Final Drainage Report

For:

Didleau Subdivision Filing 1

Project No. 2019.012

April 2020

Please add 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: ______________________________

I. REPORT 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 four (4) 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 4 lots. The sizes of the lots are:

- Lot 1: 5.11 acres north of Forest Heights Circle
- Lot 2: 4.20 acres south of Forest Heights Circle
- Lot 3: 7.34 acres south of Forest Heights Circle
- Lot 4: 15.94 acres south of Forest Heights Circle

These areas differ from the final plat. Please revise and include the area for Tract A&B.

- Lot 1 extends 450 feet north of Forest Heights Circle
- Lots 2, 3, and 4 extend 850 feet south of Forest Heights Circle

These distances are not accurate. Please revise (or remove).

A high-pressure gas line crosses Forest Heights Circle approximately 2,000 feet east of the Herring Road intersection (photo 16). The easement is ____ feet wide and extends north and south.

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 (where included with the El Paso County Drainage Criteria Manual).***
    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 130 acres. Intensity-Duration-Frequency (IDF) curves were obtained from the Colorado Springs Drainage Criteria Manual (DCM) (Appendix, Exhibit 4).

- **Culvert Evaluation**
  Sizing
  - 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 culverts under Forest Heights Drive as well as impacts on the existing structures within the vicinity of the existing swales discussed in this report.
  - The assumptions that were made in the evaluation of these culverts are described in the pertinent sections of the report.

- **Drainage Swale and Borrow Ditch Evaluation**
  - Onsite and offsite drainage swales and the borrow ditches traversing the property were evaluated for erosion potential and depth of flow.
  - The assumptions that were made in the evaluation of these 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 pond/ water quality requirements are addressed in the Section XI.

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

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.

Please also include the panel # and date.

V. FEMA FLOODPLAIN

The project is within Zone X (other) as shown on the Flood Rate Insurance Map, El Paso County, Colorado and Incorporated Areas, Map Number 080059, *(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 characteristic are described in detail in the soils report included in *Exhibit 3, Appendix*. The soil 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, in turn, 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 to accommodate the runoff.

VIII. Existing/ Proposed Conditions Characteristics

General

The proposed hydrologic conditions for this site are nearly identical as the existing conditions except for the construction of single-family residential structures. As a result, both the existing and developed conditions are discussed in this section.

The site is primarily hilly with natural drainage ways. The site, both north and south of Forest Heights Drive, slope from the northeast to the southwest with an average slope of 4.5%. The drainage ways cross Forrest Heights Drive via corrugated metal culverts at three (3) locations.

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 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 is a compacted two-lane road with borrow ditches and culvert "stream" crossings (photo 29). The road extends approximately 2,450-feet east of the Herring Drive intersection. This road is presently privately owned and maintained. Consideration is being given to improving the road to meet El Paso County.

The road has with 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. *(Exhibit 11, Appendix).* The road is currently maintained by Jon and Phyllis Didleau. This "maintenance association" will be amended with a new agreement as part of the platting process.

The road crosses three (3) of the five (5) 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 the back of the report.

The following physical characteristics of the road were obtained from the mapping and photographs obtained for the site (*Exhibit 10, Appendix*). Additional survey and geotechnical information are required in order to accurately determine the physical characteristics of the road in order to develop design construction plans if required.

Erosion and sedimentation have occurred in sections along both sides of Forest Heights Circle. The sedimentation, along with ash from the 2013 fire, has filled

The roadway will be required to be improved to County standards. Please update your analysis/design accordingly.

the majority of the culverts to a depth greater than 70%. The resulting sedimentation has encouraged the establishment of wetlands both upstream and downstream of two (2) of the three (3) culverts. It appears that the majority of the wetland areas are seasonal and typically when the ground water is near the surface.

Swales

Five (5) natural stable drainage corridors extend from northeast to southwest within the boundaries of the site. The drainageways consist of large natural "swales" with 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. Drainage easements are proposed to prevent the construction of future residential and related structures. The upper reaches of the Burgess River, noted as swale 1, crosses at the most easterly end of Forrest Heights Circle. All of the drainage ways are well established and stable with only a negligible amount of erosion.

Please coordinate with LDC so that the proposed drainage easements are shown on the plat.

Culverts

A total of three (3) corrugate metal pipe (CMP) culverts pass the water under Forest Heights Circle. The condition of each these culverts are discussed under the applicable Design Point number. The culverts contain a significant amount of 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 continues in a southwesterly direction in natural drainage ways which are stable with only negligible signs of erosion. The majority of the culverts are 75% to 95% full of sediment and ash.

Design Points

The following Design Points (DP) were located on the attached Drainage Plan based on where natural drainage ways cross Forest Heights Circle, at high points along the existing road, and at locations where the runoff exits the subdivision.

to design point 2?

Design Point 1

DP1 is located at the easterly end of Forest Heights Circle where there is a cul-de-sac. Runoff from this point travels along the northerly and southerly borrow ditches along Forest Heights Circle.

Swale 1 appears to terminate at DP 2 per the drainage plan. Please revise accordingly.

Design Point 2

Runoff from Sub basin A (17.4 Acres) is collected via a natural swale, Swale 1, (photo 4) at DP1. The water passes under Forrest Heights Circle via an 18" CMP (Culvert 1) (photo 1, 5). The culvert is approximately 75% full of sediment. There is also a significant amount of vegetation at either ends of the culvert (photo 2, 6). There are also areas of wetlands located both upstream and downstream of the culvert (photo 2, 3). Approximate boundaries are indicated on the Drainage Plan included in the back of this report. Accurate identification and boundaries of the wetland areas are beyond the scope of this report.

Swale 1 has the following *physical* characteristics:

- 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 = 3.4 cfs, Q100 =23.6 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.2 feet
- Velocity: 5 year = 1.1 fps, 100 year = 2.4 fps
- Froude #: 5 year = 0.83 Subcritical, 100 year = 1.01 Border between Subcritical and 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 = 24.6 cfs
- Headwater required to pass (for clean pipe): 5 year = 12", 100 year = 7.5 feet (significant roadway overtopping occurs) Based on conversations with the residents, roadway overtopping has frequently 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 minor storm events. The downstream end (photo 5) controls the amount of water that the culvert can accommodate. The end is buried approximately 75% in the 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 channel for a significant distance downstream.

<u>Design Point 3</u>

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.

<u>Design Point 4</u>
Runoff from Sub basin B (20.8 Acres) is collected via a natural swale, Swales 3, 3a, 3b, 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 wetland areas (photo 17) with approximate boundaries indicated on the Drainage Plan included in the back of this report. Accurate boundaries for the wetland areas are beyond the scope of this report

Swales 3, 3a, 3b have the following *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 = 4.4 cfs, Q100 = 29.1 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.3 feet
- Velocity: 5 year = 1.5 fps, 100 year = 3.0 fps
- Froude #: 5 year = 0.8 Subcritical, 100 year = .95, Subcritical

Discussion:
Swale 3a and 3b join together at approximately 300 feet upstream of the culvert. The vegetation is well established with only a minimal amount of erosion. Wetland areas are located in pockets along the swales. Approximate locations and areas are shown on the Drainage Plan included in the back of this report. 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 = 4.4 cfs, Q100 = 29.1 cfs
- Headwater for clean pipe: 5 year = 14", 100 year = >9ft (significant road overtopping occurs)

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. Sediment removal is not recommended since this would require the excavation of the existing stable channel for a significant distance downstream

Design Point 5

Runoff from Sub basin C (3.9 Acres) is collected via a natural undefined swale, Swale 5, at DP5 (photo 30). The water is directed to Culvert 3 at DP7 via the northerly borrow ditch (photo 33). A substantial number of trees occupy the borrow ditch and as a result have reduced its carrying capacity. There are only small pockets of wetlands located a significant distance upstream of where Swale 5 intersects the northerly borrow ditch along Forest Heights Circle. Accurate boundaries for the wetland areas are beyond the scope of this report

Swale 5 (undefined) has the following *physical* characteristics:

- Average slope: 5.5 %
- Bottom width: varies from 20 feet to 30 feet
- Average side slopes: varies from 10 to 1.
- Typical vegetation: meadow with high grass, bushes and Ponderosa Pine trees

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

- Design flow: Q5 = 1.4 cfs, Q100 = 7.9 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.2 feet
- Velocity: 5 year = 1.0 fps, 100 year = 2.0 fps
- Froude #: 5 year = 0.78 Subcritical, 100 year = 0.91

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 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 only 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 also 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 D (7.5 Acres) is collected by the borrow ditch along the north side of Forest Heights Circle, Swale 7. The water passes under Forest Heights Circle via an 18" corrugated metal culvert, Culvert 3 (photo 41,43). Sub basin D is developed as a single-family home site (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 at DP7. The culvert is almost silted full and 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 = 2.3 cfs, Q100 = 14.3 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.2 feet
- Velocity: 5 year = 1.2 fps, 100 year = 2.5 fps
- Froude #: 5 year = 0.8 Subcritical, 100 year = 1.0 between sub critical and critical

Discussion:

Swale 6 is very stable with a minimal amount of erosion. There is an area of wetlands located immediately upstream of the culvert. There are also wetlands southwest of Culvert 3 in Swale 8 (Photo 44). This area will be discussed in DP 10.

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 = 3.7 cfs, Q100 = 22.2 cfs (includes runoff from Sub basin C)
- Depth required to pass: 5 year = 1.1 feet, 100 year = 7.5 feet

Discussion:

The existing culvert is approximately 80% full of silt and ash from the 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.

Design Point 8

DP8 is located at the high point along Herring Road where the water in the borrow ditch flows north and south. The water sheet flows onto the lot located at the northeasterly corner of the Herring Road/ Forest Heights Circle intersection. The water is collected by the northerly roadside ditch along Forest Heights Circle. Minimal erosion has occurred between DP8 and DP9

Design Point 9

Runoff from Sub basin E (2.3 Acres) is collected via a natural swale, Swale 9, located along the east side of Herring Road. A single-family residence occupies the majority of Sub Basin E (figure 42). Swale 9 directs the water to DP7, Culvert 3 where it crosses under Forest Heights Drive and discharges into Swale 8.

Swale 8 has the following *physical* characteristics:

- Average slope: 6.0 %
- Bottom width: varies from 2 feet to 5 feet
- Average side slopes: varies from 3 to 1.
- Typical vegetation: regularly mowed and maintained

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

- Design flow: Q5 = 1.0 cfs, Q100 = 4.9 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.2 feet
- Velocity: 5 year = 1.2 fps, 100 year = 2.5 fps
- Froude #: 5 year = 0.8 Subcritical, 100 year = 1.0

Discussion:

The swale, like all of the other swales is 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.

Design Point 10

Runoff from Sub basins B, C, D, E, and I is collected at DP10. Swale 7 combines with water in Swale 6 at DP7 and passes under Forest Heights Circle. The water in Swale 8 is then carried to the southwest (photo 47). There are wetland areas with approximate boundaries indicated on the Drainage Plan included in the back of this report. Accurate identification and boundaries for the wetland areas are beyond the scope of this report.

Swale 8 has the following *physical* characteristics:

- Average slope: 3.3 %
- Bottom width: varies from 30 feet to 40 feet
- Average side slopes: varies from 30 to 1.
- Typical vegetation: meadow with high grass.

Swale 8 is identified above. Please revise the text accordingly so that the correct swale is identified.

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.

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

- Design flow: Q5 = 7.5 cfs, Q100 = 47.8 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.4 feet
- Velocity: 5 year = 1.4 fps, 100 year = 2.6 fps
- Froude #: 5 year = 0.7, Subcritical, 100 year = 0.8, Subcritical

Discussion:

Swale 8 is heavily vegetated with areas of wetlands. There are only negligible signs of erosion.

Identify the total flow at DP 11

Design Point 11

Runoff from Sub basins B and H and (44.1 acres) is collected via a natural swale, Swale 4, at DP11 where it combines with water in Swale 8. The water then exits the subdivision via an 18" CMP culvert under an existing concrete driveway (figure 48). The water is then directed in a southwesterly direction to DP11 where it passes under Herring Road via a 36" CMP culvert (photo 55, 56).

Per the drainage map it appears that flow from swale 8 converges with flow from swale 4 at DP10

Swale 4 has the following *physical* characteristics:

- Average slope: 3.3 %
- Bottom width: varies from 75 feet to 100 feet
- Average side slopes: 25 to 1.
- Typical vegetation: meadow with high grass, Ponderosa Pine trees and wetlands

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

- Design flow: Q5 = 9.7 cfs, Q100 = 63.4 cfs
- Depth required to pass: 5 year = 1.1 feet, 100 year = 7.5 feet
- Velocity: 5 year = 1.1 fps, 100 year =2.3 fps
- Froude #: 5 year = 0.65 Subcritical, 100 year = 0.79, Subcritical

Discussion:

Swale 4 is heavily vegetated with areas of wetlands. There is only a negligible amount of erosion. Water in Swale 4 combines with water in Swale 8 at DP11. The water then passes under an existing driveway via an 18" CMP culvert (photo 48). The culvert is clean with very little sediment as a result of the invert being slightly above the flowline of the upstream swale.

Culvert 6 has the following *physical* characteristics:

- Size: 18"
- Material: CMP
- Slope: Undetermined
- Condition: good, clear of sediment
- End Sections: none

Should this be culvert 4? Revise accordingly.

Culvert 4 has the following *hydrologic/ hydraulic* characteristics:

- Design flow: Q5 = 16.8 cfs, Q100 = 104.2 cfs
- Headwater to Depth Ratio: Undetermined due to no impact on the project.

Discussion:

It is expected that the existing culvert is undersized to carry both the 5-year and the 100-year storm event. Significant ponding upstream of the culvert can be expected with both storm events.

swale 11 shown on the drainage map. Revise accordingly. Please identify the total flow at DP12

Design Point 12

Runoff from Sub basin J (3.4 acres) is collected via an undefined natural swale, Swale 10, at DP12. Water in this swale exits the project site at DP12. This swale is undefined and therefore, was not evaluated.

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: 4.7 %
- Bottom width: varies from 50 feet to 70 feet
- Average side slopes: varies from 15 to 1.
- Typical vegetation: meadow with high grass and Ponderosa Pine trees

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

- Design flow: Q5 = 2.8 cfs, Q100 = 20.7 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.2 feet
- Velocity: 5 year = 1.0 fps, 100 year = 1.9 fps
- Froude #: 5 year = 0.65 Subcritical, 100 year = 0.84 Subcritical

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 included in the back of this report. 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: varies from 30 feet to 50 feet
- Average side slopes: varies from 15 to 1.
- Typical vegetation: meadow with high grass and Ponderosa Pine trees

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

- Design flow: Q5 = 6.1 cfs, Q100 = 41.4 cfs
- Depth of Flow: 5 year = 0.1 feet, 100 year = 0.3 feet
- Velocity: 5 year = 1.1 fps, 100 year = 2.2 fps
- Froude #: 5 year = 0.62 Subcritical, 100 year = 0.75 Subcritical

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.

Please include the characteristics of swale 12 (physical & hydrologic/hydraulic) as done with the previous swales. Also identify the total flow at this DP15

Design Point 15

Runoff from Sub basin A, F, G (46.0 acres) is collected via a natural swale, Swale 12, at DP15.

IX. Representative Developed Conditions Characteristics

General Overview

The developed condition was 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 the even for the "developed" conditions of the project that the controlling time of concentration would be the same as was determined for the existing conditions. Therefore, the times of concentration remain the same as was determined in this drainage study.

The following summarizes the negligible impact that the "developed" conditions have on the total runoff at the individual Design Points. Ince the

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resulting hydraulic conditions were only negligible; the existing swales and culverts were not re-evaluated for the developed conditions.

Sub Basin A

- Existing Discharge: 5 year = 3.4cfs, 100 year = 23.6 cfs
- "Developed" Discharge: 5 year = 3.7 cfs, 100 year = 24.0 cfs
- Negligible changes to hydraulic conditions

Sub Basin B

- Existing Discharge: 5 year = 4.4cfs, 100 year = 29.1 cfs
- "Developed" Discharge: 5 year = 4.6 cfs, 100 year = 29.5 cfs
- Negligible changes to hydraulic 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 hydraulic conditions

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.

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 hydraulic 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 hydraulic 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 hydraulic 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 hydraulic 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 hydraulic 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 hydraulic 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
- Negligible changes to hydraulic conditions

X. Proposed Drainage Improvements

The following drainage improvements are recommended:

- Grade the cross section of Forest Heights Circle to the typical section used by El Paso County for rural gravel roads *(Exhibit 4, Appendix)*
- Replace all of the culverts with 24" 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 incoming swale. The culvert should be installed at a sufficient slope to allow for a cleansing velocity to develop.
- Riprap erosion protection is not required at the outfall of the culverts since the velocities are minimal and the downstream swale is stable and not subject to erosion.
- Minimize any grading in the areas immediately upstream and downstream of the culverts. These areas typically are occupied by wetlands and are very stable. Disturbing the area with grading would only increase the erosion potential.
- Install stone check dams (*Exhibit 4, Appendix*) along the roadside ditches that are prone to erosion. These are permanent and will need to be maintained.

XI. 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 4 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

XII. 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.

The drainage report shall demonstrate that the runoff due to the development is at or below historic or of negligible increase (specifically at design points 10/11, 12, & 15) therefore detention is not required.
Per the indicated disturbance per lot (0.9acre/lot) along with the disturbance for the proposed roadway this project is an applicable development site (ECM I.6.1). All applicable development sites must have operational permanent stormwater quality control measures (ECM I.7.1) unless an exclusion applies (ECM I.7.1.B). Please be be sure to site any exclusions that apply such as ECM I.7.1.B.5 (large lot single family sites). Please be aware of the limitations of this exclusion and also this exclusion does not apply to the roadway.

A PBMP applicability form will be required to be submitted. See attached.

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

Please reference ECM 1.7.2 or County DCM Vol 2 CH4.1 and revise the steps accordingly

XIII. Four Step Process

As stated in the City of Colorado Springs DCM Volume 2, the Four Step Process is applicable to all new and re-developed projects with construction activities that disturb 1 acre or greater or that disturb less than 1 acre but are part of a larger common plan development. Included is the Four Step Process for SC Woodmen Filing No. 1.

Please revise

Step 1: Employ Runoff Reduction Practices:
Minimize Directly Connected Impervious Areas (MDCIA): Roof drain downspouts will drain across pervious landscape strips where possible to aid in minimizing the direct connection of impervious surfaces. The water will then travel across the natural ground cover before entering the swales described in this report.

Step 2: Implement BMPs that provide a water quality capture volume with slow release.
A detention/ Water quality Pond is not recommended for this subdivision.

See previous comment regarding water quality and revise accordingly.

Step 3: Stabilize streams.
All of the existing swales are stable with only negligible signs of erosion. The vegetation is well established. With only a minimal increase in flows it is expected that the swales will remain in a very stable condition.

Step 4: Implement site specific and other source control BMPs.
The BMPs recommended for the site are for the borrow ditches along Forest Heights Circle and for along the gravel drives that are to be constructed for each residence. These facilities include erosion control logs, staked hay bales at the entrances to the culverts under Forest Heights Circle, and stone check dams in the borrow ditches along Forest Heights Circle at locations where erosion is currently occurring.

XIV. Construction Cost Estimate

Item #	Item Description	Approx Quant	Units	Unit Price	Total Cost
1	Remove Existing 18" CMP	150	LF	$25	$3
2	Install 24" CMP	150	LF	$96	$14,400
3	Install 24" CMP Flared End Section	3	EA	$850	$5,100
	Sub Total				$23,250
	Contingency (10%)				$2,325
	Grand Total				$25,575

XV. 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):*

Drainage Fee per impervious acre	$	10,305
Bridge Fee per impervious acre	$	0
Total Fees per impervious acre	$	10,305

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 = $ 17,629.28

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

XVI. SUMMARY

The report addresses the hydrologic and hydraulic parameters for both the existing and developed conditions for the entire site even though there are 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 24" 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.

The installation of detention/ Water Quality facilities is not practical for this project since the proposed lots have different outfall locations. If evaluated separately, the area that is expected to be disturbed for each lot is less than 1 acre.

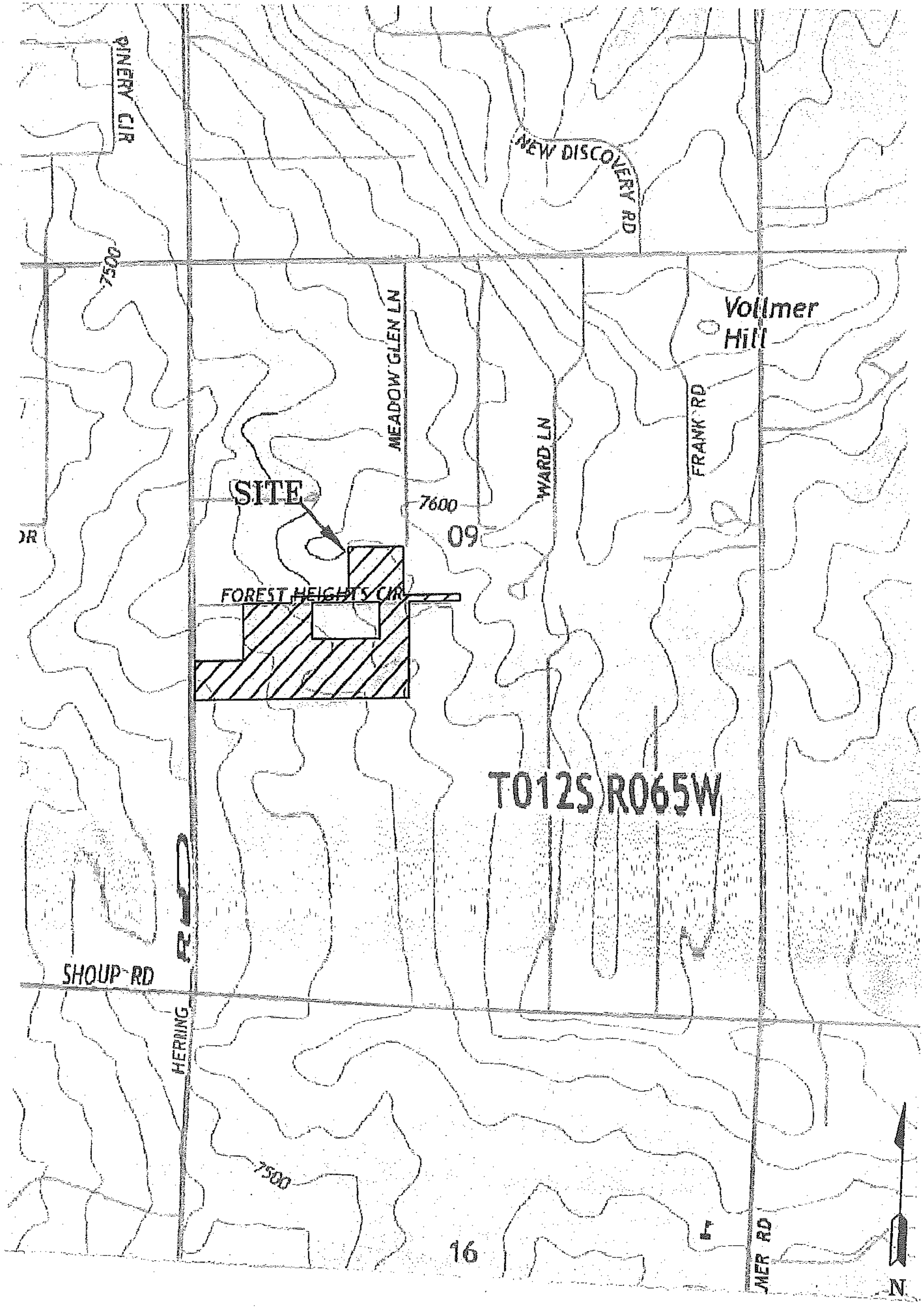
Erosion control facilities are recommended to minimize erosion in the borrow ditches along both sides of Forest Heights Circle as well as along both sides of proposed gravel driveways accessing the new residences. It is recommended that temporary facilities include the following:

