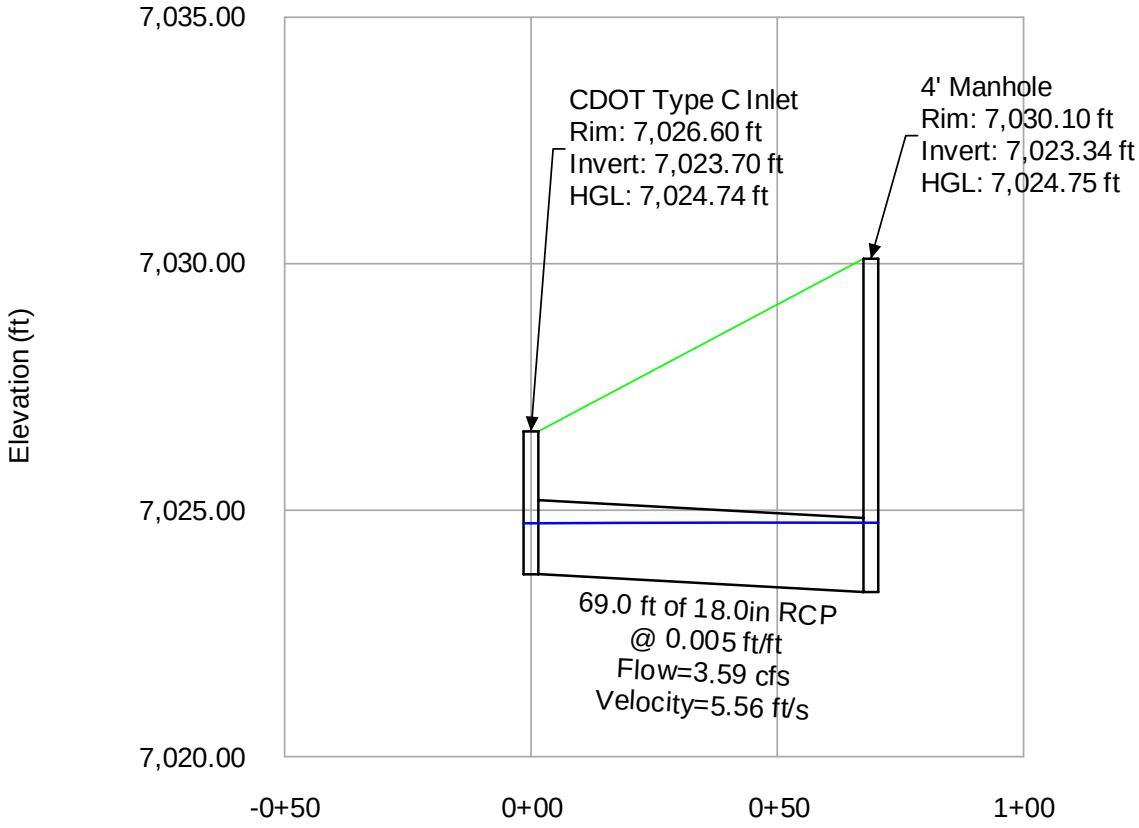


Please provide a legend for the linetypes shown.

5-Year Event

Profile Report

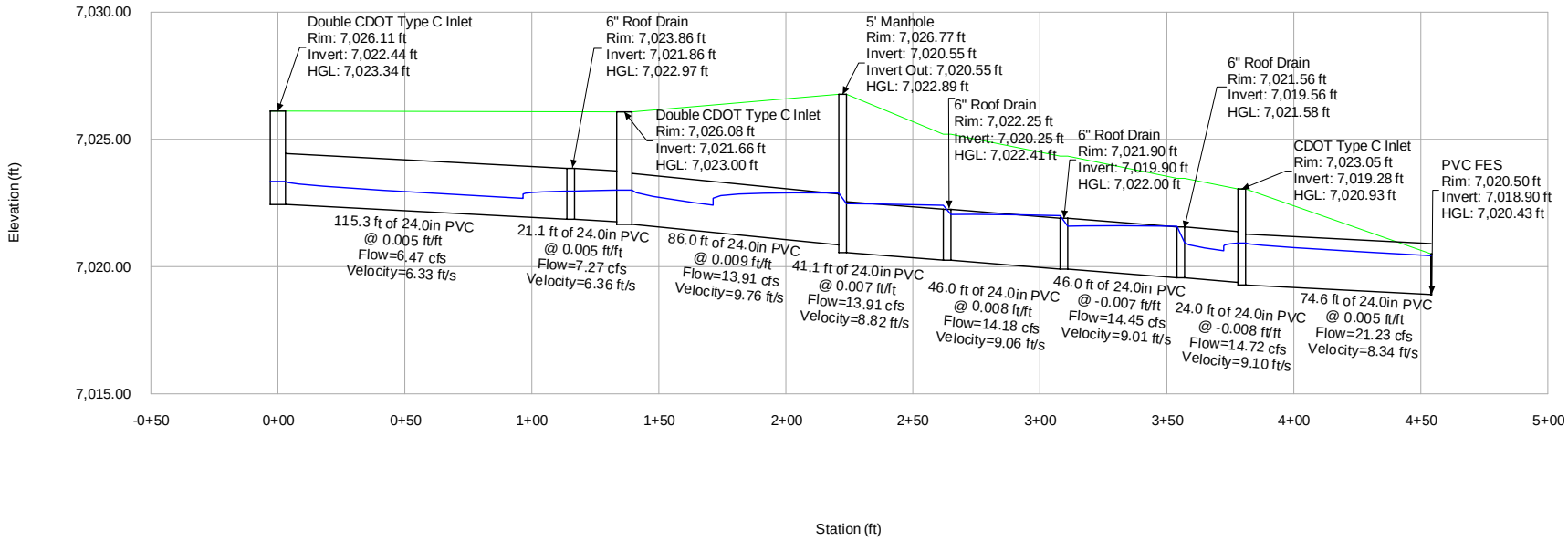
Engineering Profile - Barbarick WTS - Entrance Storm Sewer Profile (Barbarick WTS.stsw)



100-Year Event

Profile Report

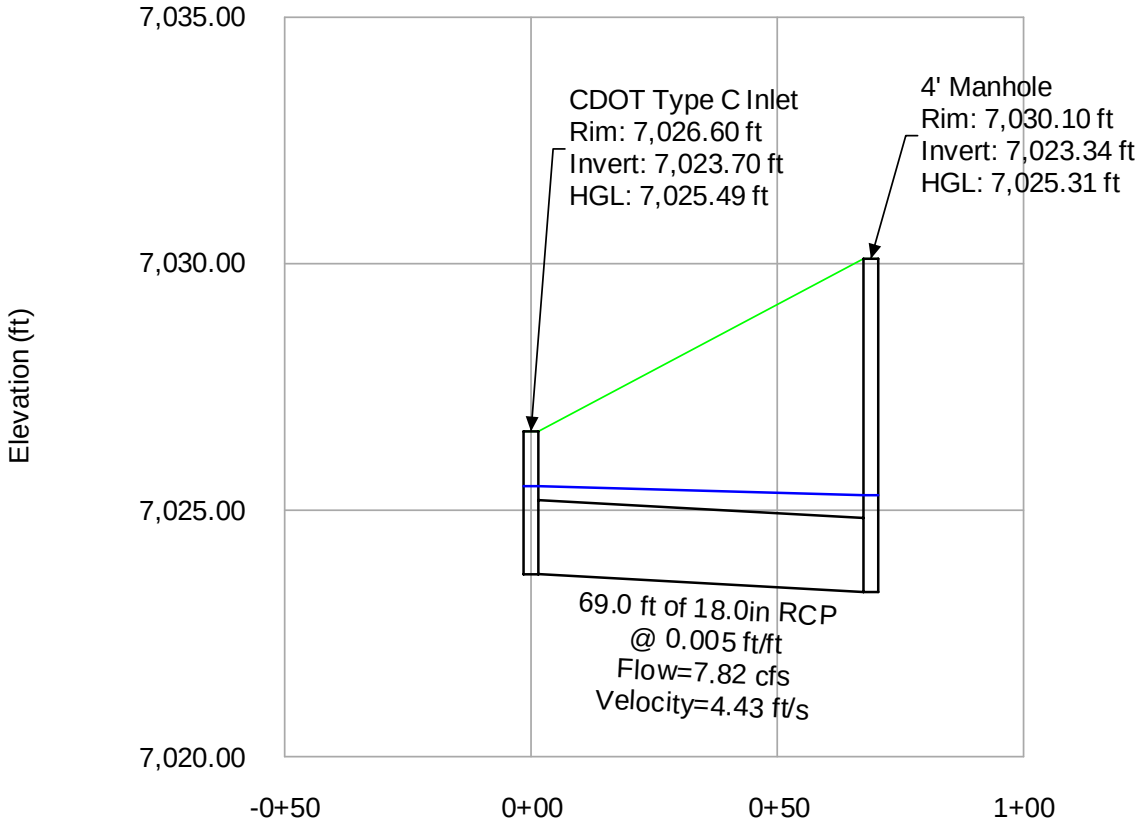
Engineering Profile - Barbarick WTS - Storm Sewer Profile (Barbarick WTS.stsw)



100-Year Event

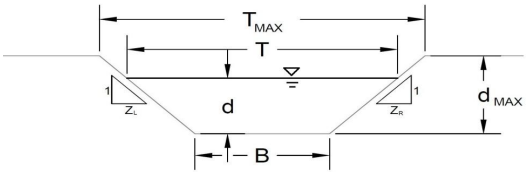
Profile Report

Engineering Profile - Barbarick WTS - Entrance Storm Sewer Profile (Barbarick WTS.stsw)



AREA INLET IN A SWALE

Inlet P3



This worksheet uses the NRCS vegetal retardance method to determine Manning's n for grass-lined channels.

An override Manning's n can be entered for other channel materials.

Analysis of Trapezoidal Channel (Grass-Lined uses SCS Method)

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D, or E =		
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	0.013	
Channel Invert Slope	S_O =	0.0089	ft/ft
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	12.00	ft/ft
Right Side Sloe	Z2 =	12.00	ft/ft

Check one of the following soil types:

Soil Type:	Max. Velocity (V_{MAX})	Max Froude No. (F_{MAX})
Non-Cohesive	5.0 fps	0.60
Cohesive	7.0 fps	0.80
Paved	N/A	N/A

Choose One:
- Non-Cohesive
- Cohesive
- Paved

		Minor Storm	Major Storm	
Maximum Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	18.00	35.00	ft
Maximum Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	0.57	0.57	ft

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	18.2	18.2	cfs
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	0.57	0.57	ft

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	3.5	6.5	cfs
Water Depth	d =	0.31	0.39	ft

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Please verify inlet type. The drainage map shows a double Type C area inlet.

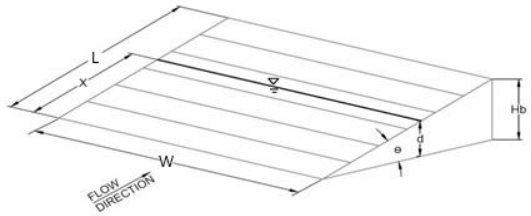
MHFD-Inlet, Version 5.03

AREA INLET IN A SWALE

Inlet P3

Inlet Design Information (Input)

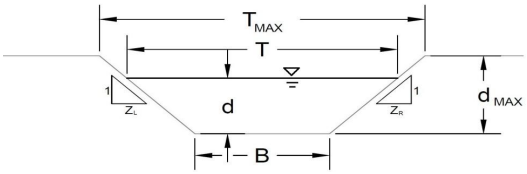
Type of Inlet	CDOT Type D (In Series	Inlet Type =	CDOT Type D (In Series)	
Angle of Inclined Grade (must be <= 30 degrees)		θ =	0.00	degrees
Width of Grade		W =	3.00	ft
Length of Grade		L =	6.00	ft
Open Area Ratio		A_{RATIO} =	0.70	
Height of Inclined Grade		H_B =	0.00	ft
Clogging Factor		C_f =	0.38	
Grade Discharge Coefficient		C_d =	0.78	
Orifice Coefficient		C_o =	0.52	
Weir Coefficient		C_w =	1.67	



		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.31	0.39	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	5.1	7.2	cfs
Bypassed Flow	Q_b =	0.0	0.0	cfs
Capture Percentage = Qa/Qo	C% =	100	100	%

AREA INLET IN A SWALE

Inlet P4



This worksheet uses the NRCS vegetal retardance method to determine Manning's n for grass-lined channels.

An override Manning's n can be entered for other channel materials.

Analysis of Trapezoidal Channel (Grass-Lined uses SCS Method)

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D, or E =		
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	0.013	
Channel Invert Slope	S_O =	0.0093	ft/ft
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	12.00	ft/ft
Right Side Sloe	Z2 =	12.00	ft/ft

Check one of the following soil types:

Soil Type:	Max. Velocity (V_{MAX})	Max Froude No. (F_{MAX})
Non-Cohesive	5.0 fps	0.60
Cohesive	7.0 fps	0.80
Paved	N/A	N/A

Choose One:
- Non-Cohesive
- Cohesive
- Paved

		Minor Storm	Major Storm	
Maximum Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	18.00	35.00	ft
Maximum Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	0.60	0.60	ft

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	21.3	21.3	cfs
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	0.60	0.60	ft

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	3.6	6.6	cfs
Water Depth	d =	0.31	0.39	ft

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Please verify inlet type. The drainage map shows a double Type C area inlet.

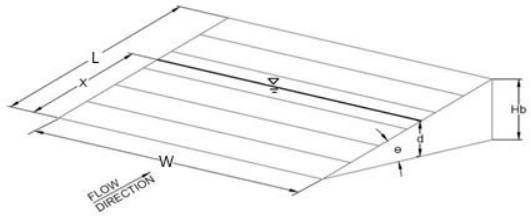
MHFD-Inlet, Version 5.03 (Au

AREA INLET IN A

Inlet P4

Inlet Design Information (Input)

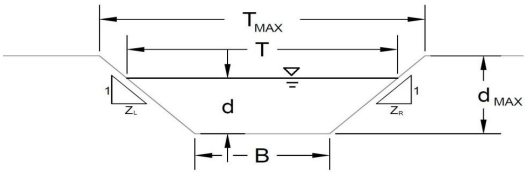
Type of Inlet	CDOT Type D (In Series	Inlet Type =	CDOT Type D (In Series)	
Angle of Inclined Grade (must be <= 30 degrees)		θ =	0.00	degrees
Width of Grade		W =	3.00	ft
Length of Grade		L =	6.00	ft
Open Area Ratio		A_{RATIO} =	0.70	
Height of Inclined Grade		H_B =	0.00	ft
Clogging Factor		C_f =	0.38	
Grade Discharge Coefficient		C_d =	0.78	
Orifice Coefficient		C_o =	0.52	
Weir Coefficient		C_w =	1.67	



		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.31	0.39	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	5.1	7.2	cfs
Bypassed Flow	Q_b =	0.0	0.0	cfs
Capture Percentage = Qa/Qo	C% =	100	100	%

AREA INLET IN A SWALE

Inlet P5



This worksheet uses the NRCS vegetal retardance method to determine Manning's n for grass-lined channels.

An override Manning's n can be entered for other channel materials.

Analysis of Trapezoidal Channel (Grass-Lined uses SCS Method)

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D, or E =	B	
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	see details below	
Channel Invert Slope	S_O =	0.0180	ft/ft
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	45.00	ft/ft
Right Side Sloe	Z2 =	20.00	ft/ft

Check one of the following soil types:

Soil Type:	Max. Velocity (V_{MAX})	Max Froude No. (F_{MAX})
Non-Cohesive	5.0 fps	0.60
Cohesive	7.0 fps	0.80
Paved	N/A	N/A

Choose One:
- ○ Non-Cohesive
- ◉ Cohesive
- ○ Paved

		Minor Storm	Major Storm	
Maximum Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	35.00	35.00	ft
Maximum Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	0.32	0.32	ft

Maximum Channel Capacity Based On Allowable Top Width

		Minor Storm	Major Storm	
Maximum Allowable Top Width	T_{MAX} =	35.00	35.00	ft
Water Depth	d =	0.54	0.54	ft
Flow Area	A =	9.42	9.42	sq ft
Wetted Perimeter	P =	35.02	35.02	ft
Hydraulic Radius	R =	0.27	0.27	ft
Manning's n based on NRCS Vegetal Retardance	n =	0.318	0.318	
Flow Velocity	V =	0.26	0.26	fps
Velocity-Depth Product	VR =	0.07	0.07	ft^2/s
Hydraulic Depth	D =	0.27	0.27	ft
Froude Number	Fr =	0.09	0.09	
Maximum Flow Based on Allowable Water Depth	Q_T =	2.5	2.5	cfs

Maximum Channel Capacity Based On Allowable Water Depth

		Minor Storm	Major Storm	
Maximum Allowable Water Depth	d_{MAX} =	0.32	0.32	ft
Top Width	T =	20.80	20.80	ft
Flow Area	A =	3.33	3.33	sq ft
Wetted Perimeter	P =	20.81	20.81	ft
Hydraulic Radius	R =	0.16	0.16	ft
Manning's n based on NRCS Vegetal Retardance	n =	0.318	0.318	
Flow Velocity	V =	0.19	0.19	fps
Velocity-Depth Product	VR =	0.03	0.03	ft^2/s
Hydraulic Depth	D =	0.16	0.16	ft
Froude Number	Fr =	0.08	0.08	
Maximum Flow Based On Allowable Water Depth	Q_d =	0.6	0.6	cfs

Note: Please see Inlet P-5 Cross Section per Flow Master Analysis. Maximum water depth at Inlet P-5, for the 100-Year Storm is 2.2in ~ 0.18 ft. 0.18ft < 0.32 ft (Dmax)

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	0.6	0.6	cfs
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	0.32	0.32	ft

Water Depth in Channel Based On Design Peak Flow

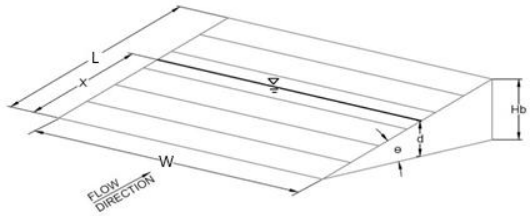
Design Peak Flow	Q_o =	3.9	6.5	cfs
Water Depth	d =	0.64	0.78	ft
Top Width	T =	41.54	50.59	ft
Flow Area	A =	13.28	19.69	sq ft
Wetted Perimeter	P =	41.57	50.62	ft
Hydraulic Radius	R =	0.32	0.39	ft
Manning's n based on NRCS Vegetal Retardance	n =	0.318	0.322	
Flow Velocity	V =	0.29	0.33	fps
Velocity-Depth Product	VR =	0.09	0.13	ft^2/s
Hydraulic Depth	D =	0.32	0.39	ft
Froude Number	Fr =	0.09	0.09	

AREA INLET IN A SWALE

Inlet P5

Inlet Design Information (Input)

Type of Inlet: CDOT Type C — Inlet Type = CDOT Type C



Angle of Inclined Grate (must be <= 30 degrees)	θ =	0.00	degrees
Width of Grate	W =	3.00	ft
Length of Grate	L =	3.00	ft
Open Area Ratio	A_{RATIO} =	0.70	
Height of Inclined Grate	H_B =	0.00	ft
Clogging Factor	C_f =	0.50	
Grate Discharge Coefficient	C_d =	0.96	
Orifice Coefficient	C_o =	0.64	
Weir Coefficient	C_w =	2.05	

		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.64	0.78	
Grate Capacity as a Weir				
Submerged Side Weir Length	X =	3.00	3.00	ft
Inclined Side Weir Flow	Q_{ws} =	5.5	7.4	cfs
Base Weir Flow	Q_{wb} =	7.9	10.6	cfs
Interception Without Cloggging	Q_{wi} =	18.9	25.4	cfs
Interception With Clogging	Q_{wa} =	9.4	12.7	cfs
Grate Capacity as an Orifice				
Interception Without Clogging	Q_{oi} =	25.9	28.5	cfs
Interception With Clogging	Q_{oa} =	12.9	14.3	cfs
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	9.4	12.7	cfs
Bypassed Flow	Q_b =	0.0	0.0	cfs
Capture Percentage = Qa/Qo	C% =	100	100	%

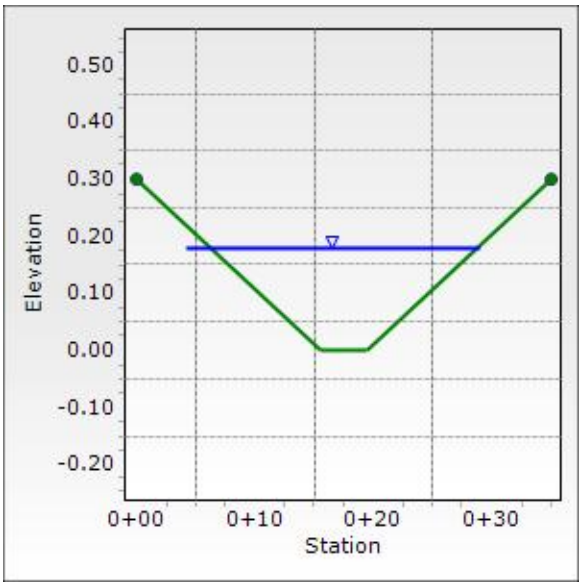
Note: Please see Inlet P-5 Cross Section per Flow Master Analysis. Maximum water depth at Inlet P-5, for the 100-Year Storm is 2.2in ~ 0.18 ft. 0.18ft < 0.32 ft (Dmax).

Bypass flows are anticipated to exist. These flows will continue south and into the existing EDB.

Inlet P5 - Cross Section

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data		
Channel Slope	0.018 ft/ft	
Normal Depth	2.2 in	
Discharge	6.51 cfs	~ 100-Year Flow



APPENDIX G: EX. FINAL DRAINAGE REPORT FOR BARBARICK SUBDIVISION

NEW DOC

Matrix DESIGN GROUP
AN EMPLOYEE-OWNED COMPANY

2435 Research Parkway, Suite 300
Colorado Springs, Colorado 80920
Phone: 719-575-0100
www.matrixdesigngroup.com

Justin Ballard
Wykota Construction
430 Beacon Light Road
Monument, CO 80132

January 16, 2017

Subject: Pond As-Built Verification for Barbarick Subdivision Lots 1-4 Construction

Dear Mr. Ballard,

Please accept this letter as certification of the post-construction measurements and volume calculations of the subject sand filter pond and the full spectrum pond. The table below depicts the design elevations and volumes from the construction plans with the post-construction measured elevations and volumes. The as-built survey was completed by Matrix Design Group on January 12, 2017 and the criteria shown below was compiled from this survey data. The benchmark used for this survey is a found 3-1/4" aluminum cap in road box designated as FIMS F_69 and having a published NGVD 29 elevation of 6975.62 feet.

