Final Drainage Report

For:

Didleau Subdivision Filing 1

Project No. 2019.012

May, 2022

PCD File No: MS206

Prepared for:
Phyllis Didleau
8250 Forest Heights Drive
Colorado Springs, CO 80908
719-440-1949

Prepared by:
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Colorado Springs, CO 80917

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APPENDIX

CERTIFICATIONS AND APPROVALS

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 El Paso County for drainage reports and said drainage 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 omission on my part in preparation this report

Signature _____
(Kenneth C. Harrison, P.E.)

Registered Professional Engineer State of Colorado No. _____

Seal

Owner's Statement
I, the Owner, Phyllis Didleau have read and will comply with all of the requirements specified in this drainage report and plan.

_____
(Signature)

_____
(Phyllis Didleau)

Address: 8250 Forest Heights Drive
Colorado Springs, CO 80908

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.

El Paso County Engineer/ ECM Administrator

_____
(Signature) *(Jennifer Irvine, P.E.)*

Date: _____

Revise to **Interim** El Paso County Engineer/ECM Administrator

Please revise to Joshua Palmer, P.E.

Unresolved. Please see the latest version of the plat drawing and revise information to match.

ORT PURPOSE

The purpose of this study is to evaluate the drainage characteristics for the historic and the developed conditions of the **Didleau Subdivision Filing 1** (the site) in accordance with **El Paso County** criteria. The subdivision subdivides the **Didleau** tract into three (3) lots for single family residences. This analysis will demonstrate that there is only a negligible increase in runoff with the development of the site.

II. GENERAL DESCRIPTION

Location

The site is a portion of the southwest quarter of Section 9, Township 12 South, Range 65 West of the 6th Principal Meridian, El Paso County, Colorado *(Exhibit 1, Appendix).*

The current tract consists of approximately 32.59 acres with 5.11 acres located north of Forest Heights Circle and 27.48 acres located south of Forest Heights Circle. It is proposed to subdivide the tract into 3 lots. The sizes of the lots are:

- Lot 1: 22.252 acres south of Forest Heights Circle
- Lot 2: 5.183 acres south of Forest Heights Circle
- Lot 3: 5.183 acres south of Forest Heights Circle
- Tract A: 0.595 acres encompassing the roadway directly east of Herring
- Tract B: 2.09 encompassing the eastern end of the road.
- The roadway is also designed with two (2)spaces to accommodate fire trucks.

There is a 40-foot-wide easement where three (3) gas lines are located and run north and south. Two (2) of them carry natural gas are owned and managed by Kinder Morgan. The third line carries liquid petroleum and is owned by Magellan. Contact information is on "flags" located directly over the lines. It is recommended that the contractor notify the companies 72 hours ij advance of construction.

III. DESIGN CRITERIA AND METHODOLOGY

The hydrologic and hydraulic characteristics for both the historic and developed conditions of the site were evaluated using the following resources;

- ***Design Manuals***
  - ***El Paso County Drainage Criteria Manual, Volume I.***
    The charts and graphs used from this manual are reproduced in *Exhibit 4 of the Appendix.*
  - ***City of Colorado Springs Drainage Criteria Manual applicable charts and nomographs were included.***
    The charts and graphs used from this manual are reproduced in *Exhibit 4 of the Appendix.*

- **Soil Survey of El Paso County Area, Colorado United States Department of Agriculture, Soil Conservation Service**
  (See Appendix, Exhibit 3)

- ***Flood Insurance Rate Map, Federal Emergency Management Agency***
  (See Appendix, Exhibit 2)

- ***Kettle Creek Drainage Basin Planning Study***
  (See Appendix, Exhibit 5)

- **Design storms**
  - Minor storm: 5-year
    This storm was used to size drainage facilities that cross under Forest Heights Circle.
  - Major storm: 100-year
    This storm was used to evaluate overland flow through the subdivision as it pertains to impacts on existing residences and the existing roadway when overtopped.

- **Drainage Areas**
  - Areas for the offsite and onsite sub basins were determined from topographic mapping from the El Paso County GIS department. This mapping was used as the base for the Drainage Map included in a map pocket (*Exhibit 11, Appendix)* at the back of this report.

- **Runoff Methods**
  - ***Rational Method***
    This method is used to determine runoff quantities for sub basins with less than 100 acres. Intensity-Duration-Frequency (IDF) curves were obtained from the EPC Drainage Criteria Manual (DCM) (*Appendix, Exhibit 4*).

- **Culvert Evaluation**
  Sizing
  - The criteria in Table 6.1 of the Drainage Criteria Manual Chapter 6 were used as the criteria by which each culvert was evaluated.
  - The 5-year storm was used to evaluate the culverts with a maximum headwater to depth ratio limit of 1.5 prior to roadway overtopping.
  - The 100-year storm was used to evaluate the over topping conditions at the three (3) culverts under Forest Heights Drive as well as impacts on the existing structures within the vicinity of the existing swales discussed in this report.

Table 6-1

- **Drainage Swale and Borrow Ditch Evaluation**
  - Onsite and offsite drainage swales and the borrow ditches on both sides of Forest Heights Drive were evaluated for erosion potential and depth of flow.
  - The assumptions that were made in the evaluation of the culverts are described in the pertinent sections of the report
  - The Froude Number was calculated to determine the state of flow, subcritical vs. supercritical. Supercritical flow only became an issue when excessive velocities were calculated for either the minor of major storm events.

- **Detention/ Water Quality**
  - The detention/ water quality pond requirements are addressed in the Section XII.

- ***Erosion control***
  - Erosion issues were identified and evaluated based on the estimated velocities in the existing swales .

IV. EXISTING REPORTS, MAPPING AND INFORMATION

- The project is located in the upper reaches of the **Kettle Creek Drainage Basin** *(Appendix, Exhibit 5).*
- No drainage reports have been prepared for any of the tracts that surround the site.

V. FEMA FLOODPLAIN

The project is within Zone X as shown on the Flood Rate Insurance Map, El Paso County, Colorado and Incorporated Areas, Map Number 08041C0320G, and dated December 7, 2018. *(Appendix, Exhibit 2).* New construction within this zone is subject to minimal flooding hazards.

VI. HYDROLOGIC SOILS INFORMATION

The hydrologic soils groups were obtained from the USDA National Resource Conservation Service website for soils types in El Paso County, Colorado ***(Appendix, Exhibit 3)***. The soils are identified as follows:

- Elbeth sandy loam (SCS No. 26)
- Kettle Gravelly Loam (SCS No. 40)

The soils and their detailed characteristics are described in ***Exhibit 3, Appendix***. The hydraulic soils group is classified within the B hydrologic group.

VII. OFFSITE DRAINAGE CONDITIONS

Topographic mapping was obtained from El Paso County GIS Department. The site drains from northeast to southwest through the site. There are five (5)

defined drainageways that enter and exit the site. All of the drainageways discharge into the Burgess River which discharges into Kettle Creek. The vegetation is characterized by highland grasses and Ponderosa Pine trees. The areas are typically developed as rural large-acre single-family residential tracts with only a small portion of each tract mowed around the residences. The majority of the roads that provide access to these tracts are two lane rural gravel roads with borrow ditches.

VIII. EXISTING/ PROPOSED CONDITIONS CHARACTERISTICS

General

The proposed hydrologic conditions for this site are
existing conditions except for the construction of sin
structures. As a result, both the existing and develop
in this section.

The site is primarily hilly with natural drainage ways.
south of Forest Heights Drive, slope from the northe
average slope of 4.5%. The drainage ways cross Fo
corrugated metal culverts at three (3) locations.

This statement "maintenance project" is not clear/confusing. The developer will be responsible for constructing the roadway per the construction plans submitted. The future maintenance of the roadway will be per the maintenance agreement. revise the statement accordingly to provide clarity.

The site is vegetated with medium height prairie grasses, small bushes, and Ponderosa Pines. A portion of the site was burned by the Black Forest fire in 2013. There are only negligible signs of erosion except for a small amount in the borrow ditches along both sides of Forest Heights Circle. A significant amount of ash has silted the existing culverts.

The subdivision is located in northerly end of El Paso County in the upper reaches of Kettle Creek ***(Exhibit 5, Appendix)***.

Forest Heights Drive

Forest Heights Drive serves as the primary access for the subdivision. The road was initially built in the 70's. Very little maintence has been done to the road. Therefore, the proposed construction will be accomplished as a maintenance project under the conditions outlined in the subdivision's Maintenance Agreement. The proposed private road is to be a compacted two-lane road with borrow ditches and three (3) "culvert" crossings . The road extends approximately 2,450-feet east of the Herring Drive intersection. This road is presently privately owned and maintained. The road will be improved to meet El Paso County standards for Rural Roadways to a proposed cul-de-sac located approximately 2,400 feet east of Herring Drive.

The road has an average "right-of-way" width of 60 feet with a small portion of only 30-feet wide adjacent to and south of the Yonce lot. The road is currently maintained by Jon and Phyllis Didleau. A permanent "maintenance association" has been established and executed by the majority of the homeowners (Exhibit 12, Appendix)

exhibit 13 is the maintenance agreement. exhibit 12 is photos

If this maintenance agreement has been executed then please provide the recording #, otherwise please change the wording to "will be established and executed"

The road crosses three (3) drainage ways, all of which will be discussed in subsequent sections of this report. The approximate locations of the crossings are shown on the drainage plan included in *(Exhibit 12, Appendix*) the back of the report.

The following physical characteristics of the road were obtained from the mapping and photographs (*Exhibit 11, Appendix*).

Erosion and sedimentation have occurred in sections along both sides of Forest Heights Circle. Very little erosion has occurred in the swales with the exception of the borrow ditches. The majority of the sedimentation consists of ash from the Black Forest fire in 2013. As a result, the hydraulic capacity of the existing swales has been significantly reduced to approximately 30%.
Very little of the sediment consists of erosion of the naural ground upstream of each culvert.

Swales
The site is drained by five (5) natural swales, three (3) of which cross Forest Heights Circle via 18-inch CMP culverts. The water is then carried in a southwest direction. All of the swales, with the exception of the borrow ditches along Forest Heights Circle, are characterized as follows:

- The drainage-ways consist of large natural cross sections characterized by large bottom widths and gentle side slopes.
- Wetland areas are present at naturally occurring low areas and at locations where seasonal ground water comes to the surface.
- The upper reaches of the Burgess River, noted as swale 1, crosses at the most easterly end of Forest Heights Circle at DP2.
- All of the drainage ways are well established and stable with natural vegetation and only a negligible amount of erosion as shown in the pictures.

Culverts
A total of three (3) corrugated metal pipe (CMP) culverts routes the water under Forest Heights Circle. All three (3) culverts were evaluated based on inlet control with a free outfqll and no sediment. Each culvert is discussed under the applicable Design Point (DP) number included in the following sections. As explained above, the sediment in the culverts consist of a significant amount of ash and silt. The culverts cross under Forest Heights Circle at 150 feet, 1,250 feet, and 2,250 feet east of the Herring Road intersection. Once under Forest Heights Circle the water is routed in a southwesterly direction in natural drainage swales with the same characteristics as described above. All of the swales are stable with only negligible signs of erosion. Headwater to depth requirements were obtained from the nomograph titled Headwater to Depth for CMP pipe with Inlet Control (*Exhibit 4, Appendix*). The depth of flow for water overtopping the road is beyond the scope of this report. In order to perform this analysis a

As indicated in previous review 1 comment the culverts shall be analyzed per criteria in DCMV1 CH6(table 6-1) and upgraded as required.

significant more field date would be required.

Design Points
The Design Points (DP) shown on the Drainage Map were located where natural drainage ways cross Forest Heights Circle, at high points, swale intersections, and any other point of interest.

Design Point 1
Forest Heights Circle is to be improved from Herring Road to a proposed cul-de-sac located approximately 2,400 feet east of the Herring Road Intersection.

DP1 is located at a high point in the existing and proposed borrow ditch adjacent to the proposed cul-de-sac. From this design point the water discharges both to the north and south. The water in the southerly borrow ditch discharges into a natural and heavily vegetated swale shown as Swale 2. The water in the northerly borrow ditch discharges into a "wetland" area located at the inlet of Culvert 1.

Design Point 2
Runoff from Sub basin A (17.4 Acres) is collected via a natural swale 1 (photo 4). The water is then routed to an existing 18" CMP culvert (STR1) which discharges into a natural broad swale 2. The culvert is approximately 75% full of ash from the 2013 fire and negligible amount of sediment from upstream. It is recommended that this culvert be replaced with another 18" CMP culvert. Both swales 1 and 2 are heavily vegetated and only show a negligible amount of erosion (photo 2, 6). Special precaution will be needed in constructing the road in the vicinity of the culvert. There is a significant number of seasonal wetlands both upstream and downstream of the culvert. Approximate boundaries are indicated on the Drainage Plan. Accurate identification and boundaries of the wetland areas are beyond the scope of this report

Swale 1 has the following *physical* characteristics:
Swale 1 collects the water in sub basin A and directs it to the existing 18" culvert under the private driveway at DP2. From DP2 the water is routed to DP14 where it combines with runoff from sub-basin F. The swale from DP2 to DP14 is noted as Swale 2 on the drainage plan.

The physical characteristics for Swale 1 are as follows:
- Average slope: 4.5 %
- Bottom width: varies from 50 feet to 75 feet
- Average side slopes: varies from 15 to 1.
- Typical vegetation: Highland grasses, bushes and Ponderosa Pines trees.

Swale 1 has the following *hydrologic/ hydraulic* characteristics;
- Design flow: Q5 = 3.7 cfs, Q100 =24.0 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.2 feet

- Velocity: 5 year = 1.2 fps, 100 year = 2.7 fps
- Froude #: 5 year = 0.91 Subcritical, 100 year = 1.16 supercritical.

Discussion:

The existing swale is very stable with areas of wetlands both upstream and downstream of the existing culvert.

Culvert 1 has the following *physical* characteristics:

- Size: 18"
- Material: Corrugated metal pipe
- Slope: Undetermined
- Existing Condition: Approximately 75% full of sediment.
- End Sections: none

Culvert 1 has the following *hydrologic/ hydraulic* characteristics:

- Design flow: Q5 = 3.4 cfs, Q100 = 23.6 cfs
- Headwater required to pass (for clean pipe): 5 year = 12.8", 100 year = greater than 7.5 feet (significant roadway overtopping occurs) Based on conversations with the residents, roadway overtopping has infrequently occurred with the larger storm events.

Discussion:

The existing culvert has minimal capacity due to sedimentation and the poor end conditions. Overtopping of the roadway is anticipated even with possibly the minor storm event. The downstream end (photo 5) controls the amount of water that the culvert can accommodate. The end is buried with approximately 75% of sediment where wetlands have been established. Sediment removal in the bottom of the existing swale is not recommended since this would require excavating the existing wetland areas for a significant distance downstream.

Design Point 3

DP3 is located at the high point between Sub basins A and B (photo 54). Water is directed both in an easterly and westerly direction in the existing borrow ditches.

Design Point 4

Runoff from Sub basin B (20.8 Acres) is collected via a natural swale, Swales 3, 3a, and 3b, and passes under Forest Heights Circle at DP4 (photos 17, 18, 19). The water passes under Forest Heights Circle via an 18" CMP, Culvert 2 (photos 21 and 24). There are areas of wetlands (photo 17) with approximate boundaries indicated on the Drainage Plan. Accurate boundaries for the wetland areas are beyond the scope of this report

Swales 3, 3a, 3b have the following average *physical* characteristics:

- Average slope: 4.6 %

- Bottom width: varies from 20 feet to 40 feet
- Average side slopes: 10 to 1.
- Typical vegetation: meadow with high grass, bushes, with a few Ponderosa Pines.

Swales 3, 3a, 3b have the following *hydrologic/ hydraulic* characteristics;

- Design flow: Q5 = 4.6 cfs, Q100 = 29.5 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.3 feet
- Velocity: 5 year = 1.8 fps, 100 year = 3.7 fps
- Froude #: 5 year = 1.04 Supercritical, 100 year = 1.26 Supercritical

Discussion:

Swale 3a and 3b join together at approximately 300 feet upstream of the culvert (STR2). The vegetation along the entire length of Swale 3 is well established with only a minimal amount of erosion. Wetland areas are located in low and flat areas along the swales. Approximate locations of the wetlands are shown on the Drainage Plan. There is no evidence of wetlands at either the upstream or downstream ends of the culvert (photos 20, 24).

Culvert 2 has the following *physical* characteristics:

- Size: 18"
- Material: Corrugated Metal
- Slope: Undetermined
- Condition: ends are crushed, heavy sediment, dense grass and weed growth at both the upstream and downstream ends.
- End Sections: no end sections are present

Culvert 2 has the following *hydrologic/ hydraulic* characteristics:

- Design flow: Q5 = 4.6 cfs, Q100 = 29.5 cfs
- Headwater for clean pipe: 5 year = 15.3" (meets criteria), 100 year = >9ft (does not meet criteria, significant road overtopping occurs, no buildings are in danger of being inundated)

Discussion:

The existing culvert has minimal capacity due to the amount of sediment and poor end conditions. Overtopping of the roadway is anticipated even with minor storm events. The downstream end controls the amount of water that the culvert can accommodate. The end is buried approximately 75% in the sediment where grass and weeds have choked the exit conditions.

Design Point 5

DP5 is located at the sub basin line between sub basins B and C. This point is only slightly higher than the elevation of the existing borrow ditches. As a result, a portion of the water that is collected in the borrow ditch east of sub basin B flows to the existing culvert at DP7.

Runoff from Sub basin C (3.9 Acres) sheet flows to the borrow ditch along the north side of Forest Height Drive (S15). The water is routed to the 18" culvert (STR3) at DP7 (photo 30). A small number of trees are located in the borrow ditch. In order to not to have to move these trees the road was diverted 6' to the south along the south edge of the Yonce tract. This will allow for the installation of the borrow ditch along the north side of the proposed Forest Heights Road without disturbing the trees. There are only small pockets of wetlands located in depressions in sub basin C where the ground water comes to or near the surface. Accurate boundaries of the wetland areas are beyond the scope of this report

Swale 5 (Borrow Ditch) will have the following *physical* characteristics:

- Average slope: 5.5 %
- Bottom width: 2 feet
- Average side slopes: varies from 3 to 1 and 6 to 1.
- Typical vegetation: meadow grass.

Swale 5 (undefined) has the following *hydrologic/ hydraulic* characteristics;

- Design flow: Q5 = 1.8 cfs, Q100 = 8.4 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.1 feet
- Velocity: 5 year = 1.3 fps, 100 year = 2.4 fps
- Froude #: 5 year = 1.0 Subcritical, 100 year = 1.2 super critical

Discussion:

Swale 5 is very stable with only minimal signs of erosion. The swale directs water to the northerly borrow ditch along Forest Heights Circle. The existing borrow ditch is poorly defined with grasses, bushes and trees. It is anticipated that only a minimal amount of water is directed to the west along the borrow ditch due to heavy vegetation in the borrow ditch. It is expected that much of the storm water enters the roadway and proceeds in a westerly direction in the roadway.

Design Point 6

DP6 is located on the north side of Forest Heights Circle where the ridge that separates Sub basin C with Sub basin D is located. All of the runoff from Sub basin C enters the northerly borrow ditch along Forest Heights Circle and is directed to the west past DP 6 (photo 33). The runoff from the south side of Forest Heights Circle (photo 34) is directed to the west along the southerly borrow ditch. This water is directed to Culvert 3. Once under the road the water enters Swale 8.

Design Point 7

Runoff from Sub basin C, D and E is collected by the borrow ditch along the north side of Forest Heights Circle, Swale 7 and Swale 16. Runoff from Sub basin E (2.3 acres) is also routed to DP7 via a natural swale (Swale 6). The cumulative water (Q5: 5.9 cfs, Q100: 28.7 cfs) passes

under Forest Heights Circle via an 18" corrugated culvert (STR3) (photo 41, 43). The water is then routed to the south in swale 8. Sub basins D and E are developed as single-family home sites (photo 42). The majority of the lot is mowed. There is no evidence of wetlands along swale 6 with the exception of immediately upstream of the culvert (STR3). The culvert is almost silted full with ash from the fire in 2013. The culvert passes only a minimal amount of water.

Swale 6 has the following *physical* characteristics:

- Average slope: 6.0 %
- Bottom width: varies from 20 feet to 30 feet
- Average side slopes: varies from 10 to 1.
- Typical vegetation: meadow with high grass and Ponderosa Pine trees

Swale 6 has the following *hydrologic/ hydraulic* characteristics;

- Design flow: Q5 = 4.1 cfs, Q100 = 20.3 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.2 feet
- Velocity: 5 year = 1.9 fps, 100 year = 3.5 fps
- Froude #: 5 year = 1.18 Supercritical, 100 year = 1.1.37 super critical

Culvert 3 has the following *physical* characteristics:

- Size:18"
- Material: Corrugated Metal Pipe
- Slope: Undetermined
- Condition: silted to about 80%.
- End Sections: none

Culvert 3 has the following *hydrologic/ hydraulic* characteristics:

- Design flow: Q5 = 5.9 cfs, Q100 = 28.7 cfs (includes runoff from Sub basin C)
- Depth required to pass: 5 year = 16.7" (meets El Paso County criteria), 100 year =>9 ft. (does not meets El Paso County criteria except that no buildings will be inundated).

Discussion:

The existing culvert is approximately 80% full of silt and ash from the 2013 fire and only passes a portion of the minor storm event. It is expected that the roadway will be overtopped during the majority of the minor storm events and well as all of the major storm events. There are no structures downstream that are in danger of being flooded.

Design Point 8

DP8 is located at the high point along Herring Road where the water, south of the high point sheet flows to the east onto private property. The water sheet flows onto the lot located at the northeasterly corner of the Herring Road/ Forest Heights Circle intersection. All of the water is

collected and is routed to the 18" CMP at DP7. There is no borrow ditch along the easterly side of Herring Road.

Design Point 9

DP9 is located at the intersection of Forest Heights and Herring Road. All runoff from the easterly half of Herring Road sheet flows to the east and is collected by an undefined swale, Swale 6. There is no borrow ditch along the east side of Herring Road. All of the water flows to Swale 6 which crosses private property. The swale is located in the lot located at the northeast corner of the Herring Drive intersection. The swale routes the water to the existing 18" CMP culvert (STR3) at DP7. There is no culvert under Forest Heights Drive or Herring Road at DP9 due to the topography of the sub basin. Runoff from Sub basin E (2.3 acres), which includes the easterly half of Herring Road, is collected via a private natural swale, Swale 6, located within the existing lot located at the northeast corner of the Herring Road and Forest Drive intersection. The water is also routed to the existing 18" CMP culvert at DP7. From DP7 the storm water runoff is routed in Swale 8 south of Forest Heights Road in a southwesterly direction. The swale is characterized by a wide bottom with very gradual side slopes. The area which Swale 8 is located in is an extensive wetland area and as a result, no erosion and sedimentation has been noted along the entire length of Swale 8. The hydrologic and hydraulic properties of Swale 8 are described in the DP10 section below.

Per the drainage plan Basin A ultimately leads to DP15 and Basin I would not be conveyed to Herring Road. Revise the design accordingly.

This does appear to be the correct design point

Structure 4

Once the water passes under Forest Heights Drive at DP3, the water is routed to an 18" CMP (STR4) located under an existing paved residential driveway just south along the southern property line of the site. The 18" culvert was installed significantly higher than the existing flowline of Swale 8. No information regarding the design and placement of this culvert could be obtained.

Per the drainage plan Culvert 4 lies within Lot 3. Please revise accordingly.

Culvert 4 is located off the project site and under a paved driveway to a residence. It has the following *hydrologic/ hydraulic* characteristics:

- Design flow: Q5 = 20.8 cfs, Q100 =124 cfs. This represents runoff from A,B,C,D,E,H, and I.
- Depth required to pass: 5 year: > over the top of road, significantly. 100 year = over the top of road, significantly (private driveway.). Determination of the depth of flow over the driveway is beyond the scope of this report.

then the majority of the developed flows from lot 1, lot 3 and the roadway, are conveyed to the east side of Herring Road. As indicated in the review 1 comment, please indicate whether the ditch is adequate to accept the developed flow of this development and whether the flow is contained within the ditch as it flows south to DP11.

Design Point 10

DP10 is located where swale 8 and swale 4 combine in the area next to Herring road. There is a minimal borrow ditch along the east side of Herring Road. The combined water in swale 4 and swale 8 is routed to DP11 where a 36" carries

culvert

the water under Herring Road. As discussed in previous sections the hydrologic and hydraulic properties of the 36" CMP is outside the scope this project mainly because the drainage area is significantly greater than the project area.

Swale 8 and **Swale 4** are like all of the other swales. They are stable with only negligible signs of erosion. Seasonal wetland areas have been established with the approximate locations shown on the attached Drainage Plan. Accurate identification and location of the wetland areas are beyond the scope of this report.

Swale 8

- Average slope: 3.3 %
- Bottom width: average of 35 feet.
- Average side slopes: varies from 3 0 to 1.
- Typical vegetation: regularly mowed and maintained

Swale 8 has the following *hydrologic/ hydraulic* characteristics;

- Design flow: Q5 = 8.7 cfs, Q100 = 43.8 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.3 feet
- Velocity: 5 year = 1.8 fps, 100 year = 3.1 fps
- Froude #: 5 year = 0.91 Subcritical, 100 year = 1.06 super critical

Swale 4 (within the project site*)* has the following *physical* characteristics:

- Average slope: 3.3 %
- Bottom width: average of 85 feet.
- Average side slopes: varies from 3 to 1.
- Typical vegetation: regularly mowed and maintained

review 1 comment: identify the total flow at DP11.
Review 2 unresolved.

Swale 4 has the following *hydrologic/ hydraulic* characteristics;

- Design flow: Q5 =10.2 cfs, Q100 = 64.2 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.2 feet
- Velocity: 5 year = 1.4 fps, 100 year = 2.9 fps
- Froude #: 5 year = 0.87 Subcritical, 100 year = 1.06 super critical

Design Point 11

DP11 is located at the easterly end of the 36" culvert under Herring Road. The water from Swale 8 and 4 join at DP10. From DP10 the water is routed in a swale alongside Herring Road. The water is routed to a 36" CMP culvert (DP11) under Herring Road. The exact location of this culvert was not obtained. The hydraulic properties of the 36" culvert were not evaluated since the design flow is generated from a drainage area significantly greater than the project area and therefore is outside the scope of this project.

Design Point 12

Runoff from Sub basin J (3.4 acres) is collected via Swale 11. Water in this swale

Review 1 comment. Please provide additional discussion regarding swale 8. It appears that swale 8 outfalls to the roadside ditch along Herring Road. Indicate whether the ditch is adequate to accept this flow and whether the flow is contained within the ditch as it flows to the south to DP11.
Review 2: unresolved. Please address the review 1 comment.

exits the project site at DP12. The upper end of the swale begins approximately at the southerly property line of Lot 3.

Swale 11

- Average slope: 3.1%
- Bottom width: average of 60 feet.
- Average side slopes: varies from 15 to 1.
- Typical vegetation: regularly mowed and maintained

Swale 11 has the following *hydrologic/ hydraulic* characteristics;

- Design flow: Q5 = 1.0 cfs, Q100 = 7.1 cfs
- Depth of Flow: 5 year = Neg, 100 year = 0.1 feet
- Velocity: 5 year = 0.6 fps, 100 year = 1.4 fps
- Froude #: 5 year = 0.7 Subcritical, 100 year = 0.86 subcritical

Design Point 13

Runoff from Sub basin F (18.7 acres) is collected via an undefined natural swale, Swale 10, at DP13 where it combines with Swale 2. Swale 10 enters the subdivision at the southeasterly corner approximately 300 feet south of Forest Heights Circle.

Swale 10 has the following *physical* characteristics:

- Average slope: 5.3 %
- Bottom width: Average 20 feet
- Average side slopes: varies from 20 to 1.
- Typical vegetation: meadow with high grass and Ponderosa Pine trees

Swale 10 has the following *hydrologic/ hydraulic* characteristics;

- Design flow: Q5 = 3.1 cfs, Q100 = 21.1 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.3 feet
- Velocity: 5 year = 1.7 fps, 100 year = 3.4 fps
- Froude #: 5 year = 1.09 Supercritical, 100 year = 1.3 Supercritical

Design Point 14

Runoff from Sub basin A and G (27.3 acres) is collected via a natural swale, Swale 2, at DP14 where Swales 2 and 10 intersect. There are wetland areas with approximate areas indicated on the Drainage Plan. Accurate identification and boundaries for the wetland areas are beyond the scope of this report.

Swale 2 has the following *physical* characteristics:

- Average slope: 3.1%
- Bottom width: average 60 feet
- Average side slopes: 15 to 1.
- Typical vegetation: meadow with high grass and Ponderosa Pine trees

Swale 2 has the following *hydrologic/ hydraulic* characteristics;

- Design flow: Q5 = 5.7 cfs, Q100 = 36.1 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.3 feet
- Velocity: 5 year = 1.5 fps, 100 year = 2.9 fps
- Froude #: 5 year = 0.84 Subcritical, 100 year = 1.02 Supercritical

Discussion:

Swale 2 is a broad grass lined swale in a stable condition with only negligible indications of erosion. Swale 2 carries the water offsite at DP15. Wetlands are located immediately downstream of culvert 1 with approximate boundaries indicated on the drainage plan (Photo 6). Accurate identification and location of the wetland areas is beyond the scope of this report.

Design Point 15

Runoff from Sub basin A, F, and the major portion of G (46.0 acres) is collected via a natural swale, Swale 12, and is routed to DP15. The swale is also noted as the upper portion of the Burgess River. The characteristics that are listed below were obtained from measurements taken from topographic data provided by El Paso County for the portion of the Burgess River located in Sub basin G. This section of the Burgess River is characterized by large bottom widths, gradual side slopes, relatively steep slopes, and established wetlands.

Swale 12 has the following *physical* characteristics:

- Average slope: 6.1%
- Bottom width: 40 feet
- Average side slopes: 15 to 1.
- Typical vegetation: meadow with well-established high grass, wetland plant species, and a few Ponderosa Pine trees

Swale 12 has the following *hydrologic* characteristics;

- Design flow: Q5 = 9.8 cfs, Q100 = 63.3 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.3 feet
- Velocity: 5 year = 2.2 fps, 100 year = 4.9 fps
- Froude #: 5 year = 1.2 Supercritical, 100 year = 1.7 Supercritical,

Roadside Swales

The following hydraulic and hydrologic analyses are based on the following conditions and assumptions:

- The areas of the sub basins contributing runoff to the roadside borrow ditches were estimated. Typically, not all of the runoff from sub basins enters the swales adjacent to the road. Some of the water is routed directly to the culvert via existing swales located within the sub basin. It was assumed that there would be no backwater due to limited culvert capacity. However, without further

field information and culvert analysis, this condition is not possible to accurately determine. Included in the drainage areas is one-half of the gravel roadway.

- The developed flows from the 5-year and 100-year storms were determined based on the percentage of the area assumed to be contributing the runoff. All flows are based on the developed conditions.
- 5 minutes was used for the Time of Concentration for all swales.
- The slopes of the swales were obtained from the roadway construction plans.
- The physical characteristics of the swales are based on the typical section indicated on the construction plans.

Swale 13

- Location: North side of Forest Heights Drive from the proposed cul-de-sac to culvert 2. A swale does not exist along the southerly side of the road. All of the runoff along the southerly side sheet flows onto the adjacent property.
- Drainage Area: 0.71 acres
- Slope: 6.9% (from roadway construction plans)
- Design flow: Q5 = 0.9 cfs, Q100 = 2.9 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.2 feet
- Velocity: 5 year = 3.2 fps, 100 year = 4.5 fps
- Froude #: 5 year = 1.83 Super critical, 100 year = 1.98 Super critical. Since the velocities are so low it is recommended that only an erosion control be installed in the borrow ditch.

Please identify the protection proposed on the GEC/CD plans

Swale 14

- Location: Roadside swale 14 is located along the north side of Forest Heights Drive from DP 4 to DP5. Flow is directed from the west to the east. Runoff from a small section of Sub basin 3 is handled by this swale.
- Drainage Area: 0.41 acres
- Design flow: Q5 = 0.2 cfs, Q100 = 0.6 cfs
- Slope: 2.1%
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.1 feet
- Velocity: 5 year = 1.3 fps, 100 year = 1.8 fps
- Froude #: 5 year = 0.9 Subcritical, 100 year = 1.0 unstable, subcritical/ supercritical boundary.

Swale 15

- Location: Roadside swale 15 is located along the south side of Forest Heights Drive. It extends from DP 5 to a short distance west of DP6. A swale does not exist along the southerly side of the road. This swale collects water from Forest Heights Drive and small area along the south side of the road (0.27 aces)

Please clarify. Is there a swale or not on the south side of the road?

- Drainage Area: 0.27 acres
- Design flow: Q5 = 0.4 cfs, Q100 = 1.2 cfs
- Slope: 4.4%
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.2 feet
- Velocity: 5 year = 2.1 fps, 100 year = 3.1 fps
- Froude #: 5 year = 1.37 Super critical, 100 year = 1.5 Super critical.

Swale 16

- Location: Roadside swale 16 is located along the north side of Forest Heights Drive from just west of DP6 to culvert 3. It collects water from a portion of Sub basin D. There is no swale along the south side of Forest Heights Drive since all of the water flows overland to the south away from the road.
- Drainage Area: 3.75 acres
- Design flow: Q5 = 2.2 cfs, Q100 = 12.1 cfs
- Slope: 3%
- Depth of Flow: 5 year = 0.2 feet, 100 year = 0.5 feet
- Velocity: 5 year = 3.1 fps, 100 year = 5.0 fps
- Froude #: 5 year = 1.4 Super critical 100 year = 1.49 Super critical

identify what protection will be provided in the ditch

Swale 17

- Location: Roadside swale 17 is located along the north side of Forest Heights Drive from Herring Road to culvert 3. It collects only a small Sub basins E and D (0.35 acres)
- Drainage Area: 0.35 acres
- Design flow: Q5 = 0.3 cfs, Q100 = 1.3 cfs
- Slope: 0.6%
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.3 feet
- Velocity: 5 year = 1.0 fps, 100 year = 1.5 fps
- Froude #: 5 year = 0.53 Subcritical, 100 year = 0.6 Subcritical. No erosion control facilities are recommended due to the low velocities.

IX. REPRESENTATIVE DEVELOPED CONDITIONS CHARACTERISTICS

General Overview

The developed conditions were evaluated based on the following conservative assumptions. The assumptions are representative of the type of "development" that has historically occurred within the adjacent areas.

Area

A hypothetical area of 1.5 acres was used to determine average runoff coefficients for the developed conditions of an individual lot. The improvements to each lot would typically include a residence, landscaping, and a gravel driveway.

Composite Runoff Coefficient (representative)
Area of proposed development: 1.5 acres; C5 = 0.08 C100 = 0.35

- Roof area: 2800 sf; C5 = 0.73 C100 = 0.81
- Lawn: 0.5 acres; C5 = 0.12 C100 = 0.39
- Gravel Drive: 4,000 sf; C5 = 0.59 C100 = 0.70
- Composite "C"; C5 = 0.16 C100 = 0.41

Time of Concentration
Design runoff is determined using the longest time of concentration. It was expected that even for the "developed" conditions of the project, the controlling time of concentration would be the same as for the existing conditions.

The following summarizes the negligible impact that the "developed" conditions have on the total runoff at the individual Design Points. Since the resulting hydraulic conditions were only negligible; the existing swales and culverts were not re-evaluated for the developed conditions.

X. COMPARISON BETWEEN EXISTING AND DEVELOPED RUNOFF

Sub Basin B

- Existing Discharge: 5 year = 4.4 cfs, 100 year = 29.1 cfs
- "Developed" Discharge: 5 year = 4.6 cfs, 100 year = 29.5 cfs

Negligible changes to hydrologic conditions

Sub Basin C

- Existing Discharge: 5 year = 1.4 cfs, 100 year = 7.9 cfs
- "Developed" Discharge: 5 year = 1.8 cfs, 100 year = 8.4 cfs
- Negligible changes to hydrologic conditions

Sub Basin D

- Existing Discharge: 5 year = 2.3 cfs, 100 year = 14.3 cfs
- "Developed" Discharge: 5 year = 2.7 cfs, 100 year = 14.8 cfs
  - Negligible changes to hydrologic conditions

Sub Basin E

- Existing Discharge: 5 year = 1.0 cfs, 100 year = 4.9 cfs
- "Developed" Discharge: 5 year = 1.4 cfs, 100 year = 5.5 cfs
- Negligible changes to hydrologic conditions

Sub Basin D & E

- Existing Discharge: 5 year = 3.3 cfs, 100 year = 19.2 cfs
- "Developed" Discharge: 5 year = 3.4 cfs, 100 year = 20.3 cfs

Unresolved. The culverts shall be re-evaluated for the proposed conditions. Please analyze and state whether the culverts meet the criteria in DCM vol 1 CH6 for cross street flow (table 6-1).
Also the swales that will receive developed flows from the proposed lots (swales 3, 4, 11, 12)should be re-evaluated and the report should demonstrate the increase flows in comparison to the existing conditions flows.

- Negligible changes to hydrologic conditions

Sub Basin F

- Existing Discharge: 5 year = 2.8 cfs, 100 year = 20.7 cfs
- "Developed" Discharge: 5 year = 3.1 cfs, 100 year = 21.1 cfs
- Negligible changes to hydrologic conditions

Sub Basin G

- Existing Discharge: 5 year = 2.7 cfs, 100 year = 17.8 cfs
- "Developed" Discharge: 5 year = 3.0 cfs, 100 year =18.2 cfs
- Negligible changes to hydrologic conditions

Sub Basin H

- Existing Discharge: 5 year = 5.3 cfs, 100 year = 34.3 cfs
- "Developed" Discharge: 5 year = 5.6 cfs, 100 year = 34.7 cfs
- Negligible changes to hydrologic conditions

Sub Basin I

- Existing Discharge: 5 year = 2.4 cfs, 100 year = 13.7 cfs
- "Developed" Discharge: 5 year = 2.8 cfs, 100 year = 14.3 cfs
- Negligible changes to hydrologic conditions

Sub Basin J

- Existing Discharge: 5 year = 1.0 cfs, 100 year = 7.1 cfs
- "Developed" Discharge: 5 year = 1.0 cfs, 100 year = 7.1 cfs It is assumed that there will be no development in "J"

XI. PROPOSED DRAINAGE IMPROVEMENTS

The following drainage improvements are recommended:

- Grade the cross section of Forest Heights Circle to the revised typical section approved by El Paso County for this project ***(Exhibit 4, Appendix)***
- Replace all of the culverts with 18" CMP culverts with flared end sections. The ends of the culvert should be installed in accordance with El Paso County standards ***(Exhibit 4, Appendix).*** Locate the inverts for both ends of the culverts at or slightly above the flowline of the upstream and downstream swales. The culvert should be installed at a sufficient slope to allow for a cleansing velocity to develop.
- Riprap erosion protection is required as determined in the field during construction. At several locations it is anticipated that erosion protection at the outfall of the culverts may not be required since the velocities are minimal and the downstream swale is stable with existing wetland vegetative growth and not subject to erosion.
- Minimize any grading in the areas immediately upstream and downstream of the culverts in order to protect the existing wetlands. The areas

Please determine whether replacement of all culverts are necessary if field investigation shows existing culverts are functioning.

identify in this report through analysis which culverts require riprap erosion protection and what size, type, width, length, depth.

occupied by wetlands are very stable. Disturbing the areas with grading would only increase the erosion potential.

- Install erosion control facilities as noted on the Grading and Erosion Control plan.

XII. DETENTION AND WATER QUALITY

Since the runoff exits the "development" in numerous locations, installation of a detention water quality pond is not practical. Also, the proposed development only consists to 3 residential lots each with an estimate area of potential disturbance of less than an acre. It is anticipated the area to be disturbed with the addition of one (1) residence is as follows;

- Roof area: 2800 sf;
- Lawn: 0.75 acres; 32,670 sf
- Gravel Drive: 4,000 sf
- Total Area to be disturbed = 39,470 acres or 0.9 acres

El Paso County Engineering Criteria Manual, Appendix I, contains the policies and procedures for Stormwater Quality. **Section I.7.1.B** provides for exclusions to the requirements to provide Post Construction Stormwater Quality facilities. All areas of the Forest Heights project qualify for the allowed exemptions. No water quality or detention facilities are required for this site as discussed below.

The project consists of 5-acre and larger single-family residential lots and a private gravel road with a 60 foot right of way (Forest Heights Drive). There are no activities or improvements that require permanent water quality facilities for this project based on the exclusions found in **Section I.7.1.5.B.2, Section I.7.1.5.B.3 and Section I.7.1.5.B.5.**

According to **Section I.7.1.B.5**,

"A single-family residential lot, or agricultural zoned lands, greater than or equal to 2.5 acres in size per dwelling and having a total lot impervious area of less than 10 percent is excluded."

The total area of the site is 32.59 acres (includes Lots 1 through 3 and the tracts along Forest Heights Road Of the total 32.59 acres are comprised of lots varying in size from 5.0 acres to 14.616 acres residential lots and the remaining 2.691 acres is right-of-way along Forest Heights Drive. The total lot imperviousness for rural residential lots is less than 10%.

Section I.7.1.B.2 of the ECM provides exclusion for Roadway Redevelopment as follows:

"Redevelopment sites for existing roadways, when 1 of the following criteria is met: 1) The site adds less than 1 acre of paved area per mile of

Note regarding the need for an ESQCP: while this highlighted explanation is acceptable for excluding the site from WQ treatment, it does not sufficiently describe the proposed improvements to the road, which will result in disturbing at least all of the 28' width of the road, if not more per the CD's. Meaning that the total soil disturbance will exceed 1ac, so an ESQCP and all accompanying documents that Daniel requested with his previous EDARP comment are required. It would be good to add this ESQCP discussion to the drainage report to document the reasoning. Also discuss if the houses will be built at the same time as each other and/or the road, because that would also lead to a total simultaneous soil disturbance >1ac. Otherwise, if the new houses are built separate from each other and the road (and each preceding site disturbance is finally stabilized before the next one begins), the houses could just get Builder's ESQCPs (BESQCPs).

roadway (3 an existing roadway, or 2) The site does not add more than 8.25 feet of paved width at any location to the existing roadway".

The project involves adding new gravel surface to the existing Forest Heights Drive roadway to meet El Paso requirements. No pavement will be added to the roadway (criteria 1). The total area of disturbance for adding the gravel is 0.74 acres (criteria 1). The roadway width will be expanded from an average of 20' wide to a consistent 28' width of the travel way (criteria 2).

Also, **Section I.7.1.B.3** excludes Existing Roadway Areas.

"For redevelopment sites for existing roadways, only the area of the existing roadway is excluded from the requirements of an applicable development site when the site does not increase the width by 2 times or more, on average, of the original roadway area. The *entire site is not excluded from being considered an applicable development site for this exclusion. The area of the site that is part of the added new roadway area is still an applicable development site".*

Again, the project will add new gravel surface to Forest Heights Drive up to 0.74 acres in area. The roadway width will be expanded from an average of 20' wide to a consistent 28' width of the travel way.

Storm Detention is not required for this site since the resulting flow increases from development is found to negligible and inconsequential as shown in the above sections.

as indicated in the review 1 comment, please provide a comparison of the existing/historic flows and developed flows at design points 10,11, 12, & 15.

XIII. EROSION CONTROL (EXHIBIT 6, APPENDIX)

It is recommended that the following erosion control measures be applied with the Forest Heights Circle improvements and with the construction of the gravel driveways:

- Erosion control logs
- Erosion control blanket
- Seeding and mulching on the disturbed areas
- Stone Check dams

XIV. FOUR STEP PROCESS

The El Paso County Engineering Criteria Manual ***(Appendix I, Section I.7.2)*** recommends the consideration of a "Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long term source controls".

It is determined in the section above that this project is exempt from the requirements of **Section I.7.1** to provide Post Construction Stormwater Management Facilities with Water Quality Capture Volume (WQCV). However,

aspects of the Four Step Process are considered and implemented in the Forest Heights project as discussed below.

Step 1: Reduce runoff by disconnecting impervious area, eliminating "unnecessary" impervious area and encouraging infiltration into soils that are suitable.
The impervious areas for the project include roofs, concrete patios and sidewalks, and the possibility of asphalt driveways. All runoff from the impervious areas drains onto open grassed surfaces. All downspouts for each residence are planned to discharge either within landscaped areas or natural areas. The majority of the site will remain in its existing natural condition.

Step 2: Treat and slowly release the WQCV.
This project meets the exemptions or providing Post Construction Stormwater Management Facilities including facilities with Water Quality Capture Volume (WQCV) such as a Full Spectrum Detention Pond and therefore does not have the slow release WQCV component.

Step 3: Stabilize stream channels.
All existing swales will remain heavily vegetated with the existing natural grasses. All of the onsite swales are "U" shaped with wide bottoms widths and gentle side slopes. Based on visual observations the swales are very stable with only negligible indications of erosion. The vegetation for each swale includes medium height prairie grasses that are periodically mowed. It is not anticipated that any of the swales will be modified in the future. No building will be permitted in an area that impedes the existing flow of water. It can be safely assumed that the negligible increase in flow as a result of development will have minimal negative impacts on the existing onsite swales.

Step 4: Implement source controls.
The rural residential site is not anticipated to contain storage of potentially harmful substances or use of potentially harmful substances. No Site Specific or Other Source Control BMP's are required.

XV. CONSTRUCTION COST ESTIMATE (DRAINAGE IMPROVEMENTS)

Item #	Item Description	Approx Quant	Units	Unit Price	Total Cost
1	Remove Existing 18" CMP	150	LF	$25	$3,750
2	Install 18" CMP	150	LF	$65	$9,750
3	Install 18" CMP Flared End Section	6	EA	$750	$4,500
	Sub Total				$18,000
	Contingency (10%)				$1,800
	Grand Total				$19,800

XVI. DRAINAGE FEE CALCULATIONS

The drainage fee was determined based on a total of 32.59 acres with the development of 4 lots of greater 5 acres each. The site is located in the Kettle Creek Drainage Basin which has the following fees per each impervious acre (*Exhibit 4, Appendix):*

2022 Drainage Fee per impervious acre	$	11,413
2022 Bridge Fee per impervious acre	$	0
2022 Total Fees per impervious acre	$	11,413

Total Project Area = 32.59 acres
% Impervious = 7% per El Paso County for 5 acre lots
Impervious Area = 2.281 acres
Fee reduction for 5-acre lots = 25%
Total Impervious area = 1.711 acres

Total Fees = $ 19,527.64

The Drainage Fees are to be paid prior to the recording of the plat.

XVII. SUMMARY

The report addresses the hydrologic and hydraulic parameters for both the existing and developed conditions for the entire site. It has been demonstrated that there will be insignificant increases in the runoff for the developed conditions. The three (3) existing culverts under Forest Heights Circle were evaluated on a limited basis in order to determine the anticipated hydraulic conditions.

It has been demonstrated that the existing 18" culverts do not have sufficient capacity due to the sedimentation and vegetative growth around the ends of each culvert. It is recommended that these culverts be replaced with 18" CMP culverts and the inverts be set so that the culvert can develop self-cleansing velocities. It has been pointed out that grading of the existing swales upstream and downstream of the culverts is not recommended because doing so would destabilize the existing wetland areas that have developed at either end of the culverts.