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

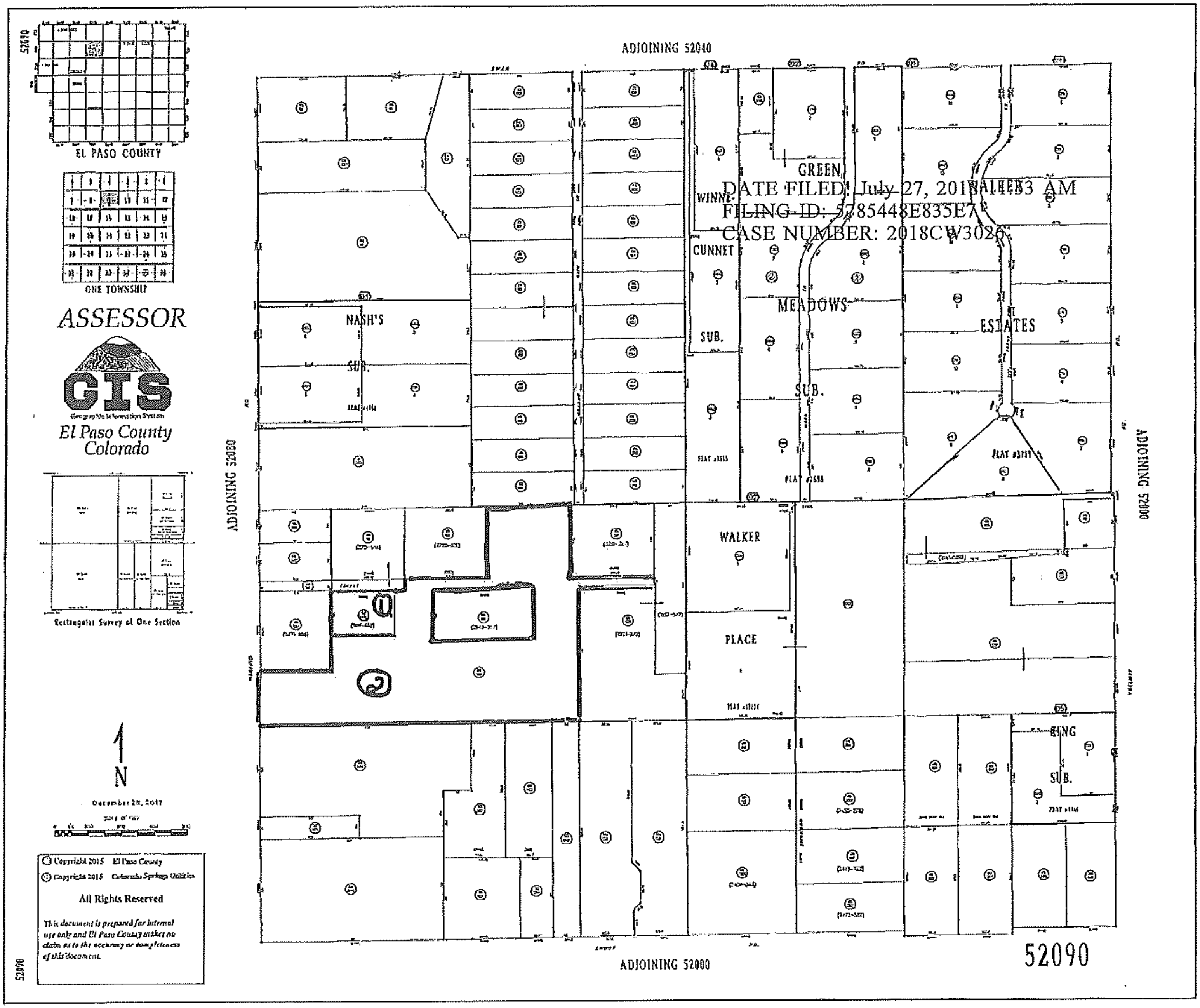
Please revise per comments provided on the previous pages

APPENDIX EXHIBITS

Exhibit 1: General Location Maps



PINERY CIR
NEW DISCOVERY RD
7500
Vollmer Hill
MEADOW GLEN LN
FRANK RD
WARD LN
SITE
7600
09
FOREST HEIGHTS CIR
T012S R065W
SHOUP RD
HERRING RD
7500
16
MER RD
N



① Parcel 1

② Parcel 2

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

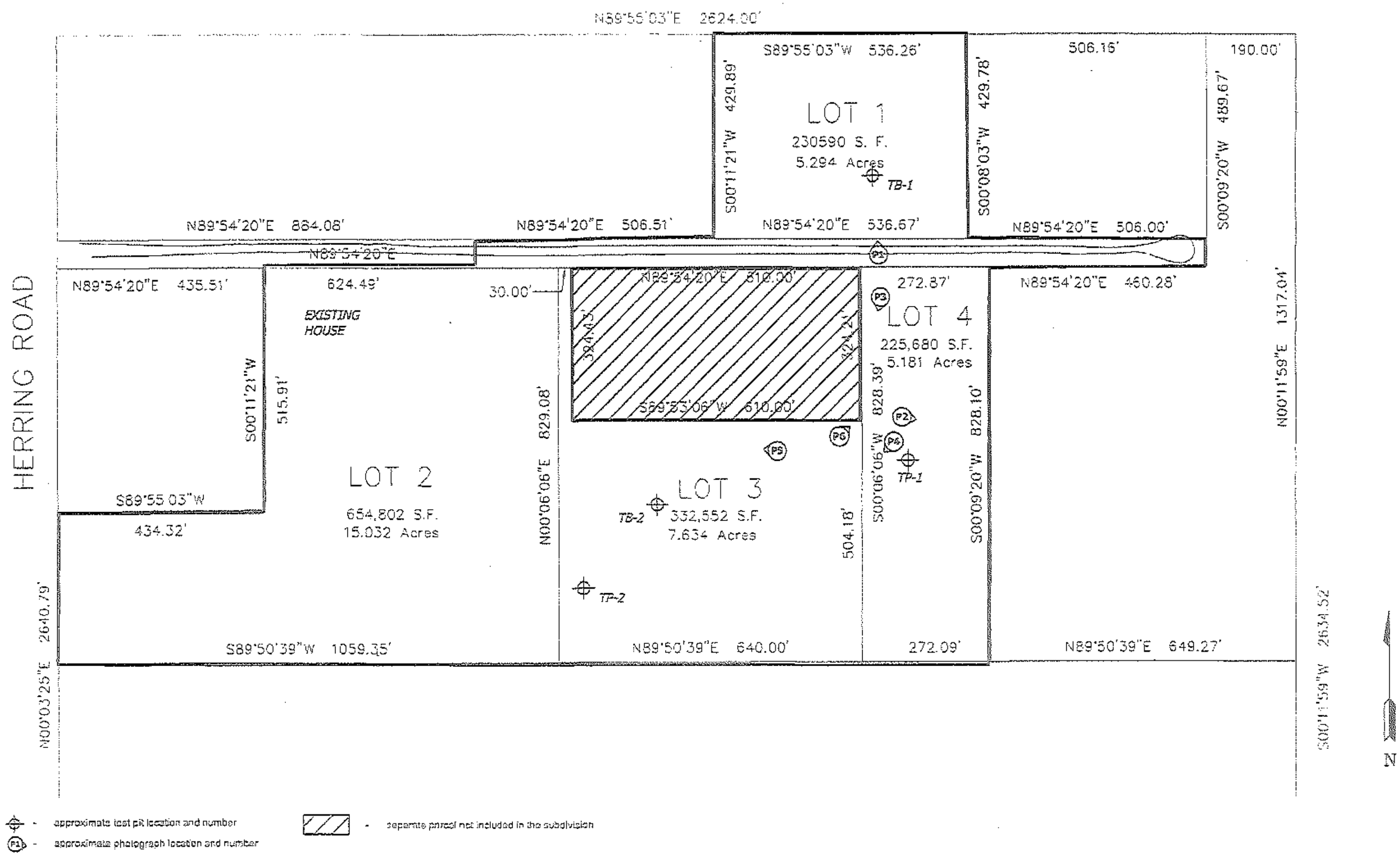


Exhibit 2: FEMA FIRM Map

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
- 513 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 represen 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

USDA United States Department of Agriculture

NRCS Natural Resources Conservation Service

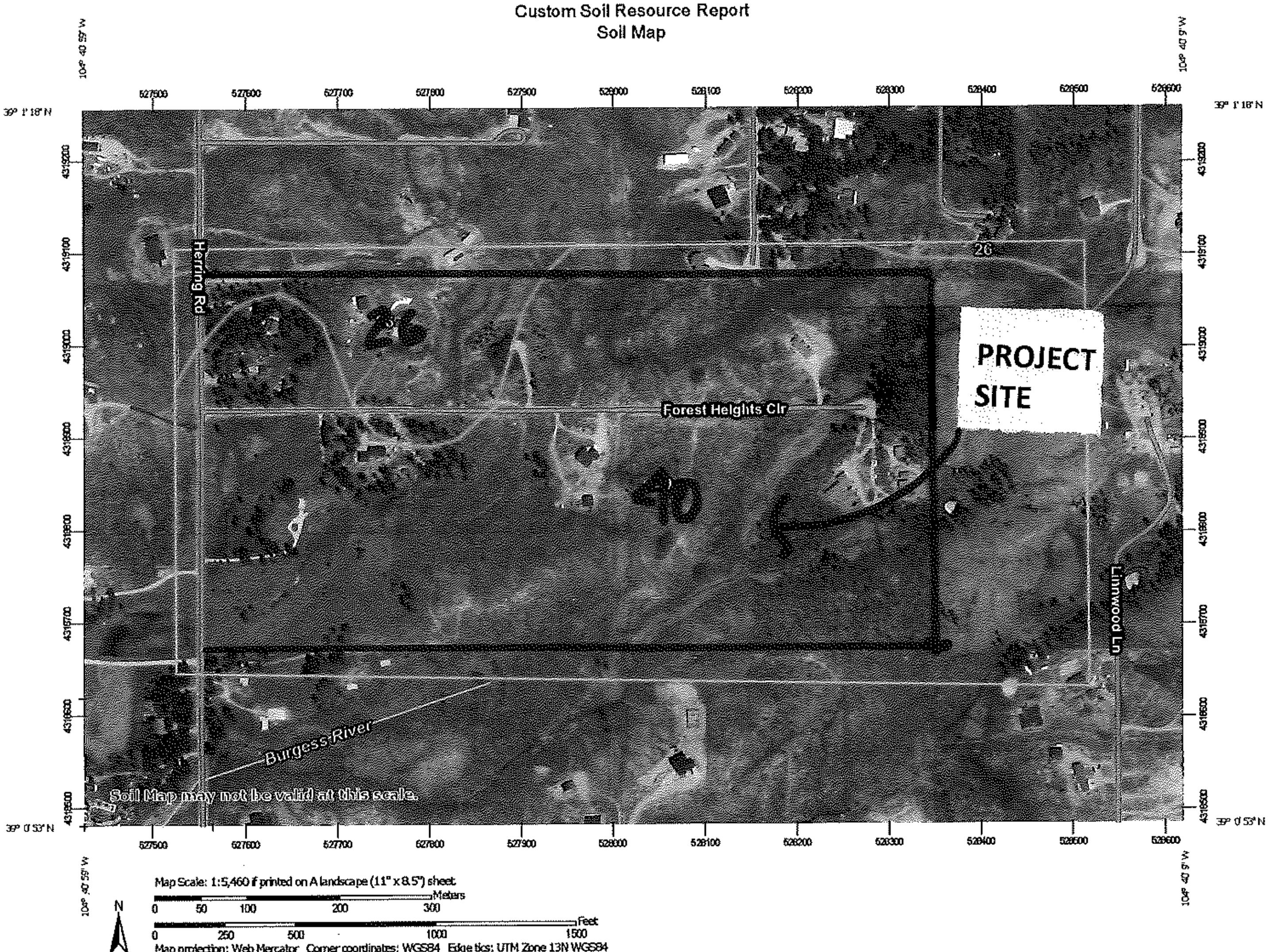
A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

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

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

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

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

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

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

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

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

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

El Paso County Area, Colorado

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

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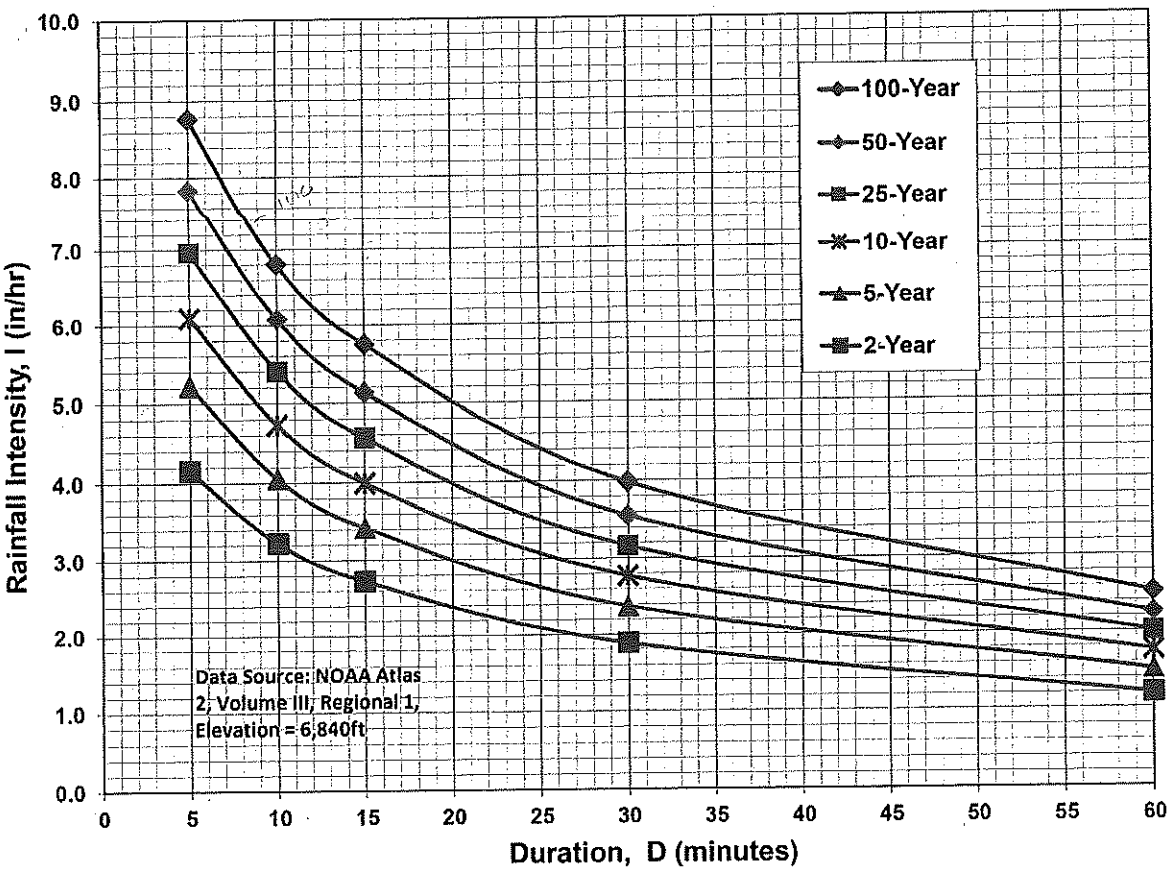
Exhibit 4: Charts and Tables

- IDF Curves
- Runoff Coefficients
- Time of Concentration Formulas
- Manning's "n" Coefficients
- Table 3.1 Typical Values of Percent Imperviousness
- Typical County Road Cross Section
- Culvert Standard Detail

Exhibit 4: Charts and Tables

- IDF Curves
- Runoff Coefficients
- Time of Concentration Formulas
- Manning's "n" Coefficients
- Table 3.1 Typical Values of Percent Imperviousness
- Typical County Road Cross Section
- Culvert Standard Detail

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

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

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 <u>maximum</u> for non-urban land uses, 100 ft <u>maximum</u> 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:

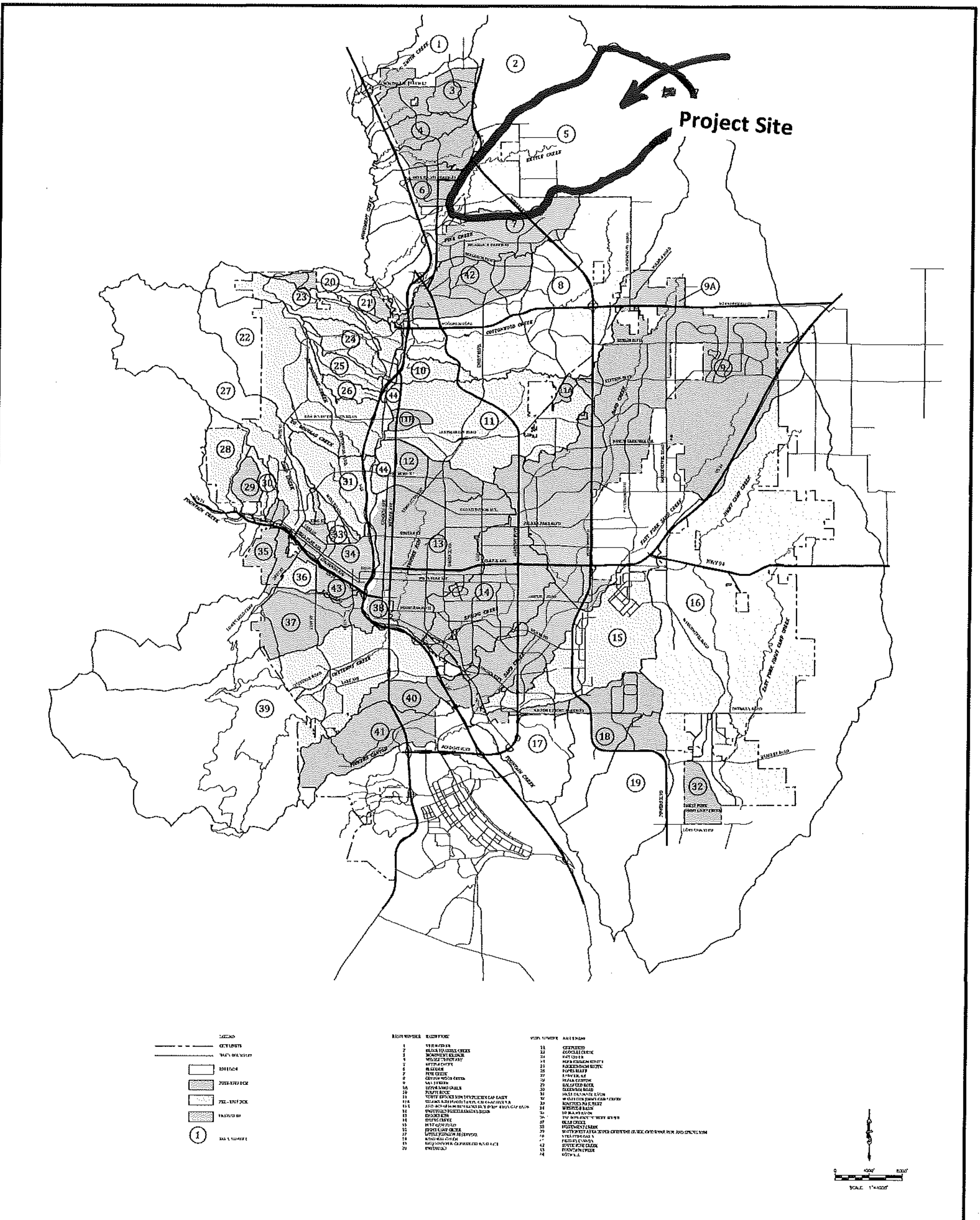
V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

Exhibit 5: Kettle Creek Drainage Basin Planning Study Exhibits

- **Regional Sub Basins Map**
- **Drainage Basin Fees Schedule**



DRAINAGE BASIN PLANNING STUDY INVENTORY

CITY OF COLORADO SPRINGS, COLORADO

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

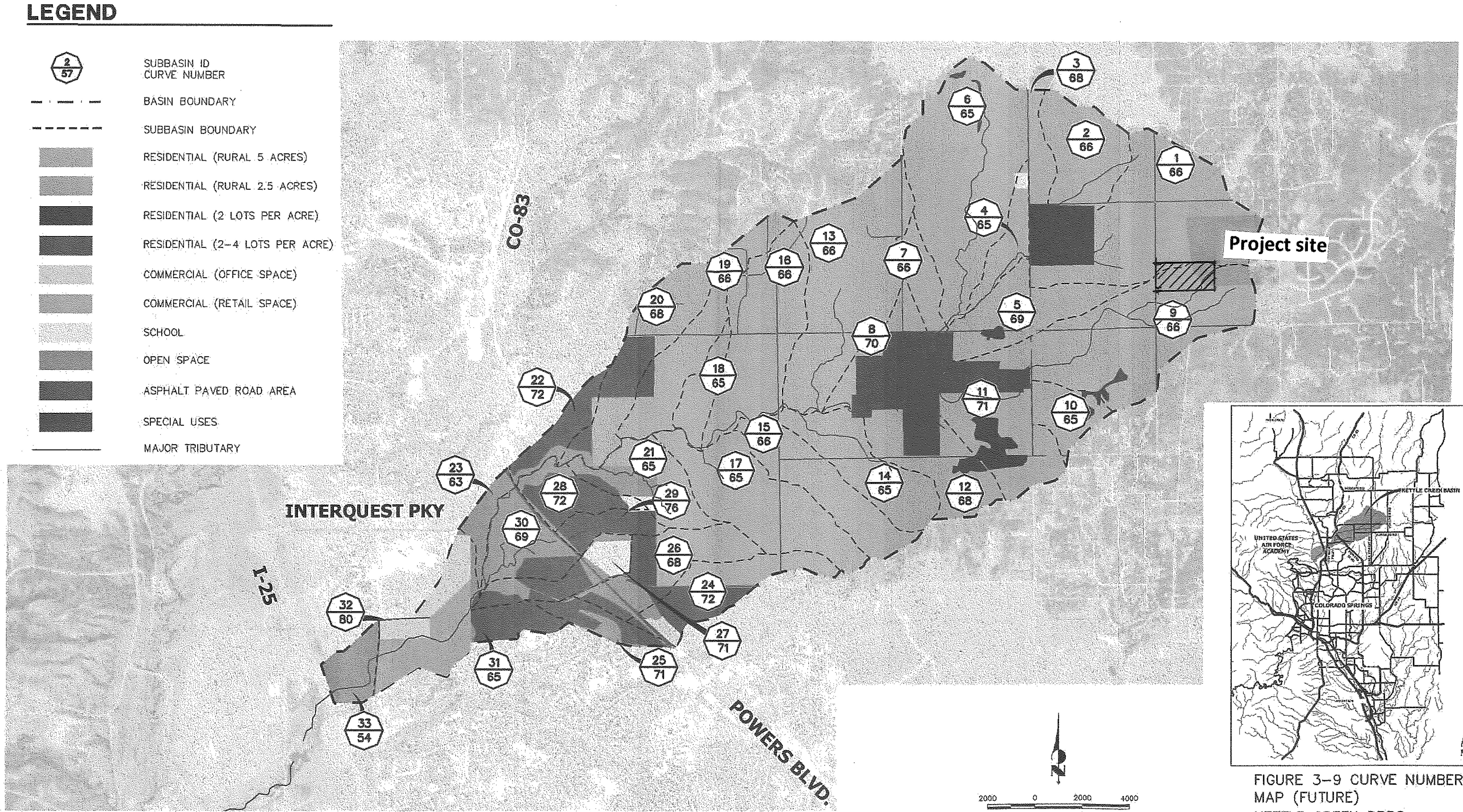
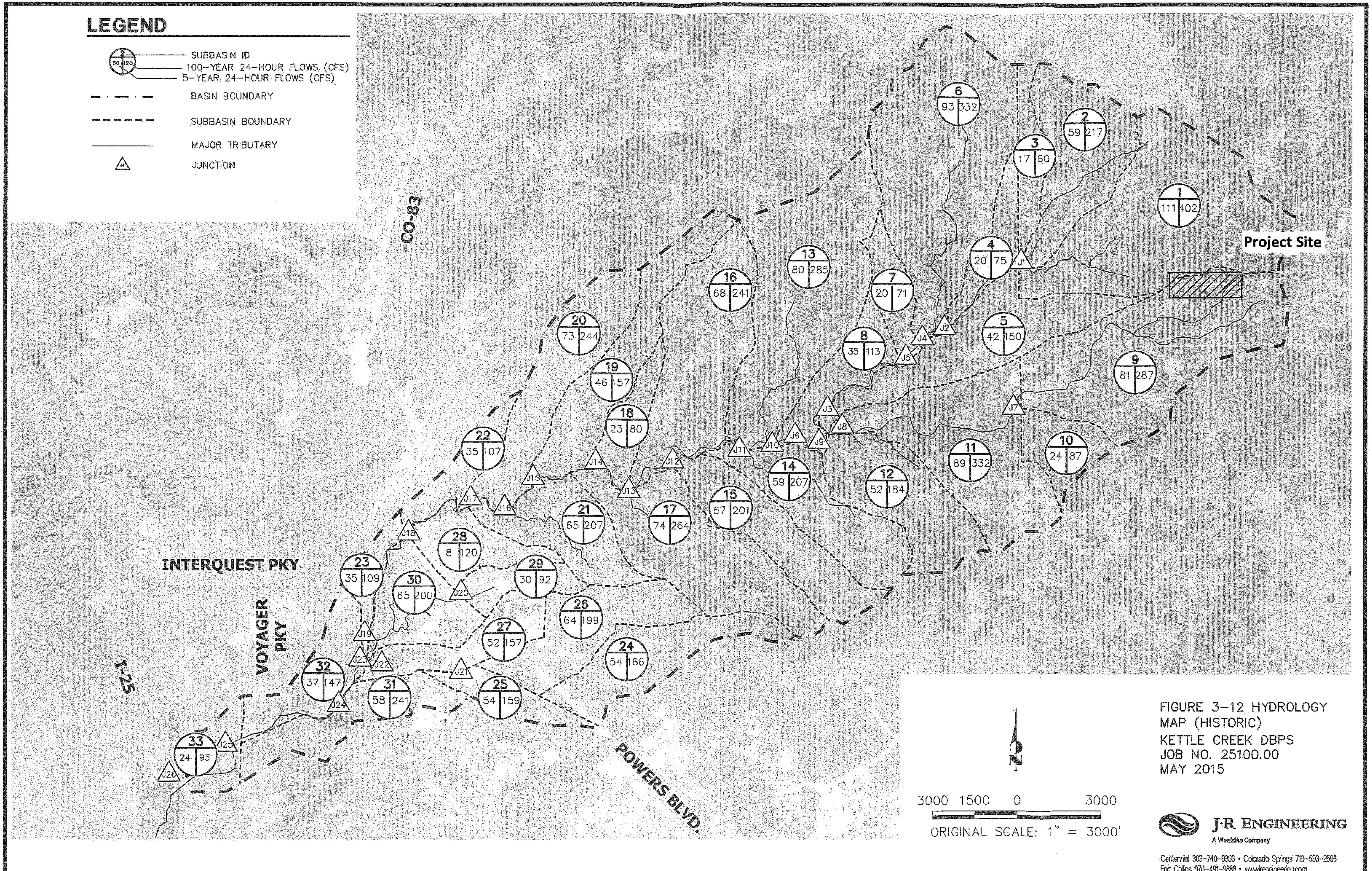