Full Spectrum Detention Pond Outlet Structure Elevations			
	Design Elevation	As Built Elevation	Delta Elevation
bottom of micropool	7016.00	7016.14	0.14
orifice slot1 CL	7018.50	7018.89	0.39
orifice slot2 CL	7019.50	7019.87	0.37
orifice slot3 CL	7020.50	7020.87	0.37
micropool wall top	7018.50	7018.60	0.10
orifice plate wall top	7021.00	7021.35	0.35
Trash Rack wall Top	7021.80	7021.90	0.10
invert 30" cpp	7017.80	7017.87	0.07

Full Spectrum Detention Pond Elevations & Volumes			
	Design Elevation	As Built Elevation	Delta Elevation
WQ WSE	7020.03	7020.17	0.14
5-Year WSE	7021.50	7021.64	0.14
100-Year (weir)	7022.76	7022.92	0.16
EURV	7021.50	7021.64	0.14
	Design Volume	As Built Volume	Delta Volume
WQ volume	0.203 ac-ft	0.182 ac-ft	(-)0.021 ac-ft
5-Year volume	0.673 ac-ft	0.695 ac-ft	0.002 ac-ft
100-Year (weir)	1.261 ac-ft	1.286 ac-ft	0.025 ac-ft
EURV	0.677 ac-ft	0.695 ac-ft	0.018 ac-ft

Sand Filter Pond Elevations & Volumes			
	Design Elevation	**As Built Elevation**	**Delta Elevation**
WQ WSE	7023.38	7023.37	-0.01
100-Year (weir)	7025.83	7025.02	-0.81
EURV	7024.52	7024.52	0.00
	Design Volume	**As Built Volume**	**Delta Volume**
WQ volume	0.039 ac-ft	0.258 ac-ft	0.219 ac-ft
100-Year (weir)	0.394 ac-ft	0.517 ac-ft	0.123 ac-ft
EURV	0.181 ac-ft	0.429 ac-ft	0.248 ac-ft

I, Justin A. Conner, a Colorado licensed Professional Land Surveyor, certify on behalf of Matrix Design Group that the above as-built elevations and volumes were derived from a field survey performed on January 12, 2017 under my direct supervision and is true and correct to the best of my knowledge and belief.

Justin A. Conner, PLS 38421
Prepared for and on behalf of Matrix Design Group, Inc.

STORM SEWER ROUTING SUMMARY		
DESIGN POINT	Q_5 (cfs)	Q_{100} (cfs)
G4A	640	1584
G5	78	146
G6	32	66
G7	82	157
G8	20	42
G9	14	29
G10	47	97
G11	4	9
G12	72	144
G13	12	25
G14	7	14
G15	3	7
G16	60	125
G17	80	130
G18	29	54
G19	11	23
G20	69	138
G21	1044	1767
G22	5	10
G23	64	133
G25	1056	1795
H1	73	139
H2	46	92
H3	103	200
H4	45	86
H5	30	61
H6	68	134
H8	16	29
H11	22	45
H12	31	62
H13	57	118
H14	196	382
H16	31	65
H17	26	54
H18	224	441

BASIN SUMMARY			
BASIN	AREA (acres)	Q_5 (cfs)	Q_{100} (cfs)
OS1	110.1	68	167
OS2	17.0	45	86
OS3	28.7	73	139
OS4	5.0	5	11

Flow Summary from the Sterling Ranch PDR

EXISTING SITE DRAINAGE DISCUSSION:

On-Site (Existing Conditions):

On-site Basin H1 This basin covers approximately 10.7 acres and represents the majority of Lots 3 & 4. This basin is modeled as good condition undeveloped rangeland. This drains to the south and generates 2.6/23.7 cfs in the 5/100 year storm events.

On-site Basin H2 This existing basin covers approximately 3.70 acres and represents the eastern half of Lots 1 & 2.This basin is modeled as good condition rangeland and generates 0.9/8.2 cfs in the 5/100 year storm events.

On-site Basin H3 This existing basin covers 1.1 acres and represents the a small portion of lots 3 & 4 that drains south easterly. This basin is modeled as good

NEW DOC

FINAL DRAINAGE REPORT
For

BARBARICK SUBDIVISION, PORTIONS OF LOTS 1, 2 and LOTS 3 & 4
El Paso County, Colorado

Sand Creek Drainage Basin

Prepared for:
El Paso County Development Services
Engineering Division

On Behalf of:
Wykota Construction
430 Beacon Light Road, Suite 130
Monument, CO 80132

Prepared by:

Matrix DESIGN GROUP
2435 Research Parkway, Suite 300
Colorado Springs, CO 80920
(719) 575-0100
Fax (719) 572-0208

June 6, 2016

15.789.001

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.

SEAL

Gregory G. Shaner
Registered Professional Engineer
State of Colorado, No. 36307

Developer's Statement:

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

Wykota Construction
Business Name

By: _____
Justin Ballard

Title: President

Address: 430 Beacon Light Road, Suite 130
Monument, CO 80132

El Paso County:

Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 and 2, El Paso County Engineering Criteria Manual and Land Development Code as amended.

_____ 9 JUNE 2016
Print Name — ~~JOHN~~ JENNIFER IRVINE Date
County Engineer / ECM Administrator

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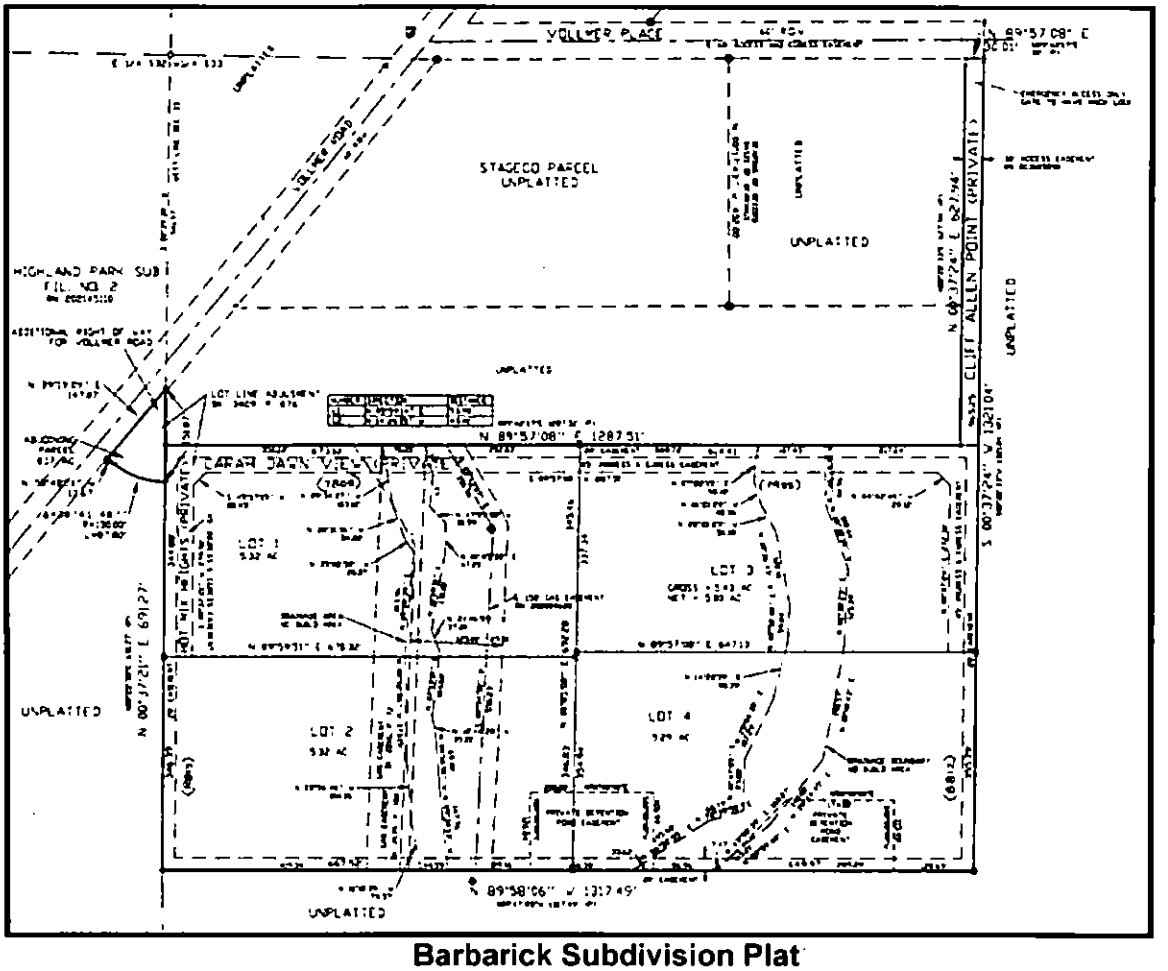
Surrounding Developments. The following are the existing or planned general land uses adjacent to the property.

North: Un-platted parcels that contain commercial/industrial uses. Carah Dawn View is on the north side of the property.

East and South: Although this adjacent area is currently undeveloped, the Sterling Ranch Master Planned area is in the process of developing this area (future single family development).

West: This is an undeveloped, un-platted lot. Across Vollmer Road is a low density single family development (Highland Park, Fil 2).



Barbarick Subdivision Plat

Property Description

1. Major Drainage Way: The entire site is located within the Sand Creek Drainage Basin. The Main Fork of Sand Creek is located about 1500 feet to the east. The site currently drains to the south into natural drainage ways that direct runoff to Sand Creek. The Sand Creek Drainage Basin is located in the northeastern portion of the City of Colorado Springs and El Paso County. The general drainage pattern of this larger basin flows to the southwest and ultimately feeds into Fountain Creek.

2. Project Site Area: This site is approximately 21.37 acres in area.

3. Ground Cover: This site is covered with native grasses.

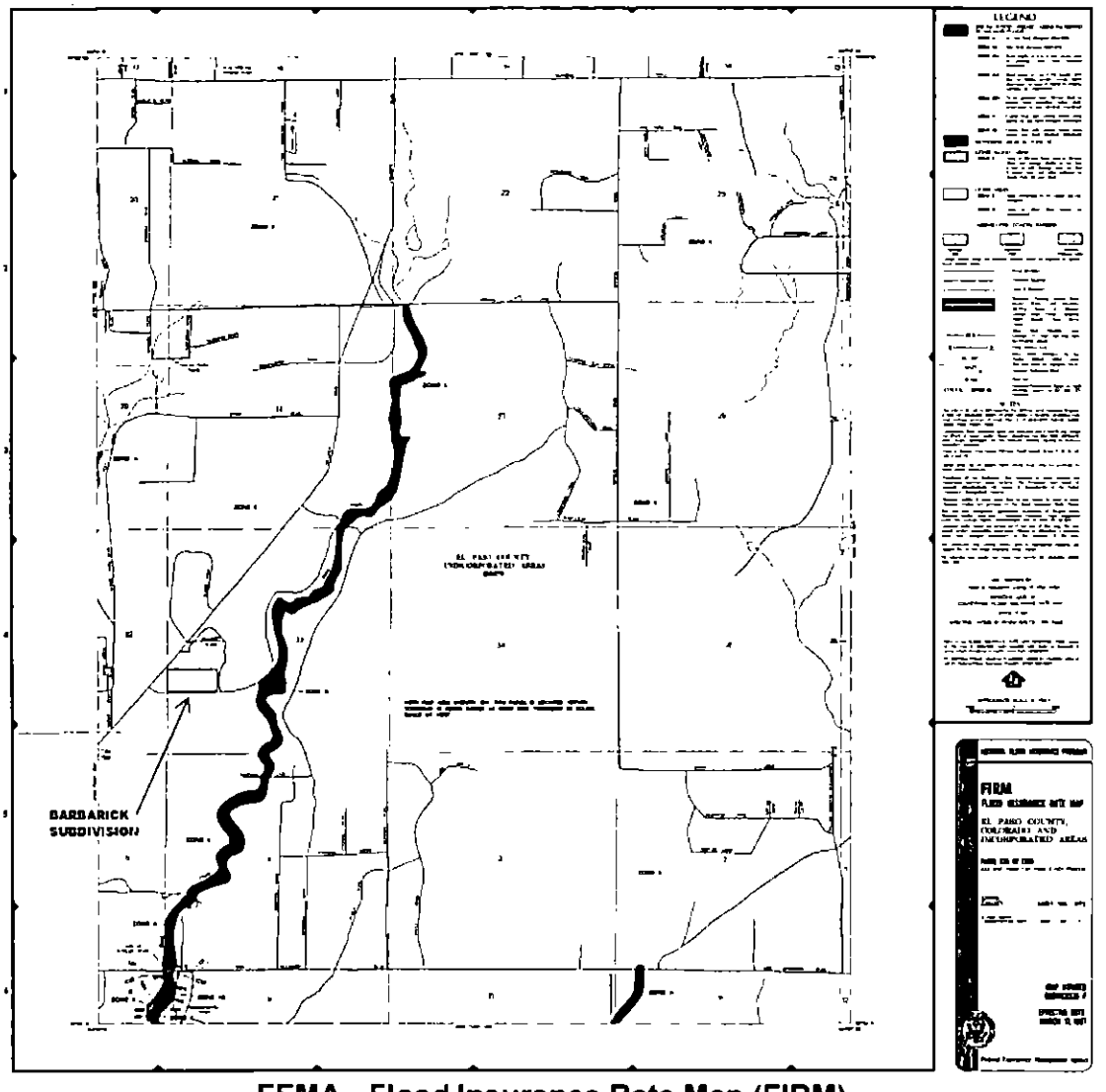
4. General Topography: The site drains from north to the south with average grades ranging from 1% to 5%. There are two natural drainage ways that drain through these lots.

5. Irrigation Facilities: No known functioning irrigation facilities are located on the site. A small detention pond does exist to the northeast of the property; however, the outfall of this pond will be re-routed in order to direct runoff around the perimeter of the proposed development.

6. Utilities: Utilities in the project area include; but are not limited to, telephone, high pressure gas/petroleum and electrical lines. Water & wastewater service is provided through wells & individual septic systems. These utilities will be examined on a case-by-case basis and avoided where feasible, or they will be relocated. Any relocation of these utilities will be coordinated with the respective utility contact. Utility services will be extended into the site as necessary. There are large gas easements that run north-south through these lots. These easements contain one 6 inch and two 20 inch high pressure gas/petroleum pipelines. These Utility Easements will be no-build zones and grading will be fill only.

7. On-Site Drainage Ways: The plat shows two "Drainage Boundary – No Build Area(s)" draining through the subdivision. These are not regulated FEMA floodplains. The site development will include the installation of pass through culverts for offsite flows, and regraded. An amended plat has been completed for the removal of the no build areas, identification of new drainage easements, and relocation of water quality ponds.

8. Floodplain Statement: Review of the Flood Insurance Rate Map (FIRM) 535 (08041CO535 F), effective date March 17, 1997, published by the Federal Emergency Management Agency (FEMA) reveals that no portion of Barbaric Subdivision lie within any designated 100-year floodplain.



FEMA - Flood Insurance Rate Map (FIRM)

HYDROLOGIC AND HYDRAULIC ANALYSIS

Basin Description

The Barbarick Subdivision is located within the Sand Creek Drainage Basin. The tributary area that drains through the Barbarick Subdivision is developed, which includes large lot single-family parcels and some commercial/industrial land uses. Sub-basins were delineated using surveyed information, proposed contours and field observations. See the Drainage Basin Maps in the Appendix.

This study is in conformance with the following two approved Drainage Reports:

1. ***Preliminary Drainage Report for Sterling Ranch-Phase 1, Sand Creek Drainage Basin***, M & S Civil Consultants, Inc., May 2015 **AKA: "SR-PDR"**

2. ***Woodmen Storage Final Drainage Report, El Paso County,*** Calibre Engineering, Inc., July 2004; Revised February, 2010; Revised May, 2010; Revised July, 2010 **AKA: "WS-FDR"**

This study is *not* in conformance with the following approved Drainage Report due to changes from the approved recent reports cited above that supercede the original report:

1. ***Preliminary and Final Drainage Plan and Report, Barbarick Subdivision a Replat of Lot "D", McClintock Subdivision, El Paso County,*** Oliver E. Watts, Consulting Engineer, Inc., August 15, 2007 **AKA: "BS-FDR"**

Design Criteria

This report has been prepared in accordance to the criteria set forth in the ***City of Colorado Springs & El Paso County Drainage Criteria Manual, Volumes I and II***, dated November 1991 including subsequent updates. El Paso County has also adopted Chapter 6 and Section 3.2.1 of Chapter 13 in the ***City of Colorado Springs & El Paso County Drainage Criteria Manual, Volumes I and II***, dated May 2014 (Appendix I of the El Paso County's Engineering Criteria Manual (ECM), 2008). In addition to the ECM, the ***Urban Storm Drainage Criteria Manuals, Volumes 1-3***, published by the Urban Drainage and Flood Control District, (Volumes 1 & 2 dated January 2016, Volume 3 dated November 2010 with some sections update November 2015), has also been used to supplement the ECM.

Hydrologic Criteria

Hydrologic analyses for the site have been completed using the Rational Method for on-site basins. The SCS Method was used in the referenced studies for the larger off-site basins (greater than 100 acres). The design storms for each method are:

Initial Storm = 5-Year Storm
Major Storm = 100-Year Storm

Rational Method: The Rational Method will be utilized to evaluate smaller basins (under 100 acres). This methodology is used for the design of localized facilities such as inlets, storm drain, drainage swales and detention:

Rational Method peak flow rate equation (cfs): Q=C*I*A
Where: Q = Maximum runoff rate in cubic feet per second (cfs)
C = Runoff coefficient
I = Average rainfall intensity in inches per hour
A = Area of drainage sub-basin in acres

Runoff Coefficient

Rational Method coefficients are derived from UDFCD Vol 1 (Chapter 6 – Runoff, 2016-01 Rev) for the various land uses, including parking areas, drives, walks, roofs, lawns and open space areas. The Runoff Coefficients associated with these land uses also have a corresponding impervious value that is used in the detention calculations. The Rational Method Coefficients used in this study include:

Land Use or Surface Type	% Impervious	Runoff Coefficient (B Soils)	
		(5-Year)	(100-Year)
Greenbelts/Agricultural	2%	.03	.46
Gravel (packed)	40%	.37	.65
Drives & Walks	90%	.84	.90

Table 6-3. Recommended percentage imperviousness values

Land Use or Surface Characteristics	Percentage Imperviousness (%)
Business:	
Downtown Areas	95
Suburban Areas	75
Residential:	
Single-family	
2.5 acres or larger	12
0.75 – 2.5 acres	20
0.25 – 0.75 acres	30
0.25 acres or less	45
Apartments	75
Industrial:	
Light areas	80
Heavy areas	90
Parks, cemeteries	10
Playgrounds	25
Schools	55
Railroad yard areas	50
Undeveloped Areas:	
Historic flow analysis	2
Greenbelts, agricultural	2
Off-site flow analysis (when land use not defined)	45
Streets:	
Paved	100
Gravel (packed)	40
Drive and walks	90
Roofs	90
Lawns, sandy soil	2
Lawns, clayey soil	2

Table 6-5. Runoff coefficients, *c*

Total or Effective % Imperviousness	NRCS Hydrologic Soil Group A					
	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
2%	0.02	0.02	0.02	0.02	0.02	0.17
5%	0.04	0.05	0.05	0.05	0.05	0.19
10%	0.09	0.09	0.09	0.09	0.1	0.23
15%	0.13	0.14	0.14	0.14	0.14	0.28
20%	0.18	0.19	0.19	0.19	0.19	0.32
25%	0.22	0.23	0.24	0.24	0.24	0.36
30%	0.27	0.28	0.28	0.28	0.29	0.4
35%	0.31	0.33	0.33	0.33	0.33	0.44
40%	0.36	0.37	0.38	0.38	0.38	0.48
45%	0.4	0.42	0.42	0.42	0.43	0.52
50%	0.45	0.47	0.47	0.47	0.48	0.56
55%	0.49	0.51	0.52	0.52	0.52	0.6
60%	0.53	0.56	0.56	0.57	0.57	0.64
65%	0.58	0.6	0.61	0.61	0.62	0.68
70%	0.62	0.65	0.66	0.66	0.67	0.72
75%	0.67	0.7	0.71	0.71	0.71	0.76
80%	0.71	0.74	0.75	0.76	0.76	0.8
85%	0.76	0.79	0.8	0.8	0.81	0.84
90%	0.8	0.84	0.85	0.85	0.86	0.88
95%	0.85	0.88	0.89	0.9	0.9	0.92
100%	0.89	0.93	0.94	0.94	0.95	0.96
Total or Effective % Imperviousness	**NRCS Hydrologic Soil Group B**					
2%	0.02	0.02	0.14	0.24	0.38	0.46
5%	0.04	0.05	0.17	0.27	0.39	0.48
10%	0.09	0.09	0.21	0.3	0.42	0.5
15%	0.13	0.14	0.25	0.34	0.45	0.53
20%	0.18	0.19	0.29	0.37	0.48	0.55
25%	0.22	0.23	0.33	0.41	0.51	0.58
30%	0.27	0.28	0.37	0.44	0.54	0.6
35%	0.31	0.33	0.41	0.48	0.57	0.63
40%	0.36	0.37	0.45	0.51	0.6	0.65
45%	0.4	0.42	0.49	0.55	0.63	0.67
50%	0.45	0.47	0.53	0.58	0.66	0.7
55%	0.49	0.51	0.57	0.62	0.69	0.72
60%	0.53	0.56	0.61	0.65	0.72	0.75
65%	0.58	0.6	0.65	0.69	0.75	0.77
70%	0.62	0.65	0.69	0.72	0.78	0.8
75%	0.67	0.7	0.73	0.76	0.81	0.82
80%	0.71	0.74	0.77	0.79	0.84	0.85
85%	0.76	0.79	0.81	0.83	0.87	0.87
90%	0.8	0.84	0.85	0.86	0.89	0.9
95%	0.85	0.88	0.89	0.9	0.92	0.92
100%	0.89	0.93	0.94	0.94	0.95	0.94

Time of Concentration

The time of concentration (T_c) for the Rational Method was calculated by methods derived from the UDFCD. The time of concentration consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an initial time or overland flow time (t_i)

plus the time of travel (t_t) in concentrated form, such as a swale or drainageway. A minimum T_c of 5 minutes and 10 minutes were used for the final calculations in developed and undeveloped conditions, respectively.

Storm Drain Systems

All proposed storm drain infrastructure will be located within private property and will be owned and maintained by the property owner.

The storm drain hydraulics is analyzed using *Bentley's* FlowMaster, CulvertMaster & StormCAD design software. Colorado Department of Transportation (CDOT) type inlets will be used where necessary.

The designated outfall locations for the proposed on-site storm drains are the natural drainage ways at the south end of the property. The proposed storm drain infrastructure will be discussed in more detail below.

EXISTING DRAINAGE REPORT DISCUSSION

The approved Barbarick Subdivision Final Drainage Report (BS-FDR) and the approved Woodmen Storage Final Drainage Report (WS-FDR) both apply to the existing general drainage conditions for this site. The off-site basins and general flow patterns in the BS-FDR and WS-FDR still apply. Excerpts from these reports are provided below for reference.

On-site and Off-Site Basin Descriptions from the BS-FDR and WS-FDR:

The following summary is taken from the Barbarick Subdivision Final Drainage Report (BS-FDR):

Off-site:

Off-site Basin O3 This basin encompasses approximately 7.03 acres and represents the area north and northwest of Lot 1. This basin drains into Lot 1 through a series of (2) 24" CMP pipes which control the flow of 14/36 cfs in the 5/100 year storm events.

Lots 1 & 2 – these lots are considered fully developed lots and drain north to south collecting at the existing concrete settling pond on Lot 2. This developed flow (20.8 cfs /57.2 cfs) combines with Off-site Basin O3 to total 30.5 cfs / 80.8 cfs in the greenbelt offsite south of Lot 2. At the time of development permit for these developed lots, a detention pond for water quality will be required, probably in the area of the existing concrete settling pond, that will accommodate Lots 1 and 2 west of the gas easement and flood plain area.