Erosion control facilities are recommended to minimize erosion in the borrow ditches along both sides of Forest Heights Circle as well as along both sides of proposed gravel driveways accessing the new residences. The erosion control facilities are indicated on the Grading and Erosion Control Plan. It is recommended that temporary facilities include the following:

- staked hay bales
- erosion control logs
- erosion control blanket
- stone check dams
- seeding

APPENDIX

1 General Location Map

2 FEMA FIRM Map

3 SCS Soils Map and Data

4 Plat

5 Charts and Tables

6 Kettle Creek Drainage Basin Planning Study Exhibits

7 Erosion Control Facilities

8 Hydrologic Calculations

9 Hydraulic Calculations

10 Entech Engineering Report

11 Discussion Summaries and Meeting minutes

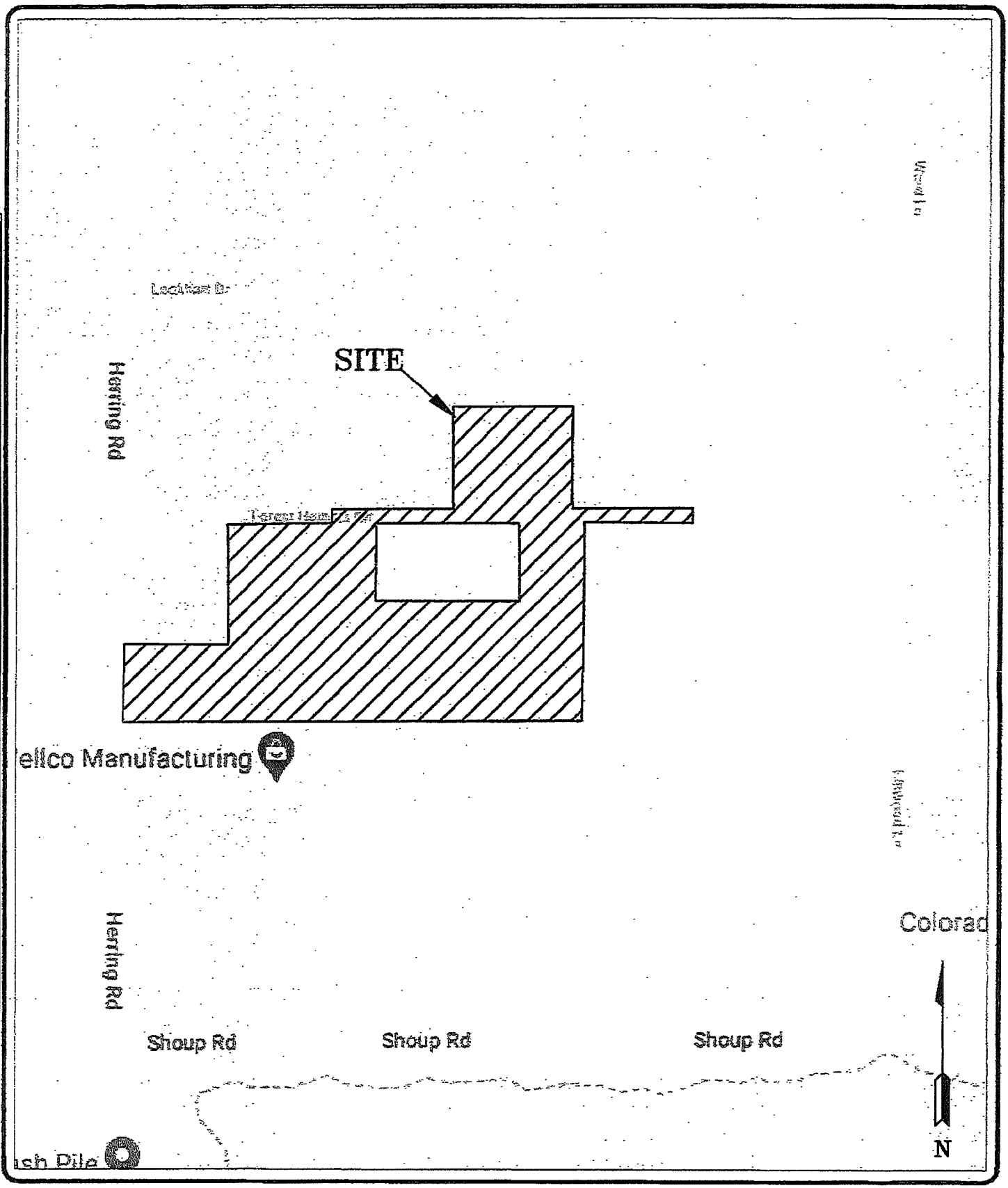
12 Photos

13 Exhibit 13

14 Historic and Developed Drainage Conditions Map

Exhibit 1:

General Location Map



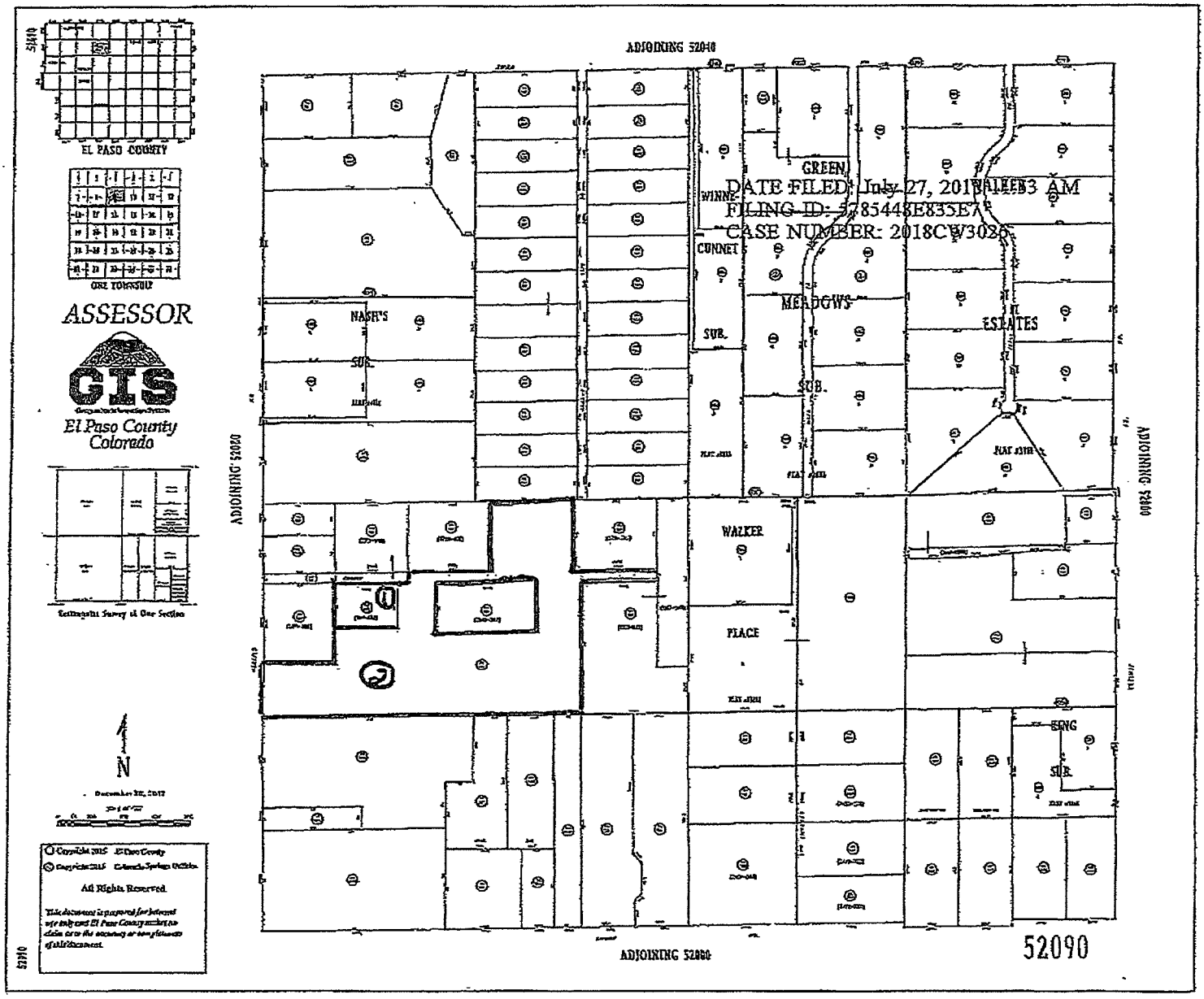
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

VICINITY MAP
DIDLEAU SUBDIVISION
HERRING ROAD & FOREST HEIGHTS CIRCLE
EL PASO COUNTY, CO.
FOR: LDC, INC.

DRAWN:	DATE:	CHECKED:	DATE:
LLL	2/28/20		

JOB NO.: 192115

FIG NO.: 1



(1) Parcel 1

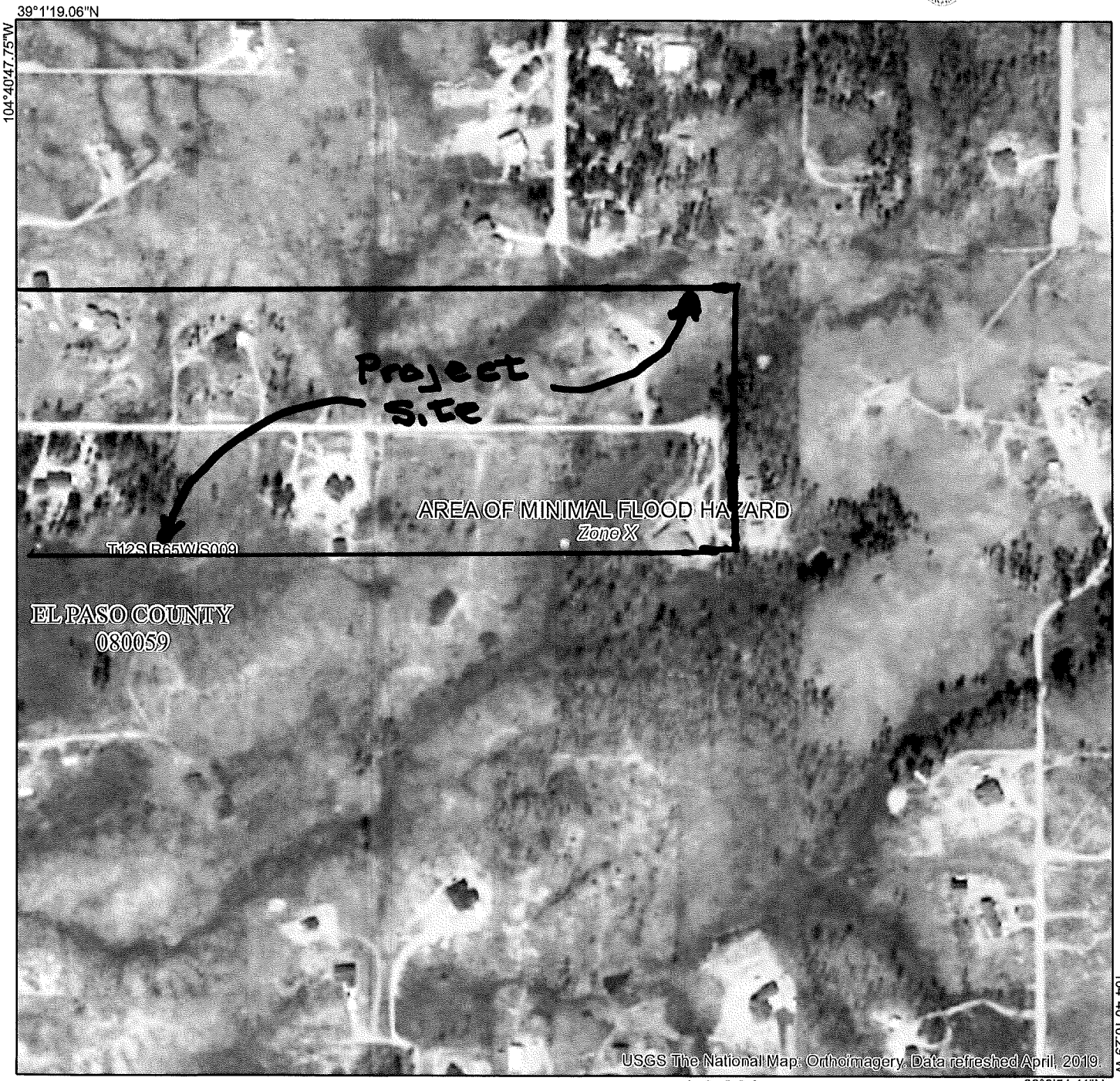
(2) Parcel 2

Exhibit 2:

FEMA FIRM Map

National Flood Hazard Layer FIRMette

FEMA



Legend

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

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN — Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 — Cross Sections with 1% Annual Chance / Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 11/14/2019 at 3:46:08 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

Exhibit 3:

SCS Soils Map and Data

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

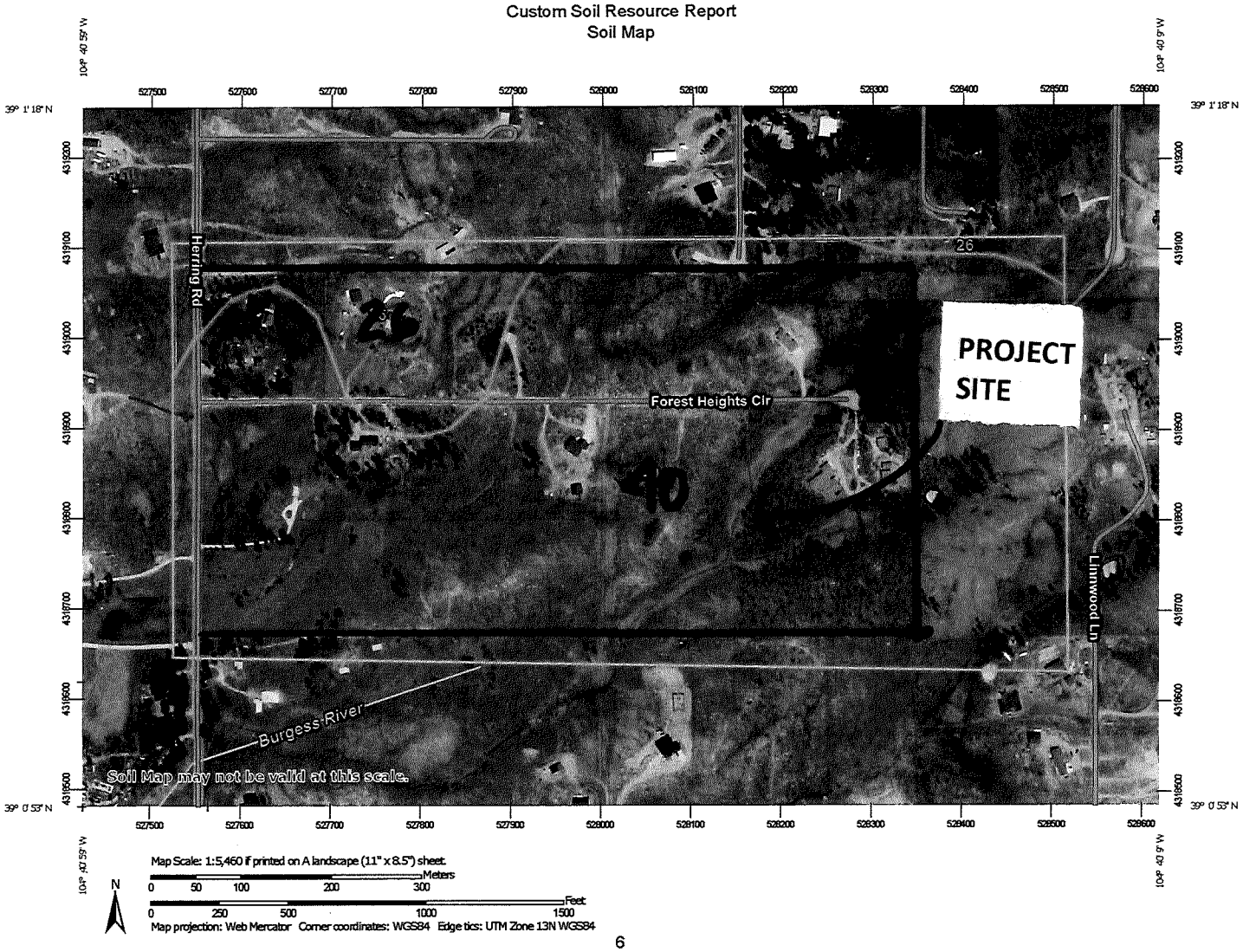
A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for El Paso County Area, Colorado

Didleau Subdivision, El Paso County

November 11, 2019

Custom Soil Resource Report
Soil Map



Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
26	Elbeth sandy loam, 8 to 15 percent slopes	14.5	12.5%
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	101.2	87.5%
Totals for Area of Interest		**115.7**	**100.0%**

Map Unit Descriptions

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,

El Paso County Area, Colorado

26—Elbeth sandy loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 367y
Elevation: 7,300 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Elbeth

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose

Typical profile

A - 0 to 3 inches: sandy loam
E - 3 to 23 inches: loamy sand
Bt - 23 to 68 inches: sandy clay loam
C - 68 to 74 inches: sandy clay loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

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

40—Kettle gravelly loamy sand, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 368g
Elevation: 7,000 to 7,700 feet
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Kettle

Setting

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

Typical profile

E - 0 to 16 inches: gravelly loamy sand
Bt - 16 to 40 inches: gravelly sandy loam
C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 3 to 8 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 (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 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
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

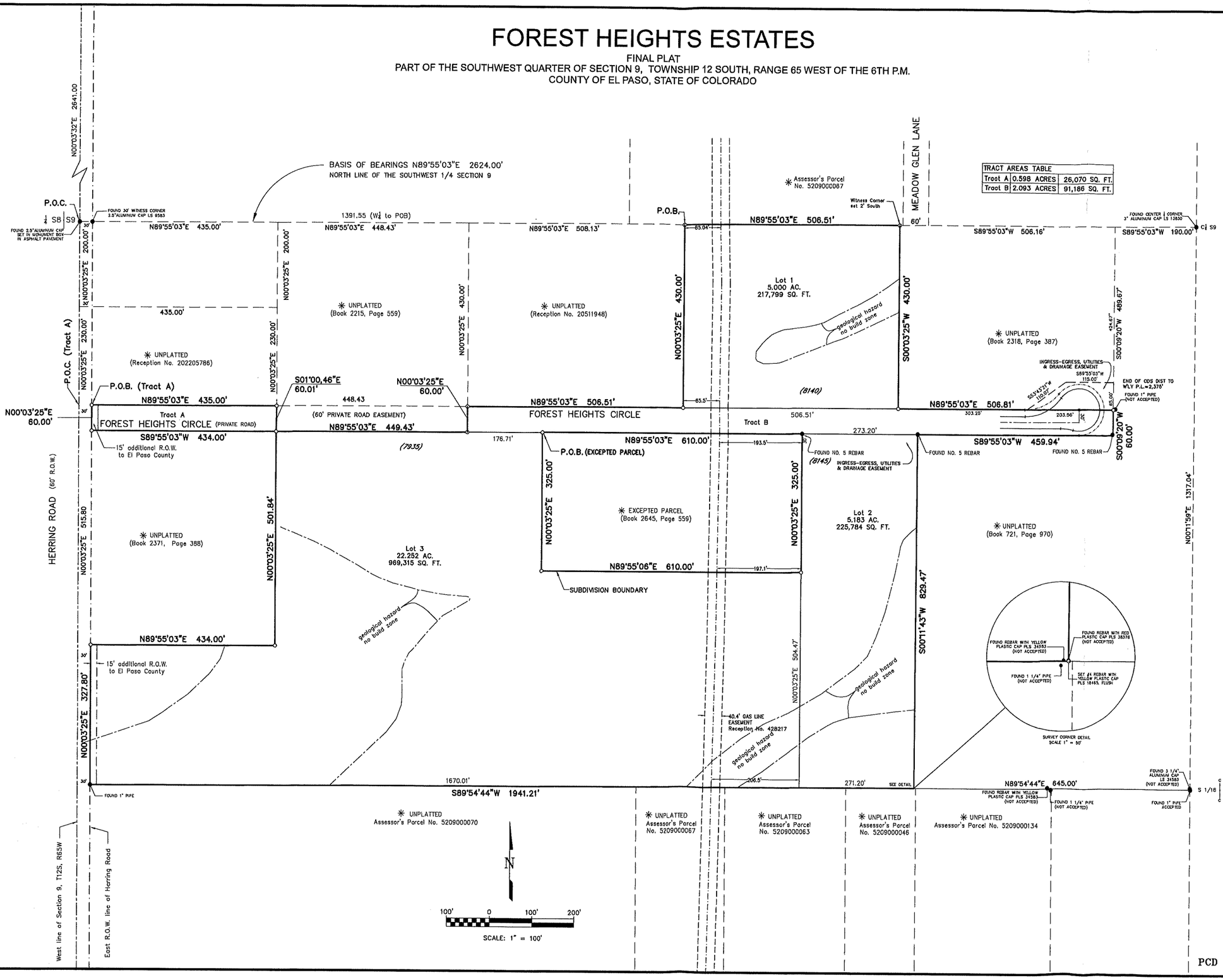
Exhibit 4

Plat

FOREST HEIGHTS ESTATES

FINAL PLAT

PART OF THE SOUTHWEST QUARTER OF SECTION 9, TOWNSHIP 12 SOUTH, RANGE 65 WEST OF THE 6TH P.M.
COUNTY OF EL PASO, STATE OF COLORADO



PCD File No. MS206

NOTICE: According to Colorado law you must commence any legal action based upon any defect in this survey within three years after you first discover such defect. In no event may any action based upon any defect in this survey be commenced more than ten years from the date of the certification shown.

CALL BEFORE YOU DIG ... 811 DIAL 811
48 HOURS BEFORE YOU DIG, CALL UTILITY LOCATORS FOR LOCATING OF UNDERGROUND ELECTRIC, WATER AND WASTEWATER.

REVISIONS

No.	Description	By	Date
1	LOT REVISIONS	DAS	6/23/22

H Scale: 1"=100'
V Scale: N/A
Designed By: N/A
Drawn By: JLG
Checked By: DLK
Date: 5/31/2020

Land Development Consultants, Inc.
PLANNING · SURVEYING
www.ldc-inc.com · TEL: (719) 528-6133 · FAX: (719) 528-6848
3898 MAIZELAND ROAD · COLORADO SPRINGS, CO 80909

FOREST HEIGHTS ESTATES
FINAL PLAT
PART OF SW ¼, SEC. 9, T12S, R65W, 6TH P.M.
COUNTY OF EL PASO, STATE OF COLORADO

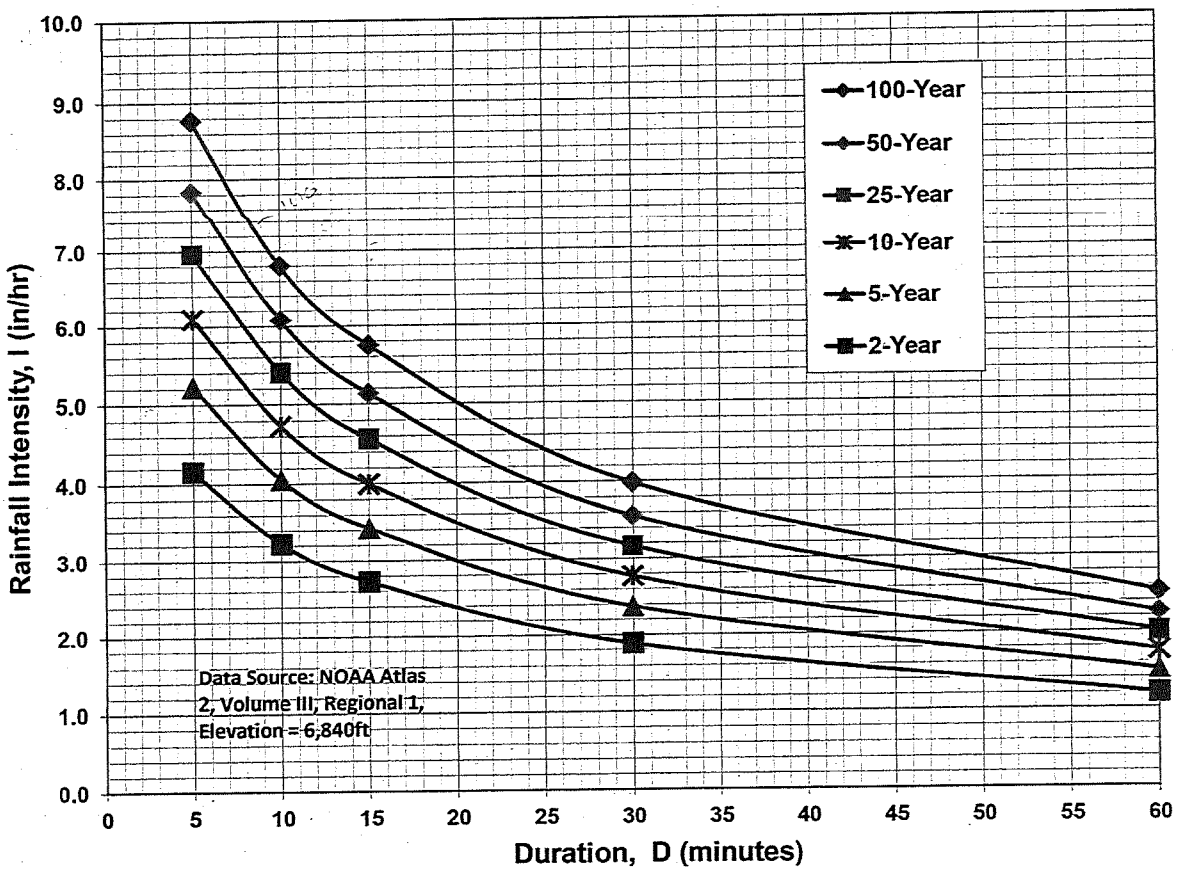
Project No.: 18070

Sheet: 2 of 2

Exhibit 5:

Charts and Tables

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

$I_{100} = -2.52 \ln(D) + 12.735$

$I_{50} = -2.25 \ln(D) + 11.375$

$I_{25} = -2.00 \ln(D) + 10.111$

$I_{10} = -1.75 \ln(D) + 8.847$

$I_{5} = -1.50 \ln(D) + 7.583$

$I_{2} = -1.19 \ln(D) + 6.035$

Note: Values calculated by equations may not precisely duplicate values read from figure.

Table 6-6. Runoff Coefficients for Rational Method
(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis– Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) 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 overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*For buried riprap, select C_v value based on type of vegetative cover.

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration (t_c) is then the sum of the overland flow time (t_i) and the travel time (t_t) per Equation 6-7.

3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

$$t_c = \frac{L}{180} + 10 \qquad \text{(Eq. 6-10)}$$

Where:

t_c = maximum time of concentration at the first design point in an urban watershed (min)

L = waterway length (ft)

Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional "calibration" of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

Table 2-7. Roadway Design Standards for Urban Collectors and Locals

Criteria	Collectors		Local	
	Non-Residential	Residential	Local	Local[4] (low volume)
Design Speed / Posted Speed (MPH)	40 / 35	40 / 35	25 / 25	20 / 20
Clear Zone	14'	14'	12'	7'
Minimum Centerline Curve Radius	565'	565'	200'	100'
Number of Through Lanes	2	2	2	2
Lane Width	12'	12'	12'	12'
Right-of-Way	80'	60'	60'[3]	60'[3]
Paved Width (Excluding Gutter Pan)	48'	36'	30'	24'
Median Width (Including Curb & Gutter)	12'	n/a	n/a	n/a
Shoulder Width (Ext., Excluding Gutter)	6'	6'	n/a	n/a
Shoulder Width (Int., Excluding Gutter)	n/a	n/a	n/a	n/a
Required Curb/ Gutter Type (Vertical)	6"	6"	6" (or ramp)	6" (or ramp)
Sidewalk Width (@ FL)	5' detached	5' detached	5' attached	5' attached
Design ADT	20,000	10,000	3,000	300
Design Vehicle	WB-50	WB-50	WB-50	SU-30
Bike Lanes Permitted	No	Yes	No	No
Access Permitted	No[5]	No[5]	Yes	Yes
Access Spacing	See Table 2-35	See Table 2-35	Frontage	Frontage
Intersection Spacing	660'[2]	660'[2]	175'	150'
Parking Permitted	No	No	Yes	Yes
Minimum Flowline Grade of Curb	.50%	.50%	.50%	.50%
Centerline Grade (Min.-Max.)	0.5-6%[1]	0.5-8%[1]	0.5-8%[1]	0.5-8%[1]
Intersection Grades (Min.-Max.)	0.5-4%	0.5-4%	0.5-4%	0.5-4%

[1] 10% maximum grade permitted at the discretion of the ECM Administrator
[2] 330 feet when intersecting local roadways
[3] 50-foot right-of-way plus two 5-foot Public Improvements Easements granted to El Paso County
[4] Section can be used for cul-de-sacs, or roads with two ways out having a maximum of 300 ADT and a maximum length of 1,200 feet
[5] Where no local public or private roadway can provide access, temporary or partial turn movement parcel access may be permitted

2.3.3 Horizontal Alignment

A. General Criteria

Proper roadway alignment provides for safe and continuous operation at a uniform design speed. Proposed road layouts shall have a logical relationship to existing or platted roads and fit within the overall transportation plan.

Centerline Grade (Min.-Max.)	1-5%	1-5%	1-5%	1-5%	1-6%
Intersection Grades (Min.-Max.)	1-2%	1-2%	1-3%	1-3%	1-4%

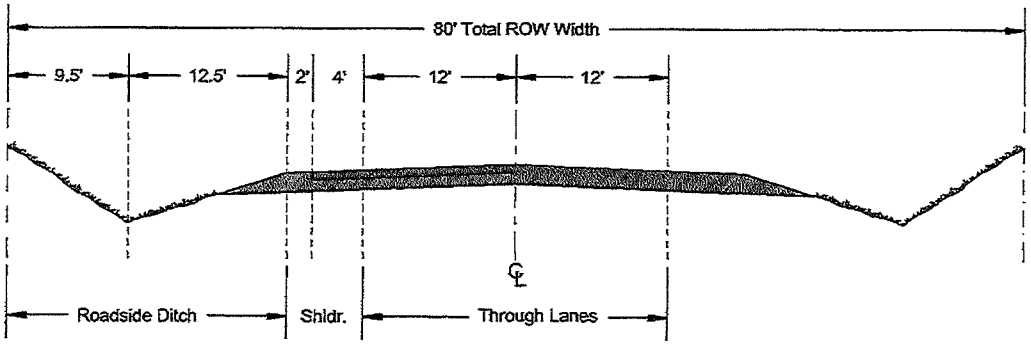
[1] Assumes 4% superelevation, 6% for 70 MPH design speeds
[2] Pavement width in each direction for divided roadways

Table 2-5. Roadway Design Standards for Rural Collectors and Locals

	Collectors		Local	
Criteria	Major	Minor	Local	Gravel
Design Speed / Posted Speed (MPH)	50 / 45	40 / 35	30 / 30	50/45
Clear Zone	20'	14'	7'	12'
Minimum Centerline Curve Radius	930'[2]	565'	300'	As Approved
Number of Through Lanes	2	2	2	2
Lane Width	12'	12'	12'	12'
Right of Way	90'	80'	70'[3]	70'[3]
Paved Width	32'	32'	28'	n/a
Median Width	n/a	n/a	n/a	n/a
Outside Shoulder Width (paved/gravel)	8'(4'/4')	6'(4'/2')	4'(2'/2')	4'(0'/4')
Inside Shoulder Width (paved/gravel)	n/a	n/a	n/a	n/a
Design ADT	3,000	1,500	750	200
Design Vehicle	WB-67	WB-67	WB-50	WB-50
Access Permitted	No	Yes	Yes	Yes
Access Spacing	n/a	Frontage	Frontage	Frontage
Intersection Spacing	¼ mile	660'	330'	330'
Parking Permitted	No	Yes	Yes	No
Minimum Flowline Grade	1%	1%	1%	1%
Centerline Grade (Min.-Max.)	1-8%[1]	1-8%[1]	1-8%[1]	1-8%
Intersection Grades (Min.-Max.)	1-4%	1-4%	1-4%	1-4%

[1] 10% maximum grade permitted at the discretion of the ECM Administrator
[2] Assumes 4% superelevation, 6% for 70 MPH design speeds
[3] 60-foot right-of-way plus two 5-foot Public Improvements Easements granted to El Paso County

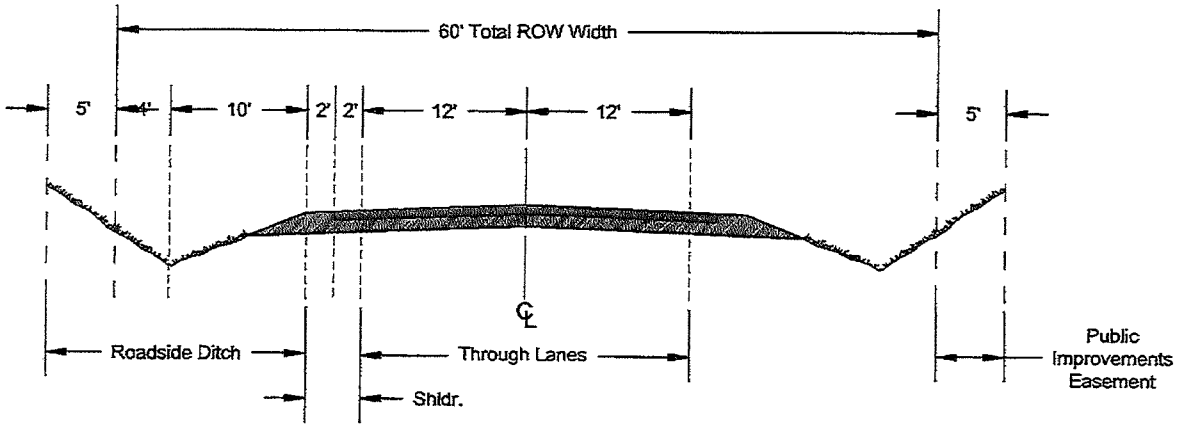
Figure 2-7. Typical Rural Minor Collector Cross Section

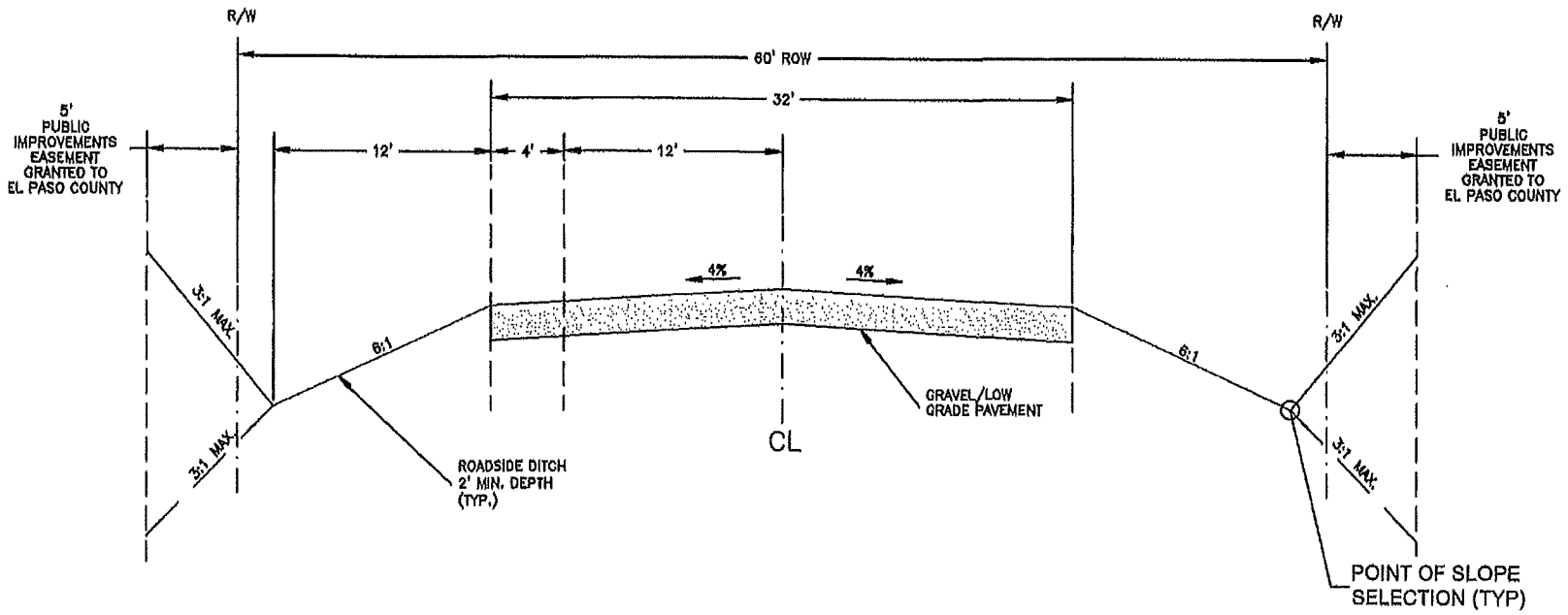


6. Local

Local roadways provide direct lot access and deliver lot-generated trips to collector roadways. Although access needs are high, accesses shall not be allowed to compromise the safety, health or welfare of roadway users (See Figure 2-8).

Figure 2-8. Typical Rural Local Cross Section





Roadway Design Parameters
Design Speed: 50 mph
Posted Speed: 45 mph
Maximum ADT: 199
Design Vehicle: WB-50

SCALE: NOT TO SCALE

9/16/10 DATE APPROVED: André P. Brackin DEPARTMENT OF TRANSPORTATION	Rural Gravel Local Roadway Standard Cross Section REVISION DATE: 12/8/15 FILE NAME: SD_2-10	EL PASO COUNTY DEPARTMENT OF TRANSPORTATION

$$t_c = t_i + t_t \quad \text{(Eq. 6-7)}$$

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

t_t = travel time in the ditch, channel, gutter, storm sewer, etc. (min)

3.2.1 Overland (Initial) Flow Time

The overland flow time, t_i, may be calculated using Equation 6-8.

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

The street capacity shall be calculated using Manning's Formula with an "n" value applicable to the actual boundary conditions encountered, when the allowable depth and inundated area is determined from Table 6-1. Also see Section 7.3

TABLE 6-1 ALLOWABLE USE OF ROADS AND STREETS

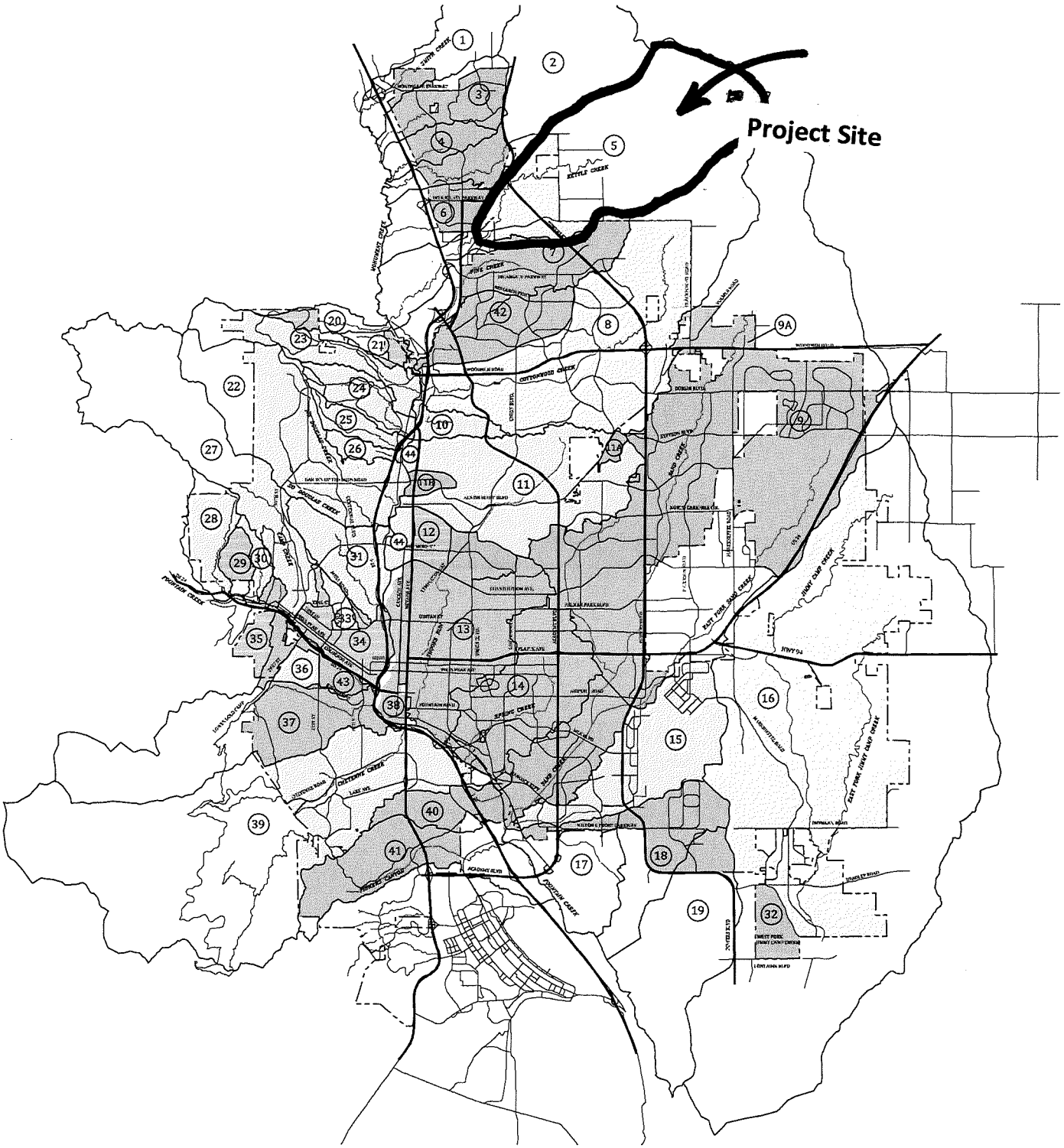
Street Classification	Use of Streets for Initial and Major Storms		Cross Flow In Streets For Initial and Major Storms	
	Initial Storm	Major Storm	Initial Storm	Major Storm
Hillside Residential (Less Than 32' F/C to F/C)	No curb overtopping, maximum street flow = 25 cfs, whichever is most limiting.	Same as Type A (Local/Residential) below.	Same as Type A (Local/Residential) below.	Same as Type A (Local/Residential) below.
Type A (Local/Residential)	No curb overtopping, flow may spread to crown of street or top of curb, whichever is the most limiting.	Residential dwellings, public, commercial and industrial buildings shall not be inundated at the ground line. The depth of water at the gutter flow line shall not exceed 12 inches.	6 inches of depth in cross pan or gutter flow line	12 inches of depth at gutter flow line
Type A (Local with Roadside Ditch)	Flow must not encroach upon street shoulder area.	Residential dwellings, public, commercial and industrial buildings shall not be inundated at the ground line. The depth of flow shall not exceed 6 inches at the shoulder.	Requires culvert. Flow shall not encroach upon street shoulder.	Requires culvert, depth of flow shall not exceed 6 inches at the street shoulder.
Type B (Collector or Minor Arterial)	No curb overtopping. Flow spread must be limited to a maximum 20 foot spread	Same as Type A (Local/Residential) above.	Where cross pans are allowed, depth of flow shall not exceed 6 inches at flow line	12 inches of depth at gutter flow line

Forest Heights Drive

As Forest heights is a rural roadway with roadside ditches the clouded is the criteria that applies. Please analyze the culverts accordingly.