FIGURE 3-9 CURVE NUMBER MAP (FUTURE)
KETTLE CREEK DBPS
JOB NO. 25100.00
MAY 2015

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
CO-83
INTERQUEST PKY
VOYAGER PKY
I-25
POWERS BLVD.
Project Site
1 111 402
2 59 217
3 17 60
4 20 75
5 42 150
6 93 332
7 20 71
8 35 113
9 81 287
10 24 87
11 89 332
12 52 184
13 80 285
14 59 207
15 57 201
16 68 241
17 74 264
18 23 80
19 46 157
20 73 244
21 65 207
22 35 107
23 35 109
24 54 166
25 54 159
26 64 199
27 52 157
28 8 120
29 30 92
30 65 200
31 58 241
32 37 147
33 24 93
J1 J2 J3 J4 J5 J6 J7 J8 J9 J10 J11 J12 J13 J14 J15 J16 J17 J18 J19 J20 J21 J22 J23 J24 J25 J26
N
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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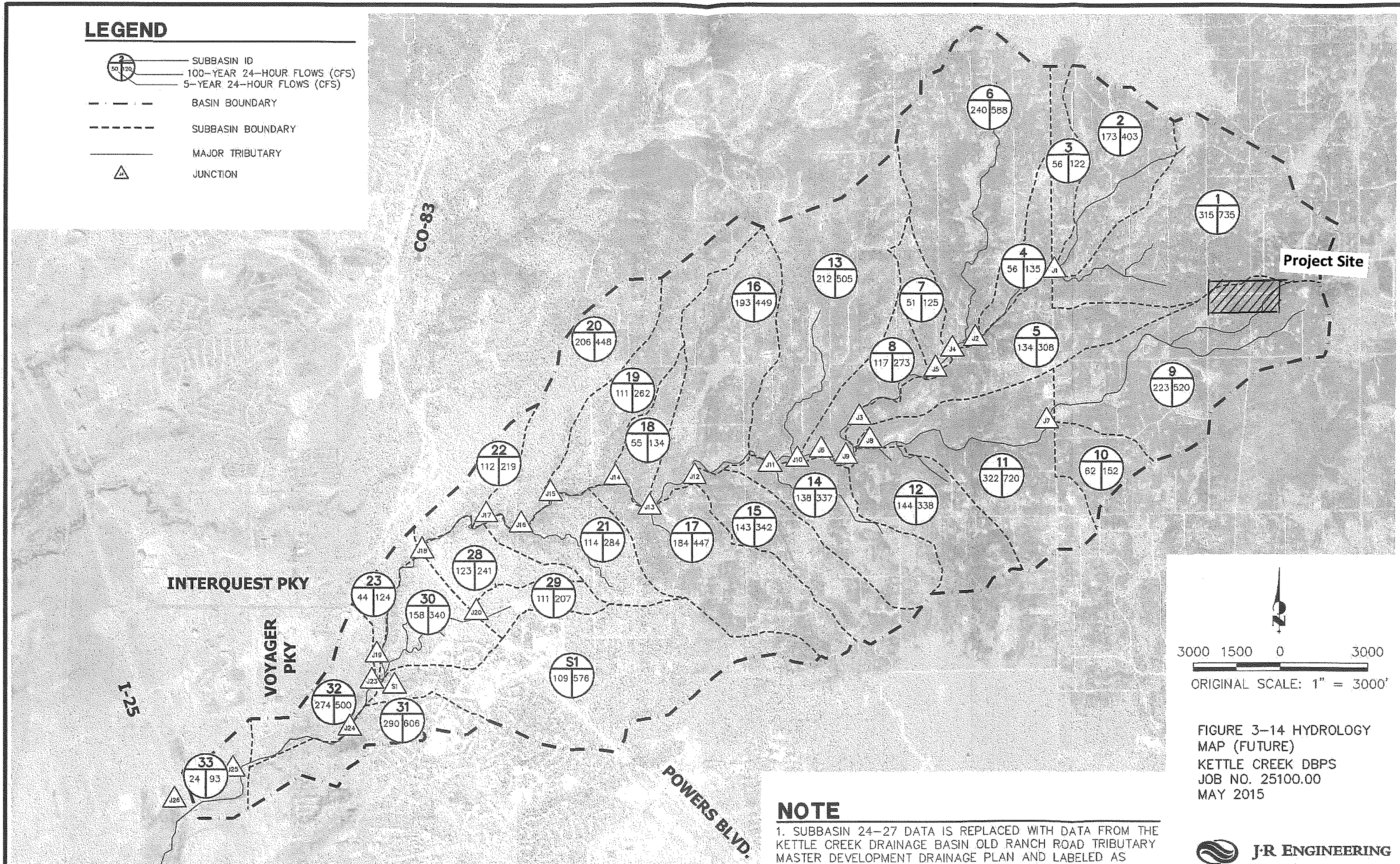
Fort Collins 970-491-9888 • www.jrengineering.com



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).

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

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El Paso County Drainage Basin Fees

Resolution No. 19-441

Basin Number	Receiving Waters	Year Studied	Drainage Basin Name	2020 Drainage Fee (per Impervious Acre)	2020 Bridge Fee (per Impervious Acre)
Drainage Basins with DBPS's:					
CHMS0200	Chico Creek	2013	Haegler Ranch	$10,737	$1,585
CHWS1200	Chico Creek	2001	Bennett Ranch	$12,020	$4,611
CHWS1400	Chico Creek	2013	Falcon	$30,807	$4,232
FOFO2000	Fountain Creek	2001	West Fork Jimmy Camp Creek	$13,066	$3,866
FOFO2600	Fountain Creek	1991*	Big Johnson / Crews Gulch	$19,084	$2,464
FOFO2800	Fountain Creek	1988*	Widefield	$19,084	$0
FOFO2900	Fountain Creek	1988*	Security	$19,084	$0
FOFO3000	Fountain Creek	1991*	Windmill Gulch	$19,084	$286
FOFO3100 / FOFO3200	Fountain Creek	1988*	Carson Street / Little Johnson	$11,640	$0
FOFO3400	Fountain Creek	1984*	Peterson Field	$13,764	$1,044
FOFO3600	Fountain Creek	1991*	Fisher's Canyon	$19,084	$0
FOFO4000	Fountain Creek	1996	Sand Creek	$19,698	$8,057
FOFO4200	Fountain Creek	1977	Spring Creek	$9,897	$0
FOFO4600	Fountain Creek	1984*	Southwest Area	$19,084	$0
FOFO4800	Fountain Creek	1991	Bear Creek	$19,084	$1,044
FOFO5400	Fountain Creek	1977	21st Street	$5,742	$0
FOFO5600	Fountain Creek	1964	19th Street	$3,756	$0
FOFO5800	Fountain Creek	1964	Camp Creek	$2,115	$0
FOMO0400	Monument Creek	1986*	Mesa	$9,982	$0
FOMO1000	Monument Creek	1981	Douglas Creek	$12,001	$265
FOMO1200	Monument Creek	1977	Templeton Gap	$12,320	$286
FOMO1400	Monument Creek	1976	Pope's Bluff	$3,823	$652
FOMO1600	Monument Creek	1976	South Rockrimmon	$4,486	$0
FOMO1800	Monument Creek	1973	North Rockrimmon	$5,742	$0
FOMO2000	Monument Creek	1971	Pulpit Rock	$6,328	$0
FOMO2200	Monument Creek	1994	Cottonwood Creek / S. Pine	$19,084	$1,044
FOMO2400	Monument Creek	1966	Dry Creek	$15,065	$545
FOMO3600	Monument Creek	1989*	Black Squirrel Creek	$8,664	$545
FOMO3700	Monument Creek	1987*	Middle Tributary	$15,925	$0
FOMO3800	Monument Creek	1987*	Monument Branch	$19,084	$0
FOMO4000	Monument Creek	1996	Smith Creek	$7,780	$1,044
FOMO4200	Monument Creek	1989*	Black Forest	$19,084	$520
FOMO5200	Monument Creek	1993*	Dirty Woman Creek	$19,084	$1,044
FOMO5300	Fountain Creek	1993*	Crystal Creek	$19,084	$1,044
Miscellaneous Drainage Basins: [1]					
CHBS0800	Chico Creek		Book Ranch	$17,906	$2,592
CHEC0400	Chico Creek		Upper East Chico	$9,755	$283
CHWS0200	Chico Creek		Telephone Exchange	$10,718	$251
CHWS0400	Chico Creek		Livestock Company	$17,655	$210
CHWS0600	Chico Creek		West Squirrel	$9,203	$3,819
CHWS0800	Chico Creek		Solberg Ranch	$19,084	$0
FOFO1200	Fountain Creek		Crooked Canyon	$5,761	$0
FOFO1400	Fountain Creek		Calhan Reservoir	$4,810	$280
FOFO1600	Fountain Creek		Sand Canyon	$3,475	$0
FOFO2000	Fountain Creek		Jimmy Camp Creek[3]	$19,084	$893
FOFO2200	Fountain Creek		Fort Carson	$15,065	$545
FOFO2700	Fountain Creek		West Little Johnson	$1,257	$0
FOFO3800	Fountain Creek		Stratton	$9,154	$409
FOFO5000	Fountain Creek		Midland	$15,065	$545
FOFO6000	Fountain Creek		Palmer Trail	$15,065	$545
FOFO6800	Fountain Creek		Black Canyon	$15,065	$545
FOMO4600	Monument Creek		Beaver Creek	$11,409	$0
FOMO3000	Monument Creek		Kettle Creek	$10,305	$0
FOMO3400	Monument Creek		Elkhorn	$1,731	$0
FOMO5000	Monument Creek		Monument Rock	$8,272	$0
FOMO5400	Monument Creek		Palmer Lake	$13,226	$0
FOMO5600	Monument Creek		Raspberry Mountain	$4,449	$0
PLPL0200	Monument Creek		Bald Mountain	$9,481	$0
Interim Drainage Basins: [2]					
FOFO1800	Fountain Creek		Little Fountain Creek	$2,440	$0
FOMO4400	Monument Creek		Jackson Creek	$7,554	$0
FOMO4800	Monument Creek		Teachout Creek	$5,245	$788

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 6: Erosion Control Facilities

- Staked Hay Bales
- Erosion Control Logs
- Erosion Control Blanket
- Stone Check Dams

Exhibit 7: Hydrologic Calculations

Sub Basin Summary

I.D.	Existing		Developed	
	Q5	Q100	Q5	Q100
	cfs	cfs	cfs	cfs
A	3.4	23.6	3.7	24
B	4.4	29.1	4.6	29.5
C	1.4	7.9	1.8	8.4
D	2.3	14.3	2.7	14.8
E	1	4.9	1.4	5.5
F	2.8	20.7	3.1	21.1
G	2.7	17.8	3	18.2
H	5.3	34.3	5.6	34.7
I	2.4	13.7	2.8	14.3
J	1	7.1	1	7.1

Design Point Summary

Design Pnt	Contrib Sub basins	Area (acres)	Q5 (cfs)	Q100 (cfs)
1	Easterly End of Cul-de-sac			
2	A	17.4	3.4	23.6
3	High Point between A & B			
4	B	20.8	4.4	29.1
5	C	3.9	1.4	7.9
6	Ridgeline intersection between C & D			
7	D	7.5	2.3	14.3
8	High Point along Herring Road			
9	E	2.3	1	4.9
10	B,C,D,E,F	19.4	7.5	47.8
11	B,H	44.1	9.7	63.4
11a	B,C,D,E,H	63.5	16.8	104.2
12	J	3.4		
13	F	18.7	2.8	20.7
14	A,G	27.3	6.1	41.4
15	A,F,G	46		

provide missing info

Please show this design point on the drainage map.

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
FINAL DRAINAGE REPORT
Existing Conditions
(Area Drainage Summary)

Please change the reference to DCM table 6-6 and verify that your numbers are consistent with the Volume I update.

From Area Runoff Coefficient Summary				OVERLAND				SHALLOW CHANNEL FLOW				Time of Travel (T_t)	INTENSITY *		TOTAL FLOWS	
BASIN	AREA TOTAL (Acres)	C_5	C_{100}	C_5	Length (ft)	Height (ft)	T_C (min)	Length (ft)	Slope (%)	Velocity (fps)	T_t (min)	TOTAL (min)	I_5 (in/hr)	I_{100} (in/hr)	Q_5 (c.f.s.)	Q_{100} (c.f.s.)
		From DCM Table 5-1														
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
Total site	112.90	0.00	0.00	0.00	0	0	#DIV/0!	0	0.0%	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

* Intensity equations assume a minimum travel time of 5 minutes.

Calculated by: Ken H
Date: 12/11/2019
Checked by: ____________

3

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

JOB Didleau Subdivision
SHEET NO. 1 OF
CALCULATED BY K. Harrison DATE 2/10/2020
CHECKED BY DATE
SCALE

Developed Conditions

A. Area

Typical area of disturbance Per a 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)

	5yr	100yr	Area
Roof Area	0.73	0.81	2800 SF
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	

PRODUCT 204-1 (Single Sheets) 205-1 (Padded)

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***

staff suggests revising the engineering company name to what is indicated on the cover sheet.

Please change the reference to DCM table 6-6 and verify that your numbers are consistent with the Volume I update.

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** *(Acres)*	C_5 *From DCM Table 5-1*	C_{100}	C_5	Length *(ft)*	Height *(ft)*	T_C *(min)*	Length *(ft)*	Slope *(%)*	Velocity *(fps)*	T_t *(min)*	TOTAL *(min)*	I_5 *(in/hr)*	I_{100} *(in/hr)*	Q_5 *(c.f.s.)*	Q_{100} *(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*
Total site	112.90	0.00	0.00	0.00	0	0	#DIV/0!	0	0.0%	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	*#DIV/0!*	*#DIV/0!*

* Intensity equations assume a minimum travel time of 5 minutes.

3

Calculated by: Ken H
Date: 12/11/2019
Checked by: ____________

Exhibit 8: Hydraulic Calculations

Didleau Subdivision Drainage Report

Swale Summary

Swale #	Contributing Subbasins	Slope	Design Flow		Depth of Flow		Velocity		Froude #	
			Q5	Q100	Q5	Q100	Q5	Q100	Q5	Q100
		%	cfs	cfs	ft	ft	fps	fps		
1	A	4.5	3.4	23.6	0.1	0.2	1.1	2.4	0.83	1.01
2	A,G	3.1	6.1	41.4	0.1	0.3	1.1	2.2	0.62	0.75
3	B	4.6	4.4	29.1	0.1	0.3	1.5	3	0.8	0.95
4	B,H	3.3	9.7	63.4	0.1	0.3	1.1	2.3	0.65	0.79
5	C	5.5	1.4	7.9	0.1	0.2	1	2	0.78	0.91
6	D	6	2.3	14.3	0.1	0.2	1.2	2.5	0.8	1
7	C	4.4	4.7	28	0.1	0.3	1.1	2.2	0.64	0.77
8	C,D,E,I	4.4	7.5	47.8	0.1	0.4	1.4	2.6	0.7	0.8
9	E	4.7	2.8	20.7	0.1	0.2	0.9	1.9	0.65	0.84
10	F	not evaluated due to no impact on development								
11	J	3.1	8.9	62.1	0.1	0.4	1.2	2.6	0.64	0.8

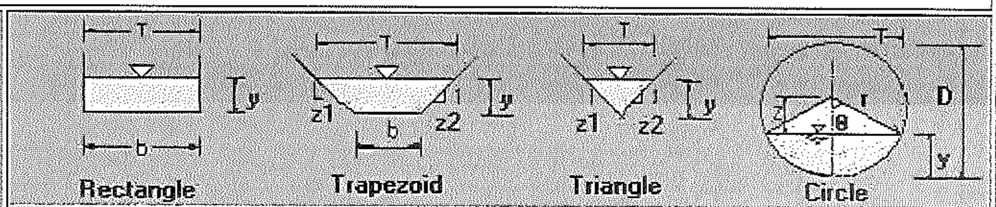
Culvert Summary

Culvert #	Size	Material	5 Year		100 Year		Condition
			Q (cfs)	Headwater Required	Q (cfs)	Headwater Required	
1	18"	CMP	3.4	12"	24.6	>7.5 ft	75% silted, roadway overtopping with 100 yr
2	18"	CMP	4.4	14"	29.1	>9 ft	75% silted, roadway overtopping with 100 yr
3	18"	CMP	3.7	1.1 ft	22.2	>7.5	75% silted, roadway overtopping with 100 yr
4	18"	CMP	16.8	4.8 ft	104.2	>9ft	Clean, roadway overtopping with both 5 year and 100 year

Swale 1
5year

The open channel flow calculator

Select Channel Type: Trapezoid ▼



Depth from Q ▼

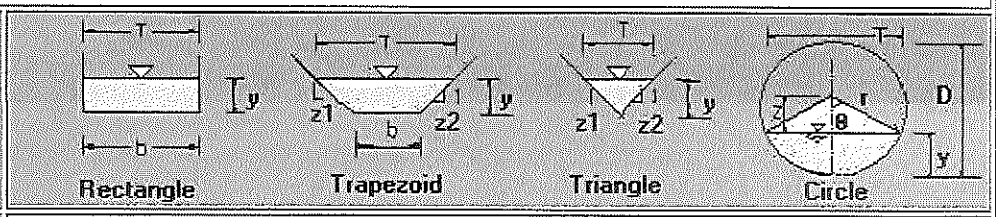
Select unit system: Feet(ft) ▼

Channel slope: .045 ft/ft	Water depth(y): 0.06 ft	Bottom width(b) 50 ft
Flow velocity 1.136416 ft/s	LeftSlope (Z1): 15 to 1 (H:V)	RightSlope (Z2): 15 to 1 (H:V)
Flow discharge 3.4 ft^3/s	Input n value .040 or select n	
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 0.83	Flow status Subcritical flow
Critical depth 0.05 ft	Critical slope 0.056 ft/ft	Velocity head 0.02 ft

Swale 1
100 year

The open channel flow calculator

Select Channel Type: Trapezoid ▼

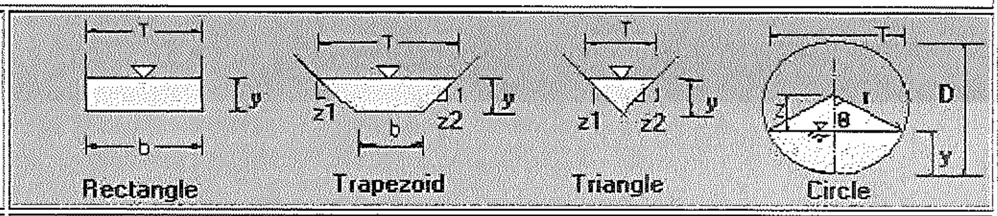


Depth from Q ▼ | Select unit system: Feet(ft) ▼

Channel slope: .045 ft/ft	Water depth(y): 0.19 ft	Bottom width(b) 50 ft
Flow velocity 2.4008 ft/s	LeftSlope (Z1): 15 to 1 (H:V)	RightSlope (Z2): 15 to 1 (H:V)
Flow discharge 23.6 ft^3/s	Input n value .040 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 55.6 ft	Flow area 9.83 ft^2	Top width(T) 55.59 ft
Specific energy 0.28 ft	Froude number 1.01	Flow status Supercritical flow
Critical depth 0.19 ft	Critical slope 0.0386 ft/ft	Velocity head 0.09 ft

Swale 3
5 year

The open channel flow calculator

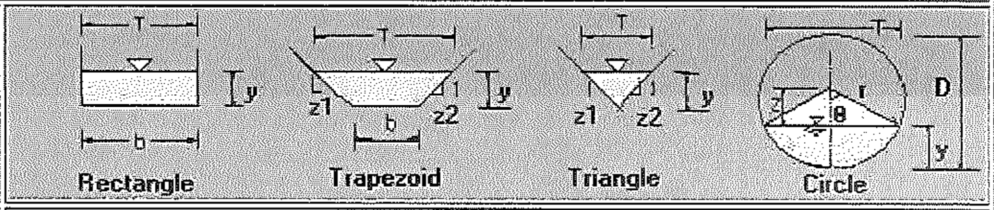
Select Channel Type: Trapezoid ▼	
Depth from Q ▼	Select unit system: Feet(ft) ▼

Channel slope: .031 ft/ft	Water depth(y): 0.09 ft	Bottom width(b) 60 ft
Flow velocity 1.067177 ft/s	LeftSlope (Z1): 15 to 1 (H:V)	RightSlope (Z2): 15 to 1 (H:V)
Flow discharge 6.1 ft^3/s	Input n value .048 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 62.8 ft	Flow area 5.72 ft^2	Top width(T) 62.79 ft
Specific energy 0.11 ft	Froude number 0.62	Flow status Subcritical flow
Critical depth 0.07 ft	Critical slope 0.0807 ft/ft	Velocity head 0.02 ft

Swale 2
100 year

The open channel flow calculator

Select Channel Type: Trapezoid ▼



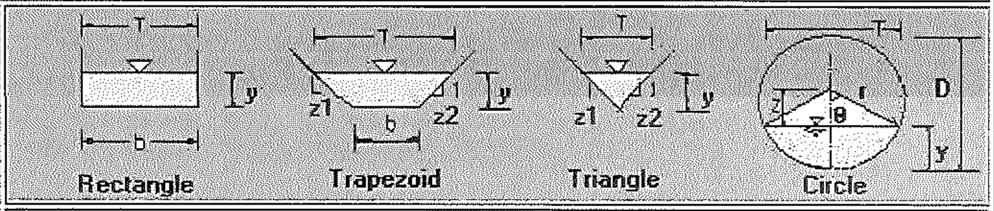
Depth from Q ▼

Select unit system: Feet(ft) ▼

Channel slope: .031 ft/ft	Water depth(y): 0.29 ft	Bottom width(b) 60 ft
Flow velocity 2.225844 ft/s	LeftSlope (Z1): 15 to 1 (H:V)	RightSlope (Z2): 15 to 1 (H:V)
Flow discharge 41.4 ft^3/s	Input n value .048 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 68.69 ft	Flow area 18.6 ft^2	Top width(T) 68.67 ft
Specific energy 0.37 ft	Froude number 0.75	Flow status Subcritical flow
Critical depth 0.24 ft	Critical slope 0.0517 ft/ft	Velocity head 0.08 ft