On-site:

On-site Basins A1 and B1 (for portions of Lots 1 and 2, and Lots 3 & 4) These basins encompass approximately 5.3 & 3.8 acres and represent the buildable portions of the property as described in the BS-FDR (see Basin Map from BS-FDR below). These basins were slated (in the BS-FDR) to drain into small detention ponds that would release to historic rates. These discharge rates were calculated to be 2.9/7.3 and 2.2/5.4 cfs (5/100 year). The BS-FDR does not include the drainage ways in any hydrology calculations due to the fact that this no-build drainage area was not planed on being developed. This drainage way allowed off-site flows from O1+O2 to pass-through Lots 3 & 4. The drainage way to the west of A1 passes through flows from offsite O3. Since the approval of this report, offsite tributary basins O1+O2 have been changed, and the development of the property encompasses the whole property, including the previously determined no-build area.

The following summary is taken from the Woodmen Storage Final Drainage Report (WS-FDR):

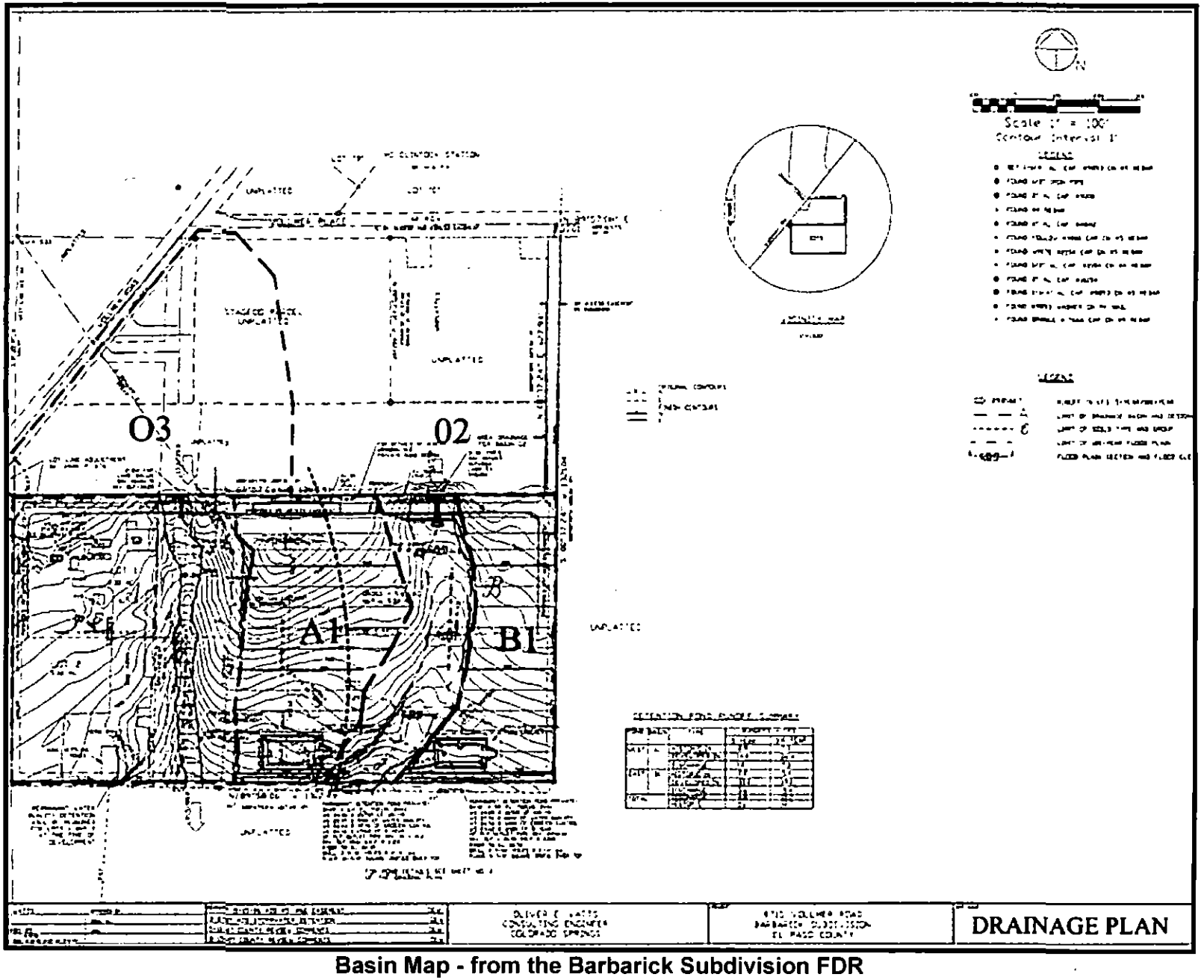
Off-site:

Design Point 5 - This design point encompasses approximately 19.69 acres and represents the tributary area north of the project site. This basin drains into a proposed detention pond near the northeast corner of the property and generates 57.4/92.7 cfs in the 10/100 year storm events, historic flows are 16.7/30.3 cfs. The releases rates from this pond are lower than historic 16.1 cfs/29.4 cfs in the 10/100-year storm events. These flows are conveyed along the east property line of the site and into the eastern natural drainage way that leaves the property to the south.

Review of the Sterling Ranch Preliminary Drainage Report (SR-PDR):

The Barbarick Subdivision is surrounded on three sides by the planned Sterling Ranch Development. The approved Sterling Ranch PDR was prepared by M&S Civil Consultants in May of 2015. This Sterling Ranch PDR re-analyzes runoff from Barbarick Subdivision and plans for storm drain improvements to convey this runoff to a full spectrum detention and water quality pond to be located down stream of Barbarick Subdivision as part of Sterling Ranch Phase One.

In summary; the Sterling Ranch PDR is planning on receiving 73.3/139.2 cfs (5/100 year) from Basin OS3. A 54" RCP is planned to convey this flow through Sterling Ranch. The Sterling Ranch PDR is planning on receiving 45/86 cfs (5/100 year) from OS2, encompasses Lots 1 & 2 and OS3 encompasses Lots 3 & 4 and the Basin north of Lot 3. A 48" RCP is planned to convey this flow through Sterling Ranch. The cumulative runoff from the northerly property and Lots 1 through 4 does not exceed the anticipated rates in the SR-PDR.



Basin Map - from the Barbarick Subdivision FDR

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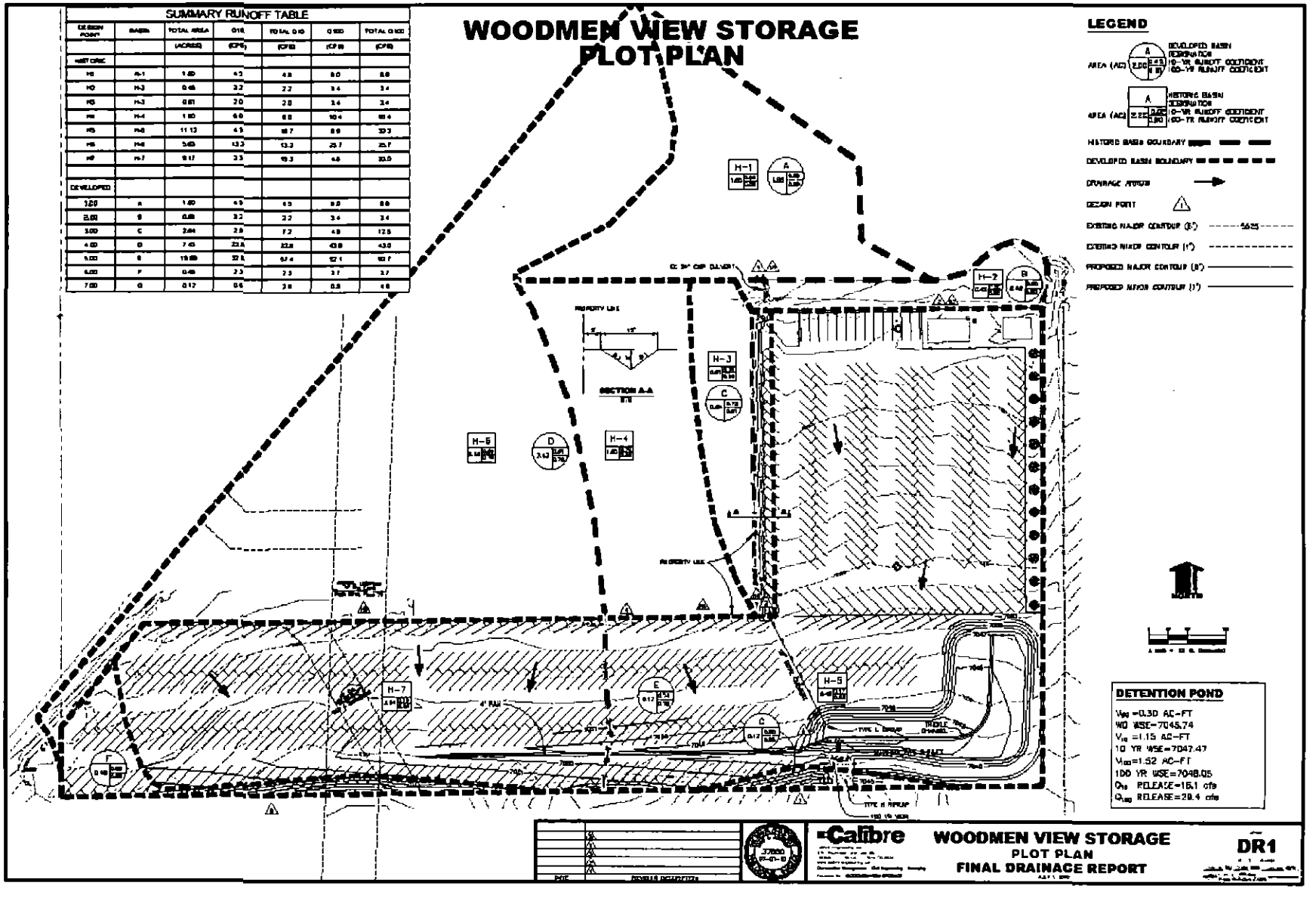

Basin Map - from the FDR

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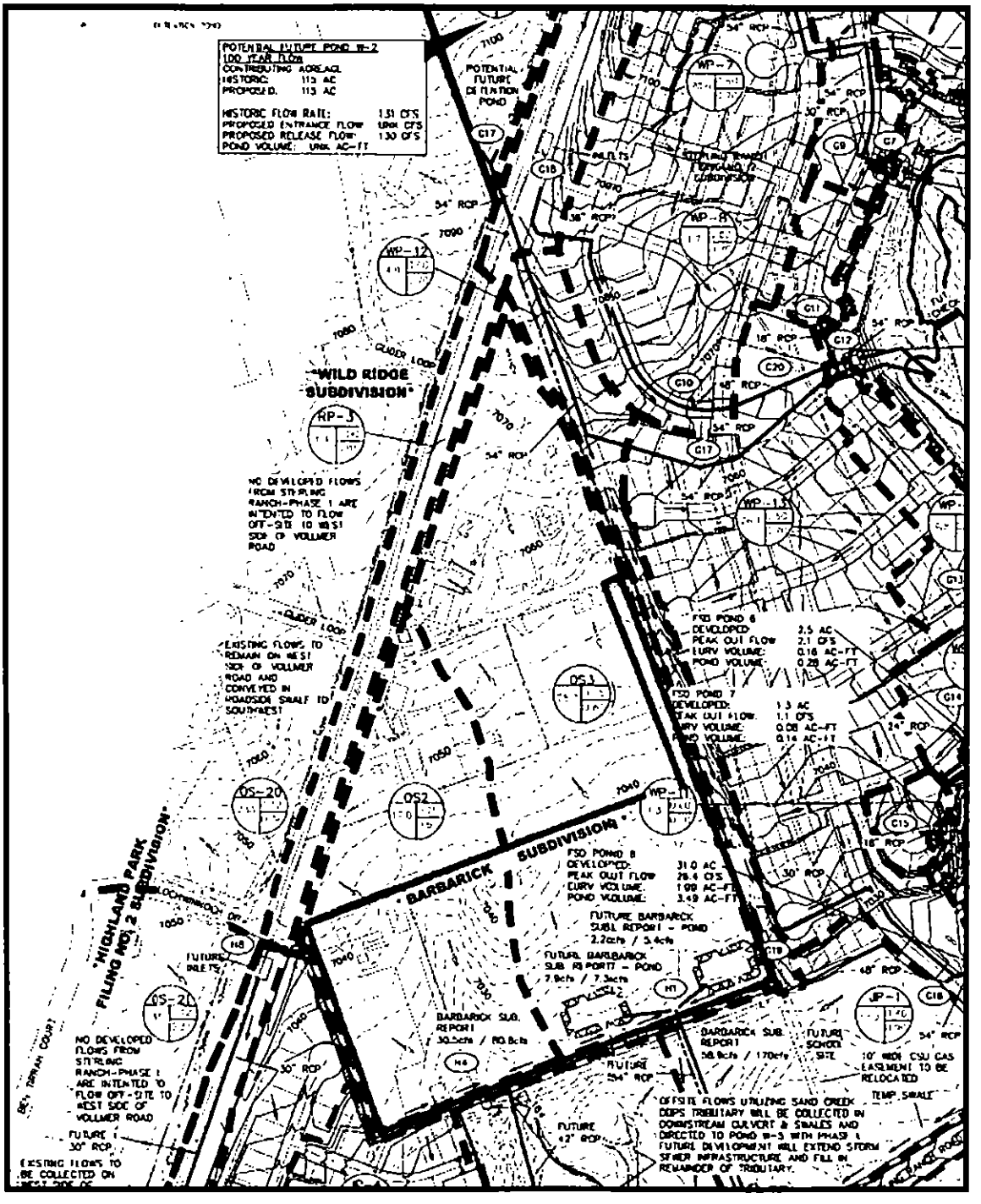
CIVIL CONSULTANTS, INC.
102 E. PIKES PEAK AVE. STE 306
COLORADO SPRINGS, CO 80903
(719) 955-5485, FAX (719) 448-8427

STERLING RANCH PHASE 1			
PROPOSED – DRAINAGE MAP (OVERALL)			
PROJECT NO. 09-001	SCALE	DATE: 5/08/15	
DESIGNED BY: DLM	HORIZ: 1"=200'		
DRAWN BY: DLM	VERT: N/A	SHEET 1 OF 1	D2
CHECKED BY: VAS			

Basin Map from the Sterling Ranch PDR



condition rangeland and generates 0.3/2.7 cfs in the 5/100 year storm events. This basin sheet flows offsite where it is captured in a small swale between the site and existing roadway and conveyed westerly to the low point south of the outfall of Basin H1.

These existing basins encompass the previously unmodelled drainage area from the BS-FDR. The total historic flow from the site is 3.8/34.6 cfs in the 5/100 year storm events. The following design point table is for combined allowable discharge rates from the property at respective locations including historic flows from the tributary upstream basins:

Design Point	5/100 Release	Comments
DP H1	16.7*/30.3 cfs	DP H5 WS-FDR - * is 10year
DP H2	13.7/35.5 cfs	O3 BS-FDR
DP H3	56.7 cfs	DPH1+H1+H3 (100-year)
DP H4	14.6/43.7 cfs	DPH2 + H2

Design Point H3 will release a flow lower than previously anticipated within the BS-FDR (52.9/170 cfs). It is the introduction of development within the Sterling Ranch site that has eliminated offsite flows from BS-FDR Basin O1 that significantly changed the drainage pattern. The historic release is now contained solely to the historic flows from WS-FDR design point H5 and the proposed onsite historic flows.

Design Point H4 will combine with the western half of Lots 1&2. Per the BS-FDR the combined portions of Lots 1&2 and O3 to release a combined flow of 30.5/80.8 cfs downstream. The flow anticipated in the BS-FDR appears consistent with the smaller basin analysis of this report and should be used for downstream analysis.

PROPOSED DRAINAGE DISCUSSION

Introduction

The proposed site will be developed differently than anticipated in the previous BS-FDR. The previous plan for this site maintained the existing native drainage way down the middle of Lots 1 & 2 and 3 & 4, thereby splitting the buildable area into the outer thirds of these lots. The native drainage way and "Drainage Boundary – No Build Area" (as shown on the Plat & FDR) will be eliminated with the proposed development. The proposed site and proposed drainage improvements will allow this native drainage way to be eliminated while maintaining the pass through of major flows. These modifications to the site and to the drainage patterns will allow a larger buildable area.

The existing retention pond, located just north of Lot 3, will be modified by others to become a water quality/detention pond pursuant to the WS-FDR. A new outlet works and a storm drain pipe will convey runoff from this detention pond (16.1/29.4 cfs in the 10/100 year storm events) discharging at the property line. This development is proposing a CDOT Type D inlet to capture the discharged flow and pipe it downstream along the east side of Lots 3 & 4 to discharge into the proposed Full Spectrum Extended

Detention Basin (EDB) in Lot 4. The EDB is designed to pass through, and not treat or detain, these offsite flows.

A new EDB will be provided in Lot 4. This detention basin will provide water quality treatment for portions of Lots 1 & 2, and Lots 3 & 4. In the approved Barbarick FDR there were to be two separate ponds. The new site development has been planned for a single pond to treat the developed flows. Tributary water sheet flow across the site to shallow swales that will direct runoff to the proposed EDB. The EDB will have a forebay at the confluence of the two pipe outfalls, a concrete trickle channel that terminates at a micropool structure, and is designed to treat the WQCV, EURV and 100-year detention.

A second SFB water quality with detention catchment basin will be provided at the south east/downstream end of Lot 2. This SFB will not have an outlet structure to release flows due to requirements from the gas main utility ownership of no structure to be built within the existing easements. There will be a small spillway to allow the release of large storm events. Runoff will be directed to the proposed SFB where possible.

Flow from the area north of Lot 1 (Basin O3) will pass through the site via two 24" culverts and will be discharged at the southern boundary of Lot 2, as historically done. An earthen channel will run north-south along the east side of the existing Lot 1 and Lot 2 developments. The channel is approximately 1-ft deep with 4:1 side slopes and will capture and convey any westerly flowing nuisance runoff from the proposed improvements to the sand filter detention pond as discussed in the original Barbarick Subdivision FDR, instead of the existing Lot 1 and 2 improved areas.

Runoff from the property is at historic flows and will not exceed the anticipated runoff as determined in the Sterling Ranch PDR. This is described in more detail below. The Sterling Ranch PDR includes an analysis of future drainage conditions and includes recommended infrastructure to convey this runoff. Since the Sterling Ranch surrounds the Barbarick Subdivision, it is appropriate to include the recommendations from the SR-PDR in this Proposed Drainage Discussion.

Proposed On-Site Basin Descriptions: (See Basin Map in the pocket)

On-site Basin D1 (D for Developed condition) - This developed basin encompasses approximately 11.4 acres - the majority of Lots 3 & 4 and small portions of Lots 1 & 2. This basin generates 19.7/56.0 cfs in the 5/100 year storm events and sheet flows into shallow swales that direct the runoff into the proposed EDB to be located in Lot 4. Lot 3 is based on Owner provided information for a gravel parking/vehicle storage area, and Lot 4 has been based on proposed building site improvements as identified in the rezoning application. Any changes to the land use will require an update to the Final Drainage Report; much like the original Barbarick Subdivision Final Drainage Report is being updated with the grading and Lot 4 development application.

On-site Basin D2 This undeveloped basin encompasses 1.2 acres and represents the south portion of Lot 4, below and south of the two detention ponds. This basin is historic in nature and generates 0.8/3.0 cfs and drains directly into a road side ditch within the Sterling Ranch development.

On-site Basin D3 This developed basin encompasses approximately 3.13 acres - the remaining proposed infill portions of Lots 1 and 2 (east of the currently built out Lots 1&2). As discussed in the original Barbarick Subdivision FDR, development of these areas will require a detention water quality pond. This basin generates 4.1/11.6 cfs in the 5/100 year storm events and sheet flows southerly to the proposed SFB located at the southern-most portion of Lot 2.

The following design point table is for combined allowable discharge rates from the property at respective locations including historic flows from the tributary upstream basins:

Design Point	5/100 Year	Comments
DP D1	85.4 cfs (100)	D1+O2 Pass Through
DP D2	48.9 cfs (100)	Pond Release+D2
DP D3	4.1/11.6 cfs	D3
DP D4	13.8/39.1 cfs	Pond Release +03 Pass Through

All release flows downstream are at or below historic levels.

RECOMMENDED DESIGN

Off-site Detention Facility:

This shallow pond will be modified for the proposed development to the north as part of the WS-FDR. This will eliminate the retention properties in this pond, will provide detention for off-site flows, will provide a suitable outlet structure, and will remove accumulated sediment. The modified pond will store up to 1.52 acft (66,211 cuft) to the principal spillway (elevation = 7048.05). A summary of flows into and out of this pond:

Off-site Pond Flow Summary (cfs)	**5 year**	**100 year**
Proposed Flow into offsite pond (Basin G/DP 5)	**57.4**	**92.7**
Increase in peak flow due to development	46.2	51.3
Proposed flow out of modified pond	**16.1**	**29.4**
Reduction in peak flow	41.3	63.3

For complete pond design, refer to the WS-FDR.

Proposed 30" HDPE Storm Drain from Modified Off-site Detention Pond:

This storm drain will capture flows from the discharged offsite pond and route them along the perimeter of the property daylighting into the EDB in Lot 4. 4' precast concrete manholes will be used for maintenance access at all bends and grade breaks. A grouted riprap forebay will help dissipate energy at the outlet of the pipe, and allow for settling prior to entering the pond. See the Appendix for the hydraulic analysis of this storm drain (StormCAD).

In the event of an emergency and the offsite pond fails, developed flow (Q100=93.0 cfs) will overtop the pond and be collected between the proposed roadway and pond berm.. Flow not captured by the proposed inlet will bypass easterly to the proposed offsite swale between this property and the Sterling Ranch property and conveyed southerly.

Proposed 18" HDPE Storm Drain Culvert:

A 18" HDPE culvert will convey collected runoff from Lot 3 (Developed Q100 = 15.90cfs) through Lot 4 to the FSD Pond and join sheet flow from Lot 4 and the 30" piped bypass flow from basin O2. This culvert will be privately owned and maintained by the property owners. See the Appendix for open channel calculations.

On-site FSD - EDB Pond in Lot 4 (Basin D1):

This On-site Full Spectrum Extended Detention Basin Pond provides water quality, EURV and 100-year detention. Onsite flows will combine with the 30-inch bypass flows from the north and pass through the EDB. The pond has been sized for the release of historic flows from Basin D1, as well as provides capacity for pass through conveyance of historic flows from the north.

The following table outlines the onsite existing and developed flow, required detention, and modifications to required detention utilizing the upstream over detention.

On-site Basin Flow Summary (cfs)	**5 year**	**100 year**
Existing On-site Flow at Pond	2.2	16.5
Developed On-site Flow (Basin D1)	19.7	56.0
Increase in peak flow due to development	17.5	39.5
Proposed Pass Through Flow from Off-Site Pond	16.1*	29.4
Proposed total flow out of EDB pond	0.3	45.9**

*Includes 10 year from WS-FDR
**Includes Pass Through flow of 29.4 cfs

Water Quality Benefits:
Stormwater from Lots 3 & 4, and portions of 1 &2 will drain directly to the proposed Full Spectrum Extended Detention Pond. This pond will be privately maintained and provide water quality treatment to approximately 11.4 acres of developed land.

The proposed Water Quality facility is sized using the methods derived from the UDFCD Stormwater FSD Design Workbook (UD-FSD 1.11) (see Appendix). The Water Quality Capture Volume (WQCV) will be provided in this EDB, where the "initial flush" of storm water will be drained over a 40-hour time period.