Exhibit 6:

Kettle Creek Drainage Basin Planning Study Exhibits



DRAINAGE BASIN PLANNING STUDY INVENTORY

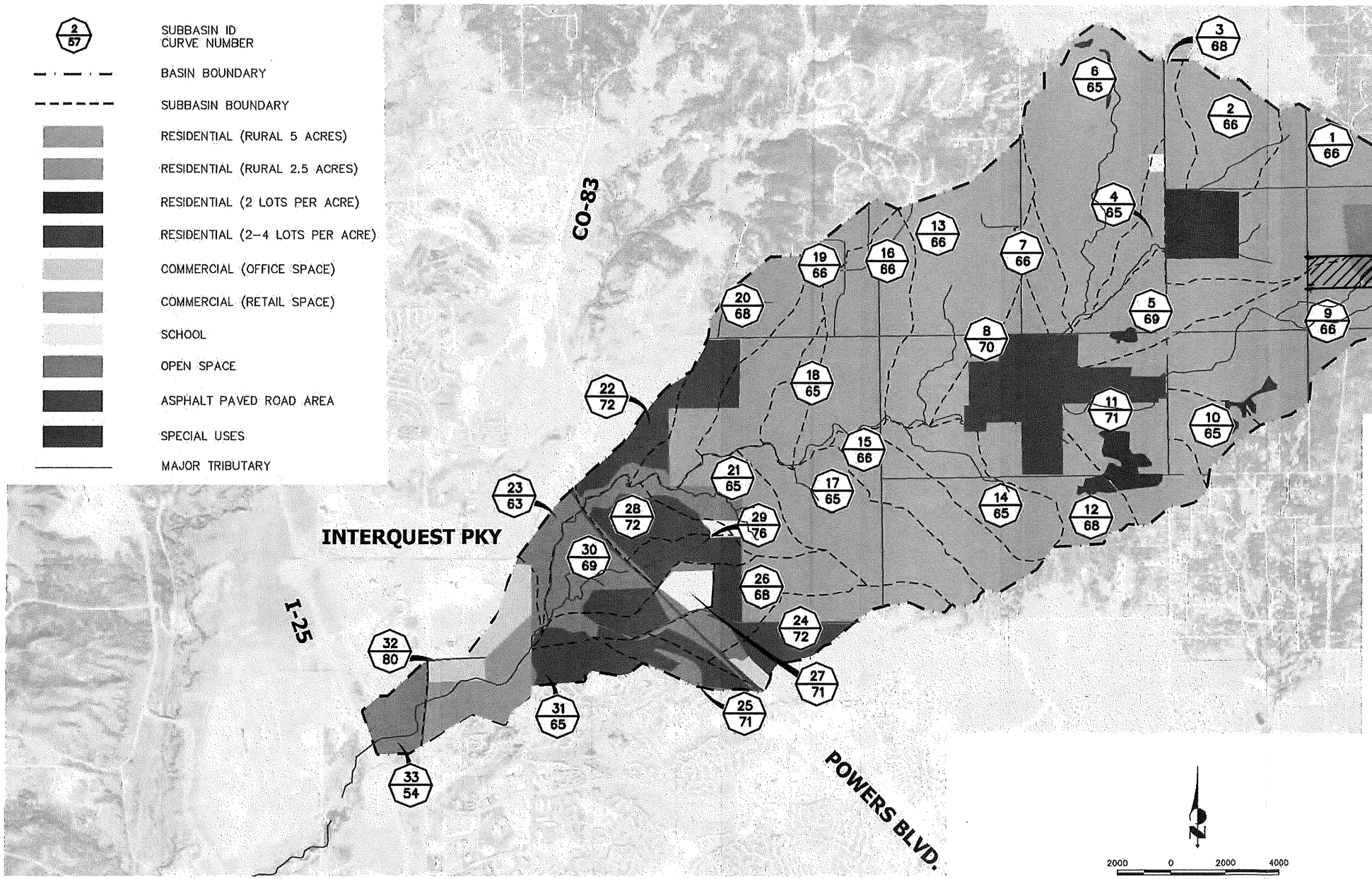
CITY OF COLORADO SPRINGS, COLORADO

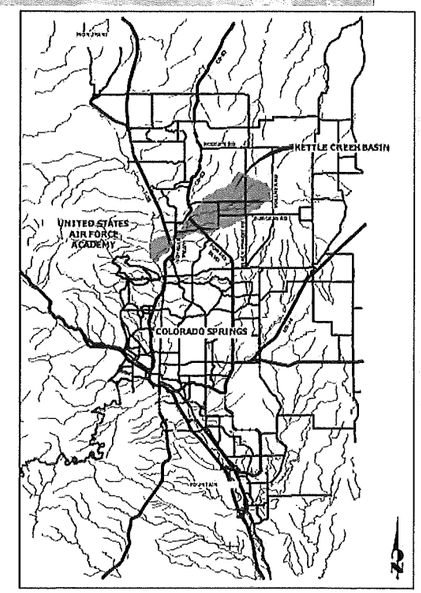
Project No.	17102
Date	7/13/17
Design	RNW
Drawn	EAK
Check	RNW
Revisions	

Kiowa Engineering Corporation
1604 South 21st Street
Colorado Springs, Colorado 80904
(719) 630-7342

LEGEND

- SUBBASIN ID / CURVE NUMBER
- BASIN BOUNDARY
- SUBBASIN BOUNDARY
- RESIDENTIAL (RURAL 5 ACRES)
- RESIDENTIAL (RURAL 2.5 ACRES)
- RESIDENTIAL (2 LOTS PER ACRE)
- RESIDENTIAL (2–4 LOTS PER ACRE)
- COMMERCIAL (OFFICE SPACE)
- COMMERCIAL (RETAIL SPACE)
- SCHOOL
- OPEN SPACE
- ASPHALT PAVED ROAD AREA
- SPECIAL USES
- MAJOR TRIBUTARY





2000 0 2000 4000

ORIGINAL SCALE: 1" = 4000'

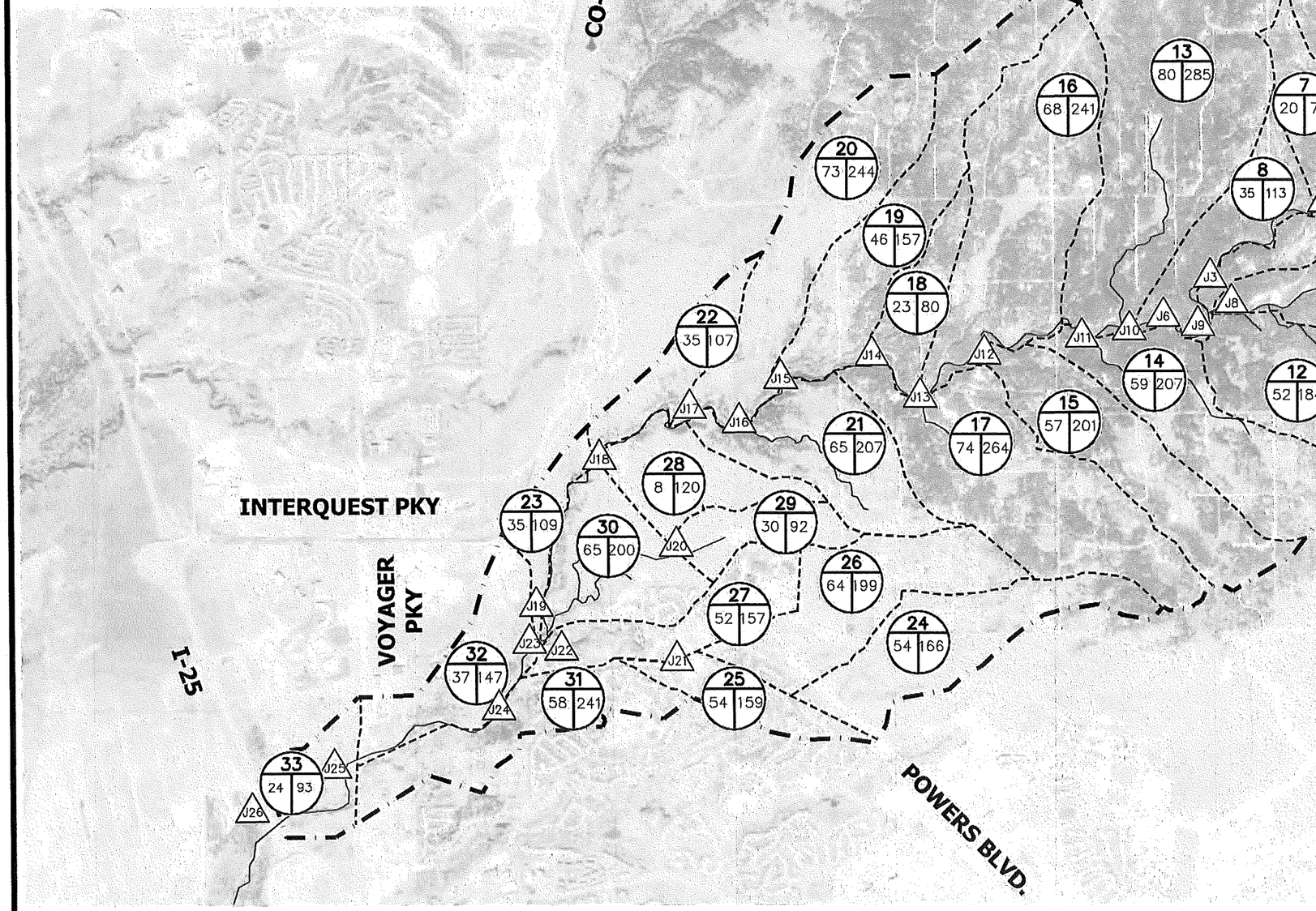
FIGURE 3–9 CURVE NUMBER MAP (FUTURE)
KETTLE CREEK DBPS
JOB NO. 25100.00
MAY 2015

J·R ENGINEERING
A Westrian Company

Centennial 303–740–9393 • Colorado Springs 719–593–2593
Fort Collins 970–491–9888 • www.jrengineering.com

LEGEND

- SUBBASIN ID
- 100-YEAR 24-HOUR FLOWS (CFS)
- 5-YEAR 24-HOUR FLOWS (CFS)
- BASIN BOUNDARY
- SUBBASIN BOUNDARY
- MAJOR TRIBUTARY
- JUNCTION



3000 1500 0 3000

ORIGINAL SCALE: 1" = 3000'

FIGURE 3-12 HYDROLOGY MAP (HISTORIC)
KETTLE CREEK DBPS
JOB NO. 25100.00
MAY 2015

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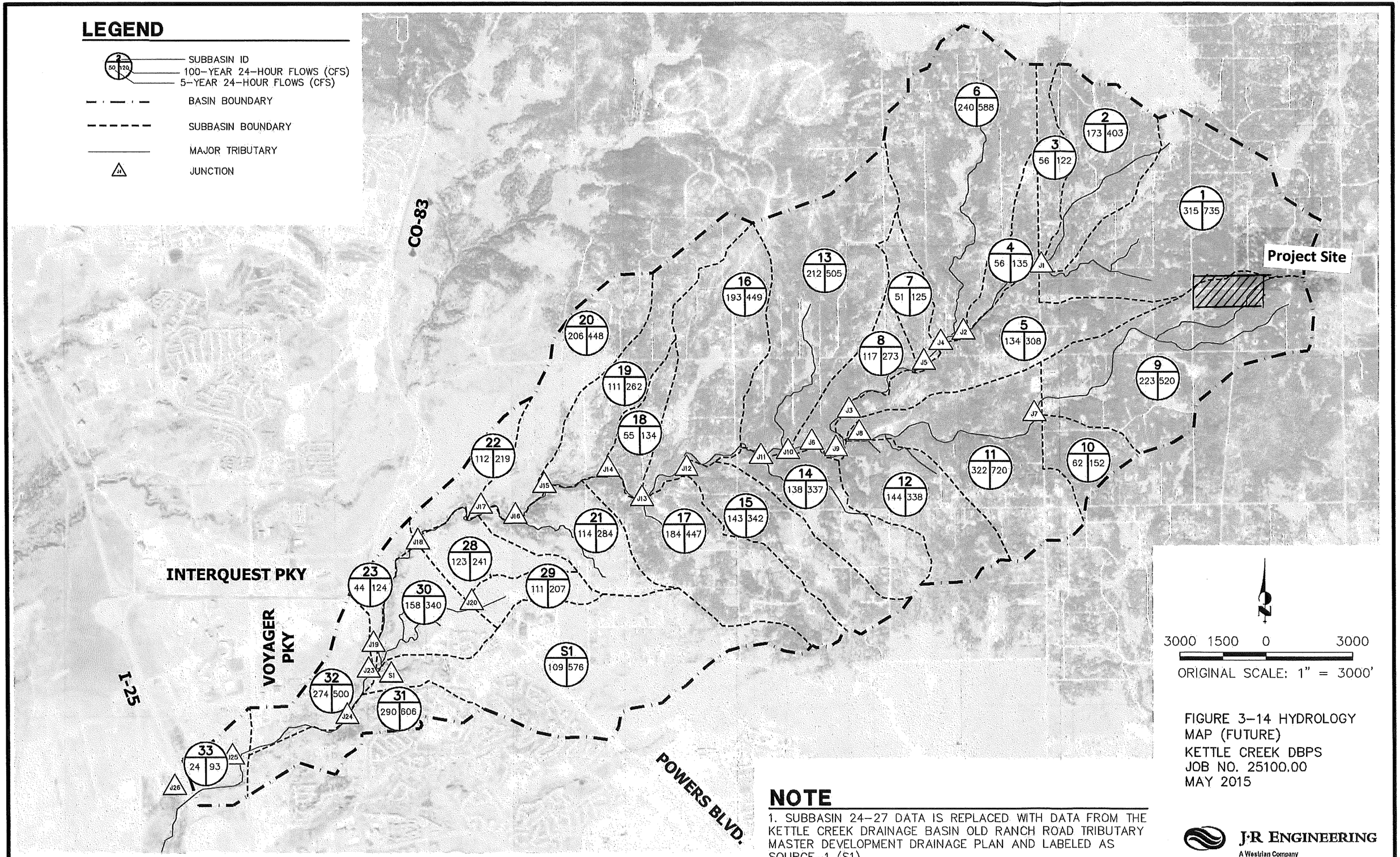
Fort Collins 970-491-9888 • www.jrengineering.com

LEGEND

- SUBBASIN ID
- 100-YEAR 24-HOUR FLOWS (CFS)
- 5-YEAR 24-HOUR FLOWS (CFS)
- BASIN BOUNDARY
- SUBBASIN BOUNDARY
- MAJOR TRIBUTARY
- JUNCTION



3000 1500 0 3000

ORIGINAL SCALE: 1" = 3000'

FIGURE 3-14 HYDROLOGY MAP (FUTURE)
KETTLE CREEK DBPS
JOB NO. 25100.00
MAY 2015

NOTE

1. SUBBASIN 24-27 DATA IS REPLACED WITH DATA FROM THE KETTLE CREEK DRAINAGE BASIN OLD RANCH ROAD TRIBUTARY MASTER DEVELOPMENT DRAINAGE PLAN AND LABELED AS SOURCE-1 (S1).

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El Paso County Drainage Basin Fees

Resolution No. 20-424

Basin Number	Receiving Waters	Year Studied	Drainage Basin Name	2021 Drainage Fee (per Impervious Acre)	2021 Bridge Fee (per Impervious Acre)
Drainage Basins with DBPS's:					
CHMS0200	Chico Creek	2013	Haegler Ranch	$11,113	$1,640
CHWS1200	Chico Creek	2001	Bennett Ranch	$12,441	$4,772
CHWS1400	Chico Creek	2013	Falcon	$31,885	$4,380
FOFO2000	Fountain Creek	2001	West Fork Jimmy Camp Creek	$13,524	$4,001
FOFO2600	Fountain Creek	1991*	Big Johnson / Crews Gulch	$19,752	$2,551
FOFO2800	Fountain Creek	1988*	Widefield	$19,752	$0
FOFO2900	Fountain Creek	1988*	Security	$19,752	$0
FOFO3000	Fountain Creek	1991*	Windmill Gulch	$19,752	$296
FOFO3100 / FOFO3200	Fountain Creek	1988*	Carson Street / Little Johnson	$12,048	$0
FOFO3400	Fountain Creek	1984*	Peterson Field	$14,246	$1,080
FOFO3600	Fountain Creek	1991*	Fisher's Canyon	$19,752	$0
FOFO4000	Fountain Creek	1996	Sand Creek	$20,387	$8,339
FOFO4200	Fountain Creek	1977	Spring Creek	$10,244	$0
FOFO4600	Fountain Creek	1984*	Southwest Area	$19,752	$0
FOFO4800	Fountain Creek	1991	Bear Creek	$19,752	$1,080
FOFO5400	Fountain Creek	1977	21st Street	$5,942	$0
FOFO5600	Fountain Creek	1964	19th Street	$3,887	$0
FOFO5800	Fountain Creek	1964	Camp Creek	$2,189	$0
FOMO0400	Monument Creek	1986*	Mesa	$10,331	$0
FOMO1000	Monument Creek	1981	Douglas Creek	$12,421	$274
FOMO1200	Monument Creek	1977	Templeton Gap	$12,752	$296
FOMO1400	Monument Creek	1976	Pope's Bluff	$3,956	$675
FOMO1600	Monument Creek	1976	South Rockrimmon	$4,643	$0
FOMO1800	Monument Creek	1973	North Rockrimmon	$5,942	$0
FOMO2000	Monument Creek	1971	Pulpit Rock	$6,549	$0
FOMO2200	Monument Creek	1994	Cottonwood Creek / S. Pine	$19,752	$1,080
FOMO2400	Monument Creek	1966	Dry Creek	$15,592	$565
FOMO3600	Monument Creek	1989*	Black Squirrel Creek	$8,968	$565
FOMO3700	Monument Creek	1987*	Middle Tributary	$16,482	$0
FOMO3800	Monument Creek	1987*	Monument Branch	$19,752	$0
FOMO4000	Monument Creek	1996	Smith Creek	$8,052	$1,080
FOMO4200	Monument Creek	1989*	Black Forest	$19,752	$538
FOMO5200	Monument Creek	1993*	Dirty Woman Creek	$19,752	$1,080
FOMO5300	Fountain Creek	1993*	Crystal Creek	$19,752	$1,080
Miscellaneous Drainage Basins: [1]					
CHBS0800	Chico Creek		Book Ranch	$18,533	$2,683
CHEC0400	Chico Creek		Upper East Chico	$10,097	$293
CHWS0200	Chico Creek		Telephone Exchange	$11,093	$260
CHWS0400	Chico Creek		Livestock Company	$18,273	$217
CHWS0600	Chico Creek		West Squirrel	$9,525	$3,953
CHWS0800	Chico Creek		Solberg Ranch	$19,752	$0
FOFO1200	Fountain Creek		Crooked Canyon	$5,963	$0
FOFO1400	Fountain Creek		Calhan Reservoir	$4,979	$290
FOFO1600	Fountain Creek		Sand Canyon	$3,597	$0
FOFO2000	Fountain Creek		Jimmy Camp Creek[3]	$19,752	$924
FOFO2200	Fountain Creek		Fort Carson	$15,592	$565
FOFO2700	Fountain Creek		West Little Johnson	$1,301	$0
FOFO3800	Fountain Creek		Stratton	$9,474	$424
FOFO5000	Fountain Creek		Midland	$15,592	$565
FOFO6000	Fountain Creek		Palmer Trail	$15,592	$565
FOFO6800	Fountain Creek		Black Canyon	$15,592	$565
FOMO4600	Monument Creek		Beaver Creek	$11,808	$0
FOMO3000	Monument Creek		Kettle Creek	$10,666	$0
FOMO3400	Monument Creek		Elkhorn	$1,792	$0
FOMO5000	Monument Creek		Monument Rock	$8,561	$0
FOMO5400	Monument Creek		Palmer Lake	$13,689	$0
FOMO5600	Monument Creek		Raspberry Mountain	$4,605	$0
PLPL0200	Monument Creek		Bald Mountain	$9,813	$0
Interim Drainage Basins: [2]					
FOFO1800	Fountain Creek		Little Fountain Creek	$2,525	$0
FOMO4400	Monument Creek		Jackson Creek	$7,818	$0
FOMO4800	Monument Creek		Teachout Creek	$5,429	$816

1. The miscellaneous drainage fee previous to September 1999 resolution was the average of all drainage fees for basins with Basin Planning Studies performed within the last 14 years.

2. Interim Drainage Fees are based upon draft Drainage Basin Planning Studies or the Drainage Basin Identification and Fee Estimation Report. (Best available information suitable for setting a fee.)

3. This is an interim fee and will be adjusted when a DBPS is completed. In addition to the Drainage Fee a surety in the amount of $7,285 per impervious acre shall be provided to secure payment of additional fees in the event that the DBPS results in a fee greater than the current fee. Fees paid in excess of the future revised fee will be reimbursed. See Resolution 06-326 (9/14/06) and Resolution 16-320 (9/07/16).

EPC Stormwater Management

Jennifer Irvine, P.E.

Exhibit 7:

Erosion Control Facilities

2. Mulching, Agricultural Straw or Hay, and Mulch Tackifier (MU)

COLORADO
Department of Transportation

1. DESCRIPTION:

Mulching is a temporary control measure used for interim and permanent stabilization that consists of mechanically placing a uniform layer of agricultural straw or hay mulch that is crimped in and sprayed with tackifiers over disturbed construction areas. It protects disturbed areas immediately after seeding from the forces of rainfall impacts; it also increases infiltration. Mulching assists with germination success of seeded areas by conserving moisture and protecting against temperature extremes until permanent vegetation is established.

Straw Mulching on disturbed side slope

2. CONTROL MEASURE OBJECTIVES

- ☒ Erosion Control
- ☐ Sediment Control
- ☐ Site/Materials Management

3. RELEVANT SPECIFICATION SECTIONS

Section 213 - Mulching

a) *213.02.(a)/(c)/(f)* - Materials
b) *213.03.(a)/(d)/(g)* - Construction Requirements
c) *213.04* - Method of Measurement
d) *213.05* - Basis of Payment

4. RELEVANT M-STANDARD DETAILS

Section not applicable for this control measure.

5. BASIS OF PAYMENT

Pay item	Description	Pay Unit
213-00002	Mulching (Weed Free Hay)	ACRE
213-00004	Mulching (Weed Free Straw)	ACRE
213-00061	Mulch Tackifier	LB

6. APPLICATIONS

- Use in conjunction with seeding to protect and stabilize disturbed soil.
- Use to cover disturbed areas for extended periods of time as a stabilization strategy.

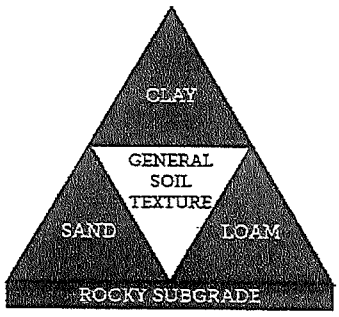
7. LIMITATIONS

- Material availability can impact feasibility of this control measure.
- Potential for introduction of weeds and other non-native plant materials.
- Potentially costlier due to increased labor requirements
- Permanent stabilization strategies for slope applications steeper than 2.5H:1V should consider Soil Retention Blanket or Mulching (Hydraulically applied)

8. SOILS TRIANGLE

SOIL TEXTURE AND SUBGRADE CONDITIONS

- APPROPRIATE
- SOMEWHAT APPROPRIATE
- NOT APPROPRIATE



Rolled Erosion Control Products (RECP) EC-6

Description

Photograph RECP-1. Erosion control blanket protecting the slope from erosion and providing favorable conditions for revegetation.

Rolled Erosion Control Products (RECPs) include a variety of temporary or permanently installed manufactured products designed to control erosion and enhance vegetation establishment and survivability, particularly on slopes and in channels. For applications where natural vegetation alone will provide sufficient permanent erosion protection, temporary products such as netting, open weave textiles and a variety of erosion control blankets (ECBs) made of biodegradable natural materials (e.g., straw, coconut fiber) can be used. For applications where natural vegetation alone will not be sustainable under expected flow conditions, permanent rolled erosion control products such as turf reinforcement mats (TRMs) can be used. In particular, turf reinforcement mats are designed for discharges that exert velocities and sheer stresses that exceed the typical limits of mature natural vegetation.

Appropriate Uses

RECPs can be used to control erosion in conjunction with revegetation efforts, providing seedbed protection from wind and water erosion. These products are often used on disturbed areas on steep slopes, in areas with highly erosive soils, or as part of drainageway stabilization. In order to select the appropriate RECP for site conditions, it is important to have a general understanding of the general types of these products, their expected longevity, and general characteristics.

The Erosion Control Technology Council (ECTC 2005) characterizes rolled erosion control products according to these categories:

- **Mulch control netting**: A planar woven natural fiber or extruded geosynthetic mesh used as a temporary degradable rolled erosion control product to anchor loose fiber mulches.
- **Open weave textile**: A temporary degradable rolled erosion control product composed of processed natural or polymer yarns woven into a matrix, used to provide erosion control and facilitate vegetation establishment.
- **Erosion control blanket (ECB)**: A temporary degradable rolled erosion control product composed of processed natural or polymer fibers which are mechanically, structurally or chemically bound together to form a continuous matrix to provide erosion control and facilitate vegetation establishment. ECBs can be further differentiated into rapidly degrading single-net and double-net types or slowly degrading types.

Rolled Erosion Control Products	
Functions	
Erosion Control	Yes
Sediment Control	No
Site/Material Management	No

- **Turf Reinforcement Mat (TRM):** A rolled erosion control product composed of non-degradable synthetic fibers, filaments, nets, wire mesh, and/or other elements, processed into a permanent, three-dimensional matrix of sufficient thickness. TRMs, which may be supplemented with degradable components, are designed to impart immediate erosion protection, enhance vegetation establishment and provide long-term functionality by permanently reinforcing vegetation during and after maturation. Note: TRMs are typically used in hydraulic applications, such as high flow ditches and channels, steep slopes, stream banks, and shorelines, where erosive forces may exceed the limits of natural, unreinforced vegetation or in areas where limited vegetation establishment is anticipated.

Tables RECP-1 and RECP-2 provide guidelines for selecting rolled erosion control products appropriate to site conditions and desired longevity. Table RECP-1 is for conditions where natural vegetation alone will provide permanent erosion control, whereas Table RECP-2 is for conditions where vegetation alone will not be adequately stable to provide long-term erosion protection due to flow or other conditions.

Staking patterns are also provided in the design details according to these factors:

- ECB type
- Slope or channel type

For other types of RECPs including TRMs, these design details are intended to serve as general guidelines for design and installation; however, engineers should adhere to manufacturer's installation recommendations.

Maintenance and Removal

Inspection of erosion control blankets and other RECPs includes:

- Check for general signs of erosion, including voids beneath the mat. If voids are apparent, fill the void with suitable soil and replace the erosion control blanket, following the appropriate staking pattern.
- Check for damaged or loose stakes and secure loose portions of the blanket.

Erosion control blankets and other RECPs that are biodegradable typically do not need to be removed after construction. If they must be removed, then an alternate soil stabilization method should be installed promptly following removal.

Turf reinforcement mats, although generally resistant to biodegradation, are typically left in place as a dense vegetated cover grows in through the mat matrix. The turf reinforcement mat provides long-term stability and helps the established vegetation resist erosive forces.

Table RECP-2. ECTC Standard Specification for Permanent[1] Rolled Erosion Control Products
(Adapted from: Erosion Control Technology Council 2005)

Product Type	Slope Applications	Channel Applications	
	Maximum Gradient	Maximum Shear Stress[4,5]	Minimum Tensile Strength[2,3]
TRMs with a minimum thickness of 0.25 inches (6.35 mm) per ASTM D 6525 and UV stability of 80% per ASTM D 4355 (500 hours exposure).	0.5:1 (H:V)	6.0 lbs/ft^2 (288 Pa)	125 lbs/ft (1.82 kN/m)
	0.5:1 (H:V)	8.0 lbs/ft^2 (384 Pa)	150 lbs/ft (2.19 kN/m)
	0.5:1 (H:V)	10.0 lbs/ft^2 (480 Pa)	175 lbs/ft (2.55 kN/m)

[1] For TRMs containing degradable components, all property values must be obtained on the non-degradable portion of the matting alone.

[2] Minimum Average Roll Values, machine direction only for tensile strength determination using ASTM D 6818 (Supersedes Mod. ASTM D 5035 for RECPs)

[3] Field conditions with high loading and/or high survivability requirements may warrant the use of a TRM with a tensile strength of 44 kN/m (3,000 lb/ft) or greater.

[4] Required minimum shear stress TRM (fully vegetated) can sustain without physical damage or excess erosion (> 12.7 mm (0.5 in.) soil loss) during a 30-minute flow event in large scale testing.

[5] Acceptable large-scale testing protocols may include ASTM D 6460, or other independent testing deemed acceptable by the engineer.

Design and Installation

RECPs should be installed according to manufacturer's specifications and guidelines. Regardless of the type of product used, it is important to ensure no gaps or voids exist under the material and that all corners of the material are secured using stakes and trenching. Continuous contact between the product and the soil is necessary to avoid failure. Never use metal stakes to secure temporary erosion control products. Often wooden stakes are used to anchor RECPs; however, wood stakes may present installation and maintenance challenges and generally take a long time to biodegrade. Some local jurisdictions have had favorable experiences using biodegradable stakes.

This BMP Fact Sheet provides design details for several commonly used ECB applications, including:

ECB-1 Pipe Outlet to Drainageway

ECB-2 Small Ditch or Drainageway

ECB-3 Outside of Drainageway

Table RECP-1. ECTC Standard Specification for Temporary Rolled Erosion Control Products
(Adapted from Erosion Control Technology Council 2005)

Product Description	Slope Applications*		Channel Applications*	Minimum Tensile Strength[1]	Expected Longevity
	Maximum Gradient	C Factor[2,5]	Max. Shear Stress[3,4,6]		
Mulch Control Nets	5:1 (H:V)	≤0.10 @ 5:1	0.25 lbs/ft^2 (12 Pa)	5 lbs/ft (0.073 kN/m)	Up to 12 months
Netless Rolled Erosion Control Blankets	4:1 (H:V)	≤0.10 @ 4:1	0.5 lbs/ft^2 (24 Pa)	5 lbs/ft (0.073 kN/m)	
Single-net Erosion Control Blankets & Open Weave Textiles	3:1 (H:V)	≤0.15 @ 3:1	1.5 lbs/ft^2 (72 Pa)	50 lbs/ft (0.73 kN/m)	
Double-net Erosion Control Blankets	2:1 (H:V)	≤0.20 @ 2:1	1.75 lbs/ft^2 (84 Pa)	75 lbs/ft (1.09 kN/m)	
Mulch Control Nets	5:1 (H:V)	≤0.10 @ 5:1	0.25 lbs/ft^2 (12 Pa)	25 lbs/ft (0.36 kN/m)	24 months
Erosion Control Blankets & Open Weave Textiles (slowly degrading)	1.5:1 (H:V)	≤0.25 @ 1.5:1	2.00 lbs/ft^2 (96 Pa)	100 lbs/ft (1.45 kN/m)	24 months
Erosion Control Blankets & Open Weave Textiles	1:1 (H:V)	≤0.25 @ 1:1	2.25 lbs/ft^2 (108 Pa)	125 lbs/ft (1.82 kN/m)	36 months

* C Factor and shear stress for mulch control nettings must be obtained with netting used in conjunction with pre-applied mulch material. (*See Section 5.3 of Chapter 7 Construction BMPs for more information on the C Factor.*)

[1] Minimum Average Roll Values, Machine direction using ECTC Mod. ASTM D 5035.

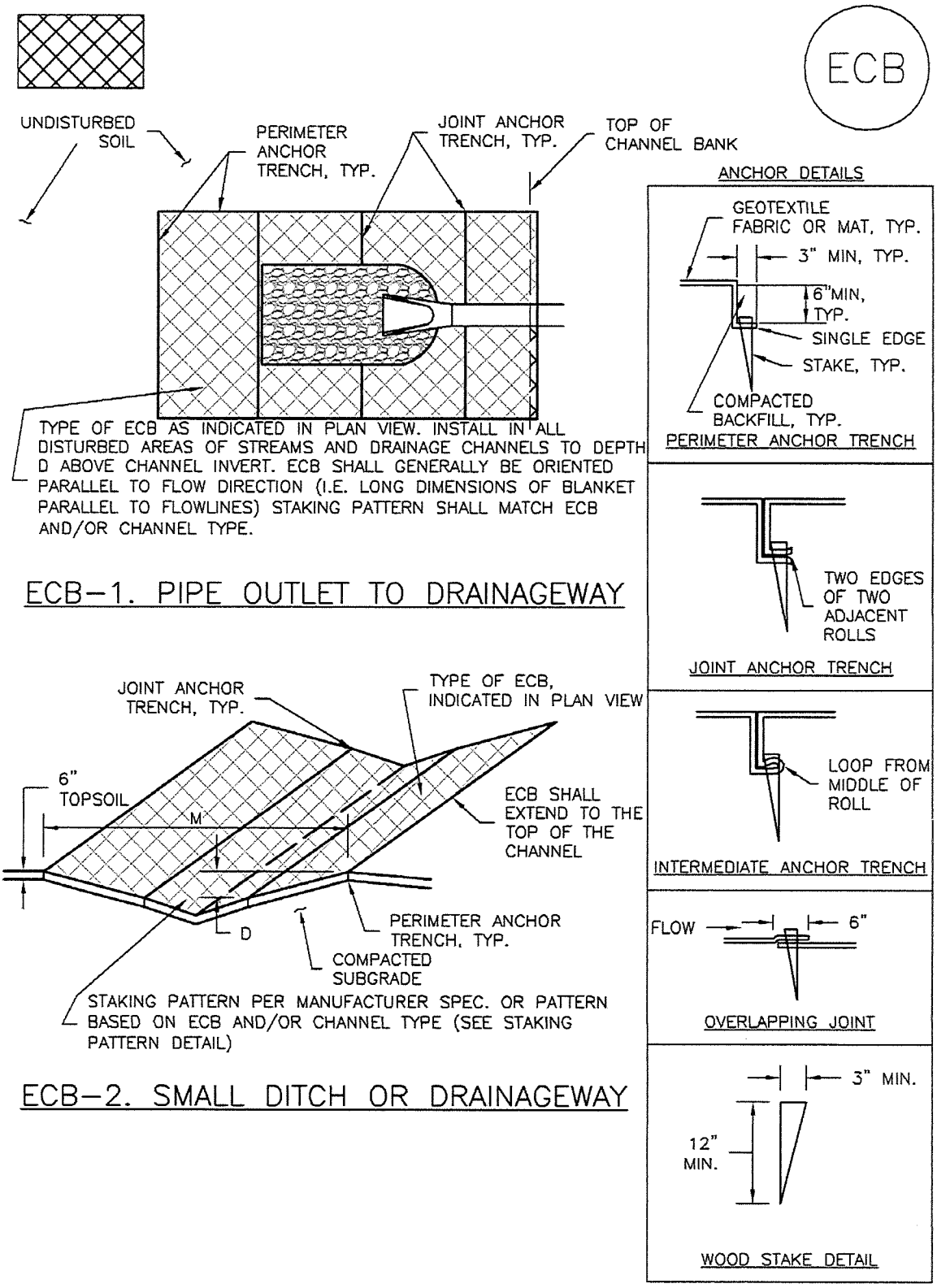
[2] C Factor calculated as ratio of soil loss from RECP protected slope (tested at specified or greater gradient, H:V) to ratio of soil loss from unprotected (control) plot in large-scale testing.

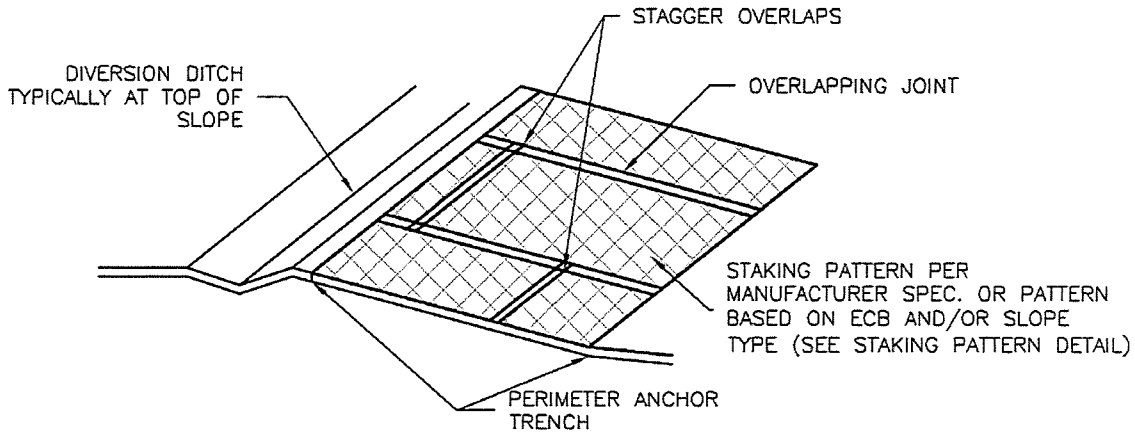
[3] Required minimum shear stress RECP (unvegetated) can sustain without physical damage or excess erosion (> 12.7 mm (0.5 in) soil loss) during a 30-minute flow event in large-scale testing.

[4] The permissible shear stress levels established for each performance category are based on historical experience with products characterized by Manning's roughness coefficients in the range of 0.01 - 0.05.

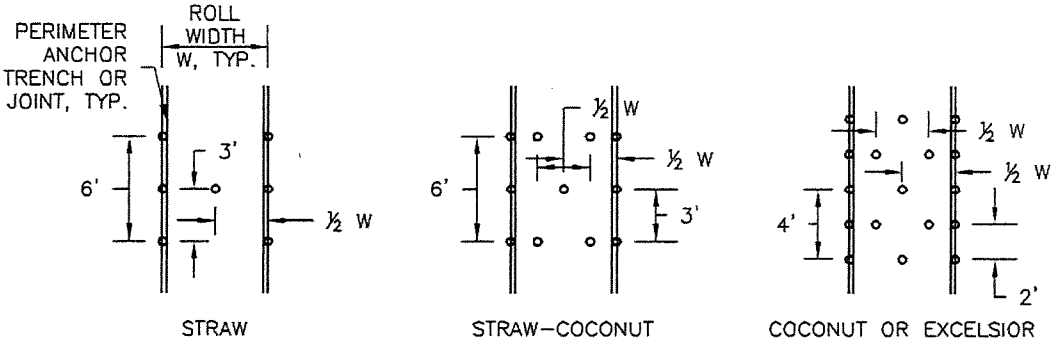
[5] Acceptable large-scale test methods may include ASTM D 6459, or other independent testing deemed acceptable by the engineer.

[6] Per the engineer's discretion. Recommended acceptable large-scale testing protocol may include ASTM D 6460, or other independent testing deemed acceptable by the engineer.

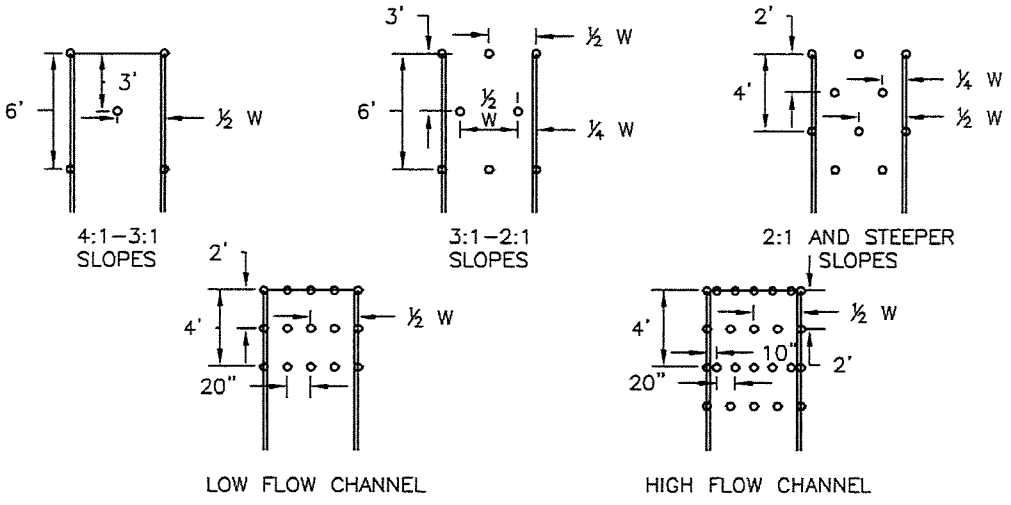

ECB
UNDISTURBED SOIL
PERIMETER ANCHOR TRENCH, TYP.
JOINT ANCHOR TRENCH, TYP.
TOP OF CHANNEL BANK
TYPE OF ECB AS INDICATED IN PLAN VIEW. INSTALL IN ALL DISTURBED AREAS OF STREAMS AND DRAINAGE CHANNELS TO DEPTH D ABOVE CHANNEL INVERT. ECB SHALL GENERALLY BE ORIENTED PARALLEL TO FLOW DIRECTION (I.E. LONG DIMENSIONS OF BLANKET PARALLEL TO FLOWLINES) STAKING PATTERN SHALL MATCH ECB AND/OR CHANNEL TYPE.
ECB–1. PIPE OUTLET TO DRAINAGEWAY
JOINT ANCHOR TRENCH, TYP.
TYPE OF ECB, INDICATED IN PLAN VIEW
6" TOPSOIL
M
ECB SHALL EXTEND TO THE TOP OF THE CHANNEL
D
PERIMETER ANCHOR TRENCH, TYP.
COMPACTED SUBGRADE
STAKING PATTERN PER MANUFACTURER SPEC. OR PATTERN BASED ON ECB AND/OR CHANNEL TYPE (SEE STAKING PATTERN DETAIL)
ECB–2. SMALL DITCH OR DRAINAGEWAY
ANCHOR DETAILS
GEOTEXTILE FABRIC OR MAT, TYP.
3" MIN, TYP.
6" MIN, TYP.
SINGLE EDGE STAKE, TYP.
COMPACTED BACKFILL, TYP.
PERIMETER ANCHOR TRENCH
TWO EDGES OF TWO ADJACENT ROLLS
JOINT ANCHOR TRENCH
LOOP FROM MIDDLE OF ROLL
INTERMEDIATE ANCHOR TRENCH
FLOW
6"
OVERLAPPING JOINT
3" MIN.
12" MIN.
WOOD STAKE DETAIL



ECB–3. OUTSIDE OF DRAINAGEWAY



STAKING PATTERNS BY ECB TYPE



STAKING PATTERNS BY SLOPE OR CHANNEL TYPE

EROSION CONTROL BLANKET INSTALLATION NOTES

1. SEE PLAN VIEW FOR:
   -LOCATION OF ECB.
   -TYPE OF ECB (STRAW, STRAW-COCONUT, COCONUT, OR EXCELSIOR).
   -AREA, A, IN SQUARE YARDS OF EACH TYPE OF ECB.

2. 100% NATURAL AND BIODEGRADABLE MATERIALS ARE PREFERRED FOR RECPs, ALTHOUGH SOME JURISDICTIONS MAY ALLOW OTHER MATERIALS IN SOME APPLICATIONS.

3. IN AREAS WHERE ECBs ARE SHOWN ON THE PLANS, THE PERMITTEE SHALL PLACE TOPSOIL AND PERFORM FINAL GRADING, SURFACE PREPARATION, AND SEEDING AND MULCHING. SUBGRADE SHALL BE SMOOTH AND MOIST PRIOR TO ECB INSTALLATION AND THE ECB SHALL BE IN FULL CONTACT WITH SUBGRADE. NO GAPS OR VOIDS SHALL EXIST UNDER THE BLANKET.

4. PERIMETER ANCHOR TRENCH SHALL BE USED ALONG THE OUTSIDE PERIMETER OF ALL BLANKET AREAS.

5. JOINT ANCHOR TRENCH SHALL BE USED TO JOIN ROLLS OF ECBs TOGETHER (LONGITUDINALLY AND TRANSVERSELY) FOR ALL ECBs EXCEPT STRAW WHICH MAY USE AN OVERLAPPING JOINT.

6. INTERMEDIATE ANCHOR TRENCH SHALL BE USED AT SPACING OF ONE-HALF ROLL LENGTH FOR COCONUT AND EXCELSIOR ECBs.

7. OVERLAPPING JOINT DETAIL SHALL BE USED TO JOIN ROLLS OF ECBs TOGETHER FOR ECBs ON SLOPES.

8. MATERIAL SPECIFICATIONS OF ECBs SHALL CONFORM TO TABLE ECB-1.

9. ANY AREAS OF SEEDING AND MULCHING DISTURBED IN THE PROCESS OF INSTALLING ECBS SHALL BE RESEEDED AND MULCHED.

10. DETAILS ON DESIGN PLANS FOR MAJOR DRAINAGEWAY STABILIZATION WILL GOVERN IF DIFFERENT FROM THOSE SHOWN HERE.

TABLE ECB-1. ECB MATERIAL SPECIFICATIONS

TYPE	COCONUT CONTENT	STRAW CONTENT	EXCELSIOR CONTENT	RECOMMENDED NETTING**
STRAW*	-	100%	-	DOUBLE/ NATURAL
STRAW-COCONUT	30% MIN	70% MAX	-	DOUBLE/ NATURAL
COCONUT	100%	-	-	DOUBLE/ NATURAL
EXCELSIOR	-	-	100%	DOUBLE/ NATURAL

*STRAW ECBs MAY ONLY BE USED OUTSIDE OF STREAMS AND DRAINAGE CHANNEL.
**ALTERNATE NETTING MAY BE ACCEPTABLE IN SOME JURISDICTIONS

EROSION CONTROL BLANKET MAINTENANCE NOTES

1. INSPECT BMPs EACH WORKDAY, AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE. INSPECT BMPs AS SOON AS POSSIBLE (AND ALWAYS WITHIN 24 HOURS) FOLLOWING A STORM THAT CAUSES SURFACE EROSION, AND PERFORM NECESSARY MAINTENANCE.

2. FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN BMPs IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.

3. WHERE BMPs HAVE FAILED, REPAIR OR REPLACEMENT SHOULD BE INITIATED UPON DISCOVERY OF THE FAILURE.

4. ECBs SHALL BE LEFT IN PLACE TO EVENTUALLY BIODEGRADE, UNLESS REQUESTED TO BE REMOVED BY THE LOCAL JURISDICTION.

5. ANY ECB PULLED OUT, TORN, OR OTHERWISE DAMAGED SHALL BE REPAIRED OR REINSTALLED. ANY SUBGRADE AREAS BELOW THE GEOTEXTILE THAT HAVE ERODED TO CREATED A VOID UNDER THE BLANKET, OR THAT REMAIN DEVOID OF GRASS SHALL BE REPAIRED, RESEEDED AND MULCHED AND THE ECB REINSTALLED.

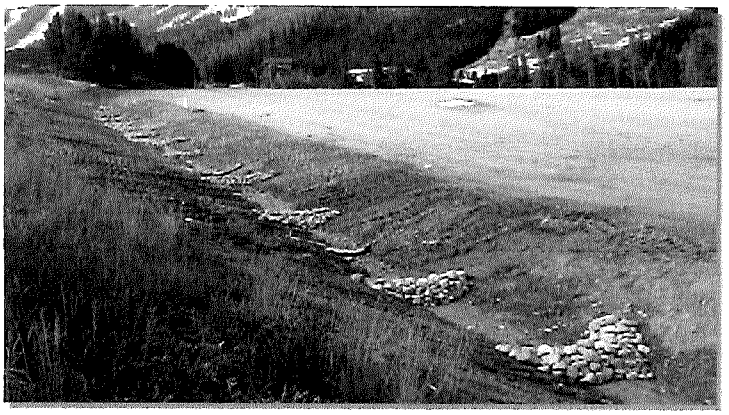
NOTE: MANY JURISDICTIONS HAVE BMP DETAILS THAT VARY FROM UDFCD STANDARD DETAILS. CONSULT WITH LOCAL JURISDICTIONS AS TO WHICH DETAIL SHOULD BE USED WHEN DIFFERENCES ARE NOTED.

(DETAILS ADAPTED FROM DOUGLAS COUNTY, COLORADO AND TOWN OF PARKER COLORADO, NOT AVAILABLE IN AUTOCAD)

Check Dams (CD) EC-12

Description

Check dams are temporary grade control structures placed in drainage channels to limit the erosivity of stormwater by reducing flow velocity. Check dams are typically constructed from rock, gravel bags, sand bags, or sometimes, proprietary devices. Reinforced check dams are typically constructed from rock and wire gabion. Although the primary function of check dams is to reduce the velocity of concentrated flows, a secondary benefit is sediment trapping upstream of the structure.



Photograph CD-1. Rock check dams in a roadside ditch. Photo courtesy of WWE.

Appropriate Uses

Use as a grade control for temporary drainage ditches or swales until final soil stabilization measures are established upstream and downstream. Check dams can be used on mild or moderately steep slopes. Check dams may be used under the following conditions:

- As temporary grade control facilities along waterways until final stabilization is established.
- Along permanent swales that need protection prior to installation of a non-erodible lining.
- Along temporary channels, ditches or swales that need protection where construction of a non-erodible lining is not practicable.
- Reinforced check dams should be used in areas subject to high flow velocities.

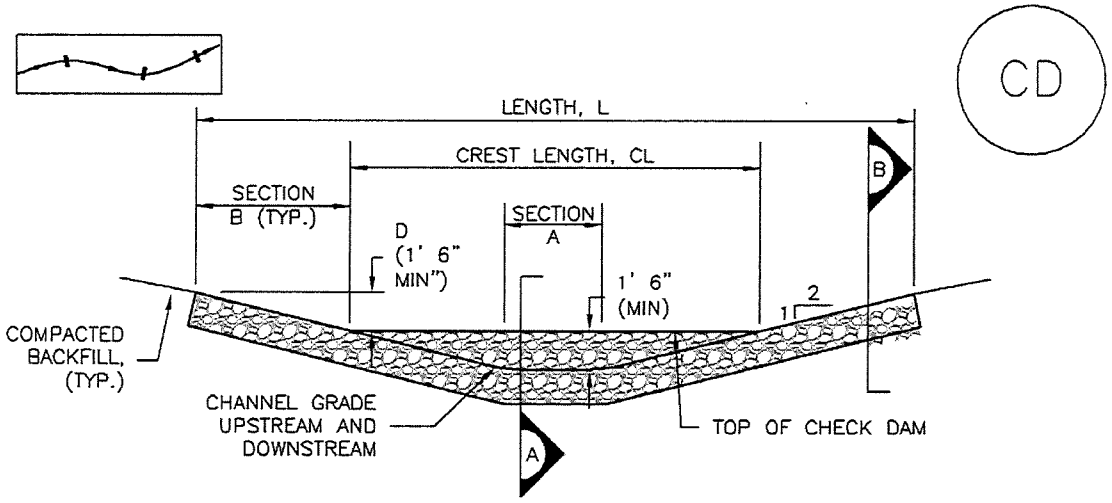
Design and Installation

Place check dams at regularly spaced intervals along the drainage swale or ditch. Check dams heights should allow for pools to develop upstream of each check dam, extending to the downstream toe of the check dam immediately upstream.

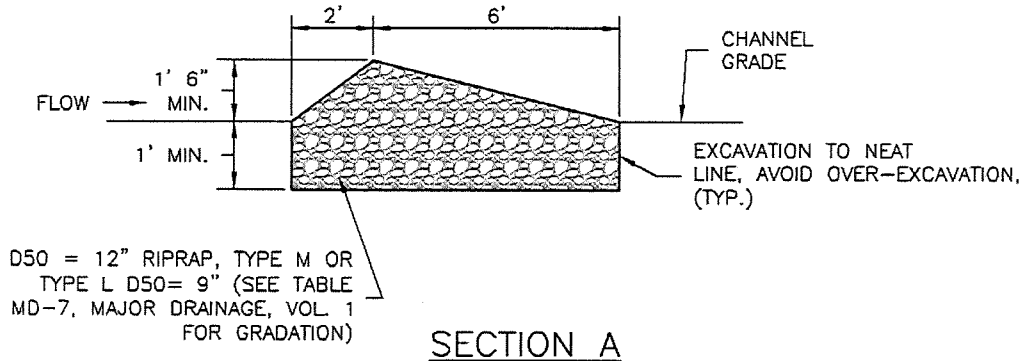
When rock is used for the check dam, place rock mechanically or by hand. Do not dump rocks into the drainage channel. Where multiple check dams are used, the top of the lower dam should be at the same elevation as the toe of the upper dam.

When reinforced check dams are used, install erosion control fabric under and around the check dam to prevent erosion on the upstream and downstream sides. Each section of the dam should be keyed in to reduce the potential for washout or undermining. A rock apron upstream and downstream of the dam may be necessary to further control erosion.

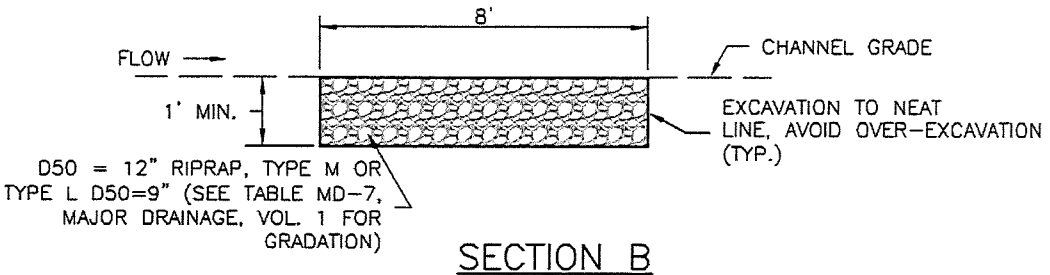
Check Dams	
Functions	
Erosion Control	Yes
Sediment Control	Moderate
Site/Material Management	No



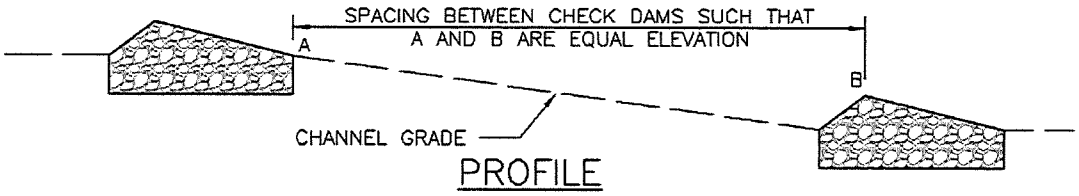
CHECK DAM ELEVATION VIEW



SECTION A



SECTION B



PROFILE

CD-1. CHECK DAM

Straw Bale Barrier (SBB) SC-3

Description

A straw bale barrier is a linear wall of straw bales designed to intercept sheet flow and trap sediment before runoff exits a disturbed area.

Photograph SBB-1. Straw bale barrier used for perimeter control. Photo courtesy of Tom Gore.

Appropriate Uses

Appropriate uses of properly installed straw bale barriers may include:

- As a perimeter control for a site or soil stockpile.
- As a sediment control at the toe of an erodible slope.
- Along the edge of a stream or drainage pathway to reduce sediment laden runoff from entering the waterway.
- As part of an inlet protection design in sump conditions (See Inlet Protection BMP).

Do not use straw bale barriers in areas of concentrated flow or in areas where ponding is not desirable. Straw bales tend to degrade quickly, so they should generally not be used in areas where longer term disturbance is expected.

Due to a history of inappropriate placement, poor installation, and short effective lifespan, the use of straw bales is discouraged or prohibited by some communities.

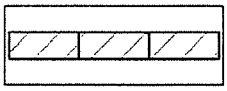
Design and Installation

The maximum recommended tributary drainage area per 100 lineal feet of straw bale barrier is 0.25 acres with a disturbed slope length of up to 150 feet and a tributary slope gradient no steeper than 3:1; longer and steeper slopes require additional measures. Design details with notes are provided in Detail SBB-1. To be effective, bales must be installed in accordance with the design details with proper trenching, staking, and binding. Jute and cotton string must not be used to bind the straw bale. The bales should be certified weed-free prior to use.