Swale 3
5 year

The open channel flow calculator

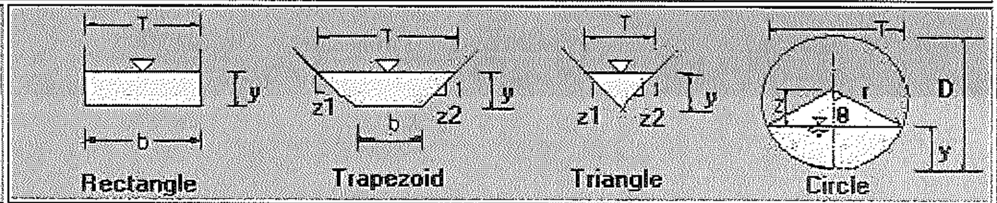
Select Channel Type: Trapezoid	
Depth from Q	Select unit system: Feet(ft)

Channel slope: .046 ft/ft	Water depth(y): 0.11 ft	Bottom width(b) 25 ft
Flow velocity 1.494305 ft/s	LeftSlope (Z1): 10 to 1 (H:V)	RightSlope (Z2): 10 to 1 (H:V)
Flow discharge 4.4 ft^3/s	Input n value .048 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 27.27 ft	Flow area 2.94 ft^2	Top width(T) 27.25 ft
Specific energy 0.15 ft	Froude number 0.8	Flow status Subcritical flow
Critical depth 0.1 ft	Critical slope 0.0725 ft/ft	Velocity head 0.03 ft

Swale #3
100 years

The open channel flow calculator

Select Channel Type: Trapezoid ▼



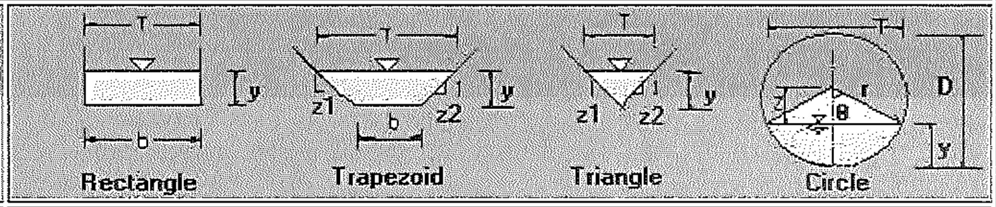
Depth from Q ▼ | Select unit system: Feet(ft) ▼

Channel slope: .046 ft/ft	Water depth(y): 0.34 ft	Bottom width(b) 25 ft
Flow velocity 2.984159 ft/s	LeftSlope (Z1): 10 to 1 (H:V)	RightSlope (Z2): 10 to 1 (H:V)
Flow discharge 29.1 ft^3/s	Input n value .048 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 31.89 ft	Flow area 9.75 ft^2	Top width(T) 31.86 ft
Specific energy 0.48 ft	Froude number 0.95	Flow status Subcritical flow
Critical depth 0.33 ft	Critical slope 0.0498 ft/ft	Velocity head 0.14 ft

Swale 4
5 year

The open channel flow calculator

Select Channel Type: Trapezoid ▼

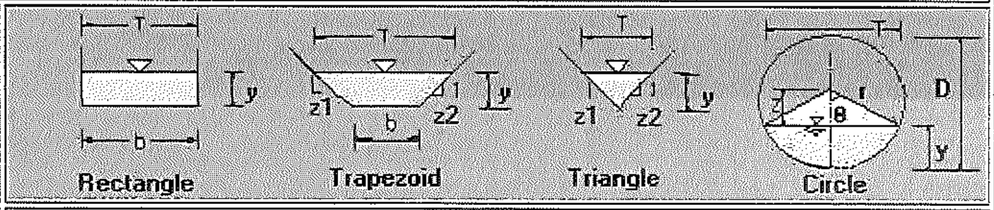


Depth from Q ▼ | Select unit system: Feet(ft) ▼

Channel slope: .033 ft/ft	Water depth(y): 0.1 ft	Bottom width(b) 85 ft
Flow velocity 1.131842 ft/s	LeftSlope (Z1): 25 to 1 (H:V)	RightSlope (Z2): 25 to 1 (H:V)
Flow discharge 9.7 ft^3/s	Input n value .048 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 89.9 ft	Flow area 8.57 ft^2	Top width(T) 89.9 ft
Specific energy 0.12 ft	Froude number 0.65	Flow status Subcritical flow
Critical depth 0.07 ft	Critical slope 0.0805 ft/ft	Velocity head 0.02 ft

Swale 4
100 year

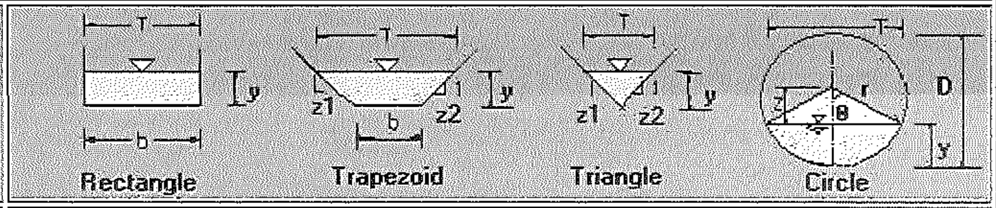
The open channel flow calculator

Select Channel Type: Trapezoid		
Depth from Q	Select unit system: Feet(ft)	
Channel slope: .033 ft/ft	Water depth(y): 0.29 ft	Bottom width(b) 85 ft
Flow velocity 2.335098 ft/s	LeftSlope (Z1): 25 to 1 (H:V)	RightSlope (Z2): 25 to 1 (H:V)
Flow discharge 63.4 ft^3/s	Input n value .048 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 99.71 ft	Flow area 27.15 ft^2	Top width(T) 99.7 ft
Specific energy 0.38 ft	Froude number 0.79	Flow status Subcritical flow
Critical depth 0.25 ft	Critical slope 0.0524 ft/ft	Velocity head 0.08 ft

Swale #5

The open channel flow calculator

Select Channel Type: Trapezoid ▼



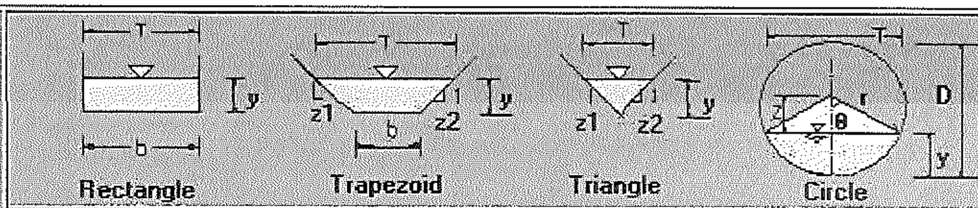
Depth from Q ▼ | Select unit system: Feet(ft) ▼

Channel slope: .055 ft/ft	Water depth(y): 0.05 ft	Bottom width(b) 25 ft
Flow velocity 1.017034 ft/s	LeftSlope (Z1): 10 to 1 (H:V)	RightSlope (Z2): 10 to 1 (H:V)
Flow discharge 1.4 ft^3/s	Input n value .048 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 26.08 ft	Flow area 1.38 ft^2	Top width(T) 26.08 ft
Specific energy 0.07 ft	Froude number 0.78	Flow status Subcritical flow
Critical depth 0.05 ft	Critical slope 0.075 ft/ft	Velocity head 0.02 ft

Swale #5
100 year

The open channel flow calculator

Select Channel Type: Trapezoid ▼



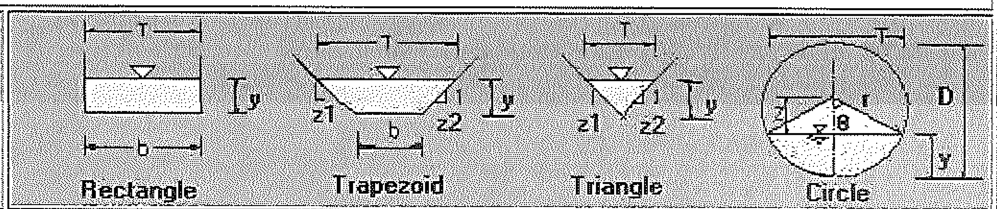
Depth from Q ▼ | Select unit system: Feet(ft) ▼

Channel slope: .055 ft/ft	Water depth(y): 0.15 ft	Bottom width(b) 25 ft
Flow velocity 1.961156 ft/s	LeftSlope (Z1): 10 to 1 (H:V)	RightSlope (Z2): 10 to 1 (H:V)
Flow discharge 7.9 ft^3/s	Input n value .048 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 28.05 ft	Flow area 4.03 ft^2	Top width(T) 28.04 ft
Specific energy 0.21 ft	Froude number 0.91	Flow status Subcritical flow
Critical depth 0.15 ft	Critical slope 0.0596 ft/ft	Velocity head 0.06 ft

Swale #6
5 year

The open channel flow calculator

Select Channel Type: Trapezoid

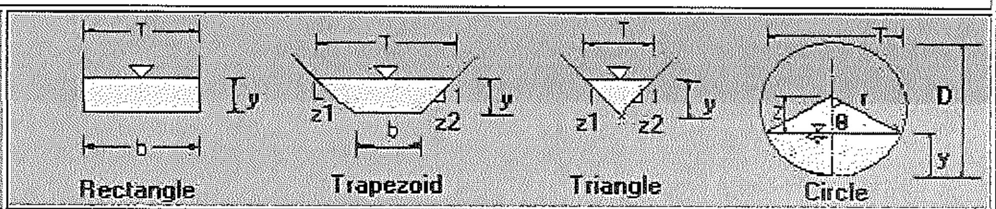


Depth from Q	Select unit system: Feet(ft)	
Channel slope: .06 ft/ft	Water depth(y): 0.07 ft	Bottom width(b) 25 ft
Flow velocity 1.215952 ft/s	LeftSlope (Z1): 10 to 1 (H:V)	RightSlope (Z2): 10 to 1 (H:V)
Flow discharge 2.3 ft^3/s	Input n value .048 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 26.48 ft	Flow area 1.89 ft^2	Top width(T) 26.47 ft
Specific energy 0.1 ft	Froude number 0.8	Flow status Subcritical flow
Critical depth 0.06 ft	Critical slope 0.0841 ft/ft	Velocity head 0.02 ft

Swale #6
100 year

The open channel flow calculator

Select Channel Type: Trapezoid ▼



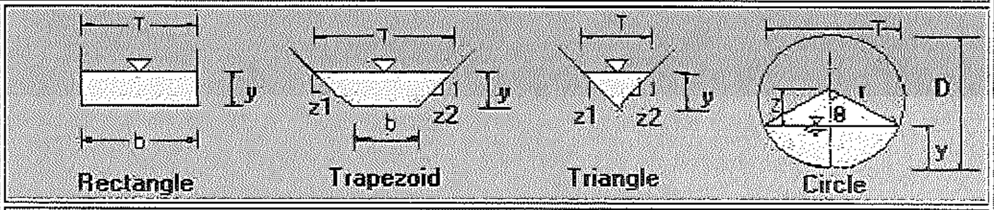
Depth from Q ▼ | Select unit system: Feet(ft) ▼

Channel slope: .06 ft/ft	Water depth(y): 0.21 ft	Bottom width(b) 25 ft
Flow velocity 2.503745 ft/s	LeftSlope (Z1): 10 to 1 (H:V)	RightSlope (Z2): 10 to 1 (H:V)
Flow discharge 14.3 ft^3/s	Input n value .048 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 29.24 ft	Flow area 5.71 ft^2	Top width(T) 29.21 ft
Specific energy 0.31 ft	Froude number 1	Flow status Critical flow
Critical depth 0.21 ft	Critical slope 0.0577 ft/ft	Velocity head 0.1 ft

Swale 7
5 years

The open channel flow calculator

Select Channel Type: Trapezoid ▼

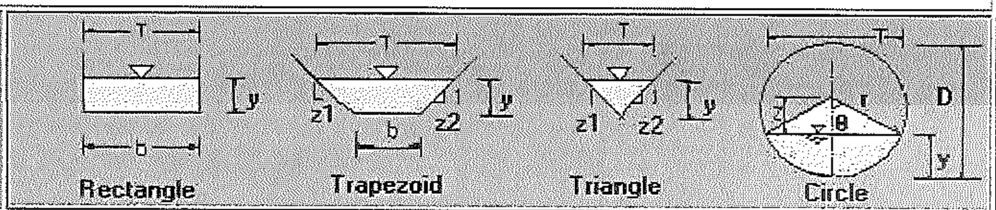


Depth from Q ▼ | Select unit system: Feet(ft) ▼

Channel slope: .033 ft/ft	Water depth(y): 0.11 ft	Bottom width(b) 35 ft
Flow velocity 1.140327 ft/s	LeftSlope (Z1): 30 to 1 (H:V)	RightSlope (Z2): 30 to 1 (H:V)
Flow discharge 4.7 ft^3/s	Input n value .048 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 41.47 ft	Flow area 4.12 ft^2	Top width(T) 41.47 ft
Specific energy 0.13 ft	Froude number 0.64	Flow status Subcritical flow
Critical depth 0.08 ft	Critical slope 0.0708 ft/ft	Velocity head 0.02 ft

Swale 7
100 year

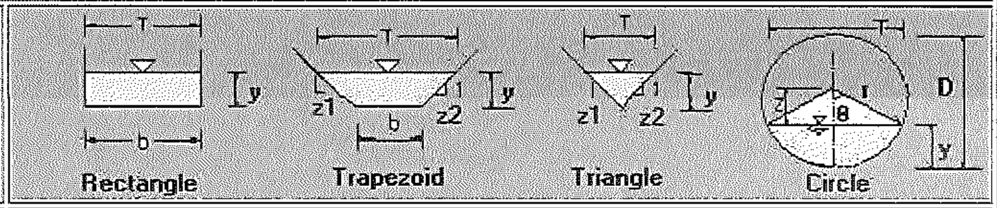
The open channel flow calculator



Select Channel Type: Trapezoid ▼		
Depth from Q ▼	Select unit system: Feet(ft) ▼	
Channel slope: .033 ft/ft	Water depth(y): 0.29 ft	Bottom width(b) 35 ft
Flow velocity 2.173393 ft/s	LeftSlope (Z1): 30 to 1 (H:V)	RightSlope (Z2): 30 to 1 (H:V)
Flow discharge 28 ft^3/s	Input n value .048 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 52.65 ft	Flow area 12.88 ft^2	Top width(T) 52.64 ft
Specific energy 0.37 ft	Froude number 0.77	Flow status Subcritical flow
Critical depth 0.25 ft	Critical slope 0.0535 ft/ft	Velocity head 0.07 ft

Swale 8
5 year

The open channel flow calculator

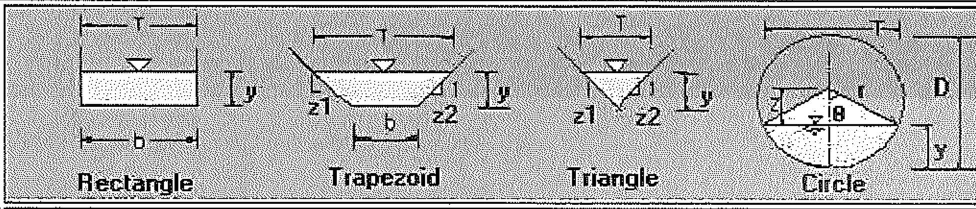


Select Channel Type: Trapezoid		
Depth from Q	Select unit system: Feet(ft)	
Channel slope: .033 ft/ft	Water depth(y): 0.14 ft	Bottom width(b) 35 ft
Flow velocity 1.397503 ft/s	LeftSlope (Z1): 30 to 1 (H:V)	RightSlope (Z2): 30 to 1 (H:V)
Flow discharge 7.5 ft^3/s	Input n value .048 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 43.24 ft	Flow area 5.37 ft^2	Top width(T) 43.23 ft
Specific energy 0.17 ft	Froude number 0.7	Flow status Subcritical flow
Critical depth 0.11 ft	Critical slope 0.0645 ft/ft	Velocity head 0.03 ft

Swale 8
100 year

The open channel flow calculator

Select Channel Type: Trapezoid ▼

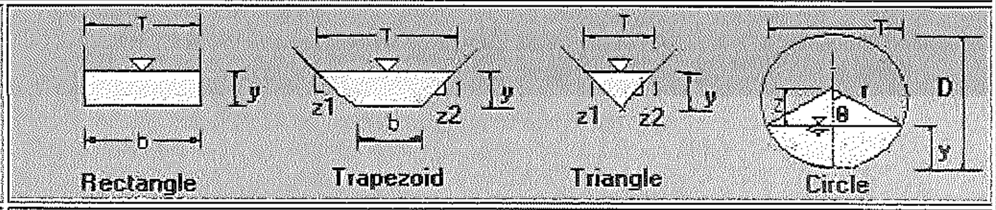


Depth from Q ▼ | Select unit system: Feet(ft) ▼

Channel slope: .033 ft/ft	Water depth(y): 0.4 ft	Bottom width(b) 35 ft
Flow velocity 2.567492 ft/s	LeftSlope (Z1): 30 to 1 (H:V)	RightSlope (Z2): 30 to 1 (H:V)
Flow discharge 47.8 ft^3/s	Input n value .048 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 58.83 ft	Flow area 18.62 ft^2	Top width(T) 58.81 ft
Specific energy 0.5 ft	Froude number 0.8	Flow status Subcritical flow
Critical depth 0.35 ft	Critical slope 0.0489 ft/ft	Velocity head 0.1 ft

Swale 9
5 year

The open channel flow calculator

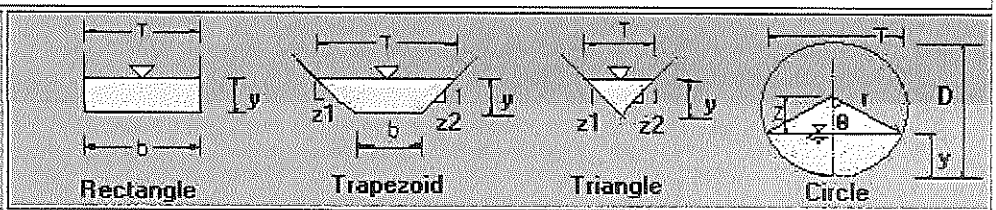
Select Channel Type: Trapezoid ▼	
Depth from Q ▼	Select unit system: Feet(ft) ▼

Channel slope: .047 ft/ft	Water depth(y): 0.05 ft	Bottom width(b) 60 ft
Flow velocity 0.854289 ft/s	LeftSlope (Z1): 15 to 1 (H:V)	RightSlope (Z2): 15 to 1 (H:V)
Flow discharge 2.8 ft^3/s	Input n value .048 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 61.62 ft	Flow area 3.28 ft^2	Top width(T) 61.62 ft
Specific energy 0.07 ft	Froude number 0.65	Flow status Subcritical flow
Critical depth 0.04 ft	Critical slope 0.0744 ft/ft	Velocity head 0.01 ft

Swale 9
100-year

The open channel flow calculator

Select Channel Type: Trapezoid ▼

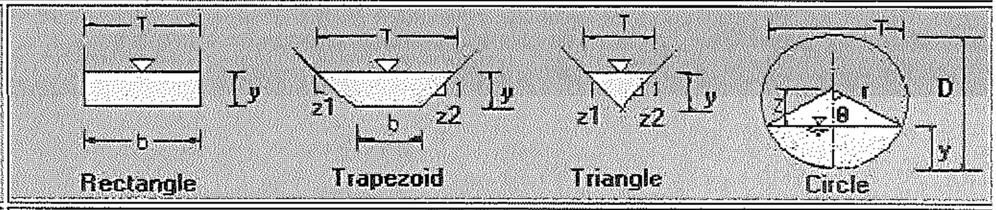


Depth from Q ▼ | Select unit system: Feet(ft) ▼

Channel slope: .047 ft/ft	Water depth(y): 0.17 ft	Bottom width(b) 60 ft
Flow velocity 1.928958 ft/s	LeftSlope (Z1): 15 to 1 (H:V)	RightSlope (Z2): 15 to 1 (H:V)
Flow discharge 20.7 ft^3/s	Input n value .048 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 65.16 ft	Flow area 10.73 ft^2	Top width(T) 65.15 ft
Specific energy 0.23 ft	Froude number 0.84	Flow status Subcritical flow
Critical depth 0.16 ft	Critical slope 0.0581 ft/ft	Velocity head 0.06 ft

Swale #11
~~10~~ 5 year

The open channel flow calculator

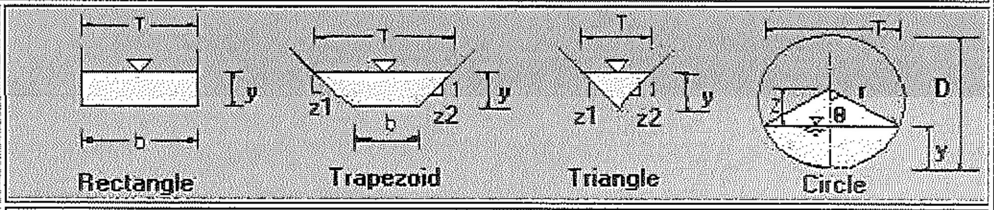


Select Channel Type: Trapezoid ▼		
Depth from Q ▼	Select unit system: Feet(ft) ▼	
Channel slope: .031 ft/ft	Water depth(y): 0.12 ft	Bottom width(b) 60 ft
Flow velocity 1.225314 ft/s	LeftSlope (Z1): 15 to 1 (H:V)	RightSlope (Z2): 15 to 1 (H:V)
Flow discharge 8.9 ft^3/s	Input n value .048 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 63.54 ft	Flow area 7.26 ft^2	Top width(T) 63.53 ft
Specific energy 0.14 ft	Froude number 0.64	Flow status Subcritical flow
Critical depth 0.09 ft	Critical slope 0.074 ft/ft	Velocity head 0.02 ft

Swale #11
100 year

The open channel flow calculator

Select Channel Type: Trapezoid ▼



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

Channel slope: .031 ft/ft	Water depth(y): 0.36 ft	Bottom width(b) 60 ft
Flow velocity 2.617141 ft/s	LeftSlope (Z1): 15 to 1 (H:V)	RightSlope (Z2): 15 to 1 (H:V)
Flow discharge 62.1 ft^3/s	Input n value .048 or select n	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter 70.9 ft	Flow area 23.73 ft^2	Top width(T) 70.88 ft
Specific energy 0.47 ft	Froude number 0.8	Flow status Subcritical flow
Critical depth 0.31 ft	Critical slope 0.0504 ft/ft	Velocity head 0.11 ft