The impervious area ratio is used in the UDFCD workbook to calculate the WQCV. An adjusted impervious ratio of 57% to correlate with the land use charts and Runoff Coefficients (provided above) is being utilized for the sizing of the facility.

The EDB Pond will have a a forebay, concrete trickle channel and micro-pool within the outlet structure (per UDFCD). This outlet structure will have a bar screen and an orifice plate containing 3 rows outlets (1.55 sq in orifices for the first two, and 3.8 sq in for the last row). The EURV has been designed to an elevation of 7021.50. The top of the inlet will have a grate to allow flows that exceed the WQCV and EURV to drain through the outlet works without overtopping the spillway, with an internal orifice plate of 2.37-ft diameter constricting flows to historic release rates ($Q100_{Onsite}$ = 16.5 cfs + $Q100_{bypass}$ = 29.4 Total Release = 45.9 cfs) .

The EDB pond can store up to 64,904 cuft (1.49 acft) to the principal spillway (7023.20). The pond bottom elevation will be at 7018.50 and the top of the embankment will be at elevation 7025.10. Should the outlet works become fully blocked; the 36' spillway will have the capacity to pass the combined 100 year peak developed runoff and northerly bypass with a flow depth = 0.90' (55.0 + 29.4 = 84.4 cfs) maintaining 1-ft of freeboard. .

Summary results include:

- WQCV Volume = 0.203 ac-ft depth 1.53-ft (40 hour release)
- EURV Volume Stored = 0.677 ac-ft at depth 2.98 ft (72 hour release)
- 5 Year Volume Stored = 0.673 ac-ft at depth 2.98 ft (72 hour release)
- 100 Year Volume Stored = 1.261 ac-ft depth 4.26-ft (77 hour release)
- Emergency Spilllway Volume at Crest = 1.49 ac-ft at depth 4.7ft.

A 30" HDPE pipe will drain this outlet structure. A Low-Tailwater basin will be provided at the outlet for energy dissipation. This storm drain will daylight into the open channel just south of Lot 4 near the entrance of an existing 12" CMP. This existing 12" CMP drains under a dirt road. This dirt road will be eliminated upon development of the Sterling Ranch. Due to the limited capacity of this existing 12" CMP, runoff in excess of 5.7 cfs will overtop this dirt road, creating tail water to 7018.0. See the Appendix for the calculation results (CulvertMaster).

On-site Sand Filter Basin w/ Detention in Lot 2 (Basin D3):

A sand filter basin detention pond is being proposed to treat runoff from the proposed gravel parking portions of Lots 1 and 2 prior to discharging from the site. Due to the high pressure gas mains within this basin, grading is limited to fill only and no structures are allowed within the gas easement, so this pond will have underdrain design with partial infiltration and a controlled overflow design for the 100-year event.

The following table outlines the onsite existing and developed flow, required detention, and modifications to required detention utilizing the upstream over detention.

On-site Basin Flow Summary (cfs)	5 year	100 year
Existing On-site Flow at Pond	0.5	4.2
Developed On-site Flow (Basin D3)	4.1	11.6
Increase in peak flow due to development	3.6	7.4
Proposed total flow out of Sand Filter pond	0.1	3.6

Water Quality Benefits:
Stormwater from portions of 1 &2 will drain directly to the proposed Sand Filter Pond. This pond will be privately maintained and provide water quality treatment to approximately 3.13 acres of developed land.

The proposed Water Quality facility is sized using the methods derived from the UDFCD Stormwater Detention Design Workbook (UD-Detention 3.04) (see Appendix). The Water Quality Capture Volume (WQCV) will be provided in this SFB, where the "initial flush" of storm water will be drained over a 12-hour time period.

The impervious area ratio is used in the UDFCD workbook to calculate the WQCV. An adjusted impervious ratio of 57% to correlate with the land use charts and Runoff Coefficients (provided above) is being utilized for the sizing of the facility.

The sand filter will contain a 4" underdrain beneath 18" of CDOT Class C material. The underdrain will contain a 1.27" diameter orifice to control the outflow time in accordance with UDFCD.

The SFB pond can store up to 16,247 cu ft (0.373 acft) to the principal spillway (7025.50). The pond bottom elevation will be at 7023.00 and the top of the embankment will be at elevation 7027.37. Because the spillway acts as the 100-year control structure and notched weir design is proposed. The spillway is 5-ft wide for a depth of 10-inches for the release of the 100-year flow (3.6 cfs which is less than the 4.2 historic) then the spillway widens to 10ft for a depth of 18-inches which will have the capacity to pass the combined 100 year peak developed runoff (11.6cfs) with a flow depth = 0.5' maintaining 1-ft of freeboard.

Summary results include:

- WQCV Volume =0.039 ac-ft depth 0.37-ft (12 hour release)
- EURV Volume Stored = 0.181 ac-ft at depth 1.52 ft (42 hour release)
- 5 Year Volume Stored = 0.181 ac-ft at depth 1.52 ft (42 hour release)
- 100 Year Volume Stored = 0.394 ac-ft depth 2.83-ft (68 hour release)

Proposed (2) 24" HDPE Storm Drain Culvert:

Two 24" pipes will convey offsite flows through Lots 1 and 2 discharging to the south. The culverts will connect to a pair of existing 24" culverts entering the property and will discharge to a riprap settling basing prior to the released downstream. These culverts will be privately owned and maintained by the property owners. See the Appendix for the hydraulic analysis of this storm drain (CulvertMaster). Flow from these pipes will join the flow from the Sand Filter and discharge at Design Point 4 (combined 39.4 cfs in the 100-year event). Per the BS-FDR this flow combines with the westerly portions of Lots 1 & 2 offsite for a total release of 30.5/80.8 cfs in the 5/100 year events.

As stated above in the summary from the Sterling Ranch PDR, the anticipated runoff from this proposed discharge point (aka: SR-PDR Basin H4) is 30.5/80.8 cfs (5/100 year) due to the large pass through flow. A 42" RCP is planned to convey this flow through Sterling Ranch.

DRAINAGE, BRIDGE, AND POND FEES

This subdivision has already been platted. No additional Drainage, Bridge or Pond fees are required.

MAINTENANCE

All proposed storm drain infrastructure will be located within private property and will be owned and maintained by the property owner. The detention pond will be owned and maintained by the property owner and will require maintenance consisting of routine inspections, removal of debris from the detention area, and bi-annual inspections for hydraulic performance of the basin. Refer to the DCM for exact maintenance criteria and for other Best Management Practices (BMP).

EROSION CONTROL

Best Management Practices (BMPs) will be utilized to minimize erosion during construction and will be shown on the construction drawings. These will be in accordance with will be utilized as deemed necessary by the contractor and/or engineer. The contractor shall minimize the amount of area disturbed during all construction activities.

In general, the following shall be applied in developing the sequence of major activities;

1. Install down slope and side slope perimeter BMPs *before* the land disturbing activity occurs.
2. Do not disturb area until it is necessary for the construction activity to proceed.
3. Cover or stabilize exposed areas as soon as possible.
4. Time the construction activities to reduce the impacts from seasonal climatic changes or weather events.
5. The construction of permanent filtration BMPs should wait until the end of the construction project when drainage areas have been stabilized.
6. Do not remove the temporary erosion controls until after all areas are stabilized.

Slopes

Erosion control soil retention blankets shall be installed where noted on slopes 3:1 or steeper. At a minimum, coconut/straw blend fiber material blankets should be used. The silt fence or erosion logs shall be installed at the toe of fill slopes where noted on a level contour. Erosion logs shall also be installed on slopes greater than ten feet in height where noted to reduce runoff length. The erosion logs shall be installed on a level contour. Disturbed surfaces shall be left in a roughened condition at all times when horizontal depressions approximately 2" to 4" deep, spaced 4" to 6" apart. Silt fence and erosion logs shall remain in place until all construction is complete and/or "finally stabilized", after which the silt fence and erosion logs shall be removed from the slopes. All material shall be installed per manufacturer's installation instructions.

Stockpiles/Mobilization/Winter Shutdown

Soils stockpiled for more than 30 days shall be mulched with mulch tackifier and native seeding within 14 days of stockpile construction. After mobilization and prior to winter shutdown, all disturbed slopes not completed shall be mulched with mulch tackifier and native seeding.

Inlet and Outlet Protection

Storm Drain Inlet Protection shall be provided at all storm inlets. Outlet protection shall be provided at all pipe outlet and runoff / rundown treatment locations. All materials shall be installed per manufacturer's installation instructions.

Concrete Washout

Concrete washout structures shall be installed for cleaning concrete trucks. The concrete washout structure shall be constructed such that water can only evaporate or infiltrate from the structure . Residue and concrete from the washout structure shall be periodically cleaned out and properly disposed.

Erosion Control Supervisor and Maintenance

The erosion control supervisor shall be a person other than the superintendent. The erosion control supervisor shall inspect at least every 14 days and after any precipitation or snowmelt event that causes surface erosion. At sites where construction has been completed but a vegetative cover has not been established, these inspections must occur at least once per month.

All erosion control measures shall remain in place until all construction is complete and final stabilization has been achieved. "Final stabilization" is where all disturbed areas

have been built on, paved, or germinated with a uniform vegetative cover with a density of at least 70% of pre-disturbance levels. Equivalent permanent, physical erosion reduction methods may also be employed. Any areas not meeting this standard shall be repaired according to the BMP guidelines. Accumulated sediment and debris shall be removed when the sediment level reaches one half the height of the BMP or when the sediment/debris adversely impacts the functionality of the BMP. The Contractor shall remove all sediment, mud, and construction debris that may accumulate in public right of ways not designated before-hand as a result of this construction project. All repairs, removals, and replacements stated above shall be conducted in a timely manner.

Cost Estimate

The proposed drainage system to be constructed will be privately owned and maintained. The developer will be responsible for constructing the proposed improvements.

An engineer's estimate of probable construction costs has been provided for the proposed improvements. The storm sewer systems will be located in the Sand Creek Drainage Basin. The construction cost for the improvements are not eligible for reimbursement.

Engineer's Estimate of Probable Construction Costs
Tri-Lakes Construction - Sand Creek Drainage Basin
Non-Reimbursable Private Improvements

Item	Unit	Quantity	Unit Cost	Total Cost
Precast Manhole	EA	4	$2,500	$10,000
18" HDPE Pipe	LF	231	$45	$10,395
24" HDPE Pipe	LF	1212	$60	$72,720
30" HDPE Pipe	LF	1128	$72	$81,216
18" Flared End	EA	2	$225	$450
24" Flared End	EA	2	$250	$500
24" CMP-HDPE	EA	2	$200	$400
30" Flared End	EA	1	$350	$350
CDOT Type D Inlet	EA	1	$4,000	$4,000
EDB Pond Outlet	EA	1	$35,000	$35,000
			SubTotal	$215,031.00
			15% Contingency	$32,254.65
			Total Estimate	**$247,285.65**

REFERENCES

1. ***City of Colorado Springs & El Paso County Drainage Criteria Manual, Volumes I and II***, dated May 2014 including subsequent updates

2. ***City of Colorado Springs & El Paso County Drainage Criteria Manual, Volumes I and II***, dated November 1991 including subsequent updates

3. **Appendix I of the El Paso County's Engineering Criteria Manual** (ECM), 2008).

4. ***Urban Storm Drainage Criteria Manuals, Volumes 1-3***, published by the Urban Drainage and Flood Control District, (Volumes 1 & 2 dated 2016, Volume 3 dated 2015)

5. ***Preliminary Drainage Report for Sterling Ranch-Phase 1, Sand Creek Drainage Basin***, M & S Civil Consultants, Inc., May 2015

6. ***Woodmen Storage Final Drainage Report, El Paso County,*** Calibre Engineering, Inc., July 2004; Revised February, 2010; Revised May, 2010; Revised July, 2010

7. ***Preliminary and Final Drainage Plan and Report for Barbarick Subdivision, El Paso County***, Oliver E. Watts Consulting Engineer Inc., January 2005; Revised October 2005; Revised December 2006; Revised May 2007; Revised August 15, 2007

8. ***NOAA Atlas 14, Volume 8 Version 2*** U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Hydrometeorological Design Studies Center.

9. FEMA Map Service Center: http://msc.fema.gov

10. NRCS Web Soil Survey. http://websoilsurvey.nrcs.usda.gov

APPENDIX A

HYDROLOGIC AND HYDRAULIC CALCULATIONS

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Barbarick Subdivision
Catchment ID: H-1 5 Year

I. Catchment Hydrologic Data

Catchment ID = H1
Area = 10.70 Acres
Percent Imperviousness = 2.00 %
NRCS Soil Type = B A, B, C, or D

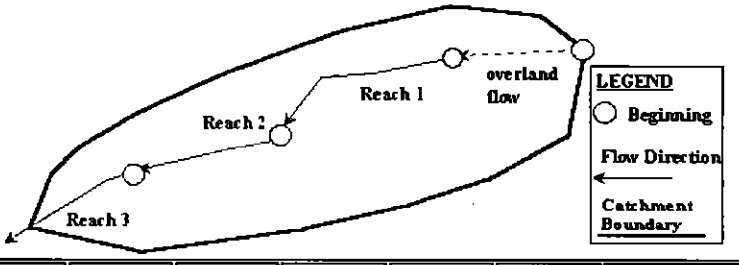
II. Rainfall Information i (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 5 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 1.23 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.08
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.08
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0300	300	0.08	N/A	0.23	22.16
1	0.0300	338		10.00	1.73	3.25
2						
3						
4						
5						
	Sum	638				

Computed Tc = 25.42
Regional Tc = 13.54
User-Entered Tc = 13.54

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 2.12 inch/hr — Peak Flowrate, Qp = 1.85 cfs
Rainfall Intensity at Regional Tc, I = 2.93 inch/hr — Peak Flowrate, Qp = 2.56 cfs
Rainfall Intensity at User-Defined Tc, I = 2.93 inch/hr — Peak Flowrate, Qp = 2.56 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Barbarick Subdivision
Catchment ID: H-1 100 Year

I. Catchment Hydrologic Data

Catchment ID = H1
Area = 10.70 Acres
Percent Imperviousness = 2.00 %
NRCS Soil Type = B A, B, C, or D

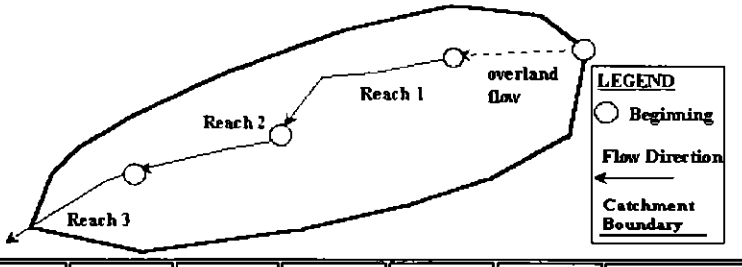
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.57 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.36
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.08
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0300	300	0.08	N/A	0.23	22.16
1	0.0300	338		10.00	1.73	3.25
2						
3						
4						
5						
	Sum	638				

Computed Tc = 25.42
Regional Tc = 13.54
User-Entered Tc = 13.54

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 4.44 inch/hr — Peak Flowrate, Qp = 17.20 cfs
Rainfall Intensity at Regional Tc, I = 6.12 inch/hr — Peak Flowrate, Qp = 23.71 cfs
Rainfall Intensity at User-Defined Tc, I = 6.12 inch/hr — Peak Flowrate, Qp = 23.71 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Barbarick Subdivision
Catchment ID: H-2 5 Year

I. Catchment Hydrologic Data

Catchment ID = H2
Area = 3.70 Acres
Percent Imperviousness = 2.00 %
NRCS Soil Type = B A, B, C, or D

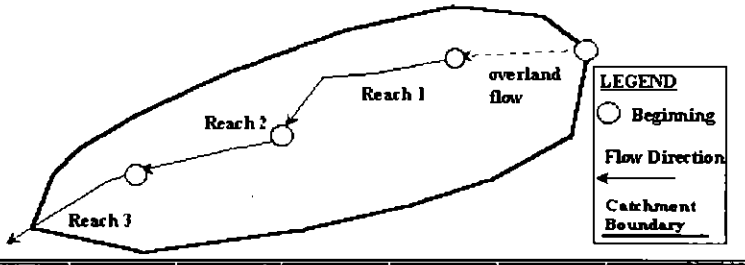
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 5 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 1.23 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.08
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.08
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0380	155	0.08	N/A	0.18	14.74
1	0.0350	515		10.00	1.87	4.59
2						
3						
4						
5						
	Sum	670				

Computed Tc = 19.32
Regional Tc = 13.72
User-Entered Tc = 13.72

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 2.46 inch/hr — Peak Flowrate, Qp = 0.74 cfs
Rainfall Intensity at Regional Tc, I = 2.91 inch/hr — Peak Flowrate, Qp = 0.88 cfs
Rainfall Intensity at User-Defined Tc, I = 2.91 inch/hr — Peak Flowrate, Qp = 0.88 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Barbarick Subdivision
Catchment ID: H-2 100 Year

I. Catchment Hydrologic Data

Catchment ID = H2
Area = 3.70 Acres
Percent Imperviousness = 2.00 %
NRCS Soil Type = B A, B, C, or D

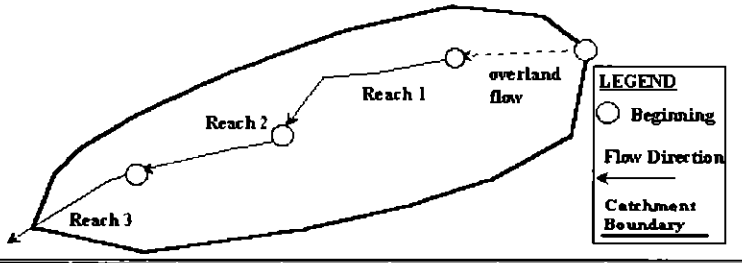
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.57 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.36
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.08
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0380	155	0.08	N/A	0.18	14.74
1	0.0350	515		10.00	1.87	4.59
2						
3						
4						
5						
	Sum	670				

Computed Tc = 19.32
Regional Tc = 13.72
User-Entered Tc = 13.72

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 5.15 inch/hr — Peak Flowrate, Qp = 6.90 cfs
Rainfall Intensity at Regional Tc, I = 6.08 inch/hr — Peak Flowrate, Qp = 8.15 cfs
Rainfall Intensity at User-Defined Tc, I = 6.08 inch/hr — Peak Flowrate, Qp = 8.15 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Barbarick Subdivision
Catchment ID: H-3 5 year

I. Catchment Hydrologic Data

Catchment ID = H3
Area = 1.11 Acres
Percent Imperviousness = 2.00 %
NRCS Soil Type = B A, B, C, or D

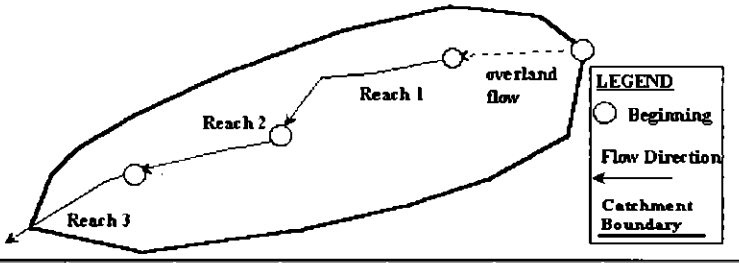
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 5 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 1.23 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.08
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.08
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0250	338	0.08	N/A	0.23	24.98
1						
2						
3						
4						
5						
	Sum	338				

Computed Tc = 24.98
Regional Tc = 11.88
User-Entered Tc = 11.88

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 2.14 inch/hr — Peak Flowrate, Qp = 0.19 cfs
Rainfall Intensity at Regional Tc, I = 3.10 inch/hr — Peak Flowrate, Qp = 0.28 cfs
Rainfall Intensity at User-Defined Tc, I = 3.10 inch/hr — Peak Flowrate, Qp = 0.28 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Barbarick Subdivision
Catchment ID: H-3 100 year

I. Catchment Hydrologic Data

Catchment ID = H3
Area = 1.11 Acres
Percent Imperviousness = 2.00 %
NRCS Soil Type = B A, B, C, or D

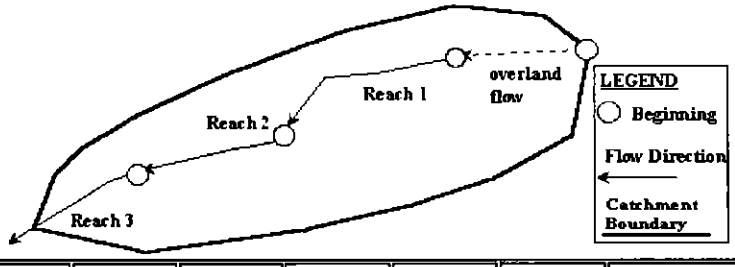
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.67 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.36
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.08
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0250	338	0.08	N/A	0.23	24.98
1						
2						
3						
4						
5						
	Sum	338				

Computed Tc = 24.98
Regional Tc = 11.88
User-Entered Tc = 11.88

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 4.65 inch/hr — Peak Flowrate, Qp = 1.87 cfs
Rainfall Intensity at Regional Tc, I = 6.73 inch/hr — Peak Flowrate, Qp = 2.71 cfs
Rainfall Intensity at User-Defined Tc, I = 6.73 inch/hr — Peak Flowrate, Qp = 2.71 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Barbarick Subdivision
Catchment ID: D-2 5 Year

I. Catchment Hydrologic Data

Catchment ID = D2
Area = 1.20 Acres
Percent Imperviousness = 2.00 %
NRCS Soil Type = B A, B, C, or D

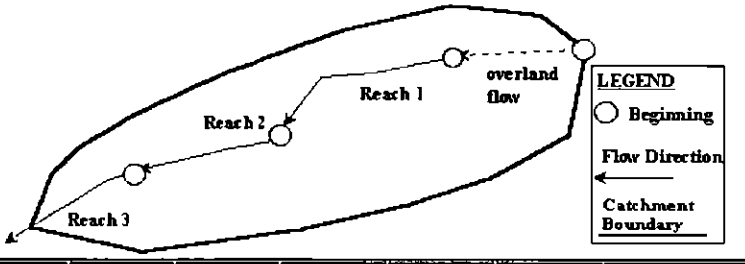
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 5 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 1.23 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.08
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.08
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0200	155	0.08	N/A	0.14	18.21
1						
2						
3						
4						
5						
	Sum	155				

Computed Tc = 18.21
Regional Tc = 10.86
User-Entered Tc = 10.86

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 2.54 inch/hr — Peak Flowrate, Qp = 0.25 cfs
Rainfall Intensity at Regional Tc, I = 3.22 inch/hr — Peak Flowrate, Qp = 0.32 cfs
Rainfall Intensity at User-Defined Tc, I = 3.22 inch/hr — Peak Flowrate, Qp = 0.32 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Barbarick Subdivision
Catchment ID: D2 - 100yr

I. Catchment Hydrologic Data

Catchment ID = D2
Area = 1.20 Acres
Percent Imperviousness = 2.00 %
NRCS Soil Type = B A, B, C, or D