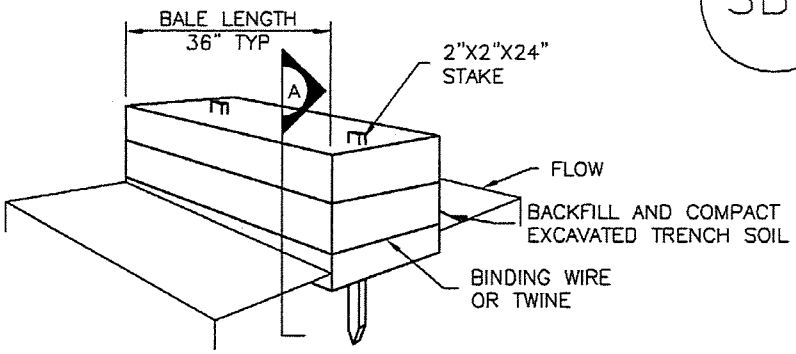
Maintenance and Removal

Check bales for rotting and replace as necessary. Straw bales degrade, and rotting bales require replacement on a regular basis (as often as every three months) depending on environmental conditions. Check for undercutting, bypassed flows, and displacement. Repair by properly re-installing the straw bale barrier and repairing washouts around the bales. Remove sediment accumulated behind the bale when it reaches one-quarter of the bale height. Remove and properly dispose of the straw bale once the upstream area has been stabilized. Areas of disturbance beneath the bale should be seeded and mulched when the bale is removed.

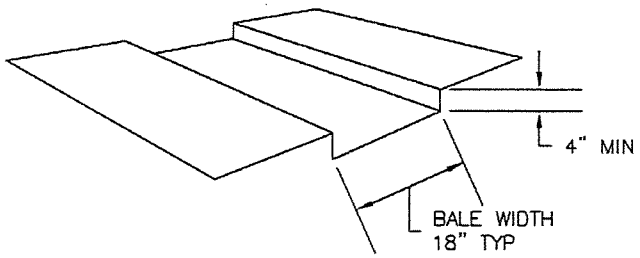
Straw Bale Barrier	
Functions	
Erosion Control	No
Sediment Control	Moderate
Site/Material Management	No



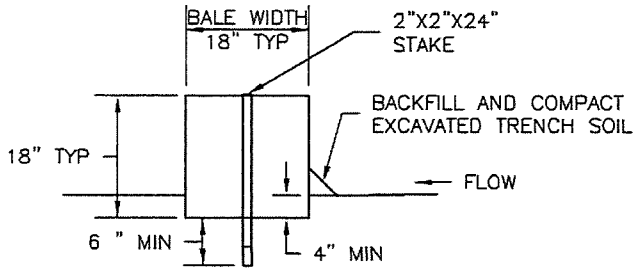
SBB



STRAW BALE



TRENCH FOR STRAW BALE



SECTION A

SBB–1. STRAW BALE

Silt Fence (SF) SC-1

Description

A silt fence is a woven geotextile fabric attached to wooden posts and trenched into the ground. It is designed as a sediment barrier to intercept sheet flow runoff from disturbed areas.

Photograph SF-1. Silt fence creates a sediment barrier, forcing sheet flow runoff to evaporate or infiltrate.

Appropriate Uses

A silt fence can be used where runoff is conveyed from a disturbed area as sheet flow. Silt fence is not designed to receive concentrated flow or to be used as a filter fabric. Typical uses include:

- Down slope of a disturbed area to accept sheet flow.
- Along the perimeter of a receiving water such as a stream, pond or wetland.
- At the perimeter of a construction site.

Design and Installation

Silt fence should be installed along the contour of slopes so that it intercepts sheet flow. The maximum recommended tributary drainage area per 100 lineal feet of silt fence, installed along the contour, is approximately 0.25 acres with a disturbed slope length of up to 150 feet and a tributary slope gradient no steeper than 3:1. Longer and steeper slopes require additional measures. This recommendation only applies to silt fence installed along the contour. Silt fence installed for other uses, such as perimeter control, should be installed in a way that will not produce concentrated flows. For example, a "J-hook" installation may be appropriate to force runoff to pond and evaporate or infiltrate in multiple areas rather than concentrate and cause erosive conditions parallel to the silt fence.

See Detail SF-1 for proper silt fence installation, which involves proper trenching, staking, securing the fabric to the stakes, and backfilling the silt fence. Properly installed silt fence should not be easily pulled out by hand and there should be no gaps between the ground and the fabric.

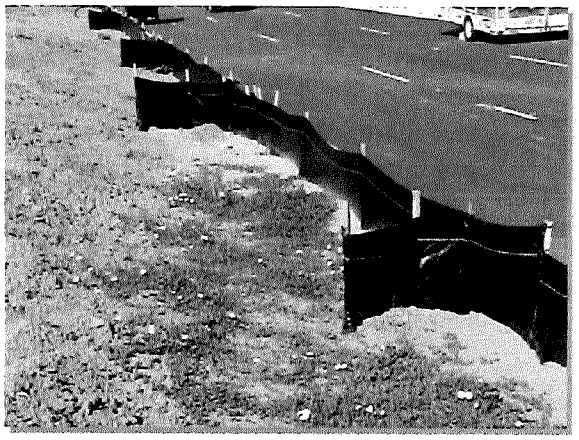
Silt fence must meet the minimum allowable strength requirements, depth of installation requirement, and other specifications in the design details. Improper installation of silt fence is a common reason for silt fence failure; however, when properly installed and used for the appropriate purposes, it can be highly effective.

Silt Fence	
Functions	
Erosion Control	No
Sediment Control	Yes
Site/Material Management	No

Maintenance and Removal

Inspection of silt fence includes observing the material for tears or holes and checking for slumping fence and undercut areas bypassing flows. Repair of silt fence typically involves replacing the damaged section with a new section. Sediment accumulated behind silt fence should be removed, as needed to maintain BMP effectiveness, typically before it reaches a depth of 6 inches.

Silt fence may be removed when the upstream area has reached final stabilization.

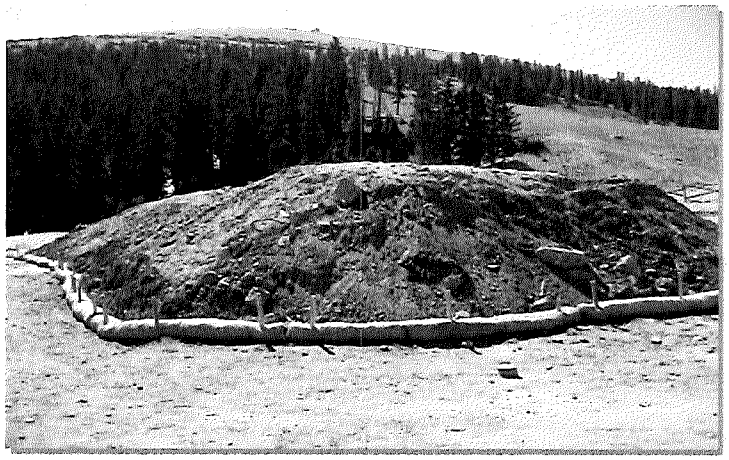


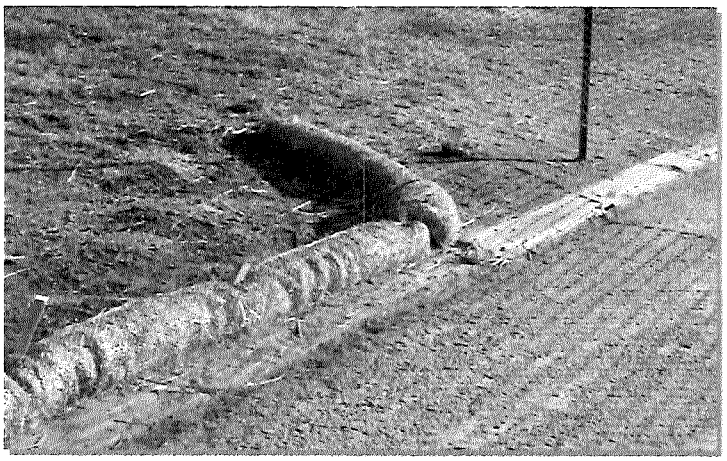
Photograph SF-2. When silt fence is not installed along the contour, a "J-hook" installation may be appropriate to ensure that the BMP does not create concentrated flow parallel to the silt fence. Photo courtesy of Tom Gore.

Sediment Control Log (SCL) SC-2

Description

A sediment control log is a linear roll made of natural materials such as straw, coconut fiber, or compost. The most common type of sediment control log has straw filling and is often referred to as a "straw wattle." All sediment control logs are used as a sediment barrier to intercept sheet flow runoff from disturbed areas.





Photographs SCL-1 and SCL-2. Sediment control logs used as 1) a perimeter control around a soil stockpile; and, 2) as a "J-hook" perimeter control at the corner of a construction site.

Appropriate Uses

Sediment control logs can be used in the following applications to trap sediment:

- As perimeter control for stockpiles and the site.
- As part of inlet protection designs.
- As check dams in small drainage ditches. (Sediment control logs are not intended for use in channels with high flow velocities.)
- On disturbed slopes to shorten flow lengths (as an erosion control).
- As part of multi-layered perimeter control along a receiving water such as a stream, pond or wetland.

Sediment control logs work well in combination with other layers of erosion and sediment controls.

Design and Installation

Sediment control logs should be installed along the contour to avoid concentrating flows. The maximum allowable tributary drainage area per 100 lineal feet of sediment control log, installed along the contour, is approximately 0.25 acres with a disturbed slope length of up to 150 feet and a tributary slope gradient no steeper than 3:1. Longer and steeper slopes require additional measures. This recommendation only applies to sediment control logs installed along the contour. When installed for other uses, such as perimeter control, it should be installed in a way that will not produce concentrated flows. For example, a "J-hook" installation may be appropriate to force runoff to pond and evaporate or infiltrate in multiple areas rather than concentrate and cause erosive conditions parallel to the BMP.

Sediment Control Log	
Functions	
Erosion Control	Moderate
Sediment Control	Yes
Site/Material Management	No

Temporary Outlet Protection (TOP) EC-8

Description

Outlet protection helps to reduce erosion immediately downstream of a pipe, culvert, slope drain, rundown or other conveyance with concentrated, high-velocity flows. Typical outlet protection consists of riprap or rock aprons at the conveyance outlet.

Photograph TOP-1. Riprap outlet protection.

Appropriate Uses

Outlet protection should be used when a conveyance discharges onto a disturbed area where there is potential for accelerated erosion due to concentrated flow. Outlet protection should be provided where the velocity at the culvert outlet exceeds the maximum permissible velocity of the material in the receiving channel.

Note: This Fact Sheet and detail are for temporary outlet protection, outlets that are intended to be used for less than 2 years. For permanent, long-term outlet protection, see the *Major Drainage* chapter of Volume 1.

Design and Installation

Design outlet protection to handle runoff from the largest drainage area that may be contributing runoff during construction (the drainage area may change as a result of grading). Key in rock, around the entire perimeter of the apron, to a minimum depth of 6 inches for stability. Extend riprap to the height of the culvert or the normal flow depth of the downstream channel, whichever is less. Additional erosion control measures such as vegetative lining, turf reinforcement mat and/or other channel lining methods may be required downstream of the outlet protection if the channel is susceptible to erosion. See Design Detail OP-1 for additional information.

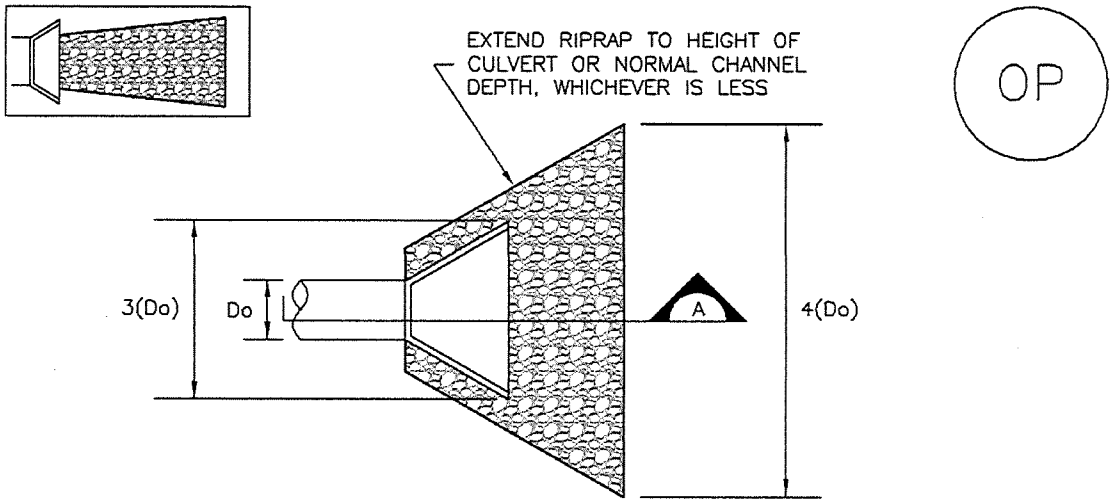
Maintenance and Removal

Inspect apron for damage and displaced rocks. If rocks are missing or significantly displaced, repair or replace as necessary. If rocks are continuously missing or displaced, consider increasing the size of the riprap or deeper keying of the perimeter.

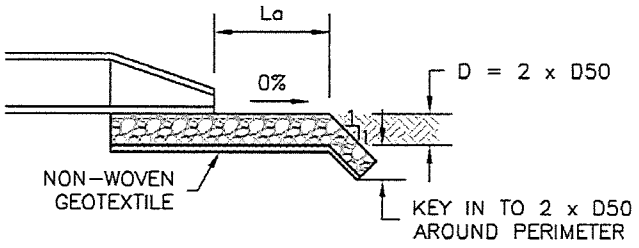
Remove sediment accumulated at the outlet before the outlet protection becomes buried and ineffective. When sediment accumulation is noted, check that upgradient BMPs, including inlet protection, are in effective operating condition.

Outlet protection may be removed once the pipe is no longer draining an upstream area, or once the downstream area has been sufficiently stabilized. If the drainage pipe is permanent, outlet protection can be left in place; however, permanent outlet protection should be designed and constructed in accordance with the requirements of the *Major Drainage* chapter of Volume 2.

Outlet Protection	
Functions	
Erosion Control	Yes
Sediment Control	Moderate
Site/Material Management	No



TEMPORARY OUTLET PROTECTION PLAN



SECTION A

TABLE OP-1. TEMPORARY OUTLET PROTECTION SIZING TABLE			
PIPE DIAMETER, Do (INCHES)	DISCHARGE, Q (CFS)	APRON LENGTH, La (FT)	RIPRAP D50 DIAMETER MIN (INCHES)
8	2.5 5	5 10	4 6
12	5 10	10 13	4 6
18	10 20 30 40	10 16 23 26	6 9 12 16
24	30 40 50 60	16 26 26 30	9 9 12 16

OP-1. TEMPORARY OUTLET PROTECTION

Exhibit 8:

Hydrologic Calculations

DESIGN POINT SUMMARY

DESIGN POINT	CONTRIB SUB BASINS	AREA (acres)	Q5 (cfs)	Q100 (cfs)
1	EASTERLY END OF CUL-DE-SAC			
2	A	17.4	3.7	24.0
3	HIGH POINT BETWEEN A & B			
4	B	20.8	4.6	29.5
5	C	3.9	1.8	8.4
6	RIDGELINE INTERSECTION BETWEEN C & D			
7	C,D,E	13.7	5.9	28.7
8	HIGH POINT ALONG HERRING ROAD			
9	E	2.3	1.4	5.5
10	D,E	9.8	4.1	20.1
11	B,C,D,E,H,I	63.5	17.9	117.9
12	J	3.4	1.0	7.1
13	F	18.7	3.1	21.1
14	A,G	27.3	6.7	41.4
15	A,F,G	46	9.8	63.3

SWALE SUMMARY

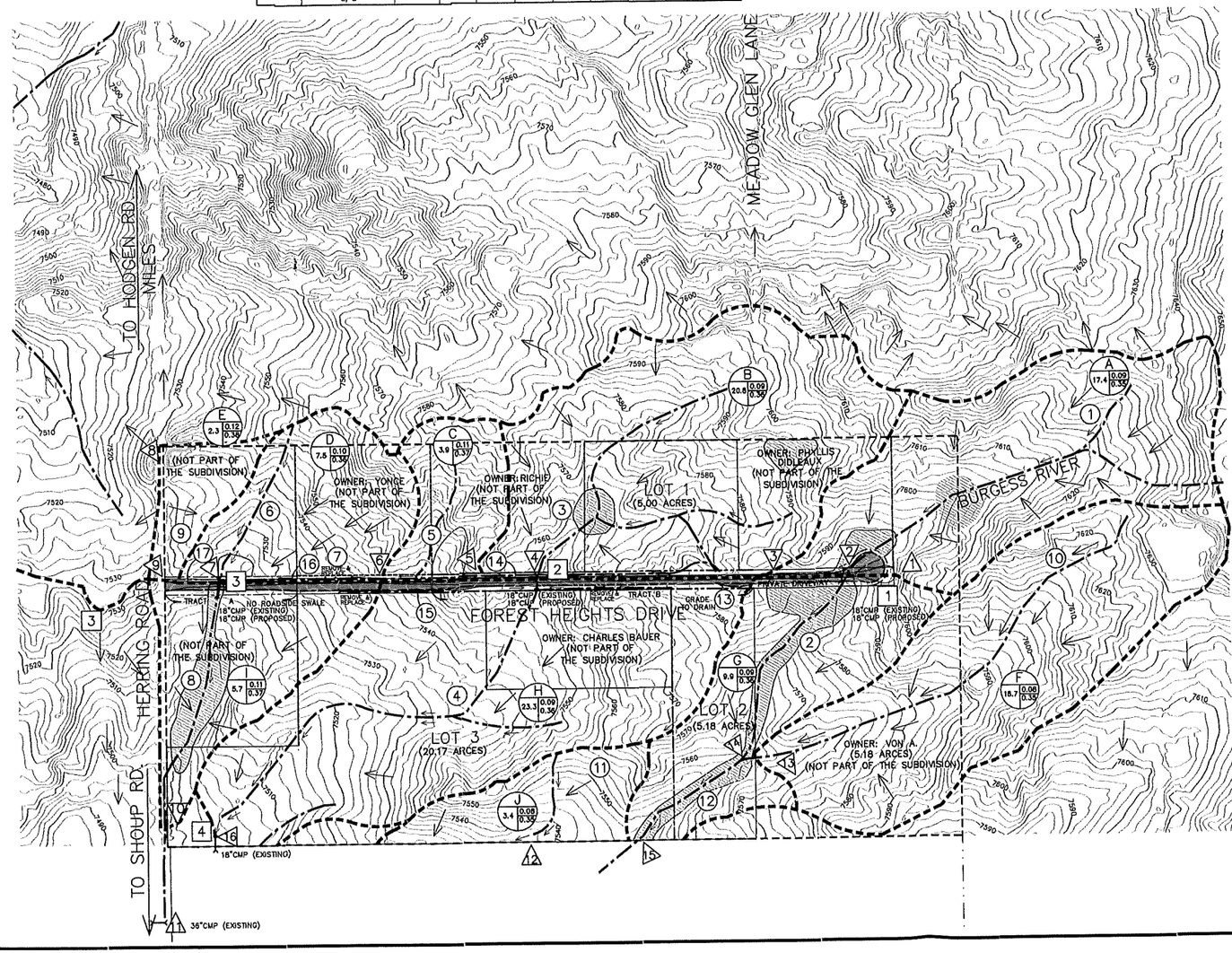
SWALE #	CONTRIBUTING SUBBASINS	SLOPE	DESIGN FLOW Q5	DESIGN FLOW Q100	DEPTH OF FLOW Q5	DEPTH OF FLOW Q100	VELOCITY Q5	VELOCITY Q100	FROUDE # 5 year	FROUDE # 100 year
		%	cfs	cfs	ft	ft	fps	fps		
1	A	4.5	3.7	24.0	0.1	0.2	1.2	2.7	0.91	1.16
2	A,G	3.1	5.7	36.1	0.1	0.3	1.5	2.9	0.84	1.02
3	B	4.6	4.6	29.5	0.1	0.3	1.8	3.7	1.04	1.26
4	B,H	3.3	10.2	64.2	0.1	0.2	1.4	2.9	0.87	1.06
5	C	5.5	1.8	8.4	0.1	0.1	1.3	2.4	1.00	1.20
6	D	6.0	4.1	20.3	0.1	0.2	1.9	3.5	1.18	1.37
7	SWALE OMMITTED FOR DRAINAGE PLAN									
8	C,D,E,I	3.3	8.7	43.8	0.1	0.3	1.8	3.1	0.91	1.06
9	SWALE OMMITTED FOR DRAINAGE PLAN									
10	F	5.3	3.1	21.1	0.1	0.3	1.7	3.4	1.09	1.30
11	J	3.1	1.0	7.1	0.0	0.1	0.6	1.4	0.70	0.86
12	A,G,F	6.1	9.8	63.3	0.1	0.3	2.2	4.9	1.20	1.70
13	PORTIONS OF AREA H ADJACENT TO ROAD	6.9	0.9	2.9	0.1	0.2	3.2	4.5	1.83	1.98
14	SMALL PORTION OF AREA B	2.1	0.2	0.6	0.1	0.1	1.3	1.8	0.90	1.00
15	PORTIONS OF AREAS C, D	4.4	0.4	1.2	0.1	0.2	2.1	3.1	1.37	1.50
16	PORTIONS OF AREA C, D ADJACENT TO ROAD	3.0	2.2	12.1	0.2	0.5	3.1	5.0	1.34	1.49
17	PORTIONS OF AREAS E, D	0.6	0.3	1.3	0.1	0.3	1.0	1.5	0.53	0.60

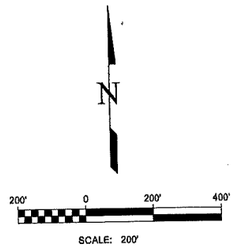
BASIN SUMMARY

BASIN I.D.	AREA (acres)	RUNOFF COEFFICIENTS (existing) C5	RUNOFF COEFFICIENTS (existing) C100	RUNOFF COEFFICIENTS (developed) C5	RUNOFF COEFFICIENTS (developed) C100	EXSITING RUNOFF Q5 cfs	EXSITING RUNOFF Q100 cfs	DEVELOPED RUNOFF Q5 cfs	DEVELOPED RUNOFF Q100 cfs
A	17.4	0.09	0.35	0.09	0.36	3.4	23.6	3.7	24
B	20.8	0.09	0.35	0.1	0.36	4.4	29.1	4.6	29.5
C	3.9	0.11	0.37	0.14	0.39	1.4	7.9	1.8	8.4
D	7.5	0.1	0.36	0.12	0.38	2.3	14.3	2.7	14.8
E	2.3	0.12	0.38	0.18	0.42	1	4.9	1.4	5.5
F	18.7	0.08	0.35	0.09	0.35	2	20.7	3.1	21.1
G	9.9	0.09	0.36	0.1	0.37	2.7	17.8	3	18.2
H	23.3	0.09	0.36	0.1	0.36	5.3	34.3	5.6	34.7
I	5.7	0.11	0.37	0.13	0.38	2.4	13.7	2.8	14.3
J	3.4	0.08	0.35	0.08	0.35	1	7.1	1	7.1
SWALE 13 AREA	SM. PORTION OF SUBBASIN H	N/A	N/A	0.25	0.46	N/A	N/A	0.9	2.9
SWALE 14 AREA	SM. PORTION OF SUBBASIN B	N/A	N/A	0.1	0.16	N/A	N/A	0.2	0.6
SWALE 15 AREA	SM. PORTION OF SUBBASIN C	N/A	N/A	0.33	0.52	N/A	N/A	0.4	1.2
SWALE 16 AREA	SM. PORTION OF SUBBASIN D	N/A	N/A	0.11	0.37	N/A	N/A	2.2	12.1
SWALE 17 AREA	SM. PORTION OF SUBBASIN D	N/A	N/A	0.17	0.41	N/A	N/A	0.3	1.3

CULVERT SUMMARY

CULVERT #	SIZE	MATERIAL	CONTRIBUTING SUBBASINS	5 YEAR Q (cfs)	5 YEAR HEADWATER REQUIRED	100 YEAR Q (cfs)	100 YEAR HEADWATER REQUIRED	CONDITION
1	18"	CMP	A	3.7	12.8"	24.0	> 7.5 FT	75% SILTED, ROADWAY OVERTOPPING WITH 100 YR
2	18"	CMP	B	4.6	15.3"	29.5	> 9 FT	75% SILTED, ROADWAY OVERTOPPING WITH 100 YR
3	18"	CMP	C, D, E	5.9	16.7"	28.7	> 9 FT	75% SILTED, ROADWAY OVERTOPPING WITH 100 YR
4	18"	CMP	A, B, C, D, E, H, I	20.8	6 FT	124.0	> 9 FT	PRIVATE CULVERT UNDER PRIVATE DRIVEWAY





LEGEND:

- ← DIRECTION OF FLOW
- – – – – PROJECT BOUNDRY
- —·—·— FLOWLINE NATURAL SWALE
- ▬ ▬ ▬ SUBBASIN BOUNDRY
- (A) DESIGN POINT
- (X) SWALE NUMBER
- SUBDIVISION I.D.
- 5 YR. RUNOFF COEFFICIENT
- 100 YR. RUNOFF COEFFICIENT
- AREA (ARCES)
- CULVERT
- [X] CULVERT NIUMBER
- INDEX CONTOURS
- INTERMEDIATE CONTOURS
- EXISTING RESIDENCE (APPROX.)
- PROPOSED RESIDENCE
- WETLAND LIMIT (APPROX.)
- EXISTING LOT LINES
- PROPOSED LOT LINE
- SUBDIVISION BOUNDRY
- EXISTING ROAD (GRAVEL)
- PROPOSED ROAD (GRAVEL)
- ROADSIDE DITCHES

NOTES:

- NO NEW CONSTRUCTION; BUILDINGS, BARNS, FENCES, DRIVEWAYS, AND/OR LANDSCAPING, SHALL BE INSTALLED IN ANY EXISTING DRAINAGEWAY AND/OR SWALE SO AS TO IMPEDE THE FLOW OF STORM WATER RUNOFF.
- TRACT AREAS:
  TRACT A = 0.598 acres
  TRACT B = 2.093 acres

NOT FOR CONSTRUCTION:

THESE PLANS ARE INTENDED FOR SUBMITTAL, REVIEW AND APPROVAL BY COUNTY PLANNING DEPARTMENTS AND SHOULD NOT BE USED ON SITE FOR CONSTRUCTION OR LAYOUT.

CALL BEFORE YOU DIG ...

DIAL 811

48 HOURS BEFORE YOU DIG, CALL UTILITY LOCATORS FOR LOCATING AND MARKING GAS, ELECTRIC, WATER AND WASTEWATER

No.	Description	By	Date
1	REV PER COUNTY COMMENTS	DAS	10/19/21
2	LOT REVISIONS	DAS	02/16/22
3			

REVISIONS

H Scale: 1" = 200'
V Scale:
Designed By: KH
Drawn By: TLC
Checked By: KH
Date: 3/23/2020

Land Development Consultants, Inc.
Planning · Landscape Architecture
Engineering · Surveying
www.ldc-inc.com · TEL: (719) 528-6133 · FAX: (719) 528-6848
2890 Scenedripity Circle West · Colorado Springs, CO 80917

DRAINAGE MAP
DIDLEAU SUBDIVISON
FOREST HEIGHT ESTATES

Project Number: 18070

Sheet: 1 of 1

F:\18000\18070-Didleau property\2022 ENGINEERING\18070 FOREST HEIGHTS DRAINAGE MAP 040122.DWG

Didleau Subdivision
FINAL DRAINAGE REPORT
Existing Conditions
(Area Drainage Summary)

From Area Runoff Coefficient Summary				*OVERLAND*				*SHALLOW CHANNEL FLOW*				*Time of Travel (T_t)*	*INTENSITY **		*TOTAL FLOWS*	
BASIN	**AREA TOTAL**	**C_5**	**C_{100}**	**C_5**	**Length**	**Height**	**T_C**	**Length**	**Slope**	**Velocity**	**T_t**	**TOTAL**	**I_5**	**I_{100}**	**Q_5**	**Q_{100}**
	(Acres)				*(ft)*	*(ft)*	*(min)*	*(ft)*	*(%)*	*(fps)*	*(min)*	*(min)*	*(in/hr)*	*(in/hr)*	*(c.f.s.)*	*(c.f.s.)*
A	17.40	0.09	0.35	0.09	300	20	17.0	1100	4.5%	1.1	17.3	34.2	2.3	3.8	*3.4*	*23.6*
B	20.80	0.09	0.36	0.09	200	14	13.6	1200	4.2%	1.0	19.5	33.1	2.3	3.9	*4.4*	*29.1*
C	3.90	0.11	0.37	0.11	100	6	9.9	550	5.5%	1.2	7.8	17.8	3.3	5.5	*1.4*	*7.9*
D	7.50	0.10	0.36	0.10	200	16	12.9	500	6.0%	1.2	6.8	19.7	3.1	5.2	*2.3*	*14.3*
E	2.30	0.12	0.38	0.12	100	4	11.1	350	4.0%	1.0	5.8	17.0	3.3	5.6	*1.0*	*4.9*
F	18.70	0.08	0.35	0.08	300	10	21.4	1500	4.7%	1.1	23.1	44.5	1.9	3.2	*2.8*	*20.7*
G	9.90	0.09	0.36	0.09	1	0.5	0.5	1100	3.1%	0.9	20.8	21.3	3.0	5.0	*2.7*	*17.8*
H	23.30	0.09	0.36	0.09	1	0.5	0.5	1600	3.1%	0.9	30.3	30.8	2.4	4.1	*5.3*	*34.3*
I	5.70	0.11	0.37	0.11	1	0.1	0.8	600	3.3%	0.9	11.0	11.8	3.9	6.5	*2.4*	*13.7*
J	3.40	0.08	0.35	0.08	150	10	12.1	200	6.0%	1.2	2.7	14.8	3.5	5.9	*1.0*	*7.1*

Calculated by: Ken H
Date: 10/4/2021
Checked by: _____

Didleau Subdivision
Drainage Calculations
Existing Conditions
(Area Runoff Coefficient Summary)

		Forest Heights Drive			*DEVELOPED LOTS*			*NATURAL*			*RUNOFF COEFFICIENT*	
BASIN	**TOTAL AREA** *(Acres)*	**AREA** *(Acres)*	C_5	C_{100}	**AREA** *(Acres)*	C_5	C_{100}	**AREA** *(Acres)*	C_5	C_{100}	C_5	C_{100}
A	17.40	0.20	0.59	0.70	0.00	0.38	0.57	17.20	0.08	0.35	***0.09***	***0.35***
B	20.80	0.40	0.59	0.70	0.00	0.38	0.57	20.40	0.08	0.35	***0.09***	***0.36***
C	3.90	0.20	0.59	0.70	0.00	0.38	0.57	3.70	0.08	0.35	***0.11***	***0.37***
D	7.50	0.30	0.59	0.70	0.00	0.38	0.57	7.20	0.08	0.35	***0.10***	***0.36***
E	2.30	0.20	0.59	0.70	0.00	0.38	0.57	2.10	0.08	0.35	***0.12***	***0.38***
F	18.70	0.00	0.59	0.70	0.00	0.38	0.57	18.70	0.08	0.35	***0.08***	***0.35***
G	9.90	0.20	0.59	0.70	0.00	0.38	0.57	9.70	0.08	0.35	***0.09***	***0.36***
H	23.30	0.60	0.59	0.70	0.00	0.38	0.57	22.70	0.08	0.35	***0.09***	***0.36***
I	5.70	0.30	0.59	0.70	0.00	0.38	0.57	5.40	0.08	0.35	***0.11***	***0.37***
J	3.40	0.00	0.59	0.70	0.00	0.38	0.57	3.40	0.08	0.35	***0.08***	***0.35***

Didleau Subdivision
Drainage Calculations
Developed Conditions
(Area Runoff Coefficient Summary)

		Forest Heights Drive			*DEVELOPED LOTS*			*NATURAL*			*RUNOFF COEFFICIENT*	
BASIN	**TOTAL AREA** *(Acres)*	**AREA** *(Acres)*	C_5	C_{100}	**AREA** *(Acres)*	C_5	C_{100}	**AREA** *(Acres)*	C_5	C_{100}	C_5	C_{100}
A	17.40	0.20	0.59	0.70	1.50	0.16	0.41	15.70	0.08	0.35	***0.09***	***0.36***
B	20.80	0.40	0.59	0.70	1.50	0.16	0.41	18.90	0.08	0.35	***0.10***	***0.36***
C	3.90	0.20	0.59	0.70	1.50	0.16	0.41	2.20	0.08	0.35	***0.14***	***0.39***
D	7.50	0.30	0.59	0.70	1.50	0.16	0.41	5.70	0.08	0.35	***0.12***	***0.38***
E	2.30	0.20	0.59	0.70	1.50	0.16	0.41	0.60	0.08	0.35	***0.18***	***0.42***
F	18.70	0.00	0.59	0.70	1.50	0.16	0.41	17.20	0.08	0.35	***0.09***	***0.35***
G	9.90	0.20	0.59	0.70	1.50	0.16	0.41	8.20	0.08	0.35	***0.10***	***0.37***
H	23.30	0.60	0.59	0.70	1.50	0.16	0.41	21.20	0.08	0.35	***0.10***	***0.36***
I	5.70	0.30	0.59	0.70	1.50	0.16	0.41	3.90	0.08	0.35	***0.13***	***0.38***
J	3.40	0.00	0.59	0.70	0.00	0.16	0.41	3.40	0.08	0.35	***0.08***	***0.35***
Rd swale 13	0.71	0.23	0.59	0.70	0.00	0.16	0.41	0.48	0.08	0.35	***0.25***	***0.46***
Rd swale 14	0.41	0.06	0.59	0.70	0.00	0.16	0.41	0.06	0.08	0.35	***0.10***	***0.16***
Rdswale 15	0.27	0.13	0.59	0.70	0.00	0.16	0.41	0.14	0.08	0.35	***0.33***	***0.52***
Rdswale 16	3.75	0.24	0.59	0.70	0.00	0.16	0.41	3.51	0.08	0.35	***0.11***	***0.37***
Rdswale 17	0.35	0.06	0.59	0.70	0.00	0.16	0.41	0.29	0.08	0.35	***0.17***	***0.41***

Basin Summary

Basin I.D.	Area	Runoff Coefficients (existing)		Runoff Coefficients (developed)		Existing Runoff		Developed Runoff	
						Q5	Q100	Q5	Q100
	(acres)	C5	C100	C5	C100	cfs	cfs	cfs	cfs
A	17.4	0.09	0.35	0.09	0.36	3.4	23.6	3.7	24
B	20.8	0.09	0.35	0.1	0.36	4.4	29.1	4.6	29.5
C	3.9	0.11	0.37	0.14	0.39	1.4	7.9	1.8	8.4
D	7.5	0.1	0.36	0.12	0.38	2.3	14.3	2.7	14.8
E	2.3	0.12	0.38	0.18	0.42	1	4.9	1.4	5.5
F	18.7	0.08	0.35	0.09	0.35	2	0.7	3.1	21.1
G	9.9	0.09	0.36	0.1	0.37	2.7	17.8	3	18.2
H	23.3	0.09	0.36	0.1	0.36	5.3	34.3	5.6	34.7
I	5.7	0.11	0.37	0.13	0.38	2.4	13.7	2.8	14.3
J	3.4	0.08	0.35	0.08	0.35	1	7.1	1	7.1
Swale 13 area	small portion of subbasin H	NA	NA	0.25	0.46	NA	NA	0.9	2.9
Swale 14 area	small portion of subbasin B	NA	NA	0.1	0.16	NA	NA	0.2	0.6
Swale 15 area	portion of subbasin C	NA	NA	0.33	0.52	NA	NA	0.4	1.2
Swale 16 area	small portion of subbasin D	NA	NA	0.11	0.37	NA	NA	2.2	12.1
Swale 17 area	small portion of subbasin D	NA	NA	0.17	0.41	NA	NA	0.3	1.3

Design Point Summary

Developed Conditions

Design Pnt	Contrib Sub basins	Area (acres)	Q5 (cfs)	Q100 (cfs)
1	Easterly End of Existing Cul-de-sac			
2	A	17.4	3.7	24
3	High Point between A & B			
4	B	20.8	4.6	29.5
5	C	3.9	1.8	8.4
6	Ridgeline intersection between C & D			
7	C, D, E	13.7	5.9	28.7
8	High Point along Herring Road			
9	E	2.3	1.4	5.5
10	D,E	9.8	4.1	20.1
11	B,C,D,E,H,I	63.5	17.9	117.9
12	J	3.4	1	7.1
13	F	18.7	3.1	21.1
14	A,G	27.3	6.7	41.4
15	A,F,G	46	9.8	63.3

KCH Engineering Solutions
5228 Cracker Barrel Circle
Colorado Springs, CO 80917
(719) 246-4471

JOB Dipleo Subdivision
SHEET NO. 1 OF
CALCULATED BY K. Harrison DATE 2/10/2025
CHECKED BY DATE
SCALE

Developed Conditions

A. Area

Typical area of disturbance Per 5 acres tract = 1.5 acres
= 65,340 S.F

Typical Roof area = 2800 S.F

Landscaping/Lawn = 3/4 acre = 32,670 S.F

Driveway (Gravel) = 20' * 200' = 4000 S.F

B Runoff Coefficients (per 1.5 acre developed area)

	5 yr	100 yr	Area
Roof Area	0.73	0.81	2800 S.F
Landscaping/Lawn	0.12	0.39	32,670 S.F
Driveway (gravel)	0.59	0.70	4,000 S.F
Natural	0.08	0.35	25,870 S.F
Composite "C"	0.16	0.41	

Didleau Subdivision
FINAL DRAINAGE REPORT
Developed Conditions
(Area Drainage Summary)

From Area Runoff Coefficient Summary				*OVERLAND*				*SHALLOW CHANNEL FLOW*				*Time of Travel (T_t)*	*INTENSITY **		*TOTAL FLOWS*	
BASIN	**AREA TOTAL**	**C_5**	**C_{100}**	**C_5**	**Length**	**Height**	**T_C**	**Length**	**Slope**	**Velocity**	**T_t**	**TOTAL**	**I_5**	**I_{100}**	**Q_5**	**Q_{100}**
	(Acres)	REF, DCM Table 6.6			*(ft)*	*(ft)*	*(min)*	*(ft)*	*(%)*	*(fps)*	*(min)*	*(min)*	*(in/hr)*	*(in/hr)*	*(c.f.s.)*	*(c.f.s.)*
A	17.40	0.09	0.36	0.09	300	20	16.8	1100	4.5%	1.1	17.3	34.1	2.3	3.8	*3.7*	*24.0*
B	20.80	0.10	0.36	0.10	200	14	13.5	1200	4.2%	1.0	19.5	33.0	2.3	3.9	*4.6*	*29.5*
C	3.90	0.14	0.39	0.14	100	6	9.6	550	5.5%	1.2	7.8	17.4	3.3	5.5	*1.8*	*8.4*
D	7.50	0.12	0.38	0.12	200	16	12.6	500	6.0%	1.2	6.8	19.4	3.1	5.3	*2.7*	*14.8*
E	2.30	0.18	0.42	0.18	100	4	10.6	350	4.0%	1.0	5.8	16.4	3.4	5.7	*1.4*	*5.5*
F	18.70	0.09	0.35	0.09	300	10	21.3	1500	4.7%	1.1	23.1	44.4	1.9	3.2	*3.1*	*21.1*
G	9.90	0.10	0.37	0.10	1	0.5	0.5	1100	3.1%	0.9	20.8	21.3	3.0	5.0	*3.0*	*18.2*
H	23.30	0.10	0.36	0.10	1	0.5	0.5	1600	3.1%	0.9	30.3	30.8	2.4	4.1	*5.6*	*34.7*
I	5.70	0.13	0.38	0.13	1	0.1	0.8	600	3.3%	0.9	11.0	11.8	3.9	6.5	*2.8*	*14.3*
J	3.40	0.08	0.35	0.08	150	10	12.1	200	6.0%	1.2	2.7	14.8	3.5	5.9	*1.0*	*7.1*
Rd swale 13	0.71	0.25	0.46	0.25			#DIV/0!			0.0	#DIV/0!	5.0	5.2	8.7	*0.9*	*2.9*
Rd swale 14	0.41	0.10	0.16	0.10			#DIV/0!			0.0	#DIV/0!	5.0	5.2	8.7	*0.2*	*0.6*
Rdswale 15	0.27	0.33	0.52	0.33			#DIV/0!			0.0	#DIV/0!	5.0	5.2	8.7	*0.4*	*1.2*
Rdswale 16	3.75	0.11	0.37	0.11			#DIV/0!			0.0	#DIV/0!	5.0	5.2	8.7	*2.2*	*12.1*
Rdswale 17	0.35	0.17	0.41	0.17			#DIV/0!			0.0	#DIV/0!	5.0	5.2	8.7	*0.3*	*1.3*

Checked by: _____

Exhibit 9:

Hydraulic Calculations

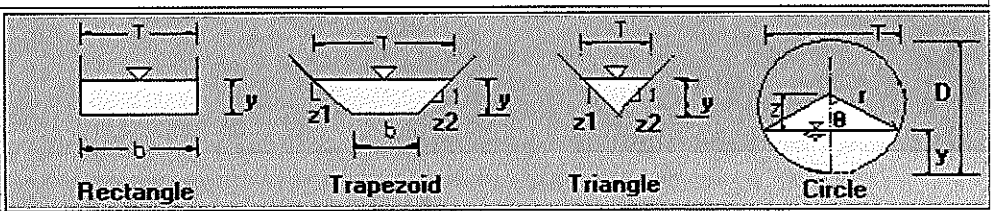
Swale Summary

Swale #	Contributing Subbasins	Slope	Design Flow		Depth of Flow		Velocity		Froude #	
			Q5	Q100	Q5	Q100	Q5	Q100		
		%	cfs	cfs	ft	ft	fps	fps	5 year	100 year
1	A	4.5	3.7	24.0	0.1	0.2	1.2	2.7	0.91	1.16
2	A,G .	3.1	5.7	36.1	0.1	0.3	1.5	2.9	0.84	1.02
3	B	4.6	4.6	29.5	0.1	0.3	1.8	3.7	1.04	1.26
4	B,H	3.3	10.2	64.2	0.1	0.2	1.4	2.9	0.87	1.06
5	C	5.5	1.8	8.4	0.1	0.1	1.3	2.4	1.00	1.20
6	D	6.0	4.1	20.3	0.1	0.2	1.9	3.5	1.18	1.37
7	Swale Ommitted for Drainage Plan									
8	C,D,E,I	3.3	8.7	43.8	0.1	0.3	1.8	3.1	0.91	1.06
9	Swale Ommitted for Drainage Plan									
10	F	5.3	3.1	21.1	0.1	0.3	1.7	3.4	1.09	1.30
11	J	3.1	1.0	7.1	0.0	0.1	0.6	1.4	0.70	0.86
12	A,G,F	6.1	9.8	63.3\	0.1	0.3	2.2	4.9	1.20	1.70
13	Portions of area H adjacent to road	6.9	0.9	2.9	0.1	0.2	3.2	4.5	1.83	1.98
14	Small portion of area B	2.1	0.2	0.6	0.1	0.1	1.3	1.8	0.90	1.00
15	Portions of areas C, D	4.4	0.4	1.2	0.1	0.2	2.1	3.1	1.37	1.50
16	Portions of areas C, D adjacent to road	3.0	2.2	12.1	0.2	0.5	3.1	5.0	1.34	1.49
17	Small portions of areas E, D	0.6	0.3	1.3	0.1	0.3	1.0	1.5	0.53	0.60

Swale 1
5 yr

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

Channel slope: .045 ft/ft	Water depth(y): 0.06 ft	Bottom width(b) 50 ft
Flow velocity 1.236688 ft/s	LeftSlope (Z1): 15 to 1 (H:V)	RightSlope (Z2): 15 to 1 (H:V)
Flow discharge 3.7 ft^3/s	Input n value 0.035 or select n: clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 51.77 ft	Flow area 2.99 ft^2	Top width(T) 51.76 ft
Specific energy 0.08 ft	Froude number 0.91	Flow status: Subcritical flow
Critical depth 0.06 ft	Critical slope 0.038 ft/ft	Velocity head 0.02 ft

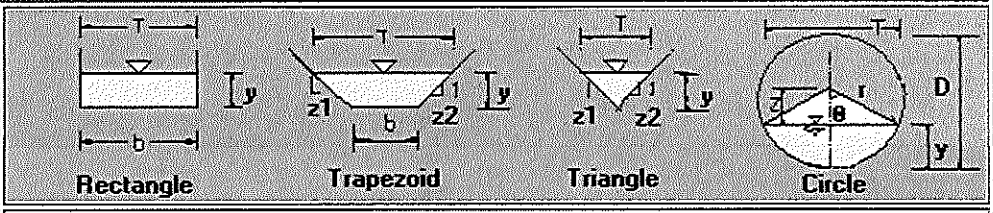
Contributing Basins

A 3.7 cfs 24.0 cfs

Swale 1
100yr

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

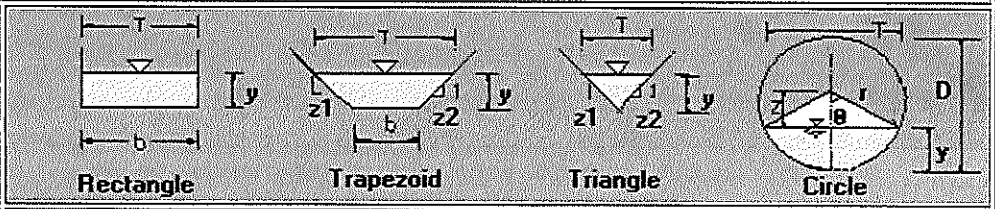
Select unit system: Feet(ft)

Channel slope: .045 ft/ft	Water depth(y): 0.17 ft	Bottom width(b) 50 ft
Flow velocity 2.66188 ft/s	LeftSlope (Z1): 15 to 1 (H:V)	RightSlope (Z2): 15 to 1 (H:V)
Flow discharge 24 ft^3/s	Input n value 0.035 or select n: clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 55.16 ft	Flow area 9.02 ft^2	Top width(T) 55.15 ft
Specific energy 0.28 ft	Froude number 1.16	Flow status: Supercritical flow
Critical depth 0.19 ft	Critical slope 0.0305 ft/ft	Velocity head 0.11 ft

Swale #2
2yr

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

Channel slope: 0.031 ft/ft	Water depth(y): 0.1 ft	Bottom width(b) 35 ft
Flow velocity 1.474312 ft/s	LeftSlope (Z1): 25 to 1 (H:V)	RightSlope (Z2): 25 to 1 (H:V)
Flow discharge 5.7 ft^3/s	Input n value .035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 40.15 ft	Flow area 3.87 ft^2	Top width(T) 40.15 ft
Specific energy 0.14 ft	Froude number 0.84	Flow status Subcritical flow
Critical depth 0.09 ft	Critical slope 0.0383 ft/ft	Velocity head 0.03 ft

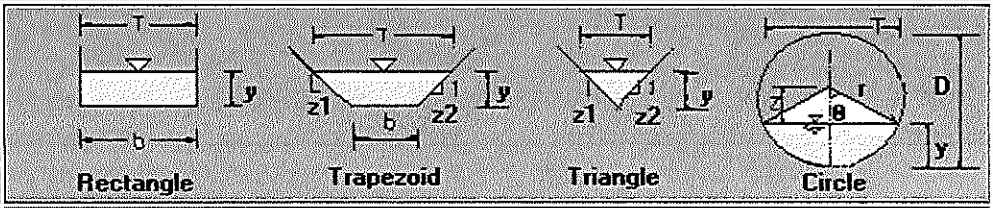
Subbasin

A	3.7	24.6
Q	$3^{2/3}$	$18.2\ (^{2}/_{3})$
	5.7	36.1

Swale #2
1990's

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

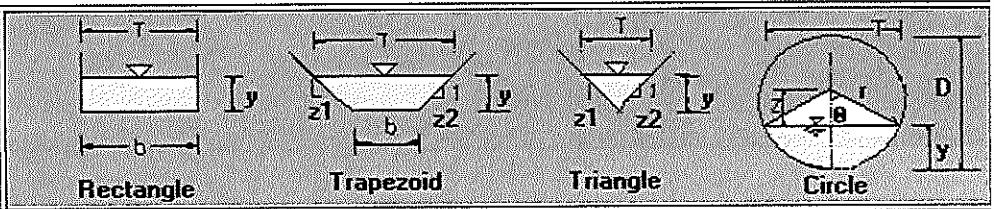
Select unit system: Feet(ft)