Culvert #1
Didleau Subdivision

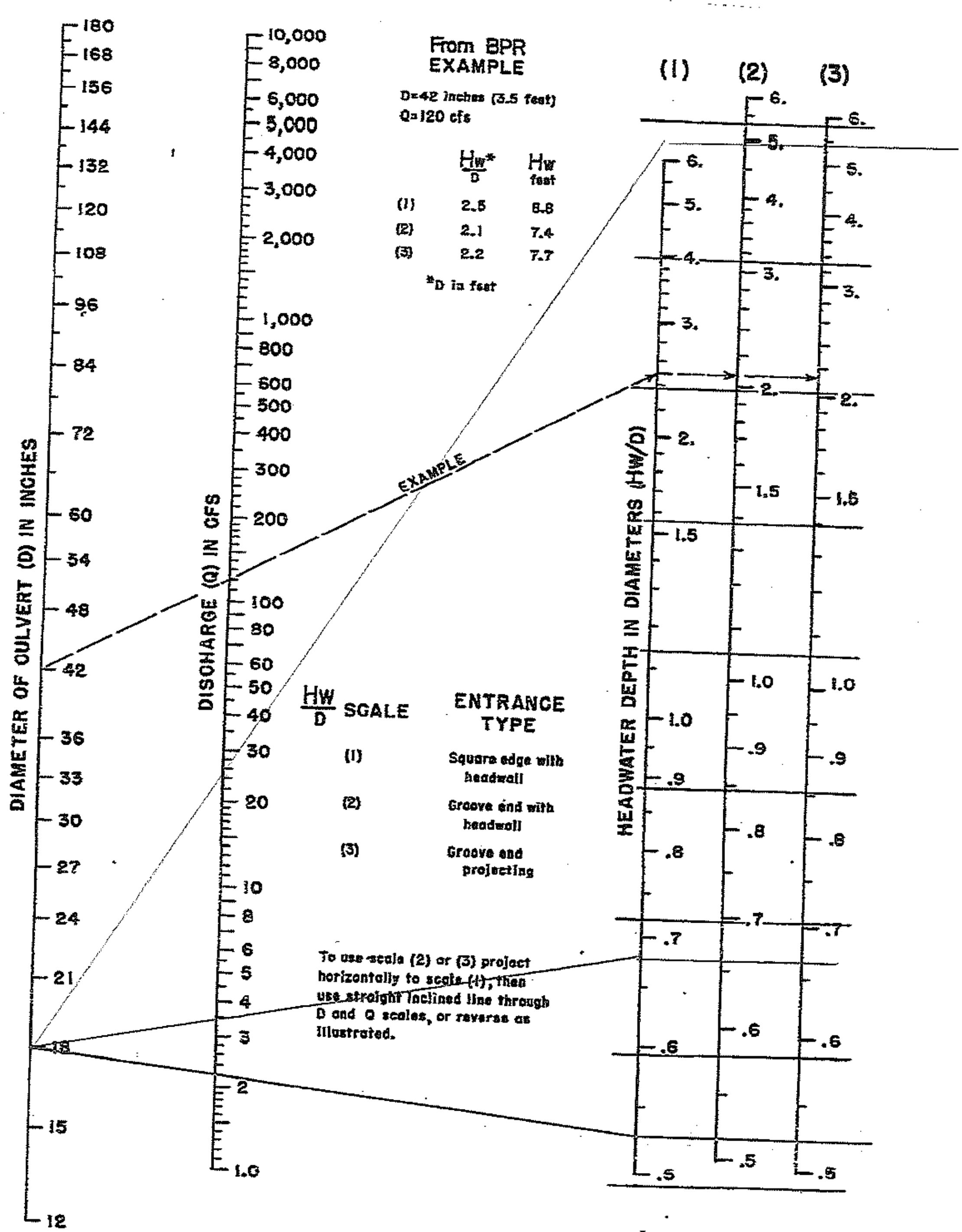


Figure CU-9—Inlet Control Nomograph—Example

Culvert #2
Q5 = 4.4cfs
Q100 = 29.1

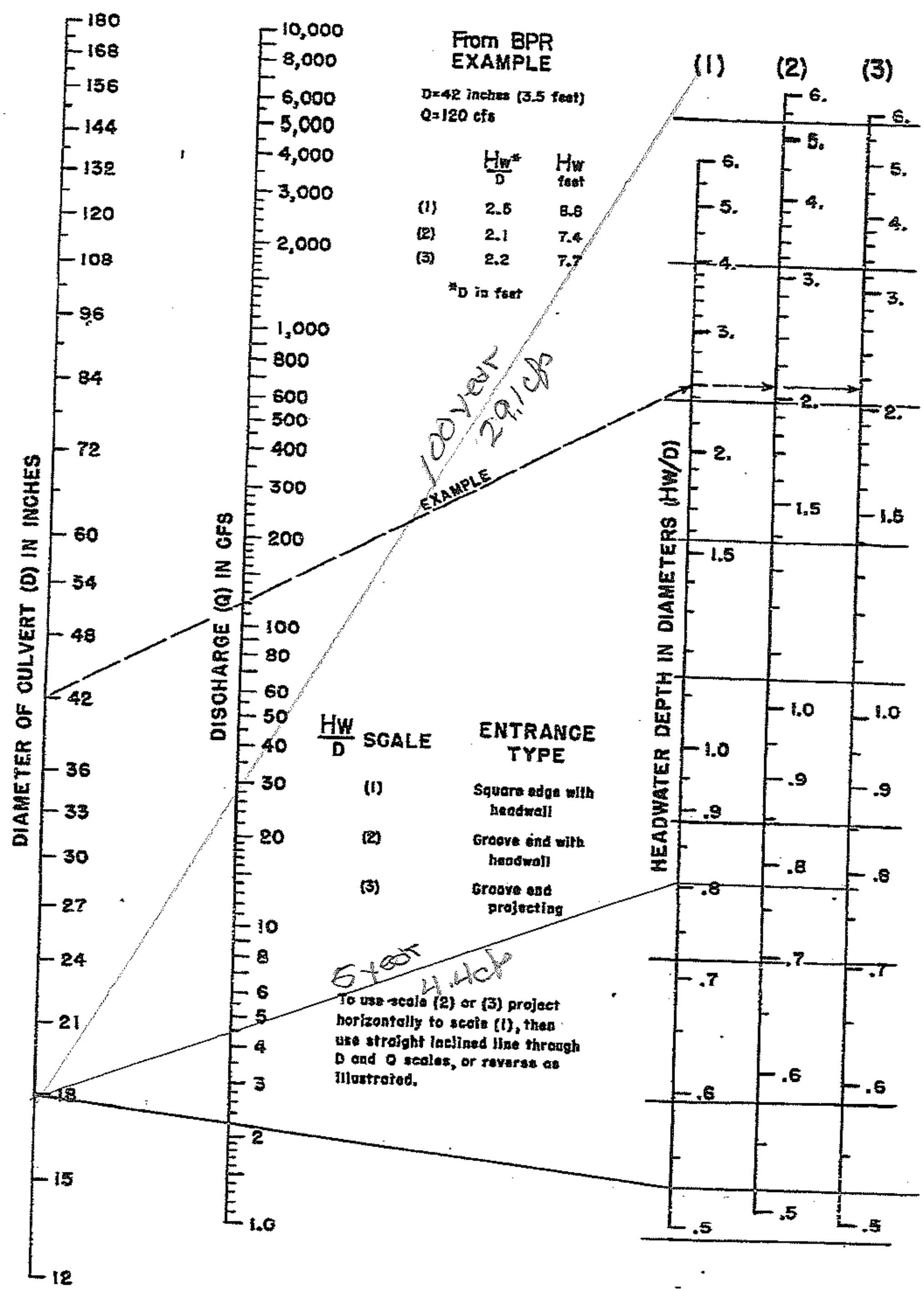


Figure CU-9—Inlet Control Nomograph—Example

Culvert #3
$Q_5 = 3.7$ cfs
$Q_{100} = 22.2$ cfs

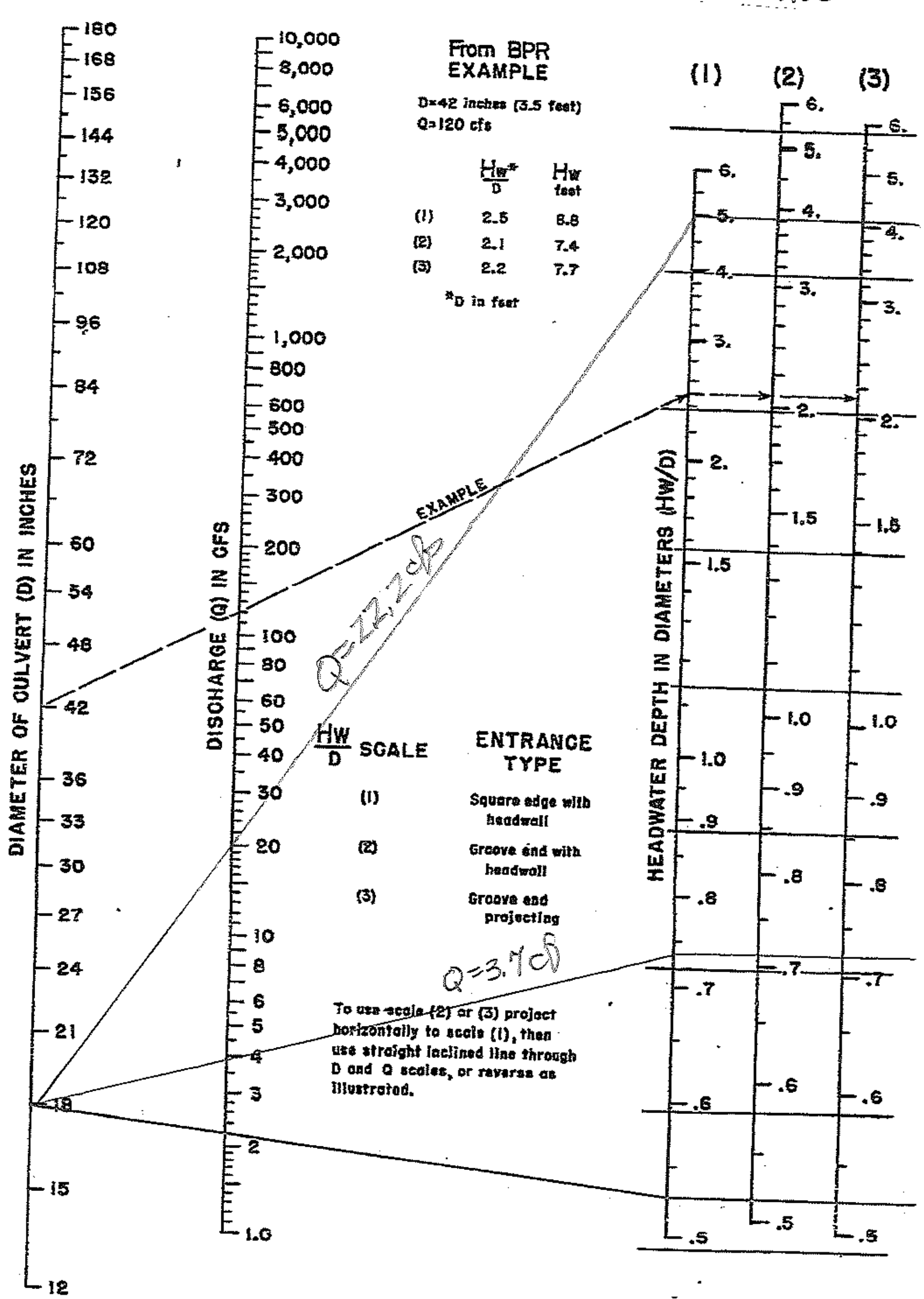


Figure CU-9—Inlet Control Nomograph—Example

Culvert 4

Q_5=16.8 cfs

Q_{100}=104.2 cfs

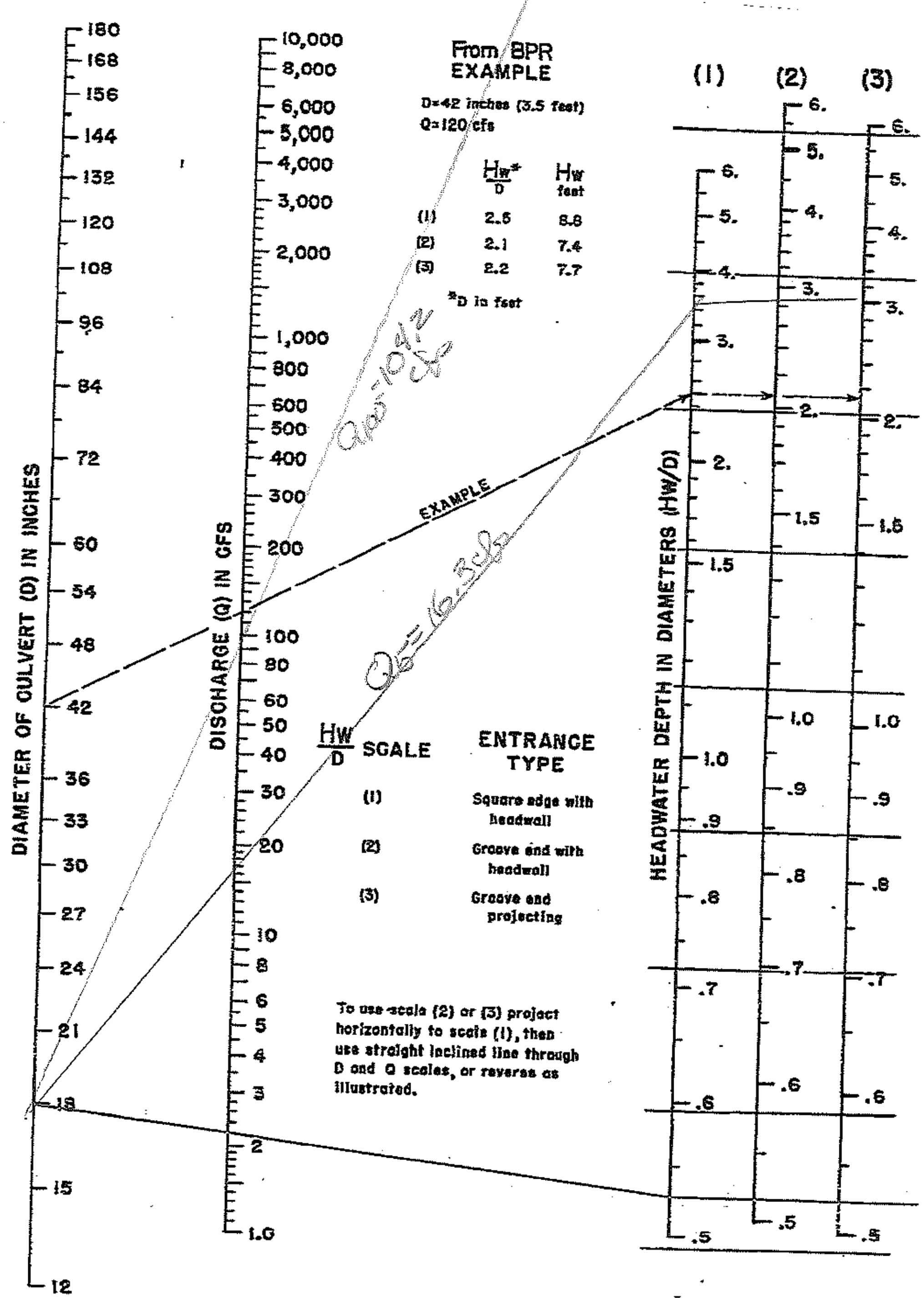


Figure CU-9—Inlet Control Nomograph—Example

Exhibit 9: Soil, Geology, and Geologic Hazard Study, Entech Engineering

Exhibit 9: Soil, Geology, and Geologic Hazard Study, Entech Engineering

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.

Land Development Consultants, Inc.
Soils, Geology, and Geologic Hazard Study
Didleau Subdivision
Herring Road & Forest Heights Circle
Parcel Nos. 52090-00-050 & 52090-00-120
El Paso County, Colorado

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

Reviewed by:

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

LLL/lll

Encl.

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

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9. Schwochow, S.D.; Shroba, R.R. and Wicklein, P.C. 1974. *Atlas of Sand, Gravel, and Quarry Aggregate Resources, Colorado Front Range Counties.* Colorado Geological Survey. Special Publication 5-B.

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TABLES

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

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

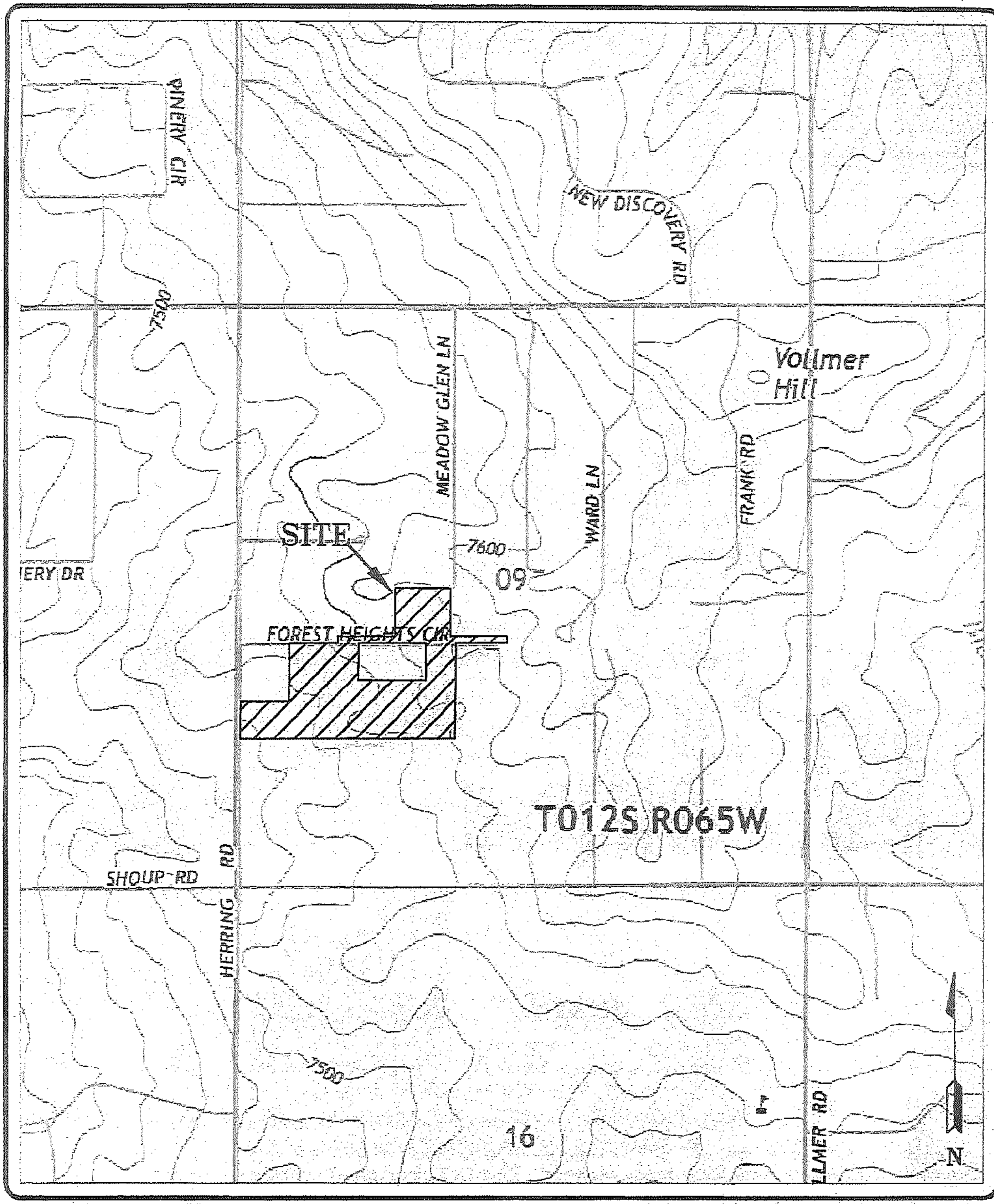
SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	FHA SWELL (PSF)	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1	1	2-3			12.2						SM	SAND, SILTY
1	2	2-3			38.4				1640		SC	SAND, VERY CLAYEY
1	TP-2	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



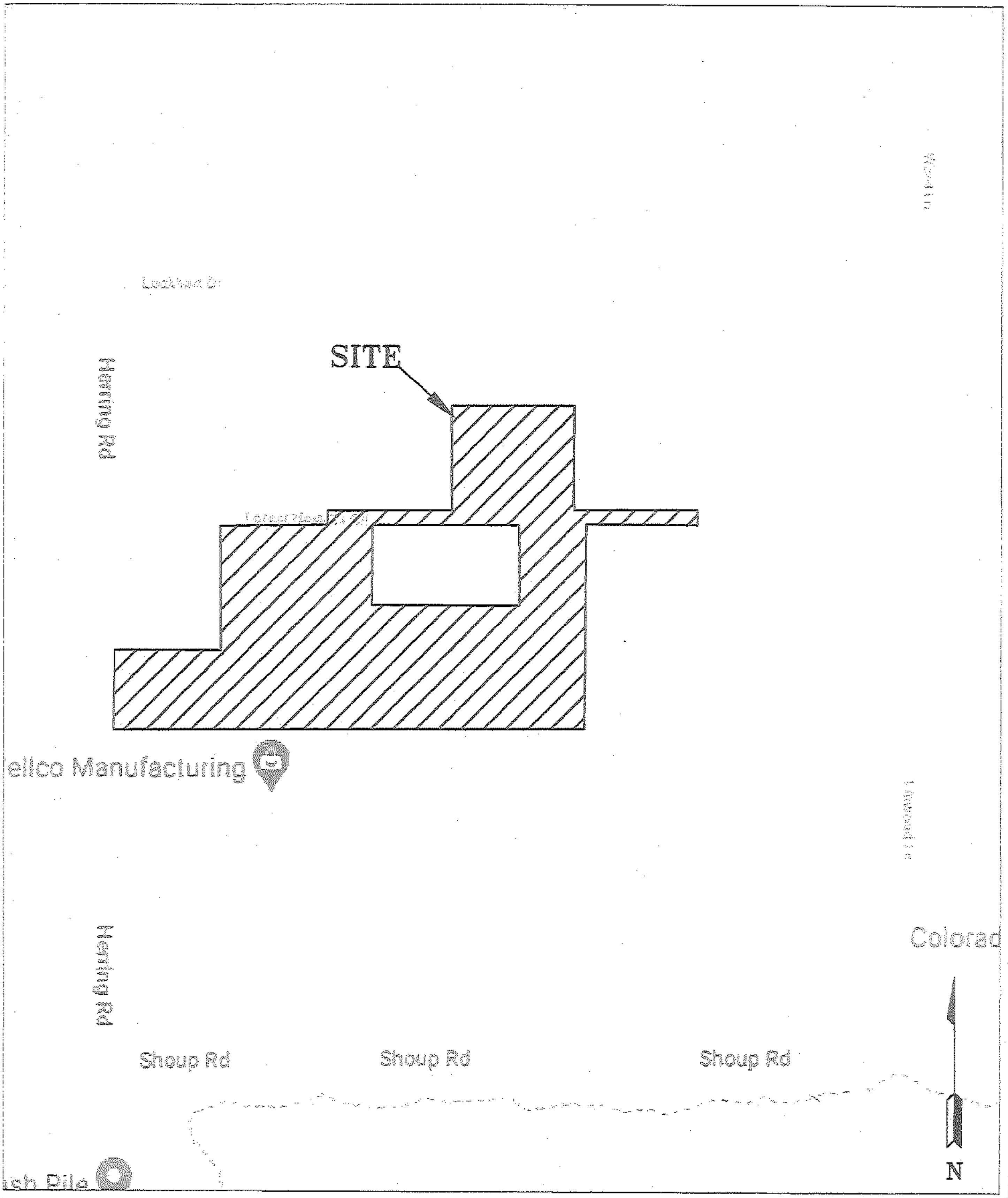
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

USGS MAP
DIDLEAU SUBDIVISION
HERRING ROAD & FOREST HEIGHTS CIRCLEEL
PASO COUNTY, CO.
FOR: LDC, INC.