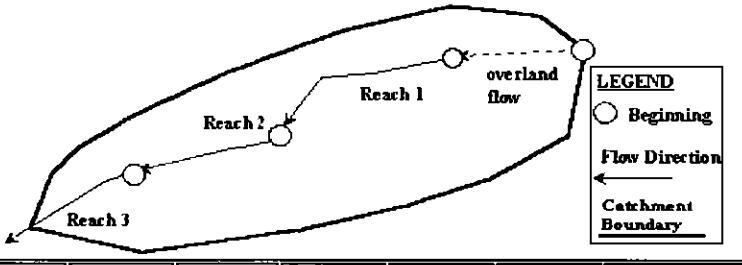
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.57	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.36
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.08
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0200	85	0.08	N/A	0.11	13.49
1						
2						
3						
4						
5						
	Sum	85				

Computed Tc = 13.49
Regional Tc = 10.47
User-Entered Tc = 10.47

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I =	6.13	inch/hr	Peak Flowrate, Qp = 2.66 cfs
Rainfall Intensity at Regional Tc, I =	6.83	inch/hr	Peak Flowrate, Qp = 2.97 cfs
Rainfall Intensity at User-Defined Tc, I =	6.83	inch/hr	Peak Flowrate, Qp = 2.97 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Barbarick Subdivision
Catchment ID: Lot3-Culvert 100yr

I. Catchment Hydrologic Data

Catchment ID = Lot 3
Area = 4.86 Acres
Percent Imperviousness = 57.00 %
NRCS Soil Type = B A, B, C, or D

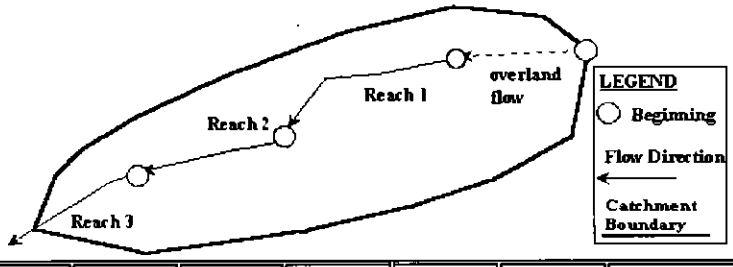
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.57 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.55
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.39
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0300	300	0.39	N/A	0.32	15.41
1	0.0100	500		10.00	1.00	8.33
2						
3						
4						
5						
	Sum	800				

Computed Tc = 23.74
Regional Tc = 14.44
User-Entered Tc = 14.44

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 4.61 inch/hr — Peak Flowrate, Qp = 12.34 cfs
Rainfall Intensity at Regional Tc, I = 5.94 inch/hr — Peak Flowrate, Qp = 15.90 cfs
Rainfall Intensity at User-Defined Tc, I = 5.94 inch/hr — Peak Flowrate, Qp = 15.90 cfs

Matrix DESIGN GROUP

Final Design for Full Spectrum Detention Basins

Project: Barbarick Subdivision

Basin ID: Lot 3 FSD Pond

User Input: Watershed Parameters

Watershed Area =	11.40	acres
Watershed Length =	668	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	57.0%	percent
Percentage Hydrologic Soil Group A =	5%	percent
Percentage Hydrologic Soil Group B =	95%	percent
Percentage Hydrologic Soil Groups C/D =	0%	percent
Location for 1-hr Rainfall Depths =	User Input	

See Outlet Structure Figure on Initial Design Worksheet

User Input: Detention Basin Parameters

Depth of Initial Surcharge Volume =	0.33	ft
Depth of Trickle Channel =	0.50	ft
Trickle Channel Slope =	0.005	ft/ft
Available EURV Ponding Depth =	3.00	ft (2.99 ft recommended)
Desired WQCV Drain Time =	40	hours

User Input: Outlet Structure Parameters

Overflow Weir Front Edge Height, H_o =	3.3	ft (relative to lowest WQ orifice)
Overflow Weir Front Edge Length =	6.0	ft
Overflow Weir Slope =	0	H:V (enter zero for flat grate)
Horizontal Length of the Overflow Weir Sides =	3.5	ft
Overflow Grate Open Area % =	70%	%, grate open area / total area
Debris Clogging % =	50%	%

Calculated Outlet Discharge Parameters

Height of Grate Upper Edge H_t =	3.3	ft
Over Flow Weir Slope Length =	3.5	ft
Grate Open Area /100-yr Orifice Area =	9.3	should be ≥ 4
Overflow Grate Area w/o Debris =	14.7	ft^2

User Input: Water Quality Orifices [numbered from lowest to highest]

	Row 1	Row 2	Row 3	Row 4	Row 5
Area [sq inch]	1.55	1.55	3.80		
Stage [ft]	0.00	1.00	2.00		

	Row 6	Row 7	Row 8	Row 9	Row 10
Area [sq inch]					
Stage [ft]					

User Input: 100-Year Orifice Parameters

100-yr Restrictor Plate Type =	Circular Orifice	
100-Year Orifice Invert Depth =	1.2	ft (below the lowest WQ orifice)
100-Year Orifice Diameter =	17.0	in

Calculated 100-yr Orifice Parameters

100-Year Orifice Area =	1.6	ft^2
100-Year Orifice Centroid =	0.71	ft
Half-Central Angle of Plate on Pipe =		radians

User Input: Emergency Spillway Parameters

Spillway Invert Stage=	4.7	ft (relative to lowest WQ orifice)
Spillway Crest Length =	23	ft
Spillway End Slopes =	4.0	H:V
Freeboard above Spillway =	1.0	ft

Calculated Spillway Parameters

Spillway Design Flow Depth=	0.8	ft
Stage at Top of Freeboard =	6.5	ft
Basin Area at Top of Freeboard =	0.63	acres

User Defined Stage [ft]	User Defined Area [ft^2]	User Defined Volume [ac-ft]
0.00	1,250	0.00
0.50	4,076	0.03
1.50	10,413	0.19
2.50	15,584	0.49
3.00	17,528	0.68
3.50	19,472	0.89
4.50	23,488	1.38
4.70	24,472	1.49
5.50	27,426	1.97
6.50	31,603	2.64

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

Project: Berhanick 1-4

Basin ID: D3

Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	SF	
Watershed Area =	3.13	acres
Watershed Length =	648	ft
Watershed Slope =	0.030	ft/ft
Watershed Imperviousness =	97.00%	percent
Percentage Hydrologic Soil Group A =	5.0%	percent
Percentage Hydrologic Soil Group B =	95.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	12.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	0.047	acre-feet
Excess Urban Runoff Volume (EURV) =	0.184	acre-feet
2-yr Runoff Volume (P1 = 0.95 in.) =	0.128	acre-feet
5-yr Runoff Volume (P1 = 1.23 in.) =	0.194	acre-feet
10-yr Runoff Volume (P1 = 1.48 in.) =	0.253	acre-feet
25-yr Runoff Volume (P1 = 1.85 in.) =	0.353	acre-feet
50-yr Runoff Volume (P1 = 2.21 in.) =	0.452	acre-feet
100-yr Runoff Volume (P1 = 2.57 in.) =	0.554	acre-feet
500-yr Runoff Volume (P1 = 0 in.) =	0.000	acre-feet
Approximate 2-yr Detention Volume =	0.122	acre-feet
Approximate 5-yr Detention Volume =	0.178	acre-feet
Approximate 10-yr Detention Volume =	0.204	acre-feet
Approximate 25-yr Detention Volume =	0.237	acre-feet
Approximate 50-yr Detention Volume =	0.273	acre-feet
Approximate 100-yr Detention Volume =	0.336	acre-feet

Optional User Input 1-hr Precipitation	
0.95	inches
1.23	inches
1.48	inches
1.85	inches
2.21	inches
2.57	inches
	inches

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.047	acre-feet
Zone 2 Volume (100-year - Zone 1) =	0.289	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.336	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	2.50	ft
Depth of Trickle Channel (H_{TC}) =	N/A	ft
Slope of Trickle Channel (S_{TC}) =	N/A	ft/ft
Slopes of Main Basin Sides (S_{main}) =	4	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	1.5	

Initial Surcharge Area (A_{ISV}) =	0	ft^2
Surcharge Volume Length (L_{ISV}) =	0.0	ft
Surcharge Volume Width (W_{ISV}) =	0.0	ft
Depth of Basin Floor (H_{FLOOR}) =	0.00	ft
Length of Basin Floor (L_{FLOOR}) =	81.0	ft
Width of Basin Floor (W_{FLOOR}) =	54.0	ft
Area of Basin Floor (A_{FLOOR}) =	4,370	ft^2
Volume of Basin Floor (V_{FLOOR}) =	0	ft^3
Depth of Main Basin (H_{Main}) =	2.50	ft
Length of Main Basin (L_{Main}) =	101.0	ft
Width of Main Basin (W_{Main}) =	74.0	ft
Area of Main Basin (A_{Main}) =	7,469	ft^2
Volume of Main Basin (V_{Main}) =	14,626	ft^3
Calculated Total Basin Volume (V_{total}) =	0.336	acre-feet

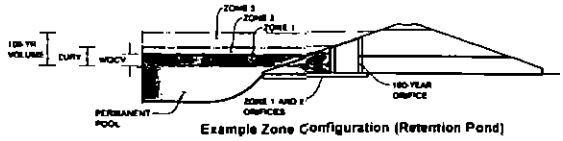
Depth Increment = 0.1 ft

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)
Media Surface	0.00		81.0	54.0	4,370		0.100		
	0.10		81.6	54.8	4,478		0.103	442	0.010
	0.20		82.5	55.5	4,577		0.105	890	0.020
	0.30		83.3	56.3	4,688		0.108	1,313	0.030
	0.40		84.1	57.1	4,801		0.110	1,788	0.041
Zone 1 (WQCV)	0.45		84.5	57.6	4,869		0.112	2,078	0.048
	0.50		84.9	57.9	4,914		0.113	2,273	0.052
	0.60		85.7	58.7	5,029		0.115	2,770	0.064
	0.70		86.5	59.5	5,145		0.118	3,279	0.075
	0.80		87.3	60.3	5,263		0.121	3,800	0.087
	0.90		88.1	61.1	5,381		0.124	4,332	0.099
	1.00		88.9	61.9	5,501		0.126	4,876	0.112
	1.10		89.7	62.7	5,622		0.129	5,432	0.125
	1.20		90.5	63.5	5,745		0.132	6,000	0.138
	1.30		91.3	64.3	5,868		0.135	6,581	0.151
	1.40		92.1	65.1	5,994		0.138	7,174	0.165
	1.50		92.9	65.9	6,120		0.141	7,780	0.179
	1.60		93.7	66.7	6,248		0.143	8,398	0.193
	1.70		94.5	67.5	6,377		0.146	9,030	0.207
	1.80		95.3	68.3	6,507		0.149	9,674	0.222
	1.90		96.1	69.1	6,639		0.152	10,331	0.237
	2.00		96.9	69.9	6,771		0.155	11,001	0.253
	2.10		97.8	70.8	6,919		0.159	11,754	0.270
	2.20		98.6	71.6	7,054		0.162	12,453	0.286
	2.30		99.4	72.4	7,191		0.165	13,165	0.302
	2.40		100.2	73.2	7,329		0.168	13,891	0.319
Zone 2 (100-year)	2.50		101.0	74.0	7,469		0.171	14,631	0.336
	2.60		101.8	74.8	7,609		0.175	15,385	0.353
	2.70		102.6	75.6	7,751		0.178	16,153	0.371
	2.80		103.4	76.4	7,894		0.181	16,935	0.389
	2.90		104.2	77.2	8,039		0.185	17,732	0.407
	3.00		105.0	78.0	8,184		0.188	18,543	0.426
	3.10		105.8	78.8	8,331		0.191	19,369	0.445
	3.20		106.6	79.6	8,480		0.195	20,209	0.464
	3.30		107.4	80.4	8,629		0.198	21,065	0.484
	3.40		108.2	81.2	8,780		0.202	21,935	0.504
	3.50		109.0	82.0	8,932		0.205	22,821	0.524
	3.60		109.8	82.8	9,086		0.209	23,722	0.545
	3.70		110.6	83.6	9,240		0.212	24,639	0.566
	3.80		111.4	84.4	9,396		0.216	25,570	0.587
	3.90		112.2	85.2	9,553		0.219	26,517	0.609
	4.00		113.0	86.0	9,712		0.223	27,480	0.631
	4.10		113.8	86.8	9,872		0.227	28,460	0.653
	4.20		114.6	87.6	10,033		0.230	29,455	0.676
	4.30		115.4	88.4	10,195		0.234	30,466	0.699
	4.40		116.2	89.2	10,359		0.238	31,494	0.723
	4.50		117.0	90.0	10,523		0.242	32,538	0.747
	4.60		117.8	90.8	10,690		0.245	33,599	0.771
	4.70		118.6	91.6	10,857		0.249	34,676	0.796
	4.80		119.4	92.4	11,026		0.253	35,770	0.821
	4.90		120.2	93.2	11,196		0.257	36,881	0.847
	5.00		121.0	94.0	11,367		0.261	38,008	0.873
	5.10		121.8	94.8	11,540		0.265	39,153	0.899
	5.20		122.6	95.6	11,714		0.269	40,317	0.926
	5.30		123.4	96.4	11,889		0.273	41,497	0.953
	5.40		124.2	97.2	12,066		0.277	42,695	0.980
	5.50		125.0	98.0	12,243		0.281	43,911	1.008
	5.60		125.8	98.8	12,422		0.285	45,144	1.036
	5.70		126.6	99.6	12,602		0.289	46,395	1.065
	5.80		127.4	100.4	12,784		0.293	47,664	1.094
	5.90		128.2	101.2	12,967		0.298	48,952	1.124
	6.00		129.0	102.0	13,151		0.302	50,258	1.154
	6.10		129.8	102.8	13,336		0.306	51,582	1.184
	6.20		130.6	103.6	13,523		0.310	52,925	1.215
	6.30		131.4	104.4	13,711		0.315	54,287	1.246
	6.40		132.2	105.2	13,900		0.319	55,667	1.278
	6.50		133.0	106.0	14,090		0.323	57,067	1.310
	6.60		133.8	106.8	14,282		0.328	58,486	1.343
	6.70		134.6	107.6	14,475		0.332	59,923	1.376
	6.80		135.4	108.4	14,670		0.337	61,380	1.409
	6.90		136.2	109.2	14,866		0.341	62,857	1.443
	7.00		137.0	110.0	15,062		0.346	64,353	1.477
	7.10		137.8	110.8	15,260		0.350	65,870	1.512
	7.20		138.6	111.6	15,460		0.355	67,408	1.547
	7.30		139.4	112.4	15,661		0.360	68,967	1.583
	7.40		140.2	113.2	15,863		0.364	70,548	1.619
	7.50		141.0	114.0	16,066		0.369	72,134	1.656
	7.60		141.8	114.8	16,271		0.374	73,751	1.693
	7.70		142.6	115.6	16,476		0.378	75,388	1.731
	7.80		143.4	116.4	16,684		0.383	77,046	1.769
	7.90		144.2	117.2	16,892		0.388	78,725	1.807
	8.00		145.0	118.0	17,102		0.393	80,425	1.846
	8.10		145.8	118.8	17,313		0.397	82,145	1.886
	8.20		146.6	119.6	17,525		0.402	83,887	1.926
	8.30		147.4	120.4	17,738		0.407	85,650	1.966
	8.40		148.2	121.2	17,953		0.412	87,435	2.007
	8.50		149.0	122.0	18,169		0.417	89,241	2.049
	8.60		149.8	122.8	18,387		0.422	91,068	2.091
	8.70		150.6	123.6	18,605		0.427	92,919	2.133
	8.80		151.4	124.4	18,825		0.432	94,790	2.176
	8.90		152.2	125.2	19,047		0.437	96,684	2.220
	9.00		153.0	126.0	19,269		0.442	98,598	2.264
	9.10		153.8	126.8	19,493		0.447	100,536	2.308
	9.20		154.6	127.6	19,718		0.453	102,496	2.353
	9.30		155.4	128.4	19,944		0.458	104,481	2.399
	9.40		156.2	129.2	20,172		0.463	106,487	2.445
	9.50		157.0	130.0	20,401		0.468	108,516	2.491
	9.60		157.8	130.8	20,631		0.474	110,567	2.538
	9.70		158.6	131.6	20,863		0.479	112,642	2.586

Detention Basin Outlet Structure Design

Project: Barbarick Subdivision

Basin ID: D3



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.45	0.047	Filtration Media
Zone 2 (100-year)	2.50	0.289	Not Utilized
Zone 3			
		0.336	Total

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

Underdrain Orifice Invert Depth =	1.00	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	1.27	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	0.0	ft^2
Underdrain Orifice Centroid =	0.05	feet

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

Invert of Lowest Orifice =	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	N/A	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (optional)	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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

	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)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Orifice Area (sq. inches)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Slope =			H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =			feet
Overflow Grate Open Area % =			%, grate open area/total area
Debris Clogging % =			%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Over Flow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			should be ≥ 4
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

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

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected	
Outlet Orifice Area =			ft^2
Outlet Orifice Centroid =			feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	2.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	5.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.66	feet
Stage at Top of Freeboard =	4.16	feet
Basin Area at Top of Freeboard =	0.23	acres

Routed Hydrograph Results

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) =	0.53	1.07	0.95	1.23	1.48	1.88	2.21	2.57	0.00
Calculated Runoff Volume (acre-ft) =	0.047	0.194	0.128	0.194	0.253	0.363	0.452	0.554	0.000
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.047	0.194	0.127	0.194	0.253	0.363	0.451	0.553	#N/A
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.17	0.34	0.80	1.04	1.33	1.89
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.5	1.1	2.5	3.2	4.2	5.9
Peak Inflow Q (cfs) =	1.0	4.1	2.7	4.1	5.3	7.6	9.4	11.6	#N/A
Peak Outflow Q (cfs) =	0.0	0.1	0.1	0.1	0.1	0.2	1.7	3.6	#N/A
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.1	0.1	0.5	0.9	#N/A
Structure Controlling Flow =	Filtration Media	Filtration Media	Filtration Media	Filtration Media	Filtration Media	Spillway	Spillway	Spillway	#N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	#N/A
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) =	12	41	29	41	51	66	65	65	#N/A
Time to Drain 99% of Inflow Volume (hours) =	13	42	30	42	52	68	68	68	#N/A
Maximum Ponding Depth (ft) =	0.37	1.52	1.04	1.52	1.91	2.55	2.71	2.83	#N/A
Area at Maximum Ponding Depth (acres) =	0.11	0.14	0.13	0.14	0.15	0.17	0.18	0.18	#N/A
Maximum Volume Stored (acre-ft) =	0.039	0.181	0.117	0.181	0.240	0.343	0.371	0.394	#N/A

APPENDIX B

STORMCAD INFORMATION

Culvert Calculator Report
Twin 24" Culvert

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.00	ft	Headwater Depth/Height	1.32	
Computed Headwater Elev	7,038.15	ft	Discharge	35.50	cfs
Inlet Control HW Elev.	7,038.10	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	7,038.15	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	7,035.51	ft	Downstream Invert	7,020.00	ft
Length	606.00	ft	Constructed Slope	0.025594	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.94	ft
Slope Type	Steep		Normal Depth	0.94	ft
Flow Regime	Supercritical		Critical Depth	1.52	ft
Velocity Downstream	12.17	ft/s	Critical Slope	0.006140	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	7,038.15	ft	Upstream Velocity Head	0.75	ft
Ke	0.50		Entrance Loss	0.37	ft

Inlet Control Properties					
Inlet Control HW Elev.	7,038.10	ft	Flow Control	Transition	
Inlet Type	Square edge w/headwall		Area Full	6.3	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Calculator Report
Outlet Pipe

Solve For: Discharge

Culvert Summary					
Allowable HW Elevation	7,023.10	ft	Headwater Depth/Height	2.07	
Computed Headwater Elev	7,023.10	ft	Discharge	55.60	cfs
Inlet Control HW Elev.	7,023.10	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	7,022.97	ft	Control Type	Inlet Control	

Grades					
Upstream Invert	7,017.92	ft	Downstream Invert	7,017.52	ft
Length	40.00	ft	Constructed Slope	0.010000	ft/ft

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	2.36	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	2.36	ft
Velocity Downstream	11.58	ft/s	Critical Slope	0.013538	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Concrete		Span	2.50	ft
Section Size	30 inch		Rise	2.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	7,022.97	ft	Upstream Velocity Head	1.99	ft
Ke	0.20		Entrance Loss	0.40	ft

Inlet Control Properties					
Inlet Control HW Elev.	7,023.10	ft	Flow Control	Submerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	4.9	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

O2-Overflow Channel

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.050	
Channel Slope	0.02000	ft/ft
Normal Depth	2.00	ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	4.00	ft

Results

Discharge	94.99	ft^3/s
Flow Area	20.00	ft^2
Wetted Perimeter	16.65	ft
Hydraulic Radius	1.20	ft
Top Width	16.00	ft
Critical Depth	1.73	ft
Critical Slope	0.03707	ft/ft
Velocity	4.75	ft/s
Velocity Head	0.35	ft
Specific Energy	2.35	ft
Froude Number	0.75	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.73	ft
Channel Slope	0.02000	ft/ft

O2-Overflow Channel

GVF Output Data

Critical Slope	0.03707	ft/ft

Worksheet for Open Channel Culvert Lot 3

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.012	
Channel Slope	0.03000	ft/ft
Diameter	1.50	ft
Discharge	15.90	ft^3/s

Results

Normal Depth	1.02	ft
Flow Area	1.28	ft^2
Wetted Perimeter	2.91	ft
Hydraulic Radius	0.44	ft
Top Width	1.40	ft
Critical Depth	1.42	ft
Percent Full	68.1	%
Critical Slope	0.01690	ft/ft
Velocity	12.41	ft/s
Velocity Head	2.39	ft
Specific Energy	3.41	ft
Froude Number	2.29	
Maximum Discharge	21.20	ft^3/s
Discharge Full	19.71	ft^3/s
Slope Full	0.01952	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	68.08	%
Downstream Velocity	Infinity	ft/s

Worksheet for Open Channel Culvert Lot 3

GVF Output Data

Upstream Velocity	Infinity	ft/s
Normal Depth	1.02	ft
Critical Depth	1.42	ft
Channel Slope	0.03000	ft/ft
Critical Slope	0.01690	ft/ft

Worksheet for Outlet with Passthrough-Weir

Project Description

Solve For	Discharge

Input Data

Headwater Elevation		1.40	ft
Crest Elevation		0.00	ft
Tailwater Elevation		0.00	ft
Weir Coefficient		3.00	US
Crest Length		32.00	ft
Number Of Contractions	0		

Results

Discharge	159.02	ft^3/s
Headwater Height Above Crest	1.40	ft
Tailwater Height Above Crest	0.00	ft
Flow Area	44.80	ft^2
Velocity	3.55	ft/s
Wetted Perimeter	34.80	ft
Top Width	32.00	ft

Weir is more restrictive than Orifice.
159.02 cfs
70% Gate Opening
50% Clogging
= 55.66 cfs > 45.9 tributary
→ Install orifice Restrictor on outlet pipe.

Worksheet for Outlet wPass - Orifice

Project Description

Solve For	Discharge

Input Data

Headwater Elevation	1.40	ft
Centroid Elevation	0.00	ft
Tailwater Elevation	0.00	ft
Discharge Coefficient	0.60	
Opening Width	4.00	ft
Opening Height	12.00	ft

Results

Discharge	273.35	ft^3/s
Headwater Height Above Centroid	1.40	ft
Tailwater Height Above Centroid	0.00	ft
Flow Area	48.00	ft^2
Velocity	5.69	ft/s

Top Box Weir is more Restrictive
USE Weir Calculations.