Channel slope: 0.031 ft/ft	Water depth(y): 0.29 ft	Bottom width(b) 35 ft
Flow velocity 2.899389 ft/s	LeftSlope (Z1): 25 to 1 (H:V)	RightSlope (Z2): 25 to 1 (H:V)
Flow discharge 36.1 ft^3/s	Input n value .035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 49.71 ft	Flow area 12.45 ft^2	Top width(T) 49.7 ft
Specific energy 0.42 ft	Froude number 1.02	Flow status Supercritical flow
Critical depth 0.3 ft	Critical slope 0.0279 ft/ft	Velocity head 0.13 ft

Swale 3
5yr

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

Channel slope: .046 ft/ft	Water depth(y): 0.1 ft	Bottom width(b) 25 ft
Flow velocity 1.806727 ft/s	LeftSlope (Z1): 10 to 1 (H:V)	RightSlope (Z2): 10 to 1 (H:V)
Flow discharge 4.6 ft^3/s	Input n value 0.035 or select n: clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 26.97 ft	Flow area 2.55 ft^2	Top width(T) 26.96 ft
Specific energy 0.15 ft	Froude number 1.04	Flow status: Supercritical flow
Critical depth 0.1 ft	Critical slope 0.0358 ft/ft	Velocity head 0.05 ft

Contributing Basins

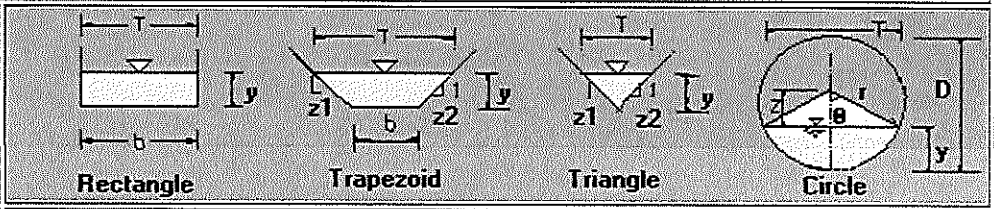
B 4.6 29.5

Swale 3

100 year

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

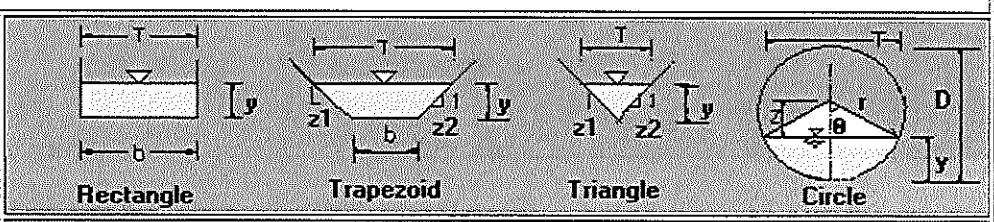
Select unit system: Feet(ft)

Channel slope: .046 ft/ft	Water depth(y): 0.29 ft	Bottom width(b) 25 ft
Flow velocity 3.658557 ft/s	LeftSlope (Z1): 10 to 1 (H:V)	RightSlope (Z2): 10 to 1 (H:V)
Flow discharge 29.5 ft^3/s	Input n value 0.035 or select n: clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 30.81 ft	Flow area 8.06 ft^2	Top width(T) 30.78 ft
Specific energy 0.5 ft	Froude number 1.26	Flow status: Supercritical flow
Critical depth 0.34 ft	Critical slope 0.0259 ft/ft	Velocity head 0.21 ft

Swale 4
5yr

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q | Select unit system: Feet(ft)

Channel slope: .033 ft/ft	Water depth(y): 0.08 ft	Bottom width(b) 85 ft
Flow velocity 1.406126 ft/s	LeftSlope (Z1): 25 to 1 (H:V)	RightSlope (Z2): 25 to 1 (H:V)
Flow discharge 10.2 ft^3/s	Input n value .035 or select n: clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 89.17 ft	Flow area 7.25 ft^2	Top width(T) 89.17 ft
Specific energy 0.11 ft	Froude number 0.87	Flow status: Subcritical flow
Critical depth 0.08 ft	Critical slope 0.0381 ft/ft	Velocity head 0.03 ft

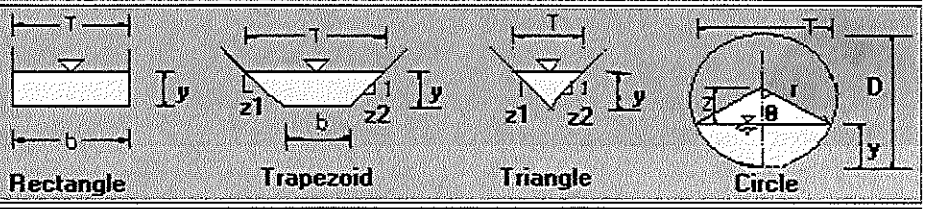
Contributing Basins

B	4.6	29.5
H	5.6	34.7
	10.2	64.2

Swale 4
100 year

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

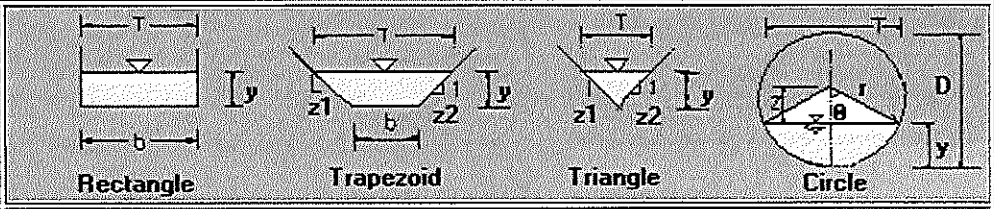
Channel slope: .033 ft/ft	Water depth(y): 0.24 ft	Bottom width(b) 85 ft
Flow velocity 2.875619 ft/s	LeftSlope (Z1): 25 to 1 (H:V)	RightSlope (Z2): 25 to 1 (H:V)
Flow discharge 64.2 ft^3/s	Input n value .035 or select n: clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 97.26 ft	Flow area 22.33 ft^2	Top width(T) 97.25 ft
Specific energy 0.37 ft	Froude number 1.06	Flow status: Supercritical flow
Critical depth 0.25 ft	Critical slope 0.0286 ft/ft	Velocity head 0.13 ft

Slide 5

5yr

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

Channel slope: .055 ft/ft	Water depth(y): 0.05 ft	Bottom width(b) 25 ft
Flow velocity 1.307615 ft/s	LeftSlope (Z1): 10 to 1 (H:V)	RightSlope (Z2): 10 to 1 (H:V)
Flow discharge 1.8 ft^3/s	Input n value .035 or select n: clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 26.08 ft	Flow area 1.38 ft^2	Top width(T) 26.08 ft
Specific energy 0.08 ft	Froude number 1	Flow status: Critical flow
Critical depth 0.06 ft	Critical slope 0.0358 ft/ft	Velocity head 0.03 ft

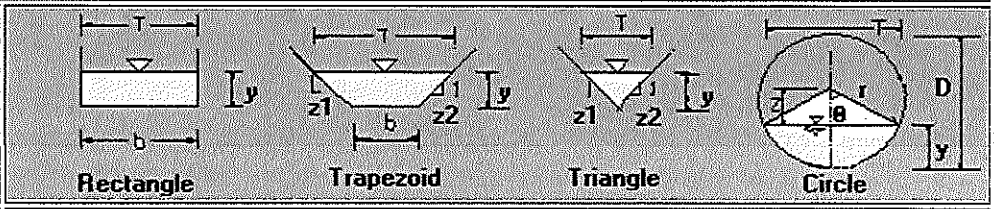
Subbasin

C 1.8 8.4

Swale 5
100yr

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

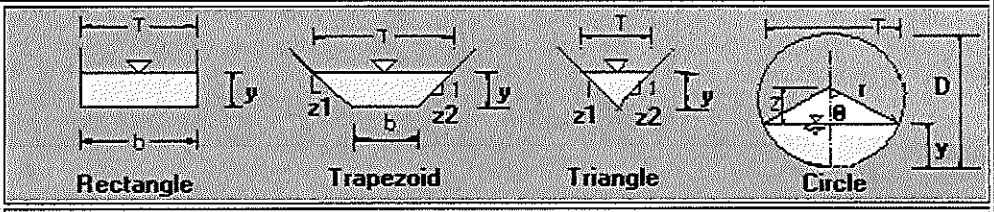
Select unit system: Feet(ft)

Channel slope: .055 ft/ft	Water depth(y): 0.13 ft	Bottom width(b) 25 ft
Flow velocity 2.412038 ft/s	LeftSlope (Z1): 10 to 1 (H:V)	RightSlope (Z2): 10 to 1 (H:V)
Flow discharge 8.4 ft^3/s	Input n value .035 or select n: clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 27.66 ft	Flow area 3.48 ft^2	Top width(T) 27.65 ft
Specific energy 0.22 ft	Froude number 1.2	Flow status: Supercritical flow
Critical depth 0.15 ft	Critical slope 0.0321 ft/ft	Velocity head 0.09 ft

Swale 6
5 year

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

Channel slope: .06 ft/ft	Water depth(y): 0.08 ft	Bottom width(b) 25 ft
Flow velocity 1.905303 ft/s	LeftSlope (Z1): 10 to 1 (H:V)	RightSlope (Z2): 10 to 1 (H:V)
Flow discharge 4.1 ft^3/s	Input n value .035 or select n: clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 26.67 ft	Flow area 2.15 ft^2	Top width(T) 26.67 ft
Specific energy 0.14 ft	Froude number 1.18	Flow status: Supercritical flow
Critical depth 0.09 ft	Critical slope 0.0398 ft/ft	Velocity head 0.06 ft

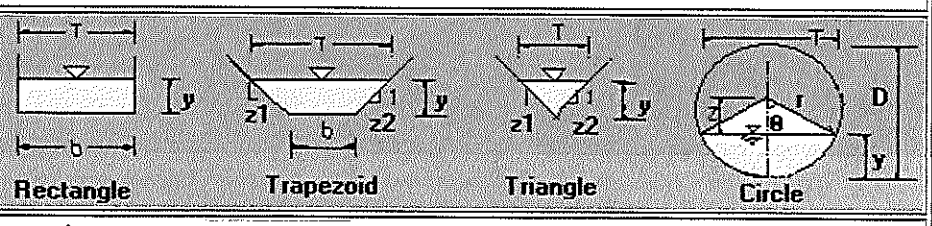
Subbasins

D	2.7	14.8
E	1.4	5.5
	4.1	20.3

Swale 6
100yr

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

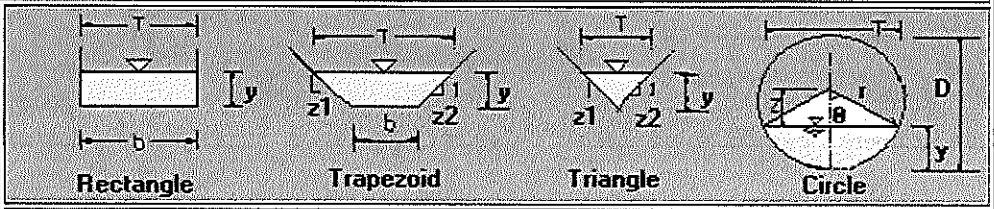
Select unit system: Feet(ft)

Channel slope: .06 ft/ft	Water depth(y): 0.22 ft	Bottom width(b) 25 ft
Flow velocity 3.467221 ft/s	LeftSlope (Z1): 10 to 1 (H:V)	RightSlope (Z2): 10 to 1 (H:V)
Flow discharge 20.3 ft^3/s	Input n value .035 or select n: clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 29.33 ft	Flow area 5.85 ft^2	Top width(T) 29.31 ft
Specific energy 0.4 ft	Froude number 1.37	Flow status: Supercritical flow
Critical depth 0.26 ft	Critical slope 0.0284 ft/ft	Velocity head 0.19 ft

Scale B

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q | Select unit system: Feet(ft)

Channel slope: .033 ft/ft	Water depth(y): 0.13 ft	Bottom width(b) 35 ft
Flow velocity 1.759025 ft/s	LeftSlope (Z1): 30 to 1 (H:V)	RightSlope (Z2): 30 to 1 (H:V)
Flow discharge 8.7 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 42.65 ft	Flow area 4.95 ft^2	Top width(T) 42.64 ft
Specific energy 0.18 ft	Froude number 0.91	Flow status Subcritical flow
Critical depth 0.12 ft	Critical slope 0.0347 ft/ft	Velocity head 0.05 ft

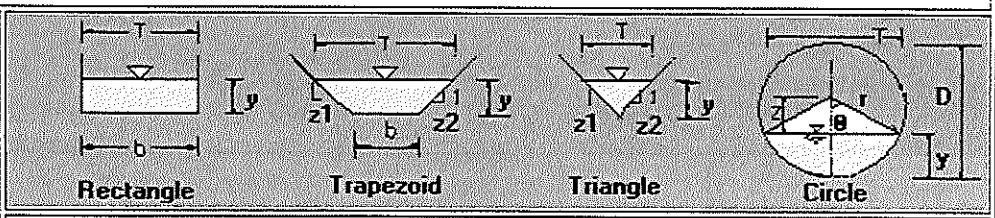
Basin

D	2.7	14.8
E	1.4	5.5
		~~8.1~~
C	1.8	8.4
I	2.8	14.3
	8.7	43.0

Swale 8
160 yds

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

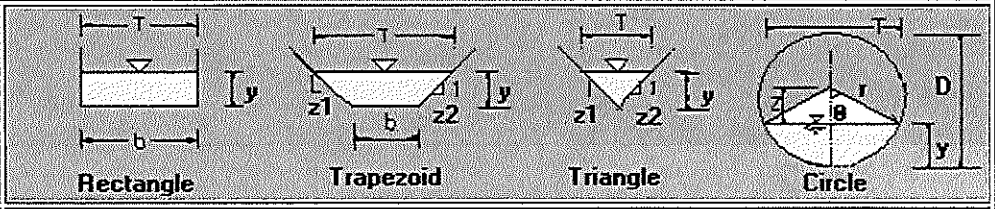
Channel slope: .033 ft/ft	Water depth(y): 0.32 ft	Bottom width(b) 35 ft
Flow velocity 3.086514 ft/s	LeftSlope (Z1): 30 to 1 (H:V)	RightSlope (Z2): 30 to 1 (H:V)
Flow discharge 43.8 ft^3/s	Input n value 0.035 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 54.12 ft	Flow area 14.19 ft^2	Top width(T) 54.11 ft
Specific energy 0.47 ft	Froude number 1.06	Flow status Supercritical flow
Critical depth 0.33 ft	Critical slope 0.0268 ft/ft	Velocity head 0.15 ft

Swale 16

The open channel flow calculator

5yr

Select Channel Type: Trapezoid



Depth from Q | Select unit system: Feet(ft)

Channel slope: .053 ft/ft	Water depth(y): 0.08 ft	Bottom width(b) 20 ft
Flow velocity 1.717663 ft/s	LeftSlope (Z1): 20 to 1 (H:V)	RightSlope (Z2): 20 to 1 (H:V)
Flow discharge 3.1 ft^3/s	Input n value .035 or select n: clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 23.34 ft	Flow area 1.8 ft^2	Top width(T) 23.33 ft
Specific energy 0.13 ft	Froude number 1.09	Flow status: Supercritical flow
Critical depth 0.09 ft	Critical slope 0.0409 ft/ft	Velocity head 0.05 ft

Basin

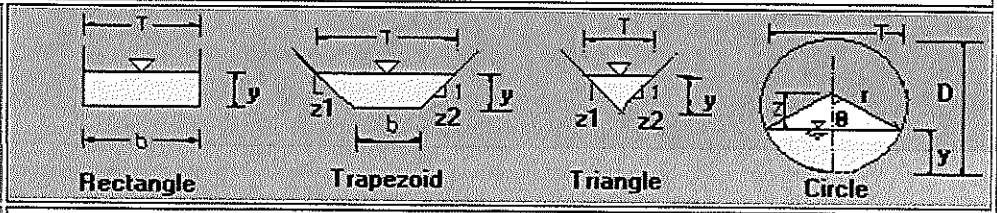
F 3.1 21.1

Swale 16

The open channel flow calculator

100yr

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

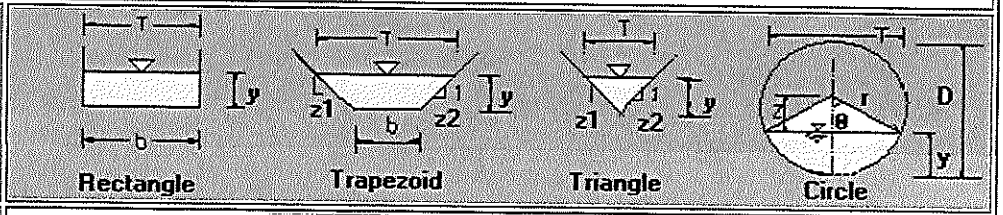
Channel slope: .053 ft/ft	Water depth(y): 0.25 ft	Bottom width(b) 20 ft
Flow velocity 3.377621 ft/s	LeftSlope (Z1): 20 to 1 (H:V)	RightSlope (Z2): 20 to 1 (H:V)
Flow discharge 21.1 ft^3/s	Input n value .035 or select n: clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 30.01 ft	Flow area 6.25 ft^2	Top width(T) 30 ft
Specific energy 0.43 ft	Froude number 1.3	Flow status: Supercritical flow
Critical depth 0.29 ft	Critical slope 0.0287 ft/ft	Velocity head 0.18 ft

Swale 11

The open channel flow calculator

5yr

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

Channel slope: .031 ft/ft	Water depth(y): 0.03 ft	Bottom width(b) 60 ft
Flow velocity 0.636886 ft/s	LeftSlope (Z1): 15 to 1 (H:V)	RightSlope (Z2): 15 to 1 (H:V)
Flow discharge 1.0 ft^3/s	Input n value .035 or select n: clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 60.78 ft	Flow area 1.57 ft^2	Top width(T) 60.78 ft
Specific energy 0.03 ft	Froude number 0.7	Flow status: Subcritical flow
Critical depth 0.02 ft	Critical slope 0.0601 ft/ft	Velocity head 0.01 ft

Basins

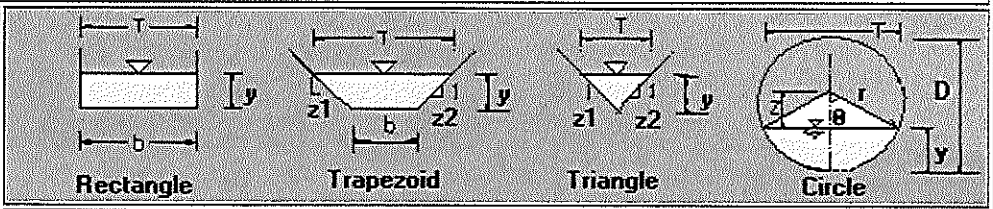
J 1.0 7.1

Swale 11

The open channel flow calculator

100 year

Select Channel Type: Trapezoid



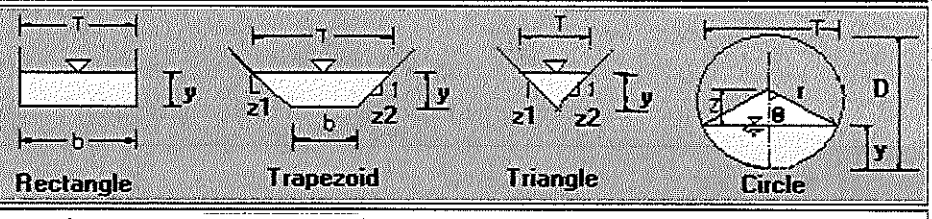
Depth from Q

Select unit system: Feet(ft)

Channel slope: .031 ft/ft	Water depth(y): 0.08 ft	Bottom width(b) 60 ft
Flow velocity 1.391588 ft/s	LeftSlope (Z1): 15 to 1 (H:V)	RightSlope (Z2): 15 to 1 (H:V)
Flow discharge 7.1 ft^3/s	Input n value .035 or select n: clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 62.5 ft	Flow area 5.1 ft^2	Top width(T) 62.5 ft
Specific energy 0.11 ft	Froude number 0.86	Flow status: Subcritical flow
Critical depth 0.08 ft	Critical slope 0.0372 ft/ft	Velocity head 0.03 ft

Swale 12

The open channel flow calculator

Select Channel Type: Trapezoid				
Depth from Q	Select unit system: Feet(ft)			
Channel slope: 0.061 ft/ft	Water depth(y): 0.11 ft		Bottom width(b) 40 ft	
Flow velocity 2.184422 ft/s	LeftSlope (Z1): 15 to 1 (H:V)		RightSlope (Z2): 15 to 1 (H:V)	
Flow discharge 9.8 ft^3/s	Input n value 0.035 or select n			
Calculate!	Status: Calculation finished		Reset	
Wetted perimeter 43.24 ft	Flow area 4.49 ft^2		Top width(T) 43.23 ft	
Specific energy 0.18 ft	Froude number 1.2		Flow status Supercritical flow	
Critical depth 0.12 ft	Critical slope 0.0353 ft/ft		Velocity head 0.07 ft	

Basins

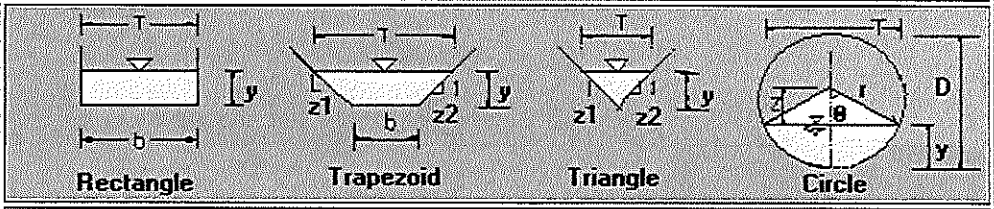
A	3.7	240
F	3.1	21.1
G	3.0	18.2
	9.8	63.3

Swale 12

The open channel flow calculator

100yr

Select Channel Type: Trapezoid



Depth from Q | Select unit system: Feet(ft)

Channel slope: .061 ft/ft	Water depth(y): 0.29 ft	Bottom width(b) 40 ft
Flow velocity 4.93849 ft/s	LeftSlope (Z1): 15 to 1 (H:V)	RightSlope (Z2): 15 to 1 (H:V)
Flow discharge 63.3 ft^3/s	Input n value .030 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 48.69 ft	Flow area 12.82 ft^2	Top width(T) 48.67 ft
Specific energy 0.67 ft	Froude number 1.7	Flow status Supercritical flow
Critical depth 0.41 ft	Critical slope 0.0182 ft/ft	Velocity head 0.38 ft

Basins

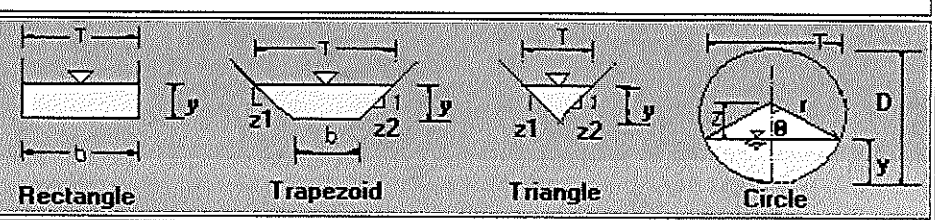
A	3.7	24.0
F	3.1	21.1
G	3.0	18.2
	9.8	63.3

Roadside Swale Roadside Swale Swale 13

The open channel flow calculator

8ft

Select Channel Type: Trapezoid



Depth from Q | Select unit system: Feet(ft)

Channel slope: 0.069 ft/ft	Water depth(y): 0.11 ft	Bottom width(b) 2 ft
Flow velocity 3.185212 ft/s	LeftSlope (Z1): 3 to 1 (H:V)	RightSlope (Z2): 6 to 1 (H:V)
Flow discharge 0.9 ft^3/s	Input n value ~~0.025~~ 0.035 or select n: clean,uncoated castiron:0.014	0.025
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 3.04 ft	Flow area 0.28 ft^2	Top width(T) 3.01 ft
Specific energy 0.27 ft	Froude number 1.83	Flow status: Supercritical flow
Critical depth 0.17 ft	Critical slope 0.0167 ft/ft	Velocity head 0.16 ft

Contributing Basins

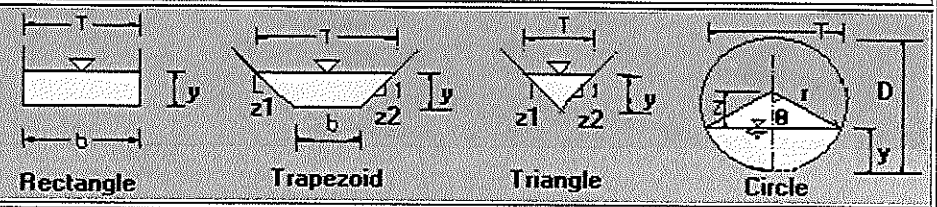
Roadside Swale

Swale 13

The open channel flow calculator

100yr

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

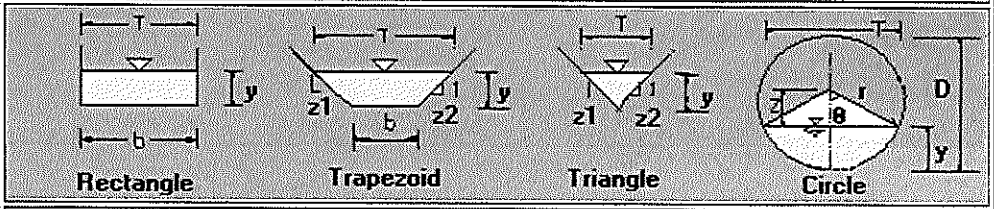
Channel slope: .069 ft/ft	Water depth(y): 0.22 ft	Bottom width(b) 2 ft
Flow velocity 4.528596 ft/s	LeftSlope (Z1): 3 to 1 (H:V)	RightSlope (Z2): 6 to 1 (H:V)
Flow discharge 2.9 ft^3/s	Input n value ~~0.025~~ .035 OK or select n .025 clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 3.99 ft	Flow area 0.64 ft^2	Top width(T) 3.94 ft
Specific energy 0.53 ft	Froude number 1.98	Flow status Supercritical flow
Critical depth 0.32 ft	Critical slope 0.0149 ft/ft	Velocity head 0.32 ft

Roadside Swale #14

The open channel flow calculator

5 year

Select Channel Type: Trapezoid



Depth from Q | Select unit system: Feet(ft)

Channel slope: 0.021 ft/ft	Water depth(y): 0.07 ft	Bottom width(b) 2 ft
Flow velocity 1.262811 ft/s	LeftSlope (Z1): 3 to 1 (H:V)	RightSlope (Z2): 6 to 1 (H:V)
Flow discharge 0.2 ft^3/s	Input n value ~~0.025~~ 0.025 or select n	0.025
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 2.63 ft	Flow area 0.16 ft^2	Top width(T) 2.62 ft
Specific energy 0.09 ft	Froude number 0.9	Flow status: Subcritical flow
Critical depth 0.07 ft	Critical slope 0.0192 ft/ft	Velocity head 0.02 ft

Contributing Basins

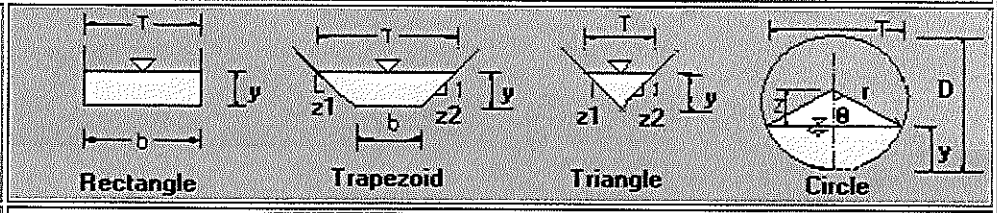
Swale 14

Roadside Swale

100 year

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q | Select unit system: Feet(ft)

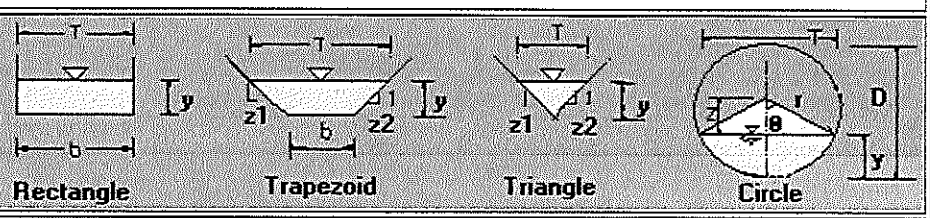
Channel slope: 0.021 ft/ft	Water depth(y): 0.13 ft	Bottom width(b) 2 ft
Flow velocity 1.83017 ft/s	LeftSlope (Z1): 3 to 1 (H:V)	RightSlope (Z2): 6 to 1 (H:V)
Flow discharge 0.6 ft^3/s	Input n value ~~0.025~~ 0.035 or select n 0.025	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 3.18 ft	Flow area 0.33 ft^2	Top width(T) 3.15 ft
Specific energy 0.18 ft	Froude number 1	Flow status Critical flow
Critical depth 0.13 ft	Critical slope 0.0196 ft/ft	Velocity head 0.05 ft

Roadside Swale #5

The open channel flow calculator

575

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

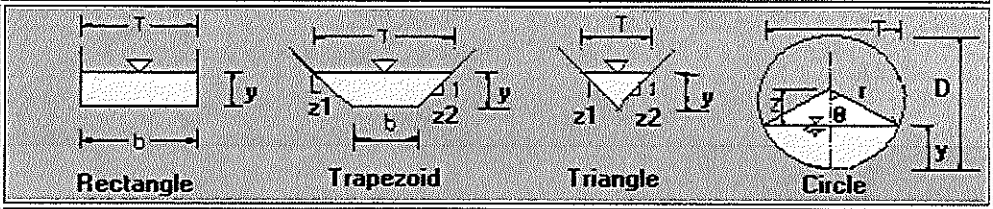
Channel slope: 0.044 ft/ft	Water depth(y): 0.08 ft	Bottom width(b) 2 ft
Flow velocity 2.134282 ft/s	LeftSlope (Z1): 3 to 1 (H:V)	RightSlope (Z2): 3 to 1 (H:V)
Flow discharge 0.4 ft^3/s	Input n value .025 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 2.53 ft	Flow area 0.19 ft^2	Top width(T) 2.5 ft
Specific energy 0.15 ft	Froude number 1.37	Flow status Supercritical flow
Critical depth 0.1 ft	Critical slope 0.02 ft/ft	Velocity head 0.07 ft

Roadside Swale #15

100 @ X5

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

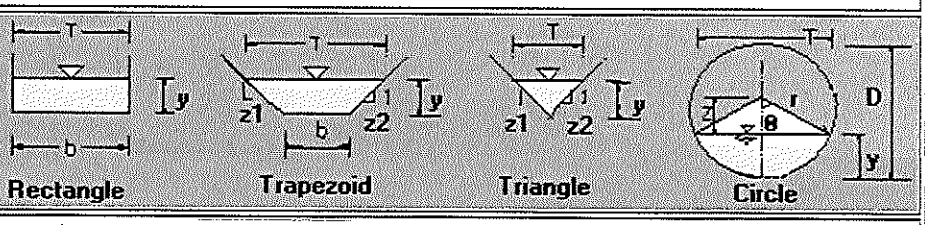
Select unit system: Feet(ft)

Channel slope: 0.044 ft/ft	Water depth(y): 0.16 ft	Bottom width(b) 2 ft
Flow velocity 3.097904 ft/s	LeftSlope (Z1): 3 to 1 (H:V)	RightSlope (Z2): 3 to 1 (H:V)
Flow discharge 1.2 ft^3/s	Input n value .025 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 2.99 ft	Flow area 0.39 ft^2	Top width(T) 2.94 ft
Specific energy 0.31 ft	Froude number 1.5	Flow status Supercritical flow
Critical depth 0.21 ft	Critical slope 0.0158 ft/ft	Velocity head 0.15 ft

Road side Swale — Swale 1b 5 year

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

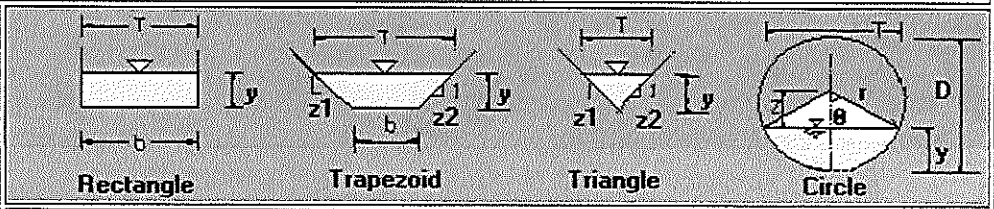
Channel slope: 0.03 ft/ft	Water depth(y): 0.23 ft	Bottom width(b) 2 ft
Flow velocity 3.146132 ft/s	LeftSlope (Z1): 3 to 1 (H:V)	RightSlope (Z2): 6 to 1 (H:V)
Flow discharge 2.2 ft^3/s	Input n value ~~0.025~~ .03 or select n 0.025 clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 4.13 ft	Flow area 0.7 ft^2	Top width(T) 4.07 ft
Specific energy 0.38 ft	Froude number 1.34	Flow status Supercritical flow
Critical depth 0.27 ft	Critical slope 0.0153 ft/ft	Velocity head 0.15 ft

Roadside Swale

Swale-16
100 years

The open channel flow calculator

Select Channel Type: Trapezoid



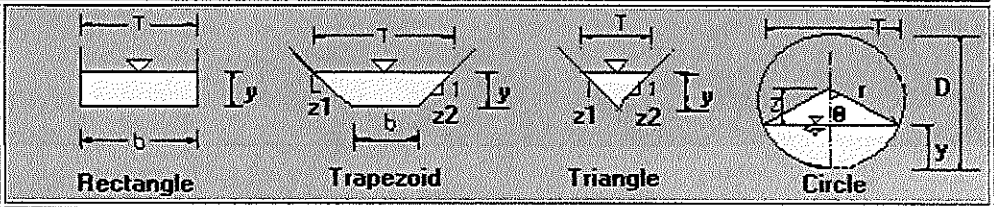
Depth from Q | Select unit system: Feet(ft)

Channel slope: 0.03 ft/ft	Water depth(y): 0.54 ft	Bottom width(b) 2 ft
Flow velocity 5.002 ft/s	LeftSlope (Z1): 3 to 1 (H:V)	RightSlope (Z2): 6 to 1 (H:V)
Flow discharge 12.1 ft^3/s	Input n value ~~0.025~~ or select n 0.025	clean,uncoated castiron:0.014
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 7.03 ft	Flow area 2.42 ft^2	Top width(T) 6.9 ft
Specific energy 0.93 ft	Froude number 1.49	Flow status Supercritical flow
Critical depth 0.67 ft	Critical slope 0.0123 ft/ft	Velocity head 0.39 ft

Roadside Swale Inside 5 year

The open channel flow calculator

Select Channel Type: Trapezoid



Depth from Q

Select unit system: Feet(ft)

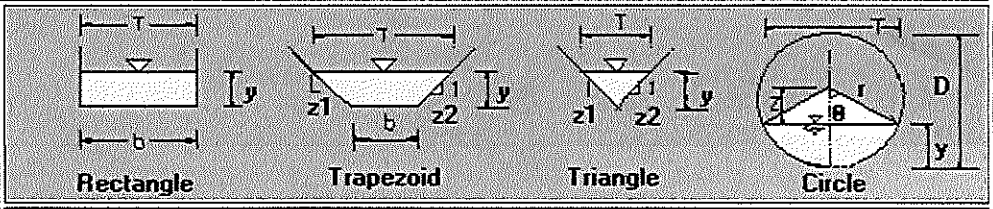
Channel slope: 0.006 ft/ft	Water depth(y): 0.12 ft	Bottom width(b) 2 ft
Flow velocity 0.959914 ft/s	LeftSlope (Z1): 3 to 1 (H:V)	RightSlope (Z2): 6 to 1 (H:V)
Flow discharge 0.3 ft^3/s	Input n value ~~0.025~~ 0.026 or select n clean,uncoated castiron:0.014	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 3.13 ft	Flow area 0.31 ft^2	Top width(T) 3.1 ft
Specific energy 0.14 ft	Froude number 0.53	Flow status: Subcritical flow
Critical depth 0.08 ft	Critical slope 0.022 ft/ft	Velocity head 0.01 ft

Roadside Swale Swale #17

The open channel flow calculator

100 year

Select Channel Type: Trapezoid



Depth from Q | Select unit system: Feet(ft)

Channel slope: 0.006 ft/ft	Water depth(y): 0.27 ft	Bottom width(b) 2 ft
Flow velocity 1.501439 ft/s	LeftSlope (Z1): 3 to 1 (H:V)	RightSlope (Z2): 6 to 1 (H:V)
Flow discharge 1.3 ft^3/s	Input n value ~~0.025~~ 0.035 or select n: clean,uncoated castiron:0.014	0.025
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 4.49 ft	Flow area 0.87 ft^2	Top width(T) 4.43 ft
Specific energy 0.3 ft	Froude number 0.6	Flow status: Subcritical flow
Critical depth 0.21 ft	Critical slope 0.0159 ft/ft	Velocity head 0.04 ft

Culvert Summary

Culvert #	Size	Material	Contributung subbasibs	5 Year		100 Year		Condition
				Q (cfs)	Headwater Required	Q (cfs)	Headwater Required	
1	18"	CMP	A	3.7	12.8"	24	>7.5 ft	75% silted, roadway overtopping with 100 yr
2	18"	CMP	B	4.6	15.3"	29.5	>9 ft	75% silted, roadway overtopping with 100 yr
3	18"	CMP	C,D,E	5.9	16.7"	28.7	>9 ft	75% silted, roadway overtopping with 100 yr
4	18"	CMP	A, B,C,D,E,H,I	20.8	6	124	>9ft	Private culvert under private drivewaay

Culvert Summary

Culvert #	Size	Material	Contributung subbasibs	5 Year		100 Year		Condition
				Q (cfs)	Headwater Required	Q (cfs)	Headwater Required	
1	18"	CMP	A	3.7	12.8"	24	>7.5 ft	75% silted, roadway overtopping with 100 yr
2	18"	CMP	B	4.6	15.3"	29.5	>9 ft	75% silted, roadway overtopping with 100 yr
3	18"	CMP	C,D,E	5.9	16.7"	28.7	>9 ft	75% silted, roadway overtopping with 100 yr
4	18"	CMP	A, B,C,D,E,H,I	20.8	6	124	>9ft	Private culvert under private drivewaay

KCH Engineering Solutions
5228 Cracker Barrel Circle
Colorado Springs, CO 80917
(719) 246-4471

JOB Culvert
SHEET NO. 1 OF
CALCULATED BY K. Harrison DATE
CHECKED BY DATE
SCALE

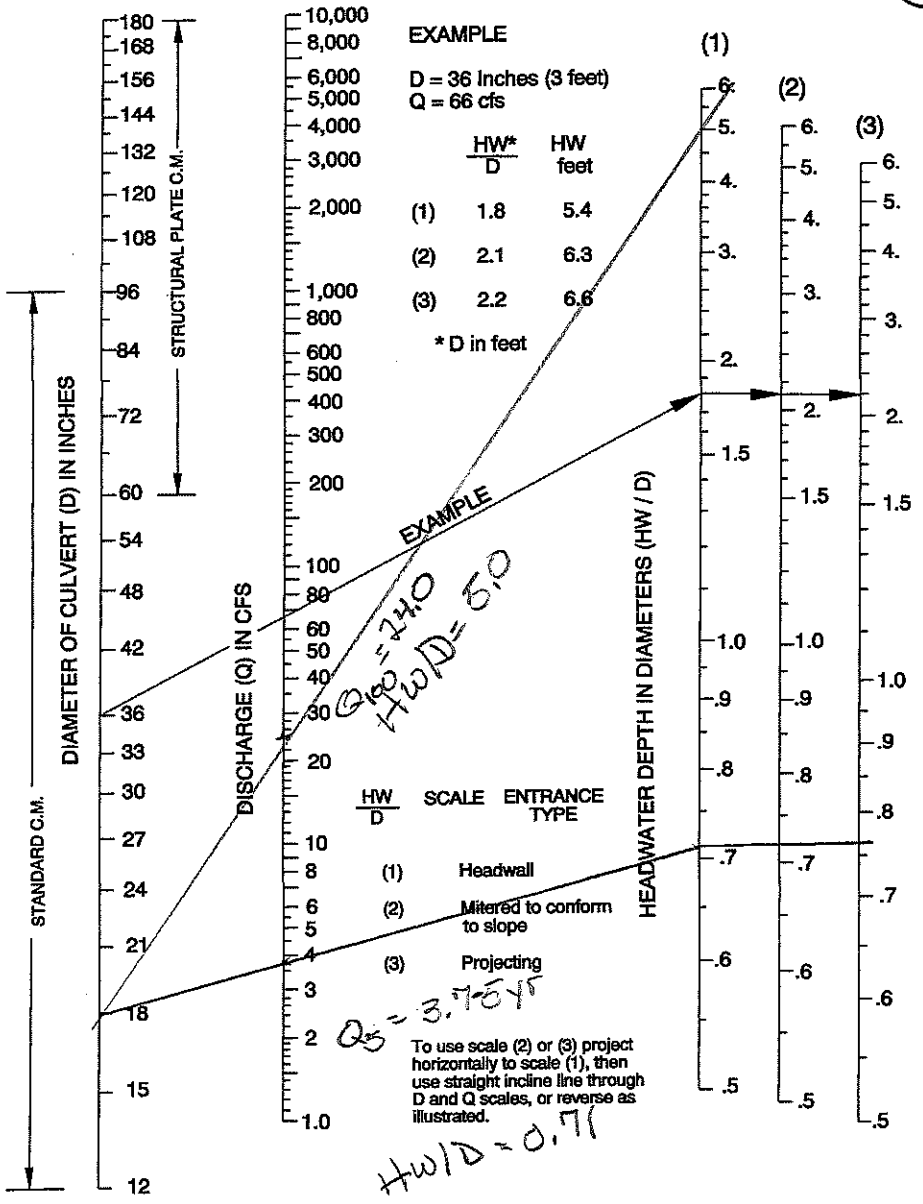
Culvert #	Subbasins	5yr	100yr
1	A	3.7	24.0
2	B	4.6	29.5
3	C	1.8	8.4
	D	2.7	14.8
	E	1.4	5.5
	Culv Total	5.9	28.7
4	A	3.7	24.0
	B	4.6	29.5
	C	1.8	8.4
	D	2.7	14.8
	E	1.4	5.5
	H	5.6	34.7
	I	1.0	7.1
		20.8	124

Culvert #1

$Q_5 = 8.7$ $Q_{100} = 24.0$

CHART 3

HEADWATER DEPTH FOR C.M. CULVERTS WITH INLET CONTROL



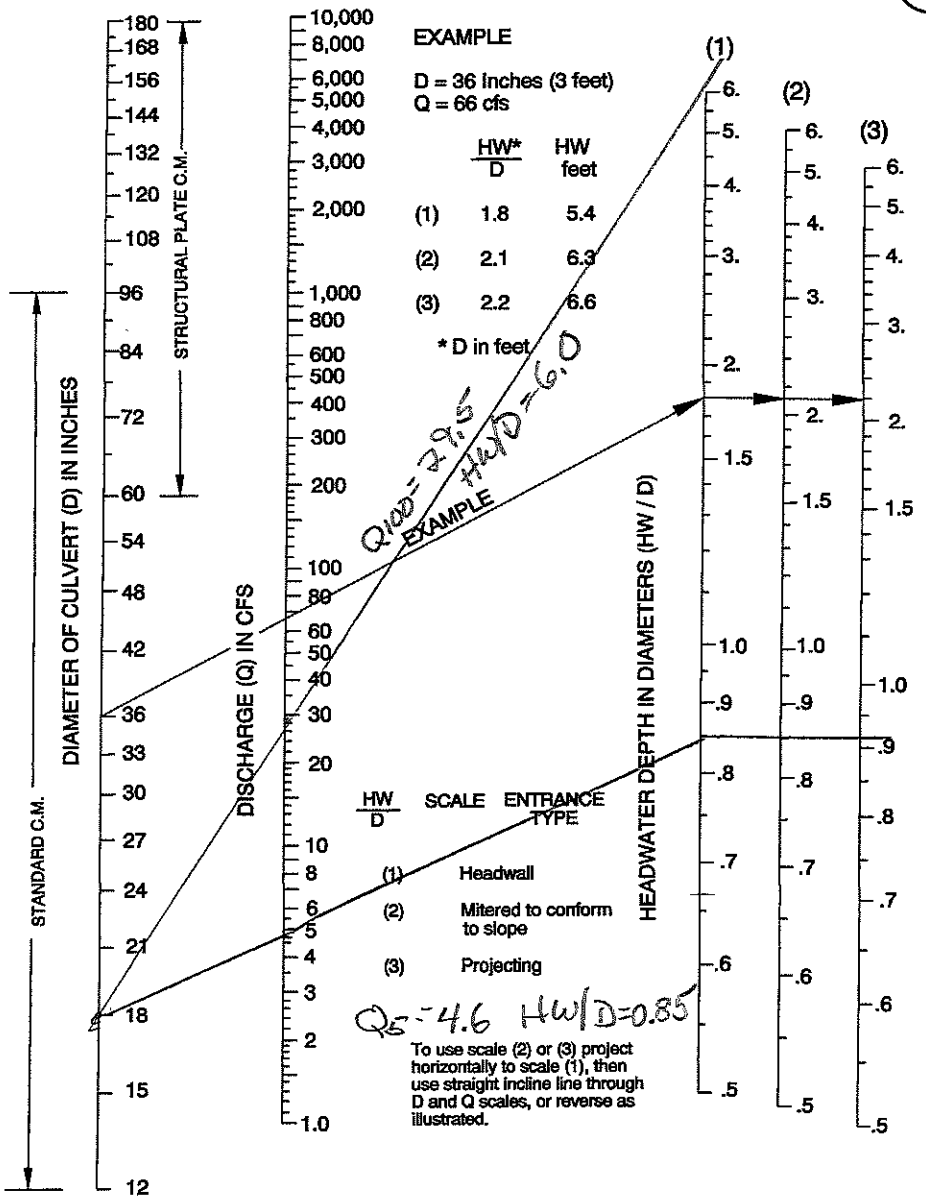
$Q_{100} = 24.0$ $HW/D = 5.0$

$Q_5 = 3.7$ $HW/D = 0.7$

Culvert #2
$Q_5 = 4.6$ cfs $Q_{100} = 29.5$

CHART 3

HEADWATER DEPTH FOR C.M. CULVERTS WITH INLET CONTROL

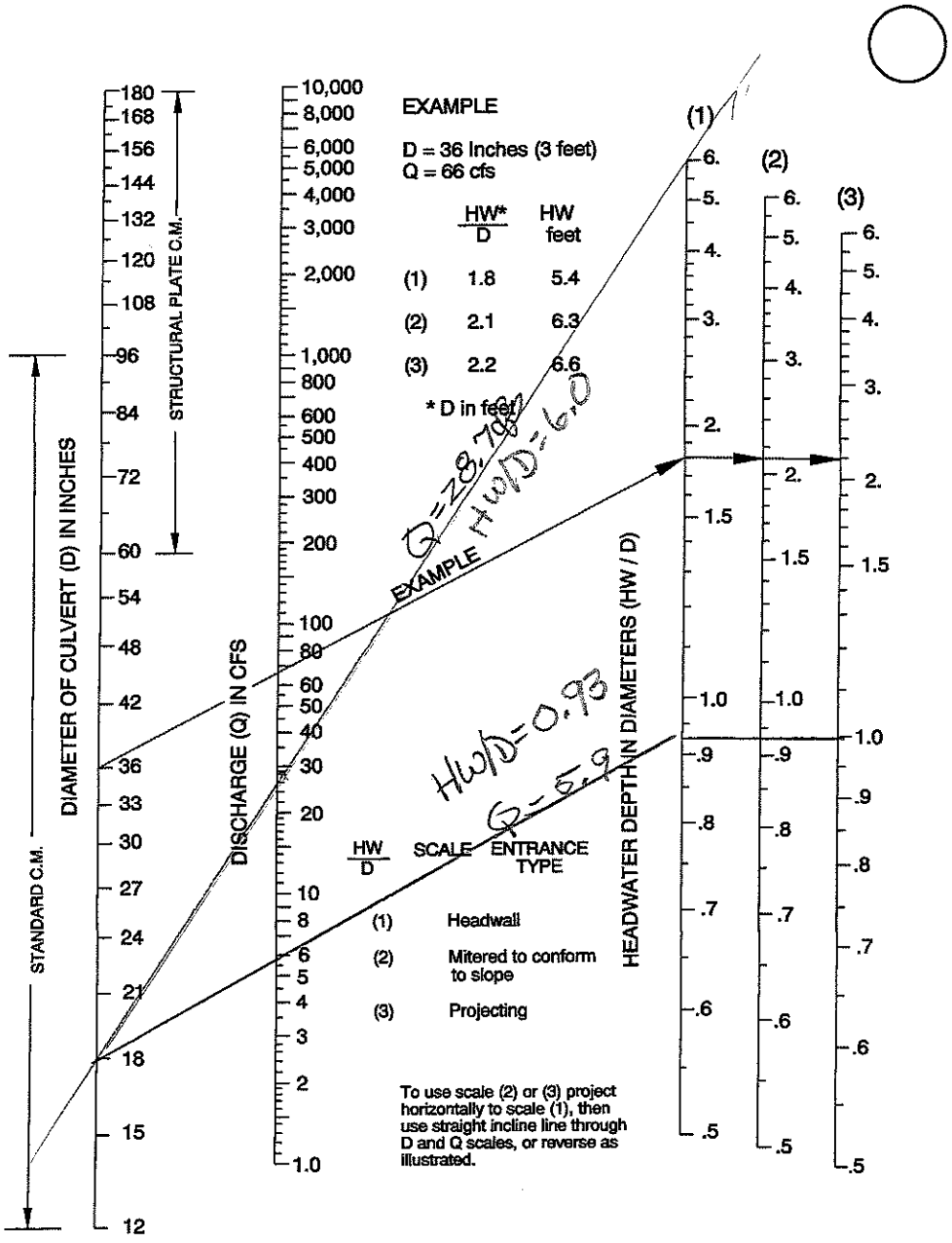


Culvert #3

$Q_5 = 5.9$ $Q_{100} = 28.7$

CHART 3

HEADWATER DEPTH FOR C.M. CULVERTS WITH INLET CONTROL



Culvert #4
Coffsite under private driveway

CHART 3

Q_5 = 20.8 Q_{100} = 124

HEADWATER DEPTH FOR C.M. CULVERTS WITH INLET CONTROL

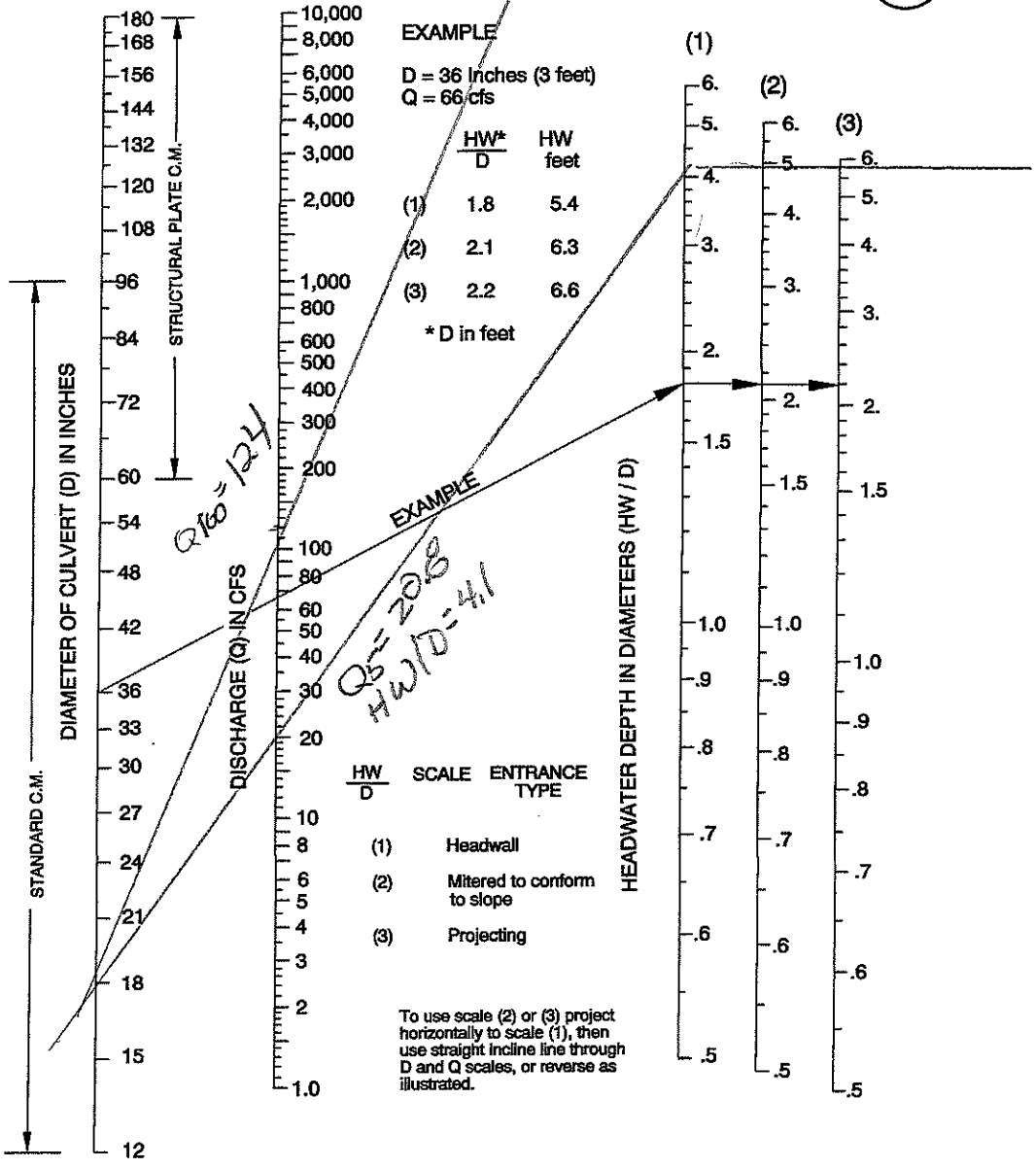


Exhibit 10:

Entech Engineering Report

March 10, 2020

ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
PHONE (719) 531-5599
FAX (719) 531-5238

Land Development Consultants, Inc.
3898 Maizeland Road
Colorado Springs, CO 80909

Attn: Daniel Kupferer

Re: Soil, Geology, and Geologic Hazard Study
Didleau Subdivison
Herring Road & Forest Heights Circle
Parcel Nos. 52090-00-050 & 52090-00-120
El Paso County, Colorado

Dear Mr. Kupferer:

GENERAL SITE CONDITIONS AND PROJECT DESCRIPTION

The site is located in a portion of the SW¼ of Section 9, Township 12 South, Range 65 West of the 6th Principal Meridian in El Paso County, Colorado. The site is located approximately 4 miles northeast of Colorado Springs city limits, northeast of Shoup Road and Herring Road in El Paso County, Colorado. The location of the site is as shown on the Vicinity Map, Figure 1.