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

JOB NO.: 192115

FIG NO.: 2



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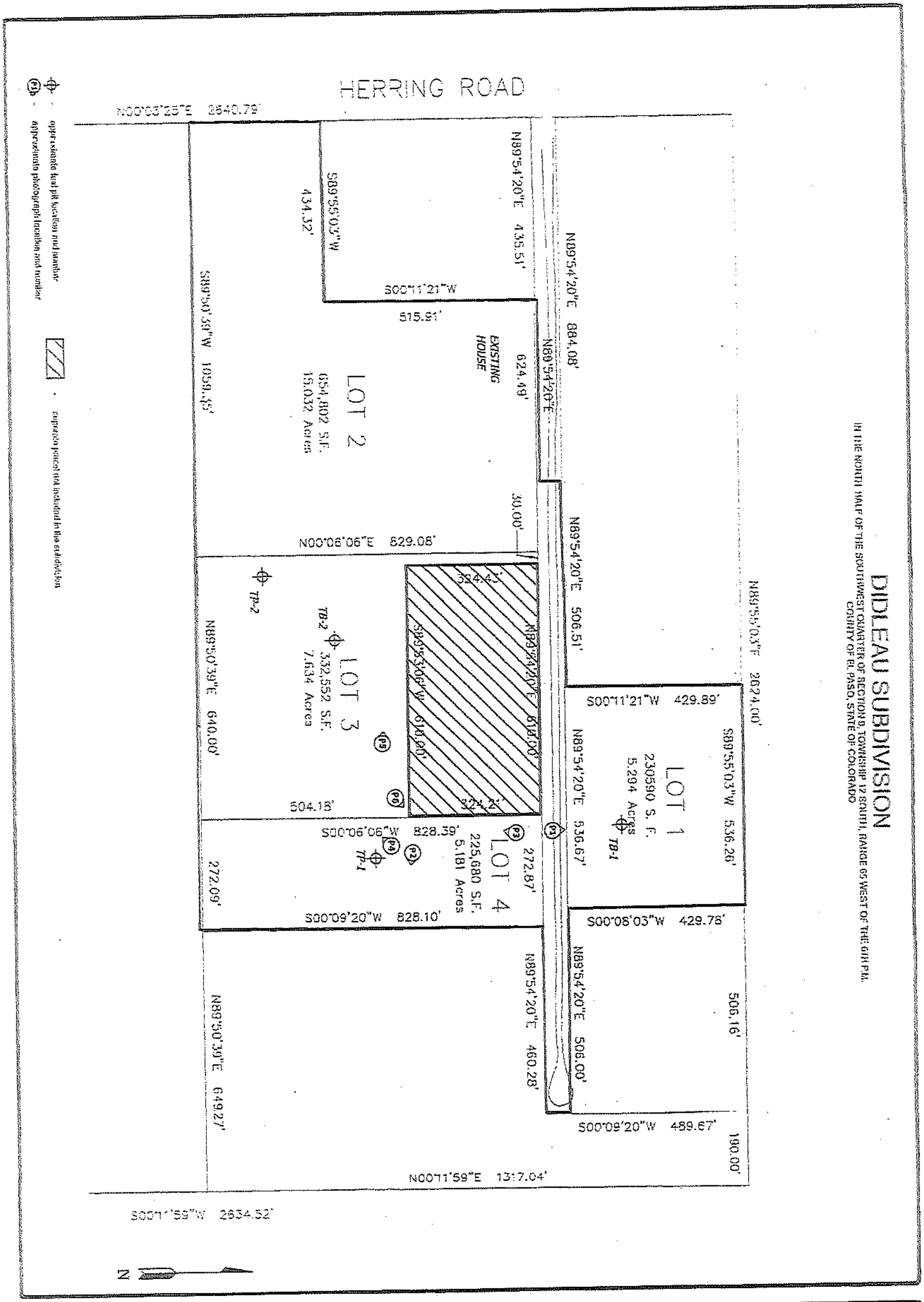
COLORADO SPRINGS, CO. 80907 (719) 531-5599

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



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

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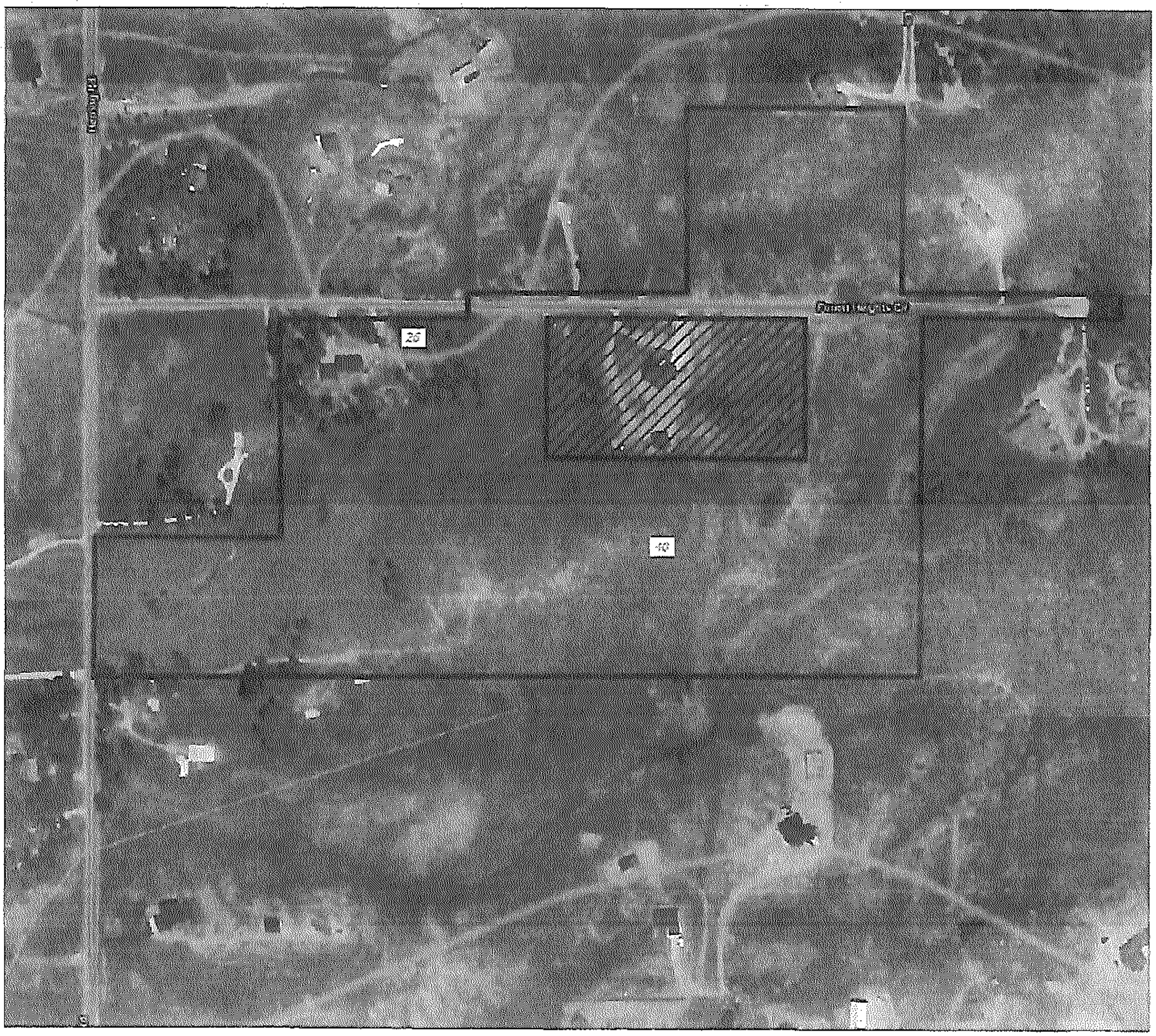
REVISION BY

3



SEPERATE PARCEL NOT INCLUDED IN THE SUBDIVISION

N

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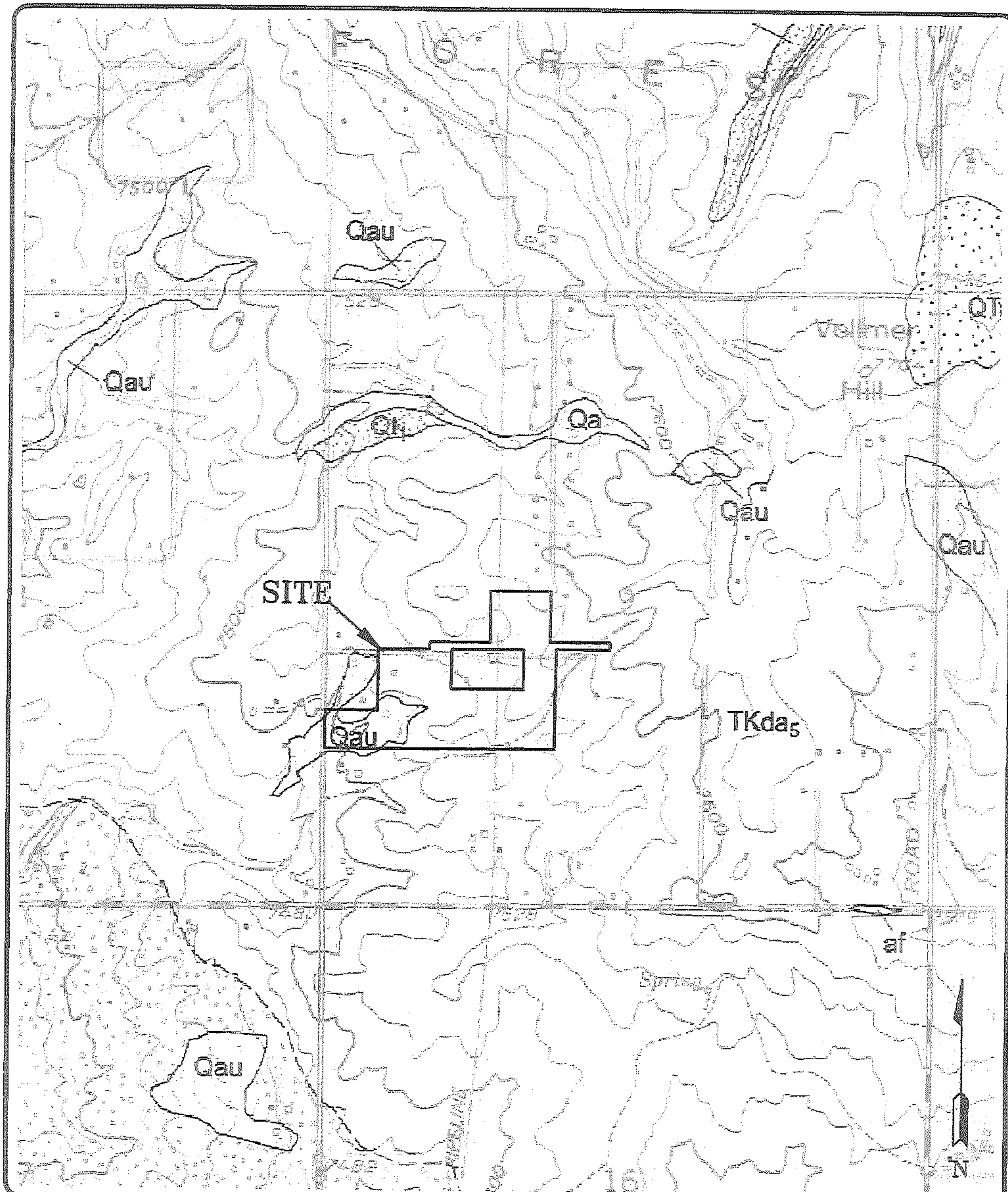
SOIL SURVEY MAP
DIDLEAU SUBDIVISION
HERRING ROAD & FOREST HEIGHTS CIRCLE
EL PASO COUNTY, CO.
FOR: LDC, INC.

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

JOB NO.: 192115

FIG NO.: 4



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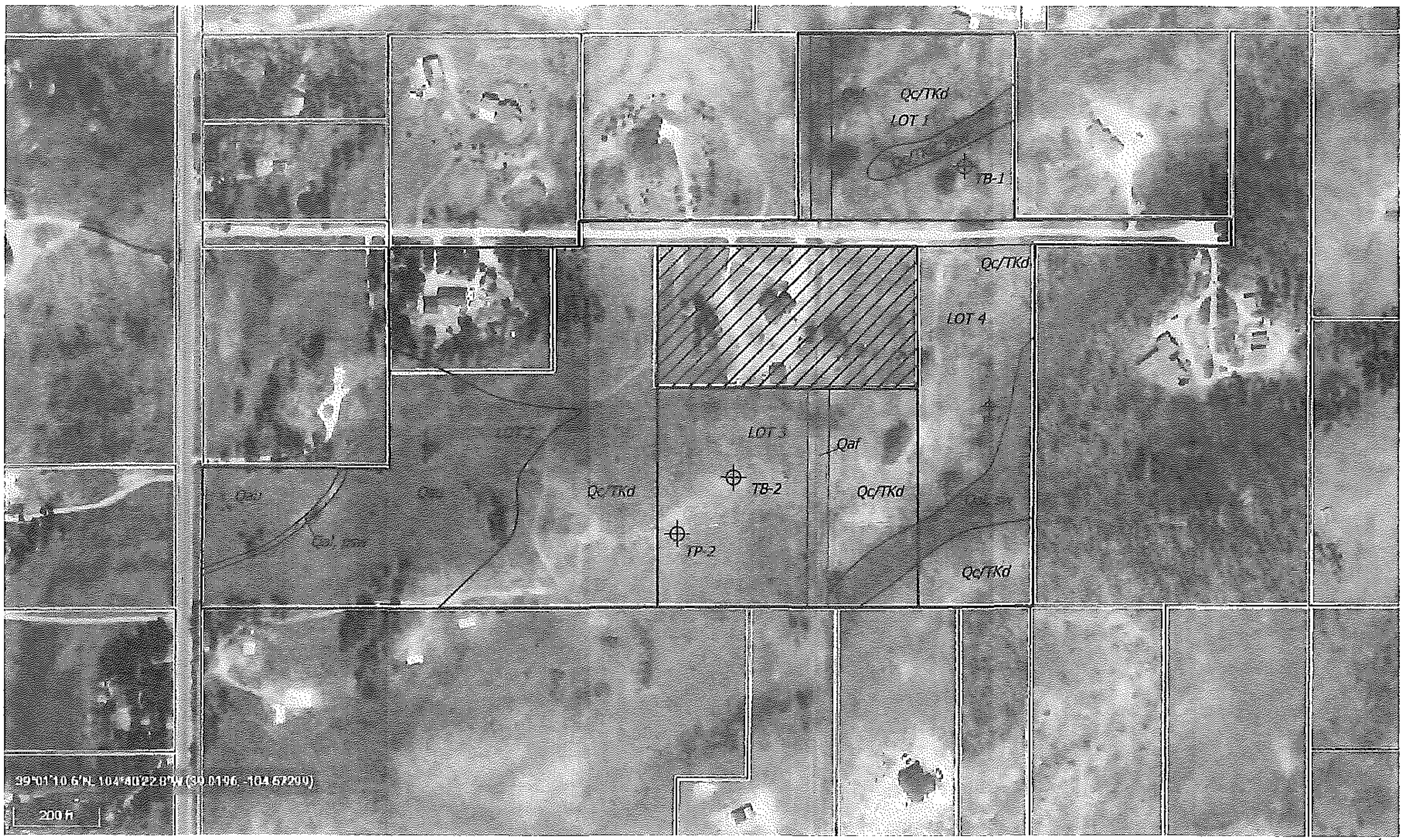
BLACK FOREST QUADRANGLE GEOLOGIC MAP
DIDLEAU SUBDIVISION
HERRING ROAD & FOREST HEIGHTS CIRCLE
EL PASO COUNTY, CO.
FOR: LDC, INC.

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 alluvial-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

REVISION	BY

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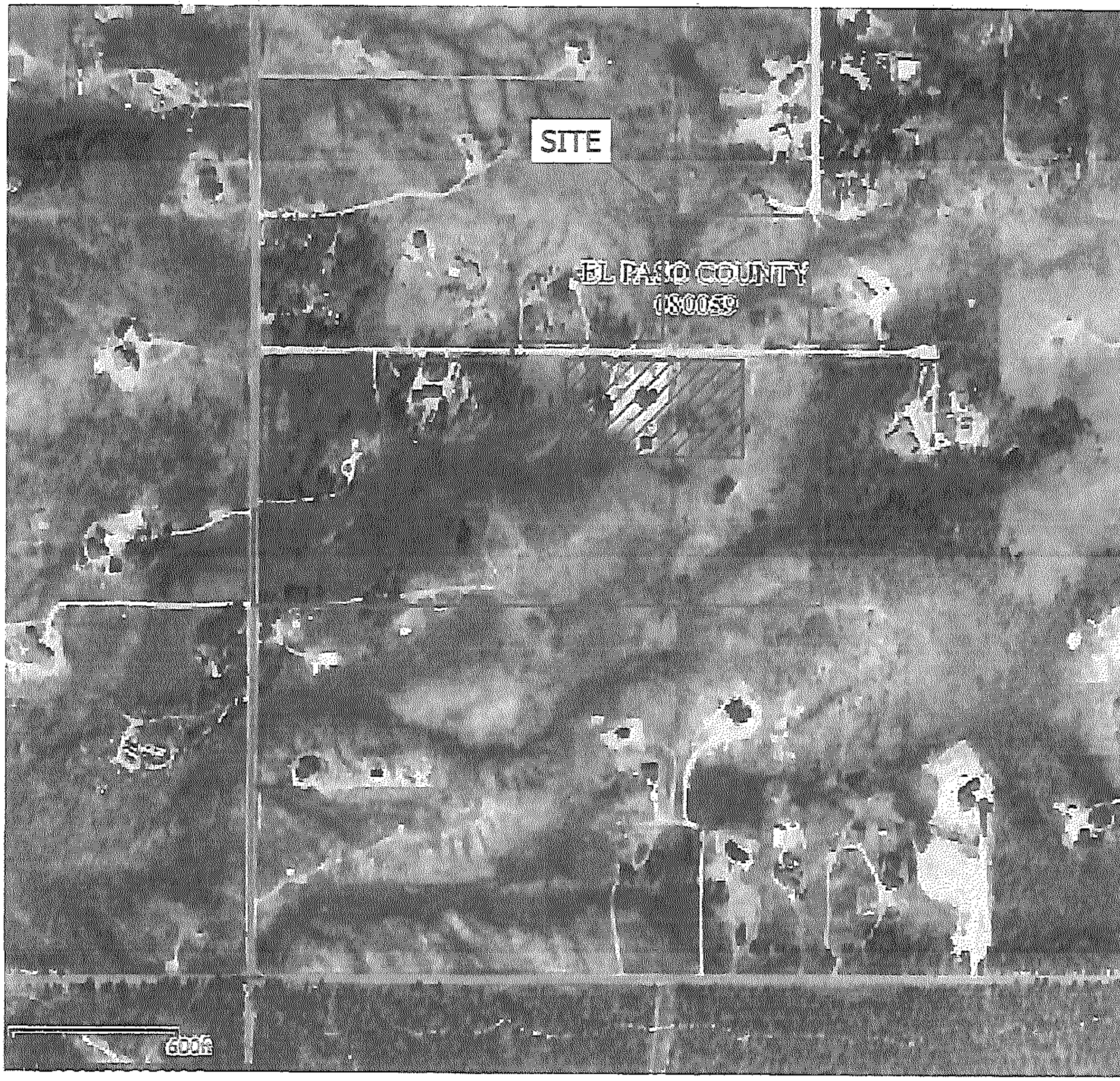
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

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

DRAWN: LLL
CHECKED:
DATE: 3/26/20
SCALE: AS SHOWN
JOB NO. 192116
FIGURE NO. 6



SEPERATE PARCEL NOT INCLUDED IN THE SUBDIVISION

N

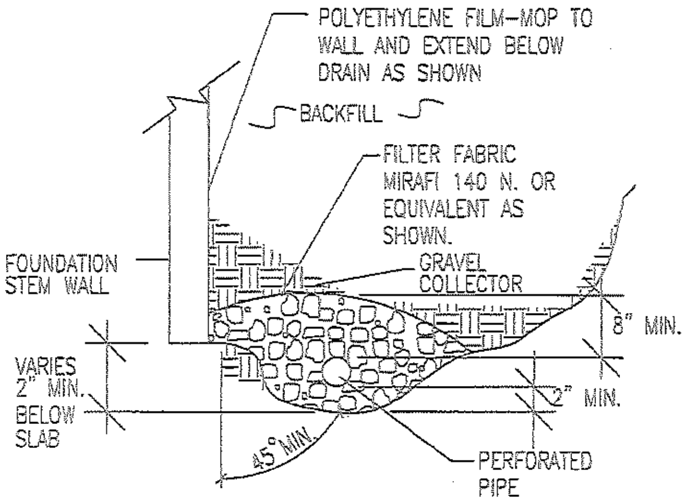
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

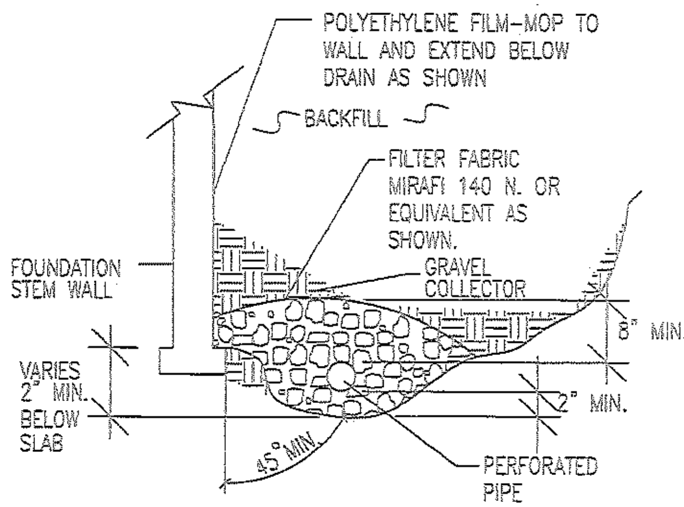
FEMA FLOODPLAIN MAP
DIDLEAU SUBDIVISION
HERRING ROAD & FOREST HEIGHTS CIRCLE
EL PASO COUNTY, CO.
FOR: LDC, INC.

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.

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
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

Looking south from the northern portion of Lot 4.

January 30, 2020

Looking south towards one of the stockpiles of cut trees.

January 30, 2020

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

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

Description	Depth (ft)	Samples	Blows per foot	Watercontent %	Soil Type
SAND, SILTY, FINE TO COARSE GRAINED, BROWN, VERY DENSE TO DENSE, MOIST		■	50	5.6	1
	5	■	42	10.8	1
SANDSTONE, SILTY, FINE TO COARSE GRAINED, BROWN, VERY DENSE, MOIST	10	■	50/10"	12.5	2
	15	■	50/9"	11.7	2
	20	■	50/7"	11.5	2

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

REMARKS

DRY TO 18.5', 1/6/20

Description	Depth (ft)	Samples	Blows per foot	Watercontent %	Soil Type
SAND, VERY CLAYEY, FINE TO MEDIUM GRAINED, BROWN, LOOSE, MOIST		■	7	23.1	1
CLAYSTONE, VERY SANDY, BROWN, HARD, MOIST	5	■	50/11"	12.7	1 / 3
	10	■	50/6"	15.2	3
SANDSTONE, SILTY, FINE TO COARSE GRAINED, BROWN, VERY DENSE, MOIST	15	■	50/5"	6.9	2
	20	■	50/6"	15.8	2

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

TEST BORING LOG

DRAWN: DATE: CHECKED: [signature] 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						
gravelly sandy loam, fine to coarse grained, light brown	1–3			gr	m	2
weathered to formational silty sandstone, fine to coarse grained, tan	4–7			ma		3A
	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						
gravelly sandy loam, fine to coarse grained, light brown	1–2			gr	m	2
weathered to formational silty sandstone, fine to coarse grained, tan	3–6			ma		3A
	7					
	8					
	9					
	10					