Worksheet for FSD Outlet Orifice Plate

Project Description

Solve For	Diameter

Input Data

Discharge	45.90	ft³/s	(16.5 Hs + 29.4 Pcc)
Headwater Elevation	4.70	ft	
Centroid Elevation	0.00	ft	
Tailwater Elevation	0.00	ft	
Discharge Coefficient	0.60		

Results

Diameter	2.37	ft
Headwater Height Above Centroid	4.70	ft
Tailwater Height Above Centroid	0.00	ft
Flow Area	4.40	ft²
Velocity	10.43	ft/s

Worksheet for FSD Overflow - Pass

Project Description

Solve For	Discharge

Input Data

Headwater Elevation	0.90	ft
Crest Elevation	0.00	ft
Tailwater Elevation	0.00	ft
Crest Surface Type	Gravel	
Crest Breadth	12.00	ft
Crest Length	36.00	ft

Results

Discharge	86.22	ft^3/s
Headwater Height Above Crest	0.90	ft
Tailwater Height Above Crest	0.00	ft
Weir Coefficient	2.80	US
Submergence Factor	1.00	
Adjusted Weir Coefficient	2.80	US
Flow Area	32.40	ft^2
Velocity	2.66	ft/s
Wetted Perimeter	37.80	ft
Top Width	36.00	ft

(55DVI + 29.4 pass = 84.4 cfs)

Worksheet for SFB Overflow Developed

Project Description

Solve For	Discharge

Input Data

Headwater Elevation		0.45	ft
Crest Elevation		0.00	ft
Tailwater Elevation		0.00	ft
Crest Surface Type	Gravel		
Crest Breadth		6.00	ft
Crest Length		10.00	ft

Results

Discharge	8.08	ft^3/s
Headwater Height Above Crest	0.45	ft
Tailwater Height Above Crest	0.00	ft
Weir Coefficient	2.68	US
Submergence Factor	1.00	
Adjusted Weir Coefficient	2.68	US
Flow Area	4.50	ft^2
Velocity	1.80	ft/s
Wetted Perimeter	10.90	ft
Top Width	10.00	ft

Worksheet for Type D Inlet - Weir

Project Description

Solve For	Discharge

Input Data

Headwater Elevation	1.50	ft
Crest Elevation	0.00	ft
Weir Coefficient	3.00	US
Crest Length	17.17	ft

Results

Discharge	94.61	ft^3/s
Headwater Height Above Crest	1.50	ft
Flow Area	25.75	ft^2
Velocity	3.67	ft/s
Wetted Perimeter	20.17	ft
Top Width	17.17	ft

Type D Weir is most restrictive
94.61 cfs
70% Grate Opening
50% Clogging
= 33.11 cfs > 29.4 cfs tributary

Worksheet for Type D Inlet - Orifice

Project Description

Solve For	Discharge

Input Data

Headwater Elevation	1.50	ft
Centroid Elevation	0.00	ft
Tailwater Elevation	0.00	ft
Discharge Coefficient	0.60	
Opening Width	2.92	ft
Opening Height	5.67	ft

Results

Discharge	97.50	ft^3/s
Headwater Height Above Centroid	1.50	ft
Tailwater Height Above Centroid	0.00	ft
Flow Area	16.54	ft^2
Velocity	5.89	ft/s

Type D Weir is more restrictive
→ Use Weir Calculations

Worksheet for Western Channel Capacity

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.02000	ft/ft
Normal Depth	1.00	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)

Results

Discharge	17.30	ft^3/s
Flow Area	4.00	ft^2
Wetted Perimeter	8.25	ft
Hydraulic Radius	0.49	ft
Top Width	8.00	ft
Critical Depth	1.03	ft
Critical Slope	0.01703	ft/ft
Velocity	4.32	ft/s
Velocity Head	0.29	ft
Specific Energy	1.29	ft
Froude Number	1.08	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.00	ft
Critical Depth	1.03	ft
Channel Slope	0.02000	ft/ft
Critical Slope	0.01703	ft/ft

Label	Start Node	Stop Node	Branch ID	Branch Element ID	Length (Unified) (ft)	Upstream Inlet C	Upstream Intensity (in/h)	Upstream Inlet Area (acres)	System Intensity (in/h)
CO-1	CB-1	MH-1	1	1	255.4	(N/A)	8	(N/A)	8
CO-2	MH-1	MH-2	1	2	295.1	(N/A)	8	(N/A)	8
CO-3	MH-2	MH-3	1	3	295.1	(N/A)	8	(N/A)	8
CO-4	MH-3	MH-4	1	4	44.9	(N/A)	8	(N/A)	8
CO-5	MH-4	OF-1	1	5	198.3	(N/A)	8	(N/A)	8

	System Rational Flow (ft^3/s)	Total Flow (ft^3/s)	Rise (Unified) (in)	Capacity (Full Flow) (ft^3/s)	Velocity (Average) (ft/s)	Invert (Upstream) (ft)	Invert (Downstream) (ft)	Slope (ft/ft)
CO-1	0	29.4	30	44.49	9.68	7032.21	7029.65	0.01
CO-2	0	29.4	30	44.43	9.67	7029.35	7026.4	0.01
CO-3	0	29.4	30	38.97	8.72	7026.2	7023.93	0.008
CO-4	0	29.4	30	57.43	11.77	7023.63	7022.88	0.017
CO-5	0	29.4	30	44.4	9.67	7022.88	7020.9	0.01

APPENDIX C

STANDARD DESIGN CHARTS AND TABLES

NOAA Atlas 14, Volume 8, Version 2
Location name: Colorado Springs, Colorado, US*
Latitude: 38.9514°, Longitude: -104.6905°
Elevation: 6984 ft*
* source: Google Maps

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)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.237 (0.195-0.290)	0.289 (0.238-0.355)	0.380 (0.311-0.467)	0.460 (0.374-0.568)	0.577 (0.456-0.746)	0.674 (0.517-0.880)	0.775 (0.573-1.04)	0.883 (0.625-1.21)	1.03 (0.701-1.46)	1.15 (0.759-1.65)
10-min	0.347 (0.285-0.425)	0.424 (0.348-0.520)	0.556 (0.455-0.684)	0.673 (0.548-0.832)	0.846 (0.667-1.09)	0.987 (0.757-1.29)	1.14 (0.839-1.52)	1.29 (0.914-1.78)	1.51 (1.03-2.14)	1.69 (1.11-2.41)
15-min	0.423 (0.348-0.519)	0.516 (0.424-0.634)	0.678 (0.555-0.834)	0.821 (0.668-1.01)	1.03 (0.814-1.33)	1.20 (0.924-1.57)	1.38 (1.02-1.85)	1.58 (1.11-2.17)	1.84 (1.25-2.61)	2.06 (1.35-2.94)
30-min	0.613 (0.504-0.751)	0.747 (0.614-0.917)	0.980 (0.802-1.21)	1.19 (0.965-1.47)	1.49 (1.17-1.92)	1.74 (1.33-2.27)	2.00 (1.48-2.67)	2.27 (1.61-3.13)	2.66 (1.80-3.76)	2.97 (1.95-4.24)
60-min	0.795 (0.654-0.974)	0.948 (0.779-1.16)	1.23 (1.00-1.51)	1.48 (1.21-1.83)	1.88 (1.49-2.44)	2.21 (1.70-2.90)	2.57 (1.91-3.46)	2.96 (2.10-4.09)	3.52 (2.39-4.99)	3.97 (2.61-5.67)
2-hr	0.977 (0.809-1.19)	1.15 (0.951-1.40)	1.47 (1.22-1.80)	1.78 (1.46-2.19)	2.27 (1.82-2.94)	2.68 (2.09-3.51)	3.14 (2.35-4.21)	3.65 (2.61-5.02)	4.38 (3.00-6.18)	4.98 (3.30-7.06)
3-hr	1.08 (0.897-1.31)	1.25 (1.04-1.51)	1.58 (1.31-1.93)	1.92 (1.57-2.34)	2.45 (1.98-3.19)	2.92 (2.29-3.83)	3.45 (2.60-4.62)	4.04 (2.91-5.55)	4.90 (3.39-6.92)	5.62 (3.75-7.95)
6-hr	1.26 (1.05-1.51)	1.44 (1.20-1.73)	1.81 (1.51-2.18)	2.19 (1.81-2.65)	2.81 (2.30-3.64)	3.37 (2.66-4.39)	4.00 (3.04-5.34)	4.71 (3.43-6.45)	5.77 (4.02-8.09)	6.65 (4.46-9.33)
12-hr	1.45 (1.23-1.74)	1.68 (1.41-2.00)	2.12 (1.78-2.54)	2.55 (2.13-3.07)	3.26 (2.68-4.19)	3.89 (3.10-5.03)	4.59 (3.52-6.08)	5.38 (3.94-7.31)	6.54 (4.59-9.11)	7.51 (5.08-10.5)
24-hr	1.68 (1.43-1.99)	1.97 (1.67-2.33)	2.50 (2.12-2.98)	3.01 (2.53-3.60)	3.80 (3.13-4.80)	4.48 (3.58-5.72)	5.23 (4.02-6.83)	6.04 (4.45-8.11)	7.23 (5.09-9.96)	8.20 (5.58-11.4)
2-day	1.95 (1.67-2.29)	2.31 (1.97-2.72)	2.95 (2.51-3.48)	3.53 (2.99-4.18)	4.39 (3.62-5.46)	5.11 (4.10-6.44)	5.88 (4.55-7.59)	6.71 (4.96-8.91)	7.89 (5.59-10.8)	8.83 (6.07-12.2)
3-day	2.15 (1.85-2.51)	2.54 (2.18-2.97)	3.22 (2.75-3.78)	3.83 (3.26-4.52)	4.74 (3.92-5.87)	5.50 (4.42-6.88)	6.30 (4.89-8.09)	7.16 (5.31-9.45)	8.37 (5.96-11.4)	9.34 (6.45-12.8)
4-day	2.31 (2.00-2.70)	2.72 (2.34-3.17)	3.42 (2.94-4.01)	4.06 (3.46-4.78)	5.00 (4.15-6.16)	5.78 (4.67-7.21)	6.61 (5.14-8.46)	7.50 (5.58-9.87)	8.75 (6.25-11.8)	9.76 (6.75-13.3)
7-day	2.74 (2.38-3.18)	3.17 (2.75-3.68)	3.92 (3.39-4.57)	4.60 (3.95-5.38)	5.60 (4.67-6.86)	6.43 (5.23-7.97)	7.32 (5.73-9.30)	8.27 (6.19-10.8)	9.60 (6.90-12.9)	10.7 (7.44-14.5)
10-day	3.11 (2.71-3.60)	3.58 (3.11-4.14)	4.39 (3.80-5.09)	5.11 (4.40-5.95)	6.17 (5.17-7.51)	7.05 (5.75-8.69)	7.98 (6.27-10.1)	8.97 (6.75-11.7)	10.4 (7.47-13.9)	11.5 (8.03-15.5)
20-day	4.18 (3.67-4.79)	4.79 (4.20-5.50)	5.83 (5.09-6.71)	6.72 (5.84-7.77)	7.99 (6.71-9.59)	9.01 (7.38-11.0)	10.0 (7.94-12.6)	11.1 (8.42-14.3)	12.6 (9.17-16.7)	13.8 (9.73-18.6)
30-day	5.05 (4.46-5.77)	5.80 (5.11-6.63)	7.04 (6.18-8.07)	8.08 (7.05-9.30)	9.51 (8.01-11.3)	10.6 (8.73-12.8)	11.8 (9.32-14.6)	12.9 (9.79-16.5)	14.4 (10.5-19.0)	15.6 (11.1-20.9)
45-day	6.14 (5.44-6.98)	7.06 (6.25-8.03)	8.54 (7.53-9.74)	9.75 (8.55-11.2)	11.4 (9.60-13.4)	12.6 (10.4-15.1)	13.8 (11.0-17.0)	15.0 (11.4-19.1)	16.6 (12.1-21.7)	17.7 (12.6-23.7)
60-day	7.05 (6.27-7.99)	8.12 (7.20-9.20)	9.80 (8.66-11.1)	11.1 (9.80-12.7)	12.9 (10.9-15.2)	14.2 (11.8-17.0)	15.5 (12.4-19.0)	16.7 (12.8-21.1)	18.3 (13.4-23.8)	19.4 (13.9-25.8)

[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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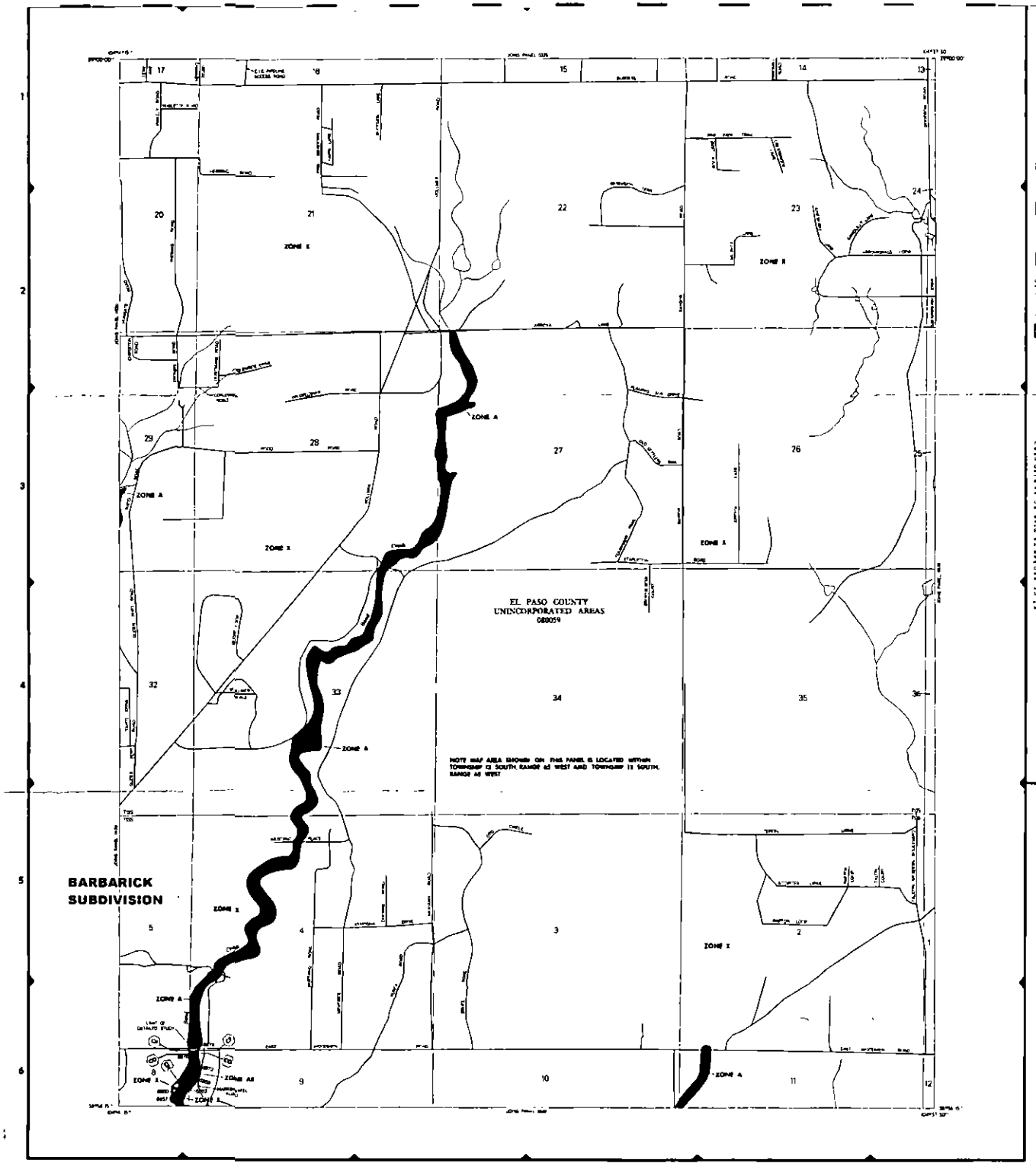


LEGEND

NOTES

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 535 OF 1200

MAP NUMBER
080410C0535 F

EFFECTIVE DATE:
MARCH 17, 1997

Federal Emergency Management Agency

Map Unit Legend

El Paso County Area, Colorado (CO625)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
9	Blakeland-Fluvaquentic Haplaquolls	12.5	76.4%
71	Pring coarse sandy loam, 3 to 8 percent slopes	3.9	23.6%
Totals for Area of Interest		**16.4**	**100.0%**

El Paso County Area, Colorado

9—Blakeland-Fluvaquentic Haplaquolls

Map Unit Setting

National map unit symbol: 36b6
Elevation: 3,500 to 5,800 feet
Mean annual precipitation: 13 to 17 inches
Mean annual air temperature: 46 to 55 degrees F
Frost-free period: 110 to 165 days
Farmland classification: Not prime farmland

Map Unit Composition

Blakeland and similar soils: 60 percent
Fluvaquentic haplaquolls and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Blakeland

Setting

Landform: Flats, hills
Landform position (three-dimensional): Side slope, talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium derived from arkose and/or eolian deposits derived from arkose

Typical profile

A - 0 to 11 inches: loamy sand
AC - 11 to 27 inches: loamy sand
C - 27 to 60 inches: sand

Properties and qualities

Slope: 1 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Available water storage in profile: Low (about 4.5 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: Sandy Foothill (R049BY210CO)

Description of Fluvaquentic Haplaquolls

Setting

Landform: Swales
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 12 inches: variable

Properties and qualities

Slope: 1 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 6.00 in/hr)
Depth to water table: About 0 to 24 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)

Interpretive groups

Land capability classification (irrigated): 6w
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: D

Minor Components

Other soils

Percent of map unit:

Pleasant

Percent of map unit:
Landform: Depressions

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 13, Sep 22, 2015

El Paso County Area, Colorado

71—Pring coarse sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 369k
Elevation: 6,800 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Pring and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pring

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock

Typical profile

A - 0 to 14 inches: coarse sandy loam
C - 14 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: Loamy Park (R048AY222CO)

Minor Components

Other soils

Percent of map unit:

Pleasant

Percent of map unit:

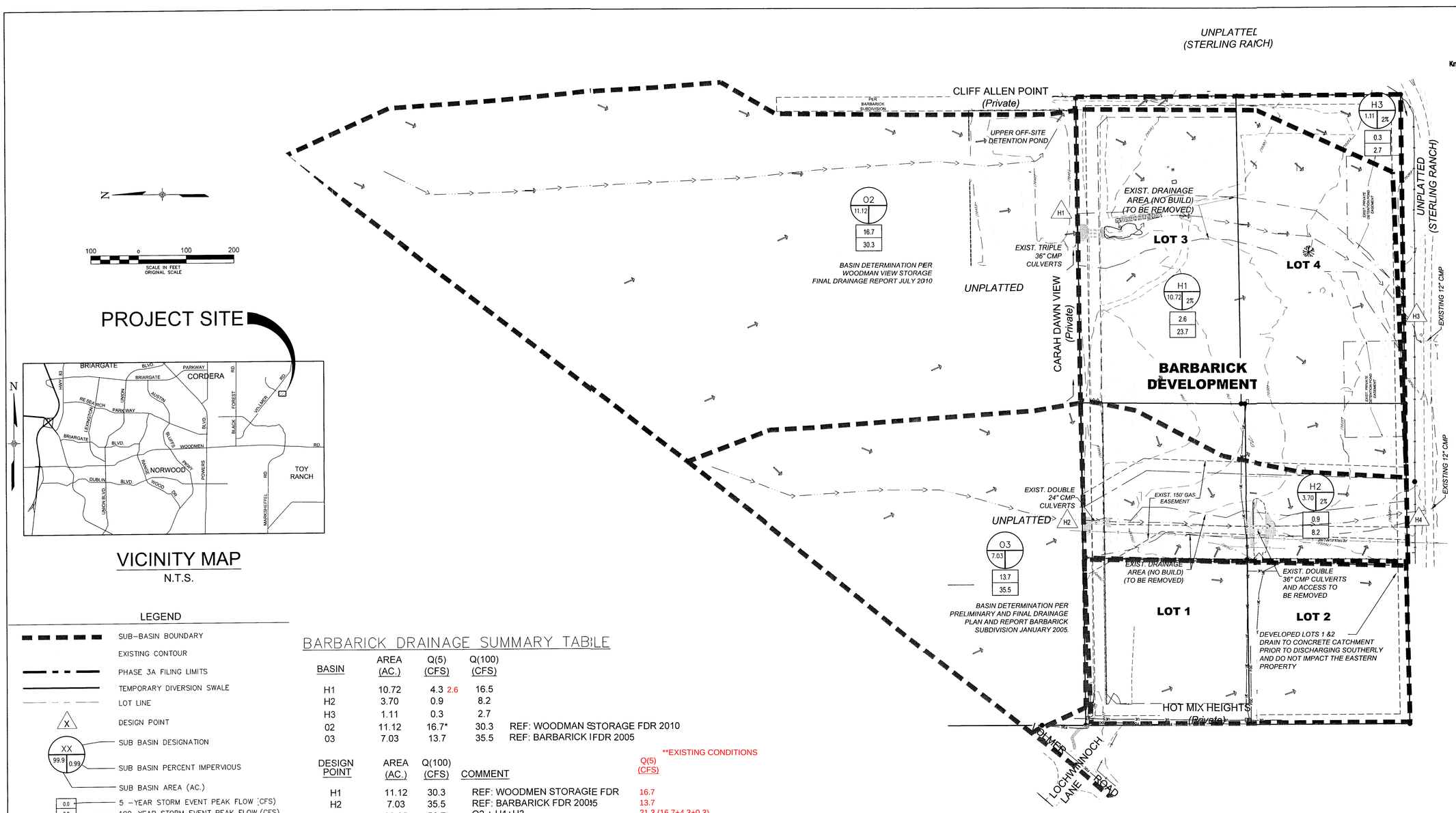
Landform: Depressions

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 13, Sep 22, 2015

APPENDIX D

MAPS



PROJECT SITE

VICINITY MAP
N.T.S.

LEGEND

- SUB-BASIN BOUNDARY
- EXISTING CONTOUR
- PHASE 3A FILING LIMITS
- TEMPORARY DIVERSION SWALE
- LOT LINE
- X — DESIGN POINT
- XX / 99.9 / 0.99 — SUB BASIN DESIGNATION; SUB BASIN PERCENT IMPERVIOUS; SUB BASIN AREA (AC.)
- 0.0 — 5 -YEAR STORM EVENT PEAK FLOW (CFS)
- 0.0 — 100-YEAR STORM EVENT PEAK FLOW (CFS)
- PROPOSED FLOW DIRECTION
- EXISTING FLOW DIRECTION

BARBARICK DRAINAGE SUMMARY TABLE

BASIN	AREA (AC.)	Q(5) (CFS)	Q(100) (CFS)	
H1	10.72	4.3 2.6	16.5	
H2	3.70	0.9	8.2	
H3	1.11	0.3	2.7	
02	11.12	16.7*	30.3	REF: WOODMAN STORAGE FDR 2010
03	7.03	13.7	35.5	REF: BARBARICK FDR 2005

**EXISTING CONDITIONS

DESIGN POINT	AREA (AC.)	Q(100) (CFS)	COMMENT	Q(5) (CFS)
H1	11.12	30.3	REF: WOODMEN STORAGE FDR	16.7
H2	7.03	35.5	REF: BARBARICK FDR 2005	13.7
H3	22.95	56.7	O2 + H1+H3	21.3 (16.7+4.3+0.3)
H4	10.73	43.7	O3 + H2	14.6 (13.7+0.9)

REFERENCE DRAWINGS
EX-TOPO
EX-PROP-BDRY
EX-FEATURES
X-Title(Drainage)
pr-site
EX-UTIL

NO.	DATE	DESCRIPTION	BY

REVISIONS

NAME: S:\15.789.001 Tri Lakes\Dwg\CD\Drainage\20160605-DP01.dwg
PCP: Matrix.ctb
PLOT DATE: Tue Jun 07, 2016 12:49pm

BENCHMARK DATA(ELEV.) _____
(DATUM) _____
(DESCRIPTION/LOCATION) _____

VERTICAL BENCHMARK:

THE VERTICAL INFORMATION ON THIS MAP IS BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 AND THE 1960 SUPPLEMENTARY ADJUSTMENT BEING A FOUND 3.25" ALUMINUM CAP IN A ROAD BOX DESIGNATED AS FACILITIES INFORMATION MANAGEMENT SYSTEM (FIMS) MONUMENT "F_69" AND HAVING PUBLISHED ELEVATION OF 6975.62 FEET WAS USED TO REFERENCE THIS VERTICAL DATUM. THE BENCHMARK IS LOCATED ON THE WEST SIDE OF BLACK FOREST ROAD, ABOUT 1.95 MILES SOUTH OF OLD RANCH ROAD, JUST SOUTH OF THE SCHMIDT CONSTRUCTION COMPANY DRIVEWAY. A CORNER FENCE POST IS 28.1 FEET TO THE SOUTHWEST, AND THE MOST SOUTHERLY GUARD RAIL POST IS 25.7 FEET TO THE NORTH.