The topography of the site is gradually sloping generally to the southwest with moderate slopes along the ridge that bisects the site. Burgess Creek is located in the eastern portion of the site and flows in a southwesterly direction. A minor drainage is located in the western portion of the property. Water was not observed in the drainages at the time of this investigation. The site boundaries are indicated on the USGS Map, Figure 2. Previous land uses have included undeveloped and a rural residential development. The site is located within the Black Forest burn scar. The site contains primarily field grasses and weeds with scattered areas of ponderosa pines in the western portion of the site and around the existing house located on Lot 2. Site photographs, taken January 30, 2020, are included in Appendix A.

Total acreage involved in the proposed subdivision is 32.25-acres. Four rural residential lots are proposed as part of the replat. The proposed lot sizes range from approximately 5-acres to 15-acres. The existing house located on Lot 2 will remain. The new lots will be serviced by individual wells and on-site wastewater treatment systems. The Site Plan with the proposed replat is presented in Figure 3.

LAND USE AND ENGINEERING GEOLOGY

This site was found to be suitable for the proposed development. Areas were encountered where the geologic conditions will impose some constraints on development and land use. These include areas of potentially seasonal shallow and seasonal shallow groundwater. Based on the proposed development plan, it appears that these areas will have some minor impacts on the development. These conditions will be discussed in greater detail in the report.

In general, it is our opinion that the development can be achieved if the observed geologic conditions on site are either avoided or properly mitigated. All recommendations are subject to the limitations discussed in the report.

SCOPE OF THE REPORT

The scope of the report will include the following:

- A general geologic analysis utilizing published geologic data. Detailed site-specific mapping will be conducted to obtain general information in respect to major geographic and geologic features, geologic descriptions and their effects on the development of the property.

FIELD INVESTIGATION

Our field investigation consisted of the preparation of a geologic map of any bedrock features and significant surficial deposits. The Natural Resource Conservation Service (NRCS), previously the Soil Conservation Service (SCS) survey was also reviewed to evaluate the site. The position of mappable units within the subject property are shown on the Geologic Map. Our mapping procedures involved both field reconnaissance and measurements, and aerial photo reconnaissance and interpretation. The same mapping procedures have also been utilized to produce the Geology/Engineering Geology Map which identified pertinent geologic conditions affecting development. The field mapping was performed by personnel of Entech Engineering, Inc. on January 3 and 30, 2020.

Two test borings and two test pits were excavated on the site to determine general suitability for the use of on-site wastewater treatment systems and general soil characteristics. The location of the test pit is indicated on the Site Plan/Test Pit Location Map, Figure 3. The Test Pit Log is presented in Appendix B. Results of this testing will be discussed later in this report.

Laboratory testing was also performed on some of the soils to classify and determine the soils engineering characteristics. Laboratory tests included grain-size analysis, ASTM D-422, and Atterberg Limits, ASTM D-4318. Results of the laboratory testing are included in Appendix C. A Summary of Laboratory Test Results is presented in Table 1.

SOIL AND GEOLOGIC CONDITIONS

Soil Survey

The Natural Resource Conservation Service (NRCS) (Reference 1, Figure 4), previously the Soil Conservation Service (Reference 2) has mapped two soil types on the site. Complete descriptions of the soil types are presented in Appendix D. In general, the soils consist of sandy loam to gravelly loamy sand. The soils are described as follows:

Type	Description
26	Elbeth Sandy Loam, 8 – 15% Slopes
40	Kettle Gravelly Loamy Sand, 3 – 8% Slopes

The soils have been described to have moderate to rapid permeabilities. The soils are described as well suited for use as homesites. Possible hazards with soils erosion are present on the site. The erosion potential can be controlled with vegetation. The soils have been described to have moderate erosion hazards (Reference 2).

Soils

The soils encountered in the test borings and test pits consisted of silty sand to very clayey sand overlying weathered to formational silty sandstone and very sandy claystone. Bedrock was encountered at depths ranging from 2 to 6 feet. The upper sands were encountered at loose to dense states and moderate moisture conditions, and the sandstone was encountered at very dense states and moderate moisture conditions. The claystone was encountered at hard consistencies and moderate moisture conditions. The samples of sand tested had approximately 12 to 38 percent of the soil size particles passing the No. 200 sieve. FHA Swell Testing on a sample of the very clayey sand resulted in an expansion pressure of 1640 psf, which indicates a moderate expansion potential. The samples of sandstone tested had 10 to 22 percent of the soil size particles passing the No. 200 sieve. The samples of claystone tested had 54 to 59 percent of the soil size particles passing the No. 200 sieve. FHA Swell Testing on a sample of the claystone resulted in an expansion pressure of 730 psf, which indicates a low to moderate expansion potential. Highly expansive claystone and siltstone lenses are commonly interbedded in the Dawson Formation.

Groundwater

Groundwater or signs of seasonally occurring water were not encountered in the test borings or test pits, which were drilled to 20 feet and excavated to 6 to 7 feet. It is anticipated groundwater will not affect shallow foundations on the majority of the site. Areas of potentially seasonal shallow and seasonal shallow groundwater have been mapped in drainages on the site that are discussed in the following sections. Fluctuations in groundwater conditions may occur due to variations in rainfall or other factors not readily apparent at this time. Isolated sand layers within the soil profile can carry water in the subsurface. Contractors should be cognizant of the potential for the occurrence of subsurface water features during construction.

Geology

Approximately 12 miles west of the site is a major structural feature known as the Rampart Range Fault. This fault marks the boundary between the Great Plains Physiographic Province and the Southern Rocky Mountain Province. The site exists within a large structural feature known as the Denver Basin. Bedrock in the area is typically gently dipping in a northerly direction (Reference 3). The bedrock underlying the site consists of the Dawson Formation of Cretaceous Age. The Dawson Formation typically consists of coarse-grained arkosic sandstone with interbedded layers claystone or siltstone.

The geology of the site was evaluated using the *Geologic Map of the Black Forest,* by Thorson in 2003, (Reference 4, Figure 5). The Geology Map for the site is presented in Figure 6. Four mappable units were identified on this site which is described as follows:

Qaf **Artificial Fill of Holocene Age:** These consist of man-made fill deposits associated with a gas pipeline that bisects the site in portions of Lot 1 and Lot 2. Fill piles consisting of logs and branches are located across the site.

Qal **Recent Alluvium of Holocene Age:** These are recent deposits that have been deposited in the drainages that exist on-site. These materials consist of silty to clayey sands. Some of these alluviums can contain highly organic soils.

Qau **Alluvium, Undivided of Holocene and Pleistocene Age:** These are sheetwash and stream deposited alluvium that exists in the western portion of the site associated with alluvial-filled valley heads. These materials typically consist of silty to clayey sands and gravel.

Qc/Tkd **Colluvium of Quaternary Age overlying Dawson Formation of Tertiary to Cretaceous Age:** The materials consist of colluvial or residual soils overlying the bedrock materials on-site. The colluvial soils were deposited by the action of sheetwash and gravity. The residual soils were derived from the in-situ weathering of the bedrock on site. These materials typically consist of silty to clayey sand with potential areas of sandy clays. The bedrock consists of the Dawson Formation. The Dawson Formation typically consists of coarse-grained, arkosic sandstone with interbedded lenses of fine-grained sandstone, siltstone and claystone.

The soils listed above were mapped from site-specific mapping, the *Geologic Map of the Black Forest Quadrangle* distributed by the Colorado Geologic Survey in 2003 (Reference 4, Figure 5), The *Geologic Map of the Colorado Springs-Castle Rock Area,* distributed by the US Geological Survey in 1979 (Reference 5), and the *Geologic Map of the Pueblo 1° x 2° Quadrangle,* distributed by the US Geological Survey in 1978 (Reference 6). The test borings and test pits were used in evaluating the site and is included in Appendix B. The Geology Map prepared for the site is presented in Figure 6.

ENGINEERING GEOLOGIC HAZARDS

Mapping has been performed on this site to identify areas where various geologic conditions exist of which developers should be cognizant during the planning, design and construction stages where new construction is proposed. The engineering geologic hazards identified on this site include potentially seasonal shallow and seasonally shallow groundwater areas. These hazards and recommended mitigation techniques are discussed as follows:

Expansive Soils

Expansive soils were encountered in Test Boring No. 2 located on Lot 3. These occurrences are typically sporadic; therefore, none have been indicated on the maps. Highly expansive claystone and siltstone are commonly interbedded in the sandstone of the Dawson Formation. These clays, if encountered beneath foundations, can cause differential movement in the structure foundation.

Mitigation: Should expansive soils be encountered beneath the foundation; mitigation will be necessary. Mitigation of expansive soils will require special foundation design. Overexcavation and replacement with non-expansive soils at a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557 is a suitable mitigation, which is common in the area. Floor slabs on expansive soils should be expected to experience movement. Overexcavation and replacement has been successful in minimizing slab movements.

Potentially Seasonal Shallow and Seasonal Shallow Groundwater Area

The site is not mapped within any floodplains according to the FEMA Map No. 08041CO320G, dated December 7, 2018 (Figure 7, Reference 7). Areas of potentially seasonal shallow and seasonal shallow groundwater were observed on the site (Figure 6). In these areas, we would anticipate the potential for periodically high subsurface moisture conditions and frost heave potential. These areas lie within low-lying areas and along the drainages in the eastern and western portions of the site. The seasonal shallow groundwater area is located along Burgess Creek located along the eastern portion of the site on Lot 4. The potentially seasonal shallow groundwater area is located in the western portion of the site on Lot 2. Water was not observed in any of the drainages at the time of our site investigation. These areas can likely be avoided or properly mitigated by development. The potential exists for high groundwater levels during high moisture periods and should structures encroach on these areas the following precautions should be followed.

Mitigation: Foundations must have a minimum 30-inch depth for frost protection. In areas where high subsurface moisture conditions are anticipated periodically, subsurface perimeter drains are recommended to help prevent the intrusion of water into areas below grade. Typical drain details are presented in Figure 8. Any grading in these areas should be done to direct surface flow around construction to avoid areas of ponded water. All organic material would be completely removed prior to any fill placement. **Specific drainage studies are beyond the scope of this report.**

RELEVANCE OF GEOLOGIC CONDITIONS TO LAND USE PLANNING

The proposed development will be rural-residential utilizing individual on-site wastewater treatment systems and water wells. Total acreage involved in the proposed subdivision is 32.25-acres. Four rural residential lots are proposed as part of the replat. The proposed lot sizes range from approximately 5-acres to 15-acres. The existing house located on Lot 2 will remain. The house on Lot 2 has an existing water well and on-site wastewater treatment system. The new lots will be serviced by an individual wells and on-site wastewater treatment systems. The existing geologic and engineering geologic conditions will impose minor constraints on development and construction. The geologic conditions on the site include potentially seasonal shallow and shallow groundwater areas, which can be satisfactorily mitigated through avoidance or proper engineering design and construction practices.

The upper granular soils encountered in the test borings and test pits on the site were encountered at loose to dense states, the sandstone was encountered at very dense states, and the claystone at hard consistencies. Highly expansive claystone and siltstone are

commonly interbedded in the sandstone of the Dawson Formation. Mitigation of expansive soils will require special foundation design. Overexcavation and replacement with non-expansive soils at a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557 is a suitable mitigation, which is common in the area. Floor slabs on expansive soils should be expected to experience movement. Overexcavation and replacement has been successful in minimizing slab movements. These soils will not prohibit development.

Areas of potentially seasonal shallow and seasonal shallow groundwater were observed on the site (Figure 6). In these areas, we would anticipate the potential for periodically high subsurface moisture conditions and frost heave potential. These areas lie within low-lying areas and along the minor drainage in the western portion of the site, and Burgess Creek in the eastern portion of the site. These areas can likely be avoided or properly mitigated by development. The potential exists for high groundwater levels during high moisture periods and should structures encroach on these areas. Subsurface perimeter drains are recommended should structures encroach on this area. Typical drain details are presented in Figure 8. Septic systems are not recommended in in these areas due to the potential for shallow groundwater. Any grading in theses areas should be done to direct surface flow around construction to avoid areas of ponded water. All organic material should be completely removed prior to any fill placement. Specific drainage studies are beyond the scope of this report. The site is not mapped within any floodplains according to the FEMA Map No. 80841C0320G (Figure 7, Reference 7).

In summary, the granular soils will likely provide suitable support for shallow foundations. The geologic conditions encountered on site can be mitigated with avoidance or proper engineering and construction practices.

ECONOMIC MINERAL RESOURCES

Some of the sandy materials on-site could be considered a low-grade sand resource. According to the *El Paso County Aggregate Resource Evaluation Map* (Reference 8), of the area of the site is not mapped with any potential aggregate resources. According to the *Atlas of Sand, Gravel and Quarry Aggregate Resources, Colorado Front Range Counties* distributed by the Colorado Geological Survey (Reference 9), the site is not mapped with any resources. According to the *Evaluation of Mineral and Mineral Fuel Potential* (Reference 10), the area of the site has been mapped as "little or no potential" for industrial minerals.

According to *the Evaluation of Mineral and Mineral Fuel Potential of El Paso County State Mineral Lands* (Reference 10), the site is mapped within the Denver Basin Coal Region. However, the area of the site has been mapped as "Poor" for coal resources. No active or inactive mines have been mapped in the area of the site. No metallic mineral resources have been mapped on the site (Reference 10).

The site has been mapped as "Fair" for oil and gas resources (Reference 10). No oil or gas fields have been discovered in the area of the site. The sedimentary rocks in the area may lack the geologic structure for trapping oil or gas; therefore, it may not be considered a significant resource. Hydraulic fracturing is a new method that is being used to extract oil and gas from

rocks. It utilizes pressurized fluid to extract oil and gas from rocks that would not normally be productive. The area of the site has not been explored to determine if the rocks underlying the site would be commercially viable utilizing hydraulic fracturing. The practice of hydraulic fracturing has come under review due to concerns about environmental impacts, health and safety.

EROSION CONTROL

The soil types observed on the site are mildly to highly susceptible to wind erosion, and moderately to highly susceptible to water erosion. A minor wind erosion and dust problem may be created for a short time during and immediately after construction. Should the problem be considered severe enough during this time, watering of the cut areas or the use of chemical palliative may be required to control dust. However, once construction has been completed and vegetation re-established, the potential for wind erosion should be considerably reduced.

With regard to water erosion, loosely compacted soils will be the most susceptible to water erosion, residually weathered soils and weathered bedrock materials become increasingly less susceptible to water erosion. For the typical soils observed on site, allowable velocities or unvegetated and unlined earth channels would be on the order of 3 to 4 feet/second, depending upon the sediment load carried by the water. Permissible velocities may be increased through the use of vegetation to something on the order of 4 to 7 feet/second, depending upon the type of vegetation established. Should the anticipated velocities exceed these values, some form of channel lining material may be required to reduce erosion potential. These might consist of some of the synthetic channel lining materials on the market or conventional riprap. In cases where ditch-lining materials are still insufficient to control erosion, small check dams or sediment traps may be required. The check dams will serve to reduce flow velocities, as well as provide small traps for containing sediment. The determination of the amount, location and placement of ditch linings, check dams and of the special erosion control features should be performed by or in conjunction with the drainage engineer who is more familiar with the flow quantities and velocities.

Cut and fill slope areas will be subjected primarily to sheetwash and rill erosion. Unchecked rill erosion can eventually lead to concentrated flows of water and gully erosion. The best means to combat this type of erosion is, where possible, the adequate re-vegetation of cut and fill slopes. Cut and fill slopes having gradients more than three (3) horizontal to one (1) vertical become increasingly more difficult to revegetate successfully. Therefore, recommendations pertaining to the vegetation of the cut and fill slopes may require input from a qualified landscape architect and/or the Soil Conservation Service.

CLOSURE

It is our opinion that the existing geologic engineering and geologic conditions will impose some minor constraints on development and construction of the site. The majority of these conditions can be avoided by construction. Others can be mitigated through proper engineering design and construction practices. The proposed development and use are consistent with anticipated geologic and engineering geologic conditions.

It should be pointed out that because of the nature of data obtained by random sampling of such variable and non-homogeneous materials as soil and rock, it is important that we be informed of any differences observed between surface and subsurface conditions encountered in construction and those assumed in the body of this report. Individual investigations for new building sites and septic systems will be required prior to construction. Construction and design personnel should be made familiar with the contents of this report. Reporting such discrepancies to Entech Engineering, Inc. soon after they are discovered would be greatly appreciated and could possibly help avoid construction and development problems.

This report has been prepared for Land Development Consultants, Inc., for application to the proposed project in accordance with generally accepted geologic soil and engineering practices. No other warranty expressed or implied is made.

We trust that this report has provided you with all the information that you required. Should you require additional information, please do not hesitate to contact Entech Engineering, Inc.

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Logan L. Langford, P.G.
Geologist

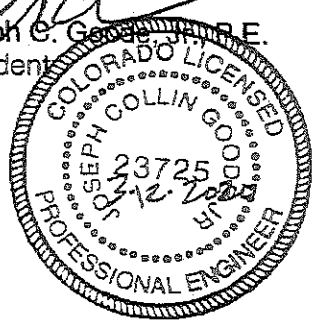
LLL/lll

Encl.

Entech Job No. 192115
AAprojects/2019/192115 sg&ghs

Reviewed by:

Joseph C. Goodale, Jr., P.E.
President



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TABLES

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT LDC, INC.
PROJECT DIDLEAU SUBDIVISION
JOB NO. 192115

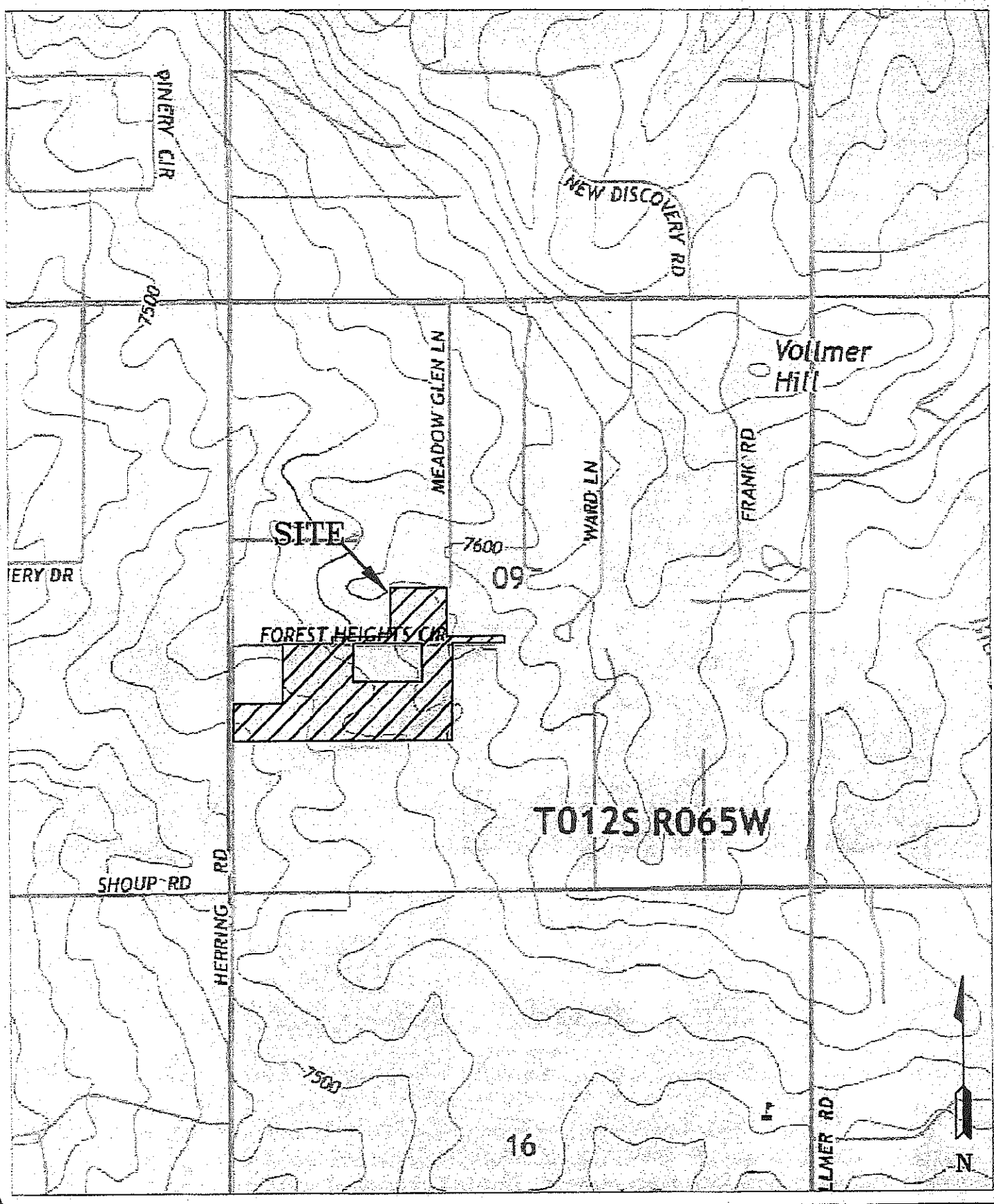
SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	FHA SWELL (PSF)	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1	1	2-3			12.2						SM	SAND, SILTY
1	2	2-3			38.4				1640		SC	SAND, VERY CLAYEY
1	TP-2	2-3			14.9						SM	SAND, SILTY
2	TP-1	5-6			9.6						SM	SANDSTONE, SILTY
2	1	15			22.2						SM	SANDSTONE, SILTY
3	2	10			59.3				730		CL	CLAYSTONE, VERY SANDY
3	2	5			54.2						CL	CLAYSTONE, VERY SANDY

Table 2: Summary Tactile Test Pit Results

Test Pit No.	USDA Soil Type	LTAR Value	Depth to Bedrock (ft.)	Depth to Seasonally Occurring Groundwater (ft.)
1	3A*	0.30*	3*	N/A
2	3A*	0.30*	2*	N/A

*- Conditions that will require an engineered OWTS

FIGURES

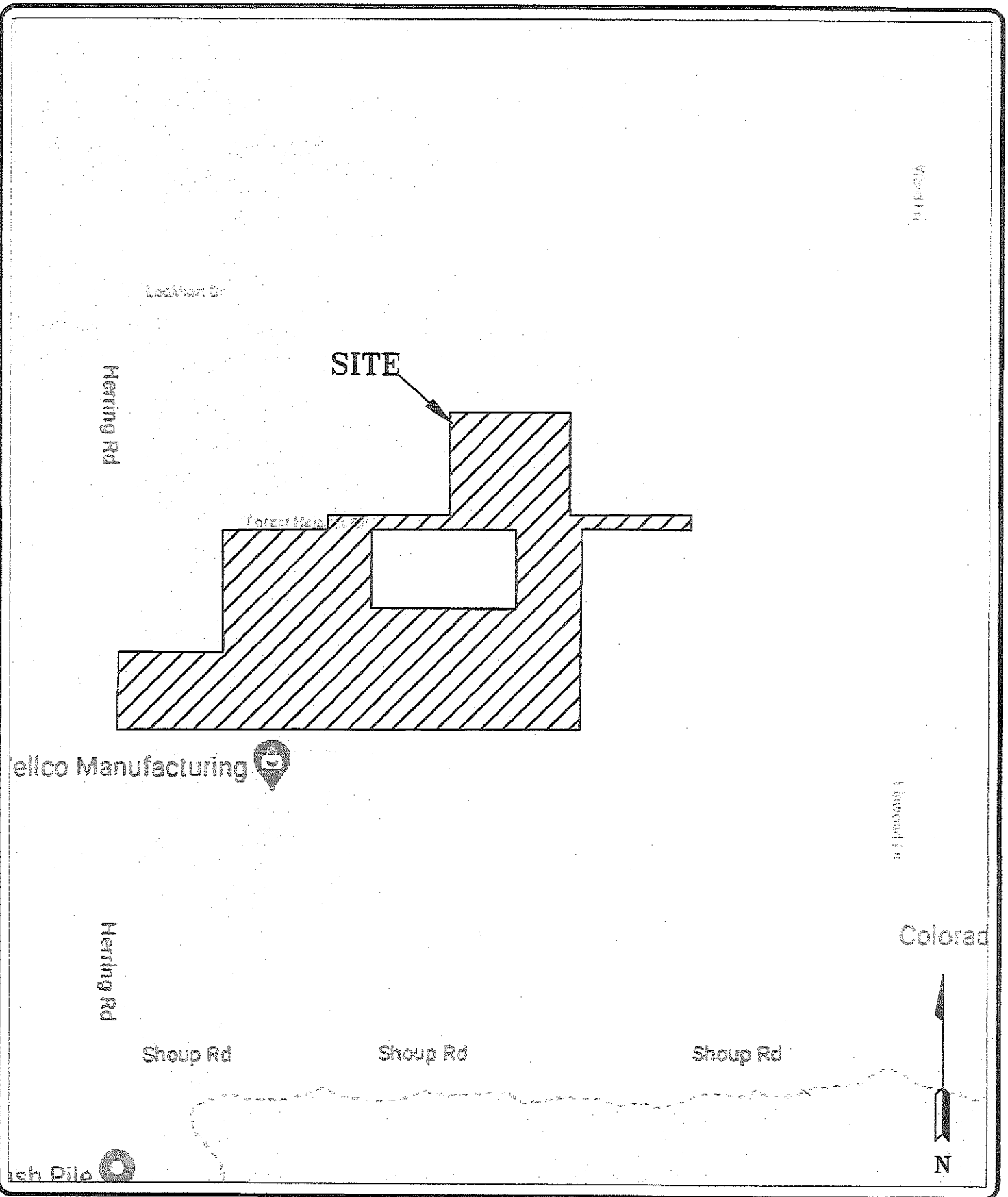


ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

USGS MAP DIDLEAU SUBDIVISION HERRING ROAD & FOREST HEIGHTS CIRCLEEL PASO COUNTY, CO. FOR: LDC, INC.			
DRAWN: LLL	DATE: 2/28/20	CHECKED:	DATE:

JOB NO.: 192115

FIG NO.: 2



ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

VICINITY MAP
DIDLEAU SUBDIVISION
HERRING ROAD & FOREST HEIGHTS CIRCLE
EL PASO COUNTY, CO.
FOR: LDC, INC.

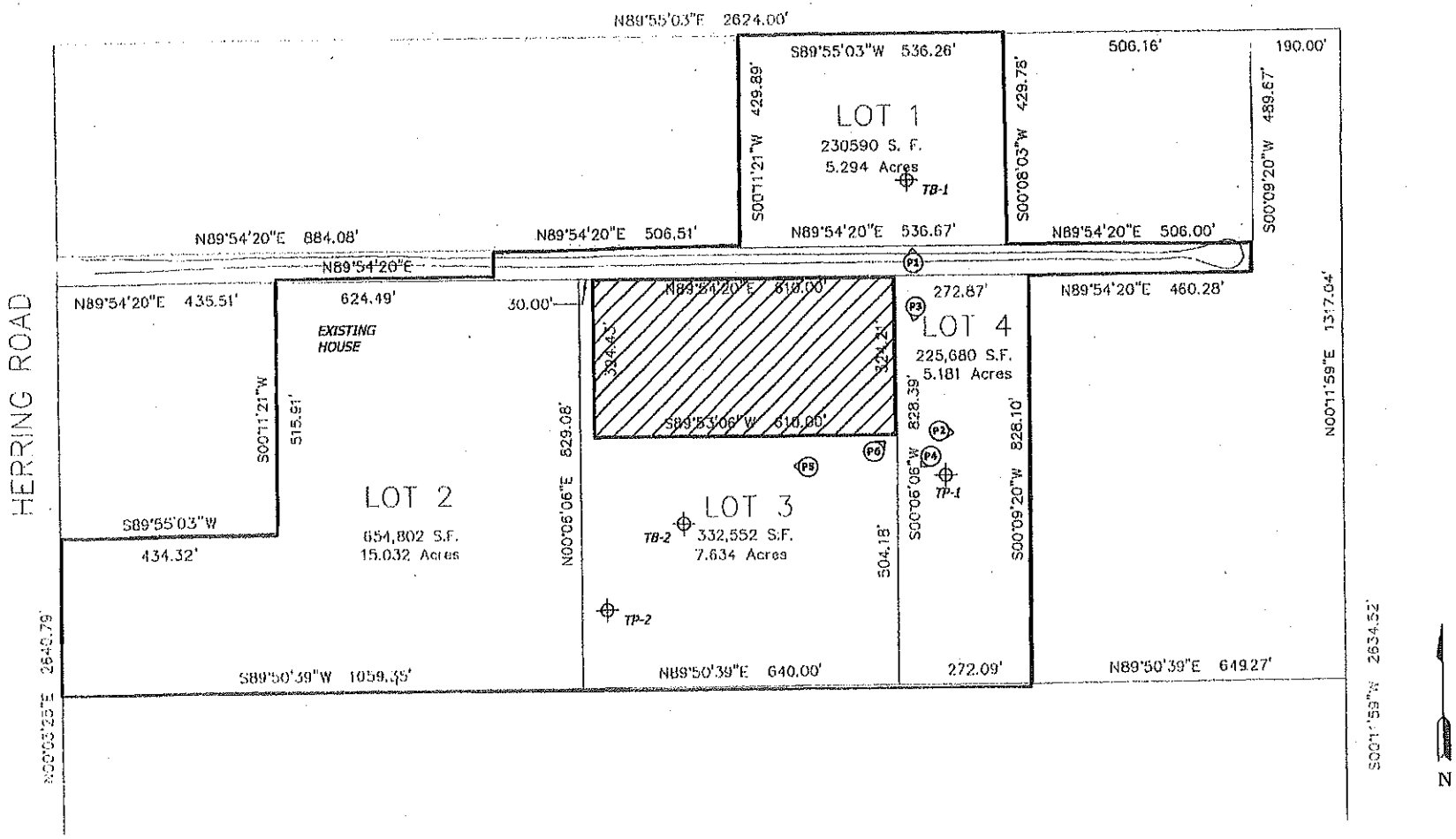
DRAWN:	DATE:	CHECKED:	DATE:
LLL	2/28/20		

JOB NO.: 192115

FIG NO.: 1

DIDLEAU SUBDIVISION

IN THE NORTH HALF OF THE SOUTHWEST QUARTER OF SECTION 9, TOWNSHIP 12 SOUTH, RANGE 65 WEST OF THE 6TH P.M.
COUNTY OF EL PASO, STATE OF COLORADO



- approximate test pit location and number
- approximate photograph location and number
- separate parcel not included in the subdivision

REVISION	BY

ENTECH ENGINEERING, INC.
2515 CLINTON DRIVE COLORADO SPRINGS, CO. 80907 (719) 531-5599

SITE PLAN/TESTING LOCATION MAP
DIDLEAU SUBDIVISION
HERRING ROAD & FOREST HEIGHTS
CIRCLECOLORADO SPRINGS, CO.
FOR: LDC, INC.

DATE 2/20/20
SCALE AS SHOWN
JOB NO. 1981.16
FIGURE NO. 3

- SEPERATE PARCEL NOT INCLUDED IN THE SUBDIVISION

N

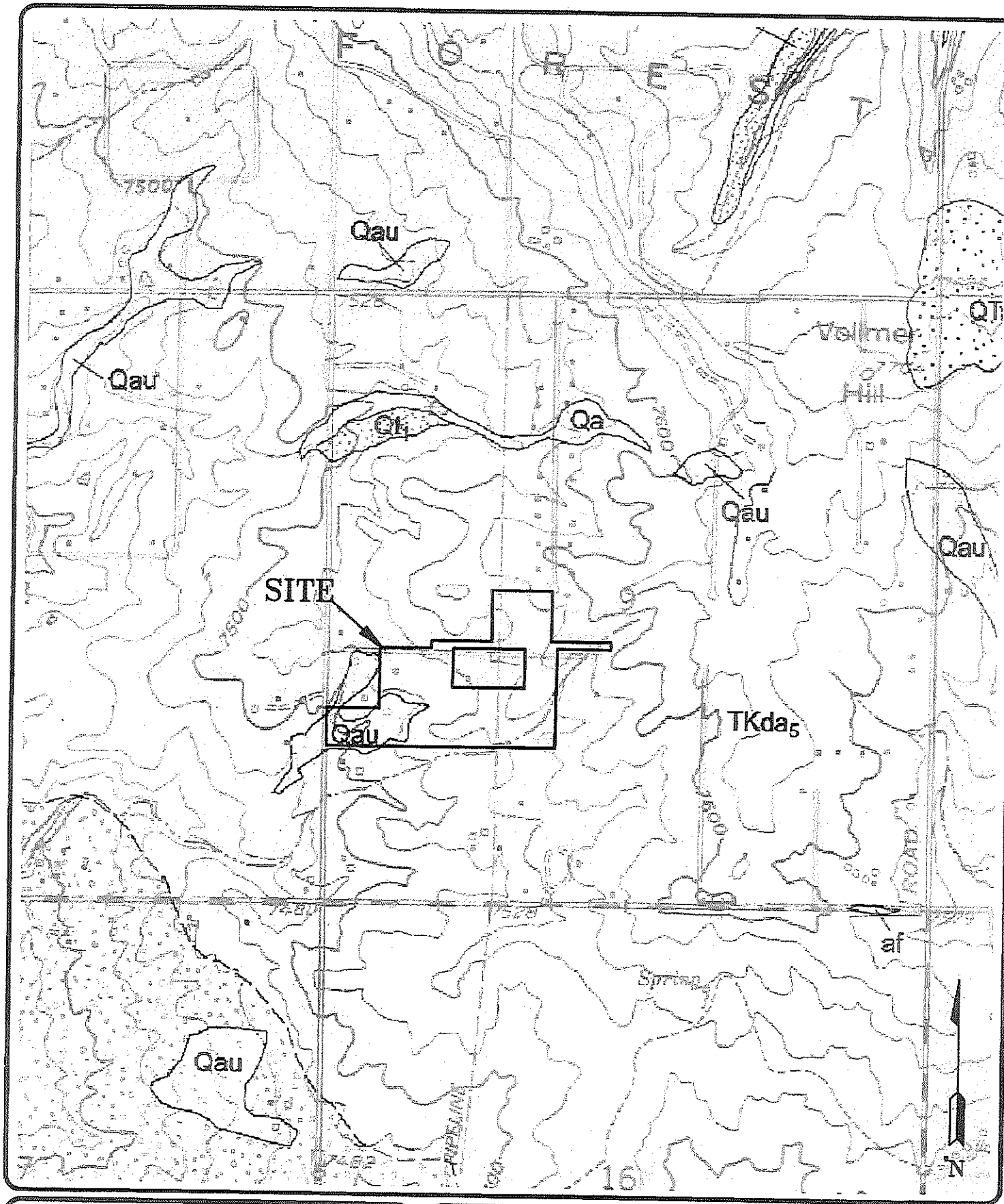
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

SOIL SURVEY MAP
DIDLEAU SUBDIVISION
HERRING ROAD & FOREST HEIGHTS CIRCLE
EL PASO COUNTY, CO.
FOR: LDC, INC.

DRAWN:	DATE:	CHECKED:	DATE:
LLL	2/28/20		

JOB NO.: 192115

FIG NO.: 4



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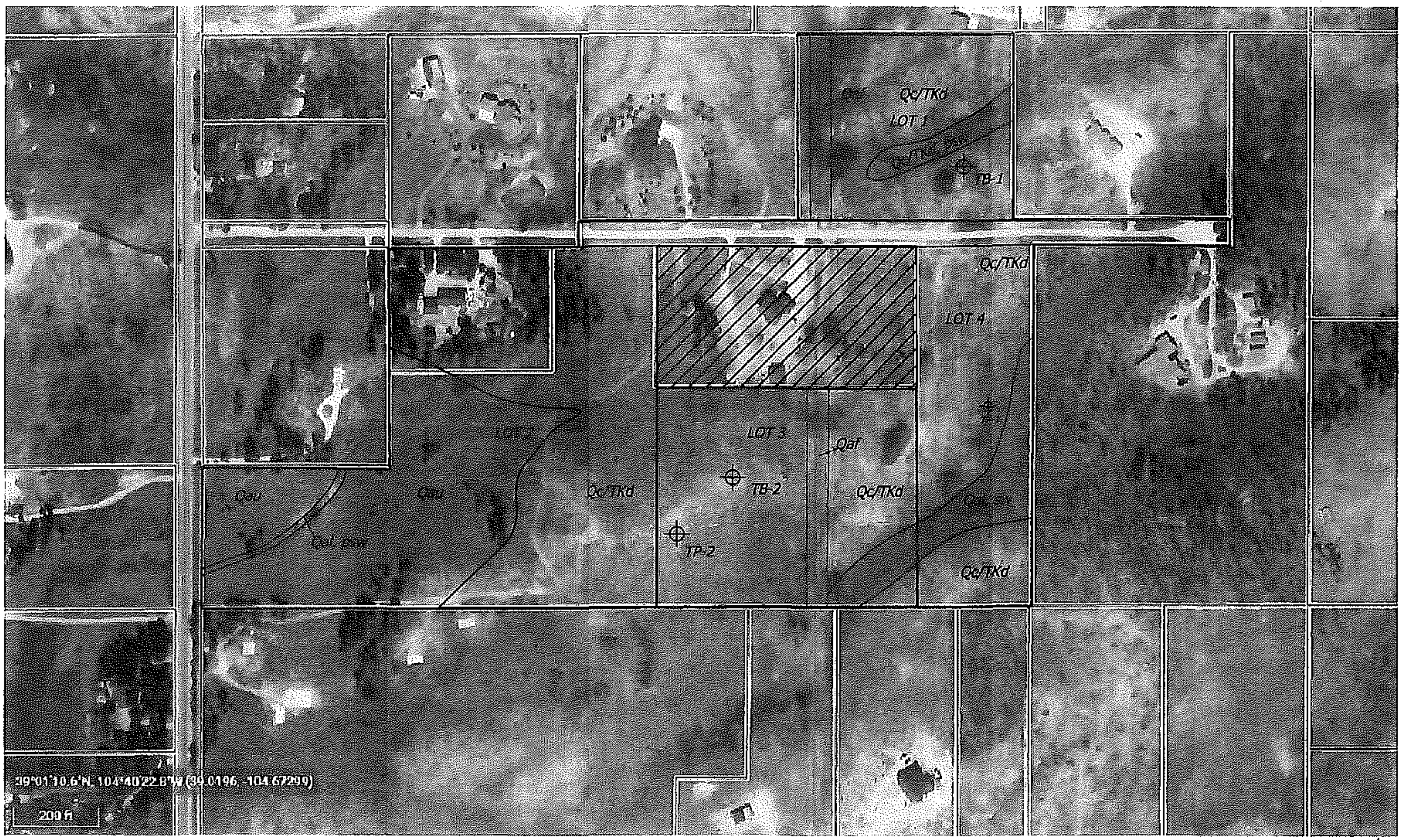
COLORADO SPRINGS, CO. 80907 (719) 531-5599

BLACK FOREST QUADRANGLE GEOLOGIC MAP
DIDLEAU SUBDIVISION
HERRING ROAD & FOREST HEIGHTS CIRCLE
EL PASO COUNTY, CO.
FOR: LDC, INC.

DRAWN:	DATE:	CHECKED:	DATE:
LLL	2/28/20		

JOB NO.: 192115

FIG NO.: 5



Legend:

Qaf - Artificial Fill of Holocene Age: man-made fill deposits

Qal - Recent Alluvium of Holocen Age: recent water deposited materials

Qau - Alluvium Undivided of Holocene and Pleistocene Age: sheetwash and stream deposited alluvium associated with eluvial-filled valley heads

QcTKd - Colluvium of Quaternary Age overlying Dawson Formation of Tertiary to Cretaceous Age: colluvial and residual soils overlying arkosic sandstone with interbedded fine-grained sandstone, siltstone and claystone

sw - shallow groundwater area

psw - potentially shallow groundwater area

(hatched box) - separate parcel not included in the subdivision

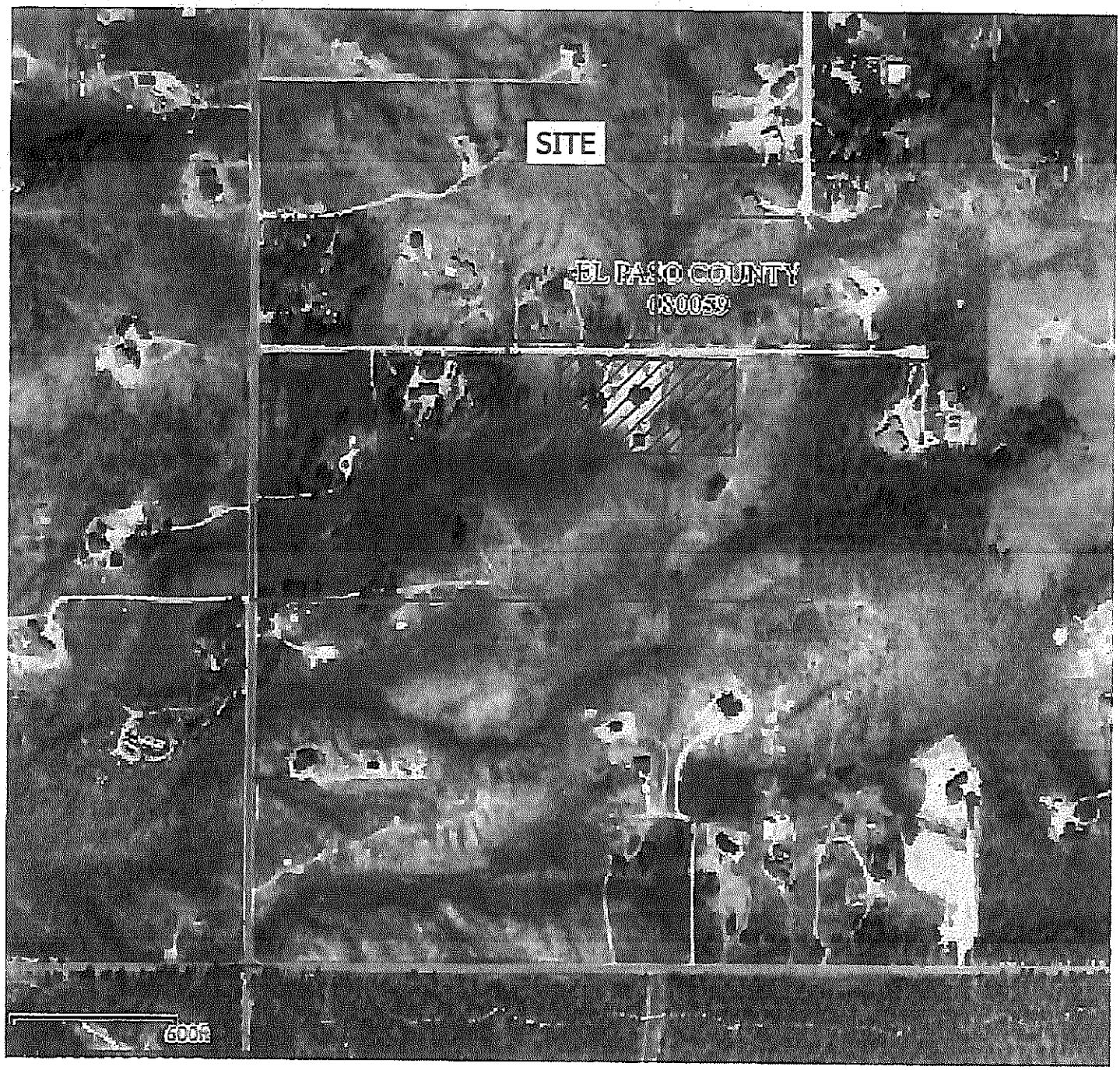
N

REVISION	BY

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

GEOLOGY/ENGINEERING GEOLOGY MAP
DIDLEAU SUBDIVISION
HERRING ROAD & FOREST HEIGHTS CIRCLE
EL PASO COUNTY, CO.
FOR: LDC, INC.