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

<u>Soil Structure Grade</u>
weak - w
moderate - m
strong - s
loose - l

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

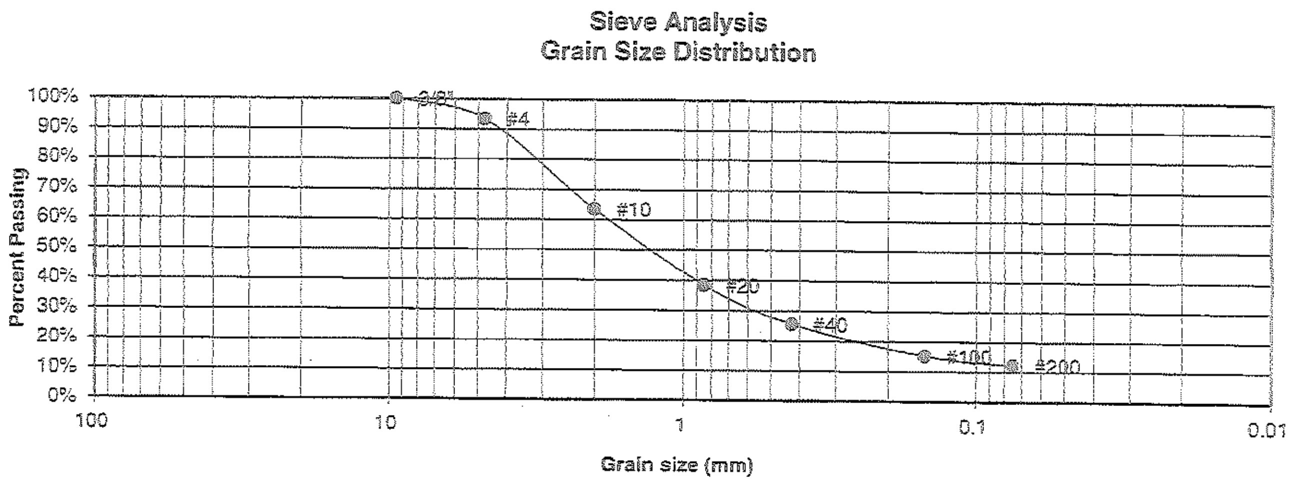
TEST PIT LOG

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

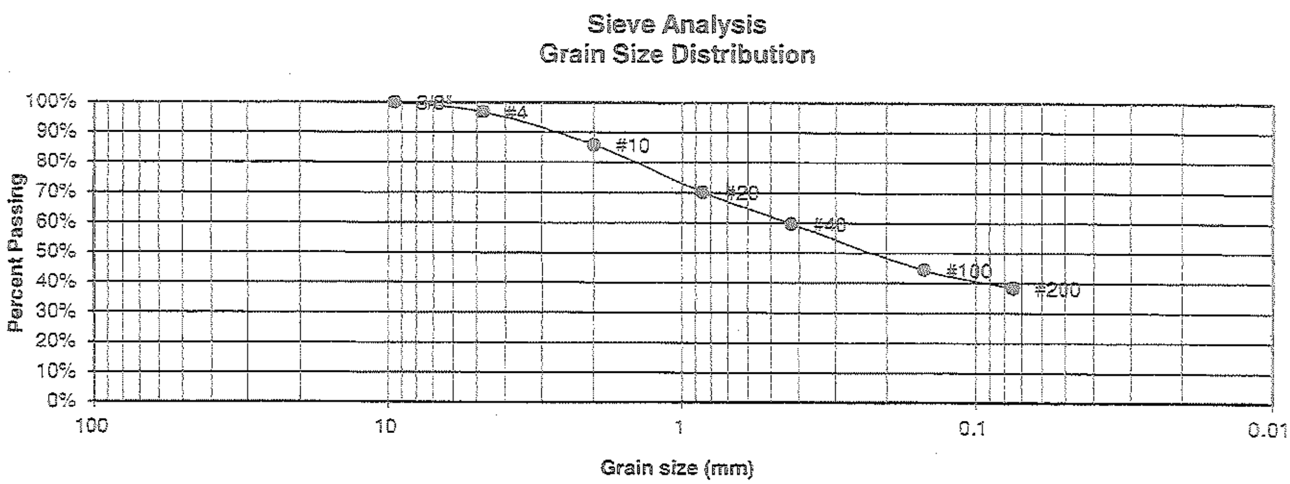
LABORATORY TEST RESULTS

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

JOB NO.: 192115

FIG NO.: C-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

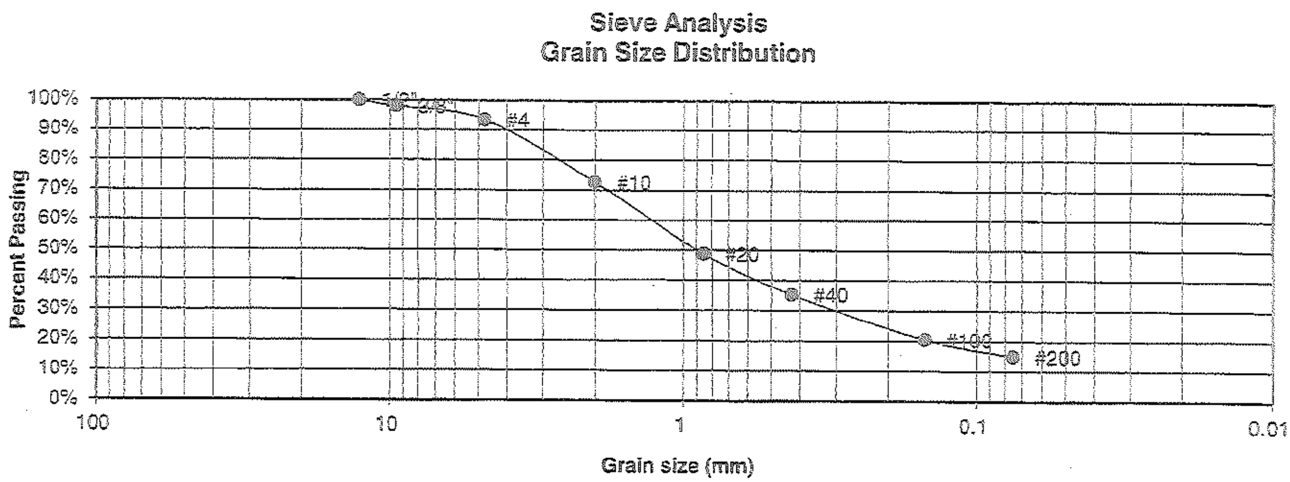
LABORATORY TEST RESULTS

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

JOB NO.: 192115

FIG NO.: C-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

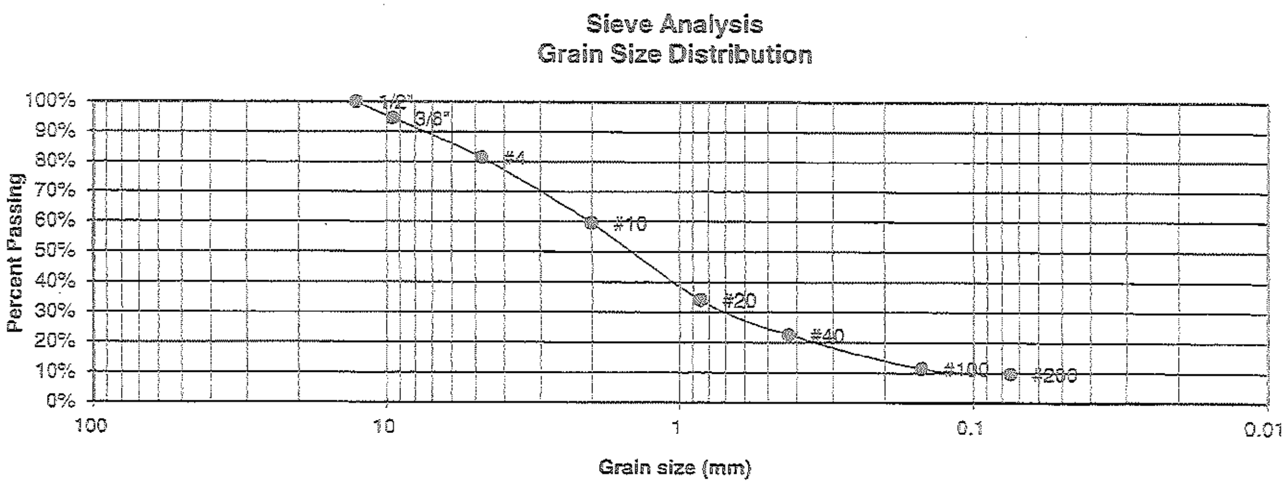
LABORATORY TEST RESULTS

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

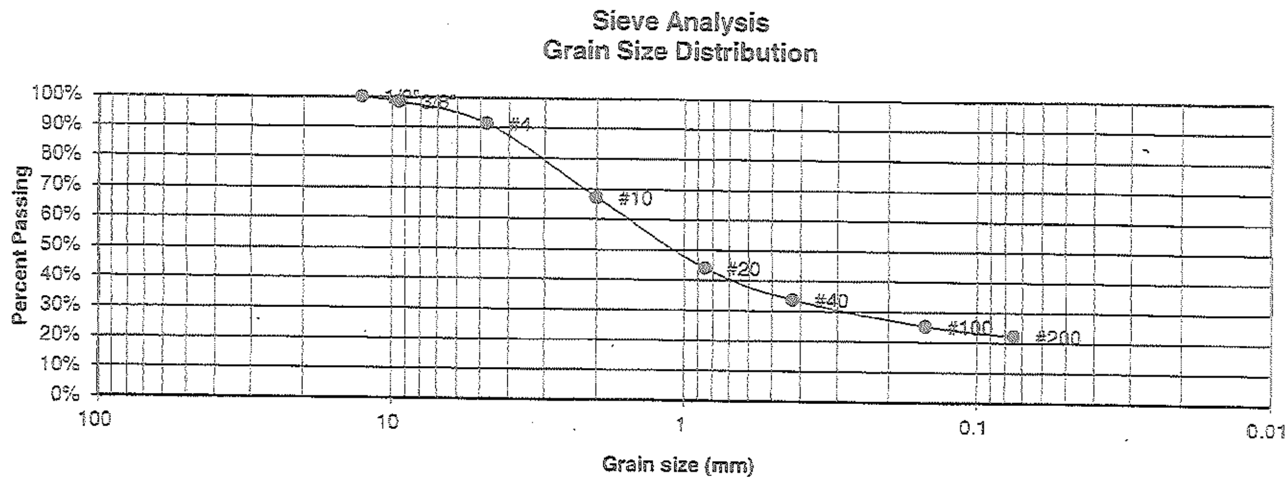
LABORATORY TEST RESULTS

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

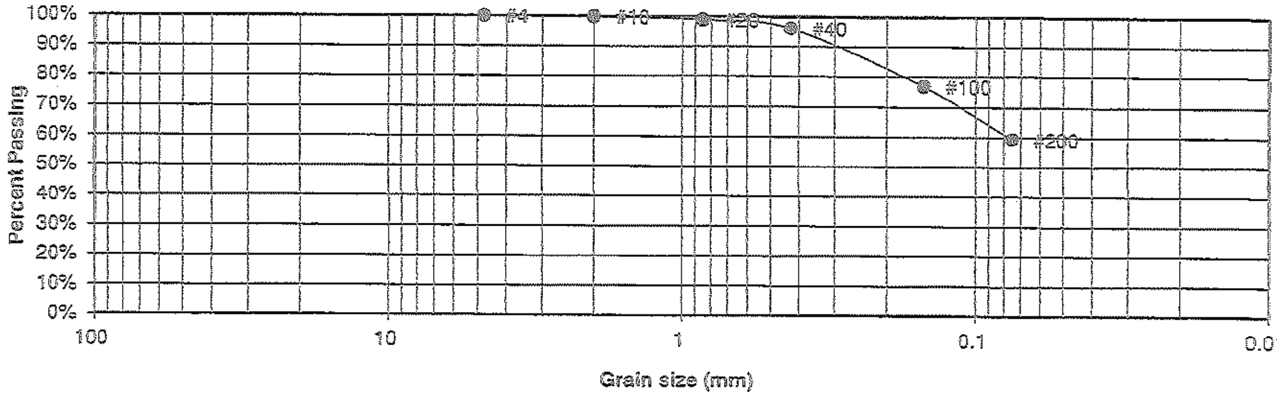
LABORATORY TEST RESULTS

DRAWN: | DATE: | CHECKED: h | 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

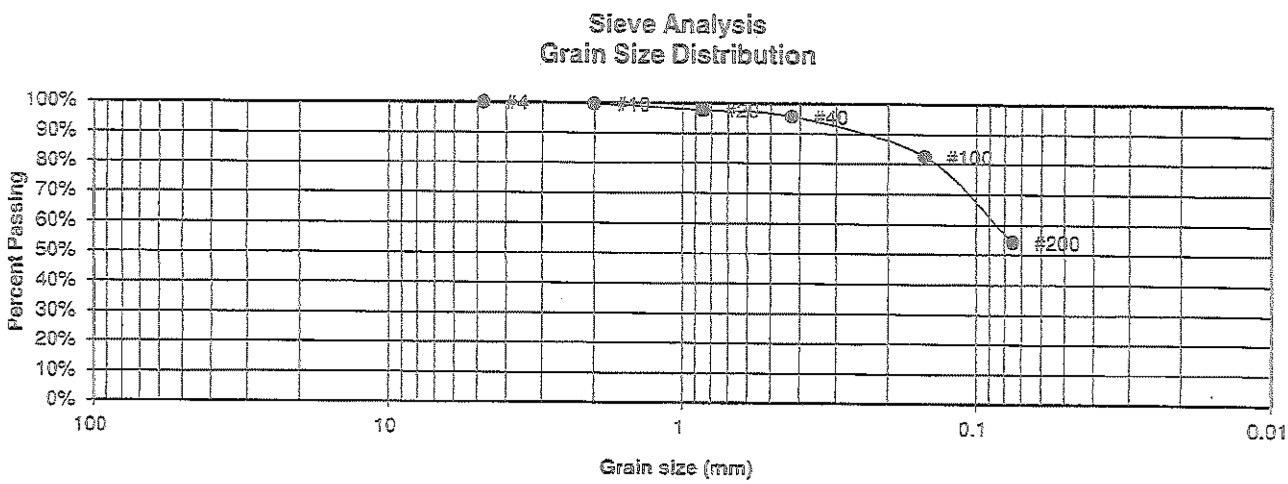
LABORATORY TEST RESULTS

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

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: a	DATE: 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 10: Photos (map pocket)