BASIS OF BEARING:

THE BASIS OF BEARINGS FOR THIS MAP IS THE NORTH LINE OF BARBARICK SUBDIVISION ACCORDING TO THE OFFICIAL MAP THEREOF RECORDED FEBRUARY 12, 2008 IN THE OFFICE OF THE EL PASO COUNTY CLERK AND RECORDER UNDER RECEPTION NUMBER 208712754,SAID LINE MONUMENTED ON THE WEST END BY A FOUND 5/8" REBAR AND ON THE EAST BY A FOUND 4/8" REBAR WITH 1" ALUMINUM CAP STAMPED "LS 2154" BEING A POINT ON THE NORTH LINE BEARING NORTH 89°12'41 EAST 1228.35 FEET FROM THE WEST END THEREOF.

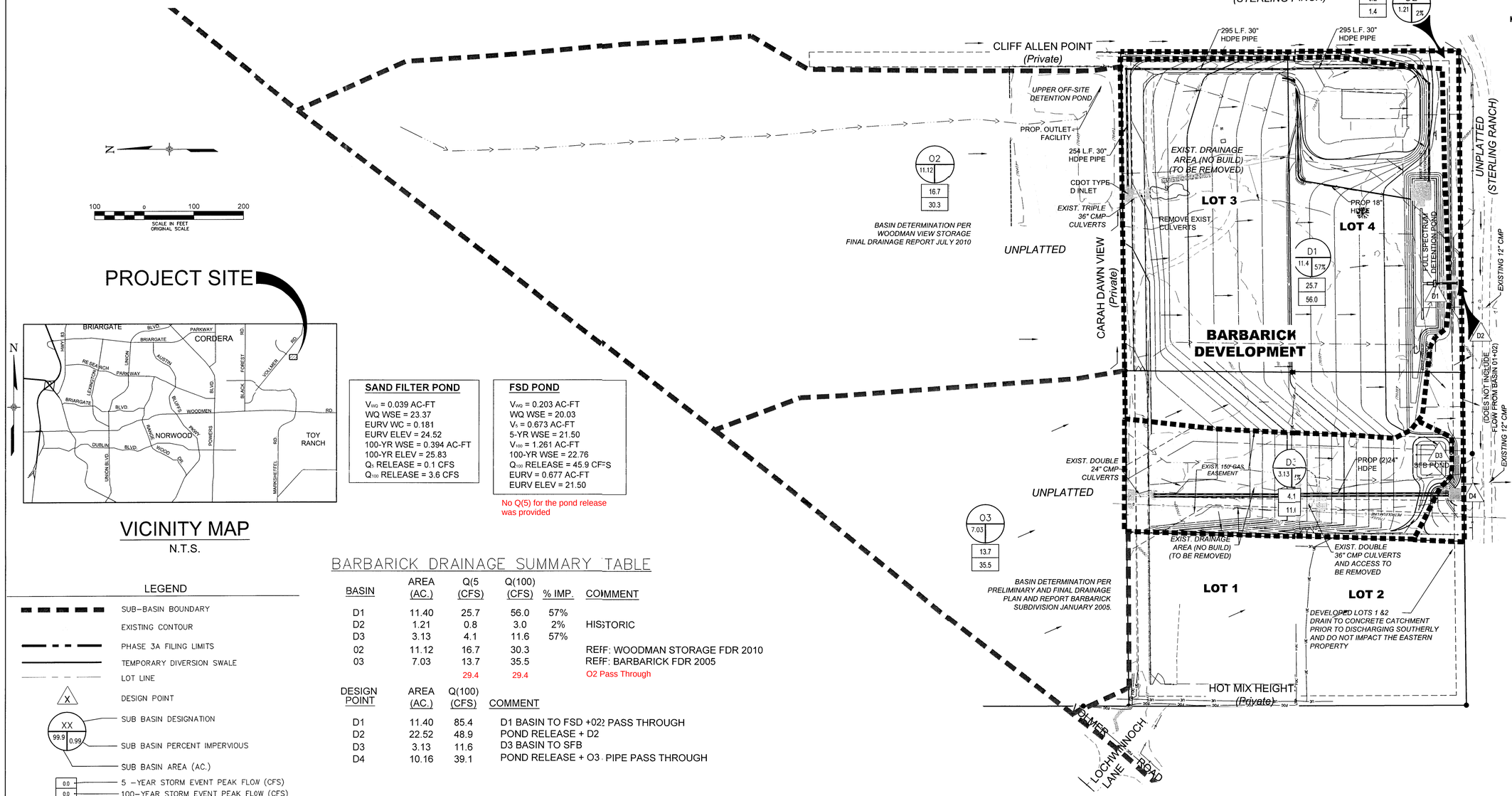
PREPARED UNDER MY DIRECT SUPERVISION, FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.

Matrix DESIGN GROUP
2435 Research Parkway, Suite
300 Colorado Springs, CO 80920
Phone 719-575-0100
Fax 719-575-0208

BARBARICK SUBDIVISION LOTS 1-4

EXISTING CONDITIONS DRAINAGE PLAN

DESIGNED BY:	BJH	SCALE		DATE ISSUED:	April 2016
DRAWN BY:	BJH	HORIZ:	1"=50'	SHEET NO. 1 OF 2 SHEETS	DP01
CHECKED BY:	ES	VERT:	N/A		



PROJECT SITE

VICINITY MAP

N.T.S.

SAND FILTER POND
V_{WQ} = 0.039 AC-FT
WQ WSE = 23.37
EURV WC = 0.181
EURV ELEV = 24.52
100-YR WSE = 0.394 AC-FT
100-YR ELEV = 25.83
Q_5 RELEASE = 0.1 CFS
Q_{100} RELEASE = 3.6 CFS

FSD POND
V_{WQ} = 0.203 AC-FT
WQ WSE = 20.03
V_5 = 0.673 AC-FT
5-YR WSE = 21.50
V_{100} = 1.261 AC-FT
100-YR WSE = 22.76
Q_{100} RELEASE = 45.9 CFS
EURV = 0.677 AC-FT
EURV ELEV = 21.50

No Q(5) for the pond release was provided

LEGEND

- SUB-BASIN BOUNDARY
- EXISTING CONTOUR
- PHASE 3A FILING LIMITS
- TEMPORARY DIVERSION SWALE
- LOT LINE
- DESIGN POINT
- SUB BASIN DESIGNATION (XX)
- SUB BASIN PERCENT IMPERVIOUS (99.9 / 0.99)
- SUB BASIN AREA (AC.)
- 5 –YEAR STORM EVENT PEAK FLOW (CFS) (0.0)
- 100–YEAR STORM EVENT PEAK FLOW (CFS) (0.0)
- PROPOSED FLOW DIRECTION
- EXISTING FLOW DIRECTION

BARBARICK DRAINAGE SUMMARY TABLE

BASIN	AREA (AC.)	Q(5 (CFS)	Q(100) (CFS)	% IMP.	COMMENT
D1	11.40	25.7	56.0	57%	
D2	1.21	0.8	3.0	2%	HISTORIC
D3	3.13	4.1	11.6	57%	
02	11.12	16.7	30.3		REFF: WOODMAN STORAGE FDR 2010
03	7.03	13.7	35.5		REFF: BARBARICK FDR 2005
		29.4	29.4		O2 Pass Through

DESIGN POINT	AREA (AC.)	Q(100) (CFS)	COMMENT
D1	11.40	85.4	D1 BASIN TO FSD +02? PASS THROUGH
D2	22.52	48.9	POND RELEASE + D2
D3	3.13	11.6	D3 BASIN TO SFB
D4	10.16	39.1	POND RELEASE + O3 . PIPE PASS THROUGH

REFERENCE DRAWINGS
EX-TOPO
EX-PROP-BDRY
EX-FEATURES
X-Title(Drainage)
pr-site
EX-UTIL

NO.	DATE	DESCRIPTION	BY

REVISIONS

NAME: S:\15.789.001 Tri Lakes\Dwg\CD\Drainage\20160605-DP01.dwg
PCP: Matrix.ctb
PLOT DATE: Tue Jun 07, 2016 12:49pm

BENCHMARK DATA(ELEV.) _____
(DATUM) _____
(DESCRIPTION/LOCATION) _____

VERTICAL BENCHMARK:

THE VERTICAL INFORMATION ON THIS MAP IS BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 AND THE 1960 SUPPLEMENTARY ADJUSTMENT BEING A FOUND 3.25" ALUMINUM CAP IN A ROAD BOX DESIGNATED AS FACILITIES INFORMATION MANAGEMENT SYSTEM (FIMS) MONUMENT ''F_69" AND HAVING PUBLISHED ELEVATION OF 6975.62 FEET WAS USED TO REFERENCE THIS VERTICAL DATUM. THE BENCHMARK IS LOCATED ON THE WEST SIDE OF BLACK FOREST ROAD, ABOUT 1.95 MILES SOUTH OF OLD RANCH ROAD, JUST SOUTH OF THE SCHMIDT CONSTRUCTION COMPANY DRIVEWAY. A CORNER FENCE POST IS 28.1 FEET TO THE SOUTHWEST, AND THE MOST SOUTHERLY GUARD RAIL POST IS 25.7 FEET TO THE NORTH.

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PREPARED UNDER MY DIRECT SUPERVISION, FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.

Matrix DESIGN GROUP
2435 Research Parkway, Suite
300 Colorado Springs, CO 80920
Phone 719-575-0100
Fax 719-575-0208

BARBARICK SUBDIVISION LOTS 1-4

PROPOSED DRAINAGE PLAN

DESIGNED BY:	BJH	SCALE		DATE ISSUED:	April 2016
DRAWN BY:	BJH	HORIZ:	1"=100'		
CHECKED BY:	ES	VERT:	N/A	SHEET NO. 1 OF 2 SHEETS	DP02

811 Know what's below. Call before you dig.

APPENDIX H: COST ESTIMATE / FINANCIAL ASSURANCES ESTIMATE

2023 Financial Assurance Est (with pre-plat construction)

Please remove FAE from the drainage report, and provide engineer's cost estimate.

ated: 12/8/2022

PROJECT INFORMATION		
Project Name: Barbarick Transfer Station	Date: December 2023	PCD File No.

Description	Quantity	Units	Unit Cost		Total	(with Pre-Plat Construction) % Complete	Remaining	
SECTION 1 - GRADING AND EROSION CONTROL (Construction and Permanent BMPs)								
Earthwork								*
less than 1,000; $5,300 min		CY	$ 8.00	=	$ -		$ -	*
1,000-5,000; $8,000 min		CY	$ 6.00	=	$ -		$ -	*
5,001-20,000; $30,000 min	8,606	CY	$ 5.00	=	$ 43,030.00		$ 43,030.00	*
20,001-50,000; $100,000 min		CY	$ 3.50	=	$ -		$ -	*
50,001-200,000; $175,000 min		CY	$ 2.50	=	$ -		$ -	*
greater than 200,000; $500,000 min		CY	$ 2.00	=	$ -		$ -	*
Permanent Erosion Control Blanket	0.0	SY	$ 8.00	=	$ -		$ -	*
Permanent Seeding (inc. noxious weed mgmnt.) & Mulching	1.2	AC	$ 1,875.00	=	$ 2,175.00		$ 2,175.00	*
Permanent Pond/BMP (provide engineer's estimate)		EA		=	$ -		$ -	*
Concrete Washout Basin	1	EA	$ 1,089.00	=	$ 1,089.00		$ 1,089.00	
Inlet Protection	8	EA	$ 202.00	=	$ 1,616.00		$ 1,616.00	
Rock Check Dam		EA	$ 605.00	=	$ -		$ -	
Safety Fence (CONSTRUCTION FENCE)	960	LF	$ 3.00	=	$ 2,880.00		$ 2,880.00	
Sediment Basin (EXISTING DETENTION POND)	0.5	EA	$ 2,132.00	=	$ 1,066.00		$ 1,066.00	
Sediment Trap		EA	$ 500.00	=	$ -		$ -	
Silt Fence	841	LF	$ 3.00	=	$ 2,523.00		$ 2,523.00	
Slope Drain		LF	$ 40.00		$ -		$ -	
Straw Bale		EA	$ 31.00	=	$ -		$ -	
Straw Wattle/Rock Sock	601	LF	$ 7.00	=	$ 4,207.00		$ 4,207.00	
Surface Roughening		AC	$ 250.00		$ -		$ -	
Temporary Erosion Control Blanket	32.0	SY	$ 3.00	=	$ 96.00		$ 96.00	
Temporary Seeding and Mulching	0.1	AC	$ 1,666.00	=	$ 166.60		$ 166.60	
Vehicle Tracking Control	1	EA	$ 2,867.00	=	$ 2,867.00		$ 2,867.00	
				=	$ -		$ -	
[insert items not listed but part of construction plans]				=	$ -		$ -	
MAINTENANCE (35% of Construction BMPs)				=	$ 5,397.56		$ 5,397.56	
* - Subject to defect warranty financial assurance. A minimum of 20% shall be retained until final acceptance (MAXIMUM OF 80% COMPLETE ALLOWED)		**Section 1 Subtotal**		=	$ 67,113.16		$ 67,113.16	
SECTION 2 - PUBLIC IMPROVEMENTS *								
ROADWAY IMPROVEMENTS								*
Construction Traffic Control		LS		=	$ -		$ -	*
Aggregate Base Course (135 lbs/cf)		Tons	$ 34.00	=	$ -		$ -	*
Aggregate Base Course (135 lbs/cf)		CY	$ 61.00		$ -		$ -	*
Asphalt Pavement (3" thick)		SY	$ 17.00		$ -		$ -	*
Asphalt Pavement (4" thick)		SY	$ 23.00		$ -		$ -	*
Asphalt Pavement (6" thick)		SY	$ 35.00		$ -		$ -	*
Asphalt Pavement (147 lbs/cf) 5 " thick		Tons	$ 106.00	=	$ -		$ -	*
Raised Median, Paved		SF	$ 10.00	=	$ -		$ -	*
Regulatory Sign/Advisory Sign		EA	$ 364.00	=	$ -		$ -	*
Guide/Street Name Sign		EA		=	$ -		$ -	*
Epoxy Pavement Marking		SF	$ 16.00	=	$ -		$ -	*
Thermoplastic Pavement Marking		SF	$ 28.00	=	$ -		$ -	*
Barricade - Type 3		EA	$ 241.00	=	$ -		$ -	*
Delineator - Type I		EA	$ 29.00	=	$ -		$ -	*
Curb and Gutter, Type A (6" Vertical)		LF	$ 35.00	=	$ -		$ -	*
Curb and Gutter, Type B (Median)		LF	$ 35.00	=	$ -		$ -	*
Curb and Gutter, Type C (Ramp)		LF	$ 35.00	=	$ -		$ -	*
4" Sidewalk (common areas only)		SY	$ 58.00	=	$ -		$ -	*
5" Sidewalk		SY	$ 72.00	=	$ -		$ -	*
6" Sidewalk		SY	$ 87.00	=	$ -		$ -	*
8" Sidewalk		SY	$ 116.00		$ -		$ -	*
Pedestrian Ramp		EA	$ 1,390.00	=	$ -		$ -	*
Cross Pan, local (8" thick, 6' wide to include return)		LF	$ 73.00	=	$ -		$ -	*
Cross Pan, collector (9" thick, 8' wide to include return)		LF	$ 111.00		$ -		$ -	*
Curb Opening with Drainage Chase		EA	$ 1,790.00	=	$ -		$ -	*
Guardrail Type 3 (W-Beam)		LF	$ 60.00	=	$ -		$ -	*
Guardrail Type 7 (Concrete)		LF	$ 87.00	=	$ -		$ -	*
Guardrail End Anchorage		EA	$ 2,538.00	=	$ -		$ -	*
Guardrail Impact Attenuator		EA	$ 4,556.00	=	$ -		$ -	*
Sound Barrier Fence (CMU block, 6' high)		LF	$ 95.00		$ -		$ -	*
Sound Barrier Fence (panels, 6' high)		LF	$ 97.00	=	$ -		$ -	*
Electrical Conduit, Size =		LF	$ 20.00	=	$ -		$ -	*
Traffic Signal, (provide engineer's estimate)		EA		=	$ -		$ -	*

PROJECT INFORMATION		
Project Name: Barbarick Transfer Station	Date: December 2023	PCD File No.

Description	Quantity	Units	Unit Cost		Total	(with Pre-Plat Construction) % Complete	(with Pre-Plat Construction) Remaining
SECTION 3 - COMMON DEVELOPMENT IMPROVEMENTS (Private or District and NOT Maintained by EPC)**							
ROADWAY IMPROVEMENTS							
Aggregate Base Course (135 lbs/cf)	962.0	Tons	$ 34.00	=	$ 32,708.00		$ 32,708.00
Asphalt Pavement (147 lbs/cf) 5" thick	872.0	Tons	$ 106.00	=	$ 92,432.00		$ 92,432.00
Epoxy Pavement Marking	233.0	SF	$ 16.00	=	$ 3,728.00		$ 3,728.00
Thermoplastic Pavement Marking	12.0	SF	$ 28.00	=	$ 336.00		$ 336.00
Electrical Conduit, Size = 1"	1,030.0	LF	$ 20.00	=	$ 20,600.00		$ 20,600.00
Electrical Conduit, Size = 2"	910.0	LF	$ 20.00	=	$ 18,200.00		$ 18,200.00
MSE Block Retaining Wall (8' max)	1,400	SF	$ 50.00	=	$ 70,000.00		$ 70,000.00
Concrete Retaining Wall (8' max)	985	SF	$ 80.00	=	$ 78,800.00		$ 78,800.00
STORM DRAIN IMPROVEMENTS (Exception: Permanent Pond/BMP shall be itemized under Section 1)							
Grated Inlet (Double Type C), Depth < 5'	2	EA	$ 7,000.00	=	$ 14,000.00		$ 14,000.00
Grated Inlet (Type C), Depth < 5'	2	EA	$ 5,611.00	=	$ 11,222.00		$ 11,222.00
Storm Sewer Manhole, Box Base	2	EA	$ 14,061.00	=	$ 28,122.00		$ 28,122.00
4" PVC Pipe	470	LF	$ 70.00	=	$ 32,900.00		$ 32,900.00
6" PVC Pipe	205	LF	$ 75.00	=	$ 15,375.00		$ 15,375.00
18" PVC Pipe	73	LF	$ 80.00	=	$ 5,840.00		$ 5,840.00
24" PVC Pipe	454	LF	$ 80.00	=	$ 36,320.00		$ 36,320.00
4' Concrete Drainage Pan (6", Fibermesh Reinforced)	848	LF	$ 100.00	=	$ 84,800.00		$ 84,800.00
PVC FES	1	EA	$ 800.00	=	$ 800.00		$ 800.00
Rip Rap, d50 size from 6" to 24"	20	Tons	$ 97.00	=	$ 1,940.00		$ 1,940.00
WATER SYSTEM IMPROVEMENTS							
Water Main Pipe (PVC), Size 8"		LF	$ 78.00	=	$ -		$ -
Water Main Pipe (Ductile Iron), Size 8"		LF	$ 91.00	=	$ -		$ -
Gate Valves, 8"		EA	$ 2,247.00	=	$ -		$ -
Fire Hydrant Assembly, w/ all valves		EA	$ 7,978.00	=	$ -		$ -
Water Service Line Installation, inc. tap and valves	2	EA	$ 1,601.00	=	$ 3,202.00		$ 3,202.00
Fire Cistern Installation, complete		EA		=	$ -		$ -
				=	$ -		$ -
[insert items not listed but part of construction plans]				=	$ -		$ -
SANITARY SEWER IMPROVEMENTS							
Sewer Main Pipe (PVC), Size 8"		LF	$ 78.00	=	$ -		$ -
Sanitary Sewer Manhole, Depth < 15 feet		EA	$ 5,305.00	=	$ -		$ -
Sanitary Service Line Installation, complete	1	EA	$ 1,696.00	=	$ 1,696.00		$ 1,696.00
Sanitary Sewer Lift Station, complete		EA		=	$ -		$ -
				=	$ -		$ -
[insert items not listed but part of construction plans]				=	$ -		$ -
LANDSCAPING IMPROVEMENTS (For subdivision specific condition of approval, or PUD)							
Trees (Ponderosa Pine)	34	EA	$ 600.00	=	$ 20,400.00		$ 20,400.00
Seeding (EPC Low Grow Mix)	50,413	SF	$ 0.50	=	$ 25,206.50		$ 25,206.50
		EA		=	$ -		$ -
		EA		=	$ -		$ -
		EA		=	$ -		$ -
** - Section 3 is not subject to defect warranty requirements		**Section 3 Subtotal**		=	$ 469,759.50		$ 469,759.50

PROJECT INFORMATION		
Project Name: Barbarick Transfer Station	Date: December 2023	PCD File No.