DRAWN: LLL
CHECKED:
DATE: 8/28/20
SCALE: AS SHOWN
JOB NO.: 192115
FIGURE No.: 6



- SEPERATE PARCEL NOT INCLUDED IN THE SUBDIVISION

N

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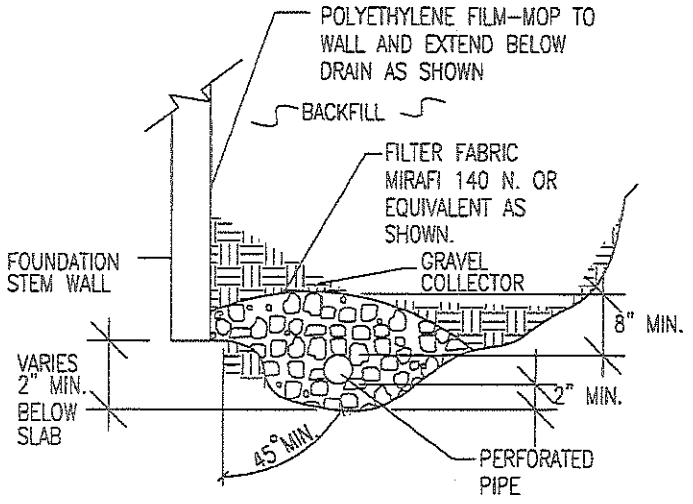
525 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

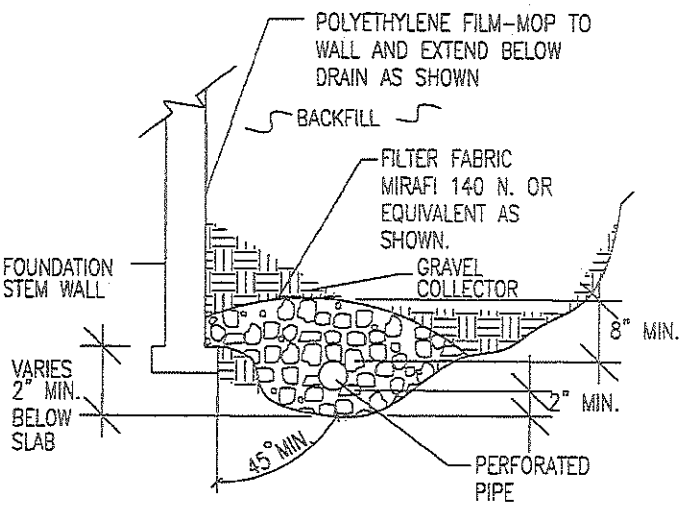
FEMA FLOODPLAIN MAP
DIDLEAU SUBDIVISION
HERRING ROAD & FOREST HEIGHTS CIRCLE
EL PASO COUNTY, CO.
FOR: LDC, INC.

DRAWN:	DATE:	CHECKED:	DATE:
LLL	2/28/20		

JOB NO.: 192115

FIG NO.: 7





NOTES:

–GRAVEL SIZE IS RELATED TO DIAMETER OF PIPE PERFORATIONS–85% GRAVEL GREATER THAN 2x PERFORATION DIAMETER.

–PIPE DIAMETER DEPENDS UPON EXPECTED SEEPAGE. 4–INCH DIAMETER IS MOST OFTEN USED.

–ALL PIPE SHALL BE PERFORATED PLASTIC. THE DISCHARGE PORTION OF THE PIPE SHOULD BE NON–PERFORATED PIPE.

–FLEXIBLE PIPE MAY BE USED UP TO 8 FEET IN DEPTH, IF SUCH PIPE IS DESIGNED TO WITHSTAND THE PRESSURES. RIGID PLASTIC PIPE WOULD OTHERWISE BE REQUIRED.

–MINIMUM GRADE FOR DRAIN PIPE TO BE 1% OR 3 INCHES OF FALL IN 25 FEET.

–DRAIN TO BE PROVIDED WITH A FREE GRAVITY OUTFALL, IF POSSIBLE. A SUMP AND PUMP MAY BE USED IF GRAVITY OUT FALL IS NOT AVAILABLE.

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COLORADO SPRINGS, CO. 80907 (719) 531-5599

PERIMETER DRAIN DETAIL

DRAWN:	DATE:	DESIGNED:	CHECKED:
		DS	LLL

JOB NO.: 192115

FIG NO.: 8

APPENDIX A: Photographs

1

Looking north towards Lot 1 in the eastern portion of the site.

January 30, 2020

2

Looking north from the central portion of Lot 2.

January 30, 2020

Job No. 192115

3

Looking south from the northern portion of Lot 4.

January 30, 2020

4

Looking south towards one of the stockpiles of cut trees.

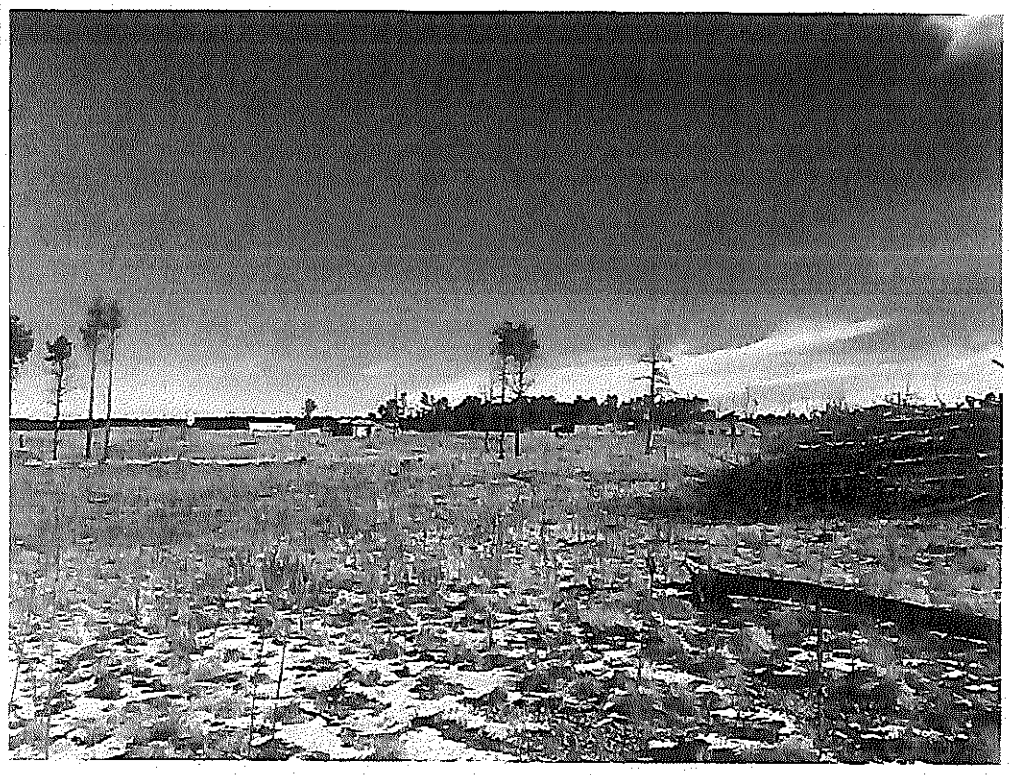
January 30, 2020

Job No. 192115

5

Looking northeast towards stockpile of trees on Lot 3.

January 30, 2020



6

Looking north from the eastern portion of Lot 3.

January 30, 2020

Job No. 192115

APPENDIX B: Test Boring and Test Pit Logs

TEST BORING NO. 1
DATE DRILLED 1/3/2020
Job # 192115

REMARKS

DRY TO 17.5', 1/6/20

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			50	5.6	1
5			42	10.8	1
10			50/10"	12.5	2
15			50/9"	11.7	2
20			50/7"	11.5	2

SAND, SILTY, FINE TO COARSE GRAINED, BROWN, VERY DENSE TO DENSE, MOIST

SANDSTONE, SILTY, FINE TO COARSE GRAINED, BROWN, VERY DENSE, MOIST

TEST BORING NO. 2
DATE DRILLED 1/3/2020
CLIENT LDC, INC.
LOCATION DIDLEAU SUBDIVISION

REMARKS

DRY TO 18.5', 1/6/20

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			7	23.1	1
5			50/11"	12.7	1 3
10			50/6"	15.2	3
15			50/5"	6.9	2
20			50/6"	15.8	2

SAND, VERY CLAYEY, FINE TO MEDIUM GRAINED, BROWN, LOOSE, MOIST

CLAYSTONE, VERY SANDY, BROWN, HARD, MOIST

SANDSTONE, SILTY, FINE TO COARSE GRAINED, BROWN, VERY DENSE, MOIST

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ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE: 1/17/20

JOB NO.: 192115
FIG NO.: B-1

TEST PIT NO. 1
DATE EXCAVATED 4/23/2019
Job # 192115

REMARKS	Depth (ft)	Symbol	Samples	Soil Structure Shape	Soil Structure Grade	USDA Soil Type
topsoil sandy loam, brown	1					
gravelly sandy loam, fine to coarse grained, light brown	2			gr	m	2
	3					
weathered to formational silty sandstone, fine to coarse grained, tan	4			ma		3A
	5					
	6					
	7					
	8					
	9					
	10					

TEST PIT NO. 2
DATE EXCAVATED 4/23/2019
CLIENT LDC, INC.
LOCATION DIDLEAU SUBDIVISION

REMARKS	Depth (ft)	Symbol	Samples	Soil Structure Shape	Soil Structure Grade	USDA Soil Type
topsoil sandy loam, brown	1					
gravelly sandy loam, fine to coarse grained, light brown	2			gr	m	2
	3			ma		3A
weathered to formational silty sandstone, fine to coarse grained, tan	4					
	5					
	6					
	7					
	8					
	9					
	10					

Soil Structure Shape
granular - gr
platy - pl
blocky - bl
prismatic - pr
single grain - sg
massive - ma

Soil Structure Grade
weak - w
moderate - m
strong - s
loose - l

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ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

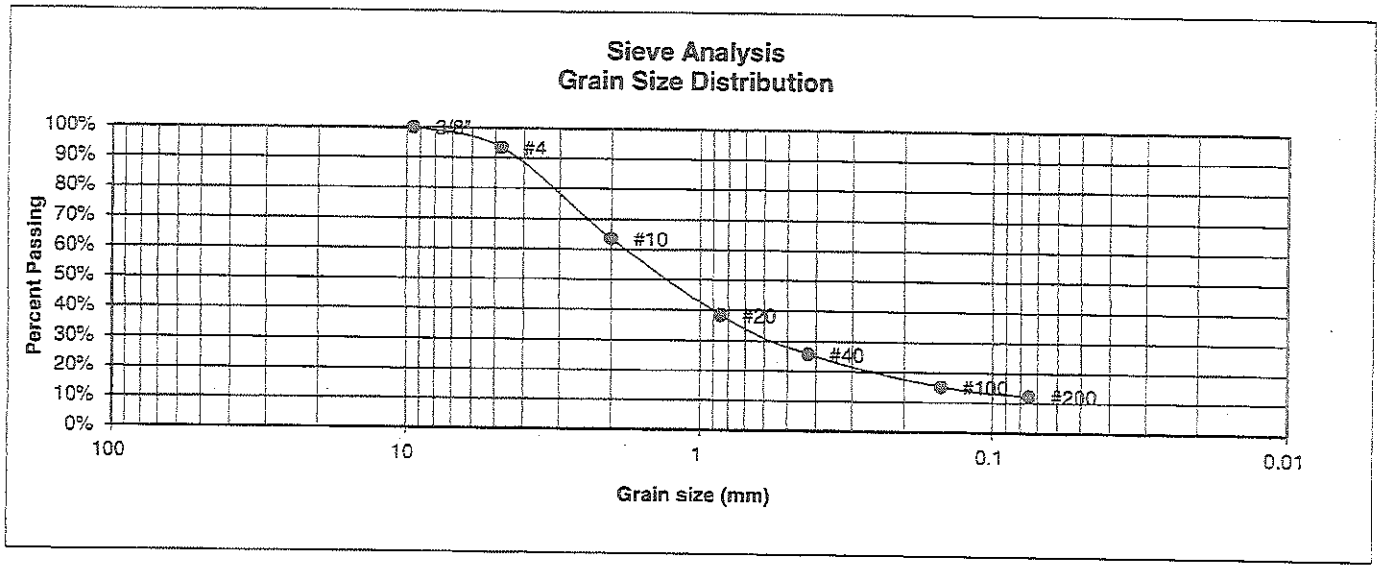
TEST PIT LOG

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	2/25/20

JOB NO.: 192115
FIG NO.: B-2

APPENDIX C: Laboratory Test Results

UNIFIED CLASSIFICATION	SM	CLIENT	LDC, INC.
SOIL TYPE #	1	PROJECT	DIDLEAU SUBDIVISION
TEST BORING #	1	JOB NO.	192115
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.4%
10	63.6%
20	38.4%
40	25.6%
100	15.1%
200	12.2%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

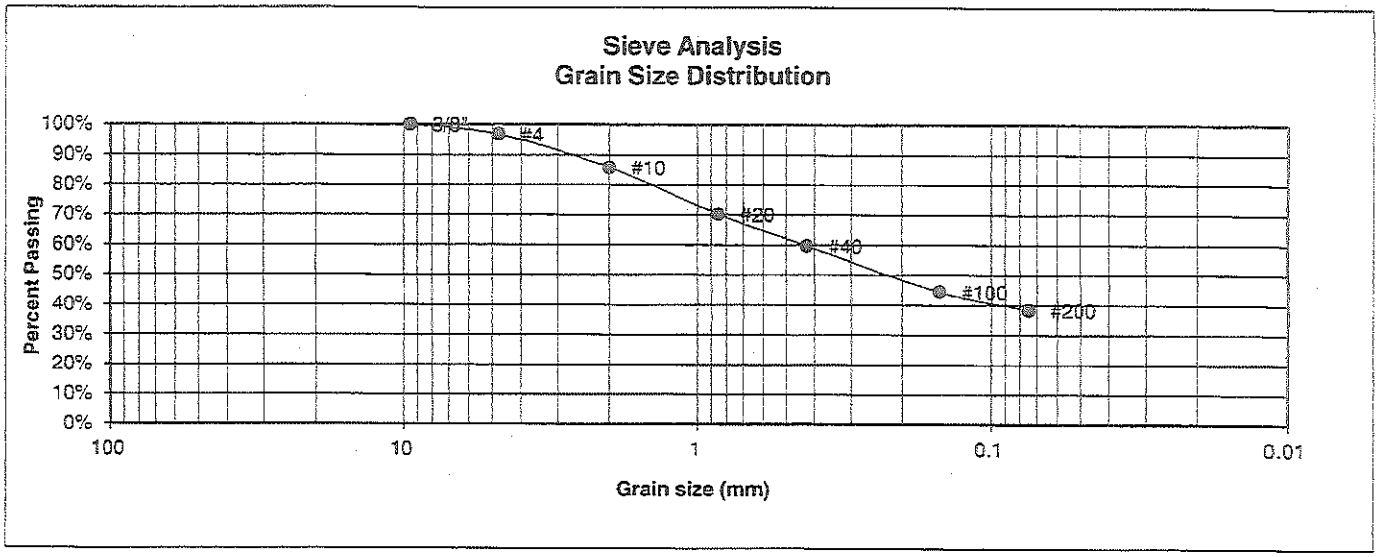
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE: 1/17/26

JOB NO.: 192115

FIG NO.: L-1

UNIFIED CLASSIFICATION	SC	CLIENT	LDC, INC.
SOIL TYPE #	1	PROJECT	DIDLEAU SUBDIVISION
TEST BORING #	2	JOB NO.	192115
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	96.8%
10	85.8%
20	70.2%
40	59.7%
100	44.3%
200	38.4%

Atterberg Limits

Plastic Limit

Liquid Limit

Plastic Index

Swell

Moisture at start	13.8%
Moisture at finish	25.6%
Moisture increase	11.8%
Initial dry density (pcf)	95
Swell (psf)	1640

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

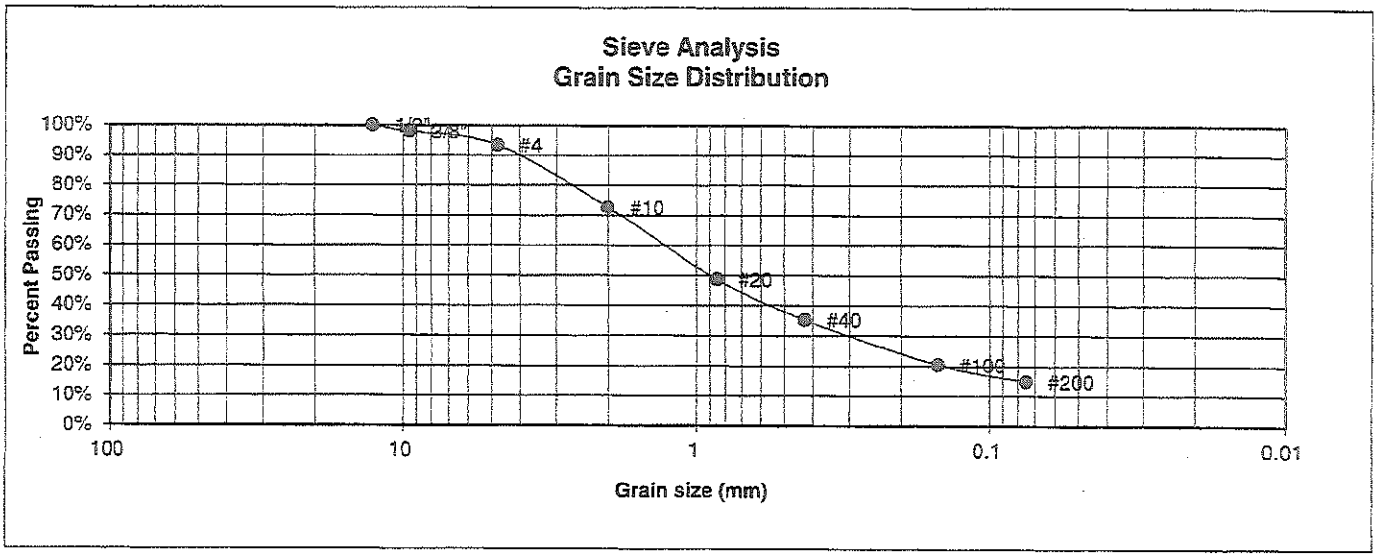
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			11/17/20

JOB NO.: 192115

FIG NO.: L-2

UNIFIED CLASSIFICATION	SM	CLIENT	LDC, INC.
SOIL TYPE #	1	PROJECT	DIDLEAU SUBDIVISION
TEST BORING #	TP-2	JOB NO.	192115
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	97.9%
4	93.3%
10	72.7%
20	48.7%
40	35.2%
100	20.5%
200	14.9%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

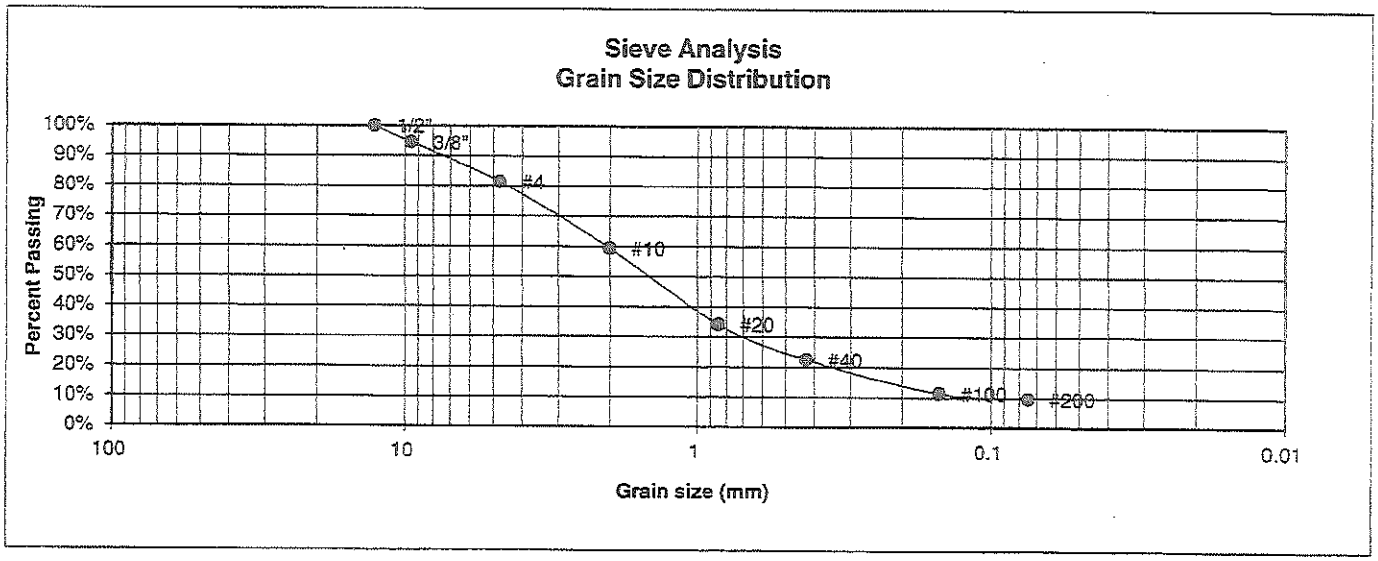
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	1/17/20

JOB NO.: 192115

FIG NO.: C-3

UNIFIED CLASSIFICATION	SM	CLIENT	LDC, INC.
SOIL TYPE #	2	PROJECT	DIDLEAU SUBDIVISION
TEST BORING #	TP-1	JOB NO.	192115
DEPTH (FT)	5-6	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	94.5%
4	81.3%
10	59.5%
20	34.1%
40	22.5%
100	11.4%
200	9.6%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

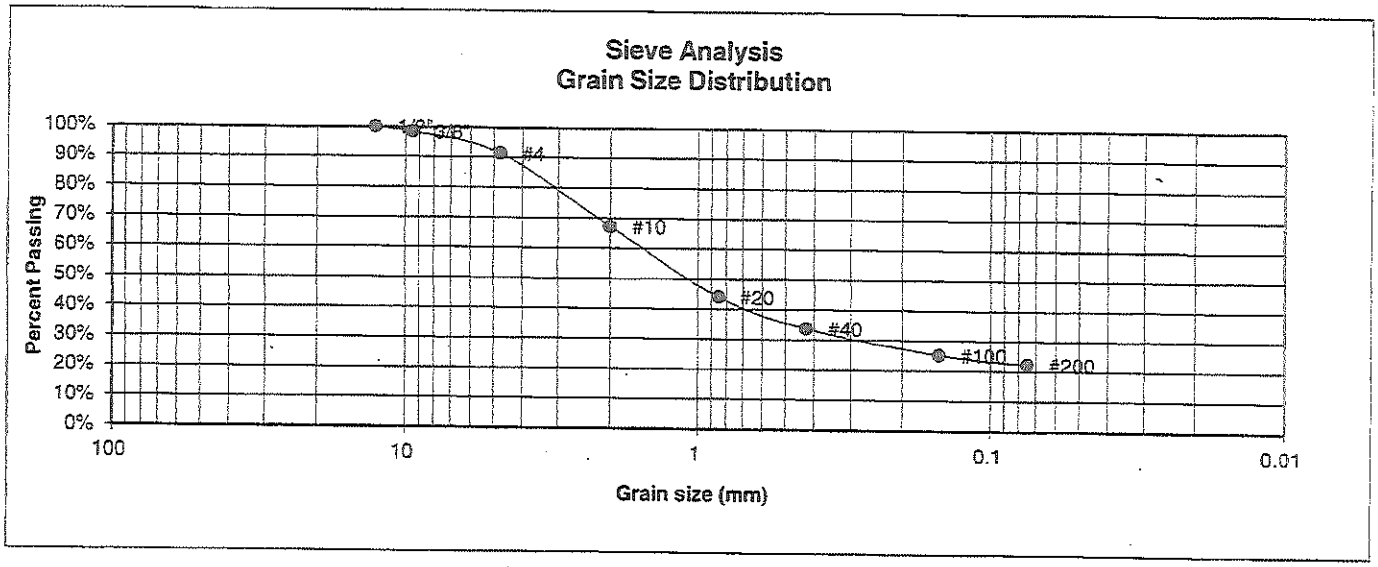
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	1/17/20

JOB NO.: 192115

FIG NO.: C-4

UNIFIED CLASSIFICATION	SM	CLIENT	LDC, INC.
SOIL TYPE #	2	PROJECT	DIDLEAU SUBDIVISION
TEST BORING #	1	JOB NO.	192115
DEPTH (FT)	15	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	98.4%
4	91.4%
10	67.2%
20	44.1%
40	33.8%
100	25.2%
200	22.2%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

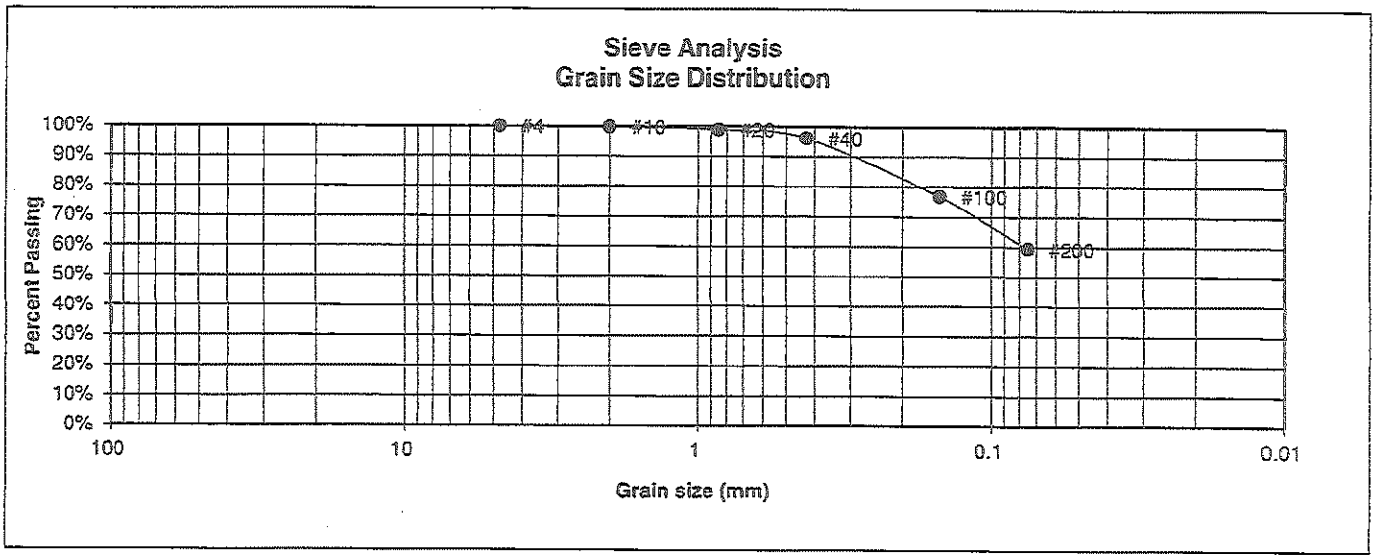
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE: 1/17/20

JOB NO.: 192115

FIG NO.: C-5

UNIFIED CLASSIFICATION	CL	CLIENT	LDC, INC.
SOIL TYPE #	3	PROJECT	DIDLEAU SUBDIVISION
TEST BORING #	2	JOB NO.	192115
DEPTH (FT)	10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.8%
20	98.9%
40	96.1%
100	76.9%
200	59.3%

Atterberg Limits

Plastic Limit

Liquid Limit

Plastic Index

Swell

Moisture at start	16.1%
Moisture at finish	20.4%
Moisture increase	4.3%
Initial dry density (pcf)	104
Swell (psf)	730

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505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

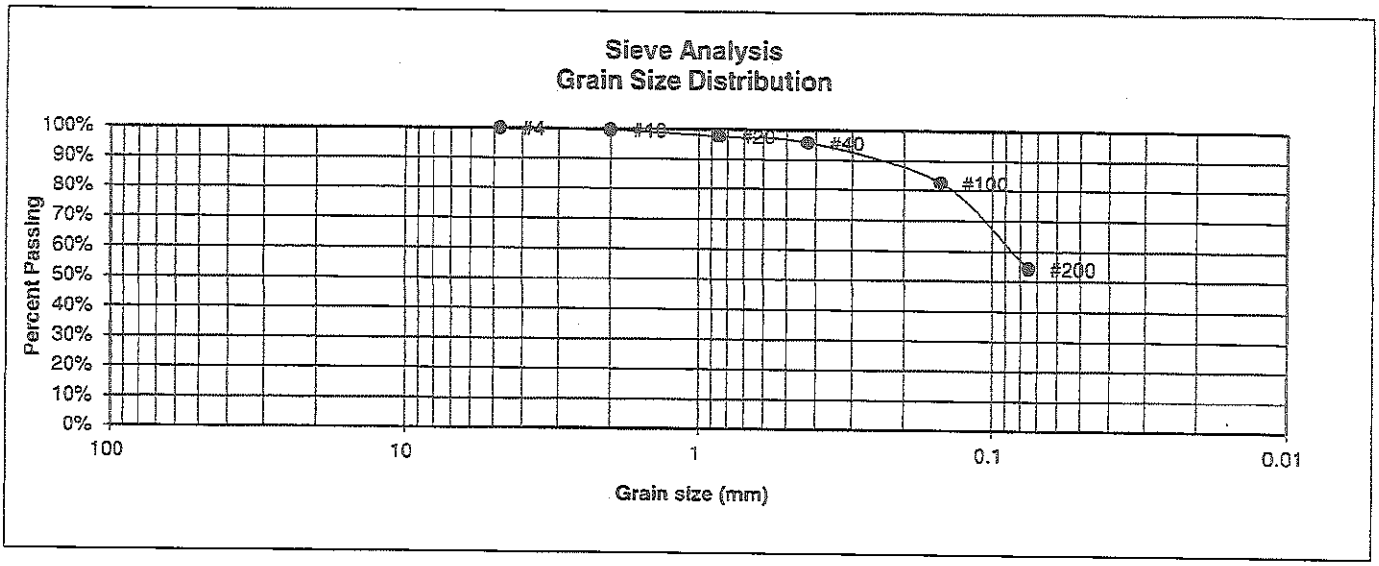
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			11/17/20

JOB NO.: 192115

FIG NO.: C-6

UNIFIED CLASSIFICATION	CL	CLIENT	LDC, INC.
SOIL TYPE #	3	PROJECT	DIDLEAU SUBDIVISION
TEST BORING #	2	JOB NO.	192115
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.6%
20	97.7%
40	95.7%
100	82.6%
200	54.2%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		a	1/17/20

JOB NO.: 192115

FIG NO.: C-7

APPENDIX D: Soil Survey Descriptions

El Paso County Area, Colorado

26—Elbeth sandy loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 367y
Elevation: 7,300 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Elbeth

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose

Typical profile

A - 0 to 3 inches: sandy loam
E - 3 to 23 inches: loamy sand
Bt - 23 to 68 inches: sandy clay loam
C - 68 to 74 inches: sandy clay loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

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

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 17, Sep 13, 2019

El Paso County Area, Colorado

40—Kettle gravelly loamy sand, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 368g
Elevation: 7,000 to 7,700 feet
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Kettle

Setting

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

Typical profile

E - 0 to 16 inches: gravelly loamy sand
Bt - 16 to 40 inches: gravelly sandy loam
C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 3 to 8 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 (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 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
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

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 17, Sep 13, 2019

Exhibit 11:

Discussion Summaries and Meeting minutes

From: Dan Kupferer
Sent: Tuesday, February 16, 2021 9:01 AM
To: Daniel Torres
Cc: Ryan Howser; Jack Patton; KEN HARRISON
Subject: RE: Forest Heights - MS206

Thank you Daniel. We appreciate your help and will get those plans prepared and submitted to EDARP.

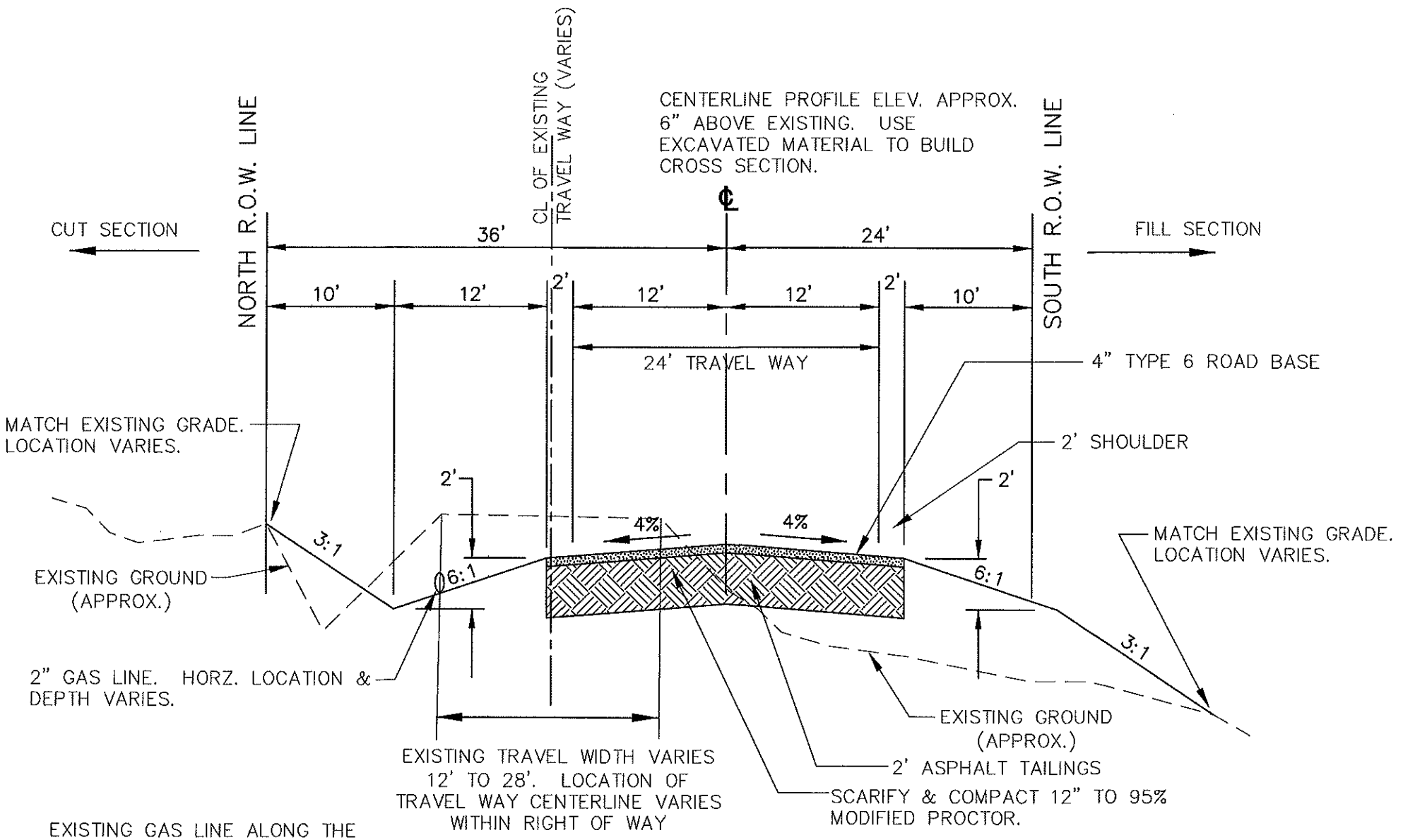
Dan

Daniel L. Kupferer, PLS
President
Land Development Consultants, Inc.
3898 Maizeland Road
Colorado Springs, CO 80909
719-528-6133 OFFICE
719-528-6848 FAX
719-338-1331 CELL

From: Daniel Torres [mailto:DanielTorres@elpasoco.com]
Sent: Tuesday, February 16, 2021 7:54 AM
To: Dan Kupferer
Cc: Ryan Howser; Jack Patton
Subject: Forest Heights - MS206

Good morning Dan,

I spoke to Elizabeth, my manager, regarding the reduced road section. She could be in support of a deviation providing 28 ft. travel way in lieu of the 32ft indicated in our Rural Gravel Local Roadway standard (detail SD_2-10, see below). All other aspects of the roadway shall meet the County standards. Also complete construction drawings shall be submitted through EDARP for review. She also agreed that the cul-de-sac should be extended to the east end of lot 1 and lot 2 as we discussed in our meeting.



EXISTING GAS LINE ALONG THE ENTIRE LENGTH OF THE NORTH SIDE OF FOREST HEIGHTS CIRCLE. CONTRACTOR IS RESPONSIBLE FOR THE HORIZONTAL & VERTICAL LOCATION OF THE PIPE.

TYPICAL ROADWAY SECTION
STA 4+35.85 TO 8+83.50

Black Forest Fire Rescue Protection District
11445 Teachout Road
Colorado Springs, Colorado 80908
Ph-719.495.4300
Fax 719.495.7504
Web- www.bffire.org

"Always Ready, Always Forward, Always Learning."

Office of the Fire Marshal

Thursday, August 27, 2020

Dear Ms. Didleau

Thank you for reaching out to me regarding your future road needs for the Forest Heights Estates sub-division. Per our current code Black Forest Fire Rescue is requiring the following Fire Access to your sub.

1. **403.3 Fire apparatus access road. (2006 WUI code)**When required, fire apparatus access roads shall be all-weather roads with a minimum width of 20 feet (6096 mm) and a clear height of 13 feet 6 inches (4115 mm); shall be designed to accommodate the loads (75,000lbs) and turning radii for fire apparatus; and have a gradient negotiable by the specific fire apparatus normally used at that location within the jurisdiction. Dead-end roads in excess of 150 feet (45 720 mm) in length shall be provided with turnarounds as approved by the code official. An all-weather road surface shall be any surface material acceptable to the code official that would normally allow the passage of emergency service vehicle.
2. Per 2015 IFC (amended), sec D103.4. Requirements for Dead-End Fire Apparatus Access Roads we are requiring a minimum of an 80-foot diameter cul-de-sac with curb and gutter or a 100-foot diameter cul-de-sac without curb and gutter.
3. As the road length is approximately 2200 ft to cul-de-sac, we will require a minimum of two turnouts along the main access roadway for emergency vehicle turnarounds. These turnouts should be spaced and located for maximum efficiency and shall be no less than 30 ft in length and 10 ft deep.

As you begin development of your project please be advised that your project, if 5 or more homes, will require a firefighting water supply source which is generally a water cistern located with the project and accessible to all fire apparatus or departments working in our district. This information is found in the NFPA sec 1142 (Standard on Water Supplies for suburban and Rural Fire Fighting) chapters 7 & 8. I will be happy to sit down and go over thee requirements with you as you progress in your project.