Figure 1: Upstream End of Culvert #1

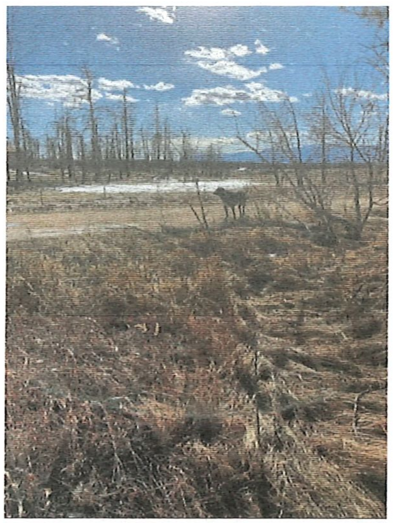


Figure 2: Facing Downstream of Culvert #1

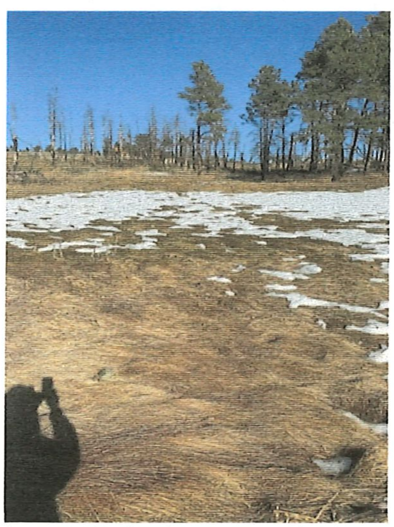


Figure 3: Wetlands upstream of Culvert 1

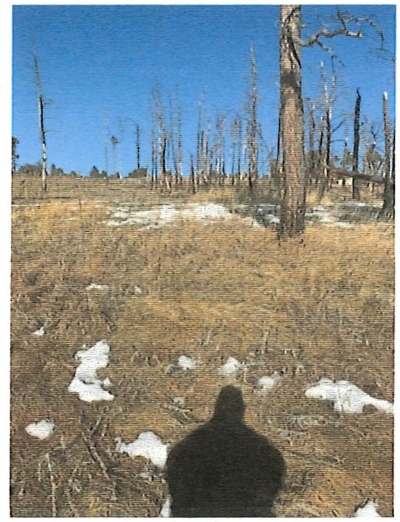


Figure 4: Facing NE from Wetland Area

Figure 5: Downstream End of Culvert 1

Figure 6: Facing downstream of Culvert 1

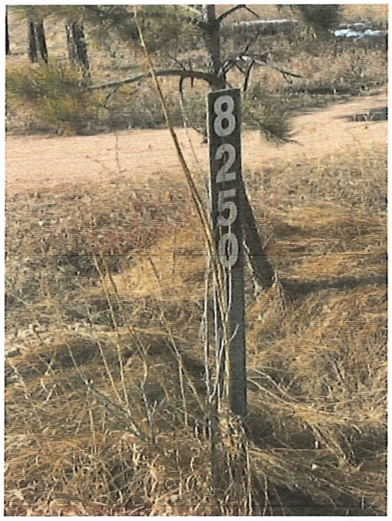


Figure 7: 8250 Forest Heights Circle

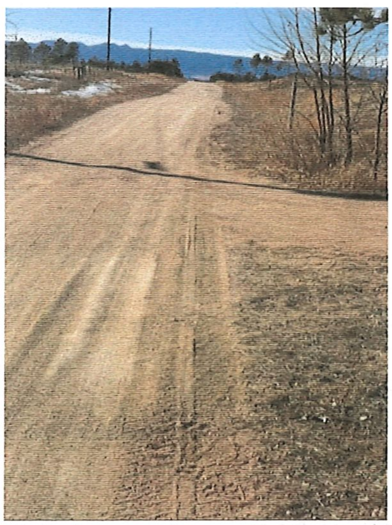


Figure 8: Facing west along northerly edge of road

Figure 9: Facing west along southerly edge of road

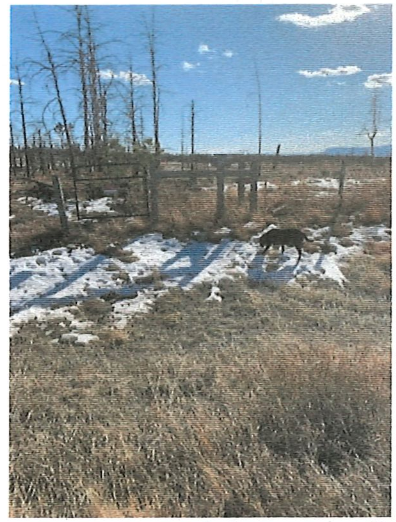


Figure 10: Facing south along property line

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

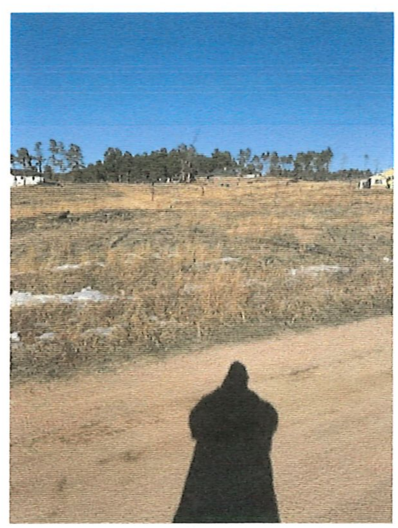


Figure 12: Facing NE to Swale 3

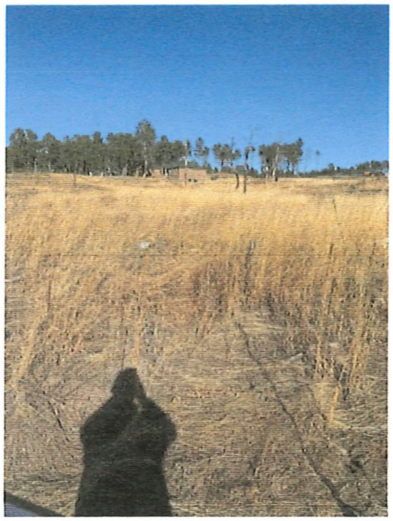


Figure 13: Wetland Area along east fork of Swale 3

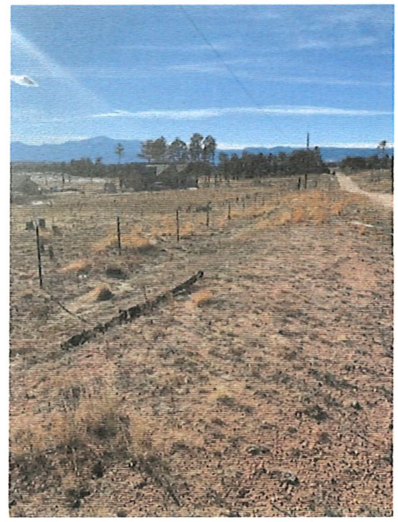


Figure 15: Facing SW of Prop Corner

2

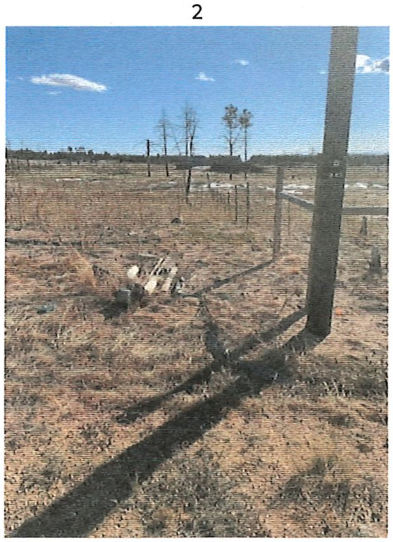


Figure 14: Facing south along prop line


Figure 16: Facing north along gas line easement

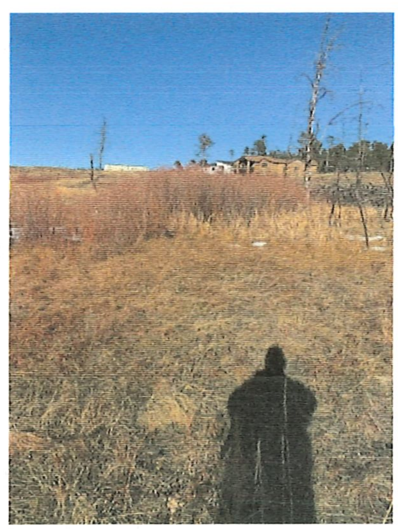


Figure 17: Wetland area in Swale 3

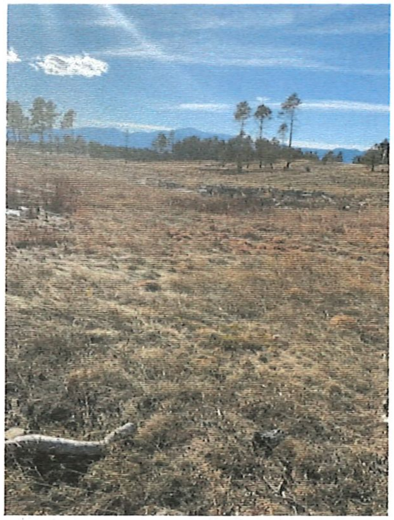


Figure 18: Facing SW at upper end of wetland area

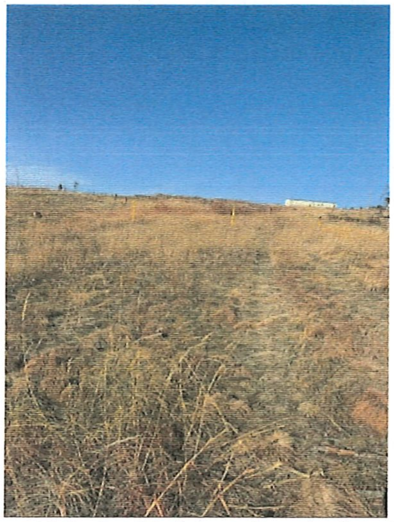


Figure 19: facing NE along w. branch of swale 3

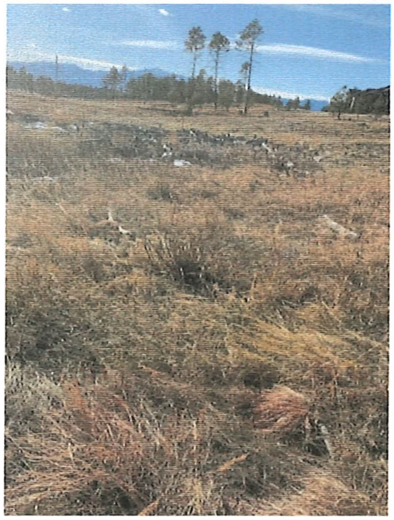


Figure 20: Facing SW along Swale 3

Figure 21: Upstream end of Culvert 2

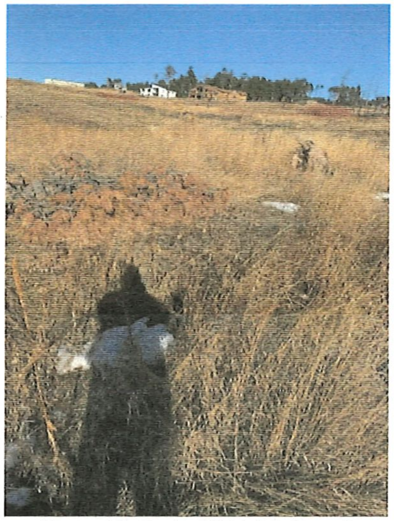


Figure 22: Facing NE of Culvert 2

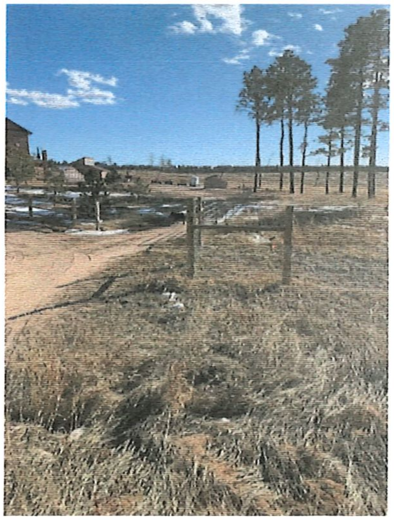


Figure 23: Facing SW along PL

Figure 24: Downstream end of Culvert 2

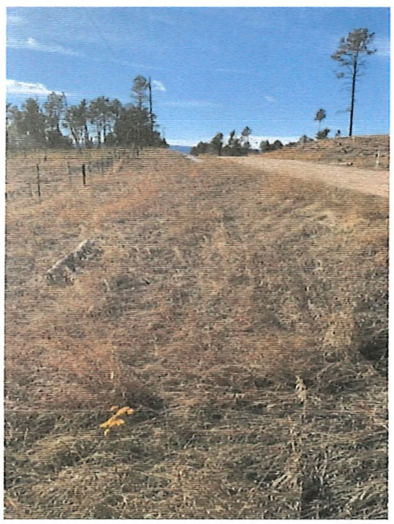


Figure 25: west along southerly edge

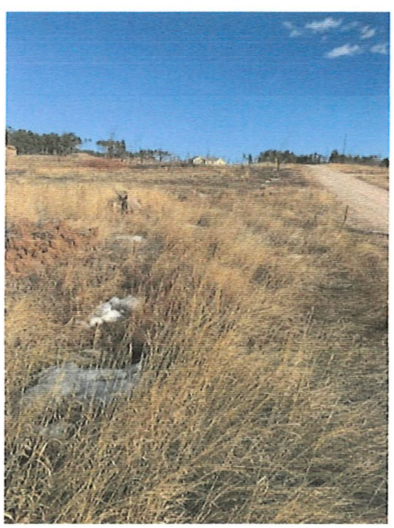


Figure 26: Facing east along northerly edge

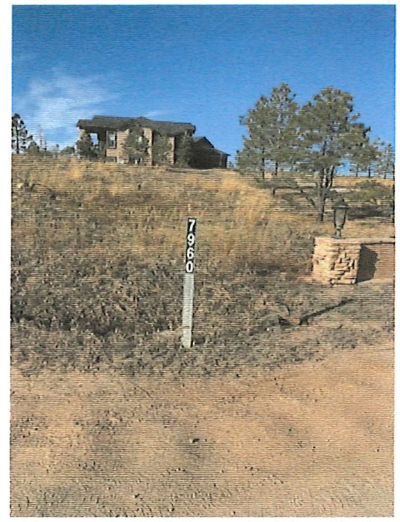


Figure 27: 7960 Forest Heights Circle

Figure 28: Facing south along PL

Figure 29:Top of high pnt facing west

Figure 30: Facing NE along Swale 5

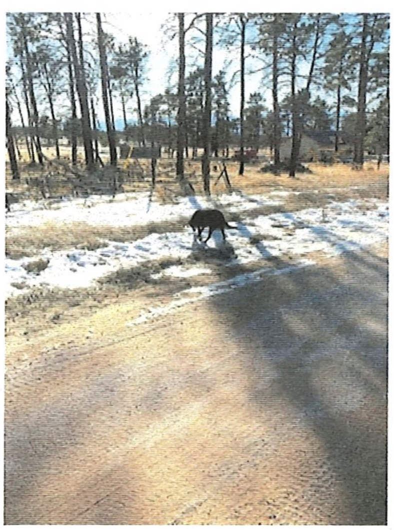


Figure 31:Facing SW along Swale 6

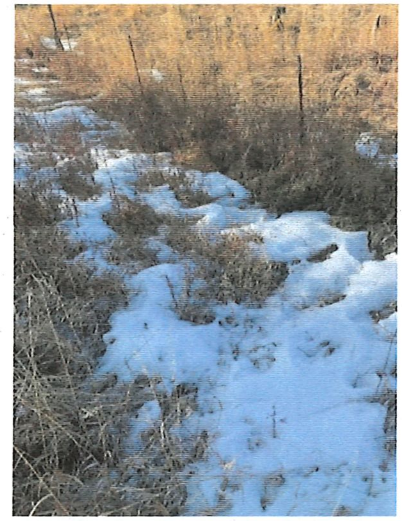


Figure 32: Water routed in northern borrow ditch

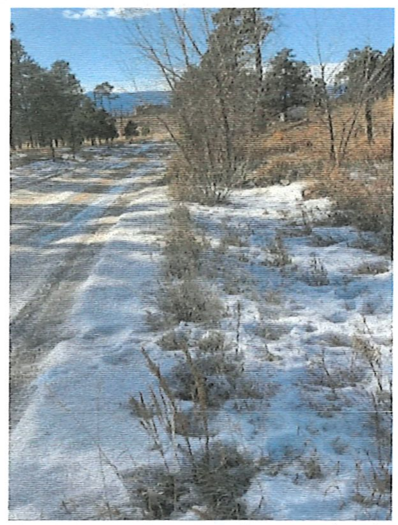


Figure 33: Facing west along north side

Figure 34: photo omitted


Figure 35: Facing west along S edge

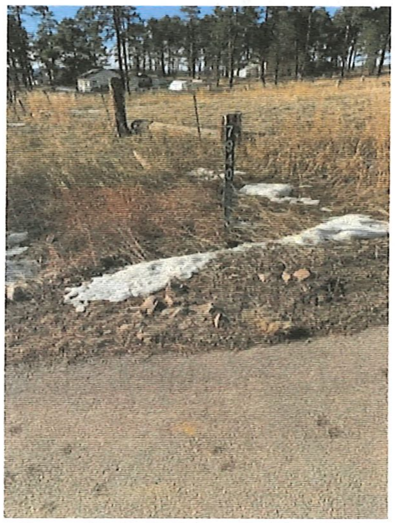


Figure 36: 7940 Forest Heights Circle

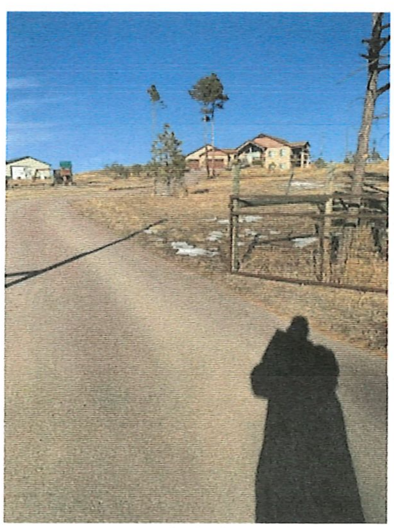


Figure 37: Asphalt drive 7940 FHC

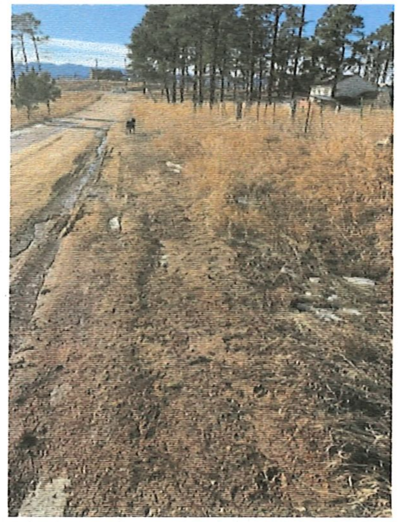


Figure 38: Facing west along northern edge

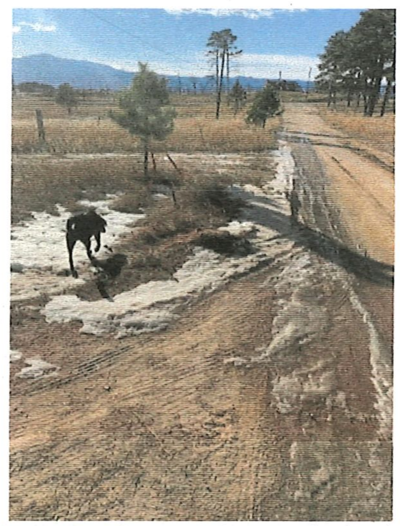


Figure 39: Facing west along southerly edge

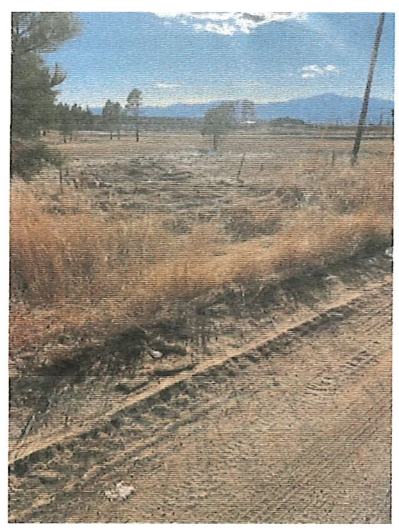


Figure 40: wetland area east of culvert 3


Figure 41: Upstream end Culvert 3

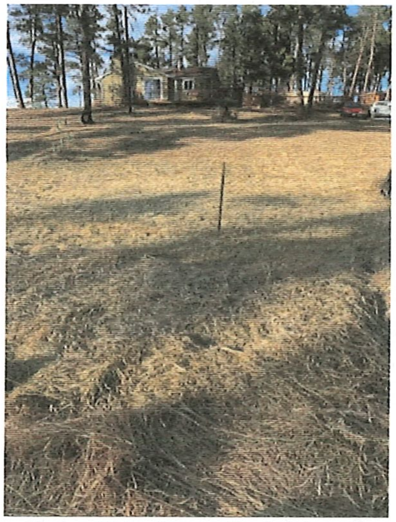


Figure 42:Facing north of Culvert 3


Figure 43:Downstream end of Culvert 3

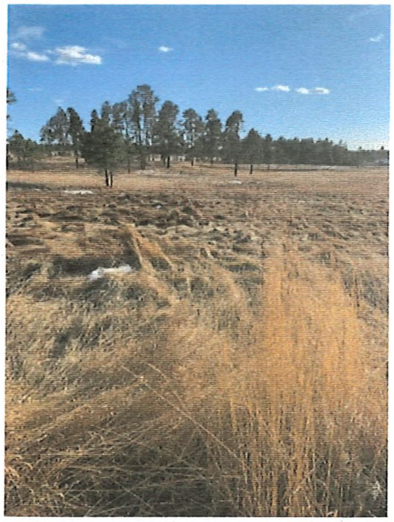


Figure 44: Facing downstream of Culvert 3


Figure 45: Herring Road Intersection

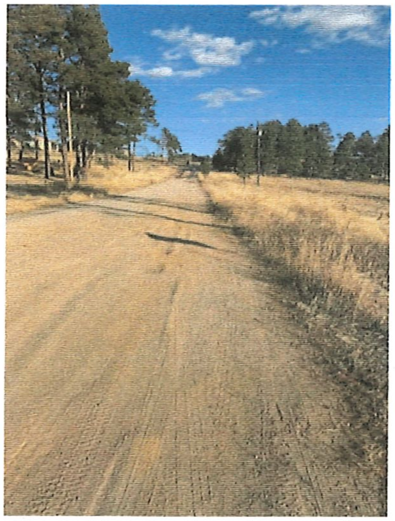


Figure 46: Facing east of intersection

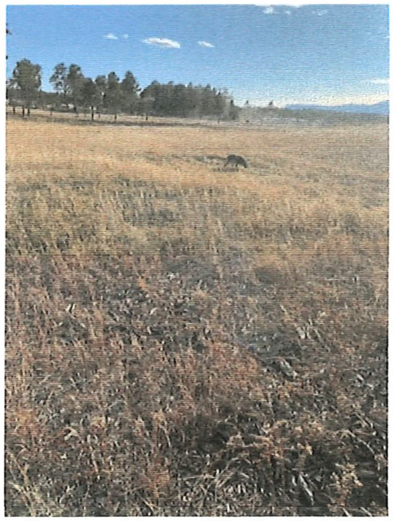


Figure 47: Facing south to culvert under Herring

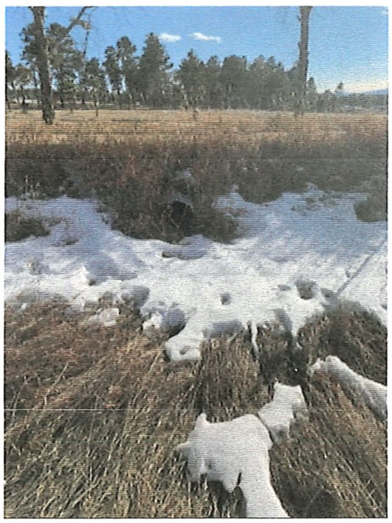


Figure 48: 18" CMP under Drive


Figure 49: Facing SW at Herring Rd Crossing

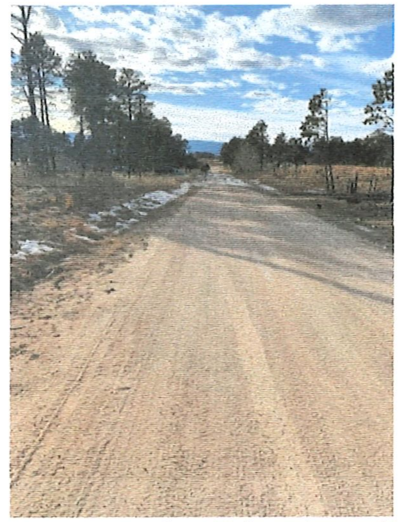


Figure 50: Facing west from High pnt 1 east of Herring

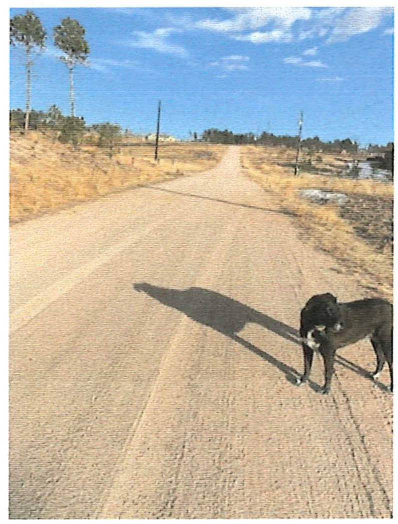


Figure 51: Facing east from first HP


Figure 52: Facing downstream of culvert 2

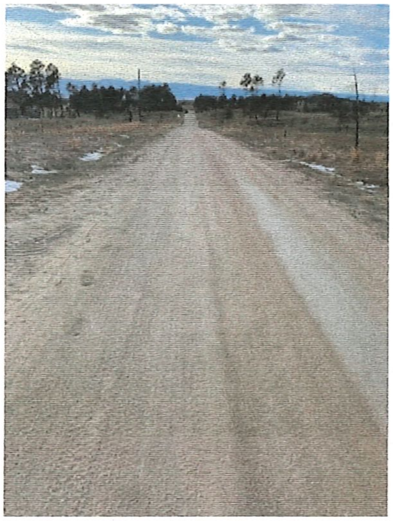


Figure 53: Facing west of 2nd HP

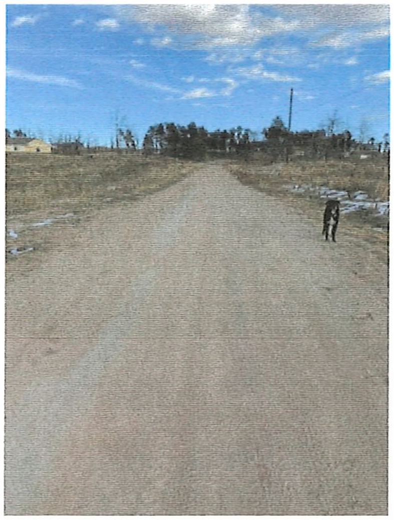


Figure 54: Facing west from 2nd HP

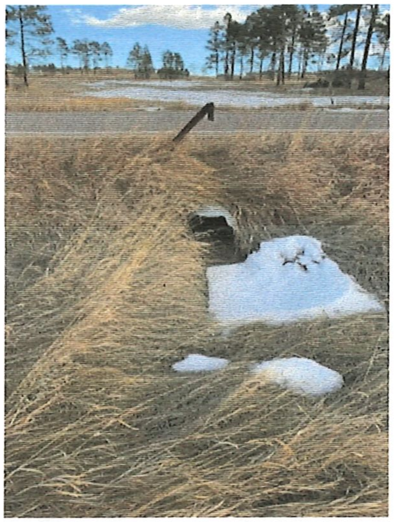


Figure 55: culvert under Herring


Figure 56: Culvert under Herring

Exhibit 11: Historic/ Developed Drainage Conditions (map pocket)

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	3.4	23.6
3	HIGH POINT BETWEEN A & B			
4	B	20.8	4.4	29.1
5	C	3.9	1.4	7.9
6	RIDGELINE INTERSCTION BETWEEN C & D			
7	D	7.5	2.3	14.3
8	HIGH POINT ALONG HERRING ROAD			
9	E	2.3	1	4.9
10	B,C,D,E,F	19.4	7.5	47.8
11	B,H	44.1	9.7	63.4
11a	B,C,D,E,H	63.5	16.8	104.2
12	J	3.4		
13	F	18.7	2.8	20.7
14	A,G	27.3	6.1	41.4
15	A,F,G	46		

SWALE SUMMARY

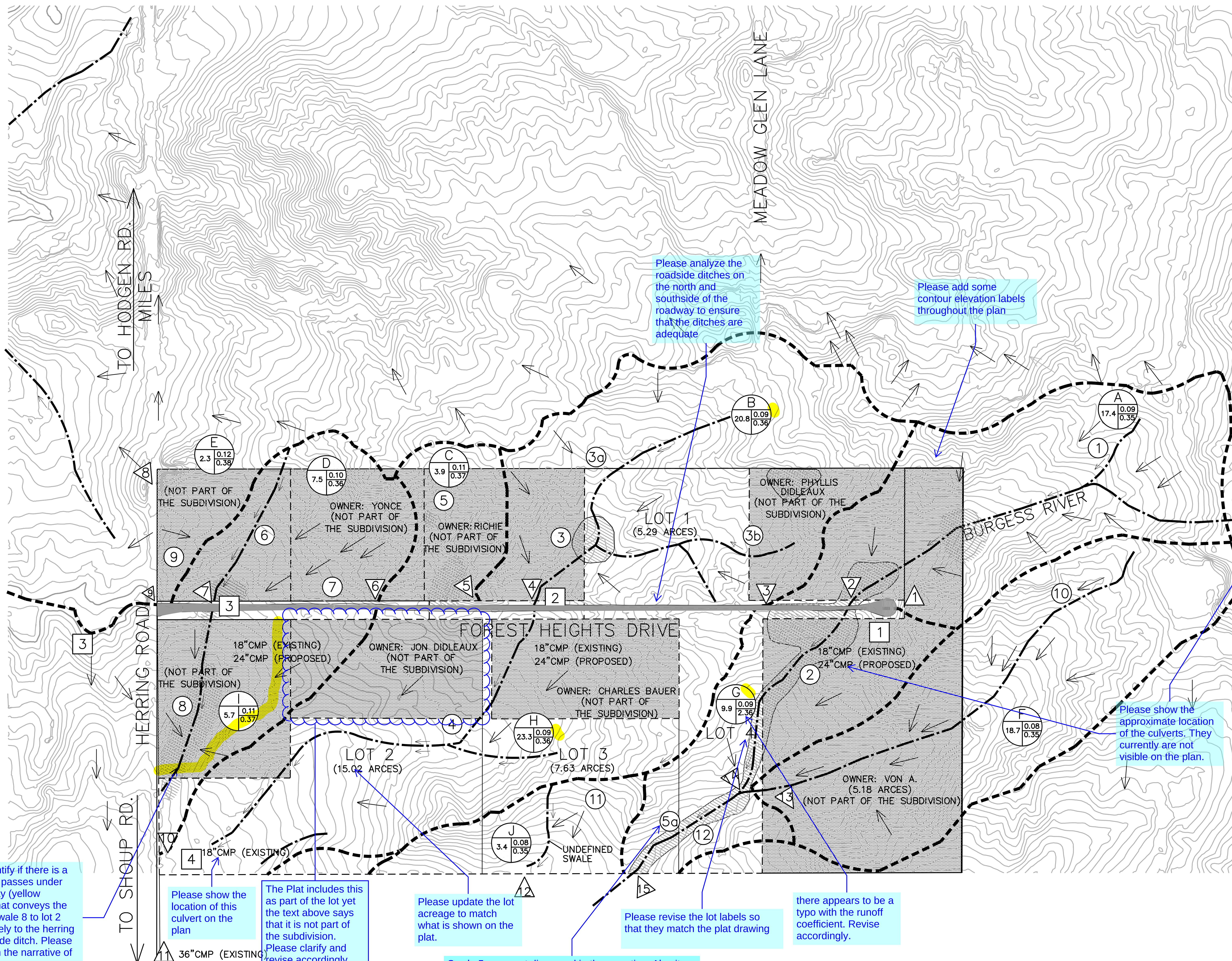
SWALE #	CONTRIBUTING SUBBASINS	SLOPE	DESIGN FLOW		DEPTH OF FLOW		VELOCITY	
			Q5	Q100	Q5	Q100	Q5	Q100
		%	cfs	cfs	ft	ft	fps	fps
1	A	4.5	3.4	23.6	0.1	0.2	1.1	2.4
2	A,G	3.1	6.1	41.4	0.1	0.3	1.1	2.2
3	B	4.6	4.4	29.1	0.1	0.3	1.5	3
4	B,H	3.3	9.7	63.4	0.1	0.3	1.1	2.3
5	C	5.5	1.4	7.9	0.1	0.2	1	2
6	D	6	2.3	14.3	0.1	0.2	1.2	2.5
7	C	4.4	4.7	28	0.1	0.3	1.1	2.2
8	C,D,E,I	4.4	7.5	47.8	0.1	0.4	1.4	2.6
9	E	4.7	2.8	20.7	0.1	0.2	0.9	1.9
10	F	NOT EVALUATED DUE TO NO IMPACT ON DEVELOPMENT						
11	J	3.1	8.9	62.1	0.1	0.4	1.2	2.6

BASIN SUMMARY

I.D.	EXSITING		DEVELOPED	
	Q5 cfs	Q100 cfs	Q5 cfs	Q100 cfs
A	3.4	23.6	3.7	24
B	4.4	29.1	4.6	29.5
C	1.4	7.9	1.8	8.4
D	2.3	14.3	2.7	14.8
E	1	4.9	1.4	5.5
F	2.8	20.7	3.1	21.1
G	2.7	17.8	3	18.2
H	5.3	34.3	5.6	34.7
I	2.4	13.7	2.8	14.3
J	1	7.1	1	7.1

CULVERT SUMMARY

CULVERT #	SIZE	MATERIAL	5 YEAR		100 YEAR		CONDITION
			Q (cfs)	HEADWATER REQUIRED	Q (cfs)	HEADWATER REQUIRED	
1	18"	CMP	3.4	12"	24.6	> 7.5 FT	75% SILTED, ROADWAY OVERTOPPING WITH 100 YR
2	18"	CMP	4.4	14"	29.1	> 9 FT	75% SILTED, ROADWAY OVERTOPPING WITH 100 YR
3	18"	CMP	3.7	1.1 FT	22.2	> 7.5 FT	75% SILTED, ROADWAY OVERTOPPING WITH 100 YR
4	18"	CMP	16.8	4.8 FT	104.2	> 9 FT	CLEAN, ROADWAY OVERTOPPING WITH BOTH 5 YEAR AND 100 YEAR



Please analyze the roadside ditches on the north and southside of the roadway to ensure that the ditches are adequate

Please add some contour elevation labels throughout the plan

Please identify if there is a culvert that passes under the driveway (yellow highlight) that conveys the flow from swale 8 to lot 2 and ultimately to the herring road roadside ditch. Please discuss it in the narrative of your report.

Please show the location of this culvert on the plan

The Plat includes this as part of the lot yet the text above says that it is not part of the subdivision. Please clarify and revise accordingly.

Please update the lot acreage to match what is shown on the plat.

Swale 5a was not discussed in the narrative. Also it appears to be identifying the same swale as indicated by the swale 12 label. Revise accordingly.

Please revise the lot labels so that they match the plat drawing

there appears to be a typo with the runoff coefficient. Revise accordingly.

Please show the approximate location of the culverts. They currently are not visible on the plan.

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).

LEGEND:

- DIRECTION OF FLOW
- PROJECT BOUNDRY
- FLOWLINE NATURAL SWALE
- SUBBASIN BOUNDRY
- DESIGN POINT
- SWALE NUMBER
- SUBDIVISION I.D. / 5 YR. RUNOFF COEFFICIENT / 10 YR. RUNOFF COEFFICIENT / AREA (ARCES)
- CULVERT
- CULVERT NIUMBER
- INDEX CONTOURS
- INTERMEDIATE CONTOURS
- WET AREA (APPROX. LACATION ONLY)
- EXISTING REIDENCE (APPROX.)
- PROPOSED RESIDENCE
- WETLAND LIMIT (APPROX.)
- EXISTING LOT LINES
- PROPOSED LOT LINE
- SUBDIVISION BOUNDRY
- EXISITING ROAD (GRAVEL)

are these existing or proposed. Please clarify

10 or 100 yr?

N

200' 0 200' 400'

SCALE: 200'

CALL BEFORE YOU DIG . . .
NOT FOR CONSTRUCTION:
THESE PLANS ARE INTENDED FOR SUBMITTAL, REVIEW AND APPROVAL BY CITY/CITY PLANNING DEPARTMENTS AND SHOULD NOT BE USED ON SITE FOR CONSTRUCTION OR LAYOUT.
DIAL 811
48 HOURS BEFORE YOU DIG, CALL UTILITY LOCATORS FOR LOCATING AND MARKING GAS, ELECTRIC, WATER AND WASTEWATER

REVISIONS		
No.	Description	By	Date

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

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DRAINAGE MAP
DIDLEAU SUBDIVISON

Project Number: 00000

Sheet: 1 of 1

F:\18000\18070-Didleau property\Engineering\KenHarrisonContoursCAD\Drainage Map - Didleau Subdivison.DWG