Description	Quantity	Units	Unit Cost		Total	(with Pre-Plat Construction) % Complete	Remaining
AS-BUILT PLANS (Public Improvements inc. Permanent WQCV BMPs)		LS		=	$ -		$ -
POND/BMP CERTIFICATION (inc. elevations and volume calculations)		LS		=	$ -		$ -

Total Construction Financial Assurance $ 536,872.66
(Sum of all section subtotals plus as-builts and pond/BMP certification)

Total Remaining Construction Financial Assurance (with Pre-Plat Construction) $ 536,872.66
(Sum of all section totals less credit for items complete plus as-builts and pond/BMP certification)

Total Defect Warranty Financial Assurance $ 9,041.00
(20% of all items identified as (*). To be collateralized at time of preliminary acceptance)

Approvals

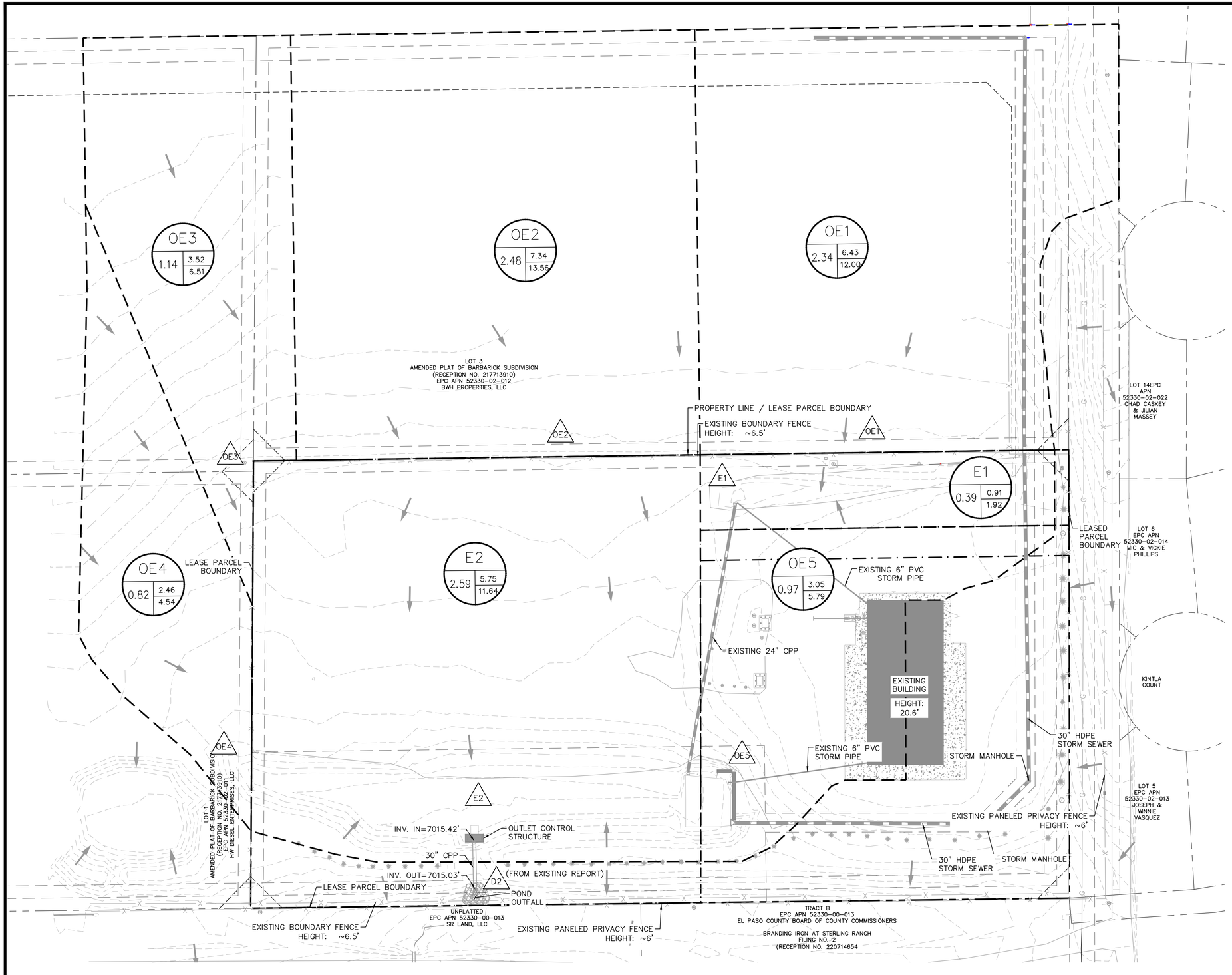
I hereby certify that this is an accurate and complete estimate of costs for the work as shown on the Grading and Erosion Control Plan and Construction Drawings associated with the Project.

Engineer (P.E. Seal Required)

Approved by Owner / Applicant — Date

Approved by El Paso County Engineer / ECM Administrator — Date

APPENDIX I: DRAINAGE MAPS



LEGEND

- PROPERTY LINE
- LEASED PARCEL BOUNDARY
- EXISTING UTILITY & DRAINAGE EASEMENT
- EXISTING FENCE
- EXISTING STORM SEWER
- EXISTING GAS MAIN
- EXISTING VEGETATION
- EXISTING TRANSFORMER
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- PROPOSED BASIN BOUNDARY

A = SUB-BASIN NAME
B = BASIN SIZE (ACRE)
C = 5-YEAR RUNOFF
D = 100-YEAR RUNOFF

DESIGN POINT

EXISTING FLOW ARROW

SUMMARY - PROPOSED RUNOFF TABLE

DESIGN POINT	BASIN DESIGNATION	BASIN AREA (ACRES)	BASIN IMPERVIOUSNESS (%)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)
E1	E1	0.39	55.3%	0.91	1.92
E2	E2	2.59	62.1%	5.75	11.64
OE1	OE1	2.34	77.5%	6.43	12.00
OE2	OE2	2.48	80.0%	7.34	13.56
OE3	OE3	1.14	80.0%	3.52	6.51
OE4	OE4	0.82	80.0%	2.46	4.54
OE5	OE5	0.97	75.3%	3.05	5.79
TOTAL		**10.73**	**73.8%**	**29.46**	**55.96**

NORTH

GRAPHIC SCALE IN FEET
0 20 40 80

PCD FILE NO. CDR-XX-XXX

811 Know what's **below.** **Call** before you dig.

CALL UTILITY NOTIFICATION CENTER OF COLORADO
1-800-922-1987
CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES

Kimley»Horn
2023 KIMLEY-HORN AND ASSOCIATES, INC.
2 North Nevada Avenue Suite 900
Colorado Springs, Colorado 80903 (719) 453-0180

DESIGNED BY: EJG
DRAWN BY: RES
CHECKED BY: EJG
DATE: 12/6/2023

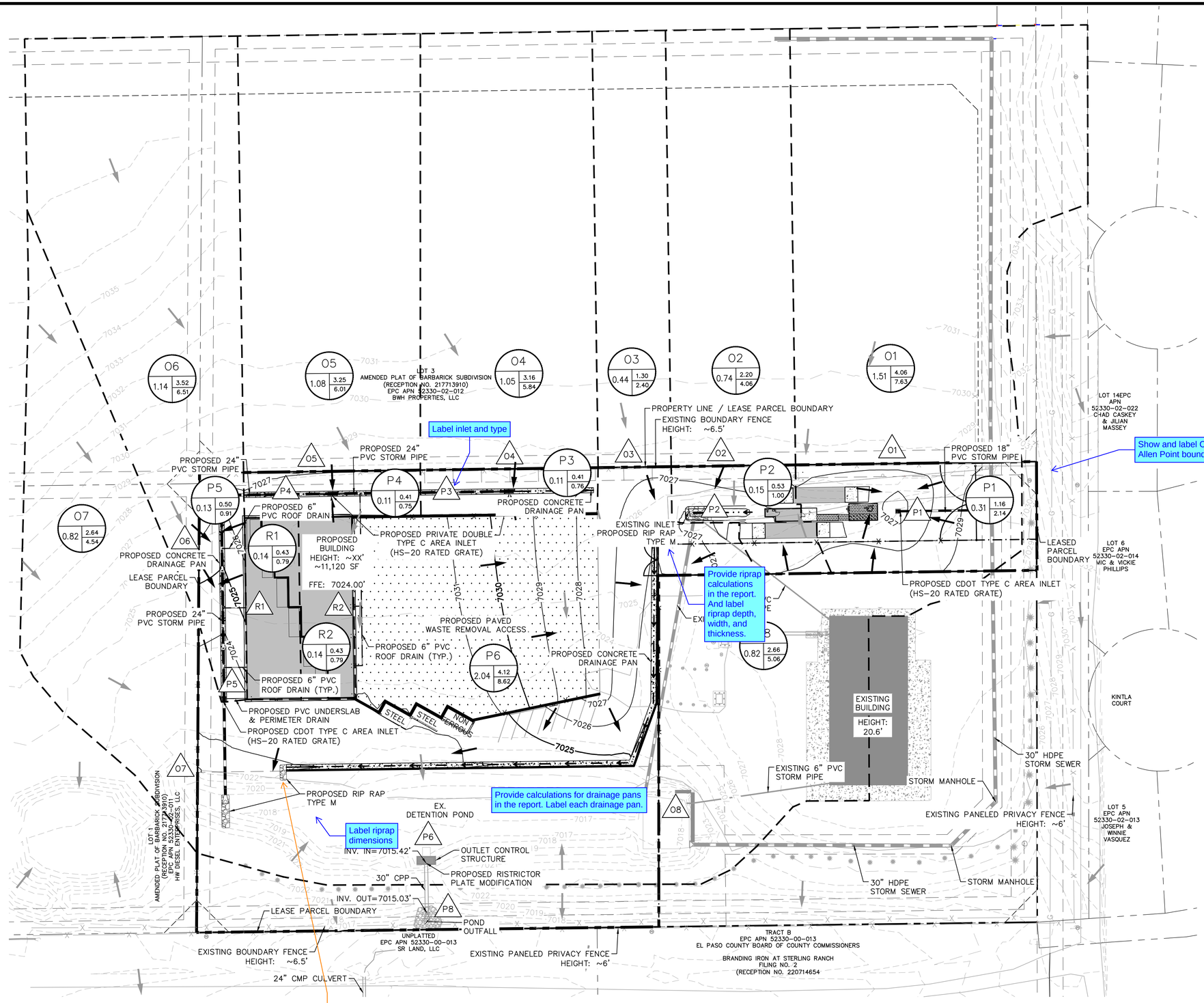
BARBARICK WASTE TRANSFER STATION
EL PASO COUNTY, COLORADO
DRAINAGE MAP
EXISTING CONDITIONS

PRELIMINARY
FOR REVIEW ONLY
NOT FOR CONSTRUCTION
Kimley»Horn
Kimley-Horn and Associates, Inc.

PROJECT NO.
196489000

SHEET
DR-1

K:\COS_Civil\196489000_Barbarick Waste Transfer\CADD\PlanSheets\DR\DR_EX_196489000.dwg Schnelbach, Ryan 12/7/2023 10:38 AM



LEGEND

- PROPERTY LINE
- LEASED PARCEL BOUNDARY
- EXISTING UTILITY & DRAINAGE EASEMENT
- EXISTING FENCE
- EXISTING STORM SEWER
- EXISTING GAS MAIN
- EXISTING VEGETATION
- EXISTING TRANSFORMER
- PROPOSED UNDERGROUND ELECTRIC
- PROPOSED STORM SEWER
- PROPOSED STORM INLET
- PROPOSED ASPHALT
- PROPOSED CONCRETE
- 60XX EXISTING MAJOR CONTOUR
- 60XX EXISTING MINOR CONTOUR
- **60XX** PROPOSED MAJOR CONTOUR
- 60XX PROPOSED MINOR CONTOUR
- PROPOSED BASIN BOUNDARY

A = SUB-BASIN NAME
B = BASIN SIZE (ACRE)
C = 5-YEAR RUNOFF
D = 100-YEAR RUNOFF

DESIGN POINT

EXISTING FLOW ARROW

PROPOSED FLOW ARROW

SUMMARY - PROPOSED RUNOFF TABLE

DESIGN POINT	BASIN DESIGNATION	BASIN AREA (ACRES)	BASIN IMPERVIOUSNESS (%)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)
P1	P1	0.31	81.7%	1.16	2.14
P2	P2	0.15	76.4%	0.53	1.00
P3	P3	0.11	82.2%	0.41	0.76
P4	P4	0.11	82.3%	0.41	0.75
P5	P5	0.13	82.0%	0.50	0.91
P6	P6	2.04	58.9%	4.12	8.62
R1	R1	0.14	90.0%	0.43	0.79
R2	R2	0.14	90.0%	0.43	0.79
O1	O1	1.51	76.1%	4.06	7.63
O2	O2	0.74	80.0%	2.20	4.06
O3	O3	0.44	80.0%	1.30	2.40
O4	O4	1.05	80.0%	3.16	5.84
O5	O5	1.08	80.0%	3.25	6.01
O6	O6	1.14	80.0%	3.52	6.51
O7	O7	0.82	80.0%	2.46	4.54
O8	O8	0.82	76.7%	2.66	5.06
TOTAL		**10.73**	**75.5%**	**30.59**	**57.81**

POND DISCHARGE

(DESIGN POINT P8)

5-YEAR	100-YEAR
3.2 CFS	11.8 CFS

NORTH

GRAPHIC SCALE IN FEET
0 20 40 80

PCD FILE NO. CDR-XX-XXX

811 Know what's **below.** **Call** before you dig.

CALL UTILITY NOTIFICATION CENTER OF COLORADO
1-800-922-1987
CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES

Kimley»Horn

2023 KIMLEY-HORN AND ASSOCIATES, INC.
2 North Nevada Avenue Suite 900
Colorado Springs, Colorado 80903 (719) 453-0180

DESIGNED BY: EJG
DRAWN BY: RES
CHECKED BY: EJG
DATE: 12/6/2023

BARBARICK WASTE TRANSFER STATION
EL PASO COUNTY, COLORADO
DRAINAGE MAP

PROPOSED CONDITIONS

PRELIMINARY
FOR REVIEW ONLY
NOT FOR CONSTRUCTION
Kimley»Horn
Kimley-Horn and Associates, Inc.

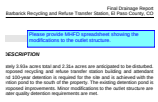
PROJECT NO.
196489000

SHEET
DR-2

K:\COS_Civil\196489000_Barbarick Waste Transfer\CADD\PlanSheets\DR\DR_PR_196489000.dwg Schnelbach, Ryan 12/7/2023 10:38 AM

Drainage Report - Final Comments.pdf Markup Summary

Carlos (23)

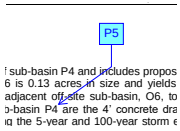


Subject: Text Box
Page Label: 5
Author: Carlos
Date: 1/25/2024 8:16:48 AM
Color:

Please provide MHFD spreadsheet showing the modifications to the outlet structure.

Subject: Highlight
Page Label: 6
Author: Carlos
Date: 1/25/2024 11:14:34 AM
Color:

The existing EDB is designed to store up to 1.49 ac-ft to
the spillway (Elev: 7023.20)



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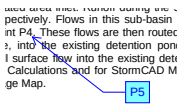
Author: Carlos
Date: 1/25/2024 11:08:23 AM
Color:

P5

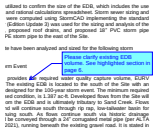


Subject: Callout
Page Label: 9
Author: Carlos
Date: 1/25/2024 11:08:36 AM
Color:

P5

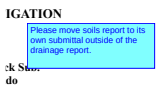
Subject: Highlight
Page Label: 12
Author: Carlos
Date: 1/25/2024 11:21:33 AM
Color:

. The existing EDB is located to the south of the Site with an
existing volume of 2.89 ac-ft



Subject: Callout
Page Label: 12
Author: Carlos
Date: 1/25/2024 11:22:20 AM
Color:

Please clarify existing EDB volume. See highlighted section in page 6.

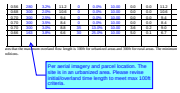


Subject: Text Box
Page Label: 33
Author: Carlos
Date: 1/24/2024 5:36:16 PM
Color:

Please move soils report to its own submittal outside of the drainage report.

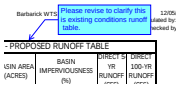
Subject: Callout
Page Label: 57
Author: Carlos
Date: 1/25/2024 1:09:28 PM
Color:

FYI: The gravel coefficients shown are higher than the coefficients listed in Table 6-6 Runoff Coefficients for Rational Method in the DCM Vol. 1. Please note where provided coefficients are being obtained/calculated or revise to match DCM.



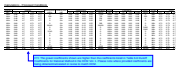
Subject: Callout
Page Label: 58
Author: Carlos
Date: 1/25/2024 1:10:43 PM
Color:

Per aerial imagery and parcel location. The site is in an urbanized area. Please revise initial/overland time length to meet max 100ft criteria.



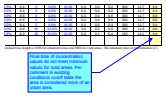
Subject: Callout
Page Label: 61
Author: Carlos
Date: 1/25/2024 1:14:13 PM
Color:

Please revise to clarify this is existing conditions runoff table.



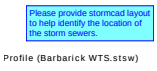
Subject: Callout
Page Label: 62
Author: Carlos
Date: 1/25/2024 1:14:41 PM
Color:

FYI: The gravel coefficients shown are higher than the coefficients listed in Table 6-6 Runoff Coefficients for Rational Method in the DCM Vol. 1. Please note where provided coefficients are being obtained/calculated or revise to match DCM.



Subject: Callout
Page Label: 63
Author: Carlos
Date: 1/25/2024 1:22:23 PM
Color:

Final time of concentration values do not meet minimum values for rural areas. Per comment in existing conditions runoff table the area is considered more of an urban area.

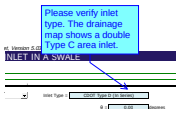


Subject: Text Box
Page Label: 68
Author: Carlos
Date: 1/25/2024 1:27:38 PM
Color:

Please provide stormcad layout to help identify the location of the storm sewers.

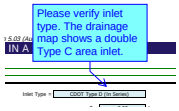
Subject: Text Box
Page Label: 68
Author: Carlos
Date: 1/25/2024 2:09:47 PM
Color:

Please provide a legend for the linetypes shown.



Subject: Callout
Page Label: 73
Author: Carlos
Date: 1/25/2024 2:14:07 PM
Color:

Please verify inlet type. The drainage map shows a double Type C area inlet.

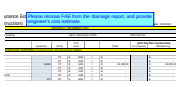


Subject: Callout
Page Label: 75
Author: Carlos
Date: 1/25/2024 2:13:59 PM
Color:

Please verify inlet type. The drainage map shows a double Type C area inlet.

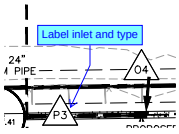
Subject: Text Box
Page Label: 86
Author: Carlos
Date: 1/25/2024 3:12:56 PM
Color:

Verify if this page is missing.



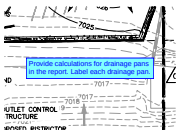
Subject: Text Box
Page Label: 159
Author: Carlos
Date: 1/24/2024 5:39:09 PM
Color:

Please remove FAE from the drainage report, and provide engineer's cost estimate.



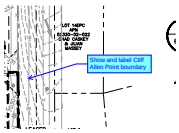
Subject: Callout
Page Label: [2] DR-2 PROPOSED CONDITIONS
Author: Carlos
Date: 1/25/2024 2:12:30 PM
Color:

Label inlet and type



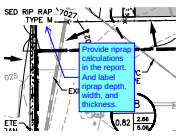
Subject: Text Box
Page Label: [2] DR-2 PROPOSED CONDITIONS
Author: Carlos
Date: 1/25/2024 4:34:09 PM
Color:

Provide calculations for drainage pans in the report. Label each drainage pan.



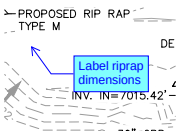
Subject: Callout
Page Label: [2] DR-2 PROPOSED CONDITIONS
Author: Carlos
Date: 1/25/2024 3:20:04 PM
Color:

Show and label Cliff Allen Point boundary



Subject: Callout
Page Label: [2] DR-2 PROPOSED CONDITIONS
Author: Carlos
Date: 1/25/2024 4:33:43 PM
Color:

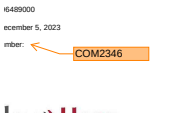
Provide riprap calculations in the report. And label riprap depth, width, and thickness.



Subject: Callout
Page Label: [2] DR-2 PROPOSED CONDITIONS
Author: Carlos
Date: 1/25/2024 4:33:57 PM
Color:

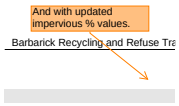
Label riprap dimensions

Glenn Reese - EPC Stormwater (12)



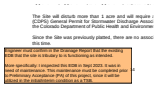
Subject: SW - Textbox with Arrow
Page Label: 1
Author: Glenn Reese - EPC Stormwater
Date: 1/24/2024 12:35:34 PM
Color:

COM2346



Subject: SW - Textbox with Arrow
Page Label: 5
Author: Glenn Reese - EPC Stormwater
Date: 1/25/2024 11:13:21 AM
Color:

And with updated impervious % values.



Subject: SW - Textbox
Page Label: 14
Author: Glenn Reese - EPC Stormwater
Date: 1/25/2024 12:58:03 PM
Color:

Engineer must confirm in the Drainage Report that the existing EDB that the site is tributary to is functioning as intended.

More specifically: I inspected this EDB in Sept 2023. It was in need of maintenance. This maintenance must be completed prior to Preliminary Acceptance (PA) of this project, since it will be utilized in the initial/interim condition as a TSB.

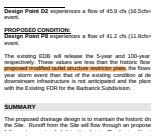
Subject: SW - Highlight
Page Label: 14
Author: Glenn Reese - EPC Stormwater
Date: 1/25/2024 11:23:46 AM
Color:

The EDB is designed to release the 5-year and 100-year on-site flows at a discharge rate of 3.2 cfs and 11.8 cfs, respectively. This is a reduction from the 5-year and 100-year on-site discharge rate of 21.3 cfs and 56.7 cfs

Subject: SW - Textbox with Arrow
Page Label: 14
Author: Glenn Reese - EPC Stormwater
Date: 1/25/2024 1:27:40 PM
Color:

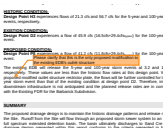
Please clarify this math more with a reference to an appendix for example. Or provide a comparison table here in this text (historic vs original design vs proposed design flowrates). Because this math does not coincide with the total flowrates shown on PDF pg 82 below.

Also update this paragraph per any updates to the table on pg 82 below per my comment on that page.



Subject: SW - Highlight
Page Label: 15
Author: Glenn Reese - EPC Stormwater
Date: 1/24/2024 11:54:07 AM
Color:

proposed modified outlet structure restrictor plate



Subject: SW - Textbox with Arrow
Page Label: 15
Author: Glenn Reese - EPC Stormwater
Date: 1/25/2024 6:37:29 AM
Color:

Please clarify that this is the only proposed modification to the existing EDB's outlet structure

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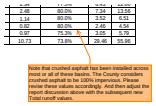
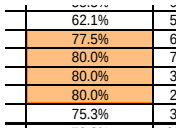
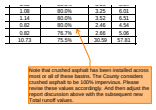


Subject: SW - Textbox with Arrow
Page Label: 61
Author: Glenn Reese - EPC Stormwater
Date: 1/25/2024 12:43:30 PM
Color:

Note that crushed asphalt has been installed across most or all of these basins. The County considers crushed asphalt to be 100% impervious. Please revise these values accordingly. And then adjust the report discussion above with the subsequent new Total runoff values.

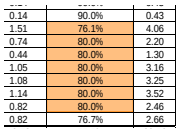


Subject: SW - Rectangle
Page Label: 61
Author: Glenn Reese - EPC Stormwater
Date: 1/25/2024 12:41:18 PM
Color:

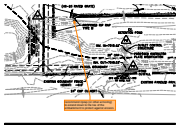


Subject: SW - Textbox with Arrow
Page Label: 66
Author: Glenn Reese - EPC Stormwater
Date: 1/25/2024 1:26:08 PM
Color:

Note that crushed asphalt has been installed across most or all of these basins. The County considers crushed asphalt to be 100% impervious. Please revise these values accordingly. And then adjust the report discussion above with the subsequent new Total runoff values.



Subject: SW - Rectangle
Page Label: 66
Author: Glenn Reese - EPC Stormwater
Date: 1/25/2024 1:26:02 PM
Color:



Subject: SW - Textbox with Arrow
Page Label: [2] DR-2 PROPOSED CONDITIONS
Author: Glenn Reese - EPC Stormwater
Date: 1/25/2024 11:07:58 AM
Color:

recommend riprap (or other armoring) to extend down to the toe of the embankment to protect against erosion.