Thank you,

James Rebitski
Deputy Fire Chief

Exhibit 12

Photos

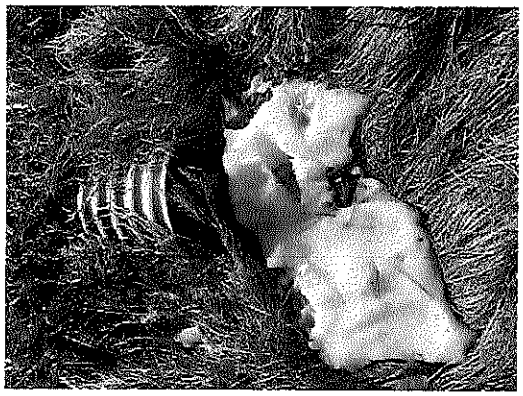


Figure 1: Upstream End of Culvert #1

Figure 2: Facing Downstream of Culvert #1

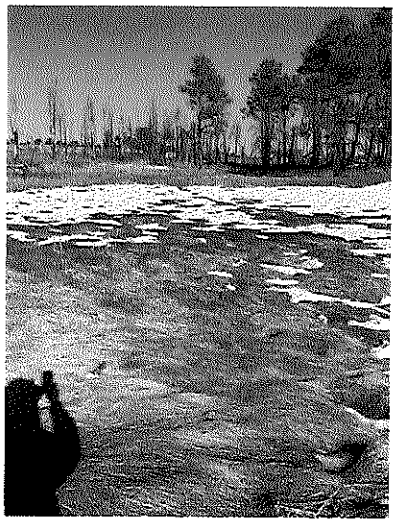


Figure 3: Wetlands upstream of Culvert 1

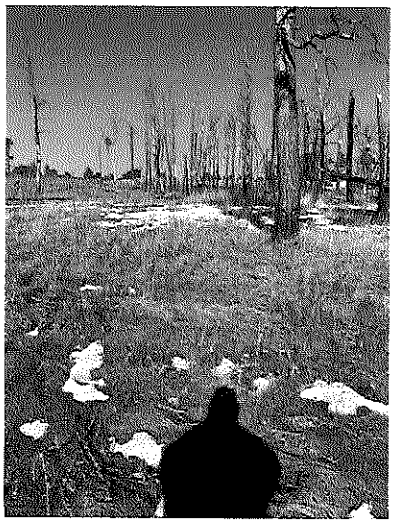


Figure 4: Facing NE from Wetland Area

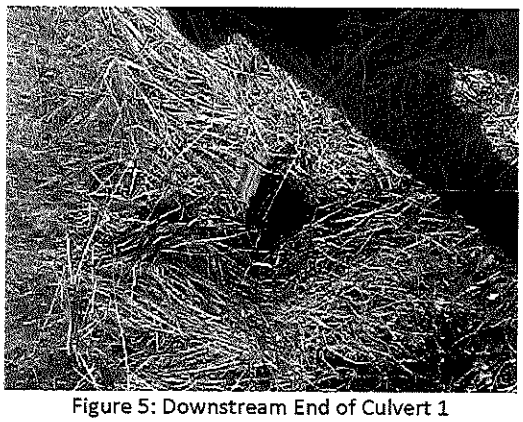


Figure 5: Downstream End of Culvert 1

Figure 6: Facing downstream of Culvert 1

Figure 7: 8250 Forest Heights Circle

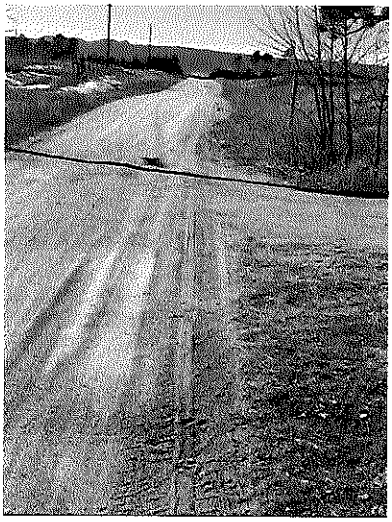


Figure 8: Facing west along northerly edge of road

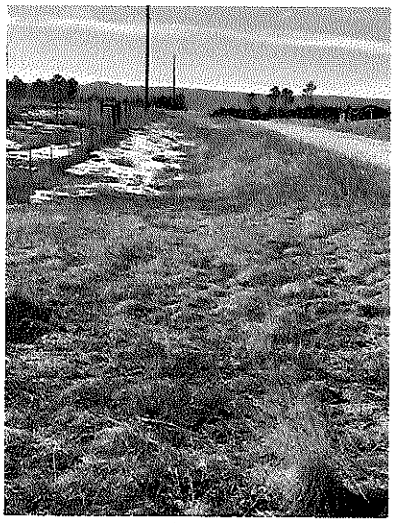


Figure 9: Facing west along southerly edge of road

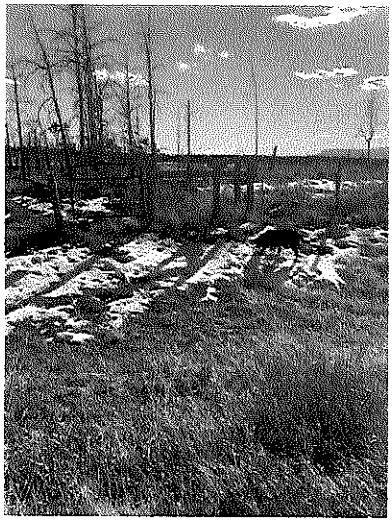


Figure 10: Facing south along property line


Figure 11: First Residence off of cul-de-sac

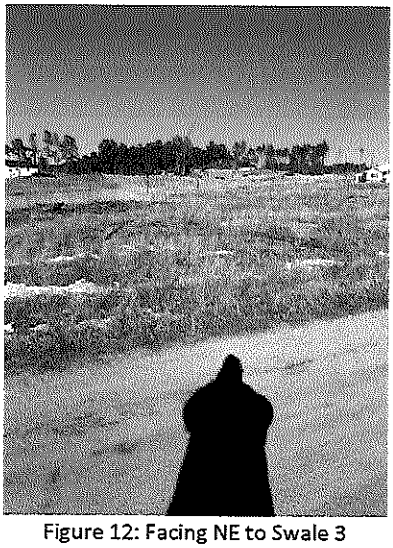


Figure 12: Facing NE to Swale 3

Figure 13: Wetland Area along east fork of Swale 3

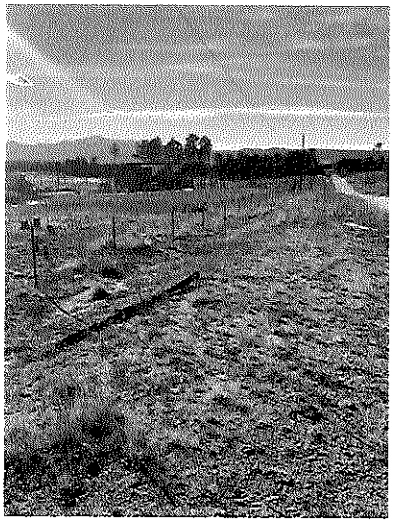


Figure 15: Facing SW of Prop Corner

Figure 14: Facing south along prop line

Figure 16: Facing north along gas line easement

Figure 17: Wetland area in Swale 3

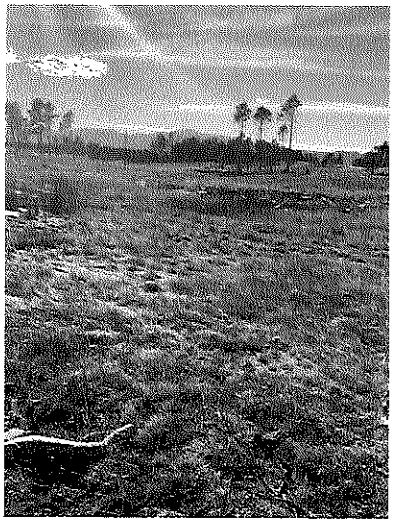


Figure 18: Facing SW at upper end of wetland area

Figure 19: facing NE along w. branch of swale 3

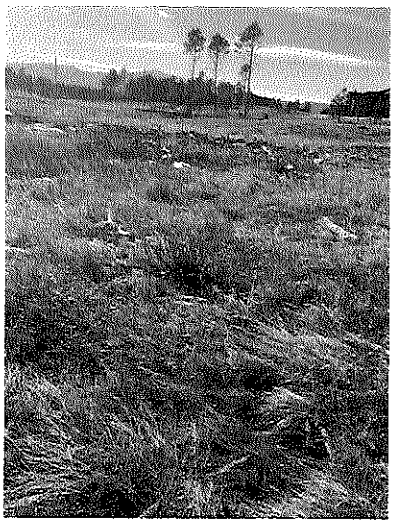


Figure 20: Facing SW along Swale 3

Figure 21: Upstream end of Culvert 2

Figure 22: Facing NE of Culvert 2

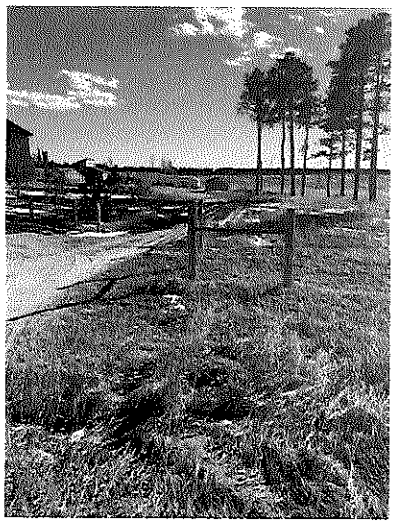


Figure 23: Facing SW along PL

Figure 24: Downstream end of Culvert 2

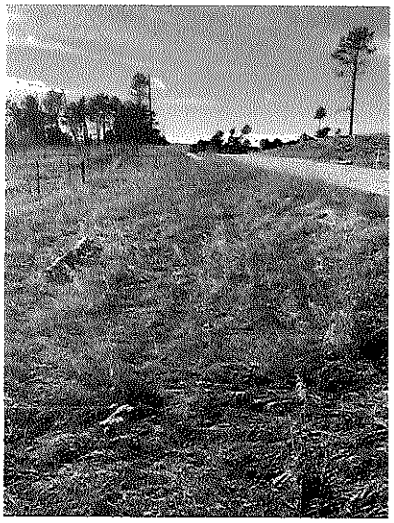


Figure 25: west along southerly edge

Figure 26: Facing east along northerly edge

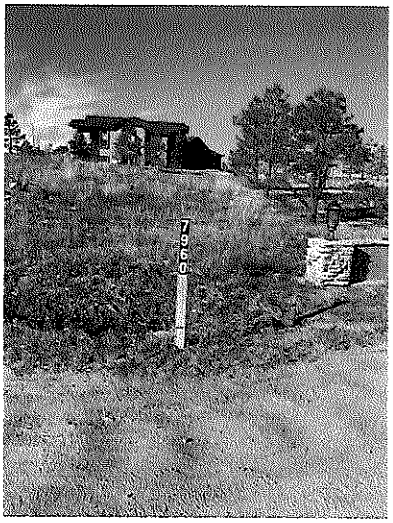


Figure 27: 7960 Forest Heights Circle

Figure 28: Facing south along PL

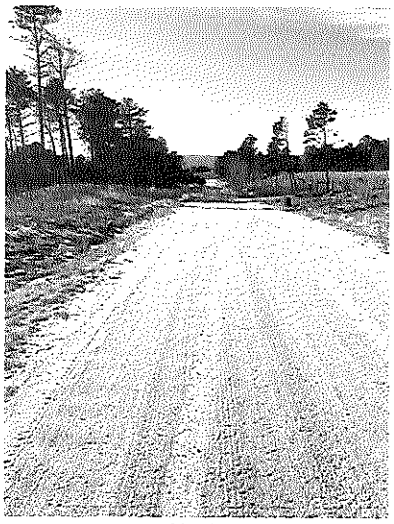


Figure 29:Top of high pnt facing west

Figure 30: Facing NE along Swale 5

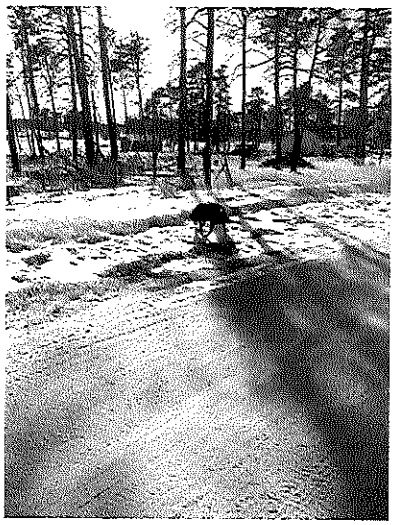


Figure 31:Facing SW along Swale 6

Figure 32: Water routed in northern borrow ditch

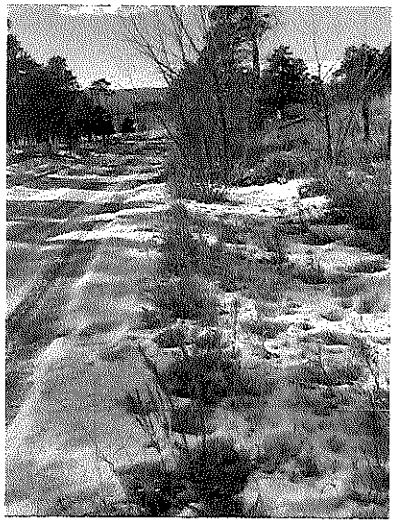


Figure 33: Facing west along north side

Figure 34: photo omitted

Figure 35: Facing west along S edge

Figure 36: 7940 Forest Heights Circle

Figure 37: Asphalt drive 7940 FHC

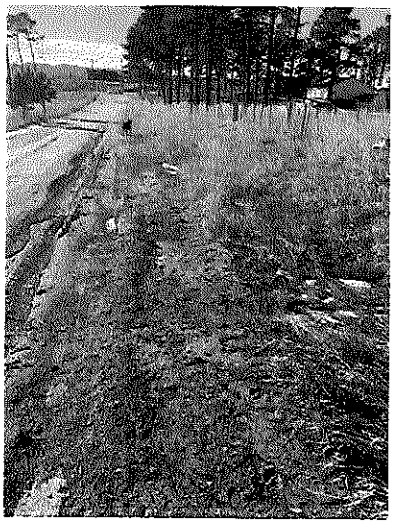


Figure 38: Facing west along northern edge

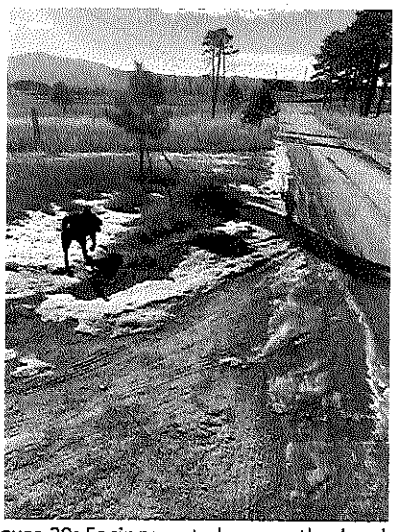


Figure 39: Facing west along southerly edge

Figure 40: wetland area east of culvert 3

Figure 41: Upstream end Culvert 3

Figure 42:Facing north of Culvert 3

Figure 43:Downstream end of Culvert 3

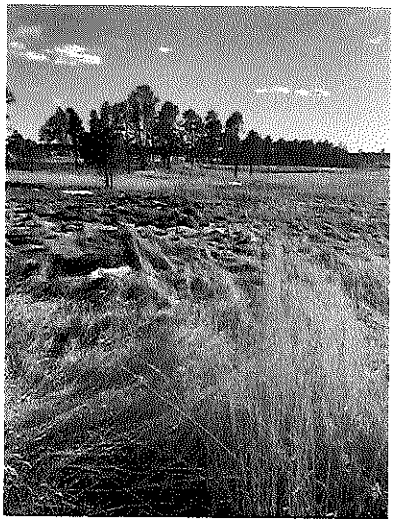


Figure 44: Facing downstream of Culvert 3

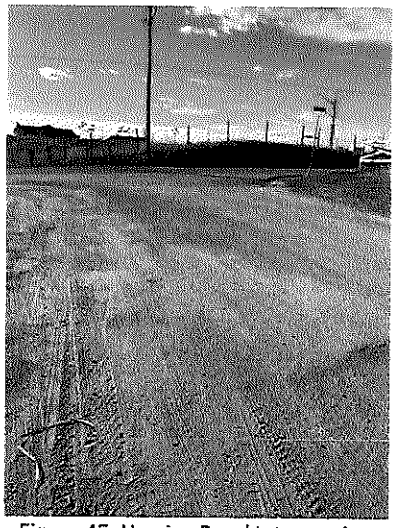


Figure 45: Herring Road Intersection

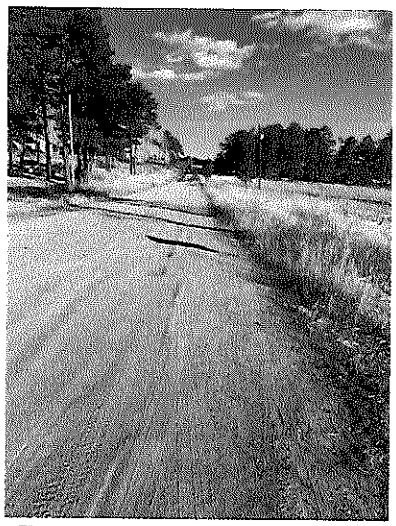


Figure 46: Facing east of intersection

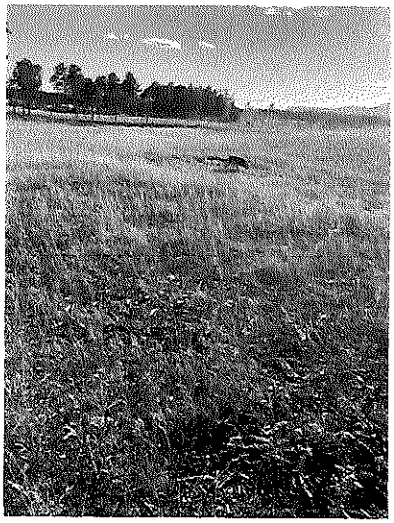


Figure 47: Facing south to culvert under Herring

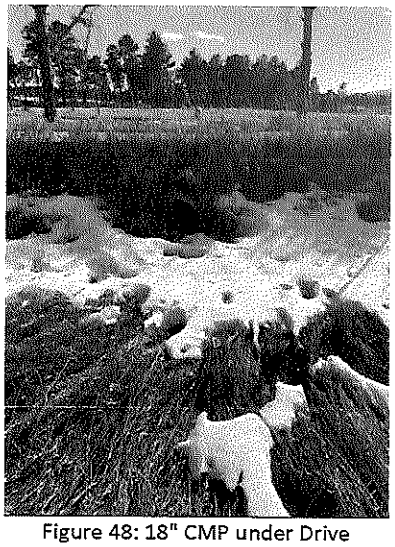


Figure 48: 18" CMP under Drive

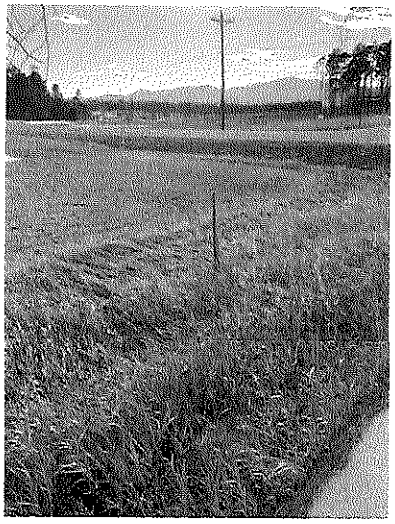


Figure 49: Facing SW at Herring Rd Crossing

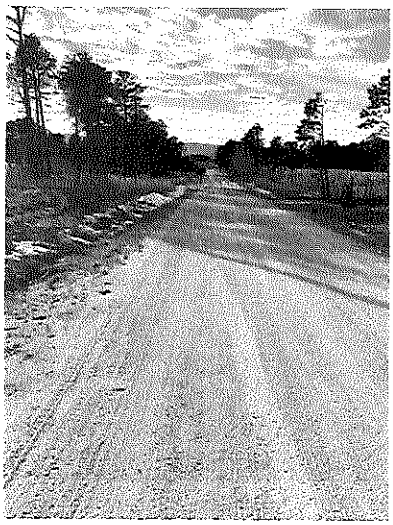


Figure 50: Facing west from High pnt 1 east of Herring

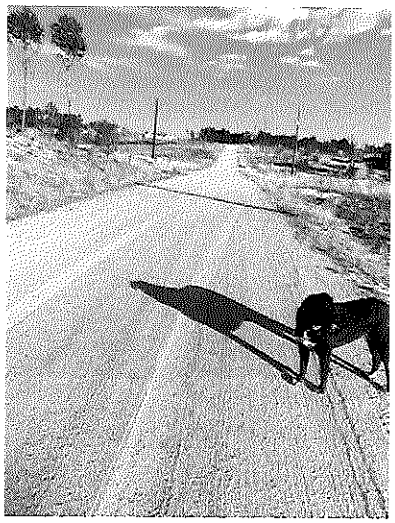


Figure 51: Facing east from first HP

Figure 52: Facing downstream of culvert 2

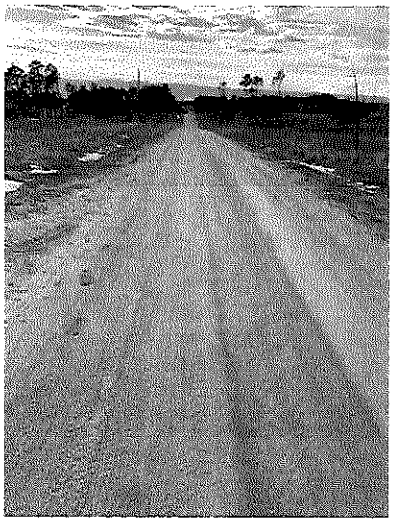


Figure 53: Facing west of 2nd HP

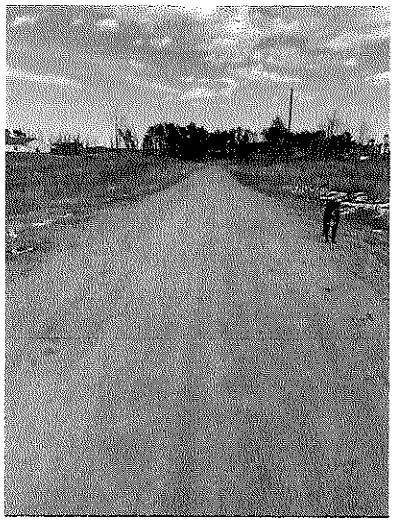


Figure 54: Facing west from 2nd HP

Figure 55: culvert under Herring

Figure 56: Culvert under Herring

Exhibit 13

Maintenance Agreement

ACCESS EASEMENT GRANT AND MAINTENANCE AGREEMENT FOR FOREST HEIGHTS CIRCLE AND RESTRICTIVE COVENANTS FOR LOTS 1, 2 & 3 FOREST HEIGHTS ESTATES SUBDIVISION

This Access Easement Grant And Maintenance Agreement For Forest Heights Circle And Restrictive Covenants For Forest Heights Estates Subdivision, dated for reference this _____ day of _____, 2022, (Agreement) is made among Phyllis J Didleau Revocable Trust, Jon P. Didleaux, Leilani A Ritchie, Charles F. Bauer and Shirley L. Bauer, and Frederick J. Yonce (each individually an "Owner" and collectively the "Owners").

RECITALS:

A. Phyllis J Didleau Revocable Trust and Jon P Didleaux are the owner of the real property situated in the County of El Paso, State of Colorado described on Exhibit A (Assessor Parcel # 5209000121).
B. Phyllis J Didleau Revocable Trust is the owner of the real property situated in El Paso County State of Colorado described on Exhibit A-1 (Assessor Parcel 5209000081)
C. Phyllis J Didleau Revocable Trust and Jon Didleaux are the owners of real property situated in the County of El Paso, State of Colorado described on Exhibit B (Assessor Parcel # 5209000120).
D. Phyllis J Didleau Revocable Trust and Jon P Didleaux are the owners of the real property situated in the County of El Paso, State of Colorado described on Exhibit C (Assessor Parcel # 5209000050).
E. Leilani A Ritchie is the owner of the real estate situated in the County of El Paso, State of Colorado described on Exhibit D (Assessor Parcel # 5209000103).
F. Charles, F. Bauer and Shirley L Bauer are the owners of the real property situated in the County of El Paso, State of Colorado described on Exhibit E (Assessor Parcel # 5209000100).

G. Frederick J. Yonce is the owner of the real property situated in the County of El Paso, State of Colorado described on Exhibit F (Assessor Parcel # 5209000119).
H. Judith P. Von Ahlefeldt is the owner of the real property situated in the County of El Paso, State of Colorado described on Exhibit G (Assessor Parcel # 5209000108).
I. Phyllis J Didleau Revocable Trust, Jon P. Didleaux (a/k/a Jon Didleaux) and Frederick J. Yonce, (collectively referred to herein as "Grantors") wish to grant an access easement to the Owners across the property described in Exhibits A, A-1, B, and F and to establish and provide for the maintenance of a private right of way and road within the access easement for the use and benefit of all Owners and Judith P. Von Ahlefeldt.
J. The access easement within which the private right of way and road is located is legally described in Exhibit H (the "Private Road Land").
K. The Owners understand that El Paso County does not maintain private roads such as the one subject to this Agreement.
L. The Owners wish to provide for and set forth their understandings and agreement with respect to use and maintenance of the private road and improvements thereon.
M. Phyllis J Didleau Revocable Trust and Jon P. Didleaux have submitted an application to subdivide the property described in Exhibits A, B, and C with El Paso County and desire to have this Agreement meet the requirements of El Paso County for County approval of such subdivision.
N. This Agreement shall become fully in force, as to all Owners who have signed, upon the recording of the Final Plat of Forest Heights Estates Subdivision in the real estate records of El Paso County, Colorado.

NOW THEREFORE, in consideration of the sum of Ten Dollars ($10.00) and other valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the following grants, agreement, covenants, declaration and restrictions are made:

PRIVATE ROAD – FOREST HEIGHTS CIRCLE

1. Grant of Easement. Each of the Grantors hereby grants to each Owner and to Judith P. Von Ahlefeldt and their successors and assigns, a nonexclusive easement for access, utilities and drainage for the benefit of each such landowner's respective parcel described above across the Private Road Land.

2. Use of the Owners' Real Estate. Use of the Private Road Land by the Owners is not confined to the present configuration of their respective properties, and the Owners or their successors may subdivide, reconfigure, construct improvements on or otherwise modify or use their property. However, the Owners agree to construct no fences or place any other obstructions on their respective properties in a manner which would prevent, or reasonably impede, vehicle or personnel travel, utility access or drainage across the Private Road Land. Otherwise, the respective Owners

each shall have full use and occupancy of their respective real estate which is subject to the easement set forth above.

3. Construction of the Private Road. After recording of the Final Plat submitted by Phyllis J Didleau Revocable Trust and Jon Didleaux, without cost to the other Owners, Phyllis J Didleau Revocable Trust and Jon Didleaux shall improve the road to meet the standards required by the County approval of the Final Plat and shall provide maintenance of the road until such improvements are substantially complete.

4. Maintenance of the Private Road. Following construction of the Private Road, as a general standard, the Owners agree that they shall provide maintenance sufficient to provide reasonable access for emergency vehicles and in no event less than has traditionally been the maintenance level of this access prior to the subdivision. The Owners may by majority vote adopt (and modify) specific standards for maintenance from time to time. The Owners of each residence shall collectively have one vote regardless of the number of Owners of that residence. The Owners agree to share the cost and expense of maintaining the improvements on the Private Road Land in good operating condition and to share equally the cost and expense of affecting any repair to said Improvements accruing from and after the date of this Agreement. For purposes of this cost sharing, each Owner shall pay a share for each residential dwelling unit on such Owner's real estate, including a dwelling unit under construction and a "mother-in-law" unit. For example, if there are seven parcels of real estate, and five residences (whether occupied or not), each Owner with a residence on such Owner's property shall pay one fifth ($1/5^{th}$) of the cost of maintaining the improvements for each such residence on such Owner's property.

5. Maintenance Process. The Owners appoint Jon P. Didleaux and Frederick J. Yonce as Co-Administrators for maintenance of the road under this Agreement. Whenever in the opinion of the Administrators the road requires such maintenance, on behalf of the Owners, the Administrators shall order and arrange for sufficient maintenance meet the standard above and to enable the Owners and emergency vehicles to use the roadway. Such maintenance shall include snow removal, grading, re-gravelling, cleaning culverts, weed treatment, tree and debris removal, and any other maintenance generally desired by Owners. The Administrators shall annually no later than September 30 submit to the Owners a budget for the succeeding 12 months. If the budget is approved by the majority of the Owners, each Owner shall by December 1 pay such Owner's share of the amount set forth in the budget into a fund run by the Administrators. The budget shall include a reasonable amount to build up a reserve to prevent the need for large expenditures in any one year. The Administrators shall use the fund to pay for maintenance to meet the standards above and any which may be adopted by the Owners. To the extent any Owner fails to pay such Owner's proportionate share of the adopted budget, the Administrators, on behalf of all the Owners, shall have a lien on each such Owner's respective real estate as set forth above until such Owner's share is paid in full with interest accruing on any unpaid amount at the rate of 10% per annum simple interest and

the Administrators shall be entitled to recover the costs of enforcing such lien and collecting such amount, including reasonable legal fees, expert witness fees and costs. The Administrators may refuse to order such maintenance until there is, in the Administrators' opinion, sufficient commitment or actual payment to pay for such maintenance. Each Owner's share shall be the proportion that the number of dwelling units (including dwelling units under construction) on such Owner's real estate above bears to the total number of dwelling units on the real estate above of all Owners. Owners of the real estate with 60% of the dwelling units accessing by the road may change who are the Co-Administrators. Administrators shall serve without compensation unless otherwise determined by Owners of the real estate with 60% of the dwelling units on the real estate of All Owners.

RESTRICTIVE COVENANTS FOR LOTS 1, 2 & 3 TO PRESERVE THE RURAL/RESIDENTIAL CHARACTER OF FOREST HEIGHTS ESTATES

6. Property Uses.
   Lots 1, 2, and 3 in Forest Heights Estates Subdivision shall be used exclusively for private residential purposes. No dwelling erected or maintained within the Subdivision shall be used or occupied for any purpose other than for a single-family dwelling. The construction of separate guest quarters and "mother-in-law" quarters may be allowed on a Lot on a case-by-case basis if approved by the appropriate zoning authority, subject to any conditions in such approvals.

7. Construction Type. All construction on Lots 1, 2 and 3 of Forest Heights Estates Subdivision shall be new.

8. Substantial Completion. A Structure shall not be occupied in the course of original construction until substantially completed and approved for occupancy by the appropriate governmental authorities.

9. Dwelling Area Requirements. No dwelling Structure shall be constructed unless the ground floor area, or footprint area, of the main Structure, exclusive of open porches, basements and garages, is more than 1,500 square feet.

10. Enforcement. Each Owner of a Lot in Forest Heights Estates Subdivision shall have the right to enforce these Covenants To Preserve The Rural/Residential Character Of Forest Heights Estates and no other persons shall gain any legal or equitable rights to enforce these Restrictive Covenants.

BINDING AGREEMENT

11. Agreement Runs With the Land. This Agreement shall be binding upon the undersigned Owners, and their respective successors, assigns, and personal representatives. This Agreement may not be revoked without the written unanimous consent of the affected Owners. This Agreement shall be recorded in the land records of the Office of the Clerk and Recorder of El Paso County, Colorado, and

shall be a covenant running with the lands of the Owners as those lands are described herein above, and shall be enforceable by the Owners' successors and assigns and personal representatives. Any persons or other entities who acquire title to the Owners' property hereinabove described, whether by purchase or otherwise, shall be subject to the provisions of this Agreement to the same extent as if such parties had been signatory to this Agreement. This Agreement may be executed in multiple counterparts, each of which shall constitute an original and all of which shall constitute one document.

12. Effectiveness. This Agreement shall be effective as to each signatory hereto, on the later of the (a) date on which they sign or the (b) date this Agreement is recorded in the real estate records of El Paso County after County approval of the Final Plat of Forest Heights Estates.

OWNERS:
Phyllis J Didleau Revocable Trust

By: _____
Phyllis J Didleau, Trustee

_____
Jon P. Didleaux (a/k/a Jon Didleaux)

STATE OF COLORADO)
) ss.
COUNTY OF EL PASO)

This instrument was acknowledged before me on _____, by Phyllis Didleau as Trustee of the Phyllis J Didleau Revocable Trust and by Jon P. Didleaux (a/k/a Jon Didleaux).

[Seal]

_____
_____, Notary Public
My commission expires: _____

_____

Leilani A Ritchie

STATE OF COLORADO)
) ss.
COUNTY OF EL PASO)

This instrument was acknowledged before me on _____, by Leilani A Ritchie.

[Seal]

_____
_____, Notary Public
My commission expires: _____

_____ _____

Charles, F. Bauer Shirley L Bauer

STATE OF COLORADO)
) ss.
COUNTY OF EL PASO)

This instrument was acknowledged before me on _____, by Charles, F. Bauer and Shirley L Bauer.

[Seal]

_____
_____, Notary Public
My commission expires: _____

_____

Frederick J. Yonce

STATE OF COLORADO)
) ss.
COUNTY OF EL PASO)

This instrument was acknowledged before me on _____, by Frederick J. Yonce.

[Seal]

_____
_____, Notary Public
My commission expires: _____

Exhibit 14:

Historic and Developed Drainage Conditions Map

DESIGN POINT SUMMARY

DESIGN POINT	CONTRIB SUB BASINS	AREA (acres)	Q5 (cfs)	Q100 (cfs)
1	EASTERLY END OF CUL-DE-SAC			
2	A	17.4	3.7	24.0
3	HIGH POINT BETWEEN A & B			
4	B	20.8	4.6	29.5
5	C	3.9	1.8	8.4
6	RIDGELINE INTERSECTION BETWEEN C & D			
7	C,D,E	13.7	5.9	28.7
8	HIGH POINT ALONG HERRING ROAD			
9	E	2.3	1.4	5.5
10	D,E	9.8	4.1	20.1
11	B,C,D,E,H,I	63.5	17.9	117.9
12	J	3.4	1.0	7.1
13	F	18.7	3.1	21.1
14	A,G	27.3	6.7	41.4
15	A,F,G	46	9.8	63.3

DP16 data is missing. Please include

SWALE SUMMARY

SWALE #	CONTRIBUTING SUBBASINS	SLOPE %	DESIGN FLOW Q5 cfs	DESIGN FLOW Q100 cfs	DEPTH OF FLOW Q5 ft	DEPTH OF FLOW Q100 ft	VELOCITY Q5 fps	VELOCITY Q100 fps	FROUDE # 5 year	FROUDE # 100 year
1	A	4.5	3.7	24.0	0.1	0.2	1.2	2.7	0.91	1.16
2	A,G	3.1	5.7	38.1	0.1	0.3	1.5	2.9	0.84	1.02
3	B	4.6	4.6	29.5	0.1	0.3	1.8	3.7	1.04	1.28
4	B,H	3.3	10.2	64.2	0.1	0.2	1.4	2.9	0.87	1.06
5	C	5.5	1.8	8.4	0.1	0.1	1.3	2.4	1.00	1.20
6	D	6.0	4.1	20.3	0.1	0.2	1.9	3.5	1.18	1.37
7	SWALE OMMITTED FOR DRAINAGE PLAN									
8	C,D,E,I	3.3	8.7	43.8	0.1	0.3	1.8	3.1	0.91	1.06
9	SWALE OMMITTED FOR DRAINAGE PLAN									
10	F	5.3	3.1	21.1	0.1	0.3	1.7	3.4	1.09	1.30
11	J	3.1	1.0	7.1	0.0	0.1	0.6	1.4	0.70	0.86
12	A,G,F	6.1	9.8	63.3	0.1	0.3	2.2	4.9	1.20	1.70
13	PORTIONS OF AREA H ADJACENT TO ROAD	6.9	0.9	2.9	0.1	0.2	3.2	4.5	1.83	1.98
14	SMALL PORTION OF AREA B	2.1	0.2	0.6	0.1	0.1	1.3	1.8	0.90	1.00
15	PORTIONS OF AREAS C, D	4.4	0.4	1.2	0.1	0.2	2.1	3.1	1.37	1.50
16	PORTIONS OF AREA C, D ADJACENT TO ROAD	3.0	2.2	12.1	0.2	0.5	3.1	5.0	1.34	1.49
17	PORTIONS OF AREAS E, D	0.6	0.3	1.3	0.1	0.3	1.0	1.5	0.53	0.60

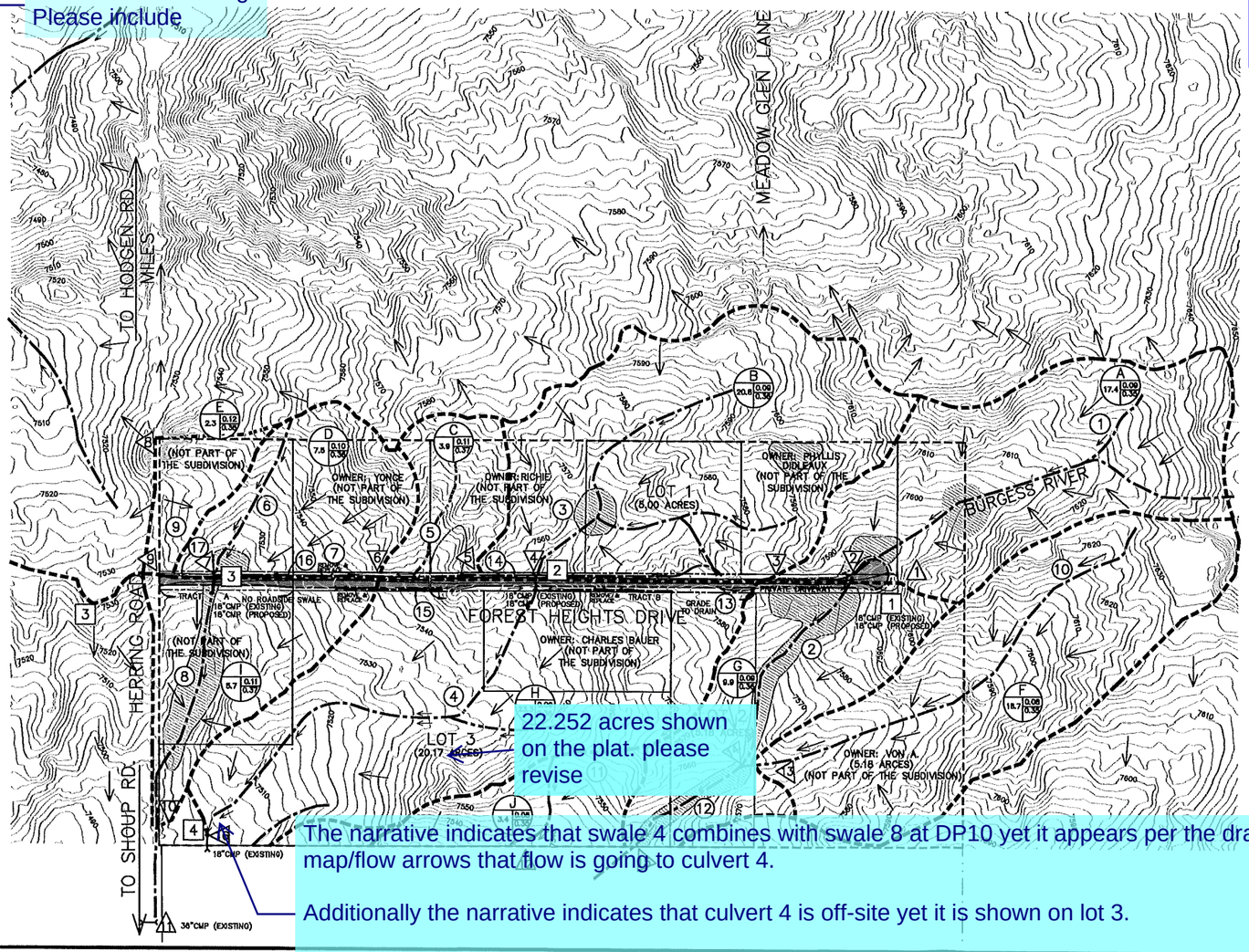
BASIN SUMMARY

BASIN I.D.	AREA (acres)	RUNOFF COEFFICIENTS (existing) C5	RUNOFF COEFFICIENTS (existing) C100	RUNOFF COEFFICIENTS (developed) C5	RUNOFF COEFFICIENTS (developed) C100	EXSITING RUNOFF Q5 cfs	EXSITING RUNOFF Q100 cfs	DEVELOPED RUNOFF Q5 cfs	DEVELOPED RUNOFF Q100 cfs
A	17.4	0.09	0.35	0.09	0.36	3.4	23.6	3.7	24
B	20.8	0.09	0.35	0.1	0.36	4.4	29.1	4.6	29.5
C	3.9	0.11	0.37	0.14	0.39	1.4	7.9	1.8	8.4
D	7.5	0.1	0.36	0.12	0.38	2.3	14.3	2.7	14.8
E	2.3	0.12	0.38	0.18	0.42	1	4.9	1.4	5.5
F	18.7	0.08	0.35	0.09	0.35	2	20.7	3.1	21.1
G	9.9	0.09	0.36	0.1	0.37	2.7	17.8	3	18.2
H	23.3	0.09	0.36	0.1	0.38	5.3	34.3	5.6	34.7
I	5.7	0.11	0.37	0.13	0.38	2.4	13.7	2.8	14.3
J	3.4	0.08	0.35	0.08	0.35	1	7.1	1	7.1
SWALE 13 AREA	SM. PORTION OF SUBBASIN H	N/A	N/A	0.25	0.46	N/A	N/A	0.9	2.9
SWALE 14 AREA	SM. PORTION OF SUBBASIN B	N/A	N/A	0.1	0.16	N/A	N/A	0.2	0.6
SWALE 15 AREA	SM. PORTION OF SUBBASIN C	N/A	N/A	0.33	0.52	N/A	N/A	0.4	1.2
SWALE 16 AREA	SM. PORTION OF SUBBASIN D	N/A	N/A	0.11	0.37	N/A	N/A	2.2	12.1
SWALE 17 AREA	SM. PORTION OF SUBBASIN D	N/A	N/A	0.17	0.41	N/A	N/A	0.3	1.3

CULVERT SUMMARY

CULVERT #	SIZE	MATERIAL	CONTRIBUTING SUBBASINS	5 YEAR Q (cfs)	5 YEAR HEADWATER REQUIRED	100 YEAR Q (cfs)	100 YEAR HEADWATER REQUIRED	CONDITION
1	18"	CMP	A	3.7	12.8"	24.0	> 7.5 FT	75% SILTED, ROADWAY OVERTOPPING WITH 100 YR
2	18"	CMP	B	4.6	15.3"	29.5	> 9 FT	75% SILTED, ROADWAY OVERTOPPING WITH 100 YR
3	18"	CMP	C, D, E	5.9	18.7"	28.7	> 9 FT	75% SILTED, ROADWAY OVERTOPPING WITH 100 YR
4	18"	CMP	A, B, C, D, E, H, I	20.8	6 FT	124.0	> 9 FT	PRIVATE CULVERT UNDER PRIVATE DRIVEWAY

Review 1 comment:. Please coordinate with LDC to indicate the required drainage easements on the proposed lots to be platted. In rural subdivisions where no overlot site grading will be performed and "natural" drainageways will be conveying developed runoff, the easement width for increased capacity of these drainage channels will be determined by the engineer (ECM 3.3.4).
REview 2: Unresolved.



22.252 acres shown on the plat. please revise

The narrative indicates that swale 4 combines with swale 8 at DP10 yet it appears per the drainage map/flow arrows that flow is going to culvert 4.

Additionally the narrative indicates that culvert 4 is off-site yet it is shown on lot 3.

Please revise the drainage map or narrative/design accordingly.

200' 0 200' 400'
SCALE: 200'

Review 1 comment: Are these existing or proposed. Please clarify
Review 2: unresolved

LEGEND:

- DIRECTION OF FLOW
- PROJECT BOUNDRY
- FLOWLINE NATURAL SWALE
- SUBBASIN BOUNDRY
- DESIGN POINT
- SWALE NUMBER
- SUBDIVISION I.D. / 5 YR. RUNOFF COEFFICIENT / 100 YR. RUNOFF COEFFICIENT (AREA (ARCES))
- CULVERT
- CULVERT NUMBER
- INDEX CONTOURS
- INTERMEDIATE CONTOURS
- EXISTING RESIDENCE (APPROX.)
- PROPOSED RESIDENCE
- WETLAND LIMIT (APPROX.)
- EXISTING LOT LINES
- PROPOSED LOT LINE
- SUBDIVISION BOUNDRY
- EXISTING ROAD (GRAVEL)
- PROPOSED ROAD (GRAVEL)
- ROADSIDE DITCHES

NOTES:
- NO NEW CONSTRUCTION; BUILDINGS, BARNS, FENCES, DRIVEWAYS, AND/OR LANDSCAPING, SHALL BE INSTALLED IN ANY EXISTING DRAINAGEWAY AND/OR SWALE SO AS TO IMPEDE THE FLOW OF STORM WATER RUNOFF.
- TRACT AREAS:
  TRACT A = 0.598 acres
  TRACT B = 2.093 acres

NOT FOR CONSTRUCTION:
THESE PLANS ARE INTENDED FOR SUBMITTAL, REVIEW AND APPROVAL BY EPC COUNTY PLANNING DEPARTMENT AND SHOULD NOT BE USED ON SITE FOR CONSTRUCTION OR LAYOUT.

CALL BEFORE YOU DIG ... DIAL 811
48 HOURS BEFORE YOU DIG, CALL UTILITY LOCATIONS FOR LOCATING AND MARKING ELECTRICAL, WATER AND WASTEWATER.

REVISIONS

No.	Description	By	Date
1	REV PER COUNTY COMMENTS	DAB	10/1/21
2	LOT REVISIONS	DAB	02/15/22
3	ROAD REVISIONS	DAB	04/12/22

H Scale: 1" = 200'
V Scale:
Designed By: KH
Drawn By: TLC
Checked By: KH
Date: 07/16/221

Land Development Consultants, Inc.
Planning · Landscape Architecture
Engineering · Surveying
www.ldc-inc.com · TEL: (719) 528-6133 · FAX: (719) 528-6848
2250 Somerset Park Circle West · Colorado Springs, CO 80917

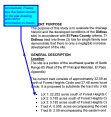
DRAINAGE MAP
DIDLEAU SUBDIVISON
FOREST HEIGHT ESTATES

Project Number: 18070
Sheet: 1 of 1

P:\18000\18070-Didleau property\0502 ENGINEERING\18070 FOREST HEIGHTS DRAINAGE MAP 040722.DWG

Drainage Report_v2_Comments.pdf Markup Summary

Callout (26)



Subject: Callout
Page Label: 4
Author: lpackman
Date: 6/13/2022 2:35:33 PM
Status:
Color:
Layer:
Space:

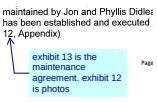
Unresolved. Please see the latest version of the plat drawing and revise information to match.

Subject: Callout
Page Label: 20
Author: lpackman
Date: 6/14/2022 7:58:17 AM
Status:
Color:
Layer:
Space:

Unresolved. The culverts shall be re-evaluated for the proposed conditions. Please analyze and state whether the culverts meet the criteria in DCM vol 1 CH6 for cross street flow (table 6-1).
Also the swales that will receive developed flows from the proposed lots (swales 3, 4, 11, 12)should be re-evaluated and the report should demonstrate the increase flows in comparison to the existing conditions flows.

Subject: Callout
Page Label: 21
Author: lpackman
Date: 6/14/2022 8:03:23 AM
Status:
Color:
Layer:
Space:

Please determine whether replacement of all culverts are necessary if field investigation shows existing culverts are functioning.



Subject: Callout
Page Label: 7
Author: Daniel Torres
Date: 6/16/2022 1:54:20 PM
Status:
Color:
Layer:
Space:

exhibit 13 is the maintenance agreement. exhibit 12 is photos

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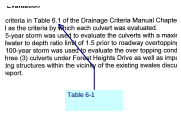
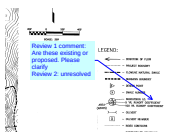


Subject: Callout
Page Label: 5
Author: Daniel Torres
Date: 6/16/2022 10:45:26 PM
Status:
Color:
Layer:
Space:

Table 6-1



Subject: Callout
Page Label: 191
Author: Daniel Torres
Date: 6/16/2022 11:09:28 PM
Status:
Color:
Layer:
Space:

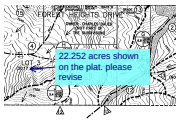
Review 1 comment: Are these existing or proposed. Please clarify
Review 2: unresolved

Subject: Callout
Page Label: 191
Author: Daniel Torres
Date: 6/16/2022 11:10:28 PM
Status:
Color:
Layer:
Space:

The narrative indicates that swale 4 combines with swale 8 at DP10 yet it appears per the drainage map/flow arrows that flow is going to culvert 4.

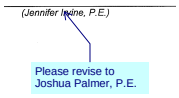
Additionally the narrative indicates that culvert 4 is off-site yet it is shown on lot 3.

Please revise the drainage map or narrative/design accordingly.



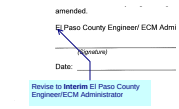
Subject: Callout
Page Label: 191
Author: Daniel Torres
Date: 6/16/2022 11:12:35 PM
Status:
Color:
Layer:
Space:

22.252 acres shown on the plat. please revise



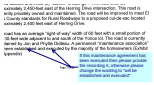
Subject: Callout
Page Label: 3
Author: Daniel Torres
Date: 6/16/2022 11:28:36 AM
Status:
Color:
Layer:
Space:

Please revise to Joshua Palmer, P.E.



Subject: Callout
Page Label: 3
Author: Daniel Torres
Date: 6/16/2022 11:29:30 AM
Status:
Color:
Layer:
Space:

Revise to Interim El Paso County Engineer/ECM Administrator

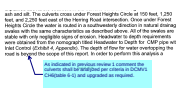


Subject: Callout
Page Label: 7
Author: Daniel Torres
Date: 6/16/2022 2:25:54 PM
Status:
Color:
Layer:
Space:

If this maintenance agreement has been executed then please provide the recording #, otherwise please change the wording to "will be established and executed"

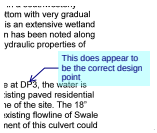
Subject: Callout
Page Label: 7
Author: Daniel Torres
Date: 6/16/2022 4:27:01 PM
Status:
Color:
Layer:
Space:

This statement "maintenance project" is not clear/confusing.
The developer will be responsible for constructing the roadway per the construction plans submitted. The future maintenance of the roadway will be per the maintenance agreement. revise the statement accordingly to provide clarity.



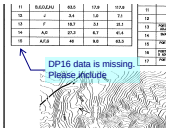
Subject: Callout
Page Label: 8
Author: Daniel Torres
Date: 6/16/2022 5:21:41 PM
Status:
Color:
Layer:
Space:

As indicated in previous review 1 comment the culverts shall be analyzed per criteria in DCMV1 CH6(table 6-1) and upgraded as required.



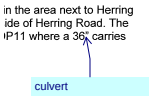
Subject: Callout
Page Label: 14
Author: Daniel Torres
Date: 6/16/2022 5:43:57 PM
Status:
Color:
Layer:
Space:

This does appear to be the correct design point



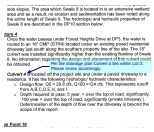
Subject: Callout
Page Label: 191
Author: Daniel Torres
Date: 6/16/2022 5:58:31 PM
Status:
Color:
Layer:
Space:

DP16 data is missing. Please include



Subject: Callout
Page Label: 14
Author: Daniel Torres
Date: 6/16/2022 7:31:19 PM
Status:
Color:
Layer:
Space:

culvert

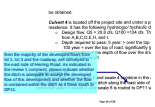


Subject: Callout
Page Label: 14
Author: Daniel Torres
Date: 6/16/2022 7:43:51 PM
Status:
Color:
Layer:
Space:

Per the drainage plan Culvert 4 lies within Lot 3. Please revise accordingly.

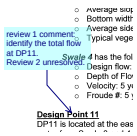
Subject: Callout
Page Label: 14
Author: Daniel Torres
Date: 6/16/2022 7:44:04 PM
Status:
Color:
Layer:
Space:

Per the drainage plan Basin A ultimately leads to DP15 and Basin I would not be conveyed to Herring Road. Revise the design accordingly.



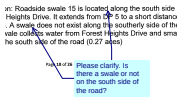
Subject: Callout
Page Label: 14
Author: Daniel Torres
Date: 6/16/2022 7:51:02 PM
Status:
Color:
Layer:
Space:

then the majority of the developed flows from lot 1, lot 3 and the roadway, are conveyed to the east side of Herring Road. As indicated in the review 1 comment, please indicate whether the ditch is adequate to accept the developed flow of this development and whether the flow is contained within the ditch as it flows south to DP11.



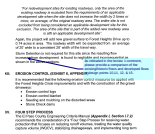
Subject: Callout
Page Label: 15
Author: Daniel Torres
Date: 6/16/2022 7:52:33 PM
Status:
Color:
Layer:
Space:

review 1 comment:
identify the total flow at DP11.
Review 2 unresolved.



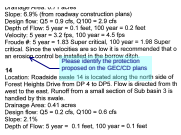
Subject: Callout
Page Label: 18
Author: Daniel Torres
Date: 6/16/2022 8:05:53 PM
Status:
Color:
Layer:
Space:

Please clarify. Is there a swale or not on the south side of the road?



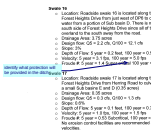
Subject: Callout
Page Label: 23
Author: Daniel Torres
Date: 6/16/2022 8:24:50 PM
Status:
Color:
Layer:
Space:

as indicated in the review 1 comment, please provide a comparison of the existing/historic flows and developed flows at design points 10,11, 12, & 15.



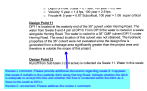
Subject: Callout
Page Label: 18
Author: Daniel Torres
Date: 6/17/2022 11:23:18 AM
Status:
Color:
Layer:
Space:

Please identify the protection proposed on the GEC/CD plans



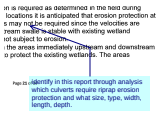
Subject: Callout
Page Label: 19
Author: Daniel Torres
Date: 6/17/2022 11:23:28 AM
Status:
Color:
Layer:
Space:

identify what protection will be provided in the ditch.



Subject: Callout
Page Label: 15
Author: Daniel Torres
Date: 6/17/2022 11:32:50 AM
Status:
Color:
Layer:
Space:

Review 1 comment. Please provide additional discussion regarding swale 8. It appears that swale 8 outfalls to the roadside ditch along Herring Road. Indicate whether the ditch is adequate to accept this flow and whether the flow is contained within the ditch as it flows to the south to DP11.
Review 2: unresolved. Please address the review 1 comment.



Subject: Callout
Page Label: 21
Author: Daniel Torres
Date: 6/17/2022 11:33:50 AM
Status:
Color:
Layer:
Space:

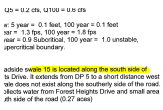
identify in this report through analysis which culverts require riprap erosion protection and what size, type, width, length, depth.

Cloud+ (1)

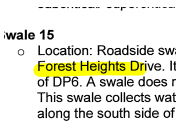
Subject: Cloud+
Page Label: 51
Author: Daniel Torres
Date: 6/16/2022 10:56:35 PM
Status:
Color:
Layer:
Space:

As Forest heights is a rural roadway with roadside ditches the clouded is the criteria that applies. Please analyze the culverts accordingly.

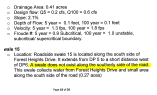
Highlight (3)



Subject: Highlight
Page Label: 18
Author: Daniel Torres
Date: 6/16/2022 8:06:01 PM
Status:
Color:
Layer:
Space:

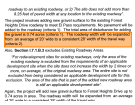


Subject: Highlight
Page Label: 18
Author: Daniel Torres
Date: 6/16/2022 8:06:03 PM
Status:
Color:
Layer:
Space:



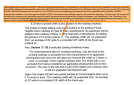
Subject: Highlight
Page Label: 18
Author: Daniel Torres
Date: 6/16/2022 8:06:10 PM
Status:
Color:
Layer:
Space:

SW - Rectangle (1)



Subject: SW - Rectangle
Page Label: 23
Author: GReese
Date: 6/15/2022 8:49:11 AM
Status:
Color:
Layer:
Space:

SW - Textbox with Arrow (1)



Subject: SW - Textbox with Arrow
Page Label: 23
Author: GReese
Date: 6/15/2022 8:57:57 AM
Status:
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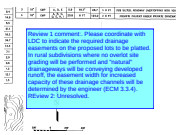
Note regarding the need for an ESQCP: while this highlighted explanation is acceptable for excluding the site from WQ treatment, it does not sufficiently describe the proposed improvements to the road, which will result in disturbing at least all of the 28' width of the road, if not more per the CD's. Meaning that the total soil disturbance will exceed 1ac, so an ESQCP and all accompanying documents that Daniel requested with his previous EDARP comment are required. It would be good to add this ESQCP discussion to the drainage report to document the reasoning. Also discuss if the houses will be built at the same time as each other and/or the road, because that would also lead to a total simultaneous soil disturbance >1ac. Otherwise, if the new houses are built separate from each other and the road (and each preceding site disturbance is finally stabilized before the next one begins), the houses could just get Builder's ESQCPs (BESQCPs)

Text Box (1)



Subject: Text Box
Page Label: 191
Author: Daniel Torres
Date: 6/16/2022 11:08:41 PM
Status:
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Review 1 comment:. Please coordinate with LDC to indicate the required drainage easements on the proposed lots to be platted. In rural subdivisions where no overlot site grading will be performed and "natural" drainageways will be conveying developed runoff, the easement width for increased capacity of these drainage channels will be determined by the engineer (ECM 3.3.4). REview 2: Unresolved.